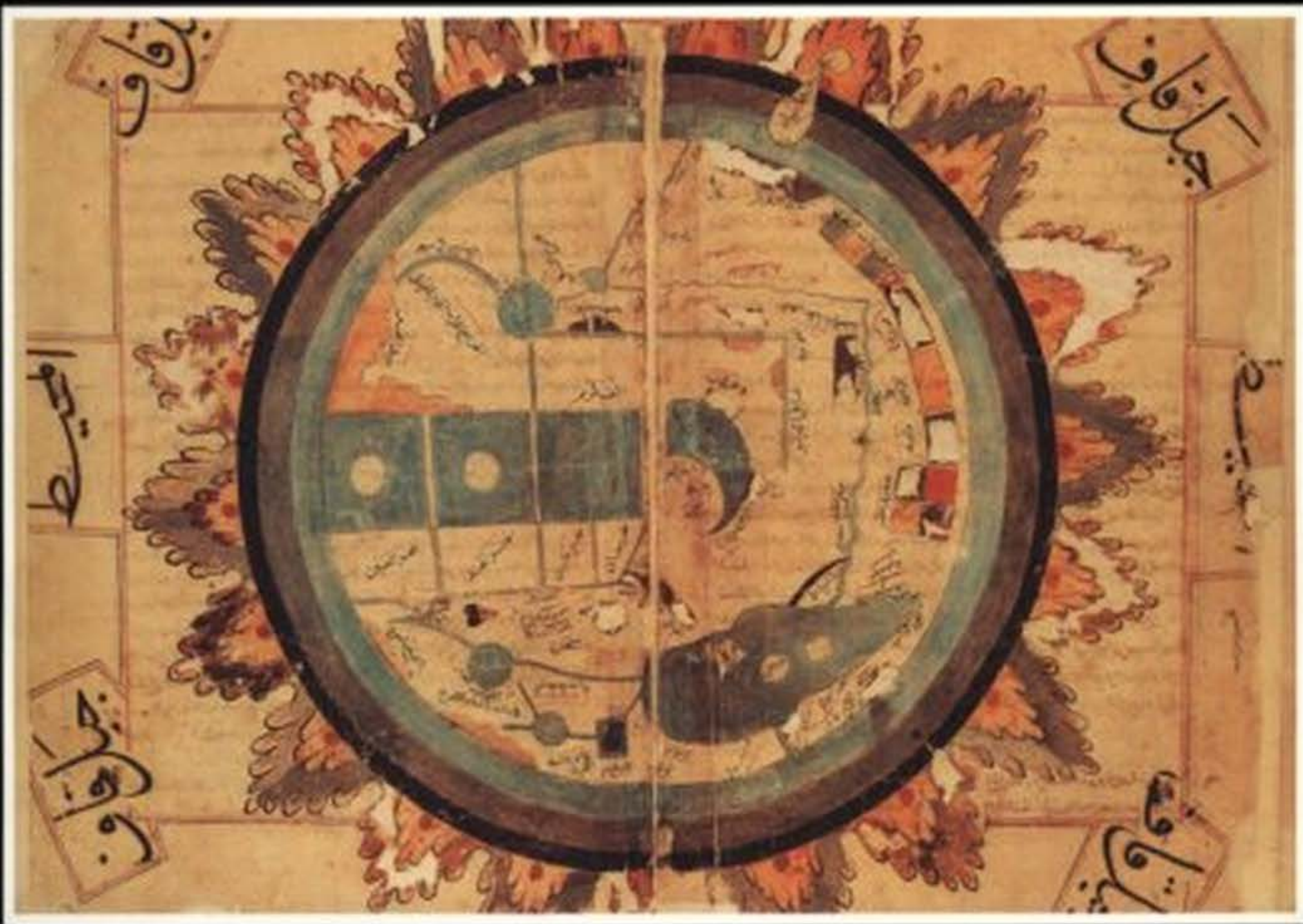
THE HISTORY OF CARTOGRAPHY



VOLUME TWO, BOOK ONE

Cartography in the Traditional Islamic and South Asian Societies

Edited by

J. B. HARLEY

and

DAVID WOODWARD

Maps tell us much more than merely how to get from here to there. As one of the oldest forms of human communication, they ultimately express the many ways we attempt to understand the world. The first comprehensive history of maps and mapping worldwide from prehistory to the present, *The History of Cartography* is both an essential reference work and a philosophical statement of maps' value to society. J. B. Harley and David Woodward have assembled an international team of specialists to compile a much needed up-to-date survey of the development of cartography as a science and an art.

Going beyond the more familiar discussions of maps as records of actual places, the editors have adopted a broader definition of a map as an illustration of the spatial relations, actual or symbolic, of a place, an event, or a concept. This scope allows discussion of an unprecedented range of maps, including those depicting the entire cosmos, the soul's spiritual journeys, and imagined worlds. The result is not only a comprehensive synthesis of cartographic knowledge, but also a narrative of our changing perception of the world and our place in it. What emerges is a fascinating picture of maps as practical tools and also as symbolic images used for magical, political, and religious purposes.

Volume 2 of *The History of Cartography* focuses on mapping in non-Western cultures, an area of study historically overlooked by Western scholars. Extensive original research makes this the foremost source for defining, describing, and analyzing this vast and unexplored theater of cartographic history. Book 1 offers a critical synthesis of maps, mapping, and mapmakers in

(Continued on back flap)

Cover illustration: Al-Qazwīnī's world map.
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THE HISTORY OF CARTOGRAPHY

VOLUME TWO, BOOK ONE

THE HISTORY OF CARTOGRAPHY

1
Cartography in Prehistoric, Ancient, and Medieval Europe and the Mediterranean

2.1
Cartography in the Traditional Islamic and South Asian Societies

2.2
Cartography in the Traditional East and Southeast Asian Societies

3
Cartography in the Age of Renaissance and Discovery

4
Cartography in the Age of Science, Enlightenment, and Expansion

5
Cartography in the Nineteenth Century

6
Cartography in the Twentieth Century

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VOLUME TWO, BOOK ONE

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To Brian

We shall not cease
from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place
for the first time.

T·S·ELIOT

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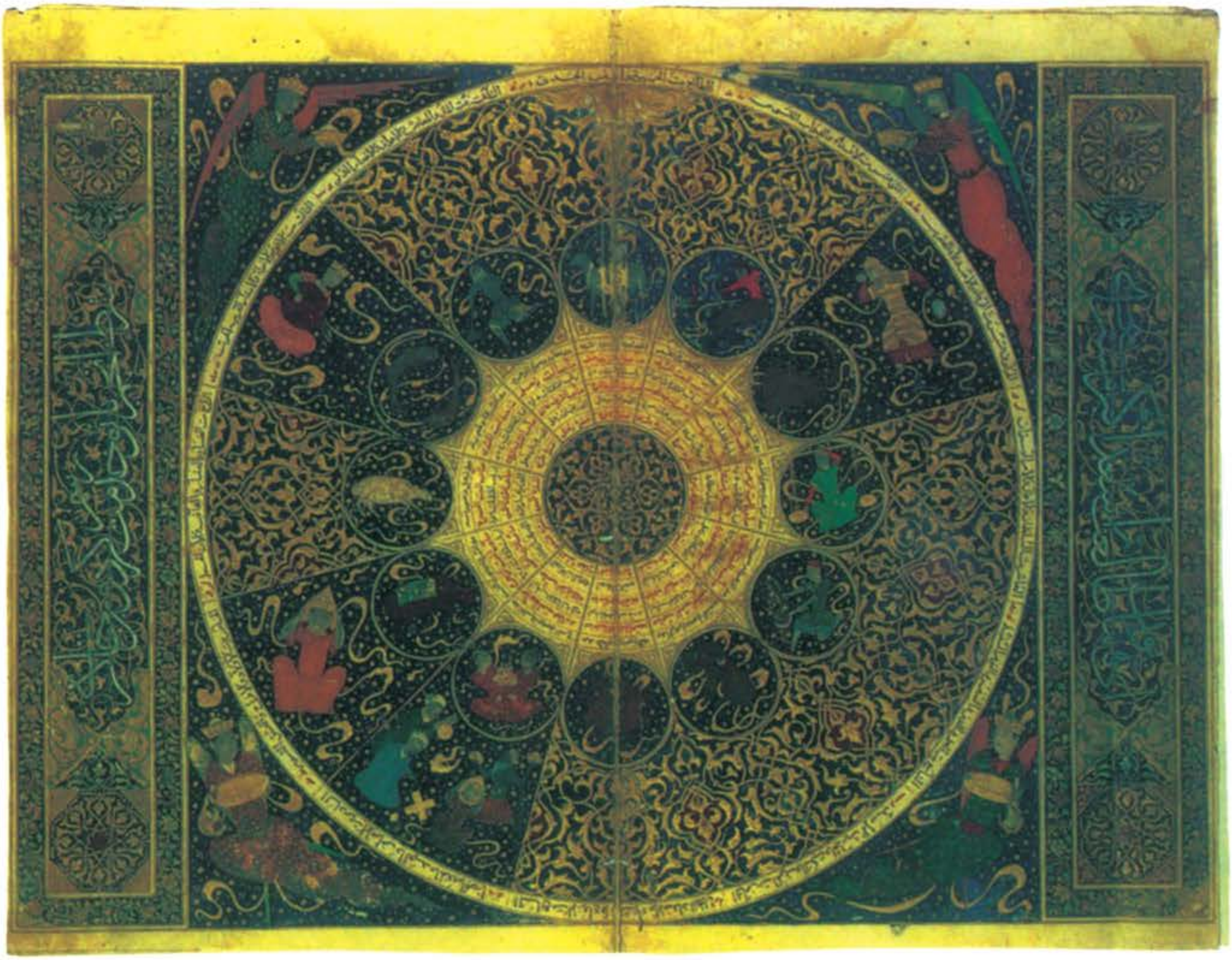

PLATE 1. THE HEAVENS AS THEY WERE ON 3 RABĪ' I 786/25 APRIL 1384, THE BIRTHDATE OF ISKANDAR SULTAN. In opaque watercolor, ink, and gold on paper in a nativity book compiled in 813/1410–11 by Maḥmūd ibn Yaḥyā ibn al-Ḥasan al-Kāshī. Size of the original: 26 × 33.5 cm. By permission of the Wellcome Institute Library, London (Wellcome MS. Persian 474, fols. 18b–19a).

PLATE 2. PLANISPHERIC MAP SHOWING NORTHERN CONSTELLATIONS. This reflects early modern European maps, from the *Sarvasiddhāntatattvacūḍāmaṇi* (Jewel of the essence of all sciences), written in Sanskrit before 1839 by Durgāshaṅkara Pāṭhaka, an astronomer of Benares.
Size of the original: 21.5 × 17.5 cm. By permission of British Library, London (MS. Or. 5259, fol. 59r).

PLATE 3. THE RELIGIOUS COSMOS FROM THE *MAʿRIFETNĀME*. The cosmos is enveloped by the worlds of absolute divine transcendence (*lāhūt*), of divine omnipotence (*jabarūt*), and of divine sovereignty (*malakūt*). On top is paradise: it has eight gates and eight layers and is permeated by the heavenly tree Ṭūbā and flanked by the preserved tablet, the pen, and the banner of praise. In the middle is the earth, surrounded by the seven heavenly spheres and the legendary encircling mountain Qāf. At the bottom is hell: it has seven gates and seven layers and is surmounted by the Straight Path and dominated by the hellish tree Zaqqūm.
Size of the original: 19.2 × 9.3 cm. By permission of the British Library, London (MS. Or. 12964, fol. 23b).

PLATE 4. AL-KHWĀRAZMĪ'S MAP OF THE RIVER NILE. The map shows the south to the right, with the Nile rising as two groups of streams in the Mountains of the Moon; at the left are the Delta and the Mediterranean. The lines across the map are climate divisions, the farthest right representing the equator. The map would be read in Arabic with south (right) at the top.

Size of the double folio: 33.5 × 41 cm. By permission of the Bibliothèque Nationale et Universitaire, Strasbourg (MS. 4247, fols. 30b–31a).

PLATE 5. THE SEA OF AZOV (BAṬĀ'IḤ MĀYŪṬĪS) BY AL-KHWĀRAZMĪ. The Black Sea (al-Baḥr) is in the top left corner. Size of the folio: 33.5 × 20.5 cm. By permission of the Bibliothèque Nationale et Universitaire, Strasbourg (MS. 4247, fol. 47a).

PLATE 6. NORTH AFRICA AND SPAIN ACCORDING TO AN IṢṬAKHRĪ I MANUSCRIPT. Dated 569/1173, this map is oriented with west at the top. North Africa is on the left, Spain on the right, with a large mountain near the Strait of Gibraltar. Size of the original: 41.5 × 29.8 cm. By permission of the Bibliotheek der Rijksuniversiteit, Leiden (MS. Or. 3101, p. 20).

PLATE 7. THE WORLD ACCORDING TO AL-IṢṬAKHRĪ. The world map from the Leiden manuscript dated 589/1173. This version of the map is the one designated Iṣṭakhrī I. (South is at the top.) Size of the original: 41.5 × 59.3 cm. By permission of the Bibliotheek der Rijksuniversiteit, Leiden (MS. Or. 3101, pp. 4–5).

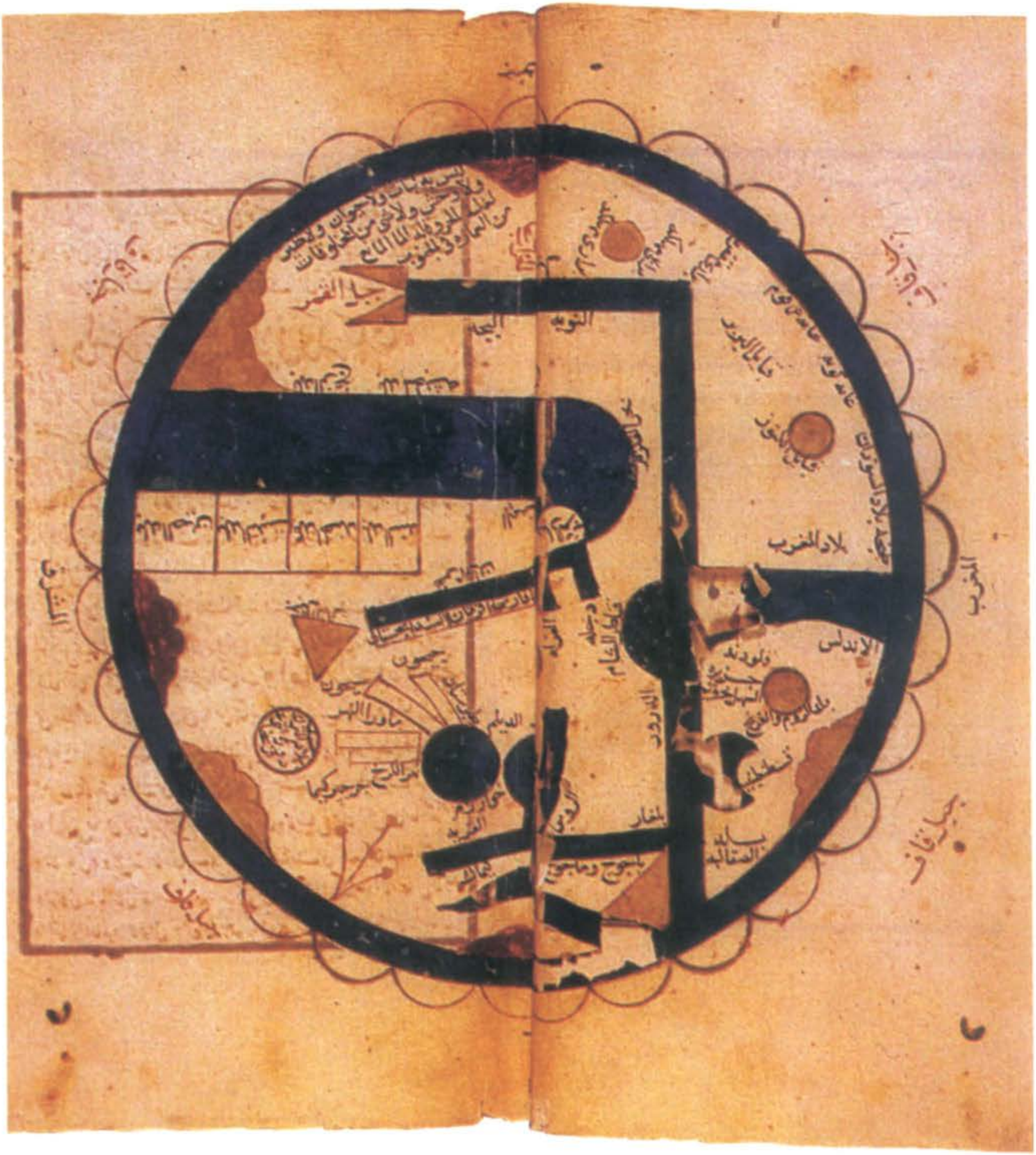

PLATE 8. THE WORLD MAP OF IBN AL-WARDĪ. Dated 1001/1593. Diameter of the original: ca. 16.5 cm. By permission of the British Library, London (MS. Or. 1525, fols. 8v–9r).

PLATE 9. AL-QAZWĪNĪ'S WORLD MAP. Manuscript copied 1032/1622. Size of the original: not known. By permission of Forschungsbibliothek, Gotha (MS. Orient A. 1507, fols. 95b–96a).

PLATE 10. WORLD MAP DATED 977/1570. From the manuscript entitled *Kitāb al-bad' wa-al-ta'rīkh*. East is at the top. Diameter of the original: ca. 28.5 cm. By permission of the Bodleian Library, Oxford (MS. Laud. Or. 317, fols. 10v–11r [formerly fols. 9v–10r; the manuscript was rearranged and refoliated in 1984]).

PLATE 11. AL-IDRĪSĪ'S WORLD MAP FROM THE OXFORD POCOCKE MANUSCRIPT. Copied by ʿAlī ibn Ḥasan al-Hūfī al-Qāsimi, this world map comes from a well-preserved and complete manuscript. Diameter of the original: ca. 23 cm. By permission of the Bodleian Library, Oxford (MS. Pococke 375, fols. 3v–4r).

PLATE 12. NORTHWEST AFRICA FROM THE OXFORD GREAVES MANUSCRIPT OF AL-IDRĪSĪ. Section 1 of climate 3 covers the northwestern part of Africa. The Mediterranean is shown in the lower left portion of the map, and the Atlantic Ocean is along the right border. Many of the color conventions for this manuscript are evident in this example: seas in blue or green with white wavy lines; rivers in green; mountains in many colored segments outlined in black with a white horizontal S shape; and towns in gold rosettes with red centers.
Size of the original: 32 × 48 cm. By permission of the Bodleian Library, Oxford (MS. Greaves 42, fols. 119v–120r).

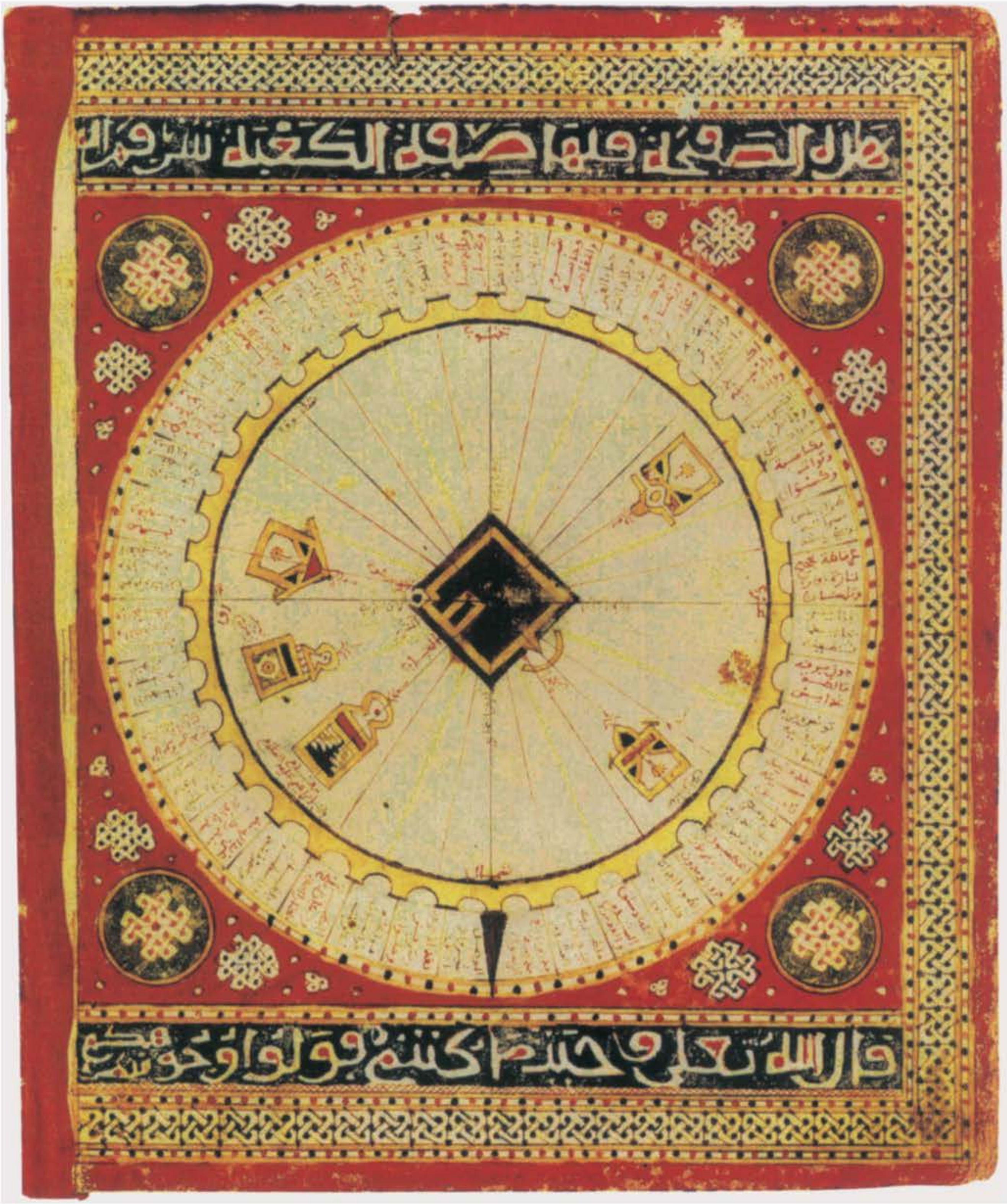

PLATE 13. QIBLA DIAGRAM FROM A SEA ATLAS. Made by ʿAlī ibn Aḥmad ibn Muḥammad al-Sharafī al-Ṣifāqsī in 958/1551. Forty *miḥrāb*s are shown around the Kaʿba, superimposed upon a thirty-two-division wind rose. Size of the original: ca. 19 × 24 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2278, fol. 2v).

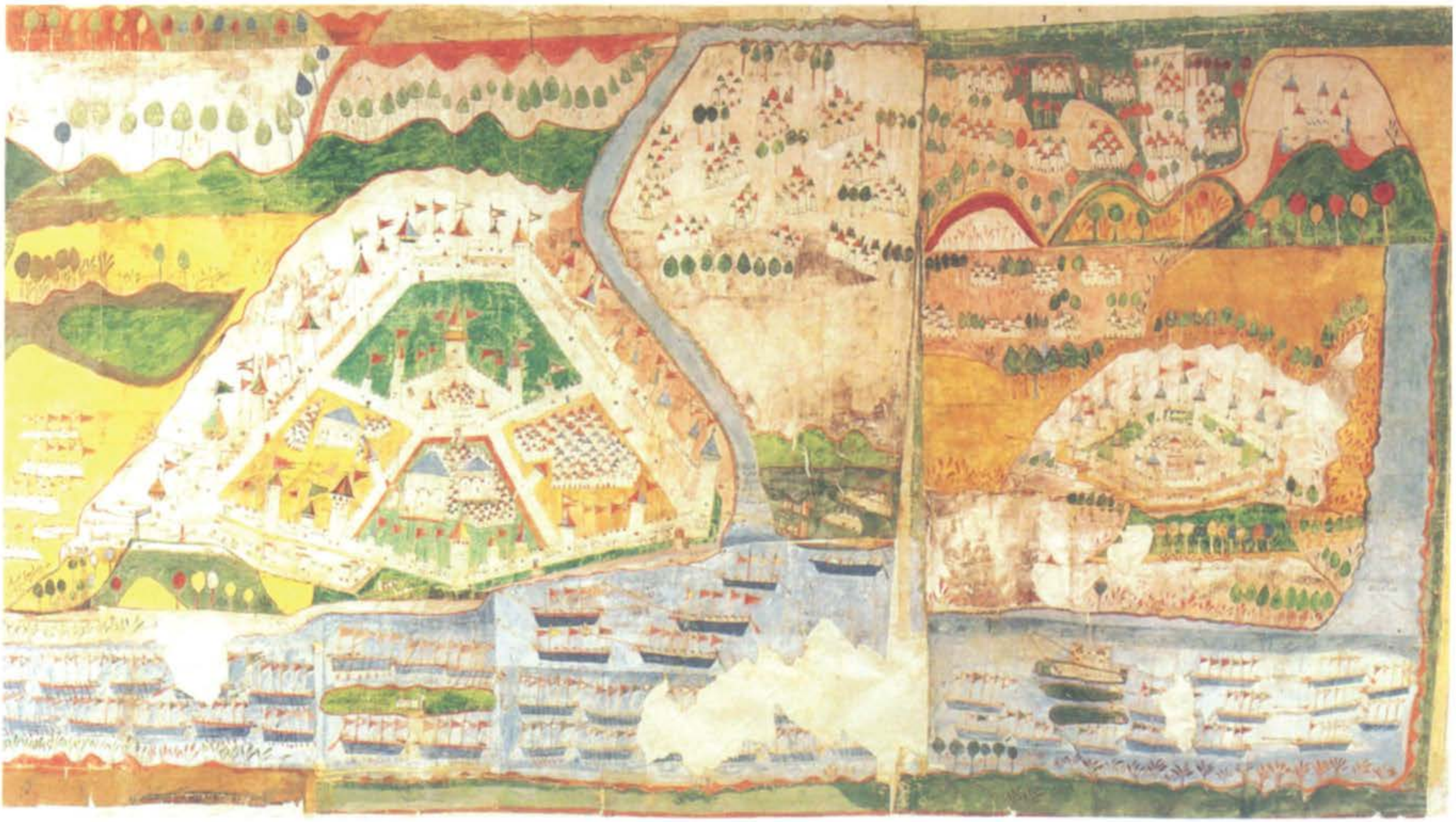

PLATE 14. SIEGE PLAN OF BELGRADE, EARLY SIXTEENTH CENTURY. (Detail.) Size of the entire original: 122 × 282 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 9440).

PLATE 15. PLAN OF THE BATTLE OF THE PRUT, 1711. Size of the image: 30 × 40 cm. By permission of the Staatsbibliothek Preussischer Kulturbesitz, Orientabteilung, Berlin (MS. Or. quart 1209, fols. 305b–306a).

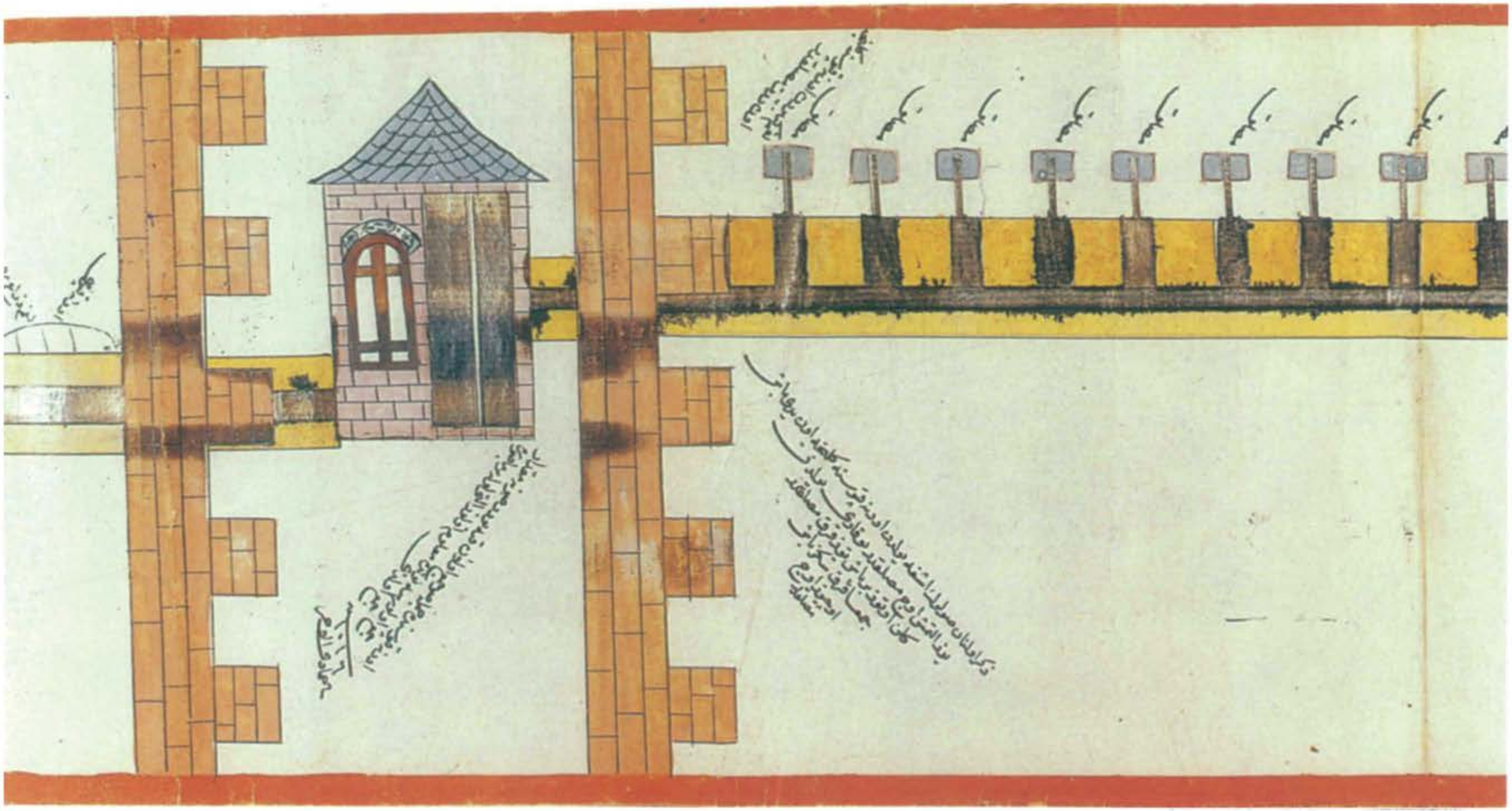

PLATE 16. DETAIL OF THE KIRKÇEŞME AND HALKALI WATER-SUPPLY SYSTEM. Dated 1016/1607, this detail is from the scroll map illustrated in figure 11.13. Size of the detail: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1816).

PLATE 17. THE PROCLAMATION OF THE CONQUEST OF EGER. A workshop scene in the making of the *Şāhnāme-i Sulṭān Meḥmed*, a panegyric history of Meḥmed III. Ṣubḥī Çelebi (Taʿlīḳīzāde), the chronicler, dictates from his notebook to the unknown calligrapher. Seated to the right, the artist Ḥasan illustrates a scene in the surrender of the fortress of Eger in Sultan Meḥmed III's victorious Hungarian campaign of 1003–5/1594–96.

Size of the original: unknown. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1609, fol. 74a).

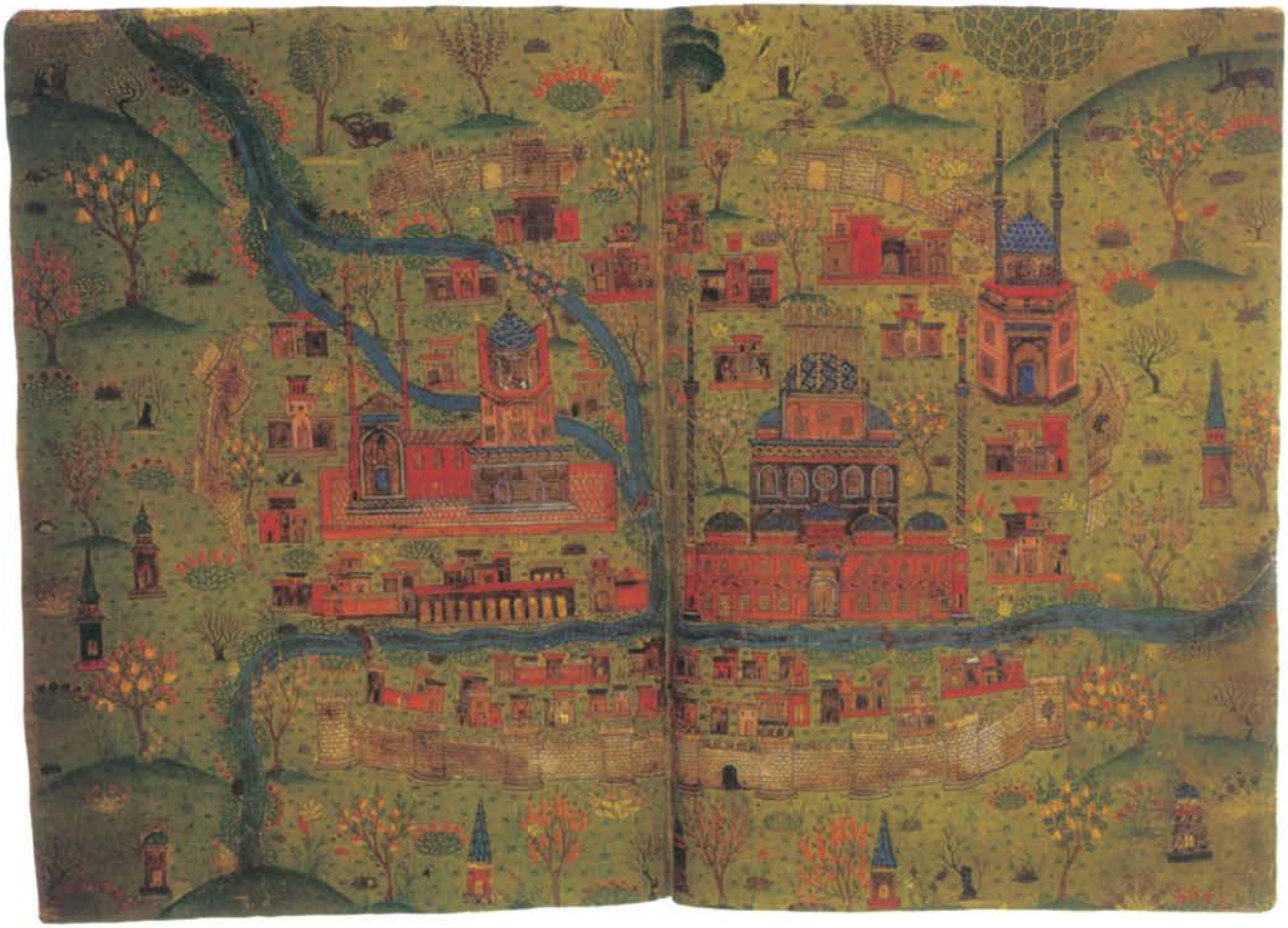

PLATE 18. VIEW OF SULṬĀNĪYE. The former Ilkhan capital southeast of Tabriz had suffered neglect and the calamity of earthquake long before Sultan Süleymān's visit in 941/1534. The view shows the remnants of city walls and three large monuments among many small, flat-roofed buildings. The mausoleum of the Ilkhanid ruler Öljeytü, just right of center on the image with eight minarets rising from the base of its blue dome, still stands today in ruins. Beautifully rendered wildlife and flora fill the urban space and the surrounding region, and numerous unidentified shrines dot the foreground. From Maṭrāḳçı Naṣūḥ, *Mecmūʿa-i menāzil.*
Size of the original: 31.6 × 46.6 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fols. 31b–32a).

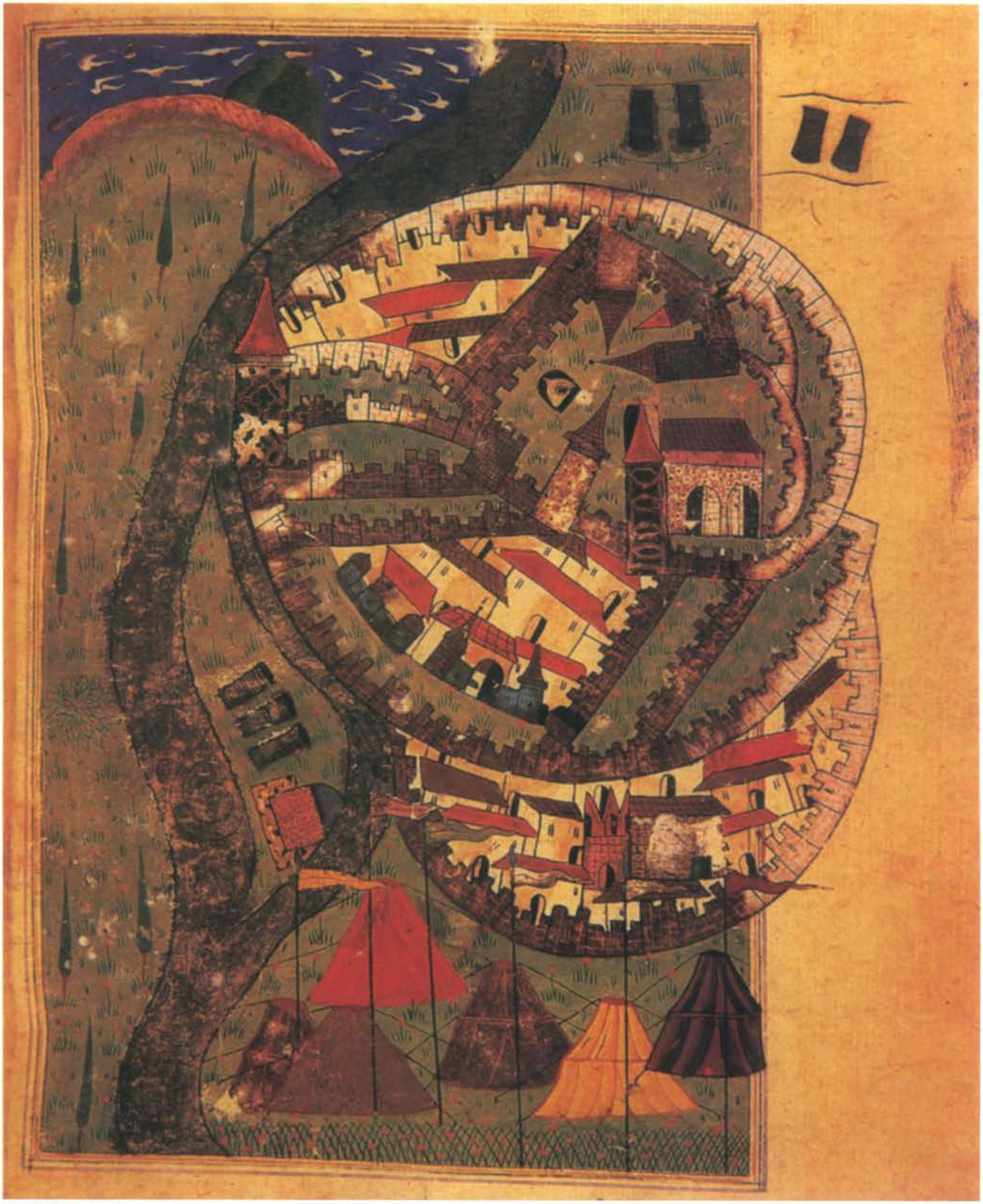

PLATE 19. THE SIEGE OF THE FORTRESS OF ESZTERGOM. The taking of this strategic fortress along the Danube River was a crucial episode in Süleymān's 950–51/1543–44 campaign against Ferdinand of Austria, the Habsburg claimant to the Hungarian throne. From Maṭrāḳçı Naṣūḥ, *Tārīḫ-i fetḥ-i Şaḳlāvūn*.
Size of the original: 26.1 × 17.5 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1608, fol. 90b).

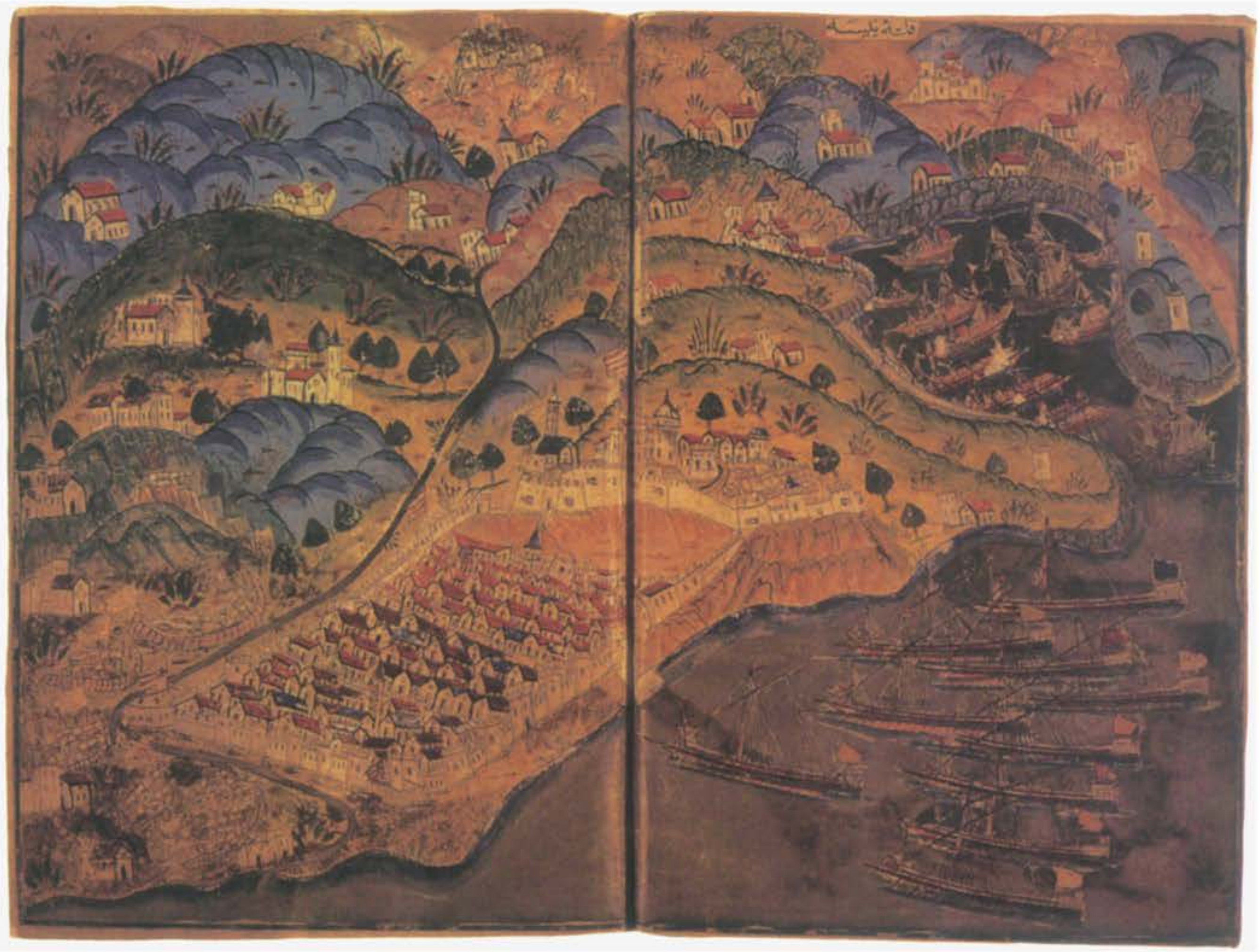

PLATE 20. VIEW OF NICE. The port city was attacked by Ḥayreddīn Barbarossa and captured on 22 August 1543. The account of this joint Ottoman-Valois naval campaign against the Italian states and Habsburg Spain precedes the chronicle of Süleymān's Hungarian campaign in Maṭrāḳçı Naṣūḥ, *Tārīḫ-i fetḥ-i Ṣaḳlāvūn*.
Size of the original: 26.1 × 35 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1608, fols. 27b–28a).

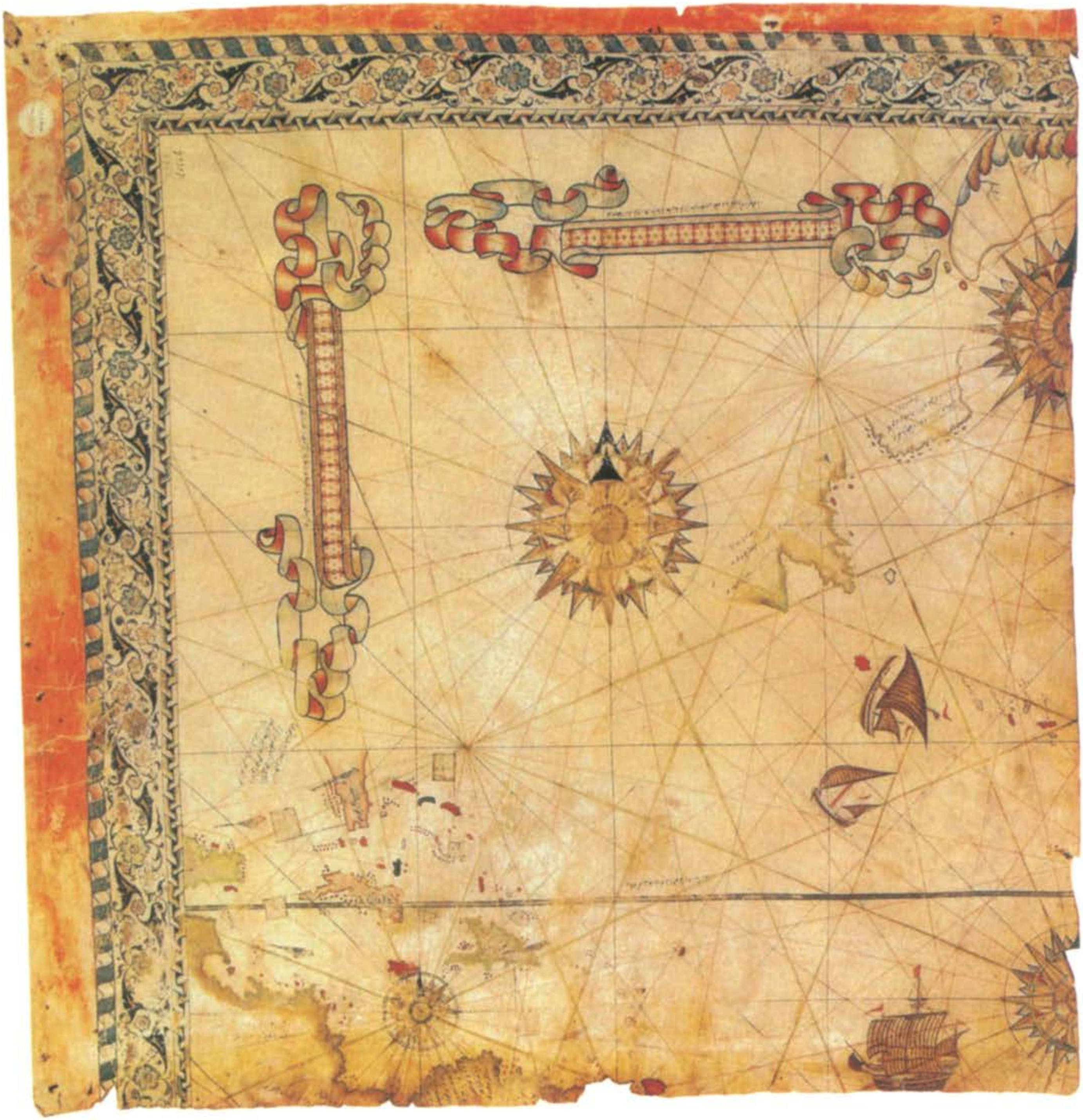

PLATE 21. NORTHWEST FRAGMENT OF THE 935/1528–29 WORLD MAP BY PĪRĪ RE'ĪS. This fragment, said to be on camel hide, is the only extant piece of what may have been a multisheet map of the world, and its rich arabesque decoration would have made an impressive border. Pīrī Re'īs states in a legend that the two landmasses south of Greenland were discovered by the Portuguese. The representation of Florida and the Yucatán Peninsula are notable in the Caribbean region, lands made known to Europeans in 1509 and 1513, respectively. A note on the Central American landmass, partially illegible, may refer to Balboa's crossing the Isthmus of Panama.
Size of the original: 69 × 70 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1824).

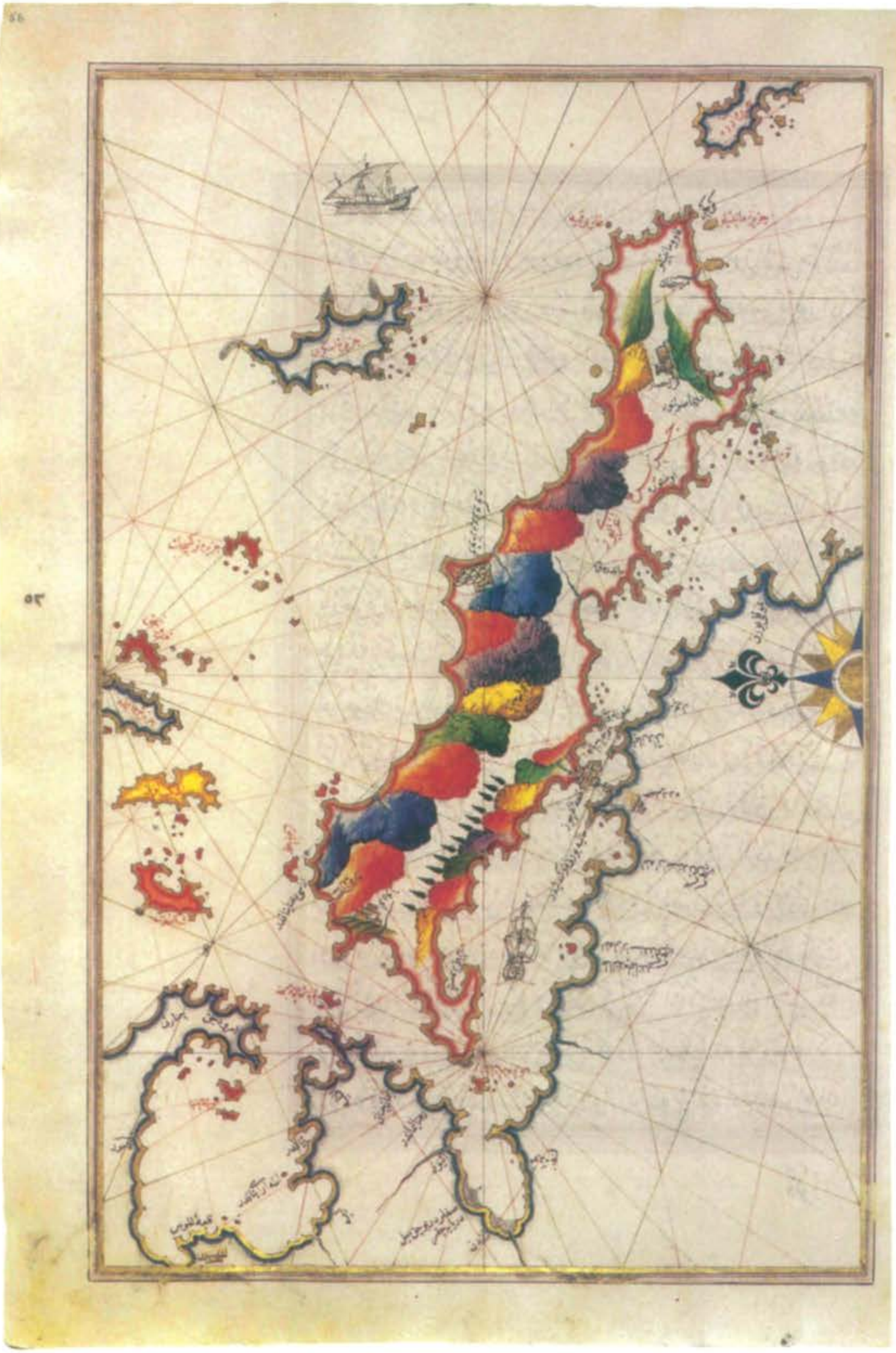

PLATE 22. VERSION 2 OF THE *KITĀB-I BAḤRĪYE:* ISLAND OF EUBOEA. Though no copies can be attributed to Pīrī Re'īs's own hand, the style of the second version of the *Kitāb-i baḥrīye*, originally made for presentation to Süleymān the Magnificent, was much more polished and elaborate than that of the first.

Size of the original: 34 × 23.5 cm. By permission of the Walters Art Gallery, Baltimore (MS. W. 658, fol. 56).

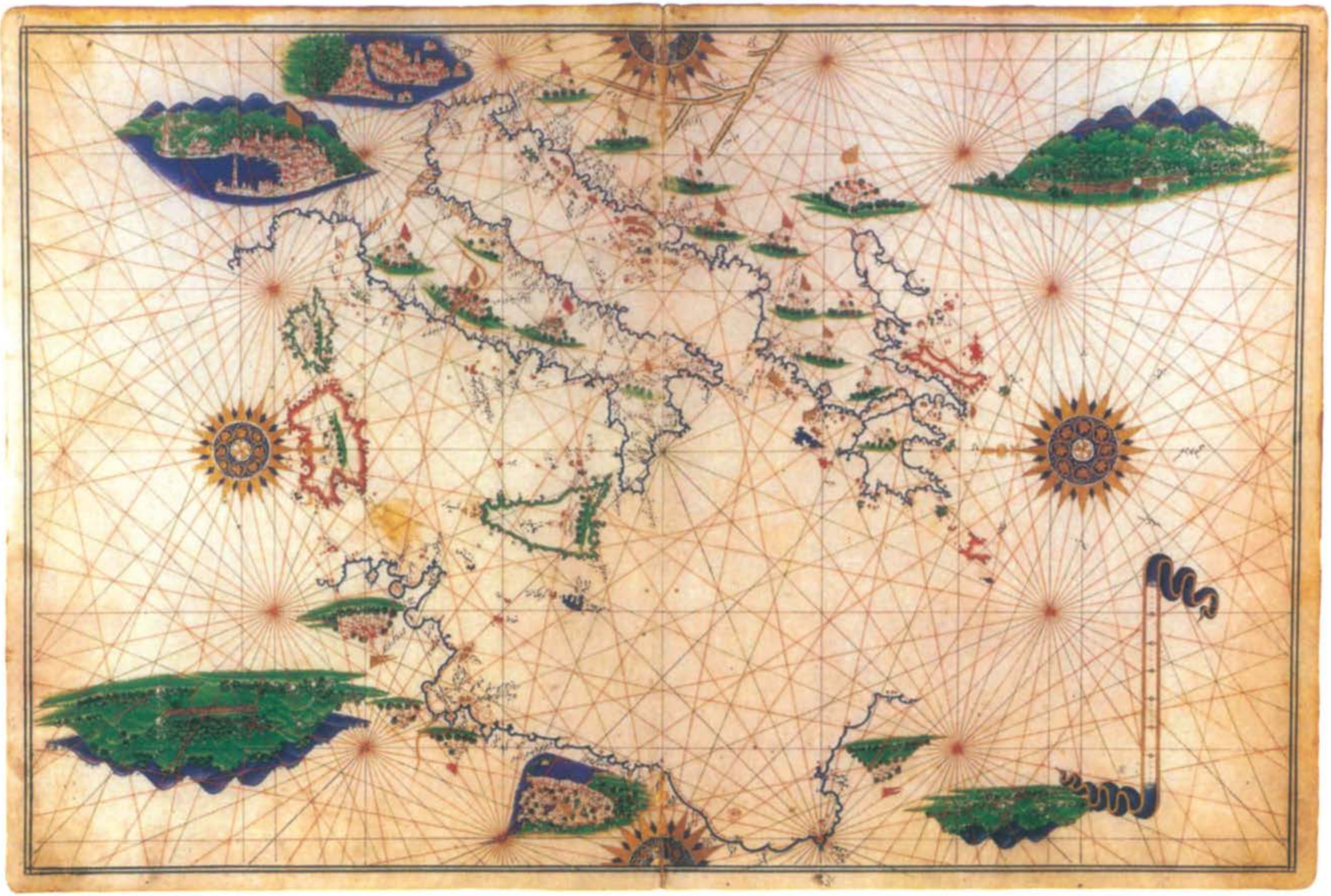

PLATE 23. WALTERS *DENIZ ATLASI:* ITALY AND THE CENTRAL MEDITERRANEAN. This portolan atlas containing eight double-page charts bears many stylistic characteristics of the small Italian atlases of the sixteenth century, but no specific workshop has been positively identified. The map has about 170 place-names, all on the coast, except for those along an unusually stylized representation of the Danube River. The North African coast extends from Bône, Algeria, to Benghazi, Libya.

Size of the image: 30.1 × 45 cm. By permission of the Walters Art Gallery, Baltimore (MS. W. 660, fols. 6v–7r).

PLATE 24. AL-SHARAFĪ AL-ṢIFĀQSĪ CHART, 1579. Size of the original: 59 × 135 cm. By permission of Istituto Italo-Africano, Rome.

PLATE 25. VISHVARUPA, THE UNIVERSAL FORM OF KRISHNA. This painting, gouache on paper (?), from Jaipur, Rajasthan, is dated eighteenth century by Philip Rawson, *Tantra: The Indian Cult of Ecstasy* (London: Thames and Hudson, 1973), pl. 48. It relates to an account in which Lord Krishna demonstrates his power to Arjuna by manifesting "the whole Universe—both animate and inanimate—within his body. . . . Here, in the centre of his cosmic form, Krishna multiplies himself by the silvery banks of the river Jamuna to dance . . . with the *gopis* [milkmaids]. The armies of the Pandavas and Kauravas [supposedly recruited from throughout the earth] are poised on opposite sides. Below the feet [of Krishna] is the hood of Sheshanaga, the cosmic serpent on whom the Universe is said to rest" (Aman Nath and Francis Wacziarg, *Arts and Crafts of Rajasthan* [London: Thames and Hudson; New York: Mapin International, 1987], 167–68).
Size of the original: 53 × 36 cm. From Nath and Wacziarg, *Arts and Crafts of Rajasthan*, 168.

PLATE 26. CONTAINER IN THE FORM OF A COSMOGRAPHIC GLOBE. This beautifully engraved hinged globe, dated Śaka 1493 (A.D. 1571) and possibly from the Saurashtra region of Gujarat, is inscribed brass. It served not only as a cosmography but also as a container, perhaps for condiments. The northern hemisphere conforms generally to the Puranic conception of Jambūdvīpa portrayed in figure 16.3, whereas the southern hemisphere shows essentially the same succession of ring oceans and continents as those shown on figures 16.2, 16.15*b*, and 16.17. In the left portion of the northern hemisphere one sees a set of rhomboids representing the major *khaṇḍa*s (regions) of Bhārata (India).
Diameter of the original: 25.8 cm; height: 22.1 cm. Museum of the History of Science, Oxford (acc. no. 27-10/2191, Lewis Evans Collection). By permission of the Bettman Archive, New York.

PLATE 27. TABLE OF ASTERISMS (*NAKṢATRAS*). The asterisms depicted here are groups of stars seen near the plane of the ecliptic that are used to separate the twenty-eight mansions of the lunar zodiac. They are shown here in a customary order beginning with Kṛittika (Pleiades) at the top of the chest of the figure in whose body they are frequently portrayed. The artifact is gouache on cloth, from Rajasthan, and dates from the eighteenth century.

Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

PLATE 28. ANTHROPOMORPHIC REPRESENTATION OF THE JAIN UNIVERSE. Suggested in this and in many similar views (compare fig. 16.6) is the relation between microcosm and macrocosm. Jambūdvīpa, the middle world, is here shown rotated ninety degrees from its horizontal plane. Below are various levels of individually identified hells (normally seven). The squares within both the heavens and the hells indicate (on more carefully drawn diagrams) their dimensions in *khaṇḍaka*s, a Jain unit of measurement of stupendous length. The artifact is gouache on paper, Gujarati, sixteenth century.
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

PLATE 29. DETAIL OF AN ECLECTIC WORLD MAP. This detail from figure 17.4 shows India and adjacent regions. Despite an abundance of detail for India, the knowledge of Indian geography this map displays is not very impressive. Proportionally, India occupies less map space here than in figures 17.2 and 17.3. Sri Lanka appears twice, as in many older European maps. The large lake toward the right is the Caspian Sea. The vignette along the bottom edge shows Alexander directing construction of a wall to protect a population against the giants Gog and Magog. The large vertical island, within which one sees dog-faced people, is Japan.

By permission of the Museum für Islamische Kunst, Staatliche Museen Preussischer Kulturbesitz, Berlin (inv. no. I. 39/68).

PLATE 30. GEOGRAPHIC PORTION OF HINDU COSMOGRAPHIC GLOBE. The essentially geographic portion of the globe represented in figure 16.15 falls in the northern hemisphere, mainly within a semicircular arc drawn 45° distant from Laṅkā (0°, 0°). The attempt on this map to make India fit into the arc between the equator and the Himachal Mountains inevitably distorts the country's shape; nevertheless, the lack of a peninsular shape is surprising. Of the places shown, those in the east are in better topological relation to one another than those in the west, over much of which the paint has flaked away. Beyond the Himachal only a few known geographic place-names appear before the globe gives way entirely to a mythical presentation.

Diameter of the globe: ca. 45 cm. By permission of Bharat Kala Bhavan, Varanasi. Photograph by Joseph E. Schwartzberg.

PLATE 31. BRAJ YATRA *PICHHVĀĪ*. This *pichhvāī*, from the Nathdwara school, Rajasthan, early nineteenth century, is painted on cloth. Though it is completely different in style from figures 17.20 and 17.21, its purpose is similar: to guide Krishna devotees on their eighty-four-*kos* pilgrimage to all the many sacred sites of the region of Braj where Krishna spent his youth. Size of the original: 275 × 259 cm. By permission of the Doris Wiener Gallery, New York.

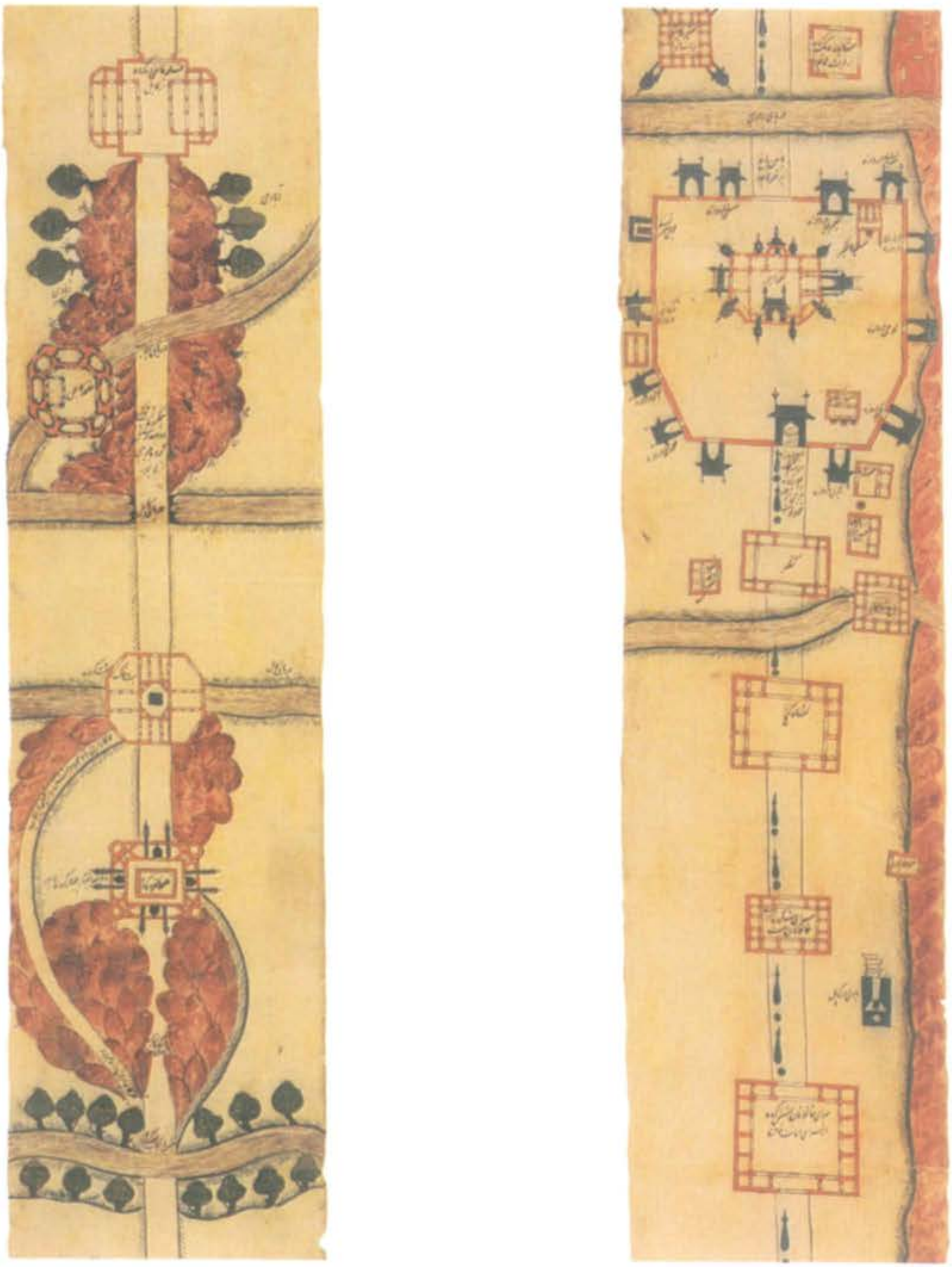

PLATE 32. SECTIONS FROM A MUGHAL SCROLL ROUTE MAP FROM DELHI TO KANDAHAR. Probably from the period 1770–80, the scroll is cloth with text in Persian. The panel on the right shows the city and fort of Lahore, within which prominent features are identified. Below the city one sees a number of other settlements, a *baolī* (large stepped well) near the lower right corner, the Ravi River, and along the eastern edge, the hills marking the edge of the Indus Plain bearing carefully rendered characteristic vegetation. The hills are made to appear much closer to the road than they really are. Along the road one sees *kos minar* (stone pillars set at roughly two-mile intervals that marked much of the road's length). In the left-hand panel Kabul fort appears to the left of the upper of the hilly areas through which the road passes. Nearby (below) a bridge is shown across the Kabul River, which is shown again with another crossing before the ascent to Zafar fort, below (east of) which some possible alternative bypass routes are depicted. Of note are the various types of vegetation in relation to the changing terrain and the tree-lined Barik River at the bottom of the panel. (Notes taken from description in Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* [New Delhi: Manohar Publications, 1989], 94–103.)

Size of the original: ca. 2,000 × 25 cm. By permission of the India Office Library and Records (British Library), London (Pers. MS. I.O. 4725).

PLATE 33. SRINAGAR. From Kashmir and dating from the third quarter of the nineteenth century, this map is embroidered in fine wool on cloth. It has exceedingly detailed (though not necessarily accurate) representations of canals, bridges, lakes, gardens, and other features for which the city is famous. Also depicted are humans engaged in various activities, animals, and vegetation.
Size of the original: 230 × 195 cm. Courtesy of the Board of Trustees of the Victoria and Albert Museum, London (I.S. 31.1970).

PLATE 34. JODHPUR. This map of Jodhpur is from Rajasthan, nineteenth century (?), painted on paper backed with cloth. Of particular note on this map is the treatment of the city wall so as to maintain a frontal perspective from the exterior in the foreground and from within the city in the rear. The map is fairly detailed but may have served no particular utilitarian end. The orientation to the north and the consistent alignment suggest a relatively recent date.

Size of the original: ca. 126 × 109 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 121). Photograph courtesy of Susan Gole, London.

PLATE 35. SHRINATHJI TEMPLE COMPLEX. This twentieth-century map is painted on paper. It depicts the temple complex (*havelī*) of the Vallabhacharya sect of Krishna devotees whose center is at Nathdwara, Rajasthan. Hereditary painters of the sect, attached to the temple complex, are entrusted with embellishing the complex throughout the year. Painted maps, mainly rendered on large cloth hangings (*pichhvāīs*), are but one form of embellishment. The paintings exhibit an exceptionally high degree of fidelity—in content, if not in scale—in depicting the buildings, rooms, courtyards, gardens, gates, lanes, and other features within the *haveli*.

Size of the original: 49 × 67 cm. By permission of Amit Ambalal, "Sumeru," Near Saint Xavier's College, Navrangpura, Ahmadabad 380009, India.

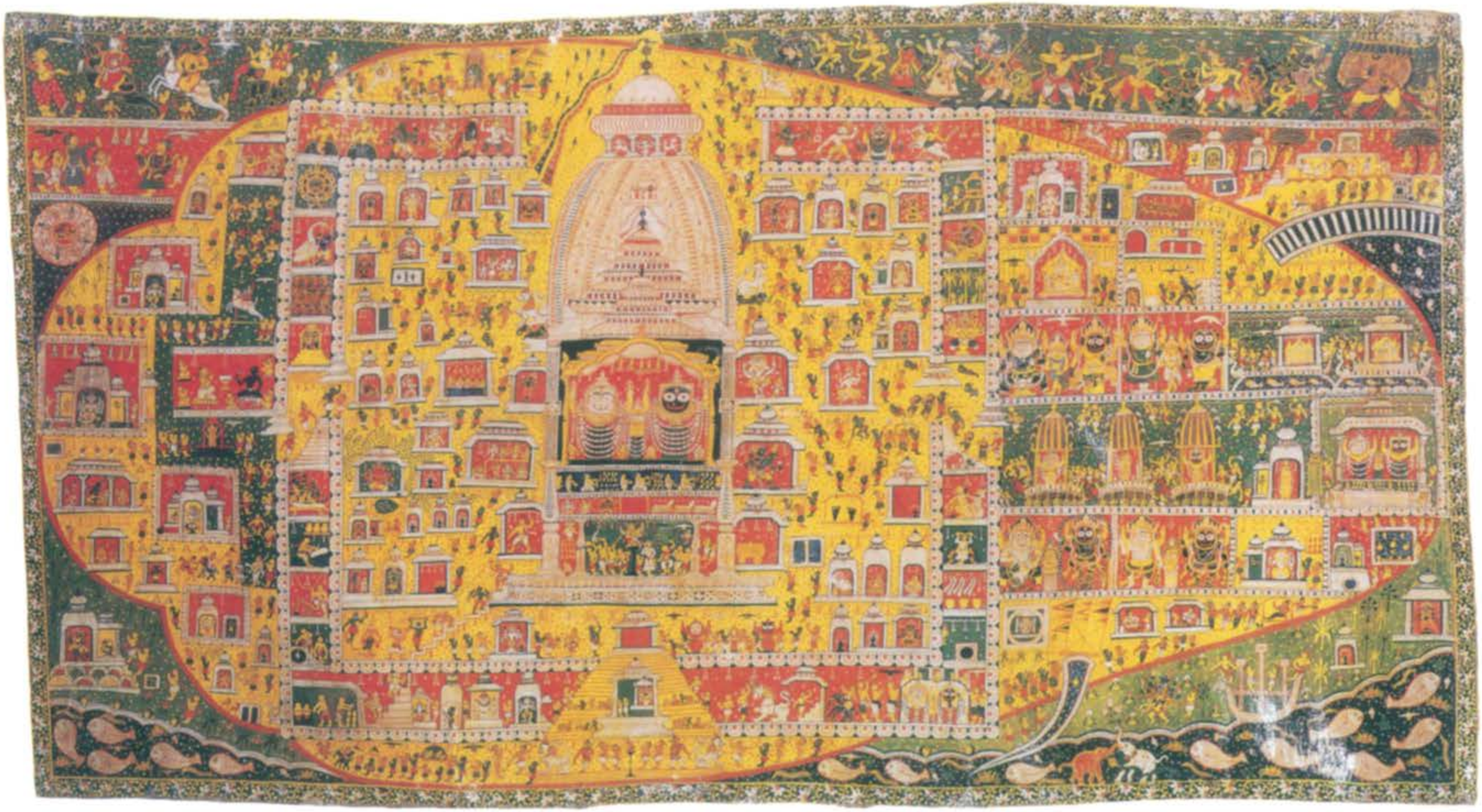

PLATE 36. JAGANNATH TEMPLE AND CITY OF PURI, ORISSA. This map in Puri style, painted on cloth and lacquered, dates from the nineteenth century. Jagannath, one of India's most sacred temples, is shown within a large square enclosure, and it and other temples are portrayed within the form of a conch, by which the city of Puri is conventionally shown. The map has brilliant colors and profuse detail.
Size of the original: 150 × 270 cm. By permission of the Bibliothèque Nationale, Paris (Département des Manuscrits, Division Orientale, Suppl. Ind. 1041).

PLATE 37. *TĪRTHAS* IN KASHMIR. The four *tīrtha*s depicted here are from Kashmir and dated mid-nineteenth century. They are painted on paper and rendered in a variety of charming, primitive styles. Each map shows a very limited area, with details of temples, springs, streams, hills, and vegetation. For additional details, see appendix 17.6, item o. Size of the originals: ca. 36.5 × 32 cm. Sri Pratap Singh Museum, Srinagar (2063). Photographs courtesy of Joseph E. Schwartzberg.

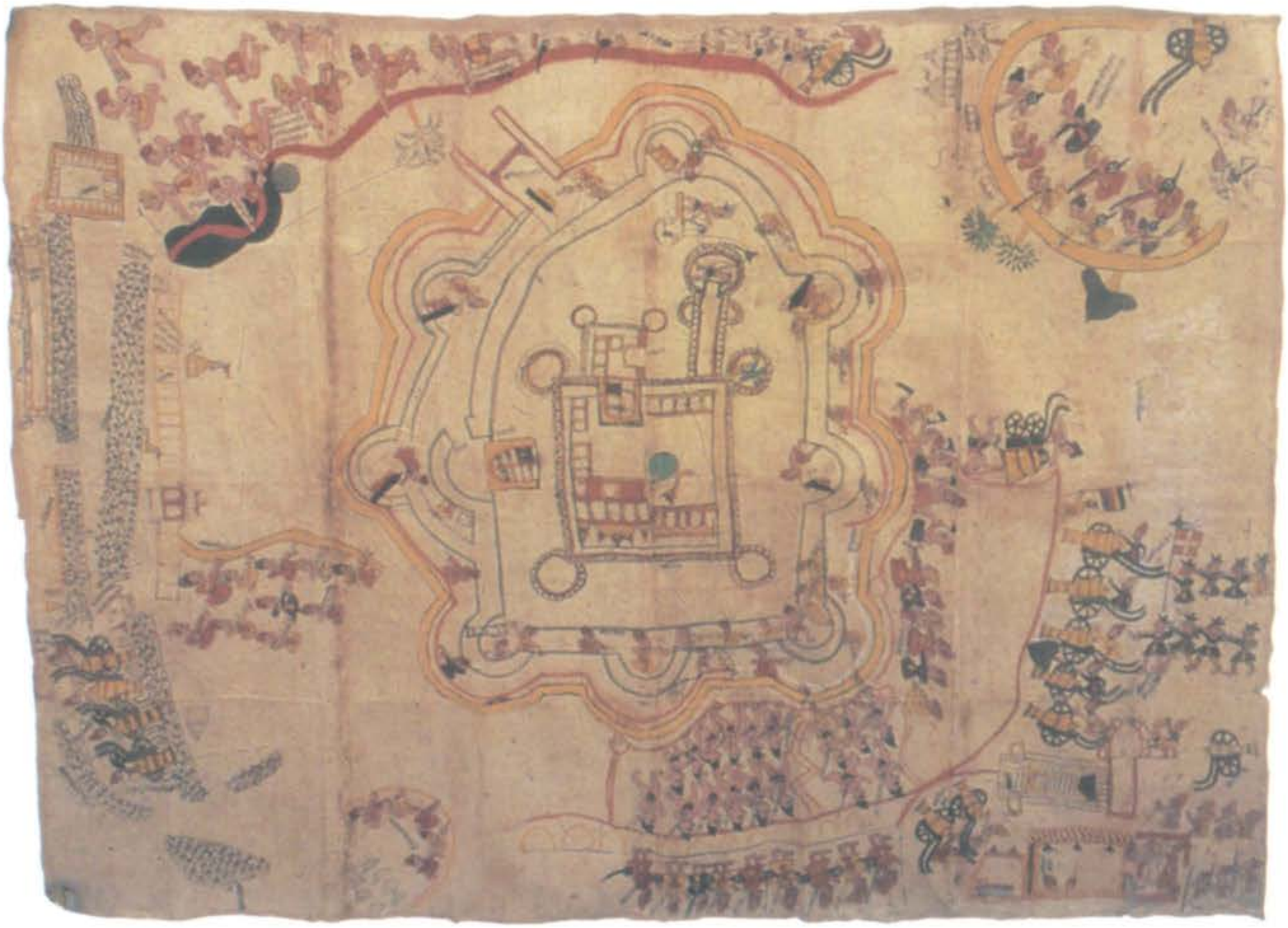

PLATE 38. A SIEGE AT BHIWAI FORT, SIKAR DISTRICT, RAJASTHAN. This lively depiction of a siege of a fort is Rajasthani, dating from the early nineteenth century, painted on paper backed with cloth, with text in Dhundari. Troops of various units are pictured in distinctive garb, trenches, ramparts, siege tunnel, artillery, and flags are shown, and commanders are named.
Size of the original: 123 × 168 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 48). Photograph courtesy of Susan Gole, London.

PLATE 39. DIWALI CELEBRATIONS AT THE ROYAL PALACE AT KOTAH, RAJASTHAN. The seemingly chaotic arrangement of several major elements within this painting underscores the levity associated with festivities it depicts, but it does so without masking the architectural details of the Kotah palace and gardens. Painted on paper, from Udaipur, Rajasthan, the painting is dated ca. 1690.
Size of the original: 48.5 × 43.4 cm. By permission of the National Gallery of Victoria, Melbourne (cat. no. 52), Felton Bequest 1980.

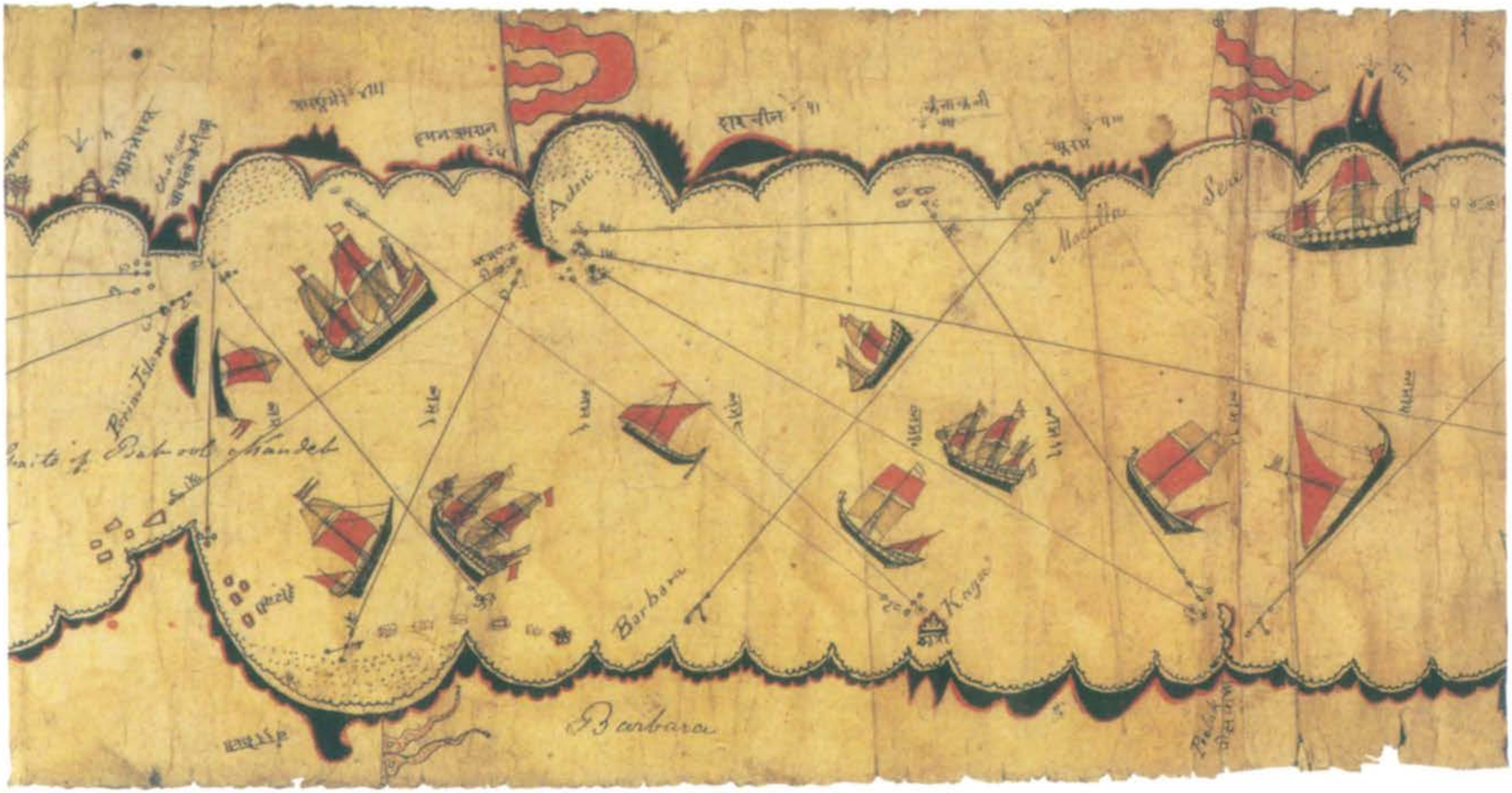

PLATE 40. DETAIL OF THE RED SEA AND ADEN FROM A NAUTICAL CHART. The area shown is that adjacent to Bab el Mandeb. Size of original: 24.5 × 47 cm. By permission of the Royal Geographical Society, London (Asia S.4).

Preface

One objective of *The History of Cartography* is to redefine and expand the canon of early maps. The corpus of maps (or map types) described in the previous literature on the history of cartography appears to us today unduly restricted and unnecessarily exclusive. It was based on assumptions that narrowed its scope and rendered it unrepresentative of the richness of mapping across the historical civilizations of the world as a whole. "Maps" meant, in that literature, primarily terrestrial maps, so that star maps, cosmographical maps, and imagined maps, for example, were generally excluded as ways of seeing the world. With the notable exception of the inclusion of China, cartographic history was pictured as largely a Greco-Roman invention or was narrated, for the later periods (the sixteenth century onward), as an accompaniment to the "miracle" of expanding European technology. Even within the core of accredited cartography, pride of place was given to the history of mathematically constructed—"scientific"—maps, so that the history of maps could culminate in the "scale" maps of the modern age and fit the notion of "progress" from a primitive past to a state of modern enlightenment.

In volume 1 we adopted a new working definition of "map" to help in recasting this history. Maps, we suggested in the Preface, "are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the human world."[1] Our strategy was to bring into the history of cartography maps that had previously been ignored or relegated to the margins of the subject. Volume 1, relating to the early cartography of Europe and the Mediterranean to A.D. 1500, vindicated the expansion of the canon in this way. We were soon to discover that such an open definition was even more desirable for volume 2 if we were to completely redescribe the history of cartography in non-Western cultures, as was our aim. The present book brings together the full range of maps produced in traditional Islamic and South Asian societies from late prehistory onward. It is salutary to compare its length with the number of pages Leo Bagrow devoted to the same areas: six to Islamic cartography, half a page each to India and Persia, and three to Ottoman cartography.[2] The image Bagrow gives is of the Western collector adding a few exotic specimens to a cabinet of curiosities. But even in narrative discussions of the history of cartography, such as those of Lloyd Brown and Gerald Crone, and notwithstanding the universal ring of their titles, the non-European mapping traditions were largely ignored.[3] Such an approach in the standard texts taught several generations of students that the history of cartography was largely a Western achievement and part of the history of European science. Quoting an Islamic historian of science, it was as if the descent of maps had passed "directly from the Greco-Roman period to the European Renaissance as if nothing took place in the history of science and technology from the fall of Rome in the late fifth century to the fall of Constantinople in the fifteenth."[4]

That these silences were ill founded was revealed as we came to plan the *History* in detail. In the original general outline sketched in the 1970s, our intention was to include the "foundations" of world cartography, down to A.D. 1500 in both Western and non-Western societies, in a single "archaic" first volume. This was to describe not only the maps of prehistoric, ancient, and medieval Europe and the Mediterranean and the premodern cartographies of the Islamic, Indic, and East Asian realms, but

1. J. B. Harley and David Woodward, eds., *The History of Cartography* (Chicago: University of Chicago Press, 1987–), 1:xvi.

2. Leo Bagrow, *History of Cartography*, rev. and enl. R. A. Skelton, trans. D. L. Paisey (Cambridge: Harvard University Press; London: C. A. Watts, 1964; reprinted and enlarged, Chicago: Precedent, 1985), 53–56, 207–8, 209–11.

3. Lloyd A. Brown, *The Story of Maps* (Boston: Little, Brown, 1949; reprinted New York: Dover, 1979); Gerald R. Crone, *Maps and Their Makers: An Introduction to the History of Cartography*, 5th ed. (Folkestone, Kent: Dawson; Hamden, Conn.: Archon Books, 1978). As if to symbolize this neglect, in Brown's book there is the curious inclusion as the frontispiece of a redrawn map from the *Kitāb-i baḥrīye* from the Ottoman period, but neither the map nor its cultural origin in the Islamic world is discussed in the text.

4. Sami K. Hamarneh, "An Editorial: Arabic-Islamic Science and Technology," *Journal for the History of Arabic Science* 1 (1977): 3–7, esp. 7. See also Roshdi Rashed, "Science as a Western Phenomenon," *Fundamenta Scientiae* 1 (1980): 7–21. For cartography, the more specific comments of Fuat Sezgin, *The Contribution of the Arabic-Islamic Geographers to the Formation of the World Map* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), are relevant.

also those of "primitive" peoples in different parts of the world in the phase of their encounter with European colonization. Logistic and intellectual reasons, however, led us to abandon that embryonic plan.

The first problem arose from the size and complexity of the non-Western mapping traditions. The more we looked, the more substantial we found them, not only in the societies of Islam and Asia but also within other major regions such as the Americas and the Pacific before European colonization. As our preliminary explorations continued—and as we recruited specialist authors and they reported on their work—it became abundantly clear that a credible cartography of the premodern world could not be accommodated within a single volume. Hence in 1982 we decided to defer the treatment of non-European mapping outside the Middle East and Asia to later volumes of the *History*[5] and to devote a whole volume (volume 2) specifically to the maps created by the Islamic and Asian societies. We continued to believe naively that a single "Asian" volume would accommodate a synthesis of secondary literature from which observations could be made about the gaps in available information and directions for future research. Indeed, work on the several regional sections of this volume started simultaneously. Once again, however, as our experts reviewed the non-Western literature for an Asian history of maps and searched out and examined the maps themselves, it at last became clear how seriously we had underestimated the sheer volume of the relevant corpora of material. In 1989, with almost all the chapters already in hand, we made the decision to split volume 2 into two books. The present book thus deals with the traditional Islamic and South Asian societies; volume 2, book 2 will be devoted to traditional East and Southeast Asian cartography. The diversity of material in both books spans a wide spectrum of historical and linguistic contexts and has demanded an extended editorial effort. It has also further encroached on the forbearance of our potential readers and sponsors in the process of preparing the text for publication.

There was also an intellectual reason for splitting volume 2 into two books and allocating a separate tome to Islamic and South Asian cartography. Our early reconnaissance of the literature revealed not only the degree to which Islamic and Asian cartography had been neglected but also the way an epistemological veil had inhibited our understanding of mapping within these cultures *on their own terms*. The traditional approach in histories of cartography had been to evaluate "Arabic" or "Indian" mapping against a Western yardstick of technical innovation. This perception of the relative importance of *our* history and *their* history[6] put Asian maps on the periphery of European cartography. They emerged as abortive or deviant stems in the "mainstream" history of maps. Thus it could be admitted that the Arabs and the Chinese had mapping traditions of their own, "but it was the European tradition which lay behind the geographical discoveries and the . . . maps of the sixteenth century, and thus came to form the basis of modern geography."[7] A similar view permeates the cartographic historiography of the Islamic realm and South Asia.[8] As A. I. Sabra put it, there was a tendency to see Islamic science (and, we can add, cartography) as "merely a reflection, sometimes faded, sometimes bright or more or less altered, of earlier (mostly Greek) examples."[9] The focus was on those early centers of the Islamic world most closely linked to Europe and the Mediterranean. Islamic cartography was thus interpreted either as an extension of Greek classical learning (especially of Ptolemy) or as a pathway along which the cartographic inheritance of Greece was transmitted before its eventual restoration in Renaissance Europe. The role of Islam in world cartography was seen as passive, preserving—along with Byzantium—an essentially Western legacy for the later cartographic dominance of Europe. No hint was given that this knowledge was "a phenomenon of Islamic civilization—a phenomenon which must be understood and explained in terms peculiar to that civilization."[10]

The maps of South Asia lacked even the transmissional "utility" of Islamic scholarship for Western progress. Moreover, they were described from an external and uncomprehending viewpoint and accorded an even lower status in the hierarchy of cartographic development. As Susan Gole tells us, "The commonly held view [was] that there were no indigenous maps made in India except the cosmographies."[11] Judging South Asian maps in this way, by Western preconceptions, encouraged the idea that any styles of mapmaking that did not conform to recognized patterns were to be "dismissed as being of no value." Maps from South Asia were "stored in libraries and museums as quaint curiosities."[12]

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5. To volume 3, on cartography in the Renaissance, and volume 4, on cartography in the Enlightenment, where they will be treated both as cartographic cultures in their own right and in terms of the encounter with European colonial societies in different world regions and historical periods.

6. Bernard Lewis, "Other People's History," *American Scholar* 59, no. 3 (1990): 397–405, esp. 397.

7. P. D. A. Harvey, *The History of Topographical Maps: Symbols, Pictures and Surveys* (London: Thames and Hudson, 1980), 12.

8. See below, pp. 8–10 and 296–302.

9. A. I. Sabra, "The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement," *History of Science* 25 (1987): 223–43, esp. 223.

10. Sabra, "Appropriation and Subsequent Naturalization," 224 (note 9).

11. Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar, 1989), 11.

12. Gole, *Indian Maps and Plans*, 13 (note 11).

It was to redress some of the consequences of such attitudes that we decided to treat Islamic and South Asian mapping as distinct areas of cartographic knowledge. The decision was liberating. Once the Western yardstick was thrown out, a new potential to broaden the cartographic canon took shape. For this to happen, though, the transition from Eurocentric to more culturally sensitive interpretations had to be made and new assumptions espoused. Value judgments based on European paradigms had to be modified. For instance, it was no longer satisfactory to see the classical school of Islamic geography of the ninth and tenth centuries as a simple period of spectacular flowering before a long era of decline.[13] Terms such as "decline," "stagnation," and "decadence" convey judgments based on the notion of a "scientific revolution" in early modern Europe.[14] As Marshall Hodgson remarked, "Western scholars discuss cultural decline in Islam . . . without really proving that such decadence really existed, and without evaluating the great works of later periods."[15] Such implicit judgments may explain the earlier neglect of cartography in the Ottoman period. By changing our cultural stance we have been able to add to this volume what we believe is the first systematic account of cartography in the premodern Ottoman Empire.[16]

The treatment of cosmographical maps in this book has also benefited from the shedding of Eurocentric attitudes. Our redefinition of cartography in volume 1 was specifically worded to include graphic representations of the human cosmos in the widest sense. Given the treatment of cosmography in that volume,[17] it would have been unthinkable to exclude from the present volume either the Islamic cosmographical diagrams or the cosmographical maps made by Buddhists, Hindus, and Jains in South Asia. Indeed, instead of omitting South Asian cosmographical maps on the grounds that they have already been treated extensively in works on Indian art and religion, or because they are in some way less than cartographic, we have emphasized them as the quintessential expression of the mapping impulse in these societies. Recognizing them as maps in their own right, the author of the South Asian section has found no need to justify them by gratuitous measurement or to include them only because they "compensate" for the sparser record of terrestrial mapping in South Asia. Rather, they remind us that the study of early maps in non-Western societies cannot be confined to examples mirroring the familiar characteristics of European cartography. The treatment of cosmography in this book is central to our mission to move the history of cartography to accept maps of territories previously regarded as marginal to the accepted core of "scientific" cartography.

The satisfaction of seeing our authors enlarge the scope of the book is considerable, but our editorial attempts to resolve other problems may have met with less success. Since the inception of the *History*, we have struggled to devise compatible geographical regions and historical periods so as to create a coherent framework for a study of cartographic change and its social interactions.[18] So vast is the canvas of the present book, however, that it has generated a series of special problems.

The basic framework for volume 2, book 1, is geographical. The Islamic heartland is treated separately from South Asia. The cultural distinctiveness of the two areas is also underpinned by long-established historical usage. The continent of "Asia"[19] is a European invention, and already in classical and medieval times it designated the lands to the east of Mesopotamia and Persia, though India was recognized as a separate cultural unit.[20] But this neat geographical-historical arrangement leaves a number of gaps in our treatment. One chronological problem is that the two sections, the Islamic world and South Asia, have different starting dates, partly because the maps of the earliest Mesopotamian and Egyptian civilizations, in view of their affinities with classical Europe and the societies of the Mediterranean, were dealt with in volume 1.[21] In this book the narrative is picked up with the expansion, from the seventh century onward, of the Islamic religion. For South Asia, however, we must go back to the late prehistoric period. Another untidiness is the way geographical regions do not match the changing map of cultural history. The modern term "Middle East"[22] does

13. See, for example, the remarks of George Sarton, "Arabic Science and Learning in the Fifteenth Century: Their Decadence and Fall," in *Homenaje a Millás-Vallicrosa*, 2 vols. (Barcelona: Consejo Superior de Investigaciones Científicas, 1954–56), 2:303–24.

14. Sabra, "Appropriation and Subsequent Naturalization," 238–42 (note 9).

15. Marshall G. S. Hodgson, "The Role of Islam in World History," *International Journal of Middle East Studies* 1 (1970): 99–123, esp. 103.

16. See chaps. 10–12 and parts of chap. 14.

17. Harley and Woodward, *History of Cartography*, 1:85–92, 203–4, 261–63, 340 (note 1).

18. For a discussion of the overall framework of the *History*, see Harley and Woodward, *History of Cartography*, 1:xviii–xix (note 1).

19. Its geographical bounds as imposed by atlas or dictionary definition comprise the lands east of Hellespont and the Urals and south of the Caucasus Mountains. On the arbitrariness of the modern map for cultural history, see Marshall G. S. Hodgson, "The Interrelations of Societies in History," *Comparative Studies in Society and History* 5 (1963): 227–50.

20. Donald F. Lach, *Asia in the Making of Europe*, 2 vols. in 5 (Chicago: University of Chicago Press, 1965–77), 1:335.

21. Harley and Woodward, *History of Cartography*, vol. 1, chaps. 6 and 7 (note 1).

22. The term Middle East was first used in 1902 by the American naval historian Alfred Thayer Mahan. See Bernard Lewis and P. M. Holt, eds., *Historians of the Middle East* (London: Oxford University Press, 1962), 1–3, for a discussion of the historical geography of regional nomenclature. See also the helpful discussion in Bernard Lewis, "The

not coincide with the areas—extending from a long-lived center of chartmaking in North Africa to the mapping of the Mughal Empire in northern India—where Islamic cartography flourished in various historical periods. A similar problem applies to the "cartographic region" of South Asia. Though this area formed the heartland for the development of the Buddhist world maps dealt with in this book, they later spread, in modified forms, to other regions of Southeast and East Asia and could have legitimately formed part of the subject matter of volume 2, book 2.

Coupled with the structural difficulties of trying to organize a balanced overview of Islamic cartography, there is the problem of unevenness of knowledge about mapmaking under the different Islamic empires—the Abbasid, the Safavid, the Mamluk, the Mughal, and the Ottoman—and the way these empires coincided (or failed to coincide) with the area's linguistic geography. Not all Islamic texts including maps were written, or written about, in Arabic.[23] There is much relevant material in languages such as Syriac, Persian, and Turkish. Even so, the extent to which our authors have been able to reconstruct cartographic traditions across the Islamic world has varied, and though we offer relatively full descriptions of mapmaking under the Abbasid, Mughal, and Ottoman empires, evidence for Persian cartography and for some aspects of Muslim mapping in Spain before the *reconquista* remains much more elusive.

There are also differences in our academic starting points. For the history of Chinese cartography in book 2 of this volume, we can build on the synthesis by Joseph Needham and his associates.[24] In contrast, the single general reference work for Islamic cartography, *Mappae arabicae* by Konrad Miller,[25] is three-quarters of a century old. Hitherto the fullest up-to-date summary of Islamic cartography has been an article in an encyclopedia.[26] Many of the original texts of manuscript sources containing maps lack critical modern editions. Specialists in Islamic and South Asian studies point to large numbers of manuscripts that remain unpublished and even uncataloged. Our authors have drawn on some of these, but the discovery of new manuscript sources not only would add new detail but could revise some of the key issues raised in this book concerning cartographic transmission. For example, increasing attention is being paid to the astronomical and mathematical sciences of the Islamic world, and much of this work will bear on the mathematical aspects of map projections. Although we have attempted to inform readers of current research directions, even work in progress, there is no way we can be sure of incorporating it all.

In technical matters, we adopt what seems to be the consensus among specialists. For South Asia we have mainly used the Christian calendar. For the maps of the Islamic world, however, we have provided both Islamic and Christian dates. In this way the Islamic sense of time is preserved. At the same time, comparisons can be made with Europe, particularly in the periods of most active interaction between Europe and regions of Islamic culture. A major problem—and, to us, new—has been the need to deal with phonetic languages, such as Arabic, and to pay particular attention to the transcription of all Asian languages. We have not attempted to reproduce Arabic characters but have adopted the Library of Congress transliteration system for Arabic and Persian. In a multiauthor work, there is never full agreement on such a personal and idiosyncratic topic as transliteration, and this book has been no exception. The decision to use the Library of Congress system was based on two considerations. First, it was recommended by *The Chicago Manual of Style* as the most widely used system. Second, we felt that—while Arabists could work back to the original Arabic characters from any rational system (including that of the Library of Congress)—nonspecialists would find it easier to look up authors and titles of Arabic works in libraries using the Library of Congress system, which is commonly used for this purpose. We are well aware, however, that in our efforts to be consistent throughout the volume we have not succeeded in pleasing everyone. As a compromise, in the very few cases where the Library of Congress form is obviously counter to modern practice, we have provided the commonly known form. For decisions on when to use a transliteration of Ottoman as opposed to modern Turkish, we have relied on the judgment and experience of our individual authors, whose practices may differ. For all languages, lengthy "book" titles and personal names are usually given in full only on the first use, and subsequently we use an abbreviated form. Wherever possible, we have added a translation of the title.[27]

Map of the Middle East: A Guide for the Perplexed," *American Scholar* 58 (1989): 19–38.

23. It is wrong, therefore, to equate Islamic cartography exclusively with the Arabic-language areas as some authors have implied: Bagrow, *History of Cartography*, 53 (note 2), is misleading when he states of Islamic cartography that "all its cartographers wrote in Arabic."

24. Joseph Needham, *Science and Civilisation in China* (Cambridge: Cambridge University Press, 1954–), esp. vol. 3, *Mathematics and the Sciences of the Heavens and the Earth* (1959); vol. 4, *Physics and Physical Technology* (pt. one: *Physics*, 1962; pt. three: *Civil Engineering and Nautics*, 1971).

25. Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31). Miller's work also typifies the emphasis of many European Orientalists on the historical geography of the regions or in the reconstruction of their place-name nomenclature.

26. S. Maqbul Ahmad, "Kharīṭa," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 4:1077–83.

27. On the grounds that they may contain substantive or allusive information relevant to our interpretation of the role of maps in these

That we were able to grapple at all with the problems involved in this work and later felt able to comment on some important interpretative issues in Islamic and South Asian cartography in our "Concluding Remarks" is largely owing to the scholarship of the specialist authors who have agreed to write on these subjects. In the fullest sense, this is their volume. We wish to acknowledge their patience during the decade it has taken for the text to come to fruition, and for the good grace with which they have accepted editorial intervention at various stages in the work. We are most deeply indebted to our two associate editors—Gerald Tibbetts and Joseph Schwartzberg—who became indispensable advisors as well as major authors. We know they have sacrificed other academic projects and personal opportunities to work with us for so long on the challenge of creating a new history. Equal thanks must be extended to Ahmet Karamustafa, our assistant editor, whose contribution to the book as a whole has been far greater than that title implies. Dr. Karamustafa began work on the Islamic section as a postdoctoral fellow at the University of Exeter and, since his appointment to the Department of Asian and Near Eastern Languages and Literature of Washington University in Saint Louis, has played a key role in introducing us to new authors and to developments in Islamic scholarship.

At various stages in the work we have also benefited enormously from the advice of a circle of specialist scholars to whom we were initially outsiders and who may have wondered whether there would ever be any product from our persistent inquiries. These individuals have generously found time to recommend new authors and, in the later stages of the work, to give critical readings of several chapters. In the initial planning of the book we received useful help on the Islamic section from William C. Brice. More recently Susan Gole has shared her extensive knowledge of Indian mapping and has made available illustrations that otherwise would have remained unobtainable. In addition to the advice of the four anonymous readers of the University of Chicago Press (two for the Islamic section and two for the South Asian), comments on particular sections by Owen Gingerich, Thomas Goodrich, Abbas Hamdani, Paul Kunitzsch, David Pingree, and Jamil Ragep have been particularly valuable. For occasional, but nonetheless essential, advice we are also in the debt of C. F. Beckingham, Simon Digby, Edward S. Kennedy, Roshdi Rashed, and Fuat Sezgin.

As the History of Cartography project has continued to grow in size and complexity—with a further three volumes already in various advanced stages of commissioning and preparation—we have become even more dependent upon the organizations, foundations, and individuals who have provided the financial support necessary for a work on this scale. We coeditors particularly wish to thank our own academic departments and the graduate schools of the University of Wisconsin at Madison and Milwaukee for their long-term institutional support of the project in both a material and a personal sense. We are also grateful for the generous grants received for this book from foundations, institutions, and individuals who are fully acknowledged on page vi. In addition, we would like to thank Jack Monckton and Kenneth Nebenzahl for their advice on fund-raising and Richard Arkway, Martayan Lan, Inc., George Ritzlin, Thomas Suarez, and Martin Torodash—map dealers who helped by publishing our call for financial support in their catalogs.

It is only this overall level of support that has enabled us to have the privilege of working with a highly qualified staff for the essential yet time-consuming editorial tasks of bringing such a book to press. All volumes of the *History* are intended to provide a basic work of reference for scholars and other readers across the spectrum of the relevant disciplines. As in volume 1, we have paid particular attention to creating a bibliographical apparatus that is full and accurate. In controlling the day-to-day operations of this work—and in liaison with the University of Chicago Press and with authors, advisors, and editors—our managing editor Jude Leimer has been the secure anchor of the whole editorial process. It is largely through her determination, organizational ability, and bibliographical flair in tracking down arcane references that we have been able to move forward. In his capacity as research associate, Kevin Kaufman has also shown great initiative and scholarship and has dealt imaginatively with a wide range of research problems and with drafting new material where gaps in the text needed to be plugged. Paula Rebert has most capably checked many of the references in this book, and for additional research help we are grateful to Matthew Edney and David Tilton. Deniz Balgamis, Judith Benade, Kathryn Kueny, and Michael Solot took time during their trips abroad to bring us crucial materials from Turkey, India, and Egypt. Ms. Balgamis and Hichem Sellami have also helped with translations of Turkish and Arabic texts. Cartography is nothing if not a visual language; a major feature of the book is its attempt to include a representative set of illustrations. In this vital editorial task Christina Dando and Guntram Herb have tenaciously pursued pictures and cleared permissions from a large number of distant libraries. The line drawings were skillfully prepared by the University of Wisconsin Cartographic Laboratory in the Department of Geography at Madison.

Anyone who has experienced the problems of managing a small office within a large organization will also

non-Western societies. G. M. Wickens, "Notional Significance in Conventional Arabic 'Book' Titles: Some Unregarded Potentialities," in *The Islamic World: From Classical to Modern Times: Essays in Honor of Bernard Lewis*, ed. Clifford Edmund Bosworth et al. (Princeton, N.J.: Darwin Press, 1989), 369–88.

appreciate how essential Susan MacKerer has become as administrator for the Project as a whole. She always works with efficiency and good humor on vital tasks that run from the diplomatic to the technical. In the Milwaukee office of the Project the editorial effort would similarly have soon come to a halt without the absolutely crucial support of Ellen Hanlon. Mark Warhus, coordinator of the Office for Map History of the American Geographical Society Collection, has also given much logistic help to our endeavor, and in the Madison office, we received essential secretarial and library help from Ellen Bassett, Karen Beidel, and Judith Gunn.

We are delighted to have the opportunity to thank several people at the University of Chicago Press. Penelope Kaiserlian, associate director, has promptly and sympathetically smoothed out any administrative problems; Alice Bennett, copy editor par excellence, has improved the consistency and efficiency of the text; and the apt design and versatile layout created by Robert Williams have proved a match for the complexities of the text, tables, and illustrations.

As our momentum increases and at this stage in the life of the Project as a whole, the professional and personal debts of the two coeditors are mounting too rapidly to enumerate here. Some of the authors with whom we worked on volume 1—notably Tony Campbell, Oswald Dilke, and Catherine Delano Smith—have continued to offer us sound advice, while our former editorial colleague Anne Godlewska continues to keep a watchful eye on our progress from Canada. At a personal level, we owe a debt to our families in England and Wisconsin that cannot be measured. Their support, tolerance, and love has been unsurpassed, and we fear that at times we must have sorely tested their patience as the *History* has taken up more and more of our energies. Rosalind Woodward has played a key role in the internal social life of the Project and in frequently bringing the external perspective of common sense to organizational problems.

With so much given to us from all quarters, readers might begin to wonder how there could be any blemishes at all in the book. For the fact that there are many, we both take full responsibility. We are conscious that in the end this is only a small first step in writing the non-Western history of cartography.

PART ONE

Islamic Cartography

1 · Introduction to Islamic Maps

AHMET T. KARAMUSTAFA

The cartographic heritage of premodern Islamic civilization is extremely varied. Different traditions of theoretical and empirical cartography coexisted for over a millennium, from about A.D. 700 to 1850, with varying degrees of interaction in a cultural sphere that extended from the Atlantic shores of Africa to the Pacific, from the steppes of Siberia to the islands of South Asia. The heterogeneity of premodern Islamic mapping was not due solely to the unusual geographical extent and temporal span of this cultural sphere. Rather, it was primarily a natural outcome of the fact that Islamic civilization developed on the multifaceted and discontinuous cultural foundations of the Middle East. The very core of this foundation, the Semitic-Iranian tradition, was itself marked by radical ruptures that separated the age of cuneiform from that of Aramaic and Middle Persian. Muslims further complicated the picture, not only by deliberately rejecting their own classical Semitic-Iranian heritage but, more dramatically, by appropriating and naturalizing in an enormously creative act the "foreign" classical tradition of Greek science and philosophy. The following chapters attempt to trace the major outlines of the conceptual as well as the practical mapping traditions of the multirooted cultural complex that resulted from this merger of cultures.[1]

This group of essays is organized into five major sections. The first three deal, in order, with celestial mapping, cosmography, and geographical mapping. A separate section is devoted to a survey of cartography in the premodern Ottoman Empire. The final section deals with the role of nautical charts in Islamic navigation in the Indian Ocean and with maritime cartography in the Mediterranean. This particular arrangement is not dictated solely by the relative significance of each type of cartography. The chapter on celestial mapping comes at the beginning largely because of the importance of these maps in Islamic culture. Cosmographical mapping follows, since it was closely associated with celestial cartography. A series of essays on early geographical cartography then forms a large subsection. The separate treatment accorded to Ottoman cartography is justified equally by the particular cultural conjuncture of the Ottoman Empire between Christian Europe and the Islamic Middle East and by the comparative wealth of its cartographic heritage. Two essays on maritime mapping complete the Islamic section.

The distinctive characteristics of Islamic cartography are owed in part to the interaction of Islamic culture with the European societies that lay to the west. In this sense the section as a whole builds on specific cartographic traditions that were studied in volume 1 of the *History*. On one hand, a major concern that runs through the sections on celestial mapping, cosmography, and geographical cartography is the delineation and analysis of the Greek heritage in Islamic cartography, and as such these chapters should be read in conjunction with chapters 8 through 11 of volume 1. On the other hand, the section on cartography in the premodern Ottoman Empire assumes familiarity with cartography in medieval Europe and the Mediterranean, which is the subject of part 3 of volume 1.

Firmly grounded in volume 1 of the *History*, the Islamic section also requires a careful reading of volume 2 as a whole. The question of Chinese influences on Islamic cartography, however minor, is brought into perspective by matters dealt with in the East Asian section. More substantially, Islamic materials deriving from the Indian cultural sphere are studied in the South Asian section. Finally, much of volume 3 of the *History* will also need to be consulted for proper appreciation of the chapters on Ottoman cartography, since Ottoman mapping practices bear clear traces of contemporary developments in European cartography. Owing to these multifaceted cultural connections, therefore, the Islamic section acts as a pivot between volume 1, the remainder of volume 2, and volume 3 of the *History*.

1. The standard general survey of Islamic history is Marshall G. S. Hodgson, *The Venture of Islam: Conscience and History in a World Civilization*, 3 vols. (Chicago: University of Chicago Press, 1974). The recent survey by Ira M. Lapidus, *A History of Islamic Societies* (Cambridge: Cambridge University Press, 1988), concentrates on institutional history. *The Cambridge History of Islam*, 2 vols., ed. P. M. Holt, Ann K. S. Lambton, and Bernard Lewis (Cambridge: Cambridge University Press, 1970), and Bernard Lewis, ed., *The World of Islam: Faith, People, Culture* (London: Thames and Hudson, 1976), are useful collections.

Greek Heritage

Roughly a century and a half after the establishment of Islamic rule over the central lands of the Middle East in the mid-seventh century, there began a massive translation movement. By the time the translation activities dwindled away at the beginning of the tenth century, much of the surviving corpus of Greek philosophical sciences was available in Arabic. Most of the translations were carried out in Baghdad, the newly founded capital of the Abbasid Empire, under the patronage of the ruling caliphs, in particular al-Manṣūr (r. 136–58/754–74), Hārūn al-Rashīd (r. 170–93/786–809), and al-Ma'mūn (r. 198–218/813–33). The active adaptation and appropriation of Greek science and philosophy exercised a decisive formative influence on the nascent Islamic civilization. It also had far-reaching consequences for the history of the classical legacy and its revitalization in medieval and Renaissance Europe.[2]

Historians of cartography are concerned equally with many facets of this major event in world history. They are eager to trace both continuities and discontinuities between Islamic and European traditions of cartography. In many ways it is tempting to see the towering figure of Ptolemy as the protagonist of this narrative. His works in Arabic translation (appendix 1.1) formed the backbone of Islamic astronomy and astrology, areas of learning in which the mathematical bases of cartographic thought were developed and cultivated. It is therefore only natural to pay much attention, as the following chapters do, to the delineation of Ptolemy's legacy within Islamic cartography.

In searching for continuity and discontinuity, however, it is crucial to shape our judgments around historically viable questions. More specifically, the temptation to adopt a teleological view of historical processes of transmission is better avoided. That Greek cartographic traditions, as a part of the Greek philosophical curriculum, should have been absorbed into Islamic civilization was not a historical necessity. It is the translation movement itself that requires explanation, rather than those apparent "defects" in the resulting maps that may emerge when it is viewed with a mechanistic understanding of cultural processes of transmitting scientific learning. Thus, when research indicates that not all of Ptolemy's writings on cartography were put into practice by Muslims, it will not do to attribute this to a mysterious failure of comprehension by Muslims simply because these same writings led to quite different results a few centuries later in Europe in substantially different circumstances. Continuity in premodern science across very real cultural barriers is as much in need of historical explanation as is discontinuity, if not more; it should not be taken for granted.

The attempt to study the history of Greek cartographic learning from ancient times through Islam to the Renaissance, however valuable in its own terms, tends to promote an externalist view of Islamic cartography. The historian of this latter subject is essentially concerned with delineating the various cartographic traditions within Islamic civilization and analyzing their place and role within this broad cultural sphere. From this perspective, the question of Greek heritage assumes a different dimension. Unlike the student of Greek cartographic traditions across cultural boundaries, the historian of Islamic cartography must assess the place of Greek learning within Islamic mapping practices *as a whole*, with an eye toward the interplay among the different formative influences. The scope of the inquiries needs expanding. It needs not only to identify all possible cartographic precedents that were available to Muslim cartographers throughout the duration of premodern Islamic civilization, but also to establish how different cartographic practices within this cultural sphere interacted with each other to create distinctly Islamic mapping styles.[3]

The question of the influence of pre-Islamic Arabian, Persian, and Indian—as well as, much later, Chinese and European—cartographic and geographic lore on Islamic cartography is complex. Different aspects of this intricate array of issues are studied with varying emphases in the essays that follow. The relevant historical record is severely discontinuous here, and many questions cannot be clearly conceived, let alone satisfactorily answered. Nonetheless, an awareness of formative influences other than those of Greek cartography serves at the very least to place the classical heritage in Islamic cartography into a broader perspective.

Map and Text

Independent map artifacts, excluding astronomical instruments, are the exceptions in the cartographic record of premodern Islamic civilization. Almost all the extant Islamic maps are integral parts of larger manuscript contexts. This prominence of the textual environment generates problems of interpretation for the student of Islamic cartographic representation.

On a technical level, the submergence of maps in texts means that their study is subject to all the difficulties associated with studying the latter. A substantial portion

2. An exhaustive review of the scholarship on the classical heritage of Islamic civilization is Felix Klein-Franke's *Die klassische Antike in der Tradition des Islam* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1980).

3. For a general and incisive statement of the problems associated with the study of the Greek scientific tradition within premodern Islamic civilization, see A. I. Sabra, "The Appropriation and Subsequent Naturalization of Greek Science in Medieval Islam: A Preliminary Statement," *History of Science* 25 (1987): 223–43.

of the textual legacy of premodern Islamic civilization is still preserved only in manuscript form in a great many public and private collections scattered throughout the world. Many of these collections are only partially and inadequately cataloged. The number of individual works that are transcribed or, much less often, critically edited and published, is disappointingly low. The researcher who compares these manuscript codices faces serious problems such as difficulty of access as well as intractable questions of authorship and copying. The student of maps faces additional problems. Often it is difficult to surmise where to search for maps, since they are found in many kinds of texts. Once located, maps present their own problems of dating, provenance, and draftsmanship, though never divorced from similar difficulties associated with the texts in which they are found.

The key question when exploring the map/text relationship, however, concerns the independence of the map artifact. In a cultural-historical account of maps in premodern Islamic civilization, it is crucial to determine how far the idea of the map was accepted as a basic form of human communication with identifiable social functions. Although the multiplicity of the Islamic maps studied in the following chapters clears all doubts about the communicative valence these maps carried within the Islamic sphere, the question whether culturally distinct cartographic traditions existed in premodern Islamic societies is more complex and elicits different responses from the contributors.

For those map artifacts that are found in texts, it seems safe to assume that they served a didactic or illustrative function subservient to the main textual narrative. Even in this context, however, graphic representation holds its own and cannot be explained away through textual comprehension. On a more general level, the Islamic cartographic heritage also harbors more independent strains, such as astronomical instruments (especially globes and astrolabes), maritime atlases, and freestanding world maps, demonstrating the existence of autonomous cartographic traditions within this cultural sphere. It is therefore helpful to view the relationship between text and image as a spectrum that extends from subservience of the image to the text at one end to its independence from textual control at the other.

The relationship of map and text is also intimately related to the question of map audience. The dominance of the textual environment suggests that most Islamic maps were directed toward the literate, cosmopolitan elites of premodern Islamic societies, who alone produced and used books. By and large maps were not available, nor were they meant, for the use of the illiterate majority. The existence of text-free map artifacts does not lead us to modify this conclusion, since these maps too were produced by elite groups such as astronomers and astrologers, sea captains, and political rulers for their own use. Nonetheless, we very rarely find hard historical evidence for the reception of maps in Islamic societies, and such relevant information is documented wherever possible in the following chapters.

The issue of the relative "cultural weight" of map artifacts in and outside textual settings is intrinsically related to that of the place images held within premodern Islamic cultures as a whole. Some scholarly attention has been paid to this latter subject, especially in the study of Islamic art history, where debate focuses on the permissibility of artistic representation of living beings under Islam.[4] There is indeed little doubt that early generations of Muslims developed an attitude toward the arts that excluded animate beings from the ambit of allowable images and that exercised the central formative influence on practically all the later Islamic artistic traditions. In itself, representational art is generally not relevant to maps in the Islamic context, but its status in the Islamic sphere should be kept in mind in undertaking a comparative perspective, since the general absence of decorative emblems in Islamic maps may appear anomalous when such maps are juxtaposed to European maps of the Middle Ages, the Renaissance, and later.

On a different level, one could ask whether "the rejection of a certain kind of imagery . . . carried with it considerable uncertainty about the value of visual symbols altogether."[5] This is an extremely complicated issue that is not directly addressed in the present volume. The historian of Islamic cartography is not on firm ground here, and at this preliminary stage of scholarly inquiry it is essential to resist preconceptions about premodern Muslims' universal iconophobia or profound ambivalence toward the use of graphic languages. However, it is clear that this broader issue of Islamic attitudes toward visual images should be considered in studying the history of Islamic cartography.

Conditions of Map Production

Throughout the length and breadth of the Islamic world, we are concerned with a manuscript culture.[6] Printing was not highly regarded, in spite of the arrival of block-printing techniques derived from China and even a short-lived attempt to print paper money at Tabriz in 693/1294.[7] Such techniques were not adopted for traditional

4. Oleg Grabar, *The Formation of Islamic Art*, rev. and enl. ed. (New Haven: Yale University Press, 1987), 72–98, with bibliography on p. 221. Also Rudi Paret, *Schriften zum Islam: Volksroman, Frauenfrage, Bilderverbot*, ed. Josef van Ess (Stuttgart: Kohlhammer, 1981).

5. Grabar, *Formation of Islamic Art*, 95 (note 4). For a thought-provoking essay on this topic, see Marshall G. S. Hodgson, "Islâm and Image," *History of Religions* 3 (1964): 220–60.

6. I thank David Woodward for his help in writing this section.

7. Thomas Francis Carter, *The Invention of Printing in China and*

Islamic cartography until the eighteenth century. The printing press, which so revolutionized the production and dissemination of knowledge in Europe, had a delayed and muted impact within Islamic culture.

There are accounts of large maps made especially for the delight and gratification of various Muslim rulers.[8] They were constructed of various materials and displayed at court to enhance the glory of the reign. The survival rate of such maps would have been low, but it is curious that not a single fragment has survived. Instead, much of the corpus of Islamic maps, especially for the pre-Ottoman period, comes down to us as illustrations to geographical works and historical annals. The maps we examine today—despite some evidence for independent artisans working outside court circles—were incorporated into imperially commissioned texts or intended for other individuals holding high office. As a result, map production in traditional Islamic cultures, as we are able to reconstruct it from the available evidence, is closely linked to the highly formalized art of illustrated manuscript texts. Even so, the physical aspects of Islamic maps have not been examined systematically or in depth as have the other products of illumination and painting.

Masters of the Islamic book arts included calligraphers, painters, illuminators, gilders, marginators, binders, and preparers of ink and paint, all of whom played an integral role in the stages of manuscript production. Maps, too, often resulted from such a division of labor among artisans, who were typically paid servants of the state working in ateliers within the palace precincts. Just like any other textual illustration, maps were drawn in spaces left in the text by the scribe. Paint was then applied, place-names were written in, and occasionally gilding and a decorative border were added. It is probable that maps constituted only a small part of the artisans' work. The relation between mapmaking and the art of the miniaturist is paralleled by the case of the instrument makers working in brass and other metals, whose astrolabes, one of the high art forms of Islamic culture, dissolved the barrier between artisan and scholar in a blend of mathematical ingenuity and stylistic harmony.

Cartographic style obviously reflects the aesthetic values of Islamic society. Calligraphy, considered directly linked to the Word of God, was its most highly valued art. The geometric structure and laws of proportion that determined the repertoire of Arabic scripts also guided graphic representation. In fact, the art of illuminating title pages, verse divisions, borders, and colophons had its origin in the ornamentation of script, and the work of Islamic miniature painters has sometimes been described as a "calligraphic art" because it suggests the smooth, rhythmic lines of Arabic characters.[9] It would be a mistake to judge the calligraphic qualities of Islamic maps by the principles of modern cartographic design. The maps of the Balkhī school, for example, could be criticized for oversimplified and stylized linework and detail and for their failure to indicate precise geographical positions. As with the medieval *mappaemundi* in the West, however, these maps must be judged in their aesthetic context and in relation to their historical purpose. The geometric simplicity of the Balkhī school style is strikingly original and no doubt fulfilled its intended mnemonic function.

Formal calligraphy annotating the maps (often in several languages) afforded greater opportunities for blending with the flowing style of the pen- or brushwork of the map detail itself, a harmony often continued in arabesque borders. Words in Arabic calligraphy could be stretched or contracted at will to fill the areas they referred to. Such a harmony between line and letter was not possible with the roman alphabet. These issues, and examination of other unusual stylistic aspects of Islamic maps, must await the attention of scholars who combine an interest in cartography with the necessary technical and linguistic skills.

Both paper and parchment were used for drawing maps. Papermaking was probably introduced to western Asia from China in the mid-eighth century A.D. From that time onward, at centers of the industry like Samarkand, Baghdad, and Damascus, Arabs monopolized papermaking in the West for several centuries.[10] The fine-quality paper used for illuminated manuscripts was highly prized and its distribution tightly controlled, though Italian sources later provided a cheaper and more accessible supply. The size of the maps was dictated by the size of the written page in the manuscript. A double-page spread on the normal-sized quarto manuscript would permit a map of approximately 80 × 40 cm. Parchment was not as highly valued a medium as paper, and the particular animal skins used for parchment are seldom specified. There are also references to a large map made of silver and another ninth-century "description of the world on Dubayqī cloth, unbleached but with dyes," neither of which has survived.

Paints and inks on maps also followed the tradition of manuscript illumination. Illustrations were sketched with a reed pen (*qalam*) in ink made from lampblack. The characteristically jewel-like, opaque colors were made from mineral pigments, with deep ultramarine (lapis

Its Spread Westward, 2d ed., rev. L. Carrington Goodrich (1925; New York: Ronald Press, 1955), 170–71.

8. See, for example, p. 95.

9. Norah M. Titley, *Persian Miniature Painting and Its Influence on the Art of Turkey and India: The British Library Collections* (London: British Library, 1983), 216–50, and Thomas W. Arnold, *Painting in Islam: A Study of the Place of Pictorial Art in Muslim Culture* (1928; reprinted New York: Dover, 1965), 3.

10. Damascus became a main source of supply to Europe; see Carter, *Invention of Printing in China*, 134–35 (note 7).

lazuli), vermilion (cinnabar), green (verdigris), silver, and gold predominating. There is no explicit reference to the adoption of color conventions for maps beyond those that had already been established in classical times, and frequently the selection of map colors follows that for other illustrations in the manuscript. Nevertheless, in the tenth century, al-Muqaddasī prescribed red for routes, yellow for sand, green for sea, blue for rivers, and brown for mountains. Existing copies of al-Idrīsī's *Nuzhat al-mushtāq* (dated from the fourteenth century onward) reflect a general compliance with these standards but at the same time show some originality in color selection. A similar mix of convention and independence characterized the design of cartographic signs on Islamic maps. In later periods the influence of European conventions is felt, and the maritime charts of the Ottoman navigators, for instance, clearly show the appropriation of standard signs from Italian charts.

Theory and Practice

A continuous reading of the chapters in this section will reveal striking gaps between theory and practice in the history of premodern Islamic cartography. Most noticeably, while great sophistication was reached in developing the mathematical and astronomical bases of celestial and geographical cartography, little or no attempt was made to translate the existing theoretical knowledge into cartographic practice. Though much effort was devoted to such issues as determining celestial and terrestrial coordinates, delineating alternative schemes of map projection, and accurately measuring the length of a degree of the earth's circumference, many mapmakers seem to have ignored the implications of such scholarly developments. In a similar vein, the geographical knowledge of Muslims as attested by the rich geographical literature preserved, especially in Arabic and Persian, was certainly impressive, but it was only rarely presented in graphic form. Again, cosmological thought is definitely not an underdeveloped part of premodern Islamic intellectual activity, though it did not find visual expression except in isolated cases.

To explain this puzzling array of circumstances, it is essential to delineate the true dimensions of the problem. On a general level, one might observe that the expectation that cartographic practice should accurately and fully reflect cartographic speculation is not well grounded in history. There is no reason theory and practice should go hand in hand. More specifically, it is crucial to note that theoretical sophistication, even where we retrospectively find it very relevant to cartographic practice, was not necessarily, or even primarily, directed toward producing maps. Thus, much of what can now be identified as the theoretical basis of cartographic practice was never seen in this light by Muslim astronomers, geographers, and cosmographers. They dealt with cartographic issues as natural parts of a wider intellectual curriculum valid for their time, not as parts of a unified cartographic discourse motivated by the aim of producing maps. From this perspective it is not so surprising that cartographic practice should have been largely incidental to rigorous investigation of the earth and the skies that went on in intellectual circles. In spite of such general explanations, the gap between theory and practice in Islamic cartography remains a puzzle, and specific information contained in the chapters that follow provides a solid basis for speculating on this subject.

Terms

Major premodern Islamic languages—Arabic, Persian, and Turkish—did not possess single words that uniquely and unequivocally denoted "map." Instead a number of words were used, sometimes simultaneously or in juxtaposition to each other, to refer to map artifacts. Most common among these were terms that derived from well-known Arabic roots: *ṣūrah* ("form, figure" from the root SWR, "to form, to shape"), *rasm/tarsīm* ("drawing, graph" from the root RSM, "to draw, to sketch"), and *naqsh/naqshah* ("painting" from the root NQSH, "to paint"). None of these terms solely denoted maps, and all were used broadly to signify any kind of visual representation. The absence of a specific map terminology in premodern Islamic languages, while suggesting a low level of map consciousness, should not be interpreted as a sign of the cognitive insignificance of maps in Islamic civilization. In the Islamic lands, as in the rest of the medieval world, the borders between what now appear to us to be different modes of visual representation were not rigidly drawn. It should not be surprising, therefore, that all modes of visual representation shared a common terminological stock. Standardization and specialization begin only with the modern period. Thus, recent and unequivocal is the term *kharīṭah* used in Turkish and Arabic, which is a loan word deriving from the Catalan *carta* through the Greek *kharti*.[11]

An important word in Islamic geographical texts is "climate." The Arabic word *iqlīm* (pl. *aqālīm*) came from the Greek κλιμα (literally, "inclination") in Ptolemy's work and bears the same meaning in Arabic texts as it does in Ptolemy.[12] However, at an early stage it assumed the meaning of a large division of the earth's surface, and from this there developed several other meanings. The

11. Henry Kahane, Renée Kahane, and Andreas Tietze, *The Lingua Franca in the Levant: Turkish Nautical Terms of Italian and Greek Origin* (Urbana: University of Illinois Press, 1958), 158–59 (term no. 177, "carta"), and 594–97 (term no. 875, χαρτί "kharti").

12. I thank Gerald Tibbetts for the information in this and the succeeding paragraph regarding terminology related to maps.

Persians had considered the world to be divided into seven regions, each containing a large empire. These regions, known as *kishvars*, were adopted by Muslim geographers, who renamed them *aqālīm*, presumably in a belief that the latter term was more Arabic. They may have noticed that the Greek κλιμα and the Persian *kishvar* were both seven in number. Yet a third meaning was given to the word by the Balkhī school authors, who equated it with the regions into which they divided the world for the purpose of convenient description. Thus al-Iṣṭakhrī and Ibn Ḥawqal both produce twenty *aqālīm* as opposed to other authors' seven. The word has since become a general word for region or province.

Islamic geographical texts also include words for measurement. Distance measurements are *dhirāʿ* (cubit), *mīl* (mile), *farsakh* (a parasang or league [three miles]), and *marḥalah* (a day's journey). Another word is *manzil* for a stage of a journey, that is, one day's travel. This also means a stage of the moon's journey, a lunar mansion. Al-Idrīsī used *majrā* for one day's sailing distance, but to Aḥmad ibn Mājid *majrā* was not a measurement. Distances at sea, according to him, were measured in *zāms* ("a watch," or three hours' sailing). André Miquel mentions several different *dhirāʿ*s, but he gives three thousand *dhirāʿ*s to the *mīl*, three *mīls* to the *farsakh*.[13] S. Maqbul Ahmad states that there are twenty-five to thirty *mīls* to the *marḥalah* and that one *majrā* is approximately one hundred *mīls* (see table 7.1, p. 160). Longitude and latitude are measured in degrees and minutes, *darajahs* and *daqīqahs*.

Historiography

Islamic geographical literature has been a generally neglected subject of study and cartography even more so, even though an abridged edition of al-Idrīsī's *Nuzhat al-mushtāq* in Arabic was printed in Italy as early as 1592.[14] The tables of longitude and latitude of Ulugh Beg and Naṣīr al-Dīn al-Ṭūsī (or the greater part of them) were published in 1652, and an edition of Abū al-Fidāʾ was issued in 1712.[15]

A translation of al-Idrīsī's text by Jaubert in 1840 first focused scholarly attention on the study of Islamic geography.[16] Its publication also marks the initial stage in the investigation of Islamic cartography, an interest that continued to develop with the editing and translation as well as the review, in survey studies, of other major geographical texts in Arabic by Wüstenfeld, Reinaud, Lelewel, and Sédillot.[17] More studies of Islamic geographical texts followed in the late nineteenth and early twentieth centuries by de Goeje and von Mžik,[18] while Nallino and von Mžik also contributed a number of more specialized analyses.[19] The attention given to cartography in these works was restricted to the study of mathematical geography, in the main a comparative scrutiny of tables

13. These words represented various lengths, depending on their use. André Miquel touches on their values in his *La géographie humaine du monde musulman jusqu'au milieu du 11ᵉ siècle*, vol. 2, *Géographie arabe et représentation du monde: La terre et l'étranger* (Paris: Mouton, 1975), 10–20, and they are given in some detail by Walther Hinz in the article "*Dhirāʿ*" in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 2:231–32. See also Walther Hinz, *Islamische Masse und Gewichte: Umgerechnet ins metrische System*, Handbuch der Orientalistik, ed. B. Spuler, suppl. vol. 1, no. 1 (Leiden: E. J. Brill, 1955).

14. For the early edition of al-Idrīsī, see *Kitāb nuzhat al-mushtāq fī dhikr al-amṣār wa-al-aqṭār wa-al-buldān wa-al-juzur wa-al-madāʾin wa-al-āfāq*, cataloged under the title *De geographia universali* (Rome: Typographia Medicea, 1592), later translated into Latin in *Geographia nubiensis*, ed. Gabriel Sionita and Joannes Hesronita (Paris: Typographia Hieronymi Blageart, 1619).

15. *Binae tabulae geographicae una Nassir Eddini Persae, altera Ulug Beigi Tatari*, ed. John Greaves (London: Typis Jacobi Flesher, 1652). This work was also published along with Abū al-Fidāʾ's description of the Arabian Peninsula in volume 3 of *Geographiae veteris scriptores graeci minores*, ed. John Hudson, 4 vols. (Oxford: Theatro Sheldoniano, 1698–1712).

16. *Géographie d'Edrisi*, 2 vols., trans. Pierre Amédée Emilien Probe Jaubert (Paris: Imprimerie Royale, 1836–40).

17. *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld (Leipzig: F. A. Brockhaus, 1866–73); *Géographie d'Aboulféda: Texte arabe*, ed. and trans. Joseph Toussaint Reinaud and William MacGuckin de Slane (Paris: Imprimerie Royale, 1840), and *Géographie d'Aboulféda: Traduite de l'arabe en français*, 2 vols. in 3 pts. (vol. 1, *Introduction générale à la géographie des Orientaux*, by Joseph Toussaint Reinaud; vol. 2, pt. 1, trans. Reinaud; vol. 2, pt. 2, trans. S. Stanislas Guyard) (Paris: Imprimerie Nationale, 1848–83); Joachim Lelewel, *Géographie du Moyen Age*, 4 vols. and epilogue (Brussels: J. Pilliet, 1852–57; reprinted Amsterdam: Meridian, 1966); Louis Amélie Sédillot, *Mémoire sur les systèmes géographiques des Grecs et Arabes* (Paris: Firmin Didot, 1842). A long introductory section to the first volume of Reinaud's *Géographie d'Aboulféda* provides a general chronological account of Islamic geographical writings that is still worth reading. The mathematics of geography are discussed, although little is said about actual examples of cartography. See also the work by Aloys Sprenger on post routes that contains an interesting introduction: *Die Post- und Reiserouten des Orients*, Abhandlungen der Deutschen Morgenländischen Gesellschaft, vol. 3, no. 3 (Leipzig: F. A. Brockhaus, 1864; reprinted Amsterdam: Meridian, 1962, 1971).

18. See Michael Jan de Goeje's series Bibliotheca Geographorum Arabicorum, 8 vols. (Leiden: E. J. Brill, 1870–94; reprinted 1967); *Das Kitāb ṣūrat al-arḍ des Abū Ğaʿfar Muḥammad ibn Mūsā al-Ḫuwārizmī*, ed. Hans von Mžik, Bibliothek Arabischer Historiker und Geographen, vol. 3 (Leipzig: Otto Harrassowitz, 1926); and *Das Kitāb ʿağāʾib al-akālīm as-sabʿa des Suhrāb*, ed. Hans von Mžik, Bibliothek Arabischer Historiker und Geographen, vol. 5 (Leipzig: Otto Harrassowitz, 1930).

19. Carlo Alfonso Nallino, "Al-Ḫuwârizmî e il suo rifacimento della Geografia di Tolomeo," *Atti della R. Accademia dei Lincei: Classe di Scienze Morali, Storiche e Filologiche*, 5th ser., 2 (1894), pt. 1 (Memorie), 3–53; idem, "Il valore metrico del grado di meridiano secondo i geografi arabi," *Cosmos* 11 (1892–93): 20–27, 50–63, 105–21 (both republished in *Raccolta di scritti editi e inediti*, 6 vols., ed. Maria Nallino [Rome: Istituto per l'Oriente, 1939–48], 5:458–532 and 5:408–57); Hans von Mžik, "Afrika nach der arabischen Bearbeitung der Γεωγραφικὴ ὑφήγησις des Claudius Ptolemaeus von Muḥammad ibn Mūsā al-Ḫwārizmī," *Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien: Philosophisch-Historische Klasse* 59 (1917), Abhandlung 4, i-xii, 1–67; idem, "Ptolemaeus und die Karten der arabischen Geographen," *Mitteilungen der Kaiserlich-Königlichen Geographischen Gesellschaft in Wien* 58 (1915): 152–76; and idem, "Osteu-

of geographical coordinates and, in the case of Lelewel and von Mžik in particular, reconstructing maps on the basis of these tables.[20]

The actual Islamic maps—except for the map of al-Maʾmūn, known only through references in other works—were neglected. Orientalists could find little scientific basis for them and so failed to take them seriously. Lelewel preferred to reconstruct maps from tables of coordinates, and his work typifies the resulting neglect of actual examples of Islamic cartography. Maps were considered at best to be useful sources for locating place-names or reconstructing the geography of earlier historical periods. Historians of European cartography, with no knowledge of the literary background of the maps, could make little sense of them, and they were moreover ill equipped to deal with the special problems related to Islamic manuscripts and script. Because of the scattered nature of the manuscripts, no real comparative research was carried out. The sources and date of the content of maps were often misleadingly related to the date and provenance of the manuscripts that contained them.

The publication in the 1920s of a major collection of Islamic maps and the beginning of another, larger compilation that included many examples from Islamic cartography marked the onset of a new phase in its study. Konrad Miller's *Mappae arabicae* still holds the distinction of being the largest anthology of Islamic maps ever published.[21] Miller himself was interested in identifying place-names, but many of his identifications are incorrect, often because of his transliterations of the original Arabic. Miller knew little of the geographical literature on which the maps depended and here as elsewhere his scholarship is in need of major revision. It is likely that his main contribution in the long run will be seen as his publication of an impressive collection of maps. Youssouf Kamal's *Monumenta cartographica Africae et Aegypti*, begun in 1926 and continued until 1951, was never intended as more than a chronological survey of references to Africa, beginning with classical antiquity.[22] Its chief merit for the study of Islamic cartography is its inclusion of a large number of Islamic maps side by side with contemporary European examples, which calls for and aids comparison. The works of Miller and Kamal remain as basic sources for the study of Islamic cartography.

The proliferation of articles and monographs relating to Islamic maps after 1950 makes it impractical to review them in detail here.[23] However, it is fair to state that even when the maps are the center of attention, the emphasis of most studies in this phase remains squarely geographical, and comparative cartographic research is still lacking. Rather than artifacts in their own right that reflect the cultural milieu in which they were produced, maps are treated at best as mere bearers of geographical and historical information—as in the predominant interest in place-names—and at worst as superfluous illustrations. Their unique characteristics, such as their frequent southerly orientation, are often left unnoted and unexplained. There is little attempt to relate individual maps to each other not in terms of genetic affinity (tracing the origin of maps is a fairly common concern of researchers) but in terms of structural similarity.

Significantly, major changes in the study of Islamic geographical texts occurred after the Second World War with the publication of the works of Krachkovskiy and Miquel. The first wrote a classical historical survey of Arabic geographical literature, and the second produced a seminal interpretive study that places early Islamic geographical literature in its wider cultural context.[24] We must also mention that numerous useful facsimiles of geographic works, many with maps, are currently being published by the Institut für Geschichte der Arabisch-Islamischen Wissenschaften in Frankfurt. The attainment of a higher level of sophistication in the study of geographical texts bodes well for the future of research on Islamic terrestrial cartography, which continues to be an integral part of the former. It is no accident that the first—

ropa nach der arabischen Bearbeitung der Γεωγραφικὴ ὑφήγησις des Klaudios Ptolemaios von Muḥammad ibn Mūsā al-Ḫuwārizmī," *Wiener Zeitschrift für die Kunde des Morgenlandes* 43 (1936): 161–93.

20. These maps have occasionally been reproduced and sometimes identified as Islamic maps, which of course they are not—it must not be imagined that Muslims of the Middle Ages saw anything like these European reconstructions. Nevertheless, scholars continue to work on this legitimate area of research; see, for instance, Hubert Daunicht, *Der Osten nach der Erdkarte al-Ḫuwārizmīs: Beiträge zur historischen Geographie und Geschichte Asiens*, 4 vols. in 5 (Bonn: Selbstverlag der Orientalischen Seminars der Universität, 1968–70), and Reinhard Wieber, *Nordwesteuropa nach der arabischen Bearbeitung der Ptolemäischen Geographie von Muḥammad B. Mūsā al-Ḫwārizmī*, Beiträge zur Sprach- und Kulturgeschichte des Orients, vol. 23 (Walldorf [Hessen]: Verlag für Orientkunde Vorndran, 1974).

21. Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31).

22. Youssouf Kamal, *Monumenta cartographica Africae et Aegypti*, 5 vols. in 16 pts. (Cairo, 1926–51), facsimile reprint, 6 vols., ed. Fuat Sezgin (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987).

23. Among these works should be noted *Ḥudūd al-ʿālam: "The Regions of the World,"* ed. and trans. Vladimir Minorsky (London: Luzac, 1937; reprinted Karachi: Indus, 1980); Ahmed Zeki Velidi Togan, ed., *Bīrūnī's Picture of the World*, Memoirs of the Archaeological Survey of India, no. 53 (Delhi, 1941); J. H. Kramers, "Djughrāfiyā," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), suppl. 61–73; and idem, "Geography and Commerce," in *The Legacy of Islam*, 1st ed., ed. Thomas Arnold and Alfred Guillaume (Oxford: Oxford University Press, 1931), 78–107.

24. Ignatiy Iulianovich Krachkovskiy, *Izbrannye sochineniya*, vol. 4, *Arabskaya geograficheskaya literatura* (Moscow, 1957), translated into Arabic by Ṣalāḥ al-Dīn ʿUthmān Hāshim, *Taʾrīkh al-adab al-jughrāfī al-ʿArabī*, 2 vols. (Cairo, 1963–65), and André Miquel, *La géographie humaine du monde musulman jusqu'au milieu du 11ᵉ siècle*, 4 vols. to date (Paris: Mouton, 1967-).

and until this work the only—essay dealing with a large corpus of Islamic maps, the article "Kharīṭa" in the new edition of *The Encyclopaedia of Islam*, was written by S. Maqbul Ahmad, the same scholar who prepared the much longer article on geography for that encyclopedia.[25]

Despite such developments, it is clear that adequate understanding of Islamic maps will not be possible without the contributions of researchers from other fields, in particular art historians. The publication of the present volume should bring the known specimens of Islamic cartography to the attention of a much broader circle of scholars than has hitherto been possible and should generate further research.

25. S. Maqbul Ahmad, "Kharīṭa" and "Djughrāfiya," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960-), 4:1077–83 and 2:575–87, respectively. Another recent summary of geographical and navigational literature can be found in M. J. L. Young, J. D. Latham, and R. B. Serjeant, eds., *Religion, Learning and Science in the ʿAbbasid Period* (Cambridge: Cambridge University Press, 1990), chap. 17.

APPENDIX 1.1
WORKS OF PTOLEMY IN ARABIC

ALMAGEST = KITĀB AL-MAJISṬĪ (OR *AL-MIJISṬĪ*)[a]

1 An early Syriac version (lost)
2 A version by al-Ḥasan ibn Quraysh made at the request of al-Maʾmūn (r. 198–218/813–33) (lost)
3 Another version made for al-Maʾmūn by al-Ḥajjāj ibn Maṭar al-Ḥāsib and Sarjūn ibn Hilīyā al-Rūmī, completed in 212/827–28 (extant)
4 A version made for the vizier Abū al-Ṣaqr Ismāʿīl ibn Bulbul by Isḥāq ibn Ḥunayn, completed 266–77/879–90 (lost)
5 A revision of Isḥāq ibn Ḥunayn's translation by Thābit ibn Qurrah (d. 288/901) (lost)

HANDY TABLES = KITĀB AL-QĀNŪN FĪ ʿILM AL-NUJŪM WA-ḤISĀBIHĀ WA-QISMAT AJZĀʾIHĀ WA-TAʿDĪLIHĀ (THEON'S REVISED VERSION)

1 A version by ʿAyyūb and Simʿān ibn Sayyār al-Kābulī made for Muḥammad ibn Khālid ibn Yaḥyā bin Barmak, ca. 200/815–16 (lost)[b]

PLANETARY HYPOTHESES = KITĀB AL-IQTIṢĀṢ OR *KITĀB AL-MANSHŪRĀT*

1 Anonymous version corrected by Thābit ibn Qurrah (extant)[c]

TETRABIBLOS = KITĀB AL-ARBAʿAH[d]

1 A version by Abū Yaḥyā al-Biṭrīq, perhaps made during the reign of al-Manṣūr (136–58/754–75)
2 A version by Ibrāhīm al-Ṣalt, apparently made ca. 200/815–16
3 A revision of Ibrāhīm al-Ṣalt's version by Ḥunayn ibn Isḥāq

GEOGRAPHY = KITĀB JAGHRĀFĪYAH FĪ AL-MAʿMŪR WA-ṢIFAT AL-ARḌ

1 A version made either by or for Abū Yūsuf Yaʿqūb ibn Isḥāq al-Kindī (d. ca. 260/874) (lost)[e]
2 A version that was either translated or simply corrected by Ibn Khurradādhbih, probably completed between 232/846–47 and 272/885–86 (lost)[f]
3 A version by Thābit ibn Qurrah (d. 288/901) (lost)[g]

[a]The following list of the different translations of the *Almagest* into Syriac and Arabic reflects the findings of Paul Kunitzsch as recorded in his recent study *Der Almagest: Die Syntaxis Mathematica des Claudius Ptolemäus in arabisch-lateinischer Überlieferung* (Wiesbaden: Otto Harrassowitz, 1974), esp. 15–82. This work is reviewed by G. J. Toomer, "Ptolemaic Astronomy in Islam," *Journal for the History of Astronomy* 8 (1977): 204–10, where a similar list of translations is given. For somewhat different views on this issue as well as complete listings of the extant manuscripts, see Fuat Sezgin, *Geschichte des arabischen Schrifttums*, vol. 6, *Astronomie bis ca. 430 H.* (Leiden: E. J. Brill, 1978), 88–94.

[b]Sezgin, *Geschichte des arabischen Schrifttums*, 6:95–96 (note a).

[c]B. R. Goldstein, "The Arabic Version of Ptolemy's Planetary Hypotheses," *Transactions of the American Philosophical Society*, n.s., 57, pt. 4 (1967): 3–55, and Sezgin, *Geschichte des arabischen Schrifttums*, 6:94–95 (note a).

[d]All three versions listed below are recorded in Fuat Sezgin, *Geschichte des arabischen Schrifttums*, vol. 7, *Astrologie—Meteorologie und Verwandtes bis ca. 430 H.* (Leiden: E. J. Brill, 1979), 42–44. It is not clear which of these three translations are preserved in the extant manuscripts listed by Sezgin on p. 43.

[e]Muḥammad ibn Isḥāq ibn al-Nadīm (d. ca. 385/995), *Fihrist*; see *Kitâb al-Fihrist*, 2 vols., ed. Gustav Flügel (Leipzig: F. C. W. Vogel, 1871–72), 1:268, English translation, *The Fihrist of al-Nadīm: A Tenth-Century Survey of Muslim Culture*, 2 vols., ed. and trans. Bayard Dodge (New York: Columbia University Press, 1970), 2:640, and Jamāl al-Dīn Abū al-Ḥasan ʿAlī bin Yūsuf al-Qifṭī (568–646/1172–1248), *Taʾrīkh al-ḥukamāʾ*; see *Ibn al-Qifṭī's Taʾrīḫ al-ḥukamāʾ*, ed. Julius Lippert (Leipzig: Dieterich'sche Verlagsbuchhandlung, 1903), 98. There is confusion in the sources about whether the translation was made *for* al-Kindī or *by* al-Kindī himself. It should be observed in this connection that al-Kindī most probably "did not know Greek well enough to translate directly from that language": Jean Jolivet and Roshdi Rashed, "al-Kindī," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 15:261–67, esp. 261. This lends some credibility to von Mžik's view that al-Kindī probably did no more than "correct" an Arabic translation that was carried out for him; see Hans von Mžik, "Afrika nach der arabischen Bearbeitung der Γεωγραφικὴ ὑφήγησις des Claudius Ptolemaeus von Muḥammad ibn Mūsā al-Ḫwārizmī," *Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien: Philosophisch-Historische Klasse* 59 (1917), Abhandlung 4, i–xii, 1–67, esp. 5 n. 2.

[f]Abū al-Qāsim ʿUbayd Allāh ibn ʿAbdallāh ibn Khurradādhbih, *al-Masālik wa-al-mamālik*; see the edition by Michael Jan de Goeje, *Kitâb al-Masâlik waʾl-mamâlik (Liber viarum et regnorum)*, Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted, 1967), Arabic text, 3, French text, 1. The interpretation of the relevant passage in the *Kitāb al-masālik wa-al-mamālik* is problematic, though it seems plausible to agree with T. Nöldeke's reading, according to which Ibn Khurradādhbih simply corrected the Arabic of a translation

he had someone else make for him; see the report of Nöldeke's view in von Mžik, "Afrika," 5 n. 2 (note e), based on a private letter of Nöldeke to von Mžik dated 28 April 1915. The dating of the translation in question follows Michael Jan de Goeje's dates for the two different recensions of the *Kitāb al-masālik wa-al-mamālik*.

[g]Ibn al-Nadīm, *Fihrist*; see Flügel's edition, 1:268, or Dodge's edition, 2:640 (note e). This version of Thābit ibn Qurrah might have been accompanied by a world map originally constructed by Qurrah ibn Qamīṭā, see p. 96.

Among references by later Muslim writers to Arabic translations of the *Geography*, the earliest and the most detailed is one by al-Masʿūdī (d. 345/956): "And all these seas [of the world] were drawn in the *Book of Geography* [of Ptolemy] in different sizes and shapes with various kinds of paint," *Murūj al-dhahab wa-maʿādin al-jawhar*, edited and translated as *Les prairies d'or*, 9 vols., trans. C. Barbier de Meynard and Pavet de Courteille, Société Asiatique, Collection d'Ouvrages Orientaux (Paris: Imprimerie Impériale, 1861–77), 1:183–85; rev. ed. under the supervision of Charles Pellat, 7 vols., Qism al-Dirāsāt al-Taʾrīkhīyah, no. 10 (Beirut: Manshūrāt al-Jāmiʿah al-Lubnānīyah 1965–79), 1:101–2 (author's translation). A much later translation from the Greek, carried out by George Amirutzes of Trebizond for the Ottoman sultan Meḥmed II, ca. 869–70/1465, was not included in this table; see p. 210.

2 · Celestial Mapping

Emilie Savage-Smith

The beginning of Islamic celestial mapping can be seen in the central Islamic lands of greater Syria and Iraq, where indigenous Bedouin ideas played a role. Celestial mapping, like many other aspects of Islamic secular culture, drew in its early days upon the techniques and concepts current (though often in a languishing state) in the Roman, Byzantine, and Persian provinces that were its immediate neighbors and over which the emerging Islamic state soon gained dominion. From both written documents and surviving artifacts we can trace, at least partially, a transmigration of ideas and techniques both west and east within the rapidly expanding Islamic empire.

The ideas and techniques associated with celestial mapping were nurtured by Muslims and non-Muslims alike. Though stimulated by the practical needs of religious ritual, their development tended to be unaffected by belief or dogma, except where celestial mapping intruded upon cosmological visualization of the universe. Political and economic changes within an area, as well as aesthetic fashion, had substantial effects on celestial mapping, as on most other aspects of society, since the training and patronage of artisans reflected shifting circumstances. Islam itself provided a particularly encouraging environment for those interested in mapping the heavens. A number of verses in the Qurʾān advocate the use of stars, sun, and moon for reckoning and navigation, as in Qurʾān 6:97: "It is He who has appointed for you the stars, that you might be guided by them in the darkness of the land and sea." The employment of a lunar calendar and the need to convert neighboring calendrical systems into their own lunar one, which began with the Hijrah of Muḥammad in A.D. 622, required knowledge of basic celestial phenomena. Even more conducive to promoting an understanding of the skies was the need to calculate prayer times, for these were based on unequal or seasonal hours, in which the time between sunrise and sunset was divided into twelve equal parts that changed every day.

Beginning in the seventeenth century we can observe a few instances when early modern European ideas on celestial mapping are introduced into the Islamic world. Yet in spite of these points of contact, the concepts and techniques of Islamic celestial mapping remained essentially medieval well into the nineteenth century, particularly in Turkey, Persia, and Mughal India. The reason has not been adequately explored by social historians.

Early Syrian Origins

An eighth-century palace in the Syrian Desert provides the earliest evidence of celestial mapping in Islamic culture. Built possibly between 92 and 97 (711–15), this provincial palace, known as Quṣayr ʿAmrah, was constructed in a remote area about fifty kilometers east of the north end of the Dead Sea, probably by the Umayyad caliph al-Walīd I, who ruled from 86–96/705–15.[1]

The Syriac-speaking community in the region appears to have had considerable interest in stereographic projection of the skies, as witnessed by the activities of Severus Sebokht (d. A.D. 666–67). Severus Sebokht was the bishop of Qinnasrīn, an ancient town that held an important position in the defense system of Syrian fortresses from Antioch to the Euphrates River and was about a day's journey from Aleppo. He not only wrote in Syriac a treatise on constellations, but he composed, also in Syriac, a treatise on the astrolabe compiled from Greek sources.[2]

1. Later dates for the building of the palace, ranging from A.D. 723 to A.D. 742, have also been suggested, primarily based on an inscription referring to an emir or a prince rather than a caliph. It was possibly built by the rather libertine al-Walīd II, who lived in the area of Quṣayr ʿAmrah before his brief rule in A.D. 743–44; see Richard Ettinghausen, *Arab Painting* ([Geneva]: Editions d'Art Albert Skira, 1962; New York: Rizzoli, 1977), 33, and Richard Ettinghausen and Oleg Grabar, *The Art and Architecture of Islam: 650–1250* (Harmondsworth: Penguin Books, 1987), 63.

2. F. Nau, "Le traité sur les 'constellations' écrit, en 661, par Sévère Sébokt évêque de Qennesrin," *Revue de l'Orient Chrétien* 27 (1929/30): 327–38; this treatise displays a familiarity with both Ptolemy and Aratus. Both the Syriac text and a French translation of the astrolabe treatise are given by F. Nau, "Le traité sur l'astrolabe plan de Sévère Sabokt, écrit au VIIᵉ siècle d'après des sources grecques, et publié pour la première fois d'après un ms. de Berlin," *Journal Asiatique*, 9th ser., 13 (1899): 56–101 and 238–303. The French translation was rendered into English, with the introduction of some errors, and printed in Robert T. Gunther, *The Astrolabes of the World*, vol. 1, *The Eastern Astrolabes* (Oxford: Oxford University Press, 1932), 82–103. A new critical edition with German translation is being prepared by E. Reich of Munich.

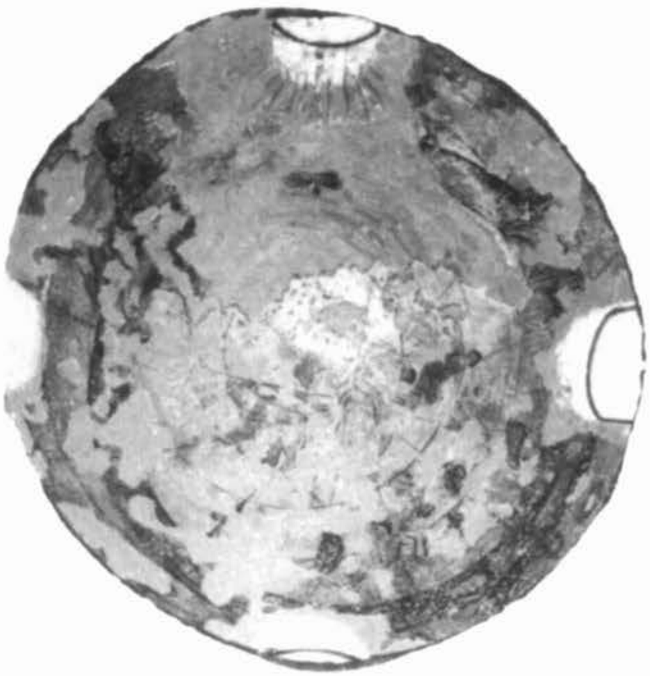


FIG. 2.1. THE REMAINS OF THE VAULT OF THE HEAVENS. Painted on a domed ceiling in the provincial palace of Quṣayr ʿAmrah built in the early eighth century A.D., the design is that which would be seen looking down on a globe.
Size of the original: not known. Photograph courtesy of Oleg Grabar.

The palace of Quṣayr ʿAmrah contains rooms covered with closely packed paintings, frescoes, and mosaics in such a chaotic mixture of themes that an observer of the recently cleaned and restored palace can only conclude that it was built as a private and personal art gallery.[3] Among the rooms is a bath consisting of three rooms: one tunnel vaulted, one cross vaulted, and the third covered by a dome. The dome of this *calidarium* was decorated to resemble the vault of the heavens, reflecting a well-established tradition of decorating cupolas with heavenly images—a custom that can be traced back to the early days of the Roman Empire. This domed ceiling at Quṣayr ʿAmrah is the oldest preserved astronomical dome of heaven (fig. 2.1).[4]

The view of the skies as represented by the painter of this fresco is not as it would appear to an observer on earth, for it displays a larger portion of the sky than could be seen at any one time from one location. The northern and zodiacal constellations recognized in antiquity are represented, along with a number of the southern ones, while the northern celestial pole is indicated directly overhead. The sequence and positioning of the constellations are painted as you would see them when looking down on a celestial globe rather than up into the sky.

It is evident from the general design that the fresco painter was copying onto the domed ceiling a type of planispheric map of the heavens that can be found in a number of Latin and Byzantine manuscripts.[5] Unfortunately, all copies of these planispheric maps preserved today were drawn after the palace of Quṣayr ʿAmrah was constructed. They are, however, clearly copies of much earlier Western planispheric maps.

One such map from a fifteenth-century Greek manuscript is illustrated in figure 2.2, while figure 2.3 demonstrates the method of polar stereographic projection used in producing the map. The map displays the heavens from the north equatorial pole to about 35° south of the equator. The innermost circle represents an ever-visible circle, marking out the area of the sky that was never seen to set for a latitude of about 36° north, roughly that of Rhodes. Proceeding outward, the next three concentric circles represent the Tropic of Cancer, the celestial equator, and the Tropic of Capricorn, with the outside circle delimiting an area approximately 10° south of the Tropic of Capricorn. The equinoctial and solstitial colures are indicated by straight lines at right angles to one another. In an eccentric broad band, the zodiacal constellations are placed in a counterclockwise sequence, in keeping with this diagram's being a polar stereographic projection of a celestial globe rather than a projection of the skies as seen from earth.

Comparing this Byzantine planispheric map with the Quṣayr ʿAmrah dome in figure 2.1 will immediately establish the similarity. Though the fresco in the Syrian dome has been damaged over the years, it is evident that it too represents a stereographic projection from the south ecliptic pole of a celestial globe, showing the skies to about 35° south declination. The iconography of most of the constellations is classical or early medieval (West-

3. See Ettinghausen and Grabar, *Art and Architecture*, 59–65 (note 1).

4. Fritz Saxl, "The Zodiac of Quṣayr ʿAmra," trans. Ruth Wind, in *Early Muslim Architecture*, vol. 1, *Umayyads, A.D. 622–750*, by K. A. C. Creswell, 2d ed. (Oxford: Clarendon Press, 1969), pt. 2, 424–31 and pls. 75a–d and 76a–b; Martin Almagro et al., *Qusayr ʿAmra: Residencia y baños omeyas en el desierto de Jordania* (Madrid: Instituto Hispano-Arabe de Cultura, 1975), esp. pl. XLVIII. For the tradition of decorating cupolas with heavenly and astronomical images, see Karl Lehmann, "The Dome of Heaven," *Art Bulletin* 27 (1945): 1–27.

5. Arthur Beer, in his astronomical interpretation of the fresco, overlooks its relation to the early medieval planispheric maps; Arthur Beer, "The Astronomical Significance of the Zodiac of Quṣayr ʿAmra," in *Early Muslim Architecture*, vol. 1, *Umayyads, A.D. 622–750*, by K. A. C. Creswell, 2d ed. (Oxford: Clarendon Press, 1969), pt. 2, 432–40. That the model the painter used was a planispheric map of the heavens produced by stereographic projection was first suggested by Francis R. Maddison, *Hugo Helt and the Rojas Astrolabe Projection*, Agrupamento de Estudos de Cartografia Antiga, Secção de Coimbra, vol. 12 (Coimbra: Junta de Investigações do Ultramar, 1966), 8 n. 9. Comparing the dome with maps made by the projection of a globe rather than of the skies resolves most of the problems arising in the interpretation of the fresco. See also Emilie Savage-Smith, *Islamicate Celestial Globes: Their History, Construction, and Use* (Washington, D.C.: Smithsonian Institution Press, 1985), 16–17, 300 n. 82.

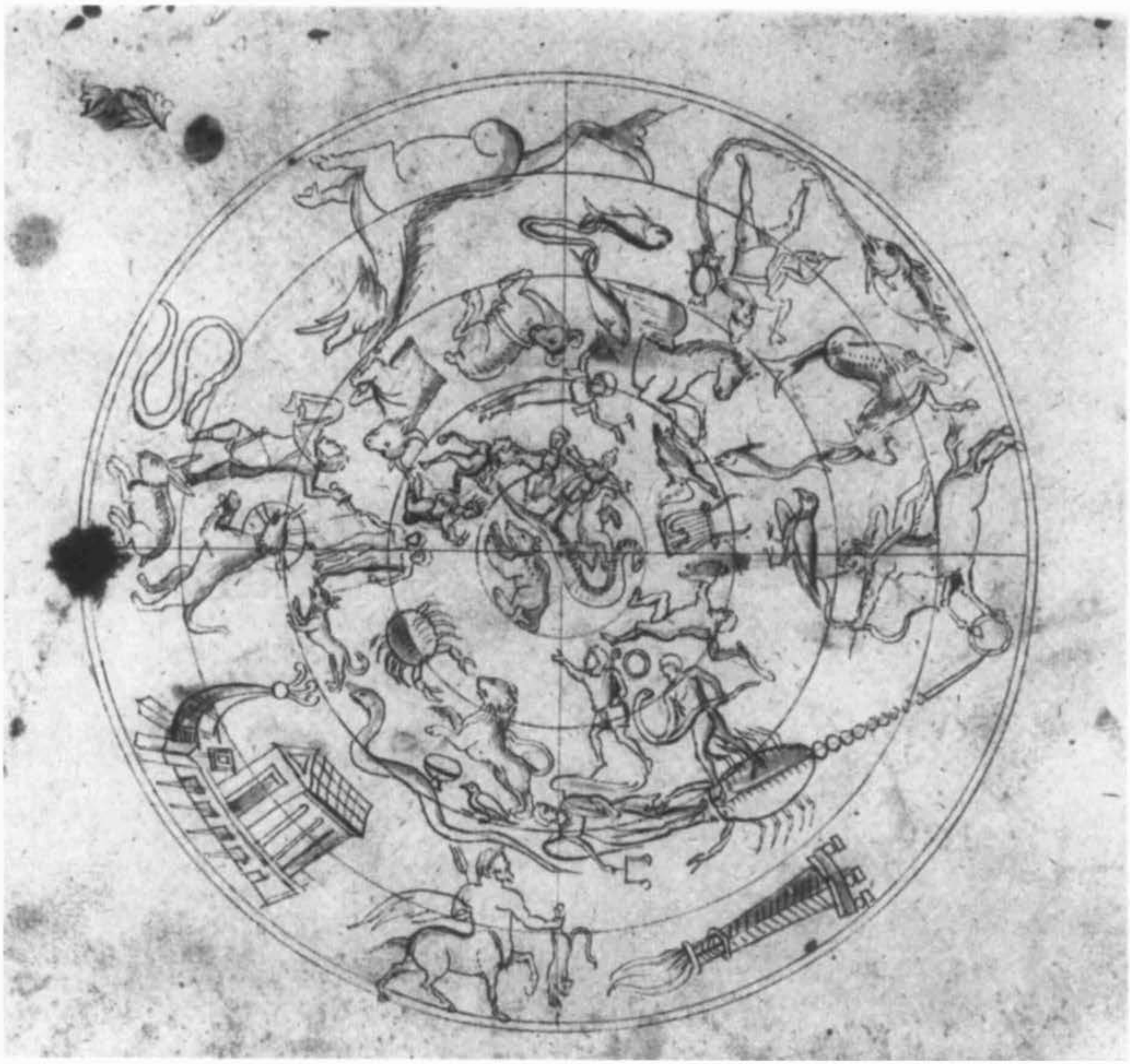


FIG. 2.2. PLANISPHERIC MAP OF THE HEAVENS FROM A FIFTEENTH-CENTURY BYZANTINE MANUSCRIPT. The solstitial colure runs horizontally through the center of the map.

Size of the original: not known. By permission of the Biblioteca Apostolica Vaticana, Rome (Vat. Gr. 1087, fol. 310v).

ern) rather than Islamic and is remarkably similar to that of the Byzantine manuscript. The counterclockwise orientation is the same, and in neither the Byzantine planispheric map nor the Syrian dome are the stars themselves shown.

The Islamic fresco has some features, however, not found on the Byzantine planispheric map. Six great circles, one of which is the solstitial colure, pass through the ecliptic poles and divide the ecliptic into twelve parts, though little more than the northern semicircles of each great circle is actually shown on the dome. These are called ecliptic latitude-measuring circles in this chapter, a term used here to designate certain circles employed in medieval Islamic celestial mapping for which there is no generally accepted modern European term.[6]

6. The phrase means circles drawn at right angles to the ecliptic, along which the celestial latitude may be measured. They are not to be found on any of the few Greco-Roman artifacts or maps, but they are ubiquitous features of later Islamic celestial globes (see, for example, several of the globes illustrated below). Though equator-based and horizon-based systems of coordinates were known in medieval Islam, the ecliptic-based system of coordinates dominated celestial carto-

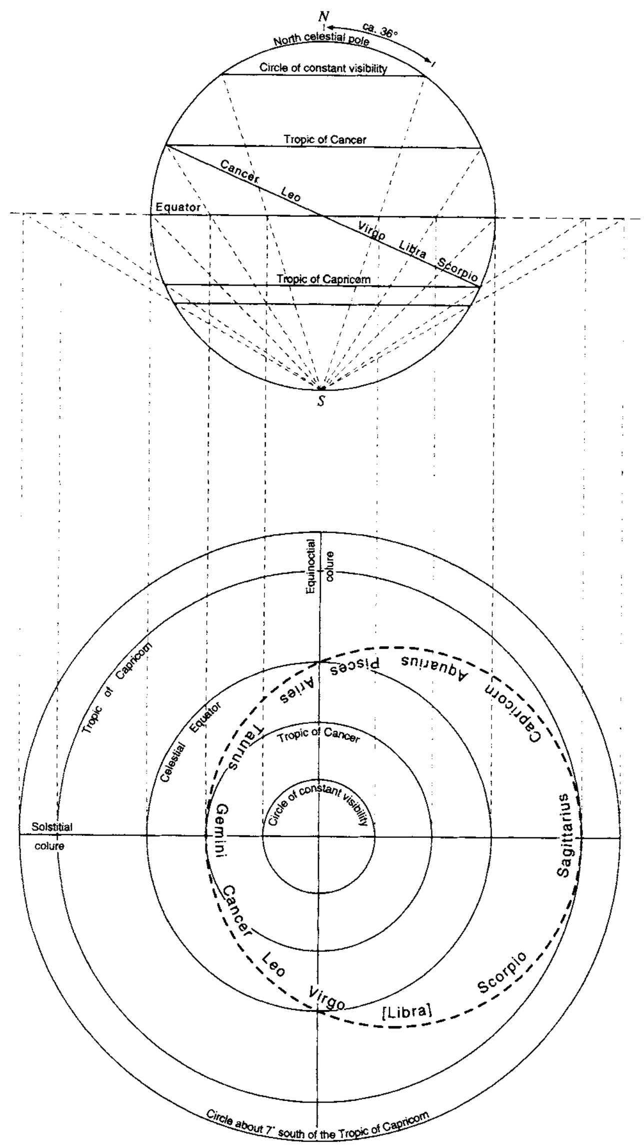


FIG. 2.3. THE BYZANTINE PLANISPHERIC MAP ANALYZED AS A STEREOGRAPHIC PROJECTION FROM THE SOUTH POLE OF A CELESTIAL GLOBE.

At the palace of Quṣayr ʿAmrah, of the six prominent concentric circles painted in dark brown on the ceiling with the equatorial pole as the center, the smallest is the polar circle passing through the ecliptic pole (where the ecliptic latitude-measuring circles intersect) about 23½° distant. This polar circle is a common feature of extant Islamic celestial globes, although it is not found in Hellenistic, Roman, or Byzantine sources. The other dark circles represent the northern tropic, the equator, and the southern tropic, with one circle spaced midway between the southern tropic and the equator and one positioned at one-third the distance between the polar circle and the northern tropic. Three additional concentric circles—one inside the northern tropic and two between the northern tropic and the equator—are very pale and appear to have been preliminary attempts at spacing that were later painted over. In rendering such a planispheric map onto the ceiling of a dome, the painter crowded some of the areas too tightly and failed to have the band of the ecliptic pass through the northern solstitial point. The artist was no doubt constrained by the four windows in the dome and furthermore may not have fully understood the model.

In painting this early Syrian domed ceiling, the unknown artist, as we have seen, was continuing a well-established pre-Islamic tradition of celestial mapping. The Byzantine planispheric map illustrated in figure 2.2 occurs in a Greek commentary on an astronomical and meteorological poem written by the Greek poet Aratus of Soli (ca. 315–240 B.C.).[7] Such illustrations accompa-

graphy, no doubt reflecting the ecliptic coordinates used in the first century A.D. in Ptolemy's star catalog, which formed the basis of all subsequent star catalogs. In Arabic such a circle at right angles to the ecliptic was called "the circle of latitude" (*dāʾirat al-ʿarḍ*), but this nomenclature is inappropriate and confusing in this context, since a "circle of latitude" by modern convention means a circle parallel to the equator and having a uniform latitude. If the medieval system were equator based, the modern term "circle of longitude" might be appropriate, for circles of longitude are circles perpendicular to the equator passing through the celestial poles. But because medieval celestial mapping employed the ecliptic as the frame of reference and the basic circles along which the celestial latitude was measured were at right angles to the ecliptic, none of the modern terms, including meridian, are suitable. In this chapter, therefore, this special term "ecliptic latitude-measuring circle" is used for those circles at right angles to the ecliptic, and the term "meridian" is used only to mean circles at right angles to the celestial equator. The representation of the solstitial colure is, of course, at right angles to both the ecliptic and the equator and thus is an ecliptic latitude-measuring circle as well as a meridian. See Savage-Smith, *Islamicate Celestial Globes*, 62–63 and esp. 305 n. 5 (note 5), where the term employed for these circles is "ecliptic latitude circles." Meridian, in the present chapter, is used in a slightly broader sense than the more technical and restrictive definition as a great circle on the celestial sphere passing through the celestial (equatorial) poles and the zenith of the observer.

7. A similar planispheric map, elegantly painted but crudely composed, is to be found in a fifteenth-century Italian manuscript made in Naples for Ferdinand II and his court; Rome, Biblioteca Apostolica Vaticana, MS. Barb. Lat. 76, fol. 3r. A small illustration of the map is given in John E. Murdoch, *Album of Science: Antiquity and the Middle Ages* (New York: Charles Scribner's Sons, 1984), 247, no. 223, and in Johanna Zick-Nissen, "Figuren auf mittelalterlich-orientalischen Keramikschalen und die 'Sphaera Barbarica,' " *Archaeologische Mitteilungen aus Iran*, n. s., 8 (1975): 217–40 and pls. 43–54, esp. pl. 52.1. Similar planispheric maps with counterclockwise rotation are to be found in a tenth-century *Aratea* (Berlin, Staatsbibliothek, Cod. Phillippicus 1830, fols. 11v–12r) reproduced by a drawing in Georg Thiele, *Antike Himmelsbilder mit Forschungen zu Hipparchos, Aratos und seinen Fortsetzern und Beiträgen zur Kunstgeschichte des Sternhimmels* (Berlin: Weidmannsche Buchhandlung, 1898), 164; in a Carolingian copy of an *Aratea*, not particularly well drawn (Basel, Öffentliche Bibliothek der Universität, Cod. Basilensi A.N. 18, p. 1), reproduced in Zick-Nissen, "Figuren auf mittelalterlich-orientalischen Keramikschalen," pl. 52.3; and in a twelfth-century Spanish manuscript in Osma cathedral reproduced in color by Gérard de Champeaux and Dom Sébastien Sterckx,

nying copies of the *Aratea* (the name given to all the translations and adaptations of the poem by Aratus) usually consisted of forty-one classical constellations and the Pleiades and frequently included either a diagram illustrating the configurations of the planets for a specific date or a planispheric map of the heavens.[8] The earliest completely preserved planispheric map of the heavens produced by stereographic projection is a diagram in a Carolingian copy of such an Aratean manuscript, one copied in A.D. 818 (fig. 2.4). In this vividly colored version the orientation of the constellations is as it would be seen in the sky, which is to say that the zodiacal constellations are drawn in a clockwise sequence, rather than counterclockwise as is found on the previously mentioned planispheric maps and on the dome roof at Quṣayr ʿAmrah. Moreover, the Milky Way is indicated by a second eccentric circle, and neither of the colures is shown.[9]

Although the fresco at Quṣayr ʿAmrah predates the Carolingian map by a century, it seems certain at this point that the extant Western manuscripts of planispheric celestial maps produced by stereographic projections represent a much older, continuous tradition of mapping that reached Syria by the early eighth century along a route at present unknown.

There are many accounts of the importing of Byzantine artisans into the capital, Damascus, by al-Walīd I for the construction of the great Umayyad mosque in the early eighth century,[10] and the ceiling at Quṣayr ʿAmrah tends to confirm such reports. An established pre-Islamic model was clearly being employed by the painter of this astronomical fresco. The dome's dependence on a planispheric map similar to that illustrated in figure 2.2 extends even to its repeating the identical, but incorrect, placement of Hercules after the serpent charmer Ophiuchus rather than face to face in front of him. The classical Greco-Roman iconography found in Aratean manuscripts is evident in most of the constellations at Quṣayr ʿAmrah. An example is the nude form of Serpentarius (Ophiuchus), who is turned partially away from the observer, with both feet firmly planted on Scorpio below and holding a thin snake whose head is toward Ophiuchus.[11] Orion maintains the shepherd's crook and animal skin over his left shoulder that later Islamic artists were to transform into a club and a long sleeve. The figures' headgear and clothing display no identifiable Islamic features. Libra is not represented on the dome, just as it was omitted on the planispheric maps and the individual constellation figures found in Aratean manuscripts. Libra was not distinguished by an iconography distinct from that of Scorpio until after the time of Ptolemy.[12] Consequently, work that reflects a pre-Ptolemaic conception of the skies, such as the Aratean treatises and the dome at Quṣayr ʿAmrah, which apparently is derived from them, would also omit Libra. A few features on the ceiling foreshadow later Islamic mapping, such as the polar circle and the ecliptic latitude-measuring circles, as well as the drawing of the constellation Cepheus as a kneeling or walking man with hands uplifted rather than the classical standing form with outstretched arms.

Introduction au monde des symboles (Saint-Léger-Vauban: Zodiaque, 1966), 66. A later version illustrating an astronomical treatise by Giovanni Cinico was drawn in Naples in 1469 (New York, Pierpont Morgan Library manuscript) and is reproduced in color by George Sergeant Snyder, *Maps of the Heavens* (New York: Abbeville Press, 1984), pl. 5.

8. See Ranee Katzenstein and Emilie Savage-Smith, *The Leiden Aratea: Ancient Constellations in a Medieval Manuscript* (Malibu, Calif.: J. Paul Getty Museum, 1988); Bruce Stansfield Eastwood, "Origins and Contents of the Leiden Planetary Configuration (MS. Voss. Q. 79, fol. 93v), an Artistic Astronomical Schema of the Early Middle Ages," *Viator: Medieval and Renaissance Studies* 14 (1983): 1–40 and 9 pls.; C. L. Verkerk, "*Aratea*: A Review of the Literature concerning MS. Vossianus Lat. Q. 79 in Leiden University Library," *Journal of Medieval History* 6 (1980): 245–87; and Anton von Euw, *Aratea: Himmelsbilder von der Antike bis zur Neuzeit*, exhibition catalog (Zurich: Galerie "le Point," Schweizerische Kreditanstalt [SKA], 1988).

9. For an analysis of this map from the standpoint of stereographic projection, see John D. North, "Monasticism and the First Mechanical Clocks," in *The Study of Time II*, Proceedings of the Second Conference of the International Society for the Study of Time, Lake Yamanaka—Japan, ed. J. T. Fraser and N. Lawrence (New York: Springer-Verlag, 1975), 381–98, esp. 386–87 and fig. 1; reprinted in John D. North, *Stars, Minds and Fate: Essays in Ancient and Medieval Cosmology* (London: Hambledon Press, 1989), 171–86, esp. 179–80 and fig. 6. Other very similar planispheric maps, with a clockwise sequence and with the Milky Way shown, occur in a ninth-century copy of Cicero's version of the *Aratea* (London, British Library, MS. Harley 647, fol. 21v) and in two tenth-century *Aratea* manuscripts (Boulogne-sur-Mer, Bibliothèque Municipale, MS. 188, fol. 26v, and Bern, Burgerbibliothek, MS. 88, vol. 11v). The last is illustrated by Zick-Nissen, "Figuren auf mittelalterlich-orientalischen Keramikschalen," pl. 52.2 (note 7), and also by Verkerk, "*Aratea*: A Review of the Literature," fig. 9(b) (note 8). The first two are illustrated in the *Encyclopedia of World Art*, 16 vols., ed. Massimo Pallottino (New York: McGraw-Hill, 1957–83), vol. 2, pl. 21.

10. Ettinghausen and Grabar, *Art and Architecture*, 42 (note 1).

11. Compare these with the separate drawings of Ophiuchus (Serpentarius) in the *Aratea* manuscripts illustrated in Katzenstein and Savage-Smith, *Leiden Aratea*, 20–21 (note 8), and in Verkerk, "*Aratea*: A Review of the Literature," 271 (note 8). For a color plate showing in detail the constellation Ophiuchus on the ceiling of Quṣayr ʿAmrah after the recent cleaning and restoration, see Almagro et al., *Qusayr ʿAmra*, pl. XLVIII (note 4). For further comparisons, see Saxl, "Zodiac of Quṣayr ʿAmra" (note 4), and Zick-Nissen, "Figuren auf mittelalterlich-orientalischen Keramikschalen" (note 7).

12. The assertion made by Willy Hartner that Aries and Taurus are combined into one constellation like Libra-Scorpio is unfounded. There is adequate space for both Aries and Taurus, though the ceiling is badly damaged in this area and only a trace of Taurus is visible today. Moreover, neither Mars nor any other planet is represented on this ceiling. See Willy Hartner, "Qusayr ʿAmra, Farnesina, Luther, Hesiod: Some Supplementary Notes to A. Beer's Contribution," in *Vistas in Astronomy*, vol. 9, *New Aspects in the History and Philosophy of Astronomy*, ed. Arthur Beer (Oxford: Pergamon Press, 1967), 225–28; reprinted in Willy Hartner, *Oriens-Occidens: Ausgewählte Schriften zur Wissenschafts- und Kulturgeschichte*, 2 vols. (Hildesheim: Georg Olms, 1968 and 1984), 2:288–91.

FIG. 2.4. A PLANISPHERIC MAP OF THE HEAVENS IN A LATIN COPY OF THE *ARATEA* DATED A.D. 818. Size of the original: 31.2 × 24 cm. By permission of the Bayerische Staatsbibliothek, Munich (Clm. 210, fol. 113v).

The influence that illustrations associated with copies of the *Aratea* had on the delineation of constellations in the Islamic world has received little consideration by historians. The original Greek poem by Aratus was translated into Arabic early in the ninth century A.D. and was used in a universal history titled *Kitāb al-ʿunwān* (The book of models) written in 330/941–42 by Agapius (or Maḥbūb), who lived in Manbij, a Syrian town northeast of Aleppo.[13] It is not known whether the copy of Aratus's poem that was translated into Arabic was illustrated, and consequently it is difficult to determine its impact on Islamic constellation iconography. The texts of the Latin and vernacular adaptations apparently remained unknown in the Near East. The dome at Quṣayr ʿAmrah, however, is evidence that at least one of the illustrations

13. Ernst Honigmann, "The Arabic Translation of Aratus' Phaenomena," *Isis* 41 (1950): 30–31.

that came to be part of later copies of the *Aratea* was known in Syria in the early eighth century. This astronomical ceiling, painted in the early days of Islamic dominion over Syria, may have been the work of an itinerant Byzantine fresco painter who slavishly copied manuscript illustrations. The dome may also be testimony to the survival of techniques of stereographic projection in the provinces of the Roman and Byzantine empires before the earliest extant astrolabes and before the translation of Greek astronomical texts into Arabic. The omission of the circle of constant visibility and the addition of the polar circle and the ecliptic latitude-measuring circles (characteristics of later Islamic celestial globes) encourage this hypothesis.

Planispheric Astrolabes as Celestial Maps

Despite the large number of medieval Islamic manuscripts preserved today, it is notable that none of them contain planispheric maps of the sky. It is only through instrument design and production that we find any further evidence for planispheric celestial mapping in the Islamic world before the nineteenth century.

The conventional astrolabe consists of a pierced planispheric star map placed over a projection of the celestial coordinate system as it relates to the observer's locality. The result is a representation of the positions of the fixed stars with respect to the local horizon. In other words, a planispheric astrolabe is a two-dimensional model of the heavens. The word astrolabe comes from the Arabic *aṣṭurlāb* or *asṭurlāb,* which was a transliteration of the Greek ἀστρολάβος or ἀστρολάβον ὄργανον, a term applied to a variety of astronomical instruments.[14] When the Arabic word was used without an adjective, it referred to the planispheric astrolabe, though in Arabic writings the planispheric astrolabe could be additionally specified by the adjective *saṭḥī* or *musaṭṭaḥ*, meaning "flat."

The method of producing this planispheric celestial map employs the same principle as that used in the Latin and Byzantine maps of the heavens mentioned earlier—that is, stereographic projection from a pole of a celestial globe onto the plane of the equator. The result is a mirror-image map of the skies, with east to the left and west to the right. Since a large portion of the southern skies was unmapped and the primary use was in the northern latitudes, the South Pole was commonly taken as the center of projection. In theory the North Pole could be used as well, but in practice it was very rarely employed in the Islamic world.

The top plate of an astrolabe, which is an openwork star map, was in Arabic called *ʿankabūt*, meaning "spider," for which reason it was later in Latin termed *aranea*, also meaning "spider." In Latin, however, it was also called *rete*, "net," and it is this term that is commonly used today. An astrolabe from the late ninth century is illustrated in figure 2.5, and a more elaborate example from a seventeenth-century workshop in northwestern India is illustrated in figure 2.6, with its constituent parts. In figure 2.7 the stereographic projection producing the basic features of the rete is illustrated. Note that the sequence of the zodiacal houses is counterclockwise, since it is a projection of the celestial sphere or globe. The rete represents the stereographic projection of an area of the celestial sphere extending from the north celestial pole to the Tropic of Capricorn, with a number of delicate pointers indicating certain designated stars. Although the positioning of the circles on the rete is relatively simple, the determination of the boundary points between the zodiacal houses is more complicated. For example, to find the zodiacal boundary points, the maker needed to determine the point of intersection of the equator with a great circle on the sphere passing through the celestial poles and the zodiacal boundary point. Once the corresponding point on the projection of the equator was located, a line could be drawn connecting it to the polar center of the projection. Where this radius crossed the projected ecliptic determined the zodiacal boundary line, as illustrated in figure 2.7. On the rete illustrated in figure 2.6*a* and diagrammatically interpreted in figure 2.8, the ecliptic has been divided by this manner (see also table 2.1). On less well-made astrolabes, the zodiacal boundary lines are sometimes approximated by using rays intersecting the ecliptic that emanate from the polar center of projection at thirty-degree intervals.[15] The unequal spacing of the zodiacal boundary lines between the northern and southern halves of the ecliptic motivated some makers to design retes of a totally different shape that would render the two halves of the ecliptic symmetrical, and several treatises consider such designs.[16]

On every rete a select number of stars are named and indicated by the tips of brass pointers. The number and selection of stars varied among makers, though the stars of greatest magnitude visible at northern latitudes were

14. King provides a detailed discussion of medieval explanations of the term astrolabe in David A. King, "The Origin of the Astrolabe according to the Medieval Islamic Sources," *Journal for the History of Arabic Science* 5 (1981): 43–83; reprinted as item III in David A. King, *Islamic Astronomical Instruments* (London: Variorum Reprints, 1987).

15. Sharon Gibbs with George Saliba, *Planispheric Astrolabes from the National Museum of American History* (Washington, D.C.: Smithsonian Institution Press, 1984), 220–22. Emmanuel Poulle, "La fabrication des astrolabes au Moyen Age," *Techniques et Civilisations* 4 (1955): 117–28, describes five alternative ways of determining the zodiacal boundaries.

16. See David A. King, "Astronomical Instrumentation in the Medieval Near East," in David A. King, *Islamic Astronomical Instruments* (London: Variorum Reprints, 1987), item I, 1–21, esp. 5 and pls. 3 and 4.

generally included. There are fifty-three stars on the astrolabe illustrated in figure 2.6*a*, which was made in 1060/1650 in Lahore (in modern Pakistan) by a prolific astrolabe maker belonging to a four-generation family of

FIG. 2.5. PLANISPHERIC ASTROLABE MADE IN THE LATE NINTH CENTURY A.D. BY KHAFĪF, THE APPRENTICE OF ʿALĪ IBN ʿĪSĀ. An inscription on the front states that it was made for Aḥmad al-munajjim al-Sinjārī (Aḥmad the astronomer of Sinjār). It is known that ʿAlī ibn ʿĪsā, the master astrolabe maker, at the orders of the caliph al-Maʾmūn, took part in an expedition to the plain of Sinjār, which lies between the Tigris and Euphrates rivers, in order to measure a degree of latitude (see pp. 178–81).
Diameter of the original: 11.3 cm. Museum of the History of Science, Billmeir Collection, Oxford (inv. no. 57-84/155). By permission of the Bettman Archive, New York.

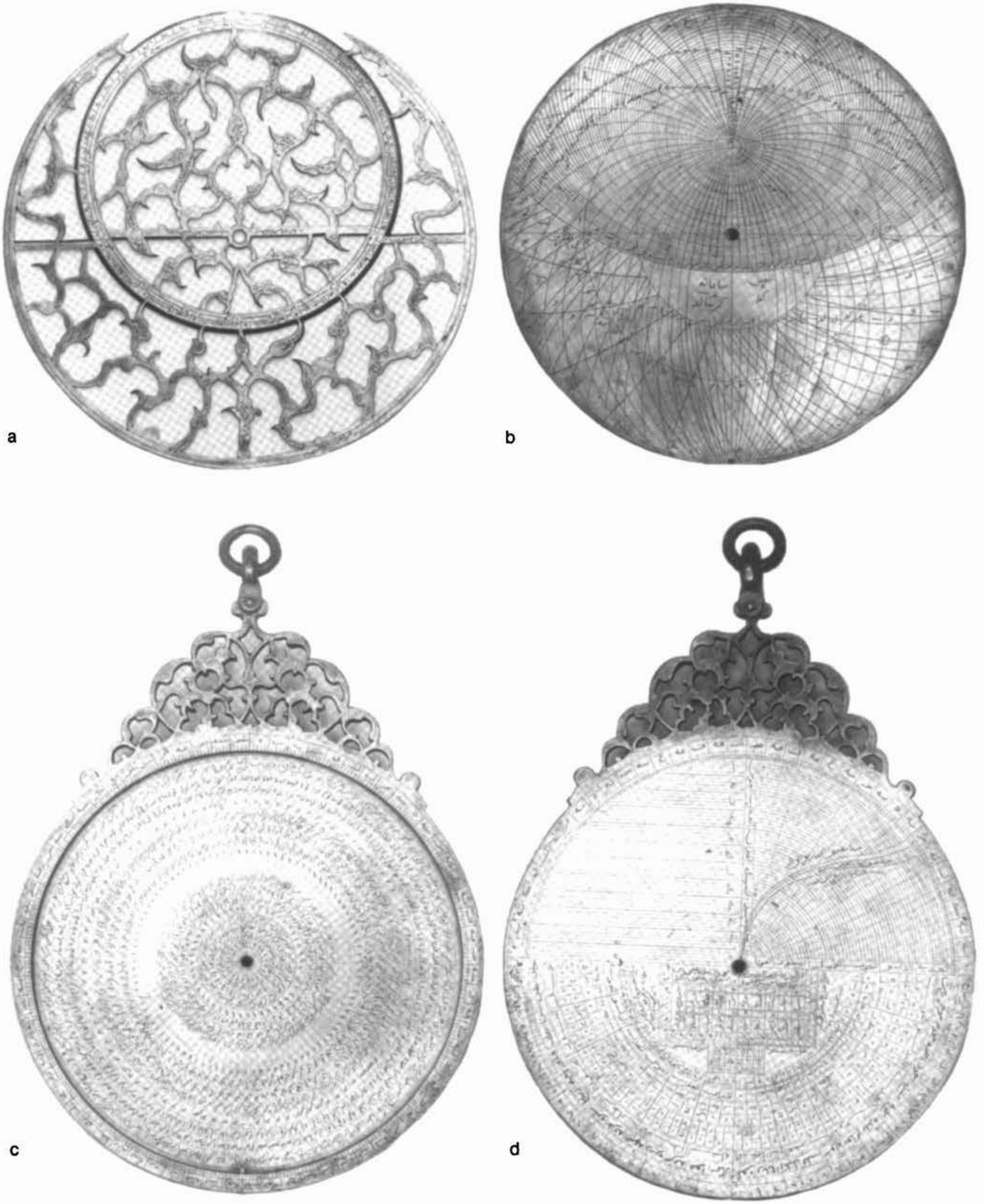


FIG. 2.6. AN ASTROLABE MADE IN 1060/1650 BY ḌIYĀ' AL-DĪN MUḤAMMAD. Made in Lahore, in modern Pakistan, the parts of this astrolabe are: (*a*) rete; (*b*) plate for latitude 29°N; (*c*) mater or base; (*d*) back of the astrolabe.

Diameter of the original: 31.4 cm. By permission of the Brooklyn Museum, Department of Asian Art, New York (acc. no. X638.2).

instrument makers.[17] The astrolabe illustrated in figure 2.5, probably made in Baghdad in the ninth century A.D., displays much simpler tracery supporting only seventeen star pointers. Because the rete of an astrolabe also has the equator shown on it, it will become outdated owing to the precession of the equinoxes. The usable life of such an instrument was the better part of a century.

This open star map in the form of a metal rete was then placed over a plate designed for a specific geographic latitude (see fig. 2.6*b*). Each plate—*ṣafīḥah* in Arabic or *tympanum* in Latin—was also produced by polar stereographic projection, thus having the north celestial pole at the center with the Tropic of Cancer and equator as concentric circles and the outside edge marking the Tropic of Capricorn. Over these circles there were then drawn three different sets of circles, or parts of circles. The basic design of a plate is shown in figure 2.9. There are almucantars,[18] which are stereographic projections of circles of equal altitude above and parallel to the horizon. There are also stereographic projections of lines of equal azimuth, which are arcs of circles running from the zenith to the horizon. Usually only the portions above the horizon are shown, but on later products, as in figure 2.6*b*, some arcs extend below the horizon. Finally, there are the stereographic projections of lines of unequal hours, which, for clarity, are usually shown on the plate only below the horizon.[19] Timekeeping and the calls to prayers were determined by unequal or seasonal hours, in which the period of daylight and the period of darkness were each divided into twelve hours. As a result, only at the equinoxes would the length of a daylight hour be equal to an hour at night.

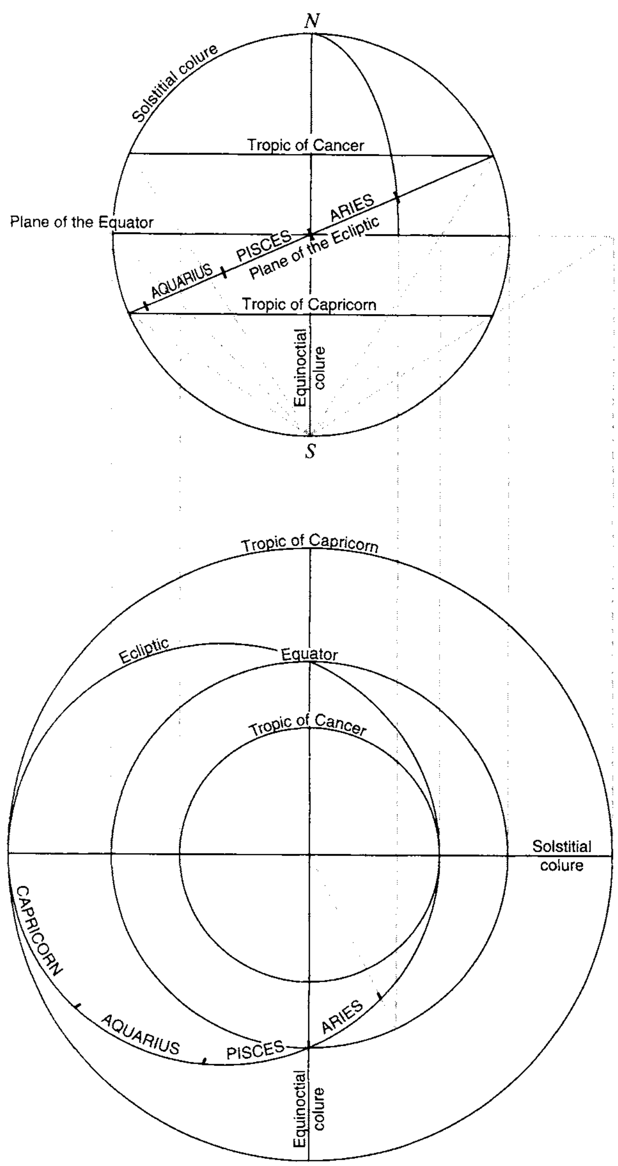


FIG. 2.7. POLAR STEREOGRAPHIC PROJECTION OF THE BASIC FEATURES OF AN ASTROLABE RETE.

The plate with the rete on top (and usually plates underneath for other latitudes not being used at the moment) was then placed in the recessed front of the body of the astrolabe. The recessed area in the base (see fig. 2.6*c*) was called in Arabic ***umm***, "mother," and in Latin ***mater***, the name still commonly used for it. It was often engraved with a gazetteer, giving different localities and their geographic longitudes and latitudes, along with the length of the longest day or the distance to Mecca

17. The rete on an astrolabe made by the same maker in 1073/1662–63 is analyzed by Owen Gingerich, "Astronomical Scrapbook: An Astrolabe from Lahore," *Sky and Telescope* 63 (1982): 358–60; see also Gunther, *Astrolabes of the World*, 1:191–200 and 1:208–10 (note 2), and Gibbs with Saliba, *Planispheric Astrolabes*, 132–34 (note 15). For further information on this workshop of instrument makers, see Savage-Smith, *Islamicate Celestial Globes*, 34–43 (note 5). For astrolabe stars in general, see Paul Kunitzsch, "The Astrolabe Stars of al-Ṣūfī," in *Astrolabica*, no. 5, *Etudes 1987–1989*, ed. Anthony John Turner (Paris: Institut du Monde Arabe/Société Internationale de l'Astrolabe, 1989), 7–14.

18. From the Arabic *al-muqanṭarah*. For Arabic nomenclature, see Paul Kunitzsch, "Remarks regarding the Terminology of the Astrolabe," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 1 (1984): 55–60; idem, "Observations on the Arabic Reception of the Astrolabe," *Archives Internationales d'Histoire des Sciences* 31 (1981): 243–52; and Willy Hartner, "Asṭurlāb," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 1:722–28; reprinted in Willy Hartner, *Oriens-Occidens: Ausgewählte Schriften zur Wissenschafts- und Kulturgeschichte*, 2 vols. (Hildesheim: Georg Olms, 1968 and 1984), 1:312–18.

19. For illustrations of the stereographic projection of almucantars, lines of equal azimuth, and lines of unequal hours, see John D. North, "The Astrolabe," *Scientific American* 230, no. 1 (1974): 96–106; reprinted in his *Stars, Minds and Fate: Essays in Ancient and Medieval Cosmology* (London: Hambleton Press, 1989), 211–20. Other useful discussions of the design and construction of astrolabes are Henri Michel, *Traité de l'astrolabe* (Paris: Gauthier-Villars, 1947); *The Planispheric Astrolabe* (Greenwich: National Maritime Museum, 1976; amended 1979); and Anthony John Turner, *Astrolabes, Astrolabe Related Instruments*, Time Museum, vol. 1 (Time Measuring Instruments), pt. 1 (Rockford, Ill.: Time Museum, 1985), 1–9.

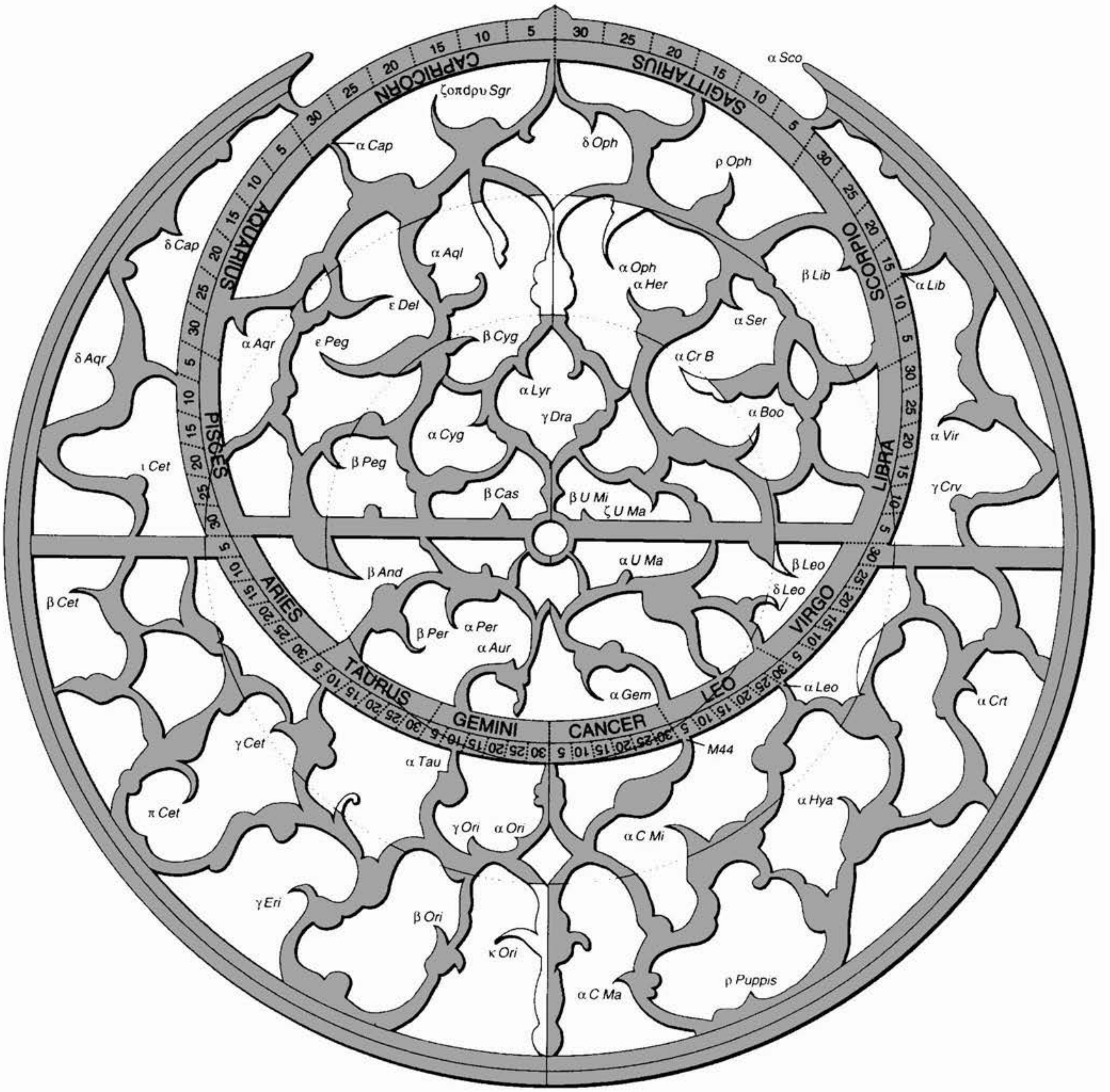


FIG. 2.8. THE STARS ON THE ASTROLABE RETE MADE IN LAHORE BY ḌIYĀ' AL-DĪN MUḤAMMAD IN THE YEAR 1060/1650. A diagram of the rete with each pointer given modern star identifications. See figure 2.6*a* and table 2.1.

TABLE 2.1 Stars on the Astrolabe Made by Ḍiyā' al-Dīn Muḥammad

Modern Identification	Arabic Name	English Translation
β Ceti (Deneb Kaitos)	Dhanab al-qīṭus al-janūbī	The southern tail of the sea monster Cetus
β Andromedae (Mirach)	Baṭn al-ḥūt	The belly of the fish
γ Ceti	Fam al-qīṭus	The mouth of the sea monster Cetus
π Ceti	Ṣadr al-qīṭus	The breast of the sea monster Cetus
β Persei (Algol)	Ra's al-ghūl	The head of the ghoul
α Persei (Algenib)	Mirfaq al-thurayyā	The elbow of *al-thurayyā*
γ Eridani	Masāfat al-nahr	The length of the river
α Tauri (Aldebaran)	ʿAyn al-thawr	The eye of the bull
α Aurigae (Capella)	ʿAyyūq	(Untranslatable)
β Orionis (Rigel)	Rijl al-jawzā' al-yusrà	The left foot of *al-jawzā'*
γ Orionis (Belletrix)	Yad al-jawzā' al-yusrà	The left hand of *al-jawzā'*
α Orionis (Betelgeuse)	Yad al-jawzā' al-yumnà	The right hand of *al-jawzā'*
κ Orionis (Saiph)	Rijl al-jawzā' al-yumnà	The right foot of *al-jawzā'*
α Canis Majoris (Sirius)	Shiʿrà yamānīyah	[The] southern *shiʿrà*
α Geminorum (Castor)	Ra's al-taw'am al-muqaddam	The head of the foremost twin
α Canis Minoris (Procyon)	Shiʿrà shāmīyah	The northern *shiʿrà*
ρ Puppis	Ṭarfat al-safīnah	The extremity of the ship
M44 in Cancer (Praesepe)	Maʿlaf	Manger
α Hydrae (Alphard)	Fard al-shujāʿ	The isolated one of the serpent
α Leonis (Regulus)	Qalb al-asad	The heart of the lion
α Ursae Majoris (Dubhe)	Ẓahr al-dubb al-akhbar	The brighter of the two calves
α Crateris	Qāʿidat al-bāṭīyah	The base of the bowl
δ Leonis (Zosma)	Ẓahr al-asad	The back of the lion
β Leonis (Denebola)	Ṣarfah	Change of weather
β Ursae Minoris (Kochab)	Anwār al-farqadayn	The brighter of the two calves
ζ Ursae Majoris (Mizar)	ʿAnāq	The goat
γ Corvi (Gienah)	Janāḥ al-ghurāb	The wing of the raven
α Virginis (Spica)	Simāk aʿzal	[The] unarmed *simāk*
α Bootis (Arcturus)	[Al-] simāk al-rāmiḥ	The armed *simāk*
$\alpha^{1,2}$ Librae (Zubenelgenubi)	Kiffah janūbī	[The] southern plate [of the balance]
β Librae	Kiffah shamālī	[The] northern plate [of the balance]
α Coronae Borealis (Alphecca)	Nayyir al-fakkah	The luminous one of *al-fakkah*
α Serpentis (Unuk)	ʿUnq al-ḥayyah	The neck of the serpent
α Scorpii (Antares)	Qalb al-ʿaqrab	The heart of the scorpion
ρ Ophiuchi	Rijl al-ḥawwā al-yamīnī al-muqaddam	The forward, right foot of the serpent charmer
α Herculis (Rasalgethi)	Ra's al-jāthī	The head of the kneeling one
α Ophiuchi (Rasalhague)	Ra's al-ḥawwà	The head of the serpent charmer
γ Draconis	ʿAyn al-tinnīn	The eye of the dragon
δ Ophiuchi	Yad al-ḥawwà al-yumnà al-muqaddam	The forward, right hand of the serpent charmer
α Lyrae (Vega)	Nasr wāqiʿ	A falling eagle
ξ^2οπdρυ Sagittarii	ʿIṣābat al-rāmī	The headband of the archer
β Cygni (Albireo)	Minqār al-dajājah	The bird's beak
α Aquilae (Altair)	[Al-]nasr al-ṭā'ir	The flying eagle
α Capricorni	Qarn al-jadī al-thānī	The second horn of the goat
ε Delphini	Dhanab al-dulfīn	The dolphin's tail
α Cygni (Deneb)	Dhanab al-dajājah	The tail of the bird
ε Pegasi (Enif)	Fam al-faras	The mouth of the horse
δ Capricorni (Deneb Algedi)	Dhanab al-jadī	The tail of the goat
α Aquarii	Mankib sākib al-mā'	The shoulder of the water pourer
δ Aquarii	Sāq sākib al-mā' al-janūbī	The southern leg of the water pourer
ι Ceti	Dhanab al-qīṭus shamālī	The northern tail of the sea monster Cetus
β Pegasi (Scheat)	Mankib al-faras	The shoulder of the horse
β Cassiopeiae (Caph)	[Al-]kaff al-khaḍīb	The dyed hand

Note: This astrolabe was made in Lahore in 1060/1650. The stars are listed in order of increasing celestial longitude beginning at the first house of the zodiac.

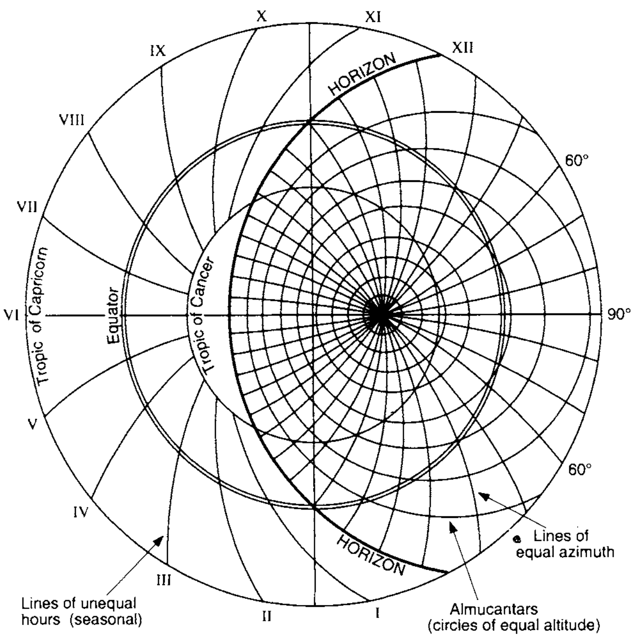


FIG. 2.9. BASIC DESIGN OF AN ASTROLABE PLATE. Since the projected curves depend on the latitude of the observer, separate plates are required for different geographic latitudes.

and angular measurements necessary for orientation toward Mecca.[20]

A pin passed through the rete and plate(s) and the body of the astrolabe and also, on the back of the device, through a rotating flat ruler with sighting holes. The pin itself was secured on top of the rete by a wedge inserted through a hole near the end of the pin, as can be seen in figures 2.5 and 2.14. The rotation of the fretted star map over the plate on the front of the astrolabe assembly represented the daily rotation of the celestial sphere relative to an observer at that particular geographic latitude and during an interval of about fifty to seventy-five years after the construction of the instrument.

On the back of the astrolabe assembly there were any number of scales and charts providing a variety of information (see fig. 2.6*d*). There could be shadow squares, calendar scales, and astrological charts, but there nearly always was a scale of degrees around the edge for use in angular measurement of altitudes. The rotating sighting device, called an alidade, from the Arabic *al-ʿiḍādah*, "rule," could be used, when the assembly was properly suspended, to find the position of the sun within the zodiac by adjusting the alidade so that a ray of light passed through the two smaller holes in its sights. The altitude of celestial bodies could be ascertained by sighting the star or planet through the two large holes. When used in conjunction with the rotating celestial map (rete) on the front of the device, the alidade could be used to tell time, day or night, as long as the sun or some star marked on the rete was visible. Similarly, the astrolabe could be used to calculate the geographic latitude, to determine information needed in casting horoscopes, and to undertake a host of other useful calculations.[21]

Over the centuries and in different regions, considerable variation occurred in the patterning of the retes, the design of the suspensory device, and the nature of the charts and grids placed on the back. This variation is evident both in the treatises written on astrolabe construction and in the legions of astrolabes preserved today. The basic nature, however, remained the same throughout the many centuries of their production—an instrument used to make simple observations and an analog computing device used to solve a variety of problems concerning the movement of the sun and stars.

EARLY HISTORY OF THE ASTROLABE

The precise origins of the astrolabe are obscure. What appears certain is that it was a Greek invention. Theon of Alexandria in the fourth century A.D. wrote on the astrolabe, for his treatise was subsequently used in the sixth century A.D. by Johannes Philoponus, also of Alexandria, who composed in Greek the earliest extant treatise we have on the subject.[22]

The method of stereographic projection used in constructing planispheric astrolabes was described in the second century A.D. by Ptolemy in a treatise now lost in the original Greek but preserved in a Latin translation titled *Planisphaerium*, made by Hermann of Carinthia in Tou-

20. Some of the gazetteers on astrolabes have been studied by Gibbs with Saliba, *Planispheric Astrolabes*, 190–206 (note 15), and by Gunther, *Astrolabes of the World*, vol. 1, passim (note 2), and a few astrolabes were surveyed by Edward S. Kennedy and Mary Helen Kennedy, *Geographical Coordinates of Localities from Islamic Sources* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987). See also the discussion of geographical tables in chapter 4, on the early development of terrestrial cartography in Islam, and for a fuller discussion of the methods of orientation toward Mecca, see chapter 9 on qibla charts, qibla maps, and related instruments.

21. For its numerous applications, see Edward S. Kennedy and Marcel Destombes, "Introduction to *Kitāb al-ʿamal biʾl-asṭurlāb*," English introduction to the Arabic text of ʿAbd al-Raḥmān ibn ʿUmar al-Ṣūfī's astrolabe treatise (Hyderabad: Osmania Oriental Publications, 1966); reprinted in Kennedy's *Studies in the Islamic Exact Sciences*, ed. David A. King and Mary Helen Kennedy (Beirut: American University of Beirut, 1983), 405–47, and Ibn al-Samḥ, *El "Kitāb al-ʿamal bi-l-asṭurlāb" (Llibre de l'us de l'astrolabi) d'Ibn Samḥ*, ed. Mereè Viladrich i Grau, Institut d'Estudis Catalans, Memòries de la Secciá Històrica-Arqueològica 36 (Barcelona: Institut d'Estudis Catalans, 1986).

22. The English translation by H. W. Greene printed in Gunther, *Astrolabes of the World*, 1:61–81 (note 2), is a poor rendering of the Greek text inadequately edited by H. H. Hase in *Rheinisches Museum für Philologie*, 2d ser., 6 (1839): 127–71. A more reliable guide to the text is Johannes Philoponus, *Traité de l'astrolabe*, trans. A. P. Segonds (Paris, 1981). Theon's treatise is also partially preserved in that of Sebokht (see note 2 above).

louse in A.D. 1143 from the Arabic version.[23] In the fourteenth chapter of the *Planisphaerium*, Ptolemy does refer enigmatically to a "spider" (*aranea*) in a "horoscopic instrument" (*horoscopium instrumentum*), but the instrument lacks attributes clearly recognizable as those of a planispheric astrolabe.[24] In Ptolemy's major astrological tract, the *Tetrabiblos*, there is a passage in which the expression δι' ἀστρολάβων ὡροσκοπίων, "by means of astrolabic horoscope instruments," is the recommended method of determining time of birth.[25] The theory among historians today, however, is that here Ptolemy is referring to the observational armillary sphere, just as he was when using the term "astrolabe" in the *Almagest* and in the *Geography*.

Beyond this, little can be said with any certainty. Vitruvius in the first century B.C. knew about stereographic projection, a necessary requisite to the astrolabe, but there is no convincing evidence that Ptolemy or any of his predecessors knew about the planispheric astrolabe; nor are there substantial grounds for considering that Hipparchus, to whom Ptolemy was much indebted, necessarily knew about stereographic projection and applied it to instrument design.[26] There is, however, evidence for interest in Ptolemy's day in its application to instruments, for there is a small portable sundial, probably made in the second century A.D. and now in the Kunsthistorisches Museum, Vienna, that has engraved inside the lid the stereographic projection of the two tropics, as well as the equator and the unequal-hour lines. This sundial, only thirty-nine millimeters in diameter, has other features reminiscent of astrolabes, for it consists of a box containing four circular plates slipped over a vertical pin attached to the bottom of the box. The four plates are engraved on both sides with sundial scales, each for use at a different geographic latitude.[27]

Certainly the early Arabic-speaking historians thought Ptolemy knew of the astrolabe, for the bibliographer Ibn al-Nadīm, writing in the tenth century A.D., said: "In ancient times the astrolabes were plane. The first person to make them was Ptolemy. It is said that they were made before his time, but this has not been verified."[28]

Early medieval compilers of biographies and histories often, however, interlaced their accounts with charming but misleading anecdotes. A particularly delightful example is the anecdotal account of the origin of the astrolabe given by the thirteenth-century A.D. Syrian bibliographer Ibn Khallikān. He related that "it is said" Ptolemy invented the astrolabe by accident while out riding and carrying a celestial globe in his hand. When Ptolemy dropped the globe, his mount stepped on it and squashed it. The result was the astrolabe.[29]

Returning from the fanciful to the more concrete, Ibn al-Nadīm stated that the earliest treatise in Arabic on the astrolabe was the *Kitāb ṣanʿat al-asṭurlābāt wa-al-ʿamal bi-hā* (The construction and use of astrolabes) by Māshā'allāh, whose dates are uncertain but who was still alive in 193/809. Māshā'allāh was a Jewish astrologer working and writing in Basra southeast of Baghdad.[30] A Latin treatise on the astrolabe under the name of Messahalla, the Romanized form of his name, had the greatest

23. Contrary to what is usually stated in the literature, the Arabic translation had probably not been made by Maslamah ibn Aḥmad al-Majrīṭī (d. 398/1007), an astronomer and mathematician of Córdoba; Paul Kunitzsch, "On the Authenticity of the Treatise on the Composition and Use of the Astrolabe Ascribed to Messahalla," *Archives Internationales d'Histoire des Sciences* 31 (1981): 42–62, esp. 50 n. 38.

24. Claudius Ptolemy, *Opera quae exstant omnia*, 3 vols., ed. J. L. Heiberg (Leipzig: B. G. Teubner, 1898–1907), vol. 2, *Opera astronomica minora* (1907), 225–59, esp. 249; German translation by J. Drecker, "Das Planisphaerium des Claudius Ptolemaeus," *Isis* 9 (1927): 255–78, esp. 271. Neugebauer interprets the "horoscopic instrument" mentioned in the *Planisphaerium* as an anaphoric clock with the stars and ecliptic forming a movable overlay, employing a design later developed in the Islamic world rather than the design that became dominant in Vitruvian or European anaphoric clocks, in which the stars and ecliptic were stationary; Otto Neugebauer, *A History of Ancient Mathematical Astronomy*, 3 pts. (New York: Springer-Verlag, 1975), 2:865–66 and 871.

25. The passage is *Tetrabiblos* 3.2; see Ptolemy, *Tetrabiblos*, ed. and trans. F. E. Robbins, Loeb Classical Library (Cambridge: Harvard University Press, 1940; reprinted 1980), 228–31. Note that ὡροσκοπίων is a noun here, and not an adjective.

26. In this interpretation of the Ptolemaic and pre-Ptolemaic antecedents of the astrolabe, Neugebauer, in *Ancient Mathematical Astronomy*, 3:858, 868–69 and 871 (note 24), severely modified and even reversed many points he had made in a study nearly thirty years earlier: Otto Neugebauer, "The Early History of the Astrolabe: Studies in Ancient Astronomy IX," *Isis* 40 (1949): 240–56; reprinted in Otto Neugebauer, *Astronomy and History: Selected Essays* (New York: Springer-Verlag, 1983), 278–94. For arguments that Ptolemy knew the astrolabe and that Hipparchus could well have developed the planispheric astrolabe, see Neugebauer, "Early History of the Astrolabe," 241–42 and 246–51, and Germaine Aujac and editors, "Greek Cartography in the Early Roman World," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:161–76, esp. 167 n. 35. An important source in these arguments is Synesius of Cyrene, who died shortly before A.D. 415 and was a pupil of Hypatia, the daughter of Theon of Alexandria; Joseph Vogt and Matthias Schramm, "Synesios vor dem Planisphaerium," in *Das Altertum und jedes neue Gute: Für Wolfgang Schadewaldt zum 15. März 1970* (Stuttgart: W. Kohlhammer, 1970), 265–311, esp. 279–311.

27. Vienna, Kunsthistorisches Museum, inv. no. VI 4098. For an illustration and discussion, see Turner, *Astrolabes*, 10–11 (note 19).

28. Muḥammad ibn Isḥāq ibn al-Nadīm, *al-Fihrist*; see *Kitâb al-Fihrist*, 2 vols., ed. Gustav Flügel (Leipzig: F. C. W. Vogel, 1871–72), 1:284, or *The Fihrist of al-Nadīm: A Tenth-Century Survey of Muslim Culture*, 2 vols., ed. and trans. Bayard Dodge (New York: Columbia University Press, 1970), 2:670.

29. The passage from Aḥmad ibn Muḥammad ibn Khallikān (608–81/1211–82) is discussed in detail by King, "Origin of the Astrolabe," 45, 55, 60–61, with Arabic text on 71 (note 14). The instrument that Ptolemy was said to be carrying was called a *kurah falakīyah*, a common designation of a celestial globe meaning literally "celestial sphere."

30. Not in Egypt, as many have asserted; Julio Samsó, "Mās͟hā' Allāh," in *Encyclopaedia of Islam*, new ed., 6:710–12; Ibn al-Nadīm, *Fibrist*; Flügel's edition, 1:273, Dodge's edition, 2:650–51 (note 28).

influence in the Latin West of all astrolabe writings and eventually became the basis of Geoffrey Chaucer's treatise on the astrolabe written in A.D. 1392 for his son Lewis. Recent scholarship, however, has shown that this immensely popular Latin version is not in fact a translation of a writing by Māshāʾallāh of the late eighth century A.D., but rather a Western compilation based on the translations of works by Ibn Ṣaffār (d. 426/1035), a mathematician and astronomer of Córdoba.[31]

From Ibn al-Nadīm we have the names of other early treatises on the subject, though few are extant today. The earliest Arabic treatise on the planispheric astrolabe still preserved today in the original is that written by the instrument maker and astronomer ʿAlī ibn ʿĪsā, who in 214/829–30 and again in 217/832–33 participated in observations at Baghdad and Damascus.[32] An astrolabe made by one of his apprentices is among the earliest to have survived and is illustrated in figure 2.5. Thereafter, numerous treatises on the construction and use of the astrolabe were composed both in Arabic and, slightly later, in Persian as well.

Ibn al-Nadīm also supplies the names of many early artisans manufacturing astrolabes. The earliest—presumably in the Islamic Near East—was Abywn (or Abiyūn; Apion the patriarch) al-Baṭrīq, who he said lived a little before or a little after the advent of Islam.[33] Elsewhere in his history, however, Ibn al-Nadīm said that al-Fazārī, a well-known astronomer in Baghdad during the reign of the caliph al-Manṣūr (r. 136–58/754–75), was the first person in Islam to make an astrolabe.[34] The identity of Abywn al-Baṭrīq is uncertain, though a later writer, the eleventh-century scholar al-Bīrūnī, who himself wrote on astrolabes, stated that Abywn al-Baṭrīq wrote a treatise on the astrolabe that was translated, presumably from Coptic or Syriac, by Abū al-Ḥasan Thābit ibn Qurrah al-Ḥarrānī at the end of the ninth century A.D. in Baghdad.[35]

Clearly from Ibn al-Nadīm's account, and other sources as well, the earliest center for astrolabe production—as well as other astronomical instruments—was within the domain of Syria, in the city of Harran, lying between the northern reaches of the Euphrates and Tigris rivers, southeast of Edessa. Though today it lies in ruins in modern Turkey, it was an ancient and important town, known to the Romans as Carrhae and to the church fathers as Hellenopolis, at the intersection of major caravan routes to Syria, Mesopotamia, and Asia Minor. In the ninth and tenth centuries A.D. it had a prominent Sabian community, whose pagan religious interest in the stars and sun perhaps was particularly conducive to the study of astronomy.[36] In any case, many of the early Islamic astronomers and instrument makers were members of the Sabian sect, whose center was in Harran. Ibn al-Nadīm also mentioned the patronage of one of the tenth-century Hamdanid rulers of Syria, Sayf al-Dawlah, whose center of power was in Aleppo during his rule from 333/944 to 356/967. Among the astrolabe makers supported by this ruler was a woman named al-ʿIjlīyah, who had been apprenticed under the same master with whom her father, al-ʿIjlī, had trained.[37]

It is clear that Syria in the eighth, ninth, and tenth centuries A.D. was a region where much information circulated and was exchanged regarding the mapping as well as metalworking techniques necessary for producing planispheric astrolabes. The earliest surviving planispheric astrolabes are Islamic products of the second half of the ninth century A.D. Knowledge and production of astrolabes rapidly spread throughout Islamic lands from southern Spain to western India. Their styles varied in different workshops and regions, from the clean simple lines of the earlier western Islamic products, as seen in figure 2.5, to the rather ornate and delicate work of the eastern Islamic areas of Persia and western India, as illustrated in figure 2.6.[38] Knowledge of the astrolabe reached southern Europe about the middle of the tenth century, as evinced by a collection of scientific treatises compiled in a scriptorium at the Benedictine monastery of Santa

31. Kunitzsch, "Astrolabe Ascribed to Messahalla" (note 23).

32. ʿAlī ibn ʿĪsā al-Asṭurlābī, *Kitāb al-ʿamal bi-l-aṣṭurlāb*, ed. by P. Louis Cheikho: "Kitāb al-ʿamal bi-l-aṣṭurlāb li-ʿAlī ibn ʿĪsā," *al-Mashriq* 16 (1913): 29–46; German translation by Carl Schoy, "ʿAlî ibn ʿÎsâ, Das Astrolab und sein Gebrauch," *Isis* 9 (1927): 239–54.

33. Ibn al-Nadīm, *Fihrist*; Flügel's edition, 1:284, Dodge's edition, 2:670 (note 28).

34. Ibn al-Nadīm, *Fihrist*; Flügel's edition, 1:273, Dodge's edition, 2:649 (note 28). For Muḥammad ibn Ibrāhīm al-Fazārī, see David Pingree, "al-Fazārī," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 4:555–56.

35. King, "Origin of the Astrolabe," 49 (note 14). See also Fuat Sezgin, *Geschichte des arabischen Schrifttums*, vol. 6, *Astronomie bis ca. 430 H.* (Leiden: E. J. Brill, 1978), 103.

36. Ibn al-Nadīm, *Fihrist*, Dodge's edition, 2:670–71 and 745–72 (note 28); G. Fehérvári, "Ḥarrān," in *Encyclopaedia of Islam*, new ed., 3:227–30; Bernard Carra de Vaux, "al-Ṣābiʾa," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), 4:21–22; Savage-Smith, *Islamicate Celestial Globes*, 18 and 23 (note 5). For further discussion of Harran as a center of instrumentation, see the historical introduction to Alain Brieux and Francis R. Maddison, *Répertoire des facteurs d'astrolabes et de leurs oeuvres: Première partie, Islam* (Paris: Centre National des Recherches Scientifiques, in press).

37. Ibn al-Nadīm, *Fihrist*; Flügel's edition, 1:285, Dodge's edition, 2:671 (note 28).

38. Numerous planispheric astrolabes are extant today, more than any other Islamic scientific instrument. For various makers and their products, see Gunther, *Astrolabes of the World* (note 2); Gibbs with Saliba, *Planispheric Astrolabes* (note 15); Sharon Gibbs, Janice A. Henderson, and Derek de Solla Price, *A Computerized Checklist of Astrolabes*, photocopy of typescript (New Haven: Yale University Department of the History of Science and Medicine, 1973); and Turner, *Astrolabes* (note 19). A comprehensive history and examination of all signed or dated astrolabes, as well as other Islamic astronomical instruments, will be found in the forthcoming Brieux and Maddison, *Répertoire* (note 36).

Maria de Ripoll at the foot of the Pyrenees.[39] During the eleventh century, knowledge of it spread to northern Europe, so that by A.D. 1092 an astrolabe was being employed in England during an eclipse of the moon.[40] The earliest European artifact preserved today dates from about A.D. 1200. After reaching great popularity in Europe in the fifteenth and sixteenth centuries, the astrolabe fell into disuse after the end of the seventeenth century,[41] but in the Islamic world its production continued, particularly in the East, through the nineteenth century.

The astrolabe was a convenient and portable multifunction instrument, combining the attributes of a two-dimensional model of the heavens, a computing device for calculating astronomical information, and an instrument for making simple observations. It should be noted, however, that its use as an observational instrument was primarily for timekeeping, determining ascendants for horoscopes, and geographical orientation. Serious observation by astronomers of planetary and stellar coordinates would have been done with other instruments, such as a parallactic ruler, the dioptra, large quadrants, and observational armillary spheres.[42] Though it was sometimes used to measure the heights of objects on earth, such as buildings or mountains, the astrolabe was not accurate enough for tasks requiring much precision. It was prized as a teaching device as well as a necessary aid to any enterprising astrologer casting a horoscope as preparation for predicting the course of an illness, the prospects of a child from the moment of birth, or the advisability of travel, marriage, war, and similar matters. In Islamic countries the astrolabe was a necessity to any *muwaqqit* of a mosque in determining the hours of prayer, which depended on calculating the sunrise and sunset at that particular location, and it was frequently used to determine the direction toward which a Muslim must face when performing the obligatory daily prayers (see chapter 9 on qibla orientation). In both Islamic Near Eastern and Christian European societies the instrument became the symbol of the professional astrologer or astronomer, as indicated by its frequent depiction in miniatures.

A remarkable full-page painting from a manuscript preserved today in Istanbul (fig. 2.10) depicts the astronomers and staff of a sixteenth-century Ottoman observatory employing a range of small instruments.[43] The short-lived observatory was built in the European section of Istanbul in 1577 under the direction of the chief astronomer in the Ottoman capital, Taqī al-Dīn Muḥammad al-Rashīd ibn Maʿrūf. In an illustrated verse chronicle of the reign of Sultan Murād III (982–1003/1574–95), who had been responsible for the building of the observatory as well as its demolition several years later, a poem described the functioning of the observatory. In figure 2.10, six lines of three couplets written in the upper section of the miniature read as follows:

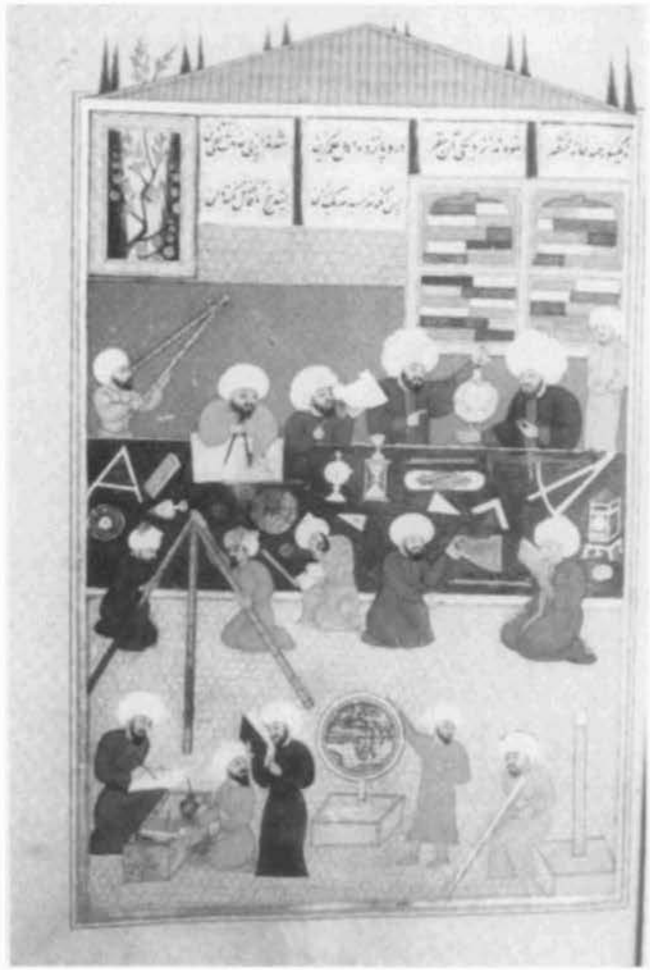


FIG. 2.10. ASTRONOMERS AT WORK. Astronomers are shown at work in this miniature of the "small" observatory, part of the observatory built in Istanbul in A.D. 1577. It is illustrated in the *Şāhanşāhnāme* (Book of the king of kings), a verse chronicle of the reign of Sultan Murād III, who was responsible for building the observatory.
Size of the original: not known. By permission of the Istanbul Üniversitesi Kütüphanesi (FY. 1404, fol. 57a).

And they also built a small-scale observatory
In the vicinity of the main building.
In it fifteen distinguished men of science
Were in readiness in the service of Taqî al Dîn.
In the observations made with each instrument
Five wise and learned men cooperated.

39. Barcelona, Archives of the Crown of Aragon, MS. Ripoll 225.

40. For the transmission to Europe of theoretical knowledge about the astrolabe as well as artifacts, see Turner, *Astrolabes*, 16–20 (note 19).

41. For reasons why it fell into disuse in Europe, see Turner, *Astrolabes*, 56–57 (note 19).

42. See King, "Astronomical Instrumentation," 1–3 (note 16), and Turner, *Astrolabes*, 29 n. 91 (note 19).

43. Istanbul Üniversitesi Kütüphanesi, MS. F. 1404 (Yıldız 2650/260), fol. 57a.

The poem goes on to say of the five men:

> There were two or three observers,
> and the fourth was a clerk,
> And there was also a fifth person
> who performed miscellaneous work.[44]

The painting itself illustrates the smaller, portable instruments that were kept in a small-scale adjunct observatory where minor observations were done, as well as recording, calculating, drawing, and studying. In front of the bookshelves drawn in figure 2.10, two astronomers discuss an astrolabe while a small figure, a student perhaps, looks on. Next to them an astronomer is using a quadrant, and far to the left another employs a dioptra. At the large table, which in the miniature forms a dark band across the middle of the painting, another astronomer constructs a diagram using a compass or dividers. In front of him on the table is what appears to be a celestial globe without rings or stand. Other instruments on the table (right to left) are a clock, an adjustable protractor, a pair of scissors, calipers, a straightedge, a pen box, a set square, triangles of various sizes, two sandglasses, a small globe without meridian ring, several plumb bobs, a book, and some type of plate. In front of the table one person reads while another demonstrates a quadrant; another writes while two work with a tripod for supporting a plumb line. In the foreground are figures variously engaged in reading and writing, while one appears to be discussing a large terrestrial globe on which Africa, Asia, and Europe are delineated in some detail.

Through this miniature we gain a glimpse of one aspect of the medieval Islamic observatory. Although the sixteenth-century Istanbul observatory was short-lived, its medieval predecessors, such as those at Maragheh in the thirteenth century or Samarkand in the fifteenth century, were active and important centers of study and research. Such illustrations also make it clear that astrolabes and related instruments as well as terrestrial globes were considered a necessary part of a working center for astronomical study. Many of the instruments preserved today, however, were clearly intended for wealthy and influential patrons who considered them an essential accoutrement for the library of any learned or cultured person.

VARIANTS OF PLANISPHERIC ASTROLABES

The conventional type of planispheric astrolabe required that a different plate be inserted under the rete for every geographic latitude where it was to be used. In Toledo in the eleventh century A.D., an important development in the design occurred, owing to the efforts of two individuals. The result was a universal astrolabe that could be used at any location without special plates. The basic principle involved substituting the plane of the solstitial colure for the plane of the equator in the stereographic projection.

ʿAlī ibn Khalaf, perhaps also known as al-Shakkāz and possibly an apothecary or herbalist, designed a plate on which he inscribed the stereographic projection of the ecliptic coordinates onto the plane of the solstitial colure. Over this plate he placed a special "rete," one half of which represented the equatorial coordinates of meridians and parallels (derived through equatorial stereographic projection onto the plane of the solstitial colure) while the other half was similar to an ordinary rete displaying the fixed stars, but with the northern and southern halves superimposed.

The result was one plate and a "rete" that could solve problems of spherical astronomy for any geographic latitude, though in somewhat more complicated fashion than with the standard astrolabe.[45] The universal astrolabe of ʿAlī ibn Khalaf was not known outside southern Spain, and no examples are known to be preserved today. His treatise on the subject, dedicated to Yaḥyā al-Maʾmūn, the local ruler of Toledo from 435/1043–44 to 467/1074–75, is known through a thirteenth-century Castilian translation prepared as part of the *Libros del saber de astronomía* compiled largely from Arabic sources for Alfonso el Sabio (the Wise), who in A.D. 1251 was crowned Alfonso X of Castile.[46]

A contemporary of ʿAlī ibn Khalaf in Andalusia, the astronomer al-Zarqēllo (d. 493/1100), known in the West as Azarquiel, also designed a universal astrolabe and wrote three treatises on it, one of them dedicated to the same Toledan ruler who had patronized ʿAlī ibn Khalaf.[47]

44. Translation is that of Aydın Sayılı, *The Observatory in Islam and Its Place in the General History of the Observatory* (Ankara: Türk Tarih Kurumu, 1960; reprinted New York: Arno Press, 1981), 294; see also 289–305 of Sayılı's study for further discussion of this poem and a general account of the observatory in Istanbul. Sayılı attributes the poem to ʿAlā al-Dīn al-Manṣūr; the authorship of the *Şāhanşāhnāme* (History of the king of kings) in which the poem appears is disputed, see appendix 12.1, footnote o.

45. King, "Astronomical Instrumentation," 7 (note 16); David A. King, "On the Early History of the Universal Astrolabe in Islamic Astronomy, and the Origin of the Term 'Shakkāzīya' in Medieval Scientific Arabic," *Journal for the History of Arabic Science* 3 (1979): 244–57; reprinted in David A. King, *Islamic Astronomical Instruments* (London: Variorum Reprints, 1987), item VII. See also Turner, *Astrolabes*, 151–55 (note 19).

46. *Libros del saber de astronomia del rey D. Alfonso X de Castilla*, comp. Manuel Rico y Sinobas, 5 vols. (Madrid: Tipografía de Don Eusebio Aguado, 1863–67), 3:1–132. For a discussion of the *Libros del saber de astronomía*, see E. S. Procter, "The Scientific Works of the Court of Alfonso X of Castille: The King and His Collaborators," *Modern Language Review* 40 (1945): 12–29; and *De astronomia Alphonsi Regis*, ed. Mercè Comes, Roser Puig [Aguilar], and Julio Samsó, Proceedings of the Symposium on Alfonsine Astronomy held at Berkeley (August 1985), together with other papers on the same subject (Barcelona: Universidad de Barcelona, 1987).

47. For the spelling of his name as al-Zarqēllo, see Lutz Richter-

Al-Zarqēllo's solution was to inscribe a plate with the ecliptic coordinates projected stereographically onto the solstitial colure. The ecliptic latitude-measuring circles and longitude-measuring circles for every five degrees were indicated, and the projection taken with the vernal equinox as the center of projection was superimposed over the projection taken with the autumnal equinox as center of projection. Over this ecliptic grid he then superimposed, at an angle equal to the obliquity of the ecliptic, a similar projection of the equatorial coordinates, with the parallels and meridians indicated for every fifth degree. Stars were then placed directly on the plate. See figure 2.11 for a reconstruction of the basic method employed by al-Zarqēllo and figure 2.12 for an illustration of one of the few astrolabes of this design preserved today, made in the late fourteenth or early fifteenth century by an otherwise unknown maker named ʿAlī (or ʿAlā) al-Wadāʿī.[48]

With this design there was no need for a rete, but only a movable rod (called *ufq māʾil*, "oblique horizon") that could rotate at the center of the plate. When set at an appropriate angle, the rod could represent the horizon. The back of this plate would have an alidade and scales similar to those on conventional planispheric astrolabes.

This particular style of universal astrolabe was later called *al-ṣafīḥah al-Zarqālliyah*, "the al-Zarqēllo plate," in Arabic after its inventor, and in Europe *azafea* (or *saphaea*) *Azarchelis*. Al-Zarqēllo himself called it *ṣafīḥah Maʾmūnīyah*, "a Maʾmūn plate," in the version of his treatise dedicated to the Toledan ruler Yaḥyā al-Maʾmūn before al-Zarqēllo moved to Córdoba. In the other two drafts of the treatise he called it *ṣafīḥah ʿAbbādīyah*, "an ʿAbbādid plate," in honor of Muḥammad II al-Muʿtamid, a ruler of the ʿAbbādid dynasty based in Seville and a rival of the Toledan ruler Yaḥyā al-Maʾmūn. The longer of the versions dedicated to al-Muʿtamid was translated into Castilian for Alfonso el Sabio,[49] while a shorter version for the same patron was transmitted to the West through translations of Jacob ben Machir ibn Tibbon of Marseilles and William the Englishman.[50] These translations subsequently influenced Gemma Frisius in the sixteenth century.[51]

Another type of universal astrolabe employing stereographic projection onto the plane of the solstitial colure was called *ṣafīḥah shakkāzīyah*, "a *shakkāzī* plate." Scholars have differed as to the origin of the design and of the name.[52] A number of treatises are extant on the instrument, including one by an important mathematician in Marrakesh, Ibn al-Bannāʾ (d. 721/1321),[53] and there are a few artifacts remaining today. The *shakkāzīyah* variant of the universal astrolabe resembled that of al-Zarqēllo except that the ecliptic system was simplified to show only the ecliptic latitude-measuring circles that are between the zodiacal houses (in other words, one every thirty degrees), and no parallels to the ecliptic were indicated at all. Stars were still placed on the plate, so that no rete was needed, and a ruler rotating over the plate served as both oblique horizon and ruler-protractor. The reverse of the plate was identical to that of a conventional astrolabe with an alidade having two sights. See figure 2.13 for an illustration of a *shakkāzīyah* astrolabe probably made in the thirteenth century.

ʿAlī ibn Khalaf and al-Zarqēllo may not have been the first to conceive the basic ideas of these universal plates. There is the intimation that the ninth-century Baghdad astronomer Aḥmad ibn ʿAbdallāh Ḥabash al-Ḥāsib al-Marwazī, who was possibly still alive in 300/912, may have written about a plate of horizons closely related to the *shakkāzīyah* plate.[54] Furthermore, a recently discovered manuscript by an astronomer of Shiraz in Persia, Abū Saʿīd al-Sijzī (d. ca. 415/1024–25), appears to be on the same topic.[55] Whatever their theories may prove to

Bernburg, "Ṣāʿid, the *Toledan Tables*, and Andalusī Science," in *From Deferent to Equant: A Volume of Studies in the History of Science in the Ancient and Medieval Near East in Honor of E. S. Kennedy*, ed. David A. King and George Saliba, Annals of the New York Academy of Sciences, vol. 500 (New York: New York Academy of Sciences, 1987), 373–401, esp. 391 n. 5. For al-Zarqēllo's life and writings, see Juan Vernet Ginés, "al-Zarqālī (or Azarquiel)," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 14:592–95. For a recent study and translation of one version of his treatise on the universal astrolabe, see Roser Puig Aguilar, *Los tratados de construcción y uso de la azafea de Azarquiel*, Cuadernos de Ciencias 1 (Madrid: Instituto Hispano-Arabe de Cultura, 1987).

48. Rockford, Illinois, Time Museum, inv. no. 3529. A full catalog description is given by Turner, *Astrolabes*, 168–73 (note 19).

49. *Libros del saber de astronomía*, 3:133–237 (note 46).

50. Vernet Ginés, "al-Zarqālī," 594 (note 47); José María Millás y Vallicrosa, ed. and trans., *Tractat de l'assafea d'Azarquiel* (Barcelona: Arts Gràfiques, 1933), critical edition of the thirteenth-century Hebraic and Latin texts by Jacob ben Machir ibn Tibbon; Turner, *Astrolabes*, 155–56 (note 19).

51. Maddison, *Hugo Helt*, 9–12 (note 5), and Turner, *Astrolabes*, 157–60 (note 19).

52. King, "Universal Astrolabe" (note 45); Hartner, "Asṭurlāb," 727, reprint 317 (note 18).

53. *Risālat al-ṣafīḥah al-mushtarikah ʿalā al-shakkāzīyah* (Rabat, Royal Library MS. 6667), recently studied by Roser Puig [Aguilar], "Concerning the Ṣafīḥa Shakkāziyya," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 2 (1985): 123–39, and Emilia Calvo, "La *Risālat al-ṣafīḥa al-muštaraka ʿalà al-šakkāziyya* de Ibn al-Bannāʾ de Marrākuš," *al-Qanṭara* 10 (1989): 21–50. For a detailed explanation of the operations of a universal astrolabe, see Roser Puig [Aguilar], ed. and trans., *Al-Šakkāziyya: Ibn al-Naqqāš al-Zarqālluh* (Barcelona: Universidad de Barcelona, 1986). Turner refers to the design termed *shakkāzīyah* by Puig Aguilar as *Saphea Azarchelis*; Turner, *Astrolabes*, 174–79 (note 19).

54. This information is based on a remark by a later astronomer; see King, "Universal Astrolabe," 255 n. 22 (note 45), and idem, "Astronomical Instrumentation," 7 (note 16). On Ḥabash al-Ḥāsib, see Sezgin, *Geschichte des arabischen Schrifttums*, 6:173–75 (note 35). The only treatises by him preserved today are on the celestial globe, the spherical astrolabe, and the armillary sphere.

55. Damascus, Dār al-Kutub al-Ẓāhirīyah, MS. 9255; King, "Universal

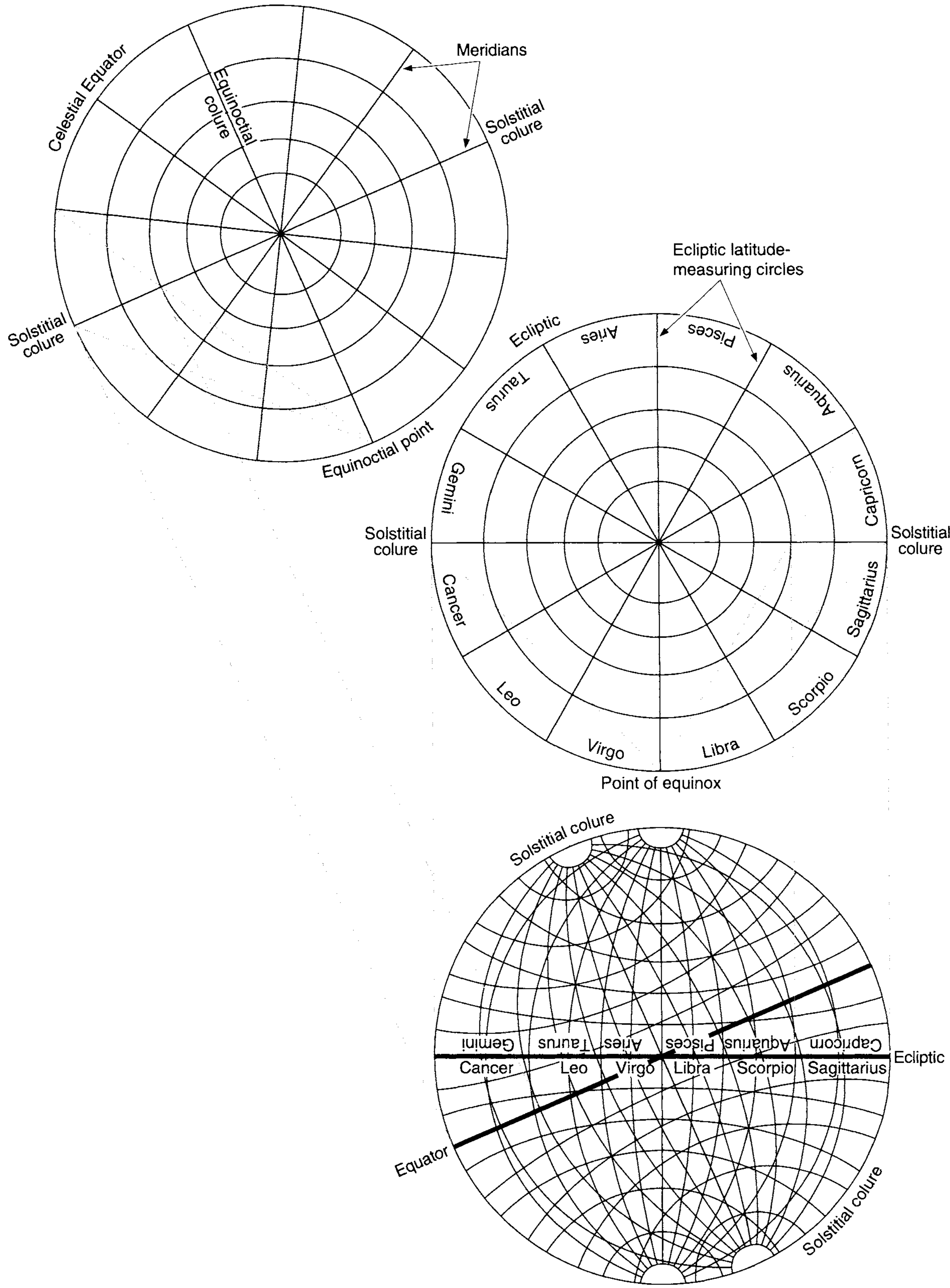


FIG. 2.11. SCHEMATIC INTERPRETATION OF AL-ZARQĒLLO'S DESIGN FOR A UNIVERSAL ASTROLABE TO BE USED AT ANY GEOGRAPHIC LATITUDE. The basic principle involved substituting the plane of the solstitial colure for the plane of the equator in the stereographic projection and superimposing a projection of the ecliptic coordinates over those of the equatorial coordinates.

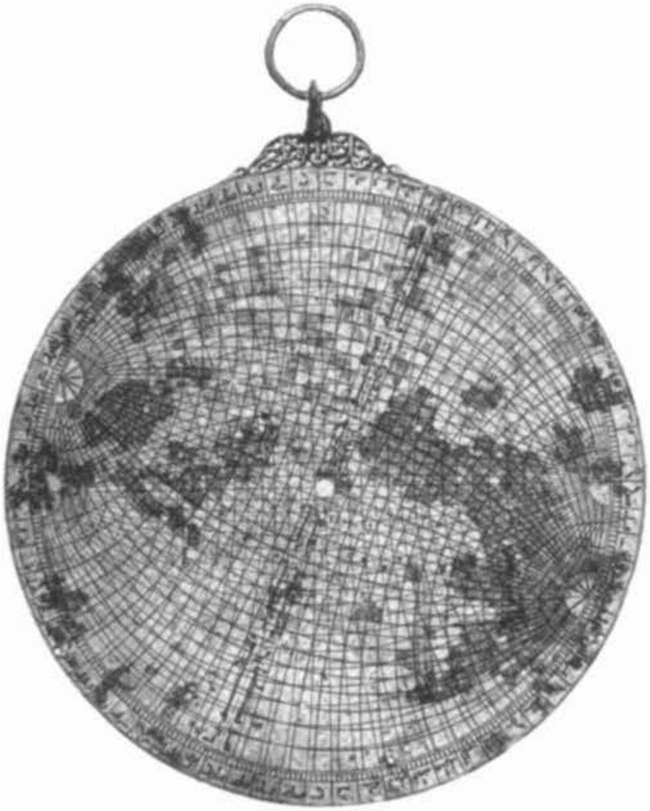


FIG. 2.12. A UNIVERSAL ASTROLABE OF THE TYPE DESIGNED BY AL-ZARQĒLLO. Undated (fourteenth or fifteenth century) astrolabe made by ʿAlī (or ʿAlā) al-Wadāʿī. This type of astrolabe is very rare.
Diameter of the original: 17 cm. By permission of the Time Museum, Rockford, Illinois (inv. no. 3529).

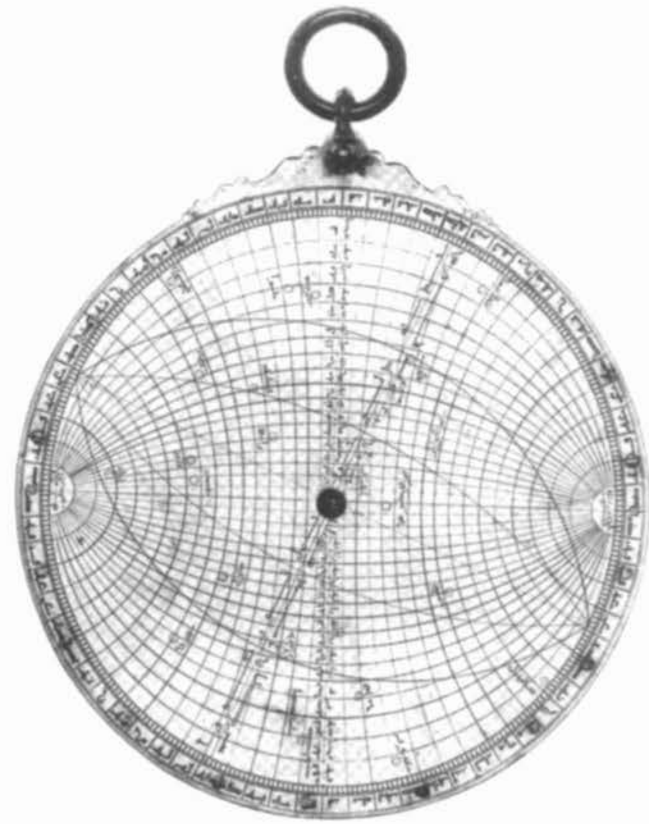


FIG. 2.13. A TYPE OF UNIVERSAL ASTROLABE CALLED *SHAKKĀZĪYAH*. Unsigned and undated (probably thirteenth century).
Diameter of the original: 22.7 cm. Museum of the History of Science, Barnett Collection, Oxford (IC-139). By permission of the Bettman Archive, New York.

have been, however, ʿAlī ibn Khalaf and al-Zarqēllo concretely applied the principle of stereographic projection onto the solstitial plane to the design and production of an astrolabe. A version of a universal astrolabe was reinvented in Syria in the early fourteenth century by the Aleppo astronomer Ibn al-Sarrāj. The only example of Ibn al-Sarrāj's instrument known to be preserved today is one he made himself (fig. 2.14). It is considerably more complicated and sophisticated than the form originally developed in southern Spain. A recent historian of Islamic instrumentation has declared that this universal astrolabe by Ibn al-Sarrāj is the most sophisticated astronomical instrument from the entire medieval and Renaissance periods.[56]

EXTENDED USE OF ASTROLABIC MAPPING

Another attempt to simplify the conventional planispheric astrolabe was devised by Sharaf al-Dīn al-Muẓaffar al-Ṭūsī, a Persian mathematician who died in the early thirteenth century. His idea was a linear astrolabe that was sometimes called "the staff of al-Ṭūsī" (*ʿaṣāt al-Ṭūsī*) after its inventor. Although stereographic projection was still employed in its design, the key elements of the mapping were reduced to the sides of one rod, which had a sight at each end and a plumb line in the middle. There was also a fixed thread at one end and a movable thread. Such an instrument had many limitations and seems to have been of little practical use. No examples are known to have survived.[57]

The astrolabic quadrant also developed from the planispheric astrolabe. In this distinctly Islamic development, a portion of an astrolabe plate was inscribed on a quadrant. A cord attached to the center of the quadrant takes

Astrolabe," 255 n. 23 (note 45). For further information on al-Sijzī, see Yvonne Dold-Samplonius, "al-Sijzī," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 12:431–32.

56. King, "Astronomical Instrumentation," 7 (note 16); David A. King, "The Astronomy of the Mamluks," *Isis* 74 (1983): 531–55, esp. 544. See also the forthcoming study by David A. King, *The Astronomical Instruments of Ibn al-Sarrāj* (Athens: Benaki Museum).

57. For a diagram illustrating the principle, see Turner, *Astrolabes*, 184 (note 19). See also Bernard Carra de Vaux, "L'astrolabe linéaire ou bâton d'et-Tousi," *Journal Asiatique*, 9th ser., 5 (1895): 464–516. For a diagram in a copy of al-Ṭūsī's treatise extant in Istanbul, see King, "Astronomical Instrumentation," pl. 5 (note 16).

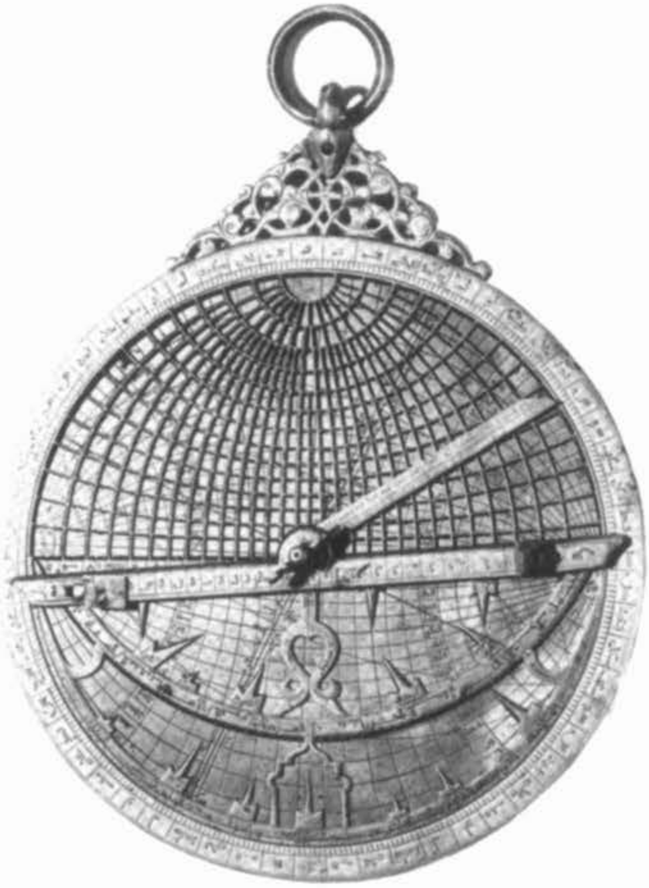


FIG. 2.14. THE UNIVERSAL ASTROLABE DESIGNED BY IBN AL-SARRĀJ IN THE EARLY FOURTEENTH CENTURY.
Diameter of the original: 15.8 cm. By permission of the Benaki Museum, Athens (inv. no. 13178).

FIG. 2.15. A WOODEN ASTROLABIC QUADRANT FOR LATITUDE 41°. This quadrant was made in Istanbul in 1094/1682–83 by Aḥmad al-Ayyūbī.
Size of the original: 10.4 cm. Museum of the History of Science, Oxford (inv. no. 60-70). By permission of the Bettman Archive, New York.

the place of the rete of the astrolabe; a bead on the cord can be adjusted to represent the position of the sun or a star, whose positions were read from markings for the ecliptic and star positions that are included on the quadrant. Thus an astrolabic quadrant also represents the position of the sun or fixed star with respect to the local horizon.[58]

A recently discovered twelfth-century Egyptian treatise indicates that the astrolabic quadrant was already known at that time. Its precise origins are unknown. Except in Persia and India, the astrolabic quadrant had to a large extent replaced the astrolabe in popularity by the end of the sixteenth century. Most of the astrolabic—also called almucantar—quadrants preserved today are Ottoman Turkish products (fig. 2.15).

There are also quadrants employing *shakkāzīyah* curves of the type developed for universal astrolabes. Several treatises were written on the subject, an especially interesting one by the late fourteenth-century astronomer Jamāl al-Dīn al-Māridīnī, who worked in Damascus and Cairo.[59] This type of quadrant was clearly related in design to the universal astrolabes of the eleventh-century Toledan astronomers, as were also the class of quadrants called meteoroscopes by later European astronomers.[60]

In Islam, anaphoric clock dials, made to simulate the motion of the heavens, resembled astrolabes in appearance. They were open star maps over a projection of the celestial coordinate system as it relates to the observer's locality. Such an astrolabic clock dial was seen, for example, by a fourteenth-century Arab historian in 743/1342–43 in the Damascus home of the astronomer Ibn al-Shāṭir.[61] Similarly, a clock in Fez, Morocco, was outfitted during a restoration in A.D. 1346–48 with an astrolabic rete still to be seen today.[62] This design is in contrast to the typical European astronomical clock dials on which the stars and constellations had an overlay of wires representing the local celestial coordinates and horizon.

58. For diagrams illustrating the principle of astrolabic quadrants and the folding of the stereographic projection that is part of their design, see Turner, *Astrolabes*, 202–3 (note 19).

59. King, "Astronomy of the Mamluks," 545 (note 56), and David A. King, "An Analog Computer for Solving Problems of Spherical Astronomy: The *Shakkāzīya* Quadrant of Jamāl al-Dīn al-Māridīnī," *Archives Internationales d'Histoire des Sciences* 24 (1974): 219–42; reprinted in David A. King, *Islamic Astronomical Instruments* (London: Variorum Reprints, 1987), item X.

60. John D. North, "Werner, Apian, Blagrave and the Meteoroscope," *British Journal for the History of Science* 3 (1966–67): 57–65 and pl. II.

61. On ʿAlāʾ al-Dīn Abū al-Ḥasan ʿAlī ibn Ibrāhīm ibn al-Shāṭir, see David A. King, "Ibn al-Shāṭir," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 12:357–64, esp. 362.

62. Derek J. de Solla Price, "Mechanical Water Clocks of the 14th Century in Fez, Morocco," in *Proceedings of the Tenth International Congress of the History of Science (Ithaca, 1962)*, 2 vols. (Paris: Hermann, 1964), 1:599–602, esp. 600 and fig. 2.

FIG. 2.16. A UNIQUE ASTROLABE, WHICH IS ALSO A MECHANICAL, GEARED CALENDAR (FRONT). This astrolabe was made in 618/1221–22 in Isfahan by Muḥammad ibn Abī Bakr al-Rashīdī.
Diameter of the original: 18.5 cm. Museum of the History of Science, Lewis Evans Collection, Oxford (inv. no. IC5). By permission of the Bettman Archive, New York.

FIG. 2.17. REVERSE SIDE OF THE ASTROLABE SHOWN IN FIGURE 2.16. The phases of the moon are displayed through the circular window near the top of the instrument. Two circular plates beneath, one with a disk for the sun and the other with a disk for the moon, rotate within a zodiacal calendar.
Diameter of the original: 18.5 cm. Museum of the History of Science, Lewis Evans Collection, Oxford (inv. no. IC5). By permission of the Bettman Archive, New York.

A unique and most remarkable astrolabe was produced by a thirteenth-century Persian metalworker who worked in Isfahan (figs. 2.16 and 2.17). This device, made in 618/1221–22, was both an astrolabe and a mechanical calendar, for it was fitted with a geared mechanism by which it could reproduce the motions of the sun and moon. It is the oldest geared machine in existence in a complete state. Because the motions of the sun and moon are displayed through windows on the back of the astrolabe, the maker, Muḥammad ibn Abī Bakr al-Rashīdī, called also al-Ibarī al-Iṣfahānī, "the needlemaker of Isfahan," had to place two lugs on the rete to serve as sights instead of the alidade on the back. The geared calendar was moved by turning the wedge and pin at the center of the rete. On the reverse of the instrument, the phases of the moon were displayed through a circular window, with the age of the moon in letter-numerals showing through a small rectangular window. Two circular plates, one with a gold disk for the sun and the other with a (now missing) disk for the moon, rotated within a zodiacal calendar scale, representing their relative positions within the zodiac. A quite similar mechanism was designed in the eleventh century by al-Bīrūnī in his *Kitāb istīʿāb al-wujūh al-mumkinah fī ṣanʿat al-asṭurlāb* (Comprehensive study of all possible ways of making an astrolabe).[63] The precise

63. The section concerned with the mechanical calendar has been edited from three manuscripts and translated by Donald R. Hill, "Al-Bīrūnī's Mechanical Calendar," *Annals of Science* 42 (1985): 139–63. For the extant astrolabe/calendar see Silvio A. Bedini and Francis R. Maddison, "Mechanical Universe: The Astrarium of Giovanni de' Dondi," *Transactions of the American Philosophical Society*, n. s., 56, pt. 5 (1966): 3–69, esp. 8–10; and J. V. Field and M. T. Wright, "Gears from the Byzantines: A Portable Sundial with Calendrical Gearing," *Annals of Science* 42 (1985): 87–138.

relation of such mechanical devices to earlier Byzantine ones as well as to later European examples has not been fully established, though it has attracted the attention of recent scholars.

Al-Bīrūnī on Celestial Mapping

One of the most versatile and original of Islamic medieval scholars, al-Bīrūnī (d. after 442/1050) is also an important source of information on celestial mapping in the late tenth century. About 390/1000, while a young man in his middle twenties, al-Bīrūnī wrote *Kitāb al-āthār al-bāqīyah min al-qurūn al-khālīyah* (The chronology of ancient nations, literally, The remaining traces of past centuries), in which he compared calendrical systems among different peoples of the world. In this treatise he devoted one chapter to several methods for projecting star maps.[64] A few years later he composed a small monograph on the same subject, entitled *Kitāb fī tasṭīḥ al-ṣuwar wa-tabṭīḥ al-kuwar* (The book of the projection of the constellations and the flattening of the sphere),[65] dedicated to an unspecified Khwārazmshāh, the title given to Central Asian rulers along the lower Oxus River (modern Amu Darya). In this case the Khwārazmshāh was probably Abū al-Ḥasan ʿAlī, who died in 399/1008–9. Though world maps are mentioned, al-Bīrūnī's focus in both these discussions is on celestial mapping.

In the course of these two major discussions, al-Bīrūnī refers to or describes seven methods of projecting a celestial sphere or globe onto a flat surface.[66] For the first four methods he does not claim originality, only better understanding that allows him to criticize them as inadequate. For the other three methods he mentions no previous authorities and offers no criticisms, which encourages the conclusion that they were his own inventions.

The first projection he says he drew from Ptolemy's *Geography*, where it is given on the authority of Marinus.[67] The projection is formed with straight and perpendicular lines of latitude and longitude, resulting in considerable deformation. It produced a rectangular projection similar to what is today called an equidistant cylindrical projection.

The second projection is one that he notes was commonly used in astrolabes—that is, it is the polar case of stereographic projection. He states that it is simply one case of what he calls conical (*makhrūṭī*) projection, which is to say that the center of projection could be moved inside or outside the sphere, as the earlier astronomer al-Ṣaghānī had suggested in the tenth century.[68] In *Kitāb al-durar fī saṭḥ al-ukar* (Book of pearls concerning the projection of the spheres),[69] a treatise on the construction of the astrolabe, al-Bīrūnī expands on the idea of conical projections whose center of projection is at various fixed points along the north-south axis of the sphere. In this latter tract, al-Bīrūnī cites no predecessors.

The third technique he called "cylindrical" (*usṭuwānī*), but from his description it is evident that it corresponded to what today would be called orthographic (fig. 2.18). In *al-Āthār al-bāqīyah*, al-Bīrūnī claimed that no one had mentioned this projection before him, though in his specialized monograph written slightly later he disparagingly

64. Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī, *al-Āthār al-bāqīyah*; see *Chronologie orientalischer Völker von Albērūnī*, ed. Eduard Sachau (Leipzig: Gedruckt auf Kosten der Deutschen Morgenländischen Gesellschaft, 1878), 357–63; and *The Chronology of Ancient Nations: An English Version of the Arabic Text of the "Athâr-ul-bâkiya" of Albîrûnî, or "Vestiges of the Past," Collected and Reduced to Writing by the Author in A.H. 390–1, A.D. 1000*, ed. and trans. Eduard Sachau (London: W. H. Allen, 1879; reprinted Frankfurt: Minerva, 1969), 357–64. Al-Bīrūnī's ideas on projection presented in this treatise are discussed briefly by Matteo Fiorini, "Le projezioni cartografiche di Albiruni," *Bollettino della Società Geografica Italiana*, 3d ser., 4 (1891): 287–94. See also chapters 6 and 8 below.

65. The treatise is extant in two manuscripts, Leiden, Universiteitsbibliotheek, MS. Or. 14, 300–314, and Tehran, Dānishgāh, MS. 5469, fols. 7b–13b. English translation and analysis, with reproduction of the Leiden manuscript, by J. L. Berggren, "Al-Bīrūnī on Plane Maps of the Sphere," *Journal for the History of Arabic Science* 6 (1982): 47–112; and an earlier partial German translation by Heinrich Suter, "Über die Projektion der Sternbilder und der Länder von al-Bîrûnî," in *Beiträge zur Geschichte der Mathematik bei den Griechen und Arabern*, ed. Josef Frank, Abhandlungen zur Geschichte der Naturwissenschaften und der Medizin, vol. 4 (Erlangen: Kommissionsverlag von Max Mencke, 1922), 79–93. See also Lutz Richter-Bernburg, "Al-Bīrūnī's *Maqāla fī tasṭīḥ al-ṣuwar wa-tabṭīkh al-kuwar*: A Translation of the Preface with Notes and Commentary," *Journal for the History of Arabic Science* 6 (1982): 113–22.

66. This count does not include his description of al-Ṣūfī's method of copying constellations from a globe, which will be discussed below.

67. This projection is not mentioned in *al-Āthār al-bāqīyah*. Marinus is certainly the correct interpretation of the name Fārabiyūs given in the Leiden manuscript; Berggren, "Al-Bīrūnī on Plane Maps," 50, 62, and 92 line 19 (note 65). It is certainly not to be interpreted as Hipparchus, as Suter did; Suter, "Über die Projektion der Sternbilder," 82 (note 65). For Marinus's projection, see O. A. W. Dilke and editors, "The Culmination of Greek Cartography in Ptolemy," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:177–200, esp. 178–80 and 185, and Neugebauer, *Ancient Mathematical Astronomy*, 2:879–80 (note 24).

68. Abū Ḥāmid al-Ṣaghānī al-Asṭurlābī (d. 379/989–90) was a famous geometer and astronomer in Baghdad and was also, judging by his name, an astrolabe maker; Sezgin, *Geschichte des arabischen Schrifttums*, 6:217–18 (note 35), and Berggren, "Al-Bīrūnī on Plane Maps," 69 (note 65). Although in *al-Āthār al-bāqīyah* al-Bīrūnī cites al-Ṣaghānī as the authority on this topic, he fails to mention him in his later monograph on projections (*Kitāb fī tasṭīḥ*). A treatise by al-Bīrūnī on the ideas of al-Ṣaghānī on the "complete projection" (*Jawāmiʿ maʿānī kitāb Abī Ḥāmid al-Ṣaghānī fī al-tasṭīḥ al-tāmm*) is preserved in Leiden, Universiteitsbibliotheek, MS. Or. 123, fols. 2b–13b, and deserves attention and study by historians.

69. Recently edited, translated, and studied from three manuscripts at Oxford by Ahmad Dallal, "Bīrūnī's *Book of Pearls concerning the Projection of Spheres*," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 4 (1987–88): 81–138. In some cases where the center of projection onto the equatorial plane was not at one of the poles, certain circles on the sphere would map as an ellipse, a parabola, or a hyperbola.

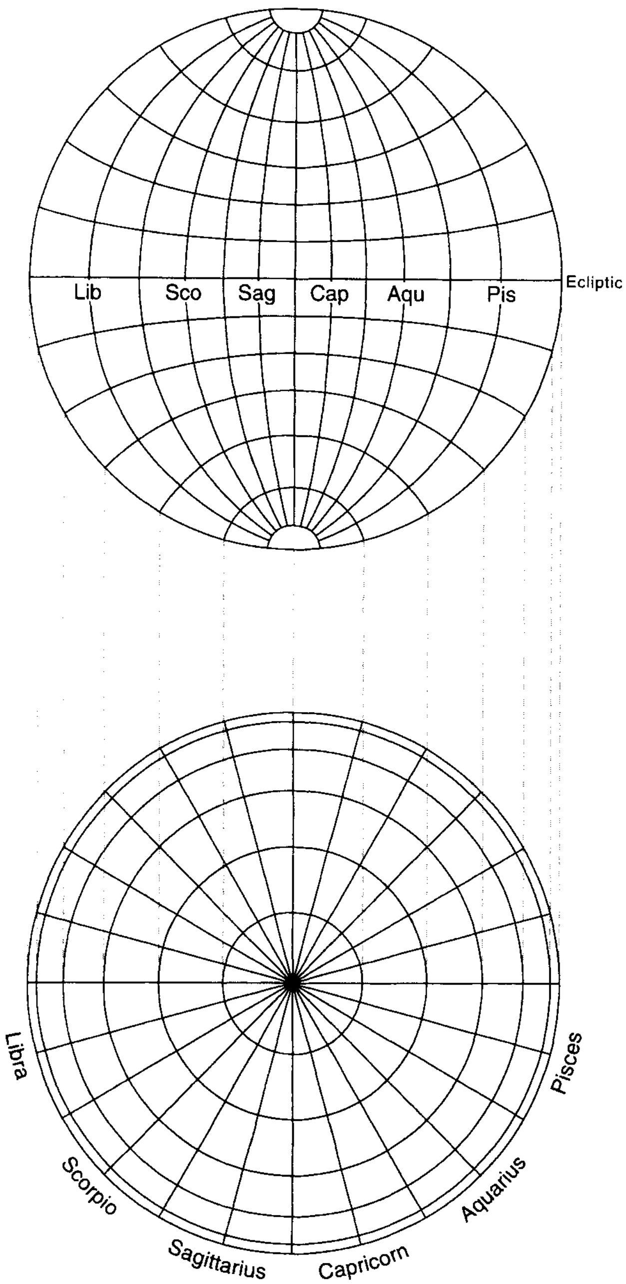


FIG. 2.18. RECONSTRUCTION OF AL-BĪRŪNĪ'S "CYLINDRICAL" PROJECTION. This corresponds to what today is called an orthographic projection.

refers to its description by the ninth-century astronomer al-Farghānī.[70] Al-Bīrūnī also stated in *al-Āthār al-bāqīyah* that he had explained this method in greater detail in his *Istīʿāb*.[71] The disadvantage of this method, al-Bīrūnī noted, is that the stars become increasingly compressed as they near the periphery of the map.[72]

The projection that al-Bīrūnī says was used in a "flattened" (*mubaṭṭaḥ*)[73] astrolabe, he admits to have also drawn from the writings of al-Farghānī. According to al-

70. Abū al-ʿAbbās Aḥmad ibn Muḥammad al-Farghānī is known to have been active between 218/833 and 247/861; Sezgin, *Geschichte des arabischen Schrifttums*, 6:149–51 (note 35). His treatise on the construction of astrolabes, *al-Kāmil fī ṣanʿat al-asṭurlāb al-shimālī wa-al-janūbī*, is extant in several manuscripts and in need of editing and analysis. See also N. D. Sergeyeva and L. M. Karpova, "Al-Farghānī's Proof of the Basic Theorem of Stereographic Projection," trans. Sheila Embleton, in *Jordanus de Nemore and the Mathematics of Astrolabes: De plana spera*, introduction, translation, and commentary by Ron B. Thomson (Toronto: Pontifical Institute of Mediaeval Studies, 1978), 210–17.

71. Extant in numerous manuscript copies. The pertinent section was not included in the partial translation and study, based on one manuscript in Leiden, by Eilhard Wiedemann and Josef Frank, "Allgemeine Betrachtungen von al-Bîrûnî in einem Werk über die Astrolabien," *Sitzungsberichte der Physikalisch-Medizinischen Sozietät in Erlangen* 52–53 (1920–21): 97–121; reprinted in Eilhard Wiedemann, *Aufsätze zur arabischen Wissenschaftsgeschichte*, 2 vols. (Hildesheim: Georg Olms, 1970), 2:516–40. *Kitāb istīʿāb al-wujūh al-mumkinah fī ṣanʿat al-asṭurlāb*, in which al-Bīrūnī also cited al-Farghānī in a different context, was apparently written before 390/1000, if the reference to it in *al-Āthār al-bāqīyah* is not a later interpolation; Richter-Bernburg, "Al-Bīrūnī's *Maqāla fī tasṭīḥ*," 115 n. 3 (note 65).

72. The plane of projection employed by al-Bīrūnī is not the one commonly used today in orthographic projection. Al-Bīrūnī advocated the plane of the ecliptic as the plane of projection, with the result that circles parallel to the ecliptic are mapped as concentric circles and those at right angles are mapped as radii. In modern orthographic projection, the plane of the solstices forms the plane of projection (or in a terrestrial map, a plane perpendicular to the equator) so that the equator and parallels are displaced as straight and parallel lines and the meridians as semiellipses. The latter form of orthographic projection was employed by Hugo Helt and published in the sixteenth century by Juan de Rojas as part of his commentary on the astrolabe. See Maddison, *Hugo Helt* (note 5), and Turner, *Astrolabes*, 161–64 (note 19).

73. Even though both the text of *al-Āthār al-bāqīyah* and the Leiden manuscript of the specialized monograph (*Kitāb fī tasṭīḥ*) clearly have the word *mubaṭṭaḥ* ("flattened"), some have interpreted this word as *mubaṭṭakh*, "melon shaped," a difference of one additional diacritical point; Suter, "Über die Projektion der Sternbilder," 84 n. 20 (note 65); Berggren, "Al-Bīrūnī on Plane Maps," 63 (note 65); Richter-Bernburg, "Al-Bīrūnī's *Maqāla fī tasṭīḥ*," 116 (note 65). There appears to be confusion between this particular type of projection and a special style of planispheric astrolabe in which the almucantars and other circles on the plates are projected as ellipses and hence called "melon shaped." For example, in al-Bīrūnī's *Kitāb al-tafhīm li-awāʾil ṣināʿat al-tanjīm* (Book of instruction on the principles of the art of astrology), he mentions a type of astrolabe called *mubaṭṭakh* (melon shaped) "because the almucantars and the ecliptic are flattened into an elliptical form like a melon" (author's translation); al-Bīrūnī's *al-Tafhīm*; see *The Book of Instruction in the Elements of the Art of Astrology*, ed. and trans. Robert Ramsay Wright (London: Luzac, 1934), 198 (sect. 328); see also Wiedemann and Frank, "Allgemeine Betrachtungen von al-Bîrûnî," 103–13, reprint 522–32 (note 71).

In the monograph on projections (*Kitāb fī tasṭīḥ*), al-Bīrūnī stated that he believed the "flattened" projection was another type of conical projection (*tasṭīḥ makhrūṭī*) like the one commonly used on astrolabes (i.e., polar case of stereographic projection), an idea he said he would discuss further in a later writing. In *Kitāb al-durar fī saṭḥ al-ukar*, which is devoted to astrolabic projections derived from various conical projections, al-Bīrūnī does not mention a melon-shaped one, though some of his projections could produce ellipses; Dallal, "Bīrūnī's *Book of Pearls*" (note 69). In the projection called *mubaṭṭaḥ* (flattened), described in great detail in *al-Āthār al-bāqīyah*, there are no elliptical curves or almucantars or other curves distinctive to astrolabic plates mentioned, only concentric circles and radii.

Bīrūnī, al-Farghānī had in turn attributed it to the ninth-century polymath Abū Yūsuf Yaʿqūb ibn Isḥāq al-Kindī or to Khālid ibn ʿAbd al-Malik al-Marwarrūdhī, astronomer to the caliph al-Maʾmūn in Baghdad in the early ninth century; different manuscript copies available to al-Bīrūnī gave different authorities.[74] Al-Bīrūnī also mentions a treatise on this type of astrolabe by Ḥabash al-Ḥāsib, the Baghdad astronomer and instrument maker of the late ninth century.[75]

From the lengthy discussion of this method given in *al-Āthār al-bāqīyah*, it seems that al-Bīrūnī had in mind a star chart rather than an instrument or astrolabe. In any case, he described what today is called a polar case of the azimuthal equidistant projection. The parallels to the ecliptic are shown as equidistant concentric circles, and the ecliptic latitude-measuring circles by radii at equal angular distances, with the north (or south) ecliptic pole at the center of the projection (fig. 2.19). Al-Bīrūnī directs that ninety concentric, evenly spaced circles be drawn, the center being one of the ecliptic poles. The circumference, which represents the ecliptic, is to be divided into four quadrants of ninety equal spaces each, and then radii are to be drawn from the center to each peripheral graduation. After selecting one point on the periphery as the beginning of the house of Aries, the coordinates taken from any star catalog (and augmented to compensate for the precession of the equinoxes) are to be plotted on the projection, measuring their celestial longitude along the periphery and their celestial latitude along the appropriate radius. All the stars in that given hemisphere are to be indicated in yellow or white paint, in different sizes corresponding to the six classes of magnitude. The circles are then to be painted in blue and the constellation outlines drawn around the stars. Al-Bīrūnī's major objection to this method is that the zodiacal constellations are only partially represented because only one hemisphere at a time can be shown. He explains that if you incorporate within the design an area past the ecliptic, as is done on the conventional astrolabic projections, the distortion becomes too great. Furthermore, he objects that the relative positions of the stars toward the periphery of this projection differ greatly from the relative positions of the stars as seen in the heavens.

The next method, al-Bīrūnī felt, was free of the inconveniences posed by the previous one. It is known today as globular projection, and al-Bīrūnī gave both a graphic description and a geometrical explanation of its construction. Since only one hemisphere at a time could be mapped (a limitation he found objectionable in the previous model but allowable here, since it is mapped pole to pole), for completeness he recommended making four maps, two showing hemispheres equinox to equinox and two with the equinoxes at the center of the map. To make one of the first type, he directed the mapmaker to

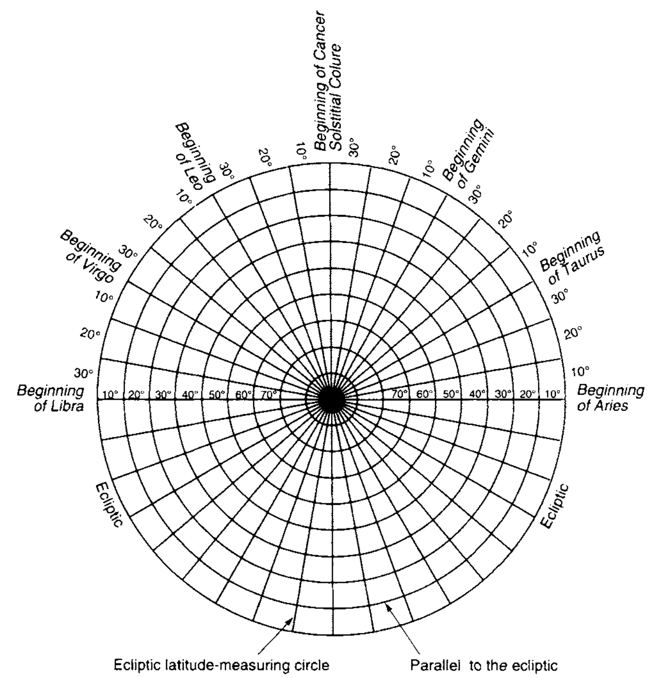


FIG. 2.19. RECONSTRUCTION OF AL-BĪRŪNĪ'S PROJECTION FOR A "FLATTENED" ASTROLABE. According to his specifications there would be ninety equally spaced concentric circles, one for each degree, representing the parallels to the ecliptic and the ecliptic at the periphery of the map. Similarly, there should be equally spaced radii to represent every degree in each quadrant. The result in modern terms is an azimuthal equidistant polar projection.

draw a circle the desired size of the map. The horizontal diameter is designated the ecliptic, and the vertical diameter at right angles is labeled the solstitial colure. By arbitrarily dividing the solstitial colure into 180 equal parts and the periphery into equal parts, 90 to each quadrant, longitude-measuring circles parallel to the ecliptic could be determined by passing arcs of circles through each degree boundary mark of the solstitial colure and the corresponding division marks of the periphery. Similarly, by marking off the ecliptic into 180 equal parts and passing through these divisions arcs of circles that also intersect the two ecliptic poles, the ecliptic latitude-measuring circles are laid out (fig. 2.20).

74. The attribution of this method through al-Farghānī to al-Kindī or to al-Marwarrūdhī is not mentioned in *al-Āthār al-bāqīyah*. In the *Kitāb istīʿāb al-wujūh al-mumkinah fī ṣanʿat al-asṭurlāb* (Comprehensive study of all possible ways of making an astrolabe), al-Bīrūnī gave al-Kindī as the source used by al-Farghānī. Apparently between the composition of *Istīʿāb* and his monograph on projections (*Kitāb fī tasṭīḥ*), al-Bīrūnī saw other copies of al-Farghānī's treatise, some of which gave al-Marwarrūdhī rather than al-Kindī as the originator. These citations are our only source of information that these two astronomers wrote on the subject; Richter-Bernburg, "Al-Bīrūnī's *Maqāla fī tasṭīḥ*," 120 (note 65).

75. Following the reading of Richter-Bernburg, who emends that of Berggren; Richter-Bernburg, "Al-Bīrūnī's *Maqāla fī tasṭīḥ*" (note 65). On Ḥabash al-Ḥāsib, see above, note 54.

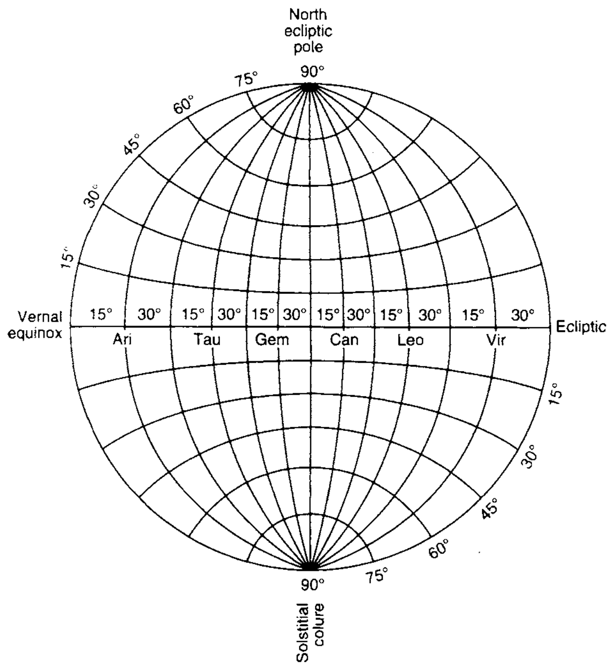


FIG. 2.20. RECONSTRUCTION OF AL-BĪRŪNĪ'S PREFERRED METHOD FOR PRODUCING A STAR MAP. The ecliptic is divided into equal parts (180 according to his specifications) by the ecliptic latitude-measuring circles, which are arcs of circles also passing through both ecliptic poles. The solstitial colure is also to be divided into 180 equal parts by arcs of circles that intersect the periphery and divide it into equal parts. The result in modern terms is a globular projection.

Al-Bīrūnī offers no criticism to the projection by this last method and in fact devotes more time to it than to any other technique, recommending it also for a map of the earth. He presented detailed directions for using it as a grid by which one could transfer the coordinates of each star onto this map by counting the star's longitude along the ecliptic, allotting one space for each degree, and its latitude north or south as the star catalog specified. The magnitudes of the stars are to be indicated by white dots of varying sizes. After all the stars are drawn on it, the background behind is to be painted blue, with the representations of the constellations painted in white over the lapis lazuli ground.

Al-Bīrūnī's sixth method for producing a star map employed dividers, a celestial globe, a graduated straightedge, and a graduated arc for measuring distances between stars on the globe. The distance between any two stars in a constellation is to be measured, then the equivalent number of graduations are to be counted on the graduated straightedge and these two stars placed on the map with that distance between them. The position of a third star was then to be determined by measuring its distance on the globe from each of the first two stars. The equivalent distances were then measured from each of the two stars on the chart, using dividers to find where the two lengths intersect. Another star could then be measured in relation to two of the three already determined, and so on. Though al-Bīrūnī offers no criticism, such mapping would quickly result in enormous angular distortions. It is essentially equivalent to a two-point equidistant projection,[76] which ceases to be useful for more than three stars. No further details are given by al-Bīrūnī, who mentions this method, as well as the final one, only in the specialized monograph on projections.

The final method al-Bīrūnī suggests is to coat each star on a celestial globe with something that will adhere to a surface when touched. The sphere, he says, is then to be rolled on a flat surface with a circular movement in all directions equally, always returning to the same point at which it started. This deceptively simple but thoroughly imprecise method is described only very briefly by al-Bīrūnī.[77]

Because he cites no previous authorities, as was his custom, and offers no critiques, the last three methods are presumably original with al-Bīrūnī. Of these last three, the final two are highly impractical, and in all three instances the descriptions betray no actual experience with practical mapmaking. For example, no one would reasonably put the ground color on after and around the stars, which number over five hundred in each hemisphere. Anyone who had tried that procedure once would thereafter paint the ground first, allowing the grid to show through only slightly. The other two techniques al-Bīrūnī invented are so briefly and vaguely described as to be useless, and it is highly doubtful he ever tried either of them. It is likely that these last three projections were simply ideas of al-Bīrūnī's quite in keeping with his creative and wide-ranging intellect.

Quite certainly the first of his original projections—that now called globular—is carefully delineated mathematically, and it was to have a vigorous and long history in later European cartography, as were the polar case of

76. John P. Snyder, *Map Projections—A Working Manual* (Washington, D.C.: United States Government Printing Office, 1987), 192; see also Berggren, "Al-Bīrūnī on Plane Maps," 67 (note 65).

77. Berggren says that the resulting map is an azimuthal equidistant projection with the pole replaced by an arbitrary point; Berggren, "Al-Bīrūnī on Plane Maps," 67 (note 65). In theory this may be true, but al-Bīrūnī's very brief, nontechnical, nonspecific, nonmathematical description is so vague and impractical that it scarcely merits being equated to a method of projection allowing sufficient precision that a mathematician can calculate a less than 2 percent difference between it and a globular projection with respect to the delineation of the parallels and meridians (not that al-Bīrūnī used meridians). Nor does al-Bīrūnī's description justify the belief that "Bīrūnī was cognizant of this fact when he conceived his . . . mapping"—that is, the fact that the globular map is a good approximation to the equatorial case of azimuthal equidistant projection; Edward S. Kennedy and Marie-Thérèse Debarnot, "Two Mappings Proposed by Bīrūnī," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 1 (1984): 145–47, esp. 147.

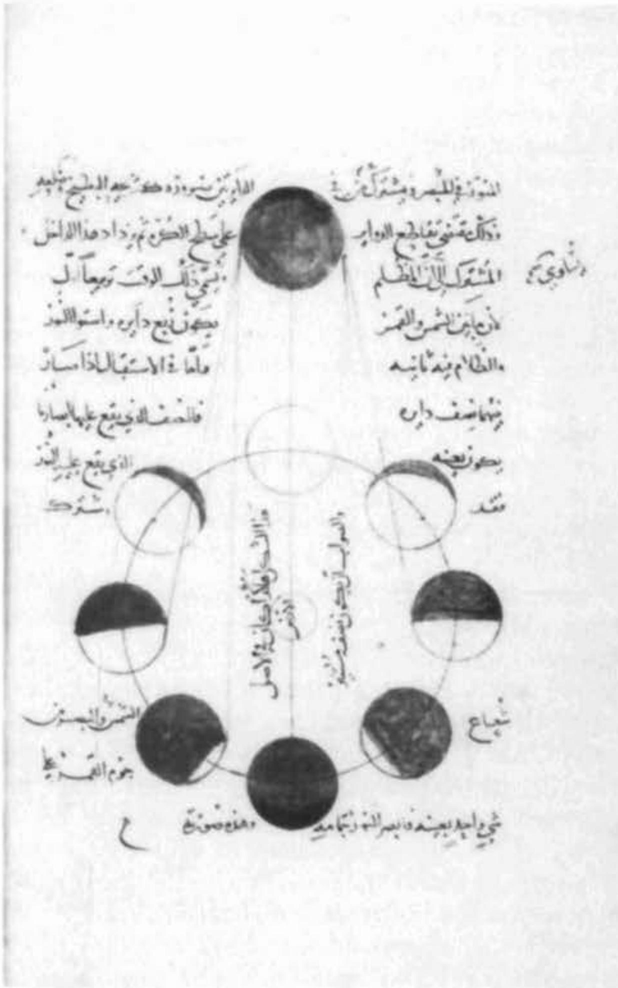


FIG. 2.21. WAXING AND WANING OF THE MOON AS ILLUSTRATED IN THE *KITĀB AL-TAFHĪM LI-AWĀ'IL ṢINĀʿAT AL-TANJĪM* (BOOK OF INSTRUCTION ON THE PRINCIPLES OF THE ART OF ASTROLOGY) BY AL-BĪRŪNĪ. This copy was produced before 839/1435–36.
Size of the folio: ca. 23 × 14.5 cm. By permission of the British Library, London (MS. Or. 8349, fol. 31v).

azimuthal equidistant projection and the orthographic projection, both of which he also carefully described though he did not originate them. How much immediate influence al-Bīrūnī's writings had on projections, however, is difficult to assess.[78] The version of orthographic projection described by al-Bīrūnī employed a plane of projection different from that subsequently used in Europe and produced a map visually quite unlike later orthographic projections. No celestial maps are known to have been produced in the medieval Islamic world by any of the methods described other than stereographic projection, which was continually employed in the construction of astrolabes.[79] These projections that al-Bīrūnī described for celestial maps are good examples of the inventive ideas generated by one of the most creative and profound of medieval savants. Yet his consideration of variant methods of projecting the sphere of stars onto a flat surface had no apparent direct effect upon subsequent celestial or terrestrial mapping in the Islamic world.

Additional Planar Mapping

Arabic, Persian, and Turkish manuscripts abound with diagrams of the celestial spheres and planetary models. It is not my purpose to survey theories of planetary models, many of which showed considerable originality and mathematical sophistication. Such a survey belongs more to the realm of the history of mathematical astronomy than to the history of celestial mapping. Here I attempt only to introduce briefly the various types of celestial maps and diagrams and their applications.

Astronomical treatises are the most important source for diagrams representing the epicycles, deferents, and eccentrics employed in mathematically modeling the course of the planets. Though no artifacts survive, a number of Islamic treatises describe an equatorium—a mechanical computing device for determining the positions of the sun, moon, and planets by means of a geometrical model rather than through calculation. The earliest Islamic treatises on equatoria were composed by three astronomers in Andalusian Spain between A.D. 1015 and 1115. The most sophisticated was the equatorium described by Ghiyāth al-Dīn Jamshīd Masʿūd al-Kāshī, a famous astronomer and mathematician working in

78. An early fifteenth-century Latin manuscript (Rome, Biblioteca Apostolica Vaticana, MS. Palat. 1368, fols. 63v–64r) contains a planispheric map of the heavens drawn in azimuthal equidistant projection. The design is closely allied with that described by al-Bīrūnī, with the ecliptic forming the boundary of the circular map, ecliptic latitude-measuring circles at five-degree intervals indicated by radii, and the longitude-measuring circles at five-degree intervals. Only a few stars and seven constellations are drawn. For a reproduction of this map, along with a trapezoidal projection from the same manuscript, see Richard Uhden, "An Equidistant and a Trapezoidal Projection of the Early Fifteenth Century," *Imago Mundi* 2 (1937): 8 and one pl.

79. Orthographic projection was employed in the unusual Islamic astrolabe, now preserved in Leningrad, made anonymously in the late seventeenth or early eighteenth century for the Safavid ruler Shāh Ḥusayn. The plane of projection al-Bīrūnī employed is different, however, for al-Bīrūnī used the plane of the ecliptic whereas this astrolabe maker used the plane of the solstices. The similarity of this late Safavid astrolabe to that used by Hugo Helt and associated with the name Juan de Rojas is so striking that it seems certain this unique Islamic example was in fact based directly on a European model; see Maddison, *Hugo Helt*, 21 n. 32 (note 5). See also Roser Puig [Aguilar], "La proyeccion ortografica en el *Libro de la Açafeha* Alfonsi," in *De astronomia Alphonsi Regis*, ed. Mercè Comes, Roser Puig [Aguilar], and Julio Samsó, Proceedings of the Symposium on Alfonsine Astronomy held at Berkeley (August 1985), together with other papers on the same subject (Barcelona: Universidad de Barcelona, 1987), 125–38.

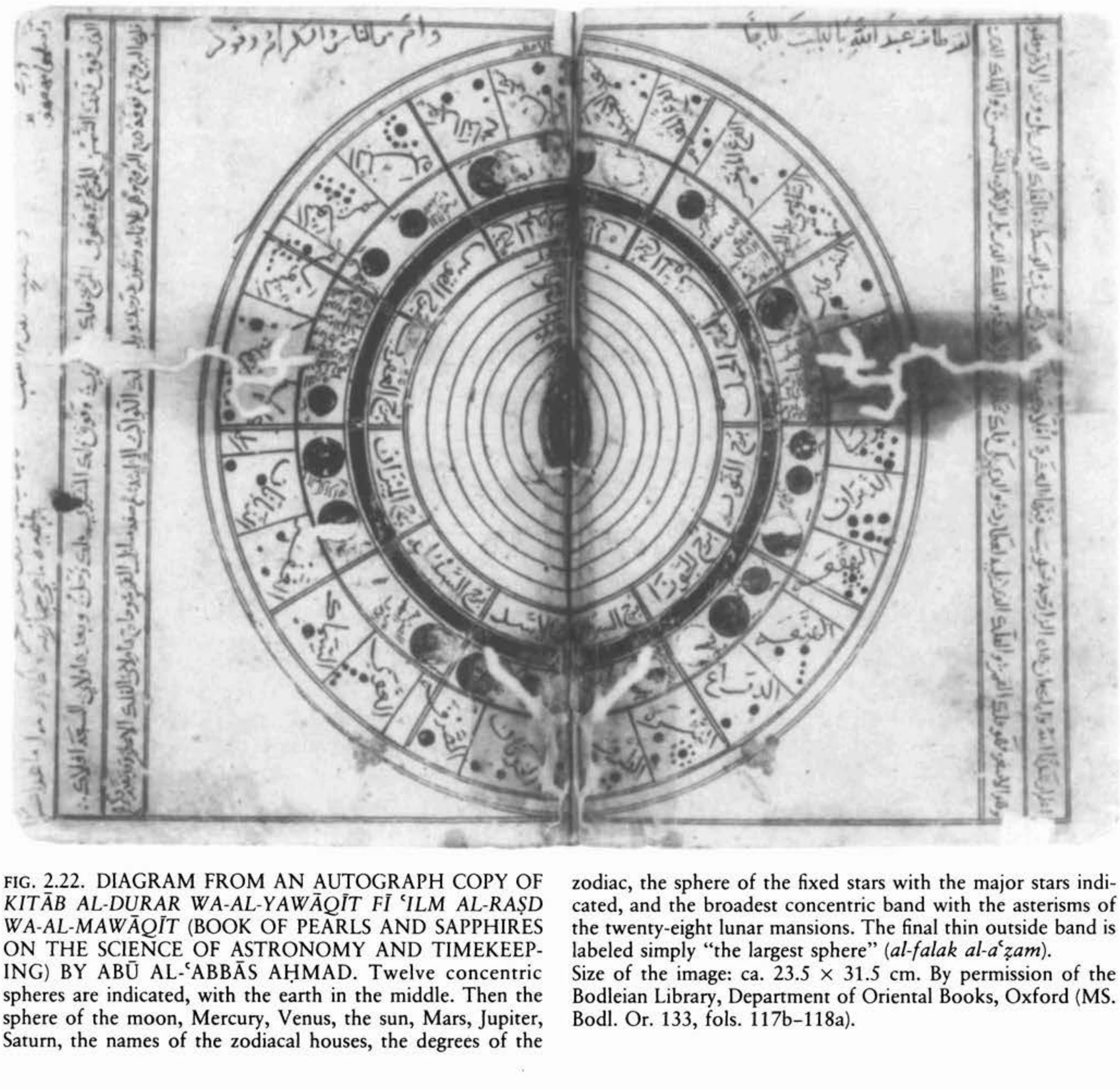


FIG. 2.22. DIAGRAM FROM AN AUTOGRAPH COPY OF *KITĀB AL-DURAR WA-AL-YAWĀQĪT FĪ ʿILM AL-RAṢD WA-AL-MAWĀQĪT* (BOOK OF PEARLS AND SAPPHIRES ON THE SCIENCE OF ASTRONOMY AND TIMEKEEPING) BY ABŪ AL-ʿABBĀS AḤMAD. Twelve concentric spheres are indicated, with the earth in the middle. Then the sphere of the moon, Mercury, Venus, the sun, Mars, Jupiter, Saturn, the names of the zodiacal houses, the degrees of the zodiac, the sphere of the fixed stars with the major stars indicated, and the broadest concentric band with the asterisms of the twenty-eight lunar mansions. The final thin outside band is labeled simply "the largest sphere" (*al-falak al-aʿẓam*).
Size of the image: ca. 23.5 × 31.5 cm. By permission of the Bodleian Library, Department of Oriental Books, Oxford (MS. Bodl. Or. 133, fols. 117b–118a).

Samarkand in the early fifteenth century.[80] One can also find in astronomical/astrological compendiums diagrams of solar and lunar eclipses and phases of the moon. An example from al-Bīrūnī's treatise on astrology is illustrated in figure 2.21.

More extensive and comprehensive diagrams of the entire heavens were, however, included in cosmological as well as astronomical/astrological writings. The example illustrated in figure 2.22 is a particularly elaborate mapping of the entire heavens from an astronomical treatise *Kitāb al-durar wa-al-yawāqīt fī ʿilm al-raṣd wa-al-mawāqīt* (Book of pearls and sapphires on the science of astronomy and timekeeping), written and illustrated in 734/1333–34 by Abū al-ʿAbbās Aḥmad ibn Abī ʿAbdallāh Muḥammad, originally of Egypt. It is unusual in that it attempts to show the major stars of the zodiacal constellations and the asterisms of the lunar mansions (to be discussed further below), in addition to the spheres of the planets, with the earth at the center.

80. Al-Kāshī, *Nuzhat al-ḥadāʾiq*; see *The Planetary Equatorium of Jamshīd Ghiyāth al-Dīn al-Kāshī (d. 1429)*, an edition of the anonymous Persian manuscript 75 [44b] in the Garrett Collection at Princeton University, translated with commentary by Edward S. Kennedy (Princeton: Princeton University Press, 1960); Edward S. Kennedy, "The Equatorium of Abū al-Ṣalt," *Physis* 12 (1970): 73–81.

FIG. 2.23. THE SPHERE OR ORBIT OF THE SUN, LOWER LEFT, AND THE PERSONIFICATION OF THE PLANET VENUS AS A LUTENIST, UPPER RIGHT. From a late fourteenth-century Iraqi copy of *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt* (Marvels of things created and miraculous aspects of things existing) by Zakariyāʾ ibn Muḥammad al-Qazwīnī.
Size of the original: 32.7 × 22.4 cm. Courtesy of the Freer Gallery of Art, Smithsonian Institution, Washington, D.C. (acc. no. 54.34v).

FIG. 2.24. DESIGN FOR A CLOCKFACE FROM *KITĀB FĪ MAʿRIFAT AL-ḤIYAL AL-HANDASĪYAH* (BOOK OF KNOWLEDGE OF INGENIOUS MECHANICAL DEVICES). The book was written in 603/1206 by al-Jazārī and copied in Ramadan 715/December 1315 in Syria.
Size of the original: 31.5 × 21.9 cm. Courtesy of the Freer Gallery of Art, Smithsonian Institution, Washington, D.C. (acc. no. 30.74v).

A number of illustrations of the orbits of the planets are included in the popular thirteenth-century cosmology *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt* (Marvels of things created and miraculous aspects of things existing), by Zakariyāʾ ibn Muḥammad al-Qazwīnī (d. 682/1283). Figure 2.23 is taken from a late fourteenth-century copy written in Iraq, in which the orbit of the sun is shown in the lower left of the page, with the personification of the planet Venus as a lutenist in the upper right. Such planetary personifications will be discussed further below.

Two-dimensional modeling can also be seen in clockface design. In addition to the astrolabic clockfaces with open star maps mentioned earlier, there were also clock designs that called for disks representing the movement of the zodiacal signs and the sun and moon. Ibn al-Razzāz al-Jazārī in his *Kitāb fī maʿrifat al-ḥiyal al-handasīyah* (Book of knowledge of ingenious mechanical devices), written in 603/1206, described the face of his first clock as having a copper zodiac disk, only half of which would be visible at any one time. Inside the circular rim containing the zodiacal signs there would be colored disks representing the sun in yellow glass and the moon in white glass. Separate movable plates were required for the sun and moon to allow for their correct positioning for a given day. These plates were to be eccentric to the center point of the zodiac plate in order to show in a general way the relative positions of the sun, moon, and zodiac.[81] A particularly fine illustration of this design is

81. Donald R. Hill, *Arabic Water-Clocks* (Aleppo: University of Aleppo, Institute for the History of Arabic Science, 1981), 92–111 and pls. 1 and 3.

found in a manuscript of al-Jazarī's treatise copied in Syria in 715/1315 (fig. 2.24).

THREE-DIMENSIONAL CELESTIAL MAPPING

SPHERICAL ASTROLABES

While the conventional astrolabe consisted of a pierced planispheric star map placed over a projection of the celestial coordinate system as it relates to the observer's locality, there was also a three-dimensional version whose construction did not require a knowledge of stereographic projection and allowed for adjustment to different geographic latitudes. It was a spherical astrolabe consisting of a metal sphere on which were inscribed the horizon, circles of equal altitude above and parallel to the horizon (almucantars), circles of equal azimuth (vertical altitude circles), and unequal hour lines. Over this sphere there was a rotating cap of open metalwork representing the ecliptic, the equator, and some fixed stars indicated by pointers. This movable cap, which was the equivalent of the rete of a planispheric astrolabe, also had a graduated vertical quadrant with a sliding gnomon for measuring solar altitudes. Stellar observations were made by using a sighting tube that projected diametrically through the globe and the slot within the graduated vertical quadrant. There is evidence that on some instruments there was a rotating alidade with two sights attached to the ecliptic pole of the "rete" or movable cap. The sphere also had holes bored at various positions to allow the openwork cap to be reset for use at different geographic latitudes.

It seems reasonable that the spherical astrolabe, which is simpler in concept, would have preceded the planispheric astrolabe in development. Historical evidence so far available, however, suggests that the spherical astrolabe may have been an early but distinctly Islamic development with no Greek antecedents.[82] Even so, though it was theoretically appealing in that it generated a number of treatises on its construction and use, it does not seem to have been a viable and practical instrument, since only two are known to exist today. Assuming that the vagaries of time and chance have not unduly skewed the evidence, the spherical astrolabe seems never to have been a very popular form of celestial modeling. The only preserved examples are one by an otherwise unknown maker, Mūsā, made in 885/1480–81 (fig. 2.25),[83] and an unsigned specimen, undated but possibly from the sixteenth century, made for use in Tunis.[84]

Arabic treatises on the spherical astrolabe (*asṭurlāb kurī*) were apparently written as early as the beginning of the ninth century, for there is extant today a treatise on the subject by Ḥabash al-Ḥāsib, who may still have been living in 300/912.[85] Not long thereafter the mathematician and translator Qusṭā ibn Lūqā (d. ca. 300/912–

FIG. 2.25. SPHERICAL ASTROLABE MADE BY MŪSĀ IN 885/1480–81. On the rotating openwork cap, the broad band represents the ecliptic, with stars indicated by pointers. The smaller circular band concentric with the north celestial pole (indicated by the suspensory device) is parallel to the equator and allows equatorial measurements without the complication of constructing a true equatorial circle. The vertical quadrant, positioned along the solstitial colure, is graduated to permit measurements and has a sliding gnomon in the middle for measuring the altitude of the sun.
Diameter of the original: 8.3 cm. Museum of the History of Science, Oxford (acc. no. 62-25). By permission of the Bettman Archive, New York.

13), of Baalbek in Syria, may have written one, though the authenticity of this treatise has been questioned, and a treatise is also attributed to Abū al-ʿAbbās al-Nayrīzī,

82. Francis R. Maddison, "A 15th Century Islamic Spherical Astrolabe," *Physis* 4 (1962): 101–9, esp. 102 n. 6; and the introductory historical essay in Brieux and Maddison, *Répertoire* (note 36). For some theories as to the origin of the spherical astrolabe, see Turner, *Astrolabes*, 185–86 (note 19).

83. Oxford, University of Oxford, Museum of the History of Science, acc. no. 62-65; Maddison, "Spherical Astrolabe" (note 82).

84. Collection of Signor Ernesto Canobbio, Como. The rotating pierced cap forming the rete is missing; Ernesto Canobbio, "An Important Fragment of a West Islamic Spherical Astrolabe," *Annali dell'Istituto e Museo di Storia della Scienza di Firenze*, 1, fasc. 1 (1976): 37–41.

85. Three copies of Ḥabash al-Ḥāsib's treatise *al-ʿAmal bi-al-asṭurlāb al-kurī wa-ʿajāʾibuhu* are preserved today, two in Istanbul and one in Tehran; see Sezgin, *Geschichte des arabischen Schrifttums*, 6:175 (note 35).

who died about 310/922–23. Quite certainly al-Bīrūnī wrote on the subject, and one of our most important sources of information on the spherical astrolabe as well as other instruments is the astronomical compendium written about 680/1281–82 by Abū ʿAlī al-Marrākushī in Cairo.[86]

In the thirteenth century a Castilian treatise on the spherical astrolabe was included in the *Libros del saber de astronomía* prepared for Alfonso el Sabio. An Arabic treatise on the subject was apparently not easily available in thirteenth-century Spain, for Isaac ibn Sid (Isḥāq ibn Sīd) was commissioned to write a new treatise for the Alfonsine collection.[87]

There is even less evidence of an interest in the design or production of spherical astrolabes in the eastern parts of the Islamic world than there is for the western regions. It is, however, recorded that a certain Abū Isḥāq al-Ṣābī constructed one for Qābūs ibn Vushmgīr, a ruler in Gurgan in northern Persia from 366/977 to 371/981 and 388/998 to 403/1012–13 and onetime patron of al-Bīrūnī, to whom al-Bīrūnī dedicated his *al-Athār al-bāqīyah*.[88] No examples made in Persia or India are known to be preserved, though the spherical astrolabe by Mūsā (fig. 2.25) is stylistically consistent with instruments produced in the fifteenth century in Persia as well as those made in the Syro-Egyptian region.[89]

Though the spherical astrolabe formed an excellent working model of the heavens and an analog computing device for solving basic timekeeping and astrological problems, it proved not very popular, perhaps because it was less convenient than the easily transportable planispheric astrolabe and because its construction presented more difficult problems to the metalworker.

CELESTIAL GLOBES

In contrast to the spherical astrolabe, which appears to have been rarely manufactured, the three-dimensional model of the skies that was commonly made in all parts of the Islamic world was the celestial globe. Given the difficulty of producing spherical astrolabes, it is interesting to observe the continuous production of celestial globes in both the eastern and western regions of Islam.

The celestial globe has the longest and most ancient history of any of the forms of celestial mapping. The idea of constructing a physical model to represent the arrangement and movement of the stars appears to have first arisen in Greek antiquity, and if the traditions are reliable it can be traced to the sixth century B.C., when Thales of Miletus first constructed a celestial globe.[90] The stars were commonly perceived—as indeed they still are by the average person looking up at the night sky—as though attached to the inside of a hollow sphere enclosing and rotating about the earth. Consequently, the earliest attempts to represent celestial phenomena in a model were by means of a celestial globe. The earth, which was known from early classical antiquity to be spherical, was imagined at the center of the globe, while the stars were placed on its surface, so that the resulting model presented the stars as seen by an observer outside the sphere of fixed stars. Thus the relative positions of the stars on a celestial globe are the reverse, east to west (or right to left), of their appearance when viewed from the surface of the earth.

The early Greco-Roman celestial globes had circles of constant visibility and constant invisibility on them. These indicated the areas of the sky in which, at a given geographic latitude, certain constellations never passed beneath the horizon or never rose to a position of visibility at that locality. The position of such circles on a globe would differ depending on the geographic latitude for which the globe had been designed. By the time of Ptolemy in the second century A.D. these always visible and always invisible circles were no longer required on celestial globes. Instead, a horizon ring around the globe showed the always visible and always invisible areas of the firmament for any latitude desired. Consequently, on

86. An inadequate summary of the section on instruments in al-Marrākushī's treatise, *Kitāb jāmiʿ al-mabādiʾ wa-al-ghāyāt*, is given by Louis Amélie Sédillot, "Mémoire sur les instruments astronomiques des arabes," *Mémoires Présentés par Divers Savants a l'Académie Royale des Inscriptions et Belles-Lettres*, 1st ser., 1 (1844): 1–229 and pls. 1–36; facsimile reprint Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1986. See also David A. King, "al-Marrākushī," in *Encyclopaedia of Islam*, new ed., 6:598.

87. For the Castilian translations of Isaac ibn Sid, see John D. North, "The Alfonsine Books and Some Astrological Techniques," in *De astronomia Alphonsi Regis*, ed. Mercè Comes, Roser Puig [Aguilar], and Julio Samsó, Proceedings of the Symposium on Alfonsine Astronomy held at Berkeley (August 1985), together with other papers on the same subject (Barcelona: Universidad de Barcelona, 1987), 43–50. For the Castilian texts as well as the treatises by al-Nayrīzī, al-Bīrūnī, and Qusṭā ibn Lūqā, see *Libros del saber de astronomía*, 2:113–222 (note 46), and Hugo Seemann and Theodor Mittelberger, *Das kugelförmige Astrolab nach den Mitteilungen von Alfons X. von Kastilien und den vorhandenen arabischen Quellen*, Abhandlungen zur Geschichte der Naturwissenschaften und der Medizin, vol. 8 (Erlangen: Kommissionsverlag von Max Mencke, 1925). A treatise by al-Rūdānī (d. 1094/1683) has been the object of study by Charles Pellat, "L'astrolabe sphérique d'al-Rūdānī," *Bulletin d'Etudes Orientales* 26 (1973): 7–82 and 28 (1975): 83–165, and Louis Janin, "Un texte d'ar-Rudani sur l'astrolabe sphérique," *Annali dell'Istituto e Museo di Storia della Scienza di Firenze*, 3, fasc. 2 (1978): 71–75. For the few European manuscripts on the subject, see Maddison, "Spherical Astrolabe," 103 n. 13 (note 82), and Murdoch, *Album of Science*, 268 (no. 239) (note 7).

88. Sayılı, *Observatory in Islam*, 158 (note 44).

89. Maddison, "Spherical Astrolabe," 106 (note 82).

90. For the history of celestial globes in classical antiquity, see the relevant chapters in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987-), specifically 1:140–47, 167–70, and 181–82, and Savage-Smith, *Islamicate Celestial Globes*, 3–15 (note 5).

all Islamic globes there are no such always visible and always invisible circles. They were replaced by polar circles having the celestial poles as centers and passing through the ecliptic poles (and on some globes ecliptic polar circles passed through the celestial poles). From our fragmentary evidence, it seems that by the second century A.D. most globes would have indicated on their surface the celestial equator, the northern and southern tropic circles, the ecliptic (or wide band for the zodiac), and a selection of stars with constellation outlines. The globe was then attached at the equatorial poles to a meridian ring and set into a horizon ring.

The *Almagest* of Ptolemy is important to the history of Islamic celestial globes for two reasons. First, his star catalog presented in the *Almagest*[91] became in the Arabic-speaking world the basis for all the star catalogs used by instrument makers in designing their instruments. In this catalog each of 1,025 stars was assigned a magnitude of one to six and described in relation to one of the forty-eight constellation outlines, as well as given a specific position in terms of the ecliptic coordinates of longitude and latitude.

Second, also in the *Almagest*, Ptolemy gave explicit instructions for the design of a celestial globe.[92] This globe, however, was not the usual type but was designed so as not to become outdated by the precession of the equinoxes. The customary globe in his day apparently had both the ecliptic and the equator shown directly upon the surface of the sphere along with the stars, which would mean that the passage of time would invalidate the instrument after three-quarters of a century. Ptolemy's design for a celestial globe was unique in that he avoided this problem by placing on the sphere only the stars and the ecliptic, not the equator or its parallel circles. In addition, an arrangement of rings could be adjusted to any time period as well as any geographic latitude. Ptolemy's design is not, however, known to have been followed in the Islamic world, even though the *Almagest* circulated widely and was for many centuries the fundamental astronomical treatise in Islam, as it was in the West.

Though the channels of information regarding celestial globes that extended to the Near East are unknown (other than Ptolemy's *Almagest*, which in this respect was not followed), there clearly were several sources available, probably including some Byzantine globes. It is evident from both written documents and preserved artifacts that by the ninth century celestial globes were being made in the Arabic-speaking world. They were mounted in two graduated rings, a meridian ring and horizon ring, which made them adjustable to different geographic latitudes. On these globes, along with the stars, both the ecliptic and the equator were shown on the sphere itself, nearly always by graduated bands. On all extant Islamic globes that have the constellation outlines on them, the human figures face outward toward the person using the globe rather than in toward the globe with their backs to the observer, as was apparently, from our very fragmentary evidence, common in the Greco-Roman and Byzantine worlds. The same basic orientation of the stars was maintained, however, so that if an Islamic globe is viewed from above the north pole, the sequence of the zodiacal constellations will be counterclockwise.[93]

On every Islamic globe preserved today there is a set of six great circles at right angles to the ecliptic, that is, six ecliptic latitude-measuring circles. When and where this convention first became customary is unknown. The circles no doubt reflect the common use of ecliptic-based coordinates for measuring star positions that had been inherited with Ptolemaic astronomy. The solstitial colure was always shown (since it is also one of the six ecliptic latitude-measuring circles) and sometimes the equinoctial colure, but a full set of six meridians (at right angles to the equator) was not usually present on Islamic celestial globes, the exceptions being nineteenth-century Indian products, just as apparently they were not on Greco-Roman globes. On Islamic globes the Tropic of Cancer and the Tropic of Capricorn were frequently shown as well as the north and south equatorial polar circles. Finally, particularly on some later globes, the ecliptic equivalents of the tropic and polar circles were indicated, apparently in an attempt to complete the symmetry. See figure 2.26 for the basic design of an Islamic globe, to which is attached a rotatable meridian ring.[94] To function, this globe and meridian ring would then be placed in a horizon ring, such as that shown in figure 2.28.

91. *Almagest*, 7.5 to 8.2; Ptolemy, *Opera quae exstant omnia*, 3 vols., ed. J. L. Heiberg (Leipzig: B. G. Teubner, 1898–1907), vol. 1, *Syntaxis mathematica* (1903), pt. 2, 38–169; *Ptolemy's "Almagest,"* trans. and annotated G. J. Toomer (London: Duckworth, 1984), 14–17, 339–99; Gerd Grasshoff, *The History of Ptolemy's Star Catalogue* (New York: Springer-Verlag, 1990); M. Shevchenko, "An Analysis of Errors in the Star Catalogues of Ptolemy and Ulugh Beg," *Journal for the History of Astronomy* 21 (1990): 187–201; Savage-Smith, *Islamicate Celestial Globes*, 8 and 114–15 (note 5). For a revisionist interpretation of the star catalog of Ptolemy, see Robert R. Newton, *The Crime of Claudius Ptolemy* (Baltimore: Johns Hopkins University Press, 1977), 211–56.

92. For an interpretation of Ptolemy's celestial globe different from that given in Dilke and editors, "Culmination of Greek Cartography," 181–82 (note 67), see Savage-Smith, *Islamicate Celestial Globes*, 8–10 (note 5).

93. Among the preserved Islamic globes, three are known to have a clockwise sequence. One is cataloged and illustrated in Savage-Smith, *Islamicate Celestial Globes*, 242 (no. 46) and 51 (fig. 23) (note 5); the other two are as yet unpublished. In all three cases there are other odd features about the globes that encourage the conclusion that they are recent forgeries. The clockwise sequence is occasionally found on modern European celestial globes.

94. For further information on the design of globes and rings, see Savage-Smith, *Islamicate Celestial Globes*, 61–95 (note 5).

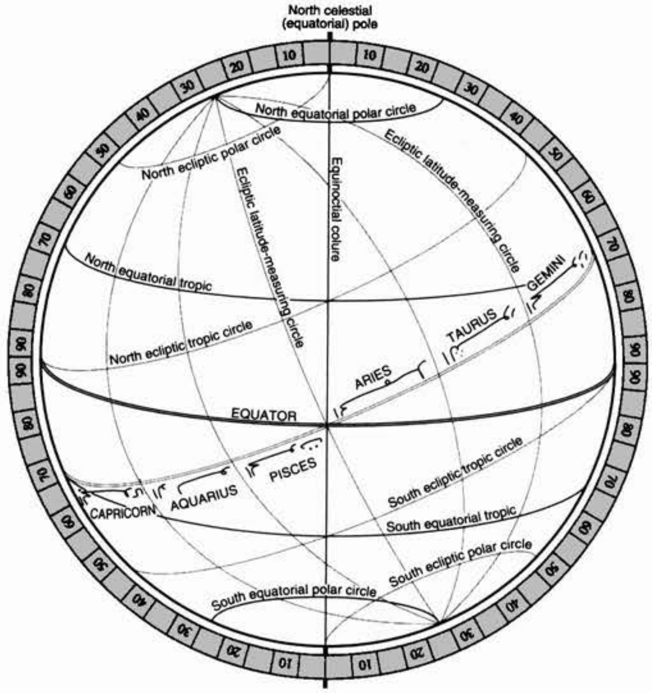


FIG. 2.26. BASIC DESIGN OF EXTANT ISLAMIC CELESTIAL GLOBES, WITH ATTACHED ROTATABLE MERIDIAN RING.

A celestial globe lacks the observational capacity of an astrolabe, for it possesses no sighting device. If, however, a carefully constructed celestial globe with stars is supplemented by a quadrant and a gnomon, as well as calendrical tables of the sort inscribed on the backs of astrolabes, then all the astronomical and astrological data accessible with an astrolabe can also be obtained by means of a celestial globe. Like the astrolabe, the celestial globe is not a direct reading instrument, for the astronomer, after making the initial observation, must manipulate and calculate the desired information. The celestial globe has the advantage of simplicity of design and the ability to function at any geographic location. The planispheric astrolabe, however, is far more portable and requires fewer supplementary instruments. It is clear from the historical evidence that celestial globes were an important part of the equipment of an astronomical observatory and were considered of practical value by astronomers. The maker of one globe informs us that his well-constructed celestial globe with a full set of constellation figures was made "in a manner useful for the knowledge of all the requirements of astrolabemakers, as an *aide-mémoire* to their craft."[95] It is questionable, however, how many of the extant globes were of more than didactic or artistic value to their owners.

Early in the ninth century the Baghdad astrolabe maker and astronomer ʿAlī ibn ʿĪsā al-Asṭurlābī is said to have made a large celestial globe.[96] As with astrolabes, however, the most important Islamic center of globe making was the city of Harran. In the latter part of the ninth century the influential astronomer of Harran, Abū ʿAbdallāh Muḥammad ibn Jābir al-Battānī al-Ṣābiʾ, known in the Latin world as Albategni or Albatenius, wrote a comprehensive astronomical treatise in which he described a celestial globe that was suspended in five rings.[97] This ingenious globe had stars carefully placed by coordinates on the sphere, with the ecliptic, equator, and ecliptic latitude-measuring circles as well. The sphere was attached at the equatorial poles to a graduated meridian ring, which was in turn nested within a second meridian ring, so that the inner ring could be moved while the outer remained stationary. There were also a horizon ring, a zenith ring, and an outside graduated ring that carried a movable gnomon for measuring solar altitudes. The entire assembly was suspended rather than set on a base. No globes exactly of this nature are known to be preserved, although some of the features are to be found on one made between A.D. 1278 and 1310 by Muḥammad ibn Muʾayyad al-ʿUrḍī, the son of the famous astronomer Muʾayyad al-Dīn al-ʿUrḍī al-Dimishqī, who made instruments for the observatory at Maragheh, about fifty miles south of Tabriz in northwestern Persia.[98]

From the ninth century at least two treatises on the celestial globe have been preserved. The Baghdad astronomer Ḥabash al-Ḥāsib wrote a treatise *Kitāb fī maʿrifat al-kurah* (Book of the knowledge of the globe) which is extant in three manuscripts.[99] Toward the end of the ninth century Qusṭā ibn Lūqā, also working in Baghdad, composed *Kitāb fī al-ʿamal bi-al-kurah al-falakīyah* (Book on the use of the celestial globe), which has also survived in several manuscripts.[100] This latter treatise was

95. Part of the signature inscription of a globe made by ʿAlī Kashmīrī ibn Lūqmān in 998/1589–90; London, private collection; see Savage-Smith, *Islamicate Celestial Globes*, 223–24 (no. 10) and 74–79 (note 5), for further information on the use of globes.

96. Abū al-Ḥusayn ʿAbd al-Raḥmān ibn ʿUmar al-Ṣūfī, *Kitāb ṣuwar al-kawākib al-thābitah* (Book of the constellations of the fixed stars); see *Ṣuwaru'l-kawākib or (Uranometry) (Description of the 48 Constellations): Arabic Text, with the ʾUrjūza of Ibn u'ṣ-Ṣūfī Edited from the Oldest Extant Mss. and Based on the Ulugh Beg Royal Codex (Bibliothèque Nationale, Paris, Arabe 5036)* (Hyderabad: Dāiratu'l-maʿārif-il-ʿOsmania [Osmania Oriental Publications Bureau], 1954), Arabic text, p. 5. The name al-Ḥarrānī has been added to ʿAlī ibn ʿĪsā by the editors; he in fact worked in Baghdad and Damascus and does not seem to have been originally from Harran.

97. See Savage-Smith, *Islamicate Celestial Globes*, 18–21 and 88–89 (note 5), for a reconstruction of al-Battānī's globe.

98. Dresden, Staatlicher Mathematisch-Physikalischer Salon; Savage-Smith, *Islamicate Celestial Globes*, 220 (no. 5) (note 5).

99. Recently edited and translated by Richard P. Lorch and Paul Kunitzsch, "Ḥabash al-Ḥāsib's Book on the Sphere and Its Use," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 2 (1985): 68–98.

100. There is a partial translation from one manuscript by W. H. Worrell, "Qusta ibn Luqa on the Use of the Celestial Globe," Isis 35 (1944): 285–93. Lorch and Kunitzsch, "Ḥabash al-Ḥāsib's Book" (note 99), have studied two of the preserved manuscripts.

FIG. 2.27. THE EARLIEST PRESERVED ISLAMIC CELESTIAL GLOBE. Made in Spain, in Valencia, in 473/1080 by Ibrāhīm ibn Saʿīd al-Sahlī al-Wazzān in collaboration with his son Muḥammad.
Diameter of the original: 20.9 cm. By permission of the Istituto e Museo di Storia della Scienza, Florence (inv. no. 2712).

translated into Latin by Stephanus Arnaldus as *De sphaera solida*, into Hebrew by Prophatius Judaeus in the thirteenth century, and into Italian in 1341 by "Maestro Bernardo Arabico ouero Saracino."[101] A Castilian translation was completed in A.D. 1259 under the collaboration of Jehuda ben Moses Cohen and Maestre Johan Daspa and forms part of the *Libros del saber de astronomía* compiled for Alfonso el Sabio.[102]

Thereafter a number of treatises on the celestial globe were composed, including one in the tenth century by Abū al-Ḥusayn ʿAbd al-Raḥmān ibn ʿUmar al-Ṣūfī (d. 372/983),[103] whose treatise on constellations was to prove fundamental to constellation iconography in the Islamic world. From the early twelfth century we have a particularly interesting treatise composed by ʿAbd al-Raḥmān al-Khāzinī, who later dedicated some other astronomical writings to the Seljuk ruler of eastern Persia. This treatise describes a celestial globe that, instead of being placed in the usual set of rings, is half sunk in a box and propelled so as to rotate once a day by a mechanism of pulleys driven by a weight resting on top of a reservoir of sinking sand.[104]

There are known to be preserved today 175 Islamic celestial globes, none predating the eleventh century.[105] The earliest bears a date equivalent to A.D. 1080 and was made in Spain, in Valencia (fig. 2.27).[106] It was made by a leading astrolabe maker Ibrāhīm ibn Saʿīd al-Sahlī al-Wazzān with the collaboration of his son Muḥammad. The most recent dated globe was made in Ottoman Turkey in 1882,[107] and a number of nineteenth-century workshops were active in northwestern India and in Iran.

The language in which a globe is inscribed is not as distinguishing a feature of Islamic celestial globes as might at first be thought, for there are Islamic globes extant today that are labeled and signed in Arabic, Persian, Turkish, Sanskrit, and even entirely in English. Yet even the globe labeled entirely in English is completely within the tradition of Islamic celestial globes. It was made for an English patron, probably in the Indian workshop of Lālah Balhūmal Lāhūrī, who made globes and astrolabes in Lahore in the 1840s.[108] It has the classical

101. Savage-Smith, *Islamicate Celestial Globes*, 21–22 (note 5).

102. *Libros del saber de astronomía*, 1:163–208 (note 46); Julio Samsó, "El tratado Alfonsí sobre la esfera," *Dynamis: Acta Hispanica ad Medicinae Scientiarumque Historiam Illustrandam* 2 (1982): 57–73, interprets the construction differently than does Savage-Smith, *Islamicate Celestial Globes*, 22, 74, and 81–82 (note 5).

103. Recently summarized and discussed by Edward S. Kennedy, "Al-Ṣūfī on the Celestial Globe," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 5 (1989): 48–93.

104. Recently edited and translated by Richard P. Lorch, "Al-Khāzinī's 'Sphere That Rotates by Itself,'" *Journal for the History of Arabic Science* 4 (1980): 287–329.

105. This total includes forty-three that were not known to exist when the history and catalog was prepared by Savage-Smith, *Islamicate Celestial Globes* (note 5). For some recently discovered globes, see Emilie Savage-Smith, "The Classification of Islamic Celestial Globes in the Light of Recent Evidence," *Der Globusfreund* 38/39 (1990): 23–35 and pls. 2–6, and the forthcoming catalog of Islamic scientific instruments in the Nasser D. Khalili Collection of Islamic Art by Francis R. Maddison and Emilie Savage-Smith.

106. Florence, Istituto e Museo di Storia della Scienza, inv. no. 2712. The date has been read as 1 Ṣafar 473/22 July 1080 and 1 Ṣafar 478/28 May 1085; see Savage-Smith, *Islamicate Celestial Globes*, 24 and 217 (no. 1) (note 5).

107. Istanbul, private collection; Savage-Smith, *Islamicate Celestial Globes*, 255–56 (no. 75) (note 5).

108. Nasser D. Khalili Collection of Islamic Art, inv. no. SCI 44. This unsigned and undated globe can with certainty be attributed to the workshop of Balhūmal, who is known to have made an astrolabe for Sir Henry Elliott, K.C.B., chief secretary to his lordship the governor-general in Kapurthala, one of the states of the Punjab. For an illustration of this globe, see Savage-Smith, "Classification of Islamic Celestial Globes," pl. 3 (note 105). For other celestial globes by Balhūmal, see Savage-Smith, *Islamicate Celestial Globes*, 52–55, 235–36 (no. 33), 275–76 (no. 127), and 304 n. 180 (note 5).

FIG. 2.28. ISLAMIC CELESTIAL GLOBE MADE IN 834/1430–31 BY MUḤAMMAD IBN JAʿFAR.
Diameter of the original: 10.5 cm. By permission of the Trustees of the British Museum, Department of Oriental Antiquities, London (inv. no. 26.3.23).

forty-eight constellations, drawn to reflect Mughal artistic conventions found on globes made two hundred years earlier in northwestern India. The star positions are adjusted for the first half of the nineteenth century, and six meridian circles have been added to the globe along with the ubiquitous ecliptic latitude-measuring circles. It can be seen from all the extant Islamic celestial globes that, except for some minor points of design and some considerable progress in construction techniques, the tradition of instrument design inherited from the Hellenistic and Byzantine world remained essentially unchanged through the end of the nineteenth century.

In terms of design, Islamic celestial globes fall into several distinct categories. The first category includes the largest and the most elaborate artifacts. They average about 168 millimeters in diameter, and they all show the forty-eight constellation outlines and approximately 1,022 stars, those found in the medieval star catalogs.[109] The earliest globe preserved today is of this design (fig. 2.27), and they continued to be made well into the nineteenth century. Other examples are illustrated in figures 2.31 and 2.37 below.[110]

The second style of design[111] is a globe that does not have constellation outlines. Only a selection of the most prominent stars, usually between twenty and sixty, are shown. The same basic great and lesser circles are to be found on these globes as on the more elaborate ones, and when well executed such globes can be fine precision pieces. They tend, in general, to be smaller than the previous category, with an average diameter of slightly over 100 millimeters, though papier-mâché examples are more than double that size. The earliest one dates from the middle of the twelfth century,[112] and this category includes the most recent dated celestial globe. The example illustrated in figure 2.28 was made in 834/1430–31 by an astrolabe and globe maker in Kirman in southeast Persia, Muḥammad ibn Jaʿfar ibn ʿUmar al-Asṭurlābī.[113] His father also made globes of a rather elaborate style with full constellations, done in the precise tradition of a specialist scientific instrument maker. The son produced, as far as is known, only two globes, both of this second type, showing just the major stars. His products tend not to be as accurately inscribed as those made by his father, having slight wobbles in the great circles and

109. This class of globe has been called, for lack of a better term, "Class A Globes" in the study by Savage-Smith, *Islamicate Celestial Globes*, 61–71, 217–47, 275–76, 278–83 (note 5).

110. One of the outstanding examples of this first category was made in 622/1225 for a nephew of the great Saladin in Egypt. This brass globe (Museo Nazionale, Naples) has the classic set of forty-eight constellations engraved and damascened with copper, with approximately 1,025 stars represented by six sizes of inlaid silver points corresponding to the various magnitudes. It also has a scale showing the sizes of silver points used for the first five magnitudes; Savage-Smith, *Islamicate Celestial Globes*, 25–26 and 218–19 (no. 3) (note 5). This globe is the fifth oldest celestial globe known to be extant today.

111. Termed "Class B Globes" in Savage-Smith, *Islamicate Celestial Globes*, 247–63, 276, and 278–83 (note 5).

112. Tehran, Mūzah-i Īrān-i Bāstān; dated 535/1140–41 by Badr ibn ʿAbdallāh Mawlā Badīʿ al-Zamān; Savage-Smith, *Islamicate Celestial Globes*, 247 (no. 59) (note 5).

113. London, British Museum, Department of Oriental Antiquities, inv. no. 26.3.23; Savage-Smith, *Islamicate Celestial Globes*, 32 and 249 (no. 62) (note 5).

some irregularity in the graduation. They are by no means, however, as technically inaccurate and nonfunctional as many of the extant globes whose makers must not have been specialists.

An interesting feature of Muḥammad ibn Jaʿfar's globe is the stationary meridian ring. On most globes the meridian ring is movable, that is, it is attached permanently to the globe and moves with it when the globe is rotated within the horizon ring to adjust for use at different geographic latitudes. In this case, however, the globe is reset within the stationary meridian ring by placing the pin at the end of the chain through the appropriate hole in the meridian ring and the celestial pole of the globe.

The third type of design is one in which the globe has neither constellation outlines nor any stars.[114] In general these globes are the smallest, having an average diameter of 85 millimeters. They have the standard great and lesser circles (equator, tropics, polar circles, ecliptic) and frequently the ecliptic equivalents of the tropic and polar circles, occasionally with additional lesser circles. All the circles are usually labeled, whereas they are seldom labeled on the previous two types. This particular design is not mentioned in any of the written treatises dealing with celestial globes. It appears, at this point at least, to be probably of Persian origin of the late seventeenth or early eighteenth century, though examples of the style were produced later in India as well. The only two dated artifacts are both from the nineteenth century; most examples are unfortunately unsigned and undated products.

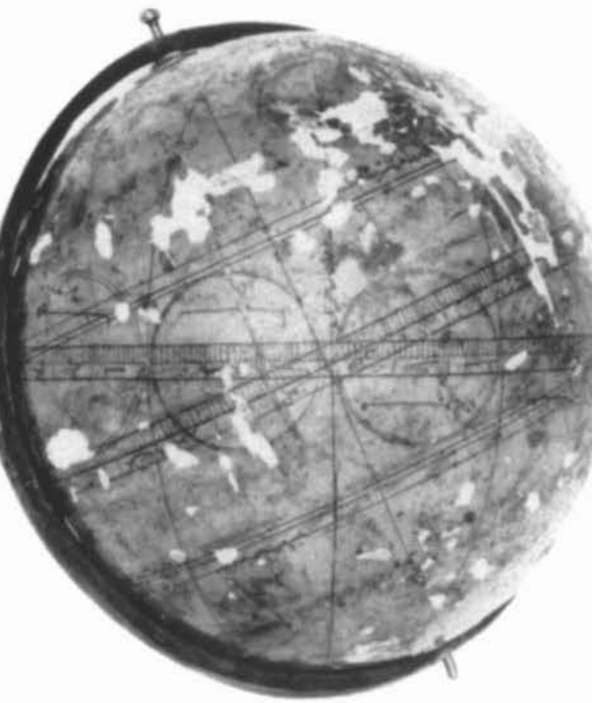


FIG. 2.29. ISLAMIC CELESTIAL GLOBE, UNSIGNED AND UNDATED. This globe, made of papier-mâché and plaster over a fiber core, is probably a seventeenth-century Persian product. Diameter of the original: 17.8 cm. Museum of the History of Science, Oxford (inv. no. 69-186). By permission of the Bettman Archive, New York.

The globe shown in figure 2.29 is unusual in two respects. It is more carefully graduated and executed than many examples of this particular design, it is larger than average, and it is made of papier-mâché and plaster over some kind of fiber core.[115] Globes other than metal are relatively rare among the preserved artifacts, primarily, one assumes, because wood and papier-mâché deteriorate easily. Indeed, the one illustrated is in bad condition. In theory, globes of this design, when accurately executed, could be used to determine much of the information (not requiring star positions) that could be found with the other types of globes. In practice, however, most globes of this simplified design were probably used only for didactic purposes, to demonstrate basic principles such as the equality of day and night for any latitude when the sun is at one of the equinoxes or the longest and shortest day for any given terrestrial latitude.

From other types of globes from that region and period, it is clear that globe makers in seventeenth-century Persia were experimenting with designs and products whose function was either decorative or didactic. A globe that defies easy categorization was made in 1012/1603–4 for Shāh ʿAbbās I, during whose reign the Safavid Empire was at its strongest and the artistic achievements of the court artisans and miniature painters were the most conspicuous. Unfortunately, its maker is unknown.[116] The globe has a few poorly positioned stars but no constellation outlines; instead it has the twelve zodiacal signs represented inside medallions. Here the zodiacal signs are not guides to the positions of stars but indicate instead an alternative tradition of displaying the zodiacal signs as emblematic motifs rather than constellation diagrams. The further use of zodiacal signs as emblematic motifs will be discussed below.

Another globe made about the same time by an unknown artisan working probably in Yazd is illustrated in figure 2.30. In this case the product is a precise instrument for instructing astronomers in the methods of deter-

114. Called "Class C Globes" in Savage-Smith, *Islamicate Celestial Globes*, 56–57, 263–75, and 278–83 (note 5).

115. Oxford, University of Oxford, Museum of the History of Science, inv. no. 69-186, unsigned and undated; Savage-Smith, *Islamicate Celestial Globes*, 264 (no. 93) (note 5).

116. Chicago, Adler Planetarium and Astronomical Museum, inv. no. A 114; Savage-Smith, *Islamicate Celestial Globes*, 45–47 and 249–50 (no. 63) (note 5). There are also two similar unsigned and undated globes; Savage-Smith, *Islamicate Celestial Globes*, 259 (nos. 82 and 83) (note 5).

mining the coordinates of a star.[117] In addition to having a full set of circles parallel to the ecliptic at five-degree intervals, the globe has the unique feature of arcs drawn through a particular star (labeled *ʿayyūq*, which is α Aurigae, Capella in modern terminology), clearly for the didactic purpose of demonstrating the various coordinate systems. The semi-great circle representing the declination circle is marked by a dotted line, while the arc of the ecliptic latitude-measuring circle through the star on which the celestial latitude is measured is an engraved solid line. In addition, there are engraved and labeled on the surface of the globe a circle corresponding to the horizon, another for the meridian ring, and an arc representing the prime vertical (the circle passing through the zenith and intersecting the horizon circle at the east-west points). The arbitrary placing of the horizon and prime vertical on the surface of the sphere thus makes it obvious that this was intended as a demonstrational model of coordinate systems. Furthermore, the coordinate systems shown for the measurement of the star are valid for only one geographic latitude, in this case 32° north, the latitude of Yazd in Persia, where a number of metalworkers and instrument makers are known to have been active.

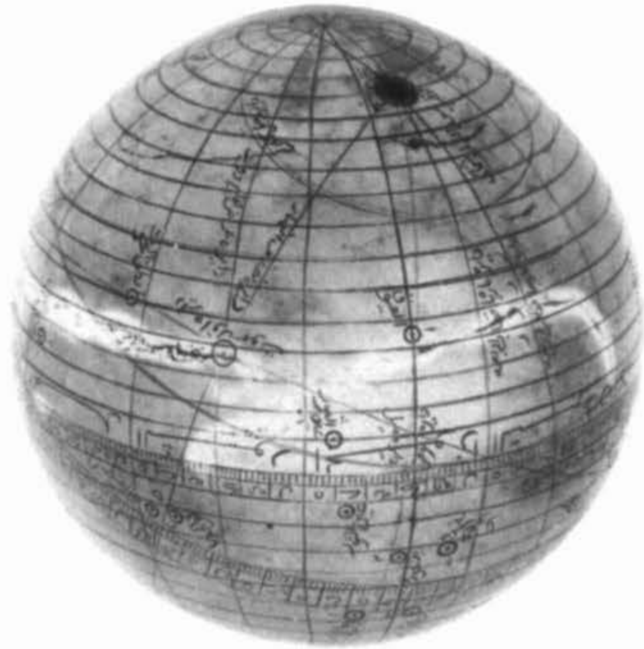


FIG. 2.30. UNSIGNED, UNDATED CELESTIAL GLOBE. Arcs are drawn and labeled through one star (α Aurigae, Capella), indicating different coordinate systems. They are valid for only one geographic latitude, 32° N. This globe is probably a product of a seventeenth-century workshop in or near Yazd. Diameter of the original: 13.1 cm. Museum of the History of Science, Billmeir Collection, Oxford (inv. no. 57-84/182). By permission of the Bettman Archive, New York.

THE MANUFACTURE OF CELESTIAL GLOBES

Islamic celestial globes can be classified not only by design but also by the method of manufacture. Only a few made of painted wood or painted papier-mâché, such as the one illustrated in figure 2.29, have been preserved. In general it seems that Islamic globes of wood or papier-mâché were hand painted or drawn, in contrast to the use of printed paper gores by Western European globe makers.

The vast majority of extant globes are hollow metal spheres set into metal rings and stands. Such globes were made in two ways: either they comprised two hemispheres of cast or raised metal, or they were cast by the cire perdue (lost wax) process, in one piece and with no seam.[118] Globes made of wood or papier-mâché or with metal hemispheres are of considerable antiquity. Seamless globes, on the basis of evidence so far available, appear to have originated in northwestern India toward the end of the sixteenth century. They became the hallmark of all workshops in the Punjab and Kashmir areas of India through the nineteenth century. Consequently, because of the association of this technique with northwestern India, we can conjecture that unsigned products made at the same time but with a seam (such as most globes having no stars at all) were probably made in Persia rather than India.

The earliest confirmed date for the manufacture of a seamless cast globe is 998/1589–90, when a globe made by ʿAlī Kashmīrī ibn Lūqmān was produced.[119] The workshop that excelled in this technique, however, was a four-generation family of instrument makers working in Lahore.[120] During more than a century, from A.D. 1567 to 1680, this remarkable workshop produced numerous astrolabes and other instruments, including twenty-one signed globes and, no doubt, a considerable number of unsigned ones as well. Examples of the craft of its most prolific member, Ḍiyāʾ al-Dīn Muḥammad ibn Qāʾim Muḥammad Asṭurlābī Humāyūnī Lāhūrī, can be seen in the astrolabe illustrated in figure 2.6 and the rather unusual celestial sphere illustrated in figure 2.33.

117. Oxford, University of Oxford, Museum of the History of Science, Billmeir Collection, inv. no. 57-84/182; Savage-Smith, *Islamicate Celestial Globes*, 49–50, 258–59 (no. 81) (note 5).

118. For details regarding this method of construction, see Savage-Smith, *Islamicate Celestial Globes*, 90–95 (note 5); Savage-Smith, "Classification of Islamic Celestial Globes" (note 105), and the forthcoming catalog of scientific instruments in the Nasser D. Khalili Collection of Islamic Art, by Maddison and Savage-Smith (note 105).

119. London, private collection; Savage-Smith, *Islamicate Celestial Globes*, 35 (fig. 11), 176 (fig. 69), and 223–24 (no. 10) (note 5).

120. For the activities and products of this workshop, see Savage-Smith, *Islamicate Celestial Globes*, 34–43 (note 5), and especially the historical introduction to Brieux and Maddison, *Répertoire* (note 36).

FIG. 2.31. ISLAMIC CELESTIAL GLOBE, UNSIGNED AND UNDATED, ENGRAVED IN SANSKRIT, DEVANAGARI SCRIPT. The sphere is a hollow seamless sphere cast by cire perdue. It is a product of the workshop of Lālah Balhūmal Lāhūrī, who was active in Lahore in the first half of the nineteenth century.

Diameter of the original: 20.5 cm. By permission of the David Eugene Smith Collection, Rare Book and Manuscript Library, Columbia University, New York (inv. no. 27-244).

The technique of making seamless globes continued to be practiced in India after this workshop ceased to make them. A nineteenth-century workshop in Lahore—that of the Hindu metalworker Balhūmal—produced excellent and precise products. He maintained the same basically medieval design with only the forty-eight Ptolemaic constellations, but he did add to all his instruments a full set of meridian circles at right angles to the equator, along with the ever-present ecliptic latitude-measuring circles. Products of his workshop are easily identified and include globes (and astrolabes) labeled entirely in Arabic, in Persian, in English for English patrons, or entirely in Sanskrit. The last type is illustrated in figure 2.31.

Throughout the ten centuries of their production in the Islamic world, celestial globes maintained the medieval tradition of displaying only the Ptolemaic constellations and stars. On none of the Islamic celestial globes known to have survived are there any of the newly recorded stars and constellations of the Southern Hemisphere that resulted from the European explorations of the sixteenth century.

ARMILLARY SPHERES

A third type of three-dimensional celestial model is the demonstrational armillary sphere—an earth-centered model in which the great and lesser circles of the ecliptic, equator, tropics, and polar circles are represented by rings encompassing a miniature earth and held in place by a graduated meridian ring, all pivoting about the equatorial axis. Moon, planets, and stars were not part of the model. Such a model of the celestial system is not subject to precessional change and consequently will not become outdated.

Armillary spheres are not often mentioned in Islamic astronomical literature. When they are described, except where there was European influence, they are nearly all observational armillary spheres in the Ptolemaic tradition

FIG. 2.32. DEMONSTRATIONAL ARMILLARY SPHERE. The illustration appears at the beginning of a treatise on astronomical tables by the fifteenth-century Cairo astronomer al-Wafāʾī.
Size of the original: not known. By permission of the Biblioteca Apostolica Vaticana, Rome (MS. Borg. Arab. 217, fol. 1a).

rather than demonstrational armillary spheres.[121] The observational armillary sphere had no earth globe at the center and had sighting devices mounted on the rings. As such, it forms a separate class of instruments distinct from demonstrational armillary spheres, celestial globes, or spherical astrolabes.[122] None are extant from the Islamic world, though they were one of the major tools for observing the coordinates of planets and stars.[123] It is the demonstrational armillary sphere, however, rather than the observational, that is most frequently illustrated, usually in relatively recent manuscripts (fig. 2.32).[124]

An unusual and apparently unique variant of a demonstrational armillary sphere is illustrated in figure 2.33. It was made in 1090/1679–80 by Ḍiyāʾ al-Dīn Muḥammad of the Lahore workshop and consists of two raised or hammered hemispheres in which the spaces between the constellations and the great and lesser circles have been cut out, or worked *à jour*.[125] The metal hemispheres have been painted with gilt and varnished, inside and out, while the stars are indicated by holes perforating the sphere, some filled with glass or mica. One might at first think this is simply an ornate version of a celestial globe with the background removed behind the forty-eight constellations. It is clear, however, from the dedicatory inscription that there was at one time a small terrestrial globe inside this gilt celestial sphere. In dedicating this sphere to the Mughal ruler Aurangzīb, whose court was at Delhi, the maker calls the sphere a *kurah-i ikhtirāʿī-i arḍwī* [*sic*] *samāʾī*, "a specially invented terrestrial-celestial sphere."

Mapping of Individual Constellations and Asterisms

The Pre-Islamic Astronomic System

The pre-Islamic traditional Arab astronomic system involved a mental mapping of the skies and employed a rich stellar nomenclature quite different from the Islamic system based on Ptolemaic concepts.[126] There was, for

121. Giuseppe Celentano, "L'epistola di al-Kindī sulla sfera armillare," *Istituto Orientale di Napoli, Annali* (suppl. 33), 42, fasc. 4 (1982): 1–61 and 4 pls.; Samuel Miklos Stern, "A Treatise on the Armillary Sphere by Dunas ibn Tamīm," in *Homenaje a Millás-Vallicrosa*, 2 vols. (Barcelona: Consejo Superior de Investigaciones Científicas, 1954–56), 2:373–82. A treatise on the armillary sphere by Ḥabash al-Ḥāsib is extant in two manuscripts in Istanbul; see Sezgin, *Geschichte des arabischen Schrifttums*, 6:175 (note 35).

122. For later versions of observational armillary spheres related to the torquetum of Jābir ibn Aflaḥ of Seville in the early twelfth century, see Richard P. Lorch, "The Astronomy of Jābir ibn Aflaḥ," *Centaurus* 19 (1975): 85–107.

123. For a rather stylized sixteenth-century Ottoman painting of astronomers using an observational armillary sphere in the observatory at Istanbul, see the miniature from Istanbul Üniversitesi Kütüphanesi, MS. F. 1404 (Yıldız 2650/260, fol. 56b), reproduced in Seyyed Hossein Nasr, *Islamic Science: An Illustrated Study* (London: World of Islam Festival, 1976), 125 (pl. 84).

124. For examples, see Stanford University, Lane Medical Library, MS. Z296, inside front cover; Los Angeles, UCLA University Research Library, Near Eastern Coll. 898, MS. 52, fol. 41b; and an eighteenth-century engraving of an Islamic demonstrational armillary sphere from an edition of Kātib Çelebi's *Cihānnümā* (World mirror) printed in Istanbul in 1732 and reproduced in O. Kurz, *European Clocks and Watches in the Near East*, Studies of the Warburg Institute, vol. 34 (London: Warburg Institute, University of London, 1975), 69 and pl. XI (fig. 21).

125. Rockford, Illinois, Time Museum, inv. no. 3406; Savage-Smith, *Islamicate Celestial Globes*, 42–43 and 232–33 (no. 30) (note 5). This unique openwork sphere cannot have been the cap or "rete" of a spherical astrolabe (as suggested by Emmanuel Poulle in a review of *Islamicate Celestial Globes* in *Revue de Synthèse*, 4th ser., 1988, 355–56), for it lacks the requisite circles, shows no signs on the interior of rubbing against a sphere (in fact the gilt surface is better preserved on the inside than on the outside), and specifically refers to a terrestrial globe as being part of the design.

126. Paul Kunitzsch, *Untersuchungen zur Sternnomenklatur der Araber* (Wiesbaden: Otto Harrassowitz, 1961); idem, "Über eine *anwāʾ*-Tradition mit bisher unbekannten Sternnamen," *Bayerische Akademie der Wissenschaften, Philosophisch-Historische Klasse, Sitzungsberichte* (1983), no. 5; Savage-Smith, *Islamicate Celestial Globes*, 117–19 (note 5).

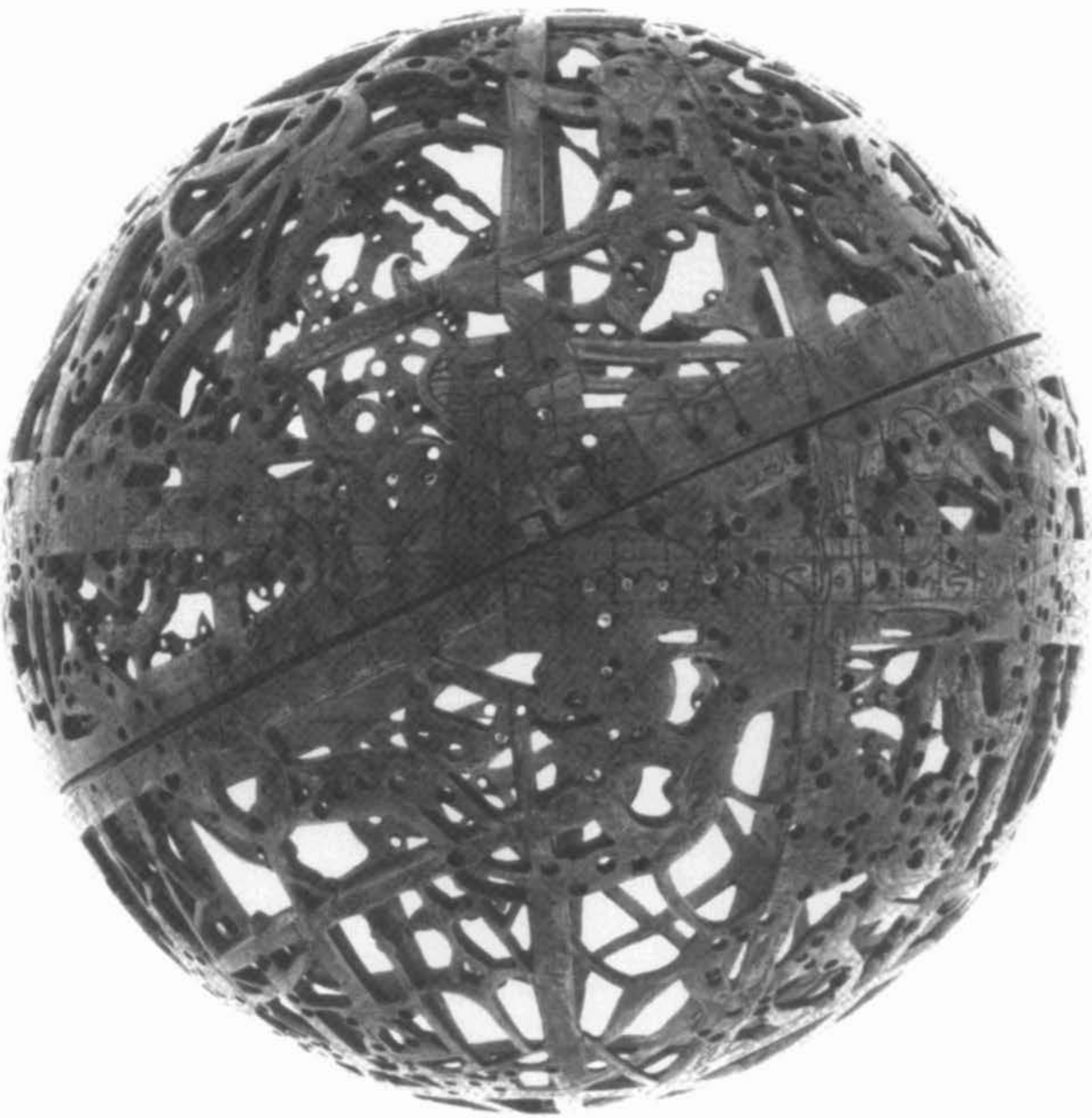


FIG. 2.33. UNIQUE VARIANT OF A DEMONSTRATIONAL ARMILLARY SPHERE/CELESTIAL GLOBE. The instrument was made in 1090/1679–80 by Ḍiyāʾ al-Dīn Muḥammad. Diameter of the original: 16.4 cm. By permission of the Time Museum, Rockford, Illinois (inv. no. 3406).

example, a lion much larger than our Leo, and a bucket covered the areas of Aquarius, Pegasus, and part of Pisces. The region of the constellations Orion and Gemini was seen by Bedouins to contain a huge giant. A bier or corpse-bearing plank with three mourning daughters accompanying it was seen in the area of Ursa Major, with a similar smaller set composing the stars of Ursa Minor. A fish covered the region of both Pisces and Andromeda. In some copies of the major treatise on constellation iconography from the Islamic period, *Kitāb ṣuwar al-kawākib al-thābitah* (Book of the constellations of the fixed stars), written in the tenth century by al-Ṣūfī, there are extra illustrations that show two alternative views of Andromeda with the Bedouin fish.[127]

Many animals, as well as other aspects of pastoral life,

127. For illustrations of these diagrams, see Emmy Wellesz, "Islamic Astronomical Imagery: Classical and Bedouin Tradition," *Oriental Art*, n. s., 10 (1964): 84–91, esp. 88 (figs. 7 and 8); and Emmy Wellesz, "An Early al-Ṣūfī Manuscript in the Bodleian Library in Oxford: A Study in Islamic Constellation Images," *Ars Orientalis* 3 (1959): 1–26 and 27 pls., esp. figs. 11 and 12.

FIG. 2.34. THE CONSTELLATION CASSIOPEIA AS SEEN ON A GLOBE, WITH AN ARAB BEDOUIN ASTERISM OF A CAMEL DRAWN OVER HER. This drawing is taken from a copy, completed in 566/1170–71, of the *Kitāb ṣuwar al-kawākib al-thābitah* (Book of the constellations of the fixed stars) by al-Ṣūfī.
Size of the original: ca. 27.5 × 21.5 cm. By permission of the Bodleian Library, Department of Oriental Books, Oxford (MS. Hunt. 212, fol. 40b).

can be seen in the constellation images described later by al-Ṣūfī as belonging to pre-Islamic Arabia. Gazelles were imagined, and the footprints of their leaps as they ran before the large lion could be seen in the area of Ursa Major. Camels with new foals were seen in the head of Draco. The region of Ursa Minor was also visualized as two calves turning a gristmill, and between the two calves and the camels in the head of Draco were wolves. A herd of goats occupied the area of Auriga, and the stars of Cepheus were viewed as a shepherd with his dog and sheep. A horse was seen above the head of Andromeda, sharing space with our Pegasus.

Some of the stars in Cassiopeia were viewed as a camel, with the brightest star of that group called the camel's hump, but this camel is very rarely illustrated in existing copies of the al-Ṣūfī treatise. One illustration is in a manuscript at Oxford, copied in 566/1170–71 and possibly dedicated, in a now partially illegible dedication, to Sayf al-Dīn Ghāzī II, at that time a ruler in Mosul, north of Baghdad.[128] In the illustration of Cassiopeia as seen on a celestial globe (see fig. 2.34), a camel is drawn over her with its head and forelegs above Cassiopeia's head. The star on her raised elbow is labeled *al-kaff al-khaḍīb wa huwa sanām al-nāqah*, "the dyed hand and it is the hump of the she-camel." The reference here is to two different Bedouin images of the sky: a large camel and an enormous human figure named *al-thurayyā* (a virtually untranslatable name), whose head was in the Pleiades and whose large open hand consisted of five stars including this one. A second illustration in this same manuscript shows the Ptolemaic constellation Andromeda with a fish beneath her, a horse overhead, and a camel to one side (the same camel as encroached on Cassiopeia's territory). All three of these elements (fish, horse, and camel) were drawn from traditional pre-Islamic mappings rather than classical Ptolemaic schemes.[129]

Another aspect of the pre-Islamic Bedouin view of the skies also found graphic expression, but outside the context of constellation diagrams. This involved the zoomorphic interpretation of individual stars. An example is the brightest star in the Ptolemaic constellation of Lyra. In the Bedouin tradition it was called *al-nasr al-wāqiʿ*, "the falling eagle." The star, α Lyrae, is the fifth brightest in the heavens, and its "modern" name Vega derives from a corrupt transliteration of *wāqiʿ* meaning "falling." In all the Arabic or Persian manuscript copies of al-Ṣūfī's treatise on constellations that scholars have examined, the constellation Lyra is always drawn as some sort of musical instrument or merely as a decorative device, with the major star labeled in Arabic. At some point, however, some instrument makers began designing the pointer for this star on the rete for an astrolabe so that it was in the form of a bird with closed wings. This can be seen, for example, in the astrolabe (fig. 2.16) made in Isfahan in 618/1221–22, where Vega is indicated by the bird at the center of the rete. Two other pointers on this astrolabe are shaped like animals, one bird at the upper left facing downward, labeled *al-ṭāʾir* (the flying bird), reflecting an ancient tradition associated with the star whose modern name is Altair (α Aquilae), the eleventh brightest star in the skies. The horsehead to the left on the rete serves as a pointer to a star in Pegasus and in this case is a visualization of a Ptolemaic image. Such pictorial interpretations of star names were quickly introduced into Europe, for a Byzantine astrolabe made in A.D. 1062 has a bird-shaped pointer for the star Vega.[130]

128. Oxford, Bodleian Library, MS. Hunt. 212.

129. Wellesz, "Islamic Astronomical Imagery," 90–91 (note 127), where both illustrations from the Bodleian Library MS. Hunt. 212 are reproduced (figs. 15 and 16).

130. O. M. Dalton, "The Byzantine Astrolabe at Brescia," *Proceedings of the British Academy*, 1926, 133–46 and 3 pls.; Neugebauer, "Early History of the Astrolabe," 249 nn. 57 and 58, reprint 287 nn. 57 and 58 (note 26).

These animal representations of stars appear to have been restricted to instruments and do not seem to have occurred in copies of Islamic treatises illustrating the constellations. It should be noted, however, that no systematic survey and comparison of such material has been undertaken.[131]

LUNAR MANSIONS

Another facet of traditional Bedouin conceptualization of the skies—the lunar mansions—arose from more complicated and obscure circumstances. Various theories have been advanced about whether the system of lunar mansions was ultimately Babylonian, Indian, or Chinese in origin. It seems evident, however, that the Arabic version was an accretion of the Indian *nakṣatra* system of junction stars upon a Bedouin grouping of fixed stars, applying the traditional Arab star names to the Indian lunar mansion division of the zodiac.[132]

The Bedouins of the Arabian Peninsula in pre-Islamic times had a system by which they estimated the passage of time and predicted meteorological events so as to find winter and spring grazing lands, whose locations varied greatly depending on rainfall. The pre-Islamic system, called *anwāʾ*, was based on a series of prominent stars whose cosmical settings (setting in the west as the sun rises in the east) and heliacal risings (rising in the east with the sun) delineated the solar year by breaking it into about twenty-eight periods. Sometime before the advent of Islam the Bedouins assimilated from India a system in which the zodiac was divided into twenty-seven or twenty-eight "mansions" (*manāzil* in Arabic) of the moon. These mansions corresponded to places in the sky through which the moon passed in twenty-seven or twenty-eight nights in its course from new moon to new moon. Because the brilliance of the moon prevents nearby stars from being observed, the mansions were named for stars in the vicinity of, but not directly along, the ecliptic. Each mansion represented one day's travel of the moon and therefore corresponded to roughly thirteen degrees along the ecliptic beginning at the vernal equinox, with the result that each zodiacal house contained two and a half lunar mansions.

In superimposing the system of *manāzil* upon the Bedouin grouping of fixed stars, the Arabs applied *anwāʾ* star names to the Hindu lunar mansion divisions of the ecliptic. These two systems are not entirely compatible, however, for one is based on the risings and settings of fixed star groups and the other reckoned on regular intervals of the ecliptic taken from the vernal equinox. With the precession of the equinoxes, no fixed star will maintain the same distance from the vernal equinox. Consequently one star group cannot be successfully aligned with one segment of the ecliptic for an extended time.

This attempted compounding of *anwāʾ* asterisms and the lunar mansions (*manāzil*) gave rise to a type of Arabic literature known as *anwāʾ* literature, in which lexicographers, such as the ninth- and tenth-century Iraqi scholars Ibn Qutaybah and Abū Isḥāq al-Zajjāj, attempted to record the Bedouin connection of meteorological phenomena with the *anwāʾ* star groups associated with the twenty-eight lunar mansions.[133] It was this type of writing that al-Ṣūfī employed when comparing the Bedouin and Ptolemaic systems. A second literary genre concerned with the *anwāʾ-manāzil* system was arranged in the form of a calendar and enumerated natural, celestial, and meteorological events of concern to peasants and herdsmen.[134] Astrologers also became seriously interested in the division of the zodiac into lunar mansions and the assigning of good or ill characteristics to each.

There was a tradition in the Islamic world of associating abstract patterns of dots or stars in small geometrical designs with the twenty-eight lunar mansions. Al-Qazwīnī, in his thirteenth-century cosmology, included an extensive section on the lunar mansions illustrated with such configurations of dots.[135] An even longer dis-

131. For a preliminary study of zoomorphic astrolabes, particularly European ones, see Owen Gingerich, "Zoomorphic Astrolabes and the Introduction of Arabic Star Names into Europe," in *From Deferent to Equant: A Volume of Studies in the History of Science in the Ancient and Medieval Near East in Honor of E. S. Kennedy*, ed. David A. King and George Saliba, Annals of the New York Academy of Sciences, vol. 500 (New York: New York Academy of Sciences, 1987), 89–104. Curiously, the occurrence of a bird-shaped pointer for Vega is a distinguishing characteristic of late nineteenth-century forgeries of astrolabes made by one particular Persian maker; Owen Gingerich, David A. King, and George Saliba, "The ʿAbd al-Aʾimma Astrolabe Forgeries," *Journal for the History of Astronomy* 3 (1972): 188–98; reprinted in David A. King, *Islamic Astronomical Instruments* (London: Variorum Reprints, 1987), item VI.

132. See Charles Pellat, "Anwāʾ," in *Encyclopaedia of Islam*, new ed., 1:523–24; Daniel Martin Varisco, "The Rain Periods in Pre-Islamic Arabia," *Arabia* 34 (1987): 251–66; and Savage-Smith, *Islamicate Celestial Globes*, 119–32 (note 5), where further references will be found.

133. Paul Kunitzsch, "Ibn Qutayba," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 11:246–47, and Daniel Martin Varisco, "The *Anwāʾ* Stars according to Abū Isḥāq al-Zajjāj," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 5 (1989): 145–66.

134. Charles Pellat, "Dictons rimés, *anwāʾ* et mansions lunaires chez les Arabes," *Arabica* 2 (1955): 17–41; ʿArīb ibn Saʿd al-Kātib al-Qurṭubī, *Le calendrier de Cordoue*, ed. Reinhart Dozy, new ed. with annotated French translation by Charles Pellat, Medieval Iberian Peninsula, Texts and Studies, vol. 1 (Leiden: E. J. Brill, 1961).

135. Zakarīyāʾ ibn Muḥammad al-Qazwīnī, *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt* (Marvels of things created and miraculous aspects of things existing); see *Zakarija ben Muhammed ben Mahmud el-Cazwini's Kosmographie*, 2 vols., ed. Ferdinand Wüstenfeld (Göttingen: Dieterichschen Buchhandlung, 1848–49; facsimile reprint Wiesbaden: Martin Sändig, 1967), 42–51. Al-Qazwīnī's text on lunar mansions is taken literally from Ibn Qutaybah's *Kitāb al-anwāʾ*; Paul Kunitzsch, "The Astronomer Abu ʾl-Ḥusayn al-Ṣūfī and His Book

cussion with fuller illustrations was included in the thirteenth-century encyclopedia of magic and occult practices written by al-Būnī (d. 622/1225), the acknowledged master of the occult sciences in Islam.[136] In many cases there is little similarity between the graphic representation of a lunar mansion and the actual appearance of the stars in that region of the sky. Even the number of dots used in a diagram may be quite different from the number of stars associated with that mansion. The designs also vary between authors and even among manuscript copies of the same work.

The abstract patterns of lunar mansions are most often associated with writings of an astrological or cosmological nature.[137] There are, however, some astronomical treatises that include diagrams of the lunar mansions. For example, Abū al-ʿAbbās Aḥmad's *Kitāb al-durar wa-al-yawāqīt fī ʿilm al-raṣd wa-al-mawāqīt*[138] has several diagrams of lunar mansions, including the one illustrated earlier in figure 2.22. Similar graphic representations of lunar mansions are not, however, to be found in copies of al-Ṣūfī's influential book on the constellations or in the writings of al-Bīrūnī, who discussed the topic at some length in his *al-Āthār al-bāqīyah*.

On instruments the representations of the asterisms comprising the lunar mansions are rare. There is an exquisite astrolabe probably made in Egypt for an Ayyubid ruler by ʿAbd al-Karīm al-Miṣrī in 633/1235–36.[139] On the back of the instrument in one of the concentric bands providing a variety of information there are the twenty-eight lunar mansions represented by stars, along with an animal or human form for each mansion. This astrolabe is also notable for having another concentric band with outlines of each of the zodiacal constellations, each depicted twice—as seen on a globe and as viewed in the sky. Only one celestial globe is known to have similar patterns of dots showing the lunar mansions. It bears the date 718 (equivalent to A.D. 1318–19), with the maker given as ʿAbd al-Raḥmān ibn Burhān al-Mawṣilī, that is, of Mosul in northern Iraq.[140] There are, however, problems with the signatures on this globe and with the method of its construction given the date on it. Consequently it is difficult to know with certainty where this product was made or even when, though it is evident the maker employed a different source for his iconography than was usual among globe makers.

ISLAMIC CONSTELLATION ICONOGRAPHY

The major guide to constellation diagrams in the Islamic world was the Arabic treatise written in the tenth century by al-Ṣūfī, who was a court astronomer in Isfahan to ʿAḍūd al-Dawlah, one of the most expansionist of the Buyid rulers in Persia. In al-Ṣūfī's *Kitāb ṣuwar al-kawākib al-thābitah* (Book of the constellations of the fixed stars), each of the forty-eight classical constellations was discussed in turn.[141] Two drawings were given for each constellation, one showing it as seen in the sky by an observer on earth and the other as seen on a celestial globe, which is to say, reversed right to left (figs. 2.35 and 2.36). In addition to the drawings for each constellation, there was an account of the traditional Bedouin star names and asterisms for that portion of the sky and a catalog of the stars in that constellation, giving celestial latitudes, longitudes, and magnitudes. The star catalog presented by al-Ṣūfī reproduced with only slight revision that given earlier by Ptolemy in the *Almagest*.[142] The stellar coordinates were given in ecliptic coordinates, augmenting the longitudes given by Ptolemy by 12°42′ to correspond to the year A.D. 964. The magnitudes given by al-Ṣūfī are, however, substantial revisions of those of Ptolemy.[143]

on the Constellations," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 3 (1986): 56–81, esp. 60 n. 13.

136. Muḥyī al-Dīn Abū al-ʿAbbās Aḥmad ibn ʿAlī al-Būnī al-Qurashī, *Shams al-maʿārif al-kubrā wa-laṭāʾif al-ʿawārif* (Cairo: Maṭbaʿat Muḥammad ʿAlī Sabīḥ, [1945]), 10–25.

137. For a comparison of some of the patterns representing lunar mansions and their relation to geomancy, see Emilie Savage-Smith and Marion B. Smith, *Islamic Geomancy and a Thirteenth-Century Divinatory Device* (Malibu, Calif.: Undena, 1980), 38–43 (including table 2).

138. An autograph copy of his treatise is the third item in Oxford, Bodleian Library, Department of Oriental Books, MS. Bodl. Or. 133, fols. 94b–130a.

139. London, British Museum, Department of Oriental Antiquities, acc. no. 855.5.9.1; the date on the instrument is not completely legible and has been read as 625, 638, and 648; Leo Ary Mayer, *Islamic Astrolabists and Their Works* (Geneva: Albert Kundig, 1956), 30 and pl. XIIb. A line drawing is given along with some errors in interpretation by Gunther, *Astrolabes of the World*, 1:233–36 (note 2). For a better interpretation, see Willy Hartner, "The Principle and Use of the Astrolabe," in *Survey of Persian Art from Prehistoric Times to the Present*, 6 vols., ed. Arthur Upham Pope (London: Oxford University Press, 1938–39), 3:2530–54 and 6:1397–1404; reprinted in Willy Hartner, *Oriens-Occidens: Ausgewählte Schriften zur Wissenschafts- und Kulturgeschichte*, 2 vols. (Hildesheim: Georg Olms, 1968 and 1984), 1:287–311.

140. Oxford, University of Oxford, Museum of the History of Science, inv. no. 57-84/181; Savage-Smith, *Islamicate Celestial Globes*, 29–31 and 247–48 (no. 60) (note 5).

141. For the printed Arabic text, see the 1954 edition of *Ṣuwar al-kawākib* (note 96). A French translation based on a seventeenth-century copy now in Copenhagen has been published: *Description des étoiles fixes composée au milieu du dixième siècle de notre ère: Par l'astronome persan Abd-al-Rahman al-Sûfi*, trans. Hans Carl Frederik Christian Schjellerup (Saint Petersburg: Commissionnaires de l'Académie Impériale des Sciences, 1874; facsimile reprint Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1986), and see Kunitzsch, "Abu ʾl-Ḥusayn al-Ṣūfī" (note 135).

142. For the revisions al-Ṣūfī made in Ptolemy's star catalog, see Savage-Smith, *Islamicate Celestial Globes*, 115 (note 5). The epoch of al-Ṣūfī's catalog is the beginning of the year 1276 of the Alexandrian era, which corresponds to A.D. 1 October 964.

143. Kunitzsch, "Abu ʾl-Ḥusayn al-Ṣūfī," 57 (note 135). The Arabic version of Ptolemy employed by al-Ṣūfī seems to have been that of Isḥāq ibn Ḥunayn.

FIG. 2.35. THE CONSTELLATION AURIGA AS SEEN IN THE SKY. From a manuscript copy of the *Ṣuwar al-kawākib* by al-Ṣūfī, written in the tenth century, made in 400/1009–10 by his son al-Ḥusayn from a holograph of his father's.
Size of the original: 26.3 × 18.2 cm. By permission of the Bodleian Library, Department of Oriental Books, Oxford (MS. Marsh 144, p. 120).

FIG. 2.36. THE CONSTELLATION AURIGA AS SEEN ON A GLOBE. From the same manuscript as figure 2.35.
Size of the original: 23.6 × 18.2 cm. By permission of the Bodleian Library, Department of Oriental Books, Oxford (MS. Marsh 144, p. 119).

According to the eleventh-century scholar al-Bīrūnī, al-Ṣūfī told the Persian geometer and astronomer Abū Saʿīd al-Sijzī that he had laid very thin paper on a celestial globe and fitted it carefully over the surface of the sphere, then traced on the paper the constellation outlines and individual stars as precisely as the transparency of the paper would allow. Al-Bīrūnī adds to this account the comment: "And that is an [adequate] approximation when the figures are small but it is far [from adequate] if they are large."[144]

Maps of individual constellations, when carefully executed, display the relative positions of the component stars and have the advantage of being true for any period, since they do not reflect through a coordinate system a relationship with the sun's movement. Al-Ṣūfī numbered each star in sequence within a constellation so as to correspond to the star catalog. Those within the outlines of the constellation, called the internal or formed stars, were given one set of numbers, while those lying outside the outlines (the external or unformed) were given a different set and frequently were in a different color. In this he followed the convention of numbering established by Ptolemy many centuries earlier. Differentiation in brightness was indicated in al-Ṣūfī's diagrams by different sizes of dots, corresponding to the six magnitudes of stars recognized by Ptolemy.

Al-Ṣūfī's star catalog was an important direct source for star coordinates used by early makers of astrolabes and celestial globes. For example, Muḥammad ibn Maḥmūd ibn ʿAlī al-Ṭabarī stated on the globe he made in

144. The passage occurs in al-Bīrūnī's *Kitāb fī tasṭīḥ al-ṣuwar wa-tabṭīḥ al-kuwar*; Berggren, "Al-Bīrūnī on Plane Maps," 53 and 89 (note 65); Suter, "Über die Projektion der Sternbilder," 86 (note 65).

FIG. 2.37. GLOBE MADE IN 684/1285–86 BY MUḤAMMAD IBN MAḤMŪD IBN ʿALĪ AL-ṬABARĪ. The maker specified on the globe that the stars were drawn from the *Ṣuwar al-kawākib* by al-Ṣūfī after increasing the longitudes five degrees.

Diameter of the original: 13.4 cm. By permission of the Nasser D. Khalili Collection of Islamic Art (SCI 21).

684/1285–86 that the stars were placed according to the *Ṣuwar al-kawākib* by al-Ṣūfī after increasing their longitudes five degrees (fig. 2.37).[145]

Later instrument makers employed revised star catalogs, especially the one Ulugh Beg prepared at

145. Nasser D. Khalili Collection of Islamic Art, inv. no. SCI 21, the "Khalili Globe." It has recently been demonstrated that this globe is the original thirteenth-century globe of which a copy is now in Paris, Musée du Louvre, Section Islamique, inv. no. 6013. The copy in Paris was described and questionable features were noted by Savage-Smith, *Islamicate Celestial Globes*, 27–29 and 220–21 (no. 6) (note 5). For a

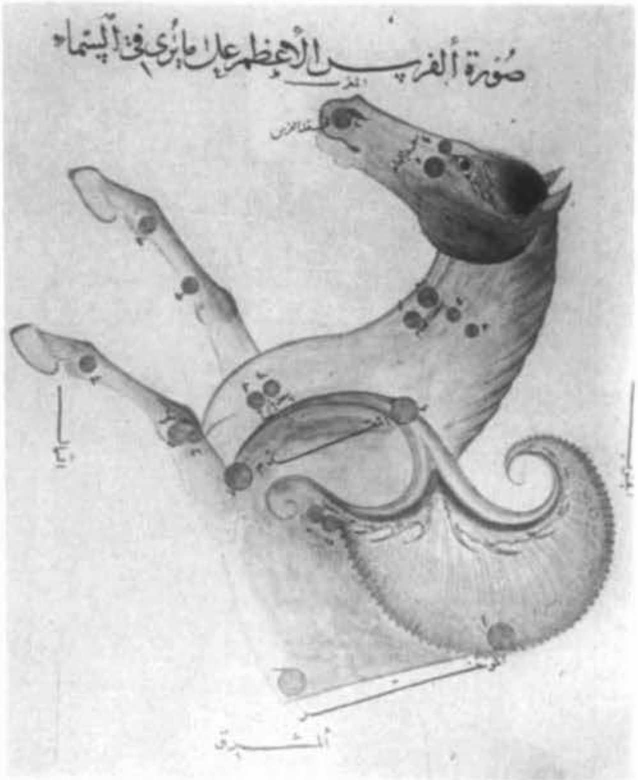


FIG. 2.38. THE CONSTELLATION PEGASUS AS SEEN IN THE SKY. From a copy of the *Ṣuwar al-kawākib* by al-Ṣūfī made ca. 1430–40, probably in Samarkand, in the library of the astronomer Ulugh Beg.
Size of the original: 23.5 × 16.5 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 5036, fol. 93b).

Samarkand[146] for the epoch 841/1437–38. This latter catalog, as Ulugh Beg freely admits, depended heavily on the one in al-Ṣūfī's *Ṣuwar al-kawākib*, which Ulugh Beg knew through a Persian translation made in the thirteenth century by an important scholar and astronomer, Naṣīr al-Dīn Muḥammad ibn Muḥammad al-Ṭūsī. Naṣīr al-Dīn al-Ṭūsī headed the observatory at Maragheh, after entering in A.D. 1257 the service of Hūlāgū Khān, the Ilkhanid ruler who was brother to Kubilay Khān. Two extant manuscripts bear the signature of Ulugh Beg, indicating that they were in his library—one in Arabic and one in Persian. The latter manuscript also claims to be the autograph copy by the translator, Naṣīr al-Dīn al-Ṭūsī. It has been demonstrated recently that Ulugh Beg actually used only the Persian version by al-Ṭūsī.[147] The Arabic copy of al-Ṣūfī's treatise once in Ulugh Beg's library, made about 1430, was probably a presentation copy prepared at Samarkand as a gift to the ruler. Its colorful renderings of the constellation diagrams reflect the current fashion in Timurid art as well as some Chinese-inspired interpretations of the beasts, in keeping with the considerable interest in Chinese art that characterized the Timurid court.[148] See figure 2.38 for an illustration from this manuscript.

A considerable number of illustrated copies of al-Ṣūfī's treatise, in both Arabic and Persian, are preserved today, the earliest being one copied by al-Ṣūfī's son, al-Ḥusayn, in 400/1009–10. The two diagrams of the constellation Auriga from this manuscript are illustrated in figures 2.35 and 2.36. This is the oldest illustrated Arabic manuscript on any topic to be preserved today.[149]

Al-Ṣūfī speaks of having seen a book on constellations by ʿUṭārid ibn Muḥammad al-Ḥāsib, a ninth-century astronomer and mathematician who is said to have also written on the astrolabe and the armillary sphere.[150] Al-Ṣūfī reports seeing a number of celestial globes made by instrument makers in Harran as well as a large one made by ʿAlī ibn ʿĪsā, whose treatise on the astrolabe is the earliest still preserved.[151] None of these earlier globes or books on constellations have survived, as far as is known, so it is impossible to evaluate al-Ṣūfī's work in terms of the sources he employed for constellation mapping. Certainly the Ptolemaic star catalog, which he repeated through its Arabic version, gave explicit verbal directions for locating each star in terms of the constellation form (e.g., on the forward hand, in the tail, etc.) in addition

comparison of the two globes, see Savage-Smith, "Classification of Islamic Celestial Globes," 26 (note 105), as well as the forthcoming catalog of the scientific items in the Nasser D. Khalili Collection being prepared by Maddison and Savage-Smith (note 105).

146. Savage-Smith, *Islamicate Celestial Globes*, 114–16 (note 5); and Kunitzsch, "Abu 'l-Ḥusayn al-Ṣūfī," 61–64 (note 135).

147. The Arabic manuscript is in Paris, Bibliothèque Nationale, MS. Arabe 5036, and the Persian in Istanbul, Ayasofya MS. 2592. The former was the basis, along with four other manuscripts, for the Arabic printed text (see note 96). The Persian manuscript was printed in facsimile in Tehran in 1969 and employed in the printed edition, *Tarjamat-i ṣuwar al-kawākib ʿAbd al-Raḥmān Ṣūfī bih qalam Khawājat Naṣīr al-Dīn Ṭūsī*, edited with analysis by Muʿiz al-Dīn Muhadawī, Intishārat-i Bunyād-i Farhang-i Īrān 136, ʿIlm dar Īrān 16 (Tehran: Intishārat-i Bunyād-i Farhang-i Īrān, 1972). Paul Kunitzsch argues that only the Persian text was actually used by Ulugh Beg, and that there is some doubt the Istanbul manuscript is in fact the autograph copy of Naṣīr al-Dīn al-Ṭūsī's translation; Kunitzsch, "Abu 'l-Ḥusayn al-Ṣūfī," 62–64 (note 135).

148. For Timurid art and this manuscript made for Ulugh Beg, see Thomas W. Lentz and Glenn D. Lowry, *Timur and the Princely Vision: Persian Art and Culture in the Fifteenth Century* (Los Angeles: Museum Associates, Los Angeles County Museum of Art, 1989), 152–53, 168–69, 177, and 374.

149. Oxford, Bodleian Library, Department of Oriental Books and Manuscripts, MS. Marsh 144; Wellesz, "Early al-Ṣūfī Manuscript" (note 127); Emmy Wellesz, *An Islamic Book of Constellations*, Bodleian Picture Book, no. 13 (Oxford: Bodleian Library, 1965). For other manuscript copies, see Wellesz, "Islamic Astronomical Imagery" (note 127), and Joseph M. Upton, "A Manuscript of 'The Book of the Fixed Stars' by ʿAbd ar-Raḥmān aṣ-Ṣūfī," *Metropolitan Museum Studies* 4 (1932–33): 179–97.

150. For ʿUṭārid, see Ibn al-Nadīm, *Fihrist*; Flügel's edition, 1:278, Dodge's edition, 2:658 (note 28); and Sezgin, *Geschichte des arabisches Schrifttums*, 6:161 (note 35).

151. See note 32.

FIG. 2.39. THE CONSTELLATION HERCULES AS SEEN IN THE SKY. From a copy of the *Ṣuwar al-kawākib* by al-Ṣūfī made in Morocco in 621/1224–25.
Size of the original: 13.6 × 16.3 cm. By permission of the Biblioteca Apostolica Vaticana, Rome (Rossiano 1033, fol. 19b).

to the precise coordinates of each star, and al-Ṣūfī can be seen to have followed this catalog description faithfully. The clothing and headgear of the constellation figures and the general artistic style of the earliest copy made by his son reflect the fashion current at the Buyid court in Isfahan in the tenth century.

This treatise by al-Ṣūfī was no doubt the most important source for the design of constellation images in the Islamic world. Numerous copies exist in which the iconography has been adapted to local tastes and artistic conventions. Some copies were carefully done for important patrons or as guidebooks to instrument designers, and others were more casually executed for an audience less likely to scrutinize them carefully. See figure 2.39 for the constellation Hercules as seen in the sky, drawn in the thirteenth century in Morocco.

The constellation diagrams were also employed in later astronomical writings. For example, a copy made in 685/1286–87 of a Persian translation of al-Bīrūnī's treatise on astrology, written in A.D. 1029, contains twenty-seven drawings of constellations.[152] Only one view is presented—that as seen in the sky—and the stars are casually placed within the figures. The interpretations of the constellations have many features in common with the al-Ṣūfī diagrams, but there are some differences as well. In figure 2.40, for example, the constellation of Auriga is drawn in the al-Bīrūnī manuscript as a standing figure rather than a kneeling or sitting person as in the al-Ṣūfī iconography illustrated in figures 2.35, 2.36, and 2.37.

It is not known whether al-Bīrūnī intended for this section of his astrology to be illustrated in this manner.

FIG. 2.40. THE CONSTELLATIONS PERSEUS (ABOVE) AND AURIGA (BELOW). From a Persian version of *Kitāb al-tafhīm li-awā'il ṣinā'at al-tanjīm* (Book of instruction on the principles of the art of astrology) written in A.D. 1029 by al-Bīrūnī, copied in 685/1286 by Ibn al-Ghulām al-Qunawī.
Size of the original: Perseus, 9.0 × 11.8 cm; Auriga, 8.8 × 11.8 cm. By permission of the British Library, Oriental Collections, London (MS. Add. 7697, fol. 44a).

There are no specific references to illustrations in the accompanying text discussing constellations, and this Persian manuscript is the only copy known to have constellation diagrams. Al-Bīrūnī, who was born about fifteen years before al-Ṣūfī died, certainly knew of al-Ṣūfī's writings. In this section of the astrological treatise, in fact, al-Bīrūnī makes it clear that he was aware of both al-Ṣūfī's interpretation and that of Aratus, for he says in regard to the constellation Andromeda: "She . . . is also

152. London, British Library, Oriental Collections, MS. Add. 7697, copied by Ibn al-Ghulām al-Qunawī. By the early fourteenth century this manuscript copy was in Turkey, where it was bought in 732/1331–32 in Sivas, according to a note written in Konya. The text on constellations can be found in al-Bīrūnī's *Kitāb al-tafhīm*; see Wright's edition, 69–73 (secs. 159–61) (note 73).

FIG. 2.41. THE ZODIACAL CONSTELLATIONS OF SAGITTARIUS AND CAPRICORN. From a late fourteenth-century Iraqi copy of the cosmology (*ʿAjāʾib al-makhlūqāt*) of al-Qazwīnī.
Size of the original: 32.7 × 22.4 cm. Courtesy of the Freer Gallery of Art, Smithsonian Institution, Washington, D.C. (acc. no. 54.45r).

FIG. 2.42. THE ZODIACAL FIGURE OF TAURUS. From what is probably an eighteenth-century copy of the cosmology (*ʿAjāʾib al-makhlūqāt*) of al-Qazwīnī.
Size of the folio: 30 × 20.5 cm. By permission of the Bayerische Staatsbibliothek, Munich (Cod. Arab. 463, fol. 27b).

called the chained woman, and she is represented as a standing woman; as for Abū al-Ḥusayn al-Ṣūfī, he placed the chains around her feet, while Aratus, in describing this constellation, placed the chain around her hands, as if she were suspended by them."[153]

If this particular copy of al-Bīrūnī's writing was produced at Maragheh, as seems likely,[154] then the artist would have had access to Naṣīr al-Dīn al-Ṭūsī's Persian translation of al-Ṣūfī's treatise. The iconography, however, suggests that there were other influences at work in the artist's rendering of the constellation diagrams.

The iconography of the constellations presented by al-Ṣūfī was also incorporated into constellation diagrams in treatises that were not primarily astronomical. The most conspicuous examples are the numerous constellation diagrams found in manuscript copies of al-Qazwīnī's thirteenth-century cosmology. In this treatise al-Qazwīnī devoted considerable space to celestial phenomena, extracting entire sections on constellations from the book by al-Ṣūfī.[155]

This enormously popular encyclopedic cosmology/cosmography by al-Qazwīnī was translated into Persian, Turkish, and even Urdu, and in nearly all the preserved

153. Al-Bīrūnī, *Kitāb al-tafhīm*; see Wright's edition, 71–72 (sec. 160) (note 73); the translation is my own. For other references to al-Ṣūfī by al-Bīrūnī, see Kunitzsch, "Abu ʾl-Ḥusayn al-Ṣūfī," 59 (note 135).

154. Norah M. Titley, *Persian Miniature Painting and Its Influence on the Art of Turkey and India: The British Library Collections* (London: British Library, 1983), 17–18.

155. Kunitzsch, "Abu ʾl-Ḥusayn al-Ṣūfī," 60–61 (note 135). For al-Qazwīnī, *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt*, see Wüstenfeld's edition, esp. 29–41 (note 135); and see also Ludwig Ideler, *Untersuchungen über den Ursprung und die Bedeutung der Sternnamen: Ein Beytrag zur Geschichte des gestirnten Himmels* (Berlin: J. F. Weiss, 1809).

copies there are copious illustrations. The constellation diagrams in the manuscript copies vary widely in style and sophistication; some are drawn with no attempt at all to indicate the stars, showing only the animal or human mythological characters that gave rise to the constellation form (figs. 2.41 and 2.42). No systematic examination of the numerous illustrated copies of al-Qazwīnī has been undertaken.

Al-Qazwīnī made four editions of this treatise. The one that was completed in 675/1276–77 was copied and illustrated in 678/1279–80, about three years before the author's death. Primarily based on this manuscript, now in Munich, it has been concluded that al-Qazwīnī retained many of the features of al-Ṣūfī's iconography, though he used only one drawing for each constellation instead of two.[156]

Al-Ṣūfī's treatise on constellations is notable not only for providing the definitive interpretation of constellation imagery for the Islamic world, but also for discussing the indigenous Bedouin conceptions of the skies. These were presented for each constellation, with the Bedouin stars identified in terms of the Ptolemaic stars. In the star catalog that accompanied the two drawings for each constellation, however, al-Ṣūfī did not include these Bedouin stars, though in a few cases he or subsequent copyists showed them in the drawings.

Islamic Asterism Mapping and Its Influence in Europe

The influence of the *Ṣuwar al-kawākib* by al-Ṣūfī was not limited to the Islamic world. The first four treatises in the *Libros del saber de astronomía* compiled in Castilian for Alfonso el Sabio are concerned with the fixed stars, and about A.D. 1341 an Italian translation was made in Seville.[157] The general description of the constellations and the tables of coordinates are derived from the treatise by al-Ṣūfī, who is cited by name at one point. There are forty-eight constellation drawings included in the Castilian and Italian versions, though their precise relation to those of the al-Ṣūfī tradition has not been determined.[158] Furthermore, it is not at present clear whether these vernacular versions had any subsequent influence on European constellation mapping.

There was a second point of entry of al-Ṣūfī's ideas into Europe. Nine Latin manuscripts have been identified as making up what has been called the "Ṣūfī Latinus" corpus.[159] There is considerable variation among them, and their origin and subsequent course of transmission and development are unknown. The oldest of the manuscripts was copied about A.D. 1270, possibly in Bologna.[160] It is not, however, the original Latin version but rather was copied from some now unknown earlier Latin manuscript. The manuscript presents a complete Ptolemaic star catalog, with augmented longitudes, and for each constellation it gives one drawing (sixteen as on a globe and thirty-two as in the sky). Latin versions of the discussions of Bedouin star names are missing, but the illustrations retain many distinctive features from al-Ṣūfī's treatise as it is known in the illustrated Arabic/Persian tradition. The other eight manuscripts fall into three groups that show assimilation of European material, to varying degrees, but all eight are derivative from the earliest extant Latin manuscript.[161]

The origin of this series of Latin versions remains a mystery. It represents a mixed tradition whose history is hard to trace. The Latin version of al-Ṣūfī's name employed in these manuscripts, Ebennesophy, seems never to have been used later. The twelfth-century Jewish scholar Abraham ben Meir ibn Ezra of Spain knew some form of al-Ṣūfī's treatise and called him in Latin "Azophi." It was by this name that al-Ṣūfī was subsequently known to European scholars.

By the early fifteenth century it is evident that elements of Islamic constellation mapping were available in Central Europe, although through what routes can only be conjectured. Preserved today is a Latin planispheric map drawn on parchment about 1440, probably made in Vienna. It has been argued that it is a copy of an Italian map made about ten years earlier, which in turn was based on a now lost tradition of Arabic planispheric star maps.[162] In figure 2.43 the northern hemisphere of this two-part map is illustrated. In it the northern and ecliptic Ptolemaic constellations are depicted as they would be seen on a celestial globe, with the constellations in a counterclockwise sequence. The ecliptic latitude-meas-

156. Kunitzsch, "Abu ʾl-Ḥusayn al-Ṣūfī," 60–61 (note 135). The manuscript copied in 678/1279–80 is in Munich, Bayerische Staatsbibliothek, Cod. Ar. 464; it is defective in that it is missing the sections containing Gemini to Orion.

157. *Libros del saber de astronomía*, 1:3–145 (note 46). The Italian version is extant in a unique manuscript (Rome, Biblioteca Apostolica Vaticana, MS. Lat. 8174), of which the section on the fixed stars has been edited by Pierre Knecht, *I libri astronomici di Alfonso X in una versione fiorentina del trecento* (Zaragoza: Libreria General, 1965).

158. Kunitzsch, "Abu ʾl-Ḥusayn al-Ṣūfī," 65–66 and 81 (note 135).

159. The following is based on the study by Paul Kunitzsch, "Ṣūfī Latinus," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 115 (1965): 65–74, which he updated and emended in "Abu ʾl-Ḥusayn al-Ṣūfī," 66–77 and 80–81 (note 135).

160. Paris, Arsenal, MS. 1036.

161. The illustrations in one of these "Sūfī-Latinus" manuscripts (Gotha, Forschungsbibliothek, M II, 141, dated A.D. 1428) are reproduced by Gotthard Strohmaier, *Die Stērne des Abd ar-Rahman as-Sufi* (Leipzig: Gustav Kiepenheuer, 1984).

162. Vienna, Österreichische Nationalbibliothek, MS. 5415, fol. 168r (Northern Hemisphere) and fol. 168v (Southern Hemisphere). See Zofia Ameisenowa, *The Globe of Martin Bylica of Olkusz and Celestial Maps in the East and in the West*, trans. Andrzej Potocki (Wrocław: Zakład Narodowy Imienia Ossolińskich, 1959), 38–41 and figs. 38 and 39.

FIG. 2.43. THE CONSTELLATIONS OF THE NORTHERN HEMISPHERE. These are as drawn in a Latin parchment manuscript titled *De composicione spere solide*, probably copied about A.D. 1440 in Austria.
Size of the original: 29.1 × 21.5 cm. By permission of the Österreichische Nationalbibliothek, Bild-Archiv und Porträt-Sammlung, Vienna (Cod. 5415, fol. 168r).

uring circles between the zodiacal houses, indicated by four diameters, and the equatorial polar circle are elements found on contemporaneous Islamic globes. A number of star names are Latinized versions of Arabic ones. Although the constellations reflect fifteenth-century Western styles of hair and clothes design and the figures are depicted with their backs to the viewers (apparently a feature common to Western but not Islamic globes), the iconography also retains some Islamic features. For example, the stance of Cepheus and the scimitar of Hercules arose within Islamic iconography.

Of particular interest is the rendering of the constellation Lyra as a bird with closed wings (near the head of the large flying bird Cygnus), which reflects the Bedouin zoomorphic interpretation of the star Vega rather than the Ptolemaic constellation Lyra in which it is situated. It is possible—indeed likely—that this imagery arose from the astrolabe-making tradition, where zoomorphic renderings of individual star names occurred, rather than from the treatise by al-Ṣūfī, where (as far as is known) Lyra is never represented by anything other than a musical instrument or a decorative device.

This Viennese manuscript of 1440 has a striking similarity to a celestial globe made in 1480, probably by Hans Dorn, a Dominican monk in Vienna.[163] The globe was first owned by Martin Bylica, master of Krakow University and one of the best-known astrologers of the fifteenth century. The Bedouin and Islamic features found on this globe and on the manuscript planispheric map are identical, except that here the polar circle is eliminated, the equinoctial colure is added, and Hercules has been further Westernized by restoring the skin of the Nemean lion that disappeared in Islamic iconography after its arrival from the Hellenistic world.

The parchment map of 1440 and the globe of 1480 reflect a prototype that, through a copy now lost, served as a direct source for Albrecht Dürer's woodcut celestial maps executed in 1515.[164] The Latinized Arabic star names are omitted, along with the polar circle and colure, and the star positions are adjusted to correspond to about 1499. In nearly all other respects the dependence on this prototype is evident, though the iconography has been even more Westernized by Dürer and the constellation of Lyra further developed. At Dürer's hand Lyra is rendered as a bird with a musical instrument over its body. The instrument drawn by Dürer is a forerunner of the modern violin, called in his day a *lira de braccio*. Later celestial cartographers, such as Johannes Bayer, represented the image of the bird with an instrument but drew a real lyre rather than a Renaissance *lira*.[165]

Dürer added to the corners of his map portraits of four authorities on celestial matters, each in the act of using a celestial globe. One of them is a turbaned figure labeled Azophi Arabus. By including them he acknowledged the general indebtedness of all astronomers of his day to the tradition of constellation iconography that came from the Islamic world. Yet it is still uncertain to what extent and in what form European astronomers of the fifteenth and early sixteenth centuries would have known the treatise on constellations by al-Ṣūfī.

It has been recently demonstrated that a nearly complete Arabic version of al-Ṣūfī's treatise on the constellations must have reached Germany by the 1530s, for information in it was employed in a limited way by Peter Apian, who from 1527 to 1552 was professor of mathematics at the University of Ingolstadt. Of interest here is a star map printed in Ingolstadt in 1533 as part of Peter

163. Ameisenowa, *Globe of Martin Bylica* (note 162).

164. The woodcut maps of Dürer have been frequently reproduced. See, for example, Deborah J. Warner, *The Sky Explored: Celestial Cartography 1500–1800* (New York: Alan R. Liss; Amsterdam: Theatrum Orbis Terrarum, 1979), 72–73. Compare also the set of maps drawn in Nuremberg in 1503; Ameisenowa, *Globe of Martin Bylica*, 47–55 and figs. 40 and 41 (note 162).

165. Paul Kunitzsch, "Peter Apian and 'Azophi': Arabic Constellations in Renaissance Astronomy," *Journal for the History of Astronomy* 18 (1987): 117–24, esp. 122.

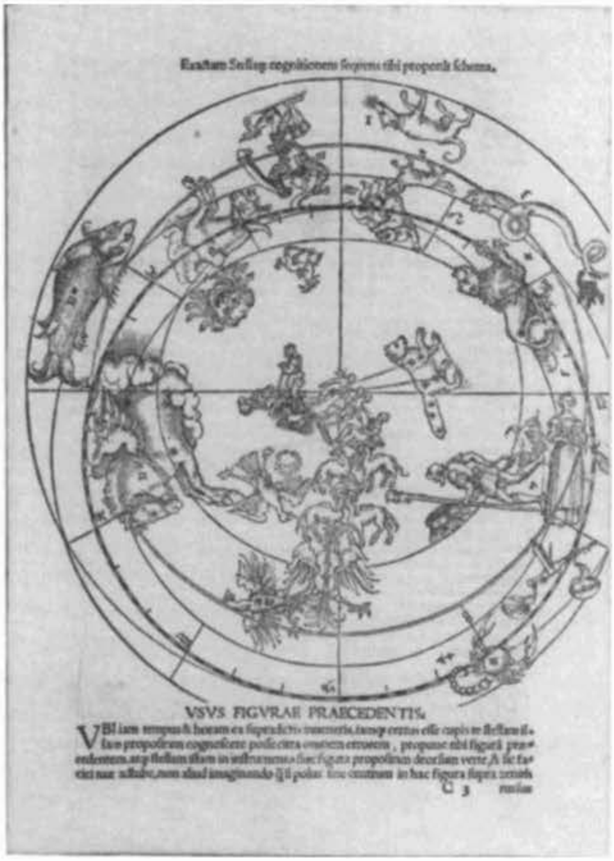


FIG. 2.44. PLANISPHERIC MAP GIVING A SELECTION OF NORTHERN AND ZODIACAL CONSTELLATIONS. Used in identifying sixteen major stars used on instruments. From Peter Apian, *Horoscopion generale* (Ingolstadt, 1533).
Size of the original: not known. Courtesy of the Library of Congress, Washington, D.C. (Rare Book Collection, QB41.A66).

Apian's *Horoscopion generale* (fig. 2.44). Produced by polar stereographic projection, it presents a selection of the northern and zodiacal constellations, oriented as seen in the sky (clockwise in sequence). The map was meant to aid an astrologer/astronomer in identifying sixteen prominent stars near the ecliptic that were used on certain instruments. What is most remarkable is its rendering of a number of Bedouin asterisms rather than Ptolemaic constellations. The stars of Cepheus are here represented as a shepherd with his sheep and dog, and camels with new foals occupy the space of our Draco. The region of Ursa Minor is occupied by three women standing in front of a fourth seated woman, the latter being his misinterpretation of the Arabic word *naʿsh*, usually translated as bier or corpse-bearing plank. These traditional Arab asterisms are not known to have been illustrated in any of the Arabic/Persian copies of al-Ṣūfī's treatise, but they are all verbally described in the text written by al-Ṣūfī to accompany the related Ptolemaic constellations.

It is evident from this star map, as well as from the star names discussed in his *Astronomicum Caesareum* of 1540, that Peter Apian knew in some form the text of al-Ṣūfī's treatise and not just the illustrations. We even know that Apian held a printing privilege issued in 1532 from the emperor Charles V to publish, in Latin presumably, "the book of the ancient astronomer Azophi" (*liber Azophi Astrologi vetustissimi*).[166] A recent historian has argued that for a brief time Apian relied on a translator to inform him of the content of al-Ṣūfī's treatise but then abandoned the project of publishing the treatise after recognizing the inadequacies of his translator.[167]

The drawing of the constellation Lyra in Apian's map of 1533, illustrated in figure 2.44, as a large bird with a violinlike instrument over its body was not Apian's invention but was taken over from Dürer's version of the constellation. It is also worth noting that in his *Astronomicum Caesareum* of 1540 Apian described the meteoroscope, a two-dimensional instrument for measuring stellar elevations that employed a form of universal astrolabe projection also derived from Arabic sources.[168]

The graphic representation of the lunar mansions through a pattern of dots also reached Europe, although not through the al-Ṣūfī constellation tradition. The term lunar mansion is not used, but patterns of dots obviously related to the twenty-eight lunar mansions are found in the Latin *Experimentarius* said to have been translated from Arabic in the twelfth century by Bernard Silvester of Tours.[169]

In the middle of the seventeenth century, a renewed interest in Arabic star names and their use on star maps is evident in a set of engraved gores for a celestial globe printed about 1630 by the Dutch mapmaker Jacob Aertsz. Colom (b. 1599), who worked in Amsterdam. On this rare set of globe gores, the names of the constellations, major stars, lunar mansions, and various circles are given in both Latin and Arabic, along with the Greek names of the Ptolemaic constellations.[170] According to an

166. Kunitzsch, "Peter Apian and 'Azophi,'" 123 (note 165).

167. A detailed account of Apian's maps and his star names, as well as possible sources, has been given by Paul Kunitzsch, "Peter Apian und Azophi: Arabische Sternbilder in Ingolstadt im frühen 16. Jahrhundert," *Bayerische Akademie der Wissenschaften, Philosophisch-Historische Klasse, Sitzungsberichte* (1986), no. 3; and Kunitzsch, "Peter Apian and 'Azophi'" (note 165).

168. North, "Meteoroscope" (note 60).

169. Savage-Smith and Smith, *Islamic Geomancy*, 39 and table 2, pp. 40–41 (note 137).

170. A possibly unique set of gores for this celestial globe (diameter 340 mm) is to be found at the Bodleian Library, Oxford, bound at the back of a treatise on the Chinese language by Jacob Golius. Regarding this celestial globe and the globe making of Colom, see Peter van der Krogt, *Globi Neerlandici: De globeproduktie in de Nederlanden* (Utrecht: HES, 1989), 179–83 (an English edition is forthcoming); see also the "globobibliography" of Peter van der Krogt, which is also forthcoming. I wish to thank Dr. van der Krogt for supplying information before publication.

inscription on the gores, the Arabic terms, which are engraved in Arabic script, were the work of one of Colom's compatriots, the Orientalist Jacob Golius (A.D. 1596–1667),[171] who made several trips to the Middle East to collect Arabic manuscripts for the University of Leiden. The terrestrial globe Colom intended as a companion piece to this celestial globe is dedicated to Golius.[172]

The constellation designs and the star positions on this set of globe gores by Colom are identical in every respect to those on the revised edition of 1603 of the earliest celestial globe designed by the Dutch cartographer Willem Janszoon Blaeu (A.D. 1571–1638).[173] The human figures are dressed for a northern European winter, with Boötes, for example, wearing a large fur hat, and in Cygnus there is clearly indicated and labeled the Nova Stella of 1600, which Blaeu had discovered on 18 August 1600. The same non-Ptolemaic constellations appear both on Blaeu's gores and on those of Colom and Golius. In the Northern Hemisphere, two constellations introduced by Mercator but based on Ptolemaic asterisms are depicted: Coma Berenices and Antinoüs, the latter being the young friend of the Roman emperor Hadrian, represented as a kneeling figure over the head of Capricorn. In the Southern Hemisphere, the new constellations of Columba Noë (Noah's dove) and El Cruzero Hispanis (the Spanish cross) are depicted along with the twelve constellations mapped by the Dutch navigators Pietr Dirksz. Keyser and Frederick de Houtman, which comprised Apous Indica (a bird of paradise), Chamaeleon (a chameleon), Vliegende Vis (a flying fish), Dorado (a goldfish), Phoenix, Grus (a crane), Pica Indica (a toucan), Hydrus (a small serpent), Indus (a native holding a spear), Pavo (a peacock), Triangulum Astrinum (the southern triangle), and Musca (a fly).

Of these non-Ptolemaic constellations, all but Coma Berenices, Antinoüs, and Vliegende Vis were given Arabic names by Golius. It is not known whether Golius himself coined the Arabic names for the newly demarcated constellations of the southern skies, but their inclusion on this set of engraved gores for a celestial globe may be the earliest recorded effort to give Arabic names to the newly outlined asterisms. The set of gores also indicates that Golius was interested in star names even before his edition and Latin translation of an astronomical compendium by the ninth-century astronomer al-Farghānī, published two years after the death of Golius and more than thirty years after the publication of the globe gores.[174] In addition, this set of gores made in Amsterdam by Colom and Golius appears to be the only known example of printed gores for a celestial globe that have Arabic star names written in Arabic script.

Personifying and Allegorical Interpretations of Celestial Bodies

The use of the twelve zodiacal signs as emblematic motifs rather than as constellation diagrams occurs frequently in Islamic art, particularly on metalwork. No attempt is made to represent stars; rather, each sign is represented by a commonly accepted convention, such as a bull for Taurus, frequently with a hump on its back and a bell round its neck, or a man sitting cross-legged with scales over his shoulders like a yoke for the sign of Libra. I noted above that some Persian celestial globes of the seventeenth century used such designs inside medallions. The globe made for the Safavid ruler Shāh ʿAbbās I is a notable example. His contemporary, the Mughal ruler Jahāngīr, prided himself on designing a series of coins employing these motifs.[175]

The seven classical planets (moon, Mercury, Venus, sun, Mars, Jupiter, and Saturn) were frequently represented by human personifications in Islamic manuscripts as well as in metalwork and other media. The form of these personifications, except those for the sun and moon, is fairly consistent and may have derived from early Babylonian conventions.[176]

A particularly fine display of the artistic interpretation of zodiacal signs and planets is also one of the outstanding examples of manuscript production to come from early fifteenth-century Persia.[177] A double-page painting

171. "Plurimarum quoque nomina Arabica operâ Iacobi Golii partim emendata, partim nunc primum addita: Inter quae xxviii Mansiones Lunae notis Arithmet. juxta seriem suam expressae et distinctae sunt" ("through the efforts of Jacob Golius the Arabic names of most of them have been emended, with some now added for the first time, among which are the twenty-eight lunar mansions represented and distinguished by numerical notations in accordance with their sequence"). It is unclear whether Golius is correcting the Arabic terms on an earlier set of globe gores, now lost, or whether the "emendata" are corrections of the Latinized forms of Arabic names used earlier in Europe. For the life and writings of Golius, see Johann Fück, *Die arabischen Studien in Europa bis in den Anfang des 20. Jahrhunderts* (Leipzig: Otto Harrassowitz, 1955), 79–84.

172. Two of the terrestrial globes are preserved at the National Maritime Museum, Greenwich, inv. nos. G. 170 and G. 171.

173. See van der Krogt, *Globi Neerlandici*, 181–82 (note 170); for Blaeu's globe, see Warner, *Sky Explored*, 28–31 (note 164).

174. For al-Farghānī, see note 70.

175. Savage-Smith, *Islamicate Celestial Globes*, 47 (note 5). For a color photograph of the coins, see Bamber Gascoigne, *The Great Moghuls* (London: Jonathan Cape, 1971), 140.

176. Maurizio Taddei, "Astronomy and Astrology: Islam," in *Encyclopedia of World Art*, 16 vols., ed. Massimo Pallottino (New York: McGraw-Hill, 1957–83), vol. 2, cols. 69–73; Fritz Saxl, "Beiträge zu einer Geschichte der Planetendarstellung im Orient und im Okzident," *Der Islam* 3 (1912): 151–77; Eva Baer, "Representations of 'Planet-Children' in Turkish Manuscripts," *Bulletin of the School of Oriental and African Studies* 31 (1968): 526–33; Ziva Vesel, "Une curiosité de la littérature médiévale: L'iconographie des planètes chez Fakhr al-Din Râzi," *Studia Iranica* 14 (1985): 115–21. The crescent moon had a slightly separate but vigorous history in Islamic art; Richard Ettinghausen, "Hilāl: In Islamic Art," in *Encyclopaedia of Islam*, new ed., 3:381–85.

177. London, Wellcome Institute Library, MS. Persian 474. Fateme Keshavarz, "The Horoscope of Iskandar Sultan," *Journal of the Royal*

(reproduced in plate 1) represents the heavens as they were on 3 Rabīʿ I 786/25 April 1384, the birthdate of Iskandar Sultan, grandson of Tīmūr (Tamerlane) and cousin of Ulugh Beg, who undertook important astronomical observations in 841/1437–38. The large nativity book of which this horoscope is a part was prepared in 813/1410–11 by Maḥmūd ibn Yaḥyā ibn al-Ḥasan al-Kāshī, who may well have been the grandfather of Ulugh Beg's famed astronomer and mathematician Ghiyāth al-Dīn Jamshīd Masʿūd al-Kāshī.

The artist who executed the horoscope was probably not the astrologer/astronomer al-Kāshī who compiled it. In the painting the twelve zodiacal signs are represented as emblematic motifs in roundels running in counterclockwise sequence. At the top is the first house, the house of the ascendant, occupied by Capricorn. The third house, moving counterclockwise, is the house of Pisces, and in it sits the figure of Venus portrayed as a woman playing a lutelike instrument (see fig. 2.23 for a similar portrayal of Venus). In the fifth house, that of Taurus, there squats a figure wearing a gold-speckled red robe and holding a disk over its face—the personification of the sun. The adjacent segment, the sixth house occupied by Gemini, has four planetary figures represented in human form. The seated turbaned man in a blue robe reading from a bookstand is Jupiter. The squatting figure in a dark blue gown with gold dots, holding a disk over its face, represents the moon. A dark-skinned bearded man (Saturn) carries two crowns rather than an ax, which is his usual attribute. The remaining figure must be Mercury, though drawn here in an unusual manner: as a turbaned man using an astrolabe instead of in the act of writing, as he is usually portrayed. In the eleventh house, that of Scorpio, the figure of Mars can be seen, with a sword in one hand and a severed head in the other. Mars wears a helmet, as befits a warrior, but all the other planetary figures are crowned except Jupiter and Mercury, to whom Saturn seems to be bringing crowns. In the corners four angels bearing gifts complete the composition. As exquisite as this painting is, the artist did make some mistakes. According to the details of the horoscope given elsewhere in the manuscript, the sun ought to have been in the fourth rather than the fifth house, and Mercury and Jupiter should have been in the fifth instead of the sixth house.[178]

In addition to these somewhat straightforward anthropomorphic and zoomorphic representations of zodiacal signs and planets, there were astrological and allegorical interpretations of designs that combine zodiacal and planetary symbols. Two basic systems of combining the zodiacal symbols with planets were used. One system, the more favored of the two, associated the "domicile" (Arabic *bayt*) of each planet with one or more zodiacal signs. Thus the moon was most frequently associated with or domiciled in Cancer and the sun in Leo. The remaining five planets were each assigned two zodiacal signs as their domiciles; for example, Venus with Libra and Taurus, Mercury with Gemini and Virgo, and Mars with Scorpio and Aries.[179] Artisans following this system would draw Taurus as a bull ridden by a figure playing the lute (Venus), Cancer with a lunar disk, and Leo surmounted by the radiant disk of the sun. Sometimes only the sun with Leo and the moon with Cancer were illustrated, while the other zodiacal signs would be depicted without planets.

The second system combined the zodiacal signs with the "exaltation" or "dejection" of a planet. The "exaltation" (Arabic *sharaf*) was a specific point in the zodiacal sign at which a planet was at its maximum influence, and conversely the "dejection" (*hubūṭ*) was the point of minimum influence. For example, the sun had its exaltation at 19° Aries and its dejection at 19° Libra; the moon's exaltation was at 3° Taurus and its dejection at 3° Scorpio, Saturn's exaltation at 21° Libra and dejection at 21° Aries, and so forth.

The "pseudoplanet" was also part of this second scheme. This consisted of the lunar nodes, the northern and southern intersections of the moon's orbit with the ecliptic. These two points were referred to as the head (*raʾs*) and tail (*dhanab*) of the dragon (*jawzahr*). Every time a conjunction or opposition of the sun and moon occurs near these lunar nodes, a solar or lunar eclipse occurs. The lunar nodes constantly change their position with respect to the fixed stars. Astrologers came to interpret the "dragon" as another planet, bringing the total number of planets to eight. The pseudoplanet was associated particularly with Sagittarius and Gemini, and this association is reflected in its artistic interpretation.[180] Two illustrations from a Turkish manuscript copied in 990/

Asiatic Society of Great Britain and Ireland, 1984, 197–208; Laurence P. Elwell-Sutton, "A Royal Tīmūrid Nativity Book," in *Logos Islamikos: Studia Islamica in Honorem Georgii Michaelis Wickens*, ed. Roger M. Savory and Dionisius A. Agius (Toronto: Pontifical Institute of Mediaeval Studies, 1984), 119–36.

178. See Elwell-Sutton, "Nativity Book," 129 and 135 n. 13 (note 177); I do not agree that the figure in the fifth house must be Jupiter.

179. For an example of a thirteenth-century mirror with zodiacal signs shown with the planets domiciled in each, see Ettinghausen and Grabar, *Art and Architecture*, 364 (note 1). See also Willy Hartner, "The Pseudoplanetary Nodes of the Moon's Orbit in Hindu and Islamic Iconographies," *Ars Islamica* 5 (1938): 112–54, esp. 115–17; reprinted in Willy Hartner, *Oriens-Occidens: Ausgewählte Schriften zur Wissenschafts- und Kulturgeschichte*, 2 vols. (Hildesheim: Georg Olms, 1968 and 1984), 1:349–404.

180. Hartner, "Pseudoplanetary Nodes" (note 179); Willy Hartner, "Djawzahar," in *Encyclopaedia of Islam*, new ed., 2:501–2; and idem, "The Vaso Vescovali in the British Museum: A Study on Islamic Astrological Iconography," *Kunst des Orients* 9 (1973–74): 99–130; reprinted in Willy Hartner, *Oriens-Occidens: Ausgewählte Schriften zur Wissenschafts- und Kulturgeschichte*, 2 vols. (Hildesheim: Georg Olms, 1968 and 1984), 2:214–45.

1582–83 show very graphically the exaltation and dejection of Mars, the sun, the moon, and the "dragon."[181]

Some have maintained that whenever the tail of the centaur in the constellation Sagittarius is drawn with a knot and a dragon's head at the tip of the tail, the reference is to the lunar node called the tail of the dragon, whose exaltation was thought to be in Sagittarius.[182] Such a rendering of Sagittarius can be seen in the horoscope prepared for Iskandar Sultan illustrated in plate 1, the drawing of Sagittarius in the al-Qazwīnī manuscript illustrated in figure 2.41, and the constellation as shown on the clockface design for al-Jazārī's water clock shown in figure 2.24.

Anthropomorphic and zoomorphic figures were also associated with the twenty-eight lunar mansions. These can be seen on the astrolabe made by ʿAbd al-Karīm al-Miṣrī in 633/1235–36 as well as in a number of manuscripts.[183] The history of these curious figures has not been traced.[184]

Occasionally on Mesopotamian and Syrian metalwork of the twelfth and thirteenth centuries a ruler assumes the mantle of the sun and in this cosmic setting is surrounded by the other six planets and the zodiacal signs.[185] Celestial symbolism was an obsession of the early Mughal rulers of northwestern India. Humāyūn (d. 963/1556), well known for his interest in astrology, had a tent designed to resemble the twelve zodiacal houses and dressed his attendants in uniforms with symbols of the planets.[186] His son and successor Akbar I took solar symbolism even more seriously and claimed descent from the sun. Consequently it is not surprising to find a number of allegorical paintings of the grandson Jahāngīr assuming the mantle of the sun.

In a painting made about A.D. 1618–22, the Mughal emperor Jahāngīr embraces the Persian emperor Shāh ʿAbbās I, while behind Jahāngīr there is a large and brilliant disk of the sun, with a lunar crescent beneath supported by two putti (see fig. 17.12, below). The illustration portrays a dream of Jahāngīr's, probably reflecting anxieties over tensions between the two great empires of India and Persia.[187] The two rulers stand on two animals of the Golden Age that rest on the globe of the earth. The lion Jahāngīr stands on extends over a considerable part of Persia, which is labeled beneath the lion's paws. The city of Tabriz, the former capital of the Safavid Empire, is labeled just beneath the head of the lamb under the feet of Shāh ʿAbbās I. The encroaching of the lion into the territory of the lamb suggests that the artist was trying to reflect an expansionist dream of Jahāngīr, who as a ruler cloaked by the heavens would dominate the earth beneath.

The Introduction of Early Modern European Celestial Mapping

It is in the workshop of an instrument maker in seventeenth-century Persia that the earliest interest in early modern European celestial mapping is displayed. Muḥammad Mahdī al-Khādīm ibn Muḥammad Amīn al-Yazdī, a well-known astrolabe maker of Yazd, southeast of Isfahan, is known to have produced over twenty astrolabes between A.D. 1640 and 1670.[188] An astrolabe made by Muḥammad Mahdī in 1065/1654–55 has two plates with engraved star maps of the Northern and Southern Hemispheres (figs. 2.45 and 2.46). The maps are polar stereographic projections with the ecliptic pole at the center and the periphery formed by the ecliptic. Each plate has the ecliptic latitude-measuring circles shown every thirty degrees as well as the equatorial polar circle, the tropic circle, and the appropriate part of the equator. In addition, the astrolabe's northern hemisphere has the equinoctial colure and is graduated by single degrees

181. New York, Pierpont Morgan Library, MS. 788, a Turkish astrology titled *Kitāb maṭāliʿ al-saʿādah wa-manāfiʿ al-siyādah*; this manuscript is closely related to one copied in the same year, now at Paris, Bibliothèque Nationale, MS. Suppl. Turc 242, and also to one at Oxford, Bodleian Library, Department of Oriental Books and Manuscripts, MS. Bodl. Or. 133, item 1.

182. Hartner, "Pseudoplanetary Nodes," 135–38 and corresponding figs., reprint 381–84 (note 179).

183. For the astrolabe, see note 139. For some manuscripts, see New York, Pierpont Morgan Library, MS. 788, fols. 33b–34a, and Paris, Bibliothèque Nationale, MS. Suppl. Turc 242, fols. 34b–35a; Hartner, "Vaso Vescovali," 124–28, reprint 240–43 (note 180).

184. For talismanic use of lunar mansions in both Arabic and Latin traditions, see Kristen Lippincott and David Pingree, "Ibn al-Ḥātim on the Talismans of the Lunar Mansions," *Journal of the Warburg and Courtauld Institutes* 50 (1987): 57–81, and Kristen Lippincott, "More on Ibn al-Ḥātim," *Journal of the Warburg and Courtauld Institutes* 51 (1988): 188–90.

185. Eva Baer, "The Ruler in Cosmic Setting: A Note on Medieval Islamic Iconography," in *Essays in Islamic Art and Architecture: In Honor of Katherina Otto-Dorn*, Islamic Art and Architecture, vol. 1, ed. Abbas Daneshvari (Malibu, Calif.: Undena, 1981), 13–19 and pls. 1–14; James W. Allan, *Islamic Metalwork: The Nuhad es-Said Collection* (London: Sotheby, 1982), esp. 23–25; Ettinghausen and Grabar, *Art and Architecture*, 362–64 (note 1).

186. William A. Blanpied, "The Astronomical Program of Raja Sawai Jai Singh II and Its Historical Context," *Japanese Studies in the History of Science*, no. 13 (1974): 87–126, esp. 112.

187. Washington, D.C., Freer Gallery of Art, Smithsonian Institution, acc. no. 45.9. For a discussion of this and similar paintings, see Robert Skelton, "Imperial Symbolism in Mughal Painting," in *Content and Context of Visual Arts in the Islamic World: Papers from a Colloquium in Memory of Richard Ettinghausen, Institute of Fine Arts, New York University, 2-4 April 1980*, ed. Priscilla P. Soucek (University Park: Published for College Art Association of America by Pennsylvania State University Press, 1988), 177–91 (figs. 1–5).

188. See Gibbs with Saliba, *Planispheric Astrolabes*, 17, 65–68, 79–82, 224 n. 44, and 225 n. 54 (note 15); Mayer, *Islamic Astrolabists*, 70–71 (note 139); Turner, *Astrolabes*, 86–91 (note 19); and Brieux and Maddison, *Répertoire* (note 36).

FIG. 2.45. CONSTELLATIONS OF THE NORTHERN HEMISPHERE ON AN ASTROLABE PLATE MADE IN 1065/1654–55 BY MUḤAMMAD MAHDĪ OF YAZD.
Diameter of the original: 16.2 cm. Present owner unknown. Photograph courtesy of the Ahuan Islamic Art Gallery, London.

FIG. 2.46. CONSTELLATIONS OF THE SOUTHERN HEMISPHERE ON AN ASTROLABE PLATE MADE IN 1065/1654–55 BY MUḤAMMAD MAHDĪ OF YAZD.
Diameter of the original: 16.2 cm. Present owner unknown. Photograph courtesy of the Ahuan Islamic Art Gallery, London.

along half of the solstitial colure. The sequence of constellations is counterclockwise, representing the projection of a globe. The iconography is completely European—human figures either nude or wearing European clothing and drawn with their backs to the user. A leaf-shaped cartouche in the northern hemisphere has the following statement in Persian: "Since there are contradictions in the locations of the fixed stars among previous scholars, and because the most accurate [star maps] are in the observatories of the Franks [western Europe], the locations of the fixed stars are shown here according to authoritative observations made within the past ten years."[189]

The plates of this astrolabe are remarkable within the Islamic world in showing for the first time the new mappings of the southern constellations after the European explorations of the sixteenth century. The non-Ptolemaic constellations of Columba Noë and those mapped by the Dutch navigators Keyser and Houtman can be seen in the southern hemispheric map engraved by Muḥammad Mahdī. Notable as well is the depiction in the Northern Hemisphere of the non-Ptolemaic forms of Coma Berenices and Antinoüs and the rendering of Lyra, which here is a bird combined with a lyrelike instrument. With this astrolabe by Muḥammad Mahdī we have the introduction into the Islamic world of a European rendering of a Bedouin asterism, or more precisely a Bedouin star name, that was not previously illustrated in Islamic constellation drawings.

These planispheric star maps engraved by Muḥammad Mahdī in 1654 are virtually identical to the map printed about 1650 by the Parisian mapmaker Melchior Tavernier,[190] illustrated in figures 2.47 and 2.48. The similarity between Tavernier's map and Muḥammad Mahdī's plates extends even to the unexplained omission of one of Keyser and Houtman's constellations (Musca, the fly). Furthermore, Columba Noë, which was to represent Noah's dove in front of the ship, is drawn on both as an unnamed triangular device. Muḥammad Mahdī has, of course, rendered the Ptolemaic constellation names into Arabic and placed his leaf-shaped cartouche exactly where Tavernier

189. *Islamic Science and Learning, Washington, D.C., July 1989*, exhibition catalog (Saudi Arabia: High Commission for the Development of Arriyadh, 1989), 14. The translation is taken from that given in the exhibition catalog. The present location of this astrolabe is unknown.

190. Warner, *Sky Explored*, 248–49 (note 164). The map by Tavernier is undated. This Melchior Tavernier (the Younger) was born in Paris in 1594 and died there in 1665. He was the son of Gabriel Tavernier, also an engraver and a seller of maps, and is often confused with his uncle Melchior Tavernier, who was born in 1564, the second son of a Huguenot artist who emigrated to France. Both Melchiors were mapmakers, and both were engravers for the king. See *Nouvelle biographie générale depuis les temps les plus reculés jusqu'à nos jours*, 46 vols. (Paris: Firmin Didot Frères, 1852–66), 44:934–35.

FIG. 2.47. CONSTELLATIONS OF THE NORTHERN HEMISPHERE ON A PLANISPHERIC STAR MAP PRINTED IN PARIS ABOUT 1650 BY MELCHIOR TAVERNIER. This star map was probably transported to Persia in 1651 by the traveler Jean-Baptiste Tavernier, brother of the mapmaker Melchior Tavernier, and was clearly the design model employed by Muḥammad Mahdī for his astrolabe plate made in 1654 and illustrated in figure 2.45.
Diameter of the original: 26.5 cm. By permission of the Bibliothèque Nationale, Paris.

FIG. 2.48. CONSTELLATIONS OF THE SOUTHERN HEMISPHERE ON A PLANISPHERIC STAR MAP PRINTED IN PARIS ABOUT 1650 BY MELCHIOR TAVERNIER. See also figure 2.47.
Diameter of the original: 26.5 cm. By permission of the Bibliothèque Nationale, Paris.

earlier gave his name as mapmaker. In contrast with Golius's collaborative effort with the Dutch mapmaker Colom, printed in Holland some years earlier, Muḥammad Mahdī did not attempt to give Arabic names to the non-Ptolemaic constellations, except for the southern triangle and Pavo, the peacock, whose Arabic name, *ṭāwūs*, was a common word for an easily recognized bird.[191]

Another Parisian mapmaker, Antoine de Fer (d. 1673), worked just across the Seine from Melchior Tavernier, and his map, printed in 1650, is remarkably similar to that of Tavernier, but with the names in French instead of Latin. So great is the similarity between these French celestial maps and the astrolabe plates made in Yazd that it seems certain either Tavernier's or de Fer's map was carried to Persia shortly after it was printed and was virtually copied in Yazd by the astrolabe maker Muḥammad Mahdī.

It is likely that the means by which the European map—most likely that engraved by Melchior Tavernier—was transmitted to Persia so soon after its publication was the traveler Jean-Baptiste Tavernier, brother of Melchior. Jean-Baptiste, who was born in Paris in 1605, made six trips to the Near East before his death in 1689.[192] His fourth trip extended from 1651 to 1655, at precisely the appropriate time for him to transport the map of his brother, printed about 1650, to Persia, where it attracted the attention of one of the most proficient Safavid astrolabe makers.

During the seventeenth century, contacts with Europe were numerous and at many different levels. Shāh ʿAbbās I, who ruled from 996/1588 to 1038/1629, established diplomatic relations with Europe, and there was considerable interchange between the Safavid court and the courts of Elizabeth I and James I of England, Philip II of Spain, Ivan the Terrible of Russia, and the Mughal emperors of India. Travelers and merchants frequented the area, although France had little contact with Persia until the end of the 1620s. With such an exchange of

191. There are other differences as well between the Arabic labels on Muḥammad Mahdī's plate and those prepared by Golius for the European gores. In addition to some differences in spelling, Muḥammad Mahdī included considerably more star names than Golius did but omitted the lunar mansions. Muḥammad Mahdī, following Tavernier, also omitted the depiction of the constellation El Cruzero Hispanis.

192. *Encyclopaedia Britannica*, 11th ed., s.v. "Tavernier, Jean Baptiste." The accounts of his travels were published in 1676, with an English version in 1678, though no mention is made in them of astrolabes or star maps; *The Six Voyages of John Baptista Tavernier, a Noble Man of France Now Living, through Turkey into Persia, and the East-Indies, Finished in the Year 1670*, trans. John Phillips (London: Printed for R. L. and M. P., 1678).

peoples, it is not surprising that an early modern European celestial map would be transported to Persia by a traveler from a family of mapmakers and that it would attract the attention of an instrument maker from Yazd who made products for the court.[193]

What is perhaps unexpected is that these astrolabe plates by Muḥammad Mahdī appear to be the whole extent of the interest in the matter. Muḥammad Mahdī is known to have made two other astrolabes with similar plates having planispheric star maps, both produced in 1070/1659–60 and clearly copies of the earlier plate, though not quite as carefully engraved.[194] His plates appear to have had no subsequent influence in instrument design, either in celestial globes or in astrolabes, and as far as is known no other planispheric maps were drawn that represent these newly outlined constellations and stars until the nineteenth century.

In the seventeenth and eighteenth centuries the tastes and fashion at the Ottoman court were also affected by exchanges with western European courts. European influence is evident in the iconography of individual constellations that were painted in 1104/1692–93 to illustrate a Turkish translation of an Arabic encyclopedia written originally in the fifteenth century by Abū Muḥammad Maḥmūd ibn Aḥmad al-ʿAynī (d. 855/1451–52). The first part of this three-volume manuscript has individual constellation figures depicted with a definite European style of hair, dress, and figural delineation, but it appears that only Ptolemaic constellations were included.[195]

These seventeenth-century introductions of early modern celestial mapping were apparently premature. It is not until the nineteenth century that any further interest in the new stars and constellations can be discerned. In 1218/1802–3 Arabic versions of the planispheric celestial maps printed in 1660 by the Dutch cartographer Andreas Cellarius (b. ca. 1630) were published. The two maps—which, like the original Dutch maps, employed polar stereographic projections—were part of a Turkish atlas of the world published in the Üsküdār district of Istanbul by ʿAbd al-Raḥmān Efendī.[196] Yet even with these new maps made available in the Near East, celestial mapping remained through most of the nineteenth century steadfastly Ptolemaic and medieval in concept.

It is fitting to end this survey of Islamic celestial mapping with a magnificent manuscript produced in India in the first half of the nineteenth century.[197] It represents well the ambivalence of Islamic astronomers/astrologers schooled in a tradition with roots that extend to antiquity and yet faced with modern European concepts. The term Islamic, of course, is here used in the general cultural rather than religious sense, for the volume presents a horoscope of the prince Nau Nihāl Singh of Lahore (1821–40), grandson of Ranjit Singh, the important leader who united the Sikhs in their bid for power. It also contains in its 293 folios a great deal of general information on astrology and astronomy and a large number of illustrations and miniatures. The name of the artist is unfortunately not known. The author of the volume was Durgāshaṅkara Pāṭhaka, a famous astronomer of Benares, who wrote the treatise in Sanskrit sometime before 1839.

In this manuscript there are two different sets of planispheric star maps. One set (figs. 2.49 and 2.50) shows the Ptolemaic constellations. Most of the iconography retains elements of Mughal renderings of constellations that can be seen on celestial globes from northwestern India. A few of the constellations, however, have been given more identifiably Indian interpretations. The style of painting is in general consistent with that of a late Mughal provincial workshop.[198]

The projections employed in these Ptolemaic planispheric maps are unusual. They represent a view of a celestial globe with one of the equinoxes at the center of each hemisphere. The southern polar circle is lightly indicated on each, as are the equator and the equinoctial colures formed by two diameters intersecting at right angles. From the south pole there can be seen lightly inscribed arcs and one straight line, which represent the ecliptic latitude-measuring circles at every thirty degrees.

193. Other European influences on instrument design can be observed at this time as well, such as a Rojas universal astrolabe projection engraved on an instrument made for the Safavid ruler Shāh Ḥusayn, who ruled from 1105/1694 to 1135/1722 (see note 79). On European contacts with Persia, see Laurence Lockhart, "European Contacts with Persia, 1350–1736," in *The Cambridge History of Iran*, vol. 6, *The Timurid and Safavid Periods*, ed. Peter Jackson and Laurence Lockhart (Cambridge: Cambridge University Press, 1986), 373–411, though it should be noted that Lockhart incorrectly refers to Tavernier as a jeweler and the son of a jeweler when in fact he was a mapmaker who married the daughter of a jeweler.

194. Greenwich, National Maritime Museum, inv. no. A64/69-6, and the University of Cambridge, Whipple Museum of the History of Science, inv. no. 1001. Both of these astrolabes were made in the same year, 1070/1659–60, for on the rete of both instruments there is the statement in Persian, "It is the mirror of Alexander and the mirror representing the entire universe," forming a chronogram that yields the date 1070 by adding the numerical values of the letters forming the statement. Not very good tracings of the plates now at the Whipple Museum are given in Gunther, *Astrolabes of the World*, 1:49 (note 2).

195. Istanbul Üniversitesi Kütüphanesi, MS. TY. 5953; see Nasr, *Islamic Science*, 101 (pl. 47) (note 123) for an illustration. A number of illustrations from a later copy of this manuscript made in 1160/1747 (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, MS. B. 274) are reproduced in *The Topkapi Saray Museum: The Albums and Illustrated Manuscripts*, translated, expanded, and edited by J. M. Rogers from the original Turkish by Filiz Çağman and Zeren Tanındı (Boston: Little, Brown, 1986), pls. 177–81.

196. See Warner, *Sky Explored*, 280–81 (note 164). There is a copy at the Royal Geographical Society in London that contains these celestial maps. They are, however, frequently missing from copies of this Ottoman atlas.

197. London, British Library, MS. Or. 5259.

198. J. P. Losty, *Indian Book Painting* (London: British Library, 1986), 78–79.

FIG. 2.49. HEMISPHERIC MAP OF PTOLEMAIC CONSTELLATIONS WITH THE AUTUMNAL EQUINOX AT THE CENTER. From the Sanskrit manuscript *Sarvasiddhāntatattvacūḍāmaṇi* (Jewel of the essence of all sciences), written before 1839 by Durgāshaṅkara Pāṭhaka, an astronomer of Benares.
Size of the original: 21.5 × 17.5 cm. By permission of the British Library, London (MS. Or. 5259, fol. 56v).

FIG. 2.50. HEMISPHERIC MAP OF PTOLEMAIC CONSTELLATIONS WITH THE VERNAL EQUINOX AT THE CENTER. From the same Sanskrit manuscript as fig. 2.49.
Size of the original: 21.5 × 17.5 cm. By permission of the British Library, London (MS. Or. 5259, fol. 57r).

The Milky Way is also shown on the map, a very unusual feature in Islamic cartography.

Near these two medieval Islamic star maps, the author has placed two early modern European planispheric star maps, illustrated in plate 2 and figure 2.51. The maps are polar stereographic projections with the equatorial pole at the center and the equator at the periphery. The sequence of constellations on the northern map is as seen on a globe, that is, counterclockwise, but on the southern map the maker has also drawn the constellations in a counterclockwise sequence, which for the southern hemisphere produces a map of stars as seen in the sky. The polar and tropic circles are indicated concentric to the center of projection. In the northern hemisphere the equinoctial colure is drawn through the equatorial pole; this is omitted in the southern hemisphere. Ecliptic latitude-measuring circles at ten-degree intervals are shown radiating from the ecliptic pole.

Though the faces of some of the human figures, particularly the women, have been painted in the style of late provincial Mughal artists, the maps are clearly close renderings of a European model. The maps of Johannes Hevelius (1611–87), a Danish astronomer, most closely resemble these maps in the selection and iconography of the constellations. The style of projection is similar to that used by the Parisian astronomer Noel André (d. 1808), also known as Father Chrysologue de Gy.[199] Numerous non-Ptolemaic constellations are depicted in this set of maps, including Antinoüs, Coma Berenices, Columba Noë, the twelve of Keyser and Houtman, and the nine devised by Hevelius. These latter include two dogs on a leash held by Boötes (Canes Venatici), the small lion over Leo (Leo Minor), and the lynx in front of Ursa

199. For Johannes Hevelius, see Warner, *Sky Explored*, 112–16 (note 164). The maps of Georg Christoph Eimmart (1638–1705) of Nuremberg, Pieter Schenck (1660–1718/19) of Amsterdam, and Tobias Conrad Lotter (1717–77) of Augsburg are also similar; Warner, *Sky Explored*, 76–77, 222–23, and 164. For Noel André, see Warner, *Sky Explored*, 4–6 (note 164).

FIG. 2.51. PLANISPHERIC MAP SHOWING SOUTHERN CONSTELLATIONS. As in plate 2, this planispheric map is from the *Sarvasiddhāntatattvaćūḍāmṇi*.
Size of the original: ca. 21 × 17.5 cm. By permission of the British Library, London (MS. Or. 5259, fol. 60r).

Major. The form of Cameleopardus can be seen over the head of Ursa Major.

The four hemispheric star maps that this nineteenth-century artist working in Benares produced to accompany a horoscope and general astronomical compendium show the later phase of medieval Islamic astronomy giving way, reluctantly and uneasily, to the European approach to celestial mapping. The workshop of Balhūmal, operating in Lahore at the same time, displayed even greater conservatism, for on none of its celestial globes are there any but the Ptolemaic constellations and stars (filtered through Arabic/Persian versions). One of the products of the Balhūmal workshop, a globe engraved in Sanskrit, is illustrated in figure 2.31. The addition of a set of meridian circles at right angles to the equator indicates some exposure to a possibly European model, and certainly the workshop excelled in producing technically precise instruments. By the last quarter of the nineteenth century, however, the Balhūmal workshop had stopped functioning, and the last traces of medieval Islamic celestial mapping disappeared.

It was not until the nineteenth century that early modern European ideas on celestial mapping made a profound impact upon the practices in Islamic lands. At first such approaches were mixed with the older medieval traditions, but by the end of the nineteenth century little trace of medieval Islamic celestial mapping could be detected. The older tradition represented primarily the Ptolemaic conceptualization of the skies, with some elements introduced from pre-Islamic Bedouin customs. Although celestial iconography formed an important part of the corpus of medieval miniatures, the interest in celestial mapping in medieval Islam was expressed primarily through instrument design. Though a substantial number of treatises dealt with the principles of planispheric projection, particularly that of stereographic projection, there are not known to be extant today any medieval Islamic celestial maps other than those in architectural remains or on scientific instruments. Yet from these remaining artifacts it is possible to detect a vigorous interest in the subject from the earliest days of Islam during the Umayyad caliphate in Syria, to the Muslim scientific communities of southern Spain in the eleventh and twelfth centuries, to the Safavid Persian empire with its interest in European ideas, and finally in the ornate products of western India, where the last vestiges of medieval celestial mapping gave way to non-Ptolemaic modern European techniques.

3 · Cosmographical Diagrams

AHMET T. KARAMUSTAFA

SCOPE

Many Islamic texts in Arabic, Persian, and Turkish contain illustrative diagrams. Although almost all such diagrams either are intended as graphic aids to the texts they accompany or are employed as clear and efficient methods of presentation, some simultaneously serve as graphic representations of cosmological ideas or, in a few cases, as complete cosmographies. The identification of a given diagram as cosmologically significant is admittedly not always a matter of certainty. For the purposes of a general survey, it will be sufficient to include those specimens that exhibit a certain measure of correlative thought—that is, diagrams where two or more different orders of existence or component parts of the universe are correlated with each other, as well as those that are presented as partial or total representations of the structure of "perceived" reality (whether material or spiritual).

It needs to be emphasized that the diagrams thus brought together are fairly broad in range, encompassing material that falls into many specialized areas such as astronomy, astrology, alchemy, geomancy, geography, philosophy, theology, and mysticism. There was in Islam no single, continuous tradition of cosmological speculation that produced a more or less homogeneous set of diagrams to illustrate the major features of a universally accepted Islamic cosmology. Instead, there existed several distinct schools of thought that rested on different, if interrelated, cosmological doctrines, and the frequency with which graphic representation was used for better presentation varied considerably from one school to another. Although this chapter focuses on the cosmographical diagrams themselves and not on the cosmologies behind them, it is necessary at this point to give a brief account of the historical development of cosmological speculation in Islam in order to place the later discussion of the diagrams themselves into its proper intellectual and cultural context.[1]

COSMOLOGY IN ISLAM

In premodern Islamic high culture, cosmological thought was cultivated primarily within three major intellectual traditions: the philosophical/scientific, the gnostic, and the mystic. Significantly, mainstream religious scholarship itself stayed for the most part clear of concentrated reflection on the structure and nature of the universe. Devotees of the religious sciences, most prominently scholars and lawyers of the Qurʾān and hadith (reports on the sayings and doings of the Prophet Muhammed), even looked askance at attempts to construct comprehensive cosmologies. The distanced attitude of the religious scholars toward cosmological speculation was dictated in large part by the rather meager cosmological content of the two major sources of Islamic religious scholarship—the Qurʾān and the hadith.

The Qurʾān, the single most important source of Islamic culture, does not contain a systematic cosmology. No single Qurʾānic verse addresses the structure of the universe directly, and materials of cosmological import that appear in the Qurʾān are as a rule devoid of descriptive detail and do not lend themselves to comparative analysis. Thus God is said to be established on a throne (Qurʾān 7:54, 10:3, 13:2, 20:5, 25:59, 32:4, 57:4), yet the Qurʾān records only that this throne either rests on water (11:7) or is borne by angels (69:17) and that it encompasses the heavens and the earth (2:255). The sky, frequently described as a canopy spread over the earth (2:22, 20:53, 21:32, 40:64, 43:10, 50:6, 78:6), was raised without any supports that humans could see (13:2) and is illuminated by the sun and the moon (25:61, 71:16, 78:12), but the seven heavens it is said to comprise (2:29, 17:44, 41:12, 65:12, 67:3, 71:15, 78:12) exist but in name—only

1. Some earlier general discussions of Islamic cosmology, of unequal quality, are Carlo Alfonso Nallino, "Sun, Moon, and Stars (Muhammadan)," in *Encyclopaedia of Religion and Ethics*, 13 vols., ed. James Hastings (Edinburgh: T. and T. Clark, 1908–26), 12:88–101; Reuben Levy, *The Social Structure of Islam* (Cambridge: Cambridge University Press, 1957; reprinted, 1965), 458–505 (chap. 10, "Islamic Cosmology and Other Sciences"); Seyyed Hossein Nasr, *An Introduction to Islamic Cosmological Doctrines: Conceptions of Nature and Methods Used for Its Study by the Ikhwān al-Ṣafāʾ, al-Bīrūnī, and Ibn Sīnā*, rev. ed. (London: Thames and Hudson, 1978); Edith Jachimowicz, "Islamic Cosmology," in *Ancient Cosmologies*, ed. Carmen Blacker and Michael Loewe (London: George Allen and Unwin, 1975), 143–71; and Anton M. Heinen, *Islamic Cosmology: A Study of as-Suyūṭī's "al-Hayʾa as-sanīya fī l-hayʾa as-sunnīya,"* with critical edition, translation, and commentary (Beirut: Franz Steiner, 1982).

the lowest heaven is described as adorned with the beauty of the stars (37:6, 41:12, 67:5). Similarly, the earth, spread wide and held firmly in place by mountains (13:3, 15:19, 16:15, 21:31, 31:10, 50:7, 51:48, 55:10, 78:7, 79:32), proves to be only one of seven earths that match the seven heavens (65:12); the other six earths, however, remain totally obscure. Consequently, though it would not be wrong to state that in broad outline the Qurʾānic universe is a hierarchical, multilayered complex that stretches from the throne of God on top through the seven heavens in between down to the seven earths at bottom, it is not possible to answer crucial questions concerning the size, shape, nature, and location of the entities that make up this universe.

The hadith corpus, the second major source of the Islamic religion after the Qurʾān, is richer in cosmological content. It not only provides many details that complement the Qurʾānic material but also attributes cosmological status to certain entities that are only nominally mentioned in the Qurʾān, such as the Tablet, the Pen, and the Balance.[2] In spite of the relative wealth of material available, however, it is hardly possible to build a homogeneous cosmology on reports transmitted by the hadith any more than on the Qurʾān because of the disconnected, inconclusive, and frequently irreconcilable nature of the reports in question.[3]

The development of a separate tradition of religious, as opposed to philosophical and scientific, cosmological speculation was also hindered by the early crystallization of theological trends that dissuaded believers from literalist interpretations of transmitted knowledge, including the Revelation. They were clearly discouraged from adopting an inquisitive attitude toward ambiguous or enigmatic sections of the Qurʾān and the hadith. In the interpretation of the Qurʾān, for instance, the "throne" was either explained away as a metaphorical expression for God's knowledge and power or simply accepted as a real entity. No attempt was made to render it more intelligible to the human mind, since the real meaning of the Qurʾānic word "throne" was thought to be beyond human comprehension.[4]

It is no doubt partially due to the entrenchment of such theological approaches that a separate tradition of religious cosmological speculation did not develop in Islam. What exists, instead, are either relatively short accounts of Creation, and thus of the universe, that are incorporated into larger historical, religious-literary, and encyclopedic works, or independent and brief collections of hadith on cosmological topics.[5]

Not all channels of inquiry relied so heavily on the Qurʾān and the hadith as did religious scholarship. Early in Islamic history several other intellectual traditions came into being that were more favorably disposed to cosmological thought. The earliest of such traditions was the philosophical/scientific, which came into its own during the third and fourth centuries of Islam (ninth and tenth centuries A.D.) under the direct influence of pre-Islamic, especially Greek, schools of learning. Already in the second Islamic century, the Muslims had begun to grow familiar with the pre-Islamic scholarly traditions of the Near East and India, and there had been considerable infusion of Indian and Iranian learning into the nascent

2. For the cosmological significance of these entities, see the following articles in *The Encyclopaedia of Islam*, 1st ed, 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), and new ed. (Leiden: E. J. Brill, 1960–): Arent Jan Wensinck (rev. Clifford Edmund Bosworth), "Lawḥ," 5:698 (new ed.); Clément Huart (rev. Adolf Grohmann), "Ḳalam," 4:471 (new ed.); and Eilhard Wiedemann, "al-Mīzān," 3:530–39 (1st ed.).

3. For examples of cosmological material in hadith literature, see Abū ʿAbdallāh Muḥammad ibn Ismāʿīl al-Bukhārī (194–256/810–70), *Ṣaḥīḥ al-Bukhārī*, 7 vols., ed. Muḥammad Tawfīq ʿUwaydah (Cairo: Lajnat Iḥyāʾ Kutub al-Sunnah, 1966/67–1976/77), 5:259 ff. ("Kitāb badʾ al-khalq"), esp. 259–69; Mubārak ibn Muḥammad, called Ibn al-Athīr (544–606/1149–1210), *Jāmiʿ al-uṣūl fī aḥādīth al-rasūl*, 10 vols., ed. ʿAbd al-Qādir al-Arnāʾūṭ (n.p.: Maktabat al-Ḥulwānī, Maṭbaʿat al-Mallāḥ, Maktabah Dār al-Bayān, 1969–72), 4:19–41 (nos. 1994–2015, "Fī khalq al-samāʾ wa-al-arḍ wa-mā fīhumā min al-nujūm wa-al-āthār al-ʿulwīyah"); ʿAlī ibn Ḥusām al-Dīn al-Muttaqī al-Hindī (d. 975/1567 or 977/1569), *Kanz al-ʿummāl fī sunan al-aqwāl wa-al-afʿāl*, 16 vols., ed. Bakrī al-Ḥayyānī, Ṣafwat al-Saqā, and Ḥasan Zarrūq (Aleppo: Maktabat al-Turāth al-Islāmī, 1969–77), 6:122–86 ("Kitāb khalq al-ʿālam"); Muḥammad ibn Yaʿqūb al-Kulaynī al-Rāzī (d. 329/940–41), *al-Uṣūl min al-kāfī*, 4th ed., 8 vols., ed. ʿAlī Akbar al-Ghaffārī (Beirut: Dār Saʿb and Dār al-Taʿāruf, 1980–81), 1:129–33 ("Bāb al-ʿarsh wa-al-kursī").

4. Different orthodox approaches to the issue of the throne of God are discussed briefly in Arent Jan Wensinck, *The Muslim Creed: Its Genesis and Historical Development* (New York: Barnes and Noble, 1932), 115–16 and 147–49. Mahmoud M. Ayoub, *The Qurʾān and Its Interpreters* (Albany: State University of New York Press, 1984–), 1:247–52, contains a succinct account of the different interpretations of the famous "Throne Verse" (2:255).

5. Notable among general works that contain accounts of the Creation are Abū ʿAlī Aḥmad ibn ʿUmar ibn Rustah (fl. ca. 290–300/903–13), *Kitāb al-aʿlāq al-nafīsah*; see the edition by Michael Jan de Goeje, *Kitâb al-aʿlâḳ an-nafîsa VII*, Bibliotheca Geographorum Arabicorum, vol. 7 (Leiden: E. J. Brill, 1892; reprinted 1967), 1–24; Abū Jaʿfar Muḥammad ibn Jarīr al-Ṭabarī (d. 311/923), *Taʾrīkh al-rusul wa-al-mulūk*; see the edition by Michael Jan de Goeje, *Annales quos scripsit Abu Djafar Mohammed ibn Djarir at-Tabari*, 15 vols. in 3 ser. (Leiden: E. J. Brill, 1879–1901; reprinted 1964–65), 1st ser., 1:1–78; Abū al-Ḥasan ʿAlī ibn al-Ḥusayn al-Masʿūdī (d. 345/956), *Murūj al-dhahab wa-maʿādin al-jawhar*, 7 vols., ed. Charles Pellat (Beirut: Manshūrāt al-Jāmiʿat al-Lubnānīyah, 1965–79), 1:31–32 and 99–110; Abū Naṣr al-Muṭahhar ibn al-Muṭahhar (or al-Ṭāhir) al-Maqdisī (fl. 355/966), *Kitāb al-badʾ wa-al-taʾrīkh*, 6 vols., ed. Clément Huart (Paris: Ernest Leroux, 1899–1919), Arabic text 1:112–208 and 2:1–73 (Huart mistakenly attributes the work to Abū Zayd Aḥmad ibn Sahl al-Balkhī); and *Rasāʾil ikhwān al-ṣafāʾ wa-khullān al-wafāʾ*, 4 vols. (Beirut: Dār Bayrūt, Dār Ṣādir, 1957), 1:114–82 ("al-Qism al-riyāḍī, rasāʾil 3 and 4" on astronomy and geography) and 2:24–51 ("risālah 16"). For a good list of independent collections of hadith on cosmological subjects, see Heinen, *Islamic Cosmology* (note 1), to which should be added Abū Bakr Muḥammad ibn ʿAbdallāh (or ʿAbd al-Malik) al-Kisāʾī (fl. eleventh century), *ʿAjāʾib al-malakūt*; see Carl Brockelmann, *Geschichte der arabischen Litteratur*, 2d ed., 2 vols. and 3 suppl. vols. (Leiden: E. J. Brill, 1937–49), 1:428–29 and suppl. 1:592.

Islamic high culture. This early eastern phase was, however, soon to give way to a most decisive Greek phase through an unprecedented movement of translation into Arabic of scientific and philosophical texts, either directly from Greek originals or from intermediate Syriac versions. This translation movement resulted in a veritable proliferation of scientific and philosophical activity and led to the establishment of *falsafah* ("philosophy," in the classical Greek sense of an encyclopedic system of knowledge that includes both "physics" and "metaphysics") as a major tradition of learning within Islamic culture.[6]

The legacy of Greek learning was far from being determinate in scope and uniform in nature, and the difficulties of translating an enormous body of specialized literature in Greek into Arabic certainly added to the confusion. It would nevertheless not be mistaken to state that the great majority of Hellenizing Muslim philosophers and scientists, who allotted a substantial role to human reason (as opposed to revelation) in their quest for the "truth," subscribed to Ptolemaic cosmology or to slightly modified versions of it. Reason fortified by scientific observation dictated that the universe was geocentric in structure, with a limited number of heavenly spheres (usually nine) arranged concentrically around the earth in the middle, and that the latter, itself spherical in shape, was only partially inhabitable. Harnessed to many different philosophical and theological systems throughout the centuries, this essentially Ptolemaic cosmology became the most widely accepted view of the universe among educated Muslims.

Mainstream religious scholars never ceased to view the "extraneous" philosophical and scientific thought with suspicion, which meant there would always be a chasm between Muslim piety on the one hand and intellectual commitment to the principles of the "sciences of the ancients" on the other.[7] Interpenetration was inevitable, however, and theological and theosophical schools in the first instance adopted Hellenistic philosophical material pertinent to their concerns with remarkable facility. Cosmologically most significant was the adoption of Neoplatonic doctrines, not by theology, which was on the whole argumentative and apologetic in character, but by Gnostic and mystic theosophy, both of which manifested a distinct tendency to philosophical speculation. Gnostic theosophy, represented most prominently by Ismāʿīlī thought, flourished especially in the tenth and eleventh centuries, whereas mystical-philosophical theosophy, which began to take shape somewhat later, came into its own during the thirteenth century under the formative influence of the philosopher-mystic Ibn al-ʿArabī and continued to be cultivated right up to the modern period. Both the Gnostics and the mystics were esotericists in religion who assigned priority to the "hidden inner truth" over its apparent outward manifestations. They therefore felt themselves free, even compelled, to venture beyond an esoteric approach to the Qurʾān and the hadith and proceeded to build elaborate cosmologies that had no parallels in the literatures of the religious sciences.

In summary, one could say that, owing to the indifferent attitude of traditionalist religious scholars toward cosmological speculation, systematic reflection on the structure of the universe was a challenge taken up only by philosophers on the one hand and by Gnostics and mystics on the other hand. It is the works produced by these groups, who felt justified in broaching areas that were viewed with suspicion in legalist circles, that form the major source of cosmographical diagrams in Islam.

General Characteristics of Cosmographical Maps and Diagrams

At the present stage of scholarship in Islamic studies it is not possible to draw up an exhaustive list of extant Islamic cosmographical diagrams. The relevant manuscript sources are as yet very far from being completely and satisfactorily cataloged. More significantly, published catalogs, which frequently exhibit a total unawareness of the "possibility" that graphic representation might form a separate field of study, largely fail to record the presence of drawings in the manuscripts they describe. In these circumstances, locating cosmographical diagrams in Islamic works is a tedious and drawn-out task that necessarily has to rely more on published texts than on unpublished manuscript sources. This dependency on the work of modern editors has its own drawbacks, since even in the case of reliable critical editions the student of cosmography is compelled to fall back on the manuscripts themselves in order to determine the exact number of diagrams contained in any given work and to further examine the originals at first hand. In a general study such as the present survey, however, it is not possible to go into such detail, nor do the diagrams themselves always warrant close scrutiny of this nature. Clearly this survey of Islamic cosmographical diagrams, the first of its kind in scholarly literature, cannot be exhaustive and will need to be supplemented as more and more manuscripts are made available to the researcher.

Almost all the diagrams presented in the following

6. The scholarly literature on the classical heritage of Islam is reviewed in Felix Klein-Franke, *Die klassische Antike in der Tradition des Islam* (Darmstadt: Wissenschaftliche Buchgesellschaft, 1980).

7. Compare Ignaz Goldziher, "Stellung der alten islamischen Orthodoxie zu den antiken Wissenschaften," *Abhandlungen der Königlich Preussischen Akademie der Wissenschaften, Philosophisch-Historische Klasse* (1915), Abhandlung 8; English translation, "The Attitude of Orthodox Islam toward the 'Ancient Sciences,'" in *Studies on Islam*, ed. and trans. Merlin L. Swartz (New York: Oxford University Press, 1981), 185–215. More discussion with profuse references can be found in Klein-Franke, *Die klassische Antike* (note 6).

pages appear as illustrative material in books and were obviously intended as visual aids to the texts they accompany. This does not mean that none of them can stand alone without their textual context or that none have any independent value on their own. There are some that would be perfectly intelligible and clear even without any textual explanation and others that serve as "graphic text," that is, that contain material otherwise not presented or explained in the text. Such diagrams cannot be treated as simple illustrations subservient to the text surrounding them.

Whether independently valuable or not, all the figures involved are primarily didactic in nature. They are intended more as general and often arbitrary visual images of certain cosmological ideas than as technically precise and measured representations of space. This is true not only of figures that graphically represent spiritual or sacred space, in which case it would hardly be appropriate to search after technical precision and accuracy, but also of those presented as realistic representations of physical space. Generally speaking, there is no consideration of scale where this could be applicable, and the emphasis is on gross outlines, with little or no attention paid to details.

The diagrams exhibit a certain graphic consistency that is perhaps best characterized by the overwhelming use of geometric forms. More specifically, concentric circles divided into equal parts by means of radii seem to be the predominant pattern used for illustrating cosmological schemes. This popularity of circular representation in Islamic cosmographical diagrams no doubt reflects the universal acceptance in Islamic culture of the Aristotelian belief that the sphere is the most perfect of all forms. Very often this belief in the perfection of the spherical form was coupled with the argument that God could only have created the best of all possible worlds, which naturally led to the conclusion that the universe was spherical. A clear statement of this kind of reasoning is provided by Ḥaydar Āmulī (720/1320 to after 787/1385), who was probably the most productive of all Islamic cosmographers:

> The form of the world, the heavenly spheres, the bodies, and the [four] elements was made spherical, since the spherical, round form is the best of all forms, as it is said: "The best of all forms is the circular form." If a form more beautiful and more perfect than the circular form were to be possible, then the world would have been created in that form, since it is established that "a world more excellent than this one is not possible, because if it were to be possible, it would have been necessary to [attribute] either impotence or avarice to God—who is [however] beyond these two [attributes]." Thus it is proved that a more excellent and more beautiful form than this one [that is, the spherical form] and this state is not possible.[8]

Others, however, had different reasons for thinking that the created universe was spherical. A case in point is that of the mystic philosopher Ibn al-ʿArabī, who built an interesting argument on Qurʾānic material:

> Know that since the world is spherical, man yearns for his beginning [when he reaches] his end; thus our coming into existence from nonexistence is from God and to him shall we return, since he said, "everything will be returned to him" [11:23], and he said, "and fear the day when you shall be brought back to Allah" [2:281], and he said, "he is the place of destination" [5:18 and others], and "the end of all things belongs to him" [31:22]. Do you not see that when you start drawing a circle . . . you do not stop drawing it until you reach its beginning [point] and [only] then it is a circle? If this was not the case so that we were to have originated from him in a straight line, we would not return to him, and his word would not be true, and yet he is the truthful one and to him shall you return. Thus everything and every being is a circle returning to him from whom it originated.[9]

It was due to the prevalence of these and similar views that the sphere figured prominently in Islamic cosmological speculation and hence the circle in Islamic cosmography.

The technical simplicity of the cosmographical diagrams under review meant there was little need for specialized draftsmen to execute them. It is safe to assume that the scribe and the draftsman were frequently the same person. Lack of specialization at the production end was paralleled by lack of differentiation at the receiving end: the figures were addressed to the same audience as the texts that contained them. On a different level, the extent to which cosmography was "submerged" in the text surrounding it is demonstrated by the absence of specific terms that apply only to cosmographical diagrams. The relevant terminology is very general in nature and could apply equally well to maps, pictures, miniatures, and marginal illumination. The following terms are used most frequently in relation to cosmological diagrams: *ṣūrah* (form); *ṣūrah* combinations like *ṣūrat al-shakl* (the drawing of the form), *ṣūrat al-dāʾirah* (the drawing of the circle); and *ṣūrat-al ʿālam* (the representation of the world); *dāʾirah* (circle); *taṣwīr* (depiction); *rasm* (picture), *shakl* (shape); and *mithāl* (representation).

8. Sayyid Bahāʾ al-Dīn Ḥaydar ibn ʿAlī al-ʿUbaydī al-Ḥusaynī Āmulī, *al-Muqaddimāt min kitāb naṣṣ al-nuṣūṣ fī sharḥ fuṣūṣ al-ḥikam* (The prefatory sections from the Book of the Text of Texts on the interpretation of *The Bezels of Wisdom*); see the edition by Henry Corbin and ʿUthmān Yaḥyā, *Le texte des textes (Nass al-nosus)* (Paris: Librairie d'Amérique et d'Orient, Adrien-Maisonneuve, 1975), 100, par. 234 (author's translation).

9. Muḥyī al-Dīn Muḥammad ibn ʿAlī ibn al-ʿArabī (560–638/1165–1240), *al-Futūḥāt al-Makkīyah*, ed. ʿUthmān Yaḥyā and Ibrāhīm Madkūr (Cairo: Jumhūrīyah Miṣr al-ʿArabīyah, Vizārat al-Thaqāfah, 1972–), vol. 4 (author's translation).

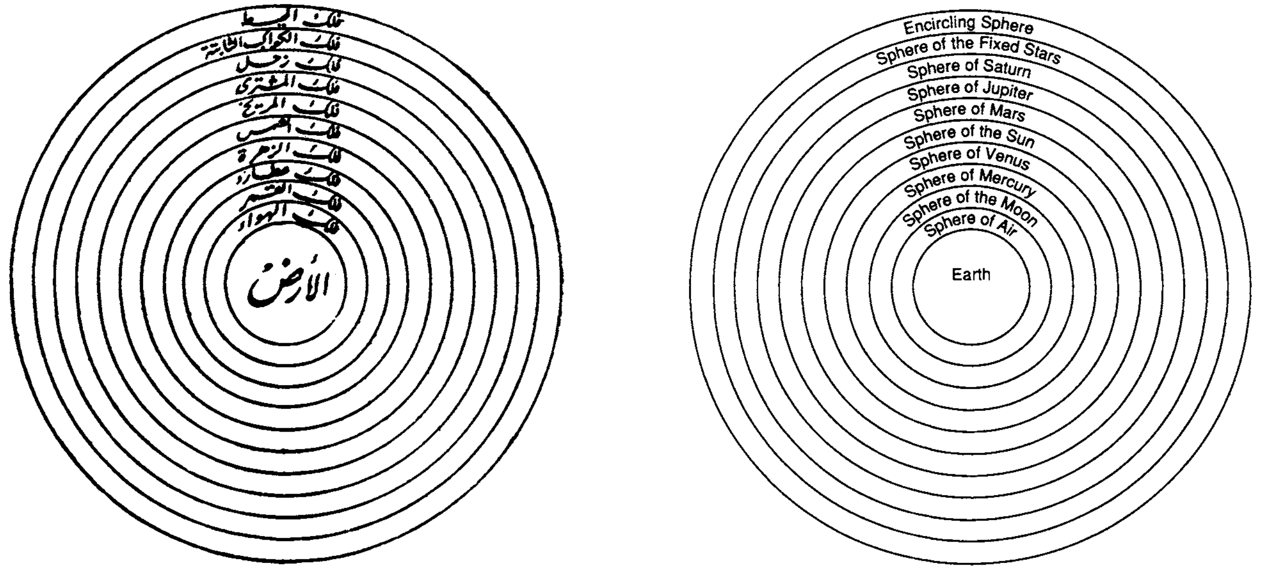


FIG. 3.1. THE CELESTIAL SPHERES FROM *RASĀ'IL IKHWĀN AL-ṢAFĀ'*. Translation on the right. The exact dating of this text has given rise to considerable controversy among modern scholars; for a recent forceful argument that the work should be dated to between 260/873 and 297/909, see Abbas Hamdani, "The Arrangement of the *Rasā'il ikhwān al-ṣafā'* and the Problem of Interpolations," *Journal of Semitic Studies* 29 (1984): 97–110, esp. 110.
Diameter of the original: 8.3 cm. From *Rasā'il ikhwān al-ṣafā' wa-khullān al-wafā'*, 4 vols. (Beirut: Dār Bayrūt, Dār Ṣādir, 1957), 1:116 ("al-risālat al-thālithah min al-qism al-riyāḍī").

Exoteric Realism: Philosophical and Scientific Diagrams

Celestial Diagrams

The Ptolemaic model of the universe formed the subject of a set of diagrams that appear in various works written by Muslim philosophers and scientists or by others they influenced.[10] In the *Almagest*, Ptolemy had adopted the traditional ascending order of seven celestial spheres (moon, Mercury, Venus, sun, Mars, Jupiter, Saturn), and in the *Planetary Hypotheses* he had described these as spherical shells contiguous with each other in such a way that the outer limit of each shell corresponds to the inner limit of the one directly above it.[11] In Islam, once it became known and accepted, this model was normally represented simply by a set of concentric circles drawn around a spherical earth in the middle. In different diagrams of the same kind, the seven planetary spheres were usually combined with those of the three elements—water, air, and fire—which were believed to surround the earth (the fourth element) in that ascending order. The outer boundary of the Ptolemaic universe was then extended beyond the sphere of fixed stars (also referred to as the sphere of the zodiac) by adding a sphere entitled the "encircling sphere" or "the sphere of spheres" to explain the diurnal motion of the sphere of the fixed stars (figs. 3.1 and 3.2).

The first examples of the celestial-sphere diagrams all date back to the turn of the eleventh century,[12] suggesting that Ptolemaic cosmology, already known to the Muslims from the ninth century onward through Arabic translations of Ptolemaic works, gained prevalence especially during this period. Thereafter, the validity of this model of the universe was on the whole never questioned by Muslim philosophers and scientists. The appearance of Ptolemaic celestial-sphere diagrams, even in completely mystical works as late as the end of the medieval period, is testimony to the spread and endurance of the model.[13]

10. No attempt was made to be exhaustive in illustrating the following section, since examples of all the types of diagrams discussed here can be found in abundance in texts of the later Islamic Middle Ages, about A.D. 1500–1800.

11. *Ptolemy's "Almagest,"* trans. and annotated G. J. Toomer (London: Duckworth, 1984), 38–47 (bk. 1.3–8) and 419–20 (bk. 9.1).

12. See *Rasā'il ikhwān al-ṣafā'*, 1:116 (note 5), reproduced here as figure 3.1; Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī (d. after 442/1050), *Kitāb al-tafhīm li-avā'il ṣinā'at al-tanjīm* (comp. 420/1029), ed. Jalāl al-Dīn Humā'ī (Tehran, 1974), 57; and Ḥamīd al-Dīn Aḥmad ibn ʿAbdallāh al-Kirmānī, *Rāḥat al-ʿaql* (comp. 411/1020–21), ed. Muḥammad Kāmil Ḥusayn and Muḥammad Muṣṭafā Ḥilmī (Cairo: Dār al-Fikr al-ʿArabī, 1953), 82.

13. Two examples of later celestial sphere drawings are in Ibrāhīm ibn al-Ḥusayn al-Ḥāmidī (d. 557/1162), *Kanz al-walad*, ed. Muṣṭafā Ghālib (Wiesbaden: Franz Steiner, 1971), 169, and Erżurumlu İbrāhīm Ḥakkı, *Maʿrifetnāme* (comp. 1170/1756), ed. Kırımī Yūsuf Żiyā (Istanbul: Maṭbaʿa-i Aḥmed Kāmil, 1911–12), 50, reproduced here as figure 3.2 from a manuscript copy of the work.

FIG. 3.2. THE CELESTIAL SPHERES FROM THE *MAʿRIFETNĀME*. For a translation see figure 3.1, diagram on the right.
Size of the original: 8.1 × 8.4 cm. By permission of the British Library, London (MS. Or. 12964, fol. 39b).

The celestial diagrams were sometimes accompanied and complemented by related diagrams. Such were the figures of the spheres of individual planets, separate diagrams of the sublunar spheres of the four elements (fig. 3.3),[14] and figures that illustrate the correlations believed to exist between the signs of the zodiac, on the one hand, and the planets, the four elements, the four directions, the mineral world, the parts of the human body, and so forth on the other hand (figs. 3.4 and 3.5).[15] In all these cases Muslim scholars were drawing upon Hellenistic material of more or less determinate origin, and it is possible that the diagrams themselves had precedents in Greco-Roman antiquity.

GEOGRAPHICAL DIAGRAMS

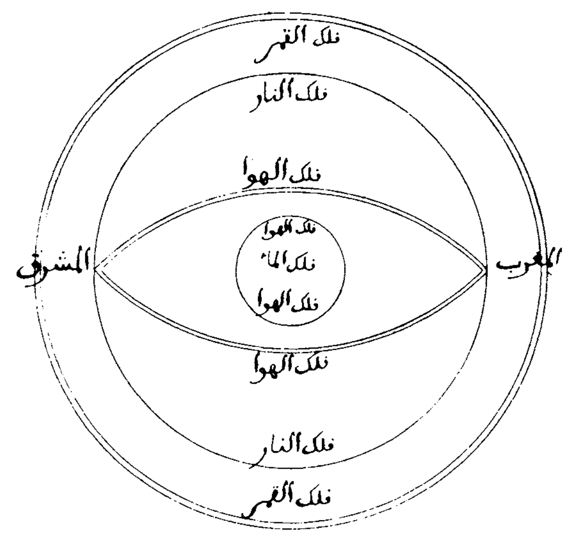
The influence of Ptolemy was also extensive in the formation of Islamic views concerning the configuration of the earth. In its Ptolemaic version, the theory that the inhabited portion of the earth was divided into seven *climata* (Arabic *iqlīm*, pl. *aqālīm*) rapidly became an inalienable part of Islamic high learning, although research on technical aspects of the theory—namely, the determination of the boundaries between *climata* based on latitude calculations—was naturally the preserve of a handful of qualified scientists. In quite a few scientific as well as nonscientific works, the seven-*climata* system was illustrated by simple diagrams consisting of eight straight parallel lines or concentric circles drawn within a circle that represented the earth (figs. 3.6 to 3.9).[16] None of these diagrams reflect a concern with accuracy in representing the *climata*. Instead, they seem to have been intended primarily to orient readers in a very general sense and probably also to demonstrate the centrality, in the inhabited world, of the fourth region where the administrative center of the Islamic empire was situated.[17]

14. Examples appear in al-Bīrūnī, *Kitāb al-tafhīm*, 29 (note 12); Shihāb al-Dīn Abū ʿAbdallāh Yāqūt ibn ʿAbdallāh al-Ḥamawī al-Rūmī al-Baghdādī (d. 626/1229), *Kitāb muʿjam al-buldān*; see the edition by Ferdinand Wüstenfeld, *Jacut's geographisches Wörterbuch*, 6 vols. (Leipzig: F. A. Brockhaus, 1866–73), 1:14–15, reproduced here as figure 3.3; and İbrāhīm Ḥaḳḳı, *Maʿrifetnāme*, 127 (note 13). This view of the earth's atmosphere draws directly upon Aristotle's *Meteorologica*.

15. Correspondence between the signs of the zodiac and the planets: *Rasāʾil ikhwān al-ṣafāʾ*, 1:120 (note 5); al-Bīrūnī, *Kitāb al-tafhīm*, 396 (note 12). Correspondence between the signs of the zodiac, the four directions, and the four elements: al-Bīrūnī, *Kitāb al-tafhīm*, 322, reproduced here as figure 3.4; Abū Muʿīn Nāṣir Khusraw Qubādiyānī, *Kitāb-i jāmiʿ al-ḥikmatayn* (comp. 462/1069–70); see the edition by Henry Corbin and Muḥammad Muʿīn, *Kitâb-e jâmiʿ al-hikmatain* (Tehran: Département d'Iranologie de l'Institut Franco-iranien, 1953), 278 reproduced here as fig. 3.5. Correspondence between the signs of the zodiac, the planets, the organs of the five senses, the brain, and the heart: Nāṣir Khusraw, *Kitāb-i jāmiʿ al-ḥikmatayn*, 287. Correspondence between the signs of the zodiac, certain minerals, and the planets: Shams al-Dīn Abū ʿAbdallāh Muḥammad ibn Ibrāhīm al-Dimashqī (d. 727/1327), *Nukhbat al-dahr fī ʿajāʾib al-barr wa-al-baḥr*; see the edition by A. F. M. van Mehren, *Nukhbat ad dahr fî ʾadschâʾib al barr wal bahr* (Saint Petersburg, 1866; reprinted Leipzig: Otto Harrassowitz, 1923), 52.

16. These drawings are also discussed in the context of geographical mapping in this volume, chapter 6.

17. André Miquel, "Iḳlīm," in *Encyclopaedia of Islam*, new ed., 3:1076–78, with further bibliography; also Ernst Honigmann, *Die sieben*



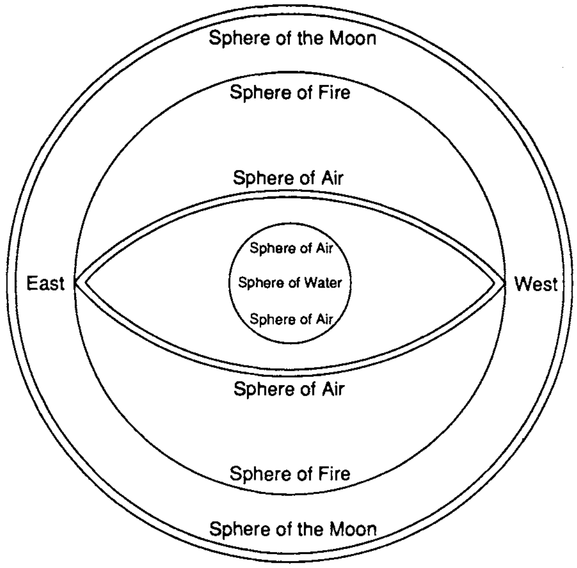
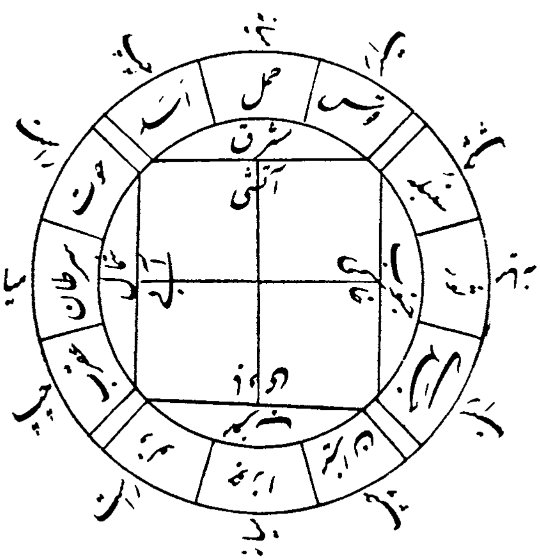


FIG. 3.3. THE LUNAR SPHERE AND THE SPHERES OF THE FOUR ELEMENTS. Illustration taken from Yāqūt's *Kitāb muʿjam al-buldān*. Translation on the right. Diameter of the original: 10 cm. From *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld (Leipzig: F. A. Brockhaus, 1866–73), 1:14–15, by permission of F. A. Brockhaus.



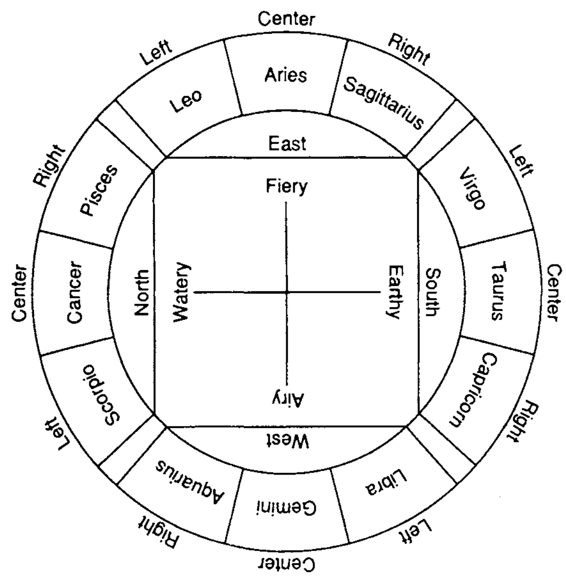


FIG. 3.4. CORRESPONDENCE BETWEEN THE SIGNS OF THE ZODIAC, THE FOUR DIRECTIONS, AND THE FOUR ELEMENTS. Translation on the right. Size of the original: not known. From al-Bīrūnī, *Kitāb al-tafhīm li-avāʾil ṣināʿat al-tanjīm*, ed. Jalāl al-Dīn Humāʾī (Tehran, 1974), 322.

The same concern was also dominant in a rival theory of dividing the earth into regions—the seven-*kishvar* system of Persian origin. In this view the inhabited portion of the world was made up of seven circular regions (Persian *kishvar*) of equal size, arranged so that six of the regions totally engulf the seventh central one. As pointed out by the celebrated scholar al-Bīrūnī, who first drew a diagram of this view of the world (fig. 3.10), "This par-

Klimata und die πόλεις ἐπίσημοι (Heidelberg: Winter, 1929). Further examples: al-Bīrūnī, *Kitāb al-tafhīm*, 191 (note 12); Yāqūt, *Kitāb muʿjam al-buldān*, 1:28–29 (note 14); Zakariyāʾ ibn Muḥammad al-Qazwīnī (d. 682/1283), *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt*; see the edition by Ferdinand Wüstenfeld, *Zakarija ben Muhammed ben Mahmud el-Cazwini's Kosmographie*, 2 vols. (Göttingen: Dieterichsche Buchhandlung, 1848–49; facsimile reprint Wiesbaden: Martin Sändig, 1967), 1:148; *Kitāb al-badʾ wa-al-taʾrīkh* (dated 977/1569–70), Bodleian Library, Oxford, MS. Laud. Or. 317, fol. 46a.

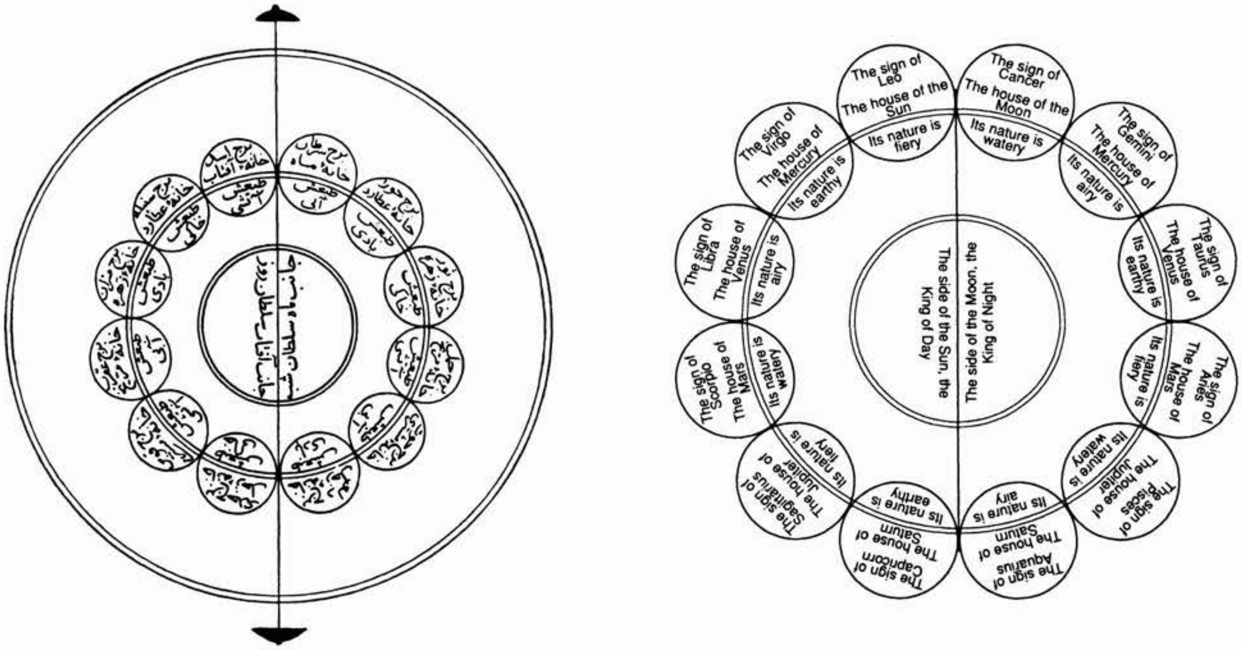


FIG. 3.5. CORRESPONDENCE BETWEEN THE SIGNS OF THE ZODIAC, THE PLANETS, AND THE FOUR ELEMENTS. Illustration taken from Nāṣir Khusraw, *Kitāb-i jāmiʿ al-ḥikmatayn*. Translation on the right.

Size of the original: 11.4 × 9.9 cm. From Henry Corbin and Muḥammad Muʿīn, eds., *Kitâb-e jâmiʿ al-hikmatain* (Tehran: Département d'Iranologie de l'Institut Franco-iranien, 1953), 278. By permission of the Institut Français de Recherche en Iran.

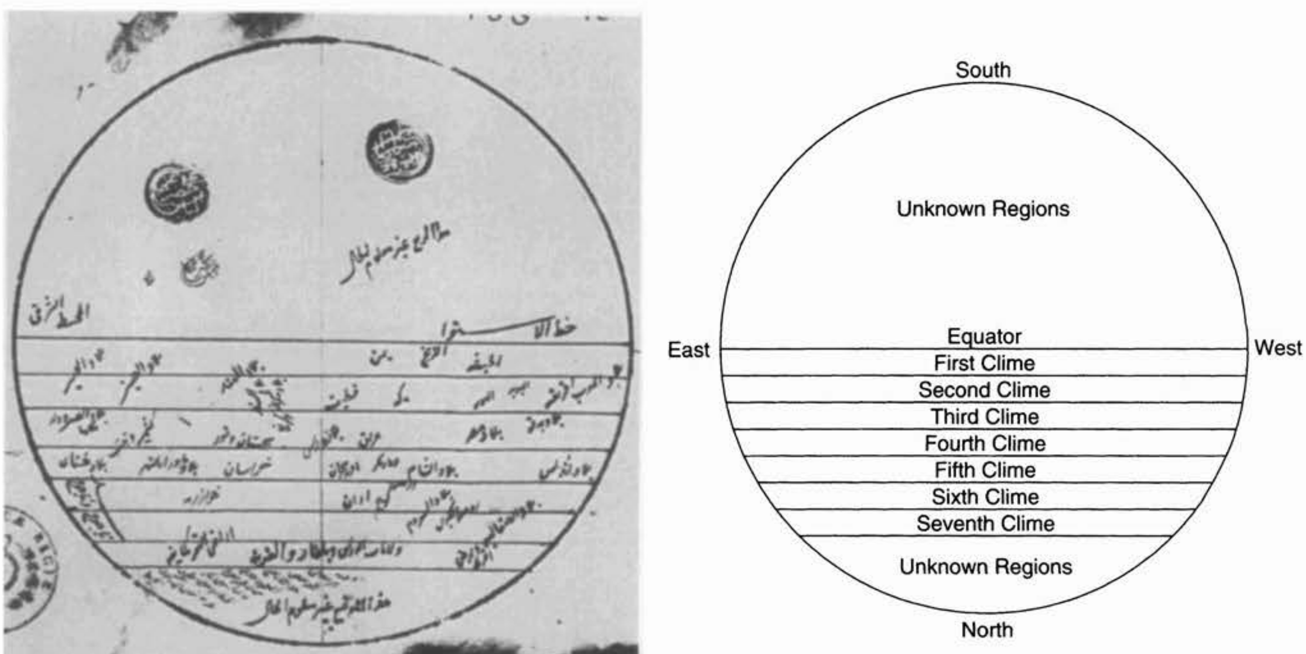


FIG. 3.6. THE SEVEN *CLIMATA* WITH INTERSPERSED PLACE-NAMES. Drawing from the title page of the anonymous manuscript *Kitāb hayʾat ashkāl al-arḍ wa-miqdāruhā fī al-ṭūl wa-al-ʿarḍ al-maʿrūf bi-jughrāfīyah*, dedicated to Sayf al-Dawlah (d. 356/967), a Hamdanid sultan. Approximate translation on the right. (This manuscript is discussed below as an abridgment of Ibn Ḥawqal, see figs. 5.11, 6.2, 6.3, 6.10, and appendix 5.1, no. 42.)

Diameter of the original: 15.2 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2214).

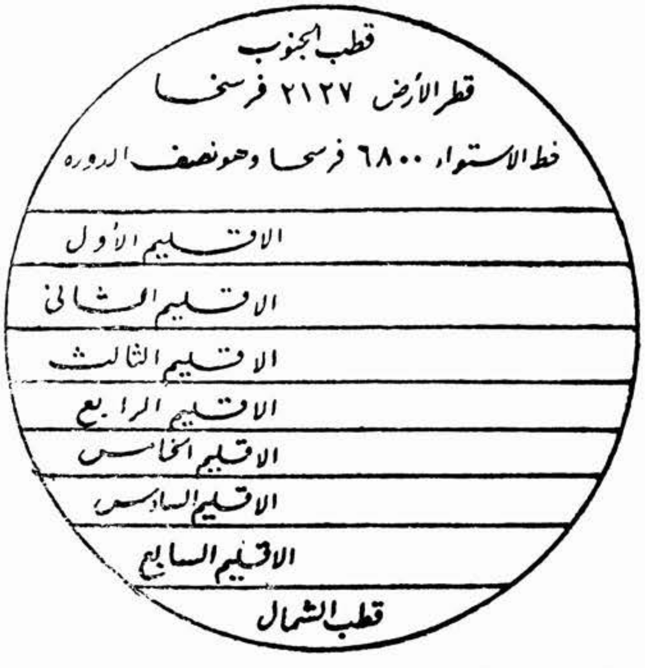


FIG. 3.7. THE SEVEN *CLIMATA* FROM *RASĀʾIL IKHWĀN AL-ṢAFĀʾ*. For an approximate translation see figure 3.6, diagram on the right.
Diameter of the original: ca. 5.5 cm. From *Rasāʾil ikhwān al-ṣafāʾ wa-khullān al-wafāʾ*, 4 vols. (Beirut: Dār Bayrūt, Dār Ṣādir, 1957), 1:165.

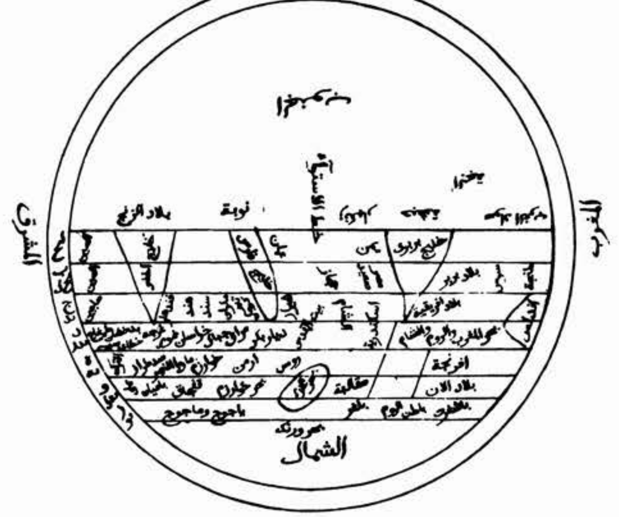


FIG. 3.8. THE SEVEN *CLIMATA* FROM AL-QAZWĪNĪ'S *KITĀB ʿAJĀʾIB AL-MAKHLŪQĀT*. For an approximate translation see figure 3.6, diagram on the right. (See also fig. 6.8 below.)
Diameter of original: approx. 11 cm. From *Zakarija ben Muhammed ben Mahmud el-Cazwini's Kosmographie*, 2 vols., ed. Ferdinand Wüstenfeld (Göttingen: Dieterichsche Buchhandlung, 1848–49; facsimile reprint Wiesbaden: Martin Sändig, 1967), 2:8, by permission of Dieterichsche Verlagsbuchhandlung, Mainz.

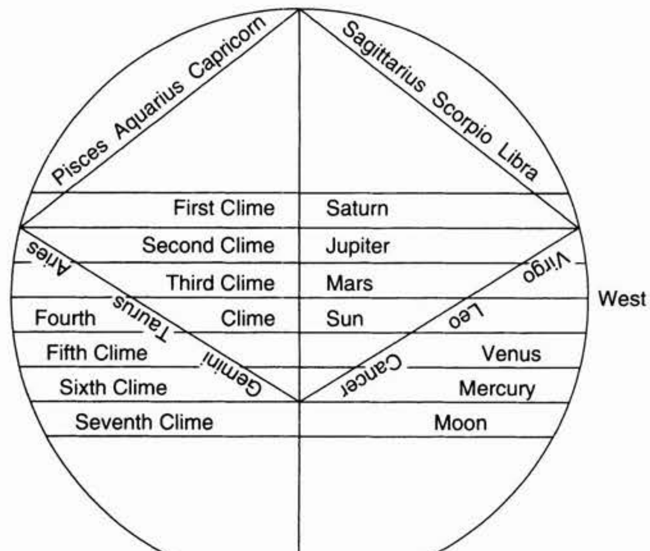


FIG. 3.9. THE SEVEN *CLIMATA* FROM *KITĀB AL-BADʾ WA-AL-TAʾRĪKH*. This diagram illustrates the correspondences between the seven *climata*, the seven planets, and the twelve signs of the zodiac. The authorship of this Arabic manuscript, dated 977/1569–70, has been the subject of some debate among scholars; see p. 145. Translation on the right.
Diameter of the original: 10.2 cm. By permission of the Bodleian Library, Oxford (MS. Laud. Or. 317, fol. 7a).

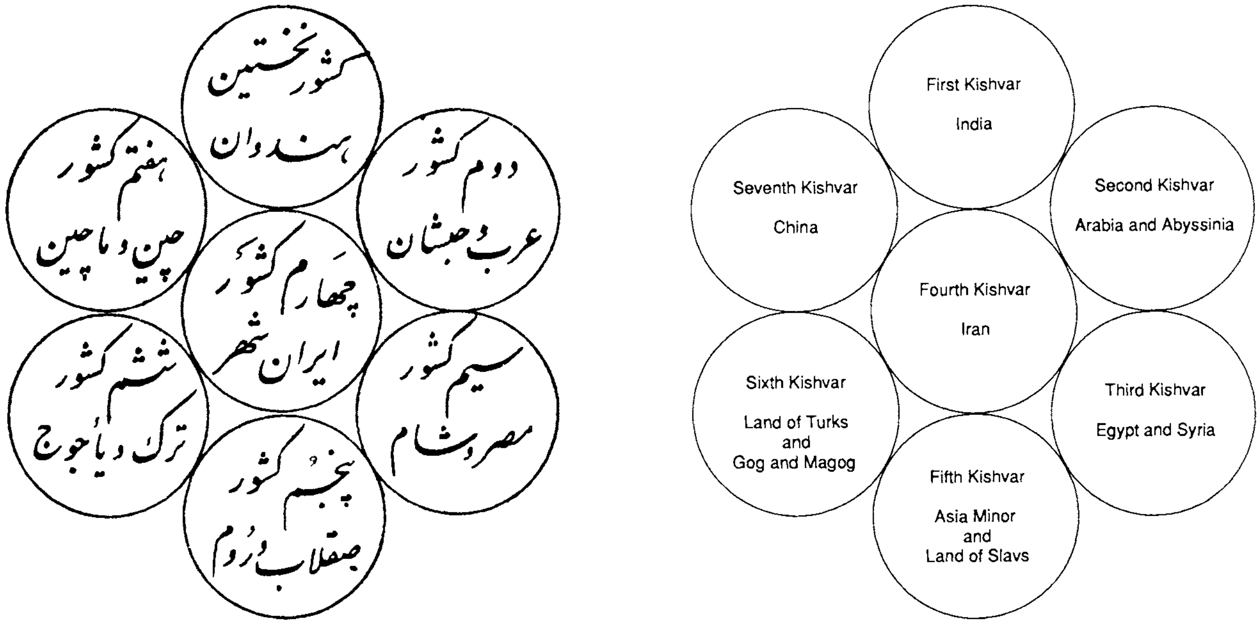


FIG. 3.10. THE SEVEN *KISHVARS*. Translation on the right. Size of the original: not known. From al-Bīrūnī, *Kitāb al-tafhīm li-avāʾil ṣināʿat al-tanjīm*, ed. Jalāl al-Dīn Humāʾī (Tehran, 1974), 196.

tition ha[d] nothing to do with natural climatic conditions, nor with astronomical phenomena. It [was] made according to Kingdoms which differ[ed] from one another for various reasons—different features of their peoples and different codes of morality and customs."[18] In reality, the seven-*kishvar* view drew directly upon the ancient Indo-Iranian belief that the world was divided into seven regions that were thought to have come into existence when the first rain fell on the earth and broke it into seven pieces. In Islamic times, however, this belief survived only marginally and never matched the Ptolemaic seven-*climata* scheme in popularity.[19]

More widespread than the Iranian *kishvar* partitioning and, properly speaking, more Islamic than either of the two "extraneous" schemes so far mentioned was a geographical regionalization of the world around the Kaʿba. The maps produced by this process are numerous enough to form a distinct class of sacred geography, with several subdivisions, and they are described in a separate chapter.[20] In themselves they can hardly have been of practical use to the believer who needed to ascertain the direction of the qibla from a given geographical location. It might have been for this reason that directions for determining the qibla in each region were at times incorporated into the text that accompanied the pictorial representations. The Kaʿba-centered scheme was preferred predominantly in religious works, most probably with the purpose of emphasizing a sacred geography over profane schemes that had their origins in non-Islamic cultures.

Esoteric Speculation: Gnostic and Mystical Diagrams

Gnostic Diagrams

Perhaps the earliest and most important corpus of occult and scientific writings in Islam is attributed to Jābir ibn Ḥayyān. Consisting of numerous tracts and treatises, some containing cosmographical diagrams, the texts were compiled at the end of the eleventh century at the latest.

18. Al-Bīrūnī, *Kitāb taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin*, ed. P. G. Bulgakov and rev. Imām Ibrāhīm Aḥmad (Cairo: Maṭbaʿah Lajnat al-Taʾlīf, 1964), 135; English translation: *The Determination of the Coordinates of Positions for the Correction of Distances between Cities*, trans. Jamil Ali (Beirut: American University of Beirut, 1967), 102.

19. On the seven-*kishvar* system in ancient Iranian thought, see Mary Boyce, *A History of Zoroastrianism*, vol. 1, *The Early Period* (Leiden: E. J. Brill, 1975), 134; Ehsan Yarshater, "Iranian Common Beliefs and World-View," in *The Cambridge History of Iran* (Cambridge: Cambridge University Press, 1968–), vol. 3, *The Seleucid, Parthian and Sasanian Periods*, ed. Ehsan Yarshater, pt. 1, pp. 343–58. esp. 351; and Henry Corbin, *Terre céleste et corps de résurrection de l'Iran Mazdéen à l'Iran Shīʿite* (Paris: Buchet/Chastel, 1960), 40–48. All three sources rely on the *Avestas* and the *Bundahishn*. The survival of this system in Islamic texts is studied briefly by Edward S. Kennedy, *A Commentary upon Bīrūnī's "Kitāb Taḥdīd al-Amākin": An 11th Century Treatise on Mathematical Geography* (Beirut: American University of Beirut, 1973), 73–74. Further examples of seven-*kishvar* diagrams appear in al-Bīrūnī, *Taḥdīd*, 136, English translation, 102 (note 18); Yāqūt, *Kitāb muʿjam al-buldān*, 1:26–27 (note 14); and al-Dimashqī, *Nukhbat al-dahr*, 25 (note 15).

20. See chapter 9 of this volume.

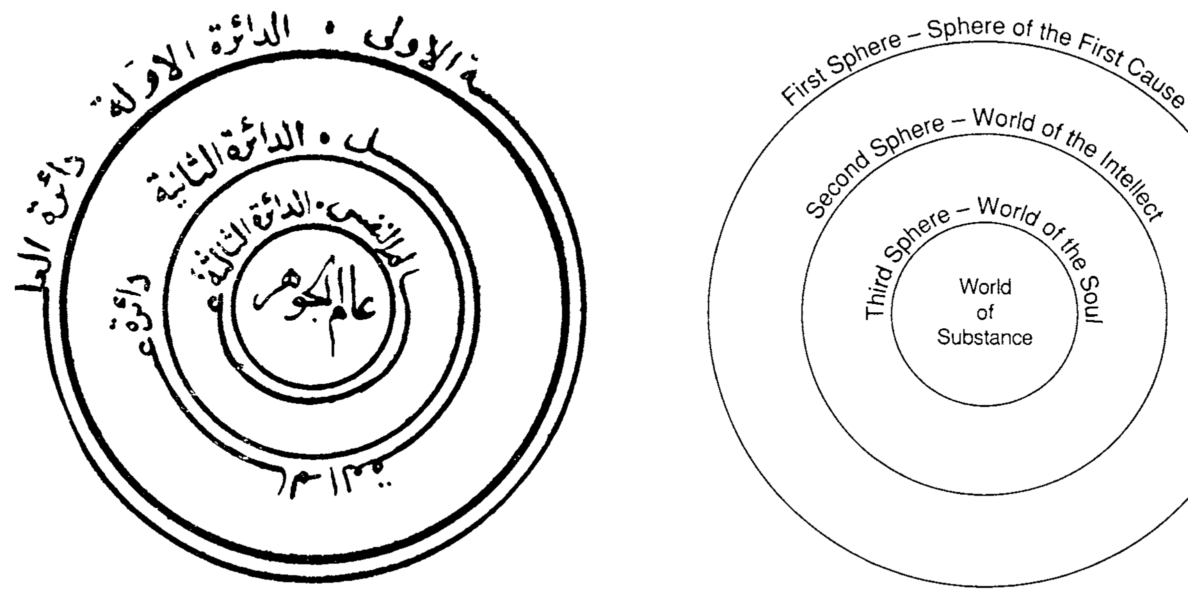


FIG. 3.11. JĀBIRIAN COSMOLOGY: THE FIRST FOUR "HYPOSTASES." Translation on the right.
Size of the original: not known. From *Jābir bin Ḥayyān: Essai sur l'histoire des idées scientifiques dans l'Islam*, vol. 1, *Mukhtār rasā'il Jābir b. Ḥayyān*, ed. Paul Kraus (Cairo: Maktabat al-Khanjī wa-Maṭbaʿatuhā, 1935), 408.

The Jābirian alchemy rests on a peculiar cosmology that combines material from Aristotelian (the sphere of the First Cause), Neoplatonic (the spheres of Intellect, Soul, and Substance), and Ptolemaic (the spheres of the seven planets, of the fixed stars, and of the four elements, in this descending order) ideas and sources. This cosmology is laid out most clearly in the treatise entitled *Kitāb al-taṣrīf* (The book of conjugation), where the views put forward are partially illustrated by simple diagrams that consist of several concentric circles (fig. 3.11).[21] The connection between this eclectic view of the universe and alchemy is then explained in another short treatise called *Kitāb al-mīzān al-ṣaghīr* (The book of the small balance). There it is stated that everything below the third and fourth spheres of Soul and Substance comes into being through a process of generation whereby the Soul unites with the Substance (which consists of the four elementary natures of heat, cold, humidity, and dryness) to produce the bodies that make up the physical world. Closely involved in this process are the four categories of quality, quantity, time, and space. The direct influence of these determines the exact composition of any given combination of the Soul and the four elementary natures. The possible combinations of influences that could be worked on the Substance by the categories are presented by means of a set of diagrams (fig. 3.12).[22] It is the purpose of Jābirian alchemy to determine the precise composition of any given physical entity through a close analysis of the influences exercised upon it by the four categories. The eventual aim was to discover the secrets of generation and apply them alchemically in the laboratory.[23]

Leaving aside partial exceptions, it does not seem that later occult scientists shared Jābir ibn Ḥayyān's enthusiasm for cosmographical diagrams.[24] Instead it was the

21. *Jābir bin Ḥayyān: Essai sur l'histoire des idées scientifiques dans l'Islam*, vol. 1, *Mukhtār rasā'il Jābir b. Ḥayyān*, ed. Paul Kraus (Cairo: Maktabat al-Khanjī wa-Maṭbaʿatuhā, 1935), 406 (the first three hypostases), 408 (the first four hypostases—reproduced here as fig. 3.11), 408–10 (the fourth hypostasis Substance, which is composed of the four elementary natures of heat, cold, humidity, and dryness). According to Jābir, the division of Substance into its components can be conceptualized in three different ways: as four equal parts of a sphere; as four small spheres within a larger sphere; and as concentric spheres inside each other.

22. *Mukhtār rasā'il Jābir b. Ḥayyān*, 443, 446, 447, and 448 (different possible combinations of the four categories of quality, quantity, time, and space) (note 21).

23. A detailed exposition of Jābir ibn Ḥayyān's thought can be found in Paul Kraus, *Jābir ibn Ḥayyān: Contribution à l'histoire des idées scientifiques dans l'Islam*, 2 vols., Mémoires Présentés a l'Institut d'Egypte, vols. 44 and 45 (Cairo: Imprimerie de l'Institut Français d'Archéologie Orientale, 1942–43). For a concise account of Jābir, see Paul Kraus (rev. Martin Plessner), "Djābir b. Ḥayyān," *Encyclopaedia of Islam*, new ed., 2:357–59.

24. A diagram illustrating the correlations between letters of the Arabic alphabet, parts of the human body, signs of the zodiac and the four elements appears in Muḥyī al-Dīn Abū al-ʿAbbās Aḥmad ibn ʿAlī al-Būnī al-Qurashī (d. 622/1225), *Shams al-maʿārif wa-laṭā'if al-ʿawārif* (Cairo: Maṭbaʿah Muṣṭafā al-Bābī al-Ḥalabī wa-Awlādihi, 1926–27), 318. An English translation of the diagram, though not totally faithful to the original, is in Seyyed Hossein Nasr, *Islamic Science: An Illustrated Study* (London: World of Islam Festival, 1976), 35. Another diagram, called *zā'irajah* and attributed to al-Sabtī (fl. end of the sixth/twelfth century), is reproduced and discussed by Ibn Khaldūn (d. 808/1406), *The Muqaddimah: An Introduction to History*, 3 vols., trans. Franz Rosenthal (New York: Bollingen Foundation, 1958), 1:238–45 and 3:182–214 (diagram in Arabic on folded insert between 3:204 and

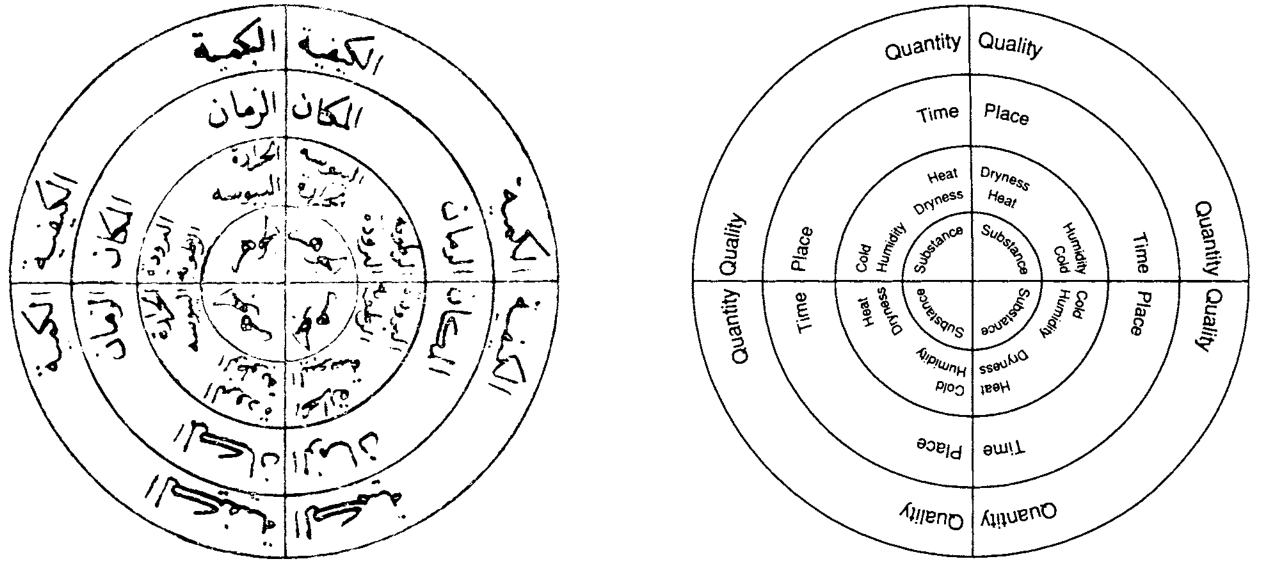


FIG. 3.12. JĀBIRIAN COSMOLOGY: ONE POSSIBLE COMBINATION OF THE FOUR CATEGORIES OF QUALITY, QUANTITY, TIME, AND SPACE. Translation on the right. Size of the original: not known. From *Jābir bin Ḥayyān: Essai sur l'histoire des idées scientifiques dans l'Islam*, vol. 1, *Mukhtār rasā'il Jābir b. Ḥayyān*, ed. Paul Kraus (Cairo: Maktabat al-Khanjī wa-Maṭbaʿatuhā, 1935), 447.

Gnostic Ismāʿīlīs who took a deep interest in cosmology and produced a great number of sacred cosmographies. Ismāʿīlism attained full maturity after it adopted Neoplatonic doctrines during the tenth and eleventh centuries. The synthesis of the original Ismāʿīlī Gnostic teachings with Neoplatonic ideas led to the development of complicated cosmologies that are characterized above all by a strict hierarchical ordering of the component elements of the universe and a symmetrical juxtaposition of the physical and spiritual worlds. This predilection for hierarchy and symmetry might explain the appearance of a large number of cosmographical diagrams in the works of prominent Ismāʿīlī thinkers.

The first name to be mentioned in this connection is al-Sijistānī (d. between 386/996 and 393/1002–3), one of the earliest Ismāʿīlī philosophers whose works are available to us in late manuscript copies. Al-Sijistānī put forward his cosmological teachings in several monographs, but he used cosmographical drawings in a work that was not primarily concerned with cosmology, *Kitāb ithbāt al-nubū'āt* (The book of the proof of prophecy). None of the diagrams contained in the *Ithbāt* are complete cosmographies. They are intended to illustrate only some of the correlations al-Sijistānī establishes between what to him are the two cosmic orders that make up the universe—the natural order (or world of nature) and the normative order (or world of religion). The former consists, in descending order, of the Intellect, the Soul, and the Substance, which in turn comprise the seven spheres (the "fathers"), the four elements (the "mothers"), and the three *mawālīd* ("offsprings") of animals, plants, and minerals, while the latter is but a hierarchy of spiritual or sacred entities that corresponds exactly to the natural order. With the exception of one diagram that is somewhat general in nature,[25] all of al-Sijistānī's drawings deal with particular aspects of these two parallel hierarchies, such as the Intellect, the Soul, physical directions, natural and "prophetic" species, natural and prophetic movements, and physical quantity.[26]

Al-Sijistānī's attempts at a systematic cosmology were taken further by the later philosopher Ḥamīd al-Dīn Aḥmad ibn ʿAbdallāh al-Kirmānī (d. after 411/1020–21)

205; English translation in pocket at the end of vol. 3). *Zā'irajah* was the generic name given to a peculiar set of circular drawings that were used as a means of divining the future through letter magic. The method is little understood, but it certainly seems to have had cosmological dimensions, since the diagrams normally included circles for the heavenly spheres, the four elements, and all kinds of physical and spiritual beings, as well as letters, numbers, and different ciphers.

25. The diagram illustrates the subdivisions of the sphere of substance with the hierarchy proceeding from the center outward; Abū Yaʿqūb Isḥāq ibn Aḥmad al-Sijistānī, *Kitāb ithbāt al-nubū'āt*, ed. ʿĀrif Tāmir (Beirut: Manshūrāt al-Maṭbaʿat al-Kāthūlūqīyah, 1966), 22.

26. Samuel Miklos Stern, "Abū Yaʿḳūb Isḥāḳ b. Aḥmad al-Sidjzī," in *Encyclopaedia of Islam*, new ed., 1:160; Paul Ernest Walker, "Abū Yaʿqūb Sejestānī," in *Encyclopaedia Iranica*, ed. Ehsan Yarshater (London: Routledge and Kegan Paul, 1982–), 1:396–98; and Ismail K. Poonawala, *Biobibliography of Ismāʿīlī Literature* (Malibu: Undena, 1977), 82–89. The bibliography from all three sources should be complemented by Mohamed Abualy Alibhai, "Abū Yaʿqūb al-Sijistānī and 'Kitāb Sullam al-Najāt': A Study in Islamic Neoplatonism" (Ph.D. diss., Harvard University, 1983).

Other drawings, not reviewed here on account of their partial nature, can be found in al-Sijistānī, *Kitāb ithbāt al-nubū'āt*, 17 (printed version not accurate), 37, 45, 52, 82, 89, 102, 126, 131, and 151 (note 25).

in a major work entitled *Rāḥat al-ʿaql* (The comfort of the intellect). In his effort to synthesize the conflicting theories of his predecessors (including al-Sijistānī), al-Kirmānī introduced into Ismāʿīlī philosophy the doctrine of ten intellects. According to this scheme, the Intellect and the Soul of al-Sijistānī's natural order were conceived as only the first two in a descending series of ten intellects. The remaining eight corresponded to the seven spheres plus the active intellect that governs the sublunar sphere. In addition, al-Kirmānī thought in terms of four rather than two cosmic orders, which were the world of creation (*ʿālam al-ibdāʿ*), the world of matter (*ʿālam al-jism*), the world of religion (*ʿālam al-dīn*), and the world of the second emanation (*ʿālam al-inbiʿāth al-thānī*). These four cosmic orders were united into a meaningful whole through a theory of evolution, the two ends of which were respectively the Primordially Originated One (*al-mubdaʿ al-awwal* = the First Intellect = the First End) and the Second Emanation (*al-inbiʿāth al-thāni* = the Human *Mahdī* = the Second End). Al-Kirmānī illustrated his theories in diagrams: the interrelations among the four cosmic orders were clarified through two sets of diagrams where al-Kirmānī resorted to numerological comparisons (figs. 3.13 and 3.14), while the theory of evolution was graphically expressed in the form of concentric circles.[27]

The Neoplatonizing cosmologies of al-Sijistānī and al-Kirmānī found varying degrees of acceptance in later Ismāʿīlī doctrinal thought. Their predilection for graphic illustration, however, certainly seems to have been taken up by subsequent Ismāʿīlī thinkers, as evidenced by the cases of Nāṣir Khusraw (394 to ca. 481/1004 to ca. 1088–89) and al-Ḥāmidī (d. 557/1162). Besides the more or less standard drawings of the heavenly spheres and of the zodiac, both Nāṣir Khusraw and al-Ḥāmidī also designed original diagrams to illustrate specific aspects of their cosmological doctrines. The former had recourse to the ever popular scheme of partitioned concentric circles on several occasions in his *Khvān al-ikhvān* (The table of the brethren) to present in simple visible form certain sets of correlations that he described at length in the text (fig. 3.15). The latter, whose tendency toward visual thinking is reflected in the many simple drawings strewn across his *Kanz al-walad* (The treasure of the son), chose to represent his innovative doctrine of the "fall" of the third intellect and the resulting cosmology in a simple cosmography.[28] That the number of printed Ismāʿīlī works is as yet very small is a real obstacle to meaningful generalizations about the degree and nature of graphic representation in Ismāʿīlī cosmological treatises as a whole. Yet it seems safe to assume that the renewed interest in Ismāʿīlism that is currently visible among historians of Islamic thought will eventually lead to the discovery of many more Ismāʿīlī cosmographies than the ones recorded here.

MYSTICAL DIAGRAMS

The literature of Islamic mysticism, vast in size and scope, is on the whole devoid of graphic elements. Given the unsusceptibility of mystical experience to any form of "representation," such a reluctance by mystics to translate inner experiences onto the plane of visual expression is hardly surprising. Even mysticism, however, is not impervious to philosophical speculation, and whenever philosophizing tendencies manifest themselves and mystics begin to subject "ineffable" mystical experiences to systematic scrutiny, there may also emerge the need for graphic illustration. Such, in any event, is the case in Islamic mysticism, where the few cosmological diagrams that can be located in the literature all bear the indelible stamp of Ibn al-ʿArabī, the mystic-philosopher whose all-encompassing philosophy of being can be said to have transformed the whole subsequent history of Islamic mystical thought.

Ibn al-ʿArabī himself drew several diagrams to illustrate certain aspects of his mystical doctrines. Two cosmographical drawings concerning the different planes of being and the creation of the world through divine names appear in a well-known short work entitled *Inshāʾ al-dawāʾir* (The production of spheres).[29] That he chose this title for the work in question suggests that Ibn al-ʿArabī

27. J. T. P. de Bruijn, "al-Kirmānī," in *Encyclopaedia of Islam*, new ed., 5:166–67; and Poonawala, *Biobibliography of Ismāʿīlī Literature*, 94–102 (note 26), both with additional bibliography, to which should be added: Faquir Muhammad Hunzai, "The Concept of Tawḥīd in the Thought of Ḥamīd al-Dīn al-Kirmānī" (Ph.D. diss., McGill University, 1986). For other, on the whole noncosmological, drawings of al-Kirmānī, see *Rāḥat al-ʿaql*, 72, 130, 135, 137, 154, 157, 168, 216–17, and 337 (note 12). See also al-Kirmānī, *Majmūʿah rasāʾil al-Kirmānī*, ed. Muṣṭafā Ghālib (Beirut: al-Muʾassasat al-Jāmiʿīyah liʾl-Dirāsāt wa-al-Nashr wa-al-Tawzīʿ, 1983), 36–37 and 69–70. A manuscript of this latter work (now in the possession of Mrs. Henry Corbin, dated 1251/1836), which I consulted in a photocopy at the Institute of Ismaili Studies in London, has two more drawings (fols. 241b and 246a) that do not appear in the printed version.

28. Al-Ḥāmidī, *Kanz al-walad*, 81 (note 13). It is not clear why a slightly different version of this same drawing is reproduced at the end of sec. 5 on p. 95. References on Nāṣir Khusraw and al-Ḥāmidī can be found in Poonawala, *Biobibliography of Ismāʿīlī Literature*, 111–25 and 141–43, respectively (note 26). Editions of their relevant works are: Nāṣir Khusraw, *Khvān al-ikhvān*, ed. Yaḥyā al-Khashshāb (Cairo: Maṭbaʿat al-Maʿhad al-Ilmī al-Faransī liʾl-Āthār al-Sharqīyah, 1940); idem, *Kitāb-i jāmiʿ al-ḥikmatayn* (note 15); and al-Ḥāmidī, *Kanz al-walad* (note 13). For other diagrams by Nāṣir Khusraw and al-Ḥāmidī that are not included in the present survey, see *Khvān al-ikhvān*, 152, 155, and *Kanz al-walad*, 119, 125, 149, 169, 251, 255, and 259.

Examples of diagrams in other Ismāʿīlī works that need further study appear in al-Dāʿī al-Qarmaṭī ʿAbdān, *Kitāb shajarat al-yaqīn*, ed. ʿĀrif Tāmir (Beirut: Dār al-Āfāq al-Jadīdah, 1982), 44 and 88, as well as Jaʿfar ibn Manṣūr al-Yaman (d. A.D. 958 or 959), *Sarāʾir wa-asrār al-nuṭaqāʾ*, ed. Muṣṭafā Ghālib (Beirut: Dār al-Andalus, 1984), 216.

29. Ibn al-ʿArabī, *Kleinere Schriften des Ibn al-ʿArabī*, ed. Henrik Samuel Nyberg (Leiden: E. J. Brill, 1919), 23 and 35 (the second diagram is not reproduced in the printed edition). The former depicts the dif-

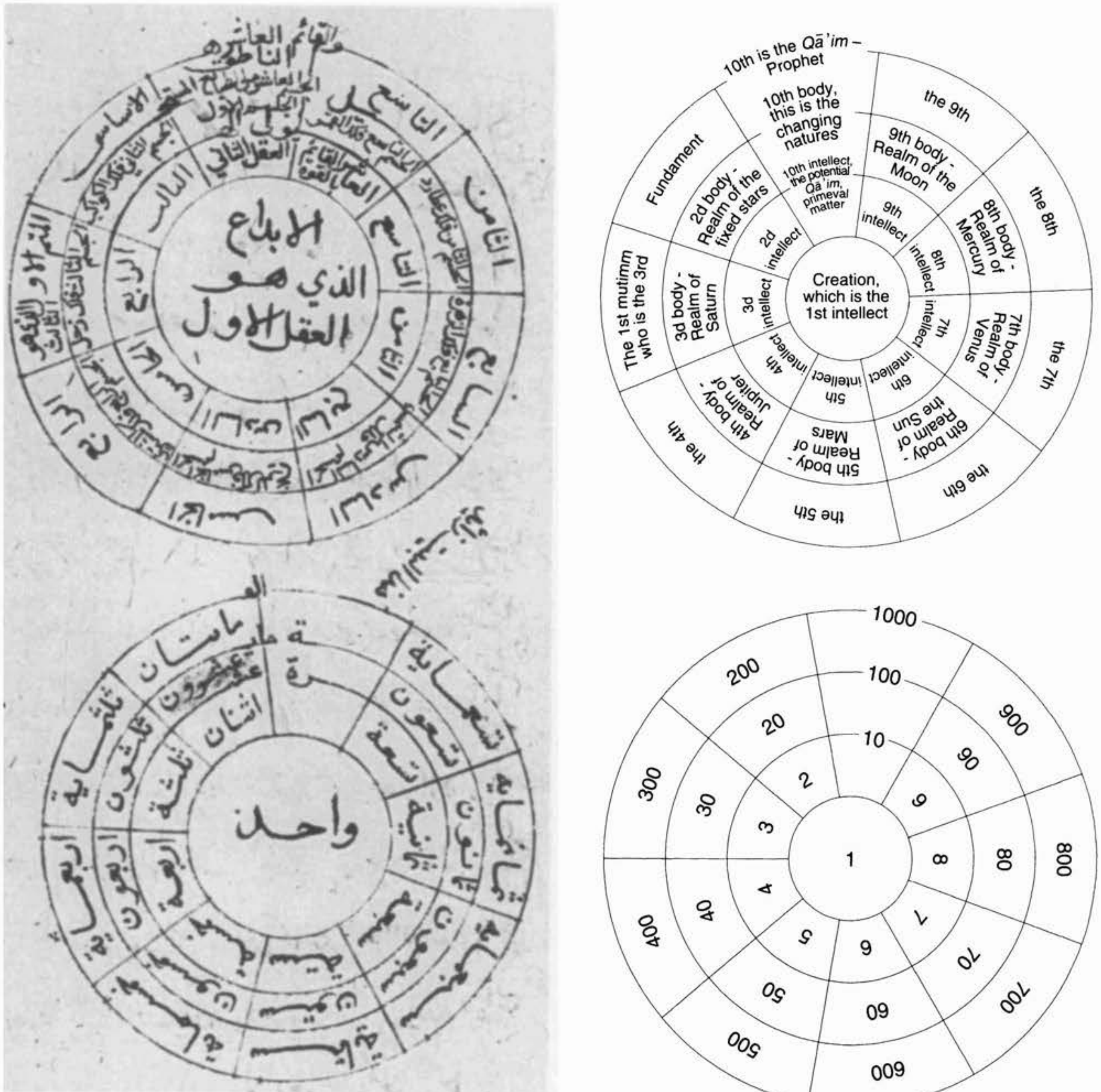
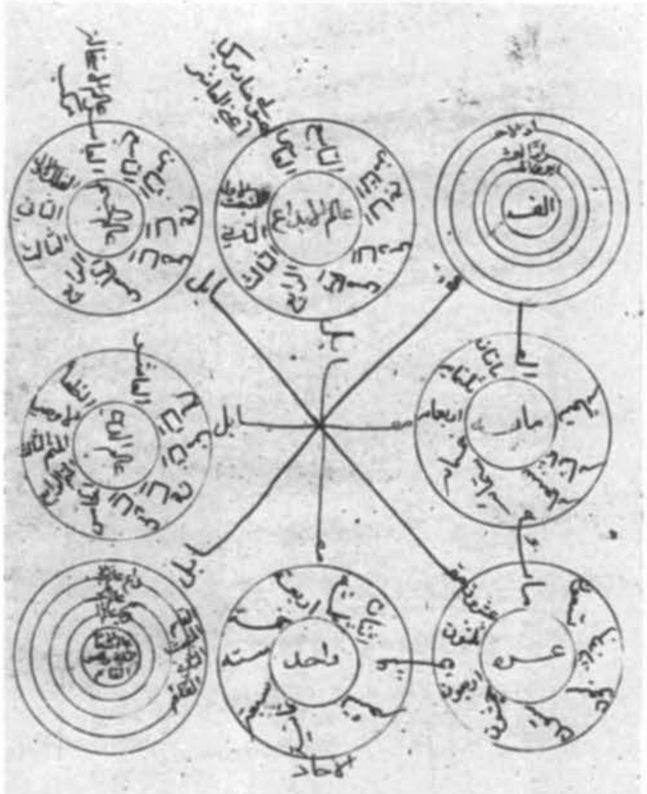


FIG. 3.13. THE FOUR COSMIC ORDERS ACCORDING TO AL-KIRMĀNĪ. The world of creation, as the "cause" (*ʿillah*) of all the other orders, is at the center and is thus correlated to the numeral 1, which is the "cause" of all other numerals. Translation on the right. The line drawing in the printed edition (*Rāḥat al-ʿaql*, ed. Muḥammad Kāmil Ḥusayn and Muḥammad Muṣṭafā Ḥilmī [Cairo: Dār al-Fikr al-ʿArabī, 1953], 128) is misleadingly inaccurate.

Diameter of the upper circle: approx. 8 cm. By permission of Abbas Hamdani, University of Wisconsin–Milwaukee (MS. al-Kirmānī, *Rāḥat al-ʿaql*, "al-mashriʿ al-khāmis min al-sūr al-rābiʿ," fol. 103a).



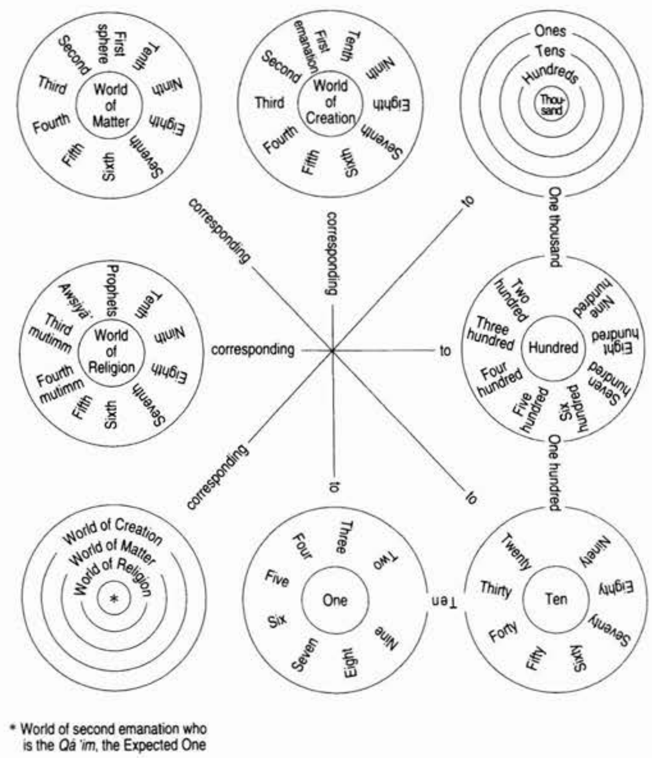


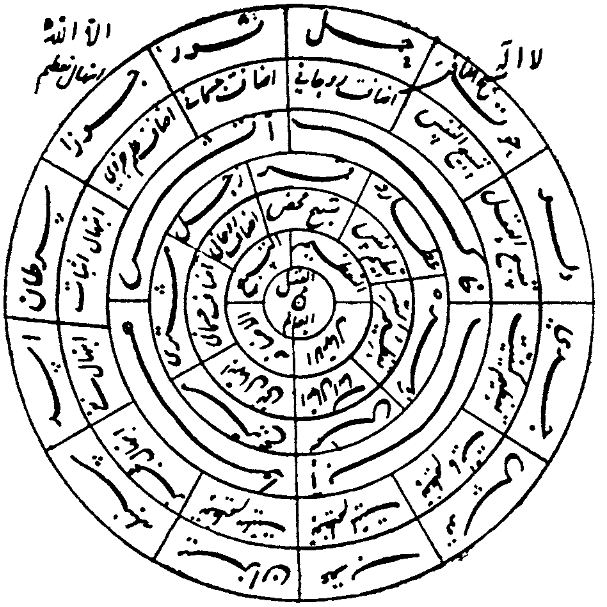
FIG. 3.14. AN ALTERNATIVE CONCEPTION OF THE FOUR COSMIC ORDERS ACCORDING TO AL-KIRMĀNĪ. The world of creation comprehends all the other cosmic orders, like the numeral 1, which is said to comprehend the other numerals. The world of second emanation is placed at the center, since it contains elements of all the other cosmic orders, like the numeral 1,000 which contains all numerals from 1 to 1,000. Translation on the right.
Size of the original: approx. 12 × 13.5 cm. By permission of Abbas Hamdani, University of Wisconsin–Milwaukee (MS. al-Kirmānī, *Rāḥat al-ʿaql*, "al-mashriʿ al-khāmis min al-sūr al-rābiʿ," fol. 127b).

assigned particular importance to the diagrams in question, though, it appears from the text, primarily for didactic purposes. Another cosmographical drawing by Ibn al-ʿArabī appears in his magnum opus, *al-Futūḥāt al-Makkīyah* (The Meccan revelations or conquests), which has as its subject the relation between the "center" (= the Absolute manifesting itself as God) and the spheres surrounding it (= "genera and species," that is, permanent archetypes; fig. 3.16).[30]

If one bears in mind that Ibn al-ʿArabī's philosophy is notoriously dense and his style of writing correspondingly convoluted, it is not surprising that at least some of his later commentators had recourse to diagrams in order to present his doctrines in a readily intelligible manner. Variations of Ibn al-ʿArabī's diagram of the different planes of being seem to have enjoyed particular popularity among his spiritual disciples. Such diverse figures as the poet Maghribī (d. 809/1406–7), the encyclopedist mystic-scholar İbrāhīm Ḥakḳı (d. 1194/1780), and the mystic Muḥammed Nūrū'l-ʿArabiyū'l-Melāmī (1228–1305/

ferent planes of being according to Ibn al-ʿArabī. Although the accompanying text does not reflect it directly, this diagram is an illustration of Ibn al-ʿArabī's theory of "five divine presences." For a clear exposition of this theory, see Toshihiko Izutsu, *Sufism and Taoism: A Comparative Study of Key Philosophical Concepts* (Berkeley: University of California Press, 1984), pt. 1, "Ibn ʿArabi," esp. 19–20. The latter diagram concerns the creation of the world through divine names. A summary of the "cosmogony" appears in Masataka Takeshita, "An Analysis of Ibn ʿArabi's *Inshāʾ al-dawāʾir* with Particular Reference to the Doctrine of the 'Third Entity,'" *Journal of Near Eastern Studies* 41 (1982): 243–60, esp. 256–58 (I owe this reference to Peter Heath, Washington University in Saint Louis). On divine names, see Izutsu, *Sufism and Taoism*, 99–109.

30. On Ibn al-ʿArabī, see Aḥmed Ateş, "Ibn al-ʿArabī," in *Encyclopaedia of Islam*, new ed., 3:707–11, the references in James Winston Morris, "Ibn ʿArabī and His Interpreters," *Journal of the American Oriental Society* 106 (1986): 539–51, 733–56, and 107 (1987): 101–19, and more recently, William C. Chittick, *Ibn al-ʿArabi's Metaphysics of Imagination: The Sufi Path of Knowledge* (Albany: State University of New York Press, 1989). The *Inshāʾ al-dawāʾir* was edited by Nyberg in *Kleinere Schriften des Ibn al-ʿArabī*, 3–38 (note 29), and *al-Futūḥāt al-Makkīyah* is currently being edited by ʿUthmān Yaḥyā and Ibrāhīm Madkūr, 10 vols. to date beginning in 1972 (note 9).



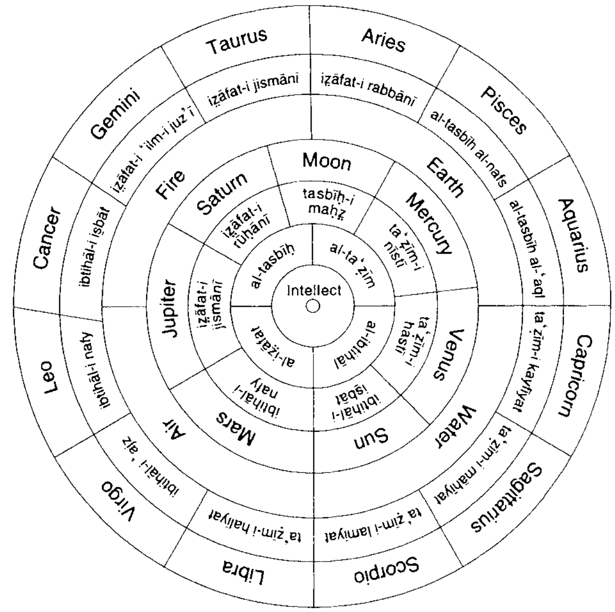
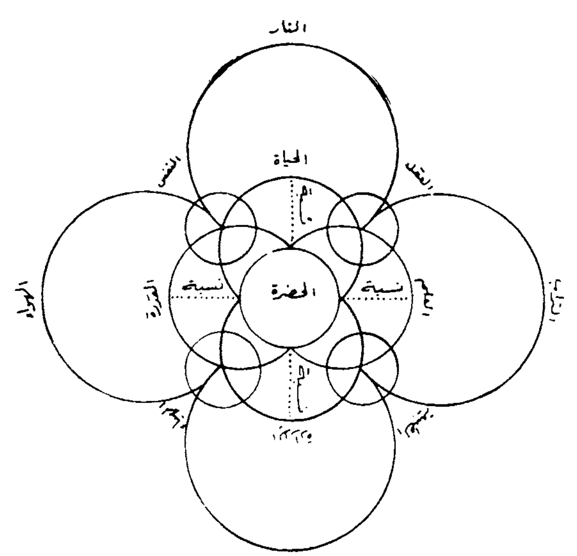


FIG. 3.15. THE UNIVERSAL INTELLECT, THE CREATOR, AND THE CONSTRUCTION OF THE UNIVERSE ACCORDING TO NĀṢIR KHUSRAW. This diagram demonstrates the correlation that exists between the way the Universal Intellect worships the Creator and the way the universe is constructed. The Universal Intellect's worship of the Creator is based on the structure of the Muslim testimony of faith, *lā ilāhah illā'llāh* (there is no God but Allah), which is composed of four words, seven syllables, and twelve letters. Thus the Universal Intellect worships the Creator based on the four fundamental modes of *tasbīḥ* (*pākīzah kardan*, "purification"), *iẓāfat* (*bāz bastan*, "tracing its origin to God"), *ibtihāl* (*gardan nihādan*, "submission") and *taʿẓīm* (*buzurg dāshtan*, "glorification") as well as based on several subdivisions of these into seven and twelve parts. This structure of worship is said to correspond to the structure of the Universe that is built out of four elements, seven planets, and twelve signs of the zodiac. Not incorporated into the diagram is another set of correlations with the human body, namely its four humors (blood, phlegm, black bile, and yellow bile), its seven internal organs (brain, heart, lungs, liver, pancreas, gallbladder, and kidneys), and its twelve "visible" organs (head, face, neck, breast, stomach, back, two hands, two legs, and two feet). Translation on the right. Size of the original: not known. From Nāṣir Khusraw, *Khvān al-ikhvān*, ed. Yaḥyā al-Khashshāb (Cairo: Maṭbaʿat al-Maʿhad al-ʿIlmī al-Faransī li'l-Āthār al-Sharqīyah, 1940), 139.



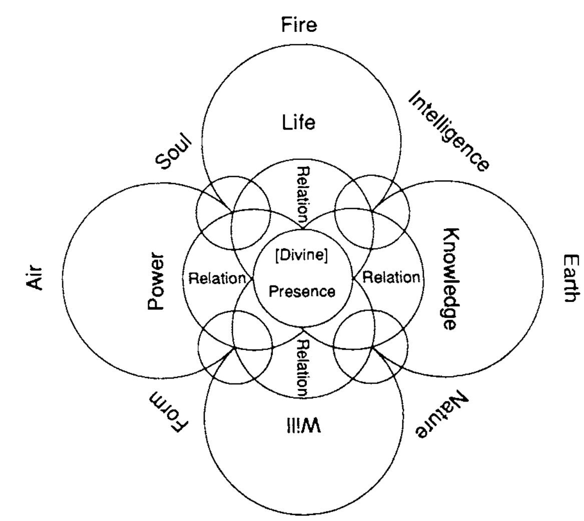


FIG. 3.16. A PARTIAL ILLUSTRATION OF THE RELATIONS BETWEEN THE "DIVINE PRESENCE" AND "PERMANENT ARCHETYPES" ACCORDING TO IBN AL-ʿARABĪ. Translation on the right. Size of the original: approx. 11 × 11 cm. From Ibn al-ʿArabī, *al-Futūḥāt al-Makkīyah*, ed. ʿUthmān Yaḥyā and Ibrāhīm Madkūr (Cairo: Jumhūrīyah Miṣr al-ʿArabīyah, Vizārat al-Thaqāfah, 1972–), 4:158 (chap. 47).

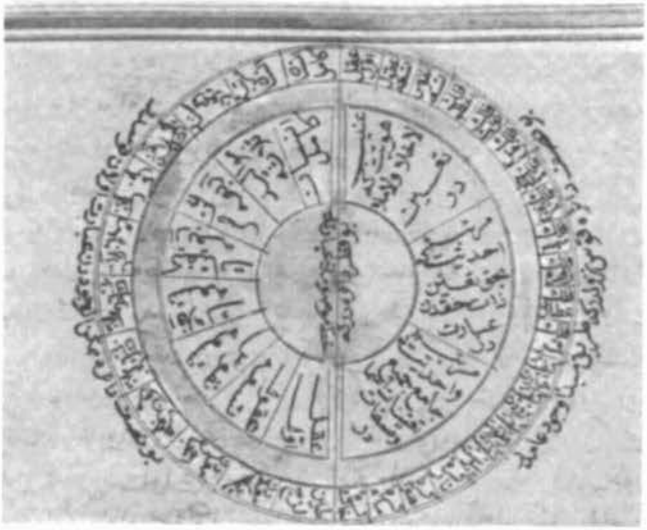


FIG. 3.17. DIAGRAM OF THE DIFFERENT LEVELS OF BEING FROM THE *MAʿRIFETNĀME.*
Size of the original: 5.6 × 8.5 cm. By permission of the British Library, London (MS. Or. 12964, fol. 28b).

1813–88) all produced slightly different versions of this diagram (fig. 3.17).[31] More significantly, however, it was one of these distant disciples of Ibn al-ʿArabī—namely, Ḥaydar Āmulī—who, to all indications, alone in the history of Islamic thought developed a veritable art of cosmographical "diagramology."

Ḥaydar Amulī stands at the pinnacle of a particular trend in *ithnā ʿasharī* Shīʿī thought that is characterized by a high degree of openness to mystical speculation and, more specifically, by an effort to integrate the thought of Ibn al-ʿArabī into Shīʿī philosophy. The argument central to his profuse philosophical output is encapsulated in the maxim "the true Shīʿīs are Sufis and the true Sufis are Shīʿīs." The Sufi par excellence for Ḥaydar Āmulī seems to have been Ibn al-ʿArabī, and he devoted his formidable intellectual energies to the task of merging *ithnā ʿasharī* doctrines and Ibn al-ʿArabi's theories into a consistent and rigorous whole.[32] In this effort he freely resorted to graphic representation and drew many cosmographical diagrams, of which only twenty-eight have so far been recovered.[33] These are extremely elaborate diagrams that reflect almost all aspects of Ḥaydar Āmulī's wide-ranging speculations, and as such they require separate collective treatment elsewhere.[34] Several of the drawings are meant to illustrate points of Ibn al-ʿArabī's teachings, and at least in some cases they derive from drawings by Ibn al-ʿArabī himself. But the great majority of Ḥaydar Āmulī's diagrams are original. They have as their subject the complex network of correspondences between the two major spheres of creation—the world of manifest, corporeal entities and the world of hidden, spiritual beings. These two complementary faces of creation are referred to by Ḥaydar Āmulī as the *Kitāb āfāqī* (Book of horizons) and the *Kitāb anfusī* (Book of souls) respectively. Also involved in this "science" of correspondences is the Book of revelation—the Qurʾān—which seems to act as a heuristic device in the effort to discover or uncover the series of correlations that underlie and connect the two spheres of creation.

Other than the sheer numbers of diagrams involved,

31. Shams al-Dīn Muḥammad Maghribī, *Jām-i jahānnumā* (Tehran, 1935) appended to the end of Naṣīr al-Dīn Muḥammad ibn Muḥammad al-Ṭūsī's *al-Jabr va-al-ikhtiyār* (1934), 8 and 17; see also *Jām-i jahānnumā*, in *Divān-i kāmil-i Shams-i Maghribī*, ed. Abū Ṭālib Mīr ʿĀbidīnī (Tehran: Kitābfurūshī-i Zavvār, 1979), 309. İbrāhīm Ḥaḳḳı, *Maʿrifetnāme*, 50 (note 13). Abdülbâkî Gölpınarlı, *Melâmîlik ve Melâmîler* (Istanbul: Devlet, 1931), 270, reproduces the diagram from Muḥammed Nūrü'l-ʿArabiyü'l-Melāmī's *al-Anwār al-Muḥammadīyah* (MS. Abdülbâkî Gölpınarlı, date and folio number not given—Gölpınarlı's manuscripts are now preserved in the Mevlana Müzesi in Konya, Turkey). Gölpınarlı is of the opinion that Seyyid Muḥammed copied this diagram from Maghribī's *Jām-i jahānnumā*. He also points out that the Turkish mystic Niyāzī-i Mıṣrī (d. 1105/1694) included a similar drawing in his *Devre-i ʿarşīyeh*, a work I could not consult.

32. E. Kohlberg, "Ḥaydar-i Āmolī," in *Encyclopaedia Iranica*, 1:983–85; Josef van Ess, "Ḥaydar-i Āmulī," in *Encyclopaedia of Islam*, new ed., suppl. fasc. 5–6, 363–65; Henry Corbin, *En Islam iranien: Aspects spirituels et philosophiques*, 4 vols. (Paris: Editions Gallimard, 1971–72), vol. 3, *Les fidèles d'amour: Shīʿisme et Soufisme*, 149–213; and Peter Antes, *Zur Theologie der Schiʿa: Eine Untersuchung des Ǧāmiʿ al-asrār wa-manbaʿ al-anwār von Sayyid Ḥaidar Āmolī* (Freiburg: Klaus Schwarz, 1971).

33. The diagrams appear in Ḥaydar Āmulī's *al-Muqaddimāt* (note 8). Originally scattered into different chapters of the Arabic text in manuscript copies, the diagrams have been brought together at the end of the printed text by Ḥaydar Āmulī's modern editors. Other works of Ḥaydar Āmulī that apparently contained diagrams but that do not appear to be extant were *Risālat al-jadāwil al-mawsūmah bi-madārij al-sālikīn fī marātib al-ʿārifīn* (The book of diagrams concerning the spiritual ranks of the Gnostics in which are marked the degrees of the mystic wayfarer) and *Kitāb al-muḥīt al-aʿẓam wa-al-ṭūr al-ashamm fī taʾwīl kitāb allāh al-ʿazīz al-muḥkam* (The book of the encircling ocean and the towering mountain concerning the esoteric interpretation of the mighty and firm book of God). For *Risālat al-jadāwil*, see Ḥaydar Āmulī, *Kitāb jāmiʿ al-asrār wa-manbaʿ al-anwār* in the edition by Henry Corbin and ʿUthmān Yaḥyā, *La philosophie Shīʿite* (Paris: Librairie d'Amérique et d'Orient, Adrien-Maisonneuve, 1969), 40 (French introduction). As for the *Kitāb al-muḥīt al-aʿẓam*, Ḥaydar Āmulī writes in his *al-Muqaddimāt* that this Qurʾānic interpretation contained seven introductory sections (*muqaddimāt*) and twelve diagrams (*dawāʾir*), with no further information (pp. 147–49 of the Arabic text [note 8]). This same passage is inaccurately translated by the editors (p. 6 of the French introduction) to read "nineteen diagrams."

34. An exhaustive analysis of six of the diagrams in question can be found in Henry Corbin, "La science de la balance et les correspondances entre les mondes en gnose islamique (d'après l'oeuvre de Ḥaydar Âmolî, VIIIᵉ/XIVᵉ siècle)," *Eranos* 42 (1973): 79–162; English translation, "The Science of the Balance and the Correspondences between Worlds in Islamic Gnosis," in *Temple and Contemplation*, by Henry Corbin, trans. Philip Sherrard (London: KPI in association with Islamic Publications, 1986), 55–131. In view of the complicated nature of Ḥaydar Āmulī's diagrams and the extensive textual material incorporated in them, it is not feasible to reproduce any of them here.

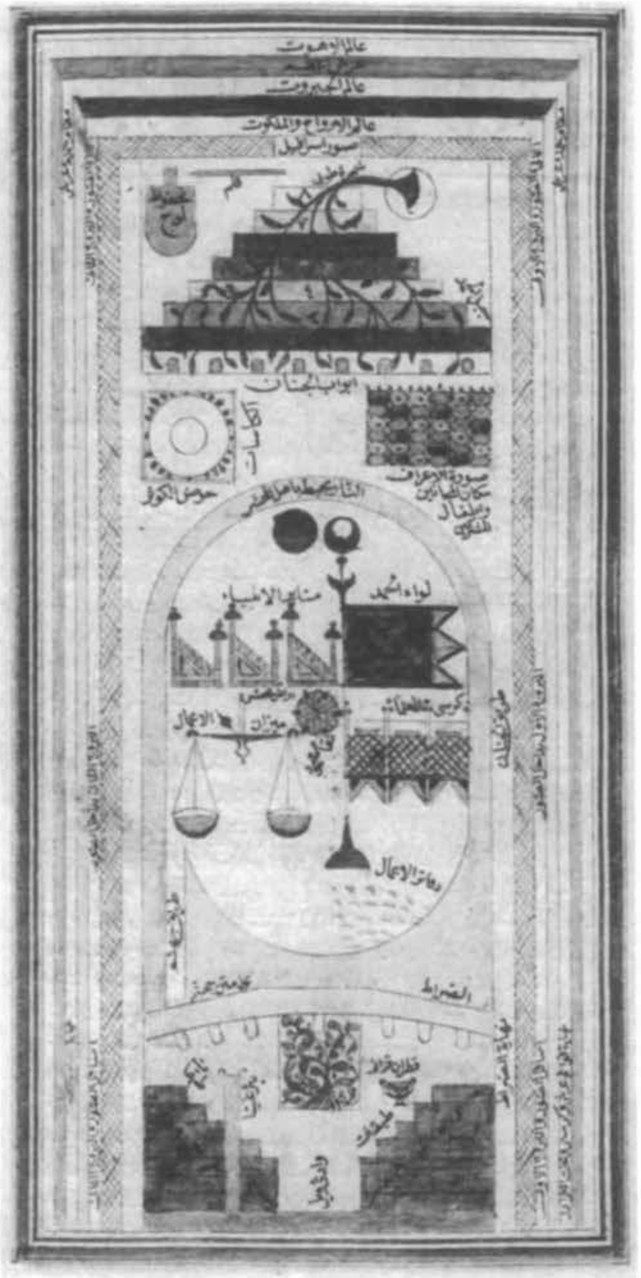


FIG. 3.18. THE "TOPOGRAPHY" OF THE DAY OF JUDGMENT FROM THE *MAʿRIFETNĀME.* The place of resurrection and judgment is in the middle, surrounded by a circle of fire and complete with the balance with which human deeds are going to be weighed, the "deed records" (*dafātir*), and the banner of praise, as well as assigned seats for all the prophets and the religious scholars who are going to oversee the process of judgment. The only exit from this place of assembly leads to the straight path that stretches above hell at bottom: only those whose good deeds outweigh their sins will be able to cross this bridge over hell and take the route to paradise on top.
Size of the original: 19 × 9.3 cm. By permission of the British Library, London (MS. Or. 12964, fol. 24a).

what is intriguing about Ḥaydar Āmulī's cosmographies is the importance the author assigns to them: they are not mere illustrations. Instead they are conceived by Ḥaydar Āmulī as an independent section of the work in which they appear.[35] It is not easy to know the intended meaning of such autonomy of the graphic image vis-à-vis the written word, yet there is reason to think that the diagrams in question were not all the results of a conscious attempt at clarity of presentation. In at least some cases, the representation on paper, far from being a mere illustrative tool, records the real visionary experiences of the author.[36] It is most likely, therefore, that in Ḥaydar Āmulī's eyes the diagrams possessed a degree of directness and intimacy far surpassing the oblique and much attenuated residue of reality contained in the written text. The graphic, in this case, was a more representative medium for conveying spiritual and metaphysical realities than the verbal. As such it demanded "preferential treatment" from the author, who responded by turning into a "diagramologist." There were many others in the history of Islamic thought, as demonstrated in this chapter, who resorted to graphic representation at certain points along several disparate paths of cosmological speculation. But Ḥaydar Āmulī is quite singular in his belief in the representational power of diagrams. In this sense he is perhaps the only true "cosmographer" in that complex history.

Religious Cosmography

The preceding survey of the cosmographical drawings found in Islamic philosophical/scientific and Gnostic/mystical texts suggests that mainstream religious literature is on the whole devoid of cosmographical representation. While this is certainly a valid generalization, it

35. Ḥaydar Āmulī, *al-Muqaddimāt*, Arabic text, 18, par. 50, lines 18–20 and French introduction, 18–21 and 32–33 (note 8). In this passage, Ḥaydar Āmulī conceived of his work in seven sections: three preliminary sections (*tamhīdāt*), three principal chapters (*arkān*), and the diagrams (*dawāʾir*). The number of diagrams is given as twenty-seven in this same section, though in fact twenty-eight all together are included in the work. It is probable that the number twenty-seven was meant to refer to the twenty-seven chapters of Ibn al-ʿArabī's *Fuṣūṣ al-ḥikam*, the work of which *al-Muqaddimāt* is ostensibly an interpretation.

36. Such is the case with *al-Muqaddimāt*, fig. 7 in the section of diagrams following the Arabic text (note 8). Ḥaydar Āmulī bases this diagram on a vision he saw in the night sky over Baghdad in the year 755/1354. In this vision the names were written in red while the figures were drawn in lapis lazuli blue. The "fourteen innocents" of Shīʿī Gnosis (the twelve Imams, the Prophet Muḥammad, and his daughter Fāṭimah) are arranged in a particular order around the square with the four Muḥammads and the four ʿAlīs on the four corners. It is probable that the vision and its subsequent recording in a work devoted to the interpretation of Ibn al-ʿArabī's *Fuṣūṣ al-ḥikam* were occasioned by Ḥaydar Āmulī's reaction to Ibn al-ʿArabī's views on *walāyah*. This question is discussed by Henry Corbin in *Les fidèles d'amour*, 201–8 (note 32).

should not be imagined that the dislike of Muslim scholars of the "religious sciences" for cosmological speculation (and perhaps also for visual representation) was universal. A case in point is the complete religious cosmography found in the encyclopedic work titled *Maʿrifetnāme* (The book of Gnosis) by the aforementioned scholar-mystic İbrāhīm Ḥaḳḳı (plate 3), which is accompanied by a striking "topographic" representation of the Day of Judgment (fig. 3.18).[37] The appearance of such exceptional visual renderings of the religious cosmos, complete with an eight-layered paradise on top of an eight-layered hell at bottom, in one of the most popular religious manuals in late Ottoman Turkish leaves open the possibility that similar cosmographies are to be found in other late religious works in Islamic languages, even though no such drawings have yet come to my attention. Equally intriguing is the likelihood that loose cosmographical drawings circulated among the populace. The ground is shaky here, since documentation on popular culture is meager and mostly of very recent origin. Nonetheless, evidence in published works indicates that research on this front is sorely needed.[38]

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37. On Erżurumlu İbrāhīm Ḥaḳḳı, see Ziya Bakıcıoğlu, "Ibrahim Hakkı (Erzurumlu)," in *Türk Dili ve Edebiyatı Ansiklopedisi*, 6 vols. to date (Istanbul: Dergāh Yayınları, 1976–), 4:325–26.

38. See for instance, the two drawings reproduced in Malik Aksel, *Türklerde Dinî Resimler* (Istanbul: Elif Kitabevi, 1967), 112 and 127.

4 • The Beginnings of a Cartographic Tradition

GERALD R. TIBBETTS

INTRODUCTION

Before the establishment of Islam in the seventh century A.D., there is no evidence that the early Arabs accepted the idea of representing the landscape in a systematic way. Practical use of maps is documented in only the slightest manner: even the tribesmen facing in the direction of their sacred tribal enclosure when praying do not seem to have needed a mnemonic for the purpose. Arabs seem to have taken up the idea of mapping only when absorbing the cultures of the peoples they conquered.

Toward the end of the first century of Islam we do find a few literary references to military maps. A map was prepared (ca. 83/702) of the country of Daylam, south of the Caspian Sea, for al-Ḥajjāj ibn Yūsuf (d. 95/714), the governor of the eastern part of the empire, so that he could understand the military situation from his capital in Iraq (fig. 4.1).[1] Similarly, he ordered a plan of Bukhara so that he could acquaint himself with the layout of the city while preparing for its siege (89/707).[2] A map of the swamps of al-Baṭīḥah near Basra was also said to be available in the time of the Abbasid caliph al-Manṣūr (d. 158/775), seemingly this time because of a dispute over the provision of fresh water.[3] A plan was also reputedly drawn in 141/758 for the round city of Baghdad planned for the caliph al-Manṣūr. Since this was virtually a strongly walled fortress in which only the privileged lived, the drawing was less a city plan than an architect's site plan,[4] but since the city had a diameter of two kilometers or more, the plan may have been a substantial cartographic attempt. What it was like we have no idea, since nothing of the plan or of the original round city has survived, and literary accounts are so much at variance that we cannot conjecture the form or extent of the cartography involved.

We have no more information about these obviously practical maps, nor is there any link to later Muslim cartography. Mapping during the period I am discussing seems to have first appeared and then continued only as an adjunct to geographical literature: surviving maps occur only as illustrations to geographical texts (table 4.1).

EARLY GEOGRAPHICAL LITERATURE

Arab geographical literature began in much the same way as other Arab literature, from a mixture of folk literature and the tradition formed by Islamic religious writing. The Qur'ān and hadith, besides having a cosmological basis that pervades most of the later geographical literature, also contained a factual geographical element. Telling stories and reciting poetry about desert life augmented this. Early in Islamic history a corpus of geographical lore must have developed based on *akhbār* (narrated historical traditions) and *ʿajāʾib* (stories about marvelous events and things), two genres of narrated information that were written down at an early stage.[5] Texts like the *ʿAjāʾib al-Hind* (Wonders of India) and the *Akhbār al-Ṣīn wa-al-Hind* (Traditions about China and India) have survived as some of the earliest written Arab literary texts, but no doubt there were other early collections that have been lost.[6]

An example of early lore that has a bearing on cartography is a concept of the world landmass in the shape of a bird. This idea may come from early Islamic times, since the information, first given by Ibn ʿAbd al-Ḥakam (d. 257/871), is mentioned as a tradition emanating from a prominent Arab of the late seventh century. Ibn ʿAbd al-Ḥakam reports that the head of the bird represented

1. Aḥmad ibn Muḥammad ibn al-Faqīh al-Hamadhānī, *Kitāb al-buldān*; see *Compendium libri kitâb al-boldân*, ed. Michael Jan de Goeje, Bibliotheca Geographorum Arabicorum, vol. 5 (Leiden: E. J. Brill, 1885; reprinted, 1967), 283.

2. Abū Jaʿfar Muḥammad ibn Jarīr al-Ṭabarī, *Taʾrīkh al-rusul wa-al-mulūk*; see *Annales quos scripsit Abu Djafar Mohammed ibn Djarir at-Tabari*, ed. Michael Jan de Goeje, 15 vols. in 3 ser. (Leiden: E. J. Brill, 1879–1901; reprinted 1964–65), 2d ser., 2:1199.

3. Aḥmad ibn Yaḥyā al-Balādhurī, *Futūḥ al-buldān*; see *Liber expugnationis regionum*, ed. Michael Jan de Goeje (Leiden: E. J. Brill, 1866), 371.

4. Aḥmad ibn Abī Yaʿqūb al-Yaʿqūbī, *Kitāb al-buldān*; see *Kitâb al-boldân*, ed. Michael Jan de Goeje, Bibliotheca Geographorum Arabicorum, vol. 7 (Leiden: E. J. Brill, 1892; reprinted, 1967), 238. Note that the Arabic word for drawing a plan here is *ikhtaṭṭa*, from which the word *khiṭṭah*, "a plan," is derived. The word usually used in classical Arabic for map is *ṣūrah*, "illustration," which is also the word used in the three examples given above.

5. Gerald R. Tibbetts, *A Study of the Arabic Texts Containing Material on South-east Asia* (Leiden: E. J. Brill, 1979), 3–4.

6. Buzurg ibn Shahriyār, *Kitāb ʿajāʾib al-Hind*; see *Livre des merveilles de l'Inde*, ed. Pieter Antonie van der Lith, trans. L. Marcel Devic (Leiden: E. J. Brill, 1883–86); *ʾAḫbār aṣ-Ṣīn wa l-Hind: Relation de la Chine et de l'Inde*, ed. and trans. Jean Sauvaget (Paris: Belles Lettres, 1948).

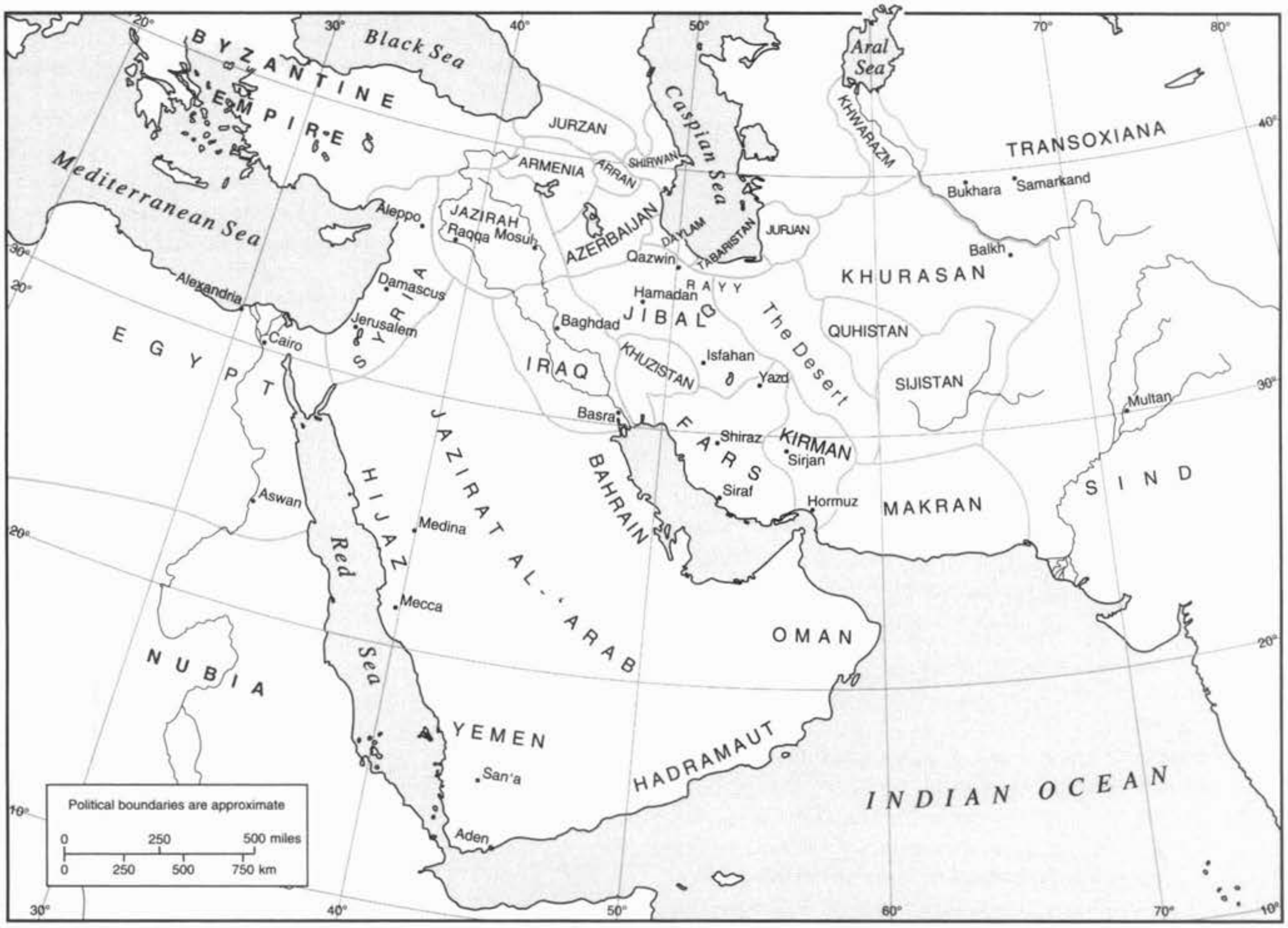

FIG. 4.1. REFERENCE MAP OF THE MIDDLE EAST. This general map of the Middle East during the early period shows the approximate borders of the provinces of the Islamic empire.

China, the right wing India, the left wing al-Khazar (North Caucasus), and the tail North Africa. The tradition may be Iranian.[7] However, the world maps of the al-Balkhī school (tenth century A.D.) show this bird clearly with Arabia as the head, Asia and Africa as the wings, and Europe as the tail, so the tradition may be a much later idea gained from looking at a map of this sort.[8]

The earliest nonliterary geographical source materials were lists of pilgrimage and post stages throughout the Islamic world, giving the distances between the stages. Though compiled for administrative purposes, these were soon adopted by writers with a geographical bent and appear in literary works. These lists and the two previous sources make up the content of early Islamic geographical literature. Works of this nature were often titled *Kitāb al-masālik wa-al-mamālik* (Book of routes and provinces), and the earliest to survive is that of Ibn Khurradādhbih, written about 231/846.[9] The bare bones of this book consist of the post or pilgrimage routes and distances throughout the Islamic world. Ibn Khurradādhbih, however, does extend the routes through known non-Islamic areas; for instance, he gives the sea route to China

7. S. Maqbul Ahmad, "Djughrāfiyā," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 2:575–87, esp. 576. Abū al-Qāsim ʿAbd al-Raḥman ibn ʿAbdallāh ibn ʿAbd al-Ḥakam, *Kitāb futūḥ miṣr*; see *Le livre de la conquête de l'Egypte du Magreb et de l'Espagne*, ed. Henri Massé (Cairo: Imprimerie de l'Institut Français, 1914), 1, emanating from ʿAbdallāh ibn ʿAmr ibn al-ʿĀs.

8. For the Balkhī school maps, see below, chapter 5.

9. Abū al-Qāsim ʿUbayd Allāh ibn ʿAbdallāh ibn Khurradādhbih (or Khurdādhbih) lived about 204–300/820–911, so his geographical work was written in his youth if this date (de Goeje) is correct. He was a government administrator by profession and held the positions of director of posts and intelligence in the province of Jibal and director general of the same in Baghdad and Samarra. His writings ranged over several subjects, but the geographical work was the most quoted. This importance was recognized by both Arabs and modern scholars. The text of Ibn Khurradādhbih's *Kitāb al-masālik wa-al-mamālik* was edited by Michael Jan de Goeje, *Kitâb al-masâlik wa'l-mamâlik (Liber viarum et regnorum)*, Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted, 1967).

TABLE 4.1 Islamic Time Chart

A.H.	A.D.	Event
0	622	The Hijrah; Muḥammad migrates to Medina
8	630	Muḥammad captures Mecca
11	632	Muḥammad dies
11–40	632–61	The four orthodox caliphs
13	634	Palestine and Iraq taken by the Muslims
13–21	634–44	Umar, caliph; Yezdigird III, shah of Persia
14	635	Battle of Qadisīya; defeat of Sassanid army
22	642–43	Muslims reach Carthage in Africa; Makran and Baluchistan in Asia
31	652	Muslims take Armenia; enter Khurasan
41–132	661–750	Umayyad dynasty of caliphs based in Damascus
73	692	al-Ḥajjāh becomes governor of Iraq
76	695	Muslim postal service inaugurated
86	704	Qutaybah, governor of Khurasan (d. 714)
90–93	708–12	Bukhara, Samarkand, and Khwārazm captured; also Sind
92	711	Muslims enter Spain
95	714	al-Ḥajjāj, governor of the eastern empire, dies
132–36	750–54	al-Saffāḥ, first Abbasid caliph
132	750	al-Fazārī, astronomer, flourishes
136–58	754–75	al-Manṣūr, second Abbasid caliph
170–93	786–809	Hārūn al-Rashīd, fifth Abbasid caliph
198–218	813–33	al-Maʾmūn, seventh Abbasid caliph
231	846	Ibn Khurradādhbih's *Kitāb al-masālik wa-al-mamālik*
232–47	847–61	al-Mutawakkil, tenth Abbasid caliph
ca. 240	ca. 850	Ḥabash al-Ḥāsib, astronomer, flourishes
247	861	al-Farghānī, astronomer, flourishes
256–79	870–92	al-Muʿtamid, fifteenth Abbasid caliph
260	874	al-Kindī, philosopher, dies
274	887	al-Marwazī dies
284	897	al-Yaʿqūbī, geographical writer, dies
286	899	al-Sarakhsī dies
288	901	Thābit ibn Qurrah dies
290	903	Ibn al-Faqīh and Ibn Rustah, geographical writers, flourish
ca. 316	ca. 928	Qudāmah, geographical writer, flourishes
317	929	al-Battānī, astronomer, dies
ca. 320	ca. 930	al-Jayhānī, Samanid *wazīr*, flourishes
322	934	al-Balkhī, scholar and geographer, dies
334	945	al-Hamdānī (*Ṣifat Jazīrat al-ʿArab*) dies
331–62	943–73	Ibn Ḥawqal's travels
340	950	Suhrāb (Ibn Sarābiyūn), geographical writer, flourishes
340	951	al-Iṣṭakhrī's *Kitāb al-masālik wa-al-mamālik*
341–65	952–75	al-Muʿizz, Fatimid caliph in Cairo
345	956	al-Masʿūdī, historian, dies
ca. 350	ca. 961	al-Khāzin, astronomer, dies
356	967	Sayf al-Dawlah, Hamdanid sultan of Syria, dies
365–86	975–96	al-ʿAzīz, Fatimid caliph in Cairo
372	982	*Ḥudūd al-ʿālam*; al-Muhallabī, geographical writer, flourishes
386–411	996–1021	al-Ḥakīm, Fatimid caliph in Cairo
377	987	Ibn al-Nadīm's *al-Fihrist*
378	988	Last recension of Ibn Ḥawqal's *Kitāb ṣūrat al-arḍ*
386	990	al-Qummī, astronomer, dies
ca. 390	ca. 1000	al-Muqaddasī dies
399	1009	Ibn Yūnus, geographer and astronomer, dies
428	1037	Strasbourg manuscript of al-Khwārazmī
after 442	after 1050	al-Bīrūnī dies
479	1086	Earliest Ibn Ḥawqal manuscript
480	1087	al-Zarqēllo, astronomer, flourishes (Toledo tables)
530	1140	al-Zuhrī flourishes
548	1154	Roger II of Sicily dies
560	1165	al-Idrīsī dies
569	1173	Earliest manuscript of al-Iṣṭakhrī
590	1190	Aḥmad al-Ṭūsī flourishes
626	1229	Yāqūt dies
685	1286	Ibn Saʿīd dies
732	1331	Abū al-Fidāʾ dies

in detail. He then supplements this material from other sources, usually with literary material like that mentioned above. That he gives distances between places provides us with at least one condition that would have encouraged the development of some sort of cartographic result.

This type of work called *al-Masālik wa-al-mamālik* became a tradition. Other authors who wrote in a similar vein and with the same title were al-Marwazī (d. 274/887), al-Sarakhsī (d. 286/899), and al-Jayhānī (tenth century A.D.). Abū ʿAbdallāh Muḥammad ibn Aḥmad al-

Jayhānī was a Samanid *wazīr* whose work most writers regarded as a serious contribution to geographical literature, and he was a forerunner, according to al-Muqaddasī, of the later al-Balkhī school. None of these works, however, has survived.[10]

Ibn Khurradādhbih is also followed by a series of authors who write in a more stylistic way by dropping the official framework that held his book together. Such writers were al-Yaʿqūbī (d. 284/897), Ibn Rustah (fl. ca. 290/903), and Qudāmah (early tenth century A.D.), who produced geographical works that have survived and are quite important yet are valueless from a cartographic point of view.[11] There are others whose works are lost, although judging from their titles they must have been similar in content. Probably the culmination of this early geographical tradition was the work of al-Masʿūdī (d. 345/956). His main works were histories, but he believed in prefacing history with a description of the world where the events occurred.[12] He was a traveler, an inveterate collector of information, and a good critic. Since much of his information was gained firsthand, he gives us an excellent sketch of the physical world as well as good criticism of Arab geographical literature.

Foreign Geographical Influence

With the formation of the Abbasid court in Iraq, especially under the caliphate of al-Manṣūr (r. 136–58/754–75), literature and science were encouraged and it was realized that the conquered nations, Sassanids and Byzantines, had much to offer. It was soon discovered, probably through Pahlevi scholars and texts, that to the east of Islam the Hindu cultures had a wealth of knowledge that could be tapped by the new elite of the Islamic world. Attempts were made to understand Indian astronomical texts, Indian scholars were invited to Baghdad, and translations were made into Arabic from the *siddhānta* literature, a word that became *sindhind* in Arabic. Several Arabic works are based on *siddhānta* texts, but it was mainly astronomical concepts that were taken from them.[13] A few geographical concepts were derived from India, the most important being the concept of the Cupola of the Earth and the use of the meridian of Ujjain (Arīn) as the prime meridian, ideas that crept from Arabic into medieval European literature.[14] A prime meridian in the extreme east based on a locality called Jamāgird or Kangdiz, with longitudes ranging west from it, appears in some early Arab tables of longitude. The Arabs themselves thought this system was of Indian or Chinese origin.[15]

As the Arabs were absorbing Indian scientific information, they also took in many Persian ideas, as well as Greek ideas that had reached Persia. There is little obvious Persian influence in Arab geographical literature, however, except for general topographical descriptions and the concept of the division of the inhabited world into *kishvars*.[16]

The Persian *kishvars* or "regions" were seven, the same number as the Greek *climata*, so the Arabs called both *iqlīm* (pl. *aqālīm*), causing a certain amount of confusion. They consist geographically of six regions encircling a central region that represents the central Iranian area, usually called in Islamic times by the name Bābil (fig. 4.2).[17] There is a possibility that the idea was ultimately

10. Al-Marwazī's work was mentioned only by title by other authors (e.g., Muḥammad ibn Isḥāq Ibn al-Nadīm, *al-Fihrist*; see *The Fihrist of al-Nadīm: A Tenth-Century Survey of Muslim Culture*, 2 vols., ed. and trans. Bayard Dodge [New York: Columbia University Press, 1970], 1:329, and Shihāb al-Dīn Abū ʿAbdallāh Yāqūt ibn ʿAbdallāh al-Ḥamawī al-Rūmī al-Baghdādi; see *The Irshād al-arīb ilā maʿrifat al-adīb; or, Dictionary of Learned Men of Yāqūt*, 7 vols., ed. D. S. Margoliouth [Leiden: E. J. Brill, 1907–27], 2:400). It was said in the latter source to be the earliest work of this nature. Al-Sarakhsī's work is just as obscure, though al-Sarakhsī himself is better known. He was a general litterateur with other lost works to his credit.

11. The works of these writers are published as volumes 6 and 7 of Bibliotheca Geographorum Arabicorum. For Ibn Khurradādbih see note 9 above, and for al-Yaʿqūbī see note 4 above. For Abū ʿAlī Aḥmad ibn ʿUmar ibn Rustah's *Kitāb al-aʿlāq al-nafīsah*, see de Goeje's edition, *Kitâb al-aʿlâk an-nafîsa VII*, Bibliotheca Geographorum Arabicorum, vol. 7 (Leiden: E. J. Brill, 1892; reprinted 1967). Qudāmah ibn Jaʿfar al-Baghdādī was another geographical writer who was also an administrative official in Baghdad; his *Kitāb al-kharāj* is in de Goeje's vol. 6 (note 9 above): *Kitâb al-Kharâj*.

12. Abū al-Ḥasan ʿAlī ibn al-Ḥusayn al-Masʿūdī's longest work is the *Murūj al-dhahab wa-maʿādin al-jawhar*, published as *Les prairies d'or*, 9 vols., trans. C. Barbier de Meynard and Pavet de Courteille, Société Asiatique, Collection d'Ouvrages Orientaux (Paris: Imprimerie Impériale, 1861–1917), esp. vol. 1 (1861). Also important is his *al-Tanbīh wa-al-ishrāf*; see *Kitâb at-Tanbîh wa'l-ischrâf*, ed. Michael Jan de Goeje, Bibliotheca Geographorum Arabicorum, vol. 8 (Leiden: E. J. Brill, 1894; reprinted, 1967), and the French translation by B. Carra de Vaux, *Le livre de l'avertissement et de la revision* (Paris: Imprimerie Nationale, 1896).

13. There were various *siddhāntas*, and which ones found their way into Arabic is in some dispute. But since they were probably received through the intermediary of Pahlevi texts, the exact provenance of the Arabic works was never clear. Examples of Arabic texts based on Indian materials are the *Kitāb al-Zīj* of Muḥammad ibn Ibrāhīm al-Fazārī and *Zīj al-Sindhind al-ṣaghīr* by Abū Jaʿfar Muḥammad ibn Mūsā al-Khwārazmī. The former is well known from quoted fragments (David Pingree, "The Fragments of the Works of al-Fazārī," *Journal of Near Eastern Studies* 29 [1970]: 103–23), while the latter exists as a whole and was translated into Latin by Adelard of Bath in medieval times. See also p. 97 n.31.

14. Arīn is a misreading of Ujjain in the Arabic script. For more detail, see below, p. 103 and p. 175 n.6.

15. See below, p. 103.

16. Nothing is known to be specifically geographical, but the astronomical tables *Zīj-i Shahriyār*, translated into Arabic as the *Zīj al-Shāh*, which had a great influence on Arab astronomers, may have had geographical tables similar to Ptolemy's *Handy Tables* or those of al-Battānī discussed below.

17. A clear account of the *kishvar* system with diagrams can be found in N. Levtzion and J. F. P. Hopkins, eds. and trans., *Corpus of Early*

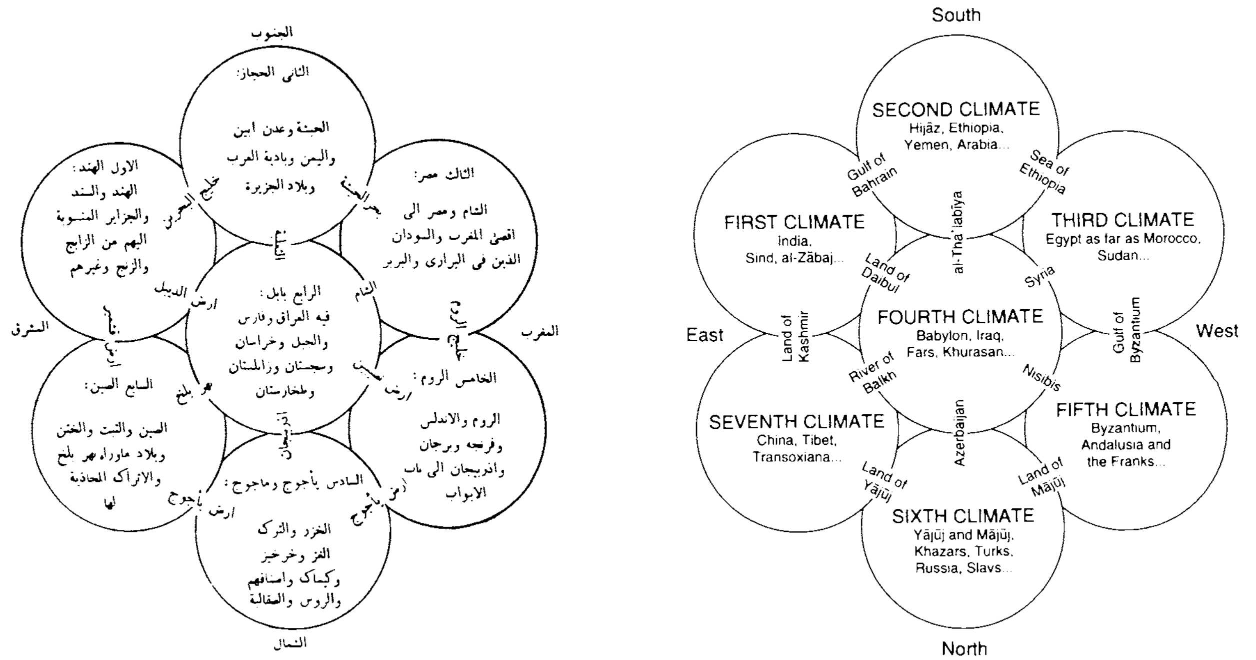

FIG. 4.2. THE PERSIAN *KISHVAR* SYSTEM. This representation is taken from al-Bīrūnī's *Kitāb taḥdīd nihāyāt al-amākin*. My translation of al-Bīrūnī's version of the system is on the right. Size of the original: 14.5 × 13 cm. From Ahmed Zeki Velidi Togan, ed., *Bīrūnī's Picture of the World*, Memoirs of the Archaeological Survey of India, no. 53 (Delhi, 1941), 61, by permission of the Archaeological Survey of India, New Delhi.

derived from Babylonian sources, although there are resemblances to the Indian cosmographic concept of Mount Meru and the lotus petals.[18]

Greek geography, by contrast, influenced the early Arabs considerably. Greek ideas again came via Pahlevi texts, but scholars acquainted with Syriac and Greek introduced directly from the former Byzantine provinces a greater knowledge of Greek geographical material, including the works of Claudius Ptolemy.[19] Ptolemy's *Geography* was more purely geographical than anything the Arabs had yet encountered. The lists of latitude and longitude values and the mathematical side of Ptolemy appealed to them, and they set out with zeal to check his results and correct them where they could.[20] For instance, one of the projects of this time was remeasuring the length of a degree of latitude on the earth's surface using the method originally attributed to Eratosthenes.[21] One thing not taken up by Arab scholars was Ptolemy's chapter on the construction of geographical map projections. In view of their interest in projections for celestial mapping (chap. 2 above) this is surprising, and perhaps it

Arabic Sources for West African History (Cambridge: Cambridge University Press, 1981), xv–xix.

18. This Indian concept is probably also derived from the Persian *kishvar* system that appears in the Avesta; see part 2 below on South Asian cartography. The concept is not old in India; George Rusby Kaye, *Hindu Astronomy: Ancient Science of the Hindus*, Memoirs of the Archaeological Survey of India, no. 18 (Calcutta: Government of India Central Publications Branch, 1924; reprinted New Delhi: Cosmo, 1981), 38. Lotus petal maps are discussed and illustrated below, see figs. 15.3, 16.1, 16.8, 16.14, 16.18, 17.20, 17.21, and related text.

19. Carlo Alfonso Nallino, "Al-Ḫuwârizmî e il suo rifacimento della Geografia di Tolomeo," *Atti della R. Accademia dei Lincei: Classe di Scienze Morali, Storiche e Filologiche*, 5th ser., 2 (1894), pt. 1 (Memorie), 3–53; republished in *Raccolta di scritti editi e inediti*, 6 vols., ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939–48), 5:458–532, esp. 459–63; Ernst Honigmann, *Die sieben Klimata und die πόλεις ἐπίσημοι* (Heidelberg: Winter, 1929), 112–22; J. H. Kramers, "Djughrāfiyā," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), suppl., 61–73, esp. 63.

20. Sezgin, in a recent work I saw after this chapter was written, discusses "Ma'munic mathematical geography" and compares it favorably with "Ptolemaic geography"; Fuat Sezgin, *The Contribution of the Arabic-Islamic Geographers to the Formation of the World Map* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987). What he does is to compare the values given in the tables of latitude and longitude of the early Arab geographers and astronomers with the values given by Ptolemy, stating that the Arab values are on the whole better than those of Ptolemy. In fact the latitude values are more accurate to some extent, but by no means in every case. Longitudes are just so much guesswork. In no case do we know how the Arabs arrived at their values except by playing with the figures of their predecessors. Nor do we know how Ptolemy arrived at his figures. Except for knowledge of the length of a degree of latitude, there can have been little mathematics involved. What it would have required was a vast organization of measurers, and we have no sign of that. Even if Ma'mūn as Commander of the Faithful managed to organize this in the Abbasid Empire, a large number of places with coordinates were found outside his domains.

21. Carlo Alfonso Nallino has dealt in detail with this in "Il valore metrico del grado di meridiano secondo i geografi arabi," Cosmos 11 (1892–93): 20–27, 50–63, 105–21; republished in *Raccolta di scritti editi e inediti*, 6 vols., ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939–48), 5:408–57; and see below, pp. 178–81.

affected all future Arab cartography. The link between Ptolemy's mathematics and actual map production seems never to have been made. The impetus Ptolemy's work gave to the Arabs, however, does seem to have aroused interest in map production, as is illustrated by the importance later geographers gave to the map of the caliph al-Maʾmūn.

THE MAP OF THE CALIPH AL-MAʾMŪN

Under the caliph al-Maʾmūn (r. 198–218/813–33), science flourished at the court, and the caliph surrounded himself with scholars. One of the achievements of the group of scholars working at his instigation was a large map of the world. Al-Maʾmūn's map, however, is likely to have been prompted as much by a political motive as by a purely scholarly one, since various early rulers (Sassanid, Fatimid, and Sicilian Norman) were said to have had similar maps constructed to show that they ruled everything in the world that mattered.[22]

This map has not survived. The only knowledge we have of it comes from a number of contradictory references in the works of later authors. The earliest and probably most detailed reference to it and also suggesting a contemporary interest in cartography is the well-known passage from al-Masʿūdī that runs,

> I have seen these climates represented [*muṣawwarah*] in various colors, without a text, and the best that I have seen has been in the book *Jughrāfiyā* [Geography] of Marinus and the commentary to *Jughrāfiyā* of the divisions of the earth and in *al-ṣūrah al-maʾmūnīyah* that al-Maʾmūn ordered to be constructed by a group of contemporary scholars to represent the world with its spheres, stars, land, and seas, the inhabited and uninhabited regions, settlements of peoples, cities, etc. This was better than anything that preceded it, either the *Geography* of Ptolemy, the *Geography* of Marinus, or any other.[23]

This reference is vague, but the representation "in various colors" must mean that he had seen maps reputed to be made by or derived from the Greeks and also that this special map created by al-Maʾmūn's scholars was known to him. The word used for map, *ṣūrah*, is not a technical term. It means "representation" or "picture" and can refer equally well to a written illustration or representation. Nevertheless, it is the term used for those maps of Daylam and Bukhara that were mentioned above, and it came to be regarded as the word for map throughout the geographical literature of the classical period.

Al-Maʾmūn's map was presumably seen by the twelfth-century geographer al-Zuhrī, who states that his own work (*Jaʿrāfīyah*) is a copy of a copy (made by al-Fazārī) of the *Jaʿrāfīyah al-Maʾmūn*.[24] The description makes it clear that a map is understood by the word *jaʿrāfīyah*. Unfortunately al-Zuhrī has not left a map, but only a text that describes the world according to the Persian *kishvar* system.

The actual form of al-Maʾmūn's map is an enigma. Al-Masʿūdī's reference to Marinus and Ptolemy in the same breath with al-Maʾmūn makes one immediately think that the map made for al-Maʾmūn was built up from longitude and latitude tables on a projection similar to that used by the Greeks. Both al-Masʿūdī and al-Zuhrī, however (and we must not forget that the latter claims to have based his work on al-Maʾmūn's map), base their surviving geographical texts on the Persian system of *kishvars*, which they call *aqālīm* or climates, and this confuses the issue. It is not known if the scholars of al-Maʾmūn really used mathematical geography to produce their map. If they did, we might envisage something resembling a Ptolemaic world map or a world map on a rectangular grid such as Marinus was supposed to have used. This form is supported in that al-Khwārazmī, one of the scholars of al-Maʾmūn's court, produced tables of longitude and latitude of which a manuscript has survived to this day, albeit from the early eleventh century (discussed below). Suhrāb, a later scholar who produced another set of tables that has also survived, gives directions for producing a map on such a rectangular grid. His tables were almost certainly derived from those of al-Khwārazmī and are nearly as long.

If al-Zuhrī used al-Maʾmūn's map and that map was based on a Greek model, why did al-Zuhrī base his work on the Persian *kishvar* system? Furthermore, al-Masʿūdī, after claiming that al-Maʾmūn's map was so good, also based his descriptive geography on this Persian system. It is difficult to read much into the latter's writing, however, for his knowledge of Ptolemy and Greek geography was very superficial, and he was probably aware of them only at second hand from Arabic material like al-Khwārazmī and al-Farghānī.[25] Al-Masʿūdī's statement that all towns in the same Ptolemaic climate have the same latitude is a misinterpretation of al-Farghānī's climatic lists, and al-Masʿūdī's use of the Greek word "climate" (as

22. Ardashir I according to several late Arab authors; see Kramers, "Djughrāfiyā," 64 (note 19). Ibn Yūnus and al-Muhallabī prepared a map on silk for the Fatimid caliph al-ʿAzīz (r. 365–86/975–96), see below. The Norman was Roger II, for whom Idrīsī produced his map (chapter 7 below).

23. Al-Masʿūdī, *al-Tanbīh*; see the edition by de Goeje, 33, or the translation by Carra de Vaux, *Livre de l'avertissement*, 53 (note 12).

24. See the edition of Muḥammad ibn Abī Bakr al-Zuhrī's *Jaʿrāfīyah* in Maḥammad Hadj-Sadok, "Kitāb al-Djaʿrāfiyya," *Bulletin d'Etudes Orientales* 21 (1968): 7–312, esp. 306. Al-Fazārī was an early astronomer (d. ca. 240/800) mainly known as a translator of Indian astronomical texts.

25. Al-Khwārazmī, Suhrāb (Ibn Sarābiyūn), and Abū al-ʿAbbās Aḥmad ibn Muḥammad al-Farghānī will all be discussed in detail in the following sections.

iqlīm) for the Persian *kishvar* also shows his misunderstanding.[26]

Of actual maps (apart from that of al-Ma'mūn) that come from the early period or might have originated before the time of al-Balkhī's school, we also have the map said to be made by Abū al-Ḥasan ʿAlī ibn ʿAbd al-Raḥmān ibn Yūnus for the Fatimid caliph jointly with al-Ḥasan ibn Aḥmad al-Muhallabī. Since Ibn Yūnus compiled tables of coordinates similar to those of al-Khwārazmī, one might expect his map to differ considerably from those of the Balkhī school. Reinaud states that Ibn Yūnus compiled a map for a Buyid ruler that was in various colors but had no graticule. The source of this statement is not given.[27]

There is also a curious reference in the *Fihrist*, the general bibliographic compilation of Ibn al-Nadīm (d. ca. 385/995). Qurrah ibn Qamīṭā, a Sabean from Harran who must have lived in the ninth century A.D., made a description of the world (*Ṣifat al-dunya*) that was copied by his more famous compatriot Abū al-Ḥasan Thābit ibn Qurrah al-Ḥarrānī. The author of the *Fihrist* saw this *ṣifat* and noted that it was made on Dubayqī cloth, "unbleached but with dyes."[28] It is possible that this passage actually refers to a map.

Geographical Tables

The Islamic tables of longitude and latitude seem to be of much more importance in this early period than the maps themselves. A considerable number of lists of geographical place-names exist in Arabic literature. Some are meant to be all-inclusive lists covering the whole of the known world, some cover specific parts of the world, and some give only an unspecified selection of names. Some lists are found directly in original works, but some appear only as extracts in the works of other writers. They are generally of two types: those that list places under climates, not always in any order, giving no longitudes and only the latitudes of the climate boundaries, and those that give longitude and latitude values individually for each place.

The first type are usually included in the works of astronomers, where they appear as a separate chapter. The best example of this category, and one of the earliest extant, appears in the work of Abū al-ʿAbbās Aḥmad ibn Muḥammad al-Farghānī (fl. 247/861).[29] Al-Farghānī's text gives only the climate boundaries in degrees (mid-climate and maximum latitude). He also gives the length of the longest day in hours and fractions and the length of the gnomon shadow. Having delineated the climate thus, he lists geographical features inside each climate, thus giving only a range of latitude where the feature is situated. No longitudes at all are given, but the features are listed approximately in order from east to west as if he had seen and copied some more detailed list. This arrangement also shows possible signs of an eastern meridian. According to Honigmann, al-Farghānī's astronomical tables bear a close resemblance to those of Ptolemy's *Prokheira kanones (Handy Tables)*, which was translated into Arabic by ʿAyyūb and Simʿān as the *Zīj Baṭlamiyūs*.[30] This is not so; there seems to be no Greek origin for the arrangement of towns and climates as given by al-Farghānī, and Ptolemy's tables are arranged by geographical regions and are similar to the fuller tables in his *Geography*. The only Greek connection of al-Farghānī is the Greek toponymy he used in areas beyond the bounds of Islam. Nor does there seem to be any precedent in Eastern works for this arrangement. It seems to be a simpler form of the arrangement used by al-Khwārazmī, who was of course al-Farghānī's contemporary. However, this form of table never has actual coordinates, and in each climate the order is east to west and not vice versa as in al-Khwārazmī. Thus there was never sufficient information in this sort of list for the

26. Al-Masʿūdī, *al-Tanbīh*; see the edition by de Goeje, 25, 32, 44 (note 12); and al-Masʿūdī, *Murūj al-dhahab*; see the translation by Barbier de Meynard and de Courteille, *Les prairies d'or*, 1:182–83, 185, 205 (note 12).

27. See Reinaud's edition of *Taqwīm al-buldān* by Ismāʿīl ibn ʿAlī Abū al-Fidā': *Géographie d'Aboulféda: Traduite de l'arabe en français*, 2 vols. in 3 pts. (vol. 1, *Introduction générale à la géographie des Orientaux* by Joseph Toussaint Reinaud; vol. 2, pt. 1, trans. Reinaud, vol. 2, pt. 2, trans. S. Stanislas Guyard) (Paris: Imprimerie Nationale, 1848–83), 1:CCLXIII. See also S. Maqbul Ahmad, "Kharīṭa," in *Encyclopaedia of Islam*, new ed., 4:1077–83, esp. 1079, and Ibrahim Shawkat, "Kharā'iṭ djughrāfiyyī al-ʿArab al-awwal," *Majallat al-Ustādh* (Baghdad) 2 (1962): 37–68.

28. See the editions of Ibn al-Nadīm's *al-Fihrist* by Dodge, 2:672 (note 10), and Gustav Flügel, ed., *Kitâb al-Fihrist*, 2 vols. (Leipzig: F. C. W. Vogel, 1871–72), 1:285. This is also cited by Ignatiy Iulianovich Krachkovskiy, *Izbrannye sochineniya*, vol. 4, *Arabskaya geograficheskaya literatura* (Moscow, 1957), translated into Arabic by Ṣalāḥ al-Dīn ʿUthmān Hāshim, *Ta'rīkh al-adab al-jughrāfī al-ʿArabī*, 2 vols. (Cairo, 1963–65), 1:206.

29. Al-Farghānī's astronomical work bears several different titles; see *Elementa astronomica, arabicè et latinè*, ed. and trans. Jacob Golius (Amsterdam, 1669); the important chapters are 8 and 9, pp. 30–39. Honigmann, *Die sieben Klimata*, 138 (note 19). See also the articles by Heinrich Suter (rev. Juan Vernet Ginés), "al-Farghānī," in *Encyclopaedia of Islam*, new ed., 2:793; by A. I. Sabra, "al-Farghānī," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 4:541–45; and by George Sarton in his *Introduction to the History of Science*, 3 vols. (Baltimore: Williams and Wilkins, 1927–48), 1:567.

30. Honigmann, *Die sieben Klimata*, 116–17, 137 (note 19). The only available edition of this work of Ptolemy is that edited and translated by Nicholas B. Halma, *Θέωνος Ἀλεξανδρέως Ὑπόμνημα εἰς τοὺς Πτολεμαίου Προχείρους κανόνας: Commentaire de Théon d'Alexandrie, sur les Tables manuelles astronomiques de Ptolemée*, 3 vols. (Paris: Merlin, 1822–25), 1:109–31. This shows that the tables of latitude and longitude are very much the same as those in Ptolemy's *Geography*, although considerably reduced in number of entries.

FIG. 4.3. FOLIO FROM THE STRASBOURG MANUSCRIPT OF AL-KHWĀRAZMĪ'S *ṢŪRAT AL-ʿARḌ*. This folio contains the beginning of the section on the mountains, showing the mountains that lie south of the equator and giving the longitudes and latitudes of both ends of the range, their colors, and in which direction of the compass their peaks should be.
Size of the original: 33.5 × 20.5 cm. By permission of the Bibliothèque Nationale et Universitaire, Strasbourg (Cod. 4247, fol. 10b).

scientific construction of a map, although information derived from this type has filtered through into later geographical works and then into later maps.

Lists of the second type, which give longitudes and latitudes for individual places, are exemplified by the sets of tables given by al-Khwārazmī and by al-Battānī as well as by several later authors.

Longitude and Latitude Tables: Al-Khwārazmī, al-Battānī, and Ptolemy

Al-Khwārazmī's tables consist of simple lists of names arranged under several classified heads—for example, towns, mountains, seas, islands, springs, and rivers (fig. 4.3).[31] Under each of these heads names are listed in climates, beginning south of the equator and working north. Under each climate entries are given in order of longitude (west to east), so that each place as it occurs is given first longitude and then latitude in degrees and minutes.

The tables of al-Battānī (who is considerably later than al-Khwārazmī) are not so systematically arranged (fig. 4.4).[32] Al-Battānī's main work was a textbook on astronomy, and in his work the tables of coordinates for important places were included with his tables for coordinates of important stars among the general astronomical tables. First he lists the "center points" of each geographical region to the number of ninety-four, taken from book 8, chapter 29 of Ptolemy's *Geography* with their respective longitudes and latitudes, and he then lists towns and other miscellaneous features in the same way (180 all together). There is no logical order of places, though the lists drift from west to east so that places in the same region appear together. However, several of these drifts occur successively throughout the total list. A final sequence lists towns and so forth in Spain and North Africa. Other astronomers followed al-Battānī's work instead of a geographical listing after the manner of al-Farghānī.[33] Also, when later geographers selected

31. Al-Khwārazmī (d. ca. 232/847) was well known to both Arabs and medieval Europeans. His fame was established by his book on algebra, but his astronomical work, *Zīj al-Sindhind al-ṣaghīr*, was also well known. His geographical work was known only from quotations until a manuscript was discovered in the late nineteenth century. The fullest account of al-Khwārazmī's contribution to Arab geography appears in Nallino's article "Al-Ḫuwârizmî e il suo rifacimento" (note 19). Also see G. J. Toomer, "al-Khwārizmī," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 7:358–65. The unique manuscript of al-Khwārazmī's geographical work, *Kitāb ṣūrat al-arḍ* (Picture of the earth), was discovered in Cairo by W. Spitta and deposited in the Bibliothèque Nationale et Universitaire, Strasbourg, Cod. 4247. It was edited by Hans von Mžik, *Das Kitāb ṣūrat al-arḍ des Abū Ǧaʿfar Muḥammad ibn Mūsā al-Ḫuwārizmī*, Bibliothek Arabischer Historiker und Geographen, vol. 3 (Leipzig: Otto Harrassowitz, 1926). There are 2,402 entries in this work. Edward S. Kennedy and Mary Helen Kennedy, *Geographical Coordinates of Localities from Islamic Sources* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), presents the coordinate lists from some seventy-four sources including al-Khwārazmī.

32. The work of Abū ʿAbdallāh Muḥammad ibn Jābir al-Battānī al-Ṣābiʾ, entitled *Zīj al-Ṣābiʾ*, was edited by Carlo Alfonso Nallino, *Al-Battānī sive Albatenii: Opus astronomicum*, 3 vols. (Milan, 1899–1907; vols. 1 and 2 reprinted Frankfurt: Minerva, 1969). The tables occur in 2:33–54. They are also given by Joachim Lelewel, *Géographie du Moyen Age*, 4 vols. and epilogue (Brussels: J. Pilliet, 1852–57; reprinted Amsterdam: Meridian, 1966), epilogue, 64–93. There are a total of 273 entries. Al-Battānī was an important astronomer, known as Albategni or Albategnius to medieval Europeans. He died in 317/929.

33. Ibn Yūnus (d. 399/1009) is the best example, with approximately 290 entries (these are mentioned by Lelewel, *Géographie du Moyen*

FIG. 4.4. FOLIO FROM A MANUSCRIPT OF AL-BATTĀNĪ'S *ZĪJ AL-ṢĀBIʿ*. This folio shows longitudes and latitudes for part of Arabia (*left*) and part of Syria (*right*).
Size of the folio: 28 × 19.3 cm. By permission of the Patrimonio Nacional, Madrid (cat. no. 908 Derembourg, fol. 175r).

the coordinate values of previous writers, they frequently used al-Battānī's values in preference to those of others.

Another similar list of place-names probably earlier than al-Battānī's may have been that of the *Kitāb al-malḥamah* (Book of the battle), which was one of the sources for longitude and latitude of places that the later author Yāqūt (d. 626/1229) used in his geographical dictionary *Muʿjam al-buldān* (Dictionary of countries). Because of the format of his work, the form of the *Kitāb al-malḥamah* was completely broken up, and we are left with a series of sixty-four separate places.[34]

Tables of this sort often give variations of the same place-names or even assign different names to the same place as well as different coordinate values. Later authors tend to pick and choose. They combine or duplicate material in a completely arbitrary manner, so that as time goes on the tables become impossible to use in any scientific way.

The tables of both al-Khwārazmī and al-Battānī strongly resemble those of Ptolemy, and the name Ptolemy (Baṭlamiyūs in Arabic) is associated with both.[35] However, the actual values of longitude and latitude in these two sets of tables frequently vary (fig. 4.5). Al-Battānī is very close to Ptolemy, especially in those values he gives for cities, where there is almost always agreement. The *Kitāb al-malḥamah* quoted by Yāqūt is also reasonably close to Ptolemy, although about a third of his localities are not in Ptolemy at all. Al-Khwārazmī lists many places that are not in Ptolemy, his latitudes vary considerably, and of course his longitudes are mainly about ten degrees less than those of Ptolemy because of his different position for the prime meridian. The differences between these Arab texts suggest that they are derived from different sources, and some explanation ought to be possible. It is therefore necessary to investigate the matter in more detail.

It is not known exactly when and where Ptolemy's *Geography* (Γεωγραφικὴ ὑφήγησις) reached Arab scholars. The date usually given for its arrival is during the reign of the caliph al-Maʾmūn, and the translation is attributed originally to Abū Yūsuf Yaʿqūb ibn Isḥāq al-Kindī and later to Thābit ibn Qurrah.[36] Since al-Kindī did not die until 260/874, he must have been quite young if he was translating Ptolemy in the reign of al-Maʾmūn. Thābit ibn Qurrah's dates are 222–88/836–901, so his translation would not have appeared until much later in the century. Both these authors were younger than al-Khwārazmī, who was certainly working under al-Maʾmūn as an astronomer and astrologer and probably died about

Age, 1:165–77 [note 32]), also al-Bīrūnī in *Kitāb al-qānūn al-Masʿūdī fī al-hayʾah wa-al-nujūm* (see *al-Qānūnuʾl-Masʿūdī (Canon Masudicus)*, 3 vols. [Hyderabad: Osmania Oriental Publications Bureau, 1954–56]), and other later astronomers. Also, al-Bīrūnī's references are quoted by later geographers such as Abū al-Fidāʾ in his *Taqwīm al-buldān*; see *Géographie d'Aboulféda, texte arabe*, ed. and trans. Joseph Toussaint Reinaud and William MacGuckin de Slane (Paris: Imprimerie Royale, 1840), 11, 74. Kennedy gives a bibliography of surviving astronomers' tables, often mentioning where geographical coordinates are given: Edward S. Kennedy, "A Survey of Islamic Astronomical Tables," *Transactions of the American Philosophical Society*, n.s., 46 (1956): 123–77. In one or two cases he states which prime meridian is used. In Edward S. Kennedy and M. H. Regier, "Prime Meridians in Medieval Islamic Astronomy," *Vistas in Astronomy* 28 (1985): 29–32, a list is given of astronomers, noting whether they use the Fortunate Isles or the African coast as a prime meridian (p. 31).

34. A list of these places is given in Honigmann, *Die sieben Klimata*, 126–31 (note 19).

35. Ptolemy is mentioned in the title of the Strasbourg manuscript of al-Khwārazmī (see von Mžik's edition, *Kitāb ṣūrat al-arḍ* [note 31], and Nallino, "Al-Ḫuwârizmî e il suo rifacimento," 477 [note 19]). Ptolemy is mentioned by al-Battānī in his sixth chapter on longitudes and latitudes (Nallino's edition, *Opus astronomicum*, 1:20, text p. 28 [note 32]). Al-Battānī also states that his ninety-four regional divisions are from Ptolemy: they come, as I have already mentioned, from bk. 8, chap. 29 of the *Geography*.

36. See appendix 1.1, pp. 10–11. The translation of Ptolemy's geographical work into Arabic is mentioned in the *Fihrist*; see the Dodge edition, 2:640 (note 10). Translations are also discussed in Kramers, "Djughrāfiyā," 63 (note 19); Honigmann, *Die sieben Klimata*, 112–18 (note 19); and Nallino, "Al-Ḫuwârizmî e il suo rifacimento," 459–63 (note 19).

	Yāqūt			Ptolemy		al-Khwārazmī		al-Battānī	
	Long.	*Lat.*	*Climate*	*Long.*	*Lat.*	*Long.*	*Lat.*	*Long.*	*Lat.*
Adana (Ἄδανα)	68° 15'	–	–	68° 15'	36° 50'	–	–	68° 15'	36° 50'
Greater Armenia (Khilāṭ)	78°	38° 20'	V	–	–	64° 50'	39° 50'	78°	39° 20' [Khilāṭ]
								77°	41° [Gr. Armenia]
Lesser Armenia (Tiflis/Tbilisi)	75° 50'	45°	–	–	–	–	–	–	–
Antioch (Ἀντιόχεια)	69°	35° 30'	IV	69°	35° 30'	61° 35'	34° 10'	69°	35° 30'
Ankara (Ἄγκυρα)	58°	49° 40'	–	62°	42°	58°	43°	–	–
Ahwaz (Σοῦσα)	84°	35° 04'	–	84°	35° 15'	75°	32°	83°	34°
Bukhara	87°	41°	V	–	–	87° 20'	37° 50'	[88°	34°?]
Barda	79° 30'	45°	VI	–	–	73°	43°	84°	42°
Cyrenaica (Barqa) (Βάρκη)	63°	33° 10'	III	49° 15'	30° 45'	43°	33° 45'	–	–
Baalbek (Ἡλιούπολις)	68° 20'	–	IV	68° 40'	33° 40'	–	–	68° 20'	33° 15'
Baghdad	75°	34°	IV	–	–	70°	33° 09'	80°	33° 09'
Balkh (Βάκτρα)	115°	37°	V	116°	41°	88° 35'	38° 40'	116°	41°
Beirut (Βηρυτός)	68° 45'	33° 20'	–	67° 30'	33° 40'	59° 30'	34°	69° 30'	33° 20'
Palmyra (Tadmur) (Πάλμυρα)	71° 30'	–	IV	71° 30'	34°	66°	35°	72°	34°
Tikrit (Βίρθα)	98° 40'	37° 30'	–	78° 45'	36° 20'	–	–	–	–
Gurgan (Ὑρκανία)	86° 30'	40°	V	98° 50'	40°	80° 45'	38° 50'	95°	40°
Haran (Κάρραι)	72° 30'	27° 30'	IV	73° 15'	36° 10'	65°	36° 40'	73°	36° 40'
Aleppo (Halab) (Βέροια)	69° 30'	35° 25'	IV	71° 20'	35°	63°	34° 30'	71°	34° 50'
Hulwan	71° 45'	34°	IV	–	–	71° 45'	34°	81°	35°
Homs (Ἔμισσα)	69°	34° 45'	IV	69° 40'	34°	61°	34°	69° 05'	–
Khiva (Khwārazm) (Ὠξείανα)	117° 30'	45°	VI	117° 30'	44° 20'	91° 50'	42° 10'	–	–
Raqqa (Νικηφόριον)	73° 06'	35° 20'	IV	73° 05'	35° 20'	66°	36°	73° 15'	36°
Rome (Rūmīya) (Ρώμη)	35° 20'	41° 50'	V	36° 40'	41° 40'	35° 20'	41° 50'	36° 40'	41° 40'
Edessa (Ruha) (Ἔδεσσα)	72° 30'	37° 30'	IV	72° 30'	37° 30'	64°	36° 40'	72° 50'	37°
Rayy (Ῥάγαια)	85°	37° 36'	IV	98° 20'	34° 20'	75°	35° 45'	86°	36° 30'
Zaura	105°	39°	V	–	–	–	–	–	–
Syracuse (Συρακοῦσαι)	39° 18'	39°	V	39° 30'	37°	–	–	–	–
Salamiya	68° 20'	37° 05'	IV	–	–	62° 45'	33° 30'	69° 50'	34° 50'

FIG. 4.5. A COMPARISON OF SOME OF THE COORDINATES OF AL-KHWĀRAZMĪ, AL-BĀTTANĪ, AND THE *KITĀB AL-MALḤAMAH* (YĀQŪT) WITH THOSE OF PTOLEMY. The first column lists the coordinates from the *Kitāb al-malḥamah*, as given in the printed edition of Yāqūt's *Muʿjam al-buldān*, and the climate where given. This is followed by the coordinates given by the other authors.
After Ernst Honigmann, *Die sieben Klimata und die πόλεις ἐπίσημοι* (Heidelberg: Winter, 1929), 126–27.

232/847. Ibn Khurradādhbih (fl. 231/846), another scholar and the nearest contemporary of al-Khwārazmī, claims to have made a translation of Ptolemy's description of the earth from barbaric (*aʿjamīyah*) into pure (*ṣaḥīḥah*) speech.[37] What this means is not clear. That he made a translation into Arabic is dubious, and in any case he may be referring not to tables but to other parts of Ptolemy's work. However, it is clear that Ibn Khurradādhbih's translation was for private use, and it does not seem to have been used by later writers. It therefore appears likely that the full translation of Ptolemy's *Geography* into Arabic did not come until much later in the ninth century, certainly after the death of al-Ma'mūn. It is thus probable that al-Khwārazmī and Ibn Khurradādhbih had to take the work straight from the Greek, or more likely from a Syriac version, and they may have had to translate themselves those parts they wished to use.

Because of the difficulties of transmission, references in Arabic literature to Ptolemy and his work that come from this early period before there was a complete translation are short and often erroneous. The orthography of place-names suffers, and figures are corrupted throughout Arabic literature by the inaccurate rendering of Greek and Syriac letters into the Arabic script. In all these languages, numbers are represented by alphabetic signs, and Semitic alphabets have many letters that are identical except for diacritical points, which are often omitted.[38]

37. See de Goeje's edition of Ibn Khurradādhbih's *Kitāb al-masālik wa-al-mamālik*, 3 (note 9); also Nallino, "Al-Ḫuwârizmî e il suo rifacimento," 462 (note 19).

38. There are many references to the peculiarities of Semitic scripts and the misinterpretations due to similar letters' being used for different numbers. Works I have been consulting that have relevant passages are Lelewel, *Géographie du Moyen Age*, epilogue, 62–63 (note 32), and von Mžik in the introduction to his edition of the Strasbourg manuscript, *Kitāb ṣūrat al-arḍ*, XVI–XXX (note 31).

Thus al-Ma'mūn's map and any tables used for it (or even derived from it) would have been very much subject to the inadequate research and rudimentary translation work available at the time.[39]

This helps reveal the difference between the work of al-Khwārazmī and that of al-Battānī. Al-Battānī's work, which was produced after translations of Ptolemy were available, is much closer to Ptolemy's and as such can easily be compared with it. If the locality occurs in Ptolemy, most of al-Battānī's figures are identical with his. The ninety-four geographical regions are also a Ptolemaic feature. There is no doubt that al-Battānī is extracting his material from an Arabic translation of Ptolemy's work. According to Honigmann, his source is the translation of al-Kindī, but Nallino has suggested the translation of Thābit ibn Qurrah is the most likely, since Thābit came from Harran and was Sabaean and thus had the same origins as al-Battānī.[40]

The *Kitāb al-malḥamah*, which is quoted frequently by Yāqūt, has coordinate values very much like those of Ptolemy. Although probably earlier than al-Battānī, it must have been produced after Ptolemy's *Geography* had been translated into Arabic.[41] Al-Khwārazmī differs considerably from Ptolemy in both his arrangement and the content of his material. Here we can see a completely independent work based on Ptolemaic (as well as other) material. In fact, this sort of work was the only kind it was possible to produce before an adequate translation was available, and it is surprising how much of Ptolemy's detail has been used.

The important point about al-Khwārazmī's work is that it is systematically presented but differs from that of Ptolemy in latitude and longitude values and the arrangement of places.[42] Ptolemy's information has been selected, abstracted, and re-presented, although it is not quite clear whether this had to be done because of the resources available at the time or whether it was done deliberately for a specific purpose. Certainly Arabic names were introduced wherever possible, but the Greek (or Syriac) names were retained where needed. This was the system adopted by all Arab scholars, although in al-Khwārazmī and al-Battānī Greek words were interspersed with the Arabic ones, whereas it has been pointed out that the lists of al-Farghānī have no Greek names preserved in the Islamic homeland (probably because they are much shorter and more selective lists).[43]

AL-KHWĀRAZMĪ'S METHODS AND PURPOSE

Nallino has examined al-Khwārazmī's coordinate values in detail and has come to conclusions on the method of compilation.[44] He states that al-Khwārazmī obtained his values by placing a grid over a map and extracting the values in what seems to be a most arbitrary way. Because of the Syriac spelling of the Greek names, the map would have to have been a Syriac version from the Ptolemy corpus. Presumably this would have been done only if this Syriac Ptolemy he used consisted of only a map with no accompanying tables, and the map would have had no graticule (otherwise the readings could have been taken directly). The result is that the longitudes are all approximately ten degrees less than those of Ptolemy, simply because the grid was superimposed with its origin ten degrees to the east of Ptolemy's prime meridian of the Fortunate Isles. The latitudes are more or less the same as Ptolemy's. Most of the other discrepancies between the two could be accounted for by irregularities in the underlying map. A further corroboration of this idea is the fact mentioned above that some places (especially mountains) have no names but have only coordinates for both ends. Mountains are also given a color that may be their color on the original map; this use of colors seems important to the Arab geographers, and we can compare al-Masʿūdī's mention of colors above.[45] Quite a number of places have no names, and in some of these al-Khwārazmī expressly states that he has not named them because no name was given "on the map."[46] This sounds like a rather haphazard and unscientific method of obtaining results, however, especially for a mathematician and astronomer of the caliber of al-Khwārazmī. The prime meridian ten degrees east of the Fortunate Isles may be based on the most westerly point

39. Scholars have produced several references from Arab literature to tables commissioned by al-Ma'mūn, known as *al-Zīj al-mumtaḥan* (The proved tables). Generally these refer to astronomical tables, but there is no reason why tables of geographical coordinates and even chronological tables should not have been included similar to those of Ptolemy's *Handy Tables* and the tables of al-Battānī.

40. Nallino, "Al-Ḫuwârizmî e il suo rifacimento," 489–90 (note 19). Honigmann, *Die sieben Klimata*, 124–25 (note 19), however, is not so sure about this; see also Nallino in his edition of al-Battānī, *Opus astronomicum*, 2:211 (note 32), and Hans von Mžik, "Afrika nach der arabischen Bearbeitung der Γεωγραφικὴ ὑφήγησις des Claudius Ptolemaeus von Muḥammad ibn Mūsā al-Ḫwārizmī," *Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien: Philosophisch-Historische Klasse* 59 (1917), Abhandlung 4, i–xii, 1–67.

41. It is possible that this may represent the translation of al-Kindī, whereas al-Battānī represents that of Thābit ibn Qurrah.

42. The two main sources of information on this are Nallino, "Al-Ḫuwârizmî e il suo rifacimento" (note 19), and Hans von Mžik, "Ptolemaeus und die Karten der arabischen Geographen," *Mitteilungen der Kaiserlich-Königlichen Geographischen Gesellschaft in Wien* 58 (1915): 152–76, esp. 162–63.

43. Honigmann, *Die sieben Klimata*, 154 (note 19).

44. Nallino, "Al-Ḫuwârizmî e il suo rifacimento," esp. 481–93 (note 19); see also von Mžik, "Ptolemaeus und die Karten," 163–64 (note 42).

45. The colors al-Khwārazmī mentions are actually thirty-three in number and seem to include various subtle shades; not what one would expect for clear cartographic differentiation.

46. These references appear on fols. 18v, 40r, 41r of the Strasbourg manuscript. The phrase is *fī'l-ṣūrah*; see Nallino, "Al-Ḫuwârizmî e il suo rifacimento," 484 (note 19).

of Africa, but the difference from Ptolemy in the length of the Mediterranean and the individual variations in latitude and longitude need some explanation. There is no doubt, however, that al-Khwārazmī's figures are thought out independently of Ptolemy's, and that al-Khwārazmī completely reworked the Greek author's tables. That Nallino calls al-Khwārazmī's work a "rifacimento" and Reinaud calls it an "imitation" spells out the truth,[47] though the Arabic word used in the title to the Strasbourg manuscript is *istikhrāj*, "extraction." Al-Khwārazmī's coordinate values are followed by Suhrāb, whose work is more or less an edition of that of al-Khwārazmī, and by quite a few later geographers including Abū al-Fidā' quoting *Kitāb rasm al-rubʿ al-maʿmūr* (Book of the picture of the inhabited quarter).[48]

For what reason were these tables produced? Al-Farghānī regarded a certain amount of description of the inhabited areas of the earth as a useful part of his astronomical work. Al-Battānī and those astronomers who followed him presumably thought the same. Al-Battānī included other tables that were not strictly astronomical, such as a historical time chart. In this he was following the example of Ptolemy in his *Handy Tables*. This seems to be the only reason for these tables. Al-Khwārazmī's tables are a different matter altogether.[49]

If al-Khwārazmī copied his tables from a Syriac map, he presumably did so to make the information available in Arabic so that it could be transferred back onto an Arab map. Did al-Khwārazmī's work really constitute notes for the compilation of al-Ma'mūn's map, about which there is so much talk? Or was it just a convenient way of preserving the information from any map because an actual map was not easily preserved? Were al-Khwārazmī's tables actually taken from al-Ma'mūn's map, especially to preserve its information and enable copies to be made from it when necessary? There is ample evidence in al-Khwārazmī's work that he was conscious of the map form, and as I have already pointed out, in two or three places he actually mentions a map. The systematic method of al-Khwārazmī is a more cartographic approach than are the astronomers' tables. This, together with the fact that some coordinates have no geographical names and that the mountain ranges are given colors as well as coordinates, has led some scholars to suggest that al-Khwārazmī's figures were actually abstracted from a map rather than from other tables. The colors given to the mountains and so forth are all pointed out by Nallino, while Suhrāb, whose tables are taken directly from al-Khwārazmī, actually gives us the directions for compiling such a map.[50] In spite of all these questions, we have no definite answer and can only continue to conjecture the reasons for this work.

Why the Arabs did not have maps with graticules at this time is not known; it is not just a case of loss of relevant artifacts. The idea of longitude and latitude tables came to the Arabs from the Greeks and essentially from Ptolemy, but translating these into a map by plotting them onto paper does not seem to have generally appealed to the Arabs, and it is possible they found it difficult to adjust to the idea of maps constructed in this way.[51] Thus, while there is no doubt that Suhrāb understood how a map could be constructed from coordinates, no one else actually describes the system. Even as late as the fourteenth century A.D., attempts to apply this part of Ptolemy's material were only partially successful. With Ptolemy's coordinates for place-names we have his coordinates for star positions, and these seem to have been regarded as more useful than the former because stars, being visible to the eye all at the same time, could be fixed in a sphere by their coordinates. As we have seen, placing the stars on a celestial globe was commonplace for Muslim scholars, and projecting star positions onto the rete of the astrolabe was also normal.[52] The geographical equivalent was more difficult to understand. There are no surviving examples of terrestrial globes, and those maps that have survived are not based on a graticule. Only very late (thirteenth or fourteenth century) were attempts made to fit the world onto a graticule, which I will describe in due course.[53]

The Length of the Mediterranean

A point where Arab geographers are given credit by many writers is their correction of the length of the Mediterranean. It is well known that Ptolemy stretched the Mediterranean longitudinally by about twenty degrees, giving the distance between Tangier (Tingis) (at 6°30′E) and Alexandria (at 60°30′) as 54° (the actual distance is 35°39′). He is thought to have done this in order to make the inhabited part of the world reach the total distance of 180°, although Toomer suggests this may be due to

47. Nallino, "Al-Ḥuwârizmî e il suo rifacimento" (note 19), and Reinaud, *Introduction générale*, XLIII n. 3 (note 27).

48. These extracts from Abū al-Fidā' were mentioned by Lelewel as coming from al-Khwārazmī's work before the Strasbourg manuscript was discovered; there are ninety-four locations all together in these extracts; see Lelewel, *Géographie du Moyen Age*, epilogue, 48–61 (note 32). Suhrāb's *ʿAjā'ib al-aqālīm al-sabʿah* is edited by Hans von Mžik, *Das Kitāb ʿaǧā'ib al-akālīm as-sabʿa des Suhrāb*, Bibliothek Arabischer Historiker und Geographen, vol. 5 (Leipzig: Otto Harrassowitz, 1930).

49. One of the most important differences is the number of entries. Most tables have under 100 entries, though al-Battānī has 273 and Ibn Yūnus has about 290. Al-Khwārazmī, however, has about 2,400 entries (Suhrāb, 2,200). Ptolemy has about 8,000 entries in his *Geography*.

50. Suhrāb is mentioned below, pp. 104–5. See Nallino, "Al-Ḥuwârizmî e il suo rifacimento," 484 (note 19).

51. In spite of the various translations of and quotations from Ptolemy, there is no indication in Arab geographical texts of the first chapter of the *Geography*, in which Ptolemy describes map projections.

52. See chapter 2 above, on Islamic celestial cartography.

53. See below under Ḥāfiẓ-i Abrū and Ḥamd Allāh Mustawfī.

error in the one longitudinal interval that he measured by means of an eclipse.[54] Al-Khwārazmī, in contrast, reduced the length of the Mediterranean to 43°20′ (Tangier being at 8° and Alexandria at 51°20′). He made up the 180° to the east of the inhabited world, however, by adding material that comes mainly from the Alexander romance.[55] This difference in the length of the Mediterranean probably means very little and does not demonstrate a significant cartographic improvement of the Arabs over the Greeks. Al-Battānī restored Alexandria to its Ptolemaic longitude, and later authors used various arbitrary values somewhere between the two given above.

It is important to stress the arbitrariness of these values. For instance, Ibn Yūnus has Alexandria at 55°, and Abū al-Fidā᾿ puts it at 52°. Abū al-Ḥasan al-Marrākashī actually increases the longitude of Alexandria to 63° but also increases the longitudes at the Spanish end, as did al-Battānī before him. Thus al-Battānī's length for the Mediterranean was 35°20′ (with Tangier at 25°10′), while Abū al-Ḥasan placed Cadiz and Tangier at 24° and Toledo at 28° (10° according to Ptolemy).[56] Taken as a whole, these coordinates are unsystematic, and this becomes clear when one tries to use them for any specific purpose. Even when errors of transmission have been eliminated, none of the figures given can be used with any mathematical precision. The Balkhī school and some other later geographers reverted to stating the distances between towns in parasangs (about four miles) or days' journeys (*marḥalah*). These figures may have been converted into degrees to produce some of the strange coordinates that appear in very late texts.

The Seven Climates and Their Boundaries

Most Arab writers divided the inhabitable part of the world into horizontal bands known as *climata* or climates (*aqālīm*), of which there were seven. In this they followed the Greek tradition that permeated later Syriac and Byzantine writings, although Ptolemy himself produced twenty-four climates based on the length of the shadow of the gnomon or on the length of the midsummer day.[57] Each climate had a center band where the midsummer day was an exact number of half hours in length, so that there was half an hour's difference between the center of each climate. Similarly with the boundaries between climates that were at the quarters. Thus the centers of climates 1–7 went from thirteen to sixteen hours, which went from 12°30′ to 50°30′ or a total of 38° according to al-Farghānī and a total of 2,140 miles on the earth's surface (fig. 4.6).[58] Most authors agree with al-Farghānī to within a minute or two unless the figures have been miscopied or misread in the Arabic. Al-Khwārazmī differs most by making his first climate begin at the equator and

THE GREEK SYSTEM				THE ARAB SYSTEM		
Climata			Number of hours in longest day	al-Farghānī	al-Battānī	al-Bīrūnī
			16.25	50° 30′	missing	50° 25′
VII	Borysthenes (Dnieper River)		16	48° 55′	48° 53′	48° 52′
		48° 30′	15.75	47° 15′	47° 12′	47° 11′
VI	Hellespont (Dardanelles)		15.5	45° 24′	45° 22′	45° 22′
		43° 05′	15.25	43° 30′	43° 25′	43° 23′
V	Rome		15	41° 20′	41° 15′	41° 14′
		38° 35′	14.75	39°	38° 54′	38° 54′
IV	Rhodes		14.5	36° 24′	36° 22′	36° 21′
		33° 20′	14.25	33° 40′	33° 37′	33° 37′
III	Alexandria		14	30° 42′	30° 40′	30° 39′
		27° 10′	13.75	27° 30′	27° 28′	27° 28′
II	Syene (Aswan)		13.5	24° 06′	24° 05′	24° 04′
		20° 15′	13.25	20° 30′	20° 28′	20° 27′
I	Meroë		13	16° 40′	16° 39′	16° 39′
		12° 30′	12.75	missing	missing	12° 39′

FIG. 4.6. THE SEVEN-CLIMATE SYSTEM ACCORDING TO THREE ARAB WRITERS, SHOWING A COMPARISON WITH THE GREEK SYSTEM. Greek values are those actually given by Ptolemy (compare O. A. W. Dilke and editors, "The Culmination of Greek Cartography in Ptolemy," in *The History of Cartography*, ed. J. B. Harley and David Woodward [Chicago: University of Chicago Press, 1987–], 1:177–200, esp. 186). After Ernst Honigmann, *Die sieben Klimata und die πόλεις ἐπίσημοι* (Heidelberg: Winter, 1929), 137, 163.

takes his inhabitable world from south of the equator to 63°N.[59] In spite of boundary latitudes for climates, places were sometimes included in a climate when their latitude was actually outside the boundary. It was these lines of climate boundary that were later superimposed upon Arab maps from the time of al-Idrīsī, either as straight lines across a semicircular inhabited world or as arcs of a circle concentric with the equator, but at this early stage these climate boundaries appear only in written texts and not on maps.[60]

Prime Meridians

The attempt to produce a standard prime meridian for Arabic works was another complicated problem. Basing himself ultimately on Ptolemy, al-Khwārazmī used a wes-

54. G. J. Toomer, "Ptolemy," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 11:186–206, esp. 200.

55. Hans von Mžik, "Parageographische Elemente in den Berichten der arabischen Geographen über Südostasien," in *Beiträge zur historischen Geographie, Kulturgeographie, Ethnographie und Kartographie, vornehmlich des Orients*, ed. Hans von Mžik (Leipzig: Franz Deuticke, 1929), 172–202.

56. Reinaud, *Introduction générale*, CCLXXV–CCLXXVI (note 27); von Mžik, "Ptolemaeus und die Karten," 163 and n. 24 (note 42).

57. Honigmann, *Die sieben Klimata* (note 19). Ptolemy's divisions appear on p. 60 and various Arab systems on pp. 160–83.

58. Al-Farghānī, *Elementa astronomica*, 33–34 of the translation and of the Arabic text (note 29).

59. Al-Farghānī makes the limits of the *oikoumene* 0° and 66°, but he mentions no places outside the actual climate boundaries.

60. Al-Idrīsī also divides his text into climates and describes the first climate completely before returning to those parts of countries that overlap the boundaries and are therefore in the second climate. In this he is followed by some later geographers such as Zakariyā᾿ ibn Muḥammad al-Qazwīnī, *Āthār al-bilād*, and ʿAlī ibn Mūsā ibn Saʿīd al-Maghribī, *Kitāb basṭ al-arḍ fī ṭūlihā wa-al-ʿarḍ*.

terly meridian, but not the same one Ptolemy used. Ptolemy's own figures for latitude and longitude were used, on the whole, by al-Battānī, whose longitude figures therefore seem based on Ptolemy's own prime meridian of the Fortunate Isles (Jazā'ir al-Khālidāt in Arabic), which was approximately ten degrees west of al-Khwārazmī's meridian, with the resulting difference of longitudinal values throughout.[61] Al-Battānī is followed in this by many later astronomers.[62] A second set of Ptolemaic figures, not quite as accurate but also based on the Fortunate Isles meridian, is given by the later encyclopedist Yāqūt when he quotes as his source the otherwise unknown work *Kitāb al-malḥamah*. Yāqūt also gives longitudes supplementary to the normal ones based on a meridian on the east, with degrees running in the opposite direction. There are other traces of this system in Arabic texts. Al-Hamdānī (d. 334/945) used it, and so did Ḥasan ibn ʿAlī al-Qummī (d. 386/990) and Abū Maʿshar (d. 272/886). According to al-Hamdānī, the eastern meridian was used by the Indians and the Chinese, and there was a difference of 13½ degrees of longitude between them and the Greek system. Al-Hamdānī quotes al-Fazārī (fl. 132/750) and Ḥabash al-Ḥāsib (fl. 240/850) as his sources.[63]

The ancient Indians had used a central meridian that they based on Laṅkā (Ceylon) for calculating sidereal and planetary motions, and it is possible that they used the same meridian as a basis for comparative longitude observations. The famous observatory at Ujjain was presumed to be on the same meridian. At 90° west and east of the Ujjain (and Laṅkā) meridian on the equator (they assumed also that Laṅkā was on the equator) they placed the cities of Romaka (Yavanapura) and Yamakoṭi, and to make the arrangement symmetrical on a spherical earth there was a city of Siddhapura at the antipodes of Laṅkā. The inhabitable world existed north of the equator between Yavanapura and Yamakoṭi.[64] The Arabs adopted this information and equated the point 90° west of Ujjain with Ptolemy's origin in the Fortunate Isles and Yamakoṭi as the 180° point or 90° east of Ujjain.[65] Laṅkā became known to the Arabs as Qubbat al-Arḍ, the Cupola of the Earth or the Cupola of Ujjain Qubbat al-Arīn, by which name it appears in medieval European texts. This system was well known to the Arabs but never had any practical use, although attempts were made to use both Ujjain and Yamakoṭi (or Jamāgird) as prime meridians.[66] India was more than 90°E according to Ptolemy, and therefore the meridian of Ujjain remained entirely theoretical and was never used practically.

Finally, in a more realistic manner, longitudes were based comparatively on convenient cities in the Islamic heartland like Basra and Baghdad. Baghdad was never considered the origin of a system but was always given a rounded figure for its longitude coordinate. Thus Yāqūt (*Kitāb al-malḥamah*) gives 75°, al-Battānī gives 80° (Baghdad was of course not mentioned by Ptolemy), and even al-Khwārazmī makes Baghdad 70° exactly.[67]

61. Reinaud, *Introduction générale*, CCXXXIV (note 27). Lelewel, *Géographie du Moyen Age*, epilogue, 64–93 (note 32), includes a table copied from al-Battānī's text giving all 273 of al-Battānī's values together with the equivalent values from Ptolemy, if possible. Some values are given by Honigmann, *Die sieben Klimata*, 126–31 (note 19). More of al-Battānī's figures are given on pp. 144–51, but without the figures from Ptolemy. See also von Mžik, "Ptolemaeus und die Karten," 164–65 (note 42).

62. A list of authors following one or the other is given by Kennedy and Regier, "Prime Meridians" (note 33).

63. Al-Ḥasan ibn Aḥmad al-Hamdānī, *Ṣifat Jazīrat al-ʿArab*; see *Geographie der arabischen Halbinsel*, 2 vols. in 1, ed. David Heinrich Müller (Leiden, 1884–91; reprinted Leiden: E. J. Brill, 1968), 27. Al-Hamdānī gives latitude and longitude values for a list of places in Arabia. These must have been available to him from a source that is not extant, perhaps Aḥmad ibn ʿAbdallāh Ḥabash al-Ḥāsib al-Marwazī or al-Fazārī (see pp. 44–46). Abū Maʿshar Jaʿfar ibn Muḥammad al-Balkhī used his eastern meridian purely for astronomical reasons, as did al-Qummī, whose geographical list of places resembled that of al-Farghānī with no coordinates. See also Honigmann, *Die sieben Klimata*, 139–41 (note 19), and Aloys Sprenger, *Die Post- und Reiserouten des Orients*, Abhandlungen der Deutschen Morgenländischen Gesellschaft, vol. 3, no. 3 (Leipzig: F. A. Brockhaus, 1864; reprinted Amsterdam: Meridian, 1962, 1971), XI.

64. See Kaye, *Hindu Astronomy*, 52 (note 18).

65. A good summary of this conception appears in the *Ḥudūd al-ʿālam: "The Regions of the World,"* ed. and trans. Vladimir Minorsky (London: Luzac, 1937; reprinted Karachi: Indus, 1980), 188–89. See also Kramers, "Djughrāfiyā," 63 (note 19), and Reinaud, *Introduction générale*, CCXLV ff. (note 27).

66. Yamakoṭi appears in the Persian form Jamāgird in Arab texts. Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī shows that the latter stands for Jamakūṭ. Al-Bīrūnī also shows that Yamakoṭi means "castle of the Angel of Death," and the Persian for this is the term Kangdiz of Abū Maʿshar and others, which appears as an island where the town of Tāra or Bāra is situated. All seem to be used for the eastern prime meridian. Arab authors mentioning this Indian cosmological arrangement are usually using al-Bīrūnī (362/973 to after 442/1050) as a source, for this system is described in detail in his *Taʾrīkh al-Hind*; see *Alberuni's India: An Account of the Religion, Philosophy, Literature, Geography, Chronology, Astronomy, Customs, Laws and Astrology of India about A.D. 1030*, 2 vols., ed. Eduard Sachau (London: Trübner, 1888; Delhi: S. Chand, [1964]), 1:303–4. However, Abū Maʿshar used Kangdiz for his eastern meridian; the Cupola of the Earth appears in al-Battānī (d. 317/929) and in al-Masʿūdī (d. 345/956), *Murūj al-dhahab* (see *Les prairies d'or*, 1:181 [note 12]), while Arīn occurs in Ibn Rustah (see J. H. Kramers, "Geography and Commerce," in *The Legacy of Islam*, ed. Thomas Arnold and Alfred Guillaume [Oxford: Oxford University Press, 1931], 78–107, esp. 93). Al-Hamdānī also mentions the Cupola of the Earth in his *Ṣifat Jazīrat al-ʿArab*; see Müller's edition, *Geographie der arabischen Halbinsel*, 27 (note 63).

67. Honigmann, *Die sieben Klimata*, 126–27, 143, 153 (note 19). Comparative longitude could be measured using eclipses of the moon. Ptolemy knew this, as did Hipparchus before him, and al-Battānī was conversant with this method. The practical difficulties were considerable, however, and exactly how much work was done in this way is impossible to know; see Reinaud, *Introduction générale*, CCLVIII (note 27); Sprenger, *Die Post- und Reiserouten*, XII (note 63). Al-Battānī's efforts to determine longitude by eclipses are mentioned by Lelewel,

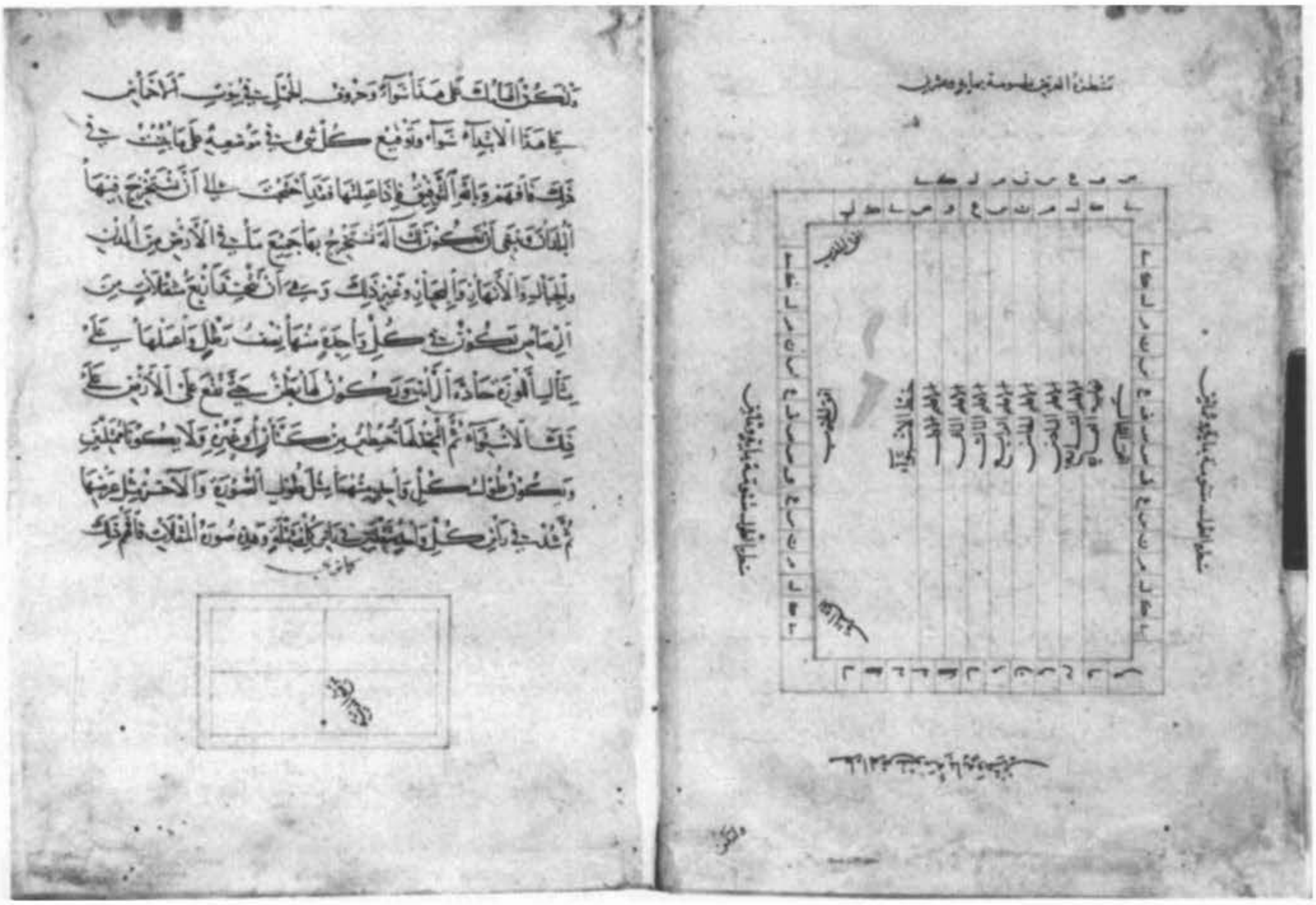

FIG. 4.7. SUHRĀB'S DIAGRAM FOR A WORLD MAP. This is from the manuscript in the British Library of the *ʿAjāʾib al-aqālīm al-sabʿah*. On the left is a diagram showing the way the threads are used to indicate the latitude and longitude, thereby finding the exact spot desired for the location on the map. The right side shows how the edges of the map are marked in divisions of ten degrees of latitude and longitude, the former from the equator poleward and the latter from the edges of the map to 90° in the center (this system disagrees with the values given in the tables). This diagram also indicates the equator and the climate boundaries.
Size of each folio: 31 × 22 cm. By permission of the British Library, London (Add. MS. 23379, fols. 4b–5a).

This ability of the Arabs to measure latitude and in some cases comparative longitude (from somewhere like Baghdad) enabled them—rightly or wrongly—to change in a haphazard manner values they had received from other sources, causing ultimate confusion in some of the later tables. Only when an author (like al-Bīrūnī) quoted several values for a place and named his actual sources was the confusion cleared up, but readers were left to choose their own values from the various ones provided.

The problem with most of the prime meridians is that they were situated in mythical places. Only Baghdad and the west point of Africa could actually be pinpointed, and the last was not known accurately by the Arabs.

Suhrāb's Construction of a Map

Al-Khwārazmī's tables are given in the extant manuscript without any form of explanation, but the tables are repeated in almost exactly the same form in the work of Suhrāb nearly one hundred years later.[68] Suhrāb gives an introduction in which he explains in detail how to draw a map of the world, and the tables that follow are linked to the introduction, showing that they are given in the form indicated for the precise purpose of drawing the map. That al-Khwārazmī's tables are in the same form shows the connection here between al-Khwārazmī and a similarly drawn map and is a strong indication that al-Maʾmūn's map was also of this form.

who points out that the corrected values do not appear in his tables; see Lelewel, *Géographie du Moyen Age*, epilogue, 97 (note 32).

68. Suhrāb, *ʿAjāʾib al-aqālīm al-sabʿah*, see the edition by von Mžik (note 48). See also Edward S. Kennedy, "Suhrāb and the World-Map of Maʾmūn," in *From Ancient Omens to Statistical Mechanics: Essays on the Exact Sciences Presented to Asger Aaboe*, ed. J. L. Berggren and Bernard R. Goldstein (Copenhagen: University Library, 1987), 113–19.

Suhrāb's construction of the map is illuminating. First he draws a rectangle, "the larger the better," and then he divides the edges into degrees and marks the equator and then the horizontal lines dividing the climates (fig. 4.7). But he makes no attempt to produce a more detailed graticule. The dimensions given for the map are 20°S to 80°N and 0° to 180°E.[69] To pinpoint his features on the map he uses a thread stretched due north and south at the longitude required, with another thread stretched due east and west at the required latitude. The feature could then be placed at the intersection of the threads. Features were inserted climate by climate down the map, but features on islands were to be left until the island itself had been inserted. According to the text, when drawing, east should be to the right and west to the left—that is, the north should be at the top—but the illustration in the text shows that most of the script is written as if north were nearest the reader. This may show that when Suhrāb originally wrote the text the Greek orientation with north at the top was regarded as the norm but that by the time of the actual manuscript, written in Arabic in the tenth century, the normal Islamic orientation had south at the top.

The rectangular projection is what one expects from Marinus and is the very form Ptolemy criticizes in the introduction to his *Geography*, the one part of Ptolemy's work that, as I mentioned before, for some reason never reached the Arabs. In the same way that Ptolemy criticized Marinus, both al-Bīrūnī and al-Zuhrī criticized the use of the rectangular projection, though al-Bīrūnī, like all Arab authors, remained unaware of Ptolemy's refinements.[70]

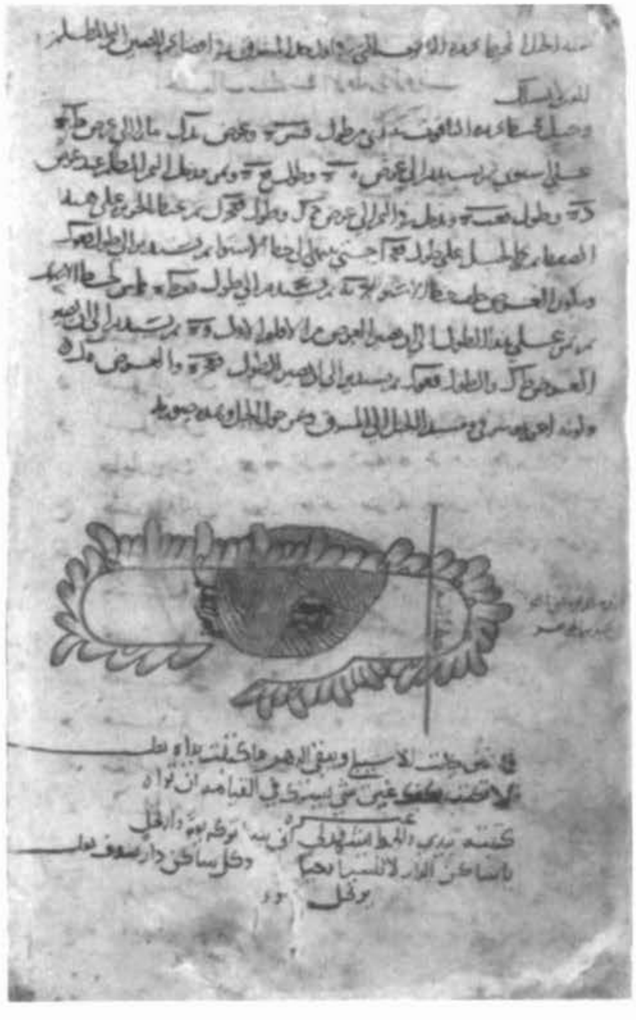

FIG. 4.8. THE ISLAND OF THE JEWEL, JAZĪRAT AL-JAWHAR, BY AL-KHWĀRAZMĪ. The equator runs through the right end.
Size of the folio: 33.5 × 20.5 cm. By permission of the Bibliothèque Nationale et Universitaire, Strasbourg (Cod. 4247, fol. 11b).

The Maps from the al-Khwārazmī Manuscript

The manuscript of al-Khwārazmī is accompanied by four maps.[71] Though they are only sketch maps and show limited areas of the world, they do appear in the manuscript against the relative texts and thus obviously belong. Most of the work consists of tables, but it breaks out occasionally into continuous prose, and the maps are of areas described in these continuous passages. It seems, therefore, that this particular manuscript was meant to have only four maps. It is never stated why these sketch maps are the only ones included. Were they regarded as sufficient examples to instruct the cartographer? There are also four blank pages in the text, and maps might have been available for these but were never drawn. However, they would most likely have been sketch maps of the same sort as those already there.[72]

The first map is the island of Yāqūt (sapphire)—Jawhar (jewel) on the map—in the Far East (fig. 4.8). This is a non-Ptolemaic feature that appears in al-Khwārazmī. The

69. Suhrāb's text has the same dimensional limits as the text of al-Khwārazmī, that is, 23°S to 63°N and 5°E to 176°E. On figure 4.7, the meridians are strangely marked from 0° to 90° from east and west toward the center.

70. For al-Zuhrī, see Hadj-Sadok's edition, "Kitāb al-Djaʿrāfiyya," 304 (note 24). Al-Bīrūnī's reference is from the *Taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin*, ed. P. G. Bulgakov and rev. Imām Ibrāhīm Aḥmad (Cairo: Maṭbaʿah Lajnat al-Taʾlīf, 1964), 233.

71. The maps appear in the Strasbourg manuscript of al-Khwārazmī on fols. 11v, 21r, 30v–31r, and 47r and are all reproduced by von Mžik, *Kitāb ṣūrat al-arḍ*, pls. 1–4 (note 31). All except the second are drawn with transcription in Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31), Band 1, Heft 1 (Bild 3, 4, and 5), with Miller's comments.

72. The four pages that are blank in the text are fols. 9v–10r, which make a double-page spread; 21v, which is the verso of one of the maps; and 29v. There is no continuous text near these pages.

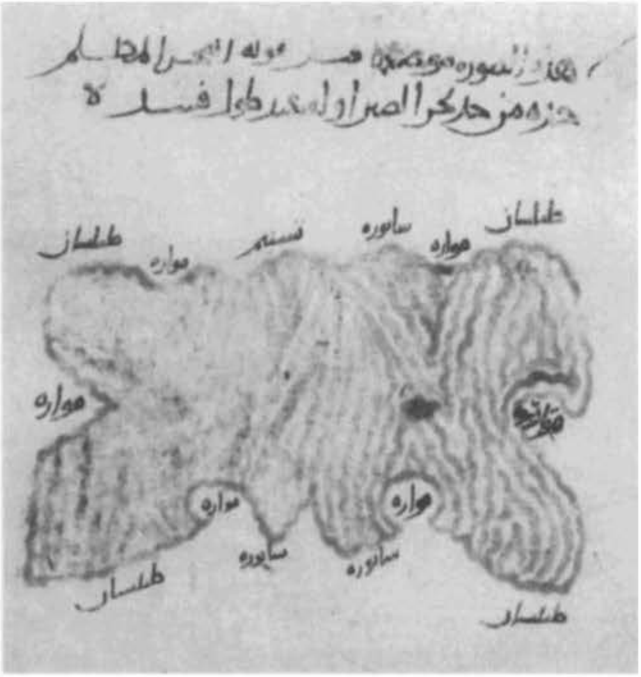

FIG. 4.9. THE WORLD OCEAN, AL-BAḤR AL-MUẒLIM, BY AL-KHWĀRAZMĪ.
Size of the folio: 30.5 × 20.5 cm. By permission of the Bibliothèque Nationale et Universitaire, Strasbourg (Cod. 4247, fol. 21a).

map has no detail, though it is finely drawn, whereas the text has a great deal of detail for the island that may be derived from Ptolemy's account of Taprobane, although there may be connections with places in the Alexander romance and even rumors of a jewel-bearing Ceylon.[73]

The second map deals with al-Baḥr al-Muẓlim, the World Ocean, and probably represents Ptolemy's Indian Ocean (fig. 4.9). No specific features are given, however. The words appearing on the map—each repeated several times—are of Persian origin and explain "convexities," "concavities," and similar terms. The next two maps are more realistic. The first of these is of the Nile (plate 4). The only place-names taken from Ptolemy are the Mountains of the Moon at the source and Alexandria at the mouth; the rest of the nomenclature is contemporary with al-Khwārazmī. There is no doubt that this representation of the Nile has affinities with that shown on Ptolemy's map.[74] The boundaries of the climates are also marked, but the distances between them do not agree with the figures given by Ptolemy or Suhrāb.[75] The final map is of the Sea of Azov, and this resembles Ptolemy's sea (Palus Maeotis) only vaguely (plate 5). Nevertheless, it does give the Greek toponyms—or rather, corruptions of them. The map, however, allowing again for corruptions, does give a fair, but not accurate, representation of the sea as given by al-Khwārazmī's tables.

Hans von Mžik thinks the maps belong to the manuscript, were placed there by the copyist, and do not go back to al-Khwārazmī. Even with the only manuscript dated 428/1037 and therefore almost two hundred years after al-Khwārazmī, these are still the earliest extant maps from the Islamic world. They are certainly more sketchy and nowhere near as confidently drawn as the earliest maps of the Balkhī school, which appear in 479/1086. This is an interval of less than fifty years, and one must assume that the extant Balkhī maps were the result of quite a few years of development. I therefore suggest that the design of these maps goes back a considerable way before the Strasbourg manuscript in which they appear, if not all the way to al-Khwārazmī. The maps would have been drawn more confidently by their original draftsman, and it appears that the copyist of the Strasbourg manuscript has copied the maps with the rest of the manuscript. None of the maps are drawn to scale using the methods dictated by Suhrāb—they are freehand sketches. It is just possible that the original manuscript written by or for al-Khwārazmī may have had more accurate drawings, but it is obvious that later scribes had no use for such maps.

Conclusion

In spite of all this activity, we have few artifacts to show, and it is doubtful there was much to show at the time. The ultimate outcome of all these tables of longitude and latitude was virtually nothing cartographic. We are given an inkling of cartographic production in the accounts of the map of al-Ma'mūn. We are shown in a roundabout way by al-Khwārazmī and in a more direct way by Suhrāb that some of the compilers of tables had a map in mind as the ultimate aim. Moreover, the tables may have been compiled from maps, so that the idea of a detailed map of the world was there even though there are no surviving examples from this early period up to the ninth century. The problem is that at a slightly later period, when maps were known to be used more by the Islamic literary public and when manuscript maps of the Balkhī school were popular, there is no sign that this earlier activity had any influence at all on the form of the map. Projections were not used, exact location of places was not desired, and the many non-Arab names that appear in all the tables are never shown on maps. Tables of coordinates continued to be copied and revised

73. See Tibbetts, *Arabic Texts Containing Material on South-east Asia*, 68 (note 5).

74. Al-Khwārazmī's map appears in the von Mžik edition, *Kitāb ṣūrat al-arḍ*, pl. 3 (note 31); it is also reproduced as a sketch in Miller, *Mappae arabicae*, Band 1, Heft 1, p. 12 (Bild 4) (note 71). Any early printed world map of Ptolemy can be used for comparison.

75. The terms Syene and Meroë connected with the climate boundaries in the Greek appear only as Aswān and Bilād al-Nuba in this map, but like Alexandria, they have no connection with the climate lines.

by astronomers and even by geographers throughout the whole period of classical Islamic literature, but no attempt to collate maps with tables has ever been found in the early period.

5 · The Balkhī School of Geographers

GERALD R. TIBBETTS

WORKS OF THE BALKHĪ SCHOOL

The earliest set of maps to survive from the corpus of Islamic cartography are those that accompany the text *Kitāb ṣūrat al-arḍ* (Picture of the earth) of Abū al-Qāsim Muḥammad ibn Ḥawqal in the manuscript dated 479/1086, found in the Topkapı Sarayı Müzesi Kütüphanesi in Istanbul.[1] Similar sets of maps occur in other manuscripts in Istanbul and in several well-known manuscripts in European libraries. The next in age is that from the Forschungsbibliothek in Gotha, dated 569/1173.[2] This manuscript, known as MS. Ar. 1521, contains a text of *Kitāb al-masālik wa-al-mamālik* (Book of routes and provinces) of Abū Isḥāq Ibrāhīm ibn Muḥammad al-Fārisī al-Iṣṭakhrī, and because it was published in facsimile by Moeller in 1839 it was better known to scholars in Europe than the copy from Istanbul.[3] Other manuscripts contain roughly the same maps and date from the twelfth century to the nineteenth. The relationship of the various sets of maps to each other is very complicated, as is the relationship of the texts that accompany them.

Most of the texts can be connected to one of the two authors mentioned above, either because their names are given in the manuscripts or because the text corresponds closely with other manuscripts that are named. Scholars have been very confused in the past, however, and even now the identity of some manuscripts is doubtful, since there are numerous anonymous abridgments and translations from the Arabic, mainly into Persian (see appendixes 5.1 and 5.2). A later author who used a version of the same maps was Abū ʿAbdallāh Muḥammad ibn Aḥmad al-Muqaddasī, and he was rather more forthcoming about himself and his predecessors, giving us some idea of the relation of each author to the next.[4]

All together, the efforts of various European scholars sorted matters out considerably, and finally the detailed work of de Goeje produced a scholarly edited text of the works of al-Iṣṭakhrī, Ibn Ḥawqal, and al-Muqaddasī that other scholars could use as a base for their research.[5] It also appeared that there was yet another author earlier than the three mentioned who seemed to be the originator of this type of work with maps attached, and that some of the extant manuscripts might represent his work. He was Abū Zayd Aḥmad ibn Sahl al-Balkhī (d. 322/934), a scholar whose background, though not his geographical work, was well known in the Arab literary milieu.[6] Since he was the earliest of these authors and the other authors admit they are indebted to him, this group has been referred to by European scholars as the Balkhī school of geographers.[7]

1. No. 6527 in Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Arapça Yazmalar Kataloğu*, 3 vols. (Istanbul: Topkapı Sarayı Müzesi, 1962–66), 3:581. Its shelf number, quoted by J. H. Kramers et al., is A. 3346. Other Topkapı Sarayı Müzesi manuscripts with maps are A. 3012 (6523), A. 3347 (6528), A. 3348 (6525), and A. 2830 (6524); see 3:580–81.

2. Wilhelm Pertsch, *Die orientalischen Handschriften der Herzoglichen Bibliothek zu Gotha*, pt. 3, *Die arabischen Handschriften*, 5 vols. (Gotha: Perthes, 1878–92), 3:142–44. The manuscript of Aḥmad al-Ṭūsī, which is earlier (see appendix 5.1), contains only six maps.

3. *Liber climatum*, ed. J. H. Moeller (Gotha: Libraria Beckeriana, 1839). This was translated into German and edited by Andreas David Mordtmann, *Das Buch der Länder* (Hamburg: Druck und Lithographie des Rauhen Hauses in Horn, 1845).

4. This will be discussed below.

5. Michael Jan de Goeje's editions of the three texts appear in his series Bibliotheca Geographorum Arabicorum, 8 vols. (Leiden: E. J. Brill, 1870–94): for al-Iṣṭakhrī, *Kitāb al-masālik wa-al-mamālik*, see vol. 1, *Viae regnorum descriptio ditionis moslemicae* (1870; reprinted 1927, 1967); for Ibn Ḥawqal, *Kitāb ṣūrat al-arḍ*, see vol. 2, *Opus geographicum* (1873), reedited by J. H. Kramers (1938; reprinted 1967); and for al-Muqaddasī, *Aḥsan al-taqāsīm*, see vol. 3, *Descriptio imperii moslemici* (1877; reprinted 1906, 1967). De Goeje's predecessors were William Ouseley, who produced a translation from a Persian redaction of al-Iṣṭakhrī that he called *The Oriental Geography of Ebn Haukal* (London: Wilson for T. Cadell and W. Davies, 1800), and Moeller, *Liber climatum* (note 3). See also Louis Amélie Sédillot, *Mémoire sur les systèmes géographiques des Grecs et Arabes* (Paris: Firmin Didot, 1842), Aloys Sprenger, *Die Post- und Reiserouten des Orients*, Abhandlungen der Deutschen Morgenländischen Gesellschaft, vol. 3, no. 3 (Leipzig: F. A. Brockhaus, 1864; reprinted Amsterdam: Meridian, 1962, 1971), and Joachim Lelewel, *Géographie du Moyen Age*, 4 vols. and epilogue (Brussels: J. Pilliet, 1852–57; reprinted Amsterdam: Meridian, 1966), who was a geographer and not an Orientalist.

6. D. M. Dunlop, "al-Balkhī," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 1:1003, George Sarton, *Introduction to the History of Science*, 3 vols. (Baltimore: Williams and Wilkins, 1927–48), 1:631, and see also the articles on maps ("Kharīṭa") and geography ("Djughrāfīya") by S. Maqbul Ahmad in the new edition of the *Encyclopaedia of Islam*, 4:1077–83 and 2:575–87, respectively.

7. The appellation "school" is justified here on the grounds that one scholar deliberately followed another.

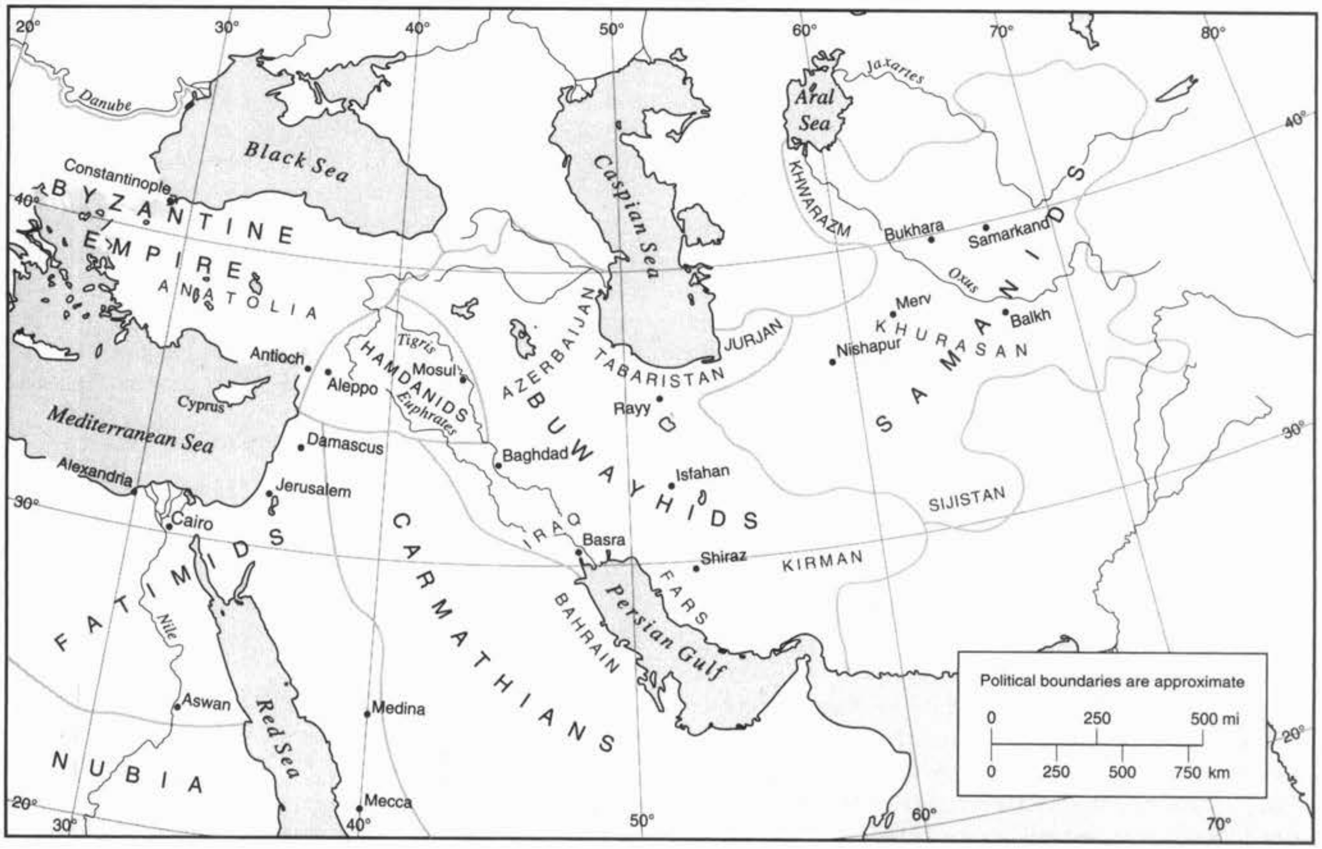

FIG. 5.1. REFERENCE MAP OF THE ISLAMIC WORLD AT THE TIME OF THE BALKHĪ SCHOOL.
After *The Cambridge History of Islam*, 2 vols., ed. P. M. Holt, Ann K. S. Lambton, and Bernard Lewis (Cambridge: Cambridge University Press, 1970), 1:155.

Al-Balkhī's work, according to al-Muqaddasī, was mainly a short commentary on a set of maps,[8] though other opinions state that al-Balkhī's work was the commentary and the maps were originally produced by Abū Jaʿfar Muḥammad ibn Muḥammad al-Khāzin (d. between 350/961 and 360/971).[9] It is all very suspect, however, since neither al-Khāzin's maps nor even the commentary of al-Balkhī, which was entitled *Ṣuwar al-aqālīm* (Pictures of the climates), have survived—only some of the earlier portions of al-Iṣṭakhrī's text can possibly be thought of as originating in the book of al-Balkhī. Al-Balkhī was primarily a general scholar and not necessarily a geographer. His life is known from the standard biographies. He was born and lived at the end of his life in Balkh in northeastern Iran, where he was supposed to have written his geographical treatise. Most of his life, however, he spent in Baghdad and Iraq, where his scholarly connections mostly belong (fig. 5.1).

Al-Iṣṭakhrī, by contrast, was virtually unknown apart from his one work. He does not appear in any of the standard Arab biographies, and all we know about him personally was his meeting with Ibn Ḥawqal, which is related in the latter's own book.[10] Even his work *Kitāb al-masālik wa-al-mamālik* can be dated only from internal evidence, to the middle of the tenth century A.D. It soon became popular, however, for there are many early

8. Al-Muqaddasī, *Aḥsan al-taqāsīm fī maʿrifat al-aqālīm*; see *Aḥsanu-t-taqāsīm fī maʿrifati-l-aqālīm*, ed. and trans. G. S. A. Ranking and R. F. Azoo, Bibliotheca Indica, n.s., nos. 899, 952, 1001, and 1258 (Calcutta: Asiatic Society of Bengal, 1897–1910), 6, and *Aḥsan at-taqāsīm fī maʿrifat al-aqālīm*, trans. André Miquel (Damascus: Institut Français de Damas, 1963), 14.

9. The theory about al-Khāzin comes from an alternative reading from Ibn al-Nadīm's *al-Fihrist* (see *Kitâb al-Fihrist*, 2 vols., ed. Gustav Flügel [Leipzig: F. C. W. Vogel, 1871–72], 1:138 n. 24) and is explained by V. V. Bartol'd in his preface to *Ḥudūd al-ʿālam: "The Regions of the World,"* ed. and trans. Vladimir Minorsky (London: Luzac, 1937; reprinted Karachi: Indus, 1980), xv, 18. Al-Khāzin's dates do not compare easily with those of al-Balkhī. See also Sprenger, *Die Post- und Reiserouten*, preface, XIII–XIV (note 5).

10. Information can be found in André Miquel, "al-Iṣṭakhrī," in *Encyclopaedia of Islam*, new ed., 4:222–23. There is a brief note (unsigned) in the first edition of *The Encyclopaedia of Islam*, 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), 2:560, and also in Sarton, *History of Science*, 1:674 (note 6). The reference from Ibn Ḥawqal comes from his chapter on Sind; see Kramers's edition of *Ṣūrat al-arḍ*, 329–30 (note 5).

editions, abridgments, and translations into Persian, often differing considerably from each other.

Ibn Ḥawqal's life has come down to us in much more detail than al-Iṣṭakhrī's, mainly because he was more open about himself in his book. He was born in Nisibis in Upper Mesopotamia and spent much of his life traveling, setting out on 15 May 331/943 and continuing on and off until 362/973, when he last appears in Sicily. Between these dates he covered most of Islamic Africa and large areas of Persia and Turkestan. It is possible that he acted as a trader on his travels, since his work is full of facts relating to economic activity. That he extols the Fatimid religious policy may mean he was a *dāʿī* or missionary of that sect, and this would be another reason for his moving constantly from place to place. Apart from a short work on Sicily, he is known only for his one geography book, *Kitāb ṣūrat al-arḍ*, also known as *Kitāb al-masālik wa-al-mamālik*, like that of al-Iṣṭakhrī.[11]

A fourth author belonging to the Balkhī school was al-Muqaddasī (d. ca. 390/1000).[12] Very little is known of his life apart from what he tells us himself, but his origin is presumably Jerusalem, and he was in Mecca in 356/966. He seems to have come from a family of architects. Since he is a native of Palestine, his work is geared to some extent to the western part of the Islamic empire, but the authors he quotes are from the east. He himself is not well known in Arab literature, but he is quoted by some of the later geographers.

The texts of the first three authors are so mixed up in the surviving manuscripts that it is difficult to disentangle them. As I have pointed out, de Goeje attempted to sort out this problem when he produced his critical texts of the work of al-Iṣṭakhrī and Ibn Ḥawqal. Al-Balkhī's work occurs only embedded in the texts of the other two, and it is impossible to distinguish exactly what is derived from him. Al-Muqaddasī states that he had seen three manuscripts of al-Balkhī's work, one mentioning no author (though it was attributed to al-Kharkhī) and another attributed to al-Iṣṭakhrī,[13] so that even within one hundred years the exact authorship was difficult to unravel. It seems that al-Balkhī's text was filled out by al-Iṣṭakhrī and that all the miscellaneous abridgments that exist, whether in Arabic, Persian, or Turkish, are only abridgments of al-Iṣṭakhrī and never al-Balkhī originals.[14] According to de Goeje, quotations given by other later authors as coming from al-Balkhī can all be found in al-Iṣṭakhrī's text.[15] De Goeje thought that al-Muqaddasī may have seen a text of al-Balkhī, but certainly Yāqūt (d. 626/1229), when he quotes al-Balkhī, uses the text we know as al-Iṣṭakhrī.[16] De Goeje also thought that al-Iṣṭakhrī compiled a much enlarged version of al-Balkhī's text between A.H. 318 and 321 (A.D. 930–33).[17] A final version of al-Iṣṭakhrī came later, about 340/951, and this seems to be the basis of most copies circulating in the eastern part of the empire.[18] Quotations appear in later authors that are not in al-Iṣṭakhrī's actual text, but some of these missing quotations are found in some of the later abridgments and Persian translations.[19] Soon after his book was completed, al-Iṣṭakhrī met Ibn Ḥawqal, who at the author's request undertook to revise the text. The results of this revision appear in the work of Ibn Ḥawqal, which follows al-Iṣṭakhrī closely.[20] Ibn Ḥawqal became carried away with his own improvements, however, and inserted miscellaneous information relating to his own travels, so that the work becomes much more than a mere revision and stands as a work in its own right (fig. 5.2).[21]

The main difference between the work of Ibn Ḥawqal and that of al-Iṣṭakhrī is in the former's discussion of the western (formerly Byzantine) part of Islam. He treats Spain, North Africa, and Sicily as three separate sections. Syria and Egypt are dealt with in more detail, and it is interesting that when later authors like Yāqūt quote Ibn Ḥawqal they are almost always referring to these western regions.

Ibn Ḥawqal's text as we know it today is again the result of three versions—a first redaction from about 350/961 dedicated to the Hamdanid Sayf al-Dawlah (d. 356/967), a second redaction containing criticism of the Hamdanids from about a decade later, and a final definitive version from about 378/988.[22]

11. Information on Ibn Ḥawqal can be found in C. van Arendonk, "Ibn Ḥawḳal," in *Encyclopaedia of Islam*, 1st ed., 2:383–84, and in the new edition by André Miquel, 3:786–88. See also Juan Vernet Ginés, "Ibn Ḥawqal," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 6:186, and Sarton, *History of Science*, 1:674 (note 6).

12. Al-Muqaddasī means "the man from Jerusalem," and an alternative form, al-Maqdisī (meaning the same), is used by some nineteenth-century scholars. Since there are other authors with the same name, there can be some confusion.

13. Al-Muqaddasī, *Aḥsan al-taqāsīm*; Miquel's translation, 14–15 (note 8), Ranking and Azoo's translation, 7 (note 8).

14. Konrad Miller has attributed four manuscripts to al-Balkhī, on what grounds is not known; see his *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31), Band 1, Heft 1, 17, and Band 5, 109.

15. Michael Jan de Goeje, "Die Istakhrī-Balkhī Frage," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 25 (1871): 42–58, esp. 47, noted in Bartol'd's preface to the *Ḥudūd al-ʿālam*, 19 (note 9).

16. De Goeje, "Die Istakhrī-Balkhī Frage," 46 and 52 (note 15), and Yāqūt, *Kitāb muʿjam al-buldān*; see *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld (Leipzig: F. A. Brockhaus, 1866–73), 2:122.

17. De Goeje, "Die Istakhrī-Balkhī Frage," 50 (note 15).

18. De Goeje, "Die Istakhrī-Balkhī Frage," 51 ff. (note 15).

19. An example is given by Bartol'd in his preface to the *Ḥudūd al-ʿālam*, 22 (note 9).

20. Miquel, "al-Iṣṭakhrī," 4:223 (note 10).

21. Miquel, "Ibn Ḥawḳal," 3:787 (note 11).

22. Miquel, "Ibn Ḥawḳal," 3:787 (note 11).

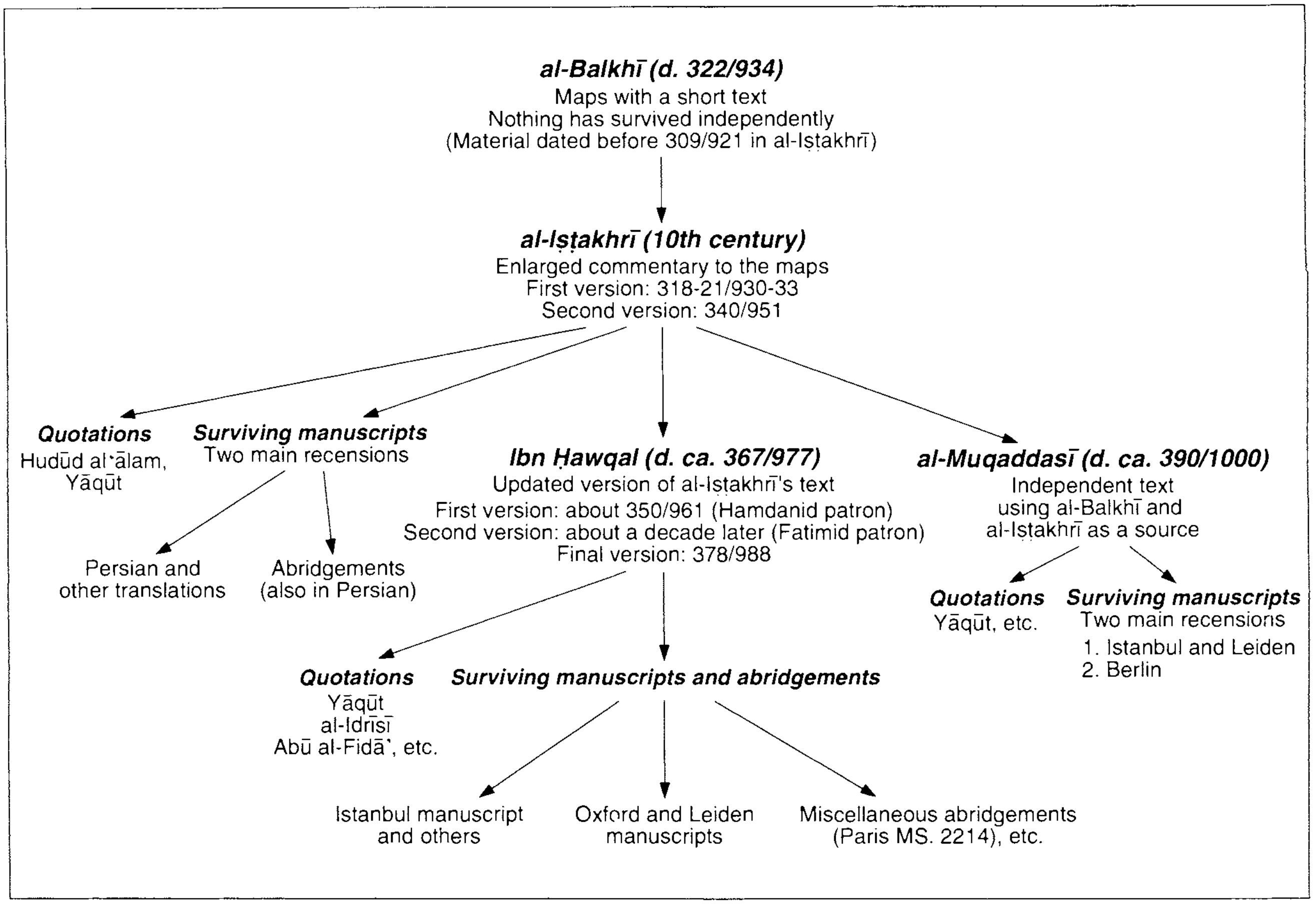

FIG. 5.2. STEMMA OF THE TEXTS OF THE BALKHĪ SCHOOL. See and compare also appendix 5.1.

There are only two early manuscripts of al-Muqaddasī's book, entitled *Aḥsan al-taqāsīm fī maʿrifat al-aqālīm* (The best of divisions on the knowledge of the provinces); both were used by de Goeje in producing the printed edition of his text. They are very close in content, but one is aimed at the Samanids as patrons and the other at the Fatimids of Egypt.[23] There therefore seem to be two attempts emanating from the author, perhaps from different dates. The text dates itself 375/985, but later information is included.

Al-Muqaddasī's text was based on the same principles as the texts of al-Iṣṭakhrī and Ibn Ḥawqal, and it covers, in the same way, only the area of the Islamic empire. Similarly, his maps are recognizably from the same mold as those of the earlier authors. The book, however, shows considerable variation from the pattern established. For instance, he includes a section on astronomical geography giving the Greek idea of the climates based on the length of the noonday shadow.[24] He has more detail, especially about those districts he has traveled through. There are detailed passages on large towns, with their population and products; there are sections in the introduction on place-names, rivers and seas, capital towns, and the dimensions of the Islamic empire as well as other things. In fact, this work is probably the most advanced of all surviving Arab geographical works. Basically its form is inherited from al-Iṣṭakhrī. The regional divisions are more or less the same, and each region has its basic map. The region is also known as a climate (*iqlīm*), and this idea clashes with the idea of the Greek climates mentioned above as appearing in his introduction.[25] Each regional area is described and then summarized under subject headings, and finally routes with their distances are given in the manner of al-Iṣṭakhrī and Ibn Ḥawqal.

23. Editions and translations of al-Muqaddasī's work are given in appendix 5.2, and manuscripts are listed in appendix 5.1. Of the two recensions, the earlier is connected with the Samanids (manuscripts from Istanbul and Leiden) and the later with the Fatimids (manuscripts from Berlin).

24. Al-Muqaddasī, *Aḥsan al-taqāsīm*; Miquel's translation, 125–36 (note 8), Ranking and Azoo's translation, 98–103 (note 8).

25. See also pp. 93–94.

THE MAPS OF THE BALKHĪ SCHOOL

The maps accompanying these texts seem at first sight to be a not entirely necessary supplement to the texts, the text being so complete in itself. This is often so with illustrative material in classical Arab texts, certainly with maps in some later geographical works. Some manuscripts of the works I am discussing have no maps at all, and some have spaces left for them in the text, though none have been inserted. However, there is every evidence that these authors were definitely, if not primarily, interested in the maps and designed their own maps even if they did not draw them themselves. According to al-Muqaddasī, al-Balkhī "intended in his book chiefly the representation of the earth by maps. . . . He described each map [only] briefly without giving useful particulars or setting forth clearly or in order the facts which were worth knowing." He also states that al-Balkhī's book is "a book with very carefully prepared maps, but confused in many places and superficial in its commentaries, and it does not divide the provinces into districts."[26] This makes it appear that al-Balkhī's main interest was in the maps, which were the important items while the text was secondary. Al-Iṣṭakhrī's work was still a commentary on the maps, and he states that "our plan is to describe, and to delineate on maps, the various seas, . . . affixing the name of each, so that it may be known in the maps,"[27] thus showing the importance he placed on the maps. The cartography, therefore, was still the essential element in the work.

He was also interested in the composition of the maps, and at his meeting with Ibn Ḥawqal they compared their maps. Ibn Ḥawqal states that al-Iṣṭakhrī

> had drawn a map of Sind, but he had made some mistakes, and he had also drawn Fars, which he had done extremely well. For my part, I had drawn the map of Azerbaijan which occurs on the following page and of which he approved, as well as that of al-Jazirah which he considered excellent. My map of Egypt, however, he condemned as wholly bad and that of al-Maghrib as for the most part inaccurate.

Because he states in the text that the map "occurs on the following page," he lets it be known that the map the reader sees is the one he drew himself.[28]

Ibn Ḥawqal himself seems originally to have wished to produce a set of maps,[29] but he was carried away by his commentary, and this becomes much more voluminous and interesting than that of al-Iṣṭakhrī, while to the ordinary reader the map loses its importance because of its inadequacy. All this shows, however, that the map is linked directly to the scholar in each case and not added by the copyist, as are many illustrations to manuscript books or even early printed books, which thus had a completely different provenance than the text.

Ibn Ḥawqal goes one stage further than al-Iṣṭakhrī. In addition to his text on a particular region, he also inserts a section that describes the map literally in the simplest terms. Whether this is meant to be an aid for the cartographer is difficult to say. This description can be understood only in conjunction with the map itself and does not add to the information in the main text. The section can easily be deleted without affecting the rest of the text. An example from the section on Kirman begins:

> Explanation of the names and legends that are found on the map of Kirman. The sea appears at the top of the map; to the right of this is [the legend] "The map of Kirman," then in the corner the word "West" while in the corner on the left is the word "South." Then there begins to the extreme right of the sea, going down [the page] an inscription, stretched out round the three sides of the map which says "Boundary of Kirman . . ."[30] (and see figs. 5.4 and 5.5 below).

What one really wishes to know is how close to the original version of these scholars is the map we see in a manuscript produced several centuries after the death of the scholar himself. This is very difficult, since probably only one of the manuscripts now extant was produced within two hundred years of the original map it was taken from. Kramers, however, has attempted to classify the surviving manuscripts using the state of the maps as his criterion.[31] This he finds fits the state of the text as well and agrees with the comments de Goeje made about them.

Kramers finds that the texts presumed to be by al-Iṣṭakhrī can be divided into two groups, and he regards one as earlier in origin. In this earlier group (Iṣṭakhrī I), the maps are more geometric than the later ones (Iṣṭakhrī II), while the text that goes with the later maps is more finished and polished. On the other hand, it is the earlier texts that mention the name al-Iṣṭakhrī, so that Miller attributes the anonymous (Iṣṭakhrī II) texts to al-Balkhī, presuming wrongly that they are earlier than the others.[32] Miller, however, gives no criteria for his decision. De

26. Al-Muqaddasī, *Aḥsan al-taqāsīm* (appendix 5.2); see de Goeje's edition, 5 n. a (note 5), Miquel's translation, 14 (note 8), and Ranking and Azoo's translation, 6 (note 8).

27. Ouseley, *Oriental Geography of Ebn Haukal*, 2 (note 5).

28. Ibn Ḥawqal, *Ṣūrat al-arḍ*; see Kramers's edition, 329–30 (note 5), J. H. Kramers, trans., and G. Wiet, ed., *Configuration de la terre (Kitab surat al-ard)*, 2 vols. (Paris: G. P. Maisonneuve et Larose, 1964), 2:322.

29. Miquel, "Ibn Ḥawḳal," 3:787 (note 11).

30. Ibn Ḥawqal, *Ṣūrat al-arḍ*; see Kramers's edition, 305 (note 5), Kramers and Wiet's edition, 2:301 (note 28).

31. J. H. Kramers, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal et l'Atlas de l'Islam," *Acta Orientalia* 10 (1932): 9–30.

32. Kramers, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal," 14–15 (note 31), and Miller, *Mappae arabicae*, Band 1, Heft 1, 17, and Band 5, 109 (note 14). The four manuscripts Miller gives as having maps by al-Balkhī

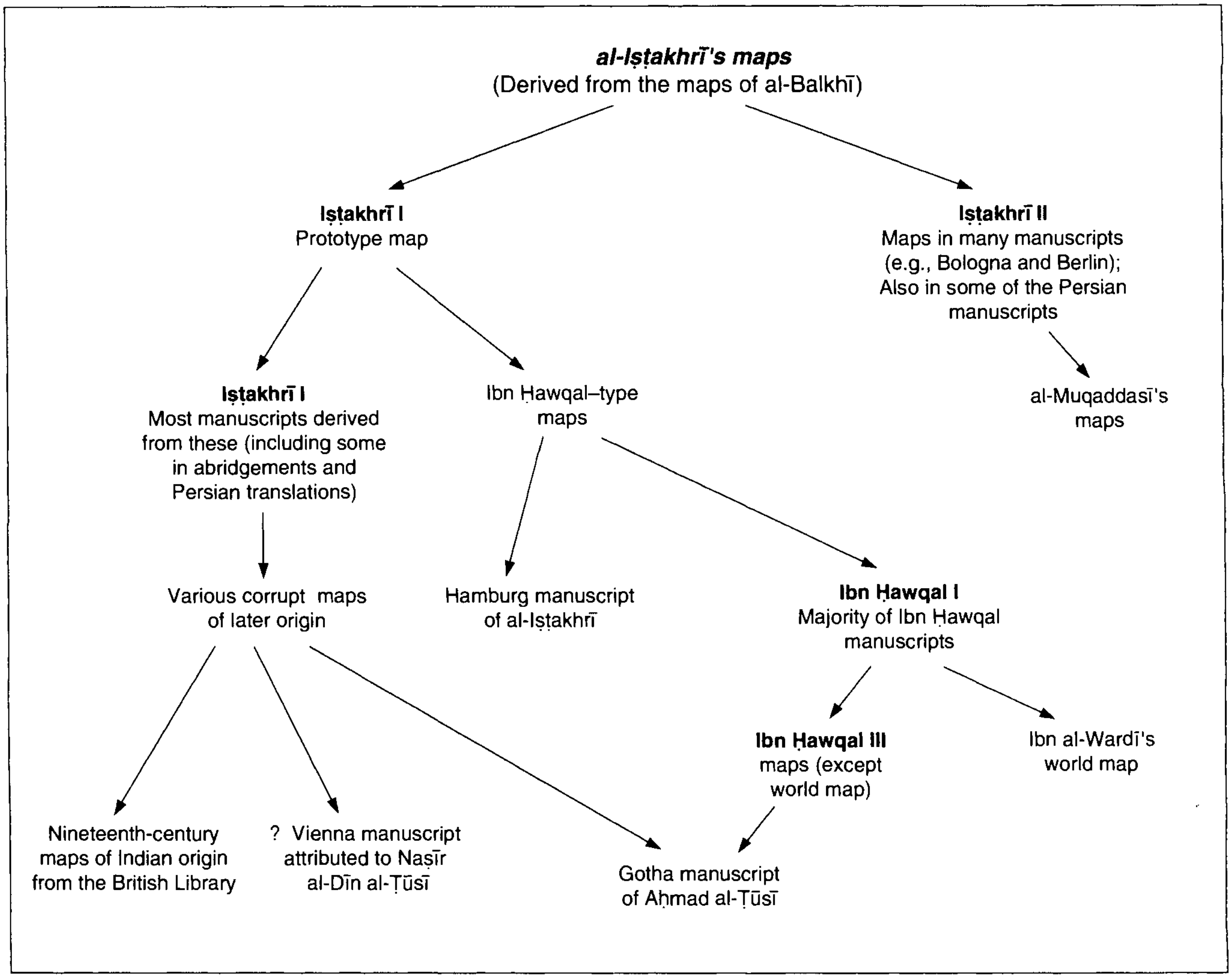

FIG. 5.3. POSSIBLE STEMMA FOR THE MAPS OF THE BALKHĪ SCHOOL. See and compare also appendix 5.1.

Goeje bases his printed edition of al-Iṣṭakhrī on these Iṣṭakhrī II texts mainly because they are more complete and less mutilated.

Kramers has also classified the texts attributed to Ibn Ḥawqal in the same way. Things here are a little more complicated, however, since the two best manuscripts contain blank pages where the maps should be. These are the Leiden and Oxford manuscripts, which have practically identical texts.[33] A manuscript in the Topkapı Sarayı Müzesi in Istanbul contains a very complete text, and this is accompanied by a set of maps, while the abridged Ibn Ḥawqal from the Bibliothèque Nationale, Paris, has a set of maps that are very different from those of Istanbul and are obviously a later development.[34] Comparing the text of the Istanbul manuscript with those of Oxford and Leiden, Kramers concludes that the Istanbul manuscript represents an earlier version of Ibn Ḥawqal (I) and the other two manuscripts (without maps) a later version (II). The maps of the Paris abridgment, however, he regards as a great improvement on those of Istanbul, so that he identifies this manuscript as a later version of Ibn Ḥawqal's work (III) even though the text may hark back to an original that is earlier than the Istanbul text.[35] He therefore has three recensions of Ibn Ḥawqal, the middle

are: (1) Hamburg, Staats- und Universitätsbibliothek, Cod. Or. 300 (dated 1086/1675); (2) Bologna, Biblioteca Universitaria di Bologna, Cod. 3521, undated but related closely to 3; (3) Berlin, Staatsbibliothek Preussischer Kulturbesitz, Orientabteilung, MS. Sprenger 1 (Ar. 6032) (dated 1840), both 2 and 3 from a copy of 589/1193; and (4) London, British Library, MS. Or. 5305.

33. Leiden, Bibliotheek der Rijksuniversiteit, Cod. Or. 314, and Oxford, Bodleian Library, MS. Huntington 538 (MS. Or. 963).

34. The Topkapı Sarayı Müzesi Kütüphanesi manuscript is the one mentioned in the first paragraph of this chapter, A. 3346. The Paris manuscript is Bibliothèque Nationale, MS. Arabe 2214.

35. Kramers, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal," 16–20 (note 31).

one having no maps to show us. The maps of other manuscripts from Istanbul, which Kramers saw, seemed to fit into the same categories of his divisions I and III. Thus there are two versions of the maps that accompany Ibn Ḥawqal's text, an earlier and a later. All together, in the Balkhī–Iṣṭakhrī–Ibn Ḥawqal set of writings, we have four distinct recensions of what is basically one set of maps (fig. 5.3). For these I shall follow Kramers's example and call the four types Iṣṭakhrī I, Iṣṭakhrī II, Ibn Ḥawqal I, and Ibn Ḥawqal III. The manuscripts of Ibn Ḥawqal III, though all undated, are much later than the other texts, probably from the late thirteenth or early fourteenth century A.D. The regional maps are nevertheless copies of the earlier versions. The world map of Ibn Ḥawqal III, however, is so different from the other world maps that it warrants special treatment in chapter 6.

Description of the Maps

This set in most cases comprises twenty-one maps, although some manuscripts lack a map or so.[36] The consistency with which the same set of maps appears in so many manuscripts and with several different authors led Miller to call the set the "Islam-atlas," and it has been called this by several other scholars. The set consists of a world map, maps of the three seas—the Mediterranean, the Persian Sea (Indian Ocean), and the Caspian Sea—and maps of seventeen "provinces" of the Islamic empire. I place the word "provinces" in quotation marks because in some cases provinces are linked together in one map (Azerbaijan, Armenia, etc., and Spain and the Maghreb) and because the Persian Desert is hardly a province. The word the texts use for "province" is *iqlīm*, from the Greek κλιμα, a word that reaches Arabic through the translation of Ptolemy. The word was used first to translate the Persian *kishvar*, which was a specific geographical region, and hence comes the present usage.[37] A complete list of these maps in the order usually found in a manuscript is as follows: (1) world map; (2) Arabia; (3) Indian Ocean; (4) al-Maghrib (North Africa); (5) Egypt; (6) Syria; (7) Mediterranean Sea; (8) al-Jazirah (Upper Mesopotamia); (9) Iraq (Lower Mesopotamia); (10) Khuzistan; (11) Fars; (12) Kirman; (13) Sind; (14) Armenia, Arran (Alvan), and Azerbaijan; (15) Jibal (central Persian mountains); (16) Daylam and its neighbors (Rayy, Tabaristan); (17) Caspian Sea; (18) Persian Desert; (19) Sijistan; (20) Khurasan; (21) Transoxiana.[38] The thirteen maps that represent the Persian-speaking provinces of the Islamic empire are fairly consistent in form throughout all the manuscripts. Their form was stereotyped by the time of the first al-Iṣṭakhrī recension, and Ibn Ḥawqal seems to have found no need to change these maps. Even Azerbaijan and al-Jazirah, of which Ibn Ḥawqal produced good versions approved by al-Iṣṭakhrī, do not seem to have changed much through the recensions. It is therefore appropriate to describe these maps of the Iranian area and then use them as a standard for the rest of the set.

The maps of each of these regions consist of an area that is roughly rectangular and usually, although not always, surrounded by a line representing its boundary with the surrounding areas. There is no projection to form the base of the map. The maps cannot be joined together as a multisheet map like the sectional maps of al-Idrīsī.[39] Even if they are reduced to the same scale, this cannot be done as it can for the sectional maps of the European edition of Ptolemy. The maps are thus individual entities and are seen as such by the draftsman.

Selection of Material

This set of maps does not cover the whole world as do the sectional maps of al-Idrīsī that follow in the twelfth century and the texts of the earlier geographers like Ibn al-Faqīh or Ibn Khurradādhbih. These latter include considerable detail on China and India and give some account of Africa and Europe. The Balkhī maps specifically cover the Islamic empire as it appeared in the tenth century. Even Spain has no separate map and is omitted in the text, though it was Muslim at the time. It was, of course, never part of the Abbasid Empire. Inside the Dār al-Islām each province is then given its own map and a description that forms an individual chapter dealing systematically with towns, rivers, mountains, and inhabitants, followed by itineraries throughout the province. S. Maqbul Ahmad has a theory that this Islamicization of the maps and geography was a deliberate policy developing away from the work of the earlier al-Ma'mūn type of geographer, which, based mainly on Ptolemy, covered the whole of the known world.[40]

Besides this policy of portraying only the areas of the Abbasid caliphate at its greatest extent, it is further obvious that there is a bias toward things Iranian: so much so that Kramers has suggested there may have been old

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36. The manuscripts from Hamburg and Bologna have a complete set as I have described them, as do also the Gotha MS. Orient. P. 36 and the set of maps in the Vienna manuscript, Österreichische Nationalbibliothek, Cod. Mixt. 344 (Flügel 1271). This was the number of maps mentioned by al-Muqaddasī belonging to the set produced by al-Balkhī; see Ranking and Azoo's translation, 6 (note 8), Miquel's translation, 14 (note 8).

37. See chapter 4.

38. A list is given by Miller, *Mappae arabicae*, Band 1, Heft 1, 23 (note 14), giving the best-known manuscripts outside Istanbul and the actual maps they contain. He also gives reproductions of all the maps from all the main manuscripts.

39. See below, pp. 162–63, esp. fig. 7.6.

40. Ahmad, "Kharīṭa," 4:1079, and also Ahmad, "Djughrāfīya," 2:581–82 (note 6).

Iranian maps that are the basis of these Balkhī maps.[41] There is no evidence for the existence of the former, but the maps may ultimately be based on early lists of postal routes surviving from Sassanid times. These lists may perhaps also be seen as the origin of the lists of Islamic postal routes found in the works of the *al-Masālik wa-al-mamālik* type. The Iranian bias also appears in the contents of the set of maps. The Iranian area is divided systematically into areas for mapping, whereas the areas the Arabs conquered from the Byzantines were treated in a much less systematic way. This may, however, reflect the administrative situation in the two empires that preceded the Islamic empire at the time when the Arab conquest took place. Al-Balkhī and al-Iṣṭakhrī were both patronized by the Samanid rulers of Persia, and the emphasis is very much on the Iranian area.[42]

Ibn Ḥawqal's interest was much more in the Mediterranean area, and his first patron was the Hamdanid Sayf al-Dawlah of Syria. Later his Fatimid interests predominated, and the center of Fatimid interests was always the Mediterranean.[43] In his maps the real innovations occur in these regions. The map of the Maghreb is itself really a detailed map of the Mediterranean (he refers to this fact in his text when describing the map).[44] The Mediterranean map is little more than a reduced version with little detail, and of course the Nile area has been completely redrawn in the map of Egypt.[45]

Al-Iṣṭakhrī and Ibn Ḥawqal show no interest in projections or mathematical astronomy. Neither do they mention longitude and latitude in any form, or any sort of map construction. They both give distances between places on their routes (*marḥalah* = day's journey), and they add these up roughly to give the dimensions of the inhabited world. These distances are not recognizable on the map, however. It therefore does not seem that the authors envisaged any kind of formal scale at all in constructing these maps.

Each map consists of a set of geometric configurations. Though some are more geometric than others, most lines are straight or arced, rivers are wide parallel lines, and lakes are often perfect circles. Towns are sometimes squares, circles, or four-pointed stars or, if they are stopping places on a straight route, resemble small tents or perhaps doors to caravansaries. Thus much of the drafting is ruled with either a straight or a curved edge. The only exceptions are mountains, which are drawn as a collection of peaks or perhaps piles of rocks, though even here the base, which probably represents the position of the range on the map, is a straight line or a regular curve.[46]

The basic purpose of the maps (especially those of the Persian-speaking areas) seems to be to incorporate the caravan routes across the province, with all the stages marked. This is most noticeable on the map of the Khurasan Desert, where the boundary of the desert is given with the bordering villages and oases marked around it. Straight lines then join those places on opposite sides where traffic flows, and the name of the route is written on the line so drawn.[47]

The Treatment of the Persian Provinces

A good example of a map from the Persian-speaking areas is that of Kirman, a province in the southeast of Persia (figs. 5.4 and 5.5).[48] This is a simple and clear example of one of these maps that can be described without great complication. However, any attempt at description is bedeviled because few of the place-names still exist, and a comparison with a modern map (fig. 5.6) reveals very little. Of the five main towns and district centers of Kirman in the tenth century, Sirjan, Jiruft, Narmashir, Bardashir (now the town of Kirman), and Bamm, only the last two exist as inhabited towns. The first two survive as district names only, yet Sirjan, the former capital, was larger than Shiraz in its heyday.[49]

The top (south) of the map in figures 5.4 and 5.5 shows a crescent shape representing the sea (Persian Gulf). The left (east) side, a straight line, is the border with Sind. The bottom (north), again a straight line, is the border with the desert of Khurasan and Sijistan. The right (west) side is more elaborate, being made of three straight lines, and represents the border of Fars. It is interesting that on the map of Fars the Kirmani border has the same

41. J. H. Kramers, "Djughrāfiya," in *Encyclopaedia of Islam*, 1st ed., suppl., 61–73, esp. 65.

42. Kramers, "Djughrāfiya," 66 (note 41). Also the following articles in the new edition of *Encyclopaedia of Islam*: Dunlop, "al-Balkhī," 1:1003 (note 6); and Miquel, "al-Iṣṭakhrī," 4:223 (note 10).

43. Miquel, "Ibn Ḥawkal," 3:787 (note 11).

44. Kramers's edition of Ibn Ḥawqal, *Ṣūrat al-arḍ*, 62–66 and plate (note 5), Kramers and Wiet's edition, 1:59–62 and pl. 4 (note 28). The reduced map appears in the section on the Mediterranean, text 190–205 and pl., translation, 1:187–200 and pl. 8.

45. Kramers's edition, 132–35 and pl. (note 5), Kramers and Wiet's edition, 1:131–33 and pl. 5 (note 28).

46. André Miquel, *La géographie humaine du monde musulman jusqu'au milieu du 11ᵉ siècle*, vol. 2, *Géographie arabe et représentation du monde: La terre et l'étranger* (Paris: Mouton, 1975), 19–20, has mentioned these geometric shapes and inferred that there are reasons for using such shapes. However, the various manuscripts have not kept rigidly to the same shape, and there is no way of reproducing the original shapes used by the authors for the map.

47. For the Khurasan Desert, see the reproductions of this map in Miller, *Mappae arabicae*, Band 4, Beiheft, Taf. 48–51 (Wüste) (note 14).

48. The Kirman section of the text appears in al-Iṣṭakhrī, *Kitāb al-masālik wa-al-mamālik*; see the edition by Muḥammad Jābir ʿAbd al-ʿĀl al-Ḥīnī (Cairo: Wizārat al-Thaqāfah, 1961), 97–101, and in Ibn Ḥawqal, *Ṣūrat al-arḍ*, Kramers's edition, 305–15 (note 5).

49. Also in Miller, *Mappae arabicae*, Band 3, Beiheft, Taf. 31–33 (note 14).

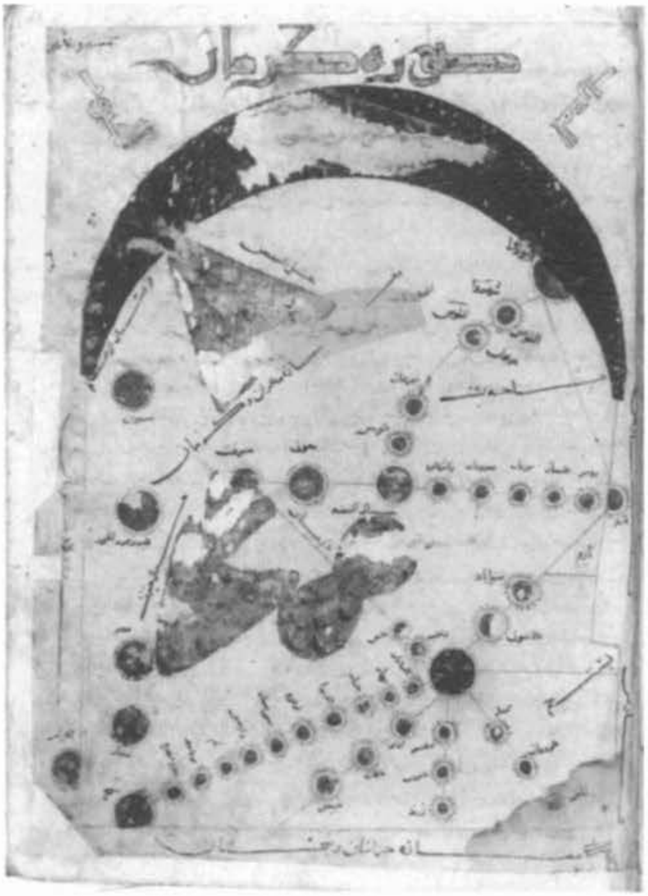

FIG. 5.4. KIRMAN ACCORDING TO IṢṬAKHRĪ I. This example is taken from the Leiden manuscript (see also fig. 5.5). North is in the lower right corner.
Size of the original: 42 × 30 cm. By permission of the Bibliotheek der Rijksuniversiteit, Leiden (MS. Or. 3101, p. 63).

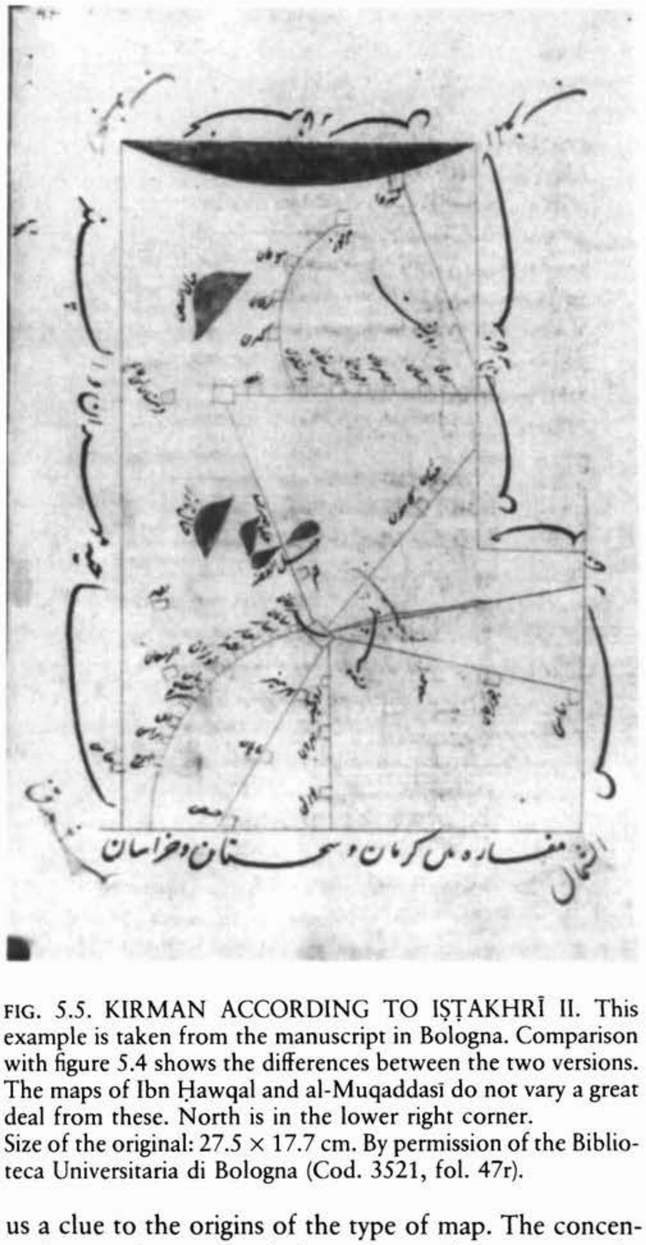

FIG. 5.5. KIRMAN ACCORDING TO IṢṬAKHRĪ II. This example is taken from the manuscript in Bologna. Comparison with figure 5.4 shows the differences between the two versions. The maps of Ibn Ḥawqal and al-Muqaddasī do not vary a great deal from these. North is in the lower right corner.
Size of the original: 27.5 × 17.7 cm. By permission of the Biblioteca Universitaria di Bologna (Cod. 3521, fol. 47r).

kink, but the angles and dimensions do not correspond. It is not possible to make a "fit." Just inside Kirman on the eastern side are two crescent-shaped areas looking like arcs of a circle on most manuscripts. These are two mountain ranges, while toward the interior from these are several small mountain groups, a partial selection from a very mountainous area. Most of the province is made up of routes starting in the north, radiating out from the capital of Sirjan. All these are difficult to follow, since the present-day road system bears no resemblance to this at all. The modern routes are based on the new capital, Kirman, which is on the main route from northeastern Iran (via Yezd) toward Sind and India—a route that is not represented on the al-Iṣṭakhrī maps at all, though it must have been centuries old. It is interesting that Ibn Khurradādhbih, writing before the Balkhī authors, gives this latter as a main route through Kirman province, showing that the Balkhī school authors are not using Ibn Khurradādhbih directly.[50]

The comparison of the various texts and this map gives us a clue to the origins of the type of map. The concentration on these routes is important and shows a continuation of an early ninth-century preoccupation with this feature. The early texts of the form *al-Masālik wa-al-mamālik* were fundamentally texts of post routes through the Islamic empire, although most early writers were not limited to the empire, extending their work through India and China as much as possible and again by sea in the Indian Ocean and mentioning as much of

50. Ibn Khurradādhbih's account of the Kirman routes appears in his *Kitāb al-masālik wa-al-mamālik*; see the edition by Michael Jan de Goeje, *Kitâb al-masâlik wa'l-mamâlik (Liber viarum et regnorum)*, Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted 1967), 49–54. See also pp. 91–92. A convenient map on which to check some of this is in William C. Brice, ed., *An Historical Atlas of Islam* (Leiden: E. J. Brill, 1981), 16–17.

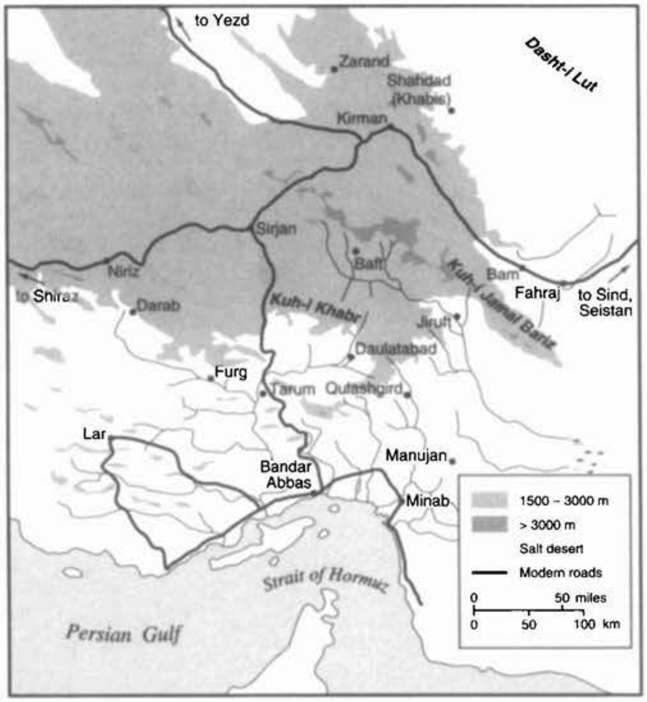

FIG. 5.6. MODERN KIRMAN AND SURROUNDING AREA. A modern map of Kirman for comparison.

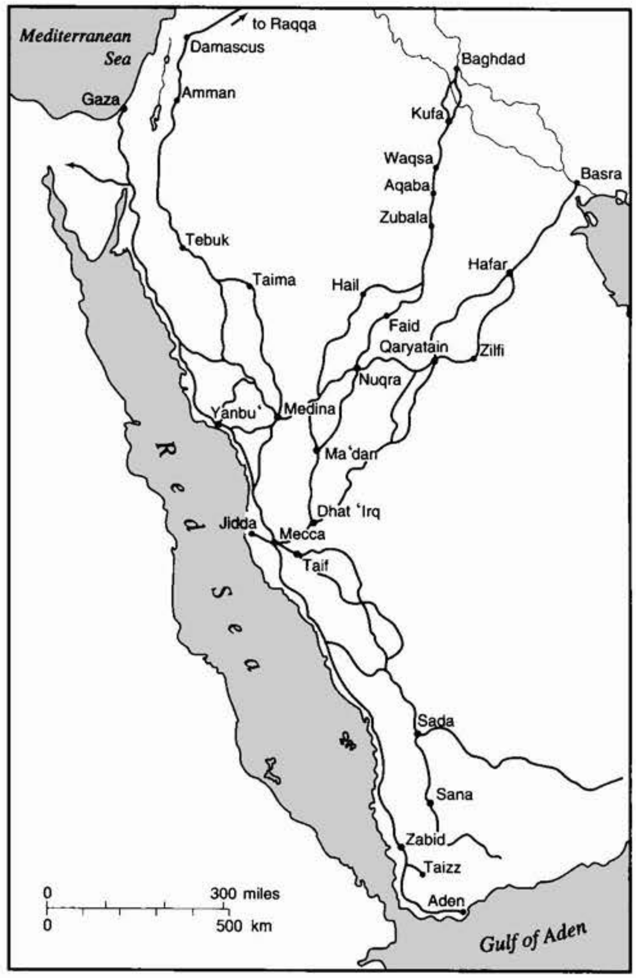

FIG. 5.7. THE ARABIAN DESERT PILGRIMAGE ROUTES. After William C. Brice, ed., *An Historical Atlas of Islam* (Leiden: E. J. Brill, 1981), 22.

Europe as they could. The text of Ibn Khurradādhbih is the only one that survives as an independent work. He was a postal official of the empire, and so his interest in the postal routes was professional. His routes through Kirman are easy to follow, giving the distance between places in parasangs (about four miles). It is possible that his routes were actually compiled from material left over from the days of the Sassanid Empire. Al-Jayhānī and al-Marwazī, who wrote similar works that are now lost and may perhaps be based on Ibn Khurradādhbih, probably followed in the same tradition.[51] The Balkhī-Iṣṭakhrī school—note that al-Iṣṭakhrī also calls his work *Kitāb al-masālik wa-al-mamālik*—likewise probably perpetuated this tradition, but it is obvious by a simple comparison with the existing texts that the routes were subsequently rethought. We have the same idea based on new facts, whose origin is not known, but contemporaries assumed that this material was new and up to date. Thus Ibn Ḥawqal copies it almost blindly for areas like Kirman. Al-Muqaddasī too follows this information. When we come to later geographers who base their works on the earliest geographers and generally eschew the Balkhī-Iṣṭakhrī traditions, we find that they take their place-names directly from al-Iṣṭakhrī for areas in Iran and neglect the important route system of Ibn Khurradādhbih.[52]

The Arabic-Speaking Provinces

The four provinces that are not Persian speaking—Arabia, Syria, Egypt, and North Africa—are treated somewhat differently from the Persian provinces, although Syria, being nearest to the Iranian area, diverges less. The Arabian Peninsula is very impractically represented when one considers that from an Islamic standpoint, as the center of the pilgrim routes, it is so very important (fig. 5.7). Also, much had been written on the Arabian Peninsula by Arab writers, and a work like al-Hamdānī's *Ṣifat Jazīrat al-ʿArab* (History of the Arabian Peninsula) had already been produced by the time of these authors.[53] Al-Iṣṭakhrī shows the peninsula as a protrusion sticking out into the Persian Sea with the African coast beyond

51. All these authors are mentioned in chapter 4.

52. The most obvious of these is the anonymous Persian text *Ḥudūd al-ʿālam*, ed. and trans. Minorsky (note 9).

53. Al-Ḥasan ibn Aḥmad al-Hamdānī died in 334/945.

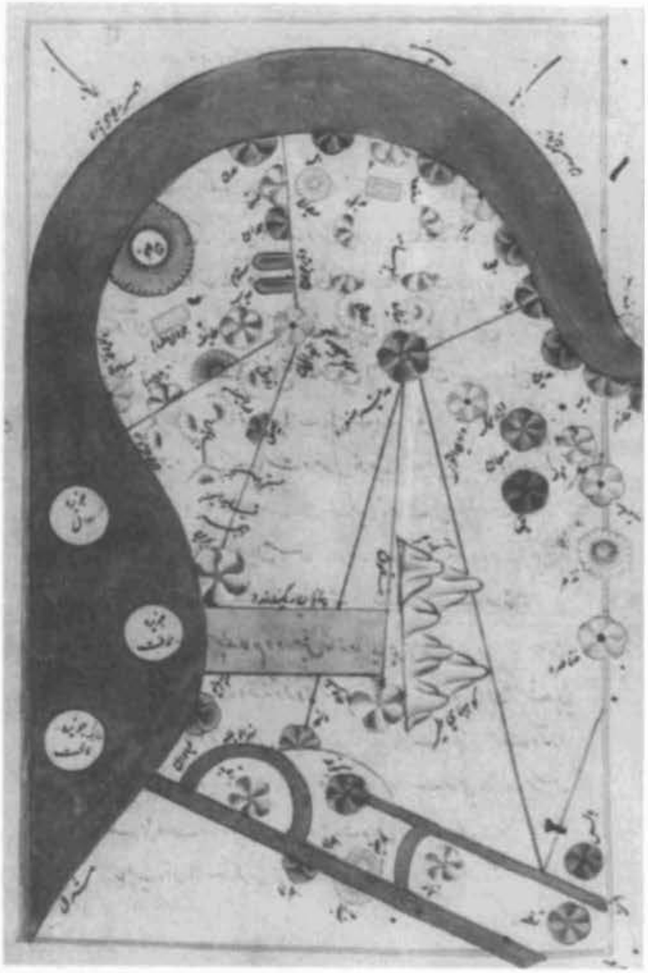

FIG. 5.8. ARABIA ACCORDING TO THE BALKHĪ SCHOOL, IṢṬAKHRĪ I. North is toward the lower right corner.
Size of the original: not known. By permission of the Otdeleniya Instituta Vostokovedeniya Akademii Nauk, SSSR, Leningrad (MS. C-610, fol. 13a).

FIG. 5.9. ARABIA ACCORDING TO THE BALKHĪ SCHOOL, IṢṬAKHRĪ II. North is toward the lower right corner.
Size of the original: 27.5 × 17.7 cm. By permission of the Biblioteca Universitaria di Bologna (Cod. 3521, fol. 5v).

(fig. 5.8).[54] South is to the top left. Most of the detail in the peninsula relates to the Ḥijāz and Yemen. Below, it is separated from the rest of the landmass by the Euphrates and the Tigris, and only the area immediately above and to the left refers to the larger part of the peninsula (Najd, Bahrain, and Oman). Most of this latter area is devoted to the sands and to the two mountains of Ṭaʾī. Routes radiate out from Mecca and Medina, as one might expect; for example, from Mecca to Bahrain, Oman, and Aden and from Medina to Basra, Kadesia (Qadisīya), Raqqa, and through Taima toward Syria. The later recension of al-Iṣṭakhrī is much more vague but has Mecca and Medina much farther north, giving more space in the southern part of the peninsula but even less for the north, east, and center (fig. 5.9). Ibn Ḥawqal's map of Arabia is even more vague, little more than a hurried sketch map based ultimately on al-Iṣṭakhrī (figs. 5.10 and 5.11).

The maps of the two westerly provinces, Egypt and the Maghreb, vary enormously from recension to recension. There can certainly have been no original Iranian lists of postal routes for these areas and probably no Byzantine or any other Western equivalent. The sources are therefore limited to Ptolemy and any Muslim writers or collectors of information active since the Islamic conquest of these areas. The early writers of *masālik* literature like Ibn Khurradādhbih did not neglect these areas, and from their works a considerable amount of geographical information could be obtained. When considering these areas we must also consider the map of the Mediterranean, one of the few places where information relating to non-Islamic areas is found in these texts (fig. 5.12). The Mediterranean begins in Iṣṭakhrī I as a com-

54. Maps of the Arabian Peninsula are in Miller, *Mappae arabicae*, Band 3, Beiheft, Taf. 19–21 (note 14).

FIG. 5.10. ARABIA ACCORDING TO THE BALKHĪ SCHOOL, IBN ḤAWQAL I. North is toward the upper right corner.
Size of the original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (A. 3346).

FIG. 5.11. ARABIA ACCORDING TO THE BALKHĪ SCHOOL, IBN ḤAWQAL III. North is toward the upper right corner.
Size of the original: 35 × 26.5 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2214, fol. 5).

plete circle with a wide entrance to the Encompassing Ocean on top.[55] Details of North Africa lie on the left and those of Europe (mainly Islamic Spain) on the right. At 90° from the mouth of the sea (Strait of Gibraltar) we have a wide, straight water channel lying due north-south that is the Bosporus, and at 270° there appears another channel, the mouth of the Nile. This has a semicircular area with the entrance of the Nile to the left, containing two islands (Tinnis and Damyāṭ). At the bottom of the design (east) are three parallel rivers. In the center of the sea symmetrically west-east are a large mountain, Jabal al-Qilāl (in the Strait of Gibraltar), and a line of three large circular islands; Sicily, Crete, and Cyprus. This shape is reflected in the maps of both North Africa and Egypt. North Africa, which includes Spain, is really a map of the western end of the Mediterranean with a circular Spain on the north and a straight (horizontal east-west) North African coast (plate 6 and fig. 5.13).[56] The large mountain is again present but farther inside the Mediterranean, and there is one island (Sicily) and a prominent circular area on the African side that seems to house Sijilmasa and the land of the blacks (Bilād al-Sūdān). Egypt (fig. 5.14) also fits roughly to the Mediterranean map except that the seacoast is straight. The delta remains semicircular, with its two islands and a long, straight Nile with ranges of mountains on each side.

The later recension of Iṣṭakhrī (II) is somewhat the same. The Mediterranean on its own map becomes elongated, and the central islands are much smaller (fig. 5.12*b*). The Nile and the Bosporus are not so symmetrically arranged, and the mountain in the strait is much smaller. In the North African map, Spain loses its circular shape, becoming extended obliquely on the east and in some manuscripts flattened on the south (fig. 5.13*b*).[57] Egypt also varies slightly (fig. 5.14*b*).

55. The maps of the Mediterranean are reproduced in Miller, *Mappae arabicae*, Band 1, Beiheft 1, Taf. 1–4 (note 14).

56. The maps of the Maghreb occur in Miller, *Mappae arabicae*, Band 2, Beiheft, Taf. 5–7 (note 14).

57. Miller, *Mappae arabicae*, Band 1, Beiheft 1, Taf. 4 (Bologna)

In the Ibn Ḥawqal recensions the map titled al-Maghrib includes the whole of the Mediterranean, and the outline of the sea has been completely revised (fig. 5.12*c* and 5.12*d*).[58] The mountain is gone, and though Spain and North Africa remain roughly the same geometric shape, they are well covered with rivers. The important thing, however, is that the eastern end of the Mediterranean is no longer a circle but has a recognizable shape. There is a peninsula for Italy and another for Greece. The Alps are visible, Corsica and Cyprus appear, and there are signs of an Anatolian peninsula (wrongly oriented). The earlier recension (Ibn Ḥawqal I, fig. 5.12*e*) has another map of the Mediterranean (this time titled correctly) that is a simplification of the other, slightly more stylized, while the second recension has only one map (also ostensibly North Africa) that is inferior to the first recension of Ibn Ḥawqal but still a great improvement of that of al-Iṣṭakhrī. Egypt too has been completely redrawn by Ibn Ḥawqal, giving more detail to the Nile Delta (fig. 5.14*c*).[59] This map of Egypt is reproduced in Ibn Ḥawqal III (fig. 5.14*d*) but is more stylized and angular—again not really an improvement on I but vastly better than al-Iṣṭakhrī.

The impression one gets of Ibn Ḥawqal's maps of western Islam is that they are the work of someone who has been there and knows what he is portraying but is working within a traditional cartographic style and does not wish to depart too far from it. Such a conclusion is emphasized by the Paris abridgment manuscript.[60] This also contains a map of the Nile basin from al-Khwārazmī that is based on Ptolemy and is drawn in a much freer and more natural style than the other Balkhī school maps.[61]

All the provincial maps of this school of geographers may be based on practical considerations like land routes. These routes and the order of towns along them must have originated from the constant observations of those who traveled them. All the maps, however, except perhaps for the western areas of Ibn Ḥawqal's work, appear to have been drawn for mnemonic purposes, rather than for any other practical use, and for this their geometric style is admirably suited.

The World Map

The world map[62] and the map of the Indian Ocean, which is enlarged from it and always referred to as the Persian Sea, are a different proposition. These two maps are built up by what might be called academic conjecture—an armchair attempt to see all the provinces set down relative to each other. The whole has to fit into a stereotyped idea of what the whole world should look like. According to Arab geographical theory based entirely on Ptolemy, this would be a sphere.[63] Since the far side of a

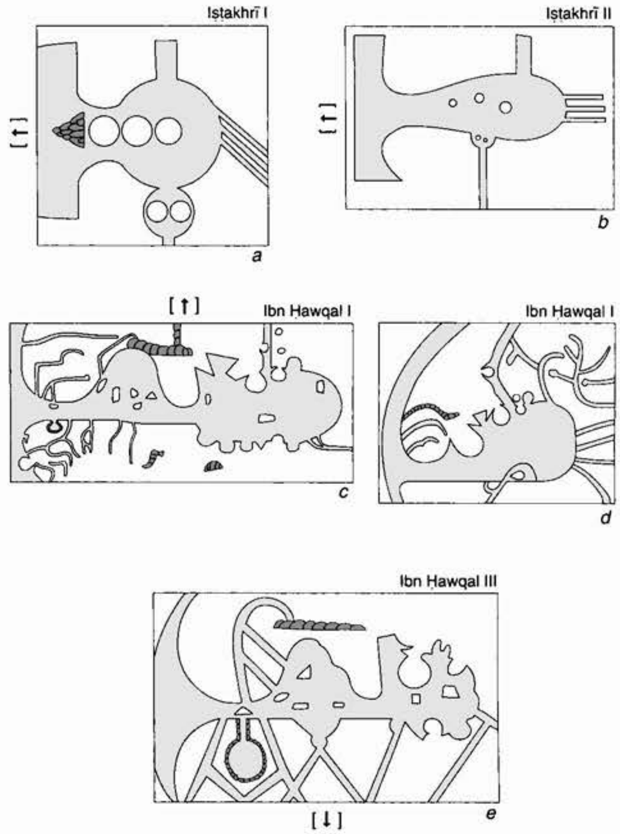

FIG. 5.12. THE DEVELOPMENT OF THE MEDITERRANEAN IN MAPS OF THE BALKHĪ SCHOOL. Five sketches of the Mediterranean based on al-Iṣṭakhrī (*a* and *b*) and Ibn Ḥawqal (*c*, *d*, *e*) (sometimes titled al-Maghrib in Ibn Ḥawqal). North is at the top for comparative purposes; the usual orientation in the manuscripts is indicated in square brackets. After J. H. Kramers, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal et l'Atlas de l'Islam," *Acta Orientalia* 10 (1932): 9–30.

(note 14). The North African map is found in Band 2, Beiheft, Taf. 5 (Berlin$_1$) and Taf. 7 (Bologna).

58. Kramers's edition of Ibn Ḥawqal's *Ṣūrat al-arḍ* (note 5) gives his map in its first recension as the plate between pp. 66 and 67. The second map of the Mediterranean appears on p. 193.

59. The first-recension maps of Egypt are reproduced in Kramers's edition, pls. between pp. 134 and 135 (note 5), and also in Kramers and Wiet's edition, vol. 1, pl. 5 (note 28). They are not reproduced by Miller. The second-recension maps (Ibn Ḥawqal III) appear in Miller, *Mappae arabicae*, Band 2, Beiheft, Taf. 9 (Paris$_2$) (note 14).

60. Paris, Bibliothèque Nationale, MS. Arabe 2214.

61. The map of the Nile basin is illustrated in figure 6.2 and can be compared with al-Khwārazmī's map, see plate 4.

62. Here we are dealing with the maps of al-Iṣṭakhrī (I and II) and the first recension of Ibn Ḥawqal (I). Ibn Ḥawqal III is discussed in more detail in chapter 6.

63. See, for example, p. 4.

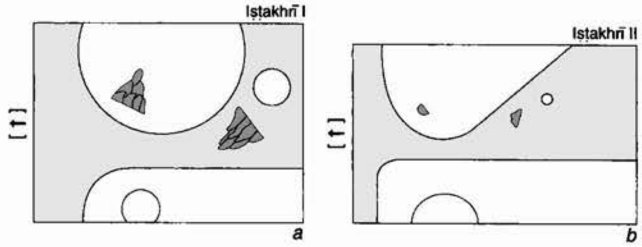

FIG. 5.13. THE DEVELOPMENT OF NORTH AFRICA AND SPAIN IN MAPS OF THE BALKHĪ SCHOOL. Two sketches of North Africa and Spain based on Iṣṭakhrī I (*a*) and Iṣṭakhrī II (*b*). North is at the top for comparative purposes; the usual orientation in the manuscripts is indicated in square brackets. After J. H. Kramers, "La question Balḫī–Iṣṭaḫrī–Ibn Ḥawḳal et l'Atlas de l'Islam," *Acta Orientalia* 10 (1932): 9–30.

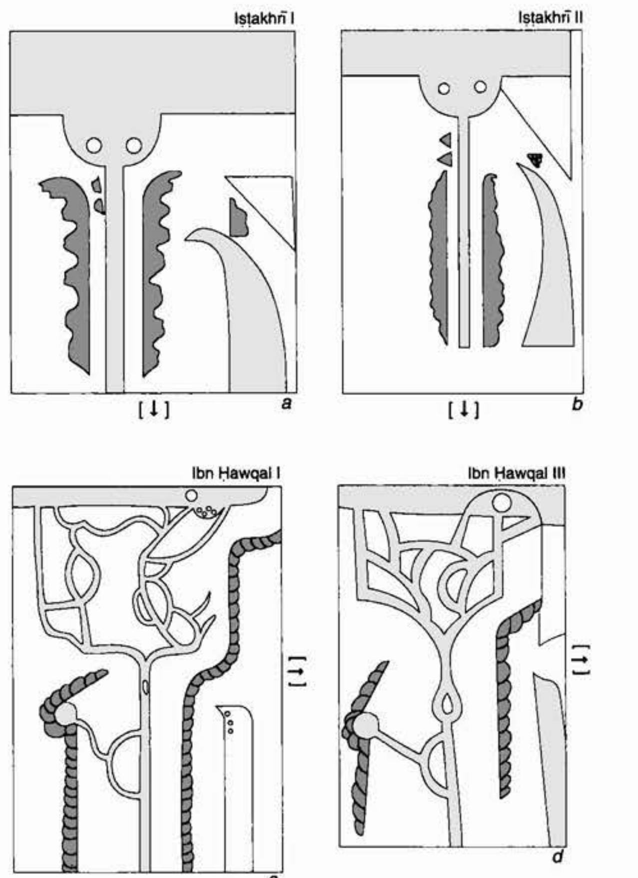

FIG. 5.14. EGYPT ACCORDING TO THE BALKHĪ SCHOOL. Sketches based on the maps of al-Iṣṭakhrī (*a* and *b*) and Ibn Ḥawqal (*c* and *d*). North is at the top for comparative purposes; the usual orientation in the manuscripts is indicated in square brackets.
After J. H. Kramers, "La question Balḫī–Iṣṭaḫrī–Ibn Ḥawḳal et l'Atlas de l'Islam," *Acta Orientalia* 10 (1932): 9–30.

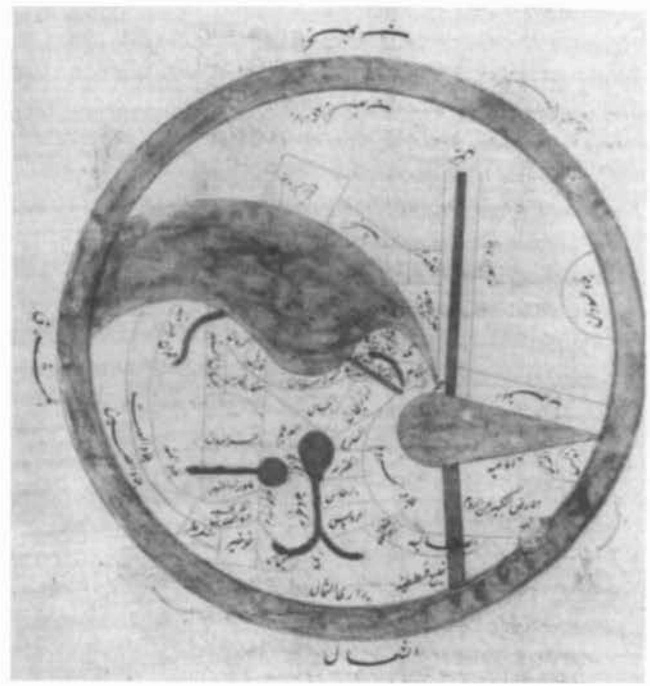

FIG. 5.15. THE WORLD, IṢṬAKHRĪ II.
Size of the original: 27.5 × 17.7 cm. By permission of the Biblioteca Universitaria di Bologna (Cod. 3521, fol. 2r).

world sphere (an upside-down world) was practically inconceivable, only a hemisphere was thought to be inhabitable. This could easily be "projected" onto a flat area and represented by a circle. That Ptolemy represented the inhabitable world as occupying 180 degrees of the earth supported this idea. Thus al-Iṣṭakhrī represented the world as a circle surrounded by the Encompassing Sea, with the two main seas reaching in from the east and the west toward the center, where they would join except for a small, narrow land barrier—the *barzakh* of the Qur'ān (plate 7 and fig. 5.15).[64]

In his text, al-Iṣṭakhrī gives a simple description of the world to explain his map. "The earth is divided into two by the two seas, so that we have a north or cold half and a south or hot half. People in these two halves get blacker as you go south and whiter as you go north etc."[65] The main kingdoms are listed together with the kingdoms that adjoin them. This is the only place where non-Islamic areas are given any mention. Measurements are attempted; thus the width from the Encircling Ocean in northwestern Africa to the Ocean in China was 400 days'

64. This is basically the system adopted by the medieval *mappaemundi*. See David Woodward, "Medieval *Mappaemundi*," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:286–370, esp. 328.

65. Al-Iṣṭakhrī, *Kitāb al-masālik wa-al-mamālik*; see the edition by al-Ḥīnī, 16 (note 48).

journey. However, the distance north to south was not measurable. There were 210 days' journey through inhabitable lands, but the extreme north was uninhabited because of intense cold and the extreme south because of intense heat. The seas were described briefly, and the fact that the Caspian (Khazar) Sea and the Aral (Khwārazm) Sea were landlocked is mentioned, as well as the sea connection between the Encircling Ocean and Istanbul—that is, the Baltic joins up to the Bosporus.

The map of the Persian Sea is an enlarged version of a portion of the world map,[66] although there are enough differences in the shape of the ocean in the two maps to necessitate some explanation. Three large islands—Khārak, Awāl (Bahrain), and Lāft (Qishm Island)—are set symmetrically in what is the Arabian Sea, with the Tigris to the left and the Indus to the right. India and China coalesce into one narrow peninsula, matching Arabia on the other side. The attempt is probably to match the Mediterranean on the other side of the world. Hence India also has a large mountain (Adam's Peak) to match the Jabal al-Qilāl near the Strait of Gibraltar. This is the Indian Ocean map in the first recension (Iṣṭakhrī I).

The second (Iṣṭakhrī II) is not so symmetrical, and the mountain and three islands become much smaller (as they also do in the Mediterranean). In the world map, the islands disappear altogether in the second recension but are there, very large, in the first. There is no "mountain" in either recension of the world map. The surprising difference is that the western tip of the Indian Ocean, which represents the Red Sea (Sea of Qulzum), points to the west in the ocean map, but in the world map it turns back on itself to almost touch the southeastern corner of the Mediterranean Sea.

The Ibn Ḥawqal maps, however, are very different.[67] This may be due to a closer reading of the earlier geographers and an attempt to incorporate features from their texts. This would include the Arabic translation of Ptolemy. But we are some way from indicating the Chinese and Golden Chersonese peninsulas of al-Khwārazmī or of Ptolemy, and there is no Taprobane. The main point is that the Red Sea and Persian Gulf are clearly shown, and the Nile rises in the Mountains of the Moon in the easterly extreme of Africa (fig. 5.16). The islands of al-Iṣṭakhrī have retreated into the Persian Gulf, where they actually belong, and other islands appear from the accounts of the non-Balkhī school geographers.[68] Ibn Ḥawqal III, like most of this set, is an inferior edition of Ibn Ḥawqal I with no new, up-to-date features.

AL-MUQADDASĪ'S MAPS

Al-Muqaddasī has the same set of maps as the other two authors, but they have become little more than illustrations to the text and are not really essential to understanding it. The maps generally give much less detail than those of al-Iṣṭakhrī and Ibn Ḥawqal, whereas his text is much more descriptive than theirs. The set of maps, however, is not quite the same as that of the earlier authors, for he has no world map and no map of the Caspian Sea or of Sijistan, but he does include a newly conceived map of the Arabian Desert showing the pilgrim routes to Mecca from the north and east.[69]

The surviving manuscript maps were apparently taken from the second recension of al-Iṣṭakhrī, although they seem to be completely redesigned.[70] Al-Muqaddasī himself says that among the more reliable maps he has found are those of al-Iṣṭakhrī, and he states that he has done his best to bring out the correct representations of the different parts of the empire in making the maps. He also explains that the colors of the maps are significant: "In the maps we have colored the familiar routes red, the golden sands yellow, the salt seas green, the well-known rivers blue, and the principal mountains dull brown."[71] He also seems to indicate the relative importance of the towns by the differing size of circles, something he is very keen on in his text. This emphasis is clear in the Leiden manuscript but not very obvious in that from Berlin, although both manuscripts have maps that look more businesslike than the more ornamental maps of the first Iṣṭakhrī recension, albeit in a sketch map style.[72]

The map of Kirman shows this tendency. It is virtually a redrawing of the al-Iṣṭakhrī map (Iṣṭakhrī I) with a few omissions but nothing new. By comparing this map with the equivalent text it is easy to see how al-Muqaddasī developed the text without developing the maps. For instance, he mentions far more towns and villages in his text than either of the earlier authors do, whereas his

66. For al-Iṣṭakhrī's maps, see Miller, *Mappae arabicae*, Band 3, Beiheft, Taf. 22 (except Gotha_3), 23, and 24 (except Berlin_2 and Paris_2) (note 14).

67. The Ibn Ḥawqal I map can be seen in Kramers's edition of *Ṣūrat al-arḍ*, pl. on 45 (note 5), and Kramers and Wiet's edition, pl. 3 (note 28). The Ibn Ḥawqal III map appears in Miller, *Mappae arabicae*, Band 3, Beiheft, Taf. 24 (Paris_2) (note 14).

68. Kramers's edition of *Ṣūrat al-arḍ*, 44 (note 5). The islands are Sribuza, Sūbāra, Sarandīb, Qanbalu, Dahlak, Sunjala, and Bāḍiʿ.

69. Examples of this are given in Miller, *Mappae arabicae*, Band 3, Beiheft, Taf. 21 (Berlin_2 and Leiden_2), as opposed to his maps of Arabia proper, Taf. 20 (note 14).

70. The Muqaddasī maps are given throughout Miller, *Mappae arabicae*, as the maps in Berlin_2 and Leiden_2: these representing the two surviving recensions of al-Muqaddasī's text. The Leiden maps are much more individual than those of Berlin and presumably reflect the maps (as it does the text) of the Istanbul manuscript, which I have not seen. See appendix 5.1.

71. Al-Muqaddasī, *Aḥsan al-taqāsīm*; Miquel's translation, 27 (note 8), Ranking and Azoo's translation, 12 (note 8).

72. Compare the Kirman maps from the two manuscripts in Miller, *Mappae arabicae*, Band 3, Beiheft, Taf. 33 (Berlin_2 and Leiden_2) (note 14).

map has, if anything, less detail than theirs. He shows that Bardashir is the seat of government, although Sirjan is the largest town. This sort of thing is not discernible from any map. The Arabian Peninsula, however, looks very different: the surrounding sea has vanished, and the peninsula becomes a square block (fig. 5.17), though rounded off in the south in the Leiden manuscript. The al-Iṣṭakhrī origin is still obvious, but someone has obviously redesigned it who shows more interest in the peninsula. The routes have been completely redrawn.

In addition, al-Muqaddasī has, as I have said, a new map of the Arabian Desert, formed on the lines of al-Iṣṭakhrī's map of the Persian Desert. Presumably al-Muqaddasī, who was more at home in this area, thought it was important to have these desert routes, especially since these were the main pilgrimage land routes. In spite of its possible importance, the final map seems sketchy to modern eyes, and it differs considerably in the two manuscripts. The Berlin manuscript (fig. 5.18) gives several routes from places on the Syrian-Iraqi border of this desert, and these routes meet at Taima, whereas the Leiden map has routes terminating in Mecca. A series of stages are given on each route in both maps in much more detail and more clearly positioned than in any of the maps of peninsular Arabia I have discussed. However, this is nothing like the detail given in al-Muqaddasī's text, where the routes terminate in Mecca, therefore agreeing with the Leiden manuscript map.

Generally the maps appearing in al-Muqaddasī manuscripts contain little detail for the Persian areas of Islam. The Mediterranean map again is little more than a hurried copy of al-Iṣṭakhrī. The Arabian areas, however, should be studied. Certainly the map of the Arabian Peninsula, together with that of the Arabian Desert, is superior to any map of the area that has appeared before.

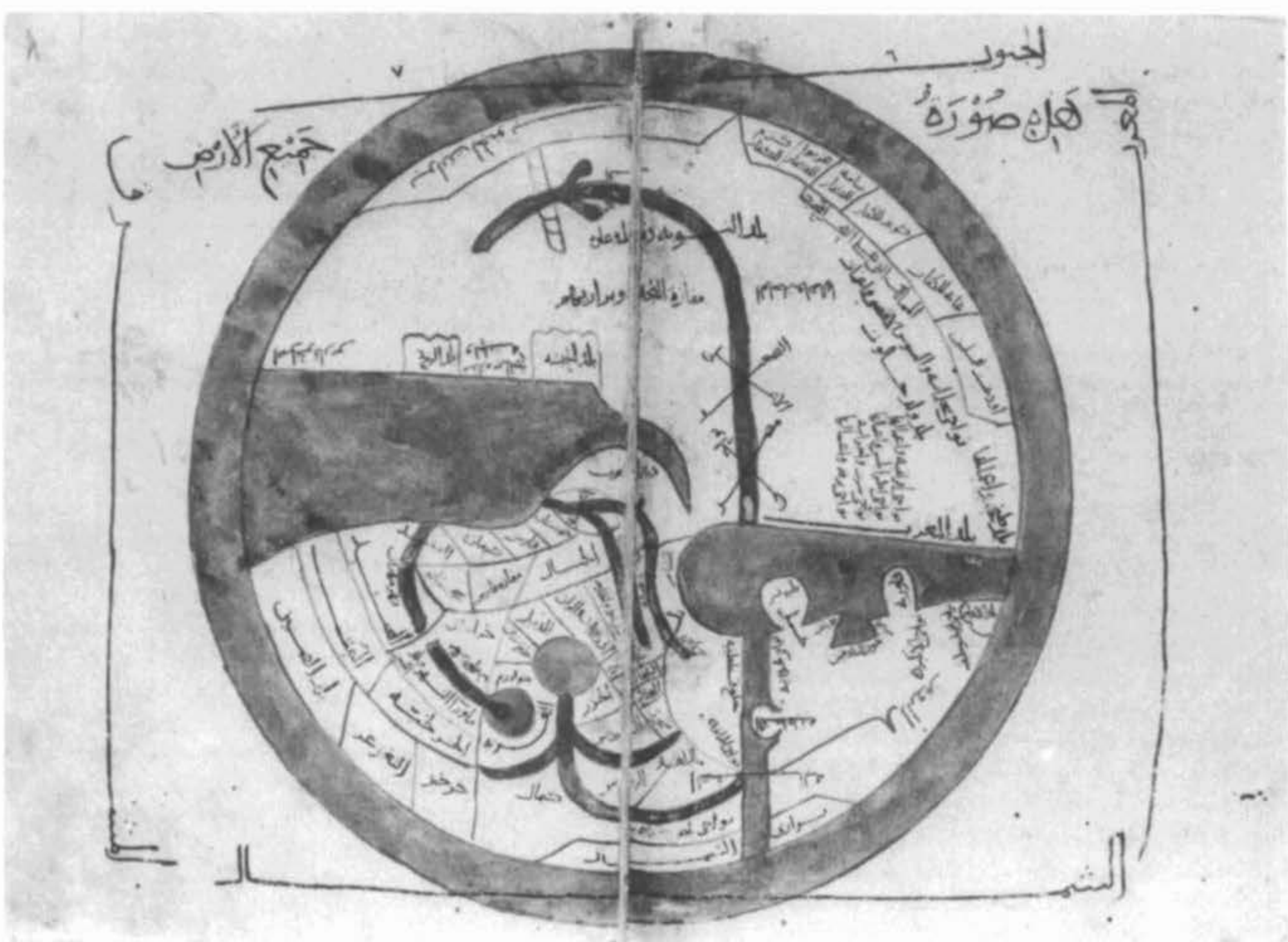

FIG. 5.16. THE WORLD, IBN ḤAWQAL I. Size of the original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (A. 3346).

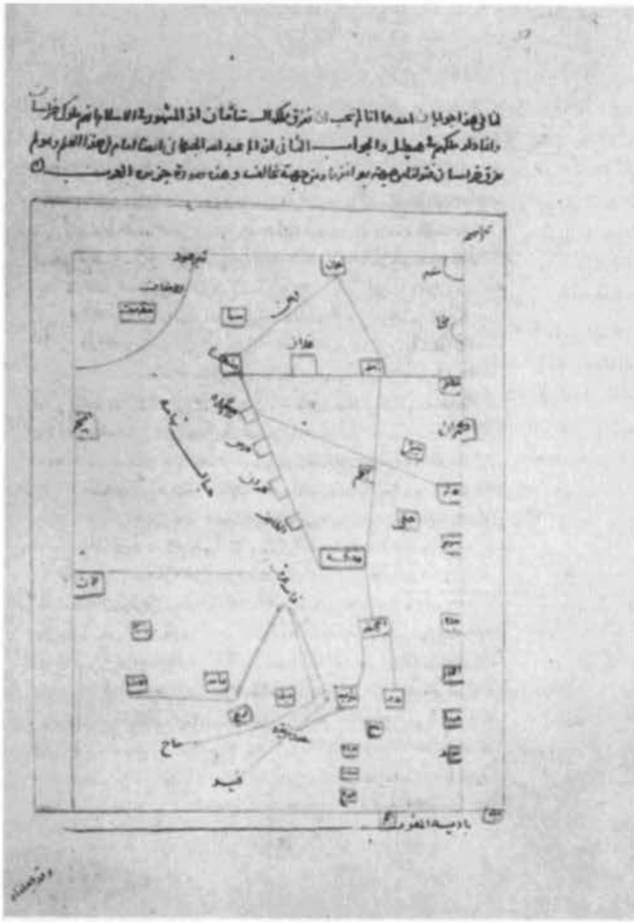

FIG. 5.17. ARABIA ACCORDING TO AL-MUQADDASĪ. The map of Arabia from the Berlin manuscript. North is at the bottom.
Size of the original map: 17 × 12.5 cm. By permission of the Staatsbibliothek Preussischer Kulturbesitz, Berlin (Orientabteilung, MS. Sprenger 5, p. 37).

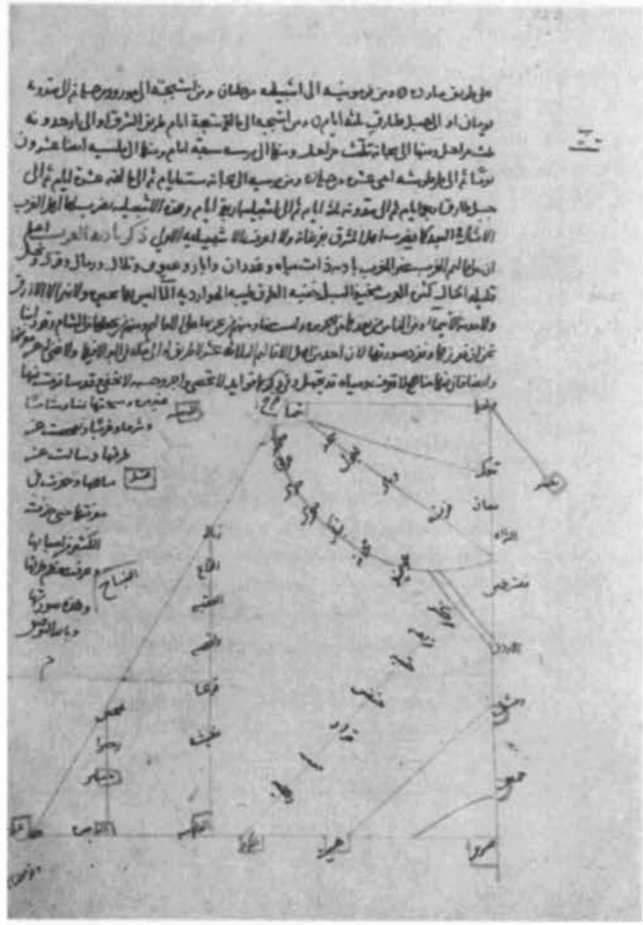

FIG. 5.18. THE ARABIAN DESERT ACCORDING TO AL-MUQADDASĪ. The map of the Arabian Desert from the Berlin manuscript. North is at the bottom.
Size of the original map: 14 × 16 cm. By permission of the Staatsbibliothek Preussischer Kulturbesitz, Berlin (Orientabteilung, MS. Sprenger 5, p. 123).

Miscellaneous Manuscripts Belonging to the Balkhī School

In addition to the manuscripts connected with these authors, three other manuscripts with maps show interesting variations on those already mentioned. The first of these is the very late copy (1675) of al-Iṣṭakhrī from the Staats- und Universitätsbibliothek in Hamburg, which, according to Kramers, shows a text relating closely to Iṣṭakhrī I.[73] He therefore classes the maps in the same category. A closer inspection of the maps, however, will show al-Iṣṭakhrī features in some of the maps, but the map of Kirman is distinctly of the Ibn Ḥawqal I type. The maps of the Persian area all compare closely with Ibn Ḥawqal's maps, that of Transoxiana being almost identical.[74] The maps of the Mediterranean Sea and the Maghreb are certainly Iṣṭakhrī I (fig. 5.19), although the Mediterranean map has only two large islands instead of the usual three. These Hamburg maps were drawn in Persia for the Safavid prince Ḥusayn in 1675.[75] They have a distinctive design, superior to many earlier manuscripts, and the nomenclature is written in a very clear Persian Naskhī script. Considerable trouble was taken over them, and it may be that what were thought to be the best features from several manuscripts of different styles were combined to construct them.

The second of the variations occurs in a manuscript from the Forschungsbibliothek, Gotha (MS. Orient. P.

73. Kramers, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal," 14–15 (note 31).

74. Compare the various maps of the Hamburg manuscript that are scattered throughout Miller, *Mappae arabicae* (note 14); the Transoxiana map is in Band 4, Beiheft, Taf. 59.

75. Miller, *Mappae arabicae*, Band 1, Heft 1, 17 (note 14).

FIG. 5.19. AL-MAGHRIB FOLLOWING IṢṬAKHRĪ I. The Hamburg manuscript from which this map comes, Staats- und Universitätsbibliothek, Cod. Or. 300, is being restored. This photograph is taken from Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.-13. Jahrhunderts*, 6 vols. (Stuttgart, 1926-31), vol. 2, Beiheft.
Size of the original: not known. By permission of the Staats- und Universitätsbibliothek, Hamburg, and from the American Geographical Society Collection, University of Wisconsin-Milwaukee Library.

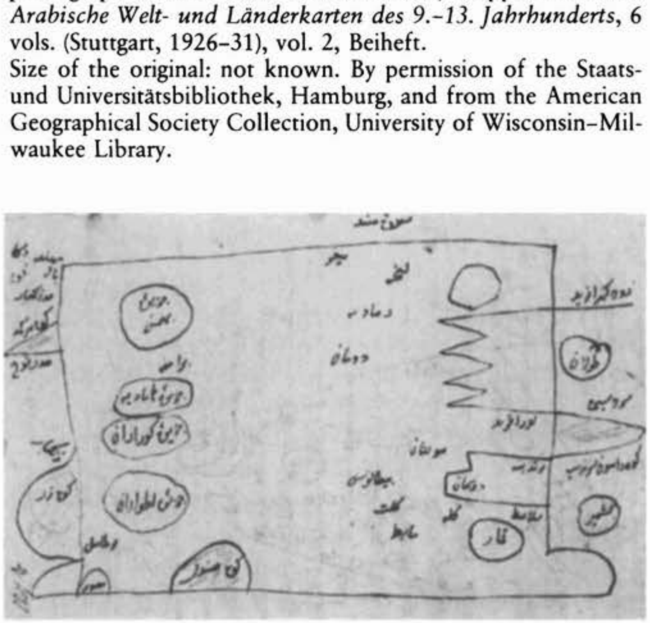

FIG. 5.20. THE INDIAN OCEAN IN THE MANUSCRIPT OF AḤMAD (OR MUḤAMMAD) AL-ṬŪSĪ. From the Gotha manuscript. West is at the top. The map is titled Ṣūrat Hind (Map of India). It should be titled Ṣūrat baḥr Hind.
Size of the original: not known. By permission of the Forschungsbibliothek, Gotha (MS. Orient. P. 35, fol. 127ᵃa).

35). The manuscript was dedicated to the Seljuk ruler Ṭughrul ibn Arslān, who died in 590/1193, so its date must be slightly earlier than that.[76] It contains the work entitled *ʿAjāʾib al-makhlūqāt* of Aḥmad (or Muḥammad) al-Ṭūsī, who was alive at the time the manuscript was written. The maps, of which only six appear (two in the text and four as separate small plates at the beginning), are drawn in very sketchily with a pen (fig. 5.20). Although these maps are sketchy, they seem to resemble recension III of Ibn Ḥawqal, as shown in the Paris manuscript (Bibliothèque Nationale, MS. Arabe 2214). The Caspian Sea, however, is more individual, while the Mediterranean is a very badly drawn Iṣṭakhrī I. The connection of these maps with the others is very uncertain, since the text itself is not related to that of al-Iṣṭakhrī.[77]

The third set of maps occurs in a manuscript from Vienna that is a Persian epitome of al-Iṣṭakhrī, in spite of being attributed to Naṣīr al-Dīn al-Ṭūsī. This is a beautifully written manuscript, but the maps (of which there is a full set) have been reduced to mere outlines, with the towns lined up in any order on the land and the rivers and mountains lined up too, so that the whole appears as a pictorial listing of the topographical features rather than as a map (figs. 5.21 and 5.22). Only those areas like the Mediterranean with a distinctive coastline are recognizable.[78]

The maps in the two nineteenth-century manuscripts in London that Miller attributed to al-Jayhānī have nothing to do with al-Jayhānī.[79] The text comes from another

76. Miller, *Mappae arabicae*, Band 1, Heft 1, 21 (note 14), and Wilhelm Pertsch, *Die orientalischen Handschriften der Herzoglichen Bibliothek zu Gotha*, pt. 1, *Die persischen Handschriften* (Vienna: Kaiserlich-Königliche Hof- und Staatsdruckerei, 1859), 58-61. According to Cevdet Türkay, *İstanbul Kütübhanelerinde Osmanlı'lar Devrine Aid Türkçe—Arabça—Farsça Yazma ve Basma Coğrafya Eserleri Bibliyoğrafyası* (Istanbul: Maarif, 1958), 3, another manuscript of this text exists in Istanbul, Hamid-i Evvel Kitaplığlı, no. 554, and Türkay dates the Istanbul manuscript 555/1160. There may be others. Whether they have maps I do not know.

77. There are empty pages that may have been meant for more maps. The existing maps are reproduced by Miller, *Mappae arabicae* (Gotha$_3$ manuscript), Band 1, Beiheft, Taf. 4 (Mediterranean); Band 3, Beiheft, Taf. 21 (Arabia), Taf. 22 (Indian Ocean), and Taf. 36 (Sind); Band 4, Beiheft, Taf. 42 (Jibal), and Taf. 48 (Caspian Sea) (note 14).

78. The maps of this manuscript, Cod. Mixt. 344 at the Österreichische Nationalbibliothek, Vienna, are beautifully reproduced with accompanying descriptions and translations in Hans von Mžik, ed., *al-Iṣṭaḫrī und seine Landkarten im Buch "Ṣuwar al-akālīm"* (Vienna: Georg Prachner, 1965). See also Gustav Flügel, *Die arabischen, persischen und türkischen Handschriften der Kaiserlich-Königlichen Hofbibliothek zu Wien*, 3 vols. (Vienna: Kaiserlich-Königliche Hof- und Staatsdruckerei, 1865-67), 2:424-25 (MS. 1271). The Mediterranean map is reproduced in Miller, *Mappae arabicae*, Band 1, Beiheft, Taf. 4 (Wien) (note 14).

79. Vladimir Minorsky, "A False Jayhānī," *Bulletin of the School of Oriental and African Studies* 13 (1949-51): 89-96. The maps for this manuscript appear in Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 66-70, 72v, 73 (note 14).

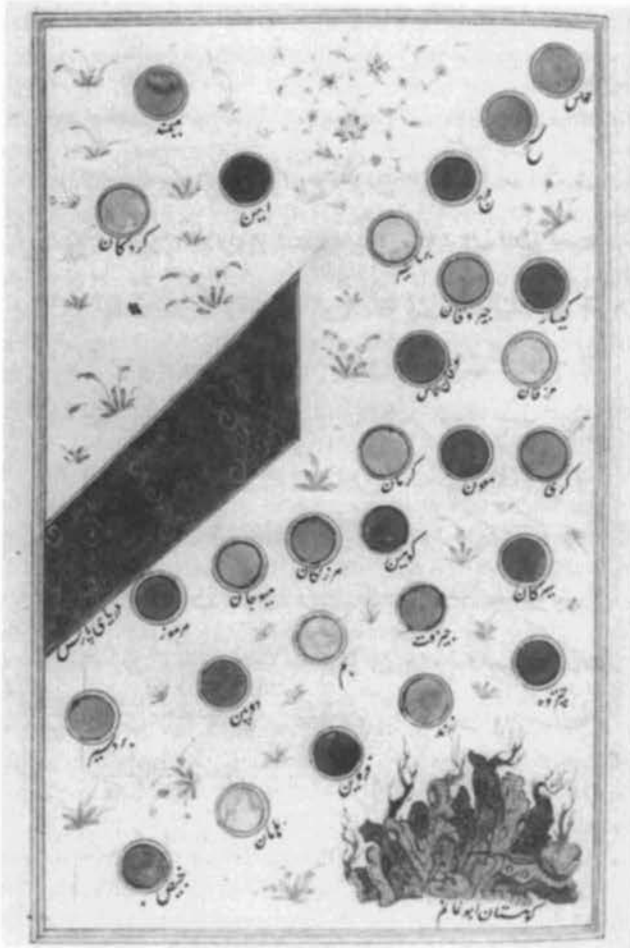

FIG. 5.21. MAP OF KIRMAN FROM A MANUSCRIPT ATTRIBUTED TO NAṢĪR AL-DĪN AL-ṬŪSĪ.
Size of the original: 31.4 × 20.8 cm. By permission of the Bild-Archiv der Österreichische Nationalbibliothek, Vienna (Cod. Mixt. 344, fol. 79r).

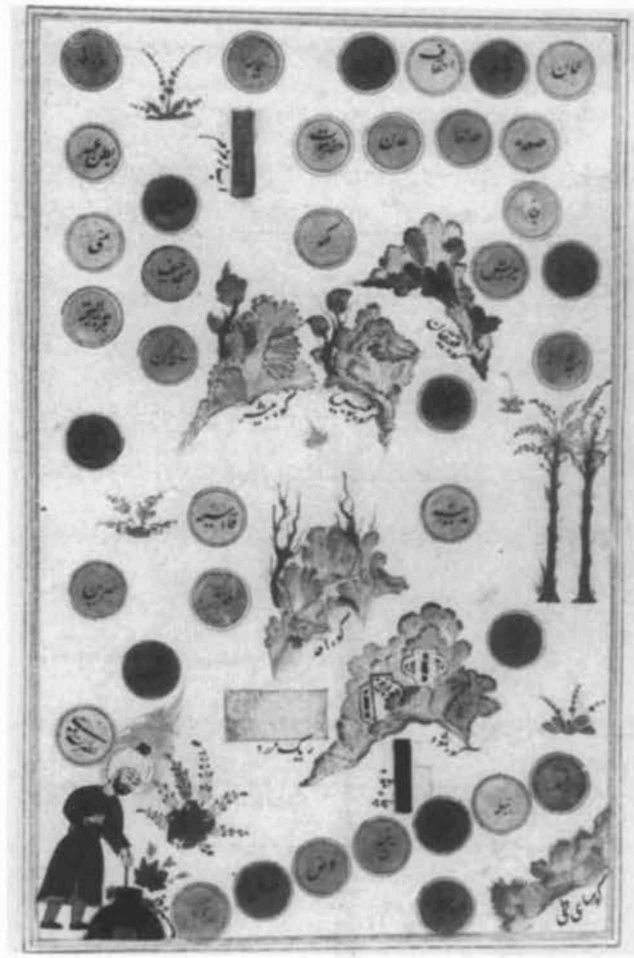

FIG. 5.22. MAP OF ARABIA FROM A MANUSCRIPT ATTRIBUTED TO NAṢĪR AL-DĪN AL-ṬŪSĪ.
Size of the original: 31.4 × 20.8 cm. By permission of the Bild-Archiv der Österreichische Nationalbibliothek, Vienna (Cod. Mixt. 344, fol. 9r).

Persian abridgment of al-Iṣṭakhrī that included a set of maps and was copied in India for a European scholar. The regional maps (especially those of the Persian areas) are quite passable examples of Iṣṭakhrī I, though less detailed than those of the twelfth-century manuscripts. The maps of the seas (with mermaids and fish), however, are very corrupt (fig. 5.23), and the world map is little more than a rough sketch of al-Iṣṭakhrī's world map (fig. 5.24). But the map of Egypt gives the source of the Nile, showing Arab Ptolemaic influence, although the delta area is taken directly from al-Iṣṭakhrī and the anchor shape of the Mediterranean again shows a comparison with the Ibn Ḥawqal III map from the Paris abridgment.[80]

There is at least one map of the Balkhī school that possesses climate boundaries. It is a very late map (ca. 816/1413) from a Timurid scientific manuscript now in the Topkapı Sarayı Müzesi Kütüphanesi in Istanbul (fig. 5.25).[81] It was obviously drawn with special care, and the climates are spaced so that the southern ones are wider than the northern ones and the boundaries are straight lines due east and west. The southern edge of the Indian Ocean follows the southern boundary of the first climate (presumably the equator, though not labeled as such and appearing well to the south of the world circle). A Pto-

80. Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 67 (Aegypten und Mittelmeer) (note 14).

81. The map is briefly mentioned and illustrated in Thomas W. Lentz and Glenn D. Lowry, *Timur and the Princely Vision: Persian Art and Culture in the Fifteenth Century* (Los Angeles: Museum Associates, Los Angeles County Museum of Art, 1989), 149–50 and fig. 50.

lemaic feature occurs in the mountains at the source of the Nile. The map itself has all the features of the Iṣṭakhrī I map (although it has only two islands in the Mediterranean) but is unusual in having detailed nomenclature in the Persian area and only selected material in the rest of the world.

Finally, some of the maps taken from the al-Iṣṭakhrī set were used as the basis of maps in some later geographers' works. Thus the occasional new work perpetuated a map when the remainder of the Balkhī maps had lost their currency (except in direct copies of existing works). The *Kitāb ʿajāʾib al-makhlūqāt* of Zakariyāʾ ibn Muḥammad al-Qazwīnī and the *Kharīdat al-ʿajāʾib* of Sirāj al-Dīn Abū Ḥafṣ ʿUmar Ibn al-Wardī are often accompanied by a world map that is based on that of al-Iṣṭakhrī but has enough individual features to allow it to be classified as an al-Qazwīnī or an Ibn al-Wardī world map. Both these works were extremely popular, and many manuscripts have survived (on the maps, see below, pp. 143–44). Also, Ḥāfiẓ-i Abrū, a Persian geographer of

FIG. 5.23. MAP OF THE INDIAN OCEAN FROM THE BRITISH LIBRARY MANUSCRIPT. A Persian epitome of al-Iṣṭakhrī from nineteenth-century India.
Size of the original: 25.5 × 13 cm. By permission of the British Library, London (MS. Or. 1587, fol. 39r).

FIG. 5.24. WORLD MAP FROM THE BRITISH LIBRARY MANUSCRIPT.
Diameter of the original: ca. 15 cm. By permission of the British Library, London (MS. Or. 1587, fol. 5).

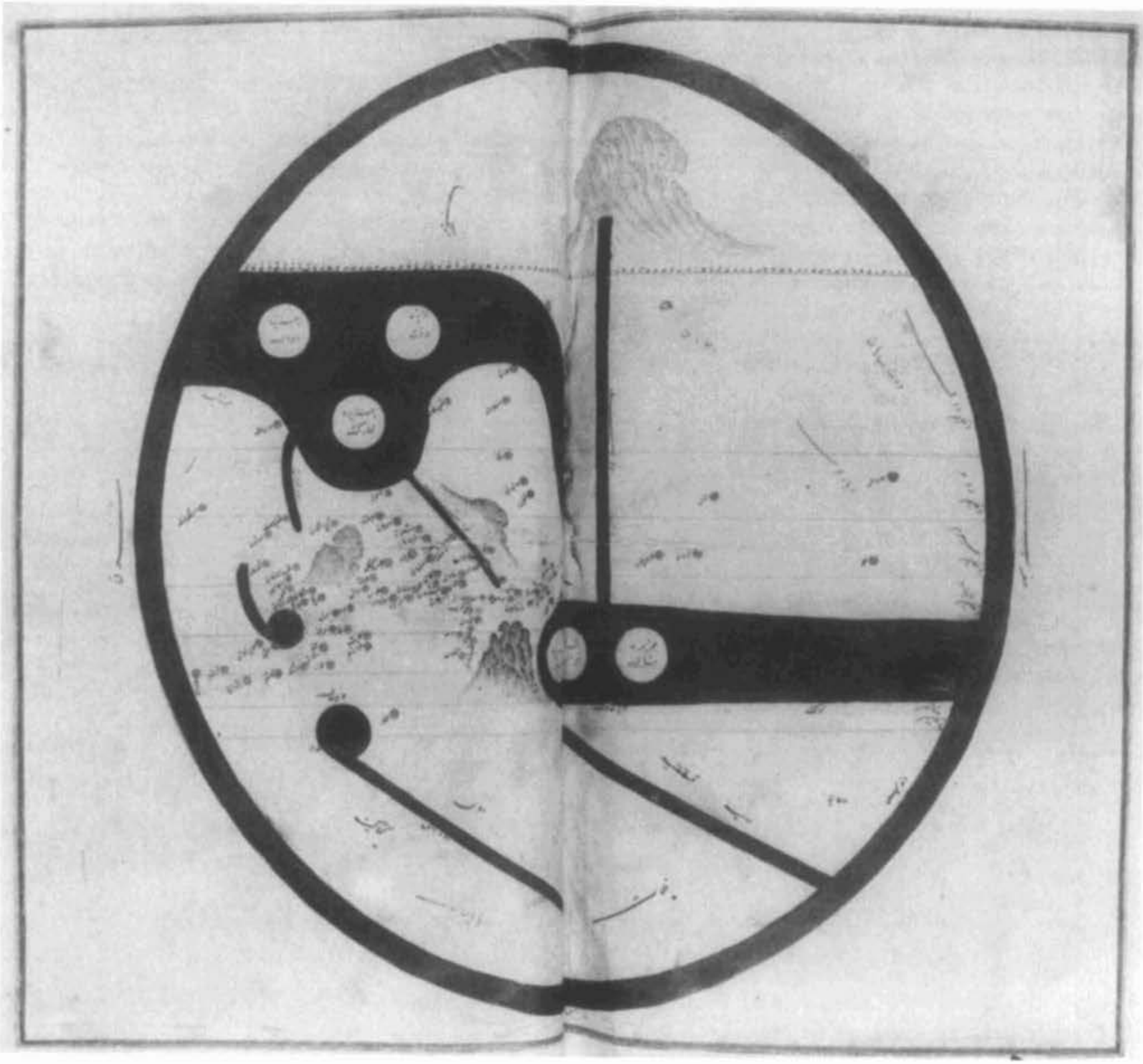

FIG. 5.25. BALKHĪ WORLD MAP WITH CLIMATE BOUNDARIES. This late example (ca. 816/1413) is opaque watercolor, ink, and gold on paper.
Size of the original: 35.5 × 48 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (B. 411, fols. 141b–142a).

the fifteenth century whose maps will be mentioned later, had sketch maps of the Persian and Mediterranean seas based on the form of al-Iṣṭakhrī's maps but including the extra islands mentioned by Ibn Ḥawqal.

Conclusion

One might ask, What are the origins of this set of maps? The only maps whose construction has been considered earlier than those of the Balkhī school are maps formed from Ptolemaic data or the world map associated with al-Maʾmūn.[82] There is nothing to show any connection between these and the Balkhī school maps. The Arab geographers before these writers have been either Ptolemaic scholars, collectors of travel writings, or listers of postal routes. The one complete survival of this last genre is the text of Ibn Khurradādhbih, and the routes across the maps of al-Iṣṭakhrī are very reminiscent of Ibn Khurradādhbih's routes except that the latter does not break his routes into provinces but follows them naturally from one end to the other before turning to another route.

82. See chapter 4 above.

Also, al-Iṣṭakhrī and al-Muqaddasī do not take their information from Ibn Khurradādhbih, so that the stages have different names even though their routes are sometimes the same.

Nevertheless one can imagine a scholar drawing out Ibn Khurradādhbih's routes and then splitting them up into areas, but the maps we are dealing with have more to them than this. They have boundaries and coastlines, lakes, rivers, and mountains—in fact, a backdrop on which to display the routes. This backdrop is not unlike some of the medieval *mappaemundi*, and the idea could be derived from Byzantine material. If one allows for the geometric style of the Arab maps, as, for instance, in the Iṣṭakhrī world map, the resemblance is quite noticeable.[83] The Ibn Ḥawqal maps of the Mediterranean may have even more of the *mappamundi* style. There is also the possibility that since the maps of the Iranian area are obviously standard they may go back before the Islamic period and have a Sassanian origin. The groupings of the maps, however, are definitely administrative in origin, and it seems possible that some scholar (al-Balkhī or someone else) took material such as the routes from a work similar to Ibn Khurradādhbih's and produced maps in an original burst of enthusiasm. This may be why the title *al-Masālik wa-al-mamālik* is taken up by the authors of this school from the Ibn Khurradādhbih–Sarakhsī–Jayhānī group of writers, whose origins were as listers of postal routes. That individuals were experimenting with map construction is shown by al-Muqaddasī's discussion about the man from Sarakhs.[84] Al-Balkhī's idea of a set of maps obviously became popular, and "atlases" of this sort became common. The number of manuscripts that have survived speak to this, but they were always based on the texts of the few authors I have described. Also, the style in which the maps are drawn became established. Future mapmakers used the cartographic style of these maps as a basis for their own efforts even when the content of their maps was completely different, as in maps of Ptolemaic origin. It is these later authors, al-Idrīsī and others, whose works will be discussed in the following chapters.

83. A difference of emphasis can be seen: the European map emphasizes the Mediterranean Sea and Palestine, whereas the Arab authors emphasize the Islamic landmass. A comparison can be made between Ibn Ḥawqal's world map (Ibn Ḥawqal I, fig. 5.16) and the *mappaemundi* illustrated in Woodward, "Medieval *Mappaemundi*," figs. 18.61 to 18.63 (note 64).

84. Al-Muqaddasī, *Aḥsan al-taqāsīm*; Miquel's translation, 19 (note 8), Ranking and Azoo's translation, 7–8 n. 4 (note 8).

	Location and Number	Date	Details of Text
	AL-IṢṬAKHRĪ		
1	Berlin, Staatsbibliothek Preussischer Kulturbesitz, Orientabteilung, MS. Sprenger 1 (Ar. 6032 [Ahlwardt])[b]	Orig. MS 589/1193, copy ca. A.D. 1840	Standard text used by de Goeje; author not named; earliest parts (pre-309/921) may be al-Balkhī
2	Bologna, Biblioteca Universitaria, Cod. 3521	Orig. MS 589/1193. Same as copy above?	Similar to no. 1
3	Cairo, Dār al-Kutub, MS. Geog. 199		Text on which al-Ḥīnī's printed text is based, resembles Topkapı Sarayı Müzesi Kütüphanesi, A. 3348
4	Cairo, Dār al-Kutub, MS. Geog. 256		Used by al-Ḥīnī, resembles de Goeje's text based on Leiden and Gotha manuscripts
5	Cairo, Dār al-Kutub, MS. Geog. 257		Used by al-Ḥīnī, similar to previous manuscript
6	Eton, Eton College, Oriental MS. 418, present location unknown		Persian translation of al-Iṣṭakhrī
7	Gotha, Forschungsbibliothek, MS. Orient. A. 1521 [Pertsch][c]	569/1173	Later abridgment of second recension of al-Iṣṭakhrī, who is mentioned by name
8	Gotha, Forschungsbibliothek, MS. Orient. P. 36 [Pertsch][d]	1012/1604	Persian translation of al-Iṣṭakhrī
9	Hamburg, Staats- und Universitätsbibliothek, Cod. Or. 300	1086/1675	Al-Iṣṭakhrī's text
10	Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2613	878/1473	Al-Iṣṭakhrī's text
11	Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2971a	n.d. (850/1450 by Kamal)	Al-Iṣṭakhrī's text
12	Istanbul, Süleymaniye Kütüphanesi, Ayasofya 3156	n.d. (ca. 800/1400 by Kamal)	Described in Türkay as al-Balkhī's *Masālik wa-al mamālik*—probably al-Iṣṭakhrī; Persian translation
13	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, B. 334	ca. 870/1460	Persian text of al-Iṣṭakhrī
14	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1646	ca. 1075/1664	Persian text of al-Iṣṭakhrī attributed (Türkay) to Ibn Khurradādhbih
15	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 2830	n.d.	Al-Iṣṭakhrī text; Arabic attributed (Türkay and Karatay) to al-Balkhī *Ṣuwar al-aqālīm*
16	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 3012	ca. 867/1462	Al-Iṣṭakhrī text

[a]The references cited by author's last name in this column of the appendix are those that follow (the bold indicates the name found in the references column): **Āstān-i Quds-i Raẓavi**, *Fihrist-i kutub-i kitāb'khānah-i mubārakah-i Āstān-i Quds-i Raẓavī* (Meshed, 1926–67). Michael Jan **de Goeje**, "Die Istakhrī-Balkhī Frage," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 25 (1871): 42–58. Ibn Ḥawqal, *Opus geographicum*, ed. Michael Jan **de Goeje**, Bibliotheca Geographorum Arabicorum, vol. 2 (Leiden: E. J. Brill, 1873), reedited by J. H. **Kramers** (1938; reprinted 1967). Al-Iṣṭakhrī, *Masālik wa mamālik*, ed. Iraj **Afshār** (Tehran: Bungāh-i Tarjamah va Nashr-i Kitāb, 1961); idem, *Viae regnorum descriptio ditionis moslemicae*, ed. Michael Jan **de Goeje**, Bibliotheca Geographorum Arabicorum, vol. 1 (Leiden: E. J. Brill, 1870; reprinted 1927, 1967); idem, *al-Masālik wa-al-mamālik*, ed. Muḥammad Jābir ʿAbd al-ʿĀl **al-Ḥīnī** (Cairo: Wazārat al-Thaqāfah, 1961); idem, *Liber climatum*, ed. J. H. **Moeller** (Gotha: Libraria Beckeriana, 1839); idem, *Das Buch der Länder*, ed. and trans. Andreas David **Mordtmann** (Hamburg: Druck und Lithographie des Rauhen Hauses in Horn, 1845); and idem, *The Oriental Geography of Ebn Haukal*, ed. and trans. William **Ouseley** (London: Wilson for T. Cadell and W. Davies, 1800). Youssouf **Kamal**, *Monumenta cartographica Africae et Aegypti*, 5 vols. in 16 pts. (Cairo, 1926–51). Fehmi Edhem **Karatay**, *Topkapı Sarayı Müzesi Kütüphanesi: Arapça Yazmalar Kataloğu*, 3 vols. (Istanbul: Topkapı Sarayı Müzesi, 1962–66). J. H. **Kramers**, "al-Mukaddasī," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), 3:708–9; idem, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawkal et l'Atlas de l'Islam," *Acta Orientalia* 10

OF THE BALKHĪ SCHOOL

Maps and Versions	Comments on Maps	References[a]
18 maps	No world map or Fars; Iṣṭakhrī II	De Goeje, Kramers, Miller (b_1); Miller attributed to al-Balkhī
Complete set of 21 maps	Iṣṭakhrī II	De Goeje, Kramers, Miller (bo); Miller attributed to al-Balkhī
?		Al-Ḥīnī
Has set of maps	Iṣṭakhrī I	Al-Ḥīnī
Has maps		Al-Ḥīnī
Blank pages left for maps		Used by Ouseley in his edition; Afshār
20 maps	Arabia missing; Iṣṭakhrī I	De Goeje, Kamal (3.2:591–94), Kramers, Miller (g_1), Moeller, Mordtmann
21 maps	Complete set of Iṣṭakhrī I	Kamal (3.2:611–15), Miller (g_2), Ouseley
21 maps	Mixed set of maps (see text above for details)	Kramers, Miller (ha); Miller attributed to al-Balkhī
Maps?	Iṣṭakhrī II	Karatay, Kramers, Ritter, Türkay (p. 12)
Maps	Iṣṭakhrī II	Kamal (3.2:600–604), Karatay, Kramers, Ritter, Türkay (p. 8)
Maps	Iṣṭakhrī II; Egypt and Kirmān reproduced in Afshār	Afshār, Kamal (3.2:606–10), Türkay (p. 12)
21 maps		Afshār, Türkay (p. 57)
20 maps		Afshār, Kamal (3.2:621–22), Türkay (p. 56)
21 maps	Iṣṭakhrī II	Karatay, Kramers, Ritter, Türkay (p. 59)
Maps		Kamal (3.2:605), Karatay, Kramers, Ritter

(1932): 9–30; and idem, "Djughrāfīya," in *Encyclopaedia of Islam*, 1st ed., suppl., 61–73. Konrad **Miller**, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31). Al-Muqaddasī, *Descriptio imperii moslemici*, ed. Michael Jan **de Goeje**, Bibliotheca Geographorum Arabicorum, vol. 3 (Leiden: E. J. Brill, 1877; reprinted 1906, 1967); and idem, *Aḥsan at-taqāsīm fī maʿrifat al-aqālīm*, trans. André **Miquel** (Damascus: Institut Français de Damas, 1963). Helmut **Ritter**, Review of Hans von Mžik, *Das Kitāb ṣūrat al-arḍ des Abū Ǧaʿfar Muḥammad ibn Mūsā al-Ḫuwārizmī*, in *Der Islam* 19 (1931): 52–57. Basil William **Robinson**, *Persian Paintings in the India Office Library* (London: Sotheby Parke Bernet, 1976). Cevdet **Türkay**, *İstanbul Kütübhanelerinde Osmanlı'lar Devrine Aid Türkçe—Arabça—Farsça Yazma ve Basma Coğrafya Eserleri Bibliyoğrafyası* (Istanbul: Maarif, 1958).

[b]Wilhelm Ahlwardt, *Verzeichniss der arabischen Handschriften der Königlichen Bibliothek zu Berlin*, 10 vols. (Berlin, 1887–99; reprinted New York: Georg Olms, 1980–81), 5:362.

[c]Wilhelm Pertsch, *Die orientalischen Handschriften der Herzoglichen Bibliothek zu Gotha*, pt. 3, *Die arabischen Handschriften*, 5 vols. (Gotha: Perthes, 1878–92), 3:142–44.

[d]Wilhelm Pertsch, *Die orientalischen Handschriften der Herzoglichen Bibliothek zu Gotha*, pt. 1, *Die persischen Handschriften* (Vienna: Kaiserlich-Königliche Hof- und Staatsdruckerei, 1859), 61–63.

APPENDIX 5.1—*continued*

	Location and Number	Date	Details of Text
17	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 3348	684/1285	Al-Iṣṭakhrī text, similar to Gotha, MS. Ar. 1521
18	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 3349	878/1473	Al-Iṣṭakhrī text
19	Leiden, Bibliotheek der Rijksuniversiteit, Cod. Or. 3101 (Cod. 1702 [de Goeje and Juynboll])[e]	569/1173	Al-Iṣṭakhrī text; author is named; similar to Gotha, MS. Ar. 1521, but without 12th-century additions
20	Leningrad, Otdeleniya Instituta Vostokovedeniya Akademii Nauk SSR, C-610	1164/1750	Persian translation of al-Iṣṭakhrī
21	Leningrad, Otdeleniya Instituta Vostokovedeniya Akademii Nauk SSR, V-797	14th century	Persian translation of al-Iṣṭakhrī
22	London, British Library, MS. Or. 1587	1256/1840	*Ashkāl al-ʿālam* Persian abridgment of al-Iṣṭakhrī attributed to al-Jayhānī in text
23	London, British Library, MS. Or. 5305	930/1523 from earlier manuscript of 878/1473	Arabic text of al-Iṣṭakhrī, *al-Masālik wa-al-mamālik*
24	London, British Library, Add. MS. 23542	1251/1835	*Ashkāl al-ʿālam* Persian abridgment of al-Iṣṭakhrī attributed to al-Jayhānī in text
25	London, India Office Library and Records (British Library), Ethé 707	n.d., early 14th century	*Tarjumah-i al-masālik wa-al-mamālik* Persian text of al-Iṣṭakhrī
26	Meshed, Āstān-i Quds-i Raẕavī, private no. 483, general no. 5623		Persian text of al-Iṣṭakhrī, corrupt and incomplete
27	Oxford, Bodleian Library, MS. Ouseley 373	670/1272	Persian text of al-Iṣṭakhrī *Ṣuwar al-buldān*
28	Paris, Bibliothèque Nationale, Cod. Pers. 355	17th century A.D.	Persian text of al-Iṣṭakhrī
29	Tehran, Mūzah-i Īrān-i Bāstān (Archaeol. Mus.), MS. 3515	726/1325	Persian version of al-Iṣṭakhrī used by Afshār in his printed edition
30	Tehran, Kitāb'khānah-i Majlis, no. 1407		Persian version of al-Iṣṭakhrī, copy of Tehran, MS. 3515 above
31	Tehran, Kitāb'khānah-i Malik, MS. 5990		Persian version of al-Iṣṭakhrī
32	Tehran, Kitāb'khānah-i Markazī-i Danishgāh-i Tihran, no. 1331	ca. 700/1300	Fragment from Persian version of al-Iṣṭakhrī
33	Tehran, Kitāb'khānah-i Salṭanatī, no. 1867		Persian version of al-Iṣṭakhrī
34	Vienna, Österreichische Nationalbibliothek, Cod. Mixt. 344 (MS. Ar. 1271 [Flügel])[f]	n.d. (10th/16th century by Kamal)	Persian text of al-Iṣṭakhrī attributed to Naṣīr al-Dīn al-Ṭūsī
	IBN ḤAWQAL		
35	Istanbul, Arkeoloji Müzesi Kitaplığı, no. 527.	n.d.	Ibn Ḥawqal

[e]Michael Jan de Goeje and Th. W. Juynboll, *Catalogus codicum arabicorum, Bibliothecae Academiae Lugduno-Batavae*, 2d ed. (Leiden: E. J. Brill, 1907), 2:1.

[f]Gustav Flügel, *Die arabischen, persischen und türkischen Handschriften der Kaiserlich-Königlichen Hofbibliothek zu Wien*, 3 vols. (Vienna: Kaiserlich-Königliche Hof- und Staatsdruckerei, 1865–67), 2:424–25.

Maps and Versions	Comments on Maps	References[a]
21 maps	Iṣṭakhrī I	Kamal (3.2:595–99), Karatay, Kramers, Ritter
21 maps		Karatay, Ritter
18 good maps	No Arabia, Egypt, or Syria; Iṣṭakhrī I	De Goeje, Kamal (3.2:587–90), Kramers, Miller (le_1)
Complete set of 21 maps	Iṣṭakhrī I	Miller (lg_1)
Incomplete set, 15 maps	Iṣṭakhrī I	Miller (lg_2)
19 maps	Described in text above, pp. 125–26	Miller attributed to al-Jayhānī
21 maps	Iṣṭakhrī II	Kramers
19 maps as atlas in center of manuscript	Mentioned in text above, pp. 125–26	Miller attributed to al-Jayhānī
18 maps	No world map, Arabia, or Persian Sea	Afshār, Miller (lo), Robinson (pp. 10–12; nos. 54–71)
		Āstān-i Quds-i Raẕavī catalog (3:356, no. 178)
17 maps	Maps not discussed by Miller	Possibly Ouseley's own text, which he used as base of his edition
18 maps	No Egypt; Iṣṭakhrī I	Miller (p_1)
20 maps given in color by Afshār	Iṣṭakhrī II	Afshār
		Afshār
18 maps		Afshār
		Afshār
Maps similar to Tehran, MS. 3515 above		Afshār
Complete set of 21 maps	Maps described in text above, p. 125; Egypt and Kirman in Afshār	Afshār, Kamal (3.2:616–20), Miller (w)
		Found only in Türkay (p. 6)

APPENDIX 5.1—*continued*

	Location and Number	Date	Details of Text
36	Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2934	n.d. (ca. 600/1200 by Kamal)	Ibn Ḥawqal text
37	Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2577	n.d. (ca. 750/1350 by Kamal)	Ibn Ḥawqal. Abridgment of Topkapı Sarayı Müzesi Kütüphanesi, A. 3346; Türkay attributed to al-Balkhī
38	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 3346	479/1086	Text of Ibn Ḥawqal naming author, original date 362/973
39	Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 3347	n.d. (ca. 700/1300 in Kamal)	Ibn Ḥawqal's text
40	Leiden, Bibliotheek der Rijksuniversiteit, Cod. Or. 314 (Cod. 314 Warn. [de Goeje and Juynboll])[g]	725/1325?	Ibn Ḥawqal II text
41	Oxford, Bodleian Library, MS. Huntington 538	n.d.	Ibn Ḥawqal II text
42	Paris, Bibliothèque Nationale, MS. Arabe 2214	n.d. (849/1445 in Kamal)	Abridgment of Ibn Ḥawqal, text of Topkapı Sarayı Müzesi Kütüphanesi, A. 3346, including material to 540/1145
43	Paris, Bibliothèque Nationale, MS. Arabe 2215	n.d.	Abridgment of Leiden, MS. Ar. 314, of Ibn Ḥawqal II
	AL-MUQADDASĪ		
44	Berlin, Staatsbibliothek Preussischer Kulturbesitz, Orientabteilung, MS. Sprenger 6 (Ar. 6033 [Ahlwardt])[h]	n.d.; recent copy (ca. 19th century)	Late and bad copy of Berlin, MS. Sprenger 5, see below; reference copy of collector (A. Sprenger)
45	Berlin, Staatsbibliothek Preussischer Kulturbesitz, Orientabteilung, MS. Sprenger 5 (Ar. 6034 [Ahlwardt])[i]	900/1494	Al-Muqaddasī text of 375/985
46	Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2971 bis	658/1260	Al-Muqaddasī text of 375/985
47	Leiden, Bibliotheek der Rijksuniversiteit, Cod. Or. 2063	1255–56/1840	Copy of Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2971 bis
	AḤMAD (OR MUḤAMMAD) AL-ṬŪSĪ		
48	Gotha, Forschungsbibliothek, MS. Orient. P. 35 [Pertsch][j]	n.d.	Persian text described as *ʿAjāʾib al-makhlūqāt* attributed to Aḥmad al-Ṭūsī
49	Istanbul, Süleymaniye Kütüphanesi, Hamid-i Evvel Kitaplığı (Murad Molla Kitaplığı), no. 554	555/1160	Same title as above according to Türkay

[g]De Goeje and Juynboll, *Catalogus codicum arabicorum*, 2:1 (note e).

[h]Ahlwardt, *Verzeichniss der arabischen Handschriften*, 5:362–63 (note b).

[i]Ahlwardt, *Verzeichniss der arabischen Handschriften*, 5:363 (note b).

[j]Pertsch, *Die persischen Handschriften*, 58–61 (note d).

Maps and Versions	Comments on Maps	References[a]
Maps	Ibn Ḥawqal III	Kamal (3.3:805–9), Karatay, Kramers, Ritter, Türkay (p. 8, with errors)
Maps	Ibn Ḥawqal I	Kamal (3.3:660–63), Karatay, Türkay (p. 9)
21 maps	Ibn Ḥawqal I	Kamal (3.2:655–59), Karatay, Kramers, Ritter
23 maps	Ibn Ḥawqal III	Kamal (3.3:810), Karatay, Kramers, Ritter
No maps		De Goeje, Kramers, Miller
No maps	Map pages left blank	De Goeje, Kramers, Miller
21 maps (including a zone map)	Ibn Ḥawqal III	De Goeje, Kamal (3.3: 811–17), Kramers, Miller (p_2) attributed to Ibn Saʿīd
No maps		Miller; n.b. MSS. Ar. 2216 and 2217, which could be copies
No maps		Kramers (*Enc. of Islam*); Miquel on al-Muqaddasī
19 maps	Includes Arabian Desert but no world map, Caspian Sea, or Sijistan	De Goeje, Kamal (3.2:674–77), Miller (b_2)
15 maps		De Goeje, Kamal (3.2:672–73), Karatay, Miller, Türkay (p. 8)
15 maps		De Goeje, Miller (le_2)
6 maps	For details see text above, pp. 124–25	Miller (g_3)
?		Türkay (pp. 1 and 28) only; this manuscript does not seem to have been inspected by anyone else

APPENDIX 5.2
LIST OF PRINTED EDITIONS AND TRANSLATIONS OF WORKS BY AUTHORS OF THE BALKHĪ SCHOOL

AL-IṢṬAKHRĪ
Printed Editions

Liber climatum. Edited by J. H. Moeller. Gotha: Libraria Beckeriana, 1839. With nineteen maps (no world map, and Arabia borrowed from elsewhere) from Gotha, Forschungsbibliothek, MS. Ar. 1521.

Kitāb al-masālik wa-al-mamālik. Edited by Michael Jan de Goeje. *Viae regnorum descriptio ditionis moslemicae.* Bibliotheca Geographorum Arabicorum, vol. 1. Leiden: E. J. Brill, 1870; reprinted 1927, 1967. No maps.

al-Masālik wa-al-mamālik. Edited by Muḥammad Jābir ʿAbd al-ʿĀl al-Ḥīnī. Cairo: Wizārat al-Thaqāfah, 1961. With reproductions of manuscript maps (eighteen maps are given [Iṣṭakhrī II], but it is not clear from which manuscript).

Masālik wa mamālik. Edited by Iraj Afshār. Tehran: Bungāhi Tarjamah va Nashr-i Kitāb, 1961. Twenty colored maps (Iṣṭakhrī II) from Tehran manuscript (Mūzah-i Īrān-i Bāstān, MS. 3515) used in the text; also Egypt and Kirman in black and white from the Vienna manuscript (Österreichische Nationalbibliothek, Cod. Mixt. 344), and Istanbul manuscript (Süleymaniye Kütüphanesi, Ayasofya 3156).

Translations

The Oriental Geography of Ebn Haukal. Translated by William Ouseley. London: Wilson for T. Cadell and W. Davies, 1800. No maps (places where maps or blanks appear in the text are indicated).

Das Buch der Länder. Edited and translated by Andreas David Mordtmann. Hamburg: Druck und Lithographie des Rauhen Hauses in Horn, 1845. Translation of *Liber climatum* above, using the same maps.

IBN ḤAWQAL
Printed Editions

Kitāb ṣūrat al-arḍ. Edited by Michael Jan de Goeje. *Opus geographicum.* Bibliotheca Geographorum Arabicorum, vol. 2. Leiden: E. J. Brill, 1873. No maps.

Kitāb ṣūrat al-arḍ. Edited by J. H. Kramers. *Opus geographicum*, 2d ed. Bibliotheca Geographorum Arabicorum, vol. 2. Leiden: E. J. Brill, 1938; reprinted 1967. Line maps of Ibn Ḥawqal I.

Translation

Configuration de la terre (Kitab surat al-ard). 2 vols. Translated by J. H. Kramers. Edited by G. Wiet. Paris: G. P. Maisonneuve et Larose, 1964. Same maps as in *Kitāb ṣūrat al-arḍ*, ed. Kramers, above with key maps in every case for identifying place-names.

AL-MUQADDASĪ
Printed Edition

Aḥsan al-taqāsīm. Edited by Michael Jan de Goeje. *Descriptio imperii moslemici.* Bibliotheca Geographorum Arabicorum, vol. 3. Leiden: E. J. Brill, 1877; reprinted 1906, 1967. No maps.

Translations

Aḥsanu-t-taqāsīm fī maʿrifati-l-aqālīm. Edited and translated by G. S. A. Ranking and R. F. Azoo. Bibliotheca Indica, n.s., nos. 899, 952, 1001, and 1258. Calcutta: Asiatic Society of Bengal, 1897–1910. First part only. No maps.

Aḥsan at-taqāsīm fī maʿrifat al-aqālīm. Translated by André Miquel. Damascus: Institut Français de Damas, 1963. Partial translation, annotated. Line maps with explanatory diagrams. Maps from various manuscripts used.

6 • Later Cartographic Developments

GERALD R. TIBBETTS

About A.D. 1000, Islamic cartographers had two existing cartographic systems on which they could base their work. The first was of Greek origin, derived from Marinus; there seem to be many textual references to it, but the only known Islamic example is the short description given by Suhrāb.[1] However, this system probably involves maps now lost, and certainly the tradition of mapmaking based on Ptolemy survives in the books of the early Muslim descriptive geographers. The second system was that of the Balkhī school, which originated in the tenth century A.D. but must have been very popular in the succeeding centuries, judging by the number of later manuscripts that have survived. The origins of this second system are obscure, although it used earlier Islamic geographical material. One gets the impression that this whole system was produced independently as a reaction against work dependent on Greek and other foreign agencies (see fig. 6.1).[2]

Another source that came into existence in the eleventh century A.D. and affected the work of Islamic cartographers and geographers was independent Islamic scientific research, although it was mainly the work of one man that influenced the subject we are interested in. This man was Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī (362/973 to after 442/1050), whom I will discuss in a moment.

Later Recensions of Ibn Ḥawqal's Maps

Adaptations of the two cartographic systems mentioned above and the geographical texts that accompany them so as to make the systems compatible with each other began almost as soon as geographers realized they included different materials. Ibn Ḥawqal (fl. second half of the tenth century A.D.) was the first of the Balkhī school geographers to reflect a knowledge of Ptolemy,[3] and his concentration on the Mediterranean area made him aware that European sources existed, if only through translation into Arabic. Although he does not state this in so many words, his text and maps have detail in the European areas that cannot be traced to earlier Arabic authors.[4] The superiority of his Mediterranean map over that of al-Iṣṭakhrī, another member of the Balkhī school, is due to these extra features, but they are roughly contemporary with Ibn Ḥawqal himself and are not based on his knowledge of Ptolemy. However, the version of Ibn Ḥawqal's maps that has been designated Ibn Ḥawqal III[5] certainly shows the reintroduction of Ptolemaic material that was excluded from the earlier maps of the Balkhī school. This again occurs mainly in the western part of the Islamic empire, around the Mediterranean Sea, and it can be seen especially in the world map from the set of Ibn Ḥawqal III maps, which clearly shows a Ptolemaic Nile as opposed to the Nile of al-Balkhī that appears in the maps of Ibn Ḥawqal designated Ibn Ḥawqal I.[6] In this set of Ibn Ḥawqal III maps, there is also a map of the Nile taken more or less directly from al-Khwārazmī (fig. 6.2).[7] A closer look at the Ibn Ḥawqal III world map reveals more features that are possibly Ptolemaic, and

1. This is the rectangular grid that could be used for converting tables of latitude and longitude to map form. See above, pp. 104–5 and fig. 4.7, for Suhrāb's version of it and for further discussion on its introduction into Islamic geographical literature. Presumably this is the projection Ptolemy criticized; see O. A. W. Dilke and editors, "The Culmination of Greek Cartography in Ptolemy," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:177–200, esp. 179–80, although the Muslims do not give any proportional relationship between parallels and meridians.

2. See chapter 5, on the Balkhī school.

3. Abū al-Qāsim Muḥammad Ibn Ḥawqal, *Kitāb ṣūrat al-arḍ*; see J. H. Kramers's edition, *Opus Geographicum*, 2d ed., Bibliotheca Geographorum Arabicorum, vol. 2 (Leiden: E. J. Brill, 1938; reprinted, 1967), 13.

4. Articles dealing with identification of toponyms reveal this fact. For example, C. F. Beckingham, "Ibn Ḥauqal's Map of Italy," in *Iran and Islam: In Memory of the Late Vladimir Minorsky*, ed. Clifford Edmund Bosworth (Edinburgh: Edinburgh University Press, 1971): 73–78.

5. See the classification system above, pp. 112–14 and fig. 5.3.

6. Compare fig. 6.3 with fig. 5.16 above; see also J. H. Kramers, "La question Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal et l'Atlas de l'Islam," *Acta Orientalia* 10 (1932): 9–30, esp. 28. Manuscripts containing maps classified as Ibn Ḥawqal III include Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2934; Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, A. 3347; and Paris, Bibliothèque Nationale, MS. Arabe 2214; see also appendix 5.1.

7. This map is also reproduced by Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31), Band 2, Beiheft, Taf. 10 ($Paris_2$ Niffauf). Abū Jaʿfar Muḥammad ibn Mūsā al-Khwārazmī (d. ca. 232/847) is discussed above, esp. pp. 97–101 and 105–6.

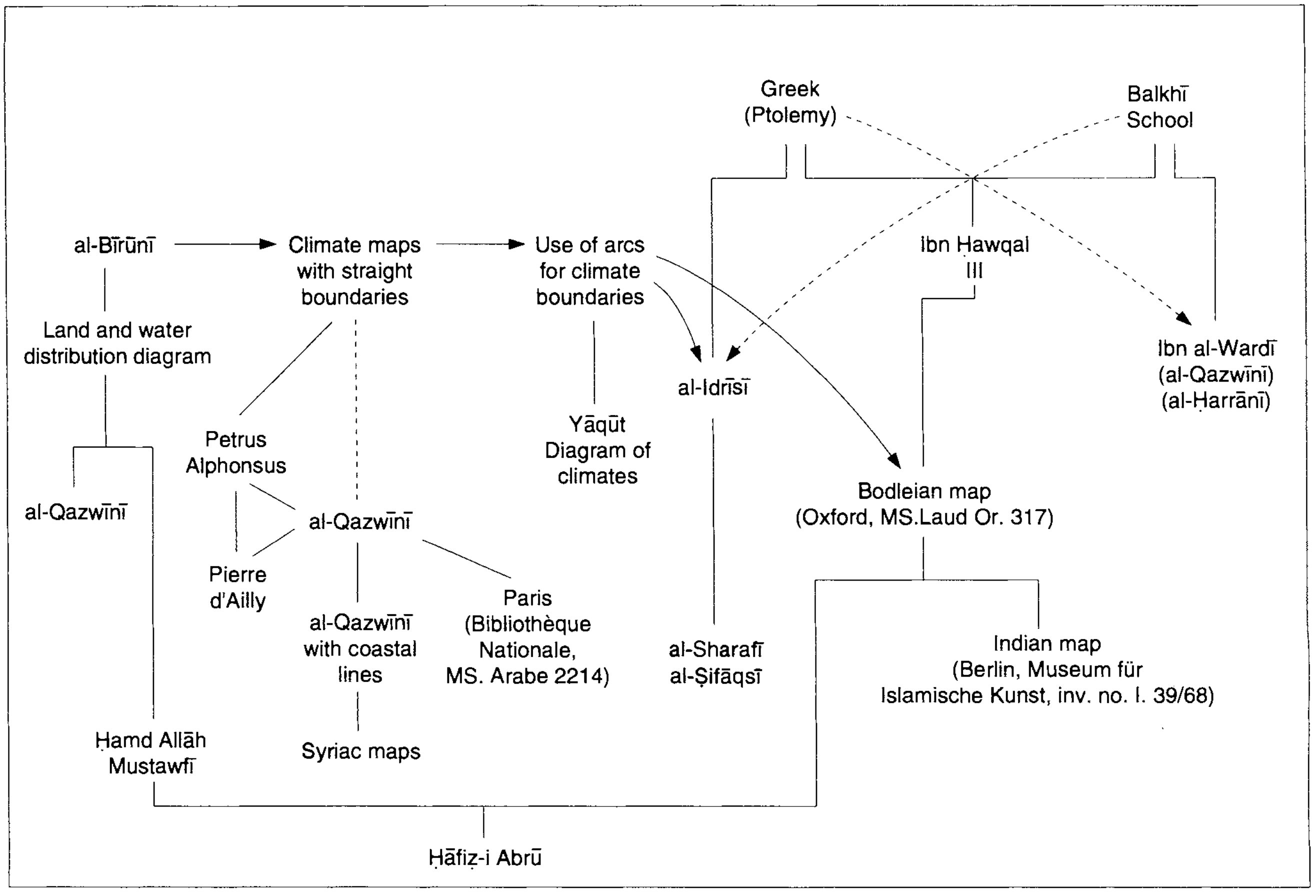

FIG. 6.1. STEMMA OF LATER ISLAMIC MAPS (A.D. 1000 ONWARD).

there is little doubt that the Ptolemaic parts come via al-Khwārazmī's text.

The world map in Ibn Ḥawqal III manuscripts is oval and may have been copied (at second or third hand) from a world map on Ptolemy's second projection,[8] with the lower border rounded off to complete the oval (fig. 6.3). The draftsman may have lacked a clear idea of the material he was meant to be representing, but it is possible to identify Ptolemy's Nile system (as I said above) and the islands of Yāqūt and al-Fiḍḍah, which lie beyond the narrow exit to the Indian Ocean formed by the extension of Africa and a peninsula of China, all features that come from al-Khwārazmī. There seems to be no doubt, because of the shape of the landmass, that the editor of this revision, whether or not it was Ibn Ḥawqal, must have used a copy of a world map on a Ptolemaic projection rather than on the rectangular projection recommended by Suhrāb. As a map derived ultimately from Ptolemy, however, it is very corrupt, and one can imagine it was copied many times over until the detail is almost unrecognizable. It seems to be not really an innovation and an improvement on Ibn Ḥawqal's earlier world map, but a degenerate survival from maps of the al-Khwārazmī variety. Earlier and better copies may have perished. The date of this map is certainly nowhere near the date of Ibn Ḥawqal himself. The earliest version of it cannot be earlier than 540/1145, although its corrupt state could show, as I have said, that the basic map had been in existence for some time.[9] In addition, in its features as well as in its

8. For discussion and illustration of Ptolemy's second projection, see Dilke, "Culmination of Greek Cartography," 184, fig. 11.3, and 187, fig. 11.5 (note 1).

9. The earliest possible date of the text, according to Kramers from internal evidence, is 540/1145 (Kramers, "La quesrion Balḫī-Iṣṭaḫrī-Ibn Ḥawḳal," 16 [note 6]). Youssouf Kamal illustrates three versions of the world map (from the three manuscripts listed above, note 6); see his *Monumenta cartographica Africae et Aegypti*, 5 vols. in 16 pts. (Cairo, 1926–51), 3.3:805, 810, 812 (this work has been reprinted in facsimile, 6 vols., ed. Fuat Sezgin [Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987]). The earliest version he

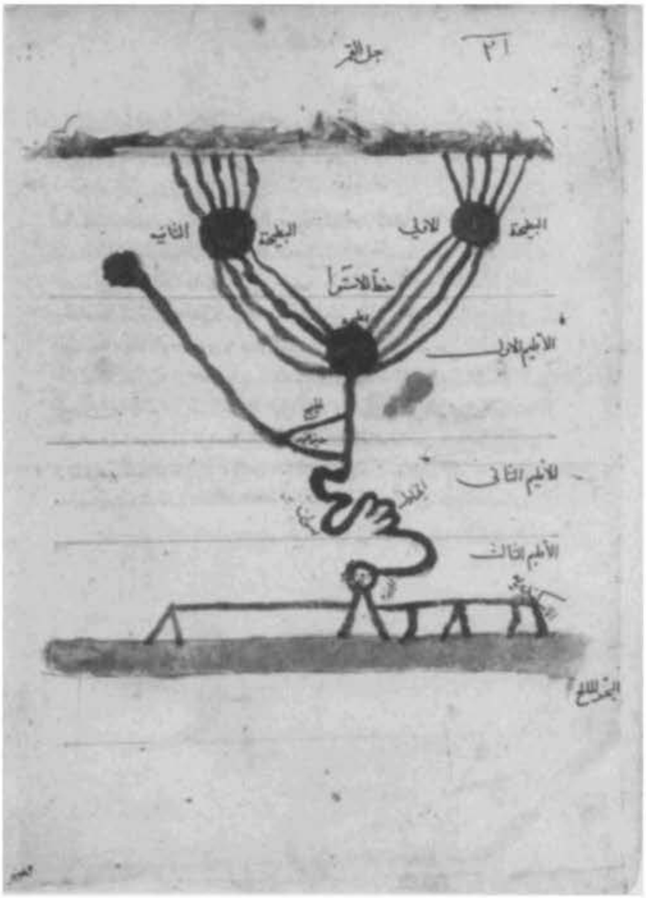

FIG. 6.2. THE NILE FROM THE IBN ḤAWQAL III SET OF MAPS.
Size of the original: 35 × 26.5 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2214, fol. 13v).

date it is comparable to the circular world map of al-Idrīsī. Yet this type of map had a future, and resemblances if not definite derivations can be seen in several later or contemporary maps, some of which I will discuss below.[10]

THE *ḤUDŪD AL-ʿĀLAM*

Another textual adaptation of these two systems (Ptolemy/Khwārazmī and Balkhī) is found in the anonymous Persian text *Ḥudūd al-ʿālam*.[11] This work was dated by its author 372/982. It is a descriptive geography very similar to the earlier descriptive work of the *Kitāb al-masālik wa-al-mamālik* (Books of routes and provinces) type, and there is strong evidence that the lost work of that name by al-Jayhānī was one of the main sources the author used.[12] It is also obvious that for the Persian-speaking areas of Islam, the work of al-Iṣṭakhrī was heavily relied on and in many cases directly quoted. Not only was al-Iṣṭakhrī used directly, but Ibn Ḥawqal's version may also have been used.[13] This work draws on a wide range of sources, so that geographical ideas appear from the descriptive geographers in close conjunction with the more technical material of the astronomer-geographers, including Ptolemaic and Indian influence.

The *Ḥudūd al-ʿālam*, however, gives no coordinates for place-names, and the manuscript that survives has no maps. There was probably no attempt to include a set of maps, in spite of the numerous references from the Balkhī school geographers. However, the text does occasionally refer back to a map, always mentioned in the singular (*ṣūrat*).[14] The impression given is that there was one map—a map of the world—although it is possible that there were other maps and that only one is being referred to at any one time. This recalls the suggestion made above that a large map was in existence at the time and that the text was compiled from the map.[15] References, however, make it appear that the reader was expected to refer to the map, and this implies a map attached to the text.[16] The reference stating that "the houses which are (seen) on the Map between Rukhudh and Multān are all villages and stations of caravans" is reminiscent of the provincial maps of al-Iṣṭakhrī, with little houses or tents sitting on the line of the route.[17]

One is left to surmise the form the map or maps took. If there was one world map, we would expect something with considerable detail, and this rather rules out the sort of world map that appears in the Balkhī school maps. Something similar to that suggested by Suhrāb (possibly with a graticule) would be more appropriate, and this fits when we figure that the basic plan of the *Ḥudūd*'s text

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regards as the one from Istanbul, Ayasofya 2934, which he dates ca. 600/1200. The Paris manuscript is dated 849/1445.

10. Oxford, Bodleian Library, MS. Laud. Or. 317, is influenced by it, and some of its features can be seen in an Indian map mentioned below. It also occurs in a Persian geographical treatise reproduced in Kamal, *Monumenta cartographica*, 3.5:996 (note 9), where the manuscript is identified as Leiden, Bibliotheek der Rijksuniversiteit, MS. Ar. 1899, and dated 646/1248.

11. This Persian geography has been mentioned in previous chapters and was edited and translated by Vladimir Minorsky, *Ḥudūd al-ʿālam: "The Regions of the World"* (London: Luzac, 1937; reprinted Karachi: Indus, 1980). The original manuscript is presumably now in Leningrad. There is also a preface by V. V. Bartol'd, 3–44.

12. See Minorsky's edition of *Ḥudūd al-ʿālam*, 24 (note 11). Bartol'd suggests that al-Jayhānī is quoted via the work of Gardīzī (ʿAbd al-Hayy ibn al-Ḍaḥḥāk Gardīzī, fl. eleventh century A.D.).

13. Bartol'd's preface to *Ḥudūd al-ʿālam*, 21–22 (note 11).

14. References to the map appear on pages 60, 69, 121, 146, and 157 of Minorsky's edition of the *Ḥudūd al-ʿālam* (note 11). References to the original manuscript are fols. $5b_{11}$, $8b_{10}$, $25b_{13}$, $33b_{16}$, and $37a_{15}$.

15. See chapter 4 above, esp. pp. 95–96.

16. Minorsky discusses the possibility of a map as a source of this text, *Ḥudūd al-ʿālam*, xv (note 11).

17. Minorsky's edition of *Ḥudūd al-ʿālam*, 121 (manuscript fol. $25b_{13}$); and compare, for example, al-Iṣṭakhrī's map illustrated above, fig. 5.5.

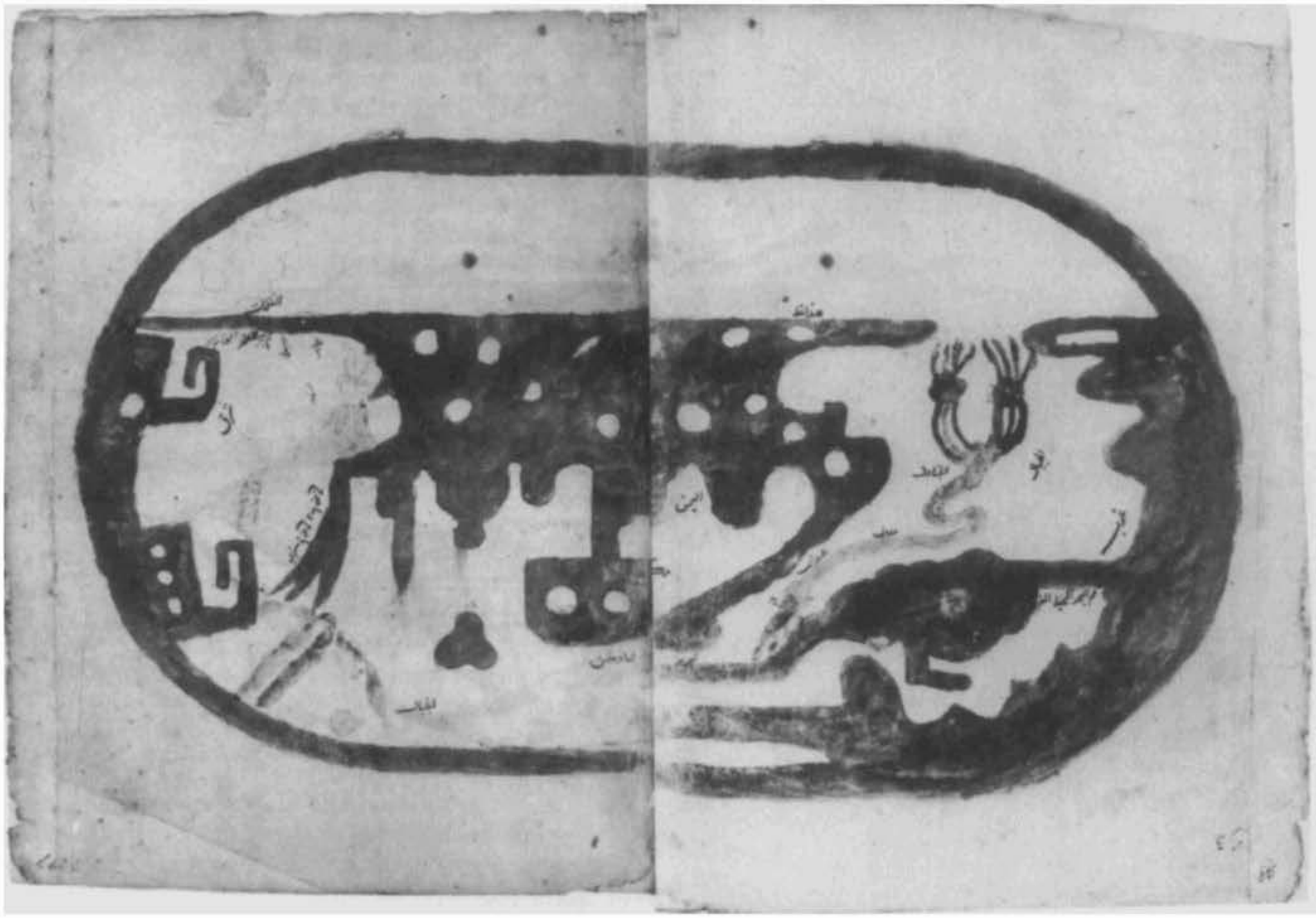

FIG. 6.3. THE WORLD FROM THE IBN ḤAWQAL III SET OF MAPS. Copied in 847/1445. The map is oriented with south at the top (pagination has north at the top). The word in Arabic for island and for peninsula is the same, and although Yāqūt and al-Fiḍḍah are usually referred to as islands in the literature, they are shown on this map (on the left) as hook-shaped peninsulas.
Size of the original: 35 × 26.5 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2214, fols. 52v–53).

is more like those of the earlier, pre-Balkhī geographers.

The idea of a basic map from which the text seems to have been compiled occurs again in the *Jaʿrāfīyah* of Muḥammad ibn Abī Bakr al-Zuhrī (fl. twelfth century A.D.), which the author describes as ultimately derived from the "Jaʿrāfīyah . . . al-Maʾmūn." By "*Jaʿrāfīyah*" he means a map, for he says that "the earth is spherical, but the 'Jaʿrāfīyah' is flat as is the astrolabe,"[18] suggesting a flat map. One feels, however, that al-Zuhrī produced a map of some sort and then derived his text from it. Al-Idrīsī worked in a similar way, and in his case a version of the map survived.[19] The latter's text is very similar to that of the *Ḥudūd al-ʿālam*, although the general arrangement of material is very different and al-Idrīsī's text is much more dependent on his maps. It is interesting that none of these authors makes any attempt to give coordinates for places.

Whether the map is important as a source for the geographical text or the text as a source for the maps is a constant dilemma when studying Islamic cartography. Surviving maps, with the exception of al-Idrīsī's, are too vague and lacking in detail to be sources for any comprehensive text, though it is possible they could be used as a framework for the text. Even here it does not seem as if a text follows a pattern that could be set by the map. On the whole, however, when authors mention the maps in their texts they state that the map is a base for the text. This is still not convincing. The opposite, that the map should act as a summary of the material given in the text, is not convincing either. Close comparison between the two is extremely difficult in most cases.

18. See the edition of al-Zuhrī's text by Maḥammad Hadj-Sadok, "Kitāb al-Djaʿrāfiyya," *Bulletin d'Etudes Orientales* 21 (1968): 7–312, esp. 306. Although several manuscripts of al-Zuhrī's work are extant, none contain any maps.

19. For al-Idrīsī and his maps, see chapter 7 below.

LATER TABLES AND AL-BĪRŪNĪ

During this period astronomers continued to produce tables of geographical coordinates in conjunction with their tables of stellar coordinates. Ibn Yūnus (d. 399/1009), who worked in Egypt, produced a set of tables similar to those of al-Battānī,[20] and he is also credited with producing a map in conjunction with al-Muhallabī.[21] There was also a tradition of table production in the Maghreb.[22] However, the next important set of tables to appear in the eastern part of the Islamic world was that of al-Bīrūnī.

Al-Bīrūnī worked during the first half of the eleventh century A.D., first in his native Khwārazm under the patronage of the last of the local rulers. In 408/1017, on the conquest of Khwārazm by the Ghaznavid ruler Maḥmūd, al-Bīrūnī was carried off to Ghazna almost as part of the booty. Under Masʿūd I (r. 421–32/1030–40), the son and successor of Maḥmūd, al-Bīrūnī was able to go on with his writing and scientific work. It was here about 427/1036 that he completed his great astronomical work *Kitāb al-qānūn al-Masʿūdī fī al-hayʾah wa-al-nujūm*, which includes not only his astronomical tables but, in the tradition of al-Battānī, a table of geographical coordinates of important places throughout the world.[23] This table has over six hundred entries and hence is double the size of that of al-Battānī or of Ibn Yūnus.[24]

Al-Bīrūnī was a first-rate scholar, interested in all branches of science, though it is as a mathematician and an astronomer that he is remembered. He was an excellent critic who read widely. He had good knowledge of Greek scientific sources and was extremely interested in Indian scientific theories, so that he could and did compare the different cultural streams that came the way of the Muslim intelligentsia of his day.

In the geographical field it was mainly the mathematical and astronomical aspects that interested him. Here he was specializing in those aspects that had been neglected by previous geographers, and thus one might expect to see an improvement in Islamic cartography.

Among the projects al-Bīrūnī mentioned in some detail was the remeasurement of the degree of latitude. He carried this out in Khwārazm and in Ghazna, and he produced a new method of measurement by using a convenient mountain from which the horizon could be observed.[25] He also attempted to measure the difference in longitude between two places using the distance between them in miles.[26] This was difficult, since the direct distances between places could not be worked out with any accuracy. However, he produced a result for the longitude of Ghazna east of Baghdad, setting out the theory behind this operation so that it was there for any later scholar to improve.[27] He also gave a complicated theory based on this for calculating the qibla, or the directions of Mecca from any place.[28] Al-Bīrūnī also criticized the projections of Ptolemy and Marinus, and by the latter he obviously meant the rectangular projection as shown us by Suhrāb.[29] In his works he gives the theory behind two different projections, one of which would be

20. Abū al-Ḥasan ʿAlī ibn ʿAbd al-Raḥmān ibn Yūnus was a well-known astronomer, his main work being *al-Zīj al-kabīr al-Ḥākimī*, named after the Fatimid caliph al-Ḥākim. The only extant manuscript containing the geographical coordinates is now in Leiden, Bibliotheek der Rijksuniversiteit, MS. Or. 143. Considerable work has been done on these tables, and a bibliography appears in B. R. Goldstein, "Ibn Yūnus," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 3:969–70. Lelewel has notes on the geographical tables (mainly from Jean Baptiste Joseph Delambre, *Histoire de l'astronomie du Moyen Age* [Paris: Courcier, 1819]) and gives a version in Arabic in Joachim Lelewel, *Géographie du Moyen Age*, 4 vols. and epilogue (Brussels: J. Pilliet, 1852–57; reprinted Amsterdam: Meridian, 1966), 1:43–61 and 165–77 (appendix 2). Abū ʿAbdallāh Muḥammad ibn Jābir al-Battānī al-Ṣābiʿ (before 244/858–317/929) is discussed above, see esp. pp. 97–98.

21. Al-Ḥasan ibn Aḥmad al-Muhallabī was an Egyptian astronomer contemporary with Ibn Yūnus. This world map was said to have been produced on silk cloth with gold and colored silk embroidery. Its form and its use as a map are not known. See S. Maqbul Ahmad, "Kharīṭa," in *Encyclopaedia of Islam*, new ed., 4:1077–83, esp. 1079. See p. 97 (text and note 27).

22. The main author was al-Zarqēllo of Toledo. His source is again mainly al-Bāttānī.

23. A critical edition of al-Bīrūnī's *Kitāb al-qānūn al-Masʿūdī* (The Masʿūdic canon) has been published by the Dāiratu'l-Maʿārif of Hyderabad, India: *al-Qānūnu'l-Masʿūdī (Canon Masudicus)*, 3 vols. (Hyderabad: Osmania Oriental Publications Bureau, 1954–56), 2:547–79, for the geographical tables. The tables are available in full in Arabic only. The geographical tables also appear in Ahmed Zeki Velidi Togan, ed., *Bīrūnī's Picture of the World*, Memoirs of the Archaeological Survey of India, no. 53 (New Delhi, 1941), 9–53.

24. The origin of al-Bīrūnī's tables must have been al-Battānī. He does not seem to have used Ibn Yūnus; see Syed Hasan Barani, "Al-Bīrūnī and His Magnum Opus *al-Qānūn u'l-Masʿūdī*," in the *al-Qānūn*, 1:i–lxxv, esp. iv (note 23).

25. See chapter 8 below for a fuller description of al-Bīrūnī's work related to geodesy. Syed Hasan Barani, "Muslim Researches in Geodesy," in *Al-Bīrūnī Commemoration Volume, A.H. 362–A.H. 1362* (Calcutta: Iran Society, 1951), 1–52, esp. 33–39.

26. J. H. Kramers, "Al-Bīrūnī's Determination of Geographical Longitude by Measuring the Distances," in *Al-Bīrūnī Commemoration Volume, A.H. 362–A.H. 1362* (Calcutta: Iran Society, 1951), 177–93; reprinted in *Analecta Orientalia: Posthumous Writings and Selected Minor Works of J. H. Kramers*, 2 vols. (Leiden: E. J. Brill, 1954–56), 1:205–22.

27. Kramers, "Al-Bīrūnī's Determination of Geographical Longitude," 179–82 (note 26).

28. In the *Kitāb taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin*, 272:17–290:13, al-Bīrūnī calculates the qibla of Ghazna by various methods as an example. See Edward S. Kennedy, *A Commentary upon Bīrūnī's "Kitāb taḥdīd al-amākin": An 11th Century Treatise on Mathematical Geography* (Beirut: American University of Beirut, 1973), 198–219.

29. Al-Bīrūnī, *Taḥdīd*, 233:15–18. For an English translation, see Jamil Ali, trans., *The Determination of the Coordinates of Positions for the Correction of Distances between Cities* (Beirut: American University of Beirut, 1967), 198–99.

FIG. 6.4. AL-BĪRŪNĪ'S SKETCH MAP OF THE DISTRIBUTION OF LAND AND SEA. Copy from a manuscript of al-Bīrūnī's *Kitāb al-tafhīm*, dated 420/1029.
Diameter of the original: ca. 9.5 cm. By permission of the British Library, London (MS. Or. 8349, fol. 58a).

known today as an azimuthal equidistant projection and the other as a globular projection.[30] Finally, he made scientific comments on the distribution of land and water on the face of the globe.[31]

Few of these points were taken up by al-Bīrūnī's successors, and his scientific work exerted very little influence on future Islamic cartographers. No one took the azimuthal projection, drew a graticule, and placed toponyms in their proper places. If al-Bīrūnī himself did so, we have no surviving examples, and his successors do not mention it. Al-Bīrūnī's latitude and longitude refinements are incorporated in his tables and were copied to some extent after his death. Perhaps the most accepted piece of information was the distribution of land and water, because the eastern extension of southern Africa toward China, which was a prominent feature of the Islamic world map up to al-Bīrūnī's time, was now discontinued. Only al-Idrīsī and direct copies of earlier maps like those of the Balkhī school insisted that the African landmass filled the southern part of the *oikoumene* from west to east. Al-Bīrūnī's only direct contribution to cartography was a sketch map showing this distribution. It appears in the manuscripts of the *Kitāb al-tafhīm li-awā'il ṣinā'at al-tanjīm* (Book of instruction on the principles of the art of astrology) (copied 635/1238) and is his version of the circular world map showing how independent his thought was from the contemporary standard of Islamic cartography (fig. 6.4).[32] He so reduced this eastward extension of Africa, which was a legacy of Ptolemy, that the Indian Ocean appeared to cover the whole Southern Hemisphere. This sketch map was occasionally used directly by later authors—for instance, al-Qazwīnī in his cosmographical work *'Ajā'ib al-makhlūqāt* (see below)—but its influence was very clear in practically all future Islamic maps of the world.

Later Geographical Writers

From this time to the end of our period, there are a considerable number of geographical writers throughout the Islamic world whose works are basically taken from earlier authors. Some authors give a wider range of sources, and throughout the period there is a tendency to name sources, first by giving a list at the beginning of

30. Edward S. Kennedy and Marie-Thérèse Debarnot, "Two Mappings Proposed by Bīrūnī," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 1 (1984): 145–47, and J. L. Berggren, "Al-Bīrūnī on Plane Maps of the Sphere," *Journal for the History of Arabic Science* 6 (1982): 47–112. On the two projections, see J. A. Steers, *An Introduction to the Study of Map Projections*, 14th ed. (London: University of London Press, 1965), 71–73 and 159–61.

31. In the printed edition of *Kitāb al-tafhīm* edited and translated by Robert Ramsay Wright, *The Book of Instruction in the Elements of the Art of Astrology* (London: Luzac, 1934), this occurs on pp. 120–24 (reproduced from British Library, London, MS. Or. 8349). There is little new in the actual text, but the map that accompanies it on p. 124 shows for the first time this new conception of the world.

32. See Wright's translation of *Kitāb al-tafhīm* (note 31), where a copy is mentioned on p. 124. J. H. Kramers, "Djughrāfiyā," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), suppl. 61–73, esp. 72, has another version from a manuscript in Berlin (Staatsbibliothek Preussischer Kulturbesitz, MS. 5666). Yāqūt's version appears in his *Kitāb mu'jam al-buldān* (see *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld [Leipzig: F. A. Brockhaus, 1866–73], 1:22), and this is reproduced with the place-names translated in *The Introductory Chapters of Yāqūt's "Mu'jam al-buldān,"* ed. and trans. Wadie Jwaideh (Leiden: E. J. Brill, 1959; reprinted, 1987), 31. See also Seyyed Hossein Nasr, *Islamic Science: An Illustrated Study* (London: World of Islam Festival, 1976), 38 (figs. 14 and 15), and Miller, *Mappae arabicae*, Band 5, 125, 129 (note 7). Kamal, *Monumenta cartographica*, 3.3:713 (note 9), gives four versions of this sketch for comparison from manuscripts of al-Bīrūnī's *Kitāb al-tafhīm*, while 3.5:1050, illustrates two versions from manuscripts of al-Qazwīnī's *'Ajā'ib al-makhlūqāt*.

the work and then by quoting the source against the individual fact. Quite often two sources are quoted, giving different results for the same piece of information. Another variation is that some authors may use special sources—for instance, local sources on particular areas—so that they may be strong in such areas but follow the usual pattern for the main part of the work. There are generally two types of geographical productions: the general geographical treatise, usually divided by the Ptolemaic climates, and the work in dictionary form. There were also (partly because of the fractionalization of the Islamic area into small dynastic states) a growing number of works of local interest, again of both forms.

The main authors of general geographical treatises are al-Kharaqī (d. 533/1138), al-Zuhrī (fl. 530/1140), al-Idrīsī (d. 560/1165), al-Qazwīnī (d. 682/1283), Ibn Saʿīd (d. 685/1286), al-Dimashqī (d. 727/1327), Abū al-Fidāʾ (d. 732/1331), and Ibn al-Wardī (d. 861/1457). Dictionary compilers of importance were al-Bakrī (d. 487/1094) and Yāqūt (d. 626/1229).[33] Although some of these authors reproduced earlier sketch maps and climate diagrams, there are no detailed maps in any of the manuscripts of these works, apart from the work of al-Idrīsī.

Abū ʿAbdallāh Muḥammad ibn Muḥammad al-Sharīf al-Idrīsī is the outstanding person in Islamic cartography. There has survived in his name a set of maps that are so important that they have been described separately in chapter 7. In spite of this importance, al-Idrīsī's influence on future Islamic cartography was minimal, and those authors who have been influenced by him (in the format of their geographical works or specifically in their maps) are discussed in that chapter below.

Thirteenth-Century and Later World Maps

By the thirteenth century we have three forms of world map that seem to persist through the following centuries in Islamic works, apart from continual reproductions of existing maps. The first of these is the world map found generally only in the work of Ibn al-Wardī (although it appears occasionally in the works of al-Qazwīnī and al-Ḥarrānī). The second is a sketch map based on al-Bīrūnī's sketch map of land and water distribution and elaborated on by al-Qazwīnī and some later authors. The third is the world map possibly based on the same model as that used in later recensions of Ibn Ḥawqal (III).

The Ibn al-Wardī world map was based on that of Ibn Ḥawqal I (plate 8 and compare fig. 5.16 above). It occurs regularly in the many copies of his *Kharīdat al-ʿajāʾib wa-farīdat al-gharāʾib* (The unbored pearl of wonders and the precious gem of marvels) and becomes a very stiff geometrical map, but always recognizable. It has the eastward extension of Africa containing the Mountains of the Moon, in which rises the Nile. This river then flows due west to make a right-angle turn to the north and enter the southeastern corner of the Mediterranean. Both the Mediterranean and the Indian Ocean have parallel north and south coasts, but the Arabian Peninsula is present as a semicircle surrounded by pincerlike arms of the Red Sea (Baḥr al-qulzum) and the Persian Gulf (Baḥr al-Yaman). The Bosporus too is prominent as a straight line of water directly opposite the mouth of the Nile.[34]

Ibn al-Wardī was known only from this one work, which is supposed to plagiarize the *Jāmiʿ al-funūn* (The gatherer of the sciences) of Aḥmad ibn Ḥamdān al-Ḥarrānī.[35] Ibn al-Wardī's work, however, was extremely popular, and there are many manuscripts of it in existence. Therefore most of the maps of this sort come from copies of his work. There is, however, a copy of al-Ḥarrānī's work in Gotha that contains one of these world maps, and it is possible that the map originated in the work of al-Ḥarrānī (fig. 6.5).[36] Unfortunately it is undated, but the map closely follows the geometrical pattern of those in the Ibn al-Wardī manuscripts.

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33. The only texts to appear in translation are al-Idrīsī's *Nuzhat al-mushtāq*; see *Géographie d'Edrisi*, 2 vols., trans. Pierre Amédée Emilien Probe Jaubert (Paris: Imprimerie Royale, 1836–40); Shams al-Dīn Abū ʿAbdallāh Muḥammad ibn Ibrāhīm al-Dimashqī's *Nukhbat al-dahr*; see *Manuel de la cosmographie du Moyen-Age*, ed. and trans. A. F. M. van Mehren (Copenhagen: C. A. Reitzel, 1874; reprinted Amsterdam: Meridian, 1964); and Abū al-Fidāʾ, *Taqwīm al-buldān*; see *Géographie d'Aboulféda: Traduite de l'arabe en français*, 2 vols. in 3 pts., trans. Joseph Toussaint Reinaud and S. Stanislas Guyard (Paris: Imprimerie Nationale, 1848–83). Al-Zuhrī's *Jaʿrāfīyah* has been edited by Hadj-Sadok with an introduction, "Kitāb al-Djaʿrāfiyya" (note 18); ʿAlī ibn Mūsā ibn Saʿīd al-Maghribī, *Kitāb basṭ al-arḍ fī ṭūlihā wa-al-ʿarḍ*; see *Libro de la extension de la tierra en longitud y latitud*, trans. Juan Vernet Ginés (Tetuan: Instituto Muley el-Hasan, 1958); Zakariyāʾ ibn Muḥammad al-Qazwīnī's *Āthār al-bilād* and *ʿAjāʾib al-makhlūqāt*; see *Zakarija ben Muhammed ben Mahmud el-Cazwini's Ḳosmographie*, 2 vols., ed. Ferdinand Wüstenfeld (Göttingen: Dieterichschen Buchhandlung, 1848–49; fascimile reprint Wiesbaden; Martin Sändig, 1967); and Sirāj al-Dīn Abū Ḥafṣ ʿUmar ibn al-Wardī, *Kharīdat al-ʿajāʾib*, only partly edited and translated by Carl Johann Tornberg, *Fragmentum libri Margarita mirabilium* (Uppsala, 1835–39) (there are also modern printed editions); Yāqūt's large dictionary, *Muʿjam al-buldān*, was edited by Wüstenfeld (note 32); and Abū ʿUbayd ʿAbdallāh ibn ʿAbd al-Azīz al-Bakrī's *Kitāb al-masālik wa-al-mamālik* and al-Kharaqī's *Muntahāʾ al-idrāk fī taqsīm al-aflāk* have never been published entirely. A set of six maps or diagrams from a single manuscript of Yāqūt's work is given in Kamal's *Monumenta cartographica*, 3.5:965 (note 9).

34. Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 75–79 (note 7), gives a number of versions of this Ibn al-Wardī world map. It also appears in Kamal, *Monumenta cartographica*, 3.5:971 (note 9), where it is reproduced from a Leiden manuscript of a work of Ibn al-ʿArabī.

35. Al-Ḥarrānī was a lawyer who flourished in Egypt. This Ibn al-Wardī (d. 861/1457) should not be confused with Ibn al-Wardī, a Syrian literary writer, who lived a hundred years earlier and was in fact a contemporary of al-Ḥarrānī.

36. Gotha, Forschungsbibliothek; MS. Orient A. 1513; see Wilhelm Pertsch, *Die orientalischen Handschriften der Herzoglichen Bibliothek*

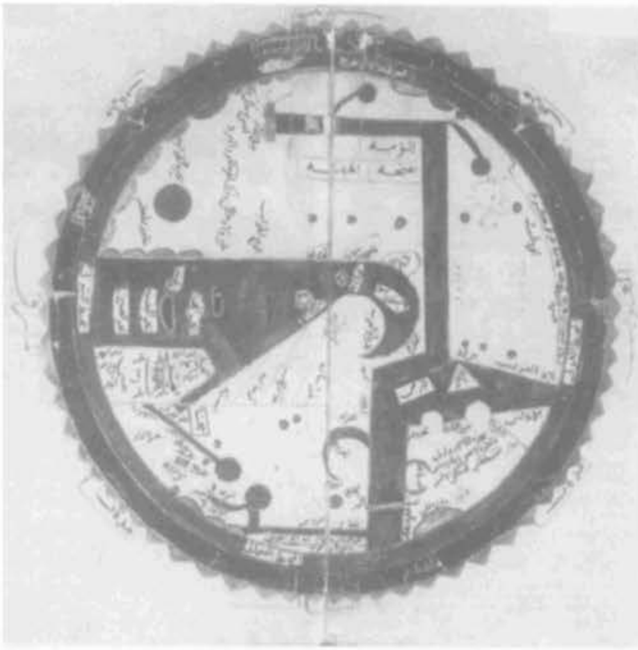

FIG. 6.5. WORLD MAP FROM AL-ḤARRĀNĪ'S *JĀMIʿ AL-FUNŪN*.
Size of the original: ca. 18 × 24 cm. By permission of the Forschungsbibliothek, Gotha (MS. Orient A. 1513, fols. 46b–47a).

A less stiff version of this map is found also in a manuscript of al-Qazwīnī's *ʿAjāʾib al-makhlūqāt* (plate 9).[37] It is dated on internal evidence to the early seventeenth century, although as a writer al-Qazwīnī (d. 682/1283) is considerably earlier than al-Ḥarrānī (fl. 730/1330) or Ibn al-Wardī (d. 861/1457). It is difficult to know whether the al-Qazwīnī map is the forerunner of the Ibn al-Wardī map or a less formal version developed at a later date. All three authors were cosmological writers whose works were popular right into the Ottoman period and in India.[38] The map from al-Qazwīnī's work has a flowing Nile instead of a rectangular one and a rather formless Mediterranean, though much of the rest has the geometrical stiffness of the true Ibn al-Wardī maps.

Most of the manuscripts of al-Qazwīnī's *ʿAjāʾib al-makhlūqāt* have a completely different map of the world. This is the second type of world map mentioned above, and it represents al-Bīrūnī's sketch map of the distribution of land and sea (compare fig. 6.4 above).[39] In al-Qazwīnī's texts this map tends to become stylized (fig. 6.6). The south coast of the land is stretched across the middle of the world circle and consists of a series of roughly parallel peninsulas separated by symmetrical bays.[40] These peninsulas are China, India, Arabia, and Africa. The northern coast of the landmass follows the circle around, leaving a series of indentations where Europe and the Mediterranean are expected. The Nile appears as a wide channel dividing Africa in two, and this may be the origin of the double peninsula for southern Africa that appears in some later maps. Finally, the Caspian Sea and the Aral Sea appear as two "bubbles" in the middle of the land.

The third type of world map was less stylized, taking considerably more notice of the accounts of the world written in geographical texts. It tends to be more detailed than those mentioned above, and Ptolemaic influence is noticeable. There were two varieties of this map, one with an eastward extension of Africa (hence making the Southern Hemisphere all land) and one following al-Bīrūnī's influence, which maintains an open Indian Ocean with the Southern Hemisphere mostly sea.

In fact, the first variety is limited to the circular world map of al-Idrīsī. This map, though it has many Ptolemaic features, has kept the look of al-Iṣṭakhrī's world map.[41] However, al-Idrīsī has much more detail and has also tidied it up, mainly by drawing in climate boundaries and inserting the material into the correct climate. This is the first time this information has appeared on a detailed world map.

It is possible that more detailed versions of the Ibn Ḥawqal III world map were produced in later times, and if so they would fit the first category of our classification here. Ibn Ḥawqal III and al-Idrīsī have several Ptolemaic features in common deriving from al-Khwārazmī that the open Indian Ocean maps do not have. The narrow entrance to the Indian Ocean and the peninsula of China with the islands of al-Fiḍḍah and Yāqūt beyond are common to Ibn Ḥawqal III and some versions of al-Idrīsī and are implicit from al-Khwārazmī's text, although Ptolemy's map is somewhat different. Al-Khwārazmī's version

zu Gotha, pt. 3, *Die arabischen Handschriften*, 5 vols. (Gotha: Perthes, 1878–92), vol. 3, no. 1513. No date is given for it.

37. Gotha, Forschungsbibliothek; see Pertsch, *Die arabischen Handschriften*, vol. 3, no. 1507 (note 36). The map is reproduced in Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 80 (Kazwini Goth.), and is mentioned in Band 5, 128–29 (note 7). It is also given by Kamal, *Monumenta cartographica*, 3.5:1049 (note 9).

38. See, for example, pp. 220–21 and 389–90.

39. Al-Qazwīnī was the author of two main works, a cosmography, *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt* (Marvels of things created and miraculous aspects of things existing), and a geography, *Āthār al-bilād* (Monuments of the lands). The influence of his texts on later geographical writers was considerable. The maps appear in copies of both works.

40. Other versions of this map are mentioned in note 32. Transliterations of al-Qazwīnī's version can also be found in Miller, *Mappae arabicae*, Band 5, 129–30 (Bild 6 and 7) (note 7).

41. For al-Idrīsī's circular world map, see pp. 160–62 and figs. 7.1 to 7.5 and plate 11.

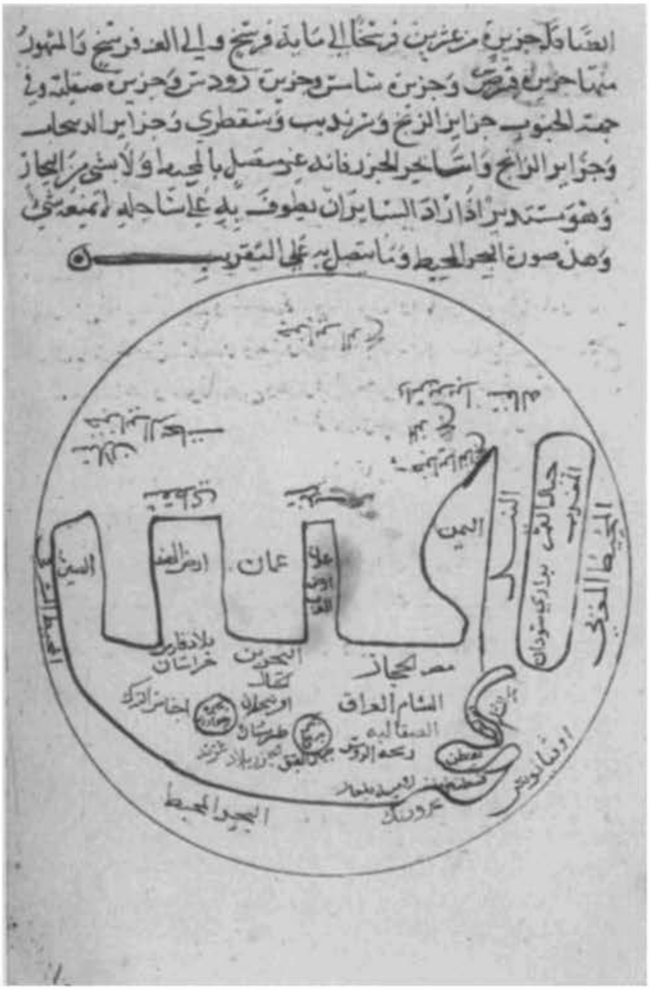

FIG. 6.6. AL-QAZWĪNĪ'S DISTRIBUTION OF LAND AND SEA. Copy from a manuscript of al-Qazwīnī's *ʿAjāʾib al-makhlūqāt*, dated 945/1539 and originating from al-Bīrūnī (compare fig. 6.4 above).
Diameter of the original: 13 cm. By permission of the Bodleian Library, Oxford (MS. Pococke 350, fol. 73v).

of Ptolemy's Nile is also in both of them. The Iberian Peninsula and the way Italy fits on to Europe are other common features and are also noticeable on the Bodleian map that follows. The Iberian Peninsula is triangular in both al-Idrīsī's map and the Bodleian map. This too is a Ptolemaic feature, but it is not so obvious on the Ibn Ḥawqal III world map.

The second variety of this world map with an open Indian Ocean is represented by a map found in a manuscript in the Bodleian Library, titled *Kitāb al-badʾ wa-al-taʾrīkh* (Book of beginning and history) (977/1569–70). Although the date of the map is very late, its derivation from Ibn Ḥawqal III is noticeable. However, one would expect a missing link somewhere between the two that may or may not have had the open Indian Ocean. For convenience I will refer to this map as the Bodleian map (plate 10). The work it accompanies is anonymous but was originally attributed to Ibn Saʿīd.[42] Kropp has shown that there is no connection with the work of Ibn Saʿid, and all we can really say is that it was produced in North Africa and in its present form dates from approximately the latter half of the sixteenth century, the period of the manuscript in which it is found.[43] But the origin of the map must be back in the twelfth or thirteenth century, and it is influenced by Ibn Ḥawqal III and by al-Bīrūnī's sketch of land and water distribution. Thus the southern half of the world circle consists mainly of water. The Northern Hemisphere is very similar to that of the circular world map of al-Idrīsī, and the pattern of arcs of circles for climatic boundaries is another feature derived from that author.[44] The south coast of Asia resembles more than anything else the same area from the Ibn Ḥawqal III world map, whereas Africa shows the two peninsulas mentioned earlier, with no landmass to the south and east—only an open ocean. This is what will be found in future Islamic world maps. This map is from the Islamic west in the al-Idrīsī tradition, but the same features will be seen in the map of Ḥamd Allāh Mustawfī in the east and in a later map of Indian origin. It is reasonably detailed and from this point of view excels the map of Ḥamd Allāh Mustawfī, but it cannot compare in detail of topographical content with the sectional maps of al-Idrīsī or the world map of his successor al-Ṣifāqsī. Nevertheless, it shows considerable development in geographical content and as such is extremely interesting.

Maps resembling this one survived until comparatively recent times, and degenerate copies appear from time to time, especially in the Indian subcontinent. An interesting and detailed map that must derive ultimately from this source exists in the Museum für Islamische Kunst in

42. Most of the maps attributed to Ibn Saʿīd by Miller and others who follow Miller are really from the later version of Ibn Ḥawqal (Ibn Ḥawqal III) mentioned earlier. Manuscripts of Ibn Saʿīd's work have no maps.

43. Oxford, Bodleian Library, MS. Laud. Or. 317. This manuscript and the map are discussed in an article by Manfred Kropp, who attributed the work to al-Shāwī al-Fāsī, the writer of the manuscript; see Manfred Kropp, " 'Kitāb al-badʾ wa-t-taʾrīḫ' von Abū l-Ḥasan ʿAlī ibn Aḥmad ibn ʿAlī ibn Aḥmad Aš-Šāwī al-Fāsī und sein Verhältnis zu dem 'Kitāb al-Ǧaʿrāfiyya' von az-Zuhrī,' " in *Proceedings of the Ninth Congress of the Union Européenne des Arabisants et Islamisants, Amsterdam, 1st to 7th September, 1978*, ed. Rudolph Peters (Leiden: E. J. Brill, 1981), 153–68. A legend on the map states that the map is compiled according to an account taken by al-Kindī and al-Sarakhsī from the book of Ptolemy. This is a dubious statement, since these two authors were not geographers and are not mentioned in connection with maps until centuries after their deaths.

44. Kropp, " 'Kitāb al-badʾ' " (note 43), compares the text that accompanies the map with that of al-Ṣifāqsī and also with that of al-Zuhrī. The former writer was certainly influenced by al-Idrīsī. Details of the al-Sharafī al-Ṣifāqsī family and their maps can be found below, pp. 284–87, and in Miller, *Mappae arabicae*, Band 5, 175–77, and Band 6, Taf. 79–80 (note 7).

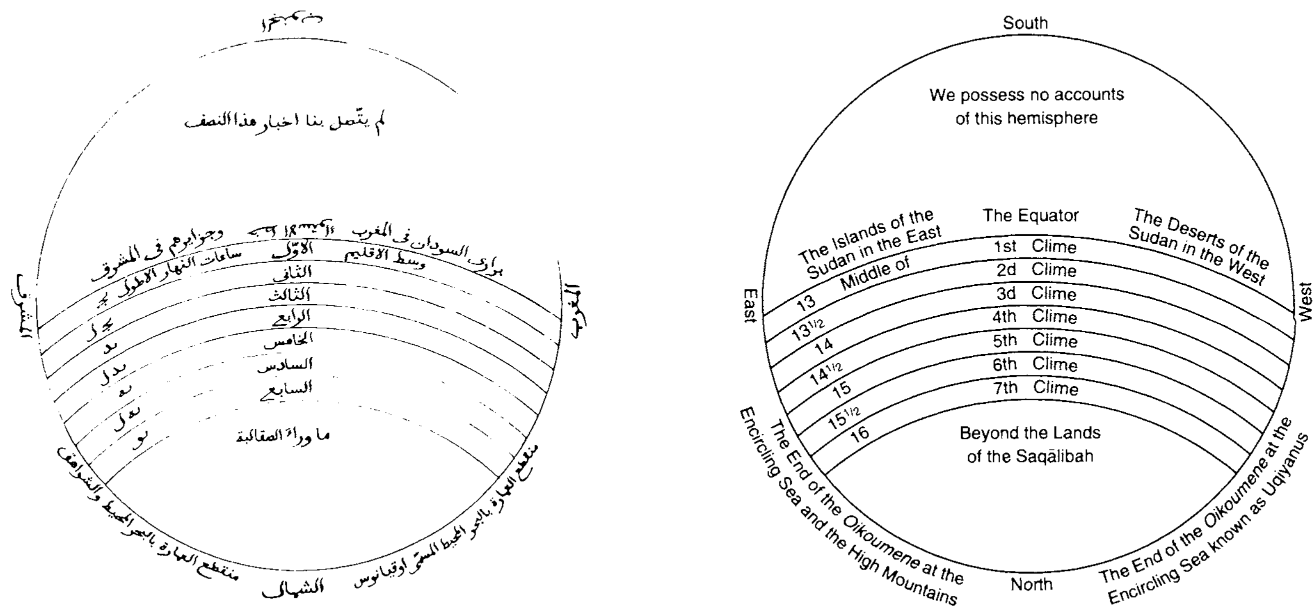

FIG. 6.7. THE CLIMATE (ZONE) MAP. The simple climate diagram as reproduced by Yāqūt from the printed edition of his *Muʿjam al-buldān*. Translation on the right.
Diameter of the original: ca. 12 cm. From *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld (Leipzig: F. A. Brockhaus, 1866–73), vol. 1, between pp. 28 and 29 (fig. 4), by permission of F. A. Brockhaus.

Berlin[45] and probably comes from the eighteenth century. It is basically an Arab map in Arabic, though some Persian forms appear and place-names in India are given in both Arabic and Hindi scripts. However, the whole map is nothing but a very decadent and late version whose ancestry goes back through some map similar to the Bodleian map to a version of Ibn Ḥawqal III, but without an African landmass spreading throughout the Southern Hemisphere. As an Indian map it has been described in detail and illustrated in part 2 of this volume (pp. 394–96, fig. 17.4, and plate 29).

The semicircular world map from the work of Ṣādiq Iṣfahānī (illustrated below, fig. 17.1) shows a similar derivation, as do several other maps of Indian origin that have been published.[46] The later they are, the more decadent they appear. The map (albeit in a European copy) Bagrow illustrates as a Persian map[47] may not appear to be related either to the world map of Ibn Ḥawqal III or to that of al-Idrīsī. It is nevertheless their ultimate descendant through a long series of maps in the Indian subcontinent.[48]

Climatic (Zone) Maps and Their Variants

Here I must mention a secondary cartographic development in the Islamic world, the climate map similar in design to that of Pierre d'Ailly (fourteenth-fifteenth century A.D.) in Europe.[49] This map develops from a cosmographical diagram whose origin is difficult to place.

The simplest and possibly the earliest form of this diagram consisted of a world circle with straight lines across it demarcating the climates. A version of this appears in al-Idrīsī's *Rawḍ al-faraj wa-nuzhat al-muhaj* (Gardens of pleasure and recreation of the souls) (dated A.D.

45. Klaus Brisch et al., *Islamische Kunst in Berlin: Katalog, Museum für Islamische Kunst* (Berlin: Bruno Hessling, 1971), "Weltkarte mit Miniaturen aus dem Alexanderroman" (no. 3, pp. 12–13) and fig. 23.

46. The world map comes from a set of maps in a manuscript in the British Library (MS. Egerton 1016) of the *Shāhid-i Ṣādiq* (Persian atlas) of the geographer/encyclopedist Ṣādiq Iṣfahānī (d. ca. A.D. 1680). The regional maps of this set resemble al-Idrīsī in that they fit together to give world coverage. They improve on al-Idrīsī cartographically in that they are formed on a grid of equal-sized squares whose sides are one degree in length. I am indebted to Susan Gole for acquainting me with the existence of this set. See figs. 17.9 and 17.10 below.

47. See below, fig. 17.2, and Leo Bagrow, *History of Cartography*, rev. and enl. R. A. Skelton, trans. D. L. Paisey (Cambridge: Harvard University Press; London: C. A. Watts, 1964; reprinted and enlarged, Chicago: Precedent, 1985), fig. 72 (p. 209).

48. Susan Gole also introduced me to these maps. They include one published by William Ouseley, "Account of an Original Asiatick Map of the World," in *The Oriental Collections*, vol. 3 (London: Cadell and Davies, 1799), 76–77, and one illustrated in Bagrow, *History of Cartography* (note 47), originally published by Edward Rehatsek, "Fac-simile of a Persian Map of the World, with an English Translation," *Indian Antiquary* 1 (1872): 369–70. Another similar map shown to me was a loose sheet found in a Delhi bazaar in 1984; see below, pp. 392–94 and figs. 17.2 and 17.3.

49. David Woodward, "Medieval *Mappaemundi*," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:286–370, esp. 253–54.

FIG. 6.8. A MORE ELABORATE CLIMATE DIAGRAM. This example shows vestiges of a coastline and comes from the *Āthār al-bilād* of al-Qazwīnī; manuscript dated 729/1329. Diameter of the original: ca. 16 cm. By permission of the British Library, London (MS. Or. 3623, fol. 5).

1192).[50] Other authors, however, prefer a diagram with climate boundaries drawn as arcs of a circle, as shown by Yāqūt in his *Kitāb muʿjam al-buldān* (Dictionary of countries), which is dated about A.D. 1224 (fig. 6.7). But in the climate (zone) maps of the world that develop from this diagram it is the straight boundaries that are most common; the arced variety are relatively rare. The arced boundary lines, however, appear on more detailed world maps like those of al-Idrīsī and the Bodleian map already mentioned.[51]

The next elaboration is the insertion of the names of countries and other features between the climate lines. This form occurs in some manuscripts of al-Qazwīnī's *ʿAjāʾib al-makhlūqāt* and his *Āthār al-bilād*, and also in one Ibn Ḥawqal manuscript (Paris, Bibliothèque Nationale, MS. 2214, which contains the abridgment of Ibn Ḥawqal) (see fig. 3.6). Whichever is the earliest manuscript would therefore represent the first appearance in Islamic sources of this type of climatic diagram.[52] A further development occurs in some of the al-Qazwīnī manuscripts when short lines are inserted that represent linear features on the earth's surface such as coastlines (fig. 6.8), and this is taken still further in some Syriac maps of this period that show an almost continuous coastline (the world landmass can often be clearly seen). The Syriac maps also have considerably more detail in the toponymy and are distinguished by representing only the northern part of the inhabited world in a semicircle instead of showing a full circle as in the Islamic diagrams (fig. 6.9).[53]

As I said, the origin of this sort of diagram is difficult to ascertain. The earliest and simplest example comes from Europe in a diagram of Petrus Alphonsus that dates from approximately A.D. 1100.[54] There seems to be nothing in Arabic texts before A.D. 1200, however. Yāqūt seems to attribute his version of this diagram to al-Bīrūnī,[55] but the extant texts of al-Bīrūnī do not give the diagram—only a table of climate boundaries with latitude values.[56] Al-Bīrūnī would be earlier than Petrus Alphonsus, and it is interesting that Petrus Alphonsus fills the southern half of his map with a representation of the city of Arīn, a conception that must have come from the

50. The climate diagram from al-Idrīsī's *Rawḍ al-faraj* is reproduced below, fig. 7.16.

51. Compare the world map from al-Idrīsī's *Nuzhat al-mushtāq* and the Bodleian map previously mentioned.

52. The earliest dated version of the map is 729/1329, in the British Library's manuscript of al-Qazwīnī (MS. Or. 3623, fol. 5r); the Paris manuscript is dated 847/1445. Two reproductions of climate diagrams from al-Qazwīnī's *Āthār al-bilād* appear in Kamal, *Monumenta cartographica*, 3.5:1050 (note 9). Reproductions of the zonal map from the Paris manuscript can be seen in Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 71 (Paris$_2$) (note 7), and in Kamal, *Monumenta cartographica*, 3.3:811 (note 9). The other manuscripts of this Ibn Ḥawqal abridgment do not seem to have this map.

53. These Syriac maps are four slightly different versions of a climate map, three appearing in three manuscripts of the *Menāreth qudhshē* (The candlestick of the sanctuary) of Bar Hebraeus (A.D. 1226–86) and one in an Arabic-Syriac lexicon by Bar ʿAlī that was written in the latter part of the twelfth century. The surviving manuscripts were not written before A.D. 1400, however, and the form of the map leads us to assume that this map was a development of the Islamic climatic map that appears in al-Qazwīnī's work. The four manuscript maps are (1) Paris, Bibliothèque Nationale, MS. Syr. 210, fol. 38r (A.D. 1404); (2) Paris, Bibliothèque Nationale, MS. Syr. 299 (Bar ʿAlī lexicon), fol. 204v (A.D. 1499); (3) Berlin, Staatsbibliothek Preussischer Kulturbesitz, no. 190 (MS. Sachau 81) (A.D. 1403); and (4) Cambridge University Library, MS. Add. 2008 (fifteenth century A.D.). All are in Miller, *Mappae arabicae*, Band 5, 168–72 (Bild 25 and 26) (Paris manuscripts), Band 5, Beiheft, Taf. 81 (Berlin and Cambridge manuscripts) (note 7). The first three are also illustrated by Kamal, *Monumenta cartographica*, 4.1:1096 (nos. 1 and 3) and 1097 (no. 2) (note 9).

54. Woodward, "Medieval *Mappaemundi*," 354–55 (note 49).

55. Yāqūt, *Muʿjam al-buldān*; see Wüstenfeld's edition, 1:27–28 (note 32).

56. Al-Bīrūnī, *Kitāb al-tafhīm*; see the translation by Wright, 138 (note 31).

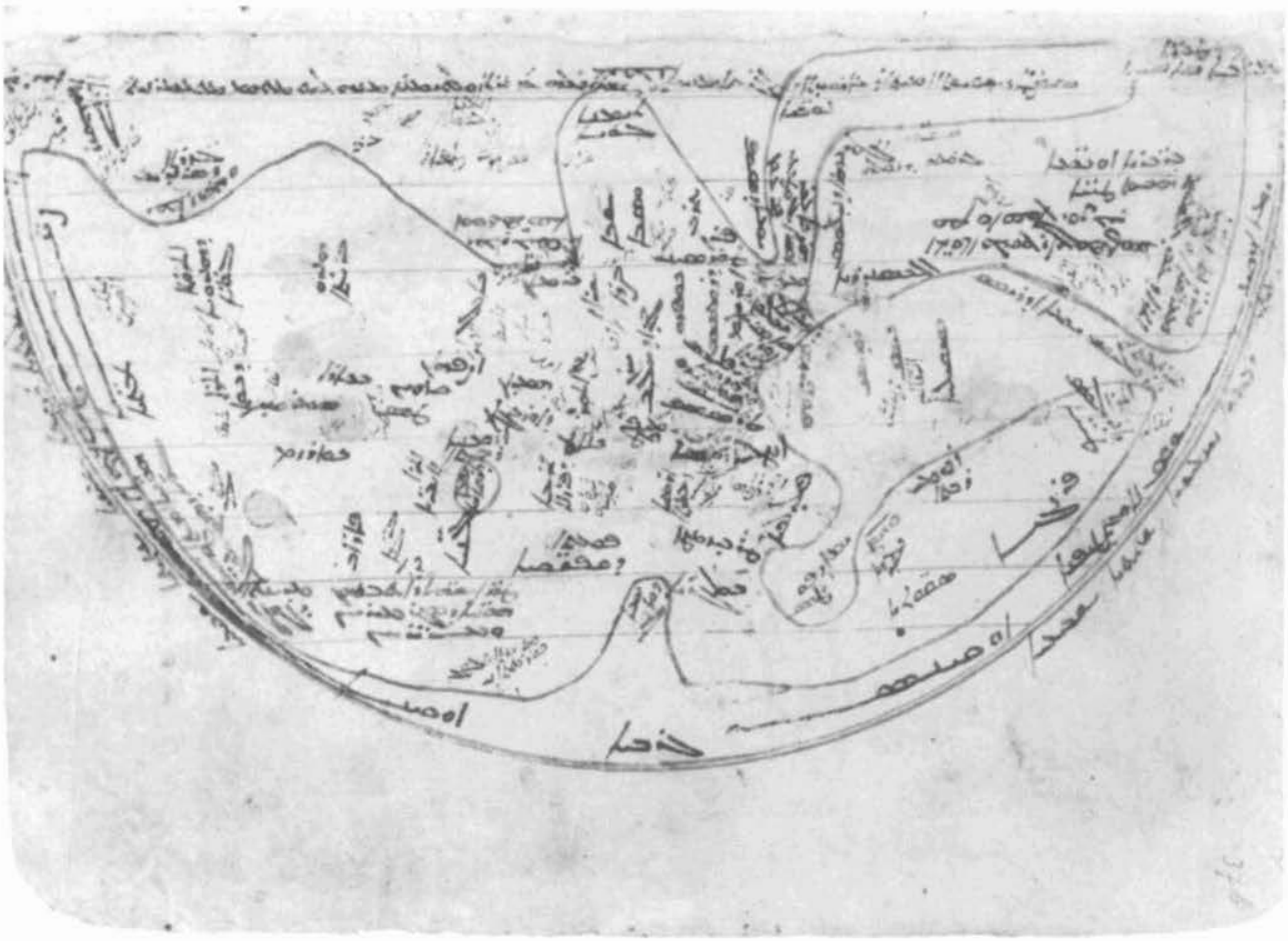

FIG. 6.9. SYRIAC MAP BASED ON THE ARAB CLIMATE DIAGRAM. This is taken from Bar Hebraeus, *Menāreth qudhshē*.

Size of the original: not known. By permission of the Staatsbibliothek Preussischer Kulturbesitz, Berlin (Orientabteilung, MS. Sachau 81, fol. 37b).

Arabs. Although it is mentioned by the Arabs much earlier,[57] the concept looms large in al-Bīrūnī because of his interest in things Indian.[58] Yet it is still possible that the origin of this diagram is from the classical world and was known to both the Muslims and the medieval Europeans. Macrobius's zonal maps seem to be related, but the Islamic maps seldom have the tropics marked—they show only the climate divisions. The equator is often mentioned along the southern boundary of the first climate. The final development as shown in the Syriac maps mentioned above does not appear in European texts. The most elaborate of these maps in Europe, dated about A.D. 1410—that of Pierre d'Ailly—is not advanced enough in the sequence to include a rudimentary coastline.[59]

First Use of a Graticule

The final development of medieval Islamic cartography was the attempt to place a graticule on the Islamic circular world map. This was first attempted not with a graticule of degrees of longitude and latitude, but with the insertion of climate divisions onto the map. This latter can first be seen through the development of the climate dia-

57. The first Arab use of Arīn appears in Ibn Rustah ca. 290/900; see p. 103 above and J. H. Kramers, "Geography and Commerce," in *The Legacy of Islam*, ed. Thomas Arnold and Alfred Guillaume (Oxford: Oxford University Press, 1931), 78–107, esp. 93.

58. Al-Bīrūnī's reference is from his history of India; see *Alberuni's India: An Account of the Religion, Philosophy, Literature, Geography, Chronology, Astronomy, Customs, Laws and Astrology of India about A.D. 1030*, 2 vols., ed. Eduard Sachau (London: Trübner, 1888; Delhi: S. Chand, [1964]), 1:304.

59. Pierre d'Ailly's map is reproduced in Bagrow, *History of Cartography*, 48–49 (figs. 7a and b) (note 47), and in Joachim G. Leithäuser, *Mappae mundi: Die geistige Eroberung der Welt* (Berlin: Safari-Verlag, 1958), 161, 173. Those of Macrobius are given in Woodward, "Medieval *Mappaemundi*," 300 (fig. 18.10) and 354 (fig. 18.70) (note 54). For discussion of other climate diagrams in a cosmographical context, see pp. 76–80.

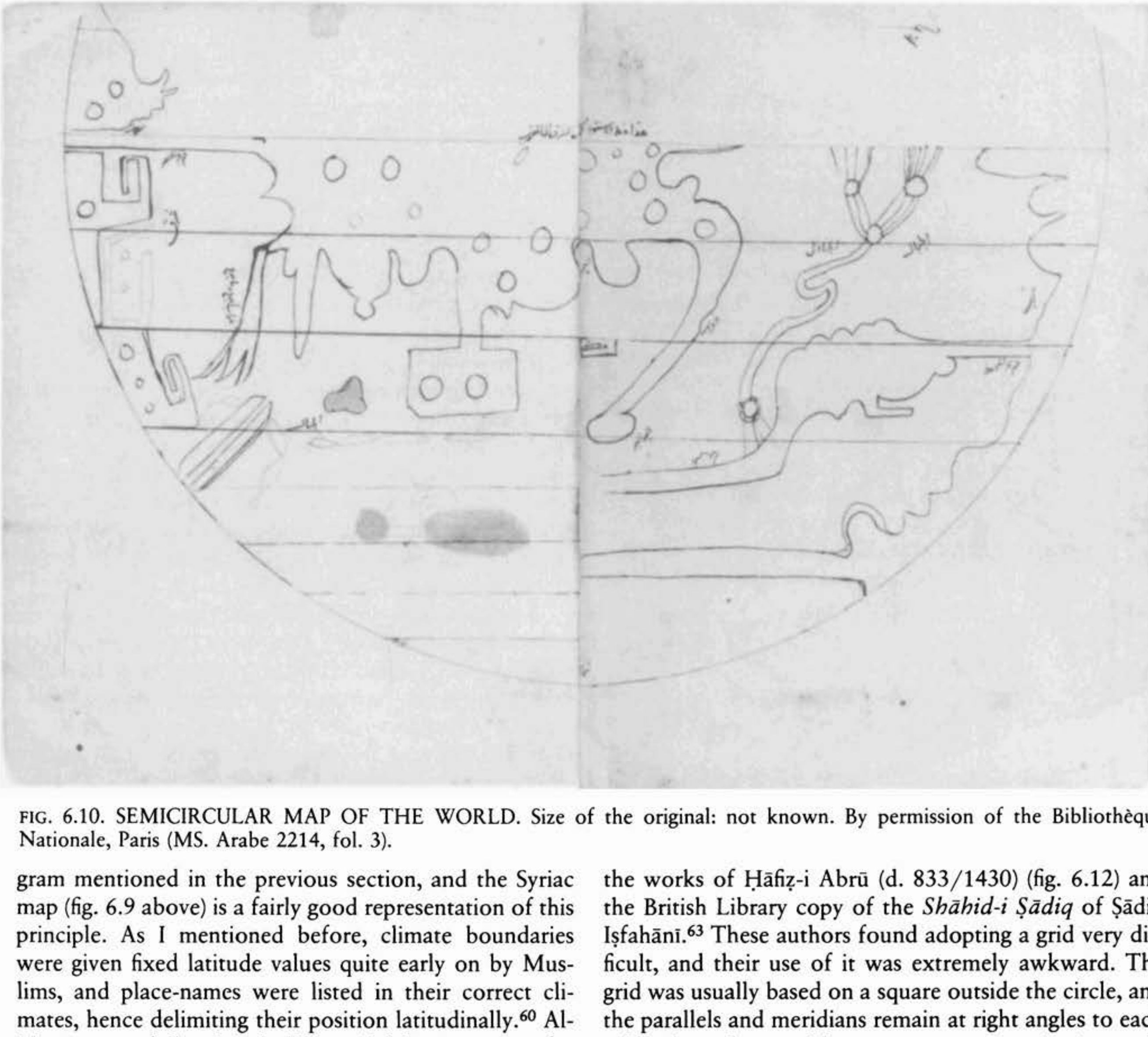

FIG. 6.10. SEMICIRCULAR MAP OF THE WORLD. Size of the original: not known. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2214, fol. 3).

gram mentioned in the previous section, and the Syriac map (fig. 6.9 above) is a fairly good representation of this principle. As I mentioned before, climate boundaries were given fixed latitude values quite early on by Muslims, and place-names were listed in their correct climates, hence delimiting their position latitudinally.[60] Al-Idrīsī successfully placed climate divisions as arcs of a circle on his circular world map and transferred them to his sectional maps as straight lines (or vice versa).[61] The Paris abridgment of Ibn Ḥawqal, in addition to its climate division diagram based on a complete circle and its oval world map, contains a semicircular map of the world with the climate divisions marked as straight lines (fig. 6.10).[62] This map has little nomenclature but has a continuous coastline based on the oval world map. However, it differs in form from the Syriac maps.

Attempts to place the world on a graticule of lines of longitude as well as latitude, which would of course simply be perpendicular to climate divisions, were fraught with difficulties. Nevertheless, by the fourteenth century such attempts were made. The earliest are two world maps attached to the work *Nuzhat al-qulūb* (Diversion for the hearts) of Ḥamd Allāh Mustawfī, a Persian writer who died in 740/1339 (fig. 6.11). Similar maps appear in the works of Ḥāfiẓ-i Abrū (d. 833/1430) (fig. 6.12) and the British Library copy of the *Shāhid-i Ṣādiq* of Ṣādiq Iṣfahānī.[63] These authors found adopting a grid very difficult, and their use of it was extremely awkward. The grid was usually based on a square outside the circle, and the parallels and meridians remain at right angles to each other throughout, with no attempt at a projection to fit

60. See chapter 4, esp. pp. 97ff.

61. The straight lines are the top and bottom borders of his sectional maps.

62. This is also reproduced in Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 71 (Paris$_3$) (note 7).

63. Ḥamd Allāh ibn Abī Bakr al-Mustawfī Qazvīnī's main work was the *Nuzhat al-qulūb*, a mainly cosmographical and geographical work, which is best known for the light it sheds on the history of the end of the Ilkhanid Empire. There are four manuscripts in the British Library containing maps: MS. Or. 7709, MS. Or. 23543, MS. Or. 23544, and MS. Add. 16736. The world maps from two of these are reproduced in Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 83 (note 7). Ḥāfiẓ-i Abrū (ʿAbdallāh ibn Luṭf Allāh al-Bihdādīnī, d. 833/1430) was a Persian historian at the time of Tīmūr and Shāhrukh. His maps appear in an untitled and unfinished geographical work written for Shāhrukh between A.D. 1414 and 1420, said to be a translation from the Arabic. In addition to the world map illustrated in fig. 6.12, a world map by Ḥāfiẓ-i Abrū appears in British Library, MS. Or. 1987. For Sādiq Isfahānī's world map, see fig. 17.1 below.

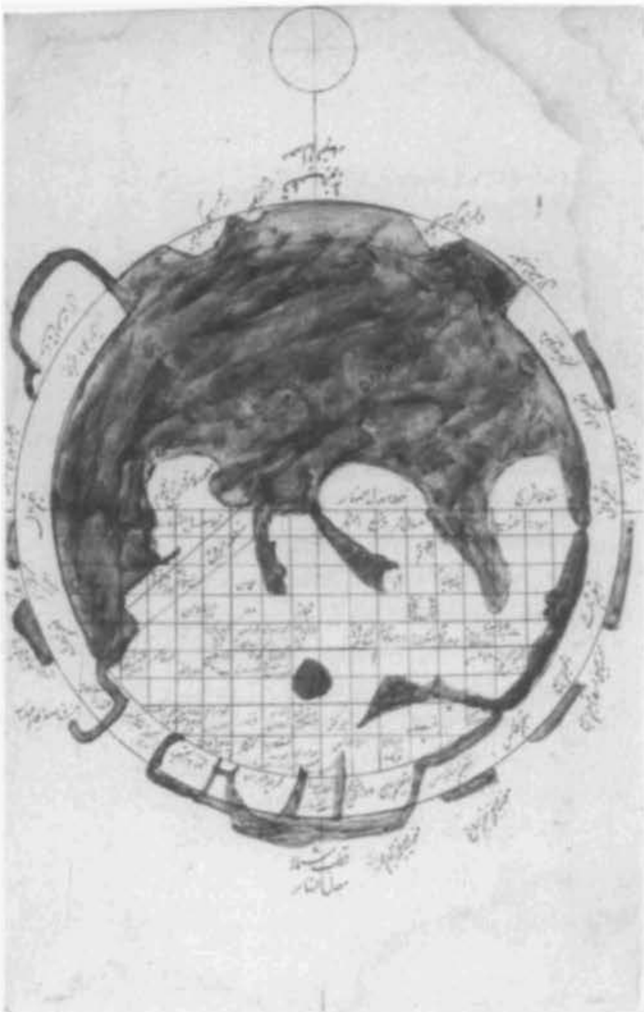

FIG. 6.11. WORLD MAP OF ḤAMD ALLĀH MUSTAWFĪ. From a seventeenth-century manuscript copy of his work *Nuzhat al-qulūb*.
Diameter of the original: ca. 15.5 cm. By permission of the British Library, London (Add. MS. 23544, fol. 226v).

into the circle. The Ḥamd Allāh Mustawfī maps have removed that part of the grid that is left outside the circle, whereas Ḥāfiẓ-i Abrū retains it: Sādiq show only vestiges of this outer grid. Ḥāfiẓ-i Abrū also has five-degree squares instead of the usual ten-degree squares, and in some cases there is a smaller grid on land or on the northern half of the grid.

The form of the world landmass in the maps of these authors does not resemble either that of the Balkhī school or al-Idrīsī. It derives ultimately from the sketch of al-Bīrūnī showing the land-water relationship, probably through al-Qazwīnī. There are comparisons with the Bodleian map mentioned above, but unlike maps of this latter sort, it has a very simple coastline. All the geographical toponyms are written on the land, including the graticule when it appears inside the world circle, leaving the sea (usually colored a heavy blue) completely featureless. Ḥamd Allāh Mustawfī also divides Africa into two peninsulas like the Bodleian map. Generally Ḥamd Allāh Mustawfī's map has more original features and Ḥāfiẓ-i Abrū's is more conventional and schematic. Climate divisions are given by Ḥāfiẓ-i Abrū outside the square of the graticule, but the climate lines are not very successfully aligned with the graticule. Ḥamd Allāh Mustawfī only numbers the climates in the outer edge of the circle.

In addition, Ḥamd Allāh Mustawfī drew a map of the Iranian-Turkestan area that was highly original when it was first drawn in the fourteenth century (fig. 6.13). Longitude and latitude lines appear, forming a graticule of one-degree squares, and in a square only one location is given, which has the coordinates belonging to that square. In two manuscripts of this map, a coastline is given but no other linear features, and a third version does not bother with a coastline.[64] Ḥāfiẓ-i Abrū has other maps of the Mediterranean and Persian seas, but they are only outline maps and are taken more or less directly from those of al-Iṣṭakhrī.

There is a map of the world reproduced in a manuscript of the work of Aḥmad ibn Yaḥyā ibn Faḍl Allāh al-ʿUmarī (d. 749/1349) titled *Masālik al-abṣār fī mamālik al-amṣār* (Ways of perception concerning the most populous [civilized] provinces) (fig. 6.14). The same manuscript also has maps of the first three climates. Although the climates are not divided into sections, the general impression is that the maps are derived from those of al-Idrīsī. These maps have been referred to by Fuat Sezgin and dated A.D. 1340, making them contemporary with the author of the work, Ibn Faḍl Allāh al-ʿUmarī.[65] There is no reason why the geographical information on the world map should not date from the time of Ibn Faḍl Allāh al-ʿUmarī; as I have said, it is ultimately derived from al-Idrīsī. However, from its appearance it seems to have been compiled from the text of the *Kitāb basṭ al-arḍ fī ṭūlihā wa-al-ʿarḍ* (Exposition of the earth in length and

64. The varying versions of this map are shown in Miller, *Mappae arabicae*, Band 5, Beiheft, Taf. 84–86 (note 7). British Library, MS. Or. 7709, has no coastline. Joseph Needham thinks these grids show Chinese influence because of their equal-sized squares; see his *Science and Civilisation in China* (Cambridge: Cambridge University Press, 1954–), vol. 3, *Mathematics and the Sciences of the Heavens and the Earth* (1959), 564–65. However, the typical Chinese grid is based on linear measurement on the ground and not on angular measure (latitudes and longitudes) like these Islamic grids. Placing nomenclature in the squares instead of against an actual point is reminiscent of Chinese mapping, however.

65. Fuat Sezgin, *The Contribution of the Arabic-Islamic Geographers to the Formation of the World Map* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), 41 and figs. 11–14. Karatay in his bibliography of Arabic manuscripts in the Topkapı Sarayı usually mentions maps in the description of a manuscript, but he does not mention any for this one or for any manuscript of this work; Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Arapça Yazmalar Kataloğu*, 3 vols. (Istanbul: Topkapı Sarayı Müzesi, 1962–66).

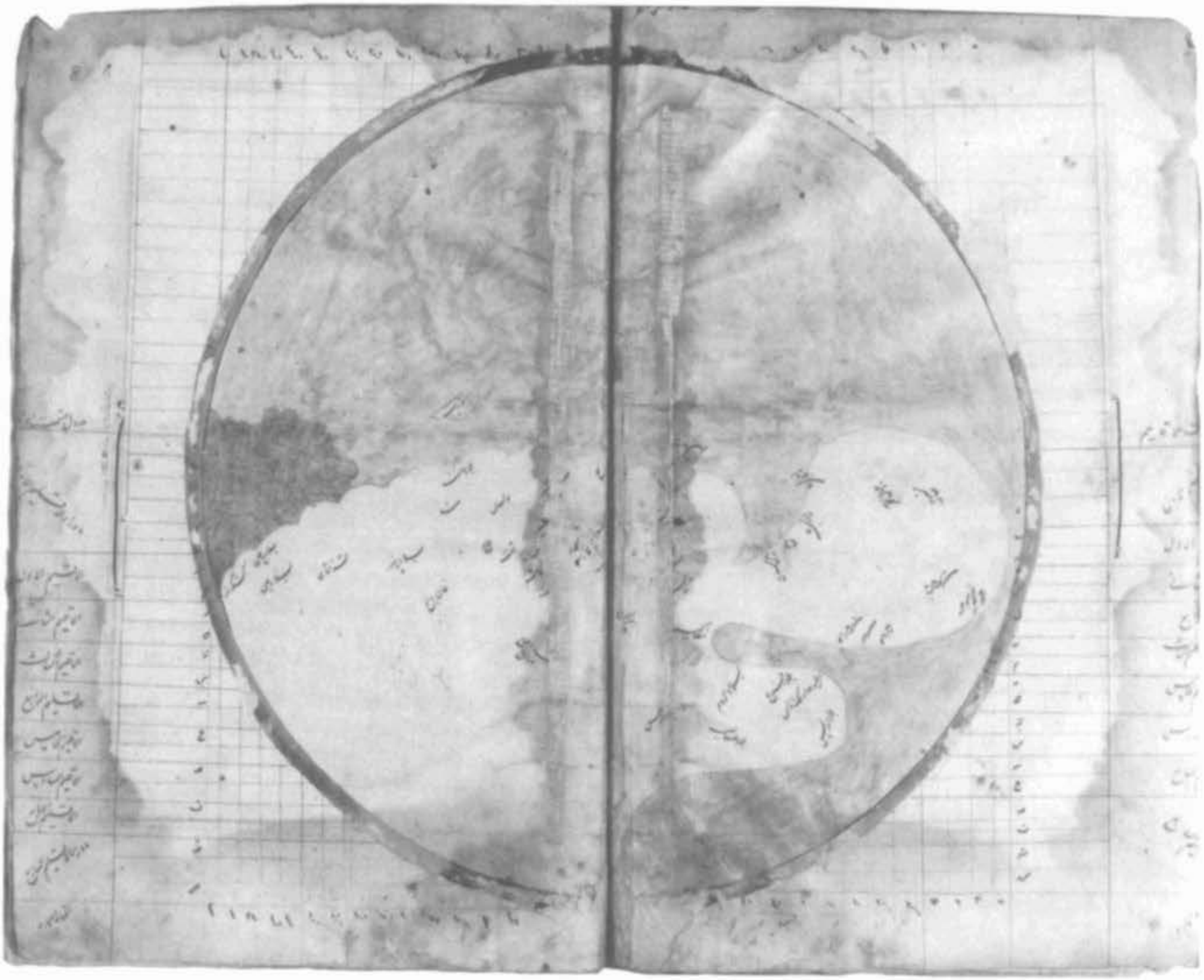

FIG. 6.12. WORLD MAP OF ḤĀFIẒ-I ABRŪ. From a manuscript of his work dated 1056/1646. Diameter of the original: ca. 29.5 cm. By permission of the British Library, London (MS. Or. 1577, fols. 7v–8r).

breadth) by Ibn Saʿīd (d. 685/1286). This is the only set of Islamic maps I have seen that could be said to have been so compiled. Al-ʿUmarī's text does mention a map and gives a few examples of longitude and latitude, but on the whole they do not correspond with the positions given on the world map.

An accurate graticule has been drawn over the world map such as I have not come across on Islamic maps of the fourteenth or even fifteenth century A.D. One cannot be certain on the origin of this graticule without seeing the original, but it looks as if the draftsman added the graticule when copying the map for this manuscript. It is likely that the original would have had a series of straight parallels representing the climate boundaries and that these were changed by the draftsman into a kind of orthographic graticule with equidistant parallels of latitude, much as the climate boundaries probably were before (some manuscripts of al-Idrīsī's world map have equidistant climate boundaries when drawn either as arcs or as straight lines). This graticule, with straight lines for parallels and arcs for meridians, appears similar to the projection Roger Bacon suggested in his *Opus Maius* (ca. A.D. 1267), but of course it is not so; the parallels are positioned according to a different principle.

Most of the Istanbul manuscripts of Ibn Faḍl Allāh's al-ʿUmarī's work are not dated. However, the earliest one to be dated is A.D. 1585, suggesting that this and most other copies were prepared for the libraries of the Ottoman sultans of that period. By that time the idea of a graticule was well known from European sources and could have been added to bring the map up to date. Note that the latitudes and longitudes given by Ibn Saʿīd for toponyms do not correspond to the actual positions on the map for the same toponyms.

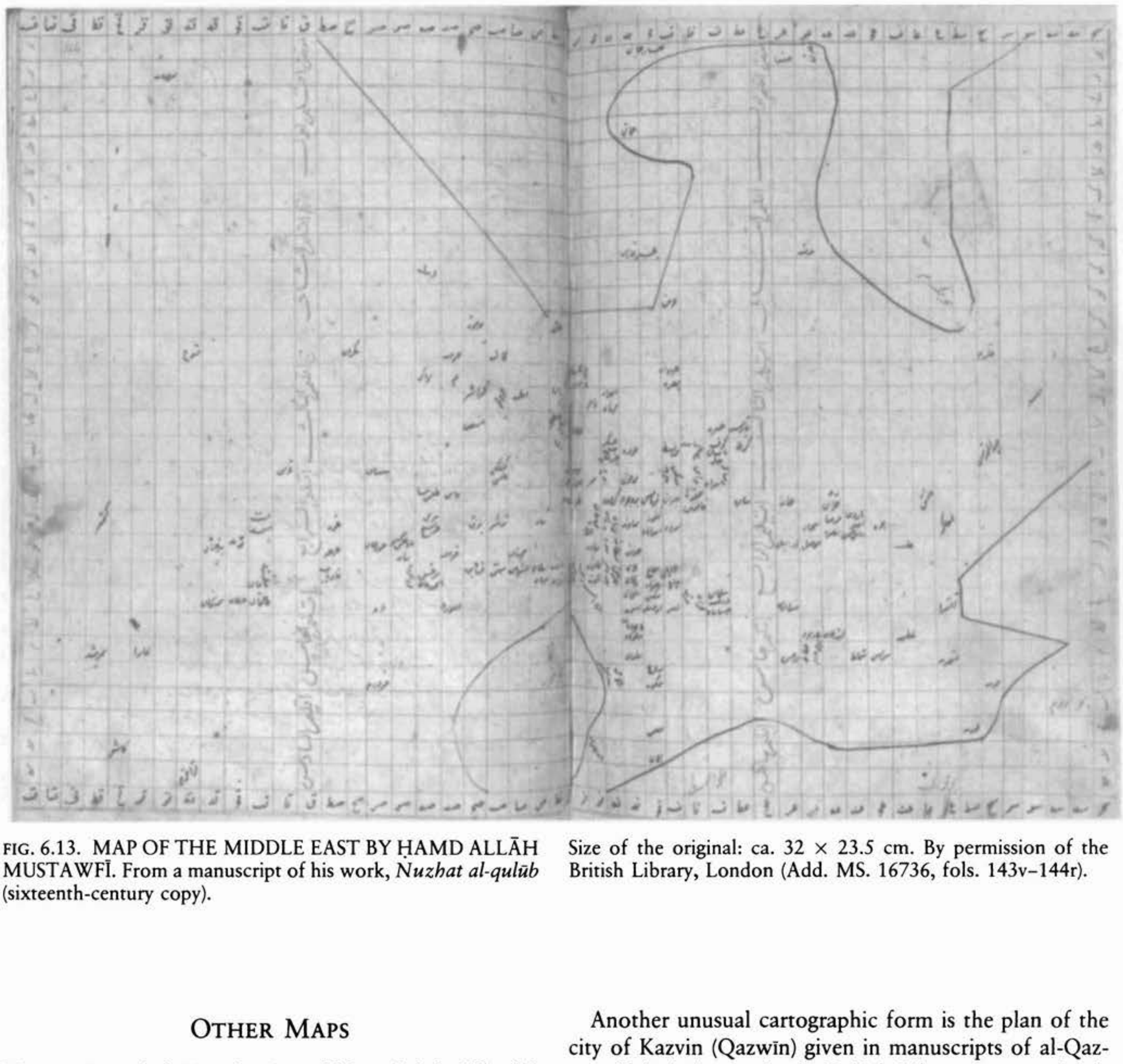

FIG. 6.13. MAP OF THE MIDDLE EAST BY ḤAMD ALLĀH MUSTAWFĪ. From a manuscript of his work, *Nuzhat al-qulūb* (sixteenth-century copy). Size of the original: ca. 32 × 23.5 cm. By permission of the British Library, London (Add. MS. 16736, fols. 143v–144r).

Other Maps

Manuscripts of al-Dimashqī's *Nukhbat al-dahr fī ʿajāʾib al-barr wa-al-baḥr* (Gems [selections] of the age from the marvels of the land and the sea) contain an odd collection of sketch maps. First we have a representation of the Persian *kishvar* system arranged in column form (3, 1, 3) instead of the usual six *kishvar*s around a central one. Next there appears a very corrupt zonal map with no climate divisions but with countries arranged in columns, and finally a freehand drawing of the Mediterranean that resembles the sketch maps from the manuscript of al-Khwārazmī (fig. 6.15).[66] This sketch appears to have no importance for the development of Islamic cartography, but it is interesting because it has north at the top and shows no apparent resemblance to any other Mediterranean map either before or since.

Another unusual cartographic form is the plan of the city of Kazvin (Qazwīn) given in manuscripts of al-Qazwīnī.[67] As it occurs in the British Library manuscript, it is a very stylized diagram consisting of four concentric circles forming the regions (1) Sharistān, the old central city, (2) the larger modern (thirteenth-century) city, (3) the gardens, and (4) the surrounding cultivated fields (fig. 6.16). No orientation is given. As such this diagram could represent any Middle Eastern city, but superimposed on

66. Al-Dimashqī lived near Damascus, from which he takes his name. He wrote several books but is mainly known for his cosmographical and geographical compilation, the *Nukhbat al-dahr* (note 33). Transliterations of the two sketch maps in fig. 6.15 can be found in Miller, *Mappae arabicae*, Band 5, 140–41 (Bild 15–17) (note 7). Al-Khwārazmī's maps are illustrated above, figs. 4.8, 4.9, and plates 4 and 5.

67. A transliteration can be found in Miller, *Mappae arabicae*, Band 5, 132 (Bild 11) (note 7).

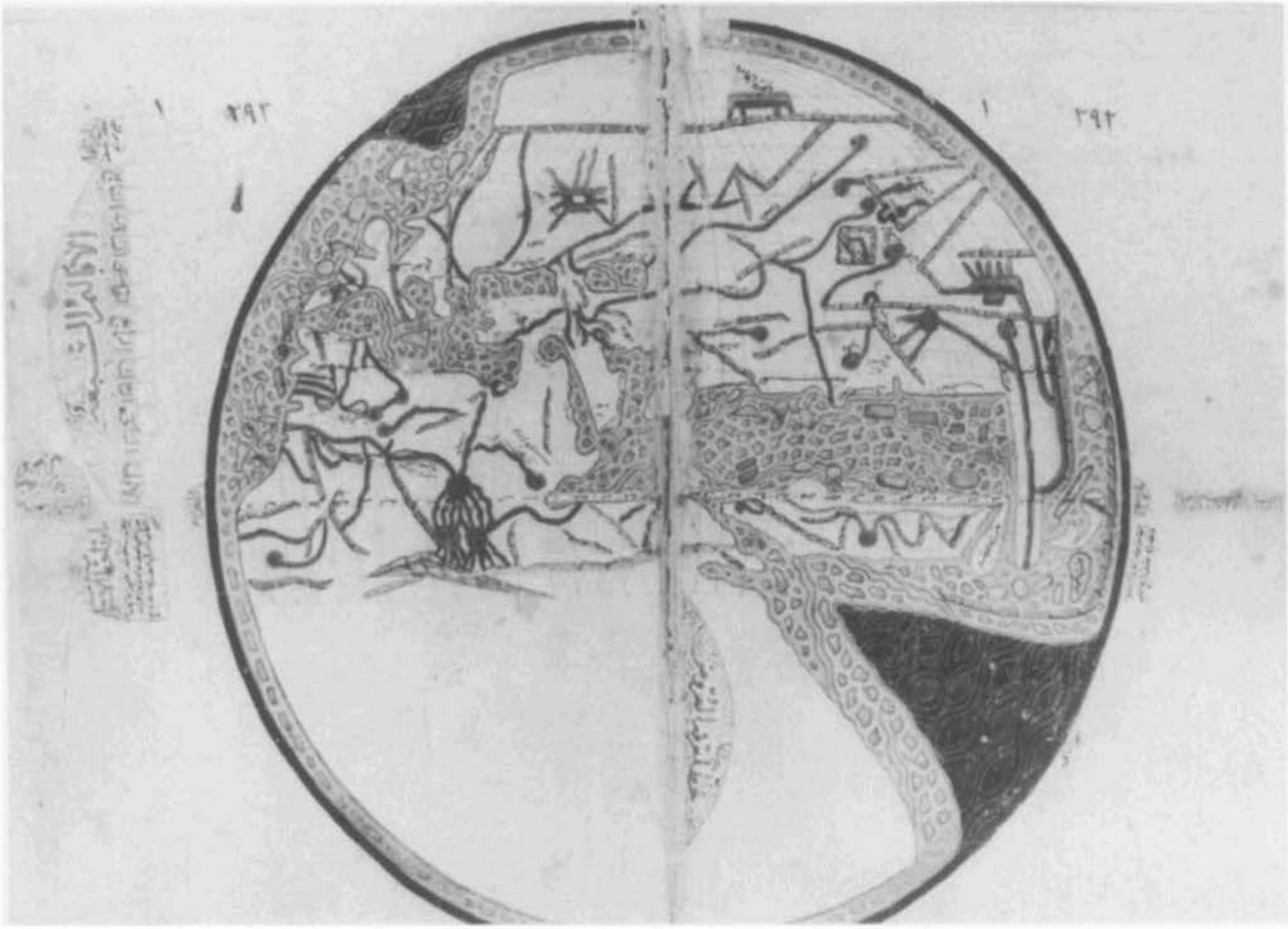

FIG. 6.14. WORLD MAP OF IBN FAḌL ALLĀH AL-ʿUMARĪ. The information on this map may derive ultimately from sources such as al-Idrīsī and Ibn Saʿīd. The graticule—which is most uncharacteristic for manuscripts from the fourteenth or even fifteenth century—appears to have been modified by a copyist at the time the map was drafted, perhaps in the sixteenth century.
Size of original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (A. 2797, fols. 292v–293r).

the whole are the two wadis or riverbeds that transverse the city of Kazvin, Wādī al-dharraj and the Wādī al-turk. The former flows right through the city, though it misses the old city, while the latter penetrates as far as the outer city and then performs a right-angle bend to depart. This second riverbed does not seem to exist on modern plans of the city.

The last map to be mentioned is that of al-Kāshgharī, a Turkish grammarian of the eleventh century A.D., whose map of the world appears as an illustration to his Turkish grammar.[68] This itself is unusual, and the map is certainly unlike any other map in Islamic literature. The individual elements of the map, symbols, and so forth, are all very much the same as those that appear on any other Islamic map, but its concept is most unusual (fig. 6.17). Although it is a map of the world, it is centered on the Turkish-speaking areas of Central Asia, with other countries receding from them toward the circumference of the world circle. In addition, the scale seems to be reduced as one gets nearer the edge of the map, so that one has the impression of a fish-eye representation of the globe with Turkestan magnified in the center.

68. Maḥmūd ibn al-Ḥusayn al-Kāshgharī was a Turkish scholar and lexicographer whose most important work was the *Dīwān lughāt al-Turk* (465–69/1072–76), a book on the Turkish language. The only surviving manuscript, in the Millet Genel Kütüphanesi in Istanbul, is dated 664/1266, and this may be the date of the map. A lengthy description and a translation of the map can be found in Albert Herrman, "Die älteste türkische Weltkarte (1076 n. Chr.)," *Imago Mundi* 1 (1935): 21–28, and a translation also appears in a recent English translation of al-Kāshgharī's *Dīwān lughāt al-Turk*: *Compendium of the Turkic Dialects*, 3 vols., ed. and trans. with introduction and indexes by Robert Dankoff in collaboration with James Kelly (Cambridge: Harvard University Press, Office of the University Publisher, 1982–85), vol. 1 between pp. 82 and 83. It can also be found illustrated and described

Conclusion

By the end of the fifteenth century classical Islamic geographical cartography was very much in decline. Various attempts by more scholarly geographers produced short bursts of productive activity in the cartographic field, but the end product was very much a rundown version of the highlights of the tenth and eleventh centuries A.D.

FIG. 6.15. MAPS FROM THE *NUKHBAT AL-DAHR* OF AL-DIMASHQĪ. (*a*) World diagram and (*b*) sketch map of the Mediterranean, both from the published version (from four manuscripts) edited by A. F. M. van Mehren, *Cosmographie de Chems-ed-Din . . . ed-Dimichqui, texte arabe* (Saint Petersburg, 1866; new impression Leipzig: Otto Harrassowitz, 1923), ed. and trans. Mehren as *Manuel de la cosmographie du Moyen Age* (Copenhagen: C. A. Reitzel, 1874; reprinted Amsterdam: Meridian, 1964), p. 26 and p. 40 of the 1923 text, by permission of Otto Harrassowitz, Wiesbaden.
Size of the originals: (*a*) 8 × 10.5 cm; (*b*) 7.5 × 12.5 cm.

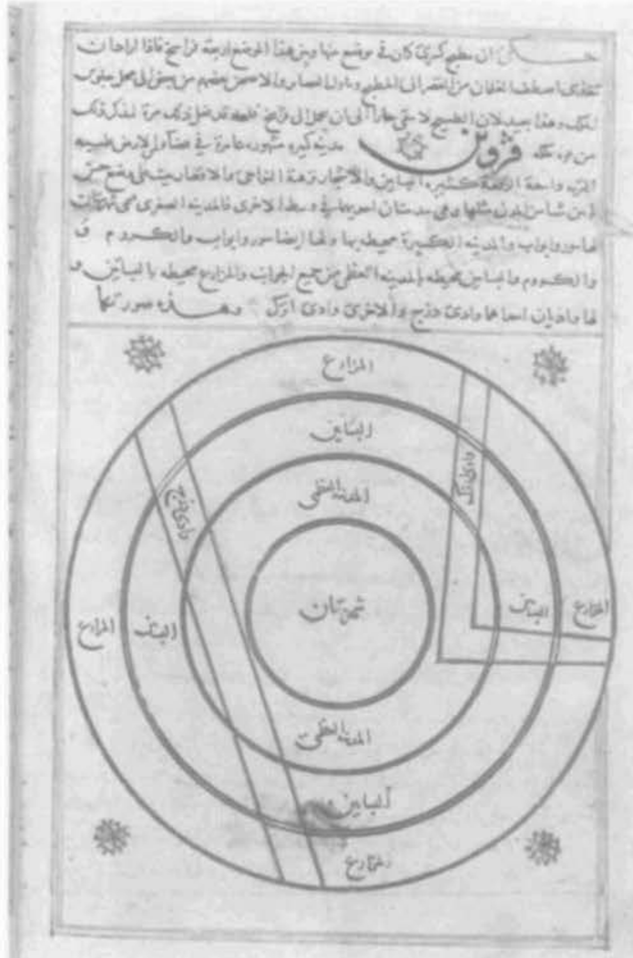

FIG. 6.16. PLAN OF THE CITY OF KAZVIN. From the *Āthār al-bilād* of al-Qazwīnī; this manuscript is dated 729/1329. Diameter of the original: ca. 15 cm. By permission of the British Library, London (MS. Or. 3623, fol. 119v).

There was a large gap between theory and practice, so that surviving finished maps do not reflect the work of the great narrative geographers or of the great scientific geographer al-Bīrūnī. The tables of Ptolemy and their Arabic adaptations were never really applied overall to Islamic maps, except perhaps in the large sectional maps of al-Idrīsī, which themselves never became the common property of the whole Islamic world. Lost maps are thought to have applied Ptolemaic construction, but nothing that has survived shows the influence of any of these missing maps. A detailed Ptolemaic projection comes to the Middle East only with a European printed version arriving in Ottoman Istanbul in the last years of the fifteenth century.[69]

in Miller, *Mappae arabicae*, Band 5, 142–48 (note 7); Bagrow, *History of Cartography*, pl. XXVIII (note 47); Leithäuser, *Mappae mundi*, 104 (note 59); and in Kamal, *Monumenta cartographica*, 3.3:741 (note 9).

69. There were Arabic translations of the Geography available in Istanbul before the end of the fifteenth century, see p. 210. See also Ahmad, "Kharīṭa," fig. 2 (note 21).

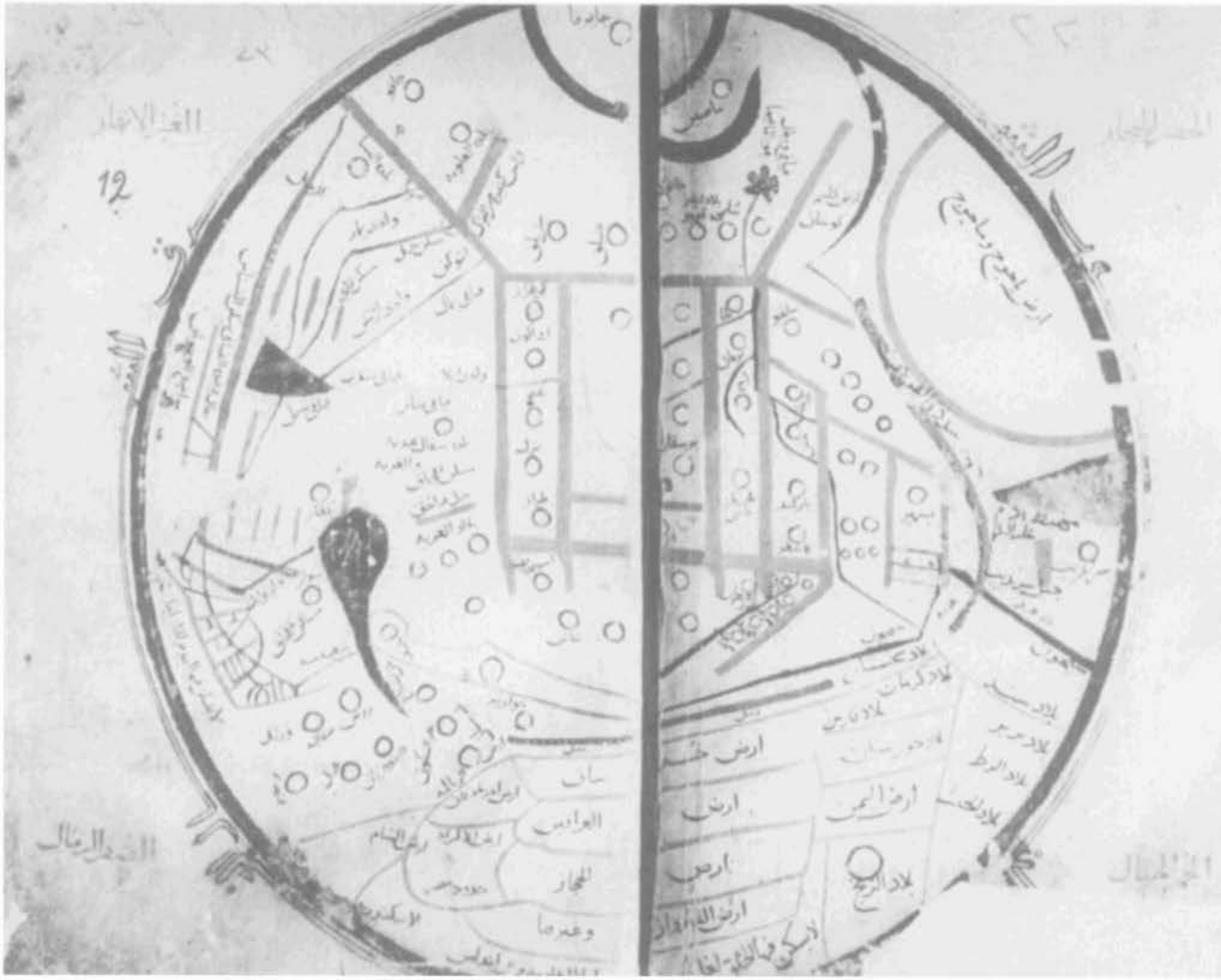

FIG. 6.17. WORLD MAP OF AL-KĀSHGHARĪ. This world map, oriented with east at the top, is from a unique manuscript of al-Kāshgharī's *Dīwān lughāt al-Turk*. The colors are described in the original as gray for rivers, green for seas, yellow for deserts, and red for mountains.

Size of the original: not known. The Millet Genel Kütüphanesi, Istanbul (Ali Emiri 4189).

Al-Bīrūnī's various theories and projections also failed to be used practically. His sketch of land and sea distribution was taken up and caused later Islamic maps to reject the large southern landmass that dominates the maps of the Balkhī school and those of al-Idrīsī. Thus the more "modern" maps showed sea over most of the Southern Hemisphere, while those of al-Idrīsī and those derived directly from the Balkhī school, such as the maps of Ibn al-Wardī, showed the Southern Hemisphere consisting of a landward extension of Africa. These various traditions of mapmaking persisted even into the nineteenth century, especially when included in new manuscripts of the work to which they were originally attached. Of course, practically all surviving Islamic maps were illustrations to texts and do not survive as independent artifacts. As manuscripts were copied from one another through the centuries, the surviving maps became more and more decadent until they were hardly recognizable and would be of no practical use.

7 · Cartography of al-Sharīf al-Idrīsī

S. MAQBUL AHMAD

Al-Idrīsī was born in Ceuta, Morocco, in 493/1100.[1] He belonged to the house of the ʿAlawī Idrīsids, claimants to the caliphate, who ruled the region around Ceuta from A.D. 789 to 985; hence his title "al-Sharīf" (the noble) al-Idrīsī. His ancestors were the nobles of Málaga, but unable to maintain their authority, they migrated to Ceuta in the eleventh century. Al-Idrīsī was educated in Córdoba and began his travels when he was barely sixteen years old with a visit to Asia Minor. Then he traveled along the southern coast of France, visited England, and traveled widely in Spain and Morocco.[2] Sometime about 1138, he was invited by the Norman king of Sicily, Roger II (A.D. 1097–1154), to Roger's court in Palermo, ostensibly to protect al-Idrīsī from his enemies, but in fact so Roger could use the scholar's noble descent to further his own political objectives.[3] Lewicki has put forward the hypothesis that Roger was more interested in al-Idrīsī as a possible pretender and potential puppet ruler than as a geographer.[4] As a descendant of the Ḥammūdids, former rulers of Málaga, he would have been useful to Roger in his plans to conquer Islamic Spain and establish his hegemony over the western Mediterranean. From al-Idrīsī we learn that Roger's territorial hold over North Africa was extensive.[5] Al-Idrīsī was conscious of Roger's expansion in North Africa, and he might even have been expecting to become ruler of some part of North Africa himself.

Whatever Roger's objective in inviting al-Idrīsī to his court, he capitalized on the scholar's rich personal experience with regard to North Africa and western Europe and asked him to construct a world map and write a commentary on it. Initially, it seems that al-Idrīsī was not well versed in either geography or cartography. He records his admiration for Roger's proficiency in mathematical and practical sciences and for his devising "iron" instruments for calculating latitudes and longitudes.[6] In time, however, al-Idrīsī himself came to be regarded as one of the foremost geographers and cartographers of medieval Europe. In collaboration with other scholars in Roger's court, he completed a world map engraved on silver (no longer extant) and the geographical compendium entitled *Nuzhat al-mushtāq fīʾkhtirāq al-āfāq* (The book of pleasant journeys into faraway lands), also known as the *Book of Roger* (containing a small world map and seventy sectional maps). These can be rated as the zenith of Islamic-Norman geographical collaboration. The task of constructing the world map and producing the book was accomplished in the month of Shawwāl 548 (January 1154). After Roger's death in 548/1154, al-Idrīsī continued to work at the court of his son and successor William I, called the Bad (r. 1154–66), but toward the end of his life he returned to North Africa, and he died in 560/1165, probably in Ceuta.[7]

AL-SHARĪF AL-IDRĪSĪ AS A MAPMAKER

Of the two cartographic schools developed during the early period—the Ptolemaic and the Balkhī—al-Idrīsī followed the former. The Ptolemaic school was the older, going back to the time of the caliph al-Maʾmūn (r. 198–218/813–33), and its origins lay in the classical geo-

1. A fuller name is Abū ʿAbdallāh Muḥammad ibn Muḥammad ibn ʿAbdallāh ibn Idrīs, al-Sharīf al-Idrīsī. For a short biography of al-Idrīsī, see Giovanni Oman, "al-Idrīsī," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 3:1032–35.

2. S. Maqbul Ahmad, "al-Idrīsī," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 7:7–9.

3. See S. Maqbul Ahmad, *India and the Neighbouring Territories in the "Kitāb nuzhat al-mushtāq fīʾkhtirāq al-ʾāfāq" of al-Sharīf al-Idrīsī* (Leiden: E. J. Brill, 1960), 3–4 and the references cited there. No primary source states the year when al-Idrīsī arrived in Sicily (although historians generally believe he arrived in 1138), and the only relatively certain date we have indicates he was present at Roger's court in 548/1154; see Tadeusz Lewicki, *Polska i Kraje Sąsiednie w Świetle "Księgi Rogera" geografa arabskiego z XII w. al-Idrīsī'ego*, 2 vols. (vol. 1, Krakow: Nakładem Polskiej Akademii Umiejętności, 1945; vol. 2, Warsaw: Państwowe Wydawnictwo Naukowe, 1954), 1:15–16 and the references cited there.

4. Lewicki, *Polska i Kraje Sąsiednie*, 1:12–14 (note 3).

5. Roger had conquered Jazīrat al-Jarbah (Djerba) in 529/1134, Aṭrābulus (Tripoli) in 540/1145, Sfax in 543/1148, and Būna in 548/1153, and al-Mahdīyah had a governor on behalf of the king in al-Idrīsī's time; see al-Idrīsī, *Opus geographicum; sive, "Liber ad eorum delectationem qui terras peragrare studeant,"* issued in nine fascicles by the Istituto Universitario Orientale di Napoli, Istituto Italiano per il Medio ed Estremo Oriente (Leiden: E. J. Brill, 19[70]–84), fasc. 3, pp. 281, 282, 291, 297, 305.

6. Al-Idrīsī, *Opus geographicum*, fasc. 1, pp. 5 and 6 (note 5).

7. Lewicki, *Polska i Kraje Sąsiednie*, 1:17–19 (note 3).

graphic work of Ptolemy (ca. A.D. 98–168). Ptolemy's *Geography* (Arabic *al-Jughrāfiyā*), sometimes rendered in Arabic as *Ṣūrat al-arḍ*, became the basis of several geographies.

Al-Idrīsī was also aware, in a limited way, of the followers of the Balkhī school, for he refers to the work of Ibn Ḥawqal as one of his sources. The special feature of the cartography of the Balkhī geographers was that they confined themselves to drawing regional maps of the Islamic empire. They divided the kingdom into twenty to twenty-two *aqālīm* (regions or provinces) and drew separate maps of each, giving their descriptions. Although their maps and descriptions gave new geopolitical and religious orientations to the growth of regional geography and cartography, their maps varied considerably from the Ptolemaic tradition, having no mathematical basis of latitudes and longitudes.

Although al-Idrīsī made Ptolemaic cartography the basis of his sectional maps in the *Nuzhat al-mushtāq*, we are able to surmise that they were an improvement over the maps drawn during the time of the caliph al-Ma'mūn (such as al-Ma'mūn's map). Although al-Ma'mūn's map is not extant, we learn from al-Masʿūdī that it was the most exquisite of all the maps he had seen.[8] Al-Masʿūdī had seen a map attached to Ptolemy's *Geography*, but the work was in Greek, as were the names of the seas, rivers, and so on, and so it was unintelligible to him. He had also seen the world map of Marinus of Tyre.[9] As for al-Ma'mūn's map, al-Zuhrī (fl. ca. 530/1140) states that a copy of it was made by al-Fazārī and that al-Zuhrī's own work, *Jaʿrāfīyah*, was based on al-Fazārī's copy. An analysis of the work of al-Zuhrī shows that the original map of al-Ma'mūn therefore must have represented a synthesis of the Iranian *kishvar* system and the Ptolemaic tradition of cartography.[10]

Another early map drawn in the tradition of Ptolemy was by Abū Jaʿfar Muḥammad ibn Mūsā al-Khwārazmī (d. ca. 232/847). Although the map has not survived, it has been reconstructed by S. Razia Jaʿfri based on the coordinates given in al-Khwārazmī's extant text titled *Kitāb ṣūrat al-arḍ*.[11] Comparing this map with Ptolemy's shows close affinity between the two, though there are some differences: for example, the Indian Ocean in al-Khwārazmī is not landlocked as in Ptolemy but is connected with the Pacific in the east. Al-Idrīsī's sectional maps are certainly an advance over both these maps (as reconstructed); as we might expect, the sections of al-Idrīsī's sectional maps that cover Europe, North Africa, western Asia, and Central Asia are more accurate than those that cover Southeast Asia, China, and the Far East. Moreover, al-Idrīsī's method of dividing the seven climates into ten sections longitudinally was original, and this method was followed later by Ibn Saʿīd in his text (discussed below).

Some scholars attribute to al-Idrīsī a second geographical work titled *Rawḍ al-uns wa-nuzhat al-nafs* (Gardens of intimacy and pleasure of the soul), prepared for Roger II's successor, William I.[12] Although no trace of this work has been found, its existence is posited on a reference to it by Ibn Bashrūn, a Sicilian-Arab poet and contemporary of al-Idrīsī, and on passages from al-Idrīsī that appear in Abū al-Fidā''s *Taqwīm al-buldān* (Survey of countries), though they do not correspond to any passages in the *Nuzhat al-mushtāq*.[13] Some recent authors have questioned the existence of this second geographical work.[14]

In the early twentieth century, yet another work by al-Idrīsī was discovered in Istanbul. There are two titles associated with it—*Uns al-muhaj wa-rawḍ al-faraj* (Intimacy of souls and gardens of pleasure), which appears at the beginning of the manuscript, and *Rawḍ al-faraj wa-nuzhat al-muhaj* (Gardens of pleasure and recreation of the souls), which appears at the end of the manuscript and which I will use in this chapter. Scholars do not agree on the exact relation of this text to al-Idrīsī's other works; some think it is related to the *Rawḍ al-uns wa-nuzhat al-nafs*, while others believe it is an abridged edition of the *Nuzhat al-mushtāq*.[15] The manuscript contains text,

8. See above, p. 95.

9. S. Maqbul Ahmad, "Al-Masʿūdī's Contributions to Medieval Arab Geography," *Islamic Culture* 27 (1953): 61–77, esp. 67.

10. S. Maqbul Ahmad, "Kharīṭa," in *Encyclopaedia of Islam*, new ed., 4:1077–83; and see above, p. 95.

11. S. Razia Jaʿfri, *al-Khwārizmī World Geography*, Tajik Academy of Sciences and Center of Central Asian Studies, Kashmir University, Dushanbe, Tajikistan (USSR), 1984.

12. In the nineteenth century by Dietrich Christoph von Rommel, *Abulfedae Arabiae descriptio commentario perpetuo illustrata* (Göttingen: Dieterich, 1802), 2 ff., and by Joseph Toussaint Reinaud, in his *Introduction générale à la géographie des Orientaux*, vol. 1 of *Géographie d'Aboulféda: Traduite de l'arabe en français*, 2 vols. in 3 pts. (vol. 2, pt. 1, trans. Reinaud; vol. 2, pt. 2, trans. Stanislas Guyard) (Paris: Imprimerie Nationale, 1848–83), CXXI. They were followed in this by many later authors.

13. See Giuseppina Igonetti, "Le citazioni del testo geografico di al-Idrīsī nel *Taqwīm al-buldān* di Abū 'l-Fidā'," in *Studi Magrebini*, vol. 8 (Naples: Istituto Universitario Orientale, 1976), 39–52.

14. See Giovanni Oman, "A propos du second ouvrage géographique attribué au géographe arabe al-Idrīsī: Le 'Rawḍ al-uns wa nuzhat al-nafs,' " *Folia Orientalia* 12 (1970): 187–93, and Igonetti, "Le citazioni del testo geografico" (note 13).

15. Seybold, who had photographs of the entire manuscript and had begun to edit it, said that it is a summary of al-Idrīsī's *Rawḍ al-uns wa-nuzhat al-nafs* (C. F. Seybold, "al-Idrīsī," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. [Leiden: E. J. Brill, 1913–38], 2:451–52); he was followed by several other authors. But J. H. Kramers believed it was an abridged edition of the *Nuzhat al-mushtāq*; see his "Djughrāfiyā," in *Encyclopaedia of Islam*, 1st ed., suppl. 61–73, esp. 67–68; and idem, "Geography and Commerce," in *The Legacy of Islam*, 1st ed., ed. Thomas Arnold and Alfred Guillaume (Oxford: Oxford University Press, 1931), 78–107, esp. 90. See also Sezgin's introduction to al-Idrīsī, *The Entertainment of Hearts and Meadows of Contemplation/Uns al-muhaj wa-rawḍ al-furaj*, ed. Fuat Sezgin (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1984).

a climate map, and seventy-three sectional maps (to be discussed below), and these have been sometimes referred to as the "Kleine Idrīsīkarte," as Miller calls it to distinguish it from the maps of the *Nuzhat al-mushtāq*.[16]

THE *NUZHAT AL-MUSHTĀQ FĪʾKHTIRĀQ AL-ĀFĀQ*

Al-Idrīsī's descriptive geography contains a preface followed by a description of the world divided into the seven climates. Each climate is further divided into ten sections, and the *Nuzhat al-mushtāq* is the first example of an Islamic geographic text that is so divided. Exhaustive descriptions in the text include the physical, cultural, political, and socioeconomic conditions of each region, and each of the seventy sections of text has a corresponding sectional map (although the text and map are not identical in content). There is also a small round world map in some extant manuscripts. Of the extant versions of the *Nuzhat al-mushtāq* (listed in appendix 7.1), five have complete text and eight have maps.

PUBLICATIONS AND TRANSLATIONS

Extracts from the Arabic text of the *Nuzhat al-mushtāq* were published in Rome for the first time in 1592, under the title *Kitāb nuzhat al-mushtāq fī dhikr al-amṣār wa-al-aqṭār wa-al-buldān wa-al-juzur wa-al-madāʾin wa-al-āfāq* (Recreation of the desirer in the account of cities, regions, countries, islands, towns, and distant lands).[17] This, however, was a rather careless selection. Passages were excluded arbitrarily, without due regard for the continuity of the text. It was then translated into Italian in 1600 but not published, and later it was translated into Latin and published in 1619 by two Maronites under the title *Geographia nubiensis*.[18] In Plessner's view these translations are "an example of how Arab geographical books helped to instruct the West at a time when Western geographical research into the Orient, let alone studies of the geographical literature of Islam, had not yet begun."[19]

Work on al-Idrīsī was revived by Orientalists in the nineteenth century, and Jaubert rendered the *Nuzhat al-mushtāq* into French under the title *Géographie d'Edrisi*.[20] Separate sections of al-Idrīsī's work together with the relevant maps have also been translated from time to time.[21] But by far the most detailed work on al-Idrīsī's cartography was done by Miller, who reproduced the original sectional maps of six manuscripts and placed the towns and other physical features on modern sketch maps of these countries. In his commentary he also attempted to identify places.[22] Many other scholars have also worked on al-Idrīsī's sectional maps, and the Iraqi Academy of Science, Baghdad, published the maps with original Arabic names, basing their research on five illustrated manuscripts of the *Nuzhat al-mushtāq*.[23]

In recent years, the enormous task of editing the complete Arabic text of al-Idrīsī's *Nuzhat al-mushtāq* was undertaken by the Istituto Universitario Orientale di Napoli under the auspices of the Istituto Italiano per il Medio ed Estremo Oriente. The work has been published in nine fascicles, titled *Opus Geographicum*.[24]

AL-IDRĪSĪ'S INSTRUCTIONS FOR MAKING A WORLD MAP

In the preface to the *Nuzhat al-mushtāq*, al-Idrīsī describes briefly how Roger collected information to prepare an up-to-date map of the world and to write a book to accompany it.[25] Lauding the political glory of King Roger, al-Idrīsī says that, having firmly established his suzerainty, Roger

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16. Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31), Band 1, Heft 3.

17. This version, cataloged under the title *De geographia universali*, was among the first secular Arabic works printed by the Medici Press (Rome, 1592). Many studies have been based on various parts of this text.

18. This edition was translated by Gabriel Sionita and Joannes Hesronita (Paris: Typographia Hieronymi Blageart, 1619). In addition, there are two abridgments of the *Nuzhat al-mushtāq* by other authors; see Oman, "al-Idrīsī," 1033 (note 1).

19. Martin Plessner, "The Natural Sciences and Medicine," in *The Legacy of Islam*, 2d ed., ed. Joseph Schacht and Clifford Edmund Bosworth (Oxford: Oxford University Press, 1979), 425–60, esp. 455.

20. *Géographie d'Edrisi*, 2 vols., trans. Pierre Amédée Emilien Probe Jaubert (Paris: Imprimerie Royale, 1836–40).

21. For a detailed survey of the work done on al-Idrīsī up to 1969, see Giovanni Oman, "Notizie bibliografiche sul geografo arabo al-Idrīsī (XII secolo) e sulle sue opere," *Annali dell'Istituto Universitario Orientale di Napoli*, n.s., 11 (1961): 25–61, and the following addenda to that article (all in the *Annali*): n.s., 12 (1962): 193–94; n.s., 16 (1966): 101–3; and n.s., 19 (1969): 45–55.

22. Miller, *Mappae arabicae*, Band 6 (note 16), reproduces the sectional maps from all of the extant manuscripts except Istanbul, Köprülü Kütüphanesi, MS. 955, and Sofia, Cyril and Methodius National Library, MS. Or. 3198. Parts of *Mappae arabicae* have been republished in at least two other forms: Konrad Miller, *Mappae arabicae*, 2 vols., Beihefte zum Tübinger Atlas des vorderen Orients, Reihe B, Geisteswissenschaften, no. 65 (Wiesbaden: Reichert, 1986); and idem, *Weltkarte des Arabers Idrisi vom Jahre 1154* (Stuttgart: Brockhaus/Antiquarium, 1981).

23. This was published by the Maṭbaʿ al-Misāḥa, Baghdad, in 1951. It was based on Miller's edition of the sectional maps (in *Mappae arabicae*) but was compared with the original maps from five illustrated manuscripts and with other Arabic geographical works.

24. See note 5 above for a full reference to this Arabic edition. This edition does not contain maps, but the Istituto Universitario Orientale may publish the maps in the future (correspondence, 1990).

25. In addition to this, al-Idrīsī's preface contains miscellaneous material that relates to the cartographic concepts of the day. For instance, he provides a description of the position of the earth as a stationary body in the celestial sphere, discusses the circumference of the earth, and speculates on matters such as the extent of the inhabited world

wished that he should accurately know the details of his land and master them with a definite knowledge, and that he should know the boundaries and routes both by land or sea and in what climate they were and what distinguished them as to seas and gulfs [what was the shape of the coastline] together with a knowledge of other lands and regions in all seven climates whenever the various learned sources agreed upon them and as was established in surviving notebooks or by various authors, showing what each climate contained of a specific country.[26]

Roger was especially keen to obtain information about the other countries of the seven climates. This would be derived from the opinions of scholars and from geographical writings. Although numerous works on the subject were studied in compliance with Roger's objective, "he did not find a clearly formulated commentary, but only considerable disagreement."[27] Roger then had discussions with scholars, and they revealed that their knowledge was not much better than that recorded in the books, so people who were well informed about his empire and had traveled far and wide in it were brought to his court.

> They studied together, but he did not find much extra knowledge from [other scholars] over what he found in the aforementioned works, and when he had convened with them on this subject he sent out into all his lands and ordered yet other scholars who may have been traveling around to come and asked them their opinions both singly and collectively. But there was no agreement among them. However, where they agreed he accepted the information, but where they differed, he rejected it.[28]

This process, according to al-Idrīsī, continued for about fifteen years. New facts were uncovered and critical discussions were held about the authenticity of the information.[29]

The next phase involved collating this material by preparing a *lawḥ al-tarsīm*, "drawing board," and entering the relevant data on it.

> He wished to make sure of the accuracy of what these people had agreed upon both of longitudes and latitudes [and in measurements between places]. So he had brought to him a drawing board [*lauḥ al-tarsīm*] and had traced on it with iron instruments item by item what had been mentioned in the aforementioned books, together with the more authentic of the decisions of the scholars.
>
> All this he examined closely until he was convinced that the information was correct.[30]

The cartographic climax of all this work was to be a map in permanent form engraved on precious metal. It was ordered that

> a disk [*dā'ira*] should be produced in pure silver of a large extent and of 400 Roman *raṭl*s in weight, each *raṭl* of 112 *dirham*s and when it was ready he had engraved on it a map of the seven climates and their lands and regions, their shorelines and hinterlands, gulfs and seas, watercourses and places of rivers, their inhabited and uninhabited parts, what [distances] were between each locality there, either along frequented roads or in determined miles or authenticated measurements and known harbors according to the version appearing on the drawing board, not differing from it at all and thus following what had been decided there without any variation.[31]

From the description above, it is obvious that Roger was keen to have an authentic, durable, and up-to-date world map prepared. Ptolemy's *al-Jughrāfiyā*, used by al-Idrīsī (al-Idrīsī calls it *Ṣūrat al-arḍ*), must have been considered out-of-date.

From this we can see that there were three distinct stages in constructing the world map. The first was to collect the data from both the written and oral sources, to test the veracity of the data, and to sort out the authentic material. The second stage was to collate the material on the drawing board and simultaneously ascertain latitudes and longitudes with the help of instruments as part of the compilation process. The third was to engrave faithfully on a silver disk the image on the drawing board. Neither the drawing board nor the silver world map is extant.[32] Although there is no positive evidence about the relation of the silver world map and the drawing-board map to the sectional maps found in al-Idrīsī's *Nuzhat al-mushtāq*, it is likely that the sectional maps were based on the drawing-board map and the silver map.[33]

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north and south of the equator, the nature of the Encircling Ocean, the division of the inhabited quarter into seven climates, and the seven seas called "gulfs" entering the landmass. His ideas do not reflect much original thought, nor are they a critical evaluation of the conceptions of the Greek or the early Islamic geographers and astronomers; for a critical analysis of his concepts, see Ahmad, *India*, 5–8 (note 3).

26. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 5 (note 5).

27. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 6 (note 5).

28. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 6 (note 5).

29. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 6 (note 5).

30. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 6 (note 5). We know nothing more about the "drawing board" or the "measuring instruments," which are reported only in this passage.

31. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 6 (note 5). The usual weight of a *dirham* was 2.97 grams (see G. C. Miles, "Dirham," in *Encyclopaedia of Islam*, new ed., 2:319–20), therefore the total weight was about 134 kilograms.

32. Miller, following others, says the silver disk was destroyed or disappeared in an A.D. 1160/61 coup d'état, although I know of no definite evidence for this.

33. Lewicki believes that the "silver planisphere" was a model (*Musterentwurf*) for the sectional maps; see Tadeusz Lewicki "Marino Sanudos Mappa mundi (1321) und die runde Weltkarte von Idrīsī (1154)," *Rocznik Orientalistyczny* 38 (1976): 169–98, esp. 177.

WRITING THE *NUZHAT AL-MUSHTĀQ*

When the silver map had been completed, Roger ordered a book to be written that would follow the format of the map. The idea was that

> they should produce a book explaining how the form was arrived at, adding whatever they had missed [in the map] as to the conditions of the lands and countries, concerning their inhabitants and their possessions and places and their likenesses, their seas, mountains and measurements, their crops and revenues and all sorts of buildings, their property and the works they have produced, their economy and merchandising, both imports and exports, and all the wonderful things relating to each and where they were with regard to the seven climates and also a description of their peoples with their customs and habits, appearance, clothes, and language. The book would be called the *Nuzhat al-mushtāq fi'khtirāq al-āfāq*. This was all completed in the first third of January agreeing with the month of Shawwāl in the year A.H. 548.[34]

The commentary that al-Idrīsī wrote in response to this agenda is one of the most exhaustive medieval works in the field of physical, descriptive, cultural, and political geography. It is dominated by the description of towns and places with their distances and directions. Al-Idrīsī is not consistent, however, in describing distances in the *Nuzhat al-mushtāq*. He uses different measures (see table 7.1), apparently because of the different sources he used: the Arabic and also those current in Sicily at the time.

To describe the world in his book, al-Idrīsī divided the seven Greek climates (after Ptolemy) into ten sections longitudinally to suit the size of the book. He informs us that "when we desired to enter up these place-names in their climates and their routes and what was relevant about their inhabitants, we divided the length of each climate into ten divisions, deciding the divisions by longitude and latitude."[35]

The vast amount of information at the disposal of al-Idrīsī, and the problem of incorporating it into the text, shows that he must have evolved a system of sifting the relevant material for each of the sections, as well as a method of indexing and classification under at least seventy headings. Because the book is not divided by natural regions or countries, it would have been necessary to carry over the descriptions of physical features such as the seas, rivers, lakes, and mountains from one section to another, either eastward within the same climate or northward across climate divisions. A proper organization of the material was clearly vital.[36]

TABLE 7.1 Measures Used by al-Idrīsī

LAND DISTANCES
1 classical Arabian *mīl* (mile) = 6,474 feet, or $1\frac{1}{15}$ geographical miles
1 *farsakh* = 3 Arabian *mīls*
1 *Frank mīl* = not certain
1 *marḥalah* = 25 to 30 Arabian *mīls* (about one day's march)
"Long *marḥalah*" = about 40 Arabian *mīls*
Distance stated in terms of number of days' journey
Distance in terms of an arrow shot = 180–275 meters
10 *manzils* = 270 Arabian *mīls*[a]
1 rashāshī cubit = 3 palm lengths[b]
SEA DISTANCES
Majrā = a day's sailing (about 104 Arabian *mīls*)
Muqayyad al-jary = another term for *majrā*
One-half a *majrā* = 52 *mīls*
2 *majrās* = 208 *mīls*
"Small *majrā*" = probably less than a day's sailing
Al-Idrīsī also uses *mīls* for sea distances
MEASUREMENT OF GULFS AND BAYS
Al-Idrīsī uses two different methods:
Ru'sīya = a distance measured along the sea on a straight line between the two tips of a bay
Taqwīr (from *quwwārah*, "scoop") = a distance measured along the coastline of a bay

[a]Compare al-Idrīsī, *Opus geographicum; sive, "Liber ad eorum delectationem qui terras peragrare studeant,"* issued in nine fascicles by the Istituto Universitario Orientale di Napoli, Istituto Italiano per il Medio ed Estremo Oriente (Leiden: E. J. Brill, 19[70]–84), fasc. 2, pp. 141–42.

[b]Compare al-Idrīsī, *Opus geographicum*, fasc. 3, pp. 265, 320.

MAPS IN THE *NUZHAT AL-MUSHTĀQ*

Although six of the manuscripts of the *Nuzhat al-mushtāq* listed in appendix 7.1 contain a small circular world map, this map is not mentioned in al-Idrīsī's text. The versions that are extant (figs. 7.1 to 7.5 and plate 11) depict a circular world surrounded by the Encircling Ocean (*al-muḥīṭ*). South is placed at the top, a method followed by the Balkhī school of geographers in their world maps. The eastern coast of Africa is shown extending toward the east longitudinally as far as what is now the Pacific Ocean, so that the Indian Ocean is shown landlocked on all sides except the east. The southern quarter of the earth is also covered by terra incognita connected with southern Africa. This is also a Balkhī school concept; al-Idrīsī was unaware of the proposed connection of the Indian Ocean with the Atlantic through channels to the south of the sources of the Nile, a theory

34. Al-Idrīsī, *Opus geographicum*, fasc. 1, pp. 6–7 (note 5).

35. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 13 (note 5).

36. Yet some mistakes are immediately apparent: e.g., Audaghust and Zawīlah belonging to North Africa are included in India; al-Idrīsī, *Opus geographicum*, fasc. 1, p. 20, and fasc. 2, pp. 107, 108, 115, 186 (note 5).

FIG. 7.1. AL-IDRĪSĪ'S WORLD MAP FROM THE PARIS MANUSCRIPT (MS. ARABE 2221). Although damaged, this copy from A.D. 1300 is the oldest surviving version of al-Idrīsī's circular world map. The south orientation and prominent representation of the source of the Nile are characteristic of earlier Islamic world maps.
Size of each folio: 26 × 21 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2221, fols. 3v–4).

FIG. 7.3. AL-IDRĪSĪ'S WORLD MAP FROM THE ISTANBUL MANUSCRIPT (KÖPRÜLÜ KÜTÜPHANESI). The manuscript, dated 1469, was copied by ʿAlī ibn Ḥasan al-ʿAjāmī.
Size of each folio: 26.5 × 17.5. By permission of the Köprülü Kütüphanesi, Istanbul (MS. 955).

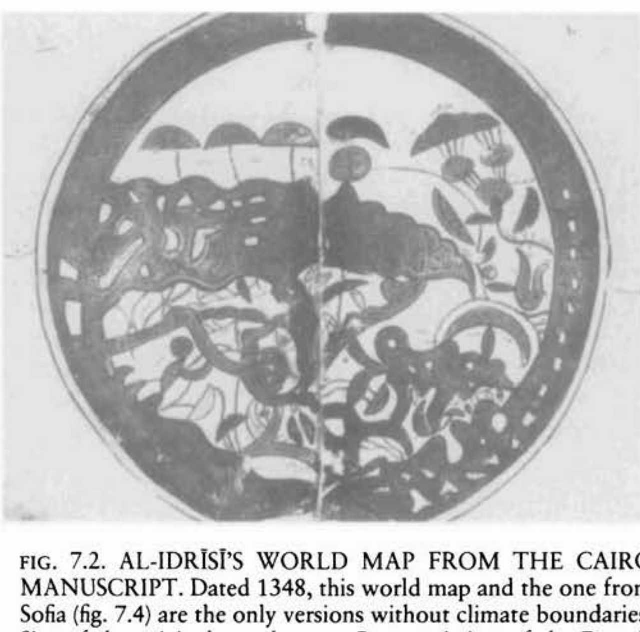


FIG. 7.2. AL-IDRĪSĪ'S WORLD MAP FROM THE CAIRO MANUSCRIPT. Dated 1348, this world map and the one from Sofia (fig. 7.4) are the only versions without climate boundaries.
Size of the original: not known. By permission of the Dār al-Kutub, Cairo (*Jugrāfiyā* 150), photograph courtesy of Istituto Universitario Orientale, Naples.

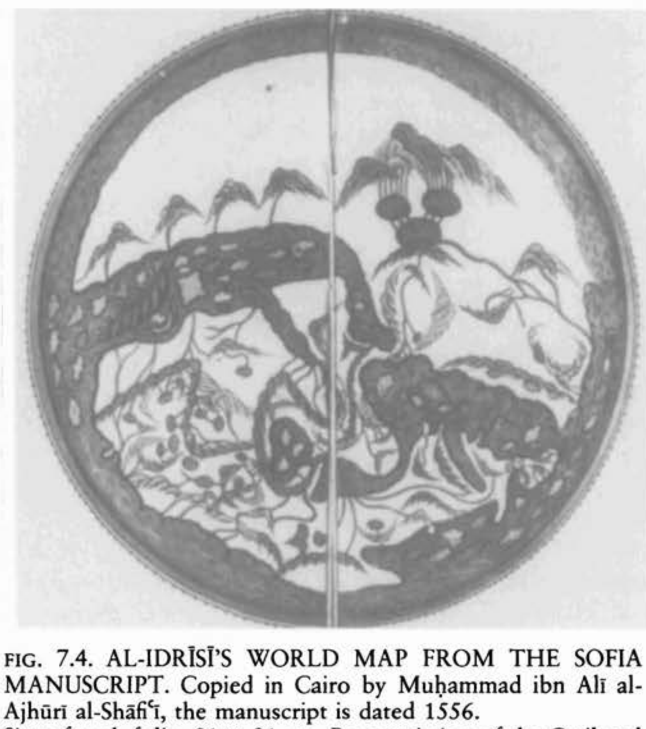


FIG. 7.4. AL-IDRĪSĪ'S WORLD MAP FROM THE SOFIA MANUSCRIPT. Copied in Cairo by Muḥammad ibn Alī al-Ajhūrī al-Shāfiʿī, the manuscript is dated 1556.
Size of each folio: 31 × 21 cm. By permission of the Cyril and Methodius National Library, Sofia (MS. Or. 3198, fols. 4v–5r).

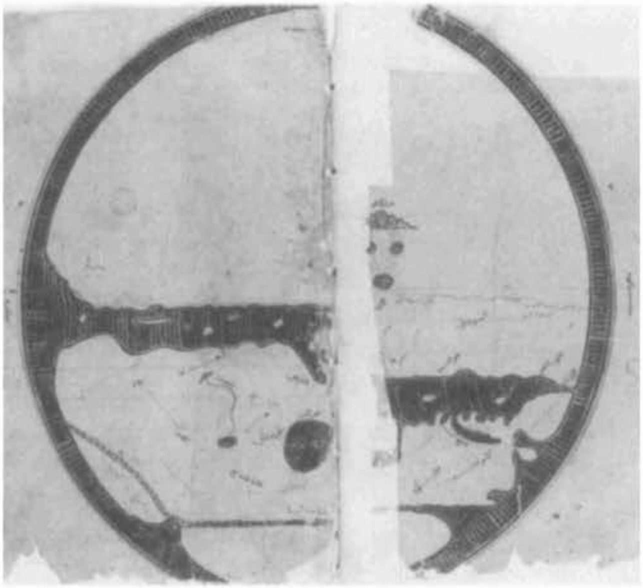


FIG. 7.5. AL-IDRĪSĪ'S WORLD MAP FROM THE OXFORD GREAVES MANUSCRIPT. This manuscript has been dated to the late fourteenth century and the late sixteenth century (see appendix 7.1). The world map, partially destroyed, has straight climate boundaries, unlike the other extant versions.
Diameter of the original: 33 cm. By permission of the Bodleian Library, Oxford (MS. Greaves 42, fols. 1v–2r).

propounded by al-Bīrūnī. Several versions of the map depict the seven climates as curved lines running east-west, beginning at the equator and continuing northward as far as the Scandinavian countries. According to Ptolemy, the northern limit of the *oikoumene* was at 63°N, whereas al-Idrīsī places it a little beyond (north of) 64°N. The climates in the circular map are not divided into ten sections longitudinally as in al-Idrīsī's sectional maps. The sources of the Nile (Mountains of the Moon) and places like Barbarah, al-Zanj, Sofalah, and al-Waqwaq are placed south of the equator. The map, though differing in details when compared with the sectional maps, is similar in general outline and presentation of physical data. It seems that this miniature circular world map was drawn by al-Idrīsī following the larger silver map, with a view to fitting in with the text and the sectional maps and giving a general view of the *oikoumene* as he conceived it.

At the end of his preface to the *Nuzhat al-mushtāq*, and just before he begins his climate-by-climate treatment, al-Idrīsī explains the reasons for preparing the sectional maps and their relation to the book. Al-Idrīsī's thoughts on this subject, as an early statement of cartographic method and purpose, clearly deserve to be fully quoted.

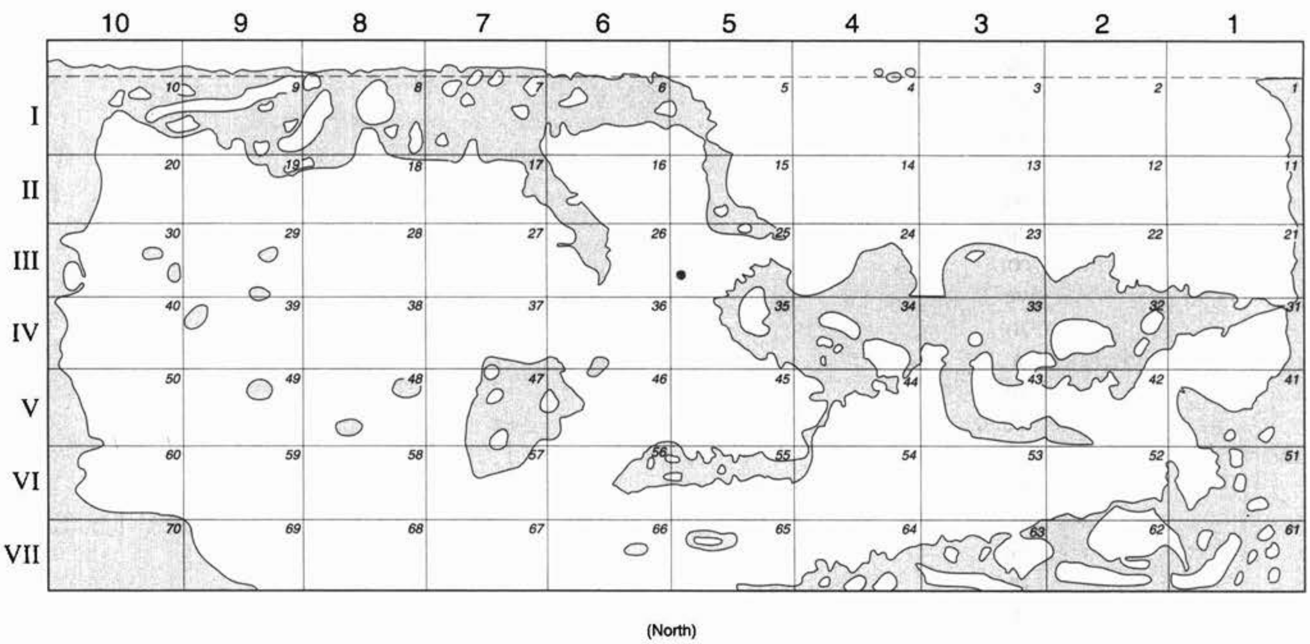


FIG. 7.6. INDEX OF THE SECTIONAL MAPS IN THE *NUZHAT AL-MUSHTĀQ*. This line drawing is a simplification of Konrad Miller's composite map showing what the sectional maps (which are interspersed throughout the text in al-Idrīsī's *Nuzhat al-mushtāq*) would look like if joined together. The climate numbers are given along the vertical axis, and the ten longitudinal divisions are given across the top. The consecutive numbers sometimes used to refer to the sectional maps are shown in the upper right corner of each section. Note that these delineations follow most closely the Paris (MS. Arabe 2221) and Oxford (MS. Pococke 372) manuscripts. The exact depictions of coastlines, islands, and so forth, differ in other manuscripts.
After Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31), Band 1, Heft 2.

> And we have entered up in each division what belonged to it of towns, districts, and regions so that he who looked at it could observe what would normally be hidden from his eyes or would not normally reach his understanding or [what he] would not be able to reach himself because of the impossible nature of the route and the differing nature of the peoples. Thus he can correct this information by looking at it. So the total number of these sectional maps is seventy, not counting the two extreme limits in two directions, one being the southern limit of human habitation caused by the excessive heat and lack of water and the other the northern limit of human habitation caused by excessive cold.
>
> Now it is clear that when the observer looks at these maps and these countries explained, he sees a true description and pleasing form, but beyond that he needs to learn descriptions of the provinces [of the world] and the appearance of their peoples, their dress and their adornments and the practicable roads and their mileages and farsangs and all the wonders of their lands as witnessed by travelers and mentioned by roaming writers and confirmed by narrators. Thus after each map we have entered everything we have thought necessary and suitable in its proper place in the book, as much as our knowledge and our ability will allow.[37]

From this it is clear that a genuine integration of map and text was envisaged throughout the work, and that al-Idrīsī fully appreciated the particular value of maps in communicating geographical information.

Eight of the manuscripts listed in appendix 7.1 contain sectional maps, although the number extant in each varies. Since the work as a whole was meant primarily to include physical and descriptive geography, latitudes and longitudes were omitted from the maps, and latitude and longitude values are not given in the text, where distances are used for specific locations. In his sectional maps, however, al-Idrīsī did follow a definite geographical order. The seventy maps, when arranged in order of climates and sections, present a broad picture of the world as conceived by al-Idrīsī (fig. 7.6). For the western limit of the inhabited world, al-Idrīsī adopted the prime meridian of the Fortunate Isles (al-Khālidāt), like Ptolemy and some other Arab cartographers. The extreme eastern limit was Sīlā Island (Korea) through which 180° was supposed to pass. The northern limit was 64°N, but al-Idrīsī did not specify the southern limit.[38]

Each of the sectional maps depicts the physical features in different colors. Latitudes and longitudes are not shown on these maps, and the locations of towns and other features do not always coincide with the distances given in the text.[39] The maps also vary in other respects from the written descriptions. A glance at the sectional maps would immediately give the impression that they generally depict Europe, North Africa, the Mediterranean region, and western Asia more accurately than they do the rest of Africa, Asia, or Southeast Asia. However, they compare well with the world map of al-Khwārazmī reconstructed from his tables by modern scholars.[40]

The cartographic style varies considerably between manuscripts, and although these stylistic differences reflect individual copyists rather than al-Idrīsī (none of the surviving manuscripts were contemporary with al-Idrīsī), it is still interesting to note how the few maps that survive depict different features. Bodies of water are usually represented with a pattern of lines or lines and circles. They range from very rushed and haphazard squiggles, sometimes incompletely rendered (figs. 7.7 and 7.8), to carefully, almost elaborately drawn combinations of lines and dots (fig. 7.9). Rivers are usually simple lines of a fairly consistent width (figs. 7.10 to 7.13). Towns are represented as small circles, some plain and others more elaborate rosettes in gold (fig. 7.13 and plate 12), and sometimes as small "towers" (fig. 7.14). Mountains, although similar in general shape and size, have small intricacies of pattern, form, and color in each manuscript (plate 12 above and fig. 7.15).

Very little is known for certain about the chronology and relationship of the maps in the various manuscripts. Studies of the *Nuzhat al-mushtāq* have generally focused on one particular region and analyzed how al-Idrīsī described and mapped it.[41] Scholars have tried to establish the chronology and relationship between the different recensions of al-Idrīsī's text, but similarly exhaustive research has yet to be done on the maps.[42]

THE *RAWḌ AL-FARAJ WA-NUZHAT AL-MUHAJ*

A copy of the *Rawḍ al-faraj wa-nuzhat al-muhaj* was discovered in Istanbul in the twentieth century. There are at least two manuscripts in Istanbul and a copy in a private collection (see appendix 7.1). The manuscripts indicate that the original was written by al-Idrīsī and copied in

37. Al-Idrīsī, *Opus geographicum*, fasc. 1, pp. 13–14 (note 5).

38. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 8 (note 5).

39. However, it is believed that to some extent al-Idrīsī did use latitudes in plotting his localities; see Edward S. Kennedy, "Geographical Latitudes in al-Idrīsī's World Map," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 3 (1986): 265–68.

40. See Hans von Mžik, ed., *Das Kitāb ṣūrat al-arḍ des Abū Ǧaʿfar Muḥammad ibn Mūsā al-Ḫuwārizmī*, Bibliothek Arabischer Historiker und Geographen, vol. 3 (Leipzig: Otto Harrassowitz, 1926), and the world map reconstructed on the basis of this work by S. Razia Jaʿfri, "A Critical Revision and Interpretation of *Kitāb ṣūrat al-ʾarḍ* by Muḥammad b. Mūsā al-Khwārizmī" (thesis, Aligarh Muslim University).

41. For a listing of many of the individual studies devoted to specific regions, see Oman, "al-Idrīsī," 1033–34 (note 1).

42. See, for example, Roberto Rubinacci, "La data della Geografia di al-Idrīsī," *Studi Magrebini* 3 (1970): 73–77, among others.

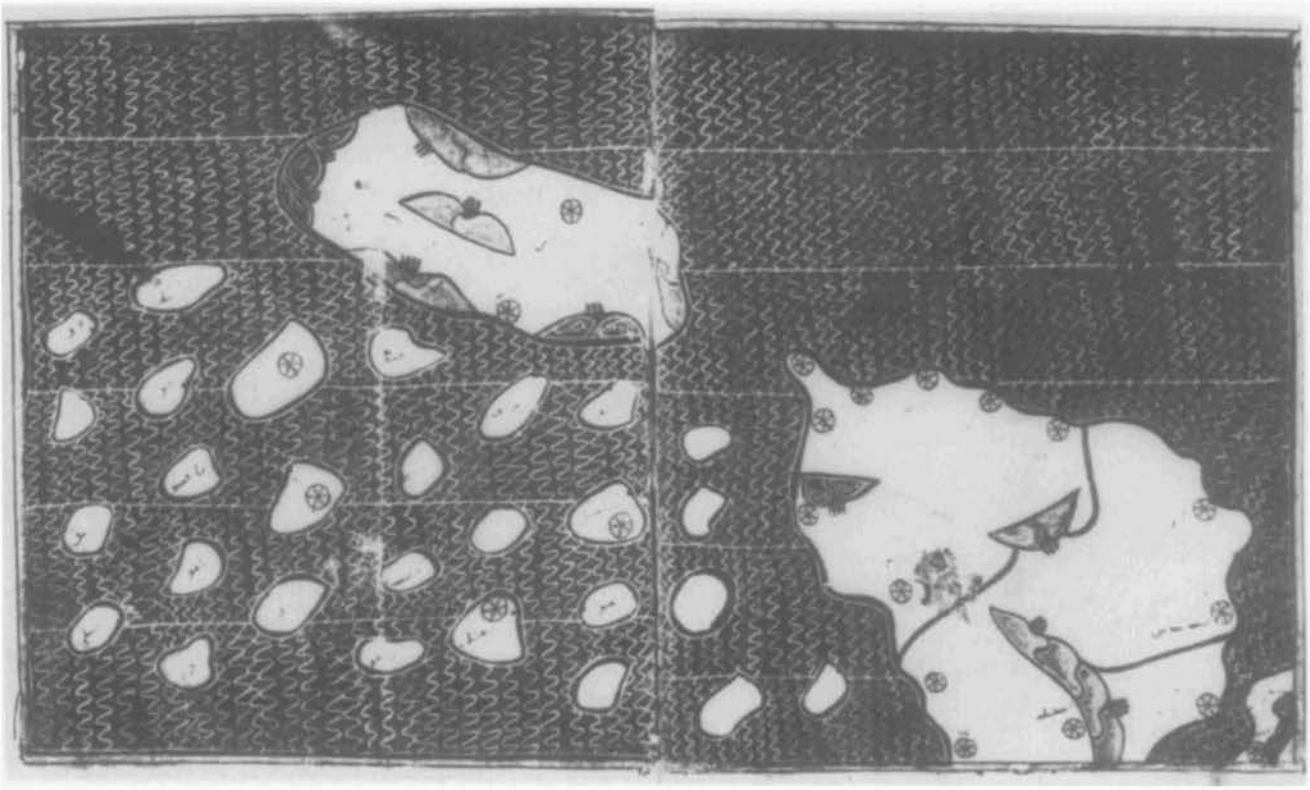


FIG. 7.7. THE AEGEAN FROM THE LENINGRAD MANUSCRIPT. Dated to the beginning of the fourteenth century, this manuscript was restored sometime before 1882. Crete and the islands of the Aegean are depicted on the left, and the water pattern in this section (climate 4, section 4) is typical of many of the extant al-Idrīsī manuscripts.
Size of each folio: 25 × 18 cm; size of the map: 19 × 32 cm. By permission of the M. E. Saltykov-Shchedrin State Public Library, Leningrad (MS. Ar. N.S. 176).

FIG. 7.8. PART OF THE INDIAN OCEAN AND TAPROBANE FROM THE OXFORD POCOCKE MANUSCRIPT. Although most manuscripts have some pattern over the bodies of water, in this section the pattern is only partially drawn in on the right. The area depicted here is section 8 of climate 1: the large central island is what is today Sri Lanka, with the southern tip of India visible at the bottom center.
Size of each folio: 30.5 × 21 cm. By permission of the Bodleian Library, Oxford (MS. Pococke 375, fols. 33v–34r).

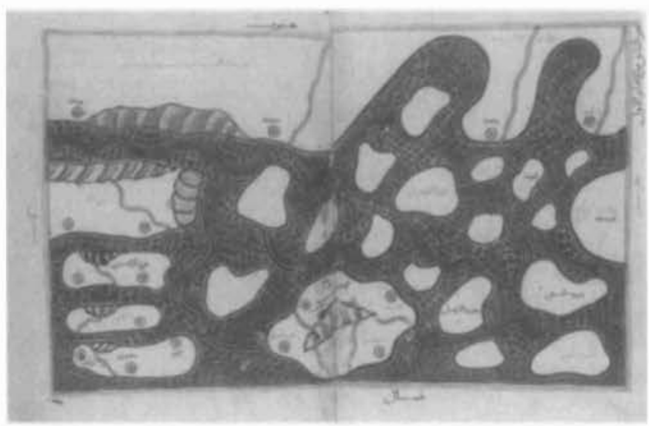
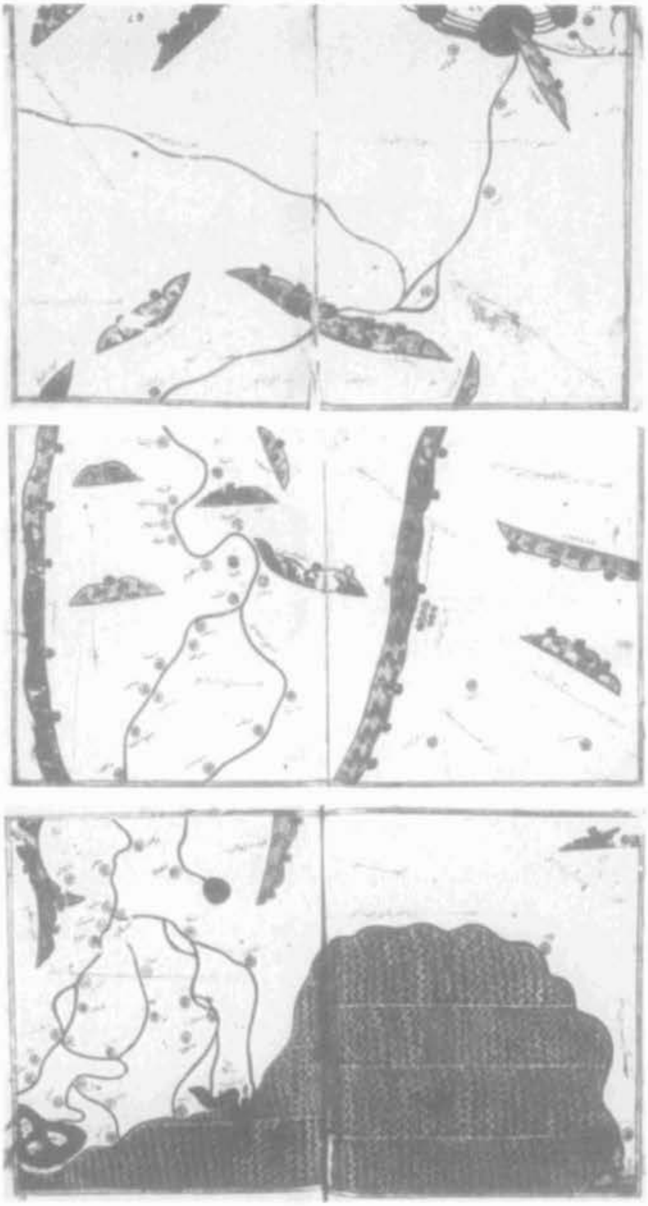


FIG. 7.9. PART OF THE INDIAN OCEAN AND TAPROBANE FROM THE OXFORD GREAVES MANUSCRIPT. Although not identical in appearance, this is also section 8 of climate 1 (fig. 7.8 left). What is today Sri Lanka can be identified as the island at the center bottom with the mountain symbol in the middle, but no peninsular tip of India is shown. The water pattern is elaborately drawn, but in other sections of the same manuscript, it consists of simple parallel wavy lines reminiscent of figures 7.7 and 7.8 above and left.
Size of each folio: 32 × 24 cm. By permission of the Bodleian Library, Oxford (MS. Greaves 42, fols. 37v–38r).



FIGS. 7.10, 7.11, AND 7.12. THE RIVER NILE FROM THE ISTANBUL AYASOFYA MANUSCRIPT. Section 4 of the first three climates is shown. Climate 1 (top, fig. 7.10) shows the source of the Nile in the upper right; climate 2 (middle, fig. 7.11) depicts the course of the Nile; and climate 3 (bottom, fig. 7.12) the Nile delta in the left folio.
Size of each original: 25.6 × 38.6 cm. By permission of the Süleymaniye Kütüphanesi, Istanbul (Ayasofya 3502).

FIG. 7.13. COURSE OF THE NILE FROM THE CAIRO MANUSCRIPT. From section 4 of climate 2 (compare fig. 7.11 left), this map shows part of Egypt south of the Nile Delta. The Nile can be seen on the left leaf, with towns simply designated by a circle with a cross inside.
Size of the original: not known. By permission of the Dār al-Kutub, Cairo (*Jugrāfiyā* 150), photograph courtesy of Istituto Universitario Orientale, Naples.

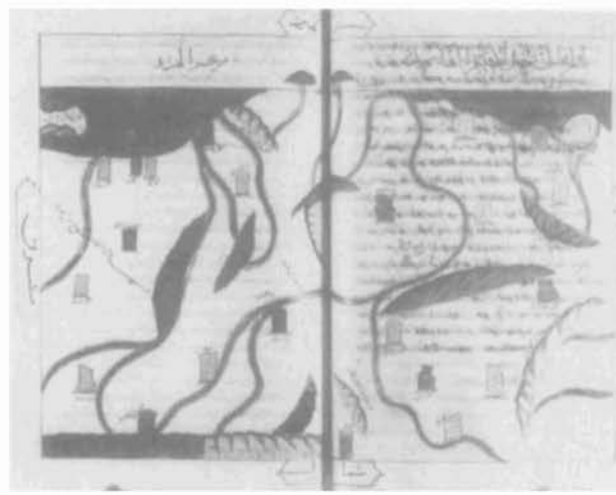


FIG. 7.14. INDIA FROM THE SOFIA MANUSCRIPT. In this depiction of climate 2, section 8, the top right corner is the Arabian Sea, the top left corner is the Bay of Bengal, and the southern tip of India extends off the map (top center). The symbols for towns are different from those on other extant al-Idrīsī manuscripts.
Size of each folio: 31 × 21 cm. By permission of the Cyril and Methodius National Library, Sofia (MS. Or. 3198, fols. 73v–74r).

588/1192.[43] The text consists essentially of itineraries and distances. There is an additional climate added south of the equator, and he includes this part of the map in the first climate. On the small circular climate map (fig. 7.16) this portion is given the name *khalf wasṭ al-arḍ* (behind, or south of, the center of the earth, i.e., the equator). The introduction to the *Rawḍ al-faraj* contains somewhat more astronomical information than al-Idrīsī's

43. See the facsimile containing both Istanbul manuscripts at the Süleymaniye Kütüphanesi (Hekimoğlu MS. 688 and Hasan Hüsnü MS. 1289): al-Idrīsī, *Entertainment of Hearts* (note 15).

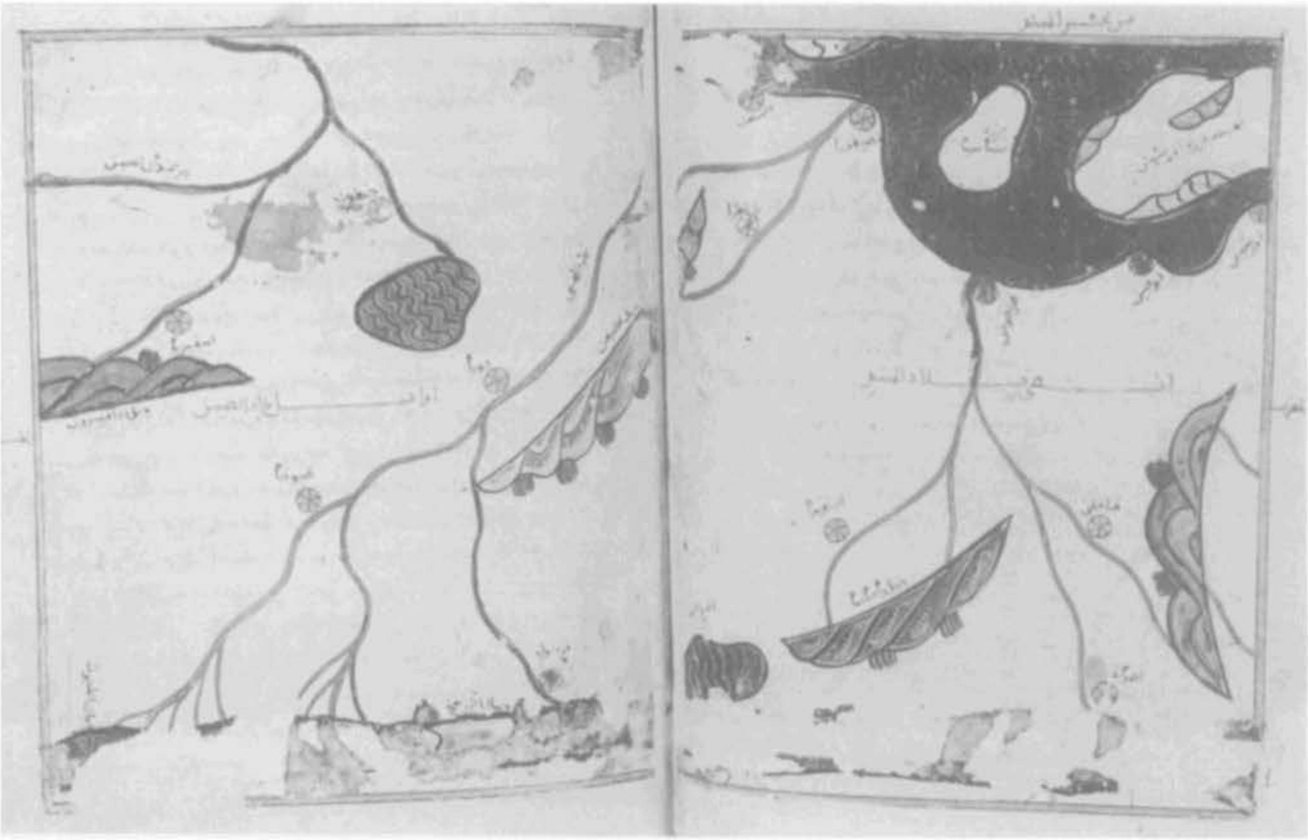


FIG. 7.15. REGION NORTHEAST OF THE BAY OF BENGAL FROM THE PARIS MANUSCRIPT. Although damaged in the lower section, this depiction of climate 2, section 9, which is of the region northeast of the Bay of Bengal (visible in the upper right), does show a few examples of mountains drawn in similar styles with minor variations in elaboration and decoration.
Size of each folio: 26 × 21 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2221, fols. 82v–83).

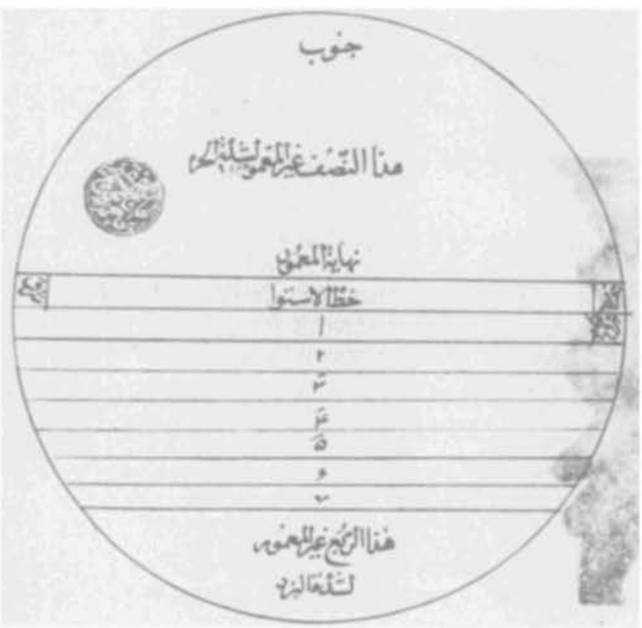


FIG. 7.16. CLIMATE DIAGRAM FROM THE *RAWḌ AL-FARAJ*.
Size of the original: not known. By permission of Süleymaniye Kütüphanesi, Istanbul (Hasan Hüsnü MS. 1289).

Nuzhat al-mushtāq, though neither text reveals any cartographic principles.[44]

There are seventy-three sectional maps. These maps resemble those in the *Nuzhat al-mushtāq* in general form and in what they depict, but they are not of equal size; sometimes there are two sections on one map, they often overlap, and they do not fit together as well as those of the *Nuzhat al-mushtāq* (figs. 7.17 and 7.18). There are fifteen sectional maps that represent the first climate, ten sectional maps each for climates two through five, and nine each for climates six and seven. Except for the first five maps, the maps have east at the top in the two extant manuscripts (south orientations and one north orientation are found in the first five maps).

Since the maps in the *Rawḍ al-faraj* are smaller than those in the *Nuzhat al-mushtāq*, they predictably show less information. The maps depict many of the same physical features, but in a more simplified manner (figs. 7.19 and 7.20). Mountains, cities, rivers, and bodies of water

44. Kramers, "Djughrāfiyā," 67–68 (note 15). Miller, *Mappae arabicae*, Band 1, Heft 3 (note 16), discusses the "Kleine Idrīsī," as he calls it, and reproduces maps from Hekimoğlu MS. 688.

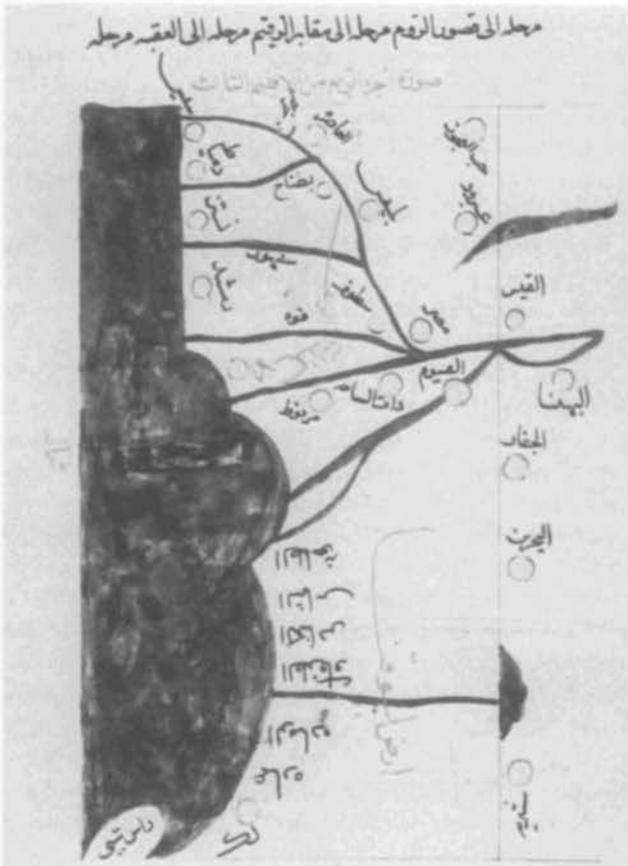


FIG. 7.17. THE NILE DELTA FROM THE *RAWḌ AL-FARAJ*. Section 4 of climate 3 is shown with east at the top and the Mediterranean on the left (see also fig. 7.18).
Size of the original: 29.3 × 18.4 cm. By permission of Süleymaniye Kütüphanesi, Istanbul (Hekimoğlu Ali Paşa MS. 688).

FIG. 7.18. THE COURSE OF THE NILE FROM THE *RAWḌ AL-FARAJ*. With east at the top, this depiction of section 4, climate 3, would be geographically adjacent to the map in fig. 7.17, and it is clear that the maps do not match up as precisely as those of the same regions in the *Nuzhat al-mushtāq* (compare figs. 7.11 and 7.12, for example).
Size of the original: 29.3 × 18.4 cm. By permission of Süleymaniye Kütüphanesi, Istanbul (Hekimoğlu Ali Paşa MS. 688).

are unadorned, without distinguishing patterns or designs.[45]

THE SOURCES FOR AL-IDRĪSĪ'S *NUZHAT AL-MUSHTĀQ*

We know that by working in Roger's court, al-Idrīsī had access to a wide range of sources, making use of some aspects of both the Balkhī and Ptolemaic cartographic traditions. He utilized Ibn Ḥawqal's work, which was rooted in the Balkhī tradition, but this source did not match al-Idrīsī's objective and described only the *mamlakat al-Islām* (Islamic empire). It left out the rest of the world, whereas al-Idrīsī was required to deal with the whole of the known world as the Ptolemaic tradition did. There is little doubt that al-Idrīsī also used a number of non-Arabic sources for his text and maps. Considerable information was supplied to him by the European travelers at Roger's court, and it is not unlikely that he also used some maritime information derived from Roger's navy, especially concerning the coastal regions of North Africa. Here I will attempt to fix al-Idrīsī's position among his predecessors and to establish his indebtedness to different traditions.

45. It was said in 1930 that except for Konrad Miller and some passages by Carlo Alfonso Nallino, this manuscript remained virtually unexplored (al-Idrīsī, *La Finlande et les autres pays Baltiques Orientaux*, ed. and trans. Oiva Johannes Tallgren-Tuulio and Aarne Michaël Tallgren [Helsinki, Societas Orientalis Fennica, 1930], 9–10, 17–18). This is still largely true, with the exception of the 1984 facsimile (note 15).

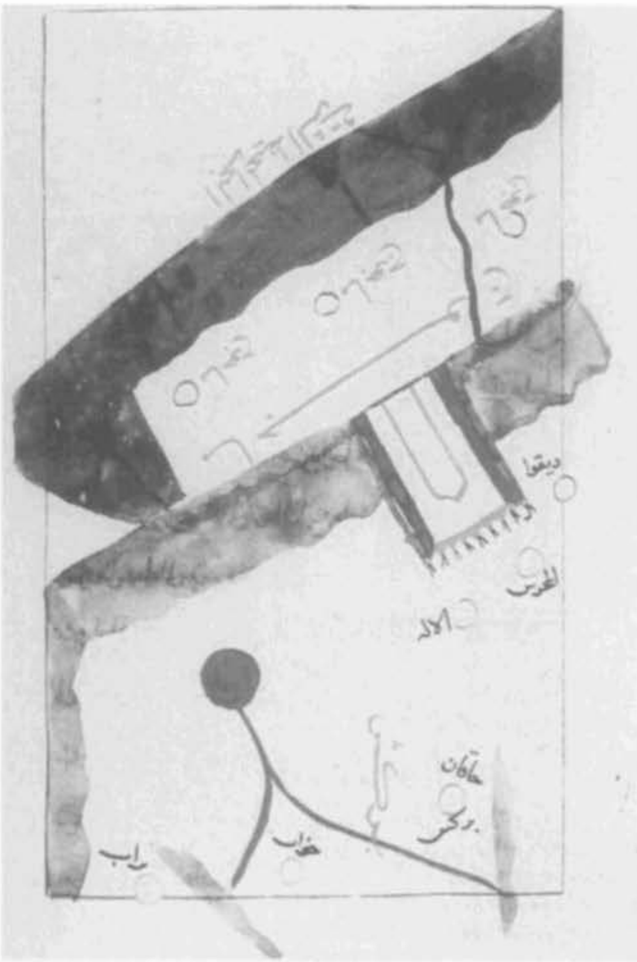


FIG. 7.19. CLIMATE 6, SECTION 9, FROM THE *RAWḌ AL-FARAJ*. Compare figure 7.20 (note that east is at the top in this figure).
Size of each folio: 29.3 × 18.4 cm. By permission of Süleymaniye Kütüphanesi, Istanbul (Hekimoğlu Ali Paşa MS. 688).

It was mentioned in chapter 4 that Ptolemy's *Geography* had been introduced into Arabic scholarly circles at least by the time of the caliph al-Maʾmūn (198–218/813–33). The map scholars produced for al-Maʾmūn has been described and also the difficulty of deciding whether this was based on Ptolemy's tables or on the Iranian *kishvar* system. According to al-Zuhrī, whose text is built up following the *kishvar* system, his work was based on al-Maʾmūn's map. Al-Masʿūdī also referred to this map, considering it superior to all the other maps he had consulted. It is therefore possible that al-Maʾmūn's map already represented a synthesis of the Iranian and Ptolemaic traditions of cartography long before al-Idrīsī worked.

About the time al-Maʾmūn's map was constructed, al-Khwārazmī compiled the coordinates of places in tabular form in his book *Kitāb ṣūrat al-arḍ*. If he drew a map apart from that of al-Maʾmūn, this map is lost, but the tabulated coordinates have survived, and a map has been reconstructed based on the data given in the book.[46] Comparing this twentieth-century reconstruction with extant maps in Ptolemy's *Geography* shows a close resemblance between them. Thus we can perhaps see how the Muslims of that time may have perceived the Ptolemaic world through the eyes of al-Khwārazmī.

It has been shown that several translations of Ptolemy into Arabic were made at this time, particularly that of Thābit ibn Qurrah,[47] and references to Ptolemy appear in Islamic geographical works. Another table of latitudes and longitudes was also compiled by Suhrāb (fl. 340/950) in his book *ʿAjāʾib al-aqālīm al-sabʿah* (Book of the wonders of the seven climates). Besides giving longitudes and latitudes broadly similar to those of al-Khwārazmī, albeit with some differences, this text gives instructions on constructing a map from the listed coordinates. Finally, it is possible that the world map of Ibn Yūnus and al-Muhallabī was ultimately based on Ptolemy,[48] so we find that by the twelfth century when al-Idrīsī drew his world and sectional maps, a rich tradition of using Ptolemaic material already prevailed in the western parts of the Islamic world.

Al-Idrīsī tells us that he used the *Ṣūrat al-arḍ* (Map of the earth), called *al-Jughrāfiyā* by Ptolemy, as the basis of his description of the earth.[49] It had been used by a number of Islamic geographers and cartographers. Some idea of the original source can be gathered from *Kitāb ṣūrat al-arḍ* of al-Khwārazmī and the world map mentioned above. We are therefore faced with the question, Which of the Arabic versions of Ptolemy's work did al-Idrīsī use? Al-Idrīsī refers to Ptolemy and his work several times in the *Nuzhat al-mushtāq*, but none of these allusions provide us with any clue which Arabic version of Ptolemy he used.[50] It should be emphasized, however, that his source was different from the *Geography* of Ptolemy and his maps as we know them today.

There are, for instance, variations between the *Geography* and al-Idrīsī's maps owing to different calculations

46. Von Mžik's edition, *Das Kitāb ṣūrat al-arḍ*, and Razia Jaʿfri, "Critical Revision" (note 40).

47. See appendix 1.1 above, pp. 10–11. According to Abū al-Fidāʾ Ismāʿīl ibn ʿAlī, *Kitāb rasm al-rubʿ al-maʿmur* (Book of the picture of the inhabited quarter) was translated into Arabic for the caliph al-Maʾmūn. It was rendered into Arabic from Greek. Then, according to the *Fihrist* of Muḥammad ibn Isḥāq Ibn al-Nadim, *Kitāb jughrāfiyā fī al-maʿmūr wa-ṣifat al-arḍ*, in eight chapters, was translated for the philosopher Abū Yūsuf Yaʿqūb ibn Isḥāq al-Kindī (d. 260/847), but it was a poor translation; then, Abū al-Ḥasan Thābit ibn Qurrah al-Ḥarrānī (d. 288/901) rendered an excellent translation of it into Arabic. A Syriac version was also available.

48. See above, p. 96.

49. Al-Idrīsī, *Opus geographicum*, fasc. 1, p. 7 (note 5).

50. Al-Idrīsī, *Opus geographicum*, fasc. 1, pp. 7, 17, 43; fasc. 2, p. 103; and fasc. 3, p. 221 (note 5).

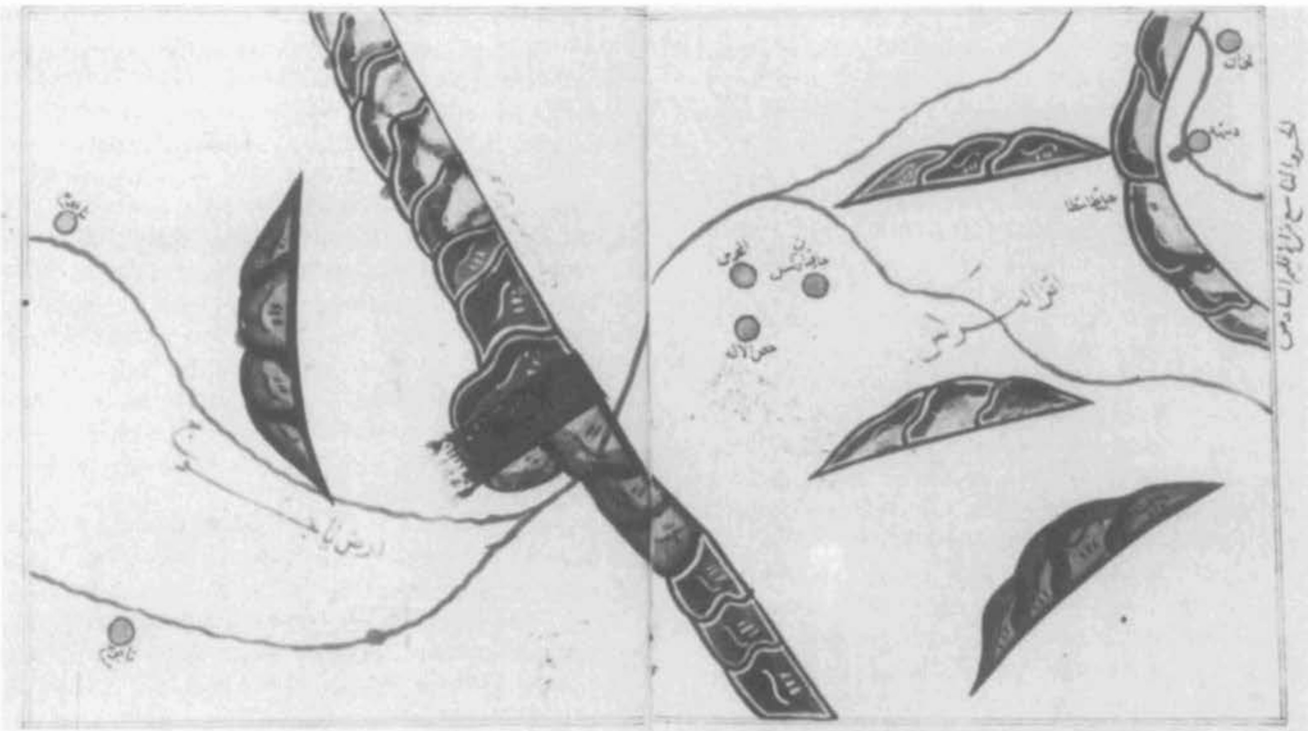


FIG. 7.20. CLIMATE 6, SECTION 9, FROM THE *NUZHAT AL-MUSHTĀQ*. This is the same region as figure 7.19 (note that south is at the top in this figure). Size of each folio: 30.5 × 21 cm. By permission of the Bodleian Library, Oxford (MS. Pococke 375, fols. 304v–305r).

of the climates and the arbitrary division of the climates al-Idrīsī adopted. Thus in Ptolemy the east coast of Africa turns eastward at 15°S, 80°E; in al-Khwārazmī it turns at approximately 14°S, 72°E; and in al-Idrīsī it turns at 4°N. Or again, al-Idrīsī gives two different figures for the junction of the Indian Ocean with the Pacific in the east: on the map it takes place between 1°S and 4°N, whereas in the text he mentions the origins of the Indian Ocean (in the east) at 13°S; in al-Khwārazmī it takes place at 14°30′S, 164°E. Such differences are inconclusive. It is almost impossible at the present stage of research to identify the Arabic version of Ptolemy's work used as a source by al-Idrīsī. A more thorough analysis and a comparative study of Arabic works on mathematical geography need to be done before we can arrive at a definite conclusion.

Besides Ptolemy, al-Idrīsī mentions a number of sources in the preface to the *Nuzhat al-mushtāq*.[51] In addition, he names a few other authors in other parts of the work,[52] but again a thorough analysis of these needs to be undertaken. Generally speaking, for Europe and the Mediterranean region, al-Idrīsī depended on the accounts and reports of the travelers and merchants that were available in Sicily. But for Asia and Africa he depended largely upon the written Arabic sources,

51. The written sources that al-Idrīsī mentions in his preface are: *Kitāb al-ʿajāʾib*; al-Jayhānī; Ibn Khurradādhbih; al-ʿUdhrī; Ibn Ḥawqal; Khanākh ibn Khāqān al-Kīmākī; Mūsā ibn Qāsim al-Qurdī; al-Yaʿqūbī; Isḥāq ibn al-Ḥusayn; Qudāmah ibn Jaʿfar al-Baghdādī; and Ursiyūs al-Anṭākī (Paulus Orosius). See al-Idrīsī, *Opus geographicum*, preface, fasc. 1, pp. 5–6 (note 5).

Al-Idrīsī attributes the *Kitāb al-ʿajāʾib* to two different authors (see *Opus geographicum*, fasc. 1, pp. 5 and 43); for more information see Ahmad, *India*, 15–17 (note 3). Abū ʿAbdallāh Muḥammad ibn Aḥmad al-Jayhānī was the author of *Kitāb al-masālik wa-al-mamālik* (written ca. 310/922), which is not extant. On Abū al-Qāsim ʿUbayd Allāh ibn ʿAbdallāh ibn Khurradādhbih (d. ca. 300/911), author of *Kitāb al-masālik wa-al-mamālik*, see chapter 4 above. Aḥmad ibn ʿUmar al-ʿUdhrī (393–478/1003–85) wrote *Niẓām al-marjān fī al-masālik wa-al-mamālik* (not extant) and *Tarṣīʿ al-akhbār wa-tanwīʿ al-āthār wa-al-bustān fī gharāʾib al-buldān wa-al-masālik ilā jamīʿ al-mamālik* (ed. ʿAbd al-ʿAzīz al-Ahwānī [Madrid, 1965]). On Abū al-Qāsim Muḥammad ibn Ḥawqal (d. ca. 367/977), see chapter 5 above. Khanākh ibn Khāqān al-Kīmākī and Mūsā ibn Qāsim al-Qurdī cannot be identified. On Aḥmad ibn Abī Yaʿqūb al-Yaʿqūbī (d. 284/897), see chapter 4 above. Isḥāq ibn al-Ḥusayn (eleventh century) was the author of *Ākām al-marjān*, which is not extant. Qudāmah ibn Jaʿfar al-Baghdādī (d. between 310–37/962–48) was the author of *Kitāb al-kharāj*; see excerpts in *Kitâb al-Kharâdj*, ed. Michael Jan de Goeje, Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted 1967). Paulus Orosius dates from the first part of the fifth century A.D.

52. See, for example, al-Idrīsī, *Opus geographicum*, fasc. 1, pp. 50–52, 66, 75–76, 93; fasc. p. 4, 419; and fasc. 6, p. 721 (note 5).

namely the geographical works and the travel accounts of merchants and explorers, as well as incorporating his own experiences. For certain parts of Asia, such as Ceylon, India, and northern Asia, he also used Ptolemy, but mainly for physical features.

The Influence of al-Idrīsī's Work on Later Authors

We can trace the influence of al-Idrīsī's text, and to a lesser extent his maps, in a number of later authors. There is strong evidence for the influence of al-Idrīsī upon ʿAlī ibn Mūsā ibn Saʿīd al-Maghribī (d. 685/1286). Ibn Saʿīd's text, *Kitāb basṭ al-arḍ fī ṭūlihā wa-al-ʿarḍ* (Exposition of the earth in length and breadth), is based on the text of al-Idrīsī, with the climates divided into longitudinal sections, and this format was transmitted through Ibn Saʿīd to later Middle Eastern authors. In addition to al-Idrīsī, Ibn Saʿīd used the work of al-Khwārazmī, Ibn Fāṭimah (twelfth century A.D., which is not extant), and the Arabic versions of Ptolemy to complete his manuscript. Ibn Saʿīd describes the works of all three authors as a "map of the earth" (*al-jughrāfiyā*), and although Ibn Saʿīd's work contains no maps, it does give latitude and longitude values similar to those of al-Khwārazmī.

Another clear case of al-Idrīsī's influence is on the Arab historian Ibn Khaldūn (d. 808/1406). This author evidently had great regard for al-Idrīsī in the fields of geography and cartography and used al-Idrīsī's book as the source for the geographic section of his world history, *Kitāb al-ʿibar*. Speaking of the seas and the rivers, he says: "Ptolemy has described all this in his book, and al-Sharīf in the *Book of Roger*. In *al-Jughrāfiyā* they depicted all the mountains and the seas and valleys found in the inhabited world."[53] Ibn Khaldūn then drew for his historical work, a "*ṣūrat al-jughrāfiyā* [map of the world] on the pattern of the map drawn by the author of the *Book of Roger*."[54] The map is extant in at least three manuscripts of *Kitāb al-ʿibar*,[55] and its similarities to al-Idrīsī's small circular world map, are evident (fig. 7.21).

Another historian who used the work of al-Idrīsī was Ḥāfiẓ-i Abrū (d. 833/1430).[56] One of the most important historians of the Timurid period, Ḥāfiẓ-i Abrū wrote copiously on world geography in his *Taʾrīkh* and quoted al-Idrīsī several times on general geography. He does not, however, follow al-Idrīsī in his maps. In the sectional maps accompanying his history, he followed the Balkhī school, and in the world map (as in his delineation of the climates) he seems to represent the latest knowledge on world geography, which is totally different from al-Idrīsī's concept of the known world. The first climate begins at 12°40′N and the seventh climate ends at 50°20′N, but the inhabitable zone goes up to over 66°N. In his map there is no trace of the eastward extension of Africa, which indicates al-Bīrūnī's influence on him.[57]

In addition to the examples above, a continuous influence of al-Idrīsī can be noted in many other authors who mention using his work in one form or another.[58] By the sixteenth century, al-Idrīsī's work was perpetuated largely by the members of the al-Sharafī al-Ṣifāqsī family of Tunisia. All of them were born in Sfax, and most of them lived there or in El Qayrawān (Tunisia), or occasionally in Cairo. The family took to teaching mathematics and astronomy.[59] At this time al-Idrīsī's works were preserved in Tunisia, which would explain why the al-Sharafī al-Ṣifāqsī family was able to use them in compiling their own maps. The surviving maps from this family pertain mainly to the Mediterranean and Black Sea areas, for which al-Idrīsī's maps were likely the only Islamic maps of reasonable detail available to the mapmakers, but there are also some world maps.

Four examples of world maps produced by the family between 1551 and 1601 have survived and all are partly based on al-Idrīsī. The first two are found in manuscript atlases dating from 1551 and 1572 and are loosely copied from al-Idrīsī's small circular world map. The second two, dated 1579 and 1601, are planispheres that use al-Idrīsī as a source for the eastern half but employ Catalan sources in the western part of the map (maps by this family are illustrated below, figs. 14.21 to 14.25 and plate 24). The work of the al-Sharafī al-Ṣifāqsī family is curiously isolated. The maps reveal no influence either of contemporary western European cartography or of the

53. Ibn Khaldūn, 1:81 (author's translation); Ibn Khaldūn, *The Muqaddimah: An Introduction to History*, 3 vols., trans. Franz Rosenthal (New York: Bollingen Foundation, 1958), esp. 1:103.

54. Ibn Khaldūn, 1:87 (author's translation); Ibn Khaldūn, *Muqaddimah*, ed. Rosenthal, 1:109 ff. and the color reproduction opposite the title page (note 53).

55. See Rosenthal's edition of the *Muqaddimah*, 109 n. 43 (note 53), and Ignatiy Iulianovich Krachkovskiy, *Izbrannye sochineniya*, vol. 4, *Arabskaya geograficheskaya literatura* (Moscow, 1957), translated into Arabic by Ṣalāḥ al-Dīn ʿUthmān Hāshim, *Taʾrīkh al-adab al-jughrāfī al-ʿArabī*, 2 vols. (Cairo, 1963–65), 1:443.

56. ʿAbdallāh ibn Luṭf Allāh al-Bihdādīnī, known as Ḥāfiẓ-i Abrū.

57. *Taʾrīkh-i Ḥāfiẓ-i Abrū*, Persian text edited by S. Maqbul Ahmad (unpublished). The world map by Ḥāfiẓ-i Abrū is illustrated above, fig. 6.12.

58. Abū al-Fidāʾ, who wrote *Taqwīn al-buldān*, used both the *Nuzhat al-mushtāq* and the *Rawḍ al-faraj wa-nuzhat al-muhaj*. See *Géographie d'Aboulféda: Texte arabe*, ed. and trans. Joseph Toussaint Reinaud and William MacGuckin de Slane (Paris: Imprimerie Royale, 1840), and the French translation, *Géographie d'Aboulféda* (note 12). Other scholars include Ṣārim al-Dīn Ibrāhīm ibn Muḥammad, Ibn Duqmāq (d. 809/1407?), Sirāj al-Dīn Abū Ḥafṣ ʿUmar ibn al-Wardī (d. 861/1457), ʿAbdallāh Muḥammad ibn ʿAbd al-Munʿim al-Ḥimyarī (d. 900/1494), Muḥammad ibn Aḥmad ibn Iyāṣ (852–930/1448–1524), Leo Africanus or al-Ḥasan ibn Muḥammad al-Wazzān al-Zayyāti (d. ca. A.D. 1552), and Muṣṭafā ibn ʿAbdallāh Ḥājjī Khalīfah (Katīb Çelebi; d. 1067/1657). For more on these authors, see Krachkovskiy, trans. Ṣalāḥ al-Dīn, *Taʾrīkh*, 2:471–72, 2:500–504, 1:447–50, 2:490–93, 1:453, 2:618–36, respectively (note 55).

59. Krachkovskiy, trans. Ṣalāḥ al-Dīn, *Taʾrīkh*, 1:455–56 (note 55).

FIG. 7.21. WORLD MAP FROM IBN KHALDŪN'S *KITĀB AL-ʿIBAR*. The map, which is nearly identical to the world map from the Oxford Pococke manuscript (plate 11), is found in only a few Ibn Khaldūn manuscripts. In the manuscripts that do contain the map, such as this one copied in 804/1401–2, Ibn Khaldūn's text contains a lengthy description of it.
Size of the original: not known. By permission of the Süleymaniye Kütüphanesi, Istanbul (Atıf Efendi 1936).

Kitāb-i baḥrīye of Pīrī Reʾīs. The latter would have provided the best representations of their native Tunisia but would not have been circulating in Tunisia at this time.[60]

The last trace of al-Idrīsī in the Islamic tradition is found in the world map of Abū al-Qāsīm ibn Aḥmad ibn ʿAlī al-Zayyānī (1147–1249/1734–1833), a historian of the Maghreb. In an account of his journeys titled *al-Tarjumānat al-kubrā fī akhbār al-maʿmūr barran wa-baḥran* (The great translator of news from the [inhabited] world, by land and sea), he drew a sketch map of the world following the sectional maps of al-Idrīsī (fig. 7.22).[61] The map has a grid of seventy squares, each corresponding to one of al-Idrīsī's sectional maps, and obviously derives from an al-Idrīsī manuscript. Al-Zayyānī is the only Muslim author I know of who combined the sectional maps in this way, but by this time the

60. The maps and atlases made by the al-Sharafī al-Ṣifāqsī family are discussed in detail below, pp. 284–87.

61. Krachkovskiy, trans. Ṣalāḥ al-Dīn, *Taʾrīkh*, 1:770–71 (note 55). See also Evariste Lévi-Provençal, *Les historiens des Chorfa: Essai sur la littérature historique et biographique au Maroc du XVIᵉ au XXᵉ siècle* (Paris: Emile Larose, 1922), fig. 3.

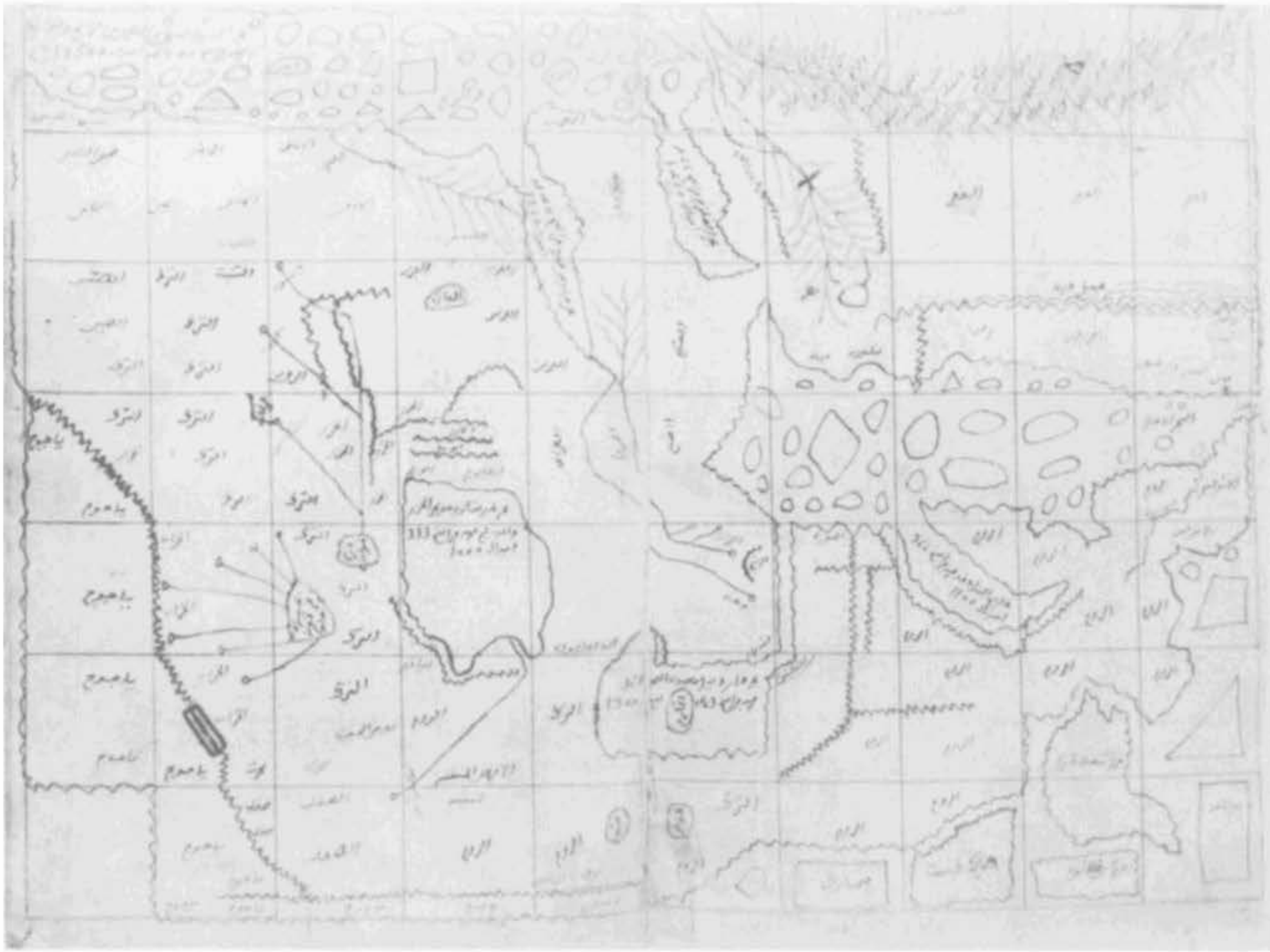


FIG. 7.22. AL-ZAYYĀNĪ'S SKETCH MAP BASED ON AL-IDRĪSĪ'S SECTIONAL MAPS. Found in al-Zayyānī's *al-Tarjumānat al-kubrā* written in 1233/1818.
Size of the original: not known. From Evariste Lévi-Provençal, *Les historiens des Chorfa: Essai sur la littérature historique et biographique au Maroc du XVI[e] au XX[e] siècle* (Paris: Emile Larose, 1922), fig. 3. Attempts to locate a manuscript of this work have proved fruitless.

Ptolemaic tradition had long given way in his own country to the newer techniques of cartography employed in European maps.

Finally, there is the question of the influence of al-Idrīsī's maps, if any, on Renaissance European cartography. In 1592, as I mentioned, an Arabic abridgment of al-Idrīsī's *Nuzhat al-mushtāq* was published in Rome. This was perhaps the only geographical work of its type that became current in Europe at the time. An engraved map by Petrus Bertius (1565–1629), apparently influenced by this 1592 edition, incorporates all of al-Idrīsī's sectional maps into one map.[62] Miller has suggested that al-Idrīsī's cartography influenced the map of Marino Sanudo (prepared by Pietro Vesconte, 1318–20) and also the Catalan maps, but this is dismissed as unlikely by Krachkovskiy.[63] If there was any influence of al-Idrīsī in western Europe, it was only indirect.

62. Chicago, Newberry Library, *Nova orbis tabula, ex fide geographi nubiensis delineata*; M. A. Tolmacheva, "Arab Geography in 'Nova Orbis Tabula' by Bertius," unpublished paper delivered at the Fourteenth International Conference on the History of Cartography, Stockholm, 1991.

63. Miller, *Mappae arabicae*, Band 1, Heft 2, p. 51 (note 16), and Krachkovskiy, trans. Ṣalāḥ al-Dīn, *Taʾrīkh*, 1:292 (note 55). But, for a conflicting view, see the article by Lewicki, "Marino Sanudos Mappa mundi" (note 33), and Fuat Sezgin, *The Contribution of the Arabic-Islamic Geographers to the Formation of the World Map* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), 33–35. For examples of European cartographers using al-Idrīsī, see Gerald R. Tibbetts, *Arabia in Early Maps* (Cambridge: Oleander Press, 1978), 26–30.

Location and Catalog Reference	Date[a] and Place	Maps	References MA[b]	OG[c]	Additional Comments
NUZHAT AL-MUSHTĀQ FI'KHTIRĀQ AL-ĀFĀQ					
Paris, Bibliothèque Nationale, MS. Arabe 2221 (Suppl. MS. Arabe 892)	1300	1 world; not well preserved; curved climate boundaries 68 sectional; missing climate 7, sections 1, 10, and half of climate 9 All maps in color; drawn and colored with care: ocean blue, waves white, mountains dark red bands, rivers green, cities with "rosettes" of gold	P_1	P	26 × 21 cm; 352 fols.; 24 lines/page; Maghribī script; oldest surviving; complete text
Istanbul, Süleymaniye Kütüphanesi, Ayasofya 3502 (Hagia Sofya 3502; *Ǧuġrāfiyā* 705)	Beginning 14th century[d]	No world 30 sectional (climates 1–3)	Co	I	25.6 × 19.3 cm (20.2 × 13.8 cm); 326 pages, 23 lines/page; written in Naskh form; text not complete
Leningrad, M. E. Saltykov-Shchedrin State Public Library, MS. Ar. N.S. 176 (Saint Petersburg, Cod. Arab. 4, 1, 64)[e]	Beginning 14th century	No world 36 whole, 2 half sectional maps (most of climates 4–7—missing climate 7, sections 7, 10, half of climate 8, and half of climate 9) All maps in color (seas in blue, mountains in brown); map size: 19 × 32 cm (each map on two pages)	Pe	L	25 × 18 cm (map size 19 × 32 across two pages); manuscript torn, damaged at beginning and end; was restored in the 19th century (before 1882, noted on sheet 1); binding is light-brown leather, 19th century (possibly prepared after restoration); manuscript given to the Public Library in 1897
London, India Office, Loth 722 (MS. Ar. 617)	Beginning 14th century	No maps		IO	Approx. 25.5 × 20 cm; 118 fols.; 27 lines/page; appended as supplement to another geographical work, the *Mukhtaṣar kitāb al-buldān* of Ibn Faqīh; fols. 109v–18r are the *Nuzhat*: section 9 of climate 6, all of climate 7 except section 1, then section 8 of climate 6
Paris, Bibliothèque Nationale, MS. Arabe 2222 (Suppl. MS. Arabe 893)	1344 (Almería)	No maps	P_2	A	30 × 21 cm; 238 fols.; 29 lines/page; complete text (fols. 2 and 3 have been redone); came to library in 1741; used by Jaubert for French edition; last fols. (236–38) contain chapter of al-Bīrūnī, *Tā'rīkh al-Hind*
Cairo, Dār al-Kutub, *Jugrāfiyā* 150 (Egyptian Library, Gezira 150; Kat. Vs. 167)	1348	1 world; no climate boundaries; in middle of introductory chapter 19 sectional (all of climate 1, and 9 sections of climate 2)	Ca	C	

[a]There is great discrepancy in the dating of some of the manuscripts. The dates in this column follow those given in al-Idrīsī, *Opus geographicum; sive, "Liber ad eorum delectationem qui terras peragrare studeant,"* issued in nine fascicles by the Istituto Universitario Orientale di Napoli, Istituto Italiano per il Medio ed Estremo Oriente (Leiden: E. J. Brill, 19[70]–84); discrepancies are noted in footnotes where they are known.

[b]This column gives the manuscript designation in Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31).

[c]This column gives the manuscript designation in al-Idrīsī, *Opus geographicum* (note a).

[d]The Süleymaniye Kütüphanesi dates the manuscript 924/1518 (correspondence, 1990).

[e]Rubinacci states that Istanbul, Ayasofya 3502, and Leningrad MS. Ar. N.S. 176 were probably part of the same manuscript and were almost contemporary with Paris, Bibliothèque Nationale, MS. Arabe 2221. Ayasofya 3502 and MS. Ar. N.S. 176 were together in Egypt in 1456, where they served as a model for Oxford, Bodleian Library, MS. Pococke 375, but their paths diverged, probably not before 1518; see Roberto Rubinacci, "Il codice Leningradense della geografia di al-Idrīsī," *Annali dell'Istituto Orientale di Napoli* 33 (1973): 551–60.

Location and Catalog Reference	Date[a] and Place	Maps	References MA[b]	References OG[c]	Additional Comments
Istanbul, Köprülü Kütüphanesi, MS. 955 (*Ğuġrāfiyā* 702)	873/1469	1 world map 70 sectional maps[f] All maps in color			Copied by ʿAlī ibn Ḥasan al-ʿAjāmī; 26.5 × 17.5 cm (20 × 12.5 cm); 344 fols.; 25 lines/page
Oxford, Bodleian Library, MS. Pococke 375 (Uri 887)[g]	960/1553[h] (Cairo)	1 world on fols. 3v–4r; well preserved; curved climate boundaries 69 sectional (missing climate 7, section 10) All maps in color: seas and lakes dark blue, usually with white wavy lines (lakes occasionally green); rivers blue or green; mountains in pink, brown, dark green, white, and gray; towns yellow, red, or pink circles outlined in black, red, or brown	O_1	O	Copied by ʿAlī ibn Ḥasan al-Hūfī al-Qāsimī; 30.5 × 21 cm; complete text
Sofia, Cyril and Methodius National Library, MS. Or. 3198 (MS. Or. 3180)	1556 (Cairo)	1 world 69 sectional maps All maps in color; ink is black, red, and rosy violet		S	Copied by Muḥammad ibn Alī al-Ajhūrī al-Shāfiʿī); 31 × 21 cm (23 × 14 cm); 325 fols.; 25 lines/page; writing in a clear, legible Naskh and Thuluth; complete text
Oxford, Bodleian Library, MS. Greaves 42 (MS. Greaves 3847–42; Uri 884)[i]	Undated, end 16th century[j]	1 world on fols. 1v–2r; partially destroyed; straight climate boundaries 30 sectional (climates 1–3) Color: seas and lakes blue with white wavy lines (lakes occasionally green); rivers green; mountains drawn in segments of pink, purple, brown, red, green, and gray, outlined in black, each segment containing in white a shape resembling a horizontal letter S accompanied by groups of white dots; towns are gold rosettes with red centers	O_2	G	32 × 24 cm; 242 fols; 23 lines/page; Maghribī script; contains part of introduction and climates 1–3
RAWḌ AL-FARAJ WA-NUZHAT AL-MUHAJ					
Istanbul, Süleymaniye Kütüphanesi, Hekimoğlu MS. 688 (Ali Paşa 688)	8th/14th century	1 climate map 73 sectional maps (climate 1, 15 maps; climates 2–5, 10 maps each; climates 6–7, 9 maps each)			29.3 × 18.4 cm (19.6 × 10.5 cm); 162 fols.; 16 lines/page
Private collection	?				
Istanbul, Süleymaniye Kütüphanesi, Hasan Hüsnü MS. 1289	Copied 1090/1679?	1 climate map 73 sectional maps (same division as above)[k]			122 fols.; 21 lines/page

[f]Ramazan Şeşen, Cevat İzgi, and Cemil Akpınar, *Catalogue of Manuscripts in the Köprülü Library*, 3 vols. (in Ottoman Turkish) (Istanbul: Research Centre for Islamic History, Art, and Culture, 1986), 1:485.

[g]This designation refers to its catalog number and description in Joannes Uri, *Bibliothecae Bodleianae codicum manuscriptorum orientalium*, pt. 1 (Oxford, 1787), no. 887.

[h]According to the Bodleian Library, the manuscript is clearly dated 960/1553 (correspondence, 1989 and 1995); Uri, *Bibliothecae Bodleianae codicum manuscriptorum orientalium* (note g) gives A.H. 906.

[i]Described in Uri, *Bibliothecae Bodleianae codicum manuscriptorum orientalium*, no. 884 (note g).

[j]The Bodleian Library dates the manuscript late fourteenth century (correspondence, 1990).

[k]A facsimile reproduction of both Istanbul manuscripts is al-Idrīsī, *The Entertainment of Hearts and Meadows of Contemplation/Uns al-muhaj wa-rawḍ al-furaj*, ed. Fuat Sezgin (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1984).

8 · Geodesy

RAYMOND P. MERCIER

INTRODUCTION

Essential to an understanding of the Arabs' contribution to mapmaking is their approach to geodesy—the measurement of distances on the curved surface of the earth.[1] Such distances can be measured either in linear units, such as the Arabic mile, or in angular units—longitude and latitude. To convert from one to the other one must know the number of miles per degree or, equivalently, the radius of the earth.

In the Greek classical period, before the general use of latitude as an angular coordinate, the inhabited area (the *oikoumene*) was divided into zones, or climates, according to the length of the longest day in the central part of the zone.[2] Thus Ptolemy, in his *Almagest*, takes seven boundaries in steps of one-half hour, running from thirteen to sixteen hours. The practice continues in Islamic mathematical geography.[3] For example, al-Bīrūnī (362/973 to after 442/1050), in his *al-Qānūn al-Masʿūdī* (The Masʿūdic canon), draws up a table showing the sizes of the successive climates in Arabic miles and *farsakhs*. He defines the boundaries again in terms of regular half-hour increments in the day length, but starting at 12¾ hours, the southern boundaries of his seven climates ranging from 12;39 to 47;11 degrees.[4] The actual measurement of latitude was a relatively straightforward matter and could be carried out by observing the altitudes of the stars or the sun. Such methods were well established in the classical world, and the tradition continued among Arab scientists.

Determining longitude raised far greater difficulties than determining latitude. Here as elsewhere, Arabic methods continued those of classical antiquity. In the classical world longer distances were taken from travelers' reports, while shorter distances were fixed by some device such as a waywiser.[5]

The first Arab astronomers and geographers began to estimate longitude from a knowledge of earlier work—Syriac, Greek, and Indian. Pre-Islamic astronomical tables were drawn up for a particular reference meridian, such as Alexandria or Ujjain.[6] In the earliest phase of Arabic astronomy, handbooks of tables were brought to Baghdad, and it was essential to recalculate them. In the subsequent development of astronomy in the Islamic world, many centers came to be used as meridians of reference.[7] This necessitated knowing the correct difference in longitude and so provided a strong motive for determining accurate geographical distances and coordinates.

1. The spherical nature of the earth had been recognized long before, in the classical world; and wherever Greek science went, in particular in the Islamic culture area, the concept of a spherical earth went also.

2. Ernst Honigmann, in his very important discussion of the history of Greek and Arabic geographical lists, sets the subject very much in the traditional context of the division of the earth into climates; see his *Die sieben Klimata und die πόλεις ἐπίσημοι* (Heidelberg: Winter, 1929).

3. The precise calculation of the corresponding latitudes depends on the obliquity of the ecliptic. This parameter was frequently revised in Arabic astronomy and was always less than Ptolemy's value of 23;51.

4. Abū al-Rayḥan Muḥammad ibn Aḥmad al-Bīrūnī, *Kitāb al-qānūn al-Masʿūdī fī al-hayʾah wa-al-nujūm*, bk. 5, chap. 9; see *al-Qānūnuʾl-Masʿūdī (Canon Masudicus)*, 3 vols. (Hyderabad: Osmania Oriental Publications Bureau, 1954–56), 2:542–45, and Ahmad Dallal, "Al-Bīrūnī on Climates," *Archives Internationales d'Histoire des Sciences* 34 (1984): 3–18. Here and elsewhere, where magnitudes are expressed sexagesimally, the division between the integer and the fraction is marked by a semicolon. This mode, rather than the decimal fraction, was a commonplace in Arabic texts and is a direct inheritance of Greek and Babylonian astronomy. When it is a question of an angle, the first and second numbers after the semicolon are the usual minutes and seconds.

5. Heron of Alexandria describes a type of waywiser, a device in which a gear train is driven by rolling a wheel over the ground, the accumulated distance being indicated by a slowly rotating pointer (*Opera quae supersunt omnia*, 5 vols. [Leipzig: Teubner, 1899–1914], vol. 3, *Rationes dimetiendi et commentatio dioptrica*, ed. Hermann Schöne, 313). A simpler form is described by Vitruvius and seems to have been used by the Romans when placing milestones; see Donald R. Hill, *A History of Engineering in Classical and Medieval Times* (London: Croom Helm, 1984), 122–23.

6. The prime meridian of Indian astronomy passed through Ujjain (longitude 75;46) in Madhya Pradesh. It came to be referred to as Arīn in Arabic texts. The *zīj*, or astronomical handbook, of al-Khwārazmī was based on this meridian, in line with its close dependence on the *Brāhmasphuṭasiddhānta*; see Raymond P. Mercier, "Astronomical Tables in the Twelfth Century," in *Adelard of Bath: An English Scientist and Arabist of the Early Twelfth Century*, ed. Charles Burnett (London: Warburg Institute, 1987), 87–118. On the demonstration that the Indian observations were actually referred to this meridian, see Raymond P. Mercier, "The Meridians of Reference of Indian Astronomical Canons," in *History of Oriental Astronomy*, Proceedings of an International Astronomical Union, Colloquium, no. 91, New Delhi, India, 13–16 November 1985, ed. G. Swarup, A. K. Bag, and K. S. Shukla (Cambridge: Cambridge University Press, 1987), 97–107.

7. Among these, Baghdad, Damascus, Raqqa, Cairo, Samarkand, Córdoba, Ghazna.

Lists of the geographical coordinates of places are commonly found in Arabic astronomical handbooks. These lists of coordinates are discussed thoroughly above (chap. 4), and recently data from as many as seventy-four such lists were collected and published.[8] Adjustments of latitude and longitude were introduced from time to time, but as a rule we are not told exactly how this was accomplished. The geodetic researches of al-Bīrūnī are a notable exception, as we will see below.

Triangulation, as it is known to the modern surveyor, appears to have played no part in determining longitudes. In classical antiquity some form of the properties of similar right triangles must have been used when it was desired, for example, to drive a tunnel through a hill, and for this purpose an instrument such as the dioptra of Heron of Alexandria would have been used to determine angles in the horizontal plane, as Heron himself explains.[9] There are no examples, however, where angles measured in that way were incorporated into a piecemeal accumulation of triangles resulting eventually in the determination of the distance between points well out of sight of each other. When we examine in detail al-Bīrūnī's determination of the longitude of Ghazna (modern Ghazni in eastern Afghanistan), it will be clear that he applies a trigonometric analysis to a succession of spherical triangles, but in each case the triangles initially known are found from latitude determinations and from distances provided by travelers.

Simultaneous observations of a lunar eclipse in two places provide in principle a means of determining the difference of longitude between places. If the two observers note the eclipse according to their local mean times, then the time difference between them is established, and hence the longitude difference is known. But such an approach proves to have no more than theoretical interest. It would have been necessary to use records of past eclipses, and in that case to reconstruct the features that were observed—for example, the time of onset or the moment of maximum obscuration. There were also difficulties in fixing the local time with sufficient precision, or indeed in agreeing on exactly what was meant by local mean time.[10] In determining longitude differences, the precision attained from the study of travelers' distances far exceeded what would have been available from the study of lunar eclipses. Al-Bīrūnī goes into the method and its problems in some detail,[11] but he makes no practical use of it, any more than others before him.

The conversion between linear and angular distances may be expressed either as a ratio—the number of units per degree of circumference—or as a proportion of the radius of the earth. The values of both these important ratios were known from various pre-Islamic sources, but the principal difficulty in employing this information arose from ignorance of the earlier units of measurement. Islamic astronomers knew, for example, of the ratio seventy-five miles per degree of latitude, which in fact is very accurate when the mile is the Roman mile of 1,480 meters. They also knew from Ptolemy's *Geography* of his measure of 500 stades per degree. They were evidently confused about such earlier results, principally because they lacked information about units such as the stade or the Roman mile. This confusion was clearly the principal reason early Abbasid astronomers, at the time of the caliph al-Ma'mūn (r. 198–218/813–33), undertook to repeat the basic measurements, measuring off the distance in terms of units familiar to them, as I shall explain below. This illustrates the interaction between translation and scientific observation that is strongly characteristic of early Islamic scholarship. Each activity assisted the other. It is important to understand that they were not simply carrying out an a priori measurement; the measurement was intended to clarify the received tradition.

Whatever geodetic investigations were carried out at the time of al-Ma'mūn were not universally used, or even understood, by later scientists and historians. Attempts to make sense of those investigations have not resulted, for either medieval or modern scholars, in a clear and convincing history. As we shall see, even the most authoritative accounts are schematic and lack convincing circumstantial details, and they contradict one another. They show confusion between traditions of pre-Islamic measurements of the length of a degree and whatever was determined at the time of al-Ma'mūn. Many Arab scholars continued to use, for example, Ptolemy's 66⅔ miles per degree,[12] plainly unconvinced by the earlier Arab effort.

We are fortunate to have one example of the use of the trigonometric conversion of travelers' distances to true coordinates, for this is well illustrated by the work

8. Edward S. Kennedy and Mary Helen Kennedy, *Geographical Coordinates of Localities from Islamic Sources* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987).

9. Heron; see Schöne's edition, *Rationes dimentiendi et commentatio dioptrica*, 215 (note 5). The dioptra is similar in concept to the modern theodolite.

10. Although the local time in nonuniform hours is easier to fix, one must convert this to mean time for purposes of the longitude difference. There was not then, as there is now, an agreed definition of local mean time; Raymond P. Mercier, "Meridians of Reference in Pre-Copernican Tables," *Vistas in Astronomy* 28 (1985): 23–27.

11. Al-Bīrūnī, *al-Qānūn al-Masʿūdī*, bk. 5, chap. 1; see the 1954–56 edition, 2:507 (note 4).

12. Abū al-Fidā' Ismāʿīl ibn ʿAlī, *Taqwīm al-buldān*; see *Géographie d'Aboulféda: Texte arabe*, ed. and trans. Joseph Toussaint Reinaud and William MacGuckin de Slane (Paris: Imprimerie Royale, 1840), and *Géographie d'Aboulféda: Traduite de l'arabe en français*, 2 vols. in 3 pts. (vol. 1, *Introduction générale à la géographie des Orientaux*, by Joseph Toussaint Reinaud; vol. 2, pt. 1, trans. Reinaud; vol. 2, pt. 2, trans. S. Stanislas Guyard) (Paris: Imprimerie Nationale, 1848–83), 1:CCLXVIIIff. and vol. 2, pt. 1, 17–18.

of al-Bīrūnī. We have a number of his works bearing on geodesy, and in the sections below summary accounts are given of his attempts to determine the earth's radius as well as the difference between the longitude of Ghazna and that of Baghdad. Ghazna served to define the meridian of reference of al-Bīrūnī's astronomical tables, *al-Qānūn al-Masʿūdī*. The strengths and weaknesses of his work are apparent in these efforts.

Arabic Metrology

In early Islamic work, the units in use were the *farsakh* (Persian *farsāng*), mile (Arabic *mīl*, following Syriac *mīl*), cubit (*dhirāʿ*), and digit (*iṣbaʿ*). The *farsakh* equaled three Arabic miles, while the mile was 4,000 cubits. As far as geodetic work was concerned, it has been demonstrated by Mahmoud Bey that the cubit, of 24 digits, was equal to the ancient Babylonian cubit of 49.3 centimeters, making the mile 1,972 meters, and the *farsakh* 5,916 meters.[13]

The cubit used for geodetic measurements, and other scientific work reported in Arabic, was the "black" (*sawdāʾ*) cubit, which we are told was adopted by al-Maʾmūn. At that time another cubit was known to Arabic scientists, the traditional Egyptian cubit.[14] This was used to calibrate the nilometer at Rawḍah (Roda), an island very near Cairo. Indeed, in the ninth century A.D. the caliph al-Mutawakkil (r. 232–47/847–61) ordered a renovation of that nilometer, and among those involved were the well-known scientists of the time al-Khwārazmī and al-Farghānī.[15]

In his investigation of the cubit in early Arabic geodesy, Mahmoud Bey initially considered the nilometer cubit, then turned to other cubit measures he found in use in Egypt, such as the canonical (*shāfʿī*) cubit. After some remarkable and ingenious efforts to determine their metric equivalents, he found that they had an average length of 49.3 centimeters. That, according to Arabic writers on geodesy, direct measurements of the length of one degree gave 56⅔ miles convinced Mahmoud Bey that the mile of 4,000 cubits must have been based on this cubit of 49.3 centimeters, which he had established by other means, and definitely not on the Egyptian cubit. Based on this value, the length of the degree is then 111,747 meters, a close approximation to the correct value of 110,959 meters for the latitude of Baghdad.

The cubit of this length had been used in Mesopotamia for a very long time. It is attested, for example, on each of the two statues of the Sumerian ruler Gudea, in which a remarkable measuring scale forms part of the plan of a building.[16] The mile of 4,000 cubits appears to be in use in the pre-Islamic period,[17] and indeed in a cuneiform text of Nebuchadnezzar II (604–561 B.C.) it is stated that "for 4000 cubits . . . to the westward of Babylon I constructed an enclosing wall,"[18] so we may believe that the Arabic mile is an ancient Mesopotamian unit, like the Arabic cubit itself.

In some classical texts the Roman mile (ca. 1,480 meters) is given as 3,000 cubits, so that evidently the same cubit was implied: 1,480/3,000 = 0.493 meter. Arabic writers make references to the Roman mile, but it is not clear how well they understood its relation to their own. Certainly some assumed that the ancient and Arabic miles were the same. For example, in the thirteenth century A.D., Abū al-Fidāʾ states that the ancient cubit consisted of 32 digits,[19] in contrast to the Arabic cubit of 24 digits, and so infers that the ancient mile, which he correctly

13. Mahmoud Bey has given the principal arguments underlying these evaluations; see his "Le système métrique actuel d'Egypte: Les nilomètres anciens et modernes et les antiques coudées d'Egypte," *Journal Asiatique*, ser. 7, vol. 1 (1873): 67–110. His work was resumed by Carlo Alfonso Nallino, who gave supplementary arguments leading to the same results in "Il valore metrico del grado di meridiano secondo i geografi arabi," *Cosmos* 11 (1892–93): 20–27, 50–63, 105–21; republished in *Raccolta di scritti editi e inediti*, 6 vols., ed. Maria Nallino (Rome: Istituto per l'Oriente, 1939–48), 5:408–57. Both Mahmoud Bey and Nallino were very much concerned with the geodetic context. Henry Sauvaire collected a mass of data from Arabic sources, related to matters other than geodesy, which he presented without much effort at critical evaluation in his "Matériaux pour servir à l'histoire de la numismatique et de la métrologie Musulmanes, quatrième et dernière partie: Mesures de longueur et de superficie," *Journal Asiatique*, 8th ser., 8 (1886): 479–536. Many of Sauvaire's reports gave the ratio of one unit to another, or the difference between two similar units, as so many digits. The survey by Walther Hinz, *Islamische Masse und Gewichte: Umgerechnet ins metrische System*, Handbuch der Orientalistik, ed. B. Spuler, suppl. vol. 1, no. 1 (Leiden: E. J. Brill, 1955), depended on such relations quoted from Sauvaire, and the units were given an absolute value by the assumption that the "black" cubit was equal to that of the nilometer at Rawḍah, which is incorrect.

14. The Egyptian units are relatively well documented and are summarized by Wolfgang Helck, "Masse und Gewichte," in *Lexikon der Ägyptologie*, ed. Wolfgang Helck and Eberhard Otto (Wiesbaden: Otto Harassowitz, 1975–), 3:1199–1209. The cubit, known to be 52.5 centimeters in the New Kingdom, appears to have been somewhat longer in the Ptolemaic period, when the cubit on the Ptolemaic nilometer was 53 centimeters.

15. K. A. C. Creswell, *Early Muslim Architecture: Umayyads, Early ʿAbbāsids and Ṭūlūnids*, 1st ed., 2 pts., (Oxford: Clarendon Press, 1932–40), pt. 2, 296–302.

16. François Thureau-Dangin, "L'u, le qa et la mine: Leur mesure et leur rapport," *Journal Asiatique*, 10th ser., 13 (1909): 79–110; for an illustration of one of the statues, see A. R. Millard, "Cartography in the Ancient Near East," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:107–16, esp. figs. 6.2 and 6.3.

17. Theodor Mommsen, "Syrisches Provinzialmass und römischer Reichskataster," *Hermes* 3 (1869): 429–38, drew attention to a Syriac text of A.D. 501 in which routes were measured in terms of a mile of 4,000 cubits.

18. Stephen Herbert Langdon, *Building Inscriptions of the Neo-Babylonian Empire: Part 1, Nabopolassar and Nebuchadnezzar* (Paris: Ernest Leroux, 1905), 65, 133, and 167.

19. Abū al-Fidāʾ, *Taqwīm al-buldān*; see *Géographie d'Aboulféda*, Arabic text, 15; translation, vol. 2, pt. 1, 18 (note 12).

says has 3,000 cubits, is of the same length as the Arabic mile of 4,000 24-digit cubits, and this leads him to a wrong interpretation of the Ptolemaic length of the degree, 66²/₃ miles.

Measurements of the Length of a Degree

In converting from linear distances on the earth's surface to angular measurement, the equivalence of one degree to 56²/₃ miles was used by many Arab scientific writers. Other values, however, were commonly found, namely, 66²/₃ miles and 75 miles per degree. The ratio 66²/₃ miles presumably arises from Ptolemy's assumption of 500 stades per degree, assuming 7¹/₂ stades to the mile.

The ratio 75 miles per degree is attributed to al-Khwārazmī by Ibn al-Faqīh (fl. 290/903), and he is followed by Yāqūt (575–626/1179–1229) in his geographical dictionary[20] and quoted by many other Arabic writers.[21] This is indeed a most accurate value if the mile is taken as Roman (1,480 m), for then 75 miles = 111,000 meters, while the true value at a latitude of 36° is 110,959 meters. It presumably reflects estimates and measurements made in the late Roman Empire. Certainly the figure of 75 miles does not originate with al-Khwārazmī but was presumably taken from Syriac sources, as indeed was much else in al-Khwārazmī's geography.[22] When converted to Arabic miles, the ratio of 75 is replaced by 56¹/₄.

One of the earliest texts reporting the ratio 56²/₃ is that of al-Farghānī: "We find in this way that to one celestial degree corresponds on the earth's surface 56²/₃ miles, of which each contains 4,000 cubits, called black [*al-sawdā*ʾ]. So it was determined in the time of al-Maʾmūn of glorious memory, by a number of scholars brought together for this measurement."[23]

The ratio 56²/₃ miles was apparently based on direct geodetic surveys first carried out early in the ninth century by teams appointed by al-Maʾmūn, although none of the accounts of that activity gave precisely that figure. There are various extant reports of this activity, and we may quote directly from Ḥabash al-Ḥāsib (fl. 240/850), from al-Bīrūnī, who quotes him, and from Ibn Yūnus (d. 399/1009), who owes his account to those of both Sind ibn ʿAlī and Ḥabash al-Ḥāsib.

In his *Kitāb taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin* (The determination of the coordinates of positions for the correction of distances between cities), al-Bīrūnī quotes at length from the account of Ḥabash al-Ḥāsib, according to which al-Maʾmūn directed certain astronomers to a place in the desert of Sinjār nineteen *farsakhs* from Mosul and forty-three from Samarra, from which point two parties set out to the north and south, respectively, each determining that fifty-six miles were equivalent to one degree.[24]

A portion of Ḥabash al-Ḥāsib's work *Kitāb al-ajrām wa-al-abʿād* (Book of bodies and distances) is extant, and a translation has recently been published.[25] It confirms al-Bīrūnī's quotation in all its essentials. The passage is as follows:

> The Commander of the Faithful al-Maʾmūn desired to know the size of the earth. He inquired into this and found that Ptolemy mentioned in one of his books that the circumference of the earth is so and so many thousands of stades. He asked the commentators about the meaning of "stade," and they differed about

20. Shihāb al-Dīn Abū ʿAbdallāh Yāqūt ibn ʿAbdallāh al-Ḥamawī al-Rūmī al-Baghdādī, *Muʿjam al-buldān*; see *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld (Leipzig: F. A. Brockhaus, 1866–73), 1:16. As Jwaideh remarks (*The Introductory Chapters of Yāqūt's "Muʿjam al-buldān,"* ed. and trans. Wadie Jwaideh [Leiden: E. J. Brill, 1959; reprinted, 1987], 24 n. 2), Yāqūt derives this from Aḥmad ibn Muḥammad ibn al-Faqīh al-Hamadhānī: *Kitāb al-buldān*; see *Compendium libri kitâb al-boldân*, ed. Michael Jan de Goeje, Bibliotheca Geographicorum Arabicorum, vol. 5 (Leiden: E. J. Brill, 1885; reprinted 1967), 5.

21. Hans von Mžik, "Ptolemaeus und die Karten der arabischen Geographen," *Mitteilungen der Kaiserlich-Königlichen Geographischen Gesellschaft in Wien* 58 (1915): 152–76, esp. 171–72; further quotations by Nallino in "Il valore metrico," 50–53 (note 13).

22. Hans von Mžik has convincingly argued for this Syriac dependence in "Afrika nach der arabischen Bearbeitung der Γεωγραφικὴ ὑφήγησις des Claudius Ptolemaeus von Muḥammad ibn Mūsā al-Ḥwārizmī," *Denkschriften der Kaiserlichen Akademie der Wissenschaften in Wien: Philosophisch-Historische Klasse* 59 (1917), Abhandlung 4, i–xii, 1–67, although the complications have been further discussed by Hubert Daunicht, *Der Osten nach der Erdkarte al-Ḫuwārizmīs: Beiträge zur historischen Geographie und Geschichte Asiens*, 4 vols. in 5 (Bonn: Selbstverlag der Orientalischen Seminars der Universität, 1968–70), 1:203–14. Indeed, Jacob of Edessa (d. A.D. 708) adopts the same figure for the geographical discussions in his *Hexameron* (see *Etudes sur l'Hexameron de Jacques d'Edesse*, trans. Arthur Hjelt [Helsinki, 1892], 20).

23. Abū al-ʿAbbās Aḥmad ibn Muḥammad al-Farghānī, *Elementa astronomica, arabicè et latinè*, ed. and trans. Jacob Golius (Amsterdam, 1669), 30 (Arabic and Latin). The "black" cubit is again referred to by al-Bīrūnī in the *Kitāb al-tafhīm*, "Each mile is a third of a *farsakh*, or 4,000 cubits, called black in Iraq, each of which equals 24 digits" (author's translation); see also Robert Ramsey Wright, ed. and trans., *The Book of Instruction in the Elements of the Art of Astrology* (London: Luzac, 1934), 208.

24. Al-Bīrūnī, *Taḥdīd*; see *The Determination of the Coordinates of Positions for the Correction of Distances between Cities*, trans. Jamil Ali (Beirut: American University of Beirut, 1967), 178–80. The distances from Mosul and Samarra fix the town of Sinjār itself on the northern edge of the desert.

Al-Bīrūnī's *Taḥdīd* is a work in twenty-five chapters giving a specialized treatment of fundamental geodetic questions such as the determination of distances on the earth and derivation therefrom of geographical coordinates. Some of the topics are treated again, more summarily, in his later *al-Qānūn al-Masʿūdī* (mentioned above). This is a far larger treatise covering every sort of astronomical theme, including geodetic topics, which are given in bk. 5, providing a scientific foundation for the long table of geographical coordinates that follows.

25. Y. Tzvi Langermann, "The Book of Bodies and Distances of Ḥabash al Ḥāsib," *Centaurus* 28 (1985): 108–28.

the meaning of this. Since he was not told what he wanted, he directed Khālid ibn ʿAbd al-Malik al-Marwarrūdhī, ʿAlī bin ʿĪsā al-Asṭurlābī [from the cognomen evidently an instrument maker], and Aḥmad ibn al-Bukhturī al-Dhāriʿ [al-Dhāriʿ means surveyor] with a group of surveyors and some of the skilled artisans including carpenters and brassmakers, in order to maintain the instruments which they needed. He transported them to a place which he chose in the desert of Sinjār. Khālid and his party headed for the north pole of Banāt Naʿsh [Ursa Minor], and ʿAlī and Aḥmad and their party headed to the south pole. They proceeded until they found that the maximum altitude of the Sun at noon had increased, and differed from the noon altitude which they had found at the place from which they had separated, by the amount of one degree, after subtracting from it the sun's declination along the path of the outward journey, and there put arrows. Then they returned to the arrows, testing the measurement a second time, and so found that one degree of the earth was 56 miles, of which one mile is 4,000 black cubits. This is the cubit adopted by al-Ma'mūn for the measurement of cloths, surveying of fields, and the distribution of way-stations.

Ḥabash al-Ḥāsib concluded by saying he had heard this account directly from Khālid.

Another much less detailed account is given by al-Bīrūnī in his *al-Qānūn al-Masʿūdī*:

Al-Ma'mūn son of al-Rashīd, wished to verify it [the amount given by the Greeks], and for this appointed a commission of scholars, who set out to determine the amount in the Plain of Sinjār, who found the degree to be $56\frac{2}{3}$ miles. Multiplying this by 360 gives 20,400 miles, the length of the circumference.[26]

Al-Bīrūnī expressed his concern about the discrepancy between the figures 56 and $56\frac{2}{3}$, wondering if it arose from the two early attempts in Sinjār or from some other reason.

In his *al-Zīj al-kabīr al-Ḥākimī* (Hakimite tables), chapter 2, Ibn Yūnus writes:

Sind ibn ʿAlī reports that al-Ma'mūn ordered that he and Khālid ibn ʿAbd al-Malik al-Marwarrūdhī should measure a degree of a great circle of the earth's surface. We left together, he says, for this purpose. He gave the same order to ʿAlī ibn ʿĪsā al-Asṭurlābī and ʿAlī [sic] ibn al-Bukhturī who took themselves to another direction [or region]. Sind ibn ʿAlī said, I and Khālid ibn ʿAbd al-Malik traveled to the area between Wāsa [or Wāmia] and Tadmor, and there we determined a degree of the great circle of the terrestrial equator, which was 57 miles. ʿAlī ibn ʿĪsā and ʿAlī [sic] ibn al-Bukhturī found the same and these two reports containing the same measure arrived from the two regions [or directions] at the same time.

Aḥmad ibn ʿAbdallāh, named Ḥabash, reported in his treatise on observations made at Damascus by the authors of the *Mumtaḥan* [Verified tables], that al-Ma'mūn ordered the measurement of a degree of the terrestrial great circle. He said that for this purpose they traveled in the desert of Sinjār, until the noon altitudes between the two measurements in one day changed by one degree. They then measured the distance between the two places, which was $56\frac{1}{4}$ miles, of each mile was 4,000 cubits, the black cubits adopted by al-Ma'mūn.[27]

From these two quotations then, we appear to have from Aḥmad ibn ʿAbdallāh, called Ḥabash:

1. A survey along a southward path in Sinjār by ʿAlī ibn ʿĪsā al-Asṭurlābī and Aḥmad ibn al-Bukhturī al-Dhāriʿ: number of miles not stated.
2. A survey along a northward path in Sinjār by Khālid ibn ʿAbd al-Malik al-Marwarrūdhī: 56, or $56\frac{1}{4}$ miles (Ibn Yūnus).

And from Sind ibn ʿAlī:

3. Sind ibn ʿAlī and Khālid ibn ʿAbd al-Malik al-Marwarrūdhī, in the region of Wāsa/Wāmia and Tadmor [ancient Palmyra]: 57 miles.
4. ʿAlī ibn ʿĪsā al-Asṭurlābī and Aḥmad ibn al-Bukhturī al-Dhāriʿ in another direction/region: 57 miles.

These two accounts are inconsistent because Khālid is said in one to have gone to Sinjār and in the other, to Tadmor and Wāsa/Wāmia (see fig. 8.1). It is also odd that Sind ibn ʿAlī is not mentioned by Ḥabash.

This is not the only difficulty. The terrain between Palmyra and Raqqa is unsuitable for this type of survey, and Wāsa/Wāmia is certainly not recognized as an Arabic place-name.[28] Moreover, al-Bīrūnī in the *Taḥdīd*

26. Al-Bīrūnī, *al-Qānūn al-Masʿūdī*, bk. 5, chap. 7; see the 1954–56 edition, 2:529 (note 4).

27. This passage is found in the manuscript in Leiden, MS. Or. 143, pp. 81–82, and in the manuscript in Paris, Bibliothèque Nationale, MS. Arabe 2495, fols. 44r–v; only the former has historical value, the latter being merely copied from it. Tranlations of this passage were given by J. J. A. Caussin de Perceval, *Le livre de la grande table Hakémite* (Paris: Imprimerie de la Républic, 1804), 94–95; and by Nallino, "Il valore metrico," 54–55 (note 13). The Leiden manuscript appears to have "Wāsa," which the copyist of the Paris manuscript read as "Wāmia."

28. Ptolemy in his *Geography* (*Claudii Ptolemaei Geographia*, 2 vols. and tabulae, ed. Karl Müller [Paris: Firmin-Didot, 1883–1901], 15.14.13) lists a place named "θεμα," with the coordinates longitude 71;30, latitude 35;30, which is on the same meridian as Palmyra and 1;30 due north of it. It may have been misread as "οεμα," hence "Wamia."

Alternatively, it has been conjectured that "Wāmia" is a corruption of "Fāmia," that is, Greek "Apamea," which was the name of a number of towns, including not only the one near Ḥims, to the west of Palmyra, but also that due north of Palmyra, near Zeugma. The former is wrongly placed to be the correct reference, however, and it seems, moreover, that the latter Apamea was known as Birejik (Bīreğik); Kurt Regling, "Zur historischen Geographie des mesopotamischen Parallelogramms," *Klio* 1 (1901): 443–76, esp. 446.

The extensive studies of this region by travelers and scholars have revealed nothing to clarify this difficulty. One should also note that a Roman road, the Via Diocletiana, ran north-east from Palmyra and then due north to meet the Euphrates at a point just west of Raqqa. This road is represented by a track, which has been explored in modern

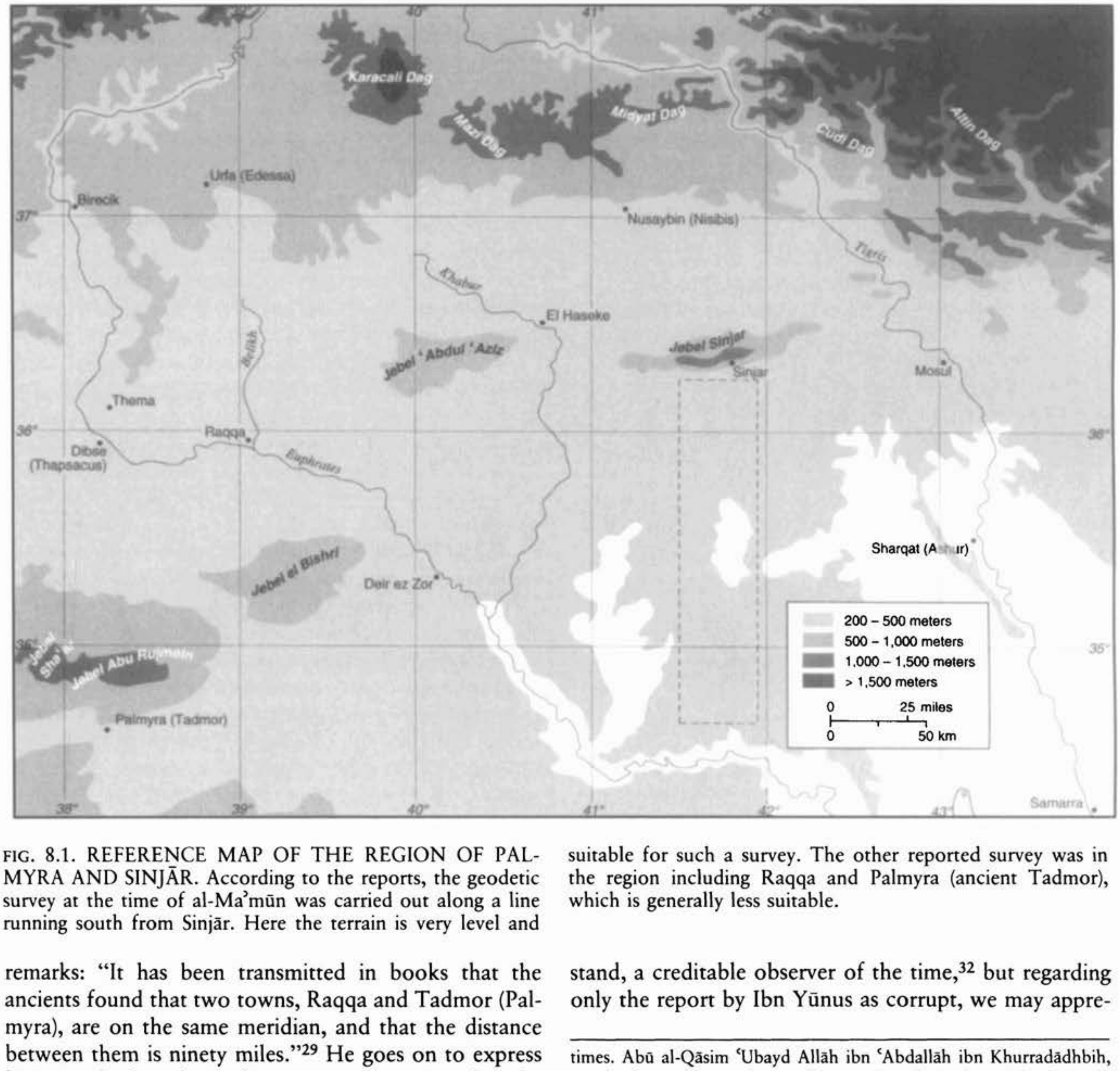


FIG. 8.1. REFERENCE MAP OF THE REGION OF PALMYRA AND SINJĀR. According to the reports, the geodetic survey at the time of al-Maʾmūn was carried out along a line running south from Sinjār. Here the terrain is very level and suitable for such a survey. The other reported survey was in the region including Raqqa and Palmyra (ancient Tadmor), which is generally less suitable.

remarks: "It has been transmitted in books that the ancients found that two towns, Raqqa and Tadmor (Palmyra), are on the same meridian, and that the distance between them is ninety miles."[29] He goes on to express his own doubts about this matter, suggesting that the manuscripts are corrupt. This remark may be linked usefully to two points. First, according to the coordinates of al-Khwārazmī's geographical list, Tadmor and Raqqa lie on the same meridian at the longitude of 66°, and at latitudes 35° and 36°, respectively, whereas in fact Raqqa lies 0;48 to the west of Tadmor, and 1;21 to the north.[30] Second, Jacob of Edessa reported that, according to some, one degree was equivalent to 90 miles.[31] From these considerations it begins to appear that we are dealing not with observations at the time of al-Maʾmūn, but with some pre-Islamic tradition of measurements near Raqqa and Tadmor, a tradition that is recast in these later Arabic accounts.

Without discrediting Sind ibn ʿAlī, who was, we understand, a creditable observer of the time,[32] but regarding only the report by Ibn Yūnus as corrupt, we may appre-

times. Abū al-Qāsim ʿUbayd Allāh ibn ʿAbdallāh ibn Khurradādhbih, *Kitāb al-masālik wa-al-mamālik*; see the edition by Michael Jan de Goeje, *Kitâb al-masâlik wa'l-mamâlik (Liber viarum et regnorum)*, Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted 1967), Arabic text, 73, translation, 53; Regling, "Des mesopotamischen Parallelogramms"; Alois Musil, *Palmyrena: A Topographical Itinerary* (New York, 1928); Antoine Poidebard, *La trace de Rome dans le désert de Syrie: Le limes de Trajan à la conquête arabe, recherches aériennes (1925–1932)* (Paris: P. Geuthner, 1934); and René Mouterde and Antoine Poidebard, *Le "limes" de Chalcis: Organisation de la steppe en haute Syrie romaine* (Paris: P. Geuthner, 1945).

29. Al-Bīrūnī, *Taḥdīd*; see Ali's translation, 176–77 (note 24).

30. Even al-Bīrūnī, in *al-Qānūn al-Masʿūdī* (1954–56 edition, 2:567 [note 4]), places them on the same meridian, although with the correct difference in latitude.

31. Hjelt's translation, *Etudes sur l'Hexameron*, 20 (note 22).

32. Ibn Yūnus, in his Hakimite tables, gives details of important solar measurements made by Sind ibn ʿAlī (*Le livre de la grand table Hakémite*, 56, 66, 146, 166 [note 27]). Aydın Sayılı discusses the observa-

ciate that pre-Islamic measurements involving Tadmor had somehow come to be included in the account of the Sinjār expedition.

Matters may be more secure regarding the survey in the desert of Sinjār. It would be natural to read this as describing two traverses, northward and southward from the same starting point, each giving (approximately) the same result, as Abū al-Fidā' believed.[33] Nevertheless it is the absence of clear circumstantial details that may give rise to serious doubts about even this account. For example, a competent astronomer would not advance along the meridian until the altitude had changed by precisely one degree. He would, of course, advance by any distance and calculate the ratio between the change in altitude of the celestial equator and the terrestrial distance. Moreover, the measurements along the two directions, north and south, are bound to have differed somewhat, but we are told nothing of this, nor why the generally accepted figure was 56⅔. In any case, the result 56¼ Arabic miles may be derived from the 75 Roman miles by a simple conversion of the units.

We have no information about the methods used to fix the latitude, and no details about the instruments or the observations. Ibn Yūnus only considers the matter in a general way and writes as follows, continuing directly the passage quoted above:

> These measurements are not without certain conditions, and it is necessary in fixing the difference of one degree in the meridian altitude, that the measurements be always in the plane of this meridian. To attain this, after having selected for the measurements two level and open places, it is necessary to lay down the meridian at the place from which the measurement starts, to take two very fine and faultless cords [*ḥabl*] of about fifty cubits each. Run one of them out to its end exactly along the meridian that was derived; then put the head of the second on the midpoint of the first and run it along the first. Continue always in this way, noting the direction and the altitude in the meridian. Then take the first cord and put its head at the midpoint of the second, etc. Continue always in this way, noting the direction, and the altitude in the meridian that changes between the first place where the meridian was derived and the second place, until the change of altitude of the celestial equator in a day is exactly one degree by two precise instruments in each of which the minutes are shown, so measuring what is between the two places. Then the [number of] cubits is the [number of] cubits of one degree of a great circle covering the sphere of the earth.
>
> It is possible to maintain the direction by means of three bodies instead of the two cords, one of them hiding the others [in line of sight], and extended along the direction of the meridian; one advances by fixing the nearest one by sight, then the second, the third, and so on.[34]

Ibn Yūnus here might seem at first to show how much care was taken with the work, but in fact this is very much an "armchair" description, quite lacking in the vital circumstantial details of an actual survey. The proposal about the cords of fifty cubits stretched from midpoint to midpoint might therefore not reflect the exact technique that was used.

Whether the result is 56, 56¼, 56⅔, or 57 miles, the fact remains that, given the cubit of 0.493 meter, this is an accurate result, indeed probably too accurate to have been determined by the methods claimed. For every minute of error in the measurement of the sun's elevation, the error would be approximately one mile, and even if the instruments were calibrated to show minutes of arc, as Ibn Yūnus said should be the case, the overall error would be much greater. The measurement of the angle of elevation of the sun involves many difficulties, not least because of the large diameter of the disk. Yet it is true that astronomers of the time had carried out new and accurate measurements of the obliquity[35] involving similar difficulties. Later generations would go to great lengths to cope with this problem, such as the installation of the aperture gnomon at Maragheh and Samarkand.[36] The balance of likelihood here is that these geodetic expeditions were intended to settle the choice among the various received values, such as 75 or 66⅔, rather than to confirm the value of 75 miles, converted to Arabic units.

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tional work of these astronomers in *The Observatory in Islam and Its Place in the General History of the Observatory* (Ankara: Türk Tarih Kurumu, 1960; reprinted New York: Arno Press, 1981), chap. 2 (50–87) passim.

33. He found that one of the two traverses gave 56⅔, the other 56: Abū al-Fidā', *Taqwīm al-buldān*; see *Géographie d'Aboulféda*, Arabic text, 14; translation, vol. 2, pt. 1, p. 17 (note 12).

34. Leiden, MS. Or. 143, p. 82; Paris, Bibliothèque Nationale, MS. Arabe 2495, fol. 44v; see also Caussin de Perceval, *Le livre de la grande table Hakémite*, 95 (note 27); and Nallino, "Il valore metrico," 55–56 (note 13).

35. The value 23;35 determined at Baghdad was more accurate than, and differed considerably from, Ptolemy's 23;51.

36. At the observatories of Maragheh (thirteenth century) and probably also at Samarkand (fifteenth century), following the pioneering work of al-Khujandī (below, note 58), use was certainly made of a technique in which the sun's light was admitted through a very narrow aperture in the roof of a darkened chamber, and then fell on a meridian scale, typically a sextant. This is a camera obscura in which the sun's image appears projected onto the scale as a well-defined disk, so permitting very precise measurements of its altitude and so forth; see, for example, Sayılı, *Observatory in Islam*, 194, 198, 283 (note 32). The instrument came to be called the Suds (sextant) al-Fakhrī. On the continuation of this technique at the seventeenth-century Indian observatories of Jai Singh in Delhi and Jaipur, see Raymond Mercier, "The Astronomical Tables of Rajah Jai Singh Sawā'i," *Indian Journal of History of Science* 19 (1984): 143–71, esp. 161–63, 167, 170–71.

AL-BĪRŪNĪ'S MEASUREMENT OF THE RADIUS OF THE EARTH

In the *Taḥdīd*, al-Bīrūnī told how he had devised another method for measuring the circumference of the earth. He explained that it did not "require walking in deserts"[37] but involved determining the radius of the earth based on the observation of the distant horizon from a mountain peak.[38] The angle of dip of that line of sight below the local horizontal determines the ratio between the height of the mountain and the radius of the earth. In figure 8.2 the line of sight from the peak H grazes the horizon at A. The peak is taken to be at a height h = HJ above the plain JA. The angle of dip d is equal to the angle subtended at the center of the earth by the arc JA, and the formula that gives the radius R in terms of h is

$$R = h \cos d/(1 - \cos d).$$

In al-Bīrūnī's observation, he stationed himself on a peak in the Salt Range, a short mountain range situated west of Jhelum in the Punjab. In figure 8.3, the peak is immediately to the southwest of Nandana, a fort situated at the southern end of a pass through the range.[39] In the *Taḥdīd*, al-Bīrūnī explains that he was detained there, at

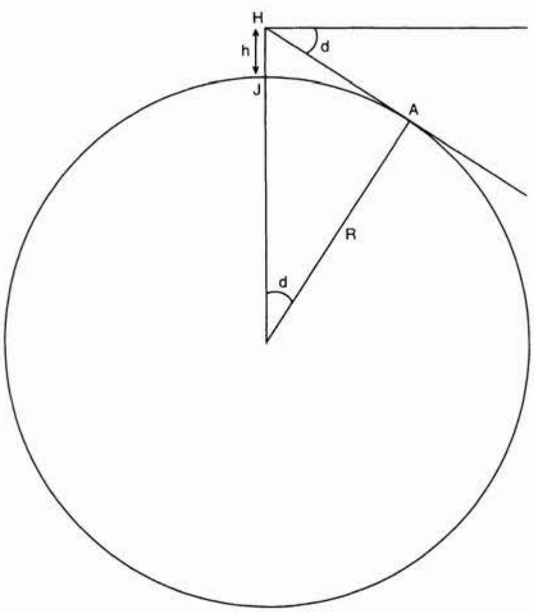

FIG. 8.2. DIP OF THE HORIZON MEASURED FROM THE MOUNTAIN. From the top of the mountain H, the visible horizon is in the direction HA, dipping below the local horizontal by the angle d. If refraction is neglected (following al-Bīrūnī) then the angle at the center of the earth between the mountain and the point A is also d. When the height of the mountain h is known, the radius of the earth R can be found from d and h. When refraction is included, the line of sight HA is curved, concave to the earth, the angle at the center is larger than d, and there is a different relation between d and h.

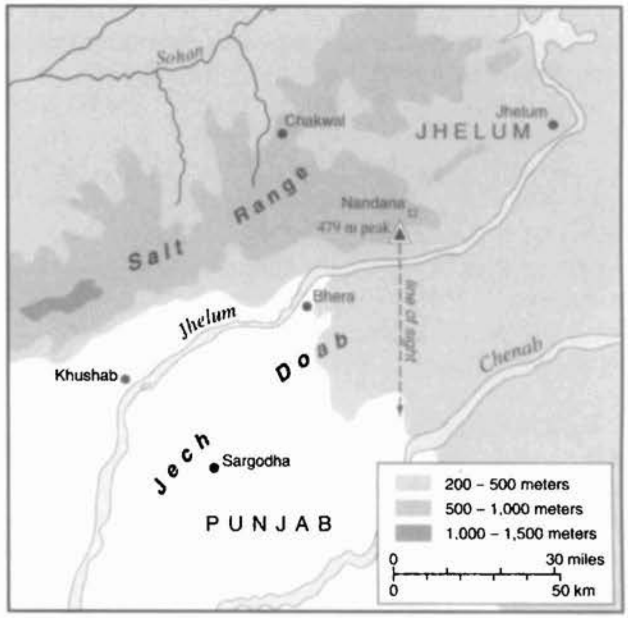

FIG. 8.3. AL-BĪRŪNĪ'S OBSERVATION AT NANDANA. Nandana, in the Jhelum district of Pakistan, is about 110 kilometers south of Islamabad. About 1.7 kilometers south-southwest of the fort at Nandana there is a peak from which al-Bīrūnī's observation was made. This peak is at an altitude of 1,570 feet (479 m) above sea level. When the atmosphere permits a view of the horizon to the south, the line of sight would graze the horizon at a point whose latitude is smaller by an amount approximately equal to the angle of dip, about 30 minutes, or about 55 kilometers to the south.

which time he came to appreciate that the site was suitable for such an observation. He had originally hoped to employ the usual geodetic method by measuring the length of the meridian line in the plains north of Dehistān, in the Jurjān region, near the southwestern shore of the Caspian Sea; there he was frustrated, apparently by lack of support. According to his accounts in *al-Qānūn al-Masʿūdī* and the *Taḥdīd*, he proceeded as follows. As he says:

> I changed to another way owing to having found in a region in India a mountain peak facing toward a wide flat plain whose flatness served as the smooth surface of the sea. Then on its peak I gauged the intersection of heaven and earth,—the horizon—in the

37. Al-Bīrūnī, *Taḥdīd*; see Ali's translation, 183 (note 24).

38. Al-Bīrūnī, *al-Qānūn al-Masʿūdī*, bk. 5, chap. 7; see the 1954–56 edition, 2:528 (note 4), and also in al-Bīrūnī's earlier work on geodesy, *Taḥdīd*; see Ali's translation, 188–89 (note 24). Syed Hasan Barani, "Muslim Researches in Geodesy," in *Al-Bīrūnī Commemoration Volume, A.H. 362–A.H. 1362* (Calcutta: Iran Society, 1951), 1–52, esp. 35–39, translated the passage in *al-Qānūn* from manuscripts accessible to him.

39. Locating this pass is assisted in that Sir Aurel Stein explored the region in his successful effort to determine where Alexander the Great entered the Indian Plain just before his famous battle with Poros; Mark Aurel Stein, "The Site of Alexander's Passage of the Hydaspes and the Battle with Poros," *Geographical Journal* 80 (1932): 31–46.

> prospect, and I found it by an instrument to incline from the East-West line a little less than 1/3 1/4 degree [0;35], and I took it as 0;34. I derived the height of the mountain by taking the summit in two places, and I found it to be 652 1/20 cubits [652;3,18].[40]

He carries out the construction shown in figure 8.2 and proceeds to derive the result above, leading eventually to 56;5,50 miles per degree.[41] This result, as he says, is near that found in the report from the teams sent out by al-Ma'mūn, 56 2/3, that is, 56;40 miles. Al-Bīrūnī accepts the earlier value because "their instrument was more refined, and they took greater pains in its accomplishment."[42]

The most likely peak is one situated about 1.4 kilometers south-southwest of Nandana, at an altitude of 478 meters above sea level, and about 265 meters, or 537 cubits, above the plain to the south. However, al-Bīrūnī gives the height as 652 1/20 cubits (321.5 m), in marked disagreement with this.[43] Rizvi, in his recent study, certainly seems to have this peak in mind (he worked from a map on a scale similar to that shown in fig. 8.3) and gave its height as 1,795 feet (547 m) above sea level, and 1,055 feet (321.5 m) above the plain, evidently not read from the map, but designed only to agree exactly with al-Bīrūnī's report of the height above the plain.[44]

As we would expect, al-Bīrūnī does not allow for refraction.[45] Indeed, astronomers of that time were not aware of refraction in astronomical observations,[46] and one would imagine that, if questioned, al-Bīrūnī would have assumed that the atmosphere is uniform up to its top, so that there is no refraction within it. On the assumption that the peak is situated 321 meters above the plain, the effect of refraction is to reduce the observed angle of dip to about 0;32 and to increase the angle subtended at the center of the earth to about 0;37. In fact the peak is 265 meters above the plain, which makes the dip, with refraction, about 0;29. Without refraction it would be 0;31,20. We have little information about his instrument and cannot judge whether he would have been able to observe the dip angle more precisely.

The difficulty of actually seeing the horizon and fixing the line of sight to it is considerable. Rizvi relates that he sought to view the horizon from the same peak and that after a number of unsuccessful attempts when it was obscured by dust, and so forth, he finally found one day that, after rainfall had cleared the air, he could see it clearly.[47] Unfortunately he does not report any measurement of the dip of the horizon. In his analysis of al-Bīrūnī's work he does not note the need to allow for refraction.

When one considers the errors in al-Bīrūnī's reported observations of both the height of the peak above the plain and the dip of the horizon, there can be no doubt that, having found the observations excessively difficult, he worked out the angle 0;34 from his assumed height of the peak and from the known length of the degree. It would not be the first time in the history of astronomy that fictitious results have been presented in lieu of true observations.[48]

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40. Al-Bīrūnī, *al-Qānūn al Mas'ūdī*, bk. 5, chap. 7; see the 1954–56 edition, 2:530 (note 4), and *Taḥdīd*, see Ali's translation, 188 (note 24).

41. The ratio between the radius of the earth and the height of the mountain is cos 0;34/(1 − cos 0;34). Al-Bīrunī calculates cos 0;34 as sin 89;26 = 0;59,59,49,2,28, giving the denominator 0;0,0,10,57,32. The height of the mountain is 652;3,18, making the radius of the earth 12,851,369;50,42 cubits. The value of π is taken as 22/7, making the circumference 80,780,039;1,33 cubits, and the length of one degree 224,388;59,50 cubits, or 56;5,50 miles. The chief error in the calculation arises from the smallness of the denominator, where the sine should be 0;59,59,49,26. This would lead to 58;11,37 miles per degree, or 58;10,13 if a better value of π is used. It is only by accident, therefore, that he gets a result so close to the received value of 56;40 miles.

42. Al-Bīrūnī, *al-Qānūn al-Mas'ūdī*, bk. 5, chap. 7 see the 1954–56 edition, 2:531 (note 4).

43. In his account in the *Taḥdīd*, al-Bīrūnī says that the cubit in question was used for measuring cloth, so it possibly is not the one used for geodetic purposes (see Ali's translation, 188 [note 24]). However, if his altitude was correct, this would mean a cubit of about 40 centimeters, very different from any value encountered elsewhere.

44. Saiyid Samad Husain Rizvi, "A Newly Discovered Book of al-Bīrūnī, 'Ghurrat-uz-Zījāt' and al-Bīrūnī's Measurements of Earth's Dimensions," in *Al-Bīrūnī Commemorative Volume*, Proceedings of the International Congress held in Pakistan on the occasion of the Millenary of Abū Rāihān Muhammed ibn Ahmad al-Bīrūnī (973–ca. 1051 A.D.) November 26, 1973 through December 12, 1973, ed. Hakim Mohammed Said (Karachi: Times Press, 1979), 605–80.

45. None of the commentators on al-Bīrūnī's work have realized that refraction is in fact a substantial part of the observed angle of dip *d*. The refracted ray is curved concave to the earth, and the exact departure from a straight line can be calculated only if one knows the pressure and temperature, and the vertical temperature gradient, at all points along the ray. In practice such detailed information is not available, and surveyors tend to use a rule of thumb according to which the path followed by the ray is an arc whose radius is seven times the radius of the earth. This is the case when typical values of pressure and temperature are assumed. Equivalently, one may assume that the angle of dip is reduced by one-fourteenth of the arc subtended at the center of the earth. This approximate rule is less secure for grazing rays, which a modern surveyor would try to avoid.

46. Indeed, calculations of the height of the atmosphere by Mu'ayyad al-Dīn al-'Urḍī al-Dimishqī and others in the thirteenth century show clearly that refraction at the top of the atmosphere played no part in their argument; George Saliba, "The Height of the Atmosphere according to Mu'ayyad al-Dīn al-'Urḍī, Quṭb al-Dīn al-Shīrāzī, and Ibn Mu'ādh," in *From Deferent to Equant: A Volume of Studies in the History of Science in the Ancient and Medieval Near East in Honor of E. S. Kennedy*, ed. David A. King and George Saliba, Annals of the New York Academy of Sciences, vol. 500 (New York: New York Academy of Sciences, 1987), 445–65.

47. Rizvi, "Newly Discovered Book," 619 (note 44).

48. In the sixteenth and seventeenth centuries similar methods were proposed by Francesco Maurolico, Johannes Kepler, and Giovanni Baptista Riccioli, who either ignored or underestimated the role of refraction. The matter was settled finally by Jean Picard, the father of modern geodesy. Writing of Maurolico's suggestion that one should discover from what distance at sea Mount Etna would be visible, he said (according to a contemporary English translation of Picard's 1671 work): "But

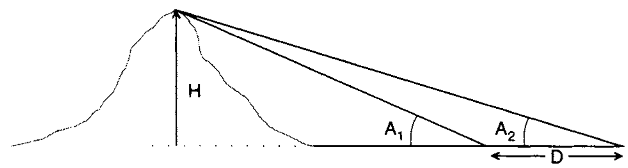

FIG. 8.4. MEASUREMENT OF THE HEIGHT OF A MOUNTAIN USING TWO ALTITUDES. Al-Bīrūnī's method made use of the altitude of the mountain taken from two different places, distance D apart. The height of the mountain, H, would then be equal to D/(cot A_1 − cot A_2).

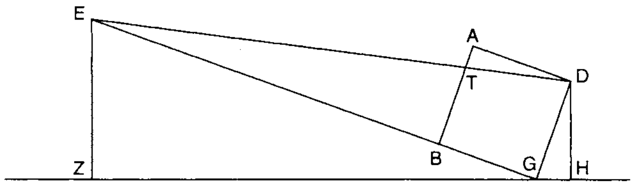

FIG. 8.5. USE OF A QUADRANT TO MEASURE THE HEIGHT OF THE MOUNTAIN. The quadrant ABGD is arranged so that the lower edge BG, and also the alidade DT, are in line of sight to the top E of the mountain ZE. The sides of the quadrant are each 1 cubit (49.3 cm). If the distance GZ is, for example, 500 meters, and the height 320 meters, then the interval AT is 0.041 centimeters. The angle ADT is arctan(0.041/49.3) = 0;2,51.

As to the measurement of the height of the mountain, in *al-Qānūn al-Masʿūdī* al-Bīrūnī says he derived it after taking its altitude in two places. That means that if the altitude is taken from two places spaced apart by a distance D in a line leading away from the peak, so that A_1 and A_2 are the altitudes, then the height of the mountain is $D/(\cot A_1 - \cot A_2)$ (fig. 8.4).[49] This method seems practical enough, but as we have seen, his result was inaccurate.

In the *Taḥdīd*, on the other hand, al-Bīrūnī explains how the altitude is determined with the use of a square plate equipped with an alidade, as shown in figure 8.5.[50] He gives the side of the quadrant as one cubit. If, for the sake of example, ZG is 0.5 kilometer, the mountain being 0.32 kilometer in height, then the angle ADT is 0;2,51, and AT is about 0.4 millimeter. Even when the scale is supplemented by transversals, as was the case in the sixteenth-century version of the instrument (shown in fig. 8.6), this is at the limit of precision. Besides, he advises that the interval at the base GH, which is also needed, is to be determined not by means of the instrument, but by dropping a stone from the corner D! This quite impractical proposal can only be intended as a jeu d'esprit.

Determining the Longitude of Ghazna

Al-Bīrūnī's substantial treatise on geodesy, the *Kitāb taḥdīd nihāyāt al-amākin li-tasḥīḥ masāfāt al-masākin*, was composed in the interval 409–16/1018–25,[51] some time before *al-Qānūn al-Masʿūdī*, which appears to date from about 420/1030. In both works he gives an account of his investigations into the longitude of Ghazna, the capital of his patron Maḥmūd,[52] and the meridian of reference of the tables in *al-Qānūn*. The chapter in *al-Qānūn* is a summary of the work described in the *Taḥdīd*. In the *Taḥdīd* he follows a much more complicated series of routes from Baghdad to Ghazna.[53]

The city of Ghazna was taken by al-Bīrūnī to define the meridian of reference of the mean longitudes in his *al-Qānūn*. He naturally wished to determine the difference in longitude between it and other cities such as Baghdad and Alexandria, which had served as meridians of reference for other tables, so that anyone using his

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the refractions which are yet greater upon the sea than upon the land, render this practice fallacious, because they enable us to discover objects at a much greater distance than the convexity of the sea ought to permit, and by consequence make the earth appear much greater than in effect it is"; Jean Picard, *The Measure of the Earth*, trans. Richard Waller (London, 1688).

49. In figure 8.6 this type of measurement is illustrated in the left part of the lower border.

50. There are two pairs of similar triangles, DAT ≡ EGD and EZG ≡ DGH, giving respectively the ratios AT/AD = GD/GE and ZE/GE = GH/GD. Thus

$$GE = GD \times AD/AT \text{ and } EZ = GE \times GH/GD.$$

The altitude of the mountain, EZ, is given by the final step. In practice it is necessary to determine AT when the angle ADT is very small, this being essentially the parallax over the line DG. The quadrant is equipped to give AT but not, however, to give GH.

In figure 8.6 this use of the quadrant is illustrated in the center of the left border. In the arrangement shown, only the interval AT can be found, giving the distance EG, but not the height EZ.

51. Editions of the Arabic text of al-Bīrūnī's *Kitāb taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin* include one edited with an introduction by Muḥammad Tāwīt al-Ṭanjī (Ankara, 1962), and one edited by P. G. Bulgakov, verified by Imām Ibrahīm Aḥmad, in *Majallat Maʿhad al-Makhṭūṭāt al-ʿArabīyah* (Journal of the Institute of Arabic Manuscripts of the Arab League), special no., vol. 8 (pts. 1 and 2) (Cairo, 1962). Translations include Ali's (note 24) and a Russian translation and commentary by P. G. Bulgakov, *Abu Reihan Biruni, 973–1048: Izbrannie Proizvedeniya* (Selected works), vol. 3, *Opredelenie Granitz Mest dlya Utochneniya Rasstoyanii Mejdu Naselennimi Punktami* (*Kitāb taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin*) Geodeziya (Geodesy), investigation, translation, and commentary (Tashkent: Akademia Nauk Uzbekskoi SSR, 1966); and see also Edward S. Kennedy, *A Commentary upon Bīrūnī's "Kitāb taḥdīd al-amākin": An 11th Century Treatise on Mathematical Geography* (Beirut: American University of Beirut, 1973).

52. Al-Bīrūnī, *al-Qānūn al-Masʿūdī*, bk. 6, chap. 2; see the 1954–56 edition, 2:609–16 (note 4), and al-Bīrūnī, *Taḥdīd*, see Ali's translation, 192–240 (note 24).

53. A number of other topics are treated in the *Taḥdīd*, including an account of the determination of latitudes, and of the obliquity of the ecliptic, of which many determinations by Arabic astronomers are cited in circumstantial detail. The work ends with an account of the determination of the qibla (the direction of Mecca). Al-Bīrūnī gives here, as well as in *al-Qānūn*, an account of his determination of the radius of the earth, which has been discussed above.

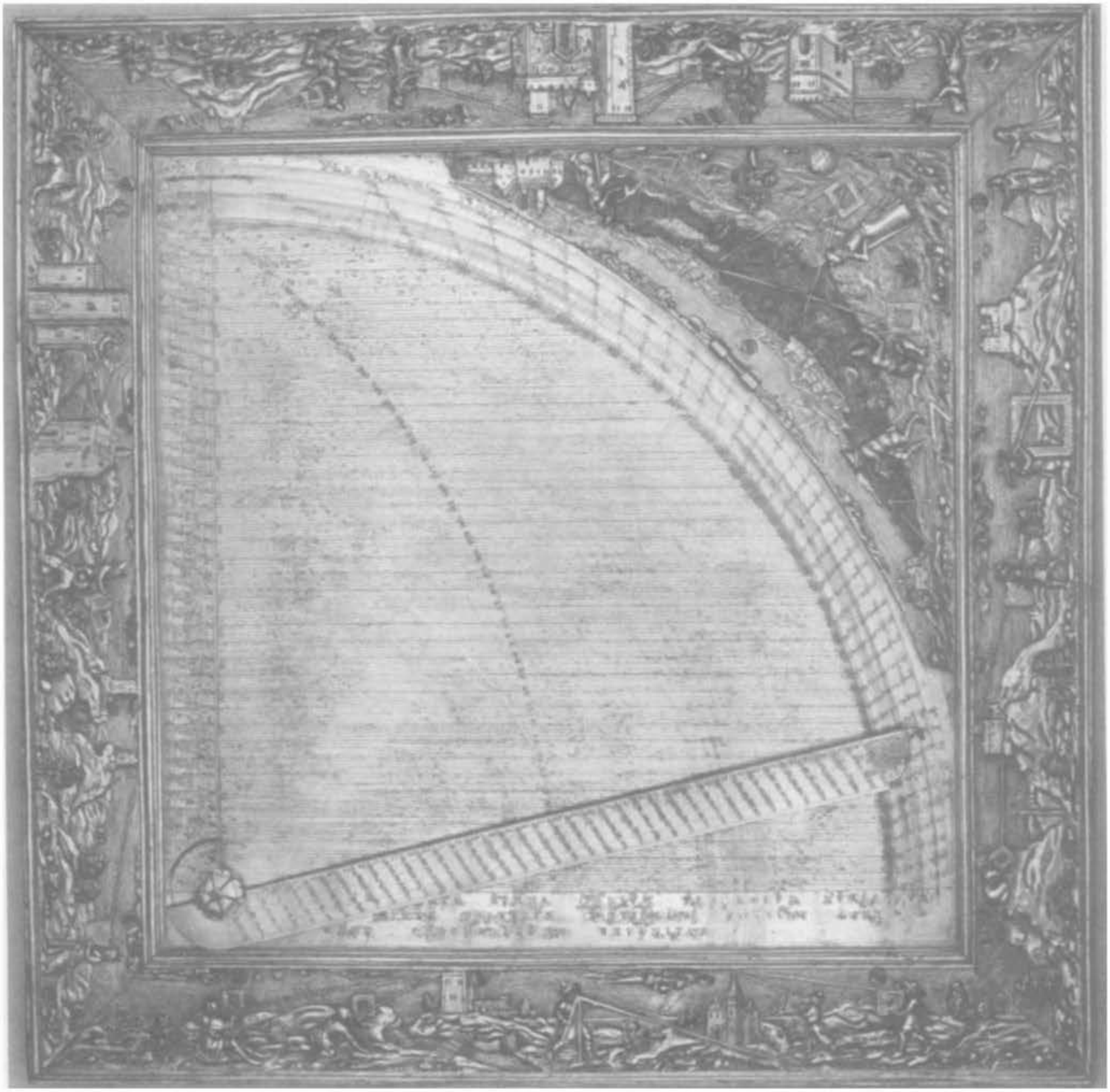


FIG. 8.6. SIXTEENTH-CENTURY QUADRANT WITH ALIDADE. The uses of the quadrant are illustrated in a series of fine vignettes on the reverse of an early European example, the sixteenth-century *Quadraticum geometricum* of Christoph Schissler. Echoes of its Oriental origin are evident in these fine pictures that decorate the four edges, showing the various turbaned observers. The history and use of the instrument, along with descriptions of the extant examples, are given by Herbert Wunderlich, *Das Dresdner "Quadratum geometricum" aus dem Jahre 1569 von Christoph Schissler d.A., Augsburg, mit einem Anhang: Schisslers Oxforder und Florentiner "Quadratum geometricum" von 1579/1599* (Berlin: Deutscher Verlag der Wissenschaften, 1960). The side of the inner, calibrated, square measures approximately 30 centimeters. In this square the scale along the edge is divided into two hundred parts, but with the aid of the transversal subdivision each of these is further divided into five parts, each therefore representing about 0.3 millimeter. There is, however, nothing to suggest that the square plate used by al-Bīrūnī was enhanced by such a transversal. That technique was used on other instruments of the sixteenth century, including those of Tycho Brahe.

Size of the original: 34.5 × 34.5 × 1.1 cm. Museum of the History of Science, Oxford (inv. no. 52–83). By permission of the Bettman Archive, New York.

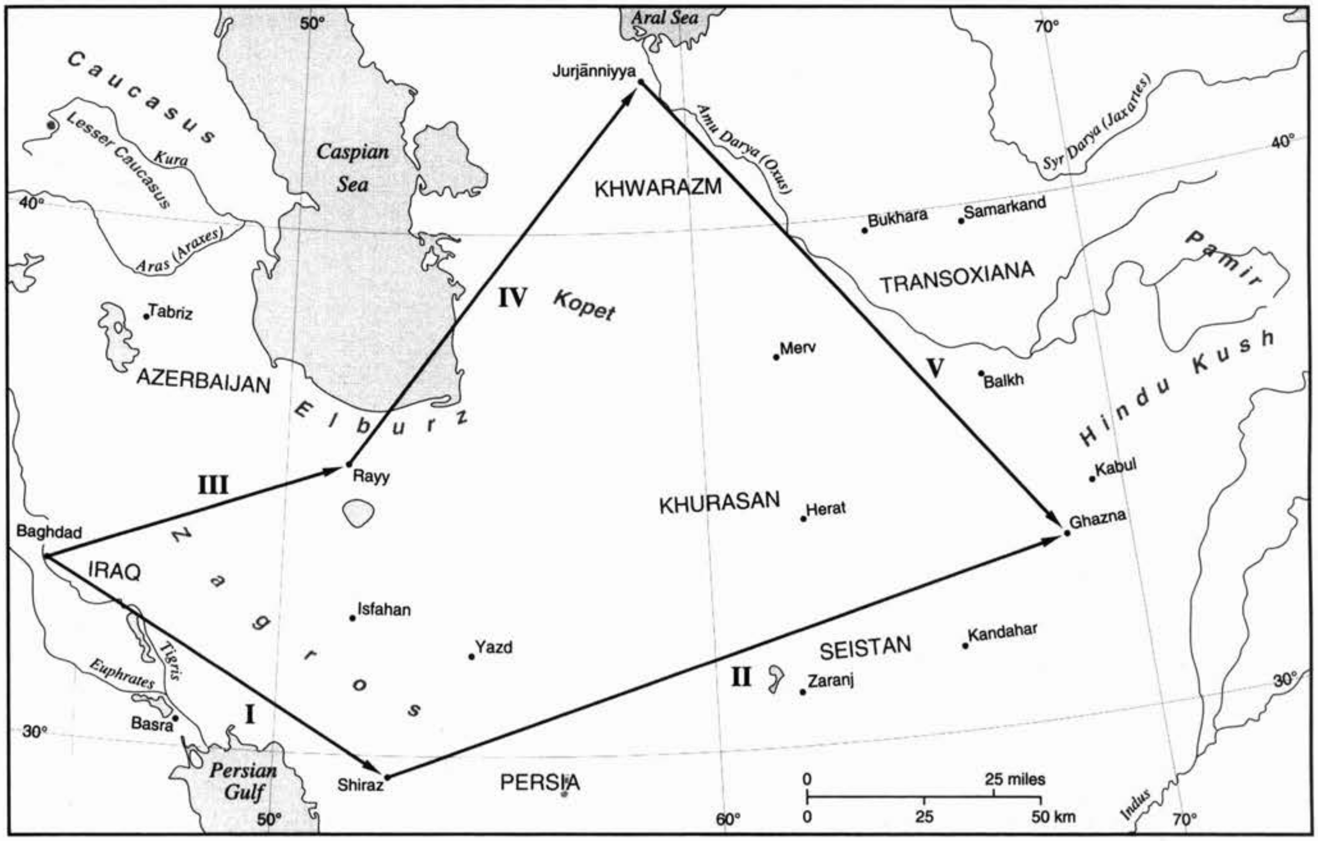


FIG. 8.7. "TRIANGULATION" BETWEEN BAGHDAD AND GHAZNA. Al-Bīrūnī arranged his "triangulation" of the region between Baghdad and Ghazna to follow two independent paths, through Rayy (near Tehran) and Jurjānīyah (near Urgench) to Ghazna, and also through Shiraz in southern Persia. In the *Taḥdīd* he subdivided the route between Shiraz and Ghazna into a number of shorter steps. The distances along these routes were taken from travelers' reports, while the latitudes were found accurately by astronomical means.

tables could calculate from them the mean longitudes at any other meridian. He proceeds, then, by a series of steps, as shown in figure 8.7, in which Ghazna is referred to Baghdad through Shiraz (steps I, II) or through Jurjānīyah[54] and Rayy[55] (steps III, IV, V). These various differences I to V are taken from travelers' accounts, and since such estimates are regarded as generally in excess, he subtracts a proportion, say one-tenth or one-sixth, according to his understanding of the particular terrain and the extent to which the traveler is likely to have to follow a crooked path. In a separate calculation he determines the difference in longitude between Baghdad and Alexandria, but in this brief summary of his work only the Baghdad-Ghazna calculations will be considered. In each of these steps he quotes the latitudes for the pair of places, and these, together with the direct distance between them, suffice to give him the longitude differences. Distances are converted to arcs in the proportion of $56\frac{2}{3}$ miles per degree or, since the *farsakh* is 3 miles, 18;53,20 *farsakhs* per degree. He had given a somewhat different analysis of this problem in the *Taḥdīd*, but the following is based on the later *al-Qānūn al-Masʿūdī*.[56]

In figure 8.8 two places (A and B) are on the meridians TAJ, TBD, T being the North Pole and JD being an arc of the equator. We are given the latitudes of the two places, that is, the arcs JA, DB, and also the arc separating

54. Jurjānīyah (in Persian "Gurgānj") is situated in Khwārazm (Khorezm), al-Bīrūnī's native country. The site is now named Kunya Urgench (Old Urgench). A modern city named Urgench is located to the southeast of the old site. In his works, al-Bīrūnī notes a number of observations he has carried out in this region. The word "Bīrūnī" is derived from the Persian *bīrūn*, "outside." It is thus frequently suggested that his birthplace was in a suburb of Kāth, the erstwhile capital, but that is essentially speculation. Kāth is now a ruin, at a site known as Shah Abbas Wali; nearby is a modern city named Biruni in honor of the astronomer.

55. Rayy (Rai) is the ancient Rhagae, very near Tehran.

56. This chapter of *al-Qānūn* has been translated twice, by Carl Schoy, "Aus der astronomischen Geographie der Araber," *Isis* 5 (1923): 51–74, and later by J. H. Kramers, who corrected some errors of translation in "Al-Bīrūnī's Determination of Geographical Longitude by Measuring the Distances," in *Al-Bīrūnī Commemoration Volume, A.H. 362-A.H. 1362* (Calcutta: Iran Society, 1951), 177–93; reprinted in *Analecta Orientalia: Posthumous Writings and Selected Minor Works of J. H. Kramers*, 2 vols. (Leiden: E. J. Brill, 1954–56), 1:205–22. Neither reviewed the calculations.

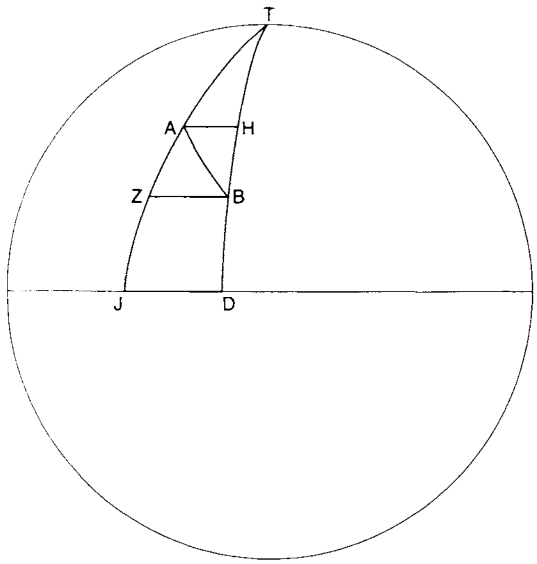


FIG. 8.8. TRIGONOMETRIC CONSTRUCTION TO DETERMINE THE DIFFERENCE OF LONGITUDE. Between the North Pole T of the earth and its equator JD, the great circle arcs TJ and TD are drawn. The arcs AH and ZB are drawn parallel to the equator (and so are not great circles), and AB is the great circle joining two places A, B, which lie at different latitudes. The latitudes are represented by the arcs JA (= DH) and BD (= JZ), with the difference represented by the arc JD. The formula derived in note 57 gives JD in terms of the known latitudes and known distance AB.

them along a great circle AB, and the problem is to find the difference of longitude JD.[57] Al-Bīrūnī proceeds to analyze the problems of the chords subtending the various arcs and derives the equation

$$\mathrm{ch}(AZ)^2 + \mathrm{ch}(AH)^2\cos(DB)/\cos(JA) = \mathrm{ch}(AB)^2,$$

in which ch(AZ) means the chord joining the points A and Z. In this equation all the quantities are known except ch(AH), for which one solves it, and then from AH, JD is derived.

He uses this equation repeatedly in his analysis, always referring back to the same diagram, with the points A and B representing in turn the successive pairs of places. He quotes either his own or earlier observations for the latitudes, the values being given in table 8.1 along with their modern values.[58]

In his account al-Bīrūnī gives all the numerical work, so that it is possible to observe the level of accuracy he achieves and also his occasional mistakes. An error to which he is prone is the accidental interchange of the two cosine terms in the ratio cos(DB)/cos(JA) in the equation above.[59]

Table 8.2 summarizes the angular distances between pairs of sites and the longitude differences, both according to al-Bīrūnī and also according to calculations based on the modern coordinates.

He averages the values obtained by the two routes to get (24;54,26 + 23;44,2)/2 = 24;19,14. Without any errors of calculation he would have had (25;36,14 + 24;57,1)/2 = 25;16,37. In the geographical table in *al-*

TABLE 8.1 Al-Bīrūnī's Latitude Values

Place	al-Bīrūnī	Modern
Baghdad	33;25	33;20
Shiraz	29;36	29;38
Ghazna	33;35	33;33
Rayy	35;34,39	35;35
Jurjānīyah	42;17	42;18

57. Draw the arcs AH and ZB parallel to the equator and lying in planes parallel to the equatorial plane. In the following we distinguish arcs and chords by writing the arc simply as AH and the chord as ch(AH), which equals 2cos(AJ) sin(JD/2) = cos(AJ)ch(JD). It may be shown that the four points A, H, B, Z lie on a circle and that as a consequence,

$$\mathrm{ch}(AZ)\mathrm{ch}(BH) + \mathrm{ch}(ZB)\mathrm{ch}(AH) = \mathrm{ch}(ZH)\mathrm{ch}(AB).$$

In the present application, AB = ZH, AZ = BH,

$$\mathrm{ch}(AZ)^2 + \mathrm{ch}(ZB)\mathrm{ch}(AH) = \mathrm{ch}(AB)^2.$$

We know AZ from the difference of latitudes and AB from the direct distance, and we wish to find JD. Substituting ch(AH) = cos(JA)ch(JD), ch(ZB) = cos(DB)ch(JD),

$$\mathrm{ch}(AZ)^2 + \mathrm{ch}(JD)^2\cos(DB)\cos(JA) = \mathrm{ch}(AB)^2.$$

Although this would provide ch(JD) directly, al-Bīrūnī usually writes the second term of the last equation in terms of ch(AH),

$$\mathrm{ch}(AZ)^2 + \mathrm{ch}(AH)^2\cos(DB)/\cos(JA) = \mathrm{ch}(AB)^2,$$

which he solves for ch(AH), getting ch(JD) from ch(JD) = ch(AH)/cos(JA).

58. Al-Bīrūnī gives the sources for the latitudes as follows:
1. Al-Bīrūnī using the Yamīnīyah ring in the period 409–10/1018–20.
2. Abū al-Ḥusayn ʿAbd al-Raḥmān ibn ʿUmar al-Ṣūfī (d. 372/983), using the ʿAḍūdī ring.
3. Al-Bīrūnī using a quadrant in 410/1019–20.
4. Abū Maḥmūd al-Khujandī, in 384/994, using his large mural sextant, equipped with a device for sharpening the sun's shadow.
5. Al-Bīrūnī using the Shāhīyah ring.

The rings in these applications are the most elementary of astronomical instruments, designed to measure altitude directly. They are likely to be brass circles, calibrated in degrees, equipped with a pointer carrying sights, and mounted securely in some way in the meridian plane.

59. In the case of the first stage, Baghdad to Shiraz, he finds that the direct distance is 170 *farsakhs*, which he reduces by one-tenth to 153. The corresponding arc is 8;6 and the chord 0;8,28,31, which he gives as 0;8,28,32. The latitude difference is 33;25–29;36 = 3;49, the chord of which is 0;3,59,46, which he gives as 0;3,59,40. The cosine ratio becomes cos(29;36)/cos(33;25) = 0;52,10,11/0;50,4,52, which he gives as 0;52,10,10/0;50,4,52. He obtains ch(AH) = 0;7,28,27, although from his figures he should have 0;7,19,27, and from a precise calculation 0;7,19,26. For the longitude difference ch(JD) = ch(AH)/cos(33;25), from which he obtains 0;8,57,16 correctly from his ch(AH); this gives the arc JD = 8;33,32. From the correct ch(AH) he would have ch(JD) = 0;8,46,28, arc 8;23,11.

The longitude of Baghdad is 70 (measured in the scale of al-Khwārazmī's geographical tables), so that of Shiraz is 78;33,32, according to his calculation. He remarks that this agrees with the received value 79.

TABLE 8.2 Summary of al-Bīrūnī's Angular and Longitudinal Differences between Pairs of Places

	Distance		Longitude Difference	
Places	al-Bīrūnī	Modern	al-Bīrūnī	Modern
Baghdad–Rayy	8;6	7;44	8;33,32	8;8
Rayy–Ghazna	15;2,7	14;5	16;20,54	15;54
Total			24;54,26	24;2
Baghdad–Rayy	7;0,21	6;12	8;5,20	7;1
Rayy–Jurjānīyah	8;10,14	9;0	6;1,26	7;43
Jurjānīyah–Ghazna	12;10,37	11;24	9;37,16	9;18
Total			23;44,2	24;2

Qānūn al-Masʿūdī he gives the longitude of Ghazna as 94;20,[60] evidently based on these calculations, whereas a better value would have been 95;17.

Except in one case, al-Bīrūnī has overestimated the angular distances, by some 8 percent on the average. This is due to an even greater overestimate of the distances in miles, because the conversion ratio 56⅔ miles per degree is itself some 0.7 percent too large. This, as one would expect, is a major source of error, since the latitudes are all well observed. The true difference in longitude between Baghdad and Ghazna is 24;2, whereas al-Bīrūnī gets 24;19,14 and would have arrived at 25;16,37 had he made no error of calculation.

Seen against the historical background of geographical coordinates, however, the results are impressive. An error of one degree in such a large distance marks a decided improvement over Ptolemy's geographical coordinates. The order of the errors in longitude would not be reduced by a further order of magnitude until the end of the seventeenth century, when observations of Jupiter's satellites were exploited.

60. Al-Bīrūnī, *al-Qānūn al-Masʿūdī*, bk. 5, chap. 10; see the 1954–56 edition, 2:561 (note 4).

9 · Qibla Charts, Qibla Maps, and Related Instruments

DAVID A. KING AND RICHARD P. LORCH

INTRODUCTION

For close to fourteen hundred years, the obligation to pray and to perform various ritual acts in a sacred direction toward a central shrine has been of paramount importance to Muslims in their daily lives. Their concern to observe this sacred direction and the means they devised to determine it are unparalleled in the history of human civilization. A verse of the Qurʾān enjoins Muslims to face the sacred precincts of the Kaʿba in Mecca during their prayers: "Turn your face toward the Sacred Mosque, wherever you may be, turn your faces toward it."[1] Accordingly, for fourteen centuries mosques have been oriented so that the prayer wall faces the Kaʿba and the *miḥrāb* (prayer niche) indicates the qibla, or local direction of Mecca. But Islamic tradition further prescribes that certain acts such as burying the dead, reciting the Qurʾān, announcing the call to prayer, and ritual slaughtering of animals for food are also to be performed in the direction of Mecca. On the other hand, bodily functions are to be performed perpendicular to the direction of Mecca.[2]

It is this fundamental importance within Islam of the concept of sacred direction (qibla in Arabic[3] and all other languages of the Islamic world) in ritual, law, and religion, applying wherever the believer was, that gave rise to the charts, maps, instruments, and related cartographic methods described in this chapter. These sources clearly reflect the dual nature of science in Islam.[4] On the one hand there was "folk science," ultimately derived from the astronomical knowledge of the Arabs before Islam, which was devoid of theory and innocent of any calculation. On the other hand there was "mathematical science," derived mainly from Greek sources and involving both theory and computation. The former was advocated by legal scholars and widely practiced over the centuries. The latter was practiced by a select few.

In the first tradition, there developed the notion of a sacred geography in which the world was divided into sections around the Kaʿba and the qibla in each section was determined by the procedures of folk astronomy. In the second, procedures were developed for finding the qibla in any locality by means of geometric construction or the application of trigonometric formulas. Of prime importance, of course, were the coordinates on which such calculations were based.[5] We now consider the charts and maps associated with these two traditions (King), and then mention other graphic methods and instruments for finding the qibla (Lorch).

QIBLA CHARTS CENTERED ON THE KAʿBA

The number and variety of texts in which this sacred, Kaʿba-focused geography is represented indicate that it was widely known from the tenth century A.D. onward.[6] Sources include treatises on folk astronomy, treatises dealing with mathematical astronomy (especially annual almanacs), treatises on geography, treatises on cosmography, encyclopedias, historical texts, and, no less important, texts dealing with the sacred law. Sometimes the methods are described in words alone, sometimes the text is clarified with diagrams. All together, more than

1. Qurʾān 2:144.

2. On the legal obligation to observe the sacred direction, see Arnet Jan Wensinck, "Ḳibla: Ritual and Legal Aspects," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 5:82–83. For more information on the sacred direction in medieval Islam, see David A. King's forthcoming monograph titled *The World about the Kaʿba: A Study of the Sacred Direction in Medieval Islam*, to be published by Islamic Art Publications.

3. The term qibla and the associated verb *istaqbala*, "standing in the qibla," appear to derive from the name of the east wind, the *qabūl*. These terms correspond to the situation where one is standing with the north wind (*al-shamāl*) on one's left (*shamāl*) and Yemen on one's right (*yamīn*); see David A. King, "Makka: As the Centre of the World," in *Encyclopaedia of Islam*, new ed., 6:180–87, esp. 181; see also idem, "Astronomical Alignments in Medieval Islamic Religious Architecture," *Annals of the New York Academy of Sciences* 385 (1982): 303–12, esp. 307–9, and idem, "Architecture and Astronomy: The Ventilators of Medieval Cairo and Their Secrets," *Journal of the American Oriental Society* 104 (1984): 97–133.

4. David A. King, "The Sacred Direction in Islam: A Study of the Interaction of Religion and Science in the Middle Ages," *Interdisciplinary Science Reviews* 10 (1985): 315–28.

5. Edward S. Kennedy and Mary Helen Kennedy, *Geographical Coordinates of Localities from Islamic Sources* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987).

6. The material in this section is analyzed in detail in David A. King, "The Sacred Geography of Islam," *Islamic Art*, forthcoming; see also King, "Makka," 181 (note 3).

thirty different texts attesting to this tradition have been found, compiled between the ninth century and the eighteenth century. Of these, only five have been published; the rest are manuscripts. Many more such works must have been written that have not survived.

Despite the multiplicity of ways that Muslims have used over the centuries to ensure they were facing the Kaʿba, these sources allow us to make some generalizations. It is immediately clear from their contexts that the qibla lies at the heart of Islamic cultural and religious life. Although this concept has obvious parallels in medieval traditions of a world centered on Jerusalem, the Islamic treatment is more sophisticated than either the Jewish or the Christian. It was true that, as in the Judeo-Christian view of Jerusalem, Mecca was regarded as the center and navel of the world, but in early Islamic cosmography the entire inhabited world outside this central point came to be precisely and constantly related, through astronomical determinations, to Mecca and to the Kaʿba itself.

The Kaʿba is a cube-shaped monument in the heart of the city, formerly a pagan shrine of uncertain historical origin. It is a simple structure on a rectangular base, and its two axes indicate significant astronomical directions.[7] The first generation of Muslims who were familiar with the structure at first hand knew, as they stood before it, which astronomical direction they faced. Similarly, Muslims in any part of the world could know which wall of the Kaʿba they wanted to face and, when required, could turn to face the direction as if they were standing directly in front of that wall of the Kaʿba. This is the basic notion of "direction" underlying Islamic sacred geography. Remember that the definition of direction toward a distant point is to some extent arbitrary.

From the ninth century onward, various sections of the perimeter of the Kaʿba came to be associated with areas in the Muslim world.[8] In the time of the Prophet Muḥammad (d. 13/632) the four corners of the astronomically aligned base had already been named according to the geographical regions they faced, which the Meccans knew from their trading contacts: Syria, Iraq, Yemen, and "the West." In due course, architectural details were used to define subdivisions. Thus, while the four walls and four corners of the structure indicated a division of the world into four or eight sectors, giving rise to a number of four- and eight-sector schemes, features such as the waterspout on the northwestern wall and the door on the northeastern wall were used to demarcate smaller sectors. In this way the sacred geography of the inhabited parts of the earth comprised a variable number of sectors (*jihah* or *ḥadd*), all directly related to the Kaʿba. The twelfth-century Egyptian legal scholar Zayn (?) al-Dīn al-Dimyāṭī, author of the illustration in figure 9.3 below, summed it up thus: "The Kaʿba with respect to the inhabited parts of the world is like the center of a circle with respect to the circle. All regions face the Kaʿba, surrounding it as a circle surrounds its center, and each region faces a particular part of the Kaʿba."[9]

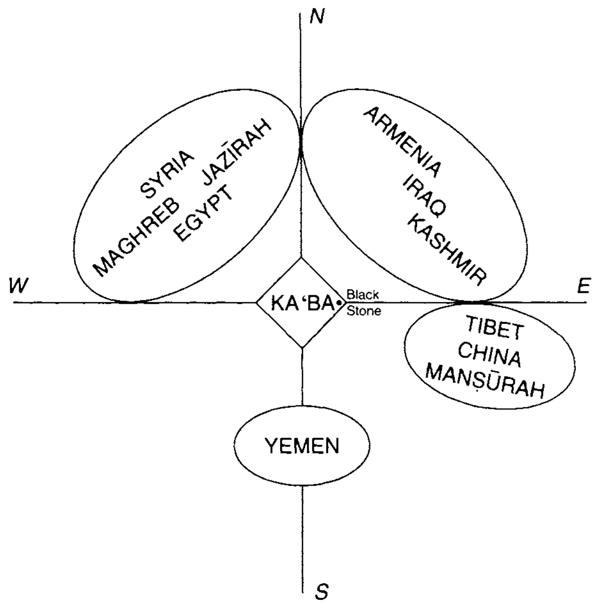


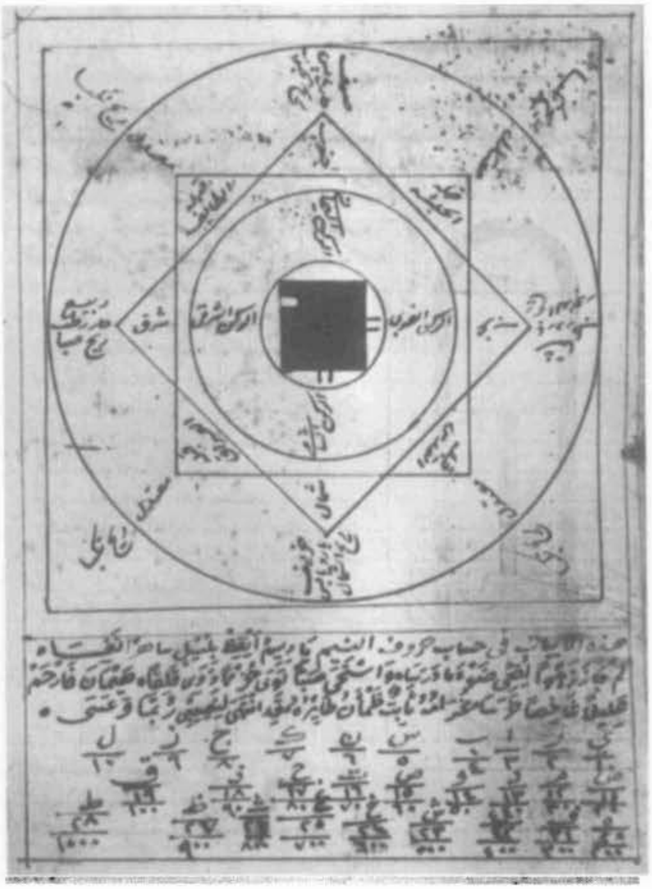
FIG. 9.1. RENDITION OF A SCHEME OF SACRED GEOGRAPHY. Described by Ibn Khurradādhbih and based on the edition of his text by Michael Jan de Goeje, *Kitâb al-masâlik wa'l-mamâlik (Liber viarum et regnorum)*, Bibliotheca Geographorum Arabicorum, vol. 6 (Leiden: E. J. Brill, 1889; reprinted 1967), 5.

The earliest known Kaʿba-centered geographical scheme is recorded in a manuscript of the *Kitāb al-masālik wa-al-mamālik* (Book of routes and provinces) by the ninth-century scholar Ibn Khurradādhbih. It may not be original, but it is most certainly early. It involves a simple four-sector scheme (fig. 9.1): each part of the

7. Various medieval Arabic texts inform us that the major axis of the Kaʿba points toward the rising of Canopus, the brightest star in the southern celestial hemisphere, and that the minor axis points toward the summer sunrise. For the latitude of Mecca, these directions are roughly perpendicular. A modern plan of the Kaʿba and its environs, based on aerial photography, essentially confirms the information given in the texts, but reveals more: for epoch 0 A.D., the major axis is aligned with the rising of Canopus over the southern horizon to within two degrees, and the minor axis is aligned with the southernmost setting point of the moon over the southwestern horizon to within one degree. This last feature of the Kaʿba is not specifically mentioned in the texts, and its significance, if any, is not yet clear. More detailed information can be found in Gerald S. Hawkins and David A. King, "On the Orientation of the Kaʿba," *Journal for the History of Astronomy* 13 (1982): 102–9.

8. See King, "Makka," 181–82 and fig. 1 (note 3) for the different schemes dividing the perimeter of the Kaʿba that gave rise to these permutations in the diagrams.

9. Oxford, Bodleian Library, MS. Marsh 592; al-Dimyāṭī wrote a shorter treatise on the qibla that was copied ca. A.D. 1350 (Damascus, Dār al-Kutub, Ẓāhirīyah 38).



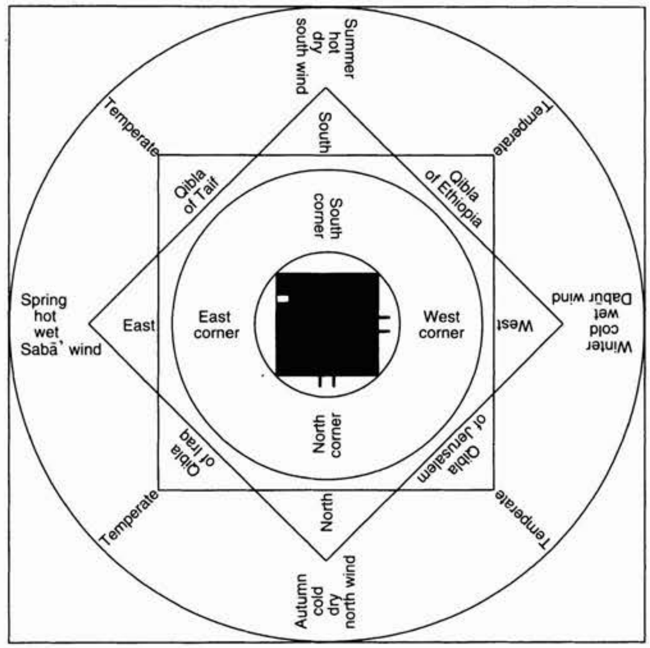


FIG. 9.2. FOUR-QIBLA SCHEME. Representation taken from an anonymous eighteenth-century Ottoman treatise (see also figs. 9.5 and 9.13), with translation to the right.
Size of the original: 18 × 13 cm. By permission of the Dār al-Kutub, Cairo (Ṭalʿat *majāmīʿ* 811, fol. 60r).

world is associated with a different segment of the perimeter of the Kaʿba. Thus the region between northwestern Africa and northern Syria is associated with the northwestern wall of the Kaʿba and has a qibla that varies from east to south. The region between Armenia and Kashmir is associated with the northeastern wall of the Kaʿba and has a qibla that varies from south to west. A third region, Manṣūrah (India), Tibet, and China (meaning Indochina), is associated with the Black Stone in the eastern corner of the Kaʿba and for this reason is stated to have a qibla a little north of west. The fourth region, the Yemen, is associated with the southern corner of the Kaʿba and has a qibla of due north. Many similar four- or eight-sector schemes are found in other texts (fig. 9.2). The tenth-century geographer al-Muqaddasī's *Aḥsan al-taqāsīm fī maʿrifat al-aqālīm* (The best of divisions on the knowledge of the provinces), for example, contains a description, with a diagram, of a simple eight-sector scheme.[10] Other schemes show a tendency toward a more complex subdivision of the sacred space of Islam.

The principal scholar involved in this further development of a Kaʿba-centered sacred geography is Muḥammad ibn Surāqah al-ʿĀmirī (d. 410/1019), a Yemeni *faqih* (legal scholar) who studied in Basra. Little is known about this man, and none of his works survive in their original form. However, from quotations in later works it appears that he devised three distinct schemes with eight, eleven, and twelve sectors focusing on the Kaʿba.[11] Although these later recensions of Ibn Surāqah's treatises lack diagrams, it is possible to use them to piece together his detailed prescriptions for finding the qibla in each of the

10. See the French translation of Abū ʿAbdallāh Muḥammad ibn Aḥmad al-Muqaddasī's work by André Miquel, *Aḥsan at-taqāsīm fī maʿrifat al-aqālīm* (Damascus: Institut Français de Damas, 1963).

11. Ibn Surāqah's eight-sector scheme is known from the writings of one Ibn Raḥīq, a legal scholar of Mecca who was the author of a treatise on folk astronomy in the eleventh century. Several significant regions of the Muslim world were omitted from this scheme. Ibn Surāqah's eleven-sector scheme is known from a fourteenth-century Egyptian treatise, and in it he has simply added three sectors to his eight-sector scheme. His twelve-sector scheme was used by al-Dimyāṭī, who was upset, however, that Ibn Surāqah put Medina and Damascus in the same sector, and so he himself presented a thirteen-sector scheme. Ibn Surāqah's twelve-sector scheme was also used by the thirteenth-century Yemeni astronomer al-Fārisī in his book on folk astronomy.

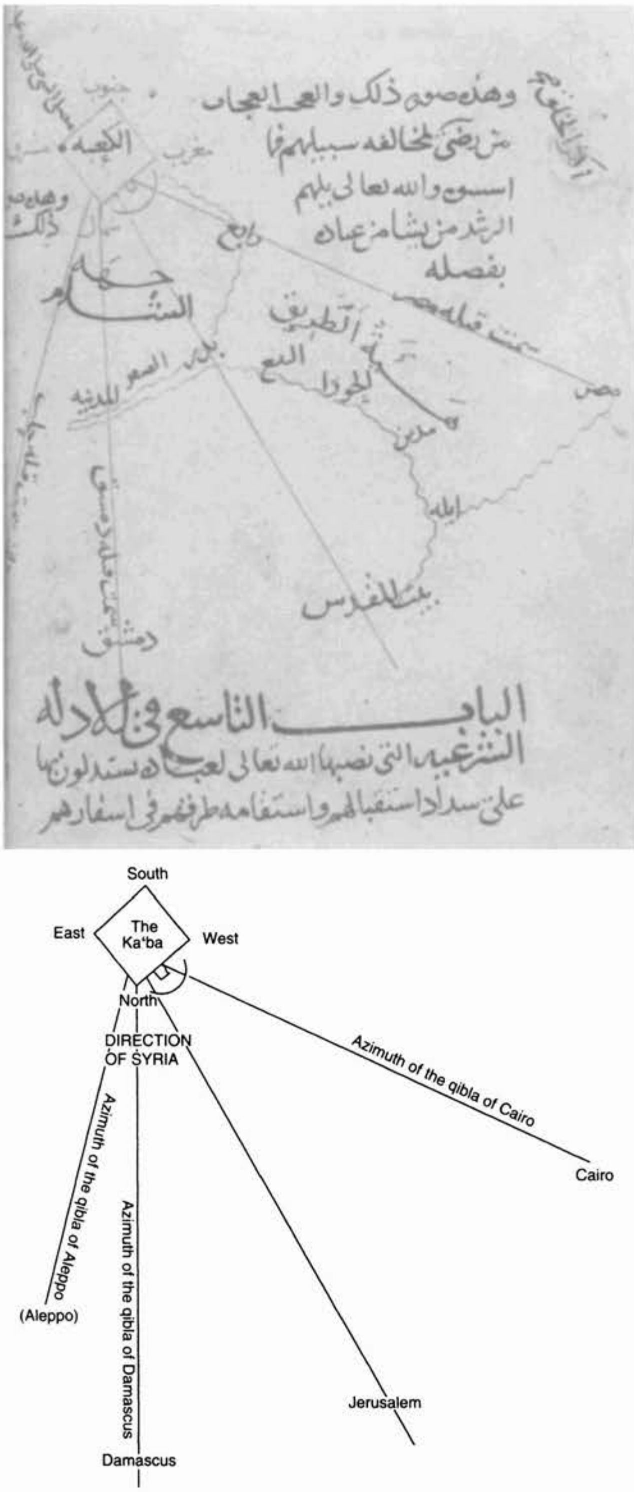


FIG. 9.3. ILLUSTRATION FROM A TREATISE ON THE SACRED DIRECTION BY AL-DIMYĀṬĪ. The diagram shows the directions of the Kaʿba for several locations including Cairo, Jerusalem, and Damascus. It was assumed that people in each locality would face a different part of the Kaʿba (partial translation provided).
Size of the original: 19 × 12.5 cm. By permission of the Bodleian Library, Oxford (MS. Marsh 592, fol. 88v).

various regions associated with his schemes. For each region, Ibn Surāqah explains how people should stand with respect to the rising or setting of four particular groups of stars and the four winds. Thus, for example, we are informed how the inhabitants of Iraq and Iran should stand in relation to the stars of the Great Bear, which rise and set behind the right ear; a group of stars in Gemini should rise directly behind the back; the east wind should blow at the left shoulder, the west wind should blow at the right cheek, and so on. That the stars of the Great Bear neither rise nor set but appear circumpolar in places as far north as Iraq and Iran indicates that Ibn Surāqah's instructions were probably formulated in Mecca. To stand in the position he described would have been to face the winter sunset, though this is not explicitly stated. The ultimate object of the exercise was to face the northeastern wall of the Kaʿba.

The qibla charts themselves do not appear in surviving manuscripts until after the eleventh century. A recurrent interpretative problem is that the charts were often corrupted in the copying process. Even in elegantly copied manuscripts, the corners of the Kaʿba have sometimes been confused. In some copies of the works of Zakariyāʾ ibn Muḥammad al-Qazwīnī (600–682/1203–83) and Sirāj al-Dīn Abū Ḥafṣ ʿUmar ibn al-Wardī (d. 861/1457) containing the twelve-sector scheme, for instance, Medina occurs in two sectors. In other copies one of these has been suppressed, and only eleven sectors appear around the Kaʿba.

Although the numbers of sectors remain one criterion for classifying the Kaʿba-centered qibla diagrams, there may be significant variations in different versions of the same scheme during the Islamic Middle Ages. Even the same authors could produce charts of different design. Al-Dimyāṭī, for example, records a simple scheme with only four directions, as well as the partial diagram showing only three sectors of a larger scheme, perhaps intended to illustrate the notion of *ʿayn al-Kaʿba* (facing the Kaʿba head on) (fig. 9.3). But he was also responsible for a rather crude eight-sector scheme where the Kaʿba is represented by a circle and each of the eight regions is associated with a wind (fig. 9.4). We may also compare this informal representation—where the scribe has done little more than arrange his text in a wheel-like form—with another eight-sector scheme that appears in an anonymous Ottoman treatise (fig. 9.5). This scheme is much more carefully drafted. The qiblas are defined by means of the Pole Star and by those stars that rise or set behind one's back when one is standing in the qibla.

The same variations also extend to the twelve-sector diagrams. Thus Ibn Surāqah's twelve-sector scheme was used and illustrated by the thirteenth-century Yemeni astronomer al-Fārisī in his book on folk astronomy, *Tuḥfat al-rāghib wa-turfat al-ṭālib fī taysīr al-nayyirayn*

FIG. 9.4. EXTRACT FROM THE SHORTER TREATISE ON THE QIBLA BY AL-DIMYĀṬĪ. This diagram shows eight parts of the world arranged in the cardinal and solstitial directions about the Kaʿba, crudely represented by a circle. No geographical regions are mentioned; rather, each part of the world is associated with a wind. The qibla was found in each region by means of the Pole Star.
Size of the original: not known. By permission of Dār al-Kutub, Damascus (Ẓāhirīyah 38, fol. 14r).

wa-ḥarakāt al-kawākib (The sun, the moon, and the movements of the fixed stars made easy as a gift to the desirous and a luxury for the seeker) (fig. 9.6). But in the same century, the well-known geographer Yāqūt (575–626/1179–1229) also reproduced a twelve-sector scheme, without the instructions for finding the qibla, in his *Kitāb muʿjam al-buldān* (Dictionary of countries) (fig. 9.7). Are we to assume that in this case the diagram and its annotations would speak for itself? The same scheme was copied by al-Qazwīnī in his celebrated cosmography *ʿAjāʾib al-makhlūqāt* (Wonders of creation).[12]

Qibla charts centered on the Kaʿba had a long tradition. In surviving manuscripts, they begin to appear in the twelfth century; they were still found, as we will see, in

12. Zakariyāʾ ibn Muḥammad al-Qazwīnī, *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt* (Marvels of things created and miraculous aspects of things existing), in *Zakarija ben Muhammed ben Mahmud el-Cazwini's Kosmographie*, 2 vols., ed. Ferdinand Wüstenfeld (Göttingen: Dieterichsche Buchhandlung, 1848–49; facsimile reprint Wiesbaden: Martin Sändig, 1967), 1:83.

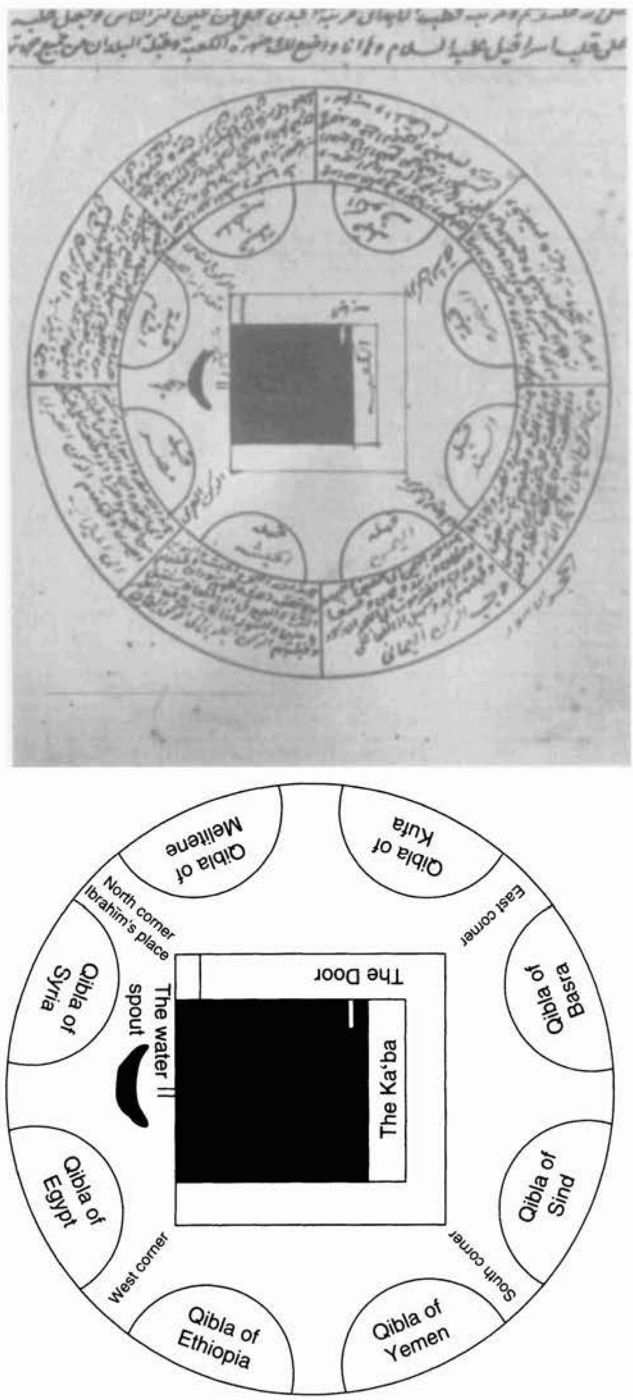


FIG. 9.5. EIGHT DIVISIONS OF THE WORLD ABOUT THE KAʿBA. According to an anonymous Ottoman treatise dating from the eighteenth century. The loops pointing toward the Kaʿba in the center contain the names of the regions or cities for which the qibla is defined (see the translation of this central part of the figure). Outside these are descriptions of the astronomical directions to be faced in the qibla for these regions and the parts of the perimeter of the Kaʿba associated with them. For each division the qibla is defined in terms of stellar risings and settings.
Size of the original: 18 × 13 cm. By permission of the Dār al-Kutub, Cairo (Ṭalʿat *majāmiʿ* 811, fol. 60v).

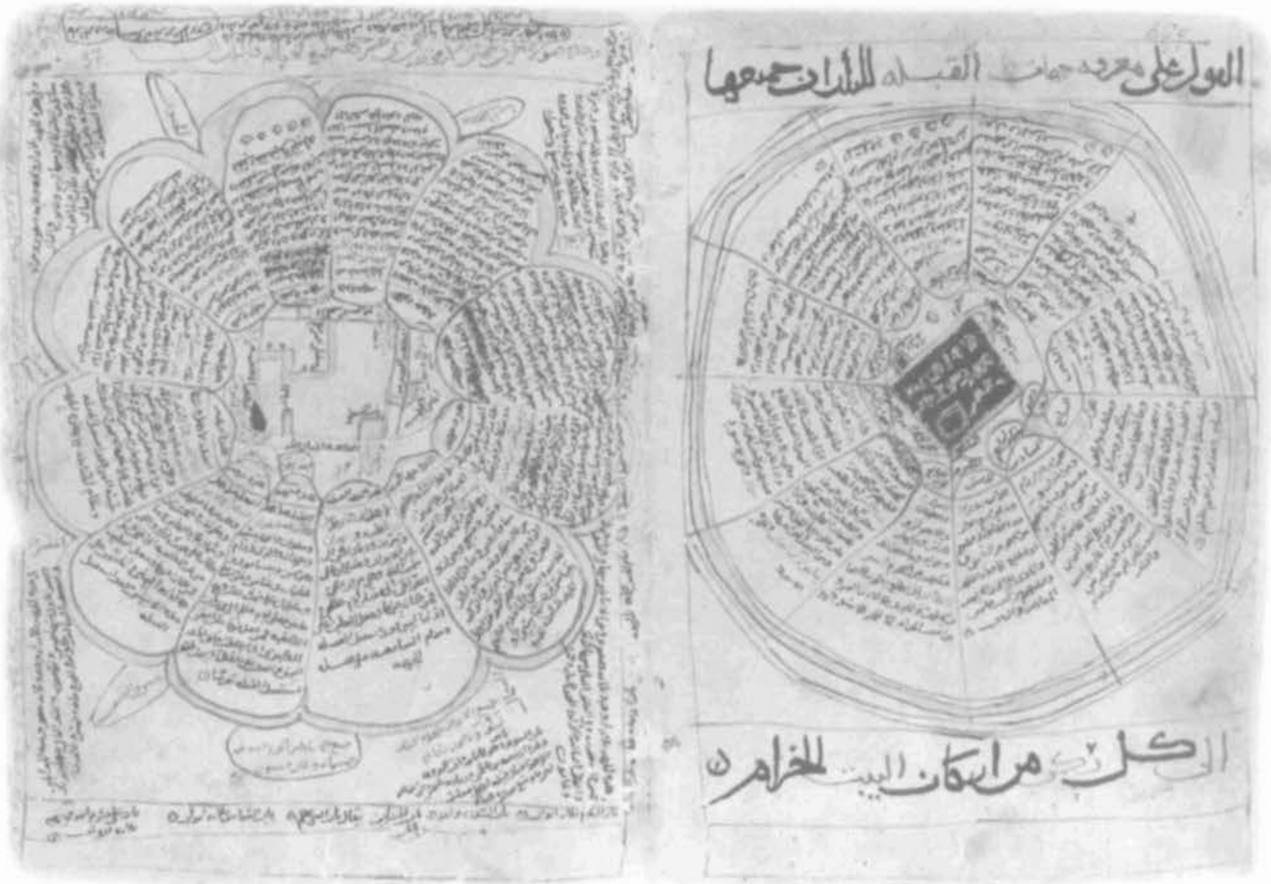


FIG. 9.6. TWO PAGES FROM A TREATISE ON FOLK ASTRONOMY. This work is by Muḥammad ibn Abī Bakr al-Fārisī, a scholar active in Aden in the thirteenth century. The two diagrams display two different schemes of the world arranged in twelve sectors about the Kaʿba. For each sector there is a statement regarding the corresponding segment of the perimeter of the Kaʿba as well as the appropriate astronomical directions that enabled the user to face that particular segment. Size of the original: not known. By permission of the Biblioteca Ambrosiana, Milan (Suppl. 73, fols. 36v–37r).

manuscripts of the later Ottoman period. The Ottoman examples show substantial development over the earlier charts, but they also contain fanciful elements. As in some earlier Arabic schemes, for instance, the orientation of the Kaʿba with respect to the cardinal directions, or with respect to localities around it, is often in error. At the same time, they also reflect particular Ottoman interests. Thus, some late schemes include Ottoman provincial cities in the Balkans as well as various European ports.

One of the main manuscripts to be illustrated was the cosmography, *Kharīdat al-ʿajāʾib wa-farīdat al-gharāʾib* (The unbored pearl of wonders and the precious gem of marvels) of Ibn al-Wardī, which was translated into Turkish several times. In one version there are eleven sectors, with instructions for finding the qibla in Turkish (fig. 9.8). In another version, prepared in 570/1562 by Maḥmūd el-Ḫaṭīb er-Rūmī, there is a chart with seventy-two sectors about the Kaʿba (fig. 9.9); this is independent of the five-, six-, and thirty-four-sector schemes attested in various Arabic copies of this work. These variations are further elaborated in other works. Two schemes of sacred geography are found in an Ottoman copy of a sixteenth-century Syrian astronomical handbook (*zīj*) among some notes at the end of the work. One of these shows twenty-four sectors, and the other has seventy-two. The latter is related to the scheme previously referred to as associated with Maḥmūd el-Ḫaṭīb er-Rūmī (fig. 9.10). A third is found in an Egyptian text. The Hanafī qadi ʿAbd al-Bāsiṭ ibn Khalīl al-Malaṭī (A.D. 1440–1514) wrote a short treatise on the qibla in which a simple twenty-sector scheme is presented (fig. 9.11). This example is unknown from any other source.

The most elaborate and visually spectacular scheme of Islamic sacred geography occurs in the navigational atlas of the sixteenth-century Tunisian chartmaker ʿAlī ibn Aḥmad ibn Muḥammad al-Sharafī al-Ṣifāqsī (plate 13) (see also pp. 285ff.). It is distinguished from all other schemes by the forty *miḥrāb*s centered on the Kaʿba, here represented by a cardinally oriented square. The scheme is superimposed upon a thirty-two-division wind rose, a

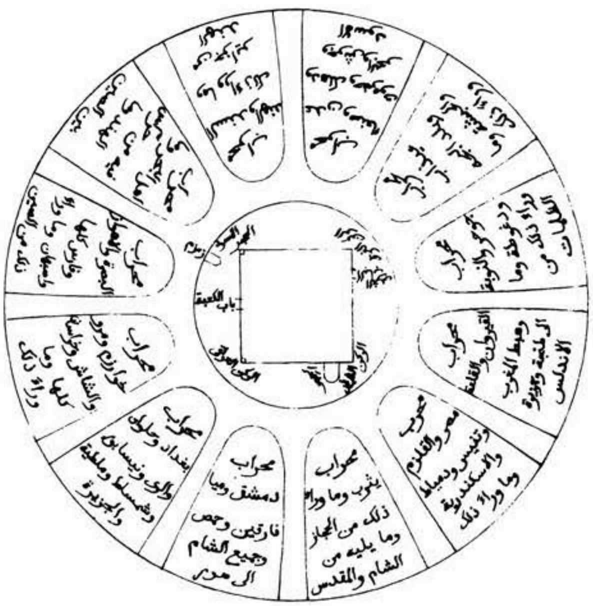


FIG. 9.7. SIMPLIFIED TWELVE-SECTOR SCHEME OF SACRED GEOGRAPHY. Taken from the published text of Yāqūt's geographical work, *Muʿjam al-buldān*.
Diameter of the original: 10.7 cm. From *Jacut's geographisches Wörterbuch*, 6 vols., ed. Ferdinand Wüstenfeld (Leipzig: F. A. Brockhaus, 1866–73), 1:36, by permission of F. A. Brockhaus.

FIG. 9.8. INSTRUCTIONS ON AN ELEVEN-SECTOR DIAGRAM OF SACRED GEOGRAPHY. Found in a Turkish translation of Ibn al-Wardī's *Kharīdat al-ʿajāʾib*. One of the sectors in the original twelve-sector scheme had already been dropped in an earlier Arabic version.
Size of the original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (R. 1088, fol. 94r).

device Arab sailors used to find directions by the risings and settings of the stars. The two known copies of this diagram have different arrangements of the localities about the Kaʿba.

By the eighteenth century, however, the notion of an Islamic sacred geography was seriously weakened by Ottoman scholars increasingly familiar with European geography. For example, Kātib Çelebī's *Cihānnümā* (World mirror), an influential work on geography printed in Istanbul in the early eighteenth century, omitted any mention of the concept of the world centered on the Kaʿba.[13] In most regions of the Islamic world traditional qibla directions, used over the centuries, were now being abandoned for a new direction computed for the locality in question from modern geographical coordinates. Nevertheless, diagrams of the kind described above were still being copied as late as the nineteenth century, if only as illustrations to Ibn al-Wardī's *Kharīdat al-ʿajāʾib*. Written instructions for finding the qibla also continued to be transmitted in one form or another. A mid-nineteenth-century anonymous Ottoman navigational compendium, recently discovered in Cairo, presents extensive instructions for finding the qibla in different localities. In fact, the information is a garbled version of one of Ibn Surāqah's schemes, taken verbatim from a treatise on folk astronomy by a fourteenth-century legal scholar working in the Hejaz. The existence of this text proves not only that such material was still available to Ottoman writers in the nineteenth century, but also that it was still considered worth copying.

Those schemes divided into thirty-six or seventy-two sectors lent themselves to representation on a horizontal disk fitted with a magnetic compass. Several examples of such qibla indicators survive,[14] but the organization of cities around the Kaʿba at the center is not based on calculation and so often departs drastically from geographical reality. Such qibla indicators were fitted to otherwise serious astronomical instruments; the motive

13. Muṣṭafā ibn ʿAbdallāh Kātib Çelebī (1017–67/1609–57) began work on a second version of the *Cihānnümā* in 1065/1654 after consulting Western sources, such as Gerardus Mercator's *Atlas Major*. It was printed in 1145/1732.

14. All such instruments are surveyed in David A. King, "Some Medieval Qibla Maps: Examples of Tradition and Innovation in Islamic Science," Johann Wolfgang Goethe Universität, Institut für Geschichte der Naturwissenschaften, Preprint Series, no. 11, 1989.

FIG. 9.9. SEVENTY-TWO-SECTOR SCHEME OF SACRED GEOGRAPHY. From a Turkish translation of Ibn al-Wardī's *Kharīdat al-ʿajāʾib* dated 1092/1681.
Size of the original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (B. 179, fol. 52r).

for including them was both aesthetic and an attempt to provide a universal solution to the qibla problem. Illustrating the mathematically computed qibla directions of specific cities would have produced unhappy clusterings and asymmetries unpleasing to the eye.

Qibla Maps Based on Coordinates

In the corpus of qibla representations as a whole, there are far fewer extant examples in the category of qibla maps based on coordinates. Nevertheless, several qibla maps have been discovered in which the positions of towns are determined by their longitudes and latitudes. A minority display a coordinate grid or at least longitudinal and latitudinal axes. A distinction may be drawn between those maps with a prime meridian at the Canary Islands, as in Ptolemy's *Geography* (defined here as type A) and those with a prime meridian on the Atlantic coast of Africa (defined as type B).

Underlying these maps is the understanding that the qibla of a locality can be found from its position relative to Mecca.[15] Ideally, said the Muslim scientists, the qibla may be defined as the direction of the great circle joining the two. But how to represent this on a map? As readers will see from appendix 9.1, Muslim scientists were in full possession of the techniques necessary to calculate the qibla. In this section we shall consider only cartographic solutions to the qibla problem. Nevertheless we shall find it convenient to use the following mathematical notation:

L	terrestrial longitude
L_M	longitude of Mecca
ΔL	longitude difference from Mecca ($L \sim L_M$)
φ	terrestrial latitude
φ_M	latitude of Mecca
$\Delta\varphi$	latitude difference from Mecca ($\varphi \sim \varphi_M$)
q	qibla (measured as an angle to the local meridian)

The first surviving example (fig. 9.12, with simplified translation), is taken from a treatise on folk astronomy by an early thirteenth-century Egyptian author. Apart from his name, Sirāj al-Dunyā wa-al-Dīn, we know nothing about him. The horizontal axis of the map, designed to measure longitudes on the equator, is divided into 170 equal parts (the last five degrees at each end have not been marked). The vertical axis, serving to measure latitudes, is divided into 80 equal parts north of the equator (the last ten degrees are likewise excluded), though in reality the vertical diameter measures not ninety degrees of longitude, but eighty-five degrees. On the map, the towns are usually located by means of two perpendicular coordinate lines. To find the qibla, one draws a line from one's locality to Mecca and investigates where this line cuts the base circle; the corresponding direction of sunrise or sunset defines the qibla. The influence of folk-astronomical methods upon the compilation makes the procedure less accurate than it might otherwise have been. It is interesting to note here that the coordinates are of type B, in the tradition of al-Bīrūnī's *al-Qānūn al-Masʿūdī*, a work that was generally unknown in medieval Egypt.

15. David A. King, "Ḳibla: Astronomical Aspects" and "Makka: As the Centre of the World," in *Encyclopaedia of Islam*, new ed., 5:83–88 and 6:180–87; idem, "The Earliest Islamic Mathematical Methods and Tables for Finding the Direction of Mecca," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 3 (1986): 82–149; and idem, "Al-Bazdawī on the Qibla in Early Islamic Transoxania," *Journal for the History of Arabic Science* 7 (1983): 3–38. For information on qibla values at Córdoba, Spain, see David A. King, "Three Sundials from Islamic Andalusia," *Journal for the History of Arabic Science* 2 (1978): 358–92; reprinted as item XV in his *Islamic Astronomical Instruments* (London: Variorum Reprints, 1987).

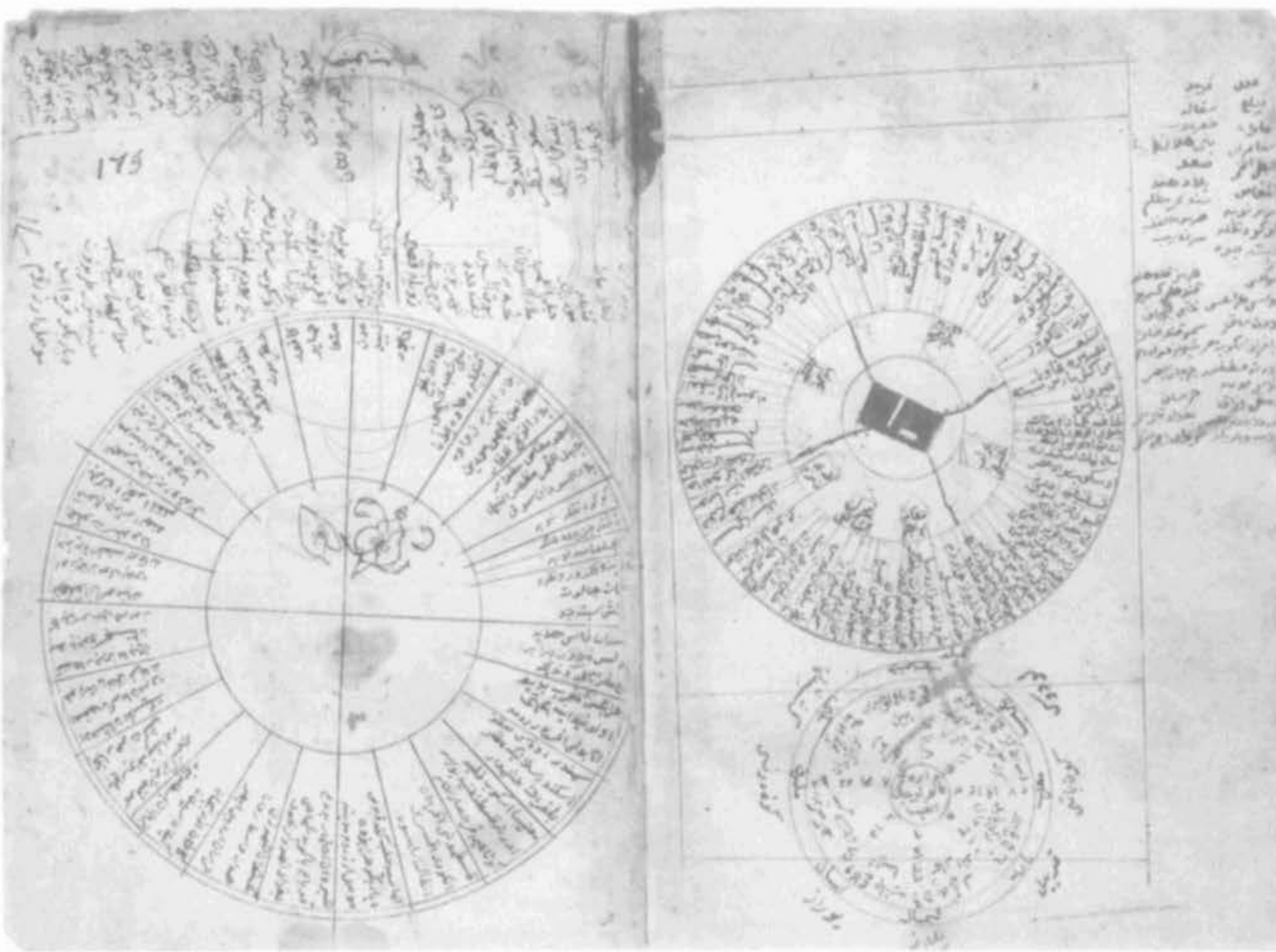


FIG. 9.10. VARIOUS SCHEMES OF SACRED GEOGRAPHY. These are appended to an Ottoman copy of a Syrian text dealing with mathematical astronomy. Size of the original: 18.5 × 25 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2520, fols. 174v–75r).

Also from Egypt is the more schematic diagram in figure 9.13. In the manuscript this appears opposite the Kaʿba-centered chart illustrated as figure 9.5. Again, the ordinates and abscissas are equally spaced, so that the configuration corresponds only roughly to geographical reality. In the coordinates (x,y), x is measured horizontally from the left and y vertically from the top. The meridians and parallels are marked with the labels listed in table 9.1. The Kaʿba is represented by a square at (1, 1) appropriately inclined to the local meridian. The names of the corners of the edifice are written in. Other localities are shown by means of circles, usually at the intersections of grid lines, sometimes with their longitudes and a letter representing 2, 3, or 4 to indicate the geographical climate in which they are situated. The longitudes are confused and do not correspond to geographical reality.

The next example, engraved on an astrolabe made in Lahore, is shown in figure 9.14. Here the positions of Mecca and various other localities are marked, and each place is connected to Mecca by a straight line representing the qibla. Both longitude and latitude scales are nonlinear, corresponding to an orthographic projection of the globe. The longitudes are of type A, for Mecca has coordinates approximately (77°, 22°). With the exception of the Atlantic coast of North Africa, which is close to (0°, 0°), Jazīr al-Zanj (?) in western Sudan, Jerusalem, and Medina, most of the localities marked are in Iran and Kashmir.

A more practical map is found on the qibla indicator displayed in figure 9.15. Mecca is shown at the center of the dial, and various places, mainly in Iran, are marked around it. Their positions are intended to be approximate, but they are nevertheless carefully arranged. For example, Jerusalem is shown about 45° west of north of Mecca (correct for medieval coordinates), and Baghdad is 10° east of north of Mecca. The other markings on the instrument south of the parallel of latitude for Mecca relate to an unusual variety of horizontal sundial for an

FIG. 9.11. SIMPLE TWENTY-SECTOR SCHEME OF SACRED GEOGRAPHY. From al-Malaṭī's short treatise on the qibla.
Size of the original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (A. 527, fol. 93r).

unspecified latitude, the gnomon of which is at the bottom of the instrument.

In 1989 a remarkable qibla indicator was sold at Sotheby's of London (fig. 9.16). The calligraphy and various ornamental features reveal the provenance: Isfahan, about A.D. 1700. It is circular with a radius of 22.5 centimeters. The rim is marked in labeled ten-degree intervals each subdivided in half, and individual degrees are indicated by dots. The cardinal directions are identified by name, and the north-south and east-west lines are drawn in. Three pieces have been cut out of the perimeter; some other parts—now missing—were added to serve other (astronomical) functions.

The instrument bears a distinctive grid with two families of markings. The first are linear, parallel meridians for each two degrees of longitude up to 48° on either side of meridian 77° (see below). The second are nonrectilinear curves for each two degrees of latitude from 10° up to 50°. The meridians are produced below latitude 10° and are cut off by a straight line parallel to the east-west line and corresponding to a latitude of about 2° (there is no indication that this was supposed to represent the equator). An inscription on the alidade indicates that the point at the center of the disk is Mecca. A scale in *farsakhs* marked on one-half of this alidade is intended to measure distances from Mecca.

The longitude of Mecca is taken as 77°10′, that is, a nonintegral value, and this is a feature that caused the maker a lot of extra work. The longitudes corresponding to the meridians for odd longitudes are marked along a band above the curve for latitude 50°. The arguments corresponding to the latitude curves are marked in a band between the meridians for 51° and 53°. The seven climates are identified (in Persian) along this scale. Localities are indicated by inlaid studs, the names being engraved on neighboring "squares" of the grid. The size of the grid was chosen so that, for example, Beijing (Khānbāligh) would just fit on it.

The now-empty frame of a magnetic compass adorns the lower center of the disk, its radius being about one-third that of the disk. There is no indication that the compass might not point due north, but this fact was known to at least some Ottoman astronomers in the sixteenth century and presumably also thereafter.

The estimated coordinates of various localities are listed in table 9.2. These estimates are sufficient to identify the source as the astronomical handbook of Ulugh Beg, compiled in Samarkand in the early fifteenth century. Variations are all within acceptable limits. Also Sri Lanka (Sarandīb), with coordinates (10°, 130°) in the *zīj*, is indeed off the grid altogether; presumably the stud right on the perimeter of the plate at about 20° south of east was intended to mark it.

The problem of constructing a rect-azimuthal grid could have been easier for a Muslim astronomer than it was for a twentieth-century researcher like Schoy, who first investigated the mathematics of such a projection.[16] The former had access to tables displaying the qibla directions for all points on the kind of grid on our instrument (and more), whereas Schoy had to make his calculations himself. The medieval tables, of which several sets are known to us, display a function such as $q(\Delta L, \varphi)$ for a range of arguments. The table of Shams al-Dīn Abū ʿAbdallāh Muḥammad ibn Muḥammad al-Khalīlī of Damascus (fl. ca. A.D. 1365),[17] for example, displays this function for the domains:

$$\varphi = 10°, 11°, \ldots 56°, \text{ and } \Delta L = 1°, 2°, \ldots 60°.$$

16. For a discussion of this projection, see Carl Schoy, "Die Mekka- oder Qiblakarte," *Kartographische und Schulgeographische Zeitschrift* 6 (1917): 184–86, and idem, "Mittagslinie und Qibla: Notiz zur Geschichte der mathematischen Geographie," *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* (1915): 558–76; both reprinted in *Beiträge zur Arabisch-Islamischen Mathematik und Astronomie*, 2 vols. (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1988), 1:157–59 and 1:132–50, respectively.

17. David A. King, "Al-Khalīlī's *Qibla* Table," *Journal of Near Eastern Studies* 34 (1975): 81–122; reprinted as item XIII in his *Islamic Mathematical Astronomy* (London: Variorum Reprints, 1987).

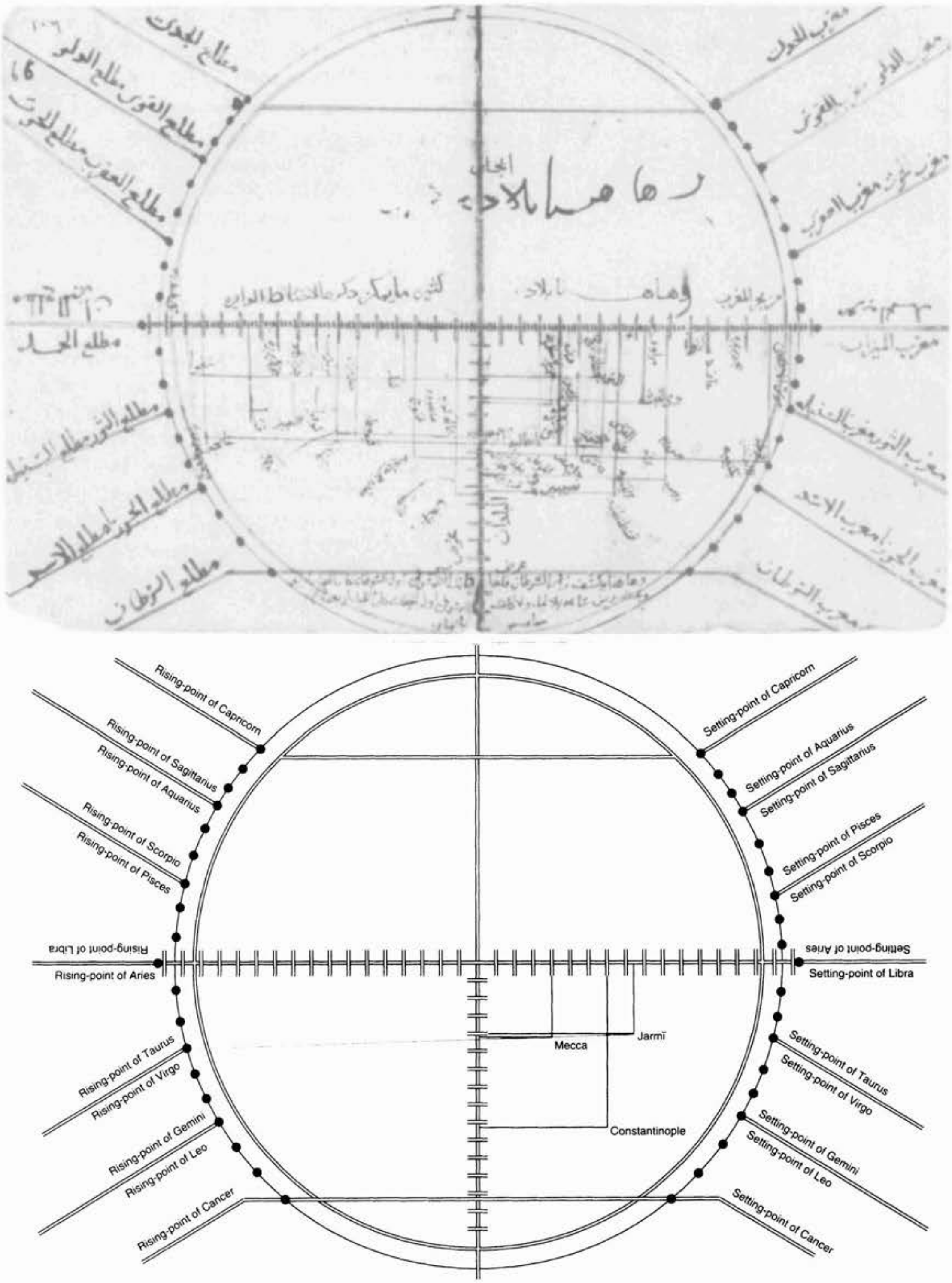


FIG. 9.12. QIBLA MAP CONTAINED IN A TREATISE ON FOLK ASTRONOMY. This is by an otherwise unknown early thirteenth-century Egyptian author named Sirāj al-Dunyā wa-al-Dīn. In the lower diagram, which illustrates his principle, only three of the localities are shown: Mecca, Constantinople, and Jarmī (Aksum) in Ethiopia. A line has been added joining Jarmī and Mecca that is extended to the circumference of the circle. According to the system of this map, the qibla of Jarmī would therefore be roughly the rising point of the sun when it is at the beginning of Taurus or Virgo.

Diameter of outermost circle: 18.5 cm. By permission of the Yahuda Collection of Arabic Manuscripts, Princeton University Library, Princeton (Yahuda Arabic manuscript no. 4657, fols. 65v–66r).

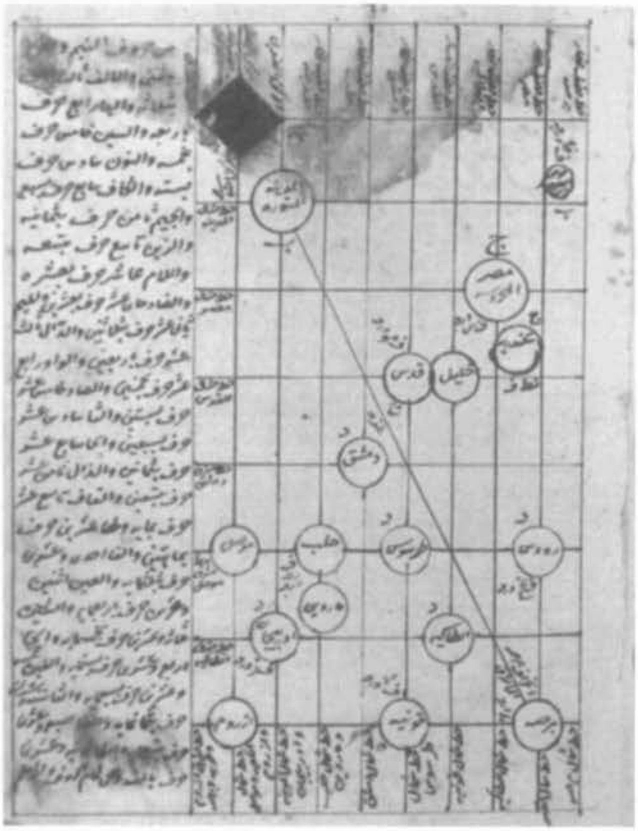


FIG. 9.13. QIBLA MAP BASED ON COORDINATES. Taken from an anonymous Ottoman treatise (see also figs. 9.2 and 9.5), this map shows the locations of various major cities with respect to the Kaʿba, the cities being shown on an orthogonal longitude-latitude grid.
Size of the original: 18 × 13 cm. By permission of the Dār al-Kutub, Cairo (Ṭalʿat *majāmiʿ* 811, fol. 61r).

TABLE 9.1 Labels for a Schematic Qibla Diagram (see figure 9.13)

MERIDIANS OF LONGITUDE

x	*Upper Frame*	*Lower Frame*
0	–	–
1	al-Kaʿba, Mosul, Erzurum	Mosul
2	Medina, Azerbaijan	–
3	Aleppo, Mardin	Medina
4	Damascus	Aleppo
5	Tarsus	Damascus
6	Konya	Jerusalem
7	Antioch	Antioch
8	Cairo	Cairo
9	Bursa	Bursa

PARALLELS OF LATITUDE

y	
0	–
1	(al-Kaʿba)
2	Medina
3	Cairo
4	Jerusalem
5	Damascus
6	Mosul
7	Antioch
8	Erzurum, Konya, Bursa

However, underlying this table is the parameter φ_M – 21°30′, and besides, our astronomer accepted 77°10′ for the longitude of Mecca (al-Khalīlī used 77°, so his tables serve all integral longitudes). This means that a table such as al-Khalīlī's would provide qibla values for integral latitudes, but for integral longitudes plus ten minutes. It is more likely that the astronomer computed a matrix of values $q(\Delta L, \varphi)$ for each degree of φ from 10° to 50° and a set of nonintegral values of ΔL (2° apart or perhaps 6° or 10°), which would yield the required values of q for the integral values of L used on his grid. In other words, he tabulated $q(L, \varphi)$. His values would no doubt have been for the parameter $\varphi_M = 21°40'$.

Our astronomer would then have proceeded as follows. First, he drew the meridians as equally spaced parallels. Actually, on the instrument the meridians are not all equally spaced: those on the outer edges are separated by about four-fifths of the distance between those closer to the center of the ensemble. This feature is still under investigation. Second, to construct the point on the meridian for longitude L corresponding to latitude φ, he simply read $q(L, \varphi)$ from the table and drew a line through the center inclined at angle q to the meridian there. That the meridians are parallel ensures that this angle is the qibla of the locality. The latitude curves on our instrument have been drawn with remarkable precision. Only in two places in the northeastern quadrant has the maker had to repeat a part of a curve that did not satisfy him.

This cartographic solution to the qibla problem is to be regarded as a brilliant achievement for an astronomer working in the medieval tradition. The basic idea is, of course, quite simple, but it required a spark of genius to realize just that. The instrument also merits mention as one of the numerous universal solutions to problems in spherical astronomy (the qibla problem is equivalent to one such) devised by Muslim astronomers and also as one of various graphical representations of two-argument functions they developed.

METHODS OF QIBLA DETERMINATION WITH SPHERES AND ASTROLABES

A direct mathematical method of finding the qibla was described by the little-known astronomer Naṣr ibn ʿAbdallāh. His dates are uncertain, but his procedure for finding the qibla is no later than A.D. 1162–63, the date

FIG. 9.14. QIBLA MAP INSCRIBED ON A SEVENTEENTH-CENTURY INDO-PERSIAN ASTROLABE.
Diameter of the original: 25 cm. By permission of the Trustees of the Science Museum, London. Photograph courtesy of Christie's of New York.

FIG. 9.15. MAP INSCRIBED ON A LATE PERSIAN QIBLA INDICATOR. Undated.
Diameter of the original: 7.5 cm. Museum of the History of Science, Oxford (ref. no. 57-84/44). By permission of the Bettman Archive, New York.

of the manuscript.[18] His method involved drawing a map on a sphere. It will be seen in figure 9.17 that the meridian line AEB and the east-west line GED are drawn on the curved surface of a hemisphere whose base represents the horizon. Then the north pole (Z) is marked on the zenith (ZB = φ, the latitude of the locality), and the equator circle GHD is drawn; a point T is marked, so that HT = ΔL (the difference in longitude); this point (T) and the pole (Z) are joined by an arc of great circle (KTMZ); from this arc TM is cut off equal to φ_M; and finally an arc of the great circle (EMN) is drawn through the end point of this arc and the zenith (E). The intersection (N) of this last arc with the horizon circle gives the azimuth of Mecca when the hemisphere is aligned with the meridian. Clearly, the instrument would have been simple enough to use where a suitable pair of compasses and a curved graduated ruler were available, though making an accurate hemisphere would be difficult. It does not, however, seem to have been well known.

Another type of instrument, the "solid sphere," called in Arabic *dhāt al-kursī* (the instrument with the frame) or, more simply, *al-kurah* (the sphere), was also sometimes used to determine the qibla directly. This consisted of a sphere—with equator and other celestial markings—that could be rotated about its poles. It was mounted in a fixed horizontal ring and (usually) a fixed meridian ring. ʿAbd al-Raḥmān al-Khāzinī (fl. early twelfth century) described an automatically rotating sphere of this sort and showed how the qibla was found with it.[19] First, Mecca is marked on the sphere according to its geographical coordinates, that is, as though its geographical longitude and latitude were the right ascension and de-

18. Damascus, Dār al-Kutub, Ẓāhirīyah 4871, fol. 83r. See Richard P. Lorch, "Naṣr b. ʿAbdallāh's Instrument for Finding the Qibla," *Journal for the History of Arabic Science* 6 (1982): 123–31.

19. Richard P. Lorch, "Al-Khazini's 'Sphere That Rotates by Itself,' " *Journal for the History of Arabic Science* 4 (1980): 287–329, and for more on al-Khāzinī, see idem, "The *Qibla*-Table Attributed to al-Khāzinī," *Journal for the History of Arabic Science* 4 (1980): 259–64.

FIG. 9.16. RECT-AZIMUTHAL QIBLA MAP. This was used for finding the qibla of any locality. Mecca is at the center, and numerous cities between Spain and China, Europe and the Yemen are marked on a cartographic grid. The rule attached at the center enables one to read off the qibla on the circular scale around the circumference of the instrument, and the scale on the rule gives the corresponding distance between the two localities. This instrument came to the attention of scholars only in 1988.
Diameter of the original: 22.5 cm. Photograph reproduced courtesy of the owner.

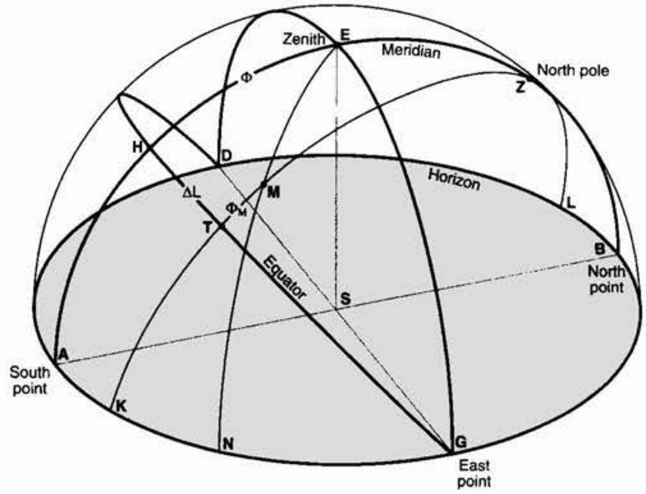


FIG. 9.17. DIRECT MATHEMATICAL METHOD FOR FINDING THE QIBLA. Naṣr ibn ʿAbdallāh (fl. before A.D. 1162–63) suggested finding the qibla by drawing a map on a hemisphere. If E and M are the zeniths of the chosen place and of Mecca, respectively, AN will be the azimuth of Mecca from this place.

TABLE 9.2 Estimated Coordinates of Localities on the Rect-azimuthal Qibla Indicator

Place	φ	L
Mecca	21°40′	77°10′
Aden	11° 0′	75°50′
Beijing	46° 0′	124° 0′
Cairo	30°20′	63°30′
Istanbul	45° 0′	60° 0′

clination of a star. Second, the place from which the qibla is to be determined is similarly marked on the sphere. The sphere is then rotated until the second mark coincides with the zenith. Then the spot marking Mecca is joined to the zenith by a curved ruler that fits the sphere, to give the point on the horizon that defines the qibla.

A much earlier treatise on the solid sphere was written by Qusṭā ibn Lūqā in the ninth century. This gives what appears to be a similar, but not identical, method. Nothing comparable, however, is included in a short account of the instrument by Ḥabash al-Ḥāsib (fl. 240/850),[20] or in the enormous treatise (157 chapters) by ʿAbd al-Raḥmān ibn ʿUmar al-Ṣūfī (d. 372/983), although the latter does give four chapters on finding the azimuth of the sun or of a star (for more information on these authors, see chapter 2).

A treatise describing the spherical astrolabe compiled for the *Libros del saber de astronomía* of King Alfonso X of Castile (r. 1252–84) gives a method for finding the azimuths of terrestrial locations. On the spherical astrolabe, a sphere carries the horizontal coordinates, that is, the lines of equal altitude and lines of equal azimuth (see pp. 41–42 and fig. 2.25). The rete (Arabic *ʿankabūt*), or net that fits over the sphere and could rotate round it about the celestial pole, carried the stars and the usual celestial circles such as the equator and ecliptic. A mark was made at that point on the rete that lies over the meridian and is distant from the equator by the latitude of the place (here Mecca) whose azimuth is required. The rete was then rotated through an angle equal to the difference of longitudes of the two places. The required azimuth could then be read off from the position of the mark among the azimuth circles. The astronomers of Alfonso's court probably took this use of the spherical astrolabe ultimately from Arabic sources, for although they found no Arabic treatise to work from, they must have found someone familiar with the instrument to be able to describe it all.

The plane astrolabe—mathematically the stereographic projection of the spherical astrolabe from the South Pole onto the equatorial plane—and the astrolabe quadrant—a quadrant made by folding the markings of an astrolabe

20. Richard P. Lorch and Paul Kunitzsch, "Ḥabash al-Ḥāsib's Book on the Sphere and Its Use," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 2 (1985): 68–98.

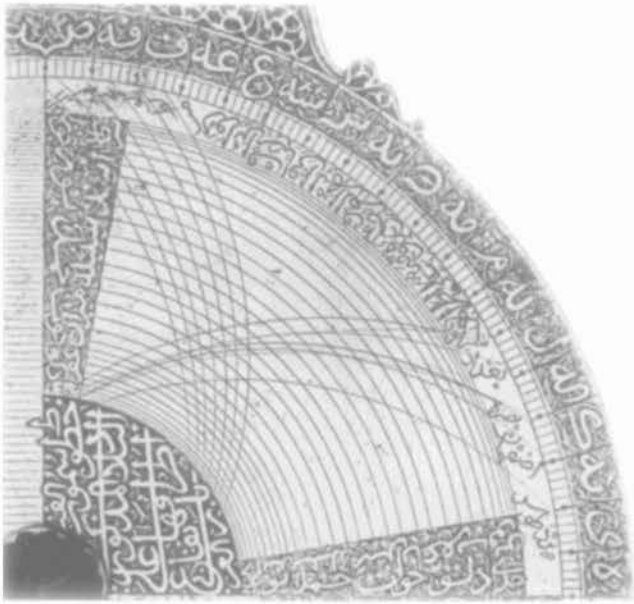


FIG. 9.18. DETAIL OF A QIBLA MAP INSCRIBED ON THE BACK OF AN ASTROLABE. Bears the signature Muḥammad Mahdī al-Khādim; undated (ca. A.D. 1650).
Size of the original: not known. Museum of the History of Science, Oxford (ref. no. 57-84/6). By permission of the Bettman Archive, New York.

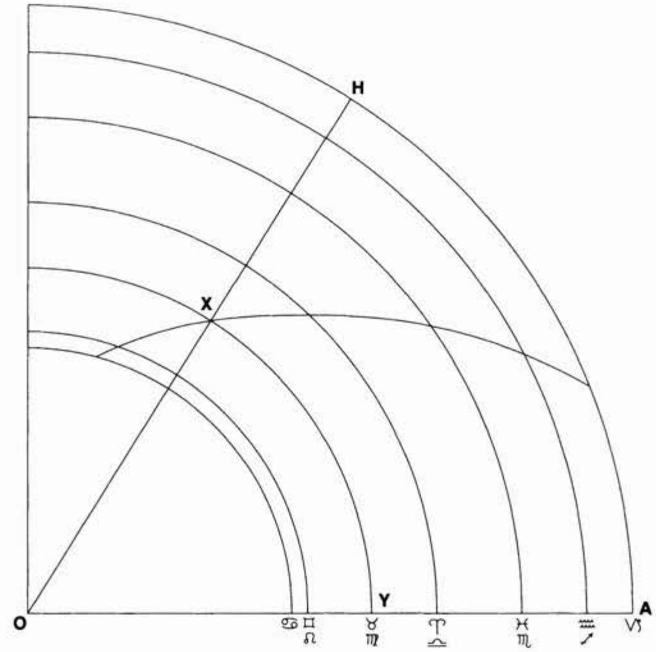


FIG. 9.19. EXPLANATORY DIAGRAM FOR FIGURE 9.18. The sun has the same azimuth as Mecca when it has the altitude (arc AH) indicated by the graph. The example taken here is the first point of Taurus or Virgo. The line OXH represents the alidade (or radial rule).

twice—were also adapted to the purpose of finding the qibla.[21] To be sure, some astrolabe treatises describe only how the instrument may be used to display a result already known or give a method by calculation. In this context it should be remembered that another type of quadrant (the sine quadrant) had the means of making trigonometric calculations and that the backs of astrolabes usually incorporated such quadrants in their markings.

A convenient means of finding the qibla using the sun is provided by the graphs on the backs of some astrolabes (fig. 9.18). These graphs (fig. 9.19) give the altitude of the sun when it has the same azimuth as Mecca—for any time of the year, which is specified on the base line OA by the position of the sun in the ecliptic. The angle AOH made with the base line by the join of the center O and the intersection X of the graph with the circle XY that corresponds to the point Y of the ecliptic occupied by the sun is the required solar altitude. The line OXH could be represented by the alidade of the astrolabe. One qibla curve is specific to one location. Several lines labeled with the names of cities were usually provided on these graphs.

The makers of such graphs must have known the qiblas in advance. The solar altitudes for these azimuths at various times of the year may be found empirically or determined by means of the astrolabe itself. Another possibility is that both the direction of the qibla and the various altitudes of the sun were read off directly from some instrument, such as the "solid sphere." Tables were also compiled for specific localities giving the altitude of the sun for the time of the year when it had the same azimuth as Mecca.

Whether or not the authors of these various instrumental determinations of the qibla were thinking in terms of a diagram or map, one factor is common to all methods: a precise notion of geographical direction, or azimuth. This is in contrast to the much vaguer and less consistent notions of folk astronomy and sacred geography. Both, however, serve the same purpose—to help one face the Kaʿba, a symbol of the presence of God.

21. Peter Schmalzl, *Zur Geschichte des Quadranten bei den Arabern* (Munich: Salesianische Offizin, 1929).

APPENDIX 9.1
METHODS TO CALCULATE THE QIBLA

An approximate method for finding the qibla was described by al-Battānī (d. 317/929) and al-Jaghmīnī (fl. thirteenth century). In essence, these authors described taking a horizontal graduated circle quartered by two diameters whose end points face north, south, east, and west (fig. 9.20*a*), and cutting off AB equal to ΔL (the difference in longitude between Mecca and the location concerned) and CD equal to $\Delta\varphi$ (the difference in latitude). Then BM was drawn perpendicular to OC and DM perpendicular to OA. The join of O and their intersection at M gave the approximate qibla. A comparison with figure 9.20*b* and perhaps figure 9.3 shows immediately the connection with cartographic procedures. Clearly, this simple procedure is equivalent to the modern formula:

$$q = \tan^{-1}\left\{\frac{\sin \Delta L}{\sin \Delta\varphi}\right\}.$$

Several other approximate formulas were known. A favorite method of displaying the results was a 20 × 20 table based on one or other of these formulas giving the azimuths of the qibla for values of ΔL and $\Delta\varphi$ going up by degrees from 1° to 20°.

Far more sophisticated were the "analemma" methods (the name coming from the title of a book by Ptolemy containing similar graphic procedures) for finding the qibla. The earliest known procedure of this kind—by Ḥabash al-Ḥāsib in the ninth century[1]—may be summarized by the following instructions (fig. 9.21*a*):

Draw the meridian ABGD, the vertical AG, and the horizon BD

$$\begin{aligned} AZ &= \varphi;\ ZH = \varphi_M;\ ZT = \Delta L \\ HY &\parallel ZK;\ \text{M is midpoint of HY} \\ ES &= HM \\ SO &\perp HY \\ OFQ &\parallel AG \\ OLN &\parallel DB \\ EF &= LN \end{aligned}$$

FEG is the required angle.

To justify the construction, we compare figure 9.21*a* with figure 9.21*b*, which carries lowercase letters corresponding where possible to the uppercase letters of figure 9.21*a*. Unfortunately, the correspondence cannot be consistent because the plane of the analemma represents different planes in the space of the diagram at various stages of the construction. At the beginning ABGD represents the meridian circle zp, with A as the zenith p. A circle HY may be imagined perpendicular to the plane of the paper with Mecca imagined on it at a point X, whose angular distance from H is equal to ΔL (X will be directly above O). Correspondingly, xo is perpendicular to the meridian plane bphz. Thus if l is the center of the circle parallel to the horizon and passing through x (the position of Mecca), then OL = ol. The required azimuth is ∠def, which is equal to ∠olx. Since xl = XL (the radius of the circle JN), this angle may be constructed by taking EF = LN. In the final result circle ABGD represents the horizon circle.

Such procedures gave rise to several sets of verbal instructions equivalent to correct trigonometrical formulas.[2] These are mathematically equivalent to the modern formula:

$$q = \cot^{-1}\left\{\frac{\sin\varphi\cos\Delta L - \cos\varphi\tan\varphi_M}{\sin\Delta L}\right\}$$

Qibla tables based on exact procedures are of considerable interest to the history of mathematics. Particularly impressive is the table of Shams al-Dīn al-Khalīlī (fl. Damascus, ca. 1365), in which $q\ (\varphi, \Delta L)$ was tabulated with remarkable accuracy for each degree of φ from 10° to 56° and each degree of ΔL from 1° to 60°.

Finally, there were several methods of finding the qibla based on the fact that the direction of Mecca is the azimuth of the sun when it is standing above the city. The day when this occurs is the day (toward the end of May or about the middle of July) when the declination of the sun is equal to φ_M, the latitude of Mecca. Since on this day the sun will stand above Mecca at noon, the difference in longitude (ΔL) was converted at the rate of four minutes per degree to find when this occurred according to local time—before or after noon according to one's location west or east of Mecca. The time of day would have been determined from the solar altitude. Graphs of the type shown in figure 9.18 may be considered an extension of this method.

1. Edward S. Kennedy and Yusuf ʿId, "A Letter of al-Bīrūnī: Ḥabash al-Ḥāsib's Analemma for the Qibla," *Historia Mathematica* 1 (1974): 3–11; reprinted in *Studies in the Islamic Exact Sciences by E. S. Kennedy, Colleagues and Former Students*, ed. David A. King and Mary Helen Kennedy (Beirut: American University of Beirut, 1983), 621–29; J. L. Berggren, "A Comparison of Four Analemmas for Determining the Azimuth of the Qibla," *Journal for the History of Arabic Science* 4 (1980): 69–80.

2. David A. King, "The Earliest Islamic Mathematical Methods and Tables for Finding the Direction of Mecca," *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 3 (1986): 82–149.

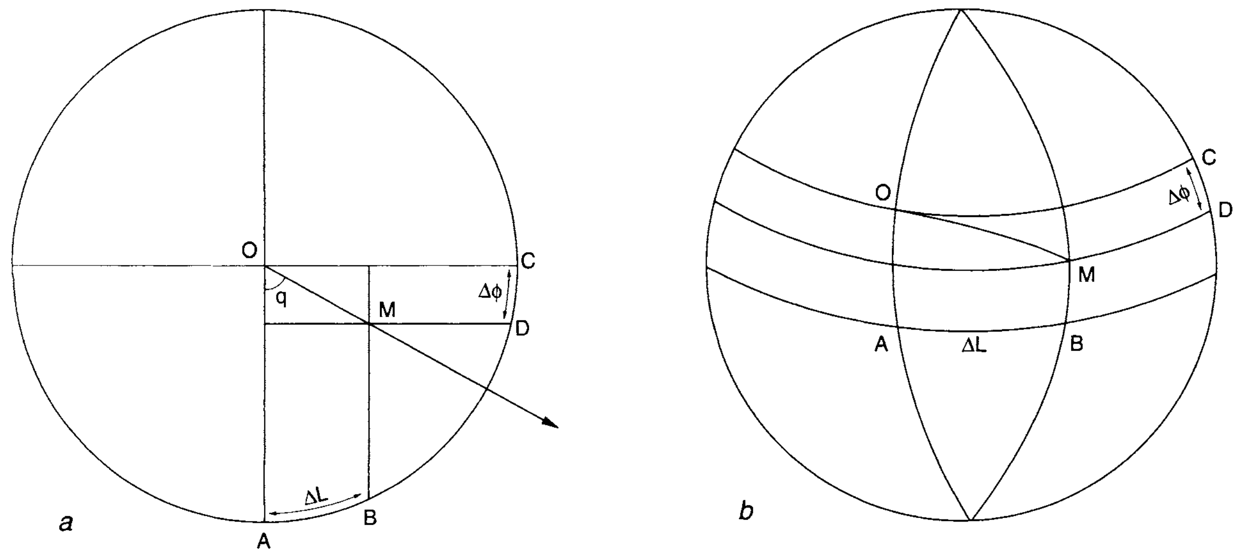


FIG. 9.20. APPROXIMATE METHOD FOR FINDING THE QIBLA DESCRIBED BY AL-BATTĀNĪ AND AL-JAGHMĪNĪ.

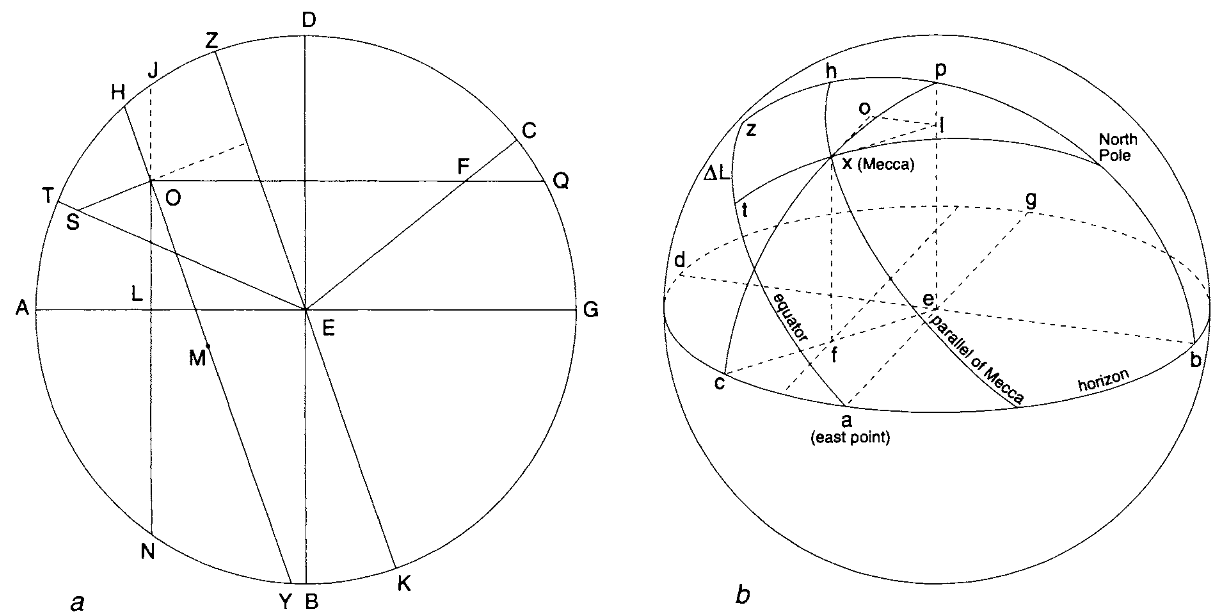


FIG. 9.21. ANALEMMA METHOD FOR FINDING THE QIBLA DESCRIBED BY ḤABASH AL-ḤĀSIB.

10 • Introduction to Ottoman Cartography

AHMET T. KARAMUSTAFA

SCOPE AND ORGANIZATION

The surviving maps of the premodern Ottoman Empire are as rich as they are variegated.[1] For roughly four hundred years—from the early decades of the fifteenth century when the distinctive institutions and culture of this world empire began to take shape to the final quarter of the eighteenth century when increasingly rapid assimilation of contemporary western European cartographic practices into Ottoman culture almost completely squeezed out older "traditional" patterns of mapmaking—Ottoman society nurtured and sustained several cartographic traditions. These ranged from various forms of state-sponsored practical cartography (military, administrative, architectural) to private scientific, religious, and artistic mapmaking. Not many recorded artifacts survive from these traditions. But the quality and diversity of extant premodern Ottoman maps certainly suggest that there was a significant and continuous level of cartographic consciousness in certain segments of premodern Ottoman high culture that merits independent scrutiny.

In the two chapters that follow this Introduction the main genres of surviving Ottoman terrestrial maps are described. A common influence in these groups of maps is the extent to which either they were made to serve some practical purpose of imperial policy or reflected the influence of imperial patronage on cartographic form and style. Thus in chapter 11 a diverse group of military plans and scroll maps of water supply systems in Istanbul highlights the key role of official architects, engineers, and soldiers in the development of Ottoman cartographic traditions. Similarly, in chapter 12 the driving force behind the town views and itinerary maps in the Ottoman historical chronicles was the conscious commemoration of imperial exploits and especially the conquest of new territories in the Mediterranean, southwest Europe, and Asia Minor. By way of contrast, there are the maps produced for everyday consumption. These include the regional and world maps that illustrated scholarly texts and are also described in chapter 11. Such maps are often far less innovative, incorporating Western traditions from the sixteenth century onward, but also perpetuating the older characteristics of Islamic geographical mapping described in chapters 4 through 7 of this book. Finally, though not included in this discrete Ottoman section, chapter 14 brings together the previously scattered corpus of Islamic marine mapping in the Mediterranean and examines a number of charts of Ottoman provenance. Many of these charts, drafted in portolan or *isolarii* style, were initially copied from Italian models, but the *Kitab-i bahriye* of Pīrī Reʾīs in particular includes non-Western sources and shows considerable cartographic inventiveness.

Taken as a whole, the Ottoman maps we have reviewed in this book may eventually turn out to be only a small part of this original corpus. This may particularly be the case for the later or transitional period of mapping from the seventeenth century onward, when the slow diffusion of Western practices transformed traditional cartography. Even so, in these examples and despite the problems described below, a foundation is laid from which to enlarge a previously neglected chapter of cartographic history.

TERMINOLOGY

The modern Turkish term for "map" is *harita*. In Ottoman Turkish, however, the word *ḫarīṭa* and its variations *ḫartī, karta, kerte* had the restricted meaning "sea chart." More specifically, this cluster of words that ultimately derive from the Catalan "carta" through the Greek "kharti" was used in Ottoman Turkish to denote "portolan charts." In this meaning, the terms were used interchangeably with *mapamundi*, *papamundi*, and *napamundi*, three Turkish variants of the medieval European term *mappamundi* when it was used as a nautical term.[2] In contrast to the specificity of the terms used for marine

1. In addition to the corpus detailed in the following two chapters, some Ottoman maps are discussed and illustrated in the chapters on qibla maps and marine charting in the Mediterranean.

2. Details with ample documentation can be found in Henry Kahane, Renée Kahane, and Andreas Tietze, *The Lingua Franca in the Levant: Turkish Nautical Terms of Italian and Greek Origin* (Urbana: University of Illinois Press, 1958), 158–59 (term 177, "carta"), 290–91 (term 394, "mappamondo"), and 594–97 (term 875, χαρτί ["kharti"]). There is no evidence that the Ottomans were familiar with the *mappaemundi* "world map" tradition.

charts, Ottoman terrestrial maps were referred to under such generic names as *resm* ("drawing," "picture") and *sūret* ("image," "representation"). The term *resm* seems to have been used more commonly than *sūret* to designate graphic representations in general. In Ottoman architectural practice it was normally this term and its cognates *tasvīr* and *tersīm* that were used to signify "ground plan" and, when modified by a suitable adjective, "three-dimensional model."[3]

Problems in the Study of Ottoman Cartography

The study of premodern Ottoman cartography is hindered by several problems—most notably, the almost complete lack of scholarship on the subject and the limited and tentative nature of the few existing studies. In addition, the cartographic record is difficult to trace, since the cultural legacy of the Ottoman Empire is both large and scattered. And, most broadly, there are considerable methodological difficulties in understanding the unique social and cultural space that the empire occupied between western Europe on the one hand and the societies of Asia and Africa on the other hand.

Scholarly examination of the cartographic record from the Ottoman Empire is only beginning. Apart from individual studies devoted to isolated Ottoman maps there still exist no systematic attempts to recover and record, let alone examine in detail, the extant cartographic output of this sprawling and long-lived world empire. The cartographic holdings of even the most central repositories of source materials for Ottoman history, the library and the archives of the Topkapı Sarayı Müzesi, the Başbakanlık Arşivi, and the Istanbul Üniversitesi Kütüphanesi, all in Istanbul, remain uncataloged.[4] The incomplete record hinders effective study of the history of Ottoman cartography as a whole. In particular, the protracted process of replacing premodern Ottoman cartographic traditions by contemporary western European ones during the eighteenth and the nineteenth centuries is impossible to trace in the absence of published, or even unpublished, inventories and catalogs. There is therefore a serious need for concerted efforts to uncover and publish all surviving Ottoman maps.[5]

The task of building the record, however, is severely hampered by the volume of existing source materials for the study of Ottoman history. The Ottomans developed and maintained a centralized and highly bureaucratized state apparatus that employed sophisticated procedures of record keeping. Moreover, an extremely literate high culture rested and centered on the state. The archival, literary, artistic, and architectural legacy of this imperial political community and its culture is staggeringly large in volume. Despite the advances of the past three decades, the scholarly sifting of this material is still in its early stages. In these circumstances, the historian of Ottoman cartography has to be content with occasional and incidental finds rather than systematic surveys of Ottoman maps.

The technical difficulties of gaining access to Ottoman maps are coupled with methodological problems in the study of premodern Ottoman history in general. At present, Ottoman studies is an insular field, with no operational ties to either European or Islamic studies. Most historians of premodern Europe and Islam, as well as the majority of Ottomanists, function with a set of assump-

3. A detailed survey of Ottoman architectural terminology for plans and models can be found in Gülru Necipoğlu-Kafadar, "Plans and Models in 15th- and 16th-Century Ottoman Architectural Practice," *Journal of the Society of Architectural Historians* 45 (1986): 224–43, esp. 240–42.

4. Many, though not all, of the Ottoman maps held at the Topkapı Sarayı Müzesi Kütüphanesi are recorded with brief descriptions in Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Türkçe Yazmalar Kataloğu*, 2 vols. (Istanbul: Topkapı Sarayı Müzesi, 1961), 1:464–77 (Portülan ve Haritalar, nos. 1407–58); English translation: E. H. van de Waal, "Manuscript Maps in the Topkapī Saray Library, Istanbul," *Imago Mundi* 23 (1969): 81–95. Of the maps preserved at the Topkapı Sarayı Müzesi Arşivi, there is only a hurried handlist that was prepared by Çağatay Uluçay, though there is apparently an ongoing attempt to catalog them (oral testimony by Ülkü Altındağ, director of the archives). The cartographic holdings of the Başbakanlık (or Başvekalet) Arşivi have so far been subjected to two separate cataloging efforts, though the results of both these classifications remain for the most part inaccessible to researchers; see Atillâ Çetin, *Başbakanlık Arşivi Kılavuzu* (Istanbul: Enderun Kitabevi, 1979), 42–43 (Haritalar Tasnifi). The Istanbul Üniversitesi Kütüphanesi maintains only an inadequate card catalog of its Ottoman map collection, which is particularly rich for the nineteenth and twentieth centuries.

5. Existing general accounts of Ottoman cartography include Klaus Kreiser, "Türkische Kartographie," in *Lexikon zur Geschichte der Kartographie*, 2 vols., ed. Ingrid Kretschmer, Johannes Dörflinger, and Franz Wawrik (Vienna: Franz Deuticke, 1986), 2:828–30; Franz Taeschner, "Djughrāfiyā: The Ottoman Geographers," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 2:587–90; Hüseyin Dağtekin, "Bizde tarih haritacılığı ve kaynakları üzerine bir araştırma," in *VIII. Türk Tarih Kongresi, Ankara 11.–15. Ekim 1976*, 3 vols. (Ankara: Türk Tarih Kurumu, 1979–83), 2:1141–81; Abdülhak Adnan Adıvar, *Osmanlı Türklerinde İlim*, 4th ed. (Istanbul: Remzi Kitabevi, 1982). More specialized studies rarely go beyond narrow examination of individual maps. Some notable exceptions that cover more ground are David A. King, "Some Ottoman Schemes of Sacred Geography," in *Proceedings of the II. International Congress on the History of Turkish and Islamic Science and Technology, 28 April–2 May 1986*, vol. 1, *Turkish and Islamic Science and Technology in the 16th Century* (Istanbul: İ.T.Ü. Research Center of History of Science and Technology, 1986), 45–57; Fevzi Kurtoğlu, *Türk süel alanında harita ve krokilere verilen değer ve Ali Macar Reis Atlası* (Istanbul: Sebat, 1935); Necipoğlu-Kafadar, "Plans and Models," (note 3); Günsel Renda, "Wall Paintings in Turkish Houses," in *Fifth International Congress of Turkish Art*, ed. Géza Fehér (Budapest: Akadémiai Kiadó, 1978), 711–35; and Zeren Tanındı, "İslam Resminde Kutsal Kent ve Yöre Tasvirleri," *Journal of Turkish Studies/ Türklük Bilgisi Araştırmaları* 7 (1983): 407–37.

tions that separates Ottoman history from mainstream European and Islamic history, thus effectively relegating it to the backstage of the purportedly more central dramas of the medieval West and of the pre-Ottoman Islamic East. The examination of the cartographic record of premodern Ottoman history cannot, however, lead to valid conclusions if Ottoman maps are not studied within the wider context of European and Islamic cartography. Even the most cursory glance at the corpus of extant premodern Ottoman maps shows that the maps that make up this corpus are both European and Islamic in nature. Many of the Ottoman cartographic traditions of the sixteenth and seventeenth centuries grew directly out of the decisive Ottoman encounter with the Latin cultural areas of the Mediterranean during the fifteenth century, while some others were continuations of pre-Ottoman Islamic patterns of mapmaking. The historian of premodern Ottoman mapmaking, therefore, has to stride over rarely crossed boundaries in order to attempt a cross-cultural examination of traditional Ottoman and premodern European and Islamic cartography. The comparative effort required should not, however, lead to a search for survivals: Ottoman maps need to be studied not as derivations from other original cartographic traditions, but primarily as heterogeneous yet organic products of Ottoman culture in all its diversity.[6]

6. Necipoğlu-Kafadar, "Plans and Models" (note 3), is a model study that pays equal and thorough attention to the European and Islamic background of Ottoman architectural plans.

11 · Military, Administrative, and Scholarly Maps and Plans

AHMET T. KARAMUSTAFA

Ottoman geographical maps can profitably be classified into two broad categories: those drafted under state patronage for administrative use and those produced for private consumption. The presence of a colossal state apparatus that functioned as the single largest consumer of cultural goods in the empire shaped patterns of map production in decisive ways. It seems appropriate, therefore, first to review the corpus of administrative cartography before turning to cartography as private enterprise.

CARTOGRAPHY IN THE SERVICE OF THE STATE

The Ottoman state, which was one of the largest administrative institutions in world history, had a pragmatic foundation that left much room for practical applications of cartography. Many areas of Ottoman administrative practice where one could expect to find signs of map use, however, seem to have been innocent of the manifold uses of cartographic representation. Periodic cadastral surveys of the empire's vast territories, for example, were recorded in writing only, with no resort to drawings.[1] Similarly, court registers reveal no sign that maps and other pictorial aids were used in settling land disputes. On another front, the major routes of the state's sophisticated courier and posting-station network were registered in verbal itineraries only.[2] In the important spheres of military operation and state-run architectural construction, however, there is ample evidence that graphic representations of space were used for administrative purposes.

ORIGINS

Only a few Ottoman administrative map artifacts date from before the sixteenth century. These include two architectural plans, of an imperial mosque and a mausoleum,[3] and one siege plan, of the fortress of Kiev.[4] In spite of the dearth of surviving maps from this early period of Ottoman history, it is clear that the events of the second half of the fifteenth century in particular played a central role in the development of cartographic practice in the Ottoman Empire. The Ottoman takeover of Byzantine territories, completed with the capture of Trebizond in 865/1461, and the consolidation and continual expansion of the holdings of the new imperial state in the Balkans led to the intensification of cultural contacts between the Turkish-Islamic and Latin-Christian regions of the Mediterranean. Even a partial listing of the non-Ottoman maps preserved in the Topkapı Sarayı Müzesi in Istanbul, the empire's administrative center, would be sufficient to demonstrate that the Ottomans came into close contact with contemporary cartographic practices of the Latin cultural areas of the Mediterranean. The record of the Ottoman encounter with Latin cartography is, however, not restricted to the interesting but largely opaque testimony of such a list, since literary sources of the era contain more revealing reports on the subject.

Independent evidence concerning growing Ottoman awareness of the practical importance of maps centers on the person of Meḥmed II (r. 848–50/1444–46 and 855–86/1451–81). It is not known if he had recourse to military drawings in the siege of Constantinople, yet his appreciation for graphic representation must have been well known even outside Ottoman domains. Thus, when

1. For a general overview of these surveys, see Halil İnalcık, "Ottoman Methods of Conquest," *Studia Islamica* 2 (1954): 103–29, esp. 107–12; reprinted in Halil İnalcık, *The Ottoman Empire: Conquest, Organization and Economy; Collected Studies* (London: Variorum Reprints, 1978), and idem, *Hicrî 835 tarihli Sûret-i defter-i sancak-i Arvanid* (Ankara: Türk Tarih Kurumu, 1954), xi–xxxvi (Giriş [Introduction]).

2. Colin J. Heywood, "The Ottoman *Menzilhâne* and *Ulak* System in Rumeli in the Eighteenth Century," in *Social and Economic History of Turkey (1071–1920): Papers Presented to the "First International Congress on the Social and Economic History of Turkey," Hacettepe University, Ankara, July 11–13, 1977*, ed. Osman Okyar and Halil İnalcık (Ankara: Meteksan Limited Şirketi, 1980), 179–86, with further references on the topic.

3. Gülru Necipoğlu-Kafadar, "Plans and Models in 15th- and 16th-Century Ottoman Architectural Practice," *Journal of the Society of Architectural Historians* 45 (1986): 224–43, esp. 229–31.

4. Zigmunt Abrahamowicz, "Staraya turetskaya karta Ukrainy s planom vzryva Dneprovskikh porogov i ataki turetskogo flota na Kiev," in *Vostochnye istochniki po istorii narodov yugo-vostochnoy i tsentral'noy Evropy*, ed. Anna Stepanovna Tveritinova (Moscow: Akademiya Nauk SSSR, Institut Vostokovedeniya, 1969), 76–96 (French summary 96–97).

in A.D. 1461 the lord of Rimini, Sigismondo Pandolfo Malatesta (1417–68), decided, probably in an attempt to forge a political alliance with the "Turks," to dispatch his secretary and advisor Roberto Valturio to Istanbul with a magnificent manuscript of Valturio's own *De re militari* as a personal present to the sultan, he reportedly appended a carefully executed map of the Adriatic Sea to the principal gift. In the event, Valturio was intercepted by the Venetians and was returned to Rimini after being put on trial, though the manuscript and the map, presumably in other copies, evidently found their way to the Ottoman palace.[5]

Venetian misgivings concerning Malatesta's real intentions seem to have been well placed, since Meḥmed II is known to have taken a special interest, primarily for military purposes, in acquiring adequate and up-to-date information on the geography of the Italian peninsula in general and on Venice in particular. When the famous painter Gentile Bellini was in court residence in Iṣtanbul from 1479 to 1481, Meḥmed II reportedly asked him to prepare a map of Venice.[6] There is, in fact, a fifteenth-century map of the Venetian territory of the *Terraferma* in Istanbul, though the intriguing possibility that this map could be the work of Bellini has not yet been explored.[7]

The geographical interests of Meḥmed the Conqueror of Istanbul were by no means restricted to the Italian peninsula. In the summer of 869–70/1465 he had the chance to examine a manuscript copy of Ptolemy's *Geography*,[8] and he ordered George Amirutzes of Trebizond to combine all the regional maps in this work into a single world map. Amirutzes' map, which is not extant today, must have been impressive, since Meḥmed II rewarded him handsomely after reviewing the world map and encouraged him and his sons to prepare an Arabic translation of the *Geography* itself. This latter task was apparently completed during Meḥmed II's lifetime, and two different but related copies of this Arabic translation are today preserved in the Süleymaniye Kütüphanesi in Istanbul.[9] Meḥmed II's interest in Ptolemy's *Geography* was apparently well known in Italy, so that Francesco Berlinghieri thought it appropriate to send a printed copy of his terzarima translation of the work to the Ottoman court with a personal dedication in late 1480.[10]

The significance of Meḥmed II's personal interest in cartography should not be overrated. His active patronage of mapmakers certainly did not lead to the formation of identifiable traditions of Ottoman cartography, and the impact of his activities on Ottoman mapmaking seems to have been minimal. His example, however, is symptomatic of larger cultural transformations that accompanied the formation of a major world empire in a border region between Christian Europe and Islamic world and thus points to the symbiotic roots of Ottoman cartographic practice.

MILITARY MAPS

The decisive Ottoman penetration into the Latin cultural areas of the Mediterranean during the reign of Meḥmed II in the second half of the fifteenth century led to the development of a tradition of cartographic reconnaissance in the Ottoman army. This was to last up until the introduction of western European military cartography into the empire in the eighteenth and early nineteenth centuries. The corpus of surviving maps from this tradition is neither large nor homogeneous, yet its temporal range and geographic spread certainly attest to a high level of cartographic literacy in the military arm of Ottoman administration.

The two earliest extant Ottoman military maps, a pictorial sketch of the area around Kiev in Ukraine (fig. 11.1) and an elaborate siege plan of Belgrade in Yugoslavia (plate 14), date back to the turn of the sixteenth century. The former, a diagrammatic plan that was drawn without regard to scale, shows in pictorial elevation the fortresses and villages around the lower courses of the rivers Dnieper and Dniester. From the inscription near the bottom right corner, it appears that the draftsman, who identifies himself as "Ilyās of Morea the Reconnoiterer" (*kulaguz*

5. Franz Babinger, "An Italian Map of the Balkans, Presumably Owned by Mehmed II, the Conqueror (1452–53)," *Imago Mundi* 8 (1951): 8–15, and idem, *Mehmed the Conqueror and His Time*, trans. Ralph Manheim and ed. William C. Hickman (Princeton: Princeton University Press, 1978), 201, where it is stated that "Giovanni di Pedrino of Forlì, a contemporary chronicler, reports that the supposed map of the Adriatic actually covered all Italy and indicated every detail that might be of interest to the sultan" (reference not given, though to judge by his article in *Imago Mundi* (p. 12 n. 7), Babinger is relying for this point on A. Campana, "Una ignota opera de Matteo de' Pasti e la sua missione in Turchia," *Ariminum* (Rimini, 1928), 107.

6. Babinger, "Italian Map of the Balkans," 12 (note 5), where more information is given to illustrate Meḥmed II's interest in Italy.

7. Topkapı Sarayı Müzesi Kütüphanesi, H. 1828–29; see Rodolfo Gallo, "A Fifteenth Century Military Map of the Venetian Territory of *Terraferma*," *Imago Mundi* 12 (1955): 55–57.

8. There are two Greek and one Latin manuscript copies of the *Geography* in the Topkapı Sarayı Müzesi Kütüphanesi today; Gustav Adolf Deissmann, *Forschungen und Funde im Serai, mit einem Verzeichnis der nichtislamischen Handschriften im Topkapu Serai zu Istanbul* (Berlin: Walter de Gruyter, 1933), 68–69 (no. 27), 80–82 (no. 44), and 89–93 (no. 57).

9. Süleymaniye Kütüphanesi, Ayasofya 2596 and 2610. Neither copy is dated. Ayasofya 2610, which alone contains maps (twenty-six double-page and twenty-four single-page, all in color), was published in 1929 by Youssouf Kamal in one hundred copies as an addition to his *Monumenta cartographica Africae et Aegypti*, 5 vols. in 16 pts. (Cairo: 1926–51). A reprint of this has recently been issued: *Klaudios Ptolemaios Geography: Arabic Translation (1465 A.D.)*, ed. Fuat Sezgin (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987). The story of the translation is given in Babinger, *Mehmed the Conqueror*, 247 (note 5) and Abdülhak Adnan Adıvar, *Osmanlı Türklerinde İlim*, 2d ed. (Istanbul: Maarif, 1943), 20–22.

10. Babinger, *Mehmed the Conqueror*, 506 (note 5) and Adnan Adıvar, *Osmanlı Türklerinde İlim*, 22 (note 9).

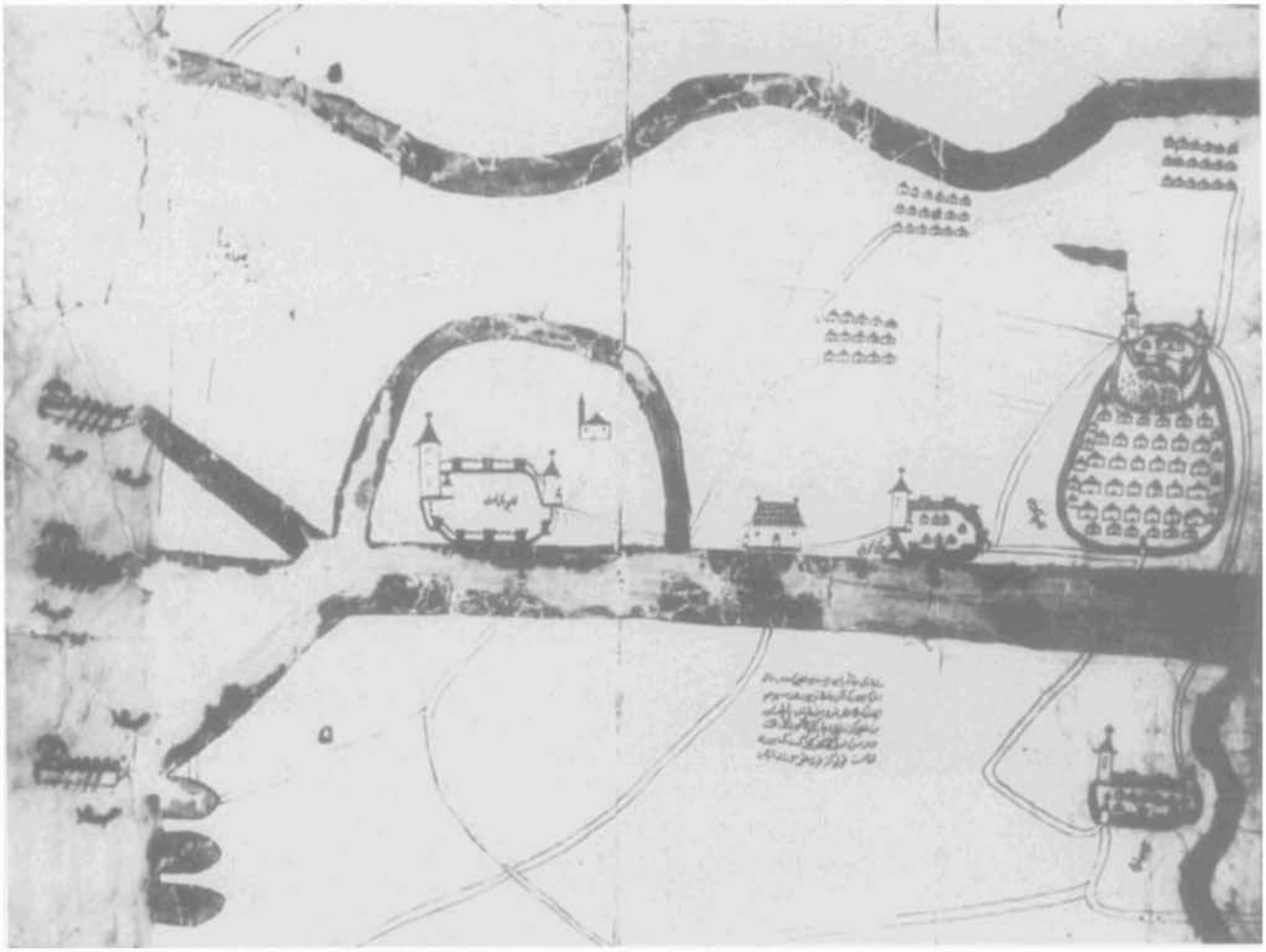


FIG. 11.1. PLAN OF KIEV AND SURROUNDINGS, CA. 1495–1506. This photograph is from a copy of the map made by Ibrahim Kemal Baybora in June 1976. The original, held at the same archive, is too fragile to be photographed.
Size of the original: 44.5 × 58.5 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 12090/1).

Morali Ilyās), made the map to bring to the sultan's attention his unspecified scheme to capture the fortress of Kiev through the use of the Ottoman navy. Its present location in the Topkapı Sarayı Müzesi in Istanbul suggests that the map did in fact reach the sultan, most probably Bāyezīd II (r. 886–918/1481–1512), though it is clear that the plan of Ilyās the Reconnoiterer itself was not implemented, since Kiev was never captured by the Ottomans.[11]

It is possible that the much more elaborate siege plan of Belgrade was prepared for and actually used in the successful Ottoman siege of the town in 927/1521 under Süleymān I (r. 926–74/1520–66).[12] Produced in color with clear attention to detail, the map is a bird's-eye view of Belgrade at the confluence of the rivers Sava and Danube as well as the nearby fortresses of Avala and Zemun. It carries thirty-four separate inscriptions that serve to identify places and to present alternative strategies for the siege of the fortress. Although the draftsman is not named in the inscriptions, they strongly give the impression that they were written by the same person who was responsible for the drafting, most likely a military reconnoiterer in Ottoman service. It is noteworthy that the primarily military nature of his objectives did not dampen the artistic ardor of the draftsman. The use—one suspects

11. Abrahamowicz, "Staraya turetskaya karta" (note 4). Abrahamowicz dates the map of Kiev and its surroundings, which does not carry a date, to between 1495 and 1506 on internal and external evidence. The text of the inscription in Ottoman Turkish is given on p. 84. An earlier reproduction of this plan appeared under the caption "MS. Turkish map of the Azov(?) Region" in Harald Köhlin, "Some Remarks on Maps of the Crimea and the Sea of Azov," *Imago Mundi* 15 (1960): 84–88, esp. fig. 6.

12. Fevzi Kurtoğlu, *Türk süel alanında harita ve krokilere verilen değer ve Ali Macar Reis Atlası* (Istanbul: Sebat, 1935), 5–9, argues that the siege plan of Belgrade most likely dates from the reign of Bāyezīd II.

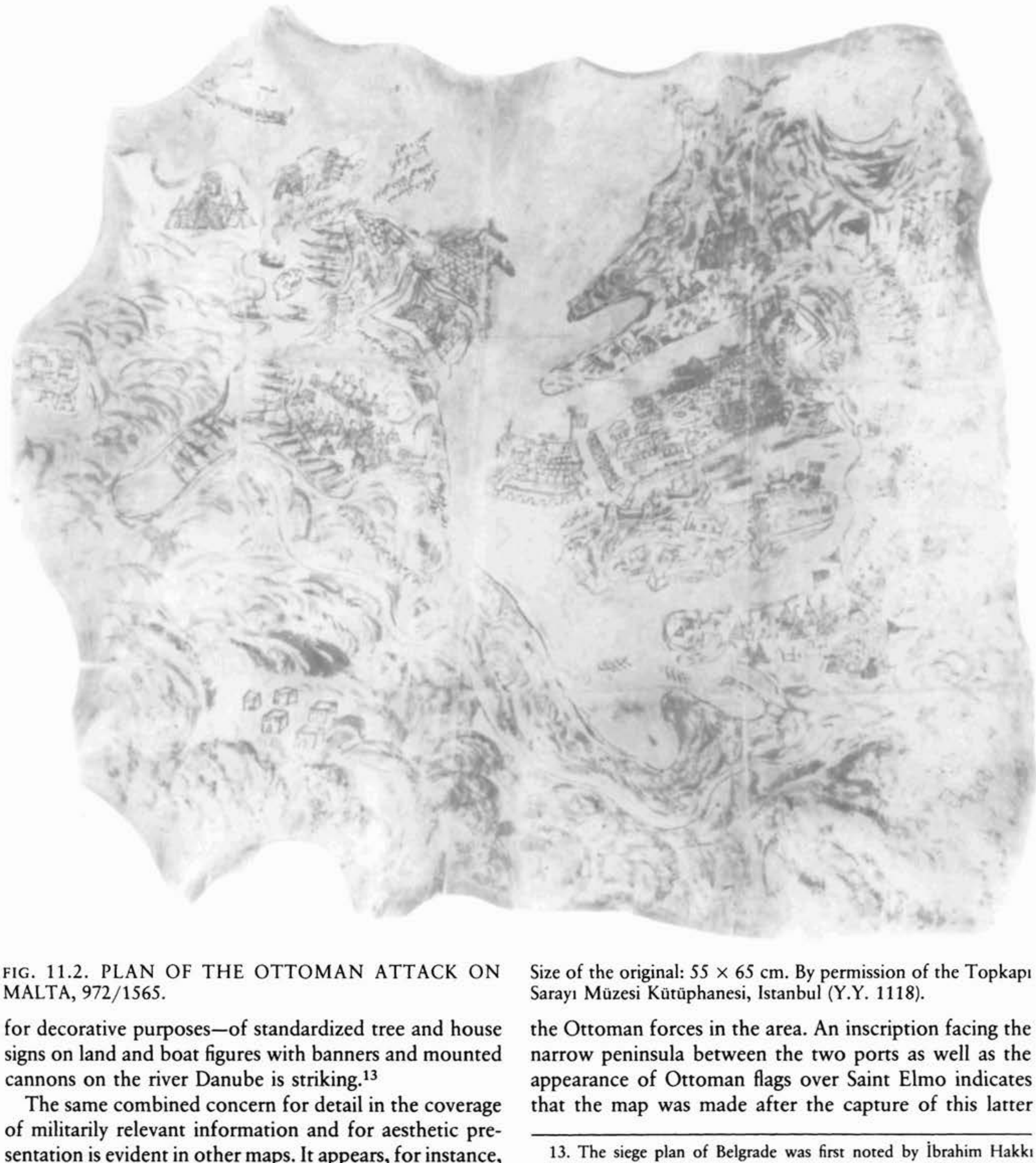


FIG. 11.2. PLAN OF THE OTTOMAN ATTACK ON MALTA, 972/1565. Size of the original: 55 × 65 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (Y.Y. 1118).

for decorative purposes—of standardized tree and house signs on land and boat figures with banners and mounted cannons on the river Danube is striking.[13]

The same combined concern for detail in the coverage of militarily relevant information and for aesthetic presentation is evident in other maps. It appears, for instance, both in the map relating to the unsuccessful Ottoman attempt to capture the ports and major fortresses of Malta from the Knights of Saint John in 972/1565 (fig. 11.2) and in the siege plan of Szigetvár in Hungary that dates back to 974/1566, when the town fell to the Ottoman army following a short siege (fig. 11.3). The former depicts the two major ports of Malta and the castles of Saint Elmo, Saint Angelo, and Saint Michael that were situated around these ports and shows the positioning of the Ottoman forces in the area. An inscription facing the narrow peninsula between the two ports as well as the appearance of Ottoman flags over Saint Elmo indicates that the map was made after the capture of this latter

13. The siege plan of Belgrade was first noted by İbrahim Hakkı Konyalı, *Topkapı Sarayında Deri üzerine Yapılmış Eski Haritalar* (Istanbul: Zaman Kitaphanesi, 1936), 132–33 n. 2. Subsequent discussions and references include Kurtoğlu, *Türk süel alanında*, 5–9, with three line drawings (note 12); Fevzi Kurtoğlu, "Hadım Süleyman Paşanın mektupları ve Belgradın muhasara pilânı," *Belleten* (Türk Tarih Kurumu) 4 (1940): 53–87, esp. 56–59, with a black-and-white reproduction (fig. II); Cavid Baysun, "Belgrad," in *İslâm ansiklopedisi*, 13 vols. (Istanbul: Millî Eğitim, 1940–88), 2:475–85, esp. 476–77; and Babinger, *Mehmed the Conqueror*, pl. XIV (note 5), who interprets the map as "a little-known rendering . . . of Mehmed [II]'s unsuccessful attempt to take the city."

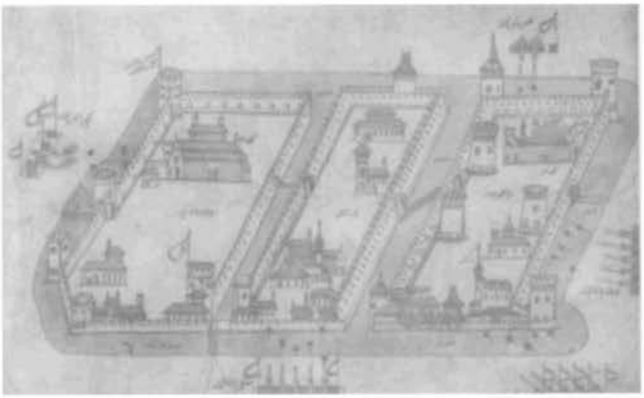


FIG. 11.3. SIEGE PLAN OF SZIGETVAR, CA. 974/1566.
Size of the original: 25 × 40 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 12356).

FIG. 11.4. SIEGE PLAN OF VIENNA, CA. 1094/1683.
Size of the original: 85.5 × 89.5 cm. By permission of the Museen der Stadt Wien (I. N. 52.816/1).

castle by the Ottomans in June 1565. The plan itself was apparently prepared as part of a general report on the ongoing siege of Malta that was sent to Sultan Süleymān I in Istanbul by the commander of the Ottoman forces that carried out the attack. It thus testifies both to the presence of mapmakers in Ottoman military campaigns and to the routine inclusion of graphic representation in Ottoman military communication.[14]

To judge by the tone of its inscriptions, the siege plan of Szigetvár could also have been produced in the field during the Ottoman attack on the fortress in 974/1566, though it is not possible to verify this point since the map does not carry a date. The plan is relatively free of ornamental features, and the draftsman apparently focused on depicting the major architectural features of the three castles that made up the Szigetvár stronghold, to the exclusion of other less essential material.[15] Compare this plan with figures 12.16 to 12.18, which appear in Ottoman imperial chronicles.

Further specimens of traditional Ottoman military cartography include a plan of the second siege of Vienna in 1094/1683 (fig. 11.4),[16] a plan of the fortress of Van in eastern Asia Minor (fig. 11.5),[17] a diagram of the Battle of the Prut from 1123/1711 (plate 15),[18] and a siege plan of the fortress on Adakale, the little island in the straits of Orsova on the Danube, from 1151/1738 (fig. 11.6).[19] All together, these plans and diagrams demonstrate that, though not institutionalized in the form of a separate corps of draftsmen, practical cartography was not unknown in the higher levels of the Ottoman military establishment even before Ottomans started to absorb contemporary military cartographic practice from Europe, especially during the eighteenth century.[20]

The adoption of European cartographic practice in the military sphere was to all indications a slow and uneven process that began toward the end of the seventeenth century and ended in the demise of traditional Ottoman military cartography about two centuries later, at the end of the nineteenth century. In the intervening transitional period, traditional Ottoman and contemporary European practice existed side by side. The first Ottoman military map artifacts drafted in accordance with contemporary European cartographic practice are a plan of the fortress

14. Tahsin Şükrü [Saraçoğlu], "Bir harp plânı," *Türk Tarih, Arkeologya ve Etnografya Dergisi* 2 (1934): 255–57, and Kurtoğlu, *Türk süel alanında*, 9–16, with a reproduction (note 12).

15. Kurtoğlu, *Türk süel alanında*, 17–18, with a line drawing (note 12).

16. Richard F. Kreutel, "Ein zeitgenössischer türkischer Plan zur zweiten Belagerung Wiens," *Wiener Zeitschrift für die Kunde des Morgenlandes* 52 (1953/55): 212–28.

17. Jean Louis Bacqué-Grammont, "Un plan Ottoman inédit de Van au XVII^{e} siècle," *Osmanlı Araştırmaları Dergisi/Journal of Ottoman Studies* 2 (1981): 97–122.

18. Akdes Nimet Kurat, "Hazine-i Bîrun kâtibi Ahmed bin Mahmud'un (1123–1711—Prut) seferine ait 'Defteri,' " *Tarih Araştırmaları Dergisi* 4 (1966): 261–426.

19. Kurtoğlu, *Türk süel alanında*, 30–33 (note 12).

20. Other known traditional siege and battle plans not discussed here include the following:

i. Plan of the Battle of Haçova/Mezőkeresztes, 1005/1596, Topkapı Sarayı Müzesi Arşivi, Istanbul, E. 5539. This is reproduced in İsmail Hakkı Uzunçarşılı, *Osmanlı Tarihi*, vol. 3, pt. 1, *II. Selim'in Tahta Çıkışından 1699 Karlofça Andlaşmasına Kadar*, Türk Tarih Kurumu Yayınları, ser. 13, no. 16^{c1b} (Ankara: Türk Tarih Kurumu, 1983) (Reprint 3), pl. XVII at the end.

ii. Plan, in color, of a naval encounter between the Ottoman and Russian fleets, possibly from the second half of the seventeenth century, Topkapı Sarayı Müzesi Arşivi, Istanbul, E. 9401.

iii. Plan of the fortress of "Zādvārya" in Makarska, not dated, Topkapı Sarayı Müzesi Arşivi, Istanbul, E. 9495/3.

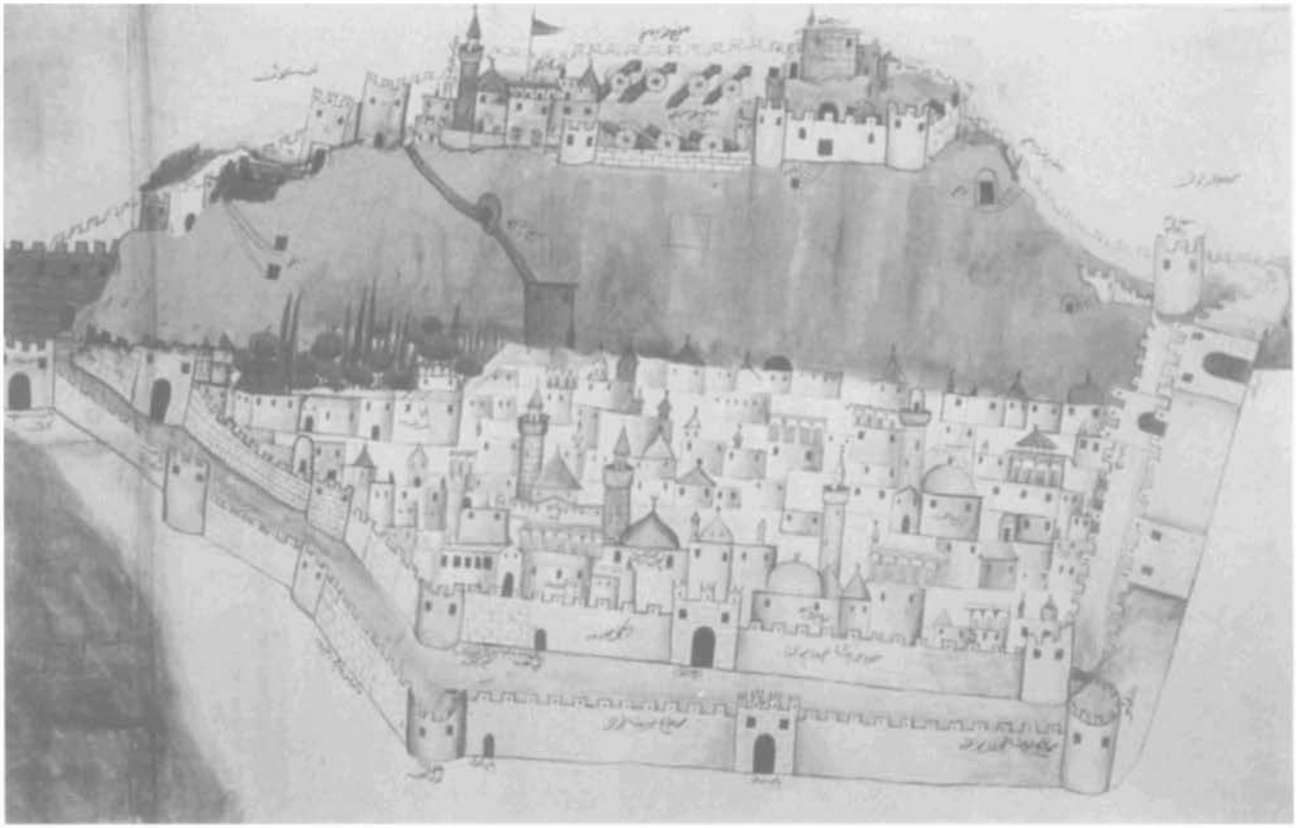


FIG. 11.5. PLAN OF THE FORTRESS OF VAN. Size of the original: 50 × 83 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 9487).

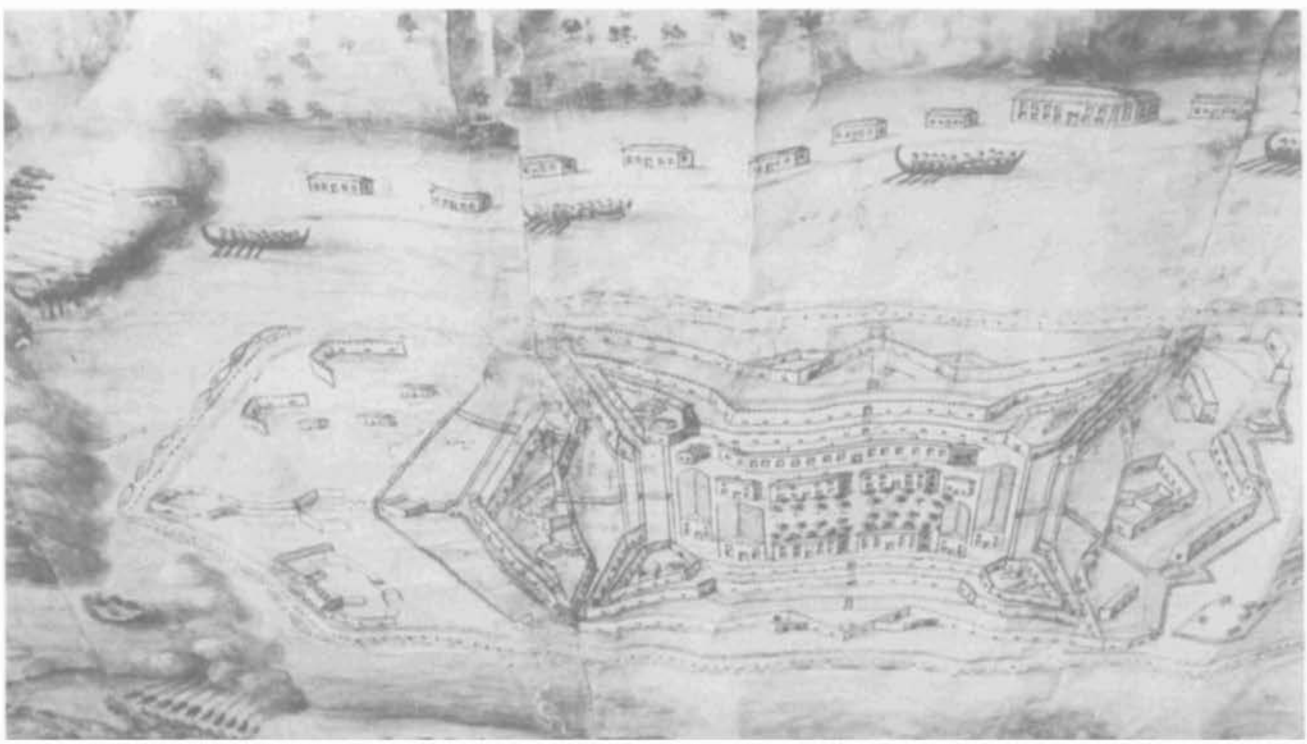


FIG. 11.6. DETAIL FROM THE SIEGE PLAN OF THE FORTRESS OF ADAKALE, 1151/1738. Size of the scroll: 123 × 250 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 9439).

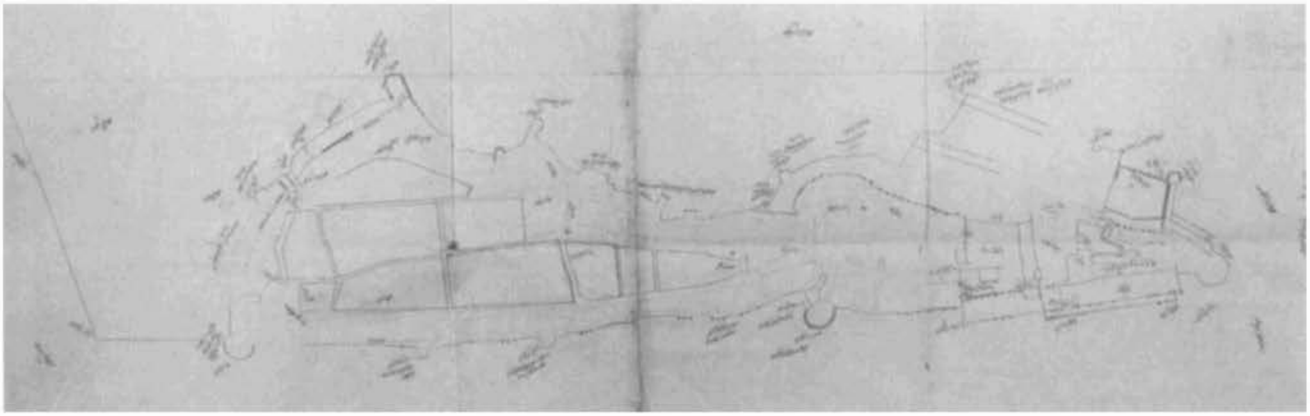


FIG. 11.7. PLAN OF THE FORTRESS OF BUDA, CA. 1095–96/1684. Size of the original: 75 × 100 cm. By permission of the Biblioteca Universitaria di Bologna (MS. Marsili 8).

of Buda made shortly after 1095–96/1684 (fig. 11.7)[21] and a plan of the Battle of the Prut from 1123/1711 (fig. 11.8).[22] These are followed by an increasing number of similar military maps in subsequent decades, so that it becomes possible to trace many different maps of a single, identifiable draftsman like Ressām Muṣṭafā (fig. 11.9) in the second half of the eighteenth century.[23] This early phase of the adaptation of European cartographic practice by the Ottoman military, hitherto not researched, is in need of close scrutiny.

ARCHITECTURAL PLANS AND WATERWAY MAPS

The Ottoman state employed a centrally directed group of royal architects (*ḫaṣṣa miʿmarları*) to administer and execute state-sponsored architectural projects. The exact nature of the way abstract architectural ideas were formulated and disseminated among this corps of royal architects is only imperfectly understood, since the great majority of the graphic aids that were used for these purposes seem to have perished. Close examination of the few surviving architectural plans suggests, however, that on-site "construction supervisors received only grid-based ground plans and sketchy elevations with some basic written measurements" from the office of the chief royal architect (*miʿmarbaşı*) in Istanbul (figs. 11.10 and 11.11).[24] The supervisor then transferred this ground plan onto the previously flattened construction site before the actual foundation was laid. He was not, however, given detailed graphic instructions on the building's elevation and had to rely in computing height on "traditional formulae deriving from proportions inherent in the geometric ground plans with modular grids."[25]

In his preference for a two-dimensional system of graphic representation, the Ottoman architect-draftsman was on essentially the same ground as his military counterpart in the Ottoman army. Indeed, a distinct set of waterway maps produced mostly by royal architects provide decisive evidence that when the occasion arose the latter readily fell back on pictorial representation.

The construction and maintenance of the major water-supply systems of Istanbul, in particular those of the palace and several prominent pious foundations, was the responsibility of the inspector of waterways (*suyolu nāẓırı*). He was an architect by profession, and indeed, the office of the chief royal architect was normally filled by previous waterway inspectors.[26] It appears that either for his own personal use or for reporting to higher authorities, the inspector of waterways drafted topographical diagrams of the different water supply systems under his supervision. These usually took the form of long rolls on which were traced the major aqueducts from their origins near the springs well outside the city

21. Oktay Aslanapa, "Macaristan'da Türk Âbideleri," *Tarih Dergisi* 1 (1949–50): 325–45, esp. 335 and fig. 27 at the end, who reproduces the plan from Fekete Lajos, *Budapest a törökkorban*, Budapest Törtenete 3 (Budapest, 1944). This last work was not available to me. See also Fekete Lajos and Nagy Lajos, *Budapest törtenete a török korban* (Budapest: Akadémiai Kiadó, 1986), figs. 199–200.

22. Akdes Nimet Kurat, *Prut Seferi ve Barışı, 1123 (1711)*, 2 vols. (Ankara: Türk Tarih Kurumu, 1951–53), 1:35, suggests that this plan is a translation from a French original.

23. Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Türkçe Yazmalar Kataloğu*, 2 vols. (Istanbul: Topkapı Sarayı Müzesi, 1961), 1:475–77 (nos. 1447–58), are mostly the works of Muṣṭafā; English translation: E. H. van de Waal, "Manuscript Maps in the Topkapĭ Saray Library, Istanbul," *Imago Mundi* 23 (1969): 81–95.

24. Necipoğlu-Kafadar, "Plans and Models," 242 (note 3). The plans that are reproduced here as figures 11.10 and 11.11 are discussed in detail in the article, 228–29 and 225–26, respectively.

25. Necipoğlu-Kafadar, "Plans and Models," 242 (note 3).

26. Cengiz Orhonlu, "XVI. Yüzyılda Osmanlı İmparatorluğunda Şuyolcu kuruluşu," in Cengiz Orhonlu, *Osmanlı İmparatorluğunda Şehircilik ve Ulaşım Üzerine Araştırmalar*, ed. Salih Özbaran, Ege Üniversitesi Edebiyat Fakültesi Yayınları, no. 31 (Izmir: Ticaret Matbaacılık, 1984), 78–82.

FIG. 11.8. PLAN OF THE BATTLE OF THE PRUT, 1123/1711. Size of the original: 39.5 × 46.7 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 1551/1).

through central cisterns and distributive centers to their final destinations within the city walls. All relevant constructions such as feeders, collection areas, weirs, water towers, underground tunnels, and bridges, as well as some other architectural or natural features en route, were also shown in pictorial elevation.

Several waterway maps survive in Istanbul archives. The two clear examples of royal waterway cartography among these are the 1161/1748 map of the Kırkçeşme and Halkalı water supply network (fig. 11.12) and the 1016/1607 map of the same network by the inspector of waterways Ḥasan (fig. 11.13 and plate 16). The former is a bird's-eye view with some concern for ornamentation, while the latter is really nothing more than a graphic itinerary. Other examples of waterway maps vacillate between these two extremes (appendix 11.1).[27] Significantly, all architectural structures that appear on these maps are either pictorial representations or conventional symbols, with no trace of scientific proportion or perspective drawing.

CARTOGRAPHY AS PRIVATE ENTERPRISE

Outside the bounds of the state, terrestrial cartography seems to have been cultivated in Ottoman culture pri-

27. In addition to the maps listed in appendix 11.1, there seem to be some waterway maps contained in manuscript codices; one such double-page representation is noted in Vladimir Minorsky, *The Chester Beatty Library: A Catalogue of the Turkish Manuscripts and Miniatures* (Dublin: Hodges Figgis, 1958), 21 ("Panorama of the System of Aqueducts of Belgrad, near the Golden Horn in Constantinople," MS. Turkish 413, fols. 22b–23a).

There is a sizable body of literature on water-supply systems of Istanbul. Other than the studies listed in Wolfgang Müller-Wiener, *Bildlexikon zur Topographie Istanbuls: Byzantion-Konstantinupolis-Istanbul bis zum Beginn des 17. Jahrhunderts* (Tübingen: Ernst Wasmuth, 1977), 517, see the following works of Kazım Çeçen: *İstanbul'da Osmanlı Devrindeki Su Tesisleri*, İstanbul Teknik Üniversitesi Bilim ve Teknoloji Tarihi Araştırma Merkezi, no. 1 (Istanbul, 1984); *Süleymaniye Suyolları*, İstanbul Teknik Üniversitesi Bilim ve Teknoloji Tarihi Araştırma Merkezi, no. 2 (Istanbul, 1986); *Mimar Sinan ve Kırkçeşme Tesisleri* (Istanbul, 1988).

FIG. 11.9. MAP OF RUSSIAN ARMY MANEUVERS ALONG OTTOMAN BORDERS WITH POLAND, MOLDAVIA, AND HUNGARY, 1768–69. This map is not dated, nor does it contain the name of the draftsman. However, a larger copy (69.5 × 64.5 cm) on silk of the same map is preserved in the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (A. 3625), which is clearly dated to 1768–69 and signed by Ressām Muṣṭafā.
Size of the original: 32.5 × 35 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 1551/2).

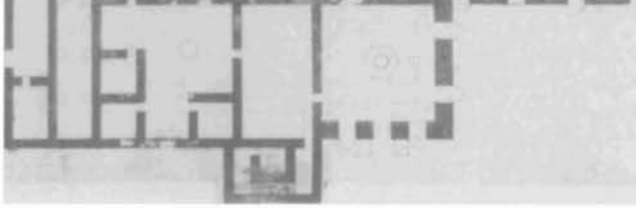


FIG. 11.10. PLAN OF A DOUBLE BATH, FIFTEENTH CENTURY. Executed in black and red ink, this plan can be dated to the second half of the fifteenth century based on watermark analysis.
Size of the original: 39.5 × 55.8 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 9495/7).

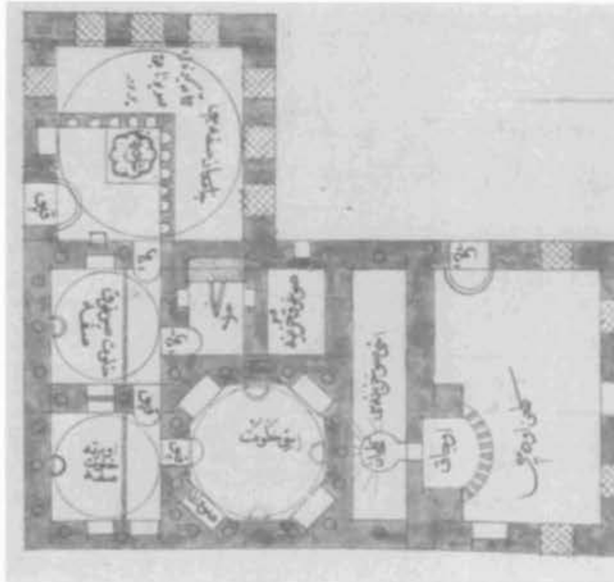


FIG. 11.11. PLAN OF A TURKISH BATH. This black-and-red-ink plan appears in a picture album compiled about 1584–86.
Size of the image: 20 × 22.5 cm. By permission of the Bild-Archiv der Österreichischen Nationalbibliothek, Vienna (Cod. 8615, fol. 151a).

marily in an academic environment. The textual presentation of geographical and historical knowledge by individual scholars in the form of manuscript codices provided the main forum for producing and disseminating terrestrial maps. Apart from a few free-standing large-scale regional maps that are not engulfed in textual environments, the only other exceptions to this rule of textual context are numerous pictorial representations of the Kaʿba and of other sacred sites in and around the holy cities of Mecca and Medina (which, however, are also to be found in books), as well as various maps that appear as wall paintings in houses.[28]

The terrestrial maps that appear in Ottoman geographical texts reflect the scholarly orientation of their producers. Leaving aside marine geography and navigation as well as travel description,[29] the development of Otto-

28. Ottoman city views and itinerary maps are discussed in chapter 12. On Kaʿba representations, see Zeren Tanındı, "İslam Resminde Kutsal Kent ve Yöre Tasvirleri," *Journal of Turkish Studies/Türklük Bilgisi Araştırmaları* 7 (1983): 407–37, and Richard Ettinghausen, "Die bildliche Darstellung der Kaʿba im Islamischen Kulturkreis," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 87 (1934): 111–37. Wall paintings are studied by Günsel Renda, "Wall Paintings in Turkish Houses," in *Fifth International Congress of Turkish Art*, ed. Géza Fehér (Budapest: Akadémiai Kiadó, 1978), 711–35; to Renda's discussion should be added two panoramas (of Aleppo and Istanbul) that are reproduced from the palace of the al-ʿAzm family in Hama by John Carswell, "From the Tulip to the Rose," in *Studies in Eighteenth Century Islamic History*, ed. Thomas Naff and Roger Owen (Carbondale: Southern Illinois University Press, 1977), 328–55 and 404–5, esp. 339–40 (pls. 10 and 11).

29. Ottoman maritime cartography is discussed in chapter 14.

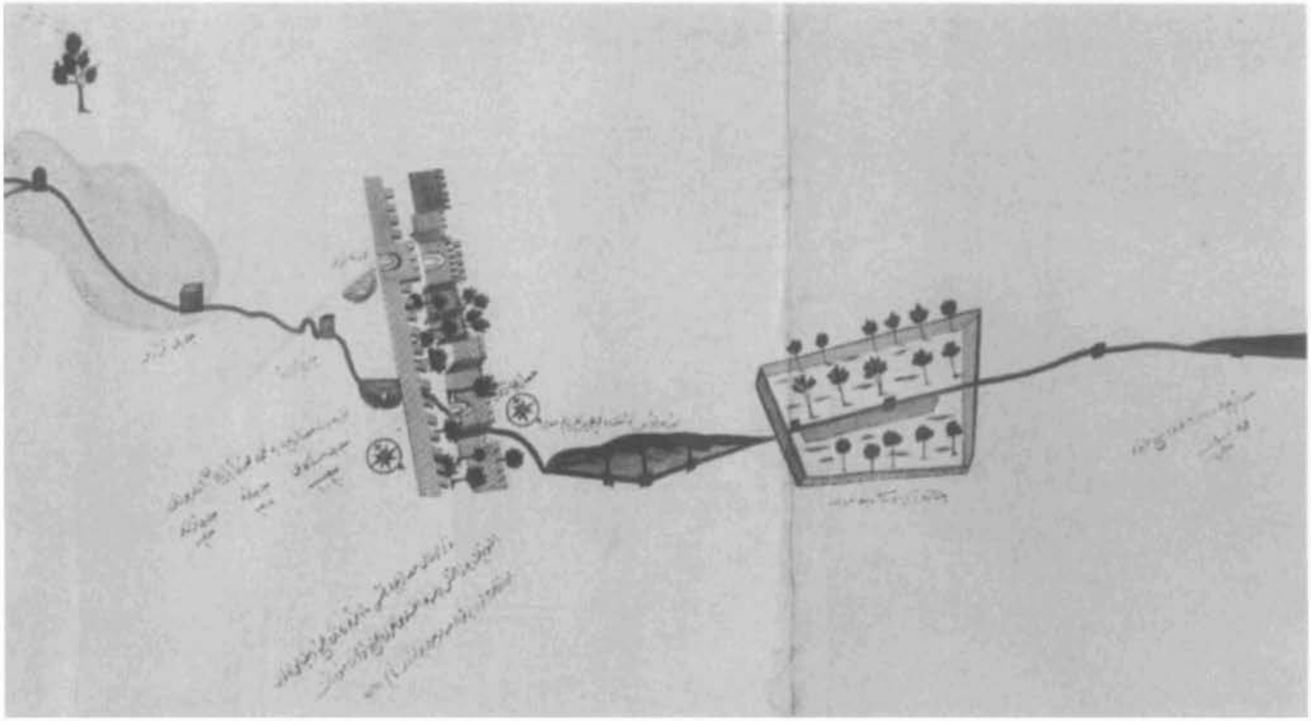


FIG. 11.12. DETAIL FROM THE MAP OF THE KIRKÇEŞME AND HALKALI WATER-SUPPLY SYSTEM (1161/1748). Size of the original: 75 × 1,098 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1815).

man geographical literature can be divided into two broad phases. During the first phase, from mid-fifteenth century to the mid-seventeenth, Ottoman scholars largely devoted their energies to adapting previous Islamic geographical knowledge to Ottoman realities by translating into Ottoman Turkish, synthesizing, and updating classical manuals in Arabic and, to a lesser degree, in Persian. In the second phase, from the mid-seventeenth century onward, their attention turned increasingly to the West, and translations from European languages gradually became the norm.[30] The watershed in the Europeanization of Ottoman geographical literature came with the translation of Gerardus Mercator's *Atlas Minor* into Turkish by the well-known scholar Muṣṭafā ibn ʿAbdallāh Kātib Çelebi in 1064–65/1653–55 with the assistance of Meḥmed Iḫlāṣ, a French convert to Islam.[31] This was followed by the translation of Joan Blaeu's *Atlas Maior* by Ebū Bekr ibn Behrām el-Dimāşķī in 1086–96/1675–85.[32] These translations mark the entry of the European terrestrial atlas into Ottoman culture. There ensued a period of transition in which the Ottomans adopted Western geographical science and cartographic practice, a long process that can be said to have reached a higher level only during the nineteenth century. The only other point in this process that should be mentioned here is the introduction of printing, and hence of printed maps, into Ottoman society in the third decade of the eighteenth century. The person responsible for this significant event, Ibrāhīm Müteferriḳa (d. 1157/1745), took particular interest in geography, and besides a set of four maps that he printed, also left behind a manuscript map of the Ottoman Empire (fig. 11.18 below).[33]

30. Ottoman geographical literature is reviewed in Franz Taeschner, "Djughrāfiyā: The Ottoman Geographers," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 2:587–90, and idem, "Die geographische Literatur der Osmanen," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 77 (1923): 31–80. The only available guide to primary sources is Cevdet Türkay, *İstanbul Kütüphanelerinde Osmanlı'lar Devrine Aid Türkçe—Arabça—Farsça Yazma ve Basma Coğrafya Eserleri Bibliyoğrafyası* (Istanbul: Maarif, 1958).

31. The translation, based on the 1621 Arnheim edition of Mercator's work, was titled *Levāmiʿü'n-nūr fī ẓulmeti atlas minūr* (Rays of light in the darkness of Atlas Minor). The autograph copy of this work is preserved in the Nuruosmaniye Kütüphanesi, Istanbul, MS. 2998.

32. El-Dimāşķī called his translation *Nuṣretü'l-islām ve's-sürūr fī taḳrīri* [or *taḥrīri*] *Atlas mayūr* (The triumph of Islam and joy in the writing of Atlas Maior). Many versions, some abridged, are housed in Istanbul libraries; a complete set is available at the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, B. 1634.

33. Niyazi Berkes, "İbrāhīm Müteferriḳa," *Encyclopaedia of Islam*, new ed., 3:996–98 and Ulla Ehrensvärd with contributions by Zygmunt Abrahamowitz, "Two Maps Printed by Ibrahim Müteferrika in 1724/25 and 1729/30," *Svenska Forskningsinstitutet i Istanbul Meddelanden* 15 (1990): 46–66. A convenient list of the maps Müteferriḳa printed appears in Osman Ersoy, *Türkiye'ye Matbaanın Girişi ve İlk Basılan Eserler* (Ankara: Güven, 1959), 37. William J. Watson, "İbrāhīm Müteferriḳa and Turkish Incunabula," *Journal of the American Oriental Society* 88 (1968): 435–41, does not list printed maps.

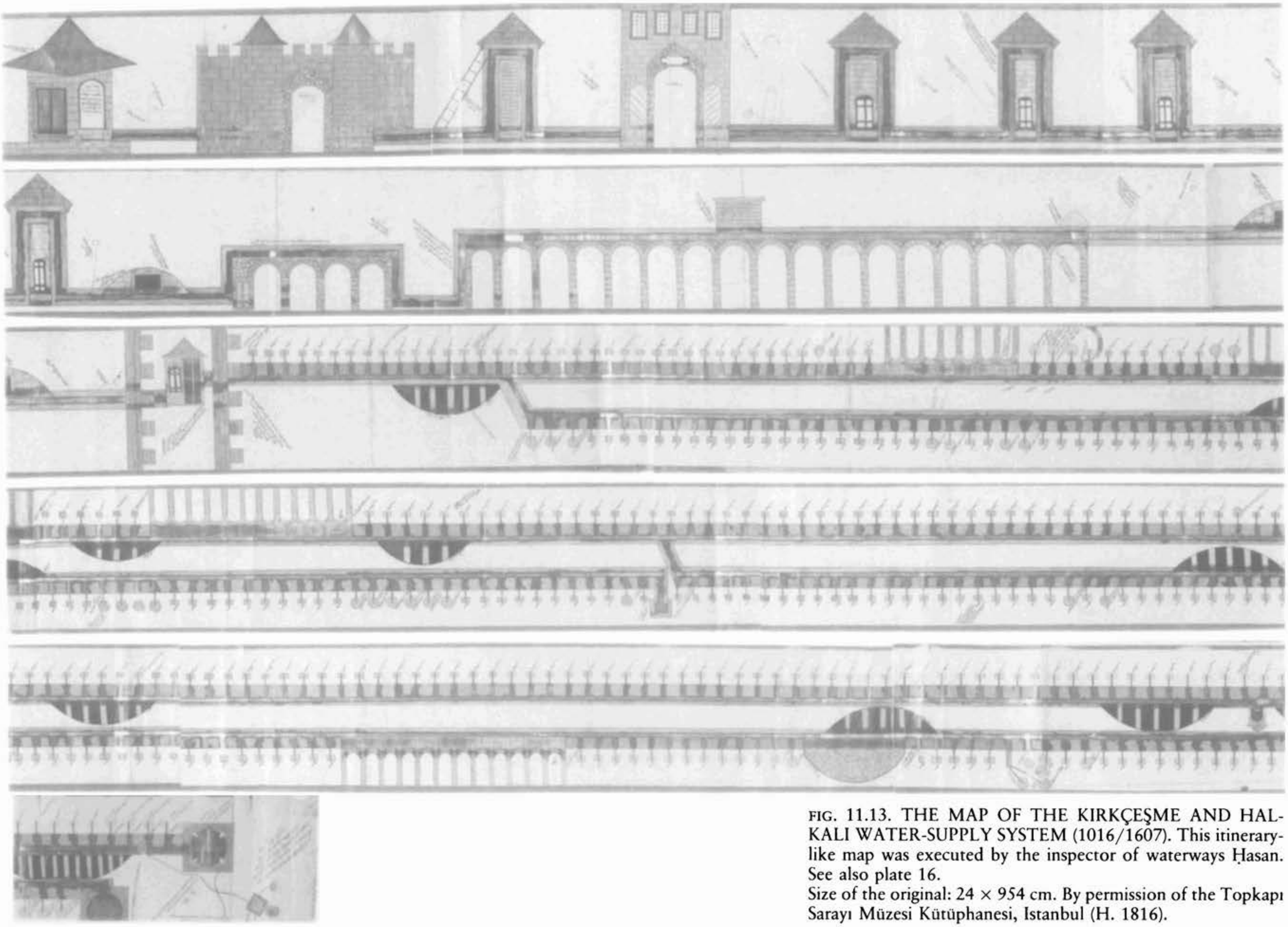


FIG. 11.13. THE MAP OF THE KIRKÇEŞME AND HALKALI WATER-SUPPLY SYSTEM (1016/1607). This itinerary-like map was executed by the inspector of waterways Ḥasan. See also plate 16.
Size of the original: 24 × 954 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1816).

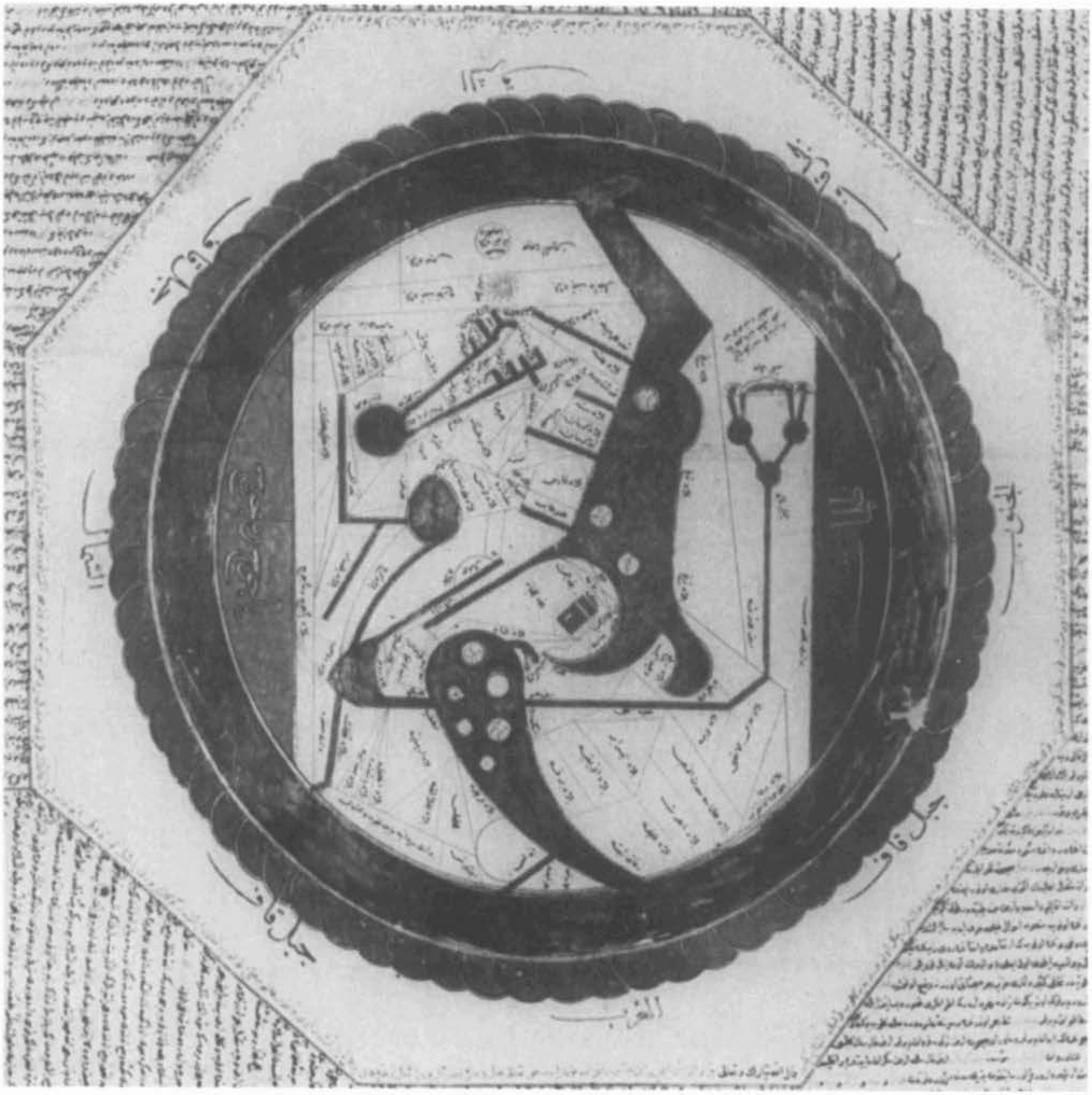


FIG. 11.14. AN OTTOMAN VERSION OF THE WORLD MAP OF IBN AL-WARDĪ. This map is contained in a genealogical scroll titled *Zübdetü't-tevārīḫ* (Cream of histories) by Seyyid Loḳmān ibn Hüseyin ibn el-ʿAşūri el-Urmevi. The scroll was started during the reign of Süleymān I (926–74/1520–66) and was taken over by Loḳmān in 977/1569 when he officially became the court historiographer. The map is in the first part of the roll; the author who started the roll is not known. The work is also called the *Silsilename* (Book of genealogy), and there are at least three manuscripts produced between 1583 and 1588 (for other works of cartographic interest by Loḳmān, see chapter 12).
Size of the original: not known. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (A. 3599).

FIG. 11.15. WORLD MAP FROM LOḲMĀN'S *ZÜBDETÜ'T-TEVĀRĪḪ*, CA. 1003/1595. From a manuscript of the same work as fig. 11.14. The name of the draftsman is given as Şunʿī. Size of the original: 39.5 × 25 cm. Reproduced courtesy of the Trustees of the Chester Beatty Library, Dublin (MS. Turkish 414, fol. 34a).

WORLD MAPS

Terrestrial maps contained in geographical and historical works that derive from earlier Islamic texts are invariably world maps. Like the textual material that surrounds them, these maps are derivative of previous Islamic geographical traditions and can be viewed as further examples of the different trends of mapping the world that existed in the Islamic Middle Ages (fig. 11.14).[34] Significantly, the world maps used to illustrate the texts begin to reflect European influence much earlier—in the second half of the sixteenth century—than the texts themselves, which gradually assume a Western outlook from the mid-seventeenth century onward.[35] In the interim, alongside attempts to combine traditional ideas with European material (fig. 11.15), there is a marked inclination to copy available European maps freely.[36] The inclusion of a terrestrial globe, of clear European origin, in a miniature painting that depicts the workshop of the short-lived observatory in Istanbul (built in 985/1577), demonstrates that Ottoman familiarity with European world maps was not negligible in scope.[37] (With the possible exception of the terrestrial globe connected with Jamāl al-Dīn,[38] this

34. Only a few examples out of the many that are extant will be cited here:

i. *Takvīm* (Almanac), prepared during the reign of Murād II (r. 824–55/1421–51), the Chester Beatty Library, Dublin, MS. Turkish 402, fols. 12b–13a, as described by Minorsky, *Chester Beatty Library*, 4 (note 27).

ii. The translation (970/1562) of Ibn al-Wardī's (d. 861/1457) *Kharīdat al-ʿajāʾib wa-farīdat al-gharāʾib* (The unbored pearl of wonders and the precious gem of marvels) by Maḥmūd el-Ḫaṭīb er-Rūmī (at least four Turkish translations of this work are known), Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, B. 179 (dated 1092/1681), fols. 2b–3a.

iii. The translation (after 1006/1597–98) of ʿAbd al-Raḥmān al-Bisṭāmī's (d. 858/1458) *Miftāḥ al-jafr al-jāmiʿ wa miṣbāḥ al-nūr al-lāmiʿ* (A key to the comprehensive *jafr* and a lamp of brilliant light) by Şerīf ibn Seyyid Meḥmed, the Chester Beatty Library, Dublin, MS. Turkish 444, fol. 234b, as described by Minorsky, *Chester Beatty Library*, 82 (note 27).

35. An interesting example, both the text and the maps of which reflect European material, is the Ottoman work known as *Tārīḫ-i Hind-i ġarbī* (History of the West Indies) from about 988/1580; see Thomas D. Goodrich, "Ottoman Americana: The Search for the Sources of the Sixteenth-Century *Tarih-i Hind-i garbi*," *Bulletin of Research in the Humanities* 85 (1982): 269–94, esp. 289–91; also idem, "*Tarih-i Hind-i garbi*: An Ottoman Book on the New World," *Journal of the American Oriental Society* 107 (1987): 317–19.

36. Most revealing in this connection are the world maps that appear in surviving sea atlases, which are discussed in chapter 14. A good example of a traditional geographical text illustrated by European world maps is Meḥmed ibn ʿAlī Sipāhīzāde's (d. 997/1588) *Awḍaḥ al-masālik ilā maʿrifat al-buldān wa-al-mamālik* (The clearest path to the knowledge of countries and empires); the earliest copy I have seen is in Süleymaniye Kütüphanesi, Istanbul, İsmihan 298, dated A.D. 1569–70, with a world map at the beginning. Another European-style world map, the so-called map of Ḥācī Aḥmed of 967/1559, formerly believed to be the work of an Ottoman geographer, has now been proved be an Italian production published by Marc' Antonio Giustinian; see Victor Lewis Ménage, " 'The Map of Hajji Ahmed' and Its Makers," *Bulletin of the School of Oriental and African Studies* 21 (1958): 291–314; cf. George Kish, *The Suppressed Turkish Map of 1560* (Ann Arbor, Mich.: William L. Clements Library, 1957), and Rodney W. Shirley, *The Mapping of the World: Early Printed World Maps, 1472–1700* (London: Holland Press, 1983), 118–19 (no. 103).

37. The miniature is contained in the first volume of the *Şāhanşāhnāme* (Persian *Shāhanshāhʾnāmah*), completed in 989/1581; a good version is in Istanbul Üniversitesi Kütüphanesi, FY. 1404, fol. 57a. For more on the observatory and a reproduction of the miniature, see pp. 27–28 and fig. 2.10. The existence of this terrestrial globe is confirmed by the testimony of Salomon Schweigger, who was in Istanbul between 985/1578 and 989/1581, *Ein newe Reyssbeschreibung auss Teutschland nach Constantinopel und Jerusalem* (Nuremberg: Johann Lantzberger, 1608; facsimile reprint, Graz: Akademische Druck- und Verlagsanstalt, 1964), 90; also quoted by Adnan Adıvar, *Osmanlı Türklerinde İlim*, 92 (note 9). The map on the globe is studied in some detail by Aydın Sayılı, "Üçüncü Murad'ın İstanbul Rasathanesindeki Mücessem Yer Küresi ve Avrupa ile Kültürel Temaslar," *Belleten* (Türk Tarih Kurumu) 25 (1961): 397–445.

38. The globe of Jamāl al-Dīn was connected with a mission the Ilkhans sent to China to assist in establishing an astronomical observ-

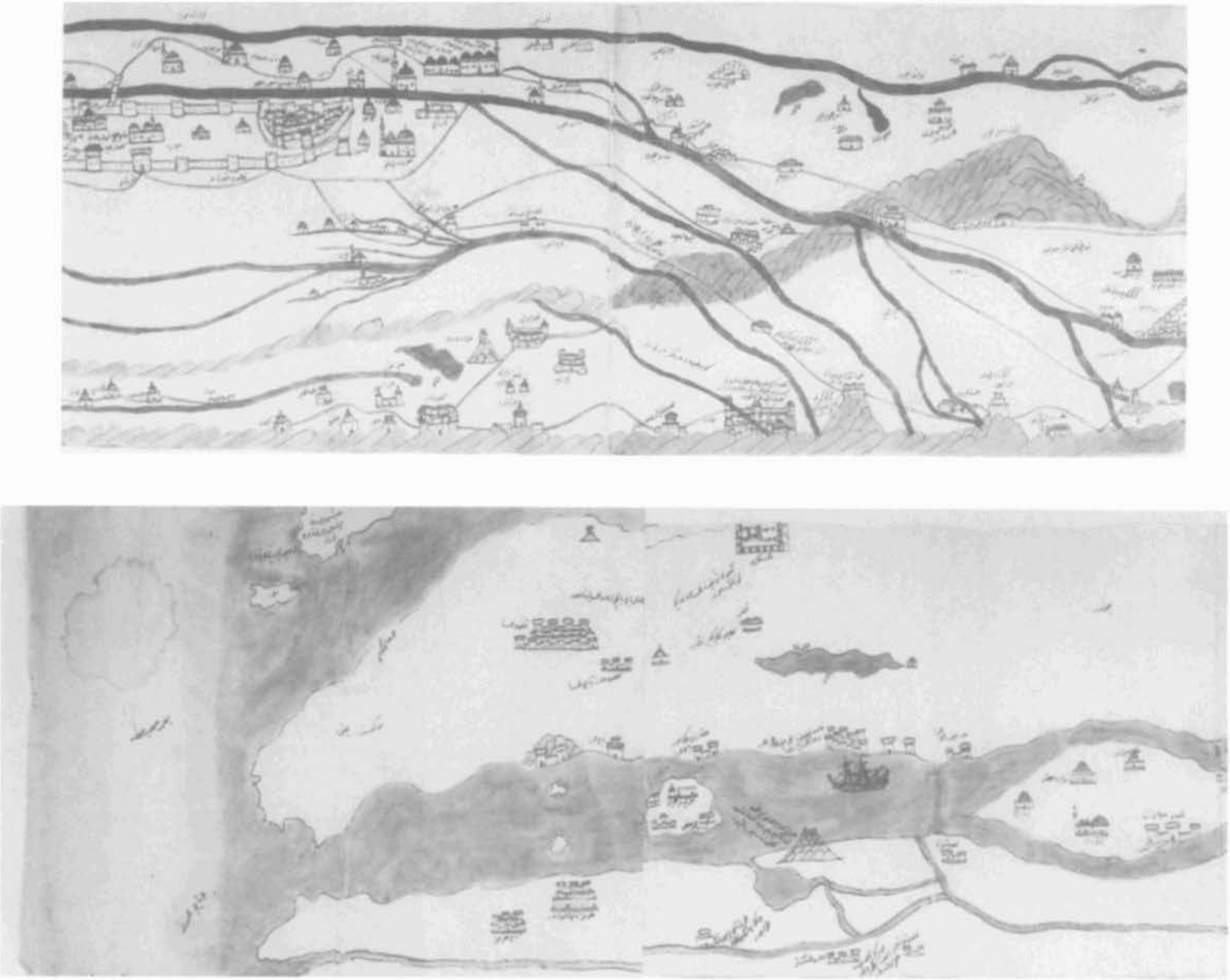


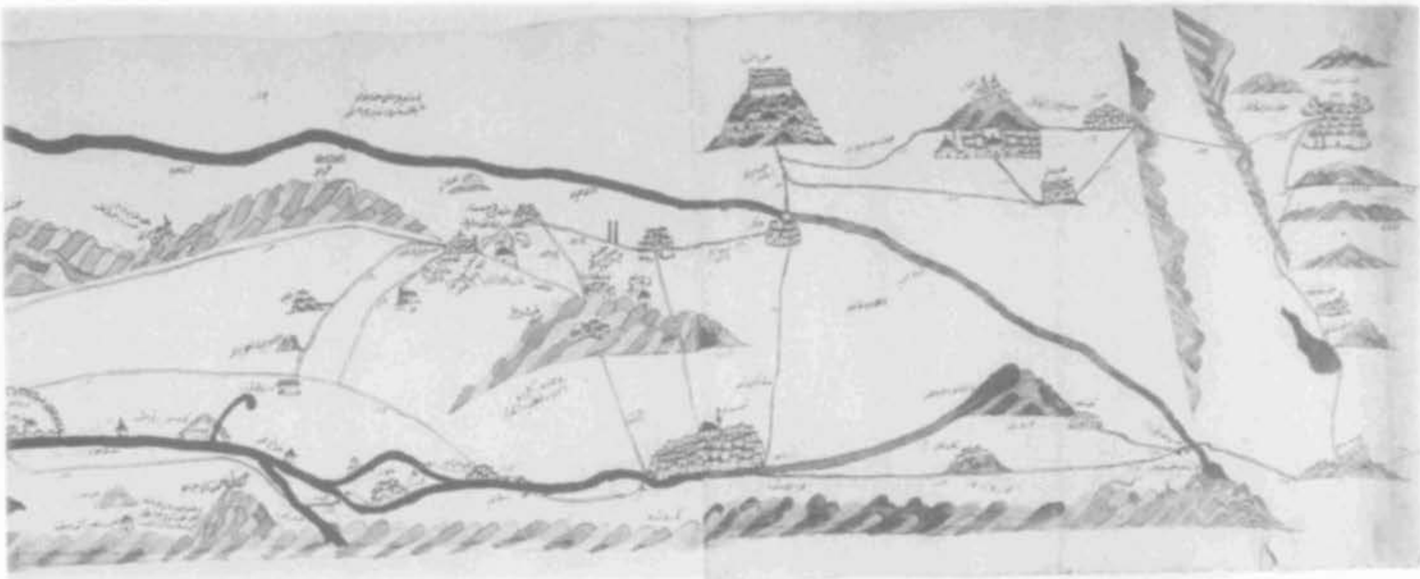
FIG. 11.16. MAP OF THE TIGRIS AND THE EUPHRATES, MID-SEVENTEENTH CENTURY. Map begins in the upper right corner.
Size of the original: 43 × 343.5 cm. By permission of Bernard Quaritch, Ltd., London (Add. 143).

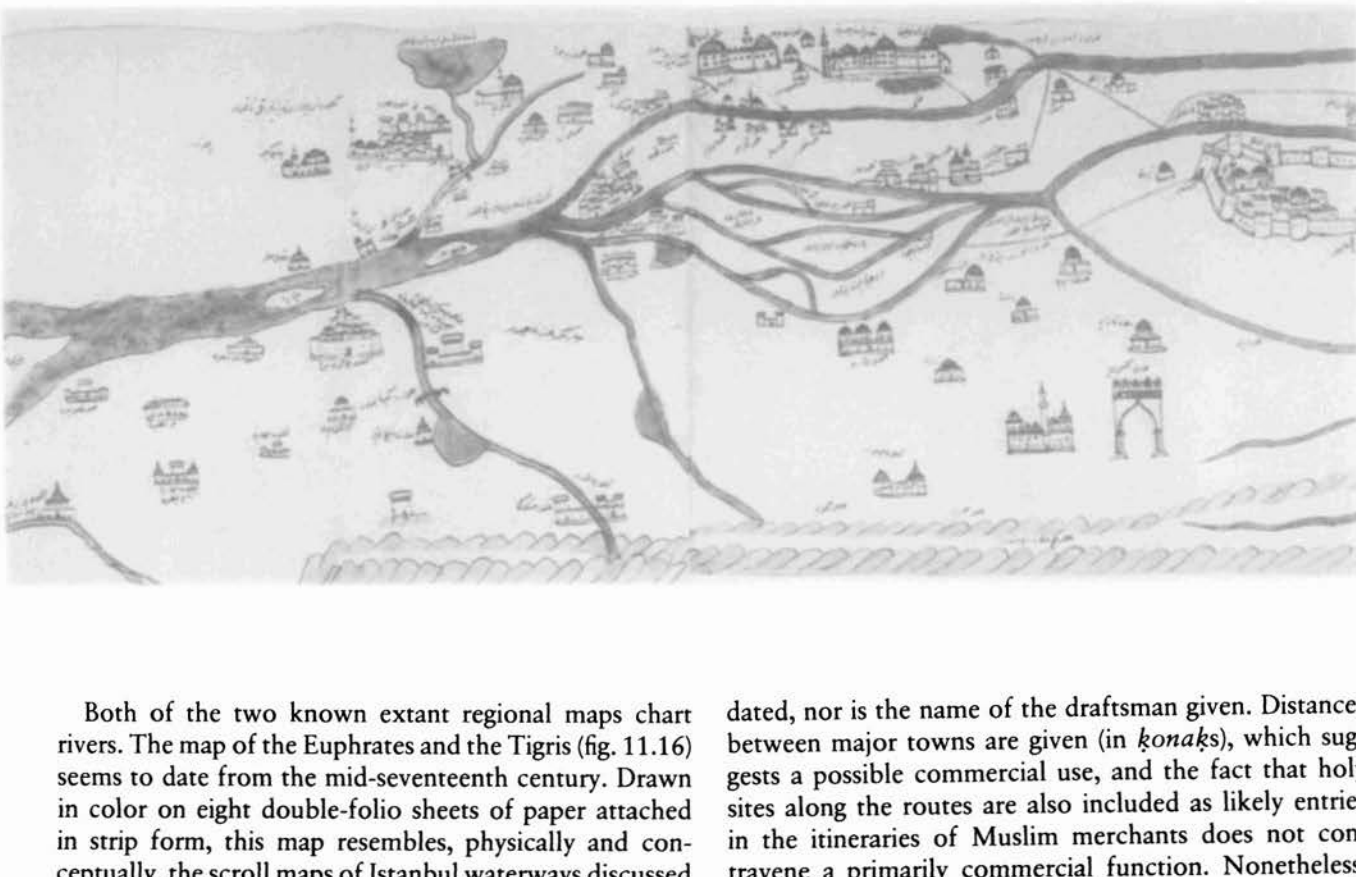
is the only terrestrial globe attested to in the history of Islamic cartography.) On balance, however, the extent of Ottoman knowledge of contemporary European mapping of the world was limited, and the reproduction of a small number of world maps in many different historical and geographical texts leaves little doubt that there was much borrowing not from European works but from much more readily available Islamic books.

REGIONAL MAPS

The corpus of traditional Ottoman terrestrial maps reviewed above seems to be curiously lacking in examples of regional cartography. Military and architectural maps produced under state patronage are overwhelmingly local in scope, while maps contained in scholarly books are invariably world maps until the introduction of European terrestrial atlases in the seventeenth century. However, there are at least two surviving examples of large-scale regional maps in a traditional style, which suggests that the mapping of extensive terrain was not unknown to the Ottomans.

atory in A.D. 1267; Willy Hartner, "The Astronomical Instruments of Cha-ma-lu-ting, Their Identification, and Their Relations to the Instruments of the Observatory of Marāgha," *Isis* 41 (1950): 184–94, and volume 2, book 2 of *History of Cartography*.





Both of the two known extant regional maps chart rivers. The map of the Euphrates and the Tigris (fig. 11.16) seems to date from the mid-seventeenth century. Drawn in color on eight double-folio sheets of paper attached in strip form, this map resembles, physically and conceptually, the scroll maps of Istanbul waterways discussed earlier. It is arranged like a graphic itinerary, and important sites along the course of the two rivers are noted in pictorial elevation. Major routes in the area depicted are schematically indicated. The topography of the terrain itself is left uncharted, with only major mountains being shown in conventional wave patterns. Every feature in the map is clearly identified in writing. The artifact is not dated, nor is the name of the draftsman given. Distances between major towns are given (in *ḳonaḳs*), which suggests a possible commercial use, and the fact that holy sites along the routes are also included as likely entries in the itineraries of Muslim merchants does not contravene a primarily commercial function. Nonetheless, the legends of the map do not allow us to venture much beyond such elementary speculation.[39]

The second extant large-scale regional map is of the river Nile (fig. 11.17). This large artifact, drawn in color

39. This map was brought to my attention by Dr. Robert Jones, Bernard Quaritch, London.

FIG. 11.17. MAP OF THE NILE, CA. 1685. The Nile Delta is also shown in detail (above).
Size of the original: 543 × 88 cm (greatest width). By permission of the Biblioteca Apostolica Vaticana, Rome (Vat. Turc. 73).

on cloth, is datable to shortly after A.D. 1685 on internal evidence. The map charts the course of the Nile from its legendary origins at the foot of the Mountains of the Moon in the south all the way to its delta at the Mediterranean in the north. The drawing is heavily annotated, and the text that runs through the map evinces genetic affinity with the description of Egypt, Nubia, and Sudan that appears in the tenth volume of the most celebrated travelogue in Ottoman Turkish literature, the *Seyāhatnāme* (Book of travels) of Evliyā Çelebi (d. ca. 1095/1684). Since Evliyā Çelebi is known to have spent the last part of his life in Egypt and died there, there is a distinct possibility that he played a role in producing this map, though there is no proof of such a connection.[40] Conceptually, the map itself should be viewed as an attempt

40. Ettore Rossi, "A Turkish Map of the Nile River, about 1685," *Imago Mundi* 6 (1949): 73–75; idem, *Elenco dei manoscritti turchi della Biblioteca Vaticana* (Rome: Biblioteca Apostolica Vaticana, 1953), 55–57.

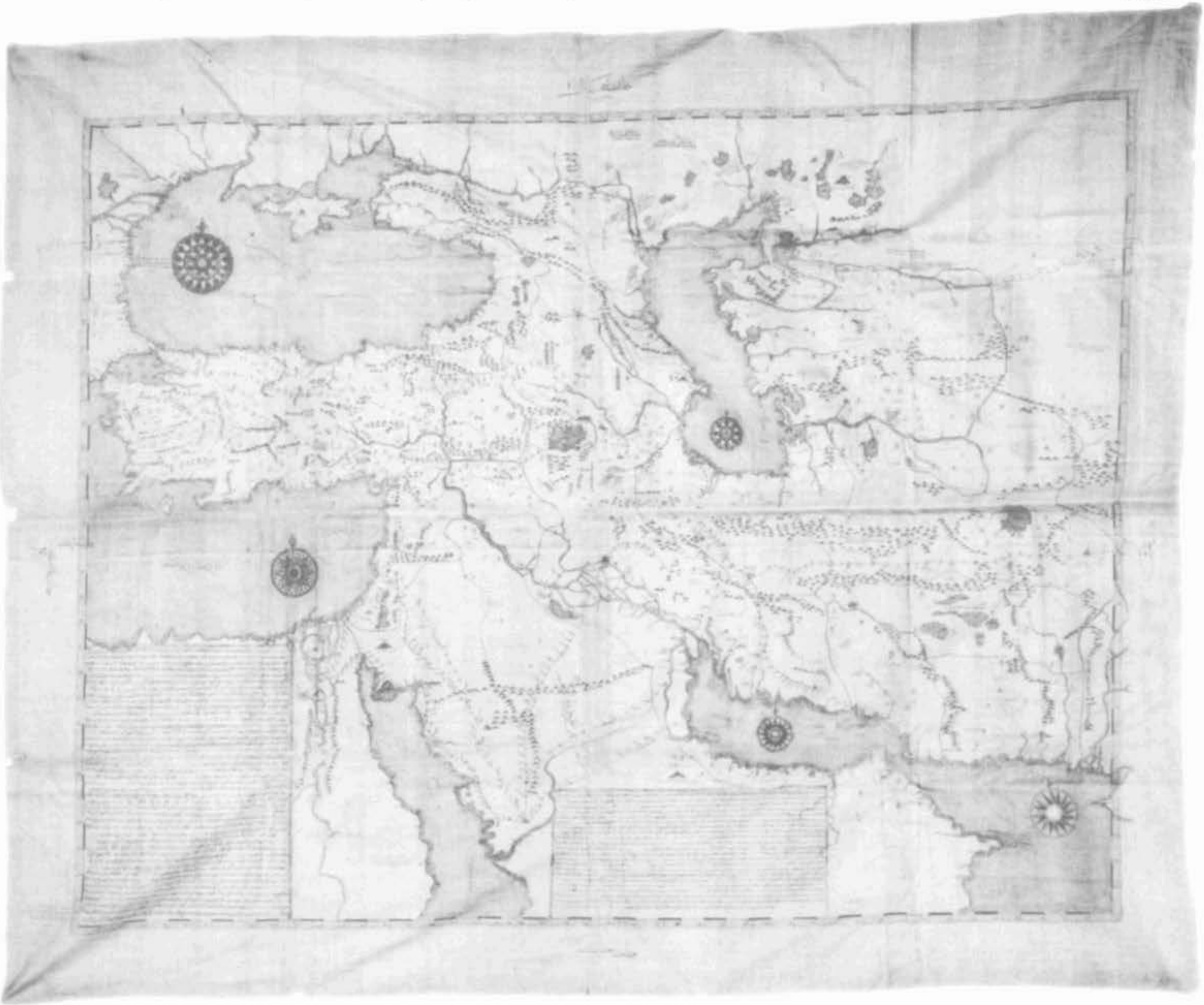


FIG. 11.18. MAP OF THE OTTOMAN EMPIRE, 1139/1726–27. This "European" map is attributable to Ibrāhīm Müteferriḳa, founder of the first printing press in the Ottoman Empire. A cloth copy of the same map is preserved in the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 447).
Size of the original: 180 × 220 cm. By permission of the Österreichisches Staatsarchiv-Kriegsarchiv, Vienna (E a 178).

to illustrate legends, historical or otherwise, that surrounded the river Nile in Islamic literature. In execution and style, it is somewhat reminiscent of the earliest extant Islamic map, namely al-Khwārazmī's map of the Nile.[41]

The replacement of such traditional regional cartography by European theory and practice was a long and uneven process. Throughout the eighteenth century, and even in the nineteenth, mediocre and impressive regional maps continued to be produced concomitantly within the Ottoman Empire. Examples of the former include an eighteen-folio atlas of color maps from before 1114/1702–3[42] and a large cloth map of Europe, Asia, and North Africa made by a certain ʿAbdülazīz ibn ʿAbdülġanī el-Erzincānī in 1228/1813[43] that show fundamental deficiencies in execution. Among the better maps produced in this period one can mention the manuscript map of the Ottoman Empire, dated 1139/1726–27 and attrib-

41. Al-Khwārazmī's cartographic contribution is discussed in chapter 4.

42. Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, B. 339; Karatay, *Türkçe Yazmalar Kataloğu*, 1:466 (no. 1412) (note 23).

43. Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 448; Karatay, *Türkçe Yazmalar Kataloğu*, 1:470–71 (no. 1429) (note 23), where the date of the map is incorrectly given as 1128/1715–16.

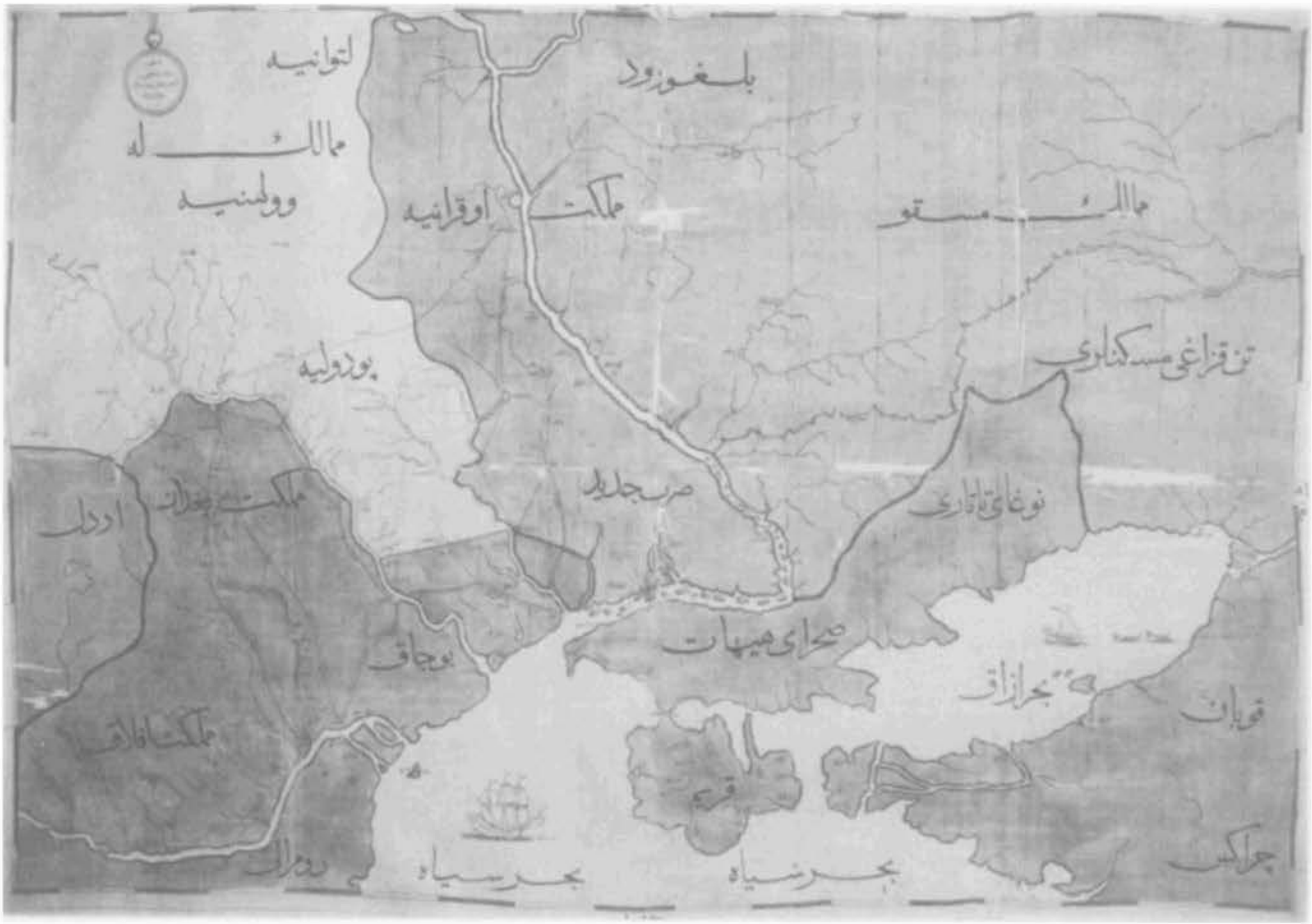


FIG. 11.19. MAP OF THE REGIONS NORTH OF THE BLACK SEA ON SILK BY RESSĀM MUṢṬAFĀ, 1768–69. Size of the original: 69 × 100.5 cm. By permission of the Topkapı Sarayı Müzesi Arşivi, Istanbul (E. 8410/2).

utable to Ibrāhīm Müteferriḳa (fig. 11.18), and a map of the regions north of the Black Sea signed by Ressām Muṣṭafā and dated 1182/1768–69 (fig. 11.19). A detailed study of this period of transition would naturally require a close scrutiny of surviving Ottoman maps, comparing them with their sources whenever these can be identified.[44]

44. A recent attempt in this direction is G. J. Halasi-Kun, "The Map of *Şekl-i Yeni Felemenk maa İngiliz* in Ebubekir Dimişkī's *Tercüme-i Atlas mayor*," *Archivum Ottomanicum* 11 (1986): 51–70.

APPENDIX 11.1
WATERWAY MAPS

Waterway maps, almost all in the form of scrolls, known to me are the following:

1. Map of the Kırkçeşme and Halkalı Water-Supply System, dated 1161/1748, 75 × 1,098 cm, Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1815.
2. Map of the Kırkçeşme and Halkalı Water-Supply System, dated 1016/1607, 24 × 954 cm, Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1816.
3. Map of the Halkalı Water-Supply System, inspector of waterways Dāvūd on the demand of Sultan Murād III, before 992/1584, 27 × 286 cm, two copies: Millet Genel Kütüphanesi, Istanbul, Ali Emiri 930; Türk ve İslam Eserleri Müzesi, Istanbul.
4. Süleymāniye Waterway Map, not dated, 30 × 2,572 cm, Türk ve İslam Eserleri Müzesi, Istanbul, MS. 3337.
5. Köprülü Waterway Map, dated 1083/1672, Köprülü Kütüphanesi, Istanbul, MS. 1027.
6. Üsküdar Waterway Map, after 1177/1763–64, 30 × 1,800 cm, Türk ve İslam Eserleri Müzesi, Istanbul, MS. 3336.
7. Map of Bāyēzid II's Waterway, probably from 1225–29/1810–14, a total of four pieces of 140 × 185, 150 × 311, 103 × 345, and 103 × 188 cm, Türk ve İslam Eserleri Müzesi, Istanbul, MS. 3337–39.
8. Köprülü Waterway Map, not dated, 43 × 676 cm, Köprülü Kütüphanesi, Istanbul, MS. 1/2441.
9. Köprülü Waterway Map, not dated, 100 × 370 cm, Köprülü Kütüphanesi, Istanbul, MS. 2/2442.
10. Köprülü Waterway Map, dated 1275/1859, 143 × 685 cm, Köprülü Kütüphanesi, Istanbul, MS. 2/2443.
11. Ayvalıdere Waterway Map, not dated, İstanbul Vakıflar Başmüdürlüğü (Directorate of Istanbul Waqfs), MS. 334 (included here on the authority of Kazım Çeçen, *İstanbul'da Osmanlı Devrindeki Su Tesisleri*, İstanbul Teknik Üniversitesi Bilim ve Teknoloji Tarihi Araştırma Merkezi, no. 1 [Istanbul, 1984], 192).
12. Unidentified waterway map, 41 × 256 cm, in the private possession of M. Douglas McIlroy, United States.

12 · Itineraries and Town Views in Ottoman Histories

J. M. Rogers

The illustrated histories of the Ottoman Empire, now considered to be an outstanding development of Turkish miniature painting, also constitute an original contribution to cartography. After the conquest of Constantinople in 857/1453, Sultan Meḥmed II concentrated his policies on consolidating power and securing prestige, through the patronage of art and architecture and the production of manuscripts for his imperial library. A significant aspect of this was the chronicling of the Ottoman dynasty: an official court historian was appointed to record the lives and achievements of the Ottoman rulers in a series of *şahnāmes* (panegyric royal histories). By about 944/1537, these were coming to be illustrated, and this pictorial element became an integral part of Ottoman historiography.

These histories were designed, above all, to record the might and power of the Ottoman Empire. In the first half of the sixteenth century, the Ottomans took advantage of the dynastic rivalry between the Habsburgs and the Valois to make extensive territorial gains in Europe and to control much of the Mediterranean. The Ottomans also faced a militant Safavid dynasty whose disruptive influence in Anatolia required constant vigilance in the empire's eastern frontier zones.[1] The illustrated histories therefore glorified the political and cultural achievements of these Ottoman campaigns, not only in the visual record of victories and military conquests they contain, but also in depictions of the pomp and circumstance of the Ottoman court.

A distinctive element of this imperial imagery was its emphasis on the "actuality of contemporary history": the realistic depiction not only of the personages involved, but also of the landscapes where events took place.[2] The itinerary map, the town plan, and the bird's-eye view incorporated as book illustrations thus became natural instruments of the palace chronicler. Sultans, viziers, and ambassadors appear as recognizable figures in specific historical settings with the architecture, the landscape, and details characteristic of each particular region.

Of the histories commissioned for imperial libraries, approximately thirty extant illustrated manuscripts composed in 944–1039/1537–1630 are devoted to the record of contemporary events in a mixture of indigenous and foreign styles (the principal works discussed in this chapter are listed in appendix 12.1). In the late fifteenth and early sixteenth centuries, distinguished miniature painters from Persia and Central Asia were brought to work in Istanbul, but the Ottoman rulers must also have been familiar with the developing fashion for town views in Europe. These respective contributions require further study, however. Likewise, there is some question when such illustrations first came to be included in the histories. Several manuscripts containing nonrealistic representations survive from the early sixteenth century.[3] There follows a remarkable forty-year period of experimentation in style and technique, characterized by the frequent use of maps or plan views to portray historical events. The images in the *Nüzhetü'l-aḫbār der sefer-i Sīgetvār*

This survey would not have been possible without the patient help of colleagues, in particular Tony Campbell, Helen Wallis, and Norah M. Titley of the British Library, Filiz Çağman, librarian of the Topkapı Sarayı, Zeren Tanındı of Bursa University, Günsel Renda, Hacettepe University, Ankara, and John Rowlands, keeper of prints and drawings in the British Museum. The European source material to which they have drawn my attention could be considerably expanded, though that, I think, would not much alter the conclusions advanced here. The Islamic material is, anyway, less familiar to readers of this work and accordingly takes first place. An attempt has been made to standardize the innumerable variant names of sixteenth-century Italian mapmakers, but it has not seemed useful to distinguish between authors and publishers, since so much remains unclear or unknown.

1. Adel Allouche, *The Origins and Development of the Ottoman-Ṣafavid Conflict*, Islamkundliche Untersuchungen, vol. 91 (Berlin: Klaus Schwarz, 1983), esp. 130–45. There is no general work on the Ottoman-Habsburg-Valois rivalry in the sixteenth century. For an overview, the essays in *The Cambridge History of Islam*, 2 vols., ed. P. M. Holt, Ann K. S. Lambton, and Bernard Lewis, vol. 1, *The Central Islamic Lands* (Cambridge: Cambridge University Press, 1970), esp. 295–353, and *The New Cambridge Modern History*, 2d ed., vol. 2, *The Reformation*, ed. Geoffrey R. Elton (Cambridge: Cambridge University Press, 1984), are recommended.

2. Eleanor G. Sims, "The Turks and Illustrated Historical Texts," in *Fifth International Congress of Turkish Art*, ed. Géza Fehér (Budapest: Akadémiai Kiadó, 1978), 747–72, esp. 750.

3. The earliest extant illustrated history, the *Şāhnāme* (Book of kings) by Melik Ümmī (ca. 906/1500), contains seven miniatures by an artist trained perhaps in Shiraz, and the *Selīmnāme* (History of Sultan Selīm I) by Şükrī Bidlisī (ca. 931/1525) contains twenty-five miniatures (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1123 and H. 1597–98, respectively).

(Chronicle of the Szigetvár campaign, composed 976/1568–69) by Aḥmed Ferīdūn, herald the appearance of a mature, formalized Ottoman illustrative style, which in turn influenced the way maps and topographical views were used to portray geographic reality.

These illustrated dynastic chronicles reached their apogee during the reigns of Murād III (982–1003/1574–95) and Meḥmed III (1003–12/1595–1603), at a time when Seyyid Loḳmān ibn Ḥüseyin ibn el-ʿAşūri el-Urmevī held the post of *şehnāmecī* (official court historian). Ottoman illustration of this later period shows its growing indebtedness to European printed views and maps that were circulating freely throughout the empire. With declining imperial power in the latter part of the seventeenth century, however, far fewer manuscripts came to be illustrated for the imperial library, and the tradition of illustrated histories, created for the personal use of the sultan, suffered the most serious neglect.

The Compilation of Illustrated Histories

Manuscript illustration in later Muslim cultures has always tended to be centralized in palaces. The value of the materials—fine paper, precious pigments, and gold—carried a constant danger of pilferage and close supervision was essential. At the same time, the urgency of imperial demand required a concentration of expert craftsmen—calligraphers, marginators, illuminators, painters (*naḳḳāşān*), and binders—to see the manuscript expeditiously through its production stages from the first draft to finished book.[4]

Some of these individuals advanced to high rank in their professions and it is highly probable that they influenced the organization of the studio. It is nevertheless difficult to trace the participation of known individuals in the fine manuscripts made for the Ottoman palace before the later sixteenth century. Though production in a palace studio by a permanent salaried staff no doubt represented an ideal in Ottoman bureaucracy, at least until the death of Süleymān I the Magnificent (r. 926–74/1520–66), the studio had no monopoly of manuscript production. Some of the most significant illustrated manuscripts of this reign were produced without direct studio supervision. The *Süleymānnāme* (History of Sultan Süleymān) of Fetḥullāh ʿĀrifī Çelebi, for instance, may well have been the work of artists specially assembled for the purpose, and the *Mecmūʿa-i menāzil* (The collection of halts) must have been commissioned independently by Maṭrāḳçı Naṣūḥ from craftsmen working outside the palace and offered by him to Süleymān the Magnificent. There is nothing in the least surprising about this. The palace craftsmen would not be underemployed; demand, particularly in innovative genres, was impossible to predict; and appropriately specialized painters must have been difficult to find. Even under Murād III, when the studio was far more thoroughly incorporated into the higher bureaucracy and the former *naḳḳāşbaşı* (chief painter) Ḥasan was actually granted the distinguished title of *paşa*, it was not unknown for illustrated manuscripts for the sultan to be commissioned and executed outside the studio. This seems notably to have been the case both with Muṣṭafā ʿĀlī's (948–1008/1541–1600) presentation copy of his *Nuṣretnāme* (Book of victories) and with his record of imperial festivities in Istanbul, *Cāmiʿ üʾl-buḥūr der mecālis-i sūr*. Though this latter work remained unillustrated, he evidently intended to have it illustrated in Baghdad.[5] Such works show the dangers of reading back into earlier sixteenth-century Ottoman Turkey the organized bureaucratic structure of the palace studio under Murād III.

Although military maps and sea charts continued to be drawn on vellum for durability, Ottoman illustrated manuscripts were practically always on paper. The sources refer to paper from Samarkand, India, and Baghdad, but Islamic paper types of the time had no watermarks, and so far it is impossible to locate the sources of manufacture with any certainty. Bağdādī paper had a standard format, a full sheet being somewhat similar to folio size. In the fifteenth and sixteenth centuries, Ottoman manuscripts increasingly came to be written on European papers, particularly, to judge from the watermarks, Genoese, although the frequent occurrence of several different watermarks in the same manuscript may indicate that the supply was limited. Alternatively, as account books for manuscript production in this period demonstrate, the paper was doled out to the calligraphers in very small quantities.

By the late sixteenth century, the production of illustrated manuscripts for the palace library was more or less standardized (plate 17). The chronicler first completed a draft, which may have been submitted to the sultan for

4. *Naḳḳāş* (Persian; plural *naḳḳāşān*) is an all-encompassing term applied to the palace painters and decorators with the *naḳḳāşbaşı* at their head. The studio where they worked is often known as the *naḳḳāşḫāne*, though the term does not seem to have been in common use in the sixteenth century. Important primary sources for the studio are payroll registers (*mevācib defterleri*) dated between 932/1526 and 963/1556, along with a series of ledgers (*inʿâmât defterleri*) that record gifts the craftsmen offered to the sultan on the great feasts of the Muslim year and the rewards, gratuities, or honoraria they received in return. For a recent evaluation of their relevance, see J. M. Rogers, "Kara Memi (Kara Mehmed) and the Role of the *Sernakkaşan* in the Scriptorium of Süleyman the Magnificent," *Revue du Louvre*, in press.

5. The *Cāmiʿ üʾl-buḥūr der mecālis-i ṣūr* (The gathering of the seas [or meters] on the episodes of the celebrations, dated 994/1585–86) is in Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, B. 203. See Cornell H. Fleischer, *Bureaucrat and Intellectual in the Ottoman Empire: The Historian Mustafa Âli (1541–1600)* (Princeton: Princeton University Press, 1986), esp. 105–6 and n. 90.

approval. The text was then written out by a professional calligrapher, leaving specified pages, or parts of pages, blank for chapter headings, illumination, or illustration. We do not know exactly who dictated this basic layout, but if it was not the *nakkāşbaşı*, it could well have been the calligrapher himself. As in scriptoria in other later Islamic cultures, the illustrations would have first been sketched in black ink, but since the pigments in a gouache medium were all opaque, these lie concealed under the paint. For economy of time, mechanical aids to reproduction, like pounced stencils, were freely used, and specialization was encouraged. As a result most illustrations are the joint work of several hands. A master painter and his apprentices or journeymen would be employed, but since many Ottoman manuscripts lack colophons—and the ones that do have them normally record only the name of the calligrapher—it is often impossible to assign illustrations to known painters.

A problem arises with Ottoman interest in historical accuracy when the painters were not in immediate contact with the events they were illustrating. We have an abundant pictorial record of sixteenth-century Istanbul from the many European painters and draftsmen who came there, sketchbooks at the ready, braving the constant danger of arrest for espionage. But there is virtually nothing in the way of an Ottoman sketchbook. Nevertheless, there must have been such things, otherwise the accurate historical detail of the later chronicles of Süleymān's reign, extending beyond the text into the illustrations, would never have been possible. Who exactly was responsible for collecting them and putting them at the disposal of the painters in the palace scriptorium we do not know, but it is highly probable that the records were made for the Ottoman general staff and held in the grand vizier's office. Here would have been the siege plans, elevations of fortresses, and all the other topographical documentation that was essential for the preparation of campaigns on land and sea. This corpus has not survived for the most part, probably because it would have been discarded as soon as it was out of date, but it clearly existed.[6]

It is in this military context that we must consider the *Mecmūʿa-i menāzil* of Maṭrāḳçı Naṣūḥ (d. 971/1564), an officer in Süleymān's Janissary corps. This campaign history depicts the sultan's itinerary in a series of maps devoid of the human figures that fill other works of the historical genre. There are no known precedents, but Maṭrāḳçı Naṣūḥ was an able chronicler, as shown by the accounts he produced of the various military campaigns conducted by Sultan Süleymān.[7] What relation his work had to the practice of recording campaign itineraries deserves closer examination. The Ottomans did not invent the campaign diary, but works of this sort had a preeminent place in the sixteenth century as a source for the annals of Süleymān's reign. It must be assumed that a draftsman accompanied the officials charged with keeping the diary in order to sketch the important sites for historical record, if not for strategic purposes. The innovation of sketching in the field may have been Maṭrāḳçı Naṣūḥ's own, although it was coming to be standard practice in Europe. But the need for such records certainly existed, and he was the first to exploit these sketches as illustrations for his own work. Though his campaign history seems largely to have been ignored in manuscripts executed in the palace library, Maṭrāḳçı Naṣūḥ's innovation in realistic portrayal certainly reflected the deep Ottoman interest in the depiction of geography in their histories.

Early Examples of Topographical Illustration in Ottoman Texts

The origins of Ottoman manuscript illustration are complex, although sixteenth-century sources suggest that an imperial studio was established at Istanbul during the reign of Meḥmed II (second r. 855–86/1451–81).[8] The few extant miniatures in texts of this early period are of an eclectic nature but reflect little of the Italian artists Sultan Meḥmed invited to serve at his court. Illustrations dating from the subsequent reign of Bāyezīd II (r. 886–918/1481–1512) were strongly influenced by Persian and Turkoman traditions, resulting from contact with artists from Herat and Tabriz.

Such foreign influences, whether drawn from East or West, cannot, however, fully account for the emergence of an Ottoman interest in the detailed representation of cities and landscapes. With the exception of views of Baghdad—occasionally, though not accurately, illustrated in fourteenth- and fifteenth-century copies of Rashīd al-Dīn Faẕl Allāh's *Jāmiʿ al-tawārīkh* (Collection of chronicles)[9] and appearing in an Akkoyunlu anthology made

6. But see Jean Louis Bacqué-Grammont, "Un plan Ottoman inédit de Van au XVIIᵉ siècle," *Osmanlı Araştırmaları Dergisi/Journal of Ottoman Studiės* 2 (1981): 97–122; see also chapter 11.

7. For a detailed account of the organization of Ottoman campaigns, see Gyula Káldy-Nagy, "The First Centuries of the Ottoman Military Organization," *Acta Orientalia: Academiae Scientiarum Hungaricae* 31 (1977): 147–83.

8. Esin Atıl, "Ottoman Miniature Painting under Sultan Mehmed II," *Ars Orientalis* 9 (1973): 103–20, and Ernst J. Grube, "Notes on Ottoman Painting in the 15th Century," *Islamic Art and Architecture* 1 (1981): 51–62.

9. There are two such illustrations, dated ca. 751/1350, in the Diez albums (Berlin, Staatsbibliothek Preussischer Kulturbesitz, Diez A, Foliant 70, pp. 4 and 7); see Mazhar Şevket İpşiroğlu, *Saray-alben: Diez'sche Klebebände aus den Berliner Sammlungen*, Verzeichnis der Orientalischen Handschriften in Deutschland, vol. 8 (Wiesbaden: Franz Steiner, 1964), 17–18 and pl. 9. A manuscript of the *Jāmiʿ al-tawārīkh* (Paris, Bibliothèque Nationale, MS. Suppl. Persan 1113), which also depicts the capture of Baghdad by the Mongols in 656/1258, has been shown by Basil Gray to be dated to 823–34/1420–30 and shows no

at Shemakhi in Shirvan in 873/1468–69[10]—urban topography is almost totally ignored within the general context of Islamic painting before the first half of the sixteenth century. Thereafter we can identify the emergence of a distinctive Ottoman cartographic element in manuscript illustration, expressed through the detailed representation of cities.

Urban topographical illustration first appears in maritime charts in the two versions of the *Kitāb-i baḥrīye* (Book of maritime matters) of Muḥyīddīn Pīrī Reʾīs (ca. 875–961/1470–1554) (fully described on pp. 272–79).[11] Since he was first a corsair and then an officer in the Ottoman navy, the extent of his artistic training or links, if any, with the artistic community is unknown. In any case, the realistic depiction of cities occupied a low priority in the *Kitāb-i baḥrīye*. The form of the book, closely derived from Italian *isolarii* in its conventions and many of its illustrations, and its purpose, part manual and part autobiography, were directed to the mariner. This explains the selection of sites and how they were represented.[12] Moreover, the treatment of architecture is extremely schematic: a fortified tower may stand for a key fortress, a single gabled building for a town or village.[13] Pīrī Reʾīs also indicated ruined sites, sometimes as columns fallen or haphazardly standing, or sometimes as fortified walls with nothing inside, as at Tyre in Lebanon.[14] Yet the sheer number of these sites casts doubt on their having been drawn from firsthand observation. On the Palestinian and Syrian coasts, in particular, right up to Iskenderun and Ayas (Laiazzo), there are so many ruined sites that one might be led to conclude Pīrī Reʾīs found these coasts deserted.

Elsewhere there is an important element of personal experience in Pīrī Reʾīs's notes to the *Kitāb-i baḥrīye*. This is reflected in the illustrations, most notably in the first half of the work, beginning with the Dardanelles and surveying the Greek islands, the coasts of Albania, and the Adriatic up to Venice and Murano, even when a derivation from earlier Italian manuals is obvious. Most of the larger cities like Dubrovnik are shown in elevation from an angle of about sixty degrees. They feature massed-up, gabled houses and churches with square campaniles, often surmounted by crosses or crockets. Crowded inside fortified walls, they give an overall impression of settlements climbing a hill. While it would be difficult to recognize Dubrovnik without a caption, its harbor fortifications, like those at Ancona, are carefully depicted.[15] This emphasis reflects the fundamental interest of such ports to a corsair. This was obviously a consideration in making a treatise to present to Sultan Süleymān in the prosecution of his struggle for supremacy in the Mediterranean.

The view of Venice deserves special notice among the depictions in the first half of the work (see fig. 14.13 below).[16] The double-page illustration gives prominence to Murano among the islands of the lagoon, but it does not show either San Giorgio Maggiore or the Giudecca in recognizable form. To the south, massive walls block the lagoon. The waterfront of Venice (to use an anachronism) shows the *darsena* (naval arsenal or dockyard) with its walls and fortified entrance (which is actually situated up a canal), a tall campanile with no resemblance to that on the Piazza San Marco, and a generalized church that likewise bears no resemblance to the Basilica of San Marco. Other buildings are then shown in successive rows split by canals. Although it is clear that Venice is represented, the usefulness of this illustration as a guide to the city is questionable. It possibly was derived from an Italian view of Venice of the late fifteenth century, for it shows little indebtedness to the Jacopo de' Barbari map (A.D. 1500), but the prominence given to the lagoon fortifications and to the arsenal strongly suggests the work of a renegade or spy.

With the exception of Ancona, the coasts of Marche, Apulia, and Calabria show towns reduced to schematic fortifications. The same occurs for Sicily, Sardinia, Corsica, and even Malta, although mountains on these islands are indicated. Perhaps the most faithfully represented port in the whole volume is Genoa.[17] Though less detailed than Ottoman representations after about 952/1545, the city is clearly recognizable, depicted in elevation

direct acquaintance with the topography of Baghdad; see his "An Unknown Fragment of the 'Jāmiʿ al-tawārīkh' in the Asiatic Society of Bengal," *Ars Orientalis* 1 (1954): 65–75.

10. London, British Library, Add. MS. 16561, fol. 60a; signed by the dervish Nāṣir Bukhārāʾī. See Norah M. Titley, *Miniatures from Persian Manuscripts: A Catalogue and Subject Index of Paintings from Persia, India and Turkey in the British Library and the British Museum* (London: British Library, 1977), no. 97. The view is reproduced in Thomas W. Arnold, *Painting in Islam: A Study of the Place of Pictorial Art in Muslim Culture* (1928; reprinted New York: Dover, 1965), fig. II.

11. The first version is dated 927/1521. Pīrī Reʾīs prepared an expanded version dated 932/1526 and dedicated to Sultan Süleymān. A manuscript of the second version (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 642) is described in J. M. Rogers and R. M. Ward, *Süleyman the Magnificent*, exhibition catalog (London: British Museum Publications, 1988), no. 40.

12. Rome, for example, is shown merely as a set of conventionalized fortifications along either side of the Tiber (p. 577). Page references for the *Kitāb-i baḥrīye* follow the pagination in the facsimile of a manuscript of the second version (Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2612): see Pīrī Reʾīs, *Kitabı bahriye*, ed. Fevzi Kurtoğlu and Haydar Alpagut (Istanbul: Devlet, 1935).

13. For example, the fortified tower on Malta; *Kitāb-i baḥrīye*, 509 (note 12).

14. For Tyre (Ḳalʿe-i Ṣūr-i ḥarāb) and, as another example, Eski Istanbulluk on the island of Lesbos (Mytilene), see *Kitāb-i baḥrīye*, 732 and 146–47 (note 12).

15. For Dubrovnik (Dobrovenedik or Dūbrevnīk) and Ancona (Ankona), see *Kitāb-i baḥrīye*, 351 and 442, respectively (note 12).

16. For Venice (Venedik), see *Kitāb-i baḥrīye*, 428–29 (note 12).

17. For Genoa (Ceneviz), see *Kitāb-i baḥrīye*, 581 (note 12).

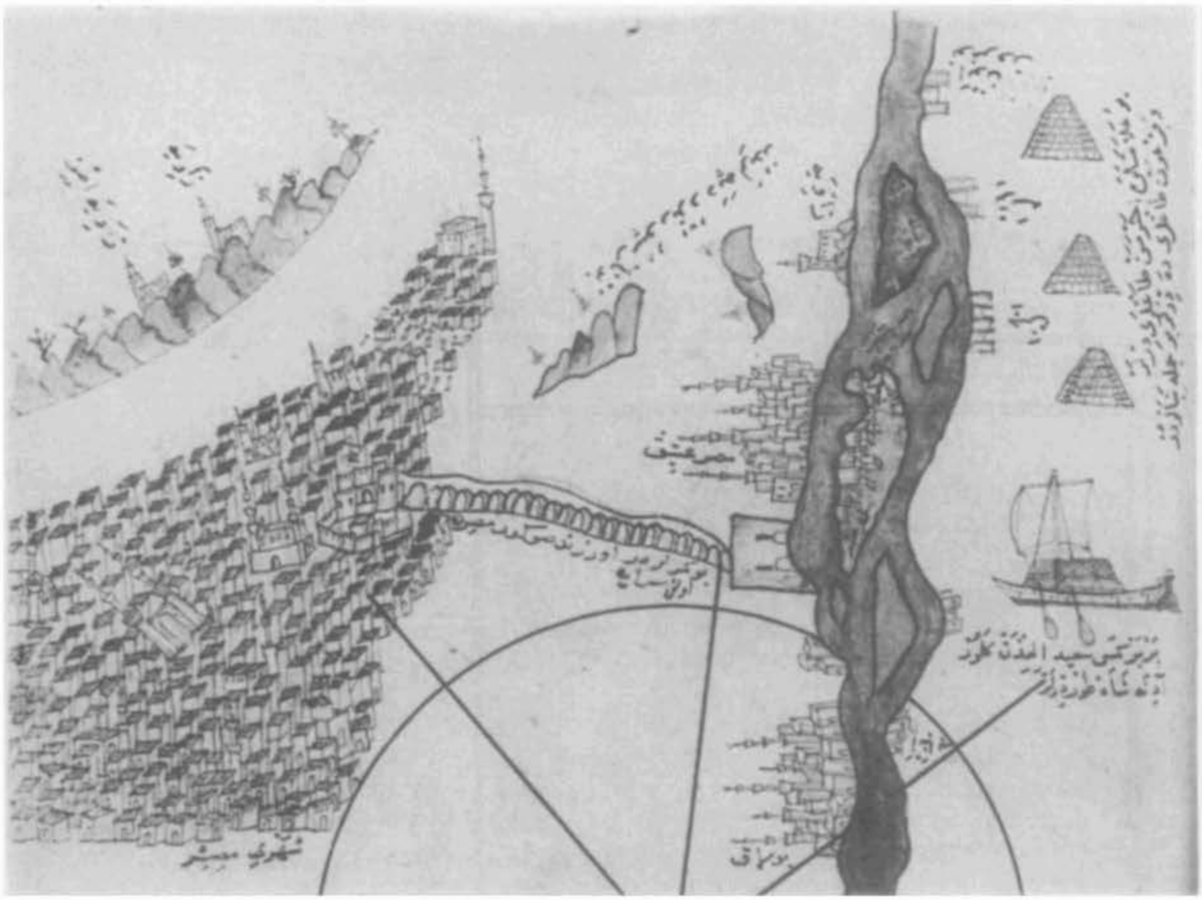


FIG. 12.1. VIEW OF CAIRO. From a map in the 932/1526 version of the *Kitāb-i baḥrīye*. Along the Nile on this south-oriented image, beside the aqueduct's great intake tower, is Old Cairo, facing the island of Rawḍah and the Giza pyramids beyond. Būlāq lies a short distance downstream. Shrines nestle in the adjacent Muqaṭṭam Hills. The *zāviye* south of Old Cairo, near the top of the image, must be the Shrine of the Footsteps of the Prophet that was restored in the reign of the Mamluk Sultan Faraj (d. 815/1412) and again in Cumādā I 910/October 1504 under Sultan Qānṣūh al-Ghawrī.
Size of the original: 31.8 × 22 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 642, fol. 352).

from an angle of about sixty degrees taken from the sea, hence very probably the work of a prisoner, possibly a siege engineer. The remaining coasts of Europe, southern France, and Spain, despite an abundance of autobiographical reminiscence by Pīrī Reʾīs, are very sketchily covered. Practically the only buildings shown are conventionalized forts to indicate cities—even those as large as Barcelona.

From Gibraltar onward, when Pīrī Reʾīs's account turns eastward, certain changes become apparent, though most of them are gradual. Ruins once again come to be indicated, like those at Cherchel in Algeria.[18] Principal mosques are shown with tiered minarets (for example, Tunis), and fortifications at Tripoli in Libya have walls with a pronounced batter.[19] When the account comes to Egypt, however, there is an immediate accumulation of detail. West of Alexandria there is even a representation of a military encampment, showing war tents, artillery, and pennons. Pīrī Reʾīs tells us in his notes that he was able to study the country while accompanying the grand vizier Ibrāhīm Paşa on his punitive expedition of 931/1524–25, and there is every reason to believe that the detail on his charts reflects Pīrī Reʾīs's own observation. Unfortunately, the absence of documentation in the Egyptian Mamluk sources or on European plans before the late sixteenth century makes some details difficult to interpret.[20] Alexandria is shown with its walls intact but with the city inside largely ruined, apart from two minarets attached to unidentified buildings and a windmill.[21] The

18. For Cherchel (Şirşel), see *Kitāb-i baḥrīye*, 633 (note 12).

19. For Tunis (Tunus) and Tripoli (Ṭarābulūs-i Garb), see *Kitāb-i baḥrīye*, 653 and 655, and 675 respectively (note 12).

20. Regarding European plans, see Viktoria Meinecke-Berg, "Eine Stadtansicht des mamlukischen Kairo aus dem 16. Jahrhundert," *Mitteilungen des Deutschen Archäologischen Instituts, Abteilung Kairo* 32 (1976): 113–32 and pls. 33–39.

21. For Alexandria (Iskenderiye), see *Kitāb-i baḥrīye*, 704–5 (note 12).

FIG. 12.2. VIEW OF ALANYA (ʿALĀʾĪYE). The small port of Alanya on the southern coast of Anatolia is one of the most detailed and accurate urban representations in the *Kitāb-i baḥrīye*. A path is shown outside the city walls leading to a source of fresh water at a well.
Size of the original: 31.8 × 22 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 642).

fortress of the Mamluk sultan Qāytbāy (d. 901/1496) is, however, shown as a three-tiered building with a conical roof on the top tier. The distinct reminiscence of the famous Hellenistic lighthouse, the Pharos, must be the result of Pīrī Reʾīs's personal acquaintance with the current, though largely legendary, Egyptian accounts of the beacon as detailed in later Mamluk chronicles.

A section covering the journey up the Nile to Cairo indicates villages, towns, and even isolated shrines in sequence.[22] In Cairo (fig. 12.1), the relative positions of Būlāq, Cairo, Old Cairo (Miṣr-i ʿAtīḳ), the island of Rawḍah, and the pyramids of Giza are roughly correct. Individual monuments, however, are not distinguishable, with a few exceptions such as the aqueduct to the citadel with its great intake tower, the Sabʿah Sawāqī built by the Mamluk sultan Qānṣūh al-Ghawrī (d. 922/1516). On close examination one can make out some of the walls and gates of the citadel but not, for example, the mosque of Sultan Ḥasan (d. 763/1362)—the most conspicuous building of Cairo that appears prominently on seventeenth-century European views of the city. *Zāviyes* (shrines) are shown on the Muqaṭṭam Hills, and also the Shrine of the Footsteps of the Prophet (Masjid Āthār al-Nabī) to the south of Cairo.

Būlāq, which came into prominence as a port only following Sultan Selīm I's occupation of Egypt in 923/1517, has almost more minarets than Cairo itself. The minarets are multitiered and are recognizably derived from late Mamluk style. We may guess that their prominence at Būlāq was less because of their newness than because there was more space for them on the page. Although as topographical illustration the section devoted to the Nile and Cairo clearly owes much, if not all, to Pīrī Reʾīs's own observations, the views are no more advanced than, for example, the town views of Wilhelm Pleydenwurff and Michael Wolgemut in Hartmann Schedel's Nuremberg Chronicle (published as *Liber cronicarum* in 1493).

The rest of the Mediterranean and the coasts of Palestine and Syria are treated fairly perfunctorily, with most towns and ports shown as deserted when they are not explicitly stated to be ruined. Though little is known of the region around Antioch under Mamluk and then Ottoman rule, it is most improbable that all there was to see at Iskenderun was ruins, or that the southern coast of Anatolia between Adana and Alanya was practically uninhabited. It may be that these sections were written up and illustrated later from inadequate notes.

The generalization and vagueness that characterizes this portion of the *Kitāb-i baḥrīye* is more than compensated for by the view of Alanya that was almost certainly drawn on the spot (fig. 12.2).[23] This image demonstrates that the concern of Maṭrāḳçı Naṣūḥ for topographical accuracy, apparent after 944/1537–38, may not have been an isolated phenomenon. It shows clearly not only the upper and lower fortresses, but also the Tersane (dockyard) and the Kızıl Kule (Red tower) built by the Seljuk sultan ʿAlāʾ al-Dīn Kayqubād (d. 634/1237), as well as the palace and mosque built by Süleymān in the upper fortress.[24] Though Alanya is only sporadically mentioned in Ottoman sources, it is not likely to have had much of a population when Pīrī Reʾīs saw it, and it is doubtful that the naval dockyard was still in use. The reason this city was chosen for such exceptional treatment must relate directly to the preparation of the work for presentation to Süleymān himself.

This discussion confirms that Pīrī Reʾīs's originality lies more with his sea charts than with the town views they contain. The latter were strongly influenced by earlier Venetian charts and contained many arbitrary simplifications. Moreover, the views continued to degenerate as contemporary topographical records. Though the *Kitāb-i baḥrīye* remained very popular into the seventeenth century, presentation copies, designed more to impress patrons than for use by the mariner, were illustrated with

22. For the Nile and Cairo (Kahire), see *Kitāb-i baḥrīye*, 711–15 (note 12).

23. For Alanya (ʿAlāʾīye), see *Kitāb-i baḥrīye*, 763 (note 12).

24. Seton Lloyd and D. Storm Rice, *Alanya (ʿAlāʾiyya)* (London: British Institute of Archaeology at Ankara, 1958), esp. 7 and 9–18.

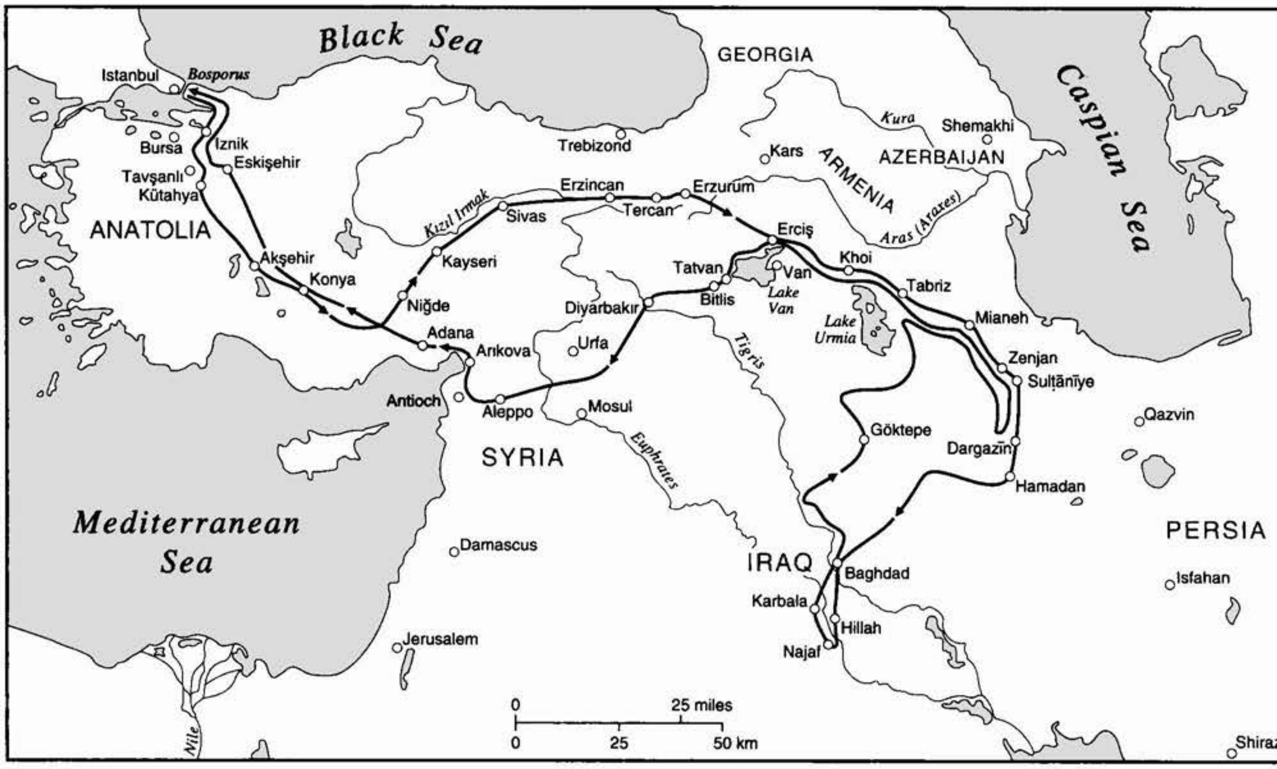


FIG. 12.3. THE ROUTE OF SÜLEYMĀN'S CAMPAIGN AGAINST THE SAFAVIDS, 940–42/1534–35.
After Maṭrāḳçı Naṣūḥ, *Beyān-i menāzil-i sefer-i ʿIrāḳeyn-i Sulṭān Süleymān Ḫān*, introduction, transcription, and commentary Hüseyin G. Yurdaydın (Ankara: Türk Tarih Kurumu, 1976), 174.

elaborate but less original views.[25] One seventeenth-century copy of the work, for example, shows Istanbul from the sea, in customary fashion, but with a surprising disregard for the Islamic monuments.[26] A view from an earlier, undated copy of the *Kitāb-i baḥrīye* represents Istanbul from a point northwest of Galata, with the Genoese tower, which dominated the city, barely visible in the foreground.[27] Evidently the bird's-eye view was prepared from the top of the tower, a rather obvious expedient, but from an illustrative standpoint entirely lacking the originality of the adapted bird's-eye view in volume 1 of Loḳmān's *Hünernāme* (Book of accomplishments; composed 992/1584–85) (see fig. 12.20).

Because of the obvious derivation of Pīrī Reʾīs's views from Venetian models, the label "portolan style" has been applied to many town illustrations in later Ottoman texts. There is, however, no historical record of portolan charts ever being consulted by illustrators of these chronicles. On the contrary, all the evidence suggests that the term "portolan style" is something of a misnomer for these works. And if there was a direct link between the work of Pīrī Reʾīs and later Ottoman topographical illustration, it was at best tenuous. The view of Alanya in the *Kitāb-i baḥrīye* that foreshadows Maṭrāḳçı Naṣūḥ's town views is exceptional and in no way typifies other urban representation in the work. The illustrations of towns in

25. Svat Soucek, "The 'Ali Macar Reis Atlas' and the Deniz kitabı: Their Place in the Genre of Portolan Charts and Atlases," *Imago Mundi* 25 (1971): 17–27, esp. 26–27, draws attention to the pseudonymous Seyyid Nūḥ, whose *Deñīz kitābı* (Book of the sea) (Bologna, Biblioteca Universitaria di Bologna, no. 3609) relies on lavish illustration for its entertainment value rather than for the accurate representation that would have been essential for a usable portolan chart. There is no demonstrable consonance between the views of Istanbul in the various early copies of Pīrī Reʾīs's *Kitāb-i baḥrīye* and those worked up to illustrate annals written for the library of Murād III.

26. London, British Library, MS. Or. 4131, fol. 195a; see Norah M. Titley, *Miniatures from Turkish Manuscripts: A Catalogue and Subject Index of Painting in the British Library and British Museum* (London: British Library, 1981), no. 57 and pl. 46.

27. The original manuscript (Berlin, Staatsbibliothek Preussischer Kulturbesitz, Diez A., Foliant 57) was supposedly destroyed in the Second World War. The view of Istanbul is reproduced in Eugen Oberhummer, *Konstantinopel unter Sultan Suleiman dem Grossen aufgenommen im Jahre 1559 durch Melchior Lorichs aus Flensburg* (Munich: R. Oldenbourg, 1902), pl. XXII. In this connection, three panoramas (of Istanbul, Galata, and Üsküdar/Kadikoy [Scutari/Chalcedon]) are an indication of how the palace craftsmen worked; see Franz Babinger, "Drei Stadtansichten von Konstantinopel, Galata (,Pera') und Skutari aus dem Ende des 16. Jahrhunderts," *Denkschriften der Österreichischen Akademie der Wissenschaften, Philosophisch-Historische Klasse*, 77, no. 3 (1959). The panoramas were originally bound in with a miscellany of images, datable on internal grounds to A.D. 1590–93, by an anonymous south German painter for the emperor Rudolf II (r. A.D. 1576–1612) at Prague (Vienna, Österreichische Nationalbibliothek, Cod. Vindob. 8626). The city views are by another hand, possibly north Italian, but are likewise datable to the late sixteenth century because

the *Kitāb-i baḥrīye* certainly influenced those of later Ottoman naval atlases, like the Walters *Deniz atlası* (see plate 23), but these are now so stylized that the vignettes of major Mediterranean and Black Sea cities are of little more than decorative value. Pīrī Re'īs provided the first clear indication of what was to become a distinctive Ottoman characteristic of manuscript illustration, but it would be highly misleading to describe the illustrations in chronicles like the *Mecmūʿa-i menāzil* as influenced by his charts.

Topographical Illustration in the *Mecmūʿa-i Menāzil*

The principal work of Ottoman topographical illustration is the *Beyān-ı menāzil-i sefer-i ʿIrāḳeyn-i Sulṭān Süleymān Ḫān* (The stages on Sultan Süleymān's campaign in the two Iraqs [modern Iraq and western Iran]), generally known by its briefer title *Mecmūʿa-i menāzil*, by Maṭrāḳçı Naṣūḥ (d. 971/1564).[28] This is an account of Süleymān the Magnificent's campaign in eastern Anatolia, Persia, and Iraq against the Safavids in 940–42/1533–35, which was to result in the occupation of Baghdad and Tabriz and bring the Ottomans to the Persian Gulf (fig. 12.3). Although this is a remarkably innovative work in Islamic painting, its existence in the library of the palace of Yıldız on the Bosporus was unknown to the world until the transfer of this collection to the Istanbul Üniversitesi Kütüphanesi in 1924.

Maṭrāḳçı Naṣūḥ was a Janissary officer of Bosnian origin, who evidently some time after Selīm I's conquest of Egypt in 923/1517 was posted there in the service of the Mamluk governor Khayr Beg (d. 1524). Early in 1517 he wrote a school textbook on arithmetic, the *Cemāl el-küttāb*.[29] Also while in Egypt he learned sufficient Arabic to read and translate the *Taʾrīkh al-rusul wa-al-mulūk* (History of prophets and kings) of al-Ṭabarī (224–25 to 311/839–923) and was evidently commissioned by Süleymān I at his accession to continue it up to the present time. He then returned to Istanbul and organized the games in the Hippodrome celebrating the circumcision of Süleymān's sons in 936/1530. In a work presented to the sultan, he described and illustrated these cavalry parades and maneuvers based on similar exercises practiced in Mamluk Egypt, as well as mock sieges of castles built of wood and cardboard with the use of real artillery and firearms.[30] For these services he received an imperial commendation and an appointment to court with a *müşāhere* (monthly stipend).[31]

At some point during this period, Maṭrāḳçı Naṣūḥ completed his translation from Arabic into Turkish of al-Ṭabarī's world history, with additions from Ptolemy and al-Bīrūnī, that seems to have begun about 926/1520. The task was accomplished in three volumes, covering the period from the Creation up to the thirteenth century A.D.[32] A continuation of this history into Ottoman times does not exist as a single volume, but the subtitle *Tevārīḫ-i āl-i ʿOsmān* (The chronicles of the Ottoman dynasty) that is included in his *Mecmūʿa-i menāzil* strongly suggests that the project was executed as a series of discrete parts sometime after 944/1537. The complex relation of these separate texts, nine in total, to the goal of extending al-Ṭabarī's world history has been studied with great ingenuity by Hüseyin Yurdaydın. The texts are

they show none of the works of Sultan Aḥmed I (r. 1012–26/1603–17). Istanbul is shown from the north with the Sea of Marmara beyond, suggesting that it may have been drawn from the Genoese tower in Galata. Galata, showing the dockyard but not the whole of the Golden Horn, and Üsküdar are shown in considerably less detail. They all suggest, however, that contemporary Ottoman bird's-eye views were in fact, as would have been logical, plotted from panoramas.

28. The *Mecmūʿa-i menāzil* was first described by Albert Gabriel, "Les étapes d'une campagne dans les deux ʿIrak d'après un manuscrit turc du XVIe siècle," *Syria* 9 (1928): 328–49. For a complete facsimile of the work, see Maṭrāḳçı Naṣūḥ, *Beyān-i menāzil-i sefer-i ʿIrāḳeyn-i Sulṭān Süleymān Ḫān*, introduction, transcription, and commentary Hüseyin G. Yurdaydın (Ankara: Türk Tarih Kurumu, 1976), with English summaries and a comprehensive bibliography. In all subsequent footnotes, this facsimile will be referred to simply as *Mecmūʿa-i menāzil*. There is an unillustrated copy of this work, which may well be later, in the Topkapı Sarayı Müzesi Kütüphanesi, R. 1286; see Hedda Reindl, "Zu einigen Miniaturen und Karten aus Handschriften Maṭraqčı Naṣūḥ's," in *Islamkundliche Abhandlungen*, Beiträge zur Kenntnis Südosteuropas und des Nahen Orients, no. 18 (Munich: Rudolf Trofenik, 1974), 146–71.

29. Istanbul Üniversitesi Kütüphanesi, TY. 2719. He later revised this work as the *ʿUmdetüʾl-ḥisāb*, of which several copies exist (see below, note 31).

30. The work is entitled *Tuḥfetüʾl-ġuzāt* (Istanbul, Süleymaniye Kütüphanesi, Esat Efendi 2206, dated late Şaʿbān 937/late March 1532). The sketches of cavalry maneuvers and fortified towers and enceintes bear rather more resemblance to illustrated European manuals on fortification (such as Roberto Valturio, *De re militari* [Verona, 1472], dedicated to Sigismondo Pandolfo Malatesta) than to illustrated *furūsīyah* manuscripts depicting military maneuvers from Mamluk Egypt. They may well be Maṭrāḳçı Naṣūḥ's own work but, unsurprisingly, had little effect on the depictions of fortresses in the *Mecmūʿa-i menāzil*. See Hugo Theodor Horwitz, "Mariano und Valturio," *Geschichtsblätter für Technik und Industrie* 7 (1920): 38–40, and John R. Hale, *Renaissance Fortification: Art or Engineering?* (London: Thames and Hudson, 1977). Meḥmed II's library contained a copy of Valturio's *De re militari*, see p. 210.

31. The commendation is dated late Ẕilḳaʿde 936/late June 1529; see a copy of this incorporated into a manuscript of the *ʿUmdetüʾl-ḥisāb* (Istanbul, Nuruosmaniye Kütüphanesi, 2984, fols. 173b–74a).

32. This work is entitled *Cāmiʿüʾtevārīḫ*. The first two volumes record the history of the world up to the reign of the Sassanian ruler Khusrau Anūshīrvān (A.D. 531–78) (Vienna, Österreichische Nationalbibliothek, Cod. Mixt. 999 and 1187, and Paris, Bibliothèque Nationale, MS. Suppl. Turc 50, respectively). Hüseyin Yurdaydın identified the third volume of the series, which continues al-Ṭabarī's text beyond the reign of the Abbasid caliph al-Muqtadir (295–320/908–32), where it originally broke off, with accounts of the Turks, the Ghaznavids, and the Seljuks up to the time of Ertuğrul, the father of ʿOsmān I (Istanbul, Fatih Kitaplığı, MS. 4278).

shown to have been made out of sequence and in some cases to exist only in rough drafts or preliminary versions.[33] Not surprisingly, to some extent they are repetitive or overlap; the author would not necessarily have had access to the previous parts before taking up the pen again. Nevertheless, Maṭrāḳçı Naṣūḥ left a fairly complete record of the reigns of sultans Bāyezīd II, Selīm I, and Süleymān I, spanning the period from 886/1481 to approximately 958/1551. Only the years 946–48/1539–41 are left unaccounted from among these texts, but a history of the Ottomans from the death of Ertuğrul, ʿOsmān I's father, up to the accession of Bāyezīd II has not been identified and indeed may never have been written. Maṭrāḳçı Naṣūḥ embarked on an abridged version of his al-Ṭabarī translation and continuation sometime about 957/1550, for presentation to the grand vizier Rüstem Paşa.[34]

Maṭrāḳçı Naṣūḥ's productive literary career and works show he was a talented amateur. Although the tone of his writing is suitably panegyric, he was never promoted to the status of *şehnāmecī*, a position created by Süleymān for the Azeri versifier ʿĀrifī sometime after 954/1547. It has been claimed that Maṭrāḳçı Naṣūḥ illustrated his works himself, but the style and content of the illustrations differs considerably from volume to volume, and perusal of the *Mecmūʿa-i menāzil* shows that its illustrations are the work of several artists. Moreover, many of the illustrations do not appear to be by a professional hand, which suggests that the team of painters he employed was not from Süleymān's own palace scriptorium. This would also explain why even in the relevant sections of ʿĀrifī's *Süleymānnāme*, which deal with Süleymān's first Persian campaign and may have been illustrated by court artists, the influence of the *Mecmūʿa-i menāzil* is barely apparent.[35]

The *Mecmūʿa-i menāzil* is now incomplete. There are some discrepancies between the route as given in the text and the sequence of halts as depicted, and the illustrations of some stages on the outward march and on the return journey are missing or may never have been executed.[36] The margins have been trimmed, possibly more than once, so that the illustrations, many of them double page, now cover the entire surface area of the page.[37] Many show signs of overpainting, and some identifications are later additions. The text is written in careful Nesiḫ in an anonymous nonprofessional hand, assiduously if not always accurately pointed. These features might suggest that it was written by Maṭrāḳçı Naṣūḥ himself, but in fact he had a considerable reputation as a calligrapher and the text shows numerous faults of dictation, which therefore rules out this possibility.

It is possible that the now unillustrated sections of this work—notably from Zenjan westward to Tatvan, Urfa to Aleppo and back, and Antioch to Ishaklı near Akşehir (with the exception of Arıkova and Adana)—may have been left unillustrated by oversight or even that they were wrongly bound from the start. This could well have occurred, because the work contained no overall plan to integrate the illustrated stages into a narrative to explain the sequence of advance followed by Süleymān and his vizier Ibrāhīm Paşa. This is a considerable drawback, but it doubtless arose from the novelty of the idea of topographical illustration in Ottoman painting.

The text of Maṭrāḳçı Naṣūḥ's *Mecmūʿa-i menāzil* shows conclusively that he was in Süleymān's suite on the Persian campaign and wrote as an eyewitness. Even more important, the accuracy of much of the illustration, particularly for those towns in Ottoman territory, is clear

33. See Yurdaydın, 128–40, in *Mecmūʿa-i menāzil* (note 28). The nine texts are: a *Süleymānnāme* recording events from Süleymān's accession up to his Corfu campaign of 944/1537 and including the *Mecmūʿa-i menāzil* text (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1286); an illustrated text of the *Mecmūʿa-i menāzil* covering Süleymān's Persian campaign of 940–42/1534–35 (Istanbul Üniversitesi Kütüphanesi, TY. 5964); the *Fetḥnāme-i Ḳaraboğdān*, completed 23 Cumādā II 945/16 November 1538 and recording the Moldavian campaign of the same year (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1284/2); the *Tāriḫ-i fetḥ-i Şaḳlāvūn* covering the years 949–51/1542–44 (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1608); a *Süleymānnāme* fragment covering the years 950–58/1543–51 (Istanbul, Arkeoloji Müzesi Kütüphanesi, no. 379); a history of the earlier part of the reign of Bāyezīd II, *Tāriḫ-i Sulṭān Bāyezīd*, dated ca. 952–57/1540–50 (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1272); a history of the latter part of the reign of Bāyezīd II and of Selīm I, written in Cumādā II 960/May-June 1553 (London, British Library, Add. MS. 23586); and an account of Süleymān's second Persian campaign of 1 Muḥarram 955–26 Rebīʿ II 956/11 February 1548–23 May 1549 (Marburg, Staatsbibliothek, MS. Hist. Or. Oct. 955).

34. One volume, recently identified by Yurdaydın, covers world history up to the reign of the Sassanian ruler Bahrām Chūbīn (London, British Library, MS. Or. 12879). Another volume in the set, completed 980/1571–72 and long known to scholars, covers Turkish and Mongol history from Oğuz Khan up to the Ottoman Empire in 968/1561 (Vienna, Österreichische Nationalbibliothek, Cod. Mixt. 339). An undated manuscript of this work copied for the library of Selīm II (London, British Library, MS. Or. 12592) continues the history beyond this to the Ottoman summer campaign of 977/1569 in the Yemen. Since Maṭrāḳçı Naṣūḥ died in 971/1564, the author of this addition remains anonymous. The Vienna copy was once attributed, implausibly, to Rüstem Paşa himself; see Ludwig Forrer, *Die osmanische Chronik des Rüstem Pascha* (Leipzig: Mayer und Müller, 1923). A volume covering the intervening period has not been found.

35. Hanna Sohrweide, "Der Verfasser der als *Sulaymān-nāma* bekannten Istanbuler Prachthandschrift," *Der Islam* 47 (1971): 286–89.

36. The correct sequence may be reconstructed by reference to the documents in Aḥmed Ferīdūn's collection of state papers, *Münşeātü'l-selāṭīn* (Writs of sultans). See Franz Taeschner, "Das Itinerar des ersten Persienfeldzuges des Sultans Süleyman Kanuni 1534/35 nach Matrakçi Nasuh: Ein Beitrag zur historischen Landeskunde Anatoliens und der Nachbargebiete," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 112 (1962): 50–93.

37. A blank page intended for illustration (fol. 69b) has ruled margins, making it likely that the other illustrations were intended to have been in ruled panels too, as would indeed have been standard Ottoman practice.

evidence for sketches made on the spot. It is conceivable, though no longer demonstrable, that it was Maṭrāḳçı Naṣūḥ himself who did these.[38] Yet the illustrations certainly are not free of elements that bear little relation to the locations they are meant to represent. The volume contains, for example, a whole series of domed shrines shown in the most stylized manner from a source far removed from actual observation, as well as fantastic representations of animal heads carefully integrated into the rocks of mountainsides. Though the distances between stages are precisely given in the text, the illustrations showing more than one stage rarely give an idea of that. Landscape features like mountains, rivers, lakes, or passes often bear no clear relation to the towns, fortifications, caravansaries, or bridges that form the central features of the depictions. Not only is there no scale included, it is not even clear that a consistent scale was used among different illustrations—though such would have been well within the capacities of Süleymān's engineers and surveyors. Nor is it easy to decide whether any consistent directional viewpoint or orientation was used. In cases such as Sulṭānīye (plate 18), we can deduce the direction from the qibla orientation of the buildings depicted, but the detail is not always sufficiently clear to determine whether the town or fortress is shown from the direction of the advancing Ottoman forces. It would be too much to expect consistency in such a pioneering work, and sketches made on the spot could anyway have been altered at a later stage of refinement. The difference between this work and much contemporary European cartography is, even so, probably no more than a matter of degree, for the idea that a map must *eo ipso* be a guide, or that an atlas must be a handbook, was far from being universally accepted.

As far as the urban topography of the *Mecmūʿa-i menāzil* is concerned, the illustrations are not obviously of European inspiration, except for a bird's-eye view of Istanbul/Galata from the southwest, possibly from a ship anchored off Saray Burnu (Topkapı Palace Point) (figs. 12.4 and 12.5).[39] This image is, however, exceptional in that it devotes minute attention to the Islamic monuments (Hagia Sophia and Hagia Eirene had of course been turned into mosques) in their state before the renovations of Süleymān in the mid-sixteenth century. The Topkapı Sarayı is shown in its original fifteenth-century form as a seven-towered fortress. The monastery of Saint John, which later became the Arslanhane (Menagerie) near Hagia Sophia, and the Eski Saray (Old Palace) appear here for the first and last time in Ottoman illustration.[40] The Hippodrome (Atmeydanı) shows the columned sphendone still standing at the south end. The obelisks and serpent column of the Byzantine *spina* (the barrier down the middle of a Roman racecourse) within the stadium are complemented by other columns, which were evidently bases for the Florentine statuary brought from Buda following its surrender to Süleymān in 932/1526.[41] They did not long survive the disgrace and execution of the grand vizier Ibrāhīm Paşa in 942/1536—thus giving some indication of the date when this view was composed.[42] The vizier's palace on the Hippodrome is shown

38. See Franz Taeschner's comparison between individual elements in Maṭrāḳçı Naṣūḥ's illustrations and the actual features they represent in "The Itinerary of the First Persian Campaign of Sultan Süleyman, 1534–36, according to Naṣūḥ al-Maṭrākī," *Imago Mundi* 13 (1956): 53–55. Interesting evidence for the way the manuscript was illustrated is given on fol. 23b, which shows the town of Erzurum, as well as the stage before it, Ilıca (Ilıca-i Erzurum), and two stages after it, Boğaz and Pasinler (Pāsin ovası), as if the scribe in charge had in mind Tercan and the stages beyond it represented on the preceding folio (fol. 23a). As it happened, this dense succession of stages left no room on the page for a proper representation of Erzurum itself, and the solution was to include Boğaz, incorrectly, inside the walls and place Pasinler just outside the walls. This shows that the caption panels were drawn first and the illustrations added elsewhere, at a stage where a mistake could not be rectified. It also shows that the town views were too important to omit. When accommodation was necessary, as here, it was the caption panels that went by the board.

39. Nurhan Atasoy, "Matrakçı's Representation of the Seven-Towered Topkapı Palace," in *Fifth International Congress of Turkish Art*, ed. Géza Fehér (Budapest: Akadémiai Kiadó, 1978), 93–101. On p. 94, the author observes that European diplomatic missions arriving by sea were often obliged to anchor for some time off Saray Burnu; see, for example, *Itinéraire de Jérôme Maurand d'Antibes à Constantinople*, ed. and trans. Léon Dorez (Paris, 1901), which was written and illustrated in A.D. 1544. This is also the viewpoint from which the group of plans of Istanbul by Giovanni Andrea Vavassore (ca. A.D. 1520) are drawn. I do not follow Walter B. Denny in seeing any influence from Greek or Slavic icon painting; see "A Sixteenth-Century Architectural Plan of Istanbul," *Ars Orientalis* 8 (1970): 49–63.

40. For a detailed study of early depictions of Istanbul architecture, see Wolfgang Müller-Wiener, *Bildlexikon zur Topographie Istanbuls: Byzantion-Konstantinupolis-Istanbul bis zum Beginn des 17. Jahrhunderts* (Tübingen: Ernst Wasmuth, 1977). Compare Zeren Akalay, "Tarihi konularda Türk minyatürleri," *Sanat Tarihi Yıllığı* 3 (1970): 151–66.

41. Victor Louis Ménage, "The Serpent Column in Ottoman Sources," *Anatolian Studies* 14 (1964): 169–73. A print of the Hippodrome by the Veronese draftsman Onofrio Panvinio (A.D. 1529–65) shows the *spina* with numerous obelisks and columns, allegedly as it was before the conquest in 857/1453. There is, however, no datable European view before the Vavassore group with any real claim to accuracy, and Panvinio's Hippodrome is substantially similar to that of the *Mecmūʿa-i menāzil.*

42. Josef von Karabacek, "Zur orientalischen Altertumskunde, IV: Muhammedanische Kunststudien," *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften in Wien, Philosophisch-Historische Klasse*, 172, no. 1 (1913), esp. 82–102 and pls. X–XI. Plate XI illustrates a page from vol. 1 of the *Şāhanşāhnāme* showing the celebrations in the Hippodrome of the circumcision of Şehzāde Muṣṭafā, the son of Süleymān, on 16 Ẕilḳaʿde 936/12 July 1530. In the foreground of this illustration is a column with three figures that in Pieter Coecke van Aelst's sketch, dated 12 November 1532, appear as three nudes. This sketch was later published in Coecke van Aelst's posthumous *Les moeurs et fachons de faire de Turcz* (Antwerp, 1553). Other contemporary visitors identify them as Hercules, Diana, and Apollo. They were evidently created for Matthias Corvinus (Matthias I, king of Hungary,

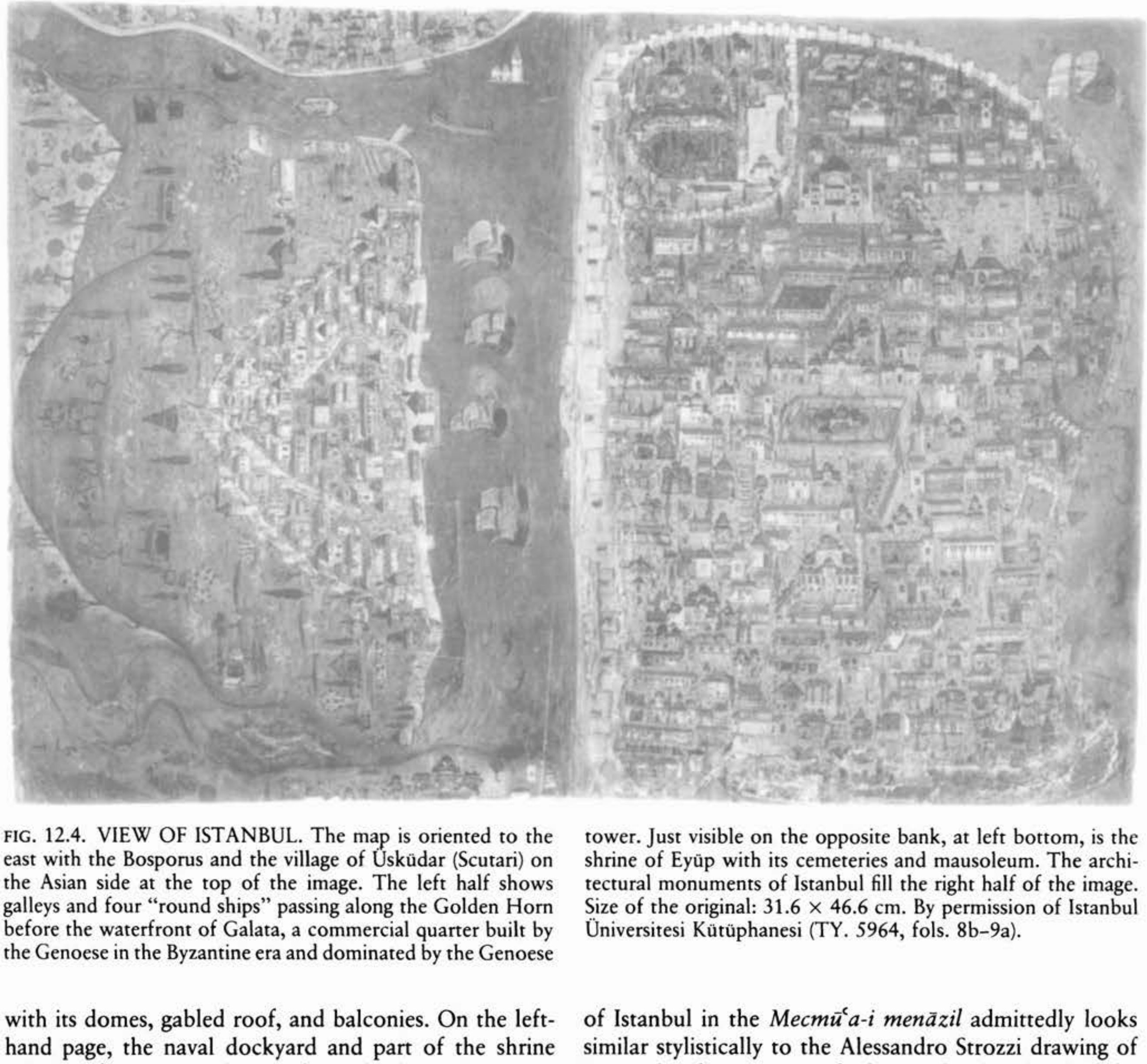


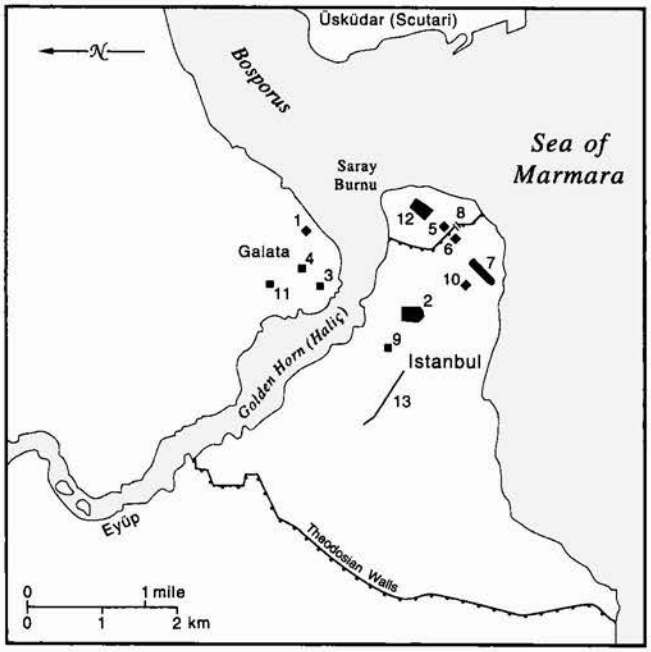
FIG. 12.4. VIEW OF ISTANBUL. The map is oriented to the east with the Bosporus and the village of Üsküdar (Scutari) on the Asian side at the top of the image. The left half shows galleys and four "round ships" passing along the Golden Horn before the waterfront of Galata, a commercial quarter built by the Genoese in the Byzantine era and dominated by the Genoese tower. Just visible on the opposite bank, at left bottom, is the shrine of Eyüp with its cemeteries and mausoleum. The architectural monuments of Istanbul fill the right half of the image. Size of the original: 31.6 × 46.6 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fols. 8b–9a).

with its domes, gabled roof, and balconies. On the left-hand page, the naval dockyard and part of the shrine suburb of Eyüp are shown along the bottom margin. Directly above is Galata with its Genoese tower, although the buildings within its walls are shown as churches or small houses without any indication of larger buildings like the Genoese Podestà or the Palazzo di Venezia. There is no living figure in this townscape, but this need not be Islamic prejudice: the Jacopo de' Barbari bird's-eye view of Venice is devoid of people too.

There is an Italian tradition of views of Constantinople that goes back at least to Cyriaco d'Ancona, well before its fall to Meḥmed II, and they regularly recur in a group of illustrated Ptolemy manuscripts in Florence associated with Pietro del Massaio (A.D. 1424–90). However, they are less related to the view in the *Mecmūʿa-i menāzil* than might appear at first sight. Earlier European plans concentrated on the Christian monuments, so that the secular buildings of the city only rarely appear. The view of Istanbul in the *Mecmūʿa-i menāzil* admittedly looks similar stylistically to the Alessandro Strozzi drawing of Rome dated A.D. 1474, which was closely related to the prototype from which Pietro del Massaio made his simplified views and could even be after a similar drawing.[43] But be that as it may, this is a conscious Ottoman adap-

A.D. 1440?–90) by the Florentine sculptor Giovanni Dalmata from Trogir and stood on Saint George's Square in the citadel of Buda. They were carried off after the sack of Buda by the Turks on 7 Ẕilḥicce 932/14 September 1526 and, according to Archduke Ferdinand of Austria's ambassador, Cornelius Duplicius Schepper, were set up on the Hippodrome in Istanbul. They did not, however, survive there very long. Jérôme Maurand d'Antibes in 951/1544 found only columns that, he was told, had borne bronze statuary from Hungary. Since volume 1 of the *Şahanşahnāme* was not illustrated before 989/1581–82, the persistence of a tradition in accord with the Ottoman historians and European travelers but not attested to by any earlier Ottoman illustration is remarkable.

43. Florence, Biblioteca Laurenziana, Redi 77; see Gustina Scaglia, "The Origin of an Archaeological Plan of Rome by Alessandro Strozzi," *Journal of the Warburg and Courtauld Institutes* 27 (1964): 137–63.



■ MONUMENTS
1. Cannon foundry
2. Eski Saray
3. Genoese Podestà
4. Genoese Tower (Galata Kulesi)
5. Hagia Eirene (St. Irene Kilisesi)
6. Hagia Sophia (Ayasofya Camii)
7. Hippodrome (Atmeydanı)
8. Imperial gate (Bāb-ı Hümāyūn)
9. Mosque of Süleymān (Süleymaniye Camii)
10. Palace of Ibrāhīm Paşa (Ibrāhīm Paşa Sarayı)
11. Palazzo di Venezia
12. Topkapı Sarayı
13. Valens Aqueduct

FIG. 12.5. REFERENCE MAP OF ISTANBUL ARCHITECTURAL MONUMENTS. Oriented with east at the top for comparison with fig. 12.4.

tation to show the principal Islamic monuments of the Ottoman city.

The remaining illustrations in the *Mecmūʿa-i menāzil*, which show greater stylistic independence, are as a whole not markedly military. When encampments are shown they are of nomads, not of soldiers. The stages depicted are often, significantly, shrines. In this the images follow the text, which is primarily a shrine book, doubtless because of Ottoman unfamiliarity with the topography of Mesopotamia and northwest Persia and also to emphasize Süleymān's piety and concern for orthodox religion and justify his campaign against the Safavids, who though Shīʿī were fellow Muslims. Unillustrated shrine books or guides for pilgrims first appeared in Islam in the twelfth century and became widespread in the fourteenth and fifteenth centuries.[44] However, those produced at Herat and Shiraz[45] no less than at Cairo[46] are more concerned to name the shrines and locate them than to describe their appearance. In this, therefore, the illustrations to the *Mecmūʿa-i menāzil* break new ground. Though some of the illustrators worked independently,[47] buildings in townscapes are generally shown either in elevation from below or from above at an angle of thirty to sixty degrees. Most views give due prominence to urban features like citadels and congregational mosques, but many architectural forms are stylized. However, there is little concern for the representation of space within the towns, and the plans are often as repetitive as in Pleydenwurff and Wolgemut's illustrations in the Nuremberg Chronicle.[48]

The western Anatolian stages that are the first images to appear in the work do not confine themselves to town views, and they place some emphasis on landmarks, sometimes even archaeological remains like the *dikili taş* (obelisk) on the way to Tavşanlı (fig. 12.6). From Erzurum onward, however (fols. 23b and following), there is a marked change from military objectives and fortresses to sites of cultural and religious significance. The ruins of Erciş (Arjish) are shown correctly as they were then, partially submerged in Lake Van (fig. 12.7), and the Armenian monastery church of Saint Thaddeus near Khoi in Persian Azerbaijan is quite recognizable with its gabled eaves.[49] The Safavid capital of Tabriz shows the no longer extant Shanb-i Ghāzānī, the walled funerary complex of the Ilkhanid ruler Ghāzān Khan (d. 703/1304), with blue dome, appurtenances, monumental gates, and a large rectangular pool. The Arg (Citadel), built on the remains of the mosque of the Ilkhanid minister ʿAlī Shāh (d. 724/1324), is omitted. In very similar style to Tabriz is the double-page plan view of Baghdad, surrounded by walled gardens and numerous shrines of saints and rulers and

44. For an early example, Abū al-Ḥasan ʿAlī ibn Abī Bakr al-Harawī (d. 611/1215), *Kitāb al-ziyārāt*; see *Guide des lieux de pèlerinage*, trans. Janine Sourdel-Thomine (Damascus: Institut Français de Damas, 1957).

45. For Herat, see Muʿīn al-Dīn Muḥammad Zamajī Isfīzārī, *Rawżāt al-jannāt fī awṣāf madīnat Harāt* (written 897/1491–92), 2 vols., ed. Sayyid Muḥammad Kāẓim (Tehran, 1959–60); see also Aṣīl al-Dīn ʿAbd Allāh ibn ʿAbd al-Raḥmān al-Ḥusaynī (d. 1478 or 1479), *Risālah-ʾi mazārāt-i Harāt*, ed. Fikrī Saljūqī (Kabul: Publishing Institute, 1967). For Shiraz, see Muʿīn al-Dīn Abū al-Qāsim Junayd al-Shīrāzī, *Shādd al-izār fī khaṭṭ al-awzār ʿan zuwār al-mazār* (written 791/1389), ed. Muḥammad Qazvīnī and ʿAbbās Iqbāl Āshtiyānī (Tehran, 1950).

46. For Cairo, notably Muḥammad ibn Muḥammad ibn al-Zayyāt (fl. 1401), *al-Kawākib al-sayyārah fī tartīb al-ziyārah fīʾl-Qarāfatayn al-Kubrāʾ wa-al-Ṣughrāʾ* (Cairo, 1907), and Aḥmad ibn ʿAlī al-Maqrīzī, *al-Mawāʿiẓ wa-al-iʿtibār bi-dhikr al-khiṭaṭ wa-al-āthār*, 2 vols. (Bulaq, 1857); the last is a general work of urban topography as well. See Yūsuf Rāġib, "Essai d'inventaire chronologique des guides à l'usage des pèlerins du Caire," *Revue des Etudes Islamiques* 41 (1973): 259–80.

47. Hence, for example, the duplication of views of the obscure town of Dargazīn, north of Hamadan, in two different styles, when it would plainly have been more economical to settle for one image (*Mecmūʿa-i menāzil*, fols. 38b and 89b–90a [note 28]).

48. Valerian von Loga, "Die Städteansichten in Hartman Schedels Weltchronik," *Jahrbuch der Königlich Preussischen Kunstsammlungen* 9 (1888): 93–107 and 184–96. Von Loga considers the low general standard of accuracy to result from the Nuremberg block makers' lack of direct acquaintance with the towns they depicted, beyond the sketches or other firsthand material at their disposal. It is scarcely to be expected that the painters employed by Maṭrākçı Naṣūḥ were in any better position to work up their sketches.

49. As in the case of Dargazīn (note 47), it is curious why such a militarily insignificant site as the monastery of Saint Thaddeus should have been selected for duplication (*Mecmūʿa-i menāzil*, fols. 27a and 89a [note 28]).

depicting curious details like a mosque within the walls where a millstone hangs from the balcony of its minaret (fig. 12.8). Süleymān's arrival in Baghdad was the culmination of the campaign, and the text records his schedule of visits to surrounding shrines and his restorations of important Islamic monuments inside the walls, notably the tomb of the religious scholar Abū Ḥanīfah (b. 80/699). None of the sites, however, is labeled on the plan view, and little attempt is made to show their architectural peculiarities.

In the account of the return journey there follows a series of Mesopotamian towns depicted in somewhat similar style (fols. 100a and following). The map of Bitlis shows the fortress and the buildings of the lower town, followed by a double-page rendering of the Bitlis gorge (fig. 12.9). In Diyarbakır (Āmid), the walls and the Great Mosque are shown but not the important bridge across the Tigris below the city. And the Aleppo (Halep) map, clearly the product of careful observation, includes a variety of different approaches to topographical illustration

FIG. 12.6. THE OBELISK ON THE ROAD TO TAVŞANLI. Size of the original: 31.6 × 23.3 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fol. 14a).

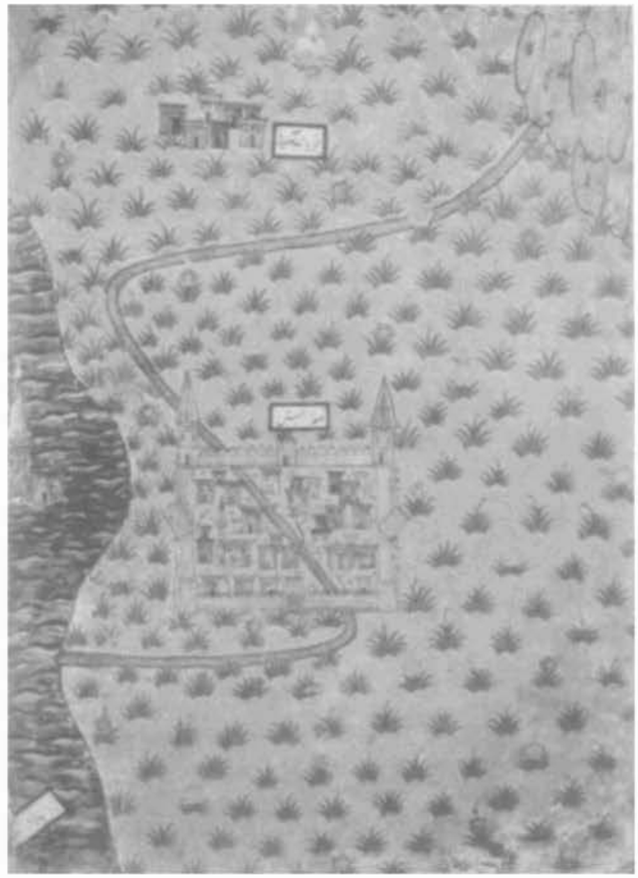


FIG. 12.7. PLAN VIEW OF ERCIŞ (ARJISH). The depiction shows the remains of a towered building partially submerged in Lake Van. A small village lies a short distance beyond. Possession of the towns around Lake Van was essential for Ottoman control of the eastern Anatolian provinces.
Size of the original: 31.6 × 23.3 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fol. 25b).

(fig. 12.10). In style and coloring Aleppo is distinct from other illustrations in the work. The Great Mosque with its conspicuous minaret is not recognizable, but below the citadel are shown curious features resembling umbrellas, now difficult to interpret.

This considerable variety raises the question of what sources Maṭrāḳçı Naṣūḥ or the artists under his supervision might have taken into account when compiling the work. A possible source of information may have been the European published plans and views that circulated in Turkey from the early sixteenth century.[50] Ottoman Istanbul was an important market for Venetian cartography. That there are no surviving European views of any towns in Anatolia, Iran, or Iraq before the later volumes of Georg Braun and Frans Hogenberg's *Civitates orbis terrarum* were published (Cologne, A.D. 1572–

50. See above, pp. 228–29.

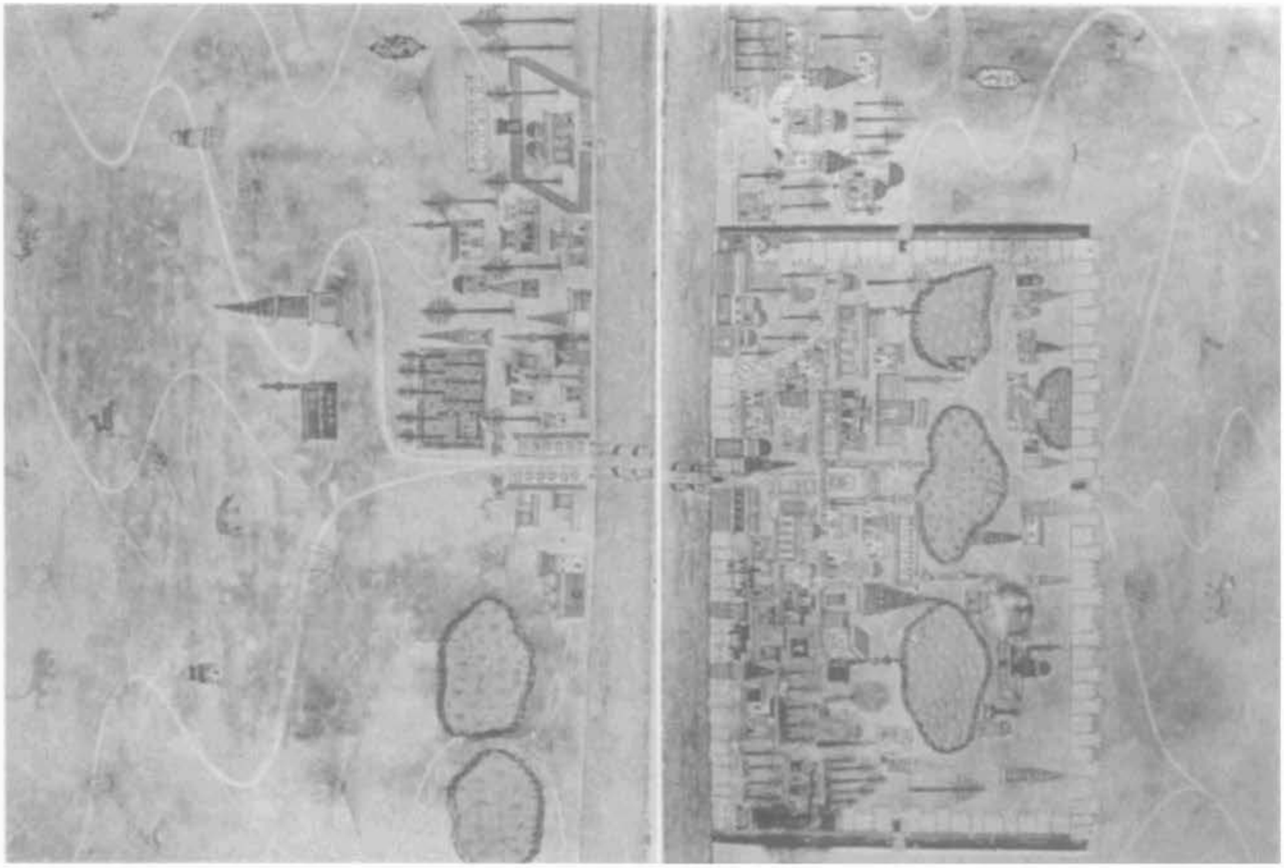


FIG. 12.8. VIEW OF BAGHDAD. The terminus of Sultan Süleymān's campaign was entered peacefully on 24 Cumādā II 941/1 December 1534, and the city was to remain, with only short interludes, in Ottoman hands. In this depiction the walled and moated city along the Tigris River is joined to the east bank by a single bridge. Two lions face each other on the road leading into the countryside. In style, the landscape is distinct from earlier depictions, such as figs. 12.6 and 12.7, but quite similar to that in fig. 12.11.
Size of the original: 31.6 × 46.6 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fols. 47b–48a).

1618), decades after the *Mecmūʿa-i menāzil* appeared, however, makes it unlikely that Maṭrāḳçı Naṣūḥ could have used the prototypes for these for his own work. Even less accessible to Ottoman cartographers were the many private European collections of maps, plans, charts, siege plans, and schemes for fortification. These were held in the naval arsenals or military headquarters of Europe and generally remained unpublished unless they were regarded as obsolete for one reason or another. There were, in addition, Ottoman siege plans and sketches from reconnaissance (see pp. 210–15), but we have no record of how systematically the archives of the grand vizier's office or the admiral of the fleet were preserving such material. This suggests that in Ottoman Turkey, no less than in Europe, no single archive of topographical drawings was substantial enough to serve for the illustration of campaign journals.

We must therefore look elsewhere among the artistic traditions of the many diverse cultures adhering to Islam for the inspiration of maps and other illustrations in the *Mecmūʿa-i menāzil.* The early period of manuscript illustration at the Ottoman palace studio was characterized by experimentation, using the indigenous traditions of local artists and imported styles. The influence of Iran was especially strong since, following his victory over the Safavids at Çaldıran (920/1514), Selīm I conscripted painters from Tabriz to the imperial ateliers. There was also probably Syrian and Egyptian influence following the conquest of Egypt in 923/1517. Maṭrāḳçı Naṣūḥ must have drawn on these important artistic traditions, and possibly also on the work of provincial draftsmen, when collecting the illustrations for his work.

In terms of such influences, three illustrations are of outstanding importance. First is the view of the already largely ruined Ilkhanid capital of Sulṭānīye in northwestern Persia (plate 18), which surpasses the other illus-

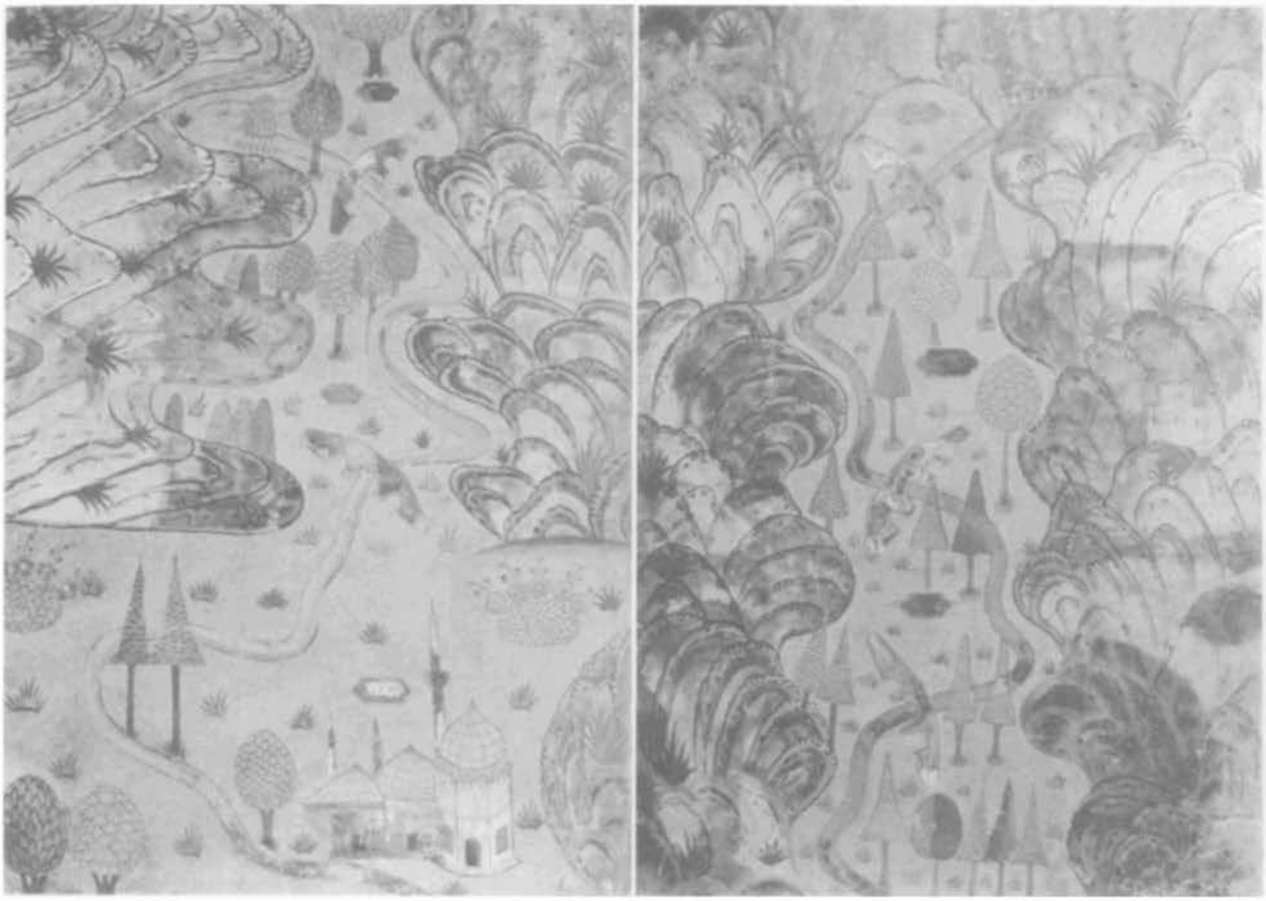


FIG. 12.9. THE COURSE OF THE BITLIS GORGE. A twisting river spanned by several bridges leads to an apparent impasse. The town of Bitlis on the preceding folio (not shown here) was a strategic point in the western approaches to Lake Van in the rugged mountain ranges of east-central Anatolia.
Size of each folio: 31.6 × 23.3 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fols. 100b–101a).

trations in style, coloring, and accuracy of detail.[51] The accompanying text states merely that Süleymān set up camp at the site on his outward journey, doubtless because of the rich summer pastures it afforded his troops. The stay must have given his staff an opportunity for careful observation, but the Mongol city was a ruin with no more than traces of walls. There was evidently a pilgrimage spot in the locality, a rather mysterious "Qaydār Payghambar" that Tīmūr visited on his return from the 804/1402 Anatolian campaign,[52] but we have no evidence from contemporary Ottoman or Safavid sources that anyone knew or cared what the monuments were. This is the most technically refined composition in the *Mecmūʿa-i menāzil.* It may have been worked up by an accomplished painter, perhaps from the court, as a model for the otherwise rather less skilled team that Maṭrāḳçı Naṣūḥ assembled to illustrate the work. In any case, the style of the Sulṭānīye plan did not significantly influence the other illustrations.

51. The appearance of the building on fol. 32b, which no longer exists, is remarkably corroborated by a drawing of a ruined building at Sulṭānīye by Michel-François Préaulx, the official draftsman of the Gardane mission sent by Napoleon to the Persian ruler Fatḥ ʿAlī Shāh (r. 1211–50/1797–1834) after the treaty of Finckenstein, 4 May 1807. The album of his drawings, formerly in the archives of the French Foreign Ministry, can no longer be traced and evidently disappeared in the Second World War. But see Germaine Guillaume, "Influences des ambassades sur les échanges artistiques de la France et de l'Iran du XVII^ème^ au début du XIX^ème^ siècle," in *Mémoires du III^e^ Congrès International d'Art et d'Archéologie Iraniens, Leningrad, Septembre 1935* (Moscow: Akademiya Nauk SSSR, 1939), 79–88, esp. 86–87 and pl. XXXVIII.

52. J. M. Rogers, trans., "V. V. Bartol'd's Article *O Pogrebenii Timura* ('The Burial of Tīmūr')," *Iran* 12 (1974): 65–87, esp. 75, citing Sharaf al-Dīn ʿAlī Yazdī's *Ẓafarnāmah*. Professor Ann K. S. Lambton kindly informs me that Ḥamd Allāh ibn Abī Bakr al-Mustawfī Qazvīnī connected "Qaydār," a son of Ismāʿīl, with Dhū al-Qifl (the Islamic Ezekiel), whose ruined tomb had long been a place of pilgrimage for the Jews, although a mosque was built there in Öljeytü's reign (d. 713/1317); see *Tārīkh-i guzīdah*, ed. ʿAbd al-Ḥusayn Navāʾī (Tehran, 1958–61), 54. A shrine of Qaydār near Sulṭānīye also appears to be an Ilkhanid foundation, but predating the Mongols' conversion to Islam. It has

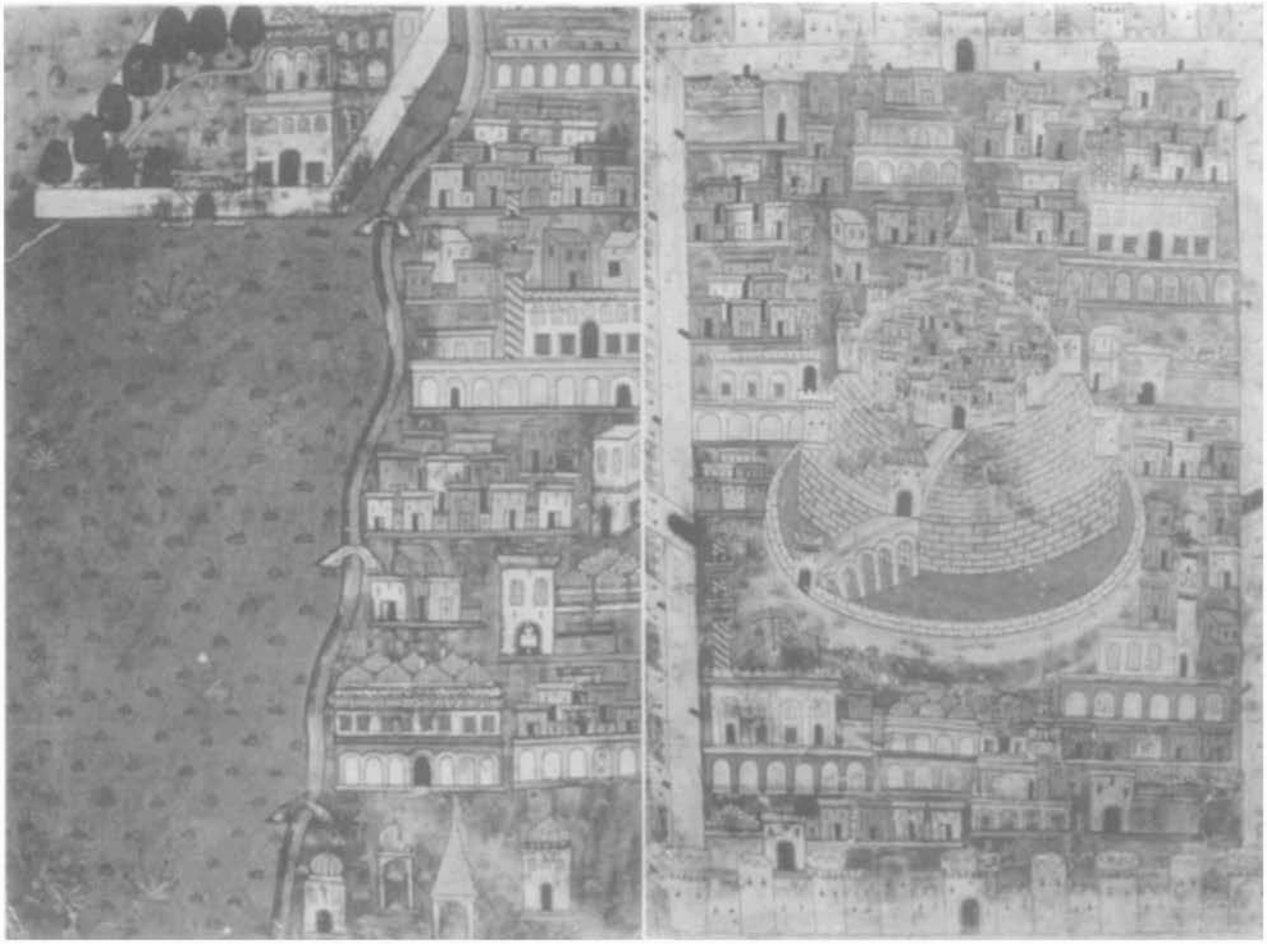


FIG. 12.10. VIEW OF ALEPPO. Size of each folio: 31.6 × 23.3 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fols. 105b–106a).

The other two illustrations of interest—views of the shrines of al-Ḥusayn at Karbala (Kerbelā) (fig. 12.11)[53] and of ʿAlī at Najaf showing the restorations of about 937/1530 by the Safavid shah Ṭahmāsp—are fundamentally different in style from the first. The views in the *Mecmūʿa-i menāzil* of Tabriz and Baghdad and possibly, but more remotely, Erzurum, Khoi, Mianeh (Miyāne), and other northwest Persian towns are closely related in style. The buildings, not always appropriately represented with tiled bulbous domes, many-balconied minarets, and stepped vaults or *muqarnas* domes, are evidently the work of painters conscripted from Tabriz or Baghdad who were familiar with the architecture of early sixteenth-century Safavid Persia and Mesopotamia.

It is clear that these painters worked in a well-established tradition. The views of the shrines at Karbala and Najaf belong to a genre, well known in the fifteenth and sixteenth centuries but going back to the twelfth century, of decorative scrolls attesting that a pilgrim had made the hajj by proxy.[54] Notable examples are a scroll in the name of Maymūnah bint Muḥammad ibn ʿAbdallāh al-

recently been argued, based on this fact, that the name Qaydār could derive from Kedāra, a Himalayan avatar of Shiva, or the Jewish demon Qayd, whose name is associated with the pre-Islamic cults of the Sulṭanīyē area. See Riccardo Zipoli, "Qeidār e Arghūn," in *Solṭāniye II* (Venice: Seminario di Iranistica, Uralo-Altaistica e Caucasologia dell'Università degli Studi di Venezia, 1979), 15–35. The overall accuracy of the view of Sulṭānīye raises the possibility that even the minor monuments depicted in its environs indicate shrines or mausoleums that have now disappeared.

53. The illustration of the mausoleum of al-Ḥusayn on fol. 62b clearly depicts Karakoyunlu and Safavid restorations that were obscured by later work, long before the monument was surveyed by any Western traveler. See Arnold Nöldeke, *Das Heiligtum al-Husains zu Kerbelâ* (Berlin: Mayer und Müller, 1909).

54. The earliest extant illustrated pilgrimage scroll is fragmentary but dated 584/1188–89 (Istanbul, Türk ve Islam Eserleri Müzesi, no. 4104). It measures 160 × 35.5 cm. See Zeren Tanındı, "Islam Resminde Kutsal Kent ve Yöre Tasvirleri," *Journal of Turkish Studies/Türklük Bilgisi Araştırmaları* 7 (1983): 407–37.

Zardalī, dated 836/1432–33,[55] and a scroll dated 951/1544–45 in the name of Şehzāde Meḥmed, Süleymān's son who had died the previous year, which shows the Kaʿba at Mecca and the principal stations of the pilgrimage, the shrine at Medina, and the shrines round about or on the road from Mecca (fig. 12.12).[56] The monuments are shown partly in elevation and partly in bird's-eye view from an angle of approximately sixty degrees. Though they are obviously not intended to be to scale, considerable trouble has been taken to label the sites and represent their distinctive features. These scroll images were then adapted to illustrate sixteenth-century verse guides to the hajj, notably the *Futūḥ al-ḥaramayn* (An encomium of Mecca and Medina) by Muḥyī Lārī.[57] The Najaf and Karbala views, unlike other illustrations in the *Mecmūʿa-i menāzil*, share this viewpoint and color scheme along with the distinctive peculiarity that the building walls are shown folded outward to display arcading. Therefore either these depictions of Najaf and Karbala are a deliberate adaptation of the views on these hajj scrolls or, alternatively, these principal shrines of the Shīʿa developed their own iconographic tradition and this

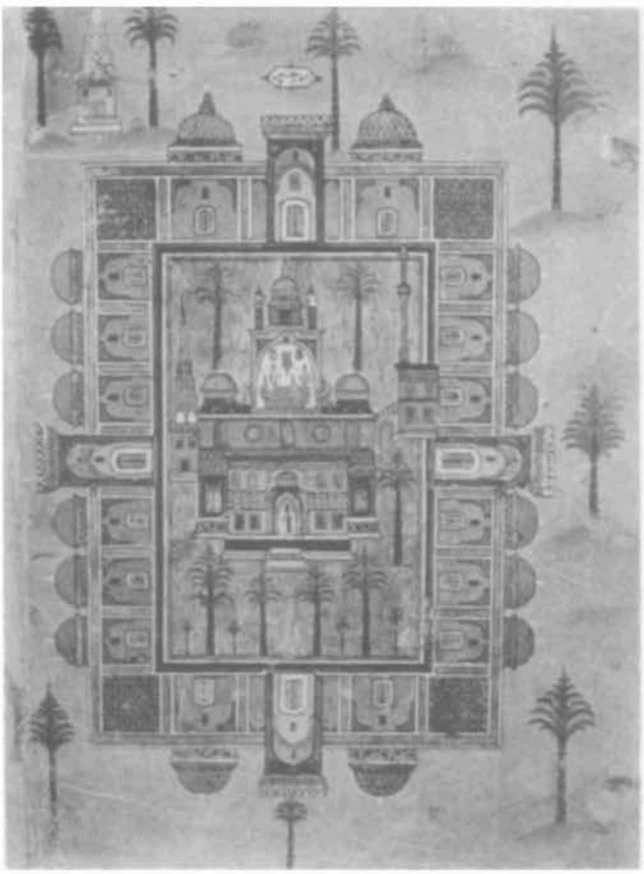


FIG. 12.11. VIEW OF THE SHRINE OF AL-ḤUSAYN AT KARBALA.
Size of the original: 31.6 × 23.3 cm. By permission of Istanbul Üniversitesi Kütüphanesi (TY. 5964, fol. 62b).

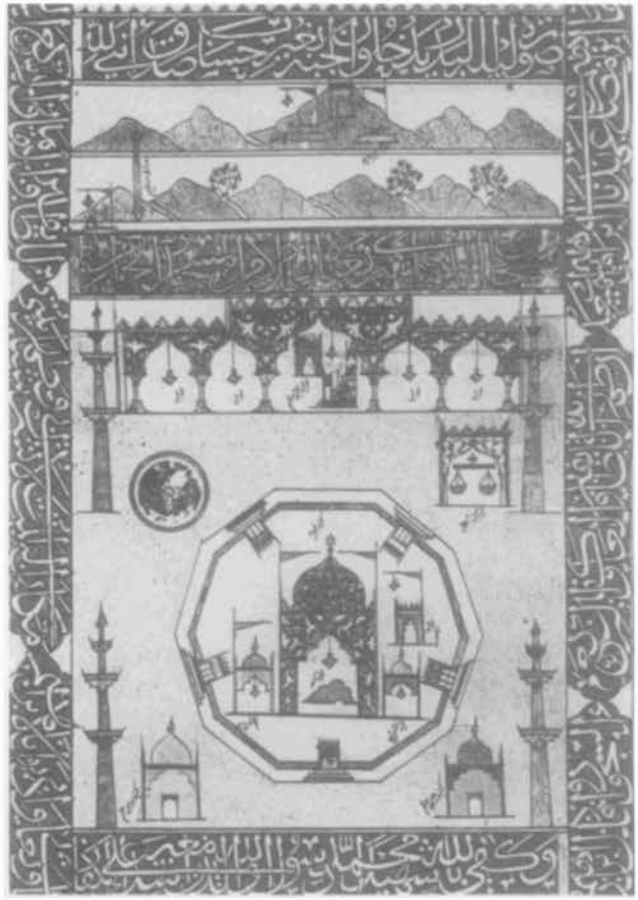


FIG. 12.12. TOPOGRAPHICAL DETAIL FROM A PILGRIMAGE SCROLL. This scroll, prepared in 951/1544–45, depicts the shrines of Jerusalem, Mecca, and Medina, as well as those on the route between them. It commemorates the posthumous proxy pilgrimage of Şehzāde Meḥmed (d. 950/1543). This section shows the Aqṣā Mosque and the monuments of the Ḥaram al-Sharīf around the Dome of the Rock in Jerusalem.
Size of the original scroll: 524 × 46 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1812).

55. London, British Library, Add. MS. 27566; see Richard Ettinghausen, "Die bildliche Darstellung der Kaʿba im Islamischen Kulturkreis," *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 87 (1934): 111–37.

56. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1812; see J. M. Rogers, "Two Masterpieces from 'Süleyman the Magnificent'—A Loan Exhibition from Turkey at the British Museum," *Orientations* 19 (1988): 12–17, which also illustrates six details from this fine scroll. See also Esin Atıl, *The Age of Sultan Süleyman the Magnificent*, exhibition catalog (Washington, D.C., and New York: National Gallery of Art and Harry N. Abrams, 1987), no. 23 on pp. 65 and 307.

57. Originally composed 911/1505–6, though the earliest illustrated manuscripts, like that in the British Library, MS. Or. 3633, dated 14 Ramaḍān 951/29 November 1544, appear to be Ottoman and mid-sixteenth century; see Rogers and Ward, *Süleyman the Magnificent*, no. 37 (note 11).

came to the notice of Süleymān's painters after he invaded Iraq.[58]

Islamic campaign journals written on the spot by eyewitnesses attached to a ruler's staff are attested at least as early as Tīmūr's Indian campaign of 801–2/1399.[59] Under Süleymān the presence of these chroniclers was evidently taken for granted. We have little idea of who, or even how numerous, they were. Maṭrāḳçı Naṣūḥ's campaign books have pretensions to being more finished productions, and his education and training as cavalry officer, courtier, and amateur historian fitted him well for the role of campaign diarist. But whose idea was it that the Persian campaign should be illustrated, if need be with sketches made on the spot? We might see here the influence of Süleymān himself.[60] This would explain why Maṭrāḳçı Naṣūḥ's later campaign journals were all evidently intended to be illustrated and why topographical illustration continued to be such an important part of the chronicles of Süleymān's reign written for his successors.[61] Yet these important and innovative works, far from founding a tradition or establishing the status of campaign illustrators, remained of limited influence.

Topographical Illustration in Later Ottoman Histories

In the decades following the creation of the *Mecmūʿa-i menāzil*, a period mostly occupied with campaigns in Europe, topographical illustration was certainly of preeminent importance. Not surprisingly, it was much more open to European source material—maps, plans, and town views, as well as sketches by renegades or prisoners of war. Such is the case with Maṭrāḳçı Naṣūḥ's illustrated *Tārīḫ-i fetḥ-i Şaḳlāvūn (Şiḳlōş) ve Ustūrġūn ve Usṭūnibelġrād* (Conquest of Siklós, Esztergom, and Székesfehérvár). The first part of this work is an account of Ḥayreddīn Barbarossa's naval campaign in 950–51/1543–44 in alliance with Francis I of France. Intent on disrupting Habsburg control of the western Mediterranean, Barbarossa besieged ports like Nice that had been lost to the Valois and pillaged the Spanish coast.[62] The second part of the *Tārīḫ-i fetḥ-i Şaḳlāvūn* records Süleymān's land campaign of 949–50/1542–43 that established total Ottoman control of Hungary, whose throne had been claimed by Ferdinand of Austria (fig. 12.13).

Maṭrāḳçı Naṣūḥ's manuscript has no colophon, and the Hungarian part, which contains bird's-eye views in the style of the *Futūḥ al-ḥaramayn*, is unfinished. Prominence is given to schematic route maps showing encampments, churches, and fortresses, with labels giving the date of arrival and the distance between the stages in *mīls* (fig. 12.14). The larger bird's-eye views like Esztergom (plate 19), Tata, and Székesfehérvár do not indicate the distance between the previous or the following stages and thus come as something of an interruption in the narrative sequence. The Mediterranean views, mostly from a vantage point at sea, were drawn on the spot by a trained draftsman (for example, Nice, plate 20), though where crosshatching appears (for example, Toulon) the source may possibly have been a contemporary European engraving. An autograph manuscript by Jérôme Maurand d'Antibes, the chaplain to the French ambassador who accompanied Barbarossa's fleet on its return voyage to Istanbul in 951/1544, contains numerous autograph sketches of Italian ports, Mediterranean islands and fortresses, and views of Istanbul, some of them very similar.[63]

One feature of the Hungarian section of the work is

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58. No contemporary scroll of the Shīʿī shrines of Iraq has yet been identified, nor do I know of any verse panegyric of them corresponding to Muḥyī Lārī's *Futūḥ al-ḥaramayn*. But there is a later scroll devoted to the shrines of Najaf and Karbala, possibly seventeenth century, in the private collection of Shaykh Nāṣir ibn Ṣabāḥ of Kuwait. I am grateful to Shaykha Hussa for showing it to me.

59. Ghiyāṣ al-Dīn Yazdī (fl. 1402), *Kitāb-i rūznamāh-ʾi ghazavāt-i Hindūstān* (Diary of Tīmūr's trip to India), with an appendix of corresponding fragments from the *Ẓafarnāmah* by Niẓām al-Dīn Shāmī (fl. 1392), ed. L. A. Zimin and V. V. Bartol'd (Petrograd: Tipografiya Imperatorskoy Akademii Nauk, 1915).

60. The parallel with the Habsburg emperor Charles V (r. A.D. 1519–56), who took the painter Jan Cornelisz. Vermeyen with him on the Tunisian campaign of 1535 in order to record it, is very striking though perhaps coincidental. In each case, however, the desire for glory seems to have stimulated the need for topographical exactitude.

61. An extraordinary, and so far unique, adaptation of this style appears on a blue-and-white Iznik jug of early sixteenth-century type (Istanbul Arkeoloji Müzesi, no. 7591), excavated in Istanbul in 1955 at the madrasa of Merzifonlu Ḳaramuṣṭafā Paşa at the Çarşı Kapı. The body bears repeated squiggles, evidently stylized rivers or roads, with domed buildings and rectangular façades surmounted by twin towers. Pictorial Iznik wares of these decades are exceptionally rare, and the conclusion that the decoration derives from topographical illustration like that of the *Mecmūʿa-i menāzil* is inescapable. See the Council of Europe, XVIIth European Art Exhibition, *The Anatolian Civilisations, Topkapı Palace Museum, 22 May–30 October 1983*, exhibition catalog, 3 vols. (Istanbul: Turkish Ministry of Culture and Tourism, 1983), vol. 3: *Seljuk/Ottoman*, intro. Filiz Çağman, trans. Esin Atıl, E. 39.

62. According to the text, the Ottoman fleet left Istanbul on 12 Muḥarrem 950/18 April 1543 and made its way, via Gallipoli, Euboea, and Korone, across the Ionian Sea to capture Reggio di Calabria on the Strait of Messina. From there it besieged and sacked towns and fortresses all along the Mediterranean coast, as far as Barcelona. The text omits reference to most of the ports attacked; Nice was captured on 22 August 1543, but Toulon and Marseilles were left unscathed. A storm forced the fleet to harbor on the Italian coast at Santa Margherita Ligure and Rapallo. After wintering at Toulon, it started on the return voyage in the spring of 951/1544. See Jean Deny and Jane Laroche, "L'expédition en Provence de l'armée de mer du Sultan Suleyman sous le commandement de l'Amiral Hayreddin Pacha, dit Barberousse (1543–1544)," *Turcica* 1 (1969): 161–211. Their attribution of the text to Sinān Çavuş has been disputed by Yurdaydın in the introduction to *Mecmūʿa-i menāzil*, 131–34 (note 28), who convincingly argues that it is a continuation of Maṭrāḳçı Naṣūḥ's chronicle of the reign of Süleymān the Magnificent.

63. Paris, Bibliothèque Nationale, MS. Lat. 8957.

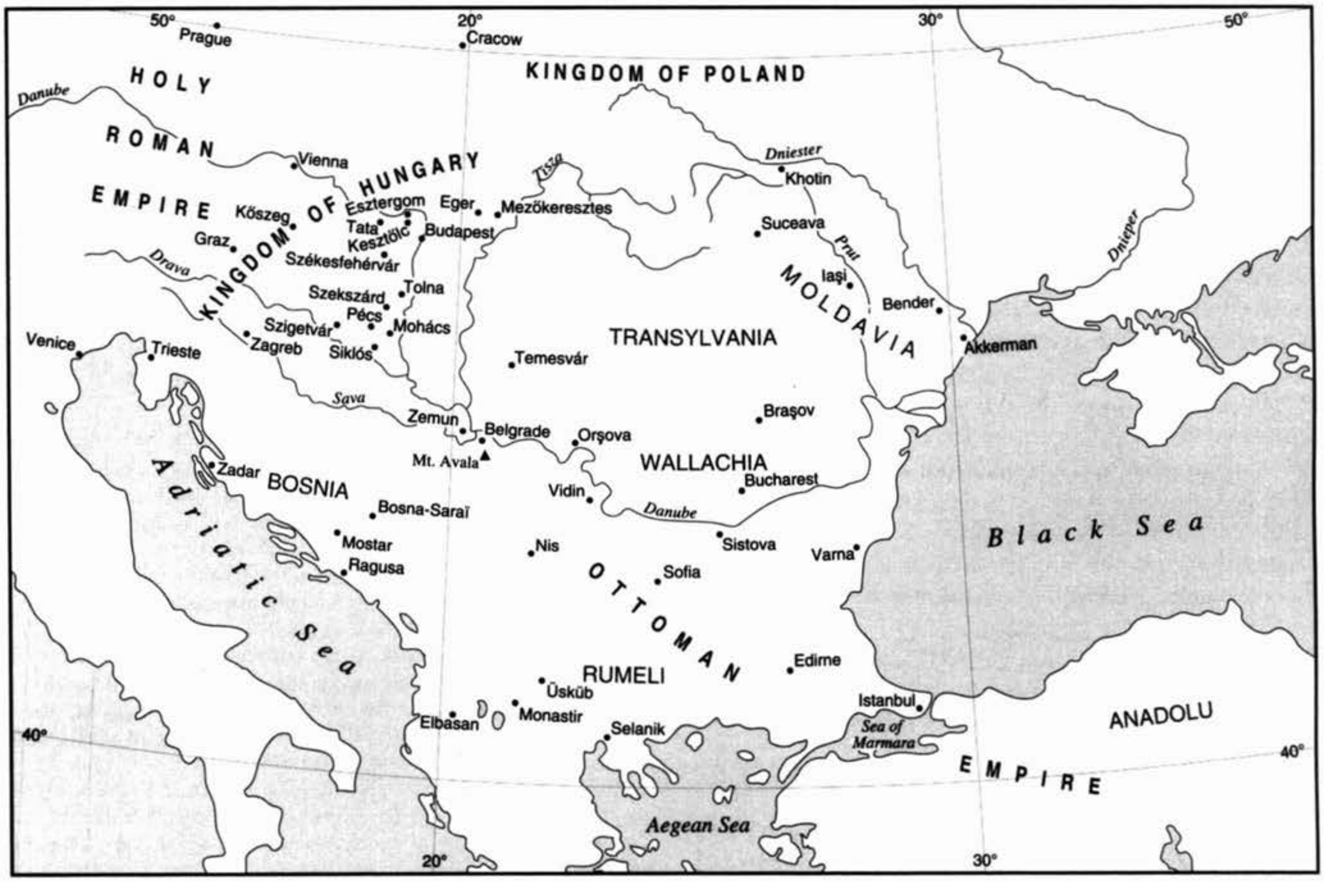


FIG. 12.13. STRATEGIC SITES IN THE OTTOMAN-HABSBURG RIVALRY FOR HUNGARY.

that some town views in elevation are stylized and somewhat misleadingly reminiscent of International Gothic painting. The archaic appearance is probably the effect of the vivid color scale chosen. Drawings of town architecture in elevation, however, characterize some of the more faithful illustrations in the Nuremberg Chronicle and remained widespread in Europe in the early sixteenth century.[64] They continue to appear even as late as the first volume of *Civitates orbis terrarum* published in A.D. 1572. Such views are equally persistent in Ottoman illustration, continuing through the *Fütūḥāt-i cemīle* (Book of five conquests) (fig. 12.15) to the annalistic works of the reigns of Selīm II and Murād III. The increasingly stylized forms in the chronicles of Meḥmed III, Aḥmed I, and ʿOsmān II (for example, the *Şāhnāme-i Nādirī* [Nādirī's book of kings]) have practically no claim to accuracy at all. The initial adoption of this convention in Ottoman Turkey has been attributed to the conscription of painters from the library of Matthias Corvinus at Buda, which Süleymān occupied in 932/1526, though it had probably been partly dispersed by Corvinus's feckless successors.[65] A specifically Hungarian connection is unlikely owing to the lapse of time between the death of Matthias Corvinus (A.D. 1490) and the popularity of the style in Ottoman painting after about 947/1540; it was in any case prevalent all over sixteenth-century Europe. The paucity of early European views of eastern European towns is thus beside the point.

In Ottoman topographical illustration the Hungarian fortress of Szigetvár occupies a preeminent position. Süleymān the Magnificent died there in 974/1566 shortly

64. Typically in the finely executed work of Duarte de Armas, *Livro das fortalezas do reino* (Lisbon, Arquivo Nacional da Torre do Tombo, Casa forte, no. 159), made for Manuel I of Portugal sometime between 1509 and 1516. It contains, generally, depictions of fortresses in two complementary elevations, showing how widespread and deeply entrenched the style already was in early sixteenth-century Europe. Closer to hand are the limestone reliefs on the tomb of the Austrian general Niclas Graf Salm (d. 1530), attributed to Loy Hering but apparently after drawings from the circle of Albrecht Dürer, which show episodes from the Ottoman siege of Vienna, with the city in the background similarly shown in elevation; see Historisches Museum der Stadt Wien, *Wien 1529: Die erste Türkenbelagerung*, exhibition catalog (Vienna: Hermann Böhlaus, 1979), pl. 9. However, it has not been possible so far to relate the elevations in Ottoman topographical illustration to specific European views.

65. Nurhan Atasoy, "1558 tarihli 'Süleymanname' ve Macar Nakkaş Pervane," *Sanat Tarihi Yıllığı* 3 (1970): 167–96, esp. 195, and Filiz Çağman, "Şahname-i Selim Han ve Minyatürleri," *Sanat Tarihi Yıllığı* 5 (1973): 411–42.

FIG. 12.14. STAGES AND DISTANCES ON THE MARCH TO THE FORTRESS OF ESZTERGOM FROM THE *TĀRĪḤ-I FETḤ-I ŞAḲLĀVŪN*. Inscribed in panels are the captions, "On this side of the village of Kestōh [Kesztölc], on 11 Rebīʿ II 950/13 July 1543, four miles." "Opposite to it Seksar [Szekszárd], on 12 Rebīʿ II 950/14 July 1543, two miles and a half." "The castle of Tona [Tolna], on 13 Rebīʿ II 950/15 July 1543, two miles."
Size of the original: 26.1 × 17.5 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1608).

before it fell, and the reign of his successor, Selīm II, had few comparable triumphs. Panoramas of this siege were published in Venice within the year and these images plainly influenced the illustrations to the *Nüzhetüʾl-aḫbār der sefer-i Sīgetvār* (Chronicle of the Szigetvár campaign), the first Ottoman account of the siege by Aḥmed Ferīdūn, written for the grand vizier Sokollu Meḥmed Paşa (d. 987/1579). This account was recapitulated in Loḳmān's annals for the library of Murād III, including the *Süleymānnāme* and volume 2 of the *Hünernāme*. Remarkably, not one of the depictions of Szigetvár in these Ottoman annals is a repeat. The three contained in the *Nüzhetüʾl-aḫbār* are the most varied:[66] a schematic view of the fortifications and the pontoons;[67] a view after a European map (fig. 12.16);[68] and a panorama somewhat adapted to depict the final stages of the desperate battle within the walls of the commandant Miklós Zrínyi's moated castle. (For another early view of Szigetvár, possibly based on firsthand sketches, see fig. 11.3.) The views in the *Süleymānnāme* are also recognizably after firsthand sketches or European views, but, not unnaturally, the concentra-

FIG. 12.15. STYLIZED DEPICTION OF THE FORTRESS OF TEMESVÁR. The cities illustrated in Ottoman histories commonly show superficial but probably misleading similarities to town views in European painting of the International Gothic style. This miniature shows an incident during the siege of Temesvár (Timisoara). Illustration from the *Fütūḥāt-i cemīle* of ʿĀrifī, a court historian contemporary with Maṭrāḳçı Naṣūḥ. Size of this detail: ca. 14 × 17.5 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1592, fol. 19a).

66. These are fols. 28a, 32b–33a, and 41b–42a. All three are reproduced in Géza Fehér, *Turkish Miniatures from the Period of Hungary's Turkish Occupation*, trans. Lili Halápy and Elisabeth West (Budapest: Corvina Press and Magyar Helikon, 1978), pls. XL–XLIIA/B.

67. Compare this, for example, with the plan view by Domenico Zenoi (Venice, 1567) in the Antonio Lafreri atlas, vol. 1, pl. 53 (British Library, Maps C. 7. e. 1–2) with a smaller-format example in the Giovanni Francesco Camocio atlas, pl. 79 (British Library, Maps C. b. 41). The Zenoi map is reproduced in Edmond Pognon, "Les plus anciens plans de villes gravés et les événements militaires," *Imago Mundi* 22 (1968): 13–19, esp. fig. 3.

68. Rogers and Ward, *Süleyman the Magnificent*, no. 46a–b (note 11). There is an early map of Hungary begun by Wolfgang Lazius, the secretary of Cardinal Tamás Bakócz of Esztergom, and completed by Georg Tannstetter before A.D. 1528; see László Irmédi-Molnár, "The Earliest Known Map of Hungary, 1528," *Imago Mundi* 18 (1964): 53–59. The view on fols. 32b–33a of *Nüzhetüʾl-aḫbār* is markedly more detailed.

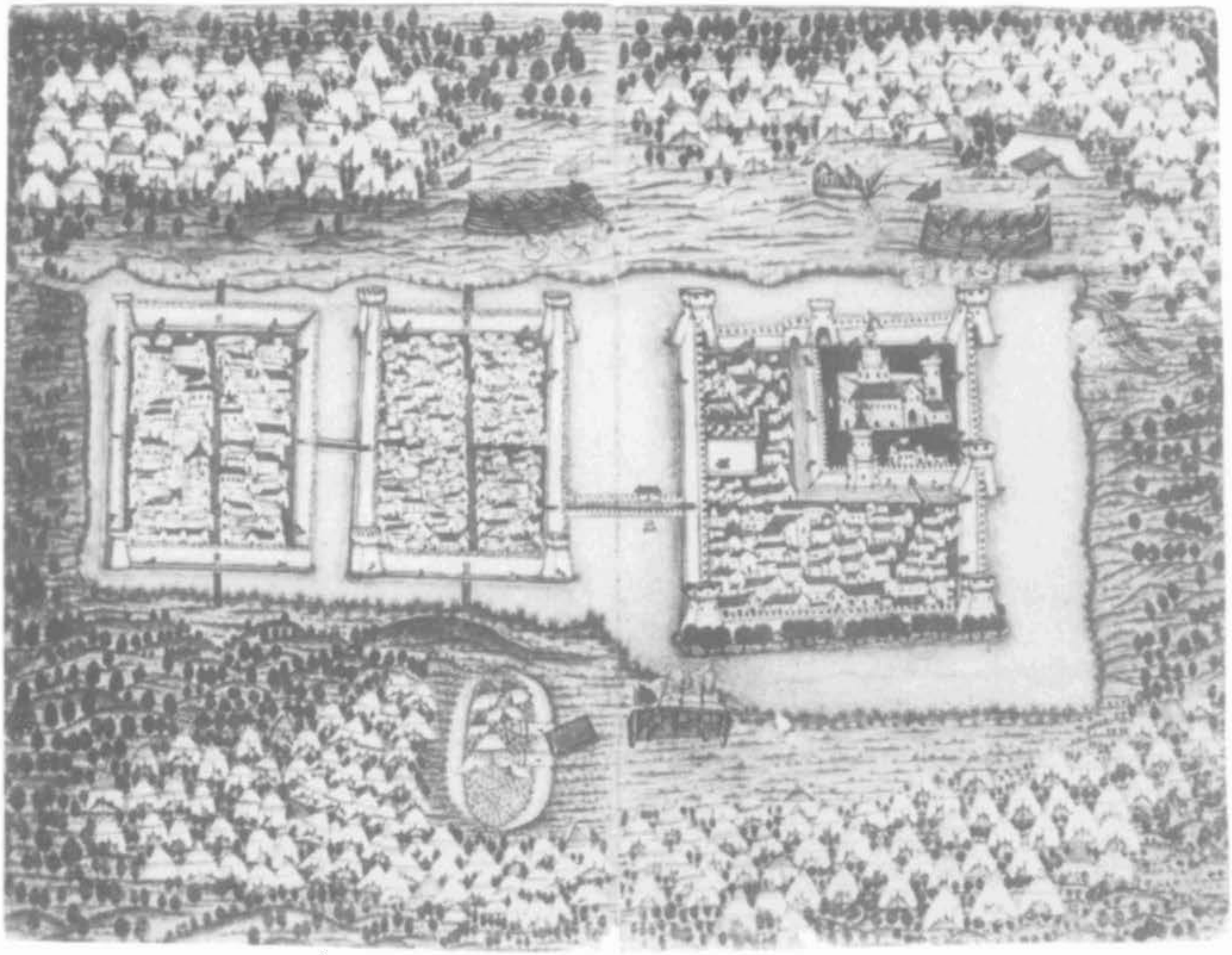


FIG. 12.16. SIEGE OF SZIGETVÁR, BASED ON A VENETIAN PROTOTYPE. This view is from Aḥmed Ferīdūn's account of Süleymān's 974/1566 Hungarian campaign in the *Nüzhetü'l-aḫbār der sefer-i Sīgetvār*. The great sultan died during the famous siege, and to commemorate this Szigetvár is frequently represented in subsequent Ottoman histories. Size of the original: 39 × 50 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1339, fols. 32b–33a).

tion upon the narrative aspects of the siege leads to a degree of stylization (fig. 12.17).[69] By the time volume 2 of the *Hünernāme* came to be illustrated, the immediacy of the event had passed, and the fortress, barely recognizable in panoramic views, has been incongruously squashed into the background of the siege (fig. 12.18).

Unlike the painters working under the supervision of Maṭrāḳçı Naṣūḥ, few if any painters in the palace studio can have known Szigetvár at first hand. The original sketches made in 974/1566 cannot have survived long, and it was the custom of studio artists to copy the work of their colleagues rather than to collect what plans, if any, remained and adapt those. That they would not generally have been encouraged to such a degree of independence is also suggested by the illustrations of Murād III's Transcaucasian campaign of the late 1570s. Here there was no European material to supplement the sources available to studio artists.[70] The views in the earliest dated manuscripts postdate the campaign by almost three years, but the buildings of Kars, which was refortified by the vizier Lala Muṣṭafā Paşa (d. 988/1580), are clearly recognizable (fig. 12.19).[71] Within a couple of years, however, images of Kars were transformed by the copying process into an anonymous fortress type, depicted for example on folios 198b–199a in the Istanbul copy of the *Nuṣretnāme* of Muṣṭafā ʿĀlī. This generalizing occurred even though, according to its author, a manuscript of the *Nuṣretnāme* was illustrated by a team

69. Five scenes are found on fols. 64b–65a, 70a, 71b, 93b–94a, and 95a.

70. Nurhan Atasoy, "Türk minyatüründe tarihî gerçekcilik (1579 da Kars)," *Sanat Tarihi Yıllığı* 1 (1964–65): 103–8.

71. Loḳmān, *Şahanşahnāme*, vol. 1, fol. 127b.

FIG. 12.17. VIEW OF SZIGETVÁR, PROBABLY BASED ON FIRSTHAND SKETCHES, FROM LOḲMĀN'S *SÜLEYMĀN-NĀME.* Although the view was completed thirteen years after the siege, the fortress clearly remains the focus of the work. Size of the original: 37.8 × 26 cm. Reproduced courtesy of the Trustees of the Chester Beatty Library, Dublin (MS. 413, fol. 65).

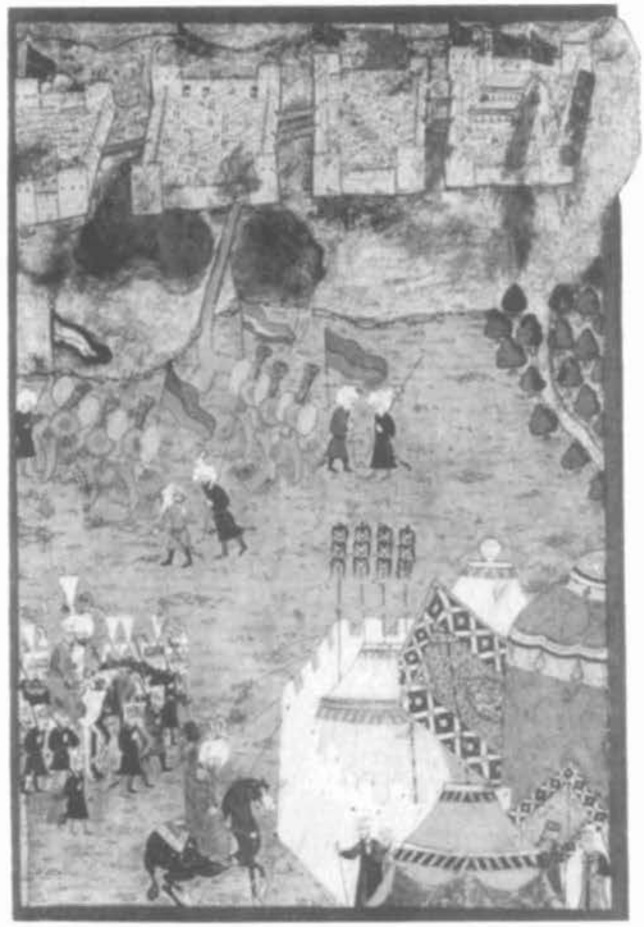


FIG. 12.18. STYLIZED VIEW OF SZIGETVÁR FROM LOḲ-MĀN'S *HÜNERNĀME.* In this miniature, executed two decades after the siege, the distinctive shape of the fortress is barely recognizable. The image extends beyond the right margin. The foreground shows an elaborate tent pitched in advance of Sultan Süleymān's arrival.
Size of the original: 33 × 22.5 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1524, fol. 277b).

of painters from the sultan's scriptorium under ʿĀlī's personal supervision. It is possible that in organizing the work ʿĀlī consciously followed the example of Maṭrāḳçı Naṣūḥ, though he evidently lacked the latter's administrative ability or his concern for topographical accuracy.[72]

After about 988/1580, although townscapes and architecture continued to figure prominently in the illustration of Ottoman historical chronicles, they only rarely corresponded to the actual places. Nevertheless, these bird's-eye panoramas show real invention and interest in topographical illustration, even if part of their originality may result from the lack of *camere ottiche* or other optical aids that Italian executants in this genre had at their disposal.[73] Volume 1 of the *Hünernāme* contains an unhistorical bird's-eye view of Istanbul to illustrate its conquest by Meḥmed II in 857/1453 (fig. 12.20). As with many northern Italian views of the city from Giovanni Andrea Vavassore (fl. A.D. 1510–72) onward, it is taken from the south, and accordingly Galata is shown small and with minimal detail. An innovation, however, is the careful depiction of the buildings on the Golden Horn, with the naval arsenal and the shrine of Eyüp at its head,[74]

72. Fleischer, *Bureaucrat and Intellectual,* 110–11 (note 5). ʿĀlī in his *Naṣīḥatü'l-mülūk* goes on to describe the fees paid to calligraphers, illuminators, and painters of the book as excessive and even accuses the goldbeaters of embezzlement; Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 406. But this treatise was intended to persuade Sultan Murād III of ʿĀlī's zeal for economy and reform, and his report may be little more than window dressing.

73. The standard account of European techniques is Juergen Schulz, "The Printed Plans and Panoramic Views of Venice (1486–1797)," *Saggi e Memorie di Storia dell'Arte* 7 (1970): 9–182, esp. 17–18, citing Eugen Oberhummer, "Der Stadtplan, seine Entwickelung und geographische Bedeutung," *Verhandlungen des Sechszehnten Deutschen Geographentages zu Nürnberg* 16 (1907): 66–101.

74. Müller-Wiener, *Bildlexikon,* 29–71 (note 40).

FIG. 12.19. VIEW OF KARS FROM THE *ŞĀHANŞĀHNĀME*. Shows the completed refortification of the city undertaken by Murād III's general, Lala Muṣṭafā Paşa (seated in the foreground). This city was a base for the Ottoman campaigns in Transcaucasia between 986/1587 and 989/1590 against the Safavids.
Size of the original: 24.5 × 14.5 cm. By permission of Istanbul Üniversitesi Kütüphanesi (FY. 1404, fol. 125b).

in marked contrast to the view of the city in the *Mecmū*ʿ*a-i menāzil* (see fig. 12.4 above). The problem of depicting relief was treated by regular clockwise shifts of the axis, so that the northern half of Istanbul, including most of the great sixteenth-century mosques, is upside down.

In the same volume is a series of views of the Topkapı Sarayı, attributable to the painter Velīcān, from the outermost court with the church of Hagia Eirene to the innermost (fig. 12.21).[75] Though they allegedly represent the palace from the reign of Selīm I (r. 918–26/1512–20), recognizable features date from that of Murād III (r. 982–1003/1574–95)—doubtless a tactful reference to the fact that the *Hünernāme* was written to celebrate not Selīm's but Murād's exploits. The panorama of the innermost court, with the gardens both inside and outside the walls and various pavilions on the Marmara, again uses the device of a rotating axis. The sultan, who is shown seated in the colonnade that fronts the Treasury apartments, must obviously be depicted the right way up, and so most of the buildings are in bird's-eye view. In contrast, the harem buildings are shown in elevation though in a vertical, not horizontal series, perhaps because it was thought to be dangerously indiscreet to show the apartments with their courtyards open to the public gaze.

There were certainly European topographical draftsmen in later sixteenth-century Istanbul, notably Melchior Lorichs (A.D. 1527–90), in the suite of the Habsburg ambassador Ogier Ghislain de Busbecq between A.D. 1554 and 1562. Lorichs's panorama of Istanbul is a valuable topographical record of the city in the reign of Süleymān the Magnificent.[76] However, it is striking that the pervasive European influence that later sixteenth-century illustrated Ottoman annals exhibit owes virtually nothing to European draftsmen and virtually everything to printed sources, mostly Venetian.

By the end of the reign of Murād III (1003/1595), the fashion for bird's-eye views was virtually dead, and the topographical element in illustrated annals began to wane. The period is notable for an interest in the architecture of individual buildings that occasionally shows through in the illustrations of the *Mecmū*ʿ*a-i menāzil* but appears more frequently after 988/1580. A notable example is the depiction of Süleymānīye (the mosque of Süleymān in Istanbul) that was evidently based on a detailed model of the mosque.[77]

75. See fols. 15b (outermost court) to 231b–232a (innermost). Rather carelessly, the outer gate on fol. 15b is labeled not the Bāb-ı Hümāyūn (Imperial gate), as it ought to be, but the Bābü'l-Seʿādet (Gate of felicity).

76. Oberhummer, *Konstantinopel*, passim (note 27). See also Semavi Eyice, "Avrupa'lı Bir Ressamın Gözü ile Kanunî Sultan Süleyman," in *Kanunî Armağanı* (Ankara: Türk Tarih Kurumu, 1970), 129–70. There is also a short account of Istanbul in an album now at Trinity College Library, Cambridge (MS. O. 17.2), depicting the mosque of Selīmīye in Edirne and Selīm II's tomb in Istanbul, as well as the Hippodrome and a standard series of the classical monuments according to Gilles's guide to the antiquities of the ancient city (Pierre Gilles, *De topographia Constantinopoleos* [Lyons, 1561]). See Edwin Hanson Freshfield, "Some Sketches Made in Constantinople in 1574," *Byzantinische Zeitschrift* 30 (1929–30): 519–22 and pl. 2. A drawing from this album is reproduced together with a sketch of the mosque of Süleymānīye in Istanbul with a German text describing its inauguration in 964/1557 (Berlin, Staatliche Museen Preussischer Kulturbesitz, Kunstbibliothek Hdz 4168) in Museum für Kunsthandwerk, *Türkische Kunst und Kultur aus osmanischer Zeit*, exhibition catalog, 2 vols. (Recklinghausen: Aurel Bongers, 1985), 1:226 (no. I/48) and 233 (no. I/55). A note on one of the pages of the Freshfield album suggests that it was executed by a member of the suite of David Ungnad von Sonneck, the imperial ambassador at Istanbul in the mid-1570s. It appears that by this time the larger diplomatic missions regularly brought their own draftsmen with them. Otherwise one might have expected some European contact with the Ottoman palace atelier.

77. Two illustrations of the model are known: one in the *Sūrnāme-i Hümāyūn* shows the model being carried by the corporation of masons parading before Murād III in the Hippodrome; the second, in

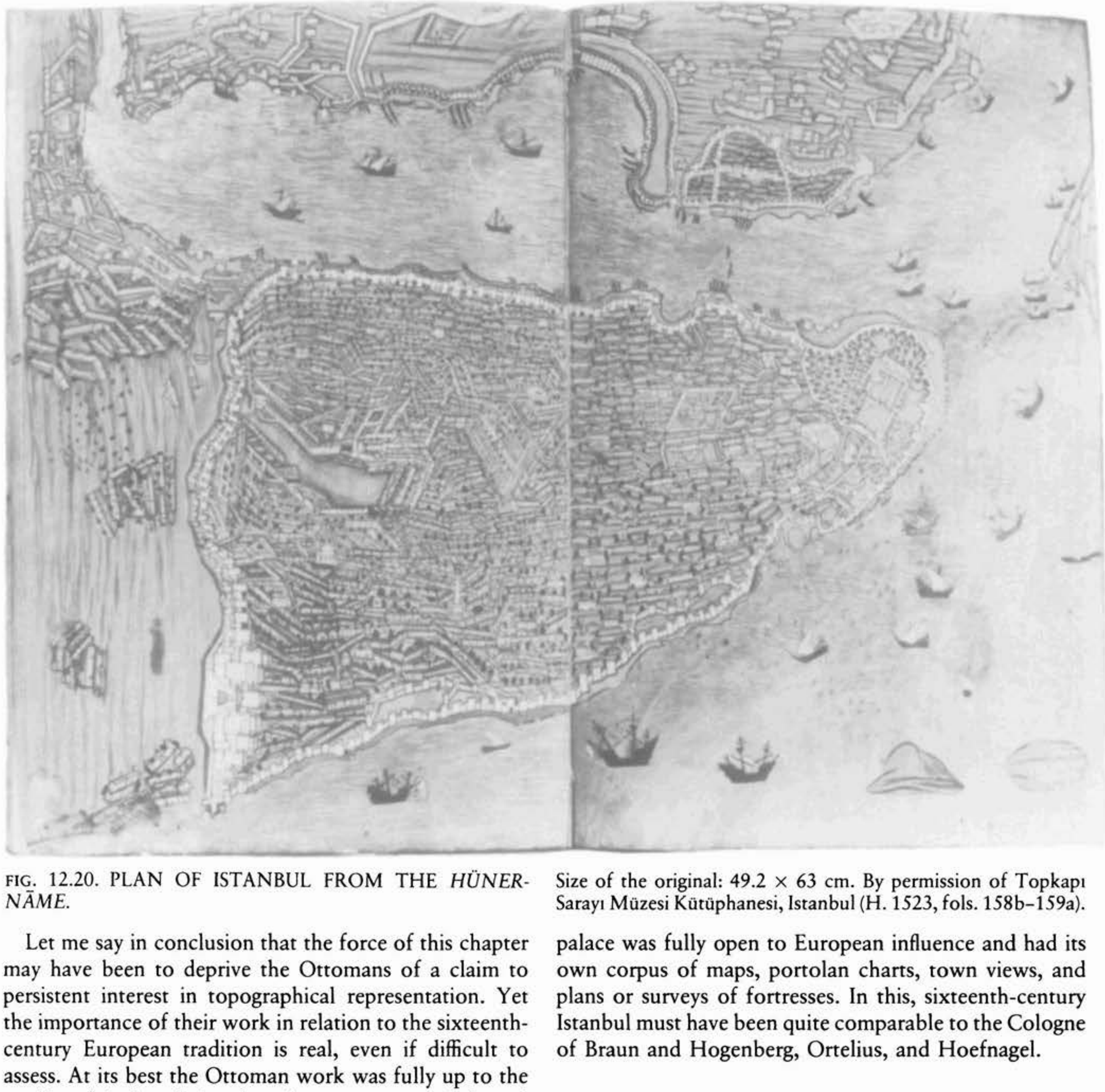


FIG. 12.20. PLAN OF ISTANBUL FROM THE *HÜNERNĀME.* Size of the original: 49.2 × 63 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1523, fols. 158b–159a).

Let me say in conclusion that the force of this chapter may have been to deprive the Ottomans of a claim to persistent interest in topographical representation. Yet the importance of their work in relation to the sixteenth-century European tradition is real, even if difficult to assess. At its best the Ottoman work was fully up to the quality of the best being done in contemporary Italy and Germany. The experimental techniques of the *Mecmūʿa-i menāzil*—although they lacked drawn plans or stereometric perspective—had no lasting effect, but they were an inventive and convincing way of depicting the imperial campaigns in itinerary maps. The adaptation of foreign town views and plans for the illustration of manuscripts in the palace library need not indicate a widespread taste for the genre, since their readership was limited to the sultan and his extended family. But the sources adapted are so varied that they suggest that a public outside the palace was fully open to European influence and had its own corpus of maps, portolan charts, town views, and plans or surveys of fortresses. In this, sixteenth-century Istanbul must have been quite comparable to the Cologne of Braun and Hogenberg, Ortelius, and Hoefnagel.

Loḳmān's *Süleymānnāme*, is closer in elevation to the actual building, but there are marked discrepancies with the plan. See J. M. Rogers, "The State and the Arts in Ottoman Turkey, Part 2: The Furniture and Decoration of Süleymaniye," *International Journal of Middle East Studies* 14 (1982): 283–313, esp. 290–92, and Gülru Necipoğlu-Kafadar, "Plans and Models in 15th- and 16th-Century Ottoman Architectural Practice," *Journal of the Society of Architectural Historians* 45 (1986): 224–43, esp. 239. A representation of Selīmīye (the mosque of Selīm II in Edirne) in the *Şāhnāme-i Selīm Ḫān* (fol. 57b) cannot even have been done after a model. It bears no resemblance to Selīm II's building, and even assuming a basic congruence between elevation and plan, it is not a convincing structure.

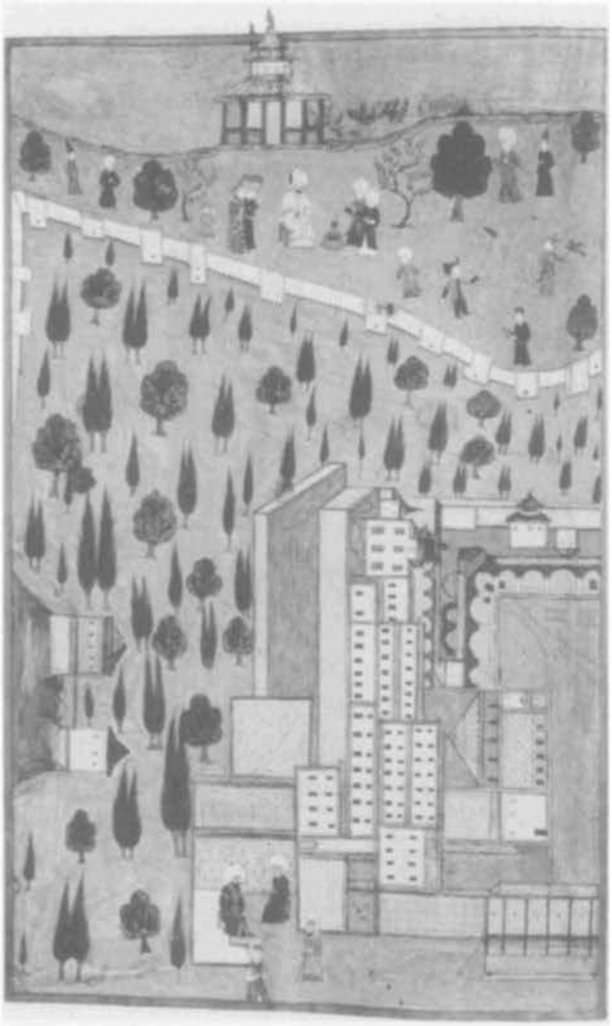


FIG. 12.21. WEST SIDE OF THE THIRD COURT AND ADJOINING GARDENS IN THE TOPKAPI SARAYI FROM THE *HÜNERNĀME*. Buildings represented include the apartments housing the sacred relics and blessed mantle of the Prophet, the hall of the pages of the privy chamber, and apartments of the harem. In a garden outside the wall, the sultan, seated before the Yalı Köşkü (Shore Kiosk), is entertained by pages.
Size of the original: 44 × 55 cm. By permission of Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1523, fol. 232a).

APPENDIX 12.1 SELECTED MANUSCRIPTS

Title	Author
Jāmiʿ al-tawārīkh (Collection of chronicles)	Rashīd al-Dīn Faẕl Allāh (Rashīd al-Dīn Ṭabīb, A.D. 1247?–1318)
Futūḥ al-ḥaramayn (An encomium of Mecca and Medina, composed 911/1505–6)	Muḥyī Lārī (d. 932/1526–27)
Kitāb-i baḥrīye (Book of maritime matters, 1st version 927/1521; 2d version 932/1526)	Pīrī Reʾīs (Muḥyīddīn Pīrī Reʾīs, ca. 875–961/ca. 1470–1554)
Beyān-i menāzil-i sefer-i ʿIrāḳeyn-i Sulṭān Süleymān Ḫān (The stages on Sultan Süleymān's campaign in the two Iraqs; also known as *Mecmūʿa-i menāzil*, A collection of the halts)	Maṭrāḳçı Naṣūḥ (Naṣūḥ al-Silāḥī [or al-Ṣalāḥī] al-Maṭrāḳī, d. 971/1564)
Fetḥnāme-i Ḳaraboğdān (Book of the conquest of Ḳarabuğdān [Moldavia])	Maṭrāḳçı Naṣūḥ
Tārīḫ-i fetḥ-i Ṣaḳlāvūn (Ṣiḳlōṣ) ve Ustūrġūn ve Usṭūnibelġrād (Conquest of Siklós, Esztergom, and Székesfehérvár; also known as *Süleymānnāme*)	Maṭrāḳçı Naṣūḥ (formerly attributed to Sinān Çavuş)
Tārīḫ-i Sulṭān Bāyezīd (History of Sultan Bāyezīd)	Maṭrāḳçı Naṣūḥ
Tārīḫ-i Sulṭān Bāyezīd ve Sulṭān Selīm (History of Sultan Bāyezīd and Sultan Selīm)	Maṭrāḳçı Naṣūḥ
Süleymānnāme (History of Sultan Süleymān)	Maṭrāḳçı Naṣūḥ

[a]Illustrated manuscripts of the *Jāmiʿ al-tawārīkh* held at Edinburgh, London, and Istanbul do not show the capture of Baghdad, as they record history far removed from its fall in A.D. 1258.

[b]A second version is held at the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, R. 917.

[c]Pīrī Reʾīs, *Kitabı bahriye*, ed. Fevzi Kurtoğlu and Haydar Alpagut (Istanbul: Devlet, 1935); see also appendix 14.2, pp. 290–91.

[d]Maṭrāḳçı Naṣūḥ, *Beyān-i menāzil-i sefer-i ʿIrāḳeyn-i Sulṭān Süleymān Ḫān*, introduction, transcription, and commentary, Hüseyin G. Yurdaydın (Ankara: Türk Tarih Kurumu, 1976).

RELATED TO OTTOMAN HISTORIES

Date of Transcription	Content/Description	Location
ca. A.D. 1307–40	General history of the world as known to the Mongol court; various leaves from a dispersed copy; "The capture of Baghdad" (pp. 4 and 7).	Staatsbibliothek Preussischer Kulturbesitz, Berlin, Diez A, Foliant 70[a]
951/1554	An illustrated verse guide to the hajj dedicated to the sultan of Gujarat, Muẓaffar ibn Maḥmūd; 50 fols., 15 illus.	British Library, London, MS. Or. 3633[b]
late sixteenth century	Maritime guide to the Mediterranean, with maps and text illustrating islands, coasts, and harbors. 421 fols., 215 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 642[c]
ca. 944/1537–38	Süleymān's first campaign against the Safavids (940–42/1534–35), resulting in the capture of Baghdad and Tabriz; 109 fols., 128 illus. (number of illus. can only be approximated)	Istanbul Üniversitesi Kütüphanesi, TY. 5964[d]
945/1537–38	Süleymān's campaign into Moldavia in 945/1537–38 is described on fols. 105b–122b of a volume of miscellany; no illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, R. 1284/2[e]
ca. 952–57/1545–50	Account of Ḥayreddīn Barbarossa's Mediterranean naval campaign (950–51/1543–44) and Süleymān's Hungarian campaign (949–50/1542–43); 146 fols., 32 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1608[f]
ca. 952–57/1545–50	Illustrates fortresses and harbors occupied by Bāyezīd II during the period of his rivalry with Prince Cem (886–87/1481–82); 82 fols., 10 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, R. 1272[g]
960/1553	Chronicles the period from the accession of Bāyezīd II (886/1481) to the accession of Süleymān the Magnificent (926/1520); copied by Ṣalāḥ ibn Ḥasan el-Konevī; 191 fols., no illus.	British Library, London, Add. MS. 23586
n.d.	Süleymān's second campaign against the Safavids (955–56/1548–49), in which the Ottomans recaptured Tabriz, Van, and most of Georgia; though allotted space, illustrations were not executed; 157 fols., no illus.	Staatsbibliothek zu Berlin, Orientabteilung Hs. Or. Oct. 955[h]

[e]A. Decei, "Un 'Fetih-nâme-i Karaboğdan' (1538) de Nasuh Maṭrāḳçı," in *Fuad Köprülü Armağanı* (Istanbul: Osman Yalçın, 1953), 113–24.

[f]Twelve illustrations of the Hungarian campaign are reproduced in Géza Fehér, *Turkish Miniatures from the Period of Hungary's Turkish Occupation*, trans. Lili Halápy and Elisabeth West (Budapest: Corvina Press and Magyar Helikon, 1978). Four views of the Mediterranean campaign are reproduced in Hedda Reindl, "Zu einigen Minaturen und Karten aus Handschriften Maṭraqčı Naṣûḥ's," in *Islamkundliche Abhandlungen*, Beiträge zur Kenntnis Südosteuropas und des Nahen Orients, no. 18 (Munich: Rudolf Trofenik, 1974), pls. 4, 5, 7, and 8.

[g]Three views are reproduced in Reindl, "Zu einigen Miniaturen und Karten," pls. 1–3 (note f).

[h]Barbara Flemming, *Türkische Handschriften*, Verzeichnis der Orientalischen Handschriften in Deutschland, vol. 13, pt. 1 (Wiesbaden: Franz Steiner, 1968), 113.

Title	Author	Date of Transcription	Content/Description	Location
Cāmiʿü't-tevārīḫ (A collection of histories)	Maṭrākçı Naṣūḥ	(1) post-957/1550; (2) completed 980/1571–72	Abridged version of al-Ṭabarī's history compiled for the grand vizier Rüstem Paşa: (1) up to the reign of the Sassanian king Bahrām Chūbīn, 430 fols., no illus.; (2) from the legendary ruler Oğuz Khan to the Ottoman campaign of 1569 in the Yemen, 230 fols., no illus.	British Library, London, MS. Or. 12879 and MS. Or. 12592[i]
Fütūḥāt-i cemīle (Book of five conquests)	ʿĀrifī (Fetḥullāh ʿĀrifī Çelebi, d. 969/1561–62)	964/1556–57	The 958/1551–52 Hungarian campaign led by the viziers Sokollu Meḥmed Paşa and Aḥmed Paşa against the fortresses of Temesvár, Pécs, Lipva, and Eger; 31 fols., 7 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1592[j]
Süleymānnāme (History of Sultan Süleymān)	ʿĀrifī	965/1558	Reign of Süleymān between 926/1520 and 962/1555; the culmination of a projected five-volume *Şāhnāme-i āl-i ʿOsmān* (Book of the kings of the family of Osman); 617 fols., 69 illus. attributed to five different artists	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1517[k]
Nüzhetü'l-aḫbār der sefer-i Sīgetvār (Chronicle of the Szigetvár campaign)	Aḥmed Ferīdūn (Ferīdūn Beg, d. 991/1583)	976/1568–69	The 974/1566 Hungarian campaign, including Süleymān's death and Selīm II's accession ceremonies. Text was presented to the grand vizier Sokollu Meḥmed Paşa; 305 fols., 20 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1339[l]
Süleymānnāme (History of Sultan Süleymān)	Loḳmān (Seyyid Loḳmān ibn Ḥüseyin ibn el-ʿĀşūrī el-Urmevī, fl. 977–1010/1569–1601)	987/1579–80	Conceived as the completion of ʿĀrifī's *Süleymānnāme*, which recorded the sultan's activities only to 962/1555; focuses on the 974/1566 Szigetvár campaign; 121 fols., 32 illus.	Chester Beatty Library, Dublin, MS. 413[m]
Şāhnāme-i Selīm Ḫān (History of Sultan Selīm, composed ca. 983/1575)	Loḳmān	988/1581	The reign of Sultan Selīm II; includes the conquest of Cyprus and La Goulette (Goletta) near Tunis; 158 fols., 43 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, A. 3595[n]
Şāhanşāhnāme (History of the king of kings)	Loḳmān	(1) 989/1581–82 (2) 1001/1592	Two-volume biography of Sultan Murād III: (1) 153 fols., 58 illus.; (2) 95 illus.	(1) Istanbul Üniversitesi Kütüphanesi, FY. 1404; (2) Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, B. 200[o]
Sūrnāme-i hümāyūn (Book of the festival)	Loḳmān	ca. 991/1583	Celebrations of the circumcision of the sons of Murād III in 990/1582; 437 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1344

Nuṣretnāme (Book of victories)	Muṣṭafā ʿĀlī (Gelibolulu Muṣṭafā ʿĀlī, 948–1008/1541–1600)	992/1584–85	Conquest of Georgia, Azerbaijan, and Shirvan by the grand vizier Lala Muṣṭafā Paşa in 986/1578; 280 fols., 11 illus.	British Library, London, Add. MS. 22011[p]
Hünernāme (Book of accomplishments)	Lokmān	(1) 992/1584–85 (2) 996/1587–88	History of the Ottoman sultans, originally a four-volume work, of which two volumes have survived: (1) the sultans up to Selīm I, 234 fols., 45 illus.; (2) the life of Süleymān, 302 fols., 65 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1523 and 1524[q]
Şāhnāme-i Sulṭān Meḥmed (Sultan Meḥmed's book of kings; also called *Eğri fetiḥnāmesi*, The proclamation of the conquest of Eger)	Ṣubḥī Çelebi (Taʿlīkīzāde, fl. end of sixteenth century)	ca. 1004–9/1595–1600	Meḥmed III's campaign in Hungary (1003–5/1594–96), including the surrender of Eger and the battle of Mezőkeresztes; 74 fols., 4 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1609[r]
Şāhnāme-i Nādirī (Nādirī's book of kings)	Meḥmed Nādirī	post-1031/1621	Records the Mediterranean campaign of 1029/1620 and ʿOsmān II's campaign of 1031/1621 into Boğdan (Moldavia) that culminated in the capture of Khotin. 77 fols., 20 illus.	Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1124

[i]Maṭrāḳçı Naṣūḥ's name is mentioned in the preface of volume 1 (fol. 4b). The second volume, titled *Tārīḫ-i Oğūziyān ve Çingīziyān ve Selcūḳiyān ve ʿOsmāniyān* but lacking a colophon, was copied for the library of Selīm II. The final section, which records Ottoman history beyond the death of Rüstem Paşa in 1561, was completed by an anonymous author.

[j]Six illustrations are reproduced in Fehér, *Turkish Miniatures* (note f).

[k]Esin Atıl, *Süleymanname: The Illustrated History of Süleyman the Magnificent* (Washington, D.C., and New York: National Gallery of Art and Harry N. Abrams, 1986).

[l]Although the text was presented to the grand vizier, the presence of this illustrated volume in the Topkapı Sarayı Müzesi Kütüphanesi suggests it was a copy for the sultan. Eight illustrations are reproduced in Fehér, *Turkish Miniatures* (note f).

[m]Vladimir Minorsky, *The Chester Beatty Library: A Catalogue of the Turkish Manuscripts and Miniatures* (Dublin: Hodges Figgis, 1958), 19–21 and pls. 5–12.

[n]A second version is held at the British Library, London, MS. Or. 7043.

[o]Authorship of the *Şāhanşāhnāme* is somewhat disputed. I follow the attribution to Lokmān given in Hanna Sohrweide, "Luḳmān b. Sayyid Ḥusayn," in *The Encyclopaedia of Islam*, new ed., 5:813–14, and Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Farsça Yazmalar Kataloğu* (Istanbul: Topkapı Sarayı Müzesi, 1961), no. 792. This chronicle has also been attributed to ʿAlā al-Dīn Manṣūr Shīrāzī, an individual who remains obscure, in Fehmi Edhem [Karatay] and Ivan Stchoukine, *Les manuscrits orientaux illustrés de la Bibliothèque de l'Université de Stamboul* (Paris: E. de Boccard, 1933), 3–6, and Aydın Sayılı, "ʿAlâ al Dîn al Manṣûr's Poems on the Istanbul Observatory," *Belleten* (Türk Tarih Kurumu) 20 (1956): 429–84.

[p]A second version dated 990/1582–83 is held at the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul, H. 1365.

[q]Nigar Anafarta, *Hünername Minyatürleri ve Sanatçıları* (Istanbul, 1969). Fourteen illustrations are reproduced in Fehér, *Turkish Miniatures* (note f).

[r]Four illustrations are reproduced in Fehér, *Turkish Miniatures* (note f).

13 • The Role of Charts in Islamic Navigation in the Indian Ocean

GERALD R. TIBBETTS

The existence of indigenous navigational charts of the Indian Ocean is suggested by several early European sources, the earliest of which is the brief mention of mariners' charts by Marco Polo. First, in connection with Ceylon Polo mentions "la mapemondi des mariner de cel mer,"[1] a reference that can only refer to a nautical map of some sort. Second, in connection with the Indian west coast he refers to "le conpas e la scriture de sajes mariner."[2] This first word has been translated as "charts," and strangely enough it is the very word (*al-qunbāṣ*) used by Aḥmad ibn Mājid (fl. A.D. 1460–1500) in connection with portolan charts.[3]

The other sources are Portuguese and come from the period when that country had reached these parts. The Portuguese mention these charts in some detail. According to João de Barros, Vasco da Gama was shown charts of the coast of India at Malindi before he set out for the first time to cross the Arabian Sea. The text states that a

> Moor of Guzarat, named Malemo Cana ... had shown him a map of all the coast of India, with the bearings laid down after the manner of the Moors, which was with meridians and parallels very small (or close together), without other bearings of the compass; because, as the squares of those meridians and parallels were very small, the coast was laid down by those two bearings of north and south, and east and west, with great certainty, without that multiplication of bearings of the points of the compass usual in our [Portuguese] maps, which serves as the root of the others.[4]

Barros also notes that certain Moorish charts show the Maldives beginning on the latitude of Mount Eli (in Malabar) and continuing on to join the land of Java and the coast of Sunda.[5]

A chart was also mentioned by Ludovic Varthema in his *Itinerario* when he traveled between Borneo and Java sometime before 1508. Here the captain of the ship he sailed in "had a chart which was all marked with lines, perpendicular and across."[6]

It is interesting that only the account of Barros respecting Vasco da Gama's voyage includes the note about the Arab charts; they are not mentioned by Correia or Lopes de Castanheda, who published earlier accounts of the voyage.[7] Barros wrote in the 1540s and could have read Varthema's work, which was in many editions by that date, including an edition in Spanish published in Seville in 1520. There are other occasions when Barros seems to have incorporated later materials into his version of the earlier Portuguese accounts of the Indian Ocean, so some doubt is cast on the accuracy of his statement.

In 1512 another possible local chart is mentioned by Afonso de Albuquerque in a letter to the Portuguese king Manuel. He reports that he had seen a large chart belonging to a pilot on which Brazil, the Indian Ocean, and the Far East were shown. This chart can only have been very sketchy, for the Portuguese pilot Francisco Rodrigues (who had seen and copied this Javanese chart) produced charts about 1513 in which the coasts not already sailed by the Portuguese were shown in a very imperfect way.[8]

1. Marco Polo, *Il milione*, ed. Luigi Foscolo Benedetto (Florence: Leo S. Olschki, 1928), 176 (MS. fol. 77d), and *The Book of Ser Marco Polo the Venetian, concerning the Kingdoms and Marvels of the East*, ed. and trans. Henry Yule, 3d rev. ed., 2 vols. (New York: Charles Scribner's Sons, 1903), 2:312–13.

2. Benedetto's text, 209 (fol. 93a), and Yule's translation, 2:424 (note 1).

3. For Ibn Mājid, see below and also Gerald R. Tibbetts, *Arab Navigation in the Indian Ocean before the Coming of the Portuguese* (London: Royal Asiatic Society of Great Britain and Ireland, 1971; reprinted 1981), 272.

4. Gaspar Correia, *The Three Voyages of Vasco da Gama, and His Viceroyalty: From the Lendas da India of Gaspar Correa*, trans. Henry E. J. Stanley (London: Printed for the Hakluyt Society, 1869), 137–38 n. 2, quoted from João de Barros, *Asia: Década I*, bk. 4, chap. 6 (1552), by Stanley in a footnote to Correia's text.

5. From João de Barros, *Asia: Década III*, bk. 3, chap. 7 (1563); mentioned by Avelino Teixeira da Mota, "Méthodes de navigation et cartographie nautique dans l'Océan Indien avant le XVIe siècle," *Studia* 11 (1963): 49–91, esp. 71.

6. Ludovic Varthema, *The Travels of Ludovico di Varthema in Egypt, Syria, Arabia Deserta and Arabia Felix, in Persia, India, and Ethiopia, A.D. 1503 to 1508*, trans. John Winter Jones, ed. George Percy Badger (London: Printed for the Hakluyt Society, 1863), 249.

7. On Correia, see note 4 above; Fernão Lopes de Castanheda, *Historia do descobrimento & conquista da India pelos Portugueses*, 8 vols. (Coimbra: Ioão da Berreyra e Ioão Alvarez, 1552–61).

8. Afonso de Albuquerque, *Cartas de Affonso de Albuquerque*, 7 vols. (Lisbon: Typographia da Academia Real das Sciencas, 1884–1935), 1:64–65; see also Teixeira da Mota, "Méthodes de navigation," 73 (note 5).

Finally, the famous map of Pīrī Re'īs that is dated 1513 (pp. 269ff. and fig. 14.5) mentions that one of its sources is an Arab map of India (*ʿArabī Hint ḫarṭisi*). The problem is that the eastern part of Pīrī Re'īs's map has not survived. It is not possible to check this information, and his Arab map may have been similar to those of the Arab classical geographers and may have been used only for place-names. That Pīrī Re'īs also mentions other Arab maps and maps drawn in the days of Alexander the Great leads one to suppose he might mean classical Arab maps of Ptolemaic origin. He contrasts these with Portuguese maps of India and China that are "geometrically drawn," as if the Arab maps were not.[9]

Thus, although neither the map of Albuquerque nor that mentioned by Pīrī Re'īs may have been practical navigational charts, the charts mentioned by Barros and Varthema were presumed to be so by those Europeans who saw them. The references of Marco Polo may also have genuinely referred to Indian Ocean navigational charts, although they are too short to give us any practical details. They could, however, indicate that examples like those mentioned by Barros and Varthema existed almost two hundred years earlier. One might therefore expect to find remains of actual charts, traces of their influence, or even descriptions from Arab sources. Yet none of these have been forthcoming.[10]

At the time of Vasco da Gama, there was in circulation in the Indian Ocean a considerable amount of Arab navigational literature in the form of practical advice for navigators and pilot guides for the coasts of the Indian Ocean and China seas. A few examples of this literature have survived in the Arabic works of Ibn Mājid and Sulaymān al-Mahrī, who wrote in the later fifteenth century and the early sixteenth, respectively, and in the Turkish adaptation of Sulaymān by Sīdī ʿAlī Çelebi (Seydī ʿAlī Re'īs) written about 1550.[11] These works are very detailed and cover the whole gamut of navigational science as known to the Muslim sailors in the Indian Ocean during this period.

The Arabs and Persians had been sailing the Indian Ocean before the Islamic era, and once the empire of Islam had become a stable entity, ocean trade was revived and the caliphate acted as a new economic stimulus for long voyages to such places as Africa and China. The Arabs sailed throughout the Indian Ocean and are known to have frequented southern China, and according to the classical Arab geographers they even reached Korea. In Ming times the Chinese reached Africa, and in both Chinese and Arab geographical literature there is a wide knowledge of the whole ocean. In this there is much to suggest that navigation was common to all peoples of the Indian Ocean. Common methods were probably used by all those bordering on the shores of that ocean, and the Arab navigational texts on the subject were to some extent representative of all Indian Ocean sailing.[12] In the same way, navigation in the Mediterranean was common to all sailors around its shores (see chap. 14). It is also clear from the texts mentioned above that Mediterranean methods were not used by Indian Ocean navigators. Ibn Mājid, a prolific writer and an experienced navigator in the Indian Ocean, wrote as if he was acquainted with Mediterranean practice and derided the use of the *qunbāṣ* and scale of miles, which were not required by the Indian Ocean pilot.[13] Both of these things were probably not known at all to the average pilot in the Indian Ocean, and both refer to the methods used in connection with the portolan chart. In fact, the *qunbāṣ* (comparing the information given by Marco Polo above) may be the portolan itself.

One might therefore expect these Arab navigational texts to throw some light on the existence and form of charts the Arabs used for sailing in the Indian Ocean. Some scholars have anticipated a study of these texts by

9. Afetinan, *Life and Works of Piri Reis: The Oldest Map of America*, trans. Leman Yolaç and Engin Uzmen (Ankara: Turkish Historical Society, 1975), 32. For the word *ḫarṭi*, see p. 206. That this is the first known use of the word in Turkish and that all early uses of the word seem to be navigational does not imply that *ʿArabī Hint ḫarṭisi* means an Arab chart of India. It would most likely be an Arab map of India, and I suspect the original map of Pīrī Re'īs is a hybrid like that of al-Ṣifāqsī (see figs. 14.24 and 14.25).

10. The reference to "charts and itineraries of mariners" reported to come from the text of the Arab geographer al-Muqaddasī's *Aḥsan al-taqāsīm* (see the edition *Descriptio imperii moslemici*, ed. Michael Jan de Goeje, Bibliotheca Geographorum Arabicorum, vol. 3 [Leiden: E. J. Brill, 1877; reprinted 1906, 1967], 10), is a false one and of no importance to us here (see William C. Brice, "Early Muslim Sea-Charts," *Journal of the Royal Asiatic Society of Great Britain and Ireland* [1977]: 53–61, esp. 54). The text uses the word *dafātir*, which has been translated by Ranking and Azoo in their edition of al-Muqaddasī's text by the double phrase "charts and itineraries" (*Aḥsanu-t-taqāsīm fī maʿrifati-l-aqālīm*, ed. and trans. G. S. A. Ranking and R. F. Azoo, Bibliotheca Indica, n.s., nos. 899, 952, 1001, and 1258 [Calcutta: Asiatic Society of Bengal, 1897–1910], 13–14). The word *daftar* means an account book or a file and in this case probably means a log book. It cannot have the implication "map." Certainly whenever al-Muqaddasī means "map" in his text, he uses the word *ṣūrah* (see above, p. 95); even "those who have made 'charts' " (Ranking and Azoo translation) is *muṣawwirūn* (from *ṣūrah*) in the text. This reference is expanded in great detail by Ahmad Y. al-Hassan and Donald R. Hill, *Islamic Technology: An Illustrated History* (Cambridge: Cambridge University Press, 1986), 128, but none of their expansion appears in al-Muqaddasī's text itself.

11. A bibliography relating to these works can be found in Tibbetts, *Arab Navigation* (note 3). Important also for this subject is the work of Tomaschek and Bittner; see Sīdī ʿAlī Çelebi, *Die topographischen Capitel des Indischen Seespiegels Moḥîṭ*, trans. Maximilian Bittner, introduction by Wilhelm Tomaschek (Vienna: Kaiserlich-Königliche Geographische Gesellschaft, 1897).

12. Tibbetts, *Arab Navigation* (note 3) has shown connections with Indian and Southeast Asian navigational practice and has elsewhere given comparisons with Chinese and Pacific Ocean navigation. This is mentioned again, note 21 below.

13. See Tibbetts, *Arab Navigation*, 272 (note 3).

assuming that the charts really existed and that their existence would be revealed by a detailed study of the texts.[14] In reality, the texts do not mention charts at all. The Indian Ocean navigators of the fifteenth century seem to have managed quite happily without what is sometimes thought to be an essential guide to navigation.

A chart was an aid to pinpointing a position on the sea, and by comparing this with the position of the destination, a course could be plotted between these two points. A perusal of the Arab pilot guides will show that this particular aid was not really required by the Arab navigator, whose plotting was done in his head. He knew the Pole Star altitude of his destination, and he used a remembered bearing until he reached this Pole Star altitude. He then sailed down the latitude line until he reached his goal. This is a simplified statement, but that is basically what every Arab pilot did. Another version of this process was to remain on the recommended bearing until land was in sight and then to make corrections using landmarks. The Arabs did not conceive of a pinpointed position on an expanse of water relative to a set of invisible coastal points or even to a set of imaginary lines. Their only visible contact with terra firma was the position of the stars relative to the horizon. This gave them their stellar altitude that let them compare their latitude with that of the coast they were aiming toward.

In translating the Arab navigational texts, stellar altitudes have been plotted against bearings and have produced some quite reasonable charts that, if corrected by continual practical use, could have been used by Arab pilots in the same way as portolan charts.[15] There is no evidence at all that the Arabs ever tried this method of navigation, however. The Arab pilots did not produce their guides with a visible representation of the coasts and islands in mind.

From the Portuguese accounts it appears that indigenous Indian Ocean charts were not constructed with rhumb lines, which would be necessary to produce the charts indicated in the previous paragraph in the same way that portolan charts were conceived. The supposed Arab charts would have had to be built up on a grid of lines at right angles, implying that distances could be measured both latitudinally and longitudinally.[16] The Arabs had a method of measuring latitude in their constant use of stellar altitudes, but they had no accurate way to measure longitude at sea, so no chart could be compiled of large oceanic areas. Also, since the longitude of the ship could not be found, it was impossible to use any chart as a later European pilot would do to pinpoint his position.

Attempts by the Arab pilots to measure longitude are noticeable in the Arab navigational texts. A primitive attempt to use stellar risings and settings east and west is ridiculed by the navigational writers. A more sophisticated way was to measure departures. The Arab navigational guides had a standard set of values for "departures" for each compass rhumb as well as a set of values for the distance sailed along the rhumb.[17] In both cases these were based on raising the latitude one *iṣbaʿ* of the Pole Star.[18] Thus, sailing so many *iṣbaʿ*s on a fixed course using a fixed northerly bearing from a point on the Indian west coast and returning on a known bearing to a point at the same latitude on the African coast theoretically would enable one, using these values, to measure the longitudinal distance *(masāfa)* between the two coasts. So although theoretically this kind of triangulation scheme might allow one to draw up a chart of the coasts, the practical difficulties of such a calculation were enormous.[19] However, if the apex of the triangle formed in such an example was a known point on the Arabian coast, things would be simpler. Large numbers of journeys over several centuries would have standardized the bearings around the Arabian Sea, and longitudes and distances could all be calculated from the standard values and the known stellar altitude values at various points. It was thus possible to plot the African coast on a chart, but only if the configuration of the west coast of India was known first. There was no way of linking this information to the earth's surface in the same way that stellar altitude could be linked to the North Pole and South Pole. In the Bay of Bengal a similar situation would occur; it could not be linked to the Arabian Sea, since the width of penin-

14. For example, Juan Vernet Ginés, "Influencias musulmanas en el origen de la cartografía náutica," *Boletín de la Real Sociedad Geográfica* 89 (1953): 35–62, who quotes various works of Gabriel Ferrand, who also expected charts to appear somewhere in the texts but failed to find them. He could only find, like everyone else, navigational statistics that might ultimately lead to charts.

15. See the charts produced in Tibbetts, *Arab Navigation* (note 3).

16. It might be noted that copies of portolan charts were made (like many medieval drawings of any size) by using a grid of lines that were usually erased in the finished chart. It is therefore possible that the Arabs also used a grid for this purpose if their charts had existed, not for the original compilation, and that on a few examples seen by the Portuguese this grid had not been erased.

17. "Departure" is the distance in linear measure traveled due east or west during an oblique sailing. It was used in connection with "raising the Pole" by a fixed interval. It was thus the horizontal distance between due north from one's point of origin and one's actual position. Arab "departures" were given in terms of the horizontal distances between two adjacent rhumbs (11¼°).

18. *Iṣbaʿ* was the Arab unit of measurement for stellar altitude. The word means "finger" and originally represented the angle subtended by one finger's width when held at arm's length from the eye. See Tibbetts, *Arab Navigation*, 313ff. (note 3).

19. A similar kind of triangulation system for the formation of portolan charts in the Mediterranean has been mentioned by Tony Campbell, "Portolan Charts from the Late Thirteenth Century to 1500," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:371–463, esp. 387–88, but the compass does not seem to have been used—only distances by dead reckoning.

sular India could not be measured by similar means at a similar latitude. Sumatra could be linked to eastern Africa in the same way at a lower latitude, but the large distance involved and the infrequency of making such journeys would make compiling this sort of chart virtually impossible. If one were looking for a practical chart compiled by Arab navigators, one would certainly expect bearings and star altitudes to be used as coordinates, not a latitude-longitude grid as the Portuguese seem to suggest.[20] Navigational treatises similar to these Arab and Turkish ones do not seem to have survived in Indian or Southeast Asian literature, and the basic principles of Chinese navigation were different. However, odd references discovered in the literatures of all these nations suggest that a navigational technique similar to that given by the Arab texts was prevalent throughout the Indian Ocean before the coming of the Europeans.[21] Nowhere is there any local evidence of charts.[22]

The history of the latitude-longitude grid in Islamic mapmaking is very obscure, as has been explained in earlier chapters. In spite of detailed tables based originally on those of Ptolemy, the idea of a grid of latitude and longitude lines does not appear on any surviving terrestrial map until the mid-fourteenth century A.D., and then it is only attached around the border of the map, with no reference to the content of the map at all. Even the maps of al-Idrīsī, which are based on interconnecting rectangular sections, have no visible graticule as a base, although the top and bottom borders of the sections are meant to coincide with the climate boundaries.[23] Of all the maps illustrated in Miller's *Mappae arabicae*, only the Iran map from Ḥamd Allāh Mustawfī's *Nuzhat al-qulūb* (Diversion for the hearts) shows an attempt to plot localities on a grid.[24] The grid in these cases consists of straight lines forming a graticule of equal-sized squares. Names of localities are then entered diagonally across the relevant squares. There is only one map of this sort in each version, and in each case it is of Iran with the neighboring regions. Three manuscripts give a coastline, and a glance at this will show that the general lack of accuracy would make them inadequate as a tool for navigation, let alone that the principle of pinpointing localities is not understood and the grid is not based on any practical projection. Teixeira da Mota, in writing of these supposed Arab charts mentioned by Barros, raises the question, How could the Arabs actually use a chart based on a grid?[25] The Mercator projection is peculiar in that all loxodromes are straight lines and their angle to the grid is equivalent to the bearing. Thus the bearing can be measured practically from the chart. The Arabs show no sign of understanding the mathematics behind the Mercator projection, and no other form of grid could be used to the same advantage.

All this points to the conclusion that the Arabs did not have the necessary technical traditions either to construct navigation charts onto a grid of latitude and longitude lines or to use such a chart practically were one available. It therefore seems probable that the maps shown to Vasco da Gama were similar to those given in the manuscripts of Ḥamd Allāh Mustawfī and Ḥāfiẓ-i Abrū and could only have been of academic or popular interest.

In the *Wubei zhi* (Treatise on military preparations)[26] is preserved the Chinese chart based on the voyages of the celebrated Ambassador Zheng He, who sailed with the fleets of the Ming dynasty. The chart shows the routes to Hormuz, the Red Sea, and eastern Africa from China and might also be advanced as evidence for the nonexistence of accurate navigational charts in pre-Portuguese times in the Indian Ocean. Zheng He's last voyage was in 1433, and he is said to have produced maps, but the extant chart is little more than a pictorial representation of the area covered. Had he seen charts of these regions

20. Henri Grosset-Grange, who has also studied these texts and who is an experienced navigator himself, has likewise failed to discover any references to charts actually used by the Arabs, although he has similarly found enough data to create charts from bearings, star altitudes, and so forth. See his "Une carte nautique arabe au Moyen Age," *Acta Geographica*, 3d ser., no. 27 (1976): 33–48, esp. 35, and also idem, "La navigation arabe de jadis: Nouveaux aperçus sur les méthodes pratiquées en Océan Indien," *Navigation: Revue Technique de Navigation Maritime Aérienne et Spatiale* 68 (1969): 437–48, esp. 447. Reinhard Wieber, "Überlegungen zur Herstellung eines Seekartogramms anhand der Angaben in den arabischen Nautikertexten," *Journal for the History of Arabic Science* 4 (1980): 23–47, has gone into great detail mathematically on how charts can be produced from the data given by the Arab navigators, but he admits that no such charts are extant. He does not explain how the Arab navigators acquired such a detailed knowledge of mathematics.

21. This has been mentioned in Gerald R. Tibbetts, "Comparisons between Arab and Chinese Navigational Techniques," *Bulletin of the School of Oriental and African Studies* 36 (1973): 97–108, and idem, *A Comparison of Medieval Arab Methods of Navigation with Those of the Pacific Islands*, Centro de Estudos de Cartografia Antiga, Série Separata, Secção de Coimbra, vol. 121 (Lisbon: Junta de Investigações Científicas do Ultramar, 1979).

22. Except for charts of the *Wubei zhi* sort found in China or similar mnemonic maps from India (see chap. 18).

23. None of al-Idrīsī's maps have lines of latitude and longitude (see chap. 7).

24. These are all from the British Library: MS. Or. 7709, Add. MSS. 16736, 16737, 23543, and 23544. The two manuscripts that do not give a coastline are MS. Or. 7709 and Add. MS. 23544. Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–30), Band 5, Beiheft, Taf. 84–86; see also p. 150 and fig. 6.13. Vernet Ginés, "Influencias musulmanas," 57–62 (note 14), also mentions these maps as the only "Arab" ones with a grid.

25. Teixeira da Mota, "Méthodes de navigation," 70 (note 5).

26. For a modern study on this map, see Ma Huan, *Ying-yai sheng-lan: "The Overall Survey of the Ocean's Shores,"* ed. and trans. Feng Ch'eng-Chün, introduction, notes, and appendixes by J. V. G. Mills (Cambridge: Published for the Hakluyt Society at the University Press, 1970), 236–302 (appendix 2), where Mills calls it the Mao K'un map. See also the Chinese section of the *History of Cartography*, vol. 2, bk. 2.

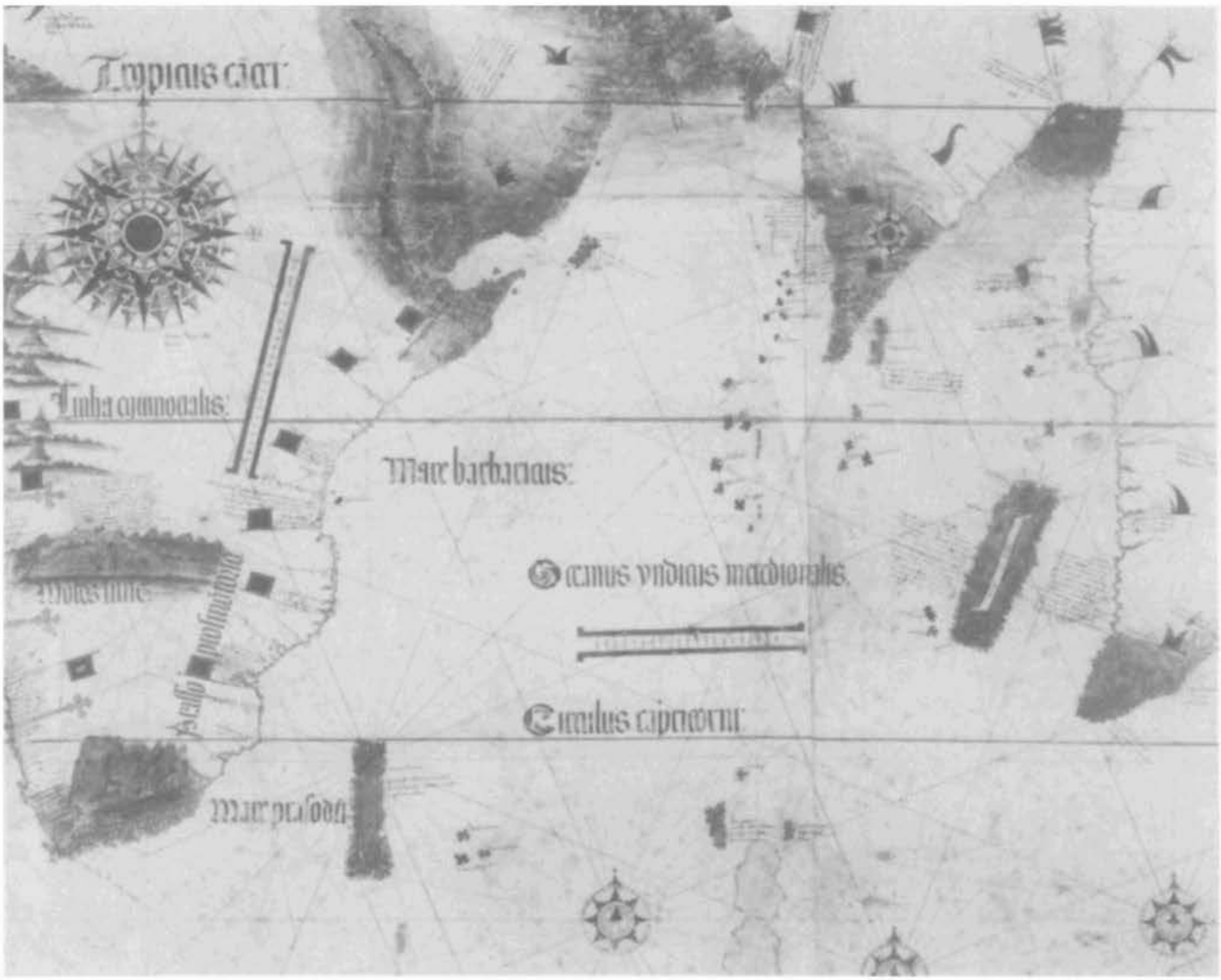


FIG. 13.1. THE INDIAN OCEAN FROM THE CANTINO MAP. The map was compiled between 1498 and 1502, and this detail of the Indian Ocean is about one-sixth of the entire map. Size of the entire map: 200 × 105 cm. By permission of the Biblioteca Estense, Modena (C.G.A. 2).

capable of being used practically, he might have incorporated them in his own attempts, and some slight influence might have penetrated into the *Wubei zhi* survival. However, this chart cannot have been used except for mnemonic purposes: no measurement could be taken from it.[27]

Attempts have been made to detect the influence of local maps or navigational charts on Portuguese cartography of the period.[28] There is, in fact, one type of map that does clearly show local Indian Ocean influence, although this influence becomes weaker as the Portuguese learn more about the Indian Ocean firsthand, until it is eliminated altogether. This type begins with the world map of 1502 of unknown authorship, named after Alberto Cantino, and includes the map of Nicolò de Caverio of 1505 and the woodcut Carta Marina of Martin Waldseemüller (1516). The Cantino map, of course, comes from a time when the Portuguese had reached no farther east than the west coast of India. It shows considerable detail in the area beyond Cape Comorin, and it has always been suspected that this detail came from local sources (fig. 13.1). In 1897 Tomaschek compared this map with the navigational works of the Turkish admiral Sīdī Çelebi, and similar comparisons have been made more recently with the works of the Arab Ibn

27. See Ma Huan, *Ying-yai sheng-lan*, 290–91 (fig. 5) (note 26), for a reproduction of part of this chart.

28. For example, Luís de Albuquerque, "Quelques commentaires sur la navigation orientale à l'époque de Vasco da Gama," *Arquivos do Centro Cultural Português* 4 (1972): 490–500, and Luís de Albuquerque and J. Lopes Tavares, *Algumas observações sobre o planisfério "Cantino," 1502*, Agrupamento de Estudos de Cartografia Antiga, Série Separata, Secção de Coimbra, vol. 21 (Coimbra: Junta de Investigações do Ultramar, 1967).

FIG. 13.2. FOLIOS FROM AN ARAB NAVIGATIONAL TEXT. These pages include a section on the *masāfāt* in the Bay of Bengal from the *Mīnhaj al-fākhir* (The splendid path) by Suleymān al-Mahrī. Size of the original: not known. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2559, fols. 80b–81a).

Mājid and of Sulaymān al-Mahrī, and the influence of the tradition in which these authors wrote was found to be extremely strong.[29] The place-names of the Cantino map are found to be in agreement in many cases with those of the navigational texts. The map gives Pole Star altitudes for a number of places that, although they do not actually agree in every case with the values given in the extant navigational works, are reasonably close and could possibly have been taken from some similar set of values occurring in a text or a tradition that has not survived. In the same way, the longitudinal distances across the Bay of Bengal bear a resemblance to the Arab *masāfāt*, although they cannot be said to agree accurately with the Arab values (fig. 13.2). All that can be said is that if the Arabs drew a straight line north and south for the coast of Burma and measured off the distances across the bay to obtain the Indian east coast, a roughly similar picture would be obtained. But even then the resulting Arab map would have shown the change of direction in the Indian coastline in the neighborhood of the delta of the Godavari River, which the Cantino map fails to do.

Now, whereas the African coasts on the Cantino map are based on material similar to that used for portolan charts, so that this area can be used to some extent as a practical navigation chart, the eastern part of the map could never have been successfully used as a chart by anyone. If the author of the Cantino map had possessed Arab charts that were used for practical navigation in this area, he would have been able to produce a much more accurate version of the Bay of Bengal. One must therefore conclude that he took miscellaneous facts from written Indian Ocean pilot guides and used them with a certain amount of guesswork to continue his planisphere as far

29. See Albuquerque, "Quelques commentaires sur la navigation," and Albuquerque and Tavares, *Planisfério "Cantino"* (note 28). Tomaschek's work appears in *Die topographischen Capitel* (note 11).

as he could obtain suitable information from these local sources. The Arab influence on the Cantino map is limited to three things. The first is the use of Arab place-names, but even some of these are taken from classical Arab sources and not from the navigational texts. The second is the use of Pole Star altitudes. In some cases values are actually given, but their use is very haphazard. What is more noticeable is that places having the same Pole Star altitudes in the navigational texts, for example, on both sides of the Bay of Bengal, are placed on the same latitudes on the Cantino map. There is no complete system, however, and the places are not spaced proportionally down the coast. Also, this map has equated eleven *iṣbaʿ*s of the Pole Star with the Tropic of Cancer and zero *iṣbaʿ*s of the Pole Star with the equator on the western part of the map—which is not true and could not have come from Arab sources. Third, it is possible that the author of the Cantino map utilized the Arab longitudinal distances *(masāfāt):* for instance, to produce his shape for the Bay of Bengal. At least four pairs of places at equal stellar altitude are given *masāfāt* by the Arab texts. The distances across the bay on the Cantino map, however, are not in proportion to those of the texts. As I said above, a similar map using Arab figures would have shown the bend in the Indian east coast near the Godavari Delta and also given some idea of the Gulf of Martaban, neither of which is noticeable in the Cantino map.

One must therefore conclude that the author of the Cantino map could not have used practical Arab charts when compiling his map. He has, however, used Arab maps appearing in literary texts, as can be seen from his nomenclature, and these may have influenced his general shape of Southeast Asia. Information from Arab navigational texts was sufficient to give him a fairly accurate idea of peninsular India, but in Southeast Asia the information in the texts was less detailed and often confusing. This is where the maps in literary texts, with their Ptolemaic approach to the southeast, become obvious. The shape of the Malay Peninsula on the Cantino map is very similar to that on al-Idrīsī's map of 1192,[30] although most of the material inserted on the former is from the navigational texts.

Teixeira da Mota has also pointed out that another map, that of Lopo Homem of 1519, shows the continuation of the Laccadives and Maldives in Java and the Sunda Islands, mentioned above as being a concept seen by Barros in certain Indian Ocean charts. There is no real evidence apart from this in the Homem map to suggest Arab influence. That this map illustrates Barros's statement may be purely coincidental, especially as the map is considerably earlier than the statement. Teixeira da Mota has observed that this concept fits in with the idea given in the Arab navigational texts that Java and the Sunda Islands continue the line of Sumatra in a southeastern direction. However, it is quite clear from these texts that these lands are continuing the line of the Andaman-Nicobar Islands and that the Laccadive-Maldive chain is quite separate.

An Islamic equivalent of the Cantino map is the surviving world map of ʿAlī ibn Aḥmad ibn Muḥammad al-Sharafī al-Ṣifāqsī, which is dated 1579 (see plate 24).[31] This is fundamentally a version of al-Idrīsī in which the Mediterranean part of the latter author is replaced by portolan chart material. It has no grid, but the rhumb lines of the portolan chart are continued across the map to cover the Idrīsī portion of Asia. Like all Islamic maps, the detail is on land and not coastal, and this to some extent confirms that Arab charts of the Indian Ocean were not available even to Muslims when they might have been required in 1579.

One final example is the passage from the Portuguese André Pires' *Livro de marinharia:* "If by chance you come across a Moorish chart."[32] This is followed by an explanation of how to convert the Arab *iṣbaʿ* (*polegadas*) to European degrees (*graus*). However, from the language of this passage it appears that Pires had probably never come across a Moorish chart. This further confirms what we would expect from the evidence already presented.

All in all, the evidence for indigenous maps (pre-1500) in the Indian Ocean that could be used for practical navigation seems to be entirely negative. The so-called charts shown to the Portuguese were much more likely to have been literary compositions similar to those that survive today in Arabic manuscript atlases and geographical works. Had the Portuguese seen something more useful, it is most likely that its influence would have been more apparent in Portuguese cartography, and the Cantino map and those of Francisco Rodrigues would have revealed something of it and been considerably different than they actually are. Perhaps we should really have been able to solve the problem if the eastern parts of the Pīrī Reʾīs map of 1513 had survived. We would at least have been able to see what contemporary Islamic marine cartography had made of the area.

30. Miller, *Mappae arabicae*, Band 1, Heft 3 (note 24), who calls it the "Kleine Idrīsī."

31. Carlo Alfonso Nallino, "Un mappamondo arabo disegnato nel 1579 da ʿAlî ibn Aḥmad al-Sharafî di Sfax," *Bollettino della Reale Società Geografica Italiana* 53 (1916): 721–36. On this family of mapmakers, see pp. 284–87.

32. See Luís de Albuquerque, *O livro de marinharia de André Pires*, Agrupamento de Estudos de Cartografia Antiga, Secção de Coimbra, vol. 1 (Lisbon: Junta de Investigações do Ultramar, 1963), 220, and Teixeira da Mota, "Méthodes de navigation," 74 (note 5).

14 • Islamic Charting in the Mediterranean

SVAT SOUCEK

INTRODUCTION

The evidence of sea charts, ship design, and navigational terminology and practice suggests a great deal of interaction between the marine traditions of Islamic and Christian states bordering the Mediterranean. This chapter examines the corpus of Arabic and Turkish portolan charts dating from the fourteenth to the seventeenth centuries, focusing on their relation to their European counterparts. As in volume 1 of this *History*, the term "portolan" is reserved for a text of sailing directions; "portolan chart" and "portolan atlas" are used for its cartographic representations. All the charts discussed in this period are manuscript; unlike their Western counterparts, there is no record that any traditional Islamic charts were printed.

The extant cartographic record can only hint at the interplay between the diverse cultures of two faiths that surrounded the Mediterranean. No examples of Ottoman Turkish portolans earlier than 906/1500 are known to have existed, but we have four charts from this early period made in the Maghreb. After a brief discussion of these artifacts, I will analyze the work of Pīrī Reʾīs and the charts of both the Ottoman portolan atlases and the al-Sharafī al-Ṣifāqsī family made at the height of Turkish naval power in the mid-sixteenth century (see appendix 14.1 for a full listing of these charts).[1] This record suggests that chartmaking centers may have existed in North Africa, in the vicinity of Tunis and Tripoli, and certainly at the Ottoman capital of Istanbul and its surrounding coastal region. While the corpus of maps continues to grow in number, the subject merits further research.

The record also reveals that Islamic chartmaking was heavily influenced by European models, but the exact nature of this relationship is undetermined. There was more involved than the mechanical copying of coastal outlines and the adaptation of place-names to Arabic or Turkish. But whether this signifies the existence of a "charting tradition" or a "school of chartmakers" in these cultures is far from clear. The voluminous literature on these charts has tended to be somewhat nationalistic from both the Islamic and the Western viewpoints. The latter has tended to stress an almost complete reliance on Italian and Catalan models, while the former has stressed the independence of the Islamic tradition. As I will show, there is truth in both assertions, depending on which charts are being discussed. All we can say with certainty is that chartmakers of North Africa and Ottoman Turkey worked in relative independence of each other, even if their maps were derived from or influenced by the same European sources.

ARAB PORTOLAN CHARTS

Four marine charts are grouped together for discussion in this section because they are in Arabic and all closely follow the content, format, and style of Italian and Catalan portolan charts. They are not direct copies, however, since all show the addition of considerable Arabic toponymy. Three of the charts were prepared in the Maghreb and are earlier than A.D. 1500, therefore representing the earliest extant examples of Islamic marine mapping. Circumstances regarding the origin of the fourth chart are uncertain.

The earliest of the extant charts in Arabic, the "Maghreb chart," has been dated by Vernet Ginés to about 730/1330 (fig. 14.1), on the grounds of a higher density of place-names in England and Ireland than is found on thirteenth-century charts, though it probably predated the Angelino Dulcert chart of A.D. 1339.[2] At first impres-

1. For a general background to the Ottoman navy, see İsmail Hakkı Uzunçarşılı, "Baḥriyya: The Ottoman Navy," in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960–), 1:947–49; Andrew C. Hess, "The Evolution of the Ottoman Seaborne Empire in the Age of Oceanic Discoveries, 1453–1525," *American Historical Review* 75 (1970): 1892–1919; Colin H. Imber, "The Navy of Süleyman the Magnificent," *Archivum Ottomanicum* 6 (1980): 211–82; and Kātib Çelebi, *Tuḥfetüʾl-kibār fī esfāriʾl-biḥār* (Gift to the notables on the subject of naval campaigns), first published in 1141/1729; see the modern Turkish edition by Orhan Şaik Gökyay (Istanbul: Milli Eğitim, 1973) and a partial English translation, *The History of the Maritime Wars of the Turks*, trans. James Mitchell (London: Printed for the Oriental Translation Fund, 1831). An excellent general bibliography to the subject of Ottoman maritime cartography is found in Wilhelm Leitner, "Die türkische Kartographie des XVI. Jhs.—aus europäischer Sicht," in *Proceedings of the Second International Congress on the History of Turkish and Islamic Science and Technology, 28 April–2 May 1986*, 3 vols. (Istanbul: İstanbul Teknik Üniversitesi, 1986), 1:285–305, esp. 293–98.

2. Milan, Biblioteca Ambrosiana, MS. S.P. II 259; see Juan Vernet Ginés, "The Maghreb Chart in the Biblioteca Ambrosiana," *Imago*

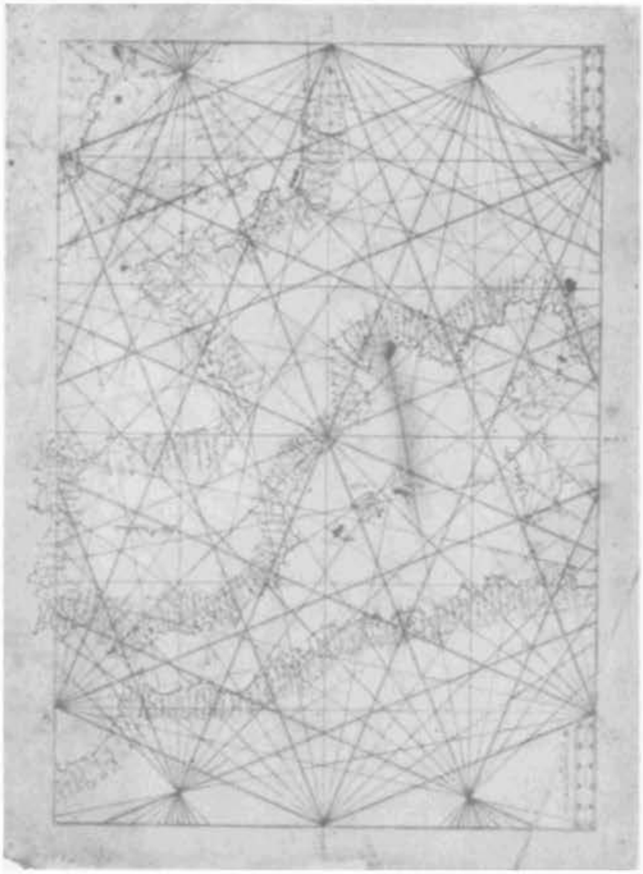


FIG. 14.1. THE MAGHREB CHART. This manuscript chart is drawn on paper in black and red ink with place-names in Maghribī script. The script cannot be used for precise paleographic dating, because little stylistic change took place during the thirteenth and fourteenth centuries when the chart is believed to have been made. There is reason to believe the chart was produced in either Granada or Morocco—probably the former. It covers an area approximately from 33° to 55°N and 10°W to 11°E.
Size of the image: 24 × 17 cm. By permission of the Biblioteca Ambrosiana, Milan (MS. S.P. II 259).

sion, in its simplicity and lack of decoration, the chart bears all the characteristics of an early Western portolan chart, with the familiar pattern of radiating rhumb lines, unnumbered scales, and names drawn perpendicular to the trend of the coastline. Only the Maghribī script appears to indicate its origin. The toponymy is of mixed derivation: Arabisms, Catalanisms, Italianisms, and Hispanisms are found for words such as "cape" and "gulf." Of the 202 identifiable place-names (not including those on the North African coast, which are all Arab or Berber in origin), 48 may be considered of Arab origin. The long, prominent name in the middle of the Iberian Peninsula reads Wasaṭ Jazīrat al-Andalus (Center of the Peninsula al-Andalus) reflecting the earlier use of the name "Andalusia" to refer to the whole peninsula.

William Brice notes that the rhumb line arrangement is almost identical to the Angelino de Dalorto chart of A.D. 1325, suggesting that one was copied from the other and adding that the two may, of course, have been copied from a single common source.[3] From the alignment of a northerly rhumb (one of sixteen) near the center of the chart, crossing Cape Nao in southeastern Spain and Beachy Head in southern England (both approximately on the same meridian), the rotation is about 13.7°. The average magnetic declination on the whole chart is about 6°. The legends state that each whole scale (labeled "house" in Arabic) represents 100 "miles"; from internal measurement, it may thus be calculated that the "mile" in use equaled about 1.9 statute miles.

A second example is a chart made by Ibrāhīm ibn Aḥmad al-Kātibī of Tunis in 816/1413–14. It covers the entire Mediterranean and includes a diagram of the lunar mansions (fig. 14.2). A red arabesque border and brilliant pigments used to color the Mediterranean islands and the mouths of the Nile and Danube rivers are prominent features of the chart. There are no flags and pennons, elaborate wind roses, or vignettes except for two small creatures (one appears to be a lion) represented on the tip of Scandinavia, which barely appears at the top of the chart. Place-names are written in red and black in *Maghribī* script. The city of Tunis, where the chart was made, is represented as a castle, alongside which is a golden symbol of the governing Hafsid dynasty. The circumstances of how this chart came to the Topkapı Sarayı library are not known, but some scholars believe it may have been there already at the time of Süleymān the Magnificent (r. 926–74/1520–66).[4]

Slightly more attention has been given to another chart from the fifteenth century by Ibrāhīm al-Mursī, dated 865/1461 (fig. 14.3).[5] This chart, drawn on gazelle hide, is of the entire Mediterranean and Black Sea, with a calendar in the neck of the parchment at its eastern end. Its margins are decorated in an arabesque red-and-white

Mundi 16 (1962): 1–16, esp. 4. This chart is drawn on paper rather than vellum, unusual for charts of this early date, and it is possible that more information on the map's origin could be gleaned by examining the paper.

3. William C. Brice, "Early Muslim Sea-Charts," *Journal of the Royal Asiatic Society of Great Britain and Ireland*, [1977], 53–61.

4. Istanbul, Topkapı Sarayı Müzesi, H. 1823; see İbrahim Hakkı Konyalı, *Topkapı Sarayında Deri Üzerine Yapılmış Eski Haritalar* (Istanbul: Zaman Kitaphanesi, 1936), 258–61 and pl. 8, and Doğan Uçar, "Über eine Portolankarte im Topkapi-Museum zu Istanbul," *Kartographische Nachrichten* 37 (1987): 222–28.

5. Istanbul, Deniz Müzesi, no. 882; see Ettore Rossi, "Una carta nautica araba inedita di Ibrāhīm al-Mursī datata 865 Egira = 1461 Dopo Cristo," in *Compte Rendu du Congrès International de Géographie (11th International Congress, Cairo, 1925)*, 5 vols. (Cairo: L'Institut Français d'Archéologie Orientale du Caire, 1926), 5:90–95, and Doğan Uçar, *Mürsiyeli Ibrahim Haritasi* (Istanbul: Deniz Kuvvetleri Komutanlığı Hidrografi Neşriyatı, 1981).

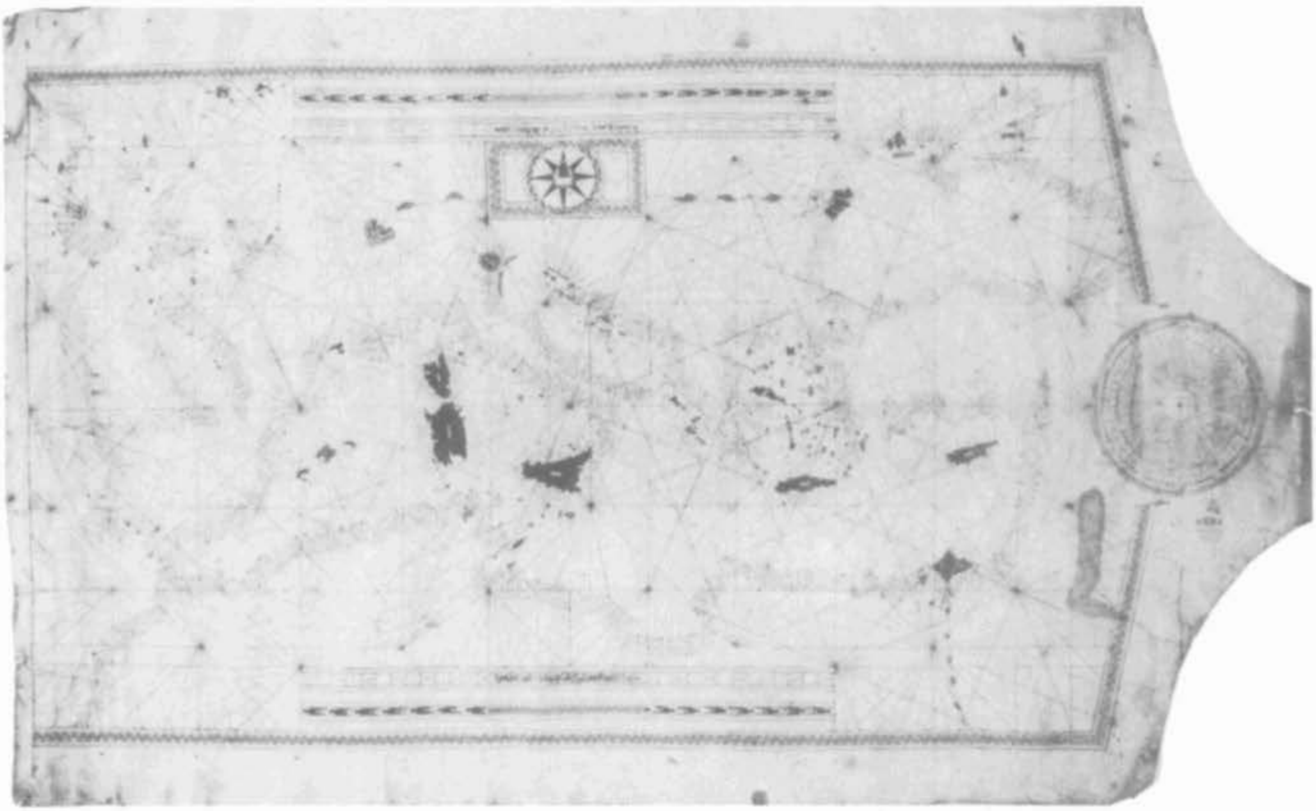


FIG. 14.2. THE AL-KĀTIBĪ CHART. Signed and dated by al-Katībī of Tunis in 816/1413–14, this chart of the Mediterranean and the Black Sea contains a lunar calendar in the neck of the vellum, two long, elaborate scales, and a single distinctive compass rose top center with north highlighted.
Size of the image: 54 × 88 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1823).

plaited border, and the place-names are written in Maghribī. A legend at the northern side of the chart reads in part: "I have made this [chart] in the city of Tripoli, may God protect it, on the 15th [of the venerated month] of Ramaḍān, in the year 865 [24 June 1461]." This is partially repeated on the southern border, where the maker identifies himself as the physician Ibrāhīm, originally from the city of Murcia in southern Spain. Among the Western charts it most closely resembles, Rossi lists several but singles out that of Albino da Canepa (A.D. 1480), with an almost identical representation of Venice and Genoa.[6] He concludes that the main sources of the chart were Western but points out that considerable original additions to the toponymy of the Islamic territories have been made.

A final example of an Arab portolan chart does not fit well chronologically into this group, since it was probably drawn after the main period of Ottoman chartmaking had gathered momentum (fig. 14.4). This large chart is signed by Ḥājj Abū al-Ḥasan but is undated. The inclusion of the Cape of Good Hope and Madagascar in the southeast corner dates it as after 905/1499 (Vasco da Gama's return from India), but the evidence of the flags places it even later, in the reign of Süleymān the Magnificent.[7] The coast of Scandinavia—with dense toponymy—has been straightened to fit the northern border and squares off the irregular shape of the vellum. In the south, similar license has been taken with a large part of the African continent, again bearing dozens of coastal place-names, which is diagrammatically fitted into the small space between the southern border of the chart and the irregular edge of the vellum.

PĪRĪ RE'ĪS

Indirect evidence suggests that charts and chartmaking were familiar to Ottoman mariners in the late fifteenth and early sixteenth centuries. During the reign of Sultan Bāyezīd II (r. 886–918/1481–1512), ambitious policies for the Ottoman navy (*baḥrīye*) began to show notable success against the Venetians. Bāyezīd recruited Aegean

6. Rossi, "Carta nautica araba inedita," 93 (note 5), and Tony Campbell, *The Earliest Printed Maps, 1472–1500* (London: British Library, 1987), 105.

7. Istanbul, Topkapı Sarayı Müzesi, H. 1822; see Konyalı, *Topkapı Sarayında*, 130–36 and pl. 2 (note 4).

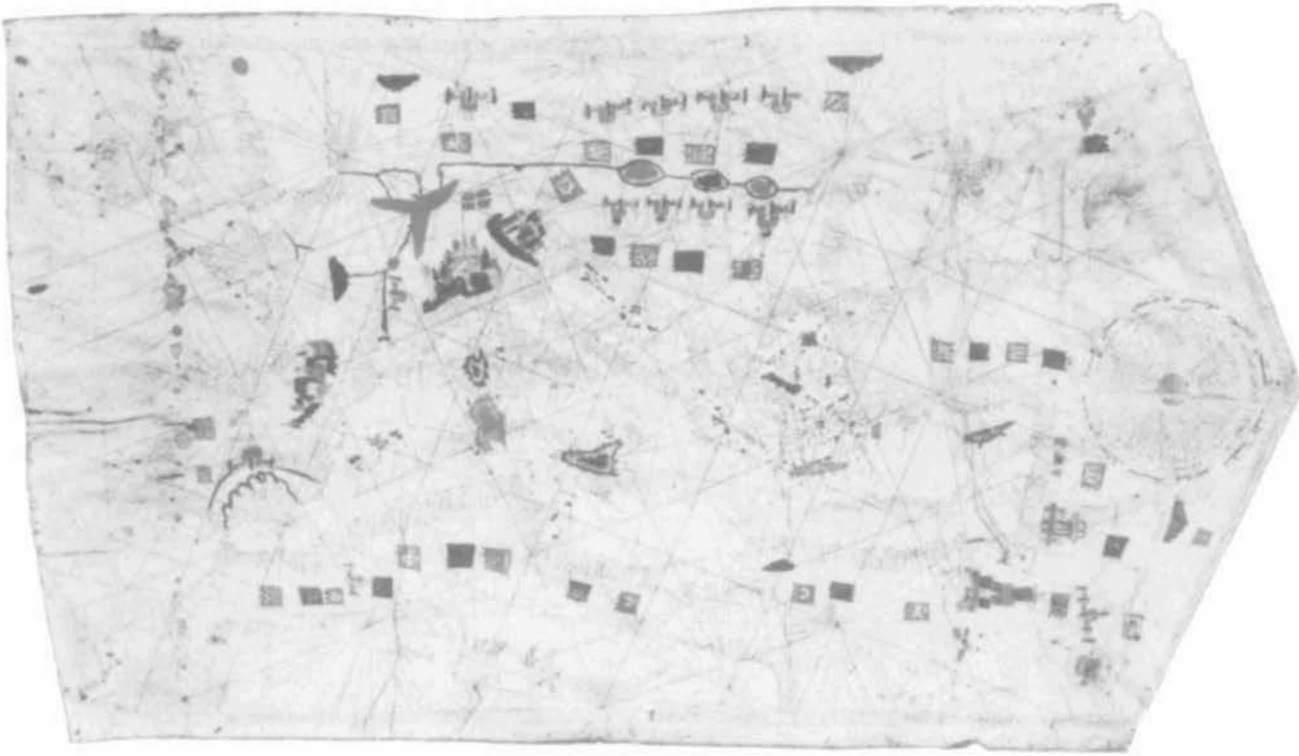


FIG. 14.3. THE AL-MURSĪ CHART. From legends on this chart, we learn that the physician Ibrāhīm al-Mursī made it in Tripoli in 865/1461. The Mediterranean islands are brightly colored in blue, red, green, and gold. The Danube River is prominently featured in green in the upper half of the chart, with three large islands and a string of brightly colored fortresses along its banks. The geographical sources for this map are similar to those used on the Genoese chart by Albino da Canepa, with considerable additions in the Islamic territories.
Size of the image: 48 × 89 cm. By permission of the Turkish Naval Forces from the collection of the Deniz Müzesi Komutanlığı, Istanbul (no. 882).

corsairs to serve as skippers on his ships, and with their expert skills the Ottoman sultan could claim supremacy in the eastern Mediterranean by 908/1503 with the capture of Korone, Methone, Navarino (Pylos), Lepanto (Naupaktos), and Durazzo (Durrës). As Brice and Imber have pointed out, the constant and increasing activities of the Turkish corsairs and official Ottoman fleets would have been difficult to accomplish without charts or sailing directions of some kind.[8] However, in this early period it is difficult to firmly establish links between the Western portolans and portolan charts, made chiefly by the Italians and Catalans, and Ottoman naval activity associated with the making or use of maps.

The first direct evidence we have of Ottoman chartmaking is several extant works by the naval captain Muḥyīddīn Pīrī Reʾīs (ca. 875–961/ca. 1470–1554). *Reʾīs* means captain in Turkish, but despite Pīrī Reʾīs's position and long experience in the Ottoman navy, almost no biographical information exists outside his own works, particularly the *Kitāb-i baḥrīye* (Book of maritime matters), a manual of sailing directions.[9] His father's name was Ḥācī Meḥmed, and unconfirmed tradition has it that Pīrī Reʾīs was born at Gallipoli in the Dardanelles, which was then the most prominent Ottoman naval base. After

8. William C. Brice and Colin H. Imber, "Turkish Charts in the 'Portolan' Style," *Geographical Journal* 144 (1978): 528–29. At the great arsenals of Galata and Gallipoli, the imperial fleet was housed and repaired, specialized naval facilities were maintained, and experienced captains (*ḫāṣṣa reʾīs*), crews, and shipyard personnel were assembled. The Turks' principal competitors, both economically and militarily, were Italian city-states in the eastern Mediterranean and the Spanish Habsburgs in the west. As Ottoman naval power grew, a network of small flotillas protected interests in the Aegean, while the Levantine coast was the responsibility of fleets stationed at Alexandria and Rhodes. After the conquest of Egypt in 923/1517, the port of Suez gave direct Ottoman access to the Red Sea and the Indian Ocean, while corsairs in imperial employ controlled strategic ports along the North African coast. To support the Hungarian campaigns, several flotillas were maintained on the Danube.

9. Standard biographical sources include Paul Kahle, *Piri Reʾīs Baḥrīje: Das türkische Segelhandbuch für das Mittelländische Meer vom Jahre 1521*, 2 vols. (Berlin: Walter de Gruyter, 1926–27; idem, "Piri Re'is: The Turkish Sailor and Cartographer," *Journal of the Pakistan Historical Society* 4 (1956): 99–108; Abdülhak Adnan Adıvar, *La science chez les Turcs Ottomans* (Paris: G. P. Maisonneuve, 1939), 63–67, and the Turkish edition, *Osmanlı Türklerinde ilim*, 4th ed. (Istanbul: Remzi Kitabevi, 1982), 74–85; and Afetinan, *Life and Works of Piri Reis: The Oldest Map of America*, trans. Leman Yolaç and Engin Uzmen (Ankara: Turkish Historical Society, 1975). Other recent biographies and listings of literature are Klaus Kreiser, "Pîrî Re'îs," in *Lexikon zur Geschichte der Kartographie*, 2 vols., ed. Ingrid Kretschmer, Johannes Dörflinger, and Franz Wawrik (Vienna: Franz Deuticke, 1986), 2:607–

FIG. 14.4. THE ḤĀJJ ABŪ AL-ḤASAN CHART. This richly ornamented chart is undated but can be assigned to the reign of Süleymān the Magnificent (mid-sixteenth century) from the evidence of the flags. In the neck of the vellum there is a prominent calendar including a compass rose with fleur-de-lis pointing east. Parts of the map have been distorted to fit the shape of the vellum.
Size of the original: 74 × 100 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 1822).

886/1481 he is believed to have sailed with his uncle Kemāl Reʾīs, the corsair who took part in the Ottoman capture of Euboea (874/1470) and who was later called to official service as an admiral in the Ottoman navy.[10] From 892/1487 to at least 916/1510, while intermittently on voyages along the North African coast, Pīrī Reʾīs gathered notes for his *Kitāb-i baḥrīye*. The voyages from Tunisia were particularly important to his subsequent charting activities. Djerba was the base from which Kemāl Reʾīs and his nephew made numerous voyages to transport Islamic (and some Jewish) refugees from Spain. Taking part in the bombardment of Málaga in 892/1487, when he was only sixteen or seventeen, Pīrī Reʾīs came to know many of the western Mediterranean coasts and harbors intimately.

After his uncle's death in 917/1511, Pīrī Reʾīs left the navy and returned to Gallipoli. It was there that he began work on both a map of the world (completed 919/1513) and the notes for the *Kitāb-i baḥrīye*. In 923/1517 he returned to active duty in the Ottoman navy and was given command of several ships in the campaign of Sultan Selīm I (r. 918–26/1512–20) against Mamluk Egypt. The

9; Sevim Tekeli, "Pīrī Rais (or Reʾīs), Muḥyī al-Dīn," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 10:616–19; Franz Babinger, "Pīrī Muḥyi 'l-Dīn Reʾīs," in *The Encyclopaedia of Islam*, 1st ed., 4 vols. and suppl. (Leiden: E. J. Brill, 1913–38), 3:1070–71; Fuad Ezgü, "Pîrî Reis," in *Islâm ansiklopedisi*, 13 vols. (Istanbul: Millî Eğitim, 1940–88), 9:561–65; and Konyalı, *Topkapı Sarayında*, 5–64 (note 4). For information on Pīrī Reʾīs's life derived from the *Kitāb-i baḥrīye*, see Svat Soucek, "A propos du livre d'instructions nautiques de Pīrī Re'īs," *Revue des Etudes Islamiques* 41 (1973): 241–55, and idem, "Tunisia in the *Kitab-i bahriye* by Piri Reis," *Archivum Ottomanicum* 5 (1973): 129–296.

10. An Ottoman source suggests that Kemāl Reʾīs was a Turk originally from the Anatolian province of Karaman, and we may assume the same origin for Ḥācī Meḥmed, Pīrī Reʾīs's father. See Hans-Albrecht von Burski, *Kemāl Reʾīs: Ein Beitrag zur Geschichte der türkischen Flotte* (Bonn, 1928), 40–58, and Nejat Göyünç, "Kemāl Reʾīs," in *Encyclopaedia of Islam*, new ed., 4:881–82.

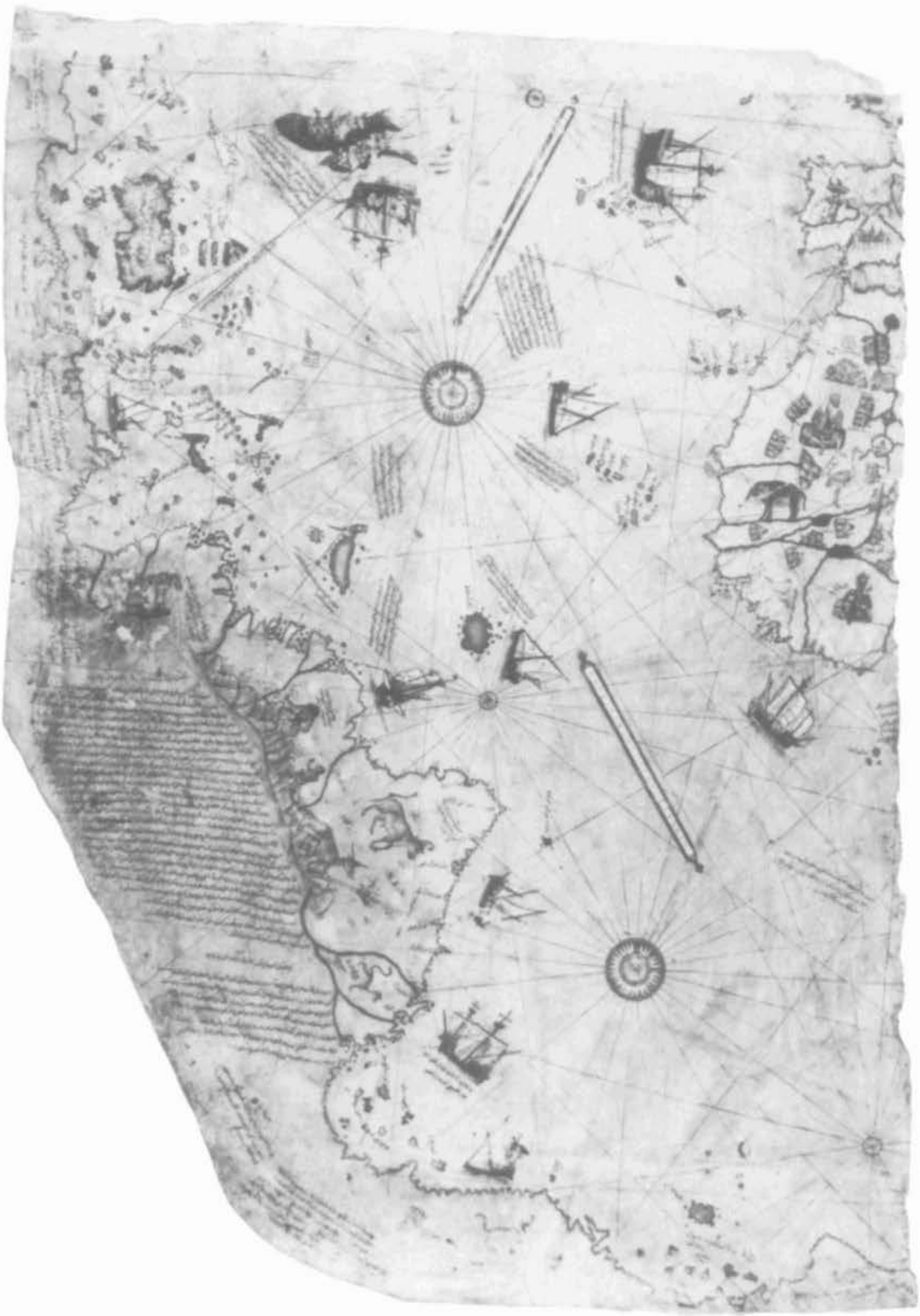
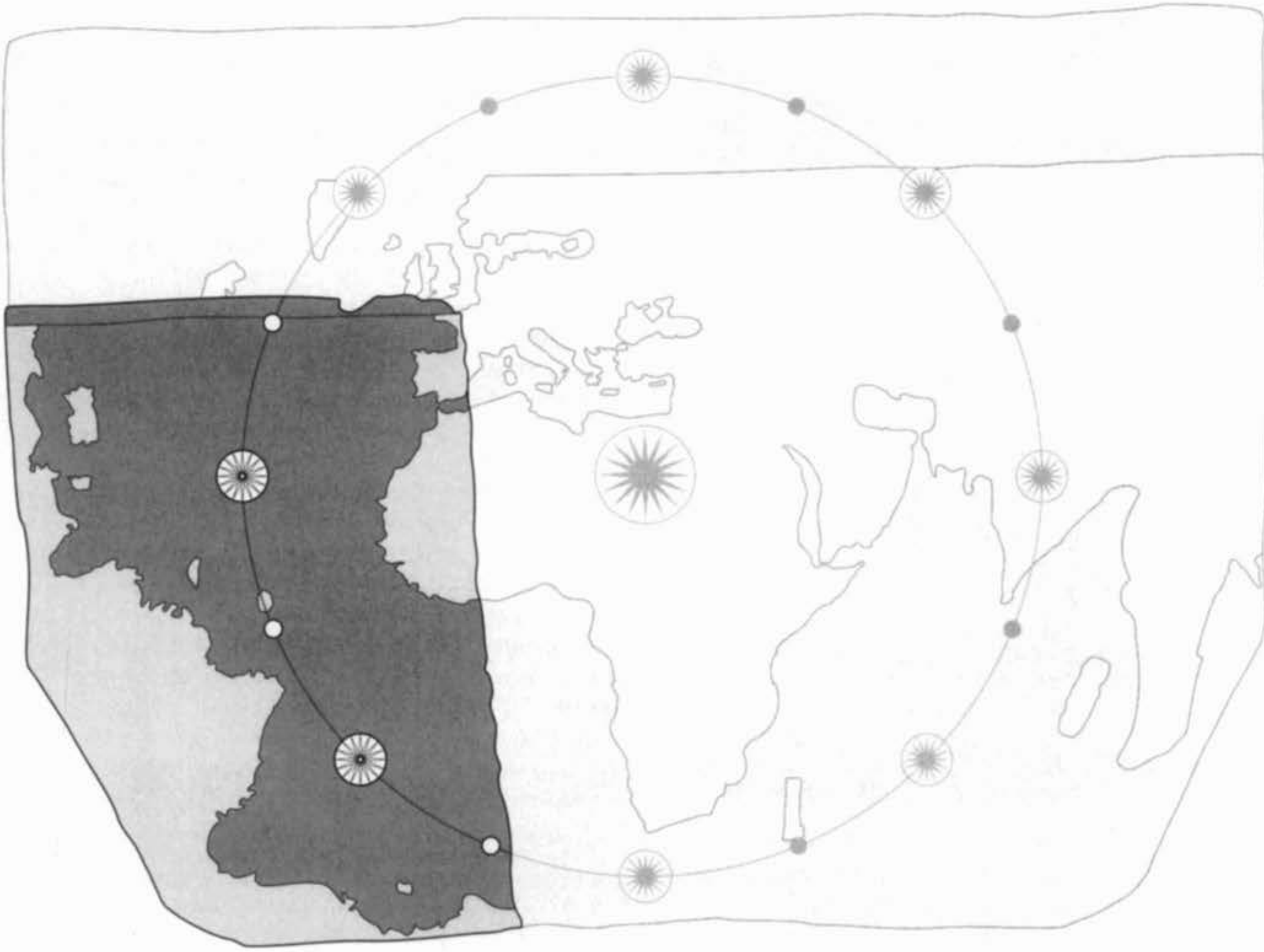


FIG. 14.5. ATLANTIC FRAGMENT FROM THE 1513 WORLD MAP OF PĪRĪ RE'ĪS. This is the only surviving fragment of a map of a large part of the known world drawn on several pieces of parchment. The circumstances surrounding its making as well as its sources are set out in its Arabic colophon (center left) and in the numerous legends in Turkish. In the long legend inscribed on the South American mainland we are told that the sources included a copy of a map "of the Western Parts" by Columbus, apparently acquired from a Spanish prisoner.

Size of the original: 90 × 63 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (R. 1633 mük).



N.B. Reconstructed coastlines are generalized from a contemporaneous world map and are intended only as a conjectural indication of the possible geographical extent.

FIG. 14.6. POSSIBLE ARRANGEMENT AND EXTENT OF THE 1513 WORLD MAP. By superimposing the existing fragment (fig. 14.5) on the 1502 Cantino planisphere, it is possible to make a provisional reconstruction of the area covered by the remaining portion of Pīrī Reʾīs's whole map. The southern and western edges of the fragment reflect the natural edges of the gazelle hide it was drawn on, and the northern edge is clearly meant to have been attached to an adjoining piece. The torn eastern edge of the parchment extended farther, but exactly how far is a conjectural matter.

first version of *Kitāb-i baḥrīye* appeared in 927/1521, and Pīrī Reʾīs hoped in vain that it would attract the attention of the new Sultan Süleymān. In 932/1526 he completed a second version of the *Kitāb-i baḥrīye*, still with the intent of gaining the sultan's favor. Sometime later he appears to have started work on another world map, although we know little about its content or even whether it was completed. Only the northwest corner of this planisphere has survived, signed in his hand and dated 935/1528.

Toward the end of his career he returned to Egypt, campaigned in the Red Sea, and was named Admiral of the Fleet of Egypt and India in 954/1547. He commanded an expedition against the Portuguese at Hormuz in 959/1552–53 that failed in its ultimate goal of taking the citadel. He was called back to Cairo and executed in 961/1554 on the grounds of a debatable decision he had made as commander to avoid direct confrontation with Portuguese warships.[11]

CHARTS OF THE NEW WORLD

In 919/1513, eight years before he completed the first version of the *Kitāb-i baḥrīye*, Pīrī Reʾīs produced the first and more famous of his two maps of the world. Only the Atlantic Ocean and the adjacent parts of the Old and

11. The exact date of his death has only recently become known through archival evidence; see Cengiz Orhonlu, "Hint Kaptanlığı ve Pîrî Reis," *Belleten* (Türk Tarih Kurumu) 34 (1970): 234–54, esp. 246.

New World have survived from what was once a larger map (fig. 14.5).[12] It clearly shows the characteristics of a portolan chart in structure and style. The three-line Arabic colophon center left reads: "Composed by the poor Pīr son of Ḥācī Meḥmed, known as paternal nephew of Kemāl Reʾīs, may God pardon them both, in the city of Gallipoli, in the month of Muḥarrem the sacred, year nine hundred and nineteen [March/April 1513]." There are many commentaries in Turkish. The longest, in the area of Brazil, describes the exploration of the Western Sea and Central America, focusing on the Columbus voyages. In a passage just below it, Pīrī Reʾīs recounts how he went about compiling the map:

> This section explains how the present map was composed. No one has ever possessed such a map. This poor man [Pīrī Reʾīs] has constructed it with his own hands. Specifically, twenty maps and world maps—[the latter] are maps made at the time of Alexander the Great; they show the inhabited part of the world, and the Arabs call them *caʿferīye*[13]—eight such *caʿferīye*s, one Arab map of India, four maps recently made by the Portuguese that show Pakistan, India, and China drawn by means of mathematical projection, as well as a map of the Western Parts drawn by Columbus: [all these sources] have been brought to one scale, and the result is this map [*bir ḳiyās üzerine istiḫrâç edip bu şekil ḥâṣil oldu*].

Pīrī Reʾīs thus confirms that it was a world map compiled from some twenty Islamic and Western sources that he had gathered together, and these will be discussed below. The top border of the map, at which the drawing stops short of the edge of the vellum, seems to have been designed to fit into a northern sheet, and the curving shape of the southwestern part follows the natural neck and shoulder of the original deerskin or gazelle hide it was drawn on. The map has been torn longitudinally on its eastern edge. The line of separation runs along the eastern coast of Spain through West Africa and on through the southern Atlantic; there is even commentary in the Gulf of Guinea that has been cut short by this separation. A possible but admittedly conjectural reconstruction of the other parts of this map is given in figure 14.6. The size and extent of the whole chart shown there have been tentatively extrapolated from the five compass circles on the fragment. The center of the circle on which these wind roses lie can be plotted roughly in the Sahara Desert, at the approximate latitude of the Tropic of Cancer. Assuming that this large circle of wind roses lay in the center of the chart, the eastern and northern extent can be conjectured by superimposing the fragment on the 1502 Cantino planisphere.

In 923/1517, Pīrī Reʾīs presented the map to Selīm I in Cairo after the latter's conquest of Egypt. A passage in the *Kitāb-i baḥrīye* tells us about the event:

> This poor man had previously constructed a map that displayed many more details of different kinds than maps hitherto in existence and even included recent maps of the Chinese and Indian seas that were until then unknown in the Ottoman Empire; and he presented this map to the late Sultan Selīm Khan in Cairo, who graciously accepted it.[14]

Any use Sultan Selīm made of the gift is not recorded, and the map fell into oblivion until 1929 when Gustav Adolf Deissmann, who was working in the Topkapı Sarayı Müzesi at the invitation of its director general, Halil Ethem Eldem, drew the surviving western portion to the attention of the German Orientalist Paul Kahle.

The discovery sparked worldwide interest that has endured owing to the map's supposed connection with an earlier map Columbus made during his third voyage to the New World and sent to Spain in A.D. 1498.[15] This original 1498 map is lost. However, we learn from the longest inscription on Pīrī Reʾīs's chart that his uncle Kemāl Reʾīs had a Spanish slave who claimed to have accompanied Columbus on three of his voyages and who was a ready source of information about the New World.[16] The same inscription states, "The coasts and islands [of the New World] on this map are taken from Colombo's map." Although it is never stated outright, we assume that this slave was the fortunate possessor of

12. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1633 mük. For a general description of the map, see Paul Kahle, *Die verschollene Columbus-Karte von 1498 in einer türkischen Weltkarte von 1513* (Berlin: Walter de Gruyter, 1933). I have not seen the English translation of this monograph ("The Lost Columbus Map of 1498 Discovered in a Turkish Map of the World of 1513") that appeared in *Aligarh Muslim University Journal* (1935), but there is a shortened translation, "A Lost Map of Columbus," in *Geographical Review* 23 (1933): 621–38. Further references may be found in Konyalı, *Topkapı Sarayında*, 64–129 (note 4); Adnan Adıvar, *La science chez les Turcs Ottomans*, 59–62, and *Osmanlı Türklerinde ilim*, 74–77 (note 9); Charles H. Hapgood, *Maps of the Ancient Sea Kings: Evidence of Advanced Civilization in the Ice Age*, rev. ed. (New York: E. P. Dutton, 1979), 1–77; and Tekeli, "Pīrī Rais," 616–19 (note 9).

13. The meaning of this term has remained unclear. It may be a reference to the seventh Abbasid caliph al-Maʾmūn (r. 198–218/813–33), in whose reign, according to the Turkish polyhistorian Muṣṭafā ibn ʿAbdallāh Kātib Çelebi, one of the translations of Ptolemy's *Geography* into Arabic was made. It is probably an echo of the Arabic name of Ptolemy's *al-Jughrāfiyā*, owing to a graphic distortion easily made in the Arabic alphabet; see Konyalı, *Topkapı Sarayında*, 80–81 (note 4).

14. Pīrī Reʾīs, *Kitāb-i baḥrīye*; see *Kitab-ı bahriye, Pirî Reis*, 4 vols., ed. Ertuğrul Zekai Ökte, trans. Vahit Çabuk, Tülây Duran, and Robert Bragner, Historical Research Foundation—Istanbul Research Center (Ankara: Ministry of Culture and Tourism of the Turkish Republic, 1988–), 1:42–43 (fol. 3a) (author's translation).

15. Henry Vignaud, *Histoire critique de la grande entreprise de Christophe Colomb*, 2 vols. (Paris: H. Welter, 1911): 2:541–43.

16. We know that Kemāl Reʾīs captured several Spanish ships in a battle off the coast of Valencia in 907/1501. The slave was probably a prisoner from this engagement; see Pīrī Reʾīs, *Kitāb-i baḥrīye* (note 14).

FIG. 14.7. DETAIL OF THE CARIBBEAN FROM THE 1513 WORLD MAP. This section is thought to derive from a lost map of Columbus. It certainly reflects information before the voyage of Juan Diaz de Solis and Vicente Yáñez Pinzón in A.D. 1508–9. The large island in the center is Hispaniola, turned approximately ninety degrees; Cuba is represented as a wedge of land jutting out from the mainland and inclining southward, just as Columbus believed it to be. Top right is an illustration of the story of Saint Brendan, whose crew lit a fire on the back of a whale, mistaking it for an island. According to the legend on the map, this incident was taken from "ancient *mappaemundi.*"
Size of the detail: ca. 39 × 29.5 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (R. 1633 mük).

a copy of the 1498 Columbus map, from which information was transferred onto Pīrī Reʾīs's chart. The possibility that evidence of a lost map by Columbus should appear on an Ottoman map became a matter of pride for modern Turks (fig. 14.7). It played a definite role in Kemāl Atatürk's two-pronged policy of encouraging the development of Turkish patriotism and of claiming for his country a rightful place in the framework of modern Western civilization.[17] Almagià concludes, after comparing the place-names on the map with those associated with Columbus, that Kahle's article might have been titled more appropriately "The imprint of Columbus on the Turkish map of 1513" and not "The missing map of Columbus of 1498 in a Turkish world map of 1513."[18]

With regard to the other maps that Pīrī Reʾīs lists as sources, he probably acquired additional charts based on recent European exploration from ships captured by Turkish corsairs.[19] In a legend in the southwest corner of his map, Pīrī Reʾīs states, "The Portuguese infidels have written it on their maps," suggesting his source for the delineation of the South American coastline. The toponymy along the African coast is an interesting mixture of Portuguese and Turkish place-names. Pīrī Reʾīs may, in fact, have gathered a working collection of charts and other relevant materials during the years of his activity as a corsair as well as after he had "retired" to Gallipoli. The reference to maps of the inhabited world "made at the time of Alexander the Great" probably means those of Ptolemy. The four Portuguese maps showing India, Pakistan, and China "drawn by means of mathematical projection" could refer to either a coordinate structure or a rhumb line structure. However, Pīrī Reʾīs does not appear to have stirred much interest or attained recognition as a cartographer and expert in nautical science from the sultan or anyone else. Worse still, his tragic end in 961/1554 may also have caused an irretrievable dispersal of whatever interesting materials he possessed.

The sources of the Pīrī Reʾīs map of the Atlantic have been the subject of much speculation, the most improbable of which are those of Hapgood,[20] who argues that the map was constructed on a projection approximating the azimuthal equidistant centered on Cairo. This framework is used to account for the apparent shift in north orientation in various parts of the map, such as the Caribbean area and the coastline at the foot of the map, which he believes to represent Antarctica before it was covered by the ice cap. Here is not the place for a detailed critique of his arguments, overdue as that might be, but two brief observations need consideration. The first is

17. One of the results was Atatürk's instruction to the Türk Tarih Kurumu (Turkish Historical Society) that a published facsimile of the map be made, together with a thorough analysis (in Turkish, German, French, English, and Italian) in an accompanying volume; see *Piri Reis Haritası*, intro. Yusuf Akçura (Istanbul: Devlet, 1935; slightly revised edition, Istanbul: Deniz Kuvvetleri Komutanlığı Hidrografi Neşriyatı, 1966).

18. Roberto Almagià, "Il mappamondo di Piri Reis e la carta di Colombo del 1498," *Bollettino della Reale Società Geografica Italiana* 71 (1934): 442–49, esp. 449.

19. For a general discussion of Ottoman interest and sources regarding the New World, see Thomas D. Goodrich, *The Ottoman Turks and the New World: A Study of "Tarih-i Hind-i garbi" and Sixteenth-Century Ottoman Americana* (Wiesbaden: Otto Harrassowitz, 1990); see also idem, "Ottoman Americana: The Search for the Sources of the Sixteenth-Century *Tarih-i Hind-i garbi*," *Bulletin of Research in the Humanities* 85 (1982): 269–94; Abbas Hamdani, "Ottoman Response to the Discovery of America and the New Route to India," *Journal of the American Oriental Society* 101 (1981): 323–30; and Andrew C. Hess, "Piri Reis and the Ottoman Response to the Voyages of Discovery," *Terrae Incognitae* 6 (1974): 19–37.

20. Hapgood, *Maps of the Ancient Sea Kings* (note 12).

that the map is drawn on a shoulder of animal hide and thus is naturally curved in one corner. The second is that it was not unusual for cartographers to adjust the orientation of a coastline to fit the surface available. For example, drastic changes of scale and orientation are present on the maritime chart of Ḥājj Abū al-Ḥasan (fig. 14.4), where the coastline of southern Africa is crammed in to fit the vellum.

A second map signed by Pīrī Reʾīs showing the Americas, dated 935/1528, is again a fragment of a larger map (plate 21). The view has been advanced that it was the first sheet of an unfinished world map.[21] It is highly decorative and contains an elaborate border, compass roses, and two large scales, the graduation of which is explained in a note as ten miles to each small division and fifty miles to each large division. The map has been overshadowed by its more famous predecessor, but the representation of the Azores, the coasts of Greenland, Labrador, and Newfoundland, Florida, the Yucatán Peninsula, the West Indies, and the coastline between Honduras and Venezuela surely deserves further comparison with the Western planispheres of the same period.[22]

KITĀB-I BAḤRĪYE

The *Kitāb-i baḥrīye* (Book of maritime [or naval] matters) is a volume of sailing directions divided into chapters, each chapter devoted to a specific location or region of the Mediterranean and accompanied by a chart. The work was produced in two versions: an earlier, shorter version (completed 927/1521) consisted of 130 chapters and charts; the later version was more extensive, with 210 charts (completed 932/1526). Both versions survive in a number of manuscripts by different copyists (appendix 14.2); none of the manuscripts has been identified as by Pīrī Reʾīs's own hand.[23] Also, the number of charts in the extant manuscripts varies owing to later copyists' inclusion of new charts and views unrelated to the chapters.

The text of both versions begins with a brief prose dedication and an explanation of why Pīrī Reʾīs composed the book: the enthronement of Sultan Süleymān in 926/1520 had prompted individuals to offer the monarch "presents from various branches of the sciences for his auspicious abode and felicitous court so that, finding a place in the world [of high society] thanks to the auspicious sovereign's unequaled favor, they might attain fame and honor."[24] The *Kitāb-i baḥrīye* was Pīrī Reʾīs's presentation. An introduction follows this opening statement. That of the second version, which is much longer and in verse, is of special interest because the author engages in a preparatory discussion of the art of navigation and chartmaking.[25] Pīrī Reʾīs emphasizes that this knowledge is necessary for the safety of the mariner. He also notes that however indispensable a portolan chart may be, it lacks the flexibility of verbal expression that alone can describe all aspects and details of navigation:

> Such knowledge cannot be known from maps; it must
> be explained.
> Such things cannot be measured with dividers,
> And that is why I have discoursed by writing at such
> length.[26]

Pīrī Reʾīs discusses the knowledge of storms and winds, the compass, portolan charts, and astronomical navigation. He also describes the world's oceans, the lands surrounding them, and the European voyages of discovery, including the Portuguese penetration into the Indian Ocean and Columbus's discovery of the New World.

In addition to this long introduction, the second version also has an epilogue in verse to inform the reader of the circumstances that led to its revision. Pīrī Reʾīs was the pilot of a ship that in 931/1524–25 took the grand vizier Ibrāhīm Paşa to Egypt to settle disturbances provoked by a rebellious governor. During this voyage, the mariner showed the vizier his *Kitāb-i baḥrīye* in its original form, which had failed to gain the sovereign's attention. Ibrāhīm Paşa advised Pīrī Reʾīs to make a more polished copy, worthier of its intended august recipient. This event was the genesis of the second version.

21. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1824. The opinion that this piece was one part of a world map is put forward in Thomas D. Goodrich, "Atlas-i hümayun: A Sixteenth-Century Ottoman Maritime Atlas Discovered in 1984," *Archivum Ottomanicum* 10 (1985): 83–101, esp. 85.

22. Hamid Sadi Selen, "Piri Reisin Şimalî Amerika Haritası, telifi 1528," *Belleten* (Türk Tarih Kurumu) 1 (1937): 515–18 (German translation, pp. 519–23). See also Erich Bräunlich, "Zwei türkische Weltkarten aus dem Zeitalter der grossen Entdeckungen," *Berichte über die Verhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig, Philologisch-Historische Klasse*, vol. 89, no. 1 (1937): 1–29, esp. 24–26.

23. Facsimile editions of the *Kitāb-i baḥrīye* are based on one of the best complete manuscripts of the 932/1526 version (Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2612). It was first reproduced in facsimile by the Türk Tarih Kurumu: Pīrī Reʾīs, *Kitabı bahriye*, ed. Fevzi Kurtoğlu and Haydar Alpagut (Istanbul: Devlet, 1935). A recent facsimile of the same manuscript contains photographic reproductions of the folios, each reproduction faced by a columned page containing the transliterated text, a modern Turkish translation, and an English translation: *Kitab-ı bahriye, Pirî Reis* (note 14).

24. Author's translation; see Pīrī Reʾīs, *Kitāb-i baḥrīye*, 1:38–47 (fols. 2a–4a), esp. 38–39 (fol. 2a) (note 14).

25. In part because of this long introduction in verse, there has been some question about the authorship of the second version. The poet Murādī implied he was a "ghost writer" of the *Kitāb-i baḥrīye* in his *Ġazavāt-i Ḫayreddīn Paşa* (Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1291, fol. 292b). For a discussion of this controversy, see Hüseyin G. Yurdayın, "Kitâb-i bahriyye'nin telifi meselesi," *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi* 10 (1952): 143–46.

26. Pīrī Reʾīs, *Kitāb-i baḥrīye*, 1:46–203 (fols. 4a–43a), esp. 48–49 (fol. 4b) (note 14).

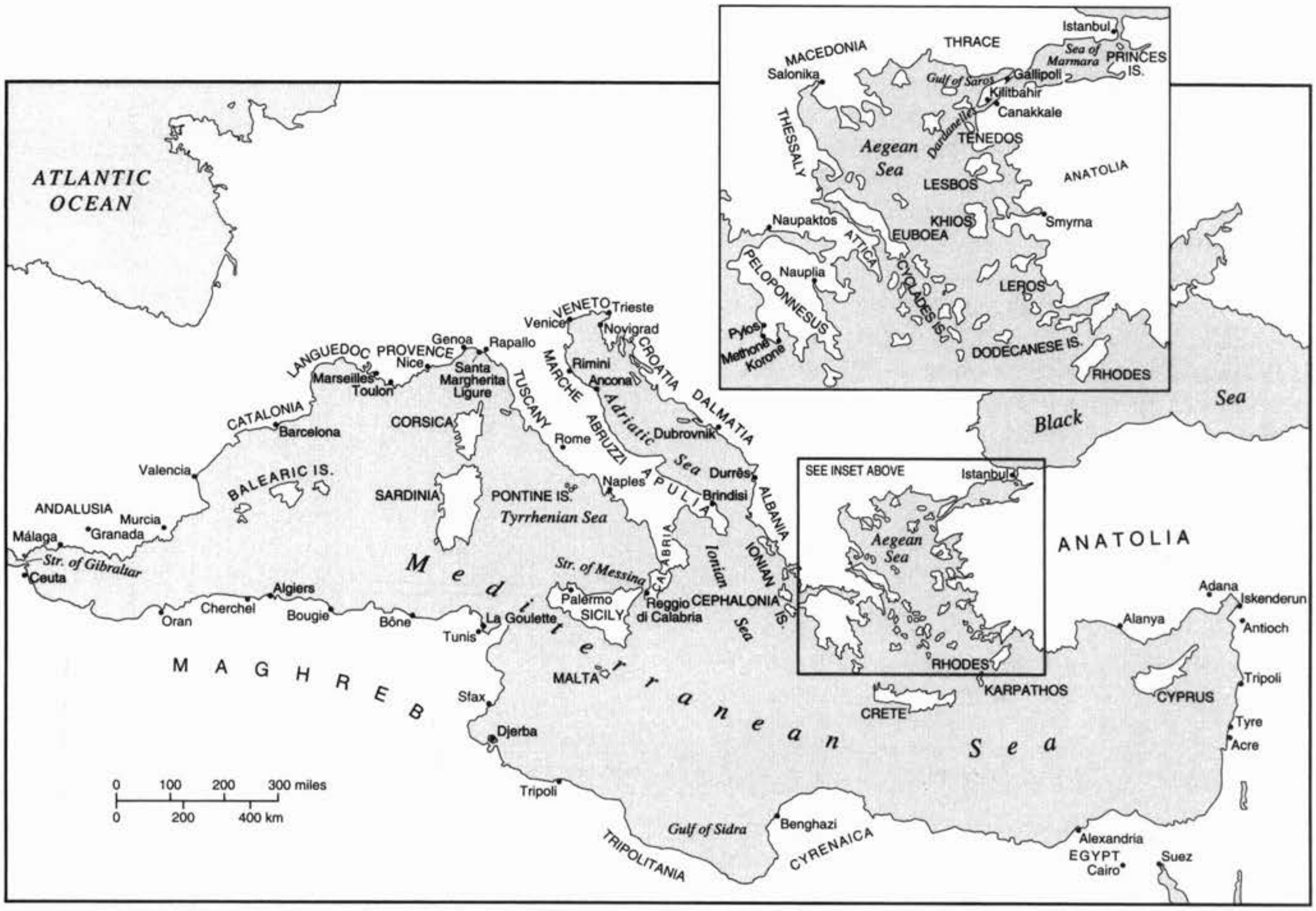


FIG. 14.8. REFERENCE MAP OF THE MEDITERRANEAN IN THE AGE OF SÜLEYMĀN.

A brief description with a few examples will better indicate the structure of the *Kitāb-i baḥrīye*. The description starts with the island of Bozca (Tenedos) in the first version, but with the Dardanelles fortresses of Kilitbahir and Çanakkale in the second (fig. 14.8). Both versions then proceed to describe the Aegean coasts and islands, chiefly those of the Anatolian side, as far as the island of Rhodes. Subsequently the description swerves westward to cover the coasts and islands of southern Greece, then the Adriatic coasts, and so forth, making a counterclockwise tour of the entire Mediterranean until it returns, with the island of Kerpe (Karpathos), to the Aegean. At this point it deals with the Aegean Islands that had been omitted in the early part of the book, and concludes with Kızıl Adalar (Princes Islands in the Sea of Marmara) in the first version and Magariz Körfezi (Gulf of Saros) in the second.

Pīrī Reʾīs intended the book to address the needs of the sixteenth-century Ottoman war fleet, which relied heavily on the galley (*ḳādırġa*) and the galliot (*kālīte*).[27] These oar-powered boats were well adapted to the Mediterranean's deep coastal waters and many protected anchorages. His simple instructions would permit galley skippers to navigate safely in a series of short voyages from one safe haven to another in the customary fashion of travel around the Mediterranean. Each chapter describes landmarks and the layout of harbors, warns of dangerous rocks, shoals, or reefs, and occasionally includes distances or depths. A characteristic passage describes entry into a port on Kifelonya (Cephalonia), one of the Ionian Islands:

> On the south-southwestern side of this island, there is an excellent, spacious natural harbor called Tuzla Limanı. Its landmark from the sea is a high, blunt cape facing southwest. This cape is called Kavu San Sidiru, and there is a ruined church atop it. At the tip of this cape, there is a rock in the sea. Placing this cape to your southwest and proceeding eastward, you will see a small islet close to the shore. This islet marks the mouth of the harbor. One proceeds northward and enters the harbor.[28]

27. Svat Soucek, "Certain Types of Ships in Ottoman-Turkish Terminology," *Turcica* 7 (1975): 233–49. For a sixteenth-century depiction of an Ottoman galley, see plate 20 in this volume.

28. Author's translation; see Pīrī Reʾīs, *Kitāb-i baḥrīye*, 2:686–87 (fol. 160a) (note 14).

Several logistic limitations had to be anticipated by the galley skippers in planning each stage of the journey. The elongated form and low freeboard of the galleys that optimized oar propulsion also made them susceptible to being swamped in storms and strong winds.[29] Knowledge of sheltered anchorages along the coast was critical. The size of the galley's crew in relation to the vessel's storage capacity required frequent stops for provisions, limiting its cruising range. Most important was the supply of fresh water.[30] Sheltered bays, lagoons and peninsulas, wells and freshwater streams are all clearly depicted on the maps. Along with his colorful anecdotes and local histories in the text, Pīrī Reʾīs described the winds and told where to find shelter and fresh water, such as on the island of Sakız (Khios) (fig. 14.9):

> A creek flows here [on the northwest side of the island] among the pine trees, and on days of southerly winds it is possible to take on water. The place is exposed to northeasterly winds, however, and ships cannot always lie here. If a shelter is sought on these shores on days of strong northeasterly winds, one should round the western side of the cape situated on the northwestern side of this island and drop anchor about a mile along the shore at a spot covered from the northeast.[31]

FIG. 14.9. *KITĀB-I BAḤRĪYE:* ISLAND OF KHIOS. The accompanying text explains how to take on water from a creek (shown flowing from a mountainside) under conditions of stiff northeasterly winds. A ship would shelter around the cape to the west and drop anchor about a mile along the shore. This is typical of the kind of navigation hints found in the work.
Size of the original: 31.5 × 22 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (MS. H. 642, fol. 85a).

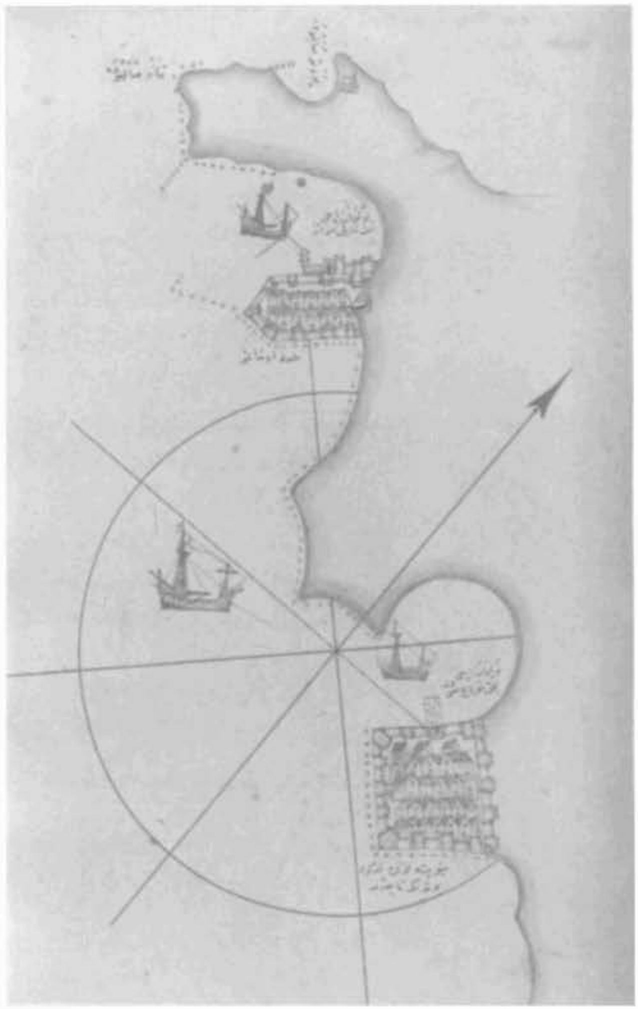


FIG. 14.10. *KITĀB-I BAḤRĪYE:* PORT OF NOVIGRAD. This chart of the Venetian-held port (in the lower portion of the map) illustrates the schematic nature of the maps in the *Kitāb-i baḥrīye*.
Size of the original: 31.5 × 22 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (MS. H. 642, fol. 202b).

Finally, one must consider the style of warfare practiced in the Mediterranean at the time Pīrī Reʾīs compiled his guide. The control of vital sea-lanes required control of the coasts from which galley fleets could carry out amphibious assaults and marshal land-based resources. Ottoman dominance in the eastern Mediterranean was achieved not by pitched naval battles but by the relentless capture of key ports and islands. Naval battles, when they

29. Imber, "Navy of Süleyman," 215–16 (note 1).

30. Some scholars generously estimate twenty days before galleys had to take on water, but records suggest that limit was only about eight or nine days; see John H. Pryor, *Geography, Technology, and War: Studies in the Maritime History of the Mediterranean, 649–1571* (Cambridge: Cambridge University Press, 1988), 83–85.

31. Author's translation; see Pīrī Reʾīs, *Kitāb-i baḥrīye*, 1:362–65 (fols. 84a–b) (note 14).

did occur, usually took place in sight of land, and their outcome was often determined by superior maneuverability, not by destructive firepower. Therefore knowledge of local conditions and the ability to use them to one's advantage was essential. The closely forged relationship between a Mediterranean navy and the shoreline along which it operated was a very different situation from that which developed in the Atlantic and the Indian Ocean.[32]

Many chapter headings of the *Kitāb-i baḥrīye* are devoted to castles and fortified ports. Pīrī Reʾīs occasionally comments on their situation and state of repair and illustrates their generalized layout on the map (fig. 14.10):

> Site-Nova [Novigrad], a town subject to Venedik [Venice], is in fact a cape. Situated on this cape, the town is a four-cornered fortress equipped with bastions and ramparts. On the northwestern side of the fortress there is a natural harbor whose depth is half a fathom; for that reason large ships lie outside, but some do put in and lie here after having tied the hawsers to the landing by the port's maritime gate and dropped anchor to the north.[33]

The impassive tone, used in this case to describe a stronghold of archrival Venice, is maintained throughout the work. In fact, unless allegiances are stated explicitly, the details of an Ottoman safe haven or that of a competitor are virtually indistinguishable, as if a neutral observer were coming into port, not a captain in the Turkish fleet.

The changes to the second version of the *Kitāb-i baḥrīye* involved more than just supplementing the original 927/1521 version with more chapters. Although the chapters in the 932/1526 version maintain the general counterclockwise order around the Mediterranean, there is a certain amount of rearrangement and replacement. Maps and text are revised and may even conflict with those of the earlier version. In some cases a long stretch of coastline described in a single chapter in the first version is broken down into several chapters in the second version, each containing new details and new maps. Determining the changes, particularly the textual revisions, is difficult; the hand of the copyist undoubtedly played a part. Nevertheless, the section of the *Kitāb-i baḥrīye* that underwent the greatest revision is along the Gulf of Venice and the Italian coast of the Adriatic, but what sources were used and how they were obtained for the new maps of Venetian ports and strongholds has not been determined.[34] The maps of Egypt are also notable and were probably a result of the encouragement Pīrī Reʾīs received from the grand vizier Ibrāhīm Paşa.[35]

The second version documents the creation of a work intended explicitly for presentation, a function so characteristic of portolan charts in general. Accordingly, we may compare manuscripts of the first version, their plain style no doubt reflecting their practical function, with the more elaborate charts of the second version, which are often beautiful specimens of the art of miniature painting meant to accompany a smoothly and exactly copied text. These were expensive artifacts produced by the imperial or private artisans of the Ottoman book arts. The first version, unencumbered by redundant stories (from the point of view of Mediterranean sailors) about the world's oceans or Columbus, or by elaborate representations of port cities, continued to be copied by the practical men of the Ottoman navy and the imperial arsenal. Some of these copies contain annotations, suggesting that they were actually put to use.[36] Figures 14.11 through 14.13 and plate 22 provide comparisons between the two versions.

The difference between the practical and presentational purposes of the two versions had distinctively Ottoman consequences. One is that the copyists of the first version often identify themselves and the place and date of the work's completion in the book's colophon, whereas those of the second remain anonymous in all known cases. This is in contrast to Western portolan charts, in which presentation copies usually mention the cartographer's or the workshop's name, whereas working charts often remained anonymous. The root of this "Turkish inversion" may lie in the attitude of Muslims toward the practical side of everyday life, which is so closely integrated into the spiritual world. Much as in the case of Pīrī Reʾīs, the scribe of the Ottoman arsenal often appealed to the users of his work to recite a *fātiḥah* (the first sura of the Qurʾān) on behalf of his soul as a means of thanks. This probably was their only reward, in contrast to the miniaturists on the payroll of the imperial workshops that produced decorative manuscripts. They, like so many other Muslim artisans, were satisfied

32. John Francis Guilmartin, Jr., *Gunpowder and Galleys: Changing Technology and Mediterranean Warfare at Sea in the Sixteenth Century* (Cambridge: Cambridge University Press, 1974), 57.

33. Author's translation; see Pīrī Reʾīs, *Kitāb-i baḥrīye*, 2:860–61 (fol. 203b) (note 14).

34. This becomes evident from comparing the two versions of the *Kitāb-i baḥrīye*; for example, a first version with 137 maps (London, British Library, Or. 4131) and a second version with 223 maps (Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2612). For the Aegean Islands and the coasts of Anatolia, the Peloponnesus, and Albania there is only slight reordering and a few added maps. When one reaches Dubrovnik there is a discrepancy of only five chapters/maps between the two versions (fifty-eight in the 1521; sixty-three in the 1526). However, at Venice this discrepancy becomes thirty-one (sixty-one in the 1521; ninety-two in the 1526) and at Brindisi, approaching the heel of the Italian "boot," the gap becomes forty-seven, and at Sicily, fifty-five.

35. On this occasion Pīrī Reʾīs mapped the Rosetta branch of the Nile and the main river above the delta as far as Cairo; see Afetinan, *Life and Works of Piri Reis*, 14 (note 9).

36. For example, in a copy at the Topkapı Sarayı Müzesi Kütüphanesi (B. 337), the chart of Djerba contains the written annotation "Turgut Reʾīs has fled through this strait" next to a breach in the bridge linking the island with the mainland. This refers to an incident between the Turkish corsair and the admiral Andrea Doria in ca. 960/1552.

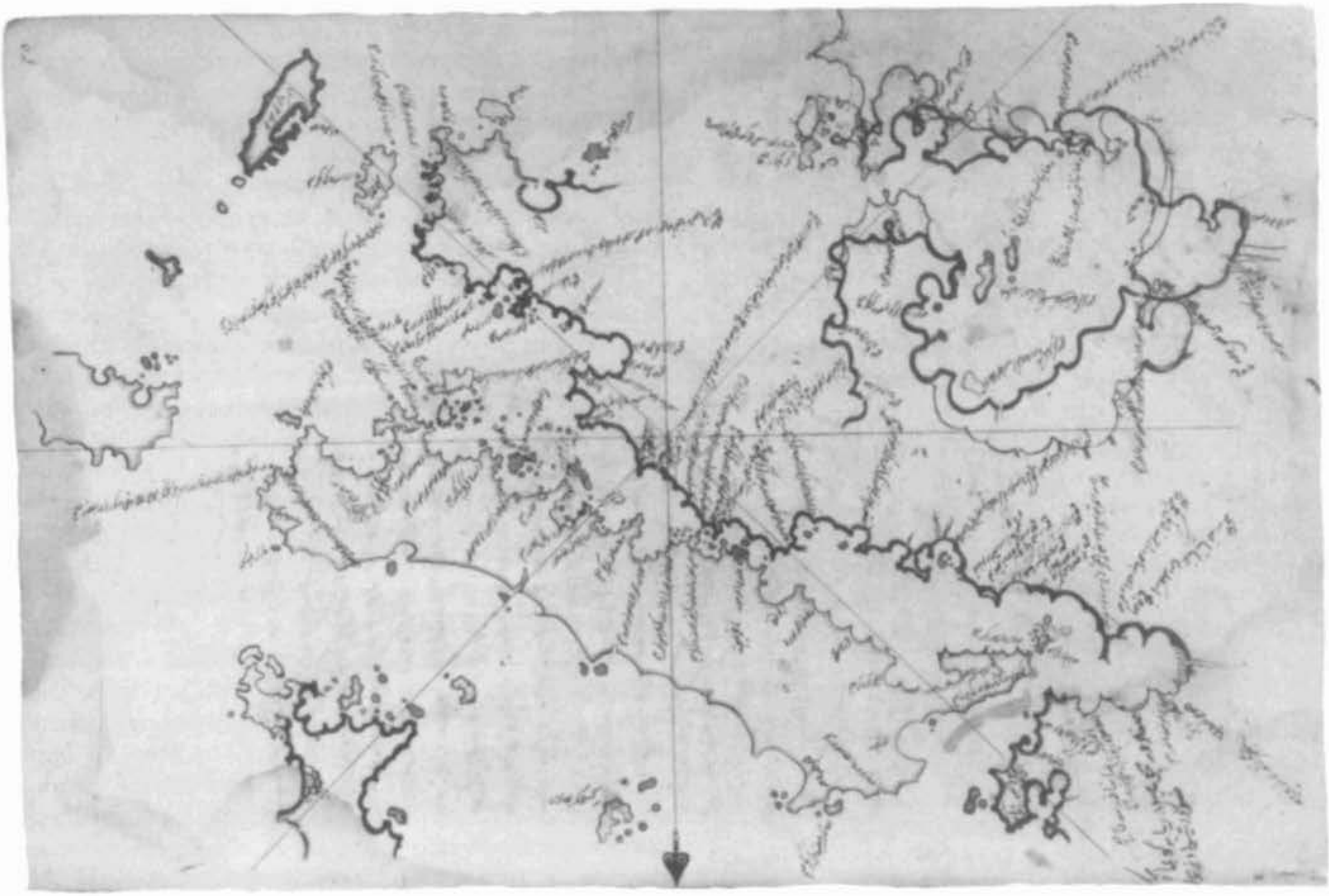


FIG. 14.11. VERSION 1 OF THE *KITĀB-I BAḤRĪYE:* ISLAND OF EUBOEA. The maps of the first version were intended primarily as working documents. This detail of Euboea was probably derived from the *isolario* of Bartolommeo dalli Sonetti. Delineated in the upper right corner is an extension of the Thessalian coast north of Euboea that would otherwise be off the map's lower right corner: the Gulf of Volos (Pagasitikós Kópos), the hook-shaped Magnesia Peninsula, and the Strait of Trikkeri. A revision (thin line) to the original delineation (bold line) provides a better representation of the small bay where the port of Volos is situated.
Size of the original: 32.5 × 22.5 cm. By permission of the Bibliothèque Nationale, Paris (MS. Suppl. Turc 220).

with the wages they earned and did not aspire to further renown. The difference between the Islamic and European approach may be due to the nascent capitalism of the latter society, where charts were made to be marketed and sold to anyone who could afford the price. High-quality Turkish charts and manuscripts were made chiefly on commission for a limited audience. Who were the artists who drew and illuminated the second-version maps of the *Kitāb-i baḥrīye*? They were presumably part of an active group of miniaturists in Istanbul in the sixteenth and seventeenth centuries at the apogee of this form of Ottoman book art, including Naḳḳāş ʿOṣmān, ʿAlī Çelebi, Meḥmed Beg, Velīcān, Molla Ḳāsim, and Molla Tiflisī or Nigārī (known also as Ḥaydar Reʾīs—a sailor as well as a poet and painter).[37]

A significant aspect of several second-version manuscripts is that the text was dropped altogether from the work, resulting in a pure maritime atlas of the Mediterranean, although in origin it was simply another copy of the *Kitāb-i baḥrīye*. These copies could easily be mistaken for a new and different work—an impression enhanced by the addition of maps of the Black Sea, which Pīrī Reʾīs does not seem to have known from his own experience and which is not mapped in the original work. The attribution of one of these copies of the *Kitāb-i baḥrīye* to a certain "Seyyid Nūḥ" has proved to be the result of a copyist adding a title page with the name of a fictitious author. This created a perfect illusion that no doubt misled his contemporaries, just as it has some mod-

37. The relationship between the "cartographic" styles of these miniaturists and their wider illustrative subjects is discussed in chapter 12. See also Esin Atıl, "The Art of the Book," in *Turkish Art*, ed. Esin Atıl (Washington, D.C., and New York: Smithsonian Institution Press and Harry N. Abrams, 1980), 137–238.

FIG. 14.12. VERSION 1 OF THE *KITĀB-I BAḤRĪYE*: CITY OF VENICE.
Size of the original: 30.6 × 21 cm. By permission of the Biblioteca Universitaria di Bologna (MS. 3613, fol. 72r).

ern scholars, who described the atlas under this authorship.[38]

When we compare the *Kitāb-i baḥrīye* (both versions) with western *isolarii*, portolans, and portolan charts, we find common traits as well as some important differences. The functional similarities of the *Kitāb-i baḥrīye* to its Italian equivalents of sailing directions and charts are clear: both aim to offer a guide to the mariner. In style, the charts show some affinity to the *isolario*, introduced by Cristoforo Buondelmonte in A.D. 1420 and developed later by Bartolommeo dalli Sonetti and Benedetto Bordone. Each chart, for example, has its own system of wind roses with north indication and uses conventional signs, such as small dots for shallow water and crosses for submerged rocks.[39]

The considerable differences have to do with the personal style of the Turkish author. Pīrī Reʾīs is highly anecdotal about his early experiences in North Africa, and he justifies his charts more fully than do authors in comparable European works. He frequently reminds the reader that text and map will complement each other, as in his chapter describing a small port on Iliryus (Leros), one of the Dodecanese Islands:

> One may enter the harbor from either side of this island [at the mouth of the harbor], but one should stay clear of the tips of the capes on the east and west of this island, for the sea there is foul. When required, look at the map.[40]

The shortcomings of contemporary charts of the Mediterranean are also stressed when Pīrī Reʾīs points out that only three place-names can be fitted into a space representing ten miles:

> It is therefore impossible to include on the map a number of symbols, such as those showing cultivated and derelict places, harbours and waters, reefs and shoals in the sea, on what side of the aforementioned harbours they occur, for which winds the harbours are suitable and for which they are contrary, how many vessels they will contain, and so on.
>
> If anyone objects, saying, "Is it not possible to put it on several parchments?" the answer is that the parchment would become so big as to be impossible to use on board ship. For this reason, cartographers draw on a parchment a map, which they can use for broad stretches of coast and large islands. But in confined spaces they will need a pilot.[41]

As for the sources of the *Kitāb-i baḥrīye*, the representation of some parts of the Mediterranean reflects stronger Western influence than that of others. For example, it is probable that for the Aegean, Pīrī Reʾīs had access to the printed *isolario* of Bartolommeo dalli Sonetti, published in Venice about A.D. 1485–86 (fig. 14.14).[42] Gallois, in his detailed analysis of the cartography of Delos (one of the Cyclades), concludes that no feature on the island represented in the *Kitāb-i baḥrīye*

38. For example, Franz Babinger, "Seyyid Nûh and His Turkish Sailing Handbook," *Imago Mundi* 12 (1955): 180–82, and Hans Joachim Kissling, *Der See-Atlas des Sejjid Nûh* (Munich: Rudolf Trofenik, 1966). See also the review of Kissling's book by Svat Soucek in *Archivum Ottomanicum* 1 (1969): 327–31, and idem, "The 'Ali Macar Reis Atlas' and the Deniz kitabı: Their Place in the Genre of Portolan Charts and Atlases," *Imago Mundi* 25 (1971): 17–27, esp. 26–27.

39. For a detailed study of Ottoman terms for cardinal points in the *Kitāb-i baḥrīye*, see Karl Foy, "Die Windrose bei Osmanen und Griechen mit Benutzung der Baḥrijje des Admirals Pīr-i-Reʾīs vom Jahre 1520 f.," *Mitteilungen des Seminars für Orientalische Sprachen an der Freidrich-Wilhelms-Universität zu Berlin* 11 (1908): 234–47. For a brief discussion of the *isolario* genre, see Elizabeth Clutton in P. D. A. Harvey, "Local and Regional Cartography in Medieval Europe," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:464–501, esp. 482–84.

40. Author's translation; see Pīrī Reʾīs, *Kitāb-i baḥrīye*, 1:426–27 (fol. 100a) (note 14).

41. Pīrī Reʾīs, *Kitāb-i baḥrīye*, 1:42–43 (fol. 3a) (note 14); this translation follows Brice and Imber, "Turkish Charts," 528 (note 8). Pīrī Reʾīs also adds that the maps in his work will show sufficient detail to obviate the need for a pilot.

42. R. Herzog, "Ein türkisches Werk über das Ägäische Meer aus dem Jahre 1520," *Mitteilungen des Kaiserlich Deutschen Archaeologischen Instituts, Athenische Abteilung* 27 (1902): 417–30 and pl. 15. On Bartolommeo dalli Sonetti, see Campbell, *Earliest Printed Maps*, 89–92 (note 6). In the introduction to the *Kitāb-i baḥrīye* (1:198–99, [fol. 42a] [note 14]), Pīrī Reʾīs refers to a mapmaker named Bortolomye, whom Leo Bagrow believed to be Bartolommeo dalli Sonetti; see his "Supplementary Notes to 'The Origin of Ptolemy's Geography,'" *Imago Mundi* 4 (1947): 71–72. However, this may also be a reference to Ptolemy (Baṭlāmiyūs in Arabic).

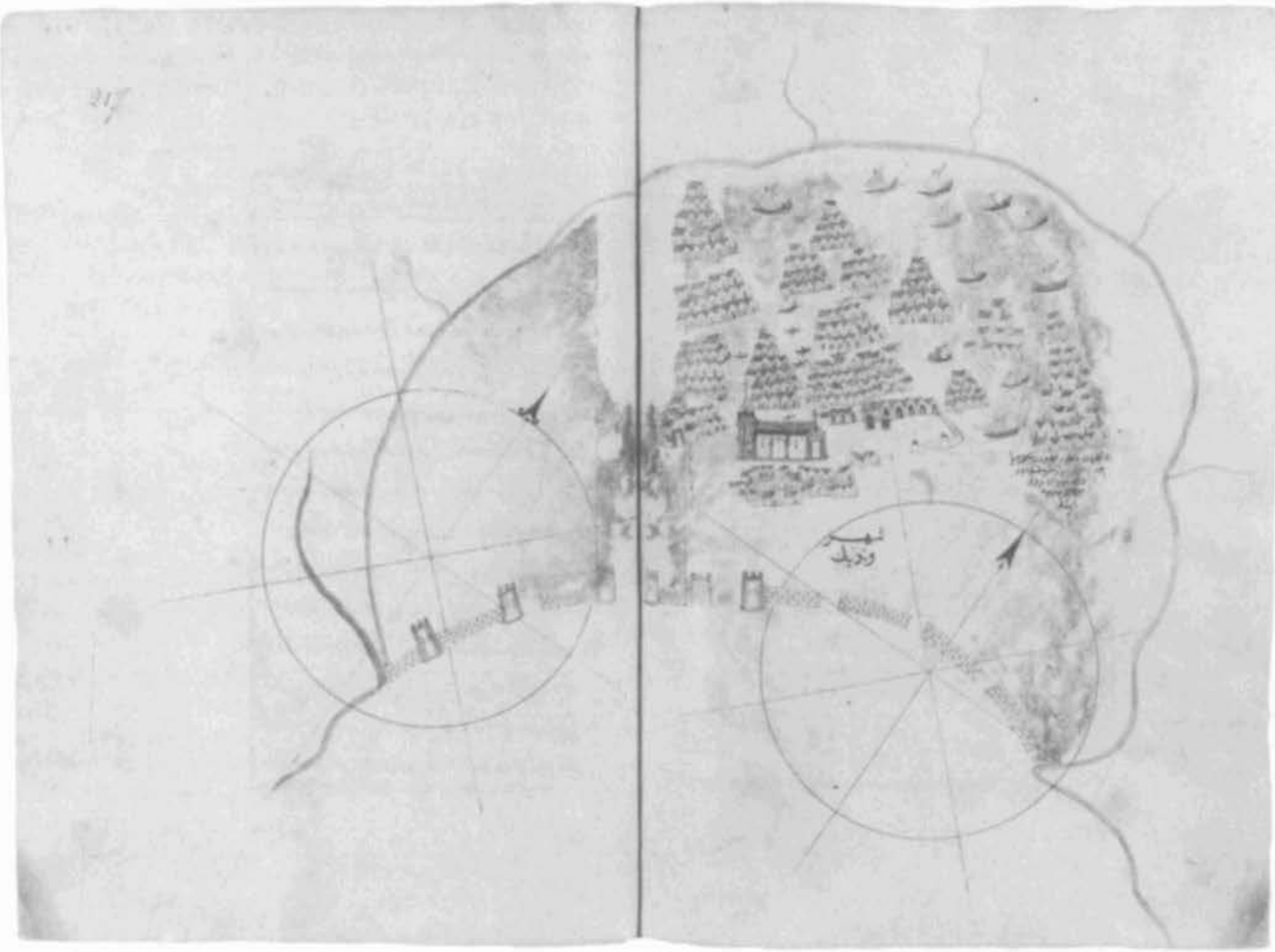


FIG. 14.13. VERSION 2 OF THE *KITĀB-I BAḤRĪYE:* CITY OF VENICE. As with figure 14.11 and plate 22, the contrast between the two versions is revealed in these views of Venice. Far more detailed views of the city were in circulation by the 1520s, such as that by Jacopo de' Barbari, but though the huge reduction in size makes such comparison difficult, they were not employed as a model by Pīrī Reʾīs. The campanile, the pillars in Piazza San Marco, and the Venetian arsenal are, however, prominently featured in the foreground of the city.
Size of the original: 35 × 46 cm. By permission of the Bibliothèque Nationale, Paris (MS. Suppl. Turc 956, fols. 216v–217r).

is absent from the Bartolommeo *isolario*.[43] Brice compares the representation of Euboea and makes a convincing case that the Bartolommeo version was the source.[44]

For the coasts of the Adriatic Sea, the Italian peninsula, Sicily, and France, for which there have been several toponymic studies but little attempt at tracing the sources of the *Kitāb-i baḥrīye*, one assumes that Pīrī Reʾīs followed models that came into his hands through booty or by purchase in neutral ports.[45] The A.D. 1500 view of Venice by Jacopo de' Barbari might have been a logical choice for the small view of Venice in the *Kitāb-i baḥrīye*, for example, but the corruption introduced by such extreme reduction renders any comparison difficult.

Along the North African coast, the originality of Pīrī Reʾīs's charts is without question. Mantran concludes

43. Lucien Gallois, *Cartographie de l'île de Délos*, Exploration Archéologique de Délos Faite par l'École Française d'Athènes, fasc. 3 (Paris: Fontemoing, 1910), 15–17.

44. Brice, "Sea-Charts," 56 (note 3).

45. Hans Joachim Kissling, "Zur historischen Topographie der Albanischen Küste," in *Dissertationes Albanicae: In honorem Josephi Valentini et Ernesti Koliqi septuagenariorum* (Munich: Rudolf Trofenik, 1971), 107–14; idem, "Die istrische Küste im See-Atlas des Pîrî-Re'îs," in *Studia Slovenica Monacensia: In honorem Antonii Slodnjak septuagenarii* (Munich: Rudolf Trofenik, 1969), 43–52; Alessandro Bausani, "L'Italia nel *Kitab-i bahriyye* di Piri Reis," *Il Veltro: Rivista della Civiltà Italiana* 23 (1979): 173–96; Eduard Sachau, "Sicilien nach dem tuerkischen Geographen Piri Reïs," in *Centenario della nascita di Michele Amari*, 2 vols. (Palermo: Stabilimento Tipografico Virzì, 1910), 2:1–10; Robert Mantran, "La description des côtes méditerranéennes de la France dans le *Kitâb-i bahriye* de Pîrî Reis," *Revue de l'Occident Musulman et de la Méditerranée* 38 (1984): 69–78.

FIG. 14.14. *KITĀB-I BAḤRĪYE:* ATTICA. The representation of the islands and mainland of Attica was probably taken from Bartolommeo dalli Sonetti's *isolario*. This published work appears to have been a common source for other islands in the Aegean.
Size of the original: 29.3 × 20.4 cm. By permission of the British Library, London (MS. Or. 4131, fol. 56r).

that the chapters describing both the Algerian and the Egyptian coasts derive from direct observation.[46] Along the coast of the Levant, however, it appears that Pīrī Reʾīs again resorted to traditional sources and, with few exceptions, depended less on personal experience.[47]

The Tunisian chapters, which have come under closest scrutiny,[48] are clearly one of the most original parts of the *Kitāb-i baḥrīye*. Pīrī Reʾīs was most familiar with these coasts, and the personal reminiscences that fill these pages reveal that much of this section relied on his memory and notes. Thus as a primary source it is far more detailed than the Italian or Catalan sailing directions or charts of the period that have come down to us. The representation of Tunisia in the *Kitāb-i baḥrīye* has been compared with four contemporary maritime sources: *Lo Compasso da navigare*,[49] a mid-fifteenth-century Italian portolan,[50] a Greek portolan printed in 1573,[51] and a printed Italian portolan of 1666.[52] The conclusion is that Pīrī Reʾīs's maps are independent of any of these books of sailing directions and that there is no trace of other Western sources for this section of coast. The map of Djerba is singled out as clearly superior to that of the contemporary Italian cartographer Giacomo Gastaldi, whose map of the island fortress has been held up as unsurpassed until the British Admiralty chart of 1827 (fig. 14.15).[53]

Ottoman Portolan Charts and Atlases

This corpus consists of three extant portolan atlases, containing twenty-four charts in total, plus several single charts. These imitate directly the cartographic style of Italian atlases such as those by Battista Agnese, and in this respect they stand closer to Western influence than to a Turkish genre engendered by the *Kitāb-i baḥrīye* of Pīrī Reʾīs. Their Ottoman identity rests in their descriptive legends in Turkish and in the way the regional charts in the atlases are placed in inverse order to the standard Agnese practice (table 14.1). There is also evidence that they were all manufactured in the Ottoman capital of Istanbul.

The first of these is the 975/1567 ʿAlī Mācār Reʾīs atlas, consisting of six portolan charts and one world map, all on double pages (figs. 14.16 and 14.17).[54] They

46. Robert Mantran, "La description des côtes de l'Algérie dans le *Kitab-i bahriye* de Piri Reis," *Revue de l'Occident Musulman et de la Méditerranée* 15–16 (1973): 159–68; idem, "La description des côtes de l'Égypte dans le *Kitâb-i bahriye* de Pîrî Reis," *Annales Islamologiques* 17 (1981): 287–310.

47. For example, see U. Heyd, "A Turkish Description of the Coast of Palestine in the Early Sixteenth Century," *Israel Exploration Journal* 6 (1956): 201–16.

48. This involves eight chapters, describing the coast between Bougie and Tripoli; see Soucek, "Livre d'instructions nautiques," esp. 246–47 (note 9); idem, "Tunisia," (note 9); and Robert Mantran, "La description des côtes de la Tunisie dans le *Kitâb-i bahriye* de Piri Reis," *Revue de l'Occident Musulman et de la Méditerranée* 24 (1977): 223–35. For additional information, see Emel Esin, "La géographie tunisienne de Piri Reʾis: A la lumière des sources turques du Xe/XVIe siècle," *Les Cahiers de Tunisie* 29 (1981): 585–605.

49. Bacchisio R. Motzo, "Il *Compasso da navigare*: Opera italiana della metà del secolo XIII," *Annali della Facoltà di Lettere e Filosofia della Università di Cagliari* 8 (1938): I–137.

50. Florence, Biblioteca Nazionale, Cod. Magliabecchianus Chartaceus XIII, 88.

51. The portolan of Démétrios Tagias; see Armand Delatte, ed., *Les portulans grecs* (Paris: Belles Lettres, 1947).

52. Venice, Biblioteca Querini-Stampaglia, Querini III 16.

53. Soucek, "Tunisia," 289–96 (note 9).

54. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 644; see Soucek, "'Ali Macar Reis Atlas,'" 17–25 (note 38); Fevzi Kurtoğlu, *Türk süel alanında harita ve krokilere verilen değer ve Ali Macar Reis Atlası* (Istanbul: Sebat, 1935), 18–30; Konyalı, *Topkapı Sarayında*, 240–49 (note 4). The projection of the world map has been the object of a

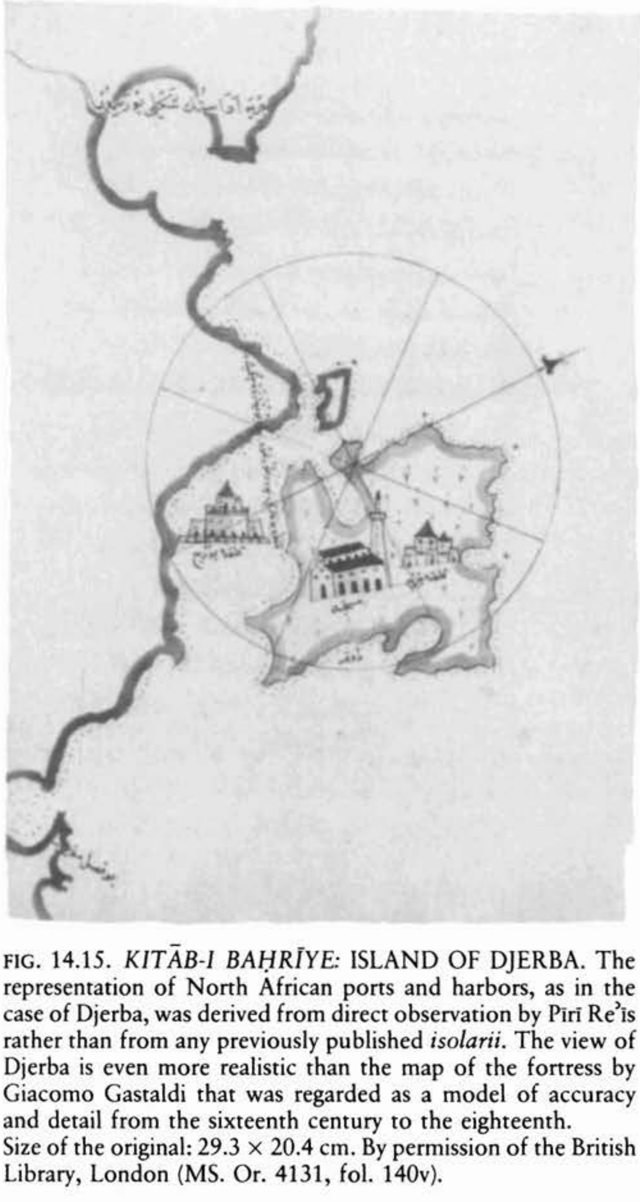


FIG. 14.15. *KITĀB-I BAḤRĪYE:* ISLAND OF DJERBA. The representation of North African ports and harbors, as in the case of Djerba, was derived from direct observation by Pīrī Reʾīs rather than from any previously published *isolarii.* The view of Djerba is even more realistic than the map of the fortress by Giacomo Gastaldi that was regarded as a model of accuracy and detail from the sixteenth century to the eighteenth.
Size of the original: 29.3 × 20.4 cm. By permission of the British Library, London (MS. Or. 4131, fol. 140v).

are drawn on parchment leaves and bound in leather in a small volume. The charts cover all the traditional areas of Western portolan atlases, from the Black Sea to the British Isles. On folio 4b, along the right margin of the page, there is the following statement in Arabic: "The humble ʿAlī Mācār Reʾīs wrote it with the aid of the Lord of Decision [God] in the month of Ṣafer, year 975 [between 7 August and 4 September 1567]." ʿAlī Mācār's name also appears on the inside cover: "This chart [or better, atlas][55] is ʿAlī Mācār's; do not leave it unnoticed!"

Despite these seemingly adequate clues, the authorship of the atlas remains elusive. Since the word *reʾīs* can mean "captain," it would thus be a professional epithet as part of the name. An ʿAlī Mācār Reʾīs (Captain ʿAlī the Hungarian) is indeed listed in a roster of skippers of the sultan's galleys (*ḥāṣṣa reʾīsleri*) who received promotion in 979/1571.[56] Thus, as with Pīrī Reʾīs, we have another example of an Ottoman sea captain who may have drawn maps. Another explanation could be that this captain simply added his name to an atlas made by someone else, possibly even by an Italian, that lacked an attribution. It may have been prepared originally for presentation to the sultan or simply to be sold in the markets of Turkey; it may have been captured elsewhere and brought to Istanbul as booty.

An intriguing twist to this question appears in a roster of the members of the Cemāʿat-i Naḳḳāşān-i Rūmiyān (Guild of Rumi painters, employed by the imperial palace) dated 965/1558, which lists an ʿAlī Mācār as one of the member painters.[57] Although the epithet "captain" is missing from the roster, the individual's ethnic Hungarian origin stands out. (A similar origin for the name of the entire company of artists, Rūmī, which can mean "European," raises further questions.) This distinctive name, coupled with the fact that the years 965/1558 and 975/1567 are close enough together, opens the possibility that we are dealing with the same person.

It is undeniable, however, that the ʿAlī Mācār Reʾīs atlas follows the cartographic style of the Italian school, particularly the small atlases of Ottomano Freducci and Battista Agnese. The question is more complex with regard to decoration. There too the inspiration is Italian, but the place of manufacture may well have been Istanbul, and the cooperation of a Turkish mariner is entirely conceivable. At this time Turkish names were superseding local Arabic names or the international maritime lingua franca, as in the case of the Pontine Islands near Naples, for which Çatal ada is used for Palmarola and Selmanlar for Ponza. It has been suggested that the use of the word *kataba* (wrote) by ʿAlī Mācār Reʾīs in relation to his signature in the atlas implies that, although he gives himself credit for writing the place-names in Turkish, he did not draw the charts, for which another verb *rasama*, "drew,"

special study: Doğan Uçar, "Ali Macar Reis Atlası," in *Proceedings of the Second International Congress on the History of Turkish and Islamic Science and Technology, 28 April–2 May 1986*, 3 vols. (Istanbul: İstanbul Teknik Üniversitesi, 1986), 1:33–43. The author claims that the projection used here is an important precursor (by 350 years) of the Eckert III projection. It should be pointed out that the map is merely copied from one of the many manuscript atlases of Battista Agnese, which used a modification of the many oval projections developed in the early sixteenth century.

55. The word *ḥarīṭa* usually carried the meaning "chart," but it could also have had the connotation of "atlas" in the absence of a specific Turkish word for such a format.

56. Istanbul, Başvekalet Arşivi, Dīvān-i hümāyūn ruʾūs defteri, 16a, p. 19 (Kâmil Kepeçi's catalog: no. 223); cited in William C. Brice, Colin Imber, and Richard Lorch, *The Aegean Sea-Chart of Mehmed Reis ibn Menemenli, A.D. 1590/1* (Manchester: University of Manchester, 1977), unpaginated.

57. Istanbul, Topkapı Sarayı Arşivi, D. 6500; see Rıfkı Melûl Meriç, *Türk nakış sanʿatı tarihi araştırmaları*, vol. 1, *Vesîkalar* (Ankara: Feyz ve Demokrat Ankara, 1953), 6.

TABLE 14.1 Map Order in the Ottoman Portolan Atlases

Region Depicted	ʿAlī Mācār Reʾīs Atlas[a]	Atlas-i Hümayun[b]	Walters *Deniz atlası*[c]	Battista Agnese Atlas (1542)[d]
Black Sea and Sea of Marmara	1	1	1	9
Eastern Mediterranean	2	2	2	8
Central Mediterranean	3	3	3	7
Western Mediterranean	4	4	4	6
Iberian Peninsula	—	—	—	5
Atlantic Coast and British Isles	5	5	5	4
Aegean Sea and Sea of Marmara	6	6	—	—
Ionian Sea	—	7	—	—
Europe and North Africa	—	9	6	—
Indian Ocean	—	—	7	3
Atlantic Ocean	—	—	—	2
Pacific Ocean	—	—	—	1
World	7	8	8	10/11

[a]Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 644.
[b]Istanbul, Arkeoloji Müzesi Kitaplığı, no. 1621.
[c]Baltimore, Walters Art Gallery, MS. W. 660.
[d]Rome, Biblioteca Apostolica Vaticana, Cod. Pal. Lat. 1886; this 1542 atlas represents the general organization of Agnese atlases. See Roberto Almagià, *Monumenta cartographica Vaticana*, 4 vols. (Rome: Biblioteca Apostolica Vaticana, 1944–55), 1:64–67.

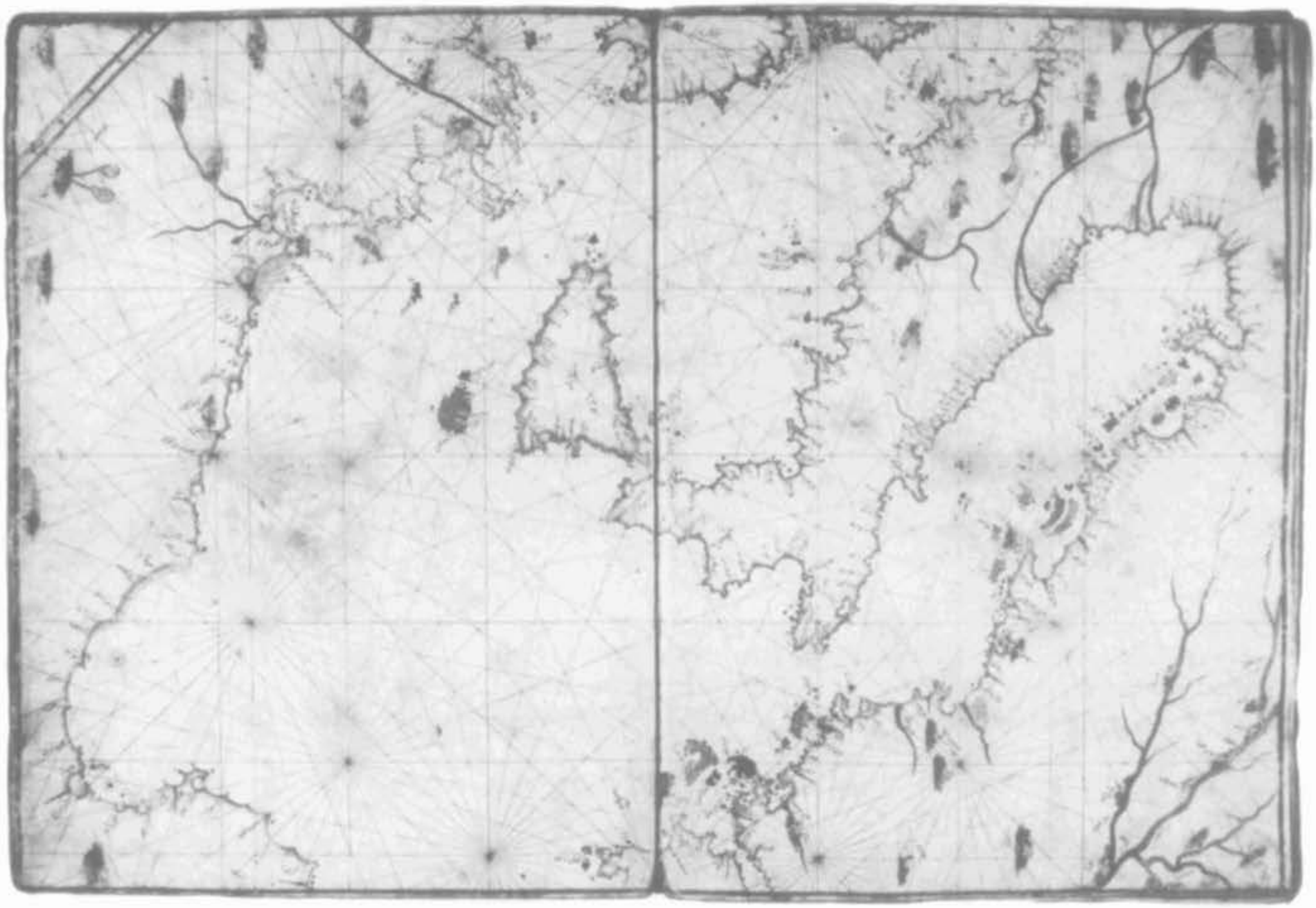


FIG. 14.16. PORTOLAN ATLAS ASSOCIATED WITH ʿALĪ MĀCĀR REʾĪS: ITALY AND THE CENTRAL MEDITERRANEAN. The identity of "Captain ʿAlī the Hungarian" is not precisely known, but he signed and dated the atlas on the chart of the western Mediterranean in 975/1567. The note near Selmanlar locating "the place where the late Sinān Paşa took ships" refers to a clash between the Ottoman fleet under Sinān Paşa and the Habsburg admiral Andrea Doria in 959/1552.
Size of the original: 29 × 42 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 644, fols. 3b–4a).

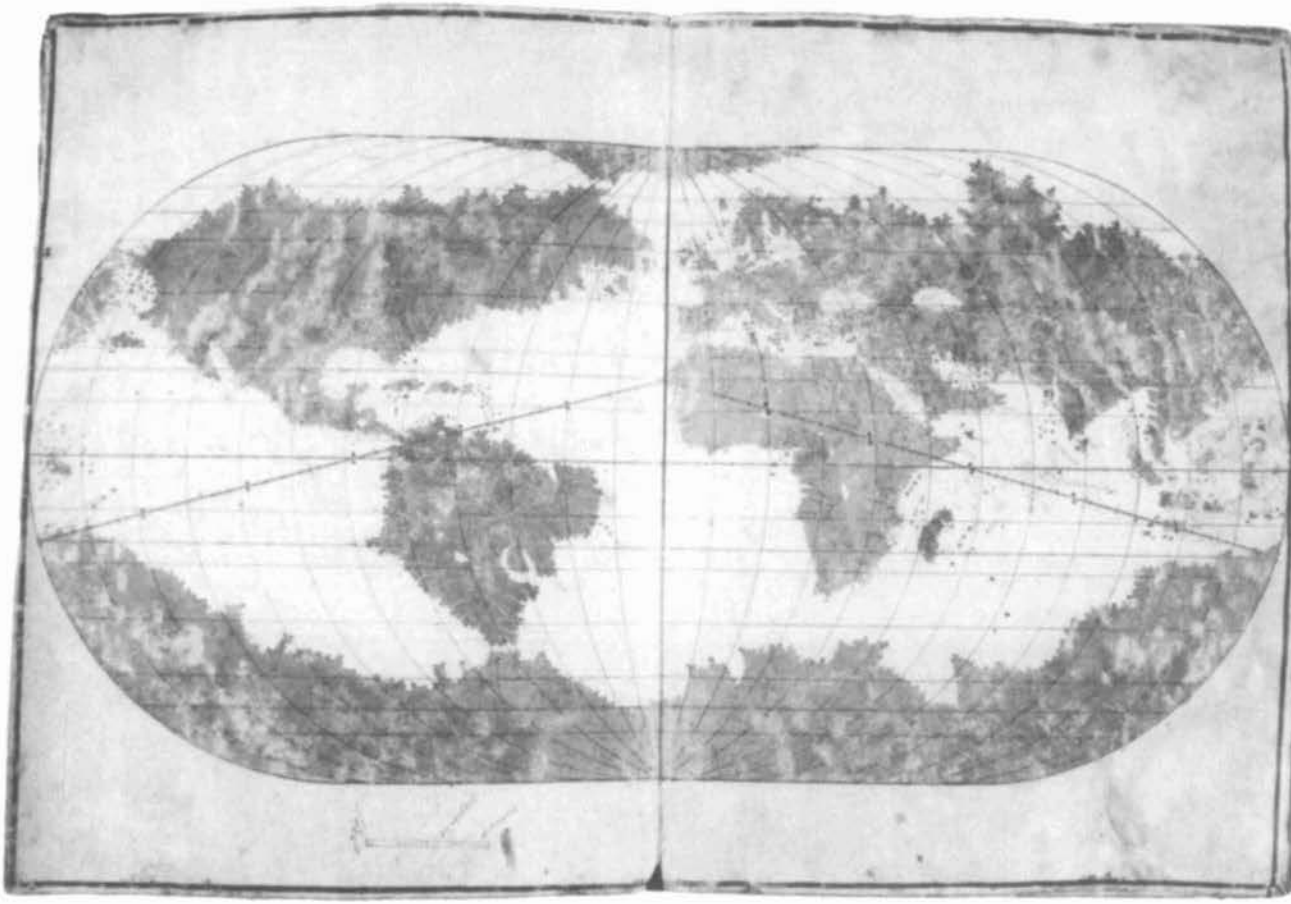


FIG. 14.17. WORLD MAP FROM THE ʿALĪ MĀCĀR REʾĪS ATLAS. World maps like this one are found in all three portolan atlases described here. They are all drawn on oval projections derived from the many Agnese atlases dated to the mid-sixteenth century, which were themselves based on earlier models by Francesco Rosselli and Benedetto Bordone. This example has a curious representation of the ecliptic as two straight-line segments and, also unusual for world maps of this type, a scale at the foot of the map. The coastal outlines are extremely similar to those on Gastaldi's woodcut world map (1561–62) in the British Library.
Size of the original: 29 × 42 cm. By permission of the Topkapı Sarayı Müzesi Kütüphanesi, Istanbul (H. 644, fols. 7b–8a).

or the phrase ʿ*amal* . . ., "work of . . .," might have been used. The theory has thus developed that originally these charts bore only coastal outlines, to which place-names would be added by the owner.

Until 1984, the ʿAlī Mācār Reʾīs maps were the only known Ottoman charts in atlas format. In that year, however, Goodrich discovered another such atlas at the Istanbul Arkeoloji Müzesi that he tentatively labeled Atlas-i hümayun (Imperial atlas) (fig. 14.18).[58] The atlas consists of nine charts on parchment bound in heavy leather. Its covers measure fifty-four by thirty-five centimeters, and it is thus larger than the ʿAlī Mācār Reʾīs atlas both in size and in the number of charts. Seven of the charts (charts 1–6 and 8) closely resemble those of the ʿAlī Mācār example, while the chart of the Ionian Sea, Greece, and Sicily (chart 7) appears to be an enlargement of one section of the chart of the central Mediterranean (chart 3). The final chart contains a very unusual depiction of Europe and northern Africa (chart 9). Unlike the ʿAlī Mācār Reʾīs atlas, this work lacks information about the author, date, and place of manufacture. Goodrich tentatively dates it to 978/1570.[59]

By a remarkable coincidence, in the same year that he discovered the Atlas-i hümayun, Goodrich also identified a third such Ottoman atlas. Since it is housed at the Walters Art Gallery in Baltimore, he named it Walters *Deniz atlası* (Walters sea atlas) (plate 23).[60] It contains the traditional portolan atlas contingent of six charts, from the Black Sea to the coast of western Europe, apparently reflecting the pattern of the other two atlases. In addition, there is a world map on an oval projection, similar in form to those in, for example, the Battista

58. Istanbul, Arkeoloji Müzesi Kitaplığı, no. 1621; see Goodrich, "Atlas-i hümayun," 83–101 (note 21).

59. Goodrich, "Atlas-i hümayun," 92 (note 21).

60. Baltimore, Walters Art Gallery, MS. W. 660; see Thomas D. Goodrich, "The Earliest Ottoman Maritime Atlas—The Walters *Deniz atlası*," *Archivum Ottomanicum* 11 (1986): 25–50.

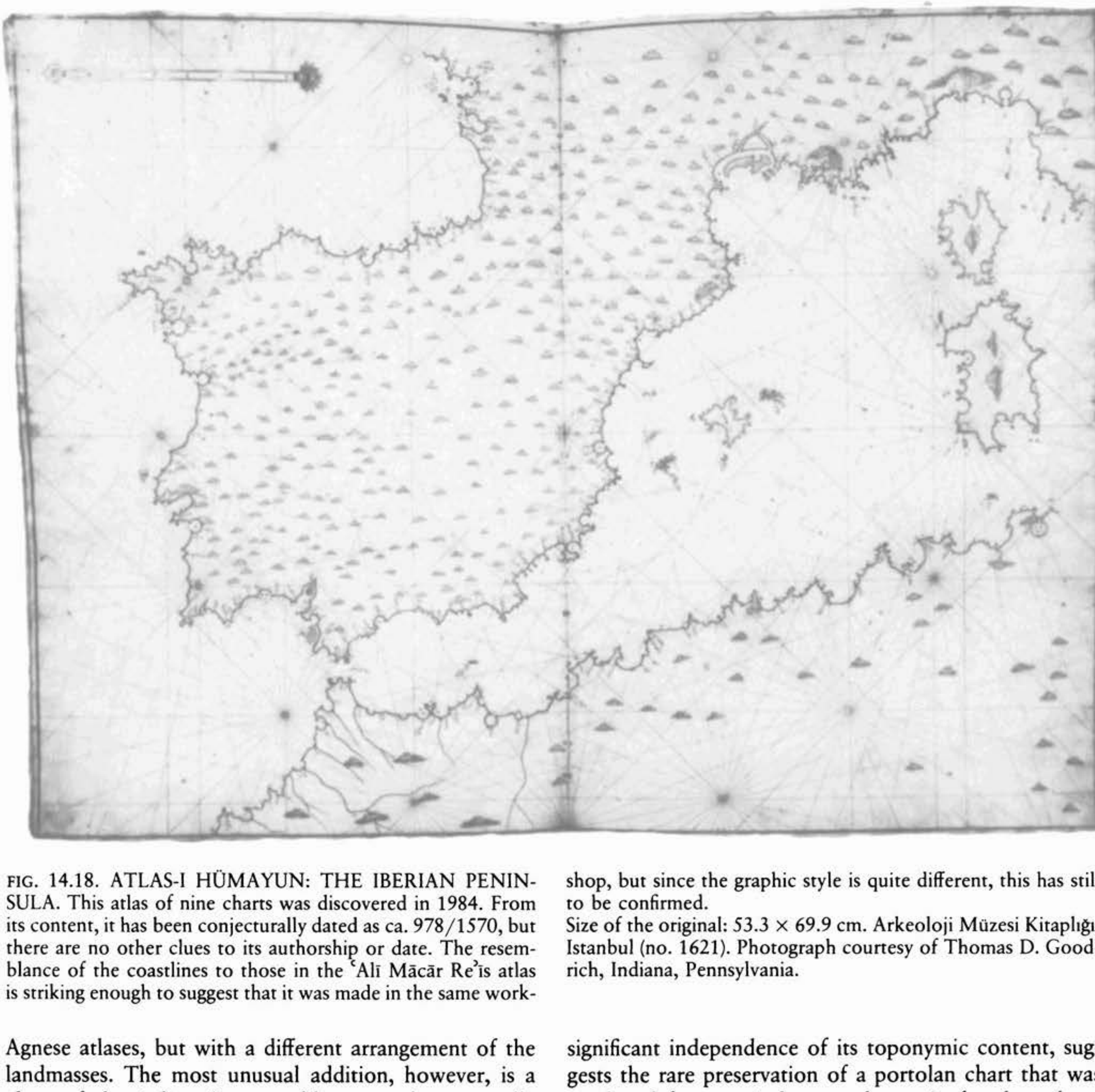


FIG. 14.18. ATLAS-I HÜMAYUN: THE IBERIAN PENINSULA. This atlas of nine charts was discovered in 1984. From its content, it has been conjecturally dated as ca. 978/1570, but there are no other clues to its authorship or date. The resemblance of the coastlines to those in the ʿAlī Mācār Reʾīs atlas is striking enough to suggest that it was made in the same workshop, but since the graphic style is quite different, this has still to be confirmed.
Size of the original: 53.3 × 69.9 cm. Arkeoloji Müzesi Kitaplığı, Istanbul (no. 1621). Photograph courtesy of Thomas D. Goodrich, Indiana, Pennsylvania.

Agnese atlases, but with a different arrangement of the landmasses. The most unusual addition, however, is a chart of the Indian Ocean unlike any other generally known. Goodrich suggested this may be the earliest Ottoman atlas, owing to some rather archaic geographical notions on the world map when compared with world maps in the other two atlases. He believed it could date from as early as ca. 968/1560, but he left the subject open to more intense study. The atlas seems to have been made strictly for presentation. The town view miniatures and compass roses are particularly fine, and the snake motifs at the ends of the graphic scales are especially unusual.

We should mention finally the Aegean sea chart by Meḥmed Reʾīs of Menemen, dated 999/1590–91 (fig. 14.19). Its less sumptuous workmanship, as well as the significant independence of its toponymic content, suggests the rare preservation of a portolan chart that was produced for practical use and may in fact have been completed in the course of that use.[61] As suggested with the ʿAlī Mācār Reʾīs atlas, it is quite possible that mariners, technically unequipped to make such charts themselves from scratch, would acquire blank ones bearing only coastal outlines, which they would then complete or emend with appropriate toponymy, perhaps adding a few hydrographic corrections. Since they lacked the money or motive to acquire refined illuminated specimens, the supplier of charts to ordinary Turkish navi-

61. Venice, Civico Museo Correr, Port. 22. The place-names reveal little similarity to comparable charts in the ʿAlī Mācār Reʾīs atlas or in the *Kitāb-i baḥrīye*; see Brice, Imber, and Lorch, *Aegean Sea-Chart* (note 56).

FIG. 14.19. THE MEḤMED REʾĪS CHART. This single, south-oriented chart is dated 999/1590–91 and signed by Meḥmed Reʾīs. The preservation of the natural shoulder of its vellum indicates that it is not a fragment of a larger portolan chart covering the Mediterranean but a rare regional chart of Greece, Crete, and the Aegean Sea. Its unadorned style has led to the view that it is a freak survivor of a working chart, possibly intended as a base for the compilation of other charts.
Size of the original: 59.5 × 82.5 cm. By permission of the Civico Museo Correr, Venice (Port. 22).

gators would not be the imperial atelier but a simpler yet specialized mapmakers' workshop.

Evidence of this activity is found in the writings of the Turkish traveler and author Evliyā Çelebi (1020/1611 to ca. 1095/1684), who mentions eight workshops of mapmakers (*eṣnāf-i ḫarīṭaciyān*) employing fifteen craftsmen in his exhaustive list of Istanbul guilds. Significantly, he places this passage just after those dealing with the guilds of the compass makers (*eṣnāf-i puslaciyān*) and of hourglass makers (*eṣnāf-i ḳum sāʿatçiyān*). These products, he states, are equally indispensable to sailors. As for the mapmakers' guild, he is explicit—mariners are its main customers:

> The Map-makers [*ḫarīṭaciyān*] are but fifteen, with eight shops. They are deeply versed in all kinds of sciences, and possess different languages, particularly the Latin, in which they read the geographical works, Atlas minor and Mappemonde [*papamonta*]. They lay down in their drawings the seas, rivers and mountains of the whole world, and sell their works to sailors and navigators. The science of charts is the soul of navigation, because on them the road is traced for ships in every direction of the compass, and there is laid down whether the places resorted to are islands, ports, shallows, rocks, deep water, &c., according to which directions, navigators undertake their voyages on the ocean.[62]

THE AL-SHARAFĪ AL-ṢIFĀQSĪ FAMILY

Although not normally associated with Ottoman marine cartography, the center of activity of the al-Sharafī al-

62. Evliyā Çelebi, *Seyāḥatnāme* (Book of travels); see the modern edition in 10 vols. (Istanbul: Iqdām, 1896–1938), 1:548. The translation in the text follows *Narrative of Travels in Europe Asia and Africa, in the Seventeenth Century by Evliya Efendi*, trans. Joseph von Hammer, 2 vols. in 1 (London: Printed for the Oriental Translation Fund of Great Britain and Ireland, 1846–50), vol. 1, pt. 2, p. 131.

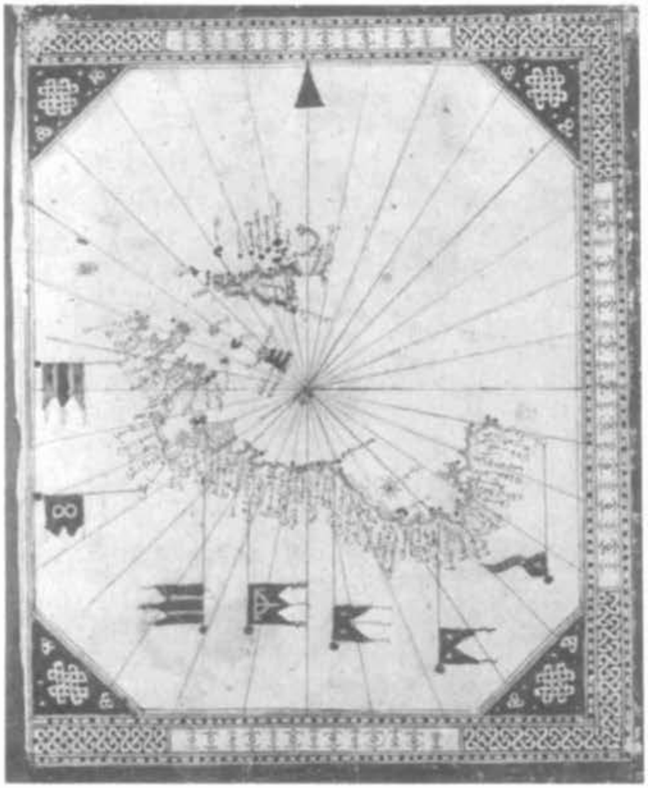


FIG. 14.20. CENTRAL MEDITERRANEAN FROM THE 1551 AL-SHARAFĪ AL-ṢIFĀQSĪ ATLAS. A chart, oriented to the south, of the Gulf of Sidra, Malta, Sicily, and part of the Calabrian coast from the earliest extant portolan atlas of the al-Sharafī al-Ṣifāqsī family of cartographers, dated 958/1551. The intricate arabesque borders are characteristic of the work of this family.
Size of the original: 25 × 20 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2278, fol. 6v).

FIG. 14.21. WORLD MAP FROM THE 1551 AL-SHARAFĪ AL-ṢIFĀQSĪ ATLAS. This family of cartographers drew extensively on the geographical tradition of al-Idrīsī, whose influence is clearly shown in this small, diagrammatic world map from their earliest extant atlas.
Size of the original: 25 × 20 cm. By permission of the Bibliothèque Nationale, Paris (MS. Arabe 2278, fol. 3r).

Ṣifāqsī family in the Tunisian town of Sfax was within the political influence of the Ottoman Empire for most of the period of its chartmaking. The Ottoman sultans never controlled the western Mediterranean but achieved a measure of success along the Maghreb coast beginning in 892/1487 when Kemāl Reʾīs began to raid Christian shipping from bases on the island of Djerba and the ports of Bône and Bougie. By the first decades of the sixteenth century, the Barbarossa brothers had established corsair activity out of Algiers, and in 924/1518 Ḫayreddīn Barbarossa requested that ports under his control be included within the boundaries of Ottoman protection.[63]

The al-Ṣifāqsī family appears to have no direct links to Ottoman chartmakers, but they had a special relationship to the tradition of al-Idrīsī, whose influence is ever present in their work (see chap. 7). Much like the Ptolemaic tradition, which was held in esteem long after the content of Ptolemy's maps ceased to serve any useful purpose in Europe, the mark of al-Idrīsī remained in their work until the seventeenth century.

The earliest extant maps made by the family are in a small portolan atlas. It consists of five charts of the Mediterranean and Black Sea and the Iberian and Moroccan coasts of the Atlantic (fig. 14.20), a world map similar to the small circular world map of al-Idrīsī (fig. 14.21), a qibla diagram (plate 13), a diagram showing the day lengths for each month of the year in the fourth climate, and an agricultural calendar for each month.[64] The author, ʿAlī ibn Aḥmad ibn Muḥammad al-Sharafī al-Ṣifāqsī, refers to his cartographic work as a *ṭablah* (Latin

63. Although it provided skilled mariners and bases from which to harass Christian shipping, the North African frontier never developed beyond a string of coastal strongholds held by semiautonomous corsairs. See Andrew C. Hess, *The Forgotten Frontier: A History of the Sixteenth-Century Ibero-African Frontier* (Chicago: University of Chicago Press, 1978), esp. 58–66; Svat Soucek, "The Rise of the Barbarossas in North Africa," *Archivum Ottomanicum* 3 (1971): 238–50; and Aldo Galotta, "Khayr al-Dīn (Khıḍır) Pasha, Barbarossa" in *Encyclopaedia of Islam*, new ed., 4:1155–58.

64. Paris, Bibliothèque Nationale, MS. Arabe 2278.

FIG. 14.22. WORLD DIAGRAM FROM THE 1571–72 AL-SHARAFĪ AL-ṢIFĀQSĪ ATLAS. The inclusion in these atlases of a circular world map from the al-Idrīsī tradition in diagrammatic form (compare with fig. 14.21) clearly served a symbolic rather than a purely geographical purpose. The scalloped outer band represents the legendary mountain of Qāf surrounding the earth. The legend on the southern continent reads, "The empty half of the earth, according to what philosophers have told: sands, wasteland, deserts; it is hot because of the proximity of the sun to it, nothing lives there because of the heat, according to what has been said."
Size of the original: 26.5 × 20.5 cm. By permission of the Bodleian Library, Oxford (MS. Marsh 294, fol. 5v).

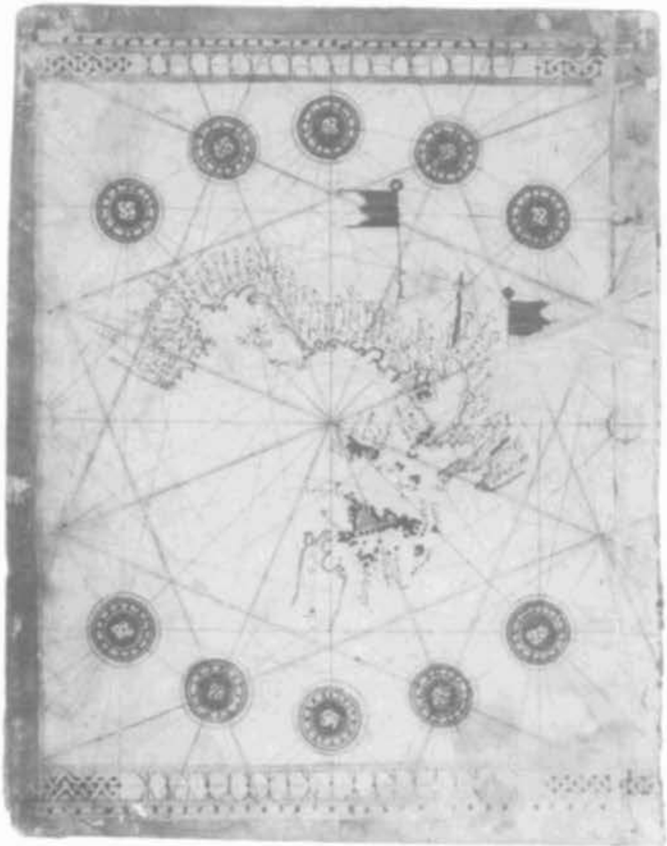


FIG. 14.23. CENTRAL MEDITERRANEAN FROM THE 1571–72 AL-SHARAFĪ AL-ṢIFĀQSĪ ATLAS. The representation on this chart may be compared with the same region depicted in figure 14.20. The place-names are practically identical, but the style has a less formal and finished look than the version of A.D. 1551.
Size of the original: 26.5 × 20.5 cm. By permission of the Bodleian Library, Oxford (MS. Marsh 294, fol. 6r).

tabula or map) and says that he finished it on 1 Ramaḍān 958 (1 or 2 September 1551).

The same author produced a second work, a world map drawn in 987/1579. As described by Nallino, it consists of two large sheets pasted together, with names in Maghribī script (plate 24).[65] Once the property of the admiral Marquis Giovanni della Chiesa, it was acquired in 1916 by the Italian antiquarian Alessandro Castagnari. Part of an inscription on the western side reads:

> The writer of these lines is the humble servant of God ʿAlī ibn Aḥmad ibn Muḥammad al-Sharafī, native of Sfax, living now in al-Qayrawān, follower of the Malikite rite. . . . it [the map] was finished in the first days of Jumādā 987 [late June–early July 1579].

The major inscription on the eastern side introduces the oldest member of the family of whom we have record: "I have copied this mappamondo from [another] drawn by my grandfather Muḥammad . . . ; he had copied the coasts of the 'mare Siro' and its ports from a *qunbāṣ* [nautical chart][66] made by the Majorcans." The reference

65. Rome, Istituto Italo-Africano; see Carlo Alfonso Nallino, "Un mappamondo arabo disegnato nel 1579 da ʿAlī ibn Aḥmad al-Sharafī di Sfax," *Bollettino della Reale Società Geografica Italiana* 53 (1916): 721–36.

66. See above, pp. 256 and 257. In Ibn Khaldūn's description of the Eternal Islands (Canaries), *qunbāṣ* was indeed the Arabic word for portolan chart, the word coming from "compass," meaning "dividers": "The countries situated on the two shores of the Mediterranean are noted on a chart (*ṣaḥīfah* [literally, vellum]) which indicates the true facts regarding them and gives their positions along the coast in the proper order. The various winds and their paths are likewise put down on the chart. This chart is called the 'compass' [*qunbāṣ*]. It is on this (compass) that (sailors) rely on their voyages." Ibn Khaldūn, *The Muqaddimah: An Introduction to History*, 3 vols., trans. Franz Rosenthal (New York: Bollingen Foundation, 1958), 1:117. See also William C. Brice, "Compasses, Compassi, and *Kanābīṣ*," *Journal of Semitic Studies* 29 (1984): 169–78, and Nallino, "Un mappamondo arabo," 734–36 (note 65).

is to Muḥammad ibn Muḥammad al-Sharafī al-Ṣifāqsī, but no map of his survives—we assume one resembled the 987/1579 chart. The western half followed Catalan models, but the eastern half, the source of which is al-Idrīsī, is incongruously tacked on and oblivious to the new European discoveries. It bears no trace of the discovery of the Americas, the circumnavigation of the world, or even the works of Pīrī Reʾīs. The lines from the compass rose are continued over the eastern section in a way that al-Idrīsī would never have considered and probably would not have understood. The author relied on al-Idrīsī for the depiction of the internal part of Europe as well. From the viewpoint of content, the map reveals the independence of Arabic nomenclature from the European names.

Finally there is a third work, a small portolan atlas dated 979 (26 May 1571–13 May 1572), by ʿAlī ibn Aḥmad ibn Muḥammad.[67] Not unlike the 958/1551 atlas, it has a small, round, very corrupt Idrīsī-like world diagram (fig. 14.22) and charts of the Gulf of Sidra (fig. 14.23), Italy and the Adriatic, the Iberian Peninsula, the western Mediterranean with the Balearics, the Aegean Sea and Crete, the Black Sea, and the eastern Mediterranean and Cyprus. All the charts are oriented to the south. The place-names are practically identical to those on his earlier atlas.

These maps originating in the sixteenth century were copied by later generations of the same family. The 987/1579 hybrid world chart of ʿAlī ibn Aḥmad ibn Muḥammad, which was a copy of a map by his grandfather Muḥammad ibn Muḥammad, was copied in its turn by his son Muḥammad ibn ʿAlī ibn Aḥmad in 1009/1600–1601. It is this copy, held at the Bibliothèque Nationale, Paris (figs. 14.24 and 14.25), that is best known to scholars through the full-sized facsimile in Jomard's *Les monuments de la géographie* and a much reduced copy in Nordenskiöld.[68] The graphic scales and elaborate wind roses that are so prominent on the western part are not included on the eastern portion.

Finally, another descendent of the same family, perhaps a grandson or great-grandson of ʿAlī ibn Aḥmad ibn Muḥammad, named Aḥmad al-Sharafī al-Ṣifāqsī, settled in Cairo, where he became a teacher in the al-Azhar mosque. In 1087/1676–77, he composed a treatise on the use of the quadrant.[69] A series of manuscripts entitled *Nuzhat al-anẓār fī ʿajāʾib al-tawārīkh wa-al-akhbār* by the late eighteenth-century chronicler from Sfax, Maḥmūd ibn Saʿīd Maqdīsh, lists several other members of the family, of which the last two died of the plague in 1199/1784–85.[70] We thus have eight or nine generations of the same family following similar cartographic, mathematical, or astronomical interests.

The general picture that emerges of Islamic marine cartography from the fourteenth to the seventeenth century is that of an eclectic and pragmatic blend of sources. Al-Idrīsī's works, Italian and Catalan sailing charts and portolans, Italian *isolarii*, and original observations of Turkish corsairs and naval officers were all drawn upon. Of the groups of maps and atlases defined here, the early charts in Arabic script seem to have borne great affinity to their Western counterparts, in structure and convention if not in toponymy. Those of Pīrī Reʾīs, although also relying on Western sources, show particular originality, especially in the *Kitāb-i baḥrīye*. The Ottoman portolan atlases, on the other hand, apart from their Arabic and Turkish legends, appear to have been based largely on Italian sources. Last, the maps of the al-Sharafī al-Ṣifāqsī family blend the traditional cartography of al-Idrīsī with that of the Catalan sea charts of the Mediterranean, combining quite different geometrical structures in an arbitrary and often anachronistic way. But even this last group of maps, like all the others, calls out for further study, as we seek a clearer explanation of the function and use of many of these charts.

67. Oxford, Bodleian Library, MS. Marsh 294.

68. Paris, Bibliothèque Nationale, MS. Rés. Ge. C. 5089. Edme François Jomard, *Les monuments de la géographie* (Paris: Duprat, 1842–62), 60–63, and Adolf Erik Nordenskiöld, *Periplus: An Essay on the Early History of Charts and Sailing-Directions*, trans. Francis A. Bather (Stockholm: P. A. Norstedt, 1897; reprinted New York: Burt Franklin, 1967), 69 and figs. 22–23.

69. Manuscripts in Paris, Bibliothèque Nationale, Suppl. Arabe 961, shown as no. 2551 in the printed catalog; and one in Cairo, Sulṭānīyah, Mīqât 58; see Nallino, "Un mappamondo arabo," 729 (note 65).

70. The manuscripts were reproduced lithographically in a rare facsimile (Tunis: Maṭbaʿah ʿIlmīyah Ḥajarīyah, 1903). See Carlo Alfonso Nallino, "Venezia e Sfax nel secolo XVIII secondo il cronista arabo Maqdîsh," in *Centenario della nascita di Michele Amari*, 2 vols. (Palermo: Stabilimento Tipografico Verzí, 1910), 1:307–56, esp. 309–12.

FIG. 14.24. ASIA AND THE MIDDLE EAST ON THE 1601–2 AL-SHARAFĪ AL-ṢIFĀQSĪ CHART. The eastern portion of this chart, on a separate piece of parchment, follows al-Idrīsī's sectional maps for the configuration of Asia.
Size of the original: 48.5 × 64.5 cm. By permission of the Bibliothèque Nationale, Paris (Rés. Ge. C. 5089).

APPENDIX 14.1
ISLAMIC MARITIME CHARTS

Early Charts in Arabic[1]

1. Milan, Biblioteca Ambrosiana, MS. S.P. II 259 ("Maghreb" chart of the western Mediterranean). Anonymous and undated (attributed to the first half of the fourteenth century); paper; 24 × 17 cm.[2]

2. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1823 (Mediterranean chart). Ibrāhīm ibn Aḥmad al-Kātibī; 816/1413–14; parchment; 54 × 88 cm.[3]

3. Istanbul, Deniz Müzesi, no. 882 (Mediterranean chart). Ibrāhīm al-Mursī; 865/1461; parchment; 48 × 89 cm.[4]

4. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1822 (Mediterranean chart). Ḥajj Abū al-Ḥasan; undated (considered post-926/1520); parchment; 74 × 100 cm.[5]

Pīrī Reʾīs

5. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1633 mük (world map fragment of the Atlantic). Pīrī Reʾīs; 919/1513; parchment; 90 × 63 cm.[6]

6. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 1824 (world map fragment of the north Atlantic). Pīrī Reʾīs; 935/1528–29; parchment; 69 × 70 cm.[7]

Ottoman Portolan Charts and Atlases

7. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 644 (ʿAlī Mācār Reʾīs atlas). Authorship attributed to ʿAlī Mācār Reʾīs; drafted in 975/1567; six charts and one world map on parchment; size of the double-page map: 29 × 42 cm.[8]

8. Istanbul Arkeoloji Müzesi Kitaplığı, no. 1621 (Atlas-i hümayun). Anonymous and undated (considered ca. 978/1570); eight charts and one world map on parchment; size of the double-page map: 53.3 × 69.9 cm.[9]

9. Baltimore, Walters Art Gallery, MS. W. 660 (Walters *Deniz atlası*). Anonymous and undated (considered ca. 1560–70); seven charts and one world map on parchment; size of the double-page map: 30.1 × 45 cm.[10]

10. Venice, Civico Museo Correr, Port. 22 (formerly Cicogna 3448) (Aegean chart). Meḥmed Reʾīs of Menemen; 999/1590–91; parchment; 59.5 × 82.5 cm.[11]

11. Munich, Bayerische Staatsbibliothek, Cod. Turc. 431 (Mediterranean chart). Dated 1062/1652; 117.5 × 81 cm.[12]

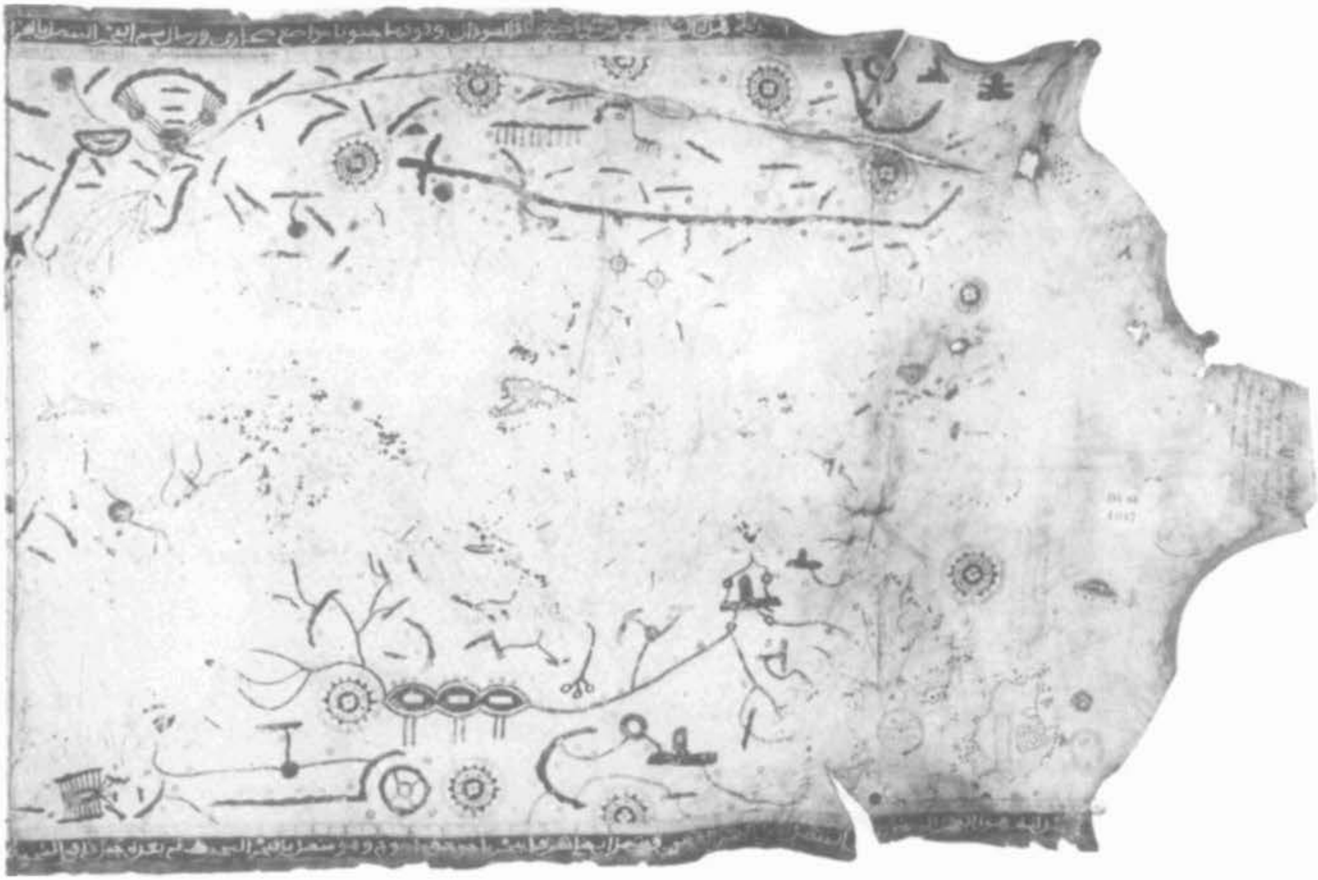


FIG. 14.25. EUROPE AND NORTH AFRICA ON THE 1601–2 AL-SHARAFĪ AL-ṢIFĀQSĪ CHART. A copy made by Muḥammad ibn ʿAlī ibn Aḥmad, a fourth-generation mapmaker of the al-Sharafī al-Ṣifāqsī family, following the A.D. 1579 chart made by his father (plate 24) and the lost chart made by his great grandfather. The European and North African portion follows the representation of traditional portolan charts.
Size of the original: 48.5 × 72.5 cm. By permission of the Bibliothèque Nationale, Paris (Rés. Ge. C. 5089).

12. Vatican, Biblioteca Apostolica Vaticana, Borg. Turco 72; 22 × 16 cm.[13] Nothing else is known about this chart.

Al-Sharafī al-Ṣifāqsī Family

13. Planisphere; not extant. Muḥammad ibn Muḥammad; referred to in an inscription on the 987/1579 chart by ʿAlī ibn Aḥmad ibn Muḥammad (see no. 15).

14. Paris, Bibliothèque Nationale, MS. Arabe 2278 (portolan atlas). ʿAlī ibn Aḥmad ibn Muḥammad, 958/1551; five charts and one world map; 25 × 20 cm.[14]

15. Rome, Istituto Italo-Africano (planisphere). ʿAlī ibn Aḥmad ibn Muḥammad; 987/1579; parchment; 135 × 59 cm.[15]

16. Oxford, Bodleian Library, MS. Marsh 294 (formerly Bodleian Uri 1787I) (portolan atlas). ʿAlī ibn Aḥmad ibn Muḥammad; 979/1571–72; seven charts and one world map; 26.5 × 20.5 cm.[16]

17. Paris, Bibliothèque Nationale, Rés Ge. C. 5089 (planisphere). Muḥammad ibn ʿAlī ibn Aḥmad; 1009/1601; parchment; 48.5 × 72.5 cm (western part), 48.5 × 64.5 cm (eastern part).[17]

1. There is, in addition to this map corpus, a 1482 chart that contains Arabic annotations by Jaime Bertran, a Jewish chartmaker from Barcelona; see Tony Campbell, "Portolan Charts from the Late Thirteenth Century to 1500," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987–), 1:371–463, esp. 374 and 451.

2. Paolo Revelli, "Codici ambrosiani di contenuto geografico," *Fontes Ambrosiani* 1 (1929): 181–82 (no. 532); Konrad Miller, *Mappae arabicae: Arabische Welt- und Länderkarten des 9.–13. Jahrhunderts*, 6 vols. (Stuttgart, 1926–31), Band 5, 173–75; and Youssouf Kamal, *Monumenta cartographica Africae et Aegypti*, 5 vols. in 16 pts. (Cairo, 1926–51), 4.3:1336–37; facsimile reprint, 6 vols., ed. Fuat Sezgin (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), 6:27–29.

3. Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Türkçe Yazmalar Kataloğu*, 2 vols. (Istanbul: Topkapı Sarayı Müzesi, 1961), 1:464–65 (no. 1407), and Campbell, "Portolan Charts," 453 (note 1). A color reproduction can be found in Fuat Sezgin, *The Contribution of Arabic-Islamic Geographers to the Formation of the World Map* (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1987), pl. 18.

4. Campbell, "Portolan Charts," 453 (note 1).

5. Karatay, *Türkçe Yazmalar Kataloğu*, 1:471 (no. 1431) (note 3). William C. Brice lists the inventory number as "No. 49356/2753" in

"Early Muslim Sea-Charts," *Journal of the Royal Asiatic Society of Great Britain and Ireland,* [1977], 55.

6. Karatay, *Türkçe Yazmalar Kataloğu,* 1:465 (no. 1408) (note 3); Gustav Adolf Deissmann, *Forschungen und Funde im Serai, mit einem Verzeichnis der nichtislamischen Handschriften im Topkapu Serai zu Istanbul* (Berlin: Walter de Gruyter, 1933), 111–22 (no. 87); and Cevdet Türkay, *Istanbul Kütübhanelerinde Osmanlı'lar Devrine Aid Türkçe—Arabça—Farsça Yazma ve Basma Coğrafya Eserleri Bibliyoğrafyası* (Istanbul: Maarif, 1958), 56. Good color reproductions are found in Michel Mollat du Jourdin and Monique de La Roncière, *Sea Charts of the Early Explorers: 13th to 17th Century,* trans. L. le R. Dethan (New York: Thames and Hudson, 1984), pl. 28; and Esin Atıl, *The Age of Sultan Süleyman the Magnificent,* exhibition catalog (Washington, D.C., and New York: National Gallery of Art and Harry N. Abrams, 1987), fig. 35.

7. Karatay, *Türkçe Yazmalar Kataloğu,* 1:465–66 (no. 1409) (note 3), and Türkay, *Yazma ve Basma Coğrafya Eserleri,* 55 (note 6).

8. Karatay, *Türkçe Yazmalar Kataloğu,* 1:466 (no. 1410) (note 3), and Türkay, *Yazma ve Basma Coğrafya Eserleri,* 54 (note 6). See also Svat Soucek, "The 'Ali Macar Reis Atlas' and the Deniz kitabı: Their Place in the Genre of Portolan Charts and Atlases," *Imago Mundi* 25 (1971): 17–27.

9. Thomas D. Goodrich, "Atlas-i hümayun: A Sixteenth-Century Ottoman Maritime Atlas Discovered in 1984," *Archivum Ottomanicum* 10 (1985): 83–101.

10. Thomas D. Goodrich, "The Earliest Ottoman Maritime Atlas—The Walters *Deniz atlası,*" *Archivum Ottomanicum* 11 (1986): 25–50, and *The World Encompassed: An Exhibition of the History of Maps Held at the Baltimore Museum of Art, October 7 to November 23, 1952* (Baltimore: Trustees of the Walters Art Gallery, 1952), no. 105.

11. For a good color reproduction, see Susanna Biadene, ed., *Carte da navigar: Portolani e carte nautiche del Museo Correr, 1318–1732,* exhibition catalog (Venice: Marsilio Editori, 1990), 94–95 (no. 26). See also Mirco Vedovato, "The Nautical Chart of Mohammed Raus, 1590," *Imago Mundi* 8 (1951): 49.

12. Bayerische Staatsbibliothek, *Das Buch im Orient: Handschriften und kostbare Drucke aus zwei Jahrtausenden,* exhibition catalog (Wiesbaden: Ludwig Reichert, 1982), 205 (no. 132).

13. Ettore Rossi, *Elenco dei manoscritti turchi della Biblioteca Vaticana* (Vatican: Biblioteca Apostolica Vaticana, 1953), 360.

14. Miller, *Mappae arabicae,* Band 5, 175–76, and Band 6, Taf. 78 (note 2).

15. Miller, *Mappae arabicae,* Band 5, 176 (note 2).

16. Miller, *Mappae arabicae,* Band 5, 176 (note 2).

17. Myriem Foncin, *Catalogue des cartes nautiques sur vélin conservées au Département des Cartes et Plans* (Paris: Bibliothèque Nationale, 1963), 98 (no. 60). See also Edme François Jomard, *Les monuments de la géographie* (Paris: Duprat, 1842–62), 60–63; Adolf Erik Nordenskiöld, *Periplus: An Essay on the Early History of Charts and Sailing-Directions,* trans. Francis A. Bather (Stockholm: P. A. Norstedt, 1897; reprinted New York: Burt Franklin, 1967), 69 and figs. 22–23; and Miller, *Mappae arabicae,* Band 5, 176–77 and Band 6, Taf. 79–80 (note 2).

APPENDIX 14.2
PRELIMINARY LIST OF EXTANT MANUSCRIPTS OF THE *KITĀB-I BAḤRĪYE*

Version 1 (927/1521)

1. Bologna, Biblioteca Universitaria di Bologna, MS. 3612. Date undetermined; 105 maps; 31.2 × 21.6 cm.[1]

2. Bologna, Biblioteca Universitaria di Bologna, MS. 3613. Copied 977/1569; 125 maps; 30.6 × 21 cm.[2]

3. Dresden, Sächsische Landesbibliothek, MS. Eb. 389. Copied 961/1554; 119 maps; 28.7 × 19.9 cm.[3]

4. Istanbul, Deniz Müzesi, no. 987 (formerly no. 3535). Date undetermined; copied by Meḥmed Seyyid; presented to the museum by Ḥasan Ḥüsnü Paşa; 368 fols., 88 maps; 29.2 × 26 cm.[4]

5. Istanbul, Deniz Müzesi, no. 990 (formerly no. 3538). Date undetermined; 269 fols., 134 maps; 31 × 22 cm.

6. Istanbul, Köprülü Kütüphanesi, Fazıl Ahmed Paşa, MS. 172. Copied 1068/1657; 123 maps; 35 × 25.5 cm.[5]

7. Istanbul, Millet Genel Kütüphanesi, Coğrafya 1; 129 maps.[6]

8. Istanbul, Nuruosmaniye Kütüphanesi, MS. 2990. Copied 1055/1645–46 by Aḥmed ibn Muṣṭafā; 126 maps; 30 × 20 cm.

9. Istanbul, Nuruosmaniye Kütüphanesi, MS. 2997. Copied 1038/1628–29 by Muṣṭafā ibn Muḥammad Cündī; 124 maps; 28.7 × 19.9 cm.

10. Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2605. Copied 1134/1721; 133 maps; 29.3 × 20.1 cm.[7]

11. Istanbul, Süleymaniye Kütüphanesi, Ayasofya 3161; 125 maps; 27.7 × 19.5 cm.[8]

12. Istanbul, Süleymaniye Kütüphanesi, Hamidiye 945. Copied in 962/1554–55 by Aḥmed ibn ʿAlī ibn Meḥmed; 42 maps; 36 × 25.4 cm.[9]

13. Istanbul, Süleymaniye Kütüphanesi, Hamidiye 971; 116 maps; 40.5 × 27.7 cm.

14. Istanbul, Süleymaniye Kütüphanesi, Hüsrev Paşa 272. Copied 978/1570; 127 maps; 30.7 × 20.7 cm.[10]

15. Istanbul, Süleymaniye Kütüphanesi, Yeni Cami 790. Copied 959/1551 by Muḥyīddīn; 128 maps; 29.9 × 20 cm.[11]

16. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, B. 337. Copied 982/1574–75; 134 maps; 30 × 20.5 cm.[12]

17. Istanbul Üniversitesi Kütüphanesi, Türkçe 123/2; 119 maps.[13]

18. London, British Library, MS. Or. 4131. Copied seventeenth century; past owners include Ibn Yūsuf (A.H. 1098) and Ibrāhīm Nāşīd (A.H. 1206); 137 maps; 29.3 × 20.4 cm.[14]

19. Oxford, Bodleian Library, MS. d'Orville 543. Copied 996/1587; 142 fols.; 29 × 20.3 cm.[15]

20. Paris, Bibliothèque Nationale, MS. Suppl. Turc 220. Copied end of sixteenth or beginning of seventeenth century; 157 fols., 122 maps; 32.5 × 22.5 cm.[16]

21. Berlin, Staatsbibliothek zu Berlin, Orientabteilung, MS. Or. Foliant 4133. Copied 1054/1644–45.[17]

22. United States (?), private collector. Copied 1131/1718; originally in the library of Sir Thomas Phillipps (MS. 3974); 223 fols., 123 maps; 32 × 22.5 cm.[18]

23. Vienna, Österreichische Nationalbibliothek, Bild-Archiv und Porträt-Sammlung, Cod. H.O. 192 (Historia Osmanica); 172 fols., approx. 130 maps; 31.6 × 21.4 cm.[19]

Version 2 (932/1526)

24. Baltimore, Walters Art Gallery, MS. W. 658. Copied end of seventeenth century; 376 fols., 239 maps; 34 × 23.5 cm.[20]

25. Istanbul, Deniz Müzesi, no. 988 (formerly no. 3537). Date undetermined; presented to the museum by Ḥasan Ḥüsnü Paşa; 426 fols., 239 maps; 34.5 × 23 cm.[21]

26. Istanbul, Deniz Müzesi, no. 989. Date undetermined; 226 maps; 31.3 × 21 cm.

27. Istanbul, Köprülü Kütüphanesi, Fazıl Ahmed Paşa, MS. 171. Copied 962/1555; 426 fols., 117 maps; 31.5 × 20 cm.[22]

28. Istanbul, Süleymaniye Kütüphanesi, Ayasofya 2612. Copied 982/1574; 429 fols., 216 maps; 32.4 × 21.5 cm.[23]

29. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, H. 642. Copied late sixteenth century; 421 fols., 215 maps; 31.5 × 22 cm.[24]

30. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, R. 1633. Copied possibly late seventeenth or early eighteenth century; 221 maps; 32.5 × 22 cm.[25]

31. Istanbul Üniversitesi Kütüphanesi, Türkçe 6605; 228 maps.[26]

32. Kuwait, Dār al-Āthār al-Islāmīyah, LNS. 75 MS. Copied A.D. 1688–89; originally in the library of Philip Hofer; 192 fols., 131 maps; 31.7 × 21.2 cm.[27]

33. Paris, Bibliothèque Nationale, MS. Suppl. Turc 956. Copied late sixteenth century; 434 fols., 219 maps; 35 × 23 cm.[28]

Manuscripts without Text

34. Bologna, Biblioteca Universitaria di Bologna, MS. 3609. Attributed to "Seyyid Nūḥ"; 204 maps; 42.1 × 27.7 cm.[29]

35. Istanbul, Topkapı Sarayı Müzesi Kütüphanesi, B. 338. Date undetermined; 189 maps; 28.5 × 19.5 cm.[30]

36. London, Nasser D. Khalili Collection of Islamic Arts, MS. 718. Formerly in the private Istanbul collection of Halil Bezmen; 119 maps.[31]

Manuscript with Text Only

37. Istanbul, Süleymaniye Kütüphanesi, Hüsrev Paşa 264. Second version text copied 1184/1770 by Süleymān el-maʿrūf [bi-]Ẓuhūrī.

Manuscript Lost or Location Unknown

38. Berlin, Deutsche Staatsbibliothek, Diez A. Foliant 57. First version copy acquired in Istanbul by Heinrich Friedrich von Diez in 1789, supposedly destroyed during World War II; copied beginning of seventeenth century; 50 maps; 42 × 55 cm.[32] [In a letter dated 2 April 1993, the Staatsbibliothek zu Berlin notified us that this version 2 manuscript survived World War II among the holdings of the Asien-Afrika-Abteilung, Deutsche Staatsbibliothek, and it was united with the holdings of the Orientabteilung, Staatsbibliothek Preussischer Kulturbesitz in 1991.]

(There are other extracts of the *Kitāb-i baḥrīye* in different Turkish collections).

I thank Thomas D. Goodrich for his generous assistance in compiling this appendix.

1. Viktor R. Rozen, "Remarques sur les manuscrits orientaux de la Collection Marsigli à Bologne," *Atti della Reale Accademia dei Lincei: Memorie della Classe di Scienze Morali, Storiche, e Filologiche*, 3d ser., 12 (1883–84): 179.

2. Rozen, "Remarques," 179 (note 1). This was the principal manuscript that Paul Kahle used for his partial edition and translation in *Piri Reʾīs Baḥrīje: Das türkische Segelhandbuch für das Mittelländische Meer vom Jahre 1521*, 2 vols. (Berlin: Walter de Gruyter, 1926–27).

3. Heinrich Fleischer, *Catalogus codicum manuscriptorum orientalium Bibliothecae Regiae Dresdensis* (Leipzig: F. C. G. Vogel, 1831), 64 (no. 389). This manuscript must have been copied by more than one individual, since the hand changes several times.

4. Maps appear first in the volume, followed by text.

5. Ramazan Şeşen, Cevat İzgi, and Cemil Akpınar, *Catalogue of Manuscripts in the Köprülü Library*, 3 vols. (in Ottoman Turkish) (Istanbul: Research Centre for Islamic History, Art, and Culture, 1986), vol. 2, and Cevdet Türkay, *Istanbul Kütübhanelerinde Osmanlı'lar Devrine Aid Türkçe—Arabça—Farsça Yazma ve Basma Coğrafya Eserleri Bibliyoğrafyası* (Istanbul: Maarif, 1958), 23.

6. Türkay, *Yazma ve Basma Coğrafya Eserleri*, 24 (note 5).

7. Türkay, *Yazma ve Basma Coğrafya Eserleri*, 9 (note 5).

8. Türkay, *Yazma ve Basma Coğrafya Eserleri*, 9 (note 5).

9. Similar to no. 4, the maps appear first (fols. 3b–42b) and text follows (fols. 43a–109b) on what appears to be the same paper.

10. Five or six folios appear to have been inserted at a later date.

11. Türkay, *Yazma ve Basma Coğrafya Eserleri*, 52 (note 5).

12. The maps are carelessly drawn and colored. There are stylistic similarities to no. 3 above. A seal indicates that the manuscript was once owned by a person named Muṣṭafā, and "ʿAbdülfaḳīr Ebū'l-. . . Maḥmūd eş-şehīr . . . [illegible name]" is written on the cover. Fehmi Edhem Karatay, *Topkapı Sarayı Müzesi Kütüphanesi: Türkçe Yazmalar Kataloğu*, 2 vols. (Istanbul: Topkapı Sarayı Müzesi, 1961), 1:445 (no. 1338) and Türkay, *Yazma ve Basma Coğrafya Eserleri*, 57 (note 5).

13. This volume is part 2 of a two-part set.

14. Norah M. Titley, *Miniatures from Turkish Manuscripts: A Catalogue and Subject Index of Paintings in the British Library and British Museum* (London: British Library, 1981), 64–66 (no. 57).

15. Hermann Ethé, *Catalogue of the Persian, Turkish, Hindûstânî and Pushtû Manuscripts in the Bodleian Library* (Oxford: Clarendon Press, 1930), pt. 2, pp. 1177–79 (no. 2079).

16. Edgar Blochet, *Catalogue des manuscrits turcs*, 2 vols. (Paris: Bibliothèque Nationale, 1932–33), 1:268 (no. 220). A manuscript translation of this copy by Cardonne, entitled "Le flambeau de la Méditerranée," is in the Bibliothèque Nationale (Fonds Français 22972).

17. Barbara Flemming, *Türkische Handschriften*, Verzeichnis der Orientalischen Handschriften in Deutschland, vol. 13, pt. 1 (Wiesbaden: Franz Steiner, 1968), 238–39 (no. 300).

18. The attention given to the elaborate script and decorative charts in this manuscript is more common to manuscripts of the second version. Perhaps it was transcribed to commemorate one of the treaties between Turkey and the European powers in the early eighteenth century; see H. P. Kraus, *Bibliotheca Phillippica: Manuscripts on Vellum and Paper from the 9th to the 18th Centuries from the Celebrated Collection Formed by Sir Thomas Phillipps*, catalog 153 (New York: H. P. Kraus, 1979), 116 (no. 106).

19. Gustav Flügel, *Die arabischen, persischen und türkischen Handschriften der Kaiserlich-Königlichen Hofbibliothek zu Wien*, 3 vols. (Vienna: Kaiserlich-Königliche Hof- und Staatsdruckerei, 1865–67), 1:428 (no. 1275).

20. Erroneously cataloged as a copy of the *Cihānnümā* by Kātib Çelebi. On fol. 1a is the title *portolan-i kebīr*. Venice and Crete are illustrated in Thomas D. Goodrich, "Ottoman Portolans," *Portolan* 7 (1986): 6–11, and Cairo is shown in *Fire of Life: The Smithsonian Book of the Sun* (Washington, D.C.: Smithsonian Institution, 1981), 32.

21. The maps in this volume are stylistically similar to those in nos. 24 and 31.

22. Şeşen, İzgi, and Akpınar, *Manuscripts of the Köprülü Library*, 2:494 (note 5), and Türkay, *Yazma ve Basma Coğrafya Eserleri*, 23 (note 5).

23. Türkay, *Yazma ve Basma Coğrafya Eserleri*, 9 (note 5). Considered one of the best complete manuscripts of the second version, it may also be the earliest, possibly close to the original. It is the subject of three facsimile editions: *Kitabı bahriye*, ed. Fevzi Kurtoğlu and Haydar Alpagot (Istanbul: Devlet, 1935); *Kitab'ı bahriyye*, 2 vols., ed. Yavuz Senemoğlu (Istanbul: Denizcilik Kitabı, 1973); and *Kitab-ı bahriye, Pirî Reis*, 4 vols., ed. Ertuğrul Zekai Ökte, trans. Vahit Çabuk, Tülây Duran, and Robert Bragner, Historical Research Foundation—Istanbul Research Center (Ankara: Ministry of Culture and Tourism of the Turkish Republic, 1988–). In style it is similar to no. 29.

24. Karatay, *Türkçe Yazmalar Kataloğu*, 1:444 (no. 1336) (note 12) and J. M. Rogers and R. M. Ward, *Süleyman the Magnificent*, exhibition catalog (London: British Museum Publications, 1988), 103–4 (no. 40). The manuscript is still in its original stamped leather binding. In style, it is extraordinarily like no. 28, suggesting that it was produced by the same individual at the same place and time.

25. The maps are poorly drawn and colored; some folios are missing. See Karatay, *Türkçe Yazmalar Kataloğu*, 1:444–45 (no. 1337) (note 12), and Türkay, *Yazma ve Basma Coğrafya Eserleri*, 56 (note 5).

26. This is the best representative of a later group of second-version manuscripts copied by expert calligraphers and decorated with lavishly illuminated maps, similar in style to those in nos. 24 and 25. See Türkay, *Yazma ve Basma Coğrafya Eserleri*, 64 (note 5).

27. This manuscript will be featured in Esin Atıl, ed., *Islamic Art and Patronage: Treasures from Kuwait* (New York: Rizzoli, forthcoming). It was on display at the Bibliothèque Nationale, Paris, for a 1990 exhibition and later at the Walters Art Gallery, Baltimore. The map of Istanbul from this manuscript was used as the frontispiece of Lloyd A. Brown, *The Story of Maps* (Boston: Little, Brown, 1949; reprinted New York: Dover, 1979).

28. Blochet, *Manuscrits turcs*, 2:108 (no. 956) (note 16). Two charts from this manuscript are illustrated in color in Michel Mollat du Jourdin and Monique de La Roncière, *Sea Charts of the Early Explorers: 13th to 17th Century*, trans. L. le R. Dethan (New York: Thames and Hudson, 1984), pls. 35–36.

29. Hans Joachim Kissling, *Der See-Atlas des Sejjid Nûh* (Munich: Rudolf Trofenik, 1966).

30. The maps are well drawn and colored. The manuscript carries the foundation seal of Selīm III and the inscription *ḫarīṭa-i akālīm*; see Karatay, *Türkçe Yazmalar Kataloğu*, 1:466 (n. 1411) (note 12).

31. This collection was formerly known as the Nour Collection of Islamic Art. The manuscript will be the subject of a forthcoming study by Svat Soucek. A microfilm copy is held at the Süleymaniye Kütüphanesi, no. 3574.

32. Wilhelm Pertsch, *Verzeichnis der türkischen Handschriften*, Handschriftenverzeichnisse der Königlichen Bibliothek zu Berlin, vol. 8 (Berlin, 1889), 203–10 (no. 184) and Kahle, *Piri Re'is Baḥrīje*, 2:xxx–xxxiv (note 2). The double-page map of Istanbul was illustrated in Eugen Oberhummer, *Konstantinopel unter Sultan Suleiman dem Grossen, aufgenommen im Jahre 1559 durch Melchior Lorichs aus Flensburg* (Munich: R. Oldenbourg, 1902), pl. 22.

PART TWO

South Asian Cartography

15 • Introduction to South Asian Cartography

JOSEPH E. SCHWARTZBERG

In terms of surviving numbers of maps, and in some ways in map quality as well, the premodern cartographic achievements of South Asia pale by comparison with those of the neighboring regions of the Islamic world and East Asia. That this should be so is a matter for wonder, given India's major contributions to astronomy, geometry, and other branches of mathematics and the remarkably creative exuberance of its culture. Although there are grounds to suppose that Indians produced maps for various purposes for roughly two millennia before the advent of the Portuguese—and possibly over a considerably longer period—virtually nothing in the way of ancient cartography survives. In fact, apart from some incised potsherds of the second or first century B.C. that bear rough plans of monasteries and a few ancient sculptures depicting sacred rivers, there is no extant cartographic or cosmographic production of a distinctly Indian stamp that can be unequivocally assigned to any date earlier than A.D. 1199–1200, the date of a Jain bas-relief representation in stone of the mythical continent Nandīśvaradvīpa (fig. 15.1), which to European eyes would not appear to be a map at all.[1]

Nevertheless, from a variety of written records, both indigenous and foreign, we can infer much about the nature of cartography in its broadest sense, including cosmography, over much of the span of Indian history; and we may reasonably suppose that some of the indigenous maps of the past several centuries carry on traditions of considerable antiquity. For this reason, when I employ the term "pre-European" in the following account, I do not necessarily imply a time before 1498, the date when Vasco da Gama first reached India. Rather, I mean that the artifact being discussed is one in which one can find no clear sign of direct or even indirect European influence. I shall not, however, limit the discussion to works with no discernible European influence. To do so would impose an arbitrary restriction on the inquiry and remove from consideration a substantial corpus of interesting maps in which indigenous and foreign elements are blended in varying degrees. Subsequent volumes of this history will consider other South Asian maps, such as those of the Survey of India, whose inspiration and execution derive almost solely from European or other modern models.

When I use the term "Indian" in this section, I do not refer only to the area of the present-day Republic of India but include the whole of the Indian subcontinent, including Sri Lanka, other nearby islands, and an indeterminate penumbra of adjacent mountainous terrain within the cultural orbit of India (fig. 15.2). There are also times when I shall refer to an even wider Indic cultural realm that would include the more or less Indianized cultures of mainland and insular Southeast Asia (modern Myanmar [Burma], Thailand, Laos, Cambodia, Malaysia, and much of Indonesia) and the vast region of southwestern China inhabited by Tibetans, an area substantially larger than the present Tibetan Autonomous Region. The Indic realm thus includes the areas of Asia over which the Hindu and Hinayana Buddhist faiths predominate as well as the Tibetan portion of the area of Lamaistic Buddhism, which has been heavily influenced by Indian culture. Some general observations on the peripheral portions of the Indic realm will appear elsewhere in this chapter, but the major discussion of their cartographic and cosmo-

For assistance with this chapter and successive chapters on the cartography of South Asia, I am indebted to numerous individuals who will be individually acknowledged in the appropriate contexts. I must express more general appreciation, however, for the contributions of several scholars. Foremost among these is Mrs. Susan Gole. She and I have regularly exchanged notes on our discoveries relative to South Asian cartography since December 1983. I acknowledge my immense debt to her for sharing with me and others of the *History of Cartography* project staff not only her knowledge of specific maps and relevant literature, but also her extensive collection of photographs of various works, not all of which I had an opportunity to study independently. Others to whom I am particularly indebted include Professor Emeritus C. D. Deshpande, the doyen of Indian geographers and a former education minister of the state of Maharashtra; Professor B. M. Thirunaranan of the University of Madras; Professor B. Arunachalam of the University of Bombay; and Professor Irfan Habib of Aligarh Muslim University, all of whom guided me to Indian maps that I might not otherwise have discovered. Thanks are due also to Mr. Robert Stolper, an art dealer now based in Bath, formerly in London, and to Dr. Chandramani Singh, director of the Jaigarh Fort Museum near Jaipur.

1. This map will be discussed on pp. 367 and 373.

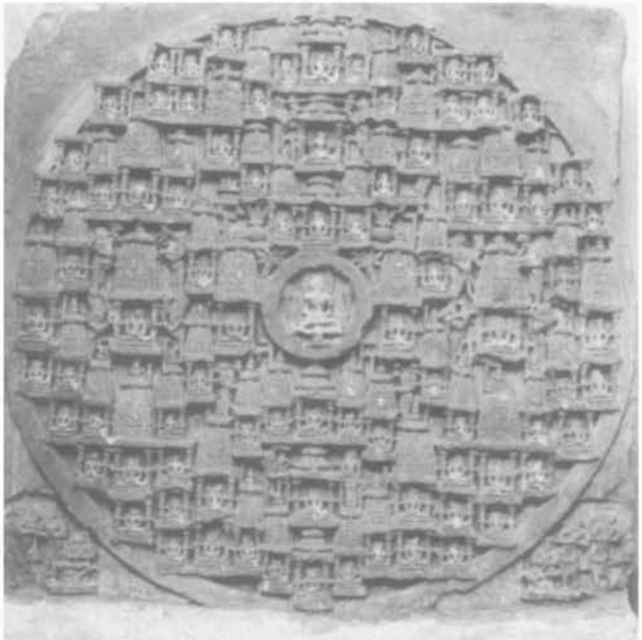


FIG. 15.1. NANDĪŚVARADVĪPA, THE EIGHTH CONTINENT OF THE JAIN COSMOS. This bas-relief in stone is at present in the Sagarām Sonī temple, Mount Girnar, Saurashtra, Gujarat; it was originally in a colonnaded cloister of the nearby Nemināthа temple. Jains belie‿ this continent is a place of festive gatherings for Siddhas (lesser deities). The tightly clustered rings and the circle in the center represent Jambūdvīpa, the innermost continent, and six additional concentric continents between it and Nandīśvaradvīpa. Dated Śaka 1256 (A.D. 1199–1200).
Size of the original: not known. By permission of the American Institute of Indian Studies, Center for Art and Archaeology, Varanasi, and courtesy of the Archaeological Survey of India.

graphic achievements will be presented elsewhere in a later volume of this history. Finally, I shall include in the discussion of South Asia a consideration of a number of Indo-Islamic works that might equally well have been discussed in other regional contexts. To the extent that these works are influenced by Hinduism or other Indic traditions, this decision seems logically defensible.

The plan of this introductory chapter on South Asia is as follows: I begin with a discussion of the literature bearing on the history of the region's cartography, including both works explicitly concerned with that subject and others throwing more indirect light on it. I then indicate the locales for study and suggest areas where future research might be fruitful. A historical survey follows, suggesting the types of maps that might have been (or are known to have been) produced at different periods in Indian history. The Introduction concludes with a consideration of the wide range of reasons for the relative paucity of maps of Indian provenance.

The State of Our Knowledge

Published Writings

The relative paucity of surviving pre-European maps from South Asia is, not surprisingly, reflected in the meagerness of the relevant scholarly literature. Further, what literature does exist failed to do justice to the available corpus of cartography until the appearance in 1989 of Susan Gole's *Indian Maps and Plans* (of which more below), making the picture appear substantially worse than it actually is.[2] Entire genres of South Asian maps received virtually no notice, and were it not for the contributions of art historians, they would have remained unknown to modern scholarship. This is particularly true for works of an essentially cosmographic nature—which Gole has elected not to discuss—and these loom much larger in importance throughout the Indic cultural realm than in the premodern West.

General histories of cartography, from Santarém to the present day, characteristically either ignore South Asia altogether or dismiss it in one or two pages or even paragraphs.[3] Similarly, most have virtually nothing to say about Southeast Asia and Tibet. Bagrow's *History of Cartography* as revised and enlarged by Skelton, for example, asserts that "India had no cartography to speak of" and that "no one in India seems to have been interested in cartography."[4] The only indigenous map of Indian provenance cited in that history is identified simply—and misleadingly—as a seventeenth-century Persian map.[5] The world map in question was found in Bombay and is undoubtedly Indian. A more sympathetic, though almost equally cursory, view of Indian cartography will be found in P. D. A. Harvey's *History of Topographical Maps*. Harvey singles out India, along with Mexico, as a source region for "picture maps," a genre that does happen to be among the most common in works of Indian provenance.[6] Kish's *La carte: Image des civilisations* refers only to Indian cosmography. Its illustrations are limited to secondary drawings taken from an early

2. Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989). To a large extent, Gole's work was stimulated by her interest in the *History of Cartography* project.

3. Manuel Francisco de Barros e Sousa, Viscount of Santarém, *Essai sur l'histoire de la cosmographie et de la cartographie pendant le Moyen-Age et sur les progrès de la géographie après les grandes découvertes du XV^{e} siècle*, 3 vols. (Paris: Maulde et Renou, 1849–52).

4. Leo Bagrow, *History of Cartography*, rev. and enl. R. A. Skelton, trans. D. L. Paisey (Cambridge: Harvard University Press; London: C. A. Watts, 1964; reprinted and enlarged, Chicago: Precedent Publishing, 1985), 207–8, quotation on 207.

5. Bagrow, *History of Cartography*, 208–9 (note 4).

6. P. D. A. Harvey, *The History of Topographical Maps: Symbols, Pictures and Surveys* (London: Thames and Hudson, 1980), 115–20.

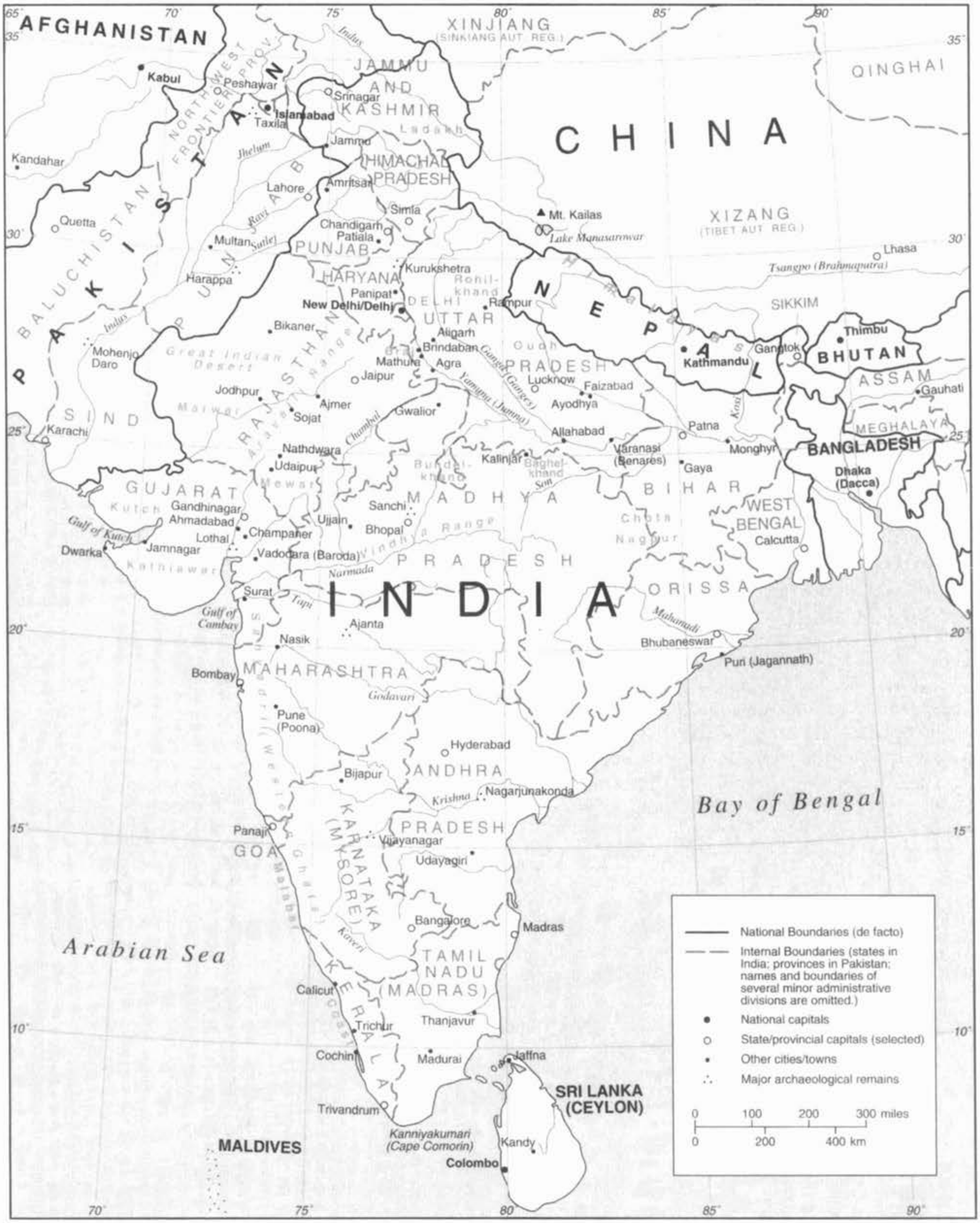


FIG. 15.2. GENERAL REFERENCE MAP FOR THE STUDY OF INDIGENOUS SOUTH ASIAN CARTOGRAPHY.

essay by Francis Wilford.[7] The histories of Brown and Crone, among others that need not be cited, totally ignore the premodern indigenous cartography of South Asia.[8] In *Acta Cartographica* from 1967 to 1981, one finds not a single reprint of any article bearing significantly on indigenous South Asian cartography.[9] *Imago Mundi* makes a somewhat better showing, with four relevant submissions, all by Colonel R. H. Phillimore, formerly of the Survey of India. These total only twelve pages, however, and include only one substantive research paper.[10]

Specialized works dealing mainly with South Asian cartography are rare and include but a handful of monographs or book-length texts. No published work compares with the magisterial coverage of cartography in Joseph Needham's *Science and Civilisation in China*.[11] Noteworthy as the earliest attempt to provide a comprehensive overview of ancient sources is Francesco Pullè's *La Cartografia antica dell'India*, but most of that work relates to productions of classical European and Middle Eastern provenance.[12] The few supposedly indigenous works Pullè discusses relate almost entirely to cosmography, and most of the images represented are secondary reconstructions derived from analyses of Indian texts.

Other secondary works on Indian cosmography abound, but their thrust is almost uniformly exegetical. Essentially, they seek to translate and explicate a large number of texts, mainly in Sanskrit and Pali, whose meanings are frequently obscure, to account for the development over time of new cosmological concepts and to reconcile, through detailed concordances, the numerous inconsistencies from one primary source to another and even from one part to another of a given text. None seeks to address the concerns of the historian of cartography. A few such monographs, however, are abundantly illustrated. Earliest among these is Adolf Bastian's *Ideale Welten*; but Bastian's engraved illustrations, like most of those in Pullè, are secondary reconstructions.[13] The first to include a substantial number of photographs of surviving primary cosmographic sources is Kirfel's *Die Kosmographie der Inder*.[14] Among more modern works, *The Jain Cosmology*, by Collette Caillat and Ravi Kumar, provides a striking collection of handsome illustrations, entirely in color.[15] As the title suggests, the work is limited almost entirely to productions derived from a single religious tradition, Jainism, a faith that has provided a profusion of cosmographic maps altogether disproportionate to the small number of its adherents. Much more comprehensive in sweep than any other illustrative work is *Ajia no kosumosu mandara* (The Asian cosmos), a richly illustrated catalog for an exhibition on Asian cosmography mounted in Tokyo in 1982.[16] The great merit of this regrettably untranslated work is that it permits comparisons among the cosmographies of the Hindu, Jain, and Buddhist traditions from India to Japan.

Among texts that seek to deal with both Indian cosmography and cartography in a more narrow, earthbound sense, the most sweeping in compass is Maya Prasad Tripathi's *Development of Geographic Knowledge in Ancient India*, in which he attempts to establish correspondences between Indian practices and concepts, in both the religious and the secular domains, and similar practices and concepts in modern cartography and other forms of geographic exposition.[17] Despite abundant citations from numerous primary texts, mainly in Sanskrit, the author all too often finds what he is looking for on grounds that are less than firm and in the absence of supporting empirical evidence. Hence I cite Tripathi only

7. George Kish, *La carte: Image des civilisations* (Paris: Seuil, 1980), 25–26, pl. 31, and 211–13. The work cited is Francis Wilford, "An Essay on the Sacred Isles in the West, with Other Essays Connected with That Work," *Asiatick Researches* (Calcutta) 8 (1805): 245–375, reprinted verbatim in *Asiatic Researches* (London) 8 (1808) and also in *Asiatic Researches* (New Delhi: Cosmo Publications, 1979).

8. Lloyd A. Brown, *The Story of Maps* (Boston: Little, Brown, 1949; reprinted New York: Dover, 1979), and Gerald R. Crone, *Maps and Their Makers: An Introduction to the History of Cartography*, 1st ed. (London: Hutchinson University Library, 1953); there are four subsequent editions up to 1978.

9. *Acta Cartographica*, 1–27 (Amsterdam: Theatrum Orbis Terrarum, 1967–81).

10. Reginald Henry Phillimore, "Three Indian Maps," *Imago Mundi* 9 (1952): 111–14, plus three map inserts.

11. Joseph Needham, *Science and Civilisation in China* (Cambridge: Cambridge University Press, 1954–), esp. vol. 3, *Mathematics and the Sciences of the Heavens and the Earth* (1959), and within that volume, chap. 22, "Geography and Cartography," 497–590.

12. Francesco L. Pullè, *La cartografia antica dell'India*, Studi Italiani di Filologia Indo-Iranica, Anno IV, vol. 4 (Florence: Tipografia G. Carnesecchi e Figli, 1901); see esp. chap. 2, "Indiani," 8–44.

13. Adolf Bastian, *Ideale Welten nach uranographischen Provinzen in Wort und Bild: Ethnologische Zeit- und Streitfragen, nach Gesichtspunkten der indischen Völkerkunde*, 3 vols. (Berlin: Emil Felber, 1892).

14. Willibald Kirfel, *Die Kosmographie der Inder nach Quellen dargestellt* (Bonn: Kurt Schroeder, 1920; reprinted Hildesheim: Georg Olms, 1967; Darmstadt: Wissenschaftliche Buchgesellschaft, 1967).

15. Collette Caillat and Ravi Kumar, *The Jain Cosmology*, trans. R. Norman (Basel: Ravi Kumar, 1981).

16. Sugiura Keohei, ed., *Ajia no kosumosu mandara* [The Asian cosmos], catalog of exhibition, "Ajia no Ucheukan Ten," held at Rafeore Myeujiamu in November and December 1982 (Tokyo: Kodansha, 1982).

17. Maya Prasad Tripathi, *Development of Geographic Knowledge in Ancient India* (Varanasi: Bharatiya Vidya Prakashan, 1969), esp. chap. 9, "Survey, Cartography and Cartographical Symbolism," 241–316. This is an expanded and revised rendering of the author's "Survey and Cartography in Ancient India," *Journal of the Oriental Institute* (Baroda) 12 (1963): 390–424 and 13 (1964): 165–94. Other relevant works by Tripathi are "Survey and Cartography in the Śulvasūtras," *Journal of the Ganganatha Jha Research Institute* 16 (1959): 469–85, and presumably, "Solution of a Riddle of Maratha Maps," *Allahabad University Studies in Humanities* 2 (1958). I have looked in vain for the last-cited work.

with caution and less frequently than at first might seem warranted. Much more cautious in his reading of the ancient texts, insofar as they relate to ancient maps and geography, is the late D. C. Sircar, an eminent epigraphist whose collection of essays, *Studies in the Geography of Ancient and Medieval India*, puts forward a more modest view of early Indian mapping capabilities.[18] A brief article by A. B. L. Awasthi, "Ancient Indian Cartography," supplements the findings of Sircar by citing a number of specific passages in several ancient texts that refer to various types of maps mainly, but not exclusively, cosmographic in nature.[19]

In the extensive *Survey of Research in Geography*, prepared under the sponsorship of the Indian Council of Social Science Research, the chapter titled "Historical Geography" refers without qualification to "the absence of . . . maps prepared in India during the ancient and the medieval periods" and adds that "there exists no evidence of an indigenous tradition of map making," not counting the Puranic cosmographies I will discuss later. Although the works of numerous non-Indian mapmakers are cited, no mention is made of any specifically Indian map.[20]

Apart from map catalogs and the work by Pullè, the only books devoted exclusively to the premodern mapping of India are by Gole. The first of her works, *Early Maps of India*, is concerned entirely with European maps from the time of Ptolemy up to the end of the eighteenth century.[21] That initial survey, however, is superseded by a richly illustrated production, *India within the Ganges*, that, while still emphasizing the voluminous corpus of European cartography, does contain a brief opening chapter on indigenous maps, five of them illustrated.[22] A later work edited by Gole is *Maps of Mughal India*, which reproduces an atlas commissioned by Colonel Jean Baptiste Joseph Gentil, an adviser to the nawab of Oudh (Awadh), and drawn in 1770 by three Indian artists relying mainly on the gazetteer portion of the *Āʾīn-i Akbarī* (Institutions of Akbar), an important Indian text (in Persian). This atlas is a valuable and hitherto little noticed work.[23]

But by far the most important in our context is Gole's recently published *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys*, in which some two hundred indigenous Indian maps are discussed and illustrated, often in color.[24] The treatment of Indian maps differs, however, from the present essay in several respects. Gole largely omits cosmographies and astronomical maps from her discussion or mentions them only in passing, but she is generally more comprehensive in her coverage of topographic maps as well as of large-scale plans of cities, forts, temples, and places of pilgrimage. Moreover, her text is essentially descriptive rather than analytical. Here I aim to deal in greater depth with a more limited set of examples representative of the known cartographic corpus.

Several major monographs dealing with astrolabes and celestial globes devote considerable space to the rather substantial number of such works that are of Indo-Islamic provenance. Earliest among these is Robert T. Gunther's *Astrolabes of the World*, first published in 1932.[25] This now rather dated work is supplemented by numerous articles, of both earlier and later date, that deal with specific artifacts, locales, and artisans. A few of these articles will be cited below in the chapter on South Asian cosmography, while others are discussed in the chapter on Islamic celestial mapping (above, pp. 12–70). Partly supplementing and partly superseding Gunther's massive work is that of Sharon Gibbs and George Saliba, *Planispheric Astrolabes from the National Museum of American History*.[26] The collection in question is the world's fourth largest. Finally, Emilie Savage-Smith's *Islamicate Celestial Globes: Their History, Construction, and Use* provides an excellent overall conspectus within which the Indo-Islamic corpus forms an exceptionally large part.[27]

Scholarly articles on South Asian cartography are limited in both scope and number. Only a few merit special citation here; others will be noted at appropriate junctures in this chapter. Early contributions appear to have come entirely from non-Indians. Francis Wilford was the first European to attempt to re-create a systematic visual representation of the cosmographic conceptions of

18. D. C. [Dineshchandra] Sircar, *Studies in the Geography of Ancient and Medieval India* (Delhi: Motilal Banarsidass, 1971), esp. chap. 28, "Cartography," 326–30; reprinted, with an additional paragraph, from "Ancient Indian Cartography," *Indian Archives* 5 (1951): 60–63. Also quite useful, especially for the study of cosmography, is Sircar's *Cosmography and Geography in Early Indian Literature* (Calcutta: D. Chattopadhyaya on behalf of *Indian Studies: Past and Present*, 1967).

19. A. B. L. Awasthi, "Ancient Indian Cartography," in *Dr. Satkari Mookerji Felicitation Volume*, Chowkhamba Sanskrit Studies, vol. 69 (Varanasi: Chowkhamba Sanskrit Series Office, 1969), 275–78.

20. Moonis Raza and Aijazuddin Ahmad, "Historical Geography: A Trend Report," in *A Survey of Research in Geography* (Bombay: Popular Prakashan, 1972), 147–69, quotations on 148 and 153.

21. Susan Gole, *Early Maps of India* (New York: Humanities Press, 1976).

22. Susan Gole, *India within the Ganges* (New Delhi: Jayaprints, 1983). A companion volume, *A Series of Early Printed Maps of India in Facsimile* (New Delhi: Jayaprints, 1980), collected by Susan Gole, is a facsimile atlas exclusively of European productions.

23. Susan Gole, ed., *Maps of Mughal India: Drawn by Colonel Jean-Baptiste-Joseph Gentil, Agent for the French Government to the Court of Shuja-ud-daula at Faizabad, in 1770* (New Delhi: Manohar, 1988).

24. Gole, *Indian Maps and Plans* (note 2).

25. Robert T. Gunther, *The Astrolabes of the World*, 2 vols. (Oxford: Oxford University Press, 1932; London: Holland Press, 1976).

26. Sharon Gibbs with George Saliba, *Planispheric Astrolabes from the National Museum of American History* (Washington, D.C.: Smithsonian Institution Press, 1984).

27. Emilie Savage-Smith, *Islamicate Celestial Globes: Their History, Construction, and Use* (Washington, D.C.: Smithsonian Institution Press, 1985).

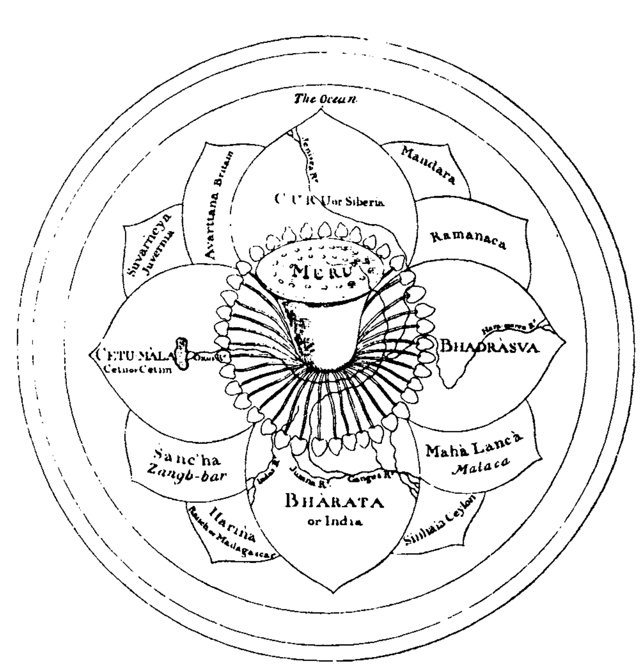


FIG. 15.3. AN EARLY SCHOLARLY ATTEMPT TO INTERPRET INDIAN COSMOGRAPHY. This drawing by Wilford is among several early attempts by European scholars to render visually the descriptions of the cosmos contained in various ancient Hindu texts collectively known as the Puranas.
Size of the original: not known. From Francis Wilford, "An Essay on the Sacred Isles in the West, with Other Essays Connected with That Work," *Asiatick Researches* (Calcutta) 8 (1805): 245–376, reprinted verbatim in *Asiatic Researches* (London) 8 (1808) and also in *Asiatic Researches* (New Delhi: Cosmo Publications, 1979).

ancient India, but his work (e.g., fig. 15.3), published in 1805 in *Asiatick Researches*, was carried out when Indological research was still in its infancy. Many of the conclusions he drew from his studies with Brahman pundits, who did not always deal honestly with him, would not be taken seriously today.[28] Among the shortcomings of Wilford's efforts was the persistent assumption that most if not all of the places named in the Puranic texts did indeed have real-world referents. No clear boundary was drawn between cosmographic ideas and more mundane terrestrial conceptions. That same shortcoming is reflected in a number of Indian studies of the eighteenth and nineteenth centuries discussed later in this essay. Even twentieth-century authors persist in crediting the Puranas with a degree of verisimilitude that is wholly unwarranted. To account for the enormous differences between the size and shape of the continents, seas, islands, and mountain ranges described in the ancient texts and those of the modern era, they postulate diastrophic events of mind-boggling magnitude occurring within a few millennia.[29] Yet there still appears to be an audience for their untenable views.

Perhaps the earliest scholarly study of a specific surviving pre-European map of Indian provenance is Rehatsek's translation and discussion of a map of the world, in Persian, that he obtained in a small town of the former Bombay Presidency.[30] Though Rehatsek's hand-drawn copy of that map was published in 1872, the original work, almost certainly from the seventeenth century, has since disappeared. This map will be discussed below in the section on Mughal cartography. Another notable early study (1905–8) is the brief discussion and translation of an indigenous map of the Vale of Kathmandu by the renowned anthropologist Sylvain Lévi in his magisterial monograph on Nepal.[31] Following these early and unconnected efforts there is a long hiatus in the study of indigenous maps. Terse notices of several maps appeared in

28. Wilford, "Sacred Isles" (note 7). As an example of Wilford's credulity, we may cite the following (p. 246): "The Sacred Isles in the West, of which *S'weta-dwípa*, or the White Island, is the principal, and the most famous, are, in fact, the holy land of the *Hindus*. There the fundamental and mysterious transactions of the history of their religion, in its rise and progress, took place. The White Island, this holy land in the West, is so intimately connected with their religion and mythology, that they cannot be separated: and, of course, divines in *India* are necessarily acquainted with it, as distant *Muselmans* with *Arabia*. This I conceive to be a most favourable circumstance; as, in the present case, the learned have little more to do than to ascertain whether the White Island be *England*, and the Sacred Isles of the *Hindus*, the *British* Isles. After having maturely considered the subject, *I think they are*."

In fact, Western scholars earlier than Wilford had tried to make sense of the cosmography of the Puranas and even to map it. Several Portuguese Jesuits attempted to grapple with those texts as early as the sixteenth century, though apart from one brief notice, dated 1599, none of the earliest writings on the subject appear to have survived. There is, however, a short study of Hindu cosmography by an anonymous Portuguese missionary that seeks to set forth its most important tenets. Though undated, this work, now in the British Library, is undoubtedly from the seventeenth century. A complete translation is provided by Jarl Charpentier in "A Treatise on Hindu Cosmography from the Seventeenth Century (Brit. Mus. MS. Sloane 2748 A)," *Bulletin of the School of Oriental Studies* (London Institution) 3 (1923–25): 317–42. This manuscript is noteworthy for including maps by the author as well as spaces that appear to have been intended for additional maps that were never actually made. The question arises, Did the anonymous author see, as Wilford claims to have done, any indigenous cosmographic works, or did he simply envisage what the texts sought to describe?

29. See, for example, Amarnath Das, *India and Jambu Island: Showing Changes in Boundaries and River-Courses of India and Burmah from Pauranic, Greek, Buddhist, Chinese, and Western Travellers' Accounts* (Calcutta: Book Company, 1931), and S. Muzafer Ali, *The Geography of the Puranas* (New Delhi: People's Publishing House, 1966).

30. Edward Rehatsek, "Fac-simile of a Persian Map of the World, with an English Translation," *Indian Antiquary* 1 (1872): 369–70 plus foldout map.

31. Sylvain Lévi, *Le Népal: Etude historique d'un royaume hindou*, 3 vols. (Paris: Ernest Leroux, 1905–8), vol. 1, map facing p. 72.

1945 in volume 1 of Phillimore's monumental four-volume history of the Survey of India, and these were later expanded into a short essay.[32]

Indians' scholarly contributions to the history of their own cartography effectively begin with C. D. Deshpande's "Note on Maratha Cartography," published in the *Indian Archives* in 1953.[33] Deshpande became the first chairman of the Commission on the History of Cartography, formed in 1982 under the auspices of the Indian National Cartographic Association. But efforts by Deshpande and the exceedingly well-informed B. M. Thirunaranan to stimulate relevant scientific research have yet to bear much fruit in India. A happy exception is provided by B. Arunachalam's carefully researched and well-documented study, published in 1985, on Indian navigational traditions and mapping.[34] Yet another signal contribution is that of Irfan Habib in an excellent, but all too brief, essay on Mughal cartography, focusing on a remarkable seventeenth-century world atlas contained within an encyclopedic work by Ṣādiq Iṣfahānī (Muḥammad Ṣādiq ibn Muḥammad Ṣāliḥ) of Jaunpur. Other cartographic works are noted by Habib only in passing, and there is also cursory discussion of the means of determining latitude and longitude.[35]

The discussions of Indian maps noted to this point have been concerned mainly with reviewing their specific content and historical context and noting their more obvious conventions with respect to orientation, scale, visual perspective, symbolism, and so forth. In terms of a deeper semiotic analysis, which takes into consideration the "logic" of the map from a particular Hindu cultural perspective, the first two articles of note are Bernhard Kölver's "Ritual Map from Nepal," published in Germany in 1976, and Jan Pieper's "Pilgrim's Map of Benares: Notes on Codification in Hindu Cartography," published in *GeoJournal* in 1979.[36] These two sophisticated contributions point to an approach by which we can significantly deepen our understanding of South Asian cartography.

In the meantime, for most of our knowledge of South Asian maps or maplike paintings and drawings we must rely on the writings of art historians. A large proportion of the extant corpus of maps from South Asia owes its survival to the fact that collectors regarded such works as having aesthetic value, however slight their perceived scientific value may have been. The perspective of art historians, however, though useful, differs substantially from that of historians of cartography. Gradual changes in artistic conventions may have little relation to evolving cartographic canons. Nevertheless, let me single out three contributions that illustrate the diversity of studies available to us. An essay by William Norman Brown analyzes an exceedingly complex and cryptic painting dating from the late seventeenth or early eighteenth century that commemorates a lengthy pilgrimage by a large party of Jains under the sponsorship of a wealthy patron, who almost certainly commissioned the work. What makes the essay remarkable is that despite the total absence of text on the painting, Brown's knowledge of the relevant iconography enabled him to reconstruct the pilgrimage route in considerable detail—even if not completely—and to recognize that the painting was in effect a map.[37] Another sophisticated study is Simon Digby's analysis of a sixteenth-century globe-shaped brass container, intricately etched to indicate the various components of the earth as conceived in the Puranas.[38] Digby's discussion, moreover, throws much light on several later works of similar

32. Reginald Henry Phillimore, comp., *Historical Records of the Survey of India*, 5 vols. (Dehra Dun: Office of the Geodetic Branch, Survey of India, 1945–68) (advance copies of the fifth volume were recalled before publication, which was then suspended; publicly accessible copies of the fifth volume exist only in England in the libraries of the Royal Geographical Society, London, and the Royal Engineers Institution, Chatham); vol. 1, *18th Century* (1945); see also Phillimore, "Three Indian Maps" (note 10).

33. C. D. Deshpande, "A Note on Maratha Cartography," *Indian Archives* 7 (1953): 87–94. An earlier article by D. V. Kale, "Maps and Charts," appeared in the *Bharata Itihasa Samshodhaka Mandala Quarterly*, special number for the Indian History Congress of 1948, vol. 29, nos. 115–16, pp. 60–65. Only three pages of this article actually refer to maps, and the author's comments are both disparaging and ill informed, but the article does include a photograph of an important Maratha topographic map of much of peninsular India that is discussed below.

34. B. Arunachalam, "The Haven Finding Art in Indian Navigational Traditions and Its Applications in Indian Navigational Cartography," *Annals of the National Association of Geographers, India*, vol. 5, no. 1 (1985): 1–23; subsequently published in slightly modified and improved form as "The Haven-Finding Art in Indian Navigational Traditions and Cartography," in *The Indian Ocean: Explorations in History, Commerce, and Politics*, ed. Satish Chandra (New Delhi: Sage Publications, 1987), 191–221.

35. Irfan Habib, "Cartography in Mughal India," *Medieval India, a Miscellany* 4 (1977): 122–34; also published in *Indian Archives* 28 (1979): 88–105.

36. Bernhard Kölver, "A Ritual Map from Nepal," in *Folia rara: Wolfgang Voigt LXV. Diem natalem celebranti*, ed. Herbert Franke, Walther Heissig, and Wolfgang Treue, Verzeichnis der Orientalischen Handschriften in Deutschland, supplement 19 (Wiesbaden: Franz Steiner, 1976), 68–80; and Jan Pieper, "A Pilgrim's Map of Benares: Notes on Codification in Hindu Cartography," *GeoJournal* 3 (1979): 215–18.

37. William Norman Brown, "A Painting of a Jaina Pilgrimage," in *Art and Thought: Issued in Honour of Dr. Ananda K. Coomaraswamy on the Occasion of His 70th Birthday*, ed. K. Bharatha Iyer (London: Luzac, 1947), 69–72; reissued in William Norman Brown, *India and Indology: Selected Articles*, ed. Rosane Rocher (Delhi: Motilal Banarsidass for the American Institute of Indian Studies, 1978), 256–58. Though he was known primarily as an Indologist specializing in Sanskrit philology, Brown's credentials as an art historian were also impressive.

38. Simon Digby, "The Bhūgola of Kṣema Karṇa: A Dated Sixteenth Century Piece of Indian Metalware," *AARP* (*Art and Archaeology Research Papers*) 4 (1973): 10–31.

conception: a large eighteenth-century papier-mâché globe and two small metal globes produced in the nineteenth century. In contrast to Digby's and Brown's narrowly focused studies is the wide-ranging survey "Early 18th-Century Painted City Maps on Cloth," by Chandramani Singh.[39] The variety of mapping styles displayed in this informative, though mistitled, article (not all of it relates to the eighteenth century, to maps of cities, or to maps on cloth) reminds us that in dealing with India we confront a portion of the world no less diverse than Europe. It points to the richness of materials to be discovered as the study of South Asian cartography receives the attention it warrants.

REPOSITORIES FOR INDIAN CARTOGRAPHY

Among the numerous repositories that hold South Asian maps and associated materials, the British Library and the India Office Library and Records, both in London, are of particular importance; but many other major European and American libraries also contain maps and secondary works describing their contexts. Libraries and archives in South Asia itself are as a rule more difficult to use because of restrictions on access and inadequate cataloging. One rather specialized type of library—to which I was unable to obtain entry—are the *bhaṇḍāra*s attached to many important Jain temples. Given the Jain preoccupation with cosmological concerns and with the institution of pilgrimage, these *bhaṇḍāra*s could prove treasure-houses of useful documents. Yet another potentially valuable resource, especially for Jain materials, is the extensive and well-maintained library of the Lalbhai Dalpatbhai Institute of Indology at Ahmadabad, but circumstances did not permit its exploration for this project.

Published catalogs of South Asian maps are few, but they are of some use in locating indigenous productions. The *Catalogue of the Historical Maps of the Survey of India (1700–1900)* lists some maps by Indians (and others by Burmese), drawn along more or less traditional lines, that are now kept in the National Archives of India, New Delhi.[40] At the National Library of India in Calcutta there is *A Register of the Maps to Be Found in the Various Offices of the Bengal Presidency Prepared under the Authority of the Right Hon'ble the Governor General of India from Returns Received by the Survey Committee, 1838*.[41] The register lists up to two dozen maps that appear to be "native" productions, though seven of these are of Southeast Asian (principally Burmese) provenance, while most of the remainder appear to have been drawn by Indians working for the British. No more than three or four items listed are unambiguously "indigenous" as defined earlier in this chapter. A similar catalog, *A Register of Maps, Charts, Plans, Etc. Deposited in the Various Offices of the Bombay Presidency*, corrected to 1858, is said to be available in Bombay.[42] It seems likely that a third register would also have been prepared for the Madras Presidency.

Even earlier than the foregoing was H. H. Wilson's 1828 *Descriptive Catalogue of the Oriental Manuscripts . . . Collected by the Late Lieut.-Col. Colin Mackenzie*. Volume 1 alludes to 79 plans, including at least 40 "Native Plans of Districts"; another 180 "Miscellaneous Plans and Views" and 8 "Hindu Maps" included in portfolios; numerous descriptive geographic texts; and 2,630 drawings, some of which might well have incorporated cartographic elements.[43] Much the greater part of the collection of the indefatigable Mackenzie was derived from southern India, an area much underrepresented in the surviving cartographic corpus. After independence, the collection was divided among the archives of the Indian states of Tamil Nadu (formerly Madras) and Andhra Pradesh and the India Office Library and Records in London.

Hundreds of additional catalogs exist, both published and unpublished, documenting the manuscripts and printed books in Sanskrit, Persian, and other South Asian

39. Chandramani Singh, "Early 18th-Century Painted City Maps on Cloth," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982*, ed. Robert Skelton et al. (London: Victoria and Albert Museum, 1986), 185–92.

40. This work was edited by S. N. Prasad and published in New Delhi by the National Archives of India in about 1975. Relevant notes by the map archivist P. L. Madan include "Cartographic Records in the National Archives of India," *Imago Mundi* 25 (1971): 79–80, and "Record Character of Maps and Related Problems," *Indian Archives* 31, no. 2 (1982): 13–22.

41. The library accession number is 164G 12. It was published in Calcutta by G. H. Huttmann, Bengal Military Orphan Press, about 1839. At least two copies of the register survive, but in a serious state of decay.

42. This work was "Prepared under the Authority of the Right Honourable Governor in Council" and published in Bombay in 1859. It is said to be in the Bombay State Archives, but I have not had an opportunity to see it.

43. Horace Ḥayman Wilson, *Mackenzie Collection: A Descriptive Catalogue of the Oriental Manuscripts, and Other Articles Illustrative of the Literature, History, Statistics and Antiquities of the South of India; Collected by the Late Lieut.-Col. Colin Mackenzie, Surveyor General of India*, 2 vols. (Calcutta: Asiatic Press, 1828). Note in particular vol. 1, p. xxiii, and vol. 2, pp. cxxix–cxxxi, cxl–cxliii, and ccxxii–ccxxiii.

None of the numerous Indian maps that may have been contained in the vast collection of papers and antiquities Colin Mackenzie amassed during his service in India (mainly with the Madras Engineers, from 1783 to 1821) can at present be located, despite searches in the several British and Indian archives among which they were divided shortly after Indian independence. The investigation was initally launched by correspondence between B. M. Thirunaranan and the India Office Library and Records and other archives. Susan Gole possesses a copy of this correspondence. For a brief biographical note on Mackenzie, see Phillimore, *Historical Records*, 349–52 (note 32).

languages. These generally relate to the holdings of particular libraries in South Asia, Europe, and America; they are usually organized by genre or subject and occasionally specify the existence of maps. An excellent compendium that might provide new cartographic leads is David Pingree's four-volume *Census of the Exact Sciences in Sanskrit*. His enumeration of *jyotiḥśāstra* texts—those relating to horoscopic astrology, mathematics and mathematical astronomy, and divination—are particularly promising in this respect.[44]

The world's largest collection of indigenous South Asian maps is undoubtedly that of the Maharaja Sawai Man Singh II Museum (also known as the City Palace Museum) in Jaipur, the capital of a former princely state of the same name. One of Jaipur's rulers, Sawai Jai Singh II (reigning from 1699 to 1743), was renowned for his scientific knowledge and skill. He took a particular interest in astronomy, maps, and architecture, and under his patronage astronomical observatories were built in five cities and many remarkable maps were produced for a wide variety of purposes.[45] Because the resplendent courtly style of one princely state was often emulated by others, the development of mapping in early eighteenth-century Jaipur was reflected in similar developments elsewhere, especially the nearby states comprising Rajasthan, Gujarat, Punjab, and Kashmir, where most of the known surviving Indian terrestrial maps are to be found. Although no other collection rivals that of Jaipur, diligent search in museums and archives, especially in the erstwhile princely states, seems likely to turn up much new material. Apart from the holdings of Rajasthan's royal families, many cartographic works, especially cosmographies, are held by the state's numerous art dealers and, in at least one case, by a privately managed museum. Individual collectors undoubtedly also possess objects of value.[46]

The written record provides abundant grounds for believing that the British in India generally disparaged such indigenous maps as they came across and took no special pains to preserve them. By contrast, Indian rulers and members of the gentry were more likely to treasure maps as works of art long after they had served their utilitarian purposes.[47] It is not surprising, therefore, given the formative role of the British with respect to higher education in South Asia, that within scientific and scholarly circles in South Asia virtually no interest has been taken in indigenous mapping. On the other hand, among connoisseurs and art collectors there is both knowledge and appreciation of many surviving productions that this history treats as maps. These maps are to be found not only, as noted, in public art museums, but also in private galleries and individual collections in South Asia and abroad. One suspects that many long-forgotten works are gathering mold in storage chests, closets, and cabinets where family heirlooms and records are preserved.

Many of the maps produced in India over the centuries and down to the present were made to serve particular religious purposes. Maps in temples, particularly Jain temples, often present cosmographies or depict the routes to specific places of pilgrimage. Cosmographies are still painted on cloth for sale to worshipers and tourists in regions where Jainism exerted a powerful influence. At major places of pilgrimage cheap printed paper maps are sold to guide the faithful to all the *mahātmya*s (glories) for which those places are famous. Such maps exist not merely for Hindu and Jain pilgrimage sites, but also for places sacred to South Asian Muslims—a use of icons quite different from what an orthodox perspective of Islam would find acceptable. Such characteristically vulgar maps are eclectic combinations of traditional and Western conventions, but the traditional element is sufficient to warrant their being discussed. Moreover, at or near a few major religious sites, such as Jagannath in Orissa or Nathdwara in Rajasthan, there still exist small

44. David Pingree, *Census of the Exact Sciences in Sanskrit*, 4 vols., Memoirs of the American Philosophical Society, ser. A, vols. 81, 86, 111, 146 (Philadelphia: American Philosophical Society, 1970, 1971, 1976, 1981). A list of catalogs appears on pp. 26–32 of vol. 1 and a bibliography on pp. 4–25. Supplementary bibliographies appear also in vols. 2 (pp. 3–7), 3 (pp. 3–6), and 4 (pp. 3–7). The same volumes also provide brief supplements to the list of catalogs in vol. 1.

45. The agencies through which these maps were produced included two of the state's thirty-four *kārkhānas* (groups of skilled craftsmen attached to a royal court): the *ʿimārat*, concerned with buildings and construction in general, and the *bāghāyat*, whose concern was gardens. The system is explained in an unpublished paper by G. N. Bahura and Chandramani Singh, "The Court as a Cultural Centre," for the Conference on Conservation of the Environment and Culture in Rajasthan, held in Jaipur, Rajasthan, on 14–17 December 1987.

46. The S. R. C. [Sri Ram Charan] Museum of Indology, founded in Jaipur in 1960, claims to possess a "splendid collection of architectural paintings [and drawings] . . . of forts and castles of medieval India and . . . of important historical buildings," as well as astrolabes, cosmographies, and astrological drawings of a cartographic nature of the type illustrated in figure 16.13. I have not visited this museum, having learned of it only after my last research visit to Jaipur, but I have had some correspondence with the founder and chairman, Acharya Ram Charan Sharma "Vyakul," who on 14 September 1989 sent me the institution's sixteen-page unpaginated brochure (dated 1986) and ten photographs of relevant museum holdings.

47. In the aforementioned *Register of Maps . . . in the Various Offices of the Bengal Presidency*, for example, the entry in the "Remarks" column for some of the small number of "native" maps listed is simply "Bad"; in not a few other cases there is no entry at all, and in no case did any entry connote appreciation. In the article "Lost Geographical Documents," *Geographical Journal* 42 (1913): 28–34 (reprinted in *Acta Cartographica* 12 [1971]: 281–87), Clements R. Markham, formerly with the Survey of India, states: "When the East India Company was abolished [in 1858], waggon-loads of papers were carted away and sold as no longer of any use" (p. 33). How many of these papers, one wonders, might have been indigenous maps? For further evidence of how English observers viewed Indian maps, see below (pp. 324–27).

caste groups of artists whose function is to embellish the shrines with sacred paintings and to provide paintings for special ceremonial occasions. As we shall see, maps in a traditional style are among the paintings done by these hereditary craftsmen.

In closing, let me note that the would-be historian of South Asian cartography must be ever alert to the serendipitous leads that come from reading, listening, and looking in a wide variety of contexts. Travel literature and accounts of early mapping by Europeans occasionally reveal their reliance on indigenous cartographic sources. The scholarly literature of art history, in particular, is constantly yielding fresh clues to the discovery of new and interesting artifacts. And purposeful inquiries in bookstores and bazaars in the cities of South Asia hold out the prospect of stumbling on long-lost cartographic treasures. Susan Gole, for example, an avid map hunter, chanced upon a unique wood-block print of a late nineteenth- or early twentieth-century world map that was being used as scrap paper in a Delhi bazaar (illustrated below). In the past decade I have learned about literally hundreds of Indian maps unrecorded in general histories of cartography. But this recently discovered corpus is in all likelihood only a small part of what still survives.

The Nature of the Indian Corpus as Revealed by Textual Sources and the Archaeological Record

Types of Materials Produced

Given the accidents of preservation and the human inclination to value and therefore conserve some things more than others, it is impossible to infer with confidence the volume and distribution of map types over the long span of Indian history. It would certainly be incorrect to assume that the premodern materials available to us today, few of which—cosmographies, celestial globes, and astrolabes excepted—antedate the eighteenth century, are representative of what was produced before the period of extensive contact with Europeans and, one would suppose, exposure to European cartography. Although all the South Asian materials discussed below do retain, in varying degrees, a traditional Indian character, many bear distinct signs of European influence. We may surmise that from at least the seventeenth century on the proportion of terrestrial to cosmographic maps increased steadily, but we have little idea how large a proportion of the total corpus they were at various periods. The following gleanings from the available literature will convey some impression of the types of maps that might have been produced.

Prehistoric and Tribal Maps

From the prehistoric period well into historic times, there is a great abundance of Indian cave paintings. Such paintings were first noted by a European scholar, the archaeologist Archibald Carlleyle, in 1867–68 in the Vindhya escarpment of north-central India and were correctly attributed by him to the Stone Age.[48] More than a thousand caves with graffiti, mainly in central India, have since been discovered. By the 1930s the body of material brought to light seemed sufficient to enable D. H. Gordon to attempt—prematurely as it turned out—to establish a chronology based on stylistic attributes, successive layers of painting, and similarity to datable ancient Indian art.[49] It was not until the 1970s, however, after the exhaustive investigations at Bhimbetka, Madhya Pradesh, by V. S. Wakankar of Vikram University, Ujjain, and V. N. Misra of Poona University, that a reasonably clear chronology and typology of paintings emerged. Wakankar and Misra concluded that cave painting began with the advent of a microlithic technology during what many archaeologists term the Mesolithic period, extending back perhaps to roughly 10,000 B.P.[50]

Despite their abundance, none of the Mesolithic works or subsequent cave painting of the Neolithic or Chalcolithic period can unambiguously be called a map. Although most of the paintings are of readily recognizable objects and activities—animals, hunting, dancing, battles, and the like—the interpretation of others is highly speculative. In at least ten Mesolithic sandstone caves in the central Indian state of Madhya Pradesh one finds geometric designs, which could be purely decorative but might also be, in some cases, symbolic plans of huts, depicted in both ground plan and elevation.[51] Figure 15.4 provides three quite disparate examples of the types of rock art we must consider. There are, in such art, unmis-

48. Erwin Neumayer, *Prehistoric Indian Rock Paintings* (Delhi: Oxford University Press, 1983), 1–2.

49. Neumayer, *Prehistoric Indian Rock Paintings*, 3 (note 48). For Gordon's work, see D. H. Gordon, "Indian Cave Paintings," *IPEK: Jahrbuch für Prähistorische und Ethnographische Kunst*, 1935, 107–14, and "The Rock Paintings of the Mahadeo Hills," *Indian Art and Letters* 10 (1936): 35–41.

50. Neumayer, *Prehistoric Indian Rock Paintings*, 3–4 and 11 (note 48). For the distribution of known microlithic sites, see Joseph E. Schwartzberg, ed., *A Historical Atlas of South Asia* (Chicago: University of Chicago Press, 1978), 7, map II.1.c, and relevant text by Lawrence S. Leshnik, 156–57. A radiocarbon date at the central Indian site of Adamgarh is 7450 B.P.

51. Robert R. R. Brooks and Vishnu S. Wakankar, *Stone Age Painting in India* (New Haven: Yale University Press, 1976), 54 and 97. The authors indicate ten Mesolithic or earlier sites in which geometric designs could be interpreted to represent huts, traps, the sun, or water. See also M. D. Khare, *Painted Rock Shelters* (Bhopal: Directorate of Archaeology and Museums, Madhya Pradesh, 1981), fig. 34.

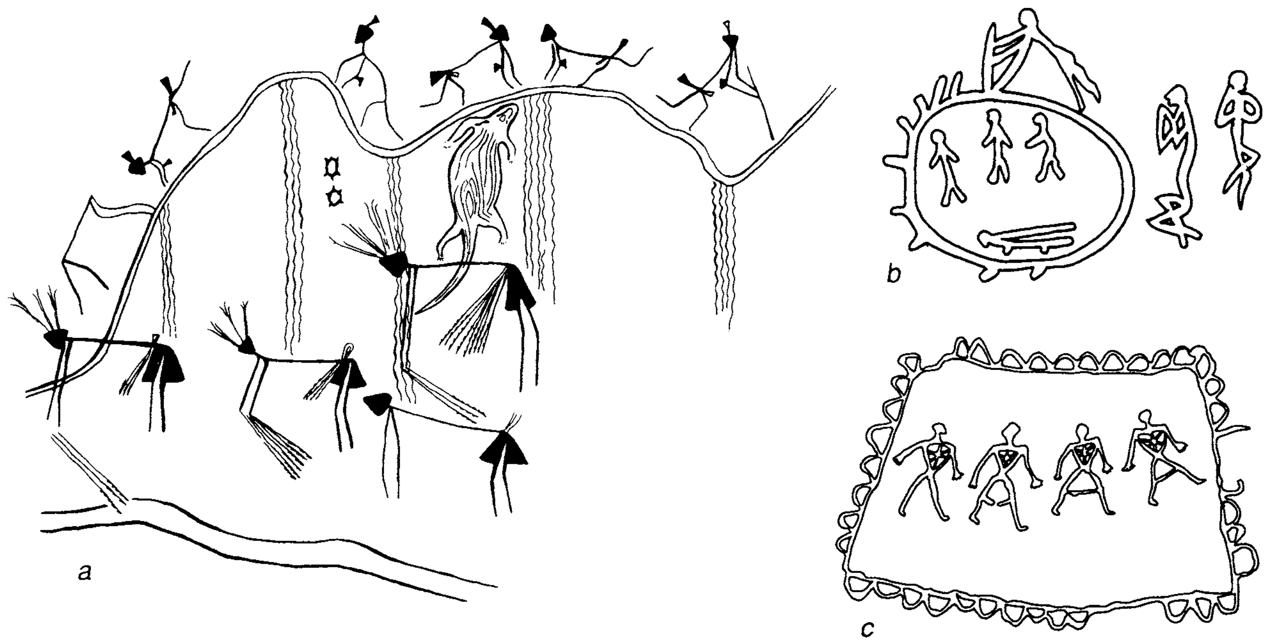


FIG. 15.4. ROCK PAINTINGS INCORPORATING SEEMINGLY CARTOGRAPHIC ELEMENTS. (*a*) Kathotia, Madhya Pradesh. In this Mesolithic depiction of some cultic activity, the wavy lines are taken as cascades of water, possibly indicating a specific sacred site. Some of the men portrayed are knocking some object against the ground with both hands, while the four large figures are carrying bundles of microlith-tipped arrows. The length of the lizard in this painting is 20 cm.
From Erwin Neumayer, *Prehistoric Indian Rock Paintings* (Delhi: Oxford University Press, 1983), 101 (fig. 62), by permission of Oxford University Press, New Delhi.
(*b*) Bhimbetka, Madhya Pradesh. This red ocher drawing has been interpreted as a representation of a Mesolithic burial ceremony.
Size of the original: width 17 cm. From Lothar Wanke, *Zentralindische Felsbilder* (Graz: Akademische Druck- und Verlagsanstalt, 1977), 80 (fig. 64a), by permission of Akademische Druck- u. Verlagsanstalt..
(*c*) Mahararia, Mirzapur district, Uttar Pradesh. Found on the roof of a rock shelter, this tribal painting in red ocher depicts four persons dancing within an enclosure and is dated between the fourth and tenth centuries A.D.
Size of the original: not known. After Rai Sahib Manoranjan Ghosh, *Rock-Paintings and Other Antiquities of Prehistoric and Later Times*, Memoirs of the Archaeological Survey of India, no. 24 (Calcutta: Government of India, Central Publication Branch, 1932; reprinted Patna: I. B. Corporation, 1982), pl. XXIa (fig. 2) and p. 18.

takable depictions of landscape elements (hills, rivers, ponds) and possibly lines signifying various kinds of boundaries, but whether they are generic pictorial representations or indications of specific landscape features is a matter for speculation.[52] There is also what Neumayer interprets to be a cosmography (fig. 15.5).[53]

Although the face of South Asia was radically transformed following the Neolithic period and the subsequent advent of cultures with writing, tribal societies still account for a significant fraction of the region's population, approximately 8 percent in India and smaller proportions in neighboring countries. Over the centuries, it seems likely that some cave graffiti of tribal groups would have been of a cartographic nature. The undoubtedly tribal painting in Mirzapur district of Uttar Pradesh (fig. 15.4*c*), for example, appears to be a plan of a man-made enclosure, within which four persons are dancing, but that "enclosure" might equally well be nothing more than an abstract frame provided by the artist.

Among certain relatively isolated tribal groups the contemporary forms of art are quite distinctive; and though rarely free from Hindu influences, they draw on other sources of inspiration that presumably have pre-Hindu origins. Cosmogonic themes, especially origin myths, as well as depictions of landscape features, frequently appear in the art of some of the tribes and are sometimes expressed through cartographic symbolism.[54]

52. For figure 15.4 and other related illustrations, see Neumayer, *Prehistoric Indian Rock Paintings*, fig. 62 (p. 101) and text on p. 18 and related figs. 4, 47, 48, 60, and 61 (note 48); Lothar Wanke, *Zentralindische Felsbilder* (Graz: Akademische Druck- und Verlagsanstalt, 1977), fig. 64a, p. 80, and fig. 3, p. 13; and Rai Sahib Manoranjan Ghosh, *Rock-Paintings and Other Antiquities of Prehistoric and Later Times*, Memoirs of the Archaeological Survey of India, no. 24 (Calcutta: Government of India, Central Publication Branch, 1932; reprinted Patna: I. B. Corporation, 1982), pl. XXI and p. 18.

53. Neumayer, *Prehistoric Indian Rock Paintings*, fig. 26e (p. 68) and p. 14 (note 48).

54. See, for example, the numerous Warli tribal paintings that incorporate maplike elements in Jivya Soma Mashe, *The Warlis: Tribal Paintings and Legends*, paintings by Jivya Soma Mashe and Balu Mashe, legends retold by Lakshmi Lal (Bombay: Chemould Publications and

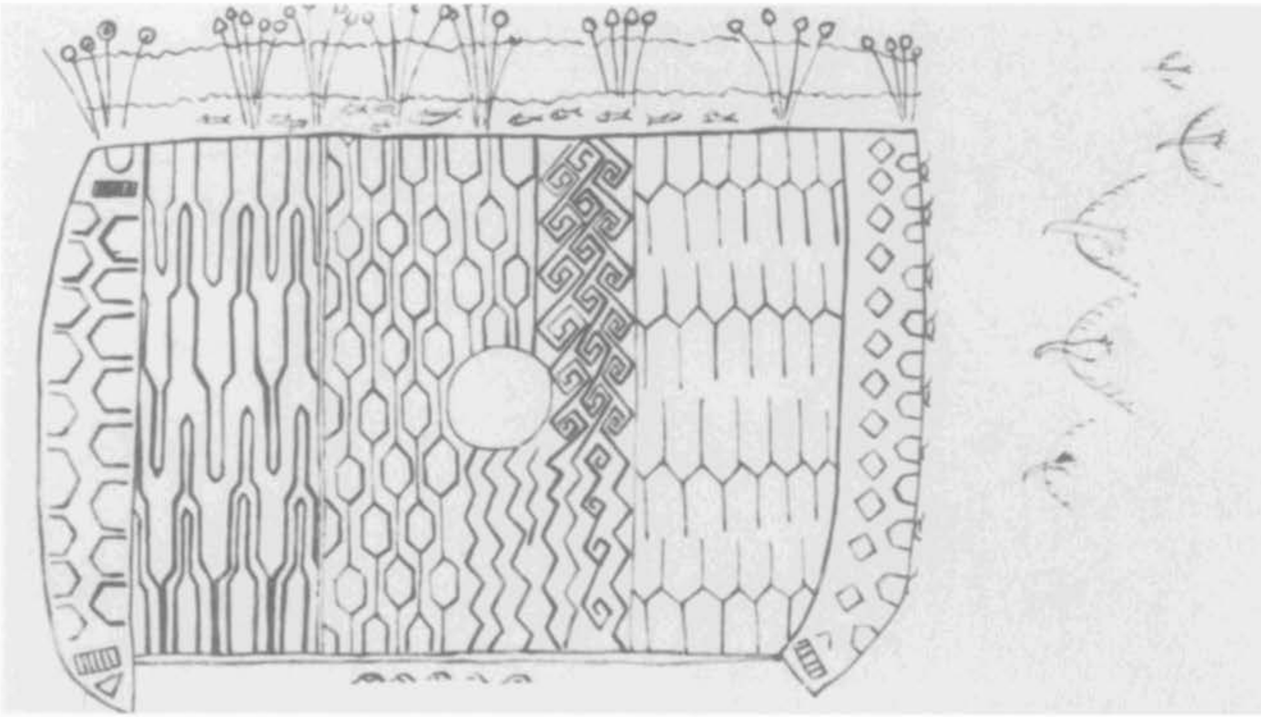


FIG. 15.5. AN INDIAN MESOLITHIC DEPICTION OF THE COSMOS? Jaora, Madhya Pradesh. Original presumably in red ocher. Of this illustration, Neumayer states (p. 14): "[It] shows a rectangular plane divided into seven vertical design stripes; on the upper side of the rectangle there are two wavy lines to denote water out of which reeds are growing; fish are swimming beneath the lower waterline. Ducks are paddling along the right and lower edge of the rectangle. Towards the right of the design are five birds in flight. This picture could be a depiction of the Mesolithic cosmos in which the rectangular plane symbolizes the earth, the wavy lines signify water with fish and reeds; the air is indicated by flying birds. The seven design stripes could indicate different features of the earth, which, when transferred to the body of an animal or man, would show the same earth quality incarnated."
Size of the original: length 50 cm. From Erwin Neumayer, *Prehistoric Indian Rock Paintings* (Delhi: Oxford University Press, 1983), 68 (fig. 26e), by permission of Oxford University Press, New Delhi.

ACHIEVEMENTS OF THE HARAPPAN CULTURE

Urban centers of economic and political control took root in South Asia in the middle of the third millennium B.C. This new Harappan or Indus culture endured for more than a thousand years, but it was recognized by archaeologists only in 1922. Since that date literally hundreds of settlement sites belonging to that culture have been discovered and partially explored. These extend not only across the whole of the Indus Plain but westward through the adjoining highlands into Afghanistan, the Pakistani province of Baluchistan, and coastal Iran, eastward to the Gangetic Plain, and southeastward into the Indian state of Maharashtra.[55]

Throughout the Harappan civilization one notes striking homogeneity and firm adherence to established standards. Harappan stone weights and linear measures are accurate and uniform in accordance with a binary-cum-decimal system. Finely engraved steatite seals are virtually identical from one site to another. Remarkable similarity also characterized the layout of settlements. Mohenjo Daro and Harappa, the two major urban centers, and also the lesser settlements at Kalibangan and Lothal all follow an elevated citadel/lower township model. The citadels were always in the west and contained the major public structures, while commercial activities and most residences were in the lower town, within which streets and lanes were laid out in a grid, crossing one another at orderly right angles. Both citadels and lower towns were fortified by thick mud and brick walls.

Arts, [1982?]), 18–19. Several additional works by Jivya Soma Mashe are held by the Department of Oriental Antiquities of the British Museum.

55. A comprehensive plotting of known sites of remains of the Indus culture appears in a series of maps appended to B. B. Lal and S. P. Gupta, eds., *Frontiers of the Indus Civilization* (New Delhi: Books and Books, on behalf of Indian Archaeological Society jointly with Indian History and Culture Society, 1984). This work is one of several recent anthologies that seek to summarize the major findings in our rapidly burgeoning knowledge of the Indus culture.

It is difficult to contemplate the remains of the Indus civilization, especially its cities, without postulating the existence not merely of a centralized—possibly sacerdotal—planning mechanism, but also of tangible physical plans to guide the architects of the period. The civilization used baked brick lavishly. Although bricks came in several sizes, the ratio among their sides was invariably 4:2:1, and major buildings and individual portions thereof were constructed in even multiples of the brick length. The "Great Bath" at Mohenjo Daro, for example, had a length equal to forty bricks (of a type that was approximately 300 mm long), a width equal to twenty-four bricks, and a depth equal to eight bricks.[56] Reflecting on the remarkable consistency of Indus weights and measures over many centuries, the archaeologist V. B. Mainkar suggests that "the regulation of denominations, accuracy and shape . . . was exercised through a well organized, direct or indirect, control over the manufacture, use and verification of weights and measures." And though the Indus civilization is a millennium or so more recent than that of Sumeria and, quite likely, in some ways derivative from it, its system of weights and measures is said to be "the oldest . . . discovered in archaeological excavations anywhere in the world" and "may have influenced Egyptian, Sumerian, Mesopotamian and Greek metrology."[57]

Baths, toilets, and drains were noteworthy features of the Indus civilization. That the drains at Lothal, a major urban site in what is now Gujarat, had uniform slopes throughout, never exceeding one in ten thousand—if the testimony of A. K. Roy is to be accepted—is one fact among many suggesting that survey instruments had to be employed. At Lothal Roy has found artifacts that he has identified as a sighting instrument, a plumb bob with a hole, a plumb bob without a hole, a plummet, a holder for a plumb line, an instrument for adjusting the length of the copper wire used for a plumb line, and an ivory measuring scale (fig. 15.6).[58] Nevertheless, no trace of a map or an architectural plan has yet been unearthed; and so long as the Indus script remains undeciphered, we are not likely to find textual support for their putative existence.

In a recent paper Asko Parpola, one of the leading scholars working to decipher the Indus script, has suggested that a symbol with three vertical strokes, appearing on some of the clay seals on which the Indus script is generally written, may represent "the three worlds transcended by Viṣṇu," who in Old Tamil (early Dravidian) texts is referred to as "he who measured the long earth."[59] The presumption here and elsewhere is that the Harappan civilization was that of a Dravidian people, that it contained many proto-Hindu elements, and that there is a connection between this literary allusion and the *Ṛg Vedic* (Aryan) myth of a "striding Viṣṇu," who with three

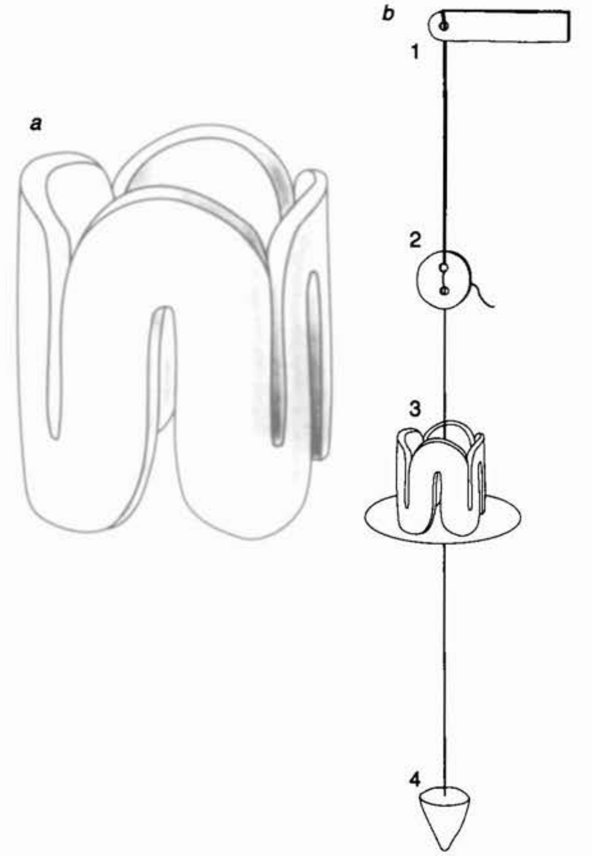


FIG. 15.6. PRESUMED SURVEY INSTRUMENTS OF THE INDUS CIVILIZATION. Found at Lothal, Gujarat, India, the objects depicted have been identified as follows: (*a*) Sighting instrument (reconstructed). (*b*) Complete sighting arrangement, with plumb line: (1) holder for plumb line; (2) round piece with two holes to adjust length of copper wire used for plumb line; (3) sighting instrument (*a*); (4) plumb bob. Several other accessories of surveying instruments were found at Lothal, according to Roy.
After A. K. Roy, "Ancient Survey Instruments," *Journal of the Institution of Surveyors* 8 (1967): 371.

56. V. B. Mainkar, "Metrology in the Indus Civilization," in *Frontiers of the Indus Civilization*, ed. B. B. Lal and S. P. Gupta (New Delhi: Books and Books, on behalf of Indian Archaeological Society jointly with Indian History and Culture Society, 1984), 141–51, esp. 147.

57. Mainkar, "Metrology," 149–50 (note 56).

58. A. K. Roy, "Ancient Survey Instruments," *Journal of the Institution of Surveyors* 8 (1967): 367–74, esp. 370.

59. Asko Parpola, "Interpreting the Indus Script—II," *Studia Orientalia* 45 (1976): 125–60, quotation on 147. For a fuller analysis, see Jan Gonda, *Aspects of Early Viṣṇuism*, 2d ed. (Delhi: Motilal Banarsidass, 1969), 55–72 and passim.

I am indebted to Frits Staal, of the University of California, Berkeley, who led me to these references. A hypothesis differing from that of Parpola and Gonda is that of R. Shama Sastry, who interprets the idea of a striding Vishnu as having an essentially chronological significance. See his "Vishnu's Three Strides: The Measure of Vedic Chronology," *Journal of the Bombay Branch of the Royal Asiatic Society* 26 (1921–23): 40–56. A critical survey of the numerous scholarly analyses of the steps measured off the sky (heaven), air (atmosphere), and earth. There is an etymological linkage between the *Ṛg Vedic* words for "to step" and "to measure," and as early as 1952, Parpola notes, scholars were "led to propose that the concept which in the human world lies behind the image of the striding Viṣṇu may be that of the surveyor."[60] Drawing on the renowned Sumerologist S. N. Kramer, Parpola points out "Mesopotamian parallels of the second half of the third millennium B.C." and concludes that "it seems quite likely that the surveyor was an important man in the Harappan society, too."[61]

VEDIC ALTARS

Following the decline of the Indus civilization—and quite possibly associated with it—came the advance of the Indo-Aryans out of Central Asia and across northern and central India. Although in most respects the life-style of the originally nomadic Aryans differed greatly from that of the sedentary Harappans, the culture did attach considerable importance to mensuration. The principal reason for regarding mensuration as important for the concomitant development of geometry was the centrality of sacrificial rites in the Aryan religion. The altars (*vedi*s) on which the sacrifices were to be performed were of various types, but each had to be constructed according to a precise set of instructions. The ten or so principal texts in which these instructions are enunciated are extensions of the Vedas themselves and are collectively known as the *Śulvasūtras* (*Śulba Sūtras*), which, "as the oldest works on Indian geometry, are of no little importance for the history of Science."[62] These texts and a somewhat earlier work, the *Śatapatha Brāhmaṇa*, which also deals with the construction of altars, have been dated to the period 900 to 200 B.C.[63]

Śulva means "measuring string" and suggests one way measurements were laid out in building the altars. Measuring rods, graduated measures, and area measures were also employed. As in other early measuring systems, the units of measurement were generally related to the human body. For measuring some parts of the *vedi* a bamboo rod was prescribed, cut to a length "as much as a man [the sacrificer] with arms extended." Fire altars were built of brick. "In general a brick . . . is one foot square, or its multiple or sub-multiple."[64] The concept of scale was well developed, and certain altars were to be built in specified scalar relationship to others. The directions for laying out the sacrificial ground and for building altars there are, in fact, so precise that modern scholars have had relatively little difficulty in reconstructing how they must have appeared.[65] Illustrations, in color, from a recently discovered seventeenth-century century Indian manuscript commenting on one of the ancient *Śulvasūtras* depict various types of fire altars. These diagrams depict the altar bricks in various colors, each indicating a mantra to be chanted while the brick of that color is being laid.[66]

Figure 15.7 provides a reconstruction of the "Six-Tipped Bird Altar," an important physical element of the elaborate *agnicayana* (fire sacrifice), the last performance of which took place in Kerala in 1975. An exhaustive

Ṛg Vedic references to the striding Vishnu is provided by F. B. J. Kuiper, "The Three Strides of Viṣṇu," in *Indological Studies in Honor of W. Norman Brown*, ed. Ernest Bender, American Oriental Series, vol. 47 (New Haven: American Oriental Society, 1962), 137–51.

60. Parpola, "Indus Script," 148 (note 59).

61. Parpola, "Indus Script," 148 (note 59).

62. Moriz Winternitz, *A History of Indian Literature*, trans. S. Ketkar, vol. 1, pt. 1, 3d ed. (Calcutta: University of Calcutta, 1962), 240.

63. Satya Prakash and Ram Swarup Sharma, eds., *Āpastamba-Sulbasūtram*, trans. Satya Prakash, Dr. Ratna Kumari Publications Series, no. 5 (New Delhi: Research Institute of Ancient Scientific Studies, 1968). Various authorities have been consulted for the dates.

64. The unit, being related to the body size of the chief sacrificer, was not constant. See "unit square" in figure 15.7.

65. The first Western scholar to translate a major Indian text dealing with the construction of altars was Julius Eggeling. *The Satapatha Brâhmana, according to the Text of the Mâdhyandina School*, was published in five volumes—volumes 12, 26, 41, 43, and 44 of the Sacred Books of the East series, ed. F. Max Müller (Oxford: Clarendon Press, 1882–1900). The work is abundantly illustrated to indicate how *vedis* were to be built. Similar illustrated translations by Western and Indian scholars have since been made of other *Śulvasūtra*s. In an article titled "Sacrificial Altars: Vedis and Agnis," *Journal of the Indian Society of Oriental Art* 7 (1939): 39–60, N. K. Majumder provides a number of diagrams that "are exact copies of a set in the collection of the Government Oriental Manuscripts Library, Madras . . . [the importance of which] lies in the fact that they are said to have been procured from a person who was still performing the Yajñas [sacrifices] and was supposed to be conversant with the details of practical construction of the Vedis and Agnis" (p. 47). *Vedi* means altar in general or, more specifically, the part of the altar complex where the sacrifice is carried out; *agni* is the part of the altar on which a sacrificial fire is kept. This passage shows that ordinary priests, as well as scholars, could draw the plans of altars from the sacred texts. Indeed, at the time of sacrifices they were compelled to do so.

66. The work, a commentary on Āpastamba's *Śrautasūtra*, was brought to light by H. G. Ranade. The diagrams are illustrated by Gole, *Indian Maps and Plans*, 18 (note 2). Published reproductions of diagrams drawn in connection with the construction of specific fire altars also appear in other published works. A group of illustrations, some in color, relating to a *yajña* (fire sacrifice) performed in Rajasthan (and including a ca. eighteenth-century diagram for the *yajña*), is provided by Ajit Mookerjee in *Ritual Art of India* (London: Thames and Hudson, 1985), 34–36 and 38. Two additional diagrams relating to a *yajña* performed in Jaipur in the nineteenth century are presented in Kapila Vatsyayan's *The Square and the Circle of the Indian Arts* (New Delhi: Roli Books International, 1983), 33–34. Vatsyayan also provides a photograph of the well-preserved remains of the altar for an *aśvamedha* (horse sacrifice) carried out in Nagarjunakonda in what is now the state of Andhra Pradesh. The specific date of that altar is not noted, but it is reported as "one of the earliest" such remains, dating from "many centuries" before the similar Jaipur altar (pp. 32 and 34). Illustrations and discussion of archaeological finds of a number of other altars—dating, in the case of an excavation at Kanśāmbi, perhaps as far back

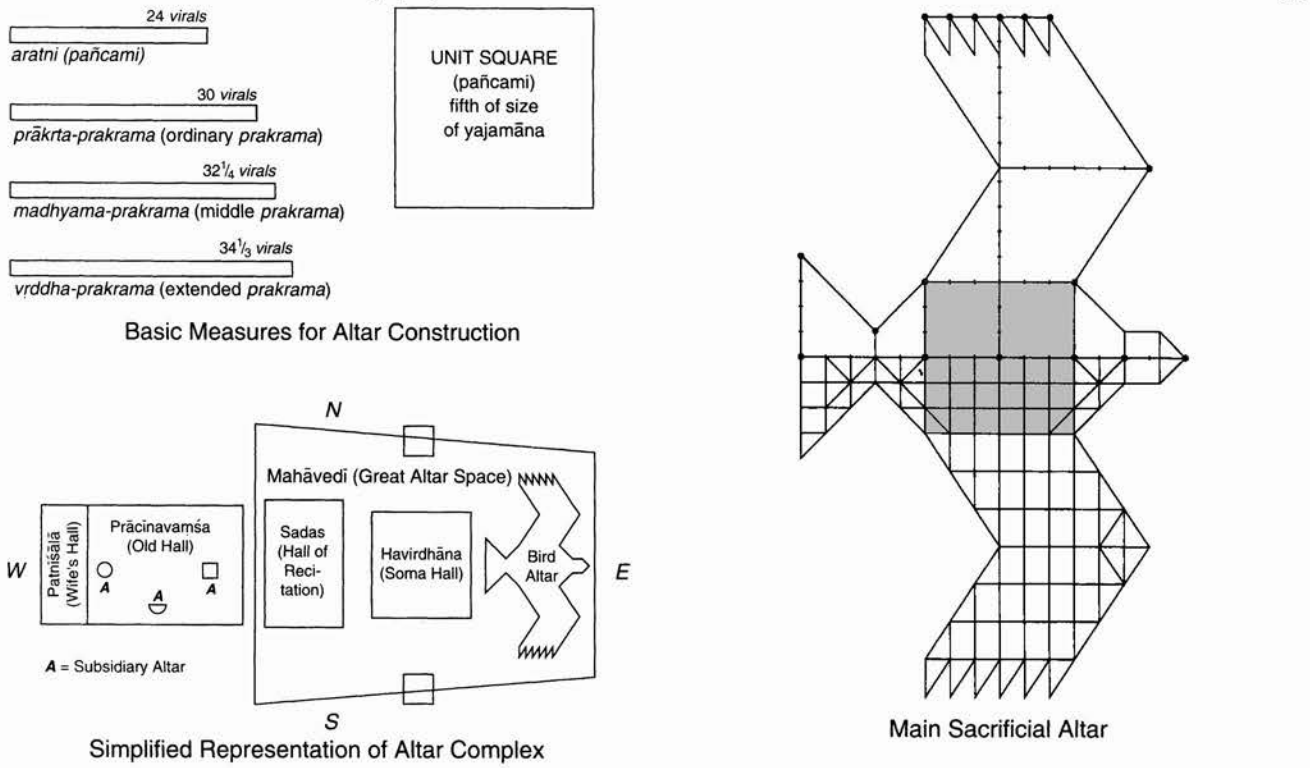


FIG. 15.7. MEASUREMENT UNITS, SCALAR RELATIONS, AND PRESCRIBED LAYOUTS OF THE ALTAR COMPLEX FOR THE VEDIC *AGNICAYANA*. The Vedic texts that prescribe the rules for building altars and carrying out different types of sacrifices are so specific that later sacrificers, as well as modern scholars, are able to construct or depict altars in precise conformity to those built several thousand years ago. The bird altar, the main sacrificial altar of the *agnicayana* (fire sacrifice), was built up of fired bricks of ten standard sizes of squares, rectangles, and triangles whose dimensions were stipulated multiples or fractions of a unit square designated as a *pañcami* (fifth), so called because the length of its side, one *aratni*, was a fifth of the height above the ground of the fingertips of the sacrificer, standing with his hands above his head. Three other measures, known as *prakramas*, were used in constructing other portions of the altar complex, the principal components of which are illustrated. All these units are conventionally assigned lengths in numbers of *virals* (finger breadths), as shown above. In the upper half of the depiction of the main sacrificial altar are shown some of the principal points in terms of which the altar is laid out and, by tick marks, some of the key measurements for the ground plan. The lower half shows the arrangement of bricks for the first of the five layers of bricks comprising the altar. (The arrangement of the upper half would be its mirror image.) In all, two hundred bricks form this layer. They include only five of the ten standard types. There are strict rules as to the sequence for laying the bricks and the verses to be chanted for each brick laid. The gray square in the middle of the bird represents its *ālman* (body or self).
After Frits Staal, *Agni: The Vedic Ritual of the Fire Altar*, 2 vols. (Berkeley: Asian Humanities Press, 1983), passim.

and profusely illustrated account of that sacrifice was provided by Frits Staal.[67] One among scores of his photographs documenting the *agnicayana* is presented in figure 15.8. Before the actual construction of an altar, its outline was traced on the ground, thus providing in effect an ephemeral map at a one-to-one scale. The orientation was invariably toward the east.

ANCIENT KNOWLEDGE OF GEOGRAPHY

There can be no doubt that the ancient inhabitants of South Asia had amassed a remarkable store of geographic knowledge, not only of the Indian subcontinent but also of other areas, well before the establishment of large states whose historicity is beyond dispute. Had the Brahmans, who committed numerous ancient texts to memory, wished to do so, there is little doubt they could have

as the mid-first millennium B.C.—are presented by Romila Thapar, "The Archeological Background to the Agnicayana Ritual," in Frits Staal, *Agni: The Vedic Ritual of the Fire Altar*, 2 vols. (Berkeley: Asian Humanities Press, 1983), 2:3–40, esp. 26–34, including figs. 2–4b.

67. Staal, *Agni*, vol. 1, passim (note 66). See also Staal, *The Science of Ritual*, Post-graduate and Research Department Series, no. 15 (Pune: Bhandarkar Oriental Research Institute, 1982). The place of performance of the sacrifice in question was the village of Panjal, about twenty-five kilometers north-northeast of Trichur (Staal, *Agni*, 1:194–95).

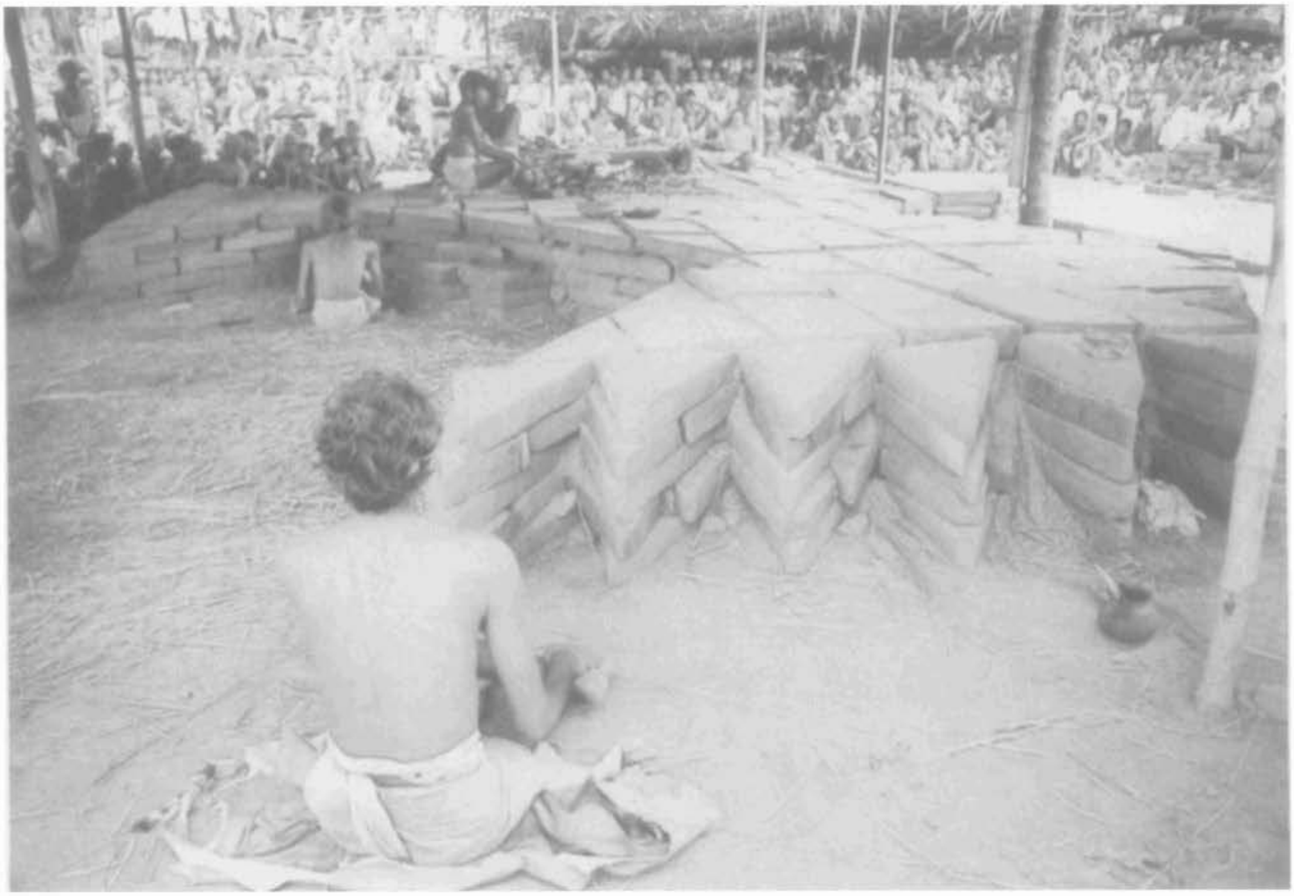


FIG. 15.8. BRAHMAN *YAJAMĀNA*'S (RITUAL PATRON'S) VIEW OF THE FIRE ALTAR. The customary place for the patron of a sacrifice is to the south of the altar. Here he looks north over the six tips of the southern wing of the bird image depicted in figure 15.7. The sacrificial ceremony at which this picture was taken lasted from 12 to 24 April 1975.
From Frits Staal, *Agni: The Vedic Ritual of the Fire Altar*, 2 vols. (Berkeley: Asian Humanities Press, 1983), 1:580–81. Photograph courtesy of A. de Menil, 1975. By permission of Asian Humanities Press, Berkeley, California.

produced some kind of map based on their contents, as later scholars have in fact repeatedly done.[68] Oldest of all the texts are the four Vedas of the Aryans (*Ṛg*, *Sāma*, *Yajur*, and *Atharva*) which, together with their appendixes, most notably the massive Brahmanas (ca. 1500–600 B.C.), refer to scores of identifiable areas, physical features, and peoples from Bālhīka (Balkh) in northern Afghanistan to as far east as Vaṅga (Bengal) and as far south as Andhra in the Deccan.

The two great Indian epics, the *Mahābhārata* and the *Rāmāyaṇa*, are far richer in geographic detail, but their dates are still controversial. The great war described in the *Mahābhārata*, though traditionally dated 3102 B.C., appears to be based on an actual event that took place early in the first millennium B.C. and has an obvious parallel in the *Iliad*, while the *Rāmāyaṇa*, akin to the *Odyssey*, would have followed soon after. However, the oldest *composed* portions of both epics are assignable only to about 400 B.C. By about A.D. 200 the bulk of the *Rāmāyaṇa* is thought to have achieved its present form, whereas composition of the *Mahābhārata*, the world's longest poem, probably extended to at least A.D. 400. Modern scholars have been able to identify places mentioned in the epics throughout South Asia and have also equated certain of them with locales in Xinjiang, Tibet, and Myanmar. The following excerpt from the *Mahābhārata* is especially rich and may in effect be considered an example of verbal cartography:

> King Bhārata, I shall depict for you this land of Bharata. . . . There are these seven Main Mountains—the Mahendra, Malaya, Sahya, Śuktimat, Ṛkṣavat, Vin-

68. Schwartzberg, *Historical Atlas* (note 50), provides numerous maps of the knowledge of India and adjacent regions revealed in a wide range of ancient texts. See especially plates III.A.1 and 2, III.B.1 and 2, and III.D.3 and associated text.

> dhya and Pāriyātra. But thousands more mountains are recognized in their general vicinity, massive and vast ones with colorful ridges. Then, there are other hills less well-known, low ones that are inhabited by short people, both Āryan and barbarian, as well as folk that are a mixture of both. The population drinks from many rivers: the great Ganges, the Indus and Sarasvatī.[69]

Following the passage cited, dozens of additional, identifiable rivers are named; and these are followed in turn by a lengthy listing of *janapadas* (regions/states, together with the groups who inhabit them). Other exceedingly valuable portions of the text are the *tīrthayātrās* (pilgrimage routes) delineated in book 3 of the *Āraṇyakaparvan* (Book of the forest), several long sections of which are devoted to the regionally organized presentation of *tīrthas* (pilgrimage places).[70]

Of all the types of natural features noted in the texts mentioned above, probably none held greater significance for the ancient Hindus than did rivers. *Tīrtha*, the word used for place of pilgrimage, literally means a ford in a river, and rivers in general were regarded as sacred. Not surprisingly, therefore, they were celebrated in stone as well as in painting and literature, and some were personified within the Hindu pantheon and rendered by distinctive icons. Figure 15.9, for example, shows a bas-relief representation of the Ganga (Ganges) and the Yamuna (Jumna) at Prayāga (modern Allahabad). Dated about A.D. 400, it is the earliest such work I am aware of. Though only a few specific features are shown on this image, the work as a whole has been taken as a symbolic representation of Madhyadesa (the central region), the core region not only of the Aryanized portion of India, but also of the then dominant Gupta Empire.[71]

Sculptures featuring rivers also appear in later periods and from other parts of India. Although I have not made an extensive investigation of the subject, we may mention, if only in passing, the renowned seventh-century Pallava representation of "the descent of the Ganga" at Mamallapuram (Mahabalipuram) on the Indian coast not far south of Madras. It is noteworthy not only because it forms part of one of India's greatest sculptural assemblages, hewed in situ from the native rock, but also because the cleft in the rock, said to represent the Ganga, is thought to have provided a channel for running water, either diverted to the site from the Palar River by builders of the period or emanating from some no longer extant receptacle.[72] If this interpretation is correct, the ensemble would have had a unique kinetic quality.

Yet another interesting work is an eleventh-century stone slab, of unknown provenance, depicting the Ganga flowing through the sacred city of Kāshī (Varanasi). This work, illustrated and discussed by Gole, was interpreted for her by N. P. Joshi. The slab is about one meter high

69. *The Mahābhārata*, Bhīṣma (62), "The Earth," translated by J. A. B. van Buitenen, unpublished volume.

70. This presentation is discussed by Surinder Mohan Bhardwaj in *Hindu Places of Pilgrimage in India (A Study in Cultural Geography)* (Berkeley and Los Angeles: University of California Press, 1973; reprinted 1983), 15–17 and passim. From among the hundreds of *tīrthas* cited in the epic, Bhardwaj has mapped and discussed several dozen of particular importance (figs. 2.1 and 3.1). He has also mapped the major *tīrthas* noted in several of the Puranas and in other texts as well.

71. Explanations of the meaning of this sculpture are provided in Steven G. Darian, *The Ganges in Myth and History* (Honolulu: University Press of Hawaii, 1978), 130 and figs. 40 and 41; and at greater length, in Frederick M. Asher, "Historical and Political Allegory in Gupta Art," in *Essays on Gupta Culture*, ed. Bardwell L. Smith (Delhi: Motilal Banarsidass, 1983), 53–66, plus ten plates, and in particular 56–57 and pl. 2. Although Prayāga, the capital of the Gupta Empire, occupied a riverine location far from the sea, Asher explains the extensive body of water below the stream confluence as if it were an ocean (*samudra*), rather than a continuing stream, by suggesting that such a sculptural play on words was a way of paying homage to the great Samudra Gupta, the founder of the Gupta state. Thus, the "merging [of] streams into a single mighty river, or great rivers into an enormous ocean" signified the emperor's drawing together "under a unified central authority the disparate states of India" (Asher, "Allegory in Gupta Art," 57). I have made no attempt to investigate or catalog Indian paintings symbolizing rivers and other features of the terrestrial landscape as deities but simply note that they are numerous and often supplement the iconic representation with a more natural rendition of the features in question.

Conventionalized representations of rivers and mountains also frequently appear on ancient Indian coins dating at least as far back as the third century B.C. The most common river symbol is a pair of parallel wavy lines with a row of fishes between them. Straight parallel and simple curved parallel lines may also be employed; and as with the Udayagiri sculpture, the personified river goddess, her *vāhana* (mount), or both, may signify a particular stream. The symbols for mountains are more varied than those for rivers but are typically compounded of several inverted U shapes. I am unaware of any personified forms. The specific identification of rivers and mountains is generally conjectural. Among rivers believed to appear with some frequency are the now dried-up Sarasvatī of Punjab, the Sipra and Bina (ancient Veṇvā) in Madhya Pradesh, and usually via the goddess or *vāhana* icon, the Ganga and the Yamuna. Among mountains, Meru seems to be most common. Occasionally legends on the coins contain the names of rivers, mountains, regions, or towns, though not necessarily in combination with a graphic symbol. There are literally millions of old Indian coins in public and private collections throughout the world and a vast corpus of relevant numismatic literature. I have made no attempt to survey this literature and leave to future scholars the task of determining which, if any, of the often enigmatic coins may legitimately be described as cartographic. Perhaps the best single-volume guide is John Allan, *Catalogue of the Coins of Ancient India* (London: Trustees [of the British Museum], 1936). Also noteworthy is Parmanand Gupta, *Geography from Ancient Indian Coins and Seals* (New Delhi: Concept, 1989).

72. Darian, *Ganges in Myth and History*, 17–30 (note 71), including eight photographs. Of this work Darian observes that the Ganga is not flowing through terrestrial space, but rather is the primordial Ganga flowing from heaven to earth as described in the *Rāmāyaṇa*. Other sculptural and architectural versions of the same theme or similar themes are also described by Darian, but their maplike qualities are less apparent than at Mamallapuram. Even in the case of Mamallapuram, an altogether different explanation of the "descent of the Ganga" is offered by some art historians; but Asher, "Allegory in Gupta Art," 64–66 (note 71), and Susan L. Huntington, *The Art of Ancient India* (New

and of a slightly greater width. In addition to a sinuous band representing the Ganga, it shows, to the right and left of the river, three horizontal registers of sculptured deities associated with the city. Such stones were allegedly made, according to a thirteenth-century text read by Joshi, "so that devotees who lived far from Varanasi or were unable to take a dip in the holy river, might worship the stone at their place of residence, and thus earn equal merit."[73] Similar slabs reportedly depict the religious sites of Prayāga and Gaya.

FIG. 15.9. THE GANGA AND YAMUNA RIVERS. This bas-relief in stone is part of a large sculptured ensemble at Udayagiri, Madhya Pradesh, ca. A.D. 400. These sacred rivers are identifiable by their iconic representations as female deities standing on their emblematic *vāhana*s (mounts), the *mākara* (crocodile) for the Ganga and the *kūrma* (tortoise) for the Yamuna. The confluence of the two rivers occurs at the ancient holy city of Prayāga (Allahabad).
Size of the original: not known. By permission of the American Institute of Indian Studies, Center for Art and Archaeology, Varanasi, and courtesy of the Archaeological Survey of India.

Other important works—in what must necessarily be a very incomplete sketch—that demonstrate the breadth of ancient Indian geographical knowledge include Pāṇini's classic *Aṣṭādhyāyī* (late fifth or early fourth century B.C.), in which the author frequently used place-names in the exposition of the rules of Sanskrit grammar; Kauṭilya's *Arthaśāstra* (fourth century B.C.), a manual of statecraft and geopolitics; and the Jataka stories (third century B.C.), a collection of folktales relating to the previous lives and times of the Buddha (ca. 563–483 B.C. for the historic Gautama Buddha).

A particularly important genre comprises the voluminous encyclopedic compendiums known as the Puranas (*purāṇa* means "old"; hence Puranas may be translated as ancient texts). These texts are, however, exceedingly problematic; for though the original compilation of a particular Purana may be attributable to some period in the first millennium, the extant versions were usually "compiled many centuries later and may have continued to be enlarged and altered even after the mention of the eighteen Mahā-Purāṇas [major Puranas] in the *Mahābhārata* redacted in c. A.D. 400."[74] A characteristic feature of the Puranas was a geographical list (*bhuvanakośa*)—a sort of protogazetteer naming peoples and their territories, tribes, mountains, and rivers. Other sections of the Puranas deal extensively with places of pilgrimage and their glories (*mahātmya*s) and significance, which indicates the antiquity of the pilgrimage tradition in India and suggests yet another reason maps might have been desired. Finally, the Puranas were exceedingly rich in cosmographic description and presented views on cosmography considerably at variance with those found in the Vedas, the *Mahābhārata*, and the early Buddhist canons.[75]

EVIDENCE OF ANCIENT COSMOGRAPHIES

In reflecting on the texts just cited, and on others as well,

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York and Tokyo: Weatherhill, 1985), 303–4 and fig. 14.18, both suggest that the interpretation I have cited is the view more widely held.

73. Gole, *Indian Maps and Plans*, 22 (note 2). At present the slab is at the Archaeological Museum at Gwalior Fort (acc. no. 285).

74. Schwartzberg, *Historical Atlas*, 182 (note 50), relevant text written in collaboration with Shiva Gopal Bajpai. Some authorities have assigned certain Puranas to periods as early as the eighth century B.C., but David Pingree (personal communication, 21 December 1988) asserts that "this is too early by about half a millennium."

75. Schwartzberg, *Historical Atlas*, 182–83 (note 50).

various scholars, most notably Tripathi, have inferred from various passages that maps and globes had to have been made in ancient times. Tripathi confidently interprets a number of words in Sanskrit and Pali (the language of the Buddhist canon) as having clear cartographic meaning. As the equivalent of map he gives the Sanskrit word *ālekhya* and its Pali equivalent, *ālekha*. He translates *sampuṭaka* as either map or atlas, *rekhacitra* as plan, and *parilekhana* as cartography, and in a glossary he offers one or more additional words for globe, equator, prime meridian, zenith, map projection, plane table, surveying, and so forth.[76] The more cautious D. C. Sircar, however, has this to say:

> There is no special word in Sanskrit for "a map." The word *nakshā* (from Arabic *naqshah*) has been adopted in most modern Indian languages in this sense, although it also signifies "a picture, a plan, a general description, an official report." In Eastern India, the word *māna-chitra* has been coined to indicate the English word "map." The absence of any special Sanskrit word raises the question whether map drawing was at all known to the Indians of old. There is, however, reason to believe that in ancient India a map or chart was regarded as a *chitra* or *ālekhya*, i.e. "a painting, a picture, a delineation." It will be seen that the Sanskrit word *chitra* and its synonyms have practically the same meaning as the Arabic word *naqshah*.[77]

Tripathi cites numerous passages in the literature indicating to his satisfaction that map drawing was not uncommon in ancient India. He refers, for example, to a passage in Edward Cowell's translation of the *Mahāummagga Jātaka* that alludes to artists who "made all manner of paintings" and then names a number of identifiable geographic features such as Mount Sineru (Meru), Himavat (the Himalayas), and Lake Anotatta (Manasarowar), as well as such generic features as the four continents, the sea, and the ocean.[78] Tripathi sees in this passage proof that the early Buddhists drew world maps and that "this work was carried on by expert cartographers."[79] The quotation is, however, cut short at the point where the original text states that the artists also painted the "Sun and Moon, the heaven of the four great kings with the six heavens of sense and their divisions."[80] Thus it hardly appears that we are dealing here with world maps drawn by "expert cartographers"; rather, it seems that the *Mahāummagga Jātaka* is describing a conventional cosmography of the so-called *catur-dvīpa vasumatī* (the four-continent earth, as described below, p. 352 and figs. 16.1 and 16.14) for the presentation of which "expert" cartographic skills—inferred by Tripathi—would not have been a prerequisite. Tripathi cites similar textual evidence in support of mapmaking from the Vedas, the Brahmanas, the Epics, and especially the Puranas. A full evaluation of these claims through a study of the original Sanskrit and Pali sources is badly needed.

Other authors also find support in the ancient literature for the drawing of cosmographic maps. Sircar and Awasthi both cite relevant passages from several of the Puranas. The following, translated from the *Padma Purāṇa*, tells of Kalā, the daughter of a minister of a south Indian kingdom, who to entertain her visiting queen takes from a chest "a wonderful book" within which were revealed, among other things:

> the pictorial representation of Bhūgola (earth) having the extent of fifty crores [1 crore = 10 million] of yojanas [a unit of distance, variously taken as 4½ or 9 miles]. . . . golden-land painted dark, Lokālokaparvata [the mountain range ringing the earth], seven continents surrounded by seven seas as well as the rivers, mountains and territorial divisions related to seven *dvīpas* (continents). . . . Bhārata-Khaṇḍa [India] comprising rivers like the Yamunā and the Gaṅgā. . . . the sacred site of Indraprastha [Delhi] placed on the bank of the Yamunā . . . the sacred spot of Prayāga [Allahabad, at the Ganga-Yamuna confluence].[81]

This suggests that the book in question, or at least a part of it, was meant to contain maps.

Apart from the textual references, there is at least one major surviving cosmographic painting of very great antiquity—the Buddhist *bhavacakra* (wheel of life), painted on the wall of cave 17 in the renowned cave complex at Ajanta. The dating of this fresco is disputed, but it appears to be from not later than the sixth century, and the art historian Walter Spink assigns it a date of roughly A.D. 470.[82]

Not all cosmographies, it appears, were two-dimensional representations. Tripathi has provided references to passages in the *Bhaviṣya Purāṇa* describing hinged metal hemispheres, which implies that some attempts were made to construct cosmographic globes as gifts to

76. Tripathi, *Development of Geographic Knowledge*, passim, esp. appendix, "Selected Technical Terms," 327–32 (note 17).

77. Sircar, "Ancient Indian Cartography," 60 (note 18).

78. Edward Byles Cowell, ed., *The Jātaka; or, Stories of the Buddha's Former Births*, 7 vols. (Cambridge: Cambridge University Press, 1895–1913; reprinted London: Pali Text Society, distributed by Routledge and Kegan Paul, 1981), vol. 6 (trans. E. B. Cowell and W. H. D. Rouse), 223; cited in Tripathi, *Development of Geographic Knowledge*, 312–13 (note 17).

79. Tripathi, *Development of Geographic Knowledge*, 313 (note 17).

80. Cowell, *Jātaka*, 6:223 (note 78).

81. Awasthi, "Ancient Indian Cartography," 276–77 (note 19).

82. Personal communication, 20 September 1988. See also Walter M. Spink, "The Vākātakas Flowering and Fall," in a forthcoming volume of proceedings of an international conference on the art of Ajaṇṭā, held at Maharaja Sayajirao University in Baroda in 1988, ed. Ratan Parimoo.

Brahmans.[83] Additionally, several literary references suggest that something akin to relief models may also have been made. The *Skanda Purāṇa*, it is said, "mentions a relief model map prepared on level ground."[84] Further, a chapter in the *Matsya Purāṇa* provides a set of rules for gift-giving ceremonies that entail the construction, from rice and wheat, of a model landscape—presumably mythical—of the region of Mount Meru, with associated rock structures, foothills, dales, ravines, streams, lakes, and forests.[85]

INDIAN ASTRONOMY

Although the Indian science of astronomy overlaps to some degree with the speculative cosmological lore associated with Brahmanic Hinduism, Jainism, and Buddhism, it produced, over a period of more than a thousand years beginning about A.D. 400, a very large body of empirically based texts.[86] Less systematic knowledge of astronomy does, of course, have much earlier roots. There are circumstantial grounds to suppose that the Indus culture had some familiarity with astronomy, but there is no proof of this in the archaeological record.[87] In Vedic times, however, various texts refer to the proper times for performing the numerous sacrifices that characterized pre-Brahmanic Hinduism according to a diversity of astronomically determined phenomena: *yugas* (periods), *saṃvatsaras* (years), *ayanas* (half-years), *ṛtus* (two-month seasons), *māsas* (months), *adhimāsas* (intercalary months), *pakṣas* (half-months), specific ordinally numbered nights, and some twenty-seven or twenty-eight *nakṣatras* (constellations). "All of these elements," notes Pingree, "survived into later periods, and profoundly affected the form into which Indian astronomers molded the foreign systems that they adapted to their own use."[88]

Early historians of Indian science were inclined to ascribe to Indian astronomical texts, many of which were traditionally regarded as revelations, greater originality than is suggested by recent research. Pingree characterizes the situation as follows:

> Astronomy shares with other scholarly disciplines in India the characteristic of being repetitive. Indian astronomers did not usually attempt innovations in theory; they wished to preserve their tradition as intact as possible. Most of their energies, therefore, were devoted to devising computational techniques. And they delighted both in simplifications or approximations and in needless complications; each type of change displayed the skill of the master. Much of the history of this science in India, then, must be simply an account of the means by which the traditions were preserved, and a recitation of the often bizarre modifications and elaborations of the basic formulas. . . .
>
> That Indian astronomy was not completely static is due almost entirely to the repeated intrusion of new theories from the West. Five times have such intrusions occurred—in the fifth century B.C., from Mesopotamia via Iran; in the second and third centuries A.D., from Mesopotamia via Greece; in the fourth century A.D., directly from Greece; in the tenth to eighteenth centuries, from Iran; and in the nineteenth century, from England. But, although the character of Indian astronomy at each such intrusion was changed, to a greater or lesser extent, these changes were accompanied by the minimum possible alterations of the earlier traditions, none of which ever completely died.[89]

As the early Vedic emphasis on religious sacrifices waned, astronomy was put to new uses. Among these were determining the proper moments for performing *saṃskaras* (personal ceremonies or sacraments); calendric computations, especially in regard to festivals; indicating auspicious and inauspicious times for performing certain types of actions; predicting eclipses; establishing the time of the sun's entry into successive zodiacal signs; and from at least the second century A.D., computing the positions of planets for the casting of horoscopes.[90]

Basham has summarized some of the more important sun-earth-moon relationships as follows:

> For purposes of calculation the planetary system was taken as geocentric, though Āryabhaṭa in the 5th century suggested that the earth revolved round the sun and rotated on its axis; this theory was also known to later astronomers, but it never affected astronomical practice. The precession of the equinoxes was known, and calculated with some accuracy by medi-

83. Tripathi, *Development of Geographic Knowledge*, 291–92 (note 17). Compare the description of a sixteenth-century hinged metal globe at Oxford, pp. 352–55.

84. R. L. Singh, L. R. Singh, and B. Dube, "The Ancient Indian Contribution to Cartography," *National Geographical Journal of India* 12 (1966): 24–37, esp. 32.

85. Tripathi, "Survey and Cartography," 415–16 (note 17). In the modern period, in the folk observance of a festival in honor of Lord Krishna, peasants and cowherds make cow-dung models of the sacred Mount Govardhan (see below, p. 379).

86. Some idea of the vast scope of Indian astronomical literature will be gained by consulting, inter alia, the following works by David Pingree: "History of Mathematical Astronomy in India," in *Dictionary of Scientific Biography*, 16 vols., ed Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 15:533–633; *Jyotiḥśāstra: Astral and Mathematical Literature*, History of Indian Literature, vol. 6, fasc. 4 (Wiesbaden: Otto Harrassowitz, 1981); and *Exact Sciences in Sanskrit* (note 44). Pingree notes that "at present there exist in India and outside of it some 100,000 manuscripts on the various aspects of *jyotiḥśāstra*" (*Jyotiḥśāstra*, 118).

87. Brij Bhusan Vij, "Linear Standard in the Indus Civilization," in *Frontiers of the Indus Civilisation*, ed. B. B. Lal and S. P. Gupta (New Delhi: I. M. Sharma, 1984), 153–56, esp. 156. See also Debiprasad Chattopadhyaya, *History of Science and Technology in Ancient India: The Beginnings* (Calcutta: Firma KLM Private Limited, 1986), 82–85.

88. Pingree, "History of Mathematical Astronomy," 534 (note 86).

89. Pingree, "History of Mathematical Astronomy," 533 (note 86).

90. Pingree, *Jyotiḥśāstra*, 8 (note 86).

eval astronomers, as were the lengths of the year, the lunar month, and other astronomical constants. These calculations were reliable for most practical purposes, and in many cases more exact than those of the Greco-Roman world. Eclipses were forecast with accuracy and their true cause understood.[91]

In reference to the earth, parallels of latitude, meridians of longitude, the equator, and a prime meridian, based since the mid-second century A.D. on the longitude of the ancient Indian city of Ujjayinī (Ujjain), were all utilized.[92] Diverse astronomical instruments were employed, including various types of gnomons and water clocks, rotating wooden models of celestial spheres (dating from as early as the fifth or sixth century and characterized by Pingree as "basically illustrative . . . or elaborate toys"), and in due course astrolabes (*yantrarājas*), quadrants, complex celestial globes, and other observational devices adapted from those used by Islamic peoples.[93]

The oldest known "Indian" astrolabe was, in fact, a modification of an instrument of the Islamic type, inscribed in the Cufic style of Arabic and dated 669/1270. The earliest Hindu text on astrolabes is, similarly, based on Arabic and Persian works of the preceding three centuries; it was written about A.D. 1370 by Mahendra Sūri, the son of a court astrologer, for the Tughluq sultan Fīrūz Shāh III. Hindu interest in astrolabes seems to have waned in the fifteenth century, however, only to be revived again with the advent of Mughal rule in the sixteenth.[94] The culmination of Indian efforts at creating precise astronomical instruments came in the 1720s and 1730s, during the reign of the astronomer king Sawai Jai Singh II of Jaipur, who oversaw the construction of monumental stone observatories at Jaipur, Ujjain, Delhi, Mathura, and Varanasi. These observatories were modeled on that of Ulugh Beg, built in the mid-fifteenth century in Samarkand.[95] Finally, I must note that numerous metal celestial globes, all ultimately of Islamic origin, though occasionally with text in Sanskrit, were also produced in India from the late sixteenth to the mid-nineteenth century.[96]

From the seventh century onward, most astronomical texts could be classified within three principal genres. The most comprehensive and important were the *siddhāntas*, which deduced the mean motions of heavenly bodies from the beginning of a particular *kalpa* (a lengthy astronomical period discussed below in the chapter on cosmography). *Karaṇas* formed more concise expositions of the mean longitudes of heavenly bodies at various times. And finally, *koṣṭhakas* were sets of astronomical tables for determining planetary positions to solve specific astronomical problems. Additionally, there were more specialized texts, among which those relating to *yantras* (observational instruments) were of particular importance.[97]

The five principal schools (*pakṣas*) of Indian astronomical writing into which authors of the foregoing texts could be grouped are generally of no particular concern for our purposes. However, in South India in the late fourteenth century an important school arose that was distinctive because of its emphasis on careful observation of the heavens rather than on devising new computational manipulations of received data. Epitomizing this approach was the *Jyotirmīmāṃsā*, written by Nīlakaṇṭha in 1504, in which the author "vigorously defends the necessity constantly to correct astronomical parameters on the basis of observation, especially with regard to eclipses, but also with regard to the planets other than the Sun and the Moon."[98]

Although the influence of Islamic Ptolemaic theory on Indian astronomy dates from as early as the tenth century, it was not until the sixteenth century that substantial

91. A succinct account of major concepts and contributions is provided by Arthur Llewellyn Basham, *The Wonder That Was India: A Survey of the History and Culture of the Indian Sub-continent before the Coming of the Muslims*, 3d rev. ed. (London: Sidgwick and Jackson, 1967), 491–93, esp. 493.

92. David Pingree, "Astronomy and Astrology in India and Iran," *Isis* 54 (1963): 229–46, esp. 234.

93. Pingree, *Jyotiḥśāstra*, 52–54, quotations on 52 (note 86). In Pingree's opinion, "serious observations were [not] made in India before the late fourteenth century, so that the contribution of instruments to the development of Indian astronomy prior to that date was minimal" ("History of Mathematical Astronomy," 629 [note 86]).

94. Pingree, *Jyotiḥśāstra*, 52–54 (note 86); see also Gunther, *Astrolabes of the World*, vol. 1, *The Eastern Astrolabes*, chapters on "Indian Astrolabes," 179–220, and "Hindu Astrolabes," 221–28, esp. 179, 186, and 221 (note 25), and Gibbs and Saliba, *Planispheric Astrolabes* (note 26). Both are beautifully illustrated works. The interest in planispheric astrolabes was accompanied by a concomitant development in the fabrication of celestial globes, for which Savage-Smith offers a remarkably detailed, wide-ranging, and lucid account in *Islamicate Celestial Globes* (note 27).

95. Numerous works have been published on these observatories and on the career of Sawai Jai Singh II. An early, richly illustrated scholarly work is George Rusby Kaye, *A Guide to the Old Observatories at Delhi; Jaipur; Ujjain; Benares* (Calcutta: Superintendent of Government Printing, India, 1920). Also abundantly illustrated (though the photographs are often of poor quality) is Prahlad Singh, *Stone Observatories in India: Erected by Maharaja Sawai Jai Singh of Jaipur (1686–1743 A.D.) at Delhi, Jaipur, Ujjain, Varanasi, Mathura* (Varanasi: Bharata Manisha, 1978). A. Rahman's *Maharaja Sawai Jai Singh II and Indian Renaissance* (New Delhi: Navrang, 1987) also contains numerous illustrations, not only of Jai Singh's instruments, but of other works he was associated with, including a town plan of Jaipur and a plan of the Jaipur observatory. Regrettably, these two plans, both apparently from the eighteenth century, are not documented as to date, provenance, and present locale (presumably Jaipur) and came to my notice too late to be included in the discussion of geographical maps below. Additional references will be made in the chapter on cosmography.

96. These are further discussed and illustrated in the chapter on cosmography below and in the chapter on Islamic celestial mapping in part 1.

97. Pingree, *Jyotiḥśāstra*, 13–14 (note 86).

98. Pingree, *Jyotiḥśāstra*, 50–51 (note 86).

numbers of Persian astronomical texts began to be translated into Sanskrit. Among Indian astronomers influenced by these works, one whose approach distinguishes him from virtually all others was Kamalākara, who in 1658 completed in Varanasi the *Siddhāntatattvaviveka*, which appears to be the sole Sanskrit treatise on geometrical optics. This work, states Pingree, "devotes many verses to the physics of the celestial spheres, referring specifically at many points to the (Aristotelian) views of the Yavanas [Greeks] or Muslims,"[99] following in particular the school of Ulugh Beg of Samarkand.

Few Indian works on astronomy contained drawings that would assist readers in solving the problems they were related to.[100] But, as with other ancient texts we have considered, the descriptions of method are so precise that modern authors have been able to recreate remarkably complex diagrams illustrating the processes for determining at various times the positions and movements of the earth, sun, moon, planets, and certain constellations in relation to one another. (The situation appears to be analogous to the precision of the *Śulvasūtras* in respect to *vedi*s, though the intellectual demands which the astronomical texts put upon the reader obviously were substantially greater.) Nor do we find in any of the texts anything that might be described as a celestial chart. Conventional iconic representations of the planets, of signs of the zodiac, and of other celestial phenomena, however, have been extremely common in India since ancient times. Such representations, often in the form of images of the presiding deities or of objects associated with them, occurred in painting, sculpture, and architecture in a wide range of contexts, very few of which would be construed as cartographic.[101]

Although astronomy had only a negligible impact on traditional Indian cartography, it did alter the cosmographic views derived principally from the Puranas. In particular, it appears to have influenced the preparation of a number of globes, to be discussed in the following chapter on cosmography. To quote Pingree once again:

> As . . . geometric models of planetary motion based on the idea of the circularity of their orbits were introduced into India, it became necessary to modify the traditional Indian cosmology as expressed in the Purāṇas and other texts. This was done by transforming the disc of Jambūdvīpa into a sphere and Meru into the terrestrial North Pole; along the equator at 90° distance from each other lie Laṅkā on the prime meridian, Romakaviṣaya, Siddhapura, and Yamakoṭi; opposite Meru at the South Pole is Vaḍavāmukha. The axis of the universe passes through Meru and Vaḍavāmukha and the poles of the spheres of the planets and of the *nakṣatras*; the spheres of the planets rotate from West to East at a uniform velocity, driven by bonds of wind, while they and the sphere of the *nakṣatras* rotate diurnally from East to West.[102]

As in many other cultures, astronomical and astrological "science" were closely intertwined in South Asia, and as we have seen the former was, from at least the second century A.D., to a large extent the handmaiden of the latter. The hold of astrology on the people of India and on many lands influenced by Indian culture remains exceedingly strong. Astrological literature and associated diagrams and devices, used to plot the position of heavenly bodies at specific moments of time and thereby to cast horoscopes, exist in great abundance. I have, however, arbitrarily decided to refrain from any detailed consideration of this genre of writing and illustration and to refer interested readers to Pingree's thorough bibliographic coverage of the field.[103] Also omitted in the coverage of South Asia is any discussion or illustration of the numerous charts, often quite detailed, associated with the practice of chiromancy.

SURVEYING IN THE MAURYAN EMPIRE

The first great empire to arise within India was founded by Candragupta Maurya in 321 B.C. Associated with the Mauryan Empire was the *Arthaśāstra*, a manual of statecraft, attributed to Candragupta's minister Kauṭilya, but in its present form almost surely the work of a number of authors writing over a span of several centuries. A central concern of the Mauryas and of subsequent Indian states was the collection of land revenue, and an elaborate bureaucratic apparatus evolved toward that end. "So complex a system of taxation," wrote the eminent Indologist A. L. Basham, "could not be maintained without surveying and accountancy."[104] He cites the Jataka

99. Pingree, *Jyotiḥśāstra*, 30–31 (note 86); and Pingree, "History of Mathematical Astronomy," 615 (note 86); quotation is from the latter source.

100. Pingree, personal communication, 21 December 1988. Pingree notes that the paucity of illustrations in astronomical texts is in marked contrast to what is found in Sanskrit works on geometry and that he cannot explain the difference.

101. See, for example, Calambur Śivaramamurti, "Geographical and Chronological Factors in Indian Iconography," *Ancient India: Bulletin of the Archaeological Survey of India* 6 (January 1950): 21–63, with twenty-seven photographic plates, esp. pp. 29–35; David Pingree, "Representation of the Planets in Indian Astrology," *Indo-Iranian Journal* 8 (1964–65): 249–67; and Stephen Allen Markel, "The Origin and Early Development of the Nine Planetary Deities (*Navagraha*)" (Ph.D. diss., University of Michigan, 1989). In the chapter on nautical maps below, note is also taken of the use of simple directional symbols based on the *nakṣatra*s in nautical charts, compass cards, and other navigational aids.

102. Pingree, *Jyotiḥśāstra*, 12 (note 86).

103. Pingree, *Jyotiḥśāstra*, chaps. 4, 5, and 6, "Divination," "Genethlialogy," and "Catarchic Astrology," 67–109 (note 86). I include some representative illustrations in the chapter on cosmography below to convey an impression of the nature of materials in question.

104. Basham, *Wonder That Was India*, 109 (note 91).

stories, which "refer to local officers as 'holders of the [surveyor's] cord' (*rajjugāhaka*)," and notes that Megasthenes, the Seleucid emissary to the Mauryan court, recorded that the "land was thoroughly surveyed."[105] Land, says Basham,

> was only transferred to a new owner after reference to the local land records, and this fact, with the names of the record keepers who had certified its transferability, was often noted in the copper-plate title deeds. The better organized kingdoms evidently kept full and up-to-date records of land ownership corresponding to the English Domesday Book. Unfortunately they were written on perishable materials, and all have long since vanished.[106]

Although collecting land taxes remained an important state function throughout subsequent Indian history, we cannot say with certainty that any precolonial Indian state, including the great Gupta, Mughal, and Maratha empires, all of which had highly evolved revenue systems, made any provision for cadastral mapping.[107] Santarêm, however, cites the discovery by James Rennell in Monghyr district of what is now Bihar of a very early geographic map engraved on copper and appended to a land grant. The text of the inscription was translated by Wilkins and dated to the time of Jesus Christ. This late eighteenth- or early nineteenth-century find was reportedly transported to England, but its present whereabouts are not known.[108] Of course a map relating to a land grant is not quite the same as a cadastral map; but if the interpretation given the find is correct, the concern for recording the limits of one's property is relevant, and one hardly expects that the Monghyr inscription would have been unique.

ARCHITECTURAL PLANS FROM ANCIENT AND MEDIEVAL INDIA

Buddhism originated in northern India early in the fifth century B.C. and, after the conversion of the great Mauryan emperor Aśoka, about 261 B.C., spread rapidly throughout the subcontinent and beyond. Buddhist monasteries (*vihāras*) and centers of learning proliferated in this period. From the ruins of several such monasteries, one close to the village of Kasrawad near Maheshwar in Madhya Pradesh and others from Salihundam and Nagarjunakonda, in the Srikakulam and Guntur districts of Andhra Pradesh, come inscribed potsherds bearing the oldest approximately datable Indian artifacts that appear to be unquestionably cartographic in nature. D. B. Diskalkar's description of the Kasrawad find, uncovered in an excavation carried out in 1937–39, is terse and inconclusive. It merely states that "some geometrical designs which look like rough plans of houses and the compartments in them are incised on the pots."[109] How many such pots were uncovered is not stated. A single photograph accompanying the published report shows few details, and other explanations could be adduced for the inscribed design. A noteworthy motif on some of the potsherds was the swastika. The use of the swastika symbol is very ancient, since it appears even at Mohenjo Daro. "The *Ramayana* also speaks of [the] Swastika as one of several ground plans for buildings in Lanka [= (?) modern Sri Lanka]."[110] In concluding his analysis of the excavation, Diskalkar states that "the antiquities . . . all belong to one period only . . . the 2nd century B.C."[111]

The Salihundam excavations, described by R. Subrahmanyam, relate to materials dated from the second or first century B.C. to the first century A.D. Though they are possibly slightly less old than those of Kasrawad, what they portray is not so open to question. A group of five inscribed sherds of black and red ware includes a dish whose exterior bears a "rough plan of a monastery and Swastika mark"[112] (fig. 15.10). Similar plans of a monastery, according to Subrahmanyam, also occur on some of the sherds and seals at the Nagarjunakonda site, which is of similar age. The evidence from these sites thus lends credibility to Diskalkar's interpretations of the map on the Kasrawad sherd and suggests further that the swastika

105. Basham, *Wonder That Was India*, 109 (note 91).

106. Basham, *Wonder That Was India*, 109–10 (note 91).

107. Organizational charts indicating the apparatus of government for all of these states, as well as for the Mauryan Empire, are provided in Schwartzberg, *Historical Atlas*, pls. III.B.4, III.D.4, VI.A.2, and VI.A.3 and associated text (note 50). The prominence of the land revenue system in all of these charts is immediately evident.

108. Santarêm, *Essai*, 1:363–64 (note 3). The date of Rennell's find, not stated by Santarêm, would have been about 1780. Santarêm cites, but again fails to date, a translation by Wilkins. In William Wilson Hunter's *Statistical Account of Bengal*, 20 vols. (London: Trübner, 1875–77), vol. 15, *Districts of Monghyr and Purniah*, 63, there is a reference to a "copper tablet found within the fort [of Monghyr] about the year 1780," and of attempts to date it by William Jones, James Prinsep, and Francis Wilford (not Wilkins), who suggested dates of 24 B.C., A.D. 123, and A.D. 132, respectively. The compiler's view, however, was that the tablet dated from the Pāla dynasty (eleventh century). Whether the tablet in question was the one Santarêm referred to is problematic in that the former describes a royal encampment at the site and the construction of a bridge across the Ganga. It is possible that Rennell's find was already forgotten by the time *A Statistical Account* was written, though that seems rather unlikely. Gole, *Indian Maps and Plans*, 18 (note 2), adds to the mystery by suggesting that Santarêm may have misinterpreted Rennell in the first instance in supposing that his reference to the inscribed copper plate had to be a map though Rennell never explicitly stated that it was.

109. D. B. Diskalkar, "Excavations at Kasrawad," *Indian Historical Quarterly* 25 (1949): 1–18, esp. 9 and photograph 5.1.

110. R. Subrahmanyam, *Salihundam: A Buddhist Site in Andhra Pradesh*, Andhra Pradesh Government Archaeological Series, no. 17 (Hyderabad: Government of Andhra Pradesh, 1964), 49.

111. Diskalkar, "Excavations at Kasrawad," 17 (note 109).

112. Subrahmanyam, *Salihundam*, 48–50, esp. 49, fig. 15, and pl. LIV (note 110).

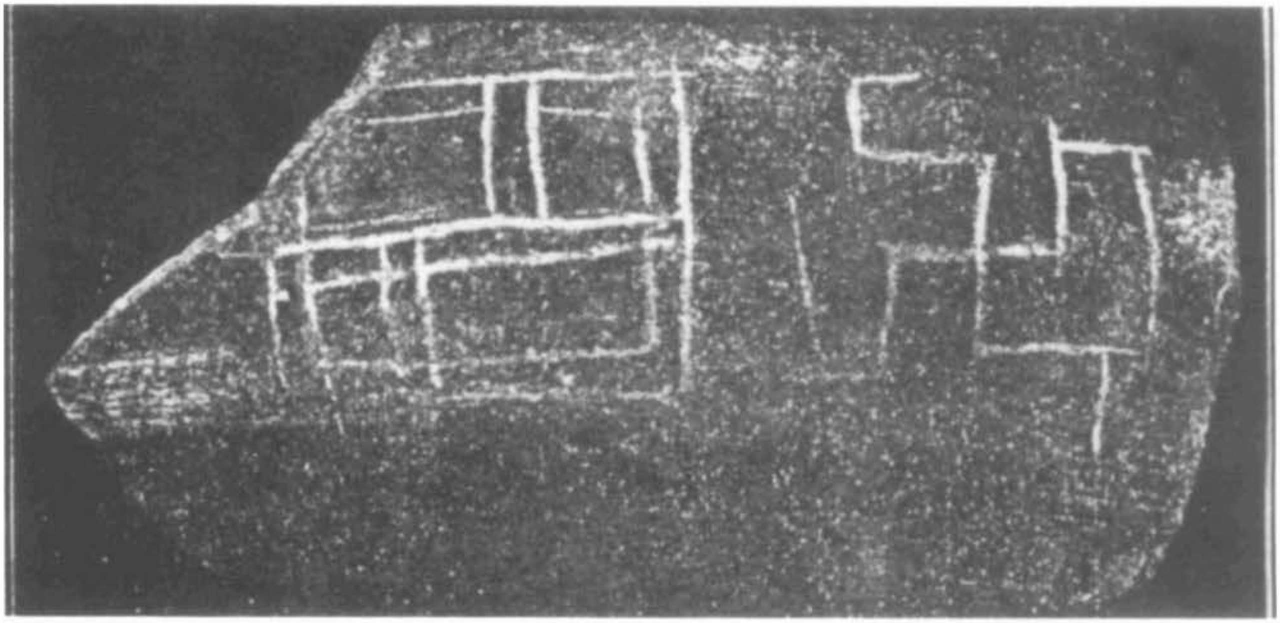

FIG. 15.10. POTSHERD WITH PLAN OF ANCIENT BUDDHIST MONASTERY. Excavated at Salihundam, a Buddhist site in Andhra Pradesh, this object is believed to date from the second or first century B.C. Size of the original: 4.5 × 9 cm. Photograph courtesy of Susan Gole, London.

motif in other ancient archaeological contexts could be a cartographic sign.[113]

In ancient India, Hindu temples and Buddhist stupas were perceived as microcosmic analogues of the cosmos. Their individual components explicitly symbolized specific portions of the macrocosm, a matter on which historians of art and religion have provided us with abundant literature. As with the preparation of *vedi*s, the construction of Hindu temples has, since ancient times, been regulated by an elaborate set of instructions covering every aspect of the work. The various scriptures containing these instructions date from at least as far back as the first century B.C. Known as the *śilpaśāstra*s (laws of architecture) or *vāstuvidyā* (knowledge of sites), these texts also relate to construction in general and include chapters on building houses and on planning, laying out, and building villages and towns.[114]

In her classic work *The Hindu Temple*, Stella Kramrisch sets forth and explains in great detail the rules for temple building. Among these rules is drawing on ground leveled for the temple a plan called the *vāstupuruṣa-maṇḍala*. This was regarded as a "forecast" of the temple, "the fundament from which the building arises," and "the place for the meeting and marriage of heaven and earth, where the whole world is present in terms of measure, and is accessible to man."[115] Thus temple construction, like building *vedi*s, required the preparation of an ephemeral one-to-one scale map. It is probable that smaller-scale plans were also prepared, at least for the large and complex temples that abound in India.[116] No example survives from ancient times, but there are some noteworthy finds from the medieval period of Indian history. In the central Indian village of Bhojpur, twenty-nine kilometers southeast of Bhopal, there stands a huge but never completed eleventh-century Shaivite temple that represents, according to B. M. Pande, a fine example of the way early Indian temples were conceived and built. There is "singularly interesting evidence," he writes, "in the form of drawings ... engraved in the rocky area adjoining the temple."[117] Both Pande and Gole provide a number of photographs relating to this site.[118] Figure

113. Subrahmanyam, *Salihundam*, 49 (note 110).

114. A list of important texts is provided by Prabhakar V. Begde, *Ancient and Mediaeval Town-Planning in India* (New Delhi: Sagar Publications, 1978), 233–34.

115. Stella Kramrisch, *The Hindu Temple*, 2 vols. (Calcutta: University of Calcutta, 1946; reprinted Delhi: Motilal Banarsidass, 1976), 1:7.

116. A north Indian inscription in Sanskrit, dated Śaka 717 (795 A.D.), "records the construction of a temple for the goddess Chaṇḍikā, for which ... the architects, appointed for that purpose, duly completed the preparation of the plan ..., complete with such environmental accessories as a grove of different varieties of fruit-bearing trees, a well and a garden." Further details are provided in K. V. Ramesh, "Recent Discoveries and Research Methods in the Field of South Asian Epigraphy," in *Indus Valley to Mekong Ḍelta: Explorations in Epigraphy*, ed. Nobaru Karashima (Madras: New Era, 1985), 1–32, esp. 26.

117. B. M. Pande, "The Date and the Builders of the Śiva Temple at Bhojpur," in *Malwa through the Ages*, ed. M. D. Khare (Bhopal: Directorate of Archaeology and Museums, Madhya Pradesh, 1981), 170–75, esp. 170. The date of the temple is ascribed to the reign of the Paramāra king Bhoja I (A.D. 1010–55).

118. B. M. Pande, "A Shrine to Siva: An Unfinished House of Prayer

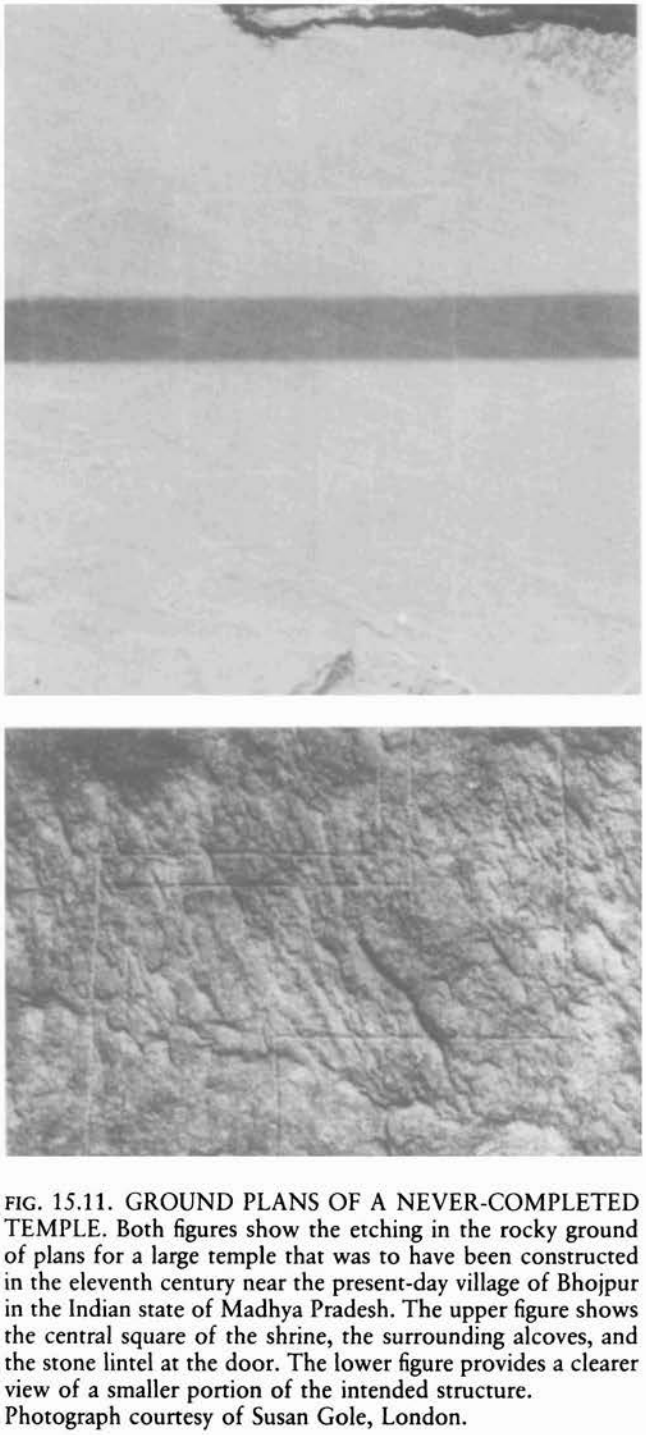

FIG. 15.11. GROUND PLANS OF A NEVER-COMPLETED TEMPLE. Both figures show the etching in the rocky ground of plans for a large temple that was to have been constructed in the eleventh century near the present-day village of Bhojpur in the Indian state of Madhya Pradesh. The upper figure shows the central square of the shrine, the surrounding alcoves, and the stone lintel at the door. The lower figure provides a clearer view of a smaller portion of the intended structure.
Photograph courtesy of Susan Gole, London.

15.11, taken from Gole, illustrates some of the exposed ground plans carved in the local stone.

Particularly interesting are a number of texts recently discovered and translated (see fig. 15.12 and below, pp. 466–68) that strongly support the hypothesis that the actual drawing of temple plans is a long-established practice among architects. When the practice commenced nobody knows, but it may be noted that the oldest surviving Hindu temples date only from the Gupta period (A.D. 320 to ca. 540). Earlier temples were built largely from perishable materials.

The *śilpaśāstras* related not only to temple architecture but also to building and settlement planning in general. Once again, these texts are sufficiently explicit to enable modern scholars to reconstruct literally scores of plans for buildings, villages, and cities. Many such reconstructions appear in published books and articles (fig. 15.13).[119] According to the texts, the planning, layout, and actual construction of large settlements, palaces, defensive works, and reservoirs should be entrusted only to a qualified *sthapati* (master builder/architect). Such an individual had to be of high moral and intellectual stature and well versed in surveying, draftsmanship, making perspectives, reconnoitering, and regional planning. Next in rank to the *sthapati* was the *sūtragrāhin*, who had to be an expert draftsman and surveyor; and among the subordinates of the latter was the *vardhaki*, whose required specialties were draftsmanship and perspective drawing.[120]

Through such officials, Indo-Aryan town planning was said to be able to fix "beyond controversy the shape, area, method of planning, and distribution of various buildings . . . according to [one's] caste, rank in society, position in the body-politic, and profession."[121] In this role, the authority of the master builder was all embracing and frequently exercised. Before a city could be laid out, reconstructed, or enlarged, the master builder was to conduct surveys that "consisted in preparing maps to indicate such matters as the degree of density of population in the different parts of the town, allocation of sites for different castes and professions, . . . distribution of parks, public and other open spaces and the extent of each." Where reconstruction was contemplated, he had "to take a historical survey of the shrines, buildings, or reservoirs

in Bhojpur," *India Magazine* 6 (1986): 28–35, and Gole, *Indian Maps and Plans*, 21–22 (note 2). Gole also notes additional ground plans that appear on the walls of the great Sun Temple at Konarak in Orissa, built in the thirteenth century.

119. See, for example, Begde, *Ancient and Mediaeval Town-Planning* (note 114); Bechan Dube, *Geographical Concepts in Ancient India* (Varanasi: National Geographical Society of India, Banaras Hindu University, 1967); Binode Behari Dutt, *Town Planning in Ancient India* (Delhi: New Asian Publishers, 1977); and Andreas Volwahsen, *Living Architecture: Indian* (London: Macdonald, 1969). The most important, perhaps, of the original texts is the *Mānasāra*; see *Architecture of Manasara*, translated from the Sanskrit by Prasanna Kumar Acharya, 2d ed., 2 vols., Manasara Series, vols. 4 and 5 (New Delhi: Oriental Books Reprint Corporation, 1980).

120. Begde, *Ancient and Mediaeval Town-Planning*, 117–18 (note 114).

121. Dutt, *Town Planning in Ancient India*, 66–67 (note 119).

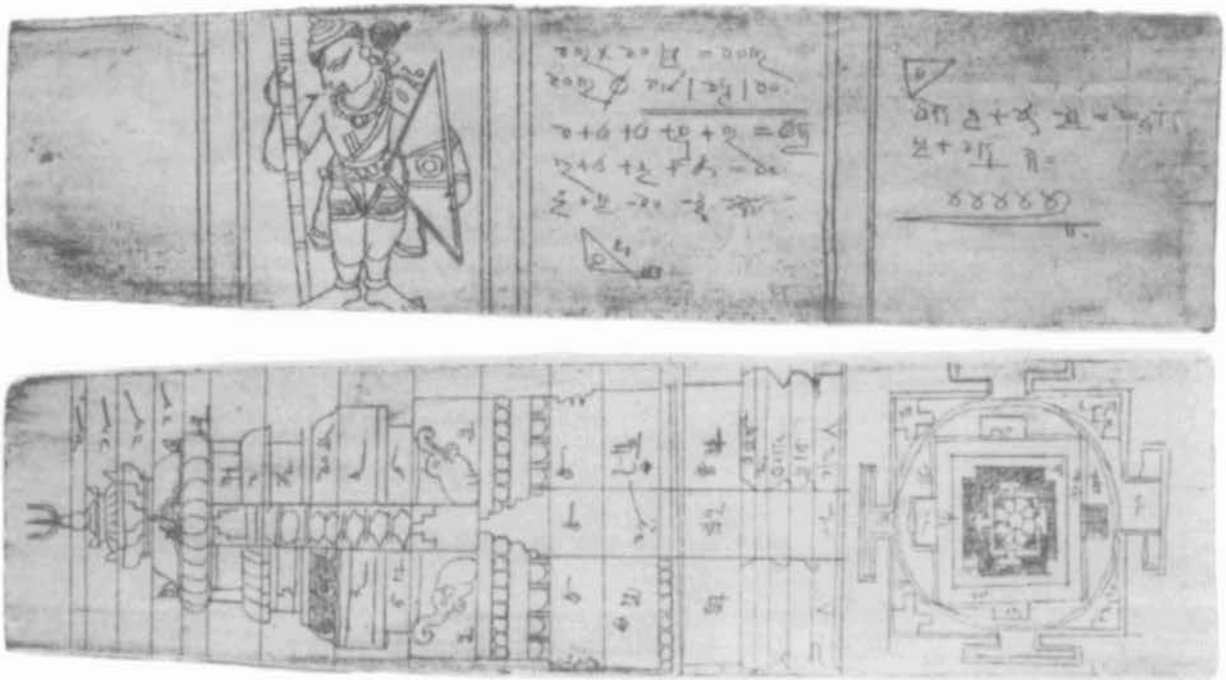

FIG. 15.12. LEAF FROM A PALM-LEAF MANUSCRIPT ON ARCHITECTURE. This excerpt from a seventeenth-century manuscript is from the Indian state of Orissa. The upper illustration depicts a surveyor with his rod and another surveying tool, along with calculations related to the construction of a temple. The bottom illustration, the reverse of the leaf shown above, indicates the ground plan of the main *śikhāra* (tower) of the temple (*right*) and the elevation of the tower (*left*).
Size of the original: not known. From Andreas Volwahsen, *Living Architecture: Indian* (London: Macdonald, 1969), 54.

of historical importance and traditional sanctity"[122] so as to do least violence to the existing order. It was as a result of this process that "maps showing the boundaries of different possessions and habitations had to be prepared. Local requirements, traditional prejudices or rules affecting the desirable size or shape of building plots for various purposes and thus influencing the distribution of the streets had to be noted on the chart."[123]

The *śilpaśāstra*s required that *pāda*s (quadrangular plots, either squares or rectangles) be laid out for each village or city "by drawing [on the ground] two to thirty-three rectilinear parallel lines and as many transverse parallel lines."[124] The number to be drawn depended not only on the purpose of the settlement but also on certain astrological considerations. From the grid thus created, "mystic diagrams" (yantras) were devised, and from these in turn was derived the layout of the streets, as shown in figure 15.13.[125]

How frequently these normative injunctions were followed in practice is a matter for speculation. Indian writers have often assumed they were regularly observed, but the art historian Amita Ray concludes, after reviewing the archaeological remains of a substantial number of ancient settlements, that the descriptions of the various *śilpaśāstra* texts "reveal most clearly that they represent not what actual city-planning as a socio-economic phenomenon was like . . . , but more a kind of abstraction following the mechanical set up of different occupational groups, castes and classes in the city with gods, kings and priests, as the centre of the whole scheme."[126] Nevertheless, there almost certainly were some planned cities that took into account the ancient architectural canons. Among these, the most notable was the Rajput city of Jaipur (figs. 15.14, 15.15, and 15.16), founded as recently as 1728.

122. Dutt, *Town Planning in Ancient India*, 67 (note 119).

123. Dutt, *Town Planning in Ancient India*, 68–69 (note 119). Without being able to read the relevant primary sources, it is difficult to decide how much of the quoted passages is based on inference and how much on firm textual grounds. Dutt's exposition seems to depend largely on the account (cf. Dutt, 178–79) of the reconstruction of the major south Indian temple city of Madurai after a great flood as described by C. P. Venkatarama Ayyar in *Town Planning in Ancient Dekkan* (Madras: Law Printing House, [1916]), 31–59, esp. 31–34. The date of this event is lost to history, but the detailed description of the reconstruction conveys a sense of verisimilitude and is buttressed by abundant citations from several ancient Tamil texts. One should, however, be cautious in making pan-Indian generalizations from data drawn from Dravidian sources.

124. Dutt, *Town Planning in Ancient India*, 142–43 (note 119).

125. Dutt, *Town Planning in Ancient India*, 142–43 (note 119), and Volwahsen, *Living Architecture: Indian*, 43–50 (note 119).

126. Amita Ray, *Villages, Towns and Secular Buildings in Ancient India, c. 150 B.C.–c. 350 A.D.* (Calcutta: Firma K. L. Mukhopadhyay, 1964), 52.

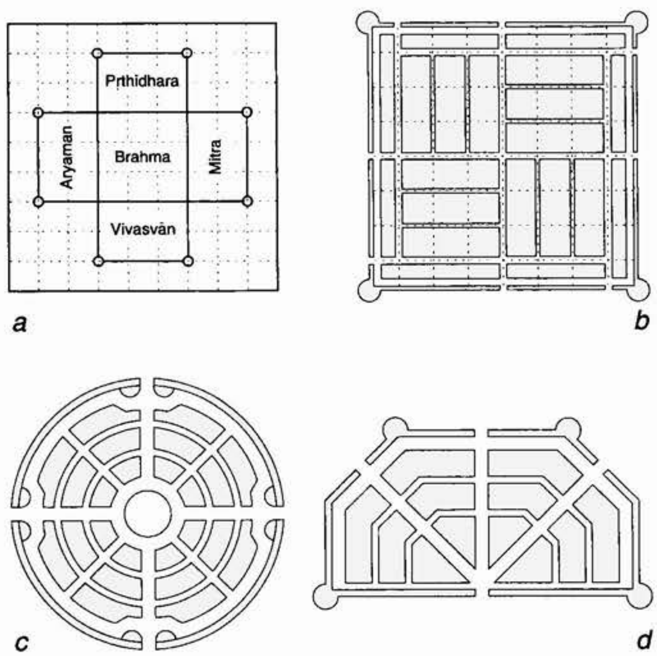

FIG. 15.13. EXAMPLES OF ANCIENT ARCHITECTURAL MANDALAS AND DERIVATIVE PLANS. Ancient canonical texts, known as *śilpaśāstras* (laws of architecture), specified a diversity of basic plans for laying out new cities, often with specifications as to the quarters to be assigned to castes and other socioeconomic groups. Four such plans are shown here. There is very little evidence in the contemporary urban landscape of widespread adherence to these models, which were described rather than drawn in the early texts. The layout of Jaipur, however (figs. 15.14 and 15.15 below), is an obvious exception. (*a*) *Paramaśāyikamaṇḍala*, containing nine by nine *pādas* (quadrangular plots). (*b*) Swastika plan for a city based on square *maṇḍūkamaṇḍala*, containing eight by eight *pādas*. (*c*) Sketch for a circular city based on the *maṇḍūkamaṇḍala* (after the *Mānasāra*). (*d*) Kheta city for Shūdras (group of serving castes).
After Andreas Volwahsen, *Living Architecture: Indian* (London: Macdonald, 1969), 45 and 49.

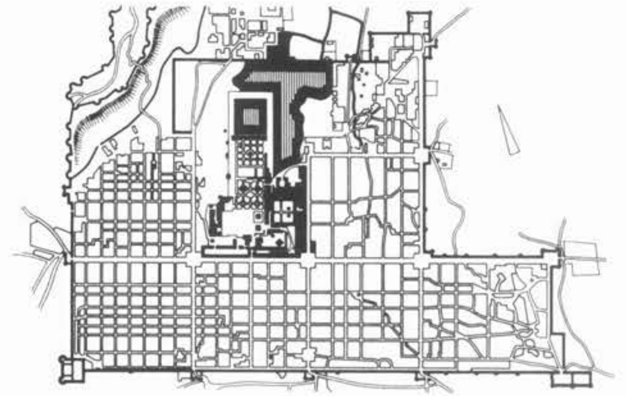

FIG. 15.14. PLAN OF THE EIGHTEENTH-CENTURY CITY OF JAIPUR. This plan shows the general division of Jaipur into nine parts. The departure from plan in the northwest was necessitated by hilly topography, while the southeastern extension represents a later addition to the city.
From Andreas Volwahsen, *Living Architecture: Indian* (London: Macdonald, 1969), 48.

MAPS NOTED IN SECULAR TEXTS

Secular literature also provides a few references to maps in ancient and early medieval India. A fifth-century Sanskrit epic, the *Bṛhatkathāślokasaṁgraha*, by the poet Budhasvāmin, appears to describe some sort of navigation chart. This work, brought to light by V. S. Agrawala, is especially rich in geographic referents from many parts of India and from Southeast Asia (Suvarṇabhūmi) as well. Several portions of the poem relate to sea voyages, and in one a treasure-bearing ship is blown off course in a hurricane and lands at a mountainous land, Śrīkuñja (in Indian mythology the home of demons called Yakṣās). The hero of the poem, a prince named Manohara, learning of this mishap,

> noted down on a wooden board, having a cover on it (*samputaka*), the details about the particular sea, direction and place.... With this information the prince ordered a boat manned by an experienced ... sailor and went out in the sea in search of that spot. ... Impelled by favourable wind.... [and] in accordance with the marks and signs as noted down on the board the prince identified the Śrīkuñja mountain and reached there.[127]

For a slightly later period, Sircar cites the *Xin Tang shu* (New history of the Tang, compiled 1032?–60), which gives an account of a campaign led by a Chinese general, aided by one thousand Tibetan soldiers and seven thousand Nepalese horsemen, who in A.D. 648 defeated Bhāskaravarman, king of Kia-mu-lu (Kāmarūpa in what is now Assam). As part of his tribute, the king "presented to the Chinese emperor some curious articles including 'a map of the country.' " What the map may have shown is not stated, but it "appears to have been prepared by the artists at king Bhāskaravarman's court."[128]

Sircar also cites an eighth-century Sanskrit drama by Bhavabhūti. In the first act an artist "painted along a walk ... the experiences ... of the Ikshvāku King Rāma of Ayodhyā in Daṇḍak-āraṇya, Kiṣkindhyā, Laṅkā and other places.... These paintings included some which are said to have depicted particular regions." Sircar con-

127. Vasudeva Sharana Agrawala, ed., *Bṛhatkathāślokasaṁgraha: A Study* (Varanasi: Prithivi Prakashan, 1974), 337–38. I am indebted to Susan Gole for steering me toward this work.

128. Sircar, *Geography of Ancient and Medieval India*, 326 (note 18).

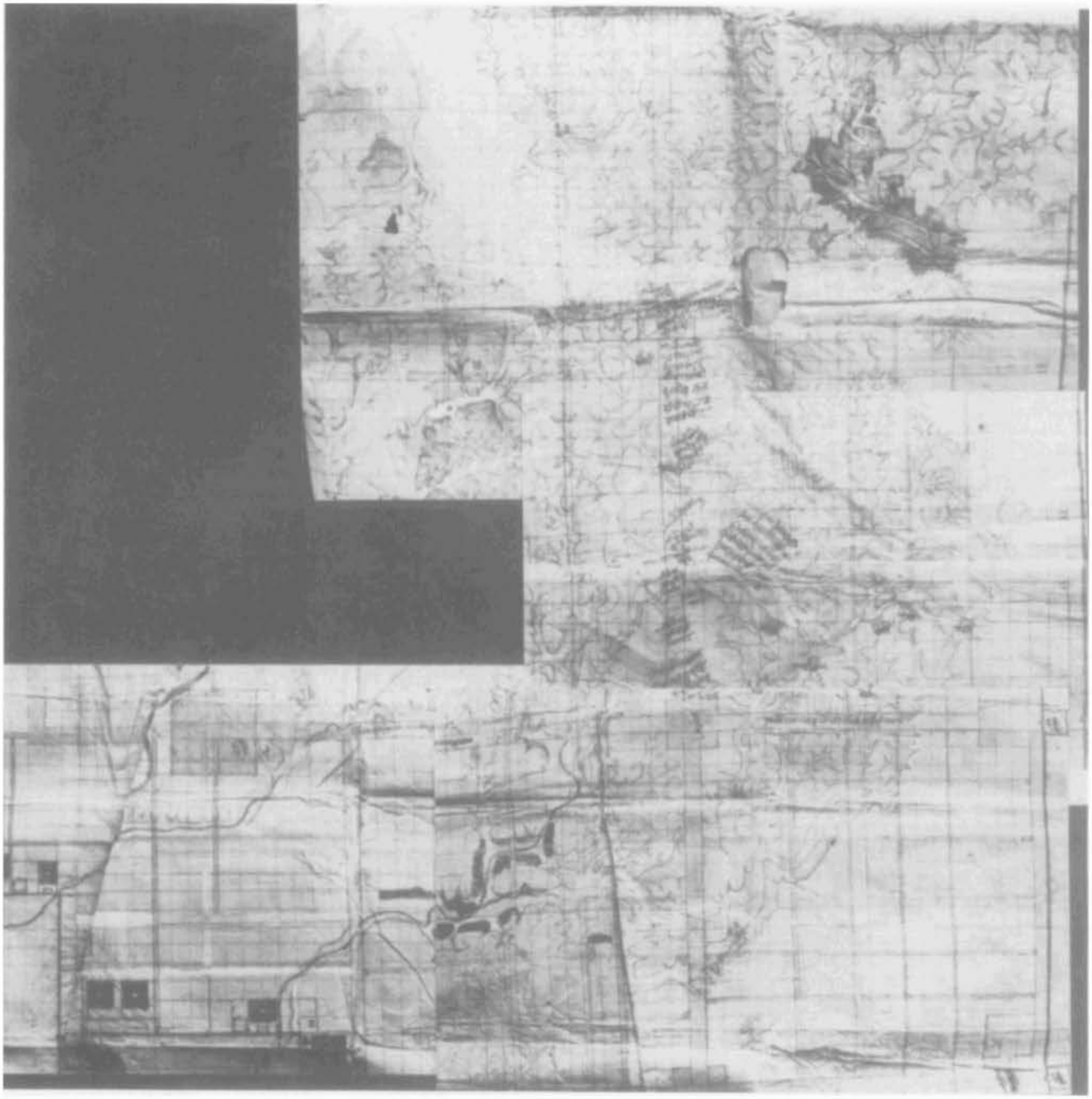

FIG. 15.15. ARCHITECTURAL PLAN, JAIPUR. A portion of the original architectural plan survives in four sheets and is kept at the Maharaja Sawai Man Singh II Museum, Jaipur.
Size of the original: not known. By permission of the Maharaja Sawai Man Singh II Museum Trust, Jaipur. Photograph by Raghubir Singh and Kanwarjit Singh Kang, courtesy of *Mārg* Publications, Bombay.

cludes that they may be regarded as maps.[129] Though partially mythic, the places shown are all well known from the *Rāmāyaṇa* epic. Sircar introduces the depiction by calling attention to these lines: " 'Here [states Lakṣamaṇa, a character in the play] is the tract . . . of the Daṇḍaka forest, known as Citrakuñjavat, to the west of Janasathāna . . . ; this is the site . . . of the hermitage of Mataṅga on the Ṛṣyamūka hill; . . . this is the celebrated lake called Pampā.' "[130]

A longer and more vivid passage from a much later

129. Sircar, *Geography of Ancient and Medieval India*, 327 (note 18).

130. Sircar, *Geography of Ancient and Medieval India*, 327 (note 18).

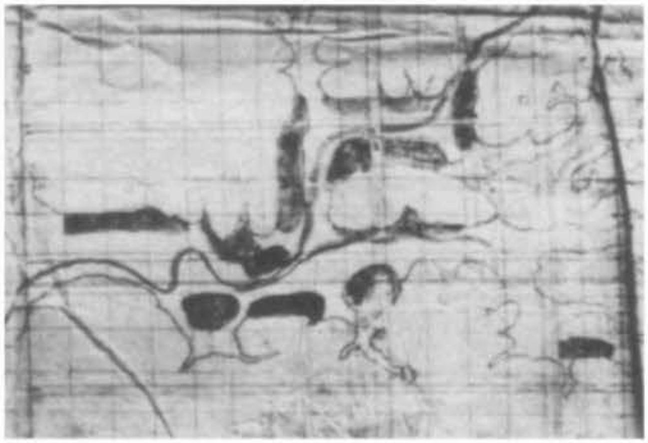

FIG. 15.16. DETAIL FROM ARCHITECTURAL PLAN, JAIPUR. This detail is taken from figure 15.15.
Size of the original: not known. By permission of the Maharaja Sawai Man Singh II Museum Trust, Jaipur. Photograph by Raghubir Singh and Kanwarjit Singh Kang, courtesy of *Mārg* Publications, Bombay.

Sanskrit drama may also relate to a map. It appears in an unpublished play by Gaṅgādhara dating from the mid-fifteenth century. Act 7 of this play relates to the Islamic siege of the fort of Champāner, in what is now Gujarat, during which Sultan Muhammad II asks one of his Hindu vassals about the topography of the fort and important places within it. The vassal, who has not personally seen the fort, consults a priest who has visited it and asks for a description, which the priest then paints for him on cloth. With map in hand, the vassal then describes the fort to the sultan in thirty verses, whose full Sanskrit text and translation are provided by B. J. Sandesara. Its scope is conveyed by the following lines, constituting about a third of the total:

> The highest building in the fort, white-washed and having a golden pitcher on its top, is the palace of Gaṅgadāsa. On the north-east of the same is the lake Rāmagaṅgā built by Rāma, and there is also a temple of Mahādeva built by him. The lake on its south is built by Sītā. On the western side is a lake called Bhīmagayā with the *Bhīmaprāsāda* ('palace of Bhīma'); it was built by Bhīma. On the far western side of the same is a lake full of water white like lime; it was built by king Gaṅgadāsa. Roundabout this lake there are numerous temples. . . . You can see, yonder, the city of Campakapura (Chāmpāner) full of beautiful houses, like the city of Indra.[131]

PAṬA-CHITRAS

In addition to the painted cosmographies noted above, cloth paintings (*paṭa-chitras*) rich in real-world topographical detail, for contemplation in both temples and private homes, became increasingly common in India. Some surviving examples go back to the fourteenth century. Most of these paintings are not maps, but the distinction between picture and map is difficult to make. Many such paintings combine relatively small areas portraying topographic detail with larger areas devoted entirely to other features, such as pictures of saints, deities, or abstract designs. One type, known as *vijñaptipatras*, were long cloth scrolls, sometimes comprising invitations to Jain pontiffs to visit particular places, with the nature of the route given along with accompanying text. Other *paṭa-chitras* were narratives arranged in a series of registers, telling a story more or less in "strip cartoon" style. Though paintings of this type were created in many parts of India, they are particularly associated with the Jain religious community and are most abundant in Rajasthan and Gujarat.[132]

FRUITS OF HINDU-MUSLIM INTERACTION

From the eleventh century onward, especially after the Ghaznavid occupation of Punjab (ca. A.D. 1018), Indic and Islamic civilization came into increasing contact, and interchange of ideas between the two became inevitable. Among early Islamic scholars no one devoted more attention to learning Indian science, including cosmography and geography, than the celebrated polymath Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī (362/973–after 442/1050). It is recorded that he studied with Brahman pundits during a long sojourn in northwestern India. It is not known that al-Bīrūnī ever made a map of India to accompany his celebrated *Ta'rīkh al-Hind* (Description of India, 1032), but he certainly could have done so and would have given a better shape to the country than that shown on any European maps up to the mid-sixteenth century. In 1025, however, he completed his compilation of a text, *Kitāb taḥdīd nihāyāt al-amākin li-taṣḥīḥ masāfāt al-masākin*, that dealt with the preparation of a world map, and like many other Muslim geographers he compiled lists of the latitudes and longitudes of numer-

131. B. J. Sandesara, "Detailed Description of the Fort of Chāmpāner in the Gaṅgadāsapratāpavilāsa, an Unpublished Sanskrit Play by Gaṅgādhara," *Journal of the Oriental Institute* (Baroda) 18 (1968–69): 45–50, esp. 46. This article was transmitted to me by Susan Gole, who in turn received it from R. N. Mehta. In his letter to Gole, Dr. Mehta stated that he had verified the description in the field and found it not only accurate but also useful in identifying many monuments and sites noted in the drama.

132. Relevant publications include Shridhar Andhare, "Painted Banners on Cloth: Vividha-tirtha-pata of Ahmedabad," *Mārg* 31, no. 4 (1978), *Homage to Kalamkari*, pp. 40–44; Moti Chandra, *Jain Miniature Paintings from Western India* (Ahmadabad: Sarabhai Manilal Nawab, 1949), esp. pt. 1, chap. 4, "Miniatures in the Paper Period (circa 1400–1600 A.D.)," 37–45, and pt. 1, chap. 5, "Painting on Cloth," 46–56; and Kay Talwar and Kalyan Krishna, *Indian Pigment Paintings on Cloth*, Historic Textiles of India at the Calico Museum, vol. 3 (Ahmadabad: B. U. Balsari on behalf of the Calico Museum of Textiles, 1979).

ous places.[133] His lists for cities in India, as well as throughout the Islamic world, appear in his magisterial work on astronomy, the *Kitāb al-qānūn al-Masʿūdī fī al-hayʾah na al-nujūm* (The Masʿūdic canon). Additionally, he prepared lists of places along a number of travel itineraries with distances between points specified either in travel time (e.g., "three to four days' march") or in linear measure. These itineraries were very likely the protosources of a number of Mughal strip maps of travel routes, of which several examples still survive (these will be discussed below).

We have no clear evidence of Hindus' copying Islamic styles of small-scale geographical cartography, but their observations of both the heavens and the sea were certainly altered by interaction with the Islamic world. Muslims produced astrolabes within India, and that instrument was adopted by Hindu science from such prototypes. Similarly, Indian marine charts may have been influenced by Muslim practice. The indirect evidence provided by Vasco da Gama's first voyage to India in 1498 in particular, though this is contested, suggests that Indian navigators not only utilized Muslim-style charts but also adopted many of the Muslims' techniques of navigation.[134]

EUROPEAN ACCOUNTS OF INDIAN MAPPING

After the coming of the Portuguese and later European powers to India, the number of notices of indigenous mapping increases. It seems likely, though most of these maps no longer survive, that enhanced attention to the history of Indian cartography will result in the discovery of additional literary references that point to Indian maps. The following brief and tantalizing notices indicate what might have existed in addition to the known corpus.[135]

The Jesuit Father Monserrate, who spent much time at the court of the great Mughal emperor Akbar (d. 1605), is one of many observers who recorded the care with which the Mughals measured their main roads. Of Akbar's march to Kabul in 1581, Monserrate wrote:

> Furthermore, he [Akbar] orders the road to be measured, to find the distance marched each day. The measurers, using ten-foot rods, follow the king, measuring from the palace. By this one operation he learns both the extent of his dominions, and the distances from place to place, in case he has to send embassies or orders, or meet some emergency. A distance of 200 times the ten-foot rod, called a *coroo* in Persian, or *cos* in the Indian language, equal to two [British] miles, is the measure for calculating distances.[136]

Rennell, too, on more than one occasion, referred to similar measurements and acknowledges the receipt of

> the registers of the actual measured distances, as taken by the orders of the Emperors Acbar, Shah Jehan, and others, on the great roads from the city of Lahore, Cabul, Ghizni, Candahar, and Moultan; and back to Lahore again: as well as those between Cashmere and the cities of Lahore and Attock, respectively; and between Cabul, Balk, and Bamiam: besides many other portions of different roads.[137]

These measurements, Rennell states, were "set forth without any intimation concerning their direction, as it respects the points of the compass," and "latitudes are seldom given."[138] He does not indicate that the compilation of registers resulted in maps, but the task of making, at a minimum, route-by-route strip maps from such registers would have been simple; and we know that such strip maps existed for periods both earlier and later than the time Rennell wrote about.[139] This does not mean, of course, that they were common.

European testimony in regard to seventeenth-century Indian maps was not confined to the Mughals. Of the great Maratha military leader Shivājī, his contemporary Barthélemy Carré, the director general of the French East India Company from 1668 to 1673, wrote that he had mastered geography "to such an extent as to know not merely all the towns including the smallest villages of the country, but even the land and the bushes of which he had prepared very exact charts."[140] It is therefore hardly surprising that a substantial portion of the surviving corpus of Indian maps is of Maharashtrian provenance and that many of those maps were drawn for military purposes.

Another French observer, who not only saw but used a number of Indian maps, was A. H. Anquetil-Duperron.

133. I prepared a map based on al-Bīrūnī's lists of latitudes and longitudes of places in and near India, which appears in Schwartzberg, *Historical Atlas*, pl. IV.3, map e, with relevant text on p. 191 (note 50). For an English translation of the *Taḥdīd*, see *The Determination of the Coordinates of Positions for the Correction of Distances between Cities*, trans. Jamil Ali (Beirut: American University of Beirut, 1967).

134. Arunachalam, "Haven-Finding Art" (note 34). See also the discussion above on pp. 256–57 and below, pp. 394–95.

135. For most of the notices provided, I am indebted to Susan Gole (various communications).

136. Father Antonio Monserrate, "Mongolicae Legationis Commentarius; or, The First Jesuit Mission to Akbar," *Memoirs of the Asiatic Society of Bengal*, 3 (1914): 513–704, esp. 580. Quoted in Phillimore, *Historical Records*, 10 (note 32).

137. James Rennell, *Memoir of a Map of Hindoostan or the Mogul Empire*, 3d ed. (London, 1793; reprinted Calcutta: Editions Indian, 1976), 170. (Note: the pagination and text vary among the several editions of Rennell's *Memoir*.)

138. Rennell, *Memoir of a Map*, 171 (note 137).

139. See, for example, the discussion of Mughal route maps below, pp. 435–42.

140. Quoted in Ramesh Desai, *Shivaji: The Last Great Fort Architect* (New Delhi: Maharashtra Information Centre, 1987), 92. Desai does not cite the source of this quotation.

Writing of his sojourn in Bombay in 1761, he states: "M. Spencer avoit bien voulu me communiquer une grande Carte de l'intérieur & des côtes du Sud de la Presqu'Isle, faite par des Brahmes; je venois d'en achever la copie." Additionally he refers to "des Cartes Géographiques faites par les Naturels du Pays," which he was unable to obtain.[141] The former map was subsequently published, as copied, by Jean Bernoulli.[142]

Rennell too repeatedly made use of Indian maps, as evidenced by the following quotations from his *Memoir of a Map of Hindoostan*:

> The position of this place [Attock], geographically, can only be regulated by the apparent bearings from Lahore and Moultan, in a Persian map of the Panjab, together with the distances collected from the different accounts in the same map; in itineraries; and in the Ayin Acbaree. . . .[143] [Persian was the most widely used lingua franca in India from the sixteenth to the early nineteenth century and the language in which official Mughal records were written.]
>
> . . . having before me, a map of this country drawn by a native, and preserved in the archives of government in Hindoostan. The names were obligingly translated from the Persian, by the late Major Davy, at the request of Sir Robert Barker. The tract, of which this map serves as a ground work, is a square of about 250 B. [British] miles; and includes the whole soubah [Mughal province] of Lahore, and a great part of Moultan proper. The points of Lahore, Attock, and Sirhind . . . determine the scale of the map; the intermediate distances from place to place in it, being given in writing, and not by a scale.
>
> I consider this MS. as a valuable acquisition; for it not only conveys a distinct idea of the courses and names of the five rivers, which we never had before: but, with the aid of the Ayin Acbaree, sets us right as to the identity of the rivers crossed by Alexander. . . .[144]
>
> . . . The Persian map [above] fills up the space pretty amply, between the Lahore road and the mountains from whence we suppose the Panjab rivers to spring. . . .[145]
>
> Many other positions are pointed out, or illustrated, by this map; which, I am informed, is the production of a native of Guzerat [Gujarat] . . . but it is remarkable, that it gives the form of Guzerat with more accuracy, than most of the European maps can boast. . . .[146]
>
> A Hindoo map of *Bundela* or Bundelcund, including generally the tract between the Betwah and Soane rivers, and from the Ganges to the Nerbudda, was obligingly communicated by Mr. Boughton Rouse, who also translated the names in it, from the Persian. This map points out several places that I had not heard of before, and assists in fixing many others of which I had been partially informed. . . .[147]
>
> Cuddapah is determined by the [European] map of the Pennar river: and the construction agrees with its reputed distance from Arcot in a *Malabar* map; or rather a map drawn by a native of the Carnatic. . . .[148]
>
> . . . The [Malabar] map alluded to, is not constructed by a scale, but rudely sketched out without much proportion being observed either in the bearings, or distances of places, from each other: and the names, and the distances between the stages, are written in the Malabar language.[149]

Phillimore also notes that other British "political officers were often able also to obtain native maps and surveys."[150] For example, Rennell cites a certain James N. Rind, an assistant to the resident at Delhi, who "was able

141. Abraham Hyacinthe Anquetil-Duperron, *Zend-Avesta*, 3 vols. (Paris: N. M. Tilliard, 1771; reprinted New York: Garland, 1984), 1:ccccxxxviij and 1:dxlj. For other relevant passages referring to maps seen by Anquetil-Duperron in Goa and in Cochin, see pp. ccxiv and clxxxvj. I thank Susan Gole for these references.

142. Jean Bernoulli, ed., *Des Pater Joseph Tieffenthaler's . . . Historisch-geographische Beschreibung von Hindustan*, 3 vols. (Berlin, 1785–88). A copy of Bernoulli's map appears in Gole's *India within the Ganges*, 22 (note 22). It bears the note, "Portion d'une Carte du Sud de la Presqu'île de l'Inde Faite par des Brahmes; qui comprend le Tanjaour, le Marava, et une partie considérable du Madurei: de la grandeur à peu près de l'Original / Zend-Avesta T.I.1.e Part. p. CCCXXXVIII . . . 1785." In that this map is but a "portion" of the original, one wonders about the territorial extent of that initial work.

143. James Rennell, *Memoir of a Map of Hindoostan; or, The Mogul Empire* (London, 1788), 76–77. The *Āʾīn-i Akbarī* (Institutions of Akbar) was the most famous of the numerous gazetteers and manuals used within the Mughal Empire and by other contemporaneous Indian states in administration and revenue collection. These provided systematic descriptions, usually in tabular form, of provinces and lower-order administrative subdivisions, noting, inter alia, their general location and their territorial extent. Although such works largely obviated the need for maps, they also provided any would-be cartographer with a clear basis for compiling remarkably detailed maps. This is evident from the atlas prepared in 1770 by the French colonel Jean Baptiste Joseph Gentil, adviser to the nawab of Oudh (discussed in chapter 17), and by the modern scholar Irfan Habib in creating *An Atlas of the Mughal Empire: Political and Economic Maps with Detailed Notes, Bibliography and Index* (Delhi: Oxford University Press, 1982). The rarity of surviving Mughal maps is underscored in that among the plethora of primary sources Habib used there is not a single map. On the other hand, it is reported that during the daily *darbārs* (audiences) held by Akbar's grandson, Shāh Jahān (r. 1627–58), "nobles and princes exhibited their plans for buildings and gardens and often in the evenings he [Shāh Jahān] would look at maps of the provinces and the designs of buildings under construction." Stephen P. Blake, *Shahjahanabad: The Sovereign City in Mughal India, 1639–1739* (Cambridge: Cambridge University Press, forthcoming), 26–27. Blake cites as his authority Muḥammad Ṣāliḥ Kanbūh, *ʿAmal-i-Ṣāliḥ*, 3 vols., ed. G. Yazdani (Calcutta: Asiatic Society of Bengal, 1912–39), 1:248.

144. Rennell, *Memoir of a Map*, 81 (note 143).

145. Rennell, *Memoir of a Map*, 90 (note 143).

146. Rennell, *Memoir of a Map*, 150 (note 143).

147. Rennell, *Memoir of a Map*, 156 (note 143).

148. Rennell, *Memoir of a Map*, 202 (note 143).

149. Rennell, *Memoir of a Map*, 206 (note 143).

150. Phillimore, *Historical Records*, 42 (note 32).

to get material for a *Map of the Country of the Seiks* [Sikhs], . . . and a *Plan of Scindia's Country* [now in Madhya Pradesh]."[151] Rind's map, said Phillimore, gives a crude but correct and recognizable representation of the five rivers of the Punjab.[152]

Wilford, the first serious British student of Indian systems of geography and cosmography, wrote in 1805 as follows:

> Besides geographical tracts, the *Hindus* have also maps of the world, both according to the system of the *Paurán'ics*, and of the astronomers: the latter are very common. They have also maps of *India*, and of particular districts, in which latitudes and longitudes are entirely out of question, and they never make use of a scale of equal parts. The sea shores, rivers, and ranges of mountains, are represented in general by straight lines. The best map of this sort I ever saw, was one of the kingdom of *Napál*, presented to Mr. HASTINGS. It was about four feet long, and two and a half broad, of paste board, and the mountains raised about an inch above the surface, with trees painted all round. The roads were represented by a red line, and the rivers with a blue one. The various ranges were very distinct, with the narrow passes through them: in short, it wanted but *a scale*. The valley of *Napál* was accurately delineated: but toward the borders of the map, every thing was crowed [*sic*], and in confusion.
>
> These works, whether historical or geographical, are most extravagant compositions, in which little regard indeed is paid to truth. . . . Geographical truth is sacrificed to a symmetrical arrangement of countries, mountains, lakes, and rivers, with which they are highly delighted.[153]

Another "old Hindu map of this type" was allegedly picked up by Reuben Burrow when he was traveling through Rohilkhand, an area bordering on Nepal, in 1789.[154]

Most indigenous maps presumably served either religious purposes or the needs of the state, but some may have been drafted with other ends in view. We cannot state with certainty that any maps were drawn explicitly for sale, but there is evidence that some maps did find their way into native markets. In the journal of Thomas Twining, a servant of the East India Company, an entry relating to a day of shopping in the bazaars of Delhi in 1794 reads: "I purchased also an accurate map of Dehli, neatly delineated with red and black lines on fine paper of a yellow hue. I already possessed a similar one of Agra, and another of the Taje [the Taj Mahal]."[155]

Legend notes to British and other European maps of the eighteenth and early nineteenth centuries sometimes acknowledge native sources for the information portrayed, albeit so obliquely that the nature of the sources and the degree of dependence is unclear. From the foregoing it is probable that indigenous maps or sketch maps made by Indians at the specific behest of Europeans were among those sources. Occasionally the legend is more explicit, as on an 1831 map entitled "A sketch of Cachar [in Assam], compiled from a Native Map."[156]

That there were in India numerous individuals who could have provided detailed mappable information, even for very large areas, cannot be doubted. The point may be illustrated by reference to a document, probably dating from the late eighteenth century, in the manuscript collection of the historian Robert Orme, titled "The Names of the Principal Rivers from the River Gangoe [Ganga] to the Cape Comareen [Kanniyakumari/Cape Comorin]." This document, stated Orme, gives river

151. Cited in Phillimore, *Historical Records*, 42 (note 32).

152. Phillimore, *Historical Records*, 233 (note 32).

153. Wilford, "Sacred Isles," 271–72 (note 7).

154. Reginald Henry Phillimore, "Early East Indian Maps," *Imago Mundi* 7 (1950): 73–74, esp. 74.

155. Thomas Twining, *Travels in India a Hundred Years Ago with a Visit to the United States: Being Notes and Reminiscences by Thomas Twining, a Civil Servant of the Honourable East India Company Preserved by His Son, Thomas Twining of Twickenham*, ed. William H. G. Twining (London: James R. Osgood, McIlvaine, 1893), 256. The casual tone of Twining's account suggests that the acquisition of indigenous maps was not regarded as a matter of great moment. That architectural plans were used in India well before Twining's day is evident from various references to the period of Shāh Jahān (one is cited in note 143). The biography of the imperial architect Mukramat Khān notes that "one day Shāh Jahān stated after looking at maps of Bag̲hdād and Iṣfahān where the *bāzārs* were octagonal and covered, and which had appealed to his fancy, that those in the new city had not been . . . finished as he would have liked." Shāhnavāz Khān Awrangābādī, *The Maāt̲hir-ul-Umarā: Being Biographies of the Muḥammadan and Hindu Officers of the Timurid Sovereigns of India from 1500 to about 1780 A.D.*, reprint ed., 2 vols. (Patna: Janaki Prakashan, 1979), vol. 2, pt. 1, 270–71. Additionally, in an inventory of the booty carried away by Nādir Shāh of Persia after his sack of Delhi in 1739, there is listed a "Draught of the Castle and City of *Shahjehanabad*"; James Fraser, *The History of Nadir Shah, Formerly Called Thamas Kuli Khan, the Present Emperor of Persia* (Delhi: Mohan Publications, 1973; reprint of 2d ed., London 1742), 221. This plan, according to Blake, so impressed Nādir Shāh that he used it as a model for a much smaller city that he had built in the Persian province of Khurāsān in 1741; *Shahjahanabad*, 71–72 (note 143). Blake's source is Khwaja Abdal-Karim, "Bayan-i Waqa'i," Persian Manuscript Collection, British Museum, fols. 43a–b. I am indebted to Professor Blake for all the sources cited in this note (various personal communications).

156. London, India Office Library and Records, Map Catalog, A.C. 114. Over the centuries, the Assamese appear to have displayed a greater propensity for keeping accurate state chronicles than did most other peoples of India. These chronicles, known as *buranji*s, date back as far as A.D. 568, and the record, in either the Ahom language or Assamese or both, is relatively complete and credible from A.D. 1228 until A.D. 1810. Particularly noteworthy is "an account of the political geography of Assam in the seventeenth century," though we have no evidence of its having been accompanied by a map. These *buranji*s were collected by Sir Edward Albert Gait when he was on government service in Assam and formed the basis for his book *A History of Assam*, 3d rev. ed. (Calcutta: Thacker Spink, 1963).

"names, sources, course, mouths. I believe by a black fellow." A sample entry reads as follows: "Tungabadrah [Tungabhadra] springs from the above mountains [Sahyadri/Western Ghats] and country [Satara, Moratta (Maratha) country] and runs from Badamore [Bednur (= Nagar)], Cammara [Kanara] Country and from Thence to Vizianagarapatnam [Vijayanagar] Country where the Tintoo [presumably a mistranscription of Gentoo (= Hindu)] king Resides and from thence to Cundanoor [presumably Kurnool] Country and Joines Kistnah [Krishna]."[157] The detail indicates an uncommonly good mental map.

Finally, despite its late date, let me call attention to a "map held by the Survey of India . . . prepared for the Amir [of Afghanistan] during the war of 1879–82, showing the north frontiers of Kabul territory, with the Hindu Kush, Turkistan, and the Oxus River, all in bold coloured lines and Persian lettering, somewhat in schoolboy style, but showing the most valuable information as regards positions of towns and villages and place-names."[158] In Phillimore's view this map—whose present location is not known—"shows no evidence of European influence"; but he does not rule out its having been drawn by a British-trained native.[159]

The preceding paragraphs, for all their lacunae, make several important points clear. Indigenous maps were obtained by the British and other Europeans from all parts of South Asia: from Nepal in the north to Malabar in the south, from Assam in the northeast to Afghanistan in the northwest, and from many localities in between. The languages these maps were made in included not only Persian—which, as the official language of the Mughal Empire, was most common—but also Sanskrit (for Puranic world maps) and various regional vernaculars (Marathi, Malayalam, etc.). The authors were largely, but by no means exclusively, Brahmans and were generally anonymous. The areas of coverage ranged from individual forts or towns to tracts extending over hundreds of thousands of square miles. The quality and content of the maps must have varied substantially. None, however, had a scale. The direction of map orientation is not noted in the descriptions.

Whatever the British may have thought about Indian maps when first encountering them, their opinions became generally disparaging as their own maps improved in accuracy. Phillimore's surmise that many Indian maps may "have been deliberately destroyed as valueless, or as having exhausted their value, for geographical purposes" is almost certainly true.[160]

REASONS FOR THE RELATIVE PAUCITY OF SOUTH ASIAN MAPS

Although the foregoing account makes it clear that the number and variety of premodern South Asian maps was substantial, and certainly far greater than conventional wisdom would lead one to believe, I am not suggesting that maps played a role in traditional India comparable to their importance in Europe at corresponding periods, or that they were comparably abundant. Nevertheless, the surviving corpus fails to reflect what once presumably existed. Various reasons may be adduced for the relative paucity of South Asian maps. Perhaps the principal factors accounting for the dearth of premodern South Asian maps are environmental. In the hot, humid monsoon environment that characterizes the greatest part of the region, paper, cloth, palm leaf, and other organic materials on which records might be kept are likely to rot and crumble in only a few decades, if not years, unless pains are taken to preserve them. Even with special care, preservation cannot long be guaranteed; what dampness and mildew fail to destroy may fall victim to white ants and other vermin. More durable materials, such as metal and stone, are also, though in lesser degree, subject to the ravages of time. Many, possibly most, of the traditional Indian maps that I have personally inspected are in various stages of decay. While we cannot attest to specific maps that the elements are known to have completely destroyed, the lack of any extant copy of works once known to have existed suggests an environmental cause for their disappearance.

The fate of noncartographic manuscripts is instructive. Most of the many millions that have survived are written on paper, which was first introduced into India by the Muslims. The oldest of these go back at least to the twelfth century.[161] Before the advent of paper, most manuscripts were set down on less durable palm leaves and strips of bark. Because of their cheapness and abundance, the writers and copiers of religious texts, including cosmographies, continued to use those materials extensively well into the nineteenth century. Not counting inscriptions, only a few manuscripts from India proper date as far back as the eleventh and twelfth centuries, whereas others of Indian provenance found in the cooler and drier climates of Nepal, Xinjiang, and Japan are con-

157. Orme manuscripts in London, India Office Library and Records, vol. 65, item 12.

158. Phillimore, "Early East Indian Maps," 73 (note 154).

159. Phillimore, "Early East Indian Maps," 73 (note 154).

160. Phillimore, "Early East Indian Maps," 74 (note 154); see also Markham, "Lost Geographical Documents" (note 47).

161. In Winternitz, *Indian Literature*, 34 (note 62), it is stated that the oldest Indian paper manuscripts date from 1223–24, but it seems likely that this observation is carried over, without correction, from the original 1908 edition. David Pingree notes that numerous manuscripts were copied before that date and cites one from the year 1179–80 (personal communication, 21 December 1988). The S. R. C. [Sri Ram Charan] Museum of Indology in Jaipur claims (in a brochure dated 1986) to possess the oldest Indian manuscript on paper, dating from 1143; the validity of this claim has not been established, however.

siderably older.[162] The finds from Xinjiang include some five hundred small wooden tablets covered with writing, unearthed by Marc Aurel Stein in 1900, which date from at least the fourth century. Other ancient writing was on cotton, leather, stone, and various metals. Copper tablets were especially important and numerous, and writings on gold plate are also known. Among readable texts, the oldest that one can date are of Mauryan origin. These include the renowned edicts of the emperor Aśoka carved in metal and stone in the third century B.C. and at least one pre-Aśokan inscription.[163] These, however, are antedated by two millennia or more by the thousands of as-yet-undeciphered inscribed clay seals of the Indus civilization. How much—if any—information on the nature of early Indian maps is still locked in these seals or, for the period of recorded history, lost to the elements one can only surmise.[164]

Intentional destruction of maps or of relevant texts also appears to have been a factor contributing to their present scarcity. The iconoclasm of the early Muslim conquerors, especially in northern India, was not limited to the destruction of Hindu idols, but led also to the razing of innumerable temples, monasteries, and libraries. The destruction of the monastic Buddhist university at Nalanda, at which—if the Chinese traveler Xuan Zang (603–64) is to be believed—no fewer than ten thousand students were simultaneously trained, was an especially great loss.[165] Though temples, unlike monasteries, did not as a rule contain many books, they were almost ubiquitously painted. It is probable that cosmographic conceptions were among the religious ideas commonly portrayed on the walls, just as they are today on the walls of many Jain religious establishments and Buddhist monasteries in Tibet and adjoining regions of India and Nepal. Destruction of manuscripts through war need not, of course, have involved a clash of differing faiths. Most wars in India were fought between contending Hindu states, and struggles between rival Islamic sultanates were also common. But whatever their origins, wars, their attendant looting, and the unsettled nature of affairs in their aftermath must have exacted a toll on the corpus of literary and cartographic records. However, insofar as most manuscripts were privately owned and even now an estimated thirty million survive, one should not carry this argument too far.[166]

Breakdowns of central authority as a result of internal insurrection, external military pressure, and cessions of territory following military defeat must have provided frequent incentive and opportunity for landed interests to destroy or falsify records. These may have included cadastral maps, which might have either established the extent of fiscal indebtedness or weakened claims to proprietary rights in land. John Beames, writing in 1885 of his attempts to reconstruct the detailed political geography of the Mughal Empire in the reign of Akbar, not only complains of the inadequate maintenance of the tax records, but also states that "there has been . . . an effort to obliterate all traces of them." He further notes the "intentional falsification of the fiscal records by the later Muhammadan Subahdars [provincial governors]."[167] Such actions probably extended beyond the cases Beames has commented on.

Until recently, rates of literacy in India were remarkably low. Apart from the traditionally learned priestly castes of Brahmans, there were few social groups among whom learning was especially advanced.[168] Before Islamicization, in fact, higher learning was virtually a monopoly of the Brahmans, though even among that group literacy was far from universal. Thus the portion of the total population that might have been called on to prepare maps—at least maps deemed of consequence for other than narrow, short-term utilitarian purposes—was relatively small, and the total corpus of maps produced would have been commensurately limited. Further, Brahmans not only constituted the mass of the literati but occupied a relatively large proportion of state offices, both high and low, and tended also to monopolize the profession of teaching. As gurus (teachers), they were not merely respected but, in the Indian tradition, revered, and their authority was not lightly challenged.[169] Few would have insinuated themselves into a position in which the

162. Winternitz, *Indian Literature*, 33 (note 62).

163. Winternitz, *Indian Literature*, 24 (note 62), and personal communication from David Pingree (21 December 1988).

164. See the preceeding pages, esp. 321–23, for published references to maps in or noted by specific texts, the extant recensions of which are without maps, and to genres of map production of which no specific example has survived. Many additional examples, not necessarily trustworthy, are given in the several works by Tripathi cited in note 17.

165. Basham, *Wonder That Was India*, 166 (note 91); see also Xuan Zang, *Da Tang xi yu ji* (Records of the Western countries in the time of the Tang, 646) (Shanghai: Renming Chubanshe, 1977), 216–17.

166. David Pingree (personal communication, 21 December 1988) writes that almost all the surviving manuscripts were copied in the past three hundred years from even earlier manuscripts. It seems likely, then, that a very large fraction, if not an absolute majority, date from after the establishment in India of the Pax Britannica. How many manuscripts disappeared without any surviving copy is an open question.

167. John Beames, "On the Geography of India in the Reign of Akbar, Part II (with a Map), No. II, Subah Bihar," *Journal of the Asiatic Society of Bengal* 54, pt. 1 (1885): 162–82, esp. 162.

168. One group of particular note was the scribal caste of Kayasthas (Prabhu in the Deccan), many of whom worked in the fiscal and other administrative services of the Mughal Empire and other Muslim-ruled states in which Brahmans were generally more reluctant to serve. A large number of young men from this caste have found employment as cartographic draftsmen in modern India. On Kayastha mobility see David G. Mandelbaum, *Society in India*, 2 vols. (Berkeley and Los Angeles: University of California Press, 1970), 2:433.

169. "A Brahman was a god on earth," states Daniel Ingalls in "The Brahman Tradition," *Journal of American Folklore* 71 (1958): 209–15, esp. 212.

wisdom of a Brahman was required.[170] Hence, if a map prepared by a Brahman official or savant did not square well with reality, it is questionable that others, however well informed they may have been, would have had the temerity to advance a contrary view.

What maps, then, might Brahmans and other literati have prepared? In their capacity as servants of the state, it is conceivable that they may have produced maps to serve a variety of practical ends, a number of which have already been discussed. But little of such work survives. Rather, most of what remains relates to a wide variety of religious needs—ritual, didactic, and soteriological—that characterize not only Hinduism but Buddhism and Jainism as well. Horoscopic charts were common and, insofar as they fix the position of the major heavenly bodies at the moment of one's birth, may also be thought of as maps. The dominant and ultimate concern of all three faiths has little to do with a single lifetime on earth. The span of a single terrestrial existence is, after all, an infinitesimal moment in the vast and endless cycle of time. The earthly home is, similarly, but a tiny speck in the stupendous expanse of only one among many universes. The principal purpose of a properly lived life is to enable rebirth into a higher state. Only thus might an individual move somewhat closer to release from the painful and potentially never-ending cycle of birth and rebirth—that is, to the attainment of moksa (in Hinduism) or nirvana (in Buddhism and Jainism).

In short, then, to those of a religious bent—which for many centuries probably included most learned persons—so mundane a task as preparing a seemingly accurate map of the finite terrestrial earth or a small segment of it could not have appeared particularly important. By contrast, making manifest the structure of the cosmos, through which the soul makes its long cosmic journey, must have been regarded as an act of considerable importance. To the devout, the diverse cosmographies put forward provided, as it were, a choice of road maps for the soul.[171] In comparison with the transcendent importance of this need, the necessity for route maps of a more mundane nature was probably not very keenly felt. And who among the laity would in any case have had the courage to posit conceptions of the universe or even of a small part of it at variance with those of the Brahmans?

The apparent lack of deep concern for maps in pre-Islamic India finds an interesting echo in a similar inattention to the writing of narrative history. What one can reconstruct of Indian history before the thirteenth century, therefore, is based largely on the accounts of foreign travelers and the evidence of epigraphy, numismatics, architecture, and archaeology. Much of the extant record with regard to political history, including many important inscriptions, is panegyric in nature and must be interpreted with appropriate caution. The concern was with making events conform to a divinely sanctioned ideal of kingship, rather than with strict historicity.[172] Whether coincidental or not, it is noteworthy that the few surviving early South Asian approaches to an extended narrative chronicle all come to us from the periphery of India. These include the Buddhist *Mahāvaṃsa* (fifth to sixth century) from Sri Lanka, the *Rājataraṅgiṇi* (twelfth century) from Kashmir, and the *buranji*s (histories; thirteenth to nineteenth century) of the immigrant Ahom dynasty of Assam.[173]

In the Indian tradition of higher Brahmanical learning, which has persisted for millennia, rote memorization plays an important role. Memory training may begin by age eight or even earlier. The oral tradition, in which one learns directly from the mouth of one's guru, places great emphasis on mastery of the spoken—not the written—word, including for certain texts the proper rhythmic incantation and accent of each memorized *śloka* (verse).[174] It has little need for visual imagery. Conceivably, the relative unimportance of graphic aide-mémoires, such as characterize primary education in so many cultures, even those of preliterate societies, is tied in with the relative scarcity of premodern Indian maps.[175]

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170. An eleventh-century treatise on architecture, the *Samarāṅgaṇa-sūtradhāra*, states, "He, who begins to work as an architect . . . without knowing the science of architecture [the oversight of which was entrusted to Brahmans] . . . and proud with false knowledge must be put to death by the king." The Brahman architect or *sthapati* was expected to act as a guru to the actual workers, *śilpin*. The passage cited and relevant discussion are from Kramrisch, *Hindu Temple*, 1:8 (note 115).

171. Some of the many works dealing with cosmography have already been mentioned; see especially Kirfel, *Die Kosmographie der Inder* (note 14), Caillat and Kumar, *Jain Cosmology* (note 15), and Sircar, *Cosmography and Geography* (note 18).

172. This problem is succinctly discussed by Basham, *Wonder That Was India*, 45–46 (note 91), and Schwartzberg, *Historical Atlas*, xxix (note 50).

173. On the *buranji*s, see Gait, *History of Assam*, x-xiv (note 156).

174. Winternitz, *Indian Literature*, 32 (note 62), and Ingalls, "Brahman Tradition," 209–10 (note 169) discuss the learning process and the prodigious feats of memorization of which young Brahman boys are capable.

175. Many practical manuals and religious texts omitted plans or cosmographies that would have been extremely helpful to ordinary readers and substituted verbal descriptions. These include the *Āpastambiyaśulvasūtra* and *Baudhāyanaśulvasūtra*, the two most important guides to the layout and construction of sacrificial altars, both composed some centuries before the Christian Era; the *Mānasāra*, a guide to town planning and architecture and most celebrated of the *śilpaśāstra*s (treatises for builders), compiled about the sixth century A.D.; numerous works in astronomy, and many of the encyclopedic Puranas, which were composed over many centuries and typically contained sections on both geography and cosmography. Modern translations of these texts and commentaries on them often include clear diagrams drawn from their explicit instructions. Some of these appear elsewhere in this chapter and subsequent chapters. The point to note here is that many of the diagrams produced by modern scholars are

Mastery of the Vedas and other sacred texts was a key to the power of the Brahmans. The recitation of particular texts was essential for the performance of the numerous sacrificial rites and other ceremonies from which many—but by no means a majority—of that caste derived their livelihood. There was a vested interest, therefore, in keeping certain branches of learning secret; for what was written down could be learned independently of a master. That this is not mere speculation is evident from certain passages in works that have been committed to writing. "This mystery of the gods," says the *Sūryasiddhānta*, a Hindu treatise on astronomy, "is not to be imparted indiscriminately: it is to be made known to the well-tried pupil, who remains a year under instruction."[176]

Along with the learned *śāstrin*s, the class of Brahmans included another sizable group, the *paṇḍitas/paṇḍās*. The two groups were not mutually exclusive, but the livelihood of the latter was derived especially from the management of pilgrimages and the care of pilgrims at the innumerable *tīrtha*s (pilgrimage places) that dot the Indian landscape. In plying their profession they relied on Sanskrit texts, called *mahātmya*s, that extolled the sanctity of specific *tīrtha*s, described the merit to be derived from visiting them, and in some cases provided directions for going from *tīrtha* to *tīrtha* along well-established circuits. *Mahātmya*s have existed at least since the time of the *Mahābhārata* and were read to pilgrims and explained by the *paṇḍita*s at each *tīrtha*. It was obviously in the economic interest of the *paṇḍita*s to have no guide to the *tīrtha*s other than themselves and the *mahātmya*s.[177] Were maps available, they might have been consulted even by unlearned and impecunious pilgrims. But whatever the cause, maps do not appear to have been associated with Hindu pilgrimage until a relatively recent date.[178]

If, then, pilgrimages did not provide a major early impetus for mapmaking in India, what might one say of long-distance commercial travel by both land and sea? Here again we can do no more than speculate. Much trade, over long periods of Indian history, especially in the Deccan, was in the hands of rival merchant guilds. Such guilds, like those of medieval Europe, had their trade secrets. Maps, if they were available, and the knowledge they portrayed may have been among those secrets.[179]

In seeking to explain why India did not develop mapping more vigorously than it did, we finally revert to the propensity of a cosmically attuned society to attach relatively little importance to the mundane concerns to which most terrestrial maps relate. This tendency, presumably, would have gained considerable strength among learned Hindus after the brief but remarkably successful pan-Indian career of the philosopher Śaṅkara (?788–820), founder of the advaita (monistic) Vedānta school of Indian philosophy. To this day this has remained the most important of the orthodox *Ṣaḍdarśana* (Six doctrines of salvation). According to Vedānta, "on the highest level of truth the whole phenomenal universe, including the gods themselves, was unreal—the world was *Māyā*, an illusion, a dream, a mirage, a figment of the imagination. Ultimately the only reality was *Brahman*, the impersonal World Soul . . . with which the individual soul was identical."[180] Similar conceptions infuse Buddhism and Jainism. If, then, to most South Asians over much of the course of history the world of the senses was only an illusion, why take pains to map it?[181]

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fairly complex—so much so, in fact, that one cannot but wonder why the written word was preferred to graphic devices for the exposition of the concepts of the ancient works. But, writes David Pingree, "the Sanskrit manuscripts on geometry almost universally are illustrated with diagrams; . . . [while] diagrams are far less frequent in astronomical manuscripts—a difference I can not now explain" (personal communication, 21 December 1988).

176. Ebenezer Burgess, *Translation of the Sûrya-Siddhânta: A Text-book of Hindu Astronomy, with Notes and an Appendix*, reprint of 1860 edition as edited by Phanindralal Gangooly in 1935, with an introduction by Prabodhchandra Sengupta (Varanasi: Indological Book House, 1977), 186. The passage cited relates to the construction of armillary spheres.

177. The importance of pilgrimage in Indian history and the nature of pilgrim circuits at various times are outlined in Bhardwaj, *Places of Pilgrimage* (note 70). The way *paṇḍita*s organize pilgrim traffic is explained by Anita L. Caplan in "Prayag's Magh Mela Pilgrimage: Sacred Geography and Pilgrimage Priests," in *The Geography of Pilgrimage*, ed. E. Alan Morinis and David E. Sopher (Syracuse, N.Y.: Syracuse University Press, forthcoming). The extent of *mahātmyas* and the way they were used were described by Mark Aurel Stein, who, about a century ago, in searching for aids for his analysis of the twelfth-century *Rājataraṅgiṇi*, collected fifty-one such texts in Kashmir alone. The relevant text appears in his *Memoir on Maps Illustrating the Ancient Geography of Kaśmīr* (Calcutta: Baptist Mission Press, 1899), reprinted from the *Journal of the Asiatic Society of Bengal* 68, pt. 1, extra no. 2 (1899): 46–52. See also discussion of Kashmiri *tīrtha* maps below, p. 457.

178. This is in contrast to the Jain tradition, in which picture maps for the use of pilgrims appear to have a rather longer history (see below, pp. 441–42 and 457–60).

179. For a discussion of trading guilds and overland caravan trade within ancient India, see Basham, *Wonder That Was India*, 225–28 (note 91). Caravan leaders (*sārthavāhas*) and land pilots (*thalaniyyāmakas*) were important figures in the commercial communities.

180. Basham, *Wonder That Was India*, 330 (note 91). See also William Norman Brown, *Man in the Universe: Some Continuities in Indian Thought*, Rabindranath Tagore Memorial Lectures, 4th ser., 1965 (Berkeley and Los Angeles: University of California Press, 1966), esp. lecture 1, "The Search for the Real," 16–42.

181. Readers should not take the foregoing speculative paragraph on faith. David Pingree, on reading it, expressed (personal communication, 21 December 1988) a sharply dissenting view: "The . . . paragraph on Maya I find totally irrelevant. The world of perception may be an illusion, but most Indians did and still do live by those perceptions. Even Śaṅkara did. It is only *after death* that one who has attained mokṣa ceases to perceive; before death there's no reason in the world why he shouldn't consult a map. I might point out that embedded in every local pañcāṅga [local almanac]—and they were made (and are

made) in the hundreds throughout India—are the local latitude and longitude. . . . This geographical knowledge was present everywhere in the subcontinent from c. 500 A.D. on." The geographic knowledge of ancient Indians is of course not in question; evidence of it has been put forward abundantly in this chapter. Rather, the issue is the extent to which Indians were disposed to put such knowledge into cartographic form. Willingness to *use* an existing map is one thing; being inclined to *construct* a map, knowing (i.e., believing) that its content is ultimately illusory is quite another. Unfortunately, the point at issue is not susceptible to proof, and differing interpretations may legitimately be held. For additional discussion of the concept of *māyā*, see the views of Lannoy in the section "Microcosmic Analogues of the Cosmos" in the following chapter.

16 · Cosmographical Mapping

JOSEPH E. SCHWARTZBERG

In light of the important role of cosmology in the worldview of South Asians over the centuries, it is hardly surprising that the surviving corpus of cosmographic artifacts, many of which can be thought of as maps, is both abundant and exceedingly varied. In this chapter we consider not only those artifacts but also the underlying cosmographical concepts necessary for their comprehension. My principal concern will be with the ancient and enduring religious traditions of Hinduism and Jainism, to which we owe most of the materials we shall examine. But since the cosmological doctrines of Buddhism, which became virtually extinct in India by about the thirteenth century, have much in common with those of Hindus and Jains, they will also receive some consideration, largely by way of comparison among the several traditions. The maplike cosmographic creations of Buddhism that are known to us come mainly from regions outside the Indian subcontinent, however, and are more appropriately discussed in subsequent chapters on Southeast Asia, the Himalayan region (including Tibet), and the several countries of East Asia. For the little-known pre-Vedic cultures, from the Paleolithic through the Indus civilization, and for South Asia's numerous tribal cultures, I shall not extend my remarks here beyond the few fleeting observations made in the introductory chapter.

In the case of Islamic cosmography, the principal conceptions have been set forth in some detail in part 1, in the chapter on Islamic cosmological drawings. Hence the few remarks I shall put forward relative to Indo-Islamic creations will refer mainly to divergent works of a heterodox or eclectic nature. Note, however, that it is likely many more works will come to light than are listed in this chapter.

Of the cosmographies of other faiths represented in India I have even less to say. I have yet to come across a distinctive Sikh, Zoroastrian (Parsi), or Indo-Christian cosmographic work. But lack of awareness of such productions should not be taken to mean none exist. Here too further investigation is warranted.

Following the introductory discussion of the principal cosmological conceptions of the ancient faiths of South Asia, this chapter considers, in order, the known cosmographic artifacts of Hinduism, Jainism, and Indian Islam. Because of the diversity of the Hindu materials, I divide my analysis of them into sections dealing with cosmographic paintings and ink drawings that are not essentially astronomical in content; cosmographic globes (only six of which are known to exist); and astronomical artifacts, including sculpture, paintings, and architecture as well as astrolabes, celestial globes, and observatories. In that South Asian astrolabes and celestial globes are all fundamentally based on Islamic prototypes, which are amply discussed in the chapter on Islamic celestial mapping in part 1, their treatment here may be relatively brief. The remarkable achievements of Sawai Jai Singh II in regard to astronomical observatories demand a somewhat more extended discussion. Astronomical painting in the Jain tradition, in contrast with that of Hinduism, is so closely associated with the canonical cosmological texts that no separate section need be devoted to its exposition.

This chapter concludes with two related discussions that seek to elucidate the place of cosmography in the dominant cultures of India: first, a consideration of a variety of perceived analogues between microcosms—as incorporated, for example, in architecture, sacrificial altars, and the human body—and the universal macrocosm; second, an inquiry into the role of cosmography in shaping the mental maps of ordinary Indians, a subject fraught with interest and one on which serious research has barely begun.

UNDERLYING COSMOLOGICAL CONCEPTIONS

Commenting on the relative unpopularity of cosmological investigations among modern Indologists, R. F. Gombrich has opined that "the most discouraging feature of traditional Indian cosmology is not its fantastic and uncritical character, but its complexity." He explains that complexity as follows:

> Just as the Indian system of social organisation, caste, has grown throughout history by aggregation and inclusion, not abolishing the practices and customs of newly assimilated peoples but assigning them a low place in the social hierarchy, so Indian cosmology—which remained largely a branch of Indian mythology—rarely abandoned a theory or idea, but allowed

> it to remain alongside the new ideas, even if it was inconsistent with them.... Nevertheless, there are certain Hindu texts, the Purāṇas, composed since the beginning of our era, which concern themselves with [among other things]... the universe in space and time, that is cosmology; and the Purāṇas do make attempts to reconcile various versions and to present a systematized picture—though no two attempts give quite the same result. Systematisation proceeds, as I have just suggested, by aggregation and encapsulation; for instance, different cosmogonies are generally accommodated by making them occur successively, rather than by, say, interpreting one story as an allegorical alternative to another. It is this... which largely accounts for the notorious fact that the dimensions of both space and time in the classical Indian cosmologies are so unconscionably large; two systems are reconciled by putting the one inside the other, and making it a cosmographical or temporal part of a much larger whole.[1]

In light of these remarks it is hardly surprising that in the lengthy article on cosmogony and cosmology in the *Encyclopaedia of Religion and Ethics*, the sections on the Buddhist and Indian views are far longer than for any other religious tradition or world region; the former—the longer of the two—is in fact allotted three times the space given to the section on the views associated with Christianity.[2] Of Kirfel's book, *Die Kosmographie der Inder*, Gombrich observes, not quite accurately, that it comprises "over 400 large pages with hardly anything more than bare quotations and tables."[3] Nevertheless, for our purposes the Kirfel text, despite being directed primarily to an audience of Indologists, possesses the great merit of containing what is perhaps the most representative sample of actual photographs of Indian cosmographic productions of any hitherto published work.[4] Among other works treating the several traditions within Indian cosmology at some length, Bastian's *Ideale Welten* analyzes at greatest length the specific cosmographic views presented, rather than the conceptual schema underlying them, though not, obviously, from the perspective of a historian of cartography.[5] Sircar's approach is not so dissimilar to Kirfel's and, on cursory inspection, appears to be much in the nature of a catalog; but he strives less for completeness and more for critical analysis and comprehensibility. Moreover, to an extent unmatched by other authors cited in this essay, he considers the real-world referents of the many places named in the cosmographies.[6]

Within the present context, it will not be possible to consider, even in a cursory fashion, many of the numerous cosmographical conceptions that have enjoyed currency within the Hindu, Buddhist, and Jain traditions. But within each of these traditions I do offer some generalizations on the purposes of the cosmographies; the media employed; their scale, orientation and directionality, use of color, and symbolization; and their degree of conformity to the real world. Finally, I shall consider the pervasiveness of cosmographic imagery in a variety of noncartographic contexts.

The inconsistencies in Indian cosmography—Hindu, Buddhist, and Jain—to which Gombrich draws our attention are evident even in the earliest of texts. Sircar notes that in the *Ṛg Veda*, composed over several centuries between 1500 and 1000 B.C., there are at least five different words to refer to the earth and that the universe therein was conceived "as consisting of either two or three units, i.e., of either the earth and the sky (heaven), or the earth, the air (atmosphere) and the sky."[7] Furthermore, "each of these constituents was regarded as having three parts or layers, so that there were either six units of three earths and three heavens or nine units of three earths, three atmospheres and three skies."[8] To these the later *Yajur Veda* and *Atharva Veda* (believed to have been composed between 900 and 500 B.C.) added a hemispheric "world of light, i.e. the vault of the sky,"[9] which was in due course matched by an antipodal nether vault. Thus the world was seen as a disk—a form frequently used in later cosmographies—suspended between "two great bowls turned towards each other," and that view led in time to the long-enduring conception of the universe as a "cosmic egg" commonly designated Brahmāṇḍa (egg of Brahma).[10] A similar early conception is that of the *Chāndogya Upaniṣad* (date uncertain, but probably composed about the time of the later Vedas), which speaks of the cosmic golden womb (or fetus) (*hiraṇ-*

1. R. F. Gombrich, "Ancient Indian Cosmology," in *Ancient Cosmologies*, ed. Carmen Blacker and Michael Loewe (London: George Allen and Unwin, 1975), 110–42, esp. 111–12, frontispiece, and pls. 21 and 22.

2. "Cosmogony and Cosmology," in *Encyclopaedia of Religion and Ethics*, 13 vols., ed. James Hastings (Edinburgh: T. and T. Clark, 1908–26), 4:125–79; in particular the sections "Cosmogony and Cosmology (Buddhist)," by L. de la Vallée Poussin, 129–38, and "Cosmogony and Cosmology (Indian)," by H. J. Jacobi, 155–61. Jacobi's contribution develops more fully the notions cited from Gombrich, "Ancient Indian Cosmology" (note 1).

3. Gombrich, "Ancient Indian Cosmology," 111 (note 1).

4. Willibald Kirfel, *Die Kosmographie der Inder nach Quellen dargestellt* (Bonn: Kurt Schroeder, 1920; reprinted Hildesheim: Georg Olms, 1967; Darmstadt: Wissenschaftliche Buchgesellschaft, 1967), pls. 1–18.

5. Adolf Bastian, *Ideale Welten nach uranographischen Provinzen in Wort und Bild: Ethnologische Zeit- und Streitfragen, nach Gesichtspunkten der indischen Völkerkunde*, 3 vols. (Berlin: Emil Felber, 1892).

6. D. C. (Dineshchandra) Sircar, *Cosmography and Geography in Early Indian Literature* (Calcutta: D. Chattopadhyaya on behalf of *Indian Studies: Past and Present*, 1967).

7. Sircar, *Cosmography and Geography*, 9 (note 6).

8. Sircar, *Cosmography and Geography*, 9 (note 6).

9. Sircar, *Cosmography and Geography*, 9 (note 6).

10. Sircar, *Cosmography and Geography*, 10 (note 6).

yagarbha) splitting apart to form the heaven and the earth.[11] On the size of the universe the Vedas themselves are silent, but the *Aitareya Brāhmaṇa* informs us that "the distance between the earth and the sky is . . . 1000 days' journey for a horse," while the *Pañcaviṃśa Brāhmaṇa* puts it, more modestly, at "the altitude coverable by 1000 cows standing one upon another."[12]

Whether the conceptions presented to this point were of purely Indian origin or were borrowed from Babylonia is debatable. Kirfel thinks the Babylonian influence is significant, whereas Gombrich finds little support for that proposition.[13] This, however, is an argument we need not enter, since the concern here is not so much with cosmology per se as with cosmography; and of visible representations of the very early Indian views we have no surviving example. But at least from the middle of the first millennium B.C., by which time the Brahmāṇḍa idea had gained currency, Indian cosmological and cosmographic speculation proceeded on a wholly independent course.

Over the next thousand years or more, during which time the Epics and Puranas were composed and written, Indian cosmography became ever more complex and expansive. Not only were our own earth and universe envisaged as increasingly differentiated segments of the cosmos, but new universes, in some views infinite in number, were imagined. At the same time, in each of the three main religiophilosophical traditions of India—Hindu, Jain, and Buddhist—the cosmos became "ethicized." This was a natural outgrowth of the eschatological preoccupations of those three faiths. Each held to a belief in the transmigration of the soul in a potentially endless round of rebirths; and the expanded, generally vertically stratified universe, with numerous heavens and nether worlds, provided the field within which the soul could find its proper niche at any stage in its long journey toward or away from ultimate release (moksa in Hinduism and Jainism and nirvana in Buddhism). As a rule, within this ethicized universe "the good go up and the bad go down, the higher up you are the better," and vice versa.[14] The implication of this, from a cartographic perspective, is that the visual representation of the multidimensional universe in a two-dimensional image (i.e., a conventional map surface) sees it extended along a vertical rather than a horizontal plane. It is perhaps understandable, then, that historians of cartography, who have little trouble recognizing Western cosmographies for what they are, might fail to recognize as maps the surviving cosmographies of India, Tibet, and Southeast Asia.

If only in passing, it is appropriate to note that just as souls moved through cycles of rebirth, so did the universe itself. Thus, although we are unaware of visual representations of the universe as it may have been imagined at different stages of its existence (apart from the early Vedic primordial egg conception), it seems reasonable to suppose that such works existed and would easily be spotted by appropriately trained specialists. As with the spatial dimensions of the universe, the temporal dimensions and constitution of time are staggeringly large and complex (e.g., the life of Brahma is calculated at 311,040,000 million years), and a host of cycles within cycles is postulated. Further, time, like space, is ethicized. The age in which we are now living, for example, the Kaliyuga, said to have begun in the year of the Mahābhārata war (traditionally dated 3102 B.C.), is the least moral of all.[15] But the present Kaliyuga is but one of a thousand Kaliyugas in the present *kalpa*, a cycle of time that in turn is but one of 720 *kalpa*s in a single year of Brahma.[16]

A concomitant of the expansion and growth in complexity of the cosmos was the remarkable multiplication and evolution of its denizens. Whereas in early Vedic times it was thought that there was but one primordial deity, or at most a few, there subsequently arose in various components of the cosmos an innumerable host of gods, demigods, bodhisattvas, spirits, demons (*asura*s), and diverse terrestrial creatures, some more or less human in size, form, and behavior, others in the nature of real or mythical animals.[17] The cartographic significance of this is that in painted cosmographies, a particular component of the cosmos will be identified by the placement within a particular field—which in itself may be more or less nondescript—of some identifiable tutelary deity, creature, or plant that to the uninitiated would not be recognized as a map symbol.

The sun, the moon, the planets (Mercury, Venus, Mars, Jupiter, Saturn, and in the Indian view, Rāhu and Ketu, the ascending and descending nodes of lunar eclipses), zodiacal mansions, and asterisms (*nakṣatra*s) were also deified and rendered iconically in sculpture and in painting, sometimes individually and sometimes in related

11. Sircar, *Cosmography and Geography*, 12 (note 6).

12. Sircar, *Cosmography and Geography*, 10 (note 6). The date of the texts cited may be placed between 900 and 500 B.C.

13. Kirfel, *Die Kosmographie*, 28–36 (note 4); Gombrich, "Ancient Indian Cosmology," 117 (note 1).

14. Gombrich, "Ancient Indian Cosmology," 119 (note 1).

15. Arthur Llewellyn Basham, *The Wonder That Was India: A Survey of the History and Culture of the Indian Sub-continent before the Coming of the Muslims*, 3d rev. ed. (London: Sidgwick and Jackson, 1967), 323.

16. The numerical relations among the several units in which cosmic time is measured (*yuga*s, *mahāyuga*s, *kalpa*s, and "life of Brahma") are discussed by David Pingree in "Astronomy and Astrology in India and Iran," *Isis* 54 (1963): 229–46, esp. 238–40.

17. Quoting Rhys Davids (*Dialogues*, 1.36), La Vallée Poussin observes that in the Buddhist cosmography "four things are infinite: space, the number of universes, the number of living beings, and the wisdom of a Buddha," cited in "Cosmogony and Cosmology (Buddhist)," 137, n. 5 (note 2).

groups. In some works, including both paintings and architectural monuments, these astronomical icons formed parts of larger cosmographic ensembles, typically incorporating numerous wholly mythic elements; in other instances they were depicted in isolation.[18] Rarely, however, except on astrolabes and celestial globes, was any attempt made to represent an actual view of a portion of the heavens at a particular moment in time. Thus empirical celestial mapping, as it developed in other parts of the world, does not form a part of the Indian cartographic tradition.

Cosmographic texts also specified natural features but attributed to them fabulous sizes, shapes, and other physical properties. Certain realms came to be characterized by the presence therein of specific trees, typically of stupendous proportions, and these too became cartographic motifs. The continent (or world) containing India, for example, came to be known as Jambūdvīpa, the Rose-Apple Island, after the *jambū* tree that grew at its center. In the Buddhist view, this eponymous tree had a trunk fifteen *yojana*s in girth (the length of a *yojana* being taken as anywhere from two to nine miles), branches fifty *yojana*s long, and a height of one hundred *yojana*s.[19] Shapes (e.g., bowlike, wedgelike, square) and positions were also elements of the cosmographies. Thus, in some views oceans and mountain ranges were conceived as concentric rings, whereas in others mountain ranges followed straight lines, generally either east-west or, less commonly, north-south.

A feature common to most of the ancient Indian cosmographies is that the earth and universe are centered on an axis, specified as Mount Meru (or Sumeru), which is commonly identified either with the Pamir Mountains of Central Asia or with the sacred Mount Kailāsa (Kailas) in Tibet. Even in Vedic times some such axis was thought to exist, joining the celestial vault and the nether world, which were viewed either as in-facing bowls, as I have noted, or as giant wheels like the earth itself. The size, shape, and composition of Mount Meru and its immediate environs varied considerably from one view to another, as will be apparent from its representation in some of the illustrations in this chapter. In most views it not only soared to heights no human could attain but was also deeply rooted in the earth. On its elevation, 84,000 *yojana*s, there is considerable agreement; the depth of its roots, however, was regarded in some Hindu accounts to be a mere 16,000 *yojana*s and by the Buddhists was seen as equal to the mountain's height. Meru's shape was unlike that of other mountains. In most conceptions it comprised several distinct layers, each the domain of a different type of supernatural being; but whereas some viewed it as narrowing toward its summit, others thought precisely the opposite. Generally, however, the summit area was thought to be flat and, even in the most conservative view, quite capacious, as would befit its divine occupants. The number of sides attributed to Meru ranged from four, which was a common view, to a thousand. Around Meru were variously described buttress ranges, rocky ramparts, and other symmetrically and concentrically arranged physical features that, for want of space, I shall not even attempt to summarize.[20]

In most Hindu, Jain, and Buddhist views of the universe, there were ranged about Mount Meru, the *axis mundi*, a number of continents. One such view (fig. 16.1), identified with early Brahmanic Hinduism and Buddhism, was that there were four, one in each of the cardinal directions, like the leaves of a lotus of which Mount Meru formed the pericarp. An alternative Hindu conception, also identified—in somewhat modified form—with Jainism, was that the earth consisted of seven concentric ring continents separated by ring oceans, each continent and ocean moving outward from the central continent (also called Jambūdvīpa) and being twice as large as the continent and ocean preceding it (see the reconstructions in figs. 16.2 and 16.3). Oddly, though some texts are explicit in regard to the geometric progression of areas, the extant graphic representations of this worldview all seem to ignore it (e.g., below, figs. 16.8, 16.9, 16.10, and plate 25). But once again we have an embarrassment of riches, for there are also texts that specify nine, thirteen, eighteen, and thirty-two continents.[21]

Which of the views above is oldest cannot be said with certainty. Because most surviving cosmographies amalgamate the two major conceptions, they throw no useful light on the subject, and historical evidence suggests that hybrid views date back at least as far as the seventh century.[22]

18. A succinct history of the changing modes of rendering astronomical icons in Indian painting, sculpture, and architecture is provided by Calambur Śivaramamurti in the article "Astronomy and Astrology: India," in *Encyclopedia of World Art*, 16 vols. (New York: McGraw-Hill, 1957–83), 2:73–77 and pls. 29–30. More specialized works will be cited below.

19. Sircar, *Cosmography and Geography*, 41 (note 6).

20. Sircar, *Cosmography and Geography*, 37 and 39–40 (note 6).

21. Sircar, *Cosmography and Geography*, 36, 38–51, and 58 (note 6); and Hemchandra Raychaudhuri, *Studies in Indian Antiquities*, 2d ed. (Calcutta: University of Calcutta, 1958), 43–45 and 66. Both texts discuss the conflation of the diverse conceptions in various Puranas.

22. That the inconsistencies in the cosmographic views of the Puranas and other early texts were apparent to their compilers is suggested by the argument in the *Vāyu Purāṇa* that "it is useless for men to offer . . . to prove or disprove anything in the description of the earth . . . , that [such] conceptions . . . are beyond the scope of human thinking . . . and that such matters . . . should be taken for granted" (Sircar, *Cosmography and Geography*, 36 [note 6]). Even among the texts advancing a particular conception, there were numerous disagreements on the names of continents and of their several constituents and physical features.

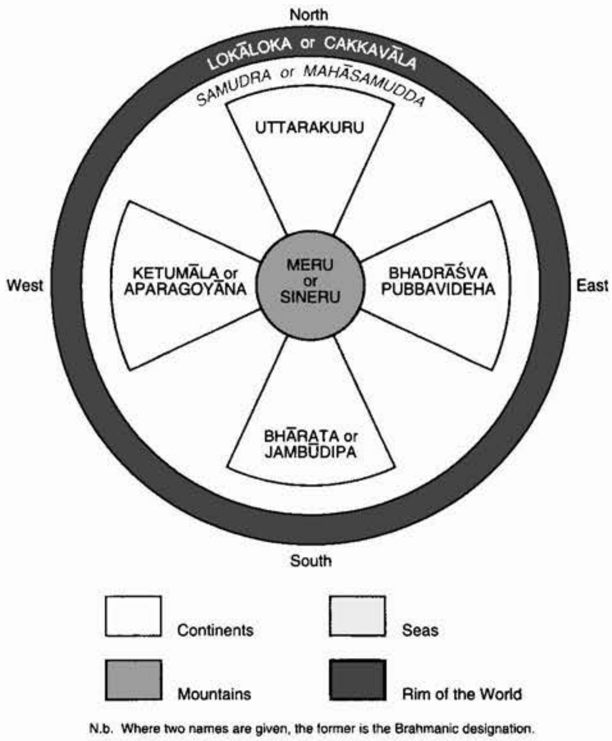

FIG. 16.1. EARLY BRAHMANIC HINDU AND BUDDHIST CONCEPTION OF THE *CATUR-DVĪPA VASUMATĪ* (FOUR-CONTINENT EARTH). This is an idealized view of one of the simpler conceptions of the earth held by ancient Hindus. In time it came to be modified so that the continents to the north and south of Meru differed from those to the east and west. But a throwback to this pristine form is evident in a portion of the globes portrayed in figures 16.14 and 16.18 below, for example.
After Joseph E. Schwartzberg, ed., *A Historical Atlas of South Asia* (Chicago: University of Chicago Press, 1978), pl. III.A.1, adapted from D. C. (Dineshchandra) Sircar, *Cosmography and Geography in Early Indian Literature* (Calcutta: D. Chattopadhyaya on behalf of *Indian Studies: Past and Present*, 1967), pl. I.

There was a high degree of consensus as to the names of the northern and southern *dvīpa*s (continents)—Kuru or Uttarakuru and Jambūdvīpa (though Bhārata was also often used for the latter)—but the names of the eastern and western continents differed widely in the Hindu and Buddhist traditions.[23] Similarly, whereas in the seven-continent view there is general accord in the Puranic texts on the names of the first and seventh *dvīpa*s—Jambū and Puṣkara—there is considerable diversity in the order of the others and also in their sizes and component *varṣa*s (parts).[24] Mere toponymic differences from one cosmography to another may have little effect on their overall visual appearance, yet to those able to read the abundant text found in so many of the extant works, the lack of concordance may loom as a serious problem. This problem was noted as early as the eleventh century by the great Muslim scholar al-Bīrūnī; but whether his concern was more with the Puranic texts, which seems most likely, or with actual cosmographic artifacts, which is also a possibility, is not known.[25]

A remarkable aspect of many Indian cosmographies is that they do not perceive distant realms as less glorious than their own revered home region (whether Jambūdvīpa or Bhāratavarṣa). In this they differ from the cosmographies of most other cultures. As Eck observes, "as we move outward from Rose-Apple Island into the *terrae incognitae* of the outer islands, the world is not imagined to be shadowy and dangerous, but on the contrary is imagined to be more and more sublime. These outer islands are not thought of as heavens, since the heavens rise in the vertical dimension of the Brahmanda, but life is idealized beyond the horizon."[26]

This idealization of distant continents or, in some views, of distant worlds would help explain why certain visual representations of portions of the cosmos, particularly as conceived by Jains and, to a lesser extent, by Buddhists, appear so strange to the uninitiated. A painted rectangle studded with glowing jewels may appear to a Western observer as being merely an abstract design, whereas to a devout Jain it might represent a specific world with a definite name and a fixed place in the cosmos.

The foregoing may be seen as a spatial analogue of the temporal conception that the age in which the world at present exists, the Kaliyuga, is the least happy and least holy of times. Also noteworthy in many cosmographic conceptions is the peripheral southerly position of Jambūdvīpa, displaying a certain lack of geocentricity that stands in marked contrast to the Jerusalem-centered or Mecca-centered cosmographies of the West.

23. Sircar, *Cosmography and Geography*, 40–41 (note 6).

24. With respect to India, a realm called Bhāratavarṣa, now equated with the subcontinent, was presented "sometimes as a part of the Jambu-dvıpa, and sometimes as identical with the latter. Likewise, the Sāgarasaṃvṛta-dvīpa, said to be the ninth part of the Bhārata-varṣa, is regarded also as co-terminous with the whole of the Indian subcontinent (together with parts of Central Asia)" (Sircar, *Cosmography and Geography*, 37 [note 6]). Similarly, Jambūdvīpa was variously described as the southern continent, as the central continent, and as the entire earth.

25. Raychaudhuri, *Indian Antiquities*, esp. 37 and 40–41 (note 21). Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī's comments on the corruption of the Puranic texts are found in his *Ta'rīkh al-Hind* (Description of India); see, for example, *Alberuni's India: An Account of the Religion, Philosophy, Literature, Geography, Chronology, Astronomy, Customs, Laws and Astrology of India about A.D. 1030*, 2 vols., ed. Eduard Sachau (London: Trūbner, 1888; Delhi: S. Chand [1964]), 1:238.

26. Diana L. Eck, "Rose-Apple Island: Mythological and Geographic Perspectives on the Land of India," unpublished manuscript sent to me on 20 November 1983.

Radically different from the cosmographies discussed to this point is the one that views the world as "a tortoise, its arched shell the heaven, its flat underside the earth."[27] Although this view retains an elevated world center, it conspicuously lacks a Mount Meru. The origin of this idea is rooted in the Brahmanas (mid-first millennium B.C.), but its elaboration appears to have occurred only in the time of the later Puranas (fourth to sixth century A.D.) and of the *Mārkaṇḍeya Purāṇa* in particular. This conception, the *kūrmaniveśa* (tortoise abode), was of particular importance to astrology, and "astrologers prepared special topographical lists to which they gave the name of *Kūrma-vibhāga* (divisions of the globe),"[28] which found their way into some major works on astronomy.

27. Gombrich, "Ancient Indian Cosmology," 116 (note 1).
28. Raychaudhuri, *Indian Antiquities*, 48 (note 21).

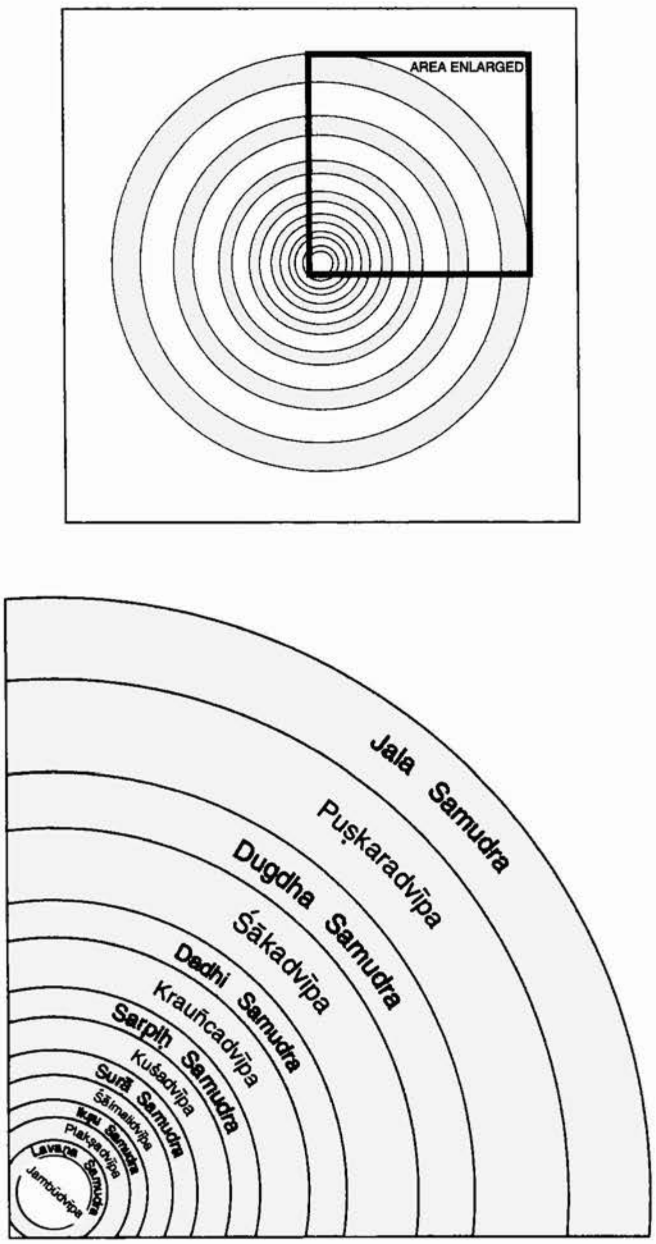

FIG. 16.2. HINDU AND JAIN CONCEPTION OF THE *SAPTA-DVĪPA VASUMATĪ* (SEVEN-CONTINENT EARTH). The seven named continents here alternate with seven seas. Starting with the innermost, Lavaṇa Samudra, the names of the seas translate as Salt Sea, Sugarcane Juice Sea, Wine Sea, Clarified Butter Sea, Curd Sea, Milk Sea, and Water Sea. The area of each successive continent is double that of the continent immediately inward from it, and the same relationship obtains for the dimensions of the rivers and mountains on those continents and the seas that separate them.
After D. C. (Dineshchandra) Sircar, *Cosmography and Geography in Early Indian Literature* (Calcutta: D. Chattopadhyaya on behalf of *Indian Studies: Past and Present*, 1967), pl. II.

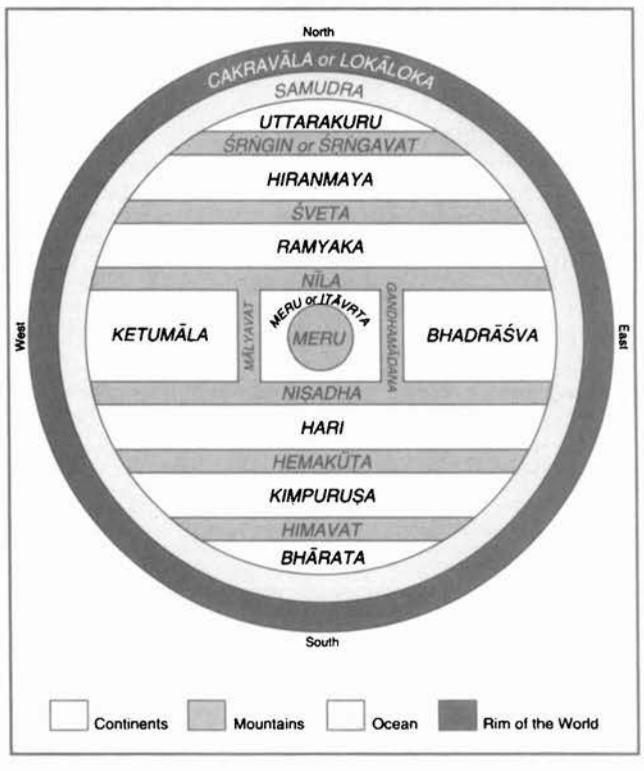

FIG. 16.3. PURANIC CONCEPTION OF THE DIVISIONS OF JAMBŪDVĪPA, THE INNERMOST CONTINENT OF THE *SAPTA-DVĪPA VASUMATĪ*. Comparing the names on this diagram with those of figure 16.1 makes it clear that this is a derivative conception. Here Ketumāla and Bhadrāśva retain their positions as the western and eastern continents, but the earlier Uttarakuru and Bhārata, in the north and south, have each been divided into three major parts separated by east-west mountain ranges.
After Joseph E. Schwartzberg, ed., *A Historical Atlas of South Asia* (Chicago: University of Chicago Press, 1978), pl. III.D.3, adapted from D. C. (Dineshchandra) Sircar, *Cosmography and Geography in Early Indian Literature* (Calcutta: D. Chattopadhyaya on behalf of *Indian Studies: Past and Present*, 1967), pl. V.

> The world as known to the *Kūrma-vibhāga* . . . is represented as resting upon Vishṇu in the form of a tortoise with its head to the east. It is divided into nine parts each of which is assigned to a triad of *nakshatras* (lunar mansions or constellations). Peoples and countries are enumerated with the corresponding *nakshatras* as they were distributed over the various parts of the tortoise's body, starting with the middle region and then running round the compass from the east to the north-east. The special object of this mode of division is to determine what *janapadas*, countries or districts, suffer disaster when the respective lunar mansions with which they are associated are harassed by malignant planets.[29]

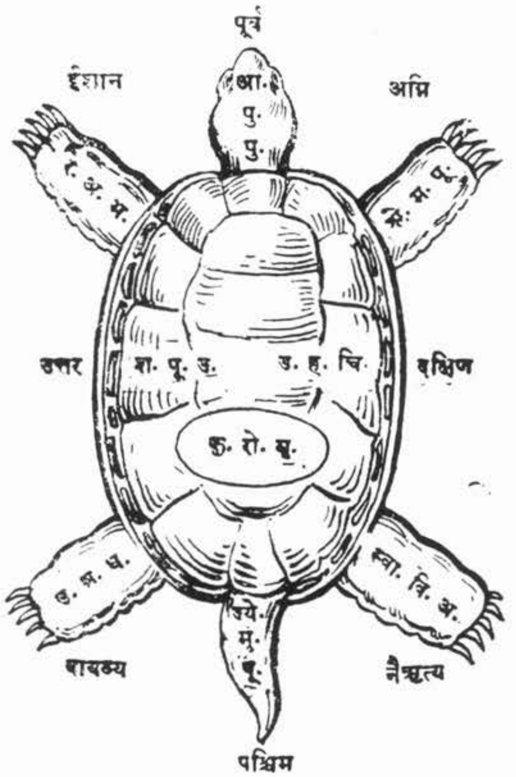

FIG. 16.4. THE WORLD SEEN AS A *KŪRMAVIBHĀGA* (DIVISIONS OF THE GLOBE), A PURANIC CONCEPTION OF THE MID-FIRST MILLENNIUM A.D. This diagram indicates for each of its nine divisions a set of three *nakṣatra*s (lunar mansions that exert an influence over the peoples and countries occupying that division). For example, on the head of the tortoise, signifying the eastern region of the earth, under the influence of the constellations Ārdrā, Punarvasu, and Puṣya, twenty-seven affected regions, peoples, mountains, and cities are listed in the *Mārkaṇḍeya Purāṇa*. These include places that can be identified with locales in the present areas of Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, Bengal, and Assam (all in northeastern India); "cannibals dwelling on the sea-coast"; and places whose present-day referents cannot be ascertained (e.g., Mount Jambū).
This drawing incorporates, among hundreds of other diagrams used as aids for divination, the Puranic conception described above. In this diagram, only the Sanskrit initials are provided. From Gaṇeśadatta Pāṭhaka, ed., *Narapatijayacaryāsvarodaya of Śrī Narapatikavi* (Varanasi: Chowkhamba Sanskrit Series Office, 1971), diagram on 109.

Regrettably, but not unexpectedly, the data of the *kūrmavibhāga*, though partly relating to the geography of the day, do not permit an accurate historical reconstruction of the map of ancient India, "due in large measure to the futile attempt of making the shape of India conform to that of a tortoise."[30]

Figure 16.4 is a reproduction of the *kūrmavibhāga* from a modern edition of a medieval astrological text, the *Narapatijayacaryā*, which was intended as a guide to divination.[31] This popular work, composed by Narapati in A.D. 1177, "describes various arrangements (*cakras*) of letters associated with time divisions and astrological entities, magical pictures of animals and objects (also called *cakras*), and arrangements of *nakṣatras* [asterisms], months, and numbers relative to the directions (bhūmis), all of which promote the military victory of their user."[32] The edition the figure was taken from contains scores of other diagrams that served purposes analogous to that of the *kūrmacakra*. I am unable, however, to specify how many of those diagrams relate primarily or largely to geographical referents. Pingree lists more than a hundred known manuscripts of the *Narapatijayacaryā*, as well as nine published editions over the period 1882 to 1955.[33] How many additional editions have been published since 1955 is not known. But the *Narapatijayacaryā* is only one among many technical texts on omens and divination (*saṃhitā*). The earliest of these is the *Gargasaṃhitā* (first century B.C. or A.D.), and the most important is the *Bṛhatsaṃhitā* of the sixth-century astronomer Varāhamihira.[34] A search through the thousands of surviving *saṃhitā* manuscripts would surely

29. Raychaudhuri, *Indian Antiquities*, 49 (note 21).

30. Raychaudhuri, *Indian Antiquities*, 49 (note 21). Niklas Müller, *Glauben, Wissen und Kunst der alten Hindus in ursprünglicher Gestalt und im Gewande der Symbolik* (Mainz: Florian Kupferberg, 1822; republished in facsimile form with afterword by Heinz Kucharski in Leipzig, 1968), provides an engraving of Müller's attempt to represent this conception of the cosmos (pl. I*).

31. Gaṇeśadatta Pāṭhaka, ed., *Narapatijayacaryāsvarodaya of Śrī Narapatikavi* (Varanasi: Chowkhamba Sanskrit Series Office, 1971), diagram on 109. For a synoptic reconstruction of the *kū-mavibhāga*, see Sircar, *Cosmography and Geography*, pl. VII, with relevant text on 90–98 (note 6).

32. David Pingree, *Jyotiḥśāstra: Astral and Mathematical Literature*, A History of Indian Literature, vol. 6, fasc. 4 (Wiesbaden: Otto Harrassowitz, 1981), 77.

33. David Pingree, *Census of the Exact Sciences in Sanskrit*, 4 vols., Memoirs of the American Philosophical Society, ser. A, vols. 81, 86, 111, and 146 (Philadelphia: American Philosophical Society, 1970, 1971, 1976, and 1981), 3:137–42.

34. Pingree, *Jyotiḥśāstra*, esp. chap. 4, "Divination," 67–80 (note 32).

reveal many diagrams of potential interest to historians of cosmography, but the task is so vast and its scholarly requirements are so formidable that such an undertaking could not be considered in the compilation of the present work. Nevertheless, I will illustrate below two examples (figs. 16.12 and 16.13) of the genre of astrological diagrams included in the *Narapatijayacaryā* and similar texts.

Divination with the aid of almanacs containing diagrams with terrestrial spatial referents—among others—is common in India, and practitioners of the art are sought out not only by simple village folk but by members of the elite as well. In the most common form of astrology, casting horoscopes, one "maps" on a chart (of which there are several standardized forms, depending on the system being followed) the position of the sun, moon, and planets at the moment of the client's birth; but of this I shall say nothing more. Other types of "mapping" take place on a person's body. In her work on the village of Pahānsu, the anthropologist Gloria Goodwin Raheja describes the process as follows:

> Settling in a new village or town involves, in the indigenous conceptualization, a matching of the person with these places, and inappropriate matchings may result in inauspiciousness. Ordinary villagers do not have a comprehension of the techniques used by the astrologer to determine whether the match will be auspicious or inauspicious, but they are aware of the sort of mapping of village to person that is involved. The mapping is carried out in the following manner.
>
> Beginning with the lunar asterism (*nakṣatra*) that corresponds with the first letter of the name of the village, the twenty-eight *nakṣatras* are mapped onto the "body" in the order in which the asterisms appear in the heavens. Thus, taking Pahansu as an example, Buddhu Pandit [the village astrologer] would start with *uttarā phālgunī*, the asterism that is associated with the Hindi syllable *pa*, and map the *nakṣatras*. . . .
>
> [Raheja here provides a table indicating seven asterisms each that are associated with the client's forehead, back, heart, and feet.]
>
> Having constructed the *nakṣatra* "body" in this way, the astrologer then notes the *nakṣatra* that corresponds to the first syllable of the name of the man who wishes to settle in the village. If that *nakṣatra* has "fallen" (*parnā*) on the forehead or heart, then the match between village and person is propitious, and the man's family will prosper there; if it falls on the back or the feet, inauspiciousness will afflict him if he settles in that village. In this procedure, the lunar asterisms are arrayed in an order specified by the particular village, and this ordering determines where the person's own name-asterism will fall. It is in this particular matching of the person with the village that the potential for auspiciousness or inauspiciousness lies.[35]

Yet another type of mapping Raheja describes relates to the way a farmer would seek to learn of an auspicious time and place to dig a well. In this case the astrologer would map the day's *nakṣatra*

> onto the space defined by the boundaries of the fields in which the farmer wishes to dig a well. The farmer gives a rough map (*nakṣā*) of his fields to [the astrologer, who] superimposes a diagram (*cakra*) of the directions over this. The squares of the diagram are propitious or not propitious for the digging because of their conjunction with the various asterisms. If the day's *nakṣatra* falls on a square that is unfavorable, then another day is chosen. Inauspiciousness (*kuśubh*) is produced if one acts in the context of an unfavorable conjunction of times and spaces.[36]

Along with this narrative, Raheja includes the diagram, oriented with east at the top. It shows the center, northeast, southeast, southwest, and north as auspicious (though only during the specified times) and the remaining three cardinal directions and northwest as inauspicious.[37] Finally, Raheja describes the procedures followed in the village of Pahansu before building a house. These are analogous to those I have just cited and also relate conceptually to practices described in the final section of this chapter concerning microcosmic analogues of the cosmos.[38]

Within the vast corpus of Indian cosmographic literature, references to regions, physical features, and peoples of the real world were not limited to texts on divination. In virtually all the Puranas the sections known as the *bhuvanakośas* (dictionaries of the world) combined not only accounts of the cosmos in its largest sense and of the general constitution of the earth, but also an abundance of geographical detail of a relatively localized nature. Unfortunately the lines of separation were not clearly drawn, and it is difficult even for the trained Indologist to ascertain when a particular text crosses the threshold between speculative fancy and empirical description.[39] In fact there exists no clear separation between the two. Portions of what is described appear to be based on dim transmuted memories of ancient

35. Gloria Goodwin Raheja, *The Poison in the Gift: Ritual, Prestation, and the Dominant Caste in a North Indian Village* (Chicago: University of Chicago Press, 1988), 52–53.

36. Raheja, *Poison in the Gift*, 53–54 (note 35).

37. She has also provided me with a copy of the rough sketch map to which the narrative relates; personal communication, 19 January 1989.

38. Raheja, *Poison in the Gift*, 54–56 (note 35).

39. Eck, "Rose-Apple Island," 8–12 (note 26). These pages also discuss the sections of the Puranas and of the *Mahābhārata* known as *tīrtha mahātmyas*, which supplement the sacred geographic texts of the *bhuvanakośas* and contain abundant references to real-world localities.

Aryan homelands far to the north of India; other passages seem to be distorted accounts, received perhaps through non-Aryans, of lands well beyond the then Aryan frontier; and still other descriptions are of real enough places within the Aryanized portions of India, but seen through the mystifying prism of religion.[40] Comparable observations can also be made in regard to the mixture of the real and the unreal in the texts of the Buddhists and the Jains, though both of those religions have been even more inclined to invention than were the ancient Hindus. In specific regard to the Jains, Sircar was moved to observe that they merited "thanks . . . for their power of imagination and passion for useless description in which they appear to have excelled the Puranic writers."[41]

A much-used and troublesome word in the cosmographic texts is *dvīpa*, which is variously rendered as continent, island, or island continent. Originally *dvīpa* "meant nothing more than a land between two sheets of water (usually rivers)" and was thus analogous to the contemporary Hindi/Urdu *doab* (interfluve).[42] This could help explain the early application of the term to certain island regions such as Videha (in this case the Malay Archipelago), but it would convey little sense in regard to desert regions such as Śākadvīpa (the Desert of Sistan). An argument sometimes invoked in regard to some of the arid *dvīpa*s in Central Asia is that they were seen metaphorically as islands in an "ocean" of sand, that is, essentially as oases. In any event, the surviving cosmographies indicate that *dvīpa*s could be separated by mountain ranges as well as by intervening seas.

The confusion about what a *dvīpa* might refer to is noteworthy because it provides a possible explanation of the persistent error on European maps derived from the *Geography* of Ptolemy or, more precisely, from later maps that sought to incorporate Ptolemy's geographic coordinates. These maps posited an enormous island of Taprobane (Sri Lanka) to the south of an India that is nonpeninsular in form. If one assumes that the Puranic Dākṣiṇātya or Dakṣiṇāpatha (the southern region or Deccan) was perceived as a *dvīpa* beyond the east-west trending Vindhya Mountains, then it might have been taken as a great southern island without any recognition of its separateness from ancient Laṅkā. Gossellin's commentary on Ptolemy lends support to that view:

> The deep embayment of the Gulf of Cambay, which is to the south of Gujarat, was able to appear to them [ancient navigators] as the beginning of the strait that they knew should separate Taprobane from India. A sense of order made them continue this strait up to the Gulf of the Ganges [Bay of Bengal], across the continents and from that time forward the eastern peninsula of India, considered as an island, could be confused with Ceylon to which one [i.e., the geographers of Alexandria] assigned the entire extent which that part of Asia ought to have had.[43]

The Jain conception of the world of man, Manuṣyaloka (below, fig. 16.24), appears to be derived from the Puranic view (fig. 16.3) that sees Jambūdvīpa within its encircling Lavaṇa Samudra (Salt Sea). But Manuṣyaloka also extends beyond that ocean to include all of a second continent, Dhātakīkhaṇḍa, the ring ocean beyond that, and half of a third ring continent, Puṣkaradvīpa, stopping at the circular chain of mountains midway across the ring. Thus, Manuṣyaloka is also styled the *adhai-dvīpa*, or earth of two and a half continents, reflecting the pervasive Jain fascination with numerology. Figure 16.5 depicts the key elements in the Jambūdvīpa of the Jains. Within this continent are subregions, also called *dvīpa*s or continents, that are separated by six east-west mountain ranges and, within what would be the large equatorial region, Videha, two north-south ranges, thus yielding a total of nine continents—three northern, three middle, and three southern—including the bowshaped Bhārata, the southernmost of all. Alternatively, one may speak of seven continents if one takes the three in the middle as a single entity. But whereas the original Puranic view saw the surrounding oceans as girdled by a single peripheral mountain ring, the Cakravāla (round perimeter) or Lokāloka (world-nonworld, i.e., the place where the world and the nonworld meet), the Jain texts expanded the number of concentric island continents to six, thereby bringing the total number of basic units to the conventional seven if one now considers the central Jambūdvīpa as a single entity.[44] And a post-Gupta work—date unknown, but not earlier than the mid-sixth century—named no fewer than sixteen inner and sixteen outer islands, each with an ocean beyond.[45] Nevertheless, relatively few surviving Jain depictions of this earth system show a large number of ring continents; one or two-and-a-half appears to be the usual number portrayed.

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40. Joseph E. Schwartzberg, ed., *A Historical Atlas of South Asia* (Chicago: University of Chicago Press, 1978), presents a set of maps (pp. 13, 14, and 27, plus relevant text on 162–65 and 182–83) that convey some sense of the extensiveness of historical geographic detail to be gleaned from the Vedas, the Epics, and the Puranas. In addition to these and other texts previously cited, the *Romaka Siddhānta*, a Sanskrit text probably dating from the sixteenth century, "displays considerable accurate knowledge of lands beyond India (Afghanistan, Iran, Central Asia); there are others as well from the 17th and 18th centuries" (David Pingree, personal communication, 21 December 1988; but he is not aware of any maps accompanying these works).

41. Sircar, *Cosmography and Geography*, 59 (note 6).

42. Raychaudhuri, *Indian Antiquities*, 68 (note 21).

43. Pascal François Joseph Gossellin, *Géographie des Grecs Analysée; ou, Les systêmes d'Eratosthenes, de Strabon et de Ptolémée comparés entre eux et avec nos connoissances modernes* (Paris: Imprimerie de Didot l'Ainé, 1790), 135, my translation. I thank Marie-Thérèse Gambin of the University of Paris VII for transmitting the relevant text. David Pingree takes issue with the argument presented here (personal communication, 21 December 1988).

44. Sircar, *Cosmography and Geography*, 57 (note 6).

45. Sircar, *Cosmography and Geography*, 58 (note 6).

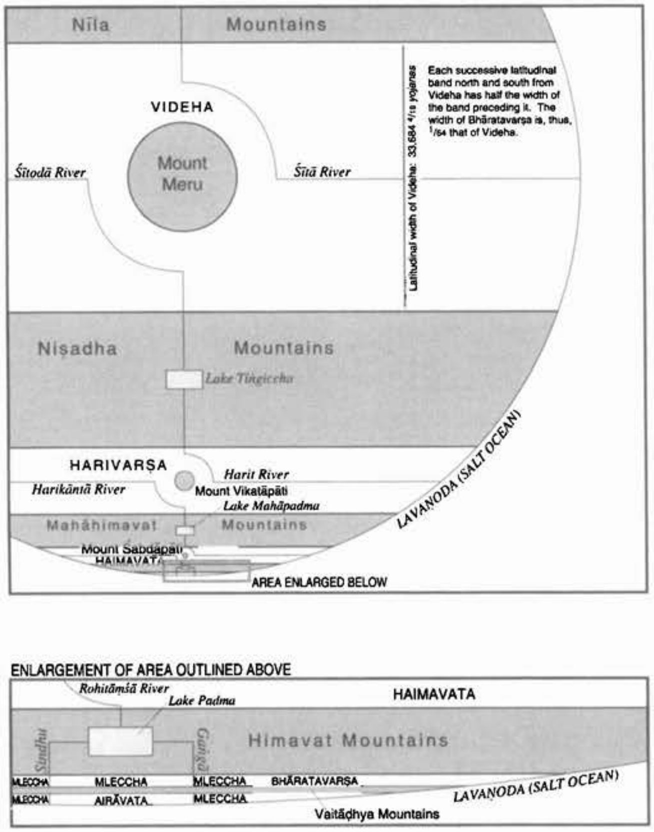

FIG. 16.5. SELECTED ELEMENTS OF A PORTION OF JAMBŪDVĪPA AS CONCEIVED BY THE JAINS. This diagram (a little more than one-fourth of the entire Jambūdvīpa) preserves the scalar relations stipulated in the Jain texts, in which the middle region, Videha, has twice the width, north-south, of the two adjacent mountain ranges, which are in turn twice as wide as the succeeding regions, Ramyaka (off the map to the north) and Harivarṣa, and so forth, until the northernmost and southernmost regions, Airāvata and Bhāratavarṣa (India), are reached. (Also beyond the northern limit of this diagram are the Rukmin and Śikharin Mountains, the equivalents of the Niṣadha and Mahāhimavat Mountains, and the Hairaṇyavata region, the equivalent of Haimavata.) Similar scalar relations obtain in respect to the heights and depths of the mountain chains; the length, breadth, and depth of lakes within the mountain ranges; the number of tributaries entering the pairs of rivers flowing east and west out of these lakes, and so forth. Not indicated in this view are the numerous east-west regional divisions within Videha and the one and a half continents and the Kāloda Ocean outward from Jambūdvīpa and the Lavaṇoda (Salt Ocean) that compose the rest of Manuṣyaloka. These are shown in figure 16.24.
The inset diagram shows an enlargement of a small area in the southernmost part of Jambūdvīpa, including much of Bhāratavarṣa and the Himavat (Himalaya) Mountains. A narrow mountain range, the Vaitāḍhya, through which the Gaṅgā and Sindhu rivers flow via great tunnels, divides Bhāratavarṣa into northern and southern halves, each with three *khaṇḍas* (divisions). Of the six *khaṇḍas*, five are domains of the Mleccha (barbarians) and only one, the southernmost, belongs to the Aryans.
Adapted from N. P. Saxena and Rama Jain, "Jain Thought regarding the Earth and Related Matters," *Geographical Observer* 5 (1969): 1–8; with additional data and nomenclature from Willibald Kirfel, *Die Kosmographie der Inder nach Quellen dargestellt* (Bonn: Kurt Schroeder, 1920; reprinted Hildesheim: Georg Olms, 1967; Darmstadt: Wissenschaftliche Buchgesellschaft, 1967), 214–33, 251.

To this point our concern with cosmography has been almost exclusively in regard to the earth. But our planet constitutes only an infinitesimal portion of the universe. That perception was shared by all three of the major indigenous religions of India, and each gave rise to a number of conceptions of the universe, some of remarkable complexity. Not only that, Buddhists and Jains came to believe in an infinite number of universes. Hindus, by contrast, seemed content to believe that a limited number of named gods—Indra, Varuṇa, Vāyu, Agni, Āditya, Yama, and so on—created their own worlds, just as Brahma created our earth and its associated heavens, netherworlds, and hells—seven or more of each, depending on the text consulted. However, "the notions as to the situation of these worlds (except those of Indra and Yama) seem always to have been rather vague."[46]

For our own universe, the Hindu views also appear relatively simple. One such view, expounded in the Puranas, is "that each generating principle or element envelops the one generated by it. The gross elements combine into a compact mass, the world-egg (brāhmāṇḍa), which rests on the waters, and is surrounded by seven envelopes—water, wind, fire, air, Ahaṁkāra [a substance producing the 'conceit of individuality'], Buddhi [the 'thinking substance'], and Pradhāna [an amalgam of darkness, activity, and goodness]."[47]

The universes envisioned by the Jains are far more complex and wondrous than those of Hinduism, though compounded of many of the same elements and similar also in presenting a vertical sequence of hells, netherworlds, earth, and heavens. Jains also postulated that their multiplicity of universes occupied only a portion of cosmic space. Each universe is called a Lokākāśa, and beyond it is the Alokākāśa, "an absolute void . . . perfectly impenetrable to anything, either matter or souls." Coterminous with the Lokākāśa are "Dharma and Adharma, the substrata of motion and rest, . . . [and] the indispensable conditions . . . of all existing things."[48]

Jains envisage our own universe as consisting of a series of netherworlds increasing regularly in size with distance below the world of man and a series of heavenly realms above it that increase regularly in size up to a certain limit and then decrease regularly beyond that limit (fig. 16.6).

46. Jacobi, "Cosmogony and Cosmology (Indian)," 159 (note 2).
47. Jacobi, "Cosmogony and Cosmology (Indian)," 159 (note 2).
48. Jacobi, "Cosmogony and Cosmology (Indian)," 161 (note 2).

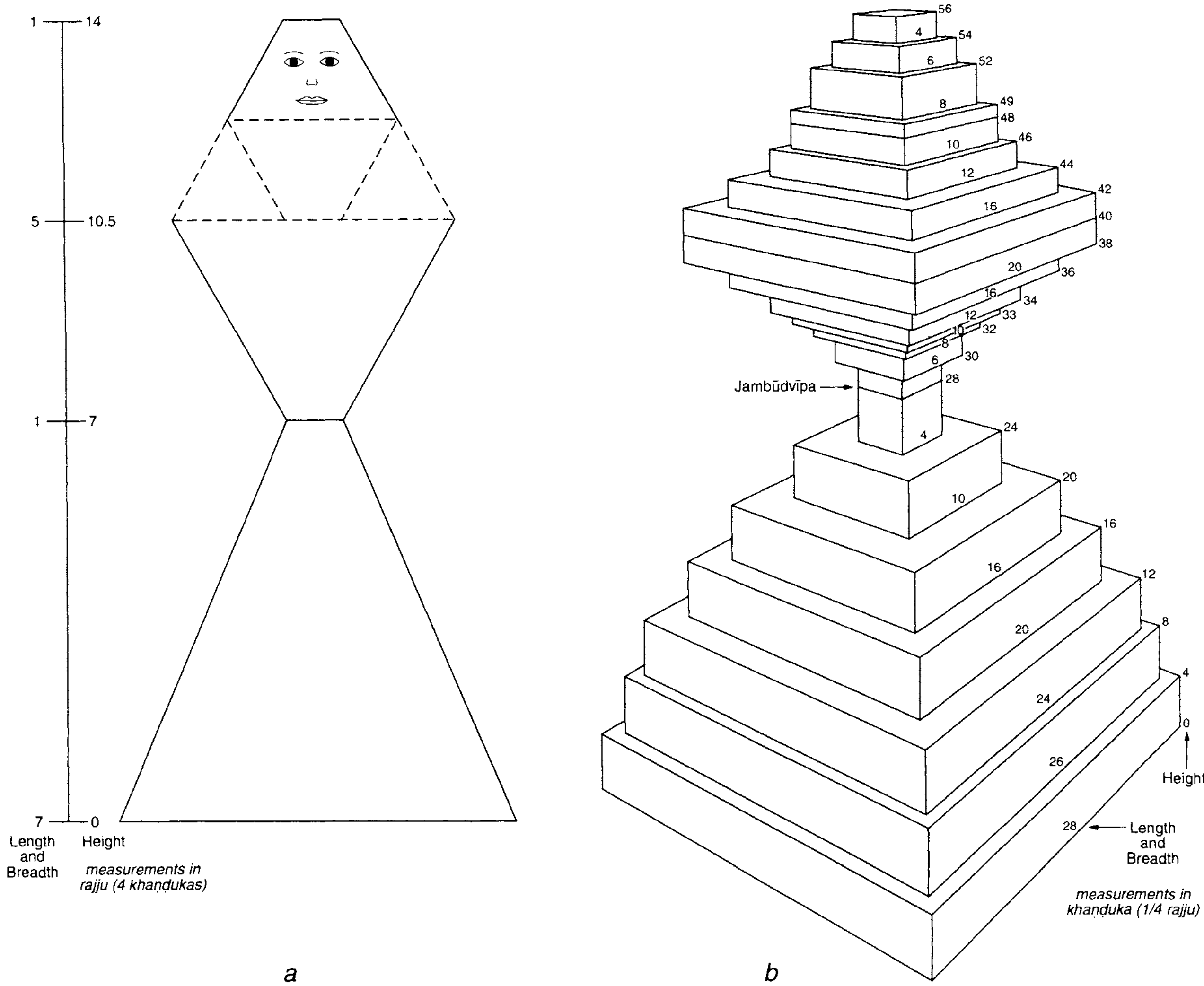

FIG. 16.6. ALTERNATIVE CONCEPTIONS OF THE FORM OF THE JAIN UNIVERSE. The dimensions in *rajjus* (see text for definition) are explicit for conceptions *a* and *b*. In each view there is a succession from the lowest and widest hell up to the middle level, that of Jambūdvīpa, with widths of seven and one *rajju*, respectively; then to successively wider heavens, the widest of which has a breadth of five *rajjus*, and finally, successively narrower heavens, the uppermost being one *rajju* in width. Figure 16.29 below provides a view in conformity with conception *b*.
After D. C. (Dineshchandra) Sircar, *Cosmography and Geography in Early Indian Literature* (Calcutta: D. Chattopadhyaya on behalf of *Indian Studies: Past and Present*, 1967), pls. III and IV.

Each heaven and hell had its own special properties. Figuratively, the ensemble was seen as a woman (or man) standing with arms akimbo, presumably a throwback to the Vedic myth of the Puruṣa (cosmic or primeval man).[49] The dimensions of the several portions of the Jain universe are a triumph of the human imagination. The unit in which they are measured is the *rajju*, literally a rope, which is defined as "the distance which a male celestial being flies in six months at the rate of 2,857,152 *yojanas* in one *samaya* or the shortest unit of time."[50] And a *samaya* has been translated as a "blink, which is about 1/5 of a second."[51]

Since Buddhism virtually disappeared from India proper not long after the establishment of the Delhi Sultanate (A.D. 1206), there is little likelihood of uncovering on the subcontinent many surviving representations of the cosmographic conceptions associated with that faith,

49. Gombrich, "Ancient Indian Cosmology," 130 (note 1). The same schema is presented in numerous other works.

50. A. Ghosh, ed., *Jaina Art and Architecture*, 3 vols. (New Delhi: Bharatiya Jnanpith, 1974–75), 3:516, n. 2. Several other sources, including Kirfel, *Die Kosmographie*, 210 (note 4), give the figure 2,057,152 instead of the 2,857,152 cited here, which indicates that a typographical error occurs in the Ghosh text.

51. Gombrich, "Ancient Indian Cosmology," 121 (note 1). An appendix to Kirfel, *Die Kosmographie*, 331–39 (note 4), provides a synoptic set of tables of spatial and temporal measures specified in the ancient literature of Hinduism, ancient Indian Buddhism, and Jainism.

apart from those embodied in stupas and other enduring architectural monuments.[52] Although there are a number of surviving South Asian Buddhist texts that describe the structure of the cosmos, none of these, so far as I am aware, incorporates relevant illustrations.[53] Hence I shall defer any additional discussion of the underlying cosmological conceptions of the Buddhists until the chapters on Tibet and Southeast Asia in volume 2, book 2, where it will be more apposite.

Cosmographies in the Hindu Tradition

Paintings and Ink Drawings Not Primarily Astronomical in Content

Compared with the surviving cosmographies of the Jain tradition—an exceedingly large number—those clearly identifiable with Hinduism are surprisingly few. The reasons for this seeming paradox are provided in the following section on Jain cosmography. With the exception of simple representations of the cosmic egg, all the examples I know are hybrid in that they combine elements of two or more of the conceptions noted above in regard to the structure of the cosmos. Simpler views were undoubtedly once made, but they do not appear to have been preserved, and it seems probable from the Puranic texts that compound views originated very early in Indian history.

A remarkably striking depiction of the *hiraṇyagarbha*, literally "golden womb or fetus," has been reproduced in a number of publications.[54] Described as the golden egg or germ that "symbolizes the birth of the cosmos. . . . [and the] source of energy for all being," the *hiraṇyagarbha* is shown floating in a field of "primordial waters."[55] Its upright position suggests that even in this nascent form the universe comprises a vaulted dome and a correspondingly shaped nether region.

Somewhat more complex is the conception illustrated by figure 16.7, which shows, according to Rawson, the "primary divisions within the fertilized world-egg."[56] This interpretation is in keeping with an enduring Tantric tradition within Hinduism that is shot through with sexual imagery. But whether or not it is correct, it does seem clear that the nine divisions of the egg that are portrayed are those of Jambūdvīpa illustrated in figures 16.3 (rotated ninety degrees) and 16.9, with three continents each to the right and left of the central continent, Ilāvṛta, one continent each above and below, and within Ilāvṛta, a proto-Meru, the emerging *axis mundi*. Separating these variously colored continents are bands that are also of various hues, indicating mountain ranges. The outer ring ocean and mountain range (Lokāloka) are missing, however. Here the world egg is lying on its side, in contrast to the vertical position of the earlier mentioned *hiraṇyagarbha* and of figure 16.3. One supposes, therefore, that east lies at the top of the painting. But possibly the orientation was an expedient one, adapting the painting to the shape of the page in the manuscript containing it, whose nature cannot now be ascertained.

A third and still more differentiated cosmography appears in figure 16.8, which "shows a world . . . very similar to that described in the Epics and Purāṇas."[57] The painting is unquestionably in the tradition of Vaishnavism, one of the two principal divisions within Hinduism,

52. A particularly important survival, however, is the giant, partially obliterated fresco of a *bhavacakra* (wheel of life) in the porch section of Cave 17 at Ajanta, which Walter Spink dates from about A.D. 470, as opposed to the more conventionally accepted date of about 530. The problem is discussed by Spink in "The Vākātakas Flowering and Fall," in a forthcoming volume of proceedings of an international conference on the art of Ajaṇṭā, held at Maharaja Sayajirao University in Baroda in 1988, ed. Ratan Parimoo. Since the work in question is said to be the basis for a similar painting in Samye monastery in Tibet, which will be discussed and illustrated in the *History of Cartography*, volume 2, book 2, I will not deal with it further at this point.

53. Although the texts themselves lack illustrations, the authors of a number of modern secondary sources have constructed illustrations based on them. Two are especially noteworthy. The first is a diagram of the *cakkavāla* (world disk), seen from above and in horizontal cross section, scaled as nearly as possible to the stipulated dimensions of the Pali *abhidhamma* (higher doctrine) by Daniel John Gogerly in *Ceylon Buddhism*, 2 vols., ed. Arthur Stanley Bishop (Colombo: Wesleyan Methodist Book Room; London: Kegan Paul, Trench, Trubner, 1908), vol. 2, frontispiece. The other, titled "The Components of the Cosmos," provides a more encompassing three-dimensional oblique perspective view reconstructed from the fifth-century *Maṇimēkalai*, the only surviving Indian Tamil Buddhist text, by Paula Richman in *Women, Branch Stories, and Religious Rhetoric in a Tamil Buddhist Text*, Foreign and Comparative Studies/South Asian Series 12 (Syracuse: Maxwell School of Citizenship and Public Affairs, 1988), diagram on 85, key on 86, and methodological note, "The Design of Figure 2: Buddhological and Cartographic Considerations," on 175–76 and 242. The Gogerly diagram is also reproduced in W. Randolph Kloetzli, *Buddhist Cosmology, from Single World System to Pure Land: Science and Theology in the Images of Motion and Light* (Delhi: Motilal Banarsidass, 1983), 32. Additionally, Kloetzli provides a series of seven tables that indicate systematically the organization of the cosmos according to various Buddhist schemata (pp. 33–39). Finally, in his discussion of bibliographical resources, he singles out numerous works that include "diagrams of the 'cakravāla-cosmology' " (pp. 146–50), not all of which I have had an opportunity to examine. A more succinct treatment, also by Kloetzli, appears in his article "Buddhist Cosmology," in *The Encyclopedia of Religion*, 16 vols., ed. Mircea Eliade (New York: Macmillan, 1987), 4:113–19.

54. Ajit Mookerjee, *Tantra Art: Its Philosophy and Physics* (New Delhi: Ravi Kumar, 1966), 68 and pl. 33 (p. 58); Anand Krishna, ed., *Chhaavi: Golden Jubilee Volume: Bharat Kala Bhavan, 1920–1970* (Varanasi: Bharat Kala Bhavan, 1971), cover illustration; and Walter M. Spink, *Krishnamandala: A Devotional Theme in Indian Art*, Special Publications, no. 2 (Ann Arbor: Center for South and Southeast Asian Studies, University of Michigan, 1971), fig. 5, p. 1.

55. Mookerjee, *Tantra Art*, 68 (note 54).

56. Philip Rawson, *The Art of Tantra*, rev. ed. (New York: Oxford University Press, 1978), fig. 161 (p. 197).

57. Collette Caillat and Ravi Kumar, *The Jain Cosmology*, trans. R. Norman (Basel: Ravi Kumar, 1981), 58.

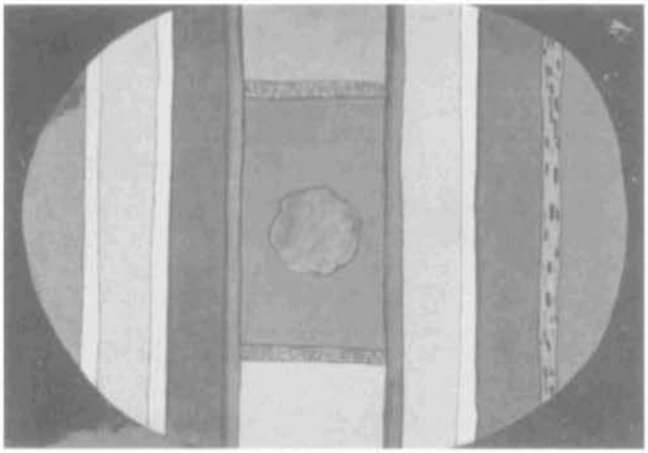

FIG. 16.7. PRIMARY DIVISIONS WITHIN THE COSMIC EGG. Though this diagram bears no text, it is immediately recognizable as a representation of the cosmographic conception illustrated by figure 16.3 above (rotated ninety degrees). It is gouache on paper, Rajasthani, and dated eighteenth century. Size of the original: 27 × 42 cm. From Ajit Mookerjee, *Tantra Art: Its Philosophy and Physics* (New Delhi: Ravi Kumar, 1966), pl. 43 (p. 70), by permission of Ravi Kumar.

characterized by worship of the lord Vishnu in his various forms and avatars with which particular realms of the universe are associated. Vishnu's most important incarnation, Krishna, for example, is here shown in paradise (Vaikuṇṭha), while Varāha, the Boar avatar, is shown in the cosmic waters from whose depths he raised the earth after it had been cast there by a demon.[58] This complex diagram includes various heavens and hells, above and below the earth, depicted in its middle register; seven protective sheaths around Brahmāṇḍa, the cosmic egg; and numerous figures from Indian mythology, only a few of which are identified in the legend.

A nineteenth-century Rajasthani painting not illustrated in this work, similar in many respects to the one described above but representative of the Shaivite branch of Hinduism, whose principal deity is Shiva, has been reproduced by the Belgian art historian Armand Neven.[59] This painting, however, though devoid of text, is much more highly structured and symmetrical than the foregoing work. The seven heavens and hells are more clearly differentiated from one another, and each is illustrated with its characteristic denizens or objects. The oblong shape of the previous cosmography is retained, as are the seven enveloping rings. At the base of the seven Pātālas is a large turtle, sustaining all the higher levels. The principal difference between the two paintings lies in the rendition of the middle band, which represents not only Jambūdvīpa, in which the nine continents noted in figure 16.3 are similarly arrayed, along with Mount Meru, but also to the left (north) and right (south), truncated arcs of the six additional concentric ring continents surrounding it. Most of the cosmography is seen ranged along a vertical axis, but the middle band is rotated ninety degrees, so that we view it horizontally as if from a point above Mount Meru. This device, as we shall see, also characterizes many Jain cosmographies.

Yet another cosmography of Rajasthani provenance, from around the turn of the eighteenth century, is presented in figure 16.9. This illustration includes all three supreme deities of the Hindu pantheon, with Brahma, the creator, occupying a central position and, as in figure 16.8, a number of lesser deities as well, in various areas of Jambūdvīpa. The portion of the tripartite cosmos depicted lies within a middle stratum, Rajas (the phenomenal world), below Sattva (the world of superior consciousness), and above Tamas (the netherworld). Since all three major strata (*trilokas*) are intersected by the seven spokes radiating out from Jambūdvīpa, the cosmos is divided into twenty-one *lokas* (zones).[60]

Of particular interest in figure 16.9 is the iconic representation, through color and other devices (e.g., the nature of specific deities) of time as well as space, and the heroic attempt to integrate the two in a two-dimensional field. The representation of Meru by a lotus, a common cosmographic motif, is also noteworthy. Here the lotus has eight petals, whereas in many other contexts it has four (cf. figs. 15.3, 16.1, 16.14, and 16.18). Seen in this cosmography, unlike those previously discussed, are four rivers emanating from Meru and flowing to the edge of Jambūdvīpa, a feature that is also characteristic of the cosmographic conceptions of Buddhism and Jainism. Other Hindu cosmographies on which these rivers appear include the globes depicted in figures 16.14, 16.15, and 16.18 and in plate 26. Also to be noted here, for the first time, are the seven radial spokes. Although Mookerjee does not comment on their material nature and function, they do find echoes in some Jain cosmographies. Finally, we may note that the elephants representing the four cardinal directions are placed near the corners of the map, which strictly speaking should represent the intermediate directions (NE, SE, SW, and NW). Presumably this was done for aesthetic reasons, which overrode any desire for exactitude.

From an uncertain locality in southern India comes a cosmography (fig. 16.10) that is strikingly different in some respects from others presented to this point, yet remarkably similar in other ways. The similarities include

58. Basham, *Wonder That Was India*, 302–9 (note 15), provides a succinct account of the place of Vishnu and his avatars in Hindu mythology and of the important myths associated with each.

59. Armand Neven, *Peintures des Indes: Mythologies et légendes* (Brussels: Crédit Communal de Belgique, 1976), fig. 10 (p. 12) and 68.

60. Ajit Mookerjee, *Tantra Asana: A Way to Self-Realization* (New York: George Wittenborn; Basel: Ravi Kumar, 1971), pl. 37, text on 66.

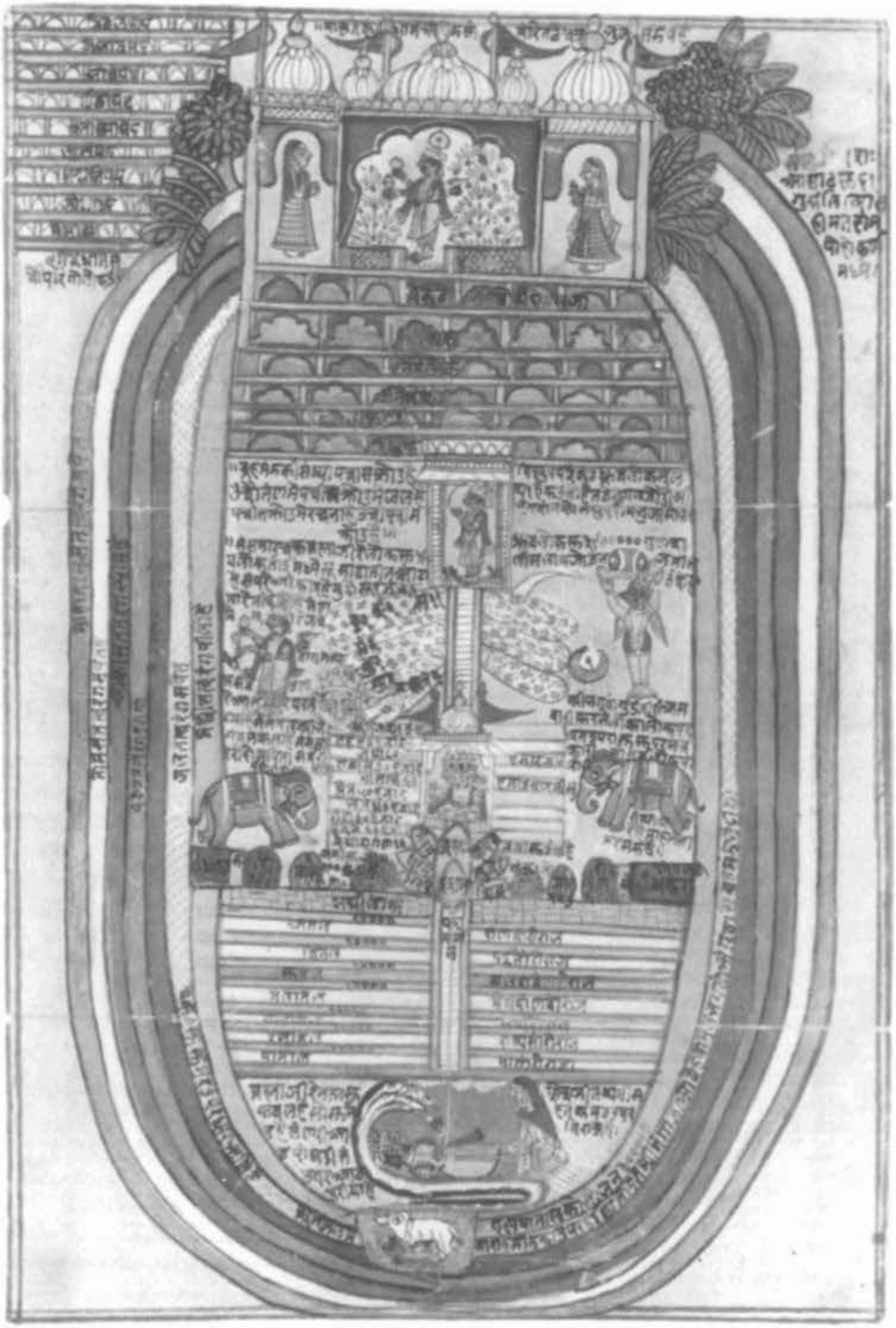

FIG. 16.8. VAISHNAVITE HINDU COSMOGRAPHY. This painting is gouache on paper, Rajasthani, eighteenth century. Collette Caillat and Ravi Kumar describe it, in part, as follows: "A brief glance shows the cosmic egg, surrounded by seven wrappings. Inside, at the bottom, in the depths of the cosmic waters are the Tortoise, the Boar, and Viṣṇu seated upon [the Serpent,] Śeṣa; from Viṣṇu's navel protrudes the lotus upon which Brahmā sits. The universe is divided into two vast aggregates. In the lower part, are the seven levels of underground regions called Pātālas, here very close together. Then barely outlined, is the lowest infernal region, of Naraka; in the upper section are the seven levels, *bhūr*, *bhuvar*, *svar*, etc., starting with the earth, continuing with space (which with its wonderful inhabitants goes right up to the course of the sun), and going still higher, to end at their peak in the paradise called Vaikuṇṭha, an enchanting spot where Kṛṣṇa dwells" (Collette Caillat and Ravi Kumar, *The Jain Cosmology*, trans. R. Norman [Basel: Ravi Kumar, 1981], 58).
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

the oblong shape of the universe, even more evident here than in the preceding view, its essentially vertical axis, the exterior sheathing of the universe by ten nested rings, the existence of eleven upper heavens and ten lower hells, two turtles below the lowest hell, a five-headed serpent atop one of the turtles, the positioning of Jambūdvīpa between the heavens and hells, and the placement around Jambūdvīpa of a number of annular continents. But absent from this view is any addiction to the auspicious number seven in respect to the features just noted. The most distinctive feature of the painting is the grouping in a line above Mount Meru of symbols depicting the planets (including the sun and moon) and their paths, along with associated deities. The two small chariots on either side are said to represent the "eclipse cycle."[61]

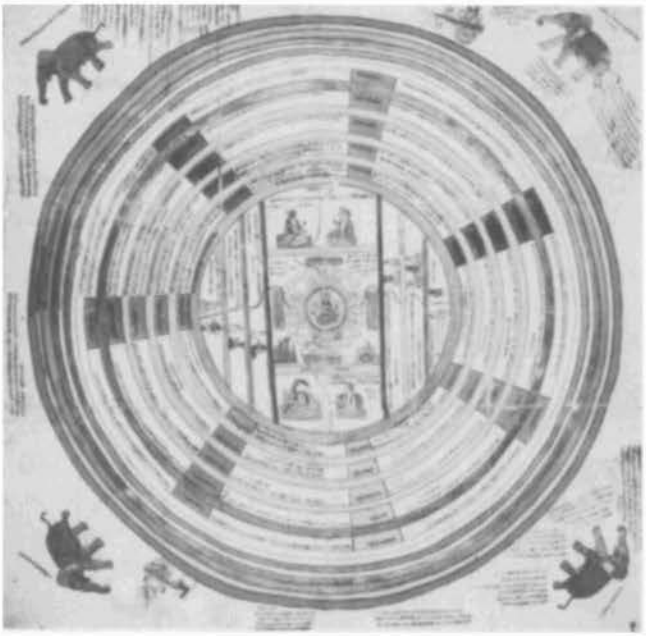

FIG. 16.9. BRAHMĀṆḌA (EGG OF BRAHMA). This gouache-on-paper rendition of the egg of Brahma is probably from Rajasthan, ca. 1700. Here, Brahma, the creator and the first deity of the Hindu trinity, occupies a central position, while Vishnu the preserver and Shiva the destroyer are seated above him (left) and below (also left). Other deities, each with a specific function in terms of world creation, preservation, and destruction appear within the ninefold central world/continent, Jambūdvīpa, which is in turn within Rajas, the middle major stratum of an essentially tripartite universe. The five innermost circles, those intercepting the seven spokes, represent mountain ranges in the following sequence, from the center outward: Suvarṇa (Gold), Puṣpaka (Flower), Devānīka (Abode of Angels), Meru (*sic*, at the center of the earth, though that is not evident here), and Mandarācala (where the earth joins the rest of the universe). The colors for these five rings are also said to signify periods of time in the following sequence: blue for the time prior to the earth's formation, gold for the Satyayuga (era of truthfulness), purple for the Dvāparayuga (era of degradation), yellow for the Tretāyuga (when good and evil coexist), and grey for the Kaliyuga (age of darkness). The seven outer circles represent different colors of the cosmos. The four elephants (Diggaja) conventionally represent the protectors of the four cardinal points. The two chariots, pulled by seven horses (upper right) and by a deer (lower left), signify the Sun (day) and Moon (night) respectively. The individual horses symbolize the seven Hindu planets.
Size of the original: not known. From Ajit Mookerjee, *Tantra Asana: A Way to Self-Realization* (New York: George Wittenborn; Basel: Ravi Kumar, 1971), 66 and pl. 37, by permission of Ravi Kumar.

Another south Indian cosmography, the largest I have seen or know about, is found in the waiting hall of the renowned Mīnākṣī (Meenakshi) temple in Madurai. Painted in oils on canvas, its dimensions are about 4.25 × 4.25 meters. The work, executed by N. S. R. Regunathan and entitled *Bhūgolam* (Globe/Geography), is one of a pair. The other member of the pair—discussed below—is entitled *Khagolam* (Celestial dome). The two works, painted in A.D. 1963 and 1966, are said to be replacements for similar productions, made in 1568, that were accidentally whitewashed and destroyed. Painted in a rich palette, with seas and continents in a variety of colors, the work has abundant text in the Tamil script and language and many numbers in the Westernized Arabic form that indicate the dimensions of and distances between various parts of the cosmos. The work includes the central continent, Jambūdvīpa, with its now familiar ninefold division and a north-south vertical axis. From a very prominent Mount Meru in the center of Jambūdvīpa flow four rivers, one in each cardinal direction (though not quite symmetrically disposed), and around Meru are nine or ten ring continents (depending on whether one includes Lokāloka, the outermost ring) with intervening seas, much as in figure 16.9. A survey of other major Indian temples would almost certainly reveal other cosmographies of this and other genres.[62]

There is yet another remarkable eighteenth-century cosmographic painting from the south Indian state of Tamil Nadu, which I was allowed to view briefly, but not to photograph, at the Sarasvati Mahal Library attached to the former royal palace of Thanjavur (Tanjore). It is an exceedingly complex work, painted on wood, possibly in oils, in a miniature style (ca. 60 × 40 cm). The painting appears to be either the model from which a very large wall painting was copied or a copy made from the wall painting, possibly to preserve the content of the latter before it was lost through dismantling or neglect. In either event, the small painting has the same content and layout as one described by Adolf

61. Kapila Vatsyayan, "In the Image of Man: The Indian Perception of the Universe through 2000 Years of Painting and Sculpture," in *Pageant of Indian Art: Festival of India in Great Britain*, ed. Saryu Doshi (Bombay: Marg Publications, 1983), 9–14, esp. fig. 6.

62. I thank B. Arunachalam for calling my attention to the paintings cited in this paragraph.

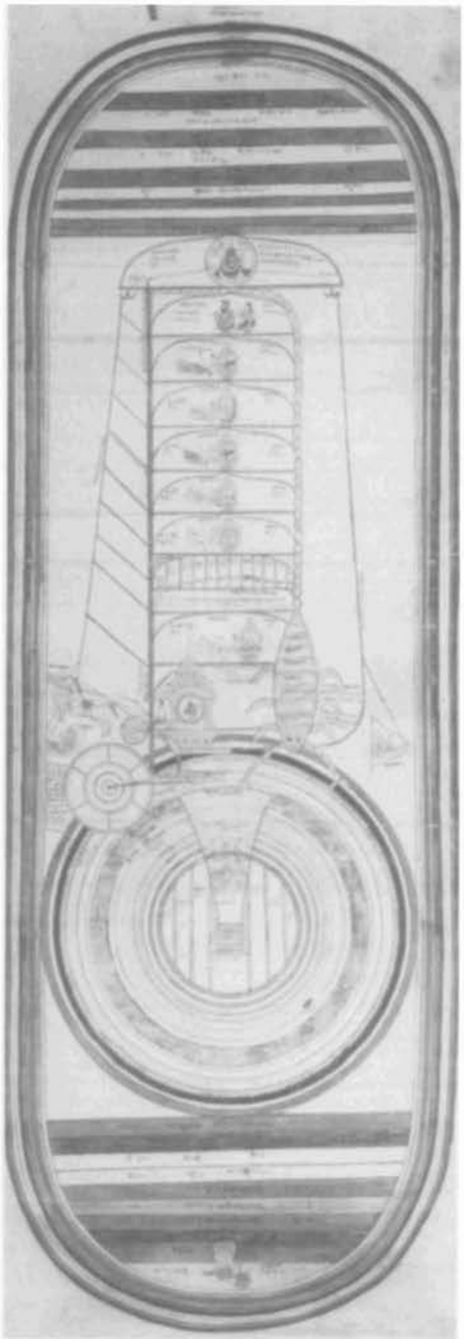

FIG. 16.10. THE PATH OF THE PLANETS. Though containing many elements in common with figures 16.8 and 16.9, this cosmography conveys a clearer sense of the vertical stratification of the universe. Jambūdvīpa, rotated ninety degrees from its horizontal plane, and the sky above it—both a part of the middle stratum of that universe—occupy most of the painting. Within the sky above Meru are the sun, the moon, and the five visible planets, their associated deities, and Rāhu and Ketu (deities associated with eclipses). The artifact is gouache on paper (?), from Deccan or Tamil Nadu, ca. 1750.
Size of the original: 160 × 48 cm. Courtesy of the Board of Trustees of the Victoria and Albert Museum, London (I.S. 09329).

Bastian in 1892, but this larger work was not visible in the library in 1984.[63] The purposes of the painting, as of many other cosmographies, were obviously both didactic and eschatological. But the emphasis appears to have been more on the world and the actions of ordinary mortals than is the case with other works previously discussed. The painting deals not only with the various components of the Brahmanical Hindu universe and their associated deities, sacred trees, animals, and other denizens, but also with the zodiac, various types of sacrifice, important pilgrimage places (pictured in four groups, by region, for the whole of India), virtuous and evil acts and their rewards and punishments, types of rebirth, and types of hell. Since Bastian provides a very full account of this work and a pen-and-ink outline showing the spatial relationship of its several parts, I shall not discuss it further.

In several of the Hindu cosmographies described to this point, I have noted the placement of major and lesser deities within various portions of the cosmos; but to the Hindu mind it would also be no less appropriate to show the cosmos within a particular deity. Plate 25 shows one among many similar artistic interpretations of that potentiality. It is inspired by an episode recounted in the *Bhagavadgītā* section of the *Mahābhārata* during which Lord Krishna demonstrates his power to the hesitant warrior Arjuna by making the whole universe appear within his body.[64]

In fact, there is much in this illustration—despite what is stated above—that is situated outside the body of Krishna, including what seems to be the equivalent of the oblong sheaths of the universe noted in figures 16.8 and 16.10. I am not able to provide the meaning of these other elements.

That the universe is shown in plate 25 as resting on a snake and in other views on a tortoise or even on a snake supported by a tortoise serves to underscore the variety and inconsistencies within Hindu mythology and the latitude that artists and art historians enjoy in portraying and interpreting it. The tortoise, we have seen, was a minor element in several cosmographies, but it also occupies a principal position, as noted above, in the *kūrmavibhāga* texts.

Apart from the reconstruction of the *kūrmacakra* (fig. 16.4), I have seen no cosmography in which the various components of the *kūrmavibhāga* are delineated. But from Nepal we do have a relevant painting (fig. 16.11)

63. Bastian, *Ideale Welten*, vol. 1, pl. 1 (note 5). The basis for assigning this painting to the eighteenth century lies in its mention in a catalog of the collections of the library prepared with the assistance of one "Scharfoji Raja," said to be a student of the German missionary Schwarz, who worked in Tanjore in the latter half of the eighteenth century (noted by Bastian, 1:273).

64. Aman Nath and Francis Wacziarg, *Arts and Crafts of Rajasthan* (London: Thames and Hudson; New York: Mapin International, 1987), 167–68.

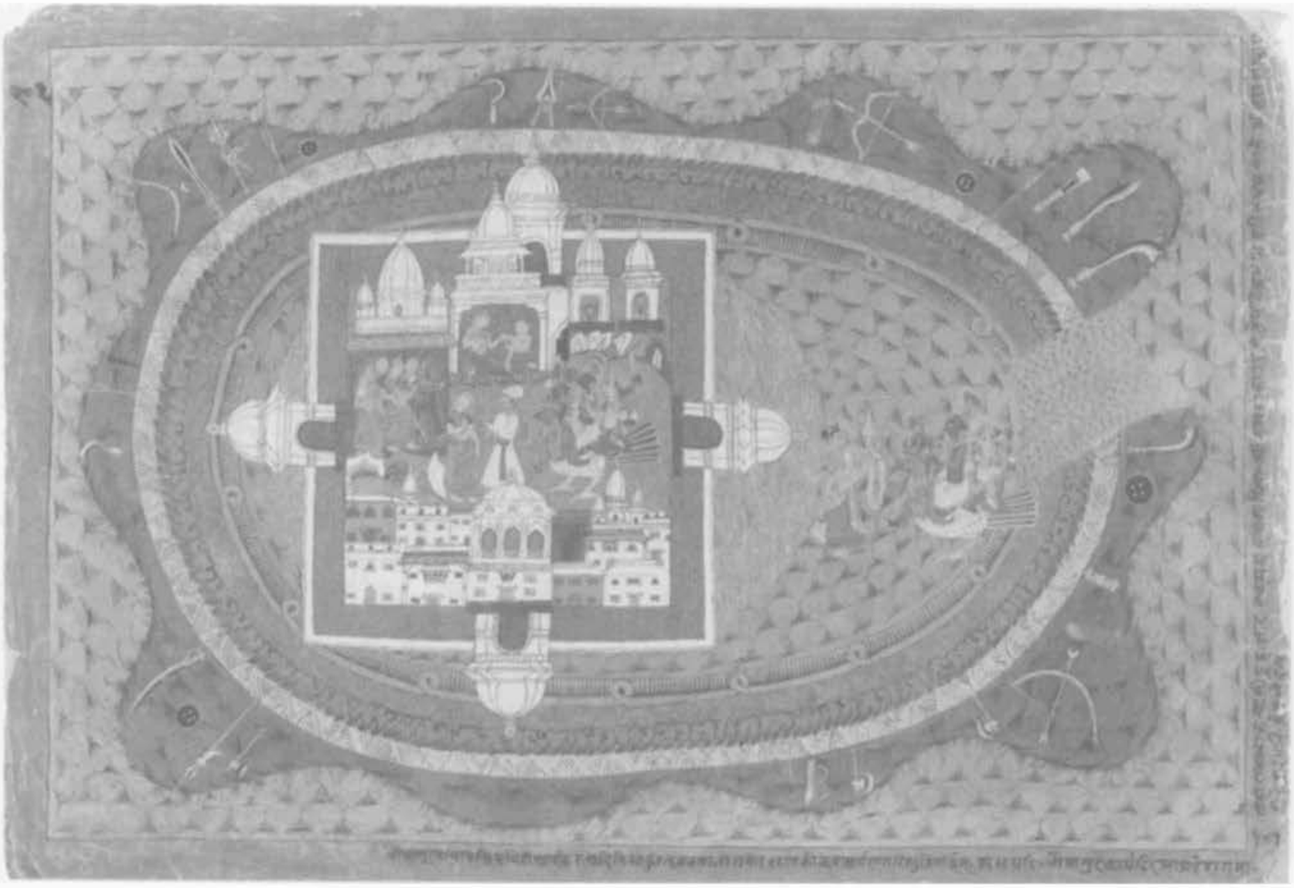

FIG. 16.11. KRISHNA AND HIS CONSORT DESCEND TO PRĀGJYOTIṢA (ASSAM), SITUATED ON A TORTOISE-SHAPED EARTH. This delightful painting, gouache on paper, Nepali, eighteenth century, is from one of many printed recensions of the *Bhāgavata Purāṇa*, recounting some of the exploits of Lord Krishna. It combines the cosmographic conception of a tortoise-shaped earth with the idea of concentric ring continents and oceans.
Size of the original: 38.1 × 55.8 cm. By permission of the Los Angeles County Museum of Art (M.72.3.1), gift of the Michael J. Connel Foundation.

from an eighteenth-century illustrated recension of portions of the *Bhāgavata Purāṇa*, a text dating from the eighth century that recounts the life of Lord Krishna. The scene depicts Krishna with his consort, descending from the sky on his avian mount to the palace of the demon Narakāsura, king of Prāgjyotiṣa (modern Assam). The palace is here placed on the back of a tortoise, which is symbolic of the earth as a whole.[65] A noteworthy feature of the painting is its inclusion of two peripheral ring oceans (one in blue swirls and the other in a white basket-weave pattern) separated by a ring of red mountains as well as an inner ocean (in a blue basket-weave pattern) on which the palace rests. Thus it does incorporate in an altered form some of the elements that have been previously noted in Hindu cosmographies.

Innumerable paintings of this type, in which individual cosmographic elements—Mount Meru, Mount Kailāsa, the Gaṅgā (Ganges) River, a particular celestial abode, and so forth—form a major component, appear in South Asian art. Comparable works are also common in sculpture. Regrettably, even a general inventory of works that have been published was deemed not to be practicable in compiling this history.

From various places in Rajasthan come a group of generically similar geometric diagrams that may be regarded as essentially cosmographic even though the names they contain relate largely, if not entirely, to terrestrial localities distributed over regions that vary widely in extent. Four of these were brought to light by Gole,

65. Pratapaditya Pal, *Art of Nepal: A Catalogue of the Los Angeles County Museum of Art Collection* (Berkeley: Los Angeles County Museum of Art in association with University of California Press, 1985), large color plate P35b on p. 77, illustration on p. 228, and caption on 229; also idem, *Nepal: Where the Gods Are Young* ([New York]: Asia Society, [1975]), fig. 85b (p. 114), and text on 133.

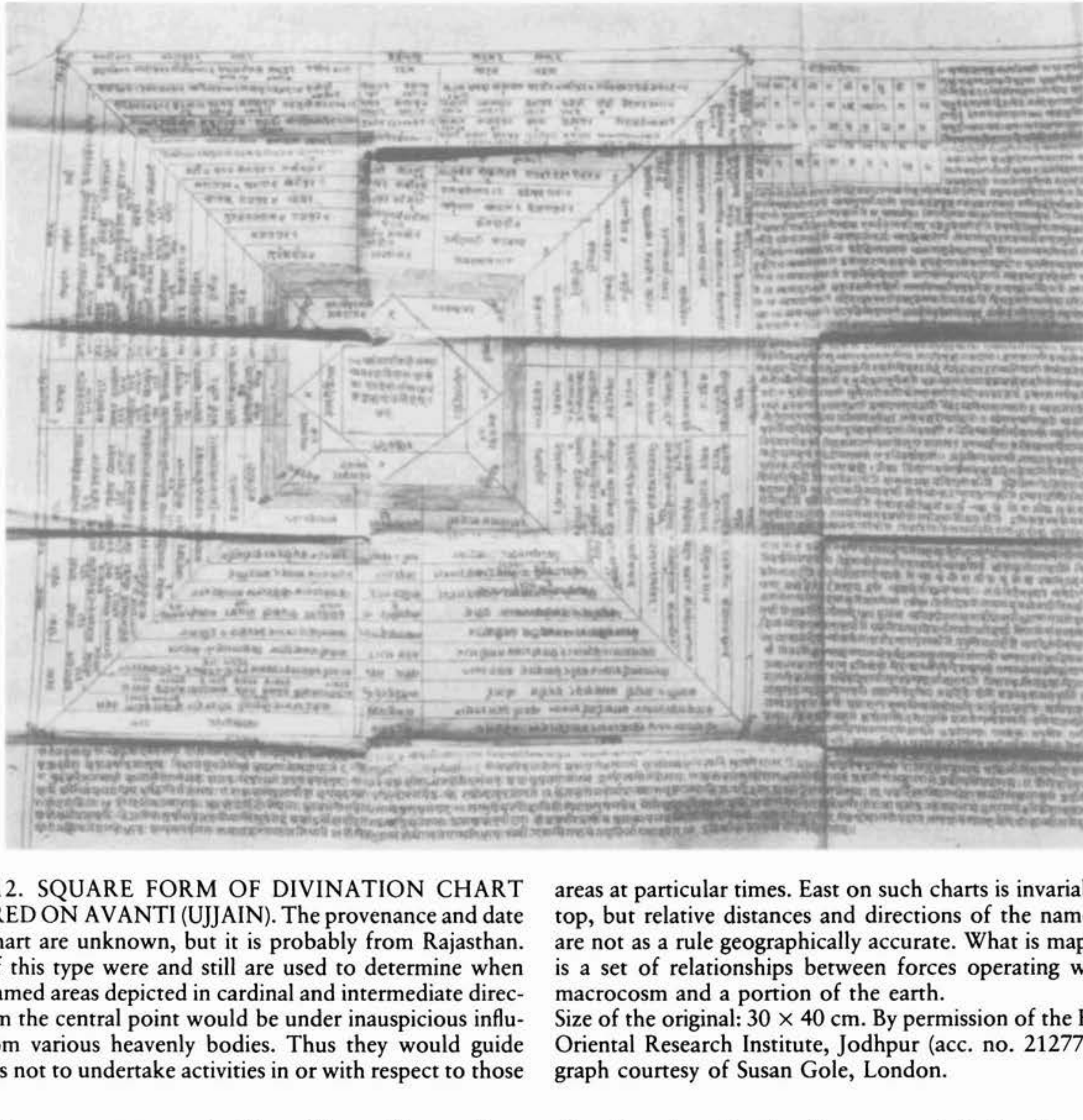

FIG. 16.12. SQUARE FORM OF DIVINATION CHART CENTERED ON AVANTI (UJJAIN). The provenance and date of this chart are unknown, but it is probably from Rajasthan. Charts of this type were and still are used to determine when certain named areas depicted in cardinal and intermediate directions from the central point would be under inauspicious influences from various heavenly bodies. Thus they would guide their users not to undertake activities in or with respect to those areas at particular times. East on such charts is invariably at the top, but relative distances and directions of the named places are not as a rule geographically accurate. What is mapped here is a set of relationships between forces operating within the macrocosm and a portion of the earth.
Size of the original: 30 × 40 cm. By permission of the Rajasthan Oriental Research Institute, Jodhpur (acc. no. 21277). Photograph courtesy of Susan Gole, London.

and a fifth was sent to me by Ram Charan Sharma in a letter suggesting that other similar works exist.[66] At least two of the four published diagrams appear to have a purpose similar to that of the *kūrmavibhāga* and other *cakra*s described above. One of these appears as figure 16.12. On this diagram, described as a *phalcakra*, and on one other, the sacred city of Avanti (modern Ujjain) occupies the center of the square. On the remaining two diagrams the central places are Jaipur and the small Rajasthani town of Sojat. Outward from the central place the squares are divided into more or less evenly spaced registers and also into directional fields corresponding to the four cardinal directions, all of which are named, and either four or eight intermediate directions. East is invariably at the top. Within each register appear a number of place-names, but the actual geographic direction of the place-names with respect to the focal location frequently does not accord, even approximately, with the direction given by the diagram, and similar discordances were evident concerning the areas signified by the various directionally designated parts of the *kūrmavibhāga*. Relative distance relationships with respect to the focal place are also unreliably presented.

In the second of the two Avanti-centered *phalcakra*s she describes, Gole provides a selective list of places and

66. Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989), 23–24 and 50–53. The specific maps illustrated are from: (*a*) the Rajasthan Oriental Research Institute, Jodhpur, Acc. 21277, cloth, ca. 40 × 30 cm, in Hindi, undated; (*b*) the S. R. C. [Sri Ram Charan] Museum of Indology in Jaipur, uncataloged, paper (partially missing), 32 × 41 cm, in Hindi, dated Samvat 1785 (A.D. 1728); (*c*) Rajasthan Shodh Sansthan, Jodhpur, cat. no. 231, paper, 19 × 16.5 cm, in Rajasthani, late seventeenth century; and (*d*) from the publication *Hitaishi*, 1941–42, paper, 30 × 30 cm, in Dhundari (a Rajasthani dialect), date of original unknown.

directions from among the much larger number actually shown. Listed below are the places on her list that could be identified, followed (in parentheses) by the approximate azimuths from Avanti of the directions and places cited:

North (0°): Kedaram (Kedarnath?, 20°)
Northeast (45°): Mathura (20°), Gwalior (35°)
East (90°): no location cited
Southeast (135°): Champāner (250°)
South (180°): Mecca (275°), Hinglaj (285°), Shiraz (300°)
West (270°): Dhar (215°)
Northwest (315°): Bikaner (335°), Kabul (335°), Nagarkot (modern Nagrota, 5°)

This list of places is noteworthy in that in addition to such sacred Hindu places as Kedarnath, Mathura, and Hinglaj (now in the Pakistani province of Baluchistan), it includes such prominent and distant Islamic cities as Mecca, Shiraz, and Kabul. This leads one to speculate on the reasons for including certain places within such diagrams and excluding others that are closer or more important. Conceivably, the specific content of the chart may be determined by the needs and travel patterns of the client who had it prepared. In the case just discussed, that individual might have been a Hindu trader who was concerned not only with pilgrimages to holy places in India but also with long-distance commerce with Afghanistan, Iran, and Arabia. In earlier days royal patrons concerned about the likely efficacy of military campaigns in directions away from their capital were undoubtedly among those for whom *phalcakra*s were prepared.

The smallest and simplest of the four charts Gole illustrates is centered on the ancient fortress town of Sojat, in the Marwar region of Rajasthan. This town also figures prominently in an important topographic map discussed in the following chapter (figs. 17.17 and 17.18). The chart comes from a manuscript of historical tales dated Samvat 1703 (A.D. 1659) and shows several dozen villages grouped in twelve directions from the focal town, some of which Gole has been able to trace on modern Survey of India maps. The most recent of the four charts, based on Jaipur, was published in 1941 or 1942 but very likely is a redrawing of an older original. It appears to contain more information than any of the others discussed and "gives the distance in *cos* beside each name, and the ownership of each *jagir* (assignment of land, or the revenue from it), [and hence] might have been made for revenue purposes."[67]

The map Sharma sent to me (fig. 16.13) resembles those published by Gole in some respects and differs significantly in others. Sharma's letter describes it as follows: "Rare old map of India indicating Mountains, Rivers, Cities in twenty-four sub-directions of main eight directions. 250 years old 'Jaipur Rashi Chakra' [*rāśi cākra* = zodiac] is included in this old map. It starts from Ujjain in centre."[68] The dimensions of the work are not known, but judging from the size of what appears to be a window grating against which it was placed for photographing, it might be on the order of 1 by 1.5 meters. Rendered in black and red ink on paper (probably several pieces pasted together), the map proper occupies about two-thirds of the field it was drawn on. Above it are twenty-one lines of Sanskrit text, in two columns. Although these are partially illegible and have yet to be translated, they begin

FIG. 16.13. CIRCULAR FORM OF DIVINATION CHART CENTERED ON AVANTI (UJJAIN). This chart is gouache and ink on paper, Rajasthani, eighteenth century. The general purpose and the manner of its construction and use are presumably similar to those of the more common square divination charts of the type illustrated in figure 16.12. The number of places named in this example, approximately four hundred, is particularly high.
Size of the original: not known. By permission of the S. R. C. [Sri Ram Charan] Museum of Indology, Jaipur.

67. Gole, *Indian Maps and Plans*, 53 (note 66).

68. Letter dated 14 September 1989 from Ram Charan Sharma "Vyakul," founder and director of the S. R. C. Museum of Indology in Jaipur, where the map is held. The map was sent in the form of a color photograph, 12.7 × 17.5 cm.

with a conventional invocation to Gaṇeśa, the god who brings good fortune. A standard horoscopic chart occupies the lower left corner of the field, and in the lower right are three nested squares, with a series of Sanskrit initials written along the sides of each. These initials include both simple letters and vowel-consonant compounds. They are not arranged symmetrically but are partially in the auspicious form of a swastika. The three squares may serve the same function as the successive registers of the four maps previously described.

The principal way the map proper differs from those described earlier is in its circular, rather than square, form. The approximately four hundred names displayed on it are arranged in twelve spokelike fields, radiating outward from the map's central circular field, in which eight short lines of text are written. This partly illegible text, which has not been translated, begins with the name of the legendary king Vikramāditya, conqueror of Avanti (Ujjain), after whom the widely used Vikrama era (beginning in 58 B.C.) is named. Four of the map spokes are labeled with the cardinal directions, with east at the top of the map. Between each pair of cardinal directions are two spokes, one with a name ending in the suffix *-kun* (?) and the other, invariably clockwise from it, ending in the suffix *-khaṇḍa* (region). The rest of the name is derived from that of one of the Dikpālas, the gods who preside over the cardinal and intermediate directions. On the map under discussion, only the deities for the intermediate directions are identified. As an example, beginning with the eastern map spoke and proceeding clockwise, we have Pūrvadishi (toward the east); Agnikun and Agnikhaṇḍa (the *kun* and *khaṇḍa* of the Dikpāla Agni, the fire god who presides over the southeast); Dakṣiṇadishi (toward the south); and so forth. The twenty-four "subdirections" Sharma alludes to derive from the fact that each of the twelve spokes contains two columns of names, a long one averaging about twenty-one names, extending from the center to the circumference, and a short one averaging about a dozen names, adjacent to it clockwise and ending at the map's outer edge. Apart from length, there is no obvious difference in the nature of the two columns. Next to each name is a number, and there are a few instances where numbers appear next to a blank space. The numbers occur in no apparent order. Not all names or numbers can be read, but among the great majority that can be, the numbers range from 2 to 400, seemingly with no repetitions. The twelve spokes are also numbered (starting from the east and proceeding clockwise) as follows: 146, 147, 147, 148, 148, 148, 150, 151, 151, 152, 153, and 153.

It seems reasonable to assume that each of the twelve spokes of this map represents one of the zodiacal mansions, that the places named within each spoke are those most affected (presumably malignly) when a particular zodiacal sign is in the ascendent, and that the numbers joined to the names have some sort of numerological or calendrical significance. Inspection rules out the possibility that distances from either Ujjain or Jaipur are indicated. Very likely they are used, in combination with the zodiacal signs and the initial letters on the chart in the lower right corner, in formulas that indicate the auspiciousness or inauspiciousness of given directions and places at particular times. We see here a likely parallel between this map (and others of its genre) and the various divination practices described in the introductory section of this chapter in respect to the *kūrmavibhāga* and the village rites described by Raheja (p. 339). As in the case of the Avanti (Ujjain)-centered map analyzed above, there is no evident relation here between the actual azimuths of the identifiable places named and their directions from the center of the map.

Among the readable names that I could recognize (perhaps a fifth of the total) were places in all quarters of the Indian subcontinent, including a number at present in Pakistan, but none from beyond the historical limits of India. There is, however, a distinct bias toward the north and the west. If, as might be surmised, a greater number of the unrecognizable toponyms are those of insignificant places in the north and west of India, then the bias just noted would be even more pronounced. Most of the recognizable names are of cities and towns, a number signify specific rivers or other physical features, and a few are regional designations. Among the names on the map are a number of generic designations, the most common being *samudra* (sea), listed no fewer than nine times and in no apparent order. *Parvata* (mountain) appears twice and *garh* (fort) three times. But no case of a repeated proper name was noted. Who might have commissioned this enigmatic map, and why, has yet to be ascertained.[69]

David Pingree, who saw poor copies of each of the four charts illustrated by Gole before their publication, expressed the opinion that despite their similarities in appearance and area of provenance, the charts are not all of the same type. The two that are centered on Avanti (and presumably the one transmitted by Sharma as well), he writes, seem "similar in principle to the *cakras* in the *Narapatijayacaryā* ... [while the others] are quite different."[70] Conceivably, then, the divinatory charts of the former type became sufficiently popular in Rajasthan, and gained enough of a vogue as a medium for portraying spatial data, that their form was copied even when the purpose to be served had little or nothing to do with divination. Additional research on this uniquely Indian cartographic genre is obviously needed.

69. The assistance of Richa Nagar, who transliterated the toponyms of the map, and of William Malandra, who helped in interpreting some of the text and symbolism, is gratefully acknowledged.

70. Personal communication, 21 December 1988.

COSMOGRAPHIC GLOBES

Apart from painted cosmographies, a half-dozen cosmographic globes (*bhūgolas*), all based largely on Puranic texts, are known to exist. Of these, I studied five before preparing the following account. These are of types described by Hindu astronomers, as far back as Āryabhaṭa (b. A.D. 476).[71] Two of these five globes are found today at the British Museum in London, and one each are at the Victoria and Albert Museum, also in London; the Museum of the History of Science at Oxford; and the Bharat Kala Bhavan in Varanasi. I shall refer to them henceforth as the BM(A), BM(B), VA, Oxford, and BKB globes. The sixth globe was reported to Gole by N. P. Joshi of the Archaeological Survey of India, who saw it in an Indian village whose location I do not know.[72]

The simplest of the five globes studied, the VA globe, is a solid wooden sphere, about nineteen centimeters in diameter (fig. 16.14). This globe is believed to have been made in Orissa in the early to mid-nineteenth century.[73] On it land is colored mainly in yellow, mountain ranges in a lighter peach tone, rivers in white, oceans in several colors, among which gray is most common, and text in red.

The northern hemisphere of this globe shows Jambūdvīpa according to the four-continent earth conception (*catur-dvīpa vasumatī*). It is depicted by a lotus with four petals whose tips virtually reach the equator. East-west mountain ranges extend across each petal: there are three ranges on each of two petals (those that appear to be centered on 0° and 180° longitude) and only one on each of the others (those that appear to be centered on 90° east and west longitude). The northernmost and southernmost of the former set of ranges are shown as forested. Near what would be the northern pole, a circle within a square denotes Mount Meru, and that appears within a larger square just north of the northernmost mountain ranges. From near Mount Meru, originating within the larger square, rivers flow southward through the middle of each continent. Painted in the four inlets of ocean that separate the northern hemisphere continents are aquatic animals, boats, and four white palaces signifying the cities of Laṅkā, Romaka, Siddhapura, and Yamakoṭi, described by astronomers as occupying cardinal points on the equator.[74] The southern hemisphere differs completely from the northern. With its six ring continents and intervening oceans, it is essentially like that of the four globes still to be discussed. Interestingly, three of the southern ring oceans are in colors other than the prevailing gray—tan, pink, and turquoise.

Substantial text, written in a rather tiny Devanagari script, appears on the globe, but neither transliterations nor translations are available at present. Finally, there are unnumbered black tick marks at five-degree intervals along the prime meridian, along another meridian approximately 150 degrees to the west (in the northern hemisphere only), and around the equator.

Much older and more interesting than the preceding globe is a not-quite-spherical thin brass container on which is inscribed not only a hybrid cosmography, but also a wealth of minute pictorial detail and text in Devanagari script. This artifact (plate 26), held by the Museum of the History of Science at Oxford, has been the object of detailed scholarly scrutiny by Simon Digby, who considers it not only from the perspective of traditional Indian cosmology, but also as an art historian.[75] Supplementing Digby's observations are a pair of diagrams kept within the sphere that provide a complete inventory of the regional features it portrays. Many of these features are also found on the BKB globe (fig. 16.15 below), to which Digby's observations also are largely applicable.

Rather exceptionally, the creator of the *bhūgola* at Oxford, one Kṣemakarṇa, undoubtedly a Brahman, inscribed on it both his own name and the date of his work, Śaka 1493 (A.D. 1571). The area of provenance, however, is not known. Digby presents evidence for several possibilities but seems to favor the view that the globe was fashioned for a wealthy patron from Saurashtra. He also suggests that the globe's function was primarily utilitarian, probably for storing food or condiments, and that "the depiction of the regions of the earth upon it was an elegant conceit suggested by its shape."[76]

The mean equatorial diameter of the *bhūgola* is about 26 centimeters, and its height 22 centimeters. Joined by a hinge at the equator, both hemispheres are slightly flattened, but the northern one, though essentially round, comes to a rather gently sloping polar peak. Tick marks at one-degree intervals are inscribed around the equator,

71. For the reference to descriptions by astronomers of globes of this type I am indebted to David Pingree (personal communication, 21 December 1988).

72. In addition to the six globes noted in this paragraph, numerous celestial globes of Indian provenance are to be found in museums in South Asia, Europe, and North America. There is also one eighteenth-century wooden globe in Jaipur, with text in Sanskrit, that appears to be adapted from a European prototype. It will be discussed briefly in the chapter on geographical mapping below.

73. Simon Digby, "The Bhūgola of Kśema Karṇa: A Dated Sixteenth Century Piece of Indian Metalware," *AARP* (*Art and Archaeology Research Papers*) 4 (1973): 10–31, esp. 12–13; Gole, *Indian Maps and Plans*, 26 (note 66); Rawson, *Art of Tantra*, fig. 125 (p. 149) (note 56).

74. These identifications were made by David Pingree (personal communication, 21 December 1988).

75. A substantially greater part of Digby's analysis ("Bhūgola" [note 73]) relates to the art-historical aspects of the globe rather than to the cosmographic aspects. The work is also briefly described by Gole, *Indian Maps and Plans*, 26 and 74 (note 66). Digby's article is illustrated abundantly, though not especially well, in black and white; Gole's presentation includes a single, but very clear, color illustration.

76. Digby, "Bhūgola," 10 (note 73).

FIG. 16.14. COSMOLOGICAL GLOBE. This relatively simple globe, painted on wood, dates from the early to mid-nineteenth century. The northern hemisphere conforms closely to the *catur-dvīpa vasumatī* (four-continent earth) conception depicted in figure 16.1, while the southern hemisphere reflects the *sapta-dvīpa vasumatī* (seven-continent) concept illustrated by figure 16.2.
Diameter of the original: ca. 19 cm. Courtesy of the Board of Trustees of the Victoria and Albert Museum, London (I.M. 499-1924).

and small circles are etched in at ninety-degree intervals. The *bhūgola*'s cosmography draws primarily on Puranic sources but modifies their content in light of knowledge derived from post-Ptolemaic Sanskrit astronomers, reconciling the two "in an unscriptural but rational manner."[77] The upper half of the container represents the continent of Jambūdvīpa, and the subequatorial remainder, except for the anomalously positioned islands of Laṅkā and Palaṅkā (= ?), is given over to the other six ring-shaped continents and their intervening oceans in concentric latitudinal bands. These continents necessarily diminish in size toward the southern pole, "in contrast to the common Purānic account in which they increase in size by geometrical progression (2, 4, 8 . . .). As on the *bhūgola* the largest ring of land is the closest to the Equator, they also in fact enclose one another in inverse order to that prescribed in the Purānas."[78] Digby notes that "theoretical distances" are inscribed in *yojana*s at the equator, but not below it; but he neglects to indicate which features those distances apply to.[79] Meru—over which, astronomers reasoned, Dhruva (the Pole Star) was situated—is positioned at the northern pole rather than at the center of the four quarters of the world, which was the usual Puranic view. This placement meant that if the southernmost Puranic continent, Bhāratavarṣa (India), and the presumably northernmost Puranic continent, Uttarakuru, were to remain opposite one another, the latter would also have to be displaced to the equator 180 degrees away, longitudinally, from the former. And

77. Digby, "Bhūgola," 11 (note 73).
78. Digby, "Bhūgola," 12 (note 73).
79. Digby, "Bhūgola," 12 (note 73).

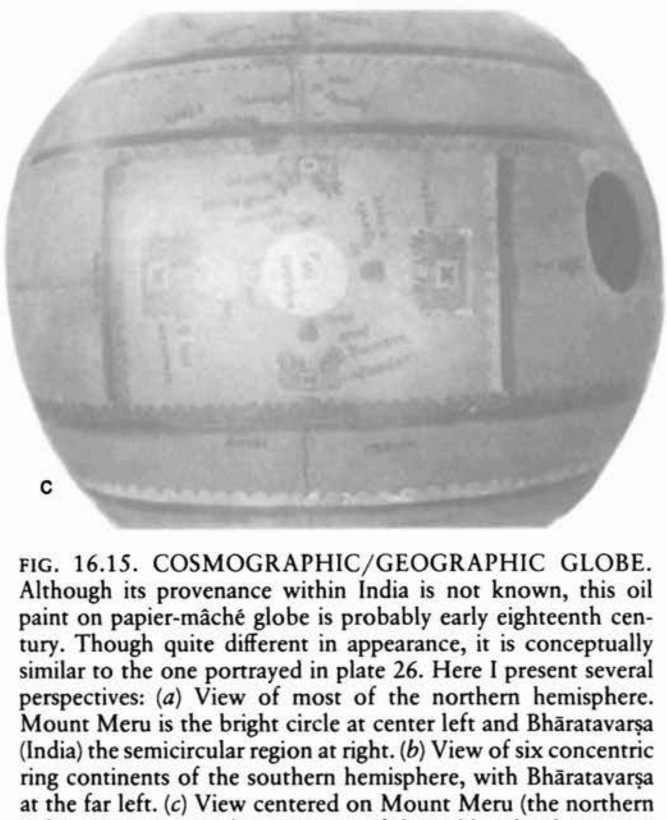

FIG. 16.15. COSMOGRAPHIC/GEOGRAPHIC GLOBE. Although its provenance within India is not known, this oil paint on papier-mâché globe is probably early eighteenth century. Though quite different in appearance, it is conceptually similar to the one portrayed in plate 26. Here I present several perspectives: (*a*) View of most of the northern hemisphere. Mount Meru is the bright circle at center left and Bhāratavarṣa (India) the semicircular region at right. (*b*) View of six concentric ring continents of the southern hemisphere, with Bhāratavarṣa at the far left. (*c*) View centered on Mount Meru (the northern pole) encompassing the continent of Ilāvṛtakhaṇḍa (the rectangular area around Meru) and neighboring continents. The Gaṅgā and Yamunā rivers flow toward the top of the picture. For an additional view of the portion of the globe providing geographic details of India and nearby regions, see plate 30.
Diameter of the original: ca. 45 cm. By permission of Bharat Kala Bhavan, Varanasi. Photographs by Joseph E. Schwartzberg.

because "Uttara" means north, the shift in position required that the continent's name be altered to Kurunāmakhaṇḍa.[80] Other topological shifts in the nine principal components of Jambūdvīpa followed logically from this situational adjustment.

Among the components of Jambūdvīpa, Bhāratavarṣa (India) is treated differently from the others on the Oxford globe in that it is devoid of pictorial elements and "divided by transverse lines into rhomboids with geographical names inscribed inside them"; but mysteriously, "the traces of an abandoned scheme of decoration similar to that on other areas of the globe, and imperfectly erased from the thin surface of the metal, are still visible."[81] Also, the Gaṅgā (Ganges) and the Yamunā (Jumna), the only two rivers represented on the globe, issue there from the bounding Himagiri (Himalayas). They join not far to the south and then flow eastward as they do in reality. This special treatment suggests that Kṣemakarṇa sought to impart some degree of verisimilitude to his depiction of India. But if so, that desire did not take him very far.

The nine rhomboidal regions (*khaṇḍas*) constituting Bhāratavarṣa include Kumārikākhaṇḍa, which the anonymous nineteenth-century transliterator/translator/interpreter of the *bhūgola*'s text identifies (mistakenly) with "N.W.P." (i.e., the former North-Western Provinces, merged with Oudh to form the United Provinces in 1877) and eight surrounding regions.[82] Proceeding clockwise from the north, the regions are Vāruṇakhaṇḍa,

80. Digby, "Bhūgola," 12 (note 73).

81. Digby, "Bhūgola," 13 (note 73).

82. Sircar, *Cosmography and Geography*, 54 (note 6), notes the Puranic division of Bhāratavarṣa into nine *khaṇḍas*.

designated as "the sea" because of the identification of the god Varuṇa with Neptune; Gāndharvakhaṇḍa, "where the Ganges flows"; Indrakhaṇḍa, identified as the "abode of mankind" (translating the accompanying Sanskrit gloss); Kaserukhaṇḍa; Tamrakhaṇḍa, "the copper portion"; Gabhastikhaṇḍa; Somakhaṇḍa; and Nāgakhaṇḍa (the region of snakes). In general these regions seem to be following lists enumerated in the early Puranas, but Kumārikākhaṇḍa is sometimes used synonymously with the whole of Bhāratavarṣa.[83] Not included among the nine regions of Bhāratavarṣa, but situated immediately to their south, is Laṅkā, the mythical geographic antecedent of which is well known. Within several of the regions are named specific places that exist in India to this day: Kurukṣetra (Kurukshetra), site of the legendary battle described in the *Mahābhārata* epic in Vāruṇakhaṇḍa (the sea; but there is no mention in the epic that the battle was fought on, or even near, the sea); the major temple town, Jagannath; and Dwarika (Dwarka), another key temple town in Nāgakhaṇḍa. All three are in locales that accord fairly well with their actual geographic locations: north, southeast, and northwest.

Though most of Digby's analysis relates to the pictorial elements of the *bhūgola*, here it suffices to note that those elements were mainly secular, as would be in keeping with the object's primarily nonreligious purpose. Objects depicted include dancers, musicians, a hunting scene, vegetation, secular architecture, furniture, and household goods. Yet minute images of deities, Shaivite sages, a temple in the jungle, and a temple cart are also shown. The deities seem mainly to occupy spaces on or fairly close to Meru, on whose summit are Brahma, Vishnu, and Rudra (an Apollo-like Vedic god). Shiva, flanked by prostrate devotees, appears elsewhere on the globe. Thus the work does not appear to be obviously associated with any particular branch of Hinduism.

The most detailed of the five globes studied in terms of both cosmographic and geographic detail is a work of unknown provenance, probably dating from the mid-eighteenth century, and now at the Bharat Kala Bhavan in Varanasi (fig. 16.15). Though the BKB globe was purchased from an art dealer in Jaipur, a Rajasthani origin for it seems out of the question because Amer (Amber), the capital of the important Kachwaha Rajput state before the construction of Jaipur, is badly misplotted, being placed in the Gaṅgā-Yamunā Doab. Other misplottings (to be discussed below, in the section on world maps) seem to rule out a northwest, west, or south Indian origin. On the other hand, the prominence given to Jagannath temple in the state of Orissa suggests that general region as a source area. But then, one wonders, if the nineteenth-century dating of the wooden VA globe (fig. 16.14), thought to be from Orissa, is correct, how could the much more sophisticated BKB globe, also thought to be east Indian, significantly predate it? In dating the globe, the omission of the name Jaipur (founded in 1728) and the inclusion of Amer are noteworthy, as is the inclusion of Calcutta (founded in 1690). One should not, however, conclude from these facts that the globe had to date from the period 1690–1728, for Jaipur would not have overshadowed Amer—at least in the minds of non-Rajasthanis—until some time after its founding, and it was not until near the middle of the eighteenth century that Calcutta became significantly more prominent than other European factories along the Hooghly River that are not indicated on the globe.

Although the globe is constructed without gores and appears to be a solid structure, it is in fact of fairly thin papier-mâché construction, only a few millimeters thick. The process entailed was: to make a large ball of string; to apply wet papier-mâché to it; to paint the dried papier-mâché as desired and add the script (all Devanagari) in ink; and finally, to remove the string from the globe through a preplanned hole in the surface. In many places the painting has chipped off and the writing has been worn away. Here and there changes in the original legends appear to have been made, which suggests that the globe received considerable use and was the object of discussion and possibly even controversy.

The essential point to make about the BKB globe is that conceptually it seems to differ little from the one at Oxford. In particular, it seeks to reconcile the received wisdom derived from the Puranas with the empirical data of subsequent astronomy.

That the two globes are as far removed from one another in time as they are (probably close to two centuries) and very likely also in space (assuming that the west Indian location of Saurashtra for the Oxford globe and a northeast Indian location for the BKB globe are correct) leads one to wonder if there was not among the pandits of India an enduring late and widespread cosmographic school of thought that was responsible for creating these two artifacts, the two BM globes (discussed below), and perhaps others yet to be found. Support for such a position is provided by the existence at the Bhandarkar Oriental Research Institute at Pune of an undated series of six ink drawings on paper (fig. 16.16) that are simply labeled "six geographical charts," but seem to provide a nearly perfect fit for the BKB globe.[84]

The chief difference between the BKB and Oxford globes is the wealth of real-world geographic detail on the former, even though almost all of that detail is confined to Bhāratavarṣa (India) and nearby regions. Like the Oxford globe, the BKB *bhūgola* has six concentric ring

83. Sircar, *Cosmography and Geography*, 33–34, 54, and passim (note 6).

84. Cataloged as item no. 93 of 1907–15, New No. Section 18.

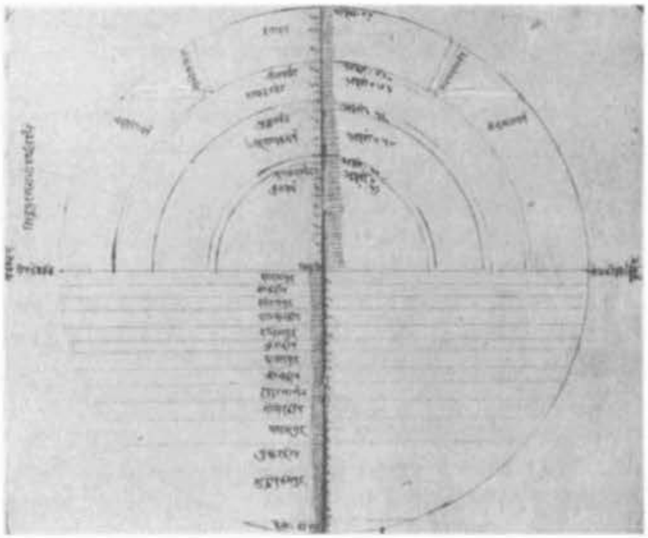

FIG. 16.16. PROJECTION FOR A COSMOLOGICAL GLOBE. This drawing is undated (nineteenth century?), and its provenance is unknown. It is one of a collection of six perspectives, all in ink on paper. The set of diagrams, though of a much later date than the globes illustrated in plate 26 and figure 16.15, would have served admirably as a guide to their construction. It suggests the existence of some unknown text prescribing the latitudinal and longitudinal limits used to delineate the major components of the globes.
Diameter of the original: 23.7 cm; size of folio: 28.5 × 24 cm. By permission of Bhandarkar Oriental Research Institute, Pune.

continents with intervening seas ranged south of the equator, and the seventh continent of Jambūdvīpa, with nine principal subdivisions, occupying the whole of the northern hemisphere. The number of toponyms and the amount of place detail, both real and mythological, it contains appear to be far greater, and it is relatively lacking in pictorial content. Few of the images it does contain (and none in the northern hemisphere) are of deities or of an anthropomorphic nature. But from a more narrowly cartographic point of view, the principal difference is that the major geographical divisions of the BKB globe are laid out with a concern for exactitude in their latitudinal and longitudinal limits. This is clear because the globe includes an equator ticked off in one-degree segments, numbered every five degrees, and a similarly graduated prime meridian extending from the northern pole at Sumeru (Mount Meru), through Ujjain, the Indian city whose observatory provides the prime meridian for Hindu astronomy, to Laṅkā on the equator.[85]

An especially noteworthy feature of the BKB globe is its use of clear color conventions: light brown for undifferentiated areas of land, dark brown for mountains in the southern hemisphere and for coastlines, various colors for mountains in the northern hemisphere (e.g., white for Himachal, the Himalayas), blue for rivers, ivory for oceans in the southern hemisphere, dark blue for oceans in the northern hemisphere, text in dark brown, and important points and areas in gold. The important points/areas include: Sumeru (northern pole), Sumeruvaḍavānala (southern pole), Laṅkā (centered at 0°, 0°), Yamakoṭi (0°, 90°E), Romakapattana (Rome, 0°, 90°W), and Siddhapura (0°, 180°) (cf. the four cities depicted on the VA globe). And as with the Oxford globe, Uttarakuru, the northern continent of the Puranas, is shifted so that it becomes the western continent, Uttarakurukhaṇḍa, just north of the equator and opposite Laṅkā, but without the rectification of the morpheme "uttara" (north) that we noted on the Oxford globe.[86]

In the northern hemisphere of the BKB globe, four lakes, each bordered by a characteristic tree, the eponymous trees of Jambūdvīpa, are ranged about Sumeru, centered at 0°, 90° east and west, and 180° of longitude. From each of these lakes, rivers flow due south along the respective meridians. Special treatment, however, is accorded the Gaṅgā and Yamunā, which flow along the prime meridian in close parallel courses (in each of the other quadrants there is only a single river) until, crossing the Himachal (at roughly 45°N)[87] and passing another unnamed range south of Kashmir, they turn more or less correctly to the southeast at Kurukṣetra, the legendary site of the great Mahābhārata war, not far northwest of Delhi. Other details will be provided below in the discussion of world maps.

A distinctive feature of the southern hemisphere is that on each of the ring island continents are seven named *parvatas* (mountains), from which named *nadīs* (rivers) flow into the sea. These *parvatas* are arranged in rows as if along seven spokes of a wheel extending toward the equator from Sumeruvaḍavānala. This recalls the seven spokes that created the twenty-one *lokas* depicted in figure 16.9.

Of particular interest are the figures depicted in the first

85. A peculiar aspect of the BKB globe is that it appears to be graduated into 365 degrees, rather than 360 degrees, along the equator. The explanation seems to be that round numbers—5, 10, etc.—are written in the middle of five-degree bands, with tick marks for each degree and an emphasized mark at every fifth degree; the series of numbers, however, starts with 0 and ends with 360, five degrees to its left, rather than coincident with the 0 band. Since the painting on this part of the globe appears to be retouched, and since the paint on part of the equatorial region to the west has flaked away, it is possible that the error just noted did not exist on the globe as it was originally painted.

86. I am indebted to Sarala Chopra of the Bharat Kala Bhavan, Varanasi, for her assistance in identifying the locations noted in this paragraph and those to be noted in subsequent discussion below of the geographic portion of this globe and also the many iconographic elements derived from Hindu mythology.

87. The latitude at which the symmetrical arc of the Himachal crosses the prime meridian appears to be 40°, but since the arc begins in the east from the equator at 45°E longitude (the paint is chipped away at the western terminus), it seems probable that the 40°N crossing of the prime meridian is an error and that 45° was in fact intended.

and second seas northward from the southern pole, regrettably too faint to be seen in figure 16.15*b*. In the southernmost sea, the Vaishnavite gods Nārāyaṇa and Lakṣmī (Vishnu's wife) also appear, seated on Śeṣa, the cosmic snake, who like the turtle Kūrma (and sometimes together with Kūrma) is thought to support the universe. In the second sea are Vishnu himself and associated symbols of Vaishnavism (e.g., elephant, seven-headed horse, conch, bow, water jar, moon, and wishing tree [*kalpavṛkṣa*]). In many Hindu legends, particularly some of a cosmogonic nature, Vishnu is associated with the ocean (e.g., the churning of the cosmic ocean, in which the snake, Śeṣa, serves as the rope and, in some accounts, Meru serves as the churning rod). This suggests that the BKB globe may have had a Vaishnavite connection.

The two most recent, the most similar, and the smallest of the five globes—BM(A) and BM(B)—are those in the Department of Oriental Antiquities at the British Museum.[88] Both are etched in metal, the BM(A) globe (figs. 16.17 and 16.18) in bronze and the BM(B) in copper. The former is dated Samvat 1915 (A.D. 1867). Although the latter bears no date, its similarity to the former suggests rough contemporaneity. Both globes were acquired by the museum in 1886. In neither case is the provenance known.

Conceptually, both globes resemble the ones at Oxford and the BKB but lack their elaborate ornamentation. The BM(A) globe, with equatorial and polar circumferences of 35.2 and 34.4 centimeters, is slightly larger than the BM(B), whose circumference is 30 centimeters, and somewhat more elaborate. Each globe originally consisted of two separately fabricated hemispheres welded together at the equator. But whereas BM(A) remains intact, with a seal that is virtually imperceptible, BM(B) has broken in two. This accident was fortuitous in that it provides a glimpse into the globe's interior, which had been filled with porous, vitreous slag. Molten slag was obviously poured into the globe through a hole in the north polar region that was subsequently plugged with a metal seal representing the region of Mount Meru. Given the weight of BM(A)—heavy, but not as heavy as if it were solid bronze—we may assume that its construction followed the same procedure as for BM(B).

Both globes abound in Sanskrit text, but none has as yet been translated. Hence all references to proper names in the description that follows are predicated on inferences based on the apparent analogies between these and other cosmographies, both globes and two-dimensional representations.

On both globes the partitioning of the northern and southern hemispheres is essentially like that of the Oxford globe, though the proportions differ. On the Oxford globe and on BM(B) the ring continents and oceans of the southern hemisphere are more or less equal in width, except for the broader southernmost polar sea (covering about seventeen degrees of arc) on BM(B). On BM(A), however, the southern ring continents are about two-thirds the width of most of the ring oceans, while the south polar sea is inexplicably large, extending to what would be approximately 58°S latitude (probably intended as 60°S). A more fundamental difference lies in the etching on BM(A) of four continents, similar to those of the VA globe but more widely spaced, extending outward from Mount Meru like petals of a lotus, roughly halfway to the equator. These are superimposed on the basic layout of the Puranic conception presented in figure 16.3, and each petal continent (cf. figs. 15.3 and 16.1) extends beyond the limits of the continent/region of Ilāvṛta that surrounds Meru. An inexplicable peculiarity of the petal continents is that three of them come to points, whereas Ketumāla, the fourth (whose axis one might take as 90°W), has a distinctly different, blunt

FIG. 16.17. SOUTHERN HEMISPHERE OF A COSMOGRAPHIC GLOBE. This globe is etched in bronze, cast in two hemispheres, and joined at the equator. Its provenance within India is unknown, and it is dated Samvat 1915 (A.D. 1867). This view depicts the seven concentric ring oceans and the intervening ring continents of the southern hemisphere. The former are identifiable by fish etched into the surface. In addition, one sees a small part of the northern hemisphere (compare fig. 16.18) in the upper portion of the photograph.
Equatorial circumference: 35.2 cm; diameter: 10.1 cm. By permission of the Trustees of the British Museum, Oriental Collections, London (cat. no. 86.11-27 1).

88. I hereby express my gratitude to Simon Digby, who brought these globes to my attention. Their accession numbers are 86.11-27 1 and 86.11-27 2.

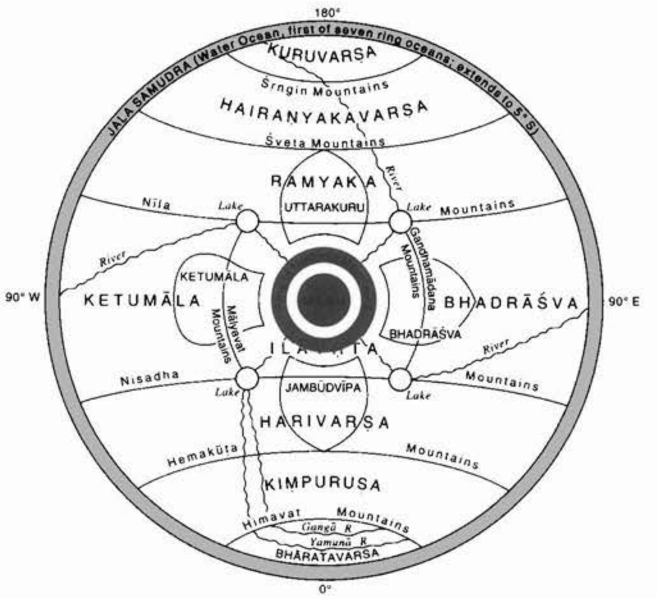

FIG. 16.18. ABSTRACT OF THE NORTHERN HEMISPHERE OF A COSMOGRAPHIC GLOBE. The northern hemisphere of the globe in figure 16.17 is represented here. It is shown in an azimuthal equal-area projection with Mount Meru centered on the northern pole. The depiction is my own freehand sketch, and the dimensions may vary slightly from those of the original. Since the Sanskrit text of the original has yet to be transliterated, the names of continents, mountain ranges, and rivers provided on this diagram are merely inferred, based on analogy to similarly positioned features in other known cosmographic maps, globes, and texts. Here the northern hemisphere appears essentially to be a conflation of the conceptions incorporated in the globes depicted in figure 16.14 and plate 26, which reflect in turn the early Brahmanic and later Puranic views represented in figures 16.1 and 16.3. Hence the dual indication of the names of the eastern and western continents Bhadrāśva and Ketumāla. No satisfactory explanation can be offered for the deviant shape of the inner of the two Ketumālas. The placement of Bhāratavarṣa (India) in the southern part of the hemisphere, centered on the Indian prime meridian, and the depiction therein of the Gaṅgā and Yamunā rivers are the globe's principal concessions to geographic reality.

shape.[89] Between the petal continents, four rivers run to circular lakes at the four corners of Ilāvṛta and then veer clockwise out of those lakes toward the equator, skirting the southern limits of the petal continents. Three of the rivers reach the equator at approximately 90°E, 180°, and 90°W, while the remaining river divides into what are presumably the Gaṅgā and the Yamunā, which flow across Harivarṣa and Kiṃpuruṣa to Bhāratavarṣa and then west to east across that continent without reaching the equator. Conspicuously missing on both globes are any features directly on the equator (e.g., Laṅkā at 0°, 0°).

On the whole, BM(B) presents a simpler picture in the northern hemisphere. While there is some indication of buttress mountain ranges on the four sides of Meru, the petal continents are absent, and beyond the lakes at the four corners of Ilāvṛta there are only two rivers that flow toward the equator, rather than the customary four—namely, those extended to Bhāratavarṣa and the near antipodal continent, which I have tentatively designated Kuruvarṣa on BM(A). Because the originally low relief on this globe has been further subdued by handling, interpreting its features is more difficult than for BM(A).

A final noteworthy difference between BM(A) and BM(B) is the etching on the former only of what I take to be eponymous trees (e.g., the *jambū* for Jambūdvīpa) in the petal continents, of fish and other sea creatures in the seven ring seas of the southern hemisphere, and in the Gaṅgā and Yamunā rivers.

CELESTIAL MAPPING

To speak of celestial mapping as a part of the cosmographical tradition of traditional Hindu culture is perhaps to extend the meaning of "mapping" beyond its customary limits. Nevertheless, attempts have been made, since ancient times, to present orderly graphic portrayals of portions of the heavens in painting, sculpture, and architecture. The relevant literature is extensive. It derives on the one hand from art historians and on the other from historians of astronomy, and I have studied and understood only a small portion of the total corpus and none of it from primary sources in Sanskrit and other Indian languages. Thus, in what follows I can do no more than to provide a brief sketch of a few of the means and forms by which attempts at celestial mapping, broadly conceived, have been carried out and to indicate something of the emergence on Indian soil of certain centers of observational astronomy that sought to arrive at more objective and accurate views of the heavens than those that sufficed for most religious purposes.

The development in India of anthropomorphic icons to represent heavenly bodies may be traced back to the time of the Kuṣāṇas (first century A.D.) in the case of Sūrya, the sun-god; to the mid-second century in the case of the planetary deities (*grahas*), including the sun and moon; and at least to the sixth and seventh centuries, respectively, in the cases of Rāhu and Ketu, the deities associated with eclipses. These "planetary deities," nine in all, were designated by the Sanskrit term *navagrahas* and were customarily portrayed in a fixed order, beginning with the seven that in turn exercised their lordship over the days of the week (sun, moon, Mars, Mercury, Jupiter, Venus, and Saturn) and ending with Rāhu and Ketu. They so appear in innumerable sculptures (espe-

89. Given the late date of the BM(A) globe (middle to late nineteenth century), it is conceivable that the great impact of the West on India through the British colonial presence led the globe maker to postulate that Ketumāla was qualitatively quite different from the other three petal continents.

cially on the lintels over the portals of temples), in paintings, and in other forms. Although their early manifestations would hardly be described as maps, we do find in later cosmographies, some of which are described below, the maintenance of both the icons and the order established in ancient times.[90]

Iconographic portrayals of astronomical phenomena were not confined to the *navagrahas*. "In some interesting paintings of the schools of Rajasthan and of Deccan we can see personifications of the lunar days (*tithi*), of the hours of good auspices (*muhūrta*), of the days of the week (*dina*, *vāra*), of the months (*māsa*), of the years (*varṣa*), of the stars (*nakṣatra*), of the signs of the zodiac (*rāśi*), etc. These are based on iconographic texts often reproduced in the same pictures."[91] Plate 27 provides a characteristic example of the way *nakṣatras* (groups of stars near the plane of the ecliptic separating various lunar mansions) have been portrayed in Rajasthan in recent centuries.[92]

Not all symbols used to represent astronomical features in painted cosmographies were pictorial. As Tantric Hinduism developed, its use of essentially geometric astronomical (and astrological) charting came to be quite important. This esoteric tradition has given rise to numerous rather varied and often complex astronomical drawings, many of which have recently found their way into semipopular art books. I have not found it possible to study the original sources, which are never cited in the works I have seen. Nor have I been able to translate the abundant text or interpret the mathematical formulas that characteristically accompany the published drawings. Thus I leave to future scholarship the necessary analysis and explication of this large and intriguing corpus.[93]

I referred above to a pair of huge cosmographic paintings in Mīnākṣī temple in the south Indian city of Madurai, both recent (1963 and 1966) replacements for accidentally destroyed works that were originally executed in 1568. One of this pair, entitled *Bhūgolam* (the earth) has already been described. The other (fig. 16.19), several meters to the left of it and of the same size (about 4.25 × 4.25 m), is designated *Khagolam* (the celestial dome). Although I am unable to interpret this painting with confidence, I suggest that much of it could correspond fairly well to the following summation, by Pingree, of a portion of the cosmological sections of various Puranas.

> Above the earth's surface and parallel to its base are a series of wheels the centers of which lie on the vertical axis of Meru, at the tip of which is located the North Polestar, Dhruva. The wheels, bearing the celestial bodies, are rotated by Brahma by means of bonds made of wind. The order of the celestial bodies varies; the earliest seems to be sun, moon, nakṣatras, and Saptarṣis (Ursa Major). Some *Purāṇas* place the grahas (planets) between the moon and the nakṣatras; in others, interpolated verses add Mercury, Venus, Mars, Jupiter, and Saturn (in that order) between the nakṣatras and the Saptarṣis.[94]

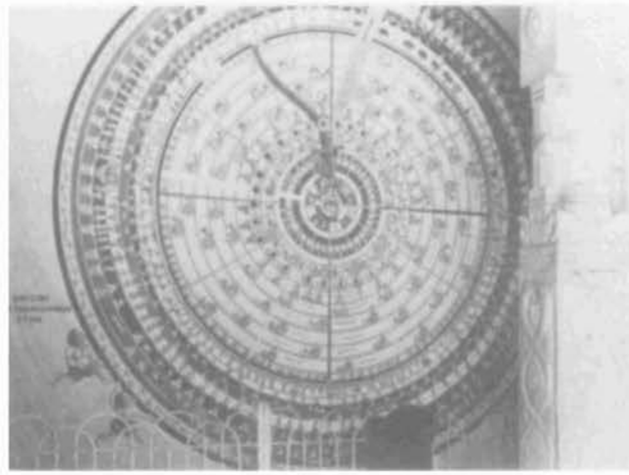

FIG. 16.19. *KHAGOLAM* (THE CELESTIAL DOME). This oil painting on canvas is in the waiting hall of Mīnākṣī temple, Madurai, Tamil Nadu. It is a repainting (1966) of an original dated 1568. This diagram is believed to represent, among other things, the twelve zodiacal months; the paths of the sun, moon, and five known planets; and presumably the ties of the celestial deities Rāhu and Ketu to other heavenly bodies.
Size of the original: approx. 4 × 4.5 m. Photograph by Joseph E. Schwartzberg.

Which of the many concentric circles shown in figure 16.19 represent the orbits (wheels) noted in the previous

90. Among studies that deal with the development of astronomical iconography, we may cite the following: Stephen Allen Markel, "Heavenly Bodies and Divine Images: The Origin and Early Development of Representation of the Nine Planets," *Annals of the Southeast Conference of the Association for Asian Studies*, vol. 9, twenty-seventh annual meeting at the University of Tennessee, Chattanooga, 15–17 January 1987, 128–33, esp. 129; idem, "The Origin and Early Development of the Nine Planetary Deities (*Navagraha*)" (Ph.D. diss., University of Michigan, 1989); Neven, *Peintures des Indes*, 19–21 (note 59); David Pingree, "Representation of the Planets in Indian Astrology," *Indo-Iranian Journal* 8 (1964–65): 249–67, esp. 249–50; Calambur Śivaramamurti, "Geographical and Chronological Factors in Indian Iconography," *Ancient India: Bulletin of the Archaeological Survey of India*, no. 6 (January 1950): 21–63, esp. 29–35; and idem, "Astronomy and Astrology: India" (note 18).

91. Śivaramamurti, "Astronomy and Astrology: India," 76 (note 18).

92. Similar views are presented in Ajit Mookerjee and Madhu Khanna, *The Tantric Way: Art, Science, Ritual* (London: Thames and Hudson, 1977), pl. 6 (102) and caption on 100, and Neven, *Peintures des Indes*, 21 (note 59).

93. Examples of the types of illustrations I am referring to here may be seen in the following works: Mookerjee and Khanna, *Tantric Way*, 99 (note 92); Mookerjee, *Tantra Art* (note 54); idem, *Tantra Asana* (note 60).

94. David Pingree, "A History of Mathematical Astronomy in India," in *Dictionary of Scientific Biography*, 16 vols., ed. Charles Coulston Gillispie (New York: Charles Scribner's Sons, 1970–80), 15:533–633, esp. 554.

description is uncertain. But it seems safe to assume that the male and female figures seated in the center of the painting represent the sun and the moon, respectively, and that the wheels for the planets occupy the relatively light space between the more central and more peripheral groups of concentric rings. Radiating outward from the center of the diagram are twelve spokes that may be described as like hour divisions of a clock. Presumably these are the divisions between the twelve zodiacal months. The spokes vary in color. Those at 1, 2, 4, 8, 10, and 11 o'clock are yellow, those at 5 and 7 o'clock white, and those at 3, 9, and 12 o'clock purple, blue, and red. Distributed over much of the painting are arabic numerals (in their Western form), which very likely indicate (as on Jain cosmographies to be discussed below) the dimensions of various portions of the cosmos or their distance from its central axis.

The snakelike figure extending upward from the center and somewhat to the left to just beyond the outermost planetary ring I take to be Rāhu, the causer of eclipses. Its open jaws appear about to swallow up the sun and the moon. Also extending upward from the center, through the light field of nine encompassing rings and slightly to the right, is a thick band that looks like a river, which perhaps represents Ketu. Rāhu's tail is tethered by seven (count not certain) fine lines (not discernible on the photograph), connected to various wheels (*grahas*?). All but one of these lines terminate in the upper half of the painting. One might suppose they are somehow associated with the "celestial bodies . . . rotated by . . . bonds made of wind" cited in the quotation from Pingree, but their tie to Rāhu, rather than Brahma, argues against such a conjecture. A final feature of note in this exceedingly complex cosmography is a gold pavilion at the very top of the wheel, possibly the abode from which Brahma observes his creation and regulates the mechanics of the entire cosmos. Despite marked differences in their appearance, I suggest a fairly close correspondence between many of the conceptions embodied in the diagram just described and in the upper, astronomical portion of the south Indian cosmography depicted in figure 16.10 and described above.

Not only are Indian temples repositories for astronomical paintings and sculpture, but in some instances the temple itself may be regarded as an astronomical artifact. Although a number of so-called astronomical temples are known to exist in India, which in various ways provide architectural reflections of a portion of the heavens, regrettably their analysis is beyond the scope of this study.[95]

None of the astronomical works I have discussed to this point has required, so far as I can discern, the use of carefully calibrated, scientific instruments or extended accurate measurements of celestial phenomena. Nevertheless, such instruments had been in use in India, mainly by Muslims, for centuries before the creation of most of the Hindu artifacts to which I have drawn attention. Despite opposition from some Brahman astronomers, however, Hindus did ultimately begin to construct and utilize astrolabes and celestial globes to some extent; but those instruments differed from their Islamic counterparts in little more than script and nomenclature.[96] This matter has been discussed above in considerable detail in the chapter on Islamic celestial mapping, and therefore there is no need to recapitulate the story here. I do not mean to suggest, of course, that astronomical instruments were of no concern to Indians before the advent of the Muslims, but they were of relatively little importance and their nature is not well known despite references to them in numerous surviving texts.[97] Space precludes discussing them further.

The earliest-known reference to an Indian observatory relates to one that apparently existed in what is now Kerala about A.D. 860. Its existence is implied by a commentary by Śaṅkaranārāyaṇa on a text known as the *Laghubhāskarīyavivaraṇa*. I quote the translation in full:

> (To the King): Oh Ravivarmadeva, now deign to tell us quickly, reading off from the armillary sphere installed (at the observatory) in Mahodayapura, duly fitted with all the relevant circles and with the Sign (-degree-minute) markings, the time of the rising point of the ecliptic (*lagna*) when the Sun is at 10° in the Sign of Capricorn, and also when the Sun is at the end of the Sign Libra, which I have noted.

95. Descriptions of astronomical temples may be found in Śivaramamurti, "Astronomy and Astrology: India" (note 18), and in Giuseppe Tucci, "A Visit to an 'Astronomical' Temple in India," *Journal of the Royal Asiatic Society of Great Britain and Ireland*, 1929, 247–58.

96. As Blanpied has observed, "The establishment of a truly Indian school of observational astronomy would . . . have had to involve Brahman astronomers who were recognized as such by the Hindus themselves. Although these Pandits made use of and interpreted the Islamic data which had infused into India, they were by tradition devoted to calculational rather than observational astronomy." He then cites al-Bīrūnī, who observed in the twelfth century that the Brahmans "cherish, of course, the most inveterate aversion towards all Muslims. This is the reason, too, why Hindu sciences have retired far away from those parts of the country conquered by us, and have fled to places which our hand cannot yet reach, to Kashmîr, Benares, and other places." William A. Blanpied, "The Astronomical Program of Raja Sawai Jai Singh II and Its Historical Context," *Japanese Studies in the History of Science*, no. 13 (1974): 87–126, quotations on 116, text and n. 97; the quotation of al-Bīrūnī is from *Alberuni's India*, 1:22 (note 25).

97. Scores of excerpts from such texts relating to instruments are quoted in the original language, together with translations, in B. V. Subbarayappa and K. V. Sarma, comps., *Indian Astronomy: A Source-Book (Based Primarily on Sanskrit Texts)* (Bombay: Nehru Centre, 1985), 74–80 (armillary spheres), 81–85 (observatories), and 86–99 (instruments). These excerpts range from two to thirty-six lines, and most, except for those on observatories, appear in verse form. Relatively few exceed ten lines.

Then again—

> Oh, Ravi, deign to tell us immediately, reading off from the armillary sphere, by means of the reverse *vilagna* method, the time for offering the daily oblations, when the Sun, shrouded under thick clouds, is 10° in the Sign Leo and also when it is the middle (i.e. 15°) in the Sign Sagittarius.[98]

But this quotation, if taken as proof that an observatory did indeed exist, may be no more than the exception that proves the rule in regard to observational astronomy; for we know of no additional Indian citation of a Hindu observatory until 1866, when, in his work *Mānamandira*, Bapudeva refers to the observatory constructed in Varanasi, approximately a century and a half earlier, by the celebrated polymath Raja Sawai Jai Singh II, whose astronomical achievements we shall now consider.[99]

Numerous studies have been written about Sawai Jai Singh (1686–1743) and his diversified scientific endeavors. For details about the physical characteristics of the four of his five observatories that have survived into the twentieth century, Kaye, despite being somewhat dated, remains an indispensable source, as is Blanpied's admirable critical historiographic analysis.[100] Given these and other works, many of them illustrated, it will not be necessary to touch on more than a few highlights to establish Jai Singh's place in the history of celestial mapping in South Asia.

Nominally a vassal of the Mughal emperor, and governor at times of the Mughal provinces of Agra and Malwa, Jai Singh was in effect a powerful and independent monarch in his own right. His mathematical and scientific bent became evident at a very early age, and his lifelong quest for knowledge, especially in astronomy and mathematics, was not constrained by barriers of culture. "Thus, although [he] was a Hindu who . . . subscribed publicly to Hindu cosmology, his emphasis on observational rather than on calculational astronomy, as well as a number of textual references, suggest that his observational program was influenced more by Islamic than by Hindu astronomy."[101]

Over the period from about 1722 to 1739, drawing upon his considerable influence and wealth, he supervised the construction and staffing of observatories at the Mughal capital of Delhi; his own new capital, Jaipur; Varanasi; Ujjain; and Mathura. The precise dates of construction of none of these are known, but there seems little doubt that the so-called Jantar Mantar (a corruption of yantra and mantra) in Delhi was first and Jaipur second. Of the five, that of Mathura is a total ruin and the one at Ujjain is in serious disrepair. The remaining three have undergone varying degrees of restoration. Jai Singh modeled his observatories largely on the one constructed in Samarkand in 1428 by his great Timurid predecessor Ulugh Beg, but the instruments installed in them, mainly masonry constructions, were hardly limited to those used in the fifteenth century. In fact, some of the most accurate and ingenious of the instruments were of Jai Singh's own design.[102] The massive scale of many of Jai Singh's instruments is attributable to his conviction that small instruments could not possibly yield satisfactory accuracy. In the preface to his *Zīj-i Muḥammad Shāhī* (New tables of Muḥammad Shāh [named for the then ruling Mughal emperor; hereafter referred to as the *Zīj*]), Jai Singh expresses himself (writing in the third person) on this and related points as follows:

> But finding that brass instruments did not come up to the ideas which he had formed of accuracy, because of the smallness of their size, the want of division into minutes, the shaking and wearing of their axes, the displacement of the centres of the circles, and the shifting of the planes of the instruments: he [Jai Singh] concluded that the reason why the determinations of the ancients, such as HIPPARCHUS and PTOLEMY proved inaccurate, must have been of this kind; therefore he constructed in . . . *Shāh-Jehanabad* [Delhi], which is the seat of empire and prosperity, instruments

98. Subbarayappa and Sarma, *Indian Astronomy*, 81 (note 97).

99. Subbarayappa and Sarma, *Indian Astronomy*, 81–85 (note 97). Blanpied, citing Dharampal, notes that various European travelers, allegedly including Jean-Baptiste Tavernier, who died in 1689, three years after Jai Singh's birth, were of the opinion that the Varanasi observatory predated that monarch. It has been variously attributed, though without proof, to Jai Singh's grandfather, who reigned from 1590 to 1614 and built in Varanasi the Man Mandir, on whose roof the observatory is situated; to 1680 (Tavernier); to the reign of the Mughal emperor Akbar (1556–1605); and to an even earlier but unspecified date. Blanpied also cites Gurjar's conjecture that "Jai Singh added his masonry instruments to what had been a small, conventional observatory established by one of his ancestors, perhaps by Man Singh himself" (Blanpied, "Astronomical Program," 96 [note 96]). See also Dharampal, *Indian Science and Technology in the Eighteenth Century: Some Contemporary European Accounts* (Delhi: Impex India, 1971), 1–91, including some reproductions of engravings indicating how the Varanasi observatory appeared to eighteenth-century European observers; and Laxman Vasudeo Gurjar, *Ancient Indian Mathematics and Vedha* ([Pune: S. G. Vidwans, Ideal Book Service], 1947), 177–78.

100. George Rusby Kaye, *A Guide to the Old Observatories at Delhi; Jaipur; Ujjain; Benares* (Calcutta: Superintendent Government Printing, India, 1920). This small but well-illustrated volume is an abridgement of Kaye's *The Astronomical Observatories of Jai Singh* (Calcutta: Superintendent Government Printing, India, 1918; reprinted Varanasi: Indological Book House, 1973). See also Blanpied, "Astronomical Program" (note 96). I am indebted to Emilie Savage-Smith for calling my attention to the highly valuable latter reference. Also very useful for its numerous photographs, technical details, and comparative analyses among observatories by type of instrument—though not well written—is Prahlad Singh, *Stone Observatories in India: Erected by Maharaja Sawai Jai Singh of Jaipur (1686–1748 A.D.) at Delhi, Jaipur, Ujjain, Varanasi, Mathura* (Varanasi: Bharata Manisha, 1978).

101. Blanpied, "Astronomical Program," 109 (note 96).

102. This account is compiled from particulars given in the sources cited in note 100.

> of his own invention, such as *Jey-pergâs* [Light of Jai, a hemispheric dial, to be explained below] and *Ram-junter* [a circular instrument for measuring altitudes and azimuths] and *Semrat-junter* [Emperor of Instruments, an equinoctial sundial, Jai Singh's chief instrument], the semi-diameter of which is of eighteen cubits, and one minute on it is a barley-corn and a half; of stone and lime, of perfect stability, with attention to the rules of geometry, and adjustment to the meridian, and to the latitude of the place, and with care in the measuring and fixing of them: so that the inaccuracies, from the shaking of the circles, and the wearing of their axes, and displacement of their centres, and the inequality of the minutes, might be corrected.
>
> Thus, an accurate method of constructing an observatory was established; and the difference which had existed between the computed and observed places of the fixed stars and planets, by means of observing their mean motions and aberrations with such instruments, was removed.[103]

A point of this account that warrants particular note is that Jai Singh was most concerned with providing stability for his instruments. It is therefore hardly surprising that in four of his five observatories he had the ground leveled and carefully prepared for the instruments to be placed there. Only Varanasi, where the observatory was built on the roof of a palace built by Jai Singh's grandfather, Man Singh, was an exception. Although this proves nothing, it does lend circumstantial support to Gurjar's conjecture (cited in note 99) that this relatively small observatory was simply added onto another of even more modest proportions that was already in existence there.

Since the Jaipur observatory contains a wider array of extant instruments than any of the others, I provide in figure 16.20 a copy of the plan of it. Space precludes discussing these instruments in more detail, but a simple inventory will convey the sense of their diversity and of the uses they were put to. I list them below in the order in which they are discussed by Kaye.

1. Saṁraṭ Yantra, the largest instrument ever constructed by Jai Singh. It is an equinoctial dial consisting of a triangular gnomon, oriented along the local meridian, its hypotenuse is parallel to the earth's surface, with two attached quadrants. It measures nearly 90 feet high and 147 feet long, and its quadrants have radii of 49 feet, 10 inches. Though it is graduated to read to seconds, "this is impossible in practice, owing to the ill-defined shadow (due to the size of the penumbra)."[104]

2. Ṣaṣṭāṁśa Yantra, a sextant with a convex arc of 60° and 28 feet, 4 inches in radius. Two pairs of such arcs are built into the masonry at the eastern and western ends of the Saṁraṭ Yantra.

3. Rāśivalaya Yantra, an ecliptic instrument consisting of a collection of twelve dials on a platform, one for each sign of the zodiac, each of the same design as the Saṁraṭ Yantra, but with quadrants in the plane of the ecliptic when that sign is on the horizon and not on the plane of the equator.

4. Jai Prakāśa, a pair of hemispheric dials, 17 feet, 10 inches in diameter (fig. 16.21); their use will be explained in some detail below.

5. Kapāli, a smaller pair of hemispheric dials, 11 feet, 4 inches in diameter, one with the plane of its upper edge representing the horizon, the other with that plane representing the solstitial colure. This instrument is found only in Jaipur.

6. Rāma Yantra, a cylindrical astrolabe employing an orthographic projection with a pillar at its center and a floor and walls graduated for altitude and azimuth observations. The four such instruments at Jaipur (not all of which appear on Kaye's plan) were actually built long after Jai Singh's death, but according to the same general specifications as larger instruments of the same type that he had constructed in Delhi. The larger of two pairs have diameters of 23 feet, 11 inches.

7. Digaṁśa Yantra, a simple azimuth instrument consisting of a pillar and two surrounding circular walls, a lower inner wall of the same height as the pillar (about 4 feet), on which an observer can walk, and an outer wall twice the height of the former over which the observer with a movable sighting string can look. In effect, this is a circular protractor.

8. Nārī Valaya Yantra, a masonry cylinder about 10 feet in diameter with a horizontal axis in the plane of the meridian and parallel dial faces in the plane of the equator. The dials are graduated into *ghaṭi*s (one-sixtieth of a day, i.e., twenty-four minutes) and *pala*s (one-sixtieth of a *ghaṭi*).

9. Dakṣiṇāvṛtti Yantra, a simple mural instrument used for taking meridian altitudes. On its east face are two intersecting quadrants 20 feet in radius and on the west a semicircle of 19 feet, 10 inches.

10. Yantra Rāja, two large, fixed metal single-disk astrolabes, 7 feet in diameter, one made of about sixty sheets of iron riveted together, the other of brass. It is likely that Jai Singh brought these from Delhi to Jaipur.

11. Unnatāṁśa Yantra, a graduated brass circle, 17 feet,

103. Excerpt from the translation of the entire preface by William Hunter, "Some Account of the Astronomical Labours of Jayasinha, Rajah of Ambhere, or Jayanagar," *Asiatick Researches; or, Transactions of the Society Instituted in Bengal*, vol. 5, 4th ed. (1807): 177–211, esp. 184–85; also cited by Kaye, *Old Observatories*, 14–15 (note 100).

104. Kaye, *Old Observatories*, 43 (note 100). This is only one of a number of instances in which Jai Singh's instruments appear to have been "overdesigned"; elsewhere they were "underdesigned." For particulars, see Blanpied, "Astronomical Program," 101 (note 96). The remainder of my inventory of the instruments in the Jaipur observatory is based mainly on Kaye, *Old Observatories*, 43–47, with reference back to some of the earlier descriptions on 26–38.

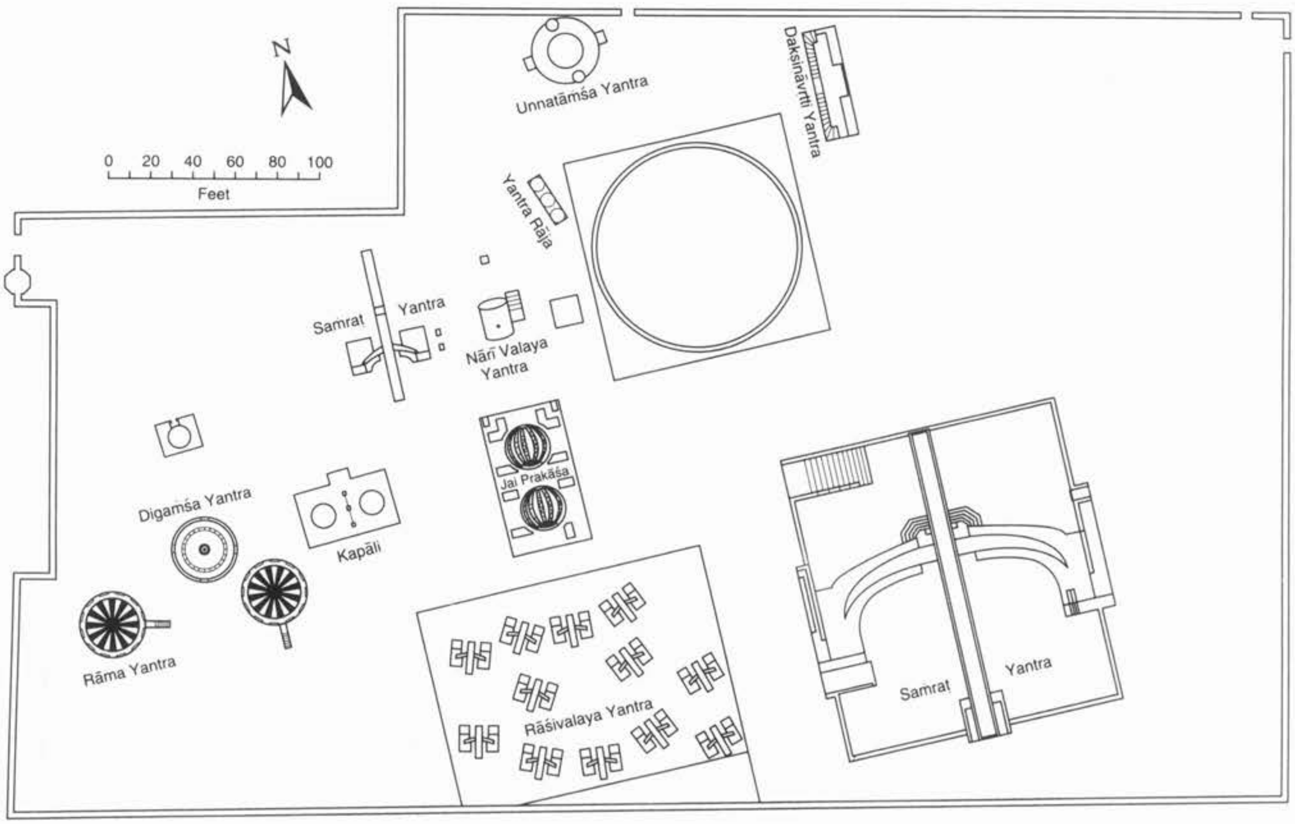

FIG. 16.20. PLAN OF JAIPUR OBSERVATORY. Built by Maharaja Sawai Jai Singh II of Jaipur between 1728 and 1739, this observatory, the largest of five he constructed, contained numerous massive fixed masonry astronomical instruments as well as other smaller mobile metal instruments. Most of the former survive and are shown in this diagram.

After George Rusby Kaye, *The Astronomical Observatories of Jai Singh* (Calcutta: Superintendent Government Printing, India, 1918; reprinted Varanasi: Indological Book House, 1973), following p. 52.

6 inches in diameter, suspended so as to revolve about a vertical axis and used to measure altitude. This was possibly of Jai Singh's own design.

12. Chakra Yantra, an equatorial, of which there are two identical examples at Jaipur. Each consists of a metal disk, 6 feet in diameter, fixed so as to revolve about an axis parallel to that of the earth, with a separate graduated hour circle at the southern end of the axis and a pointer on the axis to indicate the hour angle, and with an index and a sighter on the main circle.

13. Krāntivṛtti Yantra, an instrument of rather limited accuracy used to measure celestial latitude and longitude, consisting of two brass circles, pivoted so that one moves in the equatorial plane and the other in the plane of the ecliptic. Though the one now at Jaipur is quite modern, masonry work still exists to support a much larger instrument of the same type, presumably from Jai Singh's time.

Among the instruments cited above, the Jai Prakāśa (figs. 16.21 and 16.22) "is perhaps the most ingenious and original of Jai Singh's inventions."[105] Hence I quote in full Blanpied's description of it:

Each instrument consists of a pair of hemispherical bowls which, at the Delhi observatory, are about 4.2 meters in radius. The surfaces of these bowls are inscribed with the celestial coordinates and oriented such that the positions of celestial objects can be mapped directly onto them [fig. 16.22]. Two straight wires in the horizontal plane, one oriented north and south and one east and west, intersect at what would be the center of the complete sphere. In essence celestial bodies are mapped onto the concave hemisphere by an observer inside the bowl who sights them through the intersection point. For example, the straight line which passes through this point and is inclined at the latitude angle λ to the horizontal defines a line of sight to the north celestial pole. Therefore, the pole of the instrument is inscribed at the intersection of that line with the concrete surface. Likewise, the plane perpendicular to the aforementioned line which passes through the east-west wire is parallel to the earth's equator and would, if extended, intersect

105. Blanpied, "Astronomical Program," 98 (note 96).

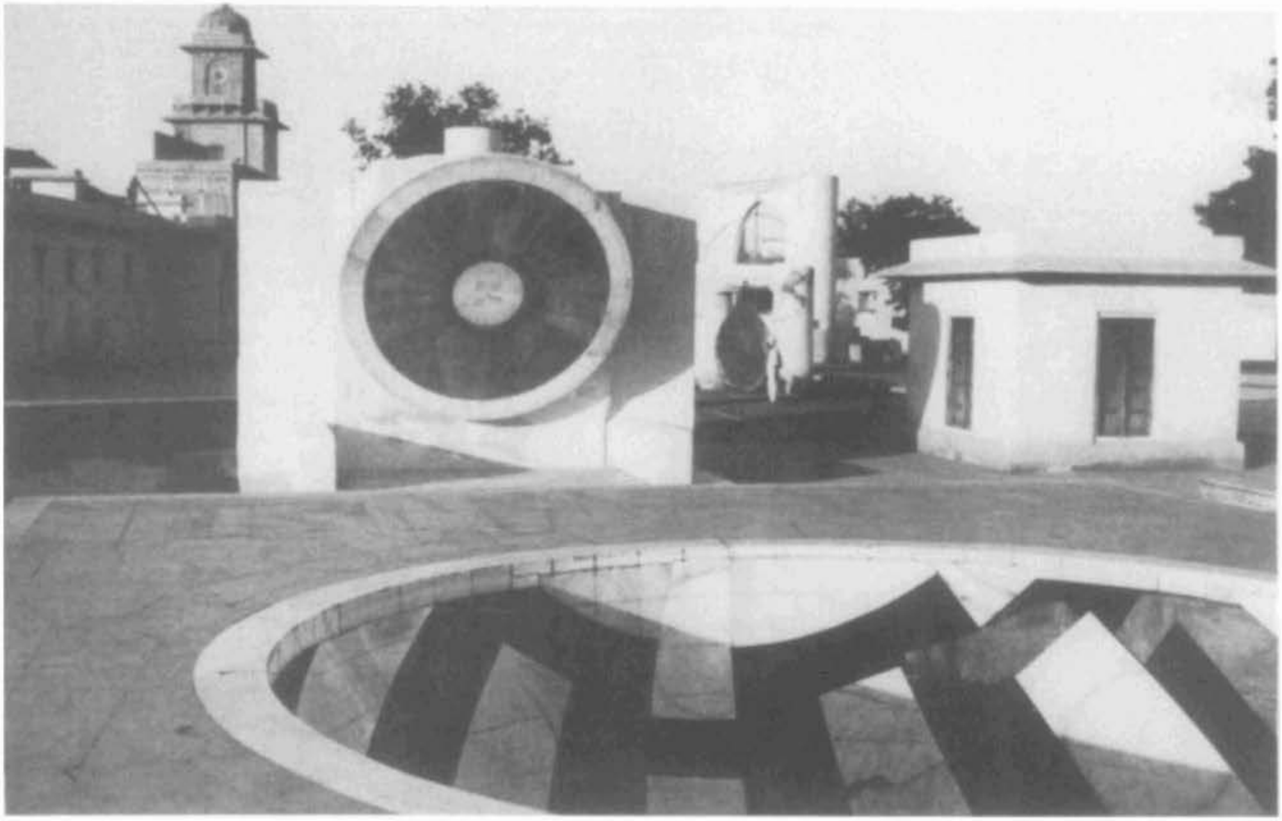

FIG. 16.21. JAI PRAKĀŚA (LIGHT OF VICTORY). This astronomical instrument, designed by Maharaja Sawai Jai Singh II and constructed by him at the Jantar Mantar observatory in Jaipur, was used to determine the stellar coordinates of celestial bodies. It comprises two sunken concave hemispheres onto whose complementary surfaces lines of sight from the observed bodies could be projected. Other instruments appear in the background.
Photograph courtesy of Robert Harding Picture Library, London.

> the celestial equator. A great circle is inscribed on the masonry surface at its intersection with this plane, and defines the instrument's equator. Circles of celestial longitude and azimuth were inscribed on the instrument by following an analogous set of prescriptions.
>
> In practice, nighttime measurements seem to have been made by fixing one end of a taut string to the intersection of two horizontal wires. The observer stood at the bottom of the concave bowl and moved about until by fixing the free end of the string he could sight the particular star or planet along it. The intersection of the string and the coordinates inscribed on the hemisphere then gave the celestial coordinates of the planet or star. In order to facilitate such measurements, passages with stairways were cut into the hemispherical bowls. These enabled the observer to move around easily and to stand at a lower level than the graduated surface. For this reason each *Jai Prakash* consists of two complementary hemispheres. Positions of the access passages on one are positions of gradations on the other, and vice versa.
>
> Daytime measurements could be made simply and directly with the *Jai Prakash*. Since the parallel rays of the sun are equivalent to lines of sight, the shadow cast upon the concave hemisphere by the intersection of the two horizontal wires falls upon the inscribed lines defining its celestial coordinates. Additional circles of zodiacal signs were inscribed on the surface in such a way that the particular circle on which the shadow of the intersection point falls determines the sign which is then on the meridian.[106]

The impressive scale of some of the instruments of Jai Singh described above is evident in figure 16.23, which shows a portion of the Jaipur observatory complex popularly known as the Jantar Mantar.

That the accuracy of the data obtained from Jai Singh's observatories far surpassed that of any of his Indian predecessors' cannot be doubted. The Saṁraṭ Yantra, for example, "could be used by a skilled observer to read solar time to a precision of 15 seconds, . . . [and] also should have been capable of yielding the solar altitude to within 2 minutes of arc . . . [and] the *Jai Prakash* and

106. Blanpied, "Astronomical Program," 98–100 (note 96).

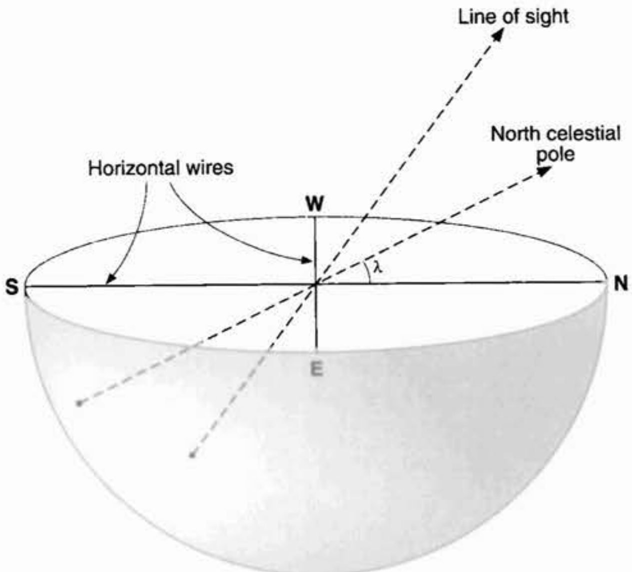

FIG. 16.22. SCHEMATIC DIAGRAM OF THE JAI PRAKĀŚA. This diagram shows how the Jai Prakāśa were used to fix the position of the North Pole and the stellar coordinates of an observed heavenly body.
After William A. Blanpied, "The Astronomical Program of Raja Sawai Jai Singh II and Its Historical Context," *Japanese Studies in the History of Science*, no. 13 (1974): 87–126, esp. fig. 2 (p. 99).

the *Ram Yantra* seem also to have been capable of precisions of about this order."[107] How the data yielded by these and other instruments compared with the data of contemporaneous European astronomy is debatable, however. Before Mercier's recent translation of the Persian tables forming the body of Jai Singh's *Zīj*, evidently compiled over about 1730–38, commentators on the subject based their judgments mainly on the observations made by various European assessments of the instruments employed and on Jai Singh's criticisms of the findings of the astronomical tables of Philippe de La Hire, transmitted to him in 1730 by the Portuguese Jesuit missionary Emmanuel de Figuerda. Jai Singh professed, for example, to have found an error of half a degree in La Hire's assignment of the place of the moon, and for this and other reasons he implied in the preface to the *Zīj* that he had nothing to learn from the astronomy of Europe. Nevertheless, he remained in contact with European missionary and lay astronomers, either by correspondence or by direct discussion with those resident in Jaipur, especially the French Jesuits Claude Boudier and Pierre Pons, who journeyed all the way from Chandernagore in 1734 at the raja's invitation.[108] Since Mercier's study of the *Zīj* is the most thorough and recent available, it is in order that I quote here, virtually in its entirety, the abstract of that work:

> The [tables of the] *Zīj-i-Muḥammed Shāhi*... are usually represented as embodying the observational work done at the observatories of Delhi and Jaipur, under the direction of Jai Singh and [his chief astronomer] Jagannātha. In this paper these Persian tables are analysed thoroughly, and their various components are identified with earlier sources. In fact no new observational results are to be found apart from a new determination of the obliquity. Instead, the tables of the Sun, Moon, and Planets are all identical with those of La Hire (1727), apart from a mere change of meridian from Paris to Delhi. There are worked examples for the time of a solar eclipse of A.D. 1734 May 3, which was total in central India. The tables and text of Book II on basic spherical astronomy are taken without alteration from the *Zīj* of Ulugh Beg, except that those functions which depend on the obliquity have been recalculated. The star table is taken from Ulugh Beg. The long geographical table includes those of Ulugh Beg and La Hire, as well as some 240 sites (many in India) from unidentified sources.
>
> The *vṛttaṣaṣṭāṃśa* of Delhi and Jaipur is a sextant totally enclosed by walls in which the Sun's image is formed as in a camera obscura. It is certainly the only instrument in those observatories susceptible of real accuracy, and it was used in determining the obliquity and the latitude. A number of accounts of its design and use are given, including those of Jagannātha and the Jesuits.[109]

Assuming that Mercier's conclusions are correct, we must ask ourselves when and how Jai Singh decided, despite the claims he made for the accuracy of his own instruments, to copy so many not only of the findings of La Hire, but also of those made in the fifteenth century by Ulugh Beg. One possible explanation is that the preface to the *Zīj* was written before a sufficient body of data had been amassed to establish the tables included there, and in the anticipation that those data would embody a degree of accuracy that they failed to realize. The instruments employed may well have been capable of achieving the sought-for level of accuracy, but the observers using them may have been deficient in their concern for careful measurement, thereby confounding Jai Singh's hopes and expectations. I know of no written source that might throw additional light on this line of speculation.

A related issue is Jai Singh's failure to make use of the telescope, of which he almost certainly had knowledge. "Perhaps," suggests Blanpied,

107. Blanpied, "Astronomical Program," 101 (note 96).

108. Blanpied, "Astronomical Program," 99 and 117–24 (note 96), and Raymond Mercier, "The Astronomical Tables of Rajah Jai Singh Sawā'i," *Indian Journal of History of Science* 19 (1984): 143–71, esp. 143–45 and 159–63.

109. Mercier, "Astronomical Tables," 143 (note 108).

FIG. 16.23. JAIPUR OBSERVATORY. This photograph, taken from atop the Saṁraṭ Yantra within the Jaipur observatory built by Jai Singh, shows several of its giant masonry instruments. The Saṁraṭ Yantra, a triangular gnomon, has a height of nearly 90 feet, above the ground and a base of 147 feet. The corresponding instrument at Delhi is substantially smaller (60 feet, 4 inches high). The two complementary concave hemispheres of the Jai Prakāśa (17 feet, 10 inches in diameter) appear in the middle ground, and beyond it are the Nārī Valaya Yantra and a smaller Saṁraṭ Yantra. The measurements cited are taken from George Rusby Kaye, *Astronomical Observatories of Jai Singh* (Calcutta: Superintendent Government Printing, India, 1918; reprinted Varanasi: Indological Book House, 1973). Photograph courtesy of Robert Harding Picture Library, London.

> one of the Jesuit missions to Jaipur did convince him that the new European observational techniques had already made even the grandest naked eye instruments obsolete, and convinced him of that fact after seven years of labor with his great instruments at Delhi, instruments erected a bare five kilometers from the throne of the Moghul emperor who had allegedly commissioned them. In that case the most intrepid of scholars might well have become discouraged with the observational program he had devised.[110]

One may also wonder why there is no mention in the *Zīj* of the dynamics of planetary motion and why Jai Singh seemingly displayed little or no interest in the Copernican heliocentric conception of the solar system, though he appears to have been informed of it. One intriguing possibility is that Jai Singh may also have learned from the Jesuits of the havoc being caused in Europe by the Copernican revolution and that he may therefore have decided to suppress the idea in India even though he may have been personally convinced of the correctness of Copernican views in regard to heliocentricity and the elliptical orbits of the planets.[111]

What, we may ask in conclusion, were Jai Singh's underlying motives in carrying out his ambitious astronomical program? Apart from the intellectual curiosity for which he was justifiably acclaimed, one primary object, one can argue, "was to provide solar data on which to base a reformed calendar" to replace the centuries-old Hindu sidereal calendar based on the *Sūrya-siddhānta*.[112] This is in keeping with the fact that Jai Singh lavished much greater care on the task of improving the Saṁraṭ Yantra, which was primarily used for solar observations, than he devoted to his other instruments.[113]

110. Blanpied, "Astronomical Program," 123 (note 96).

111. A. Rahman, *Maharaja Sawai Jai Singh II and Indian Renaissance* (New Delhi: Navrang, 1987), 75–76.

112. Blanpied, "Astronomical Program," 102 (note 96).

113. Blanpied, "Astronomical Program," 101 (note 96).

One can only speculate on the course Indian astronomy might have taken had the intrusion of European power been delayed by one or more generations. Although Jai Singh failed to achieve all his ambitious astronomical goals and seems not to have even attempted to establish a new school of astronomy, his astronomical tables, whatever their ultimate sources may have been, were used in northern India throughout the eighteenth century and were then considered among the best available.[114] And the grandeur of his astronomical conceptions, whatever the shortcomings in their realization, command admiration and set him apart from his less scientifically minded Indian contemporaries.

COSMOGRAPHIES: THE JAIN TRADITION

Of the three ancient Indian religious traditions, that of the Jains appears to have had the greatest and most continuous preoccupation with cosmographical questions. To this day it is said, "Every [Jain] monk knows by heart, from the time of his noviciate, the verses of the *saṃgrahaṇīs* [cosmographic texts]. He knows how to draw representations of them, and can sometimes even make models of them. He can also comment upon them in detail, following a long-established tradition."[115] Even to the laity the subject remains one of "absorbing interest," and allegedly "cosmographic diagrams appear in all Jain temples."[116] The purpose of preparing cosmographies was essentially didactic. "All in all, the representation of the world which the Jains have elaborated permits them to show, in a condensed way, which would have a greater impact upon the mind of a believer, the myriads of destinies through which one will transmigrate in the course of innumerable aeons."[117] The same would, of course, also have been true of cosmographies of Hindu and Buddhist conception, though their religious use—especially in Hinduism, where metaphysics was largely left to the Brahman elite—was less than in the case of the relatively well-educated and affluent Jains. There are, in fact, so many surviving examples of premodern Jain cosmographies, not only in India but in major museums and art galleries throughout the world, that an inventory of those I have seen or know of would be far from complete and serve little purpose.[118]

Most of the known Jain cosmographies derive from Rajasthan and Gujarat, the two Indian states with the largest proportions of Jains in their population. Most of the surviving works were painted in gouache on paper, mainly in pastel hues, as parts of illuminated *saṃgrahaṇī* manuscripts, the oldest thought to have been composed in the sixth or seventh century A.D. Of the extant illustrated recensions, however, none is said to be older than the fourteenth century. Additionally, there are many Jain cosmographies painted in gouache on cotton cloth, and surviving examples date at least as far back as the fifteenth century.[119] Perhaps the principal reason ancient Jain cosmographies are so much more plentiful than those of the Hindus is that they were carefully preserved both in monasteries and in the *bhaṇḍāras* (libraries) that are characteristic adjuncts to Jain temples. There are no corresponding institutions in Hinduism.[120]

A third medium in which Jain cosmographies survive is stone, especially bas-reliefs in Jain temples and shrines, as in the case of the representation of Nandīśvaradvīpa in figure 15.1. Not surprisingly, given the durability of the medium, the oldest of all the known cosmographies are sculpted in stone. These works date as far back as A.D. 1199–1200.[121]

Figure 16.24 presents a fifteenth-century view of Manuṣyaloka, in which the central continent, Jambūdvīpa, corresponds—in content, if not in relative scale—to the simplified and idealized sketch of figure 16.5.[122] The circular mountain range midway across the ring continent of Puṣkaradvīpa, marking the limit of the world of man, is shown by the wavy outermost circle. Though the arrangement of land areas, mountains, rivers, lakes, and other features is essentially symmetrical, there are several places where rivers diverge like opposite spokes of a swastika, long a sacred symbol in Indian culture. Reproduction in black and white does not convey an idea of the colors, often vivid, that are characteristic of cosmographies of this sort.

Conventions vary from one work to another, but there are certain broad tendencies. For example, it is usual to show water in blue with visual reinforcement provided by fish and a basket-weave pattern suggesting waves. Mountains are typically portrayed in one or more distinctive colors of a more intense hue than that of the continents where they are situated (though that is not so for the mountains of Puṣkaradvīpa), Meru in gold or some other prominent color, and so forth. On this work there is substantial text identifying various portions of

114. Blanpied, "Astronomical Program," 107 (note 96).

115. Caillat and Kumar, *Jain Cosmology*, 16 (note 57).

116. Gombrich, "Ancient Indian Cosmology," 130 (note 1).

117. Caillat and Kumar, *Jain Cosmology*, 26 (note 57).

118. For a partial list of sources, see notes to appendixes 16.1 and 16.2.

119. Moti Chandra, *Jain Miniature Paintings from Western India* (Ahmadabad: Sarabhai Manilal Nawab, 1949), 52–53.

120. Stella Kramrisch, personal communication, 5 January 1983.

121. I have photographs of three other exquisite examples from the thirteenth century as well as of others of later origin. I hereby thank M. A. Dhaky, associate director for research of the Center for Art and Archaeology of the American Institute of Indian Studies in Varanasi, for calling these items to my attention and sending me photographs of them.

122. This painting is now at the Victoria and Albert Museum in London. Its reference number is Circ. 91–1970. I thank Betty Tyers for bringing it to my attention.

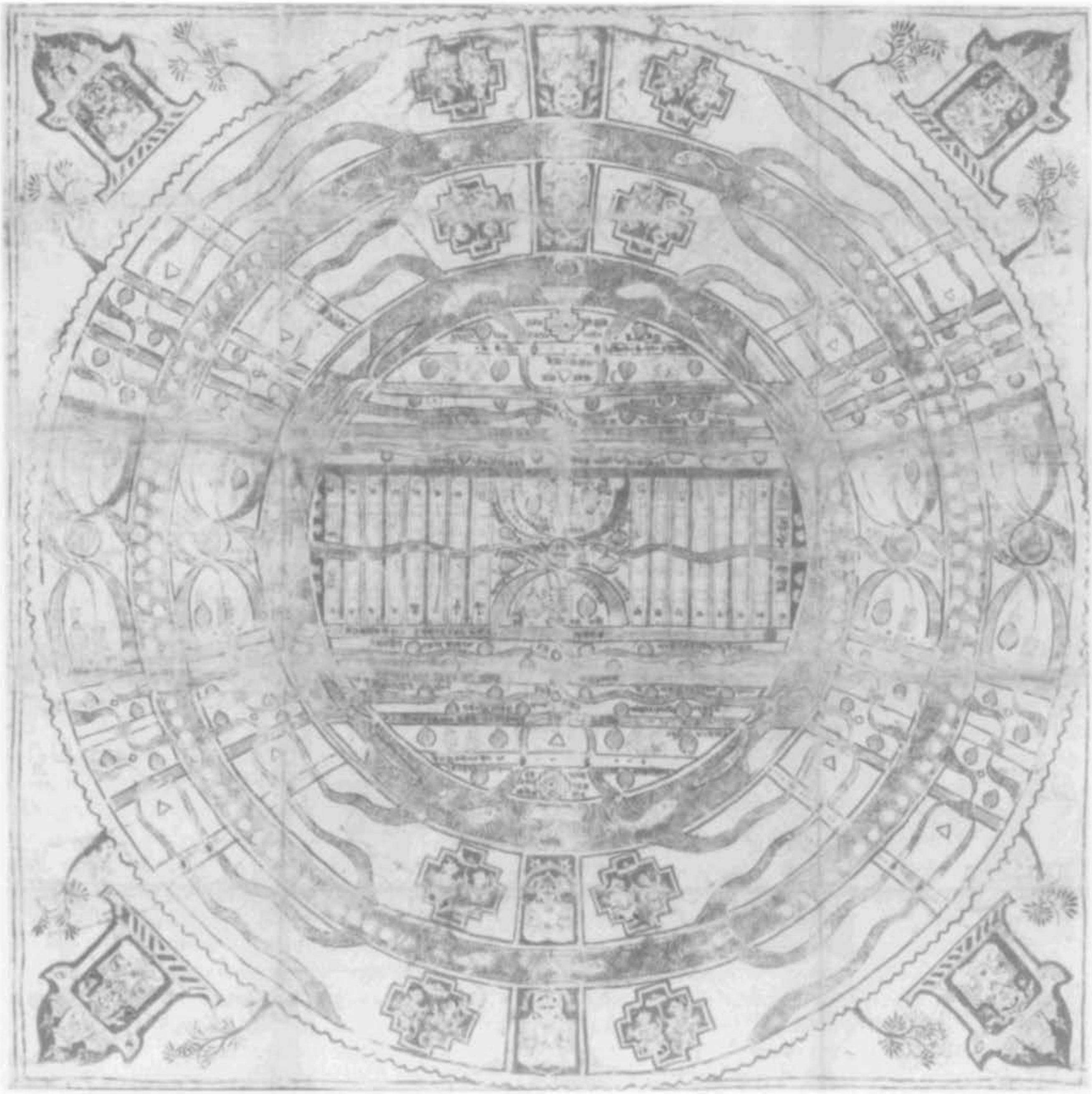

FIG. 16.24. MANUṢYALOKA (THE WORLD OF MAN) ACCORDING TO JAIN COSMOGRAPHICAL TEXTS. Depicted here are the so-called two and a half contintents (*adhai-dvīpa*) within which humans may be born. Jambūdvīpa, the central continent, is surrounded by the first ring ocean, Lavaṇa Samudra (Salt Sea); and successively Dhātakīkhaṇḍa, the first ring continent; Kālodhadi, the Black-Water Ocean; and the inner half of Puṣkaradvīpa, the next ring continent up to Mānuṣottara, the circular mountain range that limits the world of man. Various representations of Mānuṣottara are shown in figure 16.28 below. This artifact is gouache on cloth from western India, fifteenth century.
Size of the original: 54.5 × 54.5 cm. Courtesy of the Board of Trustees of the Victoria and Albert Museum, London (Circ. 91-1970, negative no. GB3636).

Jambūdvīpa but not of the one and one-half surrounding continents. Other representations have even more extensive text, sometimes identifying several hundred individual features. Still others have little text or no text at all.

In this view, as in most, the detail is greatest for the area of Mahāvideha, the region bounded north and south by transverse mountain ranges and extending in a broad east-west band across the center of Jambūdvīpa to the

Lavaṇa Samudra (Salt Sea) to the east and west. Within Mahāvideha, in addition to Mount Meru, are four "elephant-tusk mountains" (Vakṣāra) with tips close to Meru; the regions of Uttarakuru to the north and Devakuru to the south, bounded by the tusklike mountains; ten small lakes, five each in a north-south line; in each of the two *kuru*s, emblematic trees on either side of the chains of lakes (the *jambū* being placed in Uttarakuru); the great rivers Śītā and Śītodā, flowing east and west, respectively, from the two lakes closest to Meru; and thirty-two provinces, known as *vijaya*s, ranged about those two rivers, eight each to the north and south, each with its own central mountain range and bounding rivers.[123]

Another noteworthy area of Jambūdvīpa is Bhārata (India), the bow-shaped region at the continent's southern extremity. An east-west Vijayārdha mountain range crosses this region, and through it flow the rivers Gaṅgā to the southeast and Yamunā to the southwest. The central portion of Bhārata is Āryakhaṇḍa, the pure land of the Aryans, and around it on all sides is Mleccha, the land of impure peoples. Small though Bhārata appears here, it ought to occupy an even smaller area, since the *saṃgrahaṇī* texts state that it occupies only 1/190 the area of Jambūdvīpa.[124] That the area actually known firsthand to the Jain sages who composed the text should occupy so minuscule a portion of the total cosmos and, within Jambūdvīpa, so eccentric a location is wholly in keeping with the religious traditions of India.[125]

Further details about the nature of Jambūdvīpa are provided by figures 16.25, 16.26, and 16.27. Apart from its interesting detail, figure 16.25, which represents Uttarakuru, just north of Mount Meru, is noteworthy in several respects. First, its orientation, with south at the top, contrasts with the prevailing northern orientation of virtually all views of Jambūdvīpa as a whole. This change in orientation was probably intended to allow for a better composition, in portraying—within the tusklike Vakṣāra Mountains—the *jambū* tree, the wish-granting tree (*kalpavṛkṣa*), and the representative inhabitants of the region, who are here born in couples (*yugalikau*), whose desires can be met from the *kalpavṛkṣa* above them. Also noteworthy is the departure from symmetry. Note the mountains crowned by nine (left) and seven (right) sanctuaries. The meaning of the rectangle at the base of the mountain on the left is not known. At the top center one can see where the Śītā River begins its easterly course.[126]

Finally, this view, like so many others in South Asian cosmographies, combines the horizontal representation of features associated with most modern maps with variously oriented frontal perspectives in showing the figures, trees, and sanctuaries. Figures 16.26 and 16.27 relate to Mount Meru, which the Jains envisage as a series of three narrowing platforms, often portrayed as truncated cones, the highest (the *cūlikā*) surmounted by a great sanctuary.

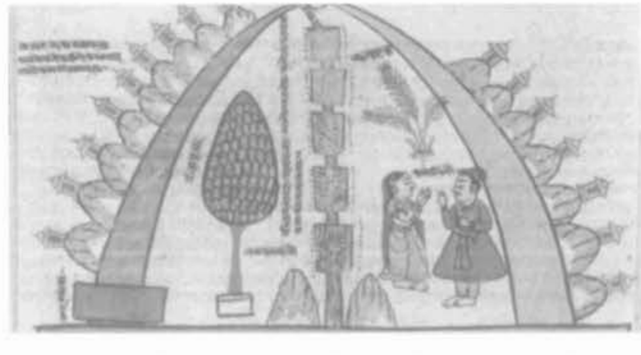

FIG. 16.25. UTTARAKURU, THE REGION NORTH OF MOUNT MERU. Represented here is a very small part of Jambūdvīpa just to the north of Mount Meru, the small circle at the top of the map. The bar at the bottom represents the east-west Nīla (Blue) Mountains from which two arcs, the Vakṣāra (Elephant-Tusk) Mountains, project toward Meru. Midway between them flows the Śītā River through five lakes. Also shown are a couple (humans here being always born in pairs) beneath the wish-fulfilling *kalpavṛksa* tree, and to their left is the *jambū* tree, from which the continent's name is derived. This leaf from a manuscript (?) is gouache on paper, Rajasthani, from the eighteenth century.
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

At the foot of the mountain and around each platform are terraces with parks full of trees and flowers, and their pictorial representation takes many forms. A view of the summit area of Meru from above is provided in figure 16.27. Two such contrasting perspectives on a single feature are common in the cosmographic art of the Jains.

Of the plethora of surviving Jain cosmographic diagrams, those relating primarily to Jambūdvīpa (with or without the additional one and a half continents included within the Manuṣyaloka) are without a doubt the most common. Despite substantial differences in the styles of painting, one is struck by the apparent consistency of not only the broad outlines, but also many of the lesser details that the works display. Cosmographies dating from the sixteenth century and later seem to be in no way affected by advances in non-Jain astronomy, either Indian or Western, or by the burgeoning of geographic knowledge.

123. Caillat and Kumar, *Jain Cosmology*, 148–49 and 156–57 (note 57). In this view, the placement of the eponymous *jambū* tree is in Uttarakuru, to the north of Meru, suggesting that the Jain cosmographers were trying—as in many other respects—to differentiate their cosmos from that of the Hindus, for whom Jambūdvīpa, the continent of the *jambū* tree, was either the southern continent (as in fig. 16.1) or the central continent.

124. Compare figure 16.5 with N. P. Saxena and Rama Jain, "Jain Thought regarding the Earth and Related Matters," *Geographical Observer* 5 (1969): 1–8, esp. 6.

125. Eck, "Rose-Apple Island" (note 26).

126. Caillat and Kumar, *Jain Cosmology*, 158–59 (note 57).

FIG. 16.26. PROFILE VIEW OF MOUNT MERU (JAIN CONCEPTION). This illustration is from a relatively recent recension of a thirteenth-century Sanskrit cosmological text, Candrasūri's *Trailokyadīpikā*. Written by one Indravarman in Jaipur in the year Samvat 1793 (A.D. 1850), the manuscript comprises eighty-six folios of eleven lines each in gouache and ink. Rising to a height of 100,000 *yojanas*, Mount Meru forms the *axis mundi* of the Jain universe (as it does also for Hindus and Buddhists). In Jain cosmography, Meru comprises three truncated cones, decreasing in diameter but increasing in their vertical dimension toward the summit. Though rarely drawn to scale, the dimensions are noted, as in this case, on many representations. Terraces at the foot of each level are marked by forests and gardens. Also present, though not shown in this view, are palaces and temples.
Size of the original: not known. By permission of the Bhandarkar Oriental Research Institute, Pune (acc. no. 603 of 1875–76, fol. 25b).

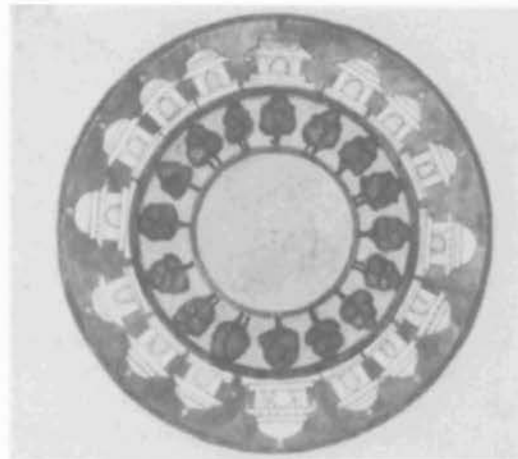

FIG. 16.27. OVERHEAD VIEW OF FLAT SUMMIT AREA OF MOUNT MERU (JAIN CONCEPTION). The medium, provenance, and date of this artifact are not known. Like the terraces leading toward the summit of Meru (compare fig. 16.26), the summit itself is a place of forest parks and palaces. This view provides a relatively rare top-down perspective.
Diameter of the original: 10.5 cm. By permission of the British Library, London (Add. MS. 26374, p. 18).

In that respect they differ substantially from the Hindu globes discussed above. In short, the hold of the canonical texts on the minds of Jains—or at least of those monks who were responsible for painting cosmographies—appears to be unbroken.[127] On the other hand, many cosmographies of the past century or so were created purely for commercial purposes, as objets d'art or as souvenirs to be sold to pilgrims and tourists, irrespective of their faith, who as a rule have only the dimmest notion of their content.

I carried out a statistical analysis on forty-four representations of Jambūdvīpa. Though I make no claim that the sample is representative, the results of the analysis may still be of interest. These are provided in appendix 16.1. This appendix indicates that the Jain Jambūdvīpa cosmographies originate overwhelmingly from Gujarat and Rajasthan; survive from at least as far back as the fifteenth century and are still being produced; and are painted on either cloth or paper in a wide range of sizes (the smaller ones generally being parts of manuscripts), typically in four to six colors. Most often they show two and a half continents, not infrequently only one, and only rarely two, virtually always centered on Mount Meru. Most representations are quite detailed, half showing more than a hundred separate components of the cosmos. Ancillary iconographic details commonly include numerous anthropomorphic figures, trees, and fish, the latter as a generic indicator of seas or, less commonly, rivers. Text too is often abundant, though about one-fourth of all representations contain no text at all. On about one-third of the sample numerical dimensional notations supplement the text. Conventional uses of color are also common, especially blue for the sea and rivers (with wave patterns reinforcing the symbolism); while various colors, especially yellow, red, green, and white, are used for mountains, frequently three or four colors on a single map. Finally, most cosmographies incorporate supplementary decorative detail—architectural, anthropomorphic, geometric, floral, and other plant and animal motifs—in the corners and in painted borders.

Figure 16.28, relating to a single feature of Jambūdvīpa, the mountain range at the outer limit of the Manuṣyaloka, indicates the variety among Jain cosmographies attributable to individual artistic license and the absence

127. An example of a modern Jain text, in Hindi, is Āryikā Jñānamatī's *Jaṃbūdvīpa* (Hastinapura, Meerut District, Uttar Pradesh, 1974). This work, by a Jain nun from Uttar Pradesh (not an important region for Jainism), is a straightforward exposition of the various parts of the Jain cosmos with twenty illustrations (including one in color on the book's cover) and numerous statistical details about the number and dimensions of the various regions, mountains, lakes, rivers, and trees that constitute the cosmos.

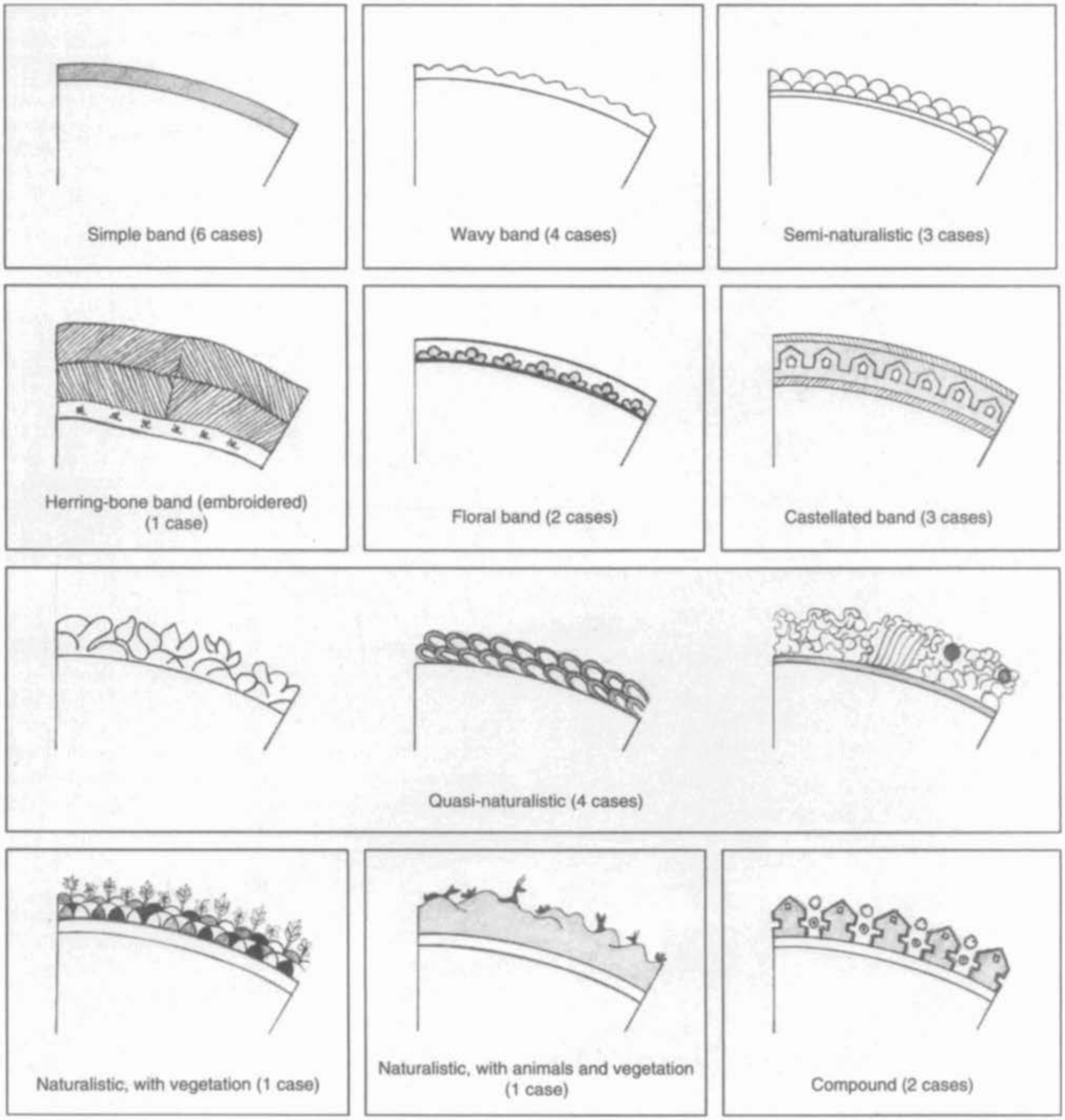

FIG. 16.28. VARYING METHODS OF DEPICTING THE MĀNUṢOTTARA MOUNTAIN RANGE MIDWAY ACROSS THE THIRD JAIN CONTINENT, PUṢKARADVĪPA. Mānuṣottara (Beyond Humankind) marks the limit of the *adhai-dvīpa* (two and a half continents) comprising the Manuṣyaloka (World of Humans).
Designed by Joseph E. Schwartzberg from the cosmographies given in appendix 16.1.

of established cartographic canons. But the drawings remain faithful to the substance of the *saṃgrahaṇī* texts.

Even though the Jains appear never to have produced a globe, their representations of the cosmos are not confined to two dimensions or even to sculpted bas-reliefs. In the Digambara Jain temple in Ajmer, Rajasthan, one encounters a grand two-story atrium wherein are "gilt wooden representations of scenes from Jain mythology.... manufactured at Jaipur and installed in... 1896."[128] At least a portion of this imposing display is cosmographic, and it includes suspended gods sailing

128. B. N. Dhoundiyal, *Ajmer*, Rajasthan District Gazetteers, vol. 4 (Jaipur: Publication Branch, Government Central Press, 1966), 720.

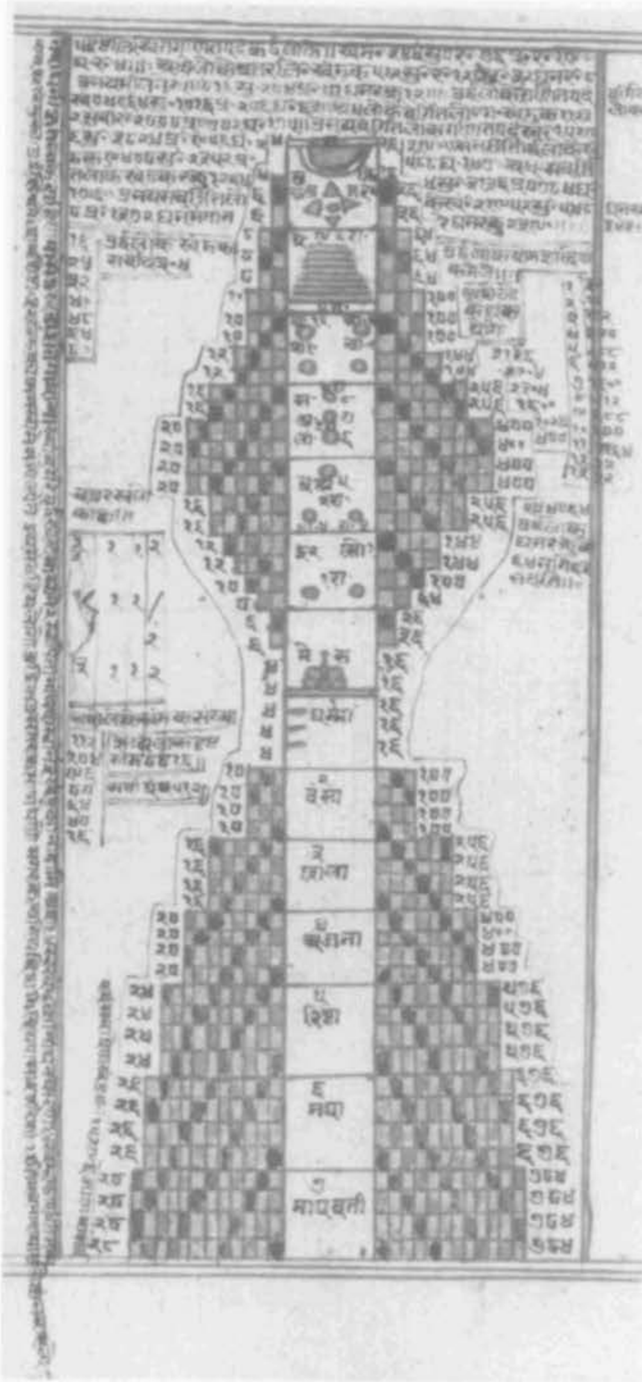

FIG. 16.29. THE LENGTH AND DIMENSIONS OF THE COSMIC MAN (LOKAPURUṢA). This diagram, gouache on paper, Gujarati, seventeenth century, shows greater concern for the actual dimensions of the cosmos than does the similar conception portrayed in plate 28. Those dimensions (expressed as numbers of *khaṇḍakas*) are indicated by numbers at each successive level among the hells and heavens. Separating the two is the plane of Jambūdvīpa, here represented by a double line in the middle of the diagram, with Mount Meru rising just above it. The dome of perfection (*siddhi*), whose attainment brings an end to the cycle of rebirth, is shown at the top of the universe. Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

about in the skies in *vimans* (airships). Other parts include representations of the sacred cities of Ayodhyā and Prayāga (modern Allahabad) and of the Tribeni, the sacred confluence of the Gaṅgā, the Yamunā, and the mythic underground river Saraswati.[129]

As I have noted, the Jain universe is ordered along a vertical axis and is composed of a series of hells and heavens below and above the world of man. Plate 28 and figure 16.29 present two variations of the way our own universe—only one among many—is characteristically represented in Jain paintings. Plate 28, an anthropomorphic rendition, shows Jambūdvīpa and its immediately surrounding ocean as a disk at the waist, where it is rotated ninety degrees from its actual horizontal position (a not uncommon convention). Alongside the view in figure 16.29 are numbers giving the dimensions, including the depths from front to back, of the various portions of the universe in *khaṇḍakas*, four of which constitute a *rajju*. The lowermost, "Thick Darkness Hell," for example, is 28 *khaṇḍakas* along each side and 4 in height and comprises 3,136 cubic *khaṇḍakas* out of a total for the whole of the lower world of 15,296 cubic *khaṇḍakas*. But the concern with scale that we find in this figure and on many other paintings is by no means a general attribute of the extant representations of Jain cosmographies. (It appears to be even less of a concern in Hindu and Buddhist cosmographies.) On this subject, Caillat observes:

> The extreme minuteness with which the smallest details of this geography are analysed and depicted is certainly more striking than the indifference of the painters to the proportions of the various parts, however strictly they are stipulated by the texts. When, from Bharata (or Airāvata) to Videha, the widths of the lands and the mountains which border them are supposed to increase geometrically, i.e. from 1 to 2, from 2 to 4 . . . from 32 to 64, all the intermediate zones are invariably reduced in size in the illustrations, to the benefit of the north, south, and centre. . . .
>
> It is the same when one considers the oceans and continents which encircle Jambūdvīpa. In relation to the diameter of the latter, the width of Lavaṇasamudra is theoretically double, that of Dhātakīkhaṇḍa which surrounds that is quadruple, and so on. This does not stop them being represented, at the limits, by mere lines.[130]

Enough has been said in regard to our discussion to

129. Dhoundiyal, *Ajmer*, 721 (note 128).

130. Caillat and Kumar, *Jain Cosmology*, 32 (note 57).

this point to convey the flavor of Jain cosmographical thinking and its visual representation. Given the availability of numerous relevant published works, especially the magnificently illustrated *Jain Cosmology*, little purpose will be served here by providing comparable details for other portions of the Jain cosmos. Appendix 16.2, however, provides a statistical summation of some of the attributes of a small sample of Jain representations of our universe.

Appendix 16.2 tells a story not greatly different in many respects from that of appendix 16.1. The identifiable source areas for the cosmographies showing the three major components of the Jain universe are west Indian, either Rajasthan or Gujarat, and the dates of surviving works go back at least to the sixteenth and possibly to the fifteenth century. The paintings, typically in at least four colors, may be on either cloth or paper and vary greatly in size, even more so than representations of Jambūdvīpa alone. The discoid portion of the cosmos representing Jambūdvīpa is almost always rotated ninety degrees to a vertical position so that the viewer can discern its three major components, even though they are ordered vertically and joined by a central column. Within Jambūdvīpa the long axis of the central region of Videha is most frequently oriented east-west, but occasionally it is north-south. Much more often than not, an androgynous anthropomorphic figure is an icon for the entire universe. The diminishing widths of successively higher hells and the widening, then diminishing widths of successively higher heavens are generally signified by a steplike outline within which a checkered grid represents the specific number of *rajju*s for the height and width of each layer, frequently supplemented by dimensional notations. Supplementary text is often present, either on or adjacent to the central figure or, less commonly, nearby, though the total amount of text is typically less than in the Jambūdvīpa cosmographies analyzed in appendix 16.1. Anthropomorphic, geometric, and other illustrations ancillary to the central figure are common. Most of the works have borders, rendered in a variety of ways but on the whole fairly simply.

In concluding this discussion of Jain cosmography, I present and briefly comment on four additional paintings that reflect the remarkable diversity of the domains constituting the Jain universe. A complete exposition, regrettably, would be well beyond the realizable scope of this history. The first of the paintings to be considered is of Nandīśvaradvīpa, the eighth Jain continent (the seventh ring moving outward from Jambūdvīpa, and hence in the same horizontal plane in the middle of their vertically disposed universe). We next move upward to the heavens immediately above these several rings, but still within the same middle stratum, and I present two views of celestial bodies. Finally, we ascend to an even more ethereal realm to regard some of the many wonders to be found in the fifth of the seven heavenly strata above the plane of Jambūdvīpa. Views of the other heavenly realms and of the many components of the seven levels of hell lying below Jambūdvīpa, as well as of the various continents ranged around Jambūdvīpa itself, may be found in various sources indicated in the introductory section of this chapter.

The view of Nandīśvaradvīpa presented in figure 16.30 stands in marked contrast to the bas-relief of the same area shown in figure 15.1. One sees here, in reduced scale, the numbered inner continents that it encircles. The authors of many views, however, including figure 15.1, have either shown these inner continents at an exceedingly small scale or have not bothered to depict them at all and have sometimes inserted in their stead some icon, such as a representation of one of the major Jain *tīrthaṅkara*s (preceptors), of whom Mahāvīra, a contemporary of the Buddha, was the greatest. It is probably he who is represented in the center of figure 15.1.

To the Jains, Nandīśvaradvīpa is the continent where lesser deities (Siddhas) assemble for festivities. Figure 16.30 portrays, in each of the four cardinal directions, a mountain of antimony crowned by a sanctuary for the Siddhas and surrounded by four lakes (*nandā*s, of which there are sixteen in all) between which four pairs of mountains rise up. On these thirty-two mountains are palaces for the Siddhas' wives. Sixteen additional palaces or sanctuaries (four in each of the four secondary directions) bring the total to fifty-two. The plan of a set of four sanctuaries about one *nandā* appears in the right half of the diagram. These sanctuaries provide the principal iconographic element of figure 15.1.

Celestial mapping based on accurate observations of the heavens does not form a part of the Jain tradition. Representations of heavenly bodies and associated phenomena within the Jain cosmos, however, are abundant. Among these representations, for example, are simple paintings of the Jyotiṣas, the five types of gods of light, who are more or less analogous to the Hindu *navagraha*s. These deities—*sūrya*s (suns), *candra*s (moons), *graha*s (planets), *nakṣatra*s (asterisms), and *tārā*s (stars)—occupy successively higher levels within a horizontal band of immeasurable breadth above the various ring continents and oceans. Vertically, they are distributed within the relatively narrow range of from 110 to 900 *yojana*s above the highest point of the middle world. Those above Jambūdvīpa revolve about Mount Meru and, like others in the remainder of Manuṣyaloka (the world of man), are ceaselessly in motion, whereas those beyond the world of man are fixed in position and shine with uniform brightness sufficient to carry their light outward for 100,000 *yojana*s. The Jyotiṣas may be symbolically portrayed by the *vimāna*s, which are at once their chariots

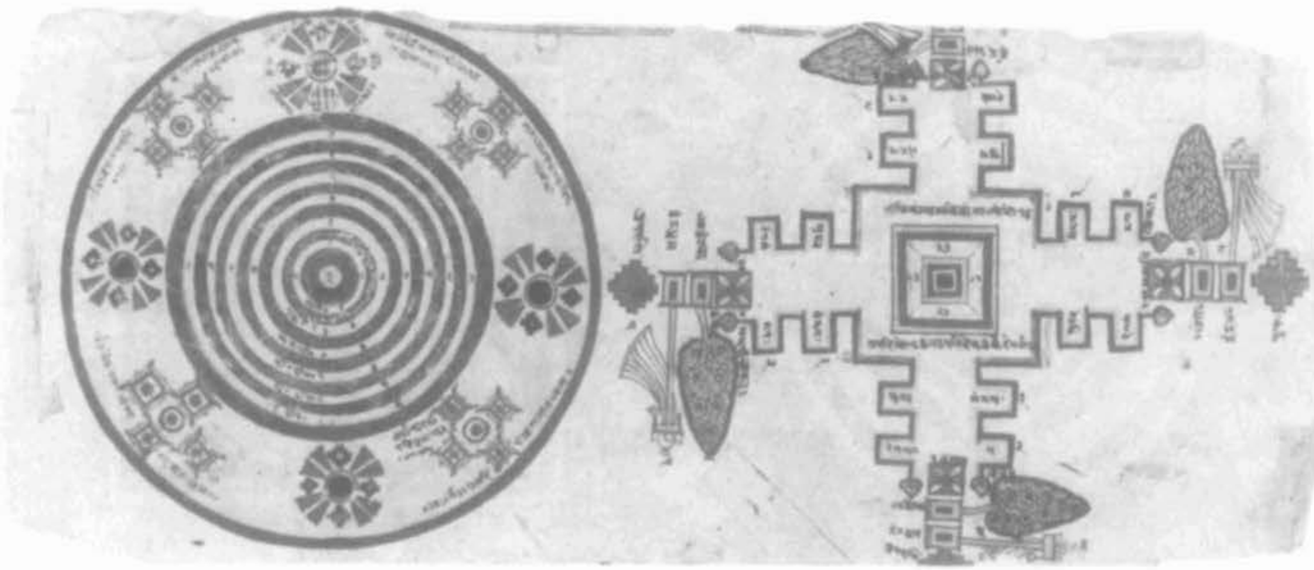

FIG. 16.30. NANDĪŚVARADVĪPA, THE EIGHTH JAIN CONTINENT. Six ring continents and seven ring oceans separate Nandīśvaradvīpa and the innermost continent of Jambūdvīpa. On this diagram, which is gouache on paper, Rajasthani, and dated to about the seventeenth century, the scale of all the features encompassed by Nandīśvaradvīpa is reduced (though not as greatly as in fig. 15.1) to provide more space for that continent. Nandīśvaradvīpa is marked by four mountains of antimony, each crowned by a sanctuary with lakes to its north, east, south, and west (right portion of diagram), and by thirty-two additional mountains arranged in four sets of eight mountains each (shown here as small triangles).
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

and palaces. In some views these *vimānas* are rendered by colored circles or semicircles (e.g., red for the sun, black for Rāhu) within surrounding circular fields; in others their characteristics are more explicitly depicted. In the vast cosmographic diorama in the three-story atrium of the principal Jain temple in Ajmer, the Jyotiṣas are rendered anthropomorphically, and they and their *vimānas* are shown in great detail and in three dimensions.[131]

A peculiarity of Jain cosmology in respect to the heavenly bodies above Manuṣyaloka is the belief that they occur in pairs separated by 180° within their respective orbits. Figure 16.31 illustrates this point with reference to the paths of the sun and the moon. The diagram relates to the day of Capricorn (the winter solstice). Hence the areas of the diagram assigned to the moon, signifying night, are somewhat broader than those assigned to the sun, signifying day, and are divided into a larger number of parts (six versus four). The attendant belief is that the sun and the moon each take two days to make a complete revolution around the earth, illuminating its southern half on one of those days and its northern half on the other.[132]

The seeming superfluity of suns and moons illuminating Jambūdvīpa pales in comparison with those for Manuṣyaloka as a whole. The actual numbers are indicated on figure 16.32, where they are written on the four diagonal spokes. Over Jambūdvīpa the figure 1 appears on each spoke, in two cases each for the sun and the moon; in the surrounding ocean, Lavaṇa Samudra, the number 2 appears on each spoke; in Dhātakīkhaṇḍa, the first ring continent, the number 6; in Kāloda, the next ring, the number 21; and in the outermost ring, which represents half the continent of Puṣkaradvīpa (up to the previously discussed Mānuṣottara mountain range that forms the outer limit of the world of man), the number 36. Thus, the total number of suns illuminating Manuṣyaloka is 132, while at distances of 90° from each of those suns there is a corresponding moon.[133]

The forms Jain artists used in depicting portions of their cosmos are not always as regular as in figures 16.30, 16.31, and 16.32. Thus, we find in figure 16.33 an illustration of "eight black fields" (*kṛṣṇarājīs*) in the third layer of the fifth heaven of the Brahmaloka (universe), which the texts describe "as being triangular or square,

131. Caillat and Kumar, *Jain Cosmology*, 176 and 190 (note 57), for general details, and facing pages for illustrations; the note on the Jain temple in Ajmer is based on a visit I made in 1980.

132. Caillat and Kumar, *Jain Cosmology*, 186–89 (note 57), for explanation and relevant illustrations.

133. Caillat and Kumar, *Jain Cosmology*, 178–79 (note 57); the illustration on 179 shows a multiplicity of symbols representing suns and moons beyond Jambūdvīpa, rather than the actual numbers indicated on figure 16.31, but this multiplicity merely suggests the increase as one moves away from the central region.

FIG. 16.31. SUNS AND MOONS ON THE DAY OF CAPRICORN. This Jain cosmography postulates two suns and two moons revolving around Jambūdvīpa, each completing one revolution every forty-eight hours. In this diagram, referring to the time of the winter solstice, the two quadrants signifying night are divided into three parts and are slightly broader than those signifying day, which are divided into only two parts. The artifact is gouache on paper, Rajasthani, eighteenth century.
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

FIG. 16.32. SUNS AND MOONS REVOLVING AROUND MANUṢYALOKA. Numerous paired moons and suns revolve around the central axis of the universe in increasing numbers over successive concentric oceans and continents outward from Jambūdvīpa. The numbers in each successive ring are here written on the map, with a total of sixty-six suns or sixty-six moons on each of the four spokes depicted. The artifact is gouache on paper, Rajasthani, eighteenth century.
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

and very thin," and "made up of particles of watery matter full of vegetable fragments which . . . flow from the Aruṇavara ocean of the middle world right up to the dizzy heights of the Brahmaloka." Allegedly the "triangular figures must be orientated to the north and south, the hexagonal ones to the east and west. It is in these masses, where every living being is born several times in the course of transmigration, that gods . . . produce rain or thunder."[134]

134. Caillat and Kumar, *Jain Cosmology*, 96–97 (note 57).

INDO-ISLAMIC COSMOGRAPHY

FIG. 16.33. THE EIGHT BLACK FIELDS IN THE THIRD LAYER OF THE BRAHMALOKA. In the third of the four layers of the Brahmaloka, the fifth Jain heaven, lie the *kṛṣṇarājīs* (eight "black fields"). The artifact is gouache on paper, Rajasthani, eighteenth century.
Size of the original: not known. By permission of Ravi Kumar, Basel, Switzerland.

Chapter 3 above presents a number of ways Muslims have attempted to portray the cosmos. Many of these conceptions undoubtedly found their way to India, though few Indo-Islamic cosmographies—apart from the distinct realm of celestial mapping (treated in chap. 2)—are known to have survived. To the views previously provided I here add some comments on various works of Indo-Islamic provenance that incorporate cosmographic symbolism and that some art historians have considered either metaphors for portions of the cosmos—most frequently paradise—or in some cases as literal re-creations of paradise on earth. Since the literature on the subject is extensive and for the most part readily available, I do not feel it is necessary to provide photographic illustrations of the ideas in question, but I do cite some key sources that will enable readers to pursue the subject independently in much greater depth than is possible here. Additionally, I describe one distinctive Indo-Islamic cosmographic conception and offer a few remarks on Mughal patronage of astronomy.

The Islamic penetration of India commenced with the Arab conquest of Sind in A.D. 711–12. Thereafter, for more than a millennium, numerous Muslim dynasties ruled over large parts of the subcontinent. In most areas, however, Muslims formed a relatively small part of the total population. Given the duration of the Muslim presence and the strength of the indigenous culture, some conjoining of religious traditions was inevitable, and with it came the diffusion of cosmological concepts. Since I have not explored in depth the dissemination of cosmological ideas within and among the several faiths of India, the discussion of Indo-Islamic cosmography that follows is intended to do no more than mention a number of themes that, in my view, warrant further research.

As far as I am aware, the earliest important instance of an Indian ruler's adopting indigenous Indian artifacts as cosmological symbols dates from the reign of the powerful and ostensibly zealously anti-Hindu Tughluq monarch Fīrūz Shāh. In the year 1360 he went to immense pains to dismantle and transport to his fort in Delhi three colossal monolithic pillars of the great Mauryan emperor Aśoka. Although all three pillars were reerected there, only one, known as the Topra pillar, still stands at that site. All three appear to have been placed by Fīrūz

> in front of his own personal mosque and Holy of Holies. . . . It is significant that the [remaining] pillar stands in the same relationship to the Islamic shrine as the sacred *dhvaja* or pillar (sometimes called "flagstaff") to a Hindu temple; or as the *yupa* (so-called "sacrificial post," but in essence another form of sacred pillar) once stood in relationship to the Vedic altar or *vedi*. In each case, its position was at the

> eastern extremity, half inside the compound and half out: a reminder of an ambivalence of acceptance and rejection which seems to have existed in many "historical" religions in the attitude to the so-called "symbols" of the *axis mundi* in earlier cosmic religions. . . . It transpires that Firuz Shah knew far more about the cosmic symbolism of "Ashokan" pillars than most historians. For instance his official chronicler places it on record that the correct name of the Topra pillar was *Minara-ye Zarrin* [golden pillar, so-called because it was gilt] and that it had grown up from . . . the Pleiades.[135]

Two centuries after Fīrūz, the mighty Mughal emperor Akbar (r. 1556–1605) also attempted, unsuccessfully, to transport to his intended but never-completed capital, Fathpur Sīkrī, another of the giant columns of Aśoka. Akbar's wide-ranging religious interests, his heretical religious practices, including sun worship, and in the years following 1575 his attempt to establish a new eclectic religious movement (later to be called the Dīn-i-Ilāhī [Divine Faith]), which he hoped would unite all Indians, are well documented. "But far less is known," observes Irwin, "about his interest in pillar worship and, in particular, his interest in cosmogonic myth, of which his so-called 'sun-worship' should be seen as a secondary aspect."[136] Another pillar that particularly fascinated Akbar was the pre-Aśokan "bull pillar" at the sacred site of Allahabad (ancient Prayāga), at the confluence of the Gaṅgā, Yamunā, and mythical Sarasvatī rivers, which has been interpreted as the " 'Place of Creation'. . . the mystical spot at which Heaven and Earth were initially separated. . . . [hence] the Navel of the Earth . . . [and] Centre of the Universe."[137] Although Akbar did not attempt to transport this pillar to his capital, he did construct in the Diwān-i-Khāss, the hall of audience at Fathpur Sīkrī, the central throne pillar that epitomizes in spirit the symbolic role of the *axis mundi*. In this, in the design of his thrones, and in other respects, Akbar sought to project himself as occupying the mystic center of the universe. Not surprisingly, therefore, one reads on the gateway to the gardens where his tomb was built the words: "These are the gardens of Eden, enter them to live for ever."[138]

Gardens were often seen metaphorically in the Muslim world as a re-creation of Eden, widely regarded as the seventh and highest level of the Muslim paradise, or, more generally, of paradise as a whole. But for Akbar's grandson Shāh Jahān, gardens were arguably more than a mere metaphor. In an abundantly and meticulously documented article, Begley seeks to demonstrate that the monarch, in his overweening pride, saw himself as God's agent on earth and the symbolic center of the world, and that he regarded the gardens he had built, especially that of his most sublime architectural monument the Tāj Mahal, *literally* as re-creations—along with the Tāj itself—of paradise. Each sector of the garden, he argues, each waterway and fountain, each gate, each basic component of the mausoleum and of the related buildings has its precise analogue in the textual representations of paradise and of the throne of God that form an important part of the Islamic religious tradition; and the calligraphy of the Tāj complex, setting forth apposite suras of the Koran, reinforces that message.[139] The cosmographic symbolism of the Islamic garden—and incidentally of the "garden rugs" into which the plans of gardens are woven—has been the focus of considerable literature, much of which Begley cites.[140] In one particularly relevant essay, Schimmel observes that

> many a writer, beginning with [the fourteenth-century Sufi poet] Amīr Khosrau, could claim that India must be Paradise itself, the very place out of which Adam was expelled. In an attempt to restore this Paradise Lost once more on earth, the Mughal rulers build their gardens and palaces: not in vain does the audience hall [of Shāh Jahān's Red Fort palace] in Delhi bear the proud inscription:
>
> If there is a Paradise on earth,
> it is here, it is here, it is here.[141]

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135. John Irwin, "Akbar and the Cosmic Pillar," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982*, ed. Robert Skelton et al. (London: Victoria and Albert Museum, 1986), 47–50, quotation on 47–48. At least one Muslim ruler before Fīrūz Shāh also reerected a pre-Islamic pillar in Delhi; Qutb al-Dīn Aibek, founder of the Delhi Sultanate (r. 1206–11), placed a Gupta-period iron pillar inside the courtyard of Delhi's first mosque, but there is no evidence that he attached any cosmological significance to this act. See Catherine Asher, "Jehangir and the Reuse of Pillars," to be published in a commemorative volume by the Archaeological Survey of India, ed. M. C. Joshi, manuscript p. 8 and n. 30.

136. Irwin, "Cosmic Pillar," 48 and the references cited there (note 135).

137. Irwin, "Cosmic Pillar," 49 (note 135).

138. Wayne E. Begley, "The Myth of the Taj Mahal and a New Theory of Its Symbolic Meaning," *Art Bulletin* 61, no. 1 (1979): 7–37, esp. 12. Concerning the words above the entrance gateway, see Edmund W. Smith, *Akbar's Tomb, Sikandarah, near Agra* (Allahabad: F. Luker, 1909), esp. 35.

139. Begley, "Taj Mahal," passim (note 138).

140. Particularly important are Ṣoubḥī el-Ṣaleḥ, *La vie future selon le Coran*, Etudes Musulmanes 13 (Paris: Librairie Philosophique J. Vrin, 1971), an exegetical work examining the relevant portions not only of the Koran itself, but of the major commentaries on it in regard, inter alia, to the topography of paradise; Elisabeth B. MacDougall and Richard Ettinghausen, eds., *The Islamic Garden* (Washington, D.C.: Dumbarton Oaks Trustees for Harvard University, 1976), an anthology of papers presented at the Fourth Dumbarton Oaks Colloquium on the History of Landscape Architecture, 1974; and L. Gardet, "Djanna" (paradise, garden), in *The Encyclopaedia of Islam*, new ed. (Leiden: E. J. Brill, 1960-), 2:447–52.

141. Annemarie Schimmel, "The Celestial Garden in Islam," in *The Islamic Garden*, ed. Elisabeth B. MacDougall and Richard Ettinghausen (Washington, D.C.: Dumbarton Oaks Trustees for Harvard University, 1976), 11–39, quotation on 20.

In his study of the Tāj, Begley notes the existence of various Islamic graphic representations of the heavenly regions that support the correspondences he has pointed out. Although most of the plans are of Middle Eastern provenance, Begley reproduces one depiction of paradise from an early eighteenth-century Indian manuscript, at present in the Bodleian Library, Oxford.[142] How many other such works may once have existed in India cannot be determined; but we know that Jahāngīr, the father of Shāh Jahān, possessed a copy of an important manuscript containing a diagram of the Plain of Assembly, in which Begley sees a close "iconographic parallel to the Taj's allegorical conception."[143]

In the discussion of world maps in the chapter on South Asian geographical mapping below, I call attention to a substantial number of paintings in which Shāh Jahān is portrayed either standing upon or holding a globe. In itself this would have no more cosmographic significance than do comparable paintings of Queen Elizabeth. But it is in order to point out here, as does Begley, that this exalted representation of the Mughal emperor was entirely in keeping with Shāh Jahān's inflated self-perception as the "vice-regent of God on earth" and, to employ the epithets of certain Sufi cosmological doctrines, "the embodiment of the Divine Pen," the " 'Shadow' of God's essence," the "Perfect Man." Thus, as for Akbar, a part of his cosmological preoccupation was with the throne, the analogue of the Koranic Divine Throne, and it is not surprising that his no longer extant Peacock Throne in the Red Fort palace in Delhi (Shāhjahānābād) was thought to be one of the most splendid creations in the rich panoply of Mughal art.[144]

Jahāngīr, the royal link between Akbar and Shāh Jahān, also utilized cosmographic symbolism and "attempted to integrate astrology with the administration of his empire. He built a tent which was divided into the twelve constellations of the Zodiac, and dressed his servants in uniforms with the symbols of the planets. 'He fitted up seven houses of audience named after the seven planets, and no other business might be effected except that appropriate to the day of the planet.' "[145]

Astrology was but one among a number of points of convergence between Indo-Islamic and Hindu cosmological thought; mystical doctrines provided others. It is conceivable that the latter may help explain one highly distinctive and eclectic Indo-Islamic cosmographic conception that appears to blend ideas taken from Hindu, Muslim, and Zoroastrian thought.

Although no indisputably Indian representation of this conception is known, a rendition of it, probably by an Indian artist, appears in an album of maps and drawings commissioned by Colonel Jean Baptiste Joseph Gentil, a French military officer in the service of the nawab of Oudh (now in Uttar Pradesh) during 1763–75.[146] (See also below, pp. 427–29.) The text accompanying the drawing is certainly by a French writer, perhaps Gentil himself.

Among the more or less "Indian" ideas in the diagram are that the world is supported by animals, one above the other, in this case a bull supported by a fish (in contrast to the serpent and the tortoise in some Hindu views); the importance of the bull (Nandi, in Indian mythology), which is shown with twenty-four horns (though the text says 80,000 "distant from one another by 1,000 days of travel for a good walker"), and the characteristic Indian hump; mountains of jewels (rubies directly above the bull and emeralds at the highest level); and an angel astride the mountain of jewels, who seems to function like the Jain cosmic man. Held aloft by the angel are seven circular lands alternating with six circular seas, though they are placed one above the other rather than in concentric rings, as in Hindu and Jain cosmographies. Additional features, possibly of Indian origin, are a supplementary mountain (in addition to the customary seven) analogous to Meru, with trees and a palace at the highest level; the large numbers and distances postulated, though modest by Jain or even Hindu standards; and finally, the dominantly vertical orientation of the universe.[147]

I am unable to state what currency the ideas presented in this cosmography enjoyed among Indian Muslims; but a note referring to some apposite text on a coin depicted with it suggests they were given some credence in Gentil's day as far away as Kandahar (now in south-central

142. Begley, "Taj Mahal," 14 and fig. 12 (p. 17) (note 138). The manuscript in question also contains sixty-six other illustrations of several holy places in Arabia, as well as depictions of both paradise and hell. "The style . . . is folkish, and undoubtedly represents a popular and provincial variant of Mughal court painting" (p. 14, n. 38).

143. Begley, "Taj Mahal," 25, including fig. 28 (note 138). Begley's n. 72 states that this manuscript, according to an autograph note by Jahāngīr, was among Jahāngīr's "most treasured books."

144. Begley, "Taj Mahal," 27–35, passim (note 138).

145. As cited in Blanpied, "Astronomical Program," 112 (note 96); some of the information comes from Jahāngīr's memoirs. Jahāngīr, like some of his Muslim predecessors, also reerected several pre-Islamic pillars, placing them in his capital at Agra and in the fort at Allahabad; but as with Aibek, we lack evidence that the pillars were intended as cosmological symbols. See Asher, "Reuse of Pillars" (note 135).

146. This work is in the Indian Department of the Victoria and Albert Museum in London. Its reference number is 15.25 1980, no. 35. Gole notes that "Gentil employed three Indian artists for a period of ten years to supply him with the illustrations needed for [his] albums." The names of two of these artists indicate that they were Hindus, while the third artist remains anonymous; Susan Gole, ed., *Maps of Mughal India: Drawn by Colonel Jean-Baptiste-Joseph Gentil, Agent for the French Government to the Court of Shuja-ud-daula at Faizabad, in 1770* (New Delhi: Manohar, 1988), 7.

147. Bess Allen Donaldson, *The Wild Rue: A Study of Muhammadan Magic and Folklore in Iran* (London: Luzac, 1938), suggests the sources for some of the features noted: the bull on the fish in the sea (p. 122); the mountain of emeralds (p. 90); a stratified series of mountains below the earth (p. 90); and the earth as the uppermost plane surrounded by the mountain of Ḳáf (pp. 89–90).

Afghanistan), where king Ahmad of the Abdali (Durrānī) dynasty ordered such coins to be struck.[148] Whether similar visual records of Indo-Islamic cosmographies will come to light is problematic. The widespread Muslim abhorrence of graven images may militate against it, but that aversion was never as strong in India as in the Middle East. In any event, we are dealing here with an exceedingly eclectic and heterodox conception.

The chapter on Islamic celestial mapping noted the achievements of Indian workshops making astrolabes and celestial globes. There is no need to reiterate that account here. But let me note in passing the existence of Indo-Islamic astronomical observatories. Although to the best of my knowledge no remains or even descriptions of such workshops survive, there are a number of textual references to them. According to Blanpied, "By implication, the Preface to the *Ziz Muhammad Shahi* [ca. 1835] admits to the existence of at least minor patronage of observational astronomy by the Moghul Emperors during the three centuries which separate Ulugh Beg from Jai Singh."[149] Akbar's father, Humāyūn, allegedly "regarded himself as something of a mathematician and astronomer. . . . [and] had a small personal observatory . . . in Delhi. . . . Abdul Fazl, writing during the reign of Akbar, claims that shortly before his death Humayun was planning to construct a larger observatory and had already chosen a site and obtained the necessary apparatus for it."[150] Further, Blanpied reports that "it has been alleged that Shah Jehan seriously contemplated erecting an observatory at Jaunpur in the province of Oudh" but was prevented from doing so by the coup against him staged by his son Aurangzīb.[151] Though little seems to have come of any of these efforts, that the Mughals were kindly disposed toward observational astronomy was presumably a factor enabling Jai Singh, whom I have already discussed, to carry out his own ambitious astronomical program.

Microcosmic Analogues of the Cosmos

Just as the Brahman, or universal spirit, infuses all things, so too, for many ritual purposes, an infinitesimal portion of the human domain is taken to represent the whole of the cosmos. Such symbology, of course, is not exclusively associated with religions of Indian origin, but what makes it noteworthy is that, when religious practitioners carry out rituals embodying cosmic symbols, those symbols are often drawn on a prepared field according to well-defined formulas with clear conventions as to how the cosmos is to be spatially differentiated and at what scale various portions of the cosmos are to be laid out. In these respects and possibly in others, the performance of certain rituals and the building of particular types of edifices incorporates an essentially cartographic process.

As noted above, the earliest Aryan sacrifices involved building altars or *vedi*s, some of which were remarkably large and elaborate structures. *Vedi*s, however, are by their nature ephemeral artifacts. One may still stumble on *vedi*s or their archaeological remains in traveling about India, but sacrifices today are much less important than they were in Vedic times, and their physical appurtenances are therefore commensurately rarer. I am aware of no *vedi*s preserved in, or specially built for, a museum or preserved in situ in their completed state for postsacrificial viewing. Rather, dismantling the *vedi* is often a part of the ritual process.

At a much more modest scale, certain folk sacrifices also entail cosmic or terrestrial symbolism, or both. One such example involves a festival known as the Govardhan Puja, in which adherents to the cult of Krishna make offerings to Mount Govardhan in the region of Braj, not far south of Delhi, where Krishna spent his youth. A legend in the *Bhāgavata Purāṇa* relates how Krishna persuaded the cowherds of Braj to give up their worship of the Vedic god Indra and worship Mount Govardhan instead. In his wrath, the angry Indra caused seven days and seven nights of rain to visit the region of Braj. But Krishna protected the cowherds by raising Govardhan on his little finger, letting them and their cattle find shelter beneath it. Today Krishna's devotees, in several parts of India, fashion mounds of cow dung into the form of Mount Govardhan, which they then worship. Into the dung they insert trees fashioned from stems of grass with tufts of cotton or rag on top, and around the mountain they place little men and cattle fashioned from balls of dung. Thus, in effect, a three-dimensional terrain model finds a place in a religious ritual.[152]

Like the preparation of *vedi*s, the construction of Hindu temples has since ancient times been regulated by an elaborate set of instructions covering every aspect of the work. The various scriptures containing these instructions—commented on briefly above—date from at least the first century B.C. These texts, as I noted, relate also to building in general and include chapters on building houses and on planning, laying out, and building villages and towns.[153] In her classic work *The Hindu Temple*,

148. I thank Iraj Bashiri of the University of Minnesota, Minneapolis, for translating the Persian text on the coin and for directing me to Donaldson, *Wild Rue* (note 147), and Monique Schwartzberg for help in translating the French text.

149. Blanpied, "Astronomical Program," 111 (note 96).

150. Blanpied, "Astronomical Program," 112 and the references cited there (note 96).

151. Blanpied, "Astronomical Program," 114 and the references cited there (note 96).

152. Deryck O. Lodrick, "*Gopashtami* and *Govardhan Puja*: Two Krishna Festivals of India," *Journal of Cultural Geography* 7, no. 2 (1987): 101–16, esp. 107–12.

153. A list of important texts is provided by Prabhakar V. Begde in

Stella Kramrisch sets forth and explains in great detail the rules for temple building. These rules include drawing on ground leveled for the temple a plan called the *vāstupuruṣamaṇḍala*, which is regarded as a "forecast" of the temple, "the fundament from which the building arises," and "the place for the meeting and marriage of heaven and earth, where the whole world is present in terms of measure, and is accessible to man."[154] Thus temple construction, like that of *vedi*s, required the preparation of an ephemeral one-to-one scale map. It seems not unlikely, however, that many smaller-scale plans would also have been prepared, at least for large and complex temples, with which India abounds. At least one such example (fig. 15.11) has survived, as we have seen, and several palm-leaf copies of exceedingly detailed, illustrated seventeenth-century copies of medieval architectural manuscripts (e.g., fig. 15.12) have also recently come to light. The latter illustrations, however, are not cosmographic in the same sense as is the *vāstupuruṣamaṇḍala*, and they are discussed below.

What is true of Hindu temples is, with appropriate modifications, also true of Buddhist stupas, whose cosmographic symbolism is in fact more explicit and easier to discern than is that of most temples. Although Buddhism became virtually extinct in India proper by about the thirteenth century and most Buddhist monuments have as a consequence fallen into ruin, dozens of massive masonry stupas have, in varying degrees, withstood the ravages of time;[155] and a few, such as the Great Stupa at Sanchi, initially constructed in the third century B.C. and greatly enlarged in the following century, are very well preserved or restored. Additionally, there are many other large stupas on or near the periphery of India, in the Himalayas and Sri Lanka, as well as in trans-Himalayan Tibet and Southeast Asia. Because of the particular association of stupas with Lamaistic (Tibetan) and Theravada (Southeast Asian) Buddhism, I shall defer my discussion of their cosmographic significance.[156]

Of cosmography in Jain architecture I shall here say nothing, since it appears not to have been a major focus for scholarly attention. Jain temples and shrines tend to be quite ornate, but in general their styles over the centuries and from one region to another have not varied significantly from those of the Hindus.

In city planning and secular architecture, Indian builders were, at least in theory, to be guided by theoretical texts that incorporated cosmographic and astrological principles. A number of these, collectively known as *vāstuvidyā*, were allegedly authored by Ṛṣis (mythical sages) and gods. In fact, the texts "appear to be collective works, built up of successive stratifications, of accretions, elaborations and modifications [over] the course of many centuries."[157] As with temples, builders were enjoined by these texts to draw mystic diagrams (yantras) on the ground as a forecast, in effect, of what was to emerge there (see also below, pp. 466–72).[158]

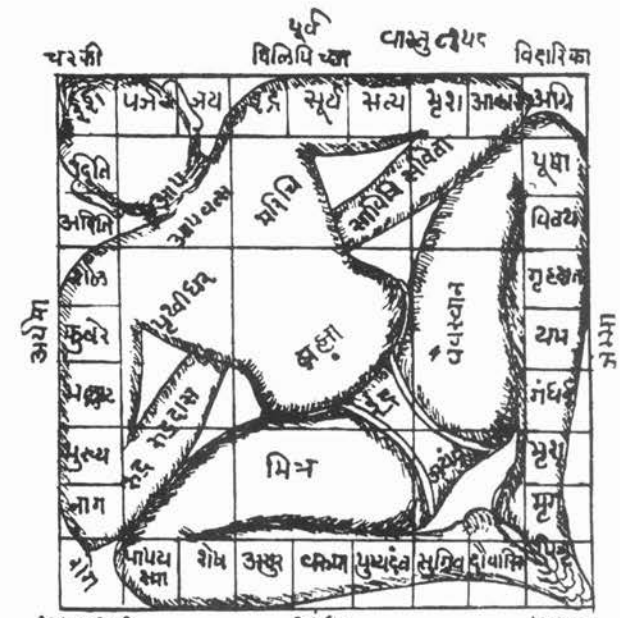

FIG. 16.34. *VĀSTUPURUṢAMAṆḌALA* (THE MANDALA OF THE COSMIC MAN). This drawing, from an old Indian manual of architecture (title, date, and provenance unspecified), shows one of thirty-two ways this mandala may be drawn (cf. fig. 15.13). By drawing the requisite horizontal and vertical lines on the ground before commencing construction, the architect summons forth from the earth the spirit of the cosmos (i.e., Brahma) personified by the cosmic man in the diagram.
Size of the original: not known. From Andreas Volwahsen, *Living Architecture: Indian* (London: Macdonald, 1969), 44.

Even in domestic architecture, there were associated cosmographic rituals. When constructing a house, one had to take into account at the outset the position within the ground of the *vāstupuruṣamaṇḍala*, the cosmic man, embodying the supreme principle or Brahman. This mandala, inherent in the earth itself, was marked on the ground before building could commence (fig. 16.34).[159]

Ancient and Mediaeval Town-Planning in India (New Delhi: Sagar Publications, 1978), 233–34.

154. Stella Kramrisch, *The Hindu Temple*, 2 vols. (Calcutta: University of Calcutta, 1946; reprinted Delhi: Motilal Banarsidass, 1976), 1:7.

155. Originally, stupas were earthen tumuli and hence not very durable (Basham, *Wonder That Was India*, 351 [note 15]).

156. See the discussion that will appear in the *History of Cartography*, volume 2, book 2.

157. Rāmacandra Kaulācāra, *Śilpa Prakāśa: Medieval Orissan Sanskrit Text on Temple Architecture*, trans. and annotated Alice Boner and Sadāśiva Rath Śarmā (Leiden: E. J. Brill, 1966), xiii.

158. Binode Behari Dutt, *Town Planning in Ancient India* (Delhi: New Asian Publishers, 1977), 142–43.

159. Andreas Volwahsen, *Living Architecture: Indian* (London: Macdonald, 1969), 43–46; and Brenda E. F. Beck, "The Symbolic Merger

Numerous household rituals entail similar considerations. The decorations that Indian women draw with rice paste in the courtyards of their homes, for example, typically contain cosmic elements, especially those designs known as *vrata alpana*, which are made in connection with sacred vows in exchange for some gift from the gods.[160] Similarly, patched shawls, coverlets, and wrapping cloths, made from cast-off pieces of fabric, are embroidered with motifs that portray portions of the cosmos.[161]

A widely held belief is that "in specialized Hindu rituals the individual joins with and even becomes identical to the cosmos itself. . . . [U]nder certain conditions the individual body and the universe are thought to actually merge."[162] Perhaps nowhere is this more apparent than in the practice of certain forms of yoga and in Tantrism, a long-lived, highly eroticized religious cult within Hinduism and also, in somewhat different form, within Tibetan and Himalayan Buddhism. Tantric art is particularly rich in illustrations fraught with cosmological symbolism. In both yoga and Tantrism, the practitioner engages in meditation, often aided by concentrating on an exterior mandala in Buddhism or yantra in Hinduism, mandalas generally being relatively complex and yantras relatively simple.[163] Both yantras and mandalas serve, to use a term coined by the renowned Tibetologist Giuseppe Tucci, as "psychocosmograms."[164] As such, they further the process by which one's self becomes a microcosm that fuses and becomes one with the enveloping macrocosm. One's spine then becomes the Meru or *axis mundi* of both. Arrayed along the spine are various centers of psychic energy that one summons up, in the practice of yoga, in moving toward the supremely illuminated *samādhi* state. These energy centers may be viewed as the psychophysiological analogues of the heavens that the soul traverses on its path to ultimate liberation—moksa in Hinduism or nirvana in Buddhism—whereby one is freed from the painful cycle of rebirth and made one with the infinite.

In regard to Tantric religious observances, Lannoy puts forward a similar concept:

> The idea that the human body is a microcosm . . . is essential to Tantric art, and it is expressed ritualistically in a number of ways. Both Tantric sexual rites and images related to this ritual are metaphors for the fire sacrifice, while the body of the woman is a homology of the Vedic altar. The ritual partner becomes a mystical terrain to be explored like the streets and sanctuaries of a holy city by a pilgrim. The Tantric poet Sahāra even discovers a sacred geography in his own body:
>
> I have walked with pilgrims, wandered round holy places.
> Nothing seems more sacred than my own body.
> Here flow the sacred Jamuna and the mother Ganges,
> Here are Prayaga and Benares, here the Sun and Moon.[165]

The mutability of space, time, and matter is related to the Hindu concept of *māyā*, of which Lannoy has this to say:

> Obviously the term *māyā*, which covers the whole of phenomenal existence, has been interpreted in many different ways. Since it is temporality it must be sacramentalized, or melt into Great Time, the cyclical cosmic rhythm. Since *māyā* is a collective hallucination veiling transcendental Reality, Absolute Truth can be grasped by various spiritual exercises (*sādhana*) through which one wakes to full consciousness. . . .
>
> The influence of this concept of *māyā* is of incalculable importance to patterns of thinking today. It is positive in the sense that it expresses India's sense of the transience of life, of mutability, and that this provides solace to those who can look forward to nothing but suffering. It is negative in the sense that the brute

of Body, Space and Cosmos in Hindu Tamil Nadu," *Contributions to Indian Sociology*, n.s., 10 (1976): 213–43, esp. 213–14 and 226–28. Other examples of *vāstupuruṣamaṇḍalas*, taken from a Nepali book of iconographic drawings dated about 1800, are illustrated and briefly discussed in Pal, *Art of Nepal*, 174–76 (note 65). A fascinating, well-illustrated analysis of the way the *vāstupuruṣamaṇḍala* and certain related cosmological conceptions figure not only in the construction but also in the subsequent organization and use of a number of actual houses in the southwest Indian state of Kerala is provided by Melinda A. Moore, "The Kerala House as a Hindu Cosmos," in *India through Hindu Categories*, ed. McKim Marriott (New Delhi: Sage Publications, 1990), 169–202.

160. Stella Kramrisch, *Unknown India: Ritual Art in Tribe and Village* (Philadelphia: Philadelphia Museum of Art, 1968), 65–66; and Sudhansu Kumar Ray, *The Ritual Art of the Bratas of Bengal* (Calcutta: Firma K. L. Mukhopadhyay, 1961), 42. Both works are well illustrated; regrettably, however, there is no illustration to support Ray's statement (p. 44): "In Rajasthan, *alpanas* are still drawn to depict cities protected by walls and cultivated lands with irrigation channels indicated by water-marks."

161. Kramrisch, *Unknown India*, 66–67 (note 160); and Stella Kramrisch, "Kanthā," *Journal of the Indian Society of Oriental Art* 7 (1939): 141–67.

162. Beck, "Symbolic Merger," 214 (note 159).

163. Numerous texts on Indian art and religion contain illustrations of yantras. A particularly rich collection with explanations of the purposes to be served by a large variety of yantras is S. K. Ramachandra Rao, *Tantra Mantra Yantra: The Tantra Psychology* (New Delhi: Arnold-Heinemann, 1979).

164. Giuseppe Tucci, *The Theory and Practice of the Maṇḍala: With Special Reference to the Modern Psychology of the Subconscious*, trans. Alan Houghton Brodrick (New York: Samuel Weiser, 1970; first published by Rider, 1969), 25. S. K. Ramachandra Rao states: "Mandala has been variously translated by experts as 'cosmogram,' 'cosmogenic model,' 'map of the soul,' 'cosmic plan,' 'symbol of Kosmos,' and 'layout of the psyche' "; see his *Tantra Mantra Yantra*, 26 (note 163).

165. Richard Lannoy, *The Speaking Tree: A Study of Indian Culture and Society* (London: Oxford University Press, 1971), 28.

> facts of life are, in the final analysis, either illusory or of secondary importance and that nothing one does can alter them for the better. While *māyā* is therefore a consolation in the face of sorrow because it implies that life need never be taken too seriously, it also serves as a rationale for apathy.[166]

Conceivably, Lannoy overstates his case, though he is hardly alone in holding the views just expressed. But to the extent that he is correct and that people's worldview is informed by the belief in *māyā*, making maps would seem a pursuit of trivial importance.

The all-important Indian concern with the process of reincarnation finds graphic expression even in play. Over much of South Asia and the adjoining realms of Lamaistic and Mahayana Buddhism, one encounters board games incorporating tracks that players follow in pursuit of moksa or nirvana. Such tracks constitute, in effect, fantasy route maps for the soul and are in relation to conventional route maps what many cosmographies are to maps of the world.[167] Although the physical format of the games varies from one region to another, most entail a series of levels leading to successively more exalted states, the highest level being moksa, nirvana, union with Shiva, or something comparable. The rules also specify circumstances that lead to dramatic rises and falls in the level of the player's (soul's) existence. The English parlor game snakes and ladders is derived from an Indian prototype of this kind.[168]

Cosmography and Mental Maps

A topic that has not yet been adequately explored is the nature of South Asian mental maps—that is, the ways South Asians envisage the spatial attributes of their immediate world and the larger areas encompassing them. To what extent, one wonders, does the preexistence of culturally conditioned and richly detailed mental maps among significant sections of a population render making tangible maps a superfluous exercise? Did such a factor greatly inhibit the making of tangible maps in the past, when the hold of religion on people's minds was even greater than it is today? Given the Indian capacity to see the large in the small (and vice versa), what need was there to map the former? Writing of Varanasi, Diana Eck observes:

> As a microcosm, Kāśī is said to contain all the *tīrthas* of India's sacred geography within her borders. Thus, in the city of Kāśī there are temples, tanks, lakes, and rivulets which represent the symbolic presence of such places as Kedārnāth and Badrīnāth in the Himālayas, Kāñcī and Rāmeśvaram in the Tamil south, Purī in the east, Dvārakā in the west, the old cities of Mathurā, Ayodhyā, and Ujjain, the Narmadā and Godāvarī rivers, the Vindhya and Himālaya mountains.
>
> In Kāśī, the whole of the sacred world is gathered together into one place.[169]

In 1975–76, a Sri Lankan Tamil anthropologist, E. Valentine Daniel, performed a series of experiments in the Indian state of Tamil Nadu in which he asked two sets of informants from the village of Kalappūr (a pseudonym) to draw for him a map of either the *kirāmam*, signifying the clearly defined revenue village (group 1), or the *ūr*, the village conceived as a space the villagers identified with (group 2). Even though the answers to prior questioning of the villagers had shown Daniel that the villagers believed the two areas were equivalent, the maps made in response to his experiment were notably different. The group 1 respondents all began by drawing boundary lines around the village that attempted, within the limits of their ability, to replicate what one would have found on a cadastral map of the village. The group 2 respondents

> began not with the periphery of the village but at its center, with the noting of the important places, such as the temple, the priest's house, the crossroads, and so on. Only then did attention shift to the periphery. All the respondents took great care to mark the shrines of the sentinel deities, the points at which roads or the village stream enters the village, and the haunted tamarind trees that dot the edge of the village.[170]

Some of the group 2 informants did draw a boundary line around the *ūr*, connecting the outermost of the points of the types just noted, but many did not. In any case, the sets of maps the two groups produced were notably different.

166. Lannoy, *Speaking Tree*, 287–88 (note 165).

167. An example of such a game will be provided in the *History of Cartography*, volume 2, book 2, in the discussion of Greater Tibet.

168. F. E. Pargiter, "An Indian Game: Heaven or Hell," *Journal of the Royal Asiatic Society*, 1916, 539–42, with foldout illustration facing 539.

169. Diana L. Eck, *Darśan: Seeing the Divine Image in India* (Chambersburg, Pa.: Anima Books, 1981), 54. The theme is developed at much greater length in Diana L. Eck, *Banāras: City of Light* (New York: Alfred A. Knopf, 1982). In this latter work, Eck notes the existence in Varanasi of "a modern temple called Bhārat Mātā, 'Mother India,' containing no ordinary image in its sanctum, but rather a large relief map of India, with its mountains, rivers, and sacred *tīrthas* carefully marked. It is a popular temple with today's pilgrims, who circumambulate the whole map and then climb to the second-floor balcony for the *darshana* [sanctifying view] of the whole" (pp. 38–39). See also Rana P. B. Singh, "The Socio-cultural Space of Varanasi," *AARP (Art and Archaeology Research Papers)* 17 (*Ritual Space in India: Studies in Architectural Anthropology*, ed. Jan Pieper) (1980): 41–46. What has been described for Varanasi also holds true in varying degrees for numerous other sacred cities of India; Singh provides a partial list on p. 45.

170. E. Valentine Daniel, *Fluid Signs: Being a Person the Tamil Way* (Berkeley: University of California Press, 1984), 72–79, esp. 74. I have described here only a portion of Daniel's experiments with maps.

The conclusion Daniel drew from this experiment is that the *ūr* "does not have, in Tamil cultural terms, a clearly delineated boundary line, as does the kirāmam, and that in the correct drawing of an ūr map, the ūr ellai [limit] is depicted most accurately by the shrines and intersecting roads that mark the vulnerable points along the village frontier." He adds that "the discovery that an ūr, the culturally more significant and indigenous concept of territory, does not have a boundary sheds a new beam of light on the continuing explorations into the issue of regionalism in India."[171] Daniel explicitly concurs with the view of a fellow anthropologist (and historian), Bernard S. Cohn, "that a region may find its defining feature in a 'symbol pool.' "[172] If so, the absence of regional boundaries, either political or of another nature, on traditional Indian maps is all the more understandable. One should of course not generalize from a single village in the Dravidian state of Tamil Nadu to the whole of India, and much less to other countries of South Asia, and one should recognize that experiments conducted in the latter part of the twentieth century cannot provide infallible guides to the worldview of Indians in the precolonial period. Nevertheless, further studies along the lines demonstrated by Daniel are called for if we are to deepen our understanding of how Indians mentally map their world and, by extension, of how the content of many traditional maps was determined.[173]

171. Daniel, *Fluid Signs*, 78 (note 170).

172. Daniel, *Fluid Signs*, 78 (note 170). The work Daniel cites is Bernard S. Cohn, "Regions Subjective and Objective: Their Relation to the Study of Modern Indian History and Society," in *Regions and Regionalism in South Asian Studies: An Exploratory Study*, ed. Robert I. Crane, papers presented at a symposium held at Duke University, 7–9 April 1966, Monograph and Occasional Papers Series, Monograph 5 (Durham, N.C.: Duke University Program in Comparative Studies on Southern Asia, 1967), 5–37; the idea of the symbol pool is developed on 22–25.

173. The scope of this work prevents my embarking on a discussion of an additional topic that is closely associated with the idea of mental maps, namely, the organization of space, especially urban space and sacred space, to conform with the mental maps of South Asians or, to put it differently, to create within the real world the homologue of a culturally shaped mental map. An interesting series of papers that explores this topic, among others, is Niels Gutschow and Thomas Sieverts, eds., *Stadt und Ritual: Beiträge eines internationalen Symposions zur Stadtbaugeschichte Süd- u. Ostasiens*; *Urban Space and Ritual: Proceedings of an International Symposium on Urban History of South and East Asia*, Beiträge und Studienmaterialen der Fachgruppe Stadt 11 (Darmstadt: Technische Hochschule, 1977). Of the eighteen papers in this volume, nine relate to South Asia and a tenth to the predominantly Hindu culture area of Bali.

APPENDIX 16.1 A STATISTICAL SUMMARY OF ATTRIBUTES OF FORTY-FOUR JAIN COSMOGRAPHIES CENTERED ON JAMBŪDVĪPA

Attribute	Findings
Provenance	Gujarat, 17; Rajasthan, 16; other "western India," 1; eastern India, 2; unspecified, 8
Date (century)	15th, 2; 16th, 7; 17th, 6; 17th or 18th, 2; 18th, 14; 18th or 19th, 1; 19th, 5; 20th, 2; unspecified, 4
Medium	Gouache, 25; gouache and ink, 5; ink, 1; silk embroidery, 1; unspecified, 12
Material	Cloth, 20 (including all 15th- and 16th-century examples); paper, 15; unspecified, 9
Height	Average (of 18), 71.8 cm; maximum, 160 cm; minimum, 11 cm; unspecified, 26
Width	Average (of 18), 71.9 cm; maximum, 162.5 cm; minimum, 9 cm
Number of colors[a]	Average (of 26), 4.5; 7, 1; 6, 6; 5, 11; 4, 6; 3, 1; 2, 0; 1, 1; unspecified, 18
Orientation	Videha region (see fig. 16.5) horizontal, 44; Videha region vertical, 3
Number of continents	2½, 27; 2, 2; 1, 14; unclear, 1
Degree of detail	More than 100 features depicted, 22; 50–100 features, 19; fewer than 50 features, 3
Centeredness	Centered on Mount Meru, 43; unclear, 1 (frayed in center)
Depiction of anthropomorphic figures[b]	16 or more figures, 13; 8 figures, 3; 4 or 2 figures, 3; without figures, 21
Depiction of trees	16 or more trees, 18; 8–15 trees, 4; 4 trees, 2; 2 trees, 2; number of trees unclear, 1; without trees, 17
Text	More than 100 words, 20; 50–100 words, 5; fewer than 50 words, 8; no text, 11
Dimensional notations	Numerical notations given for dimensions of features depicted, 14; no such notations, 25; unclear (largely because of scale of photo), 5
Symbols for sea[c]	3 or more symbols used, 8; 2 symbols used, 13; 1 symbol used, 18; no symbol used, 4; sea not depicted, 1; waves, 30; fish, 25; other, 13
Color of sea	Blue only, 20; blue and red, 1; other, 2; unclear, 20 (mainly on black-and-white photographs), 20; sea not depicted, 1
Symbols for rivers	2 symbols (waves and fish), 3; waves only (not counting color), 18; symbols indistinct, questionable, or missing, 23
Color of rivers	Blue, 19; other, 3; unclear, 22 (mainly on black-and-white photographs)
Color of mountains[d]	4 colors, 13; 3 colors, 8; 2 colors, 2; unclear, 21 (but almost all these black-and-white photos appear to have more than one shade for mountains); yellow, 20; red, 20; green, 18; white, 13; brown, 2; blue, 1
Corner detail	Text, 18 (text only, 8); architectural details, 15 (architectural details only, 2); anthropomorphic figures, 11 (figures only, 1); geometric designs, 5; trees, 2; other vegetation and/or animals, 7; flags, 1; solid colors, 2; no detail, 7; unclear, 1
Borders	Double line, 13; single line, 3; colored band, 15; floral design, 2; fringe, 1; no border, 13; unclear, 1 (border features are not mutually exclusive)

Sources: Collette Caillat and Ravi Kumar, *The Jain Cosmology,* trans. R. Norman (Basel: Ravi Kumar, 1981), photos on frontispiece and pp. 107, 119–23, 127 (two depictions), 141, 143, and 144; Moti Chandra, *Jain Miniature Paintings from Western India* (Ahmadabad: Sarabhai Manilal Nawab, 1949), fig. 189; Saryu Doshi, *Masterpieces of Jain Painting* (Bombay: Marg Publications, 1985), 14; Toby Falk and Mildred Archer, *Indian Miniatures in the India Office Library* (London: Sotheby Parke Bernet, 1981), 544; O. C. Gangoly, *Critical Catalogue of Miniature Paintings in the Baroda Museum* (Baroda: Government Press, 1961), pl. XIX; John Irwin and Margaret Hall, *Indian Embroideries,* Historic Textiles of India at the Calico Museum, vol. 2 (Ahmadabad: S. R. Bastikar on behalf of Calico Museum of Textiles, 1973), pl. 30; Willibald Kirfel, *Die Kosmographie der Inder nach Quellen dargestellt* (Bonn: Kurt Schroeder, 1920; reprinted Hildesheim: Georg Olms, 1967; Darmstadt: Wissenschaftliche Buchgesellschaft, 1967), pls. 5 and 6; Ajit Mookerjee, *Tantra Art: Its Philosophy and Physics* (New Delhi: Ravi Kumar, 1966), fig. 25; idem, *Tantra Asana: A Way to Self-Realization* (New York: George Wittenborn; Basel: Ravi Kumar, 1971), pl. 20; Ajit Mookerjee and Madhu Khanna, *The Tantric Way: Art, Science, Ritual* (London: Thames and Hudson, 1977), 19 and 70;

Armand Neven, *Le Jainisme: Religion et culture de l'Inde: Art et iconographie* (Brussels: Association Art Indien, 1976), figs. 117 and 120; idem, *Peintures des Indes: Mythologies et légendes* (Brussels: Crédit Communal de Belgique, 1976), 17; Francesco L. Pullé, *La cartografia antica dell'India,* Studi Italiani di Filologia Indo-Iranica, Anno IV, vol. 4 (Florence: Tipografia G. Carnesecchi e Figli, 1901), 33–34; Philip Rawson, *Tantra: The Indian Cult of Ecstasy* (London: Thames and Hudson, 1973), fig. 60; Joseph E. Schwartzberg, personal collection; Umakant P. Shah, ed., *Treasures of Jaina Bhaṇḍāras* (Ahmadabad: L. D. Institute of Indology, 1978), fig. 159; Chandramani Singh, "Early 18th-Century Painted City Maps on Cloth," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982,* ed. Robert Skelton et al. (London: Victoria and Albert Museum, 1986), 186; Sugiura Keohei, ed., *Ajia no kosumosu mandara* [The Asian cosmos], catalog of exhibition, "Ajia no Ucheukan Ten," held at Rafeore Myeujiamu in November and December 1982 (Tokyo: Kodansha, 1982), figs. 4/19–4/22 (six depictions); Kay Talwar and Kalyan Krishna, *Indian Pigment Paintings on Cloth,* Historic Textiles of India at the Calico Museum, vol. 3 (Ahmadabad: B. U. Balsari on behalf of Calico Museum of Textiles, 1979), pls. 92–95; *Le Tantrisme dans l'art et la pensée* (Brussels: Palais des Beaux-Arts, 1974), 5 and 21; London, British Library, Add. MS. 26, 374, OR 2116C, and OR 13476; and London, Victoria and Albert Museum, photo, negative no. GB3636.

a. In counting colors, each of the three primary and three secondary colors was considered irrespective of hue, and brown, black, and white (if painted) were also considered colors.

b. Anthropomorphic figures could be either deities or human beings; identifications frequently could not be made.

c. "Other" symbols in the sea included animals (e.g., turtles), anthropomorphic figures, geometric designs, and dots.

d. For the symbols used to depict the Mānuṣottara Mountains, midway across the third Jain continent, see figure 16.28.

APPENDIX 16.2 A STATISTICAL SUMMARY OF ATTRIBUTES OF TWENTY-FOUR COSMOGRAPHIES DEPICTING THE THREE MAJOR COMPONENTS OF THE JAIN UNIVERSE

Attribute	Findings
Provenance	Rajasthan, 11, Gujarat, 6; other "west Indian," 2; unspecified, 5
Date (century)	15th or 16th, 1; 16th, 3; 17th, 3; 17th or 18th, 2; 18th, 7; 19th, 2; 20th, 3; unspecified, 3
Medium	Gouache, 11; gouache and ink, 7; ink, 1; unspecified, 5
Material	Cloth, 10; paper, 9; unspecified, 5
Height	Average (of 15), 107.7 cm; maximum, 420 cm; minimum, 25 cm; unspecified, 9
Width	Average (of 15), 52.7 cm; maximum, 106 cm; minimum, 10 cm; unspecified, 9
Number of colors[a]	Average (of 11), 5,1; 7, 2; 6, 1; 5, 4; 4, 4; unspecified, 13
Representation of Jambūdvīpa	Rotated 90°, so that horizontal plane appears vertical, 19; shown as horizontal disk, 2; not shown, 3
Orientation of Videha[b]	Horizontal, 11; vertical, 6; ambiguous, 2; not shown, 5
Central column	Present in all three major levels, 20; present in part, 3; not present, 1
Illustration of anthropomorphic figures[c]	12 (figures in central column only, 5); geometric designs, 11 (designs only, 3); other illustrations, 4; text in column, 5; unclear elements, 3; not applicable, 1
Width of hells	Diminishing as in an ascending stair pattern ( ), 17; diminishing by a uniform slope (/), 6; uniform (|), 1
Width of heavens	Widening, then diminishing, in a stair pattern ( ), 17; widening, then diminishing, by a uniform slope (<), 5; uniform (|), 2
Checkered grid	Present in hells and heavens, 17; absent, 7
Text on or adjacent to central figure	More than 100 words, 4; 50–100 words, 1; fewer than 50 words, 7; no text, 12
Text in nearby field[d]	More than 100 words, 3; 50–100 words, 5; fewer than 50 words, 3; no text, 13
Dimensions on or adjacent to central figure	Present, 15; absent, 9
Dimensions in nearby field	Present, 9; absent (includes cases with no nearby field), 15
Universe shown as anthropomorphic figure	Explicit, 15; not explicit, 9
Ancillary illustration in nearby field	Present, 3; absent, 21
Borders	Double or triple line, 9; single line, 3; colored band, 6; floral design, 5; geometric design, 3; no border, 6 (border features noted are not mutually exclusive)

Sources: Collette Caillat and Ravi Kumar, *The Jain Cosmology,* trans. R. Norman (Basel: Ravi Kumar, 1981), 51, 53, 55, and 57; *In the Image of Man: The Indian Perception of the Universe through 2000 Years of Painting and Sculpture,* catalog of exhibit, Hayward Gallery, London, 25 March–13 June 1982 (New York: Alpine Fine Arts Collection, 1982), 126; Willibald Kirfel, *Die Kosmographie der Inder nach Quellen dargestellt* (Bonn: Kurt Schroeder, 1920; reprinted Hildesheim: Georg Olms, 1967; Darmstadt: Wissenschaftliche Buchgesellschaft, 1967), pl. 4; Ajit Mookerjee, *Tantra Art: Its Philosophy and Physics* (New Delhi: Ravi Kumar, 1966), figs. 20, 71, and 77; Ajit Mookerjee and Madhu Khanna, *The Tantric Way: Art, Science, Ritual* (London: Thames and Hudson, 1977), 71; Armand Neven, *Le Jainisme: Religion et culture de l'Inde: Art et iconographie* (Brussels: Association Art Indien, 1976), figs. 110 and 116; idem, *Peintures des Indes: Mythologies et légendes* (Brussels: Crédit Communal de Belgique, 1976), 14; Philip Rawson, *The Art of Tantra,* rev. ed. (New York: Oxford University Press, 1978), fig. 131; idem, *Tantra: The Indian Cult of Ecstasy* (London: Thames and Hudson, 1973), fig. 77; Joseph E. Schwartzberg, personal collection; Umakant P. Shah, ed., *Treasures of Jaina Bhaṇḍāras* (Ahmadabad: L. D. Institute of Indology, 1978), fig. 93; Sugiura Keohei, ed., *Ajia no kosumosu mandara* [The Asian cosmos], catalog of exhibition, "Ajia no Ucheukan Ten," held at Rafeore Myeujiamu in November and December 1982 (Tokyo: Kodansha, 1982), figs. 4/5–4/7; *Le Tantrisme dans l'art et la pensée* (Brussels: Palais des Beaux-Arts, 1974), 21, 25, 30, and 38.

a. In counting colors, each of the three primary and three secondary colors was considered, irrespective of hue, and brown, black, and white (if painted) were also considered as colors.

b. See "Orientation" in appendix 16.1.

c. The anthropomorphic figure is an androgynous cosmic being.

d. "Nearby field" signifies a part of the page or cloth that does not form an integral part of the illustration.

17 • Geographical Mapping

JOSEPH E. SCHWARTZBERG

This chapter examines well over two hundred individual geographical maps or sets of such maps. Although these works originate from many parts of South Asia, a disproportionately large share comes from only a few regions: Kashmir, Rajasthan, and Maharashtra. Eastern India, including what is now Bangladesh, by contrast, is scarcely represented. Most of the maps to be considered are from the eighteenth and nineteenth centuries, and it therefore seems probable that many of them, especially those that had some bearing on military, political, or fiscal matters, would have been directly or indirectly influenced by ideas and possibly even maps emanating from Europe. Yet they retain enough of an indigenous, traditional flavor to warrant being discussed in this survey. Many other works to be examined, however, show not the slightest trace of influence from beyond India. This is particularly true of works that relate in some way to religion; for example, certain maps concerning pilgrimage, especially with the Jain community, or copies on palm leaf of architectural plans of Hindu temples, originally prepared as early as the twelfth century.

The scales of the maps considered in this chapter vary greatly, ranging from very small-scale world maps to very large-scale plans of individual edifices or gardens. In general the account proceeds from smaller to larger scales. Thus, I begin by considering a rather limited corpus of world maps, mostly but not entirely based on Middle Eastern prototypes. Included in this group is a portion of one of the globes examined in the chapter on cosmography, on which a substantial portion of the northern hemisphere has clearly recognizable terrestrial referents.

I proceed to an examination of topographic maps, some of which cover very large areas (in two cases more than a million square kilometers) and certain others that show no more than a few hundred square kilometers. To the extent that I could determine the areas covered with reasonable precision, I have mapped their territorial extent on figure 17.7. Given the wide range of cartographic styles employed on South Asian topographic maps, I have provided in figure 17.8 a synoptic chart that conveys some sense of the diversity of map conventions utilized. That chart, however, will not help one understand some of the more abstract religious diagrams included among the group of Indian topographic maps. For several of the more important maps illustrated, I have prepared supplementary diagrams to indicate, by means of a superimposed geographic grid of latitude and longitude, their varying degrees of departure, from one part of the map to another, from a planimetrically exact representation of the areas depicted.

For ease of analysis, I have ordered the discussion of topographic maps into sections dealing with more or less coherent groups: Mughal; late premodern, with a further breakdown by region; hybrid (maps embodying collaboration between Europeans and Indians); and finally Nepali (usually also with substantial European influence). Because Nepali maps are too numerous to discuss individually, this chapter includes an appendix that indicates, in brief outline, details about their provenance, age, physical characteristics, content, and documentation. A similar appendix covers a group of maps relating to the religious topography of the sacred region of Braj, in northern India.

South Asia has given rise to a diversity of route maps, often in the form of scrolls. These form the next group of maps discussed in this chapter. Some such maps were carried on long journeys and consulted by travelers along their way. Others were largely decorative and perhaps related to specific historical events, which could be recounted by a narrator using the maps in much the same way as one might today use color slides to illustrate a public lecture. Pilgrimages and military campaigns were certainly among the activities that route maps were intended to document. Where possible I have mapped, on figure 17.29, the specific or generalized courses indicated by the route maps we know about.

In terms of total numbers, maps of small localities—the penultimate group I discuss—account for roughly half our total corpus. Figure 17.37 indicates the specific places these maps relate to. For analytic purposes, I divide the groups by sections treating, in order, maps of small rural areas, secular plans of cities and towns, secular oblique perspective views of cities and towns (with a few notes on frontal panoramas), plans of sacred places, and plans of forts. Given the large number of maps to be considered, I have had to be rather arbitrary in selecting individual maps for illustration and discussion; but this unavoidable limitation is partially mitigated by the virtually complete coverage provided for the maps on which we have information in five more tabular synoptic appendixes.

The final group of works to be analyzed comprises architectural plans. Since my research on this cartographic genre has been much less assiduous than for other map categories, what I present here is intended to do no more than suggest the types of materials a more thorough search would presumably reveal, and I make no pretense that the sample of plans I present is in any way representative. The places included in the sample are shown in figure 17.37.

Not all the maps discussed in this chapter survive. A number that have been noted and in some instances briefly described in works published over the past half-century or so have apparently vanished for a variety of reasons. But the great majority can fortunately still be located and await more penetrating study than has been possible in preparing the following account. Of the surviving corpus, I have personally inspected, though sometimes only fleetingly, a rather large proportion, including most of the works that I regard as particularly important. Susan Gole, whose indispensable work *Indian Maps and Plans* has provided much of the raw material for this section, has probably seen an even larger number.[1] She has also been able, in many instances, to obtain at least partial and sometimes complete translations of their legends as well as a substantial number of the photographs that I present in this chapter or have used for study. Many of the works I have chosen to omit are treated briefly in her book, along with one or more photographs, usually of good to excellent quality and quite often in color. I have chosen, wherever possible, to present views not available from Gole, thereby broadening the selection of photographs of primary sources for scholarly inspection.

World Maps

Although South Asians have produced, over the centuries, a number of works that may be considered world maps, the surviving corpus is so meager and diverse that it is not possible to analyze it in the same systematic way as one may the large number of medieval European *mappaemundi*.[2] In this section I take up, in order, the following: (*a*) several Indian copies of world maps of Middle Eastern provenance; (*b*) two early maps from what is now Afghanistan; (*c*) a group of three Indo-Islamic maps that borrow, in varying degrees, from Middle Eastern prototypes; (*d*) a highly eclectic, but essentially Islamic, work; (*e*) the more geographic portion of the cosmographic globe at Varanasi analyzed above (pp. 355–56) and (*f*) a Maratha world map that bears little relation to any of the foregoing. There were also some representations of globes in seventeenth-century Mughal paintings, and on at least one a fairly detailed map of much of the world was portrayed; but for reasons to be explained below, I shall treat that work along with other essentially topographic maps.[3]

One known and one presumably Indian copy of Arab world maps are illustrated and discussed by Gole in *Indian Maps and Plans*.[4] The former, now in the British Library, London, was inserted in a nineteenth-century copy of a sixteenth-century Persian translation of Zakariyā᾽ ibn Muḥammad al-Qazwīnī's *Kitāb ʿajāʾib al-makhlūqāt wa-gharāʾib al-mawjūdāt* (Marvels of things created and miraculous aspects of things existing) and is based on al-Qazwīnī's thirteenth-century original.[5] Although the general appearance of this small work (17 cm in diameter) appears to conform to that of its medieval Arab prototype (see pp. 143–45), a noteworthy addition of the Indian version is a large lake near the heart of Eurasia into (or out of) which four major rivers flow. Gole surmises that this addition might originate from the Puranic notion of Lake Anotatta (Manasarowar) in Tibet, which is the mythological source of four great rivers. But it might equally well represent the Baḥr Jurjān (Caspian Sea), which some early Islamic maps show in roughly this position.

The second and more detailed map, presumably of Indian provenance, also appeared in a copy of al-Qazwīnī's *ʿAjāʾib al-makhlūqāt*. This copy—in Persian, the lingua franca of India from the fourteenth to the eighteenth century—was made, translated, and brought back to England by Sir Robert Chambers, chief justice of the Supreme Court of Adjudicature of Bengal (1789–99). The work was subsequently extracted, translated, and pub-

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1. Susan Gole in *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989).

2. See David Woodward, "Medieval *Mappaemundi*," in *The History of Cartography*, ed. J. B. Harley and David Woodward (Chicago: University of Chicago Press, 1987), 1:286–370.

3. In addition to these works, there are some grounds to suppose that the Chinese pilgrim Xuan Zang, who visited India during A.D. 629–45, may have traced his own route on a supposed Indian world map (i.e., of Jambūdvīpa) that was the ultimate basis of much later works that survive in Korea and Japan. To have been of any use to a pilgrim, however, the map Xuan Zang used would have had to be substantially different from the dogmatic cosmographic works discussed above in the section on cosmographic mapping. The surviving works in question are noted briefly by Gole in *Indian Maps and Plans*, 26–27 (note 1), and more fully in Hirosi Nakamura, "Old Chinese World Maps Preserved by the Koreans," *Imago Mundi* 4 (1947): 3–22. If Xuan Zang did indeed obtain an Indian "world map," it is hardly likely that it would have been a unique production.

4. Gole, *Indian Maps and Plans*, 27–28 and 76–77 (note 1).

5. London, British Library, Add. MS. 7706, fol. 59b.

lished by William Ouseley in 1799.[6] It too includes the previously noted lake (here labeled the Sea of Kolzum, the Arabic name for the Red Sea) and four rivers. In the Indian Ocean it shows four stylized sailing ships. Three of these are shown as belonging to the Portuguese, English, and Dutch, while the fourth is labeled Sofala (possibly after the port in East Africa and possibly suggesting a persisting belief in the great southern continent, which on some Arabic world maps bears the notation "Sofala"). Places identified on the map include Portugal, England, Holland (shown as an island north of England), Istanbul, Bulgar (near modern Kazan in European Russia), Egypt, Arabia, Basra, Sind, Malabar, Dive a Mehel (the Maldives), Bengal, Moluc (either Malucca or the Moluccas), Sea of Cheen (China Sea), a number of rivers, and the legendary wall of Gog and Magog. Unlike the previous production, the map translated by Ouseley also delimits in the Northern Hemisphere the seven Ptolemaic *aqālīm* (climates; singular = *iqlīm*), a common feature of Arabic world maps.

A third copy, in Persian, of an originally Arabic work appears in a manuscript titled *ʿAjāʾib al-buldān* (Wonders of the countries) and is at present in the Khuda Bakhsh Oriental Public Library in Patna (MS. 635). This small work (image is 18.7 cm in diameter) in black and blue ink and pencil is not itself dated; but since the date 968/1560 is given on folio 3 of the manuscript, it cannot be earlier than that. Although the map's present location in Patna argues for an Indian copyist, that Andalus (Iberian Peninsula), Feringhi (land of the Franks), Sicily, Rus, Maghreb, and other North African place-names occur, as opposed to only two locales in India (Kashmir and Sind), suggests a prior Mediterranean source area.

Apart from the foregoing, I am not aware of other known or possible Indian copies of world maps of Middle Eastern origin, but it seems likely that a thorough search of libraries in such leading centers of traditional Islamic culture in South Asia as Ahmadabad, Aligarh, Delhi, Hyderabad, Lahore, and Rampur would reveal a number of such works. If so, that would demonstrate that ignorance of world maps, at least among the literati of Islamic society at the time of the European conquest, was not quite as widespread as suggested in the literature bearing on the history of South Asian cartography. And it would follow that, if exotic models were at hand, the probability of constructing South Asian derivatives of those models would be commensurately enhanced.

From what is now Afghanistan, most likely from the cities of Ghazni and Herat, come two additional world maps. The first is by the renowned polymath Abū al-Rayḥān Muḥammad ibn Aḥmad al-Bīrūnī, much of whose work was done under the patronage of the Ghaznavid ruler Maḥmūd (ninth/tenth century A.D.) and his successor Masʿūd I (r. 421–32/1030–40); the second is that of the Timurid geographer ʿAbd Allāh ibn Luṭf Allāh al-Bihdādīnī, known as Ḥāfiẓ-i Abrū (d. 833/1430). Some of al-Bīrūnī's contributions to our knowledge of the geography of India were noted in chapter 15. Included in al-Bīrūnī's *Kitāb al-tafhīm* (Introduction to astrology), dated about A.D. 1030, is a map of the seven seas that was in effect a rough outline map of the world's land masses as well. Since this map and other aspects of al-Bīrūnī's work have been discussed and illustrated above (esp. pp. 141–42 and fig. 6.4), I need say no more about them here except to suggest that his scientific legacy should have persisted not only among the savants whom he personally knew and with whom he corresponded, but also among their intellectual heirs, and that it might have diffused beyond the northwestern mountain girdle of the subcontinent into India itself. Though the work of Ḥāfiẓ-i Abrū is less well known, he has left us one world map, dated 1056/1646 (fig. 6.12 above).[7] The work is said by Irfan Habib to be based on the prototype of the Ilkhanid geographer Ḥamd Allāh Mustawfī (Ḥamd Allāh ibn Abī Bakr al-Mustawfī Qazvīnī), prepared in 1339–40.[8]

Undoubtedly the most important of the surviving Indo-Islamic world maps is that of a Muḥammad Ṣādiq ibn Muḥammad Ṣāliḥ of Jaunpur, known as Ṣādiq Iṣfahānī. This map (fig. 17.1) is one among thirty-three in an atlas of the "Inhabited Quarter" (northern half of the Eastern Hemisphere), which forms part of an encyclopedic work in Persian, the *Shāhid-i Ṣādiq*, finished in A.D. 1647. The only complete copy of this work, now in the British Library, has been discussed in the article on Mughal cartography by Irfan Habib.[9] Habib also includes a copy and translation of the six atlas folios that relate wholly or in part to India. The work is also prominently considered in Gole's *Indian Maps and Plans*, which includes not only a photograph of the overall map but also smaller-scale photographs of the thirty-two additional folios that make up the atlas, as well as a folio-by-folio inventory of what the atlas depicts.[10] For convenience, I

6. William Ouseley, "Account of an Original Asiatick Map of the World," in *The Oriental Collections*, vol. 3 (London: Cadell and Davies, 1799), 76–77. Gole, *Indian Maps and Plans*, 76–77 (note 1), reproduces both Ouseley's copy and his translation of the map.

7. Ḥāfiẓ-i Abrū is discussed above, pp. 149–50.

8. Irfan Habib, "Cartography in Mughal India," *Medieval India, a Miscellany* 4 (1977): 122–34, esp. 122; also published in *Indian Archives* 28 (1979): 88–105. Another Timurid world map, clearer and more detailed than that of Ḥāfiẓ-i Abrū and dated about 1413, has recently been discovered in a volume of miscellaneous scientific papers (B-411) in the Topkapı Sarayı Müzesi in Istanbul. I thank Dr. Glenn Lowry of the Freer Gallery of Art, Washington, D.C., for making this painting known to me and Marjan Adib, Department of Near Eastern Art, Arthur M. Sackler Gallery, for providing relevant details (the map is discussed above, pp. 126–27 and fig. 5.25).

9. Habib, "Cartography in Mughal India," 124–28 (note 7).

10. Gole, *Indian Maps and Plans*, 29 and 82–87 (note 1).

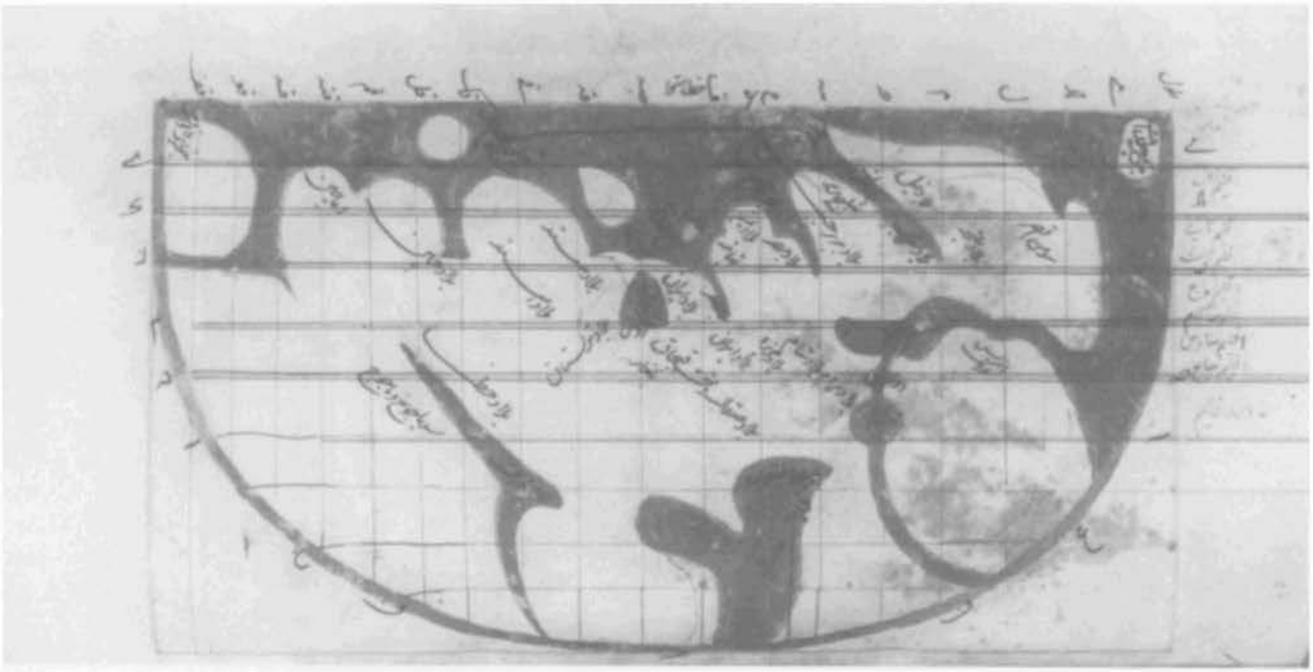


FIG. 17.1. MAP OF THE "INHABITED QUARTER." From the *Shāhid-i Ṣādiq*, an encyclopedic work in Persian by Ṣādiq Iṣfahānī. The map is ink and watercolor on paper. Longitude is measured from the island at the upper right, probably representing the ancient Insulae Fortunatae (Canary Islands). To the left of it is Sus al Aqsa, westernmost Africa, and below that are Andalusia and the country of the Franks. Near the equator the pointed tip of Africa is called the Land of Elephants. Morocco is misplaced across the long adjacent gulf, while Egypt is sited across the shorter pointed gulf and Yemen is farther to the left. Below Yemen are Syria and the region of Jazirah. Near the center of the map is the more or less triangular shape of the Caspian Sea, with Iran to the right of it, and below it are, right to left, the Kipchak Desert, Bulgar (modern Saratov), Russia, and Turkestan. The names Sind and India appear in the peninsula above and farther left, and in the two-cusped peninsula even farther left are written Chīn and Mahāchīn, both representing China. Below, on the two sides of the long sea appear Katha and the wall of Gog and Magog. The large semicircular shape at the upper left represents the Waqwaq Islands.
Size of the original: 14.2 × 26 cm. By permission of the British Library, London (MS. Egerton 1016, fol. 335r).

shall discuss the world map and the overall plan here and the sectional folios specifically relating to South Asia under the heading of topographic maps below.

In Habib's view, Ṣādiq Iṣfahānī's mapping is traceable to the work of Ḥāfiẓ-i Abrū and thence back to Ḥamd Allāh Mustawfī. Comparing Ṣādiq Iṣfahānī's work to that of Ḥamd Allāh Mustawfī, Habib observes that the former's world map is

> less detailed, and if anything, more erroneous. It does, however, represent India as a peninsula and adds Ceylon at its southern tip, though the latter improvement is spoilt by showing another island of similar size in close proximity. As with Ḥamdullāh, the South is put at the top, and North at the bottom. The degrees of longitude are shown along the Equator and the latitudes along the rim of the half disc. The seven "climes" (*iqlīm*), the Greek divisions along parallels according to the varying lengths of the longest days [a practice of Ptolemaic origin, which Ṣādiq Iṣfahānī explains on fols. 333b–334b], are also marked on the rim. But like Ḥamdullāh, Ṣādiq fails to give curvature to his meridians: These do not meet at the North Pole, but running in straight vertical lines meet the rim . . . at different points.[11]

Habib noted that Needham incorrectly inferred that the use of a grid on Ḥamd Allāh Mustawfī's map—which was followed by Ṣādiq Iṣfahānī—indicated that it belonged to the [so-called] Mongolian school and drew upon Chinese inspiration.[12] "This misunderstanding," he suggests,

> may possibly have arisen because Needham, knowing of the maps only from the *Tārīkh-i Guzīda* [a work dated 1329–30], missed the explanations provided in the text of the *Nuzhatu-l Qulūb* [1339–40]; and also because Ḥamdullāh failed to adjust his meridians to the discoidal representation of the world in his world-

11. Habib, "Cartography in Mughal India," 125 (note 7).

12. Joseph Needham, *Science and Civilisation in China* (Cambridge: Cambridge University Press, 1954-), vol. 3, *Mathematics and the Sciences of the Heavens and the Earth* (1959), 564 and fig. 240 (pl. LXXXVII).

map, thereby giving rise to the suspicion that his vertical meridians were grids.

> In his text Ḥamdullāh describes his Map of Iran as a *jadwal* (table) in which the various towns are placed according to the longitudes and latitudes assigned to them in the astronomical tables (*zījāt*). The map is indeed a table if one disregards the lines representing the coasts. The straight lines forming the squares of the table represent degrees of latitude and longitude; and the name of each place is written in the appropriate square (with no spot to indicate its position) according to the co-ordinates assigned to it. It is thus easy to see that the map originated out of an attempt at tabulating the co-ordinates in a new and concise form. The addition of the coast-line may be the only reason for treating it as a map, not a table.[13]

But Habib, in my judgment, goes too far in stating that Ḥamd Allāh Mustawfī's map—and by implication Ṣādiq Iṣfahānī's as well—was "based on the simple non-perspective cylindrical projection, precisely the kind out of which Mercator's projection was to develop subsequently."[14]

As in Ḥamd Allāh Mustawfī's map, parallels and meridians on Ṣādiq Iṣfahānī's world and sectional maps form equal squares, and towns are placed in many such squares according to their coordinates, which are listed in the accompanying text (fols. 352a–359a), though no point symbol is employed to represent a town. Names of countries are written astride several squares, thereby giving some rough intimation of their extent. Boundaries (as in all but one of the world maps discussed in this section) are lacking. Cartographic signs, however, were employed by Ṣādiq Iṣfahānī and were explained, in his own words, as follows: "In these pages . . . the straight lines in vermilion represent degrees (of latitude and longitude); cuts represent the rivers, with the insides filled in with vermilion, and (similarly) the oceans. The black straight lines represent the parallels dividing the 'climes' (*iqlīms*). The wavy lines symbolize the mountains."[15]

Although Ṣādiq Iṣfahānī's mapping improves on known earlier works in respect to scale and detail (especially for India), the thirty-two sectional maps contain numerous careless errors, some of which I shall consider in the later discussion of the six folios that relate to South Asia. To what extent Ṣādiq Iṣfahānī was himself responsible for these errors and to what extent they may be attributed to a sloppy copyist are matters for speculation.[16]

A much fuller and undoubtedly later world map than that of Ṣādiq Iṣfahānī was reproduced in facsimile, translated, and described by Edward Rehatsek in *Indian Antiquary* of 1872 (a portion is shown in fig. 17.2).[17] Regrettably, the original copy, in Persian, is now lost and cannot be accurately dated. The map, already "in a dilapidated state," was obtained from a Muslim from "Jumner" (Jamner) in East Khandesh district of what was then the Bombay Presidency, now Jalgaon district in Maharashtra, but that person could provide no hint as to its origin. Given the large number of Indian place-names (more than one hundred) on the map, the fact that India took up about a fourth of its total area, and the high proportion of places shown that have special significance for Muslims,

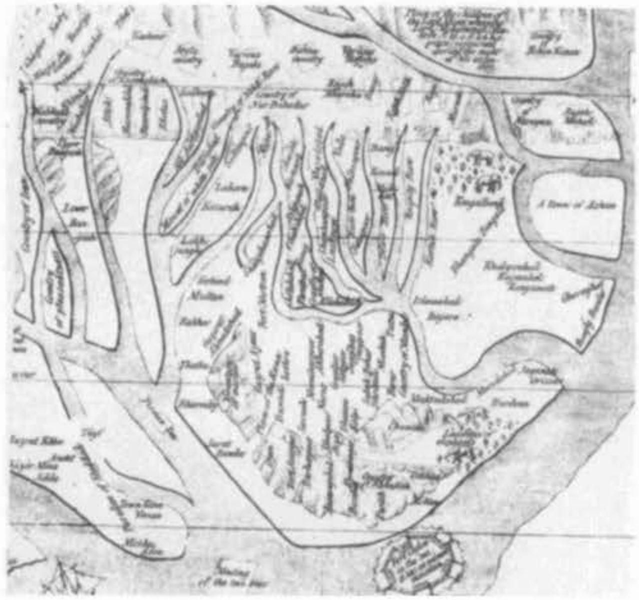


FIG. 17.2. FACSIMILE OF A PORTION OF A WORLD MAP. This map, by an unknown Indian Muslim author, was published by Edward Rehatsek in 1872. It was translated from a Persian original, which probably dated from the mid-seventeenth century. Its provenance is unknown, but it is quite likely from western India. Depicted here is the portion of the map, roughly one-third of its total area, on which India is shown. Though India is represented at a much larger scale than the areas of China, Europe, and Africa (there is not even an intimation of Southeast Asia) and is greatly contorted, the topological relationships of places within India are reasonably well maintained. Most of the names provided may easily be matched to known places, very few of which lie to the south of the Vindhya Mountains. Though the density of toponyms outside India is less than within India, the relative shortage is largely made up for by an abundance of notes of a mythological nature about many of the places indicated.
Size of the original: not known. From Edward Rehatsek, "Facsimile of a Persian Map of the World, with an English Translation," *Indian Antiquary* 1 (1872): 369–70.

13. Habib, "Cartography in Mughal India," 123 (note 7).

14. Habib, "Cartography in Mughal India," 123 (note 7).

15. Quoted from Egerton 1016, fol. 334b, MS. Or. 1626, fol. 345b in Habib, "Cartography in Mughal India," 125 (note 7).

16. Habib, "Cartography in Mughal India," 126 (note 7). My caption for figure 17.1 closely follows the description of the map in Gole, *Indian Maps and Plans*, 82, fol. 335r (note 1).

17. Edward Rehatsek, "Fac-simile of a Persian Map of the World, with an English Translation," *Indian Antiquary* 1 (1872): 369–70 plus foldout map.

it appears virtually certain that the original mapmaker was an Indian follower of Islam. Although the map does not resemble those of Arab provenance, its non-Indian details largely reflect those of Arabic maps and suggest that the ultimate source of the work is Arabic.

The map depicts the world's land area within the elliptical frame of an encompassing ocean and divides it into seven *aqālīm*. These *aqālīm*, however, do not extend northward from the equator, but rather stretch from the southern to the northern limit of the map. From west to east, the places shown in the southernmost *iqlīm* of this map are the "Country of Abyssinia," "Mokha Aden," "Meeting of the two seas," the southern limit of India, and "Fort Ceylon." Within Fort Ceylon a note states: "In the sea; it has an eminent mountain" (presumably Adam's Peak). Bombay appears on the map, but curiously, neither Calcutta nor Madras is shown, though "Hoogly Bunder" (port on the Hooghly) might be taken as a rough surrogate for the former. The name "Shahjehanabad" on the map, in place of Delhi, signifies that the map could not antedate the year 1627, when Shāh Jahān ascended the Mughal throne. In the western portion of the map, Portugal is noted (near a well labeled "Darkness"), and there are several references each to Farang (land of the Franks) and to Rus (Russia). Lack of mention of England or Holland argues for a date not much later than the 1627 limit.

Much of the northeast of the map is taken up by China (mentioned five times), and the easternmost land shown is labeled "An island of China." In the west one finds, in addition to the European places, the "Frontier of Mağrab" (northwestern Africa), and in the north the "Country of Serpents" and the "Place of Gog Magog."

The map is replete with intriguing pictorial elements, many accompanied by notes. In addition to the well labeled "Darkness," there are the Tower of Alexander (with the notation "built of Qăqăh stone, whoever sees it gives up the ghost laughing laughing"), the "Dome of a Talisman," and the "Tower which Pharao had built to make war against God the Most High, and from which he was shooting arrows." There are also pictographic elements without notes: a Portuguese caravel, Fort Khyber, herds of elephants (in both Abyssinia and India), serpents, and trees. Mountains are prominently shown with shading and suggestions of their ruggedness. An east-west range, extending across the entire map, seems not only to stand for the Himalayas but to evoke the Caucasus/Imaus/Emodus of classical antiquity. Within this east-west range are certain faintly bounded and unshaded areas with such labels as Candahar, Kashmir, Jogta Country (?), Various Rajahs, and Country of Nur Bahadur. There are enough personalized toponyms of the last type to lead one to suppose that dating the map would not be too formidable a task.

The map also abounds in allusions derived from biblical, Koranic, and other mythological sources, some rather cryptic. The "Place of [the giants,] Gog [and] Magog," it is said, was "closed [i.e., walled off] by Alexander. Their stature is one hundred cubits. Each increases till one thousand. When he dies they [the nearby serpents?] eat him." And just below that, "Here the lost ship of Alexander again came up by philosophy." In the "Grecian Sea," between Portugal and Constantinople, is an island bearing the note, "The mother of the Sultan of Rûm [the Ottoman Empire] having revolted from her son in this island made this place." And within the mountains just south of the "Frontier of China" we read, "Place of the children of the Lord Moses, where the Lord Mohammad Mustafa . . . sojourned during the night of his ascension."

Despite the fanciful nature of much of this map, the topological relationships among places in South Asia are fairly well preserved. The same may be said for much of central and southwestern Asia. Africa and Europe, however, are hopelessly garbled. The depiction of what must be the Ganga (Ganges) (not named) and its northern tributaries is fairly detailed, and a suggestion of the Indus system is also provided. On balance, the map is much more detailed, but less accurate, than that of Ṣādiq Iṣfahānī and, unlike the latter, makes no use of geographic coordinates.

Yet another rather peculiar world map (fig. 17.3) was accidentally discovered by Susan Gole "in a bazar in Delhi, as a piece of waste paper."[18] Entitled "World Map" in Persian, this circular wood-block illustration, 37 centimeters in diameter, shows considerable detail for Eurasia, indicates Africa mainly by a large oblate form labeled "Cape Island," and includes a few other African names on islands to the north. Though probably drawn in the late nineteenth or twentieth century, the map incorporates much older information (e.g., Seringapatam, in Karnataka [formerly Mysore] which the British practically destroyed in 1799), along with "such names as Iceland, Lapland, and Edinburgh (not in Scotland, also named, but in England)."[19] London is indicated twice, once in England and once "between Germany and Denmark (which also appears twice)."[20] Numerous names appear in India, including not only Calcutta and the nearby former Portuguese settlement of Hooghly but such relatively inconsequential places as Pilibhit in northern Uttar Pradesh. The seven *aqālīm* we have found on other Islamic maps also appear here; however, the "equator" they commence from has been displaced well into

18. Gole, *Indian Maps and Plans*, 28 and 81, quotation on 28 (note 1).

19. Gole, *Indian Maps and Plans*, 28 (note 1).

20. Gole, *Indian Maps and Plans*, 81 (note 1).

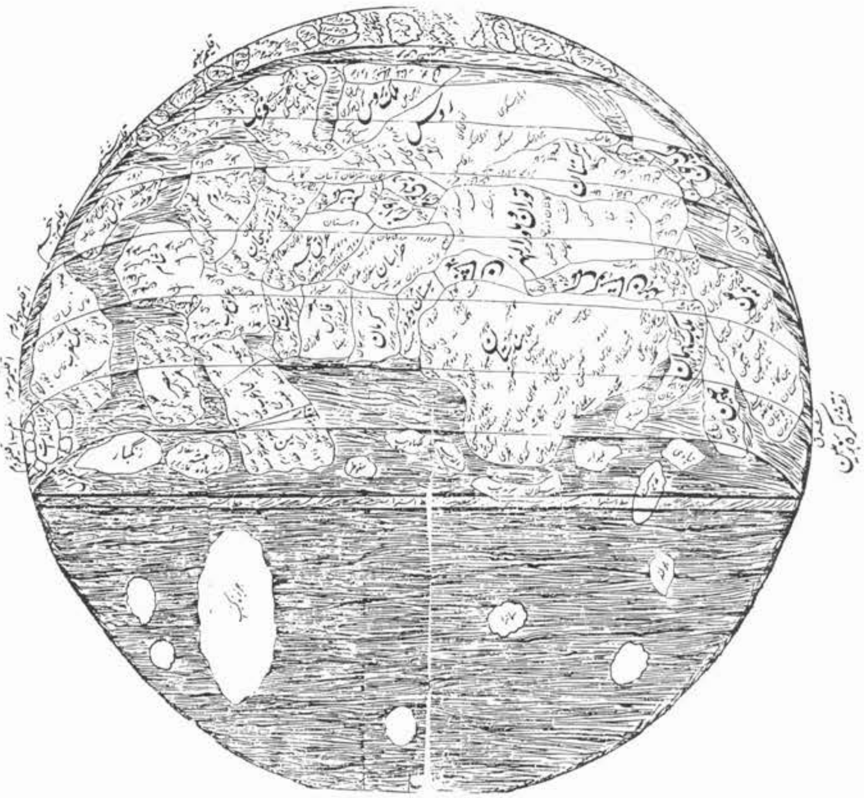


FIG. 17.3. WORLD MAP. By an unknown, presumably Indian, Muslim author, this wood-block print was found as wastepaper in a bazaar in Delhi and is now in a private collection. It dates possibly from the late nineteenth or early twentieth century, though incorporating much information of an earlier date. This map includes an abundance of Indian place-names on a disproportionately large India, but it also shows many places, some of them twice, in other parts of Eurasia, and even as far away as Iceland. Africa's presence is marked by several islands in the lower left quarter of the map. The seven *aqālīm* are shown, though they do not commence at the equator. Orientation is toward the north. The significance of the many boundaries depicted is not known.
Diameter of the original: 37 cm. By permission of Momin Latif, New Delhi. Picture courtesy of Susan Gole, London.

the Southern Hemisphere. There also appear to be numerous boundaries (whether national or regional is unclear), which are conspicuously missing on other world maps. The purpose of these lines, however, is problematic. Given its presumed late date, this map seems to be the work of a cartographer whose access to new knowledge from the West was relatively circumscribed.

A particularly beautiful and eclectic world map (fig. 17.4 and plate 29), probably dating from the middle or latter part of the eighteenth century, is at present in the Museum für Islamische Kunst in Berlin. This large map (260 × 261 cm), painted in tempera on cloth, is richly illustrated with miniature depictions, largely—but not entirely—of scenes from the *Iskandarnāmah* (a mythologized and widely disseminated account of the exploits of Alexander the Great, the origins of which date back at least to the middle of the fourth century). On stylistic grounds the painting is thought to originate from either Rajasthan or the Deccan; in both areas, schools of miniature painting were particularly well developed. A remarkable feature of the painting is the diversity of languages and scripts used for the map text. The descriptive geographic text is in Arabic; some names of countries and towns are in Persian; and in India the place-names are in both the Arabic and Devanagari scripts. The use of the latter suggests that Hindu artists might have been employed by Muslim patrons in its production. (Knowledge of Persian and the Arabic script was not uncommon among educated Hindus in eighteenth-century India, whereas this did not hold for Muslims and the Devanagari script.)

Although like many Arabic maps this one is oriented with south at the top, the depiction of the earth on the Berlin map is essentially Ptolemaic. Knowledge derived from the fifteenth-century pilot Ibn Mājid, whose no longer extant work *Asrā al-bahr* (Secrets of the sea) is cited on the map. (Whether such a work existed is problematic in that Ibn Mājid's known writings never mention the title in question.) Also included on the map is information from European contacts since the time of Vasco

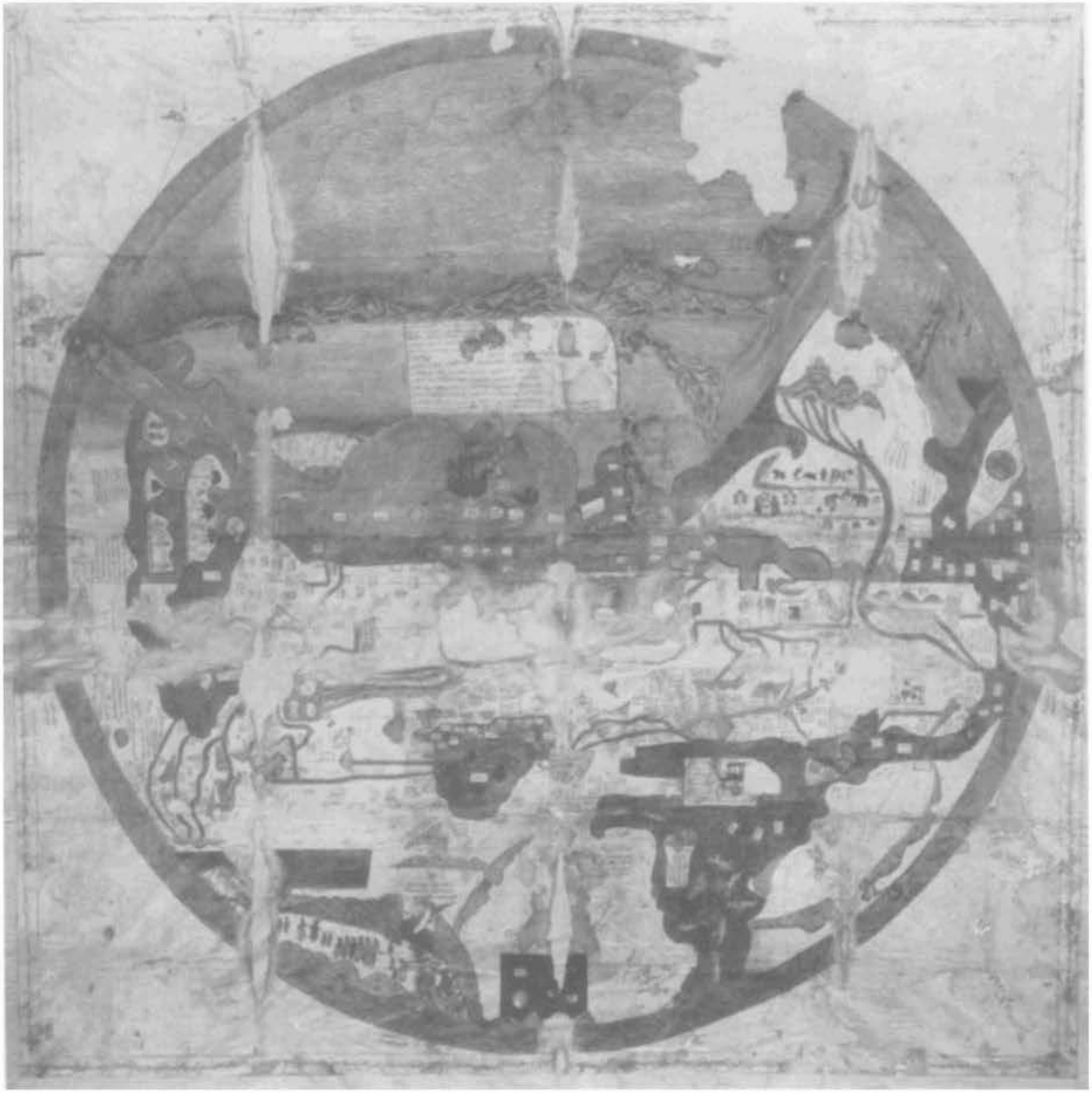


FIG. 17.4. AN ECLECTIC WORLD MAP. Essentially in the Islamic (but ultimately Ptolemaic) tradition, this map has text in Arabic and Persian and, for the area of India, in both the Arabic and Devanagari scripts. It is painted in tempera on cloth, is oriented with south at the top, and is probably an eighteenth-century work (see also plate 29). The map incorporates much of the same real and mythological detail as on figure 17.2, much of it derived from the very popular *Iskandarnāmah* (History of Alexander the Great). The style of miniature painting on the map suggests either a Rajasthani or a Deccani origin.
Size of the original: 260 × 261 cm. By permission of the Museum für Islamische Kunst, Staatliche Museen Preussischer Kulturbesitz, Berlin (inv. no. I. 39/68).

da Gama. Places noted in Europe (close to the right edge of the map) include France, Germany, and Austria. The name Portugal appears near a red caravel, with an adjacent dinghy, both at anchor in the Indian Ocean, along with the misplaced names of several Portuguese islands in the Atlantic Ocean. The largest number of place-names, however, approximately fifty in all, are in South Asia. Calcutta is named, and Amer (Amber) persists in place of Jaipur, which succeeded it as the Kachwaha Rajput capital in 1728, an apparent anachronism. (This argues more for a Deccani than for a Rajasthani source.) Curiously, Sri Lanka is depicted twice, possibly a throwback to the dual depiction of Taprobane on some European reconstructions of Ptolemy's world map as well as on Ṣādiq Iṣfahānī's. Alternatively, the dual representation may be the result of copying from two different earlier maps, each depicting the island in a different place. There is also an abundance of Middle Eastern place-names. Constantinople is prominently shown by a large rectangle joined to the mainland by a narrow tongue of land. The city is in the shape of a domed kiosk. Mecca is indicated by the black stone of the Kaʿba. In Africa, the Nile is the most prominent feature. It originates, as on many Islamic maps, in several streams in the southerly Mountains of the Moon, on which the legendary palace of Alexander is perched, and swings far to the west to join the Mediterranean near Morocco. East (left) of India there appear Japan, shown as a vertical island in which are seated a group of dog-faced creatures; China, along the edge of the earth disk; and rectangles with the names of English and Dutch colonies.

In its depiction of elements from the *Iskandarnāmah*, the Berlin map includes the "Spring of Life," whose discovery is attributed to Moses, shown as a black rectangle at the bottom center; the place of Alexander's meeting with those who sought his help against the people of Gog and Magog; the wall he built for that purpose, to the left of the foregoing; islands inhabited by ape-men; and as already noted, Alexander's palace on the Mountains of the Moon.

It is interesting to speculate on who commissioned the painting of the Berlin map and why. The chief purpose of the map was very likely ornamental, but one should not rule out an additional didactic motive. No very similar map is known—though that described by Rehatsek has some corresponding features—but it seems likely that comparable productions will eventually come to light.[21]

Of the Hindu globes discussed above, the wooden globe at the Victoria and Albert Museum in London, the bronze and copper globes at the British Museum, and the brass globe at Oxford may be regarded as wholly or almost entirely cosmological. The Varanasi (BKB) globe, however, does contain a measure of geographical content sufficient to warrant its consideration under the rubric of world maps. The essentially geographic portion of this globe (plate 30 and fig. 17.5) contains at least fifty names for which it is fairly easy to establish real-world correspondences. Most of these fall between the equator and the semicircular arc of the Himāchala (Himalayas) extending roughly 45° west, north, and east of Laṅkā (0°, 0°). Unfortunately, within that arc the paint depicting most of the area to the west of the prime meridian of Ujjain has flaked away (suggesting much handling and study of this area), as it has in smaller areas as well. Thus few place-names remain near the western rim of the semicircle. To the north, above a mountain range that might correspond roughly to the Pir Panjal, one finds Kashmir, and clockwise from Kashmir, and outside the range described, are Nepal, Assam, and Gangasagara (the place where the Ganga joins the sea). Continuing clockwise along the coast are Calcutta; Jagannath, marked prominently by a temple, in Orissa; Utkal (an ancient name for a part of Orissa); Kadalivana (Cuddalore?); Baramūla (?), not to be confused with the present-day Baramula in Kashmir; an unnamed—but prominently drawn—temple at what ought roughly to be Cape Comorin on the Ujjain meridian (but on a concave rather than convex portion of the coast); and appropriately, Drāviḍa, just to the west.

Within the interior of what would correspond to peninsular India, the topological relations of named places such as Gondwana, Telingana, Karnataka, Satara, Pune, Nasik, and Ujjain to one another are reasonably correct. So too are those on the Gangetic Plain as far west as Agra, including Bangāla (Bengal), Gaya, Kāshī (Varanasi), Prayāga (Allahabad), Ayodhya, and Gorakhpur. As previously noted, however, Delhi and Amber are both misplaced well to the east of where they ought to be in respect to the remarkably well delineated Ganga and Yamuna rivers. The large portion of the map given over to northeastern India, the relative correctness of the spatial relations in that general region, and the exceptional prominence given to Jagannath all argue for a northeast Indian origin. Moreover, the farther northwest one looks, the greater the confusion among localities: Gujarat is shown between Marwar to the north and Mewar to the south, rather than south of both those regions; and Sindhu (Sind) is shown northeast rather than southwest of Multan and Punjab.

Beyond the arc of the Himāchala Mountains and between them and the arc of the Hemakūṭa, fifteen degrees farther away from the central point at Laṅkā, one finds, moving clockwise from the sea, Mecca, Khorasan, Turkhān, and Mānasaghati (the Ghats on the sacred Tibetan Lake Manasarowar?), all west of the prime meridian; the Alaknanda River, just to the east (but above the northern horizon on fig. 17.5); and farther east, Kinnaravarṣa, Mahāchīn and Chīn, Lavaguru, and Bhatant. Kinnaravarṣa may correspond to Kinnaur, a district in what is now Himāchala Pradesh. Mahāchīn and Chīn, Greater China and China, respectively, replicate a distinction made on not a few Indian maps and also on European maps that show both Serica (northern China, as reached via the ancient Silk Route) and Sinae (southern China, as reached via the sea).[22] Lavaguru conceivably recollects the former Mon state of Luovo, with its capital

21. Most of this account was derived from the catalog description of the map provided by the Museum für Islamische Kunst in Berlin. In Gole, *Indian Maps and Plans*, 79–80 (note 1), there is an alphabetical listing of all the place-names shown in India.

22. For a discussion of the varying uses over time of the terms for China, see Henry Yule and A. C. Burnell, *Hobson-Jobson: A Glossary of Colloquial Anglo-Indian Words and Phrases, and of Kindred Terms, Etymological, Historical, Geographical and Discursive*, ed. William Crooke, 2d ed. (Delhi: Munshiram Manoharlal, 1968), 196–98.

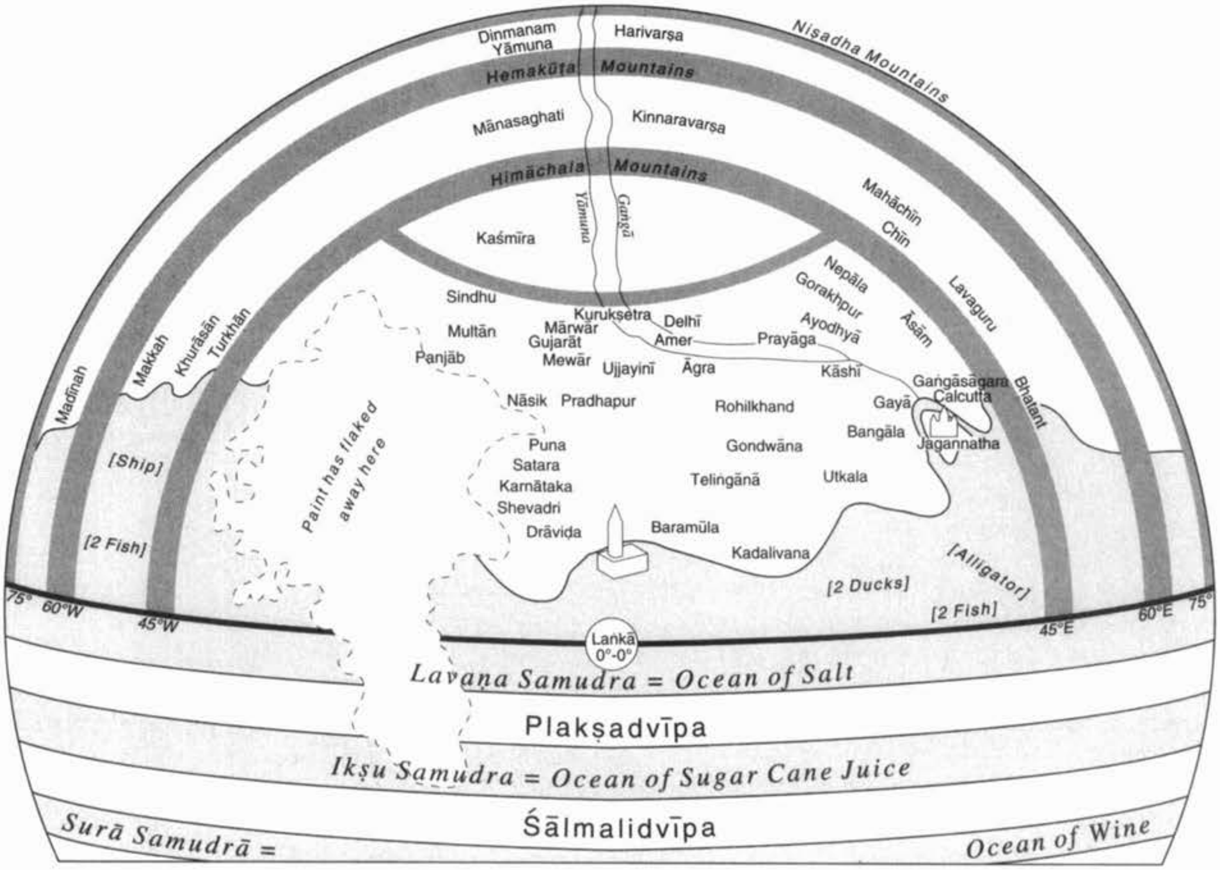


FIG. 17.5. PARTIAL TRANSLITERATION OF HINDU COSMOGRAPHIC GLOBE. Shown here is the geographic portion of the globe in plate 30 with a partial transliteration of place-names. Transliteration based on readings by Sarala Chopra.

of Lavapura (Lopburi) in what is now southern Thailand. Bhatant has no obvious former or contemporary referent. Its position just beyond the Himalayas suggests it might be Bhutan. On the other hand, given its coastal location, the once important port of Pattani on the Malay Peninsula is also a possibility.[23]

So far as I can tell, other places noted between the two mountain areas are mythical, as are virtually all places beyond the Hemakūṭa. Thus, with increasing distance from the focal area of Bhāratavarṣa (Bhārat/India), the Varanasi globe gradually changes from an essentially geographic representation of the world to a wholly cosmographic one.

In seeking to evaluate the geographic portion of the BKB globe, several questions come to mind. First, why, given the notations of latitude and longitude by one degree tick marks along both the equator and the prime meridian, is there so little evidence of the use of a grid in anything but a dogmatic way (e.g., putting Lankā at 0°, 0° and plotting the Himachal range as a semicircular arc 45° therefrom)? Second, why did the mapmaker fail to depict the peninsular form of southern India? Third, given the globe's supposed late date (mid-eighteenth century), why did it incorporate so little of the knowledge that Indians then had of Europe, Africa, Japan, and other remote areas? Finally, why did it fail to match in quality the atlas of Ṣādiq Iṣfahānī, drawn a century earlier? It is impossible to answer any of these questions with certainty, but I would speculate that the dogmatic framework provided by the space between the equator and the Himachal acted as a cartographic procrustean bed, preventing the mapmaker—despite his reasonably good knowledge of Bhāratavarṣa—from giving full play to the exercise of reason and the rules of evidence in plotting places as he did.

Altogether different from the BKB globe is a terrestrial globe that was briefly seen and photographed by Rudolf Schmidt in 1972 in a building attached to the Jaipur astronomical observatory. Although the globe appears to have been an adaptation of an eighteenth-century European

23. I am indebted to Sarala Chopra of the Bharat Kala Bhavan in Varanasi for her transliteration of the place-names noted in this and the preceding two paragraphs.

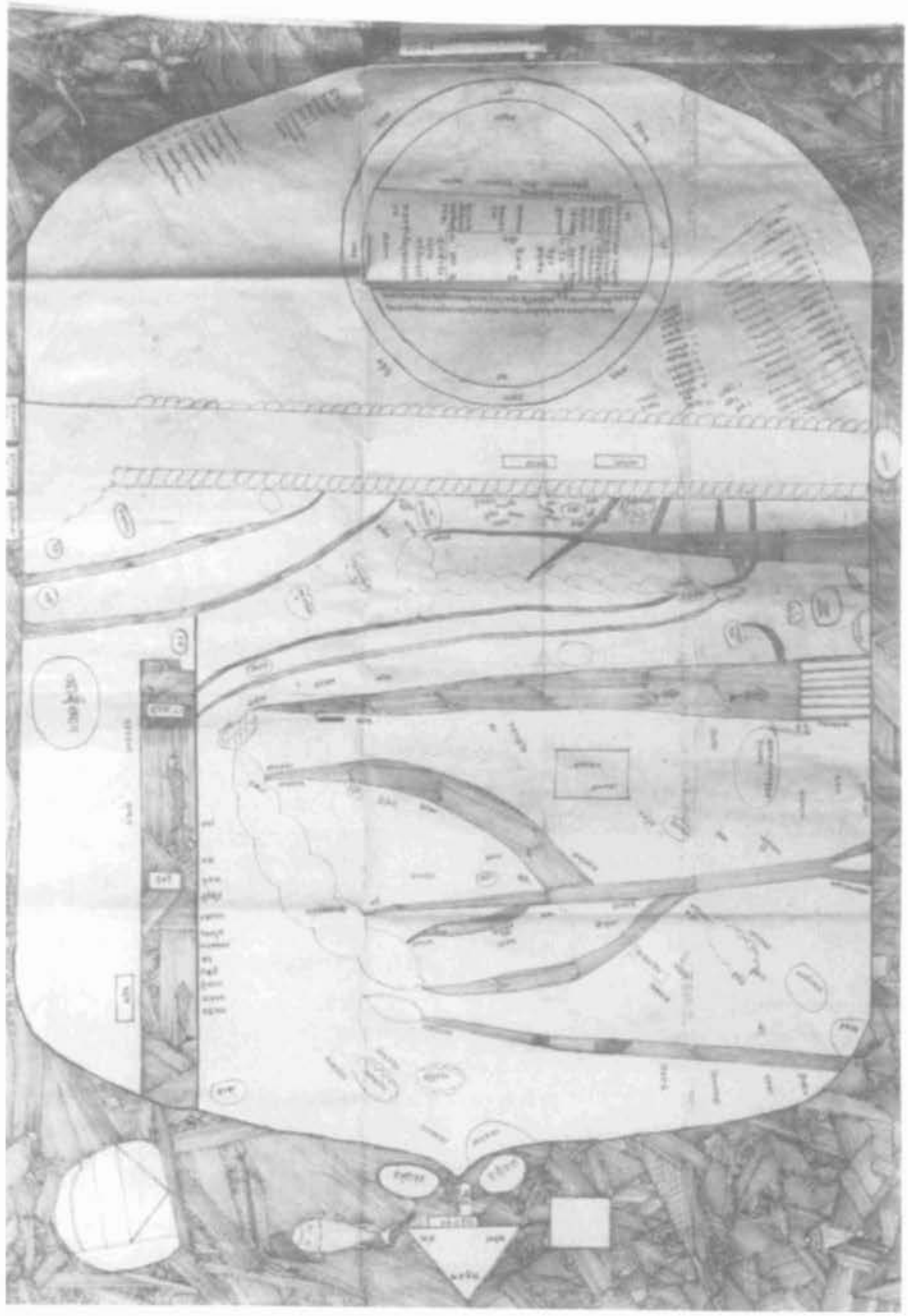
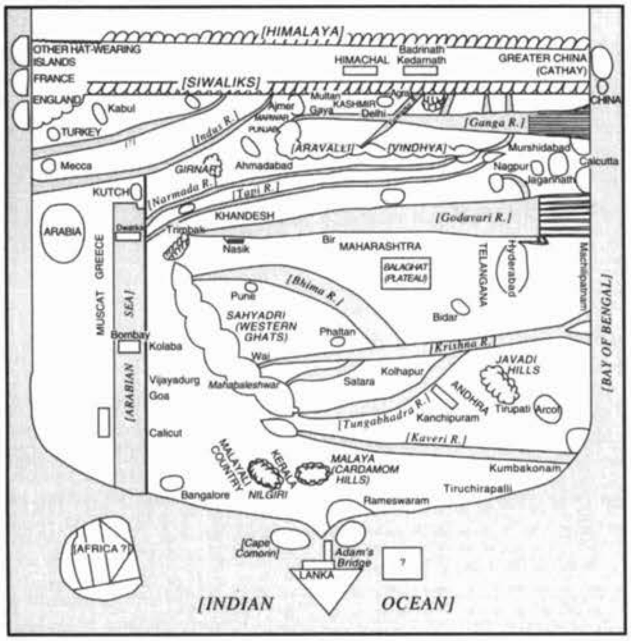


FIG. 17.6. MARATHI WORLD MAP WITH ACCOMPANYING TRADITIONAL COSMOGRAPHIC WORLD IMAGE. (*a*) The map is ink on paper with text partially in Devanagari and partially in Modi script. North of the two trans-Eurasian mountain ranges (echoing the mountains shown on fig. 17.2) is a Puranic cosmography with which, possibly, the larger part of this map was to have been compared. Much of the greater part of that area is taken up by India and, within India, by lands within the then Maratha Confederacy. Few details are provided for the lands to the west of the Arabian Sea, the vertically oriented body of water in the middle left. A few names only are given for Europe, shown mainly by three small islands in the northwest, and apart from two even smaller islands representing China, East Asia is totally ignored. Unlabeled islands in the southern part of the map might have been intended to represent the Malay Archipelago and Africa.
(*b*) Although virtually all the toponyms of this world map were transcribed from their Marathi forms, here I present fewer than half the names, all in their modern equivalents. Most are places of political or religious importance that I was able to identify with certainty. A number of such names (e.g., Mathura and Vrindaban, near Agra) were omitted, however, to avoid crowding. Also plotted, in square brackets, are the names of a number of physical features, mainly rivers and mountain ranges, whose names I inferred from their spatial relation to other features shown on the map.
Size of the original: 100 × 73.5 cm. By permission of the India Office Library and Records (British Library), London (MSS. Mar.G.28.C-K, fol. 1).



b

prototype, the inscriptions on it were in Devanagari characters (probably in Sanskrit). Schmidt's opinion is that the work may have been based on one by Delisle, but precise identification was not possible; nor was there sufficient time to determine to what degree the Indian globe maker might have altered the original conception. From its weight, the globe was judged to be made either of millboard or of hollow wood. Its estimated diameter was roughly 30 centimeters. The globe was constructed from gores that were painted and varnished. Land masses were shown in brown and sea in slate gray. What appeared to be the equator, the two tropics, and the plane of the ecliptic were painted in bands of alternating orange and black segments.[24] The present location of the globe has not been ascertained. I have no information to suggest what impact, if any, this globe had on subsequent Indian cartography.

The final world map that I shall consider is a drawing in black ink on paper with text in Marathi written in both the Devanagari and Modi scripts (fig. 17.6). Like the BKB globe, this map seeks to reconcile a traditional view of an essentially India-centered world with certain new knowledge derived through European contacts. The small symmetrical Puranic view of the world portrayed near the top of the page juxtaposes the old dogmatic view with the newer geographic perspective and suggests that, as with the geographic portion of the BKB globe, the cartographer was considering the relation of the expanding new knowledge of the world beyond India to that of received Puranic wisdom. The result is less than felicitous. Apart from the area that was under Maratha control or influence toward the middle of the eighteenth century, which takes up most of the map's area, the map displays rather little knowledge and absolutely no sense of scale. But, significantly, it has a northern orientation, which does suggest European influence. Even in the Maratha core region, the spatial relations of named places are rather badly handled. This will be evident from the orientation of the Sahyadri (Western Ghats), from which the Krishna River and three of its tributaries are shown flowing to the east. This more or less north-south trending highland swings markedly away from the vertical band representing the Arabian Sea, rather than paralleling it closely. This is, however, not so surprising in view of the mapmaker's failure to taper the width of the Deccan appropriately toward the southern tip of India.

The principal features shown on the Indian portion of the map are the rivers, although none of them are named. South of the already noted Krishna and its tributaries, the Kaveri is shown; to the north lies the Godavari, with its prominent and highly stylized delta. Beyond the Godavari are the narrow, parallel west-flowing Tapi and Narmada rivers; the Ganga, with a confusing set of northern and southern tributaries, and another prominent delta; and finally, two rivers that flow more or less southwestward, of which the more southerly is probably meant to be the Indus while the more northerly is a mystery. Mountains and hills are also fairly conspicuously shown—sometimes with names and sometimes without—by nebulous, billowy outlines, except for the two unnamed parallel ranges that extend east-west almost entirely across the northern portion of the map. Although in a straight line, rather than a semicircular arc, they recall the two parallel ranges, Himachal and Hemakūṭa, that rimmed Bhāratavarṣa on the BKB globe. On this map no places are indicated beyond these peripheral highlands, though two named rectangles between the ranges are designated as Himachal to the left and Badarīkedār to the right. Himachal signifies Abode of Snow, and Badarīkedār seems to be a conflation of the two pilgrimage places Badrinath and Kedarnath, near the source of the sacred Ganga. Apart from the unnamed encircling ocean, the only body of salt water shown on the map is the Arabian Sea, in which two rectangular islands are plotted—the island of Dwarka, the site of a renowned temple (one of several holy places prominently shown on the map), and Mumbai (Bombay) well to the south. Within the southern ocean are several additional islands. Of those that are named, the most conspicuous is Laṅkā.

I shall not comment at length on the placement of the

24. Personal communications from Rudolf Schmidt dated 21 September and 24 October 1989, the former including one ten-by-fifteen-centimeter color photograph. I extend my gratitude to him for the information provided.

hundred or so town and regional names in the subcontinent. In the upper reaches of the Krishna drainage basin and along the eastern coast of the Arabian Sea they are reasonably correct. But in all four directions beyond the Maratha domains, space is drastically compressed and contorted. Thus Nagpur in northeastern Maharashtra appears adjacent to the West Bengali city of Makhsūdābād (modern Murshidabad), which in turn lies near Calcutta and Jagannath, near the deltas of the Ganga and Godavari, respectively (the latter quite incorrectly). The major intervening river, the Mahanadi, is omitted. The placement of numerous towns north of the Ganga is hopelessly garbled. West of the Arabian Sea are such places as Yavanavastī (land of the Yavana, i.e., Ionians/ Greeks), southwest of the island of Dwarka; Maskat (Muscat), to its south; and Arbasthān (Arabia) in the large oval. Makā (Mecca) appears, curiously, well to the north of Arbasthān, between the two southwest-flowing rivers and not far south of Rūm (Turkey), which is not very distant from Kābulsāmā (Kabul). On the western edge of the map appear three islands: Ingrej Vilāyat (England), Phārasispūrlāl (France), and Śeśihār va Lande Diṅgam (other hat-wearing islands), from south to north. Finally, near the map's eastern edge are the small island of Chīn and the substantially larger island of Mahāchīn (China and Greater China).[25]

Despite its detail, the map appears not quite finished. There are a number of empty ovals for which one expects place-names were intended, a large, square anonymous island to the east of Laṅkā, and an even larger partitioned island near the southern limit of the Arabian Sea. Conceivably the square island might have been meant to signify the islands of the Malay Archipelago and the larger island, Africa—Maharashtrians would have had some slight knowledge of both in the eighteenth century. Alternatively, the square island might be an echo of the dual representation of Sri Lanka on many maps of Ptolemaic origin.

A possible key to the purpose of this map may lie in the text in the uppermost section on either side of the Puranic cosmography. This text, a portion of which has been scratched out, is written in the relatively little known Modi script and has yet to be adequately studied. Although one cannot state why the map was made, or by or for whom, it appears that at least one of its aims was to reconcile Puranic lore with later knowledge; in this sense it seems to bear some similarity to the geographic portion of the BKB globe.

Topographic Maps

Under the heading of "topographic maps" I shall consider a wide variety of maps of land areas more inclusive than a single city, town, fort, garden, or other relatively small locality. I shall, however, exclude strip maps that portray the areas along or in very close proximity to individual roads, rivers, and canals, which will be treated below. I shall also exclude a peculiarly Indian form of geometric diagram relating to areas of varying and sometimes substantial extent that was discussed above (pp. 348–51). These diagrams were originally part of a system of astrological divination but appear over time to have been put to more mundane uses.

Where I have been able to indicate the areas of coverage of South Asian topographic maps with reasonable certainty, I have done so on figure 17.7. This figure shows that, quite apart from the world maps discussed above, a very large portion of South Asia has been covered by one or more indigenous topographic maps. If one considers the provenance of these maps, however, one is struck by the paucity of works from the eastern portion of the subcontinent and from areas to the south of Maharashtra. In the period of production, no map antedates the seventeenth century. We do not know to what extent these spatial and temporal limits reflect the actual frequency with which topographic maps were prepared rather than the accidents of preservation. In all likelihood both factors have to be taken into account in explaining the composition of the surviving corpus.

Limited as the surviving corpus is, it displays, as I make clear below, considerable stylistic diversity. Some intimation of this diversity may be obtained by examining the analytic chart shown in figure 17.8.

MUGHAL MAPS

Although I have already discussed Ṣādiq Iṣfahānī's 1647 atlas of the "Inhabited Quarter" under the rubric "World Maps," each of the thirty-two sectional folios the atlas includes may in its own right be considered a small-scale map. The amount of information on these folios ranges from nil—save for notations of latitude and longitude for a few folios that cover areas of ocean or little-known land (e.g., fols. 343v and 347r)—to relatively detailed images. Not surprisingly, the areas treated in greatest detail are South and Southwest Asia; but for some unexplained reason, coverage is lacking for southernmost India and Sri Lanka. Gole provides a brief synopsis of the contents of each folio as well as a small-scale photograph.[26] Figure 17.9 shows one of the folios depicting part of northern India. Additionally, Habib provides a fuller discussion and a redrawing, with translations, of the six folios, all or part of which relate to South Asia

25. I am indebted to Indira Junghare, who transliterated the text of this map for me. The interpretation and identifications, however, are my own.

26. Gole, *Indian Maps and Plans*, 82–87 (note 1).

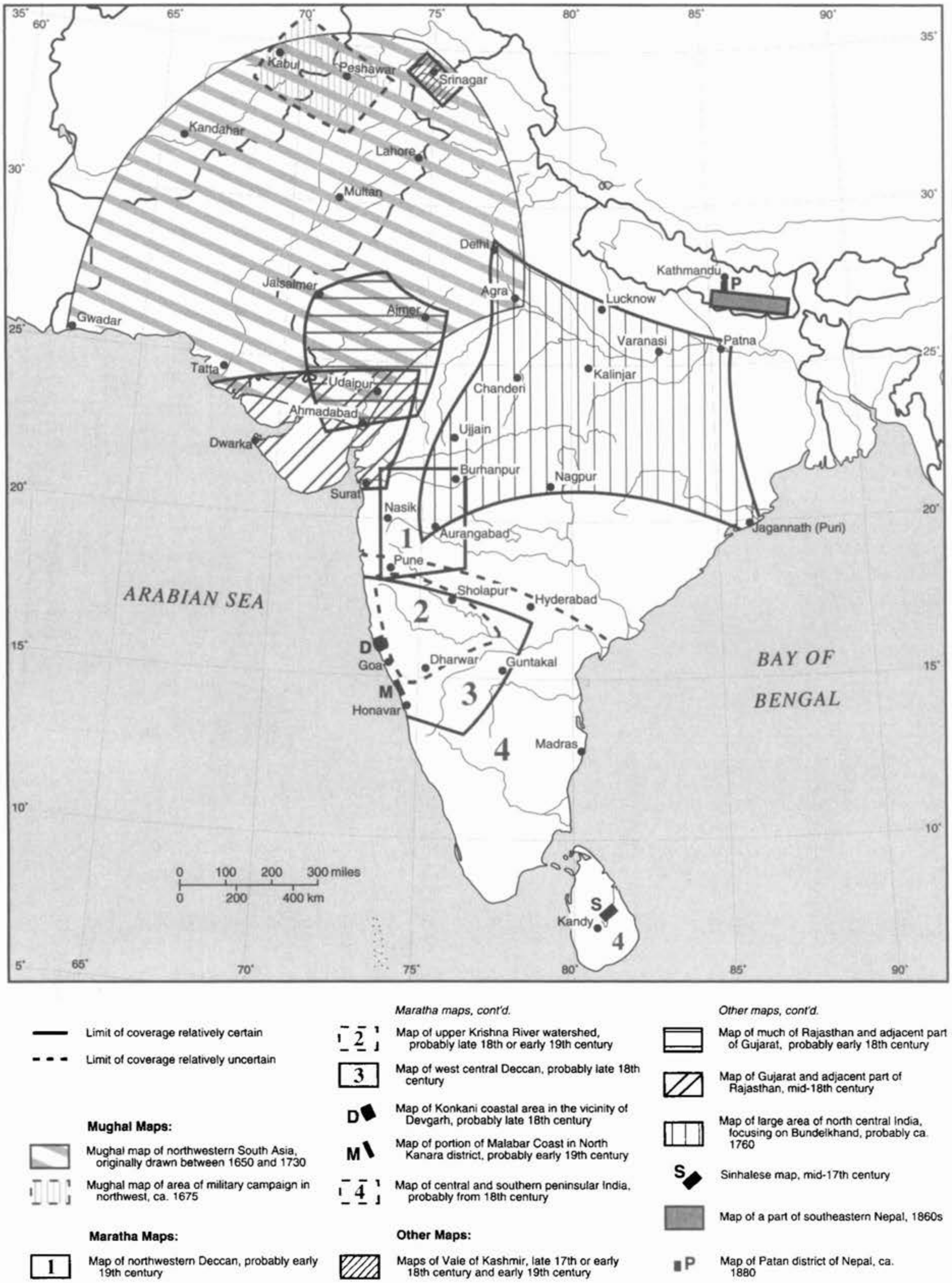


FIG. 17.7. AREAS OF COVERAGE OF SELECTED SOUTH ASIAN TOPOGRAPHIC MAPS.

MAP AREA COVERED; DATE/PERIOD; LANGUAGE/SCRIPT; WHERE ILLUSTRATED[a]	ORIENTATION	CITIES, TOWNS, VILLAGES[b]	OTHER PLACES OF SPECIAL IMPORTANCE[c]	ROADS	RIVERS AND LAKES[d]	COAST AND SEA	MOUNTAINS AND HILLS	VEGETATION
1. Northwest South Asia; Orig. betw.1650 and 1730; Persian; Fig. 17.11 and Gole, 88-90	Varies	H, mainly, et al.; all **b**	I P, for example Name all **b**	**b**	D **b**	**b**	**b**	Textual notes indicate areas of barren land
2. Vale of Kashmir; Late 17th–early 18th century; None on map proper; Gole, 116-17	Varies, generally outward from center	N Entirely pictographic	I F and P often combined	**r**	D **b** on **v** **v** edge **b**	Not applicable	**w** on **bl** Higher ranges Lower (nearer) ranges, **v**	Many types shown, for example, **g**
3. Vale of Kashmir; Probably early 19th century; Persian; Figs. 17.14 and 17.15 and Gole, 117-19	As above	As above	As above	**br** or **br** with people walking along route	D edges **b**, interior **bl**	Not applicable	**b, w** Higher ranges **v** Lower (nearer) ranges	As above
4. Kashmir; Early 19th century; Persian; Fig. 17.16 and Gole, 120-25	Varies	H **b** (outline) and **o** or **v**; **b**	As above, though few are shown	None shown	D edges **b**, interior **g**	Not applicable	**b, v** or **b, o**	As above and the **g, br** characteristic Kashmiri poplar
5. Much of Rajasthan and small part of Gujarat; Late 17th or early 18th century; Urdu and Dhundari; Figs. 17.17 and 17.18 and Gole, 109-11	Varies, but mainly to the east	H Pictographs and with names; all **b**	I P, F, and O in various combinations	**b**	Only one river shown **b** **b** Principal symbol	Not applicable	Passes noted **b**	**g** and a few palms in one area
6. Gujarat and a small part of Rajasthan; Mid-18th century; Persian and Devanagari; Fig. 17.19 and Gole,114-15	East	H Pictographs and and **b** (outline) and **r**	I F and P in various combinations	Not shown except within a few cities	D **bl**	**bl** Many types of sea creatures shown	**v**	and many other types, **g**, **b**, **y**, etc.
7. North-central India; Mid-18th century; Persian; Fig. 17.22 and 17.23 and Gole, 138	South	H (implied by figures on land revenue) **b** (outline) and **y**	None shown	**y**	**g**	Not shown	**v** or **v, b**	None shown
8. West-central Deccan; Probably late 18th century; Marathi, Modi; Deshpande, pl. IV	West	H and ; all **r**	Many temples shown in stylized F	**r**	D edges **b**, interior **bl**	**bl** **bl** Many fishes depicted	**b, v** or **b, v**	Similar to no. 6
9. West coast near Devgarh; Probably late 19th century; Marathi; Gole (1983), 19	East	H **b**, **y** and **b**	Ports, markets, and administrative centers noted by text	**r**	**b** lines on **bl** field	**b, bl** Many fishes and boats depicted	**r, v** Only crest of Western Ghats is shown	**g, y, r** Very abundant
10. Southern peninsular India; Mid-18th century; Marathi; Gole (1983), 20	East	H, , et al.; all **b** (outline) and **y**	None evident	**r**	edges **b**, interior **bl**	**b, bl** Sea full of sea creatures and boats	**b, o** Very nebulous	None shown

[a] Gole without a date refers to Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989). Gole (1983) refers to *India Within the Ganges* (New Delhi: Jayaprints, 1983). Deshpande refers to C. D. Deshpande, "A Note on Maratha Cartography," *Indian Archives* 7 (1953): 87-94.

[b] H = hierarchy explicitly stated or apparent; N = no standardized symbols.

[c] I = individual depiction; Perspective: F = frontal, O = oblique, P = planimetric.

[d] D = differentiated by width or size. Colors are indicated where known: **b** = black, **bl** = blue, **br** = brown, **g** = green, **o** = orange, **r** = red, **s** = silver or grey, **v** = violet or mauve, **w** = white, **y** = yellow. Map features painted in gouache are here represented by various grey screens. Outlines of such features are usually in black, but sometimes in red or other colors; these are generally not indicated on this figure.

FIG. 17.8. ANALYTIC CHART OF ATTRIBUTES OF SELECTED SOUTH ASIAN TOPOGRAPHIC MAPS.

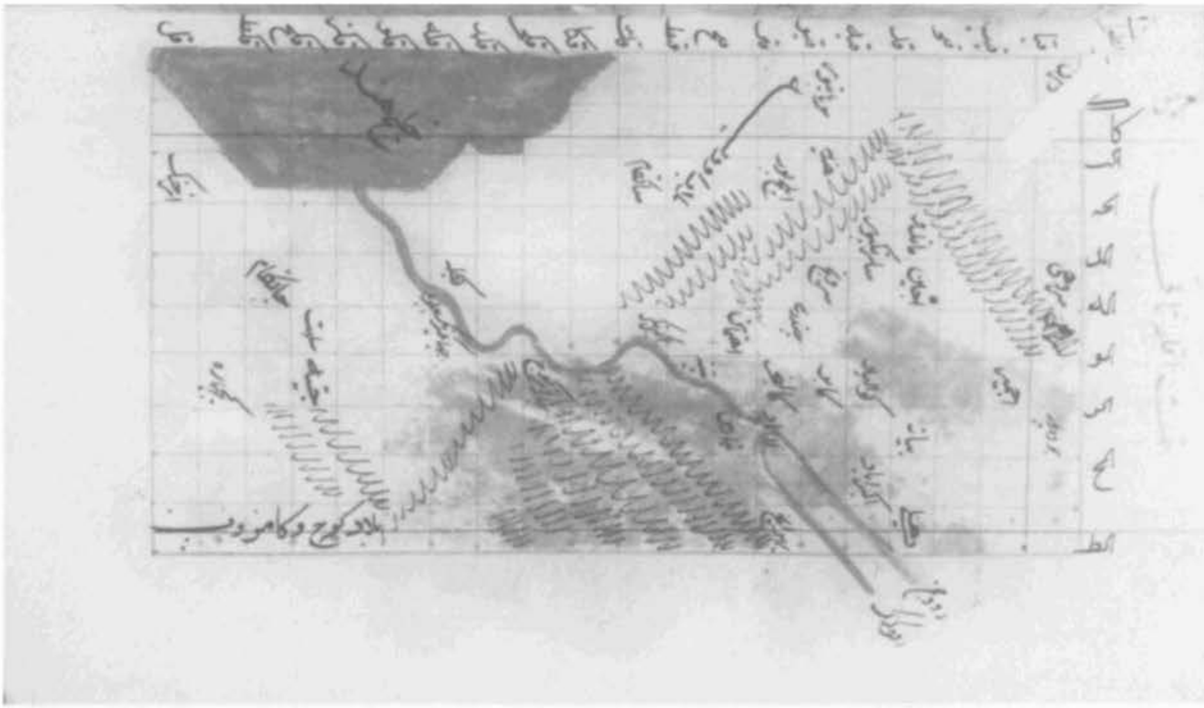


FIG. 17.9. SOUTH ASIA AS PORTRAYED ON ONE FOLIO OF THE *SHĀHID-I ṢĀDIQ*. This folio depicts part of northern India (south is at the top). Several cities are shown, including Jodhpur, Ajmer, Delhi, Agra, Allahabad, and Patna. The Ganga and Yamuna rivers flow into the Bay of Bengal (upper left corner). The Himalayas are shown with approximately the correct alignment, but the Aravalli range is oriented virtually at a right angle to its true southwest-to-northeast axis. Grid lines are at one-degree intervals.
Size of the original: 26 × 14.2 cm. By permission of the British Library, London (MS. Egerton 1016, fol. 342v).

(these form the basis of fig. 17.10).[27] I shall confine the discussion of Ṣādiq Iṣfahānī's sectional maps to the area covered by these six folios. To aid the analysis, I have also added to figure 17.10 lines that exhibit the degree of distortion within each of the folios and have noted the areas where it is impossible to match the information of one folio with that given on another.

Whatever merit one can ascribe to the use of geographical coordinates and the systematized presentation of Ṣādiq Iṣfahānī's maps, one is struck by the seeming insouciance of either the author or, much more likely, a later map copyist responsible for the one complete surviving manuscript (which Habib suggests is from the eighteenth century).[28] Hence the inconsistent plotting of Mansūra, Bhakkar, Diu, Cambay, and Burhanpur on folios 345r, 342r, 342v, and 338r and the consequent inability to make the sectional maps match along the parallels or meridians that mark their edges or in the areas where adjacent sheets provide overlapping coverage. The same is true in regard to the delineation of coastlines and, less markedly, of rivers. With respect to mountains, one is struck by the failure of the ranges shown in folios 338r and 338v to carry over into folio 342v to their north and, even more perplexingly, by the cavalier extension of the mountains of folio 338v several hundred kilometers eastward into the Bay of Hind (Bay of Bengal).

Regrettably, we do not know the sources for Ṣādiq Iṣfahānī's representation of longitude and latitude. "The detailed coverage of India," Habib states, "makes it unlikely that he had simply picked up and reproduced the maps and the accompanying lists of co-ordinates from a work written in Persia";[29] and the author himself noted in the portion of his text preceding the discussion of his map that for various reasons, including the use of "faulty instruments," he could not depend entirely on the numerous geographic works of his predecessors.[30] "He had, therefore, exercised his faculty of selection in dealing with the recorded information and also made use of what he could gather from wise and learned travellers over land and sea."[31] What Ṣādiq Iṣfahānī used as his prime meridian is unclear. If we take as accurate the longitude of Benares (Varanasi), which lies only a little to the east

27. Habib, "Cartography in Mughal India," 124–28 and map plate (note 7).

28. Habib, "Cartography in Mughal India," 124 (note 7).

29. Habib, "Cartography in Mughal India," 126–27 (note 7).

30. Habib, "Cartography in Mughal India," 126–27 (note 7).

31. Habib, "Cartography in Mughal India," 127 (note 7).

of Jaunpur, where Ṣādiq Iṣfahānī worked, then his prime meridian would have been in the Atlantic Ocean considerably west of Ptolemy's or al-Bīrūnī's prime meridian. Latitudes, as one would expect, have less margin of error than longitudes. Nevertheless, Ṣādiq Iṣfahānī's parallels vary significantly from the true position of similarly numbered parallels on modern maps (see fig. 17.10).

Generally speaking, in the spacing of Ṣādiq Iṣfahānī's

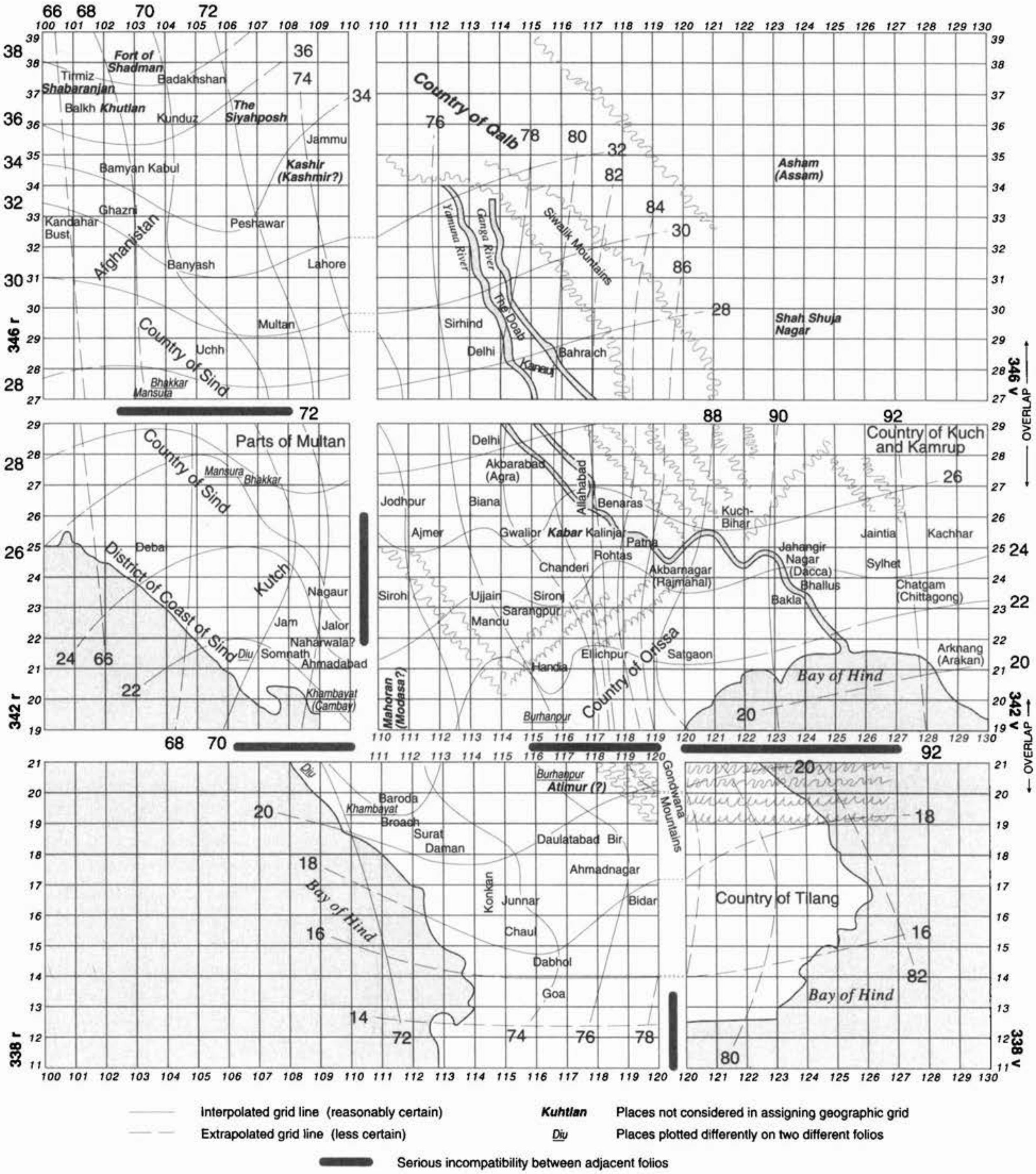


FIG. 17.10. THE DEGREE OF DISTORTION IN THE *SHĀHID-I ṢĀDIQ*. The degree of distortion is shown in the folios representing South Asia. The diagram also includes transliteration of some of the place-names from the Persian originals. The numbers along the right and left margins represent degrees of latitude, while those at the top and bottom signify longitude. The prime meridian on which Ṣādiq Iṣfahānī based his map is not known. This reconstruction has north at the top.

Base information after Irfan Habib, "Cartography in Mughal India," *Medieval India, a Miscellany* 4 (1977): 122–34, diagram facing 128; also published in *Indian Archives* 28 (1979): 88–105.

grid the greatest conformity to that of modern maps is in the real-world area west of 80°E and north of 28°N. Why he should have compressed the longitudinal breadth of the Gangetic Plain to both the west and the east of Jaunpur and Benares is a puzzle—more so, perhaps, than the even greater compression in the much less well-known highlands and the adjacent area of Orissa farther to the south. Also puzzling is his pronounced spreading of the east-west extent of Bengal, another well-known area. Conceivably, the slowness and difficulty of east-west travel caused by the need to cross numerous south-flowing rivers within the Gangetic Delta may have conveyed to seventeenth-century travelers an exaggerated impression of the actual longitudinal breadth of the region. The representation of peninsular India on folios 338r and 338v and the mismatch of the latter to the former as well as to folio 342v are especially problematic. In particular, the considerable distance of the coastal locations of Goa, Dabhol, Chaul, Konkan, Broach, and Cambay from the west coast, as depicted by Ṣādiq Iṣfahānī, is a mystery, as is the prominent east-coast promontory between 16° and 17°N.

Possibly the best feature of Ṣādiq Iṣfahānī's map is the reasonably correct representation of the Ganga (Ganges) and Yamuna (Jumna) rivers—a substantially better rendition than on the European maps of the period, and one that is rather similar to the representation on the previously discussed BKB globe.[32] One wonders, however, why there is no trace of the Indus or any of the major peninsular rivers of India. In contrast to his good rendition of the Ganga and Yamuna rivers, the depiction of India's mountains is slapdash. This shortcoming, like others noted, may well be attributable to carelessness by the copyist. The Siwaliks are correctly shown as the range flanking the Gangetic Plain, and the idea of the Himalayas parallel to and behind the Siwaliks is more or less correctly conveyed (on folio 346v); but the northern flanking mountains on folio 342v are confusingly rendered, as are the extent, location, and directionality of the mountains of peninsular India. Thus, although the unnamed Aravallis are situated, as in actuality, between Ajmer and Sirohi in Rajasthan, their trend is at right angles to their true orientation.

Who made use of Ṣādiq Iṣfahānī's map and how are matters for speculation. But as we shall see when we examine the surviving Indian topographic maps of the nearly two centuries that followed, the advances in geographic knowledge he put into cartographic form did not become sufficiently widespread to make a major impact on subsequent mapping. In particular, no later traditional map employs a geographic grid.

A second Mughal map covering a large portion of northwestern South Asia, including virtually the whole of what is now Pakistan and adjacent portions of India and Afghanistan, was brought to light by Colonel Reginald Henry Phillimore in 1952.[33] This map (fig. 17.11*a*) is a copy, with translation, of an original that is thought to have been drawn in the period between 1650 and 1730. It certainly postdates the 1627 accession of Shāh Jahān to the Mughal throne, in that it shows Delhi as Shāhjahānābād. The copy, judging from the watermark of the European paper it was drawn on, presumably dates from between 1792 and 1795. The nonextant original map and the copy published by Phillimore were in Persian. Though obviously I cannot comment on the writing style of the former, the Persian script on the latter is very clear and legible. The copy, in two sheets, is in the National Archives of India in New Delhi. The English translation was done by a competent anonymous Persian scholar. Figure 17.11*b* highlights some of the more important places and physical features depicted on the map and gives a general view of the distortion on the map.

The style of this map varies in every major respect from that of the sectional maps of Ṣādiq Iṣfahānī. Although the work makes no attempt to portray places according to latitude and longitude, it has the virtue of being exceedingly rich in detail. Roughly five hundred settlements, forts, rivers, and mountains are named on the portion of the map that was not destroyed on the original. Among these, the more prominent cities and forts are depicted with special emphasis, sometimes with pictographic detail (as in Shāhjahānābād and Thatta [Tatta], near the mouth of the Indus). The shapes and pictorial elements, however, do not conform closely to the realities they represent. The representation of the Indus River system is reasonably detailed, though the courses are not properly aligned. Exceptional prominence is given to the distributaries of the delta and to channels built around certain towns such as Pakpattan (toward the upper right), presumably for defense. In what is now Afghanistan (left center), the Helmand and one other unnamed stream, perhaps its Arghandab tributary, are shown as simple vermiform features. The rendition, in black, of the Ganga in the upper right corner, of the Yamuna to its west, and of the Nahr-i Bahisht (ʿAlī Mardān) Canal a bit farther west is strikingly different from that of other hydrographic features. Hills and mountains are inserted in many parts of the map in a realistic style, but one derives no sense from their depiction of their greatly varying heights, the modest features of the eastern portion of the map appearing about as prominently as the much loftier ranges of the west.

The principal purpose of the map was undoubtedly to guide military movement and other travel. Distances in

32. Farther west, on folio 345v, the Tigris and Euphrates are also well depicted.

33. Reginald Henry Phillimore, "Three Indian Maps," *Imago Mundi* 9 (1952): 111–14, plus three map inserts.

kos (sing. *cos*, equal to about two miles) between major points or between adjacent stages along particular routes are set down in great detail. Supplementing these indications of distance are advisory comments such as, "From hence lay in a stock of food and water for Bikaner," "No habitation over this hilly tract," "A barren country without town & trees," and so forth. Although these numerical and verbal notations would probably have sufficed

a

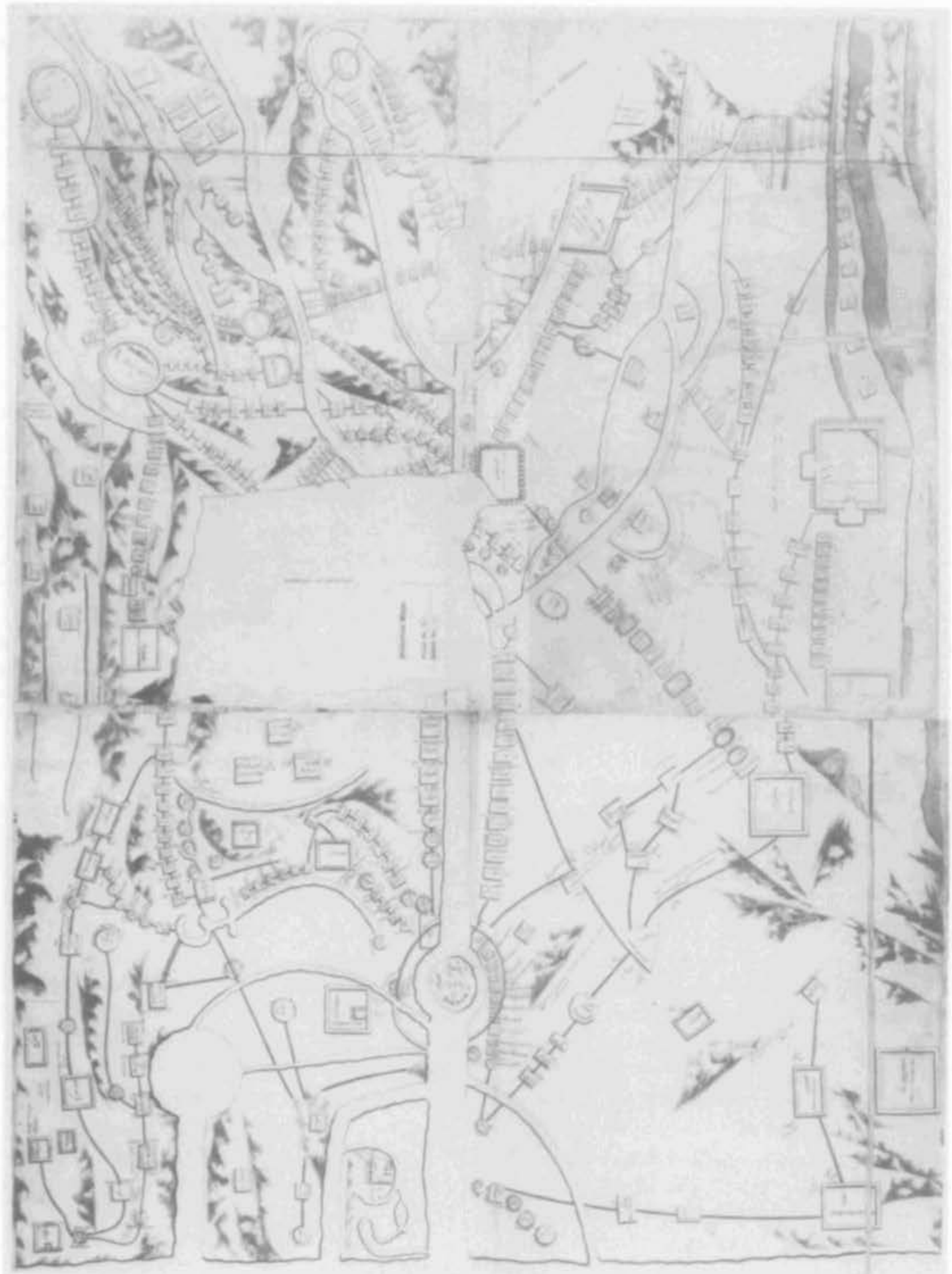
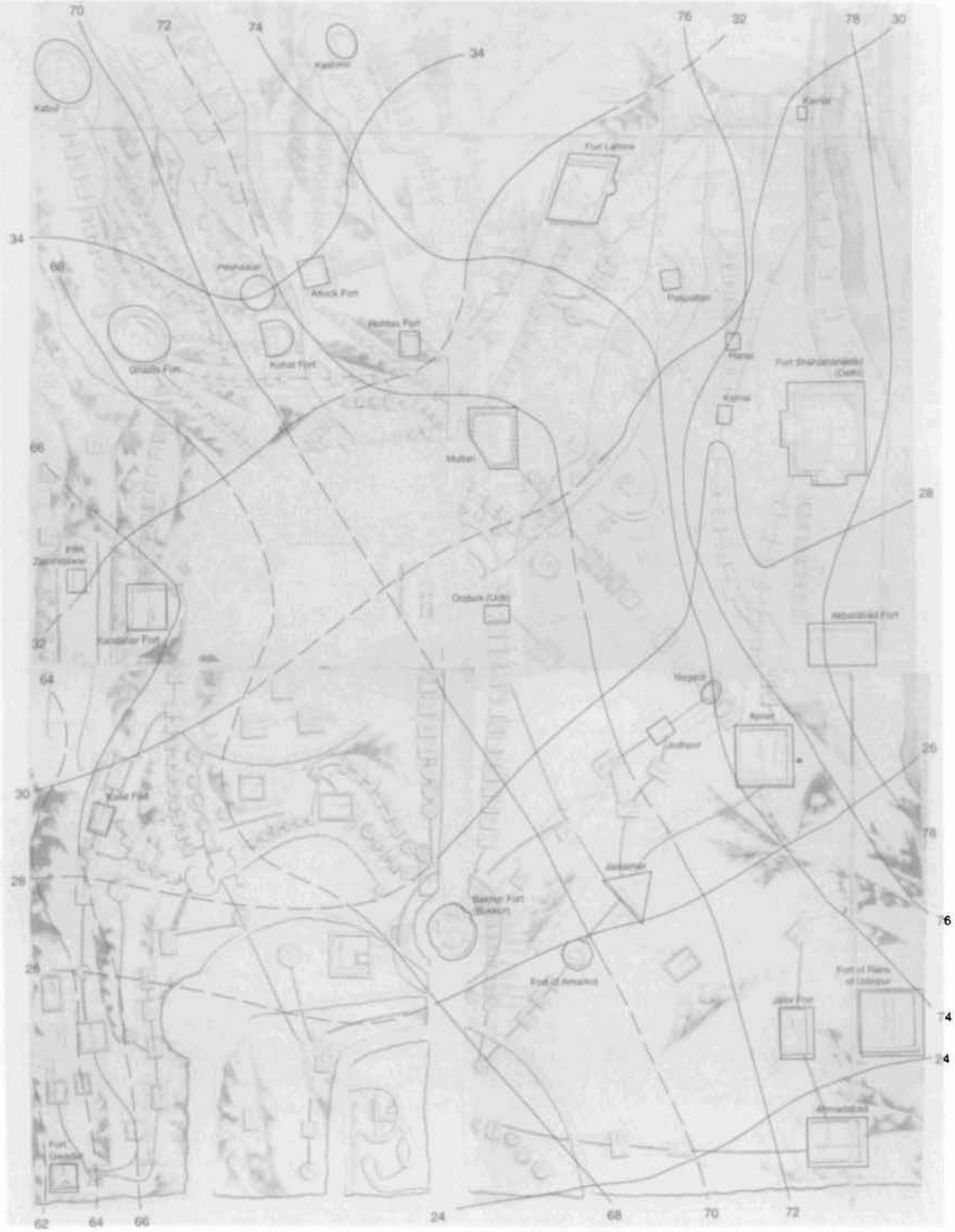


FIG. 17.11. MUGHAL MAP OF NORTHWESTERN SOUTH ASIA. (*a*) This copy of a Persian original with English translation is ink on paper in two sheets. The copy presumably dates between 1792 and 1795 and the original from between 1650 and 1730. Its provenance is unknown. The roughly five hundred toponyms on this map and the large area of its coverage place it among the most important cartographic artifacts of South Asia.

for the logistical needs of the day, the map's inattention to scale and direction presumably limited its utility. Many routes were compressed, as suggested by the closeness of the stages plotted along them, while others, space allowing, were considerably stretched out. Some routes that were tortuous, such as the mountain road between Kohat Fort through what is now the North-West Frontier Province of Pakistan to the Afghan city of Ghazni, were



b

(*b*) The degree of areal distortion in the Mughal map of northwestern South Asia. The interpolated geographic gridline is relatively certain, and selected key locations are shown. Although the sequencing of places along the many routes portrayed presumably is generally correct, the distortion of distances and directions is substantial. Nevertheless, I infer that the map had considerable utility for military planning.
Size of original two sheets: 79 × 49 cm and 79 × 69 cm. National Archives of India, New Delhi (F. 97/10, 11).

represented by nearly straight lines. Conversely, essentially direct routes, such as that between Delhi and Lahore, in the upper right corner of the map, were portrayed with sharp right angles to conform more to the size and shape of the paper than to geographic reality.

The latitudinal and longitudinal grid lines, interpolated at two-degree intervals on figure 17.11*b*, indicate in a general way where and how the distortion of the map was distributed. The stretching out of the middle Indus Plain and the east-west compression of Baluchistan (in the lower left corner of the map) are particularly noteworthy, as is the northward protrusion of the area just south of latitude 28°N to the southwest of Delhi. On the whole, the map appears to be distended in a north-south direction or, alternatively, compressed from east to west.

A third Mughal map, falling completely or almost entirely within the area covered by the foregoing (see fig. 17.7) was discovered by Chandramani Singh in 1987 in the hilltop fort of Jaigarh overlooking Amber and Jaipur.[34] The map, which has no title, shows the dispositions of the army of the Mughal emperor Aurangzīb, including Rajput troops under his vassal Maharaja Jaswant Singh of Jodhpur and under Prince Kishan Singh of Amber, and of the rival Afghan forces under various chiefs at some time during a campaign that lasted from 1674 to 1677. This map, drawn in ink on paper, was presumably prepared in the field during that campaign, which would help account for its crude appearance. Despite its sketchiness, its author still saw fit to include on it the following imprecatory observation: "Zamindari [estate] of Khushal-Khatak, the rebel who has led and joined the accursed theologian. His native place is rendered desolate." Apart from the Persian text, identifying the various forces, several Afghan clan territories and estates, several major towns (including Kabul, Jalalabad, Peshawar, and Attock), several valleys, the Khyber Pass, and the Indus River, most of the map space is taken up by undecipherable wavy lines that conceivably are intended to convey the sense of rugged terrain. The Indus, however, is denoted by a thin curved line nearly one-third of the way up from the bottom of the map, while about midway across the map appears a more irregular line that might signify where the Indus Plain meets the hills to its northwest. The depiction of the area of the map in figure 17.7 is necessarily approximate.

How the map just described might have been used in battle is not at all clear. It is not even certain, in the absence of an accompanying manuscript text, that it was so used. Although tens of thousands of Mughal Persian documents and manuscripts from the sixteenth and seventeenth centuries have survived, many relating to military matters, not one, so far as I am aware, contains or relates to a military map.

FIG. 17.12. REPRESENTATION OF A GEOGRAPHIC GLOBE IN THE MUGHAL PAINTING "JAHĀNGĪR EMBRACING SHĀH ʿABBĀS," BY ABŪ AL-ḤASAN. Although the depiction of a large part of Asia and adjacent areas in this painting of about 1618 is obviously based largely on one or more European models, the representation of India appears to incorporate much knowledge not then available to Europeans.
Size of the original: 23.5 × 15.25 cm. Courtesy of the Freer Gallery of Art, Smithsonian Institution, Washington, D.C. (acc. no. 45.9).

Before concluding this discussion of small-scale Mughal maps, let me note that fragments of maps appeared as parts of larger painted compositions commissioned by Mughal emperors. In these paintings the emperors were depicted standing atop, holding, or otherwise positioned in relation to globes to signify their temporal sway over extensive earthly domains. The most noteworthy of these works, titled "Jahāngīr Embracing Shāh ʿAbbās," is to be found in the Freer Gallery of Art

34. The account of this map is based mainly on Gole, *Indian Maps and Plans*, 146 and fig. 70 (note 1). A description also appears in G. N. Bahura and Chandramani Singh, *Documents from the Kapad-dwara* (Jaipur: P. C. Trust, 1988).

in Washington, D.C. (fig. 17.12). It depicts Jahāngīr embracing his powerful Persian rival, with whom he was disputing possession of the region of Kandahar, and signifies Jahāngīr's hope that Shāh ʿAbbās would concede the issue in his favor. The wishful thinking in the symbolism of the lion and the lamb scarcely requires comment.[35] "The ultimate inspiration for this portrait," writes Milo Beach, "must ... have come to India with Sir Thomas Roe, for such compositions are based on English allegories."[36] Roe, the first ambassador to the Mughal court, arrived in India in 1615. Paintings, including portraits, were among the many objects he presented to or showed the emperor.

There can be no question that the general shapes of the portions of Asia, Africa, and Europe indicated on the globe depicted in figure 17.12 derive from European maps, and for that reason I did not deem it appropriate to discuss the work as a South Asian world map.[37] But within the area of India, the delineation of rivers looks intriguingly distinctive (fig. 17.13). These appear to be notably more accurately aligned than on roughly contemporaneous European maps—certainly much more so, for example, than the map of the Mughal Empire in the 1625 edition of *Purchas His Pilgrimes*, which was copied from the 1619 map drawn by William Baffin on the basis of information provided by Roe. The Ganga and Yamuna rivers on the painted globe are strikingly like those of Ṣādiq Iṣfahānī's later sectional maps (fig. 17.9), and the peninsular rivers too seem more accurately represented than on Baffin's map or other European maps of the seventeenth century. Finally, the locations on the map of the names, in Persian, of various countries and provinces (shown in transliterated form in fig. 17.13*a*), are much more accurate than that of any known roughly contemporary European map.[38] This suggests that, for India at least, there were Mughal cartographic sources of which we have no surviving example.

LATE PREMODERN MAPS FROM VARIOUS REGIONS

Kashmir

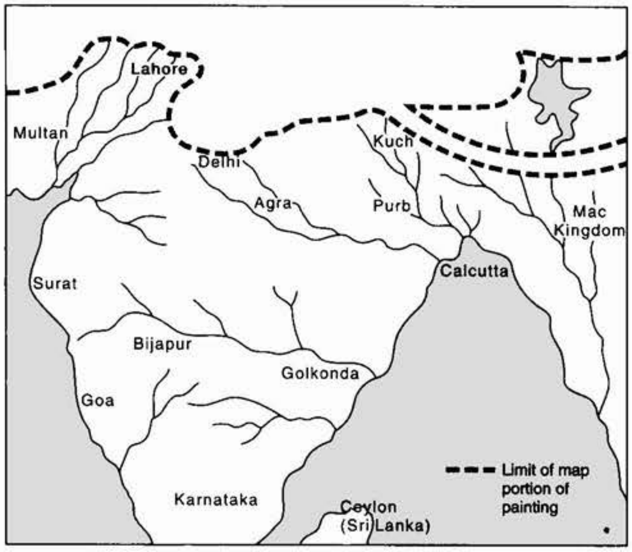
Within South Asia the region most often portrayed on surviving indigenous maps is undoubtedly the Vale of Kashmir. The maps made of that surpassingly beautiful area vary widely in scale, provenance, date, and style, but virtually all are remarkably detailed. The topographic maps are, with one exception, also similar in showing the mountain ranges encompassing the Vale around the edges of the map, thereby distorting its essentially oval shape into the form of a rectangle, and in representing the capital city of Srinagar and its environs in a particularly prominent manner with commensurate reduction in the scale at which more peripheral areas are portrayed. Further, in and around Srinagar additional prominence is given to those features for which Kashmir is famous: the Shalimar and other Mughal gardens, Dal Lake, the Jhelum River and its wooden bridges, the network of canals, the Haẕratbāl mosque, the hilltop Harī Parbat fort, and so forth. The maps characteristically and charmingly combine planimetric and frontal perspectives, the former in delineating areas and the latter in portraying works of architecture, trees, human beings (in diverse attitudes), and animals. There is no consistent orientation. Objects are normally shown as they would most likely be viewed by an observer in situ. Thus trees or houses along both sides of a road will be shown with their tops facing away from the road. Similarly, the peaks of hills and mountains (often shown as snowcapped along the outer edges) generally point away from the adjacent lowlands from which they would most frequently be seen. Text, when present, tends to be correspondingly aligned. Some of the maps

35. A fuller account is provided by Stuart Cary Welch in *Imperial Mughal Painting* (New York: George Braziller, 1978), 80–81.

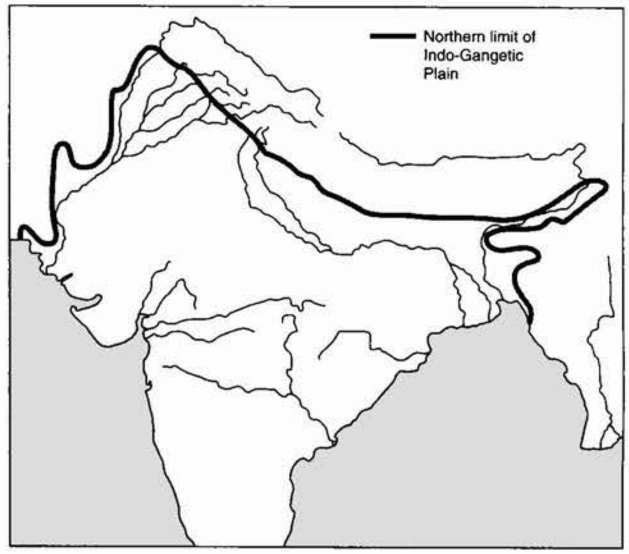
36. Milo Cleveland Beach, *The Imperial Image: Paintings for the Mughal Court* (Washington, D.C.: Freer Gallery of Art, 1981), 30–31 and 169–70, esp. 170. Although the prototype in question is unknown, a similar painting of Queen Elizabeth I (ca. 1592) by Marc Geerarts the Younger (1561–1635) is on display in the National Portrait Gallery in London. Apart from the painting reproduced in figure 17.12, one may cite paintings of *Jahāngīr on a Globe*, in the Los Angeles County Museum of Art; of *Jahāngīr with an Orb in His Hand* and *Jahāngīr Standing on a Globe*, both in the Chester Beatty Library and Gallery of Oriental Art, Dublin; *Jahāngīr Using a Globe as a Footstool*, in the Freer Gallery of Art, Washington, D.C.; *Shāh Jahān Standing on a Globe* (mid-seventeenth century), in the Kevorkian Album, cat. no. 18d; Metropolitan Museum of Art, New York; and *Portrait of Shāh Jahān*, in the Bodleian Library, Oxford, published in Wayne E. Begley and Z. A. Desai, comps. and trans., *Taj Mahal: The Illumined Tomb: An Anthology of Seventeenth-Century Mughal and European Documentary Sources* (Cambridge: Aga Khan Program for Islamic Architecture, Harvard University and Massachusetts Institute of Technology, distributed by the University of Washington Press, Seattle, 1990), pl. 9. (I thank Susan Gole for several of the foregoing references.) The depiction of lands and sea in some of the paintings cited may be fanciful. In the last of these, the globe depicted shows an equator and a series of seven concentric circles in the hemisphere below it. If the globe is oriented with south at the top, these circles might represent the *aqālīm* of the Northern Hemisphere. But that would raise two questions. First, why was the globe held in such a way that the area of interest to Shāh Jahān was not within his line of vision? Second, why was there a total of eight lines, since only seven were necessary to delineate the *aqālīm* (given that the northernmost extended to the Pole)? An intriguing, though less probable, possibility is that the emperor was holding a Hindu cosmographic globe and that the concentric circles thereon represented alternating ring continents and oceans as described in the section on globes in chapter 16.

37. The northern shore of the Arabian Sea, for example, bears a striking resemblance to the delineation of the same coast on Henricus Hondius's 1625 map of the Mughal Empire (*Magni Mogolis Imperium*). Among places beyond South Asia that are named on the globe are Portugal, France, Hungary (Majār), Moscow, Egypt, Abyssinia, Kingdom of Forest Dwellers (Africa), numerous locales in Southwest and Central Asia, the Kingdom of Mac (in Vietnam), China, and Cathay.

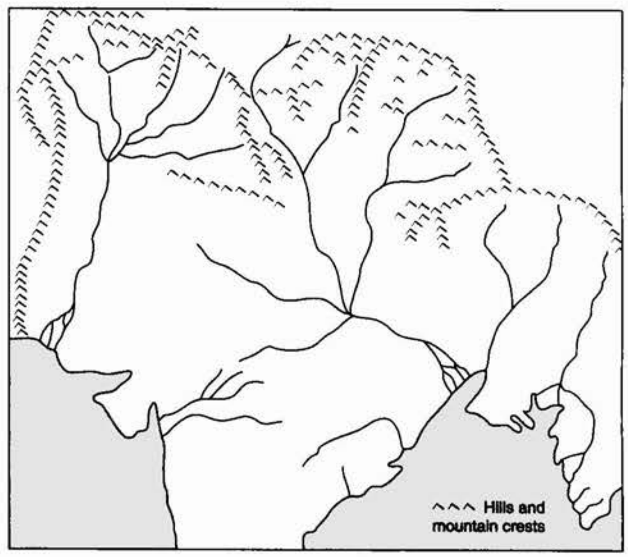
38. I am indebted to Milo Beach for sending me the transliterations.



a



b



c

FIG. 17.13. COMPARISON OF DRAINAGE PATTERNS. These diagrams compare the drainage patterns of the Indian portion of the globe in the painting "Jahāngīr Embracing Shāh ʿAbbās" (map *a*) and of the map in the 1625 edition of *Purchas His Pilgrimes* (map *c*), with a selected set of drainage features of a modern map (map *b*). Map *a* additionally shows place-names in the modernized Roman equivalents of the Persian original. All are reasonably well placed and easily identified, with the possible exception of Kuch, Mac Kingdom, and Purb. Kuch may signify the large Koch tribe of northeastern India or the etymologically related state of Cooch Behar. Mac Kingdom presumably relates to the then reigning Mac dynasty of Vietnam. Purb, which signifies east, has no obvious toponymic referent. Judging from the positions of Bijapur and Golkonda, the long river extending across peninsular India is the Krishna, no clear indication of which appears on map *c*.

probably served no utilitarian purpose other than providing pleasure to their viewers. Gole presents photographs and succinct discussion of virtually all the maps known to me.[39]

Probably the oldest of the topographic maps is the one in the Maharaja Sawai Man Singh II Museum, Jaipur (frequently called the City Palace Museum), which Singh suggests, on stylistic grounds, dates from the early eighteenth century or possibly even the late seventeenth.[40] This large work (280 × 223 cm) is on white starched cotton fabric and has a coarse cotton stitched border with the words, in Devanagari, "Map of Kashmir" written on all four sides. There is no other text. The map is painted in a rich palette, including yellows, greens, blues, vermilion, black, mauve, and brown. The work abounds in winsome details such as the

> various wandering animals, ... a tiger who is paying respect to the rising sun.... [and a] goatherd [who] follows his charges, leading a young goat by a rope. Flower-beds, green rice-fields, trees with fruit and ponds with water-birds and lotuses give the impression that the artist is depicting Kashmir sometime in October or November. Human figures in local costume are

39. Gole, *Indian Maps and Plans*, 31–32 and 116–31 (note 1). For the few maps in the following account I did not personally see, I have relied mainly on Gole and, to a lesser degree, on Chandramani Singh, "Early 18th-Century Painted City Maps on Cloth," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982*, ed. Robert Skelton et al. (London: Victoria and Albert Museum, 1986), 185–92, esp. 189–90.

40. Singh, "City Maps on Cloth," 189 (note 39); the map is cat. no. 120.

> painted on the roads, in contrast to the emptiness of the town. The rampart of the fort and its architecture are also drawn very successfully and painted in the actual colour of the stone. A windmill also finds a place on this map.[41]

Gole suggests that the map may have been commissioned by one of the rajahs of Jaipur who served the Mughal emperors and occasionally went on official visits to Kashmir, but it is also possible that it was acquired in Kashmir without having been made at the behest of any external patron.[42]

Among the few Indian maps whose probable author can be identified is an exceptionally large (408 × 226 cm) and elaborate work, on cloth, in the British Library (figs. 17.14 and 17.15). An inscription in the lower right corner of the map indicates that it was acquired by a certain Captain Wade from an otherwise unknown Abdur Rahim. Three additional inscriptions appear on the back of the map: (*a*) "Punjab. Panoramic Sketch of the Valley of Cashmeer by Abdool Raheem, a Native of Bokhara"; (*b*) "Recd. from W. H. McNaughton Esq Secy to Govt of India Poll Dept. 24th August 1836 (34)"; and (*c*) "Panoramic view of Cashmere. In a Lr. from the Poll. Agt. at Loodhiana d/4th July 1836." In the late 1830s or early 1840s, the map appears to have passed from either the Calcutta or the London authorities of the East India Company to Hugh Falconer, a botanist who went to Kashmir in 1837, and it was presented to the Royal Geographical Society in London by Falconer's daughter in 1891. In 1981 it was purchased by the British Library.[43] Gole provides some additional particulars:

> In the Political Letter dated 30th Jan. 1837, the receipt of the map was recorded, and the Surveyor General was ordered to reconstruct it on a "European Model." In a later letter, dated 10th April 1837, a sum of Rs 500 was sanctioned to be paid to "the Native Author of the Map,"—a large sum in those days. It appears from this that the map had been made shortly before it was presented to Wade, but it is also possible that Abdur Rahim claimed to have made it, when he had acquired it from somewhere. At some stage the directions were added in English, and some numbers were written beside some of the Persian legends.[44]

Though comparable in beauty to the map now in Jaipur, the Abdur Rahim map has a somewhat more naturalistic appearance and shows much greater concern for scalar relationships, and though Srinagar's position is more correctly rendered, the foreshortening with distance from that city is hardly eliminated. Both opaque and lighter wash paints are used along with ink. The map depicts cultivated fields in light green, village groves in dark green, bare earth in tan, water in blue, mountains in purple, snowcaps on the peripheral ranges in white, and roads in brown. Many features, especially of settlements, are drawn or outlined in black or gray ink. Rivers and lakes are shown in abundance, and much attention is given to the meandering course of the Jhelum. Rivers disappear behind mountains in their upper courses or, in the case of the Jhelum, when the river exits from the Vale at the Baramula Gorge. All the *pargana*s (administrative subdivisions) are named and the main towns in each are noted, and many additional villages and hamlets are shown. The network of roads, some with figures walking along them, appears to be fairly dense. Many roads are shown as lined by the characteristic Kashmiri poplar. The map text is abundant.

Much less appealingly executed than either of these two maps, but nevertheless brimming with interesting detail, is a map in the India Office Library and Records, London, probably also dating from the early to mid-nineteenth century. This medium-sized work (63.5 × 82.7 cm) was drawn in ink on paper, with spotty applications of gray, brown, and green gouache for certain features.[45] Srinagar takes up an exceptionally large part of the map, and little detail is shown to the north or east of it, though the Shalimar and Nishat gardens do appear conspicuously near the northeastern corner, with nothing between them and the mountains at the edge of the Vale. The gardens are painted in the only green used on the map. Rivers are shown with little regard to their true courses. Except for a short stretch close to its source at Achabal Spring, the Jhelum is indicated in an enormously exaggerated width and, like the lakes and canals, is painted in a heavy gray wash. A whirlpool, signified by concentric swirls, marks the mouth of the Jhelum Gorge. Mountains and what might be the Karewa terraces are lightly emphasized in tan. The mountains are drawn in a conventionalized style similar to that employed on the map details illustrated in figure 17.17 below. Vegetation is of various types and includes numerous poplars, though no poplar-lined roads are shown. Settlement is represented mainly by stylized houses, seen in frontal perspective, while important buildings (mosques, forts, etc.) are rendered in considerable detail. A distinctive feature of the map is that, except for the areas close to the northern, eastern, and southern edges, the roofs of a great majority of the houses are shown pointing toward the west. In this and other

41. Singh, "City Maps on Cloth," 190, which includes details in two photographs (note 39). Gole, *Indian Maps and Plans*, 116–17 (note 1), provides a photograph of the entire map and three more detailed views.

42. Gole, *Indian Maps and Plans*, 116 (note 1).

43. Data obtained from note on map by Andrew S. Cook, head of the Map Division, India Office Library and Records, London.

44. Gole, *Indian Maps and Plans*, 118–19 (note 1).

45. The map is cat. no. x/1817; Gole, *Indian Maps and Plans*, 126 (note 1), provides an illustration of the entire map.

FIG. 17.14. MAP OF THE VALE OF KASHMIR, ATTRIBUTED TO ABDUR RAHIM OF BUKHARA. This map is ink and watercolor on cloth with text in Persian and probably dates from the early nineteenth century. The essentially oval shape of the Vale is here altered by having its bordering mountains aligned along the four edges of the map. As on other maps of the Vale, Srinagar is depicted at a disproportionately large scale, and prominent features such as the region's renowned gardens are rendered in great detail.
Size of the original: 408 × 226 cm. By permission of the British Library, London (B.L. Maps S.T.K.).

FIG. 17.15. DETAIL FROM MAP OF VALE OF KASHMIR. This detail from figure 17.14 shows a portion of the city of Srinagar and adjacent area, including the Shalimar Gardens. By permission of the British Library, London (B.L. Maps S.T.K.).

respects this map appears to have a predominantly western orientation. Especially prominent are the ten bridges across the Jhelum; their roadbeds are shown planimetrically, and their piers, all pointing upstream, are depicted in frontal perspective. Boats of various sizes are painted in the river and in some lakes but do not constitute an important element of the map. Roads are hardly indicated outside the area of Srinagar and a few other settlements.

The general fineness of the ink line work on this map and the utter crudeness of the painting suggest that the latter may have been an ill-advised addition by someone other than the original artist. Conceivably the painting was aborted because of the slapdash way it was being carried out.[46] Added to the map in orange lettering in Devanagari script are numerous place-names, and the names of some important features are shown also in Arabic script.

A very important cartographic work, most of which Gole has illustrated, is a set of eighteen single-page and fifteen double-page maps that form a complete atlas of Kashmir within an 858-page history of that region.[47] That untranslated history, the *Tārīkh-i qalʿah-i Kashmīr*, was written by Mir Ahmed [Jalalawad] at the behest of Mihan Singh, a governor of Kashmir when it formed a province of the Sikh kingdom, sometime between the region's annexation in 1819 and the death of the powerful monarch Ranjit Singh in 1839. Formerly in a library in the Punjabi town of Kapurthala and then in the archives of the Punjabi state of Patiala, the work is now held by the Maharaja Ranjit Singh Museum in Amritsar. As a rule, separate atlas maps were prepared for each of Kashmir's former *pargana*s, but occasionally more than one *pargana* was shown on a two-folio map (fig. 17.16). Map titles appeared in red cartouches at the top of each 38 by 54 centimeter page. The pages were numbered in black, from right to left, and on some pages English-style numbers have been added in pencil. Gole describes the work as follows:

> The maps are very detailed regarding villages and rivers, but no roads have been marked, not even tracks

46. Gole's opinion, *Indian Maps and Plans*, 126 (note 1), with which I do not concur, is that the work was "unfinished, or perhaps made in preparation for a proper map." The amount of detail, especially in the representation of housing, strikes me as inconsistent with such a view.

47. Gole, *Indian Maps and Plans*, 121–25 (note 1).

FIG. 17.16. ONE OF THIRTY-THREE *PARGANA* MAPS IN AN ATLAS OF KASHMIR COMPOSING A PART OF THE *TĀRĪKH-I QALʿAH-I KASHMĪR*. Maps in this atlas are drawn on either one or two sheets of paper, usually one *pargana* (administrative subdivision) per map. The text is in Persian. This single-page map covers the *pargana* Tulub. It was probably drawn between 1819 and 1839.
Size of the original: each page 54 × 38 cm. By permission of Cultural Affairs, Archaeology and Museums, Punjab, Chd. Photograph courtesy of Susan Gole, London.

> across the mountains. Bridges, however, have been shown; on [one folio] six are shown at close intervals over the same stream. Most of the rivers have been coloured in silver paint, a style which has been seen on other maps from Kashmir, but not elsewhere. Some large buildings are shown in elevation. . . .
>
> Great attention has been paid to the mountains and hills. Some of the latter are coloured orange, while the mountains are mostly in dark purple. Trees are stylised, some round and some tall and thin, which must be the poplars so frequently planted in avenues in Kashmir.[48]

It is not known whether the atlas attempted to provide a complete inventory of the villages of Kashmir, but it seems likely that that was among its purposes. Nor can we say, in the absence of detailed study, what its territorial coverage was. A noteworthy feature of many of the atlas folios is that for the localized areas they depict they tend to replicate the rectangular mountain or hill frame that one finds on maps of the Vale as a whole, transforming the highlands around the *pargana* core into a box not quite the size of the paper the map is drawn on.

The final Kashmiri map I shall consider here is quite unlike any of the foregoing. It is a paper map, thirty-eight by sixty-nine centimeters, that shows a river system in considerable detail. Regrettably, there is virtually no textual material on the map and no information about it at the Sri Pratap Singh Museum in Srinagar where the work is kept.[49] The rivers, painted in gray and silver, quite likely represent a major portion of the Jhelum drainage basin within the limits of the Vale; but the absence on the map of the large Wular Lake in the northern part of the basin argues against that hypothesis. More study of the work in combination with modern large-scale topographic maps will be required to make a positive determination of the area it covers. The map's purpose is also a puzzle. Kashmir abounds with pilgrimage places (*tīrthas*), many situated on streams (*tīrtha* literally means "ford"), and hundreds of individual *tīrtha* maps are bound into two large albums in the Sri Pratap Singh Museum (these are discussed below). Possibly the map in question has some sort of synoptic function in respect to pilgrimages to these *tīrthas*.

Rajasthan and Gujarat

In the Maharaja Sawai Man Singh II Museum in Jaipur there is a rather large (150 × 107 cm) paper map of an extensive tract of Rajasthan together with a much smaller adjacent region of Gujarat (figs. 17.17 and 17.18) that appears conceptually to be much like the Mughal map brought to light by Phillimore.[50] This map, drawn in black ink, with vegetation added in green watercolor, is particularly rich in details of settlements and routes and indicates many distances, in *kos*, between important places. Important cities, towns, and forts are pictorially depicted in a variety of sizes that suggest their relative prominence. Udaipur, Ajmer, Nagaur, and Jaisalmer in Rajasthan and Ahmadabad in Gujarat are particularly salient, but the last seems less integrated into the map as a whole than are the major places in Rajasthan. Moreover, the interior detail of the city is fanciful, as proved by

48. Gole, *Indian Maps and Plans*, 121 (note 1).

49. The map is cat. no. 2063/107; see also Gole, *Indian Maps and Plans*, 128 (note 1), which illustrates the work.

50. Gole, *Indian Maps and Plans*, 110–11 (note 1), provides, in addition to a photograph of the entire work, three photographs of details thereon.

FIG. 17.17. DETAILS FROM TOPOGRAPHIC MAP OF MUCH OF RAJASTHAN AND A PORTION OF GUJARAT. The map these details come from is in black ink and green watercolor on paper, and the text is in Urdu and Dhundari, the latter written in the Devanagari script. It dates from the late seventeenth century or the first half of the eighteenth. The areas depicted are outlined in figure 17.18. The left photograph, like the map as a whole, is centered on the town of Sojat in the heart of the Rajasthani region of Marwar. Five villages situated at the mouths of ravines penetrating the Aravalli range are shown in the right portion of the photograph. The right photograph shows Raj Sagar Lake and the nearby hilltop fortress towns of Chittorgarh and Mandalgarh. To the left one sees the eastern portions of ravine passes through the Aravalli range. Size of the entire map: 150 × 107 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 119). Photographs courtesy of Susan Gole, London.

comparison with the way Ahmadabad is depicted on the more or less contemporaneous map of Gujarat discussed below. Hills and mountains are also prominently and naturalistically indicated, especially the Aravalli range, which extends across the middle of the map and through which numerous passes are shown linking settlements on its southeastern and northwestern flanks. Surprisingly, despite—or perhaps because of—the fact that the map covers a largely desert area, there is an almost total lack of information on drainage other than lakes. The only river shown is the Sabarmati, on which Ahmadabad is situated, and that stream is shown flowing east-west rather than north-south as it actually does. Vegetation is signified, not very systematically, by trees drawn in small green clumps. Although some slight differences exist in their rendering, they do not appear to suggest that the mapmaker intended to symbolize various vegetation types. An exception is the painting of palms in the vicinity of Ahmadabad.

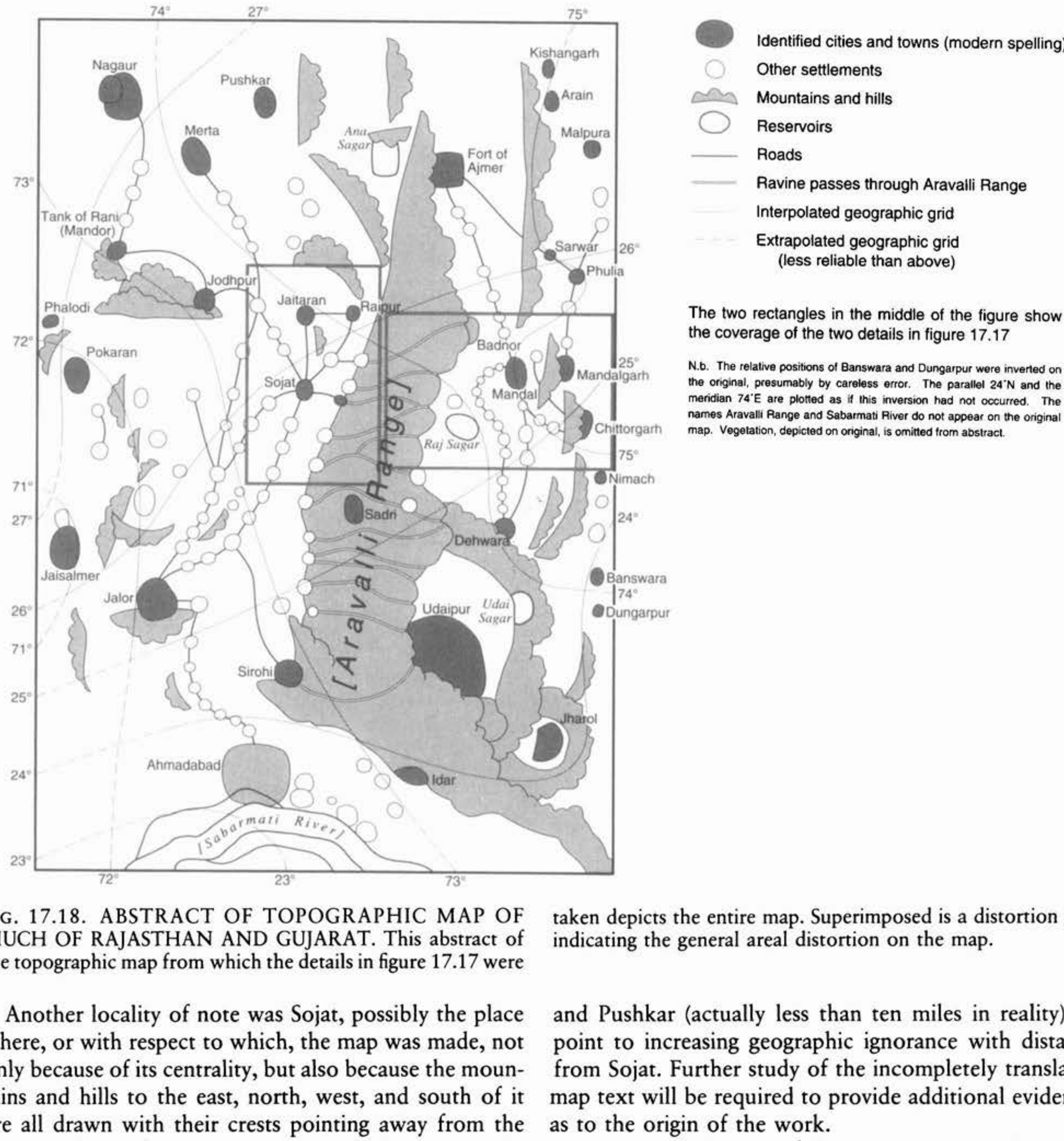
Writing on this map is aligned in all directions, largely as one might read it from the map's several edges; but the dominant orientation and the manner of depicting the Aravallis, the most prominent map feature, suggest that east is at the top. At all four edges cardinal points of the compass are indicated. The original text of the map was in Urdu, but duplicate text in Dhundari, a Rajasthani dialect, written in the Devanagari script, was subsequently added.

The date and exact provenance of the map are unknown. Chandramani Singh suggests, on stylistic grounds, that it may have been made in the late seventeenth century.[51] But near the small town of Asop, not far south of Nagaur, one of several notes with political information suggests a later date. That note identifies Asop as the residence (birthplace?) of Suraj Mal.[52] Although Indian history records several prominent individuals by that name, the most likely appears to be the Jaipuri founder of Bharatpur state (somewhat to the east of the area on the map), who reigned 1733–63.[53]

51. Noted in Gole, *Indian Maps and Plans*, 110 (note 1).

52. Gole, *Indian Maps and Plans*, 110 (note 1). I was unable to determine precisely which of the many settlements shown was Asop.

53. "Bharatpur State," in *The Imperial Gazetteer of India*, new ed. (Oxford: Clarendon Press, 1908), 8:72–86, esp. 75–76.



The two rectangles in the middle of the figure show the coverage of the two details in figure 17.17

N.b. The relative positions of Banswara and Dungarpur were inverted on the original, presumably by careless error. The parallel 24°N and the meridian 74°E are plotted as if this inversion had not occurred. The names Aravalli Range and Sabarmati River do not appear on the original map. Vegetation, depicted on original, is omitted from abstract.

FIG. 17.18. ABSTRACT OF TOPOGRAPHIC MAP OF MUCH OF RAJASTHAN AND GUJARAT. This abstract of the topographic map from which the details in figure 17.17 were taken depicts the entire map. Superimposed is a distortion grid indicating the general areal distortion on the map.

Another locality of note was Sojat, possibly the place where, or with respect to which, the map was made, not only because of its centrality, but also because the mountains and hills to the east, north, west, and south of it are all drawn with their crests pointing away from the town as if seen from that point. (This echoes the treatment of the mountains around the Vale of Kashmir as seen from Srinagar on several Kashmiri maps.) Furthermore, there seems to be less departure from the average scale of the map in the vicinity of Sojat than in other areas, in most of which the map ratio of latitudinal to longitudinal distance varies considerably from the true terrestrial ratios. The misalignment of the Sabarmati River in the south, the compression of scale around Jaisalmer in the southwest, the transposition of the locations of Dungarpur and Banswara in the southeast and, in the north, the exaggeratedly large distance between Ajmer and Pushkar (actually less than ten miles in reality) all point to increasing geographic ignorance with distance from Sojat. Further study of the incompletely translated map text will be required to provide additional evidence as to the origin of the work.

Overlapping the area of the Rajput map just discussed and of a similar date is an exceedingly large painted cloth map (440 × 406 cm) covering virtually the whole of Gujarat and an adjacent portion of Rajasthan. This map, now in the Museum and Picture Gallery, Baroda, has been illustrated and briefly described by R. N. Mehta and is discussed even more briefly by Gole.[54] Almost certainly,

54. R. N. Mehta, "An Old Map of Gujarat," in *Reflections on Indian Art and Culture*, ed. S. K. Bhowmik (Vadodara: Department of Museums, Gujarat State, 1978–79), 165–69, and Gole, *Indian Maps and Plans*, 113–15 (note 1). Both provide illustrations depicting the entire map, Gole's being the better of the two. Gole also provides more

according to Mehta, this map is identical to the one noted by a Narmadashankar Bhatt in his history of Cambay, *Khambat nu Sanskritika Darshan* (n.d.). Bhatt recorded that the work was painted by ʿAlī Moḥammad Khān, an important Gujarati historian, in 1756 and was kept in the city of Cambay with the family of the dewans (chief ministers) of the "emperor." It is not clear to whom the word "emperor" would have applied in 1756, since that Gujarat was wrested from the Mughals by the Marathas over the period 1725–57. Mehta's description of the map reads in part as follows:

> While hanging it shows east on the top. Due to this feature all the names are written in a way that they could be read from that view point. The map shows rivers as zig-zag lines, the sea as [a] large area, where rivers join. The mountains are shown as blocks from which rivers flow and also bear distinct colours and vegetation.
>
> The map shows . . . sea animals . . . , land animals, stylised trees etc. . . . The central position on the map is given to Ahmedabad which is correctly shown on the eastern bank of Sabarmati. Similarly the position of Surat, Bharuch, Khambhat, Baroda, Champaner, Ghogha, Talaja, Jafarabad, Diu, [and] Junagadh are accurately shown. The directions of Jodhpur, Anasagar lake, Udaipur, Dungarpur, Jalore, [and] Disa are fairly accurately shown.[55]

In contrast to most of the small-scale maps previously discussed, the style of this production is opulent, as may be seen from the detail of the area in the general vicinity of Dungarpur (fig. 17.19) from its northeastern section—perhaps a twelfth or so of the total map area.

The main purpose of the map, Mehta suggests, was to show the relative positions of cities and to portray their outlines and, for some, their principal internal roads. It was evident that the artist had a good knowledge of the towns he depicted. In particular, the outlines of the forts within them were well delineated. Surprisingly, roads between towns are not shown on the map; and though directions were indicated to important places in Rajasthan, indications of distance appear not to have been provided, judging from the fact that neither Mehta nor Gole mentions them. Because of the exceptionally large size of the map and the circumstances of its storage, it has yet to be reproduced well in a single photograph. For this reason and also because of the lack of a full translation of the text, it is not possible to evaluate the scalar distortions of the map in the way I have done for several other works. But clearly, the relative prominence given to the central area of and around Ahmadabad on this map is even more pronounced than for the areas around Ajmer or Udaipur on the work previously discussed. Conversely, the peripheral areas are considerably compressed, as are areas between cities and towns other than Ahmadabad, which are also depicted greatly out of proportion to their actual territorial extent.

A final point of similarity between this map and the one previously noted is the writing in two scripts, in this case Persian and Devanagari. Mehta does not state what language is being conveyed by the latter script but observes that it was not uncommon to "bear witness" to eighteenth-century Persian manuscripts through the Devanagari medium.[56]

Braj

The surviving Indian topographic maps discussed to this point were by and large drawn to meet secular needs. To most Indians, however, the religious topography of their country is also of considerable interest. Thus, for many sacred places maps have been drawn to aid the pilgrim's quest for merit. Most such maps are recent printed works relating mainly to specific holy cities, mountains, and shrines. These are properly discussed below. But at least one region, Braj—associated with the early life of Lord Krishna—has inspired a remarkable diversity of maps, originating in widely separated areas of India and ranging from exceedingly abstract representations to views in which individual features of the landscape can easily be recognized. Gole illustrates five maps of Braj, each quite different from all the others, but even these do not cover the full range from the abstract to the realistic ends of the semiotic spectrum.[57] Appendix 17.1 provides essential details of nine maps of Braj, including several for which no additional information is provided in this chapter.

The region of Braj "is often conceived of as a lotus, a flower which symbolizes devotion and love."[58] But the number of petals this lotus possesses varies, according to the many sacred texts written on Braj, from as few as 12 to as many as 966 arranged in seven concentric rings.[59] Figure 17.20, possibly drawn in Braj itself, presents an intermediate view, a lotus of 56 petals and three rings. Although each petal allegedly stands for a specific object within the region of Braj, it would be futile to try to establish a full set of real-world correspondences. Rather, one should view this figure and other similarly abstract

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detailed photographs of three separate portions of the map and possesses additional photographs of others.

55. Mehta, "Old Map of Gujarat," 166 (note 54). A search in various bibliographies has failed to reveal the present whereabouts of the history by Bhatt that Mehta refers to. It may well be a manuscript in the possession of a private individual.

56. Mehta, "Old Map of Gujarat," 167 (note 54).

57. Gole, *Indian Maps and Plans*, 25 and 58–61 (note 1).

58. Amit Ambalal, *Krishna as Shrinathji: Rajasthani Paintings from Nathdvara* (Ahmadabad: Mapin, 1987), 14.

59. Alan W. Entwistle, *Braj: Centre of Krishna Pilgrimage* (Groningen: Egbert Forsten, 1987), 247.

FIG. 17.19. DETAIL FROM MAP OF GUJARAT AND A PART OF RAJASTHAN. The map is painted on cloth with Persian and Devanagari script (it is not clear which language the latter script is employed for), and was probably painted in 1756. Shown in this view are the Mahi River and the nearby Rajasthani town of Dungarpur. The area shown is a rather small segment of what may be India's largest surviving traditional topographic map.
Size of the entire map: 440 × 406 cm. Courtesy of the Museum and Picture Gallery, Baroda (cat. no. G.R.5631). Photograph courtesy of Susan Gole, London.

creations as Tantric mandalas, or visual foci for meditation, "drawn as a means of concentrating power during worship" of the deity within the image.[60] Arguably, I might have included figure 17.20 within the discussion of Hindu cosmography, but presenting it here will aid comparison with other images of Braj.

Not quite so abstract as the image just discussed is figure 17.21, whose text is written in the Sanskrit language but employing the Bengali script. This suggests a Bengali author but not necessarily Bengali provenance, since

60. Entwistle, *Braj*, 246 (note 59).

FIG. 17.20. THE REGION OF BRAJ CONCEIVED AS A LOTUS. This diagram, ink (?) on paper, is from a nineteenth-century (?) manuscript in Braj dialect but written in Gujarati script. It is based on a textual description from the late seventeenth or early eighteenth century. Here there is no attempt to make the distribution of places shown conform to their actual geographical positions; rather, they are listed in the order of three clockwise circumambulations of Braj. The eight petals of the inner ring are the places from Mathura to Mukhrai, the sixteen of the middle ring are the places around Govardhan, and the outer thirty-two are the remaining portions of the pilgrimage circuit. The diagram thus represents a strip map topologically distorted into a set of concentric circles—by implication, a spiral with three whorls.
Size of the original: 24 × 18 cm. Vrindaban Research Institute, Vrindaban (acc. no. 5295).

FIG. 17.21. SEMIABSTRACT MAP OF BRAJ IN THE FORM OF A LOTUS. This nineteenth-century (?) map, titled "Chaurāsī Krosh Parikramā" (Pilgrimage of eighty-four *kos*), is painted in black, green, and vermilion on paper and has a Sanskrit text written in the Bengali script. It is not markedly different from figure 17.20 but conforms more closely to geographic reality. Not only is the Yamuna River clearly shown, but the names of the sacred bathing ghats along that river are written in the petals that adjoin it.
Size of the original: 57 × 44 cm. Vrindaban Shudh Sansthan, Vrindaban (MS. 4706).

Mathura has a large resident community of Bengali Krishna devotees. The Yamuna River is clearly shown on this diagram, and the names of the sacred bathing ghats along that river are written in the petals that adjoin it. How much of the remainder of the extensive text relates to now identifiable places in Braj has not been ascertained, but since the work is described as a guide to the "Chaurāsī Krosh Parikramā" (Pilgrimage of eighty-four *kos*), one may suppose that a substantial part of it would do so.[61]

Completely different from the foregoing is plate 31, one of many paintings of Braj associated with the Nathdwara school of Indian painting. This school takes its name from a small Rajasthani town to which many Krishna devotees of the Pushtimarg sect fled in 1671 when the Mughal emperor Aurangzīb sought to root out Krishna worship in its traditional core region.[62] On this map numerous places associated with the life of Krishna can readily be discerned: the Yamuna River, the sacred cities of Mathura and Brindaban along its bank, Mount Govardhan (left center), the many *ban*s (sacred groves) where Krishna played, and so forth. Though much of the detail may be nothing more than decorative space fillers, the relative locations of the principal elements of the map

61. The number eighty-four is a conventional auspicious figure that should not be taken literally. The *kos*, a traditional measure of distance in India, is about two miles, but used together with the number eighty-four it has no clear-cut distance connotation.

62. "Nāthdwāra," in *The Imperial Gazetteer of India*, new ed. (Oxford: Clarendon Press, 1908), 18:415.

FIG. 17.22. MAP OF NORTH-CENTRAL INDIA WITH EMPHASIS ON BUNDELKHAND AND BAGHELKHAND. In watercolor and ink on paper with text in Persian, this mid-eighteenth-century map is oriented with south at the top. The focal regions of Bundelkhand and Baghelkhand, actually fairly small, account for perhaps three-fifths of the total map area, which, as figure 17.23 shows, represents a very large part of north-central India.
Size of the original: 51.5 × 66 cm. By permission of the Bibliothèque Nationale, Paris (Département des Manuscrits, Division Orientale, Suppl. Pers. 1606).

are all reasonably accurate. Paintings of this type, designated *pichhvāīs* (signifying that they were intended to be hung in the back of temples), are still being produced in Nathdwara by a group of artists whose families have practiced their craft for many generations.[63]

Central India

In the Bibliothèque Nationale in Paris is a rather crudely executed, yet fairly detailed, paper map of a rather large part of north-central India (figs. 17.22 and 17.23). Although the file card relating to the map states "sans lieu, ni date," it has been possible to determine its area of coverage and probable date within reasonable limits. The map text is in Persian—still used as a lingua franca

63. Ambalal, *Krishna as Shrinathji*, 63–64 (note 58). There are also *pichhvāīs* that are maps of the city of Nathdwara itself. These will be discussed below. The Nathdwara school of painting is said to date from the year 1765. Additional illustrations of Braj *pichhvāīs* may be found in Gole, *Indian Maps and Plans*, 61 (note 1); Walter M. Spink, *Krishnamandala: A Devotional Theme in Indian Art*, Special Publications, no. 2 (Ann Arbor: Center for South and Southeast Asian Studies, University of Michigan, 1971), 10, with details on 7, 11, and 28; and Kay Talwar and Kalyan Krishna, *Indian Pigment Paintings on Cloth*, Historic Textiles of India at the Calico Museum, vol. 3 (Ahmadabad: B. U. Balsari on behalf of Calico Museum of Textiles, 1979), pls. 23 and 24, with text on pp. 26–27.

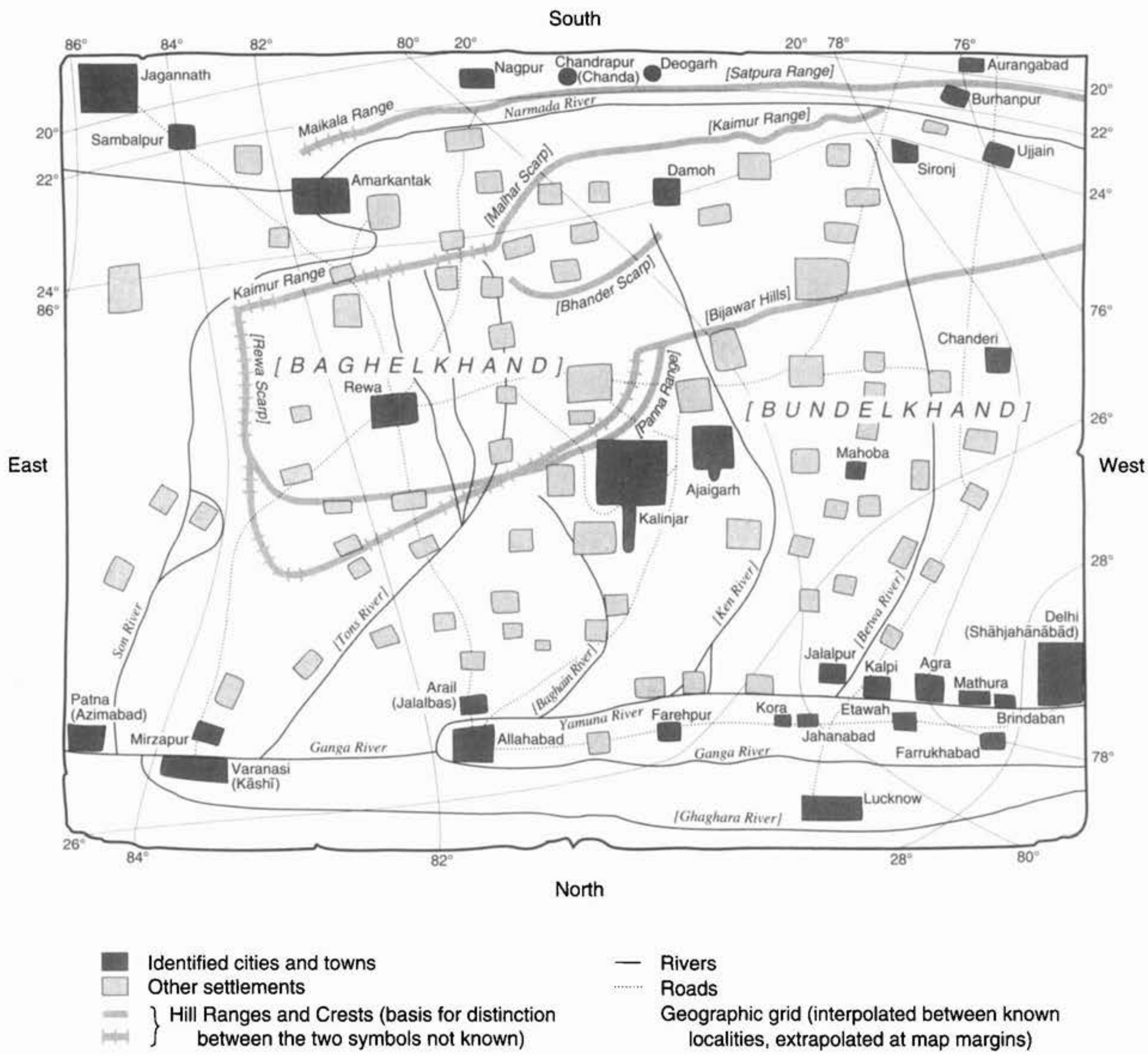


FIG. 17.23. ABSTRACT OF MAP OF NORTH-CENTRAL INDIA. The principal places and the degree of areal distortion in figure 17.22 are shown.

over much of India in the eighteenth century—in a difficult Shikasta script (without vowels and with most consonants having a variety of possible interpretations), but enough of the text has now been translated or transliterated to permit one to state that the map's principal function was to indicate the amount of revenue to be collected from the lands around many of the more than one hundred towns and cities shown.[64]

For many such places named there are notations such as "Ajaigarth. . . . In the possession of Kalyān Singh, . . . two *lakhs*" (i.e., Kalyān Singh would have been responsible for collecting two *lakh*s [200,000] of rupees from the locale named). Other persons named included Maharaja Ajīt Singh and Jehat Singh, the two most frequently mentioned; Mubārak Mahal, a woman whose possession of Mukandpur (south of Rewa, but not traceable on a modern map) yielded her revenue—according to the map text—for her household expenses; the Nizām Shāh, of Hyderabad; and Jānojī Bhonsle, one of the more powerful leaders within the Maratha Confederacy that ruled over a very large part of India in the mid-eighteenth century. In several places notes read simply "Under the con-

64. I thank Sajida Alvi and Iraj Bashiri of the University of Minnesota, Minneapolis, and Irfan Habib of Aligarh Muslim University for translating certain portions of the map and transliterating many of the place-names.

trol of the Marathas." Jānojī reigned from 1755 to 1785, and our map unquestionably dates from that period. Positive identification of the other persons named has not yet been made. Nizām Shāh, for example, is merely a title. Ajīt Singh is a fairly common name that during Jānojī's time could conceivably have referred to the maharaja of either Kotah or Bundi (1756–59 and 1770–74, respectively), but those two Rajput states lay somewhat to the west of the area covered by the map, and among the numerous petty states of the Indian regions of Bundelkhand and Baghelkhand on which the map centers, there could well have been another Ajīt Singh.

A further pair of clues to the possible date relate to the map's showing Lucknow and Farrukhabad among the small number of important places in its northwestern corner. That Lucknow, rather than Fyzabad (Faizabad), appears suggests that the map dates from a time when it and not Fyzabad was the capital of Awadh—either 1754–65 or after 1775. But the inclusion of Farrukhabad, which was incorporated into Awadh in 1771 and thereafter lost much of its importance as a princely capital in its own right, argues for a date earlier than 1771. Hence 1754–65 seems the most likely time for the creation of the map.

Gole speculates that "it may have been a map of this type that Rennell used for Bundelkund, when making his large map of Hindustan in 1782."[65] This is certainly a plausible suggestion, and it is even possible that our map was the very one that Rennell consulted. But in any event, one wonders why the map would have turned up in a French rather than a British library. Conceivably Colonel Gentil, whom I will discuss below, had a hand in the matter.

Of the authorship of the map we can say little; but it is certain that it was drawn by a Hindu, despite its use of Persian—which was known to many educated Hindus—because of the use of the honorific "*shri*" before the names of such holy places as Kāshī (Kāśī, modern Varanasi) and Jagannath. One may hazard the guess that the work was commissioned by one of the many rajas of Bundelkhand or Baghelkhand.

Apart from providing data relevant to political control and to the collection of land revenue, the map might well have served certain military purposes. Its most prominent and most central feature is the renowned hilltop fortress of Kalinjar, from which project short lines that could signify cannons; these point mainly toward the Gangetic Plain, from which any attack would have been most likely. To the west of Kalinjar the fort of Ajaigarh, of somewhat lesser importance, has been similarly depicted. Rivers, hill ranges, and escarpments also figure prominently on the map. The rivers, which are easy to identify even when not specifically named, are rendered in grayish green and the hills and escarpments in purple and violet (though the latter color could result from fading of the former). At first one is inclined to doubt that the purple and violet lines of the map relate to orographic features, since they cross rivers with seeming abandon, but examining modern medium-scale topographic maps enables one to identify, with near certainty, all such lines, though only a few are actually named.[66] Among the hill lines there is an interesting distinction between those emphasized by tick marks and those lacking such emphasis. I can assign no obvious reason for this but suggest, since all of the former lines are in the more humid east, that they might signify forested hills as opposed to those merely covered by scrub vegetation. A final important attribute of the map is its depiction of roads; these are shown by yellow lines that, regrettably, do not show up well in the photograph.

Figure 17.23 indicates the places that have been named on the map and notes as well as, in square brackets, additional unnamed but identifiable physical features and regional names. It also includes an interpolated two-degree grid of latitude and longitude indicating where and to what degree the map is distorted. The map's focus in Bundelkhand and Baghelkhand is quite clear, and as is often the case with Indian maps, peripheral areas are much compressed in scale. Certain locations near the four corners of the map that seem in effect to anchor it in space are particularly noteworthy: Shāhjahānābād, capital of the then moribund, but still important, Mughal Empire in the northwest; the major religious centers of Kāshī, Jagannath, and Ujjain in the northeast, southeast, and southwest, respectively; and the strategic pass town, Burhanpur, also in the southwest. Nagpur, the politically important capital of the Bhonsle line of the Maratha Confederacy, is shown near the south-central edge of the map. Several other outlying places appear to be included only because of their political or religious importance, for example, Lucknow, the capital of the then-rising nawabate of Awadh (Oudh), and Amarkantak, the sacred source of the Narbada River.

Maharashtra and Other Areas of Maratha Activity

A number of small-scale Maratha maps covering extensive areas of peninsular India and Gujarat are known to exist—or to have existed until recently—in addition to the so-called world map discussed above (fig. 17.6). A number of these have been reported on and partly illustrated in brief articles by D. V. Kale and C. D. Desh-

65. Gole, *Indian Maps and Plans*, 138 (note 1); see also above, p. 325.

66. See, for example, the National Atlas and Thematic Mapping Organization, *National Atlas of India* (Calcutta: Organization, 1979), vol. 1, pl. 29 (1:1,000,000).

pande.[67] Regrettably, however, some of these have not been made accessible to interested scholars; others appear to have vanished in the past few decades; and at least one is in such bad repair that studying it is all but impossible. Hence the discussion of this type of Maratha cartography will necessarily be less than satisfactory. Although it has been possible to plot the approximate areas of six of these maps on figure 17.7, it is difficult to date any of them with precision. It seems likely, however, that all belong to the last half of the eighteenth century or the beginning of the nineteenth.

Most of the maps are in the Marathi language and are written in the Modi script, which relatively few Marathis, even among the educated classes, can now read; others are written in the Marathi variant of the Devanagari script. Most are oriented with east at the top, and the alignment of text generally conforms to that perspective, though crowding and other considerations may result in departures from that rule. Frequently, compass directions are noted along the map edges. Stylistically the maps display considerable variety, ranging from rather simple ink outline sketches with relatively little detail to exceedingly crowded maps full of adornment—vegetation, animals, fish, temples—much of which lacks any specific referent. In what follows, I shall consider ten maps, proceeding from north to south in respect to the general areas of their coverage, although there is considerable territorial overlap among them.

Formerly at the Prince of Wales Museum of Western India in Bombay and illustrated and discussed by Deshpande, but now missing, was a map portraying most of Gujarat.[68] The size of this map was not recorded, but apparently it was large, since four pieces of paper appear to have been pasted together to compose the work. Judging from a published photograph, the medium appears to be black ink. The Kathiawar peninsula was included, but whether Kutch was is not certain. The shape of Kathiawar on this map was very distorted. Features shown include a multitude of settlements, their relative importance indicated by the size of lettering and by enclosure within thickly lined boxes. The administrative hierarchy of the settlements, noting seats of *prānt*s and *parganas* (larger and smaller administrative regions), was specified by special textual suffixes. Major rivers were crudely shown by double lines, and the coast, curiously, was also indicated by a double line. Boundary lines between administrative features were absent, as were relief features. The principal purpose of the map is judged to be political.[69]

In the Maratha History Museum, Deccan College, in Pune, there is a small (38 × 60 cm), fairly simple paper map that shows Pune, Bir, and Burhanpur; the sacred sites of Śrītrimbakeśvara (Trimbak) and Bhimashankar, in the Western Ghats; the site of the important battle of Rakshasbhawan (1763); a few major rivers, including the Tapi, the upper Godavari, and the Mula and Mutha tributaries of the Krishna; and the Ajanta range. The cities, shown as if from nearby hilltops, are portrayed as clumps of buildings, rendered in a wash of blue and gray. Rivers are in blue, text is in black. The name "Wellesley" appears on the map, suggesting that it may date from about the time of the second Anglo-Maratha war (1805). It departs from most Maratha maps in being oriented with north at the top, being written in the Devanagari script, and having a ruled frame on all four sides, outside which (as was customary) the four cardinal directions are noted. Although, as represented in figure 17.7, the area covered by this map extends farther from north to south than from east to west, the map itself is wider in the latter dimension, the scale being contracted from north to south.[70]

Simplest among the Maratha topographic maps is a sketch in black and white ink, on paper, of the upper portion of the Krishna River watershed, an area of approximately 30,000 square miles. On this map the Krishna and ten tributaries, as far north as the Bhima, are named, along with about fifty places—mainly situated on the named rivers—in which the Marathas were interested. A line, presumably signifying the crest of the Sahyadri, from which each of the rivers originates, is also indicated. The map is illustrated by Deshpande, who suggests that it could have been "a route map indicating the valley routes in the Maratha campaigns."[71]

Covering virtually the entire area of the previously discussed map and extending significantly farther to the south and east is a map that had been at the Prince of Wales Museum of Western India when Deshpande studied it but was subseqently transferred to the State Archives of Maharashtra, also in Bombay. This large cloth map (268 × 212 cm), which Deshpande believes to show "late eighteenth century influences,"[72] is badly torn in places and has been laminated with some type of plastic, now clouded, which renders it barely legible and virtually precludes photography. Fortunately, Deshpande was able to have it photographed before lamination and reproduces about a third of the map in his 1953 review.[73]

67. D. V. Kale, "Maps and Charts," *Bharata Itihasa Samshodhaka Mandala Quarterly*, special issue for the Indian History Congress of 1948, vol. 29, nos. 115–16, pp. 60–65; and C. D. Deshpande, "A Note on Maratha Cartography," *Indian Archives* 7 (1953): 87–94.

68. Deshpande, "Maratha Cartography," 90–91 and pl. II (note 67).

69. Deshpande, "Maratha Cartography," 91 (note 67).

70. The information in this paragraph is derived from a photograph and set of notes sent to me by Susan Gole on 28 March 1984. The map is illustrated and described in Gole, *Indian Maps and Plans*, 145 (note 1).

71. Deshpande, "Maratha Cartography," 91 and pl. III (note 67).

72. Deshpande, "Maratha Cartography," 92 (note 67).

73. Deshpande, "Maratha Cartography," 92 and pl. IV (note 67). I

Painted in black, red, blue, yellow, green, and purple, this map uses a sumptuous array of abstract and pictorial symbols to depict settlement, terrain, and vegetation. Some of these symbols are shown in figure 17.8. A settlement hierarchy is suggested by either single or double circle symbols. Forts are more boldly portrayed by red circles. Ports along the Arabian Sea coast are noted by adding the suffix "*bandar*" to place-names. Along with settlements, temples are prominently shown, frequently by drawings in frontal elevation, much larger than villages and towns. Roads are not a prominent feature of the map, being indicated by faint (possibly faded) red lines. Although no terrain feature is explicitly named, the Sahyadri and numerous interior crests—more than a dozen—are emphatically depicted in purple and outlined in black. They are often strewn with vegetation in yellow and green. Additionally, a great variety of charmingly rendered trees, painted much larger than villages and towns, occupy the interstitial spaces over most of the map, presumably indicating a dominantly forested landscape. Whether these were intended to suggest local variations in natural vegetation types is unclear.

A peculiar aspect of the map is that, contrary to the usual Maratha custom, it is oriented toward the west. Almost all of the text and most pictorial details accord with that perspective. Mountain and hill summits, however, usually point away from a hypothetical observer standing in the adjacent lowlands from which such summits would most likely be viewed. In some cases, where broad lowlands flank both sides of a hill range, the summits alternate in pointing first in one direction and then the opposite way. This is, so far as I am aware, a unique cartographic device.

At the Bharata Itihasa Samshodhaka Mandala in Pune is a beautiful medium-sized (82 × 57.5 cm) paper map that is remarkably similar in style to the map previously discussed, though oriented toward the east and drawn at a considerably larger scale. A photograph in Gole's *India within the Ganges* shows most of the work.[74] The map covers a portion of the Konkani coast in the vicinity of the port and fort of Devgarh, an area approximately thirty kilometers east-west and twenty kilometers north-south. Within this area between 100 and 110 named localities are shown, and it seems likely that every village within the area covered found a place on the map. If so, this would be the first of the Maratha topographic maps I have considered that attempts a complete village inventory. In addition to the villages, all shown within yellow ovals ringed by red or yellow perimeters, the map depicts at least half a dozen forts and several towns. For Devgarh the location of the fort gate and the adjacent port are specially shown. The names of many villages include suffixes and prefixes such as -khurd, Mauje-, and Peth- (bazaar) that signify their hierarchical or commercial functions, and often next to the names the word *taraf* (direction) denotes the relation of a village to some larger settlement. Linking the settlements there is a dense network of trails, shown by red lines. Drainage is prominently shown, with the common wave symbol and fish used both in rivers and in the Arabian Sea. Four three-masted ships and one lateen-sailed one master are also shown at sea. A wavy line at the top (eastern edge) of the map signifies the crest of the Sahyadri, through which the Phonda Pass is shown by name. No other relief features are noted. In the interstitial areas between villages, several types of trees are shown. That palms are concentrated in immediate proximity to the coast and in certain riverine localities suggests the mapmaker's desire for verisimilitude in depicting vegetation. A final noteworthy feature of the map is a straight red north-south line that bisects it. If this line was intended to be a meridian of longitude, it would be the only representation of a portion of a geographic grid on an indigenous premodern map from South Asia, apart from the individual folios in the atlas of Ṣādiq Iṣfahānī.

Covering another relatively small coastal area of North Kanara district, to the south of the map of the Devgarh region, is a crude pen-and-ink map that was brought to light and briefly described by Phillimore.[75] The map, possibly a copy, is on six small pieces of paper pasted together to form a sheet about 150 by 55 centimeters. The watermark was judged to be probably Portuguese. At the northern edge of the map is a reference to the southern boundary of Goa, written, like the rest of the map text, in the Modi script. Like the Devgarh map, this one terminates eastward at the Sahyadri (here roughly twelve miles from the coast), which is shown by a thin wavy line. Included on the map are several towns, five forts, and a great many villages, their limits roughly sketched in; the limits of lands described as jungle, hill, paddy fields, or gardens; two islands; rivers and ferries; and the names of several passes through the Ghats. On the map when it was found were faded English translations of the entire map text. "The English names are squeezed in and so badly written as to be difficult to read," says Phillimore, "but on the whole are very fair renderings of the vernacular."[76] About a dozen of the

was able to study the map at some length in 1984 with the aid of an archivist who could read its Modi script. The plotting of the area of the map on figure 17.7 was made possible by his rendition of about two dozen names of important places among the more than five hundred (my estimate) shown on the map, many of those names being close to the edges of the map. Gole subsequently searched for the map in vain, and it is questionable whether it can still be traced.

74. Susan Gole, *India within the Ganges* (New Delhi: Jayaprints, 1983), 19.

75. Phillimore, "Three Indian Maps," 113–14 and appended map 3 (note 33).

76. Phillimore, "Three Indian Maps," 114 (note 33).

names could be identified on Survey of India one-inch maps. Phillimore suggests, quite plausibly, that the map "may have been prepared for the first British Collector [district revenue officer] of 1799, for whom it would have provided the most valuable information."[77] Though the area covered by the map is in the present state of Karnataka, there can be no doubt that the author was a Marathi rather than a Kannada speaker. Stylistically, the map has little in common with other Maratha maps described in this section.

Among the now missing maps, formerly at the Prince of Wales Museum of Western India and briefly noted by Deshpande, is one that extended from northwest to southeast across peninsular India.[78] On the Arabian Sea coast it ran from a point west of the Maratha capital at Pune south to North Kanara (just south of the state of Goa) and on the Bay of Bengal from Madras to the Kaveri delta. The map's principal function apparently was to portray routes for military operations in the regions of Hyderabad, Mysore, and the Kaveri, around each of which a particular abundance of place-names was indicated, as was also true in the Krishna-Tungabhadra drainage area. Pune was shown as a transport node from which strings of place-names emanated. Distances between places were given in *kos*. Prominent places, including such important religious sites as Mahabaleshwar, Gokarn, Srisailam, and Srirangam, were boldly inscribed on the map. Deshpande has inferred that the map dates from the mid-eighteenth century.[79] He says nothing, however, about its size, the medium, the use of particular kinds of symbols, or other key map attributes that would help one compare and relate it to other known Maratha works.

An immense map, originally measuring about 450 by 300 centimeters but now in at least a dozen crumpled and tattered fragments, is kept in the library of the Bharata Itihasa Samshodhaka Mandala in Pune. It is doubtful whether this map, which allegedly covers the area from around Pandharpur (about 200 km southeast of Pune) southward to Cape Comorin at the southern tip of India, can or will ever be restored and accorded the study it deserves. A fleeting inspection of some of the map fragments shows that the work is (was) quite detailed; and it is conceivable therefore that not only poor storage but also heavy use contributed to its present sorry state.

Also at the Bharata Itihasa Samshodhaka Mandala and in reasonably good condition is a map that covers an even larger area than the work previously noted, extending from slightly north of Pune to Cape Comorin and also including the island of Sri Lanka (at a scale much smaller than that of peninsular India) and two additional islands in the Gulf of Mannar at substantially enlarged scales (fig. 17.7).[80]

The map probably dates from the mid-eighteenth century. It is on cloth-backed paper and measures 179.5 centimeters north-south and 103.5 centimeters east-west, with east at the top. Stylistically, it has some features in common with the map seen at the State Archives of Maharashtra in Bombay, though on the whole it is less ornate. Painted in yellow, blue, red, and orange watercolor and black ink, it is rich in detail in some areas and sketchy in others. It appears to have been designed to meet both military and administrative needs. Possibly it also served fiscal purposes. The exuberant depiction of vegetation that characterized the map seen in Bombay is here totally lacking, and mountains and hills are rendered relatively simply by squiggly black lines. Rivers appear in blue, and a solid blue sea teems with fish, other marine animals, and sailing ships of European appearance. (A three-master and two smaller craft lie offshore near the Kaveri delta.) Roads are abundantly shown by red lines. The most prominent features of the map are settlements, which are portrayed by a wide variety of yellow symbols outlined in black. One supposes that these symbols represent some sort of administrative hierarchy, but the standardization of symbols is not sufficient to show any obvious pattern.

The map text, in the Devanagari script, includes little or nothing but toponyms and does not indicate distances between places. Not all parts of peninsular India were well known to the Marathas, and that is reflected in the distribution of place-names—very few are shown on the Malabar coast. Elsewhere the locations of certain places are transposed or much less accurately plotted than one might expect for the mid-eighteenth century. Surprisingly, Hyderabad is placed much farther north of Pune than it should be.[81]

Finally, in his brief 1948 note on the maps and charts of the Bharata Itihasa Samshodhaka Mandala, Pune, Kale mentions that apart from maps of small specific localities, other maps covered areas "containing a number of forts and villages. These are efforts to accommodate a very wide area within the small space of 2′ × 3′, of course

77. Phillimore, "Three Indian Maps," 114 (note 33).

78. Deshpande, "Maratha Cartography," 91–92 (note 67).

79. Deshpande, "Maratha Cartography," 92 (note 67).

80. Gole, *India within the Ganges*, 20 (note 74); and Kale, "Maps and Charts," map plate facing p. 61 (note 67). The Bharata Itihasa Samshodhaka Mandala, Pune, has not granted permission to have any part of this important map reproduced in either this volume or Gole's *Indian Maps and Plans*. It did, however, allow the reproduction of a photograph of a small part of the work in Gole's *India within the Ganges* and another, of the entire map, in the article by Kale, "Maps and Charts."

81. Deshpande, "Maratha Cartography," 92 (note 67). Another now-vanished small-scale map, formerly at the Prince of Wales Museum of Western India, Bombay, is related to the area around Hyderabad. Deshpande found the work generally similar to the map of the area from Pune to Cape Comorin, which also emphasized routes and settlements.

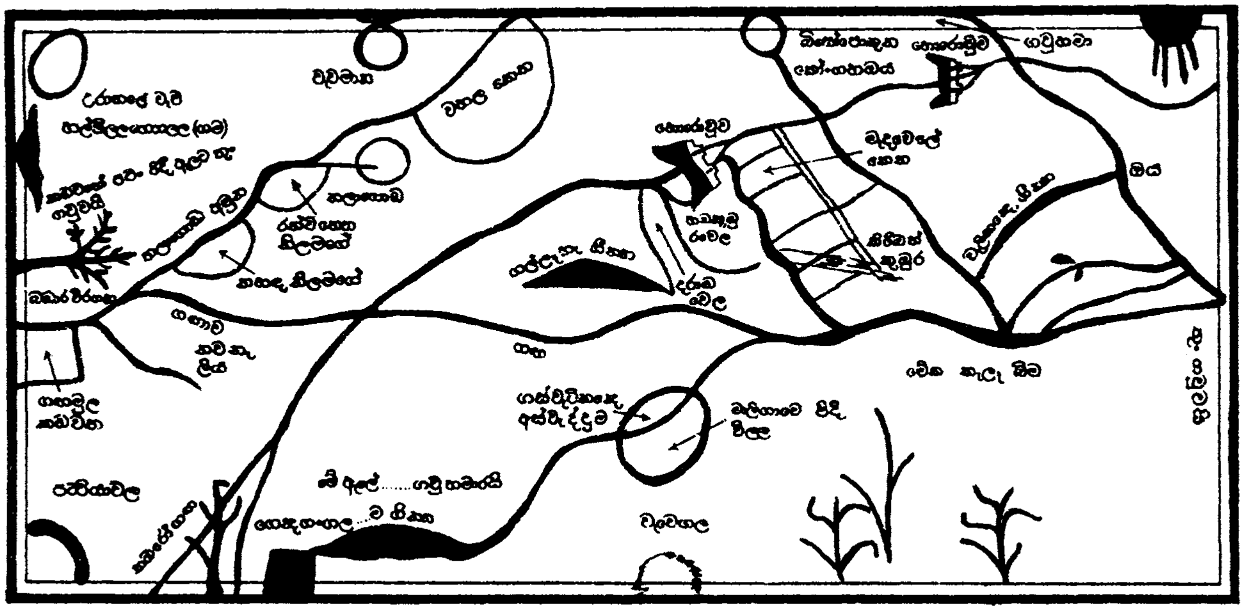


FIG. 17.24. SINHALESE MAP OF A SMALL AREA IN CENTRAL SRI LANKA. This is the sole known traditional geographical map of Sri Lankan provenance. It covers an area of several hundred square kilometers in the east-central part of the country and may have been made at the behest of a member of the Kandyan royal family. The original from which this copy was made is painted on cloth and probably dates from the seventeenth century.
Size of the original: 101.5 × 216 cm. From R. L. Brohier, *Land, Maps and Surveys*, 2 vols. (Colombo: Ceylon Government Press, 1950–51), vol. 2, pl. LIV.

without scale and without compass."[82] How many such maps he may have been referring to is not specified. Of the maps I have discussed, only the one along the Arabian Sea including an area in the vicinity of Devgarh fits the approximate dimensions of 2 × 3 feet. Thus the number of vanished Maratha maps, leaving aside the seventeenth-century productions made by or at the behest of Shivājī, may be even greater than the present account indicates.

Sri Lanka

Many inquiries have revealed only one indigenous map (not counting cosmographies) of Sri Lankan provenance. The map (fig. 17.24) is reproduced, translated, and well described by Brohier, who states: "It is an attempt to map certain lands and the topography including the irrigation system in the valley of the Amban-ganga, near Elahera, in the District of Matale."[83] The area covered extends about thirty to thirty-five kilometers from northeast to southwest and slightly more than half that distance from northwest to southeast. The circumstances in which the map was preserved and brought to light are noteworthy. The following account, as related to Brohier, is that of a Sinhalese surveyor, R. T. Samerasinghe, who, sometime before 1950, lent the map to the Colombo Museum:

> About 1935 whilst out camping in a village called Attara-gal-lewa, an old Veddah type of man residing in a hamlet a few miles deeper in the jungles, presented this cloth map to me. He told me it was found in a well-sealed earthern vessel—and that this is a plan during the days of Godopora Maharaja.
>
> The correct name is Godopola Maharaja, brother to Rajasingha the II. Pending further investigation the map may be provisionally accepted as a 17th century production.[84]

Brohier provides a partial translation of the places indicated and the corresponding area, at roughly the same scale, as shown on a modern topographic map. The following is extracted from Brohier's description.

> The material on which the drawings and lettering have been made is a close-woven fabric 40 inches by 85 inches, treated on the working surface with some vegetable dye which is dull cream in colour. The writings and line work are in three colours and include the indigo or light blue, very rare in Sinhalese art. . . .
>
> The unit of measure, as stated on the map [by local notes, rather than by a scale], is the Sinhalese mile or *gouwa*. By comparing distances between principal junctions on the old map with corresponding points on the modern map, it is possible to reconcile one inch on the drawing as equivalent to [a] quarter mile

82. Kale, "Maps and Charts," 64 (note 67).

83. R. L. Brohier, *Land, Maps and Surveys*, 2 vols. (Colombo: Ceylon Government Press, 1950–51), vol. 2, R. L. Brohier and J. H. O. Paulusz, *Descriptive Catalogue of Historical Maps in the Surveyor General's Office, Colombo*, 192 and pl. LIV.

84. Quoted in Brohier, *Land, Maps and Surveys*, 2:192 (note 83).

> on the ground. This is not quite constant, thus implying that measurement must have been carried out by pacing, or with the aid of [a] measuring-cord, or with a measuring-stick.
>
> Features used for orientation are the rising sun, shown on the right top corner, and the waning moon, on the left lower corner of the drawing. These indicate East and West respectively. Obviously the determination and expression of direction by the compass or any other means was unknown.[85]

The original contains a variety of interesting notes, identifying varying villages, the "paddyfield of the royal palace," land belonging to various other individuals, and the location of sulfur rock.

Rajasinha II, referred to above, ruled over the Kandyan kingdom from 1629 to 1687 and had considerable interaction with Europeans of various nationalities, holding many in a loose form of bondage for long periods. Among those so detained was Robert Knox, who resided in Kandy from 1659 to 1679 and left a very detailed account of the kingdom.[86] Whether he or other Europeans had any influence on Sinhalese cartography is an open question, though I see nothing in the style of the one surviving map to suggest such influence.

Northeastern India

From near the northeastern corner of the Indian subcontinent comes another large-scale map of a rather small area, which, like the North Kanara map, might better be considered a hybrid production than a truly indigenous work. This faded ink sketch is among the three maps Phillimore described and illustrated. The original (roughly 65 × 25 cm) was, as Phillimore relates, "found on a page of a volume of correspondence of 1849 of the Revenue Surveyor in charge of the survey of Goalpara District, Lower Assam."[87] The map's southern limit was the northern rim of the Garo Hills, now in the Indian tribal state of Meghalaya, but I have not been able to pinpoint the precise area covered. I surmise that it was no more than five miles north-south and perhaps ten to twenty miles east-west. The sparse map text—only eighteen toponyms and the four cardinal directions are noted—is in Bengali, very likely by a clerk of the deputy collector, who was "in no way a surveyor."[88] The map indicates several rivers, hills, estates, and one village, all in the then administrative area (*pargana*) of Habraghat. The map has no definite orientation; names are read from all directions.

HYBRID MAPS AND THE GENTIL ATLAS

A number of South Asian maps that appear to be indigenous in style were made at the behest of the British and other Europeans serving in governmental and other capacities in India and adjacent countries. I have briefly discussed two such maps in the preceding section of this chapter and taken note of others in the introduction. Still others will be discussed in the following section, "Late Eighteenth- and Nineteenth-Century Nepali Maps."

A few others exist in which the European style is so predominant that I have chosen not to consider them in any detail. Let me note in passing, however, that Gole discusses and illustrates three such maps.[89] Two of these are of Gujarat: an undated work by an otherwise unknown Hahfizjee, now in the British Library (Add. MS. 13907[e]), with map text in English; and another by Sudānand, a Brahman in the employ of the British resident at Cambay, about 1785, also in the British Library (Add. MS. 8956, fol. 2). The third, "*faites par des Brahmes*," covered the southern part of peninsular India. A portion of it was rendered into French and published in 1785, the original having been obtained when Abraham Anquetil-Duperron was in India in 1761.[90] The published map looks more European than Indian, and we do not know to what degree it varied from the original or whether that original was made expressly for Europeans. Of some interest is the plural authorship of the no longer traceable Brahman work.

Without a doubt, the most important hybrid cartographic production to emerge from Europeans' use of indigenous Indian collaborators is the atlas prepared in 1770 under the direction of Colonel Jean Baptiste Joseph Gentil, a French nobleman who served as a military advisor to the nawab of Awadh (Oudh). Gentil, who resided at the Awadhi capital of Faizabad from 1763 to 1775, engaged three Indian artists to record many aspects of contemporary Indian life and compiled a large encyclopedic album, *Recueil de toutes sortes de dessins*, in which many of the illustrations relating to relatively small localities contain cartographic components.[91] Additionally, these artists contributed to an atlas of forty-three folios titled *Empire Mogol divisé en 21 soubas ou gouvernements tirés de differens écrivains du païs en Faisabad en MDCCLXX*. Each of twenty-one map folios of

85. Brohier, *Land, Maps and Surveys*, 2:192 (note 83).

86. Robert Knox, *An Historical Relation of the Island Ceylon, in the East-Indies: Together, with an Account of the Detaining in Captivity the Author and Divers Other Englishmen Now Living There, and of the Author's Miraculous Escape* (London: Richard Chiswell, 1681).

87. Phillimore, "Three Indian Maps," 113 and appendix map 2 (note 33).

88. Phillimore, "Three Indian Maps," 113 (note 33).

89. Gole, *Indian Maps and Plans*, 112–13 and 136 (note 1).

90. For further details, see the introductory chapter to South Asian cartography, pp. 324–25 and corresponding note.

91. This album is now in London, Victoria and Albert Museum, Indian collections, cat. no. 89.

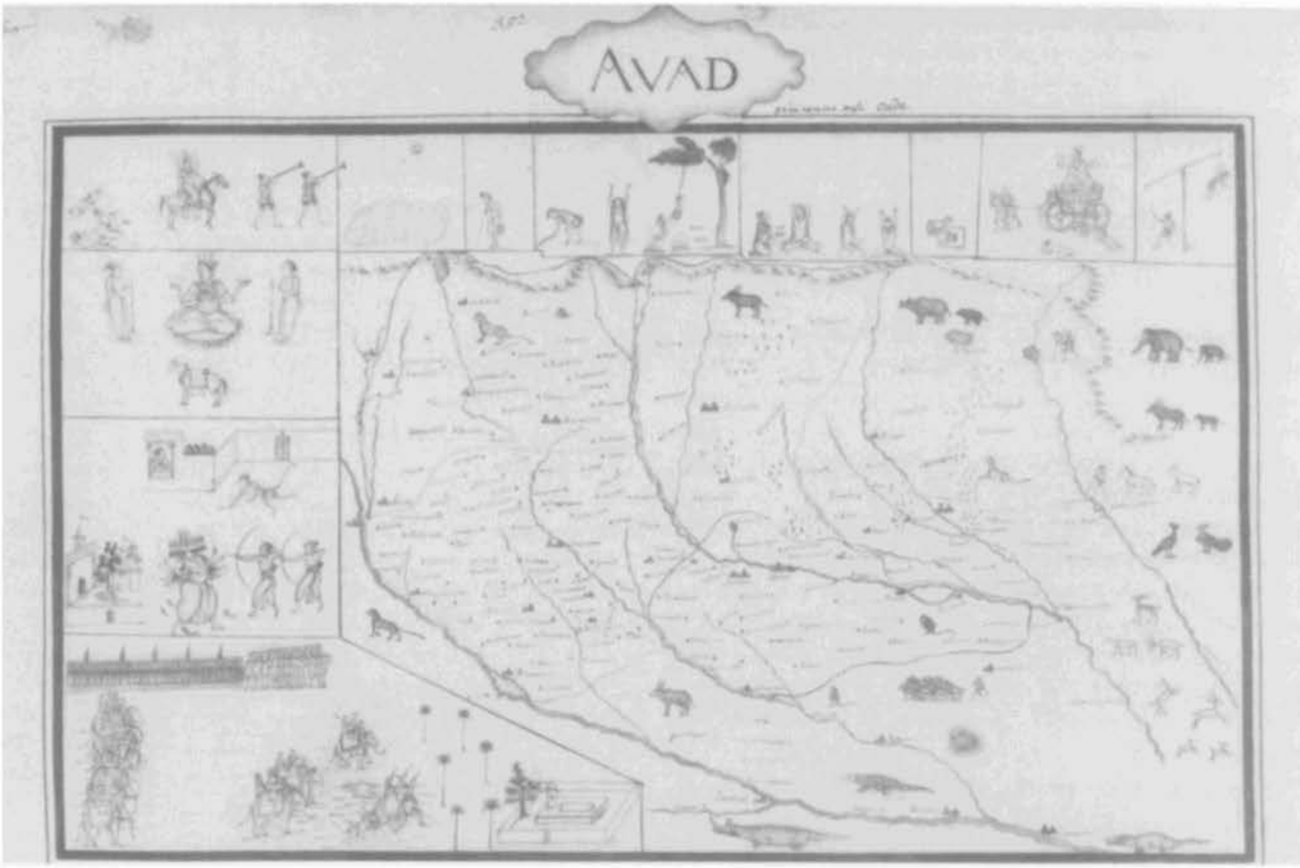


FIG. 17.25. THE ṢUBĀ OF AVAD (OUDH) AS PORTRAYED IN GENTIL'S ATLAS OF THE MUGHAL EMPIRE. This map is watercolor and ink on paper, drawn in Faizabad in 1770. It is one of a set of regional maps drawn by Indian artists for Colonel Gentil and then assembled in an atlas covering all of India. These maps are of interest not only for the depth of their detail (surpassing that of wholly European maps of the same period), but also for the accompanying regionally specific diagrams, which offer glimpses of the Indian life of Gentil's era. Size of the original: ca. 27.3 × 45 cm. By permission of the India Office Library and Records (British Library), London (Add. MS. Or. 4039, fol. 19).

the atlas (approximately 38 × 55 cm) relates to a single *ṣūba* (province), and each is preceded by a list of the various *sarkārs* and *parganas* (successively smaller administrative units) into which the *ṣūbas* were subdivided. There is also a cover page bearing the inscription, "*Cet atlas appartient à M. Gentil l'indien*," along with Gentil's Persian seal.[92] The maps were compiled mainly from literary sources, principally Abū al-Faẕl's *Āʾīn-i Akbarī* (Institutions of Akbar), rather than from surveys. The names of some of the Indian artists, including Niwasi Lal and Mohan Singh, both presumably Hindus, are known.[93] Two manuscript copies of Gentil's atlas are known to exist: his personal copy and a second, made after his return to France and presented to the king for the royal library. The latter lacks a title page and has none of the drawings that embellish the original. An annotated edition of the twenty-one map folios of Gentil's personal copy of the atlas, reproduced at a slightly reduced size and with introductory commentary, has been brought out by Gole.[94]

The scale, accuracy, and orientation of the Gentil maps differ substantially from sheet to sheet. Detailed study of the entire work is needed to ascertain fully its varying quality and its internal consistency, especially along the boundaries between *ṣūbas*, which, as Gole has indicated, often do not fit together well. Figure 17.25 represents the *ṣūba* of Avad (Oudh), of which Gentil had extensive

92. Mildred Archer, "Colonel Gentil's Atlas: An Early Series of Company Drawings," in *India Office Library and Records: Report for the Year 1978* (London: Foreign and Commonwealth Office, 1979): 41–45, esp. 41.

93. *The Indian Heritage: Court Life and Arts under Mughal Rule*, catalog of exhibit at Victoria and Albert Museum, 21 April–22 August 1982 (London: Victoria and Albert Museum and Herbert Press, 1982), 49.

94. Susan Gole, ed., *Maps of Mughal India: Drawn by Colonel Jean-Baptiste-Joseph Gentil, Agent for the French Government to the Court of Shuja-ud-daula at Faizabad, in 1770* (New Delhi: Manohar, 1988). Gentil's personal copy is in London, India Office Library and Records, Prints and Drawing Section, Add. MS. Or. 4039; the second copy, in the Bibliothèque Nationale, Paris, is cataloged as FR 24,217.

personal knowledge. All sheets, however, would compare favorably in accuracy with most of the indigenous topographic maps I have discussed, with European maps of the interiors of South Asia made before 1770, and even with many interior portions of Rennell's maps of India up to the year 1793. It is probable that Gentil relied heavily on Jean-Baptiste Bourguignon d'Anville's four-sheet map of India drawn in 1752 for his coastline and for some interior detail as well. Although both left certain lacunae in their portrayal of the more remote regions of India, the gaps were much less extensive in Gentil's coverage than in d'Anville's. It seems clear that Gentil supplemented the detailed knowledge derived from the *Ā'īn-i Akbarī* with information from numerous other sources, both indigenous and European (e.g., the Jesuit missionary to India Joseph Tieffenthaler).

There is no evidence that Rennell was aware of Gentil's atlas while he was preparing his own maps of India and various regions of that country. There is certainly no mention of it in his *Memoir of a Map of Hindoostan*. To what extent he might have placed faith in Gentil's work and altered his own maps accordingly, had he known of the atlas, is an interesting matter for speculation.

The conventions of the Gentil atlas are highly standardized and easy to interpret even without a legend. Rivers are shown in varying widths by single lines or multiple parallel lines in black ink, with yellow watercolor filling in the width of those shown by more than a single line. Lakes are also outlined in black, emphasized by closely spaced horizontal lines and colored yellow. Mountains and hills are shown naturalistically, in frontal perspective, as if seen from adjacent lowlands, though their placement is frequently very inaccurate. They are outlined and partially shaded in black ink and painted in mauve watercolor. Escarpments are similarly shown, but with vertical hatching extending down from a line at the top of the escarpment. Settlements, all in black, appear to be grouped in several hierarchical categories. The larger ones comprise aggregates of adjacent squares, while the lowest order is most frequently shown by small circles with a small vertical stroke at the top, though this last symbol does vary somewhat from map to map. Forests are selectively represented by simple vertical tree symbols. Boundaries are generally shown by black dotted lines, emphasized by thin watercolor bands in yellow, red, or violet. The rationale for the choice of colors is not readily apparent. Conspicuously missing on all but one or two sheets of the atlas is any representation of roads or of distances between settlements. Nor does any sheet include an explicit indication of scale. Most are oriented to the north, but there are a number of exceptions. On some sheets the sides are labeled *nord*, *sud*, *est*, and *ouest*.

For historians and historical geographers, much of the interest of Gentil atlas will be in its marginal illustrations.

> The maps in Gentil's personal copy of the atlas . . . are decorated with subjects that relate to the various parts of the Mughal empire. Shahjehanabad (or Delhi), for example, includes the royal insignia of the Mughal Emperor, his throne, howdah, flags and jewels. The map of Gujarat includes a painting of the Somnath temple; the desert of Ajmer is enlivened with camels, water-melons and a sarus crane. Warlike Malwa is embellished with armed elephants, horses and soldiers, Bihar with the Baijnath and Gaya temples, Kashmir with dancing-girls, Bidar with examples of Bidri ware [vessels inlaid with silver or brass], Aurangabad with the Ellora Caves and a procession of Maratha horsemen. Each map incorporates drawings depicting the costume of the region, local trades and occupations, religious festivals, ascetics, birds, animals and plants.[95]

From an art historian's perpective, the Gentil atlas is noteworthy for initiating what has come to be known as the "Company style" of drawing, for it was shortly imitated in Lucknow, after Oudh came under the protection of the British in 1775, and elsewhere by numerous other Indian artists in the employ of the British East India Company. It is significant, says Archer, "that in Gentil's atlas, subjects which were later to become the stock-in-trade of 'Company' painters were already present in miniature form."[96] Among the Company style of drawings one finds occasional architectural plans, a few of which I shall consider below.

LATE EIGHTEENTH- AND NINETEENTH-CENTURY NEPALI MAPS

Francis Wilford's description of a large Nepalese map that was presented to Warren Hastings, who served as governor of Bengal from 1772 to 1774 and then as governor general of India until 1787, was cited above. Regrettably, that wholly traditional work, which Wilford found quite accurate for the Vale of Kathmandu, no longer survives. A substantial number of other premodern Nepali maps do survive, however, including some that cover fairly extensive areas and others that relate to relatively small localities, and written testimony informs us of still others that cannot now be traced. Not surprisingly, given Nepal's situation between India and Tibet and the cultural diversity of its peoples, many of its maps are hybrid in style. Those that appear to be closer to or wholly within the Tibetan cartographic tradition are discussed elsewhere.[97] The rest are discussed along with

95. Archer, "Colonel Gentil's Atlas," 43 and 45 (note 92).
96. Archer, "Colonel Gentil's Atlas," 45 (note 92).
97. See *History of Cartography*, volume 2, book 2, forthcoming.

other maps from South Asia. Within the latter group, the surviving maps that might be considered, in a broad sense, as topographic all appear to be influenced in varying degrees by Nepali contacts with the British and other Europeans who resided for a time in Nepal. Nevertheless, they retain enough of an indigenous flavor to warrant inclusion in this section.

The Nepali geographer Harka Gurung provides us with a richly illustrated monograph, *Maps of Nepal*, that, though dealing primarily with modern works, contains a useful, if not quite complete, account of pre-twentieth-century cartography.[98] That chapter begins as follows:

> When the Newar king Jayasthiti Malla (1382–1395) first introduced [the] caste system in [the] Kathmandu Valley, the people were categorised into 64 castes or rather sub-castes according to their traditional occupation. It is interesting to note that one of the castes then recognised was of Kschetrakara or "land measurer" which in modern parlance may be termed as "surveyor." We know not whatever happened to this caste group related to geographers since it does not appear in modern surnames. There is however another current Newar caste known as Dangol which Petech interprets as "measurer of land." Whether these traditional caste groups were engaged merely in cadastral work or drew other maps is a matter of conjecture. That there was some tradition of map-making in Nepal is suggested by a distant evidence. This refers to the authority of Tsio Ying-k'i, a Chinese officer who participated in the 1720 campaign of Tibet and reported in a Chinese geography of Tibet that in 1734, the Malla King of Bhaktapur sent to the Chinese emperor a letter and some presents. Among the presents were included a geographical map of Ngo-na-k' e-t'e-k'e (India) and Pa-eul-po (Nepal).[99]

Whether Johan Grueber, who visited Kathmandu as early as 1661, or other seventeenth-century Jesuit missionaries ever saw Nepali maps is uncertain; but the accounts they were able to piece together with Nepali and Tibetan assistance formed the basis for some of the earliest European cartographic depictions of that country. Thereafter the map described by Wilford is the first unambiguous Western reference to Nepali cartography. Among early British visitors to Nepal who produced maps of their own were William Kirkpatrick (route survey in 1793), Charles Crawford (route surveys in 1802 and 1805), and Francis Hamilton (born Buchanan) (fourteen-month sojourn in 1802–3). It is not known whether Kirkpatrick and Crawford saw any indigenous maps, but it was said that Hamilton "obtained five native maps of parts of Nepal and Sikkim, which he deposited in the library of the East India Company."[100] Two of these maps, one made by a lama (Tibetan monk) and another by a Kirat, a member of an ethnic group of eastern Nepal, were presumably more Tibetan than Indian in style. The others, however, judging from the names and ethnic affiliations of their makers, were quite likely of a different type. Hamilton reports employing "a slave of the Raja of Gorkhav . . . to construct a map" and says that this slave, who was "very intelligent, and a great traveller . . . [in] order . . . to execute this with more care . . . refreshed his memory by several journies in different directions."[101] He does not mention training the slave. Of this map and the two previously cited, Hamilton states:

> as might be expected, [they] are very rude, and differ in several points; but they coincide in a great many more, so as to give considerable authority to their general structure; and, by a careful examination of the whole, many differences, apparently considerable, may be reconciled.[102]

Writing of the country between the Vale of Kathmandu and the river Kali on what is now Nepal's western border, Hamilton says that his account is based on two maps

> prepared by Sadhu Ram and Kanak Nidhi, with the assistance of Kamal Lochan, one of the natives attached to the survey of Bengal, on which I was engaged. Although they differ in some points, they agree in so many more, especially in the eastern parts, that considerable reliance may be placed on their giving some tolerable idea of the country.[103]

Finally, the account notes:

> A map of the western parts of the dominions of Gorkha . . . was composed by Hariballabh [a Brahman

98. Harka Gurung, *Maps of Nepal: Inventory and Evaluation* (Bangkok: White Orchid Press, 1983), 5–22. L. Boulnois, *Bibliographie du Népal*, vol. 3, *Sciences naturelles*, bk. 1, *Cartes du Népal dans les bibliothèques de Paris et de Londres* (Paris: Editions du Centre National de la Recherche Scientifique, 1973), should also be consulted. Although the catalog of maps it contains is exclusively of modern works, the "Aperçu historique sur les cartes européennes du Népal" (pp. 13–41) provides useful background on the ways the early Jesuits and later Europeans made use of Nepalis and Tibetans in producing their own maps.

99. Gurung, *Maps of Nepal*, 7 (note 98). I have omitted from this quotation Gurung's notes to the following: Luciano Petech, *Mediaeval History of Nepal (ca. 750–1480)*, Serie Orientale Roma 10 (Rome: Istituto Italiano per il Medio ed Estremo Oriente, 1958), 182 and 188; and L. Boulnois, personal communication, 2 March 1981.

100. Clements R. Markham, ed., *Narratives of the Mission of George Bogle to Tibet and of the Journey of Thomas Manning to Lhasa*, Bibliotheca Himalayica, ser. 1, vol. 6 (1876; reprinted New Delhi: Mañjuśrī Publishing House, 1971), cxxxi. In fact, Hamilton's account specifies no fewer than seven maps, though not all of them may have been deposited with the India Office; see Francis Buchanan Hamilton, *An Account of the Kingdom of Nepal and of the Territories Annexed to This Dominion by the House of Gorkha*, Bibliotheca Himalayica, ser. 1, vol. 10 (first published 1819; reprinted New Delhi: Mañjuśrī, 1971), 1–5.

101. Hamilton, *Account of the Kingdom of Nepal*, 2 (note 100).

102. Hamilton, *Account of the Kingdom of Nepal*, 3 (note 100).

103. Hamilton, *Account of the Kingdom of Nepal*, 4 (note 100).

from Kumaun, now in India, but part of Nepal from 1790 to 1815], with the assistance of Kamal Lochan. The same person gave me another map explaining the country, which extends some way west from the Sutluj [the river whose left bank marked the high-water mark of Nepali expansion].[104]

The need for maps for political and military intelligence during this early period of British contact with Nepal was not felt by the British alone. Gurung cites a letter, dated Vikram 1864 (A.D. 1807), from the then ruler of Nepal, Bahādur Sah, ordering payment of 325 rupees to Kesav Gurung, a relative of the Nepali commander on the western front in 1806, "as a reward for drawing a map of Kangra," now in the Indian state of Himachal Pradesh, toward which Nepal had launched an abortive military campaign.[105]

The earliest of the surviving Nepali maps are those of the Hodgson collection presented to the India Office Library and Records, London, in 1864. These were collected or, in large part, commissioned by Brian Houghton Hodgson, who lived in Nepal from the time of his appointment as assistant resident in 1820 until 1844, being promoted to acting resident in 1829 and resident in 1833. "Hodgson was an indefatigable collector, and wrote voluminously on all matters connected with Nepāl."[106] Although the portion of his vast collection of papers that is in English has been reasonably well studied and was cataloged in 1927, the portion in Nepali and other indigenous languages has yet to receive similar treatment.[107]

The several dozen vernacular maps in the Hodgson collection, though diverse in the matters they relate to, are alike in several particulars: all are drawn in either pencil or ink or both on paper; all, or virtually all, are crudely executed; and all presumably date from Hodgson's years in Nepal. In size, they fall within a fairly narrow range, being drawn on pages varying in height from approximately nineteen to forty-five centimeters and in width from sixteen to fifty-eight centimeters. However, several maps comprise two or more pages pasted together or drawn with a view to being joined later. The principal differences among the maps are summarized in appendix 17.2. For the sake of completeness, I have included in this appendix some maps that were almost certainly drawn or annotated by non-Nepalis, judging from the languages used, which in a number of instances were either Tibetan or Persian or both. To what degree the English patronage and other foreign influences—especially those of *dobāshīs* (translators) and clerical staff in the employ of the English—might have shaped the style of the maps cannot yet be stated with certainty. Some *dobāshīs* may well have been Nepalis educated during a period of British military service. It seems, however, that many of the maps are sufficiently distinctive and traditional to warrant brief consideration here.

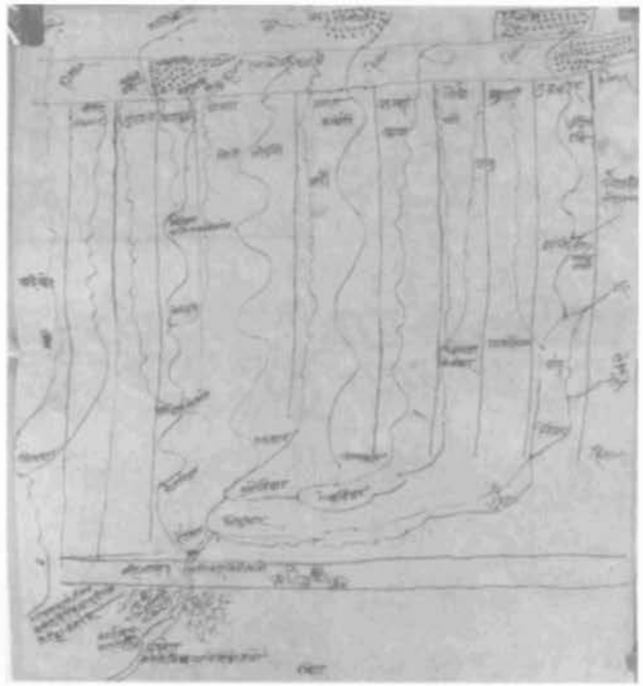


FIG. 17.26. CENTRAL NEPAL. This map covers an area of roughly 250 miles east-west and 70 miles north-south between the Himalayas and the Mahabharat Lekh, a range of hills bordering the North Indian Plain. It is ink on paper, from Nepal, ca. 1835–40.
Size of the original: 42 × 38 cm. By permission of the India Office Library and Records (British Library), London (Hodgson MS., vol. 56, fols. 59–60).

I have chosen to illustrate only two maps from the Hodgson collection. The first, figure 17.26, is an ink sketch that covers a rather extensive area of Nepal from just west of Kathmandu westward roughly 250 miles to the Karnali River valley and from the Himalayas, marked by a pair of horizontal lines near the top of the map, to the Mahabharat range, marked by another such pair of

104. Hamilton, *Account of the Kingdom of Nepal*, 5 (note 100).

105. Gurung, *Maps of Nepal*, 9 (note 98). For details of Nepali expansion in the late eighteenth and early nineteenth centuries and the Anglo-Nepali wars of 1815 and 1816, see Joseph E. Schwartzberg, ed., *A Historical Atlas of South Asia* (Chicago: University of Chicago Press, 1978), pl. VII.A.2, esp. map d, and text on p. 212.

106. George Rusby Kaye and Edward Hamilton Johnson, *India Office Library, Catalogue of Manuscripts in European Languages*, vol. 2, pt. 2, *Minor Collections and Miscellaneous Manuscripts* (London: India Office, 1937), 1063–64. It is interesting that Gurung makes no mention of the Hodgson papers, nor does he note the map cited by Wilkins and several other Nepali maps that I shall be discussing.

107. For the observations that follow on the maps in the Hodgson Collection, I am grateful for the assistance of Michael Hutt of the School of Oriental and African Studies, University of London, who has prepared a preliminary, as yet unpublished, catalog of the Nepali materials. Additional assistance was rendered by Champaka Prasad Pokharel, a graduate student at the University of Minnesota, Minneapolis.

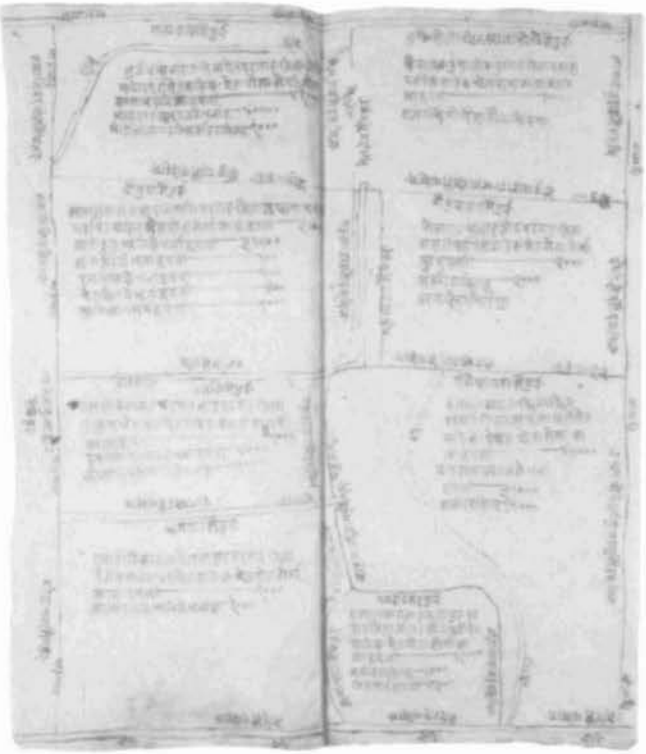


FIG. 17.27. ADMINISTRATIVE/CADASTRAL MAP OF A PORTION OF WESTERN NEPAL. This map shows the boundaries of administrative districts, names their governors, states the sources of revenue to be collected in each district, and notes the authorities to whom that revenue is to be distributed. It is ink on paper, from Nepal, ca. 1830–40.
Size of the original: 56 × 48 cm. By permission of the India Office Library and Records (British Library), London (Hodgson MS., vol. 59, fols. 25–26).

lines near the bottom. As the true north-south distance between the two named ranges averages only about 70 miles, and since the map area between them is roughly square, the east-west scale on this map is compressed to less than a third of that from north to south. This accounts for the narrow named regions between the mountain spurs indicated by straight vertical lines extending south from the Himalayas. Also named on the map are the rivers between these mountain spurs, the Gandak (here called the Saligrama) being most prominent. Among the features of the map that suggest its traditional concerns are the prominence given to Latarameswar temple near the southwest corner, not far from the place where the Gandak enters the Tarai Plain, and to the sacred Gosain Lake near Kathmandu on the east, and the seemingly de rigueur inclusion of Lhasa, plotted incorrectly nearly four hundred miles to the southwest of its true position and shown by the rectangle near the upper right corner of the map. The floral embellishment midway across the Mahabharat range provides another interesting map element whose significance is problematic.

Figure 17.27, the second example from the Hodgson papers, is one of a series of cadastral maps (fols. 25–50) extending from west to east across the whole of Nepal. In each map is indicated a number of *zillas* (districts), and within each *zilla* there is a rough indication of the amount of land revenue the area was responsible for. The revenue figures are broken down according to source (e.g., taxes on rice land, taxes on other lands, labor to be performed in lieu of taxes), and intended recipient (e.g., local governors, royal treasury). Additional topographic information (e.g., rivers, mountain crests) seems to be kept to a minimum, being provided only where it helps establish a *zilla* boundary. Along the district boundaries are notes stating the names of the adjacent districts in each direction. Curiously, the name of a particular district does not appear within the boundaries of the district itself but must be inferred from the notes along the boundaries of neighboring districts.

The series is thought to date from either the 1830s or the early 1840s. An interesting feature of this set of maps is that folios 25–40 and 49–50 are oriented with north at the top, whereas folios 41–48, beginning with the sheet for Kathmandu and proceeding eastward, are oriented toward the east. Another point of inconsistency within this series is that folios 38–40 are in Persian rather than Nepali. This suggests that the series was made at the behest of the British and was drawn up by an ethnically mixed staff of employees; any work commissioned by the Nepali government for its own use would surely have been entirely in the Nepali language. There seems to be little attempt in the series to maintain a constant scale or any high degree of planimetric fidelity. Whether the series covers all of the higher Himalayan regions of Nepal or of the southern lowland Tarai fringe has not been determined.

Gurung's monograph notes only two surviving nineteenth-century maps that remain in Nepal. One, a *pouba* (scroll painting) in the National Museum of Nepal, Kathmandu, covers an attenuated east-west tract in southeastern Nepal as indicated on figure 17.7. The map, measuring 84 centimeters from north to south and 495 centimeters from east to west, is beautifully illustrated in color on six successive pages of *Maps of Nepal*.[108] The enlarged detail in figure 17.28, whose precise locality I have not ascertained, represents less than 1 percent of this very detailed and attractive work. The map is said to have been begun on a Nepali date corresponding to February 1860. There is no indication of when it was finished. Gurung describes the *pouba* as follows:

> The map covers parts of [the] Mahabharat Lekh,

108. Gurung, *Maps of Nepal*, 10–15 (note 98). Although the reproduction is quite clear, all six pages are reversed (left to right) owing to a printing error.

FIG. 17.28. EXCERPTS FROM TOPOGRAPHIC MAP OF SOUTHEASTERN NEPAL. These are small portions of a long scroll map, begun in 1860, that is painted on paper and backed with cloth. The detail on the right shows the artist's meticulous attention to detail. For the area of coverage of the inclusive work, see figure 17.7.
Size of the entire scroll: 84 × 495 cm. From Harka Gurung, *Maps of Nepal: Inventory and Evaluation* (Bangkok: White Orchid Press, 1983), figs. 3 and 4. By permission of the National Museum of Nepal, Kathmandu.

> Chure range and Tarai tract between Hetauda and Morang. Forest areas are shown with trees in green, rivers in blue with their names at the lower margin. Routes are shown in red with staging-points and other cultural features such as settlements, [and] religious sites and forts are pictorially represented in black and white.... [Despite] the basic structure of a macro ground plan, the hills are drawn in profile while natural features like trees and all cultural features are drawn in terrestrial perspective. The composite mosaic of individually painted trees gives an impression of dense forest both in the hills and Tarai wherein settlements and cultivated areas appear as discontinuous pockets. The Tarai landscape is well-distinguished between forest area and grassland east of the Kosi River. Although houses both in the hills and plain are given in a uniform symbol of a single-storeyed hut to represent settlements, fort representation is more realistic and individualistic. For example, Makwanpur has separate complexes of a walled fort and another walled camp, Udayapur has [a] quadrate-cross plan while Hariharpur, Chaudandi, Sanguri and Bijayapur all have a hexagonal plan. Such details regarding fortifications and reference to mileage between staging-points suggest that the map was prepared for military purposes.[109]

All in all, though not yet a modern work, this map clearly appears to have been strongly influenced by Nepali contacts with the British, which by 1860 had become quite close.

The one remaining nineteenth-century map described by Gurung is a rectangular (92 × 118 cm), multicolored map of Patan district in the Vale of Kathmandu. It has been designated "Kathmandu no. 57" and may thus be the sole surviving example of a map series—not necessarily finished—of the period about 1879–84 when it was made. Although the map bears a square grid and includes compass rose, scale, legend box, and ruled borders, "the representation of elements in the landscape is of traditional style and perspective."[110] For example, hills are shown in frontal perspective, and their summits generally point away from the observer as on all the traditional maps I have examined for the Vale of Kashmir. The orientation of the map as a whole, however, is to the north, as it is for the *pouba* map previously described. The map

109. Gurung, *Maps of Nepal*, 9 (note 98).

110. Gurung, *Maps of Nepal*, 9 and 16 (note 98).

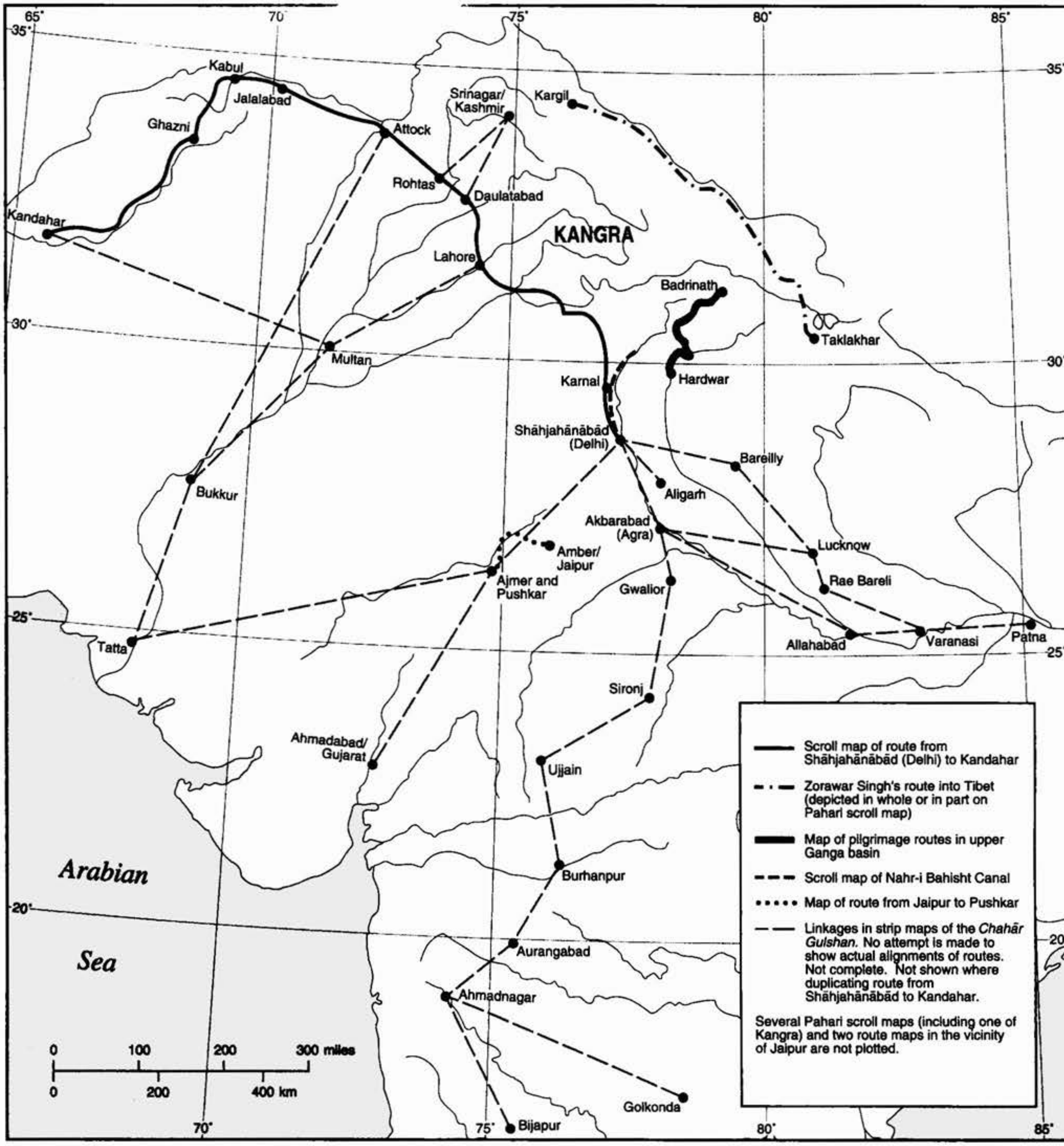


FIG. 17.29. ROUTES DEPICTED ON SELECTED SOUTH ASIAN ROUTE MAPS.

is at a rather large scale—probably averaging between 1:15,000 and 1:20,000—and quite detailed, covering an area not larger than several hundred square kilometers.

Finally, let me note the map illustrated by Sylvain Lévi in his classic work, *Le Népal*. Although described by Lévi as "une carte indigène"—and thereby used by him to raise some rhetorical questions about Nepali cartography—this map, like the two previously discussed, is obviously an eclectic production.[111] Quite likely it was made expressly for a Mr. Minayeff, professor of Sanskrit at the University of Saint Petersburg, who visited Nepal in 1875 and there collected a large number of manuscripts.[112] It was Minayeff who turned the map over to Lévi. The map covers

111. Sylvain Lévi, *Le Népal: Etude historique d'un royaume Hindou*, 3 vols. (Paris: Ernest Leroux, 1905–8), 1:72 and map on facing page.

112. Lévi, *Le Népal*, 1:144 (note 111).

the whole of the Vale of Kathmandu (see fig. 17.7), but nothing beyond the Vale. It is a moderately detailed production showing the principal settlements by neatly drawn circles, several rivers by bands of varying widths, roads by thin lines (with what appear to be distance markers alongside them), and a variety of major government buildings, temples, bazaars, and so forth. The mountain crest surrounding the Vale is rendered in a fashion that one might have found on some nineteenth-century European maps. Lévi offers no verbal description or explanation of the map, but he does provide a numbered transparent paper overlay and a key to forty-one mapped features.

Route Maps

Under the designation "route maps" I here consider a variety of geographical maps, most of which are in strip form. Such maps relate not only to roads but also, in a few cases, to canals and river courses. Only maps whose coverage extends beyond a small locality (e.g., a single street of a city) are discussed in this section. The routes depicted on some of these maps are shown on figure 17.29.

Among the surviving route maps, the most wide ranging constitute a collection in a work entitled the *Chahār Gulshan* (Four Gardens, also *Chitr Gulshan/Tārikh-i Nīk Gulshan*); several manuscript copies are known to exist in various libraries and museums. The text is a "compendium of Indian history and geography, originally compiled by Ray Chaturman Kāyat'h in 1173/1759–60," rearranged and edited by his grandson in 1789, and written in Persian in the Nastaliq script.[113] The author's name indicates that he was a Hindu of the scribal caste of Kayasthas; many of them found employment in the administrative services of the Muslim rulers of India and not a few, incidentally, have become cartographers since India gained its independence in 1947.[114] According to Gole, who illustrates and provides a detailed account of the contents of all twelve map pages of the Aligarh manuscript, "the topographical notices were mainly taken from the *A'in-i Akbari* [Institutions of Akbar], with additional information from other works."[115] Figure 17.30 depicts folio 104r, of the 1825 transcription of the manuscript in the National Museum in New Delhi along with a translation of the information on the original. The simplified rendition of many routes covered, as shown in figure 17.29, is also taken from that manuscript, whose pagination differs from that in Aligarh.

The cartographic signs of the *Chahār Gulshan*, though simply rendered, seem sufficient to satisfy the main purpose of the text—to provide a general sense of the places and obstacles (mountain ranges and rivers) along various overland itineraries. The manner of presentation is essen-

FIG. 17.30. A PAGE FROM THE *CHAHĀR GULSHAN*. This is an encyclopedic work on paper originally composed in 1759–60. It names and notes the relative importance of stages along several routes in the Deccan and shows rivers and hill ranges to be crossed. The terminal points along some of the routes are shown in figure 17.29. However, none of the places named in the lower half of the right-hand column could be located on a modern map.
Size of the original: 34.6 × 17.3 cm. By permission of the National Museum, New Delhi (MS. 688, fol. 104r).

113. M. H. Razvi and M. H. Qaisar Amrohvi, comps., *Catalogue of Manuscripts in the Maulana Azad Library, Aligarh Muslim University*, vol. 1, pt. 2 (Aligarh: Maulana Azad Library, Aligarh Muslim University, 1985), 252–53. I thank Irfan Habib for bringing this manuscript to my attention.

114. A member of this caste who worked for me over a period of years was the first of many from that group from a single village in Uttar Pradesh who have joined Indian government service as cartographers since about 1953.

115. Gole, *Indian Maps and Plans*, 91–93, esp. 91 (note 1).

tially that of the strip maps that various automobile clubs provide their members for planning and executing specified point-to-point journeys. Occasionally two alternative routes between points are noted. Here and there certain folios give special prominence to important features or places (as in the separate side-by-side designations of the city and fort of Ahmadnagar in the right-hand column of fig. 17.30). On at least five folios there are also lists of distances in *kos* from one important place to a number of others even when the road itineraries are not provided. The major places in question include Akbarābād (Agra), Shāhjahānābād (Delhi), Lahore, Kabul, and Multan. There are also occasional historical notes (e.g., "Aurangabad's first name was Kirkee and it is now famous as Khujastabunrad").

Much more detailed than the *Chahār Gulshan* are two route maps executed on long scrolls that relate to the itinerary from Shāhjahānābād to the Afghan city of Kandahar via Lahore and Kabul. Both are at present in the India Office Library and Records. One of the scrolls, made of cloth, is approximately twenty-five centimeters by twenty meters; the other measures about twenty centimeters by twelve meters. The former (I.0.4725) is said to have been "drawn up by Maulavī Ghulām Qādir, who accompanied [Lord Mountstuart] Elphinstone to Kandahar in 1841 [*sic*, should read 1814]"; the latter (I.0.4380), seemingly copied from the former (or vice versa), has no attribution of authorship and is dated "mid-19th century."[116] However, Gole, who has illustrated and commented at length on the entirety of the cloth scroll and also studied the other, asserts that on the basis of "internal evidence" the maps "are from an earlier period, . . . but may have been presented to Elphinstone at Kandahar, perhaps by Qulam Qadir." She concludes that "one or both of them may well have been drawn between 1770 and 1780."[117]

Plate 32 represents two small portions of the cloth scroll map and will convey some sense of the variety and detail of the features they depict: the towns, forts, and sarays along the route; notes on villages and towns that may be reached by roads branching off from the main road; the rivers, hills, and mountains it traverses and parallels; the natural vegetation close to the route and also as seen on the horizon; wayside gardens and groves; and the regularly spaced *kos minar* (stone monuments built at approximately two-mile intervals along much of the route to mark off distance). Differences in vegetation type as one moves from more to less arid regions are easily discerned, and there is also a differentiation in the ruggedness of mountainous terrain. The use of color on the scrolls shows a definite concern for convention: the walls of virtually all settlement and architectural features are in red; city gates are rendered in purple; various greens and a bit of yellow are used naturalistically to show vegetation; hills are done in a pink wash, with gray added for shading (generally seen as if illuminated from the southeast); and yellow lines along roads give them added emphasis.[118]

In a style quite different from the India Office Library and Records maps are four other scrolls from India's northern mountain rim. One of these, which I have not seen, was sold in April 1989 by the London auction house Sotheby's to a private individual. The work is painted on paper, measures 63 by 228 centimeters, and has text in the Devanagari script. The catalog description, accompanied by a photograph of a small portion of the work, reads in part as follows:

> A bird's-eye view of a Hill Fort and town, probably Kangra, showing the walls and fortifications enclosing barracks and encampments, rivers running on either side to join below the fort, the town located in two areas up the valley, showing temples, tanks and domestic buildings, hilly terrain on all sides with a few buildings and temples, Pahari, later eighteenth or early nineteenth century. . . .
>
> Indian bird's-eye views of this type are rare. Their production under both Mughal and Rajput patronage in the eighteenth and nineteenth centuries took place after the advent of European draughtsmanship and cartography.[119]

The view appears to be a longitudinal representation of an inner Himalayan valley in what is now the Indian state of Himachal Pradesh. It is conceivable that the work in question is the map of Kangra commissioned by the Nepali Bahādur Sah for the military campaign of 1806 (mentioned above), but the validity of any such surmise would hinge in part on the interpretation of the regional style of painting. The word *Pahari* (of the mountain) is not especially enlightening in this regard.

The remaining Himalayan scroll maps are now at the Bharat Kala Bhavan in Varanasi, accession numbers 6830,

116. Quotation from catalog cards in the India Office Library and Records, London.

117. Gole, *Indian Maps and Plans*, 94 (note 1). Gole's reasoning is as follows: "At the town of Patiala there is a note that it is the residence of Raja Amar Singh. The fort had been built by Amar Singh's predecessor, Ala Singh, the first raja (died 1765), and if it were to retain a name long after the death of the holder, one would expect it to be Ala Singh who was remembered. This argues in favour of the map being prepared while Amar Singh actually had his residence in Patiala, and not many years after his death. There is mention too of Burhan-ul-mulk, the first Nawab of Oudh, who lived in the first half of the 18th century. The maps cannot have been made earlier than the 1760s, because they mention so many serais that have fallen into ruin, and this must have happened during the turbulent years of the 60s."

118. In addition to the route maps discussed, there are, according to Irfan Habib of Aligarh Muslim University, additional examples in the Inayat Jang collection in the National Archives of India in New Delhi (personal communication).

119. Sotheby's, *Oriental Manuscripts and Miniatures*, catalog of sale, London, 10 April 1989, lot 94, pl. 27.

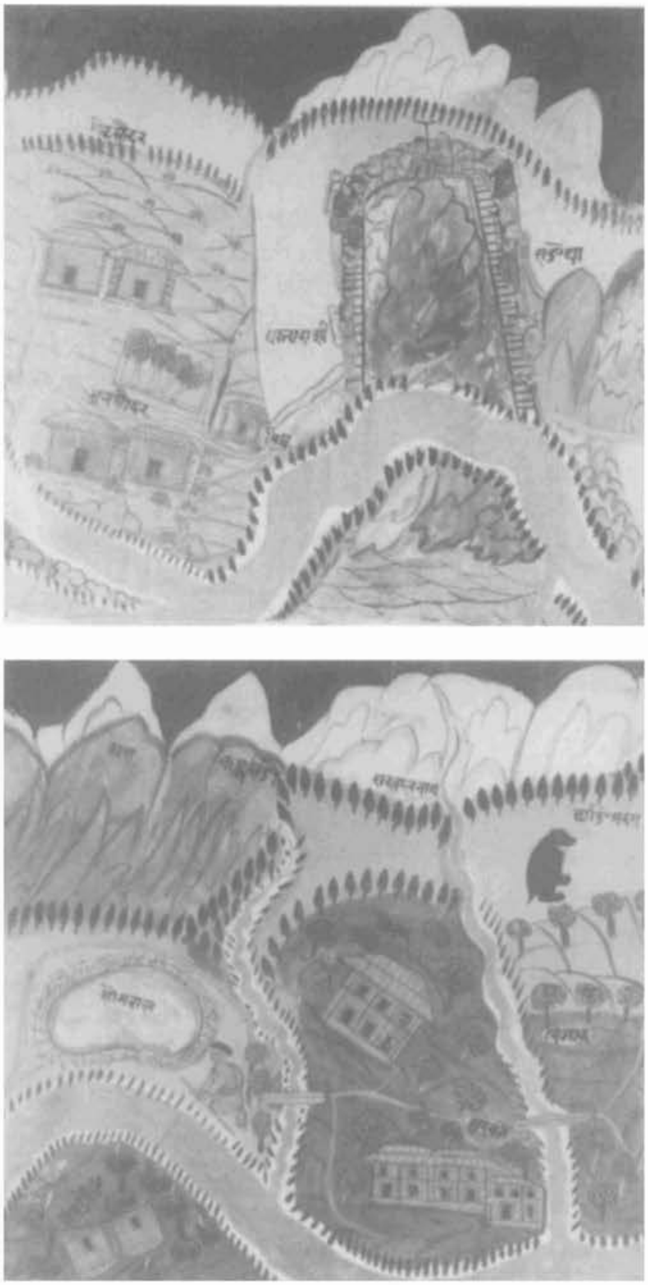


FIG. 17.31. DETAILS FROM A PAHARI SCROLL PAINTING. This mid-nineteenth-century scroll on paper depicts a route along a major river valley, possibly the Sutlej or the Beas, in what is today the Indian state of Himachal Pradesh. In the upper panel traders may be seen ascending and descending a steep mountain along the route. The lower panel shows some of the variety in the cultural landscape the route traverses. In this and other scroll paintings mountains, trees, houses, and people are shown as viewed from the central route. A single house with an accompanying name may represent an entire hamlet, several houses a village. The tame bear in the upper right is one among scores of charming touches illustrating the folkways, fauna, and flora of the region depicted.
Size of the entire scroll: ca. 55 × 600 cm, but now in many pieces. By permission of Bharat Kala Bhavan, Varanasi (acc. no. 6831).

6831, and 6832. Of these, the first relates to a military expedition of General Zorawar Singh of Bilaspur, also in Himachal Pradesh, who entered the service of the Kashmiri Dogra ruler of Jammu and in 1840 led an abortive invasion from Ladakh into Tibet. Chandramani Singh, who has written extensively on Pahari painting, says of this work:

> This scroll is a map as well as a scroll painting, full of compositions from battlefields: the army is marching in the valley, frightened *lāmās* are sitting with their folded hands in a corner, soldiers are burning the fort. Although, the battle scenes dominate the scroll, skilled artists did not miss a single chance of showing the social and religious life in that area, which is evident in the illustrations of *lāmās* worshipping in the temple, [and of] farmers ploughing their fields.[120]

Singh dates the painting about 1850, based on the date of the expedition, the artist's use of aniline dyes in his paint (introduced into India about 1825), and the styles of dress of the characters it portrays. Regrettably the map, for which Singh gives the dimensions as 51.5 by 930 cm, was improperly assembled from nine separately painted panels, so that it is now difficult if not impossible to relate the several parts of it to the terrain actually traversed by Zorawar Singh.[121] But like the painting discussed earlier, this scroll portrays a long valley, presumably that of the upper Indus, flanked on both sides by snowcapped mountains shown in frontal perspective as seen from the valley floor. Among the places named is the Ladakhi fort of Kargil. Figure 17.31 presents two small excerpts from another of the Pahari scroll paintings in the Bharat Kala Bhavan. It too shows a route along a river valley, presumably in Himachal Pradesh. The work is suffused with charming details of the bucolic outer Himalayan land-

120. Chandramani Singh, *Centres of Pahari Painting* (New Delhi: Abhinav Publications, 1981), 114–15, esp. 115, and fig. 70. See also her "Two Painted Scrolls from Bharat Kala Bhavan," *Rhythm of History* (Journal of the Institute of Post-Graduate Correspondence Studies, University of Rajasthan) 3 (1975–76): 49–52 and plate; and Gole, *Indian Maps and Plans*, 132–34 (note 1). Gole provides nine photographs of this work, and the two articles by Singh each include one.

121. Singh, "Two Painted Scrolls," 49 (note 120), and Singh, *Pahari Painting*, 115 (note 120). There seems to be considerable confusion in regard to the storage of the three paintings, each consisting of a number of panels. When I ordered a complete photograph of no. 6830 (measuring 930 × 51.5 cm according to Singh), I was sent (in twenty-six separate photographs) what appears to be, based on comparison with a photograph in Singh, "Two Painted Scrolls," complete coverage of no. 6831 (whose dimensions Singh gives as 607.5 × 55.3 cm). Similarly Gole, who also requested photographs of the campaign of Zorawar Singh, was sent another completely different set, nine photographs that were published with the appropriately skeptical heading "[March of Zorawar Singh?]" (Gole, *Indian Maps and Plans*, 132–34 [note 1]). Presumably this set represents no. 6832. The terrain depicted does not appear to be Tibetan, and none of the scenes portrays a military campaign. The area shown is probably somewhere in Himachal Pradesh.

scape and merits study for its vivid depiction of the people and settlement of the area covered. It seems likely, especially in view of the unanticipated emergence of the painting sold by Sotheby's, that new Himalayan scroll maps will come to light. Singh states that "we may assume that similar landscape maps were painted . . . for official use."[122]

FIG. 17.32. EXCERPT FROM MAP OF THE NAHR-I BAHISHT IRRIGATION CANAL. The map is Mughal, ca. 1760, painted on paper and mounted on cloth, with text in Persian. This small section of the map relates to the area not far from where the canal takes off from the Yamuna River. Distances along the canal are greatly foreshortened in comparison with those leading away from it. To the left of the canal the domed building is identified as the mausoleum of Bhu Ali Qalander, and just below it is the town of Karnal now in Haryana. Various distributaries, weirs, and a bridge (at bottom of photograph) are also depicted. Animals, fish, flowers, and trees decorate spaces for which there was no information to be plotted.
Size of the entire scroll: 1,250 × 43 cm. By permission of the Andhra Pradesh State Archives, Hyderabad. Photograph courtesy of Susan Gole, London.

A number of surviving route maps relate to engineering works. The most impressive among these was discovered by Gole in the Andhra Pradesh State Archives in Hyderabad. It relates to the Nahr-i Bahisht (Paradise) irrigation canal parallel to the Yamuna River that was originally built under the Tughluq dynasty and restored and extended by the Mughals during the first half of the seventeenth century under the supervision of the engineer ʿAlī Mardān Khān, after whom it is sometimes called. Figure 17.32 presents a view of a small portion of this very long scroll map, illustrated in full and described by Gole, beginning with the village of Benawas, near the point where the Yamuna enters the North Indian Plain, and terminating at the Mughal capital of Shāhjahānābād.[123] The map itself has not yet been dated, though that task should not prove excessively difficult in that the map provides the names of the many magnates whose palatial mansions lined the banks of the Yamuna. Gole's initial study suggests a date of about 1760. Among other noteworthy features of this richly detailed map are that it names all the towns and villages close to the canal and, in square symbols, the administrative jurisdictions each was assigned to; gives the distances of each from the canal, in oval symbols; and depicts gardens, noteworthy buildings (e.g., major mosques and mausoleums), and canal-related constructions such as residential headquarters of the canal staff and the hundreds of minor distributary canals, bridges, and Persian wheels used to lift irrigation water out of the canal. Some of the illustration is purely decorative—for example, tigers, deer, flowers, trees, and fish in the spaces along the canal or in it.

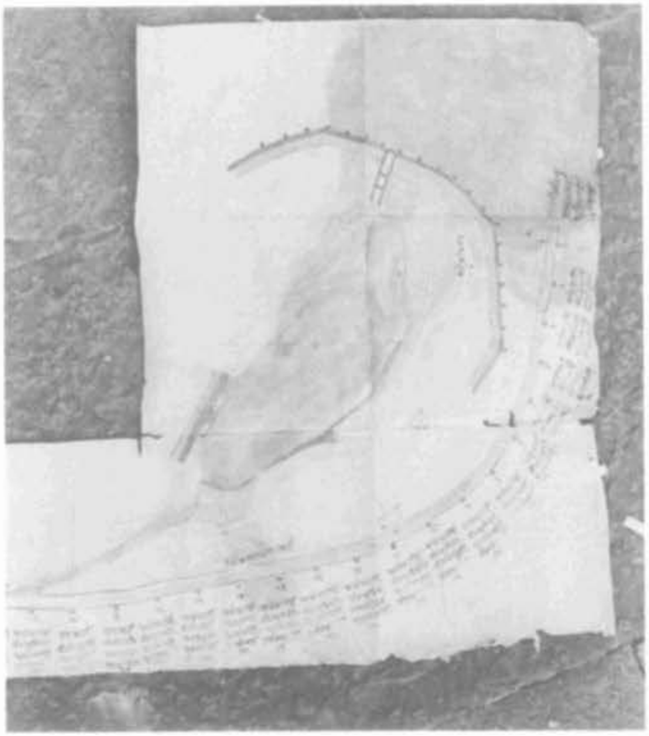
Why the map was prepared is not known. Since it postdates the seventeenth-century restoration of the canal, one might conclude that it had no relation to irrigation planning. On the other hand, since the clogging of the canal in the latter half of the eighteenth century created a need to restore it anew, it is conceivable that the map was made with such an undertaking in view. As matters turned out, however, that task was not accomplished until after the British occupation of Delhi early in the nineteenth century.

Two other eighteenth-century irrigation maps form part of the collection at the Maharaja Sawai Man Singh II Museum in Jaipur. One of these (fig. 17.33) relates to a large canal that was to bring water from a dam at Ramgarh (now in Alwar district of Rajasthan) to a reservoir near the new capital at Jaipur. Though it was never

122. Singh, "Two Painted Scrolls," 49 (note 120).
123. Gole, *Indian Maps and Plans*, 104–9 (note 1).

built, the plans for this work reveal a relatively sophisticated set of engineering specifications. Gole describes this work as follows:

a



b

FIG. 17.33. DETAILS FROM MAP OF PROPOSED CANAL IN RAJASTHAN. Although the proposed canal the map was prepared for was never built, it provides a good insight into the engineering aspects such a project would have entailed. These two details show (*a*) the dam at Bhavasagar and (*b*) a view from along the proposed canal. Gole's description (quoted in text) provides the essential details. The provenance is Jaipur, eighteenth century. The map is on paper, with text in Dhundari.
Size of the entire original: 23 × ca. 1,800 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 65). Photograph courtesy of Susan Gole, London.

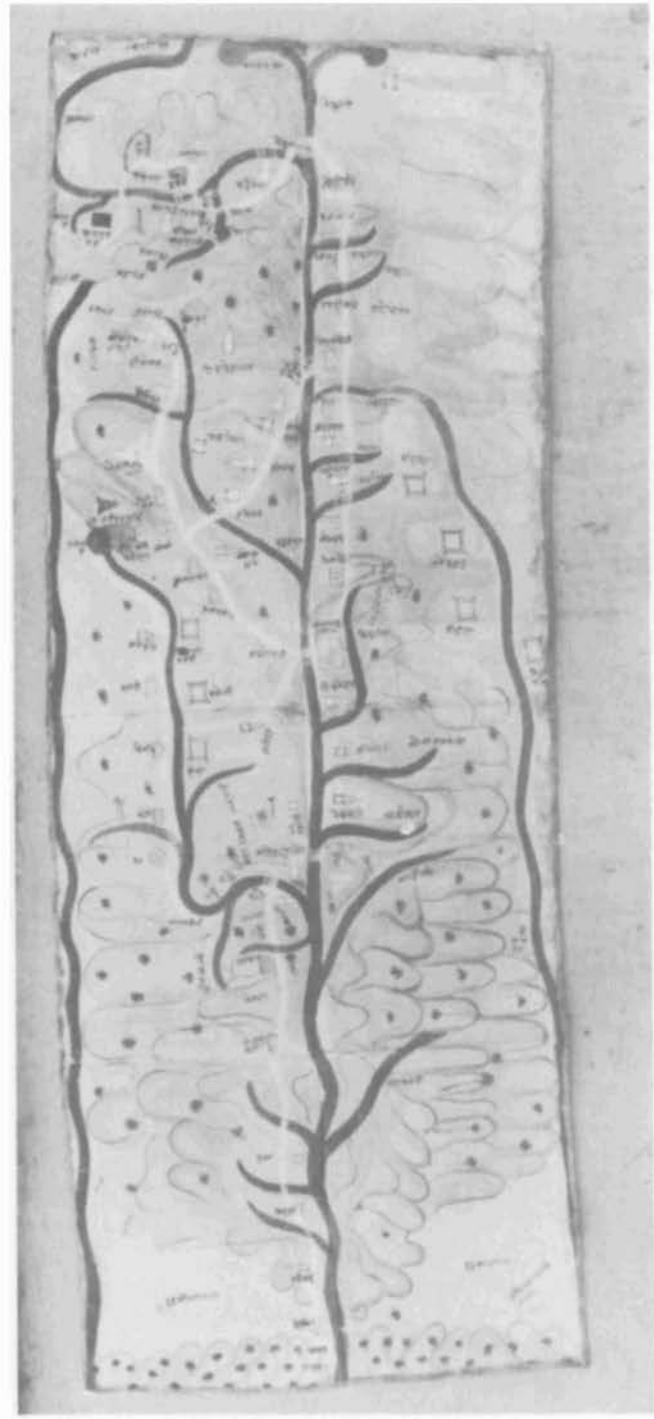


FIG. 17.34. PILGRIMAGE ROUTES ALONG THE UPPER GANGA VALLEY. This map extends from the present Indo-Tibetan frontier to where the Ganga meets the plain at Hardwar. The representation of the sacred Lake Manasarowar beyond the frontier is pro forma, since the distance of that lake from the areas depicted on the map is virtually as great as that otherwise covered by the map itself. The map, painted on paper with text in Hindi, is from Jaipur, early eighteenth century.
Size of the original: 129 × 48 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 132). Photograph courtesy of Susan Gole, London.

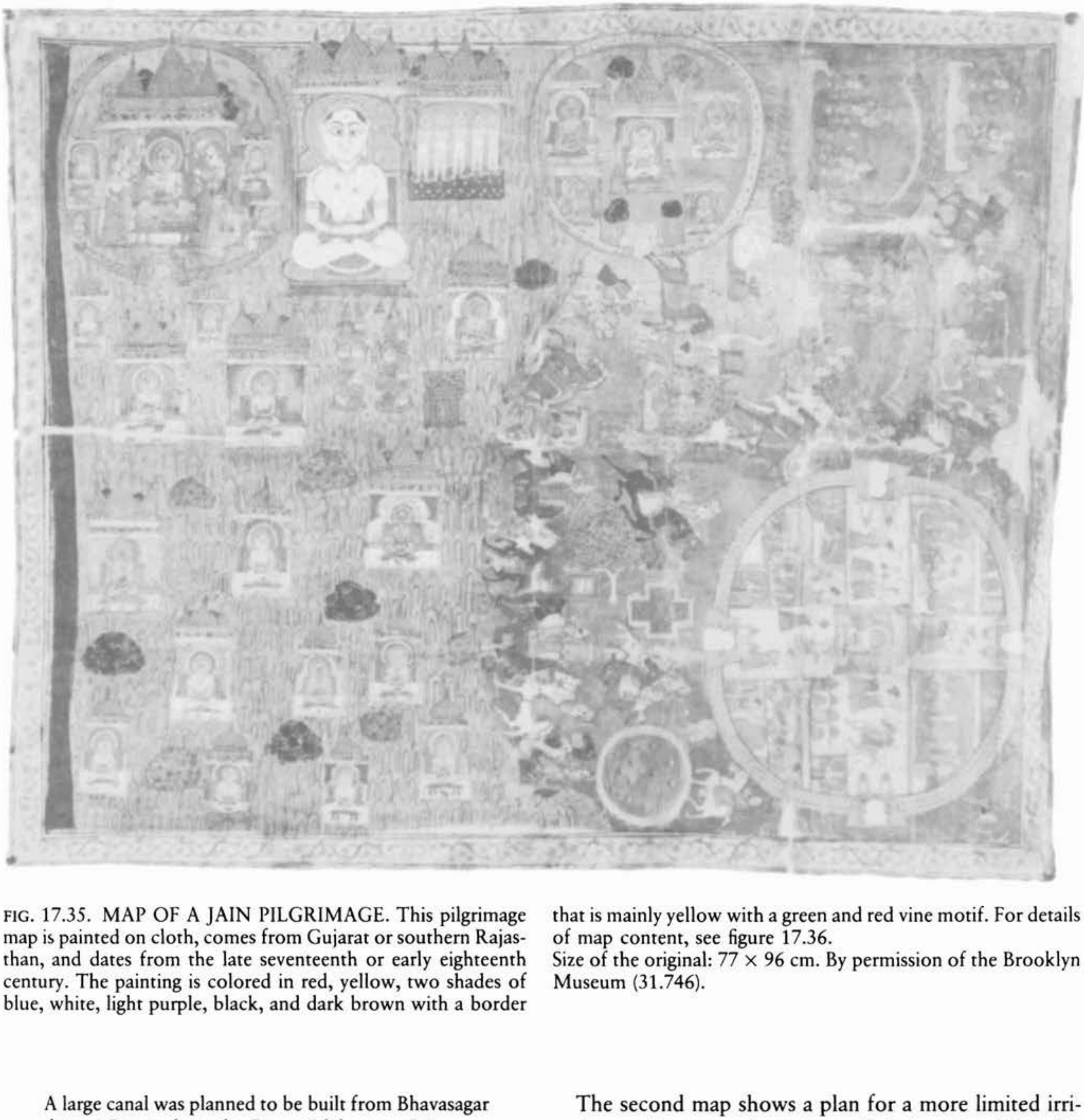


FIG. 17.35. MAP OF A JAIN PILGRIMAGE. This pilgrimage map is painted on cloth, comes from Gujarat or southern Rajasthan, and dates from the late seventeenth or early eighteenth century. The painting is colored in red, yellow, two shades of blue, white, light purple, black, and dark brown with a border that is mainly yellow with a green and red vine motif. For details of map content, see figure 17.36.
Size of the original: 77 × 96 cm. By permission of the Brooklyn Museum (31.746).

A large canal was planned to be built from Bhavasagar dam at Ramgarh to the Darwati lake near Jaipur, to bring water to the new capital of Sawai Jai Singh. It was never built, but the detailed plans for it reveal how far the project was developed.

Three thousand pillars were to be erected to carry the channel at a regular height, and the distance between the pillars is given in a textual note. Pillars at 1000 gaz [a *gaz* equals approximately one yard] intervals are shown in red, and at 100 gaz intervals in yellow. Each pillar is numbered, and the height needed to raise the water is given, mostly between four and eight gaz. Villages on either side of the canal have been shown and named, and also the hills between which the canal must pass.[124]

The second map shows a plan for a more limited irrigation project near the palace of Amber, involving the building of two dams and some associated canals. Though fairly detailed engineering specifications are noted for the dams, the map is on the whole relatively crude, perhaps intended as an initial planning aid. Apart from the features immediately associated with the irrigation works, the map shows the nearby hills, colored in mauve and covered with conventionally rendered forest symbols in green. Arguably, this large work (350 × 170 cm), covering an area approximately thirty-five kilometers from north to south, could be described as a

124. Gole, *Indian Maps and Plans*, 199 (note 1).

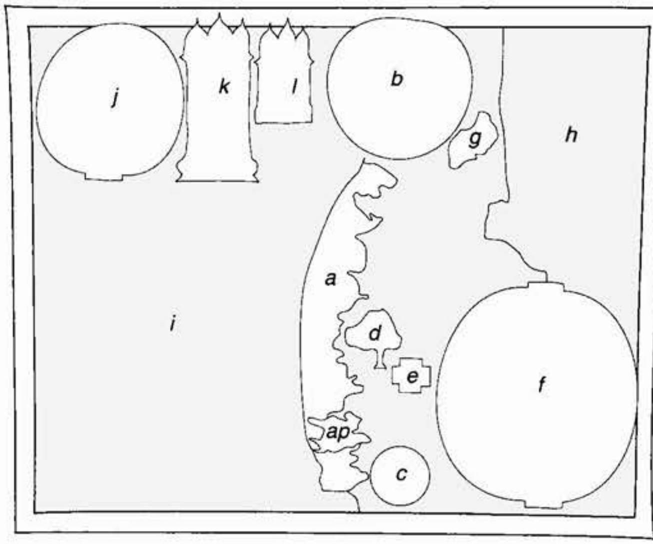


FIG. 17.36. KEY TO MAP OF JAIN PILGRIMAGE, FIGURE 17.35.

(*a*) Party of Jain pilgrims. (Actual number was probably far more than those shown here; members of party depicted in subsequent portions of route are not indicated in this key.)
(*ap*) The patron of the pilgrimage mounted on a white horse. (He appears at least nine more times in the right half of the painting and once in the upper left.)
(*b*) Group of five Jain *tīrthaṅkaras* (preceptors).
(*c*) Kuṇḍagāma, the city of birth of the *tīrthaṅkara* Mahāvīra (in Bihar).
(*d*) The tree under which Mahāvīra took *dīkṣā* (initiation).
(*e*) The *samavasaraṇa* (place of first preaching) of Mahāvīra (in Bihar). (The order of visit to *c*, *d*, and *e* is not clear.)
(*f*) Pāvā, the city of Mahāvīra's nirvana (in Bihar).
(*g*) A Jain monk preaching a sermon seated under a tree.
(*h*) Conference scene.
(*i*) Sammetaśikhara (Parasnath Peak), in Bihar, where twenty of twenty-four *tīrthaṅkaras* are said to have died; fifteen, not all individually identified, are shown, along with mang and aśoka trees and piles of pots (symbols of luck).
(*j*) Śatruñjaya (Shatrunjaya), in Gujarat, place of death of the *tīrthaṅkara* Ṛsabha (tentative identification).
(*k*) Unidentified *tīrthaṅkara*.
(*l*) Five unidentified *tīrthaṅkaras*.

topographic map rather than a route map.[125]

The Maharaja Sawai Man Singh II Museum in Jaipur also possesses several maps related to road construction, but only one of these covers a sufficiently large area to be considered here. It relates to a road from the vicinity of Jaipur to the pilgrimage town of Pushkar near the city of Ajmer, approximately 150 kilometers distant, allowing for the circuitousness of the route.[126] This map, like the second of the two Jaipuri irrigation maps I have discussed, might also be considered topographic. The remaining construction maps in the Jaipur collection, though not markedly different in style from the Jaipur-Pushkar route map, relate to rather localized areas and are therefore best treated below in the section on large-scale maps.

Also among the Jaipur holdings is a route map that was undoubtedly made to assist pilgrims to the many sacred sites along the upper Himalayan regions of the Ganga and beyond. It begins at Hardwar, where the river enters the North Indian Plain and extends to the Tibetan frontier (fig. 17.34). Details of temples, towns, villages, bridges, and fords along the route and of tributaries to be crossed appear to be rendered with some concern for fidelity to the real world; yet at the uppermost limit the Ganga is depicted in conformity with Hindu myth. Rather than showing its source just south of the Himalayan crest, the river is shown as originating in Lake Manasarowar, within Tibet and roughly 150 kilometers farther east. Paths for pilgrims to follow are shown in white, and in places alternative routes are indicated. No path is shown as traversing the Himalayan crest and going on to Lake Manasarowar, however, even though intrepid pilgrims did occasionally undertake that hazardous journey. Mountains are depicted in a highly stylized manner, with a single tree on each, to suggest that they are forest covered. Gole, who illustrates this map and provides a more detailed view of its northernmost portion, notes that "at the top an attempt has been made to correct the wrong siting of Manasarovar too far to the left, and it has been replaced to the right."[127] Although the "correction" is of course an improvement in that it situates the lake somewhat closer to its true, more easterly position, it does not seem likely that the change stems from any desire to make the map conform accurately to reality in this quarter.

The final work to be discussed under the general heading of route maps also relates to pilgrimage (fig. 17.35). It is a painting executed in Gujarat or southern Rajasthan in the late seventeenth century or, more likely, the first half of the eighteenth and is at present held by the Brooklyn Museum. The painting bears no text, and its cartographic attributes are not readily discernible. Were it not for the incisive analysis of the work by W. Norman Brown, the late doyen of American Indologists, it would not have found a place in this study.[128] The iconography

125. The map is cat. no. 75; see Gole, *Indian Maps and Plans*, 194 (note 1).

126. The map, 200 by 123 centimeters, is cat. no. 19; see Gole, *Indian Maps and Plans*, 196 (note 1).

127. Gole, *Indian Maps and Plans*, 62 (note 1); the map is cat. no. 132.

128. William Norman Brown, "A Painting of a Jaina Pilgrimage," in his *India and Indology: Selected Articles*, ed. Rosane Rocher (Delhi: Motilal Banarsidass for the American Institute of Indian Studies, 1978), 256–58 and pl. XLVII; originally published in *Art and Thought: Issued in Honour of Dr. Ananda K. Coomaraswamy on the Occasion of His 70th Birthday*, ed. K. Bharatha Iyer (London: Luzac, 1947), 69–72 and pl. XIV. The Brooklyn Museum favors a southern Rajasthani provenance and assigns a date of about 1750.

of the painting links it to the Svetambara sect of Jainism, and it was evidently commissioned by a wealthy Jain patron of a large party of devotees to commemorate their pilgrimage to the principal *tīrtha*s of the faith. It is possible, however, in light of certain apparent errors and inconsistencies in the painting, that the anonymous artist was not himself a Jain. An unusual attribute of the painting is its division into two halves, each to be seen from a different perspective. The more important and livelier section lies to the right in the illustration and is to be viewed mainly from the left; the remainder is to be viewed from below. No reason for this rendition has been put forward. Figure 17.36 identifies the more important elements of the painting from a cartographic perspective, plus a few others by way of context. The right portion of the painting presents a scene of continuous action in which the figure of the patron (whom I have singled out only at the place of his first appearance) is portrayed no fewer than ten times in the company of various members of his retinue. (He appears one more time in the circle near the upper left corner of the work.) This patron "seems to have attached the greatest importance to visiting the scenes [all in Bihar] of the four great events in the life of Mahāvīra [a contemporary of Guatama Buddha and the principal *tīrthaṅkara* (preceptor) of the Jain faith]—birth, initiation, *samavasaraṇa* [first preaching] and *nirvāṇa*."[129] It is also certain that the group went to Sammetaśikhara (Parasnath Peak), which occupies most of the left part of the painting and in which fifteen *tīrthaṅkara*s are depicted out of a total of twenty who are said to have died there. Additionally, depending on the accuracy of some of Brown's tentative identifications, they may have visited Girnar and Shatrunjaya in Gujarat, both possibly represented in the circle in the upper left corner, as well as Campā in Bihar.

Large sponsored pilgrimages were an important element of the Jain religious tradition. Brown cites one, probably carried out in the thirteenth century, that allegedly included "4,500 carts, 700 palanquins, 700 carriages, 1,800 camels, 2,900 servants, 3,300 bards, 450 Jaina singers, 12,100 Śvetāmbaras, and 1,100 Digambaras [members of another leading Jain sect]."[130] He concludes that the retinue of the patron who commissioned the work under discussion was probably much larger than the number of individuals actually portrayed. Any sponsor of so large an undertaking could reasonably be expected to wish to memorialize his meritorious act. If so, we should not be surprised at future discoveries of additional pilgrimage maps from the principal areas of Jain influence.

Large-Scale Maps, Plans, and Maplike Oblique Views of Small Localities

Here I consider a wide range of large-scale maps, other than architectural plans, that relate to relatively circumscribed localities and to periods from the mid-seventeenth to the mid-twentieth century. The principal criterion for inclusion is that the work portray an area small enough to be perceived by an individual, directly and more or less comprehensively, from personal experience and observation. Such areas will generally be no more than a day's walk from end to end in any direction. Figure 17.37 shows the places in South Asia for which such works are known to exist and classifies the known corpus of works into a number of analytic categories. Given the large number of surviving works subsumed within the category of large-scale maps and plans, the following discussion is necessarily highly selective. For works that are not explicitly described in the following analysis, readers may obtain certain essential details from appendixes 17.3 to 17.7; each is arranged alphabetically according to the relevant locales indicated on figure 17.37.

Maps of Small, Primarily Rural Localities

Appendix 17.3 provides data on a group of eleven maps of small, primarily rural areas of India. These maps are of two general styles, both associated with their areas of origin, Rajasthan and Maharashtra. The seven maps in the Rajasthan group are all relatively detailed and provide a good sense of the landforms and vegetation of the areas they depict, along with major settlements and other cultural features. Six of the seven maps, including all three maps of the locality around Khiri (somewhere in the general vicinity of Jaipur), relate to actual and planned works of construction and were presumably made by the Imārat Kārḳhāna, the agency of the Jaipur state government concerned with building and construction in general. One such map, for example, shows the plans for constructing various amenities to serve pilgrims traveling to Lohargarh, a sacred place in the vicinity of the small town of Khandela to the northwest of Jaipur.[131] The localities covered by the maps listed in appendix 17.3 generally appear to be less than twenty-five square kilometers, but the map of the area around Amber is probably at least ten times as large. Since I have not been able to locate the areas covered on some of the maps and could not determine the general alignment of features on those maps whose general locales I do know, it is impossible to specify any general rule with regard to their orientation.

129. Brown, "Jaina Pilgrimage," 258 (note 128).

130. Helmuth von Glasenapp, *Der Jainismus: Eine indische Erlösungsreligion* (1925; reprinted Hildesheim: Georg Olms, 1964), 440, cited in Brown, "Jaina Pilgrimage," 257 (note 128).

131. This work is illustrated and described in Gole, *Indian Maps and Plans*, 204 (note 1).

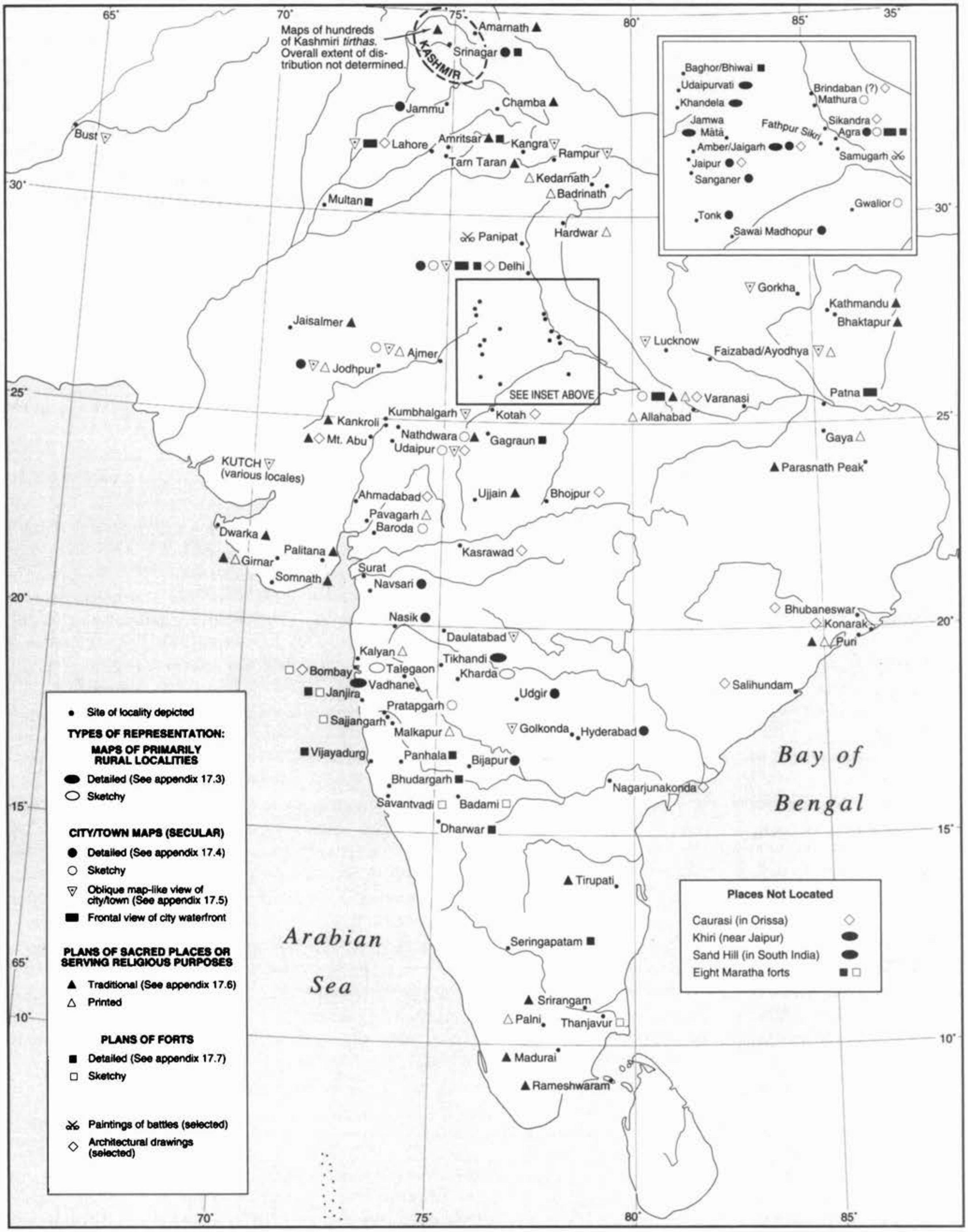


FIG. 17.37. PLACES DEPICTED ON LARGE-SCALE MAPS, PLANS, AND MAPLIKE OBLIQUE VIEWS OF SMALL AREAS AND LOCALES OF SELECTED ARCHITECTURAL DRAWINGS.

The four Maratha maps are more crudely drawn ink sketches. Two of these are of the areas of battles the Peshwa army took part in. Although those battles were significant, they were not among the most important of the numerous military engagements the several major branches of the Maratha Confederacy had with neighboring Indian states, with the British, and occasionally with one another. Thus, one might reasonably suppose that many more battle maps were made in the late eighteenth and early nineteenth centuries and subsequently lost.

The two Maratha village maps I have seen, though stylistically similar, have significant differences deriving from the fact that one predates British penetration of the region it comes from, whereas the other was made after that region was annexed. These maps, drawn in ink on paper, were photographed, translated, and brought to light by Frank Perlin of the Instituut Kern in Leiden. The earlier map (fig. 17.38), of a type Perlin believed was "comparatively rare," is of the village of Vadhane in the eastern part of Pune district in Maharashtra. It dates from the year Faslī 1193 (ca. A.D. 1784) and is one of a set of two maps made eleven years apart (of which I have been sent only one) that were drawn up in relation to a land dispute. It is not clear whether 1784 is the initial or terminal year of the pair. In describing the map, Perlin notes that

> the "whole" village is represented in respect to its actually owned and occupied lands, its settled portion (the rectangle in the centre), and tracks and neighbouring villages. The writing describes and names actual features and where relevant makes comments concerning social matters pertinent to the dispute. The modern survey map shows the village to be highly irregular in shape (by no means rectangular, or [even] four sided). It contains a large area of barren rock and pasture, which, however, is not represented in the diagram (although contemporary fiscal and survey documents do refer to them as residual categories).[132]

The second map is of the village of Tinkhandi (now Tikhandi) in the district of Ahmadnagar, also in Maharashtra, and dates from the 1820s—that is, from the first decade of British occupation. As on the first map, the village area is here forced into a rectangular frame, though rather longer than the previous map, and there is little concern for the actual shapes of land parcels. Yet the map was "drawn up for the first East India Company attempts at conducting tax-related field and village surveys. Thus whereas the numbers in the first [map] refer to measurements, those in the second . . . are a first attempt to attach numbers to units of 'holding.' "[133] Maps of the latter kind, says Perlin, are much more common than those of pre-British vintage; but both types, in his estimation,

> indicate an accomplished mode of representing social space which must have been fairly generalized. . . . Actual field surveys are extremely common for the 18th century, with what looks like the surveyor's notes sometimes accompanying the more formal listings. Maps, however, do not normally accompany them; nor would they appear to have been necessary . . . given highly effective modes of language [i.e., verbal]-reference to the bits and pieces composing the distribution of rights in a given place.[134]

In concluding this discussion, let me draw attention to the resemblance between figures 17.38 and 17.27 (and all the others in the series of Nepali land revenue maps of which the latter is an example). Although the two revenue maps vary considerably in scale, are of areas hundreds of miles apart, and are separated in time by several decades, they are fairly similar in both appearance and purpose. This leads one to wonder whether Perlin's observation about the "generalized" nature of the Maratha revenue maps he has studied might also apply to a much broader spatial and temporal frame than the evidence before us makes evident. Thus, even though land revenue maps may have been rare in pre-British days, when the exigencies of a given situation (e.g., land disputes) demanded that they be made, they may have conformed broadly to a widely used, if not a pan-Indian model—one that was perhaps inelegant but was satisfactory for the matter at hand. Further investigation is clearly warranted.

Certain Indian landscape paintings, especially of the eighteenth and later centuries, also have a distinctly maplike quality. One senses in looking at them that their creators sought to render the landscape with considerable fidelity even though the sweep of terrain covered was sometimes greater than one could take in from a single vantage point. Some artists managed to project themselves mentally well above the surface of the earth and to portray substantial areas as if seen obliquely from a balloon. Among the Indian landscape paintings none, perhaps, comes closer to the conventional idea of a map than a number of works produced in Kutch during the eighteenth and early nineteenth centuries. In discussing these paintings the art historians B. N. Goswamy and A.

132. Letter from Frank Perlin, 9 July 1985. I am grateful for this valuable communication.

133. Letter from Frank Perlin, 9 July 1985.

134. Letter from Frank Perlin, 9 July 1985. In addition, there is evidence that the Mughal revenue system provided, in some respects, a model for that of the Marathas. In Mughal revenue papers, villages and towns were listed for each *pargana* (subdistrict) along with their cultivated areas and assessed revenues. Village locations were indicated by their distances in *kos* (*kuroh*) north, east, south, or west from the *pargana* headquarters, which in turn were similarly located with respect to the chief district town. Thus, even though maps as such appear not to have been used for purposes of taxation, officials knew well enough the location of all the towns and villages within their purview.

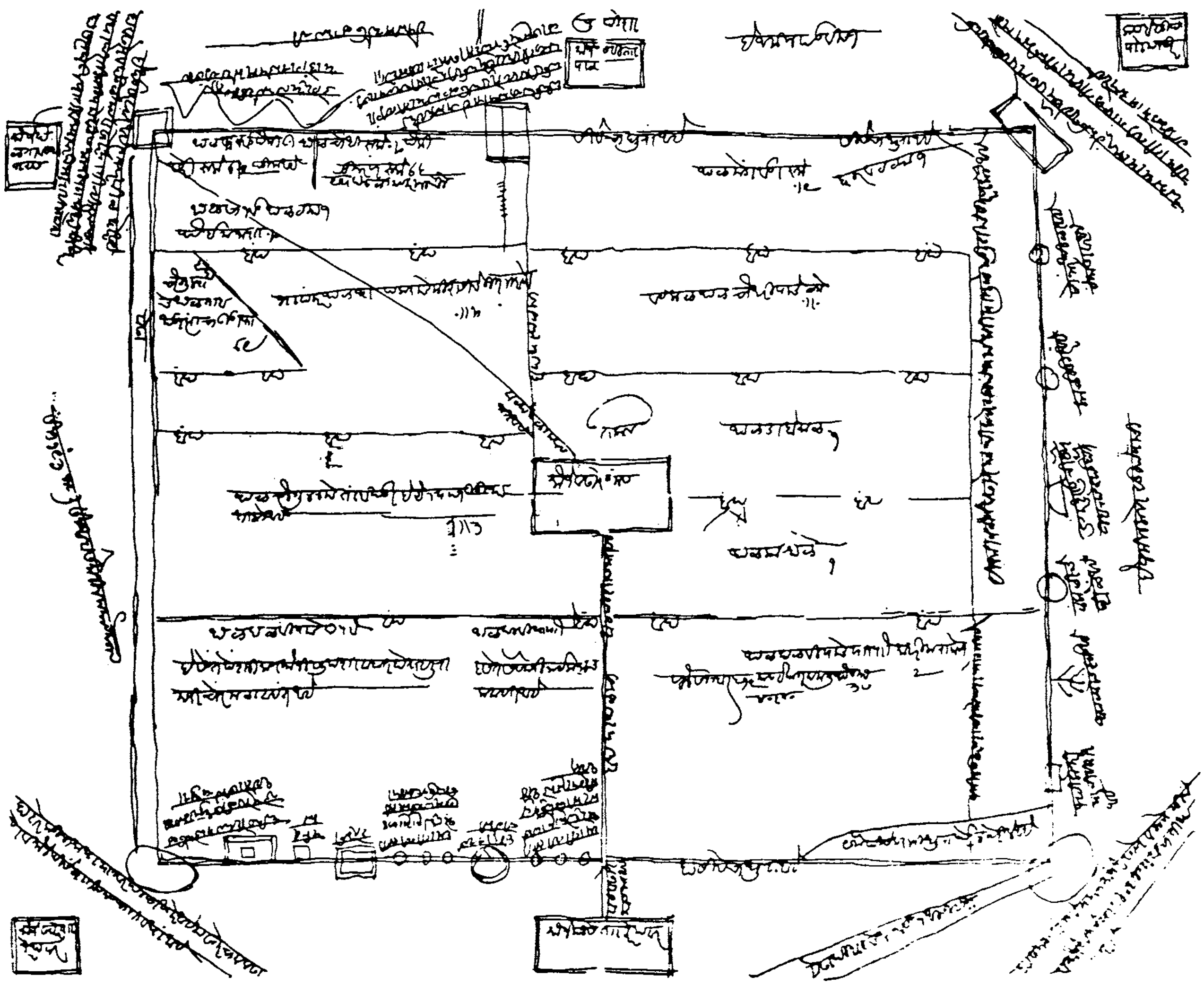


FIG. 17.38. A VILLAGE IN PUNE DISTRICT, MAHARASHTRA. This Maharashtra map, ink on paper, is dated Faslī 1193 (ca. A.D. 1784). Made in reference to a property dispute, this map indicates the settled portion of the village of Vadhane by the centrally located rectangle, the dimensions of areas owned by various persons in the village, and other noteworthy features. It also provides notes on social matters relevant to the dispute. Size of the original: not known. Collection of Frank Perlin.

L. Dallapiccola suggest that they were the result of the significant influence exerted on Kutch by its contacts with resident British and by earlier Kutchi travelers such as the architect Ram Singh Malam, who in the latter half of the eighteenth century spent many years in Britain and other foreign regions.[135] From southeastern Rajasthan, an area not far from Kutch, comes another exceptional genre of painting mainly associated with hunting scenes, from which one does derive a dramatic sense of place. Like the Kutchi paintings, these works also adopt a bird's-eye view of the terrain portrayed; but it is doubtful that the painters were greatly concerned about scalar fidelity.[136] (The same, however, can be said for many planimetric maps from India.) Again, in these works foreign influences appear to be at work, especially "Mughal and ultimately Persian antecedents," in which human control over nature is stressed.[137] Still other naturalistic European

135. B. N. Goswamy and A. L. Dallapiccola, *A Place Apart: Painting in Kutch, 1720–1820* (Delhi: Oxford University Press, 1983), passim. See also their "More Painting from Kutch: Much Confirmation, Some Surprises," *Artibus Asiae* 40 (1978): 283–306.

136. For examples of the genre, see Andrew Topsfield, *Paintings from Rajasthan in the National Gallery of Victoria* (Melbourne: National Gallery of Victoria, 1980), passim.

137. David E. Sopher, "Place and Landscape in Indian Tradition," *Landscape* 29, no. 2 (1986): 1–9, esp. 6.

influences are evident in the landscapes painted in the "Company style," which owes its origins to the influence of Colonel Gentil, whose atlas of Mughal India I have already discussed.[138]

In contrast to the more or less exceptional works just cited, most Indian landscape painting displayed relatively little concern for verisimilitude in depicting terrain and associated vegetation and cultural features. Rather, as Sopher put it:

> A particular assortment of landscape elements... does not constitute an observed landscape. It is the symbolic connotations of these elements, derived from a long literary tradition, that account for their appearance....
>
> In Indian painting... particular elements of the landscape are invoked for their emotional content. The unique organization of elements in actual landscapes and the integral role of human action in making places do not matter in this work. For the artist, it seems, place is a distraction, if not an irrelevancy. Thus, a characteristic, tutored way of seeing the land, not, however, confined to the elite, corresponds to the ideal of eventual detachment from place that is a central concept in the Indian world view.[139]

The corpus of Indian landscape painting is large, and I have not undertaken any extensive or systematic study of the subject. Notwithstanding the generalizations just cited, an exhaustive study would probably bring to light additional maplike works. But one must be cautious in interpreting paintings that have the appearance of referring to real places. Certain artists did achieve the ability to invent landscapes that on examination are seen to bear little resemblance to what they purported to portray. For example, two richly detailed paintings, said to represent Kashmir, are immediately recognizable as flights of the artists' imagination. One, painted in Lucknow about 1760, clearly reflects the Dutch and Flemish pictures that must somehow have come to the attention of the artist Mīr Kalān Khān (possibly during a sojourn in Delhi), and the other is a romantic view painted in Hyderabad at roughly the same time, presenting a similarly eclectic view.[140]

SECULAR PLANS OF CITIES AND TOWNS

Plans of cities and towns include some of the most beautiful, interesting, and detailed of Indian maps. Appendix 17.4 summarizes essential attributes of twenty such maps—all of which Gole also discusses and illustrates, often with enlargements of certain areas. The cities and towns referred to are plotted on figure 17.37. They originate from relatively few areas: Kashmir, Delhi, Rajasthan, Gujarat, Maharashtra, and the more Islamicized regions of the Deccan. The maps date from the late seventeenth to the late nineteenth century, but mainly from the eighteenth.[141]

The plans I shall consider here have enough in common to permit a number of stylistic and cartographic generalizations. They also exhibit some noteworthy differences. Almost all the maps are painted in various hues, either on paper or, less frequently, on cloth; but two, both from Kashmir, are embroidered (see, e.g., plate 33). The paper maps are sometimes backed by cloth, but the time of the backing cannot be ascertained. The sizes of the maps vary considerably, from as small as 24.5 by 13 centimeters, for the map that possibly represents Navsari, to as large as 661 by 645 centimeters, for the map of Amber. Only five of the maps are less than 0.5 square meters in area. Most are relatively square; in only five cases is the longer dimension more than one and a half times as long as the shorter, and in no case is it more than twice as long. Almost all the maps include substantial text, though one, the putative Navsari map, has no text at all. In all but a few cases the text is either Persian, the most common language used, or one or another dialect of Rajasthani. Sometimes a second language is added later.

No definitive statement can be made about map orientation because I have not been able to review closely some of the maps being discussed. Many of the maps do include notations along the edges as to the four cardinal directions (occasionally added after the map was drawn); but in the absence of these, and without direct knowledge of the physical layout of the place being mapped, one cannot state the dominant orientation. In any case, on virtually all the maps the orientation of text varies with the direction of the features being mapped, especially in the case of essentially linear features such as streets, city walls, rivers, and hill ranges. Important nonlinear features, such as monuments, temples, mosques, and dwellings, are generally depicted in frontal perspective as they would normally be seen by a viewer on the ground, and

138. A charming example of a landscape at Amarnath, in Kashmir, is provided in Stuart Cary Welch, *Indian Drawings and Painted Sketches: 16th through 19th Centuries* (New York: Asia Society in association with John Weatherhill, 1976), fig. 80, p. 139, and text on p. 138.

139. Sopher, "Place and Landscape," 5 and 6 (note 137).

140. The paintings noted appear in Toby Falk and Mildred Archer, *Indian Miniatures in the India Office Library* (London: Sotheby Parke Bernet, 1981), fig. 238, p. 435, and text on p. 137, and O. C. Gangoly, *Critical Catalogue of Miniature Paintings in the Baroda Museum* (Baroda: Government Press, 1961), pl. XIII and p. 42.

141. Gole discusses and illustrates these plans in *Indian Maps and Plans*, 158–90 (note 1). Excluded from appendix 17.4 are nine rather sketchy plans of places that are shown on figure 17.37 and collectively discussed in brief below; oblique maplike views, which are treated in appendix 17.5; and a number of additional plans made primarily for religious purposes that I will consider as part of a group, along with temple plans and other religiously motivated works, in appendix 17.6.

writing is oriented accordingly. Thus, with few exceptions, the map orientation varies from place to place, often even within a small area.

Like many small-scale topographic maps from South Asia, virtually all city plans variously combine planimetric and frontal perspectives and occasionally oblique perspectives as well. The planimetric perspective is characteristically used for streets, rivers, tanks and ponds, and large enclosed or semienclosed areas (*chauk*s), and often for city walls. But ingenious combinations of planimetric and frontal views (e.g., as in plate 34) are often used to depict the latter. Hill ranges are generally depicted with a more or less correct linear alignment but in a frontal perspective. Vegetation, especially forested areas, is generally portrayed as seen from the ground, usually with little regard for planimetric accuracy, and often is used as a decorative space filler. Gardens and cultivated fields, however, are as a rule rendered planimetrically. Ordinary residential dwellings may be shown either planimetrically, usually by conventionalized squares and rectangles, or in simplified frontal perspective, often with a door and one or more windows. Rarely is any attempt made to show

a

b

FIG. 17.39. DETAILS FROM A LARGE MAP OF AMBER, RAJASTHAN. These details come from a 1711 Rajasthani map painted on cloth. The complete map shows every house in Amber (the streets are named for the occupations of the inhabitants; e.g., street of cloth dyers), and the surrounding countryside is also shown in great detail. Many individual buildings, gardens, waterworks, and such, are rendered with remarkable individuality. Detail *a* represents a portion of the palace complex, and *b* shows a nearby village. This is the largest known surviving Indian map.
Size of the entire map: 661 × 645 cm. By permission of the National Museum, New Delhi (cat. no. 56.92.4).

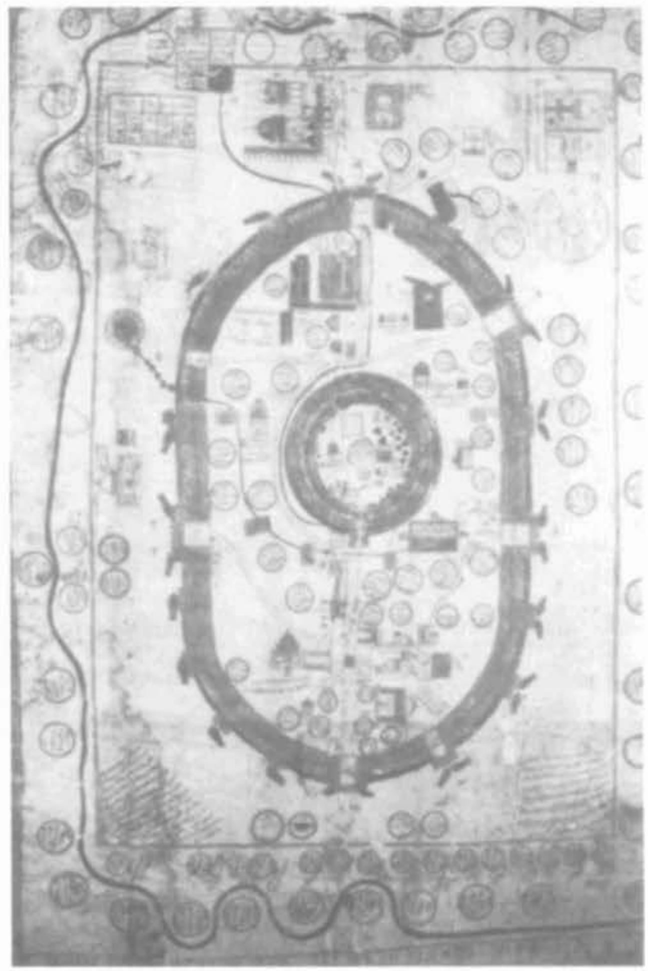


FIG. 17.40. BIJAPUR, KARNATAKA. This Deccani Muslim map dates from the late seventeenth century and is painted on paper backed with cloth. The map emphasizes matters of historical, cultural, and administrative importance: tombs of major figures, mosques, the city wall, gates, cannons, watercourses, wells, and so on. Supplementary marginal notes concern neighboring villages, the revenue due from each, and districts of the sultanate, and there are also ancillary historical notes. There are no details on the residential makeup of the city.
Size of the original: 149 × 102 cm. Archaeological Museum, Gol Gumbaz, Bijapur. Photograph courtesy of Susan Gole, London.

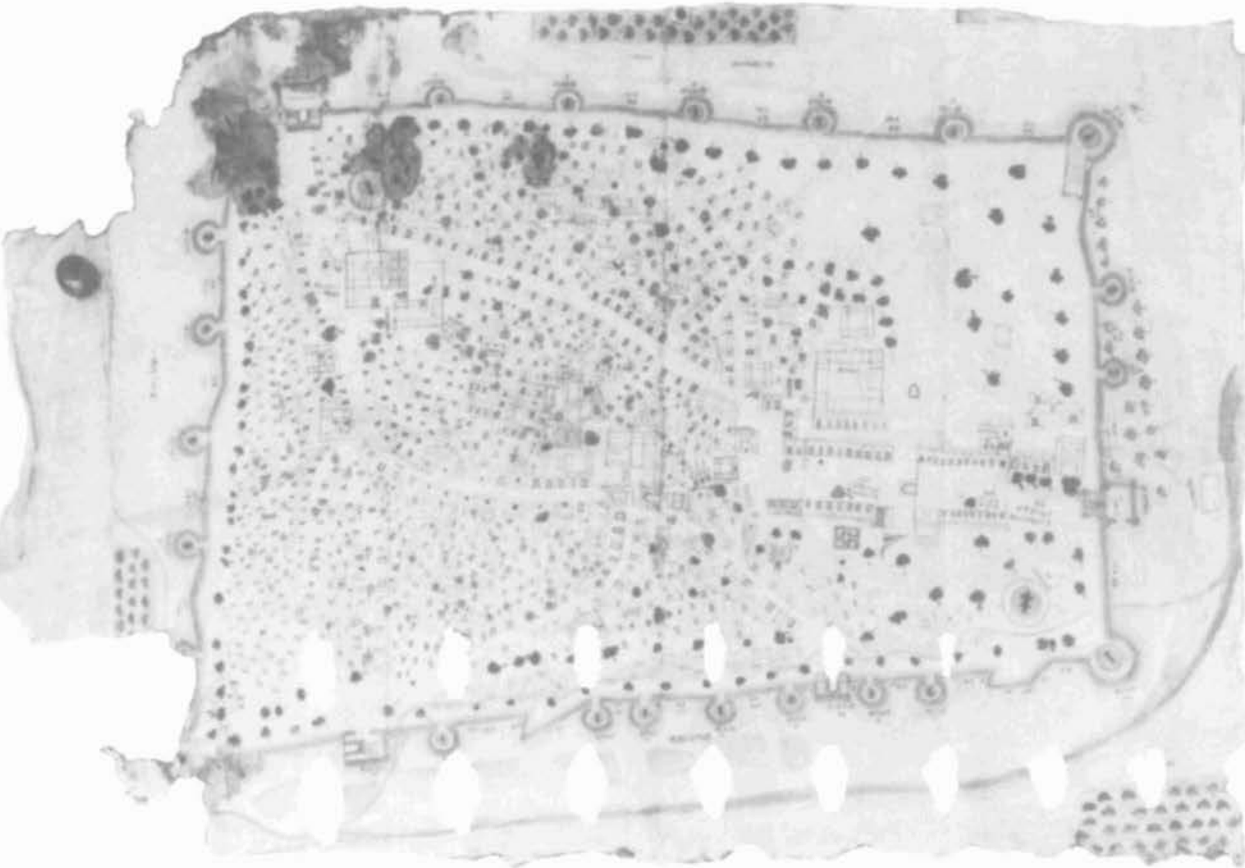


FIG. 17.41. SANGANER. This very detailed map of Sanganer (a town famous for cloth dyeing and printing), in Dhundari and painted on paper, dates from the late eighteenth or early nineteenth century. The streets, major edifices, and town wall are accurately rendered, with the distance between the towers in the wall surrounding the city given in *gaz*, while the residences are shown in a more stylized manner.
Size of the original: 124 × 165 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 114). Photograph courtesy of Susan Gole, London.

the exact disposition and actual number of houses; but the enormous map of Amber (fig. 17.39) is exceptional in that regard. Occasionally, as in the several maps of Bijapur (e.g., fig. 17.40), the residential component of the city is completely overlooked. The Bijapur map is also noteworthy for the high degree of abstraction in its symbolization—mainly by circles with internal text—of the principal features to be shown. Thus, this Indo-Islamic map is much less pictorial than most.

Certain conventions that we have come to associate with modern Western city plans are entirely or almost entirely lacking on traditional plans from South Asia. Only one such plan, that of Shāhjahānābād (Delhi)—the classification as traditional is open to question—has a graphic scale, and no other map indicates scale of any kind that is applicable to the map as a whole. Several maps in the collection of the Maharaja Sawai Man Singh II Museum in Jaipur, however, do contain numerous notes on the dimensions, usually in *gaz* (yards), of significant features that they portray (fig. 17.41). Nor has any a reference grid or ruled neat lines apart from decorative borders.

Not included in appendix 17.4 are sketch maps of cities and towns—all but one plotted on figure 17.37 and illustrated in Gole.[142] Eight of these, all rather crude ink drawings on paper, each about thirty by twenty-eight centimeters, form a set that appears to relate to the Maratha wars with the British early in the nineteenth century. The map script is a mixture of Modi and Devanagari. Notes on the map refer to dispositions of different forces, fortified points, places occupied by the British or particular Maratha leaders, buildings of special interest (not necessarily military), water supply, and distances to nearby places (up to thirty *kos* away). Gole suggests that the maps were drawn after the wars were concluded, to illustrate the campaigns, and that they may all be by a single author.[143] The places shown are Agra, Ajmer, Baroda,

142. Gole, *Indian Maps and Plans*, 158–90 (note 1).

143. The maps are at present in London, India Office Library and Records, MSS. Mar. G28, c, d, e, f, g, h, j, and k.

Brahmavarta (Varanasi), Gwalior, Mathura, Partabgarh, and Udaipur, together with the nearby religious center of Nathdwara. The maps of Udaipur and Mathura are of substantially smaller scale than the others and cover considerable portions of the surrounding countryside.

One additional sketch map, of Delhi, is much more carefully drawn than the set of Maratha maps.[144] Despite its neat outlines of various quarters within the old walled city, it contains little text, and that little is entirely in English. The title reads "Plan of Dehly Reduced from a Large Indostanny Map of That City." The large original map from which this one was made cannot be traced. This map measures approximately thirty-five centimeters square and is drawn on paper. A penciled date "1800(?)" has been added, but the year is obviously no more than a guess.

Not included among the maps discussed in this section are several, considered in the discussion of topographic maps, that depict key cities at considerably larger scales than their surroundings and in some instances incorporate substantial detail about the internal layout and major places within those cities. This is true, for example, for the maps of the Vale of Kashmir, on which Srinagar is invariably a major element (e.g., figs. 17.14 and 17.15 above); the large map of Gujarat and adjacent parts of Rajasthan (a detail of which is illustrated above, fig. 17.19), which gives much prominence to Ahmadabad; and arguably the map of the area in Rajasthan and Gujarat (fig. 17.18), which also gives some prominence to Ahmadabad.

OBLIQUE SECULAR REPRESENTATIONS OF CITIES AND TOWNS

Artists in India occasionally created paintings of cities or towns or of major portions thereof (e.g., the precincts of royal palaces) as if seen from a perch high in space. Some of these oblique perspectives are definitely maplike in character, being sufficiently detailed to give a fairly clear idea of the arrangement of the major spatial components of the areas being depicted: they include city walls, palaces, forts, religious edifices, main thoroughfares, open spaces, reservoirs, residential quarters, and bazaars, in varying degrees of detail. As in so much of Indian painting, conformity to the rules of perspective as they have evolved in the West is not a general characteristic of the oblique views of South Asian cities, though a few such paintings reflect conscious experimentation with Western conventions. Where to draw the line between paintings that may be regarded as maps and those that ought not to be is often difficult to decide, especially without reliable information on how much of what is shown was intended to represent what was actually on the ground and how much was merely the fancy of the artist seeking to create an aesthetically pleasing composition or a general sense of how the place might have appeared. Because the paintings in question seldom embody text or indicate the orientation of the perspective, and because they relate to landscapes that are no longer extant, it is all but impossible in some instances to check them against the empirical reality of the period when they were painted. Nevertheless, from among the many oblique views of South Asian cities, I have selected thirteen that seem particularly maplike. Relevant details on them are presented in appendix 17.5.

Of the thirteen paintings noted in appendix 17.5, I illustrate only two. One (fig. 17.42) is a miniature from an illustrated manuscript of the *Pādshāhnāmah* (History of the emperor) commissioned by the Mughal emperor Shāh Jahān (r. 1627–57). The painting is attributed to Murād, an artist of considerable renown, and is at present in the Musée Guimet in Paris. The work depicts a general, Qulīj Khān, accepting the keys of a conquered city, which the art historian Stuart Cary Welch claims is probably Bust (Kala [or Qala] Bist), to the west of Kandahar, where it is tentatively plotted on figure 17.37.[145] Although the focus of the painting is obviously not the city itself, the detail suggests that the rendering is based on an actual sketch made in the field. Yet we have no documentary evidence to support such a conjecture.

The second painting (fig. 17.43), rendered in the charming Pahari miniature style associated with the mountainous region of Himachal Pradesh, is of the city of Lahore. Like other Pahari works (e.g., the scroll route maps discussed above), this work incorporates a variety of perspectives for different features depicted, though the clearly dominant view is that of a person facing north. I have decided to include this work among the oblique views rather than among planimetric maps even though its overall layout was essentially planimetric, especially in regard to the walls of the city and fort and the course of the Ravi River. There are grounds to suppose that the painting was essentially decorative. Not surprisingly, it adorned the viceregal lodge in Simla before Indian independence. The total lack of toponyms or other map text, the apparent lack of concern for a faithful rendering of the layout of the city proper, and the abundance of pic-

144. The map is found in New Delhi, National Archives of India, cat. no. F183/22.

145. Welch's suggestion that the city is Bust seems tenable on historical grounds and is supported by its resemblance to the nearby city of Kandahar. (Cf. the adaptation of an 1880 map of Kandahar in Schwartzberg, *Historical Atlas*, 135, pl. XII.B.2, map e [note 105].) However, Welch entitles the painting "Qulij Khan Accepts the Keys to a City in Badakhshan." Since Badakhshan lies in northeastern Afghanistan, more than five hundred miles from Bust, this statement is inconsistent with the view that the city depicted is Bust. Either the title or the city's identification must be incorrect. Stuart Cary Welch, *India: Art and Culture, 1300–1900* (New York: Metropolitan Museum of Art and Holt, Rinehart and Winston, 1985), 247–48.

FIG. 17.42. BUST (KALA BIST)(?), AFGHANISTAN. This Mughal view, dated ca. 1646, gouache on paper, is an illustrated folio from a manuscript of the *Pādshahnāmah*. It shows Qulīj Khān accepting the keys to a conquered city, probably Bust. The upper third of the painting shows the citadel and the adjacent city, both walled, in considerable detail.
Size of the original: 34 × 24.2 cm (image); 48 × 31.5 cm (manuscript folio). By permission of the Musée Guimet, Paris.

torial detail suggestive of the life of the people support this supposition.[146]

The representation of Delhi (item c in appendix 17.5) is strikingly similar in conception to the one just described for Lahore in that it too shows the fort area taking up about half the painting in the background and presents a visually rich, but spatially truncated, adjacent city proper in the foreground. M. K. Brijraj Singh, who illustrates and describes the Delhi painting, notes that similar though less elaborate works commemorate visits of the Kotah Mahārao Ram Singh to the *durbār* (court) held at Ajmer in 1831 by the then governor general Lord William Bentinck, to whom one such scroll was presented. And similar scenes were painted on the walls of one of the Kotah palaces.[147]

Not plotted on figure 17.37 is a remarkable series of detailed paintings of religious cities on the walls of the small, long disused *bhojanasālā* (private dining room) of the maharaja in the palace at Amber. Generally these provide oblique perspective views, but in some cases a planimetric perspective predominates. These rather well preserved works, painted in the seventeenth and eighteenth centuries, are about one and a half meters high and cover a total area of more than fifteen square meters. Gole provides seven color photographs of portions of this assemblage.[148] But because none of the paintings now has a title and because the script identifying many of the specific buildings shown was not very clear, she was unable to determine the locales represented, though the task should presumably not prove excessively difficult for an art historian. As recently as 1984, two were identified with signs stating that they were Mathura and Kāshī (Varanasi); but the hilly topography shown in the vicinity of the two cities argued against those identifications and raised the possibility that they were painted entirely from the artist's imagination, despite their look of realism. Whatever the case, Chandramani Singh has suggested that these paintings may well be the prototypes for later Jaipuri city maps of unquestionable authenticity. The *bhojanasālā* paintings may, in turn, have been based on European Renaissance perpective views made available to the Jaipuri court by seventeenth-century Jesuits and other European visitors.[149]

Mural paintings, often in a bad state of preservation, adorn many other Indian palaces, and it seems likely that investigation would reveal additional examples of oblique views of cities or their specific precincts. I have already taken note of those found in Kotah, and there is also said to be a map of Jamnagar (Navānagar) painted on the ceiling of the local palace of that small Gujarati coastal city.[150]

In addition to the high oblique views I have just discussed, there are at least two painted frontal perspective views of cityscapes that function somewhat like maps. These show the riverfronts of Varanasi and of Patna. The

146. A map in Schwartzberg, *Historical Atlas*, 135, pl. XII.B.2, map a (note 105), relates to the historical growth of Lahore and shows both the fort, constructed in 1617–72, and the old city wall, erected in 1584–98. Although in figure 17.43 the fort appears to be about as big as the rest of the city, its actual area in the early seventeenth century would have been less than a tenth as large, and by the nineteenth century, when the painting was made, its relative size would have been even smaller. For a large color photograph of this map and additional photographs of selected details and background text, see M. R. A. [Mulk Raj Anand], "Architecture," *Mārg* [34, no. 1], *Appreciation of Creative Arts under Maharajah Ranjit Singh*, 27–33.

147. M. K. Brijraj Singh, *The Kingdom That Was Kotah: Paintings from Kotah* (New Delhi: Lalit Kalā Akademi, 1985), fig. 40 and pp. 20–21.

148. Gole, *Indian Maps and Plans*, 171–73 (note 1).

149. Chandramani Singh, personal communication. Singh is an art historian long resident in Jaipur.

150. Letter from Susan Gole, August 1984.

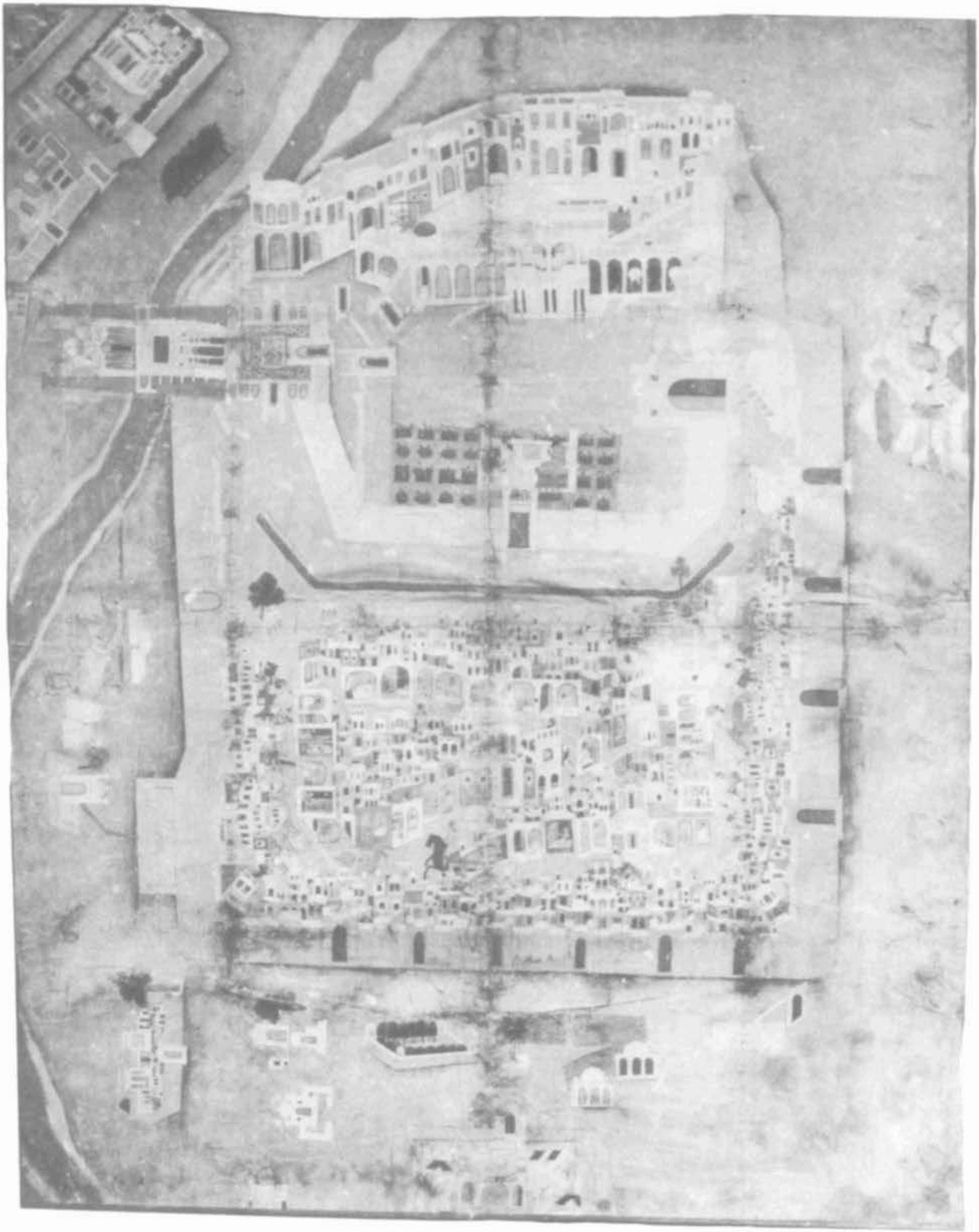


FIG. 17.43. LAHORE, PUNJAB, PAKISTAN. This map in Pahari style is dated to the early or mid-nineteenth century and is painted on cloth. An oblique perspective, looking north, predominates, but perspective alters from one part of the painting to another and the overall view is essentially planimetric. It is undoubtedly more accurate for the fort than for the adjacent city.
Size of the original: 154 × 124 cm. By permission of the Maharaja Ranjit Singh Museum, Amritsar.

Varanasi painting is on cloth and measures 98.5 by 119.5 centimeters. It depicts and names, in both Persian and Hindi, all the ghats and major riverside edifices along the Ganga, greatly compressed latitudinally and without intervening streets so as to fit within the limited compass of the canvas. The painting is at present in the Ramnagar palace outside Varanasi and belongs to the maharaja of that erstwhile princely state. It dates from the early eighteenth century and may well have been commissioned by a forebear of its present owner. The second painting is of unknown date and is apparently similar to that for Varanasi.[151]

MAPS OF SACRED PLACES

Maps of sacred places in South Asia take on a wide variety of forms, ranging from the exceedingly abstract to the highly realistic. On the whole, however, they tend toward greater abstraction than most other maps of cities and other small localities examined in this section. Since their authors' concern is not with the world of mundane experience, they tend to sublimate portions of the material landscape that are devoid of religious meaning (except insofar as it provides relevant context for the map user) and to highlight features of religious significance, which they characteristically portray in exaggerated scale and vivid hues, providing considerable detail, much of which conveys a strong iconographic message to the map user. Religious maps also tend to be among the most beautiful available to us. Many use exuberant graphic imagery to depict pilgrims and worshipers, deities and other mythic figures, the architecture of temples and other sacred edifices, and the animal and plant life and even topographic features in the sacred precincts.

Appendix 17.6 provides a summary analysis of maps, including oblique maplike perspective views, showing a substantial number of places of religious importance. The widespread distribution of the places represented is evident from figure 17.37. Not included in appendix 17.6, but also on the map, are some additional locales for which printed religious maps are known to exist. Such printed maps, though produced by modern technology, embody in varying degrees a traditional cartographic outlook and thus warrant at least brief consideration in this chapter. Space prevents me from illustrating as many maps of sacred places as I would wish, and I have therefore found it necessary to confine my selection to only nine that represent some of the more important genres and convey some impression of the breadth of coverage.

Readers will recall from the discussion of "topographic" maps of the sacred region of Braj that the entire area was conceived as if it were in the form of a lotus and that its numerous constituent localities were represented as occupying positions on one or another of the petals. A similar propensity to view sacred cities through a religiously meaningful iconographic prism is evident in the construction of many Hindu maps. Thus, both the city of Puri, where the renowned Jagannath temple is situated, and Dwarka, a city sacred to Krishna worshipers in the west of India, are associated with the form of a conch (cf. plates 35 and 36 and fig. 17.44).

How and when the imagery of the conch originated is an open question, but it is noteworthy that both Dwarka and Puri were—along with Badrinath, Sringeri, and Kanchipuram—among the five Vaishnavite centers where the great ninth-century philosopher Śaṅkara (whose name embodies the particle *śaṅka*, meaning conch) established Hindu *maṭha*s (monasteries) that survive to this day. I have noted that in Jain monasteries drawing cosmographies was part of the monastic training. Whether any comparable institution arose at the *maṭha*s at Dwarka and Puri is not known. We do know, however, that at both Puri and Nathdwara (to be discussed below) the work of providing painted images of the major deities, of their shrines, and of other sacred icons came in time to be entrusted to certain families for whom it became a hereditary profession. In the case of Puri, all such families belong to the local *chitrakāra* (artist) caste. Although that group is to be found in many villages in Orissa, those who still carry on the function of meeting the needs of

151. The work was made known to me by S. V. Sohoni, a retired officer of the Indian Administrative Service who served for an extended period in Patna. A portion of the work, whose original medium is not known, has been redrawn and published as an appendix to J. F. W. James, "The River Front of Patna at the Beginning of the Eighteenth [*sic*, should read "Nineteenth"] Century," *Journal of the Bihar and Orissa Research Society* 11 (1925): 85–90. The work was discovered among some old, poorly preserved records in the district judge's office in Patna. Its present condition and location have not been ascertained. Additional large and detailed views of the cities of Delhi, Agra, and Varanasi, as seen from the Yamuna River or Ganga River, are to be found in the Department of Oriental Antiquities at the British Museum, London. Though drawn by Indian artists, all were commissioned by European patrons. Views of each of the three cities named were commissioned by an unknown Italian patron in about 1840. These are cataloged 1962-12-31-014 (for Varanasi), 1962-12-31-015 (for Agra), and 1962-12-31-016 (for Delhi). Another view of Varanasi made for an anonymous patron is in twelve unjoined sheets. It dates from the first half of the nineteenth century and bears the catalog number 1860.7-28.675, 1-12. All four works are rendered in what has been termed the "Company style" of painting. The twelve-sheet Varanasi painting is especially rich in details of human interest, depicting activities along the riverbank. Yet another panoramic view, of three sides of the exterior of the city of Lahore, is held by the Lahore Museum. This work, drawn by an Indian artist presumably for a European patron, measures approximately sixty by twelve inches, is painted in watercolor on paper, and contains text in Urdu. An ink and wash copy of it exists in the Punjab Archives in Lahore. The supposed date is from the early nineteenth century. Accession and cataloging data are not available. I thank James Westcoat for providing me with five transparencies of this work in April 1990.

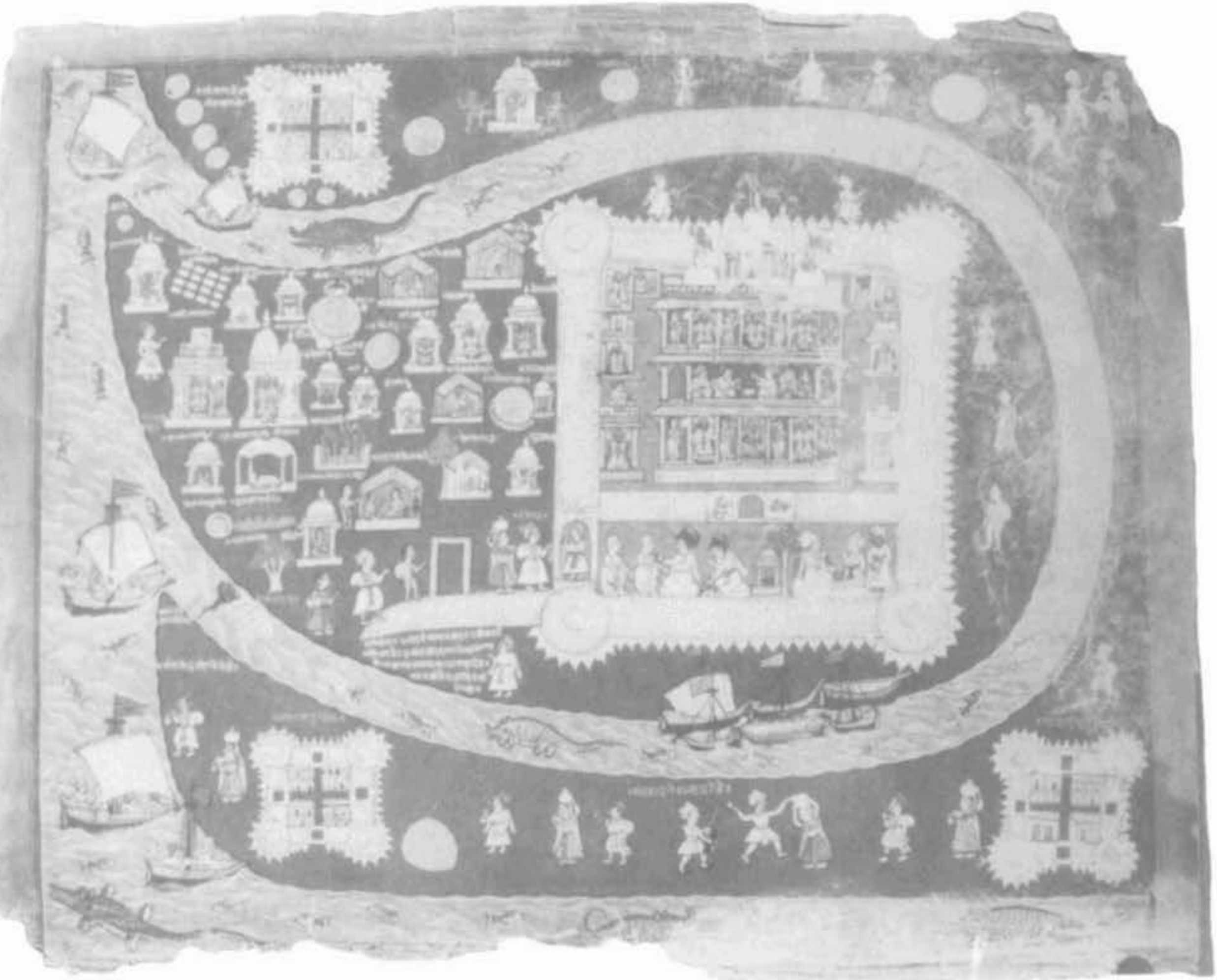


FIG. 17.44. MAP OF SANKHODAR BET, DWARKA, GUJARAT. This Rajasthani map, dated 1773, is painted on paper. The old temple and three others are shown planimetrically, but many of the ancillary temples are shown in frontal perspective. Also included are vivid depictions of pilgrims, boats, fish, and crocodiles.
Size of the original: 25.2 × 32.5 cm. By permission of the Prince of Wales Museum of Western India, Bombay (acc. no. 70.4).

the Jagannath temple are concentrated mainly in the single village of Raghurajpur, some twelve kilometers from Puri, where, among the twenty-four *chitrakāra* households, thirty-eight out of forty-three family members over age fifteen still practiced their craft about 1980.[152] Puri paintings have recently been "rediscovered" and are enjoying a new vogue. Today they are found in art museums throughout the world. Although I have seen many traditional style paintings of the Jagannath temple per se (indicated by the central square on plate 36) that could in themselves be called maps, I have arbitrarily limited those indicated in appendix 17.6 to six remarkably similar detailed representations of the whole of the sacred precincts of Puri.[153] Others undoubtedly exist. In contrast to the living artistic tradition at Puri, I have no evidence that a comparable tradition ever existed at Dwarka. Notwithstanding the broad similarities of maps h and i in appendix 17.6, maps j and k—the former quite refined and signed by a Jaipuri court artist—are of altogether different styles.[154]

Some traditional maps of Varanasi (e.g., fig. 17.45) incorporate a square within a circle, the terrestrial referents being the city itself and the *kṣetra*, or field, where

152. J. P. Das, *Puri Paintings: The Chitrakāra and His Work* (New Delhi: Arnold Heinemann, 1982), 9–10.

153. For a description of the religious landscape of Puri, see Durga Charan Sahoo, "The Sacred Geography of Jagannath Dham, Puri," *Eastern Anthropologist* 34 (1981): 63–67. A detailed key identifying each of sixty-four elements of the Puri painting identified as item gg of appendix 17.6 is provided in Talwar and Krishna, *Indian Pigment Paintings*, 110–12 (note 63).

154. I thank Arthur Duff of Dublin for sending me copies of three traditional and two more or less modern maps of Dwarka along with an unpublished paper titled "Pilgrim's Maps" (of Dwarka); letter dated 29 August 1989.

FIG. 17.45. VARANASI, UTTAR PRADESH. This map is a lithographic print on cloth with the city depicted as a square within a circle. Key religious features are emphasized, and the Ganga is shown as a bow. Size of the original: 79 × 92 cm. Photograph and permission courtesy of Jan Pieper, Berlin.

it is situated. That field may be defined as the area included within the pilgrimage route known as "the Panch Koshi Road, the ritual or processional road for the circumambulation of the entire . . . Holy Field of Kaṣhi."[155] Symbolically, however, the circle also represents mother earth, *kṣetra* being etymologically associated with a seed field and hence with nature and fertility and, more generally, the female principle. The square, on the other hand, signifies the artificial urban cultural creation and, more generally, the male principle. Pieper's well-informed discussion of these ideas is worth quoting at some length, since the broad thrust of his argument is applicable in large measure to many other religious maps from India:

> We now see the Benares pilgrims' map in a different light and can understand the peculiarities of its design and codification. Like any map, no matter in what cartographic system, it represents only a selected range of information: the city, the tirthas, and the circumambulatory path. No attempt is made to represent distances and sizes to scale, to differentiate between private and public space, to show the circulatory system, the technical infrastructure, the topographical features or other characteristics considered essential in Western cartography. Instead, it holds just sufficient factual information about the holy sites to enable the

155. Jan Pieper, "A Pilgrim's Map of Benares: Notes on Codification in Hindu Cartography," *GeoJournal* 3 (1979): 215–18, esp. 215.

> pilgrim to find his way around. But at the same time, the Square and the Circle, as well as other details of the map . . . provide unequivocal symbolic information about the ideas the city represents as a whole. The apparent "incorrectness" of the map, therefore, is no indicator of cartographic incompetency, but it is the consequence of a compromise between representation and interpretation, a compromise that characterizes the fundamental objectives of the city and at the same time they indicate how they are to be perceived. They hold information on two planes, factual and symbolic, and here Hindu cartography is certainly characteristic of all the traditional arts and sciences of India, which are often syncretistic beyond their proper objects of investigation, as their main concern is to be both instructive and educational.[156]

Much more abstract than these works made for pilgrims coming to Varanasi are two maps from Nepal. One of these presents the city of Kathmandu in the shape of its characteristic icon, a sword, which in Hindu mythology symbolizes enlightenment. The axis of the sword runs from southwest (at the hilt) to northeast, paralleling the main thoroughfare of the city, which forms part of the link from India to Tibet. Ranged along the edges of the blade are a series of thirty-three miniscule named gates representing each of the city's premodern urban quarters (*tola*s). Despite this radical topological distortion of the city's actual spatial configuration, the map is one of the very few from South Asia that incorporates a compass rose, a foreign embellishment that here serves no obvious purpose. Conceivably the directions the *tola*s face with respect to the city as a whole are not to be understood in any literal geographic sense (as azimuths), but rather are related to some particular conception of the city's cosmological setting.[157]

The second of the two Nepali religious maps (fig. 17.46), brought to light in a fascinating article by Bernhard Kölver,[158] relates to several groups of religious sites within the city of Bhaktapur, not far to the east of Kathmandu. This map, clearly meant to serve as a mandala (an object of meditation), is a curious mixture of modern and traditional elements. It was commissioned about 1925 by a Newari Brahman, "the father of [its] present owner, who claims . . . that in designing the painting his father drew upon a similar, older map which might even today be kept somewhere in the house of the family."[159] A brief search, however, failed to turn up the original. The portion of the painting that appears relatively modern is the naturalistic rendition of mountainous landscapes in cartouches along the four edges of the map, which may or may not relate to the actual scenery as viewed from Bhaktapur. Otherwise the painting is a rendition of the religious geography of the city. "Not only can most of the deities depicted be actually found within the town [their shrines are located there], but the relative position of shrines is exactly mirrored in the painting."[160]

What the painting actually depicts is shown, in part, by figure 17.46*b*. The figures in the outermost of the three rhomboids of the map represent the shrines of eight mother goddesses (Aṣṭamātṛkās). The middle rhomboid shows two sets of figures, one with and the other without surrounding halos, respectively representing shrines to two additional sets of eight deities each, known as Bhairavas and Siddhas, the former being the more potent. Similarly, the innermost rhomboid represents two more sets of eight deities each, Gaṇeśas, and a group whose identity is in some question. Finally, within the innermost rhomboid, a red triangle also includes two groups of deities, three more Gaṇeśas and three deities associated with the New Year festival, the most important period in the Bhaktapur calendar. Space does not allow me to report the systemic interconnections among these several groups, as explained by Kölver, but they are rooted in Nepalese sacred texts and exemplified not merely in the map but also in local architecture and ritual dance performance.

In describing the underlying purpose of the mandala map of Bhaktapur, Kölver, quoting Tucci, sees it as "a map of the cosmos, . . . the whole universe in its essential plan, in its process of emanation and reabsorption." Such a process, Kölver adds, "is often visualized in a series of deities of ever more universal scope, the nearer we come to its centre."[161] Tucci puts the matter thus: "Transfiguration from the plane of *saṃsāra* [the cycle of transmigration] to that of *nirvāṇa* [the state of final bliss] occurs in successive phases, by degrees; just as on the cosmic mountain and around the *axis mundi* are disposed, rank after rank, one above the other, the Gods ever purer."[162] Thus, Kölver concludes, "the town of Bhaktapur," like the map, "is itself a maṇḍala."[163]

As found in connection with the Jagannath temple in Puri, there still exists in the small Rajasthani temple town of Nathdwara a group of hereditary artists whose func-

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156. Pieper, "Pilgrim's Map of Benares," 218 (note 155).

157. Illustrated in Jan Pieper, *Die Anglo-Indische Station: Oder die Kolonialisierung des Götterberges*, Antiquitates Orientales, ser. B, vol. 1 (Bonn: Rudolf Habelt Verlag, 1977), 114, with relevant text on 99.

158. Bernhard Kölver, "A Ritual Map from Nepal," in *Folia rara: Wolfgang Voigt LXV. Diem natalem celebranti*, ed. Herbert Franke, Walther Heissig, and Wolfgang Treue, Verzeichnis der Orientalischen Handschriften in Deutschland, supplement 19 (Wiesbaden: Franz Steiner, 1976), 68–80.

159. Kölver, "Ritual Map from Nepal," 68, n. 1 (note 158).

160. Kölver, "Ritual Map from Nepal," 68 (note 158).

161. Kölver, "Ritual Map from Nepal," 77–78 (note 158). The work cited is Giuseppe Tucci, *The Theory and Practice of the Maṇḍala: With Special Reference to the Modern Psychology of the Subconscious*, trans. Alan Houghton Brodrick (New York: Samuel Weiser, 1970; first published 1969), 23.

162. Tucci, *Theory and Practice*, 29 (note 161).

163. Kölver, "Ritual Map from Nepal," 78 (note 158).

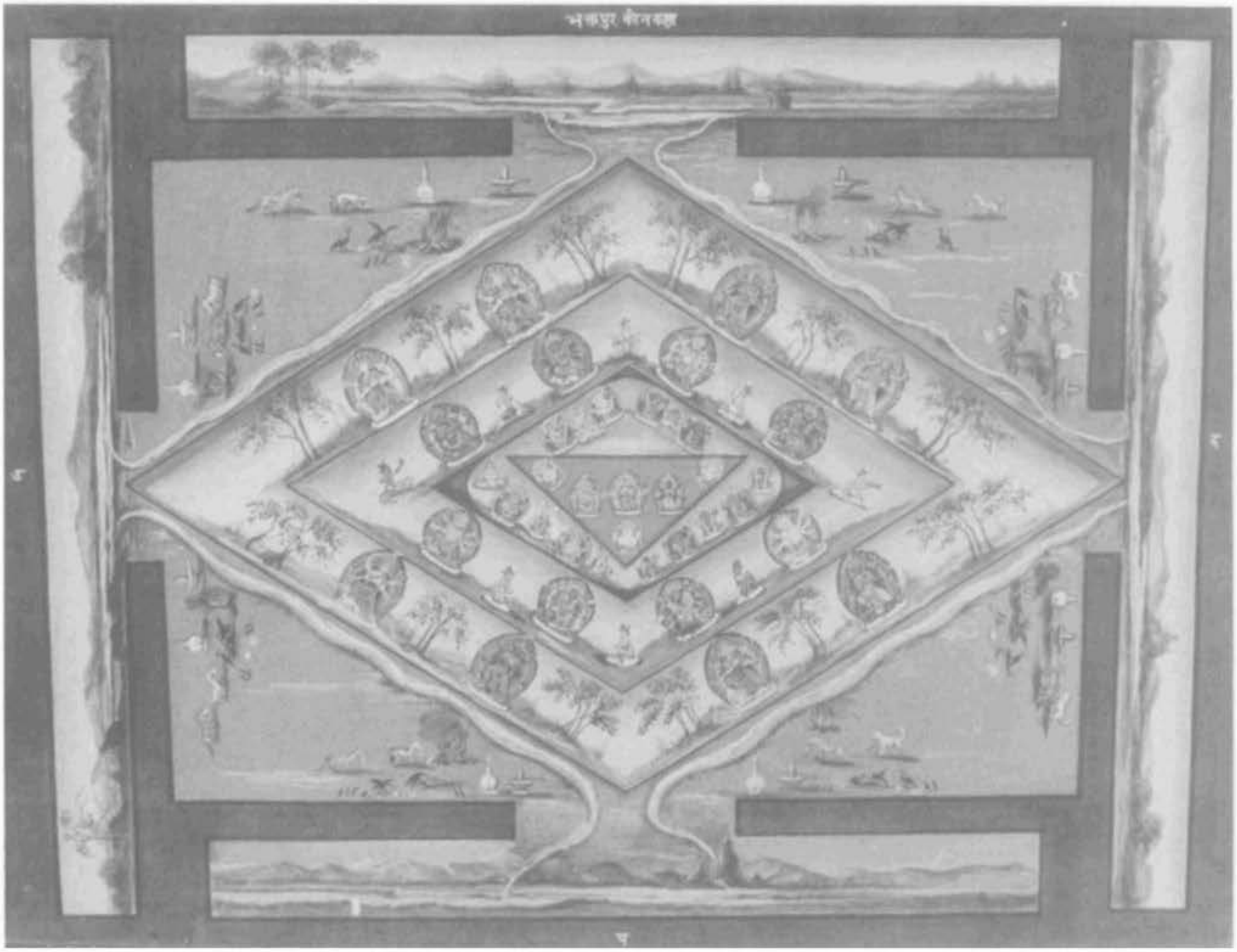
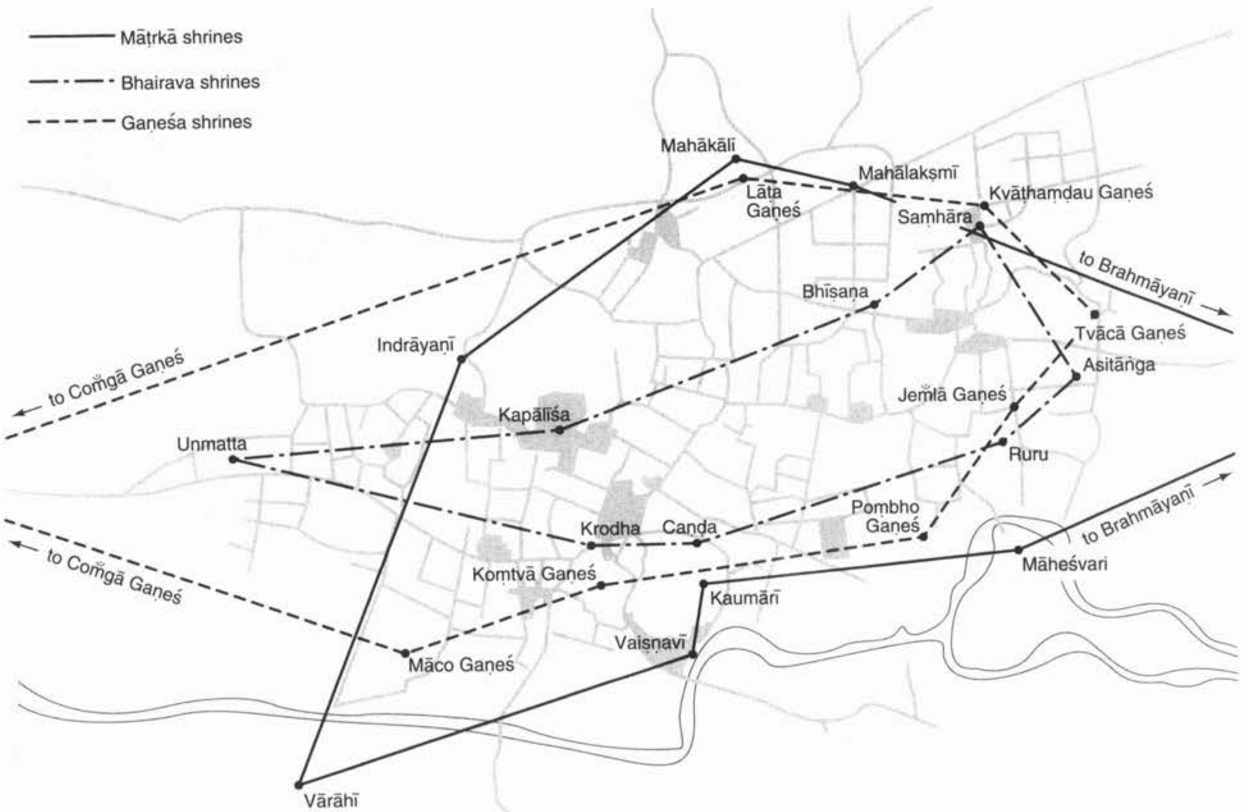


FIG. 17.46. MANDALA MAP OF BHAKTAPUR, NEPAL. This Newari map, ca. 1925 (based on an older model), is painted on paper (?). The highly abstract set of images represents, in the form of three rhomboids around a triangle, a number of important shrines and sacred precincts of the city of Bhaktapur. The mountains on the horizon are naturalistically painted on all four edges of the map. A modern map of the town (on the right) shows the Mātṛkā, Bhairava, and Gaṇeśa shrines associated with the outermost, second, and innermost rhomboids, respectively. Additional identifiable features are plotted by Bernhard Kölver on a second modern map of Bhaktapur ("Ritual Map from Nepal," 70) not shown here.
Size of the original: not known. In the collection of Pandit Ratnaraj Sharma of Ichu, Bhaktapur. Photograph courtesy of Jan Pieper, Berlin.
The modern map is after Bernhard Kölver, "A Ritual Map from Nepal," in *Folia rara: Wolfgang Voigt LXV. Diem natalem celebranti*, ed. Herbert Franke, Walther Heissig, and Wolfgang Treue, Verzeichnis der Orientalischen Handschriften in Deutschland, supplement 19 (Wiesbaden: Franz Steiner, 1976), 68–80, esp. 72.

tion is to serve the needs of the temple and the many pilgrims who come there throughout the year to pay homage to Krishna. There is an easily recognizable Nathdwara style of devotional painting that includes among its works a number of maplike paintings of the Nathdwara and nearby temple complexes (e.g., items n, r, s, and t in appendix 17.6). These skillfully rendered works convey an impression of considerable verisimilitude and thus stand in marked contrast to the other religious maps discussed to this point. Yet they are no less charming in their depiction of details of human interest relating to the ritual and profane activities that mark the religious calendar of the Vallabhacharya sect that provides the principal support for the temples. Figure 17.47 is a good example of the genre.[164]

164. A particularly good color reproduction of a small part of one of the Nathdwara paintings appears in Talwar and Krishna, *Indian Pigment Paintings*, pl. IV (note 63). Black-and-white pl. 3 is also quite useful in that it is printed with a transparent overlay on which are identified, in translation, the more important components of the Nathdwara complex.



Another rather detailed painting, one of a relatively small number of religious maps from southern India, is the plan of the Vaishnavite Srirangam temple in Tamil Nadu, the largest of all Dravidian temples (fig. 17.48). This is one of four plans in a bound album of religious paintings, in ninety-one folios, on European paper with an 1820 watermark and a date of about 1830. The text for all captions in the album is in Telugu, the official language of the Indian state of Andhra Pradesh, but the four plans included (all listed under item kk in appendix 17.6) are all of temples in the more southerly state of Tamil Nadu: Srirangam; the nearby Shaivite temple of Jambukeswaram; the Mīnākṣī temple in Madurai; and the temple at Rameswaram. The plans of the first three temples are executed in a more or less consistent style emphasizing the successive temple enclosures, the great temple gates (*gopurams*) on all four sides of the temples, and the deity to whom each temple was dedicated. The painting of Rameswaram, however, is considerably more abstract. The most prominent features of this work are its set of four nested fields of Shiva *liṅgams* around a single large central *liṅgam* and its set of four images of the elephant god Gaṇeśa at points that presumably signify the main temple gates at the midpoints of the four walls of the temple.[165] Another painting of Srirangam, fairly similar to figure 17.48 but of unknown date and provenance, is that described as item ll in appendix 17.6.

Strikingly different from the relatively rigid style of the plan of Srirangam are the 238 maps of *tīrtha*s (pilgrimage places) in Kashmir that are bound in two albums held by the Sri Pratap Singh Museum in Srinagar (plate 37). These gay, primitive renditions of the precincts of an exceptionally large number of sacred localities in Kashmir have a naive charm and exuberance that is characteristic of the maps of no other region, especially those—166 in all—that are in color.[166]

Pilgrimage, as we have seen, is as much a part of the Jain tradition as it is among India's Hindus, and Jain art abounds with images relating either to the act of pilgrimage or to the shrines that are the object of Jain pilgrimage. It is often difficult to decide, in viewing such paintings, whether they ought to be classified as maps, and one could make a case for including a substantially larger number of Jain paintings in the listing. Of all the Jain pilgrimage places, none is more popular than the vast

165. The album of paintings is in the Department of Oriental Antiquities of the British Museum, London, and bears the catalog no. 1962-12-31-013. The relevant folios are 1 (Srirangam), 59 (Rameswaram), 61 (Mīnākṣī), and 71 (Jambukeswaram).

166. Gole, *Indian Maps and Plans*, 129–31 (note 1), provides illustrations of fifteen of these maps (twelve in color) and a brief textual account of the probable circumstances in which they were made.

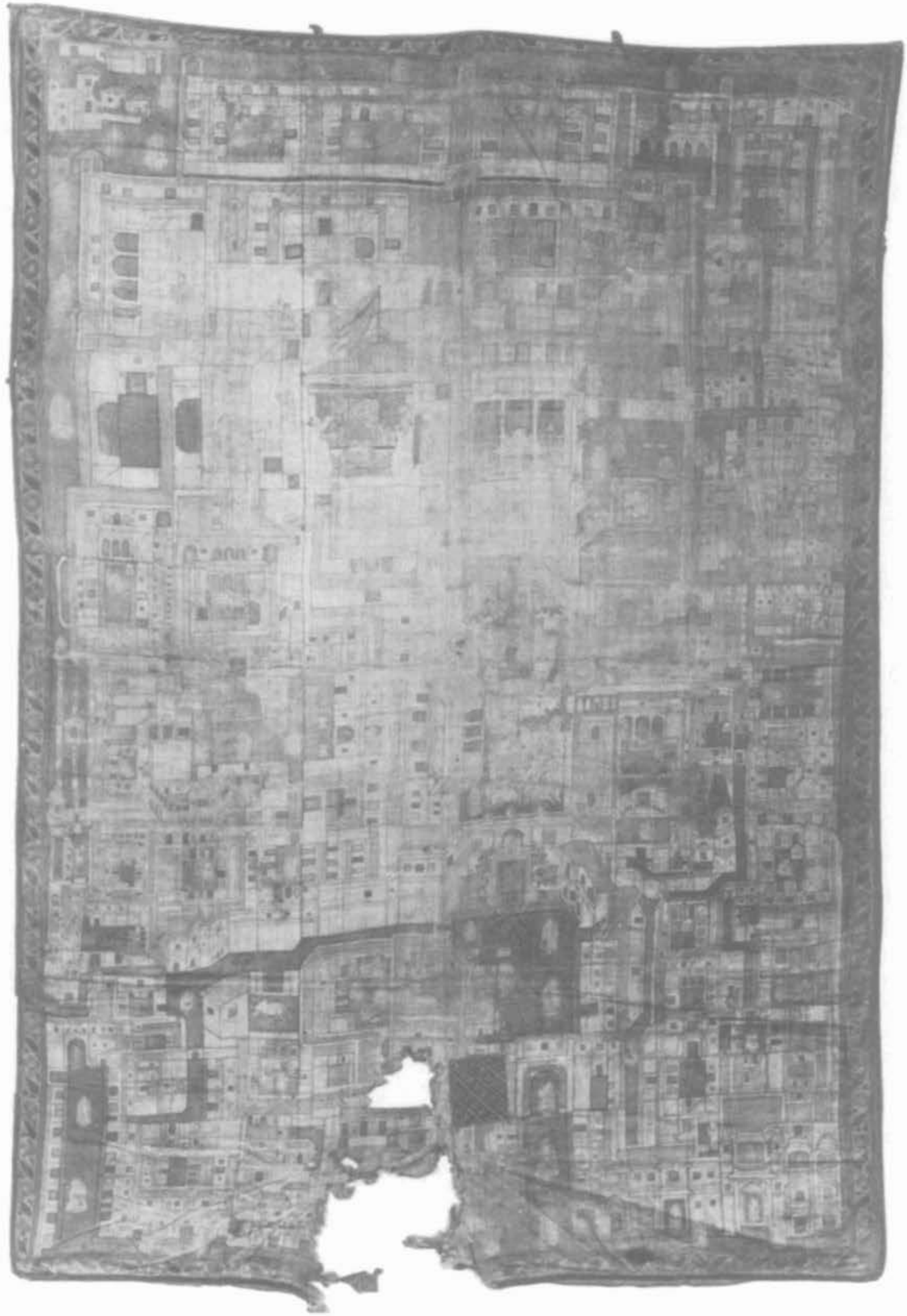


FIG. 17.47. NATHDWARA TEMPLE COMPLEX. This Nathdwara, Rajasthan, twentieth-century map is a *pichhvāī* painted on cloth. It depicts the Shrinathji temple complex with a festival being celebrated within the temple precincts. Despite the recency of this painting, it has faded badly and has lost much of its presumed original multihued luster.
Size of the original: 169 × 119 cm. By permission of the Calico Museum of Textiles, Sarabhai Foundation, Shahibag, Ahmadabad (acc. no. 1561).

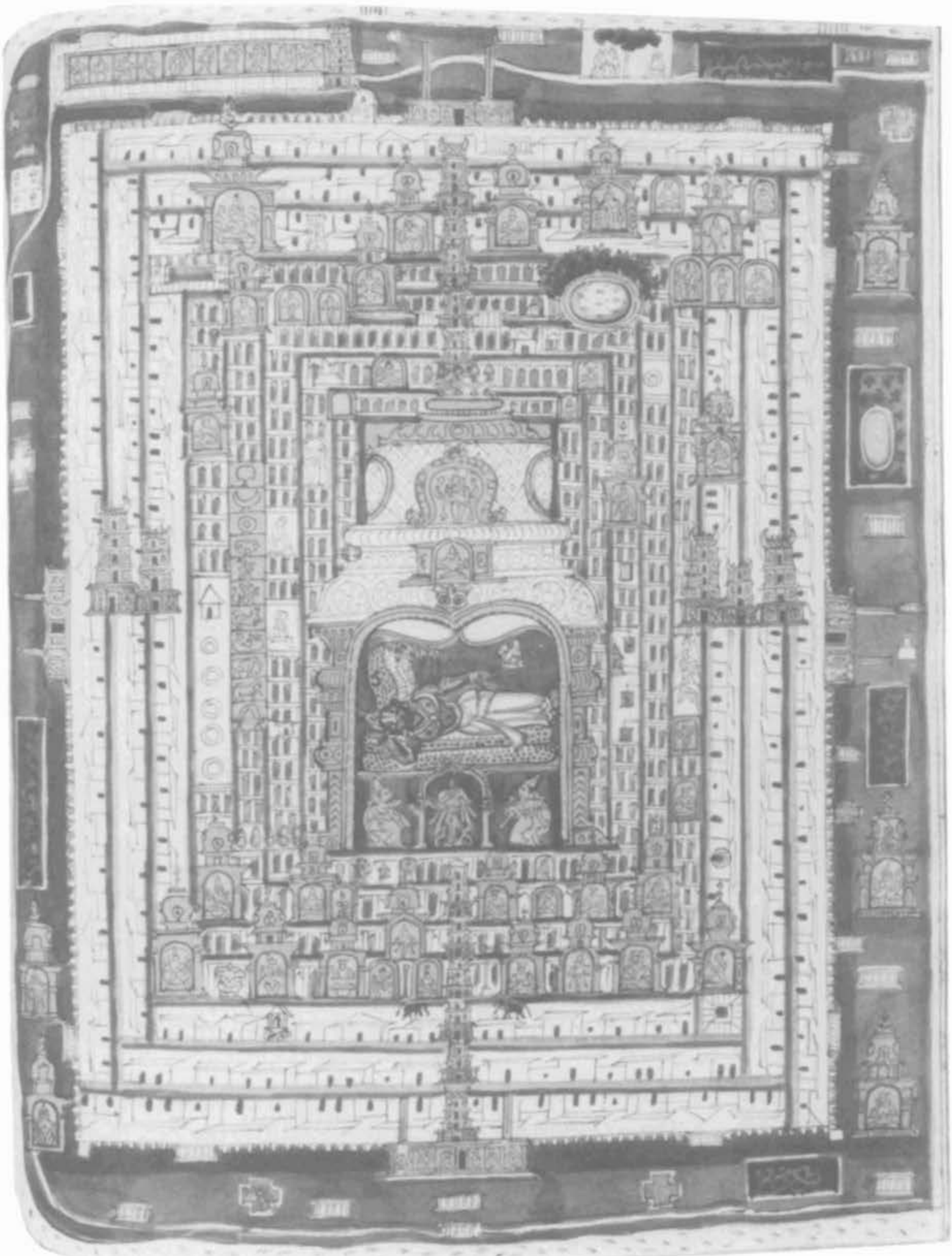


FIG. 17.48. SRIRANGAM TEMPLE, SRIRANGAM, TAMIL NADU. From an album of religious paintings, this maplike view is from South India, ca. 1830 (paper watermarked 1820). For additional details on the other maplike folios in the album, see appendix 17.6, item kk.

Size of the original: 22.6 × 17.6 cm. By permission of the Trustees of the British Museum, London (1962 12-31 013, fol. 1).

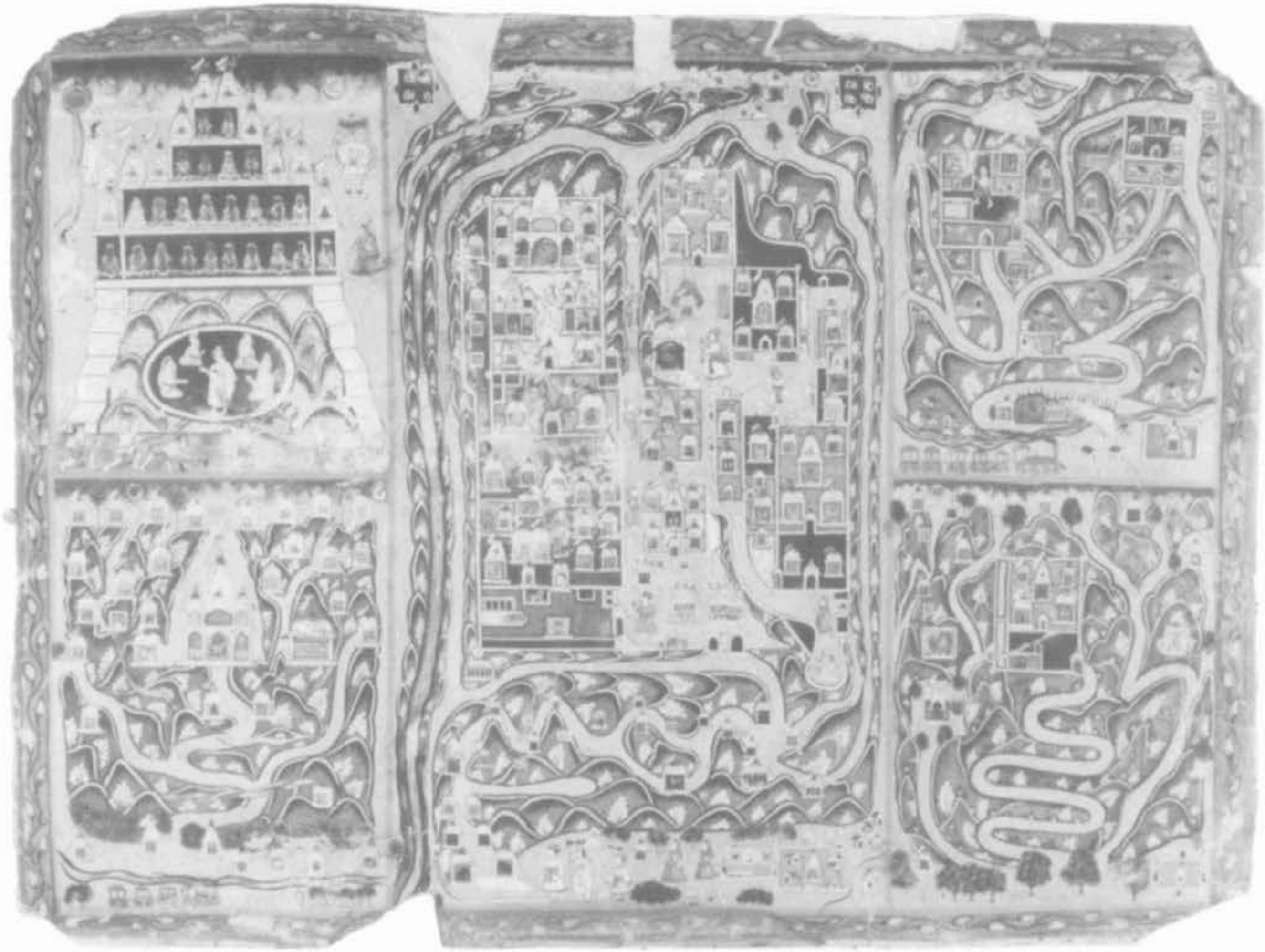


FIG. 17.49. JAIN TRIPTYCH. This work celebrates five of the most sacred places of Jain pilgrimage: Shatrunjaya Hill temple complex at Palitana in Gujarat (*center*), with its eight hundred temples; the ancient site of Prabhasa, also in Gujarat (*upper left*); Parasnath Peak in Bihar (*lower left*); Mount Abu in Rajasthan (*upper right*); and Mount Girnar, in Gujarat (*lower right*). The triptych is gouache on paper, Gujarat, mid-nineteenth century.
Size of the original: 56.5 × 76 cm. Private collection.

complex of more than nine hundred temples and shrines on Shatrunjaya Hill, rising in the Gir Mountains above the town of Palitana in the Saurashtra region of Gujarat (items u–x in appendix 17.6). Not surprisingly, therefore, it has been for centuries a subject for religious maps. Most of these maps are similar in their more or less oblique perspective, though they tend to take on a planimetric appearance because the steep rise of the hillside puts the surface closer to a right angle with the painter's hypothetical line of sight. Stylistically, however, they vary considerably. The special place that Shatrunjaya holds in the hearts of pious Jains is evident from the central position it is accorded in the unique triptych illustrated in figure 17.49, on which five major Jain *tīrtha*s are represented.[167]

The next illustration of a religious map also relates to the Jain religion and presents a genre unique to that faith. Among the several types of scroll paintings produced by Jains, those known as *vijñaptipatra*s were sent by local Jain communities as invitations to pontiffs of their faith requesting that they visit the community during the four months or so of the rainy season to impart instruction and other religious services. The scrolls, of which figure 17.50 is an example, were decorated with illustrations of what a pontiff would see en route to and in the city that was inviting him, seemingly to heighten the attractiveness of the request. Gole has seen and illustrated two such scrolls.[168] At present one can say very little about the cartographic principles, if any, that they embody. It appears, however, that what is shown may vary enor-

167. The present location of the triptych is not known. Talwar and Krishna, *Indian Pigment Paintings*, pp. 82–89 and pls. IX (color) and 86–89 (black-and-white) (note 63), provide detailed descriptions and excellent illustrations of four other large cloth wall hangings depicting Shatrunjaya.

168. Gole, *Indian Maps and Plans*, 54–55 (note 1).

FIG. 17.50. *VIJÑAPTIPATRA* SCROLL, JAISALMER, RAJASTHAN. This scroll painting (*vijñaptipatra*), 1859, painted on paper, was sent by Jains of Jaisalmer to Jain pontiffs inviting them to visit that city. It depicts places along the route to be followed and shows the city of Jaisalmer in oblique perspective and considerable detail.
Size of the original: 887.5 × 24.5 cm. By permission of the Oriental Institute, M.S. University of Baroda (acc. no. 7572).

mously in scale from one part of a scroll to another, so that, for example, a few shops along the pontiff's route may be shown as large as an entire city (e.g., Jaisalmer in the figure). We do not know if the order of objects encountered along a particular route is properly maintained on the scroll, though that seems likely, nor have we any idea what considerations guided the artists' choice of what to show or omit.[169]

A survey of appendix 17.6 reveals that a number of religious maps employing traditional modes of presentation date from as recently as the late nineteenth century or even from the twentieth. Obviously this suggests a cultural predisposition for using established semiological traditions in preference to pursuing accuracy as it is understood in modern Western cartography, even when there is no obstacle to attaining the latter goal. Thus, although the first large-scale modern surveyed map of Varanasi was prepared by J. Prinsep in 1822 and published in London three years later,[170] and though subsequent maps by the Survey of India have also portrayed the city in great detail, since 1875 numerous maps have been printed on cloth and on paper that adhere to an altogether different view of the city (e.g., fig. 17.45). This type of view is better suited to the needs of the millions of Indian pilgrims who throng there each year to bathe in the Ganga, obtain religious instruction, and seek redemption from their sins.[171] Similar maps exist for numerous other sacred places in India.[172] They are made not only for Hindus and Jains, but even to show the shrines of Muslim saints, despite the abhorrence within orthodox Islam for the use of graven images to represent religious figures.[173]

169. A substantial part of the four relatively small excerpts from *vijñaptipatras* illustrated by Gole (*Indian Maps and Plans*, 54–55 [note 1]) appears not to be cartographic in nature; but seeing the illustrations apart from the larger scroll context, I cannot be certain about this.

170. James Prinsep, *Views and Illustrations at Benares* (London, 1825).

171. Pieper's article on this subject, "Pilgrim's Map of Benares" (note 155), is particularly instructive. See also Pieper, *Die Anglo-Indische Station*, 32 (note 157).

172. I am indebted to H. Daniel Smith of Syracuse University, New York, for making a number of such maps known to me and providing me with color transparencies of them. The places in question (all Hindu shrines) are Allahabad, Ayodhya, Badrinath, Gaya, Hardwar, Kedarnath, Palni, and Puri, all plotted on figure 17.37. Additional recent pilgrim maps of similar style depict the following places: Dwarka, in Gujarat (two maps, sent to me by Arthur Duff on 29 August 1989); Girnar, a Jain *tīrtha*, in Gujarat (shown to me by Simon Digby of Rozel, Jersey); Pavagarh, another Jain shrine, in Gujarat (in the Department of Oriental Antiquities, British Museum, London, cat. nos. 1989 2-4.027 [4] and [5]); and the shrine of the new Santoshi Mata Hindu cult in Jodhpur, Rajasthan (published in Michael Brand, "A New Hindu Goddess," *Hemisphere: An Asian-Australian Magazine* 26 [1982]: 380–84, photo on 382).

173. I am indebted to Simon Digby for showing me, among other works, pilgrimage maps for the following Islamic shrines: the tomb of

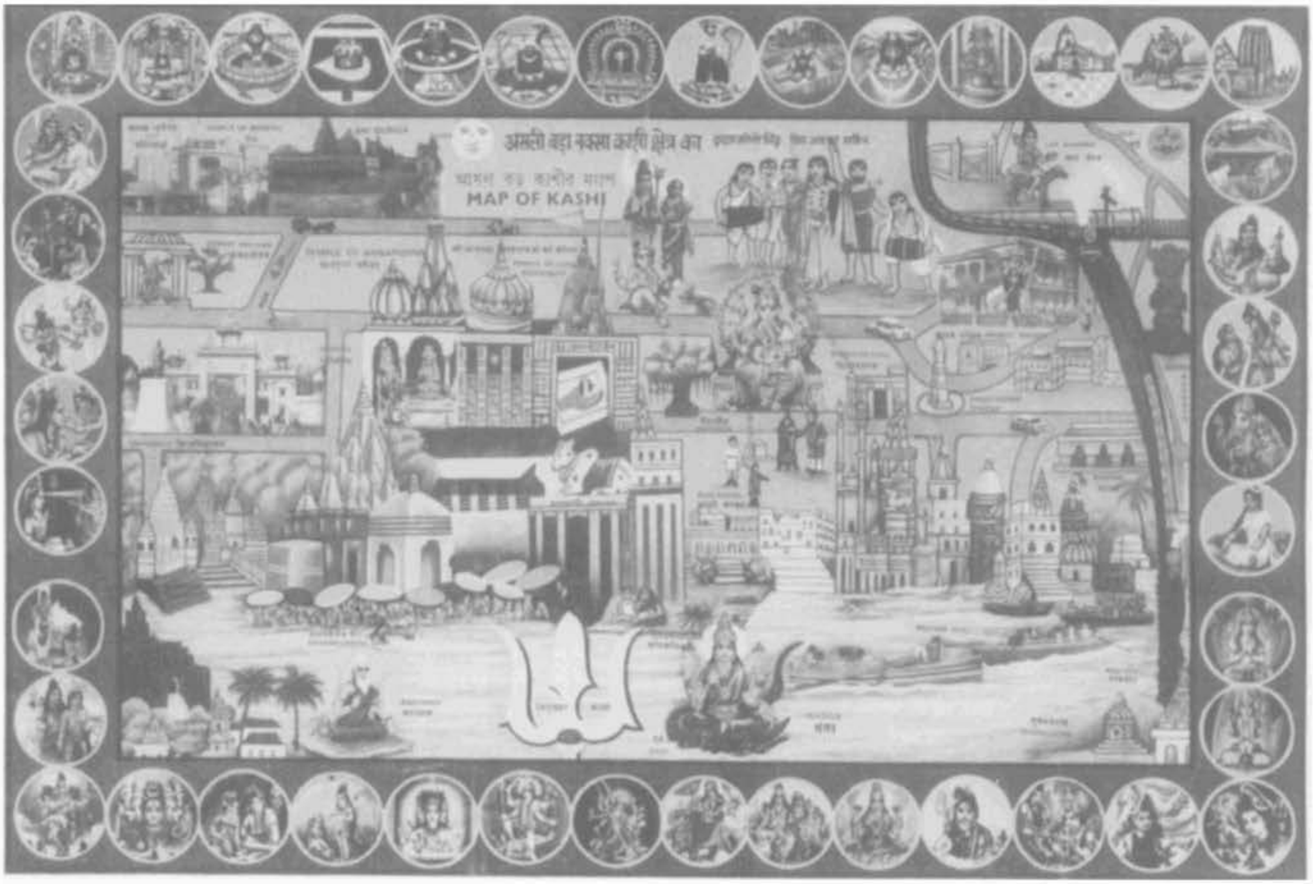


FIG. 17.51. CONTEMPORARY RELIGIOUS MAP OF KĀSHĪ (VARANASI). Cheap printed paper maps such as this one exist for a large number of sacred places in India. Despite the modern technology in their production, the cartographic conventions employed are essentially traditional.
Size of the original: 22 × 33 cm. From collection of Joseph E. Schwartzberg.

The maps currently being produced (e.g., fig. 17.51) are characteristically cheap and vulgar, printed in gaudy colors on poor paper to be sold at prices that range from less than a rupee (roughly ten cents) to no more than a few rupees. The information such maps provide is highly selective. Apart from the major shrines and other religious sites and the routes of some of the more popular pilgrimage circuits in and around the city (e.g., that of the *pāñcha koshi yātrā* in Varanasi), there may also be information on transportation (e.g., railroad and bus stations) and perhaps a few other secular features such as police stations, major public buildings, universities, and possibly even the major bazaar. Along the map borders are typically portrayed the images of a host of major and minor deities and the icons associated with them. Map text is often, if not generally, multilingual and may include not only Hindi and English but the local language of the sacred city (if other than Hindi) and possibly one or more other languages. Figure 17.37 shows cities and shrines for which printed religious maps in an essentially traditional style are known to exist. Diligent research would undoubtedly reveal a number of others, since the printing of popular religious maps began more than a century ago. (Except for three nineteenth-century maps of Varanasi on cloth, none of the printed maps of Indian religious sites are listed in appendix 17.6.)[174]

MAPS OF FORTS

Appendix 17.7 provides information on maps, plans, and

Khwāja Muʿin al-Dīn Chishti at Ajmer; the Hill of Hājjī Malang at Kalyan, near Bombay; the tomb of Sailānī Shāh at Malkapur, southeast of Bombay; the tomb of Amīr Sayyid Husayn Khingsawāi at Taragarh, a hill fort overlooking Ajmer; and (not noted on fig. 17.37) maps printed in India of several sacred places in Palestine and Saudi Arabia.

174. The oldest pilgrimage map printed on paper that I have seen is in the Bayerische Staatsbibliothek (Cod. Hind. 16). It was printed in the late nineteenth or early twentieth century in black and subsequently was partially and crudely hand colored in red and yellow. The printed area measures 48.5 by 61.5 centimeters. In general, the map resembles that in figure 17.45 but is somewhat more detailed.

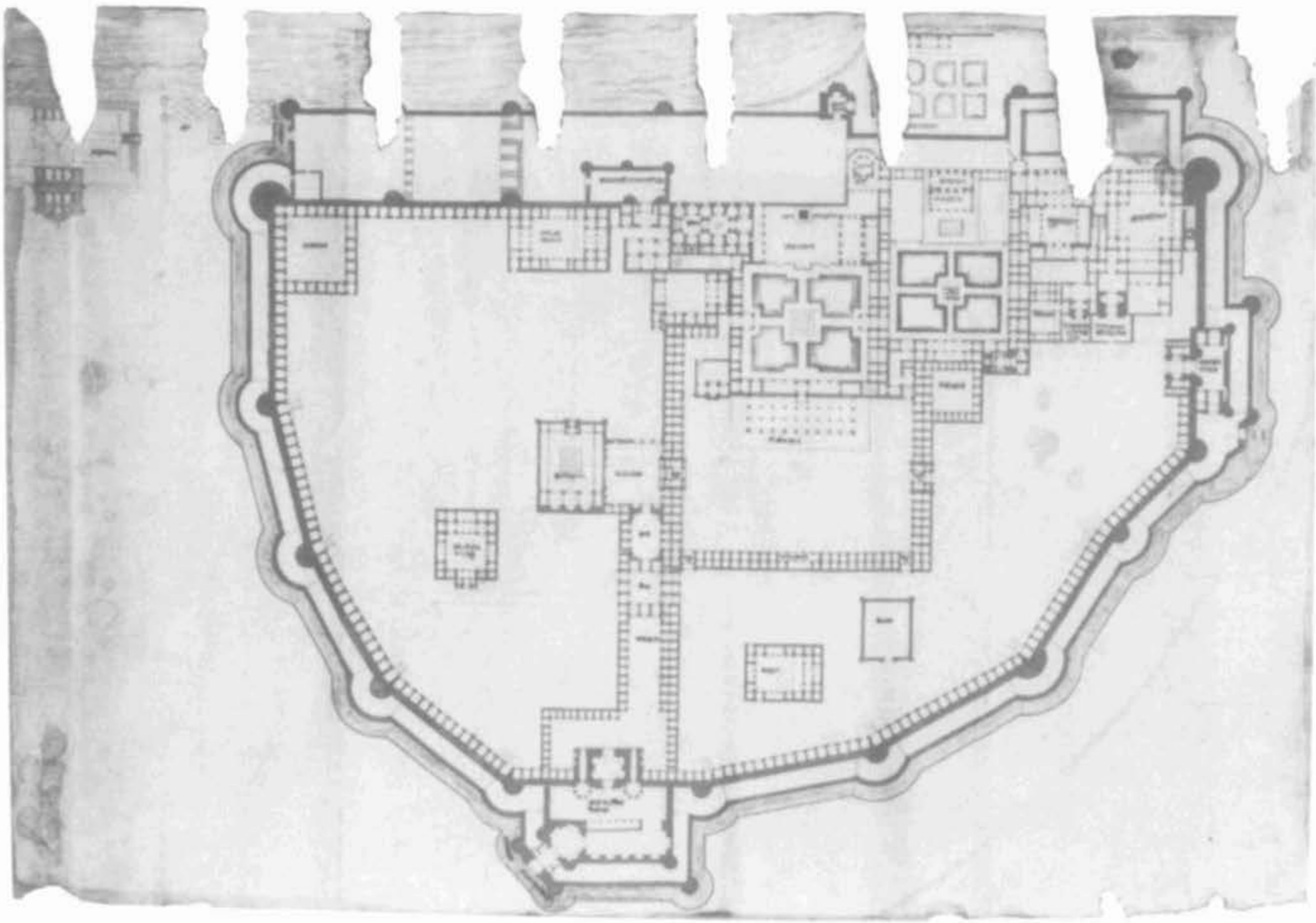


FIG. 17.52. RED FORT, AGRA. This North Indian artifact is dated from the mid-eighteenth century, painted on paper, with text in Hindi. Size of the original: 83 × 121 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 125). Photograph courtesy of Susan Gole, London.

maplike oblique views of forts. In marked contrast to the religious maps just discussed, these works tend to be both simpler and more exact, as one would expect given their generally utilitarian purposes (see, e.g., fig. 17.52). There are, however, some notable exceptions to these generalizations. Although most of the maps of forts seem to be related to military intelligence, planning, administration, or instruction (e.g., fig. 17.53, item s in appendix 17.7), some were obviously made to commemorate battles and sieges in which the mapmaker had an interest (e.g., fig. 17.55 below and items f [plate 38] and n in appendix 17.7). Still others were undoubtedly decorative and were prepared, sometimes in meticulous detail, for the delectation of the royal patrons of court artists. Among the latter group were carefully executed perspective views much like those noted for various Indian cities or major parts of them (e.g., appendix 17.7, item j).

In most of the indigenous representations of forts that we are considering, an overall planimetric perspective predominates, at least for the disposition of the major features portrayed, especially the major walls, moats, approaches, interior courts, tanks, and so forth. But individual portions of some of those features, especially city walls, may be portrayed as if viewed either from the ground or, less commonly, from an assumed oblique perspective (e.g., fig. 17.54, item m in appendix 17.7). The same is true of specific edifices within the forts, such as residential structures, temples and mosques, command posts, and the like. In this regard indigenous maps of forts scarcely differ from maps of cities. There is, however, much less likelihood that they will be crowded with decorative detail that serves no obvious purpose other than to fill map space. Nevertheless, open water next to coastal forts may still be filled with ships in full sail, and rivers may teem with fish, turtles, and crocodiles.

None of the works listed in appendix 17.7 dates from earlier than 1735 (item m). It seems highly probable, therefore, that European influences have figured in shaping both the style and the content of many of them. The compass rose on the map of Vijayadurg (fig. 17.53), for example, is surely of European inspiration. Europeans served as advisors to Indian princes in military matters, and many mercenaries were officers in Indian armies, especially overseeing the use of artillery. Though no record has been found of any such European's imparting cartographic instruction to Indians (as undoubtedly happened beginning in the late eighteenth century, if not

FIG. 17.53. MAP OF VIJAYADURG. This Maratha map, dating from the eighteenth century, is painted on paper backed by cloth, with text in Marathi in both Devanagari and Modi scripts. The map details walls, bastions, gun turrets, other emplacements, water tanks, ammunition dumps, and residential buildings. The nearby terrain features are sketched in, well-drawn European ships are shown offshore, and a compass rose is depicted in the middle of the fort.
Size of the original: 190.5 × 172.5 cm. By permission of the Prince of Wales Museum of Western India, Bombay (cat. no. 53.102).

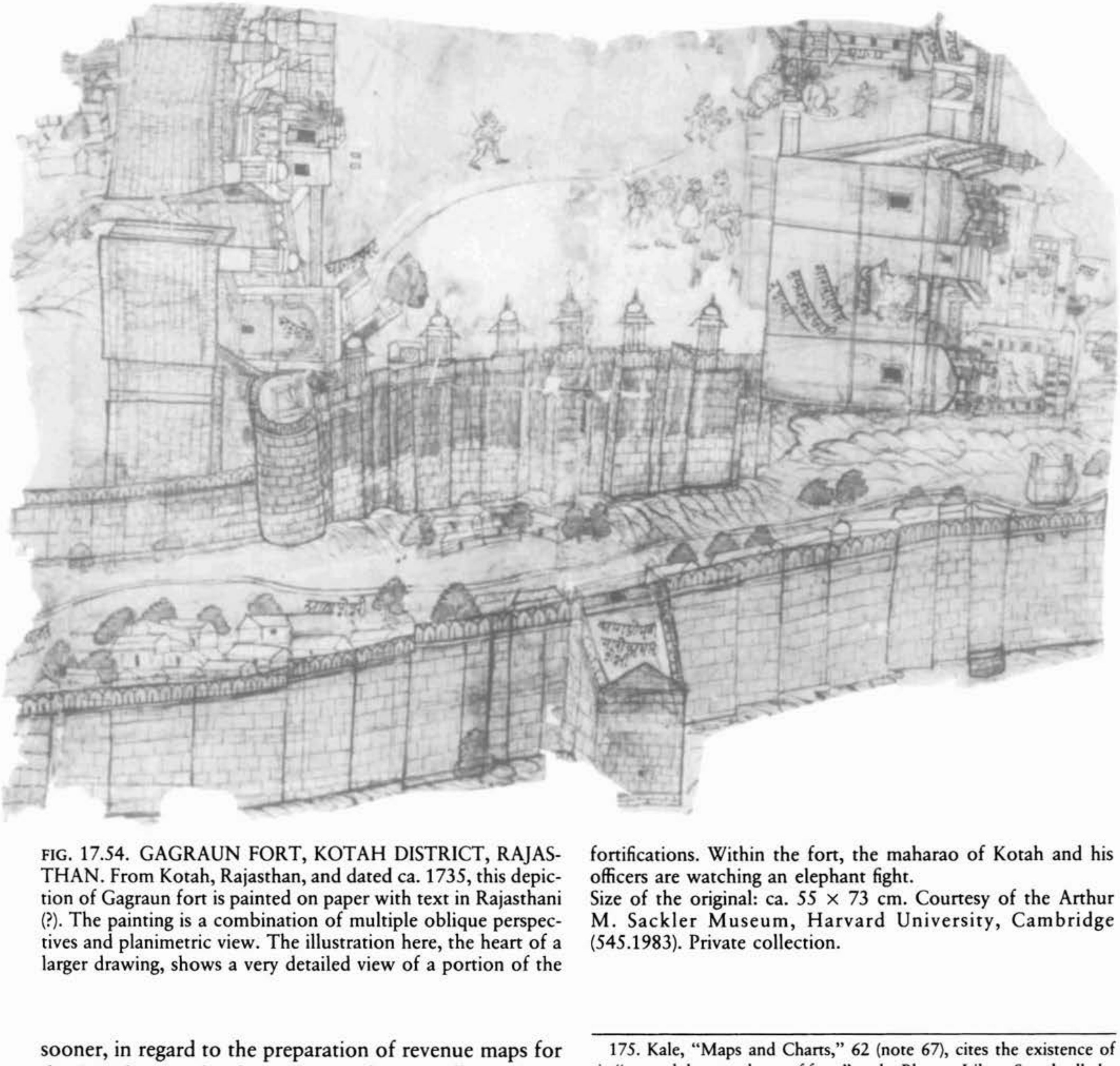


FIG. 17.54. GAGRAUN FORT, KOTAH DISTRICT, RAJASTHAN. From Kotah, Rajasthan, and dated ca. 1735, this depiction of Gagraun fort is painted on paper with text in Rajasthani (?). The painting is a combination of multiple oblique perspectives and planimetric view. The illustration here, the heart of a larger drawing, shows a very detailed view of a portion of the fortifications. Within the fort, the maharao of Kotah and his officers are watching an elephant fight.
Size of the original: ca. 55 × 73 cm. Courtesy of the Arthur M. Sackler Museum, Harvard University, Cambridge (545.1983). Private collection.

sooner, in regard to the preparation of revenue maps for the British), it is hard to imagine that an officer whose advice was sought in one domain would feel constrained not to offer advice in another that was closely related to the art of warfare.

Numerous South Asian maps of forts exist in addition to those listed in appendix 17.7. Not included there, but plotted on the map in figure 17.37, are the sites of half a dozen other relatively sketchy maps, all attributable to the Marathas, who were the dominant military power in India during much of the eighteenth century and remained a major military force until 1819. Not plotted on the map are the sites of eight more mapped forts that have not yet been located.[175]

Battle maps of the type found in Western military cartography and history textbooks are not to be found

175. Kale, "Maps and Charts," 62 (note 67), cites the existence of six "groundplans or charts of forts" at the Bharata Itihasa Samshodhaka Mandala in Pune but describes none of them. Of the six, he was able to derive the names of five: Sajjangarh, which I have plotted, plus Adgad, Chandan, Nandgiri, and Vandan, which I was unable to locate. I also saw in that library and plotted a map of Narayangarh fort in Savantvadi (not named, but identified for me by C. D. Deshpande, who assigns the work to the mid-eighteenth century). This work is illustrated in Gole, *India within the Ganges*, 18 (note 74). Deshpande, "Maratha Cartography," 89 (note 67), notes the existence at the Prince of Wales Museum of Western India in Bombay of rough sketch maps of Badami and Janjira. Though neither of these could be traced on visits by Schwartzberg and Gole, the sites have been plotted on figure 17.37. There are two additional maps at that museum: one depicting the fort at Bombay and its environs (cat. no. F/262), "prepared for the Peshwa by the Peshwa's agent in Bombay about 1770," and a second moderately detailed map of an unidentified fort (cat. no. 24/423). Of these, the former is illustrated by Gole, *Indian Maps and Plans*, 144 (note 1), but the latter seems recently to have "disappeared." Finally, at the

in the traditional South Asian corpus; though some maps do identify the combatants and even individual units and commanders in specific engagements (e.g., items f [plate 38], n, and p in appendix 17.7). Additionally, battle plans may have been drawn either to impart tactical instruction or to prepare for specific engagements. I have not included any of these plans in appendix 17.7, but Gole does illustrate one such work. Though meticulously executed, this detailed drawing remains enigmatic in that it has no text to inform readers of its precise purpose and specific place of reference, if any.[176]

Paintings of battle scenes, both real and mythical, are popular in Indian art. Most such paintings, one may assume, are based mainly if not entirely on the artist's imagination. Nevertheless, there are a few works that appear to have a genuine concern with showing the actual disposition of the opposing forces and depicting something of the terrain over which the combat took place. Particularly dramatic examples of this type relate to the battles of Sāmūgarh (1658) and Panipat (1739). The former was the climactic struggle near Agra at which Aurangzīb defeated his older brother Dārā Shikōh in their contest for succession to the Mughal throne. This remarkably detailed miniature (22.6 × 32.7 cm), held by an anonymous owner, is illustrated and discussed by Milo Beach, according to whom the action in the scene depicted conforms to the eyewitness account of the Venetian traveler Niccolò Manucci.[177] The second painting (fig. 17.55), also a miniature, relates to a battle at which an Islamic alliance led by the Afghan Ahmad Shāh Durrānī decisively defeated the Marathas defending Delhi, which the latter had occupied only a year before. The work was drawn in black, with some color added, on paper (subsequently backed with cloth) and is exceedingly rich in detail. The names of the principal combatants are inscribed in Persian characters, and a portion of a town, presumably Panipat, is shown in the lower left corner of the painting. Although the individuals depicted vary enormously in size depending on their relative importance, one senses in viewing the work that the artist sought to render a faithful view of how the battle lines were arrayed.[178]

Architectural Drawings

Here we consider the great diversity of South Asian drawings that relate in various ways to architecture (including landscape architecture). The purposes of these drawings vary greatly. A number were plans made to guide construction projects. Others were meant to record specific accomplishments. At least one served a legal purpose in respect to a deeded property.

We may recall in passing that the oldest of all South Asian cartographic artifacts to which we can assign an approximate date are a number of inscribed potsherds of the second and first centuries B.C. They were excavated at Nagarjunakonda and Salihundam in Andhra Pradesh and at Kasrawad in Madhya Pradesh and appear to show the ground plans of Buddhist monasteries. Also in Madhya Pradesh are the temple plans engraved in stone, in situ, of a great Shiva temple at Bhojpur, begun in the eleventh century A.D. but unaccountably never finished.

Among surviving architectural drawings, the most impressive, without a doubt, are those contained in a number of recently discovered palm-leaf manuscripts. Four of these are derived from the *Śilpa Prakāśa*, a Sanskrit work by Rāmacandra Kaulācāra, an Orissan temple architect who probably lived in about the twelfth century. The work is a practical guide to temple construction containing numerous illustrations, including floor plans, elevations, details for decorative sculpture, and instruction on building techniques (fig. 15.12 provides some representative examples). Two temples in Orissa have been found, "exactly corresponding to the description of the text."[179] One of these is in the capital city of Bhubaneswar, renowned for the scores of lavish medieval temples within its precincts, and the other is in Caurasī, "a remote village in the Sūrya-Maṇḍala," presumably the region within the ambit of the great Sun Temple of Konarak.[180] Since it was the custom to recopy palm-leaf manuscripts every hundred years or so and then destroy the older version, there is a possibility that the manuscripts in question vary in some particulars from the original; however, the correspondences among the manuscripts and the match of the temples just cited to the extant texts suggests their overall authenticity. The colophons of three of the manuscripts Boner and Śarmā used in their translation of the text indicate that they were copied in 1731, 1791, and 1793.[181] The first of these and a fourth manuscript (not dated and not used in their translation) were found in villages near Puri, Orissa; the other two were in the adjacent state of Andhra Pradesh.[182]

Sarasvati Mahal Library in Thanjavur, Tamil Nadu, there are two very similar plans of the fort and adjacent palace that undoubtedly date from the period of Maratha rule in that city (1676–1855). These too are illustrated by Gole, *Indian Maps and Plans*, 158–59 (note 1).

176. Gole, *Indian Maps and Plans*, 151 (note 1).

177. Milo Cleveland Beach, *The Grand Mogul: Imperial Painting in India, 1600–1660* (Williamstown, Mass.: Sterling and Francine Clark Art Institute, 1978), 167–68.

178. Falk and Archer, *Indian Miniatures*, 150 and 445 (note 140).

179. Rāmacandra Kaulācāra, *Śilpa Prakāśa: Medieval Orissan Sanskrit Text on Temple Architecture*, trans. and annotated Alice Boner and Sadāśiva Rath Śarmā (Leiden: E. J. Brill, 1966), XXIV. I have not been able to locate Caurasī, so it is not plotted on figure 17.37.

180. Rāmacandra Kaulācāra, *Śilpa Prakāśa*, XXIV (note 179).

181. Rāmacandra Kaulācāra, *Śilpa Prakāśa*, XV–XVI (note 179).

182. Rāmacandra Kaulācāra, *Śilpa Prakāśa*, XV and XXII–XXIII (note 179).

FIG. 17.55. THE BATTLE OF PANIPAT, KARNAL DISTRICT, HARYANA. This image is from Faizabad, ca. 1770. It was drawn, with some color added, on paper and backed with cloth, and it includes the names of the principal combatants in this climactic battle fought in 1739. It is inscribed with Persian characters.
Size of the original: 51 × 66 cm. By permission of the India Office Library and Records (British Library), London (Johnson Album 66, no. 3).

Four additional palm-leaf manuscripts found in villages in the vicinity of Puri relate to the magnificent thirteenth-century Padmakeśara temple (popularly known as the Sun Temple) and surrounding shrines in Konarak. One of these, a profusely illustrated work in the Oriya language, consists of twenty-three leaves and is a copy of a report of a survey ordered about A.D. 1610 by the local monarch, Puruṣottama Deva, of the three major temples in his country. The temples in question were at Bhubaneswar, Puri, and Konarak. Illustrated fragments of two other palm-leaf copies of the same report have also been found.[183] The report provides detailed descriptions and exquisite drawings of all parts of the Sun Temple. These drawings convey a vivid representation of how it appeared before it fell into disrepair in the seventeenth century after the collapse of one of its main towers. They also include ground plans of the principal structures, an elevation of the nearby Padmakeśara temple, and numerous additional illustrations of various parts of the temple complex. They are accompanied by relevant text on their construction, with an abundance of dimensional notations.[184]

183. Alice Boner, Sadāśiva Rath Śarmā, and Rajendra Prasād Dās, eds. and trans., *New Light on the Sun Temple of Konārka: Four Unpublished Manuscripts relating to Construction History and Ritual of This Temple* (Varanasi: Chowkhamba Sanskrit Series Office, 1972), xl–xli.

184. Boner, Śarmā, and Dās, *Sun Temple of Konārka*, pls. 1–5, explanatory note on 275, and translation of text on 1–35 (note 183).

A second manuscript (sixteen leaves), in Sanskrit, also illustrated, explains the religious significance of a small temple within the main temple compound and shows, among other things, how that shrine originally appeared. The largest of the manuscripts (seventy-three leaves) is a "book of accounts and . . . a detailed chronicle of the building operations of all the temples,"[185] and the fourth is a manual of the temple rituals to be performed.[186]

As noted, the longest of the four manuscripts provided a detailed chronicle of the building of the temple. Boner, Śarmā, and Dās have prepared as an appendix to the translation of that text a "Tentative Chronology of Dates and Works" that it records, including such processes as "measuring out the ground by Sūtradhara," "laying out the groundplan of the temple with the thread by Sūtradhara," making "measurements for the halls for sacrifice," and many others less germane for a history of cartography per se, but of great interest for the history of architecture.[187] The account suggests that the rules in the sacred *śilpaśāstra* texts on Hindu architecture noted above were indeed by and large followed.

Even older than the Sun Temple at Konarak are some of the five celebrated Jain Dilwara temples atop Mount Abu in southern Rajasthan, the earliest built, according to an inscription, in 1032. Another, also of great artistic merit, dates from 1231. Although I am not aware of any plans of these temples comparable in detail or age to those for various temples in Orissa, there is an undated codex of unknown authorship that does contain a number of watercolor and ink drawings (page size approximately 32 × 20 cm). These were photographed by the late architectural historian Robert MacDougall, who believed they represent specific portions of the Dilwara temples, seen in combinations of floor plans with frontal elevations. The present location of the codex is not known. Also said to be included in the codex are "drawings of ritual objects used in the temples and cosmological diagrams."[188] More recent plans, probably for a temple in Brindaban—of similar conception, though with less aesthetic appeal—appear in a manual of ritual for the Pushtimarg sect of Krishna worship (date not known) titled *Vallabha Puṣṭī-Prakāśa*.[189] There is no reason to suppose that illustrations of this kind are especially rare, and they are probably still being produced in printed form.

Also from Rajasthan comes a very finely executed side elevation of an unspecified temple drawn in pen and ink on cloth. This late seventeenth-century work, measuring sixty-one by seventy-five centimeters,[190] displays a very high level of craftsmanship, totally independent of any Islamic or European influence. Its appearance suggests great concern for fidelity to scale in rendering the several parts of a very complex structure with many minute architectural and sculptural details.

In the Maharaja Sawai Man Singh II Museum in Jaipur and in the nearby Jaigarh Fort Museum there are a number of detailed architectural drawings, generally drawn on gridded paper, that were clearly intended to guide either the construction or the repair and renovation of major architectural works. Gole reproduces a number of such plans.[191] Here I illustrate (fig. 17.56) a plan made to aid in repair of and additions to the temple in Varanasi built by Mirza Rāja Jai Singh of Jaipur in the seventeenth century. The date of the plan is not known, but it is quite likely from the first half of the eighteenth century, since similar, but more elaborate, plans relating to repairs made on the palace at Amber and the nearby fort of Jaigarh date from that period.[192] Additional illustrations are provided by Tillotson.[193]

A set of three drawings in the Victoria and Albert Museum, London, provides abundant architectural detail of the Red Fort in Delhi (Shāhjahānābād) and two important streets leading to it, Chandni Chowk (fig. 17.57) and Faiz Bazār.[194] The painting of the Red Fort has already been considered (appendix 17.7, item i). It is an obvious copy of the work, at the India Office Library and Records,

185. Boner, Śarmā, and Dās, *Sun Temple of Konārka*, vi (of preface) and see also xli–xlvi (of introduction) (note 183).

186. Boner, Śarmā, and Dās, *Sun Temple of Konārka*, xlvi–xlvii (note 183).

187. Boner, Śarmā, and Dās, *Sun Temple of Konārka*, 179–94, quotations on 179 and 193 (note 183). The account is full of human interest, even recording a period when the dissatisfied workmen went on a hunger strike.

188. Letter from Robert D. MacDougall, of Cornell University, 7 August 1985.

189. A copy of one such plan was sent to me by Paul M. Toomey of Fayetteville, North Carolina, in an undated letter received early in April 1988.

190. New Delhi, National Museum, cat. no. 58.49/1.

191. Gole, *Indian Maps and Plans*, 191–206 (note 1).

192. The works illustrated by Gole, *Indian Maps and Plans* (note 1), which do not constitute a complete set of the plans available, are as follows: the palace at Amber (300 × 97 cm) (p. 192), the Chilkatola fort at Jaigarh (125 × 292 cm) (pp. 192–93), a rougher sketch (72 × 57 cm) relating to the construction of a temple in a square called Chandni Chowk (probably in Jaipur) (p. 198), and the Mān Mandir temple and nearby temple grounds in Varanasi (193 × 70 cm) (p. 198) that are reproduced as figure 17.56. The first of these works is in the Jaigarh Fort Museum, near Jaipur, and is uncataloged. The remaining three works, at the Maharaja Sawai Man Singh II Museum, Jaipur, bear the catalog numbers 59, 123, and 130.

193. G. H. R. Tillotson, *The Rajput Palaces: The Development of an Architectural Style, 1450–1750* (New Haven: Yale University Press, 1987), 104 and 172. Two diagrams (p. 104) of Amber show a vertical section through the Ganesh Pol (Elephant Gate) and one of two plans of the Diwan-i-Am courtyard it leads to (Maharaja Sawai Man Singh II Museum, Jaipur, cat. nos. 83 and 77–78). Also shown is a portion of an early design for Jaipur (p. 172) based on a three-by-three grid also kept at the Maharaja Sawai Man Singh II Museum.

194. The maps are cataloged AL 1754, AL 1762, and AL 1763, and respectively measure 75 by 82 centimeters, 31 by 140 centimeters, and 31 by 135 centimeters.

of a Mughal artist, Nidha Mal, but is rendered in what has been designated the "Company style." If Nidha Mal also prepared prototypes of the drawings of Chandni Chowk and Faiz Bazār, as seems plausible, there is no record of it. However, that he moved from Delhi to Faizabad or Lucknow about 1760–70, when Colonel Gentil was an adviser to the nawab of that province, suggests that he might have carried with him not one but three paintings, forming the basis for the set now at the Victoria and Albert Museum.[195] Gole has carried out an exceedingly thorough study of the latter three maps and has been able, through archival research, to identify more than fifty individual houses and other architectural features (gates, mosques, baths, and so forth) lining the two streets depicted in addition to the better-known features of the Red Fort. On internal evidence she dates the information on the maps to the period between 1751 and the occupation of Delhi by Ahmad Shāh Durrānī in 1757, but the maps could of course have been drawn (or copied) in Oudh somewhat later.[196]

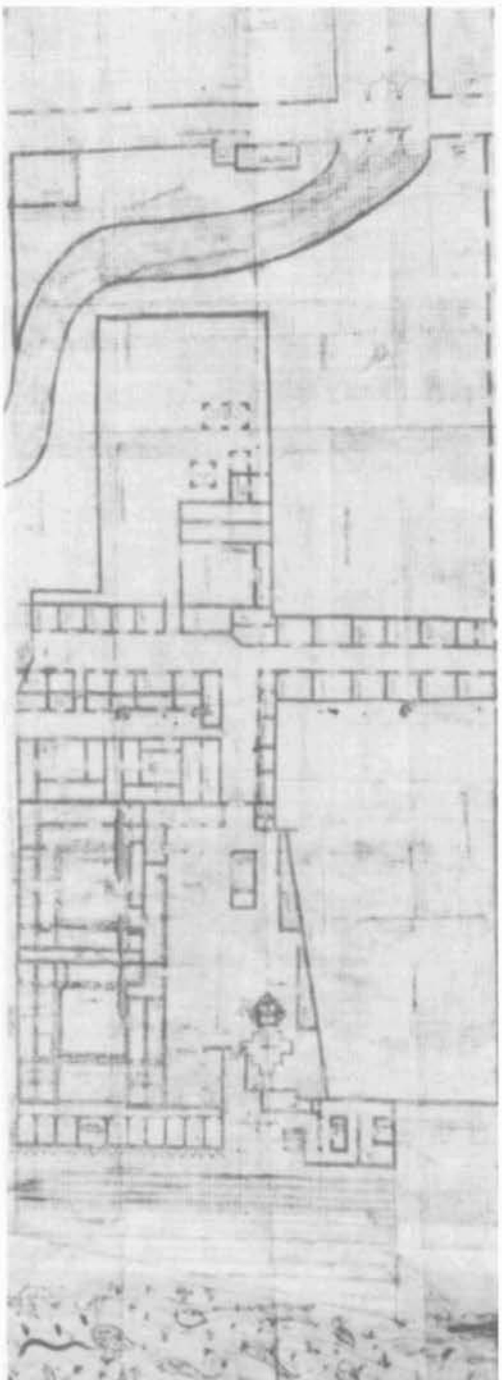


FIG. 17.56. MĀN MANDIR (TEMPLE) AND ADJACENT AREA IN KĀSHĪ (VARANASI), UTTAR PRADESH. This Rajasthani depiction is painted on gridded paper with text in Dhundari and dated to the first half of eighteenth century.
Size of the original: 193 × 70 cm. Courtesy of the Maharaja Sawai Man Singh II Museum Trust, Jaipur (cat. no. 130). Photograph courtesy of Susan Gole, London.

Richly detailed paintings and drawings were also made of many individual buildings, monuments, gardens, and other features of architectural interest. A particularly charming, if not especially accurate, work (fig. 17.58) is the painting of the emperor Akbar's tomb at Sikandra. Its provenance is Rajasthan, and its date has been given as late eighteenth century.[197] Of a very similar painting, Welch writes:

> The painter of this picture created his ideograph of Akbar's tomb according to projections, employed by "primitive" artists the world over, in which facades, walls, trees, figures, and minarets are seen head-on, in their most characteristic views, while the gardens, courtyards, and watercourses are shown as though viewed by a flying bird. This ancient approach offers certain advantages: it enables us simultaneously to see from the sides and from above, and to gain a much fuller idea of each element in the structure. It also produces a highly appealing picture, with no violation of the surface's two dimensional harmony, and in this case transforms Akbar's tomb into a sort of mandala, the Buddhist and Hindu psychocosmogram. On the other hand, it tells us very little either about relative proportions—the gardeners are tall as trees—or of the "feel" of surfaces. It presents the idea instead of the appearance, the spirit rather than the substance.[198]

Strikingly similar to the work just discussed is a watercolor painting of the mausoleum of Akbar's son and suc-

195. For details on Nidha Mal, see Falk and Archer, *Indian Miniatures*, 121–22 and 426 (note 140).

196. Susan Gole, "Three Maps of Shahjahanabad," *South Asian Studies* 4 (1988): 13–27.

197. Stuart Cary Welch, *Room for Wonder: Indian Painting during the British Period, 1760–1880* (New York: American Federation of Arts, 1978), 134, illustrated on p. 135; also illustrated in *Indian Heritage*, 50 (note 93).

198. Welch, *Room for Wonder*, 134 (note 197).

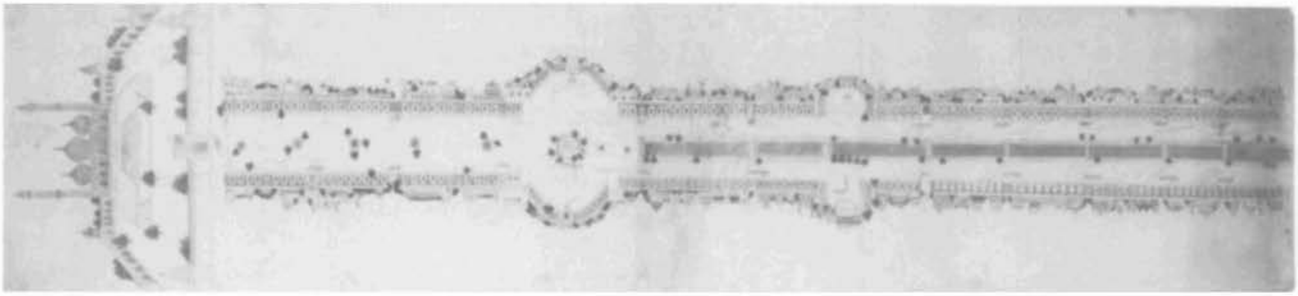


FIG. 17.57. CHANDNI CHOWK, A MAIN STREET OF SHĀHJAHĀNĀBĀD (DELHI). This map is in Company style, from Delhi or Oudh, ca. 1755, in Persian text with some French added. This is one of a set of three architectural drawings relating to the city.
Size of the original: 31 × 140 cm. By permission of the Victoria and Albert Museum, London (A.L. 1762).

cessor, Jahāngīr, at Lahore. It is also dated about 1770 but is attributed to a Mughal rather than a Rajasthani artist. It is inscribed in Persian and makes up for its deficient use of perspective by providing written measurements of the building and identifying its various parts. This painting, 146 by 130 centimeters, is also substantially larger than that of Akbar's tomb. It is on display in the library of the Royal Asiatic Society in London.[199]

The use of maps and plans as records of property holding, so commonplace in the West, was relatively rare in traditional South Asia, where exclusively verbal descriptions were the norm. Although additional research will probably reveal additional cases, I am aware of only one detailed plan of a private house. That plan was brought to light by Muhammed Abdulla Chaghatai and forms part of a long paper scroll dated 1057/1657. The scroll records the deed of a house by the mayor of Ahmadabad, Seth Shantidas, to his son Lakhshmi Chand.[200] The plans on the scroll relate to different portions of what must have been a very large two-story house and are dispersed throughout the document. Accompanying text provides details of the limits of the property, of where the walls or courtyards met with adjacent properties, and of the construction materials used in different parts of the building. Gole, who illustrates a portion of the scroll, observes that nowhere in Chaghatai's translation of the scroll's text is it suggested that plans of houses were unusual in the seventeenth century; but when and how they originated remains for the time being a mystery.[201] In passing, let me mention one additional property map from a suburb of Bombay, showing the home and adjoining gardens of Shripada Narayan Sathgar. Though drawn as recently as 1874 and printed in a biography by Sathgar's son, the work is of interest because it retains much that is traditional in the style of depicting vegetation and in its combining of planimetric and frontal perspectives.[202]

I close this chapter by noting that many Indian and Nepali artists delighted in providing vivid paintings of works of architecture as major elements of compositions whose ostensible subject was completely different. In court and religious narrative paintings (e.g., of the stories of the great Indian epics) this tendency was quite common and of long standing. A complete catalog of such works would probably be an impossible undertaking for any individual. The region of Rajasthan is particularly noteworthy for paintings in which architecture figures prominently, and within Rajasthan the state of Mewar stands out. Udaipur, the Mewari capital, has an especially picturesque setting within the mountain knot at the southern end of the Aravalli range, and the palaces, pavilions, and pleasure gardens built in and around Lake Pichola in the heart of that city were favorite subjects for local artists, forming the backdrops for many of their works.[203] Other delightful paintings came from or related to nearby states. I can think of no work more enchanting in its conception and execution than a depiction of the celebration of Diwali (the festival of lights) at the royal palace of the

199. In addition to the architectural paintings we have described, a bound album of sixty drawings, dated mid-nineteenth century and held by the Department of Oriental Antiquities at the British Museum, London (acc. no. 1984.1-24.01 [12]), contains nine architectural presentations, of which two oblique perspective views, of Bādshāhī mosque in Lahore (no. 12) and of Ranjit Singh's tomb (no. 19) (location not specified, but also in Lahore), may be considered maps. The drawings are said to be of the "Sikh school" and are quite similar in execution to the "Company style."

200. Muhammed Abdulla Chaghatai, "A Rare Historical Scroll of Shahjahan's Reign," *Journal of the Asiatic Society of Pakistan* 16 (1971): 63–77, and photos of scroll and map. I am grateful to Irfan Habib for calling this work to my attention.

201. Gole, *Indian Maps and Plans*, 188 (note 1).

202. The work is illustrated in Gole, *Indian Maps and Plans*, 189 (note 1).

203. See, for example, "The Rana's Lake Pavilion," a charming miniature painting (39.4 × 45.7 cm) of the mid-eighteenth century illustrated by Welch in *India: Art and Culture*, 377 (note 145). (The palace depicted is now a luxury hotel.) The painting is part of Welch's personal collection.

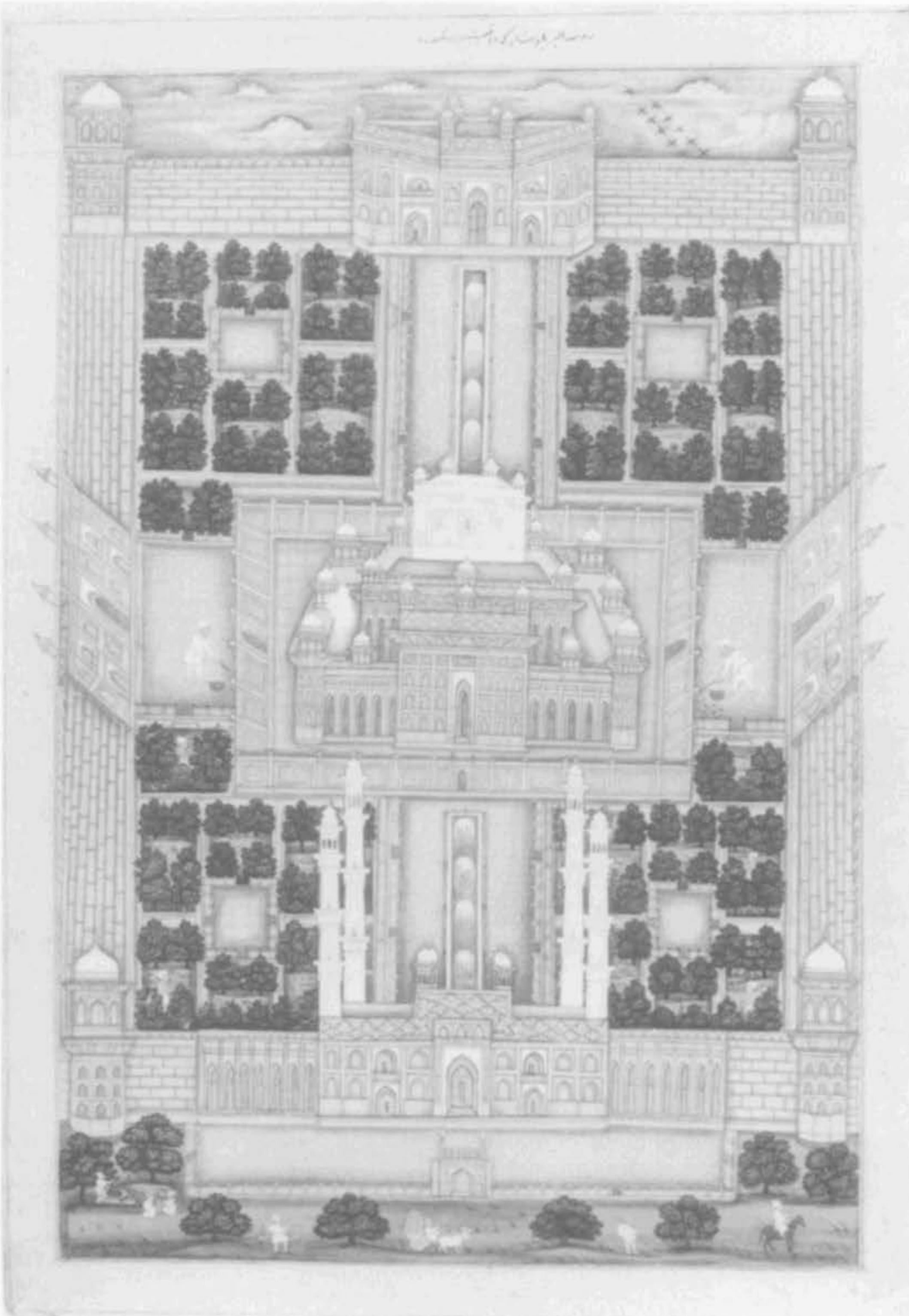


FIG. 17.58. TOMB OF THE EMPEROR AKBAR AT SIKANDRA, AGRA DISTRICT, UTTAR PRADESH. This Rajasthani painting is opaque watercolor on paper and dates from the late eighteenth century. The use of diverse perspectives is particularly effective in enabling viewers to grasp the essential character of each of the major components of this sublime architectural assemblage.
Size of the original: 48 × 32.5 cm. By permission of the India Office Library and Records (British Library), London (Add. MS. Or. 4202).

state of Kotah (plate 39). Though relating to Kotah, the work is attributed to Udaipur and dated about 1690. Within its small compass (48.5 × 43.4 cm) it manages to depict not only the king among his harem, scores of other happy celebrants, music, fireworks, acrobatics, and animal fights, but also the palace courtyards, the major components of the palace itself, and the nature of the surrounding terrain.[204]

204. Like most of the Rajasthani court paintings, this work was probably the creation of an anonymous artist of the Sutar (carpenter) caste. The work is in Melbourne, National Gallery of Victoria (cat. no. 52), and is illustrated by Topsfield in *Paintings from Rajasthan*, color plate no. 8, p. 23, with relevant text on pp. 11–12 and 57 (note 136). Topsfield's book contains numerous other figures that richly illustrate the architecture for which Rajasthan is renowned.

APPENDIX 17.1

Place Map Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)	Language
a. Vrindaban, Vrindaban Research Institute (acc. no. 5295)	Braj 19th century (?)	24 × 18	Braj dialect (Gujarati script)
b. Vrindaban, Vrindaban Shudh Sansthan (MS. 4706)	Bengal (?) 19th century (?)	57 × 44	Sanskrit (Bengali dialect)
c. Published in Indian historical text on Braj[b]	Modern	?	Hindi
d. New York, Doris Wiener Gallery	Nathdwara, Rajasthan, early 19th century	275 × 259	Braj dialect (?)
e. Ahmadabad, Calico Museum of Textiles (acc. no. 2062)	Nathdwara, late 19th century	222 × 218	Braj dialect (?)
f. Ahmadabad, Calico Museum of Textiles (acc. no. 1330)	Nathdwara, late 19th or early 20th century	180 × 193	Braj dialect
g. Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 133)	Braj (?), late 18th century (?)	141 × 79	Braj dialect
h. Baroda, Collection of Rini Dhumal	Modern (earlier than i)	49 × 30	Hindi
i. Minneapolis, Collection of Joseph E. Schwartzberg	Modern, 1970s or 1980s	57 × 38	Braj and Bengali

[a]The citations in this column are: Alan W. Entwistle, *Braj: Centre of Krishna Pilgrimage* (Groningen: Egbert Forsten, 1987); Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989); Walter M. Spink, *Krishnamandala: A Devotional Theme in Indian Art*, Special Publications, no. 2 (Ann Arbor: Center for South and Southeast Asian

Medium	Orientation	Description	Where Published[a]
Ink (?) on paper	Varies	Fifty-six-petal lotus (see fig. 17.20) from a manuscript	Entwistle, *Braj*, 441 (pl. 11)
Paint and ink on paper	Varies	Twelve-petal lotus and Yamuna River (see fig. 17.21)	Gole, *Indian Maps and Plans*, 60 (fig. 19)
Printed on paper	Varies	Twelve-petal lotus, superimposed on base with Yamuna River and pilgrimage route	Gole, *Indian Maps and Plans*, 60 (fig. 18)
Painted on cloth	North	Nathdwara style (see plate 31)	Spink, *Krishnamandala*, 9–10 and 118 (fig. 17)
Painted on cloth	North	Nathdwara style	Talwar and Krishna, *Indian Pigment Paintings on Cloth*, 26 and pl. 23
Painted on cloth	North	Nathdwara style	Talwar and Krishna, *Indian Pigment Paintings on Cloth*, 27 (no. 17) and pl. 24; Gole, *Indian Maps and Plans*, 61 (fig. 20)
Painted paper on cloth	North	More realistic representation than any of above, with greater concern for scale; much unpainted map surface	Gole, *Indian Maps and Plans*, 58–59 (fig. 17)
Printed on paper, multicolored	North	Highly stylized, emphasis on pilgrimage route, little attention to direction or scale, ornamental detail to fill all blank spaces on map	Gole, *Indian Maps and Plans*, 61 (fig. 21)
Printed on paper, multicolored	North	as h above	

Studies, University of Michigan, 1971); and Kay Talwar and Kalyan Krishna, *Indian Pigment Paintings on Cloth*, Historic Textiles of India at the Calico Museum, vol. 3 (Ahmadabad: B. U. Balseri on behalf of Calico Museum of Textiles, 1979).

[b]Prabhu Dayal Mital, *Braja kā saṃskṛtika itihāsa* (in Hindi) [1966–], vol. 1, p. 10.

APPENDIX 17.2 INDIGENOUS MAPS IN THE HODGSON COLLECTION,

Volume	Folios	Number of Maps	Areas of Coverage
3	103	1	"Ilam to Boundary" (eastern Nepal)
7	32, 197–215 (passim)	?	Not determined
55	106	1	?
56	59–60	1	Central Nepal
59	15–16	1	?
59	25–37	8 (?)	Western Nepal
59	38–40	2 (?)	West-central Nepal
59	41–48	4 (?)	Central and east Nepal
59	49–50	1	Easternmost Nepal
59	81–90	2	"Bhota" (Tibet and adjacent Nepali borderland)
59	91–92	1	?
73	111, 117, 142	3	Kosi River drainage basin

APPENDIX 17.3 LARGE-SCALE MAPS

General Area Covered	Place Map Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)	Language
a. Amber, Rajasthan	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 75)	Jaipur, mid-18th century (?)	170 × 350	Dhundari
b. Jamwa Mata, Rajasthan	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 101)	Jaipur, late 18th or early 19th century	84 × 150	Dhundari
c. Jaigarh, Rajasthan	Near Jaipur, Jaigarh Fort Museum	Jaipur, early 18th century (?)	244 × 103	Rajasthani
d. Khiri, Rajasthan	Jaipur, Maharaja Sawai Man Singh II Museum (cat. nos. 85-87)	Jaipur, 18th century (?)	42 × 58, 75 × 110, 42 × 60	Dhundari
e. Khandela and Lohargarh, Rajasthan	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 89)	Jaipur, 18th century (?)	162 × 60	Dhundari
f. Kharda, Maharashtra	Pune, Maratha History Museum, Deccan College	Maharashtra, post-1795	27.5 × 44.5	Marathi
g. Sandh Hill, in Bijapur, Golkonda region (?)	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 84)	Jaipur, late 17th or early 18th century (?)	31.5 × 44.5	Dhundari
h. Talegaon, Maharashtra	Pune, Maratha History Museum, Deccan College	Maharashtra, post-1799	44.5 × 27.5	Marathi
i. Tikhandi, Maharashtra	Pune, Peshwe Daftar (?)	Maharashtra, 1820s	?	Marathi
j. Vadhane, Maharashtra	Pune, Peshwe Daftar (?)	Maharashtra, ca. 1784	?	Marathi
k. Udaipurwati, Rajasthan	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 82)	Jaipur, mid- or late 19th century	166 × 239	Dhundari

[a]Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989).

India Office Library and Records, London

Orientation	Language	Nature of Map(s)/Remarks
North	Limbu(?)	Topographic, distances noted
?	Persian	Ink sketches
North	Nepali	Rivers and four towns (relatively modern in appearance)
North	Nepali	Mainly topographic (see fig. 17.26)
East	Nepali	? (particularly crude sketch)
North	Nepali	Cadastral (see fig. 17.27)
North	Persian	Cadastral
East	Nepali	Cadastral
North	Nepali	Cadastral
North	Tibetan	Routes and settlements, some topography; dated 1824
North	Persian	Topographic
West	Nepali	Topographic (mainly hydrographic)

of Primarily Rural Localities

Medium	Orientation	Purpose and Description	Gole[a] (page)
Painted on paper backed with cloth	?	Shows plans for irrigation works, especially of two dams, humorous topographical details	194 (fig. 107)
Painted on paper		Shows environs of family shrine of Kachwaha Rajputs	
Painted on paper backed with cloth	?	Shows outline and a few details of Jaigarh fort and walls outside fort, plus topography of broad surrounding area	191 (fig. 104)
Painted on paper	?	Three maps, showing Khiri as it was and as it would be if dam were built	202 (figs. 115, 116, and 117)
Painted on paper	?	Shows construction plans for various amenities for pilgrims to Lohargarh	204 (fig. 120)
Ink on paper	East	Sketch showing deployment of forces at battle of Kharda and main features of battle area	147 (fig. 72)
Painted on paper backed with cloth	?	Shows terrain around a South Indian fort captured by Sawai Jai Singh II when in service of the Mughal emperor Aurangzīb	203 (fig. 118)
Ink on paper	?	Sketch showing principal features of area of battle of Talegaon	147 (fig. 71)
Ink on paper	?	Identification of land parcels in a village in regard to revenue assessment	
Ink on paper	?	Identification of landholdings within a village in reference to a land dispute (see fig. 17.38)	
Painted on paper	?	Rather naturalistic symbolizations; relatively modern appearance	

City or Town Represented	Place Map Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
a. Agra	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 126)	Rajasthan, eighteenth century	272 × 292
b. Amber	New Delhi, National Museum (cat. no. 56.92.4)	Rajasthan, 1711	661 × 645
c. Bijapur	Bijapur, Archaeological Museum, Gol Gumbaz	Deccani Muslim, late 17th century	149 × 102
d. Bijapur	Hyderabad, Andhra Pradesh State Archives	Deccani Muslim, late 17th century (may be later copies)	90 × 71 and 60 × 43
e. Delhi (Shāh-jahānābād)	London, India Office Library and Records (cat. no. x/1659)	Probably European, but possibly late Mughal or hybrid, 19th century	114 × 104
f. Hyderabad	Hyderabad, Idara Adabiyat-e-Urdu	Hyderabad, 1772	215 × 275
g. Jaipur (including Amber) to Sanganer	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 16)	Rajasthan, late 18th century	127 × 64
h. Jammu	New Delhi, National Museum (cat. no. 58.33/4)	Jammu (?) probably mid- or late-19th century	121 × 198
i. Jodhpur	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 121)	Rajasthan, 19th century (?)	109 × 126
j. Nasik	Pune, Peshwe Daftar	Maharashtra, probably early 19th century	307 × 314
k. Navsari (?)	New Delhi, National Museum (cat. no. 58.13169)	Gujarat, probably mid-18th century	24.5 × 13
l. Sanganer	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 114)	Rajasthan, late 18th or early 19th century	124 × 165

[a]The citations in this column are: Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989); Sadashiv Gorakshkar, "An Illustrated *Anis al-Haj* in the Prince of Wales Museum, Bombay," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982*, ed. Robert Skelton et al. (London:

Secular Maps of Cities and Towns

Language	Medium	Purpose and Description	Where Published[a]
Dhundari	Painted on cloth	Used to guide construction and repairs. Emphasizes specific features requiring work, major monuments (e.g., Taj Mahal), and properties of prominent persons. Remainder of map is sketchy.	Gole, *Indian Maps and Plans,* 200–201 (fig. 114); Singh, "City Maps on Cloth," 190–92 (figs. 7 and 8)
Rajasthani	Painted on cloth	See figure 17.39.	Gole, *Indian Maps and Plans,* 170–71 (fig. 91)
Persian	Painted on paper backed with cloth	See figure 17.40.	Gole, *Indian Maps and Plans,* 160–61 (fig. 83)
Persian	Painted on paper	Two maps, both slight variants of the foregoing.	Gole, *Indian Maps and Plans,* 160–61 (figs. 84 and 85)
Persian	Ink and paint on paper	Exceedingly detailed, with complete street plan and decidedly European look, but text exclusively in Persian. Printed scale to right of map.	Gole, *Indian Maps and Plans,* 177 (fig. 96)
Persian	Painted on cloth	Virtual absence of text makes purpose unclear, but map appears to show every house on every street. Multistory houses are shown as such. Streets full of people engaged in various activities.	Gole, *Indian Maps and Plans,* 190 (fig. 103)
Dhundari	Painted on paper	Possibly used for planning a proposed canal and other engineering works. City of Jaipur mapped in great detail and with seeming accuracy, but countryside leading south to Sanganer is greatly foreshortened, and Sanganer is simplified. Depiction of countryside similar to style used from maps a–d and f of appendix 17.3.	Gole, *Indian Maps and Plans,* 195 (fig. 108)
Hindustani in Arabic script in a Persian style	Painted on paper backed with cloth	Rather detailed, seemingly accurate and relatively modern work, though retaining many traditional elements. Many map notes on uses of various buildings and structures. Probable European influence. Map has neat line.	Gole, *Indian Maps and Plans,* 166 (fig. 88)
Marwari	Painted on paper backed with cloth	See plate 34.	Gole, *Indian Maps and Plans,* 186–87 (fig. 100)
Marathi	Painted on paper backed with cloth	Among the most detailed and seemingly accurate of all Indian city plans. Abundant text explaining individual map features. Particular attention given to temples and ghats on Godavari River.	Gole, *Indian Maps and Plans,* 168–69 (fig. 90)
no text	Painted on paper	Nearly one-fourth of painting is of a Muslim prince or governor granting an audience to a group of Parsis, suggesting that the port city mapped could be Navsari, an important Parsi center. Details of city highly stylized; bazaar streets and port, wall, and major edifices prominently shown.	Gole, *Indian Maps and Plans,* 185 (fig. 99)
Dhundari	Painted on paper	See figure 17.41.	Gole, *Indian Maps and Plans,* 206 (fig. 122)

Victoria and Albert Museum, 1986), 158–67; John Irwin, *The Kashmir Shawl* (London: Her Majesty's Stationery Office, 1973); Chandramani Singh, "Early 18th-Century Painted City Maps on Cloth," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982,* ed. Robert Skelton et al. (London: Victoria and Albert Museum, 1986), 185–92.

APPENDIX 17.4—*continued*

City or Town Represented	Place Map Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
m. Sawai Madhopur	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 96)	Rajasthan, late 18th century	91 × 122
n. Srinagar	Srinagar, Sri Pratrap Singh Museum (cat. no. 191)	Kashmir, 1819–56	ca. 180 × 150
o. Srinagar	London, Victoria and Albert Museum (I.S.31.1970)	Kashmir, third quarter of 19th century	ca. 230 × 195
p. Srinagar, environs	Srinagar, Sri Pratrap Singh Museum (cat. no. 2063)	Kashmir, late 19th century (?)	68 × 37
q. Surat	Bombay, Prince of Wales Museum of Western India	Mughal, late 17th century	ca. 40 × 24
r. Surat	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 118)	Gujarat (?), early 18th century	210 × 186
s. Tonk	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 107)	Rajasthan, second quarter of 18th century	81 × 119
t. Udgir	Hyderabad, Andhra Pradesh State Archives	Deccani Muslim, early 19th century (?)	Roughly circular, diam. 67

Language	Medium	Purpose and Description	Where Published[a]
Dhundari	Painted on paper	Map relates to drainage projects to protect newly built town from monsoon flooding. Town walls and prominent buildings carefully depicted. Not all the town included.	Gole, *Indian Maps and Plans*, 205 (fig. 121)
Persian	Embroidered in silk on cloth	Said to have been embroidered by Ghullam Muhammad Kulu over a thirty-seven-year period as a gift to Sikh king, Ranjit Singh. Very detailed. Text identifies all key structures and gardens. Poorly displayed and hard to study (cf. map o below).	Gole, *Indian Maps and Plans*, 127–28 (fig. 56)
Persian	Embroidered in fine wool on cloth	See plate 33.	Gole, *Indian Maps and Plans*, 129 (fig. 57); Irwin, *Kashmir Shawl*, 55 and pl. 42
Hindi (?)	Painted on paper	Highly simplified and stylized representation of relatively few key features; Harī Parbat fort prominently shown.	Gole, *Indian Maps and Plans*, 127–28 (fig. 54)
Persian	Painted on paper	One of several plans of cities from a manuscript describing the pilgrimage to Mecca (Surat was an important port of embarkation for Indians; plans of Mecca and other places not here described). A highly simplified and stylized view, emphasizing the port, city wall, and a few key buildings.	Gole, *Indian Maps and Plans*, 162 (fig. 86); Gorakshkar, "*Anis al-Haj*," 160–61 (fig. 2)
Persian with later addition of Rajasthani	Painted on cloth	Simplified street pattern with emphasis on key edifices, inner and outer city walls, berths, and warehouses for European trading companies (identifiable by flags), customs house, and fort. Gardens between city walls and palm groves prominenently shown. Nearby villages named along edge of map.	Gole, *Indian Maps and Plans*, 164–65 (fig. 87); Singh, "City Maps on Cloth," 190–92 (fig. 9)
Dhundari	Painted on paper	Layout of town and its environs, with details provided to aid new construction and notes on work in progress. Generally similar to maps a–d of appendix 17.3 and map q above.	Gole, *Indian Maps and Plans*, 203 (fig. 119)
Persian	Painted on paper	Detailed rendering of city's inner and outer walls and other defenses. Relatively few interior structures are identified, and many of those are said to be in ruins (probably from the Maratha seizure of the fort in 1760).	Gole, *Indian Maps and Plans*, 167 (fig. 89)

City or Town Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
a. Ajmer, Rajasthan	Windsor Castle, *Pādshāhnāmah* (MS., fol. 205v)	Mughal, mid-18th century	?
b. Bust (Kala Bist) (?), Afghanistan	Paris, Musée Guimet	Mughal, ca. 1646	34 × 24.2 (image) 48 × 31.5 (folio)
c. Delhi	Kotah, Rao Madho Singh Museum Trust, City Palace	Kotah, Rajasthan, mid-19th century	452.1 × 259.1
d. Daulatabad, Maharashtra	Windsor Castle, *Pādshāhnāmah* (MS., fol. 144r)	Mughal, mid-17th century	?
e. Faizabad (?) Uttar Pradesh	Private collection	Oudh (Awadh), Mughal, ca. 1765	50.3 × 69.2
f. Golkonda, Andhra Pradesh	Oxford, Bodleian Library (Douce Or. B3, fol. 25)	Deccan, ca. 1750	28 × 33
g. Gurkha, Nepal	Museum in Bhaktapur, Nepal	Newari, early 19th century	?
h. Kangra, small town in Himachal Pradesh	Boston, Museum of Fine Arts, Ross-Coomaraswamy Collection (CCCCLVII. 17.2627)	Pahari, Kangra, early 19th century	22.5 × 33.1
i. Kumbhalgarh, Rajasthan	Collection of Gajendra Kumar Singh	Mewari, 18th century	?
j. Lahore, Punjab, Pakistan	Amritsar, Maharaja Ranjit Singh Museum, Rambagh Palace	Pahari style, early or mid-19th century	154 × 124
k. Lucknow, Uttar Pradesh	Private collection	Mughal, mid-19th century	54.3 × 95.2
l. Rampur, Himachal Pradesh	London, British Museum, Oriental Collections (1960 2-13 04)	Pahari school, Kangra style, ca. 1840	51.5 × 120
m. Udaipur, Rajasthan	Collection of Mr. and Mrs. William P. Wood	Mewari, ca. 1750	60 × 47.6

[a]The citations in this column are: M. R. A. [Mulk Raj Anand], "Architecture," *Mārg* [34, no. 1], *Appreciation of Creative Arts under Maharaja Ranjit Singh*, 27–33 (see also pp. 12–13 in the same journal); Wayne E. Begley and Z. A. Desai, eds., *The Shah Jahan Nama of Inayat Khan (An Abridged History of the Mughal Emperor Shah Jahan, Compiled by His Royal Librarian)* (Delhi: Oxford University Press, 1990); Ananda Kentish Coomaraswamy, *Catalogue of the Indian Collections in the Museum of Fine Arts, Boston* (Boston: Museum of Fine Arts, 1923–30), pt. 5, Rājput Painting (1926); *In the Image of Man: The Indian Perception of the Universe through 2000 Years of Painting and Sculpture,* catalog of exhibit, Hayward Gallery, London, 25 March–13 June, 1982 (New York: Alpine Fine Arts Collection, 1982); Stella Kamrisch,

Medium	Purpose and Description	Where Published[a]
Gouache on paper	The emperor Shāh Jahān with his entourage is shown encountering an allegorical figure of a Sufi saint in the vicinity of the walled city of Ajmer that occupies the middle ground of the painting. Outlying settlements are also shown along the Aravalli range in the background.	Begley and Desai, eds., *Shah Jahan Nama,* pl. 10
Gouache on paper	See figure 17.42.	Welch, *India: Art and Culture,* 247–48 (fig. 162a)
Painted, on cloth	Commemorates Maharao Ram Singh's state visit to Delhi in 1842. The city of Shāhjahānābād, the Red Fort, the Jāma Masjid (great mosque), the Chandni Chowk bazaar and other urban features are painted with great clarity, along with innumerable human figures, domestic animals, and other interesting details.	Singh, *Kingdom That Was Kotah,* 20 and fig. 40
Gouache on paper	Scene depicting Mughal conquest of Daulatabad; clearly shown are the hilltop fort atop a high steep escarpment, a moat below the escarpment, and a lower city with three concentric encompassing walls.	Begley and Desai, eds., *Shah Jahan Nama,* pl. 4
Painted, on paper (?)	Titled "Entertainment in a Harem Garden," the scene also portrays "a great late Mughal palace complex,"[b] which may or may not be modeled on the Awadhi capital of Faizabad. Strong European influence.	Patnaik, *Second Paradise,* 69 and 180–81 (pl. 14)
Painted on paper (?)	Miniature depicting royal procession entering the walled city via successive gates. Abundant detail of buildings within the city walls.	*In the Image of Man,* 133 (fig. 127)
Painted on paper	Royal palace and surrounding area at Gurkha, Nepal; rendered in a charming primitive style. Animals and trees very large. Probably little concern for accuracy of detail portrayed.	*Les royaumes de l'Himâlaya,* 202–3 (fig. 30)
Painted on paper (?)	Unnamed town on both sides of a steep-banked river. Houses, temples, watermills, etc., realistically rendered.	Coomaraswamy, *Indian Collections,* 214 and pl. CXII
Painted on paper	View of walled city and fort, with some details of surrounding countryside.	Nath and Wacziarg, *Arts and Crafts,* 162–63 (far left)
Painted on cloth	See figure 17.43.	Anand, "Architecture," 28–30 (figs. 1–3)
Painted on cloth	Centers on Kaiserbagh palace, with some detail of adjacent parts of city of Lucknow. Painting full of people in various activities and very rich in architectural detail. Strong European influence.	Patnaik, *Second Paradise,* 83–85 and 181–82 (pl. 23)
Painted on paper	Panoramic view of town (in frontal perspective) and fort (in oblique perspective) with some details also planimetrically shown. Much attention to terrain and vegetation.	
Gouache with gold and silver leaf on paper	Water pavilions in Lake Pichola. Full of details reflecting the life of the Mewari court: singing and dancing girls, boating, gardening, watching buffalo fights, listening to music, etc.	Kramrisch, *Painted Delight,* 75 and 172 (pl. 68)

Painted Delight: Indian Paintings from Philadelphia Collections, exhibition catalog (Philadelphia: Philadelphia Museum of Art, 1986); Aman Nath and Francis Wacziarg, *Arts and Crafts of Rajasthan* (London: Thames and Hudson; New York: Mapin International, 1987); Naveen Patnaik, *A Second Paradise: Indian Courtly Life, 1590–1947* (New York: Doubleday, 1985); *Les royaumes de l'Himâlaya: Histoire et civilisation. Le Ladakh, le Bhoutan, le Sikkim, le Népal,* présenté par Alexander W. Macdonald (Paris: Imprimerie Nationale, 1982); M. K. Brijraj Singh, *The Kingdom That Was Kotah: Paintings from Kotah* (New Delhi: Lalit Kalā Akademi, 1985); and Stuart Cary Welch, *India: Art and Culture, 1300–1900* (New York: Metropolitan Museum of Art and Holt, Rinehart and Winston, 1985).

[b]Patnaik, *Second Paradise,* 180 (note a).

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
a. Abu, Mount (see x below)			
b. Amarnath, Jammu, and Kashmir	Hyderabad, Jagdīsh and Kamla Mittal Museum of Indian Art (a fully painted version is in the collection of N. P. Sen, Hyderabad)	Guler, Himachal Pradesh, ca. 1830	35.6 × 27.7
c. Amarnath, Jammu, and Kashmir	Srinagar, Sri Pratap Singh Museum (cat. no. 4025)	Kashmir, late 19th century (?)	23 × 19
d. Amritsar, Punjab, India	Not known	Probably Punjabi, date unknown	Not known
e. Amritsar, Punjab, India	Not known	Probably Punjabi, but definitely later than d above	Not known
f. Bhaktapur, Nepal	Ichu, Bhaktapur, property of Pandit Ratnaraj Sharma	Bhaktapur, ca. 1925 (from an older model)	Not known
g. Chamba, Himachal Pradesh	Chandigarh, Government Museum and Art Gallery (3955)	Pahari, early 19th century	Not known
h. Dwarka, Gujarat	Baroda, Museum and Picture Gallery (P.G.5a.62)	Marwari, mid-18th century	25.5 × ca. 32
i. Dwarka, Gujarat	Bombay, Prince of Wales Museum of Western India (acc. no. 70.4)	Rajasthan, 1773	25.2 × 32.5
j. Dwarka, Gujarat	Jaipur, Maharaja Sawai Man Singh II Museum (acc. no. 139)	Jaipuri, mid-18th century ("drawn by Saligram, son of Gajadhar," a court painter)[b]	175 × 178

[a]The citations in this column are: Amit Ambalal, *Krishna as Shrinathji: Rajasthani Paintings from Nathdvara* (Ahmadabad: Mapin, 1987); *Baroda Museum Bulletin*, n.d.; Adolf Bastian, *Ideale Welten nach uranographischen Provinzen in Wort und Bild: Ethnologische Zeit- und Streitfragen, nach Gesichtspunkten der indischen Völkerkunde*, 3 vols. (Berlin: Emil Felber, 1892); J. P. Das, *Puri Paintings: The Chitrakāra and His Work* (New Delhi: Arnold Heinemann, 1982); O. C. Gangoly, *Critical Catalogue of Miniature Paintings in the Baroda Museum* (Baroda: Government Press, 1961); Helmuth von Glasenapp, *Heilige Stätten Indiens: Die Walfahrtsorte der Hindus, Jainas und Buddhisten, Ihre Legenden und Ihr Kultus* (Munich: Georg Müller, 1928); Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989); *In the Image of Man: The Indian Perception of the Universe through 2000 Years of Painting and Sculpture*, catalog of exhibit, Hayward Gallery, London, 25 March–13 June 1982 (New York: Alpine Fine Arts Collection, 1982); Bernhard Kölver, "A Ritual Map from Nepal," in *Folia rara: Wolfgang Voigt LXV. Diem natalem celebranti*, ed. Herbert Franke, Walther Heissig, and Wolfgang Treue, Verzeichnis der Orientalischen Handschriften in Deutschland, supplement 19 (Wies-

Views of Sacred Places or Serving Religious Purposes

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
No text	Black line and color on paper	Oblique view of landscape showing town, temple, and tank en route to sacred Amarnath cave. Rendered in "Company style" with lingering Pahari touches.	Welch, *Indian Drawings,* 138–39 (pl. 80)
Not known	Painted on paper	Shows the route to Amarnath cave and shrines and physical features along the way. Oblique perspective.	
Punjabi, Gurumukhi text (?)	Not known	Depicts compound including the Sikh Golden Temple. Overall planimetric layout, with facades seen in frontal perspective.	Von Glasenapp, *Heilige Stätten Indiens,* fig. 68
No text	Not known	Similar to d above, but more detailed and more realistic.	Von Glasenapp, *Heilige Stätten Indiens,* fig. 69
Newari (?) (title only)	Painted on paper (?)	See figure 17.46.	Kölver, "Ritual Map from Nepal," pl. 1; Pieper, *Die Anglo-Indische Station,* 106 (fig. 69)
No text	Painted on paper	Shows the route to and the mountainous landscape around an unnamed shrine typical of those in Chamba. Oblique perspective.	*In the Image of Man,* 166 (fig. 247)
No text (?)	Painted on paper (?)	Depicts old temple (built before erection, in early 17th century, of present temple), possibly based on an earlier plan.	Gangoly, *Critical Catalogue,* 75 (no. 35), pl. XX (fig. B)
Rajasthani	Painted on paper	Similar to h above, also showing old temple, but including larger area of island of Sankhodar Bet (see fig. 17.44).	Gole, *Indian Maps and Plans,* 69 (fig. 30)
Rajasthani	Painted on cloth	Shows all of Sankhodar Bet (see i above) and larger adjacent island, with many important features of religious landscape of Krishna's home (following his departure from Mathura) shown in oblique perspective. Very delicately rendered pictorial detail of architecture (including a temple under the sea), pilgrims, boats, sea creatures, vegetation, etc.	Gole, *Indian Maps and Plans,* 70–71 (fig. 31); Singh "City Maps on Cloth," 188 (fig. 3)

baden: Franz Steiner, 1976); Richard Lannoy, *The Speaking Tree: A Study of Indian Culture and Society* (London: Oxford University Press, 1971); Armand Neven, *Le Jainisme: Religion et culture de l'Inde: Art et iconographie* (Brussels: Association Art Indien, 1976); Armand Neven, *Peintures des Indes: Mythologies et légendes* (Brussels: Crédit Communal de Belgique, 1976); Jan Pieper, *Die Anglo-Indische Station: Oder die Kolonialisierung des Götterberges,* Antiquitates Orientales, ser B, vol. 1 (Bonn: Rudolf Habelt Verlag, 1977); Jan Pieper, "A Pilgrim's Map of Benares: Notes on Codification in Hindu Cartography," *GeoJournal* 3 (1979): 215–18; Chandramani Singh, "Early 18th-Century Painted City Maps on Cloth," in *Facets of Indian Art: A Symposium Held at the Victoria and Albert Museum on 26, 27, 28 April and 1 May 1982,* ed. Robert Skelton et al. (London: Victoria and Albert Museum, 1986), 185–92; Kay Talwar and Kalyan Krishna, *Indian Pigment Paintings on Cloth,* Historic Textiles of India at the Calico Museum, vol. 3 (Ahmadabad: B. U. Balsari on behalf of Calico Museum of Textiles, 1979); Stuart Cary Welch, *Indian Drawings and Painted Sketches: 16th through 19th Centuries* (New York: Asia Society in association with John Weatherhill, 1976).

[b]This is the inscription at the bottom right of map according to Gole, *Indian Maps and Plans,* 70 (note a).

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
k. Dwarka, Gujarat	Ahmadabad, Calico Museum of Textiles (acc. no. not available)	Kathiawar peninsula, Gujarat, early 19th century	Not known
l. Girnar (see x below)			
m. Jaisalmer, Rajasthan	Baroda, M.S. University of Baroda, Oriental Institute (acc. no. 7572)	Jaisalmer, Rajasthan, 1859	887.5 × 24.5
n. Kankroli, Rajasthan	Ahmadabad, Calico Museum of Textiles (P 300)	Nathdwara, Rajasthan, date unknown	121 × 179
o. Kashmir (numerous pilgrimage places), Set A, 166 sheets; set B, 72 sheets	Srinagar, Sri Pratap Singh Museum (set A, 2063; set B, 2066)	Kashmir, mid-19th century (probably prepared by a group of pandits led by Pandit Sahibram)	Set A, approx. 36.5 × 32; set B, approx. 35 × 21
p. Kathmandu, Nepal	Bhaktapur, National Art Gallery	Nepal, late 19th century (probably from an older model)	35 × 25
q. Madurai (see kk below)			
r. Nathdwara, Rajasthan	Ahmadabad, personal collection of Amit Ambalal	Nathdwara, Rajasthan, late 19th century	49 × 67
s. Nathdwara, Rajasthan	Ahmadabad, Calico Museum of Textiles (acc. no. not available)	Nathdwara, Rajasthan, late 19th or early 20th century	Not known
t. Nathdwara, Rajasthan	Ahmadabad, Calico Museum of Textiles (acc. no. 1561)	Nathdwara, Rajasthan, 20th century	169 × 119
u. Palitana, Gujarat (four examples, listed as i–iv)	Ahmadabad, Calico Museum of Textiles i (acc. no. 1043), ii (3056), iii (1137), iv (1095)	i and ii from Rajasthan or Gujarat; 18th century; iii from Kishangarh, Rajasthan, early 19th century (repainted, 1885); iv from Gujarat, 19th century	i, 271 × 180; ii, 172 × 115; iii, 238 × 177; iv, 180 × 154

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
Gujarati (?)	Painted and printed on cloth	Mostly given over to the walled bastion containing the principal and secondary temples. Numerous adjacent shrines, chhatris (cenotaphs), wells, and other sacred sites depicted. Water (either sea or river) along one edge of map. Map must be viewed from all four sides to be clearly read.	
Sanskrit and Gujarati	Painted on paper	See figure 17.50.	Gole, *Indian Maps and Plans*, 54–55 (fig. 13)
Hindi	Painted on cloth	Painting of local temple complex of the Vallabhacharya sect of Krishna devotees. (See items r and s below for similar works.)	Gole, *Indian Maps and Plans*, 56–57 (fig. 15)
Various: Sanskrit, Persian, Hindi, Nepali, and Bengali	Set A, painted on paper; set B, pencil and ink on paper	Believed to be parts of a never-completed work commissioned by Maharaja Ranjit Singh to provide a descriptive survey of all the pilgrimage places (*tīrthas*) of Kashmir (see plate 37).	Gole, *Indian Maps and Plans*, 129–31 (figs. 58 and 59)
Newari (?)	Painted on paper	A highly abstract view of Kathmandu compressed into the shape of a sword. Along the edges of the sword's blade are ranged thirty-three gates, each with the name of a particular section of the city. Curiously, what seem to be compass roses appear in two corners of the "map."	Pieper, *Die Anglo-Indische Station*, 114 (fig. 76)
No text	Painted on paper	Painting of the Shrinathji temple complex of the Vallabhacharya sect of Krishna devotees at Nathdwara (see plate 35).	Ambalal, *Krishna*, 138–39 and map key on 165–66
Rajasthani	Painted on paper (?)	*Pichhvāī* (painting to be hung at back of temple) depicting the Shrinathji temple complex, as noted above.	Talwar and Krishna, *Indian Pigment Paintings on Cloth*, 7–8 and pl. 3 (with overlay)
Rajasthani	Painted on cloth	This painting is even more detailed and full of human interest than s above; but it is now quite patched (see fig. 17.47).	Gole, *Indian Maps and Plans*, 56–58 (fig. 16); Talwar and Krishna, *Indian Pigment Paintings on Cloth*, 36–37 and 43 (no. 42), and pls. IV (color) and 45
Not noted (if any)	Painted on cloth	*Patas* (wall hangings), showing the Jain Shatrunjaya temple complex on Mount Girnar in Gujarat, with routes up the mountain commencing from the town of Palitana. Rendered in varying degrees of detail, though none shows more than a few score of the roughly nine hundred temples and shrines that cover the mountain. Profuse detail of vegetation, animals, birds, rocky terrain, etc., with numerous pilgrims shown along roads and elsewhere. Most detailed view is i; most naturalistic (reflecting the "Company style") is iii; simplest is iv.	Talwar and Krishna, *Indian Pigment Paintings on Cloth*, 82–89 (nos. 99–102), and pls. IX (color) and 86–89

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
v. Palitana, Gujarat	New York, Navin Kumar Gallery	Mewar, Rajasthan, ca. 1800	129 × 102
w. Palitana, Gujarat	Ahmadabad, Sheth Anandji Kalyanjipedhi	Ahmadabad, Gujarat, 1971	318 × 249
x. Palitana (Shatrunjaya Hill temple complex), Girnar, and Prabhasa, Gujarat; Parasnath Peak, Bihar; and Mount Abu, Rajasthan	Private collection	Gujarat, mid-19th century	56.5 × 76
y. Parasnath Peak (Bihar)	Not known (catalog does not list sources individually)	Rajasthan, 19th century	113 × 176
z. Parasnath Peak (Bihar)	Copied from a *Bilderbogen* (picture album)	Provenance not known; late 19th century	27.5 × 21.5 (copy)
aa. Parasnath Peak (see x)			
bb. Puri, Orissa	Paris, Bibliothèque Nationale, Département des Manuscrits, Division Orientale (Suppl. Ind. 1041)	Bir Raghuraypur village, near Puri, Orissa, 19th century	150 × 270
cc. Puri, Orissa	London, British Library (MS. Or. 13938)	Puri district, Orissa, early 19th century	59 × 80.5
dd. Puri, Orissa	New Delhi, National Museum (acc. no. 56.59/59)	Puri district, Orissa, late 19th century	96.5 × 147.6
ee. Puri, Orissa	Baroda, Museum and Picture Gallery	Puri district, Orissa, date not known	85 × 147
ff. Puri, Orissa	Not known	Probably Puri district, Orissa, date not known	Not known
gg. Puri, Orissa	Ahmadabad, Calico Museum of Textiles (acc. no. 401)	Puri district, Orissa, mid-20th century	164 × 226
hh. Rameswaram (see kk below)			
ii. Somnath (see x above)			
jj. Srirangam, Tamil Nadu	Not known	Not known	Not known

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
No text	Painted on cloth	Most resembles map ii of u above.	
No text except title	Oil paint on cloth	Subject as in u above, but rendered in a naturalistic style, with attempt at providing a modern oblique perspective.	
No text	Painted on paper	Unique triptych illustrating five principal Jain shrines. Details similar to those noted for u above (see fig. 17.49).	Neven, *Le Jainisme*, 32 and fig. 72
No text	Painted on cloth	Wall hanging showing great detail of routes connecting numerous Jain shrines on Parasnath Peak. Shrines shown in combined planimetric and frontal perspectives. Abundant detail of terrain, rivers, vegetation, etc.	Neven, *Peintures des Indes*, 68 (fig. 8)
Hindi	Original not known (copy in black ink)	Bastian's copy of a very detailed original drawing, similar to y above but more modern in appearance. Abundant text identifying shrines and other features of map.	Bastian, *Ideale Welten*, 1:288–89 and pl. 9 (frontispiece)
No text	Painted on cloth, lacquered surface	See plate 36.	Das, *Puri Paintings*, fig. 30; Gole, *Indian Maps and Plans*, 63
No text	Painted on cloth	Similar to bb above, but showing a somewhat smaller area outside the main temple.	
No text	Painted on cloth	Similar to bb and cc above, with still smaller area outside the main temple.	
No text	Painted on cloth	Not seen, but presumably like bb above.	*Baroda Museum Bulletin*, n.d.
No text	Probably painted on cloth	Essentially as bb above. Since only a black-and-white photograph is available, statement on color is uncertain.	Von Glasenapp, *Heilige Stätten Indiens*, pls. 198–203
Oriya (?), Devanagari script	Painted on cloth (?)	Essentially as t or bb above.	Talwar and Krishna, *Indian Pigment Paintings on Cloth*, 110–12 (no. 130) and pl. 109
No text	Not known	Depicts layout of major Vishnu temple on island in Kaveri River.	Von Glasenapp, *Heilige Stätten Indiens*, pl. 159

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
kk. Srirangam, Madurai, and Rameswaram, Tamil Nadu	London, British Museum, Oriental Collections (1962 12-31 013)	South India, ca. 1830 (paper watermarked 1820)	four folios (of total of ninety-one), each 22.6 × 17.6
ll. Srirangam (?), Tamil Nadu	New Delhi, collection of K. N. Goyal	Not known, possibly Rajasthani, mid-19th century (?)	122 × 63.5
mm. Tarn Taran, Punjab, India	Not known	Not known	Not known
nn. Tirupati, Andhra Pradesh	Hyderabad, Andhra Pradesh State Archives (B.P. Press no. 28 February 1874)	Andhra Pradesh 1873 (by Alim Sher Ahmed)	68 × 87
oo. Udaipur, Rajasthan	Bikaner, Abhaya Jain Granth Bhandara	Udaipar, Rajasthan, 1840	23 × ?
pp. Ujjain, Madha Pradesh	New Delhi, National Museum (acc. no. 59.1284/7)	Scindia branch of Marathos, early 19th century (?)	24 × 32.5
qq. Varanasi, Uttar Pradesh	New Delhi, National Museum (acc. no. 61.935)	North Indian, late 19th century	234 × 330
rr. Varanasi, Uttar Pradesh	Berlin, in personal possession of Jan Pieper	Varanasi, 1875	79 × 92
ss. Varanasi, Uttar Pradesh	Varanasi, Bharat Kala Bhavan (4/12129)	Varanasi, 1887	ca. 100 × 86
tt. Varanasi	Private collection of Richard Lannoy	North India, late 19th or early 20th century	Not known

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
Telugu	Painted on European paper	Maplike views from a bound album of religious paintings. Fol. 1, of the temple at Srirangam, is very much like jj above. Fol. 59, of Rameswaram temple, is the most stylized of the group showing nested courtyards lined with Shiva *liṅgams* and black squares presumably signifying four main temple gates and towers (*gopurams*). Fol. 69, of Minakshi temple in Madurai, is in a style similar to that of fol. 1 and focuses on shrines to Shiva and Parvati. Fol. 71, very similar to fol. 69, is of Jambukeswaram temple at Srirangam and also focuses on shrines to Shiva and Parvati (see fig. 17.48).	
No text	Painted on paper backed with cloth	Depicts a Shiva temple on an island. Might be Jambukeswaram temple, half a mile east of kk above. Also shows nearby roads lined with shops.	Gole, *Indian Maps and Plans,* 67 (fig. 28)
No text	Not known	Depicts compound and Sikh temple complex built around sacred tank in late eighteenth century.	Von Glasenapp, *Heilige Stätten Indiens,* pl. 76
Telugu, with later English additions	Painted on paper	Though map depicts Sri Venkateswara temple complex, that it was drafted by a Muslim makes it clear that its purpose was not religious. Gole presents evidence that it may have been drawn as part of an enquiry into a murder case.	Gole, *Indian Maps and Plans,* 139 (fig. 65)
Hindi	Painted on paper	Scroll painting of same genre as m above. Small portion depicted by Gole depicts types of shops that Jain monks would pass on entering the city of Udaipur.	Gole, *Indian Maps and Plans,* 54 (fig. 12)
No text	Painted on paper	Highly stylized map showing city wall, major temples and other prominent edifices, tanks outside the city, and the winding Sipra River. Much charming pictorial detail of people, architecture, and vegetation.	Gole, *Indian Maps and Plans,* 64 (fig. 24)
Sanskrit	Painted on cloth	Centered on Visvanath temple in heart of city, map shows routes for circumambulations for pilgrims: (a) immediately around the temple; (b) and (c) an inner- and outer-city ring; and (d) an exterior ring beyond the city. Hundreds of pilgrims are painted along these rings. Bathing ghats, boats and fish in the Ganga, temples, Aurangzībi mosques, other major buildings, tanks, wells, gardens, animals, trees, etc., adorn all portions of map. Faded colors and poor state of repair suggest that map was much used.	
Sanskrit	Lithographic printing on cloth	See figure 17.45	Pieper, "Pilgrim's Map," 215–18 (fig. 1)
Sanskrit	Lithographic printing on cloth	Similar, but not identical, to oo above.	
Sanskrit and Bengali (?)	Woodcut on paper (?)	Similar, but not identical, to rr above.	Lannoy, *Speaking Tree,* xi and fig. 42

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
uu. Varanasi, Uttar Pradesh	Paris, private collection	North Indian, 20th century (?)	76 × 72

APPENDIX 17.7 DETAILED MAPS, PLANS, AND

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
a. Agra, Uttar Pradesh (Red Fort)	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 125)	Agra (?), mid-18th century	83 × 121
b. Agra, Uttar Pradesh (Red Fort)	London, India Office Library and Records (Persian inv. 11)	Agra (?), ca. 1750	27 × 29.5
c. Agra, Uttar Pradesh (Red Fort)	London, India Office Library and Records (Add. MS. Or. 4392)	Agra, ca. 1810, by Shaykh Ghulam Ahmad	?
d. Amritsar, Punjab, India (Govindgarh fort)	Patiala, Punjab State Archives	Punjab (?), 19th century	?
e. Baghor, Rajasthan	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 112)	Rajasthan, early 19th century	118 × 160
f. Bhiwai, Rajasthan (near Baghor)	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 48)	Rajasthan, early 19th century	168 × 123
g. Bhudargad, Maharashtra	Bombay, Prince of Wales Museum of Western India (15.430) (now not traceable)	Maratha, 19th century	?
h. Delhi (Red Fort)	London, India Office Library and Records (Add. MS. Or. 1790)	Mughal (by Nidhamal), ca. 1750	80 × 73.5
i. Delhi (Red Fort)	London, Victoria and Albert Museum (AL 1754)	Company style, ca. 1755 (probably a copy)	82 × 75
j. Delhi (Red Fort)	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 122)	Rajasthani, late 18th century	64 × 137
k. Delhi (Red Fort)	London, India Office Library and Records (Add. MS. Or. 948)	Lucknow, ca. 1785	29.2 × 41.5

[a]The citations in this column are: Mulk Raj Anand, "Transformation of Folk Impulses into Awareness of Beauty in Art Expression," *Mārg* [34, no. 1], *Appreciation of Creative Arts under Maharaja Ranjit Singh*, 8–26; Bhalchandra Krishna Apte, *A History of the Maratha Navy and Merchantships* (Bombay: State Board for Literature and Culture, 1973); K. N. Chitnis, "Glimpses of Dharwar during the Peshwa Period," in *Studies in Indian History and Culture: Volume Presented to Dr. P. B. Desai*, ed. Shrinivas Ritti and B. R. Gopal (Dharwar: Karnatak University, 1971), 262–69; C. D. Deshpande, "A Note on Maratha Cartography," *Indian Archives* 7 (1953): 87–94; Toby Falk and Mildred

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
Sanskrit	Painted on paper	A relatively simple map emphasizing the Ganga, its tributaries (Varuna and Asi), and the major shrines to be visited on the five-*kos* pilgrimage, one of the circuits noted above.	Gole, *Indian Maps and Plans,* 66 (fig. 27)

Maplike Oblique Views of Forts

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
Hindi	Painted on paper	Carefully executed plan on gridded paper (see fig. 17.52).	Gole, *Indian Maps and Plans,* 175 (fig. 94)
No text	Painted on paper	Miniature painting, oblique perspective, seen from east with Yamuna River in foreground.	Falk and Archer, *Indian Miniatures,* 122 (pl. 191) (description only)
Persian (?)	Ink and watercolor on silk	Walls, gateways, and palace facades rendered in frontal elevation, other structures planimetrically. Very carefully executed on gridded field.	
No text	Painted, on paper	Detailed oblique perspective (view presented by Anand seems to be cut out from larger composition).	Anand, "Folk Impulses," 15 (fig. 5)
Dhundari	Painted on paper backed with cloth	Shows fort in larger setting of cultivated fields and nearby Bhiwai fort. Distances between bastions of outer wall of fort are noted.	Gole, *Indian Maps and Plans,* 150 (fig. 75)
Dhundari	Painted on paper backed with cloth	See plate 38.	Gole, *Indian Maps and Plans,* 149 (fig. 74)
Marathi (Modi and Devanagari script)	Ink on paper	Detailed legends on components of fort, conventional symbol to show scarps. Distances to nearby villages and forts noted on edge of map.	Deshpande, "Maratha Cartography," 89 (description only)
Urdu (with English added)	Painted on paper	Emphasis is on wall and gates of fort and nearby moat and river. No detail of interior, but considerable detail of fort's surroundings.	Falk and Archer, *Indian Miniatures,* 121–22 and 426 (pl. 190)
Persian (with French added)	Painted on paper	Similar to h above.	Gole, "Three Maps" (figs. 3a–3b), and Gole, *Indian Maps and Plans,* 178–79 (fig. 97.2)
Rajasthani	Paint and pencil on paper	Very detailed, carefully drafted plan. Includes plan, in pencil, of house of Ghadzi Khan (identity not established) to right of plan of city.	Gole, *Indian Maps and Plans,* 176 (fig. 95)
No text	Gouache and gold on paper	Very detailed oblique perspective, seen from the east. Careful attention to perspective (one-point). Many people drawn in interior courtyards.	Falk and Archer, *Indian Miniatures,* 160 and 446 (pl. 343)

Archer, *Indian Miniatures in the Indian Office Library* (London: Sotheby Parke Bernet, 1981); Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989); Susan Gole, "Three Maps of Shahjahanabad," *South Asian Studies* 4 (1988): 13–27; Naveen Patnaik, *A Second Paradise: Indian Courtly Life, 1590–1947* (New York: Doubleday, 1985); S. R. Tikekar, "The Battle for Janjira," *Illustrated Weekly of India,* 20 March 1949; Stuart Cary Welch, *Indian Drawings and Painted Sketches: 16th through 19th Centuries* (New York: Asia Society in association with John Weatherhill, 1976).

Place Represented	Place Representation Is/Was Held	Provenance and Date	Dimensions (cm) (h × w)
l. Dharwar, Karnataka	Pune, Maratha History Museum, Deccan College	Maratha (Visaji Narayan Vadadekar had it drawn up), probably 1791	Irregular, 80 × 110
m. Gagraun, Rajasthan	Cambridge, Arthur M. Sackler Museum, Harvard University (545.1983) (private collection)	Kotah, Rajasthan, ca. 1735	ca. 55 × 73
n. Janjira, Maharashtra	Pune, Raja Dinkar Kelkar Museum	Maratha, late 18th century	70 × 95
o. Multan, Punjab, Pakistan	London, India Office Library and Records (acc. no. 1985)	Rajasthani (?), ca. 1849	41.5 × 80
p. Panhala, Maharashtra	Jaipur, Maharaja Sawai Man Singh II Museum (cat. no. 47)	Rajasthani, 18th century	160 × 110
q. Seringapatam, Karnataka	Bombay, Prince of Wales Museum of Western India (not now traceable)	Maratha, ca. 1799	?
r. Srinagar (Harī Parbat Fort)	Srinagar, Sri Pratap Singh Museum (2063)	North Indian	68 × 37
s. Vijayadurg, Maharashtra	Bombay, Prince of Wales Museum of Western India (cat. no. 53.102)	Maratha, 18th century	190.5 × 172.5
t. Two unidentified, presumably Maratha, forts	Bombay, Prince of Wales Museum of Western India: i (53.101) and ii (53.104) (not now traceable)	Maratha, 18th or early 19th century	i, 173 × 205; ii, 121 × 161
u. An unidentified fort (map titled "Siege of a Fort")	Delhi, Red Fort Museum	Provenance not known, 18th century	Ca. 50 × 63

Language	Medium	Purpose and Description (all essentially planimetric, unless otherwise specified)	Where Published[a]
Marathi	Painted on paper	Bastions and walls of fort shown in great detail. Interior of structures partially depicted in frontal perspective. Attached panels on three sides sketchily depict unspecified localities.	Chitnis, "Glimpses," 267 and pl. XLIa and b; Gole, *Indian Maps and Plans,* 148 (fig. 73)
Rajasthani (?)	Painted on paper	See figure 17.54.	Patnaik, *Second Paradise,* 112 and 183–84 (pl. 40); Welch, *Indian Drawings,* 95–96 (pl. 49)
Marathi (Modi script)	Painted on paper backed with cloth	Exceedingly vivid representation of a naval engagement between Marathas and the small Sidi coastal state whose main fort was on the island of Janjira. Abundant detail of Janjira fort, nearby forts and military installations on mainland, and ships surrounding island.	Tikekar, "Janjira," 36–37; Gole, *Indian Maps and Plans,* 153 (fig. 79)
Hindi	Ink (?) on paper	Presumably made at or shortly after British capture of Multan in 1849 by a native (Rajasthani?) artist in their employ. Details are mainly, but not exclusively, of military interest.	Gole, *Indian Maps and Plans,* 151 (fig. 76)
Dhundari	Painted on paper	Siege of a Maratha fort involving Rajput forces in army of Mughal emperor. Headquarters of nine separate besieging units are shown in great detail, along with unit flags. Earthworks, battlements of fort, and some details of terrain and vegetation also shown.	Gole, *Indian Maps and Plans,* 152 (fig. 78)
Marathi (Modi script)	Ink on paper	Detailed map of major fort of Tipu sultan, presumably made on eve of its siege by Maratha forces. Major buildings and their occupants named. Channels of and canals from Kaveri River rather accurately delineated. Attempt to show relief by crude contourlike lines and by identifying text.	Deshpande, "Maratha Cartography," 89–90 (description only)
Hindi	Painted on paper	Details not only of fort but of adjacent portion of Srinagar. Highly decorative style suggests that map was not drawn for any military purpose.	Gole, *Indian Maps and Plans,* 127–28 (fig. 54)
Marathi (Devanagari and Modi scripts)	Painted on paper backed with cloth	See figure 17.53.	Apte, *Maratha Navy,* 21–24 (fig. 7), including full translation; Deshpande, "Maratha Cartography," 88–89 and pl. I; Gole, *Indian Maps and Plans,* 137 (fig. 63)
Marathi (Modi script)	Painted on paper backed with cloth	i, Style and nature of detail similar to s above (although this is an inland fort on a river); ii, Details similar to above, but style is more decorative. Vegetation abundantly depicted.	
Not known (possibly Marathi in Modi script)	Painted on paper	Hilltop fort near a river, with moat at base of hill. Fort is under siege by large force, largely cavalry with some elephants and one camel. Metal siege machines, trench leading to mine, and palisades depicted; abundant explanatory text on map.	

18 · Nautical Maps

JOSEPH E. SCHWARTZBERG

Although, as I noted in the introductory chapter on South Asian cartography, there is a brief description of what appears to be a nautical map in a Sanskrit epic poem composed as early as the fifth century, that description does not give any clear idea of how the map might have looked or of how it was drawn.[1] In subsequent centuries, various writers left records that certain scholars have interpreted as suggesting that Indian navigators, among others sailing in the Indian Ocean region, may have produced some type of maritime charts before the advent of the Portuguese. But, in his review of the available literature, summarized above in "The Role of Charts in Islamic Navigation in the Indian Ocean" in part 1, Gerald Tibbetts concludes that there are no firm grounds for believing that Arabs, or by implication South Asians, made or possessed "practical" navigation charts before the sixteenth century.[2] Of one fact, however, we are certain: the earliest known nautical maps from South Asia date only from 1664. In what follows, we shall examine the few maps that have survived and consider textual evidence on others that are no longer extant. Whether we can project this evidence back before 1500 to postulate the earlier existence of such charts is still an open question and awaits solid evidence. But even without such evidence it will be in order to present some factors bearing on the likelihood that cartographic concepts, and possibly even maps themselves, were diffused before 1664, the date that can now be firmly established.

Based on conversations with informants residing in some of the port towns of Gujarat that are still visited by small commercial sailing craft (now usually with auxiliary motors), Varadarajan observes:

> Those navigating the high seas do possess maps and charts. These records do not fall into the category of log books, as skippers were not accountable in the European sense. The records which they maintained were for their own professional guidance rather than constituting a daily record of the voyage. Such books called *roz nama* were passed on from one ***mullam*** to another, each adding what was considered important for enlarging the compendium of knowledge rather than accumulating quotidian details. . . . Shri Dushyanta Pandya (resident of Jamnagar), and Dr. Manubhai Pandhi (resident of Kutch-Mandvi) have such *roz nama* in their possession. Details of successive voyages are entered, direction rather than speed is mentioned. . . . Some *roz nama* contain shoreline silhouettes, directional instructions presented in the form of riddles, and one, at least, has a coastal map of western India including Ceylon. Various calculations may also be found. The sun appears to be used for position-finding during the day.[3]

The Dushyanta Pandya that Varadaraja mentions had, in 1980, no fewer than seven *roz nāma* in his possession. The oldest, dated not later than A.D. 1664, written in Kutchi and comprising some thirty-five folios, was acquired by the National Museum in New Delhi in the early 1980s. The cartographic portion of that manual (also called *pothi*) has been the object of a detailed and exceedingly well informed study by B. Arunachalam.[4] I also inspected the original document in New Delhi in February 1984.[5] Photographs of all five maps contained in the manual are provided in figures 18.1, 18.2, and 18.3. Figure 18.4 indicates the area of coverage of each of these charts.

1. See above, p. 321.
2. See pp. 256–62, esp. 262.
3. Lotika Varadarajan, "Traditions of Indigenous Navigation in Gujarat," *South Asia: Journal of South Asian Studies*, n.s., 3, no. 1 (June 1980): 28–35; quotation on 29.
4. Professor Arunachalam is head of the Department of Geography at the University of Bombay; see his "The Haven-Finding Art in Indian Navigational Traditions and Cartography," in *The Indian Ocean: Explorations in History, Commerce, and Politics*, ed. Satish Chandra (New Delhi: Sage Publications, 1987), 191–221. This essay was originally published under the title "The Haven Finding Art in Indian Navigational Traditions and Its Applications in Indian Navigational Cartography," *Annals of the National Association of Geographers, India* 5, no. 1 (1985): 1–23. I will cite the 1987 publication, which differs minimally from that of 1985, because of its presumed greater accessibility, the greater clarity of its illustrations, and its relative lack of typographical errors. The essay is based not merely on careful inspection of the surviving nautical charts and on archival research, but also on fieldwork at many localities along the Indian coast, among communities whose members include individuals who can recall navigational traditions that are now either moribund or dead.
5. I found the work in a serious state of decay. At least two and probably more folios of the original appear to have been lost. On many pages the ink from one side of the folio has bled through on either the

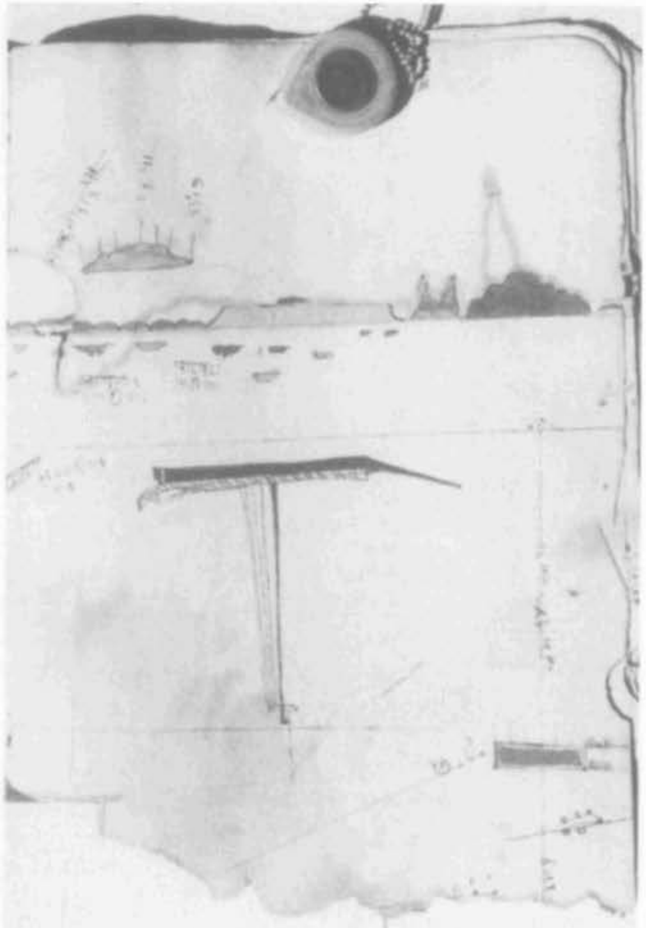


FIG. 18.1. FOLIO OF AN INDIAN *ROZ NĀMA* (NAUTICAL MANUAL). This Gujarati chart is watercolor and ink on paper, Kutchi language in Gujarati script, and dated V.S. 1710 (A.D. 1644). The short portion of the Indian coast depicted here is in the vicinity of the port of Coondapoor in Karnataka (area A on fig. 18.4).
Size of the original page: approx. 29 × 21 cm (untorn). By permission of the National Museum, New Delhi (MS. 82.263). Photograph by Joseph E. Schwartzberg.

Essential to the traditional way of navigation by the stars and to the making of the maps under discussion was the use of a compass card; an example, from the National Museum manuscript, appears as figure 18.5. A transliteration of the text of a comparable compass card, dated 1780, is provided by figure 18.6.[6] Such cards correspond closely to Arabic star compasses described by Prinsep and Tibbetts and probably are derived from Arabic prototypes that characteristically showed thirty-two rhumbs or sailing directions marked off at even intervals of 11¼°. Some Indian compass cards, however, were much simpler than the two I have illustrated. Chinese compass cards, while showing only twenty-four points, were in other respects similar to those of the Arabs.[7] The symbols at the periphery of the card represent the perceived appearance of specific constellations toward which ships were steered, together with the number of stars used to identify that constellation. In figure 18.6, east (Ṭā'ir = α Aquilae = Skt. Sravana *nakṣatra*) is at the top, and Jāh-Qutb represents the north-south axis. Each symbol appears twice on the card, at the directions of the rising and setting on the horizon of the constellation represented; hence the bilateral symmetry on either side of north. The cards were relatively accurate sailing guides for rhumbs close to north but increasingly inaccurate for sailing farther to the south.[8]

The compass card was used by providing a pair of symbols to be inscribed at either end of each of the numerous stellar rhumb lines drawn on the chart, so as to indicate sailing directions for specific legs of a voyage. Figure 18.7, adapted from Arunachalam (and corresponding to the area represented by the right portion of fig. 18.3 and also rectangle E on fig. 18.4) illustrates the system for sailing to the northeast of Kanniyakumari (Cape Comorin) at the southern tip of India and for sailing along any of the coasts of Sri Lanka.[9] The lowest rhumb line on the map shows a west-east bearing and has symbols signifying those two directions. Above the eastern terminus of that line is a rhumb, its symbols signifying a route from southwest to northeast. That it does not actually appear to go to the northeast (as it would on a European portolan chart or a Mercator projection) poses no difficulty, since it is the symbols rather than the apparent direction of the line that matter to the map user. The next rhumb indicates, according to the symbols, a north-south bearing; but the line actually appears to be veering slightly farther to the east. Again, the apparent map direction is without significance.

We may also note in the examples above that the linear distances along the stellar rhumb lines are not proportional to the actual distances represented on the earth's surface, which were not particularly well known. Since the coastal sailors had to rely on reaching visible landmarks that *were* depicted on the map (about which I shall say more below), the nautical distances traversed were

overleaf or the facing page. The folios were not individually numbered.

6. Arunachalam, "Haven-Finding Art," 201, fig. 2 (note 4); see also his figure 1 (p. 197) for various wind and star direction roses in use along different parts of the Indian coast.

7. James Prinsep, "Note on the Nautical Instruments of the Arabs," *Journal of the Asiatic Society of Bengal* 5 (1836): 784–94, esp. 788–92; Gerald R. Tibbetts, *Arab Navigation in the Indian Ocean before the Coming of the Portuguese* (London: Royal Asiatic Society of Great Britain and Ireland, 1971; reprinted 1981), esp. 290–95; and Arunachalam, "Haven-Finding Art," 200 (note 4); also *History of Cartography*, volume 2, book 2, forthcoming, and Mei-ling Hsu, "Chinese Marine Cartography: Sea Charts of Pre-modern China," *Imago Mundi* 40 (1988): 96–112, esp. 100, 102, and 103, fig. 4.

8. Arunachalam, "Haven-Finding Art," 200–201 (note 4).

9. Arunachalam, "Haven-Finding Art," 215–17 and fig. 8 (note 4).

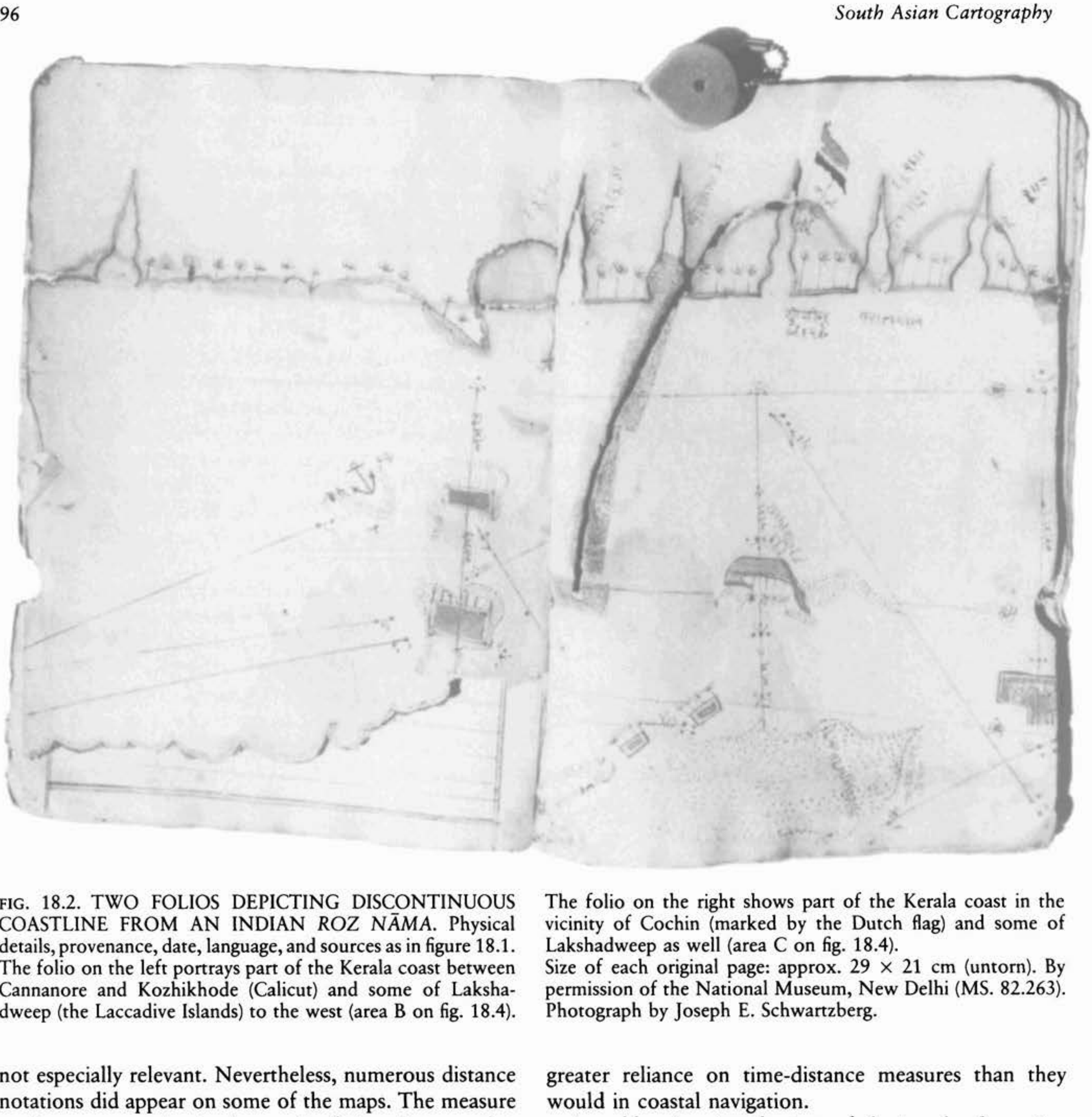


FIG. 18.2. TWO FOLIOS DEPICTING DISCONTINUOUS COASTLINE FROM AN INDIAN *ROZ NĀMA*. Physical details, provenance, date, language, and sources as in figure 18.1. The folio on the left portrays part of the Kerala coast between Cannanore and Kozhikhode (Calicut) and some of Lakshadweep (the Laccadive Islands) to the west (area B on fig. 18.4). The folio on the right shows part of the Kerala coast in the vicinity of Cochin (marked by the Dutch flag) and some of Lakshadweep as well (area C on fig. 18.4).
Size of each original page: approx. 29 × 21 cm (untorn). By permission of the National Museum, New Delhi (MS. 82.263). Photograph by Joseph E. Schwartzberg.

not especially relevant. Nevertheless, numerous distance notations did appear on some of the maps. The measure used was a *zam* (or *jam*), a unit of time-distance that corresponded to what, on average, could be covered during a single three-hour watch (watch being the original meaning of *zam*).[10] But the *zam* notations often referred to distances from the sailing route to specific mapped points along or near the shore or to specific offshore islands. Figure 18.8, also adapted from Arunachalam, shows some of the *zam* measures indicated in the chart that correspond to the right portion of figure 18.2 and also the area of rectangle C on figure 18.4. Since this chart extends from Lakshadweep (the Laccadive Islands) to the Malabar Coast, the distances it covers are such that pilots sailing the west-east rhumbs would be out of sight of land for much of the time and would then place greater reliance on time-distance measures than they would in coastal navigation.

A problem in using the type of chart under discussion is that it combines details about landmarks that would be visible mainly by day (lighthouses are an obvious exception) with stellar bearings, which would be maximally useful only between dusk and dawn, when the constellations designated would appear or disappear along the horizon. (On this point Arunachalam is silent.) One could set a course during these hours, but maintaining such a course throughout the night and into the next day, especially if there were a shift in wind direction, would not be easy. This problem, however, would be somewhat mitigated by the relative steadiness of the mon-

10. Arunachalam, "Haven-Finding Art," 205–6 (note 4).

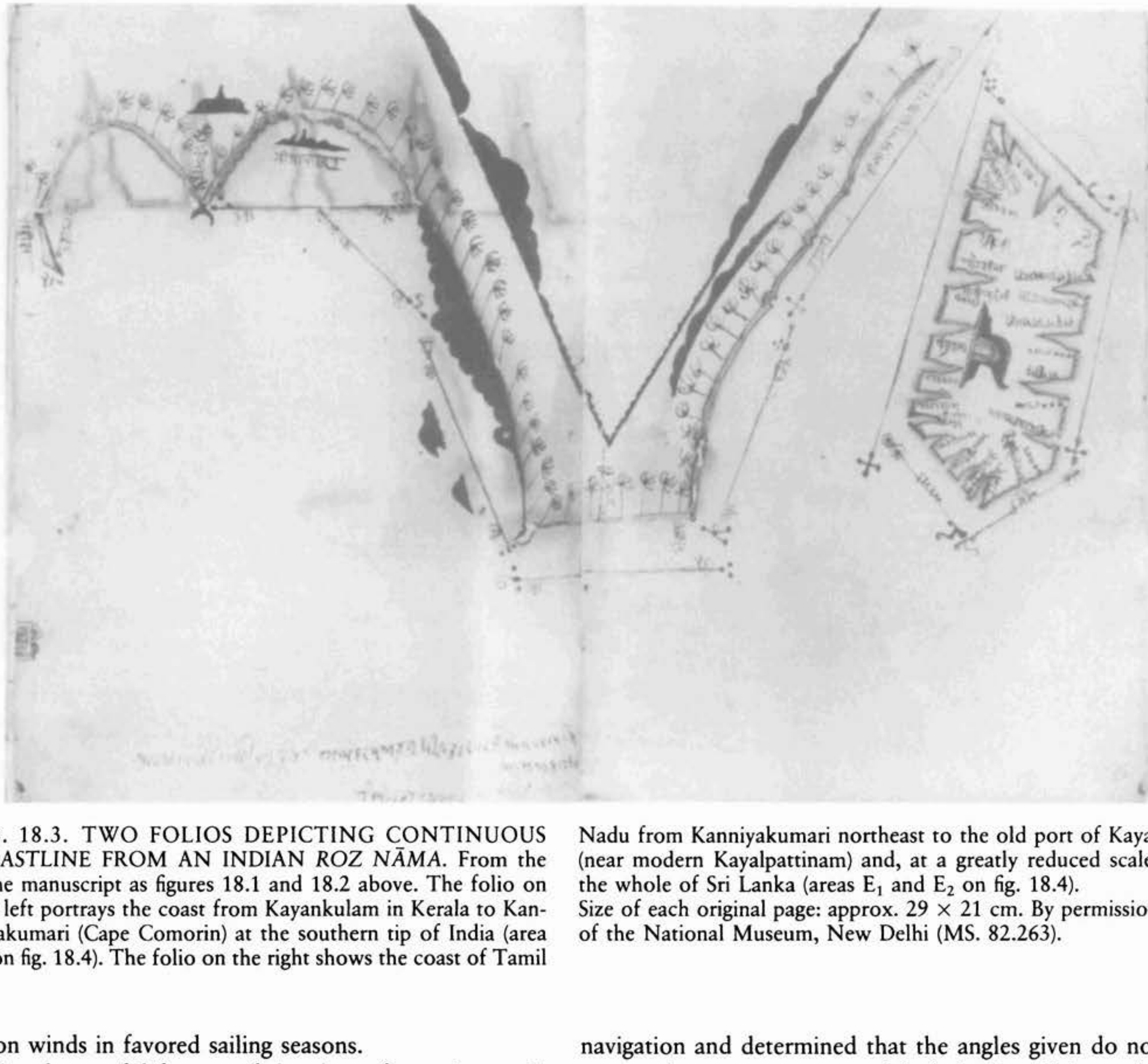


FIG. 18.3. TWO FOLIOS DEPICTING CONTINUOUS COASTLINE FROM AN INDIAN *ROZ NĀMA*. From the same manuscript as figures 18.1 and 18.2 above. The folio on the left portrays the coast from Kayankulam in Kerala to Kanniyakumari (Cape Comorin) at the southern tip of India (area D on fig. 18.4). The folio on the right shows the coast of Tamil Nadu from Kanniyakumari northeast to the old port of Kayal (near modern Kayalpattinam) and, at a greatly reduced scale, the whole of Sri Lanka (areas E_1 and E_2 on fig. 18.4).
Size of each original page: approx. 29 × 21 cm. By permission of the National Museum, New Delhi (MS. 82.263).

soon winds in favored sailing seasons.

Another useful feature of the charts for navigators is their notation of Pole Star altitudes for many identified ports. These are written in numerical figures (integers and fractions) and preceded by the prefix *dhru*, signifying *Dhruva*, the North Star. Thus, if one were sailing at night and could ascertain from the altitude of the North Star that one had attained the latitude of a port one wished to sail toward on an east or west bearing, one could seek to continue along that parallel until the destination was in sight. The unit in which Pole Star altitudes were expressed was the *iṣbaʿ*, taken as 1°36′. This was the distance one had to sail to raise (or lower) the measured altitude of the Pole Star by one integer in meridional sailing and was equivalent to eight *zams*, or roughly one day's sailing (which would yield an average distance for a *zam* of approximately 20 km).[11] Arunachalam has compared the Pole Star altitudes on Indian charts with those given in the maps and text of Tibbetts's work on Arab navigation and determined that the angles given do not accurately represent geographic latitudes. This results from the increased refraction caused by the earth's atmosphere as one approaches the equator; observed Pole Star altitudes nearer the equator are likely to be lower than if there were no atmospheric refraction.[12]

Apart from distance, direction, and Pole Star altitude notations, the surviving Indian nautical charts display substantial additional details of use to mariners.[13] These include numerous toponyms for coastal localities; skyline profiles featuring prominent hills and other landmarks; offshore islands, headlands, bays, lighthouses, anchorages, shoals, banks, and reefs, shown by special symbols (e.g., stippling) supplemented occasionally by explanatory notations (e.g., "troublesome shores"); the nature of

11. Arunachalam, "Haven-Finding Art," 208 (note 4).
12. Arunachalam, "Haven-Finding Art," 207–8 (note 4).
13. Arunachalam, "Haven-Finding Art," 209–17 (note 4).

FIG. 18.4. AREAS OF INDIA AND SRI LANKA COVERED BY SURVIVING NAUTICAL CHARTS. The areas covered are portrayed in figures 18.1 (area A), 18.2 (areas B and C), and 18.3 (areas D, E_1, and E_2).
After B. Arunachalam, "The Haven-Finding Art in Indian Navigational Traditions and Cartography," in *The Indian Ocean: Explorations in History, Commerce, and Politics*, ed. Satish Chandra (New Delhi: Sage Publications, 1987), 191–221, esp. 204 (fig. 3).

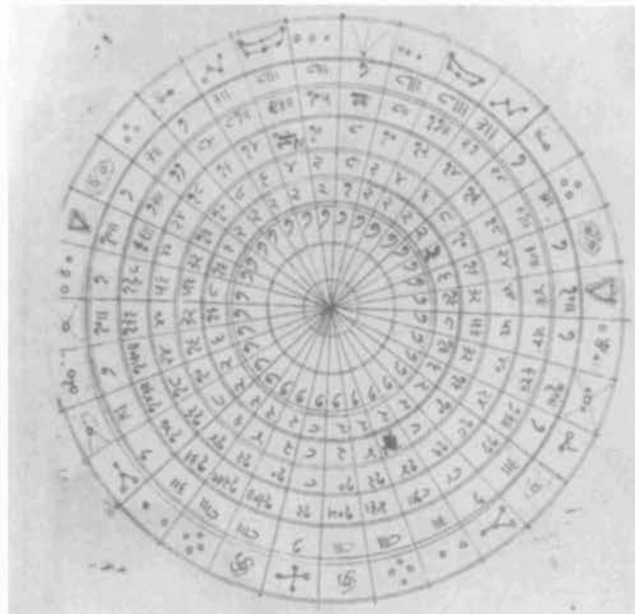


FIG. 18.5. COMPASS CARD FROM AN INDIAN *ROZ NĀMA*. Ink on paper, this chart is divided into thirty-two equal directional segments, each identified by a symbol standing for the azimuth on the horizon of the rising or setting of a particular constellation. Hence the bilateral symmetry of the symbols with respect to Dhruva, the Pole Star, the symbol for which appears at the top of the chart.
Size of the original page: approx. 29 × 21 cm. By permission of the National Museum, New Delhi (MS. 82.263).

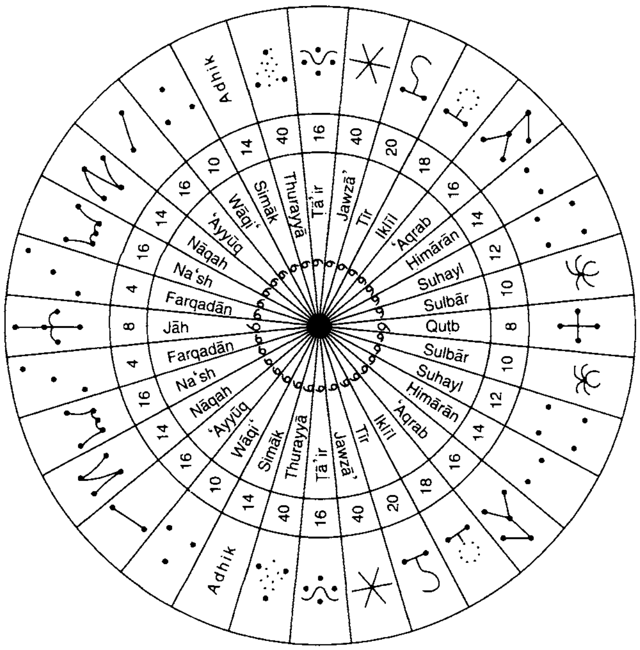
coastal vegetation (see the palm-fringed shores in figs. 18.2 and 18.3); ocean depths, measured in units called *wam* (roughly one fathom); and what seems to be a Dutch flag at Cochin and a written note to indicate the presence of Europeans (*firinghi*) in Sri Lanka.

The colors used for particular symbols appear to have significance. Noting, for example, one area in which the profiles to the rear of the coast are shown in red, in contrast to their usual black, Arunachalam wonders whether that is intended to "indicate the reddish appearance of the laterite caps of low plateaus behind the shores."[14] He also suggests that showing some islands in red and others in black might differentiate between those that are low and sandy and others that are rocky.[15] He offers no suggestion about long sections of the coast proper that are represented in yellow (bounded in brown ink), though obviously that might signify sandy strands.

Apart from the five pages with maps and the one showing the compass card, four other pages among the thirty-five surviving folios of the manual (at least two pages of maps appear to have disappeared) also contain illustrations. Arunachalam discusses none of these. One shows an enigmatic ten-spoked wheel with the Gujarati numbers one through ten in the segments between the successive spokes and a personal name inscribed in the hub. Two almost surely are essentially astrological diagrams, each with considerable text. One of these diagrams contains a central three-by-three rectangular matrix comprising an empty middle rectangle and eight peripheral rectangles, each with a constellation symbol from the compass card indicating a cardinal or secondary direction, with east at the top. The final illustration shows the same symbols, though with north at the top, several inscriptions, and a drawing of two snakes. The rear halves of the snakes, in the lower left quarter of the diagram, are intertwined, while the front halves diverge toward the upper right. Conceivably this represents the seasonal fluctuation in the position of some visible portion of the heavens, either a particular constellation or a group of constellations. The rest of the manual consists of text that has yet to be translated. Taken as a whole, the manual seems to deal not merely with navigation using the heavens and nautical charts, but also with the astrological influences that would have a bearing on when and when not to sail or engage in other nautical activities. Other information of potential use to mariners may also be incorporated in the work.

Another nautical chart of Gujarati provenance was

14. Arunachalam, "Haven-Finding Art," 210 (note 4).
15. Arunachalam, "Haven-Finding Art," 210 (note 4).



On this chart, in pairs:

Jāh = al-Juday, the Pole Star
Quṭb = Pole, not only the point about which the heavens revolve, but also denotes here the north point on the horizon

Farqadān = nearest of the rhumbs to the poles, Bγ*Ursa minoris*
Sulbār = Θ*Eridani*

Na'sh = the Plough αβγδ*Ursa majoris*
Suhayl = Canopus α*Carinae*

Nāqah = the first star of the group called Sanām that forms the hump of the camel seen by Bedouins in the constellation Cassiopeia – no modern identification
Ḥimārān = the two asses, could be γδ*Cancri*, but here probably αβ*Centauri*

'Ayyūq = α*Aurigae*, Capella
'Aqrab = Shawlah, the raised tail of the scorpion, λυ*Scorpii*

Wāqi' = "falling," from the expression *naṣr wāqi'* (the falling eagle), here referring to the star Vega, α*Lyrae*
Iklīl = the crown, βδπ*Scorpii*

Simāk = Arcturus, α*Boötis*
Tīr = Sirius, α*Canis majoris*

Thurayyā = the Pleiades
Jawzā' = here probably only in the sense of the constellation Orion or the Bedouin large giant seen in the area of Orion and Gemini; it is not likely to be Gemini in this context, though the name has been applied to all three at one time or another

Ṭā'ir = from the expression *naṣr ṭā'ir* (the flying eagle), α*Aquilae* or three stars in Aquila

FIG. 18.6. TRANSLITERATION OF A COMPASS CARD FROM AN INDIAN *ROZ NĀMA*. On this diagram east is at the top, but the bilateral symmetry about north noted on figure 18.5 still holds. Symbols here are similar but not identical to those of figure 18.5. This is a redrawing of an adaptation by B. Arunachalam of an illustration in an eighty-page leather-bound volume dated V.S. 1836 (A.D. 1780) and found in the National Museum, New Delhi.

After B. Arunachalam, "The Haven-Finding Art in Indian Navigational Traditions and Cartography," in *The Indian Ocean: Explorations in History, Commerce, and Politics*, ed. Satish Chandra (New Delhi: Sage Publications, 1987), 191–221, esp. 201. Additional information provided by Emilie Savage-Smith.

obtained from a local pilot by Sir Alexander Burnes in June 1835 and was subsequently presented to the Royal Geographical Society, London (fig. 18.9 and plate 40). Its age was not recorded, but Burnes wrote in a corner of the chart that it showed "the Coast of Arabia and the Red Sea [and was] drawn by an inhabitant of Cutch and used by pilots at the present time in that navigation." This may suggest that the chart was compiled not long before its acquisition. Kammerer assigned the work to the end of the eighteenth century, presumably on the strength of comments made on it by Edgar Blochet, who transliterated the Gujarati text into French for the Bibliothèque Nationale, Paris, which possesses a facsimile of the map.[16] The original copy in London also includes a large number of transliterated place-names, possibly adapted from Blochet.

Even though at least a century separates the Red Sea chart from the charts of southern India and Sri Lanka discussed above, the stylistic similarities between them are striking. In particular, they appear to employ identical means of using stellar rhumb lines with constellation symbols at each end to indicate sailing directions. Pole Star altitudes are similarly recorded, both at regular intervals along the African shore of the Red Sea and at selected localities elsewhere. As with the southern India charts, the apparent direction and length of the rhumb lines is of no great importance, for not only is their compass card direction conveyed by symbols, but their distances, in *zam* of sailing time, are also noted. Accordingly, the right-angle bend in the Arabian coastline at the Bab el Mandeb Strait between the Red Sea and the Gulf of Aden is totally ignored, doing no disservice to the informed map user. Arunachalam had little difficulty in transforming the chart into a form comprehensible to a contemporary non-Indian student of geography, using methods identical to those he applied to the charts previously discussed.[17]

Compared with the southern India charts, which include a richer array of detail for onshore features, the Red Sea chart puts greater stress on features at sea:

16. Albert Kammerer, *La Mer Rouge: L'Abyssinie et l'Arabie aux XVIe et XVIIe siècles et la cartographie des portulans du monde oriental: Etude d'histoire et de géographie historique*, 3 vols., Mémoires de la Société Royale de Géographie d'Egypte, vol. 17 (Cairo: Institut Français d'Archéologie Orientale pour la Société Royale de Géographie d'Egypte, 1947–52), vol. 1, pls. LXXII–LXXIII, presents a large facsimile of the map, and p. 132 gives a description of it.

17. Arunachalam, "Haven-Finding Art," 219–20, fig. 11 (note 4).

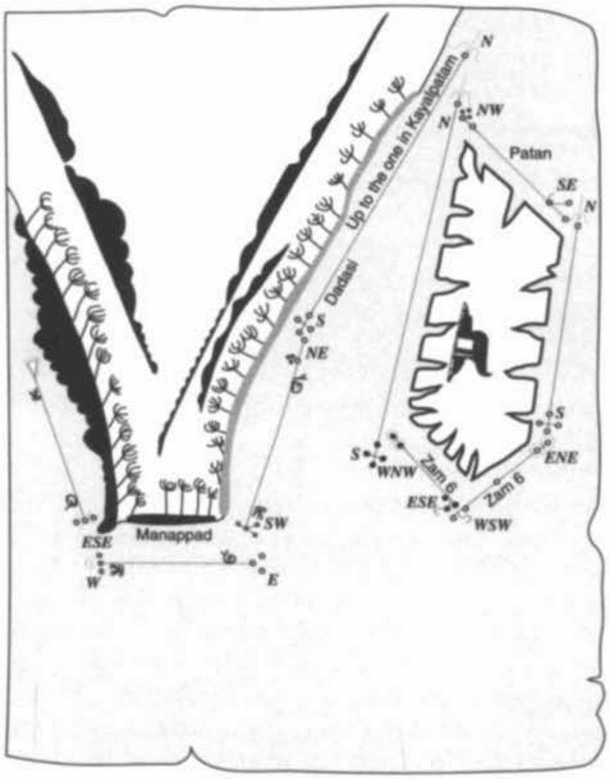


FIG. 18.7. DRAWING OF A SHORT STRETCH OF THE SOUTHERN COAST OF INDIA AND THE WHOLE OF SRI LANKA. The thin straight lines paralleling the coast represent stellar rhumbs or sailing courses. The symbols at both ends of each such line are taken from the compass card illustrated in figure 18.5 (abbreviations for the directions signified have been provided). The designations "Zam 6" along each of the two rhumbs adjacent to southern Sri Lanka signify the number of three-hour watches normally required to sail that course. The numerous ports named on the original have been omitted and also several figures (e.g., "008 1/4") indicating Pole Star altitudes above the horizon, expressed in *iṣba*ʿs (units of 1°36′). The nature of the Indian coastal region is shown by the fringe of palms and the profiles of the horizons to their rear. The peculiarly shaped feature in Sri Lanka is presumably Śrīpada (Adam's Peak). The scale at which Sri Lanka is shown is several times smaller than that used for the mainland.
After B. Arunachalam, "The Haven-Finding Art in Indian Navigational Traditions and Cartography," in *The Indian Ocean: Explorations in History, Commerce, and Politics*, ed. Satish Chandra (New Delhi: Sage Publications, 1987), 191–221, esp. 216, 218.

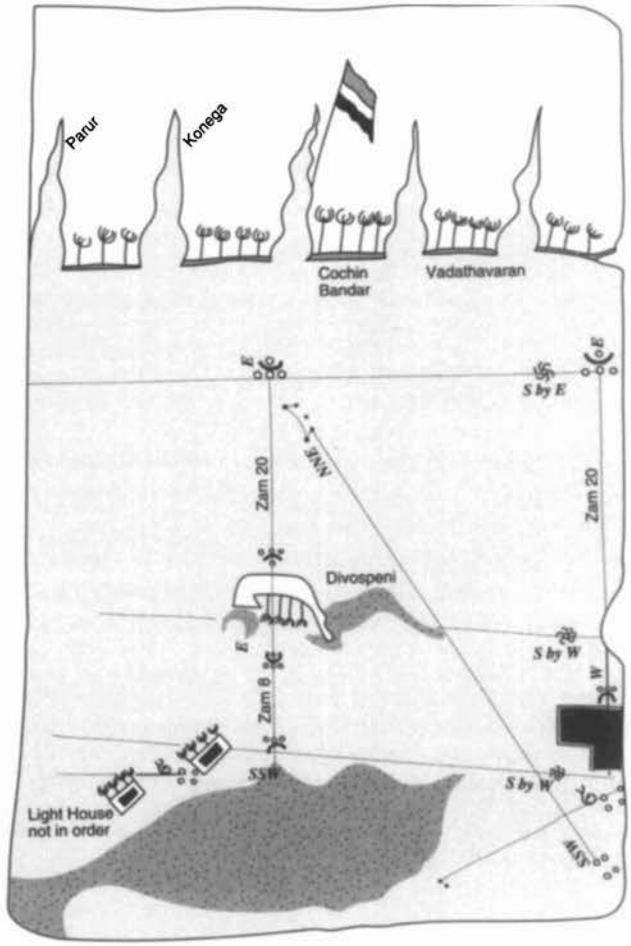


FIG. 18.8. DRAWING OF A SHORT STRETCH OF THE MALABAR COAST AND THE LACCADIVE ISLANDS OF INDIA. In this figure, note the great contraction of the east-west extent across the open reaches of the Arabian Sea. The conventions on this diagram are by and large the same as for figure 18.7. The most important feature of this map, however, is its emphasis on depicting sailing times in *zam* between Lakshadweep (the Laccadive Islands) and the Malabar Coast.
After B. Arunachalam, "The Haven-Finding Art in Indian Navigational Traditions and Cartography," in *The Indian Ocean: Explorations in History, Commerce, and Politics*, ed. Satish Chandra (New Delhi: Sage Publications, 1987), 191–221, esp. 213.

islands, shoals, reefs, shallows, and the like. A part of the difference presumably relates to the different scales employed and to the differences in the sizes of the ships the maps were intended for. The larger-scale southern India charts were probably used mainly by small vessels carrying on coastal trade in short stages, whereas the small-scale Red Sea chart would have served craft capable of crossing the open waters of the Arabian Sea and linking the ports of Gujarat with those of Arabia and the horn of Africa. The effective northern limit of the Red Sea map was Jiddah, the port for Mecca, which suggests that carrying pilgrims on the hajj was among the functions those ships performed. Yet despite its scale, the chart did find room for profiles of selected stretches of coastline, for symbols designating forested shorelines (which would have been rare, even in the relatively humid Yemeni portion of Arabia), for major mosques and other coastal monuments, and for the flags of the potentates whose domains included the coastal regions depicted.

A study of the documents relating to the Red Sea chart notes that "Burnes was also shown the Kutchi copies of English charts which had been brought 'a hundred years before' from Holland by Ram Singh, and he found no similarity between them and this 'native' chart."[18] That Gujarati pilots, even after seeing and copying European charts, continued to rely on charts of their own device suggests their ongoing faith in the reliability of the latter as an aid to navigation. It does not, of course, imply that one type of chart was inherently superior to the other, since there is normally a cultural predisposition in favor of what is familiar; but it does allow one to believe that Gujarati navigators saw no great advantage in converting to charts of Western origin.

Burnes's note in regard to the Red Sea charts is so matter-of-fact that we may surmise he saw nothing especially unusual about it, though just how common such maps might have been we cannot say. Kammerer has a rather deprecatory paragraph on the Red Sea map that makes it clear that he did not really understand how it was used. Nevertheless he seems to have recognized, although with no statement as to the source of his knowledge, that the map was one of a type habitually employed by Indian pilots in the service of Gujarati *bania*s (merchants) during the eighteenth and nineteenth centuries, but that had since become very rare.[19]

Gujaratis were not the only South Asians known to have made original nautical charts or to have copied or adapted European charts. Clarence Maloney states:

> In the 1830s, Captain Moresby saw Maldivians make and repair astrolabes, quadrants and wooden sextants, and they copied the English nautical tables. He noted schools for navigation on some islands. But there were indigenous charts too, for James Tennent wrote in 1860 that he had seen Maldivian sailors with "charts, evidently copied from very ancient originals" perhaps derived from those developed by the Arabs, which did show the Maldive Islands.[20]

When the Maldivians first began to make charts is not suggested, nor do we know when they gave up the practice.

In a historical review by Brohier devoted primarily to land surveys in Ceylon, to which the Maldives were formerly administratively attached, a catalog of historical maps gives details on two allegedly Maldivian nautical charts and provides a facsimile illustration of one.[21] The look of the map, said to measure 90 by 60 centimeters, and the relevant title and text, however, are rather discordant and confusing. The illustration is titled "Chart of Southern Asia and East Africa (Used by Early Arabian Navigators, circa 13th Century)," but the map, which extends all the way to the Malay Archipelago, appears very much like a seventeenth-century European portolan chart, bears the Western style of Arabic numerals, and seems in no obvious way an indigenous Maldivian production. To confound matters further, Brohier's text indicates that the map was drawn on paper with an 1801 watermark, while a catalog box preceding the text reads: "MAP No. 50 17th Century." The second allegedly Maldivian chart is not illustrated, but the text says it is "almost identical with Map No. 50 save that the total area mapped is not so extensive" and notes an 1815 watermark.[22] On the former map is a note, presumably relating to the pair, that reads, "Charts upon which the Maldivians navigate and which were given to Sir Alexander Johnston (Chief Justice) by the chief man whose business it was to navigate the vessels of the Sultan of Male which brought the annual presents from the Sultan to the King of England in the year 1817."[23]

Although the foregoing paragraph throws no clear light on the alleged "ancient" style of chart that Tennent wrote about, it does suggest that Maldivian sailors, who presumably felt as much at home in their neighboring seas as any maritime group in the Indian Ocean basin, might have made use of charts and might have felt a need to adapt them to their own purposes. In passing, let me note that, along with the charts, Johnston was also given "a book in the Maldive language on astrology to which the Maldive navigators referred for directions as to the days of sailings and other circumstances which might occur during the different voyages which they made."[24] In this they resembled their Gujarati counterparts.

A related note of similar date bearing on the links between navigation, charts, and astrology is provided by H. H. Wilson in his 1828 catalog of the vast collection of manuscripts of the deceased surveyor general of India, Lieutenant Colonel Colin Mackenzie. In the section on Tamil books, a palm-leaf manuscript is described as follows:

18. Susan Gole, *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989), 156. "The titles of the English charts that Burnes gives," says Gole, "suggest that they were early 18th century English charts by John and Samuel Thornton."

19. Kammerer, *La Mer Rouge*, 1:132 (note 16).

20. Clarence Maloney, *People of the Maldive Islands* (Bombay: Orient Longman, 1980), 156. For Tennent's comments, see James Emerson Tennent, *Ceylon: An Account of the Island Physical, Historical, and Topographical, with Notices of Its Natural History, Antiquities and Productions*, 5th ed., thoroughly rev., 2 vols. (London: Longman, Green, Longman, and Roberts, 1860), 1:636, n. 2. Robert Moresby's work, "Nautical Directions for Maldive Islands" (1839), was not published.

21. R. L. Brohier, *Land, Maps and Surveys*, 2 vols. (Colombo: Ceylon Government Press, 1950–51); vol. 2, R. L. Brohier and J. H. O. Paulusz, *Descriptive Catalogue of Historical Maps in the Surveyor General's Office, Colombo*, 2:158–59 and pl. LI.

22. Brohier, *Land, Maps and Surveys*, 2:159 (note 21).

23. Brohier, *Land, Maps and Surveys*, 2:158 (note 21).

24. Brohier, *Land, Maps and Surveys*, 2:158 (note 21).

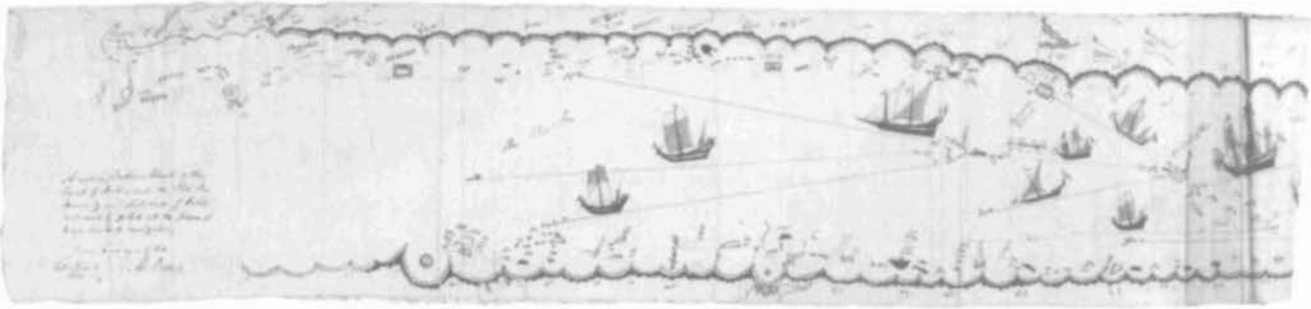


FIG. 18.9. NAUTICAL CHART OF THE RED SEA AND THE GULF OF ADEN. This nautical chart has text in Kutchi, Gujarati script, with English transliterations and a handwritten note by Sir Alexander Burnes added. Dating from the late eighteenth or early nineteenth century, it was given to Burnes by a Kutchi pilot in 1835. A noteworthy feature of the map is the prolongation, in a straight line, of the axis of the Red Sea beyond Bab el Mandeb and into the Gulf of Aden, the axis of which is actually at roughly a 90° angle to that of the Red Sea. Given the conventions incorporated within this map, however, this posed no difficulty to the pilots who used it. Seemingly the map was not used for travel farther north on the Red Sea than Jiddah, the port for Mecca, since there are no rhumbs depicted north of that city. Left and right photographs respectively show the northern and southern portions of the map. Watercolor and ink on paper, with heavier paper backing.
Size of the original: 24.5 × 195 cm. By permission of the Royal Geographical Society, London (Asia S.4).

> A work professedly on navigation, but in fact an astrological account of the destinies of Ships, and those who sail in them, according to certain marks and planetary aspects. The substance of it is thus described at starting; "Sitting opposite to the sun, a figure of a Ship is to be delineated, with three masts, of three yards each, and three decks, amongst these the twenty eight asterisms are to be distributed, nine amongst the rigging, six in the interior of the hull, one at the bottom, and twelve on the outside. In calculating them the person is to begin with the star in the main top mast yard, and then count those on the right side, and according to the distance between it and the asterisms, in which the sun happens to be, will be foretold future events, the good or evil fortunes of the Vessel and its commander. By *Terukuta nambe*."[25]

This entry is immediately followed by another relating to a work written on paper entitled *Kāpilaśāstra*, which in its entirety reads, "A work of a similar character as the last, attributed to the *Muni Kapila*."[26]

Although the evidence we have examined to this point relates to the use of navigation charts by South Asians in the western portion of the Indian Ocean basin after contact with Europeans, there is at least one notice, apart from Wilson's puzzling observations about the two Tamil manuscripts, that indicates Indian familiarity with charts in Java. Referring to the first Dutch voyage to Java (in 1596), Meilink-Roelofsz notes that "the high Bantemese functionaries with whom the Dutch came into contact (both of whom ... came from India) were very well acquainted with nautical charts, and they immediately asked to be allowed to inspect those of the newcomers so that they might know from which country their strange visitors had come."[27]

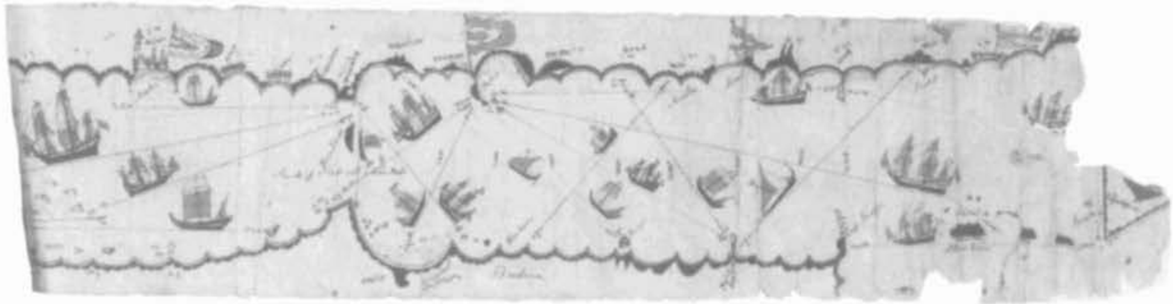
However suggestive these notes may be with regard to early South Asian use of nautical maps, the lack of surviving tangible evidence of maps from before 1664 leaves one uncertain when such maps were first used. That the examples we have described are fairly sophisticated, as well as fairly reliable, makes it reasonable to suppose they were not the earliest prototypes of their genre. But how much time would have been required for charts such as those to evolve is an open question—as is the question of where they evolved. That the surviving examples all come from Gujarat, yet relate to areas as distant from that region as Sri Lanka, southern India, and the Red Sea, suggests further that there probably existed—at least by the seventeenth century, if not earlier—many other charts of intervening areas, not to mention Gujarat itself. About 1500, Gujaratis, even more than the Arabs, were the dominant traders on most of the routes of the Indian Ocean from East Africa to Indonesia and beyond, all the way to China.[28] If any mercantile community in Asia then had a need for maps, it would have been that of Gujarat. The inspiration for Gujarati mapping, whenever it did originate, may well have come from the Arabs; but it also seems plausible that at least in part the inspiration could have come from China.

25. Horace Hayman Wilson, *Mackenzie Collection: A Descriptive Catalogue of the Oriental Manuscripts, and Other Articles Illustrative of the Literature, History, Statistics and Antiquities of the South of India; Collected by the Late Lieut.-Col. Colin Mackenzie, Surveyor General of India*, 2 vols. (Calcutta: Asiatic Press, 1828), 1:261–62.

26. Wilson, *Mackenzie Collection*, 1:262 (note 25).

27. M. A. P. Meilink-Roelofsz, *Asian Trade and European Influence in the Indonesian Archipelago between 1500 and about 1630* (The Hague: Martinus Nijhoff, 1962), 354, n. 123.

28. Michael N. Pearson, *Merchants and Rulers in Gujarat: The Response to the Portuguese in the Sixteenth Century* (Berkeley: University of California Press, 1976), 10.



In her discussion of Chinese cartography in *Imago Mundi*, Mei-ling Hsu states that the literature on maritime activities has shown that Chinese nautical cartography originated at least as far back as the thirteenth century. Of the various types of nautical maps known to have been produced in China, the most remarkable was the one that appeared in the *Wubei zhi* (Treatise on military preparations), a work that, among other things, documents the seven great maritime expeditions into the Indian Ocean region that were led by the Ming admiral Zheng He between 1405 and 1433.[29] I will not attempt to summarize here what will be discussed in volume 2, book 2 of the *History of Cartography*, but let me simply observe that the *Wubei zhi* chart (in forty sheets), though strikingly different in appearance from those emanating from Gujarat, did in certain respects resemble them functionally.

In his chapter in part 1, Tibbetts drew attention to the wide knowledge of the Indian Ocean contained in both Chinese and Arabic geographical literature and suggested that certain methods of navigation were common to all of its littoral peoples, and he noted that the Arabic texts on the subject were more or less indicative of the nature of all Indian Ocean sailing.[30] Similar ideas about the commonality of certain cultural traits within the region have been expressed by numerous other authors. Neville Chittick, for example, has stated that until about 1500 the Indian Ocean was "arguably the largest cultural continuum in the world" and that in its western region "the coasts had a greater community of culture with each other and with the islands than they had with the land masses of which they formed the littorals."[31] A characteristic of Asia's great port cities was the heterogeneity of their populations. Because the seasonal nature of the monsoons enforced long layovers when sailing in particular directions—or sailing at all—was impractical, representatives of all the major seafaring communities from the Arab world to China (and later also from Europe) would necessarily live close together for long periods in small coastal communities. In such circumstances, exchange of information relative to sailing—which was potentially a matter of life or death to all concerned—was inevitable. Whereas shipowners might have put a premium on secrecy and enjoined it on those in their employ, the interests of sailors were diametrically opposite.[32]

In light of the maritime interaction over many centuries among India, China, the Malay Archipelago, and the Middle East, and taking into consideration the views expressed by numerous writers about the remarkable cultural convergence within the Indian Ocean basin, it seems reasonable to suppose that cartographic innovations could have diffused from any one of its littoral regions to any or all of the others. From 1498 onward, the Portuguese and other European powers could also have played an important role in spreading new ideas about nautical maps. Yet despite many broad cultural similarities within the overarching region, local differences obviously persisted. It therefore seems likely that diffusion processes within that region—to whatever extent they did occur—would have been accompanied by some adaptation of innovations to the indigenous cultures of the peoples they spread to, thereby masking in varying degree the identity of the source area. In conclusion, then, one may plausibly suggest that the spread of new ideas that affected cartographic thinking and practice among Asian mariners was an interactive process in which many peoples and areas, including those of the West, may have played significant roles.

29. Hsu, "Chinese Marine Cartography," passim (note 7).

30. Tibbetts, "Role of Charts," esp. 257 (note 2).

31. Neville Chittick, "East Africa and the Orient: Ports and Trade before the Arrival of the Portuguese," in *Historical Relations across the Indian Ocean*, General History of Africa: Studies and Documents 3 (Paris: United Nations Educational, Scientific and Cultural Organization, 1980), 13–22, esp. 13.

32. Michael N. Pearson, "Introduction I: The State of the Subject," in *India and the Indian Ocean, 1500–1800*, ed. Ashin Das Gupta and Michael N. Pearson (Calcutta: Oxford University Press, 1987), 12–14.

19 · Conclusion

Joseph E. Schwartzberg

Bagrow was incorrect when he stated that "no one in India seems to have been interested in cartography."[1] So too were other historians of cartography who, echoing Bagrow, at various times expressed similar opinions. The four preceding chapters on South Asia make this judgment evident. Nevertheless, Bagrow was merely reflecting the conventional wisdom of his day. The reasons for that widely accepted viewpoint are not far to seek. First, there was a pervasive ignorance of the surviving cartographic corpus and an even more profound ignorance of works that no longer exist. This ignorance stemmed from several causes: (*a*) the loss of untold numbers of cartographic artifacts through decay and through accidental and intentional destruction;[2] (*b*) the unavailability of many relevant artifacts that are without a doubt stored among the personal possessions of families in many parts of South Asia;[3] (*c*) the disdain that British colonial officials and other Europeans came to develop for such indigenous cartography as they did know about, once they were able to make more accurate maps on their own;[4] (*d*) the failure, until very recently, of indigenous and foreign scholars to give the history of South Asian cartography the attention it warranted;[5] and (*e*) the general inability of nonindigenous scholars to read South Asian languages and pursue research accordingly. Second, and closely related to this massive ignorance, is the question of culture blindness or, at the very least, obtuseness on the part of foreign scholars of South Asia, even when they are sympathetically disposed toward the region. The conception of what merited the designation "map" and thereby was worthy of study by historians of cartography was often excessively narrow and failed to encompass many items that I have considered maps in this discussion. Works that did not resemble known European models elicited little or no interest and were viewed as beyond the pale of cartographic research. This was particularly the case with cosmographies. The uninitiated non-South Asian scholar would have no way of recognizing as a map some of the most interesting creations that I have called attention to: the anthropomorphic representations of the vertically ordered Jain cosmos (plate 28 and fig. 16.29), maps of the sacred region of Braj in the form of a lotus (figs. 17.20 and 17.21), maps of the environs of the great Jagannath temple in Puri in the shape of a conch (plate 36), the rhomboidal mandala map of Bhaktapur (fig. 17.46), and the geometric Rajasthani divination charts guiding their users to auspicious and inauspicious localities at times of particular astrological influences (figs. 16.12 and 16.13).

In the foregoing chapters I have considered literally hundreds of maps, a vastly greater corpus than I imagined existed when I began research on this project nearly a decade ago.[6] A relatively small fraction of that corpus had received any notice, not to mention serious analysis, by historians of cartography. For most of the works that have been studied and published we are in the debt of historians of art and religion. Although their concerns and methods of analysis differ from those of historians of cartography, they have nevertheless greatly enriched our understanding of South Asian maps, broadly conceived. Regrettably, the distribution of the surviving corpus is very uneven, from both a temporal and a spatial perspective.

As might be expected, few cartographic artifacts survive from the remote past. Works from before the seventeenth century are rare. They include a few cosmographies, the oldest dating from the years 1199–1200,

1. Leo Bagrow, *History of Cartography*, rev. and enl. R. A. Skelton, trans. D. L. Paisey (Cambridge: Harvard University Press; London: C. A. Watts, 1964; reprinted and enlarged, Chicago: Precedent Publishing, 1985), 207.

2. See above, pp. 327–30.

3. The recent discovery in Orissa of numerous centuries-old palm-leaf manuscripts containing richly detailed architectural drawings illustrates how materials of great value may suddenly come to light even though there was no prior intimation of their existence. Discoveries of this type are commonplace in India, and there are millions of old, unstudied manuscripts in private hands throughout South Asia.

4. See above, esp. p. 327.

5. The published writings on indigenous South Asian cartography are reviewed above. Susan Gole's *Indian Maps and Plans: From Earliest Times to the Advent of European Surveys* (New Delhi: Manohar Publications, 1989) is the first book-length study of traditional indigenous cartography.

6. In a letter to David Woodward, dated 23 April 1980, I hazarded a guess that I would require "not more than 3,000 words" to set down all I could readily gather about indigenous South Asian maps. At that time the editors of this history did not yet contemplate an entire volume devoted to the traditional cartography of Asia and North Africa.

and not a single topographic map, city plan, or navigation chart. In the case of cosmographies, however, the textually based models according to which they were drawn are all much older than the seventeenth century, and it is reasonable to assume that many similar works of considerable antiquity were made, only to succumb to the ravages of time. Whether a comparable judgment can be made for other forms of maps is less certain. Despite numerous allusions to maps in literary texts and historical records, their descriptions are too fragmentary to enable us to form a very clear image of how they might have looked.[7] Apart from cosmographies, this leaves us with very little: a certain number of undatable maplike graffiti on the walls of central Indian caves;[8] a few potsherds of the second or first century B.C. on which are inscribed what appear to be the rooms of ancient Buddhist monasteries (fig. 15.10); the plan, carved in stone, for a large unfinished eleventh-century temple in Madhya Pradesh;[9] and most important perhaps, the detailed architectural drawings from an Oriya architectural text dating from about the twelfth century.[10] What makes that text and later (early seventeenth-century) architectural texts from the same region particularly noteworthy is that they prove—as common sense alone suggests—that the stupendous, as well as the not-so-magnificent, monuments of Indian architecture were built to the specifications of plans that were actually drawn rather than merely envisaged. That is also true for the construction of the *vedi*s (altars) on which elaborate sacrifices were performed. Whether the same can be said about the building of towns is more problematic, since, with such notable exceptions as Madurai and Jaipur, their present layouts rarely suggest that their founders followed the instructions set down in the *śilpaśāstras*. However, the archaeological remains of the gridded cities of the Indus civilization (dating from as far back as the mid-third millennium B.C.) and also of certain later cities such as Taxila strongly lead one to believe that town planning was accomplished with the aid of formally drawn plans.[11]

What is particularly remarkable about "traditional" Indian and Nepali cartography is that it continues to be produced to this day. This is evident not only with respect to the cheap printed pilgrimage maps that one may obtain at so many of India's holy cities, but also in the persistence of hereditary groups of artists who derive their livelihood from meeting the iconographic needs of certain major temples, such as Jagannath and Nathdwara. Jain monks must still learn to paint richly detailed cosmographies as a part of their monastic training, and oblique, maplike views of the more important sacred *tīrtha*s of the Jains are still painted on the walls of modern Jain temples.

The regional distribution of surviving traditional South Asian maps is most uneven. Kashmir is without question the best covered area, in both absolute and relative terms. Rajasthan, especially the former princely state of Jaipur, was also relatively well mapped; and if one considers the variety and accuracy of its maps along with their number, it may be regarded as the premier region of South Asian cartography. Mughal maps, mainly from north-central India; Maratha maps, mostly relating to military needs and in a few cases to questions of land ownership and revenue; and Nepali maps (even excluding those to be considered in the discussion on Greater Tibet in volume 2, book 2 of *The History of Cartography*) are also fairly numerous. Otherwise coverage is perplexingly spotty. While the relative preeminence of the regions and peoples mentioned is presumably real, rather than being due mainly to the accidents of survival, the latter factor obviously has a bearing on what is known to us. The most glaring lacuna among the areas for which we have traditional maps is Bengal. This is all the more remarkable in light of Bengal's high level of cultural development, including a literary heritage that is arguably the richest in India (though much of it dates from the period since the British conquest). The four southern states of India, in which Dravidian peoples predominate, and the neighboring region of Sri Lanka are also culturally advanced regions from which very few maps survive. Although Karnataka offers a partial exception to this generalization, much of what survives from that state is of either Maratha or Muslim rather than indigenous Dravidian authorship. The same may also be said of the Pakistani regions of Punjab and Sind.

Several factors must be taken into account in explaining these regional disparities. In the case of Bengal and the South, the long duration of foreign rule is almost certainly a factor. We know from British and French accounts that Europeans made use of Indian maps in gaining knowledge of the country or engaged Indians to make maps for them. We know too from the register of maps held in various offices of the Bengal Presidency and

7. A number of such references were provided in the introductory chapter on cartography in South Asia. Many additional references will be found in the several works by Maya Prasad Tripathi cited in that chapter. Because of Tripathi's inclination to read more into his sources than I believe in many cases is warranted, I have elected not to provide complete coverage of his references to ancient maps, many of which in any event can be confirmed only by someone with a good knowledge of Sanskrit.

8. See above, pp. 304ff.

9. See above, pp. 318–19.

10. See above, p. 466.

11. The definitive work on Taxila (ancient Takṣaśilā), in the north of the present Pakistani province of Punjab is John Hubert Marshall, *Taxila: An Illustrated Account of Archaeological Excavations Carried out at Taxila under the Orders of the Government of India between the Years 1913 and 1934*, 3 vols. (Cambridge: Cambridge University Press, 1951); a detailed plan appears in vol. 3, pl. 1.

from Wilson's catalog of the Mackenzie Collection that scores, if not hundreds, of now vanished Indian maps were collected and, for a time, preserved.[12] But it appears, as already noted, that British disdain for indigenous cartography militated against efforts to preserve what had been gathered by early collectors and very likely resulted in the wholesale discarding of "inferior" native productions. In contrast to the British, the royal patrons of princely states, especially in Rajasthan, encouraged the making and saving of maps both for utilitarian purposes and as works of art. Similarly, certain religious communities, most notably the Jains, who were concentrated in Rajasthan and Gujarat, encouraged the making not only of cosmographies, but also of maps of places of pilgrimage. Further, certain temples, as we have seen, gave rise to what were in effect schools of religious mapmakers. Climatic differences are also a factor. The hot, wet conditions of Bengal and the southern coastal regions favor the breeding of vermin and the accumulation of mildew, which destroy palm leaf, paper, and cloth. Conversely, the relatively dry areas of Rajasthan and the cooler air of Kashmir would favor map preservation.

Finally, we must reckon with the differential research opportunities presented by different areas of South Asia. The base from which Susan Gole, an Indian citizen, and I operated, while carrying on research in India, was New Delhi. Locales within relatively easy reach of that city, especially Rajasthan, were the objects of more thorough investigation than were southern and eastern India. For political reasons, it was not possible to carry on research in either Pakistan or Afghanistan. Nor did we visit Bangladesh and Sri Lanka, since inquiries suggested that the returns from study there would not warrant the requisite investment of time and money. It is noteworthy, however, that for all four of these neglected countries I discovered little or nothing during visits to museums and libraries in the United States and Europe that have rich holdings on South Asia.

In organizing the materials to be discussed, my strategy was to proceed along a continuum from the universal to the highly local. Thus I began with a consideration of cosmography, including astronomy, and discussed in turn world maps, regional topographic maps, route maps, relatively large-scale maps of small areas, and finally, architectural drawings; or to put the matter differently, maps of boundless three-dimensional space (or even four-dimensional space-time), bounded three-dimensional space, areas, lines, and "points" (relatively small areas) of larger and smaller size. Although this might appear eminently logical from a Western cartographic perspective, one may question that it was the wisest choice from an Indian cultural point of view. To a devout Hindu, a sacred space, whether a great religious city such as Varanasi or a mandala at a family altar, can be seen as the embodiment of the entire cosmos, and the conceptual transmutation of finite, directly sensed objects into the infinite is a religious end that many Indians seek to attain in certain ritual practices. This was evident in the discussion of the religious maps of Kāshī (Varanasi) or Bhaktapur (in Nepal); in the latter the deities depicted in the mandala represented not only actual shrines in the city, but also the gods themselves in an all-encompassing pantheon. Similarly, the petals in the various lotus maps portraying the region of Braj stood not only for various combinations of real and mythic places but, in the aggregate, for the entire cosmos. Moreover, although I classified all the Braj maps as "topographic" in that they related to a well-known, circumscribable region, the true purpose of the maps, however varied their form (contrast the maps in fig. 17.20 and plate 31), was to serve as route maps for Krishna devotees making the *chaurāsī krosh* pilgrimage, whether physically or as a sedentary mental quest.

Culturally, South Asia is not all of a piece. Although Hindus predominate numerically, certain areas are overwhelmingly Islamic, and more than a millennium of Islamic presence has put an indelible stamp on much of the region. Other religious traditions are also present. Thus, to have attempted to cast the discussion in such a way as to make it most consonant with a Hindu worldview would necessarily run counter to other worldviews represented in the region. Because culture in South Asia is to such a large extent religiously defined, it is hardly surprising that much of the cartography of the region is religiously inspired. This is particularly true of the Hindu and Jain cosmographies and also holds for maps of sacred places. But even on secular maps, religious sites and structures tend to be given prominence that would appear inordinate in modern cartography. Some tendency toward regional styles is also evident. Jaipuri maps from Rajasthan do not closely resemble those made by Marathas, though both fall within the Hindu tradition, and Kashmiri maps, whether made by Muslims or by Hindus, are also distinctive.

With respect to influences from neighboring regions on the style and content of South Asian maps, we are not yet in a position to make definitive statements. Cartographic influences from Tibet seem to have played a great influence in Nepal and Himalayan India, but there is no clear evidence of any significant effect on South Asian cartography due to contact with China proper or other parts of East or Southeast Asia—despite more than two millennia of cultural and economic intercourse among those regions and the occasional historical records of maps' having been sent from one region to another. On the other hand, the influence of Hinduism and especially

12. See above, p. 302.

Buddhism on the cosmological thinking of East and Southeast Asia was profound, and Buddhist cosmographies abound in their cartographic corpus.

Somewhat surprising is the seemingly minor role exercised by Southwest and Central Asia (excluding Tibet) in shaping the cartography of the Indian subcontinent and the even smaller influence, if any, in the opposite direction. There can be no question, of course, that the world map of Ṣādiq Iṣfahānī is derived from a Persian prototype; it is clear that the other Islamic world maps we have considered incorporate certain elements from the cartography of regions to the west. Examples include the seven *aqālīm* (climes), the all-encompassing sea, and the mythical land of Gog and Magog, the Wall of Alexander, and the Mountains of the Moon. Yet one wonders that there was not even more exchange and marvels at the seeming immunity of Hindu mapmakers, such as they were, to Islamic influences. In his article on Mughal cartography, Habib cites no obvious debt of Mughal mapmakers, other than Ṣādiq Iṣfahānī, to their coreligionists elsewhere in Asia.[13] Nor have I independently come across such evidence in respect to topographic mapping at any scale. Concerning nautical charts, there does appear to be a sharing of traditions between Indian navigators and those of the Middle East. Although Tibbetts argues that true nautical charts were not employed by Asian navigators, a number of Indian navigation charts have recently been discovered, one set dating back at least as far as 1644.[14] Although there are grounds to suppose that the Indian charts were derived from Arabic prototypes, one should not rule out transmission in the opposite direction.

A priori, there are strong reasons to believe that, from the seventeenth century onward, the influence of Europeans on indigenous South Asian cartography, apart from modern printed maps, was substantial; yet, with only a few exceptions, we cannot establish firmly the times, places, and agencies through which ideas were transmitted. Sir Thomas Roe, who presented the Mughal emperor Jahāngīr an atlas and, in all probability, a painting of Queen Elizabeth standing on a globe, very likely played a role, though the evidence suggests that the atlas was little understood at the time. The Jesuit missionary, Monserrate, who was also at the Mughal court, and other Jesuits who interacted with the scientifically minded Sawai Jai Singh II in both Jaipur, his capital, and Varanasi, where he had also established an astronomical observatory, were probably even more influential. And European military advisors to various Indian states, whether acting as agents of their home governments or of chartered trading companies or functioning as mercenaries, could well have played the greatest role of all, influencing the making of maps first for military purposes and then, indirectly, for more general use. Among these advisors perhaps none was more important than Colonel Gentil, whose long sojourn in Oudh resulted in the remarkable Gentil Atlas (fig. 17.25). A final influence was European painting of landscapes and cityscapes that the court artists in various Indian states were enjoined to emulate. A great deal more archival research will be required before we can specify the lines of transmission of cartographic information.

A number of generalizations may now be about the style and content of traditional South Asian maps. Of cosmographies we may note that their complexity and temporal and spatial scales are far greater than those produced in Europe, that their influence has been more pervasive and enduring, and that they constitute a much greater proportion of the total corpus than is true in the West. Since the dominant alignment of the cosmos of the Hindus, Buddhists, and Jains is vertical, the axis in all cases being provided by Mount Meru, one must condition oneself to seeing many cosmological maps as projected onto a vertical plane, rather than the horizontal plane that has become standard for most modern terrestrial mapping. Many specific elements of the cosmos, however, such as the Jain *adhai-dvīpa* (two-and-a-half-continent) world of man are customarily depicted on a horizontal plane. Although notations as to the dimensions of various elements of the cosmos are often inscribed on the painted cosmographies, the images themselves are almost never scaled proportionally to the figures given, because the geometric progressions commonly employed tend to make a "true" scale representation impracticable.

Terrestrial maps from South Asia also frequently contain numerical designations of distance or of the size of specific features portrayed; but the maps themselves seldom display much concern for scalar fidelity in a geometric sense. Gole has this to say about the rich assemblage of works that she illustrates in *Indian Maps and Plans:*

> None of the maps carry a scale. To those used to maps developed in the West, this may seem to preclude their usefulness for the geographer or traveller. But those who made them seem to have had their own idea of scale, based not on distance but on importance. On the map of Gujarat in the Baroda Museum, the town of Ahmedabad covers a vast area, if the map were drawn on a European idea of scale. Some of the villages too, especially those noted for something special, perhaps the strain of bulls bred there, are drawn larger than one might expect. This reflects a scale of importance rather than measurement, where it is necessary to know the intent of the map-maker, and not

13. Irfan Habib, "Cartography in Mughal India," *Medieval India, a Miscellany* 4 (1977): 122–34; also published in *Indian Archives* 28 (1979): 88–105.

14. These issues are discussed above, chaps. 13 and 18.

> treat the map as an objective item that can have only one interpretation.[15]

Nor does any Indian map, except those of Ṣādiq Iṣfahānī's atlas, have a geographic grid. Only a handful have compass roses (an innovation derived from Europe), though many note cardinal directions at or near the four edges of the map. Relatively few include a neat line. While the size of many maps was such that they had to be drawn on several pieces of paper or cloth and joined together to make up the entire composition, the idea of a map series of sheets covering adjacent or slightly overlapping areas was seldom employed. Exceptions were the already noted Ṣādiq Iṣfahānī atlas and, arguably, the atlas of Kashmir *pargana* maps contained in the *Tārīkh-i qalʿah-i Kashmīr* (fig. 17.16). How well the individual *pargana* maps relate to one another, however, has not been tested. A third map series is the set of Nepalese revenue maps now included in the Hodgson Collection, India Office Library and Records, London (fig. 17.27). Whether this polyglot work deserves to be regarded as truly indigenous is open to question; but the resemblance of its maps to the few known Maratha maps relating to landownership and revenue assessment suggests the possible existence of a widespread genre before the British presence.

Standard symbols were not characteristic of traditional South Asian maps. This is hardly surprising in light of their strong reliance on pictorial representations, along with text, to identify features of particular interest. Although a fair degree of standardization does seem to have marked the Kashmir atlas, on many other works that do use more or less abstract symbols there is no great consistency from one part of the map to another. Nevertheless, as figure 17.8 makes clear, there did seem to be emerging—on topographic maps at any rate—a set of conventions for representing various features, especially settlement, and the notion of portraying a settlement hierarchy had definitely taken hold. Color was also effectively used to show both the nature and the relative importance of certain features. Red and yellow (or gold) were often used to highlight important places, especially cities and towns and their major edifices. Not surprisingly, blue was most frequently used for water and green for vegetation. Mountains were typically shown in brown, orange ocher, or especially on Mughal and Rajasthani maps, in mauve, a color much used in Iran for the same purpose. Distinguishing mountains according to their relative height was a task that South Asian mapmakers seldom undertook.

Relatively few South Asian maps were wholly planimetric. Most combined a planimetric perspective for relatively extensive features (e.g., mountain ranges and cities) with a frontal or oblique perspective for such localized features as individual houses, temples, and forts. City walls, typically, were planimetrically depicted in terms of their overall extent yet shown, section by section, as if viewed from ground level. Similarly, within the planimetrically shown forested areas, trees and other vegetation types were pictorially rendered—often very large—as if seen individually on the ground. On a great many maps, artists seem to abhor empty space. This was especially true for religious maps and least true for utilitarian military maps. Naturally, where trees and flowers fill what would otherwise be a map void, one should not place any faith in the accuracy of depiction. Similarly, roads shown as crammed with pilgrims do not necessarily imply high year-round traffic.

The inclusiveness of South Asian maps varies greatly from one artist and map type to another. One detects no obvious rules for what ought to be included and what it is permissible to leave out. Presumably, available knowledge and the stated interests of those commissioning the works, along with the criteria of presumed importance and the time at the artists' disposal, were the principal determinants of what was shown. In the case of religious maps, tradition was also a major factor. The scale and purpose of the map played a role. Small-scale topographic maps of large regions, of which there are not many examples, would seldom show individual houses, and maps and plans of religious shrines, which were quite common, would not likely emphasize elements of terrain.

Conspicuously missing from virtually all traditional South Asian maps are political boundaries. Obviously, territory in South Asia was politically partitioned among different states as well as between administrative units within states, but clearly delimited (not to mention demarcated) boundaries scarcely existed until they were imposed by the British.[16] There were, of course, fluctuating frontiers between neighboring powers that reflected the shifting tides of their political fortunes, but these were never, to my knowledge, mapped. Nor were maps consciously made to define regions as such. In at least one case, however, the sacred region of Braj, the limits of the maps made—diverse though those maps were—were also symbolically coterminous with the limits of the region. And in the cases of the Vales of Kashmir and Kathmandu, the mountains forming the horizon on

15. Gole, *Indian Maps and Plans*, 14 (note 5).

16. This issue is extensively addressed in Joseph E. Schwartzberg, ed., *A Historical Atlas of South Asia* (Chicago: University of Chicago Press, 1978), xxix–xxx, xxxiii–xxxv, and passim, and also by Ainslie T. Embree, "Frontiers into Boundaries: From the Traditional to the Modern State," in *Realm and Region in Traditional India*, ed. Richard G. Fox, Monograph and Occasional Papers Series, Monograph 14 (Durham, N.C.: Duke University Program in Comparative Studies on Southern Asia, 1977), 255–80.

the four sides of their respective maps also established the limits of natural regions.

In the chapter on cosmography, I considered the likelihood that the Indian belief in *māyā*, which considers the world of the senses an illusion, was a factor inhibiting the making of maps in past centuries. Nevertheless, as I have subsequently shown, hundreds of Indian maps have recently come to scholarly notice. Furthermore, that corpus is in all probability no more than a miniscule fraction of the total South Asian traditional cartographic heritage. What then guided South Asians, especially Hindus and Jains, when they decided that maps were in fact needed? What led them to favor certain types of maps over others and to plot certain features in preference to others? I suggest that religious concerns at all times tended to outweigh concerns of a secular nature (though the distinction in India is often far from clear) and that producing images that conveyed the essence of places was often more important to mapmakers than measuring and reproducing elements of the landscape with geometric exactitude, even though relatively recent works, especially from Jaipur, tended to conform to the latter type. The mapping experiments of the anthropologist E. Valentine Daniel in Tamil Nadu, described in the discussion of cosmography and mental maps above, are noteworthy in this regard. They are also relevant in explaining the almost total absence of boundaries on Indian maps.

The study of the history of cartography in South Asia is still in its infancy. There are undoubtedly many serious lacunae in our knowledge. In all likelihood, only a small portion of the surviving cartographic corpus has yet been brought to light. For large and important areas of South Asia (e.g., Bengal) I am as yet not aware of a single traditional indigenous map. The links in the dissemination of cartographic ideas within South Asia and between South Asia and other parts of the world have yet to be firmly established. But at least we have a platform from which to launch future efforts.

Postscript

After the foregoing chapters on South Asia went to press, I received in the mail—as if in fulfillment of the prediction implicit in the final paragraph—a catalog of a vast trove of maps and plans newly discovered in a palace of the Maharaja of Jaipur. Their time span is from the late sixteenth to the early nineteenth century. Approximately two-thirds of the approximately 350 works included relate to Rajasthan, but many cover other parts of northern India as far east as Bengal and Assam, as well as peninsular India, Afghanistan, and Nepal, while three (presumably based on seventeenth-century European models) include the whole world. The collection includes topographic maps, administrative maps, town plans, engineering plans, and architectural drawings. The range of sizes is great, at least one map measuring about four by four meters. For further particulars, see Gopal Narayan Bahura and Chandramani Singh, *Catalogue of Historical Documents in Kapad Dwara, Jaipur*, part 2, *Maps and Plans* (Jaipur, 1990).

20 · Concluding Remarks

J. B. Harley and David Woodward

In this book we have sought to provide an adequate description and characterization of the wide range of cartographic phenomena that flourished in premodern Islamic and South Asian societies before the impact of Western cartographic influence. Together the nineteen essays represent a new contribution toward our stated goal of broadening the canon of cartography beyond the more familiar products of Western mapmaking. The difficulties of delineating a corpus of maps for cultures for which nothing comparable has hitherto been written should not be underestimated. Much of the material in this book will be new to most Western (and indeed many Eastern) readers both in itself and as a corpus. Moreover, the essays go beyond mere description. They offer interpretations from which generalizations about the nature of cartography in these non-Western societies can be advanced for the first time.

As editors we have set ourselves three tasks in these concluding remarks. First, we want to focus on the salient similarities between the cartographic histories of premodern Islamic and South Asian societies on the one hand and of Christian Europe and the Mediterranean before A.D. 1500 on the other. Second, we shall review the interaction of maps and society within the Islamic and South Asian cultures described in this book. And finally, we shall try to identify the agendas for future research that have emerged from the essays as a whole.

Comparative Cartographies

A relativist approach risks seeing premodern cartography as impervious to outside influences. By setting traditional Islamic and South Asian cartography in a wider cultural context, however, and by identifying characteristics common to premodern mapping in general, we see that this in fact was never the case. This is true despite the slow pace of cartographic change and innovation in the periods and regions described in this book, especially as compared with the rate of change in the Western world since A.D. 1500. As many of the essays demonstrate, the cartography of premodern Islamic and South Asian societies did not develop in isolation from external influences, and each in turn contributed to the mapping knowledge of distant cultures. Such relationships remind us that it is a mistake to divide, as is usual in the history of cartography, the Old World into East and West as if these were two separate as well as distinctive parts. Long before the rise of Europe in the sixteenth century, trade and other cultural exchanges bound Asia, Europe, and the Mediterranean regions, however loosely, into one vast Old World system. In this system, cartography and cartographic relations had their place. Not surprisingly, both Islamic and South Asian mapmaking shared in the cartographic experiences of other societies in the premodern world at the same time as they retained many aspects unique to themselves.

One of the characteristics common to the history of the mapping covered in this book and that of the Old World regions described in volume 1 is the way both the making and the use of maps were geographically fragmented. Though we have included in our scope mapping processes involved with building houses and geomancy, and even the use of "mapping" the body as an aid to prognostication, centers of map production were like islands in a sea of cartographic silence. As in the case of the classical Mediterranean societies or those of medieval Christian Europe, such silence cannot be dismissed as a result of the loss of historical records, even in areas where their chances of survival admittedly were poor. The likelihood is that, away from the main cities of South Asia and of the Middle East in the Islamic period, entire populations existed with little or none of the cartographic knowledge our authors have described. This should not surprise us, given the unevenness of mapping and map use in the modern world. But why cartography should have become established in some areas and not in others is an interesting question. Why, for example, was the production of portolan charts and of local and regional maps in Europe in the late medieval period concentrated within a relatively small number of areas in Italy, Catalonia, and northern Europe? Why, in premodern India, did terrestrial mapping develop particularly in Kashmir and Rajasthan or marine mapping in Gujarat?

In its details, the regional mosaic of mapping traditions was of course always more complex than such bald questions imply, but they remind us that what we have to interpret is not so much the distribution of a "generic cartography" as the distribution of often quite separate map genres, each with its own history. Although, for example, a distinctive Greco-Islamic form of celestial and terrestrial cartography had developed in the Islamic heartland by the Middle Ages, this appears not to have been diffused to either non-Islamic India—at least not until the time of Sawai Jai Singh of Jaipur—or to large areas of western Europe. Yet there are few clues to explain these discontinuities and little to show why we should differentiate the medieval Islamic world and South Asia from Christian Europe or from the earlier cartographic cultures of the Mediterranean area that preceded them. We have to begin from the premise that even among literate populations a knowledge of maps was less usual in earlier periods than it is today.

The essays here deal with each island in the cartographic archipelago of the Islamic world and South Asia. At the same time they point to a broadly similar level of map consciousness that existed within these regions and in the classical and medieval Christian societies of Europe and the Mediterranean. By "map consciousness" we mean the relative awareness of cartographic knowledge vis-à-vis other aspects of learning and artistic skills. We discover that, if ever the notion of cartography was articulated in traditional Islamic or South Asian societies (remembering that the word "cartography" is a nineteenth-century neologism), it would have conveyed concepts much closer to those of premodern Europe than to those of the modern world.

One symptom of such affinities lies in the lack of a specific word for map, not only in ancient Greek and Latin but also in languages such as Persian, Arabic, Sanskrit, and Hindi. In Ottoman cartography, where there was a specific term for marine charts, one word had to serve for terrestrial maps as well as for drawings and pictures. We would not go to the extreme, as some historians of cartography have done recently, of inferring from such etymological details that maps were practically unknown in the medieval world. At the same time, we do recognize that much of the technological terminology of our own times is imposed on traditional or earlier societies only with an element of risk.

A similar caveat applies to the occupational specializations of modern cartography. Neither in the premodern cultures of Christian Europe and the Mediterranean regions nor in those of the Islamic and South Asian worlds do we encounter an exclusive maker of maps, a "cartographer," or even any group of people engaged in a mapmaking "profession"—yet another anachronistic concept. Only the portolan chartmakers of some of the Mediterranean ports later in the Middle Ages, such as the family of al-Sharafī al-Ṣifāqsī, or many of the instrument makers of the Islamic world who specialized in astrolabes, quadrants, and globes constituted exceptions. More usual were the Indian temple artists who were specialists in religious art and who sometimes made maps. And like their counterparts in medieval Europe, the calligraphers, scribes, and illuminators were never exclusively cartographic illustrators in the Islamic book arts. Such characteristically capitalist divisions of labor had little place in the traditional workshops where most of our maps were made.

The danger of inserting anachronisms is no less real in the theoretical aspects of early Islamic and South Asian mapmaking. The ancient scholars who copied or translated texts and their illustrations cannot properly be referred to as "cartographic scholars" or even "geographers" or "astronomers" in the modern disciplinary sense. Many were polymaths aspiring to be possessors of *adab* (general culture) rather than specialists. Their intellectual interests ranged widely, and their skills were equally considerable. Even a practitioner as influential in establishing a mapmaking tradition as was al-Balkhī would have devoted himself no more exclusively to maps than did the authorities to whom medieval maps are traditionally attributed in a European context. Nor do we find in the essays in this book much evidence for the existence of a discrete body of theory concerning mapmaking. Even Ptolemy, in both his *Geography* and his *Almagest*, was addressing the substantive problem of where places are as well as such theoretical aspects of cartography as projections. Other writings touching on the theory and practice of mapping are—like the maps themselves—scattered widely throughout the traditional literatures. They are to be found (to adopt a modern classification of knowledge) in texts on subjects as diverse as astrology, astronomy, engineering, geodesy, geography, history, linguistics, mathematics, natural science, philosophy, law, and theology. This lack of a central focus for cartography identifies yet another similarity in the organization of knowledge between the societies described in volume 1 and those described here.

This conceptual and functional gulf separating both Islamic and Indian mapping from the cartography of the modern world leads us to seek a new interpretation of their history. In the absence of a cartographic science in the modern sense, an internalist historiographic approach—studying mapmaking as a discrete practical and intellectual activity—is hardly likely to advance our understanding of the cultures described here. Those who made maps seeking to chart a divine order in the heavens or on the earth were not bound by the same canons of rationality and positivist criteria for proof or accuracy that characterize most science today. So even the most esoteric cosmographical diagram was not merely an idealist conception but was linked to a wider body of philosophical lore, speculation, and practice. Premodern cartography, in the Islamic world and in India as much as in Christian Europe, was no autonomous development, whatever form it took. It is understood only as part of the wider history of representation and thought: artistic, literary, and scientific. Within these broader contexts cartography continuously interacted with other images and texts but seldom claimed a discrete territory in the modern sense.

The way is now open for a more appropriate interpretation of the history of Islamic and Indian cartography. We can no longer exclude from our scholarly agenda those maps, whether derived from tenth-century Europe, thirteenth-century Islamic society, or eighteenth-century India, that apparently lack a scientific basis. Nor can we regard societies without "advanced" mapmaking skills, according to Western practice, as "primitive," meaning intellectually inferior or lacking some innate ability shown by those peoples who value the techniques of accurate measurement. The day has passed when an Islamic specialist such as Marshall G. Hodgson could dismiss the maps of the Balkhī school in a line as "crude, not standardized by printing."

Similarly, we now recognize that it is inappropriate, for example, to compare Greek and Indian cartography only by assuming that the Greeks had invented a global reference system inherently superior for all purposes. Many Jain cosmographies are of—at the very least—comparable intellectual sophistication to those of the Romans or inherent in the *mappaemundi* of Christian Europe. If the drawing of a Vedic altar or of a qibla diagram has in the past been deemed less "cartographic" than the *Forma Urbis Romae*, it was merely because the latter better fit the modern notion of what a map ought to be.

Thus, in aiming at a general appreciation of non-Western cartography, it may be that more attention must be paid to cognitive similarities than to external differences of form and content. Many of the maps described and illustrated in this book reveal a curiosity about the nature of space beyond the immediate environs of the mapmakers that is no less keen than that of today. To understand this curiosity better, and to see how it was translated into a mapping impulse and with what results, we now turn to aspects of the social history of the regions concerned.

Cartography and Society

Neither the form nor the content of the knowledge expressed in maps in any society can be understood apart from the social basis for the production and use of that knowledge. Thus Islamic and South Asian maps reflected the particular interactions of their respective societies; the maps are social constructions. Their history does not conform to any "grand theory" of cognitive development, nor can the rise of cartography be associated with scientific revolution or technical progress toward an Enlightenment ideal of a carefully measured geographical truth. As noted above, many of the maps reviewed here are not purely geographical in content, nor do they represent actual measurement in the modern sense. To take account of this all-important difference, our authors deliberately adopted a culturally relative position. They have attempted to interpret the maps they describe in the light of both the long-term social and religious beliefs of the mapmaking society and the ever-changing distribution of political power. They have viewed their maps as expressions of local situations and of circumstances that either encouraged or inhibited the transmission of map knowledge. They are sensitive to the way all maps are inextricable elements of a people's culture as a whole and to their function as visual expressions of the terrestrial, celestial, or cosmological knowledge held by that society. In providing a historically relevant framework for their explorations into premodern Islamic and South Asian cartographic history, our authors have moved toward an understanding of the reciprocal interactions between society and its cartography.

From our authors' individual assessments, we can draw our own more general conclusions. Three points in particular call for brief elaboration here. All concern some aspect of the social context of mapping. The first is perhaps the simplest. We are struck, once again, by the remarkable continuity of mapping practice over long periods in those areas traditionally engaged in mapmaking. Though often modified or exhibiting stylistic variation, cartography was usually an inherited rather than a newly invented knowledge. Even where most of the surviving maps are no earlier than the seventeenth century, as in much of South Asia, many undoubtedly descended from earlier models. We know that Indian cosmographical mapping—as befits the Indian soteriological tradition—was of great antiquity, with roots extending back to the *bhuvanakosá* portions of the encyclopedic Puranic texts. The power of tradition is well illustrated also by the pilgrimage maps that are still being produced for mass consumption. The longevity of Islamic cartography is even better documented, with roots reaching back into the pre-Islamic period. Qibla mapping has survived for over a millennium until today, and the maps of classical Arab geographers, such as those from the Balkhī school (initiated in the tenth century A.D.), were still current in the nineteenth century. World maps based on al-Idrīsī's work were still being compiled in the early modern period. Constellation pictures, under new names, remained basically unchanged in astronomical manuscripts from the eleventh century to the eighteenth. Even a series of political events as far reaching and disruptive as the rise of the Mongol Empire, the Crusades, and the Turkish infiltration into the Islamic world did not lead to a new beginning in the ways the world was conceived and mapped.

Our second point also relates to this matter of continuity. It draws attention to the mechanisms of cartographic transmission. In traditional Islamic and Indian mapping, it was the authority of the text that provided scholarship in general and cartography in particular with its elements of continuity. With the exception of some world maps, marine charts, and astronomical instruments, it was the literary treatise—often written in the lingua franca of Arabic and characteristically devoted to a multiplicity of subjects—that became the primary vehicle transmitting the information maps were based on or the narrative texts that maps sometimes illustrated. Only toward the end of traditional mapping, and more markedly in South Asia (perhaps because of the comparative modernity of the surviving artifacts as opposed to those of the Islamic societies), does this union of map and text break up. Up to then, however, it was the textual format that constrained cartographic development. Most obviously, the page or folio limited the physical size and detail of maps, but more subtly it influenced the balance of intellectual authority in map-text relationships. In some instances, as with al-Idrīsī, the roles were reversed and the map played the primary role in structuring the text or in facilitating the compilation of tables of geographical coordinates. Generally, however, maps were subordinate to text. One clue to this is the way scribes sometimes left spaces in books for maps and other illustrations. Blanks in a text may suggest the lack of a competent artist or even the loss of a patron at some point in the bookmaking process. But such gaps also show how in these cases, and in instances where no attempt was made to integrate map and text, that the word was the primary medium and always more authoritative than the picture. In premodern culture, apart from astrolabes, globes, and some world maps, the "independent" map was the exception in the spectrum of cartographic representation.

The relation between marine charts and written sailing directions illustrates another aspect of the map and text problem. There is no unequivocal evidence for the existence of Indo-Islamic sea charts in the Indian Ocean before 1500. Nevertheless, it is tempting to surmise, owing to the survival of later fully developed examples, that an earlier indigenous charting tradition might have existed. This, however, may be an example of a retrospective attempt by scholars to impose on the premodern Islamic world modern Western sailors' practice of using charts, even though Muslim and Indian navigators might have found oral or written instructions wholly sufficient for wayfinding at sea.

The essays in this book thus document a variety of relationships between text and map even within a single cartographic tradition. This variety suggests that maps were subject to frequent modification as they were transmitted in the literate Islamic and Indic cultures. Abridgment or enlargement of the text could alter the scope for cartographic inventiveness and artistic embellishment. Surviving maps from a single textual stemma show considerable variations. The textual medium, we may decide, was in some respects extremely flexible and, far from stultifying cartography, may have stimulated it, at least in certain directions. For instance, we have seen how the iconography of celestial maps, or the maps in various versions of the texts of al-Idrīsī and Pīrī Reʾīs, were adapted to local artistic tastes and to local conventions. Transmission was seldom simply a matter of copying.

Even more significant—especially in the Islamic societies—to understanding the mechanism of transmission was the process of translating key texts. This determined both the eclecticism and the cosmopolitan nature of traditional cartography. Among the translations of texts dealing with the making of maps, or actually containing maps, we can include not only the crucial translations of key Greek works into Arabic from the ninth century onward but also a series of intermediate or secondary translations into or from Syriac, Hebrew, Middle and New Persian, Sanskrit, and Turkish, and in the European Middle Ages some retranslations into Latin or Western vernacular languages such as Castilian or Italian. If translation was the principal means of cartographic dissemination, such moments of linguistic naturalization constituted the threshold of cartographic innovation. In the case of the instructions for mapmaking in Ptolemy's *Geography*, only partial translations were made into Arabic, with few changes to the text; but in other cases, as with the astronomical and geographical tables of coordinates, revision and supplementation were soon put in hand. Yet while cultures shared a capacity for absorbing cartographic knowledge, they could equally well resist it. There was nothing inevitable about either transmission or translation. Islamic craftsmen did not follow the precise instructions for making celestial globes translated from Ptolemy's *Almagest*, but they adapted these instructions to make superior instruments of their own design. There was also a conscious resistance to innovation. Some Islamic scholars were opposed to the "foreign sciences," and Hindu mapping practices have been shown to be remarkably immune to Islamic influence.

Thus our third concern, the social factors of transmission—those that impinged on or modified cartographic knowledge as it passed from generation to generation or workshop to workshop—can now be identified. A different key word applies here: appropriation. The process of transmission, the essays in this book make clear, was never a simple one, merely the mechanical passing on of information or technique. We cannot ascribe loss of information from an original text to a "failure" of translation. What we find is a highly selective operation, determined by the social agenda of individuals at particular periods. Two main motives—perpetuating established religion and maintaining the political power of rulers—underlay the patterns of intention and appropriation in premodern Islamic and Indian cartography.

The common denominator was religion. Few maps in these cultures were not touched in some way by religious belief. Even on essentially secular maps, such as those found in Maṭrāḳçı Naṣūḥ's *Mecmūʿa-i menāzil*, religious sites were emphasized to an unusual degree. Religion gave authority to particular types of representation, just as it did to the states that were their patrons; religion decreed the uses of cartography; and religion inhibited the development of some types of mapping. Yet there is danger in overgeneralizing. Religion in India, beyond the alien Muslim sphere of influence, resulted in maps that were very different from those of the Islamic world.

In India, especially for adherents of the Jain religion, whose maps tended to take the form of an artistic image unconstrained by any textual format, maps had a much more central place in the practice of religion than they did in areas of Islamic faith. Cosmographs, often of great complexity and beauty, not only dominated Indian cartographic representation but, as symbolic articulations of the universe, in whole or in part, were also tools of religious instruction and adjuncts to the performance of certain rituals. As vertically or horizontally oriented scrolls, wall hangings, or murals, whether anthropomorphized as pictures, expressed as mandalas, or codified in sacred symbols such as the conch or the lotus, maps were often microcosmic analogues of the universe. Displayed in the temple or monastery, they enshrined talismanic powers and were objects of meditation. Cosmographic maps did not just represent territory, they *were* the territory, an expression of the created universe, and routed the soul on its future journeys. Invariably they expressed otherworldly beliefs. With the exception of astrolabes, the geometric divination charts used for astrological purposes, and maps of pilgrimage routes, the Indian maps were not primarily instruments for objective wayfinding or measuring. One consequence may have been that preparing accurate terrestrial maps was not given particularly high priority in cultures where religious maps were of such importance, despite the existence of appropriate mathematical knowledge.

The emphasis was different in the Islamic provinces. Though the Qurʾān encouraged its adherents to observe nature, and though there are a number of Muslim maps of paradise, maps were seldom elevated to become emblems of sacred space as in the Christian and indigenous Indian religions. There was no place for a map in a mosque, for example, as a mandala was displayed in an Indian temple or a *mappamundi* in a Christian cathedral. What our authors have revealed is that maps, astrolabes, and globes (especially the last two) became practical instruments used in determining religious ritual or in astrological practice but were not themselves objects of veneration. The use of maps as tools rather than icons was due not so much to some universal iconophobia—for scientific manuscripts translated from Greek, Iranian, and Indian texts were often illustrated—as to the requirements of day-to-day ritualistic needs. Celestial mapping thus developed to help calculate the religious calendar and to determine the hours of prayer, which varied with the seasons. The astrolabe, diffused widely throughout the Islamic world from Spain to India, functioned for the same purpose. Such instruments—like the qibla maps and charts—were products of an applied religious science that sometimes displayed the distance to Mecca or could be used to determine the azimuth of Mecca and the Kaʿba. Though they encouraged a high level of mathematical and graphic sophistication and might show Mecca as the center of the world, they were not a surrogate in the Indian sense for firsthand experience of the sacred territory.

It is thus often impossible to disentangle the sacred from the profane in the cartography of the major cultures described in this book. Geographical maps in India, as well as the maps in Indo-Islamic illuminated histories, often emphasized religious topography but neglected other material aspects of the landscape. And in the Islamic world, political and religious strategies sprang from a single discourse. The Qurʾān commanded Muslims to search the earth for God's patterns in nature and in the affairs of men and women, and this gave legitimacy and form to geographical inquiry. The maps of the Balkhī school, for example, were part of a religiously motivated trend toward Islamization as much as an attempt to better reflect geographical reality. Nevertheless, though the distinction between the secular and the religious was less clear than in Christendom, the role of state politics in the development and spread of mapping in these traditional societies was considerable. Maps were as much a means of demonstrating the power of the state as an expression of piety. They were at once the product of sovereignty and practical and symbolic instruments by which that political and military power was legitimized or maintained.

The patronage of mapping shows how closely cartographic knowledge was linked with political power. Wherever we encounter a center of mapmaking or a flourishing cartographic tradition—usually associated with major cities—we find it had been developed with the support of a powerful monarch or local potentate. Indeed, the expansion of cartographic learning from the cities of the Mediterranean to those of the Middle East that occurred from the sixth century can be related to the rise and fall of empires. The roll call of imperial cartographic patrons extends from the rulers of the early Abbasid Empire in the eighth century to those of the Ottoman and Mughal empires in the sixteenth and seventeenth centuries. It covers the royal courts of Muslim Spain in the West and those of India in the East.

The long-term cartographic influence of individual imperial patrons varied. Apart from the unified caliphate from the seventh century to the early tenth century, and the Ottoman Empire from the fifteenth century to the early twentieth century, there were no enduring political units in either the premodern Islamic or the Indian region that possessed the power and coherence in their heyday of the Roman, Byzantine, or Chinese empires. The ever-changing map of imperial conquest and accession did, however, channel the course of cartographic appropriation and use. It was not by accident, for example, that the powerful Abbasid Empire, with rulers such as the caliphs al-Manṣūr and al-Ma'mūn, was closely linked to the core traditions of Islamic cartography. With the political and territorial disintegration of the caliphal state, centers of cartographic activity were correspondingly fragmented and thus weakened, divided among a series of virtually autonomous states. A succession of local or regional rulers created highly individual cultural foci and patronized only those aspects of mapping described in the available texts, or promoted by individual scholars and craftsmen, that most interested them.

Thus in Islamic Spain, individual rulers of Castile and Seville at different times involved themselves in mapmaking. So did King Roger II in Sicily in the twelfth century, the Fatimid caliphate in Egypt, the Buyid rulers of Persia, and in India, the Mughal emperors at Delhi or Agra or their feudatory Rajputs of Jaipur. Our authors note that the activities of these and many other individual patrons did much to impart a strong regional character both in the practice of cartography and in the form and content of the artifacts themselves. For instance, we learn that the making of the universal astrolabe usable at various latitudes long remained unknown outside southern Spain; that there was less interest in producing spherical astrolabes in the Indian areas of the Islamic world than elsewhere; and that terrestrial maps were often reflections of regional spheres of territorial influence. Even the geographic scope of astrolabes, globes, and maps was often adapted to such regional geopolitical factors.

Palaces and courts became nodes of scientific transmission as well as innovation. Scholars were invited, attracted, or otherwise brought to court from rival or conquered states; translations were initiated from "imported" texts; workshops were established to produce illuminated manuscripts and scientific instruments; libraries were created; observatories were built; and uniquely, under the patronage of al-Ma'mūn, geodetic measurements were ordered in an attempt to establish the length of a degree. The history of cartography in these traditional societies was driven, we can now see, by innumerable undocumented decisions taken by individual patrons and their advisors, who appropriated knowledge to meet the needs of the political establishment. These needs—as much as the sum of knowledge theoretically available—fashioned cartographic artifacts. Moreover, the exigencies of practical use help explain the apparent gap between theory and practice noted in several essays. The decision not to use Ptolemy's *Geography* according to Ptolemy's own instructions, for example, could be interpreted not as an intellectual failure among Arab scholars but an improvisation or preference in the light of local circumstances.

These rulers found fewer secular uses for maps than those recognized either in a modern society or in the Roman Empire. Though al-Maqdisī wrote that geography is an absolute prerequisite for the merchant, the traveler, the sultan, and the *faqih* (legal scholar), in practice this did not always result in maps. Yet to some princes—such as Sawai Jai Singh of Jaipur and the Peshwa rulers of Maharashtra—terrestrial maps were recognized adjuncts of statecraft. However, though the route maps of the Balkhī school, with their travel distances, may have played a role in imperial government and administration or served some commercial purposes by depicting markets during the Abassid period, similar bureaucratic uses for maps are not recorded for many of the smaller dynasties.

As in Rome, imperial propaganda was also a recognized function for maps. World maps, like that of al-Ma'mūn, were probably drawn principally to show the extent of worldly empires. The tenth-century maps of the Balkhī school, concentrating on the provinces of the Islamic empire, were similarly designed as statements about political identity to portray the Abbasid caliphate at its greatest extent. Al-Idrīsī, eager to laud the glory of his patron, drew his world map with the express intention that Roger should "accurately know the details of the land and master them with a definite knowledge." Such maps, though of practical use, were also symbolic articulations of imperial visions. The use of celestial symbolism by the early Mughal rulers of northwestern India, such as Jahāngīr embracing Shāh ʿAbbās atop a globe, and the commemoration of successful military campaigns in the itinerary maps of the Ottoman period served similar purposes.

More strictly utilitarian types of maps were little developed in these traditional Islamic and Indian cultures despite the many potential uses for cartography and the existence of a literate mercantile class in many cities. Maps were drawn for didactic purposes, a practical use in at least one sense. Only near the end of our period, largely from the sixteenth century onward, as evinced by numerous Mughal, Rajput, Maratha, or Ottoman examples, were maps made for uses such as the planning and prosecution of military campaigns, siegecraft, navigation, engineering, and irrigation, or for taxation and resolving land disputes. By this time, however, both Islamic and Indian societies, though still maintaining an overall emphasis on religious rather than secular roles for maps, were being seriously challenged by the different cartographic values of the Western world.

Future Agendas

The essays in this book together constitute the beginning of a systematic account of the cartographic history of two major world regions in the premodern era. It is only a beginning, however. Despite the achievements of our authors—indeed, as a consequence of their achievements—it has become clear that much remains to be accomplished. The tasks are unevenly distributed. The foundation of earlier scholarship is shakier for South Asia than for the core Islamic regions, and the subcontinent offers future researchers some daunting tasks. At this juncture it may be useful to review what we can already see as the major outstanding lacunae in our knowledge of the history of cartography in the Islamic and Indian cultures. Since both the minutiae of map-by-map investigative work and broader issues are involved, a similar distinction is needed in our agendas. The dual tasks of basic scholarship and wider interpretation are intended, however, to be seen as entirely complementary.

In the essays on South Asia, our author has taken special pains to identify a number of directions for future research. For him "the study of the history of cartography in South Asia is still in its infancy." There is still scope for expanding the cartographic corpus by continuing the search for yet more maps in other libraries and archives. One focus should be on the apparently blank areas, such as Bengal and Sri Lanka, of the present distribution of known cartographic activity in these traditional societies. Not only the standard documentary sources but also those of the art historian invite diligent searches: Who knows what remains to be discovered in the region's vast reservoir of temples and private palaces? At the same time, new discoveries may not only add quantitatively to the cartographic record but in time also alter our perception of it by pushing back the record of known noncosmographic artifacts beyond the seventeenth century. Another prime focus should be on the gaps in our knowledge of the different map genres found in the Indian areas. So far we have barely sketched the outlines of some of these traditions. Yet there are plenty of starting points. The production of architectural plans could have considerable bearing on hitherto unnoticed traditions of large-scale mapping, for instance. The maplike elements in the vast corpus of Indian landscape painting merit further work, as does the evidence for celestial mapping in the designs of Tantric Hinduism, the symbolic role of the *axis mundi* in Indo-Islamic culture, the meaning and purpose of the divination charts of Rajasthan, and the products of cartographic hybridization resulting from the cross-cultural encounters of various mapping traditions.

Concerning individual maps, many of the tasks we take for granted in the historiography of Western cultures remain outstanding in the case of premodern Islamic and South Asian cartography. Some of these reflect language difficulties. Thus, particularly pressing is the need for translations of the legends and endorsements that appear on so many maps and globes, together with an index of the names of patrons and mapmakers with their places of origin. Future historians of cartography will have to deal not only with cartographic texts and contextual material of every variety in the better-known languages such as Persian and Sanskrit, but also with lesser-known vernaculars or scripts as Dhundari, Modi, or Kutchi that may hold clues to the origins and history of Indian maps. Other problems concern chronology. Many maps need precise dating. Stemmata and prototypes need to be reconstructed. Yet other maps await careful comparison with modern topographical maps before their geographical content can be precisely identified. Even so well documented a work as the Gentil atlas demands a detailed study of its content and style. One desideratum for the future would be the publication of a *Monumenta cartographica* on the European model for the history of Indian cartography, entailing a series of map facsimiles, each with full scholarly apparatus, designed so as to make each part of the existing corpus more widely available and to facilitate comparative studies of new maps as they come to light.

Notwithstanding the longer historiographic tradition of Islamic cartography, there remains a large and important scholarly agenda. As with India, it cannot be assumed that the corpus of known maps is representative of all Islamic mapping traditions. New maps continue to come to light, but significant gaps remain. There are many map genres and cultures we know little about. The study of cosmographical diagrams, for instance, is at an early stage. Tantalizingly little of a Persian cartographic tradition has been unearthed, though Persian, as the second major language of the Islamic world, was a lingua franca as far east as India. And despite the importance of the Ottoman Empire as a cultural bridge between European and Islamic practices, we probably know no more about it than we do about mapping in parts of the Indian subcontinent. We still need to search for maps, especially those that would document the transitional period up to the late nineteenth century, when traditional practices declined in the face of western European influence. In truth, we need to search every corner of the Islamic world and beyond for more of the corpus that undoubtedly survives somewhere. Hitherto most research has focused on celestial and terrestrial mapping related to ancient literary traditions, but we may expect to find more maps of a practical nature from the modern period. Some pointers are available from the Indo-Islamic and Ottoman areas. Irrigation maps, maps for revenue collection, route maps, plans of fortifications, and delineations of property were all made, more or less frequently, in some parts of India under Muslim rule, so why should we not anticipate a similar variety awaiting rediscovery in other Islamic areas in the Middle East or North Africa?

In general, too, far more attention has been paid to the texts of individual manuscripts than to the maps they contain. Thus, before many of the central research questions can be answered, much more detailed analysis on the maps of particular traditions remains to be carried out. For instance, of the thirty or so known texts associated with qibla maps, no more than five have so far been published. The others require scholarly editing that alone will give proper weight to the illustrations. Even for the maps of the Balkhī school—the classical terrestrial maps of the premodern Islamic world—the identity of several manuscripts has still not been settled, others have yet to be given their place in a well-documented sequence, and in all cases the relation between maps and associated tables of latitude and longitude needs to be worked out. It is the same with the manuscripts of al-Idrīsī's works. We still do not know which Arabic version of Ptolemy's *Geography* he drew upon, and though the recensions of his text have been studied, thorough research now has to be conducted on the maps.

There are also a number of more general interpretive problems to be tackled before we can start moving toward a more complete understanding of the place of Indian and Islamic cultures in the general history of traditional, premodern cartography. Such questions often transcend cultural realms and the individual mapping traditions described in this book. The question of transmission is one such problem, still partly unresolved and promising to be yet more complex once the reciprocal lines of influence within the "Old World system" start to be reconstructed. Our knowledge is still incomplete. We do not know, for example, what happened to the cartographic traditions of the ancient Near East (described in volume 1 of the *History*) when the political systems that had formerly supported them started to decline. Nor is it certain that there really was a complete cartographic hiatus in this region between the third century A.D. and the ascendancy of Islam from the seventh century onward. Moreover, once a distinct Islamic cartography emerges, we shall still lack a firmer understanding of the relative contributions of Indian, Iranian, Judaic, and Greek learning to this evolving form, and of the various routes by which each of these elements reached Islamic mapmaking. The cartographic interactions of premodern Islamic societies with Europe also still await a detailed examination, and little is known about the influence of China on the lands west of it. Joseph Needham believed the Chinese grid system, transmitted through an Arab intermediary, could be detected on Marino Sanudo's map of Palestine (early fourteenth century), but in fact we lack definite documentation of such a transmission.

Other lines of inquiry seem more promising. The cultural origins of the iconography on celestial maps have been traced on stylistic grounds, and this aspect of maps may illuminate the transmission of European, Byzantine, Islamic, Iranian, Indian, and Chinese conventions that appear on various maps discussed in this book. This could in turn help to resolve broader questions of cartographic diffusion from East to West or from West to East.

Then there are all the technical aspects of the maps in our corpus remaining to be studied. Our general emphasis on the social context of mapping does not deny the importance of being sensitive to "internal" questions of how maps were graphically conceived and executed. The comparative study of early maps in Islamic society, in particular, has usually focused on geographical content and place-names while overlooking the intrinsic quality of the artifacts. Many studies have run the risk of misinterpretation as a result. Konrad Miller's reconstruction of al-Idrīsī's sectional maps as a single composite map in the nineteenth century (or Petrus Bertius's in the early seventeenth century) has thus implied, without reviewing the physical evidence of the artifacts, that al-Idrīsī created a large single world map by joining all the sectional maps. Similarly, the controversy concerning the world map in a manuscript of Ibn Faḍl Allāh al-ʿUmarī of the early fourteenth century, which bears a modern-looking graticule, is largely based on disagreement about the date when the actual manuscript was copied and whether it bears later additions. A resolution of this problem will surely include as careful a stylistic and physical examination of the manuscript as would be accorded a work of art of the particular period. We have not reached the enviable position of art history, in which much more of the corpus has been cataloged, analytically described, and—in the case of key artifacts—subjected to close chemical scrutiny of inks, pigments, and base materials such as paper and parchment. Such technical descriptions of maps will, however, need to take stock of other graphic media, such as painting, calligraphy, and the metalworking arts, to which mapmaking and geographical instrument making were closely allied. The best way forward may lie in interdisciplinary cooperation between art history and map history.

In a similar way, the cartographic signs on Islamic maps require systematic comparative examination of the kind our author has attempted for South Asian maps. How closely, for example, does their design match the abstract quality of Islamic art in general? Do their color conventions relate to wider artistic practices, or did they embody some measure of color sensitivity to different environments?

Equally problematic is the orientation of maps. Despite the large sample of maps represented in this book, the resolution of this issue remains elusive. Many Indian maps were oriented to the east, but no dominant convention emerges from the evidence we have reviewed. There is, moreover, the complicating tendency, especially evident in the maps of Kashmir, for certain maps to have multiple orientations, with features (especially mountains) pointing away from the usual point of view of the observer. Clearly it would be premature to advance generalizations even for localized cultures. The evidence from Islamic society is no less ambivalent. Many Islamic world maps were oriented to the south, but by no means all maps, or all types of maps, share this feature. Among those with different orientations are some of the regional maps of the Balkhī school, the sectional maps in al-Idrīsī's shorter work, the *Rawḍ al-faraj wa-nuzhat al-muhaj*, and the world map in *Kitāb al-badʾ wa-al-taʾrīkh* dated 977/1050. This suggests there was no hard and fast convention. Given the powerful symbolism of orientation in the Islamic world in general, as in other cultures, absence of a "rule" dealing with map orientation in so formal a cartographic school as the Balkhī suggests that the question mattered less in Islamic mapping than in Western mapping, descended directly from the Greek tradition. One danger to bear in mind is that Europeans' reasoning about the influence of sacred directions on their own medieval maps has led to reading too much from the orientation of Islamic maps. Examples are the suggestion that a southerly orientation was derived from the Arabs' early conquest of the Zoroastrians, for whom south was a sacred direction, and the idea that the practice arose because of Islamic reverence for the cities of Mecca and Medina. Other explanations are possible. A custom of southerly orientation could have been derived from accepted Greek cosmographic models, such as the Aristotelian tradition of the universe described in *De caelo*. But this is still conjecture. All we can say is that such differences of orientation exemplify the highly selective assimilation of knowledge that is so characteristic of Islamic cartography. Though it is clear that the Ptolemaic model was not followed in cases of southerly orientation, the exact reasons for this practice have to be researched in more detail before a definite conclusion is reached.

In sum, this book has offered many rich new perspectives on the history of Old World cartography in the premodern era. Whereas in our first volume we were in many respects still searching for the origins of Western modernity in the maps of the classical and late medieval worlds, here in both the Islamic and South Asian narratives an understanding of a cartography has been reached without recourse to Western models. No longer can one doubt the existence of a mapping impulse in these early societies. Each essay has made clear how different cultures created their own maps in just the same way as they created their own histories, their own literature, their own art. And we have been shown how, though distinctively indigenous in many respects, all these cartographies were at times transformed by social forces external to their area of origin. Interestingly, to the extent that it applied, such a cultural openness to the "foreign" can be seen as the very antithesis of later Western cartography, where a European "standard" of mapping was imposed on other areas of the world during the advance of European power and culture. Neither in the Islamic world, despite its remarkable degree of cultural unity, nor in South Asia was there ever any overarching cartographic paradigm. There was not even a consensus on how best to measure and represent earth, sea, sky, or universe. It is this unpredictability that makes traditional mapping in these areas of the premodern world at once so fascinating and so tantalizingly difficult to encompass from a late twentieth-century viewpoint.

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J. B. HARLEY (1932–1991) was professor of geography at the University of Wisconsin at Milwaukee. DAVID WOODWARD is professor of geography at the University of Wisconsin at Madison.

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