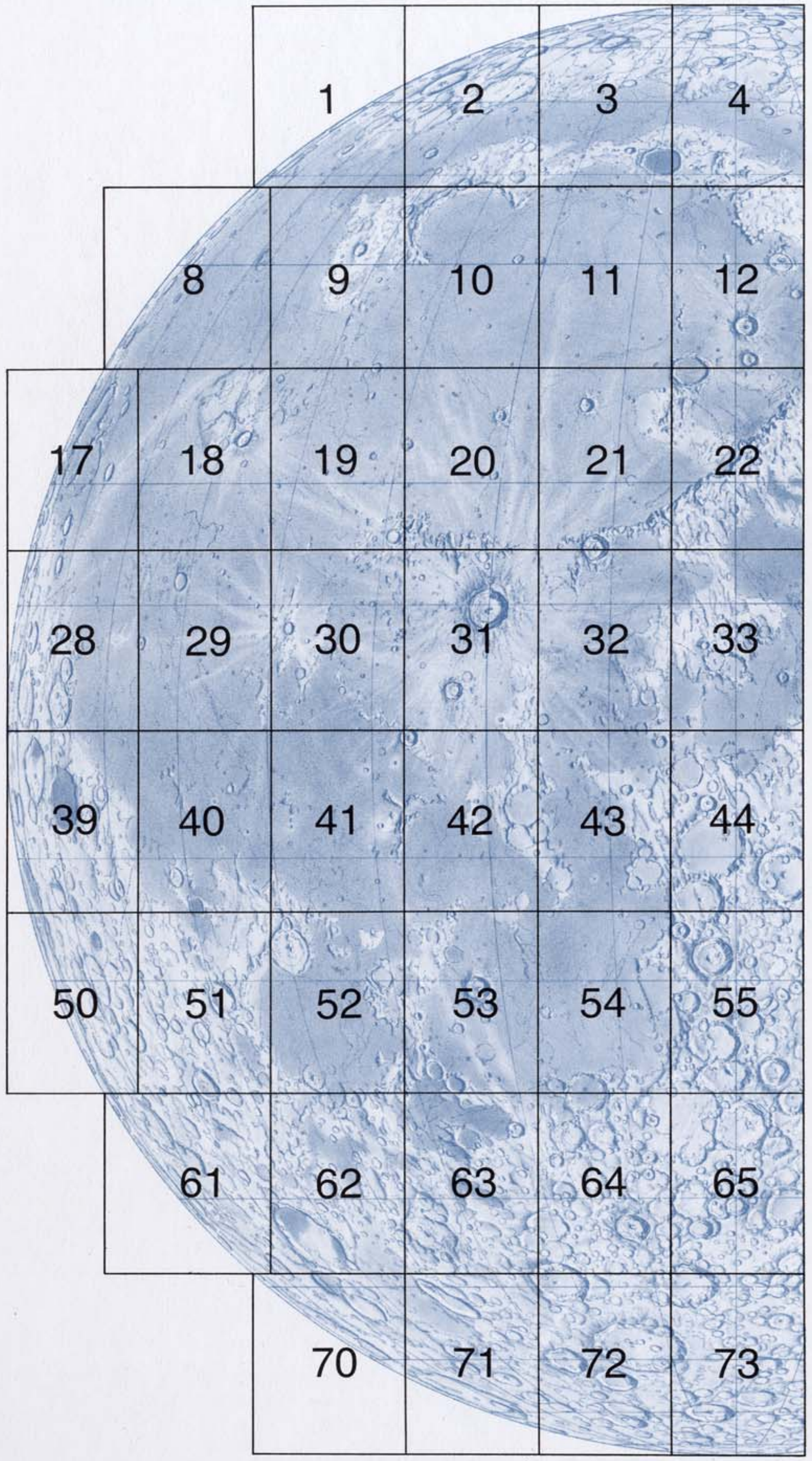
ATLAS OF THE Moon

Revised, updated edition

Antonín Rükl

Edited by Gary Seronik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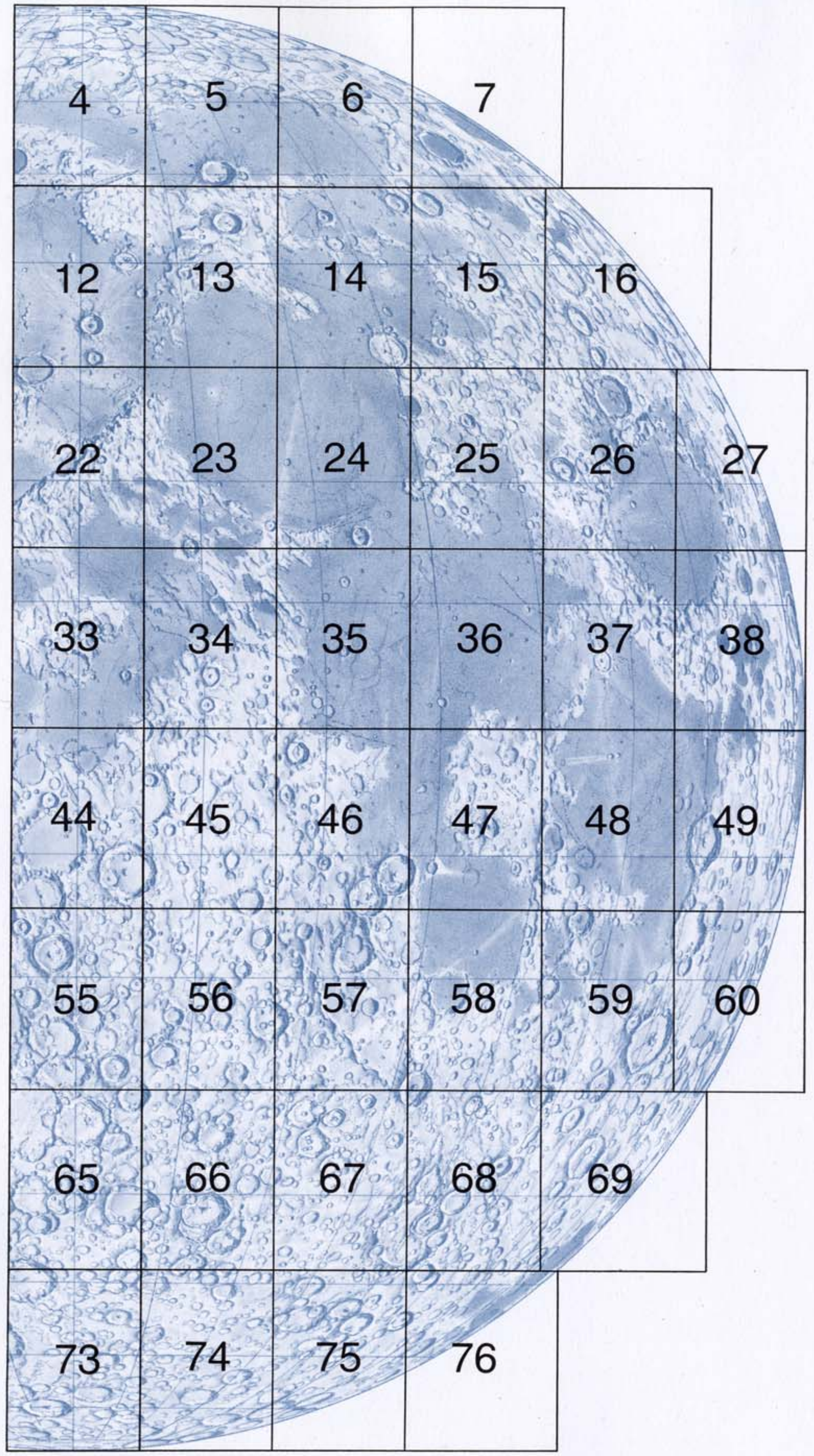
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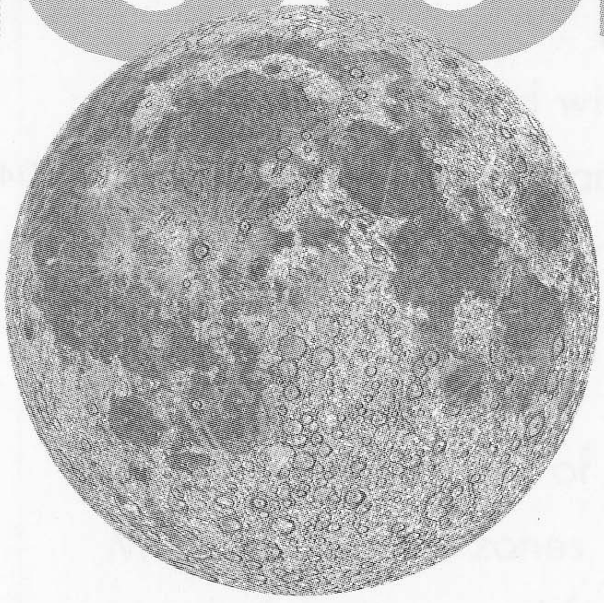

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Introduction

The Moon, our closest celestial neighbor, has been attracting the attention of the inhabitants of the Earth since ancient times. This is hardly surprising for, apart from the Sun, it is the most conspicuous astronomical object seen from the surface of our own planet. Its changing phases were used by ancient scholars to compile the first calendars, and even now they remind us of the passage of time. It is the only world whose surface features may be observed in detail with a small telescope.

The Moon's proximity and the ease with which it can be observed resulted in a vast accumulation of knowledge, which eventually made it a tempting first target for space flights beyond Earth orbit. It was the first celestial body to be reached by space probes and, so far, is the only natural extraterrestrial body to bear the footprints of man. Intense exploration of the Moon during the 1960s and 1970s, followed by more robotic space probes in the 1990s, greatly improved our knowledge of the earliest phases of development of the solar system and shed light on the history of the primordial Earth.

The science and technology of the second half of the 20th century have brought the Moon so close to us that we now regard it much the same way that 15th-century navigators contemplated the exploration of distant continents. But our object of discovery, the Moon, is plainly visible, inviting us to explore its surface with the aid of maps and telescopes. Looking through the eyepiece, we can easily imagine ourselves observing the cratered lunar surface like an astronaut peering out the window of a spaceship.

The present atlas is intended for anyone interested in becoming familiar with the lunar features visible from the Earth. The main part of this book consists of a detailed atlas of the near side of the Moon, subdivided into 76 sections with complete nomenclature as authorized by the International Astronomical Union (IAU), including recent amendments up to 2003. Each section is accompanied by a "Who's who on the Moon" summary containing information about the individuals whose names have been given to lunar formations, and a brief description of the features themselves.

An additional series of libration-zone charts depict the difficult-to-observe region near the Moon's limb. Finally, there is the "Fifty views of the Moon" section that highlights some of the lunar surface's most interesting features.

Readers will find numerous changes and updates in this edition of *Atlas of the Moon*. The atlas charts are updated to match the current IAU-approved lunar nomenclature (including recent additions adopted at the IAU General Assembly in 2000); the libration charts for the south polar region have been replaced with new ones that utilize imagery from the *Clementine* spacecraft and Arecibo Observatory to show more detail near the pole; and crater terminology is updated throughout the atlas to reflect the terms used by geologists. Gone are obsolete terms like "walled plains" or "ring mountains," introduced long ago by selenographers. Also, the book has been revised throughout to incorporate results from the *Galileo*, *Clementine*, and *Lunar Prospector* missions. Naturally, tables of lunar phases, colongitude, and eclipses are updated too.

Finally, because research of our closest celestial neighbor is ongoing, the reader is encouraged to keep up with the "lunar news" by reading *Sky & Telescope* magazine and by searching the Internet.

The Moon: A satellite of the Earth

Just as the planets orbit the Sun, taking with them their families of orbiting moons, so our Moon describes an elliptical path around the Earth (Fig. 1). That is why its distance from our planet is constantly changing. When it occupies the orbital point at which it is closest to the Earth, the Moon is said to be at *perigee*. *Apogee* occurs when it reaches its most distant point. At perigee the Moon's distance from the Earth is 356,400 kilometers and the angular diameter of its disk is about 33.5 minutes of arc (33.5′)*. At apogee its distance increases to 406,700 km, while its angular diameter shrinks to 29.4′.

Such significant changes in angular diameter can be detected easily by comparing photographs of the Moon taken at perigee and apogee using the same optics. Coincidentally, the apparent angular diameter of the Moon is similar to that of the Sun as seen from the Earth – about a half degree.

Theoretically, when the Moon is at perigee finer details should be observable than when it is at apogee, but in practice telescopic visibility is governed by the ever-changing and often turbulent state of the Earth's atmosphere, not forgetting the experience and skill of the observer.

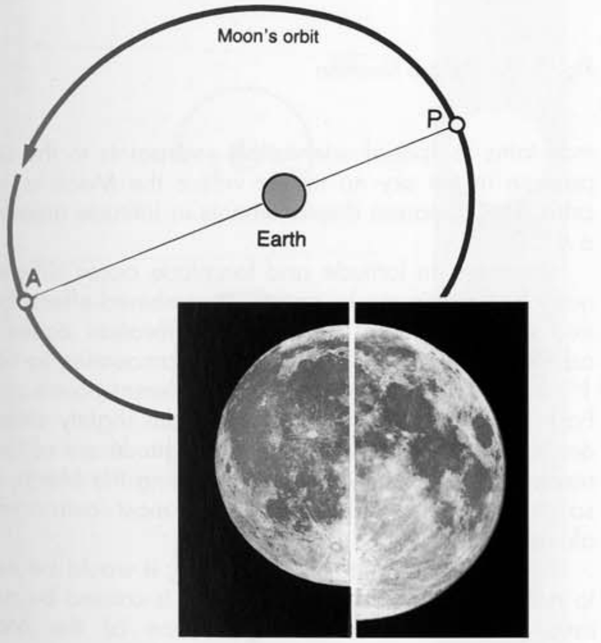


*Fig. 1. The Moon's orbit. Comparison of the Moon's angular diameter at perigee, **P** (to the right), and at apogee, **A** (to the left).*

Our star, the Sun, is 400 times farther away from the Moon than the Earth, yet the Sun and the Earth produce the principal gravitational effects that constantly influence the Moon's orbit. Not only does the orbital velocity of the Moon vary, but changes also occur in the shape, dimensions, and orientation of the plane of the orbit as measured against the stars. A precise description of the Moon's motion is one of the most difficult tasks of theoretical astronomy. The plane of the Moon's orbit around the Earth is within about 5° of the plane of the Earth's orbit around the Sun. It is perhaps surprising that the resulting trajectory of the Moon around the Sun is an orbit similar to that of the Earth, which is at all times concave toward the Sun (see Fig. 6).

Since the distance of the Moon from the Earth is a mere 30 Earth diameters, it is little wonder that the Moon exerts a considerable gravitational effect on the Earth: this is clearly observed in the alternating ebb and flow of the ocean tides. The Earth-Moon system is, in fact, regarded as a double planet, for both bodies are planetary sized, orbiting around a common center of gravity that lies some 4,700 km from the Earth's center, along a line joining the centers of the two bodies.

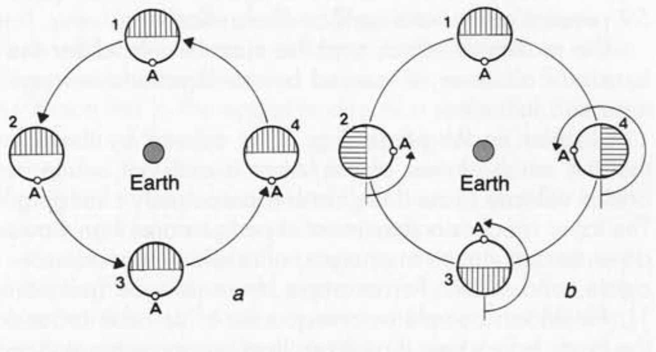


Fig. 2a, b. The Moon's rotation.

Among the many dynamical properties of moons in general is *synchronous rotation*. This is shown by our Moon, which completes one rotation on its axis in the same time as it takes to orbit the Earth, which is why it always presents the same hemisphere to the Earth. This well-known fact has often been explained erroneously by asserting that the Moon does not rotate on its axis at all! If this were so, the Moon would orbit the Earth as shown in Fig. 2a. A defined lunar crater A, which in position 1 would occupy the center of the near side, would in position 2 be at the edge of the visible hemisphere, and in position 3 be out of sight in the middle of the averted hemisphere. In fact, the Moon spins on its axis of rotation as shown in Fig. 2b: from position 1 to position 2 it completes one-quarter of its orbital revolution while simultaneously turning one-quarter of a rotation (90°) on its axis, so that crater A stays in the middle of the side facing the Earth. In the course of one complete orbital revolution, one lunar hemisphere (indicated by hatching in Fig. 2b) remains forever hidden from the Earth, although the whole Moon is successively illuminated by the Sun.

* For numerical data on the Moon, see p. 19

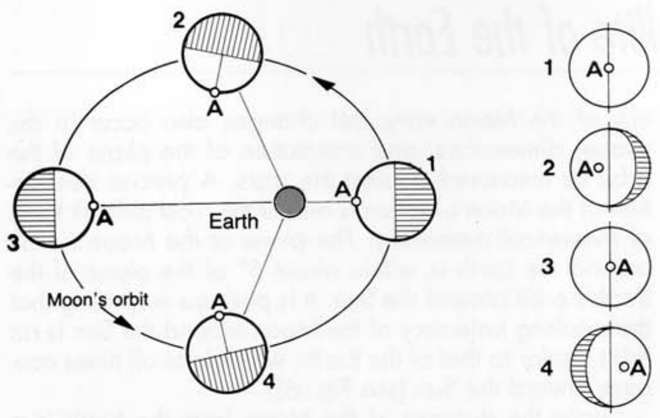


Fig. 3. *Libration in longitude.*

If what has been considered so far about synchronous rotation is true, we would expect just 50 percent of the lunar surface to be visible from the Earth. In reality, the complexities of lunar dynamics favor terrestrial observers. While we can never see more than one hemisphere at a time, slender "crescents" of the averted hemisphere are brought into view by swinging or oscillating motions called *librations*, which enable us to see some 59 percent of the total surface (theoretically).

The maximum effect, and the most beneficial for the terrestrial observer, is caused by the librations in longitude and latitude.

Libration in longitude (Fig. 3) is caused by the fact that the axial rotation of the Moon is constant, while its orbital velocity around the Earth is perpetually changing. The latter reaches a maximum at perigee and then slows down to a minimum at apogee, after which it accelerates again, and so on. For example, from perigee (position 1), the Moon completes one-quarter of its orbit around the Earth in less time than it requires for an axial rotation of 90°. This manifests itself by an apparent "swinging" to the left of the lunar globe to reveal an area that normally lies beyond the right-hand edge of the Moon (left and right directions are in this book designated for an Earth-based observer in the Northern Hemisphere). Similarly, from apogee (position 3), the Moon takes longer to reach position 4 than it does to make a quarter of an axial rotation; therefore, features that are usually beyond its left-hand edge are brought into view. Libration in longitude can cause an east-west displacement of ± 7°54′.

Libration in latitude (Fig. 4) is caused by the fact that the Moon's equator is inclined to its orbital plane. This tilt (6.41°) inclines first one pole and then, when the Moon is on the opposite side of its orbit, the other toward the Earth, as the rotational axis of the Moon (like that of the Earth and any other massive "gyroscope") maintains its spatial orientation and points to the same position in the sky no matter where the Moon is in its orbit. The apparent displacements in latitude amount to ± 6°50′.

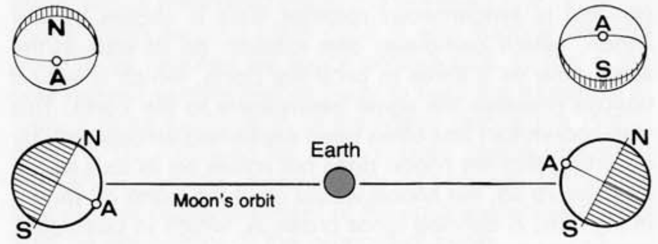


Fig. 4. *Libration in latitude.*

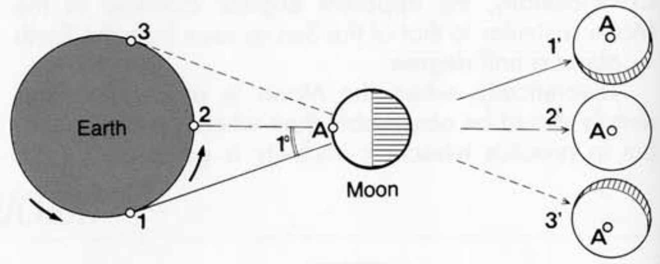


Fig. 5. *Diurnal libration.*

Librations in latitude and longitude occur simultaneously and continuously, and their combined effects bring into view peripheral areas called *libration zones*. An additional *diurnal libration* (Fig. 5), amounting to about 1°, arises from the fact that from different points on the Earth's surface the Moon is seen from slightly different angles. Librations in latitude and longitude are of fundamental importance to anyone observing the Moon, and so their values are tabulated in most astronomical almanacs.

Before passing on to other topics, it would be useful to mention physical libration, which is caused by gravitational irregularities in the rotation of the Moon. Although the angles involved are small (several minutes of arc), they are of importance to astronomers studying the shape and internal structure of the Moon.

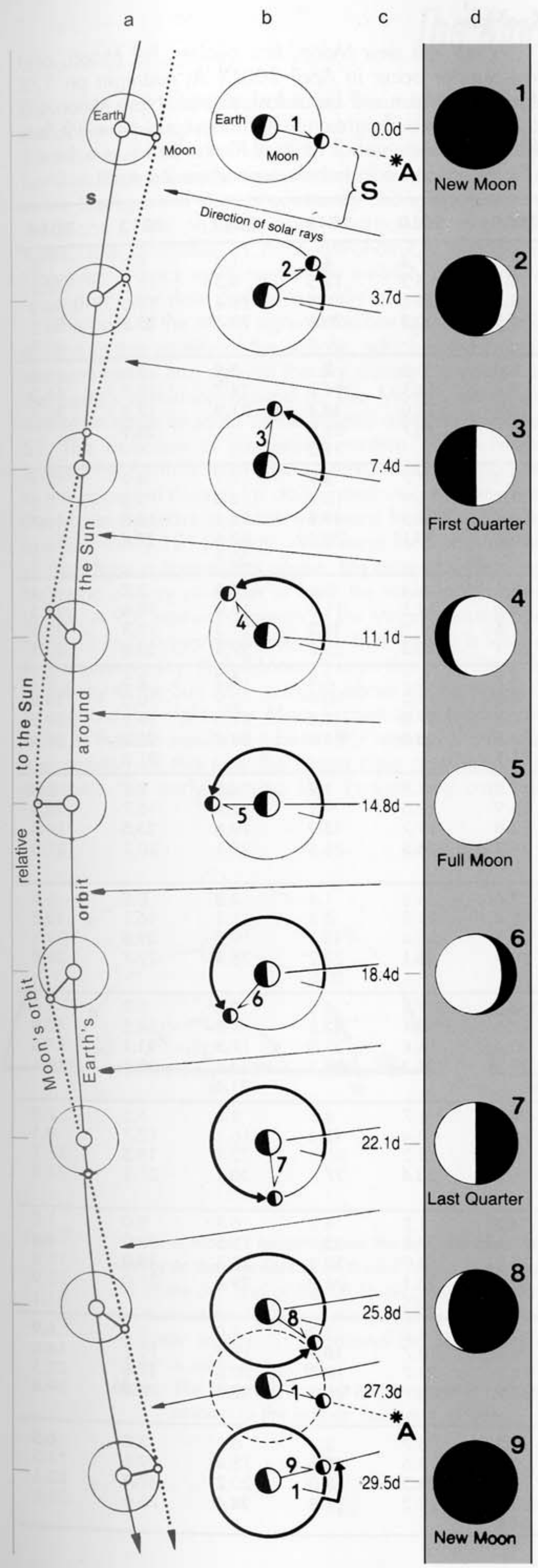


Fig. 6. *Orbital motion and phases of the Moon. The Moon's orbit around the Earth and around the Sun in column **a** are not shown to scale. The section **s** of the Moon's orbit around the Sun is, in fact, equal to about 12 times the diameter of the Moon's orbit around the Earth.*

Phases of the Moon

The most striking phenomenon arising from the Moon's revolution around the Earth is its changing phases. The light of the Sun falls upon the Moon, and those parts that are illuminated can be observed from the Earth, depending on the angle separating the Sun and the Moon as seen from the Earth. In Fig. 6 successive values of this angle are shown in column **b** and the corresponding appearance or phase of the Moon is illustrated in column **d**. In position 1 the Moon lies in the same direction, **S**, as the Sun as seen from the Earth, and what we call the new Moon is not observable. Starting from this instant, the age of the Moon in Earth-days is given in column **c**. As the Moon *waxes* it gradually becomes visible. After about 3.7 days it has completed one-eighth of its orbit (45°), having arrived at position 2, and from the Earth a part of its illuminated hemisphere is seen as a narrow crescent. At this time the remainder of the lunar disk is also faintly visible, because its "night-time" side is lit by "earthshine," which is sunlight reflected from the Earth. The boundary between day and night on the Moon is called the terminator.

In position 3, the age of the Moon is about 7.4 days and precisely half of the illuminated hemisphere is observable: the Moon is at first quarter. The whole of the illuminated hemisphere can be seen at position 5, when the Moon lies in the opposite direction to the Sun. This is full Moon. After the "full" phase, the Moon begins to *wane*, and the illuminated area, as seen from the Earth, diminishes through last quarter (position 7) and the ever-narrowing crescent phases to new Moon.

Consider a straight line passing through the centers of the Earth and Sun and projected beyond the Sun to a point "on the sky." As the Earth and Moon orbit the Sun, this line will change its direction in space and its projected "end" will move through the so-called fixed stars. Returning to Fig. 6, let us imagine that when the Moon is in position 1, a fixed star **A** is exactly at the end of this imaginary projected line. In other words, the centers of the Earth, Moon, and Sun are in line with star **A**. From the instant of this celestial lineup, 27.3 days will elapse before the Moon, having apparently encircled the sky in the meantime, will return to be in line with the position of star **A**. This period is called one *sidereal month*. However, the Moon will not now be aligned with the Sun because the Sun has apparently moved to a different position against the background stars. It takes the Moon an additional 2 days to catch up with the Sun and again show the phase of new Moon. The period of 29.5 days between successive new Moons is known as a *synodic month* or *lunation* (lunar month). The numbering of lunations was introduced in 1923, with lunation no. 1 starting at new Moon on January 17, 1923. Lunation no. 1,000 started at new Moon on October 25, 2003. Most astronomical almanacs and computer programs contain the lunation numbers, together with the dates of the main lunar phases and the age of the Moon at 0 hours Universal Time (UT) for each day of the year.

LUNAR PHASES 2004–2014

This table contains the dates of new Moon, first quarter, full Moon and last quarter. Each vertical column represents a particular year. Months are represented by the numerals I–XII in the left-hand margin. All dates are based on UT with a precision of 0.1 day. The date of full Moon is printed in **bold type**.

Example

When will new Moon, first quarter, full Moon, and last quarter occur in April 2005? At midnight on 1/2 April, the Moon will be at last quarter. New Moon will occur before midnight on 9 April. First quarter will follow this on the afternoon of 16 April (0.6 × 24 hours = 14.4 h UT). Full Moon occurs before noon on 24 April.

Month / Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
I	**7.6** 15.2 21.9 29.2	3.7 10.5 17.3 **25.4**	6.8 **14.4** 22.6 29.6	**3.6** 11.5 19.2 26.0	8.5 15.8 **22.6** 30.2	4.5 **11.1** 18.1 26.3	7.4 15.3 23.5 **30.3**	4.4 12.5 **19.9** 26.6	1.3 **9.3** 16.4 23.3	5.2 11.8 19.0 **27.2**	1.5 8.2 **16.2** 24.2 30.9
II	**6.4** 13.6 20.4 28.1	2.3 8.9 16.0 **24.2**	5.3 **13.2** 21.3 28.0	**2.2** 10.4 17.7 24.3	7.2 14.2 **21.2** 29.1	3.0 **9.6** 16.9 25.1	6.0 14.1 22.0 **28.7**	3.1 11.3 **18.4** 25.0 31.2	**7.9** 14.7 21.9	3.6 10.3 17.9 **25.9**	6.8 **15.0** 22.7
III	**7.0** 13.9 21.0 29.0	3.7 10.4 17.8 **25.9**	6.8 **15.0** 22.8 29.4	**4.0** 12.2 19.1 25.8	7.7 14.4 **21.8** 29.9	4.3 **11.1** 18.7 26.7	7.7 15.9 23.5 **30.1**	4.9 13.0 **19.8** 26.6	1.1 **8.4** 15.1 22.6 30.8	4.9 11.8 19.7 **27.4**	1.3 8.6 **16.7** 24.1 30.8
IV	**5.5** 12.2 19.6 27.7	2.0 8.9 16.6 **24.4**	5.5 **13.7** 21.2 27.8	**2.7** 10.8 17.5 24.3	6.2 12.8 **20.4** 28.6	2.6 **9.6** 17.6 25.1	6.4 14.5 21.8 **28.5**	3.6 11.6 **18.2** 25.2	**6.8** 13.4 21.3 29.4	3.2 10.4 18.5 **25.8**	7.4 **15.3** 22.3 29.3
V	**4.9** 11.5 19.2 27.3	1.3 8.4 16.4 **23.8** 30.5	5.2 **13.3** 20.4 27.2	**2.4** 10.2 16.8 23.9	5.5 12.2 **20.1** 28.1	1.9 **9.2** 17.3 24.5 31.1	6.2 14.0 21.0 **28.0**	3.3 10.9 **17.5** 24.8	**6.2** 12.9 21.0 28.8	2.5 10.0 18.2 **25.2** 31.8	7.1 **14.8** 21.5 28.8
VI	**3.2** 9.8 17.8 25.8	6.9 15.1 **22.2** 28.8	4.0 **11.8** 18.6 25.7	**1.0** 8.5 15.1 22.6 **30.6**	3.8 10.6 **18.7** 26.5	**7.8** 15.9 22.8 29.5	4.9 12.5 19.2 **26.5**	1.9 9.1 **15.9** 23.5	**4.5** 11.4 19.6 27.1	8.7 16.7 **23.5** 30.2	5.8 **13.2** 19.8 27.3
VII	**2.5** 9.3 17.5 25.2 **31.8**	6.5 14.6 **21.5** 28.1	3.7 **11.1** 17.8 25.2	7.7 14.5 22.3 **30.0**	3.1 10.2 **18.3** 25.8	**7.4** 15.4 22.1 28.9	4.6 11.8 18.4 **26.1**	1.4 8.3 **15.3** 23.2 30.8	**3.8** 11.1 19.2 26.4	8.3 16.1 **22.8** 29.7	5.5 **12.5** 19.1 26.9
VIII	7.9 16.1 23.4 **30.1**	5.1 13.1 **19.8** 26.6	2.4 **9.5** 16.1 23.8	5.9 13.0 21.0 **28.4**	1.4 8.8 **16.9** 24.0 30.8	**6.0** 13.8 20.4 27.5	3.2 10.1 16.8 **24.7**	6.5 **13.8** 22.0 29.2	**2.1** 9.8 17.7 24.6 **31.6**	6.9 14.5 **21.1** 28.4	4.0 **10.8** 17.5 25.6
IX	6.6 14.6 21.7 **28.6**	3.8 11.5 **18.1** 25.3	1.0 **7.8** 14.5 22.5 30.5	4.1 11.5 19.7 **26.8**	7.6 **15.4** 22.2 29.3	**4.7** 12.1 18.8 26.2	1.7 8.4 15.2 **23.4**	4.8 **12.4** 20.6 27.5	8.6 16.1 22.8 **30.1**	5.5 12.7 **19.5** 27.2	2.5 **9.1** 16.1 24.3
X	6.4 14.1 20.9 **28.1**	3.4 10.8 **17.5** 25.0	**7.1** 14.0 22.2 29.9	3.4 11.2 19.4 **26.2**	7.4 **14.8** 21.5 29.0	**4.3** 11.4 18.2 26.0	1.2 7.8 14.9 **23.1** 30.5	4.2 **12.1** 20.2 26.9	8.3 15.5 22.1 **29.8**	5.0 12.0 **19.0** 27.0	1.8 **8.4** 15.8 23.9 31.1
XI	5.2 12.6 19.2 **26.8**	2.1 9.1 **16.0** 23.9	**5.5** 12.7 20.9 28.3	1.9 10.0 17.9 **24.6**	6.2 **13.3** 19.9 27.7	**2.8** 9.7 16.8 24.9	6.2 13.7 **21.7** 28.9	2.7 **10.9** 18.7 25.3	7.0 13.9 20.6 **28.6**	3.5 10.2 **17.6** 25.8	**6.9** 14.6 22.5 29.4
XII	5.0 12.1 18.7 **26.6**	1.6 8.4 **15.7** 23.8 31.1	**5.0** 12.6 20.6 27.6	1.5 9.7 17.4 **24.0** 31.3	5.3 **12.7** 19.4 27.5	**2.3** 9.0 16.5 24.7 **31.8**	5.7 13.6 **21.3** 28.2	2.4 **10.6** 18.0 24.8	6.6 13.4 20.2 **28.4**	3.0 9.6 **17.4** 25.6	**6.5** 14.5 22.1 28.8

The Moon in the sky

Day after day substantial changes occur in the times of the Moon's rising and setting, as well as in the arcs (sometimes called *diurnal arcs*) it describes above the horizon. Consequently, the position of the Moon relative to the background stars is constantly changing. Data on the Moon's position, expressed in astronomical coordinates, are available in most astronomical almanacs. However, a quick estimation of the visibility of the Moon for a particular date can quite easily be made.

The path of the Moon against the background stars is always in the vicinity of the *ecliptic*, which is the apparent path of the Sun against the sky during the course of the Earth's revolution around it. The Moon's maximum deviation north or south of the ecliptic amounts to about 5°. The direction of the orbital motion of the Moon around the Earth is from west to east, which is opposite to the apparent diurnal (or daily) rotation of the sky, and the Moon appears to move eastward from the Sun by approximately 12° per day. With these facts in mind, let us start from a convenient phase, the date of which can be found on any calendar or from the table in this book (p.10). A 90° eastward motion of the Moon from the Sun brings it to first-quarter phase, at which time it is visible in the evening sky. At full Moon it is on the opposite side of the sky to the Sun and, rising at about sunset, it shines throughout the night. The Moon's continuing motion relative to the Sun results in it being 90° west of the Sun at last quarter. At this time the Moon rises at midnight to dominate the early-morning sky. Further, we can estimate, relative to the Sun, the direction and altitude of the arc that represents the path of the Moon above the horizon. We can also guess the time of the Moon's rising and setting.

The above relationships are illustrated in Fig. 7, where, for simplicity, the inclination of the Moon's orbit with respect to the ecliptic has been neglected. In this graph the annual variations of the Sun's altitude and the main phases of the Moon above the horizon are indicated. For example, in March, at the beginning of spring, the Sun and the full Moon are both located on, or very near, the celestial equator, and their paths attain mean or average altitudes above the horizon. Under these conditions, both bodies remain above the horizon for about 12 hours. In spring, the path of the waxing Moon at first quarter attains the altitude of the path of the midsummer Sun. At the other extreme, the path taken by the waning Moon at last quarter in spring is akin to that of the Sun in midwinter – very low in the sky. Therefore, when trying to determine the visibility of the Moon, we can begin by considering the apparent path of the Sun during the course of a year.

To sum up, the Moon's altitude above the horizon varies like that of the Sun, the main difference being that the Sun completes one revolution along the ecliptic in a year whereas the Moon makes a similar journey around the sky in 27.3 days. In other words, the motion of the Moon around the sky in one lunation is nearly identical to that of the Sun in a whole year.

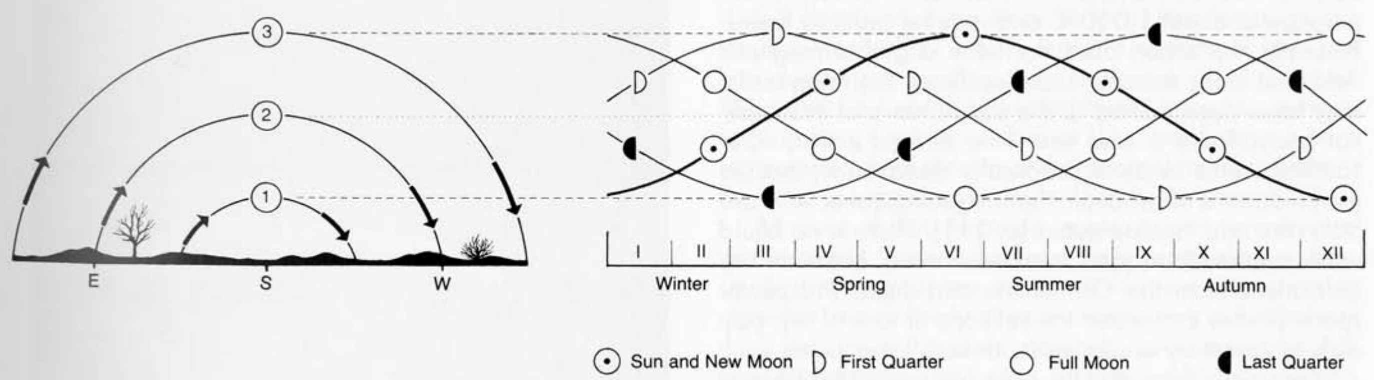


Fig. 7. *How the Moon's height above the horizon changes. 1. The path of the Sun above the horizon in early winter, which is similar to the diurnal arc of the full Moon in early summer, of the first-quarter Moon in early autumn, etc. 2. The diurnal arc of the Sun and of the full Moon at around the time of the vernal or autumnal equinox, when each body stays above the horizon for 12 hours; it is similar to the path of the first- or the last-quarter Moon at around the time of the summer or winter solstice. 3. The diurnal arc of the Sun in early summer, of the full Moon in early winter, of the first-quarter Moon in early spring, etc.*

Note: *The diagram is valid for an observer in the Northern Hemisphere, and the inclination of the Moon's orbit with respect to the ecliptic has been ignored.*

The surface of the Moon

In 1610 Galileo Galilei discovered that there are mountains and craters on the Moon. By the middle of the 17th century, astronomers using improved telescopes were able to observe craters as small as 10 km in diameter. Three hundred years later, thanks to continued developments in optical technology, it is possible to discern lunar crater pits as small as 150 m across, which is about the limit for the most powerful Earth-based telescopes currently in use.

The development of space flights in the late 1950s opened up new horizons (p. 192). In October 1959 the probe Luna 3 photographed the lunar far side. In July 1964 Ranger 7 images revealed pits and boulders that were a half meter across and therefore some 1,000 times smaller than anything that could be seen from the Earth. Millimeter-sized grains and fragments were visible in images sent back by Luna 9 in January 1966. So rapid was the progress that scientists were examining lunar rocks under the microscope by the summer of 1969! In just one decade the Moon had forfeited its remoteness, and lunar research largely shifted from astronomy to geology.

The Moon is a spherical body with a diameter of 3,476 km (for numerical data on the Moon see p. 19), and its surface, which does not enjoy the protection of an atmosphere, is immersed in the near vacuum of space. The lunar soil, or *regolith*, consists of an incoherent mixture of loose but sticky dust, small rock fragments, and stones in a layer many meters deep. This shallow layer covers the Moon's crust, which is composed of crushed layers of rock with an average depth of about 70 km. Below this is the lunar *mantle*, which encloses a 500- to 900-km-diameter iron-rich core that has a temperature of about 1,000°C and may be partially liquid. Presently, the Moon does not have a global magnetic field, but lunar samples show evidence that magnetism may have been existed in the early history of this celestial body. There is also very little seismic activity. Our satellite seems to be a practically dead body, and its manifestations of residual internal geological activity are both rare and inconspicuous (p. 211). There is no liquid water on the Moon (and there never was), but there are indications from the *Clementine* and *Lunar Prospector* space probes that water ice (millions of tons of it!), possibly of cometary origin, exists at both lunar poles.

Keeping in mind that the main function of this book is to serve as a guide for Earth-based observation, I will concentrate mostly on the general appearance of the lunar surface and its portrayal. But for a complete understanding of this strange world, we should also undertake some excursions closer to the lunar surface. Fortunately, such a virtual journey is quite easy and safe now, thanks to numerous images and movies from the Apollo missions and other flights to the Moon. Comparing the astronaut's view with the telescopic appearance of the same feature is very instructive; just compare the features shown in Fig. 10 with how they are portrayed on their respective maps.

What can we observe on the lunar surface from the Earth, at a distance of 400,000 km? The first things that we notice are the dark areas, which can be seen easily with the naked eye. Early observers of the 17th century mistakenly believed them to be seas and named them accordingly, giving them the Latin name *maria* (see p. 22). Naturally, the brighter areas were taken for continents (Latin: *terrae*) and this convention has been preserved to the present time despite the fact that there is no water on the Moon at all!

With a small telescope it is easy to see that the terrae are the lunar highlands and are covered with craters of all sizes (Fig. 9). By contrast, the maria exhibit the characteristics of smooth plains, only here and there rippled by low mare ridges and solidified lava flows (Fig. 8). Limiting crater sizes to 1 km or more, it has been established statistically that a given highland area contains 30 times more craters than an equivalent mare region. At first glance it would seem that craters are comparatively rare in the maria. However, close inspection by unmanned lunar probes and by Apollo astronauts shows the whole of the lunar surface is pockmarked with countless small craters ranging in size from tens of meters down to microscopic dimensions.

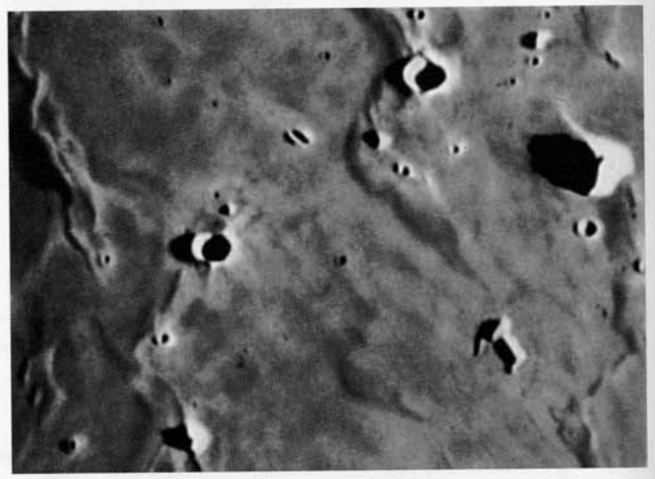


Fig. 8. The surface of a lunar mare.

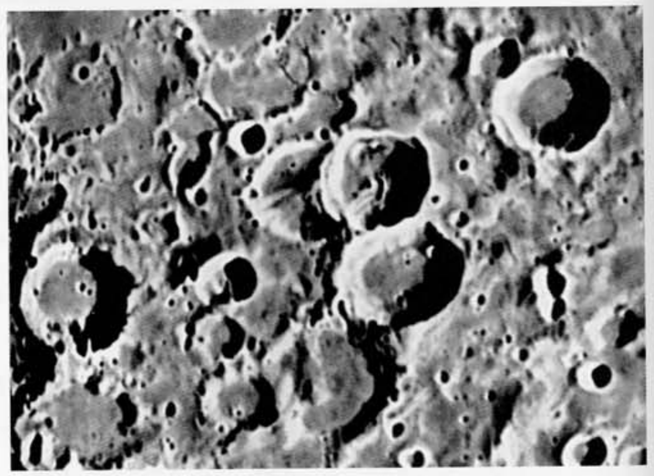


Fig. 9. The lunar highlands in the area of the crater Geber (see map 56).

The maria represent 31.2 percent of the surface area of the near side of the Moon but, oddly, only 2.6 percent of the surface area of the far side. They are volcanic in nature, and their dark hue is due to their chemical composition; the maria consist of basalts abundant in magnesium, iron, and titanium, while the bright terrae regions are rich in calcium and aluminum. It is also worth noting that the maria do not represent what might be called level surfaces; instead, they are irregularly inclined and undulating.

Craters are the most common formations on the lunar surface (and, of course, on many solar-system bodies). On the near side there are about 300,000 craters larger than 1 km, including 234 craters with diameters exceeding 100 km. Before spacecraft visited the Moon, the origin of lunar craters was the subject of heated discussions between astronomers who defended either the endogenic/volcanic or the exogenic/impact origin for craters. Early Moon mappers and selenographers had only vague ideas about the true nature of lunar formations and classified craters according to their appearance. The largest craters, with diameters ranging from approximately 60 to 300 km, were frequently called "walled plains" or "ringed plains" (e.g., Clavius (1)*, Ptolemaeus (4), Bailly (48)). The most prominent craters featuring mighty terraced walls and diameters ranging from about 20 to 100 km were classified as "ringed mountains" or "mountain rings" (e.g., Copernicus (7), Tycho (10), Theophilus (9)). These and other classic terms, found in older literature (and, for the sake of continuity, also in previous editions of this book), are now considered obsolete and are seldom used anymore.

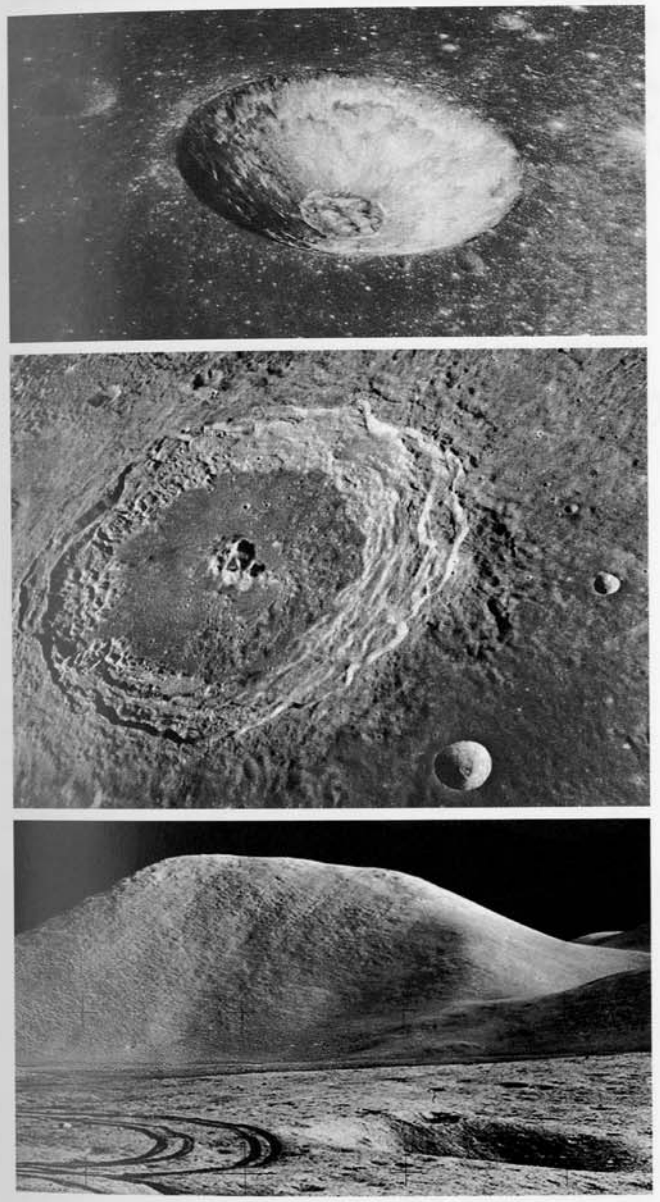


Fig. 10. Some typical lunar formations.
Above: simple crater (Taruntius H, diameter 2.5 km; map 37. Apollo 10, NASA).
Middle: complex crater (Langrenus, diameter 132 km; map 49. Apollo 8, NASA).
Below: mountain massif (Mons Hadley, rising 4,200 m above the plain shown in foreground; note also the tracks of lunar rover; map 22. Apollo 15, NASA).

In the post-Apollo era, after the extensive evaluation of mountains of observational data and the analysis of lunar rock samples, there is no longer any doubt that virtually all lunar craters are the result of impacts of cosmic projectiles. Only a few craters associated with dark mare material are thought to be volcanic. The morphological characteristics (size, shape, depth, etc.) of lunar craters result from the properties of the cosmic projectiles that formed them — primarily the impactor's approach velocity (typically from 16 to 20 km/s, but up to 70 km/s) and its size (from dust particles to asteroids). The resulting kinetic energies of such impactors from space can be enormous. No wonder these projectiles excavated cavities up to hundreds of kilometers in diameter!

Following the initial impact, ejected fragments with velocities less than lunar escape velocity (2.4 km/s) widely bombarded the lunar surface, thus forming innumerable secondary craters that are sometimes grouped into clusters surrounding their respective primary crater. The pulverized and fragmented ejecta from the youngest large craters are often visible as long, bright rays streaming outward from the site of the original impact. Tycho is the most spectacular example of a rayed crater (11).

Because of their common impact origin, primary craters resemble one another, and their morphologies, from smallest to largest, are mainly a function of increasing diameter. Accordingly, primary craters are classified into three groups, with simple, complex, and basin morphology, respectively. This series, introduced by leading geologists at the US Geological Survey at Flagstaff, Arizona (ref. 31, 32, p. 220), is called the *crater main sequence* (as an analogy to the classification of stars in the famous Hertzsprung-Russell temperature/luminosity diagram).

Simple craters have circular, smooth rims, smooth walls lacking terraces, level floors, and depth-to-diameter ratios of about 1:5. On the left-facing pages accompanying the maps in this atlas are many examples of small simple craters, with depths and diameters given. These craters are also suitable objects for testing the observer's eyesight and the telescope's resolving power. When close to the terminator, the interiors of these

* In this chapter, the bracketed numbers refer to pictures on pp. 194 – 207.

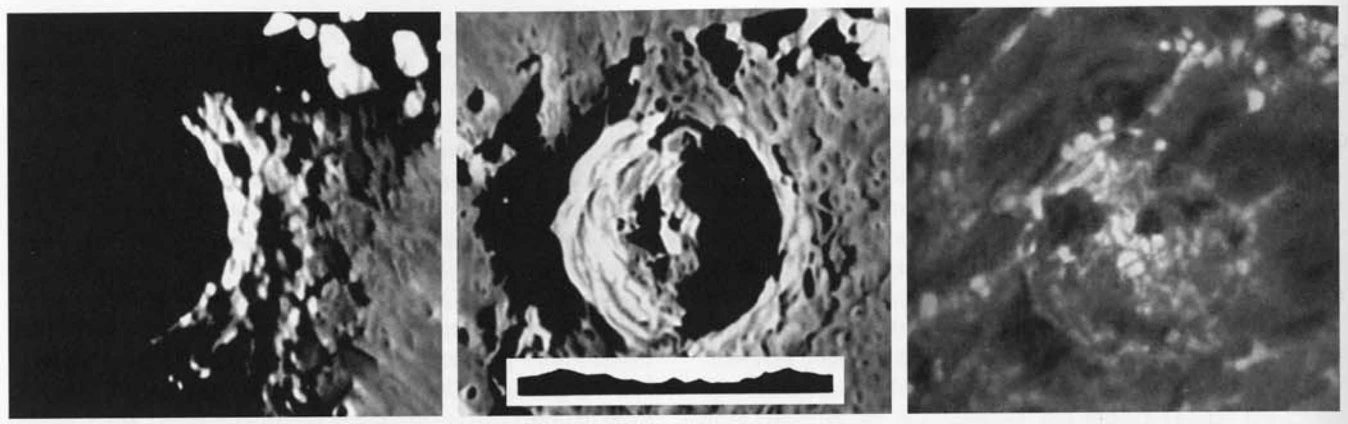


Fig. 11. Variations in the appearance of the complex crater Eratosthenes (diameter 58 km, depth 3,570 m, map 21) owing to different illumination by the Sun.
Left: at sunrise, the eastern rim of the crater is illuminated, though the inside is still immersed in shadow. Center: 16 hours after sunrise, the western wall and central peak are illuminated; the crater looks like a very deep hole, but the scaled profile (below) shows the true, relatively shallow form of the crater. Right: at full-Moon illumination, the shadows have disappeared and the crater is hard to identify.

craters are filled with shadows that might lead a novice to believe that they are deep hollows with steep inner walls, so strong is the illusion! The actual nature of a typical simple crater is evident in the astronaut's view of Taruntius H (Fig. 10, above).

At diameters of approximately 16 to 21 km (16 km in maria and 21 km in terrae) crater morphology changes almost abruptly into a more complex configuration. These so-called complex craters have rims that are generally circular but often scalloped and irregular. Their walls are often terraced with large blocks of material that has slumped down the crater walls. The inner slopes of complex crater walls can be quite steep (in lunar terms) with gradients of 20° to 30°, and the flank outside the raised rim slopes more gently, with gradients ranging from 5° to 15°. Hills and mounds clutter the broad floor of complex craters. An additional characteristic of large complex craters is a central peak, or group of peaks, rising to a considerable height above the floor level. Complex-crater floors are usually lower than the surrounding terrain. The depth-to-diameter ratio for the smaller complex craters is about 1:5, but for the largest formations it may be only 1:40 — describing a very shallow depression. As with simple craters, when observing a typical complex crater like Eratosthenes, for example, close to the terminator (Fig. 11), it can be hard to believe that the depth of this "hole" represents only one-sixteenth of its diameter! An astronaut's view of Langrenus (Fig. 10, middle) illustrates the profile of a magnificent complex crater.

The largest impact formations, and one of the most fundamental features on the Moon, are *basins* (also called "ringed basins" or "multiringed basins"). The transition from the complex craters to basins occurs at a diameter of about 300 km. Here, the morphologic complexity of the impact cavities increases again, and another characteristic appears: multiple concentric rings (craterlike rims, arcuate ridges). The definition of the term "basin" is somewhat fuzzy, mainly because the transition from complex craters to basins is not sharply defined — some features smaller than 300 km also contain rings or ringlike patterns. The nature and importance of lunar basins, which played a fundamental role in the configuration of the familiar face of the Moon, was recognized by geologists (ref. 31, 32, p. 220) in the 1960s. By utilizing spacecraft imagery and laser altimetry and by measuring anomalies in lunar gravity field, etc., more and more basins have been discovered. Today, about 30 basins are known (see maps on pp. 190 and 191 for the locations and names of basins).

A magnificent example of a lunar basin is the Orientale basin on the western limb of the Moon (see map VII on p. 188 and the maps on pp. 190 and 191). Readily visible (but only partially from the Earth) are a nearly complete set of concentric mountainous rings, parts of which are known as Montes Cordillera and Montes Rook. Another example, much easier for telescopic observers to view, is the Nectaris basin, illustrated in Fig. 12. Its main rim is well defined by Rupes Altai (Altai scarp). The next time Nectaris is suitably illuminated, try to see if you can identify the rest of its basin rings.

The second-largest basin (after the South Pole–Aitken basin) is the Imbrium basin, which is described by a monumental ring arc that includes Montes Carpatus, Apenninus, and Caucasus. This leads us to the principal difference between typical lunar mountains and terrestrial mountains: the former are mainly parts of impact structures (rings, craterlike rims); the latter were produced on the Earth by internal, endogenic forces (like plate tectonics, which never existed on the Moon). No wonder that the lunar mountains bear little resemblance to their terrestrial counterparts — they are truly otherworldly.

The Moon features no networks of valleys like those that were carved by water and ice in the Earth's mountain ranges. The lunar massifs generally possess gradual slopes of about 15° to 20°, with occasional steeper inclines of 30° to 35°. A typical example is Mons Hadley in the Apennines, depicted in Fig. 10 (below) as seen from the lunar surface by Apollo 15 astronauts. This reality is in stark contrast to the steep, spirelike lunar mountains that appeared in old drawings and in fanciful movies. The long, spikey shadows visible near the terminator surely created this mistaken impression.

The vast amount of debris ejected from dozens of basin-forming impacts and other impact craters formed a thick layer of deposits that covered the entire surface of the Moon. The older basins and associated debris were gradually covered over and disappeared under younger impact craters. However, the lunar maria did not develop immediately after the impact basins formed, but hundreds of millions of years later. From depths ranging from 100 to 300 km, basaltic magma reached the surface as lava flows and gradually filled parts of some basins and other lowland regions. Volcanic activity associated with the formation of maria left its signature on the surface in the form of solidified lava flows, volcanic domes, lava channels, and other features. In many places the mare surfaces were folded into complex "wrinkle ridges" or "mare ridges" (called *dorsum* and *dorsa*), resembling protruding veins beneath the skin (maps 37 and 38).

Another volcanic feature, lunar domes, rank among the most popular objects for skilled observers. Lunar domes have diameters of about 10 to 20 km and heights of only several hundred meters; consequently, the slopes of these rounded bulges range from about 1° to 3°. Some domes have a small crater pit on top. Typical examples of domes can be found in the vicinity of the craters Hortensius and Milichius (map 29).

Another group of challenging objects for a good scope and a trained eye are lunar *rilles* (called *rima, rimae*). Sinuous rilles, which resemble dry riverbeds with numerous meanders extending for hundreds of kilometers, are of special interest. These are probably the last vestiges of lava channels that may have been active when the maria were being formed. The largest of these, visible even with small telescopes, is known as Vallis Schröteri (map 19). Lunar rilles are mostly shallow features, resembling trenches with wide, flat floors and low, inclined walls. Even in the early years of the 20th century, rilles were described as bottomless canyons, and it is evident that this was another erroneous interpretation resulting from the interplay of light and shadow near the terminator.

Numerous examples of the various types of typical lunar formations, as well as anomalous and rare features, are illustrated on pp. 194–207 and are shown in the maps of the near side of the Moon on pp. 29–179.

The origin and evolution of the Moon

Thanks to decades of direct exploration, the history of the lunar surface is now understood to a great extent. However, the first 500 million years of our satellite's existence remain, for the most part, a mystery. The question of the Moon's origin still lacks a completely satisfactory answer. Did it originate simultaneously with the Earth from the primordial gas and dust of the solar nebula (the co-accretion theory), or was the material that formed the Moon spun off a rapidly rotating early Earth (the fission theory)? Another scenario (the capture theory) proposes that the Moon came into being in some other part of the solar system and, by passing too close to the Earth, was captured by our planet's strong gravity. None of these three traditional hypotheses is able to explain convincingly all the facts known about our satellite world. The Moon's chemical composition, which is so unlike that of the Earth, favors the capture theory, but the celestial dynamics of the Earth-Moon system argues against both the capture and the fission models.

A new attempt to solve this puzzle appeared in the 1970s. It suggests that a planetary body about the size of Mars collided with the primeval Earth and that this cataclysmic impact ejected a mixture of material from both bodies into space. This material later coalesced to form

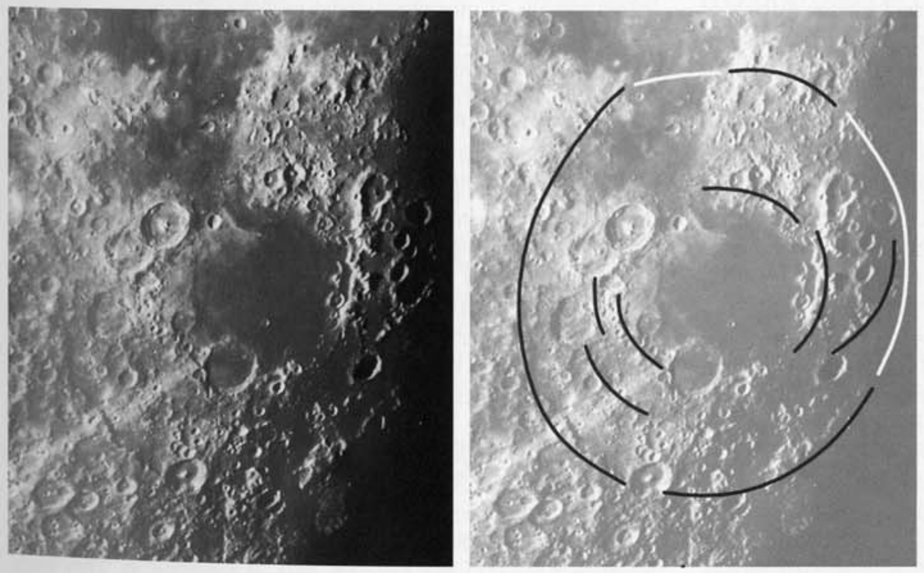


Fig. 12. The Nectaris basin. On the right picture, the concentric ring structure of the basin is marked by the preserved arcs of the individual rings (gray where uncertain). The main topographic rim of the huge impact excavation (diameter 860 km) is well defined by Rupes Altai (see also maps 57 and 46); other, discontinuous ring-arcs are discernible around Mare Nectaris, which represents the mare-basalt flooded central cavity of the basin. The age of the Nectaris basin is about 3.92 billion years.

a new celestial body — the Moon. Was this how it happened? We do not know, but it is to be hoped that future research will lead to a more definite answer to the mystery of the origin of the Moon.

Regardless of how the Moon originated, most lunar scientists agree with the sequence of events that followed. The early Moon should have become hot enough that it would have melted to a depth of hundreds of kilometers. In the resulting global ocean of molten rock, chemical differentiation would have taken place, causing heavier elements to sink toward the Moon's center and lighter ones to float to the surface. About 4.3 billion years ago the most intense period of bombardment started to ease off and the magma ocean solidified. Even so, debris left over after the formation of the solar system continued to rain down and produce craters of all sizes and forms. The impacts of the largest asteroid-size projectiles excavated the multiring basins, mostly in a period of 4.1 to 3.8 billion years ago. The last of these cataclysmic impacts created the Imbrium basin, about 3.85 billion years ago, and the Orientale basin somewhat later. During the next half billion years the rate of impacts declined further, yielding to a much slower, steady cratering.

From about 3.8 to 3.1 billion years ago, radioactive heating at depths of 100 to 300 km partially melted the lunar mantle, producing magma that rose to the surface through fractures and pooled on basin floors and other lowlands. These lava flows solidified within a few years to leave a layer of basaltic lava no more than a few tens of meters thick. However, the radioactive heating period extended over hundreds of millions of years, and many later lava flows eventually submerged earlier ones, building up layers to a thickness of a few kilometers. Volcanism and faulting, related to maria, have also left their mark on the Moon, with features such as sinuous rilles, domes, mare ridges, faults, arcuate rilles, and some craters and crater chains.

About 3 billion years ago the Moon's endogenic activity rapidly ceased, and the most active geologic processes came to an end. However, unprotected by an atmosphere, the lunar surface continued to be eroded by a steady rain of countless smaller cosmic projectiles, which further fragmented and pulverized the Moon's surface. Thus, over a period of billions of years, a loose lunar soil (regolith) built up into a layer many meters thick. If this were the end of the story, we would not have to mention the sporadic impacts by larger meteorites that excavated the youngest craters that are at the centers of radial systems of bright ejecta rays. Examples of such relatively fresh craters include the magnificent Copernicus, which was formed by an impact some 800 million years ago, and the spectacular Tycho, which is about 110 million years old.

How did geologists succeed in unraveling the secrets of the Moon's history? They utilized a very powerful geologic tool known as the stratigraphic approach. Well established by geologists studying the Earth, when this approach is applied to the Moon, scientists can construct a sequence of events by noting, for example, that younger material (crater, deposits of ejecta, rays, etc.) lies atop, embays, or intrudes upon older material. This allows scientists to determine the relative ages of individual formations, but for it to be completely successful, assigning absolute dates is essential. This is made possible by analyzing the lunar rock samples returned by astronauts and robotic probes. So we now have a credible outline of the Moon's history, albeit with many gaps and unanswered questions awaiting further clarification in the years to come.

Lunar cartography

Mapping of the Moon's surface dates from the first half of the 17th century. Until 1959 this was limited to the near side, and the vast majority of maps presented the Moon in the same way as it was observed from the Earth. The Soviet probe Luna 3 heralded a new epoch of global cartography, when it photographed a part of the far side in October 1959, and during the American Lunar Orbiter program in 1966–67 the whole sphere was surveyed, with the exception of less than 1 percent of the south polar region. In addition, the Apollo lunar expeditions made considerable contributions to the precision of lunar mapping. Precise and detailed lunar maps are indispensable not only for observers; they also serve as a basis for scientific studies as well as for the planning of future flights to the Moon.

The mapping itself is preceded by the determination of the actual figure or shape, as well as the dimensions, of the Moon's globe. This is a task for the science known as *selenodesy*. Selenodetic measurements have indicated that the deviations of the Moon's actual surface from a perfect spherical shape lie within limits of ± 8 km, from the lowest to the highest points. However, for mapping purposes the Moon is regarded as a sphere with a radius of 1,738 km.

Just as geography is concerned with mapping of the Earth, so selenography deals with practical mapping of the Moon. This includes determination of the exact location of lunar formations, as well as estimation of the relative height of mountains above the surrounding terrain, the depth of craters, etc. The mapping starts with the selection of a suitable cartographic projection, which in turn involves consideration of the scale of the map and of the number of sections into which it is to be divided. Last but not least comes the system of names or nomenclature to accompany each map.

Selenographic coordinates, namely selenographic latitude and longitude, define the precise and unambiguous position of individual points on the Moon's surface. They have terrestrial counterparts in the familiar geographical latitude and longitude. For the sake of completeness, a third dimension may be used to give the distance of a point from the Moon's center. This is not usually given on ordinary maps.

The basic grid of selenographic coordinates is illustrated in Fig. 13. It is oriented in the same way as it would be seen from the Earth and the fundamental circle in the system is the lunar equator, **r**, which lies in a plane perpendicular to the Moon's axis of rotation, **o**. This axis

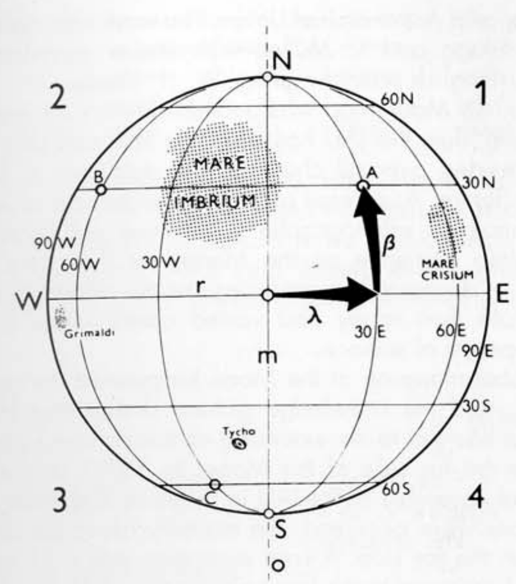


Fig. 13. Selenographic coordinates. The equator, **r**, *and prime meridian,* **m**, *divide the near side of the Moon into four quadrants, designated 1, 2, 3, and 4. The coordinates of the three marked points are as follows:* ***A*** *(30°N, 30°E);* ***B*** *(30°N, 60°W);* ***C*** *(60°S, 30°W).*

intersects the surface of the Moon at two points: the north pole, **N**, and the south pole, **S**. When lunar observations are made with the naked eye (or through a noninverting telescope) from the Northern Hemisphere of the Earth, lunar north is uppermost and well beyond the easily identified Mare Imbrium. South, on the lower, opposite edge of the lunar disk, is in the hemisphere containing the bright crater Tycho.

In 1961 the International Astronomical Union (IAU) decided to discard an older convention and adopt the system used to determine the directions of east and west on the Earth. This "astronautical" convention means that an observer on the Moon would see the Sun rising in the east and setting in the west. Consequently, when we look at the Moon with the naked eye from the Northern Hemisphere, east (E) is to the right, in the direction of Mare Crisium, while west (W) is to the left toward Oceanus Procellarum. This is the orientation used in all modern maps of the Moon. It should be mentioned that the formerly used reverse, or astronomical, orientation assisted terrestrial observers, for east and west on the lunar disk coincided with east and west on the celestial sphere.

North and south of the lunar equator are the parallels of selenographic latitude. Other circles that intersect at the north and south poles and are perpendicular to the equator are termed *meridians*: these connect points of equal selenographic longitude. The central meridian is defined as that which passes exactly through the center of the lunar disk at the moment when librations in latitude and longitude are zero, as seen from the Earth.

Selenographic longitude, λ (lambda), is measured along the equator from the central meridian to the meridian containing a given point. It is positive to the east and negative to the west of the central meridian, and always lies between 0° and 180°. The longitude of 180° corresponds to the meridian crossing the center of the far side of the Moon. In this atlas, both on the maps and throughout the text, the abbreviations E (for east) and W (for west) are used instead of the signs + and –. For example, 30°W signifies 30° of western selenographic longitude, which could also be written as λ = –30°.

Selenographic latitude, β (beta), is the angular distance of a given point from the lunar equator. It is measured along the appropriate meridian, is positive to the north and negative to the south, and always lies between 0° and 90°. The abbreviations N (for north) and S (for south) are often used instead of the corresponding signs + and –. For instance, 60°S means 60° of southern selenographic latitude, or β = –60°.

Lunar mapping is based on a network of numerous control points, usually small circular craters whose coordinates have been measured to a high degree of precision using selenographical measuring equipment. From this basic network, the positions of other features to be included in the map can be determined.

The old problem of producing a two-dimensional map of a three-dimensional sphere is well known to cartographers, who, over the years, have experimented with many different map projections. The orthographic projection is commonly used for lunar charts and represents the Moon as it is observed on the celestial sphere at zero librations. It is the projection used in Fig. 13 and in the 76 sections comprising the detailed map of the Moon (pp. 29–179). For scientific purposes and flights to the Moon, maps drawn to the so-called "conformal projections" are especially suitable, since they show particular lunar formations without distortion: in these a circular crater always looks circular, instead of elliptical (as seen from the Earth).

A cartographic representation of the lunar surface can be schematic, generalized, or realistically detailed. In the first case, a crater may be represented by a single circular outline, while in the second it could be portrayed to resemble its photographic image. The airbrush technique of relief representation, which was developed in the early 1960s in the USA for the production of the 1:1,000,000 LAC series of charts, has proved to be the most convenient one. Lunar slopes, which at certain periods during a lunation would be immersed in shadow, are depicted as inclined surfaces receiving grazing illumination from the Sun; in other words, the altitude of the Sun is made to equal the gradient of a given slope. Shadows are absent with this technique, so no details are hidden, and this is one of the advantages of this form of presentation over that of a photographic atlas. Moreover, a map can reflect the quality of the best photographs, to make the interpretation of depicted details easier. One thing is important for the user: when one examines a drawing or photograph of the Moon's relief, the direction of solar illumination has to be taken into account, otherwise the eye can be deluded into accepting optical reversals, which results in concave, partly shadow-filled craters taking on the appearance of convex domes that bulge out of an "upside-down" surface!

Numerical data must also be given to reinforce the cartographical interpretation, as should the relative heights of selected points. The technique of determining the heights of mountains by measuring shadow lengths dates back to the 18th century. If we know the length of a given feature's shadow and the corresponding angle of the Sun above the horizon, we can calculate the height of the shadow-casting peak above the surrounding terrain. The method is fairly precise, since at sunrise and sunset a shadow is approximately 100 times longer than the height of the feature from which it was cast. This technique has been adapted for use on lunar images returned to Earth from satellites in lunar orbit, and relative-height measurements with a precision of up to a few meters have been obtained.

An essential component of every map is the system of names of selected formations – the nomenclature. This facilitates prompt identifications and aids description, as well as assisting in the search for a particular formation without the need for lengthy positional specifications. It is, in fact, an easily remembered short-form coding method.

Following Galileo's first telescopic observations of the Moon, lunar charting started in earnest, and by the middle of the 17th century several charts had been produced. Michel Floret van Langren, in his lunar map of 1645, was the first to assign names to features. Two years later Hevelius of Gdańsk published his chart, in which lunar mountain ranges were named after those on the Earth – e.g., the Alps, Carpathians, Apennines. It was, however, Giovanni Baptista Riccioli, a professor of philosophy, theology, and astronomy in Bologna, who laid the foundations of the current system of lunar nomenclature. In 1651 he published a map of the Moon that included the names of "seas," mountain ranges, and craters; he divided these names into three categories: people's names, terrestrial names, and symbolic names. Riccioli discarded most of the names proposed by Hevelius (who had disregarded those of van Langren) and gave the maria exotic names, which are perhaps more romantic than suitable – e.g., Mare Imbrium (Sea of Rains), Oceanus Procellarum (Ocean of Storms). He also preserved van Langren's idea of naming lunar craters after astronomers and other personalities and located them in historical order from north to south on the lunar disk.

Lunar nomenclature was further developed by the German selenographers J. H. Schröter (*Selenotopographical Fragments*, 1791 and 1802) and, in particular, W. Beer and J. H. Mädler. Included in Beer and Mädler's *Mappa Selenographica* (1837) were as many as 427 named features: 200 of these had been taken from Riccioli's map, 60 from Schröter's, and Mädler added another 145 names of seafarers and geographers. Beer and Mädler also introduced a system of naming small, secondary craters by the capital letters of the Latin alphabet, and mountain peaks, domes, etc., by lowercase Greek letters.

Succeeding selenographers, for the first decades of the 20th century, increased the confusion by adding, deleting, replacing, duplicating, and generally changing lunar names. The task of restoring order to this accumulated mass of discrepancies and coming up with an acceptable nomenclature was taken on by the International Astronomical Union. The work was done by M. A. Blagg and K. Müller, with earlier contributions from an English scientific artist, W. H. Wesley. In 1935 the first IAU Moon map was published with 681 names. Since that time the IAU has been the sole authority that has presided over all changes and additions to lunar nomenclature. As a result of the joint endeavors of many generations of selenographers, a unique pantheon has come into existence on the Moon, for it is here that names of deceased personalities can be added to commemorate their many and varied contributions to the development of science.

Global mapping of the Moon burgeoned during the 1960s, and the knowledge gained during that fruitful decade has led to an extension of the nomenclature to include the far side of the Moon. In 1970, at the XIV General Assembly of the IAU in Brighton, England, 513 additions were accepted, the majority being for formations on the far side. A rare exception was also made: the IAU assigned to the lunar pantheon, and in so doing immortalized, the names of 12 living people: six American astronauts and six Soviet cosmonauts.

In 1973, at the XV General Assembly of the IAU in Sydney, Australia, lunar nomenclature was again the subject of extensive and controversial reform. Since 1935 the so-called subsidiary craters had been designated by using the capital letters of the Latin alphabet; for example, Mösting A was associated with the larger crater, Mösting. Also mountain peaks, domes, etc., were identified by lowercase Greek letters, and rilles associated with nearby named formations by Roman numbers. These conventions were revised in 1973, when it was proposed that letter-designated craters should gradually be given the names of individuals. Also, some small craters were to be bestowed with a male or female forename. Such were the requirements for detailed mapping of the Moon to a scale of 1:250,000, as was used to produce the NASA Lunar Topographic Orthophotomaps. In such an atlas, the scale is so large that manageable sheets or plates can depict only very small areas of the lunar surface, and for easy identification each sheet ought to contain at least one named formation. With this purpose in mind, as of 2000, 145 craters that had hitherto been designated by letters had been given names (e.g., Bowen instead of Manilius A). In the future, thousands of new names could appear.

In 1976, during the changeover period, the IAU agreed to compromise and allow charts containing the newly introduced substitute names also to include the original letter designations in brackets below the new names. For the sake of continuity with earlier selenographic literature, it is convenient to retain the traditional capital-letter designations of the subsidiary craters on modern maps as well. As of 2000, 6,235 craters have been designated on the near side of the Moon, of which 810 bear names and 5,425 are identified by letters added to the name of a nearby prominent crater.

In addition to craters, the following types of formation are also usually designated by a Latin name:

Catena	crater chain
Dorsa	network of ridges
Dorsum	mare ridge
Lacus	lake
Mare	sea
Mons	mountain
Montes	mountain range or group of peaks
Oceanus	ocean
Palus	marsh
Promontorium	cape
Rima	rille
Rimae	network of rilles
Rupes	scarp
Sinus	bay
Vallis	valley

Formations such as catena, rima, rimae, rupes, and vallis usually derive their names from those of nearby formations, though exceptions have been made in the cases of Rupes Altai and Rupes Recta, and Vallis Bouvard and Vallis Schröteri. Some of the other types of formations have been assigned individual names that are unrelated to those of neighboring features.

Lunar nomenclature has had a long and intricate history – full of mistakes, confusion and amendments, and with many modifications – and finally, a unique selection of names has been created. Soon we shall be referring to those people who, for all intents and purposes, have their names inscribed on the Moon. Recalling these names in historical succession constitutes a review of the processes of learning that have led to our present knowledge of the Earth and space.

Numerical data on the Moon

Average distance of Moon from Earth	384,401 km = 60.27 × Earth's equatorial radii
Minimum distance of Moon at perigee	356,400 km
Maximum distance of Moon at apogee	406,700 km
Time taken for light to travel from Moon to Earth	1.3 seconds
Eccentricity of Moon's orbit around Earth	0.0549
Mean distance of center of gravity of Earth-Moon system from center of Earth	4,670 km
Mean angular diameter of Moon in sky (geocentric)	31′05.2″
Angular diameter of Moon at perigee	33′28.8″
Angular diameter of Moon at apogee	29′23.2″
Stellar magnitude of full Moon,	–12.55 mag
Inclination of Moon's orbit to ecliptic	5°8′43.4″
Sidereal orbital period (i.e., with respect to stars)	27.321661d = 27d 7h 43m 11.5s
Synodic month (from new Moon to new Moon)	29.530588d = 29 d 12h 44m 2.8s
Anomalistic month (from perigee to perigee)	27.554550d = 27d 13h 18m 33.1s
Rotation period of line of nodes (retrograde motion)	18.61 years
Rotation period of point of perigee (direct motion)	8.85 years
Average orbital velocity of Moon around Earth	3,681 km/h = 1.023 km/s
Average angular velocity of Moon's motion in sky	33′/h
Mean diurnal motion of Moon with respect to stars	13.176358°
Mean interval between two successive meridian passages of Moon	24h 50.47m
Optical libration in longitude	up to 7°54′
Optical libration in latitude	up to 6°50′
Total surface area of Moon theoretically observable from Earth	59%
Inclination of Moon's equator to plane of ecliptic	1°32.5′
Inclination of Moon's equator to its orbital plane	6°41′
Diameter of Moon	3,476 km
Circumference of Moon at equator	10,920 km
Surface area of Moon	37.96 × 10^6 km^2 = 7.4% of surface area of Earth
Volume of Moon	21.99 × 10^9 km^3 = 2.03% of volume of Earth
Mass of Moon	7.352 × 10^{25} g = 1.23% of mass of Earth
Mean density of Moon	3.341 g.cm^{-3} = 60.6% of density of Earth
Moon's surface gravity	162.2 cm.s^{-2} = 16.5% of Earth's surface gravity
Moon's escape velocity	2,38 km.s^{-1} (11.2 km.s^{-1} on Earth)
Illumination of surface of Earth by full Moon	0.25 lux
Illumination of surface of Moon by full Earth	16 lux
Surface temperature on night hemisphere of Moon	–170 to –185°C
Maximum temperature on sunlit side of Moon	+ 130°C
Constant temperature at depth of 1 m under surface	–35°C
Total surface area of lunar maria	16.9% of Moon's surface
Total surface area of lunar maria on near side of Moon (one hemisphere)	31.2% of near side of Moon
Total surface area of lunar maria on far side of Moon (one hemisphere)	2.6% of far side of Moon
Range of topography [highest-lowest elevation on the Moon]	16 km

Becoming acquainted with the Moon
The Moon at first quarter

The most suitable time to get acquainted with the Moon's surface features is at or close to first or last quarter, when the terminator regions are dramatically illuminated. Farther away from this day-and-night boundary, toward the illuminated edge of the lunar disk, the shadows cast by mountains and crater walls gradually diminish until they disappear, giving an illusion of smoothness and absence of relief. A useful method of finding one's way around the Moon's disk is to learn the shapes, relative positions, and names of the dark seas, bays, and lakes. With a little practice, a keen eye can identify the positions of large craters, groups or chains of craters, craters surrounded by bright rays, and long mountain ranges.

Our map shows the names of only the most prominent formations, which serve, collectively, as a guide to the lunar surface. All of them can be seen easily with a pair of binoculars. It must be borne in mind that the position, and therefore the appearance, of the lunar maria can be markedly different from that shown on the map, owing to the effects of libration (see p. 8). The variations in the appearance of Mare Crisium, in particular, can be very striking because of the changing values of libration in longitude. From the prominent groups of craters, we should try to remember the trio Theophilus, Cyrillus, and Catharina, the pairs Atlas and Hercules, and Aristoteles and Eudoxus. Other useful lunar landmarks include Proclus, a bright crater with a ray system just west of Mare Crisium, the large crater Posidonius, and the extensive Altai scarp, which runs south from Catharina toward the sizable crater Piccolomini.

The Moon at last quarter

At one time people generally believed (and some still do) that the weather on Earth is influenced by the Moon in accordance with an old adage that states "When the Moon is waxing the weather will be fine, and when it is waning the weather will be cloudy, rainy, stormy, and generally unpleasant." This explains why the maria coming into view on the waxing crescent leading to first quarter were given names associated with fine weather, e.g., Mare Tranquillitatis (Sea of Tranquillity) and Mare Serenitatis (Sea of Serenity), while on the other side of the lunar disk the maria visible on the waning crescent were labeled with rainy names, e.g., Mare Imbrium (Sea of Rains), Mare Nubium (Sea of Clouds), and Oceanus Procellarum (Ocean of Storms).

On the western side of the visible disk, there is a fine contrast between the dark surface of the large maria and

the bright ray systems that originate from the relatively young craters Copernicus, Kepler, and Aristarchus. The crater Tycho dominates the southern hemisphere with its vast system of bright rays, the longest of which can be traced into the northern hemisphere and across Mare Serenitatis. South of Tycho is the enormous crater Clavius. Other points convenient for orientation purposes include the dark-floored craters Plato and Grimaldi, and large craters such as Archimedes, Eratosthenes, Bullialdus, and the trio of craters Ptolemaeus, Alphonsus, and Arzachel. Orientation is also assisted by the long mountain ranges that border Mare Imbrium: the Carpathians (Montes Carpathus), the Apennines (Montes Apenninus), the Caucasus (Montes Caucasus), and the Alps (Montes Alpes). Often observed close to the terminator of the waning crescent is the very conspicuous Sinus Iridum (Bay of Rainbows), which adjoins Mare Imbrium to the north.

The full Moon

During the full-Moon phase, almost no shadows can be observed on the lunar disk from the Earth. Instead, the near side is transformed into a complex pattern of areas of contrasting brightness, or *albedo*. These include the already discussed dark maria, bright highlands, ray craters, etc. At this phase it seems unbelievable that some sizable craters all but disappear, while others that are normally small and inconspicuous become bright and easily identifiable under the high-angle illumination. The latter can be used as markers to monitor the passage of the Earth's shadow across the Moon's disk during lunar eclipses. While such an event is progressing, the observer records the times when the craters enter, or emerge from, the Earth's shadow. Naturally, since no two eclipses are identical, the actual sequence of crater contacts is unique to each eclipse. Opposite is a list of 50 suitable features that are shown on the adjacent map. Note that the identification numbers increase from west to east.

Lunar features useful for timing the progress of a lunar eclipse

1. Lohrmann A
2. Byrgius A
3. Hansteen, Mons[1]
4. Aristarchus
5. Mersenius C
6. Encke B
7. Kepler
8. Bessarion
9. Brayley
10. Sharp A
11. Milichius
12. Euclides
13. Dunthorne
14. Agatharchides A
15. Darney
16. Gambart A
17. Pytheas
18. la Condamine A
19. Guericke C
20. Birt
21. Tycho[2]
22. Pico, Mons[1]
23. Bancroft[3]
24. Mösting A
25. Bode
26. Chladni
27. Werner D
28. Cassini A
29. Egede A
30. Manilius[2]
31. Pickering
32. Abulfeda F
33. Eudoxus A
34. Menelaus
35. Dionysius
36. Nicolai A
37. Dawes
38. Hercules G
39. Polybius A
40. Janssen K
41. Maury
42. Censorinus
43. Rosse
44. Carmichael[4]
45. Proclus
46. Bellot
47. Stevinus A
48. Furnerius A
49. Firmicus[5]
50. Langrenus M

[1] mountain, [2] center of a crater, [3] formerly Archimedes A, [4] formerly Macrobius A, [5] dark-floored crater

Atlas of the near side of the Moon

Explanatory note

The main part of this atlas consists of a detailed map of the near side of the Moon, subdivided into 76 sections. This is a traditional map based on the orthographic projection, and it depicts the Moon as it appears from the Earth at zero libration. The appearance of craters and other features is therefore nearly the same through a telescope, so the comparison between the map and reality presents no problems. The libration zones, however, cannot be shown completely here because the edge of the map is defined by the meridians at 90°E and 90°W. (Special maps of the libration zones are found on pp. 182–189.)

A grid of selenographic coordinates (see p. 16) is superimposed on all map sections. The parallels of latitude are drawn as segments of straight lines; the meridians of longitude as ellipses. North is always uppermost, and east is to the right. This is the same view as would be observed through a non-inverting telescope. Circular craters at the center of the lunar disk are shown as circles, while those toward the edge are distorted into ellipses by the angle of view. This must be remembered when the dimensions of a foreshortened crater are measured, for its true diameter will correspond to the length of the major (longer) axis of the ellipse. In general, lengths measured along arcs whose centers coincide with the center of the lunar disk are not distorted. To give meaning to this rule, the graphical scale used throughout the book and on all sections of the map corresponds to a lunar diameter of 1,448 mm and a scale of 1:2,400,000.

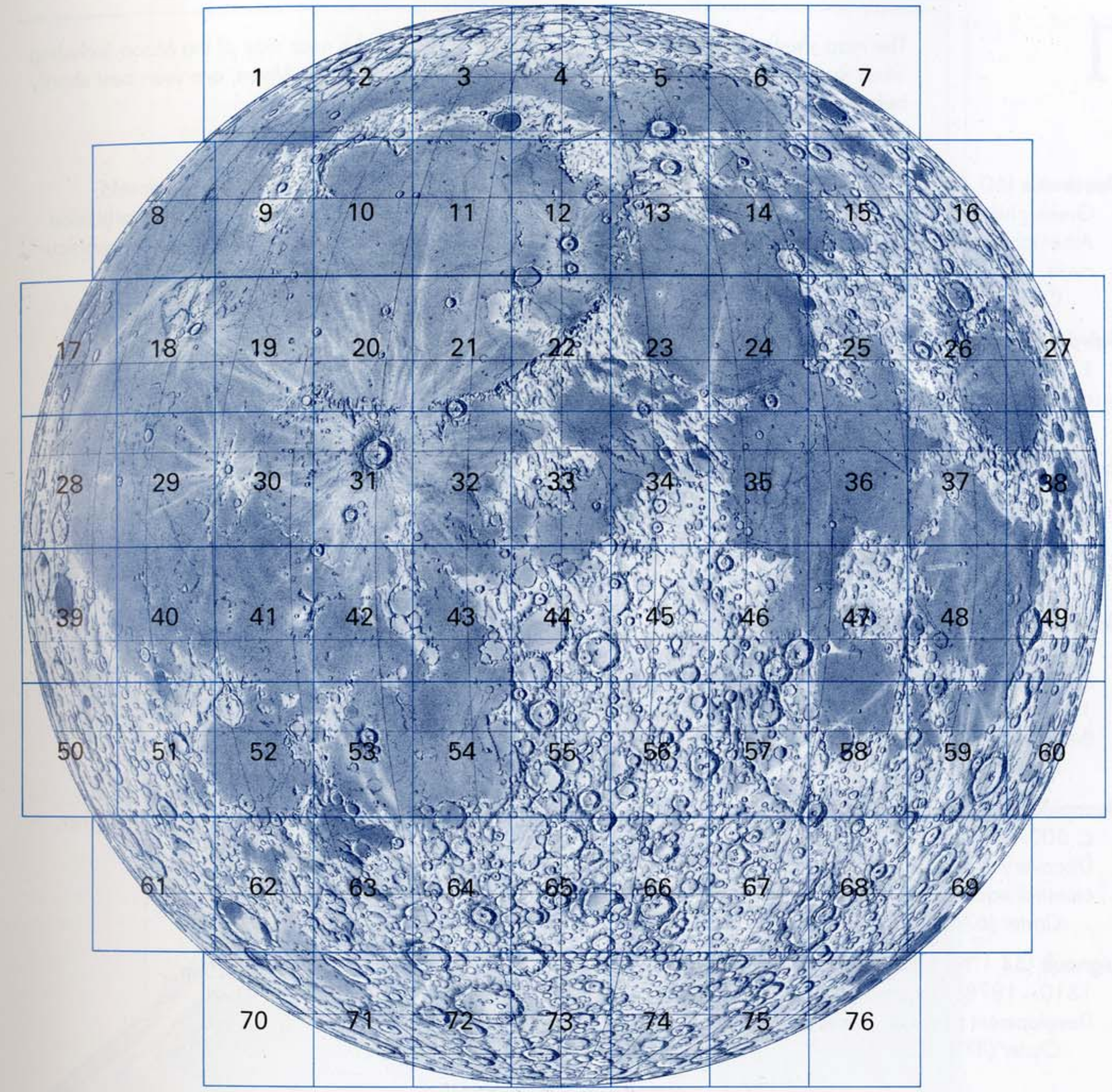
The layout of the map is shown opposite, and a key for rapid location of a particular area is presented on the front endpaper. Each section of the map is numbered and bears the name of a prominent crater within it. In addition, the numbers of adjacent sections are printed alongside, and at the bottom there is a miniature map of the near side of the Moon with the position of the particular section marked upon it.

The Moon's surface is drawn as it appears under morning illumination, i.e., when sunlight is falling upon it from the east (from the right). To emphasize the undulating character of the relief, shadows of west-facing slopes are shown. Accordingly, we can distinguish between elevated and depressed formations, e.g., mountains and craters. Albedo differences are indicated by light or dark shading.

The map presents the official nomenclature of lunar formations as accepted by the IAU up to the end of 2003. For the sake of continuity with previous selenographic literature, we also include the traditional (though unofficial) letter designations (see p. 18). To determine unambiguously which name corresponds to a given letter, we have obeyed the rule introduced by Beer and Mädler. The adjacent letter, designating a subsidiary small crater, is printed on the side nearest to the primary crater from which it derives its name. The centers of these associated craters are marked by black dots, and, as a rule, the letter is located on a line linking one of these points with the name of the parent crater. In places where confusion could occur, an arrow pointing to the relevant name is added to the corresponding letter.

In some map sections the places where unmanned, soft-landing lunar probes and the manned Apollo lunar-landing missions touched down are marked.

Each left-hand page opposite a map section contains a description of the principal features of the adjacent mapped area. In addition, the reader's attention is drawn to features of special interest, as well as to lunar-landing sites, etc. Also on these pages is an alphabetical list of the people after whom the features were named. This listing contains surnames and forenames, dates of birth and death, nationalities, professions, and other biographical information. In order to make identification on the map section easier, the selenographic coordinates of the features are given, and for quick reference, craters are classified as explained on pp. 13 to15. These descriptions of craters are accompanied by their diameter in kilometers and, where applicable, their maximum depth, measured from rim to floor in meters. For example, 12 km/2,440 m means that a crater's diameter is 12 km and its depth is 2,440 m. Among the data on small craters, the reader will find considerable diversity in the diameter-to-depth ratios. For amateur astronomers, small craters can serve as convenient objects for testing the resolving power of a telescope and the quality of the seeing (the steadiness of the atmosphere).



Layout of the map of the near side of the Moon in 76 sections.

1 Markov

The map shows a section of the northwestern portion of the near side of the Moon including Sinus Roris. The craters near the limb, in a libration zone of the Moon, are seen best shortly before full Moon.

Cleostratus [60.4°N, 77.0°W] Cleostratus, c. 500 BC. Greek philosopher and astronomer. Improved Athenian calendar by introducing 8-year luni-solar cycle.
Crater (63 km).

Galvani [49.6°N, 84.6°W] Luigi Galvani, 1737–1798. Italian physicist and physician. Specialist in comparative anatomy.
Crater (80 km).

Langley [51.1°N, 86.3°W] Samuel P. Langley, 1834–1906. American astronomer and physicist. Determined transparency of atmosphere for different wavelengths in the solar spectrum.
Crater (60 km).

Markov [53.4°N, 62.7°W] (1) Andrei A. Markov, 1856–1922. Russian mathematician. Specialist in the theory of probability. (2) Alexander V. Markov, 1897–1968. Soviet astrophysicist. Photometry of the Moon.
Crater with a sharp rim (40 km).

Oenopides [57.0°N, 64.1°W] Oenopides of Chios, c. 500–430 BC. Greek astronomer and geometer. Discovery of the inclination of the ecliptic to the celestial equator is ascribed to him.
Crater (67 km).

Régnault [54.1°N, 88.0°W] Henri Victor Régnault, 1810–1878. French chemist and physicist. Development of steam engine.
Crater (47 km).

Repsold [51.4°N, 78.5°W] Johann G. Repsold, 1751–1830. German manufacturer of precision optical and mechanical apparatus and, in particular, astrometric devices.
Disintegrated crater (107 km).

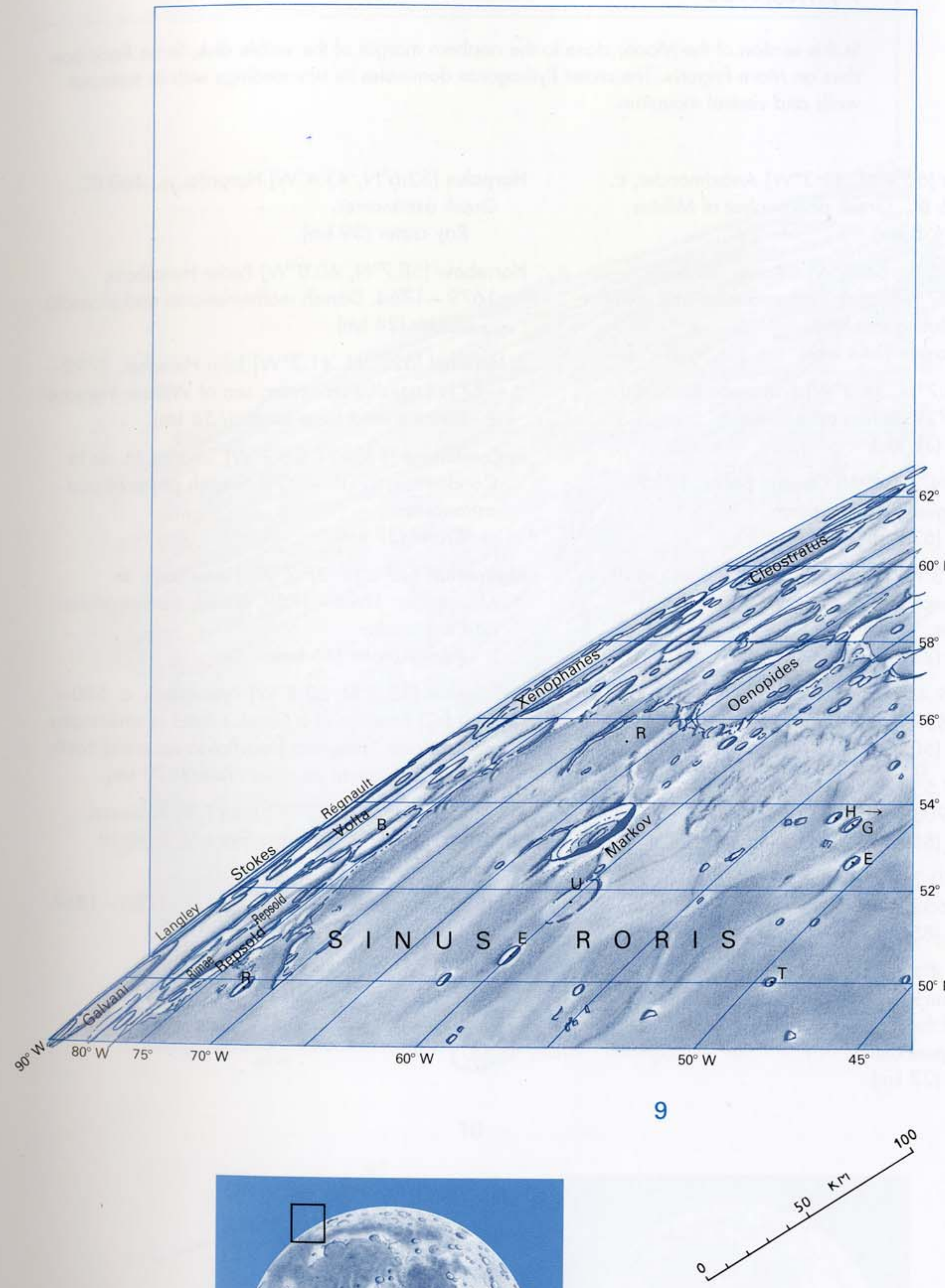
Repsold, Rimae [51°N, 80°W]
Rilles, length 130 km.

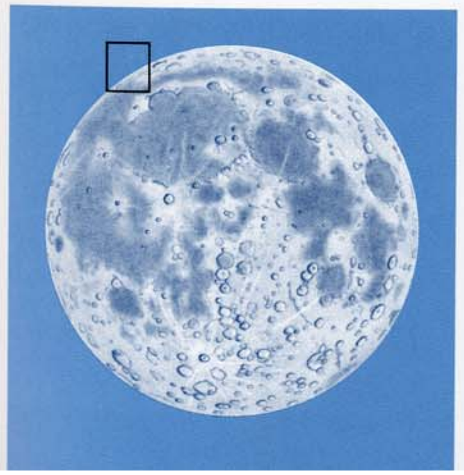
Roris, Sinus (Bay of Dew). Riccioli's name for the mare area that links Mare Frigoris and Oceanus Procellarum.

Stokes [52.5°N, 88.1°W] Sir George G. Stokes, 1819–1903. British mathematician and physicist. Foundations of hydrodynamics, spectral analysis. Shape and gravitational field of the Earth.
Crater (51 km).

Volta [54.0°N, 84.9°W] Count Allessandro G. A. A. Volta, 1745–1827. Italian physicist. Made first electric battery in 1800.
Crater (113 km).

Xenophanes [57.6°N, 81.4°W] Xenophanes of Colophon, c. 570–478 BC. Greek philosopher, satirist, and poet. Believed in flat Earth.
Crater (120 km).





2

Pythagoras

In this section of the Moon, close to the northern margin of the visible disk, Sinus Roris borders on Mare Frigoris. The crater Pythagoras dominates its surroundings with its terraced walls and central mountain.

Anaximander [66.9°N, 51.3°W] Anaximander, c. 610–546 BC. Greek philosopher of Miletus.
Crater (68 km).

Babbage [59.5°N, 56.8°W] Charles Babbage, 1792–1871. English mathematician and inventor of a calculating machine.
Large crater (144 km).

Bianchini [48.7°N, 34.3°W] Francesco Bianchini, 1662–1729. Italian astronomer.
Crater (38 km).

Boole [63.7°N, 87.4°W] George Boole, 1815–1864. English mathematician.
Crater (63 km).

Bouguer [52.3°N, 35.8°W] Pierre Bouguer, 1698–1758. French hydrographer, geodesist, and astronomer.
Crater (23 km).

Carpenter [69.4°N, 50.9°W] James Carpenter, 1840–1899. English astronomer.
Crater (60 km).

Cremona [67.5°N, 90.6°W] Luigi Cremona, 1830–1903. Italian mathematician.
Crater (85 km).

Desargues [70.2°N, 73.3°W] Gerard Desargues, 1593–1662. French mathematician and engineer.
Crater (85 km).

Foucault [50.4°N, 39.7°W] Léon Foucault, 1819–1868. French physician and physicist. First demonstration of the rotation of the Earth on its axis (Foucault pendulum).
Crater (23 km).

Harpalus [52.6°N, 43.4°W] Harpalus, c. 460 BC. Greek astronomer.
Ray crater (39 km).

Horrebow [58.7°N, 40.8°W] Peder Horrebow, 1679–1764. Danish mathematician and physicist.
Crater (24 km).

J. Herschel [62.1°N, 41.2°W] John Herschel, 1792–1871. English astronomer, son of William Herschel.
Disintegrated large crater (156 km).

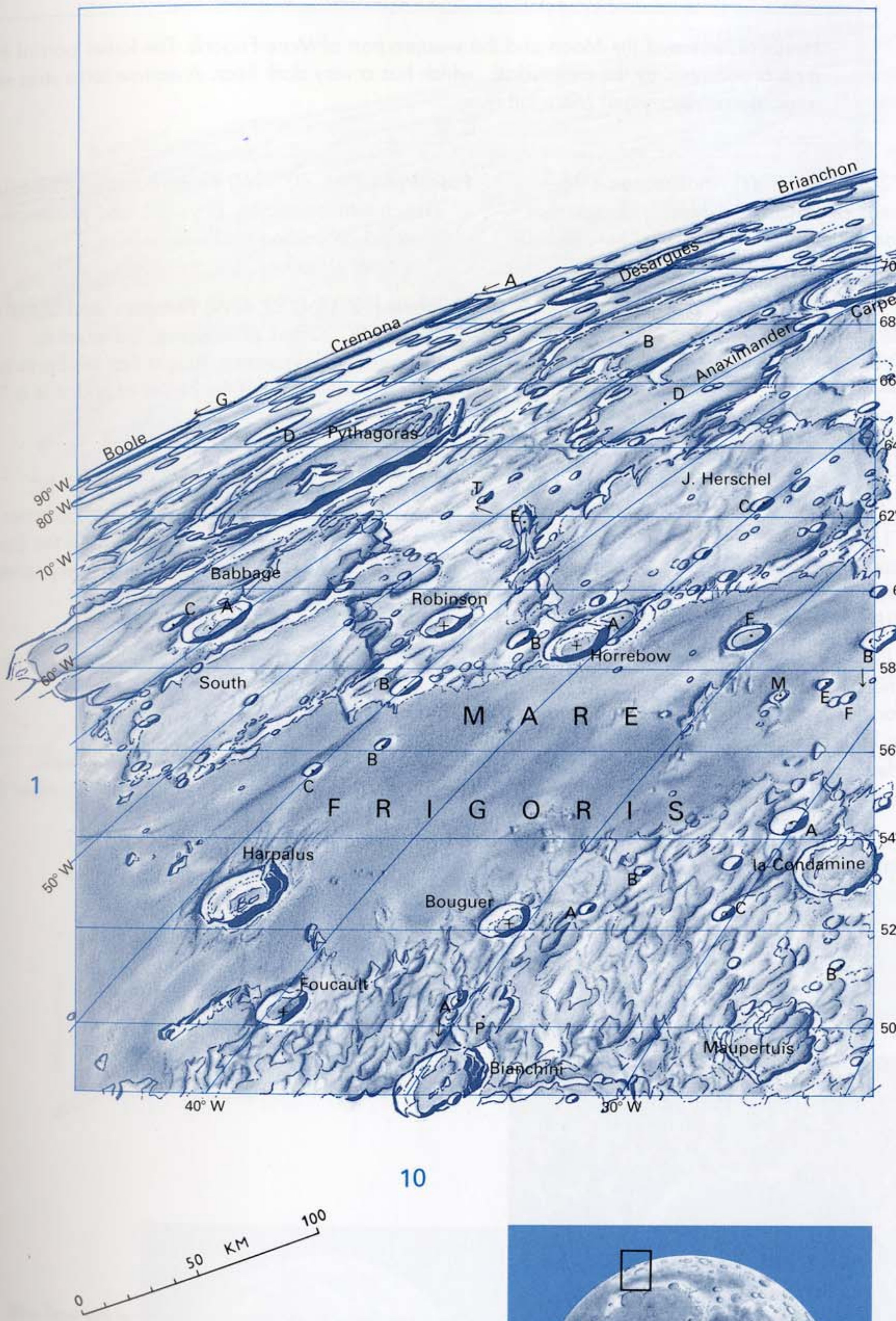
la Condamine [53.4°N, 28.2°W] Charles M. de la Condamine, 1701–1774. French physicist and astronomer.
Crater (37 km).

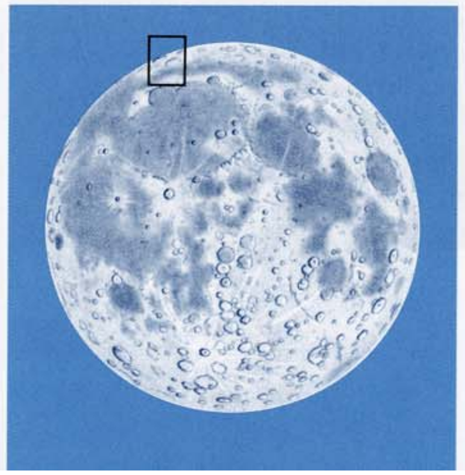
Maupertuis [49.6°N, 27.3°W] Pierre Louis de Maupertuis, 1698–1759. French mathematician and astronomer.
Ruined crater (46 km).

Pythagoras [63.5°N, 62.8°W] Pythagoras, c. 580–500 BC. Founder of a Greek school of philosophy and science. Transition from flat to spherical Earth.
Very prominent complex crater (130 km).

Robinson [59.0°N, 45.9°W] John T. R. Robinson, 1792–1882. Irish astronomer and physicist.
Crater (24 km).

South [57.7°N, 50.8°W] James South, 1785–1867. English astronomer.
Ruined crater (108 km).





3

Plato

Northern region of the Moon and the western part of Mare Frigoris. The lower part of the map is occupied by the crater Plato, which has a very dark floor. A narrow terra strip separates Mare Frigoris and Mare Imbrium.

Anaximenes [72.5°N, 44.5°W] Anaximenes, 585–528 BC. Greek philosopher of Miletus. Taught that the Earth was flat and that the Sun was hot because of the speed of its revolution around the Earth.
Crater (80 km).

Bliss (Plato A) [53.0°N, 13.5°W] Nathaniel Bliss, 1700–1764. English Astronomer Royal.
Crater (20 km).

Brianchon [74.8°N, 86.5°W] Charles J. Brianchon, 1783–1864. French mathematician.
Crater in a libration zone (145 km).

Fontenelle [63.4°N, 18.9°W] Bernard Le Bovier de Fontenelle, 1657–1757. French astronomer, popularizer of science, and one of the early members of the French Academy of Sciences.
Crater (38 km).

Frigoris, Mare (Sea of Cold). Riccioli's name for an elongated mare in the northern polar region.
The surface of Mare Frigoris occupies an area of 436,000 sq km *(Lacus Mortis and the area west of the crater Hercules included – see map no. 14) and is comparable in size with the Black Sea on Earth.*

Maupertuis, Rimae [51°N, 22°W]
Rilles, length 100 km.

Mouchez [78.3°N 26.6°W] Ernest A. B. Mouchez, 1821–1892. Officer of the French Navy, later director of the Paris Observatory.
Remains of a crater (82 km).

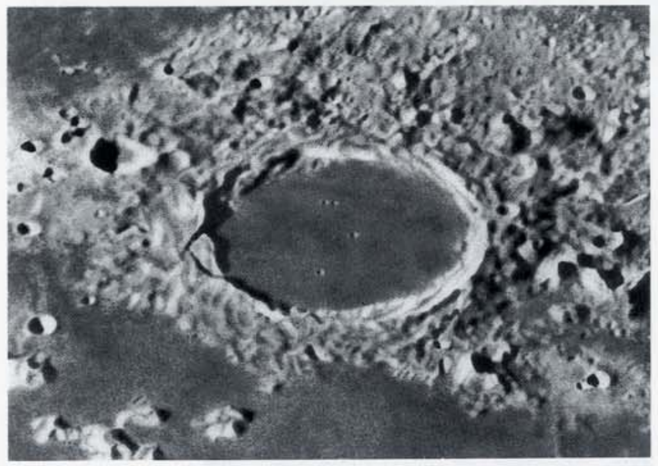
Pascal [74.3°N, 70.1°W] Blaise Pascal, 1623–1662. French mathematician, physicist, and philosopher. Invented an adding machine.
Crater (106 km).

Philolaus [72.1°N, 32.4°W] Philolaus, end of the 5th century BC. Greek philosopher, adherent to Pythagorean astronomy. Taught that the Earth is moving. Believed that the center of space is a "central fire."
Crater (71 km).

Plato [51.6°N, 9.3°W] Plato, c. 427–347 BC. Prominent Greek philosopher, pupil of Socrates. His astronomy is Pythagorean; conceived of the Earth as a round body surrounded by planetary spheres and stars.
Large crater (101 km).

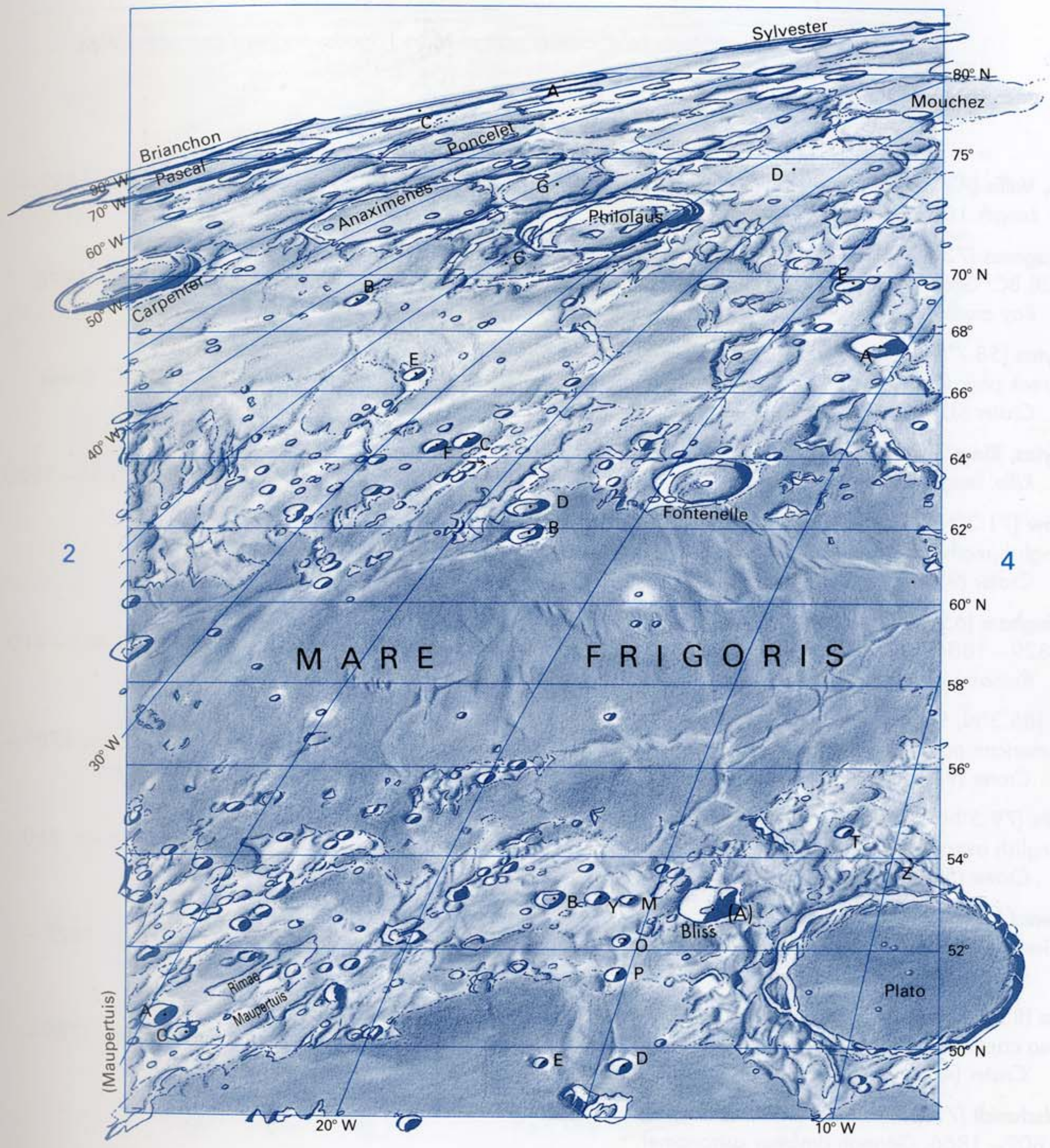
Poncelet [75.8°N, 54.1°W] Jean V. Poncelet, 1788–1867. French mathematician.
Crater (69 km).

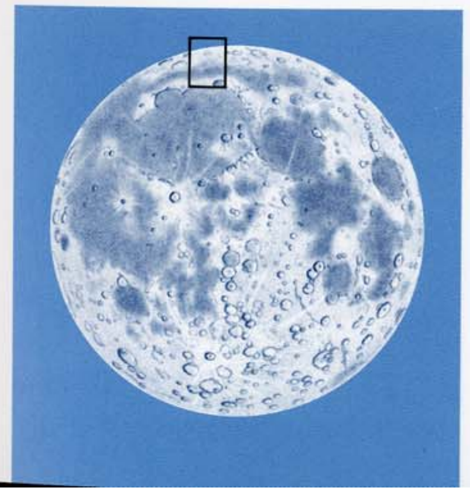
Sylvester [82.7°N, 79.6°W] James J. Sylvester, 1814–1897. British mathematician. Number theory, analytical geometry.
Crater in a libration zone (58 km).

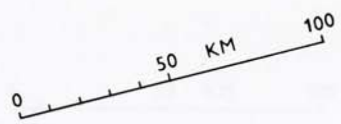


*The lunar crater **Plato**. Note that a part of the wall with triangular contours is separated from the western rim of the crater by a landslide of rock. There are four craters between 1.7 and 2.2 km in diameter on the floor of Plato.*

3







4

Archytas

Area surrounding North Pole, central part of Mare Frigoris, northern part of the Alps.

Alpes, Vallis (Alpine Valley) [49°N, 3°E]
Length 180 km, *narrow rille in floor.*

Anaxagoras [73.4°N, 10.1°W] Anaxagoras, 500–428 BC. Greek philosopher.
Ray crater (51 km).

Archytas [58.7°N, 5.0°E] Archytas, c. 428–347 BC. Greek philosopher, statesman, and geometer.
Crater (32 km).

Archytas, Rima [53°N, 5°E]
Rille, length 90 km.

Barrow [71.3°N, 7.7°E] Isaac Barrow, 1630–1677. English mathematician, friend of Sir Isaac Newton.
Crater (93 km).

Birmingham [65.1°N, 10.5°W] John Birmingham, 1829–1884. Irish selenographer.
Remains of a crater (92 km).

Byrd [85.3°N, 9.8°E] Richard E. Byrd, 1888–1957. American polar explorer, pilot.
Crater (94 km).

Challis [79.5°N, 9.2°E] James Challis, 1803–1862. English astronomer.
Crater (56 km).

Epigenes [67.5°N, 4.6°W] Epigenes, 3rd century BC. Greek astronomer.
Crater (55 km).

Gioja [83.3°N, 2.0°E] Flavio Gioja, c. 1302. Italian sea captain.
Crater (42 km).

Goldschmidt [73.0°N, 2.9°W] Hermann Goldschmidt, 1802–1866. German amateur astronomer.
Crater (120 km).

Hermite [86.4°N, 87.3°W] Charles Hermite, 1822–1901. French mathematician.
Crater (110 km).

Main [80.8°N, 10.1°E] Robert Main, 1808–1878. English astronomer.
Crater (46 km).

Meton [73.8°N, 19.2°E] Meton, c. 432 BC. Greek astronomer and mathematician.
Remains of a crater (122 km).

Peary [88.6°N, 33.0°E] Robert E. Peary, 1856–1920. American polar explorer.
Crater (74 km).

Plato, Rimae [51°N, 2°W]
Isolated rilles east of the crater Plato.

Protagoras [56.0°N, 7.3°E] Protagoras, c. 485–410 BC. Greek philosopher.
Crater (22 km).

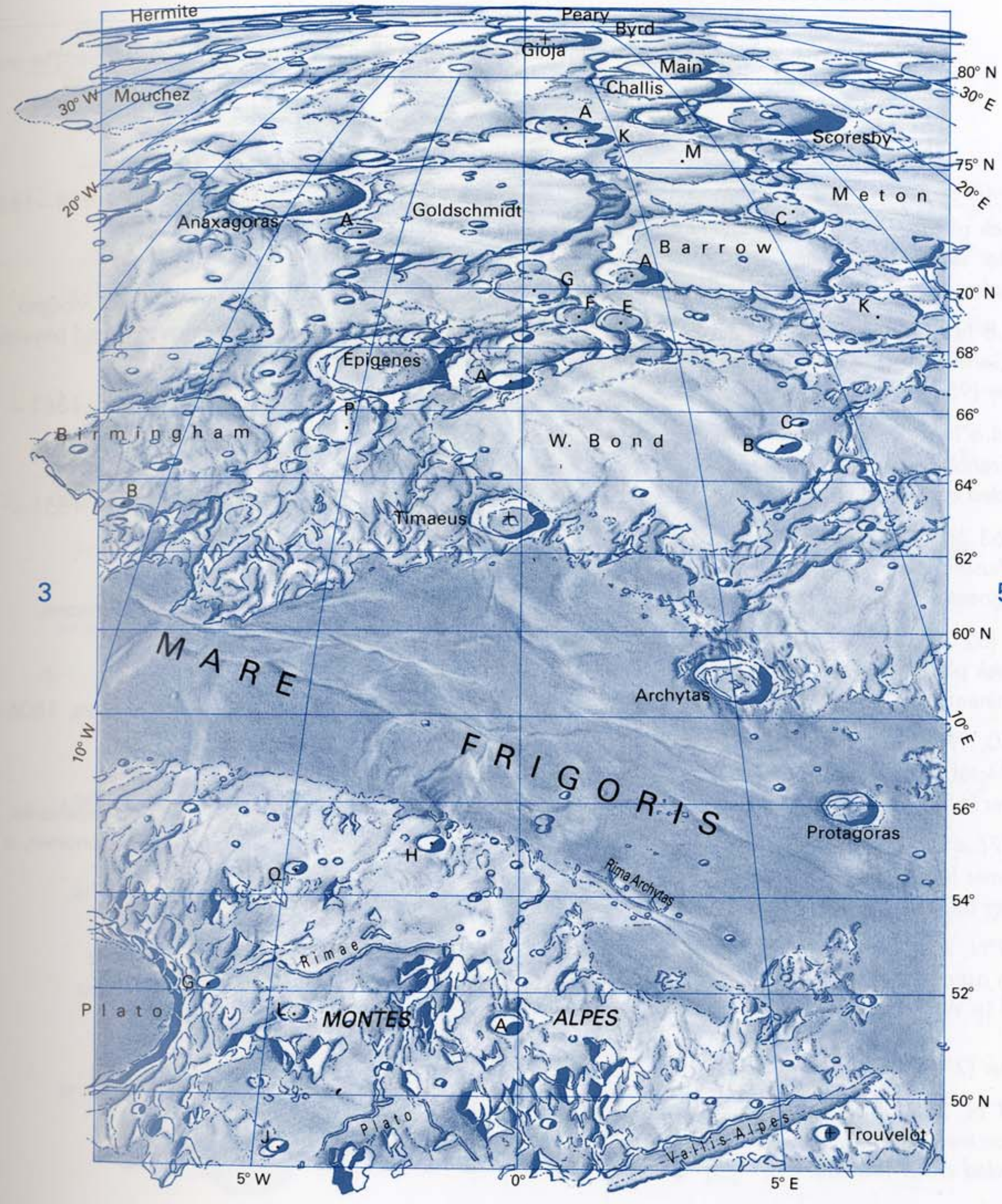
Scoresby [77.7°N, 14.1°E] William Scoresby, 1789–1857. English navigator, oceanographer.
Crater (56 km).

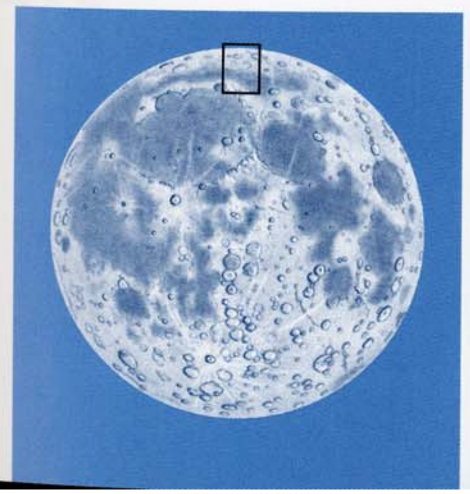
Timaeus [62.8°N, 0,5°W] Timaeus, c. 356–c. 260 BC. Greek historian.
Crater (33 km).

Trouvelot [49.3, 5.8°E] Étienne L. Trouvelot, 1827–1895. French astronomer.
Crater (9 km).

W. Bond [65.3°N, 3.7°E] William C. Bond, 1789–1859. American astronomer.
Large crater (158 km).

4





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Aristoteles

5

The eastern part of Mare Frigoris and the area east of the north pole of the Moon. The most interesting formation in this section is the crater Aristoteles.

Aristoteles [50.2°N, 17.4°E] Aristoteles, c. 384–322 BC. Greek philosopher, his teaching influenced Europe for several centuries.
Complex crater with terraced walls (87 km).

Arnold [66.8°N, 35.9°E] Christoph Arnold, 1650–1695. German amateur astronomer.
Crater (95 km).

Baillaud [74.6°N, 37.5°E] Benjamin Baillaud, 1848–1934. French astronomer.
Flooded crater (90 km).

C. Mayer [63.2°N, 17.3°E] Christian Mayer, 1719–1783. Austrian astronomer.
Prominent crater (38 km).

Democritus [62.3°N, 35.0°E] Democritus, c. 460–370 BC. Greek philosopher (atomic theory).
Prominent crater (39 km).

de Sitter [80.1°N, 39.6°E] Willem de Sitter, 1872–1934. Notable Dutch astronomer.
Crater (65 km).

Euctemon [76.4°N, 31.3°E] Euctemon, c. 432 BC. Astronomer from Athens, contemporary of Meton.
Crater (62 km).

Galle [55.9°N, 22.3°E] Johann G. Galle, 1812–1910. German astronomer. Discovered Neptune on the basis of Le Verrier's calculations on 23 September 1846.
Crater (21 km).

Kane [63.1°N, 26.1°E] Elisha K. Kane, 1820–1857. American traveler and explorer.
Flooded crater (55 km).

Mitchell [49.7°N, 20.2°E] Maria Mitchell, 1818–1889. American astronomer.
Crater (30 km).

Moigno [66.4°N, 28.9°E] Francois N. M. Moigno, 1804–1884. French mathematician and physicist.
Crater (37 km).

Nansen [81.3°N, 95.3°E] Fridtjof Nansen, 1861–1930. Norwegian polar explorer.
Crater in a libration zone (122 km).

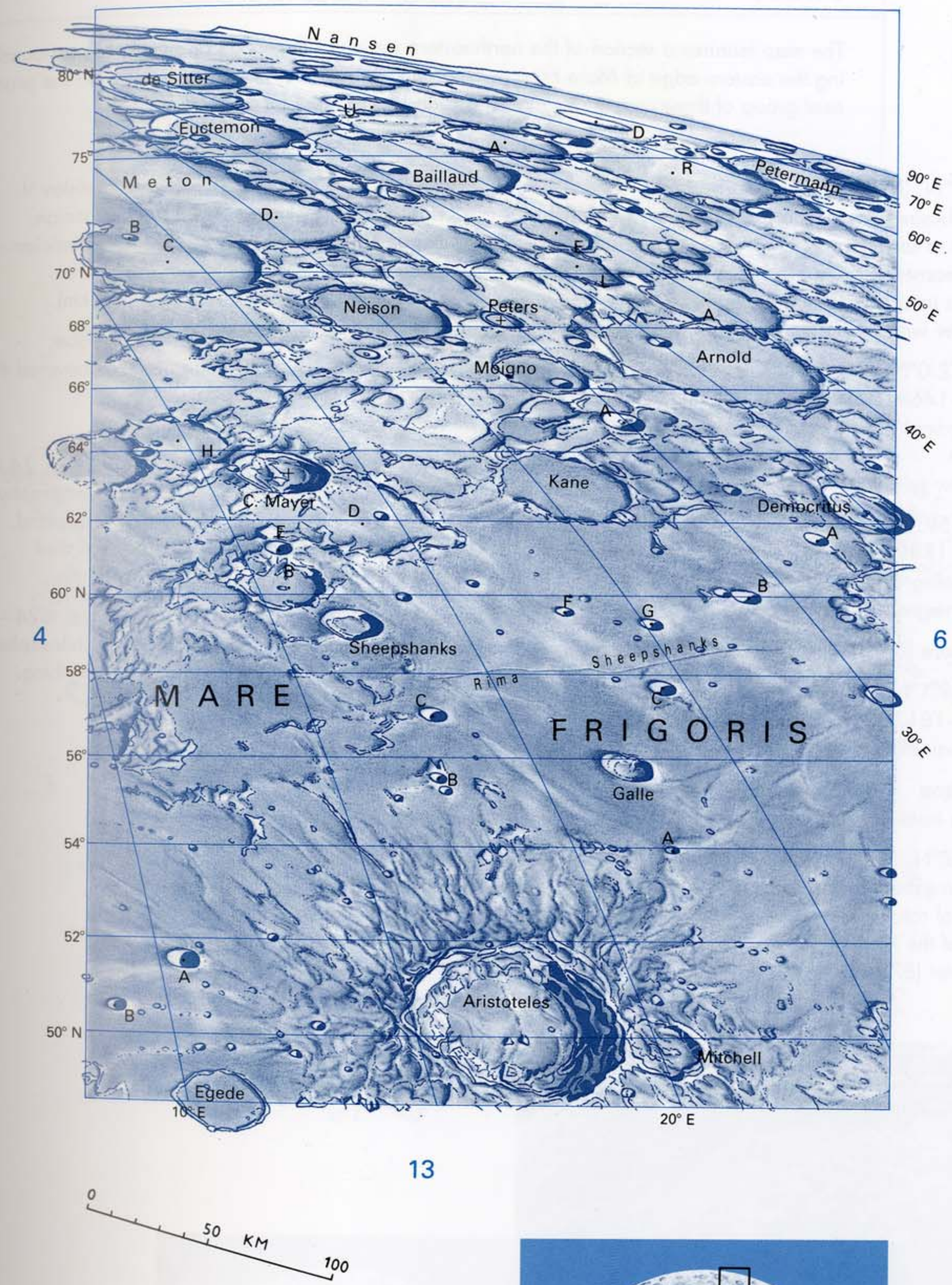
Neison [68.3°N, 25.1°E] Edmund Neison, 1851–1940. English selenographer.
Crater (53 km).

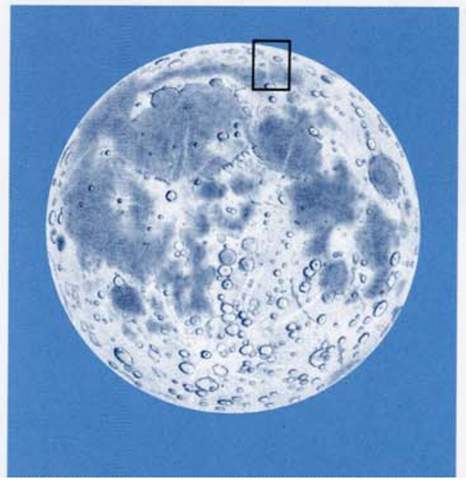
Petermann [74.2°N, 66.3°E] August Petermann, 1822–1878. German geographer.
Crater (73 km).

Peters [68.1°N, 29.5°E] Christian A. F. Peters, 1806–1880. German astronomer.
Crater (15 km).

Sheepshanks [59.2°N, 16.9°E] Anne Sheepshanks, 1789–1876. Sister of an English astronomer, a benefactress to astronomy.
Crater (25 km).

Sheepshanks, Rima [58°N, 24°E]
Rille, length 200 km.





6 Strabo

The map features a section of the northeastern region of the Moon and the areas surrounding the eastern edge of Mare Frigoris. The pair of craters Strabo and Thales, and the prominent group of three craters, Strabo N, B, and L, are useful for orientation.

Baily [49.7°N, 30.4°E] Francis Baily, 1774–1844. English businessman, who from 1825 devoted himself fully to astronomy. He was the first to describe the phenomenon Baily's beads, which he observed during a total eclipse of the Sun in 1836.
Crater with a disintegrated wall (27 km).

Cusanus [72.0°N, 70.8°E] Nikolaus Krebs Cusanus, 1401–1464. German by origin, mathematician and cardinal. Opposed the concept of a geocentric universe.
Crater with a flooded floor (63 km).

de la Rue [59.1°N, 53.0°E] Warren de la Rue, 1815–1889. Englishman, one of the pioneers of astrophotography.
Disintegrated crater (136 km).

Frigoris, Mare (Sea of Cold). See p. 32.

Gärtner [59.1°N, 34.6°E] Christian Gärtner, c. 1750–1813. German mineralogist and geologist.
Remains of a crater (102 km).

Gärtner, Rima
Rille inside a crater, length 30 km.

Hayn [64.7°N, 85.2°E] Friedrich Hayn, 1863–1928. German astronomer. Improved upon the existing theory of rotation of the Moon, mapped the limb areas of the Moon.
Crater (87 km).

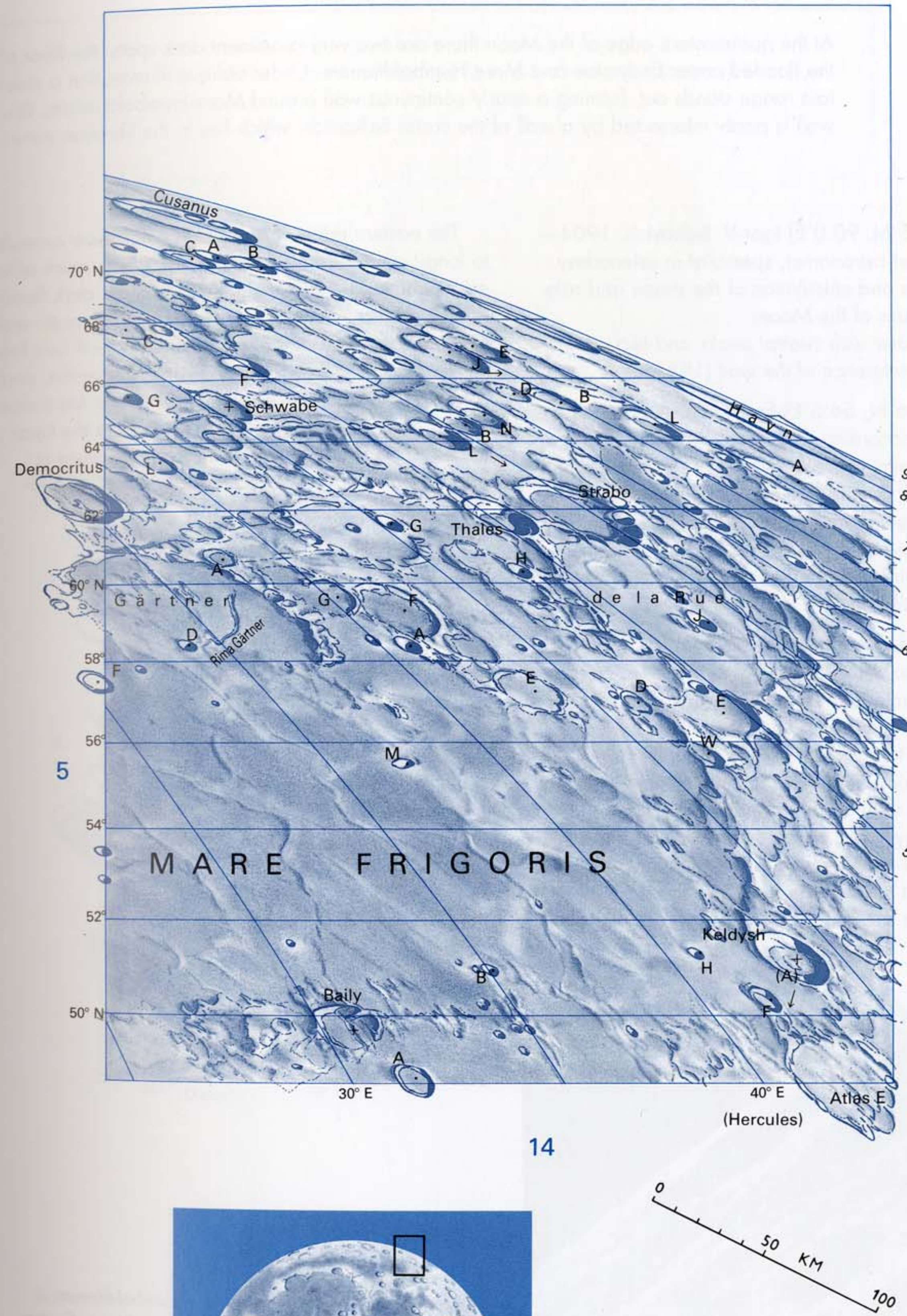
Keldysh (Hercules A) [51.2°N, 43.6°E] Mstislav V. Keldysh, 1911–1978. Soviet mathematician, mechanic, and engineer, prominent theoretician and organizer of Soviet astronautics.
Regular crater with a sharp rim (33 km).

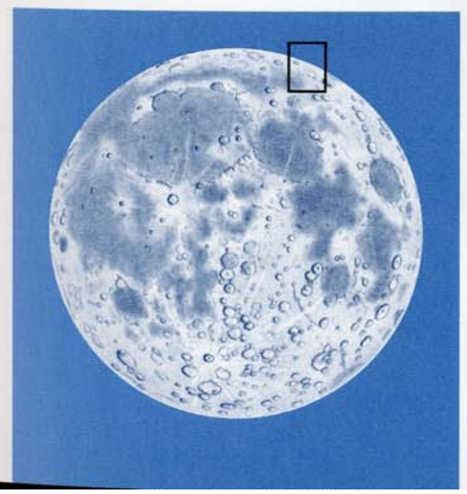
Schwabe [65.1°N, 45.6°E] Heinrich Schwabe, 1789–1875. German astronomer. Discovered the 11-year cycle of solar activity.
Crater with a flooded floor (25 km).

Strabo [61.9°N, 54.3°E] Strabo, c. 64 BC – c. 24 AD. Greek geographer and historian. His Geography survived as the most significant work of its kind.
Prominent crater with a terraced wall and flooded floor (55 km).

Thales [61.8°N, 50.3°E] Thales of Miletus, c. 624–c. 543 BC. Founder of Greek geometry, philosopher. Taught that water is the principle of everything.
Crater with a sharp rim (32 km).

Under high illumination, the bright ray crater ***Thales*** *stands out close to the eastern edge of Mare Frigoris.*





6

Endymion

At the northeastern edge of the Moon there are two very prominent dark spots: the floor of the flooded crater Endymion and Mare Humboldtianum. Under oblique illumination a mountain range stands out, forming a nearly continuous wall around Mare Humboldtianum: this wall is partly intersected by a wall of the crater Belkovich, which lies in the libration zone.

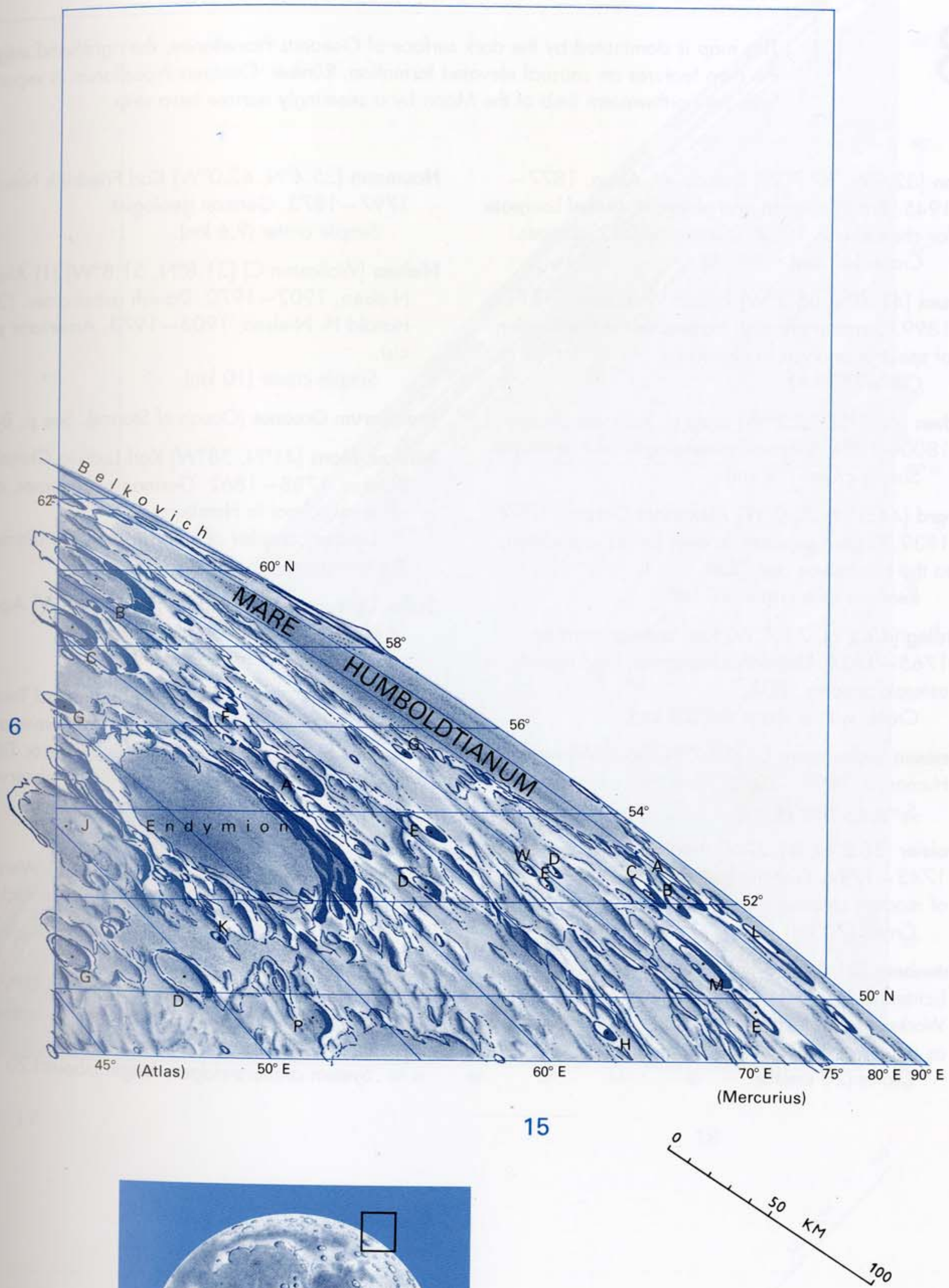
Belkovich [61.5°N, 90.0°E] Igor V. Belkovich, 1904–1949. Soviet astronomer, specialist in selenodesy. Observation and calculation of the shape and rotational elements of the Moon.
Large crater with central peaks and two craters on the circumference of the wall (198 km).

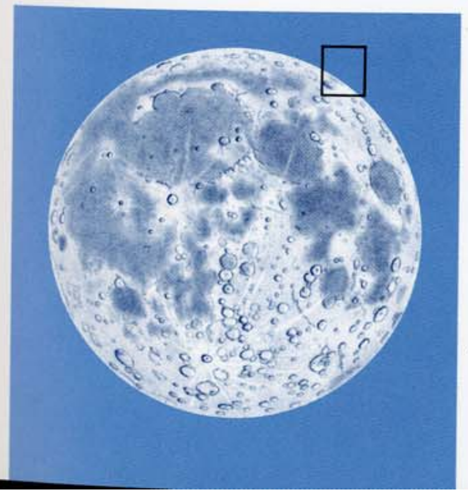
Endymion [53.6°N, 56.5°E] Endymion. A young shepherd who, according to a Greek legend, went to sleep on Mount Latmos; his beauty so aroused the cold heart of Selene, Goddess of the Moon, that she came down to Earth and kissed Endymion, who slept on forever.
Very prominent complex crater with sizable wall and flooded dark floor (125 km).

Humboldtianum, Mare (Humboldt's Sea) [57°N, 80°E] Alexander von Humboldt, 1769–1859. German naturalist and explorer. In South America in 1799, he observed the Leonid meteor shower. Exploratory expeditions to the Orinoco and Amazon rivers, the Andes, Mexico, and Siberia. Mädler gave Humboldt's name to this formation because he recognized a symbolic parallel between Humboldt's explorations of unknown terrestrial continents and the way that this lunar mare seems to form a link between the known and unknown hemispheres of the Moon.

The eastern edge of Mare Humboldtianum extends to longitude 90°E and hence its visibility is much affected by libration. Mare Humboldtianum is a dark flooded center of a lunar basin with a concentric outer wall approximately 640 km in diameter. This wall runs from the crater Strabo (see map 6), east of Endymion, and continues southeastward; around the crater Mercurius E it turns eastward and finally passes over to the lunar far side. The diameter of Mare Humboldtianum is approximately 160 km and it occupies an area of 22,000 sq km.

At favorable libration the small ***Mare Humboldtianum*** *is observable on the northeastern limb of the Moon. Farther from the limb, the dark floor of the crater* ***Endymion*** *is visible. The image shows this region under high illumination.*





8

Rümker

This map is dominated by the dark surface of Oceanus Procellarum; the right-hand edge of the map features an unusual elevated formation, Rümker. Oceanus Procellarum is separated from the northwestern limb of the Moon by a seemingly narrow terra strip.

Aston [32.9°N, 87.7°W] Francis W. Aston, 1877–1945. British chemist and physicist, Nobel Laureate for chemistry in 1922. Discovered 212 isotopes.
Crater (43 km).

Bunsen [41.4°N, 85.3°W] Robert W. Bunsen, 1811–1899. German chemist. Pioneer in the application of spectral analysis in chemistry.
Crater (52 km).

Dechen [46.1°N, 68.2°W] Ernst H. Karl von Dechen, 1800–1889. German mineralogist and geologist.
Simple crater (12 km).

Gerard [44.5°N, 80.0°W] Alexander Gerard, 1792–1839. English explorer, known for his expeditions to the Himalayas and Tibet.
Remains of a crater (90 km).

Harding [43.5°N, 71.7°W] Karl Ludwig Harding, 1765–1834. German astronomer. Discovered asteroid Juno in 1804.
Crater with a sharp rim (23 km).

Humason (Lichtenberg G) [30.7°N, 56.6°W] Milton L. Humason, 1891–1972. American astronomer.
Simple crater (4 km).

Lavoisier [38.2°N, 81.2°W] Antoine Laurent Lavoisier, 1743–1794. French chemist. One of the founders of modern chemistry.
Crater (70 km).

Lichtenberg [31.8°N, 67.7°W] Georg Christoph Lichtenberg, 1742–1799. German physicist. Worked in the field of static electricity. Known also as a satirist.
Crater (20 km).

Naumann [35.4°N, 62.0°W] Karl Friedrich Naumann, 1797–1873. German geologist.
Simple crater (9.6 km).

Nielsen (Wollaston C) [31.8°N, 51.8°W] (1) Axel V. Nielsen, 1902–1970, Danish astronomer. (2) Harald H. Nielsen, 1903–1973, American physicist.
Simple crater (10 km).

Procellarum Oceanus (Ocean of Storms). See p. 84.

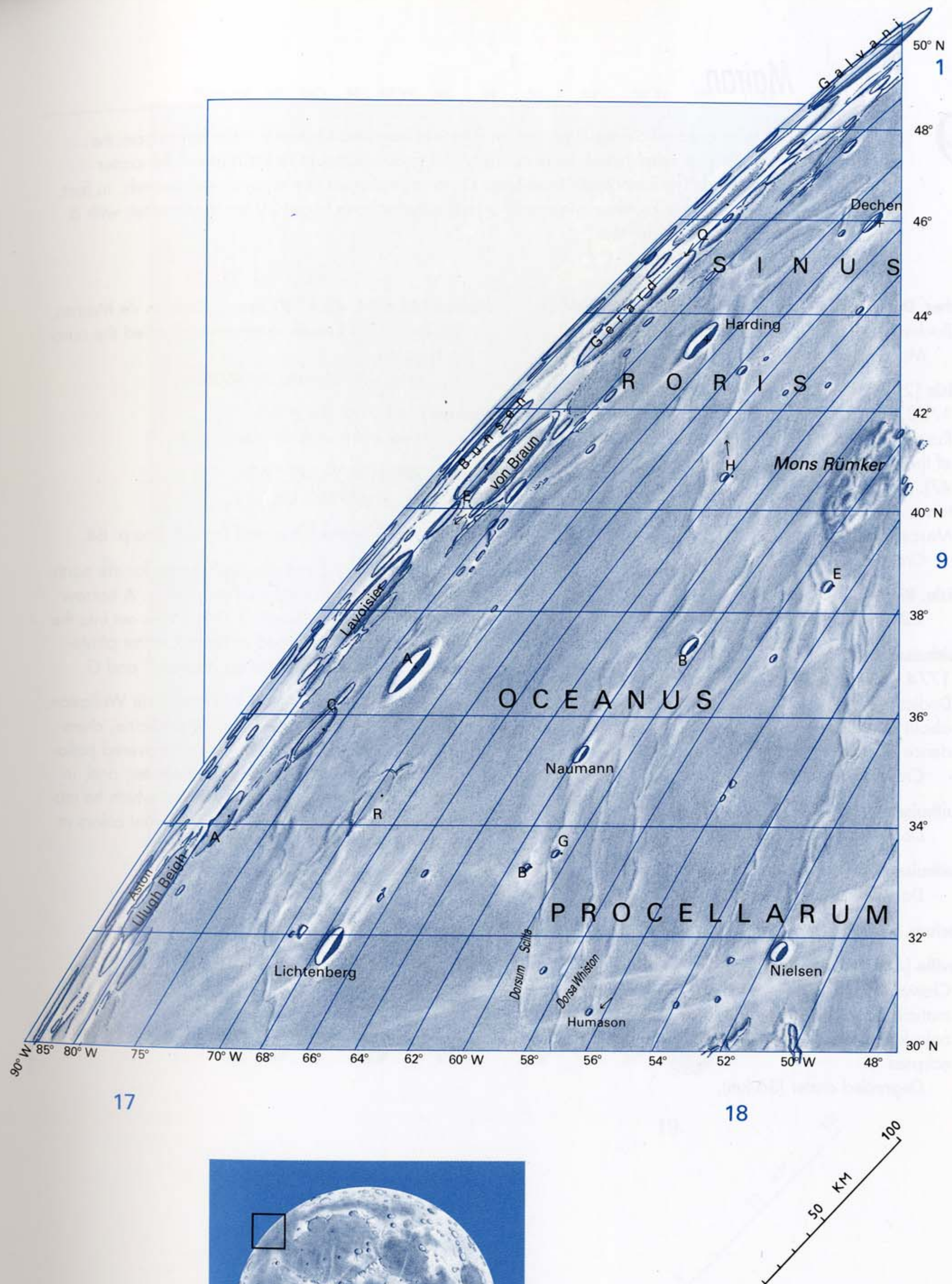
Rümker, Mons [41°N, 58°W] Karl Ludwig Christian Rümker, 1788–1862. German astronomer, director of naval school in Hamburg.
Unique complex of lunar domes; the diameter of the formation is c. 70 km.

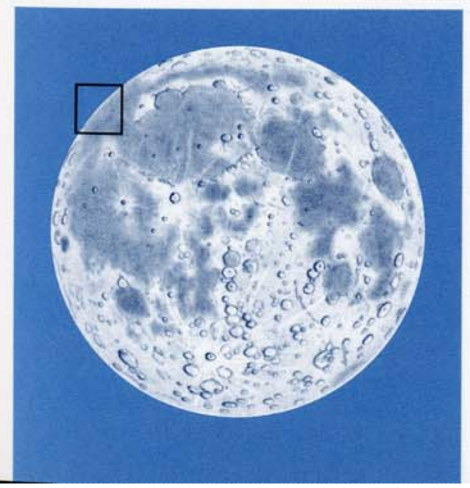
Scilla, Dorsum (Scilla's Ridge) [32°N, 60°W] Agostino Scilla, 1639–1700. Italian geologist.
Mare ridge, length about 120 km.

Ulugh Beigh [32.7°N, 81.9°W] Muhammad Taragaj Ulug-bek, 1394–1449. Uzbek astronomer and mathematician, grandson of the conqueror Timur. Founded astronomical school, built an observatory with 40-m quadrant near Samarkand.
Disintegrated, flooded crater (54 km).

von Braun (Lavoisier D) [41.1°N, 78.0°W] Werner von Braun, 1912–1977. German-American rocket pioneer.
Crater (60 km).

Whiston, Dorsa (Whiston's Ridges) [30°N, 57°W] William Whiston, 1667–1752. British mathematician.
System of mare ridges, length about 120 km.





9

Mairan

The terra area adjoining Sinus Iridum stretches here into Oceanus Procellarum from the northeast (see map 10). A local curiosity is a group of peaks to the north of the crater Gruithuisen. The formation Gruithuisen Gamma is shaped like an upturned bathtub; in fact, it is a tall domelike mountain massif with a circular base about 20 km in diameter, with a 900-m crater on the top.

Bucher, Dorsum (Bucher's Ridge) [31°N, 39°W] W. H. Bucher, 1889–1965. Swiss geophysicist.
Mare ridge, length about 90 km.

Delisle [29.9°N, 34.6°W] Joseph N. Delisle, 1688–1768. French astronomer. At the invitation of the Russian Empress Catherine I he was put in charge of the new observatory at St. Petersburg (1726–47). Suggested a method for determining the distance of the Sun from observations of the transits of Mercury and Venus.
Crater (25 km/2550 m).

Delisle, Rima [31°N, 33°W]
Rille, length 50 km.

Gruithuisen [32.9°N, 39.7°W] Franz von Gruithuisen, 1774–1852. German physician and astronomer. Dedicated but eccentric observer. Wrote a book about his "discovery" of buildings and other evidence of "Moon-dwellers."
Crater (16 km/1860 m).

Gruithuisen Delta, Mons [36°N, 39.5°W]
Domelike mountain massif, base diameter 20 km.

Gruithuisen Gamma, Mons [36.6°N, 40.5°W]
Domelike mountain massif, base diameter 20 km.

Imbrium, Mare (Sea of Rains). See p. 48.

Louville [44.0°N, 46.0°W] Jacques E. d'Allonville, Chevalier de Louville, 1671–1732. French mathematician and astronomer. Discovered a method for calculating the precise circumstances of solar eclipses.
Degraded crater (36 km).

Mairan [41.6°N, 43.4°W] Jean J. Dortous de Mairan, 1678–1771. French astronomer. Studied the aurora borealis.
Crater with a sharp rim (40 km).

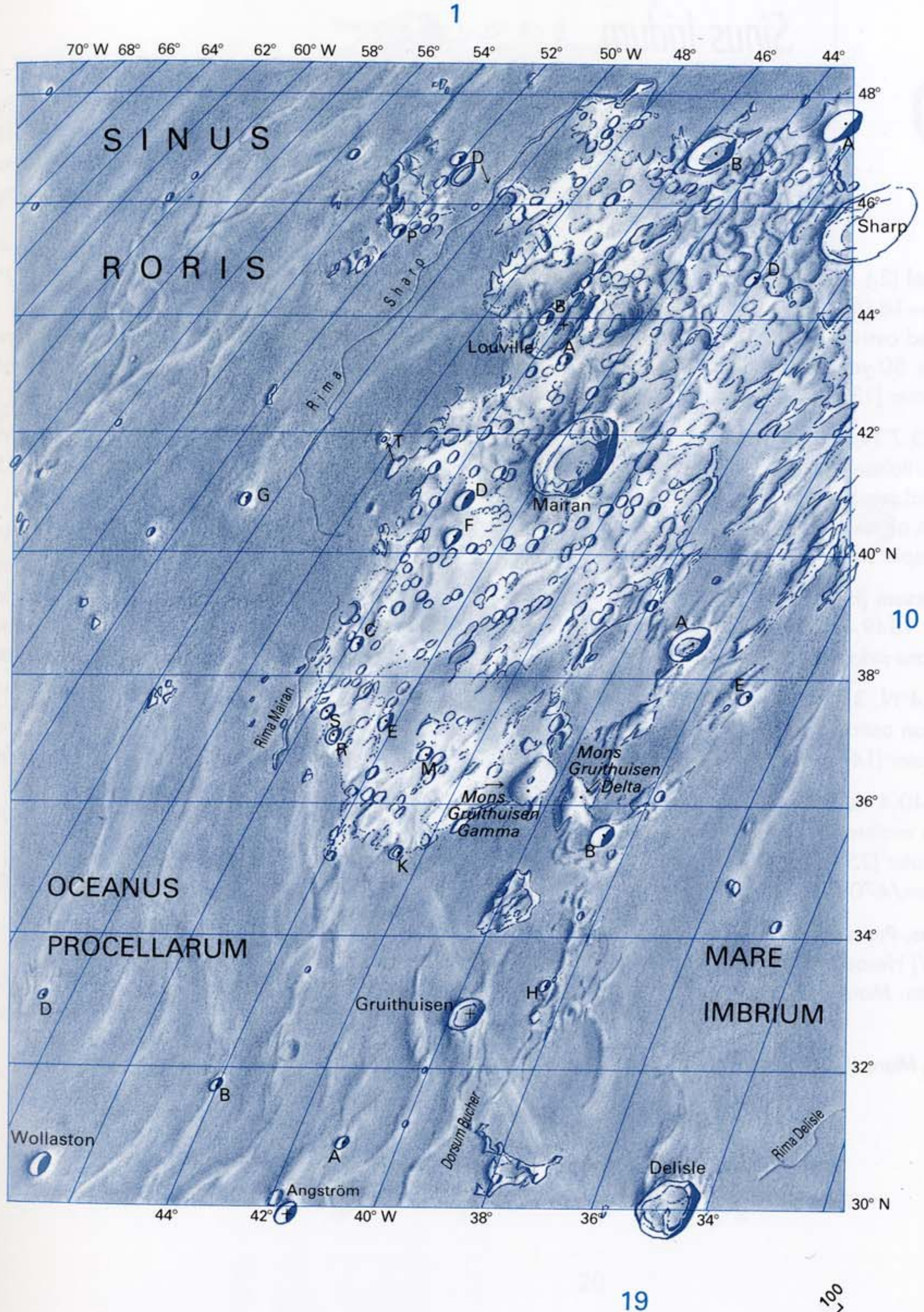
Mairan T [41.7°N, 48.2°W]
Dome with summit crater (3 km).

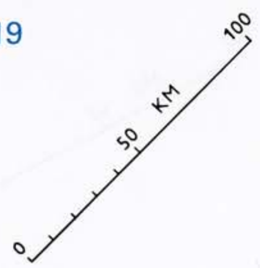
Mairan, Rima [38°N, 47 °W]
Rille, length 100 km.

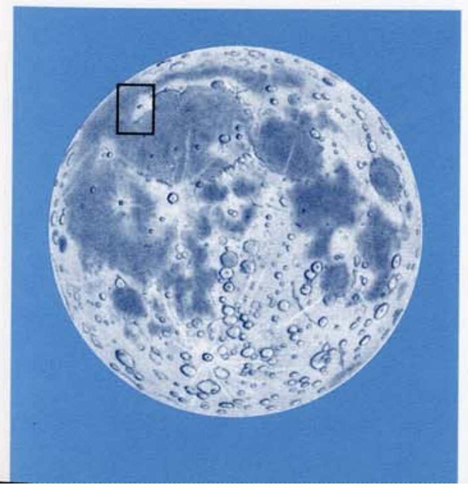
Procellarum, Oceanus (Ocean of Storms). See p. 84.

Roris, Sinus (Bay of Dew). Riccioli's name for the northern elongation of Oceanus Procellarum. A narrow rille of Rima Sharp (length 210 km) runs out into the bay, which can be traced in Lunar Orbiter photographs to between the craters Mairan T and G.

Wollaston [30.6°N, 46.9°W] William Hyde Wollaston, 1766–1828. English scientist – medicine, chemistry, mineralogy, and astronomy. Discovered palladium and rhodium, devised a goniometer, and, in 1802, observed the Fraunhofer lines, which he mistook for the boundaries between different colors in the solar spectrum.
Simple crater (10.2 km).







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10

Sinus Iridum

The northwestern part of Mare Imbrium with the beautiful Sinus Iridum, and the Jura mountain range, which forms its edge. Sinus Iridum is crossed by mare ridges. Luna 17, which landed to the south of Cape Heraclides, transported an automatic mobile laboratory, Lunokhod 1, to the Moon.

C. Herschel [34.5°N, 31.2°W] Caroline Herschel, 1750–1848. Sister of William Herschel. As a devoted assistant to her brother, she worked with him for 50 years. She also discovered eight comets.
Crater (13.4 km/1850 m).

Carlini [33.7°N, 24.1°W] Francesco Carlini, 1783–1862. Italian astronomer. Worked in the field of celestial mechanics, improved the theory of the motion of the Moon.
Simple crater (11.4 km/2200 m).

Heim, Dorsum (Heim's Ridge) [31°N, 29°W] Albert Heim, 1849–1937. Swiss geophysicist.
Mare ridge, length about 130 km.

Heis [32.4°N, 31.9°W] Eduard Heis, 1806–1877. German astronomer, observer of variable stars.
Crater (14 km/1910 m); **Heis A** (6.1 km/650 m).

Helicon [40.4°N, 23.1°W] Helicon, 4th century BC. Greek mathematician and astronomer.
Crater (25 km/1910 m); *nearby is* **Helicon E** (2.4 km/470 m)

Heraclides, Promontorium (Cape Heraclides) [41°N, 34°W] Heraclides Ponticus, c. 390–310 BC. Pupil of Plato. Maintained that the Earth rotates on an axis.

Imbrium, Mare (Sea of Rains). See p. 48.

Iridum, Sinus (Bay of Rainbows) [45°N, 32°W]. Named by Riccioli.
Large crater, diameter 260 km. *Formed after the Imbrium basin but before the subsequent flooding by mare lavas.*

Jura, Montes (Jura Mountains) [47°N, 37°W]. Named by Debes. The mountain range borders Sinus Iridum as the wall of a flooded crater.

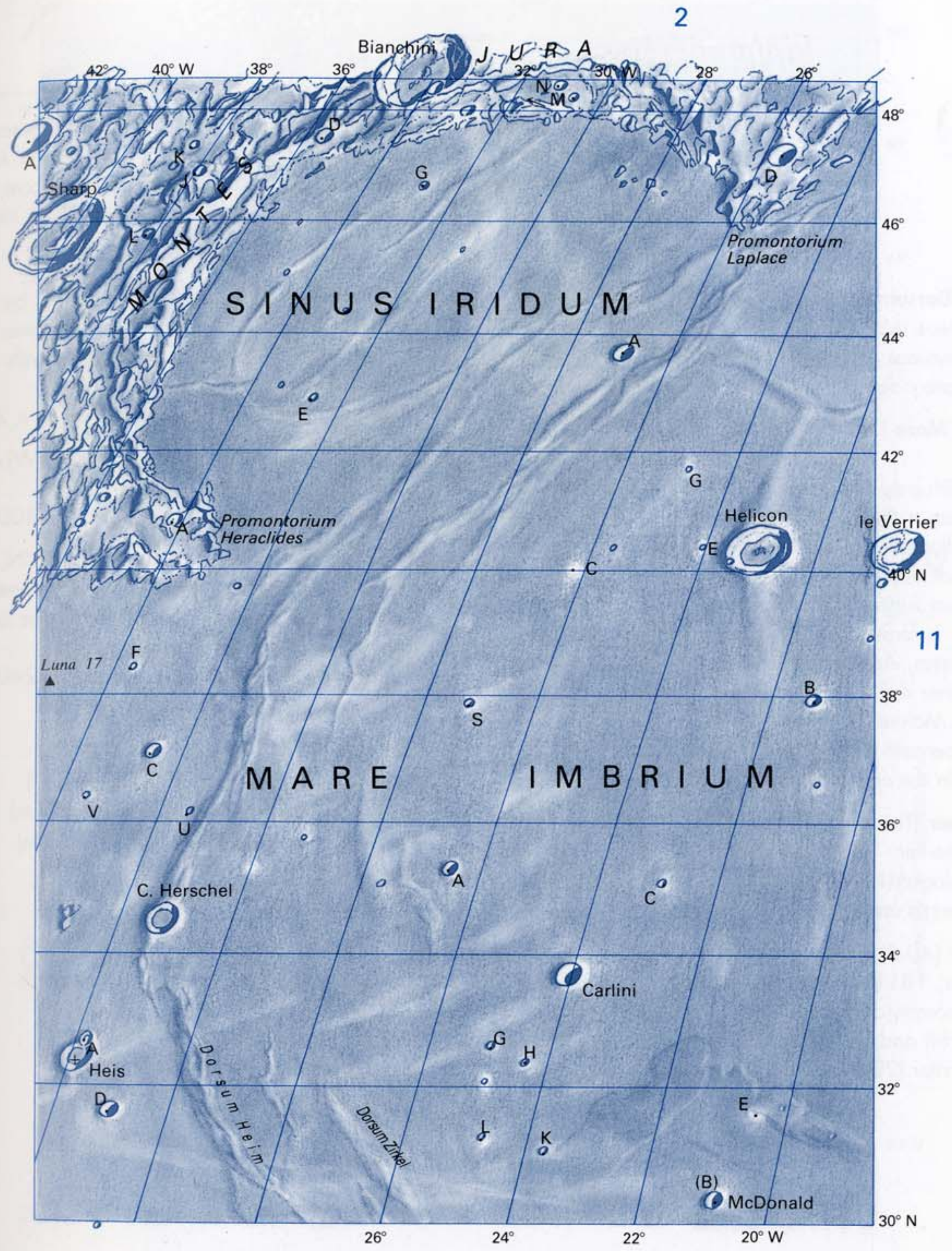
Laplace, Promontorium (Cape Laplace) [46°N, 26°W] Pierre Simon Laplace, 1749–1827. Outstanding French mathematician, disciple of Newton. Worked in the field of celestial mechanics. "Nebula Hypothesis" of the origin of the solar system.

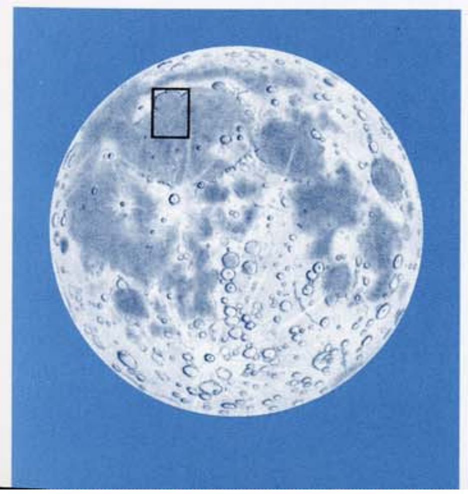
McDonald (Carlini B) [30.4°N, 20.9°W] (1) William J. McDonald, 1844–1926. American benefactor. (2) Thomas L. MacDonald, died in 1973. Scottish selenographer.
Simple crater (8 km/1470 m).

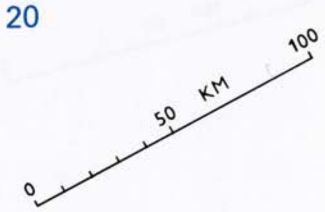
Sharp [45.7°N, 40.2°W] Abraham Sharp, 1651–1742. English astronomer, assistant to Flamsteed at Greenwich Observatory.
Crater (40 km).

Zirkel, Dorsum (Zirkel's Ridge) [29°N, 24°W] Ferdinand Zirkel, 1838–1912. German geologist and mineralogist.
Mare ridge, length about 210 km (continued on map 20).

10







le Verrier

The central and northern areas of Mare Imbrium have no large craters, but a telescope pointed at the area shown along the northern edge of the map at lunar sunrise or sunset will reveal the long, pointed shadows of isolated peaks. In the past, such shadows cast by a low Sun helped to create the false impression that the lunar mountains are very high, steep, and jagged.

Grabau, Dorsum (Grabau's Ridge) [30°N, 14°W] Amadeus W. Grabau, 1870—1946. American geophysicist.
Mare ridge, length about 120 km.

Imbrium, Mare (Sea of Rains). Named by Riccioli. See p. 18
With a surface area of 830,000 sq km, *Mare Imbrium is the second-largest mare after Oceanus Procellarum. At the same time, it is the mare material fill of one of the largest lunar basins, called the Imbrium basin. The main basin rim – the* 1,160-km *ring – is formed by the mountain ranges Montes Caucasus, Apenninus, and Carpatus. Remains of the inner ring of the basin are formed by Montes Recti, Montes Teneriffe, Mons Pico, and Montes Spitzbergen. One of the first mascons was discovered in the center of this basin.*

Landsteiner (Timocharis F) [31.3°N, 14.8°W] Karl Landsteiner, 1868—1943. Austrian-born American pathologist, Nobel Laureate.
Simple crater (6 km/1350 m).

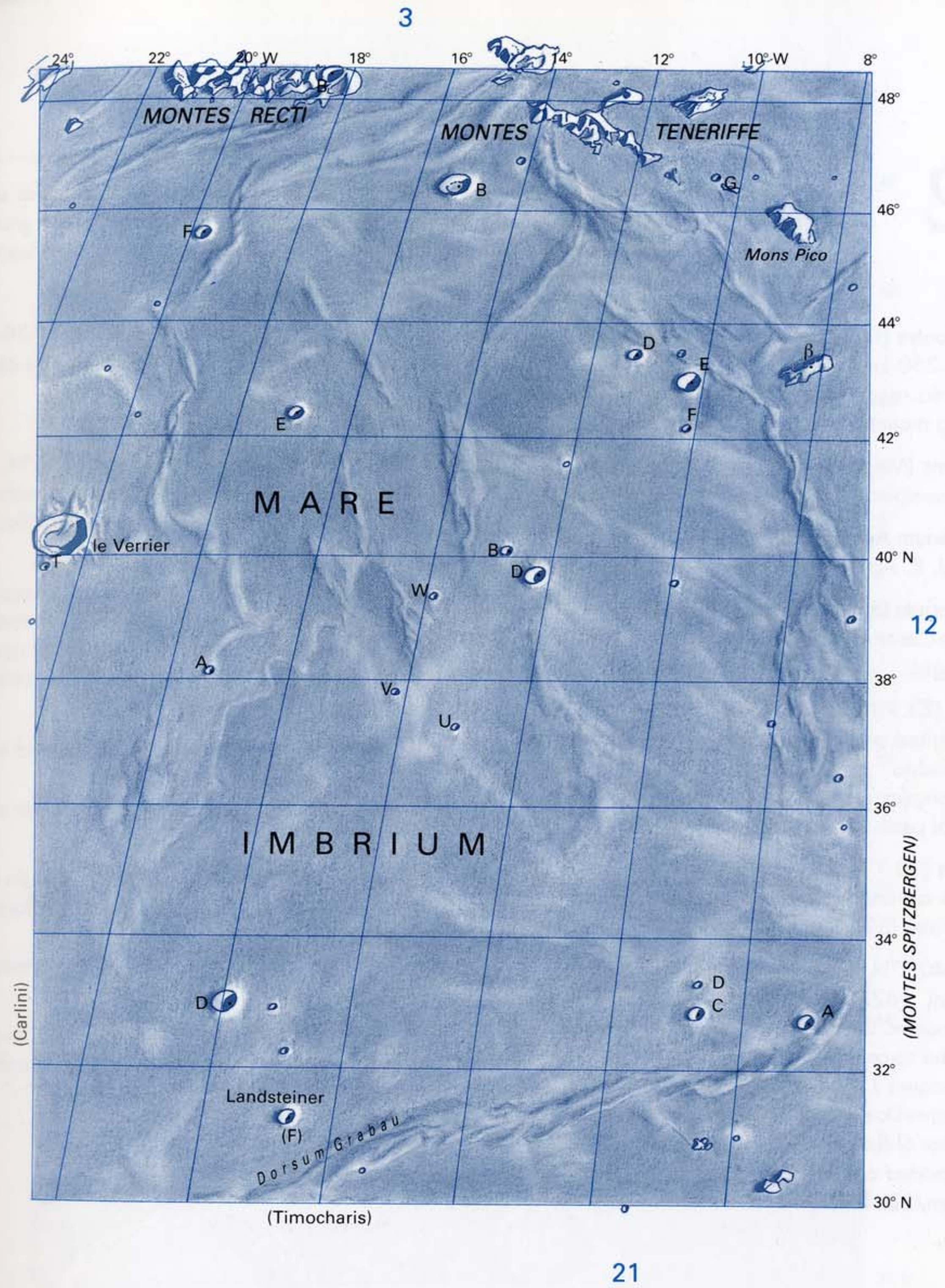
le Verrier [40.3°N, 20.6°W] Urbain Jean Joseph le Verrier, 1811—1877. French mathematician and astronomer, calculated (independently of Adams) the orbit and position of Neptune.
Crater (20 km/2100 m).

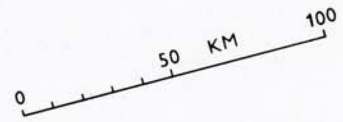
Pico, Mons [46°N, 9°W] Mountain named by Schröter, who evidently had in mind "Pico von Teneriffe"; he compared the height of this mountain with the height of other lunar mountain ranges.
2400 m *high, its base measures* 15 x 25 km.

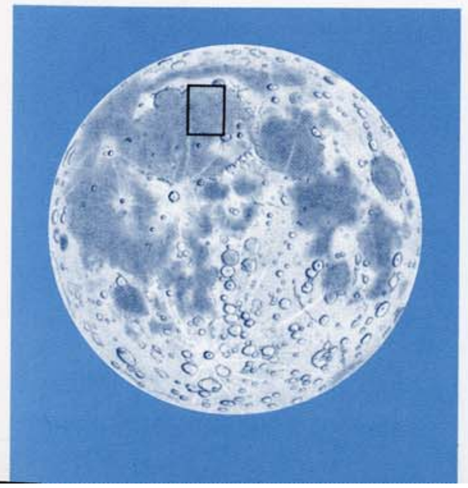
Recti, Montes (Straight Range) [48°N, 20°W]. Named by Birt because of its shape.
Length about 90 km, *height up to* 1800 m.

Teneriffe, Montes (Teneriffe Mountains) [48°N, 13°W]. Name reminiscent of the mountains of Teneriffe, where Piazzi Smyth first tested telescopic observational conditions high above sea level.
Length about 110 km, *height up to* 2400 m.

Small craters: **le Verrier B** (5.1 km/980 m)
le Verrier D (9.1 km/1830 m)
le Verrier W (3.3 km/620 m)







12

Aristillus

The eastern edge of Mare Imbrium is one of the most interesting parts of the lunar surface. The lunar Alps with their well-known valley, the solitary mountain Piton, and the group of three craters Archimedes, Autolycus, and Aristillus are magnificent objects for telescopic observation. Luna 2 crash-landed close to the crater Autolycus.

Alpes, Montes (The Alps). Mountain range (length about 250 km) named by Hevelius. The heights of its peaks range from 1800 m to 2400 m. The following mountainous features are named:

Mons Blanc (Mt. Blanc) [45°N, 1°E]
Mountain 3600 m *high, base diameter* 25 km.

Promontorium Agassiz (Cape Agassiz) [42°N, 2°E]
Louis J. R. Agassiz, 1807–1873. Swiss naturalist.

Promontorium Deville (Cape Deville) [43°N, 1°E]
Sainte-Claire Charles Deville, 1814–1876. French geologist.

Aristillus [33.9°N, 1.2°E] Aristillus, c. 280 BC. One of the earliest astronomers of the Greek school of Alexandria.
Complex crater (55 km/3650 m) *with rays and central peak* (900 m).

Autolycus [30.7°N, 1.5°E] Autolycus, c. 330 BC. Greek astronomer and mathematician.
Crater (39 km/3430 m).

Cassini [40.2°N, 4.6°E] (1) Giovanni-Domenico Cassini, 1625–1712. Italian-born French astronomer. Discovered four of Saturn's satellites and the so-called Cassini Division in Saturn's rings. (2) Jacques J. Cassini, 1677–1756, son of Giovanni-Domenico Cassini, whom he succeeded as director of the Paris Observatory.
Flooded crater (57 km/1240 m); **Cassini A** (17 km/2830 m)

Kirch [39.2°N, 5.6°W] Gottfried Kirch, 1639–1710. German astronomer. Discovered a large comet in 1680.
Crater (11.7 km/1830 m).

Lunicus, Sinus (Bay of Luna or "Lunik") [32°N, 1°W] Site of the first touchdown of a space probe on the Moon (Luna 2, 1959). The name was allocated by the IAU in 1970.

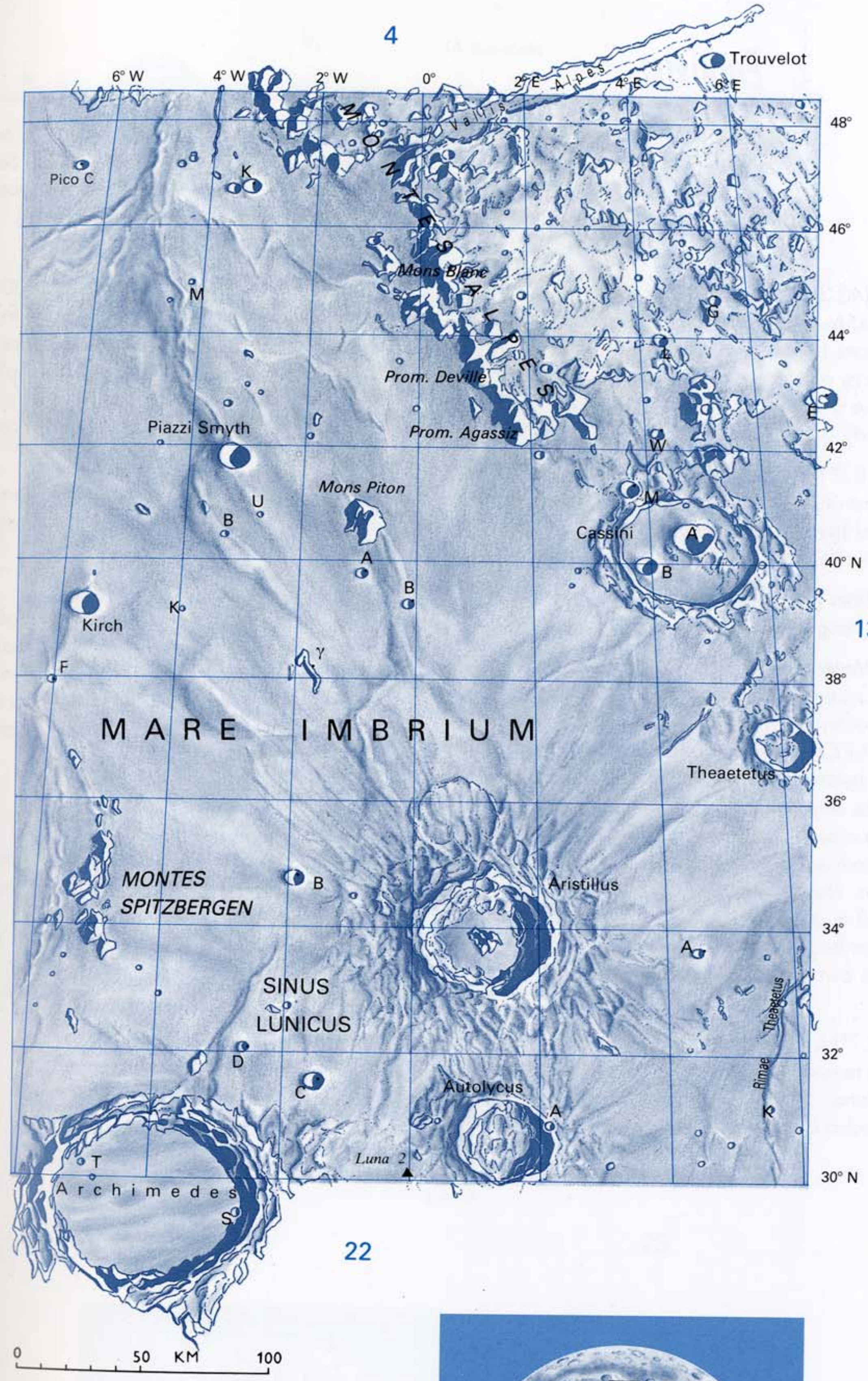
Piazzi Smyth [41.9°N, 3.2°W] Charles Piazzi Smyth, 1819–1900. British astronomer, Astronomer Royal for Scotland. Author of the mysticism of numbers concerning Khufu's pyramid (Great Pyramid).
Crater (12.8 km/2530 m).

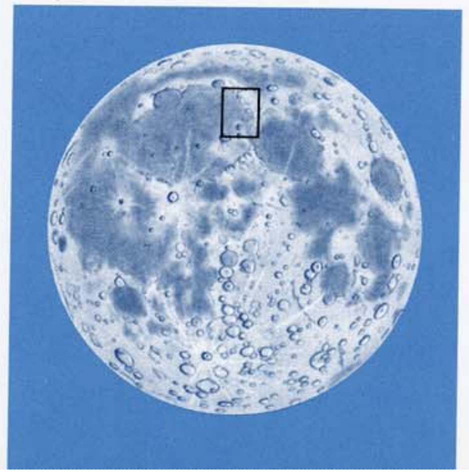
Piton, Mons [41°N, 1°W]. Mountain named after a peak in the Teneriffe massif.
Isolated mountain 2250 m *high, base diameter* 25 km.

Spitzbergen, Montes [35°N, 5°W]. Mountain range named by M. Blagg because of its similarity in shape to the terrestrial Spitsbergen.
Chain of mountains (length 60 km) *reaching a height of* 1500 m.

Theaetetus [37.0°N, 6.0°E] Theaetetus, 415–369 BC. Athenian philosopher, friend of Plato (on the Moon the crater is near the crater Plato).
Crater (25 km/2830 m).

Theaetetus, Rimae [33°N, 6°E]
Group of rilles, length about 50 km.





13

Eudoxus

The left-hand part of the map is occupied by the Caucasus Mountains, which lie on the boundary of Mare Imbrium and Mare Serenitatis. The northwestern part of Mare Serenitatis, crossed with bright rays from the crater Aristillus (map 12), is situated at the bottom of the map. The large crater Eudoxus forms a striking companion to Aristoteles (map 5).

Alexander [40.3°N, 13.5°E] Alexander the Great of Macedon, 356–323 BC. Statesman and commander; his expeditions broadened Greek knowledge of the Earth. The city of Alexandria in Egypt, named after him, became a center for science.
Greatly degraded crater, mare fill (82 km).

Calippus [38.9°N, 10.7°E] Calippus, c. 370–300 BC. Greek astronomer, pupil of Eudoxus. Improved the system of homocentric spheres.
Crater (33 km/2690 m).

Calippus, Rima [37°N, 13°E]
Rille, length 40 km.

Caucasus, Montes [39°N, 9°E] Caucasus Mountains.
This mountain range, named by Mädler, is a direct continuation of the lunar Apennines, from which the Caucasus are separated by a 50-km-wide "strait" between Mare Imbrium and Mare Serenitatis. The length of the Caucasus is about 520 km and the mountain range extends from the strait (in the bottom left-hand corner of map 13) to the crater Eudoxus. The peaks of the Caucasus reach a height of 6000 m above the level of the adjacent "seas"; from that height, an observer's horizon would be 110 km away and he could view parts of the both maria.

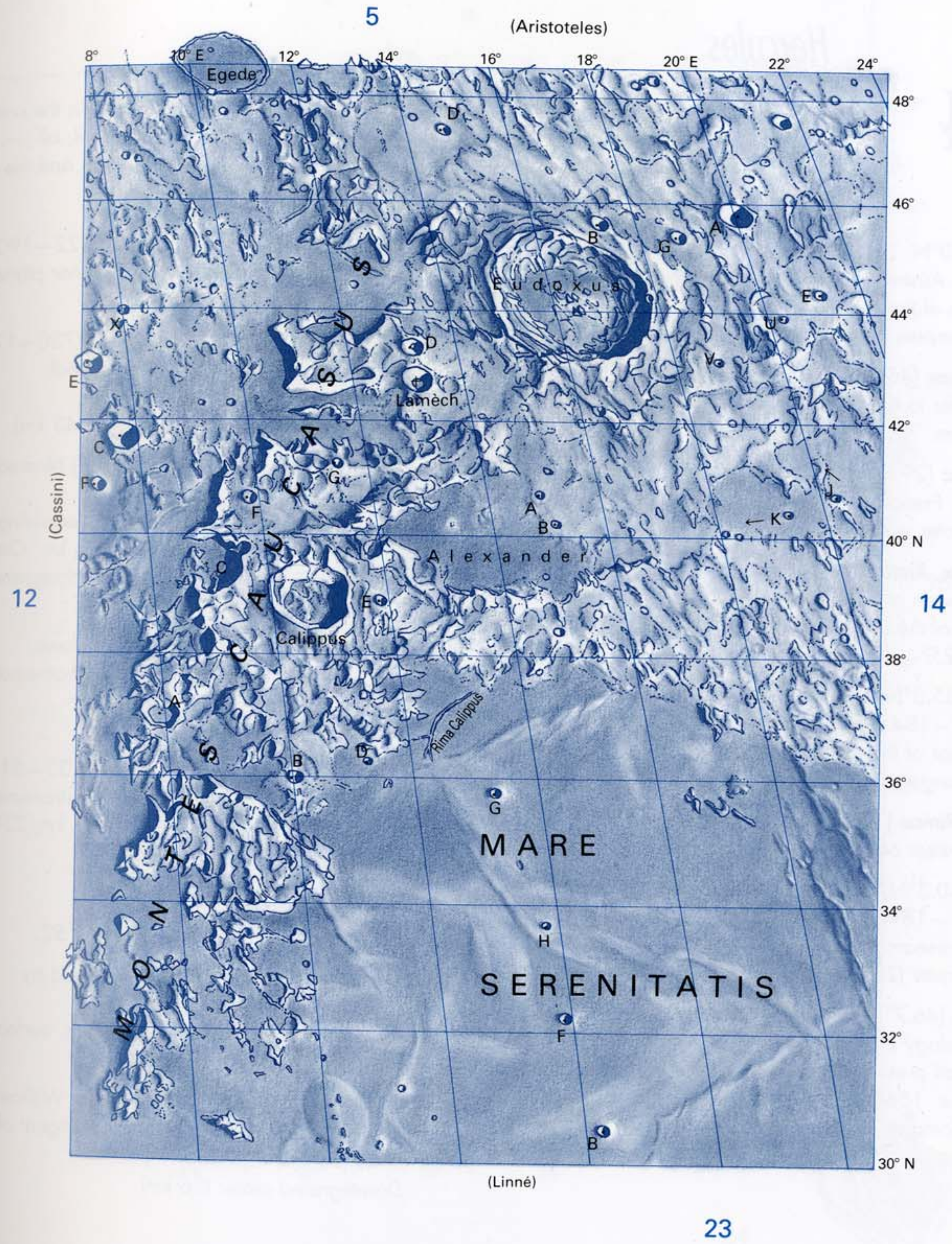
Egede [48.7°N, 10.6°E] Hans Egede, 1686–1758. Danish missionary who worked for 15 years in Greenland.
Flooded crater with a low wall (37 km).

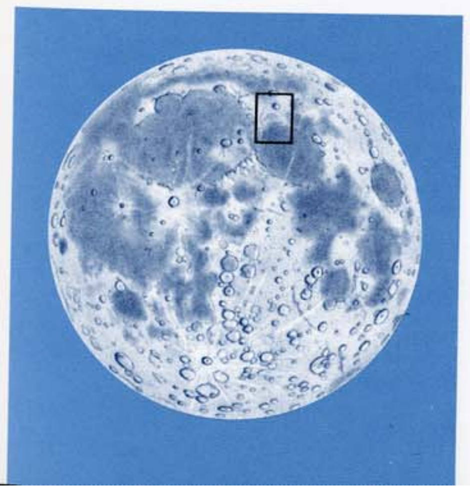
Eudoxus [44.3°N, 16.3°E] Eudoxus, c. 400–347 BC. Famous Greek astronomer, pupil of Plato, outstanding geometer. Devised a system of concentric spheres, rotating about the Earth, to explain the motions of celestial bodies.
Prominent complex crater with terraced walls (67 km).

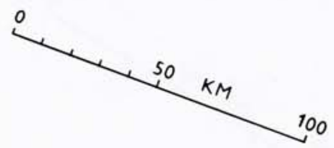
Lamèch [42.7°N, 13.1°E] Felix Chemla Lamèch, 1894–1962. French astronomer and selenographer.
Crater (13 km/1460 m).

Serenitatis, Mare (Sea of Serenity).
Circular plain, with a surface area of 303,000 sq km, the sixth-largest among lunar seas. It is smaller, however, than the terrestrial Caspian Sea, which covers an area of 370,000 sq km. The eastern part of Mare Serenitatis is occupied by an extensive series of mare ridges (see map 24).

Small craters: **Cassini C** (13.7 km/2420 m)
Eudoxus D (9.6 km/1300 m)
Linné F (5.0 km/1050 m)
Linné H (3.2 km/730 m)







14

Hercules

A very interesting landscape with a great variety of lunar formations. The rilles in the crater Bürg and on the floor of the crater Posidonius, as well as the rilles Rimae Daniell, all demand attention. Dark areas include the lakes Lacus Mortis, Lacus Somniorum, and the northeastern edge of Mare Serenitatis.

Bürg [45.0°N, 28.2°E] Johann Tobias Bürg, 1766–1834. Austrian astronomer. Developed theory of the motion of the Moon.
Complex crater in Lacus Mortis (40 km).

Bürg, Rimae [45°N, 26°E].
Rilles to the west of the crater Bürg, length up to 100 km.

Chacornac [29.8°N, 31.7°E] Jean Chacornac, 1823–1873. French astronomer. Discovered six asteroids.
Crater with a disintegrated wall (51 km/1450 m).

Chacornac, Rimae
System of rilles inside Chacornac and to the south of the crater, length up to 120 km *(see also map 25).*

Daniell [35.3°N, 31.1°E] John Frederick Daniell, 1790–1845. English physicist and meteorologist, inventor of the hygrometer.
Elongated crater (30 × 23 km/2070 m).

Daniell, Rimae [37°N, 26°E]
System of rilles, length up to 200 km.

Grove [40.3°N, 32.9°E] Sir William Robert Grove, 1811–1896. English lawyer who carried out valuable research in physics.
Crater (28 km).

Hercules [46.7°N, 39.1°E] Hercules, hero of Greek mythology endowed with superhuman strength. Riccioli presumed that he was an astronomer who lived c. 1560 BC.
Complex crater with dark material on its floor (69 km).

Luther [33.2°N, 24.1°E] Robert Luther, 1822–1900. German astronomer. Discovered 24 minor planets.
Crater (9.5 km/1900 m).

Mason [42.6°N 30.5°E] Charles Mason, 1730–1787. English astronomer, assistant at Greenwich Observatory.
Flooded, partly ruined crater (33 × 43 km).

Mortis, Lacus (Lake of Death) [45°N, 27°E] Named by Riccioli.
A formation 150 km *in diameter, resembling a flooded crater, surface area* 21,000 sq km. *On the floor are the rilles Rimae Bürg, mare ridges, and faults.*

Plana [42.2°N, 28.2°E] Giovanni A. A. Plana, 1781–1864. Italian astronomer and mathematician.
Crater with a central peak (44 km).

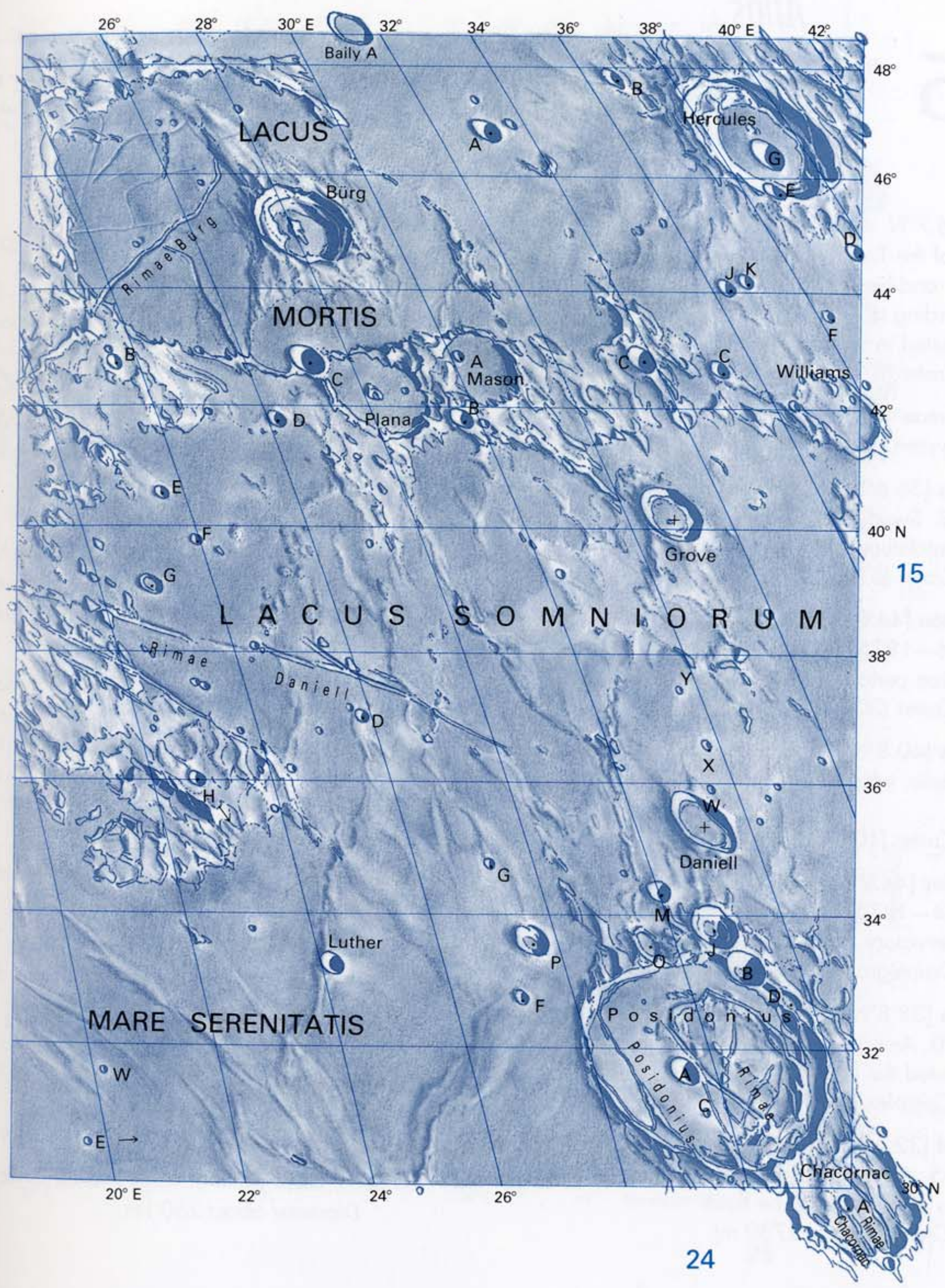
Posidonius [31.8°N, 29.9°E] Posidonius, 135–51 BC. Greek philosopher, geographer, and astronomer.
Large crater with fractured floor (95 km/2300).

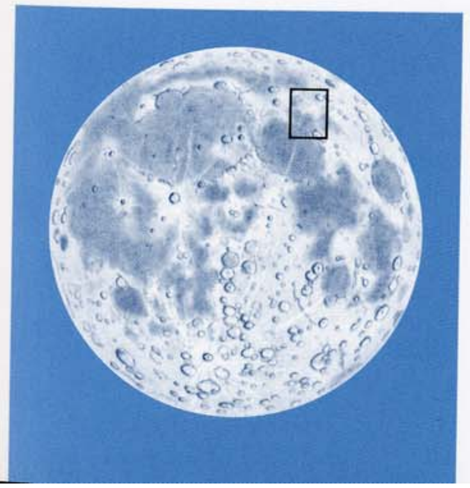
Posidonius, Rimae
System of rilles inside the crater.

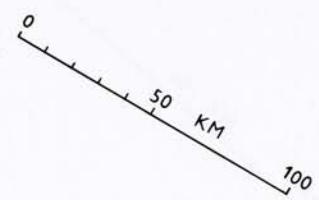
Serenitatis, Mare (Sea of Serenity). See p. 52.

Somniorum, Lacus (Lake of Dreams). Named by Riccioli.
Irregular contours, indefinite borders, surface area about 70,000 sq km.

Williams [42.0°N, 37.2°E] Arthur Stanley Williams, 1861–1938. English lawyer and a diligent observer of the planets, especially Jupiter.
Disintegrated crater (36 km).







15

Atlas

A landscape close to the northeastern limb of the Moon. The eastern promontory of Lacus Somniorum has a wide rille, Rima G. Bond. Hills along the bottom of the map link up with the Taurus mountains.

Atlas [46.7°N, 44.4°E] According to Greek mythology, one of the Titans, standing at the western end of the Earth and bearing the sky on his shoulder. According to Riccioli, Atlas was a Moroccan king, interested in astronomy, who lived about 1580 BC.
Crater (87 km).

Atlas, Rimae
System of rilles on the floor of Atlas.

Berzelius [36.6°N, 50.9°E] Jöns J. Berzelius, 1779–1848. Swedish chemist, author of modern chemical nomenclature.
Crater (51 km).

Carrington [44.0°N, 62.1°E] Richard C. Carrington, 1826–1875. English astronomer. Determined the rotation period of the Sun.
Crater (30 km).

Cepheus [40.8°N, 45.8°E] Mythological king of Ethiopia, whose name was also given to a constellation.
Crater (40 km).

Chevallier [44.9°N, 51.2°E] Temple Chevallier, 1794–1873. French by origin, director of Durham Observatory in England.
Disintegrated, flooded crater (52 km).

Franklin [38.8°N, 47.7°E] Benjamin Franklin, 1706–1790. American statesman, diplomat, and physicist. Invented the lightning conductor.
Complex crater (56 km).

G. Bond [32.4°N, 36.2°E] George P. Bond, 1826–1865. American astronomer. Postulated that the rings of Saturn must be fluid.
Crater (20 km/2780 m).

G. Bond, Rima [33°N, 35°E]
Rille, length 150 km.

Hall [33.7°N, 37.0°E] Asaph Hall, 1829–1907. American astronomer; discovered the moons of Mars.
Disintegrated, flooded crater (39 km/1140 m).

Hooke [41.2°N, 54.9°E] Robert Hooke, 1635–1703. Outstanding English physicist, experimenter, and inventor.
Flooded crater (37 km).

Kirchhoff [30.3°N, 38.8 °E] Gustav R. Kirchhoff, 1824–1887. German physicist. Discovered the basic principles of spectroscopic analysis.
Crater (25 km/2590 m).

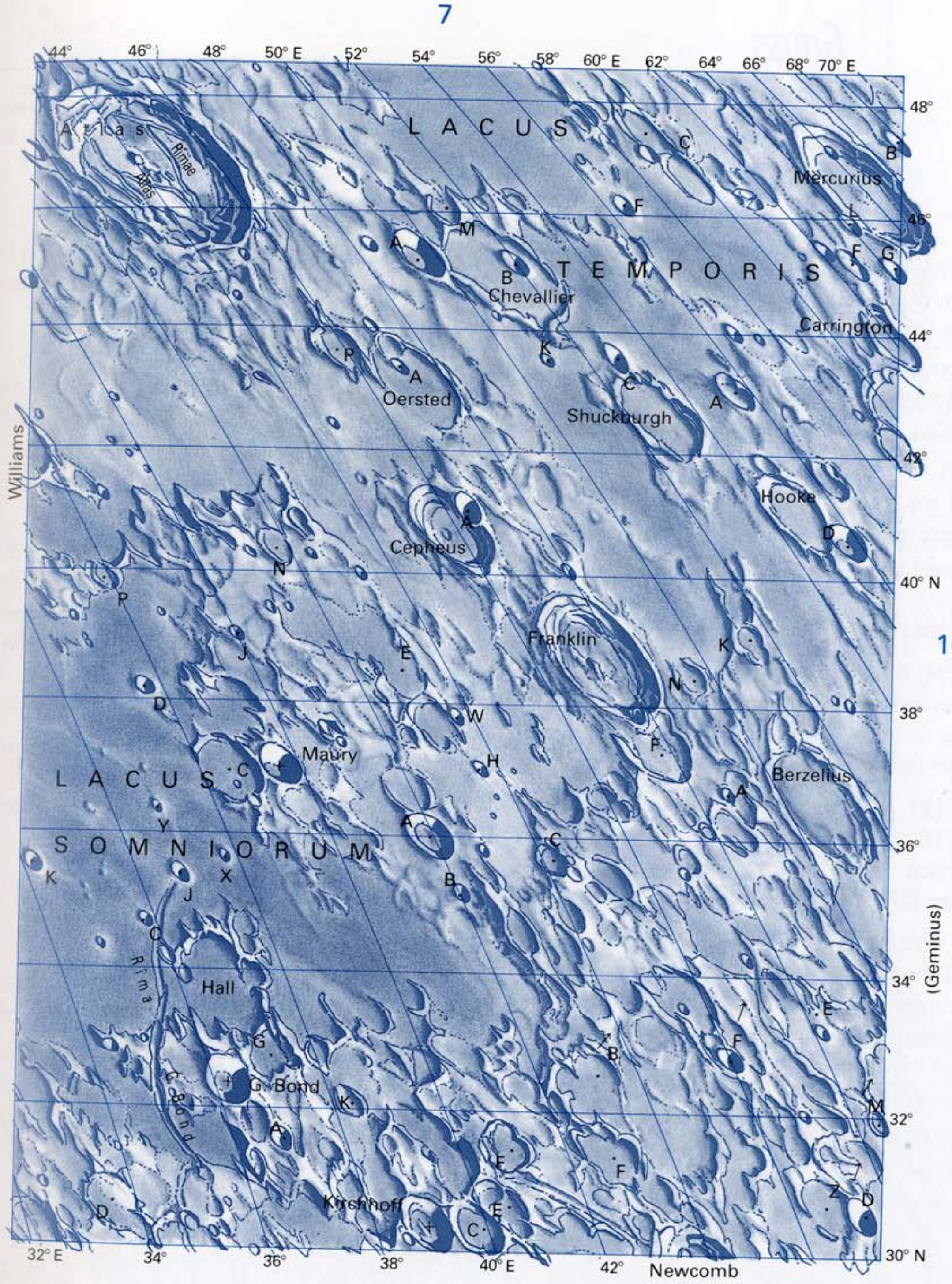
Maury [37.1°N, 39.6°E] (1) Matthew F. Maury, 1806–1873. American oceanographer. (2) Antonia C. Maury, 1866–1952. American astronomer, pioneer in the classification of stellar spectra.
Crater (17.6 km/3270 m).

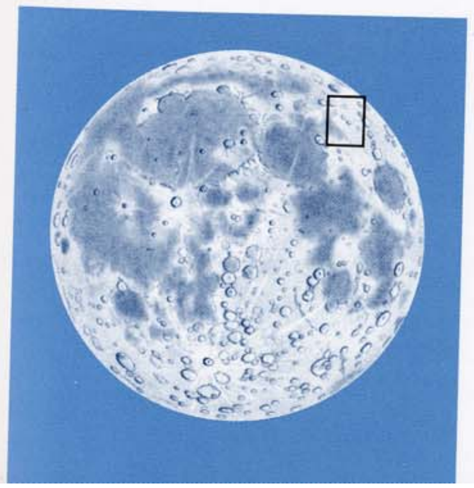
Mercurius [46.6°N, 66.2°E] Mercury. Legendary messenger of the Gods.
Crater (68 km).

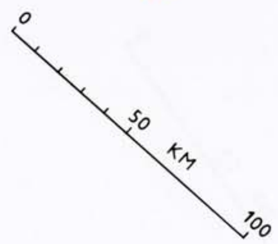
Oersted [43.1°N, 47.2°E] Hans C. Oersted, 1777–1851. Danish physicist and philosopher.
Flooded crater (42 km).

Shuckburgh [42.6°N, 52.8°E] Sir George Shuckburgh, 1751–1804. British astronomer.
Crater (39 km).

Temporis, Lacus (Lake of Time) [46°N, 57°E]
Diameter about 250 km.







16

Gauss

The northeastern limb of the Moon containing the large crater Gauss and prominent craters Geminus, Berosus, and Hahn. To the east of the crater Schumacher is a dark spot, Lacus Spei.

Beals [37.3°N, 86.5°E] Carlyle F. Beals, 1899–1979. Canadian astronomer.
Crater (48 km).

Bernoulli [35°N, 60.7°E] (1) Jacques Bernoulli, 1654–1705. (2) Jean Bernoulli, 1667–1748. Two brothers, Swiss mathematicians, Dutch by origin.
Crater (47 km).

Berosus [33.5°N, 69.9°E] Berosus of Chaldea, 3rd century BC. Babylonian priest, historian, and astronomer; noted the synchronous rotation of the Moon.
Flooded crater (74 km).

Boss [45.8°N, 89.2°E] Lewis Boss, 1846–1912. American astronomer, compiler of positional star catalogs.
Crater (47 km).

Burckhardt [31.1°N, 56.5°E] Johann K. Burckhardt, 1773–1825. German astronomer. Worked in the time service.
Crater (57 km).

Gauss [35.9°N, 79.1°E] Karl Friedrich Gauss, 1777–1855. Famous German mathematician, physicist, geodesist, and theoretical astronomer; director of the observatory in Göttingen. Invented the magnetometer.
Large crater (177 km).

Geminus [34.5°N, 56.7°E] Geminus, c. 70 BC. Greek astronomer.
Prominent complex crater (86 km).

Hahn [31.3°N, 73.6°E] Friedrich, Graf von Hahn, 1741–1805. German amateur astronomer, diligent observer.
Crater (84 km).

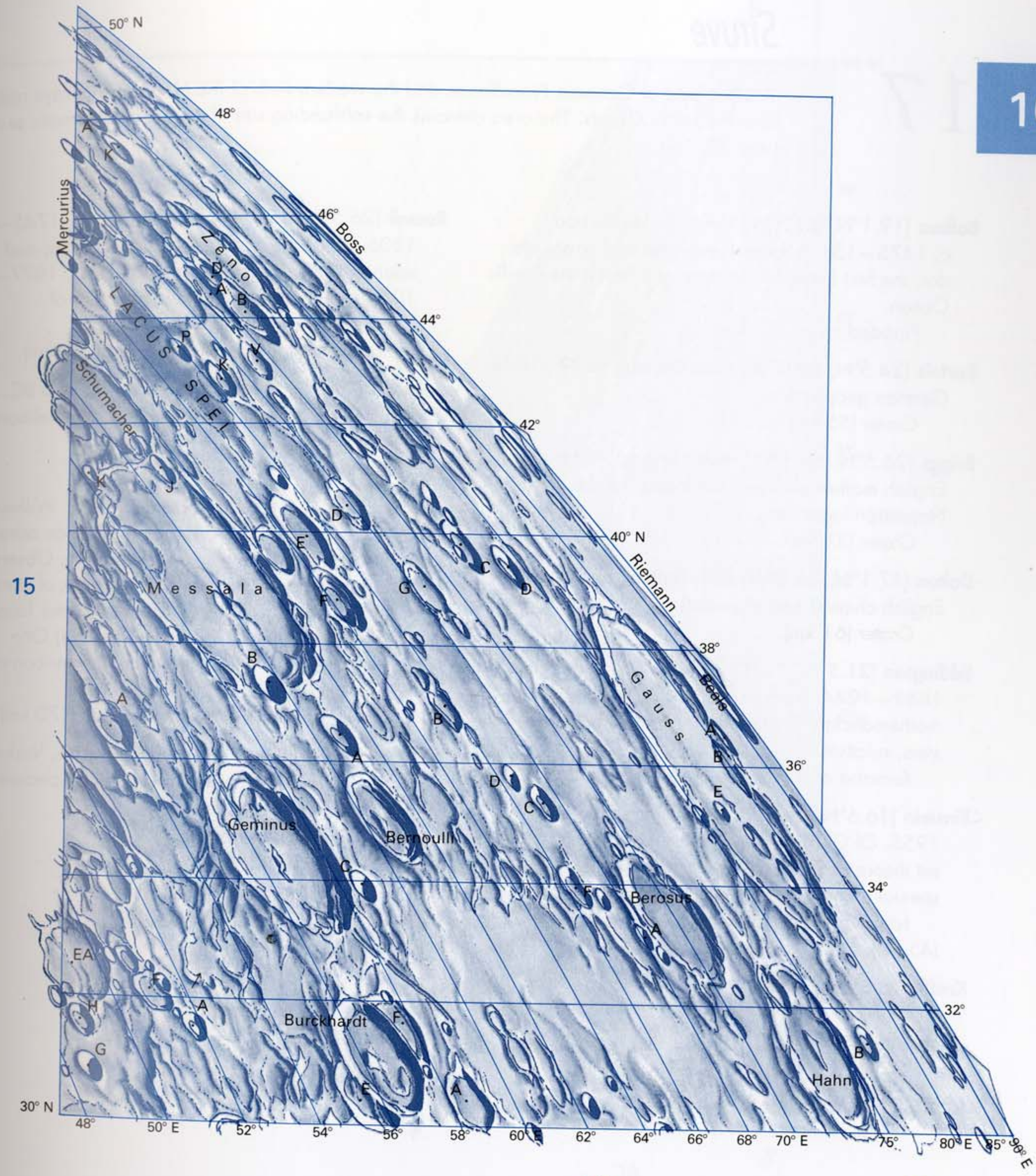
Messala [39.2°N, 59.9°E] Ma-sa-Allah (or Mashalla), died c. 815 AD. Jewish astronomer and astrologer, author of textbooks that were still used in Europe during the Middle Ages.
Large crater (124 km).

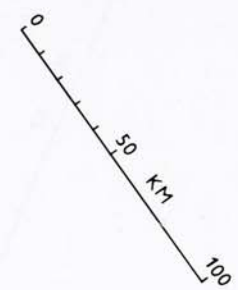
Riemann [39.5°N, 87.2°E] Georg Bernhard Riemann, 1826–1866. German mathematician. Developed "Riemannian geometry" and the fundamental mathematics (calculus) for the geometry used in modern physics.
Large crater (110 km).

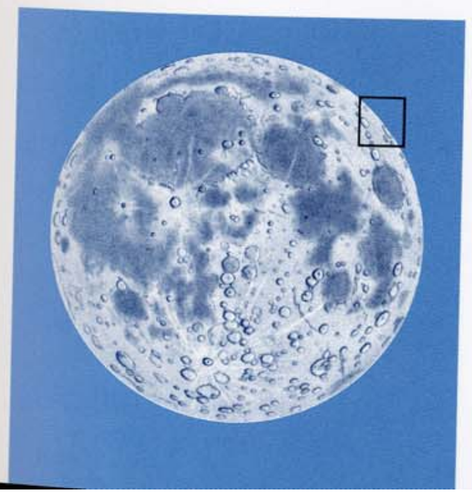
Schumacher [42.4°N, 60.7°E] Heinrich Christian Schumacher, 1780–1850. Danish-born German astronomer; founder of the special periodical Astronomische Nachrichten.
Flooded crater (61 km).

Spei, Lacus (Lake of Hope) [43°N, 65°E]
Diameter 80 km.

Zeno [45.2°N, 72.9°E] Zeno, c. 335–263 BC. Greek philosopher and astronomer who correctly explained the reasons for solar and lunar eclipses.
Crater (65 km).







17

Struve

Western part of Oceanus Procellarum and the western limb of the Moon. Bright rays radiate from the crater Olbers. The area contains the soft-landing site of the Soviet automatic probe Luna 13.

Balboa [19.1°N, 83.2°W] Vasco N. de Balboa, c. 1475—1517. Spanish explorer and conquistador, the first European to sight and reach the Pacific Ocean.
Flooded crater (70 km).

Bartels [24.5°N, 89.9°W] Julius Bartels, 1899—1964. German geophysicist.
Crater (55 km).

Briggs [26.5°N, 69.1°W] Henry Briggs, 1556—1630. English mathematician. Developed the use of Napierian logarithms.
Crater (37 km).

Dalton [17.1°N, 84.3°W] John Dalton, 1766—1844. English chemist and physicist.
Crater (61 km).

Eddington [21.5°N, 71,8°W] Sir Arthur S. Eddington, 1882—1944. Prominent English astrophysicist and mathematician. Studied the internal structure of stars, relativity.
Remains of a flooded large crater (125 km).

Einstein [16.6°N, 88.5°W] Albert Einstein, 1879—1955. Of German origin. One of the world's greatest theoretical physicists; author of the general and special theories of relativity.
Large crater (170 km) *with a central crater* (45 km), *in a libration zone, partly beyond* 90°W.

Krafft [16.6°N, 72.6°W] Wolfgang Ludwig Krafft, 1743—1814. Astronomer and physicist of German origin, worked all his life in St. Petersburg.
Crater with flooded floor (51 km).

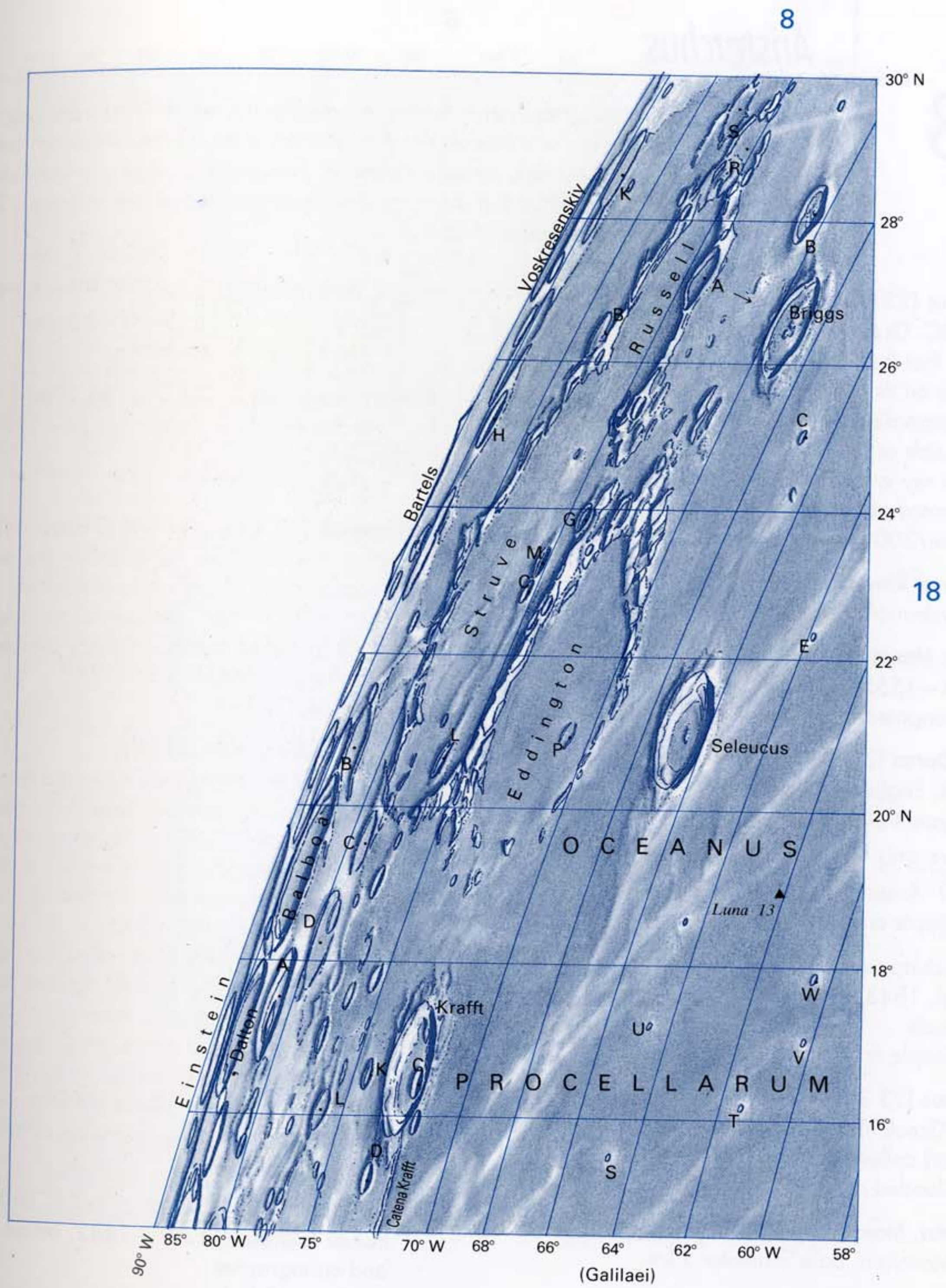
Krafft, Catena [15°N, 72°W]
Crater chain, length 60 km.

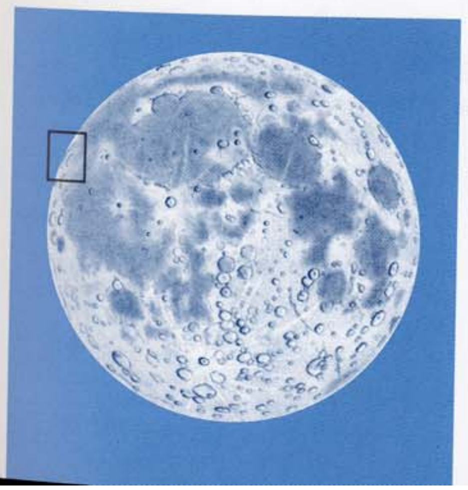
Russell [26.5°N, 75.4°W] (1) John Russell, 1745—1806. British painter, amateur astronomer, and selenographer. (2) Henry Norris Russell, 1877—1957. American astronomer, co-author of Hertzsprung-Russell diagram.
Remains of large flooded crater (103 km).

Seleucus [21.0°N, 66.6°W] Seleucus, c. 150 BC. Babylonian astronomer, defender of the heliocentric theory.
Prominent crater (43 km).

Struve [23.0°N, 76.6 °W] (1) Friedrich G. Wilhelm von Struve, 1793—1864. German-Russian astronomer. Director of Pulkovo Observatory. Observed double stars and measured the parallax of stars. (2) Otto von Struve, 1819—1905. Son of the former and director of Pulkovo Observatory. (3) Otto Struve, 1897—1963. Russian-born American astrophysicist, grandson of Friedrich (1).
Remains of a flooded large crater (170 km).

Voskresenskiy [28.0°N, 88.1°W] Leonid A. Voskresenskiy, 1913—1965. Eminent Soviet specialist in the field of rocket technology.
Flooded crater (50 km).





18

Aristarchus

In this part of Oceanus Procellarum there are exceptionally interesting formations; these include Schröter's Valley, which is visible through even quite a small telescope, and the long sinuous rilles Rima Marius and Rimae Aristarchus. Herodotus Omega is a lunar dome and numerous domes can be found in the vicinity of the crater Marius (see also map 29). This area is dominated by the crater Aristarchus.

Aristarchus [23.7°N, 47.4°W] Aristarchus, c. 310–230 BC. Greek astronomer from Samos; the first to teach that the Earth revolves around the Sun and rotates on its axis.
Extraordinarily bright crater, visible also on the night side of the Moon in earthshine; center of bright ray system; the crater is believed to have originated about 450 million years ago (40 km/3000 m).

Aristarchus, Rimae [28°N, 47°W]
System of rilles, length 120 km.

Agricola, Montes [29°N, 54°W] Georgius Agricola, 1494–1555. German physician and naturalist.
Elongated mountain range, length 160 km.

Burnet, Dorsa [27°N, 57°W] Thomas Burnet, 1635–1715. English naturalist.
System of mare ridges, length 200 km.

Freud [25.8°N, 52.3°W] Sigmund Freud, 1856–1939. Austrian physician and psychoanalyst.
Simple crater (3 km).

Golgi (Schiaparelli D) [27.8°N, 60.0°W] Camillo Golgi, 1843–1926. Italian physician, Nobel Laureate.
Simple crater (5 km).

Herodotus [23.2°N, 49.7°W] Herodotus, c. 485–425 BC. Greek historian from Halicarnassus (Asia Minor) called the "Father of History."
Flooded crater (35 km).

Herodotus, Mons [27°N, 53°W]
Mountain, base diameter 5 km.

Marius, Rima [17°N, 49°W]
Typical sinuous rille, named after the nearby crater Marius (map 29). The rille starts about 25 km northwest of the crater Marius C, where it is about 2 km wide, winds north, and by the crater Marius B then turns west and narrows down to 1 km. The rille ends about 40 km west of the crater Marius P, where its width is only 500 m. Total length of the rille is about 250 km.

Niggli, Dorsum (Niggli's Ridge) [29°N, 52°W] Paul Niggli, 1888–1953. Swiss naturalist.
Mare ridge, length 50 km.

Raman (Herodotus D) [27.0°N, 55.1°W] Chandrasekhara V. Raman, 1888–1970. Indian physicist.
Crater (11 km).

Schiaparelli [23.4°N, 58.8°W] Giovanni V. Schiaparelli, 1835–1910. Italian astronomer. Discovered relationship between meteor showers and comets. In 1877 discovered the apparent *canali* (so-called canals) on Mars; developed terminology used in Mars charts.
Crater (24 km).

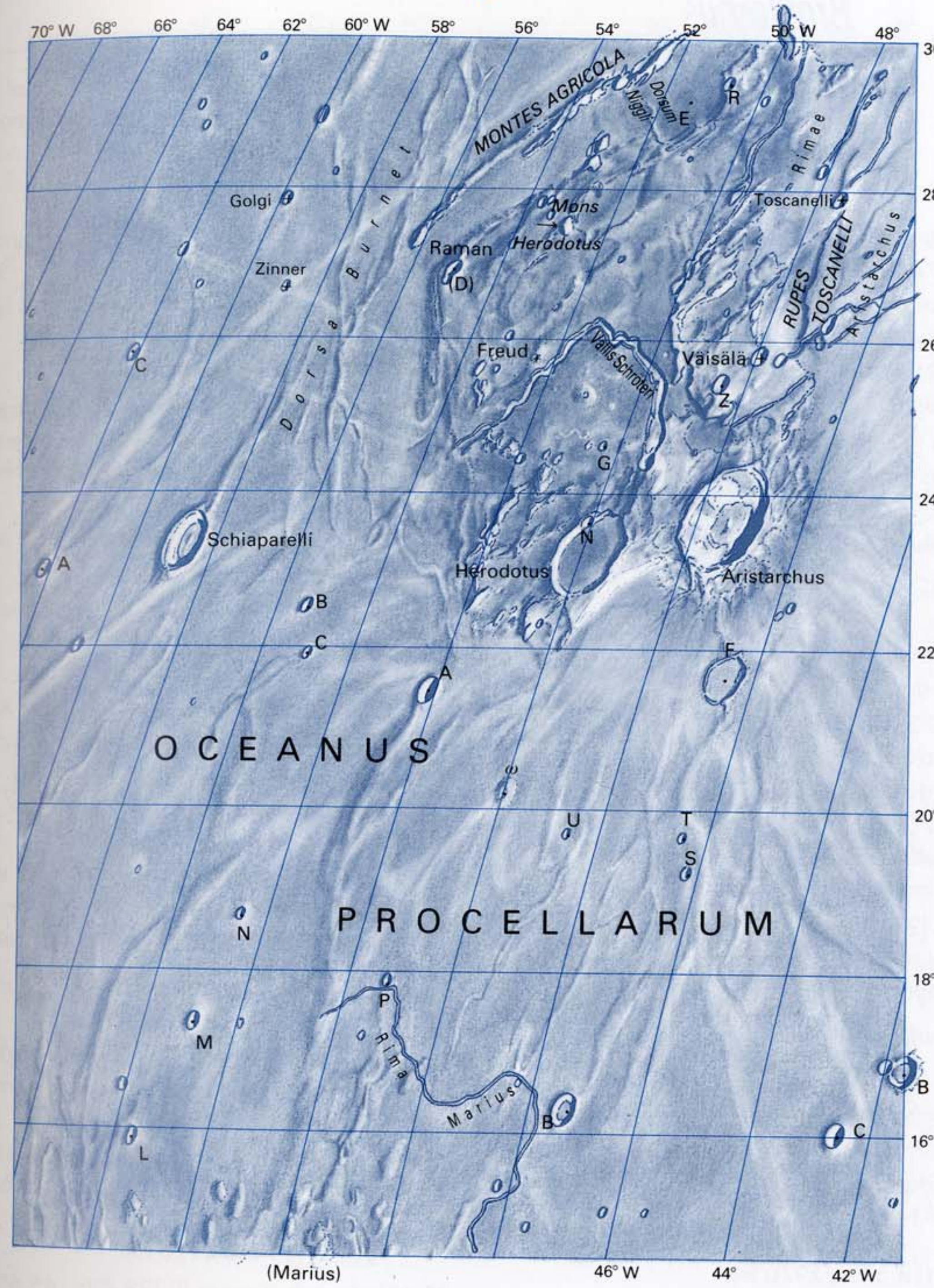
Schröteri, Vallis [26°N, 51°W]
The largest sinuous valley on the Moon, named after the German selenographer Johannes Schröter (crater, see p. 91). The valley starts 25 km north of the crater Herodotus and resembles a dry riverbed with numerous meanders. Starting at a crater 6 km in diameter, the valley widens to 10 km to form a shape that observers have called the "Cobra's head." From this it gradually narrows to 500 m and, still narrowing, terminates at a 1000-m-high bank on the edge of a tetragonal "continent." The total length of this flat-floored valley is 160 km and its maximum depth is about 1000 m. Another sinuous rille on the floor of the valley cannot be seen from the Earth.

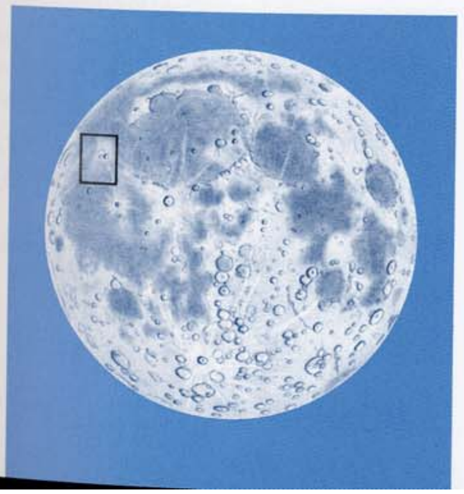
Toscanelli (Aristarchus C) [27.9°N, 47.5°W] Paolo Dal Pozzo Toscanelli, 1397–1482. Italian physician and cartographer.
Crater (7 km).

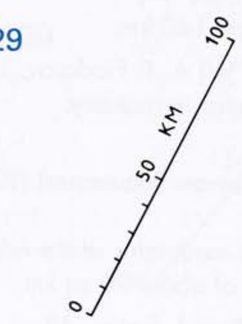
Toscanelli, Rupes [27°N, 47°W]
Fault, length 70 km.

Väisälä (Aristarchus A) [25.9°N, 47.8°W] Yrjo Väisälä, 1891–1971. Finnish astronomer.
Crater (8 km).

Zinner (Schiaparelli B) [26.6°N, 58.8°W] Ernst Zinner, 1886–1970. German astronomer.
Crater (4 km).







19 Brayley

Southwestern part of Mare Imbrium with numerous mare ridges and a network of bright streaks radiating mainly from the craters Copernicus and Aristarchus. An interesting object for larger telescopes is the system of sinuous rilles near the crater Prinz.

Angström [29.9°N, 41.6°W] Anders J. Angström, 1814–1874. Swedish physicist.
Simple crater (9.8 km/2030 m).

Arduino, Dorsum [26°N 36°W] Giovanni Arduino, 1713–1795. Italian naturalist.
Mare ridge, length 110 km.

Argand, Dorsa [28°N, 40°W] Emile Argand, 1879–1940. Swiss naturalist.
System of mare ridges, length 150 km.

Aristarchus, Rimae. See map 18.

Artsimovich (Diophantus A) [27.6°N, 36.6°W] Lev A. Artsimovich, 1909–1973. Soviet physicist.
Simple crater (9 km/860 m).

Bessarion [14.9°N, 37.3°W] Johannes Bessarion, 1389–1472. Greek scholar.
Simple crater (10.2 km/2000 m).

Brayley [20.9°N, 36.9°W] Edward W. Brayley, 1801–1870. English professor of physical geography and meteorology at the Royal Institution, London.
Simple crater (14.5 km/2840 m).

Brayley, Rima [23°N, 36°W]
Narrow rille, not observable with small telescopes, length 240 km.

Delisle. See map 9.

Delisle, Mons [29°N, 36°W]
Mountain, base diameter 30 km.

Diophantus [27.6°N, 34.3°W] Diophantus, c. 4th century AD. Greek mathematician from Alexandria; established principle for solving mathematical equations.
Crater (18.5 km/2970 m).

Diophantus, Rima [29°N, 33°W]
Narrow rille, length 140 km.

Fedorov [28.2°N, 37.0°W] A. P. Fiodorov, 1872–1920. Russian specialist in rocketry.
Crater (7 km).

Harbinger, Montes (Harbinger Mountains) [27°N, 41°W]
Group of isolated mountains at the edge of Mare Imbrium, area of about 90 sq km.

Imbrium, Mare (Sea of Rains). See p. 48.

Ivan (Prinz B) [26.9°N, 43.3°W] Russian male name.
Simple crater (4 km).

Jehan (Euler K) [20.7°N, 31.9°W] Turkish female name.
Simple crater (4.8 km/730 m).

Krieger [29.0°N, 45.6°W] Johann N. Krieger, 1865–1902. German selenographer. Drew details of lunar surface features on enlarged photographs.
Flooded crater (22 km).

Louise [28.5°N, 34.2°W] German female name.
Simple crater (1.5 km)

Natasha (Euler P) [20.0°N, 31.3°W] Russian female name.
Crater (12 km/290 m).

Prinz [25.5°N, 44.1°W] Wilhelm Prinz, 1857–1910. German selenographer. Undertook comparative studies of lunar and terrestrial surfaces.
Remains of a flooded crater (47 km/1010 m).

Prinz, Rimae [27°N, 43°W]
System of sinuous rilles, observable with larger telescopes (length of rilles up to 80 km).

Procellarum, Oceanus (Ocean of Storms). See p. 84.

Rocco (Krieger D) [28.9°N, 45.0°W] Italian male name.
Simple crater (4.4 km/880 m).

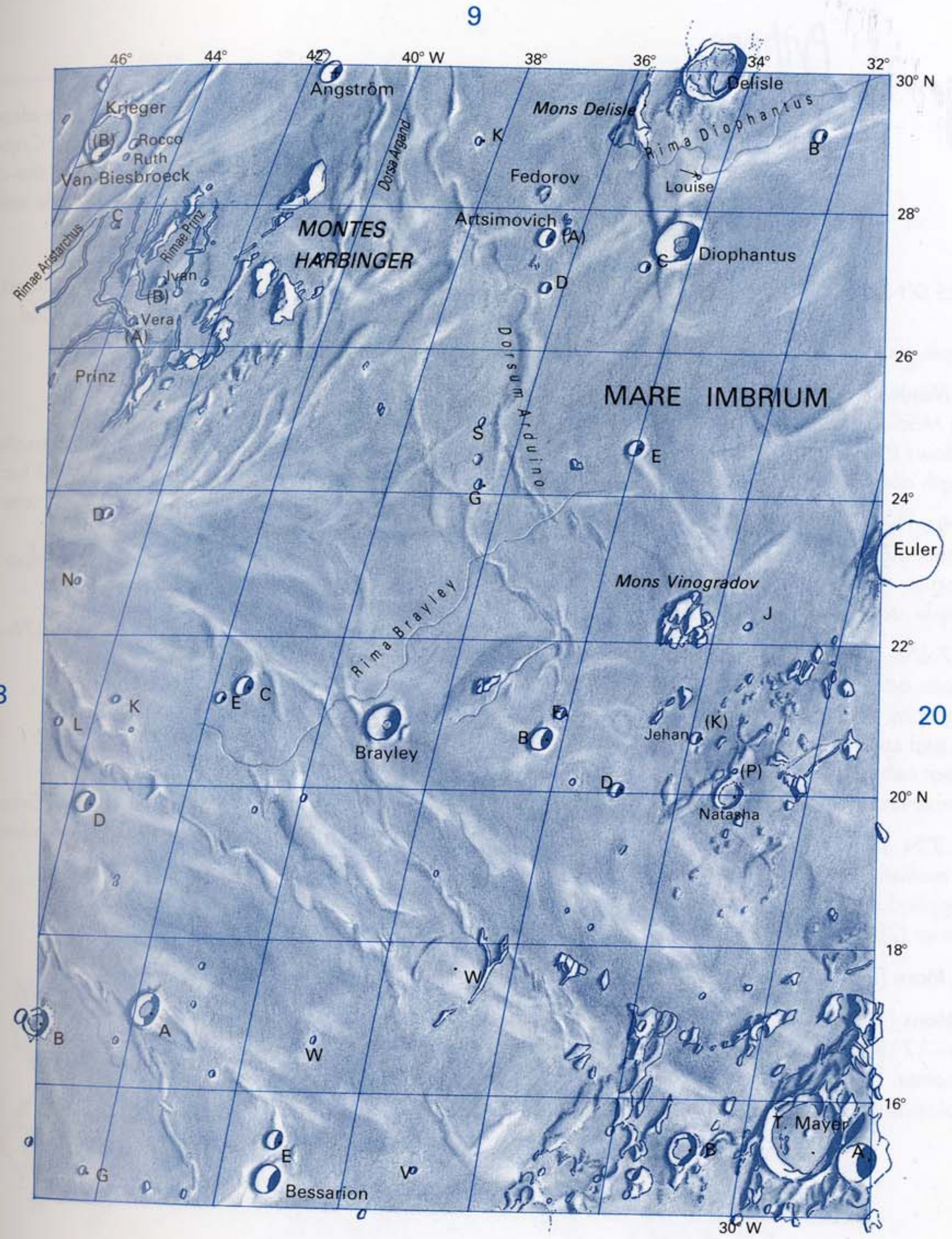
Ruth [28.7°N, 45.1°W] Jewish female name.
Simple crater (3 km).

T. Mayer [15.6°N, 29.1°W] Tobias Mayer, 1723–1762. German selenographer, author of an accurate map of the Moon.
Crater (33 km/2920 m).

Van Biesbroeck (Krieger B) [28.7°N, 45.6°W] George A. Van Biesbroeck, 1880–1974. Belgian-born American astronomer.
Simple crater (10 km).

Vera (Prinz A) [26.3°N, 43.7°W] Latin female name.
Simple crater (4.9 km/180 m): *the longest rille of Rimae Prinz originates at this crater.*

Vinogradov, Mons (Euler, Mons) [22.4°N, 43.4°W] Alexander P. Vinogradov, 1895–1975. Soviet geochemist.
Group of mountains, base diameter 25 km.



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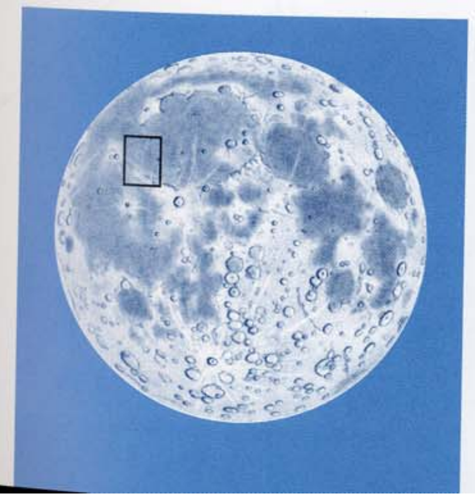
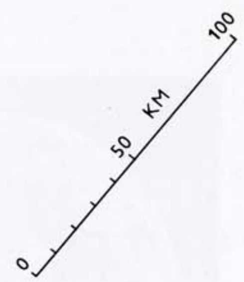




20 Pytheas

The southern part of Mare Imbrium, bordered by the Carpathian Mountains (see also map 31). A complex pattern of bright rays in this area originate from the crater Copernicus (see map 31). Interesting objects for observation include a crater chain north of the crater Stadius M, at the bottom right of the map, and the ghost crater Lambert R, visible only when close to the terminator.

Artemis [25.0°N, 25.4°W] Greek goddess, sister of Apollo.
Simple crater (2 km).

Carpatus, Montes (Carpathian Mountains) [15°N, 25°W] Mädler's name for a lunar mountain range that follows the southern border of Mare Imbrium.
Length about 400 km.

Caventou (La Hire D) [29.8°N, 29.4°W] Joseph B. Caventou, 1795–1877. French chemist and pharmacologist.
Simple crater (3 km/400 m).

Draper [17.6°N, 21.7°W] Henry Draper, 1837–1882. American astronomer, one of the pioneers of astrophotography and spectroscopy. Photographed the Moon and spectra of the stars; first to photograph the great nebula in Orion.
Simple crater (8.8 km/1740 m).

Euler [23.3°N, 29.2°W] Leonhard Euler, 1707–1783. Swiss mathematician; worked in the fields of pure and applied mathematics and celestial mechanics.
Crater (28 km/2240 m).

Imbrium, Mare (Sea of Rains). See p. 48.

La Hire, Mons [28°N, 25°W] Philippe de La Hire, 1640–1718. French mathematician, surveyor, and astronomer.
Isolated mountain massif (10 × 20 km).

Lambert [25.8°N, 21.0°W] Johann H. Lambert, 1728–1777. German mathematician and astronomer.
Prominent crater with terraced walls (30 km/2690 m).

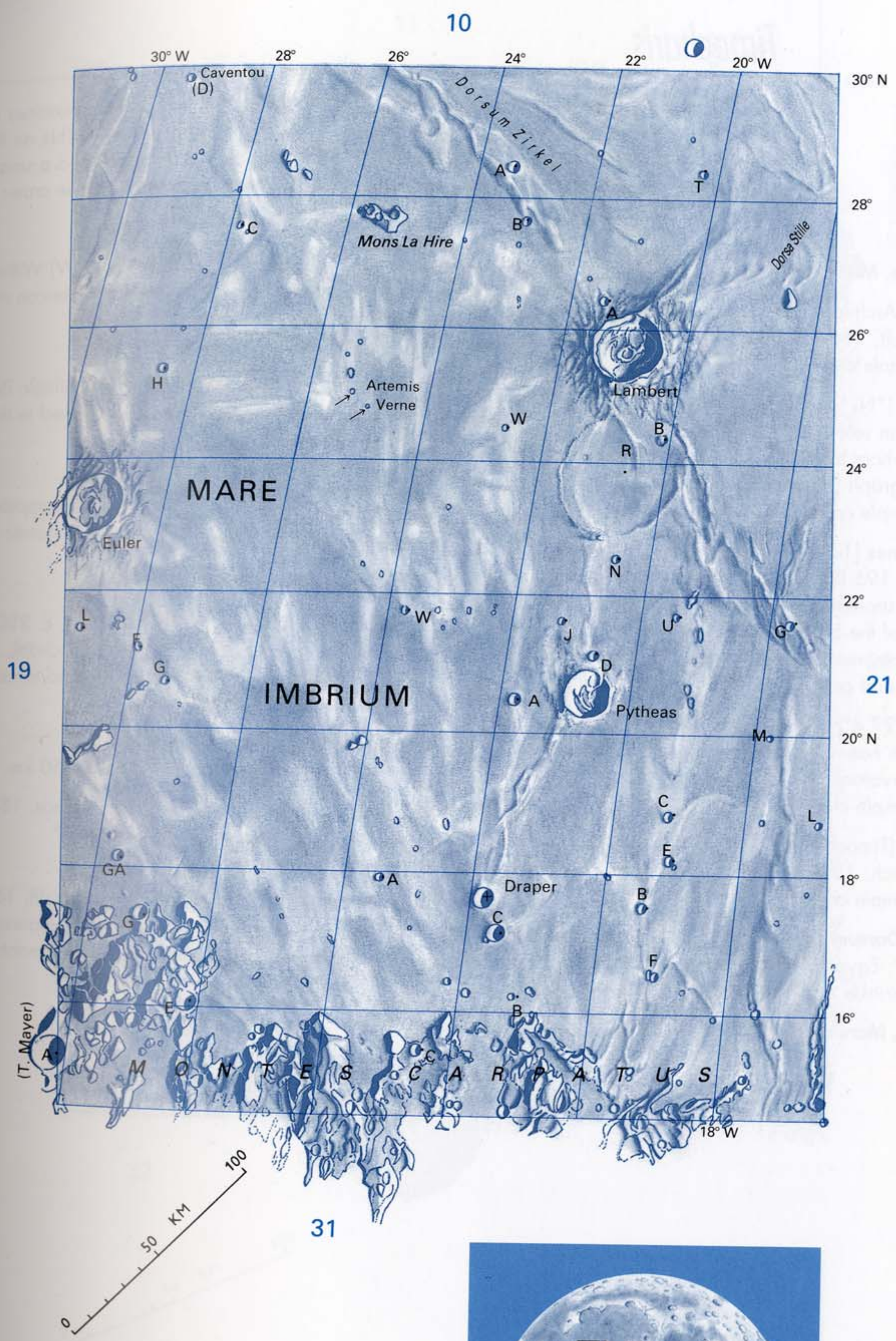
Pytheas [20.5°N, 20.6°W] Pytheas of Massalia, c. 350 BC. Greek navigator who sailed far to the north of Britain. First Greek to associate the tides with the Moon.
Crater with a sharp rim and a hilly floor (20 km/2530 m).

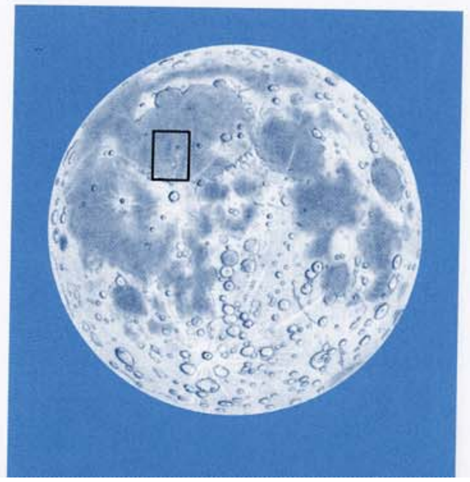
Stille, Dorsa [27°N, 19°W] Hans Stille, 1876–1966. German naturalist.
System of mare ridges, length 80 km.

Verne [24.9°N, 25.3°W] Latin male name.
Simple crater (2 km).

Zirkel, Dorsum [29°N, 24°W] Ferdinand Zirkel, 1838–1912. German geologist and mineralogist.
Mare ridge, length 210 km.

Small craters: **Draper C** (7.8 km/1610 m)
Pytheas A (6.0 km/1180 m)
Pytheas D (5.2 km/370 m)
Pytheas G (3.4 km/490 m)





Timocharis

21

The southeastern part of Mare Imbrium and southwestern promontory of the Apennines terminated by the crater Eratosthenes. Bright rays from the crater Copernicus are visible on the surface of Mare Imbrium under high illumination. A system of wrinkle ridges and a small dome can be seen under oblique illumination about 15 km south-southeast of the crater Beer.

Apenninus, Montes (Apennines). See map 22.

Bancroft (Archimedes A) [28.0°N, 6.4°W] W. D. Bancroft, 1867–1953. American chemist.
Simple crater (13.1 km/2490 m).

Beer [27.1°N, 9.1°W] Wilhelm Beer, 1797–1850. German selenographer, collaborator of Mädler, with whom he published a map of the Moon and monograph Der Mond (1837).
Simple crater (10.2 km/1650 m).

Eratosthenes [14.5°N, 11.3°W] Eratosthenes, c. 275–195 BC. Greek mathematician, geographer, and astronomer; the first to determine the circumference of the Earth.
Prominent complex crater with large terraced walls and central peaks (58 km/3570 m).

Fouillée [27.4°N, 9.4°W] Louis Feuillée, 1660–1732. French naturalist, director of Marseilles Observatory.
Simple crater (9.5 km/1810 m).

Heinrich (Timocharis A) [24.8°N, 15.3°W] Vladimír Heinrich, 1884–1965. Czechoslovak astronomer.
Simple crater (7.4 km/1420 m).

Higazy, Dorsum [28°N, 17°W] Riad Higazy, 1919–1967. Egyptian naturalist.
Wrinkle ridge, length 60 km.

Imbrium, Mare (Sea of Rains). See p. 48.

Macmillan (Archimedes F) [24.2°N, 7.8°W] William Duncan Macmillan, 1871–1948. American mathematician and astronomer.
Crater (7.5 km/360 m).

Pupin (Timocharis K) [23.8°N, 11.0°W] Mihajlo Pupin, 1858–1935. Yugoslav physicist, worked in the USA.
Simple crater (2 km/400 m).

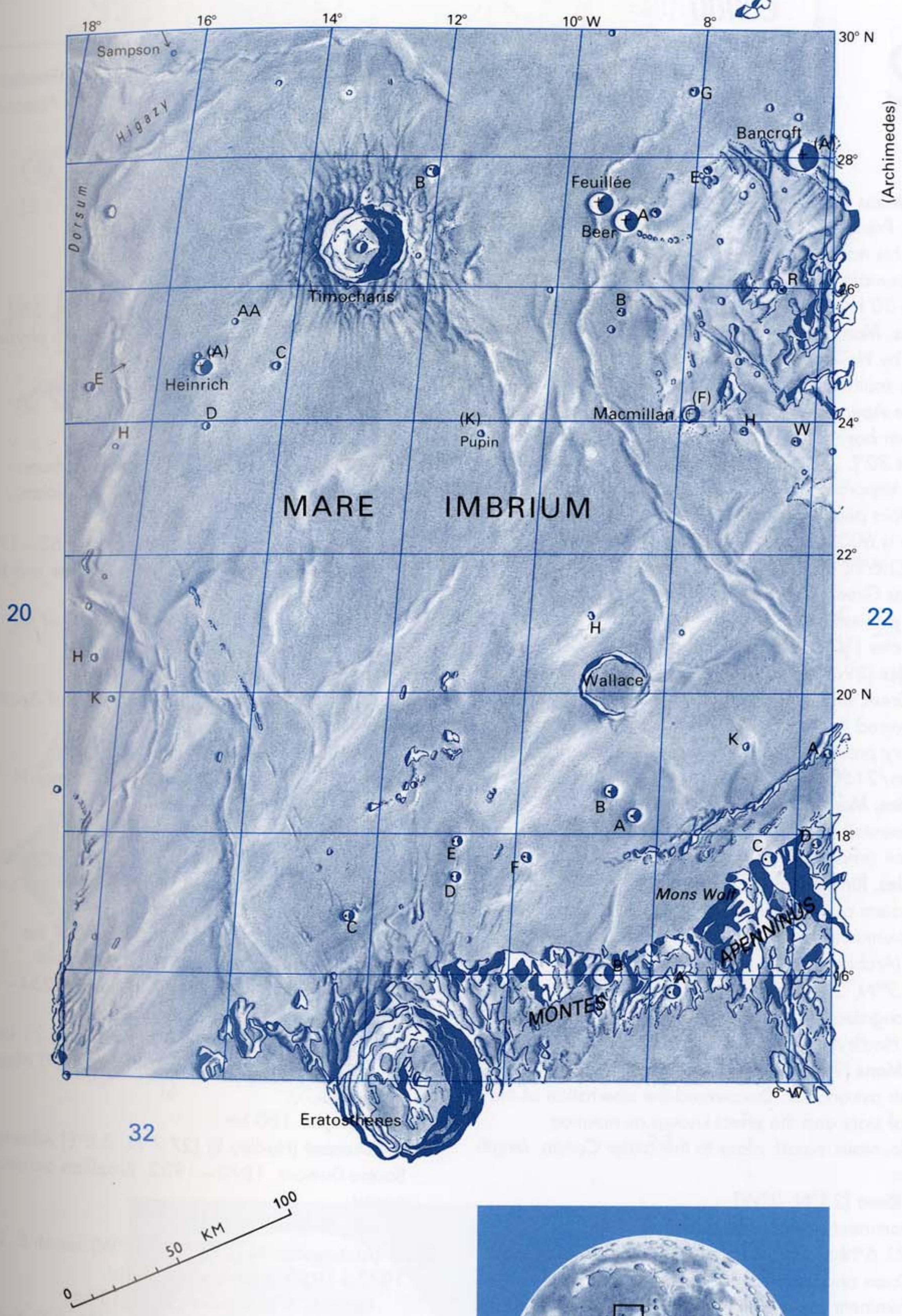
Sampson [29.7°N, 16.5°W] Ralph Allen Sampson, 1866–1939. British astronomer; Astronomer Royal for Scotland.
Simple crater (1.5 km).

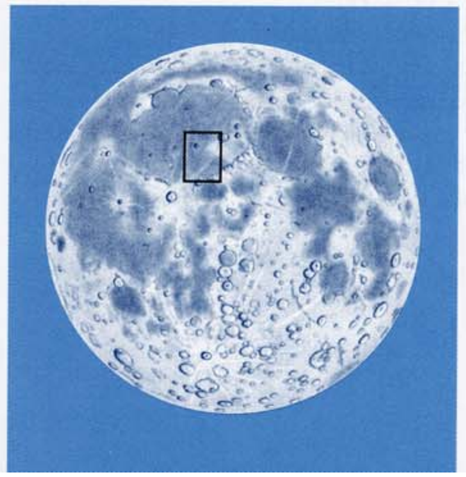
Timocharis [26.7°N, 13.1°W] Timocharis, c. 280 BC. Greek astronomer of the Alexandrian school.
Complex crater with a sharp rim and terraced walls (34 km/3110 m).

Timocharis, Catena [29°N, 13°W]
Narrow crater chain, length about 50 km.

Wallace [20.3°N, 8.7°W] Alfred R. Wallace, 1823–1913. English naturalist and explorer.
Remains of flooded crater (26 km).

Volff, Mons [17°N, 7°W] Christian von Wolff, 1679–1754. German philosopher and mathematician.
Mountain massif in the southwest promontory of the Apennines, diameter 35 km.





22 Conon

The largest lunar mountain range, the Apennines, and the prominent crater Archimedes dominate this part of the Moon close to the prime meridian. It was at the foot of the Apennines, close to Rima Hadley, that the Apollo 15 expedition landed.

Ampère, Mons [19°N, 4°W] André M. Ampère, 1775–1836. French physicist. The unit of electric current bears his name.
Mountain massif in the central part of Apennines, length 30 km.

Apenninus, Montes (Apennines) [20°N, 3°W] Name given by Hevelius to the impressive mountain range on the southeast border of Mare Imbrium.
The Apennines form part of the main ring of the Imbrium basin, which they descend relatively steeply (about 30°). The slopes of the Apennines toward Mare Vaporum are gradual. The height of some mountain peaks exceeds 5000 m; the length of the range is 600 km.

Aratus [23.6°N, 4.5°E] Aratus, c. 315–245 BC. Popular Greek poet. Author of the oldest description of 48 ancient constellations.
Crater (10.6 km/1860 m).

Archimedes [29.7°N, 4.0°W] Archimedes, c. 287–212 BC. Greek mathematician and physicist of Syracuse. Discovered the principle of hydrostatic equilibrium.
Very prominent flooded crater with terraced walls (83 km/2150 m).

Archimedes, Montes [26°N, 5°W]
Mountain range south of Archimedes, extending over an area about 140 km *in diameter.*

Archimedes, Rimae [27°N, 4°W]
System of rilles southeast of Archimedes, length approximately 150 km.

Bancroft (Archimedes A). See map 21.

Běla [24.7°N, 2.3°E] Slavic name.
Elongated crater (11 x 2 km) *at the beginning of Rima Hadley.*

Bradley, Mons [22°N, 1°E] James Bradley, 1692–1762. English astronomer. Discovered the aberration of the light of stars and the effect known as nutation.
Mountain massif, close to the crater Conon, length 30 km.

Bradley, Rima [23°N, 2°W]
Prominent straight rille, length 130 km.

Conon [21.6°N, 2.0°E] Conon, c. 260 BC. Greek mathematician and astronomer, friend of Archimedes.
Prominent crater with a sharp rim (22 km/2320 m).

Conon, Rima [18°N, 2°E]
Sinuous rille in the Sinus Fidei, length 45 km.

Felicitatis, Lacus (Lake of Happiness) [19°N, 5°E]
Diameter 90 km.

Fidei, Sinus (Bay of Faith) [18°N, 2°E]
Length about 70 km.

Fresnel, Promontorium (Cape Fresnel) [29°N, 5°E] Augustin J. Fresnel, 1788–1827. French physicist, distinguished in optics (Fresnel's lens).
Northern promontory of the Apennines.

Fresnel, Rimae [28°N, 4°E]
System of rilles, length about 90 km.

Galen (Aratus A) [21.9°N, 5.0°E] Galenos from Pergamum, c. 129-200 AD. Greek physician.
Crater (10 km).

Hadley, Mons [27°N, 5°E] John Hadley, 1682–1743. English pioneer of the reflecting telescope and the reflecting quadrant.
Mountain massif in the northern part of the Apennines, length 25 km.

Hadley Delta, Mons [26°N, 4°E]
Mountain massif, at the landing site of Apollo 15.

Hadley, Rima [25°N, 3°E]
Sinuous rille, length 80 km.

Huxley (Wallace B.) [20.2°N, 4.5°W] Thomas H. Huxley, 1825–1895. British biologist.
Simple crater (4 km/840 m).

Huygens, Mons [20°N, 3°W] Christiaan Huygens, 1629–1695. Dutch astronomer and optician, recognized the true identity of Saturn's rings.
Mountain massif in the central part of the Apennines, height 5400 m, *length* 40 km.

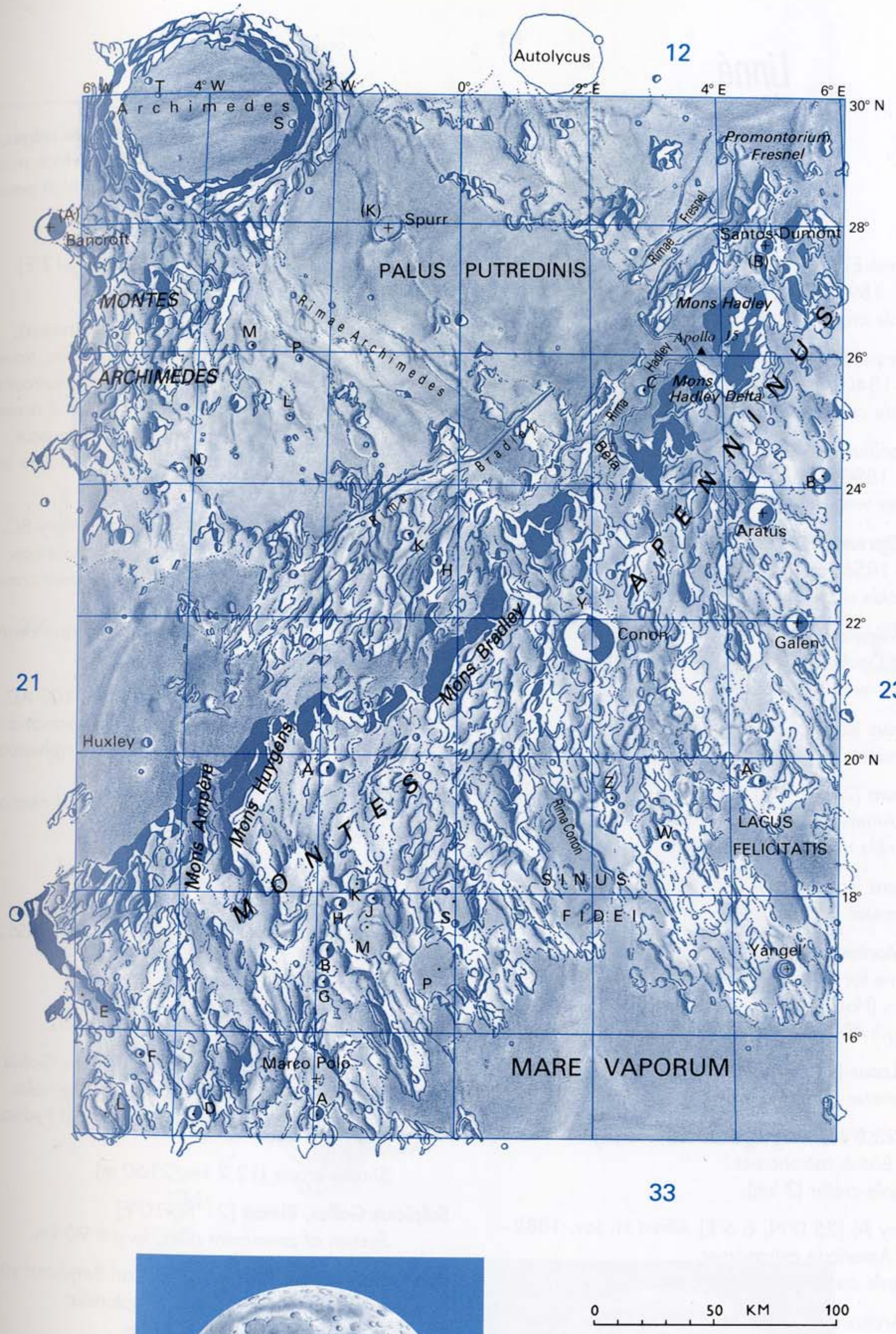
Marco Polo [15.4°N, 2.0°W] Marco Polo, 1254–1324. Famous Venetian traveler to the Far East.
Remains of an elongated crater (28 × 21 km).

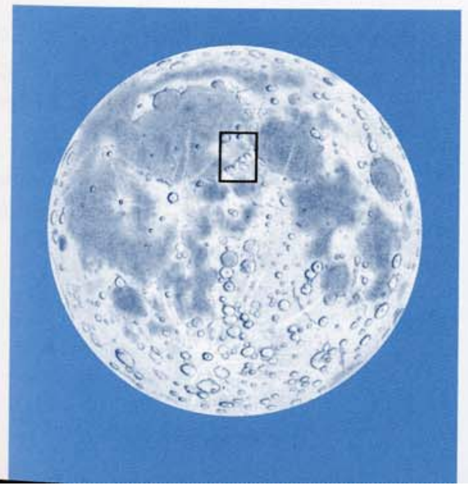
Putredinis, Palus (Marsh of Decay) [27°N, 0°] Named by Riccioli.
Diameter 180 km.

Santos-Dumont (Hadley B) [27.7°N, 4.8°E] Alberto Santos-Dumont, 1873–1932. Brazilian aeronautical expert.
Simple crater (9 km).

Spurr (Archimedes K) [27.9°N, 1.2°W] Josiah E. Spurr, 1870–1950. American geologist.
Remains of a flooded crater (13 km).

Yangel' (Manilius F) [17.0°N, 4.7°E] Mikhail K. Yangel', 1911–1971. Soviet specialist in rocket propulsion.
Crater (9 km).





23 Linné

The western part of Mare Serenitatis offers the observer simple craters, long mare ridges, and also the simple crater Linné, famous for apparent "metamorphoses" about which much has been written. There is a series of rilles west of the crater Sulpicius Gallus, which parallel the Haemus mountain range.

Banting (Linné E) [26.6°N, 16.4°E] Sir Frederick G. Banting, 1891–1941. Canadian physician.
Simple crater (5 km/1100 m).

Bobillier (Bessel E) [19.6°N, 15.5°E] E. Bobillier, 1798–1840. French geometer.
Simple crater (6.5 km/1230 m).

Bowen (Manilius A) [17.6°N, 9.1°E] Ira Sprague Bowen, 1898–1973. American astronomer.
Crater with a flat floor (9 km).

Buckland, Dorsum [21°N, 12°E] William Buckland, 1748–1856. British naturalist.
Wrinkle ridge, length 150 km.

Daubrée (Menelaus S) [15.7°N, 14.7°E] Gabriel-Auguste Daubrée, 1814–1896. French geologist.
Crater with a flooded floor (14 km/1590 m).

Doloris, Lacus (Lake of Suffering) [17°N, 9°E]
Diameter 110 km.

Gast, Dorsum [24°N, 9°E] Paul Werner Gast, 1930–1973. American geochemist.
Wrinkle ridge, length 60 km.

Gaudii, Lacus (Lake of Joy) [17°N, 13°E]
Diameter 100 km.

Haemus, Montes (Haemus Mountains) [17°N, 13°E] An old name for a Balkan mountain range given by Hevelius (Haemus, mons Thraciae)
Length 400 km.

Hiemalis, Lacus (Winter Lake) [15°N, 14°E]
Diameter 50 km.

Hornsby [23.8°N, 12.5°E] Thomas Hornsby, 1733–1810. British astronomer.
Simple crater (3 km).

Joy (Hadley A) [25.0°N, 6.6°E] Alfred H. Joy, 1882–1973. American astronomer.
Simple crater (6 km/1000 m).

Krishna (Aratus CA) [24.5°N, 11.3°E] Indian male name.
Irregular, probable endogenic crater (8 × 3 km).

Lenitatis, Lacus (Lake of Tenderness) [14°N, 12°E]
Diameter 80 km.

Linné [27.7°N, 11.8°E] Carl von Linné (Linnaeus), 1707–1778. Swedish botanist, physician, traveler.
Fresh simple crater (2.4 km/600 m), *surrounded by light material; under high illumination it resembles a brightly shining white patch; in the past numerous observer recorded alleged changes in the size and appearance of the formation.*

Manilius [14.5°N, 9.1°E] Manilius, 1st century BC. Roman poet, author of the poem Astronomicon, which contains a description of well-known constellations.
Very prominent crater with terraces and central peaks (39 km/3050 m).

Menelaus [16.3°N, 16.0°E] Menelaus, c. 100 AD. Greek geometer and astronomer of Alexandria. Author of "Spherica," which deals with spherical trigonometry.
Prominent crater with a sharp rim and central peaks (27 km/3010 m).

Odii, Lacus (Lake of Hate) [19°N, 7°E]
Diameter 70 km.

Owen, Dorsum [25°N, 11°E] George Owen, 1552–1613. British naturalist.
Wrinkle ridge, length 50 km.

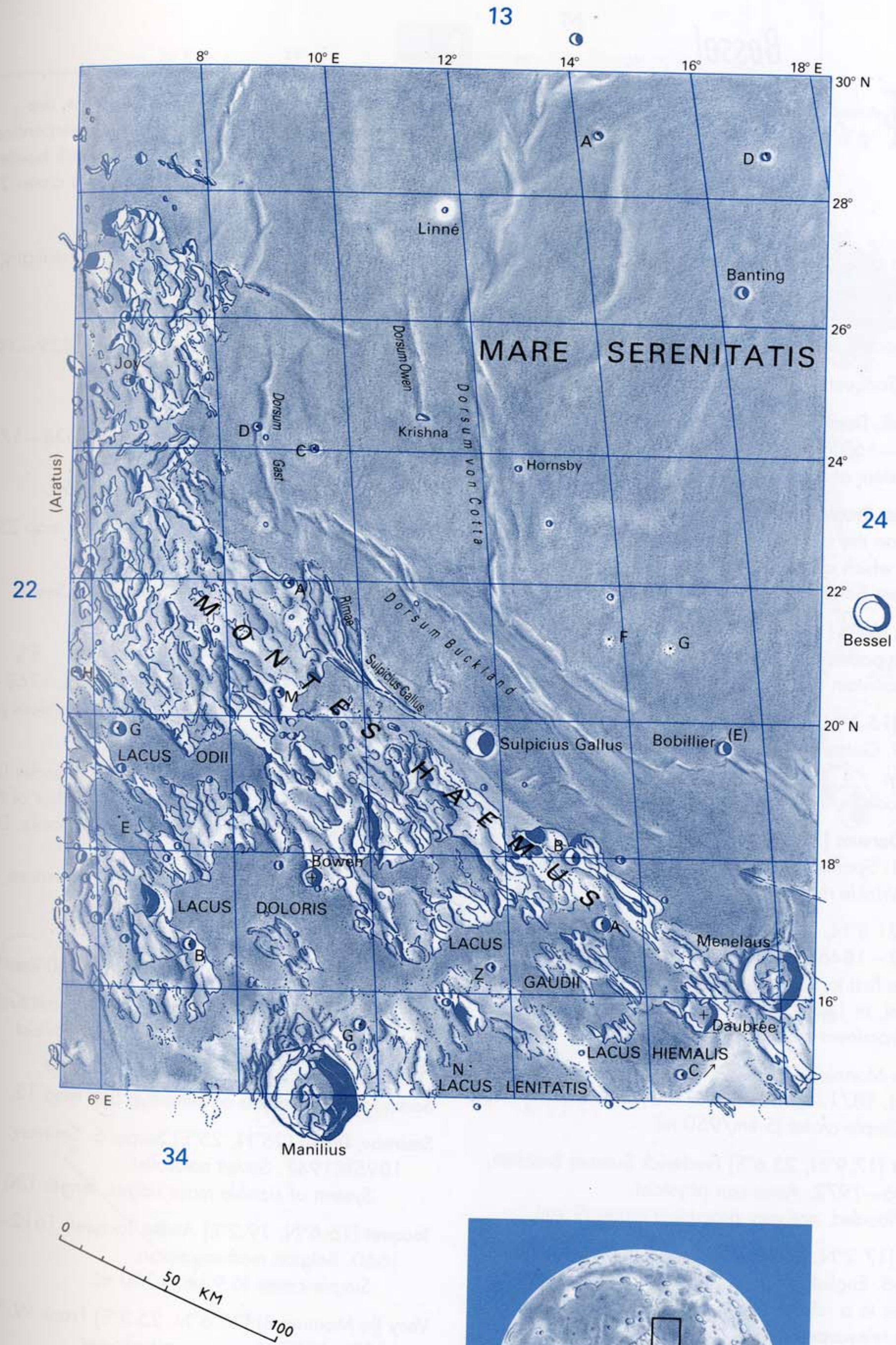
Serenitatis, Mare (Sea of Serenity). See p. 52.

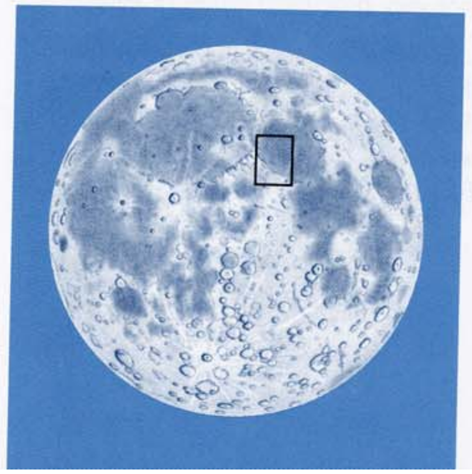
Sulpicius Gallus [19.6°N, 11.6°E] Sulpicius Gallus, c. 168 BC. Roman consul, orator, and scholar. Foretold lunar eclipse on eve of battle of Pydna, Macedonia.
Simple crater (12.2 km/2160 m).

Sulpicius Gallus, Rimae [21°N, 10°E]
System of prominent rilles, length 90 km.

von Cotta, Dorsum [24°N, 12°E] Carl Bernhard von Cotta, 1808–1879. German naturalist.
Wrinkle ridge, length 220 km.

Note: Tiny, simple craters Bessel F (0.5 km/50 m) and Bessel G (1 km/70 m) when observed from the Earth appear as mere bright patches. Their sizes were determined from photographs taken by Lunar Orbiter 4.





24 Bessel

The eastern part of Mare Serenitatis is intersected in many places by mare ridges, the largest of which approximately follows the line of the meridian 25°E and has a serpentine shape (formerly called Serpentine Ridge). The edge of Mare Serenitatis has a dark border and a series of shallow rilles. The summit of Posidonius Gamma (old name) has a crater 2 km in diameter.

Abetti [19.9°N, 27.7°E] (1) Antonio Abetti, 1846–1928; (2) Antonio Abetti, 1882–1982. Italian astronomers.
Flooded, not very prominent crater (7 km).

Al-Bakri (Tacquet A). See map 35.

Aldrovandi, Dorsa [24°N, 29°E] Ulisse Aldrovandi, 1522–1605. Italian naturalist.
System of mare ridges, length 120 km.

Archerusia, Promontorium [17°N, 22°E] Old name for a cape on the southern edge of Pontus Euxinus (Black Sea), which on Hevelius' map was marked in place of Mare Serenitatis and Mare Tranquillitatis.

Argaeus, Mons [19°N, 29°E] Old name for a mountain in Cappadocia.
Mountain massif, length 50 km.

Auwers [15.1°N, 17.2°E] Arthur von Auwers, 1838–1915. German astronomer, director of Gotha observatory.
Flooded crater, open to the north (20 km/1680 m).

Azara, Dorsum [26°N, 20°E] Felix de Azara, 1746–1811. Spanish naturalist.
Wrinkle ridge, length 110 km.

Bessel [21.8°N, 17.9°E] Friedrich Wilhelm Bessel, 1784–1846. Prominent German astronomer. One of the first to measure the parallax of a star (61 Cygni, in 1838).
Prominent crater (16 km/1740 m).

Borel (le Monnier C) [22.3°N, 26.4°E] Felix E. E. Borel, 1871–1956. French mathematician.
Simple crater (5 km/950 m).

Brackett [17.9°N, 23.6°E] Frederick Sumner Brackett, 1896–1972. American physicist.
Flooded, not very prominent crater (9 km).

Dawes [17.2°N, 26.4°E] William R. Dawes, 1799–1868. English physician and astronomer, gave his name to a rule for the testing of the resolving power of a telescope (Dawes Limit).
Crater (18 km/2330 m).

Deseilligny [21.1°N, 20.6°E] Jules A. P. Deseilligny, 1868–1918. French selenographer.
Simple crater (6.6 km/1190 m).

Finsch [23.6°N, 21.3°E] O. F. H. Finsch, 1839–1917. German zoologist.
Flooded, simple crater (4 km).

Lister, Dorsa [19°N, 22°E] Martin Lister, 1638–1712. British zoologist.
System of mare ridges, length 290 km.

Littrow, Catena [22°N, 29°E] J. Littrow. See map 25.
Small crater chain, length 10 km.

Menelaus, Rimae [17°N, 17°E] Menelaus. See map 23.
System of rilles, length 140 km.

Nicol, Dorsum [18°N, 23°E] William Nicol, 1768–1851. Scottish physicist, inventor of the Nicol prism.
Wrinkle ridge, length 50 km.

Plinius [15,4°N, 23.7°E] Gaius Plinius Secundus (senior), or Pliny the Elder, AD 23–79. Author of the encyclopedia *Historia Naturalis* in 37 books. Died during the destruction of Pompeii.
Prominent crater with a sharp rim, terraces, and central peaks (43 km/2320 m).

Plinius, Rimae [17°N, 24°E]
System of prominent rilles, length 120 km.

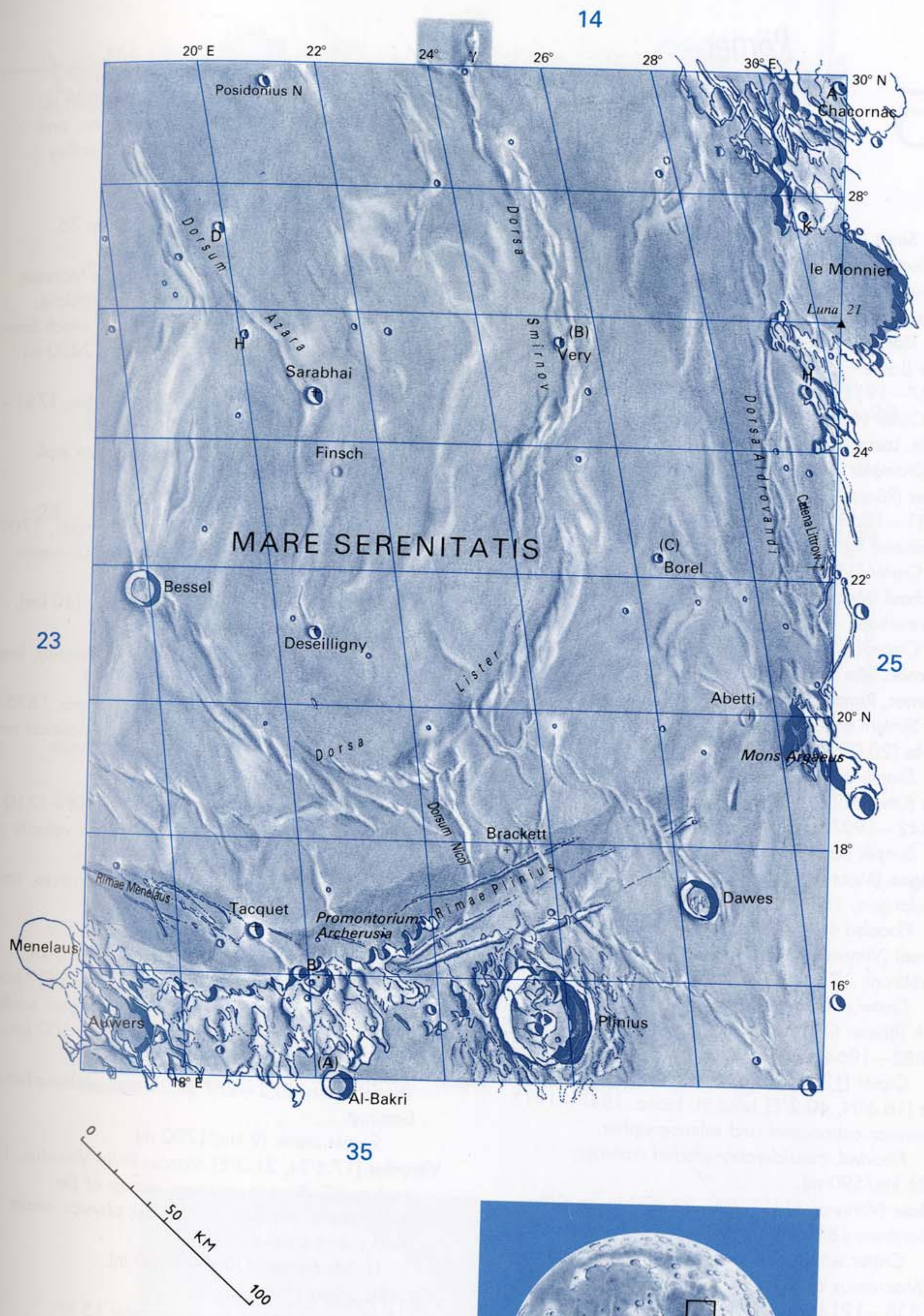
Sarabhai (Bessel A) [24.7°N, 21.0°E] Vikram Ambalal Sarabhai, 1919–1971. Indian astrophysicist.
Simple crater (7.6 km/1660 m).

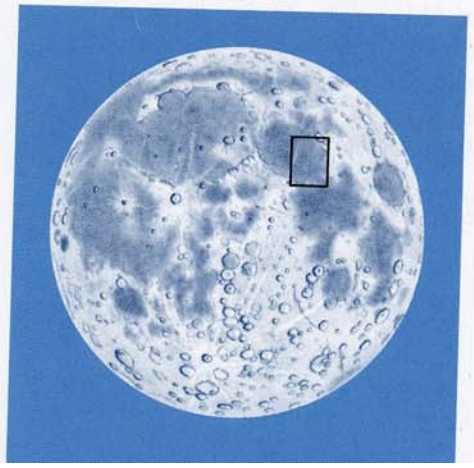
Serenitatis, Mare (Sea of Serenity). See map 13.

Smirnov, Dorsa [25°N, 25°E] Sergei S. Smirnov, 1895–1947. Soviet naturalist.
System of sizable mare ridges, length 130 km.

Tacquet [16.6°N, 19.2°E] André Tacquet, 1612–1660. Belgian mathematician.
Simple crater (6.9 km/1260 m).

Very (le Monnier B) [25.6°N, 25.3°E] Frank W. Very, 1852–1927. American astronomer.
Simple crater (5.1 km/950 m).





25 Römer

Mountainous area adjoining Mare Serenitatis and Mare Tranquillitatis. A dense field of craters with disintegrated walls surrounds Römer. The region of Römer, Chacornac, and Littrow has a system of conspicuous rilles. The Apollo 17 expedition landed in a valley between mountains to the north of Littrow. Lunokhod 2 was active in le Monnier.

Amoris, Sinus (Bay of Love) [19°N, 38°E]
Reaches 250 km *from the border of Mare Tranquillitatis.*

Argaeus, Mons. See map 24.

Barlow, Dorsa. See map 36.

Beketov (Jansen C) [16.3°N, 29.2°E] N. N. Beketov, 1827–1911. Russian chemist.
Crater (8.4 km/1000 m).

Bonitatis, Lacus (Lake of Good) [23°N, 44°E]
Diameter 130 km.

Brewster (Römer L) [23.3°N, 34.7°E] David Brewster, 1781–1868. Scottish optician. Experimented with polarized light.
Crater (11 km/2130 m).

Carmichael (Macrobius A) [19.6°N, 40.4°E] Leonard Carmichael, 1898–1973. American psychologist.
Crater (20 km/3640 m).

Chacornac. See map 14.

Chacornac, Rimae [29°N, 32°E]
System of rilles, length 120 km.

Ching-te [20.0°N, 30.0°E] Chinese male name.
Simple crater (3.9 km).

Clerke (Littrow B) [21.7°N, 29.8°E] Agnes Mary Clerke, 1842–1907. British astronomer.
Simple crater (7 km/1430 m).

Esclangon (Macrobius L) [21.5°N, 42.1°E] Ernest B. Esclangon, 1876–1954. French astronomer.
Flooded crater with a low wall (16 km).

Fabbroni (Vitruvius E) [18.7°N, 29.2°E] Giovanni V. M. Fabbroni, 1752–1822. Italian chemist.
Crater (11.1 km/2090 m).

Franck (Römer K) [22.6°N, 35.5°E] James Franck, 1882–1964. German physicist and Nobel Laureate.
Crater (12 km/2510 m).

Franz [16.6°N, 40.2°E] Julius H. Franz, 1847–1913. German astronomer and selenographer.
Flooded, considerably eroded crater (26 km/590 m).

Gardner (Vitruvius A) [17.7°N, 33.8°E] Irvine Clifton Gardner, 1889–1972. American physicist.
Crater with a flat floor (18.4 km/3000 m).

Hill (Macrobius B) [20.9°N, 40.8°E] George W. Hill, 1838–1914. American astronomer and mathematician.
Crater (16 km/3340 m).

Jansen, Rima [15°N, 29°E] Jansen. See map 36.
Narrow rille, length 35 km.

le Monnier [26.6°N, 30.6°E] Pierre Charles le Monnier, 1715–1799. French astronomer and physicist.
Flooded crater with a very dark floor, which forms a small bay in Mare Serenitatis (61 km/2400 m).
See also map 24.

Littrow [21.5°N, 31.4°E] Johann J. von Littrow, 1781–1840. Austrian astronomer.
Flooded crater with damaged southern wall (31 km).

Lucian (Maraldi B). See map 36.

Maraldi [19.4°N, 34.9°E] Giovanni D. Maraldi, 1709–1788. Italian astronomer, assistant to Giovanni-Domenico Cassini.
Flooded crater with a very dark floor (40 km).

Maraldi, Mons [20°N, 35°E]
Mountain ridge to the northeast of Maraldi, length 15 km.

Newcomb [29.9°N, 43.8°E] Simon Newcomb, 1835–1909. Canadian-born American mathematician and astronomer.
Crater (39 km/2180 m).

Römer [25.4°N, 36.4°E] Olaus Römer, 1644–1710. Danish astronomer. First to determine the velocity of light by observations of Jupiter's satellites.
Prominent crater with a sharp rim, terraces, and a central peak (40 km).

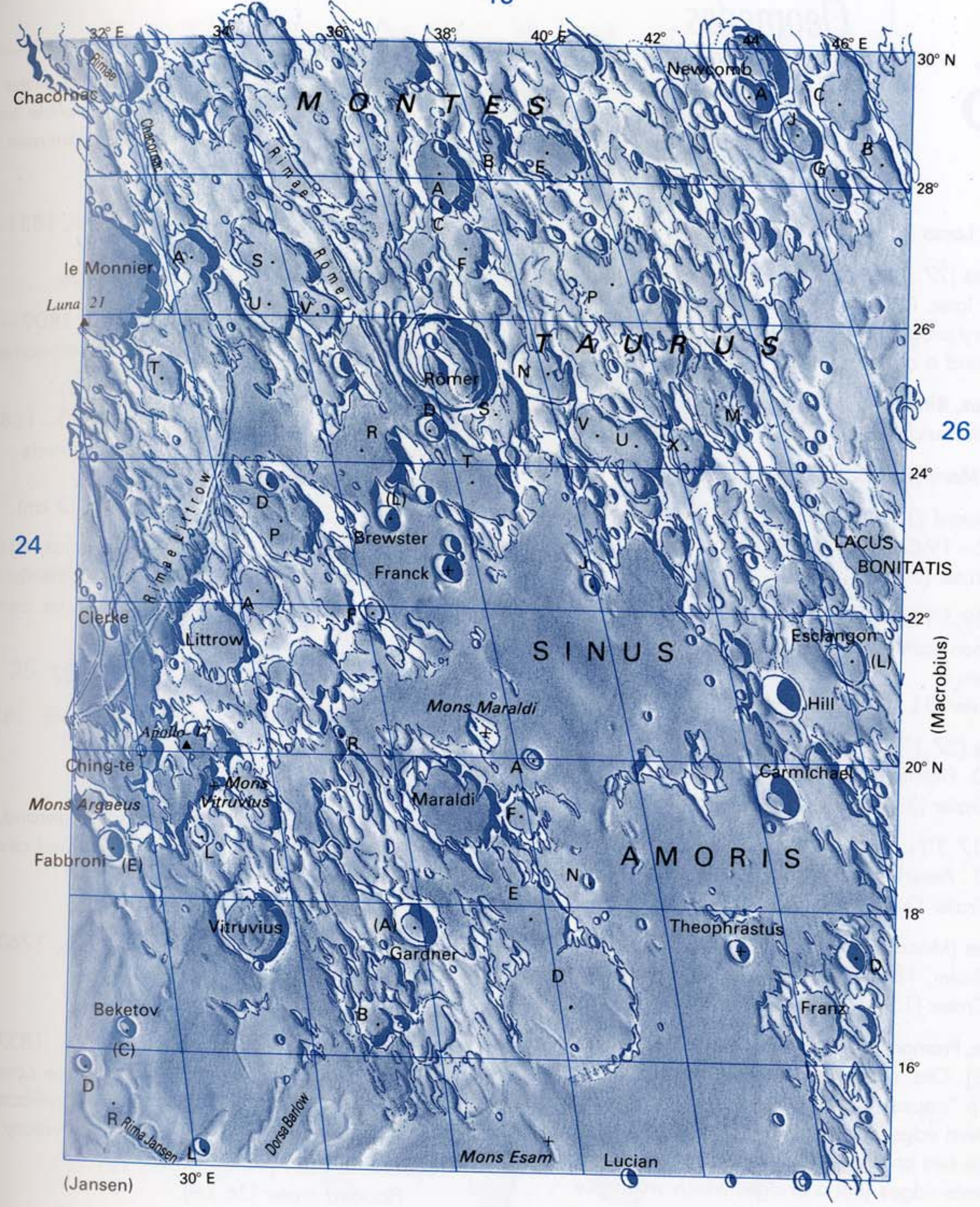
Römer, Rimae [27°N, 35°E]
System of pronounced rilles, length 110 km.

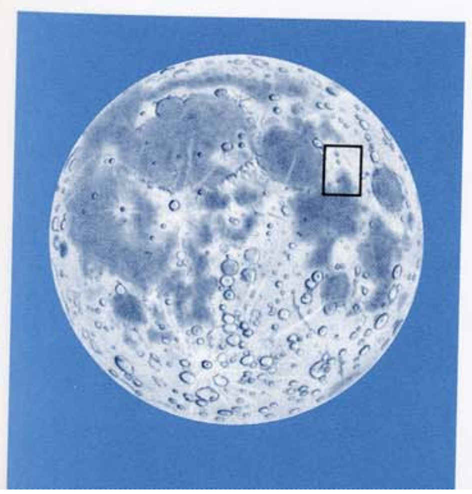
Taurus, Montes (Taurus Mountains) [26°N, 36°E] Name given by Hevelius to the mountainous region north of Römer. Mountainous region, span about 500 km.

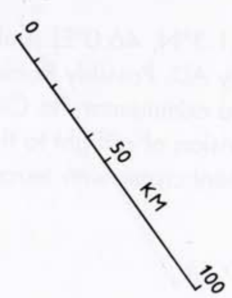
Theophrastus (Maraldi M) [17.5°N, 39.0°E] Theophrastus, 372–287 BC. Greek philosopher and botanist.
Simple crater (9 km/1700 m).

Vitruvius [17.6°N, 31.3°E] Marcus Polio Vitruvius, 1st century BC. Roman architect, author of *De Architectura*. Interests: astronomy, physics, water clocks, and sundials.
Flooded crater (30 km/1550 m).

Vitruvius, Mons [19°N, 31°E]
Mountain massif, base diameter 15 km.







26

Cleomedes

The northwestern part of Mare Crisium in encircled by the large mountain massifs of the Crisium basin's ring structure. Under oblique illumination, numerous ridges are visible on the surface of the mare. Under high illumination, rays from the crater Proclus are prominent.

Bonitatis, Lacus (Lake of Good). See map 25.

Cleomedes [27.7°N, 55.5°E] Cleomedes, 1st century BC or later. Greek astronomer.
Very prominent crater (126 km) *with rilles on the floor and a central peak.*

Cleomedes, Rima
Rille inside Cleomedes, length 30 km.

Crisium, Mare (Sea of Crises). See p. 80.

Curtis (Picard Z) [14.6°N, 56.6°E] Heber Doust Curtis, 1872–1942. American astronomer.
Crater (3 km).

Debes [29.5°N, 51.7°E] Ernest Debes, 1840–1923. German cartographer. Prepared lunar maps and atlases.
Crater (31 km) *connected with the crater Debes A.*

Delmotte [27.1°N, 60.2°E] Gabriel Delmotte, 1876–1950. Prominent French selenographer.
Crater (33 km).

Eckert [17.3°N, 58.3°E] Wallace J. Eckert, 1902–1971. American astronomer.
Crater (3 km).

Fredholm (Macrobius D) [18.4°N, 46.5°E] Erik Ivar Fredholm, 1866–1927. Swedish mathematician.
Crater (15 km).

Lavinium, Promontorium; Olivium, Promontorium [15°N, 49°E]. Old, unofficial names, now little used. Two sharp "capes" situated opposite each other on the western edge of Mare Crisium (named by Birt). These two promontories are separated by two low, arcuate ridges (not a bridge, which was once claimed).

Macrobius [21.3°N, 46.0°E] Ambrosius T. Macrobius, 4th century AD. Possibly Roman grammarian, author of a commentary to Cicero's "Scipion's Dream" (vision of a flight to the stars).
Prominent crater with terraces (64 km).

Oppel, Dorsum [19°N, 52°E] Albert Oppel, 1831–1865. German paleontologist.
Prominent mare ridge, length 300 km.

Peirce [18.3°N, 53.5°E] Benjamin Peirce, 1809–1880. American mathematician and astronomer.
Crater (18.5 km).

Picard [14.6°N, 54.7°E] Jean Picard, 1620–1682. French astronomer, founder of the ephemeris Connaissance des Temps.
Prominent crater with a sharp rim (23 km).

Proclus [16.1°N, 46.8°E]. Proclus Diadochos, 410–485 AD. Athenian philosopher and mathematician.
Very prominent crater with a sharp rim, center of a bright ray system (28 km/2400 m).

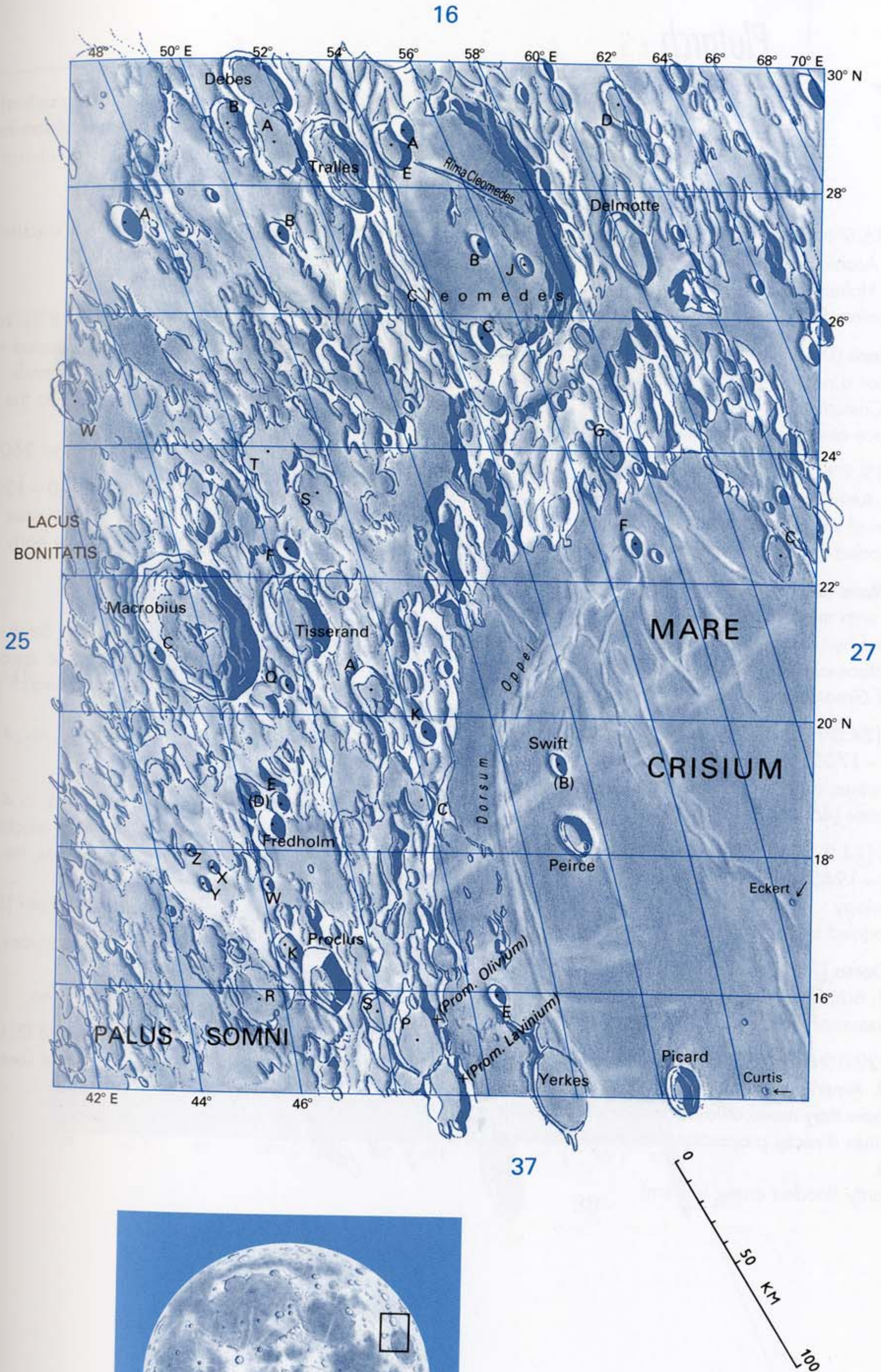
Somnii, Palus (Marsh of Sleep). See map 37.

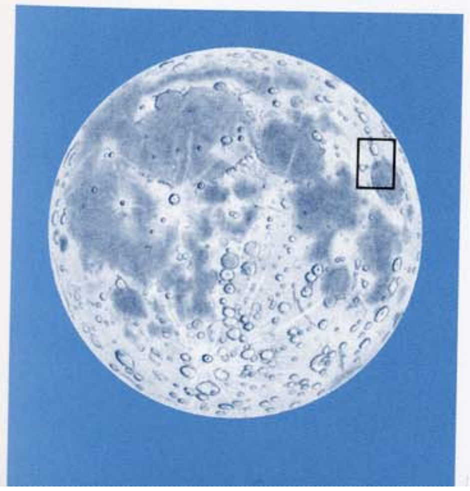
Swift (Peirce B) [19.3°N, 53.4°E] Lewis Swift, 1820–1913. American astronomer.
Simple crater (11 km).

Tisserand [21.4°N, 48.2°E] Francois F. Tisserand, 1845–1896. French astronomer. Studied celestial mechanics, orbits of comets.
Crater (37 km).

Tralles [28.4°N, 52.8°E] Johann G. Tralles, 1763–1822. German physicist.
Crater (43 km).

Yerkes [14.6°N, 51.7°E] Charles T. Yerkes, 1837–1905. Chicago millionaire. Financed the construction of an observatory with the largest refractor in the world, 1 m diameter (Yerkes Observatory, opened in 1897).
Flooded crater (36 km).





27 Plutarch

The eastern part of Mare Crisium and eastern margin of the Moon. Convenient points of orientation are the craters Eimmart, Alhazen, and Plutarch. During a favorable libration the crater Goddard, with its dark floor, and Mare Marginis are clearly visible.

Alhazen [15.9°N, 71.8°E] Abu Ali al-Hasan, 987–1038. Arabian mathematician at the court of Caliph Hakem in Cairo.
Prominent crater with a sharp rim (33 km).

Anguis, Mare (The Serpent Sea) [22°N, 67°E] Franz's name for a narrow sinuous lowland area east of Mare Crisium.
Surface area 10,000 sq km, *length about* 130 km.

Cannon [19.9°N, 81.4°E] Annie J. Cannon, 1863–1941. American astronomer. Worked on the classification of stellar spectra.
Flooded crater with a lighter floor (57 km).

Crisium, Mare (Sea of Crises) [17°N, 59°E] Oval mare, with major axis running east - west and surrounded by a mountainous wall.
Surface area 176,000 sq km *(comparable with that of Great Britain), diameter* 570 km.

Eimmart [24.0°N, 64.8°E] Georg Christoph Eimmart, 1638–1705. German engraver and amateur astronomer, author of a map of the Moon.
Crater (46 km).

Goddard [14.8°N, 89.0°E] Robert H. Goddard, 1882–1945. American physicist, pioneer of rocket technology.
Flooded crater with a dark floor (89 km).

Harker, Dorsa [14°N, 64°E] Alfred Harker, 1859–1939. British petrologist.
System of mare ridges, length 200 km.

Hubble [22.1°N, 86.9°E] Edwin P. Hubble, 1889–1953. American astronomer. Investigated galaxies and how they move away from each other, with velocities directly proportional to their distances apart.
Partly flooded crater (81 km).

Liapunov [26.3°N, 89.3°E] Alexander M. Liapunov, 1857–1918. Russian mathematician.
Crater (66 km).

Marginis, Mare (The Border Sea) [12°N, 88°E]. Name given by Franz to a small, irregularly shaped mare along the eastern edge of the Moon. Extends beyond the normally visible hemisphere to the lunar far side.
Surface area 62,000 sq km, *diameter* 360 km.

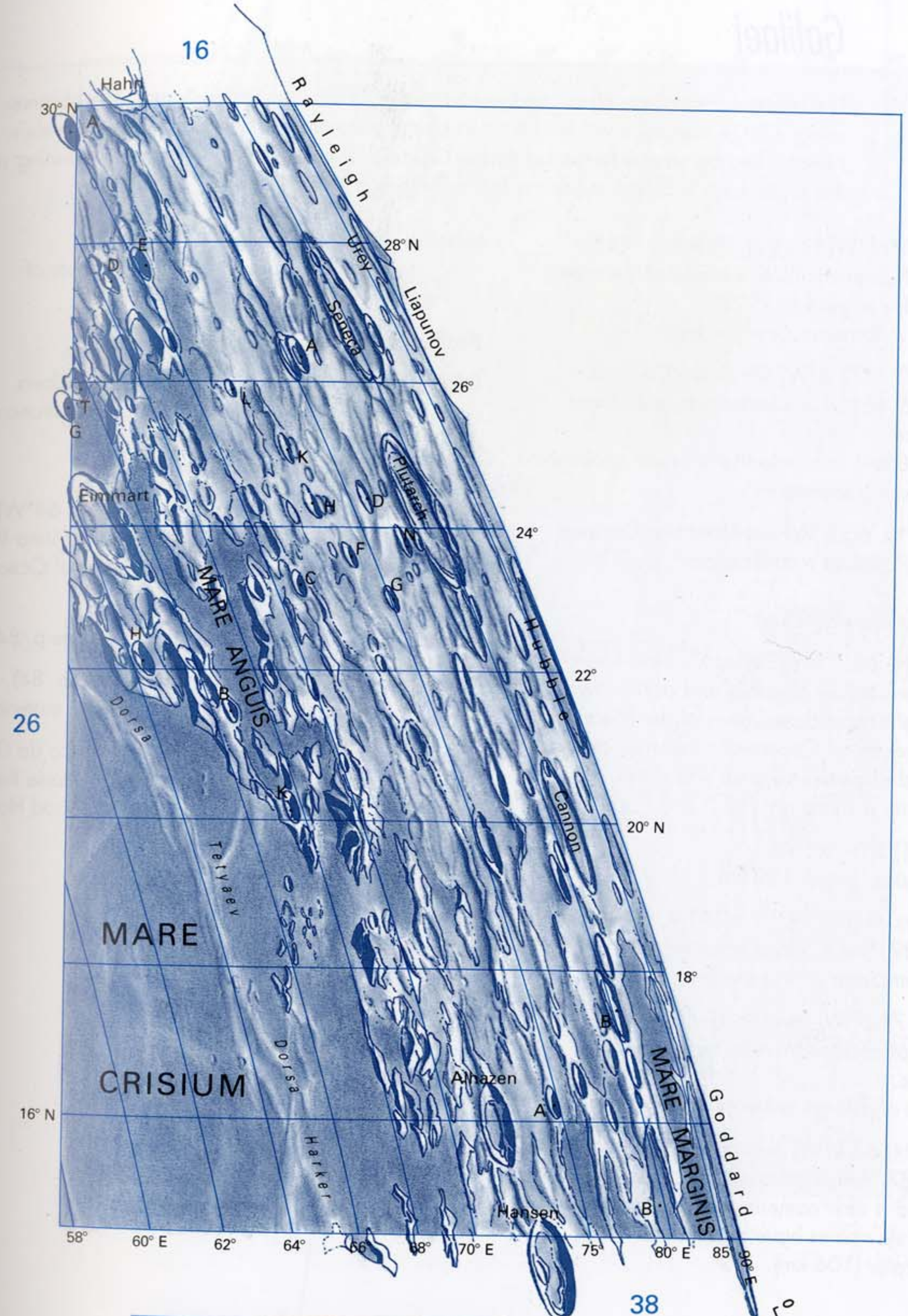
Plutarch [24.1°N, 79.0°E] Plutarchos, c. 50–120 AD. Greek philosopher and writer. In his dialogue De facie in orbe lunae, he developed some early theories on the nature of the Moon.
Prominent crater (68 km).

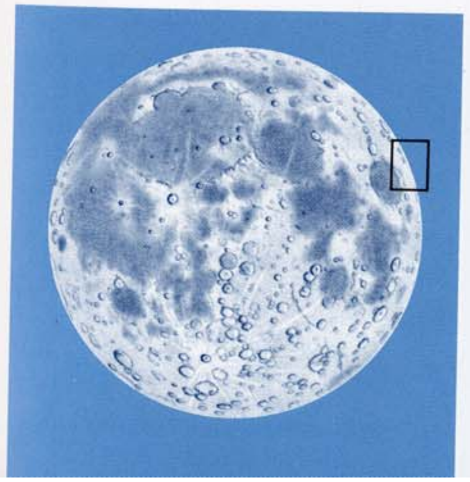
Rayleigh [29.0°N, 89.2°E] (Lord) John W. Strutt Rayleigh, 1842–1919. British physicist, awarded Nobel Prize for Physics in 1904 for research in optics.
Crater (107 km) *along the eastern limb of the Moon.*

Seneca [26.6°N, 80.2°E] Lucius A. Seneca, c. 4 BC–65 AD. Roman philosopher and writer, teacher of Nero. In his work Quaestiones Naturales, he concluded that comets are celestial bodies.
Inconspicuous, irregularly shaped crater (53 km).

Tetyaev, Dorsa [19°N, 65°E] Mikhail M. Tetyaev, 1882–1956. Soviet geologist.
System of mare ridges, length 150 km.

Urey (Rayleigh A) [27.9°N, 87.4°E] Harold C. Urey, 1893–1981. American chemist, Nobel Laureate.
Crater (38 km).





28 Galilaei

The western limb of the Moon and western edge of Oceanus Procellarum. The observer using a large telescope will be attracted by the rilles on the floor of the crater Hevelius. Nearby lies the unique formation Reiner Gamma. The region also contains the landing site of the probe Luna 9 (which made the first soft-landing on the Moon).

Bohr [12.8°N, 86.4°W] Niels H. D. Bohr, 1885–1962. Danish physicist (Bohr's model of the atom). Nobel Prize for physics in 1922.
Crater in a libration zone (71 km).

Cardanus [13.2°N, 72.4°W] Girolamo Cardano, 1501–1576. Italian mathematician, astrologer, and physician.
Crater (50 km) *connected by a crater chain with the crater Krafft* (see map 17).

Cavalerius [5.1°N, 66.8°W] Buonaventura Cavalieri, 1598–1647. Italian mathematician, pupil of Galileo.
Prominent crater (58 km).

Galilaei [10.5°N, 62.7°W] Galileo Galilei, 1564–1642. Famous Italian physicist and astronomer. Made first telescopic observation of the Moon and planets; advocate of Copernican theories; observed sunspots and discovered Jupiter's satellites.
Crater with a sharp rim (15.5 km).

Galilaei, Rima [13°N, 59°W]
Sinuous rille, length 180 km.

Glushko (Olbers A) [8.4°N, 77.6°W] V. P. Glushko, 1908–1989. Soviet space scientist.
Prominent crater with a sharp rim (43 km).

Hedin [2.9°N, 76.5°W] Sven A. Hedin, 1865–1952. Swedish explorer and traveler, expeditions to Central Asia.
Remains of a large crater (143 km).

Hevelius [2.2°N, 67.3°W] Johann Hewelcke (Hevel), 1611–1687. Polish astronomer and selenographer. Proposed a new nomenclature for the Moon, of which only six names have been preserved.
Large crater (106 km).

Hevelius, Rimae [2°N, 66°W]
System of rilles inside and to the south of Hevelius, length 190 km.

Krafft, Catena. See map 17.

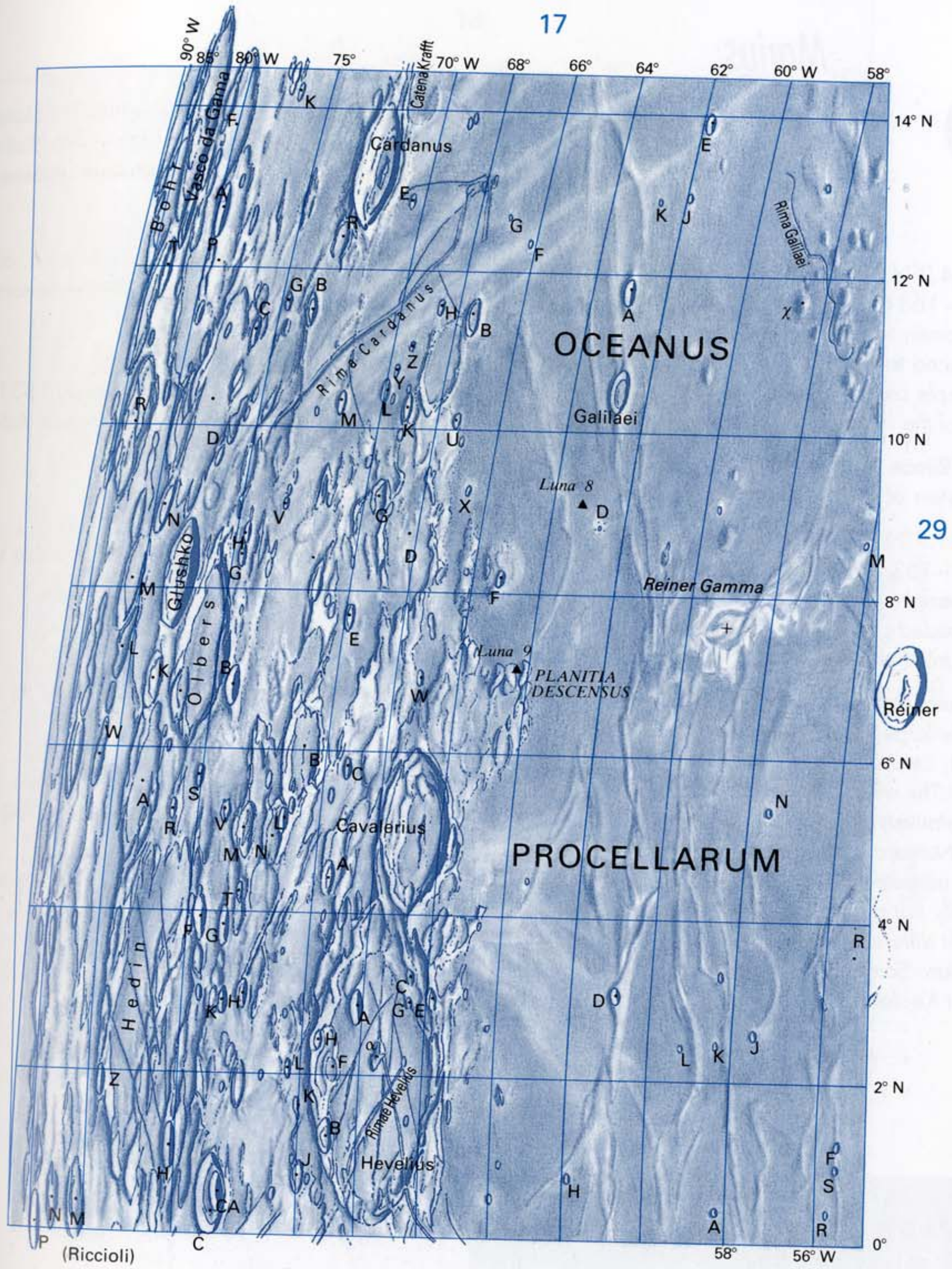
Olbers [7.4°N, 75.9°W] Heinrich W. H. Olbers, 1758–1840. German physician and astronomer. Discovered and observed comets.
Crater (75 km).

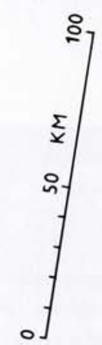
Planitia Descensus (Plain of Descent) [7°N, 64°W]. Site of the first soft-landing on the Moon, by Luna 9. It is situated among low hills at the border of Oceanus Procellarum.

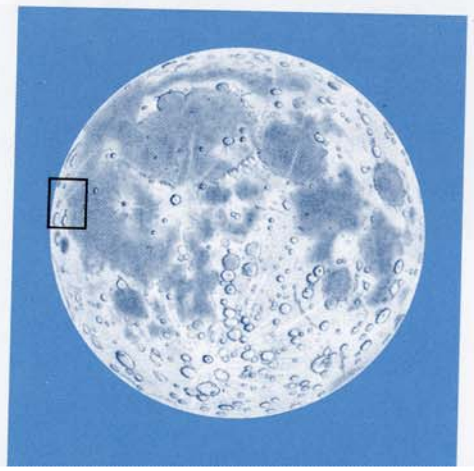
Procellarum, Oceanus (Ocean of Storms). See p. 84.

Reiner Gamma [8°N, 59°W] (Reiner, see p. 84).
Entirely flat feature formed of bright material.

Vasco da Gamma [13.9°N, 83.8°W] Vasco da Gama, 1469–1524. Portuguese navigator. Made the first voyage to India around the Cape of Good Hope (1498).
Crater (96 km).







29

Marius

The western part of Oceanus Procellarum, poor in large craters but very rich in lunar domes, especially near the crater Marius. This area, geologically very interesting with distinct traces of volcanic activity, was selected as a target for one of the Apollo missions, subsequently canceled.

Maestlin [4.9°N, 40.6°W] Michael Möstlin (Maestlin), 1550–1631. German mathematician and astronomer, teacher of Johannes Kepler, whom he introduced to the Copernican heliocentric system.
Simple crater (7.1 km/1650 m) *located to the north of the remains of the crater Maestlin R* (60 km).

Maestlin, Rimae [2°N, 40°W]
System of short, straight rilles, length 80 km.

Marius [11.9°N, 50.8°W] Simon Mayer (Marius), 1570–1624. German astronomer. Independently discovered Jupiter's satellites.
Flooded crater (41 km); *a simple crater Marius G* (3.3 km) *is situated on its flat floor.*

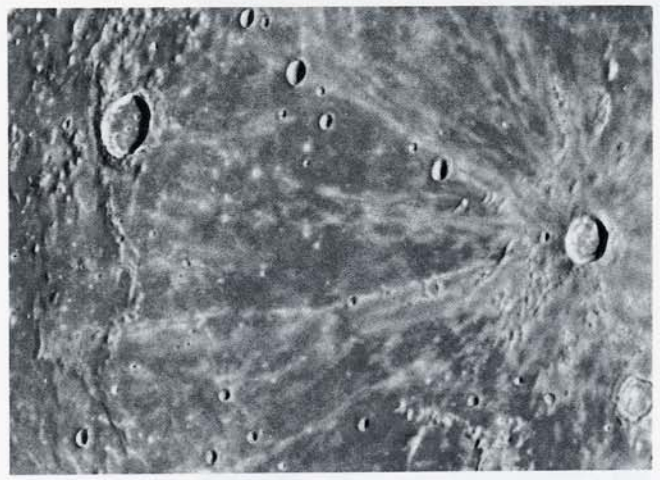
Procellarum, Oceanus (Ocean of Storms).
The largest lunar mare. Surface area 2,102,000 sq km, *i.e., less than the Mediterranean Sea on Earth. The western, northern, and southern borders are relatively distinct, but the eastern edge is indefinite. Numerous mare ridges furrow the surface. The laser altimeter of Apollo 15 discovered some exceptionally flat places in Oceanus Procellarum with height differences of* ±80 m *over a distance of* 200 km. *Some of the bright rays radiating from the crater Kepler are visible in this area.*

Reiner [7.0°N, 54.9°W] Vincentio Reinieri, died in 1648. Italian mathematician and astronomer, pupil and friend of Galileo.
Prominent crater (30 km).

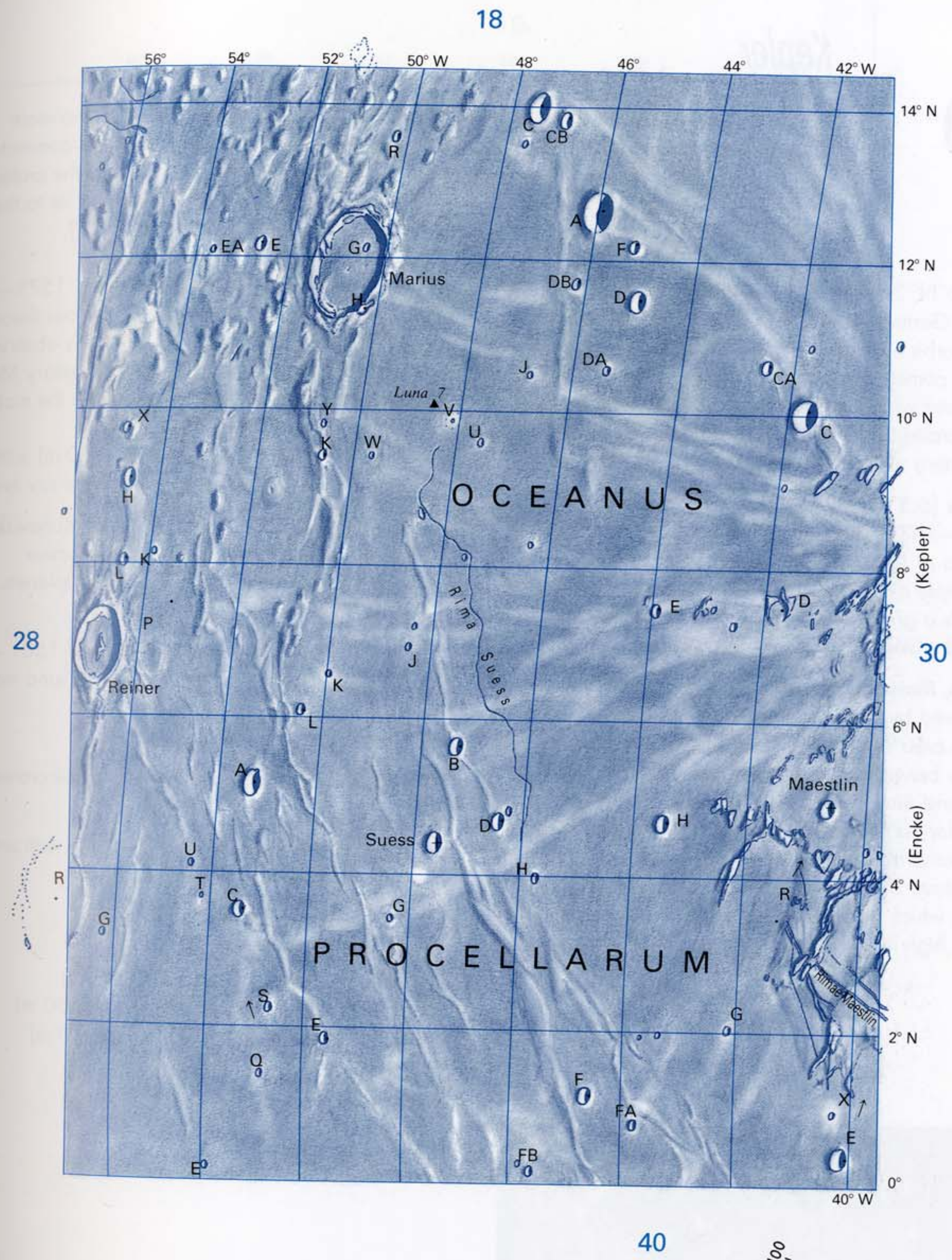
Suess [4.4°N, 47.6°W] Edward Suess, 1831–1914. Austrian geologist and selenographer. Advocated cosmic origin of tektites.
Simple crater (9.2 km)

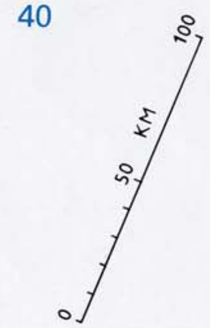
Suess, Rima [6°N, 47°W]
Narrow, sinuous rille, not observable with small telescopes, length 200 km.

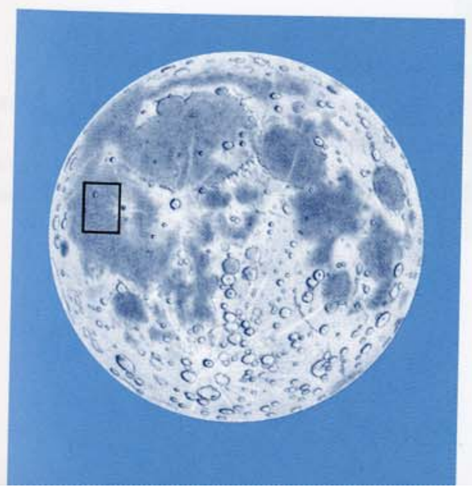
Small craters: **Kepler C** (12.2 km/2170 m)
Kepler D (10.0 km/350 m)
Kepler E (5.2 km/1000 m)
Maestlin G (2.8 km/670 m)
Maestlin H (7.1 km/1370 m)



Bright rays radiating from the crater ***Kepler*** *are conspicuous on the dark area of the Oceanus Procellarum. They reach up to the vicinity of the crater* ***Marius***.







Kepler

The dark background of Mare Insularum contrasts with bright ray systems from two main centers: the crater Copernicus (in the east) and, especially, the crater Kepler that dominates this area. Perhaps the best-known group of lunar domes is that situated north of the crater Hortensius. Other domes that can be seen through even quite a small telescope lie to the west of the crater Milichius and to the south of the crater T. Mayer (see map 19).

Encke [4.6°N, 36.6°W] Johann Franz Encke, 1791–1865. German astronomer. Calculated the elements of the orbit of Encke's Comet (the first known short-period comet).
Crater with uneven floor (29 km/750 m)*; a small crater Encke N* (3.5 km/590 m) *is situated on its western wall.*

Hortensius [6.5°N, 28.0°W] Martin van den Hove, 1605–1639. Dutch astronomer, professor of mathematics at Amsterdam.
Simple crater (14.6 km/2860 m)*; to the north there is a group of domes, most of them having summit craters.*

Insularum, Mare (Sea of Isles) [7°N, 22°W] Name approved by the IAU in 1976.
An area of about 900 km *in diameter, approximately between the craters Kepler and Encke in the west and Sinus Aestuum in the east. The northern boundary is formed by the Carpathian Mountains; the southern border is indefinite, linking with Mare Cognitum. The largest "isle" here is the crater Copernicus, which is surrounded by light ejecta, visible under high illumination. (See also maps 31 and 32.)*

Kepler [8.1°N, 38.0°W] Johannes Kepler, 1571–1630. German astronomer and ingenious theoretician who, on the basis of Tycho Brahe's observations, formulated the three Laws of Planetary Motion that bear his name and which describe the motions of the planets around the Sun.
Very prominent crater (32 km/2570 m) *with uneven floor; center of an extensive bright ray system.*

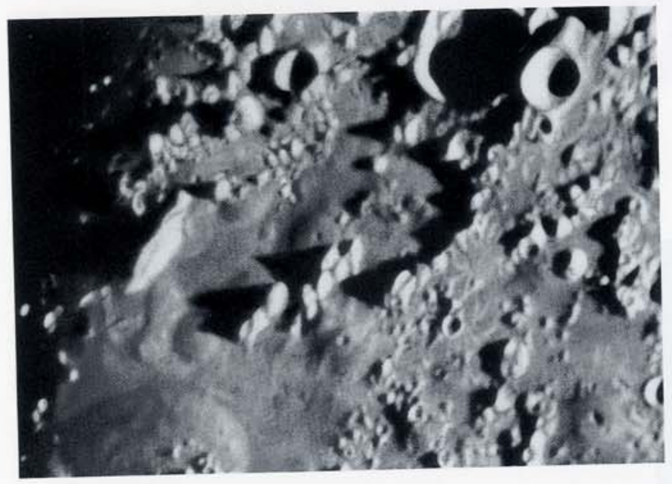
Kunowsky [3.2°N, 32.5°W] Georg K. F. Kunowsky, 1786–1846. German lawyer and amateur astronomer, observer of the Moon and planets.
Flooded crater (18 km/850 m).

Milichius [10.0°N, 30.2°W] Jacob Milich, 1501–1559. German physician, philosopher, and mathematician.
Simple crater (13 km/2510 m).

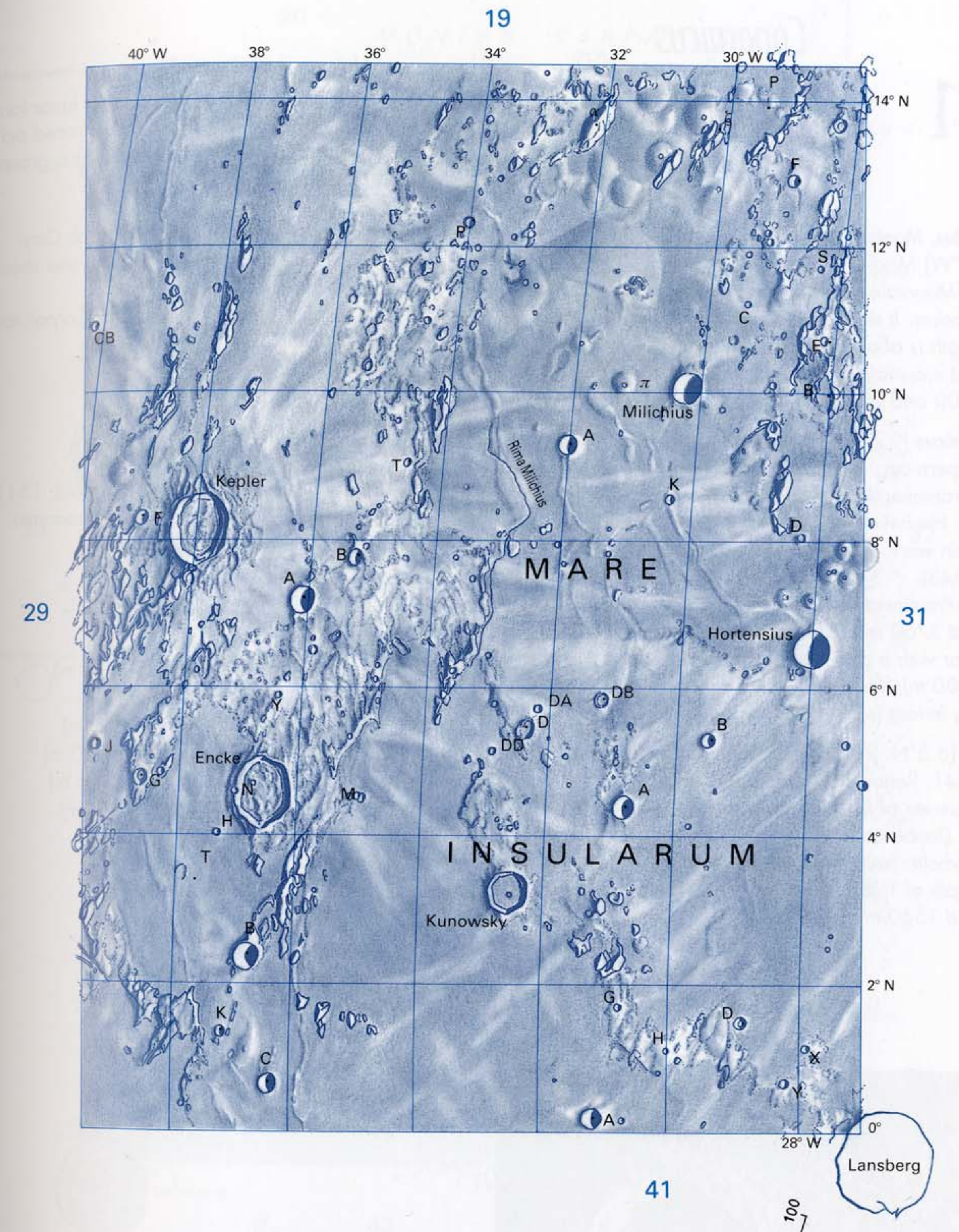
Milichius Pi *is a typical dome with a summit crater.*

Milichius, Rima [8°N, 33°W]
Sinuous, narrow rille, unobservable with small telescopes, length 110 km.

Small craters: **Encke B** (11.5 km/2230 m)
Hortensius A (10.2 km/1850 m)
Hortensius B (6.7 km/1170 m)



A group of numerous ***lunar domes*** *is situated in a broad valley between the mountain massifs T. Mayer Alpha and T. Mayer Zeta (as shown in the top right-hand corner of map 30). These very low formations are observable only in the vicinity of the terminator.*



Copernicus

The crater Copernicus is undoubtedly one of the best known and most typical of lunar formations; it is also the center of a very prominent system of bright rays that can be traced across the surface of Mare Imbrium (see maps 20 and 21). To the west of Copernicus is a group of scattered solitary hills that rise to a height of several hundred meters.

Carpatus, Montes (Carpathian Mountains) [15°N, 25°W] Mädler's name.
Mountain range at the southern margin of Mare Imbrium. It stretches approximately east-west, and its length is about 400 km. It consists of individual hills and mountain massifs whose heights are between 1000 and 2000 m. (See also maps 19 and 20).

Copernicus [9.7°N, 20.0°W] Nicolas (Nicholas) Copernicus, 1473–1543. Renowned Polish astronomer, one of the founders of modern astronomy. His heliocentric system was explained in his main work *De Revolutionibus Orbium Celestium* (1543).
Prominent complex crater, 93 km in diameter and 3760 m deep; terraced walls, relatively flat floor with a group of central peaks (heights up to 1200 m); the height of the rim above the surrounding terrain is 900 m.

Fauth [6.3°N, 20.1°W] Philipp J. H. Fauth, 1867–1941. Renowned German selenographer and observer of the planets, author of lunar maps.
Double-crater Fauth and Fauth A is shaped like a keyhole; Fauth has a diameter of 12.1 km and a depth of 1960 m, Fauth A is 9.6 km in diameter and 1540 m deep.

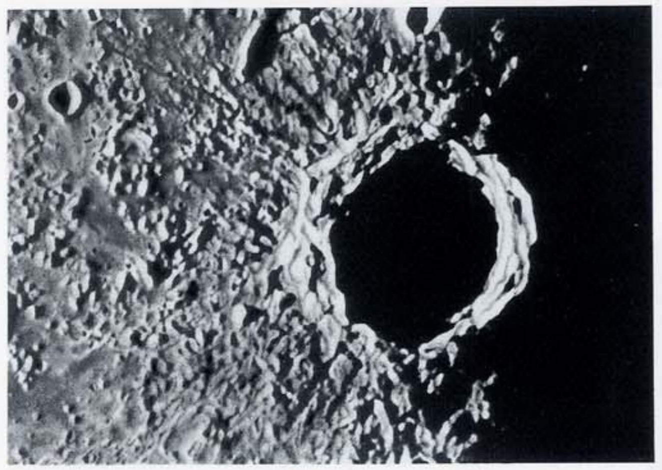
Gay-Lussac [13.9°N, 20.8°W] Louis Joseph Gay-Lussac, 1778–1850. French physicist and chemist (Gay-Lussac laws).
Crater at the southern edge of the Carpathian Mountains (26 km/830 m).

Gay-Lussac, Rima [13°N, 22°W]
Wide, distinct rille, length 40 km.

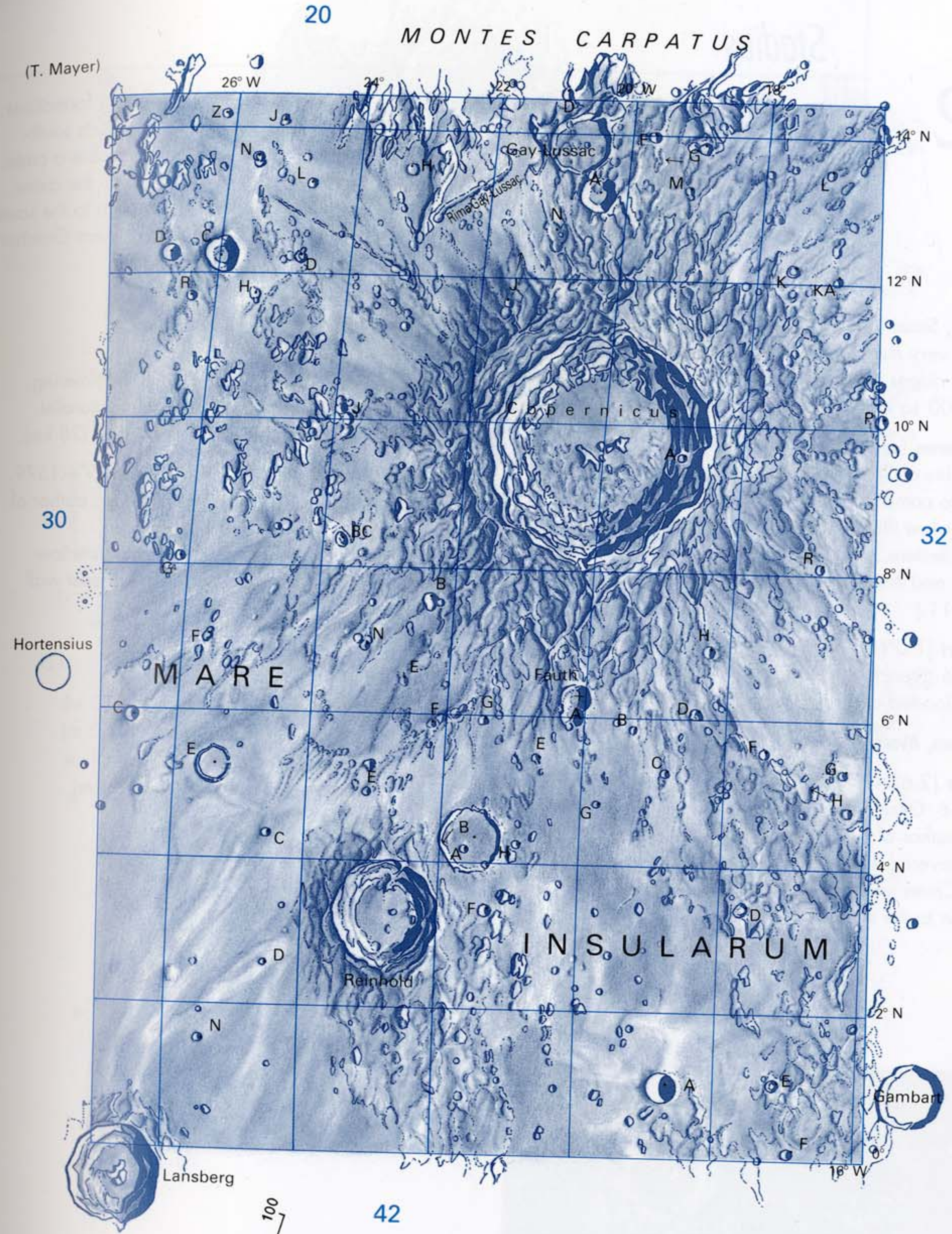
Insularum, Mare (Sea of Isles). See map 30.

Reinhold [3.3°N, 22.8°W] Erasmus Reinhold, 1511–1553. German mathematician and astronomer.
Prominent crater with terraced walls (48 km/3260 m).

Small craters: **Copernicus H** (4.6 km/870 m) *— dark halo crater*
Gambart A (12 km/2440 m)
Gay-Lussac A (14 km/2550 m)
T. Mayer C (15.6 km/2510 m)
T. Mayer D (8.6 km/1470 m)



*The crater **Copernicus** is a magnificent sight shortly before sunset, when the whole floor disappears in shadow and the narrowing part of the eastern wall appears as a crescent Moon shining brightly at the terminator.*



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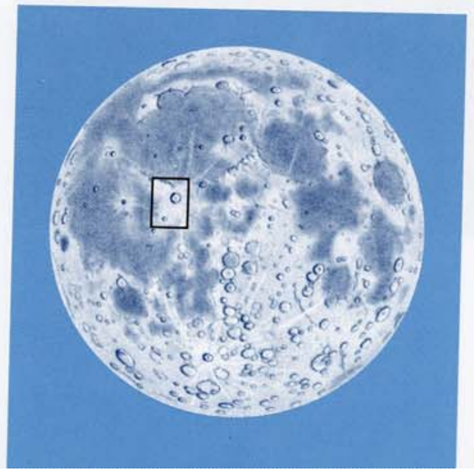


32 Stadius

The dark monotonous area of Sinus Aestuum is surrounded by several interesting formations, the most striking being the beautiful crater Eratosthenes. A mountain range projects southwest of Eratosthenes toward the "submerged crater" Stadius. Northwest of Stadius is a crater chain that continues further north (see map 20).A dome is clearly visible close to the crater Gambart C. Under high illumination, large, prominent dark patches can be seen to the south of the crater Copernicus C and to the north of the crater Schröter D. The area near Gambart C was the landing site of Surveyor 2.

Aestuum, Sinus (Bay of Billows) [12°N, 8°W]
A very flat marelike area, with inconspicuous mare ridges and small craters; total surface area 40,000 sq km, *diameter about* 230 km.

Eratosthenes (see map 21). In contrast with nearby remains of Stadius, Eratosthenes offers an example of two completely different appearances. Whereas under low illumination it appears as a most prominent feature, at full Moon it seems almost to disappear and is as faint as Stadius. (See also p. 14, Fig. 11.)

Gambart [1.0°N, 15.2°W] Jean F. Gambart, 1800–1836. French astronomer. Discovered 13 comets.
Flooded crater (25 km/1050 m).

Insularum, Mare (Sea of Isles). See map 30.

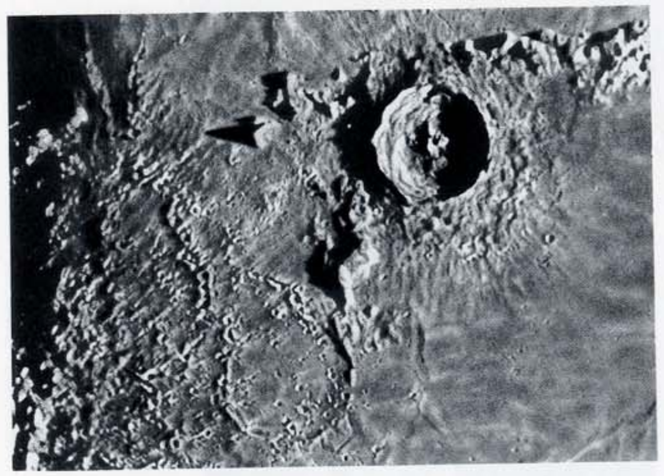
Schröter [2.6°N, 7.0°W] Johann H. Schröter, 1745–1816. German selenographer, experienced observer, author of Selenotopographische Fragmente. Discovered numerous rilles on the Moon.
Crater with considerably disintegrated wall, open to the south (34.5 km).

Schröter, Rima [1°N, 6°W]
Rille, length 40 km.

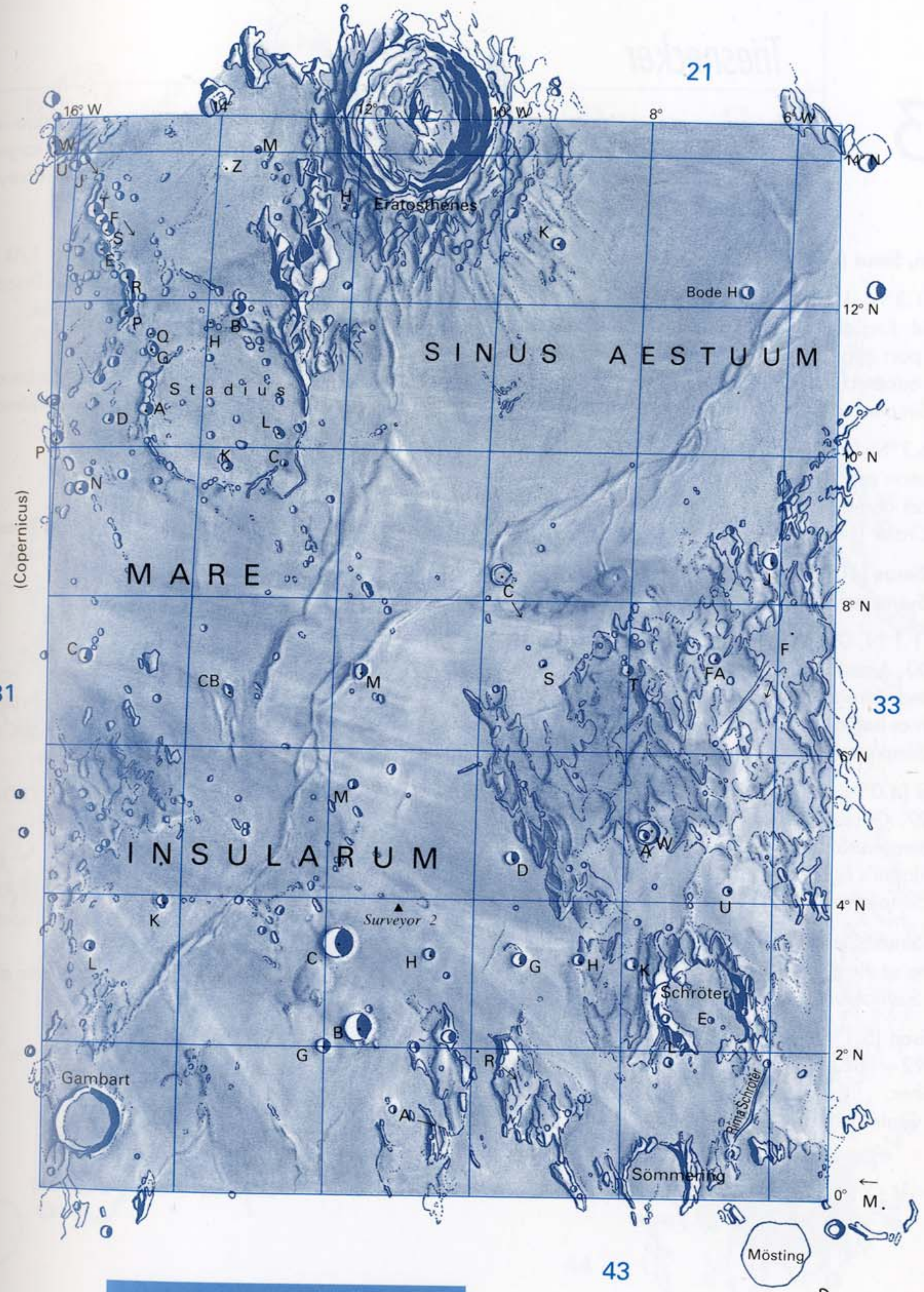
Sömmering [0.1°N, 7.5°W] Samuel T. Sömmering, 1755–1830. German surgeon and naturalist.
Crater with considerably ruined wall (28 km).

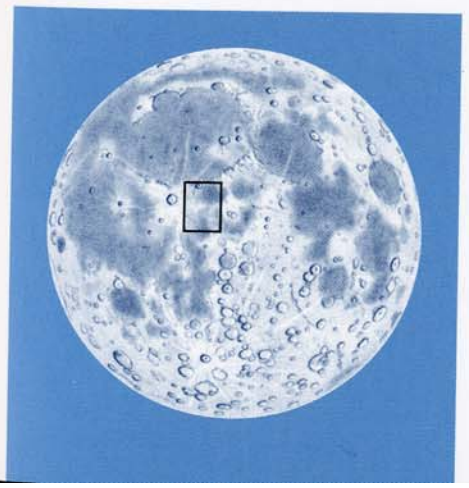
Stadius [10.5°N, 13.7°W] Jan Stade, 1527–1579. Belgian mathematician and astronomer, author of planetary tables Tabulae Bergenses.
Heavily flooded crater with incomplete low walls; diameter 69 km, *height of northeast wall* 650 m.

Small craters: **Gambart B** (11.5 km/2170 m)
Gambart C (12.2 km/2300 m)
Schröter A (4.2 km/620 m)
Schröter W (10.1 km/610 m)



A considerable number of secondary craters, which originated from material ejected during the formation of the crater Copernicus, are found in the vicinity of the lunar formation ***Stadius****. The prominent crater at the top is* ***Eratosthenes****.*





33 Triesnecker

A terra area surrounded by Mare Vaporum, Sinus Medii, and Sinus Aestuum. There is a complex system of rilles in the vicinity of the crater Triesnecker, a most attractive target for amateur observations. The region also contains the landing sites of the probes Surveyor 4 and Surveyor 6.

Aestuum, Sinus (Bay of Billows). See map 32.

Blagg [1.3°N, 1.5°E] Mary Adela Blagg, 1858–1944. English selenographer who played an important part in preparing the modern lunar nomenclature adopted by the IAU in 1935.
Simple crater (5.4 km/910 m).

Bode [6.7°N, 2.4°W] Johann E. Bode, 1747–1826. German astronomer. "Bode's Law" relates the distances of individual planets from the Sun.
Crater (18.6 km/3480 m).

Bode, Rimae [10°N, 4°W]
System of rilles visible through larger telescopes.

Bruce [1.1°N, 0.4°E] Catherine W. Bruce, 1816–1900. American patron of art and science who supported astronomers and astronomical institutions both at home and abroad.
Simple crater (6.7 km/1260 m).

Chladni [4.0°N, 1.1°E] Ernst F. F. Chladni, 1756–1827. German physicist. In 1794, he was the first to demonstrate that meteorites are of cosmic origin. "Chladni's figures" relate to the vibrations of sound.
Simple crater (13.6 km/2630 m).

Medii, Sinus (Central Bay). Mädler's name for a small mare at the center of the near side of the Moon.
Surface area 52,000 sq km, *diameter* 350 km.

Murchison [5.1°N, 0,1°W] Sir Roderick I. Murchison, 1792–1871. Scottish soldier, geologist, and geographer.
Crater with a considerably ruined wall (58 km).

Pallas [5.5°N, 1.6°W] Peter Simon Pallas, 1741–1811. German naturalist and explorer. Discovered the Pallas meteorite, close to Krasnoyarsk.
Crater (50 km/1260 m).

Rhaeticus [0°N, 4.9°E] Georg Joachim von Lauchen (Rhaeticus), 1514–1576. German mathematician and astronomer, pupil of Copernicus.
Irregular crater with disintegrated wall (43 × 49 km).

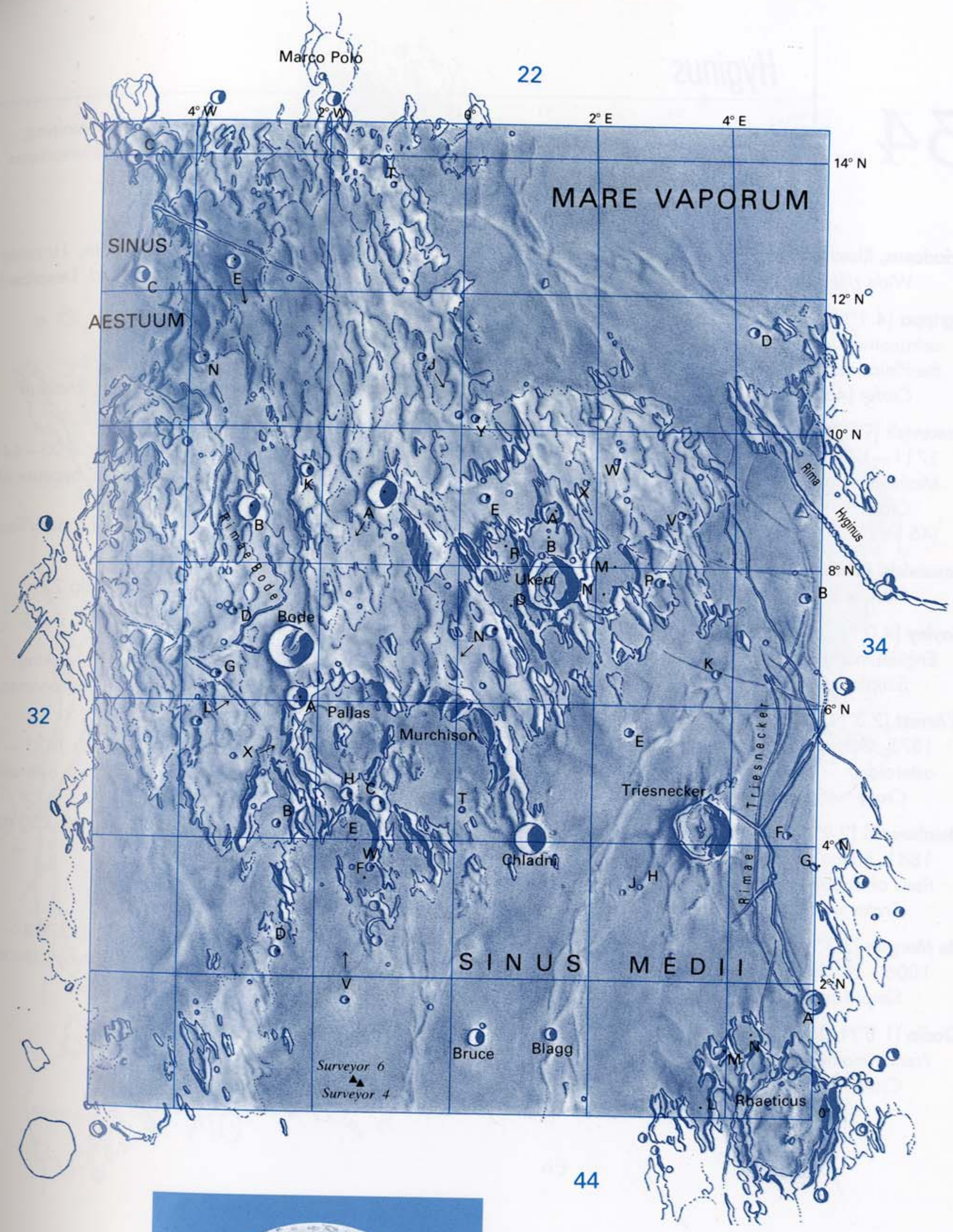
Triesnecker [4.2°N, 3.6°E] Franz de Paula Triesnecker, 1745–1817. Austrian mathematician and astronomer.
Prominent crater with central peak (26 km/2760 m).

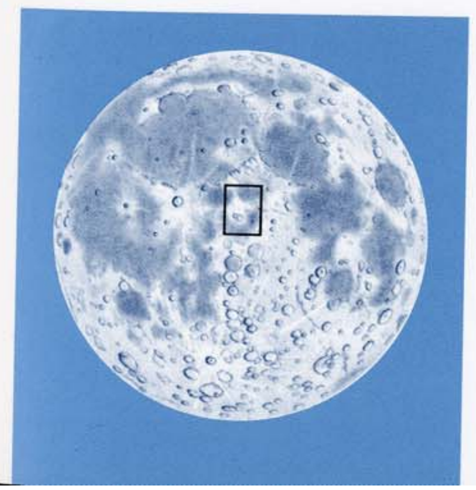
Triesnecker, Rimae [5°N, 5°E]
The richest and best-known system of rilles, visible through even a small telescope. Length, measured from north to south, about 200 km.

Ukert [7.8°N, 1.4°E] Friedrich A. Ukert, 1780–1851. German historian and philologist.
Crater (23 km/2800 m).

Vaporum, Mare (Sea of Vapors) [13°N, 3°E] Riccioli's name for a circular mare situated to the southeast of the Apennines.
Surface area 55,000 sq km, *diameter about* 230 km.

Small craters: **Bode A** (12.3 km/2820 m)
Bode B (10.2 km/1780 m)
Bode C (7.0 km/1300 m)
Pallas A (10.6 km/2080 m)





34 Hyginus

A region with a prominent radial structure, directed toward the Imbrium basin, containing the rilles Rima Hyginus and Rima Ariadaeus, which are easy objects even in small telescopes. An interesting plateau is situated about 10 km north of the crater Godin C.

Ariadaeus, Rima [7°N, 13°E] (Ariadaeus, see map 35).
Wide rille, length 220 km.

Agrippa [4.1°N, 10.5°E] Agrippa, c. 92 AD. Greek astronomer. In 92 AD observed an occultation of the Pleiades by the Moon.
Crater (46 km/3070 m).

Boscovich [9.8°N, 11.1°E] Ruggiero G. Boscovich, 1711–1787. Croatian from Dubrovnik. Mathematician, physicist, and astronomer.
Crater with a considerably disintegrated wall (46 km/1770 m).

Boscovich, Rimae
Rilles in Boscovich, length 40 km.

Cayley [4.0°N, 15.1°E] Arthur Cayley, 1821–1895. English mathematician and astronomer.
Simple crater (14.3 km/3130 m).

d'Arrest [2.3°N, 14.7°E] Heinrich L. d'Arrest, 1822–1875. German astronomer. Studied comets and asteroids.
Crater with a disintegrated wall (30 km/1490 m).

Dembowski [2.9°N, 7.2°E] Ercole Dembowski, 1812–1881. Italian astronomer. Measured 20,000 positions of double stars.
Crater with open wall to the east (26 km).

de Morgan [3.3°N, 14.9°E] Augustus de Morgan, 1806–1871. English mathematician.
Simple crater (10 km/1860 m).

Godin [1.8°N, 10.2°E] Louis Godin, 1704–1760. French mathematician and geodesist.
Crater (35 km/3200 m).

Hyginus [7.8°N, 6.3°E] Caius Julius Hyginus, 1st century AD. Spanish by origin, friend of Ovid. Described constellations and their mythology.
Crater (10.6 km/770 m).

Hyginus, Rima [7.8°N, 6.3°E]
Shallow valley, partially formed by a chain of craters. Length 220 km.

Julius Caesar [9.0°N, 15.4°E] Julius Caesar, 100–44 BC. Roman Emperor honored by Riccioli because of his reform of the calendar.
Flooded crater with a wide wall and a dark floor (90 km).

Lenitatis, Lacus (Lake of Tenderness). See map 23.

Manilius. See p. 72.

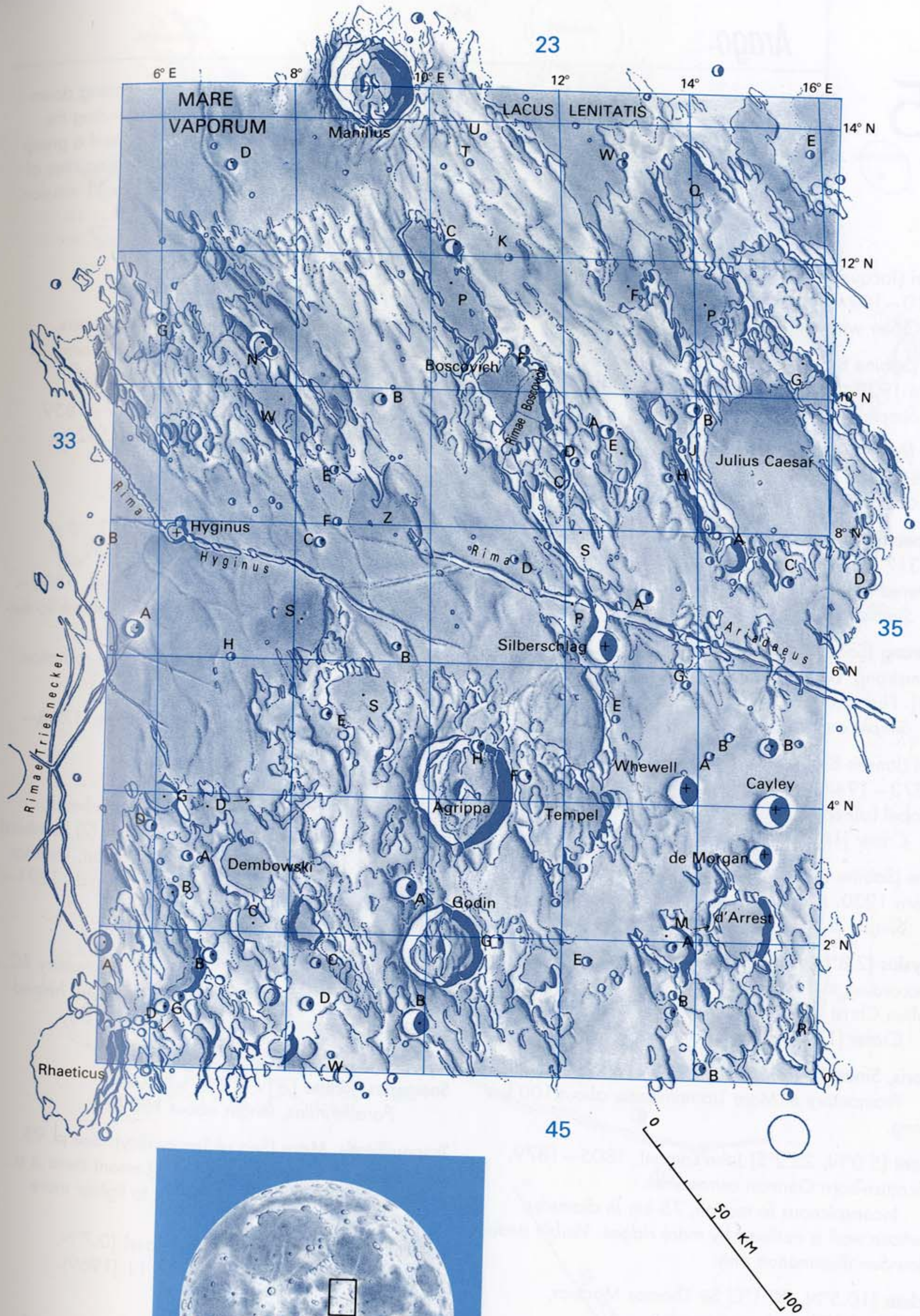
Silberschlag [6.2°N, 12.5°E] Johann E. Silberschlag, 1721–1791. German theologian and astronomer.
Simple crater (13.4 km/2530 m).

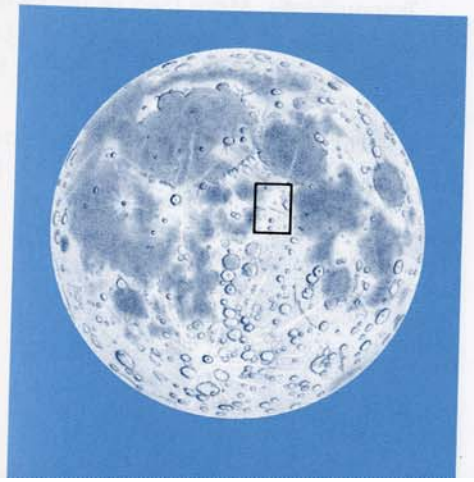
Tempel [3.9°N, 11.9°E] Ernest W. L. Tempel, 1821–1889. German astronomer. Discovered six asteroids and many comets.
Crater with a disintegrated wall (48 km/1250 m).

Triesnecker, Rimae. See map 33.

Vaporum, Mare (Sea of Vapors). See p. 92.

Whewell [4.2°N, 13.7°E] William Whewell, 1794–1866. English philosopher and historian of science.
Simple crater (14 km/2260 m).





35

Arago

The western part of Mare Tranquillitatis. Note the remarkable system of rilles running down the western edge of the mare, and the prominent network of mare ridges surrounding the formation Lamont. Also of interest are the large domes Arago Alpha and Beta, and a group of four small domes northwest of Arago Alpha. This area contains the crash-landing sites of Ranger 6 and Ranger 8; also the soft-landing sites of Surveyor 5 and the Apollo 11 mission.

Al-Bakri (Tacquet A) [14.3°N, 20.2°E] A. A. Al-Bakri, 1010–1094. Arabian geographer from Spain.
Crater with a flat floor (12 km/1000 m).

Aldrin (Sabine B) [1.4°N, 22.1°E] Edwin E. Aldrin, Jr., born 1930. American astronaut (Apollo 11).
Simple crater (3.4 km/600 m).

Arago [6.2°N, 21.4°E] Dominique F. J. Arago, 1786–1853. French astronomer.
Crater (26 km).

Ariadaeus [4.6°N, 17.3°E] Philippus Arrhidaeus, d. 317 BC; Macedonian king, whose name was entered in the Babylonian list of eclipses.
Simple crater (11.2 km/1830 m).

Armstrong (Sabine E) [1.4°N, 25.0°E] Neil A. Armstrong, born 1930. American astronaut (Apollo 11). First man to set foot on the Moon (1969).
Simple crater (4.6 km/670 m).

Carrel (Jansen B) [10.7°N, 26.7°E] Alexis Carrel, 1873–1944. French physician and physiologist, Nobel Laureate.
Crater (16 km).

Collins (Sabine D) [1.3°N, 23.7°E] Michael Collins, born 1930. American astronaut (Apollo 11).
Simple crater (2.4 km/560 m).

Dionysius [2.8°N, 17.3°E] St. Dionysus, died AD 120. According to Riccioli, he observed a solar eclipse when Christ was crucified.
Crater (17.6 km), *very bright at full Moon.*

Honoris, Sinus (Bay of Honor) [12°N, 18°E].
Promontory of Mare Tranquillitatis, about 100 km *long.*

Lamont [5.0°N, 23.2°E] John Lamont, 1805–1879. Scottish-born German astronomer.
Inconspicuous formation, 75 km in diameter, whose wall is outlined by mare ridges. Visible under low-Sun illumination only.

Maclear [10.5°N, 20.1°E] Sir Thomas Maclear, 1794–1879. Irish astronomer.
Flooded crater (20 km/610 m).

Maclear, Rimae [13°N, 20°E]
Parallel rilles, length 100 km.

Manners [4.6°N, 20.0°E] Russell Henry Manners, 1800–1870. English admiral and astronomer.
Crater (15 km/1710 m).

Ritter [2.0°N, 19.2°E] (1) Karl Ritter, 1779–1859, German geographer. (2) August Ritter, 1826–1908, German astrophysicist.
Crater with an uneven floor (31 km).

Ritter, Rimae [3°N, 18°E]
Parallel rilles, length about 100 km.

Ross [11.7°N, 21.7°E] (1) Sir James C. Ross, 1800–1862, English polar explorer, gave his name to the Ross Sea. (2) Frank E. Ross, 1874–1966, American astronomer, studied ultraviolet radiation.
Crater with an elongated shape (26 km).

Sabine [1.4°N, 20.1°E] Sir Edward Sabine, 1788–1883. Irish astronomer.
Crater (30 km).

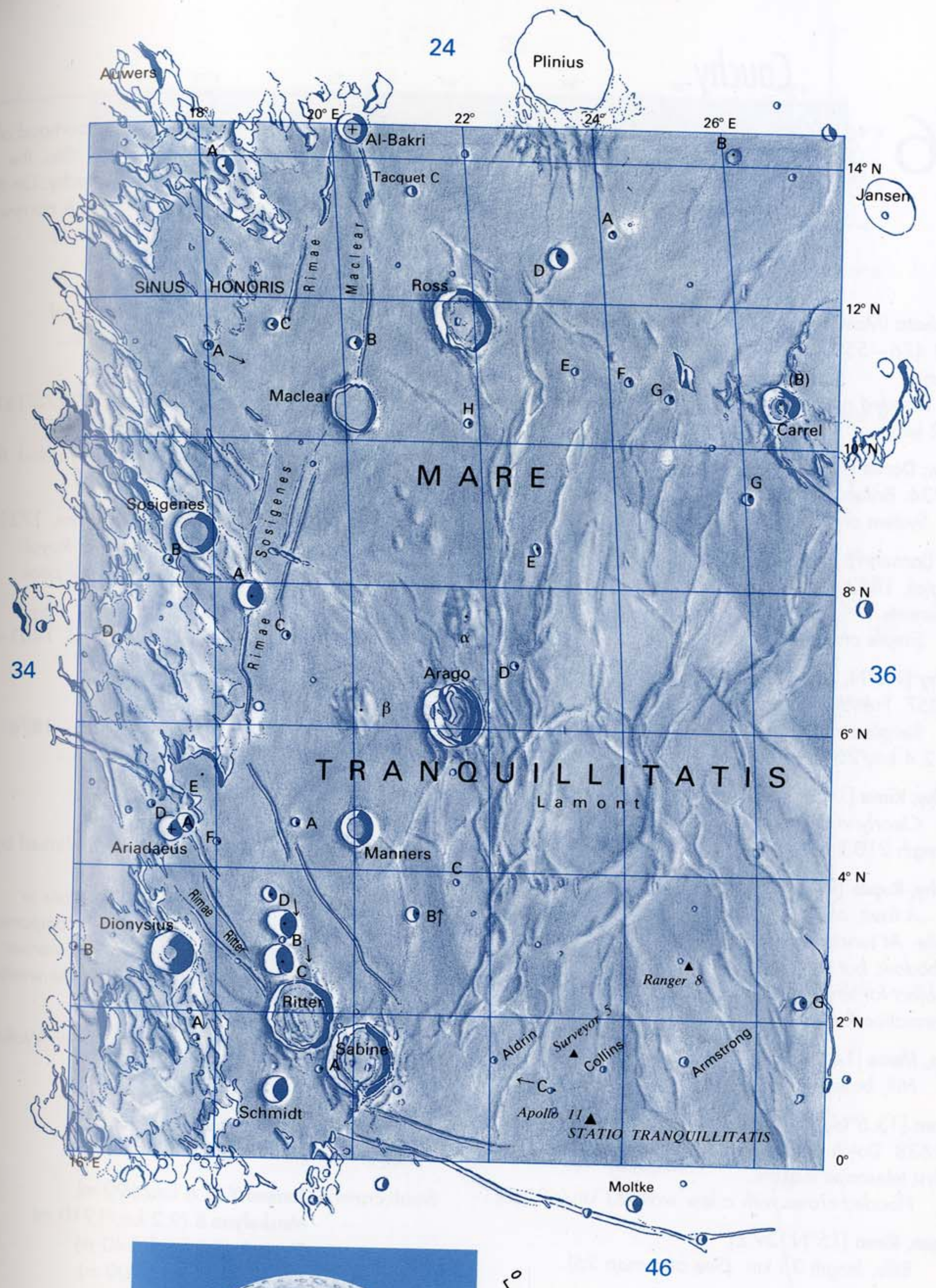
Schmidt [1.0°N, 18.8°E] (1) Johann F. J. Schmidt, 1825–1884, German selenographer. (2) Bernhard Schmidt, 1879–1935, German optician, inventor of the Schmidt camera. (3) Otto J. Schmidt, 1891–1956, Soviet naturalist.
Simple crater (11.4 km/2300 m).

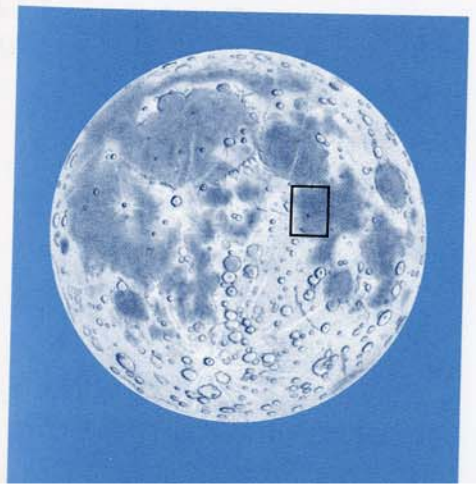
Sosigenes [8.7°N, 17.6°E] Sosigenes, 1st century BC. Greek astronomer. Julius Caesar's adviser, helped introduce reformed Julian calendar, 46 BC.
Crater (28 km/1730 m).

Sosigenes, Rimae [7°N, 19°E]
Parallel rilles, length about 150 km.

Tranquillitatis, Mare (Sea of Tranquillity). See p. 98. Between the craters Carrel and Lamont there is a remarkable transition from dark to lighter mare material.

Tranquillitatis, Statio (Tranquillity Base) [0.7°N, 23.5°E]. Landing site of Apollo 11 (1969).





36 Cauchy

The central part of Mare Tranquillitatis. The most interesting area is in the neighborhood of the crater Cauchy, where, under low illumination, a modest telescope will show rilles, the striking fault Rupes Cauchy, and the typical domes Omega Cauchy and Tau Cauchy. On the summit of Omega Cauchy is a small crater that is visible with a large telescope. A narrow rille is present to the west of the crater Maskelyne (lower left-hand edge of the map).

Aryabhata (Maskelyne E) [6.2°N, 35.1°E] Aryabhata, AD 476–550. Indian astronomer and mathematician.
Flooded crater with part of its eastern wall intact (22 km).

Barlow, Dorsa [15°N, 31°E] William Barlow, 1845–1934. British crystallographer.
System of mare ridges, length 120 km.

Cajal (Jansen F) [12.6°N, 31.1°E] Santiago Ramón y Cajal, 1852–1934. Spanish histologist, Nobel Laureate.
Simple crater (9 km/1800 m).

Cauchy [9.6°N, 38.6°E] Augustin L. Cauchy, 1789–1857. French mathematician.
Simple crater, bright at full Moon (12.4 km/2610 m).

Cauchy, Rima [10°N, 39°E]
Clearly visible with small scopes, wide rille, length 210 km.

Cauchy, Rupes [9°N, 37°E]
A fault, about 120 km *long, changes over into a rille. At sunrise the northeastern wall casts a striking shadow, but it is bright under the setting Sun. Easy object for small telescopes; compare with the similar formation Rupes Recta (map 54).*

Esam, Mons [14.6°N, 35.7°E] Arabian male name.
Hill, base diameter 8 km.

Jansen [13.5°N, 28.7°E] Zacharias Janszoon, 1580–1638. Dutch optician from Middleburg, one of the first telescope makers.
Flooded crater with a low wall (23 km/620 m).

Jansen, Rima [15°N, 29°E]
Rille, length 35 km. *(See also map 25).*

Lucian (Maraldi B) [14.3°N, 36.7°E] Lucian of Samosata, AD. 120–180. Greek writer.
Simple crater (7 km/1490 m).

Lyell [13.6°N, 40.6°E] Sir Charles Lyell, 1797–1875. Scottish geologist and explorer.
Crater with a disintegrated wall and a dark floor (32 km).

Maskelyne [2.2°N, 30.1°E] Nevil Maskelyne, 1732–1811. Englishman, the fifth Astronomer Royal.
Crater with terraced wall and central peak (24 km).

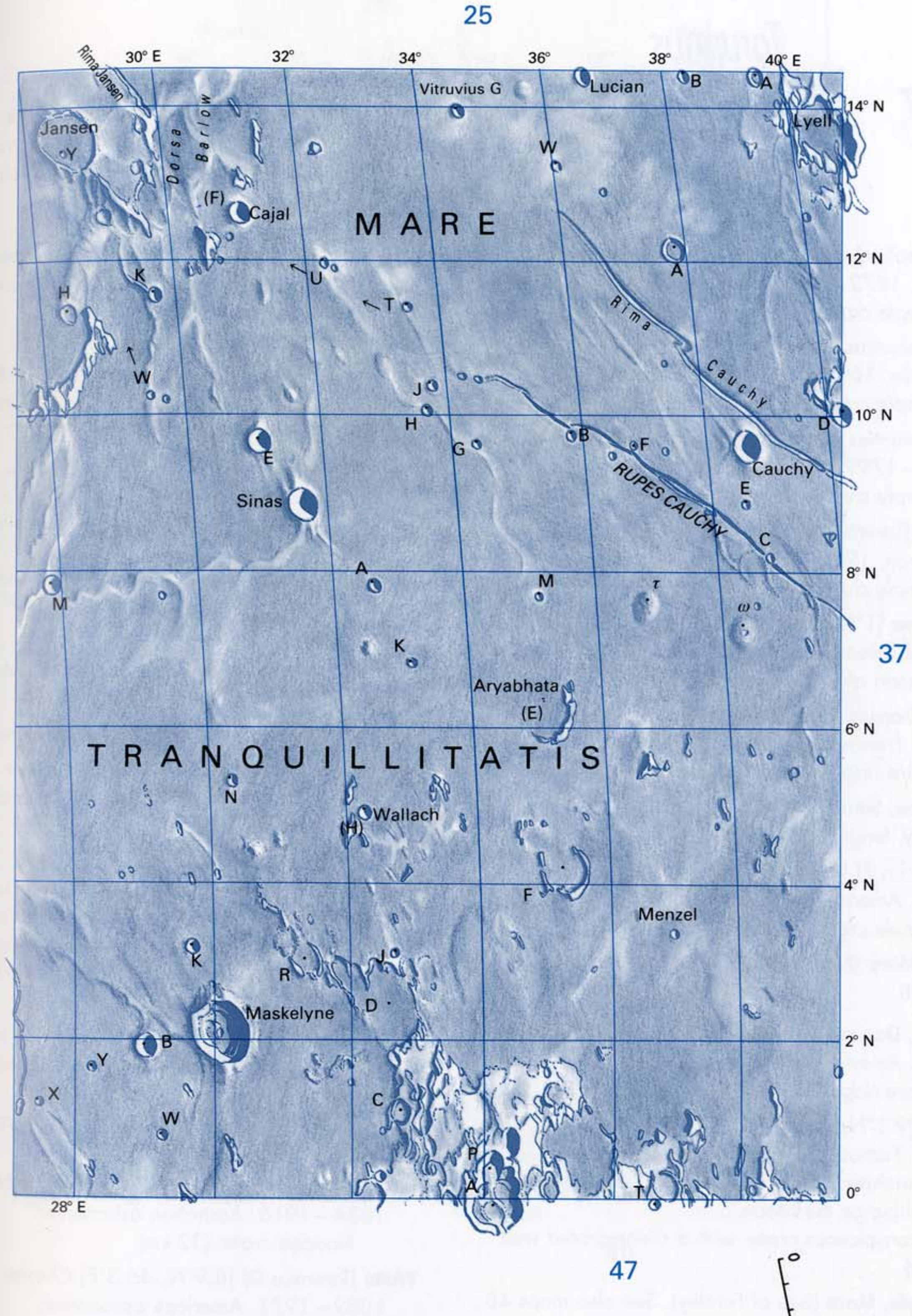
Menzel [3.4°N, 36.9°E] Donald H. Menzel, 1901–1976. American astrophysicist.
Simple crater (3 km).

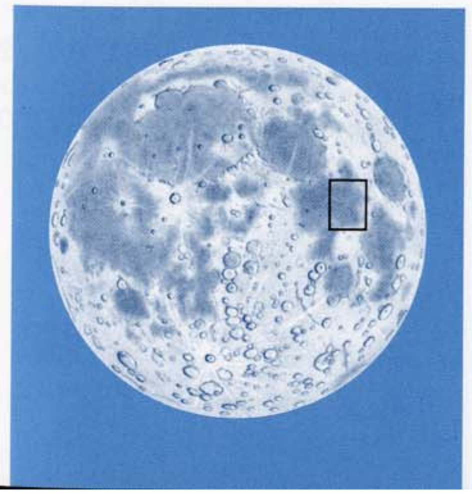
Sinas [8.8°N, 31.6°E] Simon Sinas, 1810–1876. Greek merchant, patron of astronomers. Bequeathed Athens Observatory.
Simple crater (12.4 km/2260 m).

Tranquillitatis, Mare (Sea of Tranquillity). Named by Riccioli.
The surface area of Mare Tranquillitatis is 421,000 sq km *and therefore can be compared with that of the Black Sea. There are numerous mare ridges and domes, especially in the western part.*

Wallach (Maskelyne H) [4.9°N, 32.3°E] Otto Wallach, 1847–1931. German chemist.
Simple crater (6 km/1140 m).

Small craters: **Jansen Y** (3.6 km/690 m)
Maskelyne B (9.2 km/1910 m)
Sinas A (5.8 km/1140 m)
Sinas E (9.2 km/1700 m)





37 *Taruntius*

A narrow terra strip separates Mare Tranquillitatis from Mare Fecunditatis. To the northeast is the dark area of Mare Crisium, bordered by a mountain massif and numerous craters. Under low illumination the edge of Mare Crisium provides a beautiful view. This area is intersected from the west by the rille Rima Cauchy.

Abbot (Apollonius K) [5.6°N, 54.8°E] Charles G. Abbot, 1872–1973. American astrophysicist.
Simple crater (10 km).

Anville (Taruntius G) [1.9°N, 49.5°E] Jean Baptiste d'Anville, 1697–1782. French cartographer.
Simple crater (11 km).

Asada (Taruntius A) [7.3°N, 49.9°E] Goryu Asada, 1734–1799. Japanese astronomer.
Simple crater (12 km).

Cameron (Taruntius C) [6.2°N, 45.9°E] Robert C. Cameron, 1925–1972. American astronomer.
Simple crater (11 km).

Cato, Dorsa [1°N, 47°E] Marcus Porcius Cato, 234–149 BC. Roman architect.
System of mare ridges, length 140 km.

Cayeux, Dorsum [1°N, 51°E] Lucien Cayeux, 1864–1944. French geologist.
Mare ridge, length 130 km.

Concordiae, Sinus (Bay of Concord) [11°N, 43°E]
Bay, length about 160 km.

Crile (Proclus F) [14.2°N, 46.0°E] G. Crile, 1864–1943. American physician.
Simple crater (9 km).

Crisium, Mare (Sea of Crises). See also maps 26, 27, and 38.

Cushman, Dorsum [1°N, 49°E] J. A. Cushman, 1881–1949. American micro paleontologist.
Mare ridge, length 80 km.

da Vinci [9.1°N, 45.0°E] Leonardo da Vinci, 1452–1519. Famous Florentine artist, sculptor, mathematician, architect, and engineer. The first to explain earthshine on the Moon.
Inconspicuous crater with a disintegrated wall (38 m).

Fecunditatis, Mare (Sea of Fertility). See also maps 48, 49, and 59.

Glaisher [13.2°N, 49.5°E] James Glaisher, 1809–1903. English meteorologist.
Prominent crater at edge of Mare Crisium (16 km).

Greaves (Lick D) [13.2°N, 52.7°E] William M. H. Greaves, 1897–1955. British astronomer, Astronomer Royal for Scotland.
Crater (14 km).

Lawrence (Taruntius M) [7.4°N, 43.2°E] Ernest O. Lawrence, 1901–1958. American physicist, Nobel Laureate.
Flooded crater (24 km/1000 m).

Lick [12.4°N, 52.7°E] James Lick, 1796–1876. American financier and philanthropist. Endowed Lick Observatory in California.
Flooded crater (31 km).

Secchi [2.4°N, 43.5°E] Pietro Angelo Secchi, 1818–1878. Italian astronomer, pioneer of stellar spectroscopy.
Inconspicuous crater with an open wall (24.5 km/1910 m).

Secchi, Montes [3°N, 43°E]
Inconspicuous mountain range, length about 50 km.

Secchi, Rimae [1°N, 44°E]
Pair of rilles occupying a 40-km-diameter area.

Smithson (Taruntius N) [2.4°N, 53.6°E] James Smithson, 1765–1829. British chemist and mineralogist.
Simple crater (6 km).

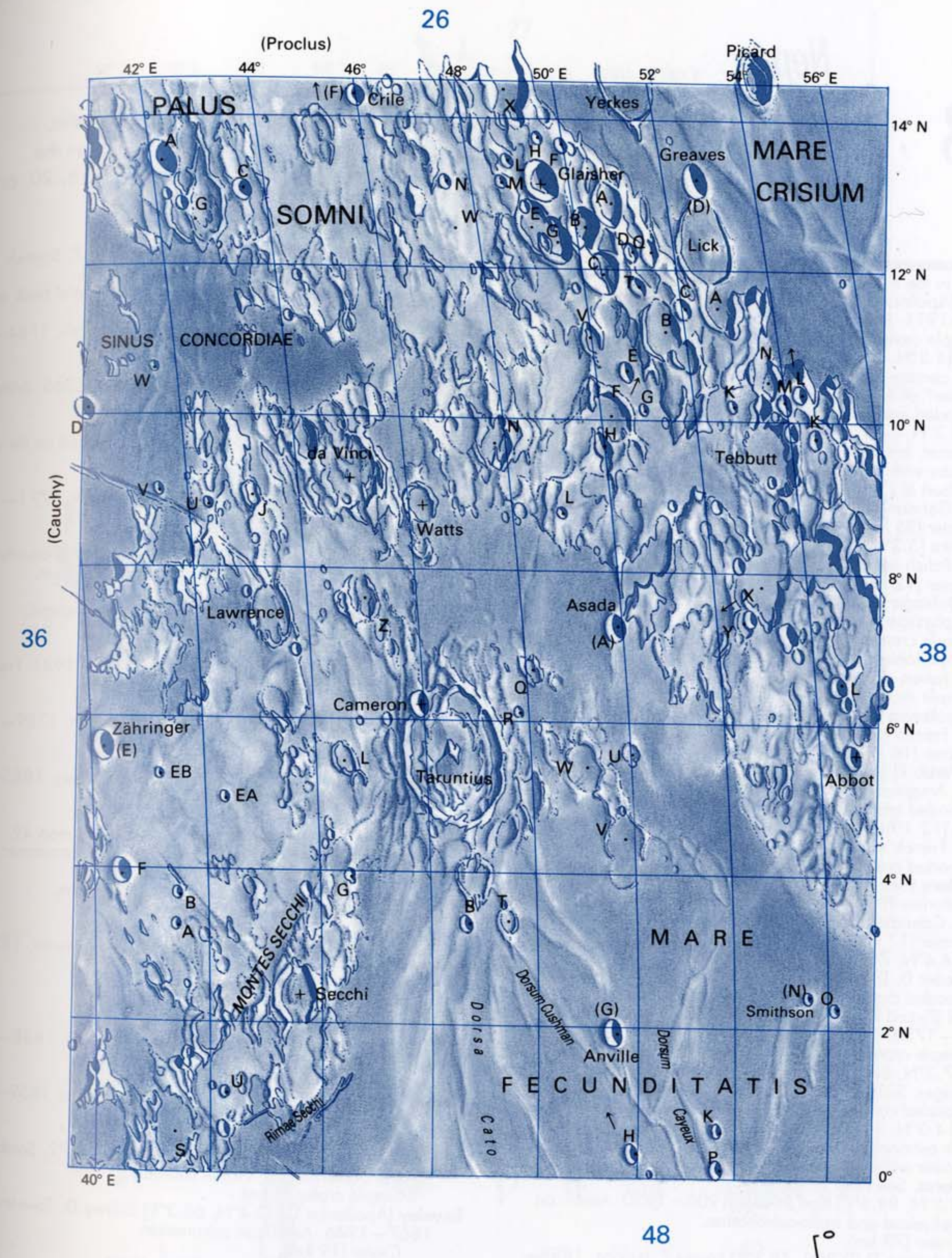
Somni, Palus (Marsh of Sleep).
A terra region stretching into Mare Tranquillitatis and separated from the remaining terra region in the vicinity of Mare Crisium by bright rays from the crater Proclus. It stands out as a light-dark surface area at full Moon.

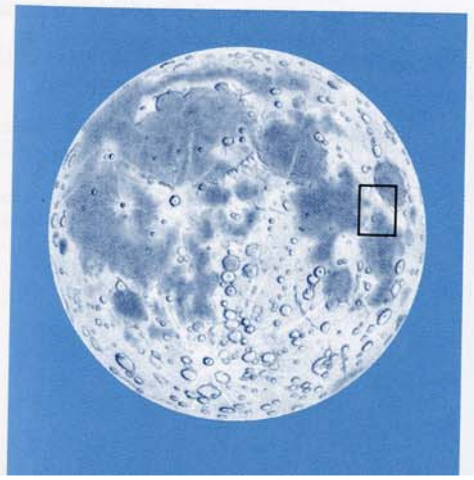
Taruntius [5.6°N, 46.5°E] Lucius Taruntius Firmanus, c. 86 BC. Roman mathematician, philosopher, and astrologer.
Fresh impact crater with bright rays and a central peak (56 km).

Tebbutt (Picard G) [9.6°N, 53.6°E] John Tebbutt, 1834–1916. Australian astronomer.
Flooded crater (32 km).

Watts (Taruntius D) [8.9°N, 46.3°E] Chester B. Watts, 1889–1971. American astronomer.
Flooded crater (15 km).

Zähringer (Taruntius E) [5.6°N, 40.2°E] Joseph Zähringer, 1929–1970. German physicist.
Simple crater (11.3 km/2110 m).





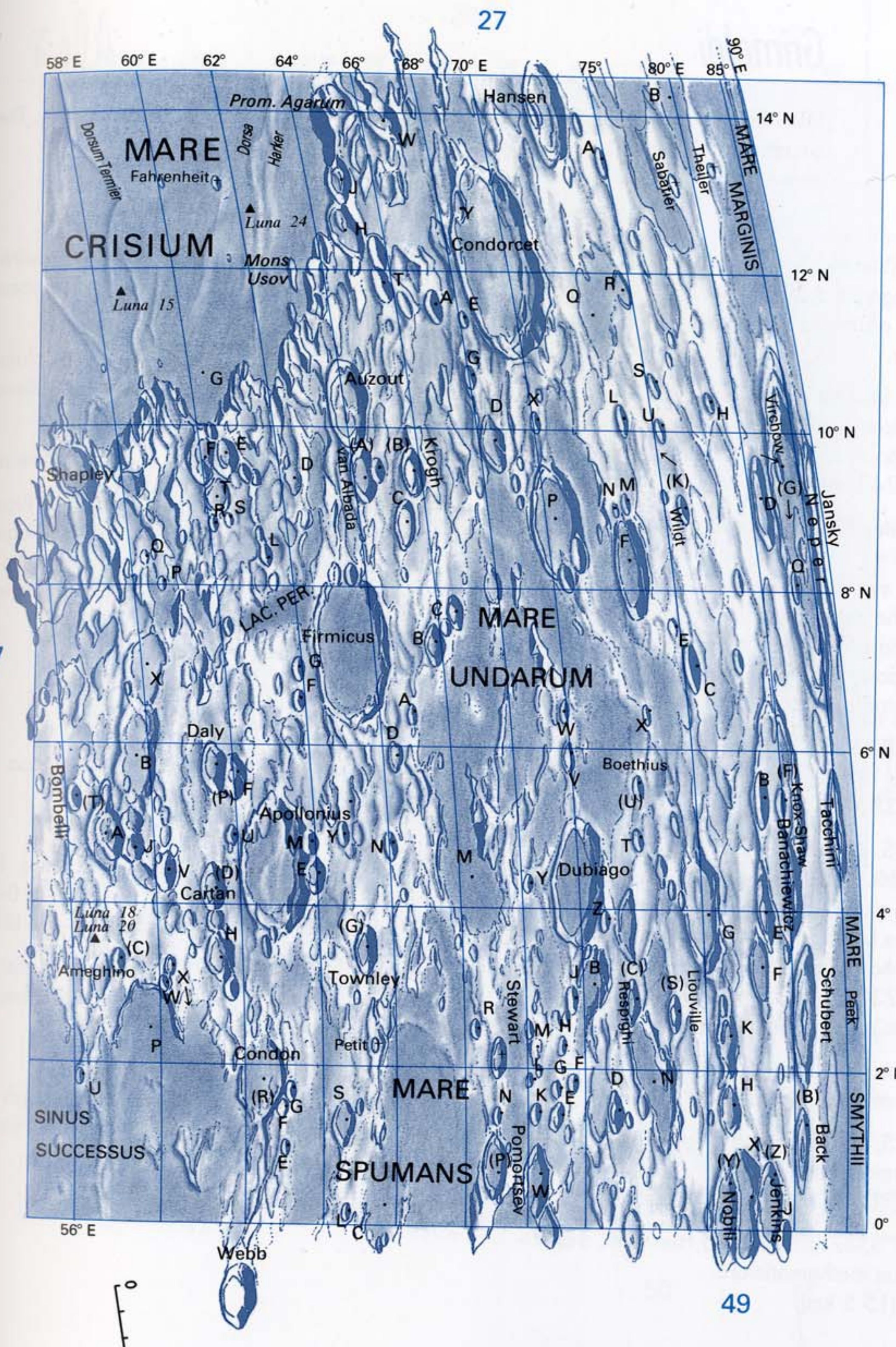
38

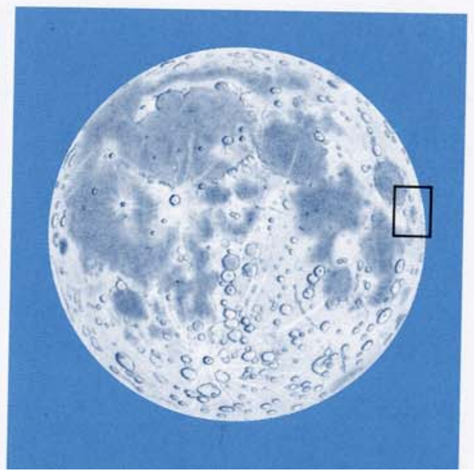
Neper

The eastern limb of the Moon, with a group of small lunar maria: Marginis, Smythii, Spumans, and Undarum. This region appeared in its true form for the first time on the historic photograph taken by Luna 3. The landing sites of the probes Luna 15, 18, 20, and 24 are shown on the map.

Agarum, Promontorium (Cape Agarum) [14°N, 66°E] Named after a cape in the Azov Sea, near the Crimea in Russia.
Ameghino (Apollonius C) [3.3°N, 57.0°E] Florentino Ameghino, 1854–1911. Italian historian of natural sciences.
Simple crater (9 km).
Apollonius [4.5°N, 61.1°E] Apollonius of Perga, second half of the 3rd century BC. Greek mathematician, the "Great Geometer" of Alexandria.
Flooded crater with a dark floor (53 km).
Auzout [10.3°N, 64.1°E] Adrien Auzout, 1622–1691. French astronomer, inventor of the filar micrometer.
Crater with peaks rising from its floor (33 km).
Back (Schubert B) [1.1°N, 80.7°E] Ernst E. A. Back, 1881–1959. German physicist.
Crater (35 km).
Banachiewicz [5.2°N, 80.1°E] Tadeusz Banachiewicz, 1882–1954. Polish astronomer and mathematician.
Crater (92 km).
Boethius (Dubiago U) [5.6°N, 72.3°E] Boethius, AD 480–524. Greek physicist.
Simple crater (10 km).
Bombelli (Apollonius T) [5.3°N, 56.2°E] R. Bombelli, 1526–1572. Italian mathematician.
Simple crater (10 km).
Cartan (Apollonius D) [4.2°N, 59.3°E] E. J. Cartan, 1869–1951. French mathematician.
Crater (16 km).
Condon (Webb R) [1.9°N, 60.4°E] Edward W. Condon, 1902–1974. American physicist.
Flooded crater (35 km).
Condorcet [12.1°N, 69.6°E] Jean A. de Condorcet, 1743–1794. French mathematician and philosopher.
Flooded crater with a dark floor (74 km).
Crisium, Mare (Sea of Crises). See p. 80.
Daly (Apollonius P) [5.7°N, 59.6°E] Reginald A. Daly, 1871–1957. Canadian geologist.
Crater (17 km).
Dubiago [4.4°N, 70.0°E] (1) Dmitri Dubiago, 1849–1918; (2) Alexander D. Dubiago, 1903–1959. Russian astronomers.
Flooded crater with a dark floor (51 km).
Fahrenheit (Picard X) [13.1°N, 61.7°E] Daniel G. Fahrenheit, 1686–1736. German physicist.
Simple crater (6 km).
Firmicus [7.3°N, 63.4°E] Firmicus Maternus, c. AD 330. Astrologer, Sicilian by origin.
Flooded crater with a dark floor (56 km).
Hansen [14.0°N, 72.5°E] Peter Andreas Hansen, 1795–1874. Danish astronomer.
Crater with a central peak (40 km).
Harker, Dorsa. See map 27.
Jansky [8.5°N, 89.5°E] Karl Jansky, 1905–1950. American radio-physicist and radio-astronomer.
Crater (73 km).
Jenkins (Schubert Z) [0.3°N, 78.1°E] Louise F. Jenkins, 1888–1970. American astronomer.
Crater (38 km).
Knox-Shaw (Banachiewicz F) [5.3°N, 80.2°E] Harold Knox-Shaw, 1885–1970. British astronomer.
Simple crater (12 km).
Krogh (Auzout B) [9.4°N, 65.7°E] Schack A. S. Krogh, 1874–1949. Danish zoologist.
Crater (20 km).
Liouville (Dubiago S) [2.6°N, 73.5°E] Joseph Liouville, 1809–1882. French mathematician.
Crater (16 km).
Marginis, Mare (The Border Sea) [12°N, 88°E].
Surface area 62,000 sq km.

Neper [8.8°N, 84.5°E] John Napier, 1550–1617. Scottish mathematician, inventor of logarithms in 1614.
Very prominent, complex crater with a central peak and a dark floor (137 km).
Nobili (Schubert Y) [0.2°N, 75.9°E] Leopoldo Nobili, 1784–1835. Italian physicist.
Crater (42 km).
Peek [2.6°N, 86.9°E] Bertrand M. Peek, 1891–1965. British astronomer.
Simple crater (13 km).
Perseverantiae, Lacus (Lake of Persistence — marked on the map as LAC.PER.) [8°N, 62°E]
Diameter 70 km.
Petit (Apollonius W) [2.3°N, 63.5°E] Alexis T. Petit, 1771–1820. French physicist.
Simple crater (5 km).
Pomortsev (Dubiago P) [0.7°N, 66.9°E] Mikhail M. Pomortsev, 1851–1916. Russian pioneer of rocket propulsion.
Crater (23 km).
Respighi (Dubiago C) [2.8°N, 71.9°E] Lorenzo Respighi, 1824–1890. Italian astronomer.
Crater (19 km).
Sabatier [13.2°N, 79.0°E] Paul Sabatier, 1854–1941. French chemist, Nobel Laureate.
Simple crater (10 km).
Schubert [2.8°N, 81.0°E] Theodor F. von Schubert, 1789–1865. Russian cartographer.
Crater (54 km).
Shapley (Picard H) [9.4°N, 56.9°E] Harlow Shapley, 1885–1972. American astronomer.
Crater (23 km).
Smythii, Mare (Smyth's Sea) [2°S, 87°E] See also map 49. William Henry Smyth, 1788–1865. British astronomer, writer, and admiral.
Circular mare; surface area 104,000 sq km.
Spumans, Mare (Foaming Sea) [1°N, 65°E]
Surface area 16,000 sq km.
Stewart (Dubiago Q) [2.2°N, 67.0°E] John Q. Stewart, 1894–1972. American astrophysicist.
Crater (13 km).
Successus, Sinus (Bay of Success) [1°N, 58°E]
Diameter 100 km.
Tacchini (Neper K) [4.9°N, 85.5°E] Pietro Tacchini, 1838–1905. Italian astronomer.
Crater (40 km).
Termier, Dorsum [11°N, 58°E] Pierre-Marie Termier, 1859–1930. French geologist.
Mare ridge, length 90 km.
Theiler [13.4°N, 83.3°E] Max Theiler, 1899–1972. South-African bacteriologist, Nobel Laureate.
Simple crater (8 km).
Townley (Apollonius G) [3.4°N, 63.3°E] Sidney D. Townley, 1867–1946. American astronomer.
Crater (19 km).
Undarum, Mare (Sea of Waves) [7°N, 69°E]
Surface area 21,000 sq km.
Usov, Mons [12°N, 63°E] Mikhail A. Usov, 1883–1933. Soviet geologist. *Mountain, diameter* 15 km.
van Albada (Auzout A) [9.4°N, 64.3°E] Gale B. van Albada, 1912–1972. Dutch astronomer.
Crater (22 km).
Virchow (Neper G) [9.8°N, 83.7°E] Rudolph L. K. Virchow, 1821–1902. German physician and pathologist.
Crater (17 km).
Wildt (Condorcet K) [9.0°N, 75.8°E] Rupert Wildt, 1905–1976. German-born American astronomer. Studied the constitution of the planets.
Crater (11 km).





39 Grimaldi

The western limb of the Moon, the southwestern border of Oceanus Procellarum. The northeastern edge of the Orientale basin. A small lunar basin Grimaldi.

Aestatis, Lacus (Summer Lake) [15°S, 69°W]
Two elongated dark patches north of the crater Crüger (see also map 50); total surface area about 1000 sq km.

Autumni, Lacus (Autumn Lake) [14°S, 82°W]
Dark patches situated on the inside of the Cordillera Mountains; total surface area 3000 sq km, *span up to* 240 km.

Cordillera, Montes (Cordillera Mountains) [20°S, 80°W]
Circular mountain formation 900 km in diameter, that forms the outer ring of the Orientale basin (continued on map 50). Length about 1500 km. *From Earth only part of the mountainous ring is visible, during favorable librations.*

Damoiseau [4.8°N, 61.1°W] Marie Charles T. de Damoiseau, 1768–1846. French astronomer.
Crater (37 km).

Grimaldi [5.2°S, 68.6°W] Francesco M. Grimaldi, 1618–1663. Italian physicist and astronomer, author of a map of the Moon that was used by Riccioli as a basis for his nomenclature.
Basin whose flooded center is surrounded by an inner wall 230 km in diameter; the damaged external ring has a diameter of 430 km.

Grimaldi, Rimae [9°S, 64°W]
System of rilles, length about 230 km.

Hartwig [6.1°S, 80.5°W] Karl E. Hartwig, 1851–1923. German astronomer.
Crater (80 km).

Hermann [0.9°S, 57.3°W] Jacob Hermann, 1678–1733. Swiss mathematician.
Crater (15.5 km).

Lallemand (Kopff A) [14.3°S, 84.1°W] André Lallemand, 1904–1978. French astronomer.
Crater (18 km).

Lohrmann [0.5°S, 67.2°W] Wilhelm G. Lohrmann, 1796–1840. German geodesist and selenographer.
Crater (31 km).

Procellarum, Oceanus (Ocean of Storms). See p. 84.

Riccioli [3.0°S, 74.3°W] Giovanni Baptist Riccioli, 1598–1671. Italian philosopher, theologian, and astronomer, author of Almagestum Novum in which he introduced the system of lunar nomenclature still in use today.
Large crater (146 km).

Riccioli, Rimae [2°S, 74°W]
System of rilles, length up to 390 km.

Rocca [12.7°S, 72.8°W] Giovanni A. Rocca, 1607–1656. Italian mathematician.
Disintegrated crater (90 km).

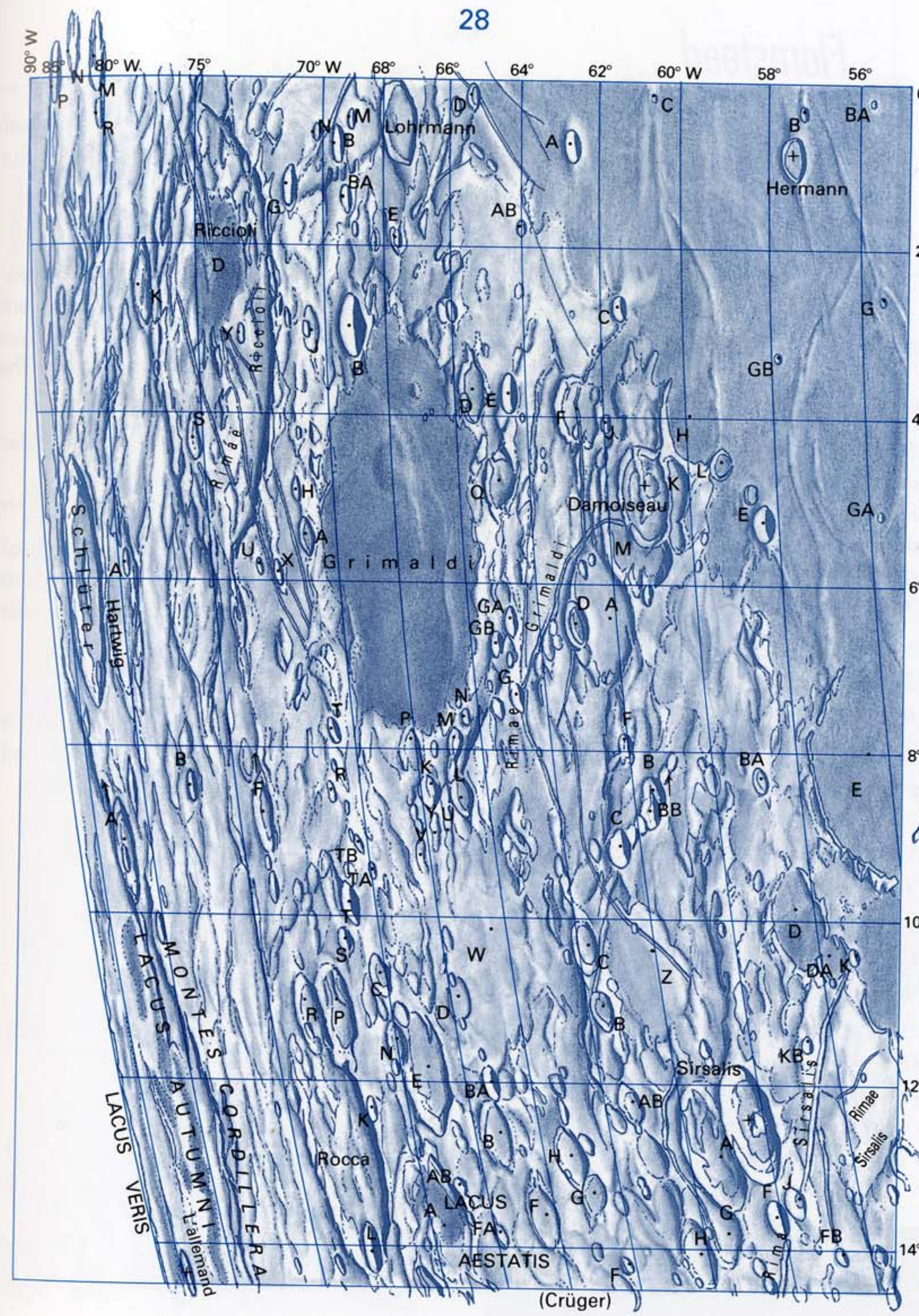
Schlüter [5.9°S, 83.3°W] Heinrich Schlüter, 1815–1844. German astronomer, assistant to Bessel.
Prominent crater with terraced walls (89 km).

Sirsalis [12.5°S, 60.4°W] Gerolamo Sirsalis (Sersale), 1584–1654. Italian Jesuit selenographer.
Crater (42 km).

Sirsalis, Rimae [14°S, 60°W]
System of rilles, clearly visible through even a small telescope; the largest is called Rima Sirsalis (see also map 50).

Veris, Lacus (Spring Lake). See map 50.

28



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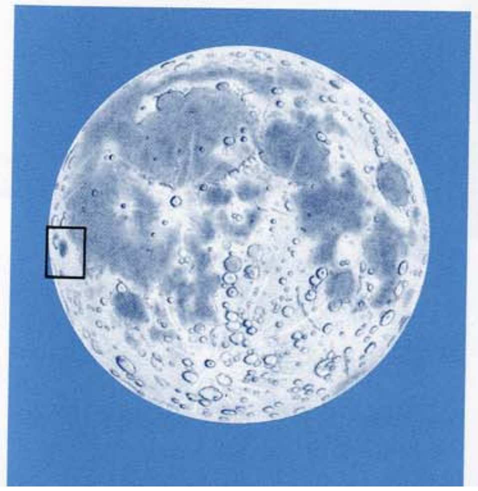


Flamsteed

The southern part of Oceanus Procellarum. The craters Billy and Hansteen are useful landmarks for the observer's orientation: the massif Mons Hansteen separates them. Surveyor 1 landed close to the remains of the wall of the flooded crater Flamsteed P.

Billy [13.8°S, 50.1°W] Jacques de Billy, 1602–1679. French Jesuit mathematician and astronomer. Rejected astrology and superstitious ideas about comets.
Flooded crater with a very dark floor (46 km).

Flamsteed [4.5°S, 44.3°W] John Flamsteed, 1646–1719. Englishman, the first Astronomer Royal. Author of the first star catalog since that of Tycho Brahe. Flamsteed's system of numbering the stars is still in use today.
Crater (21 km/2160 m).

Hansteen [11.5°S, 52.0°W] Christopher Hansteen, 1784–1873. Norwegian geophysicist. Discovered the position of the north geomagnetic pole.
Crater with hills on its floor (45 km).

Hansteen, Mons (formerly Hansteen Alpha) [12°S, 50°W]
Mountain massif of triangular outline, that appears very bright under high illumination; diameter 30 km.

Hansteen, Rima [12°S, 53°W]
Inconspicuous rille, length 25 km.

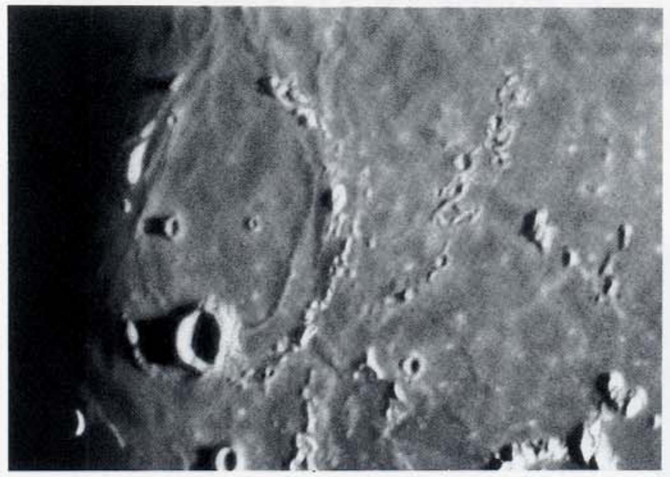
Letronne [10.6°S, 42.4°W] Jean Antoine Letronne, 1787–1848. French archaeologist, in his time an authority on the civilization of ancient Egypt.
Remains of a flooded crater 119 km *in diameter; it resembles a semicircular bay in Oceanus Procellarum.*

Procellarum, Oceanus (Ocean of Storms). See p. 84.
This part of Oceanus Procellarum contains numerous mare ridges, remains of the walls of flooded craters, and many small hills. The adjacent area on map 41 is of similar character.

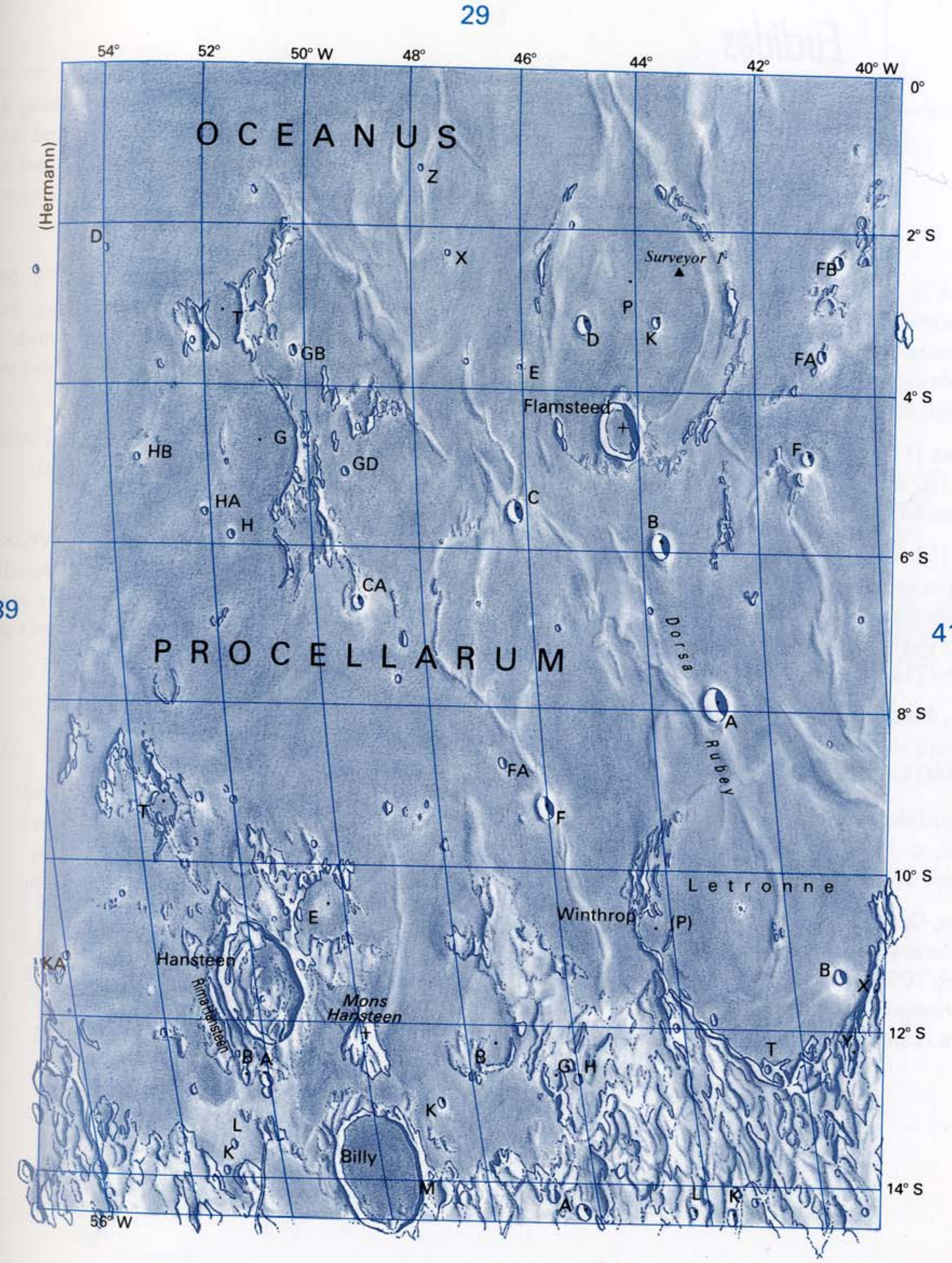
Rubey, Dorsa [10°S, 42°W] William Malden Rubey, 1898–1974. American geologist.
System of mare ridges, length 100 km.

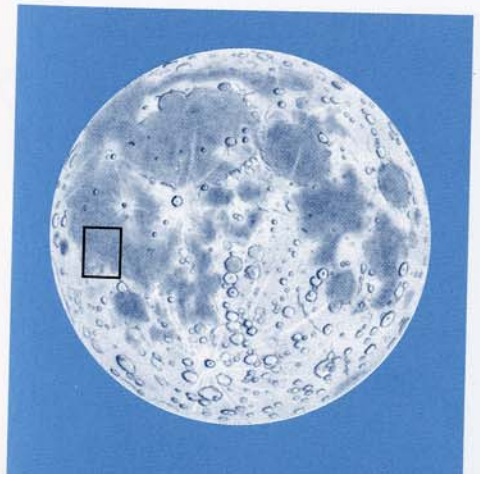
Winthrop (Letronne P) [10.7°S, 44.4°W] John Winthrop, 1714–1779. American astronomer.
Remains of a flooded crater, diameter 18 km.

Small craters: **Flamsteed F** (5.4 km/1050 m)
Letronne B (5.2 km/1000 m)
Letronne T (3.0 km/620 m)



*The crater **Flamsteed** lies on the southern edge of the circular formation Flamsteed P, which is a flooded crater 110 km in diameter.*





Euclides

The southeastern part of Oceanus Procellarum. The Riphaeus Mountains stretch along the eastern edge of the map. To the southeast of the crater Lansberg D there is a large dome. This part of Oceanus Procellarum contains numerous mare ridges and small isolated hills, and is interesting for telescopic observation, especially under low illumination. Larger telescopes will reveal the narrow sinuous rille Rima Herigonius.

Euclides [7.4°S, 29.5°W] Euclid, c. 300 BC. Famous Greek mathematician, founder of the Alexandrian mathematical school; Euclidean geometry.
Simple crater (12 km), *very prominent and bright under high illumination.*

Ewing, Dorsa [11°S, 38°W], William M. Ewing, 1906–1974. American geophysicist.
System of mare ridges, total length 320 km.

Herigonius [13.3°S, 33.9°W] Pierre Herigone, c. 1644. French mathematician. His six-volume Cursus Mathematicus includes spherical astronomy and the theory of the motion of the planets.
Crater (15 km/2100 m).

Herigonius, Rima [13°S, 37°W]
Sinuous rille with numerous meanders, length about 100 km.

Norman (Euclides B) [11.8°S, 30.4°W] Robert Norman, c. 1590. British naturalist.
Simple crater (10.3 km/2000 m).

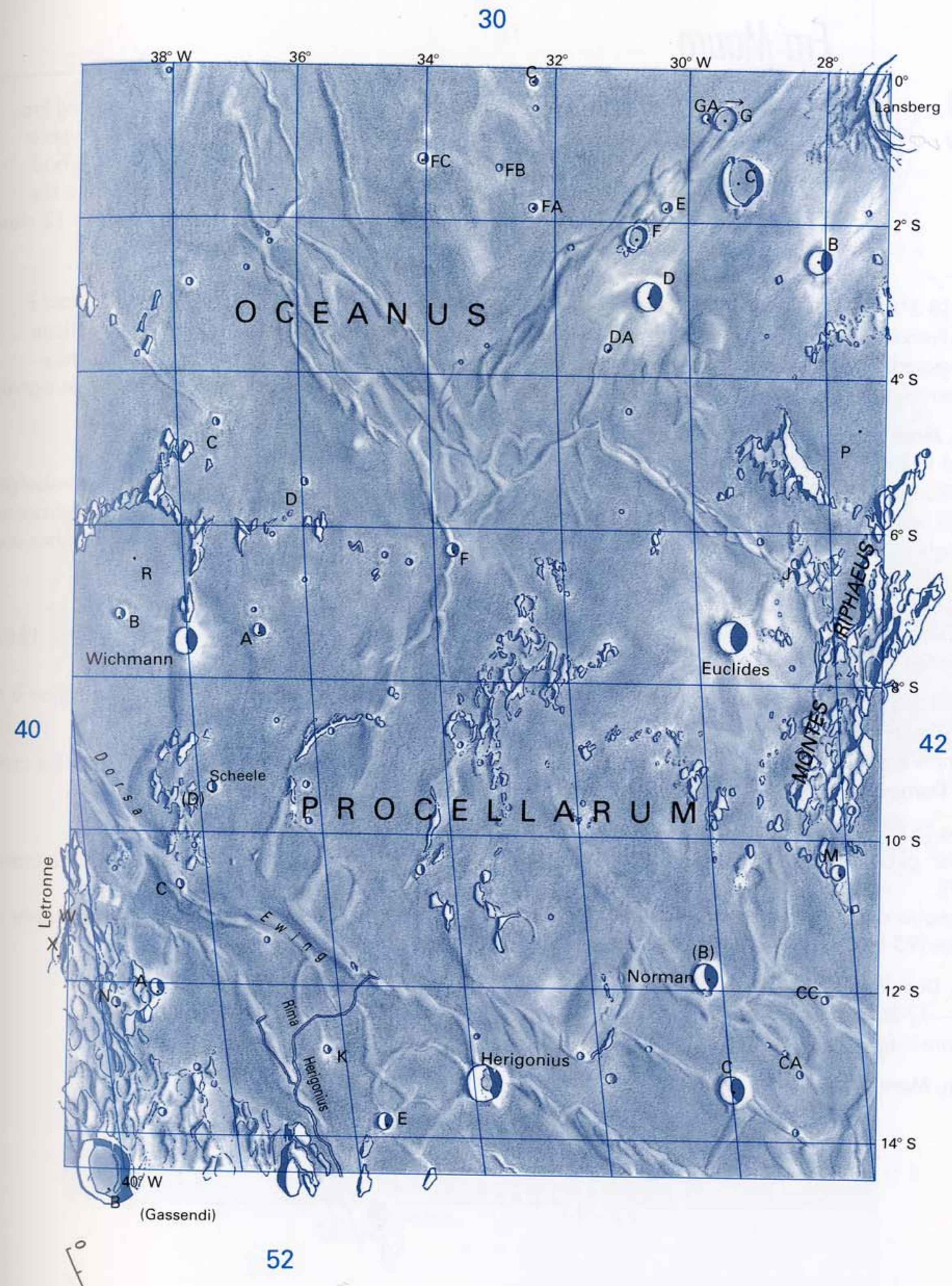
Procellarum, Oceanus (Ocean of Storms). See p. 84.
The areas north of the crater Euclides F (5.2 km/1090 m) *and in the neighborhood of the crater Herigonius contain one of the richest systems of mare ridges on the Moon.*

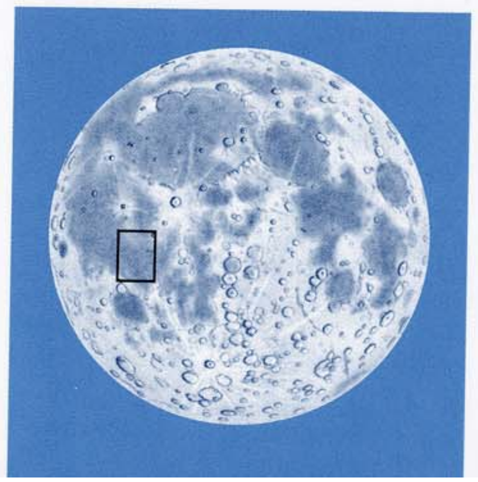
Riphaeus, Montes (Riphaeus Mountains) [7°S, 28°W] According to ancient Greek geographers, this was the mountain range from which north winds used to blow (today the Ural Mountains). (See also map 42.)
Range 150 km.

Scheele (Letronne D) [9.4°S, 37.8°W] Carl Wilhelm Scheele, 1742–1786. Swedish chemist.
Simple crater (5 km/750 m).

Wichmann [7.5°S, 38.1°W] Moritz L. G. Wichmann, 1821–1859. German astronomer. Determined the inclination of the lunar equator and was one of the first to confirm the existence of the Moon's physical librations.
Simple crater (10.6 km)

Small craters: **Lansberg B** (9.9 km/2030 m)
Lansberg C (19.8 km/810 m)
Lansberg G (9.9 km/270 m)
Wichmann C (2.8 km/490 m).





42

Fra Mauro

The southern edge of Mare Insularum extends to between the craters Lansberg and Fra Mauro. The lower half of the map is occupied by Mare Cognitum. Although this area is seemingly uninteresting, it contains a number of geologically important locations and therefore was one of the most visited regions of the Moon. This is the area where the probe Ranger 7 crash-landed and where two Apollo expeditions landed: Apollo 12 close to Surveyor 3, and Apollo 14 in the hills outside the rim of the crater Fra Mauro.

Bonpland [8.3°S, 17.4°W] Aimé Bonpland, 1773–1858. French botanist who accompanied Humboldt on his expeditions to Mexico and Colombia.
Remains of a crater with rilles on its floor (60 km).

Cognitum, Mare [10°S, 23°W] (the "Known" Sea). Named in 1964 after the successful flight of the probe Ranger 7, which transmitted to Earth the first detailed television pictures of the lunar surface. The seemingly smooth, flat surface of the mare is pitted with numerous craters, some of which are a thousand times smaller than the smallest visible through large Earth-based telescopes. A new stage in the exploration of the Moon began here.

Darney [14.5°S, 23.6°W] Maurice Darney, 1882–1958. French observer of the Moon.
Simple crater (15 km/2620 m); *west of it is crater* **Darney C** (13.3 km/2330 m).

Fra Mauro [6.0°S, 17.0°W] Fra Mauro, d. 1459. Venetian geographer; prepared a map of the world (1457).
Remains of a crater whose interior is intersected by rilles (95 km).

Guettard, Dorsum [10°S, 18°W] Jean-Etienne Guettard, 1715–1786. French geologist.
Mare ridge, length 40 km.

Insularum, Mare (Sea of Isles). See maps 30, 31.

Kuiper (Bonpland E) [9.8°S, 22.7°W] Gerard P. Kuiper, 1905–1973. Dutch-born American astronomer, director of Lunar and Planetary Laboratory, University of Arizona. Made significant discoveries in the solar system.
Simple crater (6.8 km/1330 m).

Lansberg [0.3°S, 26.6°W] Philippe van Lansberge, 1561–1632. Belgian physician and astronomer, author of a treatise on the use of astrolabes and gnomons.
Prominent crater (39 km/3110 m).

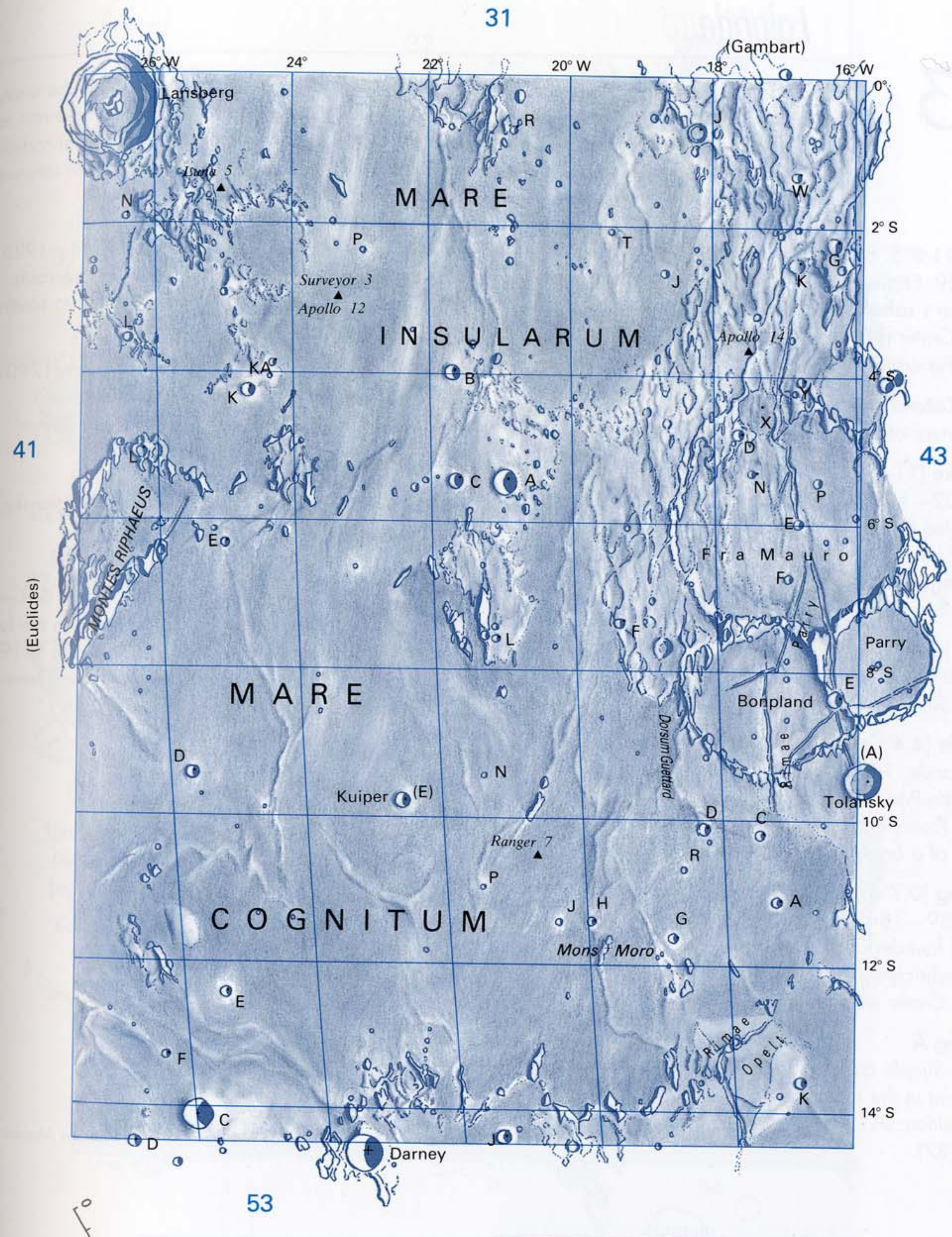
Moro, Mons [12°S, 20°W] Antonio L. Moro, 1687–1764. Italian naturalist.
Elevation about 10 km *long, situated on a mare ridge.*

Opelt, Rimae [13°S, 18°W]. Named after the crater Opelt (map 53).
System of rilles, length 70 km.

Parry, Rimae [8°S, 17°W]. Named after the crater Parry (map 43).
System of rilles, visible through even quite a small telescope, length 300 km.

Riphaeus, Montes. See map 41.

Tolansky. see map 43.



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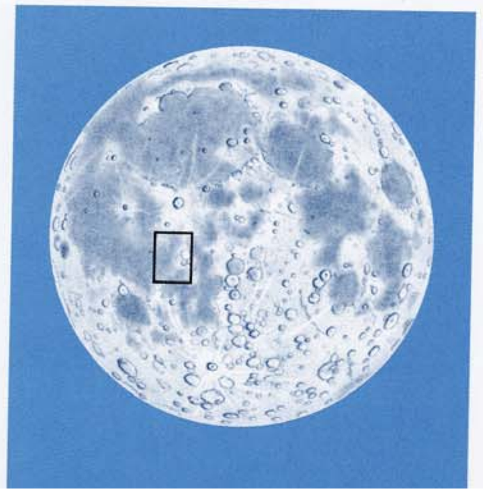


43

Lalande

Predominantly mare area, that is penetrated by Mare Nubium from the south. In the west, it adjoins the group of three craters Bonpland, Parry, and Fra Mauro. The edge of a vast terra area, which shows traces of the development on the Imbrium basin (faults, valleys, radial structures), protrudes into this region from the east. The crater Davy Y contains an interesting chain of small craters.

Davy [11.8°S, 8.1°W] Sir Humphry Davy, 1778–1829. English physicist and chemist, inventor of the miner's safety lamp.
Crater (35 km), *the wall of which is intersected by the crater* **Davy A** (15 km).

Davy, Catena [11°S, 7°W]
Linear chain of simple craters, length about 50 km.

Guericke [11.5°S, 14.1°W] Otto von Guericke, 1602–1686. German physicist. In 1654 demonstrated the existence of atmospheric pressure by the well-known experiment with the so-called "Magdeburg hemispheres."
Remains of a crater (58 km).

Kundt (Guericke C) [11.5°S, 11.5°W] August Kundt, 1839–1894. German physicist.
Simple crater (11 km).

Lalande [4.4°S, 8.6°W] Joseph J. le Francois de Lalande, 1732–1807. French astronomer, director of the Paris Observatory.
Prominent terraced crater (24 km/2590 m), *center of a bright ray system.*

Mösting [0.7°S, 5.9°W] Johann S. von Mösting, 1759–1843. Danish patron of astronomers, one of the founders of the journal Astronomische Nachrichten.
Crater with terraced walls (26 km/2760 m).

Mösting A
Simple crater (13 km/2700 m), *the fundamental point in the selenographical network of coordinates. Position:* 3°12′43.2″S, 5°12′39.6″W (Davies, 1987).

Palisa [9.4°S, 7.2°W] Johann Palisa, 1848–1925. Austrian astronomer. Discovered 127 asteroids.
Crater with disintegrated wall, open to southwest (33 km).

Parry [7.9°S, 15.8°W] Sir William E. Parry, 1790–1855. English admiral and Arctic explorer.
Crater with a flooded floor (48 km/560 m).

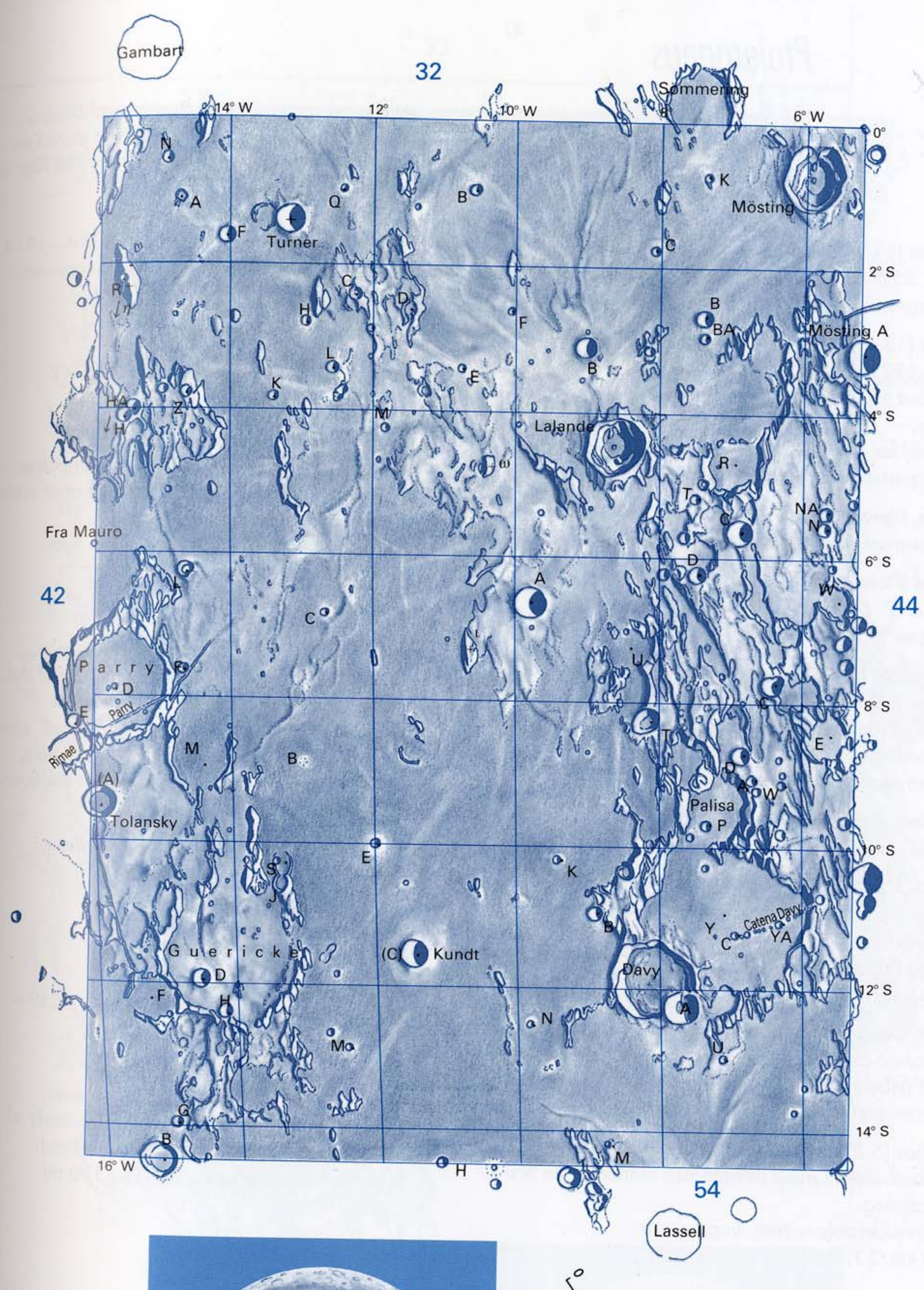
Parry, Rimae. See map 42.

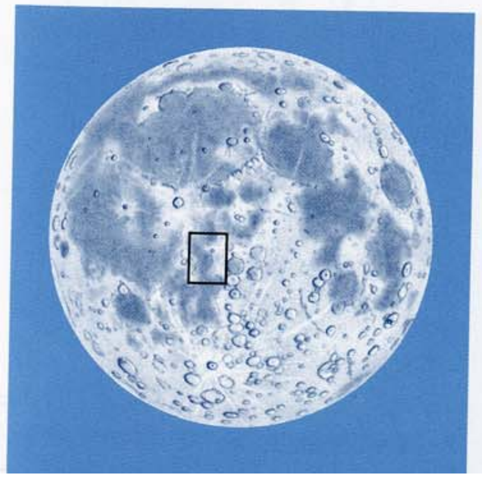
Tolansky (Parry A) [9.5°S, 16°W] Samuel Tolansky, 1907–1973. British physicist.
Crater with a flat floor (13 km/880 m).

Turner [1.4°S, 13.2°W] Herbert H. Turner, 1861–1930. English astronomer. Participated in the formulation of international lunar nomenclature. In 1903 he discovered a nova in the constellation Gemini.
Simple crater (11.8 km/2630 m).

Small craters: **Davy C** (3.4 km/540 m)
Fra Mauro R (3.4 km/650 m)*
Guericke D (7.6 km/1500 m)
Lalande A (13.2 km/2600 m)
Parry D (2.8 km/330 m)

* *This crater is situated on the top of the hill Fra Mauro Eta.*





Ptolemaeus

The central part of the near side of the Moon, with large craters. The dark surface of Sinus Medii, bordered by rilles, extends into this area from the north. This region, like that shown on map 43, contains a structure of valleys and lineaments radiating from Imbrium basin. The floor of the crater Alphonsus was the crash-landing site of the probe Ranger 9.

Albategnius [11.2°S, 4.1°E] Muhammed ben Geber al Batani, 852–929. Arabian prince and astronomer.
Complex crater (136 km).

Alphonsus [13.4°S, 2.8°W] Alfonso X, "El Sabio" (The Wise), 1221–1284. King of Castile, astronomer. Compiled "Alphonsine Tables" of planetary positional data.
Complex crater with a central peak, rilles and simple craters with dark halos on its floor.

Alphonsus, Rimae
System of rilles inside Alphonsus.

Ammonius (Ptolemaeus A) [8.5°S, 0.8°W] Ammonius, c. AD 517. Greek philosopher.
Crater (9 km/1850 m).

Flammarion [3.4°S, 3.7°W] Camille Flammarion, 1842–1925. French astronomer, famous popularizer of astronomy.
Flooded crater (75 km); *Mösting A rises from its western wall.* See also map 43.

Flammarion, Rima [2°S, 5°W]
Rille, length 80 km.

Gyldén [5.3°S, 0.3°E] Hugo Gyldén, 1841–1896. Finnish astronomer, director of Stockholm Observatory.
Disintegrated crater (47 km).

Herschel [5.7°S, 2.1°W] William Herschel, 1738–1822. German-born English astronomer, discoverer of Uranus; pioneered stellar astronomy. Discovered 2500 nebulae and galaxies.
Prominent terraced crater (41 km/3770 m).

Hipparchus [5.5°S, 4.8°E] Hipparchus, c. 190–125 BC. Renowned Greek astronomer, author of the first star catalog.
Considerably ruined, large crater (150 km/3320 m).

Klein [12.0°S, 2.6°E] Hermann J. Klein, 1844–1914, German selenographer, popularizer of astronomy.
Crater (44 km/1460 m).

Medii, Sinus (Central Bay). See also map 33.

Müller [7.6°S, 2.1°E] Karl Müller, 1866–1942. Austrian selenographer.
Elongated crater (24 × 20 km).

Oppolzer [1.5°S, 0.5°W] Theodor E. von Oppolzer, 1841–1886. Austrian astronomer, author of tables of solar and lunar eclipses to AD 2163.
Remains of a crater (43 km), *rille on floor.*

Oppolzer, Rima [1°S, 2°E]
Rille, 110 km *long.*

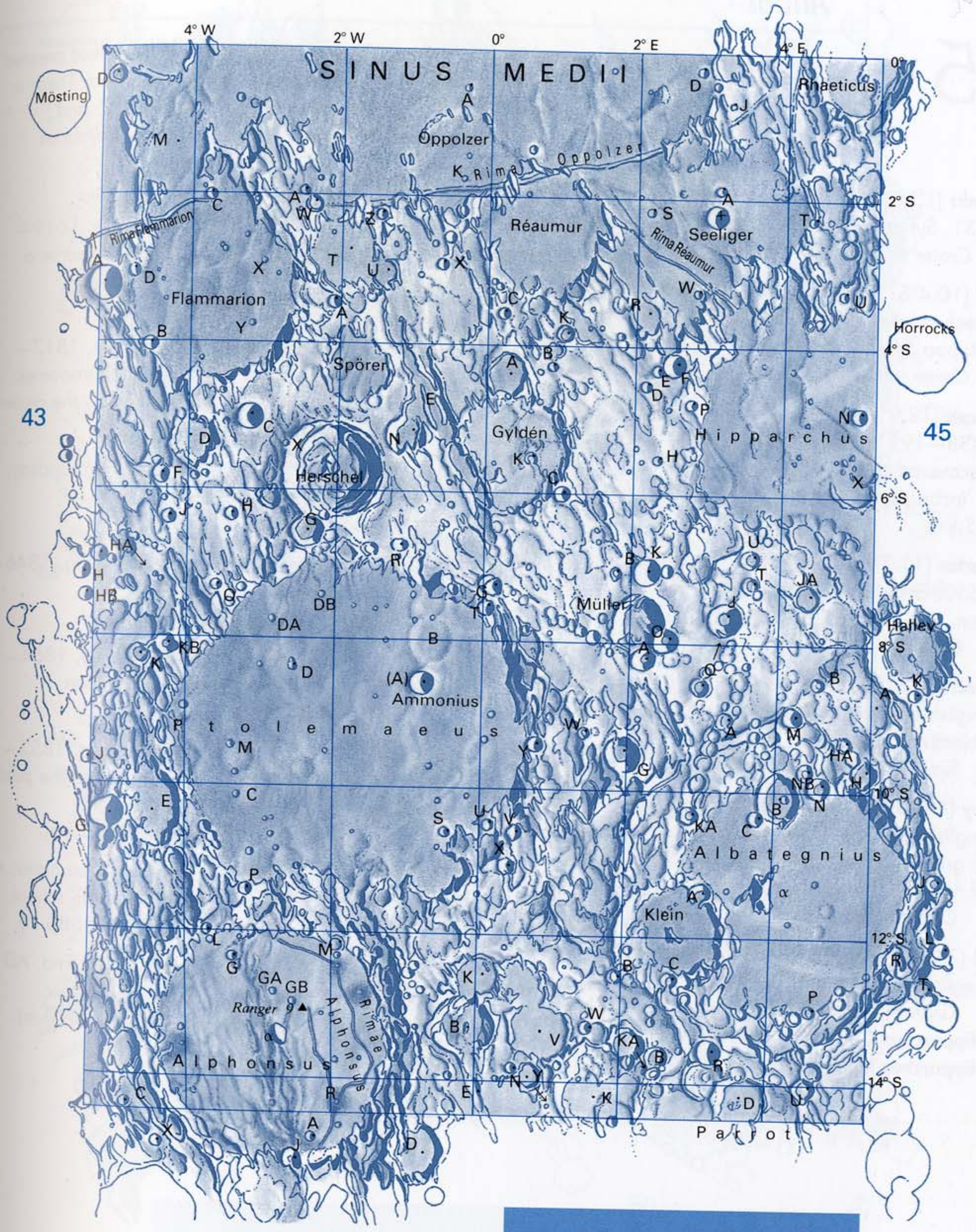
Ptolemaeus [9.2°S, 1.8°W] Claudius Ptolemaeus, c. AD 90–160. Greek astronomer, author of the Almagest. Geocentric model of the Universe.
Very prominent crater with plenty of small, simple craters on its floor (153 km/2400 m). *Also, numerous "subdued", shallow craters on the floor, visible under low illumination only.*

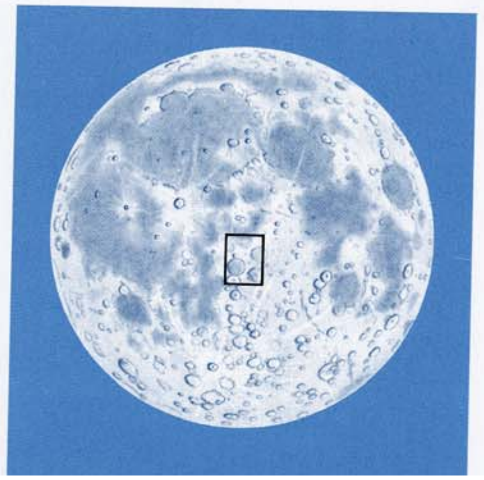
Réaumur [2.4°S, 0.7°E] René A. F. de Réaumur, 1683–1757. French physicist.
Remains of a crater (53 km).

Réaumur, Rima [3°S, 3°E]
Rille, length 45 km.

Seeliger [2.2°S, 3.0°E] Hugo von Seeliger, 1849–1924. German astronomer.
Simple crater (8.5 km/1800 m).

Spörer [4.3°S, 1.8°W] Friedrich W. G. Spörer, 1822–1895. German astronomer. The study of solar activity (law of distribution of sunspots).
Indistinct, shallow crater (28 km/310 m).





45 Anděl

A terra area with many ancient, degraded craters. The effects of the cataclysm that created the Imbrium basin can be seen as a distinct radial structure overlapping this area. There is an interesting arcuate row of "diminishing" craters: Halley, Hind, Hipparchus C, and Hipparchus L. The Apollo 16 mission landed some distance north of the crater Descartes.

Abulfeda [13.8°S, 13.9°E] Ismail Abu'l Fida, 1273–1331. Syrian prince, geographer, and astronomer.
Crater (62 km/3110 m).

Anděl [10.4°S, 12.4°E] Karel Anděl, 1884–1947. Czech teacher and selenographer. Lunar map *"Mappa Selenographica"* (1926).
Crater whose wall is open to the south (35 km).

Burnham [13.9°S, 7.3°E] Sherburne W. Burnham, 1838–1921. American amateur astronomer. Discovered over 1,300 double stars.
Inconspicuous crater with a disintegrated wall (25 km).

Descartes [11.7°S, 15.7°E] René Descartes, 1596–1650. Great French philosopher and mathematician.
Crater (48 km).

Dollond [10.4°S, 14.4°E] John Dollond, 1706–1761. English optician, devised the achromatic telescope objective.
Simple crater (11.1 km/1580 m).

Halley [8.0°S, 5.7°E] Edmond Halley, 1656–1742. English astronomer. On the basis of Newton's laws of gravitation he proved the periodicity of the orbit of the comet later named after him.
Crater (36 km/2510 m).

Hind [7.9°S, 7.4°E] John Russell Hind, 1823–1895. English astronomer.
Crater (29 km/2980 m) *in line with the craters* **Hipparchus C** *(17 km/2940 m) and* **Hipparchus L** *(13 km/2630 m).*

Hipparchus. See map 44.

Horrocks [4.0°S, 5.9°E] Jeremiah Horrocks, 1619–1641. English astronomer; the first to observe a transit of Venus across the Sun, in 1639.
Complex crater (30 km/2980 m).

Lade [1.3°S, 10.1°E] Heinrich E. von Lade, 1817–1904. German banker and amateur astronomer.
Remains of a flooded crater (56 km); *the crater* **Lade B**, *to the north, is filled to the rim.*

Lindsay (Dollond C) [7.0°S, 13.0°E] Eric M. Lindsay, 1907–1974. Irish astronomer.
Crater (32 km/1550 m).

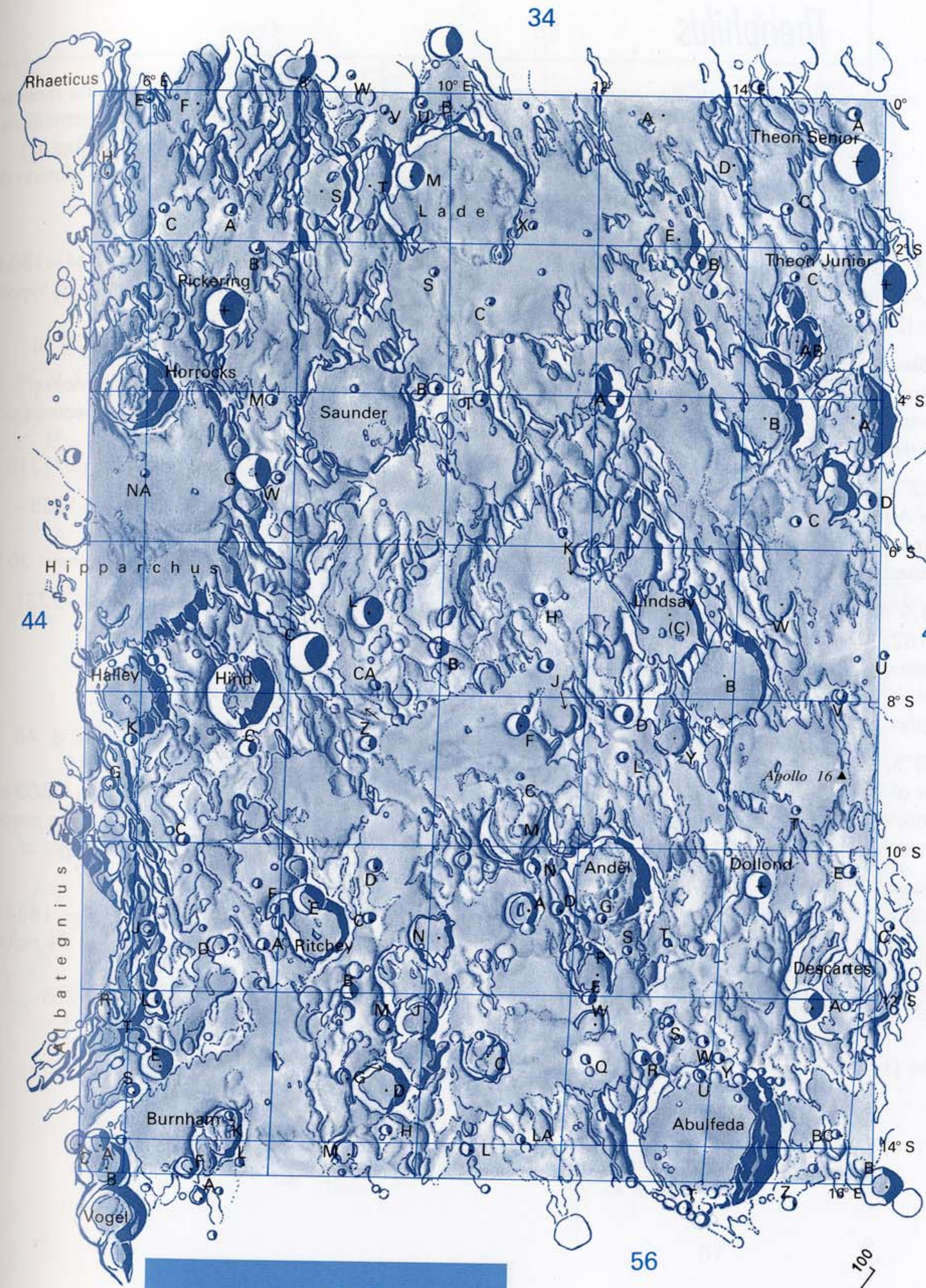
Pickering [2.9°S, 7.0°E] Edward C. Pickering, 1846–1919. American astronomer.
Simple crater (15 km/2740 m).

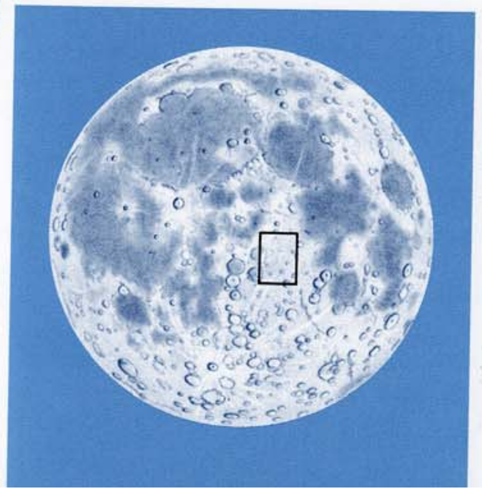
Ritchey [11.1°S, 8.5°E] George W. Ritchey, 1864–1945. American astronomer and optician.
Crater (25 km/1300 m).

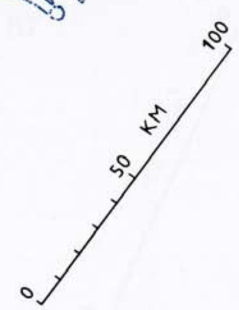
Saunder [4.2°S, 8.8°E] Samuel A. Saunder, 1852–1912. English selenographer. Cataloged the positions of 3,000 points on the Moon.
Crater with a low, irregular wall (45 km).

Theon Junior [2.3°S, 15.8°E] Theon of Alexandria, AD 380. Last astronomer of the Alexandrian school.
Prominent simple crater (18.6 km/3580 m).

Theon Senior [0.8°S, 15.4°E] Theon of Smyrna, AD 100. Greek mathematician and astronomer.
Prominent simple crater (18.2 km/3470 m).







46

Theophilus

From the north, this area is penetrated by the edge of Mare Tranquillitatis with the shallow rilles Rimae Hypatia. The large crater Theophilus is one of the most spectacular formations on the Moon; it forms a prominent trio with the craters Cyrillus and Catharina (map 57). Craters Kant B and Zöllner E are situated on the opposite edges of an extensive plateau that resembles a filled crater similar to Wargentin (map 70).

Alfraganus [5.4°S, 19.0°E] Muhammed ebn Ketir al Fargani, AD 840. Persian astronomer.
Crater (21 km/3830 m).

Asperitatis, Sinus (Bay of Asperity) [6°S, 25°E] The name corresponds to the very uneven character of this mare area.
Diameter about 180 km.

Cyrillus [13.2°S, 24.0°E] St Cyril, d. AD 444. Bishop of Alexandria, after Theophilus.
Prominent complex crater with a considerably disintegrated wall (98 km).

Delambre [1.9°S, 17.5°E] Jean B. J. Delambre, 1749–1822. French astronomer; collaborated in trigonometrical surveys that led to the derivation of the meter.
Complex crater (52 km).

Hypatia [4.3°S, 22.6°E] Hypatia, d. AD 415. Daughter of Theon of Alexandria; astronomer and mathematician.
Irregular crater (41 × 28 km).

Hypatia, Rimae [1°S, 23°E]
System of rilles, length 180 km.

Ibn Rushd (Cyrillus B) [11.7°S, 21.7°E] Ibn Rushd, Averroes, 1126–1198. Arabian philosopher, physician, and lawyer at the Royal Court in Muslim Spain.
Crater (33 km).

Kant [10.6°S, 20.1°E] Immanuel Kant, 1724–1804. German philosopher, author of the nebular hypothesis of the formation of the solar system.
Crater with central peak (32 km/3120 m).

Moltke [0.6°S, 24.2°E] Helmuth Karl von Moltke, 1800–1891. Prussian field marshal. Secured publication of Schmidt's map of the Moon.
Simple crater with bright halo (6.5 km/1310 m).

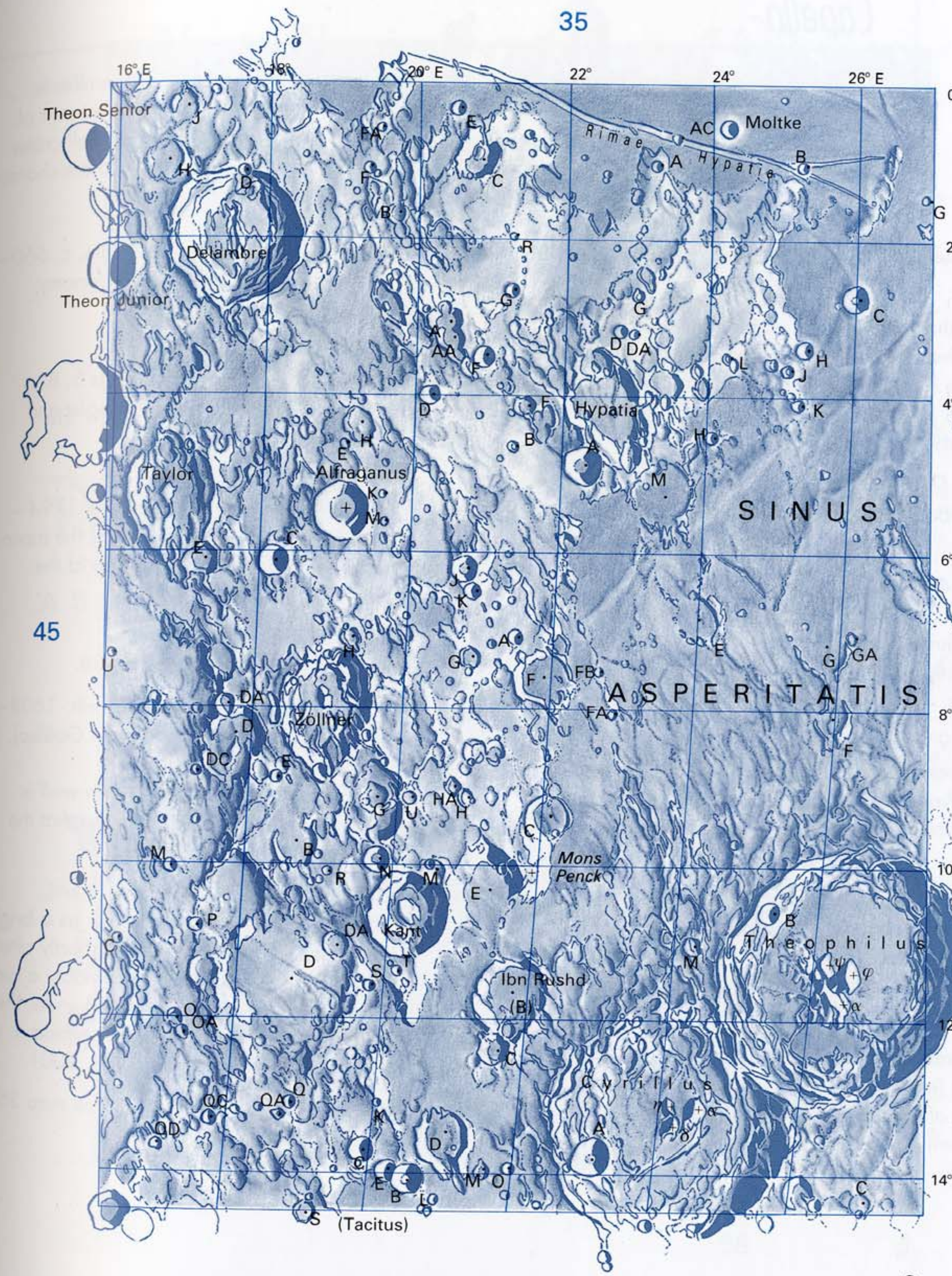
Penck, Mons [10°S, 22°E] Albrecht Penck, 1858–1945. German geographer.
Mountain massif, height 4000 m, *diameter* 30 km.

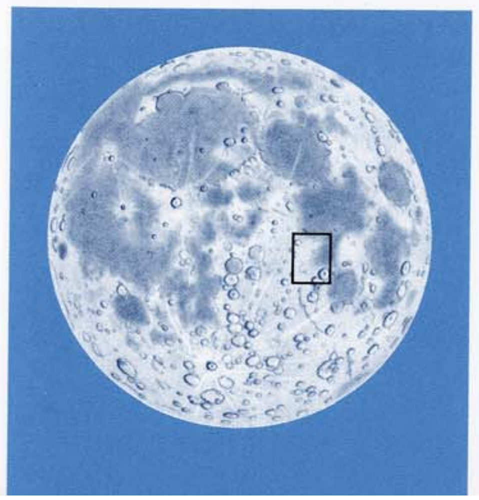
Taylor [5.3°S, 16.7°E] Brook Taylor, 1685–1731. English mathematician and philosopher.
Elongated crater (41 × 34 km).

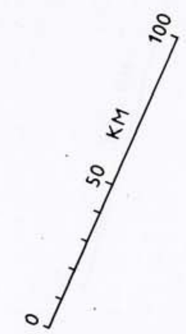
Theon Junior. See map 45.

Theophilus [11.4°S, 26.4°E] St. Theophilus, d. AD 412. Bishop of Alexandria from AD 385.
Spectacular complex crater (100 km/4400 m). *The rim of its wall rises* 1200 m *above the surrounding terrain; its central peaks reach a height of* 1400 m.

Zöllner [8.0°S, 18.9°E] Johann K. F. Zöllner, 1834–1882. German astronomer, inventor of the polarizing astrophotometer.
Elongated crater with disintegrated wall (47 × 36 km).







47 Capella

This terra area, intersected by the rilles Rimae Gutenberg, separates Mare Tranquillitatis from Mare Nectaris. The northern edge of Mare Nectaris is close to the prominent pair of craters Capella and Isidorus. The double, pear-shaped crater Torricelli and the small crater Censorinus, which is one of the brightest objects on the Moon, also contribute to the character of this region.

Asperitatis, Sinus (Bay of Asperity). See map 46.

Capella [7.6°S, 34.9°E] Martianus Capella, 5th century AD. Carthaginian lawyer. Copernicus refers to his theory that Mercury and Venus orbit the Sun, and that the Sun, together with the rest of the planets, revolves around the Earth.
Crater (49 km).

Capella, Vallis [7°S, 35°E]
Valley about 110 km *long, through the crater Capella.*

Censorinus [0.4°S, 32.7°E] Censorinus, AD 238. Roman astronomer. His letter De Die Natali deals with the influence of stars and chronology.
Small simple crater (3.8 km) *with exceptionally bright halo.*

Daguerre [11.9°S, 33.6°E] Louis Daguerre, 1789–1851. French landscape painter, inventor of daguerreotype photographic process.
Heavily ruined, lava-flooded crater, diameter 46 km.

Gaudibert [10.9°S, 37.8°E] Casimir M. Gaudibert, 1823–1901. French amateur astronomer and selenographer.
Inconspicuous crater divided by mountain ranges and ridges (33 km).

Gutenberg, Rimae [5°S, 38°E]. Named after the crater Gutenberg (map 48).
System of wide rilles (length 330 km*) visible through even a small telescope.*

Isidorus [8.0°S, 33.5°E] St. Isidore of Seville, c. 560–636. Bishop of Seville, interested in astronomy, believed the Earth to be a sphere.
Crater (42 km/1580 m).

Leakey (Censorinus F) [3.2°S, 37.4°E] Louis S. B. Leakey, 1903–1972. British archaeologist and palaeoanthropologist.
Crater (13 km).

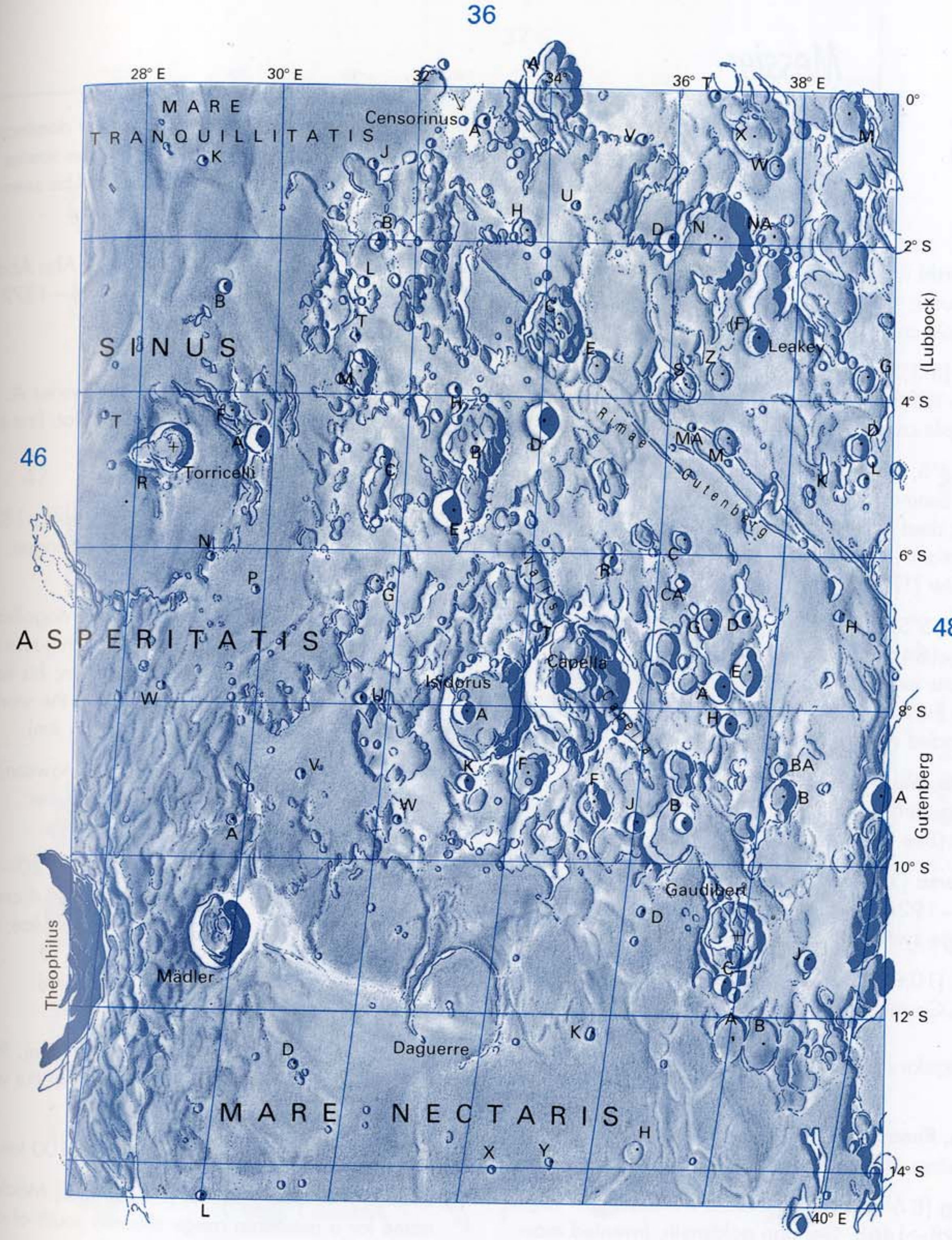
Mädler [11.0°S, 29.8°E] Johann H. Mädler, 1794–1874. German selenographer, author of the monograph Der Mond, which includes a map of the Moon.
Regular crater (28 km/2670 m).

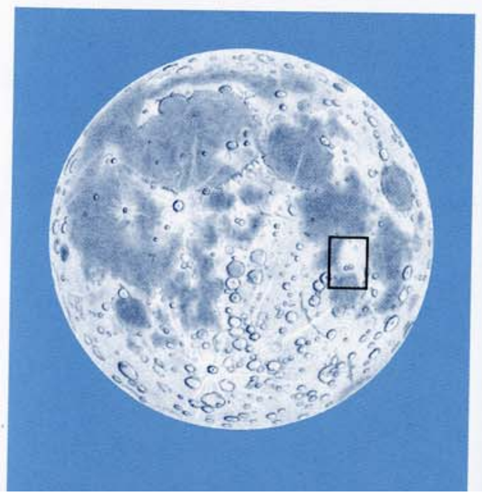
Nectaris, Mare (Sea of Nectar). See map 58.

Torricelli [4.6°S, 28.5°E] Evangelista Torricelli, 1608–1647. Italian physicist (contemporary of Galileo), inventor of the mercury barometer.
Crater 23 km *in diameter; its western wall is open and linked with a smaller crater, so that the whole formation appears pear-shaped.*

Torricelli B [2.7°S, 29.2°E], simple crater (8 km), reported to have appeared anomalously as a bright spot on the lunar disk for a few hours, shortly after full Moon on January 29, 1983. Presumably a sunglint, this phenomenon wasn't confirmed under the identical illumination (exactly one Saros period, i. e., 18 years 11 days, later) on February 9, 2001.

Tranquillitatis, Mare (Sea of Tranquillity). See map 35 and 36.





48 Messier

The vast area of Mare Fecunditatis, which is crossed by numerous mare ridges, is dominated by the well-known pair of craters Messier and Messier A, the latter of which is the source of two bright rays radiating to the west. In oblique illumination, "ghost craters" can be seen on the mare surface and a system of rilles around the crater Gutenberg.

Al-Marrakushi (Langrenus D) [10.4°S, 55.8°E] Al-Marrakushi, c. 1262. Arabian astronomer.
Simple crater (8 km).

Amontons [5.3°S, 46.8°E] Guillaume Amontons, 1663–1705. French physicist.
Simple crater (3 km).

Bellot [12.4°S, 48.2°E] Joseph R. Bellot, 1826–1853. French seaman. Participated in two Antarctic expeditions; died while attempting to rescue Franklin in the Arctic.
Crater (17 km).

Crozier [13.5°S, 50.8°E] Francis R. M. Crozier, 1796–1848. English naval captain. Participated in the Arctic expedition of Parry and accompanied Ross to the Antarctic. Died in the Arctic with Franklin.
Flooded crater (22 km).

Fecunditatis, Mare (Sea of Fertility).
Irregularly shaped mare, surface area 326,000 sq km. (See also maps 37, 49, and 59.)

Geikie, Dorsa [3°S, 53°E] Sir Archibald Geikie, 1835–1924. Scottish geologist.
Large system of mare ridges, length 240 km.

Goclenius [10.0°S, 45.0°E] Rudolf Gockel, 1572–1621. German physician, physicist, and mathematician.
Irregular crater (54 × 72 km) *with rilles on its floor.*

Goclenius, Rimae [8°S, 43°E]
System of wide rilles, length 240 km.

Gutenberg [8.6°S, 41.2°E] Johann Gutenberg, c. 1398–1468. German goldsmith. Invented movable-type printing and developed printing presses.
Crater 74 km *in diameter; its eastern wall is broken by the flooded crater* Gutenberg E *and is connected to the south with the crater* Gutenberg C; *its floor has a number of peaks and rilles; the crater* Gutenberg A (15 km/3430 m) *lies on the southwestern wall.*

Ibn Battuta (Goclenius A) [6.9°S, 50.4°E] Abu Abd Allah Mohammed Ibn Abd Allah, 1304–1377. Arabian geographer.
Crater (12 km).

Lindbergh (Messier G) [5.4°S, 52.9°E] Charles A. Lindbergh, 1902–1974. American pilot, first solo flight across the Atlantic.
Crater (13 km).

Lubbock [3.9°S, 41.8°E] Sir John W. Lubbock, 1803–1865. English mathematician and astronomer.
Crater (14.5 km).

Magelhaens [11.9°S, 44.1°E] Fernão de Magalhães (Magellan), 1480–1521. Famous Portuguese navigator, the first to sail around Cape Horn; his fleet completed the first circumnavigation of the world.
Flooded crater with a dark floor (41 km).

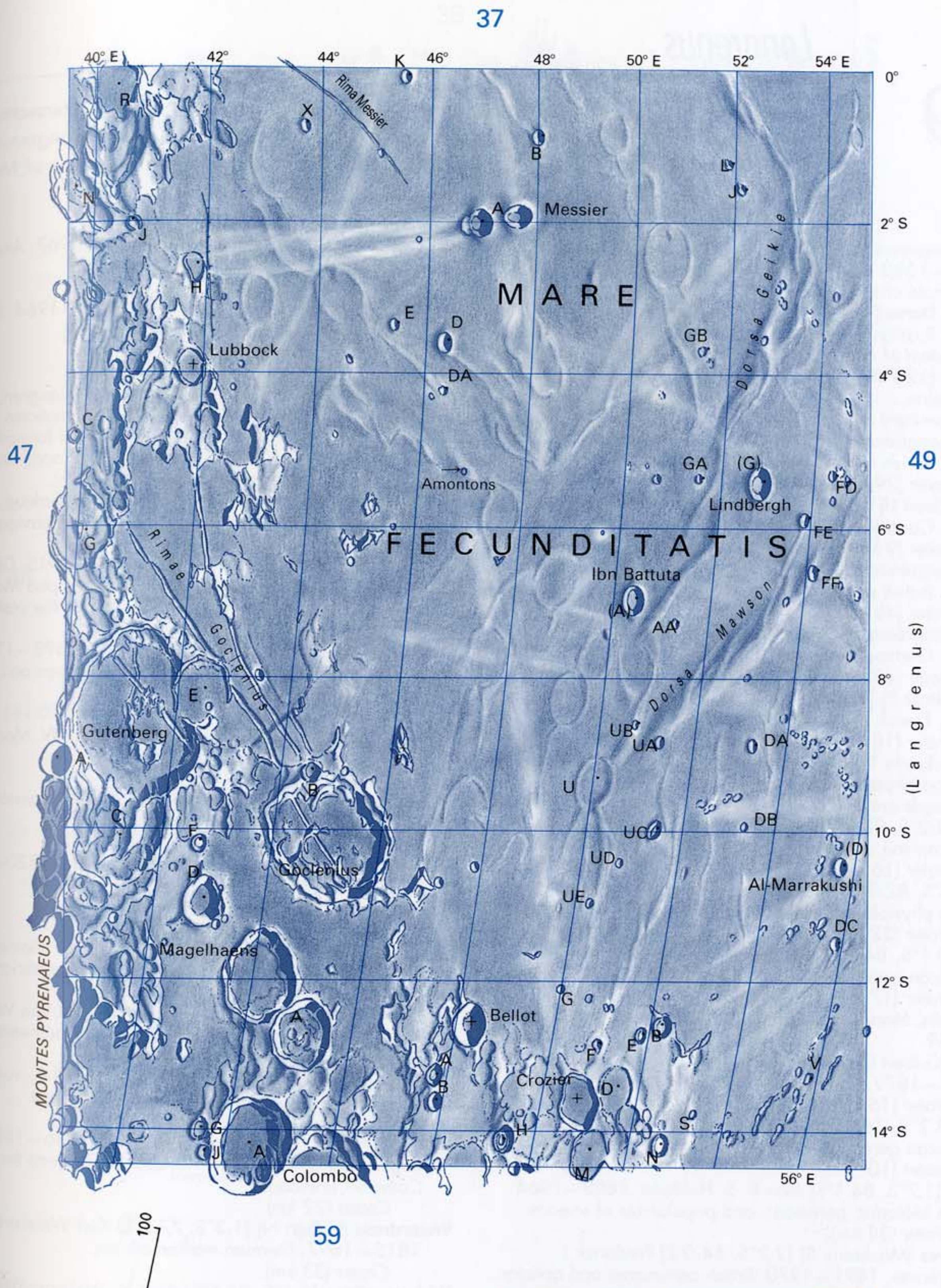
Mawson, Dorsa [7°S, 53°E] Sir Douglas Mawson, 1882–1958. Australian Antarctic explorer.
System of mare ridges, length 180 km.

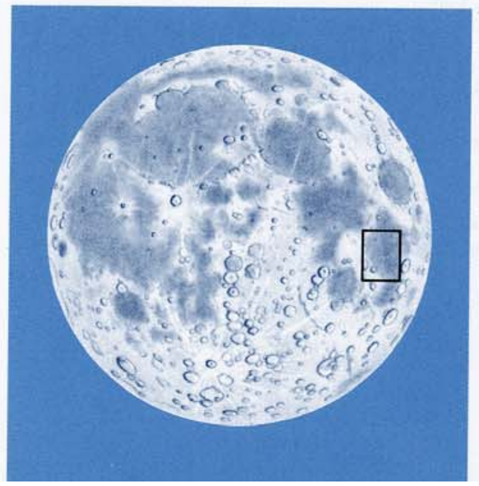
Messier [1.9°S, 47.6°E] Charles Messier, 1730–1817. French astronomer, discoverer of 14 comets, author of the catalog of star clusters, nebulae, etc., known as Messier's Catalogue.
Atypical, elongated crater (9 × 11 km).

Messier A (previously W. H. Pickering)
Atypical, elongated crater (13 × 11 km), *that is the center of two bright rays radiating to the west.*

Messier, Rima [1°S, 45°E]
Narrow, barely visible rille, length 100 km.

Pyrenaeus, Montes (Pyrenees) [14°S, 41°E] Mädler's name for a mountain range situated south of crater Gutenberg.
Length 250 km. (See also maps 47, 58, and 59.)





Langrenus

49

The eastern edge of Mare Fecunditatis and the eastern limb of the Moon are intersected by a wide and dense field of craters, in which orientation is not easy. The crater Langrenus is a beautiful sight through a telescope. During favorable librations the dark surface of Mare Smythii is visible close to the limb of the Moon.

Acosta (Langrenus C) [5.6°S, 60.1°E] Cristobal Acosta, 1515–1580. Portuguese physician and historian.
Simple crater (13 km).

Andrusov, Dorsa [1°S, 57°E] Nikolai I. Andrusov, 1861–1924. Russian geologist.
System of mare ridges, length 160 km.

Ansgarius [12.7°S, 79.7°E] St. Ansgar, 801–864. German theologian.
Prominent crater with terraced walls (94 km).

Atwood (Langrenus K) [5.8°S, 57.7°E] G. Atwood, 1745–1807. British mathematician and physicist.
Crater (29 km).

Avery (Gilbert U) [1.4°S, 81.4°E] Oswald T. Avery, 1877–1955. Canadian physicist.
Crater (9 km).

Barkla (Langrenus A) [10.7°S, 67.2°E] C. G. Barkla, 1877–1944. British physicist, Nobel Laureate.
Crater (43 km).

Bilharz (Langrenus F) [5.8°S, 56.3°E] T. Bilharz, 1825–1862. German physician.
Crater (43 km).

Black (Kästner F) [9.2°S, 80.4°E] Joseph Black, 1728–1799. French chemist.
Crater (18 km).

Born (Maclaurin Y) [6.0°S, 66.8°E] Max Born, 1882–1970. German physicist and optician.
Simple crater (15 km).

Carrillo [2.2°S, 80.9°E] Flores N. Carrillo, 1911–1967. Mexican soil engineer.
Crater (16 km).

Dale [9.6°S, 82.9°E] Sir Henry H. Dale, 1875–1968. British physiologist, Nobel Laureate.
Crater (22 km).

Elmer [10.1°S, 84.1°E] Charles W. Elmer, 1872–1954. American astronomer.
Crater (17 km).

Fecunditatis, Mare (Sea of Fertility). See also maps 37, 48, and 59.

Geissler (Gilbert D) [2.6°S, 76.5°E] Heinrich Geissler, 1814–1879. German physicist.
Crater (16 km).

Gilbert [3.2°S, 76.0°E] Grove K. Gilbert, 1843–1918. American geologist.
Crater (107 km).

Haldane [1.7°S, 84.1°E] John B. S. Haldane, 1892–1964. British biologist, geneticist, and popularizer of science.
Crater (38 km).

Hargreaves (Maclaurin S) [2.2°S, 64.0°E] Frederick J. Hargreaves, 1891–1970. British astronomer and optician.
Crater (16 km).

Houtermans [9.4°S, 87.2°E] Friedrich G. Houtermans, 1903–1966. German physicist.
Crater (30 km).

Kapteyn [10.8°S, 70.6°E] Jacobus C. Kapteyn, 1851–1922. Dutch astronomer.
Prominent crater (49 km).

Kästner [7.0°S, 79.1°E] Abraham G. Kästner, 1719–1800. German mathematician and physicist.
Large crater, flat floor (105 km).

Kiess [6.4°S, 84.0°E] Carl C. Kiess, 1887–1967. American astrophysicist.
Crater (63 km).

Kreiken [9.0°S, 84.6°E] E. A. Kreiken, 1896–1964. Dutch astronomer.
Crater (23 km).

Lamé. See map 60.

Langrenus [8.9°S, 60.9°E] Michel Florent van Langren, c. 1600–1675. Belgian engineer and mathematician. Drew the first map of the Moon with the names of formations.
Very prominent complex crater with terraced walls, hills, and central peaks on its floor (132 km).

la Pérouse [10.7°S, 76.3°E] Jean Francois de Galoup, Comte de la Pérouse, 1741–1788. French navigator.
Crater (78 km).

Lohse [13.7°S, 60.2°E] Oswald Lohse, 1845–1915. German astronomer. Photographed the planets, mapped Mars.
Crater (42 km) *by the northern edge of the crater Vendelinus (map 60).*

Maclaurin [1.9°S, 68.0°E] Colin Maclaurin, 1698–1746. Scottish professor of mathematics at Aberdeen and Edinburgh.
Inconspicuous crater with central peak (50 km).

Morley (Maclaurin R) [2.8°S, 64.6°E] Edward W. Morley, 1838–1923. American chemist.
Crater (14 km).

Naonobu (Langrenus B) [4.6°S, 57.8°E] Ajima Naonobu, 1732–1798. Japanese mathematician.
Crater (35 km).

Rankine [3.9°S, 71.5°E] William J. M. Rankine, 1820–1872. Scottish physicist.
Simple crater (9 km).

Smythii, Mare (Smyth's Sea). See map 38.

Somerville (Langrenus J) [8.3°S, 64.9°E] Mary F. Somerville, 1780–1872. Scottish physicist and mathematician.
Crater (15 km).

Van Vleck (Gilbert M) [1.9°S, 78.3°E] John M. Van Vleck, 1833–1912. American astronomer and mathematician.
Crater (31 km).

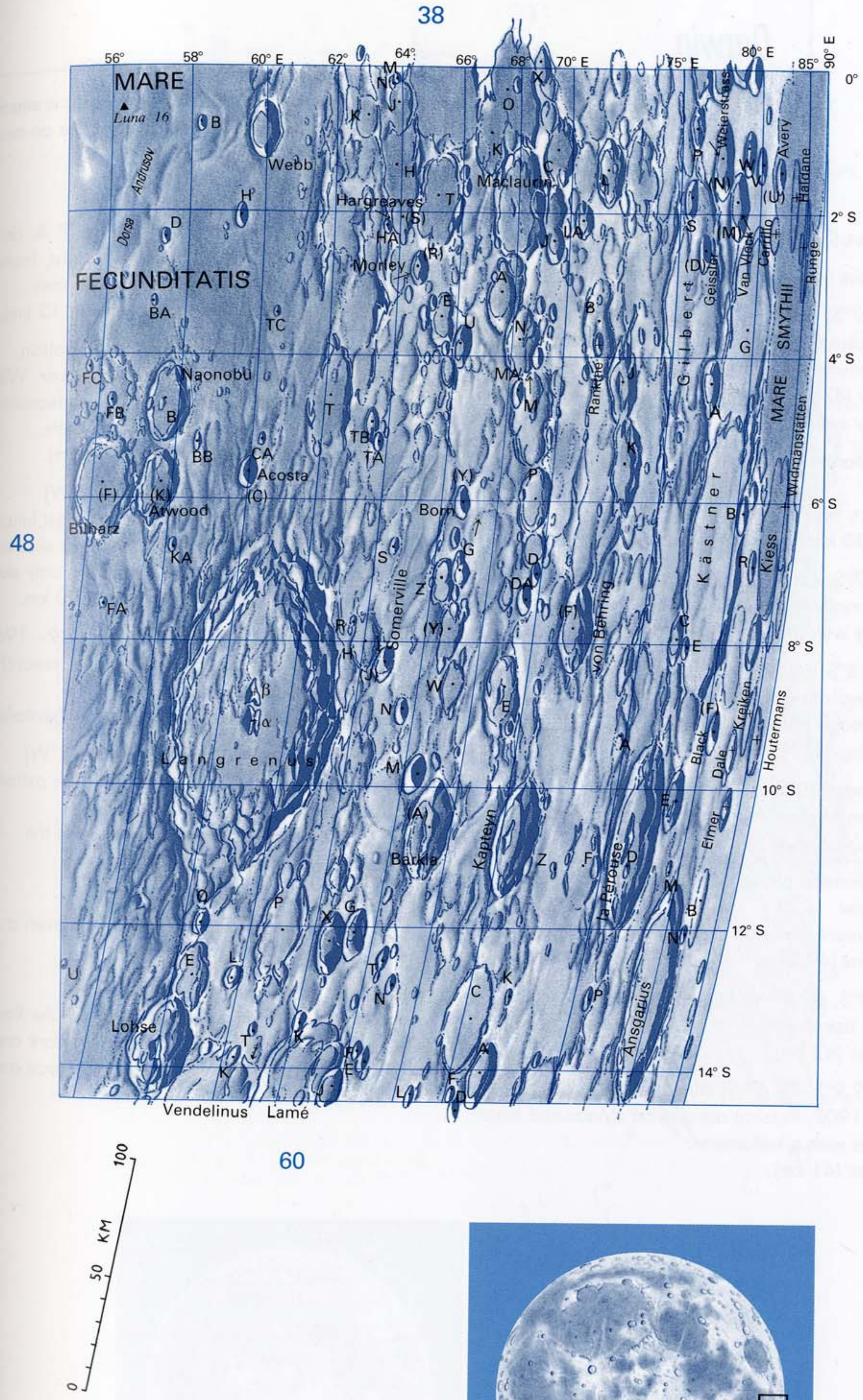
von Behring (Maclaurin F) [7.8°S, 71.8°E] Emil A. von Behring, 1854–1917. German bacteriologist.
Crater (39 km).

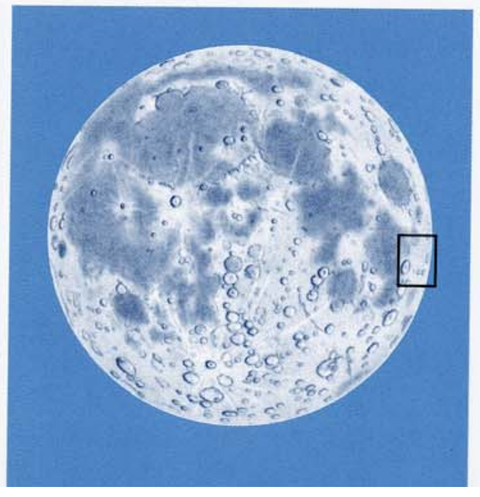
Webb [0.9°S, 60.0°E] Thomas W. Webb, 1806–1885. English astronomer, author of Celestial Objects for Common Telescopes.
Crater (22 km).

Weierstrass (Gilbert N) [1.3°S, 77.2°E] Karl Weierstrass, 1815–1897. German mathematician.
Crater (33 km).

Widmanstätten [6.1°S, 85.5°E] Alois B. Widmanstätten, 1754–1849. Austrian scientist. "Widmanstätten patterns" can be seen on the etched and polished surfaces of iron meteorites, revealing their crystalline structure.
Crater (46 km).

Note: Nine other named craters in Mare Smythii are marked on the libration zone map, on page 185: Helmert, Kao, Lebesgue, Runge, Slocum, Swasey, Talbot, Tucker, and Warner.





50 Darwin

The western limb of the Moon, on which part of the remarkable Orientale basin is situated. The observer's attention will be attracted by the wide Rima Sirsalis, which continues on map 39.

Aestatis, Lacus (Summer Lake). See map 39.

Autumni, Lacus (Autumn Lake) See map 39.

Byrgius [24.7°S, 65.3°W] Joost Bürgi, 1552–1632. Swiss clockmaker, outstanding mechanic. Made astrometric instruments, including Tycho Brahe's sextant.
Crater (87 km)*;* **Byrgius A** *is the center of a bright ray system.*

Cordillera, Montes (Cordillera Mountains) [20°S, 80°W]
Eastern part of an outermost ring of Orientale basin, 930 km *in diameter* (see map 39).

Crüger [16.7°S, 66.8°W] Peter Crüger, 1580–1639. German mathematician, teacher of Hevelius.
Crater with a very dark floor (46 km).

Darwin [19.8°S, 69.1°W] Charles R. Darwin, 1809–1882. English naturalist, author of the theory of evolution through natural selection.
Disintegrated crater (130 km).

Darwin, Rimae [20°S, 67°W]
System of rilles, length 280 km.

Eichstadt [22.6°S, 78.3°W] Lorenz Eichstadt, 1596–1660. German physician, mathematician, and astronomer.
Prominent crater on the edge of the Cordillera Mountains (49 km).

Kopff [17.4°S, 89.6°W] August Kopff, 1882–1960. German astronomer.
Crater (42 km).

Krasnov [29.9°S, 79.6°W] Alexander V. Krasnov, 1866–1907. Russian astronomer. Measured lunar librations with a heliometer.
Crater (41 km).

Lamarck [22.9°S, 69.8°W] Jean Baptiste P. A. de M. Lamarck, 1744–1829. French naturalist, founder of the study of the zoology of invertebrates.
Considerably disintegrated crater (115 km).

Nicholson [26.2°S, 85.1°W] Seth B. Nicholson, 1891–1963. American solar astronomer. With Pettit, he invented a thermocouple for measurement of the surface temperatures of the planets.
Crater in the Rock Mountains (38 km).

Orientale, Mare (Eastern Sea) [20°S, 95°W]
Flooded center of one of the youngest lunar basins. The whole of Mare Orientale is situated on the far side of the Moon and is visible only during very favorable librations. Diameter 300 km.

Pettit [27.5°S, 86.6°W] Edison Pettit, 1889–1962. American astronomer. First systematic research in infrared astronomy.
Crater (35 km), *one of a pair with Nicholson.*

Rook, Montes (Rook Mountains) [20°S, 83°W] Lawrence Rooke, 1622–1666. English astronomer, observer of Jupiter's satellites.
One of the inner rings that surround the Orientale basin, length about 900 km.

Sirsalis, Rima [17°S, 62°W]
Sizable, wide rille, visible through even a small telescope.

Veris, Lacus [13°S, 87°W] (Spring Lake)
Narrow mare on the inner edge of the Rook Mountains; it is formed by separated dark areas. The total span is 540 km*; the total surface area is* 12,000 sq km.

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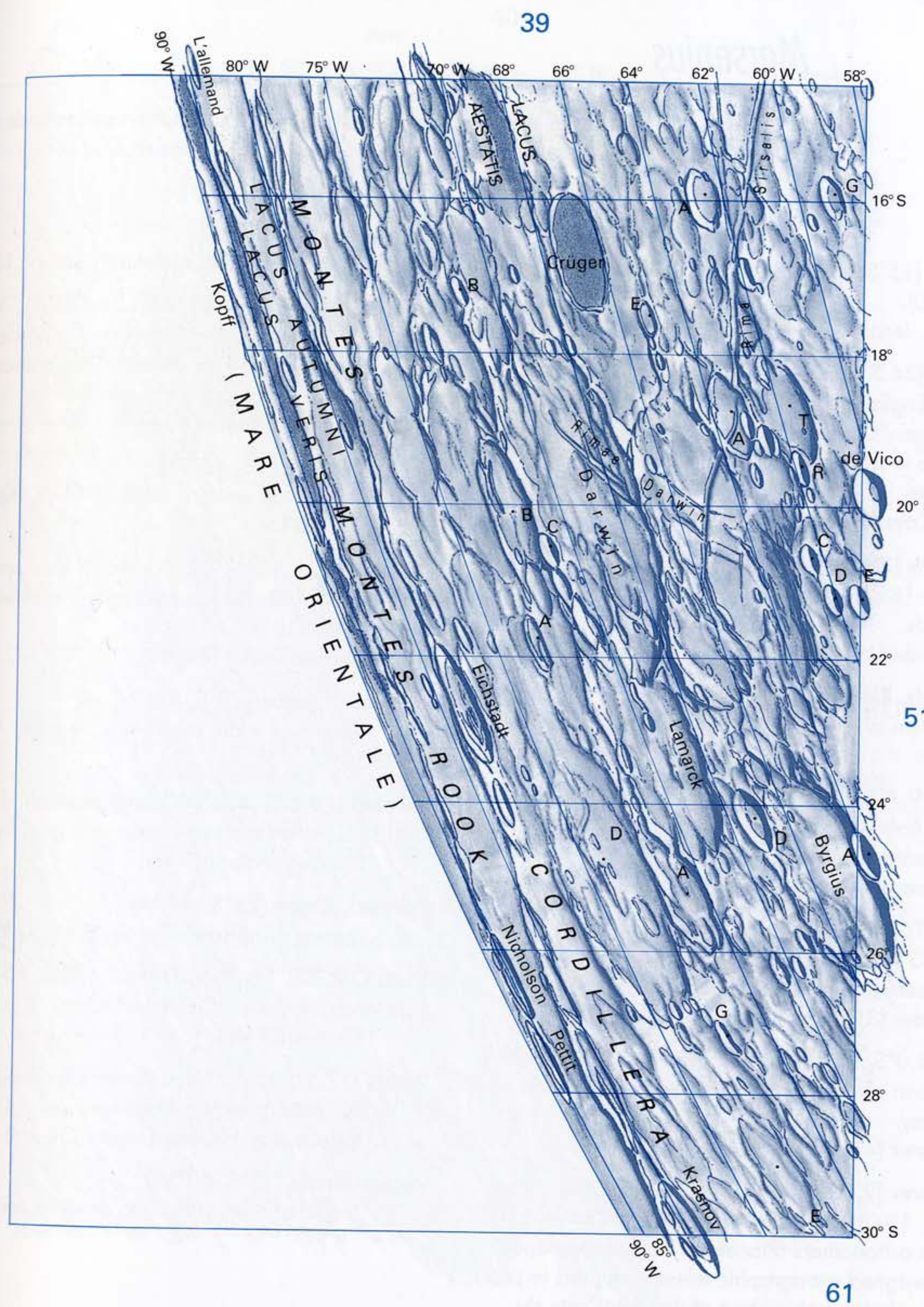

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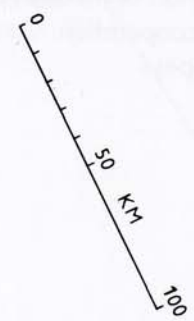
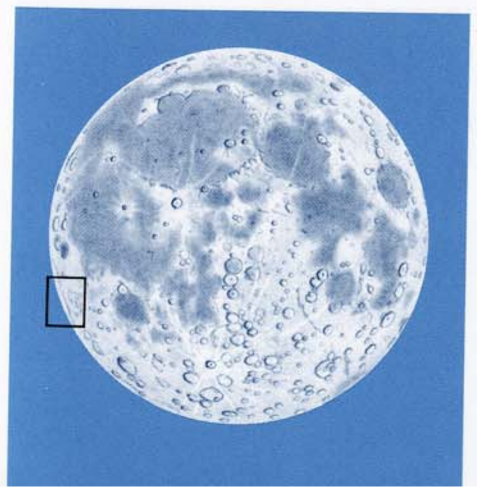




51 Mersenius

A hilly region between the western edge of Mare Humorum and the western limb of the Moon. Numerous rilles run parallel with the edge of Mare Humorum.

Billy, Rima [15°S, 48°W]. Named after the crater Billy (map 40).
Rille, length 70 km.

Cavendish [24.5°S, 53.7°W] Henry Cavendish, 1731–1810. English chemist and physicist. Discovered hydrogen; "Cavendish's experiment" used a torsion balance to determine the mass of the Earth.
Crater (56 km) *whose wall is interrupted by the crater* **Cavendish E**.

de Gasparis [25.9°S, 50.7°W] Annibale de Gasparis, 1819–1892. Italian astronomer. Discovered nine asteroids.
Flooded crater with rilles on its floor (30 km).

de Gasparis, Rimae [25°S, 50°W]
System of rilles covering an area spanning 130 km.

de Vico [19.7°S, 60.2°W] Francesco de Vico, 1805–1848. Italian astronomer, observer of Venus. Discovered six comets.
Crater (20 km).

Fontana [16.1°S, 56.6°W] Francesco Fontana, c. 1585–1656. Italian lawyer and amateur astronomer, observer of the planets.
Crater (31 km).

Henry [24.0°S, 56.8°W] Joseph Henry, 1792–1878. American physicist. Invented electric motor and electric relay.
Crater (41 km).

Henry Frères [23.5°S, 58.9°W] Henry brothers; Paul Henry, 1848–1905; Prosper Henry, 1849–1903. French astronomers. Pioneered astrophotography and designed astrographic telescopes used to produce a photographic chart of the sky (Carte du Ciel), by international cooperation. Constructed large refracting telescopes.
Crater (42 km).

Humorum, Mare (Sea of Moisture). See p. 130.

Liebig [24.3°S, 48.2°W] Justus von Liebig, 1803–1873. German chemist. Invented a process for silvering glass, used for astronomical telescope mirrors.
Crater (37 km).

Liebig, Rupes [25°S, 46°W]
Fault at the western edge of Mare Humorum, length 180 km.

Mersenius [21.5°S, 49.2°W] Marin Mersenne, 1588–1648. French theologian, mathematician, and physicist.
Flooded crater (84 km).

Mersenius, Rimae [20°S, 45°W]
System of wide, clearly visible rilles, length 230 km.

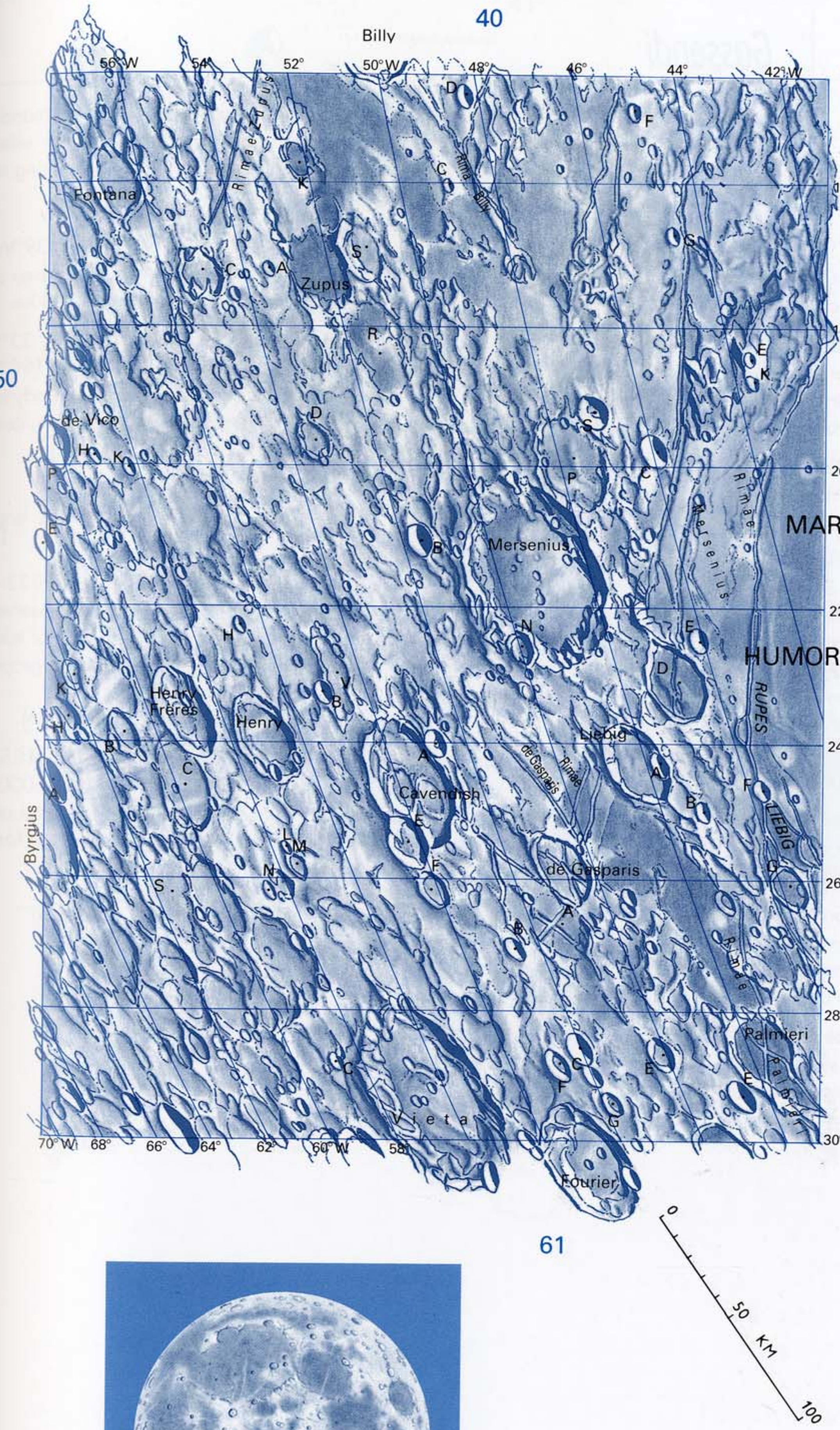
Palmieri [28.6°S, 47.7°W] Luigi Palmieri, 1807–1896. Italian mathematician and geophysicist.
Flooded crater (41 km).

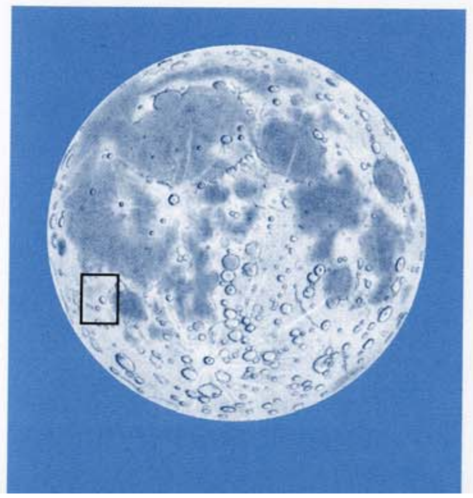
Palmieri, Rimae [28°S, 47°W]
System of narrow rilles, length 150 km.

Vieta [29.2°S, 56.3°W] François Viète, 1540–1603. French lawyer and mathematician.
Crater (87 km).

Zupus [17.2°S, 52.3°W] Giovanni B. Zupi, c. 1590–1650. Italian Jesuit astronomer.
Remains of a flooded crater (38 km).

Zupus, Rimae [15°S, 53°W]
Indistinct rilles, difficult to observe, length 120 km.





52 Gassendi

The Humorum basin and a magnificent crater Gassendi, which resembles a diamond ring, are among the most prominent features of the southwestern quadrant of the near side of the Moon. The system of concentric mare ridges in Mare Humorum and the neighboring rilles Rimae Hippalus are attractive objects for telescopic observation.

Agatharchides [19.8°S, 30.9°W] Agatharchides, c. 2nd century BC. Greek geographer and historian.
Flooded crater (49 km/1180 m).

Doppelmayer [28.5°S, 41.4°W] Johann G. Doppelmayer, 1671—1750. German mathematician and astronomer, author of a map of the Moon.
Greatly ruined crater (64 km).

Doppelmayer, Rimae [26°S, 45°W]
System of narrow rilles, total length about 130 km.

Gassendi [17.5°S, 39.9°W] Pierre Gassendi, 1592—1655. French theologian, mathematician, and astronomer. Supported Copernicus' theories, exchanged letters with Kepler and Galileo. The first to observe a transit of Mercury across the Sun in 1631, which was forecast by Kepler.
Prominent crater (110 km/1860 m) *with numerous rilles, hills, and central mountains on its floor. The wall is interrupted by the crater* **Gassendi A** (33 km/3600 m).

Gassendi, Rimae
Complex system of rilles inside Gassendi.

Hippalus [24.8°S, 30.2°W] Hippalus, AD 120. Greek navigator. Sailed the open sea from Arabia to India. Discovered the importance of the monsoons in navigation.
Remains of a crater (58 km/1230 m).

Hippalus, Rimae [25°S, 29°W]
Sizable system of arcuate rilles, length 240 km, *visible through even a small telescope.*

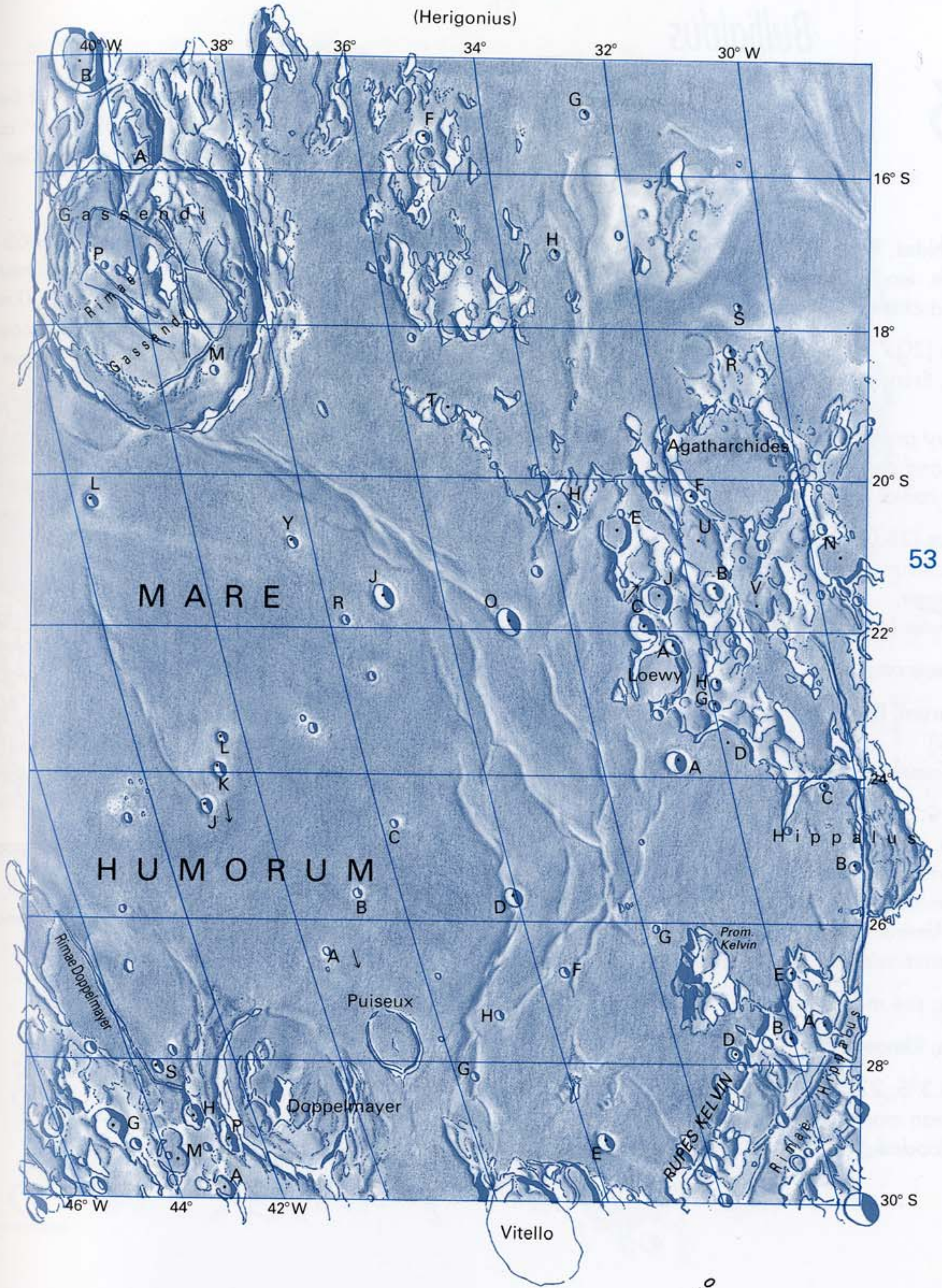
Humorum, Mare (Sea of Moisture) [24°S, 39°W]
Circular lunar mare with a surface area of 113,000 sq km *and a diameter of* 380 km.

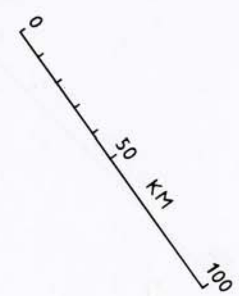
Kelvin, Promontorium (Cape Kelvin) [27°S, 33°W]. William Thomson, Lord Kelvin, 1824—1907. British physicist. Worked in the fields of thermodynamics and electricity, made over 60 inventions, constructed submarine cables.

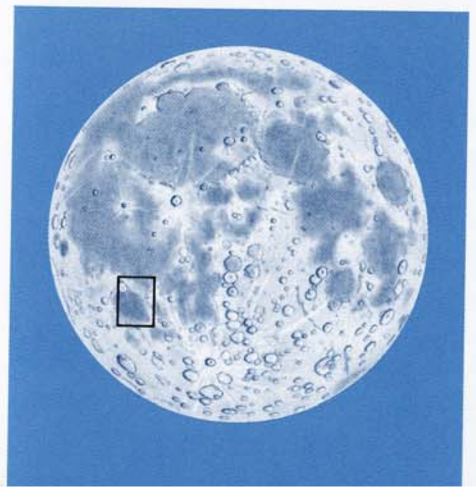
Kelvin, Rupes [28°S, 33°W]
Fault at the edge of Mare Humorum, length about 150 km.

Loewy [22.7°S, 32.8°W] Moritz Loewy, 1833—1907. French astronomer, director of Paris Observatory. Designed the "equatorial coudé" type of telescope, worked in the field of astrometry. Photographic Atlas of the Moon (with Puiseux).
Flooded crater (22 × 26 km/1090 m).

Puiseux [27.8°S, 39.0°W] Pierre Puiseux, 1855—1928. French astronomer. Made over 6000 photographs of the Moon using the "equatorial coudé" (see Loewy), co-author with Loewy of the famous *Paris Atlas of the Moon.*
Flooded crater (25 km/400 m).







53 Bullialdus

The western part of Mare Nubium with the prominent Bullialdus, which is one of the most attractive lunar craters. Other interesting objects include an elevated "causeway" across the valley Bullialdus W close to the crater Agatharchides O, a typical lunar dome Kies Pi, and the prominent rilles Rimae Hippalus and Rima Hesiodus.

Agatharchides, Rima [20°S, 28°W]
Rille, length about 50 km, named after the crater Agatharchides (map 52).

Bullialdus [20.7°S, 22.2°W] Ismaël Boulliau, 1605–1694. French astronomer, historian, and theologian.
Very prominent complex crater with terraced walls and central peaks (61 km/3510 m), *conspicuous radial structure on the outside of the crater.*

Campanus [28.0°S, 27.8°W] Giovanni Campano, 13th century. Italian theologian, astronomer, and astrologer.
Crater (48 km/2080 m).

Darney: see map 42.

Epidemiarum, Palus (Marsh of Epidemics) [32°S, 27°W]
Diameter 300 km, *surface area* 27,000 sq km.

Gould [19.2°S, 17.2°W] Benjamin A. Gould, 1824–1896. American astronomer, founder of the Astronomical Journal. Used the transatlantic cable to determine longitude differences between Europe and America.
Remains of a crater (34 km).

Hippalus: see map 52.

Hippalus, Rimae. See map 52.

Kies [26.3°S, 22.5°W] Johann Kies, 1713–1781. German mathematician and astronomer.
Flooded crater (44 km/380 m).

König [24.1°S, 24.6°W] Rudolf König, 1865–1927. Austrian selenographer, musician, and merchant. Built his own observatory, made 47,000 measurements of lunar formations; König's telescope, made by Zeiss works, is still in use at the Prague Observatory in the Czech Republic.
Crater (23 km/2440 m).

Lubiniezky [17.8°S, 23.8°W] Stanislaus Lubiniezky, 1623–1675. Polish astronomer. Studied and published details of the movements of 415 comets.
Flooded crater (44 km/770 m).

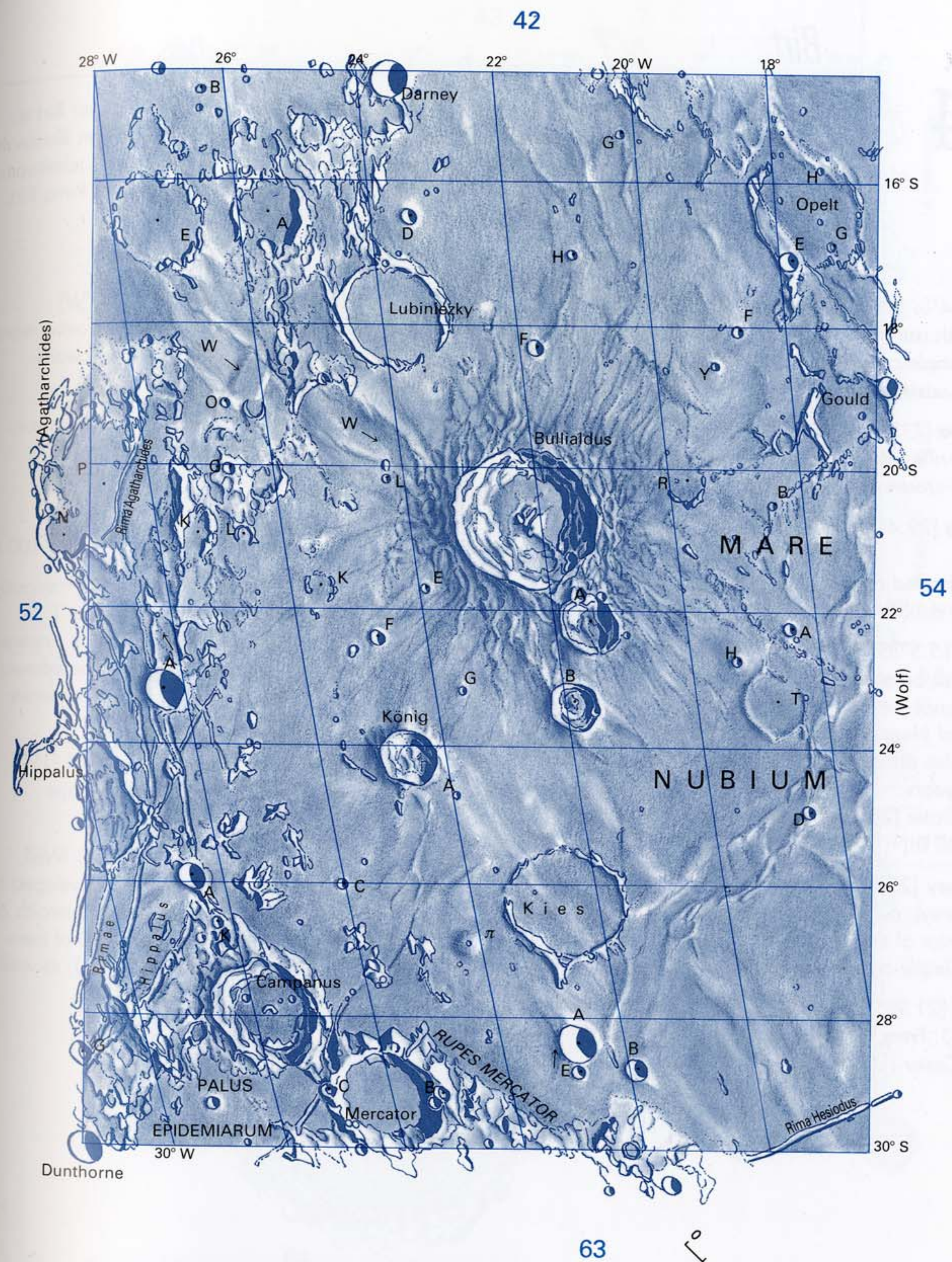
Mercator [29.3°S, 26.1°W] Gerard de Kremer (Gerhardus Mercator), 1512–1594. Belgian cartographer. Originated the Mercator projection, frequently used in terrestrial and astronomical maps.
Crater with flooded floor (47 km/1760 m).

Mercator, Rupes [30°S, 23°W]
Fault on the southwestern edge of Mare Nubium, length about 180 km.

Nubium, Mare (Sea of Clouds). See also map 54.

Opelt [16.3°S, 17.5°W] Friedrich W. Opelt, 1794–1863. German financier, patron of selenographers Lohrmann and Schmidt.
Remains of a crater (49 km).

Simple craters: **Kies E** (6.5 km/1120 m)
Opelt E (8.0 km/1370 m)



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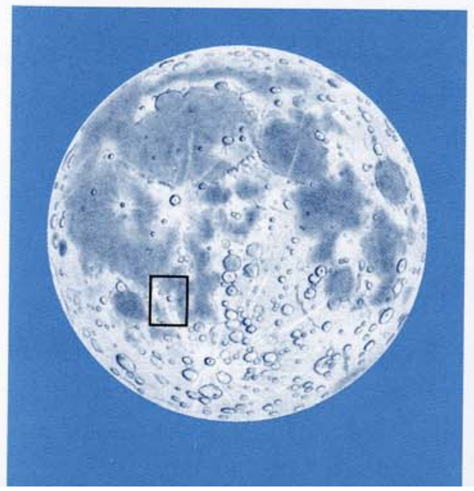


54

Birt

The eastern part of Mare Nubium with many mare ridges. Not far from the crater Birt is Rupes Recta (the "Straight Wall"), the most remarkable fault on the Moon. When illuminated from the east it casts a wide shadow that is clearly visible through even a small telescope; in the setting Sun it resembles a fine white line. Larger telescopes reveal a rille, Rima Birt, between the craters Birt E (4.9 x 2.9 km/600 m) and Birt F (3.1 km/470 m).

Birt [22.4°S, 8.5°W] William R. Birt, 1804–1881. English astronomer and selenographer.
Simple crater (17 km/3470 m); **Birt A** *is linked to its eastern rim* (6.8 km/1040 m).

Birt, Rima [21°S, 9°W]
A rille, about 50 km *long, that connects the small craters* **Birt E** *and* **Birt F**.

Hesiodus [29.4°S, 16.3°W] Hesiod, c. 700 BC. Greek poet.
Flooded crater (43 km); **Hesiodus A** *appear to have double concentric walls.*

Lassell [15.5°S, 7.9°W] William Lassell, 1799–1880. English amateur astronomer. With his homemade telescope he discovered four planetary satellites: one of Neptune, one of Saturn, and two of Uranus. He also discovered 600 nebulae in the course of two years.
Crater (23 km/910 m);
Lassell D (1.7 km/400 m) *looks like a bright spot.*

Lippershey [25.9°S, 10.3°W] Hans Lippershey (Jan Lapprey), d. 1619. Dutch spectacle-maker, reputed inventor of the telescope.
Simple crater (6.8 km/1350 m).

Nicollet [21.9°S, 12.5°W] Jean N. Nicollet, 1788–1843. French selenographer.
Crater (15.2 km/2030 m).

Nubium, Mare (Sea of Clouds) [20°S, 15°W]
Surface area 254,000 sq km, *approximately circular shape; its northern border is not clearly defined.*

Pitatus [29.8°S, 13.5°W] Pietro Pitati, 16th century. Italian mathematician and astronomer.
Large, flooded crater (97 km).

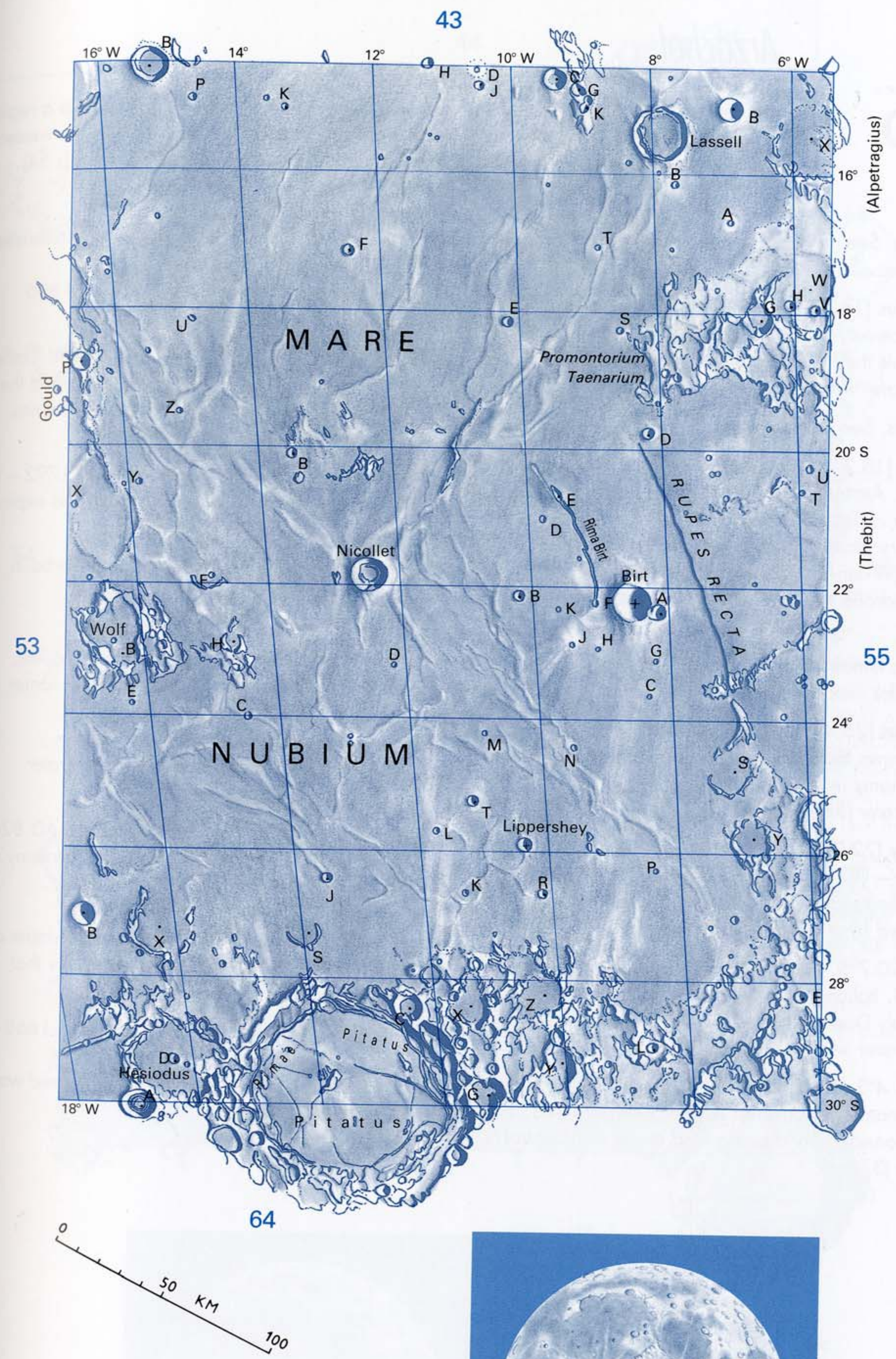
Pitatus, Rimae
System of rilles inside Pitatus, length about 100 km.

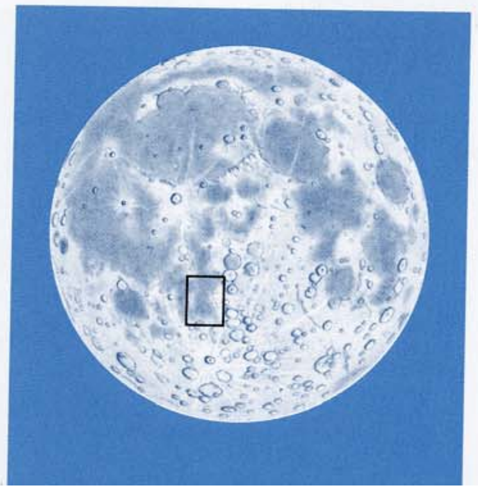
Recta, Rupes (Straight Fault) [22°S, 7°W]. (Previously called the "Straight Wall" or "Wall Beta.")
Length 110 km, *height* 240–300 m, *apparent width about* 2.5 km; *it is not a steep escarpment, as was believed in the past, but a rather moderate slope.*

Taenarium, Promontorium (Cape Taenarium) [19°S, 8°W]. Name given by Hevelius after Cape Matapan (Tainaron) on Peloponnesus.

Wolf [22.7°S, 16.6°W] Maximilian F. J. C. Wolf, 1863–1932. German astronomer. Developed a photographic method for discovering asteroids and with his assistants discovered over 300 of them.
Remains of a flooded crater (25 km); *its wall is linked to that of the crater* **Wolf B**.

54





55 Arzachel

The area surrounding the prime meridian, south of Ptolemaeus and Alphonsus, is a region of large craters. These two, together with Arzachel, form an impressive trio. On the western edge of the map, the terra terrain borders the dark plains of Mare Nubium (map 54).

Aliacensis. See map 65; forms a pair with the crater Werner.

Alpetragius [16.0°S, 4.5°W] Nur ed-din al Betrugi, 12th century. Arabian astronomer. Attempted to improve the Ptolemaic system.
Crater with central peak (40 km/3900 m).

Alphonsus. See map 44.

Arzachel [18.2°S, 1.9°W] Al Zarkala, c. AD 1028–1087. Arabian astronomer from Muslim Spain, author of Toledo Tables.
Very prominent complex crater with rilles in its floor (97 km/3610 m); *formations E and F are valleys parallel to and within the elevated southern walls.*

Arzachel, Rimae
Rilles inside Arzachel, length 50 km.

Blanchinus [25.4°S, 2.5°E] Giovanni Bianchini (Johannes Blanchinus), c. 1458. Italian teacher of astronomy in Ferrara.
Crater (58 × 68 km).

Delaunay [22.2°S, 2.5°E] Charles E. Delaunay, 1816–1872. French astronomer.
Heart-shaped formation 46 km *in diameter, divided by a central mountain range.*

Donati [20.7°S, 5.2°E] Giovanni B. Donati, 1826–1873. Italian Astronomer. Discovered seven comets, notably Donati's comet in 1858.
Crater with central peak (36 km).

Faye [21.4°S, 3.9°E] Hervé Faye, 1814–1902. French astronomer. Discovered Faye's comet in 1843.
Considerably disintegrated crater with central peak (37 km).

Krusenstern [26.2°S, 5.9°E] Adam J. von Krusenstern, 1770–1846. Russian naval officer. Circumnavigated the world in 1803–1806.
Crater with a flat floor (47 km).

la Caille [23.8°S, 1.1°E] Nicolas Louis de la Caille, 1713–1762. French astronomer. Mapped the sky, gave names to several southern constellations.
Crater with a flat floor (68 km).

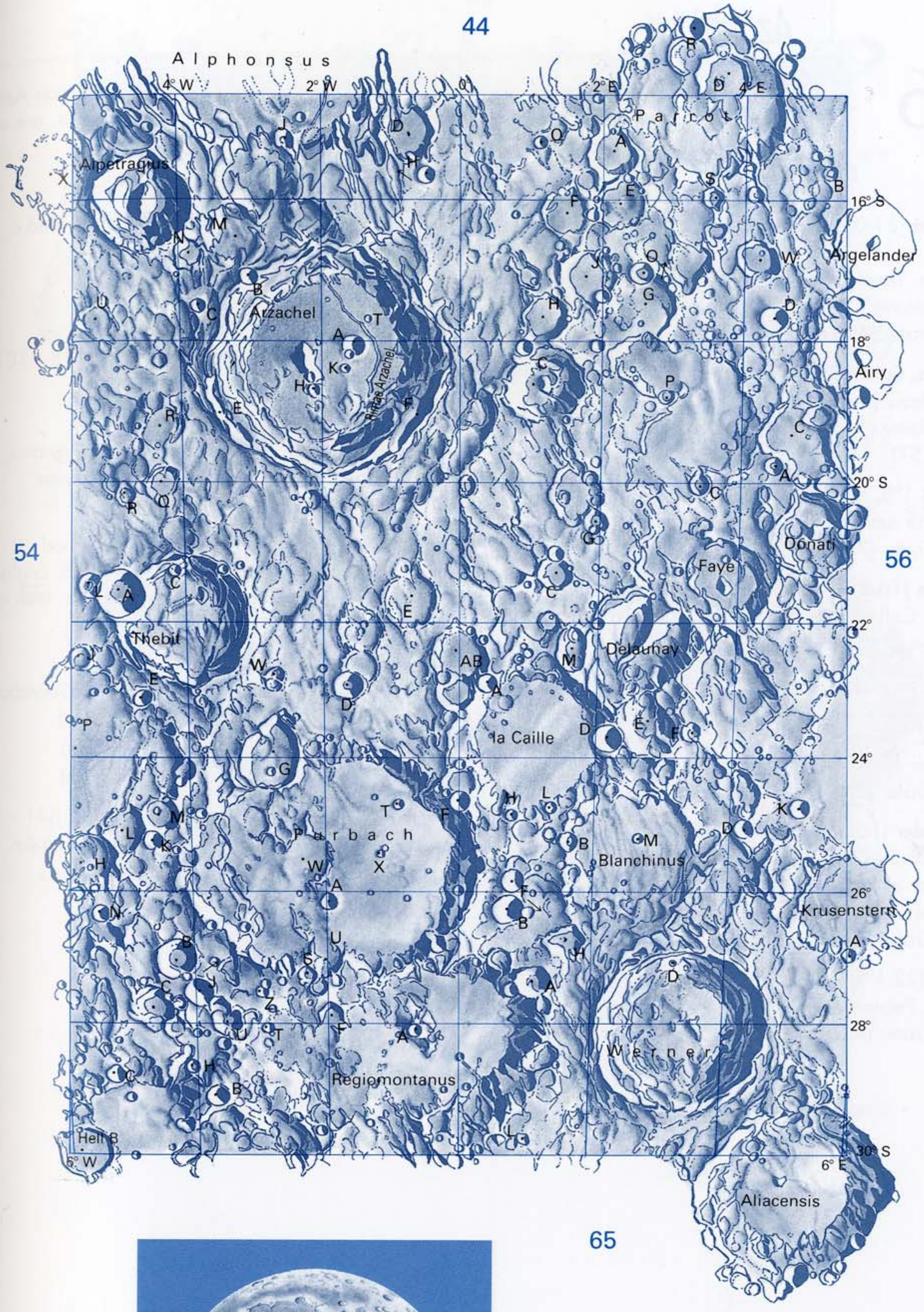
Parrot [14.5°S, 3.3°E] Johann J. F. Parrot, 1792–1840. German surgeon, physicist, traveler, and explorer.
Crater, ruined rim (70 km).

Purbach [25.5°S, 1.9°W] Georg von Peuerbach, 1423–1461. Austrian astronomer.
Large crater (118 km/2980 m).

Regiomontanus [28.4°S, 1.0°W] Johann Müller, 1436–1476. Prominent German astronomer. Critically assessed Ptolemy's Almagest.
Irregular, disintegrated crater (126 x 110 km/1730 m)*; central peak with crater* **Regiomontanus A** (5.6 km/1200 m).

Thebit [22.0°S, 4.0°W] Thebit ben Korra, AD 826–901. Arabian astronomer. Translated Ptolemy's Almagest into Arabic.
Crater (57 km/3270 m)*;*
Thebit A (20 km/2720 m) *overlaps the main crater; a third crater, Thebit L (10 km), overlaps that, making a conspicuous triple formation.*

Werner [28.0°S, 3.3°E] Johannes Werner, 1468–1528. German astronomer.
Prominent complex crater with terraced walls (70 km/4220 m).



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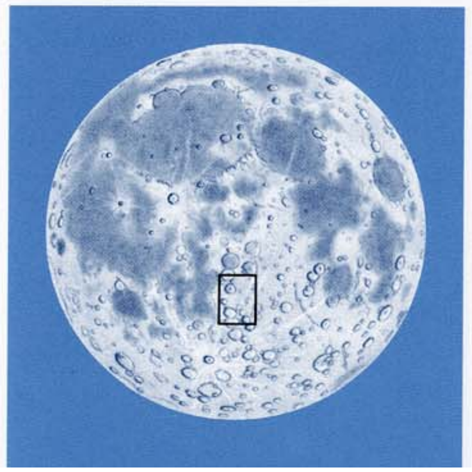


56 Azophi

A terra region with a number of craters rather difficult to identify. However, the pair Azophi and Abenezra and the prominent craters Almanon, Geber, Playfair, and Apianus, are useful landmarks. Also conspicuous is the row of craters Airy, Argelander, and Vogel.

Abenezra [21.0°S, 11.9°E] Abraham bar Rabbi ben Ezra, c. 1092–1167. Jewish scholar from Toledo, Spain. Theologian, philosopher, mathematician, and astronomer.
Crater (42 km/3730 m).

Abulfeda, Catena [17°S, 17°E] Named after the crater Abulfeda (map 45).
Crater chain, length 210 km (continued on map 57).

Airy [18.1°S, 5.7°E] George B. Airy, 1801–1892. English astronomer, seventh Astronomer Royal.
Crater (37 km).

Almanon [16.8°S, 15.2°E] Abdalla Al Mamun, 786–833. Caliph of Baghdad, son of Harun al-Raschid, patron of sciences.
Crater (49 km/2480 m).

Apianus [26.9°S, 7.9°E] Peter Bienewitz, 1495–1552. German mathematician and astronomer, author of Astronomicum Caesareum.
Crater (63 km/2080 m).

Argelander [16.5°S, 5.8°E] Friedrich W. A. Argelander, 1799–1875. German astronomer, author of Bonner Durchmusterung, a positional catalog of 300,000 stars in the northern sky.
Crater (34 km/2980 m).

Azophi [22.1°S, 12.7°E] Abderrahman Al-Sufi, 903–986. Persian astronomer. Compiled a star catalog.
Crater (48 km/3730 m).

Geber [19.4°S, 13.9°E] Gabir ben Aflah, died c. 1145. Spanish-Arabian astronomer.
Crater (45 km/3510 m).

Krusenstern. See map 55.

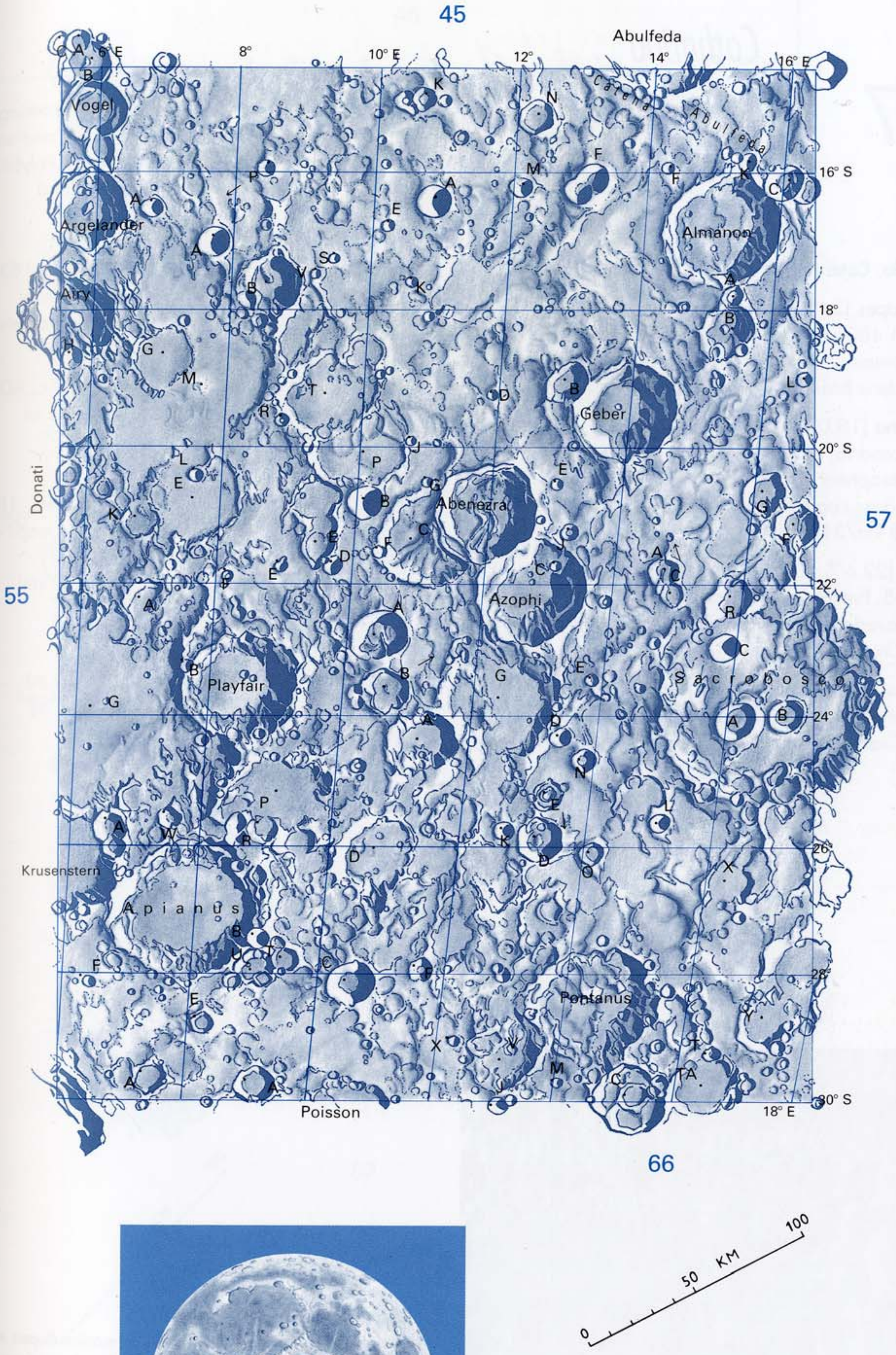
Playfair [23.5°S, 8.4°E] John Playfair, 1748–1819. Scottish mathematician and geologist.
Crater (48 km/2910 m).

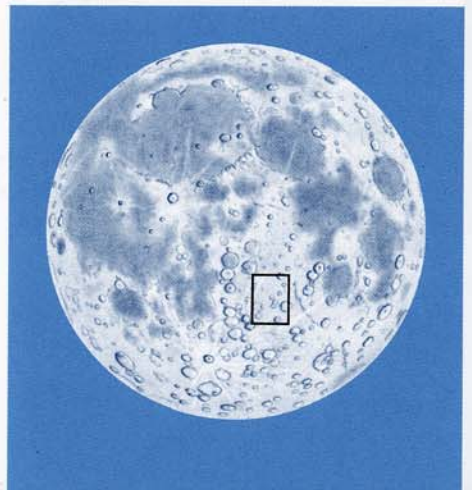
Pontanus [28.4°S, 14.4°E] Giovanni G. Pontano, 1427–1503. Italian poet and astronomer.
Crater (58 km).

Sacrobosco [23.7°S, 16.7°E] John Holywood (Johannes Sacrobuschus), 1200–1256. English (Yorkshire born) teacher of mathematics, later at Oxford.
Crater (98 km).

Conspicuous lettered craters inside Sacrobosco:
Sacrobosco A (17.7 km/1830 m)
Sacrobosco B (14.4 km/1210 m)
Sacrobosco C (13.4 km/2630 m)

Vogel [15.1°S, 5.9°E] Hermann K. Vogel, 1841–1907. German astrophysicist. Applied spectroscopy, spectral classification of the stars.
Crater (27 km/2780 m).





57

Catharina

The mighty mountainous formation Rupes Altai, in this map illuminated by light coming from the east, commences near the crater Tacitus and crosses the region to the south and southeast. A bright, wide ray from the crater Tycho (map 64) runs across the craters Polybius A and B. The large crater Catharina forms a most conspicuous trio with Cyrillus and Theophilus (map 46).

Abulfeda, Catena. See map 56.

Altai, Rupes [24°S, 23°E] Altai Scarp (Altai Range).
A 480-km-long scarplike range; constitutes a continuous, well-defined topographic rim of Nectaris basin.

Catharina [18.0°S, 23.6°E] St. Catharina of Alexandria, d. 307 AD. Patron of Christian philosophers.
Large complex crater, considerably degraded, (100 km/3130 m).

Fermat [22.6°S, 19.8°E] Pierre de Fermat, 1601–1665. French scholar and mathematician. Made discoveries in the theory of numbers.
Crater (39 km).

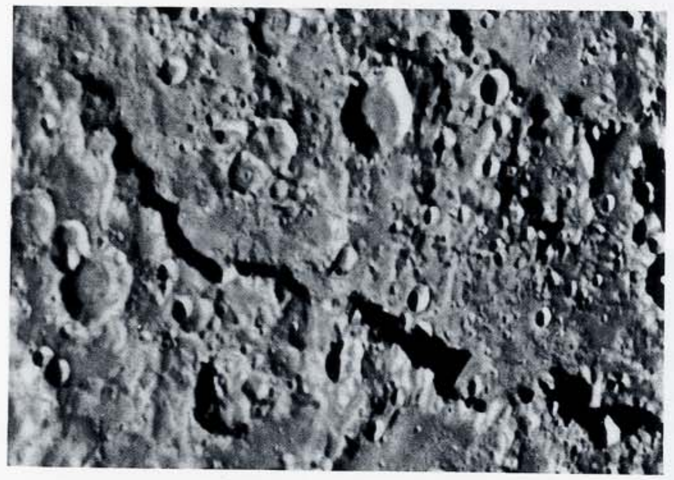
Polybius [22.4°S, 25.6°E] Polybius, 200–120 BC. Greek historian and statesman.
Crater (41 km/2050 m).

Pons [25.3°S, 21.5°E] Jean L. Pons, 1761–1831. French astronomer, director of the Museum Observatory, Florence. Discovered 36 comets.
Irregular crater (44 × 31 km).

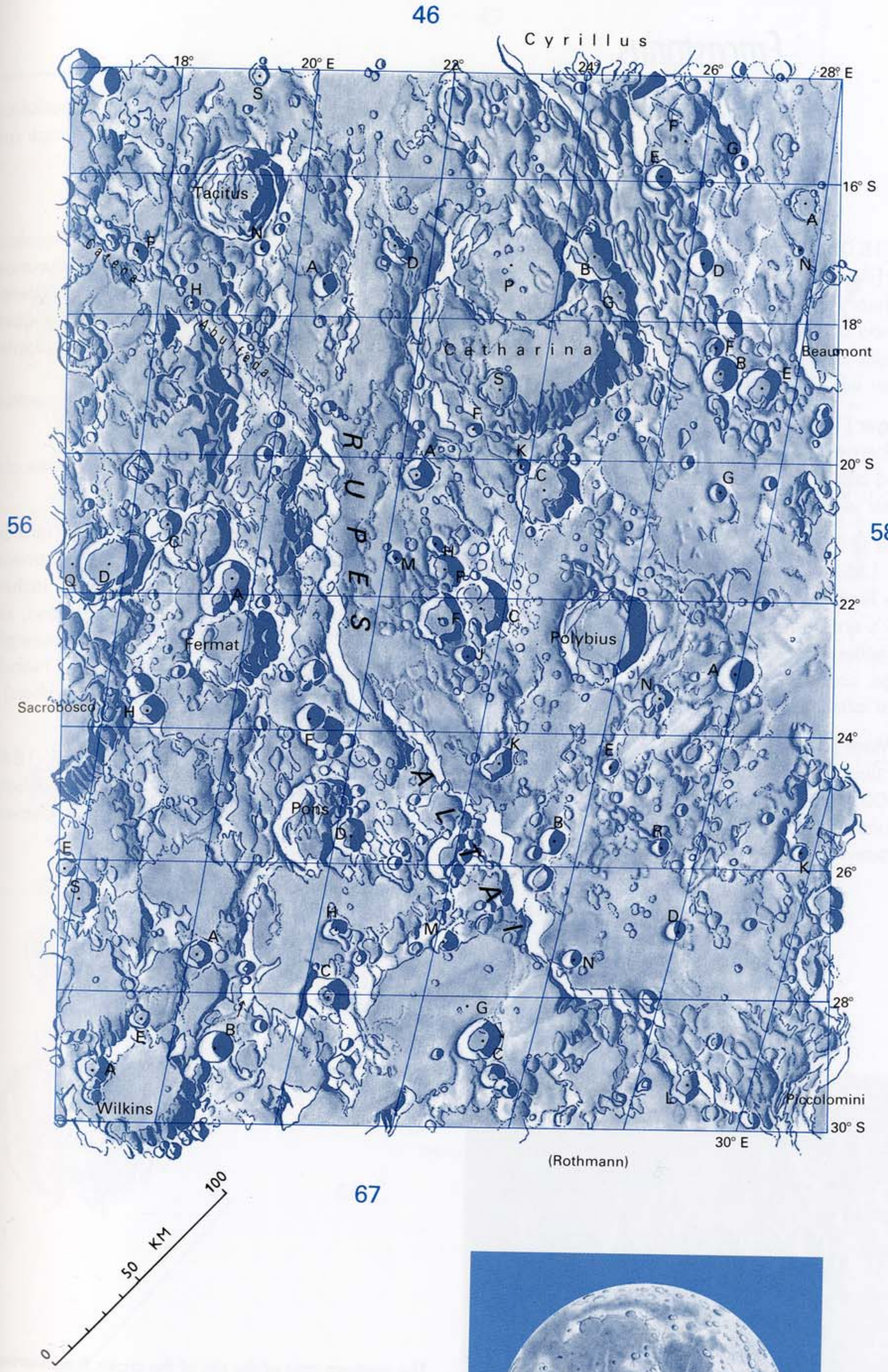
Tacitus [16.2°S, 19.0°E] Cornelius Tacitus, c. AD 55–120. Roman historian, author of the Life of Agricola, Germania, etc.
Prominent crater (40 km/2840 m).

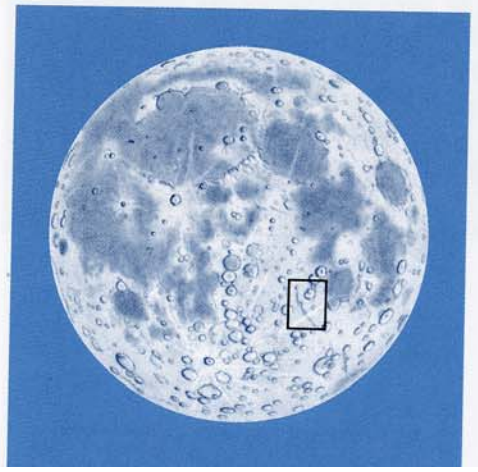
Wilkins [29.4°S, 19.6°E] H. Percival Wilkins, 1896–1960. British selenographer, author of maps of the Moon.
Crater with flat floor, ruined rim (57 km).

Small craters: **Polybius A** (16.8 km/3720 m)
Polybius B (12.8 km/2630 m)
Pons B (13.9 km/3050 m)
Tacitus N (7.1 km/1050 m)



At sunset the conspicuous mountain formation ***Rupes Altai*** *is bordered by deep shadows, that reveal a drop of more than 1,000 meters to the lower-lying area.*





58 Fracastorius

The dark surface of Mare Nectaris, the flooded crater Fracastorius, and the beautiful crater Piccolomini are the most prominent formations in this part of the Moon. A low ridge runs north of the crater Beaumont.

Beaumont [18.0°S, 28.8°E] Léonce Élie de Beaumont, 1798–1874. French geologist. Developed von Buch's theory of orology and demonstrated the method of determining the relative ages of individual rock layers.
Crater with interrupted wall to the east (53 km).

Bohnenberger [16.2°S, 40.0°E] Johann G. F. von Bohnenberger, 1765–1831. German mathematician and astronomer.
Crater with uneven hilly floor (33 km/1060 m).

Fracastorius [21.2°S, 33.0°E] Girolamo Fracastoro, 1483–1553. Italian physician, astronomer, and poet. In his Homocentrica he attempted to replace Ptolemy's system with an inflexible system of homocentric spheres.
Large, conspicuous crater (124 km), *northern rim segment missing, mare filled floor.*

Nectaris, Mare (Sea of Nectar) [15°S, 35°E].
Circular mare (diameter about 350 km, *surface area* 100,000 sq km*) that is the central part of an older lunar basin, flooded with lava. The outer rim of the basin follows the Rupes Altai* (map 57).

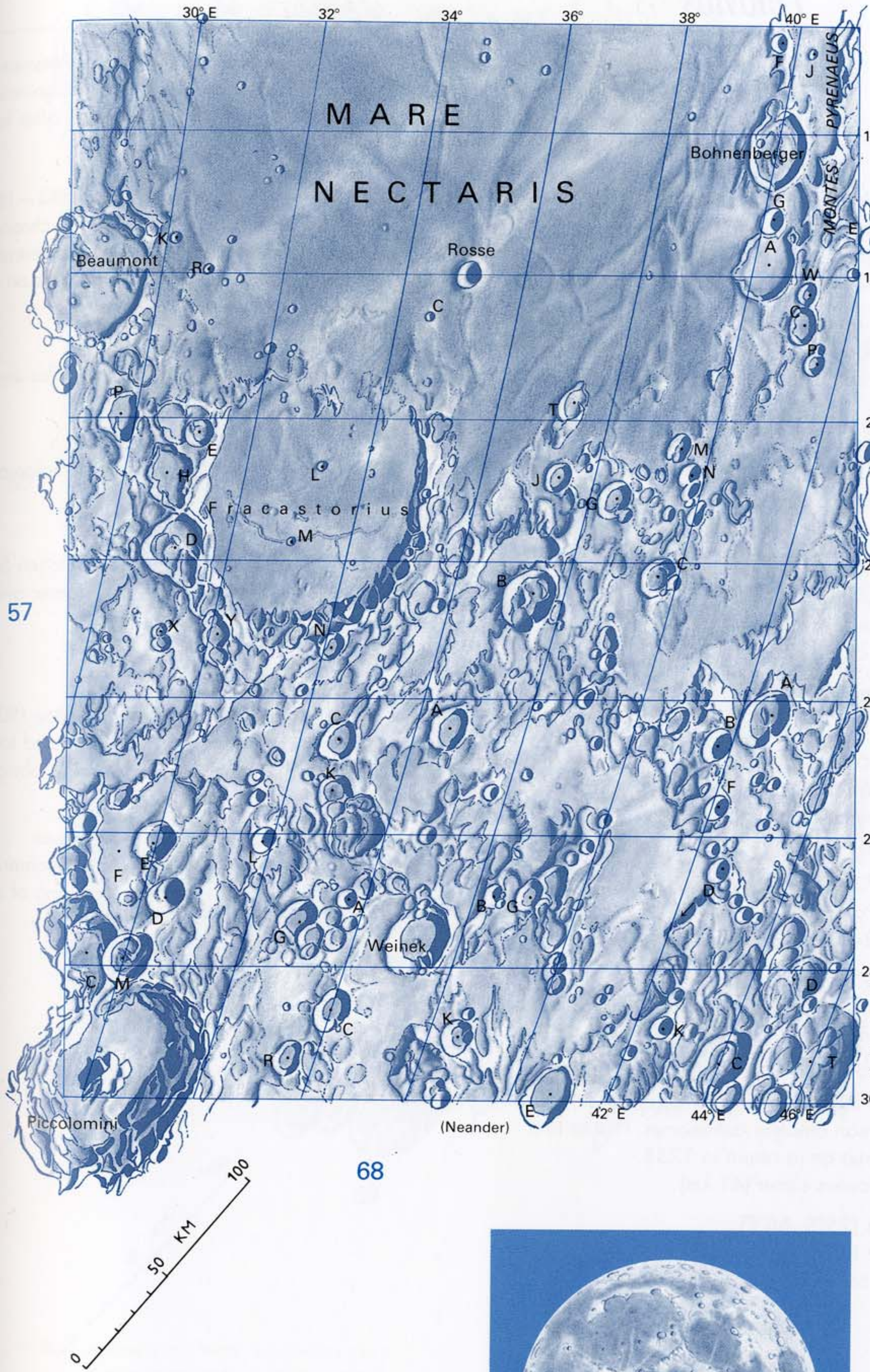
Piccolomini [29.7°S, 32.2°E] Alessandro Piccolomini, 1508–1578. Italian archbishop and astronomer. Made star maps in which the stars were identified for the first time by letters of the Latin alphabet; Bayer's system using Greek letters was adopted later.
Very prominent complex crater with central peak (88 km).

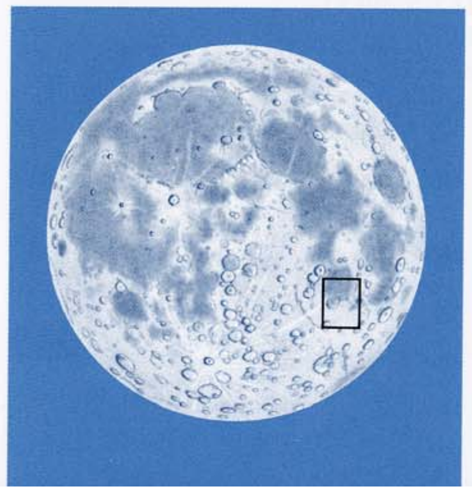
Pyrenaeus, Montes (Pyrenees Mountains). See also maps 47, 48 and 59.

Rosse [17.9°S, 35.0°E] William Parsons, Third Earl of Rosse, 1800–1867. Irish nobleman, astronomer. Erected giant reflecting telescope of 72 inches (183 cm) aperture at Parsonstown, Ireland; studied nebulae and discovered the spiral structure of some galaxies; named various nebulae (Owl Nebula, Crab Nebula, Dumbbell Nebula, and others).
Simple crater (12 km/2420 m).

Weinek [27.5°S 37.0°E] Ladislaus Weinek, 1848–1913. Austrian astronomer who in 1883 became director of the Prague Observatory at Klementinum. Prepared an atlas of the Moon.
Crater (32 km/3370 m).

The northern part of the rim of the crater ***Fracastorius*** *is disturbed and flooded by lava flows, which once filled the central part of the Nectaris basin.*





59

Petavius

The southern elongation of Mare Fecunditatis, with bright rays from the craters Petavius B and Snellius A, includes the giant crater Petavius (which forms a magnificent but coincidental chain with Langrenus, Vendelinus, and Furnerius) and a group of craters named after famous navigators.

Biot [22.6°S, 51.1°E] Jean-Baptiste Biot, 1774–1862. French astronomer, geodesist, and historian of astronomy.
Simple crater (13 km).

Borda [25.1°S, 46.6°E] Jean C. Borda, 1733–1799. French naval officer and astronomer.
Crater with disintegrated wall and central peak (44 km).

Colombo [15.1°S, 45.8°E] Cristoforo Colombo (Christopher Columbus), 1451–1506. Italian-born Spanish navigator. Discovered America in 1492.
Prominent crater with central peaks (76 km).

Cook [17.5°S, 48.9°E] James Cook, 1728–1779. English naval captain and explorer. Twice circum-navigated the world.
Flooded crater with a low wall (47 km).

Fecunditatis, Mare (Sea of Fertility). See also map 37, 48, and 49.

Hase [29.4°S, 62.5°E] Johann M. Hase, 1684–1742. German mathematician and cartographer.
Disintegrated crater (83 km).

McClure [15.3°S, 50.3°E] Robert le M. McClure, 1807–1873. British naval officer. Discovered the Northwest Passage.
Crater (24 km).

Monge [19.2°S, 47.6°E] Gaspard Monge, 1746–1818. French mathematician. One of the founders of descriptive geometry.
Crater (37 km).

Palitzsch [28.0°S, 64.5°E] Johann G. Palitzsch, 1723–1788. German amateur astronomer. First to find Halley's comet on its return in 1758.
Inconspicuous crater (41 km).

Palitzsch, Vallis [25°S, 65°E]
A valley 110 km long that follows the eastern wall of the crater Petavius.

Petavius [25.3°S, 60.4°E] Denis Petau, 1583–1652. French theologian and historian. Studied chronology.
Prominent complex crater with large central peak and ridge, distinct rilles, and dark patches on the floor (177 km).

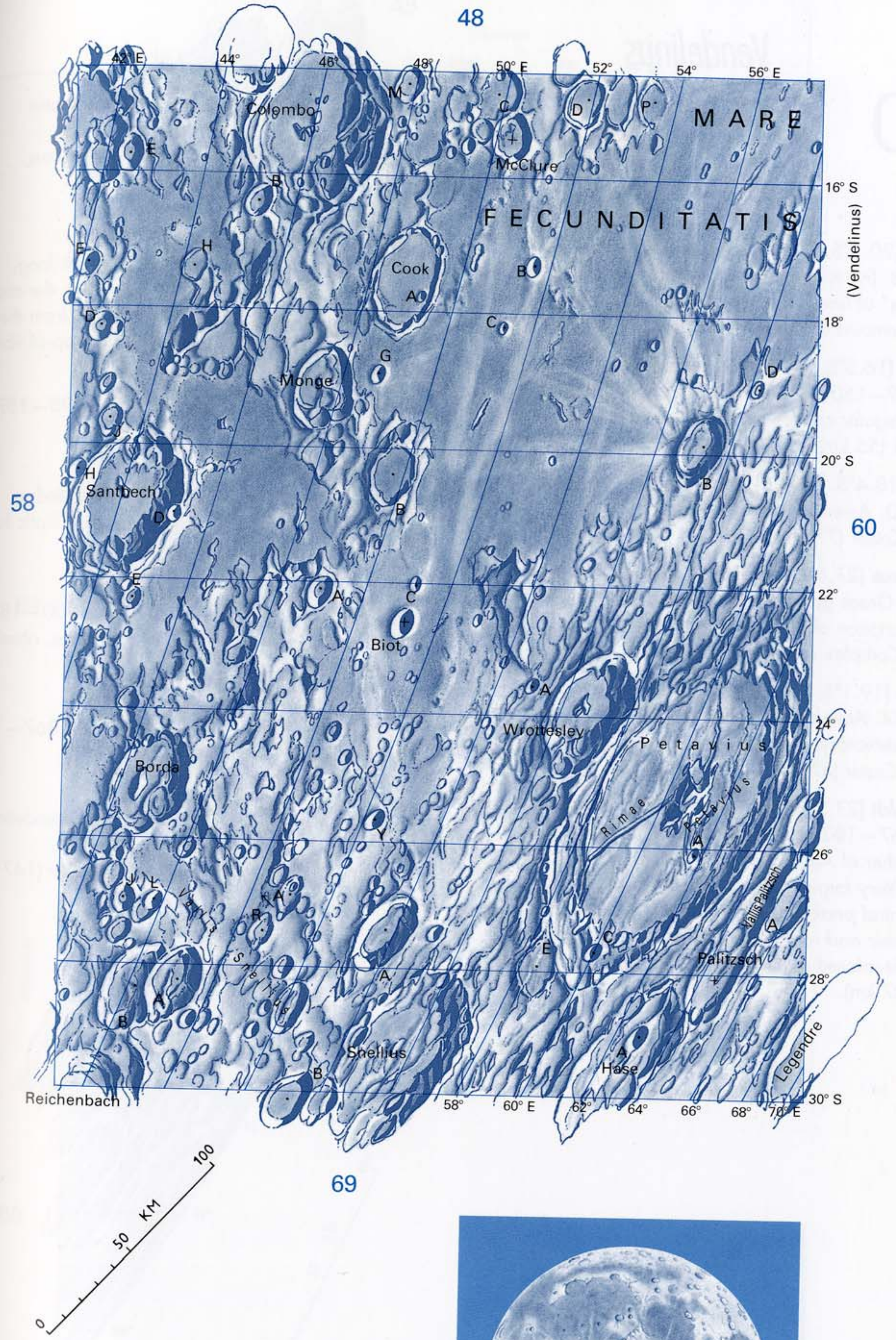
Petavius, Rimae
System of large, easily observable rilles inside Petavius, length about 80 km.

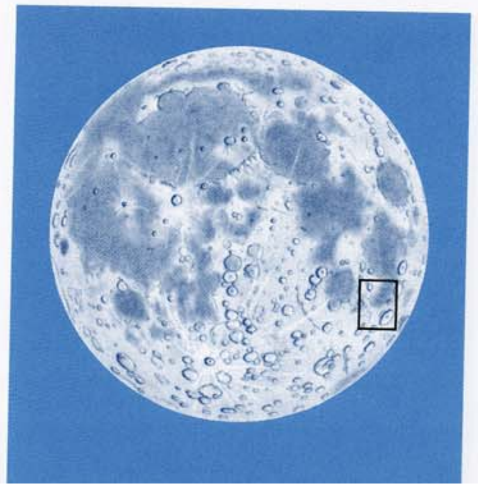
Santbech [20.9°S, 44.0°E] Daniel Santbech Noviomagus, c. 1561. Dutch mathematician and astronomer.
Crater (64 km).

Snellius [29.3°S, 55.7°E] Willibrord van Roijen Snell (Snellius), 1591–1626. Dutch astronomer and geodesist. "Snell's Law" in optics.
Crater (83 km).

Snellius, Vallis [31°S, 59°E]
One of the longest valleys on the Moon (500 km) *continues on map 69; the valley is directed toward the center of the Nectaris basin which is obviously connected with its origin.*

Wrottesley [23.9°S, 56.8°E] John, First Baron Wrottesley, 1798–1867. English astronomer. Worked in the field of astrometry; catalog of double stars.
Prominent crater (57 km).





60

Vendelinus

This region of the eastern limb of the near side of the Moon contains the large crater Humboldt, which is best seen shortly after full Moon. The crater Vendelinus is part of a conspicuous coincidental line of craters that also includes Langrenus, Vendelinus, Petavius, and Furnerius.

Balmer [20.1°S, 70.6°E] Johann J. Balmer, 1825–1898. Swiss mathematician and physicist. "Balmer series" of lines in the spectrum of hydrogen.
Remains of a flooded crater (112 km).

Behaim [16.5°S, 79.4°E] Martin Behaim (Behem), 1459–1506. German navigator and cartographer.
Regular crater with terraced walls and a central peak (55 km).

Gibbs [18.4°S, 84.3°E] Josiah W. Gibbs, 1839–1903. American mathematician and physicist.
Crater (77 km).

Hecataeus [21.8°S, 79.6°E] Hecataeus, 550–480 BC. Greek geographer of Miletus, author of a description of the world, with map.
Complex crater (127 km).

Holden [19.1°S, 62.5°E] Edward S. Holden, 1846–1914. American astronomer, first director of Lick Observatory.
Crater (47 km).

Humboldt [27.2°S, 80.9°E] Wilhelm von Humboldt, 1767–1835. German statesman and philologist. Brother of Alexander von Humboldt.
Very large crater or crater-to-basin transition. Central peak and line of peaks. A network of concentric and radial cracks (rilles) on the floor, also light-colored plains and dark patches of mare fill (207 km).

Humboldt, Catena [22°S, 85°E]
Chain of small craters about 160 km long, directed toward the center of Humboldt; the chain, which resembles a wide rille, is visible from the Earth only at extreme librations (see map of libration zone IV).

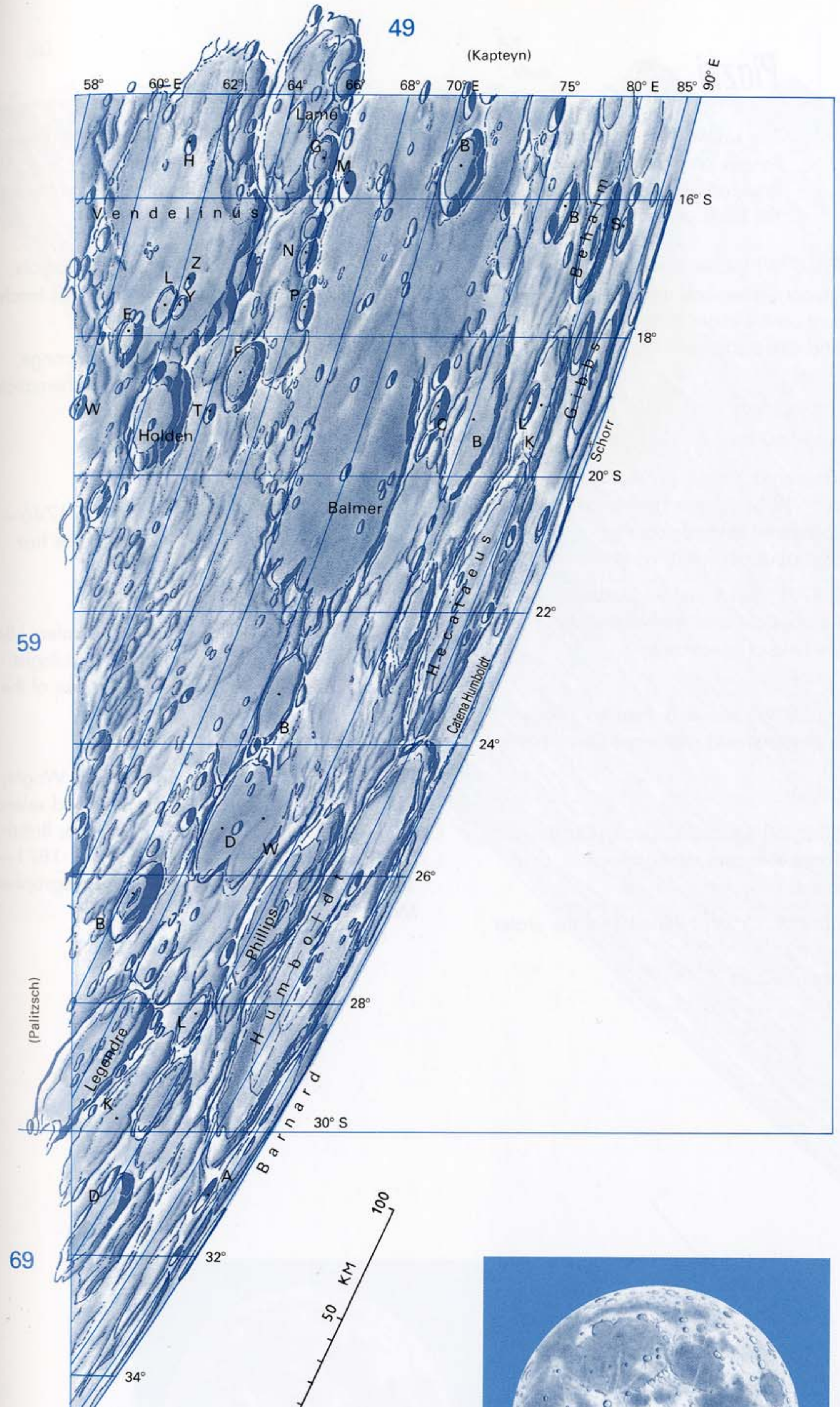
Lamé [14.7°S, 64.5°E] Gabriel Lamé, 1795–1870. French mathematician.
Crater (84 km).

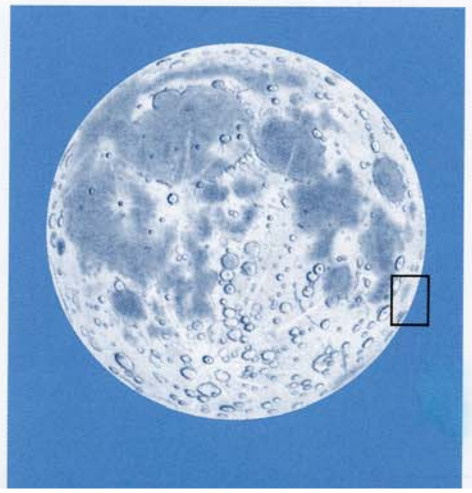
Legendre [28.9°S, 70.2°E] Adrien M. Legendre, 1752–1833. French mathematician. Elliptic functions, theory of numbers.
Crater (79 km).

Phillips [26.6°S, 76.0°E] John Phillips, 1800–1874. British geologist, popularizer of sciences, observed Mars and the Moon.
Crater (124 km).

Schorr [19.5°S, 89.7°E] Richard Schorr, 1867–1951. German astronomer.
Crater (53 km).

Vendelinus [16.3°S, 61.8°E] Godefroid Wendelin, 1580–1667. Belgian astronomer.
Large, degraded crater, smooth floor (147 km).





61

Piazzi

The southwestern limb of the Moon. This area displays a rich system of radial mountain ranges and valleys, which are directed toward the center of the Orientale basin, e.g., Vallis Bouvard, Vallis Inghirami, and Vallis Baade. However, the first of these is observable from the Earth under the most favorite librations only.

Baade [44.8°S, 81.8°W] Walter Baade, 1893–1960. German-born American astronomer who made significant contributions to understanding our own galaxy and other galaxies.
Crater (55 km).

Baade, Vallis [46°S, 76°W]
Valley, length 160 km.

Bouvard, Vallis (Bouvard's Valley) [39°S, 83°W]. Alexis Bouvard, 1767–1843. French mathematician and astronomer discovered several comets.
Valley, length about 280 km, *width* 40 km.

Catalán [45.7°S, 87.3°W] Miguel A. Catalán, 1894–1957. Spanish physicist and mathematician. Research in the field of spectroscopy.
Crater (25 km).

Fourier [30.3°S, 53.0°W] Jean-B. J. Fourier, 1768–1830. French physicist and mathematician. "Fourier series."
Crater (52 km).

Graff [42.4°S, 88.6°W] Kasimir R. Graff, 1878–1950. Polish-born Viennese astronomer.
Crater (36 km).

Inghirami, Vallis [44°S, 73°W] Named after the crater Inghirami (map 62).
Valley, length 140 km.

Lacroix [37.9°S, 59.0°W] Sylvestre F. de Lacroix, 1765–1843. French mathematician and teacher.
Crater (38 km).

Lagrange [33.2°S, 72.0°W] Joseph L. Lagrange, 1736–1813. Outstanding French mathematician, author of Mécanique Analytique.
Large degraded crater (160 km).

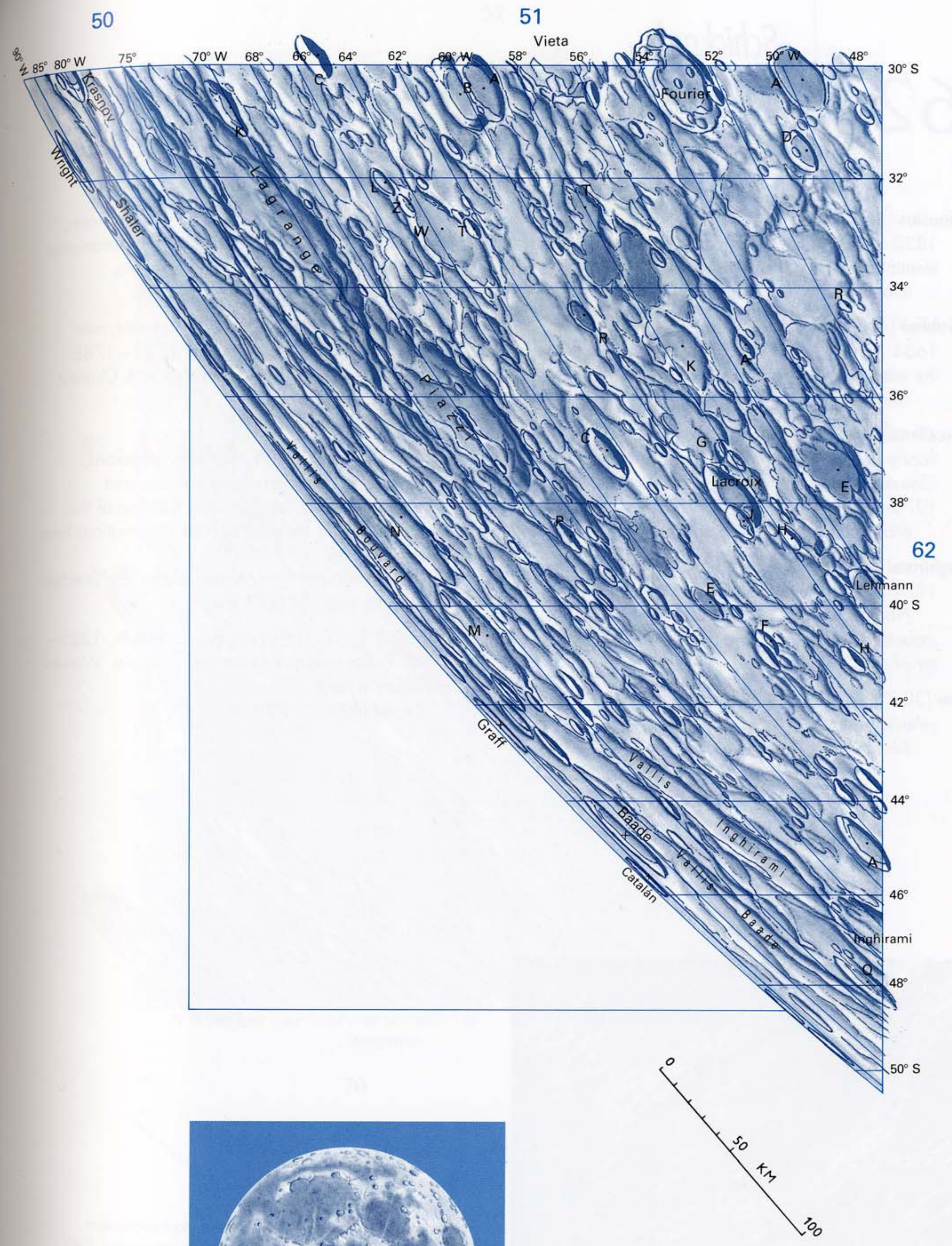
Lehmann. See also map 62.

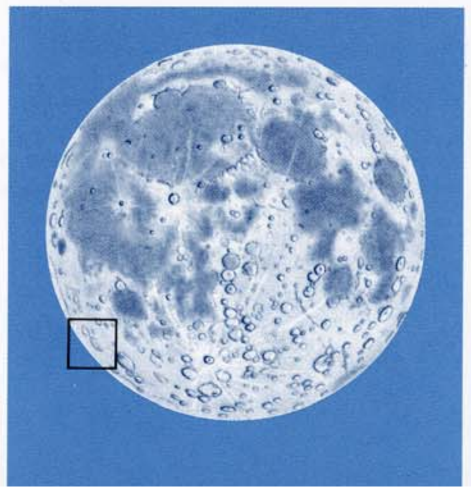
Piazzi [36.2°S, 67.9°W] Giuseppe Piazi, 1746–1826. Italian astronomer. Discovered the first asteroid (Ceres).
Large degraded crater (101 km).

Shaler [32.9°S, 85.2°W] Nathaniel S. Shaler, 1841–1906. American geologist and paleontologist. Geological interpretation of photographs of the Moon.
Crater (48 km).

Wright [31.6°S, 86.6°W] (1) Frederick E. Wright, 1878–1953; American astronomer and selenographer. (2) Thomas Wright, 1711–1786; British natural philosopher. (3) William H. Wright, 1871–1959; American astronomer who photographed Mars.
Crater (40 km).

61





62 Schickard

Mountainous region along the southwestern limb of the Moon that in the north adjoins Mare Humorum. One of the largest lunar craters, Schickard, with characteristic dark patches on its floor, is in this area.

Clausius [36.9°S, 43.8°W] Rudolf J. E. Clausius, 1822–1888. German physicist. Thermodynamics, kinetic theory of gases.
Crater with a flooded floor (25 km).

Drebbel [40.9°S, 49.0°W] Cornelius Drebbel, 1572–1634. Dutch physicist. Claimant to the invention of the telescope and microscope.
Crater (30 km).

Excellentiae, Lacus (Lake of Excellence) [36°S, 43°W] Poorly defined area of mare close to the crater Clausius. The name was accepted by the IAU in 1976.
Maximum span about 150 km.

Inghirami [47.5°S, 68.8°W] Giovanni Inghirami, 1779–1851. Italian astronomer.
Prominent crater (91 km) *crossed by radial mountain ranges and valleys running from the center of the Orientale basin.*

Lee [30.7°S, 40.7°W] John Lee, 1783–1866. English selenographer and collector of antiquities.
Remains of a flooded crater (41 km/1340 m).

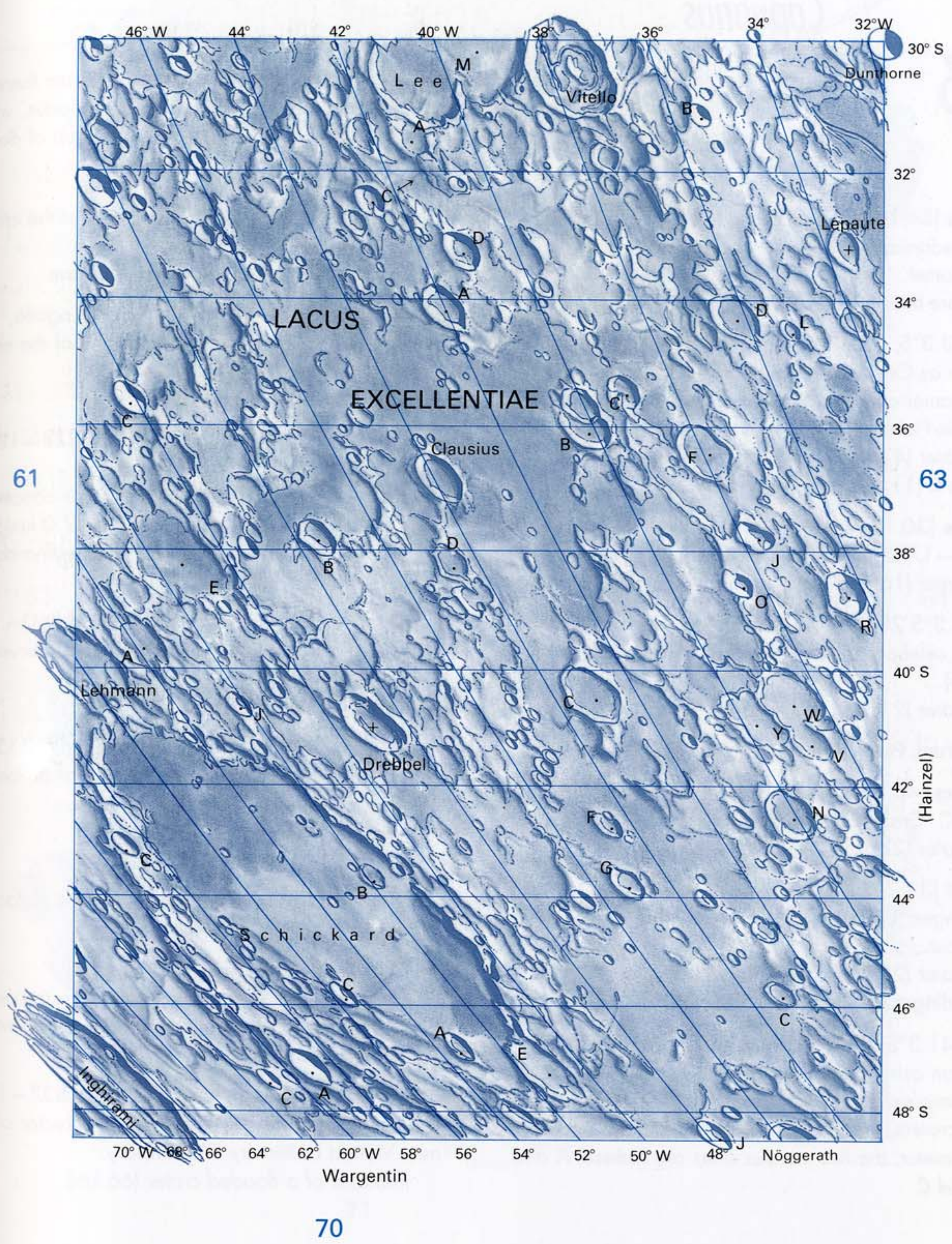
Lehmann [40.0°S, 56.0°W] Jacob H. W. Lehmann, 1800–1863. German theologian and astronomer. Worked in the field of celestial mechanics.
Considerably eroded crater (53 km).

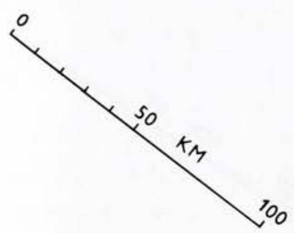
Lepaute [33.3°S, 33.6°W] Madame Lepaute, née Nicole Reine Etable de la Brière, 1723–1788. French mathematician. Co-operated with Clairaut and Lalande.
Crater (16 km/2070 m).

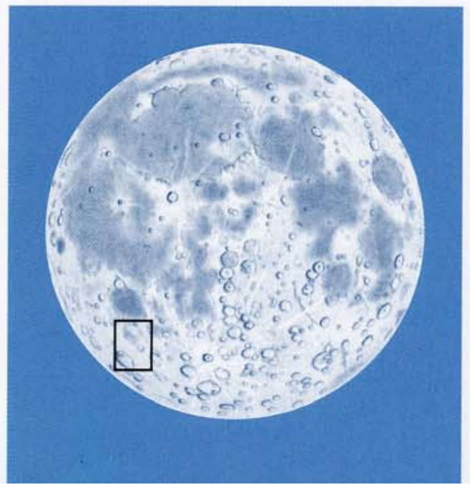
Schickard [44.4°S, 54.6°W] Wilhelm Schickard, 1592–1635. German mathematician and astronomer. First to attempt determination of the path of a meteor by simultaneous observations from different places.
Vast crater with light-colored plains and patches of the dark mare fill (227 km).

Vitello [30.4°S, 37.5°W] Erazmus C. Witelo, 1225–1290. Polish mathematician and physicist. Worked at Padua in Italy.
Crater (42 km/1730 m).

*The huge crater **Schickard**, one of the most prominent lunar formations of its kind, lies on the southwestern limb of the Moon.*







63

Capuanus

Area in the southwestern sector of the Moon. On the surface of Palus Epidemiarum there is a system of rilles close to the crater Ramsden. Notice also the wide rille Rima Hesiodus, which continues on maps 53 and 54. The floor of the crater Capuanus contains a group of domes.

Capuanus [34.1°S, 26.7°W] Francesco Capuano di Manfredonia, 15th century. Italian theologian and astronomer.
Mare-filled crater (60 km).

Cichus [33.3°S, 21.1°W] Francesco degli Stabili, also known as Cecco d'Ascoli, 1257–1327. Italian astronomer and astrologer; accused of heresy and burnt in Florence.
Crater (41 km/2760 m)*; on its western wall is* **Cichus C** (11.1 km/1250 m).

Dunthorne [30.1°S, 31.6°W] Richard Dunthorne, 1711–1775. British geodesist and astronomer.
Crater (16 km/2780 m).

Elger [35.3°S 29.8°W] T. Gwyn Elger, 1838–1897. British selenographer. Produced a map of the Moon (1895).
Crater (21 km/1250 m).

Epidemiarum, Palus (Marsh of Epidemics). See map 53.

Epimenides [40.9°S, 30.2°E] Epimenides, late 7th century BC. Cretan poet and prophet.
Crater (27 km).

Haidinger [39.2°S, 25.0°W] Wilhelm Karl von Haidinger, 1795–1871. Austrian geologist and physicist.
Crater (22 km/2330 m)*; on its southeastern wall is* **Haidinger B** (10.3 km/1500 m).

Hainzel [41.3°S, 33.5°W] Paul Hainzel, c. 1570. German astronomer, co-operated with Tycho Brahe.
Complex formation consisting of three overlapping craters, the largest of which (Hainzel) is 70 km in diameter; the two smaller ones are **Hainzel A** *and* **Hainzel C**.

Hesiodus, Rima [30°S, 21°W] Named after the crater Hesiodus (map 54).
Conspicuous wide rille, length 300 km.

Lagalla [44.6°S, 22.5°W] Giulio Cesare Lagalla, 1571–1624. Italian philosopher, one of the earliest telescopic observers of the Moon.
Remains of a crater (85 km).

Marth [31.1°S, 29.3°W] Albert Marth, 1828–1897. German astronomer.
A curiosity: smaller crater (3.5 km) *is concentrically positioned inside a larger crater* (7.0 km)*; accordingly, Marth looks like a crater with a double wall.*

Mee [43.7°S, 35.0°W] Arthur B. P. Mee, 1860–1926. Scottish astronomer and writer. Observer of the Moon and Mars.
Eroded crater (132 km).

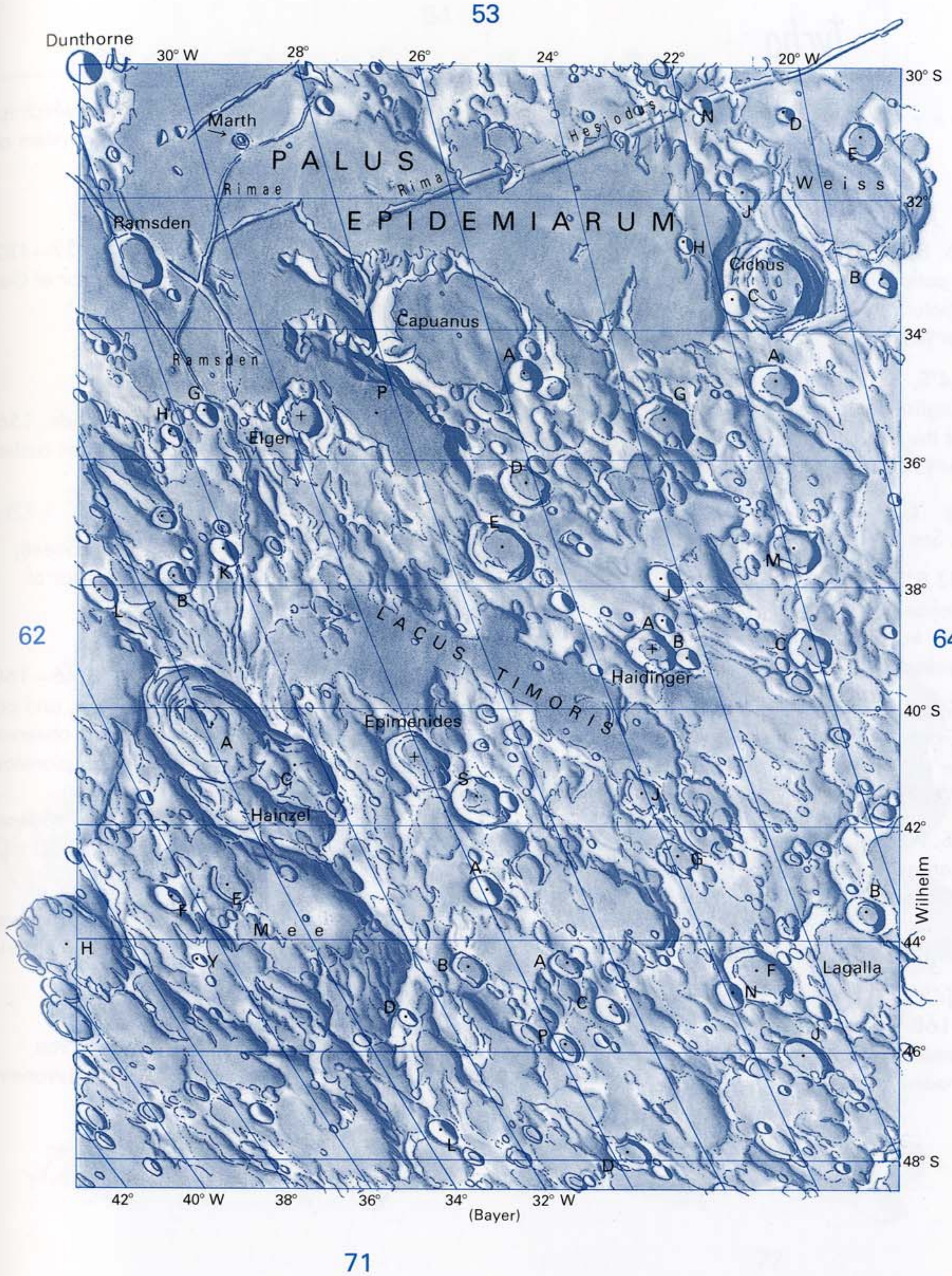
Ramsden [32.9°S, 31.8°W] Jesse Ramsden, 1735–1800. British mechanician and maker of astronomical instruments.
Flooded crater (25 km/1990 m).

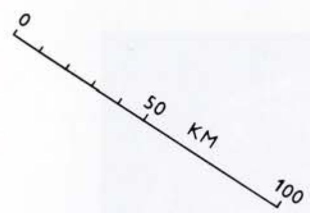
Ramsden, Rimae [33°S, 31°W]
System of jointed rilles, that occupy a surface area about 130 km *in span.*

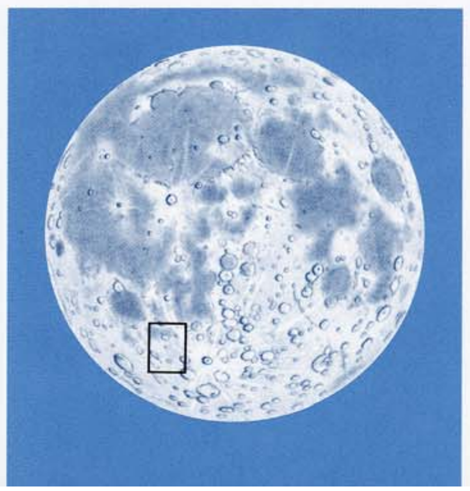
Timoris, Lacus (Lake of Fear) [39°S, 28°W]
Elongated region of mare material, surrounded by mountains and other terra formations; its length is about 130 km.

Weiss [31.8°S, 19.5°W] Edmund Weiss, 1837–1917. Austrian astronomer, co-founder and director of the new Vienna University Observatory.
Remains of a flooded crater (66 km).

63







64

Tycho

Crater field south of Mare Nubium. This area is dominated by the crater Tycho, which is one of the most prominent craters on the Moon and the center of the most extensive system of bright rays. Surveyor 7 soft-landed close to the northern rim of Tycho.

Ball [35.9°S, 8.4°W] William Ball, d. 1690. English amateur astronomer. Confirmed Huygens' observations of Saturn's rings.
Crater (41 km/2810 m).

Brown [46.4°S, 17.9°W] Ernest W. Brown, 1866–1938. English-born American astronomer, author of theory of the motion of the Moon.
Crater (34 km); *the crater* **Brown E** *penetrates its wall.*

Deslandres. See also map 65.

Gauricus [33.8°S, 12.6°W] Luca Gaurico, 1476–1558. Italian theologian, astronomer, and astrologer, translator of Ptolemy's Almagest.
Considerably eroded crater (79 km).

Heinsius [39.5°S, 17.7°W] Gottfried Heinsius, 1709–1769. German mathematician and astronomer.
Crater (64 km/2650 m), *merges with* **Heinsius A** (20 km/3270 m), **Heinsius B** *and* **Heinsius C**.

Hell [32.4°S, 7.8°W] Maximilian Hell, 1720–1792. Hungarian astronomer, founder of the original Vienna Observatory. Observed transit of Venus in 1769.
Crater (33 km/2200 m).

Montanari [45.8°S, 20.6°W] Geminiano Montanari, 1633–1687. Italian astronomer. First micrometric measurements for the mapping of the Moon.
Degraded crater (77 km).

Pictet [43.6°S, 7.4°W] Marc A. Pictet, 1752–1825. Swiss astronomer and naturalist. Director of Geneva Observatory.
Crater (62 km).

Pitatus. See map 54.

Sasserides [39.1°S, 9.3°W] Gellio Sasceride, 1562–1612. Danish physician and astronomer, assistant to Tycho Brahe.
Ruined crater (90 km).

Street [46.5°S, 10.5°W] Thomas Streete (Street), 1621–1689. English astronomer, author of *Astronomia Carolina.*
Crater (58 km).

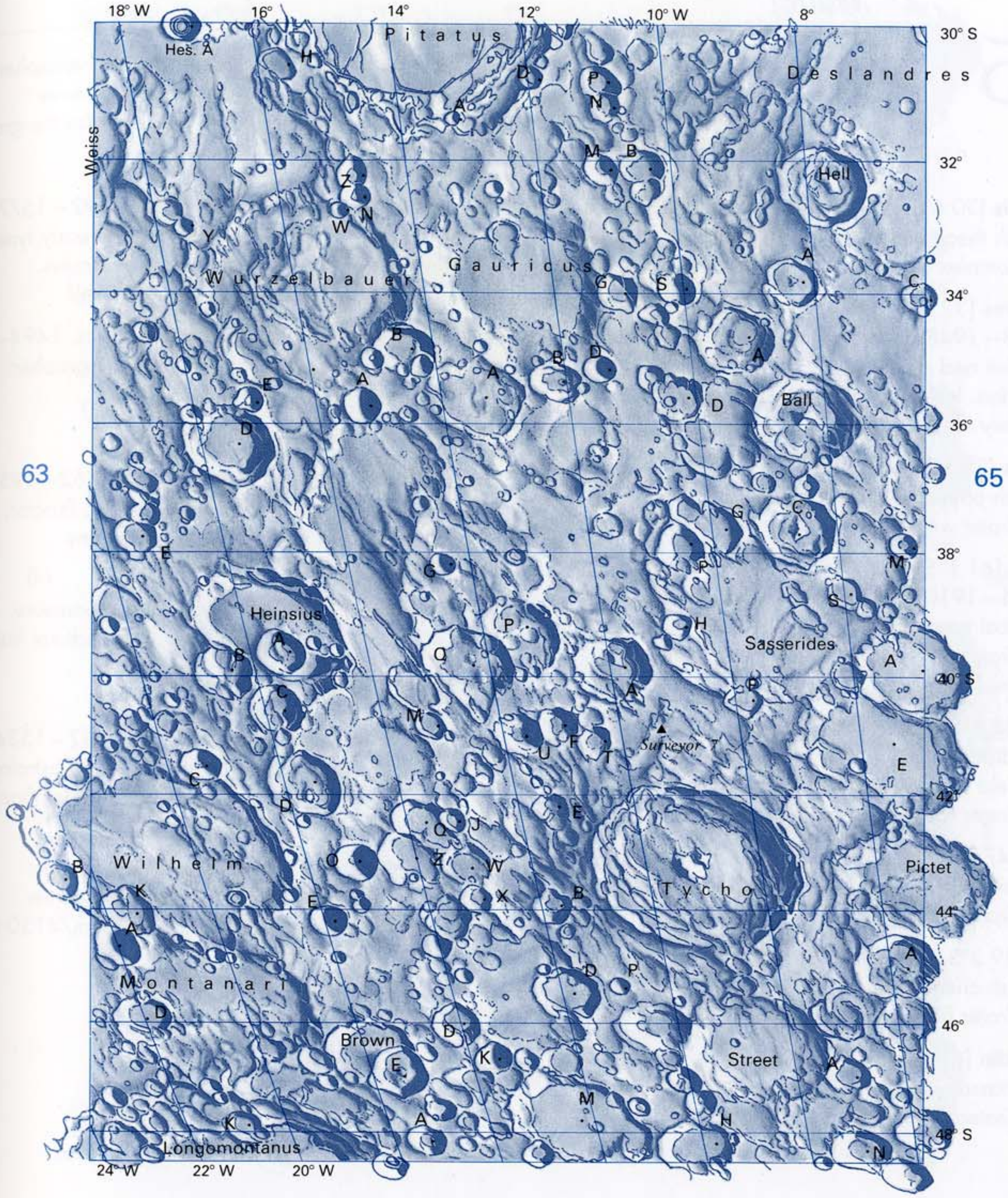
Tycho [43.3°S, 11.2°W] Tycho Brahe, 1546–1601. Danish astronomer, prominent observer, and organizer of scientific research. His accurate observations enabled Kepler to discover the laws of planetary motion.
Prominent complex crater, very fresh appearance, age about 100 million years (85 km/4850 m), *with the most extensive ray system.*

Wilhelm [43.1°S, 20.8°W] Wilhelm IV, Landgrave of Hesse, "The Wise," 1532–1592. German prince and astronomer.
Large crater (107 km).

Wurzelbauer [33.9°S, 15.9°W] Johann P. von Wurzelbauer, 1651–1725. German astronomer, observer of the Sun.
Greatly eroded crater (88 km).

54

63



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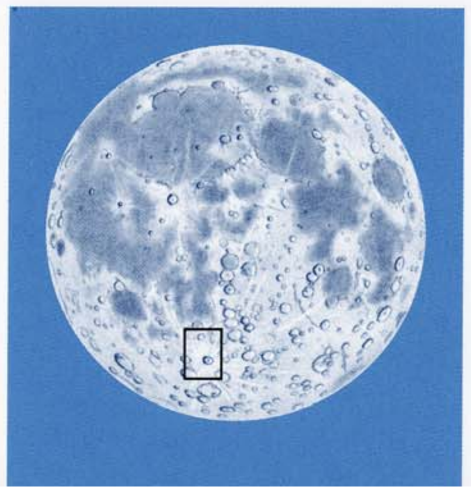
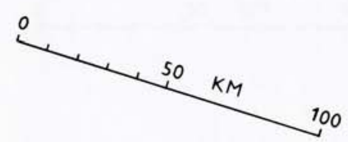
72





65 Walter

This is a dense crater field in the vicinity of the prime meridian on the southern hemisphere of the Moon. The presence of the conspicuous crater Stöfler and the crater Aliacensis to the northeast facilitate identification of the individual named features. Note also the group of craters bordering Huggins.

Aliacensis [30.6°S, 5.2°E] Pierre d'Ailly, 1350–1420. French theologian and geographer.
Complex crater (80 km/3680 m).

Deslandres [32.5°S, 5.2°W] Henri A. Deslandres, 1853–1948. French astronomer and observer of the Sun and director of Paris Observatory at Meudon. Invented spectroheliographs.
Very large crater, heavily ruined wall (234 km).

Fernelius [38.1°S, 4.9°E] Jean Fernel, 1497–1558. French physicist.
Crater with a smooth floor (65 km).

Huggins [41.1°S, 1.4°W] Sir William Huggins, 1824–1910. English astronomer. Pioneered astronomical spectroscopy.
Crater (65 km), *merges with the crater Nasireddin.*

Lexell [35.8°S, 4.2°W] Anders J. Lexell, 1740–1784. Swedish mathematician and astronomer. Worked in the field of celestial mechanics.
Crater (63 km).

Licetus [47.1°S, 6.7°E] Fortunio Liceti, 1577–1657. Italian physicist and philosopher.
Crater (75 km).

Miller [39.3°S, 0.8°E] William A. Miller, 1817–1870. English chemist.
Crater (75 km).

Nasireddin [41.0°S, 0.2°E] Nasir-al-Din, Mohammed Ibn Hassan, 1201–1274. Persian astronomer.
Crater (52 km).

Nonius [34.8°S, 3.8°E] Pedro Nuñez, 1492–1577. Portuguese mathematician. Devised an early type of vernier for reading setting circles and scales.
Disintegrated crater (70 km/2990 m).

Orontius [40.3°S, 4.0°W] Orontius Finaeus, 1494–1555. French mathematician and cartographer.
Large crater (122 km).

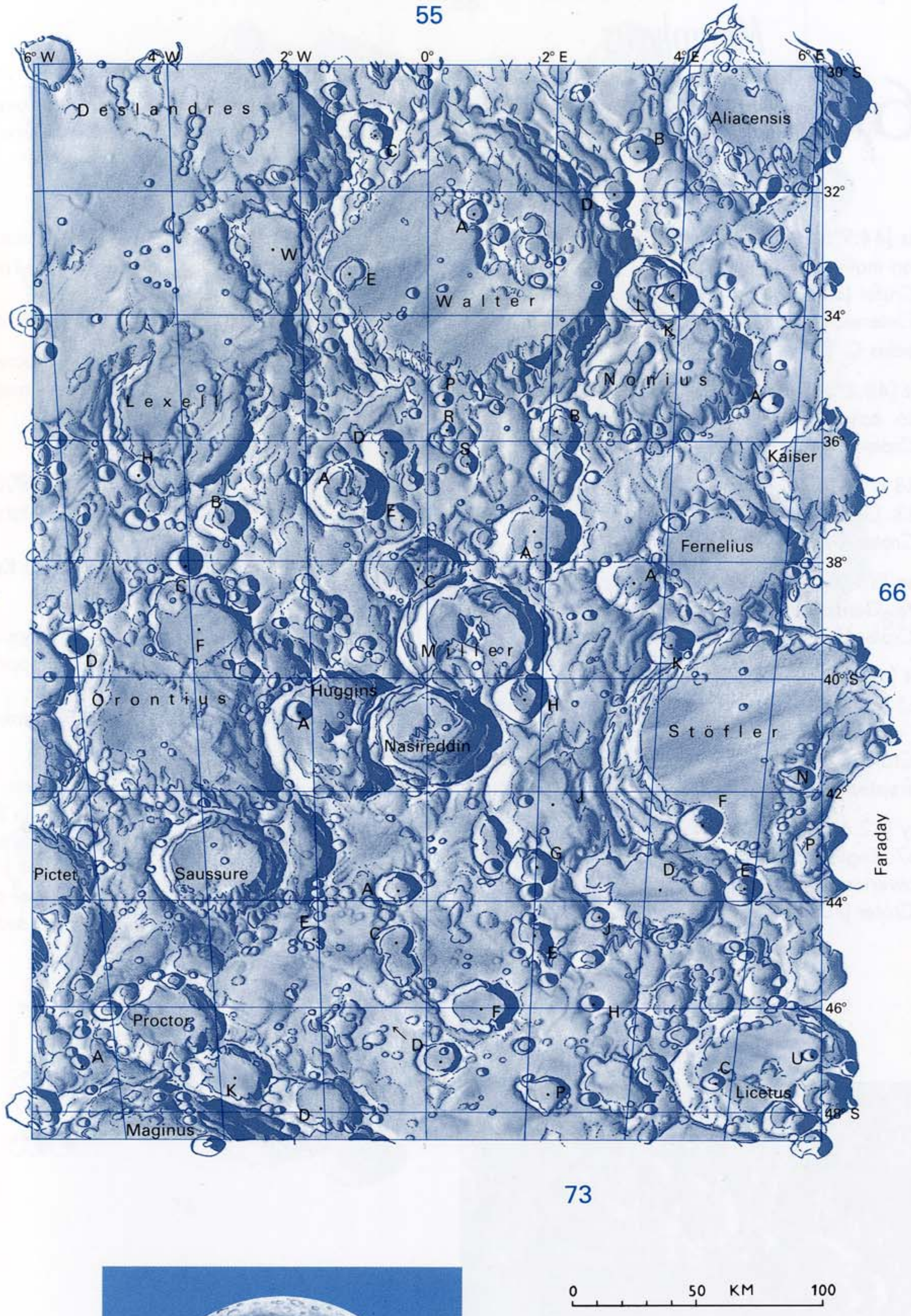
Pictet. See map 64.

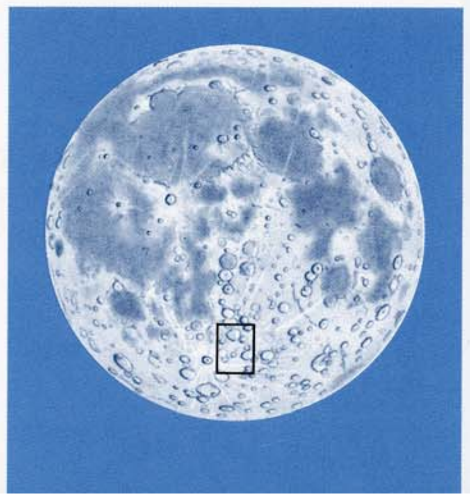
Proctor [46.4°S, 5.1°W] Mary Proctor, 1862–1957. Daughter of the British astronomer R. A. Proctor; astronomer and popularizer of astronomy.
Crater (52 km).

Saussure [43.4°S, 3.8°W] Horace B. de Saussure, 1740–1799. Swiss philosopher and natural historian.
Crater (54 km/1880 m).

Stöfler [41.1°S, 6.0°E] Johann Stöfler, 1452–1534. German mathematician, astronomer, and astrologer.
Large crater, smooth plain inside, lighter than mare fill (126 km/2760 m).

Walter (Walther) [33.0°S, 0,7°E] Bernard Walter (Walther), 1430–1504. German astronomer.
Large complex crater (132 × 140 km/4130 m).





66

Maurolycus

Crater field in the southeastern sector of the Moon. The prominent crater Maurolycus forms a characteristic trio with the neighboring craters Faraday and Stöfler (map 65). The crater Gemma Frisius is remarkable for its exceptionally high wall — over 5,000 m.

Barocius [44.9°S, 16.8°E] Francesco Barozzi, c. 1570. Italian mathematician.
Crater (82 km) *whose wall is ruined in the north and intersected by the craters* **Barocius B** *and* **Barocius C**.

Breislak [48.2°S, 18.3°E] Scipione Breislak, 1748–1826. Italian geologist, chemist, and mathematician.
Crater (50 km).

Buch [38.8°S, 17.7°E] Christian L. von Buch, 1774–1853. German geologist.
Crater (54 km/1440 m).

Büsching [38.0°S, 20.0°E] Anton F. Büsching, 1724–1793. German geographer and philosopher.
Crater (52 km).

Clairaut [47.7°S, 13.9°E] Alexis C. Clairaut, 1713–1765. Eminent French mathematician, geodesist, and astronomer.
Crater (75 km)*; the southern part of its wall is interrupted by the craters* **Clairaut A** *and* **Clairaut B**.

Faraday [42.4°S, 8.7°E] Michael Faraday, 1791–1867. English chemist and physicist, known for his discoveries in electricity, magnetism, etc.
Crater (70 km/4090 m).

Gemma Frisius [34.2°S, 13.3°E] Reinier Jemma, 1508–1555. Dutch physician (born in Friesland), cartographer, and astronomer.
Crater with degraded wall (88 km/5160 m).

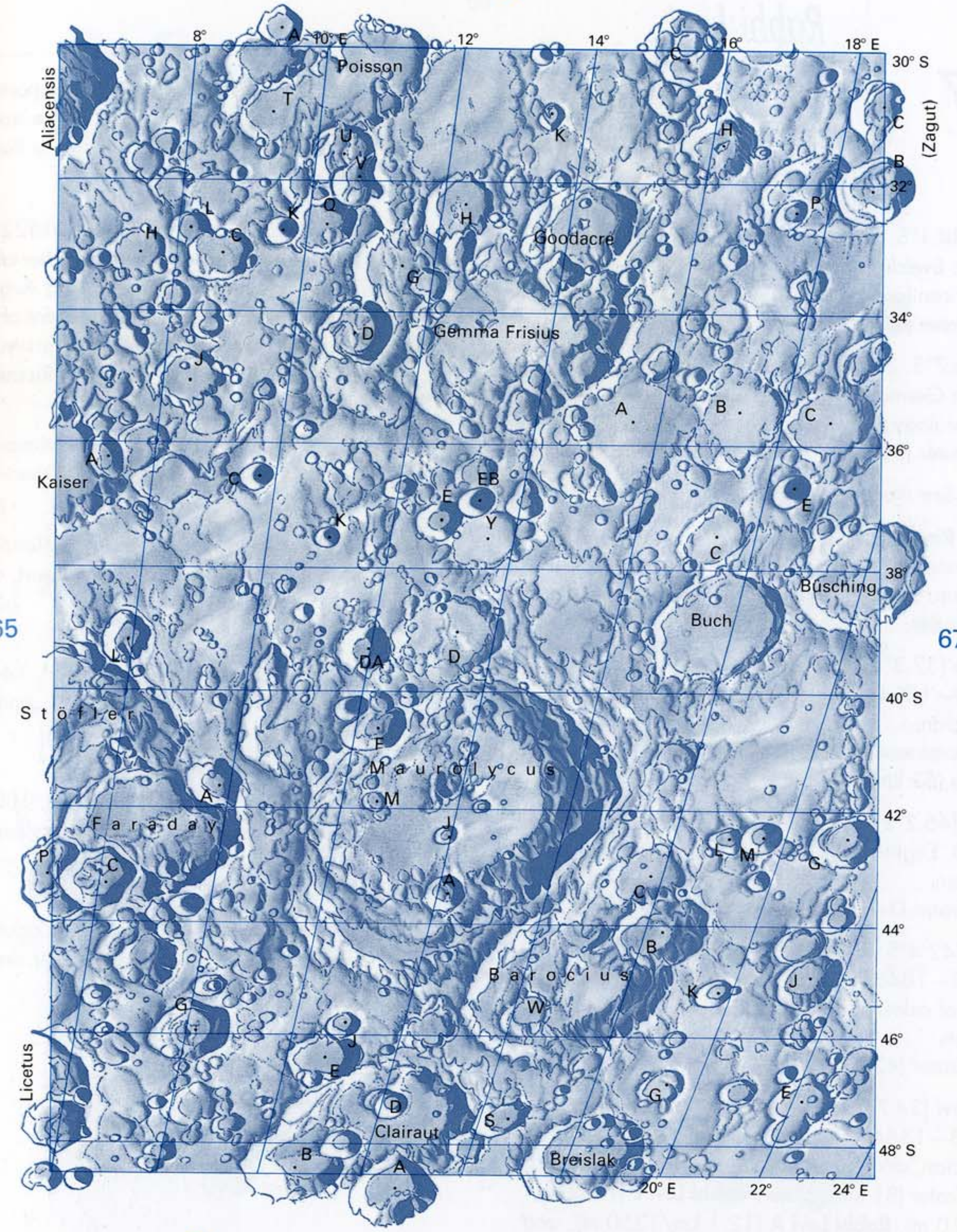
Goodacre [32.7°S, 14.1°E] Walter Goodacre, 1856–1938. English selenographer. Made a map of the Moon.
Crater (46 km/3190 m).

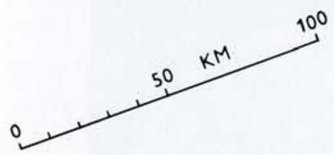
Kaiser [36.5°S, 6.5°E] Frederick Kaiser, 1808–1872. Dutch astronomer, observer of double stars and Mars.
Crater (52 km)*; on its eastern wall is* **Kaiser A** (21 × 14 km/2330 m).

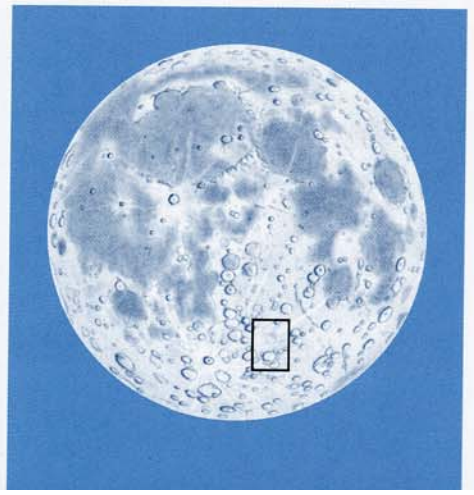
Maurolycus [41.8°S, 14.0°E] Francesco Maurolico, 1494–1575. Italian mathematician, opponent of the Copernican theory.
Large complex crater with central peaks (114 km/4730 m).

Poisson [30.4°S, 10.6°E] Siméon D. Poisson, 1781–1840. French mathematician. Worked in the field of celestial mechanics. Friend of Langrange and Laplace.
Remains of a crater (42 km), *the floor of which is connected to that of Poisson T to the southwest.*

The complex crater ***Maurolycus****, with terraced walls and central peaks, stands out in the southeastern sector of the near side of the Moon, which is densely covered with craters.*







67 Rabbi Levi

Very dense and chaotic crater field in the southeastern sector of the Moon. An important landmark is the crater Rabbi Levi, which contains two pairs of small craters. At the bottom right of the map is a part of the conspicuous crater Janssen with a wide rille on its floor.

Celsius [34.1°S, 20.1°E]. Anders Celsius, 1701–1744. Swedish physicist and astronomer, inventor of the centigrade temperature scale.
Crater (36 km).

Dove [46.7°S, 31.5°E] Heinrich W. Dove, 1803–1879. German physicist. Research in the field of meteorology and electricity.
Crater (30 km).

Janssen. See map 68.

Janssen, Rimae
System of rilles on the floor of Janssen, length 140 km; *suitable target for observation with small telescopes.*

Lindenau [32.3°S, 24.9°E] Bernhard von Lindenau, 1780–1854. German astronomer, soldier, and politician.
Prominent crater with terraced walls and central peaks (53 km/2930 m).

Lockyer [46.2°S, 36.7°E] Sir Norman Lockyer, 1836–1920. English astrophysicist. Discovered helium in the Sun.
Crater (34 km) *on the wall of Janssen.*

Nicolai [42.4°S, 25.9°E] Friedrich B. G. Nicolai, 1793–1846. German astronomer. Worked in the field of celestial mechanics, computed the orbits of comets.
Crater (42 km).

Rabbi Levi [34.7°S, 23.6°E] Levi ben Gershom, 1288–1344. French Jewish philosopher, mathematician, and astronomer.
Crater (81 km); *craters* **Rabbi Levi L** (12.6 km/ /2410 m), **Rabbi Levi A** (12.1 km/1350 m), *and others are situated on its floor.*

Riccius [36.9°S, 26.5°E] (1) Matteo Ricci, 1522–1610. Italian missionary in China, teacher of mathematics and astronomy, geographer. (2) Augustine Ricci, c. 1513. Italian astronomer, student of Abraham Zagut at the Salamanca University.
Ruined crater (71 km); *south of it is* **Riccius E** (22 km/3520 m).

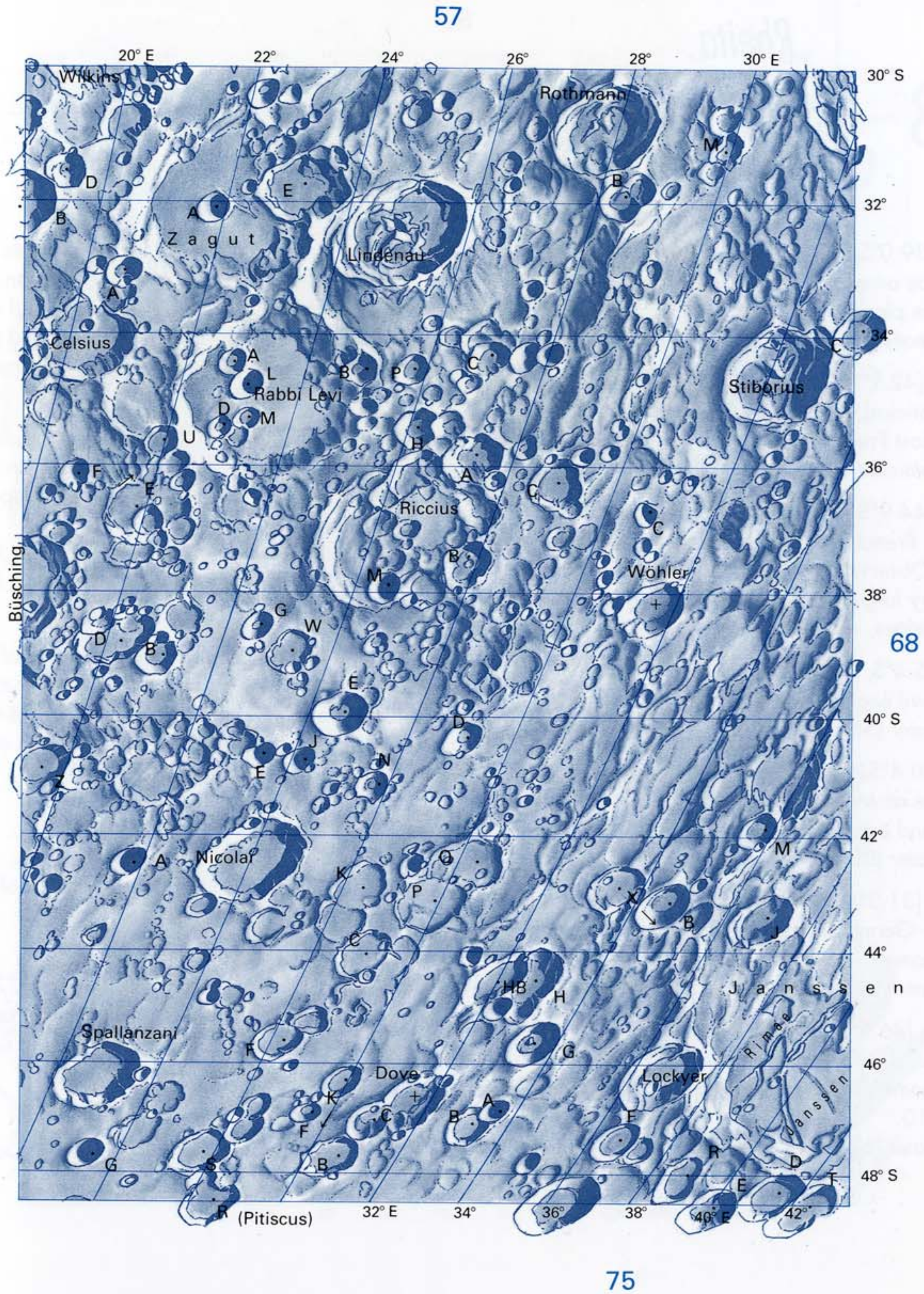
Rothmann [30.8°S, 27.7°E] Christophe Rothmann, died c. 1600. German astronomer and theoretician.
Crater (42 km/4220 m).

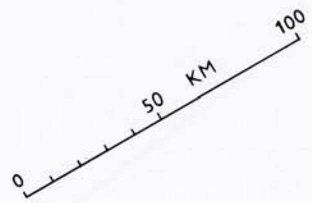
Spallanzani [46.3°S, 24.7°E] Lazzaro Spallanzani, 1729–1799. Italian scientist, physiologist, and traveler.
Crater (32 km).

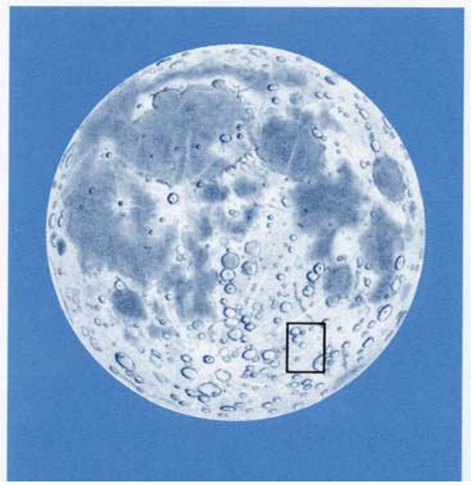
Stiborius [34.4°S, 32.0°E] Andreas Stoberl, 1465–1515. Austrian philosopher, theologian, and astronomer.
Crater (44 km/3750 m).

Wöhler [38.2°S, 31.4°E] Friedrich Wöhler, 1800–1882. German chemist. Discovered beryllium and yttrium.
Crater (27 km/2050 m).

Zagut [32.0°S, 22.1°E] Abraham ben S. Zaguth, late 15th century. Spanish Jewish astronomer and astrologer.
Crater (84 km); *west of it is*
Zagut B (32 km/3410 m).







68

Rheita

The crater field situated along the southeastern limb of the Moon. It is intersected by a system of radial structures and valleys that are directed toward the center of the Nectaris basin. The long Rheita Valley especially deserves attention.

Brenner [39.0°S, 39.3°E] Leo Brenner, 1855–1928. Austrian amateur astronomer, observer of the Moon and the planets.
Greatly eroded crater (97 km).

Fabricius [42.9°S, 42.0°E] David Goldschmidt (known as Fabricius), 1564–1617. Amateur astronomer from East Friesland.
Prominent crater (78 km).

Janssen [44.9°S, 41.5°E] Pierre J. C. Janssen, 1824–1907. French astronomer. Became director of the Paris Observatory at Meudon in 1875.
Very large, old, degraded crater with a wide rille, ridges, etc., on its floor (190 km).

Mallet [45.4°S, 54.2°E] Robert Mallet, 1810–1881. Irish civil engineer and seismologist.
Crater (58 km) *adjacent to Vallis Rheita.*

Metius [40.4°S, 43.3°E] Adriaan Adriaanszoon (known as Metius), 1571–1635. Dutch mathematician and astronomer.
Crater (88 km).

Neander [31.3°S, 39.9°E] Michael Neumann, 1529–1581. German mathematician, physician, and astronomer.
Crater with central peaks (50 km/3400 m).

Peirescius [46.5°S, 67.6°E] Nicolas C. Fabri de Peiresc, 1580–1637. French natural historian and astronomer. Discovered the Great Nebula in Orion in 1610.
Crater (62 km).

Reimarus [47.7°S, 60.3°E] Nicolai Reymers Bär (or Ursus), d. 1600. German mathematician, professor of mathematics in Prague. Was charged with plagiarism for publishing a description of a planetary system very similar to that of Tycho Brahe.
Crater (48 km).

Rheita [37.1°S, 47.2°E] Anton Maria Schyrleus (Šírek) of Rheita, 1597–1660. Czech optician and astronomer; constructed Kepler's telescope. Prepared a map of the Moon.
Crater on the northern edge of Vallis Rheita (70 km); *crater valley* **Rheita E** (66 × 32 km).

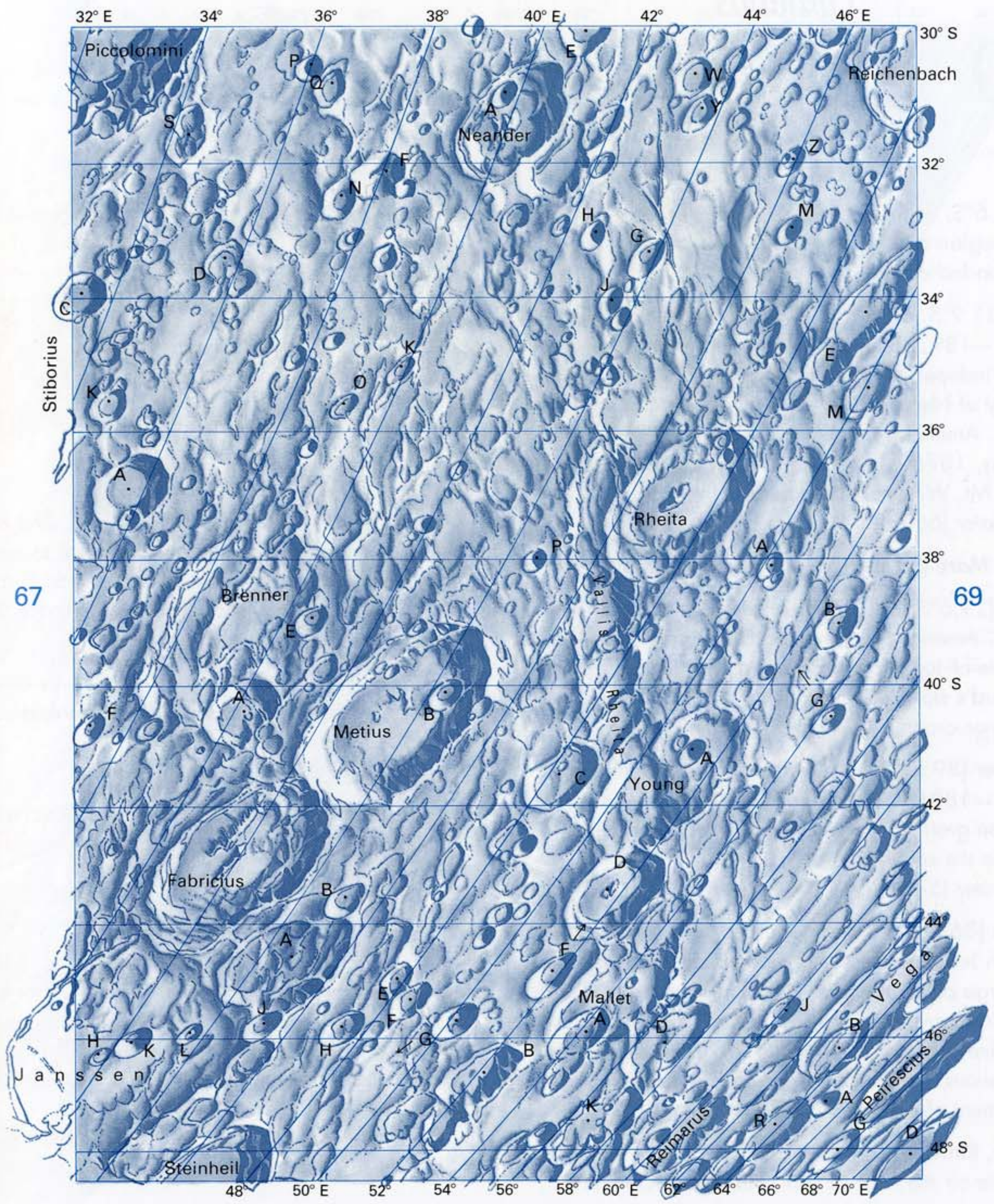
Rheita, Vallis (Rheita Valley) [42°S, 51°E]
The longest valley on the near side of the Moon, length about 500 km; character similar to that of Vallis Snellius (maps 59 and 69), *i.e., it is directed toward the center of the Nectaris basin and seems to share a common origin.*

Steinheil. See map 76.

Vega [45.4°S, 63.4°E] Georg F. von Vega, 1756–1802. German mathematician, author of accurate logarithmic tables.
Crater (76 km).

Young [41.5°S, 50.9°E] Thomas Young, 1773–1829. English physician, physicist, and universal natural scientist. Discovered the interference of light.
Crater (72 km).

58



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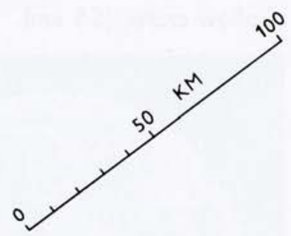
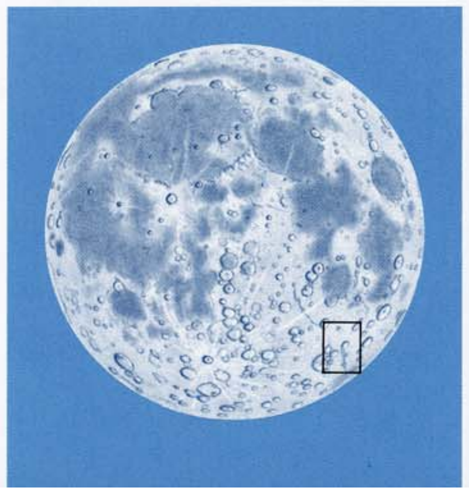




69

Furnerius

The southeastern limb of the Moon. Useful landmarks are the craters Stevinus, Furnerius, and Oken (with a dark floor). From the south Mare Australe extends into this area.

Abel [34.6°S, 85.8°E] Niels H. Abel, 1802–1829. Norwegian mathematician.
Flooded crater (114 km).

Adams [31.9°S, 68.2°E] (1) John Couch Adams, 1819–1892. English astronomer, made calculations, independently of Le Verrier, leading to the discovery of Neptune. (2) Charles H. Adams, 1868–1951. American amateur astronomer (3) Walter S. Adams, 1876–1956. American astronomer, director of Mt. Wilson Observatory.
Crater (66 km).

Australe, Mare (Southern Sea) See map 76.

Barnard [29.6°S, 86.4°E] Edward E. Barnard, 1857–1923. American astronomer. Discovered the fifth satellite of Jupiter; photographed the Galaxy. Barnard's star in Ophiuchus.
Large crater (100 km).

Fraunhofer [39.5°S, 59.1°E] Joseph von Fraunhofer, 1787–1826. German optician. Invented the diffraction grating, first to observe the Fraunhofer's lines in the solar spectrum.
Crater (57 km).

Furnerius [36.3°S, 60.4°E] Georges Furner, c. 1643. French Jesuit, professor of mathematics in Paris.
Large complex crater (125 km); **Furnerius A** *is a prominent crater with a ray system. Furnerius is part of a fine chain of craters with Langrenus, Vendelinus, and Petavius, which is a coincidental alignment of unrelated craters.*

Furnerius, Rima
Rille on the floor of Furnerius, length 50 km.

Gum [40.4°S, 88.6°E] Colin S. Gum, 1924–1960. Australian astronomer.
Flooded, shallow crater (55 km).

Hamilton [42.8°S, 84.7°E] Sir William R. Hamilton, 1805–1865. Irish mathematician.
Regular, deep crater (57 km).

Harlan (Marinus D) [38.5°S, 79.5°E] Harlan J. Smith, 1924–1991. American astronomer.
Crater, dark floor (65 km).

Hase, Rima [33°S, 66°E] Named after the crater Hase (map 59).
Wide, shallow rille, 300 km *long.*

Marinus [39.4°S, 76.5°E] Marinus of Tyre, 2nd century AD. Eminent Greek geographer, the first to point out that Asia and Africa might be larger than Europe and that the Roman Empire did not embrace the whole world.
Crater (58 km).

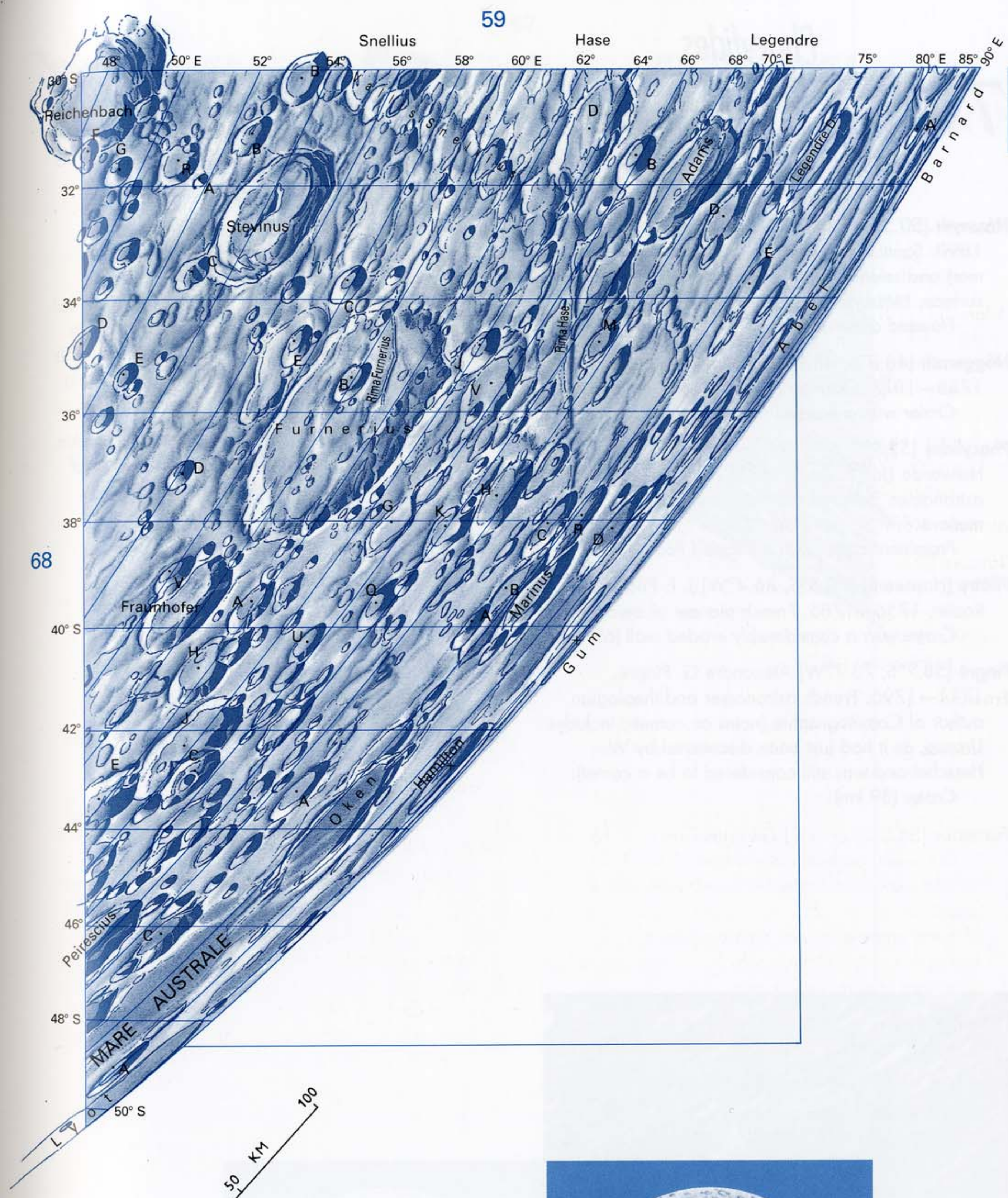
Oken [43.7°S, 75.9°E] Lorenz Oken (Okenfuss), 1779–1851. German naturalist.
Flooded crater, dark floor (72 km).

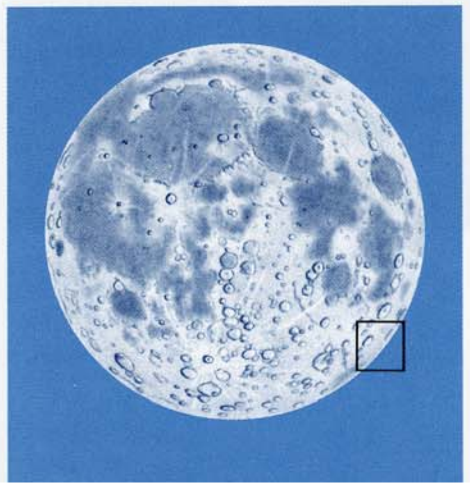
Reichenbach [30.3°S, 48.0°E] Georg von Reichenbach, 1772–1826. German maker of surveying and astronomical instruments.
Crater (71 km).

Snellius, Vallis
Continuation of a crater valley described on map 59.

Stevinus [32.5°S, 54.2°E] Simon Stevin, 1548–1620. Belgian-born mathematician, optician, soldier, and engineer.
Prominent complex crater with central peak (75 km); **Stevinus A** *is a very bright crater with a ray system.*

69





70 Phocylides

This area adjacent to the southwestern limb of the Moon includes an exceptionally interesting crater, Wargentin, which is filled with lava nearly up to its rim so that its floor forms a plateau. The crater Pingré is situated further south, close to the arcuate ridges adjacent to the Mendel-Rydberg basin (see map on p. 190).

Nasmyth [50.5°S, 56.2°W] James Nasmyth, 1808–1890. Scottish engineer (invented the steam hammer) and selenographer; made models of the lunar surface. Nasmyth telescope mounting.
Flooded crater (77 km).

Nöggerath [48.8°S, 45.7°W] Johann J. Nöggerath, 1788–1877. German geologist and mineralogist.
Crater with a flooded floor (31 km).

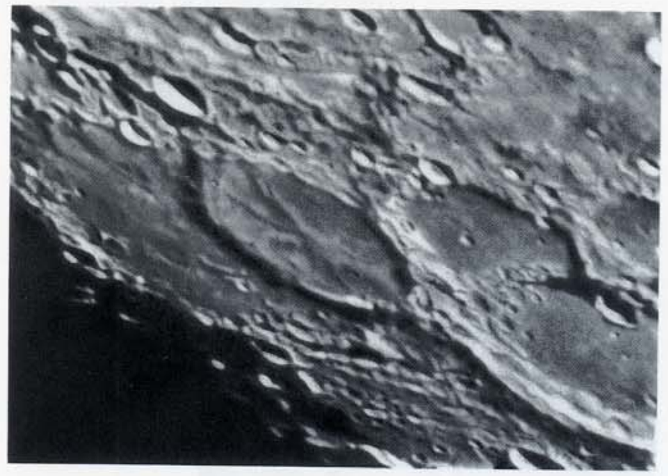
Phocylides [52.9°S, 57.3°W] Johannes Phocylides Holwarda (Jan Fokker), 1618–1651. Dutch astronomer. Believed that the stars had their own motions.
Prominent crater with a flooded floor (114 km).

Pilâtre (Hausen B) [60.3°S, 86.4°W] J. F. Pilâtre de Rozier, 1756–1785. French pioneer of aeronautics.
Crater with a considerably eroded wall (69 km).

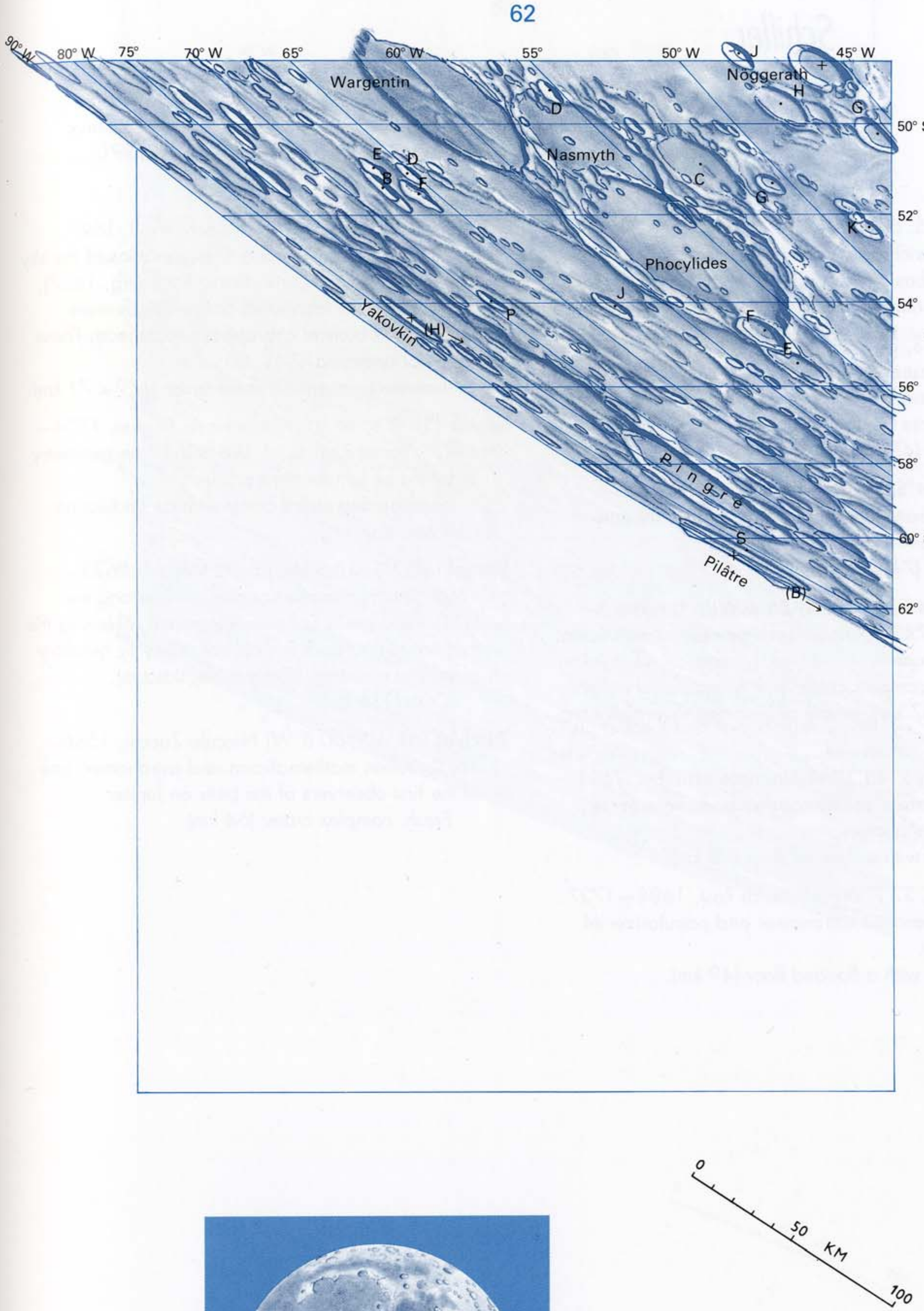
Pingré [58.7°S, 73.7°W] Alexandre G. Pingré, 1711–1796. French astronomer and theologian, author of Cométographie (notes on comets; includes Uranus, as it had just been discovered by W. Herschel and was still considered to be a comet).
Crater (89 km).

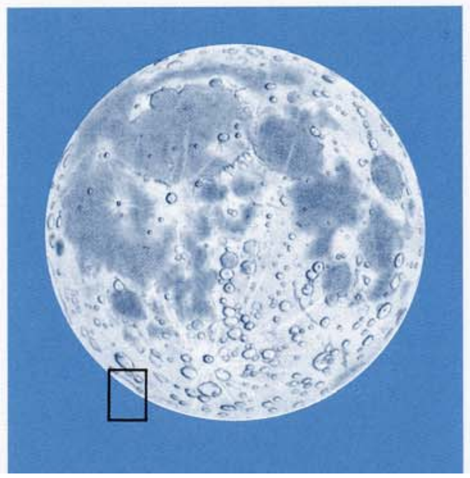
Wargentin [49.6°S, 60.2°W] Pehr V. Wargentin, 1717–1783. Swedish astronomer, director of Stockholm Observatory.
Very unusual crater, filled by a thick layer of volcanic material, with light-colored surface deposits (probably ejecta of Orientale basin); its diameter is 84 km and its raised floor has numerous low wrinkle ridges.

Yakovkin (Pingré H) [54.5°S, 78.8°W] A. A. Jakovkin, 1887–1974. Soviet astronomer. Investigation of the rotation and shape of the Moon.
Crater (37 km).



*At sunrise, the western edge of the crater **Wargentin**, which is filled to the rim with lava, is bordered by a prominent shadow.*





71 Schiller

This part of the southwestern limb of the Moon contains two basins; one of them is coincident with the crater Bailly, and the second, the 325-km-diameter Schiller-Zucchius basin, is situated between the craters Schiller, Zuchius, and Phocylides (see map 70).

Bailly [66.8°S, 69.4°W] Jean Sylvain Bailly, 1736–1793. French astronomer and politician.
Lunar basin 300 km *in diameter, degraded craterlike rim. Discontinuous inner ring.*

Bayer [51.6°S, 35.0°W] Johann Bayer, 1572–1625. German astronomer. Prepared the star atlas Uranometria, in which he introduced Greek letters to designate the stars.
Crater (47 km).

Bettinus [63.4°S, 44.8°W] Mario Bettini, 1582–1657. Italian philosopher, mathematician, and astronomer.
Crater (71 km).

Hausen [65.5°S, 88.4°W] Christian A. Hausen, 1693–1743. German astronomer, mathematician, and physicist.
Large complex crater with terraces and central peaks (167 km), *visible only during favorable librations.*

Kircher [67.1°S, 45.3°W] Athanasius Kircher, 1601–1680. German mathematician and professor of Oriental languages.
Crater with a flooded floor (73 km).

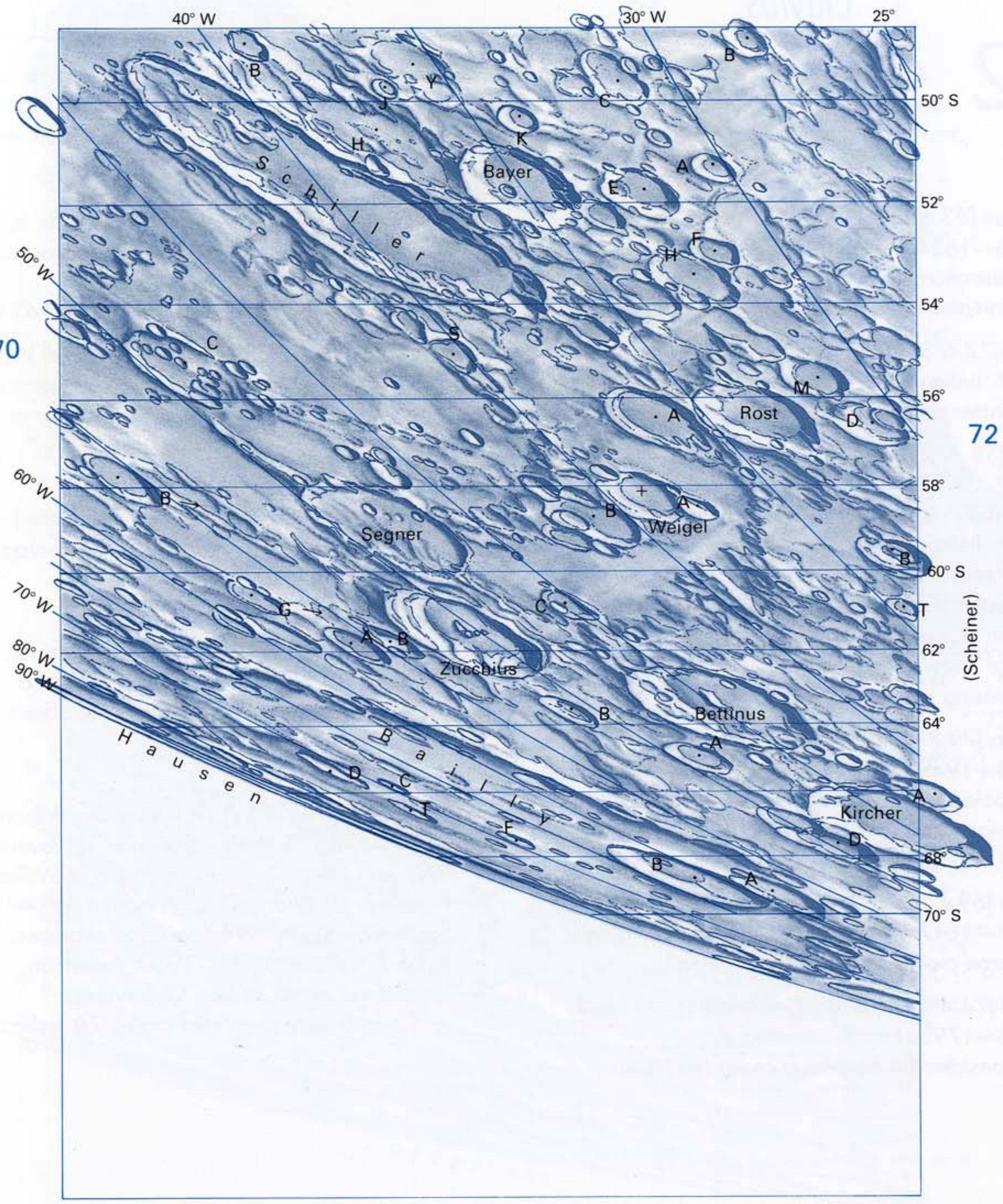
Rost [56.4°S, 33.7°W] Leonhardt Rost, 1688–1727. German amateur astronomer and popularizer of astronomy.
Crater with a flooded floor (49 km).

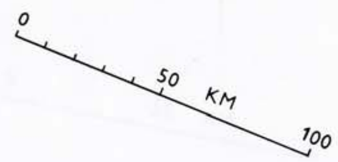
Schiller [51.8°S, 40.0°W] Julius Schiller, d. 1627. German monk, author of a Christian atlas of the sky (Coelum Stellarum Christianum, Augsburg, 1627), in which the old traditional constellations were replaced by biblical characters and objects. These were not accepted.
Anomalous, footprint-shaped crater (179 × 71 km).

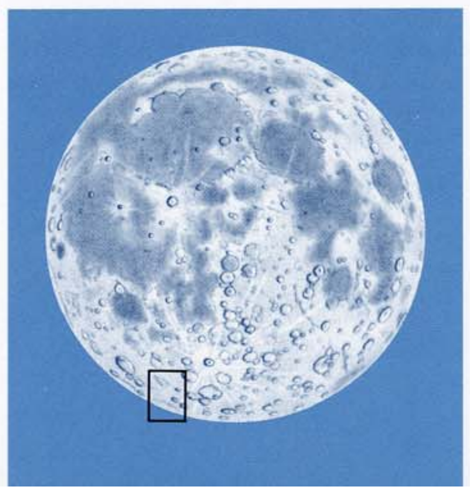
Segner [58.9°S, 48.3°W] Johann A. Segner, 1704–1777. German physicist. Worked on the geometry of solar and lunar eclipses.
Shallow, degraded crater with an undulating floor (67 km).

Weigel [58.2°S, 38.8°W] Erhard Weigel, 1625–1699. German mathematician and astronomer. In his Astronomia Spherica suggested replacing the traditional figures of the constellations by heraldry of various countries (Coelum Heraldicum).
Crater (36 km).

Zucchius [61.4°S, 50.3°W] Niccolo Zucchi, 1586–1670. Italian mathematician and astronomer, one of the first observers of the belts on Jupiter.
Fresh, complex crater (64 km).







Clavius

The mountainous limb area of the Moon adjacent to the south pole is densely covered by craters, including several large complex craters. The foreshortening close to the Moon's limb and the deep shadows make Earth-based observation and mapping of this region very difficult. This also applies to the limb regions on maps 73 and 74.

Blancanus [63.6°S, 21.5°W] Giuseppe Biancani, 1566–1624. Italian mathematician, geographer, and astronomer.
Complex crater (105 km).

Casatus [72.6°S, 30.5°W] Paolo Casati, 1617–1707. Italian theologian and mathematician.
Crater with flooded floor (111 km).

Clavius [58.4°S, 14.4°W] Christoph Klau, 1537–1612. German mathematician and astronomer, described as the "Euclid of the 16th century."
Very large crater, or crater-to-basin transition, with huge mountainous ring (225 km)*; small craters inside Clavius are suitable objects for testing the resolution of small telescopes. An interesting arcuate row of craters crosses the floor from Rutherfurd, decreasing in size: these are* **Clavius D, C, N, J, JA**.

Drygalski [79.7°S, 86.8°W] Erich D. von Drygalski, 1865–1949. German geographer, geophysicist, and polar explorer.
Large complex crater (163 km), *only partly visible during favorable librations.*

Klaproth [69.7°S, 26.0°W] Martin H. Klaproth, 1743–1817. German chemist and mineralogist.
Large crater, smooth floor (119 km).

le Gentil [74.4°S, 76.5°W] Guillaume H. le Gentil, 1725–1792. French astronomer.
Considerably degraded crater (113 km).

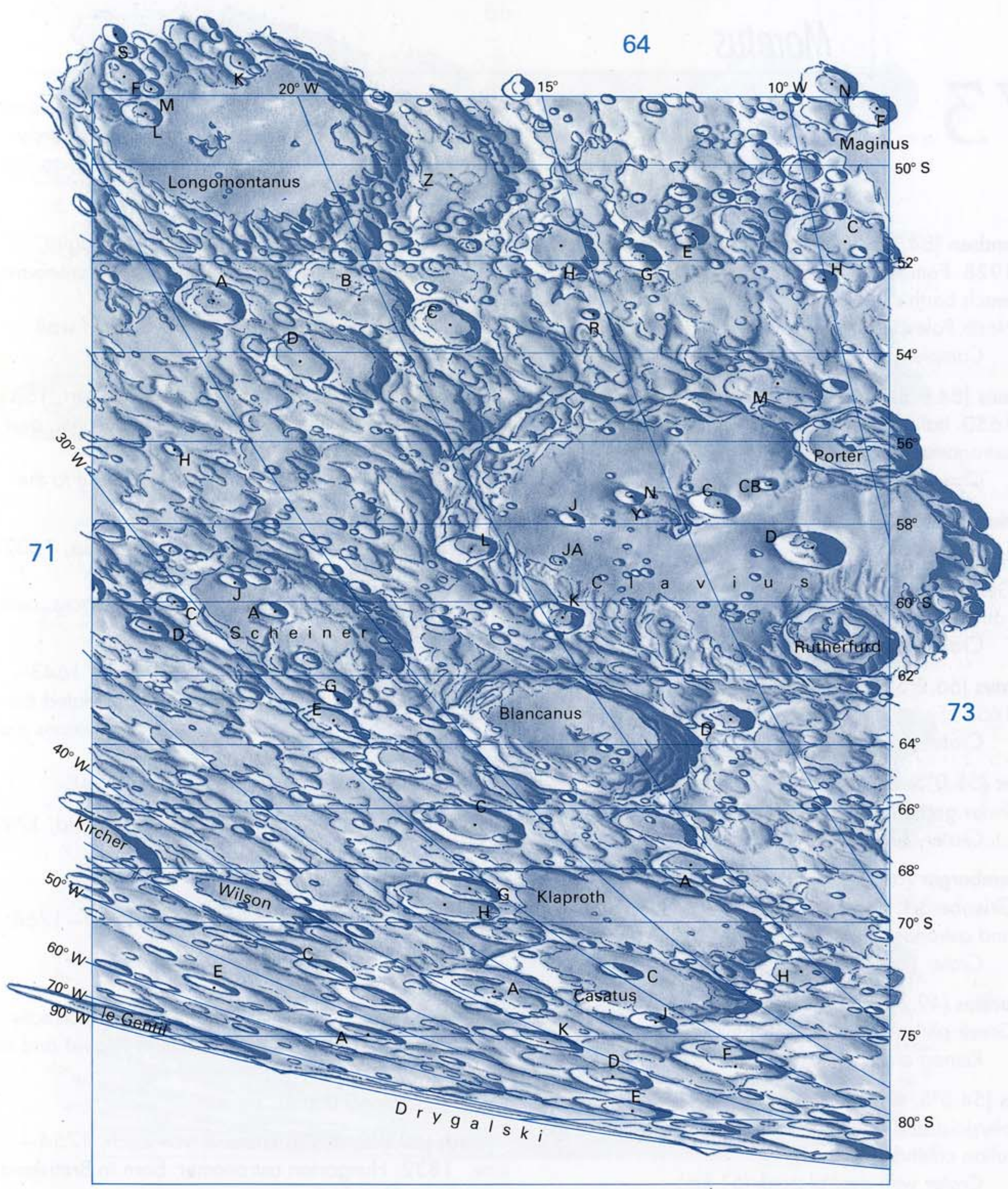
Longomontanus [49.5°S, 21.7°W] Christian S. Longomontanus, 1562–1647. Danish astronomer, assistant to Tycho Brahe.
Large complex crater with mare fill (145 km).

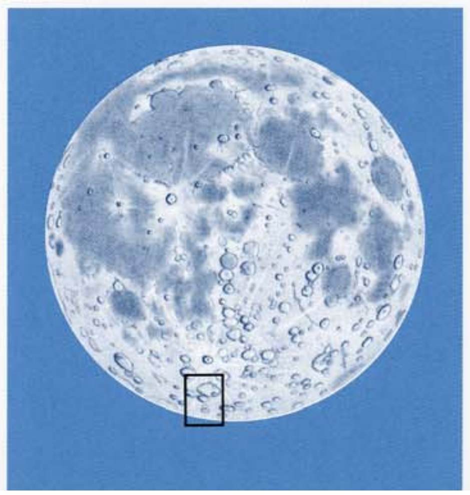
Porter (Clavius B) [56.1°S, 10.1°W] Russell W. Porter, 1871–1949. American architect; designer of large telescopes, including the 5-meter reflector at Palomar Observatory.
Crater (52 km).

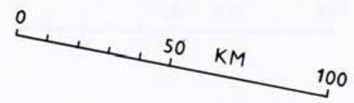
Rutherfurd [60.9°S, 12.1°W] Lewis M. Rutherfurd, 1816–1892. American astronomer. Photography of the Sun and Moon.
Crater (48 × 54 km).

Scheiner [60.5°S, 27.8°W] Christoph Scheiner, 1575–1650. German mathematician and astronomer. Made the first systematic observations of the Sun.
Crater (110 km).

Wilson [69.2°S, 42.4°W] (1) Alexander Wilson, 1714–1786. Scottish astronomer, discoverer of the "Wilson's Effect" in sunspots; friend of William Herschel. (2) Charles T. R. Wilson, 1869–1959. Scottish physicist. "Wilson's cloud chamber." (3) Ralph E. Wilson, 1886–1960. American astronomer at Mt. Wilson Observatory.
Considerably degraded crater (70 km).







73 Moretus

The south pole of the Moon lies in the center of the bottom edge of the map. Earth-based observation of the area close to the pole is very difficult, and some parts are constantly hidden behind hills and crater walls. The Clementine space probe mapped this region first time in detail (1994). (See the maps of libration zones V and VI.)

Amundsen [84.5°S, 82.8°E] Roald Amundsen, 1872–1928. Famous Norwegian polar explorer. First to reach Earth's South Pole (1911); flew across the North Pole (1928).
Complex crater (105 km).

Cabeus [84.9°S, 35.5°W] Niccolo Cabeo, 1586–1650. Italian mathematician, philosopher, and astronomer.
Crater (about 98 km*)*.

Clavius. See map 72.

Curtius [67.2°S, 4.4°E] Albert Curtz, 1600–1671. German astronomer. Published Tycho Brahe's observations.
Crater (95 km).

Cysatus [66.2°S, 6.1°W] Jean-Baptiste Cysat, 1588–1657. Swiss mathematician and astronomer.
Crater (49 km).

Deluc [55.0°S, 2.8°W] Jean A. Deluc, 1727–1817. Swiss geologist and physicist.
Crater (47 km).

Gruemberger [66.9°S, 10.0°W] Christopher Grienberger, 1561–1636. Austrian mathematician and astronomer.
Crater (94 km).

Heraclitus [49.2°S, 6.2°E] Heracleitus, c. 540–480 BC. Greek philosopher of Ephesus.
Ruined crater with an inner ridge (90 km).

Lilius [54.5°S, 6.2°E] Luigi Giglio, d. 1576. Italian physicist and philosopher. Suggested reform of the Julian calendar.
Crater with central peak (61 km).

Maginus [50.0°S, 6.2°W] Giovanni A. Magini, 1555–1617. Italian mathematician, astronomer, and astrologer.
Large, conspicuous crater, degraded wall (163 km).

Malapert [84.9°S, 12.9°E] Charles Malapert, 1581–1630. Belgian mathematician, philosopher, and astronomer.
Degraded crater (about 69 km*) close to the south pole.*

Moretus [70.6°S, 5.5°W] Théodore Moretus, 1602–1667. Belgian mathematician.
Fresh, beautiful complex crater, terraces, central peak (114 km).

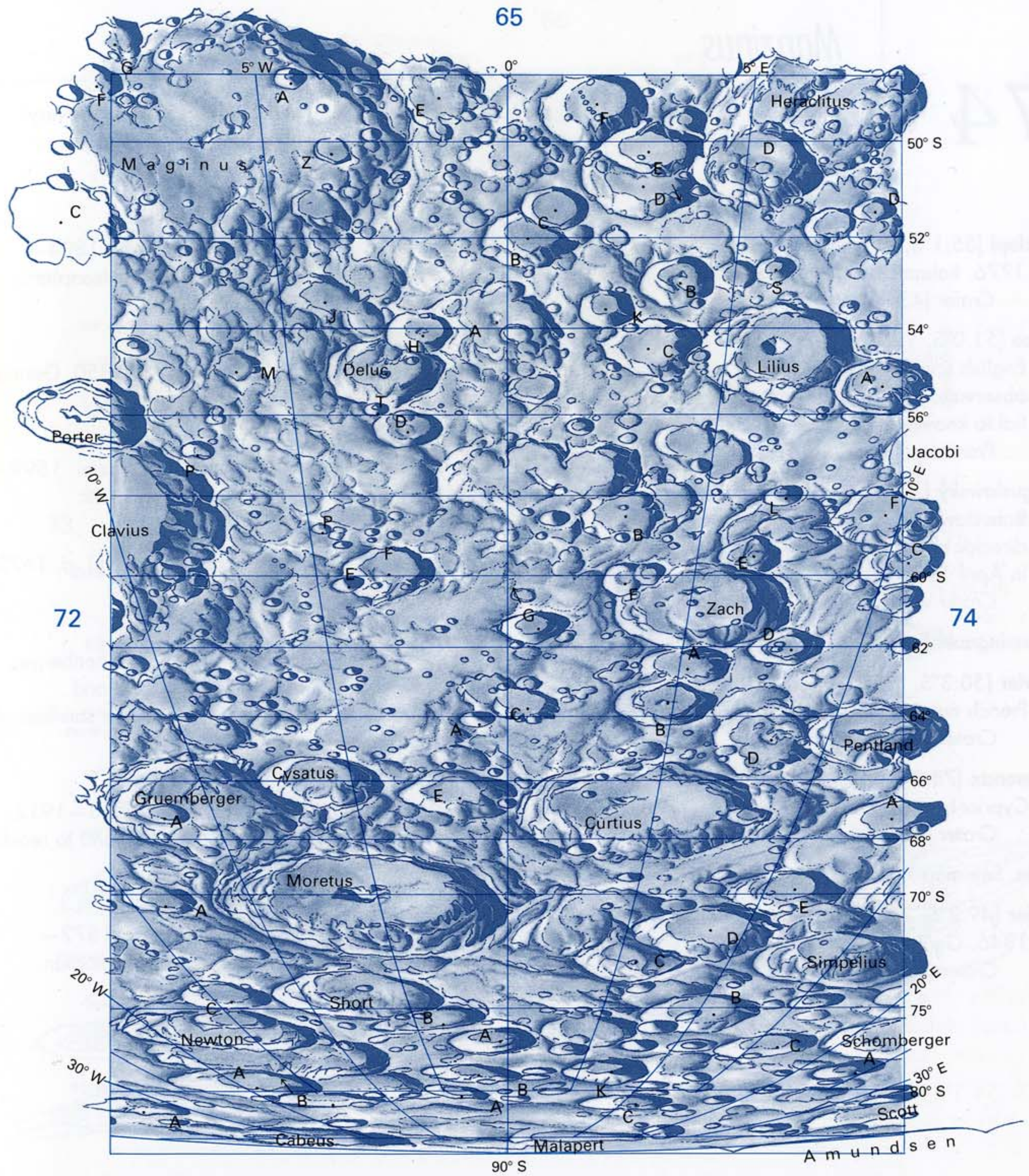
Newton [76.7°S, 16.9°W] Isaac Newton, 1643–1727. Famous English physicist. Formulated the laws of gravitation and the theory of fluxions (calculus); also experimented with optics.
Crater (79 km).

Pentland [64.6°S, 11.5°E] Joseph B. Pentland, 1797–1873. Irish politician and geographer.
Crater (56 km).

Short [74.6°S, 7.3°W] James Short, 1710–1768. Scottish mathematician and optician.
Crater (71 km).

Simpelius [73.0°S, 15.2°E] Hugh Sempil (correctly Sempilius), 1596–1654. Scottish linguist and mathematician.
Crater (70 km).

Zach [60.9°S, 5.3°E] Franz X. von Zach, 1754–1832. Hungarian astronomer, born in Bratislava (now Slovakia).
Crater (71 km).



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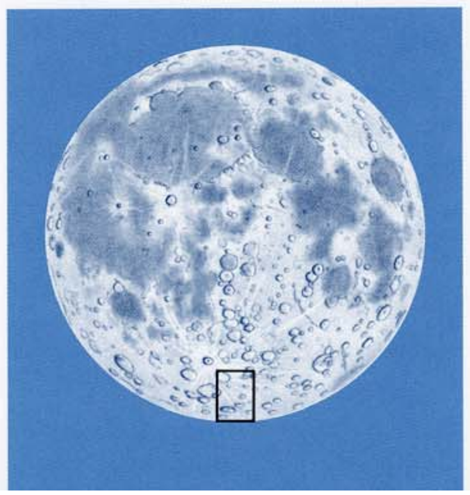


74 Manzinus

The limb of the Moon east of the South Polar Region. The crater field in this area is very dense and chaotic. The pair of craters Mutus and Manzinus make orientation easier.

Asclepi [55.1°S, 25.4°E] Giuseppe Asclepi, 1706–1776. Italian Jesuit, astronomer, and physicist.
Crater (43 km).

Baco [51.0°S, 19.1°E] Roger Bacon, 1214–1294. English scientist and Franciscan friar. Asserted that observational and experimental methods are essential to knowledge.
Prominent crater (70 km).

Boguslawsky [72.9°S, 43.2°E] Palon H. Ludwig von Bohuslawski, 1789–1851. German astronomer, director of Breslau Observatory. Discovered a comet in April 1835.
Crater with a flooded floor (97 km).

Boussingault. See map 75.

Cuvier [50.3°S, 9.9°E] Georges Cuvier, 1769–1832. French naturalist and paleontologist.
Crater with a flooded floor (75 km).

Demonax [78.2°S, 59.0°E] Demonax, 2nd century BC. Cypriot-born Greek philosopher.
Crater (114 km).

Hale. See map 75.

Ideler [49.2°S, 22.3°E] Christian L. Ideler, 1766–1846. German chronologist.
Crater (39 km).

Jacobi [56.7°S, 11.4°E] Karl G. J. Jacobi, 1804–1851. German mathematician and philosopher. Invented the "Jacobian functions."
Crater (68 km).

Kinau [60.8°S, 15.1°E] C. A. Kinau, c. 1850. German botanist and selenographer.
Crater (42 km).

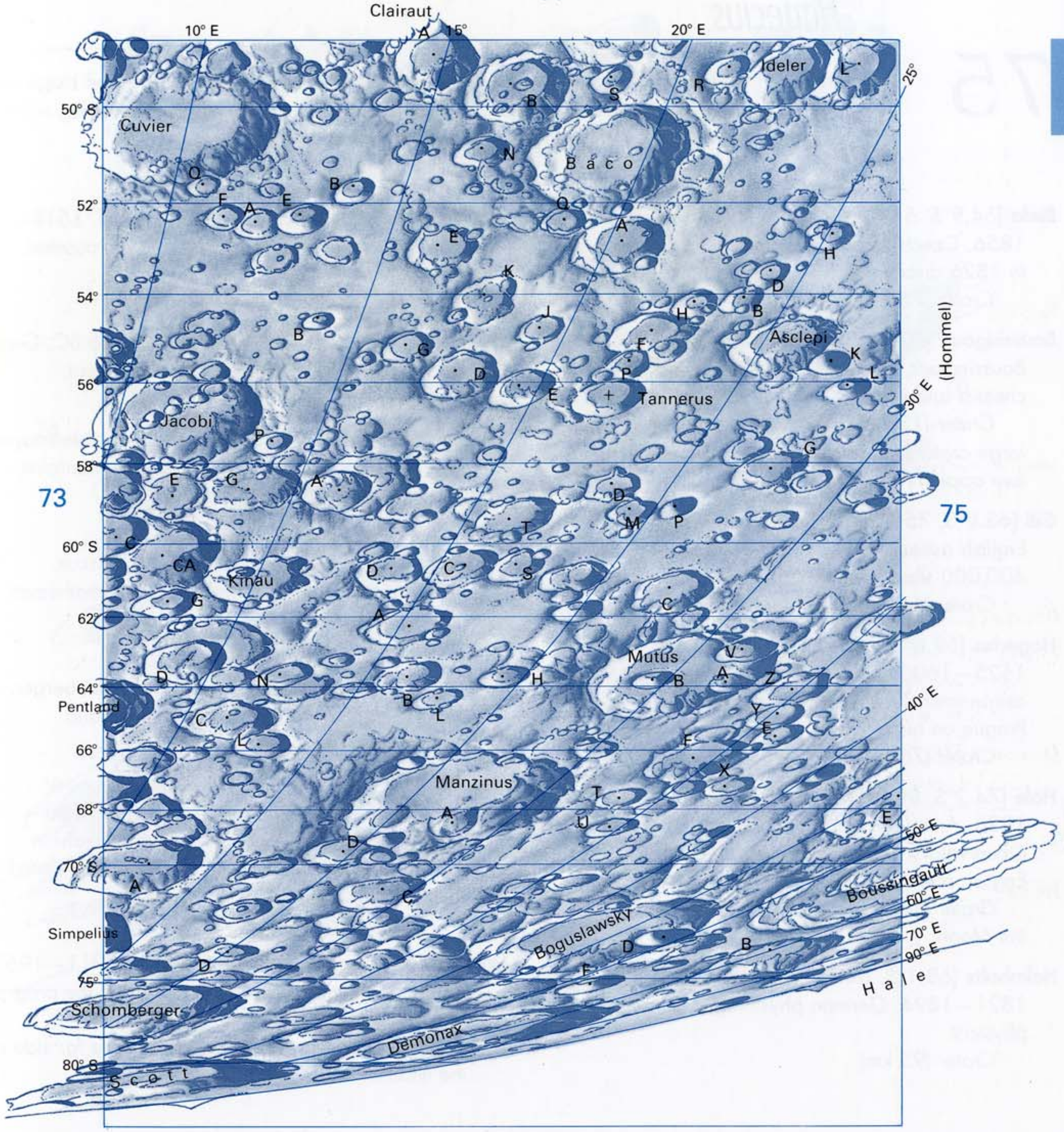
Manzinus [67.7°S, 26.8°E] Carlo A. Manzini, 1599–1677. Italian philosopher and astronomer.
Crater with a flooded floor (98 km).

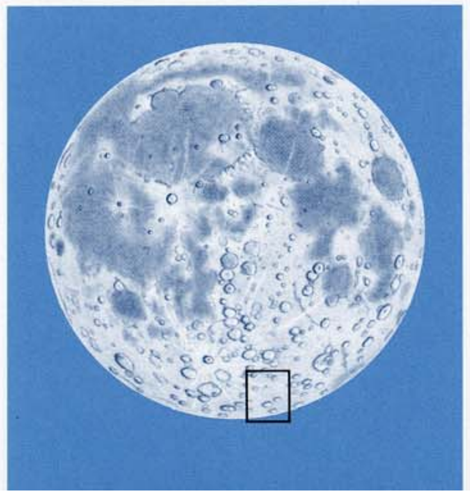
Mutus [63.6°S, 30.1°E] Vincente Mut (Muth), d. 1673. Spanish astronomer and navigator.
Crater (78 km).

Schomberger [76.7°S, 24.9°E] Georg Schoenberger, 1597–1645. Austrian mathematician and astronomer. Believed that sunspots were satellites of the Sun (stellae solares).
Crater (85 km).

Scott [81.9°S, 45.3°E] Robert F. Scott, 1868–1912. English polar explorer. He was the second to reach Earth's South Pole.
Crater with a ruined wall (108 km).

Tannerus [56.4°S, 22.0°E] Adam Tanner, 1572–1632. Austrian mathematician and theologian.
Crater with a sharp rim (29 km).





75

Hagecius

A part of the southeastern limb of the Moon with a group of large craters around Hagecius. Useful for orientation in this crater field is the crater Hommel, which is an interesting sight since it features several small craters on its wall.

Biela [54.9°S, 51.3°E] Wilhelm von Biela, 1782–1856. Czech-born Austrian soldier and astronomer. In 1826 discovered Biela's comet.
Crater (76 km).

Boussingault [70.4°S, 54.7°E] Jean-Baptiste Boussingault, 1802–1887. French agricultural chemist and botanist.
Crater (131 km)*; inside the formation is the large crater* **Boussingault A***, so that the whole feature appears as a crater with a double wall.*

Gill [63.9°S, 75.9°E] Sir David Gill, 1843–1914. English astronomer. Compiled a catalog of about 400,000 stars, measured the distances of 22 stars.
Crater (66 km).

Hagecius [59.8°S, 46.6°E] Tadeus Hajek of Hajek, 1525–1600. Czech naturalist, mathematician, and astronomer. Tycho Brahe and Kepler were invited to Prague on his advice.
Crater (76 km).

Hale [74.2°S, 90.8°E] (1) George E. Hale, 1868–1938. American astronomer, director of Mt. Wilson Observatory. (2) William Hale, 1797–1870. English scientist in the field of rocket technology.
Crater (84 km)*, stretching over to the far side of the Moon.*

Helmholtz [68.1°S, 64.1°E] Hermann von Helmholtz, 1821–1894. German physiologist, surgeon, and physicist.
Crater (95 km).

Hommel [54.6°S, 33.0°E] Johann Hommel, 1518–1562. German mathematician and astronomer, teacher of Tycho Brahe.
Crater (125 km).

Nearch [58.5°S, 39.1°E] Nearchus, c. 325 BC. Greek commander, friend of Alexander the Great.
Crater (76 km).

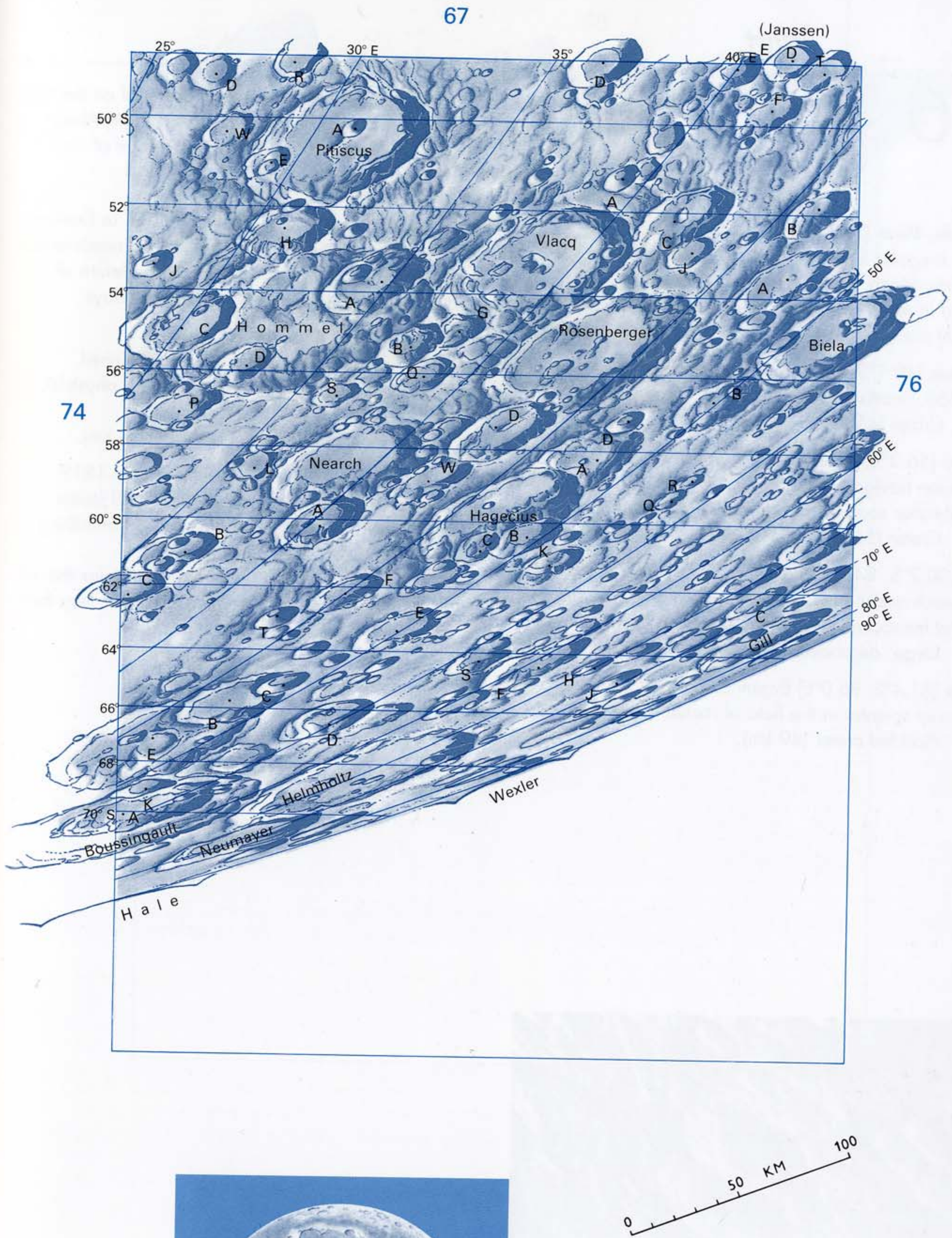
Neumayer [71.1°S, 70.7°E] Georg B. von Neumayer, 1826–1909. German meteorologist, naturalist, and explorer.
Crater (76 km).

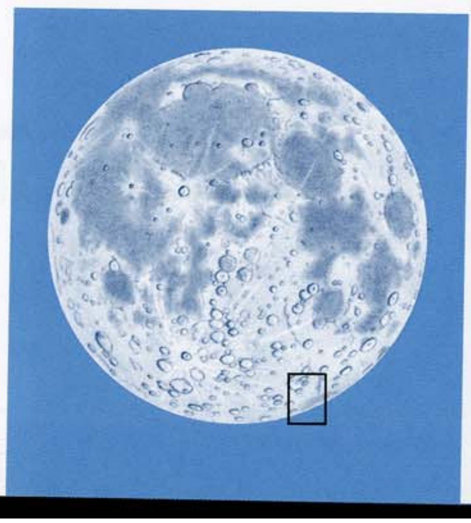
Pitiscus [50.4°S, 30.9°E] Bartholomäus Pitiscus, 1561–1613. German theologian and mathematician.
Prominent crater (82 km).

Rosenberger [55.4°S, 43.1°E] Otto A. Rosenberger, 1800–1890. German mathematician and astronomer.
Crater (96 km).

Vlacq [53.3°S, 38.8°E] Adriaan Vlacq, c. 1600–1667. Dutch bookseller and mathematician. In 1628, he published logarithmic tables calculated to ten decimal places.
Prominent crater (89 km).

Wexler [69.1°S, 90.2°E] Harry Wexler, 1911–1962. American meteorologist. He elaborated the program of weather satellites.
Crater (52 km)*, stretching over to the far side of the Moon.*





Watt

The southeastern limb of the Moon. The numerous dark patches of mare material on the limb form Mare Australe. As determined from photographs taken by the Lunar Orbiters, Mare Australe is circular with a diameter of about 900 km. From an evolutionary point of view, it is evidently a very old lunar basin.

Australe, Mare (Southern Sea) [46°S, 91°E]
Irregular lunar mare that stretches to the far side of the Moon; its surface area is 151,000 sq km and in many places it is covered by craters and light plains.

Brisbane [49.1°S, 68.5°E] Sir Thomas Brisbane, 1770–1860. Scottish soldier, politician, and astronomer.
Crater (45 km).

Hanno [56.3°S, 71.2°E] Hanno, c. 500 BC. Carthaginian navigator, who sailed through the Straits of Gibraltar southward to the West African coast.
Crater (56 km).

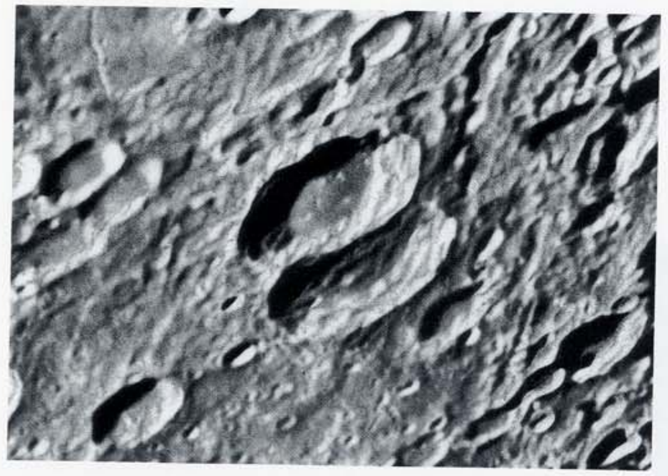
Lyot [50.2°S, 84.1°E] Bernard F. Lyot, 1897–1952. French astronomer. Invented the solar coronograph and monochromatic polarizing filter (Lyot filter).
Large, degraded, mare-filled crater (141 km).

Petrov [61.4°S, 88.0°E] Evgeni S. Petrov, 1900–1942. Soviet scientist in the field of rocket technology.
Flooded crater (49 km).

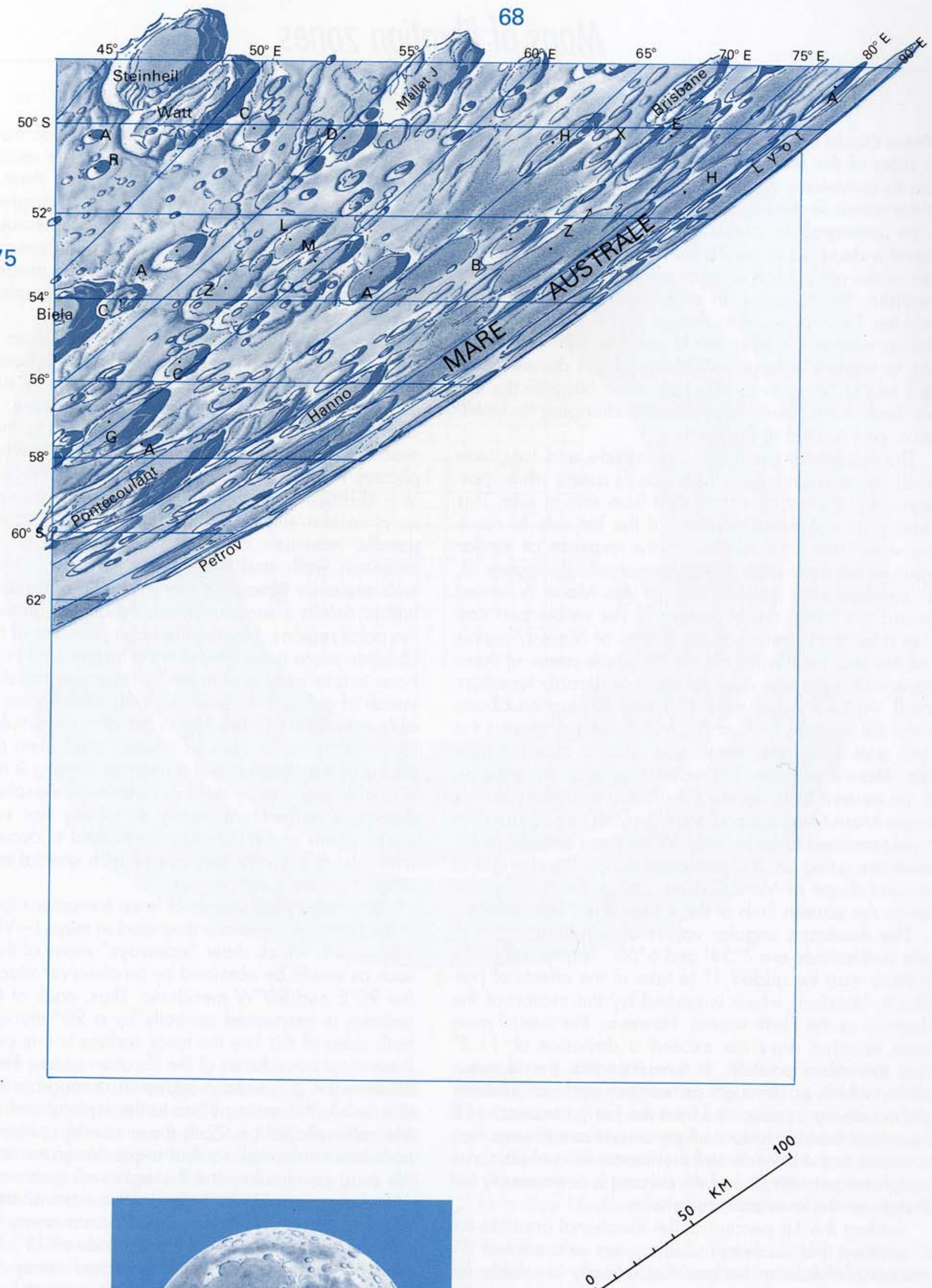
Pontécoulant [58.7°S, 66.0°E] Philippe G. Le Doulcet, comte de Pontécoulant, 1795–1874. French mathematician and astronomer. Forecast the return of Halley's comet in 1835 to within three days.
Prominent crater (91 km).

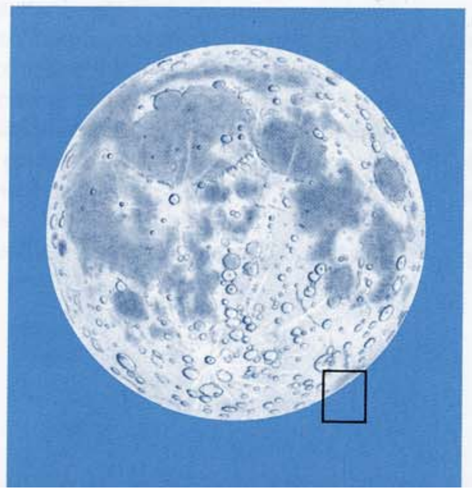
Steinheil [48.6°S, 46.5°E] Karl A. von Steinheil, 1801–1870. German mathematician, physicist, optician, and astronomer.
Prominent crater with a flat floor (67 km).

Watt [49.5°S, 48.6°E] James Watt, 1736–1819. Scottish engineer. Invented the improved steam engine. Watt's governor was used for controlling the mechanical drives of telescopes.
Crater (66 km); *the western wall adjoins that of the neighboring crater Steinheil. Together they form a prominent pair of large craters.*



The conspicuous pair of large craters **Steinheil** *and* **Watt** *is a good example for an estimation of the relative age of lunar formations. Watt is older because part of its wall is overlapped by Steinheil.*





Maps of libration zones

Where should the boundary that separates the near and far sides of the Moon be drawn? We can do no better than to commence with the meridians 90°E and 90°W, which constitute the edge of the lunar disk as it is drawn in an orthographic projection of the near side. This aspect is depicted in the 76 sections that form the major part of this atlas. Such an approach, however, is far too simplistic, for it means, in effect, that the area visible from the Earth is equal to that of the invisible far side, and, as we noted earlier, this is certainly not the case! In fact, to see an "orthogonal" Moon as it is drawn in the atlas would be an extremely rare event because the visible lunar hemisphere is continually changing its orientation with respect to the Earth.

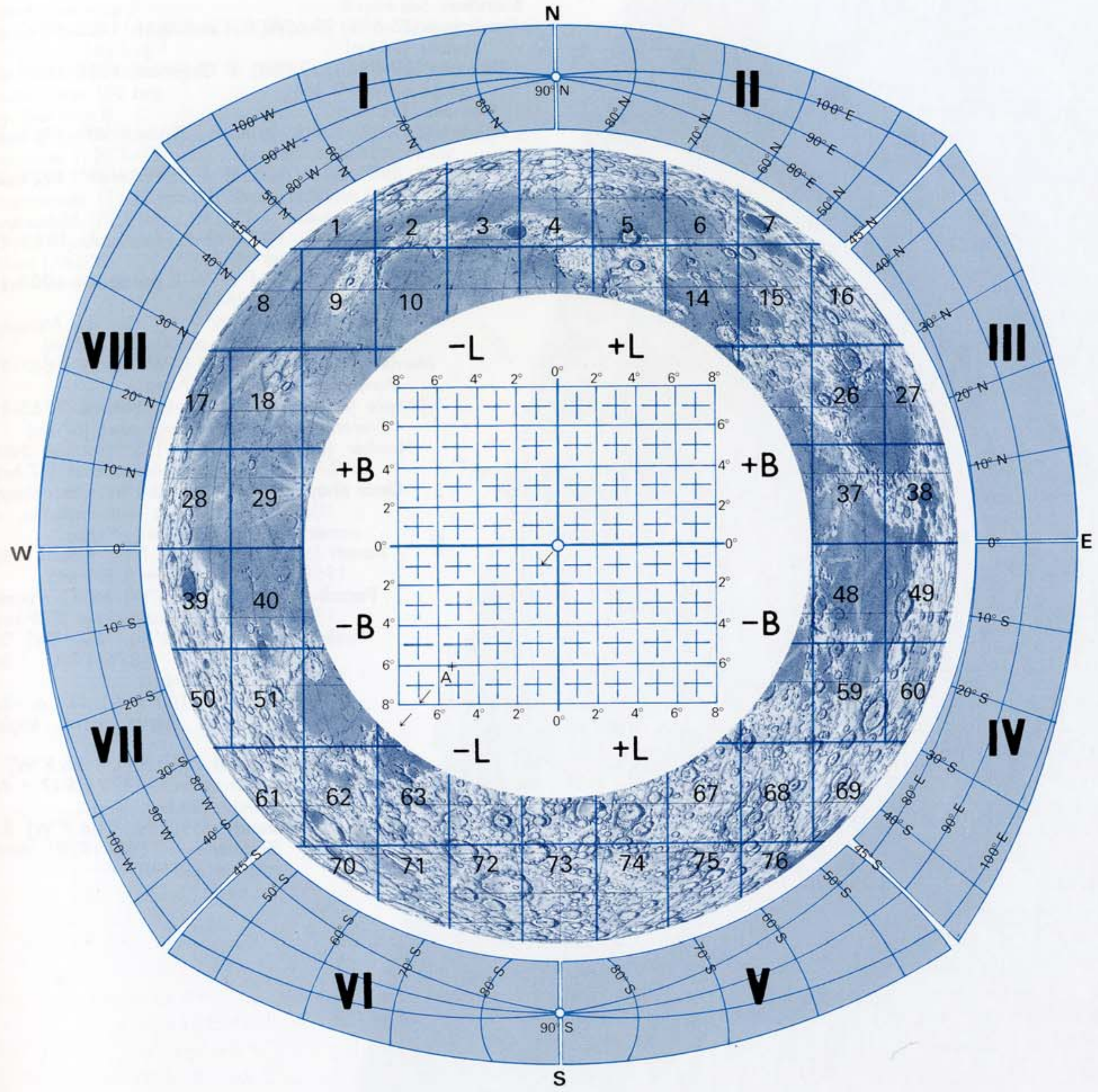
The librational oscillations in latitude and longitude (p. 8) create a lunar face that nods its assent while, paradoxically, dissentingly shaking it from side to side. This effect causes slender crescents of the far side to come into view from time to time at the expense of similar areas of the near side, which temporarily disappear. If, for example, the eastern limb of the Moon is turned toward the Earth, the boundary of the visible part can slide over to the very eastern shores of Mare Marginis and Mare Smythii, and almost the whole areas of these maria will come into view (albeit considerably foreshortened). As one would expect, a similar situation occurs when the western limb of the Moon swings toward the Earth and brings into view, onto what is then the near side, Mare Orientale. This advantage is at the expense of the eastern limb, where the limiting boundary moves across Mare Marginis and Mare Smythii, which are then mainly confined to the far side. While these extreme movements are going on, it is instructive to note the changes in the oval shape of Mare Crisium and its position in relation to the eastern limb of the visible lunar hemisphere.

The maximum angular values of librations in longitude and latitude are 7°54′ and 6°50′, respectively, and to these must be added 1° to take in the effects of parallactic libration, which is caused by the motion of the observer as the Earth rotates. However, the overall maximum libration does not exceed a deviation of 11.5° from the mean position. It turns out that the libration zones, which go through an endless cycle of visibility and invisibility as observed from the Earth, amount to 18 percent of the total lunar surface area. From this we may conclude that 41 percent of the near side is always visible (phase permitting) and 41 percent is permanently out of sight on the averted hemisphere.

Adding the 18 percent of the librational areas to the 41 percent that is always visible gives us a total of 59 percent of the lunar surface theoretically available for observation from the Earth. In practice, however, the peripheral areas are extremely difficult to observe with Earth-based telescopes, so the theoretical 59 percent has to be reduced to approximately 50 percent in practice. This is confirmed by the efforts of generations of selenographers, who attempted to map the libration zones. All maps before 1967 are unreliable in the vicinities of meridians 90°E and 90°W, and beyond them, in the librational "crescents" of the far-side hemisphere, the mapping is incomplete and subject to numerous errors. Fortunately, our knowledge of the libration zones is now much better, thanks to imaging from space probes, starting with the Lunar Orbiters in 1960s and completing the coverage with Clementine's images in 1994.

Why are observations of the libration zones so difficult? First of all, the geometrical determinations of the boundaries of these zones are based on a simplified assumption that the Moon is a smooth sphere; anyone can see that it is definitely not so! Added to this is the problem of perspective, or foreshortening, which complicates the interpretation of observations. For example, in a libration zone the rim of a circular crater appears as a narrow ellipse — or are they two disconnected, parallel mountain ridges? Countless numbers of high mountain walls and ridges add their confusion in the limb areas by obscuring more remote landscapes, and further details disappear into the shadows, especially in the polar regions. No, the life of an observer of the lunar libration areas is sometimes not a happy one! Finally, we have to take into account the fact that a successful observation of a libration zone depends not only on a favorable orientation of the Moon but also on suitable solar illumination in the area of interest. And even then, the efforts of the observer will amount to nothing if he or she is troubled by cloudy skies or turbulent atmospheric conditions. It is therefore hardly surprising that successful observations of the libration zones tend to occur at rare intervals; this is why they are of such special interest to diligent amateur astronomers.

The undistorted shapes of lunar formations lying within the libration zones are illustrated in maps I—VIII on pp. 182—189, which show "sideways" views of the Moon, such as would be obtained by an observer situated over the 90°E and 90°W meridians. Thus, each of the eight sections is intersected centrally by a 90° meridian. On both sides of this line the lunar surface is mapped to the theoretical boundaries of the libration zones. The sectors close to the poles are mapped in stereographic projection, while the sectors close to the equator are drawn in Mercator projection. Both these cartographical projections are conformal, so that a circular crater is seen on the map as circular, but the scales of such maps vary with selenographic latitude. In the case of the stereographic projection, the scale increases away from the poles to (in this case) a limiting latitude of 45°. The scale of the Mercator projection increases away from the equator to meet the polar projection maps at latitudes of +45° and –45°. These changes in scale result in some distortions, particularly in those areas close to selenographic latitudes +45° and –45°, where individual areas have to be depicted larger than they really are.

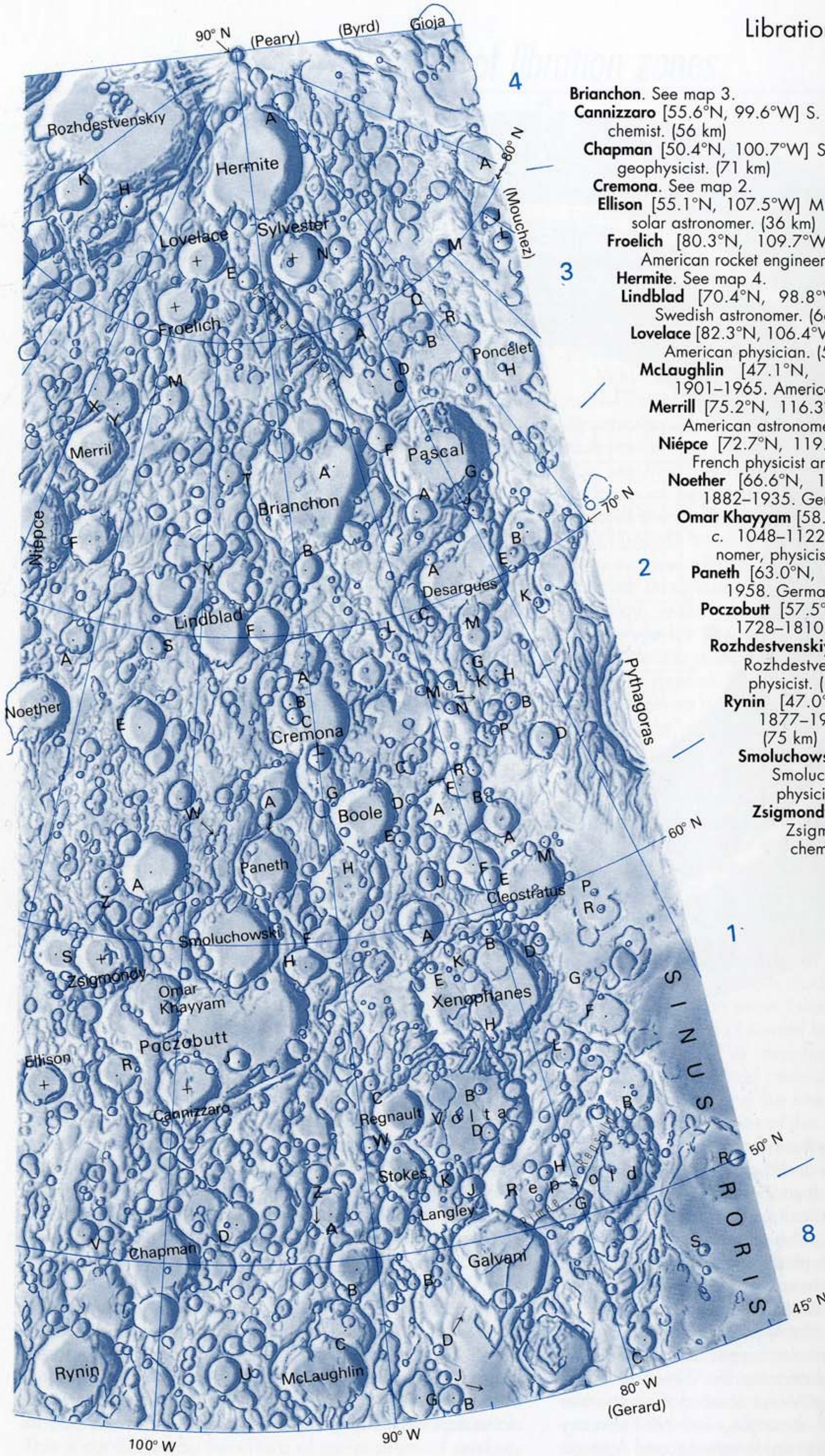


Explanatory note

The above diagram shows the relationship between the maps of the libration zones and the map of the near side of the Moon in 76 sections (pp. 29—179). The identities of adjacent maps to a particular map are indicated by numbers along the edges. The nomenclature uses the names that have been adopted in recent years by the IAU for formations in those areas that lie beyond the 90° meridians, in the direction of the far-side hemisphere.

The central diagram facilitates the selection of maps according to the librations in longitude, **L**, and latitude, **B**. Its purpose is to determine the direction of the maximum inclination of the Moon toward the observer for a given libration. For example, on 24 February 1986 the values of libration in longitude and latitude were: L = –5.2° and B = –6.0°. These coordinates, transferred to the diagram, define the position of point A. The line connecting the center of the diagram with point A indicates the southwestern limb of the Moon (sections VI and VII). In this specific case, full Moon occurred on 24 February, thus providing ideal illumination at the time of favorable libration for observations of the sections VI and VII.

The libration constants (L, B) are usually published in astronomical almanacs, along with details of the illumination of the Moon for each day of the year. Also, many computer programs offer the necessary observational data. These enable the observer to anticipate those dates that would be particularly favorable for librational studies.



Libration Zone I. **BRIANCHON**

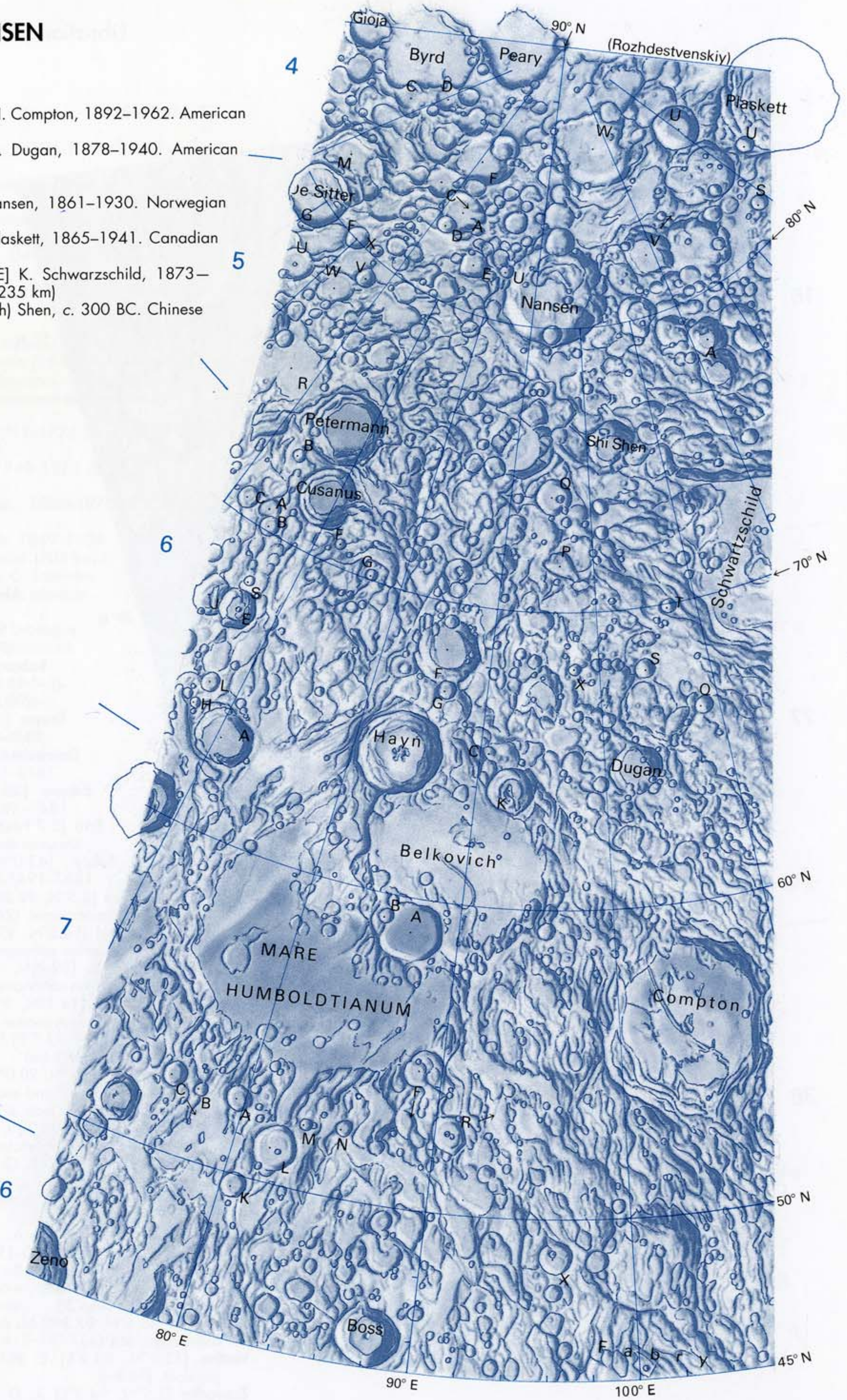
North-northwestern sector

Brianchon. See map 3.
Cannizzaro [55.6°N, 99.6°W] S. Cannizzaro, 1826–1910. Italian chemist. (56 km)
Chapman [50.4°N, 100.7°W] S. Chapman, 1888–1970. British geophysicist. (71 km)
Cremona. See map 2.
Ellison [55.1°N, 107.5°W] M. A. Ellison, 1909–1963. British solar astronomer. (36 km)
Froelich [80.3°N, 109.7°W] J. E. Froelich, 1921–1967. American rocket engineer. (58 km)
Hermite. See map 4.
Lindblad [70.4°N, 98.8°W] B. Lindblad, 1895–1965. Swedish astronomer. (66 km)
Lovelace [82.3°N, 106.4°W] W. R. Lovelace II, 1907–1965. American physician. (54 km)
McLaughlin [47.1°N, 92.9°W] D. B. McLaughlin, 1901–1965. American astronomer. (79 km)
Merrill [75.2°N, 116.3°W] P. W. Merrill, 1887–1961. American astronomer. (57 km)
Niépce [72.7°N, 119.1°W] N. Niépce, 1765–1833. French physicist and photographer. (57 km)
Noether [66.6°N, 113.5°W] E. Noether (Nöther), 1882–1935. German mathematician. (67 km)
Omar Khayyam [58.0°N, 102.1°W] Omar Khayyam, *c.* 1048–1122. Persian mathematician, astronomer, physicist, and poet. (70 km)
Paneth [63.0°N, 94.8°W] F. A. Paneth, 1887–1958. German geochemist. (65 km)
Poczobutt [57.5°N, 99.3°W] M. O. Poczobutt, 1728–1810. Polish astronomer. (209 km)
Rozhdestvenskiy [85.8°N, 159.1°W] D. S. Rozhdestvenskiy, 1876–1940. Soviet physicist. (178 km)
Rynin [47.0°N, 103.5°W] N. A. Rynin, 1877–1942. Soviet rocket engineer. (75 km)
Smoluchowski [60.3°N, 96.8°W] M. Smoluchowski, 1872–1917. Polish physicist. (83 km)
Zsigmondy [59.7°N, 104.7°W] R. A. Zsigmondy, 1865–1929. Austrian chemist. (65 km)

Libration Zone II. **NANSEN**

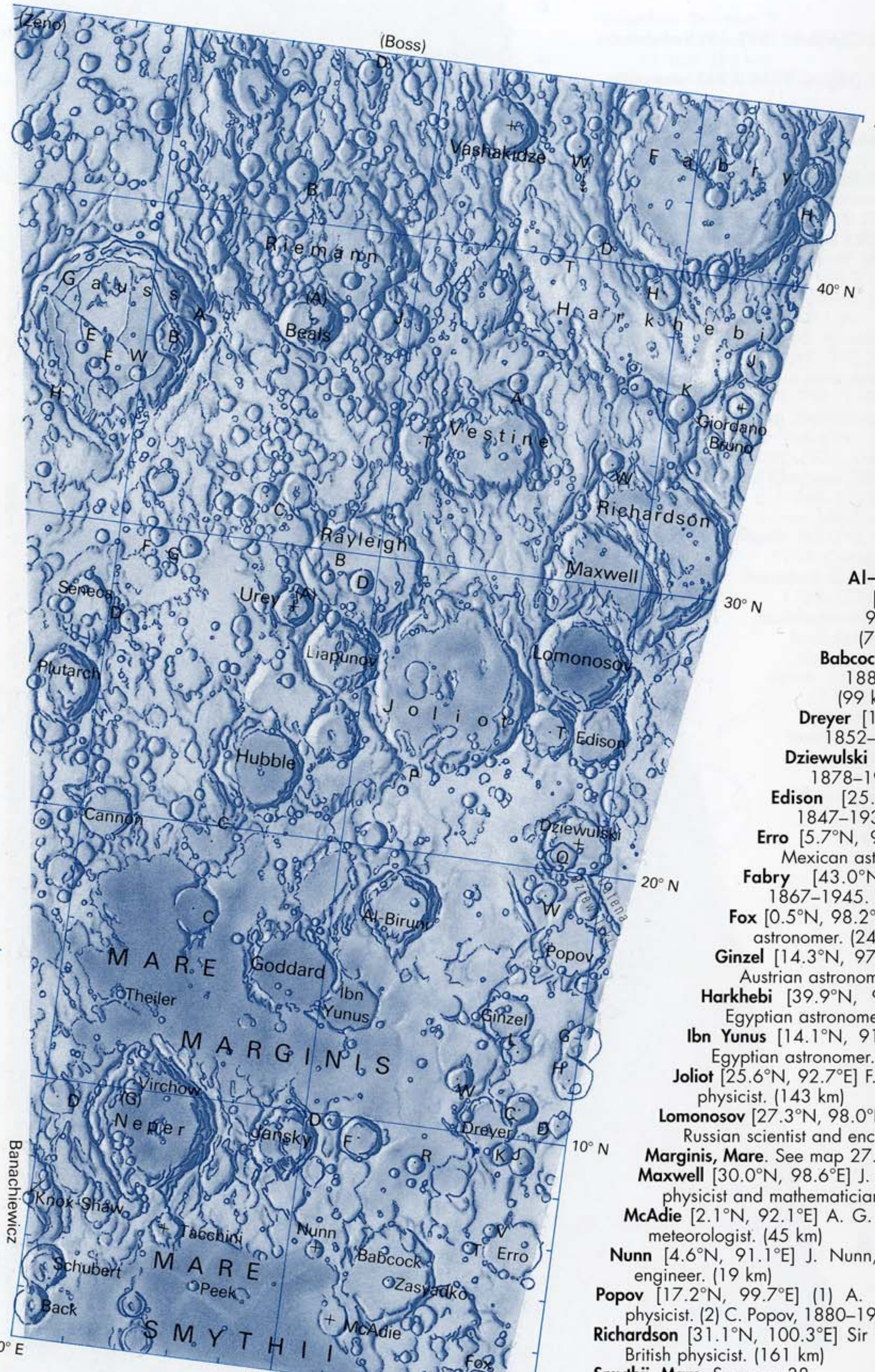
North-northeastern sector

Belkovich. See map 7.
Compton [56.0°N, 105.0°E] A. H. Compton, 1892–1962. American physicist. (162 km)
Dugan [64.2°N, 103.3°E] R. S. Dugan, 1878–1940. American astronomer. (50 km)
Fabry. See map III.
Nansen [81.3°N, 95.3°E] F. Nansen, 1861–1930. Norwegian explorer. (122 km)
Plaskett [82.3°N, 176°E] J. S. Plaskett, 1865–1941. Canadian astronomer. (110 km)
Schwarzschild [70.6°N, 119.6°E] K. Schwarzschild, 1873–1916. German astronomer. (235 km)
Shi Shen [76.0°N, 104.1°E] Shi(h) Shen, *c.* 300 BC. Chinese astronomer. (43 km)



Libration Zone III. **MARE MARGINIS**

East-northeastern sector

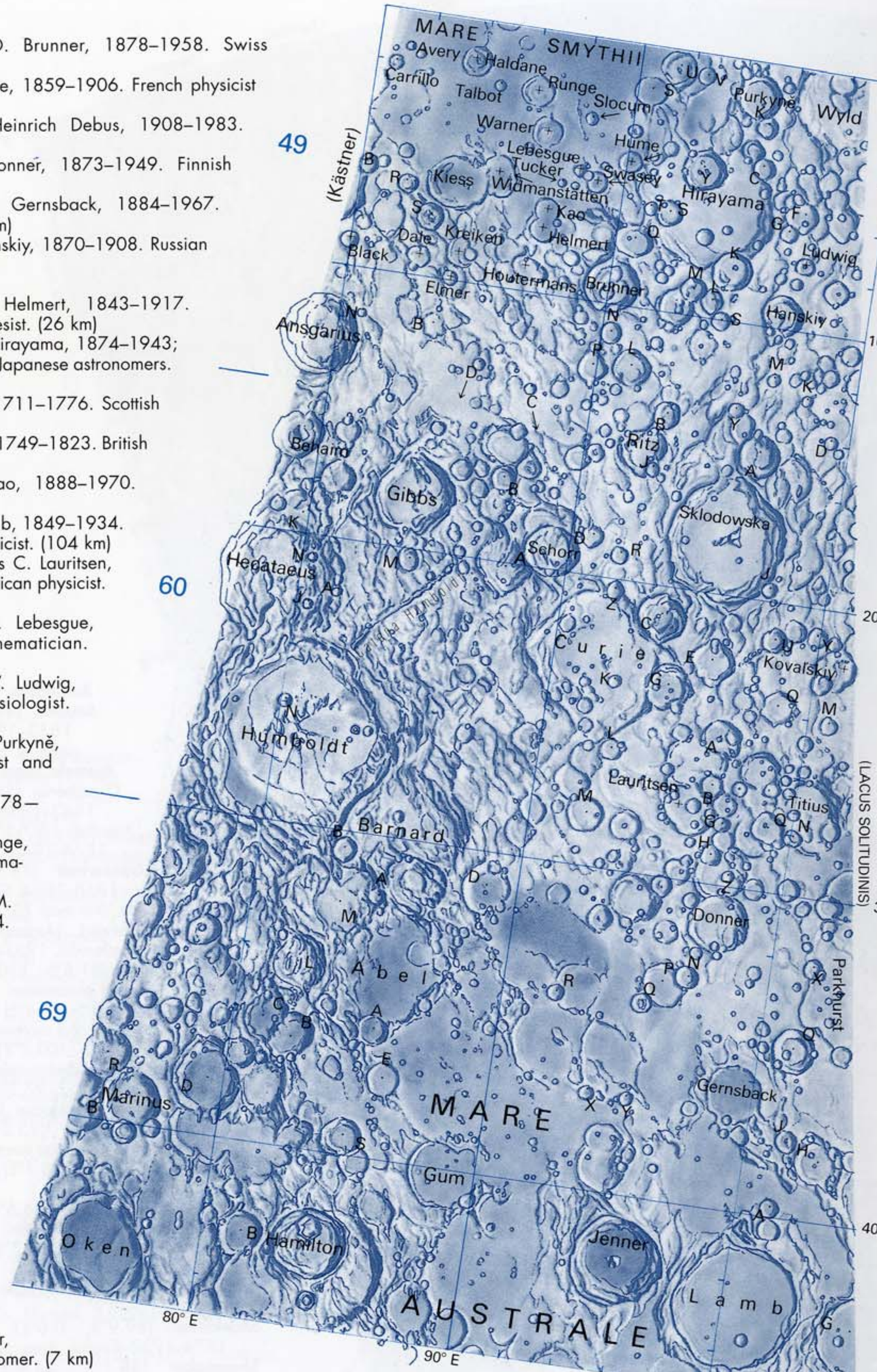


Al-Biruni [17.9°N, 92.5°E] Al-Biruni, 973–1048. Persian astronomer. (77 km)
Babcock [4.2°N, 93.9°E] H. D. Babcock, 1882–1968. American astronomer. (99 km)
Dreyer [10.0°N, 96.9°E] J. L. E. Dreyer, 1852–1926. British astronomer. (61 km)
Dziewulski [21.2°N, 98.9°E] W. Dziewulski, 1878–1962. Polish astronomer. (63 km)
Edison [25.0°N, 99.1°E] T. A. Edison, 1847–1931. American inventor. (62 km)
Erro [5.7°N, 98.5°E] L. E. Erro, 1897–1955. Mexican astronomer. (61 km)
Fabry [43.0°N, 101.2°E] Charles Fabry, 1867–1945. French physicist. (179 km)
Fox [0.5°N, 98.2°E] P. Fox, 1878–1944. American astronomer. (24 km)
Ginzel [14.3°N, 97.4°E] F. K. Ginzel, 1850–1926. Austrian astronomer. (55 km)
Harkhebi [39.9°N, 99.8°E] Harkhebi, *c.* 300 BC. Egyptian astronomer. (282 km)
Ibn Yunus [14.1°N, 91.1°E] Ibn Yunus, *c.* 950–1009. Egyptian astronomer. (58 km)
Joliot [25.6°N, 92.7°E] F. Joliot-Curie, 1900–1958. French physicist. (143 km)
Lomonosov [27.3°N, 98.0°E] M. V. Lomonosov, 1711–1756. Russian scientist and encyclopedist. (92 km)
Marginis, Mare. See map 27.
Maxwell [30.0°N, 98.6°E] J. C. Maxwell, 1831–1879. British physicist and mathematician. (115 km)
McAdie [2.1°N, 92.1°E] A. G. McAdie, 1863–1943. American meteorologist. (45 km)
Nunn [4.6°N, 91.1°E] J. Nunn, 1905–1968. American design engineer. (19 km)
Popov [17.2°N, 99.7°E] (1) A. S. Popov, 1859–1905; Russian physicist. (2) C. Popov, 1880–1966; Bulgarian astronomer. (65 km)
Richardson [31.1°N, 100.3°E] Sir O. W. Richardson, 1879–1959. British physicist. (161 km)
Smythii, Mare. See map 38.
Vashakidze [43.6°N, 93.3°E] M. A. Vashakidze, 1909–1956. Soviet astronomer. (44 km)
Vestine [33.9°N, 93.9°E] E. H. Vestine, 1906–1968. American physicist. (96 km)
Zasyadko [3.9°N, 94.2°E] A. D. Zasyadko, 1779–1837. Russian rocket engineer. (11 km)

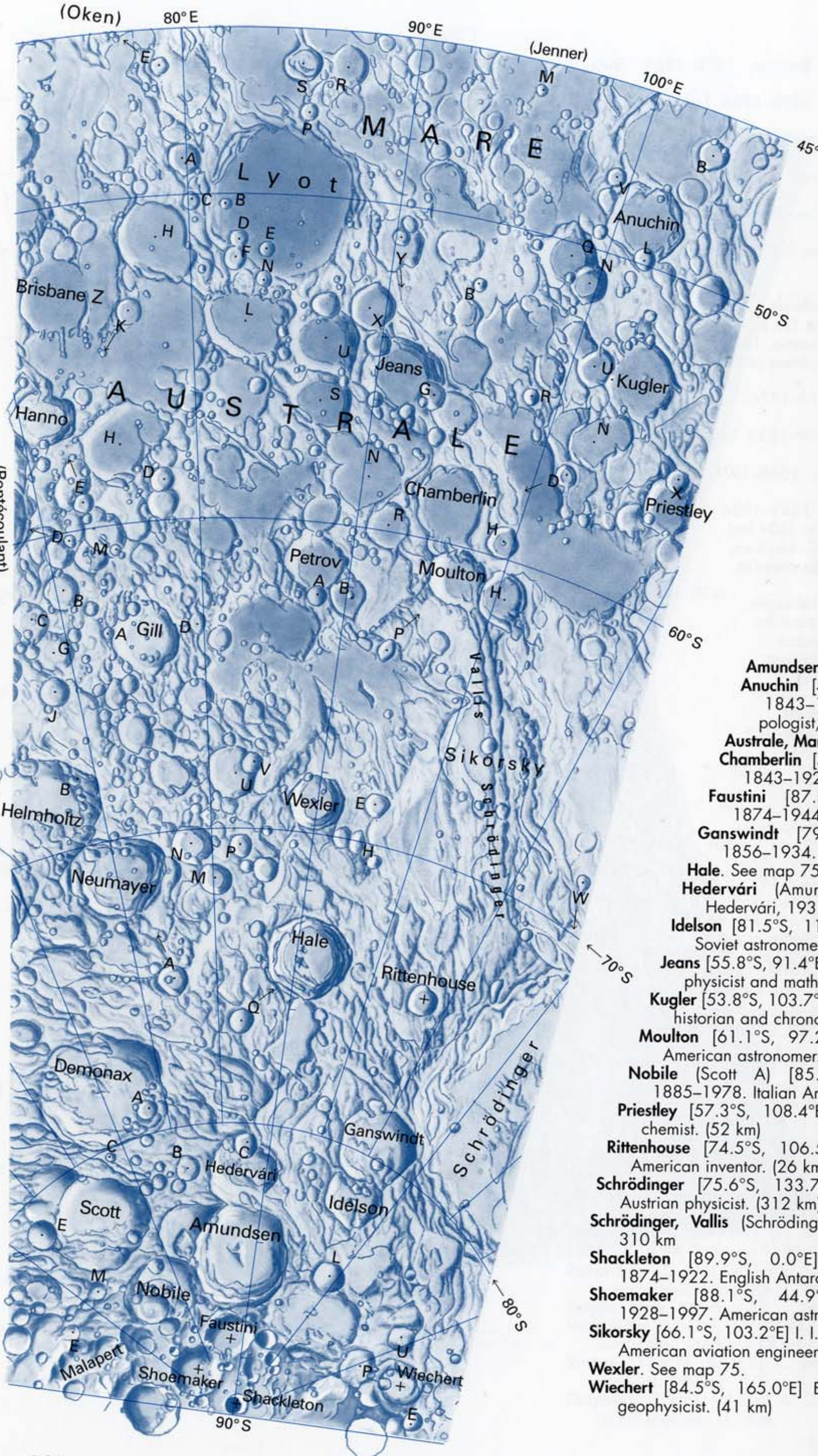
Libration Zone IV. **CURIE**

East-southeastern sector

Australe, Mare. See map 76.
Brunner [9.9°S, 90.9°E] W. O. Brunner, 1878–1958. Swiss astronomer. (53 km)
Curie [23.0°S, 91.8°E] Pierre Curie, 1859–1906. French physicist and chemist. (138 km)
Debus [10.5°S, 99.6°E] Kurt Heinrich Debus, 1908–1983. German physicist. (20 km)
Donner [31.4°S, 98.0°E] A. Donner, 1873–1949. Finnish astronomer. (58 km)
Gernsback [36.5°S, 99.7°E] H. Gernsback, 1884–1967. American man of letters. (48 km)
Hanskiy [9.7°S, 97.0°E] A. P. Ganskiy, 1870–1908. Russian astronomer. (43 km)
Harlan. See map 69.
Helmert [7.6°S, 87.6°E] F. R. Helmert, 1843–1917. German astronomer and geodesist. (26 km)
Hirayama [6.0°S, 93.7°E] (1) K. Hirayama, 1874–1943; (2) S. Hirayama, 1867–1945. Japanese astronomers. (139 km)
Hume [4.7°S, 90.4°E] D. Hume, 1711–1776. Scottish philosopher. (23 km)
Jenner [42.1°S, 95.9°E] E. Jenner, 1749–1823. British physician. (71 km)
Kao [6.7°S, 87.6°E] Ping-Tse Kao, 1888–1970. Taiwanese astronomer. (34 km)
Lamb [42.8°S, 100.8°E] Sir H. Lamb, 1849–1934. British mathematician and physicist. (104 km)
Lauritsen [27.6°S, 96.1°E] Charles C. Lauritsen, 1892–1968. Danish-born American physicist. (52 km)
Lebesgue [5.1°S, 89.0°E] H. L. Lebesgue, 1875–1941. French mathematician. (11 km)
Ludwig [7.7°S, 97.4°E] C. F. W. Ludwig, 1816–1895. German physiologist. (23 km)
Purkyně [1.6°S, 94.9°E] J. E. Purkyně, 1787–1869. Czech naturalist and physiologist. (48 km)
Ritz [15.1°S, 92.2°E] W. Ritz, 1878–1909. Swiss physicist. (51 km)
Runge [2.5°S, 86.7°E] C. D. T. Runge, 1856–1927. German mathematician. (38 km)
Sklodowska [18.0°S, 96.0°E] M. Sklodowská-Curie, 1867–1934. Polish physicist and chemist, twice Nobel Laureate. (130 km)
Slocum [3.0°S, 89.0°E] F. Slocum, 1873–1944. American astronomer. (13 km)
Smythii, Mare. See map 38 and 49.
Swasey [5.5°S, 89.7°E] A. Swasey, 1846–1937. American inventor. (23 km)
Talbot [2.5°S, 85.3°E] W. H. Fox-Talbot, 1800–1877. British physicist and photographer. (11 km)
Titius [26.8°S, 100.7°E] J. D. Titius, 1729–1796. German astronomer. (73 km)
Tucker [5.6°S, 88.2°E] R. H. Tucker, 1859–1952. American astronomer. (7 km)
Warner [4.0°S, 87.3°E] W. R. Warner, 1846–1929. American inventor. (35 km)
Wyld [1.4°S, 98.1°E] J. H. Wyld, 1913–1953. American rocket engineer. (93 km)

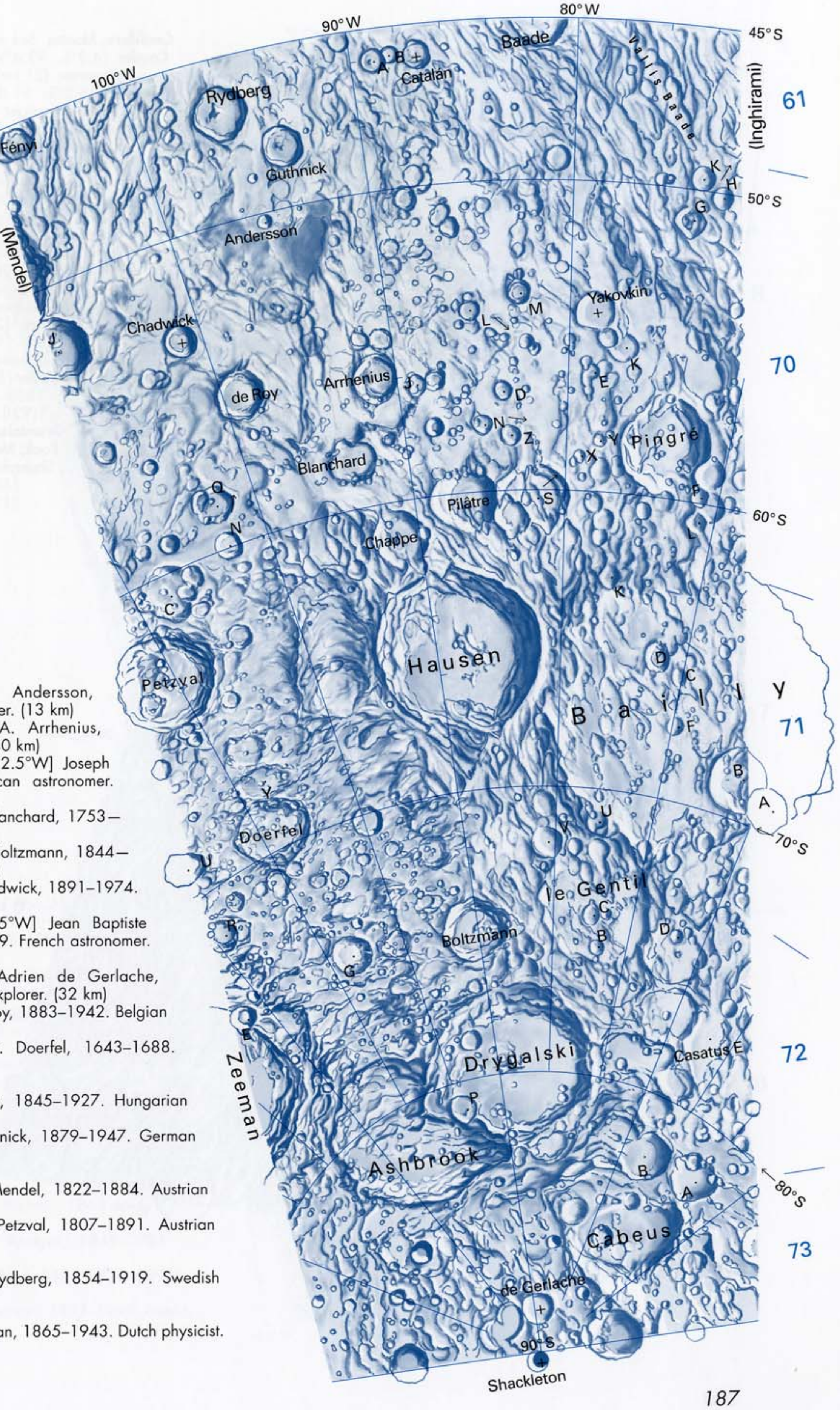


South-southeastern sector



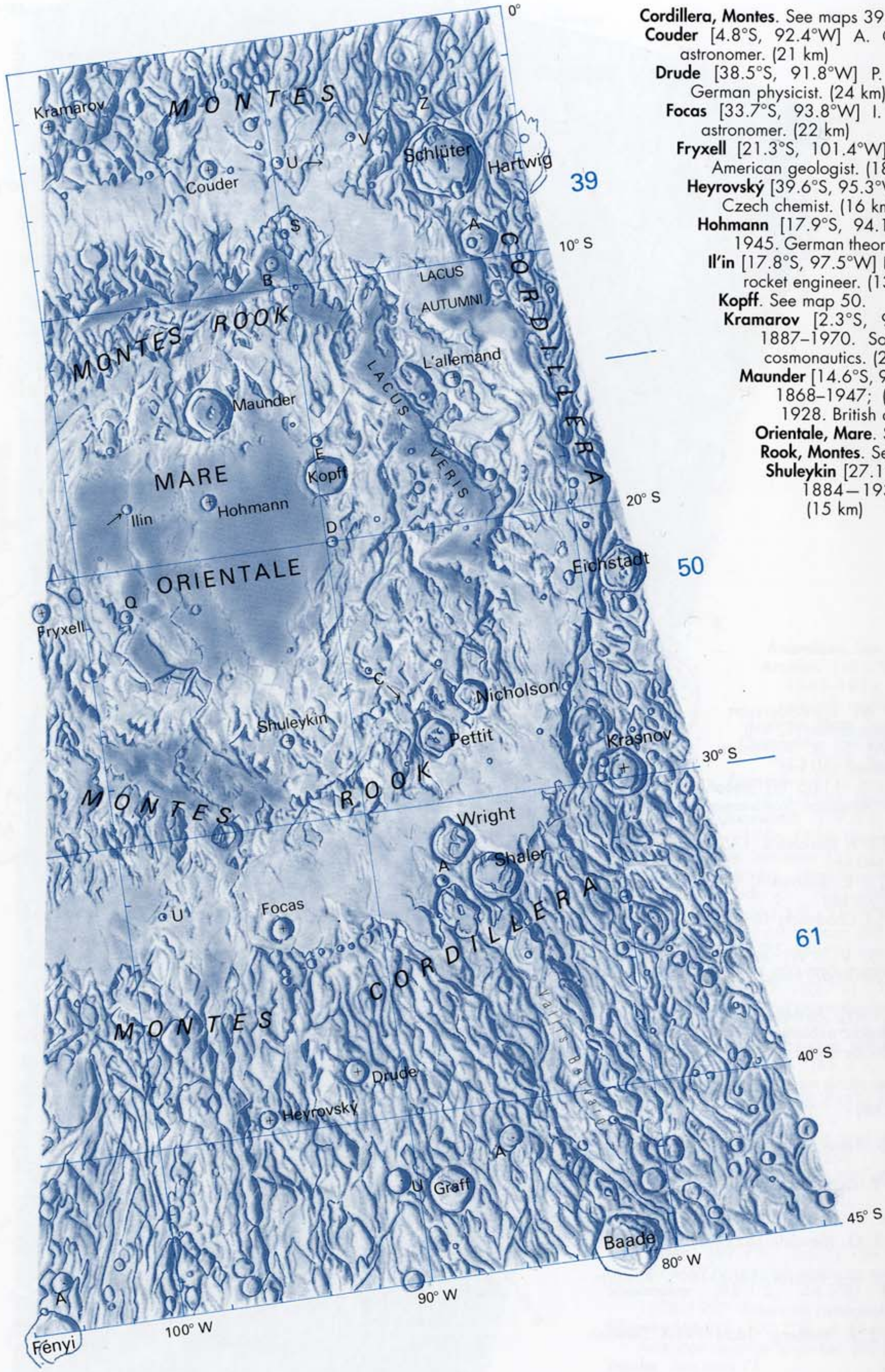
Amundsen. See map 73.
Anuchin [49.0°S, 101.3°E] D. N. Anuchin, 1843–1923. Soviet geographer, anthropologist, and archaeologist. (57 km)
Australe, Mare. See map 76.
Chamberlin [58.9°S, 95.7°E] T. C. Chamberlin, 1843–1928. American geologist. (58 km)
Faustini [87.3°S, 77.0°E] Arnoldo Faustini, 1874–1944. Italian polar geographer. (39 km)
Ganswindt [79.6°S, 110.3°E] H. Ganswindt, 1856–1934. German rocket engineer. (74 km)
Hale. See map 75.
Hedervári (Amundsen A)[81.8°S, 84.0°E] Peter Hedervári, 1931–1984. Hungarian scientist. (69 km)
Idelson [81.5°S, 110.9°E] N. I. Idelson, 1885–1951. Soviet astronomer. (60 km)
Jeans [55.8°S, 91.4°E] Sir J. H. Jeans, 1877–1946. British physicist and mathematician. (79 km)
Kugler [53.8°S, 103.7°E] F. X. Kugler, 1862–1929. German historian and chronologist. (65 km)
Moulton [61.1°S, 97.2°E] F. R. Moulton, 1872–1952. American astronomer. (49 km)
Nobile (Scott A) [85.2°S, 53.5°E] Umberto Nobile, 1885–1978. Italian Arctic explorer. (73 km)
Priestley [57.3°S, 108.4°E] J. Priestley, 1733–1804. British chemist. (52 km)
Rittenhouse [74.5°S, 106.5°E] D. Rittenhouse, 1732–1796. American inventor. (26 km)
Schrödinger [75.6°S, 133.7°E] E. Schrödinger, 1887–1961. Austrian physicist. (312 km)
Schrödinger, Vallis (Schrödinger's Valley) [67°S, 105°E] *Length* 310 km
Shackleton [89.9°S, 0.0°E] Sir Ernest Henry Shackleton, 1874–1922. English Antarctic explorer. (19 km)
Shoemaker [88.1°S, 44.9°E] Eugene Merle Shoemaker, 1928–1997. American astrogeologist. (51 km)
Sikorsky [66.1°S, 103.2°E] I. I. Sikorsky, 1889–1972. Russian-born American aviation engineer. (98 km)
Wexler. See map 75.
Wiechert [84.5°S, 165.0°E] E. Weichert, 1861–1928. German geophysicist. (41 km)

South-southwestern sector



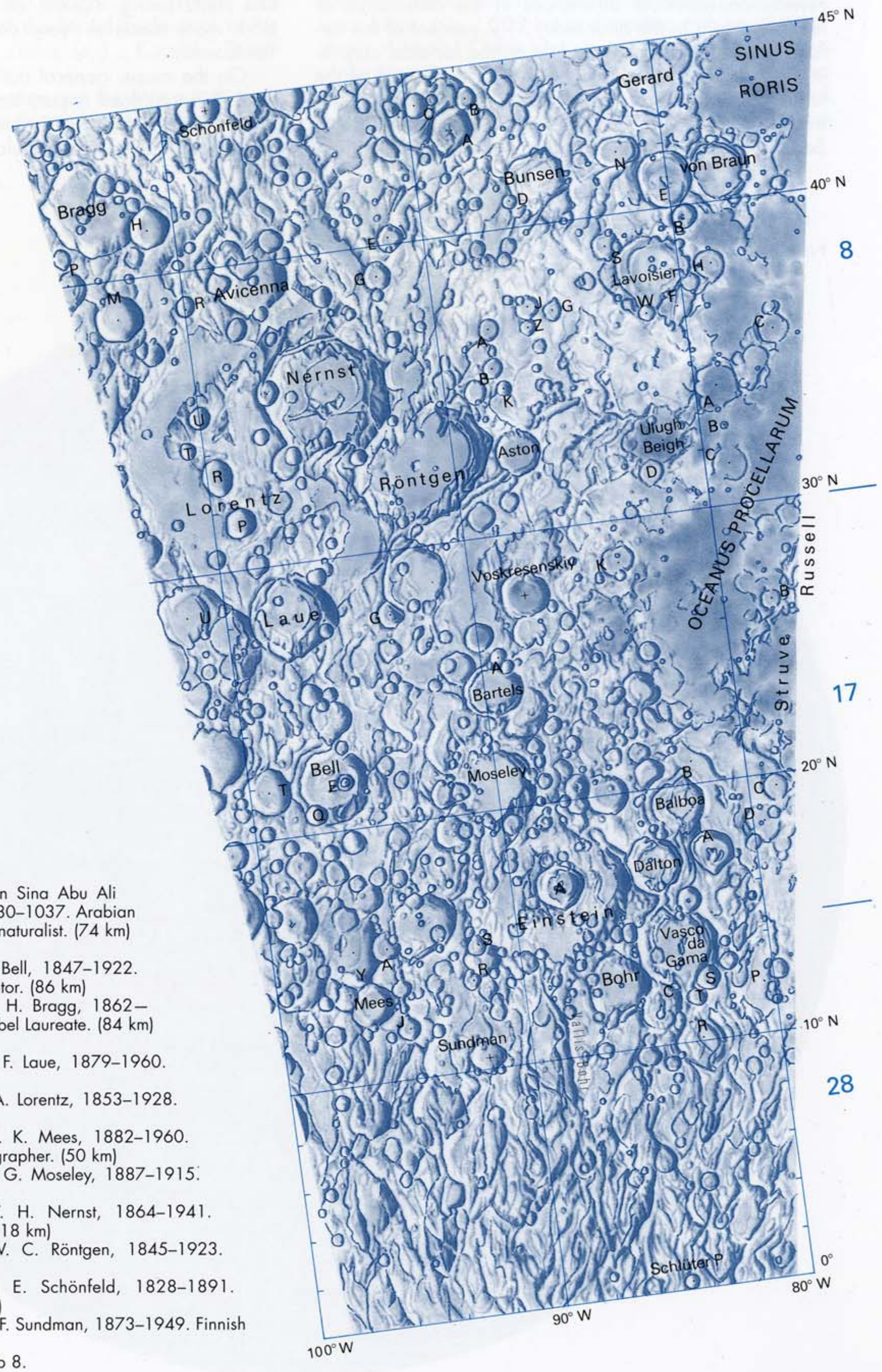
Andersson [49.7°S, 95.3°W] L. Andersson, 1943–1979. American astronomer. (13 km)
Arrhenius [55.6°S, 91.3°W] S. A. Arrhenius, 1859–1927. Swedish chemist. (40 km)
Ashbrook (Drygalski Q)[81.4°S, 112.5°W] Joseph Ashbrook, 1918–1980. American astronomer. (156 km)
Blanchard [58.5°S, 94.4°W] J. P. Blanchard, 1753–1809. French balloonist. (40 km)
Boltzmann [74.9°S, 90.7°W] L. E. Boltzmann, 1844–1906. Austrian physicist. (76 km)
Chadwick [52.7°S, 101.3°W] J. Chadwick, 1891–1974. British physicist. (30 km)
Chappe (Hausen A) [61.2°S, 91.5°W] Jean Baptiste Chappe d'Auteroche, 1728–1769. French astronomer. (59 km)
de Gerlache [88.5°S, 87.1°W] Adrien de Gerlache, 1866–1934. Belgian Antarctic explorer. (32 km)
de Roy [55.3°S, 99.1°W] Felix de Roy, 1883–1942. Belgian astronomer. (43 km)
Doerfel [69.1°S, 107.9°W] G. S. Doerfel, 1643–1688. German astronomer. (68 km)
Drygalski. See map 72.
Fényi [44.9°S, 105.1°W] G. Fényi, 1845–1927. Hungarian astronomer. (38 km)
Guthnick [47.7°S, 93.9°W] P. Guthnick, 1879–1947. German astronomer. (36 km)
Hausen. See map 71.
Mendel [48.8°S, 109.9°W] J. G. Mendel, 1822–1884. Austrian biologist. (138 km)
Petzval [62.7°S, 110.4°W] J. von Petzval, 1807–1891. Austrian optician. (90 km)
Pilâtre. See map 70.
Rydberg [46.5°S, 96.3°W] J. R. Rydberg, 1854–1919. Swedish physicist. (49 km)
Shackleton. See page 186.
Zeeman [75.2°S, 134.8°W] P. Zeeman, 1865–1943. Dutch physicist. (184 km).

West-southwestern sector



Cordillera, Montes. See maps 39 and 50.
Couder [4.8°S, 92.4°W] A. Couder, 1897–1978. French astronomer. (21 km)
Drude [38.5°S, 91.8°W] P. K. L. Drude, 1863–1906. German physicist. (24 km)
Focas [33.7°S, 93.8°W] I. Focas, 1908–1969. French astronomer. (22 km)
Fryxell [21.3°S, 101.4°W] R. H. Fryxell, 1934–1974. American geologist. (18 km)
Heyrovský [39.6°S, 95.3°W] J. Heyrovský, 1890–1967. Czech chemist. (16 km)
Hohmann [17.9°S, 94.1°W] W. Hohmann, 1880–1945. German theoretician of astronautics. (16 km)
Il'in [17.8°S, 97.5°W] N. J. Il'in, 1901–1937. Soviet rocket engineer. (13 km)
Kopff. See map 50.
Kramarov [2.3°S, 98.8°W] G. M. Kramarov, 1887–1970. Soviet scientist in the field of cosmonautics. (20 km)
Maunder [14.6°S, 93.8°W] (1) A. S. D. Maunder, 1868–1947; (2) E. W. Maunder, 1851–1928. British astronomers. (55 km)
Orientale, Mare. See map 50.
Rook, Montes. See map 50.
Shuleykin [27.1°S, 92.5°W] M. V. Shuleykin, 1884–1939. Soviet radio engineer. (15 km)

West-northwestern sector



Avicenna [39.7°N, 97.2°W] Ibn Sina Abu Ali Al-Husain ibn Abdullah, *c.* 980–1037. Arabian physician, philosopher, and naturalist. (74 km)
Bartels. See map 17.
Bell [21.8°N, 96.4°W] A. G. Bell, 1847–1922. Scottish-born American inventor. (86 km)
Bragg [42.5°N, 102.9°W] W. H. Bragg, 1862–1942. Scottish physicist, Nobel Laureate. (84 km)
Einstein. See map 17.
Laue [28.0°N, 96.7°W] M. T. F. Laue, 1879–1960. German physicist. (87 km)
Lorentz [34.3°N, 96.9°W] H. A. Lorentz, 1853–1928. Dutch physicist. (371 km)
Mees [13.6°N, 96.1°W] C. E. K. Mees, 1882–1960. British-born American photographer. (50 km)
Moseley [20.9°N, 90.1°W] H. G. Moseley, 1887–1915. British physicist. (90 km)
Nernst [35.4°N, 94.5°W] W. H. Nernst, 1864–1941. German physical chemist. (118 km)
Röntgen [33.0°N, 91.4°W] W. C. Röntgen, 1845–1923. German physicist. (126 km)
Schönfeld [44.8°N, 98.1°W] E. Schönfeld, 1828–1891. German astronomer. (25 km)
Sundman [10.8°N, 91.6°W] K. F. Sundman, 1873–1949. Finnish astronomer. (40 km)
von Braun (Lavoisier D). See map 8.

Maps of the near and far sides of the Moon

A comparison of the near and far sides of the Moon reveals considerable differences in the distribution of mare terrain. On the near side, 31.2 percent of the surface is covered by maria, while on the far side, surprisingly, maria can be found on only 2.5 percent of the lunar surface: Mare Orientale (Eastern Sea), Mare Ingenii (Sea of Longing), Mare Moscoviense (Moscow Sea), parts of Mare Australe, Mare Marginis, and Mare Smythii. Also, parts of some impact basins like Hertzsprung, Apollo, or Poincaré are filled with dark mare material. Very dark is the floor of crater Tsiolkovskiy.

On the maps, general outlines and names **(in bold)** mark 30 confirmed impact basins (pp. 12–15). These names are (to date) not included in the IAU nomenclature system, but they are regularly used in this form in the scientific literature. Basin names are derived either from the maria that fill the basin (e.g., the Imbrium basin derives from Mare Imbrium) or from the named craters within the basin (e.g., the Mendel–Rydberg basin). Some basins were originally thought of as craters, and in such cases the name of the basin is identical to the name of the respective crater (e.g., Korolev, Schrödinger).

The distribution of elevations on the Moon is distinctly irregular, and the near side and far side differ in mean elevation by about 3 km. The heavily cratered far-side surface is generally higher. The largest (however, not directly visible on photographs) topographic feature on the Moon is the South Pole–Aitken basin. Revealed by the *Galileo* remote sensing and the *Clementine* laser-altimeter measurements, this is the oldest discernible lunar basin. It is 2,500 km in diameter, with an average depth of nearly 13 km (rim crest to floor), making it one of the largest and deepest impact basins yet discovered in the solar system. The crater Aitken [17°S, 173°E] and the lunar south pole near the basin's rim give the giant feature its name.

Near side of the Moon

Far side of the Moon

Flights to the Moon

The map opposite calls attention to the initial period of very intensive exploration of the Moon from 1959 to 1976. On the map the locations of impacts and soft landings of successful automatic probes and manned space vehicles are indicated. During that period, two long-term Soviet and American programs were in progress. The Soviet program was based on the use of sophisticated automatic space probes. The American program, from the very beginning, was aimed at manned landings on the Moon. Both programs were complementary to each other and produced a rich harvest of new data about the Moon.

The Soviet program comprised three generations of *Luna* probes. The simple probes of the first generation bypassed the Moon (*Luna 1,* 1959), and then, for the first time, crash-landed on the Moon (*Luna 2,* 1959), and photographed part of the far side (*Luna 3,* 1959). After several abortive attempts, probes of the second series (*Lunas 5–14,* 1965–1968) achieved the first soft landing on the Moon (*Luna 9,* 1966) and established the first artificial lunar satellite (*Luna 10,* 1966). Of particular importance were the probes of the *Zond* series. These orbited the Moon, took photographs and measurements from close range, and in some cases returned to the Earth (*Zond 3,* 1965; *Zonds 5–7,* 1968–1969). The probes belonging to the third series were inaugurated by an experiment with *Luna 15* in 1969. Its basic form consisted of a multipurpose transport platform, which made a soft landing on the Moon by means of a four-legged undercarriage. This landing section transported to the Moon either a Moon-Earth rocket equipped for the automatic collection and return of rock samples (*Luna 16,* 1970; *Luna 20,* 1972; and *Luna 24,* 1976) or a remote-controlled mobile laboratory (*Luna 17* with vehicle *Lunokhod 1,* 1970, and *Luna 21* with *Lunokhod 2,* 1973).

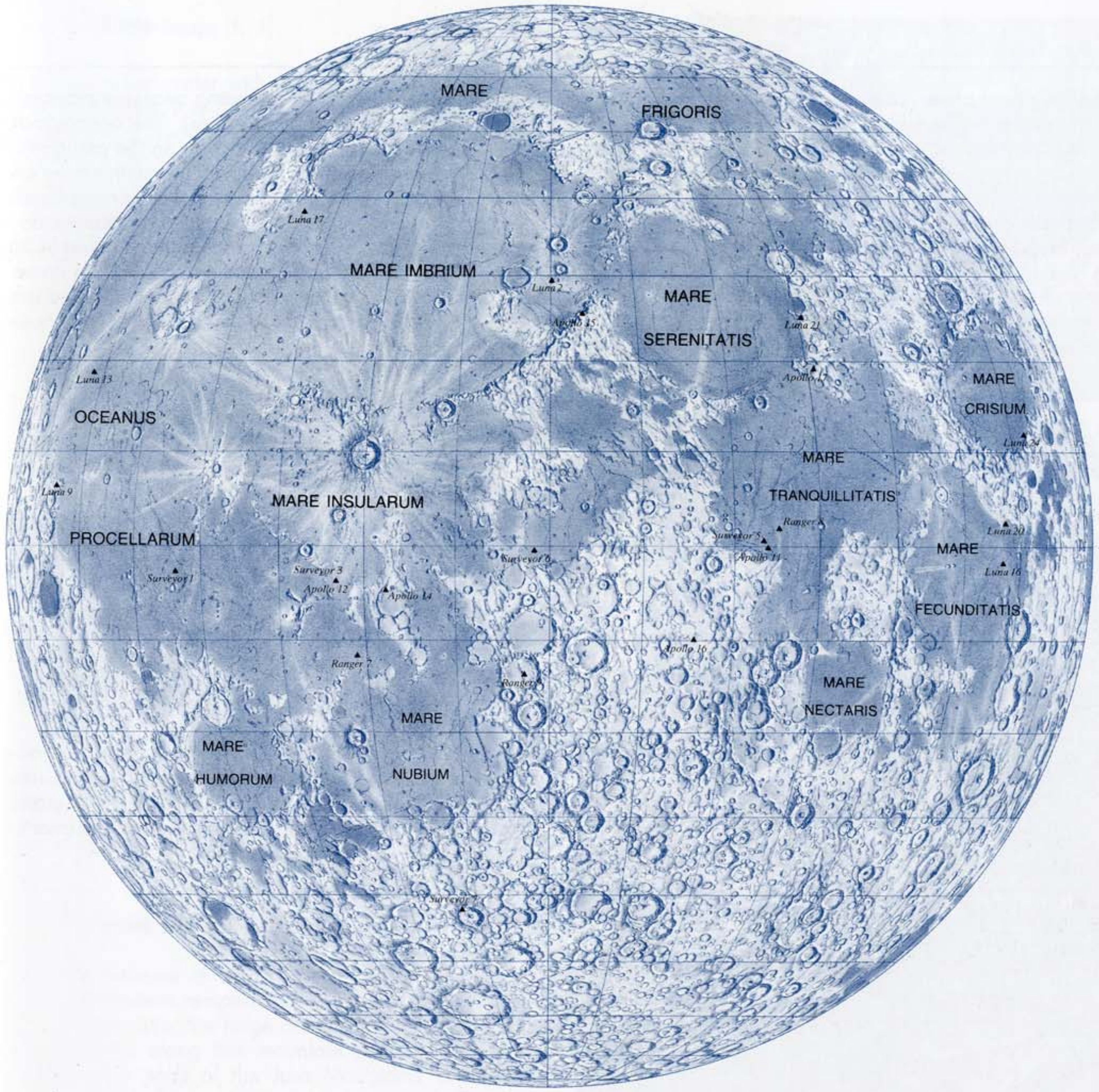
The American program began with a series of probes called Ranger, which were crash-landed on preselected areas of the lunar surface. Shortly before the final descent, their television cameras photographed the Moon, and these photographs were immediately transmitted to the Earth (*Rangers 7, 8,* and *9* in 1964–1965). Between 1966 and 1968 two further programs were carried out, in preparation for the landing of astronauts on the Moon. These involved direct research into the nature of the lunar surface by the soft-landing *Surveyor* probes and the mapping of the Moon in fine detail by the *Lunar Orbiter* satellites. In all, seven *Surveyor* probes were launched, but two attempts were unsuccessful. They were equipped with remote controlled TV cameras, mechanical surface-samplers (*Surveyors 3* and *7*), and facilities for chemical analysis using alpha-particle scattering (*Surveyors 5, 6,* and *7*). Five successful *Surveyor* probes transmitted a total of 87,674 photographs of the lunar surface to Earth.

The five *Lunar Orbiter* satellites completed some very important work. Their original task was to photograph ten areas chosen for possible landing sites for the *Apollo* expeditions. The first three Orbiters completed this mission, and the program was subsequently extended to include the global mapping of the Moon's surface. The American program culminated in a series of manned flights to the Moon, known as the *Apollo* missions. These were preceded by orbital flights around the Moon (*Apollo 8,* 21–27 December 1968; and *Apollo 10,* 20–26 May 1969). The first manned landing on the Moon (*Apollo 11,* 20 July 1969) was followed by another five successful expeditions (*Apollos 12, 14, 15, 16,* and *17,* between 1969 and 1972). The *Apollo* spacecraft consisted of three main sections: a command module, a service module, and a lunar module. The crew of the spacecraft consisted of three astronauts, who spent most of their time aboard the command module. Following insertion into lunar orbit, two astronauts transferred to the lunar module, which separated from the command module to soft-land on the Moon. The third member of the crew remained in the command module, which, connected to the service module, continued to orbit the Moon. The activity of the astronauts on the lunar surface mainly consisted of geological survey work, the collection of rock samples, photographic documentation, and the installation of scientific experiments.

In the mid-1970s flights to the Moon ceased, and for the following decades scientists occupied themselves with efforts to analyze, evaluate, and describe what had been discovered. In the 1990s a new generation of robotic space probes (*Galileo, Clementine,* and *Lunar Prospector*), equipped with advanced remote-sensing instruments, began the next stage of lunar research. *Clementine* and *Lunar Prospector* in particular contributed greatly to our understanding of the Moon. The resulting data were used to map the Moon's chemical composition, gravitational and magnetic fields, topography of many impact basins, and more. This information will be used to plan new missions and, possibly, to support the establishment of permanently manned bases on the Moon in the 21st century.

In spite of all this research and effort, much remains to be accomplished. For example, there are vast areas of the Moon for which there isn't sufficient imagery to allow compiling detailed topographic charts. So, paradoxically, at the very beginning of the third millennium, some much more distant solar-system bodies (such as Mars and the largest Jovian moons) are more completely mapped than is our closest celestial neighbor.

Note: In addition to the list of successful lunar landings (p. 193), about 30 rockets, probes, etc., have crash-landed on the Moon. On July 31, 1999, after completing a most productive mission, the *Lunar Prospector* crash-landed close to the Lunar south pole in a crater, thereafter named Shoemaker (p. 186).



Probe	Date of reaching the Moon	Results
Luna 2	13. 9. 1959	First probe to reach the Moon.
Ranger 7	31. 7. 1964	4,308 photographs of the Moon, details down to 1 m and below (crash-landing).
Ranger 8	20. 2. 1965	7,137 photographs (crash-landing).
Ranger 9	24. 3. 1965	5,814 photographs, details down to 25 cm (crash-landing).
Luna 9	3. 2. 1966	First soft-landing, 4 panoramic photographs.
Surveyor 1	2. 6. 1966	Soft-landing, 11,240 photographs.
Luna 13	24. 12. 1966	Three panoramic photographs, mechanical soil probe.
Surveyor 3	20. 4. 1967	6,326 photographs, later the *Apollo 12* expedition landed here.
Surveyor 5	11. 9. 1967	19,118 photographs; properties of lunar surface analyzed.
Surveyor 6	10. 11. 1967	29,952 photographs.
Surveyor 7	19. 1. 1968	21,038 photographs, mechanical scoop, chemical analysis.
Apollo 11	20. 7. 1969	First men on the Moon (Armstrong and Aldrin; Collins in orbit).
Apollo 12	19. 11. 1969	Conrad and Bean on the Moon, Gordon in orbit.
Luna 16	21. 9. 1970	Automatic collection of lunar rock samples, brought back to Earth.
Luna 17	17. 11. 1970	Mobile laboratory *Lunokhod 1* (drove 10,540 m across the lunar surface).
Apollo 14	5. 2. 1971	Shepard and Mitchell on the Moon, Roosa in orbit.
Apollo 15	30. 7. 1971	Scott and Irwin on the Moon, Worden in orbit.
Luna 20	21. 2. 1972	Automatic collection of rock samples, brought back to Earth.
Apollo 16	21. 4. 1972	Young and Duke on the Moon, Mattingly in orbit.
Apollo 17	11. 12. 1972	Cernan and Schmitt on the Moon, Evans in orbit.
Luna 21	15. 1. 1973	Mobile laboratory *Lunokhod 2* (covered a distance of 37 km).
Luna 24	18. 8. 1976	Core sample taken automatically, down to a depth of 2 m.

Fifty views of the Moon

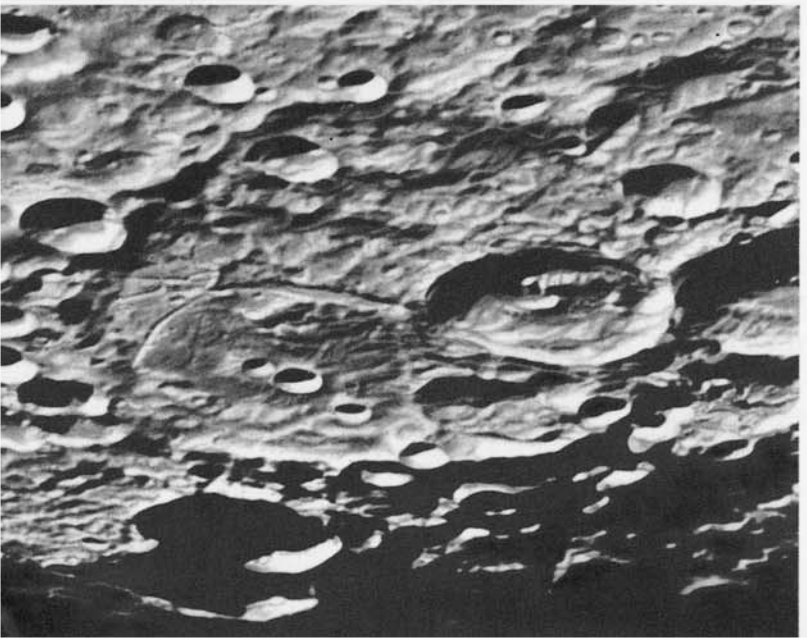
The wealth of observable details on the Moon's surface is demonstrated here by a selection of images of diverse formations, such as craters, valleys, rilles, mare ridges, domes, mountain ranges, and other peculiar and rare features. These photographs may help amateur observers choose suitable objects to view, depending on the resolving power of their telescopes.

The following pages contain a selection of 50 interesting lunar formations. Each is briefly described and its dimensions are given. The reference numbers adjacent to the names of formations indicate the map or maps on which they are shown (1—76 being near-side maps and I—VIII depicting the libration zones). The approximate times of sunrise and sunset are given on the assumption that all librations are zero. However, in practice there can be deviations of up to three-quarters of a day to take into account. The illustrations show each lunar feature as it would appear under the lighting condition imposed by the colongitude value (col.) given next to the feature name.

For the most part the photographs are oriented with north up. The locations of the these features are shown on the layout map on the back endpaper.

1. **Clavius** (maps 72, 73) *col. 44°*

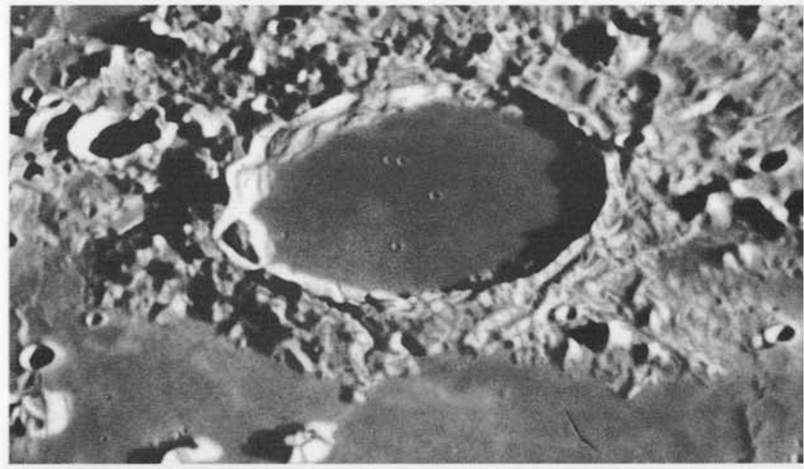
One of the largest near-side craters, also regarded as a crater-to-basin transition. Small off-center peaks. Crater diameter 225 km. There is a fine arc of lesser craters crossing the floor. Sunrise is 1—2 days after first quarter, and sunset 1—2 days after last quarter.



2. **Janssen** (maps 67, 68) *col. 128°*

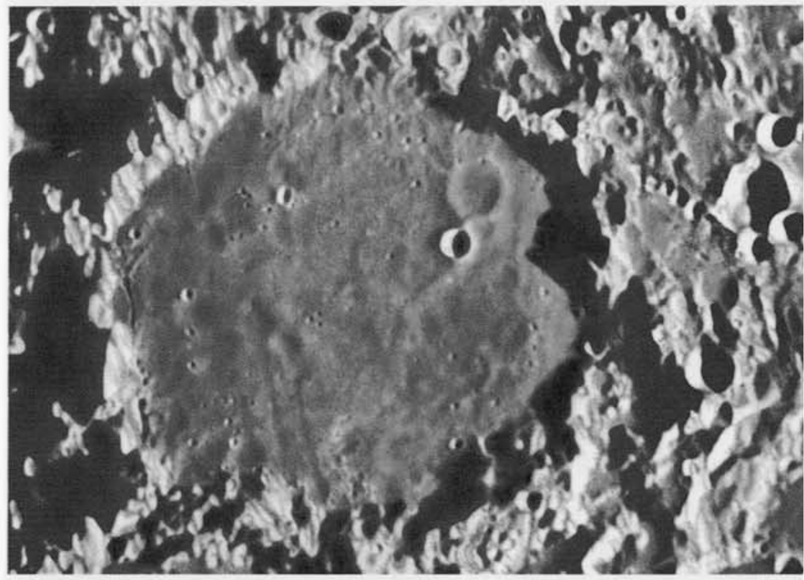
A large, old crater with a considerably ruined wall, 190 km in diameter. On the floor there are mountains and a system of rilles. The largest of the rilles is visible through even a small telescope; its length is 110 km and it is up to 6 km wide. Sunrise is 4 days after new Moon, and sunset 4 days after full Moon.

3. **Plato** (maps 3, 4) *col. 24°*



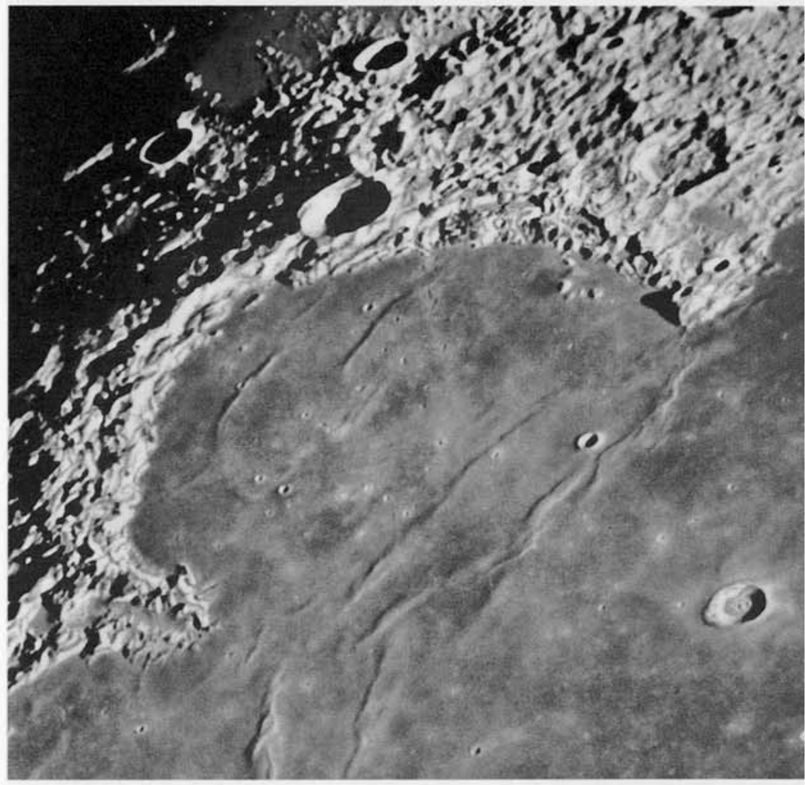
Prominent crater with a dark floor, visible even through binoculars. It is 101 km in diameter and has an average depth of about 1,000 m. Individual mountain peaks on the eastern and western walls rise to more than 2,000 m above the floor, on which there are four craterlets about 2 km across (besides many smaller ones). Sunrise 0.5 day after first quarter, and sunset 0.5 day after last quarter.

4. **Ptolemaeus** (map 44) *col. 7°*



A large crater with a light plain on its floor. It is 153 km in diameter and has an average depth of 2,400 m. What appears to be a flat floor is covered with numerous small simple craters and with old, subdued craters or shallow circular depressions, which are visible only under low illumination. Sunrise occurs at first quarter, and sunset at last quarter.

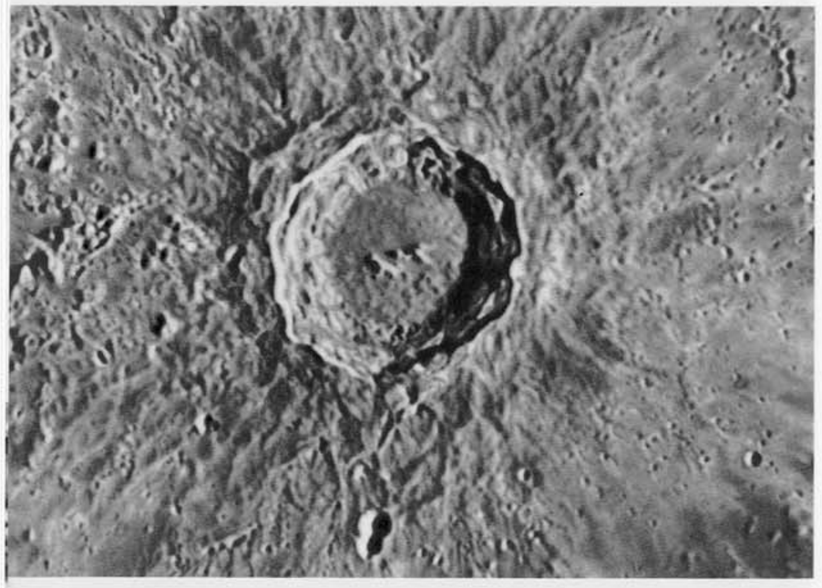
5. **Sinus Iridum** (map 10) *col. 44°*



The remains of a 260-km-diameter crater. Its northern and western ramparts are well preserved and are called Montes Jura; the large crater Bianchini is situated about halfway along this mountain range. The eastern and western ends of the Jura Mountains terminate at the "capes" Promontorium Laplace and Promontorium Heraclides, respectively. The interior of Sinus Iridum is flooded with mare material on which there are several mare ridges and many simple craters. Sunrise and sunset take place 2—3 days after first quarter and last quarter, respectively.

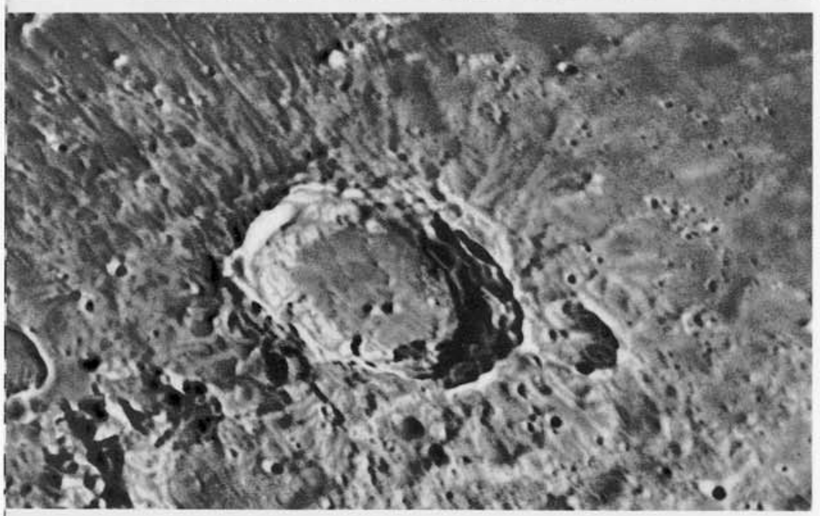
6. **Gassendi** (map 52) *col. 53°*

A characteristic crater, 110 km in diameter. The interior contains a group of central peaks, a complex system of rilles, and numerous elevations on the floor. In the south the height of the rim is less than 200 m; to the east and west it reaches more than 2,500 m above the floor; in the north it is interrupted by the crater **Gassendi A** (33 km/3600 m). Sunrise is 3 days after first quarter, and sunset 3 days after last quarter.



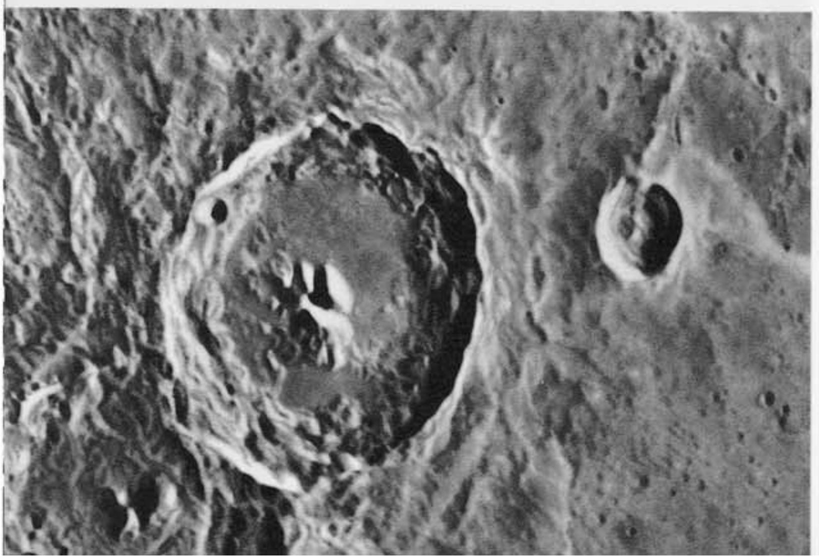
7. **Copernicus** (map 31) *col. 31°*

Spectacular complex crater, one of the most prominent centers of bright rays. The terraced walls are elevated 900 m above the surrounding terrain, the depth of the crater is about 3760 m, and its diameter is 93 km. A group of central mountains rise to 1,200 m above the floor. Bright rays can be traced as far as 800 km from the crater. Sunrise is 1.5 days after first quarter, and sunset 1.5 days after last quarter.



8. **Aristoteles** (map 5) *col. 7°*

A beautiful complex crater with internal terracing, 87 km in diameter. There is a group of small off-center peaks on its floor. Outside, radial structure is clearly visible in the ejecta blanket. Aristoteles is one of a prominent pair with the crater Eudoxus (map 13). Sunrise is 1. 5 days before first quarter, and sunset 1.5 days before last quarter.

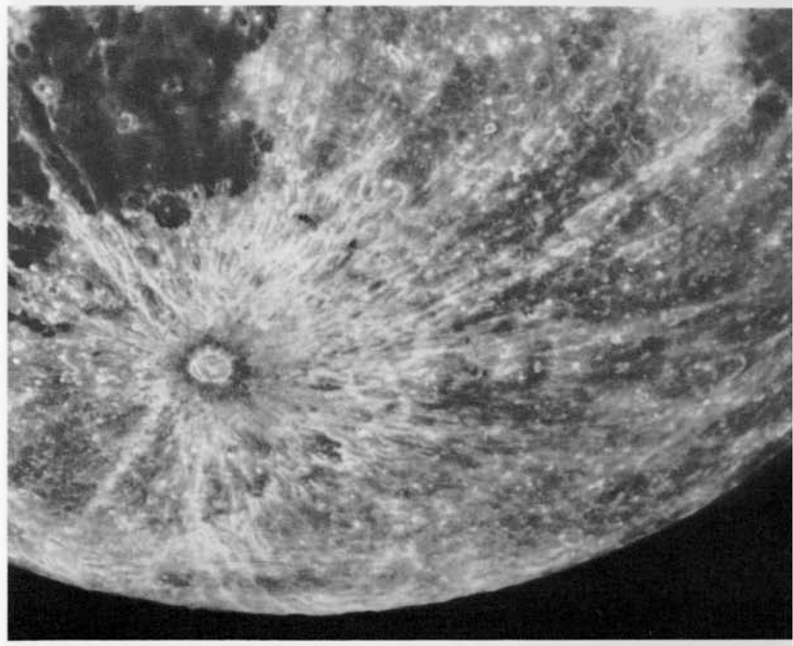


9. **Theophilus** (maps 46, 47) *col. 351°*

One of the most prominent complex craters with a considerable terraced interior wall. It is 100 km in diameter and has a depth of 4,400 m; the rim rises 1,200 m above the surrounding terrain. A group of central mountains rises to about 1,400 m above the floor. The wall of Theophilus interrupts that of neighboring Cyrillus, proving that the former is the younger formation. Sunrise is 5 days after new Moon, and sunset 5 days after full Moon.

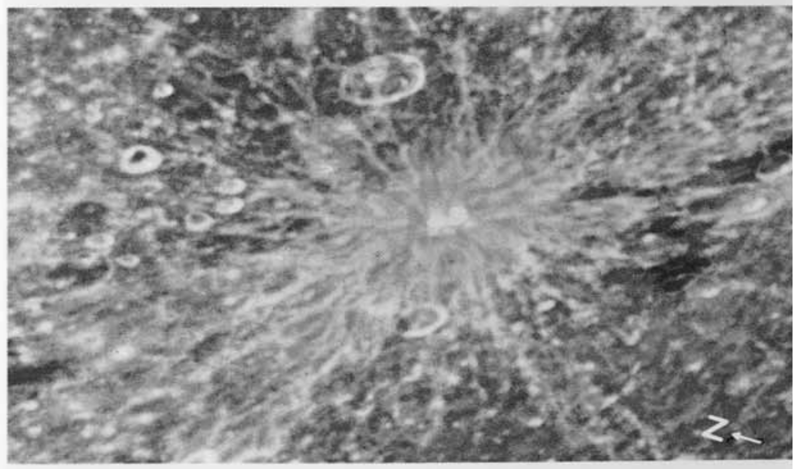
10. **Tycho** (map 64) *col. 168°*

A most conspicuous complex crater, one of the youngest on the Moon: the approximate age is 110 million years. The crater's diameter is 85 km, and its depth is 4,850 m. There is a central peak, 1,600 m high, terraced walls, and a very uneven floor. Sunrise is 1 day after first quarter, sunset 1 day after last quarter.



11. **Tycho** (map 64) *col. 93°*

Under high illumination, and especially around full Moon, Tycho is the most prominent crater on the Moon and the most distinct center of a bright ray system, which can be traced over a distance of more than 1,500 km. A darker ring, over 150 km in diameter, surrounds the crater. Individual parts of the ray system are observable even when Tycho is immersed in shadow on the night side of the Moon.

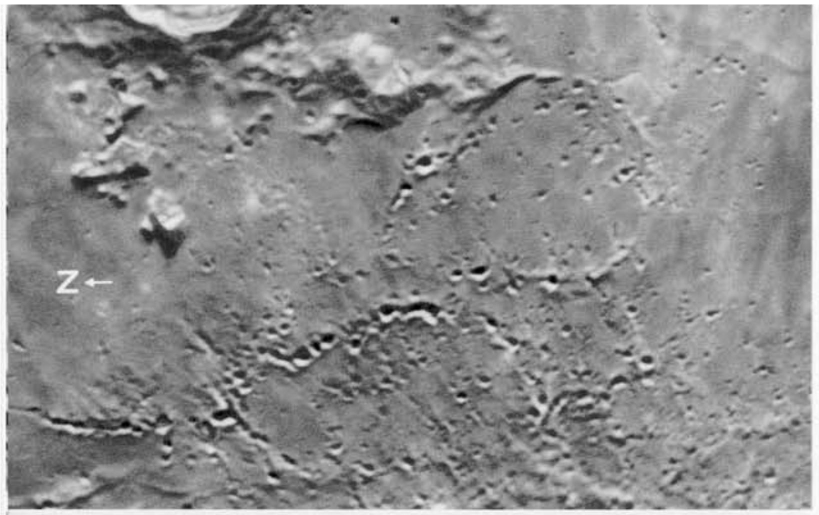


12. **Byrgius A** (maps 50, 51) *col. 134°*

A regular, circular crater, 19 km in diameter, with a sharp rim interrupting the eastern wall of the crater Byrgius. Close to the terminator, Byrgius A does not stand out at all; however, under high illumination during the period from approximately full Moon until last quarter, it is one of the most prominent centers of bright rays.

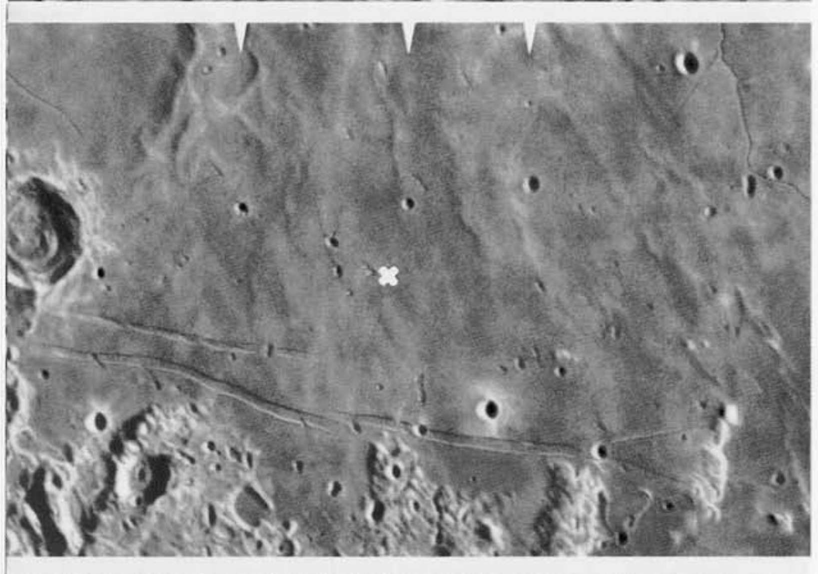
13. **Proclus** (map 26) *col. 93°*

A prominent crater with a sharp rim, 28 km in diameter, 2,400 m deep. It is a conspicuous center of an asymmetric system of bright rays that radiate mostly in three directions. These rays border the darker Palus Somni. Sunrise is 3.5 days after new Moon, and sunset 3.5 days after full Moon.



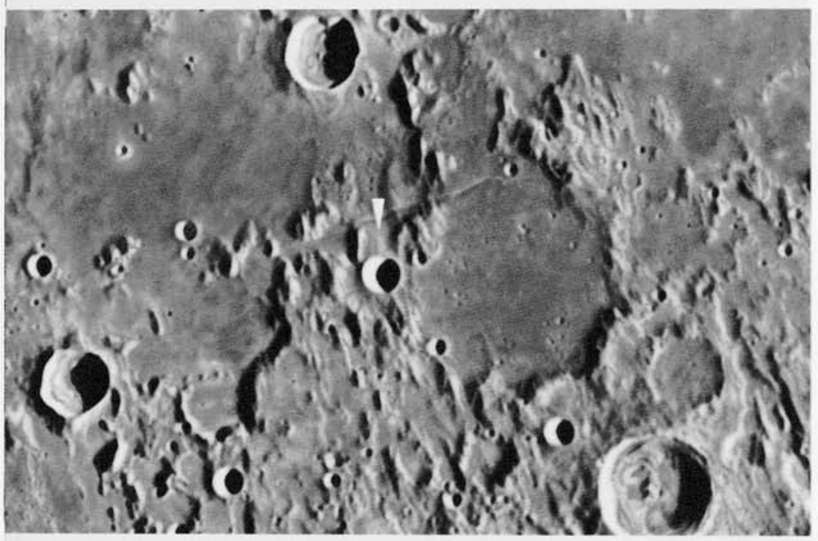
14. **Crater chain close to Stadius** (maps 20, 32) *col. 24°*

A remarkable row of craters north northwest of the flooded crater Stadius and reaching as far as the edge of Mare Imbrium, where it continues in the form of linked craters, resembling a rille. They are obviously secondary formations related to the origin of nearby Copernicus. Sunrise is about 1 day after first quarter, and sunset 1 day after last quarter.



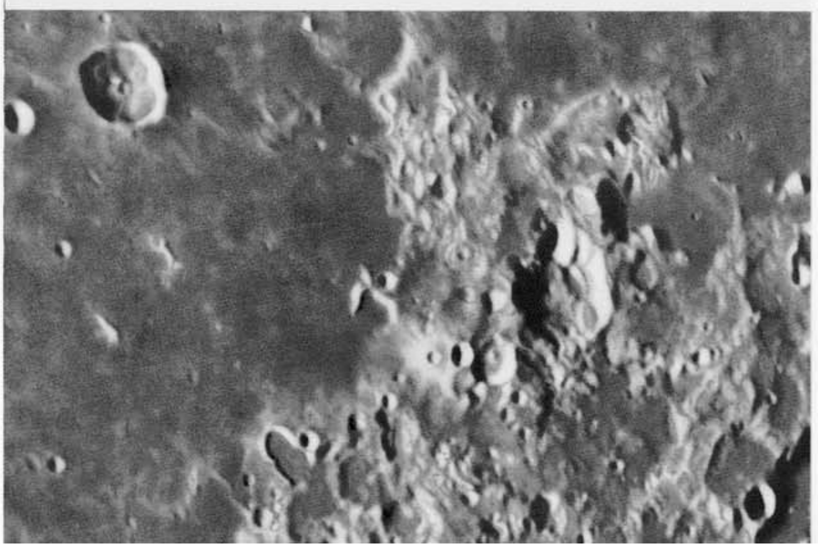
15. **Statio Tranquillitatis** (map 35) *col. 351°*

The soft-landing site of the *Apollo 11* expedition. Close to it are the three small craters Aldrin, Armstrong, and Collins (3.4 km, 4.6 km, and 2.4 km in diameter, marked by arrows), named after the *Apollo 11* crew. These are the only examples of lunar formations named after living persons and found on the near side of the Moon. Sunrise is 2 days before first quarter, and sunset 2 days before last quarter.



16. **Mösting A** (maps 43, 44) *col. 20°*

A simple crater, 13 km in diameter, 2700 m deep. It is situated close to the center of the lunar disk and is easily observed under any angle of illumination. It is well known because of its importance as the basic reference point in the system of selenographic coordinates. Sunrise and sunset occur shortly after first and last quarters, respectively.

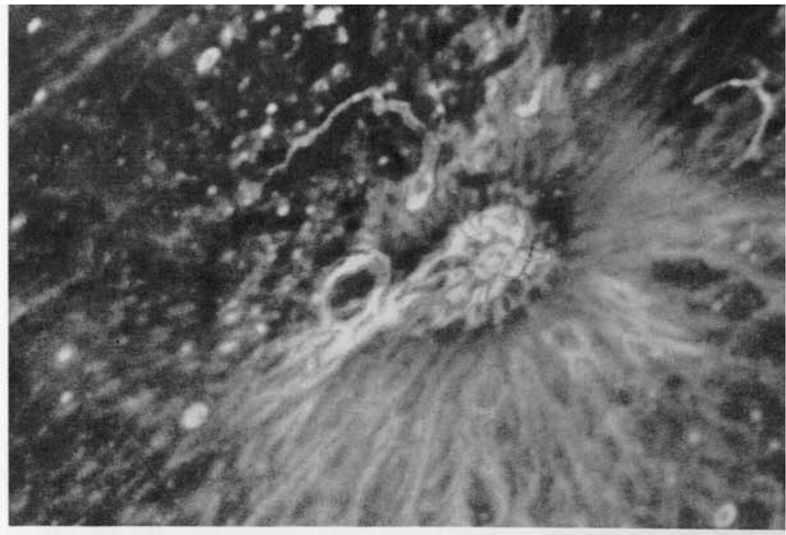


17. **Censorinus** (map 47) *col. 134°*

A fresh, simple crater, 3.8 km in diameter, surrounded by very light material. The rim of the crater is not elevated much above its surroundings, and the crater itself is observable only when close to the terminator. Under high illumination it is one of the brightest features on the Moon. Sunrise occurs somewhat less than 5 days after new Moon, and sunset approximately 3 days before last quarter.

18. **Aristarchus** (map 18) *col. 134°*

One of the brightest objects on the Moon and one of the most conspicuous centers of bright rays. The crater's diameter is 40 km, its depth 3,000 m. It is so bright that it is clearly visible even on the night side of the Moon illuminated only by earthshine. A number of transient lunar phenomena (TLPs) such as hazes, brightenings, colorations etc., in the vicinity of Aristarchus have been reported. Sunrise occurs almost 4 days after first quarter, and sunset about 4 days after last quarter.



19. **Vallis Schröteri** (map 18) *col. 64°*

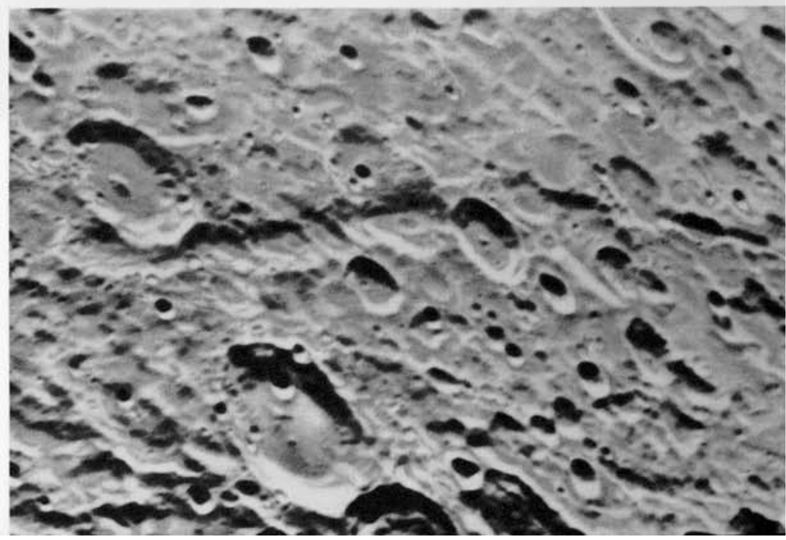
The largest lunar sinuous rille, resembling a dry riverbed with numerous meanders. It starts in the crater to the west of Aristarchus, then widens to 10 km, changes its direction several times, then narrows down and, finally, at a distance of about 160 km from its origin, disappears. The floor of the valley is flat, and a very narrow sinuous rille, which is not visible from the Earth, zigzags along it. Sunrise is 4 days after first quarter, and sunset occurs 4 days after last quarter.

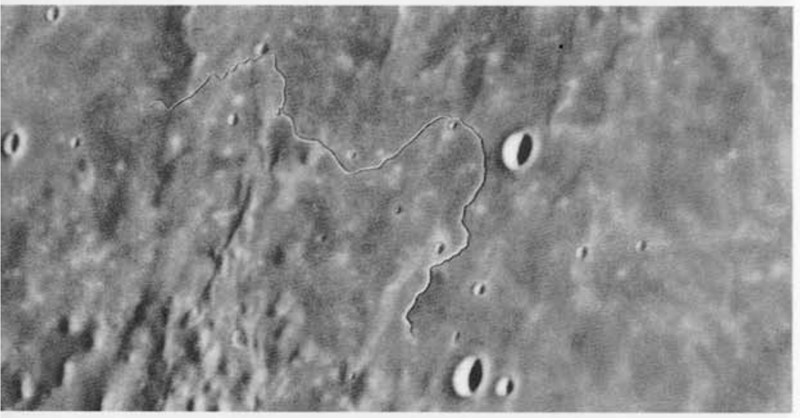
20. **Vallis Alpes** (maps 4, 12) *col. 20°*

One of the best-known lunar valleys, about 180 km long. In the west, mountains enclose it. The floor of the valley is flat and flooded with mare material. A narrow sinuous rille, which is a challenge for smaller telescopes, runs along the middle of the valley. Sunrise and sunset occur just before first and last quarter, respectively.

21. **Vallis Rheita** (map 68) *col. 340°*

A large valley, 30 km wide in places, starting near the western wall of the crater Rheita and continuing for a distance of about 500 km, where it narrows down to 10 km. The valley is considerably ruined and in several places interrupted by larger craters, so that it appears to end near the crater Young, though in fact it continues to the crater Reimarus. Sunrise is 3—4 days after new Moon, and sunset occurs 3—4 days after full Moon.





22. **Rima Marius** (map 18) *col. 61°*

A typical sinuous rille, resembling a dry meandering riverbed. Close to the crater Marius C (map 29), the rille is about 2 km wide; at the opposite end, near Marius P, it narrows down to 1 km. The total length is about 250 km. It has been suggested that such rilles may be the remains of lava channels that once contributed to the flooding of the maria. This object repays observation with larger telescopes and will tax the skill of experienced observers. Sunrise is 4 days after first quarter, and sunset occurs 4 days after last quarter.

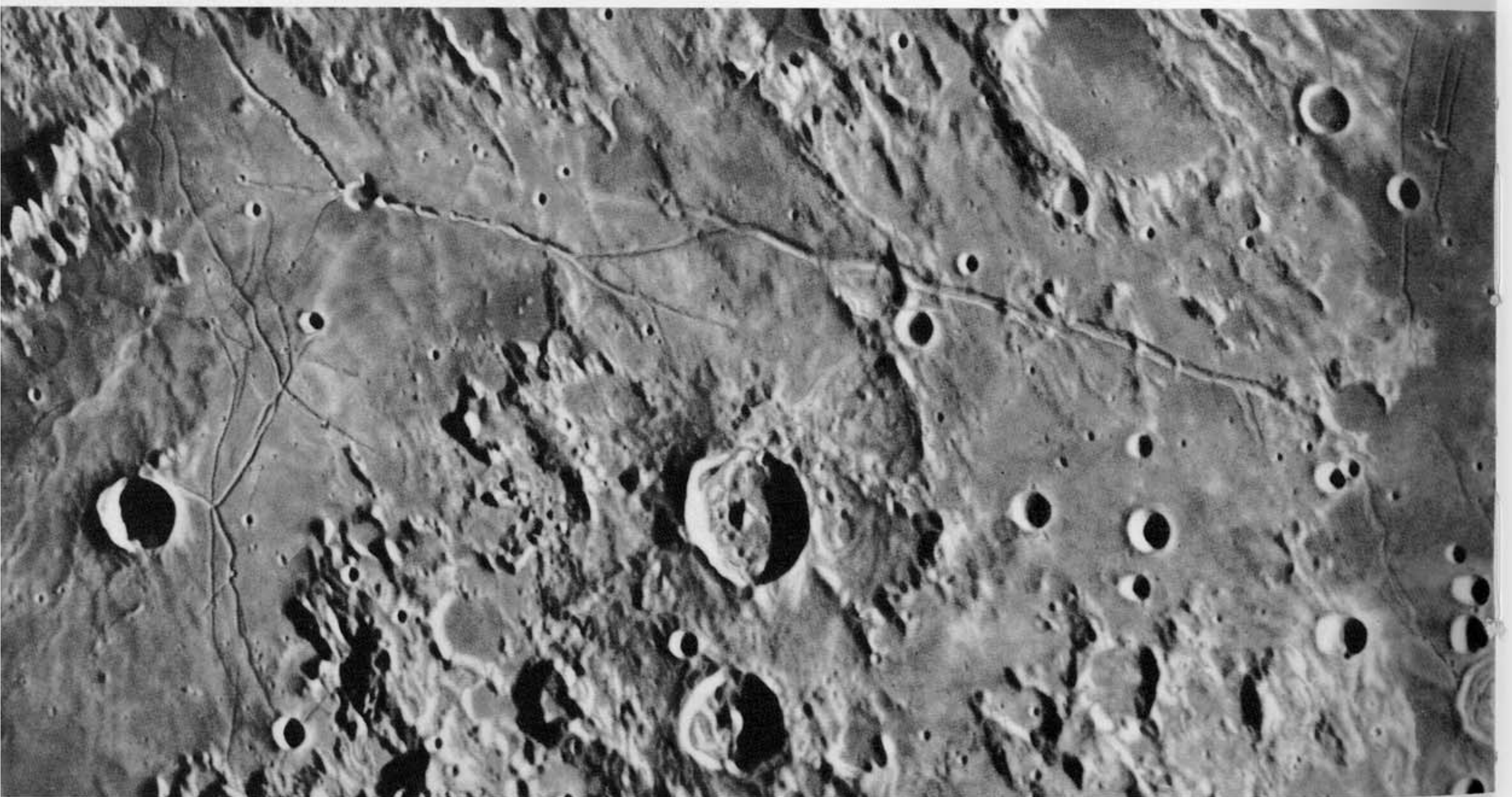
23. **Rimae Triesnecker and Rima Hyginus**

Rimae Triesnecker
(*below, bottom left*) (map 33) *col. 357°*

A complex system of rilles creating the illusion of deep clefts. In fact, these are shallow valleys with flat floors, usually 1–2 km wide. The greatest extent of the system is about 200 km. A very attractive telescopic object. Sunrise is just before first quarter, and sunset occurs just before last quarter.

Rima Hyginus (*below, top left*) (map 34) *col. 357°*

One of the most unique lunar formations. The 220-km-long rille is divided by the crater Hyginus into two sections of different length. The average width of the rille is 2–3 km; its depth is only a few hundred meters. The rille in some places changes into a line of linked craters. A small telescope shows just a simple rille. Sunrise is almost 1 day before first quarter, and sunset 1 day before last quarter.



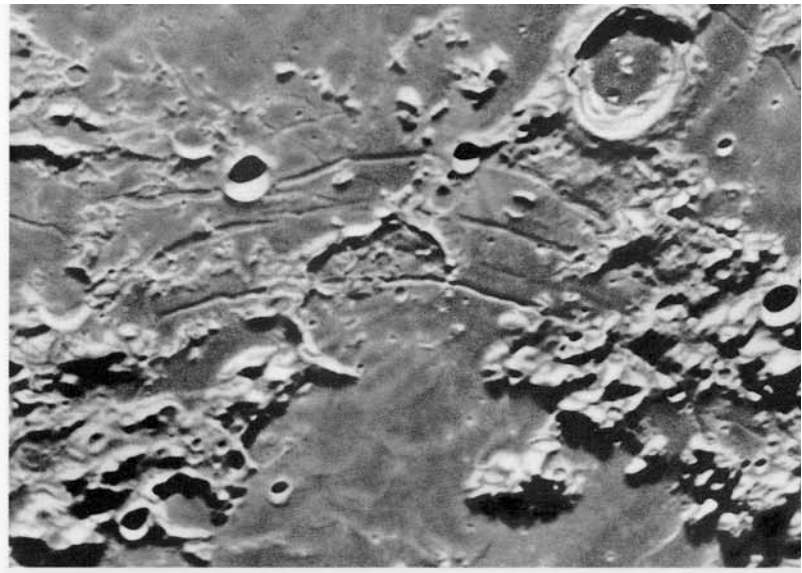
24. **Rima Ariadaeus**

(*fabove, top right*) (map 34) *col. 351°*

This rille, 220 km long, assumes the form of a shallow valley with a flat floor, 3–5 km wide. The valley is in many places interrupted by elevations intruding from the surrounding terrain. Along the western extension of Rima Ariadaeus a narrow rille branches off to join the rille Rima Hyginus. Close to the terminator, Rima Ariadaeus is easily observable through small telescopes. Sunrise is 1 day before first quarter, and sunset 1 day before last quarter.

25. **Rimae Hippalus** (maps 52, 53) *col. 40°*

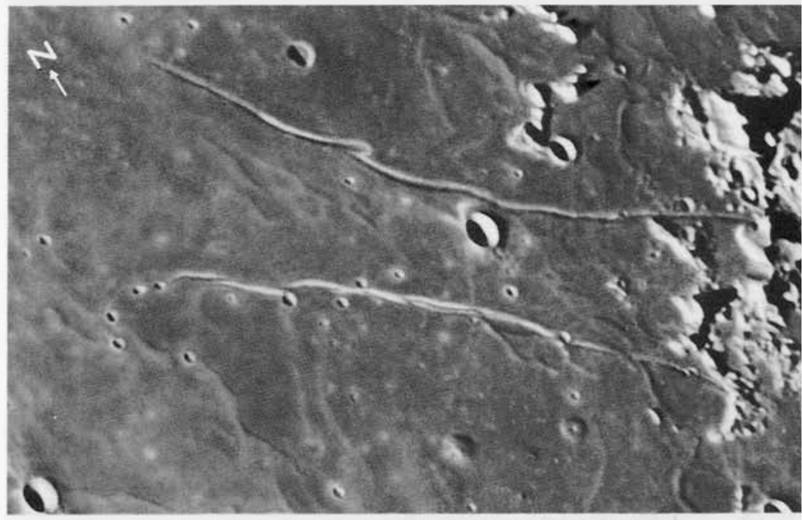
A system of wide, easily observable rilles that, in concentric arcs, follow the eastern edge of the Humorum basin. The greatest span of the system is about 240 km from north to south. The westernmost rille crosses the lava floor of the flooded crater Hippalus. The rille on the extreme east of this system is interrupted by the simple craters Campanus A (11 km in diameter) and Agatharchides A (16 km in diameter). Sunrise and sunset occur 2.5 days after first quarter and last quarter, respectively.



26. **"Hyperbolas" near Cauchy**

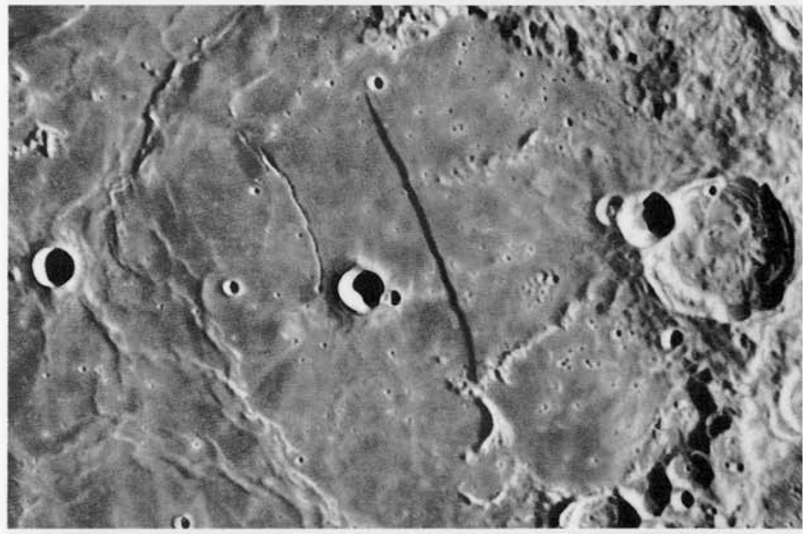
(map 36) *col. 134°*

An extraordinarily interesting landscape. The rilles and faults near the crater Cauchy have an appearance reminiscent of the two branches of a hyperbola. To the north of the crater there are two rilles, Rimae Cauchy, which link up to produce a total length of 210 km. South of Cauchy, on the eastern edge of Mare Tranquillitatis, a rille proceeds to the northwest, where, in the vicinity of Cauchy C, it continues as the narrow escarpment Rupes Cauchy, 120 km long. If illuminated by the rising Sun (4 days after new Moon) it casts a narrow shadow, while under the setting Sun (4 days after full Moon) the brightly illuminated slope of the fault can be seen. South of this fault there are two large lunar domes.



27. **Rupes Recta** (map 54) *col. 20°*

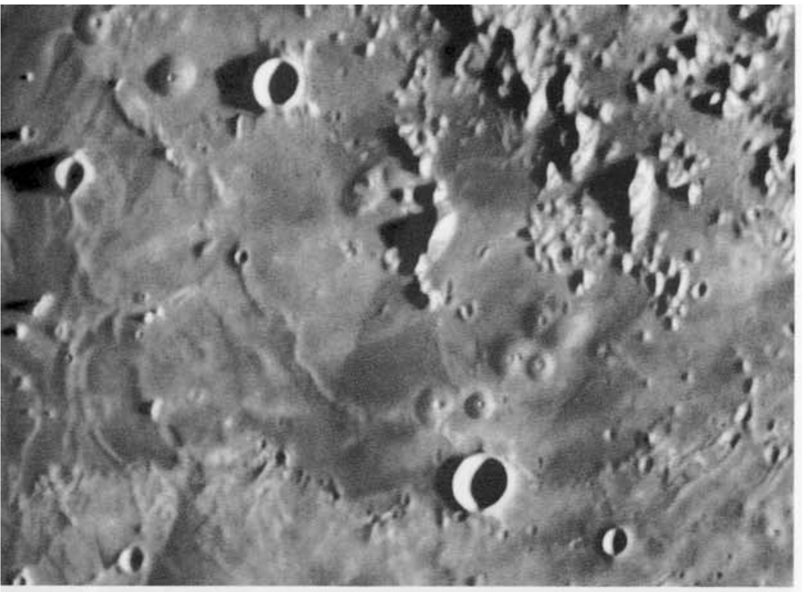
The best-known fault on the Moon, easily observable even through a small telescope. The length of the fault is 110 km, its height 240–300 m, and its apparent width 2.5 km. Thus, it is not a steep scarp but a moderate slope. When illuminated by the rising Sun (less than a day after first quarter) it casts a striking shadow. Before sunset (shortly after last quarter) the illuminated slope of the fault shines brightly. Between the small craters Birt E and Birt F runs Rima Birt, 1.5 km wide and 50 km long.



28. **Mons Gruithuisen Gamma**

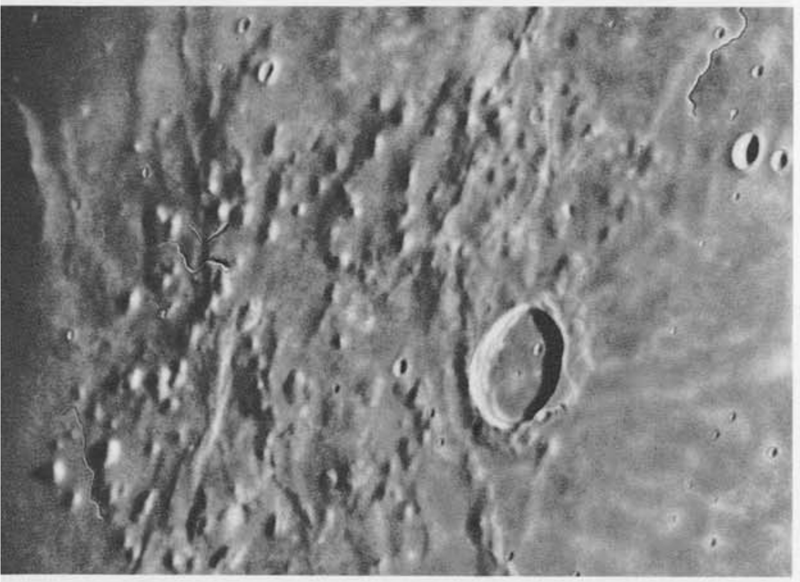
(map 9) *col. 52°*

A mountain in the form of a lunar dome, with a circular base 20 km in diameter. The foreshortening effect in this area gives the formation the appearance of an upturned bathtub. There is a summit crater 900 m in diameter, which is a suitable test object for larger telescopes. Sunrise is 3 days after first quarter, and sunset 3 days after last quarter.



29. **Domes near Hortensius and Milichius** (map 30) *col. 34°*

One of the best-known groups of lunar domes, north of Hortensius, and a solitary dome to the west of Milichius. The domes have approximately circular bases, 10–12 km in diameter, and are 300–400 m high. The majority have summit craters about 1 km in diameter. Domes are manifestations of lunar volcanism and are observable only when close to the terminator. Sunrise is 2.5 days after first quarter, and sunset 2.5 days after last quarter.

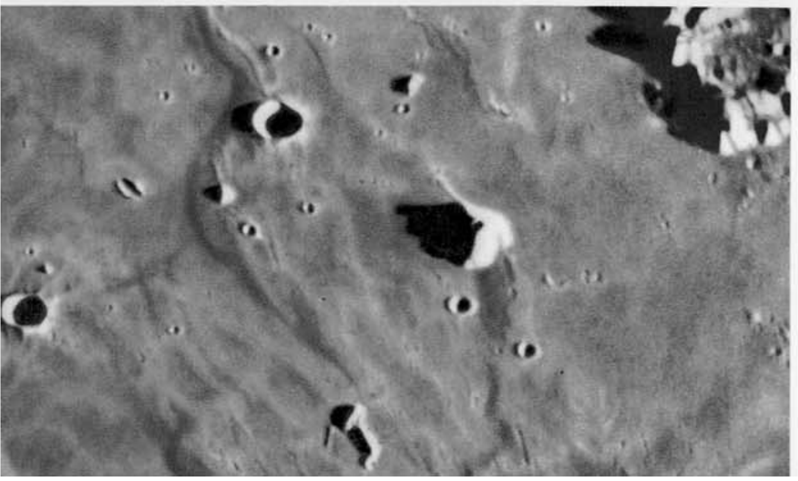


30. **Domes near Marius** (map 29) *col. 61°*

An extensive field of low domes in the vicinity of Marius (41 km in diameter) is an apparent manifestation of former volcanic activity in this part of Oceanus Procellarum. This area was one of the selected (but never used) landing sites for the *Apollo* missions. The domes are observable only when close to the terminator, i.e., at sunrise (4 days after first quarter) or sunset (4 days after last quarter).

31. **Mons Pico and Montes Teneriffe** (map 11) *col. 20°*

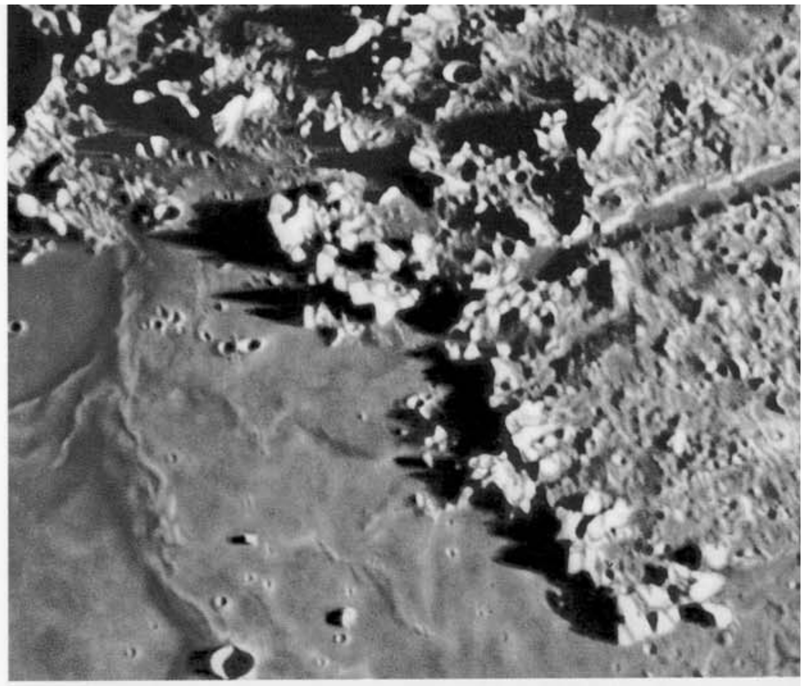
Mons Pico is an isolated mountain with a base area of 15 × 25 km and a height of 2,400 m. The peaks of Montes Teneriffe also reach a height of 2,400 m above the surrounding surface of Mare Imbrium. In the neighborhood there are prominent mare ridges. Sunrise is 1 day after first quarter, and sunset 1 day after last quarter.



32. **Mons Piton** (map 12) *col. 10°*

A typical isolated mountain reaching a height of 2,250 m above the surface of Mare Imbrium. The diameter at the base of the mountain (25 km) is 11 times its height. Thus, it is a relatively flat formation with gentle slopes, despite the shadows cast under oblique illumination, which give a false impression of a very steep mountain. Sunrise and sunset takes place at the quarter phases.

33. **Montes Alpes** (maps 4, 12) *col. 10°*

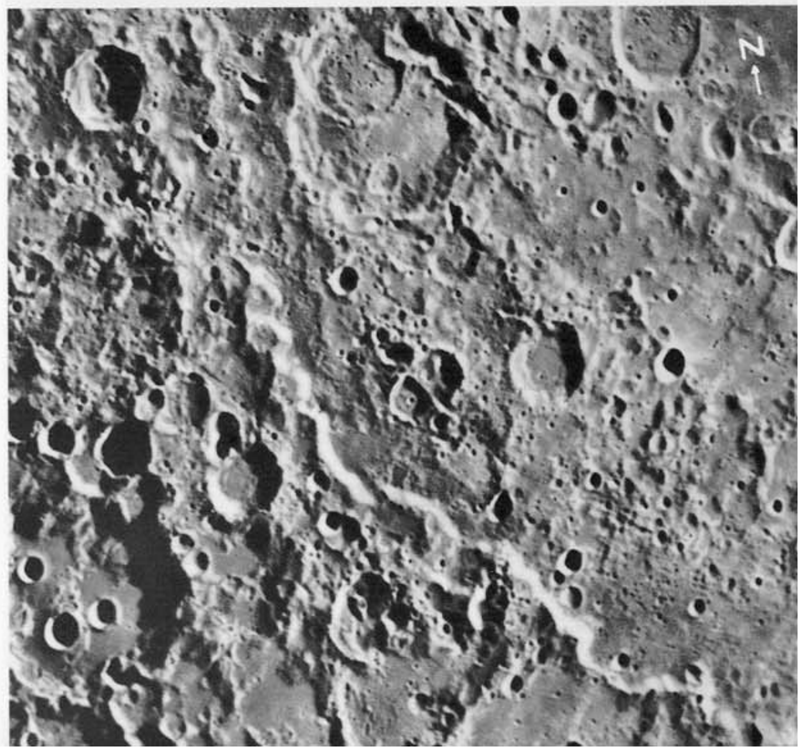


A part of one ring of the Imbrium basin, the lunar Alps are composed of separate mountainous formations with peaks rising about 1,800–2,400 m above the adjacent Mare Imbrium. The highest mountain, Mons Blanc, is 3,600 m high. The lunar Alps offer dramatic views, especially at sunrise (at first quarter) when long tapering shadows give a completely false impression of jagged, towering peaks.

34. **Montes Apenninus, Rima Hadley** (map 22) *col. 156°*

The most prominent part of the main ring of Imbrium basin, which attains a height of 5,000 m above the level of adjacent maria. Through a larger telescope, the rille Rima Hadley (width about 1.5 km, depth 300 m), in the vicinity of the *Apollo 15* landing site, can be distinguished. The Apennines are a magnificent sight at sunset (at last quarter), when their western slopes are illuminated by the Sun.

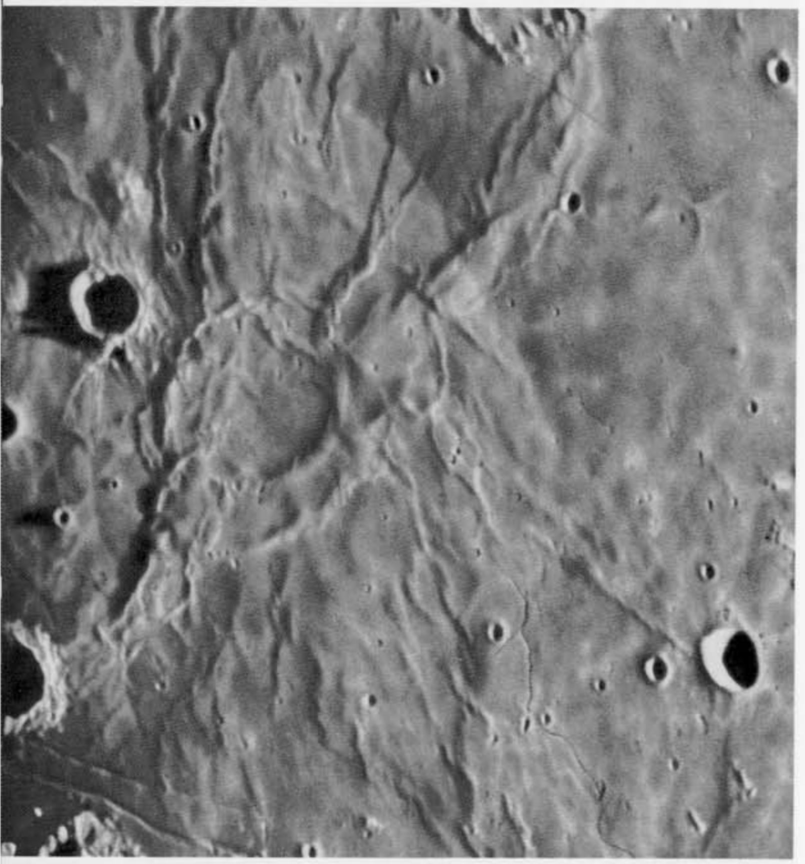
35. **Rupes Altai** (map 57) *col. 351°*

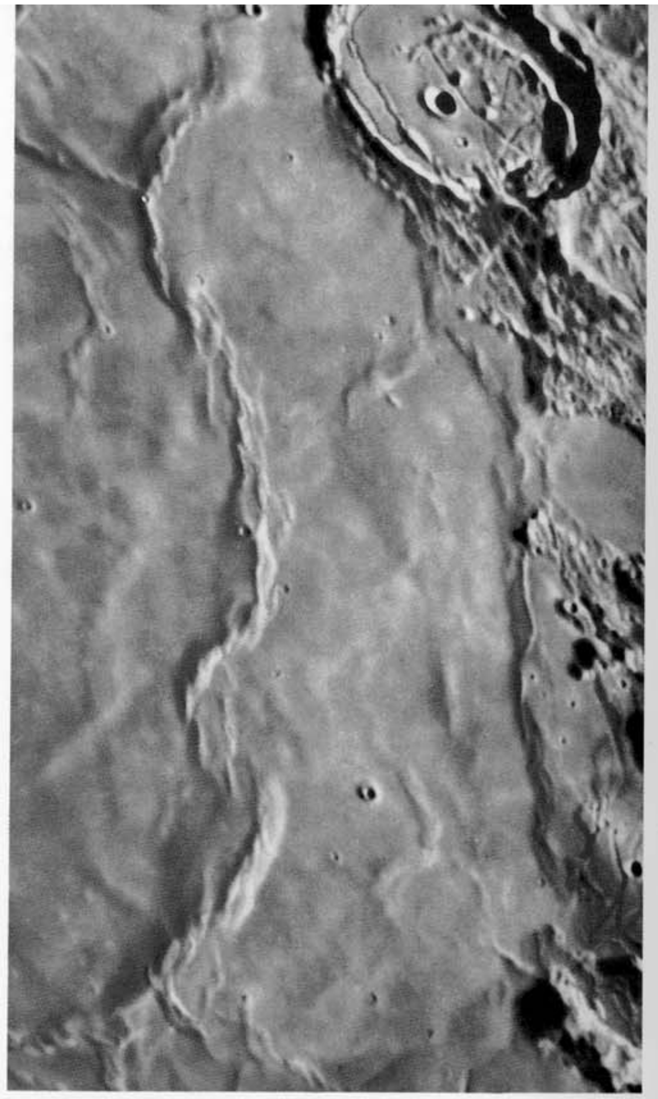


The Altai fault, formerly called the Altai Scarp, is a substantial remnant of the concentric "walls" or rings surrounding the Nectaris basin. The length of the arc-shaped fault is 480 km. The slopes descending into the basin shine brightly under the rising Sun (2–3 days before first quarter) and, vice versa, they disappear into their own shadows under the setting Sun (2–3 days before last quarter).

36. **Lacus Mortis** (map 14) *col. 340°*

Lacus Mortis occupies the floor of a considerably degraded crater approximately 150 km in diameter. The remains of its rim are preserved, mostly in the west. The observer's attention will be attracted by the crater Bürg (diameter 40 km), which is a center of mare ridges running to the north and southwest. Other easy objects are two wide rilles from the Rimae Bürg system; the shorter one passes by the southern edge of Lacus Mortis into a fault, which casts a wide shadow at sunrise (2 days before first quarter) and shines brightly at sunset (2 days before last quarter).





37. **Dorsa Smirnov and Posidonius** (maps 14, 24) *col. 340°*

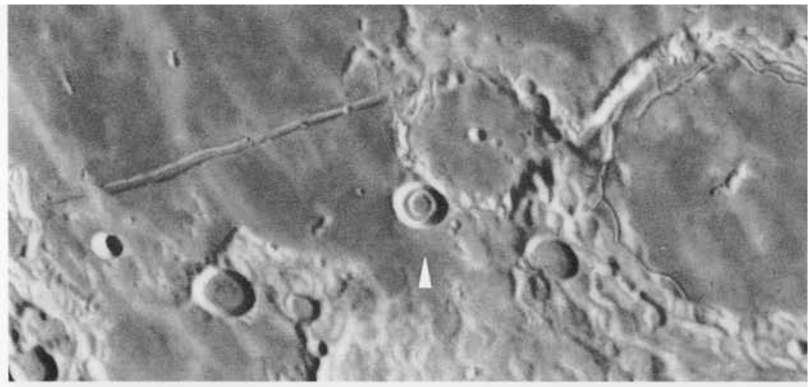
Parallel to the eastern edge of Mare Serenitatis is a prominent system of mare ridges. Formerly known as the Serpentine Ridge, its northern part is now called Dorsa Smirnov. The mare ridges are rounded, are of modest height (tens to hundreds of meters), and are observable only when they are close to the terminator. At their highest point, formerly named Posidonius Gamma, lies a simple crater about 2 km across. The crater Posidonius (95 km in diameter, 2,300 m deep) has a complex system of rilles on its floor. Sunrise is 2 days before first quarter and sunset 2 days before last quarter.

38. **Lamont** (map 35) *col. 340°*

The mare-ridge feature or "ghost crater" Lamont is a unique formation measuring some 75 km in diameter. The circular walls, which resemble typical mare ridges, range from 5–10 km in width and are up to 200 m in height. An extensive system of mare ridges is associated with Lamont in the western region of Mare Tranquillitatis. Sunrise and sunset occur 2 days before first quarter and last quarter, respectively.

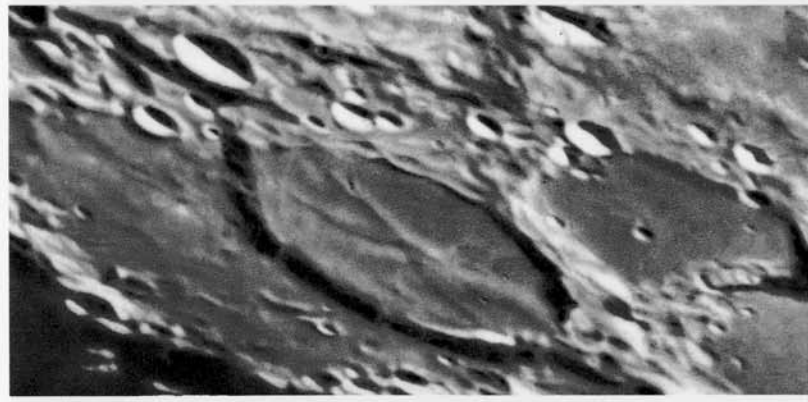
39. **Hesiodus A** (map 54) *col. 40°*

One of the rare examples of a crater with an inner ring. The diameter of the main (outer) rim of Hesiodus A is 15 km. Sunrise is 2–3 days after first quarter, and sunset 2–3 days after last quarter.



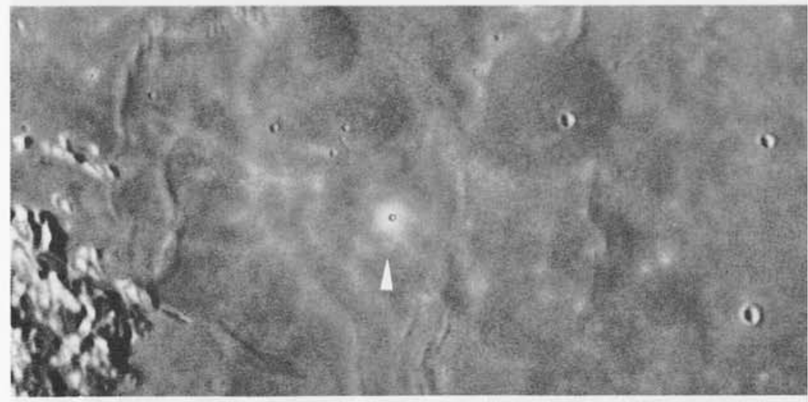
40. **Wargentin** (map 70) *col. 66°*

A rarity, breaking the normal rule that a crater's floor always lies below the level of the exterior terrain. The crater Wargentin, 84 km in diameter, is filled up to its rim with solidified lava, forming an elevated plateau with low wrinkle ridges on its surface. Sunrise is 2–3 days before full Moon, and sunset 3 days before new Moon.



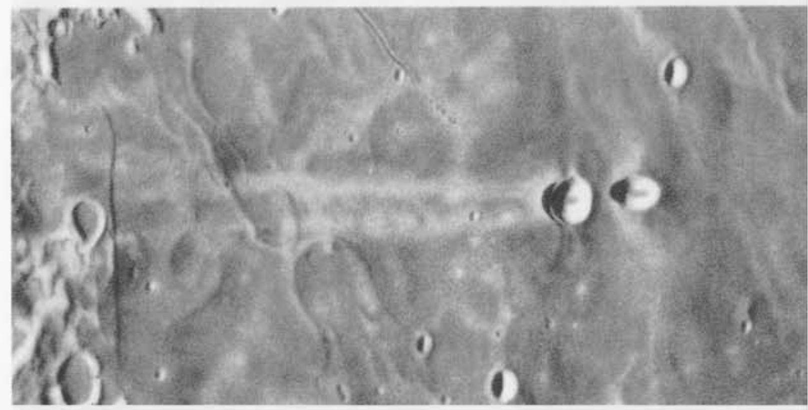
41. **Linné** (map 23) *col. 156°*

A simple, relatively young crater, 2.4 km in diameter, 600 m deep. It is surrounded by bright ejected material; under high illumination it appears through the telescope as a bright spot. In the literature, since the second half of the 19th century, numerous mysterious changes and disappearances of Linné have been recorded. These are classic examples of observing errors, which occur when lunar details are close to the limit of resolution of a telescope. Sunrise and sunset take place 1 day before first quarter and last quarter, respectively.



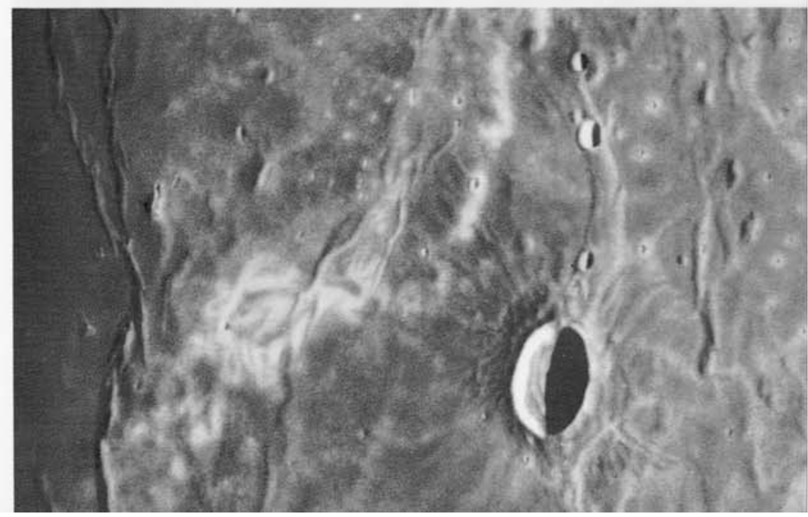
42. **Messier and Messier A** (map 48) *col. 118°*

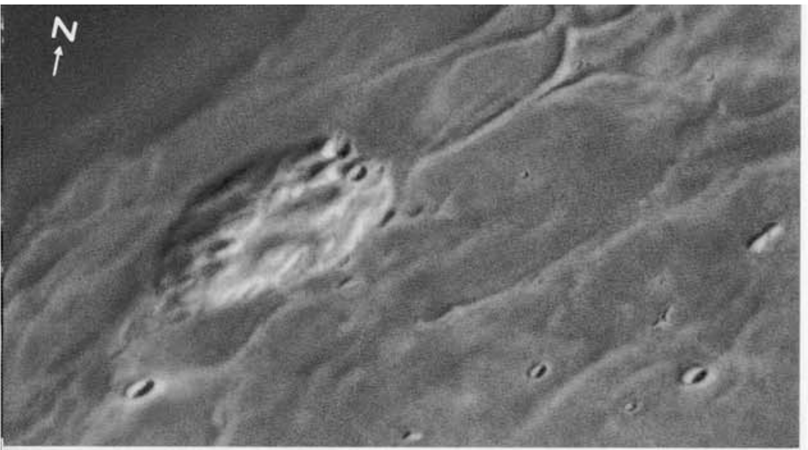
An interesting pair of craters. Messier is an oval crater elongated in an E-W direction. Its size is 9 × 11 km and it likely originated as the result of an oblique meteorite impact. Messier A comprises two circular craters; the younger, eastern crater overlaps part of the smaller, older formation. This twin-crater measures 11 × 13 km. To the west, two straight narrow rays, resembling the tail of a comet, trail across the surface of Mare Fecunditatis to a distance of about 120 km. Sunrise is 3–4 days after new Moon, and sunset 3–4 days after full Moon.



43. **Reiner Gamma** (map 28) *col. 64°*

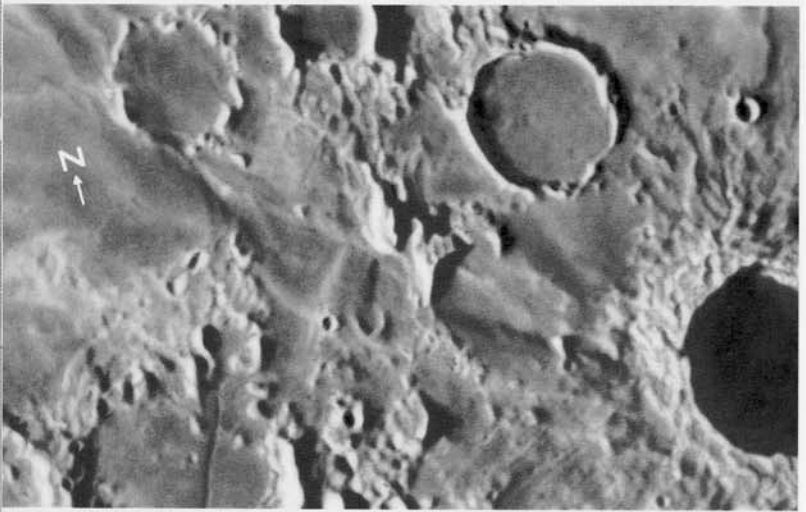
On the near side of the Moon, this is an extraordinary and unique formation in Oceanus Procellarum, some distance west of the crater Reiner. It is formed by swirls of extra-bright material on the surface of the mare, and even detailed photographs taken by the *Lunar Orbiter* probes do not show any evidence of relief. Sunrise is 5 days after first quarter, and sunset 3 days before new Moon.





44. **Mons Rümker** (map 8) *col. 64°*

The most extensive complex of domes on the Moon. The diameter of this volcanic formation is about 70 km. Several low, flattish domes add to the irregular shape of this structure, and there are dozens of tiny craters, which are too small to be discerned from Earth. Sunrise is 5 days after first quarter, and sunset 3 days before new Moon.

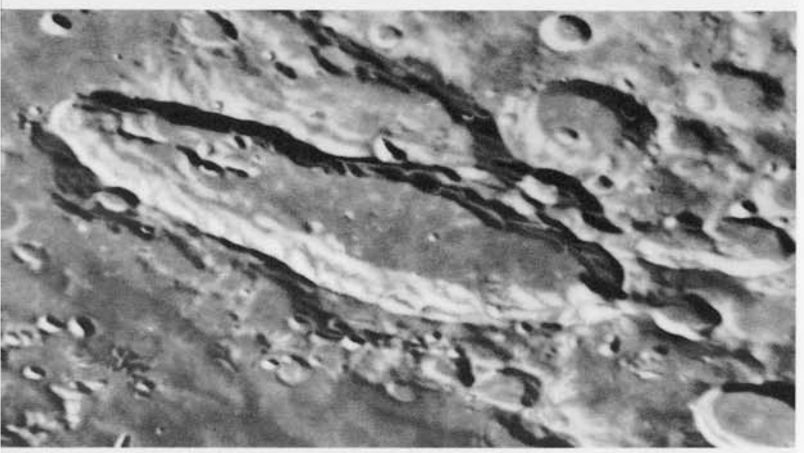


45. **The "bridge" over the valley Bullialdus W** (map 53) *col. 198°*

A lunar rarity. From the crater Bullialdus (61 km in diameter, 3,510 m deep) a shallow valley denoted by the letter W progresses in a northwesterly direction. Approximately 100 km from the crater Bullialdus, the valley is interrupted by a flat, 10-km-wide wall that gives the illusion of a bridge. Sunrise is 2 days after first quarter, and sunset 2 days after last quarter.

46. **Hainzel — a composite crater** (map 63) *col. 198°*

Three craters overlap each other to form a single composite formation. The oldest and largest of these is Hainzel (70 km in diameter); Hainzel C is of intermediate age, while the youngest is Hainzel A (53 km in diameter). Sunrise is 3 days after first quarter, and sunset 3 days after last quarter.

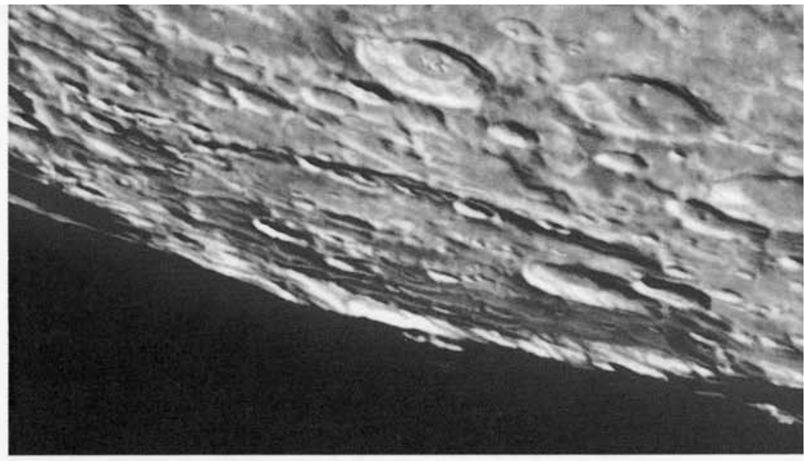


47. **Schiller** (map 71) *col. 61°*

An extraordinarily elongated crater, measuring 179 × 71 km, the shape of its rim resembles a footprint. The floor of the crater is smooth, as if flooded with lava. Noncircular formations have complicated structural histories, and Schiller, by virtue of its size, is the most remarkable example on the Moon. Sunrise is 3 days after first quarter, sunset: 3 days after last quarter.

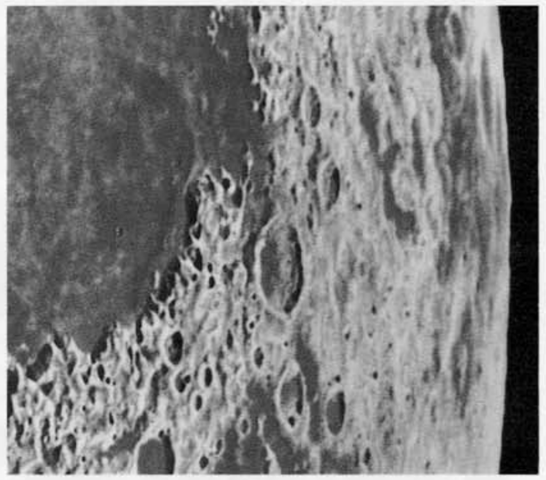
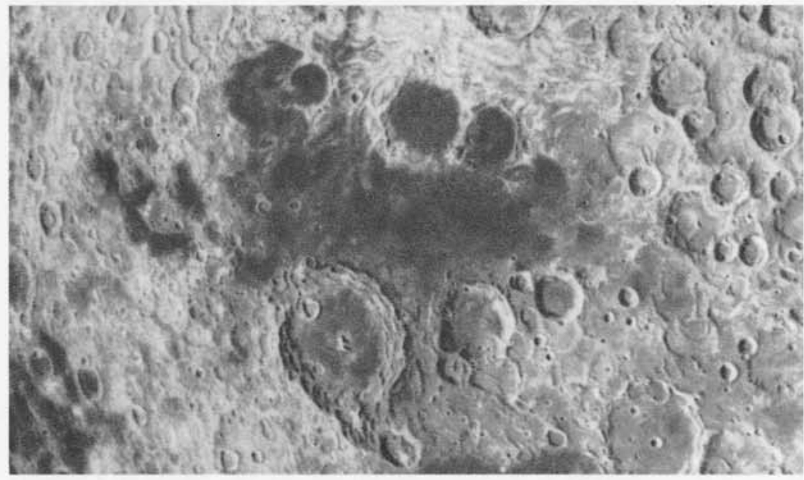
48. **Bailly** (map 71) *col. 81°*

With a diameter of over 303 km, Bailly was once thought to be the largest crater on the near side of the Moon, but is now regarded as the smallest multiring basin on the lunar surface. However, because of its unfavorable position near the south pole and its degraded condition, Bailly's basin-ring fragments are very difficult to discern. Sunrise is 3 days before full Moon, and sunset 3 days before new Moon.



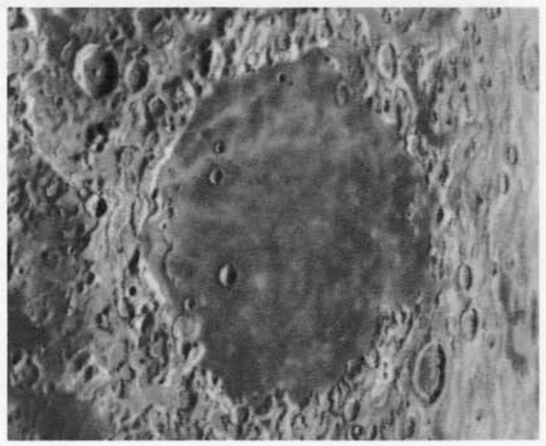
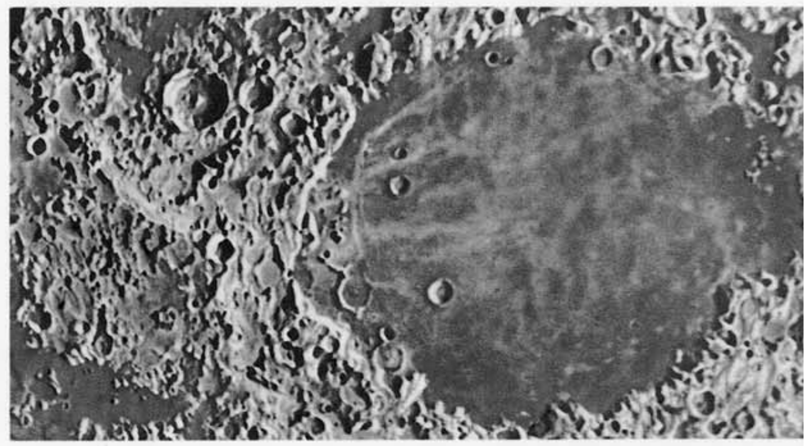
49. **Mare Marginis** (maps 27, 38, III)
(Left), col. 329° *(Right), col. 50°*

Mare Marginis is elongated in a SE-NW direction. It is observable east of Mare Crisium at favorable librations. The undistorted shape of Mare Marginis can be seen in the right-hand photograph, which is from *Apollo 16*. The large crater Neper (diameter 137 km) dominates the southern shore of Mare Marginis. Sunrise is shortly after new Moon, and sunset follows full Moon.

50. **Mare Crisium** (maps 26, 27, 37, 38)
(Left), col. 335° *(Right), col. 329°*

A circular structure resembling a giant crater 570 km in diameter. It is a typical lunar basin of impact origin. In the distant past the floor was submerged under thick layers of lava. These cover deeper and denser material that causes an anomaly in the local gravitational field (as detected by orbiting space probes). These mass concentrations are called *mascons*. Numerous mare ridges interrupt the smooth surface of the mare, which, being close to the limb, appears as an ellipse with its major axis running N-S. The shape of this ellipse changes dramatically, especially at the extremes of longitudinal libration. The actual, undistorted shape of the mare is elongated in an E-W direction as shown in the right-hand photograph. Sunrise is 2—4 days after new Moon, and sunset 2—4 days after full Moon.

Observation of the Moon

No other celestial body offers such a wealth of detail, changing appearance, and favorable opportunities for viewing. The most basic observation we can make is to try to forecast the Moon's visibility: for example, if the Moon is visible this evening, in which direction will it lie relative to the Sun, and what will be its altitude above the horizon? Let us consult the calendar to find the next principal lunar phase. From this we can determine the respective positions of the Sun and Moon, and estimate where the Moon will be at a certain hour and what phase it will exhibit. We can then verify our assessment by going outside to look at the sky.

The beginning lunar observer should familiarize himself or herself with the names, shapes, and positions of the lunar maria. These dark areas can be distinguished with the naked eye, but a pair of binoculars or small telescope will improve the view and allow positive identifications to be made by referring to the map (Fig. 14). The best binocular views are obtained when the instrument is mounted on a fixed tripod. If a tripod is not available, the binoculars can be steadied against a window frame or tree, etc. But since a typical pair of binoculars will have a magnification of only 7× or 10×, hand holding is usually sufficient for short periods of time.

Binoculars are perfectly adequate for getting one's bearings on the Moon and for learning the basic nomenclature. However, for more detailed observations an astronomical telescope is a necessity. This can take a form of a small, portable instrument, or a larger, fixed telescope on a permanent mounting under a dome or perhaps in some sort of shelter with a sliding roof.

There are many different sizes and types of telescopes to choose from on the market. **Refractors** employ an objective lens to form an image. The aperture (diameter of the objective) of amateur refractors starts at about 2 inches, and as the lens diameter increases, so does the price — by dramatic leaps and bounds. **Reflecting telescopes**, as the name implies, contain metal-coated parabolic mirrors as objectives. They range in size from about 3 inches upward. Apertures in the 6- to 8-inch range are most popular, but many amateur astronomers use larger instruments of 10- or 12-inch aperture and even bigger. Fortunately, the price for a given aperture is lower for a reflector than for a refractor of the same size. Another widely used type is the **catadioptric telescope**, which combines both lenses and mirrors. Examples include the popular Schmidt-Cassegrain and Maksutov telescopes. These instruments are usually very compact and portable.

The choice of telescope and its accessories depends on the requirements of the observer who must decide which type to purchase and how much to spend. For a novice, it's a good idea to ask advice from an experienced telescope user at a nearby astronomy club, public observatory, or planetarium.

The role of the scope's objective (lens or mirror) is to collect the light rays and bring them to focus at the focal plane. The image formed there is very small, so we need to observe it through a magnifying eyepiece. A set of good-quality eyepieces is important for every observer. Telescopic **magnification**, *z*, is simply the ratio *F*:*f*, where *F* is the focal length of the objective and *f* the focal length of the eyepiece expressed in the same units. For example, if our telescope has an objective with a focal length of 1 m and an eyepiece with a focal length of 10 mm, then the magnification $z = 1000/10 = 100\times$. From this we can see that magnification depends on focal length only and is unrelated to the diameter of the objective lens or mirror.

Often the new owner of a telescope seems obsessed with its magnifying power, as if this alone determines the excellence of the optical system. This is rather like judging the performance of a car by the maximum speed shown on the dial of the speedometer! Needless to say, magnifying power is important, but even more so is the resolution of the telescope, which determines how much fine detail can be discerned on such objects as the Moon and planets. This is the main question to be addressed.

The **resolution** of a telescope can be determined by measuring the minimum angular distance between two points that can be barely separated; the limit is reached when the images of the two points merge into one. This is expressed in arcseconds (") and can be calculated by the simple formula $r'' = 120''/d$, where r'' is the resolving power and *d* is the diameter of the objective in millimeters. For example, an objective of 80 mm diameter should have a resolving power of 1.5".

From the Earth, a lunar crater with a diameter of about 1.9 km may be discerned using a telescope with a resolution of 1" (1 second of arc), so, theoretically, we ought to be able to distinguish a 3-km-diameter lunar crater with an 80-mm objective. This assumes, of course, that our telescope has a high-quality objective and a stable mounting, that the eyepiece is perfectly focused, and that all this is being used under ideal conditions in which the atmosphere is clear and still. The actual quality of the atmospheric seeing conditions can be tested empirically by using small lunar craters as test objects, of which dozens are listed in the descriptions accompanying the 76 sections of the map of the Moon.

Another property of an objective lens (or mirror) is its *speed*, which is defined as the ratio of its diameter to its focal length. (For example, an objective with a diameter of 3 inches and a focal length of 45 inches has a focal ratio or speed of f/15). For lunar and planetary work, refractor telescopes with focal ratios of f/10 to f/15 and reflectors in the f/6 to f/10 range usually provide the best performance. The diameter and quality of the objective, together with the design and quality of the eyepiece (of which there are many), all influence the actual resolution, contrast, and color accuracy of the image and the overall level of detail that is visible.

And what role is played by the magnifying power in all this? While it does not affect the theoretical resolution of a telescope, choosing a suitable eyepiece allows you to optimize the performance of the telescope to suit prevailing atmospheric conditions. For every telescope objective there is an optimum magnification that allows the telescope to attain its maximum performance in rendering fine detail in a particular situation. This property is sometimes known as **useful magnification** and, for smaller instruments, is approximately equal to two times the aperture in millimeters. So for an 80-mm refractor, the maximum useful magnification is approximately 160×. Of course, we can employ eyepieces of shorter focal length to increase the magnification to anything we like, but unless the atmosphere is unusually steady and the telescope is of excellent quality, no additional detail will be seen. Most of the time atmospheric turbulence, amplified by magnification, forces the observer to use magnifications that are less than what the instrument is capable of. However, even with magnifications of only 30× to 40×, an experienced lunar observer will be able to detect fine detail if he or she is familiar with the appearance of the feature from previous observations or from photographs and maps.

Up to now we have considered only the optical parameters, but no matter how good these are, all will be lost if the telescope is inadequately mounted. It should be possible to point the scope to any part of the sky without introducing excessive vibration. Beware of lightweight, portable tripods and similar mounts, supplied with the telescopes in department stores – they are worse than useless; they shake like aspen leaves at the lightest touch or in the slightest breeze.

For observing the Moon, the basic requirement is a stable mounting that enables the instrument to be moved about two axes that are perpendicular to each other. The **altazimuth** mount is the simplest kind, and it allows the telescope to move up and down and left and right. The Dobsonian telescope is a particularly popular implementation of the atazimuth design. Dobsonians are usually 6-inch and larger Newtonian reflectors that combine excellent stability with simplicity and ease of construction.

For high-magnification observing, the best kind of mount is one on which the telescope can be driven by a small motor made to cancel the Earth's rotation and thus follow objects automatically. Such a setup is known as a motor-driven **equatorial** mount and work by having one axis of the mount aligned with the Earth's pole. Recent years have seen the emergence of motorized computer-controlled mounts that can be either altazimuth or equatorial. These units not only track objects like a traditional equatorial mounting but also have many other functions, including "go to," that are not essential for lunar work.

Last but not least, a **trained eye** at the eyepiece is indispensable to making the best of a telescope's capabilities. *An experienced observer is one of the most important parts of the whole observation system.* This is why it is necessary to train the eye to accurately interpret the incoming image. A telescope works differently than a television set in which everyone essentially sees the same image. Very often the new telescope user is disappointed by what he or she sees (or think they see) and how different it is from the miraculous accounts and magnificent images published in the astronomical literature. Observing with a telescope is a skill that has to be learned and exercised. Fortunately, this skill is easy to obtain since it comes with experience and careful viewing — the more one observers, the more skillful one becomes. Persistence leads to success!

Visual observations

To begin observing the Moon, let us concentrate on some of the named formations shown on the maps. Finding them, remembering their names, positions, and appearances, and observing them is in itself an absorbing and long-term program involving a step-by-step scrutiny of the lunar surface during different phases.

Although the lunar surface near the terminator is the most dramatic, telescopic exploration of the Moon's face can continue even during full Moon, bearing in mind that the absence of shadows removes nearly all evidence of vertical relief. Full Moon is also when lunar eclipses occur, and, as described on page 213, it can be rewarding to observe the contact of small bright craters with the Earth's shadow as it moves across the lunar disk using the map on page 25. It should be noted that it is only during a lunar eclipse that we get to see a true full Moon. When the Moon passes outside of the Earth's shadow, it is never exactly "full" in the sense that the phase angle is always greater than zero (normally

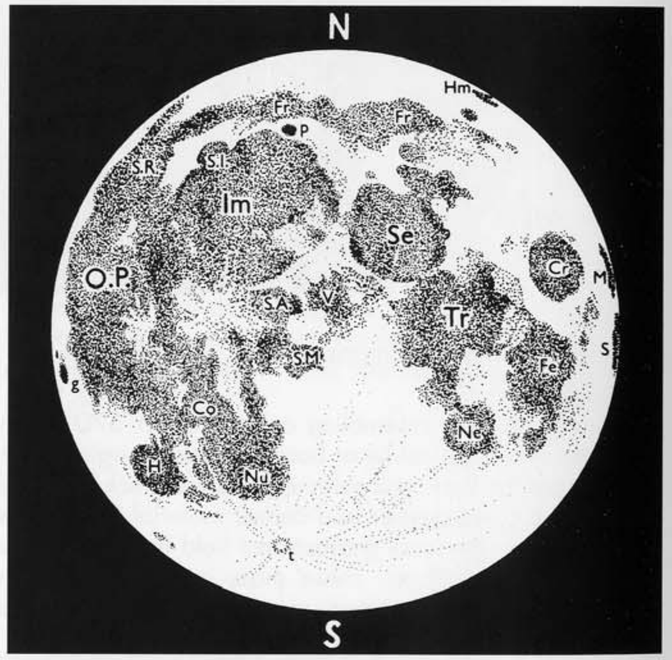


Fig. 14. *A map of the lunar maria and craters visible with the naked eye or using a pair of binoculars. Key:* **N** *= north,* **S** *= south; Co = Mare Cognitum (Known Sea), Cr = Mare Crisium (Sea of Crises), Fe = Mare Fecunditatis (Sea of Fertility), Fr = Mare Frigoris (Sea of Cold), H = Mare Humorum (Sea of Moisture), Hm = Mare Humboldtianum (Humboldt's Sea), Im = Mare Imbrium (Sea of Rains), M = Mare Marginis (Border Sea), Ne = Mare Nectaris (Sea of Nectar), Nu = Mare Nubium (Sea of Clouds), O. P. = Oceanus Procellarum (Ocean of Storms), S = Mare Smythii (Smyth's Sea), Se = Mare Serenitatis (Sea of Serenity), S. A. = Sinus Aestuum (Bay of Billows), S. I. = Sinus Iridum (Bay of Rainbows), S.M. = Sinus Medii (Central Bay), S. R. = Sinus Roris (Bay of Dew), Tr = Mare Tranquillitatis (Sea of Tranquillity), V = Mare Vaporum (Sea of Vapors); g = Grimaldi (crater), p = Plato (crater), t = Tycho (crater).*

attaining several degrees of arc). As a result, we can observe how the terminator, marked by perspective-shortened shadows of craters and mountains, proceeds from the western limb over the pole (north or south, depending on the Moon's position with regard to the plane of the ecliptic) to the eastern limb of the lunar disk. If you have the rare opportunity to observe the Moon around the predicted time of the full-Moon phase (as given in almanacs), don't miss it!

Relating the Moon's face as seen through the telescope with its portrayal on lunar maps can often be challenging for the observer. Depending on the telescope type and configuration, the image of the Moon (or anything else viewed through it) may appear upright, upside down, or mirror-reversed, in addition to being rotated when compared with north-up oriented charts or with the naked-eye view. The "classic" straight-through view in an astronomical telescope (e.g., a refractor or catadioptric telescope without a star diagonal, or a Newtonian reflector) shows the Moon oriented south up. It is easy to turn a north-up map upside down for a comparison (though reading the upside-down crater names is not very enjoyable). But perhaps the most frustrating situation is a mirror-reversed image, well known to users of telescopes that have an odd number of reflections (e.g., refractors and catadioptric scopes that utilize a 90° star diagonal for viewing comfort). Flipping everything in one's brain is very tiring. The totally disoriented observer could consider duplicating the atlas pages left-right reversed or (an even more hopeless idea) reading the maps reflected in a hand-held mirror. Fortunately, manufacturers of astronomical equipment offer accessories (like erecting prisms) for terrestrial viewing that yield upright, nonreversed images. The perfectionist will note that the extra optical components will degrade the image quality somewhat, but usually this only becomes noticeable at higher magnifications.

If we want to test the performance of our telescope and, at the same time, improve our observational prowess, we can resort to the methods used by the classical selenographers and attempt to draw the detail we see as faithfully as possible with a pencil and paper. How should we proceed? Well, first we must assemble the usual drawing implements: paper, pencils (HB or softer), and an eraser. In addition, we need a small lamp or flashlight to illuminate the paper. If you are a solitary observer, don't hesitate to use a normal white light instead of an astronomer's red light — bright Luna doesn't require a dark-adapted eye. But if you are attending a star party and are surrounded by many observers, you will need to use a red light to make sure you don't interfere with other folks.

We could commence drawing on a blank sheet of paper, but life can be made easier if an outline of the chosen formation is sketched in advance, referring to a photograph or map. Such a procedure saves time and allows us to focus on the actual appearance of the formation under that night's particular angle of illumination, and to record the shapes of shadows, the distribution of lighter and darker tones, and any other details. More experienced observers sometimes attempt to mark tiny details directly onto a prepared enlarged photograph or map of the area under scrutiny. As a rule, it is best to restrict our detailed drawings to small areas that can be depicted within a reasonable amount of time, say 10 to 30 minutes. If the work takes too long, not only does the eye get tired but the appearance of the lunar landscape changes, particularly those areas situated near the terminator. For example, it is impossible to portray accurately, in a short time, a crater such as Copernicus, which is full of minute and complicated detail. Each drawing should be inscribed with the date and time of the observation, the type of telescope used, the magnifying power, and an evaluation of the atmospheric seeing conditions.

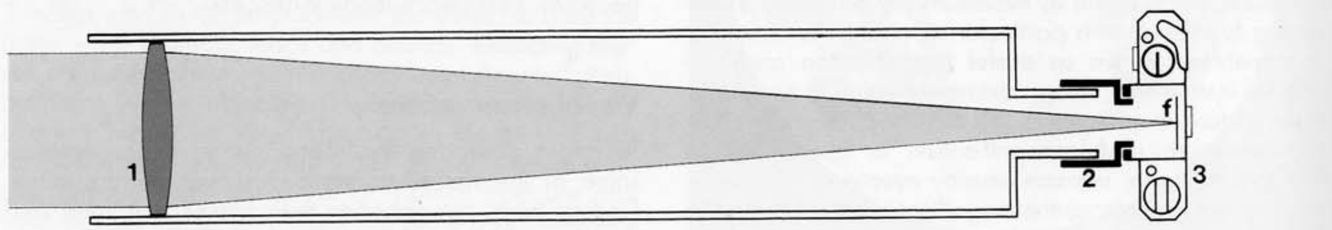


Fig. 15a. The scheme of photographing in the focal plane of the objective lens of a telescope. 1 = objective lens of telescope, 2 = tube for attaching the camera body, 3 = camera body (minus lens), f = focal image of the Moon.

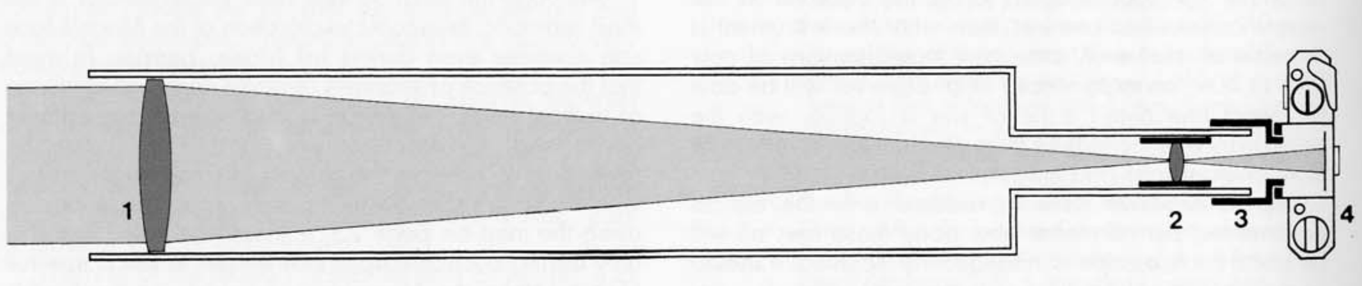


Fig. 15b. The scheme of photographing by eyepiece projection. 1 = objective lens of telescope, 2 = projection eyepiece (or Barlow lens), 3 = tube for attaching the camera body, 4 = camera body (minus lens).

The section entitled "Fifty views of the Moon" (p. 194) provides plenty of suggestions for regular observations of interesting formations and regions under varying angles of illumination. Substantial changes in the appearances of Moon features occur in the course of a lunar day, sometimes leading to apparent invisibility and at other times emphasizing their conspicuousness. The period when an area of interest will be close to the terminator can be determined beforehand by referring to the colongitude tables on page 218 or by consulting an astronomical almanac or a computer program. A morning or evening terminator crosses every part of the lunar surface 25 times per year. Supposing that the fine detail of a given formation may be observed under a suitable illumination for perhaps two days or slightly longer, this equates to a possible 50 observational opportunities per year. However, about two-thirds of these cannot be exploited because of bad weather, and about one-third of the remaining 16 nights are subject to acute atmospheric turbulence.

Disregarding five nights of average, indifferent seeing, we are left with five opportunities per year to observe the selected area under excellent or at least good conditions! Furthermore, some low-profile or small features are visible only when they are positioned very close to the terminator. Indeed, many years can elapse before an observer is able to repeat his or her observation of a given area under almost identical phase, libration, and excellent seeing conditions. This is why all systematic observations are unique and valuable.

Imaging the Moon

Up to now we have only been discussing visual observations of the Moon. In the history of lunar studies, however, there is no doubt that photography has played an important role in producing precise and objective representations of the Moon's surface. The Moon is also a popular target for the photographically inclined amateur astronomer. Ordinary cameras can take impressive black-and-white or color photographs of the Moon above a terrestrial landscape. But with the standard photographic lens (e. g., f = 50 mm) the size of the lunar image is only 0.5 mm, which is hardly sufficient to resolve the lunar phase. Far more useful are telephoto lenses, with their longer focal lengths. As a rule, we can calculate the size of the lunar image, d, in the focal plane of our camera by dividing the image-forming focal length in centimeters by 115. For example, for a telephoto lens of focal length f = 13.5 cm, the image size d = 0.12 cm or 1.2 mm; with an even longer focal-length lens of, e. g., f = 30 cm, the image size d = 2.6 mm, which is sufficient to reveal the phase and the shapes of the lunar maria.

It is obvious from the above that something more than the usual type of photographic equipment must be used in order to obtain detailed images of the Moon. The answer is to use the telescope's long-focus objective lens or mirror as a camera lens and to attach a camera, minus its lens, to the tube that normally houses the eyepiece (Fig. 15a). (If the lens of your camera isn't removable, *afocal* photography is recommended; see below.) This is called **prime-focus photography**. In this, the telescopic lunar image passes through the open camera shutter and falls onto the photographic emulsion. Focusing is easy with a 35-mm single-lens reflex (SLR) camera, which, minus its lens, is attached to the telescope's focuser with a special adapter. This kind of camera also allows the photographer to check that the lunar image will actually fall onto the film when the camera's shutter is released. As explained above, the size of the Moon's image at the focal plane depends on the focal length of the objective. If, for example, we have a telescope objective with a focal length of 120 cm, the image of the Moon will be approximately 1 cm in diameter on the film and will show the jagged edge of the terminator and the large craters. However, the image will still not show fine detail, and some information will be lost in the grain of the photographic emulsion.

A larger image scale can be achieved by using a second method, called **eyepiece-projection photography**, which uses the telescope's eyepiece to enlarge the primary image formed by the objective and project it onto the film plane, located inside the camera (Fig. 15b). A Barlow lens may also be used for this purpose. As with prime-focus photography, a special adapter will be needed to fit the camera and eyepiece to the telescopes. Eyepiece-projection adapters are widely available. Focusing is carried out as before. The greater the camera's distance behind the eyepiece (or Barlow), the greater the size of the lunar image; it can be several times larger than the image formed in the principal focal plane of the telescope objective. Theoretically, there is no limit to enlarging the image. Practically, a larger scale results in a progressively dimmer image, which in turn requires longer and longer exposures and the problems that accompany them: vibration of the instrument, atmospheric turbulence (a most serious problem!), tracking the Moon's motion in the sky, etc. Using faster films can reduce exposure times, but, since the extra sensitivity is accompanied by increased graininess, films with medium sensitivity (around ISO 100) produce the best results.

The shutter speed depends on many factors. Fortunately, the camera's built-in metering system will usually give a reading that at least provides a starting point, but experimentation is inevitable. Differences in exposures can be considerable, depending on which part of the Moon is being photographed. An exposure setting suitable for the terminator will overexpose the bright areas on the opposite side of the lunar disk, whereas the terminator region will be underexposed if we overcompensate. This is why it is preferable to make several exposures and select the best ones. And even more film is necessary to catch those rare moments when the air is steadiest. No wonder an astrophotographer using film generates a pile of waste before making a single excellent shot.

For cameras with non-detachable lenses, and especially for digital cameras, another method of combining a camera and a telescope is required. This is the **afocal photography** method. With afocal photography, you simply put your camera (lens and all) up to the eyepiece of the telescope instead of your eye. To proceed, first, carefully focus the image visually, then set the camera to infinity focus and position its lens near the eyepiece. The camera could be hand-held or, much better, firmly attached to the eyepiece. Adapters for this purpose can be purchased commercially from several sources. Digital cameras are particularly well suited to this method and the experimentation that lunar photography entails. These electronic marvels allow instant evaluation of the snapshot so that the photographer can know immediately if adjustments in focus or positioning are necessary. In addition, the best images can then be processed in the "digital darkroom" with a computer and suitable software.

The above description of afocal photography sounds simple (and the method is indeed straightforward), but for good results, some tricks are essential. The optical axis of the camera lens should be perfectly aligned with the optical axis of the eyepiece; for that purpose, a fixed connection of camera-to-telescope is strongly recommended. The camera's mass on one end of the scope should be compensated for by a suitable counterweight, attached close to the opposite end of the telescope in order to have the system approximately balanced. It is also important to ensure that the vibrations of the telescope/camera system are eliminated, especially when the camera's shutter is open. It is a good idea to use a self-timer with at least a 10-second delay, or a remote control, if available. A motor-driven equatorial mount is not a necessity, providing the exposures are short (e. g., less than 0.1 sec), but a drive is convenient for keeping the image centered and well composed.

To take full advantage of digital imaging, careful image processing is essential. An amateur acquainted with the basics of computer graphics software will find this final part of the procedure an exciting hobby in itself. Many Internet sites showcase fine digital photographs of the Moon and provide useful how-to information that will serve beginners and advanced astrophotographers very well.

Similar photographic principles also apply to **CCD imaging**. Instead of a photographic camera body, a CCD camera is attached to the scope (Figs. 15a and 15b). And in place of photographic film emulsion, a CCD chip is exactly positioned at the scope's focal plane. Two types of hardware are applicable for CCD imaging: single-shot CCD cameras and CCD video cameras. Both types are available as items designed specifically for astronomical imaging, but CCD video cameras also take the form of non-astronomical consumer video cameras or camcorders. If you have one of these already, why not try it out using the afocal method with your telescope?

Like digital cameras, CCD cameras are good for taking single shots. One can take a lot of pictures during an observing session and then select the best of them for further computer processing. But for lunar and planetary imaging, CCD video imaging has greater potential with its capability of taking thousands of frames in a few minutes, dozens every second. Viewed on a monitor as live video, you can clearly see a "boiling" image, blurred by atmospheric turbulence. But even in these conditions it is always possible to find some good or excellent individual frames recorded in fleeting instances of good seeing. Later, the sharpest video frames can be selected, extracted as digitized images, stacked, and processed with the appropriate computer software.

Another method that is rapidly gaining popularity is the use of low-cost computer **webcams** for imaging the Moon. Like video cameras, these have the advantage of recording many frames per second, but instead of the images being recorded on tape, they are stored directly on the computer's hard drive. By using free software available on the Internet, you can select, stack, align, and process the individual frames for stunningly sharp images of individual lunar features.

To achieve the best results with various imaging techniques, know-how is as essential as equipment. This short chapter is intended only to outline some of the basic procedures and offer encouragement to the newcomer. To become more acquainted with the details, utilize the knowledge of experienced experts. Many of them have excellent Web sites with informative articles, examples, and instructions. The growing popularity of digital imaging is also apparent in astronomy magazines, recent books, and numerous Web pages where the interested amateur can find more complete information (see p. 220).

From its earliest modest efforts to the final years of the 20th century, it was apparent that lunar and planetary photography was unable to capture the finest details glimpsed visually through the same telescope in rare moments of atmospheric steadiness. This situation is now changing. The CCD revolution has opened a new world of possibilities, especially for amateur astronomers. With affordable off-the-shelf equipment, the experienced amateur is now able to produce amazing images comparable to (if not better than) the best shots taken a few years ago with large professional telescopes armed with specialized cameras. The technology is progressing constantly, so who knows what may appear in the coming years? Only one thing is certain — the future of amateur imaging looks very promising.

The targets

After the discussion about how to observe and image the Moon, perhaps we ought to think about what and why to observe. A favorite observational program for many amateur astronomers is an occasional survey of the Moon's face just for the sheer enjoyment of it. Viewing through the eyepiece of a telescope, one can feel like a space traveler admiring the beauty of a distant world, with this atlas serving as a handy travel guide, helping you identify and appreciate various features of the Moon's exotic landscape. For many observers this kind of lunar sightseeing satisfies the urge to view the Moon. This casual approach is not a bad thing, since it helps to keep alive general interest in our closest celestial neighbor. Also, a single enjoyable view might turn out to be the first step toward the deeper level of interest necessary for more systematic and intensive observations. Perhaps from that starting point a closer study of the lunar topography could follow. Observing different lunar formations under varying illumination provides observers with both pleasure and an increased knowledge of the lunar surface. Identifying the remains of lunar basins or tracing the imprints of giant impacts could be another challenging theme for lunar students.

Now that the Moon has been mapped in detail, following the glorious successes of the unmanned lunar probes and the Apollo lunar missions, it might seem that there is little point in continuing to observe the Moon from the Earth. But this would be a misunderstanding, for much remains to be investigated. Here is one example: as a rule, the photographs taken by space probes (including *Clementine*) show the lunar surface under only one angle of illumination, while a whole succession of angles of illumination, both morning and evening, are required to reveal the detail that is actually there. Systematic observation of the terminator has not been accomplished by the lunar probes, so we still have much to learn about the surface structure of the maria, including low mare ridges, flat lunar domes, and other low-profile features that show up only under grazing or oblique illumination. Such observations can be conducted from the Earth, and they may result in new findings.

For those who wish to contribute systematic observations, it is a good idea to ask the advice of your local/regional astronomy club, society, or association, or to contact the Association of Lunar and Planetary Observers (ALPO). This is a highly regarded international organization, coordinating a wide range of observing programs for both casual and serious amateur astronomers. ALPO's Lunar Section caters directly to observers interested in lunar studies. More information about ALPO may be found on its Web site: www.lpl.arizona.edu/alpo/.

Since the 18th century, numerous lunar observers have occasionally reported witnessing mysterious happenings on the Moon. So far, over 1,500 sightings of what are now called *lunar transient phenomena* (LTPs or TLPs) have been reported. However, an observer wishing to search for such events will soon find that it is not an easy undertaking. Phenomena reported include local hazes, temporary color variation (sometimes red), localized brightness changes (glows), and temporary obscurations of surface formations visible as "fog" or "mist," etc. The reliability of many of these reports is questionable, since the eye, working under extreme conditions, is easily deceived, especially if the observer has limited experience. No wonder that a long-term discussion between the LTP believers and nonbelievers still continues. For an LTP observation to be credible, it should be confirmed by experienced observers or, even better, by separate and independent observers. Certainly impersonal observation methods such as photographs or video images would be most desirable. If an observer visually notices a possible brightening, darkening, coloring, or anything anomalous, images of the suspect area on the Moon (before *and* after the event) should be recorded on video, in both polarized and nonpolarized light. These are quite demanding requirements, but not beyond the capabilities of an advanced amateur. From the technical point of view, a large (at least 15-cm refractor or 20-cm reflector), well-mounted, high-quality telescope is a necessity.

The causes of LTPs are unknown, but although lunar volcanism ceased in the remote past and present seismic activity is negligible, one might conclude that the Moon is not a completely dead world. If parts of the Moon's interior are still in a molten state, it would seem reasonable to expect the occasional escape of gases, or mixtures of gas and dust, from fissures near the surface. Also, the luminescence of some gaseous substances or movement of lunar dust sounds feasible. Could these be the causes of LTPs? Obviously, more reliable observational data is necessary to find an answer. Here, then, is a field of study that demands much time, skill, and patience along with a thorough knowledge of the lunar surface and, of course, the willingness to observe the Moon regularly, year after year.

In addition to looking for such short-lived events as LTPs, another observing program might be to address long-term phenomena. One such study would be to monitor variations in the tone or hue of a given area that cannot be explained by varying solar illumination and that do not repeat systematically from lunation to lunation. For an experienced observer interested in monitoring these rare and elusive short- or long-term phenomena, the ALPO Lunar Section is both a guide and a coordination center.

Another challenging and pioneering program, also coordinated by ALPO, is the lunar meteoritic impact search. The first confirmed lunar impact observations occurred on November 18, 1999, when impact flashes on the Moon's night side were recorded on video during the activity of the Leonid meteor shower. Naturally, the chances of success with similar observations improves during major meteor showers when the Moon is favorably placed. For an observation to be credible, it is vital to have at least two independent observers, one (or both) of them recording with a video camera. Such studies require techniques similar to those used for recording lunar occultations, though these can be predicted in advance with great accuracy, which is not the case for lunar flashes.

There is no doubt that people will return to the Moon in the 21st century. By then, priority should be given to the establishment of a lunar base, leading, perhaps, to permanent settlements for scientists and explorers. And who knows, it might be possible to see some manifestations of their activities with Earth-based telescopes. Isn't this an exciting prospect for future Moon observers?

Lunar eclipses

Lunar eclipses are one of the most fascinating astronomical phenomena and, naturally, a very popular phenomenon for amateur astronomers.

The geometrical conditions leading to lunar eclipses are indicated in Fig. 16a. The participants of this celestial "hide-and-seek" are the Sun, Earth, and Moon. From the Sun's rays, **S**, coming from the left, we choose those that, for the present purpose, may be described as the "outer" common tangents to the Sun and Earth. These, which are denoted by **t**, form the limits of the convergent cone of the Earth's total shadow. Similarly, the rays that are called the "inner" common tangents, **t′**, define the limits of the divergent cone, in which the light of the Sun is reduced. Let us imagine a large projection plane, π (pi), situated at the distance of the Moon and perpendicular to the axis of the shadow cones. When the shadow cones are projected onto this plane, the total, circular shadow, which is termed the **umbra**, **u**, surrounded by an annulus of far less dense shadow, the **penumbra**, **p**, appears. It can be appreciated that when the Moon passes across this shadowy area, an eclipse will occur. We may then ask what are the conditions that have to be fulfilled for this to happen.

First, the Moon has to line up with the Sun and the Earth so that the centers of all three bodies are close to being in a straight line. Naturally, this can happen only at full Moon, but for a lunar eclipse there is another constraint: the Moon must also be close to the ecliptic (the plane of the Earth's orbit around the Sun). The Moon's orbit, however, is inclined to the ecliptic by an angle of about 5°, and its orientation is continually changing in space. This is why the full Moon does not pass through the Earth's shadow every month — it usually passes a little bit above or below or, more correctly, to the north or south of the shadow cone. Thus, an eclipse cannot occur at every full Moon.

If the geometrical conditions are favorable as stated above, then there are three possible lunar-eclipse configurations (Fig. 16b). In configuration **1**, the Moon passes through only the penumbra, **p**, and a **penumbral lunar eclipse** occurs. These are often difficult to observe at all because the decrease in the Moon's brightness is very subtle. In configuration **2**, the Moon, having entered the penumbra, passes through the edge of the umbra, and observers witness a **partial lunar eclipse**. Finally, in configuration **3**, the entire Moon enters the umbra, and a **total eclipse** is seen. A lunar eclipse reaches its maximum when the Moon is closest to the center of the umbra. At that moment the magnitude, **m**, of the eclipse is specified in units of the Moon's diameter. If 0 < **m** < 1, the eclipse is partial; if **m** > 1, the eclipse is total. The maximum possible magnitude of a total eclipse is **m** = 1.888. The greater the magnitude, the longer the duration of the entire phenomenon. Usually an eclipse of the Moon lasts from tens of minutes for a partial eclipse to several hours for a total eclipse.

The exact times and other data necessary to observe lunar eclipses are published in astronomical almanacs and astronomy magazines such as *Sky & Telescope*. Also, many computer programs provide these data. It is obviously essential to know in advance whether the phenomenon in question is going to be visible from a given geographical location. In general, it can be said that a lunar eclipse will be visible from any part of the terrestrial hemisphere that is just turned toward the Moon. (If this seems obvious, remember that astronomers often have to travel to distant places to witness a total eclipse of the Sun.)

Ancient astronomers knew how to forecast lunar and solar eclipses; they even discovered the lengths of the recurrent periods that determine when eclipses occur. The fundamental period, called the **Saros**, is 6585.32 days (approximately 18 years 10 days, or 18 years 11 days), as can be verified from the accompanying table .

An apparent paradox is that during a total lunar eclipse the Moon's disk is faintly visible and is usually reddish in color. This is caused by the Earth's atmosphere (the depth of which, **a**, has been considerably exaggerated in Fig. 16a), which, like a glass prism, bends the light passing through it (this is called *astronomical refraction*), so that the dark umbral cone of shadow is diluted. In effect, this reduces the length of the shadow cone (the cone's tip, **X**, being always closer to Earth than the Moon's distance), resulting in the Moon never being near enough to the Earth to be totally immersed. Simultaneously, another important phenomenon occurs: the Sun ray, **r**, passing through the Earth's atmosphere, is selectively scattered by the air molecules (the so-called Rayleigh scattering). As a result, the shorter wavelengths, mostly violet and blue rays, are trapped in the air (giving us the nice blue sky we enjoy on Earth), and only the longer wavelengths, mostly the red end of the spectrum, pass through the atmosphere into the shadow cone. Also, the amount of scattering depends on the size and quantity of the particles suspended in the air. The resulting compound effect of the refraction and scattering of sunlight in the Earth's atmosphere is very complex and variable, giving the eclipsed Moon a wide range of appearances.

Differences in the brightness and color of the eclipsed Moon arise, owing to the varying amounts of cloud, dust, etc., in the Earth's atmosphere, and may be described using the so-called Danjon classification:

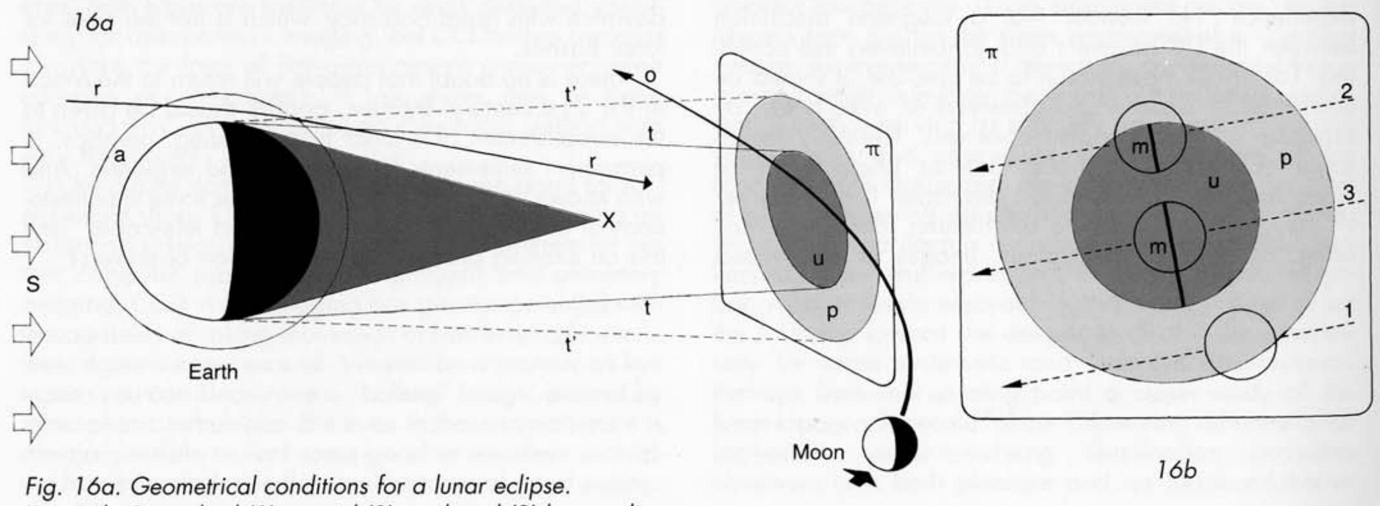


Fig. 16a. Geometrical conditions for a lunar eclipse.
Fig. 16b. Penumbral (1), partial (2), and total (3) lunar eclipse.

Total and partial lunar eclipses 2004–2028

Date	Maximum eclipse Time UT	Magnitude	Visible in
2004 May 4	20.30	1.31	Africa, Europe, Asia, Australia, Indian Ocean
2004 October 28	03.04	1.31	North and South America, Europe, Africa, Atlantic Ocean
2005 October 17	12.03	0.07	Pacific Ocean, Australia, eastern Asia, North America,
2006 September 7	18.51	0.19	Indian Ocean, Asia, Australia, Africa, Europe,
2007 March 3	23.21	1.24	Africa, Europe, Asia, South America, North America, Atlantic Ocean
2007 August 28	10.37	1.48	Pacific Ocean, Australia, North America, South America, eastern Asia
2008 February 21	03.26	1.11	North and South America, Atlantic Ocean, Africa, Europe
2008 August 16	21.10	0.81	Africa, Europe, Asia, Australia, Antarctica
2009 December 31	19.23	0.08	Asia, Europe, Africa, Australia, Indian Ocean
2010 June 26	11.38	0.54	Pacific Ocean, Australia, Antarctica, Americas (part)
2010 December 21	08.17	1.26	North and South America, eastern Asia, Pacific Ocean
2011 June 15	20.13	1.70	Africa, Europe, Asia, Australia, Indian Ocean
2011 December 10	14.32	1.11	Asia, Australia, Pacific Ocean, North America, Africa
2012 June 4	11.03	0.38	Pacific Ocean, Australia, Americas, Australia, east Asia
2013 April 25	20.07	0.02	Africa, Europe, Asia, Indian Ocean, Australia
2014 April 15	07.46	1.30	Pacific Ocean, North and South America, Australia
2014 October 8	10.54	1.17	Pacific Ocean, Australia, eastern Asia, eastern part of North America
2015 April 4	12.00	1.00	Pacific Ocean, Australia, eastern Asia, Americas
2015 September 28	02.47	1.28	Atlantic Ocean, North and South America, Africa, Europe
2017 August 7	18.20	0.25	Indian Ocean, Asia, Africa, Australia, Europe
2018 January 31	13.30	1.32	Asia, Australia, Pacific Ocean, North America
2018 July 27	20.22	1.61	Indian Ocean, Africa, Europe, Asia, Australia,
2019 January 21	05.12	1.20	North and South America, Atlantic Ocean, Pacific Ocean
2019 July 16	21.31	0.66	Africa, Europe, Indian Ocean, Atlantic Ocean, western Asia
2021 May 26	11.18	1.02	Pacific Ocean, Australia, Antarctica
2021 November 19	09.03	0.98	Pacific Ocean, North and South America, eastern Asia
2022 May 16	04.11	1.42	South and North America, eastern Africa, Antarctica, Atlantic Ocean, Pacific Ocean
2022 November 8	10.59	1.36	Pacific Ocean, North America, eastern Asia, Australia
2023 October 28	20.14	0.13	Africa, Europe, Asia, Indian Ocean
2024 September 18	02.44	0.09	South and North America, Atlantic Ocean, Africa, Europe
2025 March 14	06.59	1.18	South and North America, Pacific Ocean
2025 September 7	18.12	1.37	Asia, Africa, Europe, Australia, Indian Ocean
2026 March 3	11.33	1.16	Pacific Ocean, Americas, eastern Asia, Australia
2026 August 28	04.13	0.94	South and North America, Africa, Europe, Atlantic Ocean, eastern Pacific Ocean
2028 January 12	04.13	0.07	South and North America, Africa, Europe, Atlantic Ocean
2028 July 6	18.19	0.39	Indian Ocean, Asia, Africa, Australia, Antarctica
2028 December 31	16.52	1.25	Asia, Australia, Indian and Pacific Oceans, Europe, Africa

After: Eclipse Predictions by Fred Espenak, NASA/GSFC, http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html
(also, on these pages, an amateur photographer can find many useful tips for eclipse photography).

Class	Description
0	Very dark eclipse; Moon almost invisible, especially during the middle of totality.
1	Dark eclipse, gray or brownish coloring, details hardly recognizable.
2	Dark red or rusty red coloring with dark patch in the middle of the shadow, brighter edges.
3	Brick-red eclipse; sometimes shadow bordered with bright or yellowish margin.
4	Copper- or orange-red, very bright eclipse with a bluish and very bright marginal zone.

Small amateur telescopes and binoculars are most convenient for estimating the brightness and color of a lunar eclipse according to the above scheme. It is recommended that the estimates be repeated several times during the course of totality, as well as during the partial phases. Other possible observations include the recording of the times selected craters enter and emerge from the eclipse shadow (see also page 25). Those interested in crater-contact observations should consult their local astronomical club or observatory to ensure the data are collected and processed.

Glossary

Age of Moon The period that has elapsed since the last new Moon.

Albedo A measure of surface reflectivity. The ratio of incident to reflected light. A good reflecting surface has a high albedo (e.g., clouds, 0.70); a poor reflector has a low albedo (e.g., granite, 0.31; the Moon, 0.12; lava, 0.04).

Angular measure The division of a circle into 360° (degrees), each consisting of 60′ (minutes), each of which can be further subdivided into 60″ (seconds). The apparent (angular) diameter of a lunar or planetary disk, or of a lunar crater, is often expressed in angular measure.

Apogee The point of the orbit of the Moon (or of an artificial Earth satellite) where it is farthest from the Earth.

Apollo (program) US manned space program, 1968–1972. The first soft landing of a human on the Moon was that of *Apollo 11* on 20 July 1969. Exploration of the Moon; collecting rock samples (a total of 382 kg were returned to Earth); installation of geophysical stations, etc.

Basalt Igneous rock, solidified lava or magma; fine-grained, black or dark gray in hue. Various kinds were found on the Moon and also exist on the other terrestrial planets (Mercury, Venus, and Mars).

Caldera A large volcanic crater formed by an eruption of magmatic material, followed by the collapse of the interior as molten rock drains away into an underground cavity.

Cartographic representation (projection) A mathematical or geometrical method of representing the surface of a spherical (or ellipsoidal) body on the plane of a map. **Orthographic projection** is often used for lunar mapping because it depicts the Moon as it is seen from the Earth. **Conformal projection** is useful for preserving the shapes of formations that would otherwise be distorted. Examples of conformal projections include stereographic and Mercator projections.

Celestial equator The prime circle on the celestial sphere. It is a geocentric projection of the Earth's equator onto the sky. Also, the celestial equator is the dividing line separating the northern and southern celestial hemispheres. Its declination is 0°.

Clementine Advanced US lunar probe. During 71 days in lunar orbit, from 19 February to 3 May 1994, the probe acquired nearly 2 million digital images of the Moon at visible and infrared wavelengths. These data enable the global mapping of the rock types of the lunar crust and the first detailed investigation of the geology of the lunar polar regions and the lunar far side. The global topographic figure of the Moon and the topography of many ancient impact basins have been measured by laser ranging.

Colongitude The selenographic longitude (λ) of the morning terminator, measured from the central meridian westward from 0° to 360°. Colongitude values are used to determine the position of the terminator with respect to lunar formations.

Coordinates, astronomical Pairs of spherical coordinates that define the positions of celestial bodies. They are given in angular units, measured in degrees, minutes, and seconds of arc (°, ′, ″), which in some cases need to be converted to time units measured in hours, minutes, and seconds (h, min, s). These systems are analogous to the well-known terrestrial coordinates of latitude and longitude, but despite these similarities, there are many differences between the definitions of fundamental planes of reference and orientations, not forgetting the nomenclature. The Moon's selenographic coordinates, called latitude, β, and longitude, λ, are defined by the direction of the lunar axis of rotation.

Crater A circular depression, usually with an elevated rim. These formations are found on solar-system bodies with solid surfaces, most notably planetary moons, asteroids, and terrestrial planets.

Crater, impact (also meteorite crater) A crater formed by the impact of a meteoritic body, or (in the case of **secondary craters**) by the ejecta from such impacts.

Declination A celestial coordinate similar to geographical latitude. It is the angular distance north or south of the celestial equator of a point on the celestial sphere. The declination of the celestial equator is 0°, of the north celestial pole +90°, and of the south celestial pole -90°. See also **right ascension**.

Diameter, apparent The diameter of a celestial object expressed in angular measure, e.g., the apparent diameter of the Moon is about 30′ = 0,5°. Also called the **angular diameter.**

Eccentricity One of the elements of an elliptical orbit of a celestial body. It is the parameter of the ellipse, obtained by dividing the distance between the two focal points by the length of the major axis. The eccentricity **e** = 0 means a circular orbit. For an elliptical orbit, **e** lies between zero and 1.

Ecliptic 1. The apparent orbit of the Sun around the celestial sphere. The Sun appears to complete one circuit along the ecliptic in one year. 2. The Earth's orbit around the Sun.

Elevation, absolute The height of any point on the lunar surface with respect to the so-called *reference sphere,* which is defined as a perfect sphere of 3,476 km diameter.

Elevation, relative The height of any point, e.g., a mountaintop, above its immediate surroundings.

Erosion Disintegration of a lunar or planetary surface caused by natural forces, e.g., water, wind, frost, etc. On celestial bodies without atmospheres, e.g., the Moon, erosion is caused mainly by the impacts of meteorites and micrometeorites.

Escape velocity The minimum velocity that a body has to attain to escape from the gravitational field of a more massive body, e.g., a planet.

Focal length The distance from the center of a lens or mirror to its focal point or focus.

Focus (focal point) The point to which a parallel beam of light entering an optical system is refracted or reflected. It lies on a focal plane that is perpendicular to the optical axis of the system; in this plane, a sharply defined or focused image is formed.

Galileo US interplanetary robotic probe launched in October 1989. After traveling more than 3.8 billion kilometers past Venus, Earth, the Moon (twice), and two asteroids, the probe reached Jupiter on December 1995. *Galileo's* new CCD imaging system was successfully tested during a flyby of the Moon, discovering the South Pole — Aitken basin and confirming the advantages of multispectral imaging for global, multipurpose mapping (see also *Clementine*).

Greek alphabet On detailed lunar maps, lowercase Greek letters denoted isolated hills, mountain massifs, and other convexities until the early 1970s. Nowadays, however, these identities are used only unofficially and to limited extent.

α	alpha	ι	iota	ρ	rho
β	beta	κ	kappa	σ	sigma
γ	gamma	λ	lambda	τ	tau
δ	delta	μ	mu	υ	upsilon
ε	epsilon	ν	nu	φ	phi
ζ	zeta	ξ	xi	χ	chi
η	eta	ο	omicron	ψ	psi
θ	theta	π	pi	ω	omega

Libration The lunar librations in latitude and longitude are the apparent vertical and horizontal swinging motions of the Moon as it orbits around the Earth. Their combined effect enables us to observe more than 50 percent of the Moon's surface in the course of time.

Libration zones Peripheral areas close to the lunar limb, alternately turned toward and away from the Earth because of lunar librations. The approximate longitudinal centers of these zones are the meridians 90°E and 90°W.

Light-gathering power The ratio of the diameter, **d**, of a telescope objective to its focal length, **f**, i.e., the ratio **d : f**. It is also called the **focal ratio** (or **speed**).

Line of nodes The line joining the two points where the Moon's orbit intersects the ecliptic, to which it is inclined by 5°. The point at which the Moon crosses the ecliptic from south to north is termed the **ascending node**; similarly, the point at which it crosses if moving from north to south is termed the **descending node**. The line of nodes continually changes its orientation in space, making one full rotation in the plane of ecliptic every 18.61 years.

Luna A series of Soviet lunar probes and automatic stations that explored the Moon during the period 1959—1976. The following are of special importance:

Luna 2: First crash-landing of a man-made body on the Moon, 12 September 1959.

Luna 3: First photographs of the far side of the Moon, 10 October 1959.

Luna 9: First soft-landing on the Moon, 3 February 1966.

Luna 10: First artificial satellite of the Moon, 3 April 1966.

Lunas 16, 20, and *24:* Automated sampling of lunar rocks, which were brought back the Earth, 1970, 1972, and 1976, respectively.

Lunas 17, 21: Automatic mobile laboratories *Lunokhod 1* and *2*. 1970—1971 and 1973.

Lunar Orbiter A series of five US lunar probes, all of which were successfully put into orbit around the Moon and undertook detailed photographic mapping of almost the entire lunar surface during 1966 and 1967.

Lunar Prospector US lunar orbiter; remote sensing detectors, global mapping of radioactivity, gravity and magnetic fields, elemental composition of lunar surface. Gathered observational data indicating the possibility of polar water ice, as announced on March 1998. Launched 6 January 1998, orbiting Moon from 11 January 1998 to 31 July 1999, when crash-landed close to the south pole. The probe carried one ounce of the ashes of the notable lunar scientist Eugene M. Shoemaker; he will rest forever on his beloved Moon.

Lunation The synodic month, which is the time taken by the Moon to complete one set of phases, e.g., from new Moon to new Moon: 29 days 12 hours 44 minutes 2.8 seconds. To facilitate computations, lunations are numbered, no. 1 commencing on 16 January 1923. Lunation no. 1,000 commenced with the new Moon of October 25, 2003.

Magma Subterranean molten rock, which emerges as lava during volcanic eruptions.

Mascon Abbreviated form of the term "mass concentration," which refers to denser material under the lunar basins that was manifested by local anomalies in the Moon's gravitational field. The mare fill of the basins, formed about 4 billion years ago, contains solidified magma to a considerable depth, and this is thought to be responsible for these anomalies.

Month, anomalistic The time that elapses between two successive orbital passages of the Moon through perigee: 27 days 13 hours 18 minutes 33.1 seconds. Since perigee successively moves in the direction of the Moon's motion, the Moon travels an angle of slightly more than 360° during an anomalistic month. This is why an anomalistic month is longer than a sidereal month.

Month, sidereal The time taken by the Moon to complete one revolution around the Earth with respect to the background stars: 27 days 7 hours 43 minutes 11.5 seconds.

Month, synodic The time taken by the Moon to complete one set of phases, e.g., from new Moon to new Moon. Also called a **lunation**, it is 29 days 12 hours 44 minutes 2.8 seconds.

Mounting, telescope A telescope support comprising two mechanical bearings, set at right angles, which form the rotation axes. There are two principal designs: **altazimuth** and **equatorial**. In the former, the movements conform to the horizon system of coordinates, i.e., altitude and azimuth. In the latter, the principal axis of rotation is parallel to the Earth's axis, so that when rotated about this axis the telescope can be made to follow the apparent path of a star across the sky.

Nodes (of the Moon's orbit) The two points of intersection of the Moon's orbit with the plane of the ecliptic. See also *line of nodes.*

Perigee The point of the orbit of the Moon (or of an artificial Earth satellite) where it is closest to the Earth.

Phase The amount of the illuminated disk of a dark body, e.g., the Moon, which shines by reflected sunlight, that is visible from the Earth. It depends on the ever-changing angle between the Sun, the dark body, and the Earth. The main lunar phases are new Moon, first quarter, full Moon, and last quarter.

Phase angle The angle between a line connecting a dark body, e.g., the Moon, which shines by reflected sunlight, with the Earth, and another line connecting the Moon with the Sun. It determines the part of the illuminated hemisphere of the body that will be seen by an observer from the Earth.

Ranger A series of US lunar probes, of which *Rangers 7, 8,* and *9*, which were launched to the Moon in 1964 and 1965, returned detailed photographs of the area where they were due to impact, showing surface details less than 1 meter across.

Regolith The incoherent surface layer of the Moon and many other solar-system bodies that do not have a protective atmosphere. It consists of crushed, pulverized, and fragmented rocks, resulting largely from billions of years of meteorite impacts. The lunar regolith is said to have an average depth of about 5–15 m, being deeper in lunar highlands and shallower in mare regions.

Right ascension (RA). An equatorial coordinate, that, together with declination, unambiguously defines the position of a point on the celestial sphere. It is analogous to terrestrial longitude and is measured eastward along the celestial equator from the **vernal equinox** (the point where the Sun appears to cross the celestial equator, moving from south to north around 21 March) to the declination circle passing through the given point. By convention, it is measured in time units ranging from 0 to 24 hours.

Rotation, captured or synchronous The axial rotation of a satellite in a period equal to the duration of its revolution around its primary, so that the satellite always presents the same hemisphere to its primary (as in the case of our Moon). It is a consequence of the action of tidal forces between the two bodies.

Saros The period of 6585.32 days, or 223 synodic months. After this period, the Earth, Moon, and Sun, together with the nodes of lunar orbit, return to the same mutual position; then the lunar and solar eclipses repeat in the same sequence and magnitudes. During one Saros period 29 lunar and 41 solar eclipses occur.

Selenodesy The branch of astronomy that deals with the shape, size, and gravitational field of the Moon. By using selenodetic methods, precise three-dimensional coordinates of selected points on the lunar surface can be determined, including their absolute elevations with respect to the Moon's reference sphere. A net of such control points allows the shape of the Moon to be found.

Selenography The mapping of the Moon, together with descriptions of its surface detail, the development of nomenclature, etc.

Sidereal period The time taken by a planet or satellite to complete one revolution around its primary with respect to the background stars. In the case of the Moon, it is the sidereal month.

Surveyor A series of US lunar probes, of which *Surveyors 1, 3, 5, 6,* and *7* soft-landed on the lunar surface and carried out a program of photography and chemical analysis of the lunar surface between 1966 and 1968.

Synodic period The time taken by a planet or satellite to complete one revolution around its primary as observed from the (moving) Earth. In the case of the Moon, it is the time elapsed between two successive similar phases, i.e., the synodic month.

Temperature scale A graduated scheme for measurement of the quantity of heat energy possessed by a body. In astronomy, temperatures are usually quoted in Kelvin (K) or degrees absolute (0 K = −273.16°C). For more mundane purposes, the Celsius (or Centigrade) scale is replacing the Fahrenheit scale, which is, however, still widely used in some countries.

Water (H_2O)	°C	°F	K
Freezing point	0	32	273.16
Boiling point	100	212	373.16

Terminator The boundary between illuminated and non-illuminated surface, or between day and night, on a celestial body that does not shine by its own light. In the case of the Moon, the morning terminator heralds sunrise; at the evening terminator the fortnight-long lunar night is beginning.

Tidal forces The mutual gravitational forces between two or more neighboring celestial bodies, which can deform their shapes, change their rotation, and, in extreme cases, cause their disintegration. Familiar terrestrial phenomena are the tides caused by the gravity of the Sun and Moon.

SOURCES USED FOR CREATING THE MAPS AND ILLUSTRATIONS

The main part of the present atlas, i.e., the detailed map of the near side of the Moon in 76 sections, was compiled largely from catalogs, atlases, and maps edited by the Lunar and Planetary Laboratory of the University of Arizona, USA. The positions of lunar formations were derived from references 2, 3, 10, 13, and 14. The lunar charts drawn by the author were based primarily on references 11 and 13. The *Consolidated Lunar Atlas* (ref. 11), published in 1967, is still the best and most detailed Earth-based photographic atlas of the Moon; it shows the individual surface areas under different solar-illumination angles, which is essential for the work of the cartographer. Fine surface details, such as narrow rilles, which are not resolved in Earth-based photographs, are derived from references 6, 7, and other photographs taken by *Lunar Orbiters IV* and *V*.

The maps of the libration zones (pp. 182–189) and the pair of maps of the near and far side of the Moon (pp. 190—191) are based on references 6, 7, 13, 15, 17, 26, and 29. Also, individual images from Apollo missions have been used for filling some gaps. *Clementine* imagery (15) and Arecibo radar mapping (26, 29) revealed the last hidden 1 percent of the lunar globe, located in the vicinity of the south pole (formerly known as "Luna Incognita"); therefore, libration maps V and VI on pp. 186—187 have been revised in this edition.

The nomenclature of lunar formations, their approximate coordinates, and their dimensions, which facilitate their identification on the maps, were taken from references 1 through 3; the recent data are adopted from the Web version of the *Gazetteer of Planetary Nomenclature* (ref. 4), which is the most authoritative source, guaranteed by the International Astronomical Union (IAU). Names and biographical data have been extracted from the respective volumes of the *Transactions of the IAU* and from reference 4.

The illustrations in the section "Fifty views of the Moon" (pp. 194—207) are based mainly on reference 11. For printing purposes and distinct representation, photographs of selected parts of the lunar surface were either adjusted or completely redrawn using the airbrush technique. The drawings, presented in these pages, are mainly derived from several different views of the same surface area, as shown on photographs in 6, 7, and 11. These illustrations should, therefore, be regarded as precise drawings or maps and not necessarily the views that would be obtained photographically by a single exposure. The same can be said about the representation of the lunar phases on pp. 20—24.

Tables for the calculation of colongitude

Table I: year

Year	c°	M°
2000	201.76	1.0
01	331.38	0.7
02	101.01	0.5
03	230.63	0.2
04	12.44	1.0
2005	142.07	0.7
06	271.69	0.5
07	41.31	0.2
08	183.13	0.9
09	312.75	0.7
2010	82.38	0.4
11	212.00	0.2
12	353.81	0.9
13	123.44	0.6
14	253.06	0.4
2015	22.68	0.1
16	164.50	0.8
17	294.12	0.6
18	63.75	0.3
19	193.37	0.1
2020	335.18	0.8
21	104.81	0.6
22	234.43	0.3
23	4.05	0.0
24	145.87	0.8
2025	275.49	0.5
26	45.11	0.8
27	174.74	0.0
28	316.55	0.7
29	86.18	0.5
2030	215.80	0.2

Table II: month

Month	c°	M°
January	0.00	356.0
(January)*	347.81	355.0
February	17.91	26.6
(February)*	5.72	25.6
March	359.25	54.2
April	17.17	84.7
May	22.89	114.3
June	40.80	144.8
July	46.53	174.4
August	64.44	204.9
September	82.35	235.5
October	88.07	265.1
November	105.99	295.6
December	111.71	352.2

* The figures for January and February given in parentheses are valid for leap years.

Table III: day

Day	c°	M°
1	12.19	1.0
2	24.38	2.0
3	36.57	3.0
4	48.76	3.9
5	60.95	4.9
6	73.14	5.9
7	85.34	6.9
8	97.53	7.9
9	109.72	8.9
10	121.91	9.9
11	134.10	10.8
12	146.29	11.8
13	158.48	12.8
14	170.67	13.8
15	182.86	14.8
16	195.05	15.8
17	207.24	16.8
18	219.43	17.7
19	231.62	18.7
20	243.81	19.7
21	256.01	20.7
22	268.20	21.7
23	280.39	22.7
24	292.58	23.7
25	304.77	24.6
26	316.96	25.6
27	329.15	26.6
28	341.34	27.6
29	353.53	28.6
30	5.72	29.6
31	17.91	30.6

Table IV: hour

Hour	c°	M°
1	0.51	0.0
2	1.02	0.1
3	1.52	0.1
4	2.03	0.2
5	2.54	0.2
6	3.05	0.2
7	3.56	0.3
8	4.06	0.3
9	4.57	0.4
10	5.08	0.4
11	5.59	0.5
12	6.10	0.5
13	6.60	0.5
14	7.11	0.6
15	7.62	0.6
16	8.13	0.7
17	8.64	0.7
18	9.14	0.7
19	9.65	0.8
20	10.16	0.8
21	10.67	0.9
22	11.17	0.9
23	11.68	0.9
24	12.19	1.0

Table V: correction

M°	Correction	M°
0	0.0	360
10	-0.4+	350
20	-0.7+	340
30	−1.0+	330
40	−1.3+	320
50	−1.5+	310
60	−1.7+	300
70	−1.8+	290
80	−1.9+	280
90	−1.9+	270
100	−1.9+	260
110	−1.8+	250
120	−1.6+	240
130	−1.5+	230
140	−1.2+	220
150	−1.0+	210
160	-0.6+	200
170	-0.3+	190
180	0.0	180

ACKNOWLEDGMENTS

The author's intention in producing this book was to create an up-to-date atlas of the observable part of the Moon, based on modern catalogs, atlases, maps, and photographs. These sources are cited on p. 220. Such a task would not have been possible without the valuable cooperation of prominent specialists, who readily gave advice and allowed access to essential materials. Foremost among these were: Dr. M. E. Davies, RAND Corporation, USA; Mr. E. A. Whitaker, Lunar and Planetary Laboratory, University of Arizona, USA; Ms. Jennifer Blue and Dr. Eric Eliason, US Geological Survey, Flagstaff, Arizona, USA; Professor Z. Kopal, University of Manchester, England; Dr. T. W. Rackham, Jodrell Bank, England; Professor H. Mucke, Astronomisches Büro, Vienna, Austria; Dr. V. V. Shevchenko, Gosudarstvennyi Astronomitsheskii Institut im. Sternberga, Russia, and Dr. L. D. Jaffe, Jet Propulsion Laboratory, USA. It is a pleasure for the author to express his gratitude to all of them for their friendly help.

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Last, but not least, the author extends his thanks to his wife, Sonja, for the patient moral support she gave him while he was working on this atlas.

Explanatory note

An observer of the Moon needs to know the position of the terminator at any given moment. For this purpose, the value of the so-called *colongitude (c)* is usually specified in astronomical almanacs: it is, in fact, the selenographic longitude of the morning terminator, measured westward from the prime or central meridian, and its numerical value ranges between 0° and 360°. The selenographic longitude of the evening terminator is equal to the colongitude plus 180°. The relationship between selenographic longitude, λ, and colongitude, *c*, is as follows:

λE = selenographic longitude of morning terminator = 360° — c
(see note 1, p. 213)
(sunrise on the Moon)

λW = selenographic longitude of evening terminator = 180° — c
(sunset on the Moon)

To simplify matters, let us suppose that the terminator coincides with one or other of the meridians (neglecting the selenographic *latitude* of the Sun).

If an astronomical almanac or a suitable computer program is not at hand, we can calculate the colongitude by referring to the tables, given on p. 212, which are derived from those of J. Meeus (*Terminatortabellen voor Maanwaarnemingen,* Hemel en Dampkring, Vol. 61 (1963), No. 12). Universal Time (UT) is used throughout.

Example 1

What is the position of the terminator on 19 April 2010 at 21h UT?
Referring to Tables I, II, III, and IV, we obtain the following figures:

Time	Table	c°	M°	(correction)
2010	I	82.38	0.4	
April	II	17.17	84.7	
19	III	231.62	18.7	
21h	IV	10.67	0.9	
		341.84	104.7	(totals)

From Table V we see that the nearest value for M° is 100° and that the appropriate correction is therefore −1.9° (notice the change in sign for values of M greater than 180°). Subtracting this correction from c (i.e., 341.84° – 1.9° = 339.9°), we get the true value of the colongitude, c. Since the prime or central meridian of the Moon has a value of 0° or 360°, it can be seen that our derived value of c is not far from it. In fact 360° – 339.9° = +20.1°, i.e., the selenographic longitude east, λ_E = 20.1°E. Since, however, the other terminator is 180° away, we can also subtract the above value of c from 180°: 180° – 339.9° = 159.9°, i.e., the selenographic longitude west, λ_W = 159.9°W.

From the above calculations we have found that the morning terminator occupies the position defined by the meridian 20.1°E; and from the map we can see that the Sun, at that instant, is rising over the craters Sabine and Kant and that the trio of Theophilus, Cyrillus, and Catharina and the fault Rupes Altai came right into view. It goes without saying that the evening terminator is on the averted hemisphere.

Example 2

When does the Sun rise above the crater Bullialdus (λ = –22°) in April 2010?

By definition the selenographic longitude, l_E, of the morning terminator is λ_E = 360° – c; therefore the colongitude, c = 360° – λ_E. The date and hour in April 2010 will be that when the value of the colongitude, c, is numerically equal to that of the selenographic longitude of the meridian of Bullialdus. Hence, c = 360° – (–22°) = 382° = 22°.

From tables I and II we obtain the following values:

Time	Table	c°	M°	(correction)
2010	I	82.38	0.4	
April	II	17.17	84.7	
		99.55	85.1	(totals)

Subtracting 99.55 from the required value of c, i.e., 382°, we get 382° – 99.55° = 282.45°. Referring now to Table III, we discover that the closest value to 282.45° is 280.39° (M = 22.7°) for the 23rd day (in April). By adding the three "year, month, day" values of the colongitude, c, for this date, we obtain: c = 82.38°+17.17°+280.39° = 379.94°. Subtracting 360°, c = 379.94° – 360° = 19.94°.

We now apply a correction by adding the three values in the M columns and by referring to Table V. In this case, M = 0.4° + 84.7° + 22.7° = 107.8°. From Table V the nearest correction value is –1.8°. Therefore the true value of the colongitude c = 19.94° – 1.8° = 18.14°.

Thus, the colongitude for 23 April 2010 at 0h UT is 18.14°. But this is still 3.9° away from the meridian of Bullialdus (λ_W = 22°). In Table IV, 3.9° is equivalent to about 8h UT, so this is the time that an observer would see the Sun rising over Bullialdus.

Note 1
When the difference 360°– c is greater than 180°, subtract 360°. Starting from the prime or central meridian, the selenographic longitude, λ, is measured positively to the east and negatively to the west, from 0° to 180° or 0° to –180°.

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http://www.best.com/akkana/moon/hitchhiker.html (Akkana Peck's Hitchhiker's Guide to the Moon, many useful links)
http://www.flag.wr.usgs.gov/USGSFlag/Space/clementine/ (*Clemetine* images)
http://www.lpl.arizona.edu/alpo/ (ALPO Web page)
http://www.pdsimage.wr.usgs.gov/PDS/public/explorer/html/moonlvls.htm (PDS Lunar Image Atlas)
http://SkyandTelescope.com/ (Sky & Telescope Magazine)
http://SkyandTelescope.com/howto/imaging (imaging with digital and video cameras)
http://www.lpi.usra.edu/research/cla/ (on-line Consolidated Lunar Atlas)
http://www.lpi.usra.edu/research/lunar_orbiter/index.html (on-line Lunar Orbiter Atlas of the Moon)
http://members.telocity.com/hjamieson/TKWebPage.htm#Jamieson's (Jamieson's Lunar Observer's ToolKit — Software for the Serious Lunar Observer)
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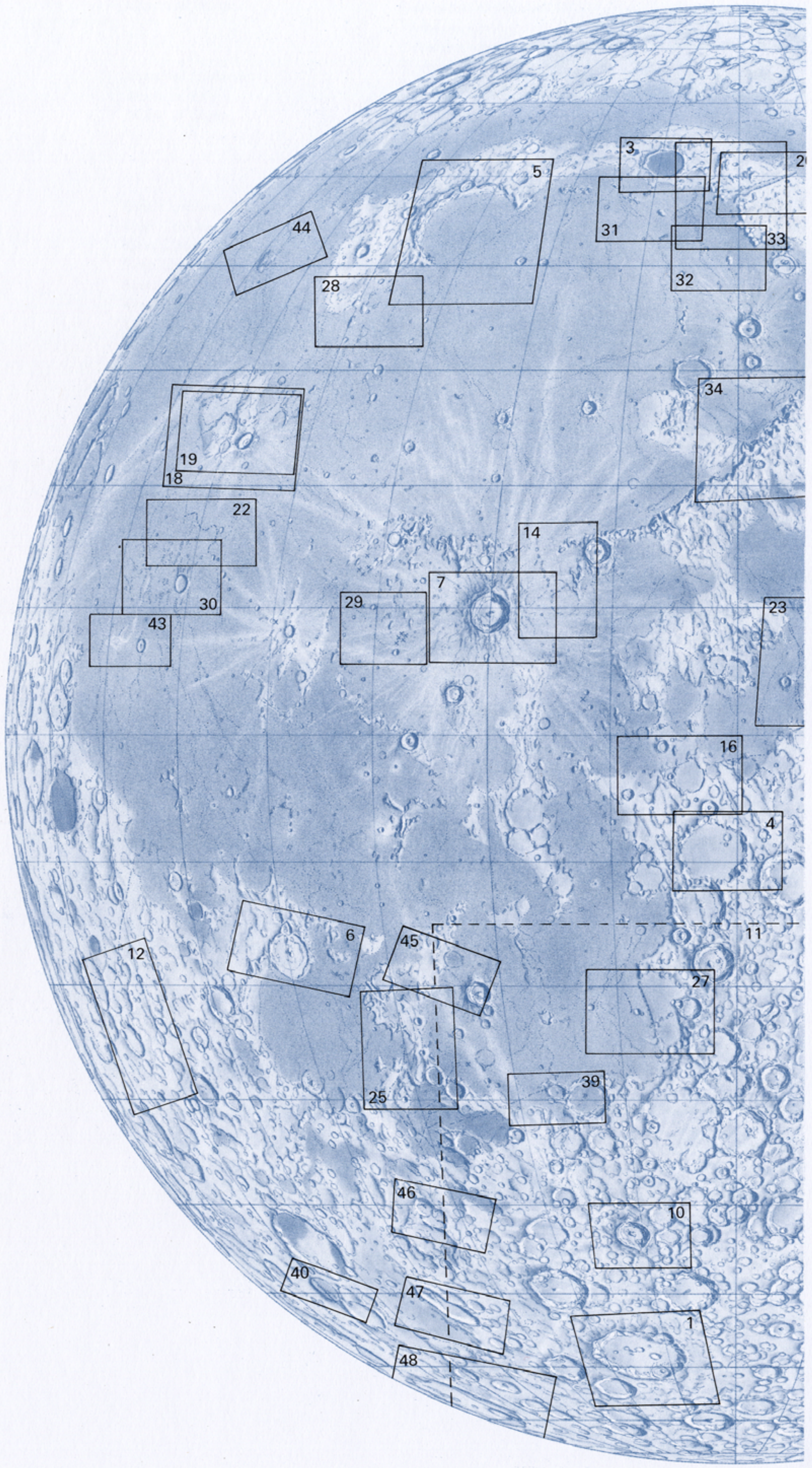
http://www3.telus.net/public/aling/home.html (Lunar Calculator and Mini-Skimmer programs)
http://www.astrosurf.com/avl (Virtual Moon Atlas)

Index of named formations

This index lists in alphabetical order within the appropriate category, the names of lunar formations and indicates by a number adjacent to each name the appropriate section of the map of the near side of the Moon in which a particular formation may be found. Where a formation is shown in the libration-zone maps, Roman numerals are used.

Craters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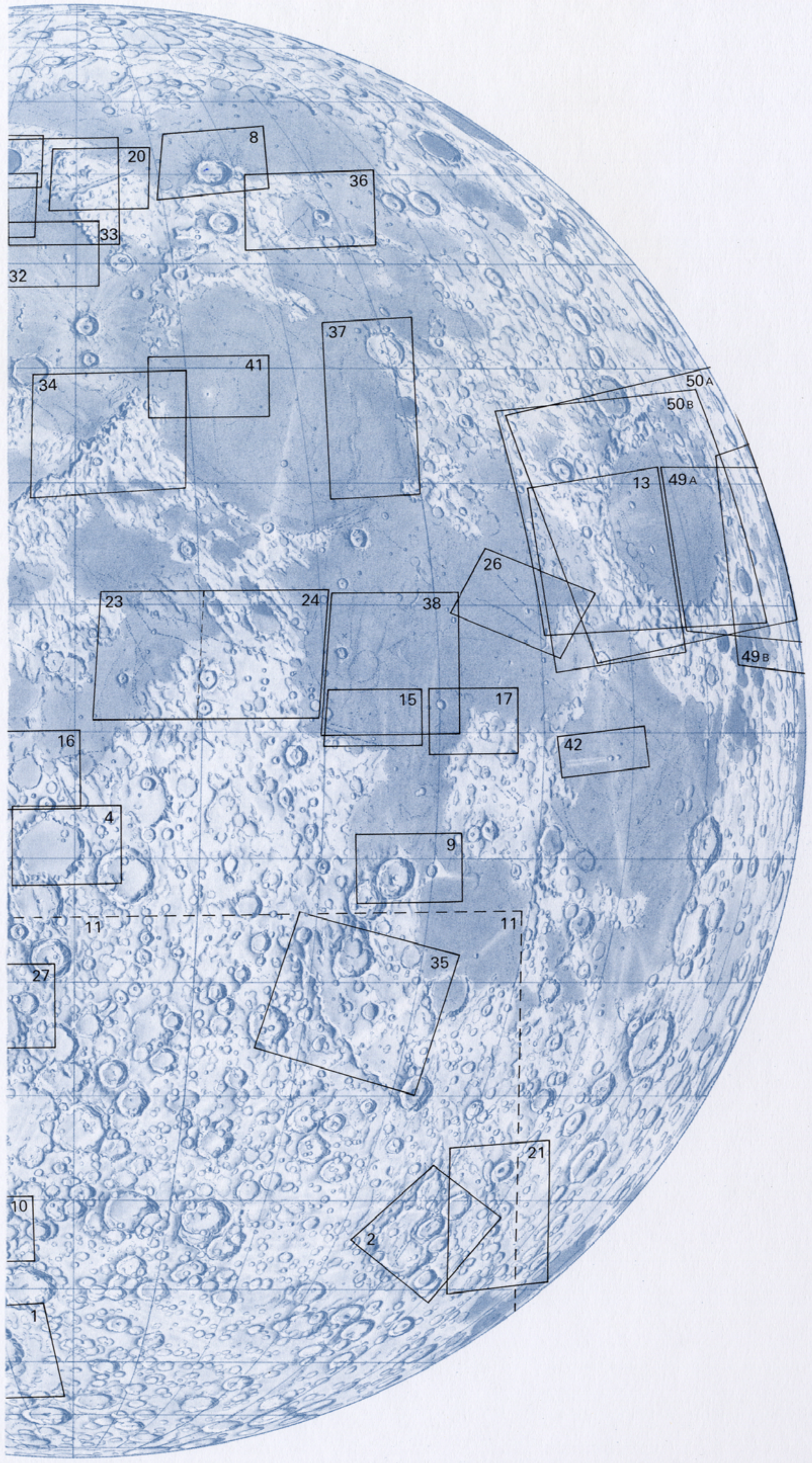
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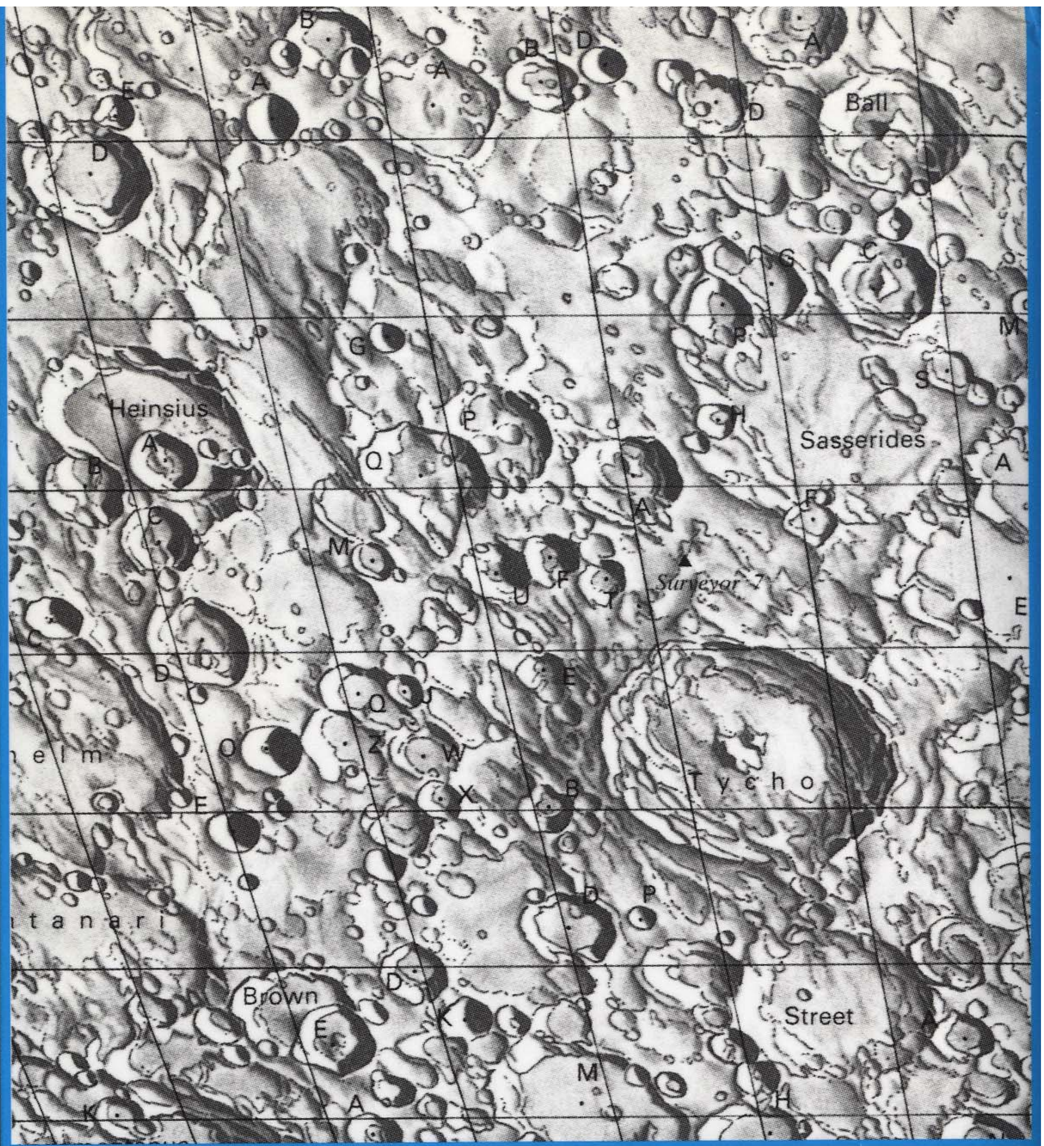

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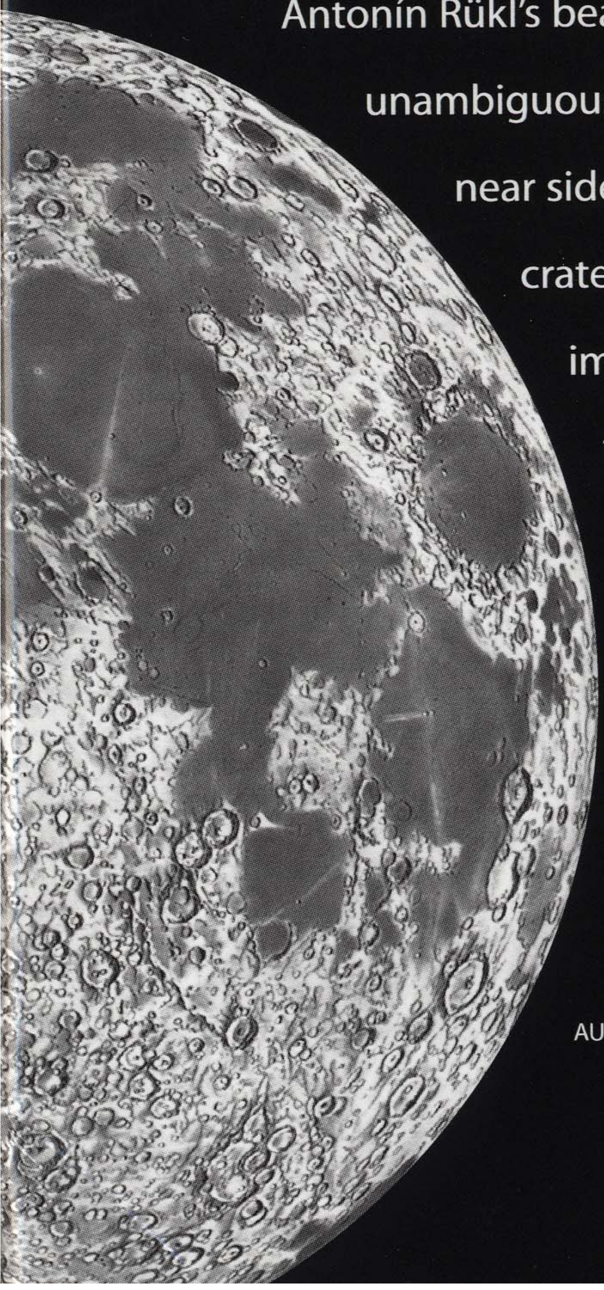

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