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mining crafts and archaeology in ancient Iran

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Introduction

The rich and ancient history of the Iranian Plateau and the immense wealth of metallurgical remains distributed in various forms in different parts of the country have been a source of attracting archaeometallurgists and scholars for many years. Systematic archaeological excavations as well as illicit diggings of ancient remains in Iran in the last few decades have resulted in unearthing and continually revealing of a vast number of prehistoric metal artefacts and other related materials. Through the growing interest in the field of archaeology in Iran by the Iranian and foreign scholars in the last three decades, a number of prehistoric sites have been uncovered during the second half of the 20th century, many of them yielding valuable information concerning ancient metal working in the Iranian plateau during several millennia BC. Metal objects and moulds, slags, crucibles and various other necessary tools and materials belonging to the prehistoric metal workers have been recovered from a range of excavations carried out in different geographical regions: Sialk in Kāshān (Central Iran), Ali Kosh in Khuzestan (SW of Iran), Khabis (Shahdad) in Dasht-e Lut (SE of Iran), Tappeh Yahya in Kerman (Southern Iran), Hasanlu (NW of Iran), Tal-i Iblis (Southern Iran), Arrajan (SW of Iran) as well as Susa (SW of Iran) and Luristan province in the west of the country. These and many other archaeological sites in different geographical locations in Iran have produced information and materials to be studied in relation to different aspects of ancient Iranian metallurgy. Copper and copper alloy objects belonging to different millennia of prehistoric period, from the seventh millennium BC (Hole *et al.* 1969) down to the first millennium BC (Towhidi & Khalilian 1983), uncovered from these sites, are evidences for the earlier metallurgy in Iran. From the time of the discovery of pieces of corroded copper pieces from Tappeh Ali Kosh dated to the 7th millennium BC in Khuzestan province to current archaeological excavations in various parts of the country, numerous metal artefacts have been discovered. Hundreds of archaeological sites, old copper mines and deposits related to the beginning of the metallurgy still need to be investigated. Although the requirement for a comprehensive and systematic investigation in the field of archaeometallurgy in Iran had always been greatly felt but until the implementation of so called "Arisman Project" there had been only some useful efforts in the past in trying to reveal some of the most urgent

Fig. 1: The site of Arisman (Prov. Isfahan) with its enormous slag heaps before archaeological and archaeometallurgical research has been started; Photo: R. Vatandoust.

questions (Fig. 1). To this end a number of metal artefacts belonging to private or museum collections have been catalogued and analysed. There have been pioneers in undertaking research in this field: Excavations at Tappeh Hesār (Schmidt 1937) showed the existence of copper working in North-Eastern Iran. Metallurgical analyses of some Luristan bronzes published by Desch (1938) are among early scientific works on Iranian prehistoric metal objects. The analyses of a piece of metal found at "M" period of Geoy Tappeh (3rd mill. BC) proved that the object was of pure copper and suggested that at the beginning of the third millennium BC copper was used almost pure in that region, but during the first half and middle of the third millennium BC, the presence of arsenic in copper began to become evident (Burton-Brown 1951). The analytical results for some eighteen Iranian bronzes in the collection of Nicholson Museum, University of Sydney (Birmingham 1963) showed a proportion of lead varying in amounts from 0.01 to 5%, which was indeed very interesting in those days, as it was a first hint for deliberate alloys with lead. Examinations of Iranian bronzes in the collection of the Institute of Archaeology, University of London, mentioned the importance of the "casting on" technique applied to some daggers from Northern Iran. This subject was again studied in joining of a mounting of the blade to the hilt of some daggers from North-West Iran (Maxwell-Hyslop 1962; Maxwell-Hyslop & Hodges 1964). The metallurgical examinations of a Luristan dagger by Birmingham, Kennan & Malin (1964) revealed a series of scientific indications regarding the methods of fabrication applied by ancient metal workers.

Hasanlu is another prehistoric site in Iran where a number of interesting metal objects of bronze and iron have been discovered (Muscarella 1966; 1988; De Schauensee 1988). Other attempts have also been made concerning the metallic culture in Iran, paying attention to the coloured flame reaction used by the ancient founders for ascertaining the temperature of the melt (Tsurumatsu 1967). The results of scientific works on Hasanlu's metal objects have clearly shown the bronze working as well as the emergence of iron used at this site in prehistoric Iran (Vatandoust-Haghighi 1977; Pigott 1989). As a result of an archaeological and metallurgical project undertaken by a group of scientists in Bardsir valley in Kerman province, in the south-west of Iran, evidence for very early metallurgy was discovered (end of 5th mill. BC; Caldwell 1967; 1968). This investigation was followed by an international reconnaissance expedition made in 1968 by a team (Tylecote 1970), travelling from Kabul (Afghanistan) across Iran to Ankara (Turkey) examining 40 sites of early metal working. Although most of the surveyed sites belonged to the Islamic period or later it was concluded that many of them could have been worked earlier, especially those containing native copper. The important review of all the aspects of the development of metallurgy in Iran including an extensive and very useful bibliography by P. R. S. Moorey following his preliminary study of the historical development of metalworking in western Iran with special reference to Luristan (Moorey 1971; 1982), categorising the concept of the investigation of ancient metallurgy to mines and mining, smelting, workshops, attempts to draw a clear map, retrospecting and prospecting the investigation of ancient metallurgy in Iran. A point to consider is that, in view of the subject's immaturity, his conclusions are not appropriate. The analyses of six artefacts from Tappeh Yahya in the south of Iran, belonging to period V (4000-3800 BC) of the site, revealed a proportion of arsenic of up to 3.7% in copper, and the conclusion was drawn for the technique of casting and shaping the object by hot and cold working (Lamberg-Karlowsky & Potts 2001; Thornton 2001). Further studies including analyses of artefact material and examination of technological evolution of metal smelting at Hesār (Pigott *et al.* 1982) noted the change in ore source and the possibility of reuse of industrial wastes or by-products in bronze-technology. Several seasons of excavations in Shahdad yielded distinctive features of very early metallurgy in Kerman province. Further excavations in various archaeological sites in Iran, such as Arrajan (Towhidi & Khalilian 1982; Vatandoust-Haghighi 1988) in Khuzestan, Bookab in Azarbaidjan, Pishva in Varamin (near Tehran) have produced very interesting metal objects.

Mineralogical background

Iran is also rich in mineral deposits, including copper. The abundance of copper in different parts of Iran could well be one of the main causes for the extensive copper metallurgy in ancient times. In fact the coincidence of the locations of copper deposits with the prehistoric sites in the country appears to demonstrate the early recognition and utilisation of these sources.

The major copper occurrences discovered are located in Kerman in Southern Iran, Anarak in Central Iran near the town of Kāshān, Abbasabad (NE of Iran), northern Azarbaidjan, and Tarom (SW of the Caspian Sea). There are many ancient copper deposits believed to have been utilised by the prehistoric metal workers. Qaleh Zari (southern Khorasan) and Veshnāveh (between Qom and Kāshān), only 45 km from Tappeh Sialk, a site which has revealed many copper and bronze artefacts, are just two important deposits to be mentioned here.

The copper deposits in the vicinity of Kerman are abundant. The discovery of metalworking activity in prehistoric sites such as Tappeh Yahya, Tal-i Iblis and Shahdad, all located in Kerman province, and the frequency of copper occurrences in this region can be taken as an indication that the Kerman district could well have been one of the major metalworking centres of the old world. The evidence of copper smelting in Tal-i Iblis, dated to the end of the 5th mill. BC, and also the discovery of the "city of Artisans" in Shahdad (Hakemi 1992; 1997) belonging to the later part of the fourth millennium BC, well support the idea of placing Kerman as the oldest area, in which copper ores were smelted in Western Asia.

Among various copper mines in this region, traces of old working on some of the deposits have been observed. The presence of copper carbonate and some native copper in Chah-e Messi (copper well) is reported (Bazin & Hübner 1969). Although geologists believe that most of the current active copper mines have also been used by ancient metal workers, it should be said that old copper mines in Iran do need more thorough and detailed investigations and research by archaeologists, geologists and archaeometallur-

Fig. 2: Participants of the 2nd seminar on "Old mining and Metallurgy at the Iranian plateau", held in December 2001 in Tehran; Photo: RCCCR.

gists. Recent works (Abbass-Nejad 1994) in Kerman province have shown that Zangalou mine situated close to the Rafsanjan-Sarcheshmeh road and approximately 3 km from Sar Cheshmeh may have been utilised by ancient metalworkers. There is a hole of 2 m depth in Zangalou, which is believed to have been used for mining. The bushes growing around this old mine are locally called Kollah-e Qazi and it is said that if fired it burns for two hours producing a very high temperature. Sheikh Ali deposit located in 25 km SW of Tappeh Yahya and Zaqdar mine again not far from Tappeh Yahya have been indeed used in old times. The ancient mine of Sheikh Ali has been investigated by a team of archaeologists and geologists (Berthoud *et al.* 1976). A first usage could date back to the end of the 4th through the beginning of the 3rd millennium BC.

The Project on mining and metallurgy

Although some interesting studies have been carried out, further systematic and comprehensive investigations have always been felt to be most necessary. To understand Iran's role in developing early metallurgy and technology an appropriate interdisciplinary project had to be settled and started. This certainly needed several years of preparation. First in 1991, an initial collaboration between the Geological Survey of Iran (GSI) and the Department of Mineralogical Studies of the University of Mainz was reached, followed shortly after by a joint teamwork between these partners and the Iranian Cultural Heritage Organization (ICHO). This resulted in a first international meeting in Iran and the establishment of the Committee for Studies of Old Mining and Metallurgy at the Research Centre for Conservation of Cultural Relics (RCCCR) at the ICHO. In 1997 the Committee organised an International Symposium on Archaeometallurgy in Central and Western Asia: as a result the Committee was joined by other German institutions such as the German Archaeological Institute (DAI), the TU Bergakademie Freiberg (TUBAF) and the German Mining Museum Bochum (DBM). This conference as well as a Compact Course on Old Mining and Metallurgy held two years later in Kāshān established a friendly and scientifically supportive atmosphere within the partners and consolidated the idea of a joint and international project between Iranian and German partners.

Starting point became the recently discovered settlement of Arisman, which was presented to the ICHO by Mr. Davoud Hasanalian, a local geologist, in 1996. Arisman's importance in early metallurgy initially became apparent by first Radiocarbon dating results, dating the site back to the 4th and 3rd millennium BC, as well as its abundant metallurgical remains on a vast settlement area. These initial outcomes and further various visits and excursions by members of the Committee during various meetings gave reason to decide for the envisaged comprehensive project and to start it in Arisman itself (Fig. 2). Later and based on the progress and development of initial programme the investigations were to be extended to other potential sites and areas as well. From the very beginning the Project, currently being extended to a much larger region and identified as Studies on Old Mining and Metallurgy in Central Iranian Plateau, were to comprise of five distinct research disciplines: archaeology, geology and mineralogy, mining archaeology, metallurgy and archaeometry and conservation and restoration. During 2000 and 2002 seasons a joint Iranian and German team was able to carry out a series of field campaigns (Fig. 3): the excavations in Arisman soon were followed by surveys and soundings in the mining district in Veshnāveh.

These archaeological investigations were accompanied from the beginning by geological and mineralogical surveys in the hinterland of Arisman, later also in other mountainous regions stretching between Veshnāveh and Natanz (Chegini *et al.* 2001) (Fig. 4). An archaeometallurgical survey was also included later on, focused mainly on the region of Anarak and Nakhlak: due to their abundant metal resources especially of native copper, scholars have regarded the region as the most important for the earliest steps of metallurgy – but an exact proof has not been reached so far.

Beside the field work several investigations were undertaken in Iranian and German laboratories: geochemical analyses of ores and metals should help to understand the work-flow from the ores to the end-product. Radiocarbon-dating gave a first secure chronology especially for the mining site of Veshnāveh and different layers in Arisman. Archaeozoological and Archaeobotanical studies carried out at several German Institutions revealed a series of insights into the economy and subsistence of the early metal-producing societies at the western part of the Central Plateau. Although there are still a lot more detailed investigations to be carried out the first research period have brought many important results to light such as:

- The settlement of Arisman can be regarded as specialised site for producing copper and silver metals at least over time period of more than half a millennium (from the 1st half of the 4th millennium to the beginning of the third millennium). Similar to other sites at the Iranian plateau there is the evidence for primary copper smelting on site and the production of finished products such as heavy shaft-hole axes and flat axes. Most important is the evidence for silver production by cupellation of silver-bearing lead ores. It can be likewise presumed that fine silver products like prestigious pendants have been produced on site. First results concerning wood management suggest that Arisman was based in a semi-arid zone that was able to deliver sufficient wood-stock for smelting and living there.

- Field surveys in the hinterland of Arisman brought the evidence that the land-stripe around Karkas-mountains and the flat zones east of Arisman and Badrod have been chosen in several periods for crafts activities from the late 5th millennium on, especially in late Chalcolithic and Early Bronze Age as well as during the Iron Age and historical periods. Main reason may be sought in comparably favoured conditions for trade and access to natural resources. But still there is no evidence for a local copper source on which the settlement of Arisman especially was based.

Fig. 3: Arisman – work on site: conservation of pottery kilns by colleagues of the RCCCR in 2000; Photo: R. Vatandoust.

- Geochemical analyses of ores, slags and metals have given us the possibility of drawing two remarkable conclusions: first of all copper seems not to originate from one main source but more from several, perhaps small scaled regional deposits. Despite that there is strong evidence for some ore delivery from Nakhlak-Baqoroq region. Lead-Isotope investigations do suggest the provenance of those silver-bearing lead ores worked in Arisman, originating from Nakhlak. Some geochemical hints also indicate a copper deposit like Baqoroq situated nearby Nakhlak as one possible source for Arisman.

- Investigations in Veshnāveh proved copper-mining during the early 3rd millennium in a first phase as surface and small scaled underground work. According to radiocarbon-dating a second mining period can be assumed for the beginning of the second millennium BC, now related with extensive underground workings. This periodisation suggests the influx of Veshnāveh copper to regional markets during the 3rd millennium at a small scale, but more extended during the beginning of the 2nd millennium – a period when archaeology has noted again small scaled permanent settlement activities at the Central plateau. Techniques and logistics of mining suggest a seasonal mode of exploitation perhaps by nomadic groups who were responsible either for exploitation as well as for transport of concentrated ores to metal-working settlements at the plateau. As an important by-product of the Veshnāveh research, the excavators discovered a Parthian/Sasanian offering area in one of the mines (Stöllner & Mireskanderi 2003) – this site not only provides insight in religious practices during the 1st mill. AD, but also documents the changes in the human usage of the mountainous landscapes during these periods. On the basis of archaeobotanical and archaeozoological data a clear differentiation between these periods now is possible. Evaluating these data provides a more accurate insight into Bronze Age land use as the ecological data widely differ from those of the later Iron Age.

Fig. 4: The outcrops of the native copper deposits of Darhand near Natanz (Prov. Isfahan), view to northeast; Photo: B. Helwing.

The future

These first results have made apparent the wide-scaled economic attitudes of the prehistoric people at the Central Plateau – trading ores over hundreds of kilometres seems nowadays more likely as twenty years before. In general the project has started to develop from single local sites to a regional scope – therefore it has been renamed into "Early Mining and Metallurgy on the Central Iranian Plateau" – the working area now spans from the Qazvin Plain in the Northwest to the Anarak area in the Southeast and from the southern foothills of the Alborz in the Northeast to the Plain of Isfahān in the Southwest. The chronological framework extends from the Neolithic period to the 1st millennium BC. The need for reorganising the project also was reasoned in the increasing complexity of scientific questions and results: the distinctive metal economy recently becomes understood as part of a complex resource management necessarily based on the special regional character of the Central plateau. Naturally such complex research aims only can be answered by a long lasting and intensive research work and a research team fully devoted to these common aims. So it is envisaged that these fruitful collaborations will be continued during the coming years in a smooth and attractive scientific atmosphere.

To get this exhibition organised it is also a great chance for the project itself, especially to present results and research programs to a broader scientific and public audience. A major project like the one introduced here has besides its scientific scope also an educational and political task: young scholars shall be attracted to join this program and devote their practical and theoretical studies to the interdisciplinary frame of this project. The needs for more acceptances of cultural heritage and particularly for the values of economic and industrial history are strongly felt worldwide and Iran is no exception. Iranian people, appreciating their long-lasting history and facing the realities of the current world, begin more enthusiastically to understand the worth of archaeology as an important scientific and social task. An exhibition like the one organised by the Deutsches Bergbau-Museum and Iranian Cultural Heritage and Tourism Organization may help to stimulate and fill us with enthusiasm for our future work.

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Metallic mineral resources of Iran, mined in ancient times. A brief review

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Introduction

The Iranian plateau is one of the earliest parts of the world in which metal is mined and gained. A general view on the ancient mining and metallurgy in this archaeologically critical part of the world is missing which generally suggests a bi-lateral international project for studying the temporal-geographic-commercial and cultural relationships between mining-metallurgy industries in ancient mining sites and the neighbouring and regional archaeological settlements. The present work is indeed a very preliminary example and can be considered as a proto-type of a suggested program. The examples about commercial-cultural relationships between some ancient mining districts and the ancient civilization settlements which are discussed in this paper show that such a program is capable to bring about unexpectedly important information, which can explain "old questions" in the field of archaeology.

Of course it is a difficult task to compact the information about geological and mineral resources of a country, being three times bigger than a country like France, in a few pages without missing a lot of important data. Therefore the author tries to concentrate on the very important geological elements and on a few metallic minerals which have been used in prehistoric times. It is also a difficult task to present a complete list of ancient mines, even for a few metallic minerals in a country with more than six millennia history of mining and thousands of ancient mining sites. Although several types of mineral resources have been exploited in prehistoric times, but metallic minerals, especially Cu, Au, Ag, and Fe are of more importance for the purpose of the present volume. Therefore the provenance of raw materials like flint, clay, building stones, salts, fuels, asphalt, plaster, decorative stones and gemstones as well as soapstone, mica, talc, onyx, jasper, etc. are not mentioned.

Metallogeny

The temporal-spatial distribution of mineral resources in nature is a result of the tectono-magmatic events of the earth's crust "orogenic movements". Such events occur in definite periods of the earth's history (tectono-magmatic episodes) and in definite parts of the earths crust (tectono-magmatic zones). Hence the tectono-magmatic zonation and episodes of the Iranian crust is briefly reviewed. Meanwhile the evolution of Cu, Au, Fe, and Pb, Zn, Ag is reviewed (Fig. 1 & Tab. 1).

The Iranian plateau, excluding folded Zagros belt in southwest and Koppeh Dagh range in northeast, makes up the central part of the Alp-Himalayan orogenic-metallogenic belt (Fig. 1). Numerous tectono-magmatic episodes, have affected this part of the Earth since one billion years ago, i.e. from late Proterozoic to the present time (Tab. 1).

Tab. 1: Major tectono-magmatic episodes.

1	Uppermost Proterozoic-lower Cambrian episode (Assyntic)
2	Early Palaeozoic episode (Caledonian)
3	Late Palaeozoic-early Triassic episode (Early Cimmerian)
4	Late Jurassic-early Cretaceous episode (Late Cimmerian)
5	Late Cretaceous-Palaeocene episode
6	Oligocene plutonism
7	Young magmatism

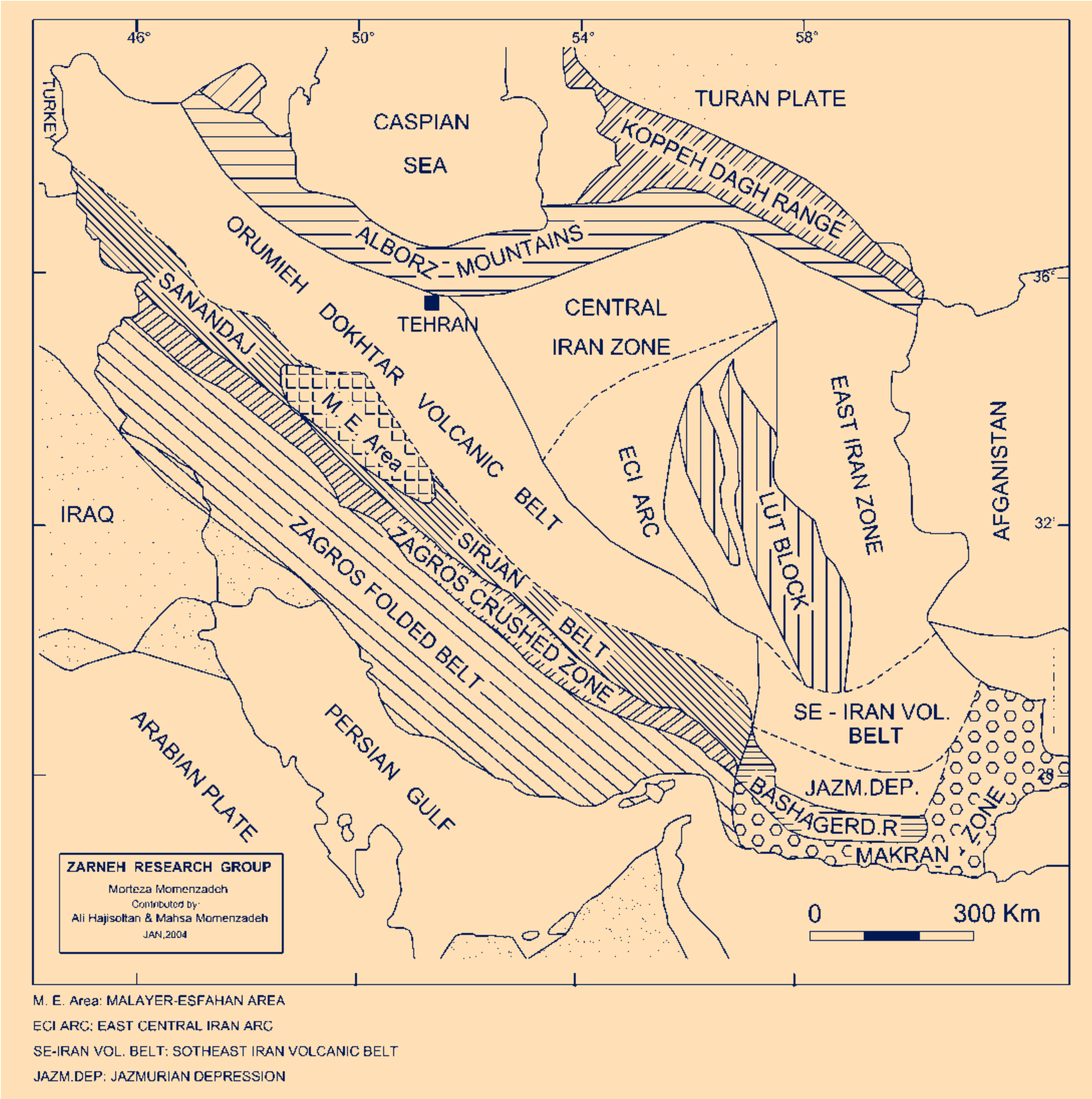

Fig. 1: Tectono-magmatic zonation of Iran; after Stöcklin 1968; revised by the author.

The Assyntic tectono-magmatic episode of latest Proterozoic-early Cambrian age has caused generation of big iron and zinc-lead-silver resources in central, northwest and southeast Iran.

The Caledonian and Variscan tectono-magmatic episodes of early and late Palaeozoic times, as well as the early Cimmerian episode of early Mesozoic time have caused the generation of hundreds of gold, zinc-lead-silver, iron and some copper, copper-gold, and copper-tin-tungsten-gold mineral resources. The hostrocks of the mineral resources of all these episodes are the plutono-metamorphic belts, extending E-W wards in Alborz Mountains, NW-SE wards along Sanandaj-Sirjan belt and N-S wards in east Iran zone

(Fig. 1). Similar hostrocks are exposed in east central Iran along a N-S extending arc (ECI arc in Fig. 1). The eastern extension of the Alborz Mountains of Palaeozoic plutono-metamorphic belt is the host of similar mineral resources in Afghanistan, Uzbekistan and Tadjikistan.

Except zinc-lead-silver resources, which are mainly hosted by carbonates and shales, other resources are hosted mainly by phyllites, schists, meta-volcanics, meta-volcanogenic sediments and occasionally by the plutons. Iron resources are mostly associated with submarine meta-volcanic rocks and intrusives. Gold, copper and gold-copper, (as well as Au, Cu, Sn, W association) resources are mainly hosted by metamorphic rocks, more frequently close to the contacts of plutons. The copper-tin-tungsten-gold resources, although hosted by metamorphic rocks, almost in all cases are close to the granite-granodiorite plutons.

The late Cimmerian orogenic episode in early Cretaceous times is characterised by zinc- lead-silver mineralization in almost all over the Iranian plateau. The abundance of Pb, Zn, Ag-resources is more along Malayer-Isfahān area (M.E. area in Fig. 1). But many other similar resources are scattered in central Iran. Iron ore is the next frequent mineral which has been formed in early Cretaceous time. The hostrocks of zinc-lead-silver, as well as iron are lower Cretaceous carbonates and shales.

The younger stages of Alpine tectono-magnetic episodes have caused the most intensive and extensive resources of numerous types of minerals including copper, gold, lead-zinc-silver, iron and turquoise in the Iranian plateau. Hundreds of occurrences of these minerals, especially copper are hosted by Eocene submarine volcanic-pyroclastic rocks, mainly the andesite-basalt layers. A majority of the copper occurrences have different amounts of gold, silver, lead, zinc, nickel and cobalt. The ore bodies are generally veins, which are indeed fracture-fillings. There are occasionally stratiform resources as well. The mineral association is characterised by chalcosite and copper oxides, with lesser amounts of native copper. Chalcopyrite is not a common mineral in this group of copper resources. The veins contain usually high grade copper. Therefore they were very attractive for ancient miners, who wanted to dig less and gain more. The ratio of copper/lead-silver (zinc) and copper/gold may vary in different occurrences, as a function of variation in lithology, tectonics and the age of the hostrocks. Therefore a percentage of the total number of volcanic hosted Eocene occurrences may be considered, not as a copper occurrence, but as a copper bearing lead-silver mineralization and some may be considered as gold-silver rich copper mineralization. The well known Nishapur turquoise deposit is hosted by the Eocene submarine andesites.

The Eocene submarine volcanic rocks and their mineral resources are extended along the Orumieh-Dokhtar belt, as well as in central, east and southeast Iran. Similar mineral resources are hosted by the Eocene submarine rocks in the southern foothills of the Alborz Mountains.

The youngest Alpine tectono-magmatic episode is the late Tertiary-Quaternary episode “young magmatism”. This can be considered as the most important episode concerning generation of gold and copper resources in the Iranian plateau. During this episode an intensive and extensive magmatic activity affected vast areas of Iran. The outstanding manifestation of this magmatism is a sequence of subaerial volcanoes, especially in upper Miocene-Pliocene to the present times. The volcanoes are indeed the surface manifestations of domal structures. A chain of such domal structures occurs along the NW-SE Orumieh–Dokhtar and SE Iran volcanic belts (Fig. 1). These belts extend from the Turkish border at northwest to the Pakistani border at southeast. The well known Ararat, Sahand and Sabalan volcanoes in Azarbaidjan province and Bazman and Taftan in Baluchistan province are some examples of these domal structures. Another chain of domal structures and volcanoes extends E-W wards from Azarbaidjan through south Alborz to northeast Iran.

Distribution of copper, gold, silver, iron, and turquoise

Copper, gold, silver, and iron are the main metals which have been used in ancient times. Some other metals and non-metallic elements like tin, arsenic, nickel, cobalt, tungsten, lead, zinc, mercury, antimony etc. may be associated in different quantities with the ore minerals of copper, gold, silver, and iron. In the case of copper the presence of tin, arsenic, antimony, zinc and lead in the natural ores may have caused different types of natural alloys, without especial intention of the ancient miners and metallurgists. Therefore describing the distribution of copper resources in Iran the mineral association is also considered. On this basis the copper occurrences with copper-tin-tungsten (with or without gold) association are described in a separate group. Silver being associated with lead in lead-zinc-silver mineralization is discussed under the lead-zinc-silver group of minerals.

Copper: Natural resources and ancient mining

Natural resources

Copper is one of the metals which have a higher geological potential per square kilometre in the Iranian crust in comparison with the average of the world potential. The number of porphyry copper deposits of Iran which enter the world rank of big and medium porphyry copper deposits is growing by recent exploration activities. Sar Cheshmeh is known as a big porphyry copper deposit of world scale since 30 years. Sunghun and Meduk are under mobilization. There are at least four other porphyry deposits under exploration. Besides these there are more than 400 known copper deposits and

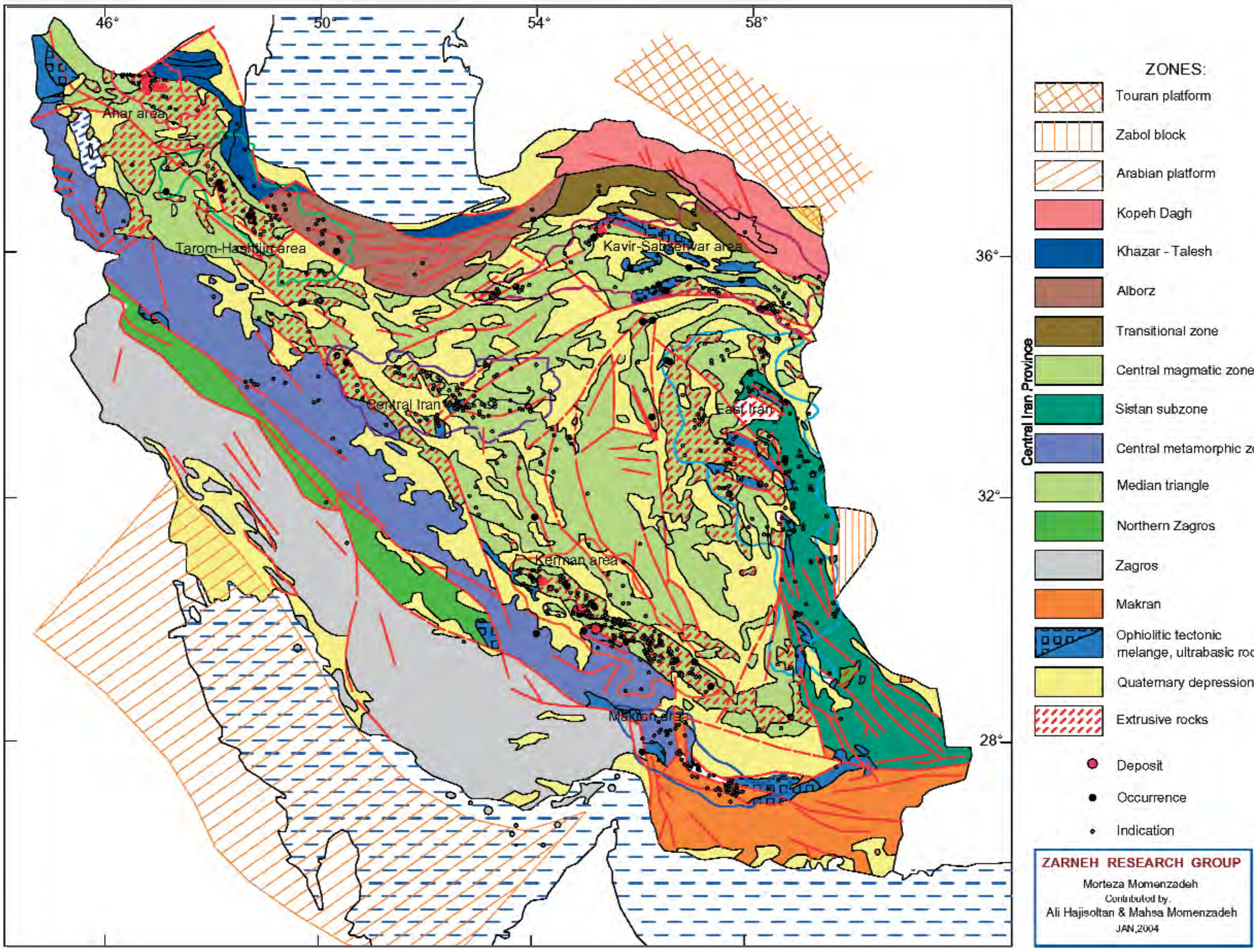

Fig. 2: Distribution of copper deposits and occurrences; after Ghorbani 2002.

occurrences, some of which may come out as big and medium porphyry type deposits (Fig. 2).

Copper in Tertiary igneous rocks

As noted in chapter "metallogeny episodes" most of the copper resources of Iran, both in number and in total metal volume are of the Tertiary age. They are distributed along the Orumieh-Dokhtar volcanic belt, south central Iran (Anarak), north central Iran, and southern Alborz foothills (Abbasabad-Toroud) and east Iran areas (Fig. 1, 2). Within these zones, the Orumieh-Dokhtar volcanic belt is by far the most important Tertiary copper belt of Iran. The most important sectors in the Orumieh-Dokhtar belt are Kerman and Ahar areas (Fig. 2). The next areas along this belt are Tarom-Hashtjin and Qom-Kāshān-Natanz. Concerning genesis the copper mineralization of Tertiary age can be categorised to two types:

1.) Mineralization which is hosted by Eocene submarine volcanics and pyroclastics; the volcanics are mainly andesites and andesite-basalts. The morphology of ore bodies is mainly veins, which have usually sharp contacts with host rocks. The mineral association is usually simple and is characterised by chalcosite, copper oxides and occasionally native copper. The copper grade is usually high, i.e. in the order of several percent Cu. The absence or rareness of chalcopyrite is also a characteristic feature of this type. The hydrothermal alteration is either absent or rare and if present, is limited. This type of mineralization was much desired by ancient miners due to high grade ore, simple mineralogy and simple extraction metallurgy, especially copper oxides and native copper. Although the reserves of vein type deposits are usually limited, hence not much attractive for modern mining but the ancient miners were not sensitive to the reserve factor because of their limited production per year. Therefore hundreds of such occurrences are mined in prehistoric and historic periods (Talmessi, Meskani, Damanjala and Veshnāveh are typical examples of this type).

2.) Mineralization which is in relation to hydrothermal activities of late Tertiary time; the alteration and mineralization are in asso-

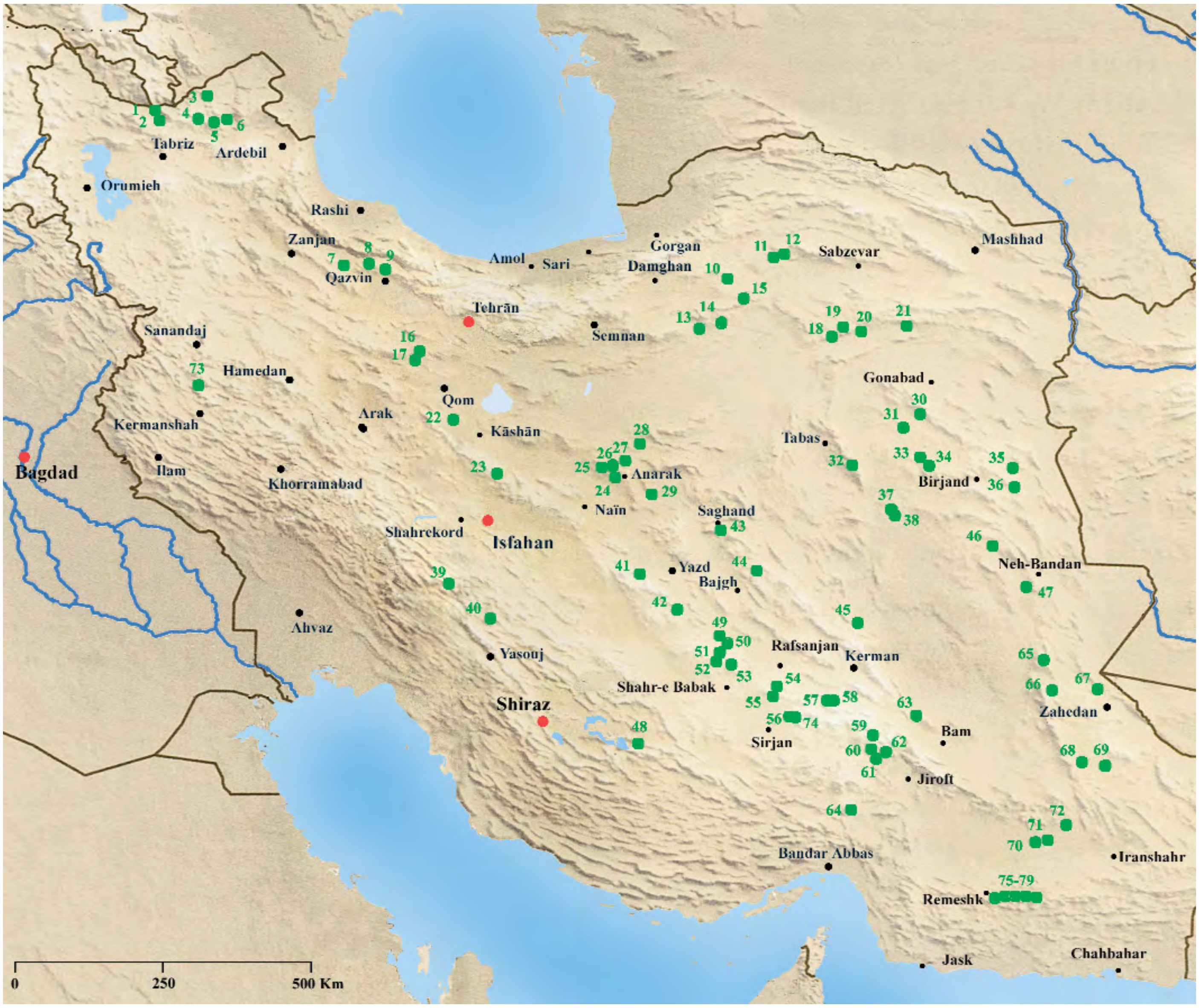

Fig. 3: Distribution of ancient copper mines.

1) QARACHILAR (GULAN), Cu (Mo), 2) CHESHMEH KHAN (ASTMAL), Cu, 3) AYNELU, Cu, 4) SUNGHUN, Cu (Mo, Au), 5) ANJERT, Cu (Mo), 6) MAZRAEH (GOWDEL), Cu (Fe, W, Bi, Au, Ag), 7) DAVA YATAGHI, Cu, 8) DIZEJIN, Cu (Au, Fe), 9) ZARRIN KHANI (ALAMUT), 10) BIARJO-MAND, Cu, 11) DAMANJALA, Cu, 12) MADEN-E-BOZORG, (ABBASABAD), Cu, 13) CHAH MESI, Cu, 14) BAGHALU, Cu, 15) RUGHERU CHAH, Cu, 16) ABBASABAD-E-NARBAGHI, Cu, 17) TAKHT-E-CHAMAN, Cu, 18) BATO, Cu, 19) CHESHMEH GAZ, Cu, 20) TAKNAR, Cu (Pb, Zn, Au, Ag), 21) SORKHDARREH, Cu, 22) VESHNOVEH, Cu, 23) GHAMSAR, Cu, (MADAN-E-LAJEVARD), Cu, (Co, Fe), 24) TALKHEH, Cu (Pb, Ag), 25) MESKANI , Cu (Ni, Co), 26) TALMESI, Cu (Ni, Co), 27) CHAH MILEH, Cu (Pb, Zn), 28) BAGH GHOROGH, Cu (Pb), 29) CHAH PALANG, Cu (Au, W), 30) KALATEH AHANI, Cu (Pb), 31) KAKHK, Cu (Zn), 32) GAZU, Cu (Tq), 33) MIR-E-KHASH, Cu, 34) SHIKASTEH SABZ, Cu, 35) DARMIAN, Cu, 36) LOTFABAD, Cu, 37) HOWZ-E-RAIIS, Cu (Pb, Zn), 38) SEH CHANGI, Cu (Zn, Pb, Mo, Ag), 39) DEH-E-MADAN(KARUNRUD), Cu (Co), 40) KHANEGAH (RAVAK), Cu, 41) KHUT (MAZRAEH), Cu (W), 42) TANG-E-CHENAR, Cu (Mn), 43) KHOSHUMI, Cu (Pb, Zn), 44) NARIGAN, Cu (Fe), 45) KHANUK, Cu, 46) GHALEH ZAR, Cu, (Au, Pb, Zn, Ag), 47) GHOLLEHA, Cu, 48) KUHN-E-MES, Cu, Tq, 49) TEZARJ (TIZARK), Cu, 50) DAR-BIDU, Cu, 51) LACHAH (MEDUK), Cu, (Tq, Au), 52) CHAH MESI, Cu (Pb, Ag, Zn), 53) ADEA BAGH, Cu (Tq), 54) DEH SIAHAN, Cu (Tq), 55) SARCHESHMEH, Cu (Mo, Au, Tq), 56) BOLBOLU (SOLTAN HOSEIN), Cu, 57) GHALEH NARP, Cu, 58) ALLAH ABAD, Cu, 59) TALL-E-MADAN, Cu, 60) BAGHRAII, Cu (Au), 61) GERDU KULU, Cu, 62) KAMADURAN, Cu, 63) DARBINI (BIDE SORKH), Cu, 64) SHEIKH ALI, Cu, 65) CHEHEL KOUREH, Cu (Zn, Pb), 66) SIAH JEKUL, Cu, 67) HAJI KOSHTEH, Cu, 68) CHAH DOUST, Cu, 69) SHEIKH AHMAD, Cu (Pb, Ag), 70) ISHPASH, Cu, 71) MEHGUII (BORJAK), Cu, 72) PIRUZAKI (BAZMAN), Cu, 73) SHIRVANEH, Cu, 74) CHAHAR GONBAD, Cu (Au, Ag), 75) SARSOW, Cu, 76) TANGASHKUN, Cu, 77) KALLE GUN, Cu (Au?, Ag?), 78) KONAR GABON, Cu (Au?), 79) KISH PATIEL, Cu.

ciation with subaerial volcanism and their shallow intrusive roots. This type of mineralization has generated porphyry and scarn type, as well as vein type copper in association with extended alteration zones. Gold is present in association with copper in many deposits. The copper-gold association in late Tertiary mineralization is very variable in different areas. Gold in some areas (like Tarom-Hashtjin and Kerman areas) and in some individual deposits (like Qaleh Zari and Chahar Gonbad) may be high enough to increase the economic value of the copper product. The variation in Cu/Au ratio may be so much in some areas that some deposits can be considered as copper-gold and some as gold-copper. Even in a single deposit the Cu/Au ratio may change so much in short distances that a sector of deposit being mined for Au and another sector for Cu (Qaleh Zari is mined in a sector as Au in ancient times and is mined in the present time as copper in another sector). Concerning zonation of Cu and Au in the Orumieh-Dokhtar belt it is of interest to note that the gold content of copper in the Ahar area is the lowest and in the Tarom-Hashtjin area is the highest. The number of gold occurrences (with or without copper) in the Ahar area is also not so plenty as in the Tarom-Hashtjin area. The ratio of Au/Cu in individual copper deposits in the west central Iran and Kerman areas is moderate in comparison to the Ahar and Tarom-Hashtjin areas. The Tertiary copper mineralization, both the Eocene hosted type and late Tertiary porphyry and vein types are more abundant in the Orumieh-Dokhtar volcanic belt than in other parts of Iran.

Copper-tin-tungsten-gold association in Cretaceous plutono-metamorphic terrains

The Cu, Sn, W, Au element association is not well known in Iran. But the metallogenic evidence, like wide extension of Caledonian, Variscan and early Cimmerian plutono-metamorphic terrains (chapter metallogeny episodes) implies more unexplored Cu, Sn, W, Au resources. The available information about this association is limited to four metallogenic fields in the central part of the Sanandaj-Sirjan belt and central, northeast and east Iran zones. The *"first field"*, i.e., the central part of the Sanandaj-Sirjan belt is in southwest of Arak. The Astaneh gold deposit and Nezamabad-Bamsar-Revesht axis, as well as the Deh Hosein deposit are the known examples of Cu, Au, Sn, W association in the Sanandaj-Sirjan belt. The *"second field"* is in the Chahpalang deposit in central Iran. This deposit which is known as a tungsten deposit seems to be a copper-tin ancient mine. The *"third field"* is in the Mokhtaran-Sahlabad-Basiran triangular area south of Birjand and northeast of the Qaleh-Zari gold mine. The recent geochemical survey by the Geological Survey of Iran showed W-Sn anomalies in the Shakuh at southeast of Qaleh Zari mine in east Iran. The *"fourth field"* is situated in northeast Khorasan. The Tarik Darreh occurrence, east of Mashhad is an example of this type. The Cu, Au, Sn, W association is proved to be extended in the Mashhad granite pluton and its aureole by geochemical surveying (Geological Survey of Iran, 1970-73). The Torqabeh gold deposit (Fig. 7) and several gold indications and W, Sn, Cu anomalies were discovered in the Mashhad granite and its enclosing metamorphic complex.

Ancient mining

Mining for copper in the Iranian plateau is one of the oldest in the world. This subject has been the topic of research by archaeologists since last century. In the last decade the attempts are intensified, especially by the performance of the Arisman project. The provenance of raw materials for the production of the Lurestan bronzes is the next subject of interest by archaeometallurgists. By a review of geographical distribution of natural resources of copper (Fig. 2) and copper associated Sn, Au, As elements and presentation of the list of some known ancient copper mines the author seeks the provisions and pre-requisitions for a better approach to these two problems.

The geographical distribution of ancient copper mines, the age and lithology of country rocks, the element association of ore minerals, and the correlation of this information (Fig. 3) with the geographic distribution of major archaeological sites (Fig. 4) provide the least necessary requirements to approach to these two questions. Although the inferred period is neither reliable nor precise enough for a chronological correlation between the mining period of the concerned mine and the nearest major archaeological site but such correlation brings about the first logical impression about the provenance of metal objects found in the nearest archaeological site. As copper, gold and tin resources may occur together in nature the production of copper may be accompanied by gold or tin as by products. On the other hand as most of the late Tertiary copper resources of Iran carry variable amounts of gold and some gold resources carry copper the ancient copper-gold and gold-copper mines are clustered in the areas of the late Tertiary copper-gold mineralization. The Cu, Au ancient mines of late Tertiary in the Ahar, Tarom-Hastjin, central Iran, Kerman and east Iran areas are of this type (see Fig. 2 & 3). The copper-tin-tungsten-gold association in pre Cretaceous plutono-metamorphic terrains although not well known to the modern miners has been widely mined in ancient times. Chahkalap and Chah e Chaharnafari in the Mokhtaran-Sahlabad-Basiran triangular area south of Birjand, in east Iran are two examples of Cu, Au, Sn, W association which have been mined in ancient times. In these localities several ancient workings are scattered along the contact of marble and schist in the Palaeozoic metamorphic complex. Some slag piles (20 km north of Basiran and elsewhere) indicate ancient metal mining and metallurgy in this area.

The plutono-metamorphic complex of Palaeozoic (to early Mesozoic?) age in Iran hosts Cu, Sn, Au, W element association in the Sanandaj-Sirjan belt, central Iran, east Alborz Mountains and east Iran zone (Fig. 1). The same metamorphic complex hosts similar element associated mineralization in the north-eastern and eastern neighbouring countries, i.e., Uzbekistan, Tadjikistan and Afghanistan. The modern geochemical surveying, geological explorations and archaeological studies revealed that this mineral association has been feasible for mining and has been mined by ancient miners in prehistoric and historic periods (Fig. 3). But the vast extension of plutono-metamorphic hostrocks and abundance of unstudied ancient mining and metallurgy relicts (slags, furnaces, and settlement sites) and abundance of place names which have inherited their meaning from mining-metallurgy activities indicate that these

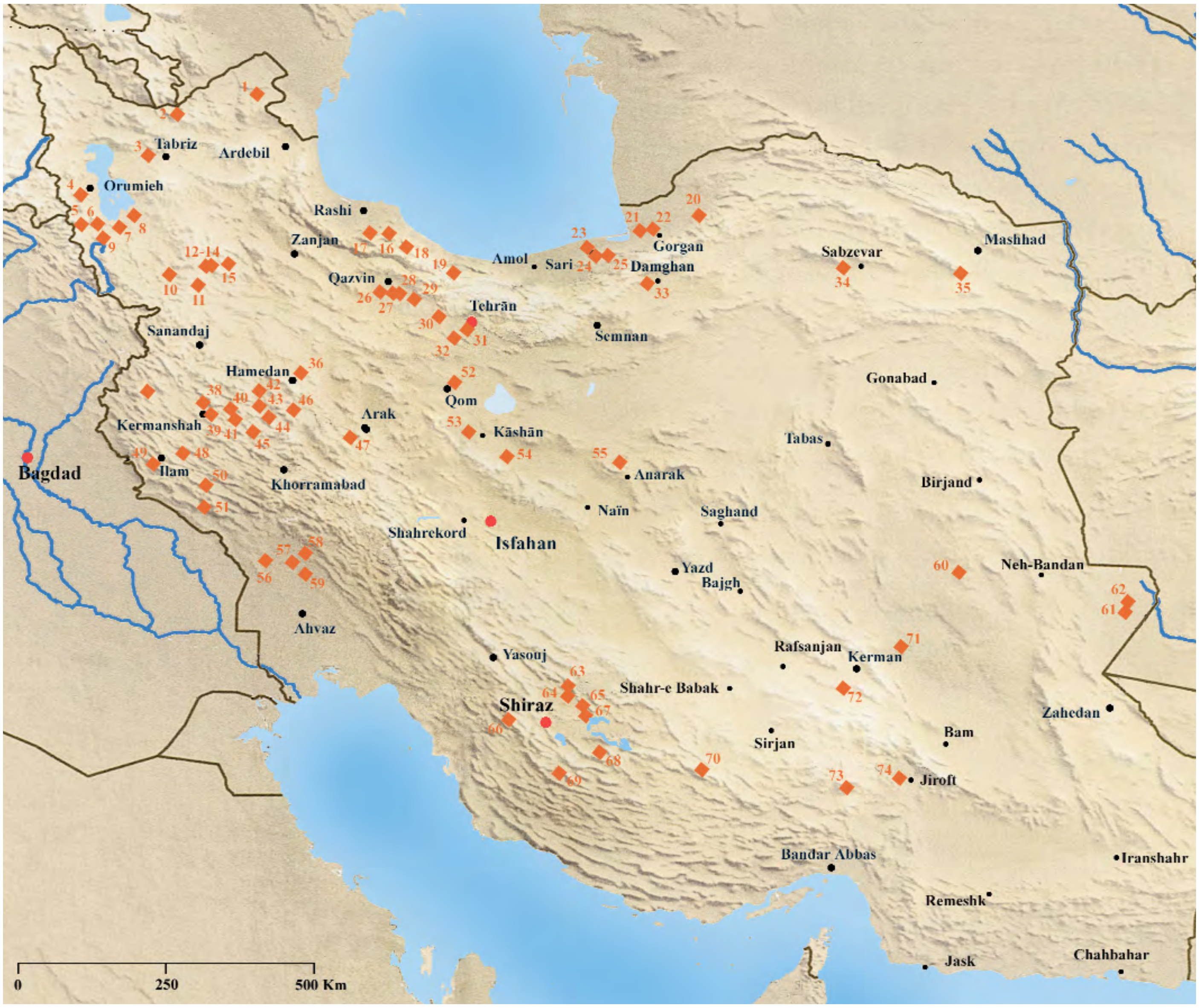

Fig. 4: Major archaeological sites in Iran.
1) SHEIKHLAR TAPPEH, ?, 2) AGHCHE GHALEH, Sasanian, 3) TALL-E-PALANG, ?, 4) GOY TAPPEH, Prehistoric, 5) DINKHAH TAPPEH, Prehistoric, 6) HASANLU, Prehistoric, 7) HAJI FIRUZ, Prehistoric, 8) PESIDELI, Prehistoric, 9) DALMA TAPPEH, Prehistoric, 10) ZIWIYE, Median, 11) KARAFTU(GHAR), Prehistoric, 12) TAKHT-I-SULEIMAN, Parthian-Sasanian, 13) ZENDAN-I SULEIMAN, Prehistoric, 14) CHERAGH TAPPEH, Parthian-Sasanian, 15) TAPPEH NIZA, Parthian, 16) AMLASH, Prehistoric, 17) MARLIK, Prehistoric, 18) DEILAMAN, Prehistoric, 19) KALARDASHT, Prehistoric, 20) YARIM TAPPEH, Prehistoric, 21) SHAH TAPPEH, Prehistoric, 22) TURENG TAPPEH, Prehistoric, 23) HUTU (GHAR), Prehistoric, 24) KAMARBAND (GHAR), Prehistoric, 25) ALI TAPPEH (GHAR), Prehistoric, 26) TAPPEH ZAGHEH, Prehistoric, 27) TAPPEH GHABRISTAN, Prehistoric, 28) SAGZABAD, Prehistoric, 29) TAPPEH OZBAKI, Prehistoric-Median, 30) TAPPEH KHORVIN, Prehistoric, 31) RAY (CHESHMEH ALI), Prehistoric, 32) TAPPEH MAMOURIN, Prehistoric, (FORUDGAH-E-EMAM KHOMEINI), 33) TAPPEH HESAR, Prehistoric, 34) RAYBAND, ?, 35) GHARE-E-MOGHAN, ?, 36) HAKMATANEH, Median-Achaeminidian, 37) BANZARDEH, Sasanian, 38) TAPPEH ASIAB, Prehistoric, 39) TAPPEH SARAB, Prehistoric, 40) GHAR-E-KHAR, Prehistoric, 41) TAPPEH GANJDARREH, Prehistoric, 42) KANGAVAR, Parthian-Sasanian, 43) GOWDIN TAPPEH, Prehistoric, 44) TAPPEH ABDOLHOSEIN, Prehistoric, 45) TAPPEH BABAJAN, Median, 46) NUSHIJAN TAPPEH, Median, 47) DEH HOSEIN, Prehistoric, 48) TAPPEH GURAN, Prehistoric, 49) BORDBAL, Prehistoric, 50) DARREH SHAHR, Sasanian-Islamic, 51) TAPPEH ALI KOSH, Prehistoric (TAPPEH MUSIAN), 52) QOMROUD, Prehistoric, 53) TAPPEH SIALK, Prehistoric, 54) ARISMAN, Prehistoric, 55) NAKHLAK, Sasanian, 56) SHUSH (SUSA), Prehistoric-Historic-Islamic, 57) HAFT TAPPEH, Prehistoric, 58) CHOGHA MISH, Prehistoric, 59) TCHOGHA ZANBIL, Elamides, 60) QALEH ZARY CASTLE, Sasanian, 61) SHAHR-E-SOKHTA, Prehistoric, 62) KUH-E-KHAJEH, Sasanian, 63) TALL-E-NOKHODI, Prehistoric, 64) TALL-E-BAKUN, Prehistoric, 65) TAKHT-E-JAMSHID, (PERSPOLIS), Achaeminidian, 66) BISHAPUR, Sasanian, 67) TALL-E- MUSHAKI, Prehistoric, 68) SARVESTAN, Sasanian, 69) FIRUZABAD, Sasanian, 70) DARAB, Sasanian?, 71) SHAHDAD (KHABIS), Prehistoric, 72) TALL-I-IBLIS, Prehistoric, 73) TAPPEH YAHYA, Prehistoric, 74) SHAHR-E-DAGHYANOUS, Prehistoric.

Fig. 5: Distribution of ancient lead-silver-zinc mines.
1) ANGURAN, Zn, Pb (Ag), 2) SHAKIN, Pb, Ag, Zn (Ba), 3) KALARDASHT (GROUP), Zn, Pb, Ag (Ba, F), 4) DUNA, Pb, Ag, Zn (Ba), 5) TUY-EH-DARVAR (GROUP), Pb, Ag, Zn (Ba, F), 6) ANARU, Pb, Ag, Zn (Ba), 7) RESHM (KHANJAR), Pb, Ag, Zn, 8) NORTH NEYSHABOUR (GROUP), Pb, Ag, Zn, 9) PIVEZHAN, Pb, Ag, Zn, 10) AHANGARAN, Pb, Ag, Zn, Fe (Au, Ba), 11) EMARAT-SHAMSABAD (GROUP), Pb,Zn, Ag, (Fe), 12) LAKAN, Pb, Zn, Ag (Fe, Ba), 13) KHUGAN, Pb, Zn, Ag (Fe, Ba), 14) DARREH NOGHREH, Pb, Ag, Zn (Ba), 15) RAVANJ, Pb, Ag, Zn (Ba), 16) PINAVAND, Pb, Zn, Ag (Cu, Ba), 17) NAKHLAK, Pb, Zn, Ag (Ba), 18) OZBAKKUH (GROUP), Zn, Pb, Ag, 19) TIRAN (GROUP), Pb, Zn, Ag (Ba), 20) KHAN-E-SORMEH, Pb, Ag, Zn (Ba), 21) IRANKUH (SHAHKUH), Zn, Pb, Ag (Ba), 22) HAFTAR (AGHDA), Pb, Zn, Ag, 23) KOHRUYEH, Zn, Pb, Ag, 24) DARREH ZANJIR, Pb, Ag, Zn (Ba), 25) ANJIREH (YAZD), Pb, Ag, Zn (Ba), 26) ZIREKAN (ZARIGAN), Pb, Ag, Zn, 27) PUDANU, Zn, Pb (Ag?), 28) AHMADABAD, Pb, Zn, Ag (Ba, Fe), 29) KUSHK, Zn, Pb (Ag), 30) MEHDIABAD, Zn, Pb, Ag (Fe), 31) TAJKUH, Zn, Pb (Ag?), 32) GOWJAR, Zn, Pb (Ag), 33) TARZ, Zn, Pb, Ag, 34) NAYBAND, Pb, Zn, Ag, 35) KUH SORMEH, Zn, Pb, Ag (Ba).

terrains are excellent targets for Cu, Sn, Au resources, as well as targets for archaeometallurgical studies for the detection of provenance of Lurestan bronze. The southwest Arak and Sahlabad-Mokhtaran-Basiran triangular areas are the most promising areas for archaeological studies in order to discover the provenance of raw materials for production of bronze. The mineral association likely is proper to produce bronze without any blending of ore or mixing Cu, Sn metals. The south Arak area, being closer to Mesopotamia and being a part of ancient Lurestan territory is more likely one of the main suppliers of Cu, Sn ore in production of Lurestan bronze. The recently found relicts of tin mining in second to first millennium BC in Deh Hosein and Nezamabad-Bamsar-Revesht areas (Momenzadeh et al. 2002) are exciting due to their probable provenance of Lurestan bronze.

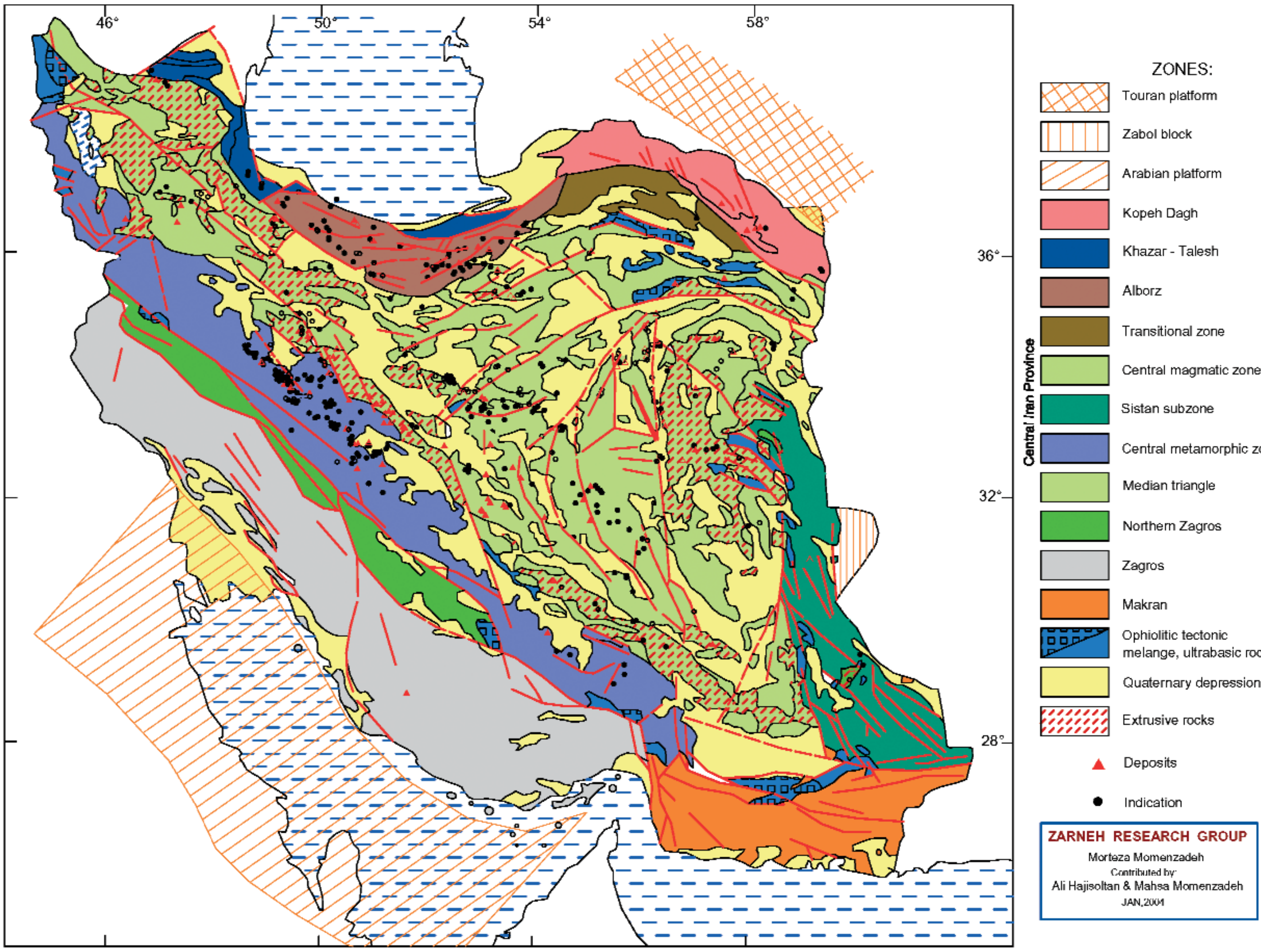

Fig. 6: Distribution of lead-zinc-silver deposits and occurrences; after Ghorbani 2002.

Silver, lead, and zinc: natural resources and ancient mining

The Iranian plateau is the oldest or one of the oldest areas where silver is mined and used. As the main natural source of silver is the lead-zinc ore minerals almost all silver mines are known indeed, not as silver mines but as lead-zinc mines by geoscientists. This fact may have affected fluent exchange of information between these two groups of researchers. Due to this reason many of the ancient mines may come to production in modern times as Pb, Zn mines without being known as ancient silver mine.

Lead as a by product of silver mining has been mined and used in ancient times in many of the Pb, Zn, Ag deposits for production of "Sormeh"[1]. There are even Pb, Ag deposits in which mining of Pb, Ag ore was likely for production of "Sormeh" (not necessarily for silver?) because of the today's name of many of the ancient mining localities (e.g. Kuh "Sormeh" and Khan-e-"Sormeh").

Although zinc, as a metal was not produced and used in ancient times but zinc ore has been wildly mined for production of Tutti ("Tutia" in Persian and "Tuthia" in Latin languages)[2]. Tutti was produced, used and exported, especially from south central Iran, i.e., Kuhbanan area (Fig. 5) in medieval times.

Natural resources

The lead-zinc and silver resources are distributed almost all over the Iranian plateau. Even in the Zagros Mountains, which is known as missing metallic mineral resources, there is one lead-zinc-silver deposit (Kuh Sormeh deposit). A general view of the geographic distribution of Pb, Zn, Ag deposits and indications of Iran is shown in Fig. 5. Almost all Pb, Zn, Ag resources of Iran are hosted by carbonates with a few exceptions. The country rocks, which host these resources are of lower Cambrian, Devonian, Permian, Trias-

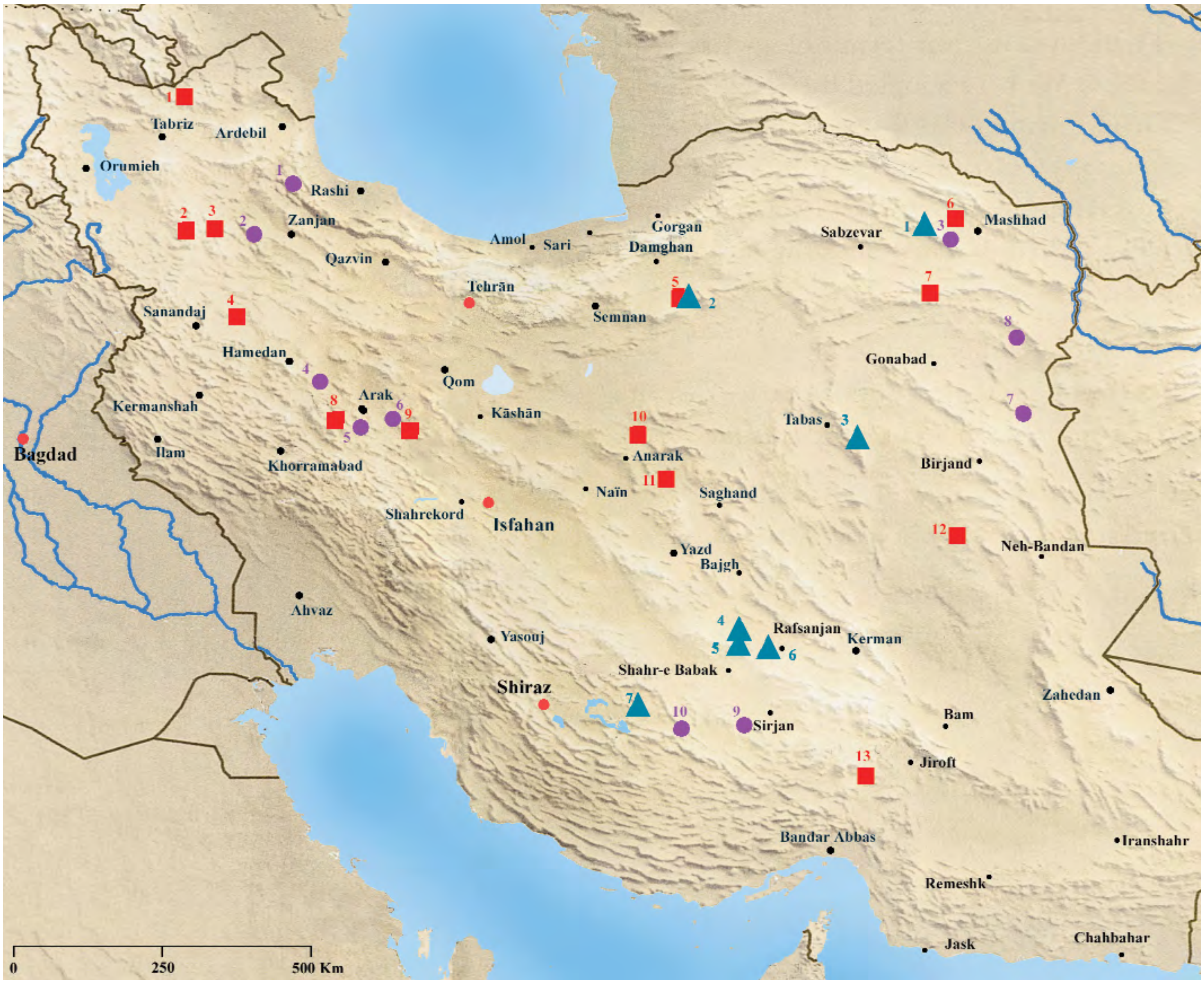

Fig. 7: Distribution of ancient gold, iron and turquoise mines.
Gold (red): 1) KHOYNARUD, Au, 2) AGHDARREH, Au (As, Sb, Hg, Pb, Zn), 3) ZARSHURAN, Au (As, Sb, Hg, Pb, Zn), 4) DASHKASAN, Au (As, Sb), 5) KUHZAR (DAMGHAN), Au, Cu, Tq, 6) TORGHABEH, Au, 7) KUHZAR (KASHMAR), Au, 8) ASTANEH, Au, 9) MUTEH, Au, 10) KHUNI, Au, 11) ZARRIN, Au, 12) GHALEH ZARI, Au, Cu, 13) ZARTOROSHT, Au.
Iron (lilac): 1) MASULEH, Fe, 2) KAVAND (DAMIRLI GROUP), Fe, Au?, 3) PIVEZHAN, Fe (Pb, Zn), 4) AHANGARAN (EAST MALAYER), Fe, Pb, Zn, Ag, (Au, Cu, Ba), 5) SHAMSABAD, Fe, (Pb, Zn, Ag, Cu), 6) KHUGAN, Fe, Pb, Ag, (Ba), 7) SANGAN, Fe, 8) AHANGARAN (EAST IRAN), Fe, Cu, Pb, Zn, Ag , 9) GOLEGOHAR, Fe, 10) NEIRIZ, Fe.
Turquoise (turquoise): 1) NEYSHABOUR (MADAN), Turquoise (Cu, U), 2) KUHZAR (DAMGHAN), Turquoise Au, (Cu), 3) GAZU, Turquoise, Cu, 4) LACHAH (MEDUK), Turquoise Cu, (Au, Mo), 5) ADEABAGH, Turquoise, Cu, 6) SARCHESHMEH (CHAH FIRUZEH), Turquoise, Cu, Au, (Mo), 7) KUHN-E-MES (RUNIZ), Turquoise, Cu.

sic, Cretaceous and Tertiary ages. The lower Cambrian resources are hosted by shales and carbonates. The ratio of Zn/Pb is high. The Kushk and Anguran deposits, which are among the biggest zinc producing mines of Iran are the best examples of this group. The country rock of resources, rather than lower Cambrian age is carbonates with some exceptions in Jurassic and Eocene. The genetic type of Pb, Zn, Ag resources is mainly Irish and Mississippi Valley type. The ratio of Zn/Pb varies in different horizons and different geographic settings but it is almost always over 2 and in some cases it may reach over 5. The Zn/Pb ratio is considerably high in the resources hosted by Triassic carbonates almost all over Iran. The Ag content, being a function of Pb content is considerably high in the resources, hosted by Permian carbonates (Duna and Shakin are two examples). The Triassic carbonate hosted resources are the most frequent and geographically the widest spread deposits in Iran. The Cretaceous hosted ores are next frequent. The

Eocene hosted Pb, Zn, Ag resources are characterised by element association of Cu, Ba, and Au. The element association of Ba, Cd, Ge, Ga, and Cu varies as functions of Zn/Pb ratio, geographic situation and type and age of country rocks.

Ancient mining

The Pb, Zn, Ag resources have been mined in Iran from prehistoric periods to the modern times. The mining of these resources was mainly for extraction of silver from lead, but lead has been also produced as by product. Zinc ore was also mined for production of Tutti. Galena was produced and used directly (without any smelting or reduction) for production of "Sormeh". The ancient mining of Pb, Zn, and Ag deposits is extremely extended in the Iranian plateau. The relicts of ancient mining can be found in and around almost all known Pb, Zn, Ag deposits of Iran. The relicts of mining, like the shape of waste dumps, digging tools, hauling implements, waste material and pottery fragments are more or less available in the mining sites. The relicts of metallurgy works like slags, occasionally crucible fragments, blowing pipe fragments, ruined furnaces etc. can be occasionally found close to the mining sites. Ancient ruined settlements being the miners' and metallurgists' living sites can be easily recognised in some cases. The place name of some of the Pb, Zn, Ag deposits reflects the ancient mining for silver and lead sulfide "Sormeh".

The number of deposits with ancient mining relicts is much more than 35 whose geographic distribution is shown in Fig. 5.

Gold: natural resources and ancient mining

The natural resources of gold in Iran are of two types, first: gold as the main product of mining, second: gold as a by product of copper mining. From the total 113 known gold- and gold bearing copper deposits and occurrences only 13 are mined for gold (Fig. 7). In the rest cases gold is an associated element with copper (Fig. 3).

Concerning metallogeny and the type and age of country rocks the gold deposits of Iran are of two categories, first: those hosted by a pre-Cretaceous plutono-metamorphic complex (mainly Palaeozoic), second: epithermal gold of late Tertiary age which is hosted by volcanic, volcanogenic and sedimentary rocks. Many of the gold occurrences are at the aureoles of the porphyry copper systems in the Kerman and Ahar areas. All 13 known gold deposits have been exploited in ancient times. There are a few gold occurrences which have been explored in recent years in which the relicts of ancient mining are not found.

Ancient gold mining and metallurgy has been intermittently continued from prehistoric to the present time. The modern gold mining in Iran is in its first steps of development. The only modern gold mine is Muteh in west central Iran (no. 9 in Fig. 7). There are two other gold producing mines in which gold is a by product of copper production, i.e., Sar Cheshmeh and Qaleh Zari (Fig. 3).

Iron: Natural resources and ancient mining

Iron mining and metallurgy, as a modern industry is running in Iran since 35 years. Although the number of known iron ore deposits and resources is plenty (Fig. 8) so the main volume of iron ore comes from three mining fields in east central, northeast and southeast of Iran (Choghart-Chadormalu axis, Sangan and Golegohar mines). Several other smaller mines are in operation for consumption and production of steel, cement, heavy media etc. From these main iron ore mines only Golegohar is known to be mined in ancient times. The Choghart-Chadormalu axis of iron deposits in east central Iran which covers several big iron ore deposits and the Sangan deposit in Khorasan may have been mined in ancient times, but no archaeological studies have been conducted in this respect as yet.

There are several iron occurrences, which have been mined for iron ore. But some of the ancient workings in the iron ore bodies may not be worked for iron but for silver (Ahangaran, Shamsabad and Khugan, numbers 4, 5, 6 in Fig. 7). Masuleh and Kavand are well known for their iron production in ancient times. The names of these two mines appeare in the archaeological and historical texts. Ahangaran, in east Iran has been likely worked in ancient times for iron due to the name of the village east of the mine. Ahangaran means "site of ironsmith". The place name "Ahangaran" is frequent in Iran. It is a valuable indication for hunting ancient mining sites for iron.

Turquoise: Natural resources and ancient mining

Turquoise is a typical mineral at the top and aureoles of the porphyry-epithermal systems. The Nishapur, Kuhzar, Lachah (Meduk) and Sar Cheshmeh ancient turquoise mines are all located in the alternation zones of porphyry-epithermal systems with Cu, Au mineralization.

Turquoise mining in Iran (Fig. 7) has been discontinuously continued from prehistoric to the present time. The most important, best known and long living mine is the Nishapur turquoise mine. But some other mines have been producing turquoise in west of Kerman, south of Damghan, and southeast of Tabas. Turquoise from Kerman

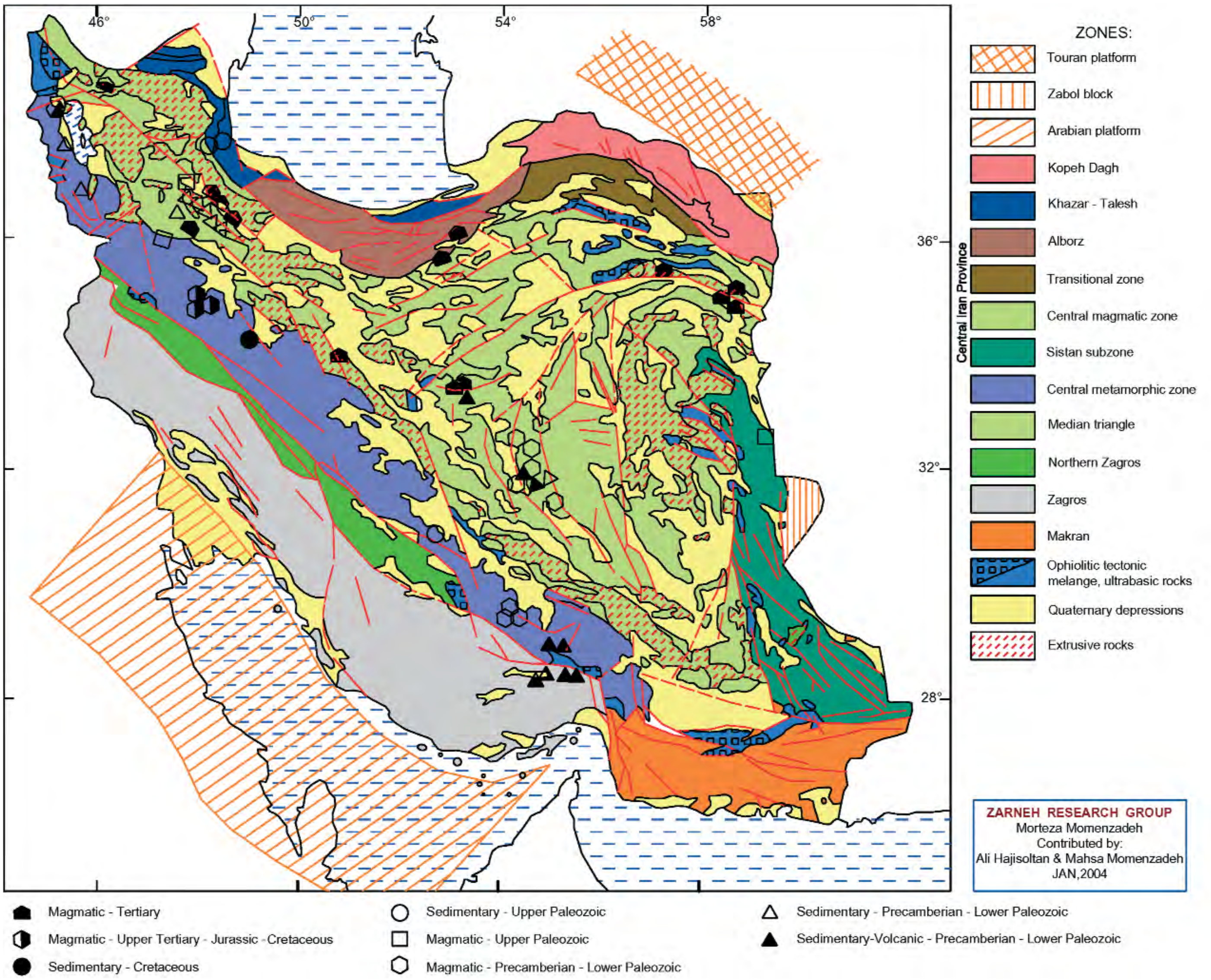

Fig. 8: Distribution of iron deposits and occurrences; after Ghorbani 2002.

area is well known in the history and archaeology of Iran. The provenance of the "Kerman turquoise" is at least partly from the Sar Cheshmeh and Meduk (Lachah) porphyry copper deposits.

Archaeological sites

The most important and best known archaeological sites of Iran are plotted on a general map of Iran (Fig. 4). The main purpose of presentation of the archaeological sites is to compare their geographic situation to the situation of the ancient copper, gold and silver mines. Another intention is to highlight the question if it is possible that some of the ancient settlements have been formed and expanded due to mining of mineral resources specially copper, gold or silver. The author confesses that there are many ambiguities in answering this question, for example: 1) Mining-metallurgy sites are usually small sites, whereas the prepared list presents only the main sites. 2) The chronological coincidence of living periods in ancient sites with the periods of mining is a decisive parameter for such a comparison, which has not been investigated. Therefore geographical correlation of mining-metallurgy sites (with the major archaeological sites) is not merely sufficient for any conclusion about the cultural and technical relationships. Despite these constraints and many others there is a rough correlation between the archaeological sites, the ancient mining-metallurgy sites and the geographical distribution of copper and lead-zinc resources.

Correlation of geographic location of ancient mines and major archaeological sites

The chronological-geographical correlation between the position of ancient mining-metallurgy sites and archaeological settlements is an ideal method for interpretation and comprehension of the commercial-cultural relationships between these sites and a better understanding of the cultural history of a given civilization. But a precise correlation depends on the function of a precise knowledge about archaeology of mining activities and living periods in the relevant sites. The state of the art of knowledge about ancient mines in Iran is too far from the least requirements for such a correlation. The list of known ancient mines is far from being complete. The knowledge about known ancient mines, specially the period or periods of mining-metallurgy in each mine is almost nothing. Therefore a chronological correlation is almost impossible. But the geographical correlation, although not very effective in interpretation, is still important as one of the first attempts in approaching to the question of such commercial-cultural relationships.

Conclusions

This paper is indeed an introduction to the subject of ancient mining in Iran. The presented list of ancient mines can be considered as some examples of a long list of the unknown, unvisited and unstudied ancient mines of Iran. This list is too short to be complete. The number of ancient mines for copper, gold, lead--silver, zinc, and iron can be estimated to several times more than what is presented here. Besides these there are many metals, non-metals, industrial minerals, gems, salts, chemicals etc. which have been mined and used in ancient times but are not considered in this paper. The main purpose of presenting this paper is to show the critical importance of our knowledge about ancient mining in answering of many questions in archaeological investigations. Where are the provenances of raw materials for gold, copper and silver objects, where are the provenances of raw materials for the Lurestan bronze? Where are the provenances for products and objects found in several archaeological sites? The presented information has to be considered as illustrating and justifying "a question" rather than an answer.

From more than 400 copper deposits and occurrences and about the same number of lead-silver ones which are known until now only 79 copper and 35 lead-silver mines are listed as ancient mines. The reason is that almost no organised and planned archaeological investigations have been performed for a documentation of ancient mining in these deposits. The very short list, 79 cases of ancient copper mines (Fig. 3) out of more than 400 known deposits (Fig. 2) and 35 cases of ancient lead-zinc-silver mines (Fig. 5) out of several hundred known Pb, Zn, Ag deposits (Fig. 6) is mainly prepared by non professional volunteers like the present author without any defined program. Therefore the lists of ancient copper and silver mines are too short for a reliable interpretation about the commercial-cultural correlation between the major archaeological sites and ancient copper and silver mines. According to personal experience the author believes that it is very unlikely to meet any exposed copper or lead-silver deposit in Iran without relicts of ancient mining. This means that the number of ancient mines in Iran is at least equivalent to the number of known Cu and Pb-Ag deposits. Hence a correlation of geographic distribution of major archaeological sites with the distribution of known deposits is more meaningful than a correlation with known ancient mines. Concerning the commercial-cultural relationships between ancient mining sites and archaeological settlements the following examples are outstanding:

1) The clusters of major archaeological sites in Kurdestan and south of Urumieh lake do not fit well with the clusters of ancient Pb, Ag mines in the neighbouring areas.
2) The geographic distribution of major archaeological sites fits somehow well in central Alborz and southwest and central Iran.

The author anticipates that this paper may be a motive for the initiation of an international research project in order to record thoroughly the ancient mining-metallurgy sites of Iran, study the archaeological mining methods, the periods of mining activities and the cultural relationships to their contemporaneous living settlements and cultural centres. This study is expected to answer many questions about the provenance of metallic and non-metallic objects found in archaeological sites.

Acknowledgement

The author is indebted to several colleagues who have given contribution in data collection, scientific statements and editing of the present work. Dr. Mohammad Rahim Sarraf has contributed sincerely in giving advice for the archaeological periods of the major archaeological sites of Iran. Mr. Mohammad Amin Emami has prepared the geographical distribution map and the list of major archaeological sites of Iran. Dr. Th. Stöllner and Professor Dr. G. Weisgerber have stimulated the author's interest to prepare this article. Zaryaban and Zarnab Consultant Engineers, especially Mr. B. Ojaghi supported some expenses of preparation of the article. The author's colleagues in the Zarnab Research Group helped the author in typing and drafting and computer works. The author's co-workers, Ali Hajisoltan and Mahsa Momenzadeh have managed the preparation of maps and tables, digitising the maps and collecting data, as well as editing partly the text. Without their help, this work could not have been prepared. The author appreciates the efforts of all colleagues who he named above or he neglected to name.

Notes

1 "Sormeh" is a black powder, made of crushed and milled galena, mixed with some oils and additives, used as cosmetics and/or medicine. It was rubbed on eyelashes as cosmetics because of its black colour and as medicine because of lead being a toxic and a mild poison, useful for curing of trachoma. "Sormeh", as many other cosmetics was used by women, but also by men. "Sormeh" is mentioned in literature to be made of silver, antimony and iron, but the observed facts, specially the place names of the Pb, Zn, Ag old mines and the inquiry in a few cases from the sellers of "Sormeh" mainly "Attars" in remote markets in Iran convinced the author that "Galena" is the original material for the production of "Sormeh". The author has not met any ancient mining in Iran in the sites of antimony mineralizations. Therefore it is unlikely that antimony ore was used for production of "Sormeh". "Kohl" is used to be the synonym of "Sormeh" in literature.

2 "Tutti" is a delightful white zinc oxide powder. It was produced in ancient times (well popular in Medieval) by sublimation of zinc ore (natural oxide and/or sulfide?) in special furnaces. The process is described by a few scientists including Marco Polo. It was practiced in Iran, India and elsewhere in the Middle East. The vapor of zinc oxide was precipitated on wet clay bars, which were put on a meshwork of iron bars in the furnace. "Tutia" was precipitated on bars as a rim. When the furnace was cool the zinc oxide was separated from the clay bars as tubes, like scabbard of sword. Then it was powdered and mixed with some other media and used as cosmetics and/or medicine for beauty of eyelashes and/or curing of eyes (curing of trachoma).

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A Short History of Archaeological Research in Iran

Sadegh Malek Shahmirzadi

Fig. 1: The French excavations in Susa in the late 19th century; in the background the castle of the French delegation in an early construction stage; Photo: Départment des Antiquités orientales, Louvre.

Fig. 2: The French Archaeologists Roland de Mecquenem, Louis Le Breton and Jamshedji Maneckji Unvala having a lunch break during the excavations of Djaffarabad in 1934; Photo: Département des Antiquités orientales, Louvre.

Archaeological activity in Iran began in the early 19th century, though at this early stage exploration was little more than treasure hunting. The earliest literature pertaining to these archaeological activities dates to the middle of the 19th century. While visiting Iran from 1880 to 1881, French architect and historian Marcel Dieulafoy met with some of the close companions of King Nasr al-Din Shah of the Qajar Dynasty. The result of these meetings may be considered the beginning of the era of enlightenment in Iranian archaeological history.

Six years later, during his second visit to Iran in 1886, Dieulafoy began excavations at the Biblical site of Susa in the south-western province of Khuzestan (Fig. 1). His work was later continued by other French excavators such as Jacques de Morgan, Roland de Mecquenem, Roman Ghirshman and others (Fig. 2). The last of them was Professor J. Perrot, who directed the last season of excavations at Susa in 1979, a few months before the establishment of the Islamic Republic (Fig. 3).

In 1901, the French archaeological mission under the directorship of de Morgan obtained a monopoly on all foreign archaeological activities in Iran; from that time until 1930, French archaeologists were the only active excavators in the country.

The coup d'état of 1921 was the beginning of Iranian modernisation. Political and economic treaties with Russians, French and British were invalidated. Among the new administrative activities in Iran was the passing of the Antiquities Law by the parliament in 1928-29, an event which marked the end of the French domination of archaeological research in Iran, and the establishment of the Antiquities Service in 1930. By 1932, archaeologists and scholars from many different countries were permitted to work in Iran, except in Khuzestan and especially at Susa.

After the French monopoly of archaeological research in Iran was invalidated and the Antiquities Law was passed by the Iranian parliament, the Iranian authorities were looking for some experts to organise the new office of Antiquities Service. In the beginning there was a close competition between Ernst Hertzfeld (German origin), Arthur Upham Pope (American) and André Godard (French), archaeologists and art historians, for organising the newly established office. First there was a close coalition between Hertzfeld and Pope. Later on Pope tilted toward Godard and Hertzfeld, who was working in Iran and excavating in the most prestigious and important historical site of Persepolis, who was left alone and forced to leave Iran after nine years and to migrate to America. His successor Erich Schmidt (German origin) took over and excavated in Rey, south of Tehrān and Tappeh Hesār at Damghan (Fig. 4). Later Pope was also put aside by Godard who became the

Fig. 3: The French excavations in Susa in the 1970s: Pierre Amiet from the Louvre nearby the most important statue of Darius the Great, found in 1972; Photo: Départment des Antiquités orientales, Louvre.

Fig. 4: Work in the Tappeh Hesār I settlements 1931; E. F. Schmidt, Excavations at Tepe Hissar Damghan, Philadelphia 1937, Fig. 20.

only decision making person in Iranian archaeology and directed the Iranian Archaeology Service for more than 30 years. Pope stayed in Iran and spent all of his time publishing the monumental volumes of the Survey of the Persian Art. He died in 1960th and was buried on the southern bank of Zayandeh Rood in Isfahān. After getting rid of his rivals for one or another reason, André Godard, the French architect and art historian, was appointed as the first director of the Antiquities Service in Iran in 1930 and stayed in that office for some 30 years. During his service in Iran he had accomplished one of his duties by completing the building of the Iran Bastan Museum, now the Iranian National Museum in 1936. A year later, in 1937, all objects were transferred to this newly built museum from the Masoudieh palace – a Qajar period fancy building that nowadays accommodates the Institute of Archaeological Research of the Iranian Cultural Heritage Organization where the objects had been kept until then.

The period from 1930 to 1950, from the establishment of the Antiquities Service to the development of radiocarbon dating, may be considered a second era of archaeological work in Iran. This work was undertaken by archaeologists from a variety of academic and national backgrounds. Susa in Khuzestan (R. Ghirshman, French), Persepolis in Fars (E. Hertzfeld, German), Sialk in Kāshān (R. Ghirshman, French) (Fig. 5), Bakun in Fars (E. Schmidt, A. Langsdorff, and McCown, American), Shah Tappeh in Gurgan (T.J. Arne, Swedish), Geoy Tappeh in Azarbaidjan (T. Burton Brown, British), and many other sites were investigated during this period.

In this second era, there was a divergence from the earlier methods of excavation and approaches to stratigraphy. The early French excavators had based their excavation records on the metric system. Beginning in 1957, this method was refined through the introduction of the Wheeler excavation method, which was first used at the site of Hasanlu in Azarbaidjan.

The primary goal of archaeologists in this second era was to establish a chronology for the prehistoric periods using typological studies of artefacts, specifically pottery. McCown notably established a typological division of Iran into two cultural areas, the "red ware" and "buff ware" cultures. This typology was accepted until

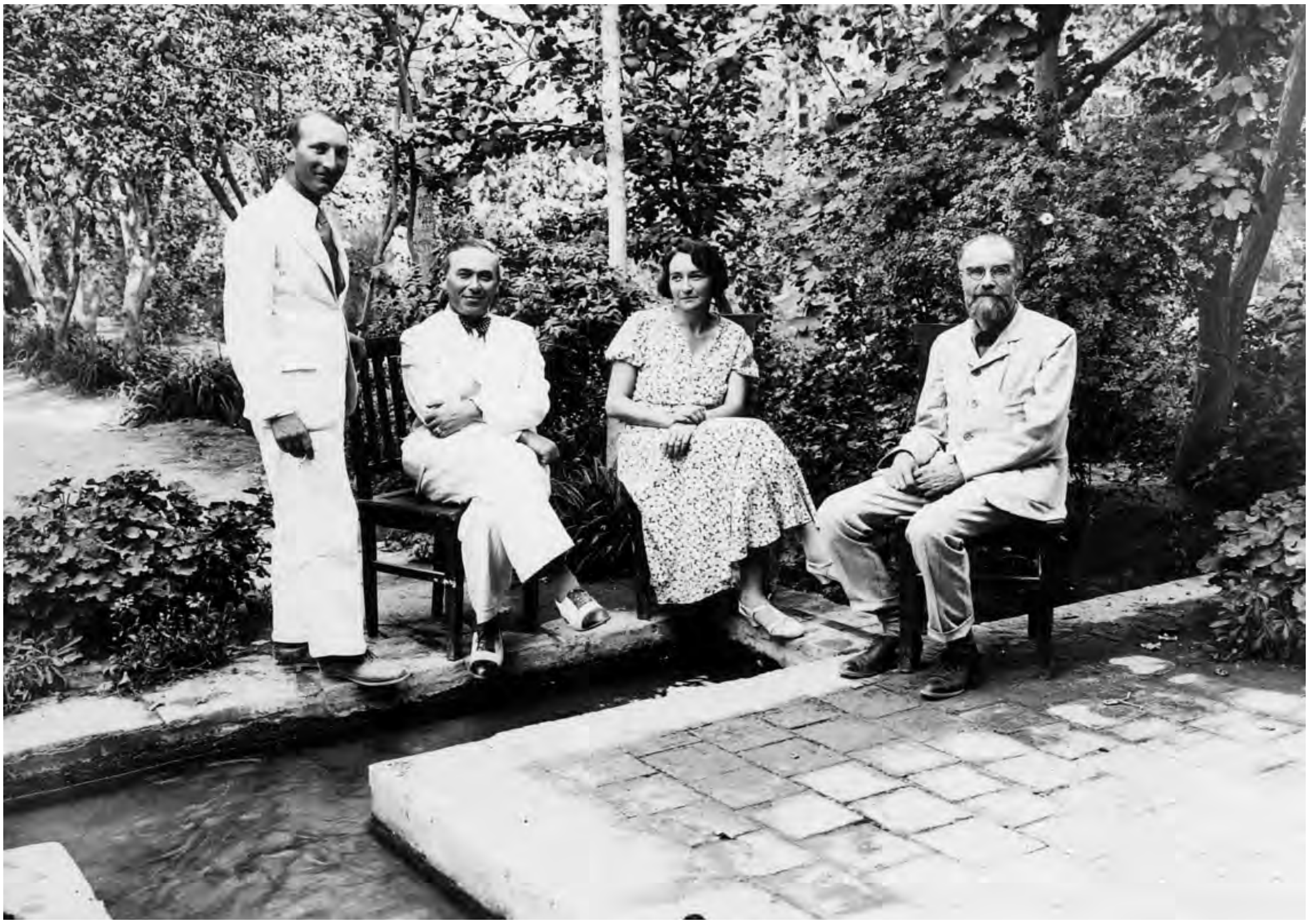

Fig. 5: Roman Ghirshman and his wife Tania Ghirshman in the Fin Garden of Kāshān during the visit of the director of the Départment des Antiquités orientales, Georges Contenau, at the excavations of Tappeh Sialk in 1934, left: Maxime Siroux; Photo: Départment des Antiquités orientales, Louvre.

the 1950s, when its validity was questioned by a new group of scholars, which included anthropologically oriented archaeologists; they questioned the validity of the existing interpretations and began to develop a new set of objectives for the investigation and study of existing data. While establishing an acceptable chronology of Iranian prehistory remained a major goal for this group of scholars, they also believed that a reliable chronology must be based on stratigraphic context rather than an inferred stylistic change in artefacts.

The Iraqi coup d'état brought Robert Braidwood and his team to western Iran, specifically into the Zagros highlands. Braidwood's research centred on the development of economic and subsistence patterns; the focus of his studies shows that although chronology was still an important goal of Iranian archaeology in general, it was no longer the major one concerning material culture.

Indeed, it became popular to reinvestigate previously excavated sites with such new research objectives. There are two outstanding examples of such reinvestigation: Hasanlu in Azarbaidjan (R.H. Dyson, American), previously been excavated by Rad and A. Hakemi (Archaeological Service of Iran); and Tureng Tappeh in Gurgan (J. Deshayes, French), previously investigated by E.R. Wulsin (American).

After the establishment of the Iranian Antiquities Service, Iranian archaeologists began investigations side-by-side with their non-Iranian colleagues. At first, Iranian archaeologists were mostly trained at French, German, British, Italian, and American institutes and universities. In the long list of non-Iranian archaeologists excavating and investigating in Iran from 1960 until the establishment of the new political regime of the Islamic Republic in 1980, one can read the name of many well known scholars from America, Canada, Denmark, England, France, Germany, Italy and Japan.

During this extremely productive archaeological research period in Iran we often come across many very active German scholars and archaeologists such as R. Naumann, who was excavating at Takht-i Suleiman in Azarbaidjan, his associate director and later the researcher at Taq-i Bustan near Kermanshah H. Luschey, W. Kleiss

who in addition to survey nearly in all over Iran was the director of the German Institute of Archaeology in Iran and the director of the excavations at Bastam in Azarbaidjan and last but not the least H. v. Gall and D. Huff who are famous for their studies about the Sasanian period in Iran.

In 1940, the first group of students of archaeology graduated from the Department of Archaeology of the Faculty of Letters at Tehran University. Some of these graduates later studied at prestigious universities in Europe and the United States, as did Ezat O. Negahban, for example, who at his return to Iran began excavating the Royal Cemetery at Marlik in the province of Gilan. The glamorous and exotic gold and silver treasures of Marlik attracted the attention and interest of Iranian officials, who began to pay special attention to the development of archaeological research in the field and at the university. Negahban soon established the Institute of Archaeology at Tehran University; the graduates of this institute became active in field archaeology all over Iran, some also going abroad to earn their PhD and other higher degrees. In 1957 Negahban invited Braidwood to come to Iran (Fig. 6). Braidwood`s presence in Iran cleared the road towards new direction in study of the Iranian Prehistoric period, since Braidwood, in addition to survey the Kermanshah region, excavated at the Neolithic sites of Sarab, Asiab and Siabid, near the city of Kermanshah.

From 1960 on the Archaeological Research Centre of Iran, which was the new name for the older Antiquities Service of Iran, there were many new nations. When F. Bagherzadeh took the office, many permissions were issued for archaeological field work, both for surveying or excavations. Some of the permissions were issued for the joint projects. Among them were the joint project of Chogha Mish and Susa, the two most outstanding ones.

1960 to the Islamic revolution of 1980 was a period during which the major goal of archaeologists in Iran was to understand past cultures and cultural mechanisms. From 1980 to 2000, only Iranian archaeologists were active in Iran; since then, the Iranian Cultural Heritage Organization has begun issuing special permission for archaeological research and excavation in Iran within the new framework of the “Joint Project”. The two first were the joint Iranian-French team that began surveying the Marv Dasht region in Fars and the Iranian-Italian team continuing the earlier study at Old Atigh Mosq in Isfahan. The first Joint project which was actually active in excavations was an Iranian-German team that began surveys and excavations at Arisman and Veshnāveh on the Central Iranian Plateau near Kāshān. They were soon followed by an Iranian-Japanese team excavating and surveying in Rostamabad in Gilan province in north Iran in 2003.

The “German Mining-Museum Bochum” exhibition will be the first exhibition outside of Iran that will introduce the results of scientifically oriented archaeological research, directed by both Iranian and non-Iranian scholars. The purpose of the exhibition is to help understand the role of Iran, the heart of “the Cradle of Civilization”, in man’s development and use of technology.

Fig. 6: Ezat O. Negahban (left) in discussion with Seyfollah Kambakhsh Fard during a field trip in the 1950s; Photo: DAI, Eurasien Abteilung.

On the Importance of Iran in the Study of Prehistoric Copper-base Metallurgy

Vincent C. Pigott

Introduction

Current archaeological evidence argues strongly in favour of the commonly held assumption that the origins of metallurgy occurred in Southwest Asia, in particular on the ore-rich Anatolian and Iranian Plateau. In assessing the importance of Iran in the study of prehistoric copper-base metallurgy, the discussion to follow will focus on what is distinctive about Iran and the developmental contexts of its earliest metallurgy. Succinctly put, the importance of ancient Iran lies in the fact that it comprises a 'heartland of metallurgy' – *i.e.*, a central region that is technologically vital in its own right as well as a source area for surrounding areas. Iran's pre-eminence in 'prehistoric' metallurgy extends from the Neolithic period in the 7th millennium BC to the protohistoric Iron Age of the 1st millennium BC. It is particularly important not to lose sight of the people who undertook this technological experimentation and of the social, cultural, economic, and geological contexts in which it flourished. Settled village agriculturalists in the Neolithic Period of western Iran – *c.* 8500-4000 BC (see Voigt & Dyson 1992 for chronology) – recognised a geologically occurring metal, native copper, as a distinct material and collected it initially for decorative purposes (see Hole 1987a; b; see also Voigt 1990; Stech 1990 for overviews). The earliest and most famous example is a single native copper bead that comes from the site of Ali Kosh on the Deh Luran Plain where it was deposited *c.* 6500 BC (Smith 1968; 1969) (Fig. 1).

With the advent of the Chalcolithic Period in the 5th millennium, agriculturalists somehow mastered the art of smelting copper from its ores. While the process leading to this mastery is not yet well understood, technological advances in other heat-related crafts (pyrotechnology) may have played a significant role (*e.g.*, Wertime 1973b; Schoop 1995a; 1995b, 33, Fig. 4). What is clear is that in a relatively short time, the Iranian Plateau became a centre of metallurgical innovation and activity defined by various unique contexts that facilitated further technological developments as millennia passed.

Contexts of development

The Iranian Plateau as 'Technological Oikumenê'

In attempting to characterize the overall context and to understand the unique set of circumstances that set the stage for innovative pyrotechnological developments in this particular region of the Old World, we invoke here the concept of an oikumenê as coined by A.L. Kroeber, the eminent 20th century anthropologist (Kroeber 1946)[1]. For our purposes, an oikumenê is a spatially-defined region in which a particular combination of cultural processes, with a focused technological component, achieved what Kroeber termed, "an interwoven set of happenings and products". The ancient Iranian oikumenê was what we might term a well-defined, socio-technic interaction sphere (see Caldwell 1964; see also Clarke's definition of a technocomplex[2]), which was from the outset of settled village life a 'cultural laboratory' in which a variety of materials and pyrotechnological processes were being 'played' with often to achieve decorative/aesthetic effects (Smith 1976). One cannot ignore the potential for interaction between the various possible pyrotechnologies during the Neolithic/Chalcolithic – *e.g.*, heat treatment of flint, the chambered atmospheres of tanours (bread ovens) and pottery kilns, the calcining of lime with ensuing lime plaster production, and the visual transformation of these materials from their natural state into their often dramatically different anthropogenic conditions (see Paléorient 2001 26/2 on ancient applications of fire). Metallurgy did not spring sui generis from the minds of Neolithic peoples as either a 'discovery' or an 'invention' based on need or necessity. It was an innovation in the true sense of the word, one that evolved over time based in part on the application of traditional techniques to new materials. There is little question that the context of settled village life sustained by new subsistence strategies played a significant and facilitating role in such innovation. In these early millennia, most metal objects (*e.g.*, a native copper bead or 'pin') served consciously or (more probably) unconsciously to satisfy symbolic or aesthetic norms, while, at the same time, the odd awl or punch was used to perform specific utilitarian tasks. Thus, it is this continuing process of defining contexts in which metallurgical developments took place that we stand to gain an enhanced understanding of why ancient Iran was particularly important to the understanding of the development of metallurgy in the Old World. The discussion turns now from cultural/behavioural contexts to the geological landscape of raw materials, the natural context in which Iran's prehistoric metallurgy emerged.

The Geological Context

"Natural processes prepared the way for those of man" -- (Charles 1980, 160)

In looking at the origins of metallurgy from region to region on a world-wide basis, it is cleared that initial developments are most often centred in metallogenically rich regions, i.e., those characterised by an abundance and diversity of ore bodies. This is certainly true for Iran. One need only look at the metallogenic map of Iran (Geological Survey of Iran) to see the remarkable mineral richness of the Iranian Plateau (see also Ladame 1945; Bazin & Hübner 1969 for geological reports on ore deposits of the Plateau). The Iranian archaeologist Dr. Abdulrasool Vatandoust[3] (1999, 123) has published an abridged version of this map showing the distribution of copper ore bodies and deposits (Fig. 2)[4]. While it must be remembered that this map is based on modern geological field surveys intent on locating economically viable ore deposits, it makes clear two important points. First, it demonstrates how widely available copper ore and possibly metal would have been from the earliest periods of human occupation on the Plateau and second, how these deposits tend to cluster in certain regions. Thus, the importance of Iran as a metallurgical heartland can be measured by the fact that, compared to elsewhere in Southwest Asia, the relative frequency of exploitable deposits is perhaps the highest on the Iranian Plateau. People in the region would have noticed the surface indications of these deposits, distinct in their configuration and coloration from the surrounding landscape. Many of these deposits lie in or near the fringes of what are today the great central Iranian deserts – i.e., the Dasht-e Lut and Dasht-e Kavir. The presence of these vast interior deserts comprises one of the major geographical differences between the Iranian and Anatolian Plateau. Such a harsh and, for the most part, inhospitable environment certainly would have exerted its own specific influence on both human habitation and attempts at exploitation of ore reserves.

Over the vast span of geological time that has transpired since the polymetallic, copper-rich ore bodies were tectonically emplaced on the Iranian Plateau, the weathering process has transformed these predominantly sulfidic deposits into stratified geological structures

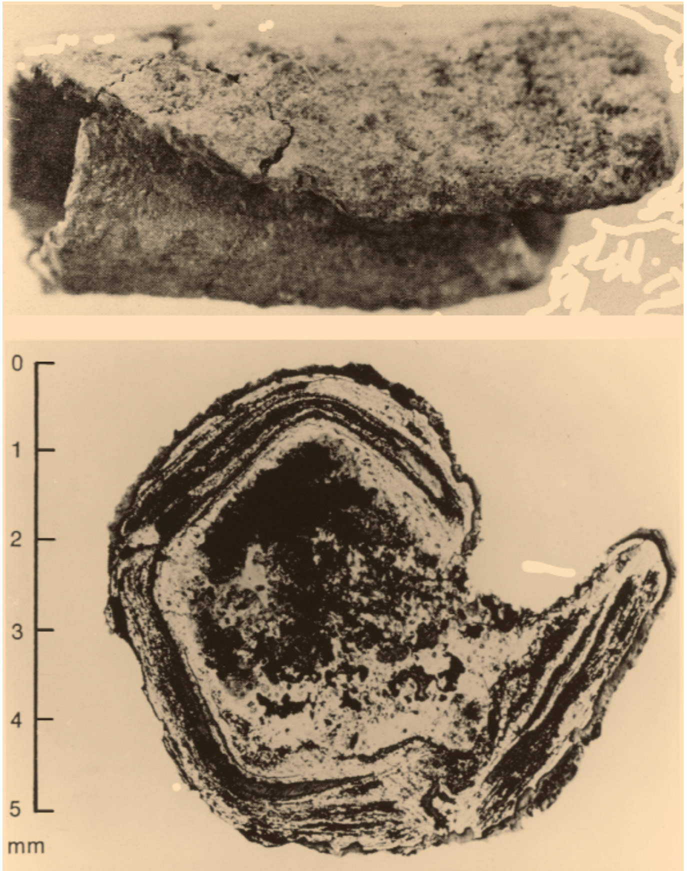

Fig. 1: a) Native copper rolled bead from Ali Kosh (mid 7th millenium), Length ca. 12 mm, b) Polished cross-section of Ali Kosh bead. The metal is corroded but the resulting cuprite and malachite have preserved the original shape; after Smith 1968; 1969.

that, at the surface, were capped by distinctive gossan or 'iron hat' deposits (Charles 1980, 158) (Fig. 3). To this day, these gossans are readily identifiable on the arid landscape of central Iran and would have signalled, based on their configuration and coloration, the presence of particular minerals contained within. Some of the more important deposits archaeologically speaking include Sheikh Ali in Kerman Province, Veshnāveh near Qom, and, most significantly, the deposits in the Anarak mining district of central Iran (see Bazin & Hübner 1969 for more detailed descriptions).

Geologically speaking, the Anarak mining district is notable because it is home to two unusually large deposits of native copper. Such sizeable concentrations of native metal are rare anywhere in the world, but the deposits at Talmessi and Meskani, each almost 5 ha in size at the surface, are unique in that they contain high concentrations of two rare copper arsenides, algodonite (Cu_6As) and domeykite (Cu_3As) (Schürenberg 1963; Bazin & Hübner 1969). The significance of these copper/arsenic-bearing minerals (cobalt and nickel are also common impurities) contained in the native copper is that from the moment when early metalworkers began to

Fig. 2: Prehistoric sites and copper and tin deposits in Iran, after Vatandoust 1999.

melt the native copper in order to cast it, they would have been producing arsenical copper. Based on current knowledge, this potential scenario is unique to ancient Iran, and it most probably represents a starting point down the long path leading to the discovery of smelting. However, the native copper and associated arsenides would not have to have been reduced (i.e., smelted); rather, they could have been melted together in a crucible, with the arsenides dissolving into the melt. This copper alloy, assuming its arsenic concentrations were sufficiently high enough (ca. 4% by weight), would have performed in the manner of bronze, the alloy of tin and copper that lends its name to the epoch beginning *c.* 3000 BC and lasting for almost two millennia in Southwest Asia. Although tin-bronze does make its appearance on the Iranian Plateau in some quantity by the early 2nd millennium BC, arsenical copper remained the alloy of choice for mundane items from the Chalcolithic to the advent of large-scale iron production in the 1st millennium BC (Moorey 1982, 87-88; Stech & Pigott 1986; Pigott 1999). Thus, a certain technological conservatism, which was perhaps even a matter of cultural choice, appears to characterise prehistoric Iranian metallurgy.

Given the long duration of this reliance on arsenical copper in ancient Iran, one of the major research questions still before us concerns to what extent did early metalworkers depend on the

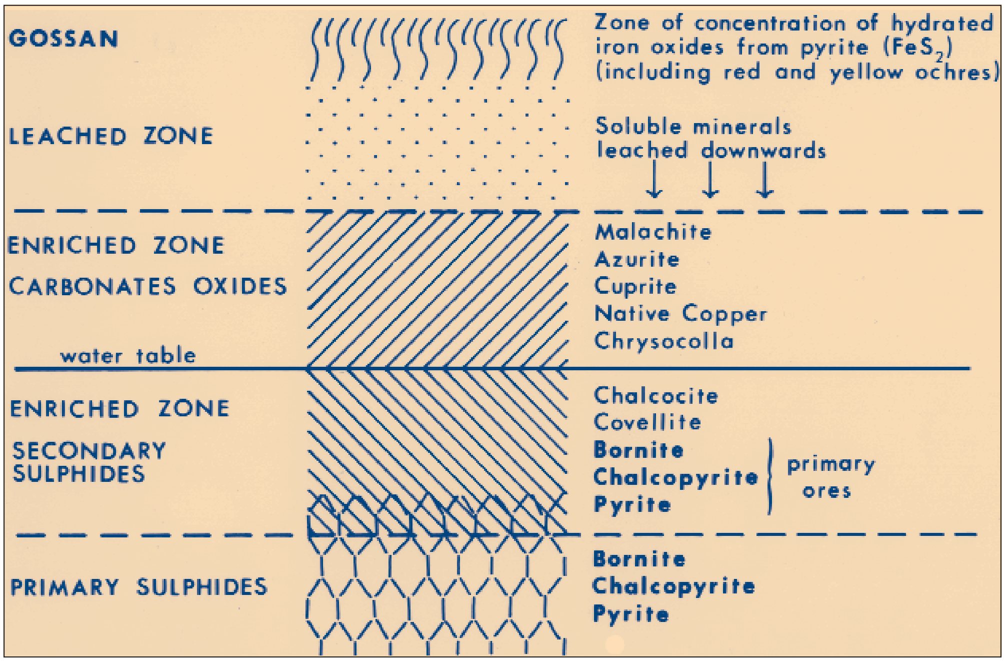

Fig. 3: Schematic diagram of an ore lode with a typical zone structure of sulphicid, carbonatic ores and gossan, caused by weathering processes.

arsenic-rich native copper from Talmessi and Meskani as their primary source of copper? The main reason that this question needs to be addressed is that arsenic-bearing copper ores (the so-called copper sulfarsenides), which could be smelted to produce arsenical copper, are decidedly rare in the region (Heskel 1982; Heskel & Lamberg-Karlovsky 1980). In Bazin & Hübner's Copper Deposits of Iran (1969), only three copper ore deposits with arsenic mineralisations are noted: Talmessi and Meskani in the Anarak mining district in central Iran and the deposit at Taknar, some 300 km east of Tappeh Hesār (Pigott et al. 1982, 231-232). Moreover, the recent restudy of the massive prehistoric copper mining complex at Veshnāveh confirms earlier indications that it was not a source of arsenical copper ores (Chegini et al. 2000; see also Holzer & Momenzadeh 1971).

The mounting archaeological evidence of early copper production on the Plateau argues against the single source exploitation hypothesis. For example, at Chalcolithic Tappeh Qabristan, the evidence strongly suggests that people there were smelting copper oxide ores in crucibles. The presence of 20 kg of malachite found in a broken ceramic vessel in the workshop replete with an intact crucible and several moulds comprises among the earliest and best evidence for smelting anywhere in Southwest Asia (Majidzadeh 1979; 1989). At Tappeh Hesār, from a 5th to 2nd millennium stratigraphic sequence, analyses of almost 200 excavated copper-base artefacts indicate a predominant use of arsenical copper (Pigott et al. 1982). Major surface concentrations of slag and furnace linings and the lack of crucible fragments suggest furnace-based smelting of ores, and it seems likely that one local deposit with arsenical copper ores (Taknar) may have been exploited by Hesār metalworkers (Pigott et al. 1982; Pigott 1989; 1999). At Tappeh Arisman, a large number of 3rd millennium copper smelting furnaces were recently excavated in situ within a large slag heap (Chegini et al. 2000, 294-298). Some 33 rebuilding phases of the furnaces were documented and a number of crucible fragments were found. One would not expect that such furnaces were being used to melt native copper not to mention that the large slag heap present would not result from processing native copper. The Arisman furnaces are the only well-documented such installations on the Plateau, if one excludes the rather enigmatic 'furnaces' excavated in the 3rd millennium workshops at Shahdad (Hakemi 1992; Hakemi & Sajjadi 1997; Pigott 1999, 89-90) (Fig. 4). These so-called furnaces, which are unlikely to have been used for smelting purposes, are almost without parallel elsewhere in Southwest Asia. At Tappeh Sialk, a recent study of 4th millennium smelting slag collected at the site also works against the hypothesis of native copper utilisation (Schreiner 2002). While Tal-i Iblis appears to be a site where crucibles were used to process metal and oxidic ores (Caldwell 1967; 1968; Caldwell & Shahmirzadi 1966), virtually no slag was recorded by the excavators and a recent project suggests that two of the three artefacts analysed may have been made from native copper (Pigott & Lechtman 2003). Analyses of early Tappeh Yahya copper-base artefacts also tend to argue for the use of native copper, probably from the local Sheikh Ali source (Berthoud et al. 1982; Berthoud & Cleuziou 1983, 243). One exception may be the arsenical copper awl discussed by Thornton & Lamberg-Karlovsky (this volume) from the late 5th millennium, which may have been produced from native arsenical copper from one of the Anarak deposits (see also Thornton et al. 2002).

Issues of importance

Was the Iranian Plateau a Sumerian 'El Dorado'?

The relative abundance of production sites on the Plateau raises the question above first posed by Prof. Roger Moorey (1993), one of the preeminent scholars of ancient Iran and its metallurgical traditions. In the central Iranian deserts, habitation was relatively

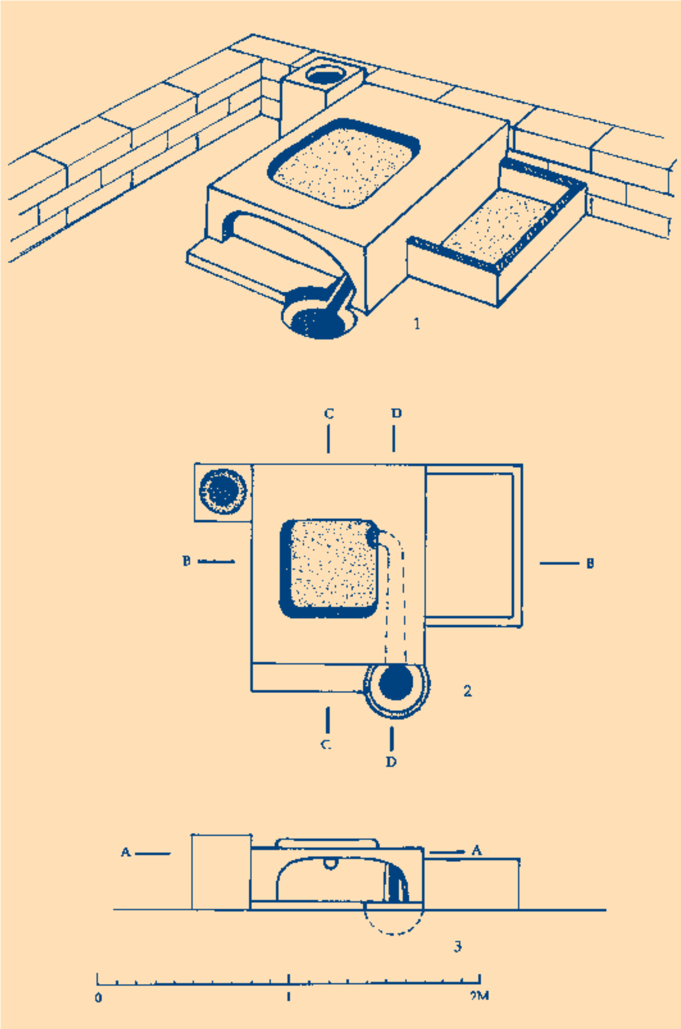

Fig. 4: So called metallurgical furnace from the "city of artisans" of Shahdad, after Hakemi 1997, Fig. 50.

sparse and owed its existence primarily to the qanat irrigation systems of the historical periods. Modern archaeological surveys conducted along the desert margins in association with various excavation projects have not revealed particularly high site densities until the late historic/Islamic period. Much of what is desert today in central Iran (Kavir or Lut) was also inhospitable in antiquity. Thus, Neolithic occupation in the environs of the greater desert region was predictably sparse, while during the Chalcolithic and Bronze Ages occupation expanded into the Iranian hinterland along the desert margins. Access to ample supplies of raw materials, copper ores perhaps preeminent among them, might well have been among the reasons for increasing attempts at occupation of the marginal regions. The density of copper deposits in proximity to Iblis and Shahdad in the south, to Shahr-i Sokhta in the east, to Hesār in the north-east, and to Sialk and Arisman in central Iran provides a strong argument as to why substantial debris of primary copper production/smelting can be found at all of these sites (see Fig. 2). It is also important to note here that Mesopotamian peoples were linked to the surrounding Iranian highlands by "exchange systems which were in some cases very old by the 4th millennium" (Yoffee 1993, 31).

Dr. Roger Matthews of the Institute of Archaeology (University College London) has made the case in a recent lecture for a Chalcolithic (4th millennium) link between Sumerian consumers in the Mesopotamian lowlands and the exploitation of Iranian Plateau copper deposits. He noted the presence of a typical Sumerian pottery type (the bevelled-rim bowl[5]) at a number of copper-producing sites on the Plateau including Qabristan (Majidzadeh 1979; 1989), Sialk (Schreiner 2002; Ghirshman 1938), Arisman (Chegini et al. 2000), Iblis (Caldwell 1967), and in the south-western lowlands at Susa (Voigt & Dyson 1992, 132). One can add to this list another copper production locus: late 4th/early 3rd millennium Banesh Period excavations at the TUV area of Tall-i Malyan (William Sumner, pers. comm.; see Nicholas 1990; Pigott et al. 2003a). The point here is that significant quantities of copper begin to appear in Mesopotamian sites of this Chalcolithic to Bronze Age transitional period and it had to have come from a region in relative proximity to ample reserves and established production capability such as the Iranian Plateau.

The location of the majority of Iranian copper deposits in the interior meant that Mesopotamian consumers in search of metal would have had to negotiate their way through the Zagros mountains, past its frequently inhospitable tribal groups, and then devote time in a difficult environment to mining and processing the copper ores to metal for ease of transport (see Moorey 1993, 39-41). A more reasonable solution may have involved trading with Plateau communities who already had stockpiles of processed raw copper ingots. This would explain the paucity of evidence for the smelting of copper ores in Mesopotamia proper – even at Susa (see Moorey 1994, 242-254). The evidence, therefore, would suggest previously underestimated levels of interaction between highland and lowland, between Iran and Mesopotamia. This reemphasises just how critical Iran's natural resources in concert with its long established metal production traditions may well have been in the context of the emergence and growth of the world's first urban centres located in ancient Sumer. In Moorey's (1993, 31) words, "Whatever role internal factors played in the precocious development of the Sumerian civilization, it was sustained by materials received from its highland neighbors". Iran clearly had a pivotal role as one, if not the only, early supplier of materials such as metal. However, with the advent of the Bronze Age *c.* 3000 BC, the technological scene, at least in Mesopotamia, was undergoing a gradual shift in its focus, for it is in the 3rd millennium that we see in the archaeological record evidence for the increased usage of tin-bronze.

Tin-bronze in Bronze Age Iran: A Question of Availability?

Since archaeologists revealed in the 1980s that Afghanistan held significant reserves of tin ore often in association with alluvial gold (Cleuziou & Berthoud 1982) (Fig. 5), the relative lack of 3rd millennium tin-bronze artefacts at Iranian Plateau sites has been puzzling (Stech & Pigott 1986; Thornton et al. in press). It remains so to this day, especially in light of the more recent documentation of archaeologically relevant tin sources in Central Asia (Cierny 1995;

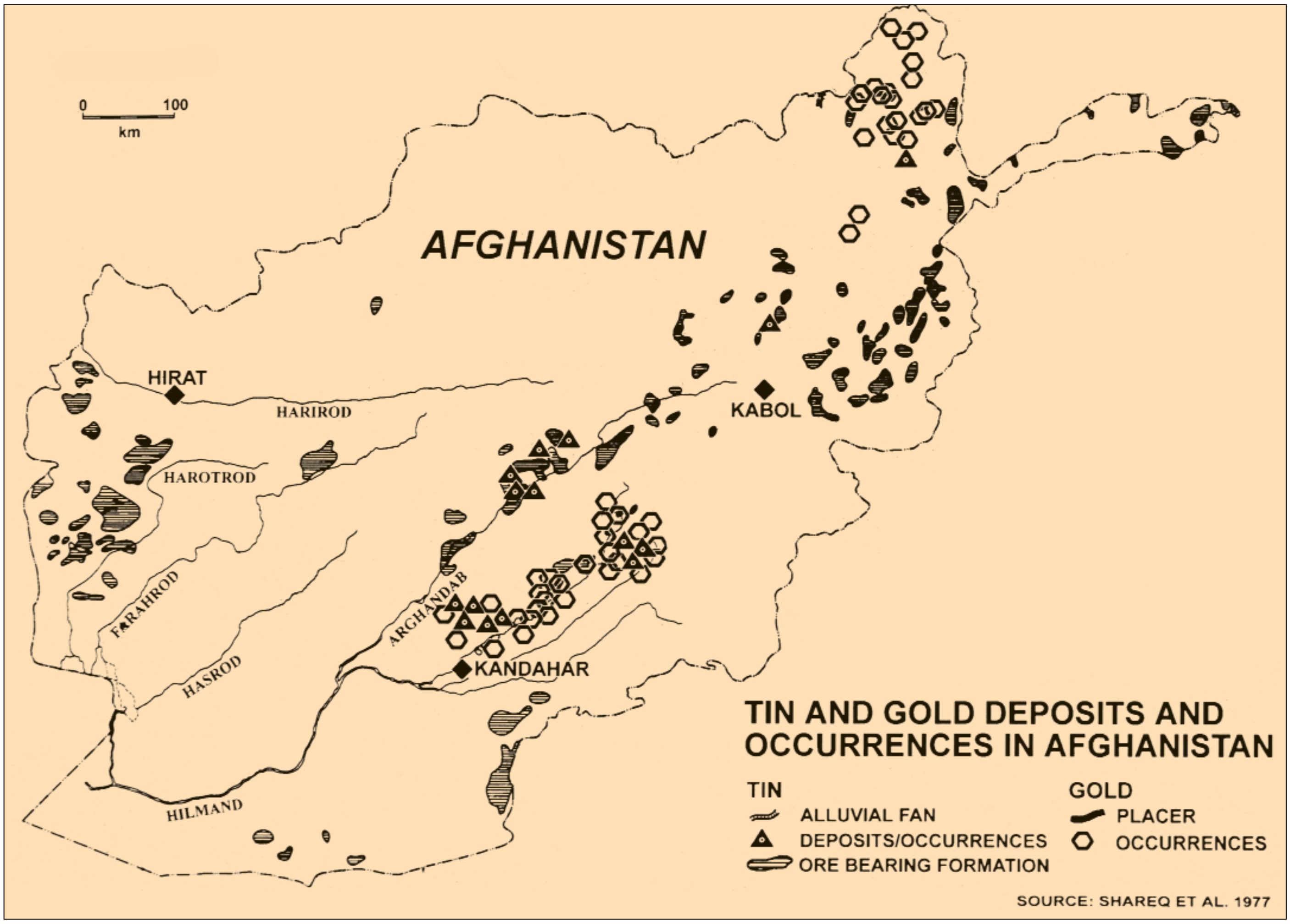

Fig. 5: Gold and Tin deposits and occurrences in Afghanistan, after Pigott 1999.

Weisgerber & Cierny 1999; Boroffka et al. 2002; Parzinger & Boroffka 2003). While Iran appears to lack any significant tin reserves that might have supplied Bronze Age metalworkers, Vatandoust (1999, 123) locates four tin 'deposits' in eastern Iran near Afghan Sistan (Strabo's (xv.ii.10) "Drangiana"), which is a legendary ancient source of tin. The Bronze Age settlement of Shahr-i Sokhta, which yielded an important copper smelting component, lies in the vicinity (Heskel 1982; Tosi 1983; Hauptmann et al. 2003)[6]. There has been no independent confirmation of the nature of these tin deposits and whether they might yield any indications of ancient exploitation, but it is surely significant that no tin-bronze has been documented at Shahr-i Sokhta (see Thornton & Lamberg-Karlovsky, this volume). From the standpoint of elemental analyses, tin-bronze artefacts from 3rd millennium contexts are rare at Plateau sites with the exception of cemetery sites in Luristan (Moorey 1993, 42). In north-eastern Iran, out of almost 200 emission spectroscopic analyses of some 1100 copper-base artefacts excavated from Tappeh Hesār's entire 4000-year sequence, only six artefacts revealed the presence of tin (Riesch & Horton 1937, 359; Pigott et al. 1982, 230; Berthoud et al. 1982, 50, n. 66). This is generally representative of the use of tin-bronze on the Plateau and it is not until the early 2nd millennium BC that tin-bronze appears with any substantial regularity in, for example, the IVA Period at Tappeh Yahya (Thornton et al. 2002) or the Kaftari Period at Tall-i Malyan in Fars province (Pigott et al. 2003b).

Malyan was the ancient highland capital of the Elamites known as "Anshan," and it lay at the southern end of the kingdom from Susa, the lowland capital located in Khuzestan. Perhaps due to its long-term connections with Mesopotamia, Susa is the one settlement in Iran that shows an appreciable presence of tin-bronze by the early 3rd millennium (Berthoud et al. 1982; Malfoy & Menu 1987). Interestingly, by the mid-3rd millennium in Luristan, the mountainous region to the north of Elam, tin-bronze is as common as at Susa (Moorey 1993, 42; Fleming et al. in press).

Why the link between Elam and tin?

During the 3rd millennium, there is strong evidence to support the suggestion that Mesopotamia (and Susa) imported much of its copper from ancient Magan, modern Oman, and clearly had a strong involvement in trade from the Gulf (see Weeks 2003). Based on textual evidence, Elam is not only strongly implicated in the trade of tin and lapis lazuli in the late 3rd/early 2nd millennium, but also other classes of artefacts link it to Gulf contexts (*e.g.*, Muhly 1973: 292-3; Moorey 1994, 90, 298; Weeks 1999, 51; Potts 1999; Pigott et al. 2003b, 163-165). Lapis lazuli, based on current evidence, probably came from the Badakhshan province in north-eastern Afghanistan and was transported across the Plateau or down through the Indus Valley and via the Gulf in order to reach Mesopotamia (Hermann 1968; Tosi 1974a; 1990; Casanova 1992; 1999; Delmas & Casanova 1990; Weisgerber 2004; Weisgerber, this volume). This scenario suggests that the Elamites may have held a concession of some sort with Gulf middlemen moving tin and other rare commodities to elite Mesopotamian consumers. Among the likely candidates for securing the tin and moving it to the Gulf and Mesopotamia proper are the Harappans, who used tin-bronze with similar frequency to Mesopotamians (Kenoyer & Miller 1999; Agrawal 2000). Again, both texts and artefacts link Mesopotamia and "Meluhha," now identified with the Indus Valley, and evidence suggests that Meluhhans may even have been in residence at Ur (Mackay 1943 and Woolley 1933 in Possehl 1996; see also Parpola et al. 1977).

Thus, another reason to recognise Iran's importance in the development of metallurgy rests in the fact that an ancient polity based in South-western Iran – i.e., Elam – appears to have played a major role in the tin trade. Interestingly, this trade from Afghanistan to Mesopotamia seems to have benefited primarily Elam, Mesopotamia, and Luristan exclusively, while somehow bypassing the entire area in between. Possible reasons for this cultural pattern are numerous, such as tin being too expensive for local consumption or communities actively choosing to express their 'local' identity through arsenical copper[7] (Thornton et al. in press). One way to explore this question further is to look at the transitional zone between lowland and highland communities – i.e., Luristan.

Tin-Bronze in Luristan

The single class of Iranian copper-base artefacts that is perhaps best known on a world-wide basis is the so-called 'Luristan Bronzes'. Most previous research into these artefacts has been focused on the quantities of them found in the collections of the world's museums (*e.g.*, Calymeyer 1969; Moorey 1971; Muscarella 1988; 1989), which are regrettably the result of massive looting of cemeteries in the region during the 1930s. The single most important initiative that saved these artefacts from an acontextual limbo is the Belgian Mission in Iran from 1965 to 1979 directed by the late Louis Vanden Berghe (University of Ghent). A preliminary report is in press on a major program of laboratory analyses (PIXE analysis and metallography) of Belgian Mission copper-base artefacts undertaken at the University of Pennsylvania Museum's Applied Science Center for Archaeology (MASCA). This research was undertaken by MASCA's Scientific Director, Stuart J. Fleming, physicist Charles P. Swann, metallurgist Samuel K. Nash, and the author.

Among the intriguing results of the program of PIXE analysis is that 3rd millennium copper-base artefacts from the cemetery at Kalleh Nisar in Luristan are predominantly tin-bronzes with appreciable arsenic content. However, change comes with the Iron Age and its distinctive cultural transition, which includes the fluorescence of the localised tradition of canonical 'Luristan Bronzes'. In these canonical tin-bronzes, arsenic is no longer present. Moreover, there is no apparent correspondence between tin content and artefact function as weapons and ornaments have decidedly variable contexts. Analyses from three Iron Age cemetery sites, Kutal-i Gulgul, Bard-i Bal, and War Kabud, support this observation. Tentative arguments put forth by Ernie Haerinck & Bruno Overlaet (2002; in press), who are now publishing the Belgian Mission excavations, suggest that much of the tin-bronze used to make Bronze Age Luristan copper-base artefacts may have come from Mesopotamia/south-western Iran (Khuzestan). We, in supporting this argument, have further suggested that Mesopotamia in turn acquired it from points further to the south – i.e., the Gulf (Fleming et al. in press). The study of the 'Luristan Bronzes', unquestionably one of ancient Iran's (and Southwest Asia's) most distinctive metalworking craft traditions, should now continue to be a source of much scholarly interest and debate.

The Significance of Archaeometallurgical Field Survey in Iran

While Vanden Berghe's archaeological expeditions to Luristan were of crucial importance to the understanding of a major Iranian prehistoric metallurgical tradition, there have been a number of significant, archaeological investigations that focused specifically upon the metallurgical remains themselves. Two archaeometallurgical field surveys are highlighted here, in particular because of the ramifications for research that followed these projects. The onset of the modern era of archaeometallurgical research in Iran is signalled by several essentially independent research initiatives. The resulting publications include C. C. Lamberg-Karlovsky's 1965 Ph.D. dissertation in the Dept. of Anthropology, University of Pennsylvania, which provided the first summary of the important metallurgical remains from this area (see also Lamberg-Karlovsky 1967), the 1966 publication of Hans Wulff's The Traditional Crafts of Persia with its chapters on mining and traditional metalworking, the 1967 publication by Prof. Joseph R. Caldwell of the excavations at Tal-i Iblis with its significant evidence for early copper production, and by the publication of analytical work done by Cyril Stanley Smith on the Ali Kosh native copper bead and a Sialk pin (Smith 1968; 1969).

Professor Smith played a crucial role in generating broad scholarly interest in the study of archaeometallurgy and Iran was a particular focus of his. His interest in Iran most certainly came about due to the considerable efforts of Theodore A. Wertime, an historian of technology and the organiser of a series of 'metallurgical expeditions' through Southwest Asia, with special emphasis on Iran. The

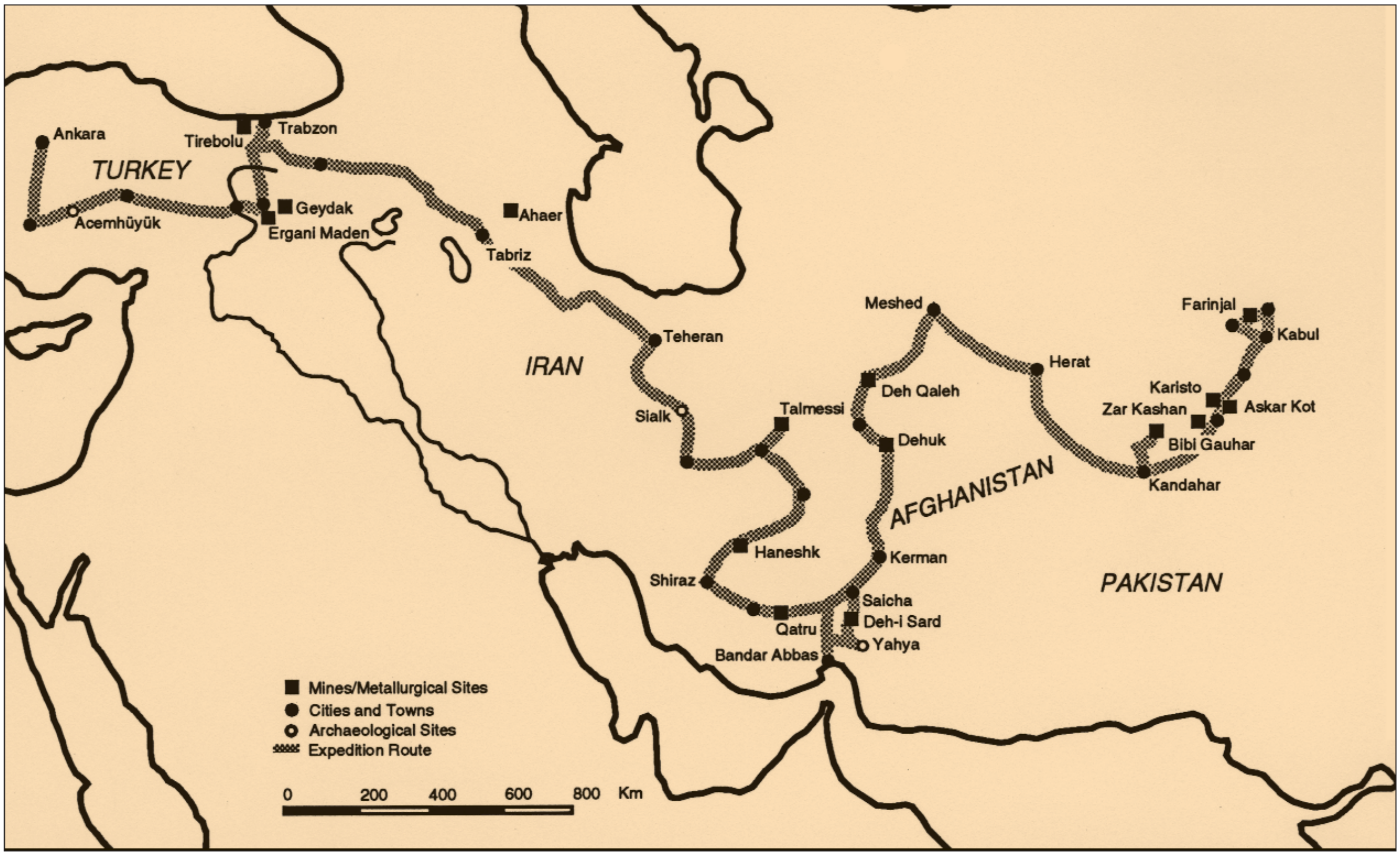

Fig. 6: Travelling route of the 1968 expedition to metallurgical sites in Anatolia, Iran and Afghanistan carried out under direction of C. S. Smith and Th. A. Wertime.

first of these took place in 1961 when Wertime was serving with the U.S. embassy in Tehran. Smith participated in the next expeditions in 1962 and 1966, perhaps 1967 and again in 1968 (see Arab 2003; also Rehren & Arab, this volume) (Fig. 6). These field visits to important ore bodies, mines and excavations past and present, and sundry other historical locations were among the very first such focused efforts to characterise the 'landscape' of ancient metallurgical activity anywhere in the Old World.

Other than Smith, Wertime was joined at various times on his Southwest Asian surveys by eminent scholars including Frederick Matson (ancient ceramics specialist), Beno Rothenberg (director of the excavations at Timna in Israel), R. F. Tylecote (metallurgist/historian of metallurgy), Robert Brill (ancient glass and Pb-isotope specialist), and Radomir Pleiner (see Pleiner, this volume) (archaeologist/ancient iron specialist). Iran was of particular interest to Wertime because of his diplomatic service experience in Tehran and, in the end, the Iranian evidence received special attention in his publications in the journals Science (see Wertime 1968; 1973a) and American Scientist (1973b) as well as in those by Tylecote (1970) and Pleiner (1967). This loose-knit community of specialists, all focused on different aspects of archaeometallurgy, either saw firsthand the richness of the Iranian evidence or learned of it through their colleagues. These scholars were among the 'founding fathers' of the modern study of archaeometallurgy and their personal interest in Iran have made it a focal point of scholarly attention ever since.

The attention being paid to Iranian archaeometallurgy in situ was not to abate as the Wertime expeditions came to an end. Between 1975 and 1978, a French Ph.D. candidate in physics at the L'Université Pierre et Marie Curie in Paris, Thierry Berthoud, led a multidisciplinary team of French archaeologists and geologists on an extensive sample collecting survey of important sites associated with mining or archaeometallurgical activity in Iran, Oman, and Afghanistan (*e.g.*, Berthoud 1979; Berthoud et al. 1982) (Fig. 7). This survey was a joint mission between the Centre Nationale de Recherches Scientifiques, the Laboratoires des Musées de France, and the Commissariat à L'Energie Atomique. This mission differed from Wertime's in that team geologists were charged with sampling known major copper deposits across a wide region in order to compile a database of trace element compositions. These, in turn, were compared to the elemental analyses performed by Berthoud using emission and mass spark spectrometry on Bronze Age copper-base artefacts from Iranian sites (Susa in particular). Their work appeared to corroborate a link between the native copper from Talmessi and 3rd millennium BC artefacts excavated from Susa in Khuzestan (Period I) and the Jebel Hamrin in Iraq (Berthoud et al. 1982, 43). In addition, this analytical program appeared to support the link between Omani copper and Bronze Age artefacts from Susa[8].

Fig. 7: Map of the most important ore deposits visited by the French mission 1975 and 1978.

A third important result of their research was the identification of tin deposits in eastern Afghanistan in the Sarkar Valley with its numerous Bronze Age sites. These were the first such deposits documented by an archaeometallurgical team in Southwest Asia, and they lie not far from the Iranian border (Cleuziou & Berthoud 1982).

French research was to continue to reinforce just how rewarding the study of Iranian metallurgy could be. During the 1980s, following the combined field and laboratory investigations of Berthoud and colleagues, came the major study of metals and metallurgy at Susa authored by François Tallon with the laboratory assistance of Michel Malfoy and Michel Menu (1987). This study is one of the most intensive investigations of metallurgy from its earliest appearance down to the 2nd millennium BC with a focus on artefact typology and composition in the context of a single major urban centre anywhere in Southwest Asia. Metallurgical developments over time at lowland Susa provide a microcosmic perspective on technological change and trends in greater Mesopotamia, while at the same time offering useful insights into lowland-highland interaction in prehistory.

Pressing Questions for Future Research in the Archaeometallurgy of Iran

There are numerous large-scale research questions on the early phases of metallurgical development in ancient Iran that merit future attention, but only two can be mentioned here. Beginning with the Neolithic/Chalcolithic, it is imperative that the native copper ore bodies at Talmessi and Meskani in the Anarak mining district in central Iran be restudied by a combined team of archaeologists, geologists, and mining archaeologists. It must be born in mind that the centuries of mining into the modern era have irrevocably altered the configuration of the mining evidence, perhaps even to the point that modern restudy will not be fruitful. But this should be determined. Systematic surface and local regional survey for cultural remains in the vicinity of the deposit should be undertaken by archaeologists, as no such evidence has been reported thus far. Mining archaeologists could document the vestiges of human acti-

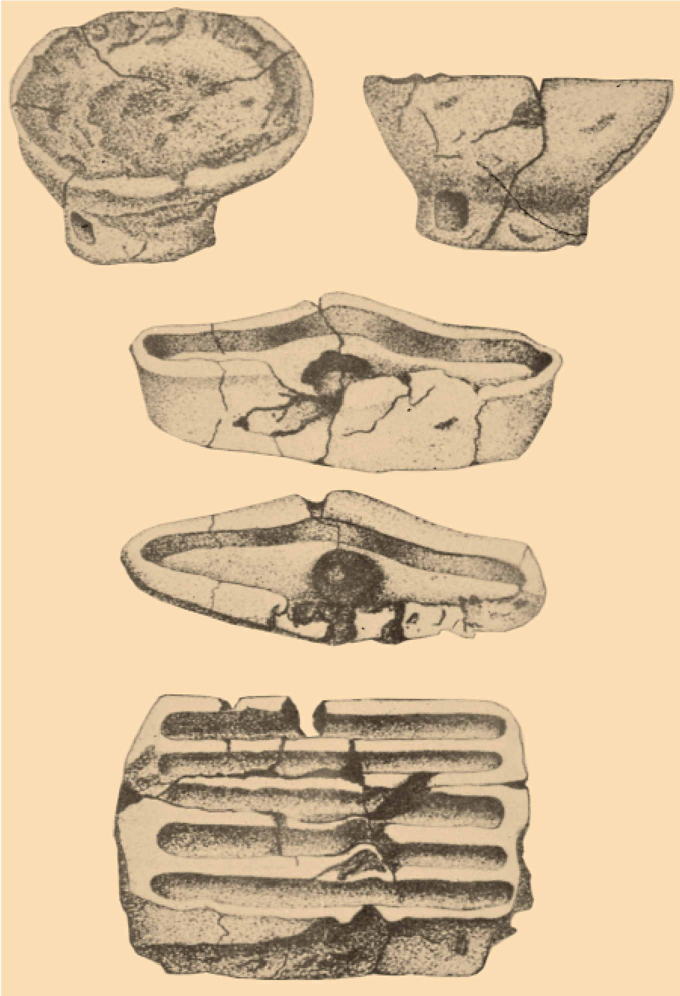

Fig. 8: Casting moulds and crucible from the excavation of Y. Majidzadeh at Tappeh Ghabristan, level II, after Majidzadeh 1979, 1st half of the 4th millennium BC.

vity at the deposit including surface workings as well as deeper-lying workings as they exist with an eye to suggesting where ancient exploitation may have proceeded. Geologists, having taken a statistically valid set of ores and host rock samples from the deposits, could initiate a laboratory program of x-ray diffraction, trace element analysis, and Pb-isotope analysis (if applicable) to characterise the composition of these ore bodies in terms relevant to archaeometallurgical issues. The descriptions in Bazin & Hübner 1969 and in Schürenberg 1963 are not sufficiently informative for purposes of archaeometallurgical research. Future research programs would be able to take advantage of the scientific characterisation of these ore bodies, which may be able to offer an elemental and/or isotopic profile for the native copper taken from these deposits and used in antiquity. Such profiles could be used in comparative studies of early copper-base artefacts which have been or which will be excavated from sites in Iran.

Among the major research issues remaining about the Chalcolithic and Bronze Ages is the question of the sources of arsenical copper on the Plateau. An initial review of this question with geologists from the Geological Survey of Iran concerning current knowledge of the availability of copper sulfarsenides might well reveal new information. Are the known deposits as limited as have been suggested (Heskel 1982; Heskel & Lamberg-Karlovsky 1980)? In archaeological terms, copper-base artefacts from the periods in question, when surveyed in an integrated study of context, typology, and scientific analysis, could provide new information on where arsenical copper was being produced and exchanged on and off the Plateau. As a result, the notion of Iran as a Sumerian 'El Dorado' may well become more concrete.

Site Specific Investigations

If we move to more artefact specific discussions, again only a few early sites can be mentioned briefly here. The archaeometallurgical remains from Chalcolithic Tappeh Qabristan merit a site specific laboratory investigation. Much could be learned from a study focused on the excavated crucible and moulds (Fig. 8) and their pyrotechnological history in concordance with a program of elemental and metallographic analysis of the copper-base artefacts from the site's sequence. An attempt at sourcing the 20 kg of malachite found in the workshop to a local ore body would be an original undertaking. Qabristan provides one of the very best examples of an early copper smelting workshop in Southwest Asia and its remains are deserving of an intensive laboratory study to characterise its 'technological style' (see Lechtman 1977; Hegmon 1992; 1999) of copper production and artefact manufacture. $ Abb. 8
There is little question that the archaeometallurgical remains excavated at Shahdad (ancient Xabis) are in need of critical review. This would depend very much on whether or not any of the so-called 'furnaces' in the five workshops excavated have been preserved to the extent that they might be restudied scientifically (Fig. 9). Were samples taken during excavation of the production debris? If so, where are they? Salvatori & Vidale (1982) report significant slag on the surface of the site. Is any of it available for analysis? Certainly new samples could be systematically collected at the site itself. The publication of these pyrotechnological installations unfortunately does not make clear the exact nature of the metals-related activities that were taking place in them (Hakemi 1992; Hakemi & Sajjadi 1997, 85-114). The 'furnaces' are unlike anything that has been excavated elsewhere and do not appear to be appropriate to the smelting or even the melting process. Given that the Shahdad workshops are among the largest concentration of such installations anywhere in Southwest Asia, they should not be allowed to remain enigmatic in perpetuity.

A restudy of the evidence from Tal-i Iblis would also yield new information about the metallurgical activities undertaken at that site. While it must take into consideration that the site has been heavily damaged by local villagers digging away its rich soil, systematic surface survey might yield new samples worthy of investigation. If the site is not completely obliterated, additional crucible and copper ore fragments may still be obtained via systematic surface survey. Further test trenching may yield carbon for dating and other metallurgical remains. The surface appears littered with large cobbles which might have been used for ore crushing and these

Fig. 9: Shahdad, the "city of artisans" after its excavation in 1977 by A. Hakemi.

could be collected and investigated with this in mind (Caldwell 1967).

Production evidence from major Bronze Age settlements is a particularly important focal point for research and the current research precedents on Iranian sites are encouraging. Taking the lead from the recent analytical programs focused on Tappeh Sialk (Schreiner 2002) and Shahr-i Sokhta (Hauptmann 1980; Hauptmann & Weisgerber 1980; Heskel 1982, 97-120; Hauptmann et al. 2003), which hopefully will be continued, the site of Tappeh Hesār (Pigott et al. 1982; Heskel 1982; Pigott 1989) has a major unstudied assemblage that could shed dramatic new light on large-scale copper-base metallurgical production in its Bronze Age floruit. We look forward to their future study as well as that of the other remarkable and abundant archaeological remains of the early technological traditions that make ancient Iran such a fruitful source of continuing investigations into metallurgy's earliest development.

Acknowledgements

The author is indebted to several scholars for their comments, criticisms and contributions to this manuscript. Christopher Thornton's pointed comments assisted me in clarifying a number of crucial points under discussion. Gregory Possehl brought to my attention his important chapter on 'Meluhha' in Reade 1996 and the references to Meluhhans at Ur. Gerd Weisgerber made available to me his soon to be published manuscript on prehistoric and historic mining in Afghanistan with its synthetic discussions of the lapis trade and the metallurgical remains in the Gardan-i Reg. William Sumner offered useful comments on the presence of the bevelled-rim bowl at Iranian sites.

Notes

1 For brief background comments on the term oikumenê see Pigott 1999b, 118, note 3. Alternatively, while the term oikumenê, with its connotation of technological and behavioural interactions, may remain too imprecise for current discussion, one can explore E. N. Chernykh's (1980; 1992) somewhat more concrete concept of the 'metallurgical province' – a model which, like that of the oikumenê, not only underpins the discussion in this chapter, but also is distinctly apropos to the Iranian Plateau. However, the time is now ripe for a proper critique of the validity of such models and their fundamental constructs in the light of the most recent field and laboratory investigations and anthropological theory.

2 David Clarke (1968, 357) defined a technocomplex as "a group of cultures characterised by assemblages sharing a polythetic range but differing specific types of the same general families of artefact-types, shared as a widely diffused and interlinked response to common factors in environment, economy, and technology." This term shares much in common with the concepts of the oikumenê, interaction sphere, and metallurgical province.

3 Dr. Abdulrasool Vatandoust, the chief of international affairs of Iran's Cultural Heritage in Tehran, trained at the Institute of Archaeology (Ph.D. 1977) under Prof. R. F. Tylecote. Tylecote was a member of Theodore A. Wertime's metallurgical expedition through the Persian desert (published 1968) and was thus thoroughly familiar with the potential for archaeo-metallurgical research in Iran.

4 For another published map of the copper deposits in Iran (and Anatolia), see Pigott 1999, 83, Fig. 4.6.

5 Numerous discussions of bevelled-rim bowls have often mentioned them as possible grain measures. In this regard, discussions of Sumerian foodstuffs being traded for highland natural resources such as copper would merit further attention (*e.g.*, Kohl 1978; Ratnagar 2001). It is worth noting, however, that not all so-called bevelled-rim bowls found at Plateau sites are identical with typical Mesopotamian examples (William Sumner, pers. comm.)

6 This article has not attempted to wade into the controversies surrounding the locations of such Iranian hinterland polities as the lands of Aratta, Marhashi, and Shimaski. Moorey (1993, 37) asks if Aratta was "more than a literary phenomenon – a mythical El-Dorado compounded of truths and half truths, a land of dreams rather than realities?" But, most interestingly, he goes on to state, "The Periplus Maris Erythraei, describing Rome's maritime trade in the Red Sea, Gulf of Aden, and Indian Ocean, refers to a people known as Aratrioi when listing inhabitants of southern Afghanistan and north-eastern Pakistan, but their earlier history is unknown." One wonders if there is any link between these peoples, the legendary mineral riches of the land of Aratta, Strabo's tin-rich Drangiana (Sistan), and the enormous, possibly Bronze Age deposits of copper-base smelting slag known to exist in the Gardan-i Reg in Afghanistan along the southern reaches of Irano-Afghan border (see Dales & Flam 1969; Dales 1992; Weisgerber 2004; Weisgerber, this volume).

7 An additional material divide between Mesopotamia and Iran may be seen in the frequency of use of turquoise in Iran vs. the use of lapis in Mesopotamia (see Tosi 1974a; b).

8 Pleiner, who had been hosted by Smith at MIT for an interval, also wrote the initial treatise on iron in ancient Iran (1969).

9 Criticism of the French team's survey has been mounted; *e.g.*, Seeliger et al. (1985, 643) who, "questioned some of the analytical and geological assumptions and procedures of this project, with the result that decisive analytical evidence for whether the copper of a particular range of objects came originally from Oman or Iran remains elusive" (Moorey 1994, 249-250; see also Müller-Karpe 1990, 108; Hauptmann et al. 1988, 34).

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Prehistoric and Ancient Ore-Mining in Iran[1]

Thomas Stöllner

On the State of Research

Not without reason, the rich deposit-region of Iran has several times been called a "province of metallurgy" (following E. N. Cernych 1992) or even the "heartland of metallurgy" (following Pigott 1999a). The stock of metal ores counts among the most important ones in the Middle East. Still today its exploitation is profitably done. Older research again and again pointed out to this but at the same time there was only very few reliable information about it. As late as during the 60s and 70s this gap of knowledge about primary production of raw materials in the pre- and early Islamic periods began to close. At first the numerous expeditions, which had been carried out by European scholars and experts in what had been Persia those days in the 19th and also in the 20th century, served as a basis for these works. Some of the earliest evidence come from the British traveller H. C. Rawlinson who in 1838 travelled as far as to Gilan via Tabriz and Takht-i Suleiman and who *a. o.* described the lead-zinc pits of Anguran. Further information was collected by the Persian general of German origin, A. Houtum-Schindler who at the same time was chief-supervisor of Persian telegraphy (1881). His observations on mining are as fundamental as the works by German/Finnish Alexander v. Stahl who as General Postmaster was able to travel freely at the end of the 19th century and who described many deposits (1893; 1894a; 1895; 1904; 1911). In the late 19th century the British J. Mactear travelled on Houtum-Schindler's tracks (Mactear 1894-95). Scholars like E. Titze, R. Helmhacker, H. B. Vaughan must also be mentioned. In the first half of the 20th century, together with the economic engagement of foreign mining companies, professional geologists and deposit experts also came (E. Baier, E. Diehl, G. Ladame, G. Burnial, P. Bariand). Only after the 60s it was finally possible to carry out some expeditions and surveys concerning the archaeology of mining (see below).

In the 60s, the then founded Geological Service (Geological Survey of Iran) started a voluminous prospection program on the economic evaluation of the national deposits. Since then, ancient mining has also been reported again and again. Concerning this, working with the Austrian geologist Herwig Holzer proved to be extremely fruitful: together with the geologist Morteza Momenzadeh it was possible for the first time to carry out archaeological surveys of mining areas which helped for a better understanding of single mining districts like e.g. the one at Duna in the Alborz mountains or the well known mining district of Veshnāveh (Holzer & Momenzadeh 1971; 1973). Also in the 60s, the surveys by the American MIT Boston (Th. Wertime, C. S. Smith) and the Illinois State Museum (J. Caldwell) started which concentrated mostly on archaeo-metallurgy and started out from single settlement regions (Caldwell 1967; Caldwell & Shahmirzadi 1966). This was the first purposeful survey on the archaeology of mining (Wertime 1967; Smith et al. 1967; Pleiner 1967). While the early beginnings of research were mostly in Central and South-eastern Iran, some recent expeditions in the 70s significantly extended the regional frame: in 1975 and 1976 a French group around Thierry Berthoud visited several sites and deposits not only in Central and South-eastern Iran but also in Afghanistan where the Americans had been travelling already at the end of the 60s (Berthoud et al. 1975; 1976; 1982). Instead, the focus of the works of the Deutsches Bergbau-Museum in the course of two journeys (1976; 1978) was mostly on North-western Iran and Azarbaidjan, besides Sistan (Weisgerber 1990; Weisgerber et al. 1990). These beginnings lead to a first summarising view at a number of prehistoric settlements and their relations to raw materials which all give evidence of extractive metallurgy after the late 5th millennium BC (*e.g.* Shamirzadi 1979). Further connections stayed to be unknown, however, may it be that the significance of Iran for supplying neighbouring regions stayed unexplained or that also the regional inclusion into the development of culture and economy was not done. Thus, the necessary indications for dating the single mining districts and mines were missing and of course all the further results concerning organisation and technique of early mining. Many references were based on sheer presumptions and were not confirmed by the appropriate geo-chemical analyses. Doubtlessly, the investigation of the craftshop area ("city of artisans") at Shahdad at the rims of the Dasht-e Lud desert in the province of Kerman by A. Hakemi (Hakemi 1992) count among the outstanding discoveries of this time. In the years after the Islamic Revolution there were some investigations but usually there was no purposeful approach. Insofar, the project "Ancient Mining and Metallurgy", which was started in the year 2000 after some preliminary work, was a definite new start. The goal of this program, initiated by DAI, Technische Universität Freiberg, and DBM together with Iranian institutions, was mostly to get information about activity patterns of regional metal supply and about its technical and economic structures between Chalcolithic and late Bronze Age. The settlement at Arisman, discovered by the teacher D. Hasanalian just a few years before (see essay by Chegini et al.), was the starting point. The Deutsches Bergbau-Museum together with the Geological Service and the Bergakademie Freiberg had the task of analysing the origins of the ores (see essay Pernicka). The prehistoric mining district of Veshnāveh, which had been known since the 1960s, was the starting point (see essay Stöllner et al.). Here, the first mining-archaeological excavations in Iran ever could be carried out. But more and more, surveys concerning deposits and the archaeology of mining were extended to different regions of the Western Central Plateau, as everything was about achieving a basic understanding of metal supply during different periods of Iranian cultural history.

Iran is so rich in deposits that an overview on the ancient exploitation of deposits is hardly possible today – there is hardly one among the ancient deposits without traces of ancient exploitation. As early as today it is more difficult to offer a definite picture of the economic dynamism of this production of raw materials or of the development of its technical components. This is mostly due to the fact that still today the areas of the mining districts have not completely been investigated and there are hardly any reliable data for dating them. Instead, the investigations up to today show that mining technology did not develop like in the Mediterranean region: before the 19th century, when mining technology was stimulated by Europe, regularly built mines with horizontal galleries and drainage system were almost unknown. Similar to metallurgy (see essay Pigott), also mining technology shows individual features. Understanding them basically offers the possibility of roughly dating the monuments – a crucial precondition for connecting them with single periods of cultural history. But of course the mining-archaeological analyses of the sources is not restricted to dating the field-evidence into the course of the history of technology. Mining metal raw materials is often a part of the context of the neighbouring cultures' demand for metal. These economic conditions do not only determine both way and size of mining but also the social conditions of early mining. Technologic inventions (like *e.g.* the introduction of iron) caused significant changes of the demand for metal ores or caused different concepts of exploitation, as now other metals were produced, *e.g.* from poly-metal ore bodies. Naturally, in cultures without writing find it is somewhat more difficult to name such wide connections and to understand them. On the other hand, it is just mining which offers deep insight into economy-related fields, even of a society without writing.

Copper

If we look at the distribution of copper (pers. mez) deposits in Iran, we clearly see that they are spread among several regions and that they are very rare in the West, e.g. in the Zagros Mountains. In principle, this is also true for other types of deposits. The main zone of copper mineralisation is the belt of volcanic rock in Central Iran (Urumiyeh-Dokhtar-copper-belt). Like being the backbone of the country, it stretches from the Northwest as far as to the Southeast and consists of rock which is mostly of tertiary, volcanic and sediment origin. Particularly, the region of Kerman may be called the copper stock of Iran – here, at Sar Cheshmeh, there is the biggest and most important deposit of the country. Other regions with rich copper deposits are in the East, in Birjand (Qaleh Zari) and near the Hilmand-basin in Sistan (Chehel Kureh). Beside the important deposits of the Anarak region, those of the Zabsebar/Shahroud-zone surround the Kavir-desert in the North. In the Fahar-zone, finally, there is hardly anything else than copper mineralisations (Weisgerber et al. 1990; Weisgerber 1990). Besides those of the oxidic series (cuprite, tenorite), ore deposits also include carbonate ores (malachite, azurite) as well as sulphides (chalcocite, chalcopyrite) (Bazin & Hübner 1969). The huge deposit at Talmessi (Fig. 1) and Meskani in the Anarak region is of special importance and has become well known for its important deposits of native copper. Older investigations mostly pointed out to the significance of Talmessi for the early steps of metallurgy in Iran. Already C. Smith (1968, 241) discovered enclosures of copper-arsenic minerals in the material of a needle from Sialk and connected them to Talmessi. Th. Berthoud et al. (1982) and D. Heskel (1982) thought in a similar way when suggesting that the origin of the early copper objects from Susa, Tappeh Sialk, or Tappeh Yahya was the Anarak region due to their high content of arsenic. Mostly, they referred to the high content of arsenic of the finds of native copper at this rich deposit – but for this we must assume that mostly native copper was used in big amounts.[2] Now, just this cannot be proven for the development of metallurgy in the 4th and at the beginning of the 3rd millennium. The contents of arsenic rather seem to be due to some early process of alloying than to a certain group of minerals.[3] Arsenic, giving a certain silverish colour to the bronze objects, dominates the alloys up to the early 2nd millennium BC (Vatandoust 1999). The detailed analyses concerning Arisman (Pernicka et al. in this volume) show that several copper ores were alloyed which in the phase of developed metallurgy around 3000 BC suggests a copper ore supply from several deposits.

Thus, we may state that – despite the rich deposits of native copper – Talmessi and Meskani are rather doubtful to have been the central deposits of the earliest extractive metallurgy at the

Fig. 1: Landscape of Talmessi/Meskani in the 1970s; Photo: G. Weisgerber.

plateau. But what is the situation concerning local evidence for the history of mining archaeology? The region, which has again and again been described since the 19th century (E. Baier, P. Bariand, G. Ladame), has also been searched in the course of a number of surveys (Pleiner 1967; Wertime 1967; Berthoud et al. 1976; Weisgerber 1976/78; Pernicka in this volume): today there are still extensive traces of modern exploitation in both mining districts, indicating mining before World War II until about 1960. Despite intensive search, clear traces of any prehistoric exploitation are missing – even if surface exploitation of native copper or of the oxidic parts of ore bodies is difficult to prove. Some slag heaps at Talmessi and some older looking traces of mining at Meskani probably belong to mining in the early Modern Age, as a slag sample from 1978 might suggest (Ham -1045: 270±70 BP; 1σ–intercept 1490-1680 [59.9%], 1770-1800 [6.9%], 1940-1950 [1.4 %]). Remnants of older mining activities come from the deposit of Baqoroq which also was mostly exploited in the first half of the 20th century. There, we know indications of some simply organised phase of exploitation before the Modern Age, due to slag heaps, old mining (Fig. 2), and finds of sherds – similar to the neighbouring lead-zinc pit of Nakhlak (Weisgerber, pers. inf.). Concerning the region of Anarak-Nakhlak, we may suggest some prehistoric mining activity though for the time being we cannot clearly recognise it.

The situation in the area around Qom-Kāshān is different, as there the mining district of Veshnāveh offers a good example of prehistoric mining (Stöllner et al. in this volume). The mining method proven for Veshnāveh may be called an adjusted method concerning the impregnation deposits of the belt of volcanic rock in Central Iran: fire setting and crushing work by help of stone hammers gets to be the usual mining method in all the regions in the course of the 3rd and 2nd millennium (Weisgerber & Willies 2000) (Fig. 3). Even after the introduction of metal (iron) tools (picks), fire setting stays to be the most important means of exploitation.

Due to the investigations at Veshnāveh, we now know that these techniques were probably introduced at the plateau after the early 3rd millennium – a period, when exchange of technology among different regions of the Middle East can often be observed.[4] But in Iran, the technique of fire setting and crushing work by help of grooved hammers has been definitely proven only at a few places (see below Shakin, Anaru): due to the find of a grooved hammer,

Fig. 2: Ancient mining pits at Baqoroq; Photo: G. Weisgerber.

the mining district of Mazrayeh in Northern Iran may be supposed to have been one of those but further investigations are lacking (Weisgerber 1990, 77 fig. 2, 2). Traces of ancient mining have been proven for many other mining districts, just Bazin & Hübner (1969, 195ff. [appendix]) report them at 65 copper deposits.

The oldest evidence for extractive metallurgy come from the Southeast of the country, where mostly at the important settlement of Tall-i Iblis copper ores were smelted in melting pots at the turn of the 5th/4th century (Thornton & Lamberg-Karlovsky in this volume). This is hardly surprising, as the copper deposits there count among the richest of the country. Surveys in the Bardsir-valley, South of Tal-i Iblis, brought clearer insights: at Tal-i Homi, R. Pleiner found evidence of round surface depressions – traces of open mining which could be dated at least to Parthian and Sasanian periods, due to pottery (Pleiner 1967, 373 ff., fig. 13). The heaps of copper slags, which were found in the area around, fit to these periods. More indications of ancient mining were found by the French expedition in the volcanic mountains of Kuh-e Ahurak farther to the East (Qaleh Narp, Sang-e Sayat a. o.: Bazin & Hübner 1969, No. 184, 186; Berthoud et al. 1975, 20ff., 23). Here and elsewhere, older traces of mining can hardly be found without intensive surveying but there is no reason to doubt that there are relations to metallurgy in the settlements of the Bardsir valley.

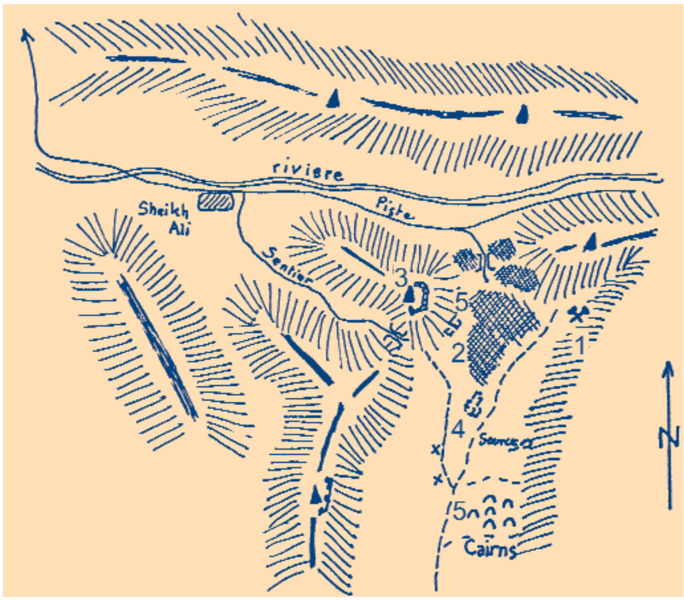
Fig. 3: Veshnāveh, mine 3-4, photography of fire setting and traces of picks; Photo: Th. Stöllner.

Fig. 4a: Deposit at Sheikh Ali, general view; Photo: Th. Stöllner.

Early copper metallurgy is also known from the well known site of Tappeh Yahya in the Soghun valley. There, there was also some debating on early use of the regional copper deposits, though – due to the contents of arsenic (s. a.) – also import of copper arsenides from the region of Anarak was suggested. Around 3600-3200 BC (period VB-VA) there is a significant change of metallurgy at Tappeh Yahya: after a long period, when working with native copper was basic, in this period a number of complex metallurgic methods and the use of poly-metal, sulphidic ores are included (Thornton 2001, 113f.). This leads to the suggestion that in this phase new deposits of complex ores were prospected: in this region, mostly the ophiolite, Cretaceous period sulphide deposit of Sheikh Ali is the right place. Additionally, this deposit shows a close correlation of copper and zinc by help of chalcopyrite and sphalerite (Rastad et al. 2002): processing such ores also produces natural brass alloys as we know them from Tappeh Yahya mostly in the 2nd millennium BC (Thornton & Ehlers 2003, tabl. 1). This is an important indication of the early exploitation of the Sheikh Ali deposit.

Also in this case it is not possible to give proof for the deposit itself: Particularly the Sasanian and early Islamic exploitation overlaid any older traces. But still Sheikh Ali is an outstanding example

Fig. 4b: Schematic map of Sheikh Ali, following Th. Berthoud et al., map 8: 1 mine, 2 slag heaps, 3 castle, 4 settlement, 5 burial fields.



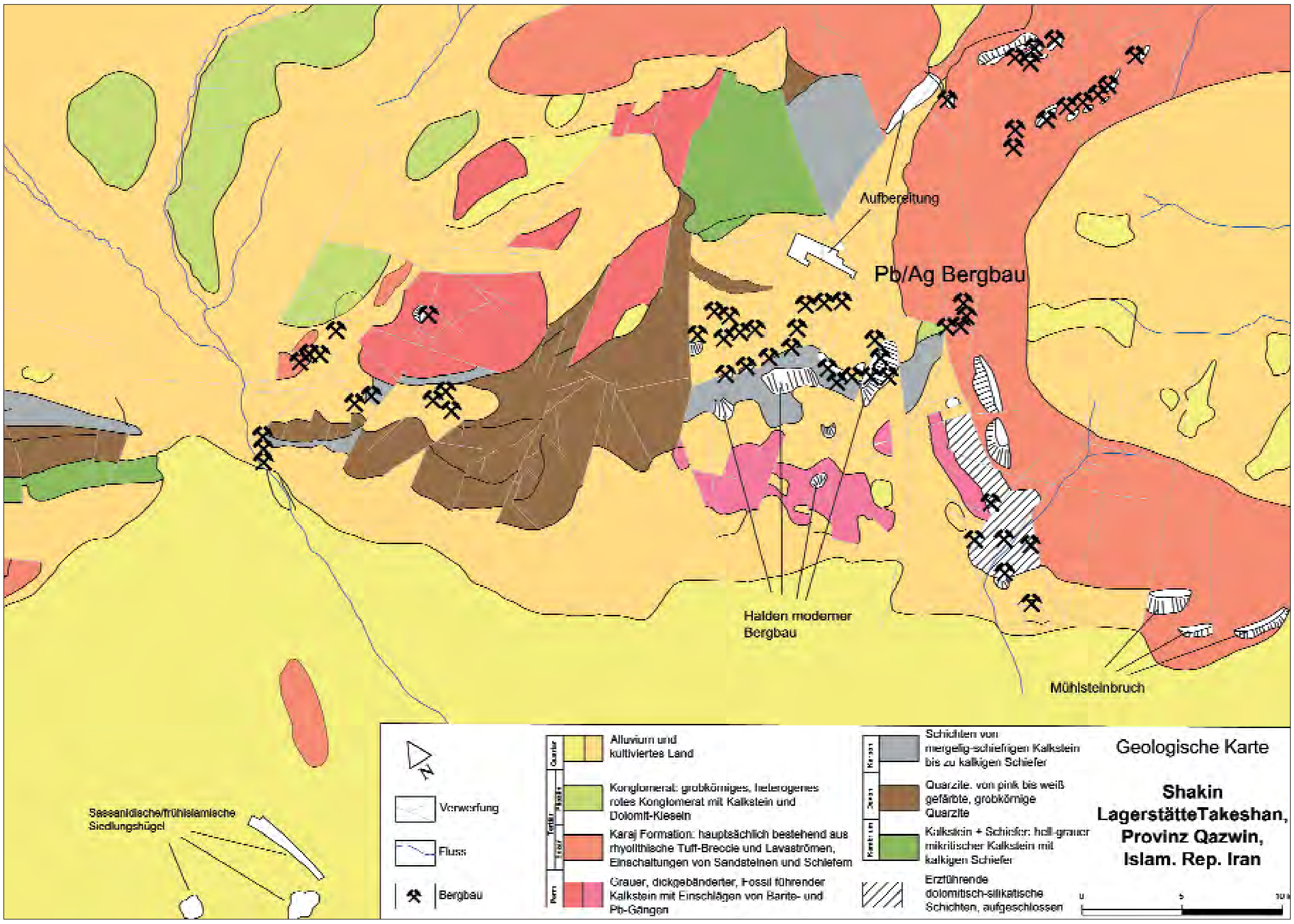


Fig. 5: Shakin, map of deposits, following Kansaran Consulting and Ing. Sepahi; realisation: J. Garner, DBM.

of a prehistoric production site in Iran: the vein deposit was mined firstly by an open-pit mine, later even by underground mining (Fig. 4a). In the valley there are vast slag heaps some hundred metres long; remnants of buildings, a fortification and burials suggest - permanent production of copper including the appropriate infrastructure (Fig. 4b). Such production sites are reported several times in Iran in this period, they suggest a radical rejection of seasonal production like it was usual until the early Iron Age in the 1st millennium BC (s. b.). Other copper deposits were also exploited in this way during this period: Khut, east of Yazd (Berthoud et al. 1976, 11ff., map 5-6), the deposit of Qaleh Zari in the North of the Dasht-e Lut (ibid. 25ff., map 11-13), or Chehel Kureh (ibid. 22ff., map 10) are good examples of this strategy of production. In the Sasanian and early Islamic period, the mining of huge deposits was probably centrally controlled and organised; this is also suggested by the evidence of fortresses and forts. Often the ore was taken to central smelting places in high glens from the surrounding mining places – in these glens there were also the settlements. Similar strategies can also be observed for later periods, like e.g. the Islamic mining district of Komjan/Karwand in the Karkas Mountains (report Arisman project, see Hezarkhani et al.). This functional principle can also be observed in the mining district of Ahar, where G. Weisgerber was able to discover a waste tip from copper processing from the early Islamic period, consisting of the nozzles of bellows, fine grained slags, and ashes (Weisgerber 1990, 78ff.; Ham 1168: 2σ –intercept: AD 770-1040 [95.4%])

Only at first sight the mining techniques which were used during these earlier phases are similar to the prehistoric methods of mining – besides fire setting, now shafts are sank, often combined with inclined drifts which follow the lode. Often, the shafts show a rectangular cross-section and are drifted by using picks. In vein deposits we can observe back stoping and also sublevel stoping, if not done very systematically. At Ardjin near Sultaniyeh, Northwestern Azarbaidjan, an ensemble of smelting, settlement, and pits is described. Furthermore, lamp recesses and air shafts are reported (Weisgerber 1990, 80ff., fig. 4). This method can be called a traditional technique which in the course of time was improved by single elements (air supply, hauling, lighting) – it was kept in Iran until European mining technology was introduced in the 19th and 20th century (e.g. Wulf 1966, 14ff.). This is probably also due to the fact that only seldom mine drainage was a problem in the mostly mountainous and arid mining districts of Iran. As long as simple mining techniques were profitable there was no need to change anything at this system which had been developed since the Iron Age.

Lead, Silver, and Zinc

Lead, silver, and zinc ore deposits are also found everywhere in Iran and count among the most important metal raw materials of the country: we find the deposits in basically younger palaeo- and mesozoic layers, e.g. in carbonates (lime and marl) from the Lower Cambrian, from the Devonian, the Permian, the Triassic Age, and from the Cretaceous Age (see essay by Momenzadeh). In contrast to the copper deposits, they are only very seldom accompanied by volcanic rock, therefore they are also found in other geologic-petrologic zones. The most important areas are in the Malayer-Isfahān ore district, which stretches from Arāk to the Southeast as far as Isfahān, or in the Alborz Mountains North of Tehrān. However, the biggest zinc-lead deposits of the country are in metamorphic, old Cambrian rock formations at Anguran. Other deposits – like the lead-zinc deposits between Yazd and Bafq – are also embedded in older layers of rock which were moved by mesozoic vulcanism during the Triassic Age. Still today, the zinc-lead pits of Naiband and Seh Changi are working. Lead and zinc are also mined at the well known deposits at Kushk, Tars, or Mehdiabad, East of Bafq – they again are in a stratigraphical sequence from the Upper Jurassic. Finally, the well known deposit at Nakhlak in the region of Anarak exists due to a geological window.

Today, lead, silver, and zinc mining is not only an important economic factor for Iran – the number of evidence of ancient exploitation makes this statement also to be true for the prehistoric period, but mostly for antiquity. E.g. trade in lead is mentioned as early as in sources from the early Babylonian period, when it was coming from Elam and was being traded at Susa. It seems reasonable to suggest that the origin of this raw material were the deposits in Central or South-eastern Iran (Moorey 1994, 293). These deposits are much more numerous than shown by the geological map – reports from the late 19th century show something like a peak of the exploitation of smaller deposits (Helmhacker 1898, 430; Houtum-Schindler 1881, 170; Diehl 1944, 336ff.; Ladame 1945, 276ff.; Bariand 1962/63). Today it is the more difficult to get a reliable overview of the exact number of exploitable deposits of lead carbonate and lead sulphide. Due to its comparably high content of silver, Nakhlak to the Northwest of Anarak definitely counts among the most important – the ensemble there from the 1st millennium AD is impressive. Forts secured two mining settlements and a number of production sites: besides underground mining of galena and cerussite, there are also alluvial mining and smelting sites which have not yet been researched closely (Stöllner et al. in this volume; Stöllner & Weisgerber 2004). The production of lead and silver at Nakhlak might go back as far as to the late 4th millennium, as there is evidence for by provenance studies (see essay by Pernicka). But Nakhlak is not the only site which offers evidence of Chalcolithic or Bronze Age production.

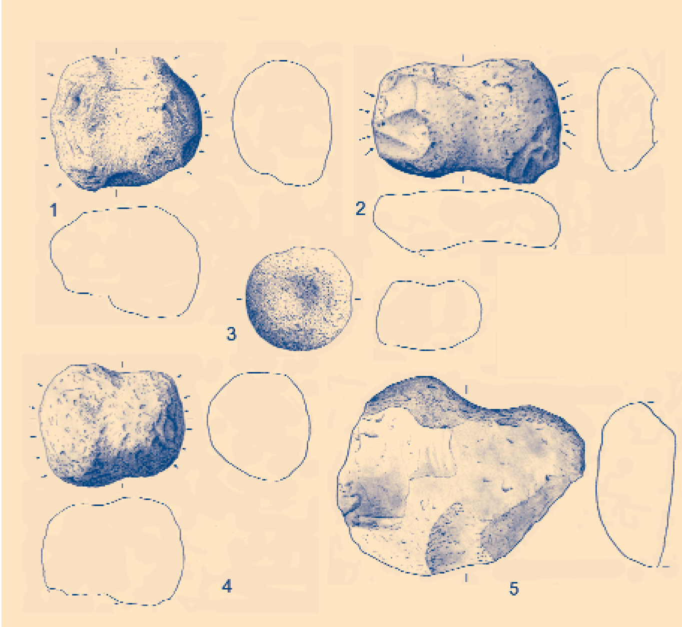


Fig. 6: Shakin, finds of hammers from the heap areas of the prehistoric mines (scale=1:3); drawing: P. Thomas.

Fig. 7: Shakin, underground photography of pick-traces and recesses for lamps; Photo: Th. Stöllner.

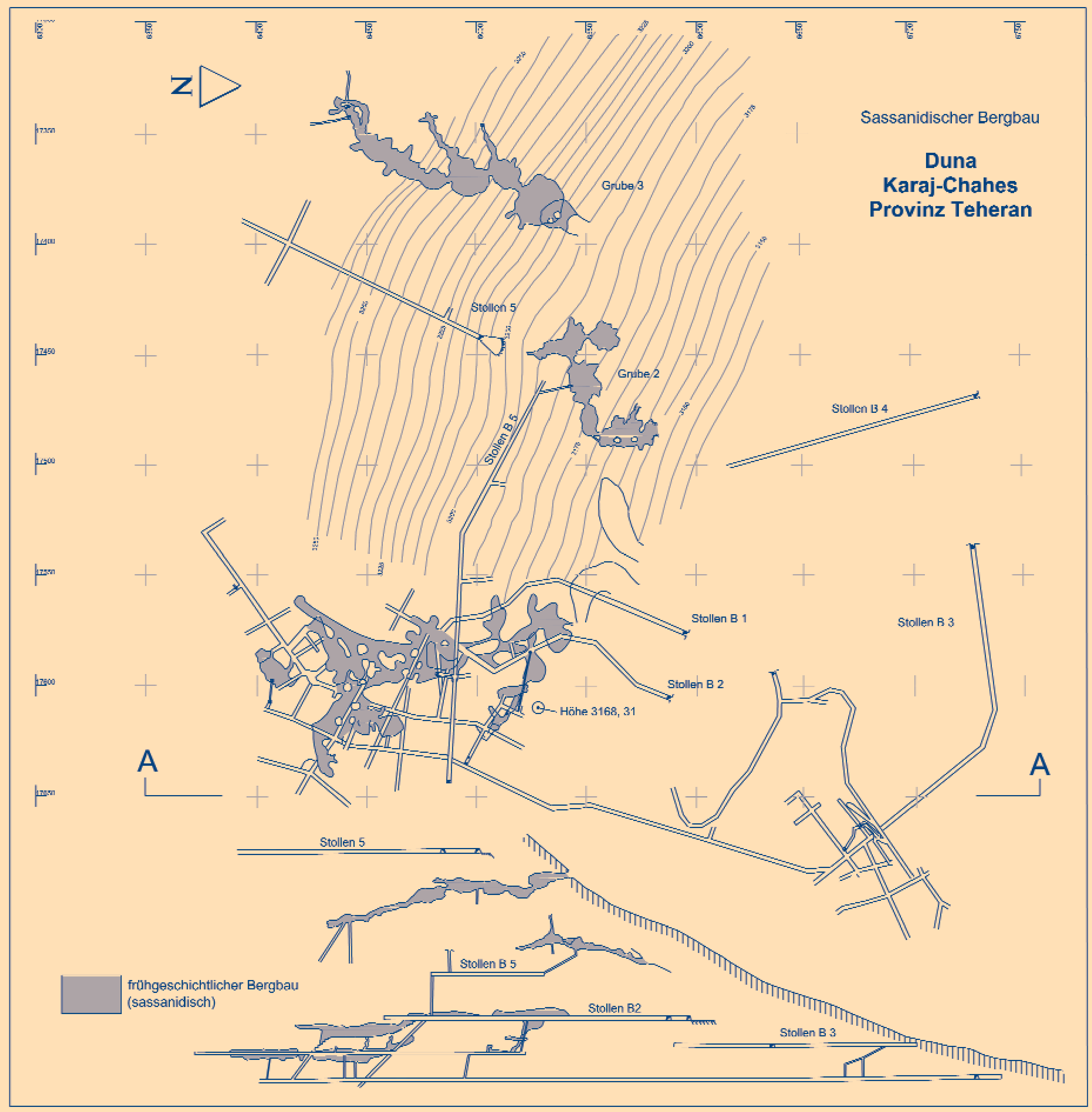


Fig. 8a: Duna, ground plan and vertical section of modern mining galleries with Sasanian mines listed, following sketch by H. Holzer and M. Momenzadeh, total view; realization: J. Garner, DBM.

At Shakin, near Takestan, there is a silver deposit embedded in Permian dolomite (Fig. 5). Sloping, fire set irregular workings, heaps, and finds of grooved hammers as well as of hammerstones clearly suggest prehistoric dating (Fig. 6).Younger mining phases can also be proven, e.g. by drifts and sloping dip workings which were driven by help of fire setting, use of picks as well as of hammer and chisel. This, together with recesses for lamps, suggest dating to a time between Iron Age and early Islamic period (Fig. 7).[5] However, it must be investigated if the production, which was started again in the Iron Age at the earliest, went on until the early Islamic period. Anyway, this kind of mining already seems to have come together with steady settlements and agriculture in a valley

Fig. 8b: Mining close to the surface in the Duna mining district in the year 1978; Photo: G. Weisgerber.

nearby, as there is evidence by settlement mounds in the plain. It is a tempting idea that Shakin might have counted among the early suppliers of lead-silver on the plateau.

Possibly, the high content of silver of the Kuh-e Dom metamorphite of the deposit at Gorgab IV, 50 km East of Arisman, was also exploited very early. The irregular workings in the iron gossan the deposit show every feature of prehistoric mining by help of fire setting are clearly distinguished from some younger mining by help of shafts and sloping dip workings. In the catchment area of Tappeh Hesār and its rich silver finds after the 2nd half of the 3rd millennium there is the deposit of Anaru, about 100 km South of Damghan – fire setting and irregular workings close to the surface as well as finds of grooved hammers are clear indications (Momenzadeh in this volume).

All these deposits around the Kavir desert or at the rims of Qazvin plain, which is favourable for settlement, have probably been

Fig. 9: Anguran, general view including Laal-Maaden (at the ridge of the slope of the left underground mine) and Pb-Zn-opencast mine 2003; Photo: Th. Stöllner.

exploited since the late 4th millennium. This is indicated by the early lead-silver metallurgy at settlements like Sialk, Arisman, or Hesār and is the more likely as the exploited deposits are near the economic areas of those days.

Concerning the deposits of Duna and Elikah, the situation is different as they are in the mid of the Alborz mountains, far away from the ancient centres of settlement. Ancient traces of mining have been described already in the 60s of the 20th century (Diehl 1944, 340f. [Paskaleh]; Holzer & Momenzadeh 1973; Weisgerber 1990, 82f.). In the Duna mine, which was working until recently, ancient mining was met at the N-flank of the deposit: here, zinc, lead, and barium sulphate containing ores were mined by help of rather straight, slightly sloping, hall-like irregular workings (fig. 8a-b) which show the typical traces of fire setting but in some parts also the use of picks. Like the find of a small oil lamp, also radiocarbon dating (Ham 1170: 2σ-intercept: AD 590-870 [95.4%])secures dating to the late Sasanian/early Islamic period.

Concerning this period, there are several indications of the production of silver in Khorasan and Transoxania (e.g. in the famous Panjhir, Weisgerber in this volume) but also around Isfahān, as Ibn Rusta reports at about 900 and Maffārākhā some time later (Allen 1979, 15f.). From this peak of the production of lead, zinc, and silver (Pers. *noghreh*) there comes also the evidence which we know from the area of Seh Changi near Naiband (Sistan) and from Chubanan near Tars (Pleiner 1967, 353ff.). The ore veins of Seh Changi show older phases of exploitation. A vertical shaft seems to date from more recent times. To this belong tailings of crushed drift material from separating the ore as well as huge heaps of slags, giving evidence to the smelting of lead-zinc ore at the place (Pleiner 1967, 354, fig. 5). In the pit of Garkheshti, only 3 km to the Northeast, there is a similar mine, also in combination of double shafts and accomodation structures – enamelled pottery dates it to the early Islamic period (Pleiner 1967, 356, pl. 7, 2-3). In the mining district of Chubanan near Tars, a sloping shaft is reported which was cut by modern mining and is said to have brought numerous finds like small lamps of clay, baskets made of palm leaves and even a mummified miner.

One of the biggest Pb/Zn-deposits of Iran is the pit of Anguran, West of Zanjan – today, zinc is mined there in a gigantic opencast mine (Fig. 9). Only twenty years ago, extended underground mining was observed in the opencast mine, and now and then the miners produced parts of skeletons out of it (Fig. 10), like those of a youth as well as parts of a child, about six or eight years old (Weisgerber 1990, 77) (Cat. no 268, radio-carbonate dating to the 7th to 9th century AD). Reports from the 19th century offer indications of numerous casualties in the Anguran mine; e.g. A. Houtum-Schindler reports: "The present shafts are driven into the rubble of the old pits and are very dangerous and often collapse. It is estimated that every year two or three workers die in this pit" (Houtum-Schindler 1881, 184f.). Just a few years later, J. Mactear reports bad air, insufficient stability of the ground and many deaths in the underground pits: *"... the air was so foul that our candles would not burn. The miners were, however, working 20 or 30 feet lower than this and without lights at all, trusting to their sense of touch to enable them to follow the ore, which they took out in*

Fig. 10: Anguran, fragment of an adult's skull from the underground mine, collection of the Geologic Service in Tehrān (GSI); Photo: DBM, M. Schicht.

skin bags, hauling them up behind them as they scrambled out of the burrow, for this is the only name one can give it. Many deaths have occurred from the bad air ..." (Mactear 1894-95, 11).

All these structures prove the intensive exploitation of the Pb/Zn-deposits since the Iron Age at the latest and particularly in the Sasanian and early Islamic period, silver, lead, or zinc being in the focus of exploitation, depending on the deposit.

The Chubanan area (Marco Polo's Cobinan) has become famous mostly for producing *tutiya*, that zinc oxide which was traded as a demanded remedy for eye diseases at the time of Marco Polo's visit in the 13th century. But mostly, *tutiya* was used for the production of brass, which was very popular particularly in the early medieval Islamic world as a "golden yellow" alloy of copper and zinc.

The production of *tutiya*, an artificial zinc oxide, has been well reported by Arabian *writers*, but also by Marco Polo. The residues of this specialized production are found in certain parts of Iran, in some amounts mostly Southeast of Yazd and Northeast of Kerman in the ore district of Tars and Kushk. Often they are huge heaps of fingerthick, broken rods, like they are reported from Kushk, Savand near Tars, or Dah-Qala Southwest of Kerman (Pleiner 1967, 364ff., pl. 10, 1-2; Allen 1979, 39ff.) (cat. no. 538); analyses by J. Barnes (1970) showed a significant enrichment of zinc oxide at the surface of these rods. This indicates a sublimation of the volatile zinc oxides on the surface of small rods of sand or clay in special, long furnaces at a temperature between 800 and 1130° C, as it is reported by Iranian and Arabian authors (Al Birdānā, in the 11th century; al-Muqaddasā in the 10th century; Al-Hamdāni in the 13th century, and Marco Polo). Still today it is unclear in which way these rods were stacked (e.g. on a kind of iron grill). Concerning processing, there are contradictory reports, maybe indicating a second, very different way of processing which might have worked without sublimation of the oxides (detailed: Barnes 1970; Allen 1979, 40ff.; Craddock et al. 1990). It is also unclear if only lead-zinc ores, e.g. galena or sphalerite, were used for the production of the zinc oxides or if also polymetal ores of copper sulphide with a higher content of zinc were used.

Anyway, the product must have been widely popular, Persian tutiya was exported to far away places, probably due to its healing power: in the year 990, a small bottle of Persian tutiya is said to have been taken as far as to the Chinese emperor's court via Canton (Gabriel 1963, 162, annot. 6).

Gold, Mercury, and Arsenic

In Sumerian sources, gold (pers. *sar*) coming from Iran is mentioned after the 3rd millennium BC, e.g. from the country of Aratta (Pettinato 1972, 79). This information may perhaps be refered to gold deposits in Kerman (on identification: Majidzadeh 1976). *E.g.* Strabo reports the river Hyktanisin in Carmania as being rich in gold (Kerman: Wulff 1966, 13). Also from the West of Iran there are several reports on gold, both from the late 3rd millennium BC (report by Shu-Sin: Moorey 1994, 220) and in Neo-Assyrian sources concerning the territory of the Medes. On the other hand, Darius's building inscription at Susa mentions the origin of the gold, which was used for building, from Baktria (alluvial gold from the Oxus/Amu Darja) or from Sardis (river Patoklos: Ramage & Craddock 1999). Particularly the gold from the Oxus and its neighbouring rivers was famous at all times for being very economical (Allen 1979, 3f.).

From the metal-genetic view, gold exists as two completely different types which are also the basis for the way of its production: first, pre-Cretaceous, palaeozoic, plutono metamorphic deposits and, second, epithermal gold which in the late Tertiary was deposited in volcanic and sedimentary surrounding rock, together with copper containing deposits. Thus, the production of gold happens as a by-product of the production of copper, mostly since the Modern Age when modern techniques of processing allowed a better separation from copper (e.g. Sar Cheshmeh in Kerman, Qaleh Zari in Sistan, or in the district of Ahar).

In contrast to copper ores and lead-silver ores, classical production of mountain-gold is relatively rare in Iran; altogether, M. Momenzadeh counts 13 evidences of ancient, pre-Modern Age production of gold, besides those places whose names refer to this precious metal (Momenzadeh & Sadighi 1989; Momenzadeh in this volume). Regular production of mountain-gold is completely different from the production of river-gold which was mostly done with alluvial gold at rivers (Weisgerber 2001, 38). The gigantic heaps of overburden, which were piled up to some hundred metres at Zarshuran ("Place of Separating Gold") and Yar Aziz, Northwest to the famous Takht-i Suleiman (Fig. 11), show the efforts which were done to get to the gold containing sands. Obviously, bigger amounts of river-gravel and pebbles had to be removed from the riverbed. Maybe this was done every spring, when meltwater had again deposited amounts of sediment. As also reported from Baktria (Ibn Khurdādhba; Nasīr al-Dīn Tūsī: Allen 1979, 7), the gold itself may be supposed to have been produced by help of the usual separating benches, basins and sheepskins. From the place of Chah Baq in the gold district of Muteh this traditional way of production is reported as late as from recent times – there also in combination with the production of mountain-gold as a kind of wet processing (Wertime 1967, 329; Pleiner 1967, 342ff.).

Also due to another reason the well known gold district of Muteh (probably the ancient al-Taymara: Allen 1979, 4) is worth mentioning – here, there is one of the richest gold deposits in Iran; up to 35 kg of gold are said to have been produced out of one ton of rich ore. Several pit districts with claybed mining of the gold containing drifts are reported. Finds of lamps, iron picks, and finds of pottery are clear indications for dating this phase of production to the Sasanian and early Islamic period (Pleiner 1967, fig. 1-3). But what is particularly numerous is the goldmills which were found on the heaps in front of the mines – they always show those typical, concentric grooves. Probably, single goldmills from Muteh were later fixed to the rotational axis by help of flat, iron pegs – probably due to intensive use. Such goldmills may be considered a definite indication of the fact that drifts in mountain-gold deposits contain quartz. Concerning Iran, they are known from several prehistoric deposits: from Khoynari in Azarbaidjan (Weisgerber 1990, fig. 10, 1; here fig. 12), from the so called Maden Kharabe North of Zarshuran (Weisgerber 1990, fig. 6, 2), from Kuhzar in Semnan (unpubl. report by Momenzadeh), or from Zartorosht in Southern Kerman (Momenzadeh 2002, fig. 4). From Zartorosht there also exist grooved hammers, indicating prehistoric mining.

The numerous goldmills prove that the gold containing quartz-sands were finely ground, and it may be supposed that in many cases further separation was done by help of water. It stays unclear when production by help of mercury (pers. *simab*), the so called amalgamating, was done for the first time in Iran; early Islamic sources, anyway, know this method (Al-Hamdāni: Allen 1979, 1ff.). In nature, mercury sometimes appears in the form of small metal drops but mostly it is condensed from the steam of roasted cinnabar. Deposits of cinnabar in the Afshar Mountains around Takht-i Suleiman are reported. They are said to be the only ones in modern Iran, besides the rich mercury deposits in Trans-Oxania about which Arabian scholars report (see ibid.): at Zarshuran, Yar Aziz, and Shirmard there is native mercury or cinnabar in the river or in the surrounding hills of alluvial sand; also it is said to be found in the form of pure metal in the basalt rocks near the villages of Kiz Kapan, Karakeya, and Sandjud (Houtum-Schindler 1881, 188; Diehl 1944, 347f.; Ladame 1945, 268; Tardieu 1998,

Fig. 11: Zarshuran, Yar Aziz, separation heaps from prehistoric gold production; Photo: Th. Stöllner.

part. 253ff.). Thus, it is reasonable to suggest a centre of gold production and of working with metal in the surroundings of the Sasanian and early Islamic crafts-centre at Takht-i Suleiman (the ancient Shiz). Thus, at Khoynari in the district of Ahar, where cinnabar or metal mercury do not exist, the existence of mercury in the ground is the more suspicious and may be supposed to be actually related to this extremely unhealthy way of production (Weisgerber 1990, 80).

But the Afshar Mountains are also known for their deposits of orpiment and realgar (Titze 1879, 589f.; Diehl 1944, 348f.; Ladame 1945, 191ff.). According to finds from Takht-i Suleiman, it was mined and stirred to a paste for being used as a hair remover or as yellow colour as early as in the Middle Ages. In those days, orpiment from Azarbaidjan was a demanded product of trade and was sold as far as in Istanbul. Regular mining of arsenic ores is known from Valilu, North of Tabriz at the road to Ahar. According to a radiocarbon dating of the well preserved pit-finds, it was done at least since the 15th-17th century (Weisgerber 1990, 78; Ham 1169: 2σ-intercept: AD 1400-1640)

Fig. 12: Khoynari, Azarbaidjan, goldmills; Photo: G. Weisgerber 1978.

Iron

From the 5th millennium, several iron balls are reported from Tappeh Sialk, which are considered meteoric iron. However, the older analyses (evidence of so called Widmanstättsche-structures) have been doubted – possibly it is natural hematite which was used for working copper (sanding down) (Ghirshmann 1939, 206; Waldbaum 1980, 69f.; Pigott 1984, 625). But the use of iron reduced by smelting (pers. *ahan*) appears in Iran only at the end of the 2nd millennium and is very rare in the period of Iron I. Only after the 11th and 10th century BC iron is more and more accepted and now appears in bigger quantities as metal for tools, weapons, in the beginning also jewellery; also bi-metal weapons are frequent (Iron II, 1100-800/750 BC: Pigott 1984;1989; 1999b). The evidence from the destruction-layer of Hasanlu IVC (9th century BC) for the first time shows bigger quantities with about 2000 iron objects – Hasanlu also shows that now iron was used mostly for functional and military purposes while bronze was used for harnesses and decorative elements (Pigott 1989; 1999b; de Schauensee 1989). By the period of Iron III, iron is generally accepted and is now found in bigger quantities also at the burial fields of Luristan (see *e.g.* Moorey 1991). The increasing use of iron in the West and Northwest of Iran as well as in the Urartean Southeast of Turkey may be related to numerous military struggles with Assyria mostly. Assyria seems to have established a well working iron based economy (Maxwell-Hyslop 1974). Before, there is rather a strong upholding the tradition of bronze and at best the production of irregularly coaled, soft iron on a provincial level – this fits to the situation in Eastern Turkey, in the region which would later be Urartean (Mc Conchie 1998).

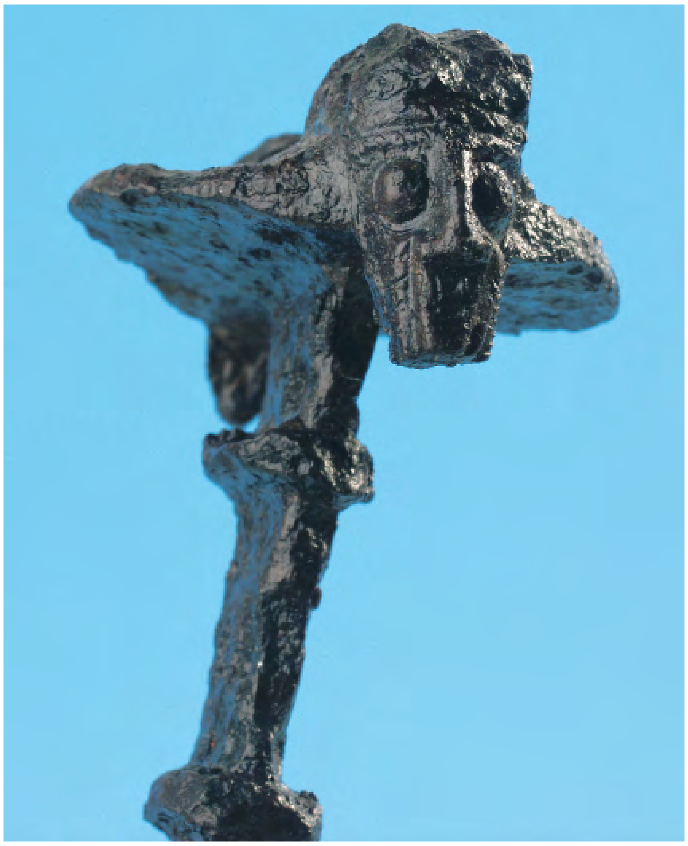


Fig. 13: Iron sword with mask-decoration from the period of Iron II (about 1000 BC); Koninglyke Musea voor Kunst en Geschiedenis (Brussels); Photo: DBM, M. Schicht.

Concerning this, particularly the swords with mask-decoration are conspicuous which exist in bigger numbers from Western Iran (Luristan) and are dated to the 11th and 10th century BC only by their style and by radiocarbon-dating due to the lack of appropriate finds (Fig. 13). These swords are technologically outstanding pieces: the three-dimensional mask was not cast but probably carved by help of hardened chisels and then applicated to the handle like other decorations (Hummel 1974; Moorey 1991; Rehder 1991; Pigott 1999, 92f.).

However, concerning these outstanding finds there are hardly any further analyses concerning the metallurgy of the earlier periods (Pigott 1984; 1999); at best they show that high-quality steel was more usual only in the post-Achaemenid period, i.e. due to trade with Trans-Oxania which in the Parthian period was done via Merv (today Turkmenistan, 2nd century AD: Pigott 1984, 628). Just like in the early Islamic period, its centres may be supposed to have been in Ferghana (today Uzbekistan), in Baktria as well as in Eastern Khorasan (today Afghanistan). E.g. Ibn Hauqal reports the export of steel-cakes from Herat to the West (Allen 1979, 66f.). Also the famous Salmānī-swords, probably made of damascinated steel, may be supposed to have come from Trans-Oxania and to have been traded further via Iran. In this period a number of sword types is mentioned referring to their iron-steel alloy, e.g. by Al-Kindī (Allen 1979, 82ff.).[6] But the numerous sources from the early Islamic period also show another fact: In Iran, a lot of innovative centres of working with iron products have developed (Allen 1979, tabl. 13-14), *e.g.* for protective weapons in the ancient royal city of Gur (Firuzabad), arrowheads at Damavand, scissors at Ray, or polished (steel-) mirrors and vessels for incense at Hamadan (Pigott 1984, 628). These products were traded both in Iran and far beyond. The iron products of this period are hardly inferior to those made of non-ferrous heavy metals or to pottery products (Allen 1979; 1982). This impressingly shows the special esteem of crafts in the towns which partly go back as far as to Achaemenid times; probably, this specialising goes back even farther than the sources make possible to see. Thus, the differentiated Pahlavi-expressions for iron-craftsmen in the Sasanian period are speaking: Besides the *ahangar* (smith), e.g. the *ahan-paykar* is reported, someone who was able to make cast iron. Thus, in the early Islamic period three kinds of iron are generally reported, besides *fuladh*, probably fine steel, there is also *shaburqan*, probably cast iron, as well as wrought iron, some soft mixed steel which is called *narm-ahan*. Also, the contribution of the metal-centres of Iran to the development of damascinated steel was probably not small, which in Marco Polo's account of his journeys is reported as *ondanique/Andanicum* from Kerman and Chubanan (Marco Polo I 17, 21).[7] According to the sources, by the Mongolian period a certain shift of the iron-based economy to North-western Iran or rather to Hormuz on the Persian Gulf seems to begin (Allen 1979, 66ff.).

Though the development of some specialised iron-steel crafts in Iran can be sketched – if including some gaps – our knowledge of the primary production of iron is insufficient; before the Islamic period the production of iron is completely unclear, away from single slags like at Hasanlu (Moorey 1994, 280; Pigott 1989; Cat. no. 370). In NW-Iran, in the pit district of Andab Jadid, G. Weisgerber was able to document the remnants of smelting by the shaft furnace method – this is suggested by the numerous blocks of slag which indicate shaft furnaces with slag pits; the constructions date from the 9th-5th century BC was surprising and can be regarded as one of the oldest Iron smelting sites in the Middle East (radiocarbon dating see Cat. no. 374). Also, well dated mining archaeological evidence is lacking for the time being.

Concerning the 1st millennium AD, the situation is better: concerning the Parthian-Sasanian and the early Islamic era, some evidence can be named, indicating extended exploitation of local iron deposits. Altogether, Momenzadeh (in this volume) describes four zones of different ore genesis in mesozoic or metamorph, palaeozoic contexts; concerning this, poly-metal deposits with enrichments of iron in the gossan can be distinguished in principle from those mostly consisting of iron ore: for the former it is difficult to decide if mining actually aimed for iron and not for silver (like e.g. at Ahangaran in the district of Malayer) or for copper (like e.g. at Shamsabad near Arāk). A pit in the Kuh-e Qar Lawan, South of Qazvin, is a good example of mining drift-shaped deposits in historic times. There, a deposit, which is limonite at least on the surface, was prospected by help of simple irregular workings, later maybe by help of inclined hading drifts and shafts (Fig. 14). The ore was separated by hand and smelted elsewhere.[8] More extended ore mining was also documented at Holabad near Natanz by the Iranian-German research – surrounding castles from the Parthian period might offer an appropriate reference for dating (Fig 15).

Fig. 14: Iron mine of Kuh-e Ghar Lawan, province of Qazwin: rectangular shaft, sank by help of picks and iron hammers, early historic period; Photo: Th. Stöllner.

Away from such single observations, systematic work on primary production of iron only exists from the old expedition by Th. Wertime: At Haneshk, about 60 km North of Pasargadae, R. Pleiner documented an early historic iron ore district. Drift-shaped hematite ore was mined in several mining claims. After this, the ore was further processed in shaft furnaces with bellows in the valley of Cheshmeh Gol. The well run slag from the shaft furnaces gives evidence for good redox-conditions in the furnace – the Y-shaped nozzle forks, which were found, suggest a sophisticated ventilation into the furnace (Pleiner 1967, 379ff.). Yellow enamelled pottery, found on the heaps, is said to date the complex to the 11th century AD.

Anyway, the Eastern part of the Fars did not play an unimportant role with the production of iron in the early Islamic period, as there is evidence for by remnants of older mining and slag heaps at Neiriz and Golegohar (see essay by Momenzadeh). Contemporary Arabian geographers report on the quality of iron from Neiriz/Niriz, like Ibn Ahmed al Muhammad al-Idrisi, the Jahán Numá, the Big Turkish Geography, or also Marco Polo in the 13th century (Yule & Cordier 1992, 92f., annot. 2).

There are also indications concerning the iron which was produced at Kerman: Al-Muqaddasī (Muqaddasī, 311), Al-Idrisi (Yule & Cordier 1992, 92) and also Dimasqi´s Cosmography (1874, chapt. VII, 3) mention the silver and the iron which were produced in the "Cold Mountains" between Jiroft and "Bariz" (Bardsir?). Doubtlessly, this means the springs of the Halil-Rud near Rahbour and the Kuh-e Hazar mountains North of Baft. From there, a number of archaeo-metallurgic indications exist (Pleiner 1967, 389ff), *e.g.* several slag heaps with slags from shaft furnaces and hematite ore. Also, more recent research by the archaeologic department of the ICHO shows extensive exploitation of deposits in this region.

Other Ores: Cobalt, Tin, Antimony

The question of tin has again and again drawn the attention of research during the last decades. In Iran, since the early 2nd millennium BC it appears more regularly as an ingredient for alloying bronzes and is dominating mostly in Western Iran (Luristan, early Iron Age-cultures of Northern Iran) in the cultures of the early Iron Age (Vatandoust 1999, tabl. 2). But for the time being it is unclear if it was also produced in Iran. Recently, there has been evidence for tin pits only from Uzbekistan, Tajikistan, and Eastern Kazakhstan; there is heavy debating on appropriate evidence from farther West, e.g. in Anatolia (Kestel) (see most recently: Alimov *et al.* 1998; Pigott 1999, 81f., fig. 4, 5; Weisgerber & Cierny 2002). In Iran itself, tin in the form of kassiterite is extremely rare: there are

Fig. 15: Parthian castle at Holabad near Natanz, province of Isfahān, near an extended complex of iron mining; Photo: Th. Stöllner.

several reports of tin pits in the North of Iran but there has been no definite evidence for one of the reported deposits (e.g. the copper deposit of Anjert in the region of Karadagh) (Mactear 1894-95, 3; Diehl 1944, 347). Only from Sistan there are clearer indications, clearly related to the deposits in the West of Afghanistan, according to more recent geologic reports (Stöcklin et al. 1972). Finally, Stahl reports a tin deposit at Kuh-Benan, Northwest of Kerman (Stahl 1911). For the time being, none of these deposits shows definitely proven ancient exploitation.

Concerning a pre-Modern Age use of antimony from sulphidic antimony ores, the stibnite, the situation is similarly difficult. Written evidence of antimony in Mesopotamian written sources from the late 3rd millennium is heavily debated (see Moorey 1994, 240f.) and is also seriously doubted concerning early Islamic sources, in contrast to arsenic ores, for which there are indications by the use of colours and make-up (see Allen 1979, 55-58).

There is no evidence of ancient mining at the few stibnite deposits of Iran at Shurāb in Sistan, at a deposit near Anarak or at the Kuh-e Sorkh in Khorasan. Thus, we must rather think that the few finds of antimony, like e.g. rings from Assur or from early Iron Age Hasanlu, are made of native antimony from the rich antimony deposits in the Caucasus (see Moorey 1994, 241f.).

Concerning our knowledge of cobalt ores, the situation is better, though they were only used as pigment and not as metal until far into the Modern Age, similar to arsenic sulphides. As "Lāgward Stone", cobalt oxides from Qamsar near Kāshān were an important ingredient for colouring cobalt-blue enamels in the 13th century. Mining-archaeological evidence shows at least medieval, Islamic mining (see essay by Pernicka/Stöllner). Other cobalt sources in Iran are related to nickel several times and are found around copper deposits (e.g. in the district of Anarak); in an ancient copper pit at Meskani a drift of red nickel pebbles is reported which is said to consist of safflorite ($CoAs_2$) and erythrine in the salbands. As late as at the beginning of the 20th century, this deposit was profitably exploited. It is unknown if these deposits were purposefully mined in earlier times (Titze 1879, 626f.; Diehl 1944, 349f.; Ladame 1945, 196f.).

Conclusion

Our view at the knowledge of pre-Modern Age ore mining in Iran mainly showed the fundamental problems of a not systematically researched mining district: most traces of ancient exploitation are not dated and thus cannot clearly be classified as belonging to a certain historic context. The approach of relating deposits and remnants of settlement in their environment to each other, as suggested by several researchers (see Shahmirzadi 1979; Momenzadeh in this volume), is only partly helpful due to various reasons. First, only in rare cases it is possible to state sufficiently that settlements and mining districts were existing in related periods. Furthermore, without archaeo-metallurgic and geo-chemical supporting research it is hardly possible to decide where and in what way certain ores or metals were used afterwards. And finally, the early socio-economic structures of the production and distribution of raw materials around the Central Plateau does not really suggest such relations. During the prehistoric phases and probably until far into historic times, the exploitation of the deposits happened sporadically or seasonally. For the time being, there is no evidence of settlements and long lasting structures in the mining districts before the Sasanian period. Thus, we might rather think of nomadic groups which achieved intensive knowledge of deposits and ores due to their extended nomadic cattle holding, who mined them and also took over their distribution to the markets. This suggestion is indicated by the great significance of those groups for economy and communication between Central Plateau on the one hand and the Zagros-provinces, the Fars, and Khuzestan on the other hand (see essay by Alizadeh; Besenval 1987). Some time ago, P. Amiet already suggested that the wealth in metal finds among the burial finds in Luristan might have mostly been based on such exchange with the deposits on the Central Plateau (Amiet

1986) – just think of the few metal deposits in Luristan and Kermanshah. In various regions of Iran, wandering metal-craftsmen have been a common sight until modern times. Thus, we know the Sibbi in Khuzestan and the Kuli-smiths (Wulff 1966, 35, 48f.); single tribal groups, like the Bakhtiari tribes, are considered possessing special knowledge of metallurgy (see essay by Alizadeh). But the economic situation cannot similarly be judged concerning the complete period after the 5th millennium BC, as it was mentioned here. After the 1st millennium BC at the latest there was an increasing stately control of traditionally organised mining and metallurgy, something which is mirrored by increasingly steady structures in the mining districts. Thus, now the smelting is done at the place and settlements are steady. In some cases, also military structures are found (see e.g. Nakhlak: Stöllner et al. in this volume; Stöllner & Weisgerber 2004). In the course of time, also changes of mining-techniques are indicated, as suggested by a systematic view at the mining-archaeologic evidence. Of course, this technical development must also be embedded into social and economic basic conditions. Thus, today it is possible to describe at least three technological steps of the development of mining and metallurgy:

1. In a prehistoric phase mining is done mostly by fire setting and crushing work (fire setting, pick-work) while at the deposit there is dry processing and ore-concentration. The pyro-technical processing is done at the settlements (e.g. Arisman, Tappeh Sialk, Tal-i Iblis).
2. After the end of the 2nd millennium BC, early historic development leads to a shift of smelting to the deposit, mostly due to the metallurgy of iron. Now, types of metal tools are introduced which are used together with the traditional methods. Iron picks make the extracting of ore possible and allow the systematic clearing-out of deep vein deposits by help of building ventilation and drawing shafts. The find of a punched iron pick in the Urartean fortress of Bastam (8th century BC) gives evidence to the early introduction of such types of tools (Weisgerber 1982; Cat. no. 257). Probably since those days there was the use of oil-lamps for underground lighting (Fig. 16).
3. By the 1st millennium AD (Parthians, Sasanians, early Islam), mining gets technically perfected by large scale mining, partly under control of the state. Steady settlements at the deposits develop. In single cases, also military sites for protecting the exploitation are built. Improved knowledge of tunnel lining also leads to the development of efficient water management by help of Qanat-technique which on the other hand makes steady crops possible.

Hopefully, this rough scheme will be developed and secured by new technological details. For the time being, it is mostly unclear if and when breaks of development, peaks or decline of productivity must be awaited. The question if the decline of settlement activities on the Central Plateau at the end of the 3rd millennium and at the beginning of the 2nd millennium led to a decline of metal production, must be doubted, at least according to the dates from Veshnāveh (Stöllner et al. in this volume).

According to the number of evidence, a peak in the Sasanian and also in the early Islamic period is indicated. This is mirrored by numerous mining-archaeological evidence, mainly concerning the production of iron and silver, but interestingly there is only restricted evidence in the descriptions by Arabian authors of the 10th-13th century. This is the more surprising as several of these authors came from the country.[9] Several reasons may have caused this. It is reasonable to suggest that most of the cosmographies compiled knowledge from older works, which are lost today, and thus only restricted knowledge was reported (e.g. in the case of Al-Hamdānī, who spent most of his lifetime at Sanaa). Thus, the mentioned silver production at Darfarid near Jiroft in Kerman (Muqaddasi, 311; Dimasqi 1874, chapt. VII, 3) is hardly imaginable to refer to real exploitation of a deposit, may be it is rather about extended silver toreutics in these towns, being supplied from various sources. Also, the news about the rich silver deposits of Balkh (Panjhir valley) are found again and again, like those about steel production in the Margiana/Ferghana. Both are definitely correct (see essay by Weisgerber) but as a topos this is probably exaggerated. The rare mining-archaeological evidence from Iran, which for the time being has only been presented in parts, shows numerous early medieval evidence both of lead-silver production and of iron production. The production of copper may also be supposed to have played some role in the early Middle Ages and the high Middle Ages, as shown by mining-finds e.g. from Kerman (Naku near Sirjan; Sheikh Ali or Bardsir-Tal-i Homi) or from Azarbaidjan. Conspicuously, detailed information about it is lacking in literature. E.g. in the Hudud al-Alam,[10] 28, it says: "Kerman, here there are numerous mountains with gold, silver, copper, lead, and magnetite". Even concerning the well documented early Islamic period, most of those indications are too general for further interpretation. For the time being, a lot of mining-archaeological evidence in Iran stays unresearched and its relations concerning the history of economy are only to be seen in outline. But there is no doubt that it offers a fundamental contribution to Iranian history and culture.

Fig. 16: Different lamps from early historic mines at Darreh Zanjir (Yazd) and Mansurabad, collection of the Geological Service in Tehrān (GSI); Photo: DBM, M. Schicht.

Notes

1 I express my thanks especially to Dr. M. Momenzadeh, Tehrān, and to Prof. Dr. G. Weisgerber, Bochum, for numerous suggestions, discussions and advice.

2 In contrast to higher contents of nickel, nickel-arsenites or the minerals algondite and domeykite are not very prominent among the phases of poly-metal ores in the region of Anarak: Bazin & Hübner 1969, 66f.

3 The question of arsenic alloys is a bit complicated and still today it has not clearly been answered if arsenic was added only from the original ores or also as an alloying agent, on this see Hauptmann et al. 2003, part. 200f.: here in the 3rd millennium, the evidence of speiss shows the additional melting of arsenopyrite and suggests arsenic ores to have been added to the melted copper – but if this is the fact, arsenic will be unsuitable as an indication of the origin of the copper ores. Also at Arisman the existence of speiss was proven: Hezarkhani et al. 2003, 27f.

4 E.g. the Arisman furnace, excavated in the year 2000, shows relations to the draught furnaces of the Fenan region (trench D). The technique of cupellation for the production of silver also spreads in this period (see Hess et al. 1998).

5 Generally, oil lamps are an important indication for dating the pit; probably, vegetable oils were burned. Until modern times the so called Roghan-e Mandab was used for lighting the pits at Nakhlak, which was made of a local plant, as the local people told us. For this, special leather pots were made which allowed exact portions of lamp oil.

6 On the origin of iron raw materials according to written sources see: Allen 1979, 66ff., tabl. 13.

7 Ondanique is also reported by al´Idrisi and Avicenna and is related to appropriate high quality steel from India, see the detailed explanations at Yule & Cordier 1992, 92ff., annot. 3.

8 Due to the fact that it was a short visit, the pit could not be descended into; the colleagues from Tehrān University were friendly enough to show us the spot, something for which Mr. Abbas Nejad, doctoral candidate at Tehrān University, deserves our thanks.

9 The author was able to visit the area several times in the year 2003; the area shows a number of smaller copper and iron deposits but I could not find any lead-/silver deposits. I like to express my thanks to the Geological Service Kerman as well as the ICHO Kerman/Jiroft, Mr. Pas as well as Mr. Soleimani and Mr. H. Tofighian for their advice and help.

10 Due to his restricted knowledge of the local lead-/silver production, Blanchard 2001, 33f. gets to the misleading idea that neither in the Sasanian nor in the early Islamic period there was a production of silver in Iran which is worth mentioning.

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Decorative Stones in the Ancient Orient (Lapis lazuli, turquoise, agate, carneole)

Gerd Weisgerber

On the settlement mound of Yarim Tappeh in Iraq, dating from about the middle of the 6th millennium BC, beads made of azurite, cornelian, rock crystal, and turquoise were found (Moorey 1994, 77). As none of these minerals autochtonously exist in Mesopotamia, there is the question where these decorative stones came from. Besides Anatolia, several mountain chains with ore deposits, like Zagros, Alborz, Hindukush a. o. surrounding the Iranian Plateau, are just right to have been the sources. But with the exception of turquoise and lapis lazuli, ancient Persia did not have any interregionally considerable deposits of decorative stones. Even the one supplying lapis lazuli is located in the farest Northeast in what is Afghanistan today.

Also al-Ta'alibi at the end of the 1st millennium (961-1038) was of the same opinion, as for each kind of decorative stone there were prominent places of origin: *"Turquoise is only found at Nishapur. ... Turquoise from Nishapur counts among the valuable precious stones, like Jaqut (Corundum) from Ceylon, the Pearl of Oman (here: Persian Gulf), the Zabargad (emerald) from Egypt, the cornelian from al-Jemen, the bigadi (garnet) from Balch, the lal (ruby) from Badachschan, the onyx from Zafar and coral from Africa"* (Wiedemann 1969, 242).

What makes turquoise and lapis lazuli so special is their incredibly long history of mining, manufacturing, and esteem. This is partly due to the blue colour of both kinds of jewellery, as it is conspicuous that after red having been popular during the Old Stone Age and after the green of the New Stone Age blue became the preferred colour of the 3rd millennium Bronze Age in the ancient Orient. Perhaps, already in those days this colour was thought to protect from the evil like it is still the case in the countries round the Mediterranean and as far as to Iran. Today, the levels of meaning of jewelry, amulet, talisman, valuable object, and symbol of prestige can only in single cases be distinguished from each other.

Fig. 1: Sar-e Sang, view at the massive with the lapis lazuli deposit. View from the central Kohe Madane Surb to SE across the Koktcha valley to Sar-e Sang at the group of trees (at the bottom half-right position) and on Kohe Lajaward. The peak of Kohe Lajaward appears in front of the 5698 m cliff of Kohe Shake Safed; Photo: Kulke 1973.

Lapis Lazuli

The occident owes its knowledge of the origin of this stone, from which mostly during the Middle Ages the pigment of ultramarine blue (= "from beyond the sea") was produced, i.e. Badakhshan in Afghanistan, to the Venician Marco Polo: *"In the same country there is another mountain where stones are found from which azure of the finest quality in the world is made. Like silver, these stones come from veins"* (Polo 1958, 76f.).

Among gemmologists and archaeologists, lapis lazuli is the most famous product from Afghanistan. It is found on the river Koktcha, a tributary of the Panj/Amu Darja, high in the Hindukush mountains.[1] The minerals lasurite, sodalite, and afghanite are responsible for its cornflower blue colour (Bariand 1979; Bariand et al. 1968; Wyart et al. 1981).

The mountain of the deposit is called Koh-e Ma´din (=mountain of the mine), it is the outermost spur of the Koh-e Lajaward (lapis lazuli-mountain). Lapis lazuli is mainly found in a bed of only a few centimetres embedded in marble. Also there is fine crystalline lapis in the form of nests, nodules, and – though very seldomly – in the form of (mixed) crystals. The valley ground, widened by the mouth of the brook is about 2300 m above sea level and is wide enough for the space needed by the small settlement of Sar-e-Sang for seasonal workers and the government's soldiers. The mines are more than 300 m above the valley and difficult to reach on foot or on the back of donkeys (Lapparent et al. 1965; Kuhlke 1976). Today, extremely steep heaps of tailings run down to the river. For the year 1968 the total amount of production was quoted to have been 10 t (Herrmann 1968) (Fig. 1 & 2).

Fig. 2: Sar-e Sang, view into the cleared drift of pit 4; Photo: G. Bowersox, Gem Industries, Hawaii.

Concerning the oldest prehistoric periods when this stone was already used (5th millennium BC), we may perhaps presume that most of this decorative stone was gained by picking it up from the debris at the slopes and by searching the pebble stones in the river. Such picking up might also explain the minor quality of the one or other piece of lapis lazuli, such as the decorated axe from Troy. Within the mountain itself, there would probably have been better material to be exploited. But it may also be that by choosing the best pieces on the some thousands of kilometres long journey to the West the stones lost more and more of their quality. Anyway, in prehistoric Persia the quality is still outstanding (Fig. 3).

Lapis lazuli from Afghanistan was already exported to Neolithic Egypt. Younger is the sensational find from Abydos, where in 2003 in a clay bottle 6.5 kg of lapis lazuli were discovered.[2] But the peak of its use is in Bronze Age Mesopotamia. Though in the Indus culture of the 3rd millennium lapis lazuli is used it seems that it did not play an important role there. For the time being, the manufacturing of this decorative stones into beads in Mehrgarh in Southern Pakistan stands isolated: the earliest traces at all of such activities (Tosi & Vidale 1990). Obviously, the blue decorative stone from the Hindukush gained such a significance for its owners' prestige on the Euphrate and the Tigris or for those who donated it that people made every effort to take hold of it from distant lands. Besides for beads, the blue stone was often and skillfully used for mosaic-like inlays like the famous Standard or the Harp of Ur, even if it seems as if not the best quality was at hand or provided for this. Rulers had themselves depicted as small statues of the noble material (Moortgat-Correns 1967). Obviously, this meaning reached as far as to Troy in the West of Anatolia. For a decorated axe made of lapis lazuli, which was already found by Heinrich Schliemann, together with two more axes of jade and jadite it also served for their owner's image and prestige. The fact that great amounts of lapis were imported is evident from a newly published text from Tell Fara (the Sumerian Shuruppak in Southern Mesopotamia) from about 2700 BC which tells about donkey-loads of 70 kg of lapis lazuli (Steible & Yildiz 2000). From the 2nd millennium BC there is a depot of 27 raw pieces at Mari/Syria (Pinnock 1988; 1990). The role of the Iranian Plateau, of its people and its towns as mediators of the goods of the East and the Northeast towards the West becomes obvious.

In the 3rd millennium BC the way of the blue stone from the Northeast of Afghanistan to Mesopotamia via the Iranian Plateau can easily be recognised by the findspots of raw material, waste from workshops, and readily manufactured products. Most sufficiently researched was the manufacturing of the imported blue stone into beads for necklaces at Shahr-i Sokhta. There, complete sets of flint blades, drills, rejected semi-finished products, and appropriate waste had been found (Bulgarelli 1977; Bulgarelli & Tosi 1977;

Fig. 3: Mari, Syria. Eagle-amulet with golden lion's head and wings made of lapis lazuli, height 12.8 cm, about 2650 BC, Damascus Museum (1993).

Casanova 1992; 1999; Piperno & Tosi 1973; Tosi 1974a) (Fig. 4). Rough lapis lazuli was cut by help blades, separated by beating, formed into small prisms and then pierced by help of pointed flint drills before being ground and polished to cylinders. Due to the author's observations, Tal-i Iblis/Iran can be added to the trade posts which have been known for longer time (Herrmann 1968; Tosi 1974a; 1976a; Delmas & Casanova 1990). From this it can be deduced that at least in the 3rd millennium BC the production of beads was done at each place more or less for own or local demand. Mainly the raw material itself was traded to the West.

Fig. 4: Shahr-i Sokhta, tools from a lapis lazuli-craftshop: flint blades for saws and drills, waste and beads; Photo: G. Weisgerber 1976.

Fig. 5: Sarazm, Tadjikistan. Beads and jewellery from the excavation (Pendzikent Museum).

Then in Mesopotamia and in Egypt the demanded products were manufactured from it at the place.

In the Bronze Age settlement of Sarazm in the valley of Zerafshan in Central Asia and in its graves necklaces made of numerous lapis lazuli and turquoise beads were found. It is easy to imagine that the dark blue beads had been swapped from the upper Koktcha valley, which is not really far away, for local turquoise beads (Fig. 5) (Isakov 1981). In the 2nd millennium BC the stone played a minor role. Because of this the about 6 cm high dove of lapis lazuli from Susa shall particularly be pointed out to. It is decorated with round gold inlays (Amiet 1966, 435, fig. 25; Ry 1969, 124) (Fig. 6).

In Iran, lapis lazuli was highly appreciated again since the Achaemenid period, as shown by the numerous works of art. Darius I in his inscription on the building of his palace at Susa names the province of Sogdiana as the origin of lapis lazuli, which in those days included Badakhshan (Derakhshani 1999).

Fig. 6: Susa, Iran. Torso of a dove made of lapis lazuli with gold inlays (Musée de Louvre, Paris).

Turquoise

Turquoise is a porous copper-aluminium-phosphate with a degree of hardness of 5 to 6, thus it is much softer than quartz (Mohs-hardness 7). Its colour ranges from sky blue to grey green, and only the best quality is "turquoise blue". It resulted from copper containing hydro-thermal solutions intruding into fissures and hollow spaces from sediments and volcanic rocks which were rich in aluminium-phosphate and then hardening mostly in the form of a many-branched network of plates and nodules neighbouring copper deposits. Turquoise of precious stone-quality is hard and shows only few pores as in the course of its creation it was stabilised and the pores were closed by silicic acid. Iran still is the main supplier of the highest quality.

The Persian name *(Firuzeh)* means the victorious. Our name turquoise was invented in France as late as in the Middle Ages when the Ottoman Empire mediated trade of the "Turkish" stone. It is and was the most valuable non-transparent mineral in jewel-trade. No other stone is and was valued in so many cultures as protective stone or talisman.

Essentially, for the ancient Orient there were five turquoise deposits at hand which were on the Sinai peninsular, in Iran, and in Central Asia (Fig. 7). As turquoise resulted in connection with copper deposits, there may well be more deposits being known as copper deposits but which have not yet been noticed to be also deposits

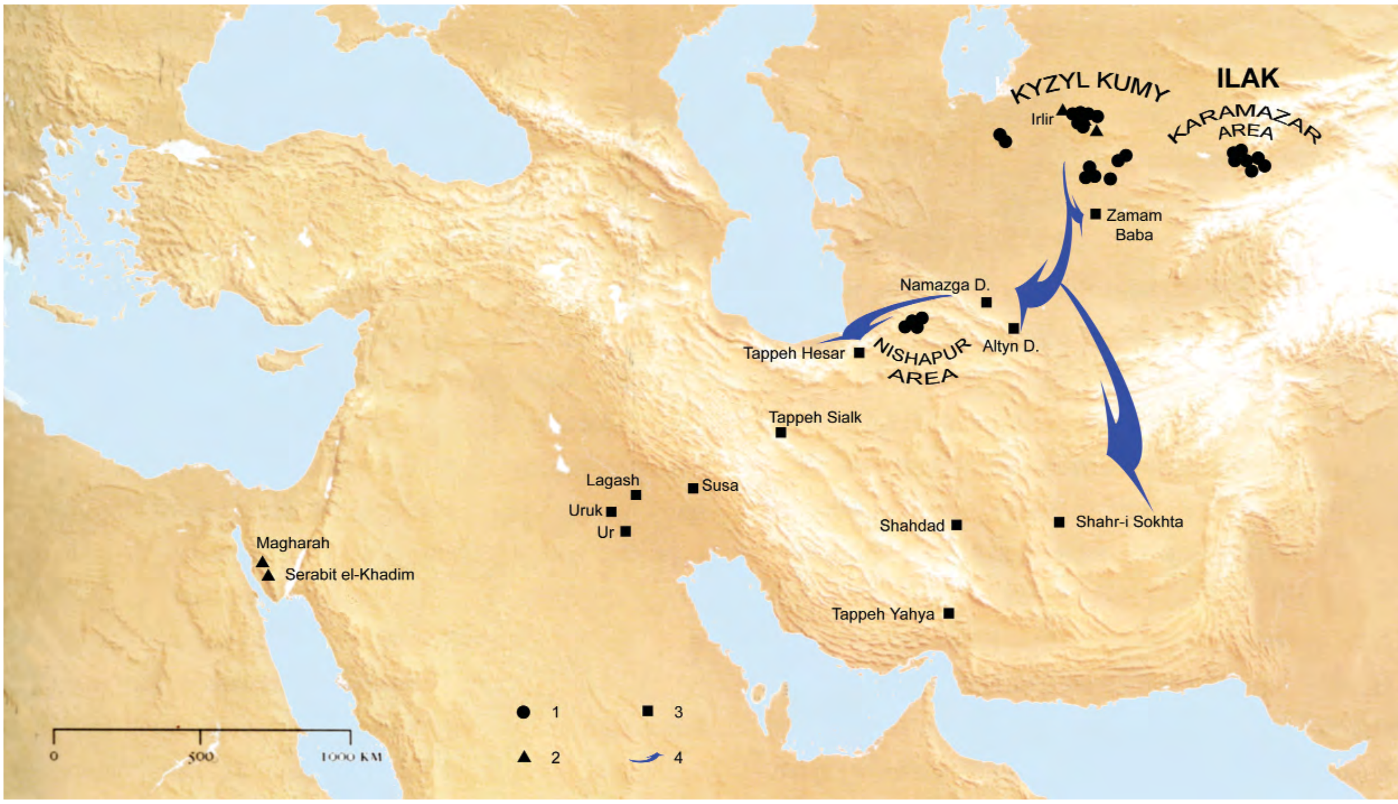

Fig. 7: Map of main turquoise deposits in Egypt and Asia with possible directions of trade. 1 Turquoise mining according to historic sources; 2 mines from the 3rd millennium; 3 important sites from the 3rd millennium and their functions for trade;, 4 presumed ways of turquoise trade (Map: DBM; after Tosi 1974b).

Fig. 9: Maghara on Sinai, view at the steep cliff with heaps and openings of the mines.

Fig. 10: Nishapur, ruins of a multi-levels mine; Photo: G. Weisgerber 1976.

of turquoise, such as the one at Kuh-i Dashak South of Herat in Afghanistan.

Sinai-turquoise was systematically exploited as early as in the Chalcolithic of the 4th millennium, manufactured at the place (Beit Arieh 1980), and exported e.g. to Beersheba in the Levantine (Mellaart 1966, 28). Later, it was highly appreciated already by the pharaos of the 3rd dynasty, like by Pharao Chephren. They conquered the native "Asian" population and took the mining in the Nubian sandstone into their own hands by sending out special mining-expeditions until far into the 2nd millennium BC. Overwhelming remnants of mining and infrastructure at Serabit el-Khadim and Maghara are still waiting to be researched (Weisgerber 1976; 1991) (Fig. 8 & 9). Unfortunately, the Sinai-turquoise was not very long-lasting, it tended to getting greenish.

Fig. 8: Serabit el Khadem on the Sinai peninsular, two-levels mining chamber; Photo: G. Weisgerber 1976.

According to the information from the clay tablets, Haratta in Iran played an important mediating role for the trade in decorative stones, metals, and precious metals. In Iran there are several turquoise deposits (see essay by Momenzadeh). It seems as if only those of the region around Kerman and Yazd in Central Iran and those in the North around Damghan and Nishapur in Khorasan were of greater significance (Fig. 10). For the time being, no traces of prehistoric and ancient mining have been found anywhere. But archaeological finds indicate earliest exploitation. Both in Iran and in Iraq (Yarim Tappeh), there are turquoise beads at findspots as early as the 6th millennium.[3] In Iran there are turquoise beads from Tappeh Zagheh and from Ali Kosh. Turquoise beads from the 5th millennium were found at Bakun and Tappeh Yahya, in most cases together with those of lapis lazuli. Besides agate and mountain crystal, there is turquoise also on Tappeh Malyan (*Anshan)* in the 3rd millennium, just like at Shahr-i Sokhta and Tappeh Hesār (Fig. 11). The site of Tappeh Hesār is almost neighbouring the Northern deposits. At Shahr-i Sokhta, also the appropriate flint drills were discovered in big numbers. But pieces of turquoise make only 2% of all the waste from the manufacturing of beads, in contrast to the

Fig. 11: Tappeh Hesār, excavated craftshop where turquoise was manufactured; Photo: G. Weisgerber 1976.

90% of lapis lazuli. In the graves, on the other hand, more than two thirds of all beads are made from turquoise, 557 pieces, much more than those of lapis. This might indicate that turquoise came to the towns in the form of finished products, in contrast to lapis lazuli which was manufactured at the place (Tosi 1974b).

Occasionally, turquoise appears also in the Harappa culture and in Bahrein at the Persian Gulf. Also in Iraq there are turquoise beads as early as in the 6th millennium (Hassuna, Halaf, Tell-es Sawwan). In the 3rd and 2nd millennium there are inlays (Telloh) besides beads (Uruk, Nippur, Babylon). On Tappeh Gaura in Iraq there is turquoise in some graves from the Early Dynastic period (2900-2450 BC): besides gold and lapis lazuli beads, the bead necklaces also show turquoise beads of considerable size, often in an irregular shape (Strommenger 1978, Cat. no. 102). A remarkable piece from a later period is a 2.2 x 1.6 x 0.6 cm big inscripted amulet of the Assyrian king Ninurta-apal-Ekur from Nimrud, who ruled from c. 1192-1180 BC (Fig. 12), which shows a second bore hole from earlier use (Ismail & Tosi 1976). The beads in the graves of the famous kurgan of Maikop in the Northern Caucasus from about 2200 BC are to be considered as a findspot very far to the West.

After this time turquoise does not play any big role in Mesopotamia for a long period, but occasionally appears with some beautiful artefacts, such as a votive plaque from Nippur. But from a rich grave from the late Achaemenid period there come two big cloisonné buttons. The dead was lying in a bronze sarcophagus, he was wearing a golden neck ring with lions´ heads at the ends, silver vessels were standing near his legs and the already mentioned buttons were lying on his chest. They are of gold and show inlays of lapis lazuli and turquoise (Amiet 1988, 136). The graves of the Assyrian queens from Nimrud, which were discovered only in 1989, come from the 1st millennium. More than in others, in the grave of King Tiglatpilesar III's wife Jaba there were undreamt golden gifts of jewellery. Many of them are inlaid with turquoise and agates (Damerji 1998). The turquoise inlays in some of the Scythian kurgans, particularly those in the recently discovered grave at Arzhan in Siberia, shall not be forgotten.

In Central Asia the turquoise deposits are concentrated in two regions, first in the area of the desert of Kyzylkum, then in the Karamazar Mountains. The latter are particularly known from written sources of the Middle Age, "turquoise from Chodschend" was a common term. The peak of mining was from 11th-14th century. But about some mining districts it is also reported that they had been given up due to exhaustion of the deposits. In the geological museum at Tashkent, turquoise from Bukantau, Bessopan, and

Garabutan (all in Uzbekistan), and from Birjuzaban (= turquoise village) in Tadjikistan is on exhibition (Fig. 13).

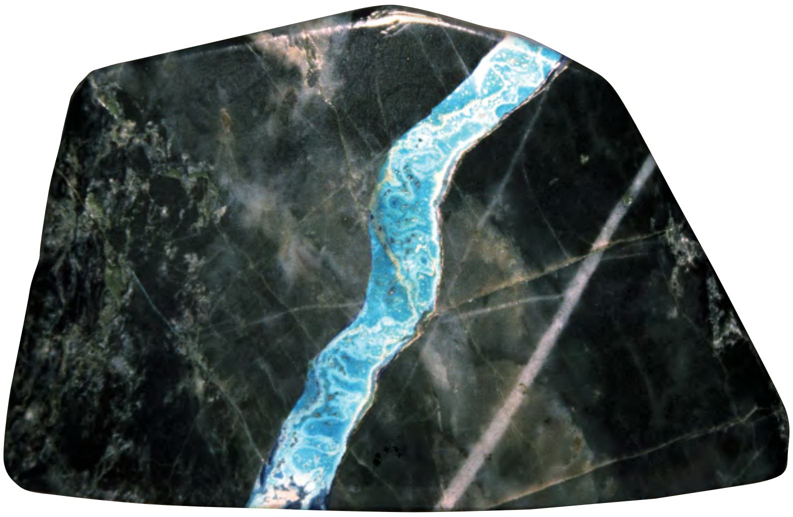

Fig. 13: Turquoise veins in a handpiece from Central Asia in the geological museum of Tashkent (1992).

The turquoise mines mentioned were discovered by Russian geologists and researched by the archaeologists A. V. Vinogradov (1972; Vinogradov et al. 1965) and E. B. Pruger (1971; 1989). They lay between the Amu Darja and the Syr Darja in silificated slate. Twenty deposits show traces of older mining. At Taskazgan they cover an area of 20 x 4 km. At least at Irlir in the Bukantau Mountains it was possible to prove mining in the 4th/3rd millennium BC near a spring. Only five about 1 m deep flat pits are preserved, mining reached down to 6 m depth only. Here, flint tools were discovered which can be considered to belong to the Kel'teminar culture.

It is perfectly possible that also at other places in Central Asia there was mining in those days. At Auminsatau in Koktau/Dangiz the author was able to see a small turquoise mining area which showed no traces, however. At numerous settlements of the Kel'teminar culture small flint drills were found together with turquoise waste, most impressively at Beshbulak 1 near Dhzmankum NE of the desert of Kyzylkum. A North-South link via the sites of Zaman Baba and Altyn Tappeh to the settlements on the Iranian Plateau seems possible, as there are also numerous turquoise finds like at Tappeh Hesār, but which also might have lead further to the South to Shahdad in the Lut and to Shahr-i Sokhta in Sistan.

All in all, turquoise does not seem to have been of the same great importance like lapis lazuli, with the exception of Egypt and Shahr-i Sokhta. Due to its lack of hardness and its great delicateness, only very seldomly it was used for seals (Cat.-no. 426). Also in the culture of the Indus valley, at least in its central part, it does not appear really often.

Fig. 12: Nimrud, turquoise pendant of King Ninurta-apal-Ekur (c. 1192-1180 BC) (Iraq-Museum, Baghdad).

Agate

In Bronze Age Iran people started to appreciate banded agate. Mostly, it was manufactured into big pendants but also into beads. Being a silicium oxide, this material is very hard and besides great efforts and considerable perseverance its manufacturing mostly required the necessary technique. Thus, however, the products have been perfectly preserved until today. Agate druses show differently coloured layers inside. Depending on how they are cut the bands are different. If the wall is cut vertically, the result is a cross-section through the layers; i.e. the beads which are made from this show changing layers in the longitudinal direction, this was the method which was employed most times. If a small druse is cut into slices, the result are plates showing more or less concentric coloured bands. This method was popular with costly jewellery in the Iron Age but it also appears much earlier (Fig. 14). If a druse is cut about parallel to the wall, then out of so called layered stones one can make plates of several layers one on top of the other; the ideal

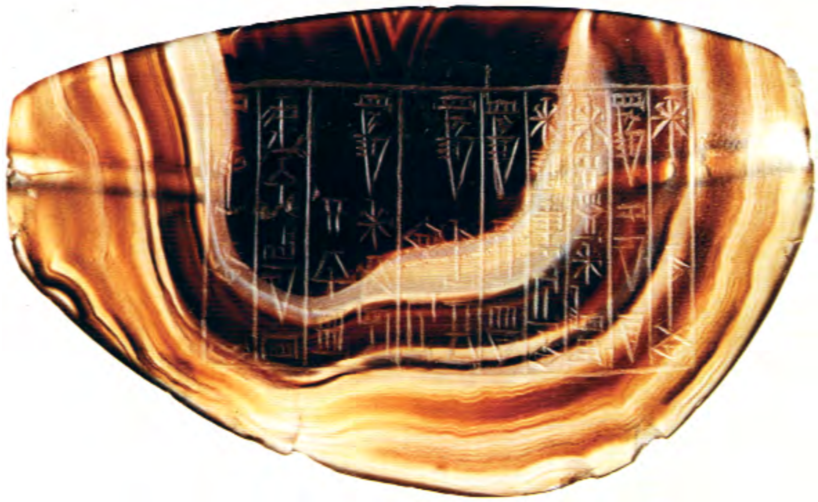

Fig. 14: Ur, big agate bead with the inscription of the New Sumerian king Ibbi-Sin (c. 2000 BC) (Musée de Louvre, Paris).

is a darker layer on top of a brighter one (so called "onyx"). If the uppermost layer was black, it was possible to cut it to "eyes" which were popular in the Iron Age.

Via famous Anshan, found to have been on Tappeh Malyan in Iran, Mesopotamia in the 3rd millennium BC was supplied with agate and turquoise. The latter appears at Hesār IIIC and in Ur III contexts in the form of beads. From the New Sumerian period (2036/2028 BC) there comes the 1.80 m long decorated chain of the priestess Abasti, containing 13 big, set agate beads besides gold beads and round cornelian beads. There are also both set cross-section plates (10 cm in diameter!) and beads cut from the piece (Boese in: Ortmann 1975, 212, tabl. 123b). Also in the above mentioned grave of Jaba there are beautiful agates, both cut agates which were chosen after their patterns and so called eye-beads in the form of inlays.

In the New Babylonian period and the Persian period agates and cornelians get to be even more important than lapis lazuli (Cat.-no. 414) (Moorey 1994).

In the Achaemenid empire stone vessels were highly popular, in the treasure-house at Persepolis 626 vessels were found, some of them made of agate/chalcedony with lapis lazuli (Bühler 1973, 37).

Carneole

We may rightly say that for 5000 years cornelians has been the most common and most popular decorative stone in the Orient (Moorey 1994, 97f.; Tosi 1976b). The name of this mineral is derived from Latin "carneus" or from the dark red colour of the cornel-cherry. This mineral is pale red or deep red, sometimes brown red, now and then it is transparent, and it is rather even coloured or slightly banded and shining like wax. The colour is due to very fine-graded hematite. Cornelian is a variant of chalcedony from the family of quartz. It is very hard (Mohs-hardness 6, 5-7). Still today, the best quality comes from India (Inizan 1999).

In Iran, cornelian can easily be exploited from the pebbles of rivers in the Alborz mountains and on the Central Plateau, at Busheir on the Gulf it is even found in the form of huge blocks. It also exists on the other side of the Gulf and in Oman. But numerous long, thin beads at Ur are so perfectly appropriate to beads from the Harappa culture that there is no doubt that at least the big beads (> 12 cm) in the rich graves in Iraq (Ur) come from Meluhha/India, as also suggested by texts in cuneiform writing. Still today, the best quality comes from Gujarat. (Much of what is sold under the name of cornelian today is actually coloured agate from Southern America.)

At Uruk, cornelian together with mountain crystal and chalcedony as well as flint drills appears as early as in a craftshop from the 4th millennium. In the Early Dynastic period it appears in the 3rd millennium together with gold, silver, and lapis lazuli. Its beauty is shown to its fullest advantage in connection with lapis and gold, often extensively layed out in the form of tiny beads, now and then in inlays. Early Dynastic period craftshops for simple cornelian beads were found at Diqdiqqa near Ur and at Uruk. Then in the

Fig. 15: Three recently arranged necklaces made of etched cornelian beads, small turquoise beads and tiny beads of precious metal (private collection).

late 3rd millennium it is joined by agate and mountain crystal besides other stones which are not to be considered precious. Due to its hardness and in contrast to turquoise it was very well suited for making stamp seals (Cat. no. 430-431) A skillfully worked ring from Telloh in Eastern Iraq is famous (Louvre, Paris).

Cornelian is the first decorative stone to have been treated chemically. The idea was not (like today) to improve the quality of the stone but it was to make it more beautiful for a long time by multiplying its colours. For this, patterns are applied to already cut beads by using alkali. The result are white lines on red cornelian after the material was exposed to temperatures of more than 300 degrees C. Additionally, the quality of the colour is improved (Roux 2000; Inizan et al. 1999).

Etched cornelian beads (Fig. 15) are found in big numbers e.g. in the graves at Ur, like the marvellous chain with its five big bi-convex beads from the period of the I Dynasty of Ur from the 2nd half of the 3rd millennium (Bolz-Augenstein 1964, cat. no. 90), or the one from Tappeh Malyan (Anshan). In the course of the 2nd millennium they get to be more and more rare and finally nearly disappear, until they appear again as late as in the Achaemenide period, as shown by our piece in this exhibition. They were continued to be produced for a long time and are found – probably always imported from India – e.g. in many graves of the pre-Islamic Samad culture in Oman from the Sasanian period.

Notes

1 Bauer 1932; Brückl 1935, 375; 1937; Blaise & Cesbron 1966; Kuhlke 1976. Presented in detail in: Weisgerber 2004. Newest essays in: Caubet 1999.

2 Internet www. Selket. De/news20032505.htm. Communicated to by J. Cierny.

3 Set following Moorey 1994, 101f.

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Nomads in eastern Sistan with their dwellings made of stones and wood (1976); Photo: G. Weisgerber.

Mobile Pastoralism and Prehistoric Exchange

Abbas Alizadeh

Introduction

The domestication of certain species plants and animals some 10,000 years ago ushered a drastic change of life in the Near East that enabled humans to exercise an unprecedented control over their food supply, with far-reaching consequences we still experience today. A corollary of this groundbreaking revolution seems to be the development of mobile pastoralism in south-west Asia (particularly in highland Iran), and possibly elsewhere.[1] But the evidence for interactions between the highlands mobile pastoralist and lowlands settled farming communities in preliterate times in Iran has been elusive. There are two main reasons for this seeming elusiveness: 1) the lack of material evidence due to high residential mobility of pastoralists; and 2) the prevailing perception of ancient mobile pastoralists as wandering people with minimum contact and interaction with settled agricultural communities. There are now a few lines of evidence or clues available that can shed more light on this problem. Before we present the recent discoveries and interpretations on the existence of ancient mobile pastoralist communities in prehistoric Iran, and discuss their social and economic interaction with settled farmers, it would be useful to offer some introductory remarks on the current topic.

In almost all the theories and hypotheses concerning the development of state organizations that were centred at large, prominent sites in the Near East, a large population is considered a major factor.[2] Propositions designed to explain the formation of early states are primarily based on the models derived from systems analysis and information theory. Briefly stated, the greater the population, the more information is generated, which in turn forces societies to develop the necessary institutions to process accumulating information (Wright & Johnson 1975). Those that can respond to such challenges would then evolve into a society with higher level of social order. We will argue here that this is equally valid for the ancient mobile pastoralist communities in highland Iran and that there are some archaeological clues (as well as ethnographic evidence), indicating that high residential mobility is not necessarily a feature of vertical mobile pastoralism, defined here as the herders (the Qashqaii and Bakhtyiari) who regularly move between the high altitudes and lowlands and the intermontane valleys of south-central Iran (Fars) through certain migration routes.

I have argued (Alizadeh 1988a; 1988b; 2003a; 2003b; 2004) that the fifth millennium BC was the period of the crystallization of mobile pastoralist life in south-western Iran. I also argued that – Tall-e Bākun A, in highland Fars, was a production and exchange nexus that was operated by the mobile pastoralists of the region. The site demonstrates a number of features associated with the level of social complexity that has been attributed to some later proto-historical urban centres; but the small size of the site and the regional settlement patterns during the Bākun A phase (*c.* 4300-4000 BC) as a whole does not conform to the Central Place theory or tributary economic models, where higher level of settlements are expected to exhibit larger populations and more functions. We have attributed the socio-economic complexity at Bākun to the presumed underlying mobile pastoralist structure of the region.[3]

By itself, Tall-e Bākun A may be considered an anomaly; but it is not unique. There are a number of other sites that exhibit most of the characteristics of the larger regional centres, but are nevertheless too small to have included a large population as a factor. Prominent among these special sites are Tappeh Gawra (Tobler 1950)[4], Tell Abada (Jasim 1985), Kheit Qasim (Forest-Foucault 1980; Margueron 1987), and possibly Tell Madhhur (Roaf 1982; 1987). These sites constitute a category of settlements that does not fit our current models of early urban development in which large, circumscribed farming populations played a fundamental role in creating socio-economic and political complexity. In all the descriptive and explanatory models, the number of sites determines the size of a regional population and the population of each site is determined by its size. Such estimates obviously account for the settled farming and urban population of a given region. These models, however, do not account for ancient Near Eastern mobile pastoralist communities, though these communities seem to have coexisted for thousands of years with the settled communities as part of the socio-economic continuum of local polities. This omission is understandable, and even justifiable, given the difficulty in attributing material evidence to communities with high residential mobility.

Residential mobility among the contemporary vertical mobile pastoralist tribes in south-western and south-central Iran is not high compared to the horizontal pastoralists of the vast steppes of central Asia. The Qashqaii and the Bakhtyari tribes were only highly mobile during their annual migrations. Once they reached their designated or traditional summer and, especially, winter pastures, they would spend at least several months of the year in relatively fixed areas among the settled farmers, with high levels of socio-economic interaction.

There seem to be geographic reasons for the high degree of interaction between Iranian mobile pastoralists and settled farmers. Marginal areas unsuitable for grain agriculture, but with excellent pasture grounds and thus with low population density (such as the Negev in Israel and the Jezireh in north-western Iraq), are extremely rare in south-western and south-central Iran. The available winter pastures for the Zagros mobile pastoralist tribes include the fertile intermontane valleys in Fars and the south-western lowlands, both with high density of settled farmers and vast tracks of cultivated lands. Thus, regardless of when vertical mobile pastoralism developed in Iran as a specialised way of life, from the beginning they must have had a higher degree of interaction with the settled farmers of their winter haunts than those in the vast steppes of Central Asian and the Sahara, for example. More importantly, unlike highly mobile pastoralist groups of the vast steppes and arid zones (*e.g.* the Sahara, the Negev and the Sinai), some vertical mobile pastoralist tribes of the Zagros Mountains possess(ed) in both their summer and, especially winter haunts, semi-permanent villages with solid architecture and in close proximity to the settled farmers and urban centres (see Alizadeh 1988a; 2003b; 2004). If this pattern obtained in late prehistory, as we argue here, then semi-permanent nomadic villages cannot be distinguished from permanent farming villages in surface surveys. The assumption of the existence in late prehistoric times of semi-permanent villages in the midst of rich agricultural regions is therefore based on ethnographic and historical data, as well as on some archaeological clues that are discussed below. This assumption is theoretically significant because it addresses the problem of the economy of scale, which discourages non-agricultural production, especially pottery, among mobile groups.[5]

Recent studies suggest that ancient mobile pastoralists may have had some measure of influence in the development of complex societies in the ancient Near East, particularly in south-western Iran (*e.g.*, Wright 2001; 1987a, 141-155; Zagarell 1982). Nevertheless, in the study of the formation of state organisations in the Near East, the role of mobile pastoralist communities is either completely ignored or viewed mostly as a contributing factor. This is perhaps due to the fact that the scope for structural and economic variations is limited in mobile pastoralist societies, so much so that a level of state organisation cannot develop internally in such societies. Nevertheless, in areas with a high degree of interaction between mobile pastoralist and settled farming communities, what Rowton (1981) calls 'enclosed nomadism', chiefly aspirations to a higher level of political and economic control could, under favourable circumstances, be materialised only if that control is extended to include sedentary farming communities. Because of the undiversified pastoral economy and its limitations in accumulating wealth, the desire of mobile pastoralists, particularly the tribal elite, to acquire land-based wealth and power is an important variable in the dynamic relationship between the settled and mobile pastoralist communities in the Middle East. The ethnographic literature abounds with references to acquisition of land by tribal leaders. In fact, Rowton (1981, 26-27) has shown that in enclosed nomadism it was common for the nomadic tribes to include fully sedentary tribes of a regional population. The same is remarkably true about the contemporary mobile pastoralist tribes of the Zagros Mountains (see for examples, Barth 1961; Beck 1986; Garthwaite 1983).

Using these insights together with the evidence of surveys and excavations, we have proposed that a number of mounded sites in late prehistoric Fars and lowland Susiana were established as a result of crystallization of mobile pastoralist economy (Alizadeh 1988a; 1988b; 2004).[6]

When, in 1995 in a joint ICHO (Iranian Cultural Heritage Organization)-Oriental Institute project, we conducted an archaeological survey in north-western Fars to test the validity of our hypothesis that the spatial distribution of Fars 5th millennium pottery corresponds to the migration routes of some of the modern-day mobile pastoralist tribes of the Qashqāii, we encountered many permanent and semi-permanent Qashqāii villages with strong ties with their pastoralist tribesmen (Alizadeh 2003b).[7] In such a bipolar socio-economic and political context, the entire settled, semi-settled and mobile populations of a tribal territory will have to be taken into consideration.

Once, based on ethnographic evidence, we assume the existence of pastoral semi-permanent villages in antiquity, then the difficult problem of attributing to the ancient highland mobile tribes industrial activities, artistic creation, and the spread over vast territories of certain regional styles of pottery decoration is not as daunting. Moreover, recent studies show that even nomads can produce pottery (see below). In our case study, the spread of the specific 5th millennium BC "dot motif" (see Alizadeh 1992) style of pottery (Fig. 4) from Fars into the Zagros Mountains, lowland Susiana, and even the Central Plateau (Alizadeh 1992) may be described as a combined outcome of both segments of the pastoralist society, *i.e.*, the client villages where material goods could be manufactured, and the mobile population that could carry, use, or exchange them. The spread of this specific class of pottery could also have been augmented through marriage alliances when decorated vessels may be part of the dowry.[8] Since inter-regional marriage alliances occur among the ruling elite of societies, then the spread of decorated pottery vessels could also be viewed as symbolically significant.

Following Earle (1994), one may postulate that because mobile pastoralist groups operate regionally over vast areas on regular basis, the hierarchy that arises from within can be in a position to generate overarching levels of social and political organisation not present in any one segment of the society. Such levels of organisation would then result in the integration of economically and politically segmented groups.[9] The potential military power of the highland mobile pastoralists can, however, be a double-edged sword. As Earle argues (1994, 956), military power can be an equalising force, which not only coerces submission, but also creates resistance to domination, which would generate an important variable in the adaptive reorganisation of lowland farming societies. In this scenario, the military capability of mobile pastoralists could be considered an important factor in the development of state organisation in lowland Susiana.

Because of their highly specialised and undifferentiated economy, mobile pastoralists are more interested in trade – either exchanging their own products or serving as intermediaries in long-distance trade – than sedentary people. But self-sufficient farming villages by definition are not viable markets for the tribesmen. On the other hand, mobile herders cannot trade among themselves because of their undiversified economic mode of production. So, we know historically, and expect prehistorically, an association between the crystallisation of the highland mobile pastoralist communities and the rise of large population centres with diversified economy and a large population not necessarily engaged in subsistence agriculture.

Once the necessary demographic, economic, and political conditions were present for a pastoral society to engage in the production and distribution of surplus animal products and material goods, a fixed locus combining production, administration, and residential quarters would have to be chosen. Tall-e Bākun A, and the similar sites mentioned above, may have been the residences of some of the wealthier and higher-ranking individuals whose economic strength and social status allowed them to be engaged in sedentary trade economy. A common ethnic background and perhaps kinship ties between the settled and mobile communities in Fars and the Zagros Mountains may have facilitated processes of economic and socio-political development and regional integration in Fars.

Vertical Mobile Pastoralism

Until recently the two major mobile pastoralist tribal confederations in south-western and south-central Iran were the Qashqāii and the Bakhtyari. Their socio-economic and political structures are the best examples of what Salzman (1972) calls "multi-resource nomadism", allowing for a high degree of economic and social complexity and diversity. These characteristics, as noted above, arose from the environmental and geological features of the Zagros Mountains that impose specific migration routes and the choice of winter and summer pastures. It will therefore be helpful to outline some major characteristics of these mobile tribes before presenting the pertinent archaeological evidence.

Rich and complex societies of mobile pastoralists have a long history in the Middle East, and elsewhere.[10] Near Eastern mobile pastoralist communities in general and those of the Zagros Mountains in particular have had a high degree of economic and social interaction with the settled farming villages and urban centres. This interaction has been attributed to ecological and geographic factors that force mutually dependent, territorially bound, and autonomous entities to share regions that provide the matrix for a web of social, economic, and political interaction. Territorial coexistence and economic interdependence of mobile pastoralists and sedentary agriculturists are suggested as significant factors for this high degree of integration (Rowton 1973a; 1973b; 1974; 1981).

Iran's topographic features that helped shape its multi-cultural and multi-lingual societies have not changed much since the Neolithic period. The emergence of civilisation and state organisations around 3400 BC, and the rise of powerful empires with regulated mechanisms for information flow created a fertile environment for many cultural regions to interact and exchange goods and ideas. However, it was not until the advent of the modern nation-state in Iran in the early 20th century that we begin to see the forging of several regional cultures into a nation-state with an overarching central authority. Thus to develop a deep understanding of the complex relations between mobile pastoralists and farmers, we will have to approach the problem from an evolutionary and historical perspective, which includes prehistory.

The mobile pastoralist way of life can be seen as an environmental, economic and sometimes political adaptation. Given the geographic and geological features of western Iran, and the relatively stable climatic conditions since the 4th millennium BC, one can assume that, until recently, this strategy of coping with the environment had not changed drastically, for in the case of vertical mobile pastoralism in the Zagros Mountains, the spatial and temporal distribution of certain ecological niches and resources imposes particular migration patterns through certain predetermined routes. The most important aspect of Iranian highland mobile pastoralist tribes is their close proximity to the sedentary farmers in their winter haunts (primarily in Fars and Khuzestan) for more than four months of the year. This proximity not only creates tension, but also fosters economic and social interaction not present in the vast steppes of central Asia, northern Africa, the Sinai and the Negev.

Despite numerous programs initiated by the central government to forcefully settle mobile pastoralist tribes during the second half of the last century, south-western Iran is still relatively teeming with mobile tribes, particularly the Qashqāii. Until recently, such tribes were not only active and free in their movement, but also had significantly influenced the political life of the settled population throughout the recorded history of Iran (Beck 1986; Garthwaite 1983). At this point it is important to outline some aspects of mobile pastoralism in highland Iran, particularly in Fars, that must have contributed to social and political complexity in highland Iran.

Externalisation of Pastoral Economy

Agriculture

The complexities involved in mobile pastoralist seasonal migration and pastoral production are important factors in their high interaction with the settled farmers. I have discussed these issues in details elsewhere (Alizadeh 1988a; 1988b; 2004). Here I will focus on the specialised economic aspects of the highland mobile pastoralism.

Wide-range anthropological and historical studies have shown that there has never been a totally pastoral society, for non-pastoral production, particularly grain crops, have always been an important part of the mobile pastoralist diet (see Levy 1983, 17; Spooner 1972, 245-268; Teitelbaum 1984). The interdependence of settled farming and mobile pastoralist communities would create a market in which both societies benefit. This interaction in turn creates a context within which political and economic hegemony is exercised. It is this interdependence and close proximity of the two societies in highland and lowland Iran that underlie much of the socio-political and economic development in the Near East in general and in Iran in particular.

Though farmers supply the bulk of the grains needed by the mobile pastoralists, the practice of agriculture is also widespread among the latter in highland Iran. Members of many mobile pastoralist tribes invariably relied on dry farming and took advantage of arable lands in both summer and winter pastures. In the high altitude of summer pastures, just before leaving the area, some members of the tribe sowed crops which would be covered by winter snow, sprout in spring, and ready to be harvested by the time the tribe returned. Similarly, tribal families planted small plots of barley and wheat in December, harvesting them in April just before they departed for their summer pastures in the mountains (see for example, Amanollahi-Baharvand 1981, 47-48, 86-89; Garrod 1946a, 33). At times when the winter crop was not ready, some local workers were hired to harvest it for the tribe. For example, in the Bakhtyiāri Mountains, the tribe of Bamadi usually headed for the mountains in March/April, one month before the crop was ready. The tribesmen, then either would leave some members behind to harvest the crop and hide it under rocks in makeshift storage, or they would hire some sedentary local farmers to harvest it for them while they were gone.[11] Stack (1882, 68, 100) reports of the same practice among the Qashqāii; he reports: "They leave some men behind to reap their scattered fields which they have ploughed and sown in their Firouzābād qeshlāq or winter haunts. The grain is buried in pits against the return of the tribe next year." Garthwaite (1983, 21, 40) also notes the importance of agriculture among the Bakhtyiāri and that when the tribe moves to its summer/winter pastures some men stay behind to harvest and collect the crop.[12] This strategically important practice reduces the risk of total dependence on the farming communities and ensures some security if the crop failed in other areas. In addition, some Bakhtyiāri chiefs showed great interest in even large-scale agriculture by investing, building and maintaining irrigation systems in western Iran (Garthwaite 1983, 30).

Among the factors that would encourage individual mobile pastoralists to invest in agricultural land is their awareness of the importance of agriculture (Barth 1961, 101 ff.; 1965; Garthwaite 1983, 21, 40), as well as the danger of losing the entire flock to epidemics and prolonged spells of dry weather. This reinvestment does not mean that the mobile pastoralists see any advantage in sedentary life; rather, it is practised as a measure of security in the event that their livestock breeding should fail. Barth notes that sometimes individuals gradually acquire sufficient parcels of land that once their economy is determined by such possession, sedentarisation seems to be the natural result.[13] While the interest of a rank and file mobile pastoralist in acquiring farmland may be economic and a response to risk, that of the higher ranking individuals, particularly the chiefs, in acquiring agricultural land can be also seen as politically motivated, for mobile pastoral economy has a limited capacity for furthering political ambitions of tribal chiefs.

The processes of sedentarisation do not necessarily lead to sedentism, the outcome of sedentarisation; moreover, sedentism is by no means irreversible and absolute.[14] This is particularly true in times of economic and political uncertainty when mobile pastoralists keep their options open for shifting from one way of life to another (Marx 1980, 111; see also Adams 1978). In fact, the processes of sedentarisation, as argued by Barth, do not constitute a threat to the existence of mobile pastoralism; these processes rather augment pastoralism by maintaining environmental equilibrium through various mechanisms (Barth 1961: 124).

Though part-time farming would relieve the mobile tribes from total dependence on the farmers, it would not satisfy their grain requirement, which is procured either through barter or purchase in market towns. Nevertheless, the practice of agriculture by mobile pastoralists and their knowledge of farming have a strategic significance with allowing them a greater flexibility in adapting to various environmental and political calamities (Spooner 1972, 245-268). Of strategic importance is also mobile pastoralists superior knowledge of the environmental resources and geographic features of their vast territories. Mobile pastoralists are much more familiar with climatic changes, types of soils, and location of water sources and natural resources, so that they can easily shift to settled life. The reverse transition is by far more difficult for the sedentary farmers, particularly if they are not genealogically related to the mobile tribes of their area. In a favourable environment with multitude natural resources and ideal pastures, such as the Zagros Mountains and its piedmonts, the shift from mobile pastoralism to sedentary farming and vice versa seems to have been the major adaptive response to either environmental and/or political pressures.[15] The most recent example is the return of part of the Qashqāii tribes to mobile life after the Iranian revolution in 1979 (Hottinger 1988, 126-130, and my own observations).

As noted above, the vertical mobile pastoralist way of life requires organisation and planning; it also requires a wide range of information that needs to be processed. Vertical mobile pastoralism is an elaborate adaptation to the socio-political, economic, and ecological features in highland Iran. Growth in both mobile and settled populations can result in an increase in the amount of farming and pasture lands. This in turn would create closer proximity of the two populations and intensification of social interaction. In the context of state organisation or faced with outside encroaching threat, mobile tribes may forge confederations that, albeit ephemeral, come close to state-level of political organisation. In such a context, social complexity would develop from the constant requirement of the pastoralists for communication and co-operation to maintain economic and social cohesion, characterised usually by a loosely structured centralised system culminated in the single office of chief and welded together the seemingly dispersed tribes (Barth 1961, 71 ff.).

Exchange/Trade

Another factor thought to have contributed to the processes of centralisation is the existence of trade routes in the territories under the tribal control.[16] Before the introduction of modern roads in Iran, there were only a few natural and narrow passes linking south-central and south-western Iran to the Central Plateau and points east. In this regard ancient mounded sites such as Tall-e Bakun, Tall-e Deh Bid, Tall-e Do Tulun, Tall-e Nourabad, and Tall-e Arjān, may be analogous to the modern-day mobile pastoralist market towns of Marv Dasht, Deh Bid, Nourabad, Ardekān, Jahrom, Firuzabad and Deh Dasht.

Thus it seems reasonable to assume that, though not as complex as in modern-day pastoralist societies, the nascent characteristics of mobile pastoralism, as discussed above, began to develop with its crystallization in highland Iran in the early 5th millennium BC. Before they were forced to settle by Reza Shah, in the first half of the 20th century, the number of mobile pastoralists in Iran fluctuated between one and two million (Barth 1961; Beck 1986; Garthwaite 1983; Safinezhad 1989; Amanollahi-Baharvand 1981). But these numbers, though large in themselves, do not indicate the importance of the highland mobile pastoralists within the framework of Iranian history. Mobile pastoralists were of much greater significance throughout the history of Iran than their mere numbers suggest. They occupy an important place in society because they constitute well-organised economic, social, and political units (Briant 1982; Ehmann 1975; Sunderland 1968) that either within a state or in the absence of state organizations can pose a military threat to farming and urban communities. Aside from the fact that as a moving target mobile pastoralists are difficult to overwhelm militarily, there are the organisational aspects of the mobile pastoralist societies in highland Iran that enabled them to rule supreme in their regions over the settled communities in the absence of a strong centralised state – a rule in the history of Iran rather than an exception. In fact, it took the Pahlavi regime several decades of military campaign, aided with fighter jets, gunship helicopters, and artillery, to politically subdue the Qashqāii and the Bakhtyiāri. One, therefore, can envisage that even in prehistoric times, bands of mobile pastoralists would have been superior to agriculturists in terms of military and organisational aspects, so that in the absence of centralised state organisations, the mobile pastoralists would be in a dominating position vis-à-vis the sedentary agriculturists.

It can be argued that the military superiority of mobile pastoralists to a large degree depended on horses and camels. This is certainly true for the vast steppes of central Asia and the Sahara. In regions with comparatively high population density, such as lowland Susiana and Fars, the sheer superior numbers of settled farmers would certainly be a deterrent to any nomadic intrusion and raids on foot. In the case of Zagros vertical mobile pastoralism, hiding places were readily available in the nearby mountains, but comparatively inaccessible and hazardous to the settled farmers. As the numerous raids to subdue the Qashqāii and the Bakhtyāri pastoralists by government troops during the reign of Reza Shah in the 1920s and 1930s demonstrated, even a well-organised army with modern technology could not easily overwhelm the mountain tribes. The military advantage of the vertical mobile pastoralist tribes lies is their way of life, the geographic and geological features of their surroundings, their high mobility, and general lack of fixed assets.

It is probably true that without horses and camels, it is not easy to imagine how mobile pastoralist tribes could exert their hegemony on settled farmers, but in the absence of state organisations or in situations where organised military response cannot be immediate, fleet-footed mobile tribesmen could bring a settled regional population to submission by sheer harassment. It is easy to imagine the vulnerability of farmers during the harvest time; a small band of mobile pastoralists could easily set fire to the harvest and disappear without a trace into the mountains; similarly, flocks of sheep and goats sent by the farmers to the nearby hills can easily be stolen by the mobile tribesmen, as there are numerous reports of such events (whether real or imagined) in the major tribal regions in Iran. This built-in military superiority of vertical mobile pastoralists should be considered another factor in their socio-political development. As Sáenz (1991) argues in the case of the Twaregs of northern Africa, the military advantage of vertical mobile pastoralist communities alone can lead to extortion that in turn may lead to warrior-client interaction and subsequently to stratification and increased social complexity.

The Archaeological Clues

The Zagros Mountains

Apart from the archaeological evidence from Fars, three lines of evidence provide additional clues to the presence and activities of mobile pastoralist communities in Iran. Archaeological surveys and excavations in the Iranian Central Plateau, the Zagros Mountains, and lowland Susiana primarily provide these clues.

The earliest clues to the presence of and socio-economic differentiation among mobile pastoralists in prehistoric Iran is found in the isolated cemeteries of Hakalān and Parchineh in Lurestan, the oldest nomadic cemeteries in Iran, and in fact in the entire ancient Near East. L. Vanden Berghe (1973a; 1973b; 1973c; 1975;

1987)[17] excavated both cemeteries from 1971 to 1973. The cemeteries are located along the Meimeh River in the Pusht-e Kuh region of Lurestan in the south-western piedmont of the Zagros Mountains. The sites are considered nomadic cemeteries because they are not associated with any known settlements; they are similar in location and tomb construction to the later nomadic Bronze and Iron Age tombs in the same region; and finally because the region is unsuitable for grain agriculture and almost devoid of permanent ancient as well as modern-day villages with agriculture as subsistence base (for a detailed analysis see Alizadeh 2003b; 2004).

In both cemeteries, pottery vessels (*c.* 200) were the most abundant funerary objects. Based on a general comparison to the ceramics of the Early Middle Chalcolithic in central Zagros (Henrickson 1985), Haerinck & Overlaat (1996, 27) date the cemeteries in Area A at Parchineh to 4600-4200 BC. Pottery vessels from both cemeteries show strong affinities with the pottery of the Ubaid 3 and 4 phases in Mesopotamia and Late Middle and Late Susiana 1 phases (5000-4300 BC) in lowland Susiana. The most interesting characteristic of the cemeteries artefacts, particularly the pottery vessels, is therefore the various specific regional styles they exhibit, representing Mesopotamia, lowland Susiana, and highland Iran.

The obvious varying richness of the funerary gifts deposited in the tombs suggests differentiated status among those who were buried in the cemeteries. At this level of social evolution, and with their military superiority over the settled farming communities by virtue of their mobility, it is not difficult to assume their desire to control rich agricultural regions in their territories (see below).[18]

Given the archaeological presence of mobile pastoralists in the 5th millennium BC, when nascent urban centres were growing in both Mesopotamia and lowland Susiana, it is not difficult and unwarranted to assume that the mobile pastoralist mode of subsistence economy and way of life put them in a position to become intermediaries between lowland Susiana, Mesopotamia and highland Iran. Similarly, population increase in the settled farming communities of the lowlands and vast intermontane valleys of Fars would have created a context conducive to the creation of nomadic surplus production including meat, dairy by-products, leather, wool, and possibly kilims. Apart from these tangible products, mobile pastoralist groups could also interact economically with the settled farmers in providing services such as labour, military protection, scouting and protection of commercial routes (Bates 1973; Black-Michaud 1986; Rosen 2003).

Whether such items of exchange included pottery is a question that seems to depend on the degree of residential mobility that imposes restriction on pottery production (Close 1995; Rice 1999; Skibo & Blinman 1999). Arnold (1985), while suggesting that less than 30% of mobile societies make and use pottery, argues that a number of practical, logistical, and economic (economies of scale) problems involved in the production of pottery by groups with high residential mobility. However, in a series of articles, Jelmer Eerkens (2003) and her colleagues (Eerkens & Bettinger 2001; Eerkens *et al.* 2002) discuss a number of strategies through which such obstacles were overcome by the highly mobile tribes of Paiute and Shoshone of the southwest Great Basin in North America. The pottery manufactured by these native American tribes are basically simple, crude and limited in shape and accessories (Eerkens *et al.* 2002, 203-205). The same is true of the Negbite pottery of the Negev that has been attributed to the nomadic groups of the region (Haiman & Goren 1992). These observations suggest that even when mobile groups do manufacture pottery, their product is technologically and aesthetically inferior to those produced by sedentary peoples.

In the case of the vertical mobile pastoralists of the Zagros Mountains, there is no need for this distinction. First, despite their migratory way of life, the Zagros pastoralists spend only a fraction of the year moving from their summer to winter pastures and vice versa. While in their summer pastures they occupy regions not suitable for grain agriculture and thus lightly populated, in their winter pastures of Fars and lowland Khuzestan they spend several months in heavily populated and agriculturally rich areas. Some tribes even own villages with solid architecture or a mixture of tents and mud-brick or stone houses. If this situation obtained in the 5th millennium BC and thereafter, to some extent attributing to the mobile pastoralist groups the manufacture and thus spread of the very specific class of the 5th millennium BC pottery in south-western Iran is theoretically not far-fetched. Inter-regional marriages, an important factor in forging inter-regional alliances through kinship could also be considered as a contributing factor in the spread of some classes of pottery (see below).

Lowland Susiana

Chogha Mish (KS-001) enjoyed a central status in the entire Susiana plain from the Archaic Susiana (6900 BC) through the end of the Middle Susiana period (5000 BC) when its monumental building was destroyed by fire and the site, along with a number of its satellites, was subsequently deserted (Delougaz & Kantor 1996). It is not at all certain whether hostile forces destroyed the monumental building or the fire was accidental. However, this event coincided with others that, taken together, suggest a changing organisation in the settlement pattern during the first half of the 5th millennium BC. The destruction of the monumental Burnt Building coincided not only with the abandonment of Chogha Mish, but also with the abandonment of a number of sites in the eastern part of the plain, the appearance of a specific class of painted pottery, and the appearance of the communal cemeteries of Hakalān and Parchineh in the highlands (Vanden Berghe 1973a; 1973b; 1975; 1987). A number of pottery shapes and decorative motifs we have considered specific to the Late Susiana 1 phase (the period when Chogha Mish remained unoccupied) are characteristics of the pottery found in highland Fars, Central Plateau and the Zagros Mountains.[19] We tentatively attributed this development to the regional conflicts that resulted from the crystallisation of mobile pastoralist communities in the highlands.

With Chogha Mish lying deserted during the Late Susiana 1 phase (*c.* 4800-4300 BC), it appears that no single site attained a central status in terms of size and population.[20] The observed westward movement of the Susiana settlements around 4800 BC and the appearance of the highland communal burials provide a relevant context for the observation made by Hole that ". . . sites were often occupied for only short periods, then abandoned for a time and reoccupied. About half of sites changed status from occupied to unoccupied or vice versa . . . implying that settlements were unstable and that land was not particularly scarce and therefore not valuable" (Hole 1987, 42, Tab. 8). This westward movement continued until the region east of the Shur River became almost completely deserted before the Protoliterate period. Even during the Protoliterate period, only six sites are reported from this area (Hole 1987, Fig. 10).

The presumed correlation between the increased activities of the highland mobile pastoralists and the westward shift of Susiana settlements at the end of the Middle Susiana period becomes more tenable when we note that the eastern part of the Susiana plain traditionally has been, and still is, the locus of the winter pasture for the mobile pastoralists of the region. If this environmental niche was also used in antiquity, as one might expect, then the westward shift of the settled community may also be taken as an indication of an increase in the activities of the mobile pastoralist groups in the area, and the conflict of interest between the settled and mobile populations of the region, a dichotomy that remains the *leitmotif* of Iranian history throughout the ages.

As part of a joint Iranian Cultural Heritage Organisation (ICHO), the Oriental Institute and Department of Anthropology of the University of Chicago project, and with a grant from the National Science Foundation (BSC-0120519), we decided to conduct geomorphologi-

Fig. 1: Aerial photo of lowland Susiana indicating the location of KS-1626.

Fig. 2: Square 36 before excavations showing the thick alluvial deposit.

Fig. 3: Contour map of KS-1626.

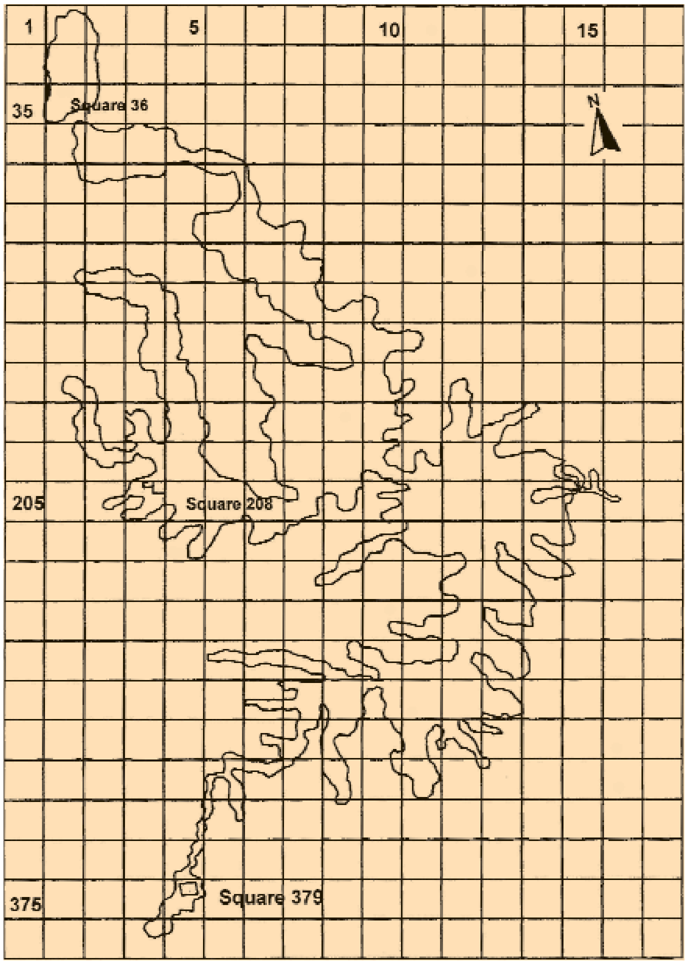

Fig. 4: The site and the wadi at KS-1626, looking southwest.

cal surveys in this part of the region. To gain additional data on the important Late Susiana 1 phase, we also decided to conduct excavations at Dar Khazineh (KS-1626). The results that we obtained from KS-1626 were certainly serendipitous, as we had no idea about the nature of the site prior to its excavation.

KS-1626 is located some 30 km south-east of the provincial town of Shushtar (Fig. 1). In this part of the Susiana plain, both prehistoric and historical sites are buried under some two meters of alluvial deposits, a feature that Lees and Falcon (1952) had already noticed (Fig. 2). Tony Wilkinson, Nick Kouchoukos, and Andrew Bauer, who participated in the geomorphological survey,[21] concluded that the construction of the huge irrigation canal (now the Gargar river/canal) during the Parthian/Sasanian period was responsible for this situation in this region (Alizadeh 2003). As a result, the archaeological sites in this region are only visible in the exposed sections of the wadis.

The wadi at Dar Khazineh had sliced the mound in such a way that an extensive section was exposed on its western part (Fig. 3, 4). This gave us an excellent opportunity to study its stratigraphy and collect archaeological, botanical, and faunal samples without having to excavate it for several seasons. From the exposed sections, we could see that under the 2 m alluvium, the cultural layers continued down to the bed of the wadi. When we eventually cleared the sections to the bed of the wadi we realised that the depth of the mound ranged only from 30 cm to about 180 cm and that in some parts of the mound there was no cultural deposit at all. Excavations in our main trench (Square 379) revealed a peculiar depositional pattern not seen before. Clayish and sandy sediments ranging 5 to 10 cm thick superimposed thin lenses of cultural deposits. No solid architecture was found except for extremely badly preserved pisé partition walls whose faces were usually burnt; we also found postholes, traces of ash and fireplaces. In fact, the "floors" on which these activities took place consisted of alluvial deposits. Thus, when in the main area of excavation, we factored out the alluvial levels from the cultural lenses, we were left with just over 30 cm of deposit for perhaps the entire duration of the 5th millennium BC. We did not find any extensive organic horizon that would indicate the presence of animal pens. But this is not surprising for most of the site is destroyed; in any case, our exposures were too small.

We also excavated two more squares on the central, highest part of the mound (Square 208) and on the extreme north-western part (Square 36). In Sq. 208 under the alluvial deposits we found three simple grave pits dug into another layer of clayish alluvium. The

Fig. 5: Skeletal remains of the body in Grave 3.

Fig. 6: Funerary objects found in Grave 3.

Fig. 7: Fragmentary stone pavement in square 36.

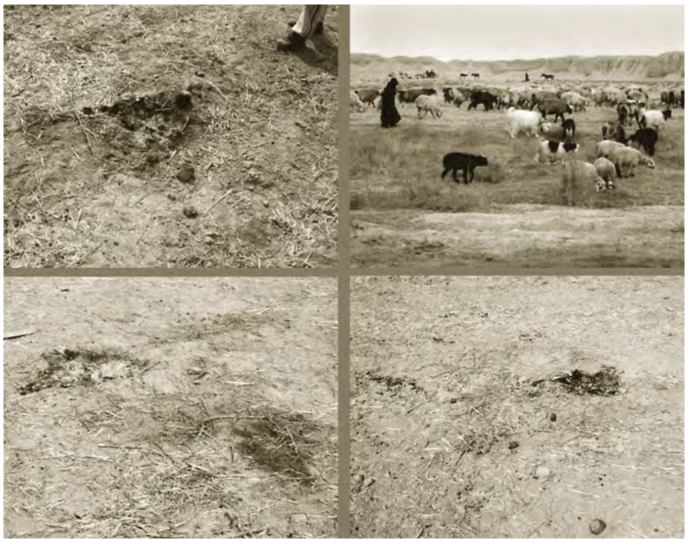

Fig. 8: The Bakhtyari temporary camp at KS-1626.

skeletons were fragmentary and very badly preserved – legs and hipbones were completely absent. Graves 1 and 2 (Features 1-2) yielded some rubbing stones and pounder. Grave 3 (Figs. 5-6), presumably belonging to a female yielded a saddle-shaped stone mill, stone pounder, and a copper pin that, judging by its position, was used as a hairpin. No other archaeological deposit was found below the level of these grave pits.

In square 36, again below the alluvial deposit, we found a fragmentary stone pavement embedded with potsherds of Late Susiana 1 date (Fig. 7). Again, we encountered no cultural deposit below this stone pavement.

It thus seems that the main locus of cultural activities at KS-1626 was the area of Square 379. Judging by our test trenches in other parts of the mound, it seems that the occupants of KS-1626 moved horizontally across the site. This is analogous to the modern-day mobile pastoralist campsites. In fact we were fortunate enough to observe one of these campsites during our excavations at Dar Khazineh.

As we mentioned above, eastern Khuzestan is the main area where some mobile pastoralist Bakhtyari tribes use in the months of winter. While working at KS-1626, we noticed that the area was used by some mobile pastoralist tribes as temporary campsite (Fig. 8). Specifically, we noticed that these tribes used the western bank of the stream in the wadi as overnight camp. This gave us an excellent opportunity to make some ethnoarchaeological observations. When, after one tribe left the area early in the morning, we examined what they left behind, we were surprised to see that they had dug three shallow fire pits some 10 m apart. They used the available twigs and animal dropping as fuel. The lumps of clay that had been dug out to make fireplace were burnt and blackened by the overnight fire. But not much else was left behind. This was very similar to the patterns we excavated in Square 379. We also knew that mobile pastoralists who use a place overnight or for a longer period, create a stone bedding to protect their belongings against moisture and rain, a feature similar to the stone bedding in Square 36. In addition, mobile pastoralists use the highest point of natural hills or artificial mounds to bury their dead, a practice analogous to the graves we found in Square 208.

Subsistence Economy

Marjan Mashkour of the CNRS, Paris, analysed the faunal samples. Even though we collected every piece of bones from every layer and feature, only some 400 pieces of bones were found, which is not surprising given the nature of the site. The main domesticated species identified were goats and sheep; cattle (6-7%) were also present. Wild species included onagar (*Equus heminous onager*), fallow deer (*Dama dama mesopotamica*), medium size rodents and some mollusk remains.

Naomi Miller of the University of Pennsylvania MASCA analysed the floral samples. Only a small volume of seeds was recovered, despite the fact that we wet-sieved huge quantities of dirt, especially from the fire pits. Again, the poor recovery of charred botanical remains is consistent with the nature of the site, which was exposed to the elements for much of the year. According to Miller, the charred seeds include two plant families, the grasses (*Poaceae*) and the legumes (*Fabaceae*). The only cultivated plant in the grass family was barley (*Hordeum*). Marco Madella of the University of Cambridge is in the process of analysing the phytolith samples we collected from the site.

Based on these observations, we concluded that KS-1626 may have been used seasonally by the prehistoric mobile pastoralists of the region, a pattern that is still evident in eastern Khuzestan. The analyses of the fauna and flora samples from the site also corroborate our characterisation of the site as a mobile pastoralist camp. It is also important to bear in mind that the primary occupation at Dar Khazineh coincides with the Late Susiana 1 phase, a period we consider the crystallisation of mobile pastoralist mode of production in Iran.

KS-1626 was not unique in the region. Our inferences about the nature of KS-1626 and in general about the events in the fifth millennium in Susiana are also based on a number of similar sites in the same general area. One – we called "Chogha Kuch" (Mound of Migration) because it was in the middle of a vast stretched of uncultivated land with no village around and no one knew any name for it – was brought to our attention by Miss Gudarzi of the Shushtar ICHO. The site is located some 20 km south of KS-1626. The pottery on the site dates to Late Middle Susiana and Late Susiana 1 phases (*c.* 5200-4300 BC). It is a shallow mound with several pottery kilns still visible on the surface (see Alizadeh *et al.* 2004 for a detailed analysis).

The Central Plateau

As mentioned above, another line of evidence is now available from the Central Plateau, the primary source of copper in Iran. This remarkable evidence for contact between Fars, lowland Susiana and highland Central Plateau, comes from a series of surveys conducted by Mir Abedin Kaboli (2000) of Tehrān ICHO. The survey region is located northeast of the city of Qom, some 100 km south of Tehrān. The unmistakable characteristic ceramics of the Late Susiana 1 phase were found on at least six mounds.[22] Other contemporary prehistoric mounds in the region yielded only the typical late Cheshmeh Ali pottery. Although I have not had chance to examine the actual pottery, the illustrations and description of the ware leave no doubt that the illustrated pieces represent genuine Susiana and highland Fars ceramics of the early 5th millennium BC.

According to Kaboli (2000, 133) mobile pastoralism is still practiced in the region by some small tribes. Sheep and goats are the primary stocks, but camels are also raised. In the hot summer months, the pastoralists move to the mountains near the provincial town of Saveh, northwest of Qom, or to the nearby Marreh Mountains. While much research is needed to shed light on the dynamics of the appearance in the Central Plateau of the typical 5th millennium ceramics of Fars and Susiana, it may be related to the demand for copper in south and south-western Iran.

The typical pottery decorated primarily with the dot motif has also been found in the Arisman area in the Kāshān region, the locus of numerous copper mines. The pottery was found during a survey by Barbara Helwing of the German Archaeological Institute and Naser Chegini of the ICHO in the Arisman area[23]. The typical dot motif pottery was found, as in the Qom area, with the contemporary local late Cheshme Ali pottery (early 5th Millennium BC). Excavations at the sites with this typical south-western Iran pottery should tell us a great deal about the dynamics through which this pottery was introduced into the Central Plateau.

If the appearance in the central plateau of the typical 5th millennium BC south-western and south-central pottery decorated with the dot motif implies interactions between south-western Iran and the Central Plateau, the presence of typical central plateau pottery in the Zagros Mountains provides support for our argument (Fig. 9). While no genuine pottery of the Sialk II type (Cheshme Ali phase) has been reported from south-western Iran, Sialk III type pottery has been reported from surveys and excavations in the heart of the Bakhtyari mobile pastoralist tribes of central Zagros regions of Khaneh Mirza (Zagarell 1975, 146) and from Godin period VI and the mound of She Gabi in the Kangavar area.[24] This, together with the evidence of the later 3rd millennium BC grey ware that is found both in the Zagros region and in the central plateau provide evidence for the continuity of interactions between south-western and south-central Iran with points north and east that seem to have begun in the beginning of the 5th millennium BC.

Conclusion

The introduction of the specific Late Susiana 1 pottery in the copper-rich Central Plateau may be linked with exchange activities of south-western mobile pastoralist tribes in procuring copper, turquoise, and lapis, which began to appear in Fars and lowland Susiana and Mesopotamia[25] in the 5th millennium BC. Much work in the region, however, is required to shed more light on this inference. The presence of the typical 5th millennium south-western pottery in the Central Plateau can also be explained in terms of a reciprocal social system involving pottery vessels and/or their contents as gifts to gain access in 'foreign' contries (*e.g.*, Earle 1994; Gregory 1982; Hodder 1980).

Another factor in the socio-economic development of mobile pastoralism in south-western Iran may be related to the gradual rise of nascent urban centres with industrial and economic specialisation and the rise of regional elite. Specifically, the rising demand for wool may be considered as a contributing factor (Kouchoukos 1998). In an approach that favours ratios of NISP (number of identified specimen present) values among taxa, Richard Redding (1981; 1993) has shown that, with the exception of Hassunan and Halafian sites in northern Mesopotamia and Syria, prior to 5500 BC sheep/goat ratios were more or less uniformly low (>0.5). By 4500 BC the ratios changed to 1.5-4.5, indicating a changing trend in herding strategy from a subsistence economy to an economy where animal by-products became important (see Kouchoukos 1998, 294-301).

By the late Middle Susiana phase (*c.* 5000 BC) sheep and goats became dominant in Susiana accounting for *c.* 65% at Jafarābād, with sheep becoming more dominant in later phase (Kouchoukos 1998, 68). Similar development occurred at the contemporary Chogha Mish. If we consider this development as an indication of the increasing importance of wool in Susiana, as well as in southern Mesopotamia,[26] then the concomitant appearance of the large cemeteries of Hakalān and Parchineh may not be coincidental. We

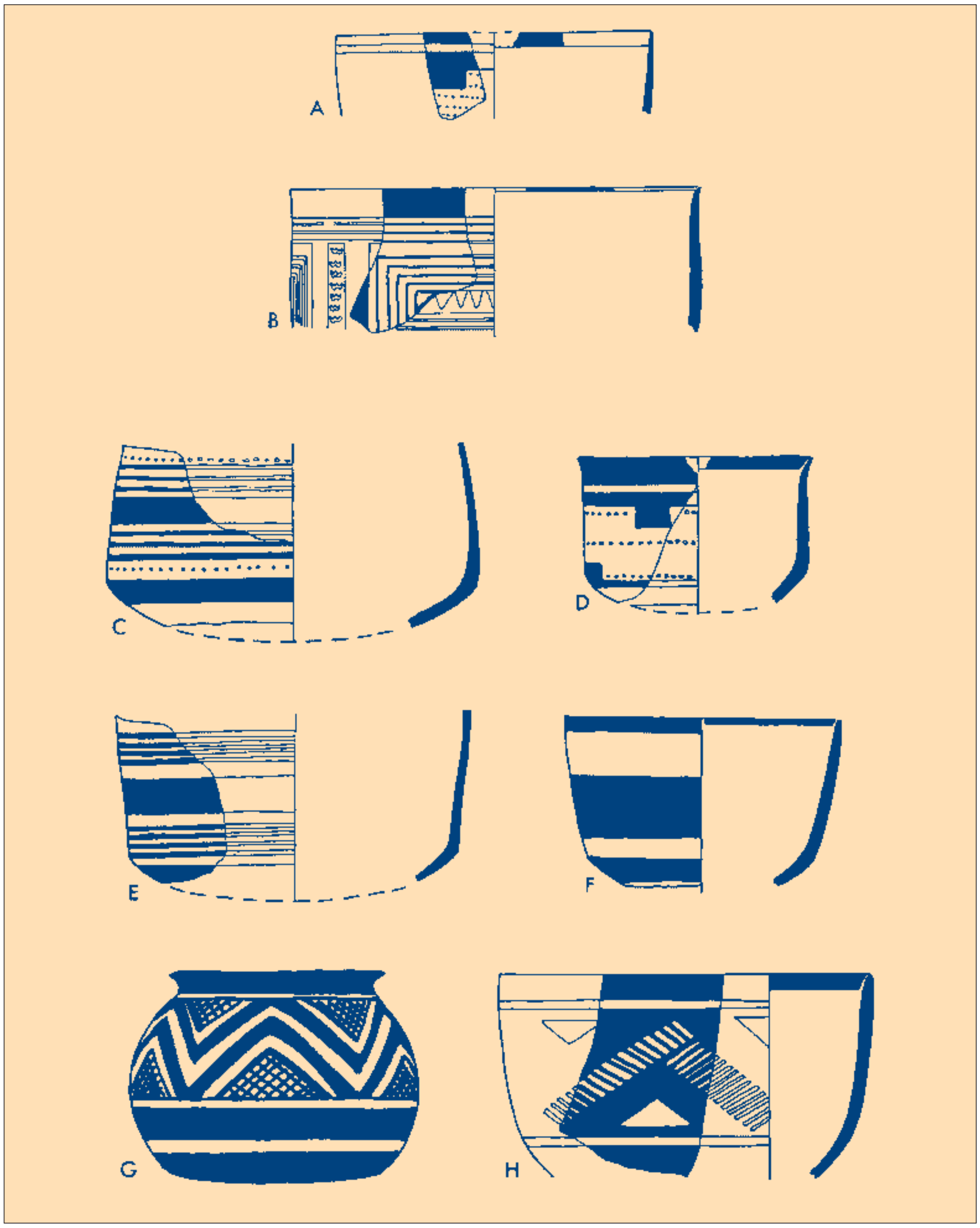

Fig. 9: Examples of Late Susiana 1 pottery (c. 4800-4300 BC).

can envisage a situation where the initial development of highland mobile pastoralism in late prehistory was perhaps related to the importance of wool in the economies of both Susiana and southern Mesopotamia.

Taken together, the available evidence suggests that as craft specialisation developed and nascent urban centres became more populated, more organised and differentiated socially and economically in the 5th millennium BC, the demand for grains, wool, dairy products, animal by-products, timber and exotic goods (*e.g.*, copper, turquoise, lapis, Persian Gulf shells) increased. In this context, the mobile pastoralist groups were in a strategic position to become the intermediaries between the lowlands and highlands. While small farming villages could provide the necessary grains for these newly developed population centres, items of trade not found in the lowlands were procured through the mobile tribes of south-western Iran. On the other hand, if as a result of population increase and specialisation of crafts, more land was brought under cultivation in central eastern Khuzestan to feed that portion of the population that was not engaged in producing food, one expects to see a reduction in pasture lands in the same area. This situation could have created a context where the mobile tribes may have taken measure to reclaim the lands they lost to the farmers. While no direct evidence is available for intensification of agriculture and the subsequent loss of pasture in the 5th millennium BC Khuzestan, the pattern of competition for the available land between the contemporary mobile pastoralist tribes and settled farmers is familiar in Iran.

Notes

1 See for examples, Adams 1974; Bernbeck 1992; Cribb 1991; Geddes 1983; Gilbert 1975; 1983; Köhler-Rollefson 1992; Levy 1983; Oates & Oates 1976; Smith 1983.

2 See for examples Carneiro 1967; Earle 1991; Flannery 1972; Friedman & Rowlands 1977; Sanders & Price 1968; Upham 1987. See also Feinman 2000 for a detailed analysis of the role of this factor in social organization.

3 Akkermans & Duistermaat (1996) attribute the much earlier evidence of sealings found at Tell Sabi Abyad in Syria to the nomadic component of the region.

4 Rothman 1988, 461, 599-625, considers Gawra as an independent specialised site with perhaps a nomadic clientele population.

5 See Eerkens 2003 for a full treatment of this problem and the question of residential mobility.

6 See also Alizadeh *et al.* 2004.

7 "Strong ties" include "endotribal" marriages (both with the settled and mobile Qashqāii), settling of non-criminal dispute through the local Qashqāii chiefs, and economic interaction primarily involving hiring of Qashqāii shepherds to tend flocks of sheep and goats.

8 If women were active potters or pot painters in prehistory, and there is no reason not to consider this alternative, inter-regional marriages in patrilocal societies certainly would lead to the spread of specific pottery styles that in the course of time would become either diluted or would undergo hybridisation.

9 See Earle 1994 for a detailed discussion of various aspects of socio-economic integration in societal evolution.

10 See for examples, Bosworth 1973; Bottero 1981; Castillo 1981; Cribb 1991; Digard 1981; Edzard 1981; Herodotus 1972; Khazanov 1984; Lambton 1973; Luke 1965; Malbran-Labat 1981; Melink 1964; Oppenheim 1977; Postgate 1981; Roux 1966; Rowton 1981; Strabo 1969.

11 See Varjavand 1967, 19. For similar practice among the Sudanese mobile pastoralists, see Teitelbaum 1984, 51-65.

12 See also the lively description of Freya Stark (1934), who reports the same practice in parts of Lurestan.

13 Barth 1961, 104 ff.; see also Ehmann 1975, 113-115, where he reports the same tendency among the Bakhtyiāri tribes.

14 For a different view on the processes of sedentarisation see Galaty 1981 and Salzman 1980.

15 See Adams 1974 for the role of mobile pastoralism in environmental and political adaptation; see also Adams 1978.

16 See Barth 1961, 130, where he discusses the importance to Fars' mobile pastoralists of the trade routes leading to major ports of the Persian Gulf.

17 The final report was superbly published posthumously by E. Haerinck & B. Overlaet (1996).

18 See Flannery 1999b for a comparative study of the modern-day mobile pastoralist confederacy of Khamseh and chiefdom societies in the Near East.

19 Vanden Berghe 1975, fig. 5: 6, fig. 6: 7-8, 17, 20 (Late Ubaid style); fig. 5: 13-15, 18, fig. 6: 9, 13, 16, 18 (Late Susiana 1 style); fig. 6: 11 (Central Plateau style); fig. 5: 2, 12 (Fars style).

20 Site KS-04, about 10 km southwest of Chogha Mish is considered by Kouchoukos (1998) as a large (3-8 ha) population centre dating to this phase. But it is not certain how much of the site had been occupied during the Late Susiana 1 phase.

21 Other members of the survey team included Kourosh Rustaei and A. Moqadam of the ICHO.

22 See for examples Kaboli 2000, pls. 19: 1; 29: 1-3; 33: 15-16; 36: 10; 37: 1-5; 39: 11.

23 Barbara Helwing personal communication.

24 See Young 1969, Fig. 7: 1-17; Young & Levine 1974, Fig. 14: 1-20; Levine & Young 1987, Figs. 10: 50.2-5, 12: 10, 17: 1-12.

25 The evidence from Mesopotamia is even earlier, except for that found at Gawra: Yarim Tappeh I, level 9 (Merpert & Munchaev 1987, 15, 17); Arpachiyah, Half levels (Mallowan & Rose 1935, 97, pl. ivb) Gawra level XIII (Tobler 1950, 192).

26 For the detailed study of the importance of wool in southern Mesopotamian economy during the Uruk period, see Kouchoukos 1998.

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Iran and Germany – Scientific, Economic, and Political Contacts and Relations in the Course of the Centuries

Rainer Slotta

Summary

For a long time, Germany and Iran used to exist just alongside each other – a situation which, due to the great distance between the two countries and peoples, is not at all surprising. However, since the beginning of the early Modern Age there have again and again been points of contact, resulting from human curiosity about foreign regions and from interest in new experiences and relations: they were of political, economic, and cultural nature.

In the following, from the many examples only some important contacts and relations shall be presented. This compilation is not the result of the author's own investigations and research but it is a summary of the results by Bast (Bast I; Bast II), Blücher (Blücher 1960), Catanzaro (Catanzaro), Fragner (Fragner), Gabriel (Gabriel 1952), Huff (Huff), Kochwasser (1960; 1961), and Kröger (Kröger).

Persia in the Reports of German or German Speaking Travellers and Researchers until 1950

In the year 1396 the knight Johann Schiltberger (1381-1440?) from the Bavarian town of Freising was captured by Sultan Bajasid I. in the battle of Nikopolis who kept him among his entourage as his personal prisoner (Schiltberger 1859). Six years later, both prince and slave were captured by Tamerlan's (1336-1404) Mongols in the battle of Ankara. Schiltberger followed the Mongols from what is the Turkish frontier today to the Gulf, to the Caspian Sea, and to Khorasan, even to China until in the year 1427 he succeeded with escaping. Having returned to Bavaria he wrote down his adventures and mentioned Isfahān, Yazd, Shiraz, and the coast of the Persian Gulf: his report was widely published and is of interest as it is the first in the line of German reports on Persia though rather exploiting the European knowledge of his time than enlarging it: in those days, there already was some knowledge of the Middle and Far East in Germany from Marco Polo's (1254-1324) writings, from Ruy Gonzalez de Clavijo (?-1412), the Venecian ambassador and envoy of the Church. However, the detailed descriptions of Persia by the Arabian geographers were unknown to Europe.

Politics seem to dominate the German-Iranian relations; starting point in the Renaissance was "lust for research" born from the ancient writers and newly fed by the reports by a Marco Polo on the legendary rich countries in the Orient and in Persia. The sea voyages by adventurers and researchers like Christopher Columbus (*c.* 1451-c. 1506) and Fernando Maghellan (1480-1521) and the expansion of states like Spain and Venice to previously unknown markets led to "new shores". Thus, also Rudolf II, emperor of the Holy Roman Empire of the German Nation and residing at Prague, in the year 1602 sent an embassy to Persia led by the Transsylvanian magnate Stephan Kakasch von Zalonkemeny as an answer to the visit of a Persian envoy in the year 1600 who had been sent by the great Shah Abbas I (1558-1628). The embassy's task was to found a political alliance of Persia and the Holy Roman Empire of the German Nation against the Ottoman Empire. The expedition ended in tragedy, the Saxon Georg Tectander von der Jabel, writer of the embassy, was the only one to survive and in the year 1610 he reported on this journey, telling about it "just left on my own in heavy mourning and grief". According to his account, he travelled through Gilan and Azarbaidjan and spent some time at Tabriz before accompanying Shah Abbas I during the latter's campaign to Trans-Caucasia. Tectander only slightly impro-

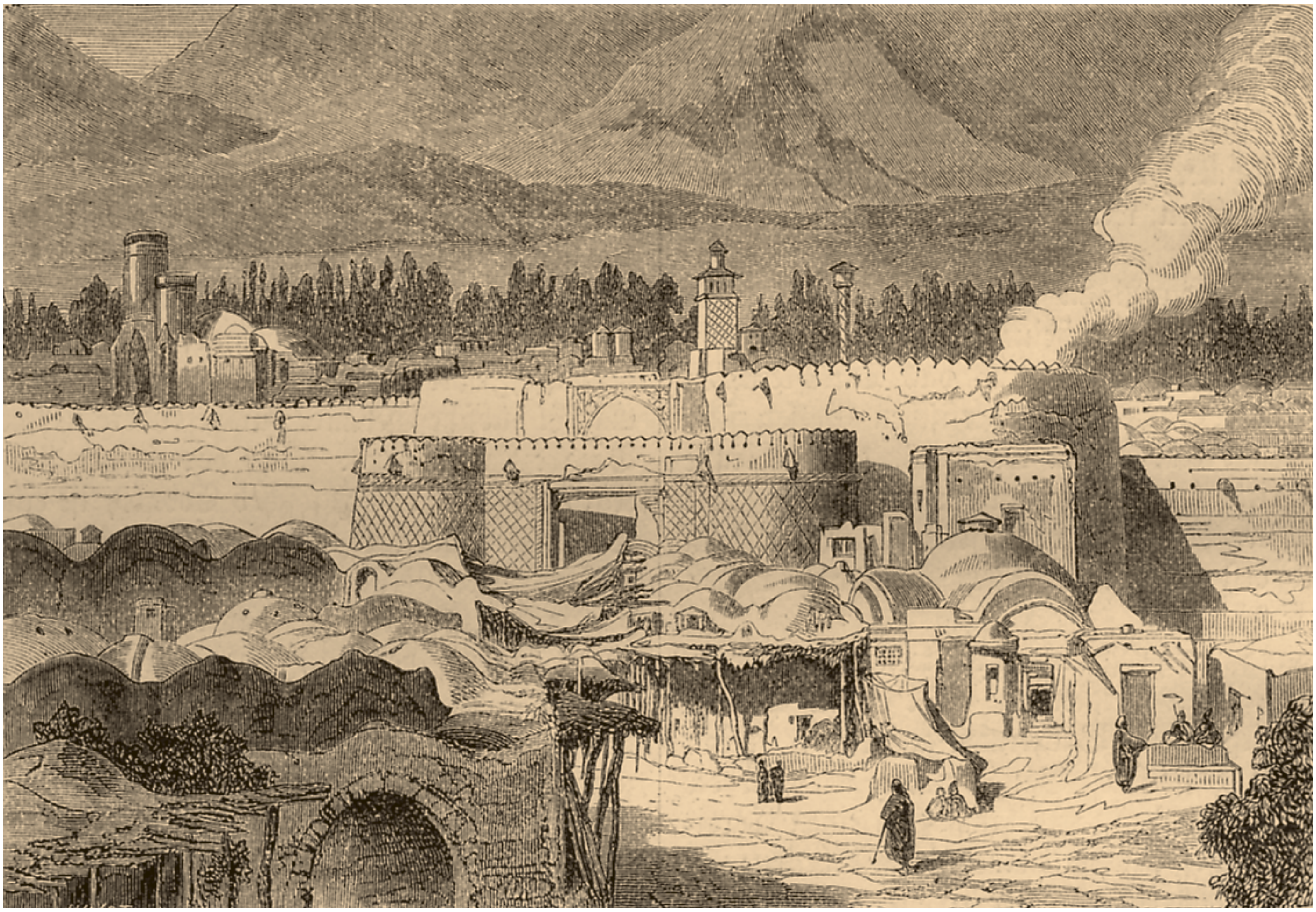


Fig. 1: "The gate of Shah Abdulazim in Tehrān" , Globus 1862a, 33.

ved Central Europe's knowledge of Persia but at least exceeded the results of a second embassy seven years later, led by Wratislaw von Dohna who died in Persia: there exists no report on this journey, the same is true for the journey of an embassy of Karl V (1500-1558) which was one of the first of such missions of German politicians (Hinz 1935, 408).

The line of people who tried to achieve knowledge of Persia out of their own interest starts with the Silesians Heinrich von Poser and Groß-Nedlitz who travelled to India via Persia on a different route and who came back three years later via Bander Abbas and Isfahān. Groß-Nedlitz for the first time reported on various regions in the East of Persia: his descriptions of Isfahān, where he met the famous Italian traveller Pietro della Valle (1586-1652), and of Jolfa, Tabriz, Sultaniyeh, Golpaygan, and Kunsar are limited but seem to be reliable. Von Poser wanted to go to India but instead of taking the shorter route across the sea via Bander Abbas he chose the one via Yazd, the Lut desert, and Afghanistan. On his way back he went via Bander Abbas and Isfahān. Von Poser's report was published in Jena in the year 1675 "by his grateful son Heinrich von Poser und Groß-Nedlitz". (Poser 1675).

The first scientifically educated travellers to Persia were Hans Christoph von Teufel von Krottendorf, Baron von Guntersdorf-Eckartsau, and Georg Christoph Fernberger von Egenberg who in the year 1588 went together from Austria to the Orient and reached Ormus on the Gulf via Aleppo and the Euphrates. There, two split up: von Teufel chose the way to Qazwin via Isfahān and was robbed of all his possessions after having preferred the longer way to Qazwin via Isfahān in order of trying to avoid robbers. His descriptions of country and roads show reality, he tells about "very infertile, very mountainous country (though with bare, rocky mountains)". For the sake of safety, Fernberger crossed Persia on his way back from Indochina – from Isfahān to Tabriz – by joining one of the gigantic caravans of those days with some thousands of donkeys on known routes and in 1590 he returned to his home (Stratil-Sauer 1960, 268).

When after World War I a public limited company tried to install trade exchange by help of motor yachts via the Baltic Sea, the Marienkanal, the Volga, and the Caspian Sea, this enterprise was a failure just like the so called Holstein mission (1635 to 1639) of Duke Friedrich III von Holstein-Gottorp (1597-1659). It had been started to transport silk and other goods from the Safawide court to Friedrichstadt via Russia. The participant Adam Ölschläger (Olearius in Latin) (1599-1671) reported on this mission. His descriptions and astronomic observations, based on his own judgements, were of special significance, the map which he drew following his position findings meant to be a decisive progress concerning the geography of Persia. For example, he corrected the position finding of the Southeast of the Caspian Sea by shifting it four degrees to the South and showed the interior, which only ten years before on the map of the Englishman Herbert had hardly played any role, almost according to its correct shape (Olearius 1656; 1658). When in the year 1638 the Holstein embassy left Persia and Shah Safi (1629-1642), Johann Albrecht von Mandelslo (1616-1644) went his own ways: he continued his journey together with a man from Gdansk and two men from Mecklenburg, visited Persepolis and the mission of the Carmelites at Shiraz. Being ill from drinking the "mash-thick, stinking water", von Mandelslo reached the Gulf to go on to India, Ceylon, and Madagascar after having recovered (Mandelslo 1651; Kochwasser 1960, 37-41). In 1647 Jürgen Andersen, also by order of Duke Friedrich III von Holstein-Gottorp, joined the service of Shah Abbas II (1642-1667) as an officer of artillery: he returned by the end of 1650 and wrote a report on his journey which was also published by Olearius (Gabriel 1952, 88-92; Olearius [publ. by v. Haberland], 18-21; Kochwasser 1960, 246-255).

Engelbert Kämpfer (1651-1719) distinguished himself by scientific seriousness. Being a physician, he accompanied a Swedish embassy under Dutch leadership; among all the early German travellers he was the most accurate observer. Though only visiting already known places in the years 1683 to 1688, he published many new insights due to his accurate and critical explanations: he came to Isfahān in 1684, stayed there for 20 months, studied the plants of Persia there (most of all on "asa foetida" and on date palms) and devoted himself to medicine and cartography. By the end of 1685 he travelled to Bander Abbas, spent three days at Persepolis on his way, and at Bander Abbas had to wait for more than two years to find a ship. Thus, there he fulfilled the tasks of a physician of the Dutch East-India Company. In 1688 he continued his journey as far as to Japan: his "Amoenitates exoticae", written in Latin in five volumes (the last volume on Japan, indeed), were forgotten but in the middle of the 20th century they were "newly discovered" and published as they were considered a valuable addition to the sciences (Kaempfer 1712; Stratil-Sauer 1960, 268).

Again and again single Germans came to the Safawides' Persia, such as Daniel Parthey, a soldier in the service of the Dutch East-India Company fighting Arabian pirates near Bander Abbas. In 1717 Johann Gottlieb Worm accompanied an envoy of the Dutch East-India Company to the Safawides' court and travelled from India to Isfahān via Bander Abbas where he met the German physician Wenzel von Altenburg who lived in Persia for 18 years. Worm brought additional news to the West about the route from Bander Abbas to Isfahān; five years later the then Persian capital was burned down and almost depopulated by Afghans. The last German visitors to Persia in the 17th century were the two catholic clergymen Wilhelm Weber and Wilhelm Mayr in the year 1700, the student Ernst Hanxleben (1681-1732) as well as young Franz Kaspar Schillinger who published a report: they crossed Persia by taking the route Tabriz, Qazwin, Isfahān to Bander Abbas on their way to India; only two of them survived (Gabriel 1952, 98, 111-112, 118; Kochwasser 1961, 41-42; Parthey 1697; Worm 1737; Schillinger 1716).

For Persia, the 18th century brought the devastating raid of the Afghans and the end of the Safawide dynasty as well as wars against Turks and Russians, the conquest of India by Nadir Shah (1688-1744), and again and again lootings by nomad tribes: the troubled times of the first half of the century did hardly invite strangers and travellers to Persia.

Carsten Niebuhr (1733-1815), the researcher of the Jemen, was in Persia in 1765 where at Persepolis he was the first to copy inscriptions in cuneiform writing as a basis for later tries to decipher them. On his way back he was the only survivor of an expedition which had been sent to India and Arabia by the Danish king Frederick V (1723-1766). Niebuhr travelled from Busheir to Shiraz but made a considerable detour through Kormuj and Lar (Gabriel 1952, 123) and also visited the island of Karg in the Persian Gulf. His very observant eye and his skills as a cartographer considerably improved the knowledge of Persia (Scurla 1876, 243-249).

The Russian Czarina Elisabeth I (1709-1761) sent a great embassy to Nadir's preacock throne – captured in India – but according to the reports by the physician J. J. Lerch it had to be given up due to numerous casualties and cases of illness. By Russian support, the natural scientists from the St. Petersburg Academy Samuel Gottlieb Gmelin (1744-1774) and C. Hrablitzl carried out studies around the Caspian Sea. To these young scientists, of which the former would die young in prison, we owe informative descriptions of the flora and fauna in Persia (Stratil-Sauer 1960, 268-269; Gabriel 1952, 129; Gmelin 1784).

If in the past Persia had been important for the European powers as a partner in trade, as a transit country, or as an ally, with increasing political weakness in the 19th century it was understood to be a bulwark against India or Russia: thus at the same time the interest in intensive (political, military, and economic) insight into this region rose. It was mostly Balts in Russian service who now are of interest: Moritz von Kotzebue (1798-1861) accompanied and described the journey of a Russian embassy which in 1817 via Tabriz went from Tbilissi to Tehrān, the new capital of the Qadshar dynasty, where it was welcomed by the Persian crown prince, and then on to Zanjan and Soltaan; his report was published by his father at Weimar (Stratil-Sauer 1960, 269; Kotzebue 1919, 153-174, 319-327).

In the 1840s, the German geographer Moritz Wagner (1813-1887) travelled through Western Azarbaidjan. He was particularly interested in the region around Lake Rezaiye (former Lake Urmia) (Gabriel 1952, 150; Wagner 1852). In 1849, F. A. Buhse, who had already carried out considerable research in the Alborz mountains and in Azarbaidjan, dared a journey to the Great Kewir which had not been crossed by any European before: he was the one who for the first time informed the sciences about these vast salt marshes, being dry in summer, with their grey-yellowish soil whose main

Fig. 2: "Suburb of Tehrān"; Globus 1862a, 36.

components he had already analyzed. Thus, a complete new world was discovered (Stratil-Sauer 1960, 269)!

C. Grewink (1819-1887) in 1853 described "the geognostic and orographic situation in Northern Persia", including a big map and pictures. In 1856 we find N. v. Seydlitz to be in Azarbaidjan, there mostly in the region of Lake Rezaiye. Also extraordinarily strong was the Baltic contribution to the great expedition of the Petersburg Geographical Society, led by Nikolaus v. Khanikoff: to the astronomer R. Lenz we owe the position findings which at last allowed to draw reliable maps of Eastern Persia; the geologist A. Goebel during his studies visited on his own the ancient copper mines at Qaleh Zari near Besiran at the rims of the Lut desert, and the botanist A. v. Runge was the first to be able of researching the Eastern Persian mountains and the Lut desert. The zoologist Count Keyserling disappointedly turned away from Persia as in the deserts of Iran there was no rich material for research.

In 1857, the Austrian attaché to Constantinople, Otto Blau, travelled the Turkish-Persian border-region while coming from Trabzon; his interest was in economy and trade. Resulting from his investigations, Blau speaks of the high economic potential and suggests increase of trade (Blau 1858, 251-262; Kochwasser 1961, 61-63); Martin 1959, 20). Also under the impression of the possible perspective as described by Blau a Prussian military mission, led by Julius Freiherr von Minutoli (1817-1891), travelled through Western and Central Persia between April, 1860, and April, 1861; the enterprise did hardly produce any result worth mentioning but in his publication the orientalist Heinrich Brugsch (1827-1894), who had taken over leadership of the mission after Minutoli's death, reported new information particularly about the region between Hamadan and Tehrān. In 1885, Brugsch came back to Persia as a member of the German embassy in Tehrān (Brugsch 1862-1863; Scurla 1876, 322-325).

Since 1851 the physician Jacob Eduard Polak from Vienna (1818-1891) had been working at the medical school in Tehrān and later also as the Shah's personal physician. Due to his extended journeys and his profound knowledge of Persian language and literature, Polak was a subtle expert on Persia, as proven by his two-volumed main issue from 1865 as well as by his specialized studies (Polak 1865; 1888). He made decisive suggestions to other researchers: among them, there counts mostly Emil Tietze, born in Breslau in 1845, who came to the K. K. Geologische Reichsanstalt

Fig. 3: "In a room of the court in Tehrān"; Globus 1862a, 37.

(Royal and Imperial Geological Institution of the Empire) in Vienna in 1970. During his work in Persia from 1873 to 1875 he made a thrust to the Sia-Kuh at the Northern rim of the vast salt desert. From these studies there sprang his important paper "Zur Theorie der Entstehung der Salzsteppen" (On the Theory on the Formation of Salt Steppes). His analysis in the Alborz mountains and at the Damavand massive layed the foundations of our knowledge of these mountains, as the synopsis of his research he wrote his publication "Bodenplastik und Geologie Persiens" (On Formations and Geology in Persia) (Stratil-Sauer 1960, 269).

The geologist Hermann Abich (born in Berlin in 1806, was offered a chair at the University of Dorpat in 1842, and died in 1886) devoted his life to the Caucasian, Trans-Caucasian, and partly also to the Azarbaidjan mountains until he went to Vienna in 1876. Gustav Radde (1831-1903), founder of the Caucasian Museum in Tblissi in Georgia, and also in the Russian service, was successfully employed in the West of the Russian-Persian border-region in 1879/1880 and in the East of the region in 1886. By the end of the 19th century, the Finno-German A. F. v. Stahl – being Iran's postmaster – by extended journeys gained high credit for his geological research of the country, most of all of the mostly unknown border country of the interior deserts. Several times he worked in the Northwest of Persia and intensively studied the formation of the Alborz Mountains. To him we owe important reports on ore deposits and mining. After having come back to Persia several times, he offered an incomplete but exemplarily summarizing report on the country. For a long time, his geological maps were the starting point of much research (Stratil-Sauer 1960, 269).

Though the geographer Franz Stolze (1836-1910) had been sent to Isfahān as an astronomer to observe the passing of Venus in 1874, he – just as the later arriving philologist Friedrich Carl Andreas (1846-1930) – was that much captivated by the monuments of ancient Persian history that both of them published important books of pictures on them. Stolze visited Persepolis, Fasa, Darab, and Firuzabad where Andreas joined him. Both researchers stayed in Persia until 1880 or rather 1881; they expressed their observations in a widely recepted report on trade and infrastructure in Persia (Stolze & Andreas 1882; 1885; Kochwasser 1961, 89ff.).

Johann Wilhelm Helfer (1810-1840), born in Prague, on his journey through Turkey was able to join a huge British expedition which for the project of postal service from London to India via Mesopotamia also researched the delta-area of Khuzestan. Helfer died in the year 1840 but 33 years later his wife was able to publish his results which partly are on territory being Iranian still today. Among the Austrians, who came to the fore in the 19th century, Theodor Kotschy (1813-1866) was the first: in 1842, he was maybe not the very first but one of the first to climb the 5680 m high Mount Damavand, he started important collections on botany and zoology, and he published the first geological observations on the Alborz mountains; furthermore, he was also active in the South of the country. His unique collections have been preserved but part of his records is lost. Ida Pfeiffer from Vienna (1797-1858) shall also be mentioned here: in the course of her journeys she was one of the first women to step into hitherto unknown regions. In 1848 she crossed the Zagros chains in the Kurdish territories to come back from her journey around the world via Tabriz with a rich collection of insects and reptiles (Stratil-Sauer 1960, 269).

On his way from Hamadan to Qazwin in the year 1882, Polak together with the geologist F. Wähner made numerous important observations. In 1885 he initiated basic fundamental research of the Rezaiye basin in Noth-western Persia by the geologist A. Rodler who in 1886 also researched the Bakhtiar Mountains (Central Zagros) on hitherto unknown paths. Before that, H. Pohlig had already carried out geological studies in the Sahand Mountains and at Lake Rezaiye. Also supported by Polak, there travelled O. Stapf: besides a rich collection of plants from the Southern Zagros chain we owe to him research of the hitherto unvisited Gaw-Khane, i.e. the lake or rather marsh at the mouth of River Isfahān (Stratil-Sauer 1960, 269).

In 1976, the Austrian vice-consul in Constantinople, C. von Call-Rosenberg, made a journey to Persia: he climbed the Damavand and most of all studied the economic situation of the coastal province. Among the Austrian researchers, also the Tyrolese A. Gasteiger von Ravenstein-Kobach must be mentioned (as a Persian general he was called Gasteiger-Khan) who between 1860 and 1882 was able to collect extraordinary knowledge of the country and its people and who, being the only engineer with the numerous Austrian military missions, knew how to improve geographic insights on Persia. Also the Austrian major A. Krziz must be emphasized whose measurements of Tehrān were published by Polak in 1877. Gasteiger travelled to Mazandaran and Astarabad, built mountain roads into the Alborz and in Baluchistan, and marched on paths which no European before him or – like at Gjaz Muriyan – only Alexander the Great had set a foot on. Also the Austrians G. v. Riederer (as General Postmaster) and C. von Taufenstein (as General Governor) were in the Shah's service. Both of them reported on their enthusiastic but mostly vain efforts. In the year 1899, H. Winklehner published a report on deposit-research in Southern Persia. Finally, the geologist Carl Ludwig Griesbach, born in Vienna in 1847, shall be mentioned who from 1893 to 1903 worked as director of the Geological Service in British India: his life's work is a two-volumed geology of Afghanistan in which he also repeatedly payed attention to the Persian province of Khorasan (Stratil-Sauer 1960, 269-270).

The cause of this particular preference of Austrians is as simple as it is typical: when in the second half of the 19th century the Persian Shah Nasr-ed Din was repeatedly and in grand style paying visits to Europe, the courts, having contact to rulers from the Middle East for the first time, reacted in very different ways. The majority smiled at the foreign customs and felt more sensation than respect towards the oldest crown – with one exception: Franz Josef I. definitely treated his guest as a monarch of equal rank. Thus, while recognizing this attitude, in the following the Shah would prefer to reach back to Austrians when his country needed specialized knowledge.

But there were also numerous Germans who in the 19th century rendered outstanding services to the research of Persia. After a journey to the Orient from the year 1852 to 1855, H. Petermann described his route from the Gulf of Shiraz to Tehrān (Petermann

Fig. 4: "Persian physiognomies"; Globus 1862a, 40.

1865). Moritz Wagner (1813-1887) however, whose goal was the research of North-western Persia, faced so many difficulties that he had to restrict his activities to the area around Lake Urmia (Rezaiye) (Wagner 1852). Unfortunately, there is only very few information about W. Faber's observations of the Kurds, South of the lake. In 1867, the botanist G. Hausmann was able to advance as far as to the Kurdish part of the Zagros Mountains where a. o. he followed the upper course of the Djala. As a contribution to H. Kiepert's (1818-1899) map, he told the latter about his studies on the flora of the high mountains (Stratil-Sauer 1960, 270).

As one of the most enthusiastic and most reliable authors on Persia A. Schindler must be mentioned who under the name of Persian general Houtum-Schindler was extraordinarily renowned. Like his predecessor Gasteiger-Khan, having served the Shah mostly as a builder of roads, Schindler travelled through the country to build up a telegraph network. Even more than his descriptions, his careful records of his routes are striking, supplying valuable foundations of the Persian cartography. To his "Beschreibung einiger weniger bekannter Routen in Chorassan" (Description of Some Less Known Routes in Khorassan), telling not only about the telegraph line to Mashad which he erected but also about excursions off the road, we owe crucial insights. To him we owe one of the first descriptions of turquoise mining at Nishapur. In 1877 he travelled through Luristan, wandered through the territory of the warlike Bakhtiarii and there discovered two lakes. During his work on the line from Hamadan to Tehrān he discovered an ancient temple – as Herzfeld was to find out later, it was the only Seleucian temple of those days in Persia. In 1879, Schindler layed a double-line from Kerman to Bander Abbas through (often) unknown territory and researched the Khabis (Kerman) mountains at the Western rim of the Lut desert. In 1881/1882 he layed telegraph lines in Azarbaidjan, was active as a cartographer in Kurdistan and worked out reliable routes as far as to Tehrān. Having returned to his home, he published plates on Persian climate as early as in 1909, twenty years after W. Gotthardt in his very commendable dissertation thesis had already collected and published earlier travellers' records on the climate (Stratil-Sauer 1960, 270).

During the second half of the 19th century and until the beginning of World War I, Persia was very often visited by German travellers so that here only those shall be mentioned whose publications offered new results to sciences and research. E.g. Max von Thielmann during his "Streifzüge im Kaukasus, in Persien und in der Asiatischen Türkei" (Wanderings through the Caucasus, through Persia, and through Asian Turkey) in 1872 crossed the Rezaiye basin and the Kurdish parts of the Zagros chains (Thielmann 1875). At Rasht, on the shores of the Caspian Sea, the Saxon physician J. C. Häntzsche opened a clinic and during his stay of seven years he collected profound information of the country and its people: by his "Spezialstatistik von Persien" (Special Statistics on Persia), published in 1869, which for the first time offered insights into the complicated ethnographic situation, he made particular contribution (Stratil-Sauer 1960, 270).

The botanist J. Bornmüller (1862-1948) in 1892/1893 worked in the high mountains South and East of Kerman and as far as to the Gulf as well as ten years later at the Damavand Mountain and at other peaks of the Alborz: mostly, he is famous as a reviser of Persian herbaria. Also Franz Theodor Strauß must be mentioned who as a merchant was living for 20 years at Sultanabad (Arāk): between 1889 and 1910 he visited the territory of the Bakhtiarii, travelled from Kermanshah back to Sultanabad across the 4000 m high mountains, and in the gorges of the Luristan Zagros saw a country which had once been full of life and meaning. His carefully worked out maps contributed much to the knowledge of Central Persian mountainous areas. C. F. Lehmann-Haupt's (1898) and O. Mann's (1901-1903) journeys were mostly for archaeologic purpose but the latter's extended journeys in Fars, through the Bakhtiarii mountains, through Luristan, and Southern Kurdistan were also of some help for geography (Lehmann-Haupt 1910; Mann 1903; Stratil-Sauer 1960, 270).

German contribution to archaeology (a. o. by Friedrich Sarre and Ernst Herzfeld) is considerable (s. b.) so that here it shall not be described in detail. With Ernst Herzfeld (and his successor E. F. Schmidt, a German who had emigrated to the USA) a new chapter of Iran's archaeology started (s. b): both of them turned research on Persia's history towards a new direction and meaning and also geography owes much to them, particularly to Herzfeld due to his sometimes dangerous journeys through Luristan and the then unknown East, and to Schmidt for his impressive aerial photographies.

In 1904, the Munich zoologist E. Zugmayer worked at Lake Urmia which H. Bruck was able to map in detail eight years later; during World War I we find Zugmayer at Serhad. In 1907, Hugo Grothe dared a thrust to the Pusht-i Kuh in Central Zagros but faced great difficulties in this nearly independent region. However, his publications supplied a lot of good material concerning regional studies on Western Persia (Zugmayer 1905; Grothe 1910; Stratil-Sauer 1960, 271). In 1912, we find Oskar von Niedermayer (1885-1948) in North-eastern Persia for the first time where, after with difficulties having crossed the North-eastern outlying mountains, he was able to considerably extend the then existing level of research. In parts he was accompanied by the Austrian art historian Ernst Diez who reported on the then hardly known building monuments in Khorassan. During World War I it was Captain von Niedermayer's task to lead an expedition of German and Austrian soldiers through Persia, which was mostly occupied by enemy troops, to Afghanistan. Though the small unit was almost annihilated it was still possible to accomplish the mission as despite all terrible hardships Niedermayer, on whom a title had been bestowed because of his military performance, was able to carry out scientific observations which he put down in his dissertation thesis on the interior basins of the Persian highlands. First Lieutenant Seiler, who with the same military mission led a unit in Southern Persia, reported on the crossing of the Lut desert from Khabis to Dehsalm (Niedermayer 1924; 1925; Stratil-Sauer 1960, 271).

Fig. 5: "Persians"; Globus 1862a, 41.

In the time between the two World Wars the Austrians again distinguished themselves with the research on Persia. The physician Alfons Gabriel (1892-1976) together with his wife carried out first expeditions in the South of the country (Baschakirt) in the year 1927, in the course of later journeys the two were also able to research the mountainous country of Hudiyan, which had never before been visited by Europeans, and the unknown North of Serhard. But the Gabriels' greatest success was in the Lut desert: while crossing this desert two times under dangerous conditions, they discovered the so called Lut-Boulevards, "streets" skirted by phantastic shapes made by the desert storm blowing through the sea loess. In the Southern Lut they found Iran's biggest sand sea with gigantic dunes of hitherto unknown height. Gabriel was the first to mention the pre-historic site of Shahdad in the Lut. They also crossed the Great Kewir on paths which were used for the first time. Besides four books and seven fundamental studies, this country doctor and passionated explorer also published a book on the exploration of Persia (Gabriel 1952; Stratil-Sauer 1960, 272).

Similar to the Gabriels, also Gustav Stratil-Sauer (1894-1975) travelled through Iran on his own in 1925 and with his wife in 1931 and 1933. The first journey resulted in a study on the geography of Persian traffic, the results of the second journey he worked into publications on Mashad, the "Eastern Persian meridian-road", "Routen durch die Wüste Lut und ihre Randgebiete" (Ways through the Lut Desert and its Outlying Areas) as well as on the "Umbruch im Morgenland" (Radical Change in the Orient). Studies on Pleistocene sedimentations and climate in the Lut, on morphology and climate at the Kuh-e Hazar, the highest mountain in Southern Persia, on the summer storms in Eastern Persia, on Sistan, on the migrations of the Eastern Iranian people, on the economic geography of the Northeast, on the town of Birjand, on the irrigation systems (qanats), and on many other subjects. In their books "Kampf um die Wüste" (Fight for the Desert) and "Iranisch-Ironisches" (Ironical Iran) the couple tells about their experiences (Stratil-Sauer 1960, 272).

H. Bobek was active in Iran several times after 1934 and finally as a visiting professor at the University of Tehrān. Besides a study on the country's natural forests, several of his essays reported mostly on the Northwest, the lowlands on the Southern coast of the Caspian Sea, on dry farming, on glaciers, and on the climate in prehistoric times and modern times: furthermore, he published a photogrammetric record of the Takht-i Suleiman region (Stratil-Sauer 1960, 272).

The geologist A. Pruttner made mappings for the North-eastern part of the Trans-Siberian railroad. Also on geology, F. Künel was working in Persia for some years during the war, while O. Kühn, palaeontologist of the University of Vienna, analyzed numerous fossils which had been brought to him as to a specialist, and A. M. Sedlacek worked on Gabriel's collection of rocks. Also the contribution to biological field research is considerable. E. Gauba reported on a botany-inspired journey to the Persian date region which supplied valuable indications of regions which had been hardly known, and afterwards on his trip through the "Hyrkanian Forest" on the shores of the Caspian Sea (Mare Hyrkanum). Gauba's studies were supported by the fact that already before World War II he had been in the service of the Persian boards for agriculture and had seen a lot of the country. Also Karl Heinz Rechinger (1906-1998), Kotschy's successor in Vienna, had been to Persia in 1937 before in 1948 he was able to carry out his studies in remote mountainous regions (Stratil-Sauer 1960, 272).

Also the Zoological Institute of Vienna carried out some expeditions to Persia. In 1949, a group of students under F. Starmühler and H. Löffler started to the little known Djas Murian region. Most of all Starmühler worked at Lake Niris in 1957 and, after having published significant results of his research, understood his goal to be a summarizing limnology of Iran. In 1934, P. Arzt at the College for World Trade published a dissertation thesis on Persia's economy and traffic. At this time, also Swiss scientists arrived on the scene: H. Rieben, who had been working in Azarbaidjan between 1925 and 1931, while summarizing his predecessors' results wrote a modern geology of North-western Persia. E. G. Bonnard and I. W. Schroeder presented new ideas on Iran's tectonics, H. Hirschl analyzed salt outcrops in the North and the South, and P. Aellen botanized near Kāshān in 1948. E. Becker presented new ideas on the structure of the interior basins, though – like E. Boehme – he only stayed at their outlying areas. On the basis of a journey shortly before the beginning of World War II, H. Wenzel explained the development of Mazandaran, while V. Segner researched and wrote on Persian cities and towns. H. Melchior concentrated mostly on the botanic geography of the Alborz Mountains, K. Kaehne researched special questions on the Rezaiye basin. K. Scharlau stated his view on the debated pluvial periods (Stratil-Sauer 1960, 272).

Political Relations between Germany and Persia

Only rather late the European powers got to be interested in Persia. The first official contact between the Safawides and the Holy Roman Empire of the German Nation dates from the year 1523 when Shah Ismail I (1501-1524) sent a letter to Karl V suggesting joint military operations against the Ottoman Empire. When as a reaction to that Johann Balbi arrived at Persia as Karl's V envoy, Ismail I had already been dead for five years (Hinz 1934, 37). Shah Abbas I contacted Emperor Rudolf II and in 1598 sent a delegation to Prague which arrived there on October 7th, 1600, and again sent two more envoys in the year 1604. It was the goal of the delegation to work out plans against the Ottoman Empire which was the common enemy. These contacts lasted until 1609 but they do not seem to have led to any concrete results (Hinz 1935, 408-409).

Due to economic reasons, Duke Friedrich III von Holstein-Gottorf in October 1635 sent an embassy to the Safawide court to import Persian goods to Central Europe. The delegation stayed at Isfahān for more than one year and on August 8th, 1639, returned, being accompanied by a Persian delegation. But in the end no lasting trade relationship resulted from this (Kochwasser 1960, 246-254). Though single travellers again and again brought news from Persia

Fig. 6: "Persian ladies in the women's chamber"; Globus 1862a, 42.

to Central Europe and Germany (s. a.) the political relations between Persia and Germany started to develop as late as in the last quarter of the 19th century, the German Reich at first playing a rather hesitating role. On June 25th, 1857, the German Customs Union signed a treaty of friendship and a trade agreement with Persia (Martin 1959, 20): while the development of trade was judged optimistically by the first Prussian envoy in the year 1857 (Blau 1858) the first Prussian delegation in 1860/1861 contradicted sharply so that no serious relation was built up (Brugsch 1862-1863).

In the second half of the 19th century, for almost 50 years there was a prudent and capable ruler in Persia in the person of Shah Nasr-ed Din (1848-1896) who, though still ruling his country in oriental ways, at the same time had a clear understanding that his state would not be saved from competing with the European world. As Nasr-ed Din feared that Russia's and Great Britain's desire for expansion would not stop at Persia's borders and as Germany after her victory over France was on the peak of her power, he hoped to find a protector in the German Reich (Blücher 1960, 234).

Thus, in the year 1873 he went on his first journey to Europe which also led him to Berlin for a few days. Before his arrival in Germany, in St. Petersburg he had had a treaty of friendship, trade agreement, and a treaty of mutual assistance formulated by the German ambassador there and by his own ambassador. Nasr-ed Din was friendly welcomed to Germany by Emperor Wilhelm I (1859-1888), the Persian shah wrote down his impressions of the German Reich in an amusing diary. He was received by Otto von Bismarck and with him exchanged the ratification instruments of the treaty which had been negotiated in St. Petersburg. But Bismarck was not at all ready to give up on the good relationship with Russia in favour of Persia. When later the Shah pressed for a German embassy to be opened in Tehrān Bismarck acted hesitantly and on his side demanded a Persian embassy to be opened in

Berlin first. However, it took until spring 1885 until Ernst von Braunschweig was sent to Tehrān as Germany's first ambassador (Blücher 1960, 234).

Also, when the Shah expressed his wish of Persia's neutrality being guaranteed by Germany and Austria, Bismarck adopted a disapproving attitude. In the autumn of 1885 the Shah sent a special emissary to Berlin and asked for military instructors for the Persian Army. But Bismarck only allowed sending officers having been retired from active service as "privateers", as a result of which the former generals Fellmer and Weth left for Persia (Blücher 1960, 234-235). In September 1885 from the English side the project of opening up Persia by help of railroad lines was suggested to Bismarck. Bismarck at that time wrote a short "no" on the margin of the concept and had an announcement made that such a project was directed against Russia and thus was unacceptable for the German Reich. When in the year 1889 the Shah paid his second visit to Berlin, Bismarck stayed on his estate Varzin, allegedly due to bad health, so that the two statesmen did not meet (Blücher 1960, 235).

With Nasr-ed Din, who in the year 1896 was murdered by a fanatic in the Abdul Asim mosque, the last shah died who was able to keep his country free from the influence of the European great powers, as under his successors Persia became the stage of rivalries between Great Britain and Russia. The two great powers were economically and politically active in Persia, acquired concessions, founded banks, paid financial advances to the Persian government and for this had themselves pawned tolls.

After Bismarck's dismissal in the year 1890 under Emperor Wilhelm II (1859-1941) Germany's foreign policy had been turned to a new direction; the monarch was looking for new foreign markets for Germany's growing industries, in the Orient this meant mostly Turkey. In this field, the building of the Baghdad railroad played a major role. By this project the German Reich was not following originally political interests but it wanted to restrict to be a freighter, as well as it wanted to exploit the rivalries between Great Britain and Russia in such a way that by "at one time a bow before the British lion, at the other time a curtsey before the Russian bear" the railroad project could be continued as far as to Kuwait on the Persian Gulf; there was no idea of continuing the railroad line as far as to Persia. However, the British foreign minister, Lord Lansdowne, considered the building of the railroad affecting British interests as up to then Great Britain alone held the shortest connection to India. Also the Russian government considered building a railroad line from West to East which was not under its control detrimental to the Russian position in Persia (Blücher 1960, 235).

Under such conditions the German trade found it difficult to establish itself on the Persian market: however, by skill, reliability, and perseverance it succeeded. Besides German companies of medium size, which imported German goods, there were two big companies: the Persian Carpet Association (Petag – Persische Teppichgesellschaft), possessing a modern factory for spinning and dyeing wool in Tabriz and branches in the most important cities of the country, and the firm of Robert Woenkhaus & Co which had branches in the harbours on the Gulf and was engaged in exporting grain, mother-of-pearl, and oyster shells. The first company was a thorn in the Russians' side, the second one in the British side so that there happened numerous unpleasant incidents which even involved the Foreign Office in Berlin. Furthermore, the Hamburg-America Line employed a regular shipping service between Hamburg and the harbours on the Gulf which due to its punctuality was very popular with the Persians but was watched suspiciously by the British (Blücher 1960, 235).

To support the German position and to let Persia directly take part in the progress of German sciences as well as to offer gifted young Persians a possibility to join German universities, in Tehrān in the year 1906 a German-Persian higher educational institution was established which was granted the right of certifying the German "Abitur". It employed eight German and eight Persian teachers and received a yearly subsidy of 40,000 Marks by the German and the Persian government each. It was a "Gymnasium" (grammar school) following the German example but the difference was that instead of Latin and Greek there was teaching of Persian and Arabian (Blücher 1960, 235-236; Rehs 1960, 276-278).

As a summary we may say that between 1884 and 1914 the German Reich was hardly interested in anything else than economy and considered a reform of the situation in Persia the guarantee for its interests. Given Persia's gradually growing significance for the economy of the German Reich it would have been natural for the Berlin government also to be politically interested in this country's fate: but this was not the case. Still Bismarck's influence was working too strongly on the Foreign Office. Also Emperor Wilhelm II in the year 1902 uttered the statement: "For me, Persia is completely uninteresting. We haven't got anything to do with her". In the same sense, Secretary of State v. Tschirsky wrote in an instruction from July 29th, 1902: "Instead, we will still set only economic goals, no political goals at all". But German trade hoped for and wished an open door in Persia and the most-favoured nation treatment which had been granted in the German-Persian trade agreement while Russia and Great Britain were considering the German Reich an unwelcomed intruder. From this there resulted numerous complications which made the relationship between the German Reich on one side and Russia and Great Britain on the other side troublesome. But during the following period Persia knew how to establish successful foreign and trade policy between the two great powers and the German Reich. This situation changed in 1907 when Great Britain and Russia came to an agreement on their interests in Persia and divided the country into Russian, British, and neutral zones, the Russians being granted the entire North.

After the British had had to accept that Russia, due to her geographical neighbourhood, considered her main interest to be in Persia, also in Berlin the conviction was more and more growing that in the Shah's empire Russia was holding the whip in hand and that one had to accept the facts. After difficult negotiations, on August 19th, 1911, there was agreement on the German-Russian Potsdam Treaty, the German Reich giving up railroad, road, and telegraph concessions in the Russian zone of influence. On the other hand, Russia gave up resistance against the Baghdad railroad and offered to build appropriate connecting railroad lines through

Fig. 7: "The Demavend in Persia"; Globus 1862a, 251.

Persia (Blücher 1960, 236). When World War I broke out, Persian patriots tried to take their chance and to lead Persia towards independence. In Berlin, under the leader of the Democratic Party, Taqi Sadeh, they founded a Persian committee which wanted to work with the Central Powers. In the beginning, the German government only very hesitantly answered the Persian ideas as Persia had no army and was more than 3000 km away from the German Reich; furthermore, the Baghdad railroad, being the only possible connection, had not yet been finished. But when, at the suggestion of Enver Pasha (1881-1922), a German-Turkish mission, led by secretary von Hentig and First Lieutenant Niedermayer, was sent to Kabul in September, 1914, to persuade the Emir of Afghanistan to join the war, the situation was different: the Emir had a regular army, the borders of his territory were at the Khaiber pass, the strategically weakest spot of British ruled India. For carrying out these plans, freedom to move in Persia was needed: thus, the Foreign Office decided for action in Persia under Fieldmarshal von der Goltz Pasha (1843-1916) who took command of the 6th Turkish army, being completed in Baghdad. For his action in Persia the fieldmarshall was supplied with a staff of 20 German officers who got the task of organizing and unanimously bringing into action the numerous liberation fighters in the country who were well armed but undisciplined. But this task was more than the German officers could cope with: when Grand Duke Nikolai Nikolajewitsch (1831-1891) moved a Russian corps against Persia from the North he drove the Persian liberation fighters away and came as far as to the Persian-Turkish border near Qasr-i Shirin. The Central Powers were lucky that meanwhile Kut-el Omara with its British garrison, which had been besieged by the Turkish 6th army, had surrendered so that Ottoman forces were at hand to take the offensive against the Russians and to throw them back as far as beyond Hamadan (Blücher 1960, 236; Gehrke 1960).

Thus, the German Reich in the summer of 1916 had the opportunity of supporting on Persian soil in the city of Kermanshah the national government under Nisam-es Saltaneh: the privy counsellor

Nadolny in those days worked as German chargé d'affaire and did everything to help the national Persian powers with their liberation from the Russians and the British and with their coping with the Western ways of life. But also this enterprise had to be given up when in March, 1917, a British army coming from the South took Baghdad and thus the connection to the German Reich was lost: the German and Ottoman troops had to leave Persia, Russian and British forces occupied the country.

When in Russia the revolution was spreading and the Empire of the Csars declined, also in Persia the Russian troops dissolved: the Persian patriotic powers gathered renewed hope, the government of the German Reich met these hopes by including into the Brest-Litowsk armistice from December 15th, 1917, the regulation that Russia was to recognize Persia's sovereignty and integrity and committed herself to leave the country: by this, the German Reich had consequently continued its Oriental policy.

Persia knew how to exploit this new situation and on February 26th, 1921, sign a treaty with the Soviet government in which the latter gave up all privileges the Csarist government had gained in Persia. Thus, also the division into the three zones was dropped and Great Britain had no choice than to accept the new situation (Blücher 1960, 236-238; Gehrke 1960).

During World War I and the fist years after it, Shah Ahmad Qadshahr sat on the Peacock Throne – an indolent young man who was not able to cope with the tasks lying ahead. He was dethroned and was replaced by General Reza who called himself Pahlewi and was to be Persia's reformer. He built a railroad line crossing the entire country from the North to the South, under him industrialization was started by building spinnings and weaving mills, sugar and jute factories, he abandoned the men's traditional head-gear and the women's veil, sometimes by brute force he crushed the power of the nomadic tribes, and established a central government in Tehrān (Blücher 1960, 238).

During these years the German Reich was represented in Persia by one of his most capable diplomats, Count von der Schulenburg (1875-1944), who recognized the great chances, offered to the German economy by Persia's beginning industrialization. In the years between 1926 and 1934 the German-Persian relationship grew to be extraordinarily good. In April, 1928, the Persian government signed contracts with leading German companies (*e.g.* Siemens and Ferrostaal), in the same year German banks granted a loan of 40 million Reichsmark. In July, 1928, the Julius Berger building firm was commissioned to build part of the Trans-Iranian Railroad, in November, 1927, Junkers had opened the Persian network of aerial traffic. German counsellors occupied leading positions in the Persian financial administration, Karl Lindenblatt functioned as chief executive of the newly founded Persian National Bank which was able to start business on September 8th, 1928: 70 German bank employees gave reconstruction aid, Otto Schniewind held an important position in the treasury. Also the German school in Tehrān, which had fallen victim to World War I, revived in 1925 in the form of a vocational school, as requested by the Persians, teaching the main subjects of crafts, most of all carpentry and metal working. The number of students was about 300, head of the five German teachers was the senior civil servant Dr. Strunk (Blücher 1960, 238; Rehs 1960).

In 1929 the oncoming economic crises led to a decline in the German-Persian economic relationship but already in the spring of 1930 German companies again were increasingly employed with building up Persian textile and sugar industries which were supervised and coordinated by the Persian National Bank. On the other hand, the German Reich's strong influence on Persia was again viewed at by Russia and Great Britain with rising suspicion. When Persia's "strong man" Abd-al Hossein Teymurta tried to play off Russia and Great Britain against Germany this resulted in serious disagreements between Persia and Germany, even increased by a press scandal as the Münchner Illustrierte Presse had made a laugh of Reza Shah. In April, 1932, Junkers was forced to give up its aerial service, Lindenblatt was dishonourably discharched and in 1933 had to appear in court, his successor Horschitz-Horst never achieved his predecessor's influence in this service, and the commission for further building the Trans-Iranian Railroad not Julius Berger was contracted but the Nordic competitor Kampsax. In the beginning on 1934, the German-Persian relations reached their deepest point, with building the country Persia increasingly turned towards countries like Italy, Belgium, Denmark, Sweden, and Czechoslovakia.

With the National Socialists seizing power, the strategy of the German Reich's foreign policy towards Persia diametrically changed and after 1934 there was a renewed convergence. Alfred Rosenberg drew up plans of a German sphere of influence from the Balkans to Turkey and from there to Persia and India which resulted in improved relations. In November, 1936, Hjalmar Schacht, the Reich's economic minister, went to Tehrān, in the following German companies like DEMAG and Ferrostaal again committed themselves in Iran, German firms contributed to a mining project at Meskani, Talmessi, Nakhlak, and Baqeroq near Anarak, and after April, 1937, the Deutsche Lufthansa offered regular flights to Tehrān and Mashad. But despite all convergence, the Iranian government was not interested in ever too close ties to the German Reich. However, in 1937 there was another Iranian-Soviet disagreement due to which the German-Iranian economic development was again hindered. When the German Reich reacted by drastically increasing the prices for its goods, Iran and the German Reich signed a new agreement on January 4th, 1939, thus improving the relations again. After the annection of Bohemia in the spring of 1939, German companies executed the orders which had been commissioned to former Czechoslovakian firms. German products were highly appreciated, the share of German trade in Persia's total trade rose to more than 40% in the last year before World War II and the number of Germans in the country rose to about 2,000 (Blücher 1960, 238; Hirschfeld 1980).

When World War II broke out, Iran feared an invasion by the Soviet Union. The German Reich's invasion in Russia lead to a renewed convergence of Iran towards the German Reich. With the war lasting on and the USA taking part in it, Iran on August 23rd, 1941, decided to expell all Germans from her territory and on January 29th, 1942, signed a treaty with Great Britain and the Soviet Union, accepting the country's occupation by the Allies; in the following Persia declared war on the German Reich on September 9th, 1943 (Blücher 1960, 238; Hirschfeld 1980; Madani 1986).

When after World War II the German economy was again able to compete on the world market, the German-Persian relations which had been interrupted by the war but had not really brought to an end were developing again. By both sides they were taken up again with remarkable energy. On October 2nd, 1950, a trade agreement between the Federal Republic of Germany and Iran was fixed, a supplementary agreement on June 3rd, 1952; both countries established diplomatic relations in October, 1953. The contracts which had been existed before World War II were revalidated on November 4th, 1954, together with an agreement of economic-technical cooperation; in the last days of February, 1955, the Shah visited the Federal Republic of Germany, Konrad Adenauer's return visit was in March/April, 1957. One result of this visit was a free trade agreement which allowed large scale German exports to the Iran. Now, the number of Germans in Iran grew fast again to reach 3,000, and the most important German companies established branches in the country. In the year 1959 German export reached the record of 515 million Marks, import rose to 410 million Marks. A German school with 16 German teachers and 250 students was established in a suburb of Tehrān, the number of Persian university students who were matriculated at German universities rose up to 2,800 (Blücher 1960, 238; Rehs 1960; Ansari 1967, 36-42; Bast I).

Also during the 1960s the good relationship between the Federal Republic of Germany and Iran were further developed; the visits of the Iranian Prime Minister Ali Alam to Bonn (1962), of President

Fig. 8: "The Chobshah-Rebi Mosque, North of Mesheb"; Globus 1862b, 97.

Lübke to Tehrān (1963), and the Shah's second visit (May/June 1967) reflected the intensification of the bilateral relationship. Also during the first years of the social-democrat/liberal coalition (1969-1982) the economic relations were further improved; German export to Iran was 1.3 billion Marks in 1972 and 5.7 billion Marks in 1976. After the effects of the oil-crises (1973) Iran increasingly tried to promote West-German investions and transfer of technology. The federal government of those days with Hans-Dietrich Genscher being foreign minister acted rather in a passive way due to the inner-Iranian situation. Though the Iranian Revolution in 1978/1979 meant a drastic break, it meant at no time a break up of relationship: out of 250 German companies there stayed about 100, the political situation could never really endanger the economic relations. In 1984, Foreign Minister Hans-Dietrich Genscher was the first hing-ranking Western politician to visit Iran again. Furthermore, the Federal Republic of Germany played an important role with the truce-agreement between Iraq and Iran in July, 1988 (Bast I; Genscher 1995).

The so called critical dialogue with Iran, which several times set the United States against the Federal Republic of Germany, stabilised the relationship despite some setbacks (e.g. closing down the Goethe-Institute in Tehrān in February, 1987, or the "Mykonos-Affair" in the year 1993). In July, 2000, the Iranian president Mohammad Khatami visited Germany, him and President Johannes Rau confirming the importance of the dialogue of cultures. In 2001, President of the Bundestag Wolfgang Thierse went to Tehrān for maintaining parliament contacts.

In the year 1973, Iran established diplomatic relations with the German Democratic Republic, after both German states having fixed their foundation agreement. From the side of the GDR, establishing diplomatic relations was due to the desire of being recognised a sovereign state by as many states as possible, Iran was looking for contacts to the Eastern Block due to neighbouring the Soviet Union. In 1975, both states signed a trade agreement, they founded a common economic council and decided about

Fig. 9: "Ruins of the Mussalah at Mesheb"; Globus 1862b, 99.

regular meetings of ministers: the steel mill in Isfahān, which had been erected by the Soviet Union, was supplied with GDR equipment as a result of the agreement. In 1975, a bilateral cultural agreement was signed, however, in February, 1978, there was a certain setback when exiled Iranians occupied and destroyed the Iranian embassy in East Berlin. The fact that an intended visit of the Shah to the GDR did not happen was favourable for the GDR's relations to the new Iranian government after the revolution of the years 1978/1979.

In 1989, the Iranian vice-minister Abd-Allah Jafer-Ali visited the GDR, increase of trade was the result: the GDR supplied military and electric equipment and modernized the Isfahān steel mill. The visit of the Iranian prime minister Hossein Musaw to Berlin in October, 1986, marked the peak of political relations but due to the economic difficulties of the GDR there was no further extension of bilateral relations (Bast I).

German Culture in Persia

The Persians' interest in Germany and German culture can be explained from the political situation in the late 19^{th} century and from the alliances during World War I. Germany, being a powerful enemy of Great Britain and Russia, was supposed to be Persia's friend and to help to liberate the country from being dependent on these two great powers: since then Germany's image – despite some political discords – has been positive, still today, more than 20 years after the revolution, Germany's popularity is unbroken, despite sporadic critical situations. But this popularity is not due to the intensity of cultural relations but is clearly based on economic and technical cooperation and on Persian esteem of German products. Thus, German culture is highly appreciated in Iran but its influence on Persian culture is rather overestimated: lasting influence is only to be seen with Iranians who either attended the German school in Iran, have personal contact to Germans, or studied or worked in Germany.

German Schools

By the time when Persia politically opened up in the late 19^{th} century and with the introduction of modern education to Persia, French was the only European language to be taught at Persian schools; in some cases French was the language of teaching and exams. In 1907 a cultural agreement between the German Reich and Persia resulted in founding the first German school in Tehrān where students were learning German from their first year on, nine lessons per week. Financed by the Persian and the German governments, the school was very well equipped with laboratories and possibilities for sports. The school was recognised to be an "Oberrealschule", thus mostly for the students the road to German colleges and universities should be cleared. Graduation included knowledge which was supposed to open up high-ranking governmental positions to Persian graduates. Some graduates which carried on their studies in Germany belonged to the technical elite and developed the Persian railroad system.

After the German school had to be closed down after the end of World War I (the last graduation certificates were passed in 1919/1920), the "Iranisch-Deutsche Gewerbeschule" (Iranian-German Vocational School) in Tehrān was founded again in 1922 on request of the Persian government and in 1925 it started teaching. In 1937 it was taken over by the Iranian government. After the allied occupation of Iran in 1941, German lessons were prohibited but the German teachers were still employed until the 1950s. During the 1930s some more vocational schools with German participation were founded in Tabriz, Isfahān, Shiraz, and Mashad where qualified technicians were trained who evidently brought on the country's industrialization. Also many politicians under Reza Shah Pahlewi were graduates of these schools; they were considered definitely friendly towards Germany.

In 1932, the German colony in Tehrān established a German school which had to be closed down during World War II. In 1955, the German school was founded a second time with the German embassy contributing, in 1964 it comprised all primary and secondary classes and was considered a grammar school in a foreign country. By the end of 1978 it had 1,500 students and thus was the biggest German school in any foreign country. A high percentage of students came from German-Persian families or they were Iranians who had been living in Germany and had started school there.

After the cultural agreement had been revoked and the Goethe-Institute had been closed down in 1987, which in 1978 had had 1,000 students and had tried to bring Iranians into closer contact to German language and culture, the years of the Austrian Cultural-Institute's monopoly started. The new institute for German language, founded in the spring of 1995 by the German embassy, was not allowed to commit itself to culture as during the Salman Rushdie controversy the new cultural agreement between Tehrān and Bonn from September 29^{th}, 1988, was not ratified.

German language and literature could be studied at the University of Tehrān, founded in 1935, but far into the 1960s there were only few students of these subjects. In the 1960s and 1970s, classes for German language and literature were established at the National University and at the college for teachers in Tehrān as well as at the Universities in Isfahān, Shiraz, and Kerman. These classes are offered still today and during the last five years they have aroused increasing interest. In September 1977, a German-orientated university was founded in Rasht, resulting from an agreement between the gouvernments of Iran and the Federal Republic of Germany. Besides other subjects, it offered German language and literature; but the agreement was nullified in 1980 and the university closed down for two years. In 1982 it started classes again but without German orientation (Rehs 1960, 276-278; Peters 1928; Draeger 1928).

Persian Students at German Universities

A big number of persons receiving a scholarship by the government or sons from rich families, who were studying between 1811 and the founding of the University of Tehrān in 1935, chose France or the French speaking part of Switzerland for their university education. Only a few went to Great Britain and only a tiny fraction chose Germany. Due to both financial and language problems, only during the 1950s there started a rush of Iranian students towards Germany, in the 1960s and 1970s almost one quarter of all Iranian university students abroad chose universities in the Federal Republic of Germany. Until the revolution of 1978/1979 more than 40,000 students were trained in Germany, mostly in medicine and engineering. Only a few stayed in Germany, the majority returned to Iran and helped with improving the bilateral relations. Some of the home-comers achieved positions at Persian universities where they taught to their students knowledge and methods learned in Germany (Blücher 1960, 235-238).

German and Persian Literature: Knowledge of Each Other

Again and again the connections between Persia and Germany concerning literature have been described as being very old and characterized by mutual understanding. German scholars played an important role with the introduction of Persian intellectual life to the West, a role which particularly manifests in sciences and in numerous German translations of Persian works.

Here, at first and most of all Johann Wolfgang von Goethe (1749-1832) must be mentioned: all his life Goethe was interested into Oriental history, poetry, and religion. He started out from the Bible, then he got to know the Quran and the Moallakat Beduins' poems from before Muhammad's time; from both works he translated paragraphs which particularly excited him. About Persia he learned for the first time by Carsten Niebuhr's printed description of the latter's journey from 1761 to 1767, Herder's script "Persepolis" from 1787 resuming this. Then Dshami's love novel "Medshnun and Leila" was the first original Persian poetry he read in 1808. How big Persia's cultural performance had been from the 10^{th} to the 15^{th} century was something he had constantly learned from literary products from Turkey and Muslim India: in these countries, Persian poetry was considered "classical" and an example.

But only in 1815, when Goethe knew the "Diwan" by the Persian poet Hafiz (1327 to 1390) by Hammer-Purgstall's translation, he was as seized by this Persian poet from the 14^{th} century as he had been in his youth by Homer and Shakespeare. "Towards this I had to take a productive attitude as otherwise I would not have been able to make a stand at this mighty appearance". Because what this poet, having lived 400 years before, had been experiencing from the world and the convictions he expressed was showing the same great law which the old Goethe considered above all human deeds and their relationship to God. Thus, he decided to write a "German Diwan" and, like Hafiz, to bear witness to the poet's eternal task of "taking his share of the world's abundance, having a look from the far into the god's mysteries, as anyway this kind of poetry must definitely keep up some sceptical flexibility". Most of the poems were written during the two journeys of 1814 and 1815 which took Goethe back to his old home on the Rhine, the River Main, and the Neckar. His disturbance coming from being with and departing from Marianne von Willemer in Frankfurt and Heidelberg flowed into the volume "Suleika" and into the "Buch der Liebe" (Book of Love) in the form of lyrical lines where, like in Hafiz's poetry, nightingale and rose are lifted up towards mystic significance and are praised as an allegory.

At the same time, by the numerous publications of the Orientalists Hammer-Purgstall and Heinrich Friedrich von Diez (1751-1817), Goethe learned about the full scale of Oriental poetry, by older and by contemporary travel books and research accounts he learned about political history and the succession of the cultures of the East. Traces of this reading are found at innumerable parts of the "West-Östlicher Diwan" (West-East Diwan). By the "Noten und Abhandlungen" (Annotations and Papers), which he applied to the poetry volume "for better understanding" and which are more voluminous than the work itself, Goethe wrote a history of Eastern intellectual life not having been written by anyone before him. Here, his Western attitude towards history and interpretation found original forms and metamorphosis which this European considered working in his own time: "Orient and Occident cannot be divided anymore". For, "what we Germans call intellectual spirit, predecessor of the higher leading principle, is the highest feature of the Oriental art of poetry" (von Maltzahn 1962, 42).

Highly distinguishing themselves for their translations of Persian poetry were: Friedrich Rückert (1788-1866), Count Schack (1815-1894) who restricted the 60,000 lines of Firdouzi's (940-1020) "Shahnahme" to three volumes by his German translation, and most of all Friedrich Rosen (1856-1935) who by his congenial translation of the aphorisms – Rubayat – made Omar-I Chajjan's works known to Germany.

Thus, the efforts of translating classical Persian literature into the German language reach back to the period of enlightenment; not much later German literature was known in Persia. In the second half of the 19^{th} century, when with the general orientation towards the West European literature was translated into the Persian language, French was the key-language for introducing Western culture to Persia. Until far into the 1930s, all the German classics found their way to Persia in French translation, *e.g.* Johann Wolfgang von Goethe's "Leiden des jungen Werther" (Young Werther's Sufferings) and the first part of "Faust". Among the few works being translated directly from the German language by Persian writers who were living in Germany between the two World Wars there count *e.g.* Friedrich von Schiller's "Jungfrau von Orleans" (Virgin of Orleans) and "Maria Stuart".

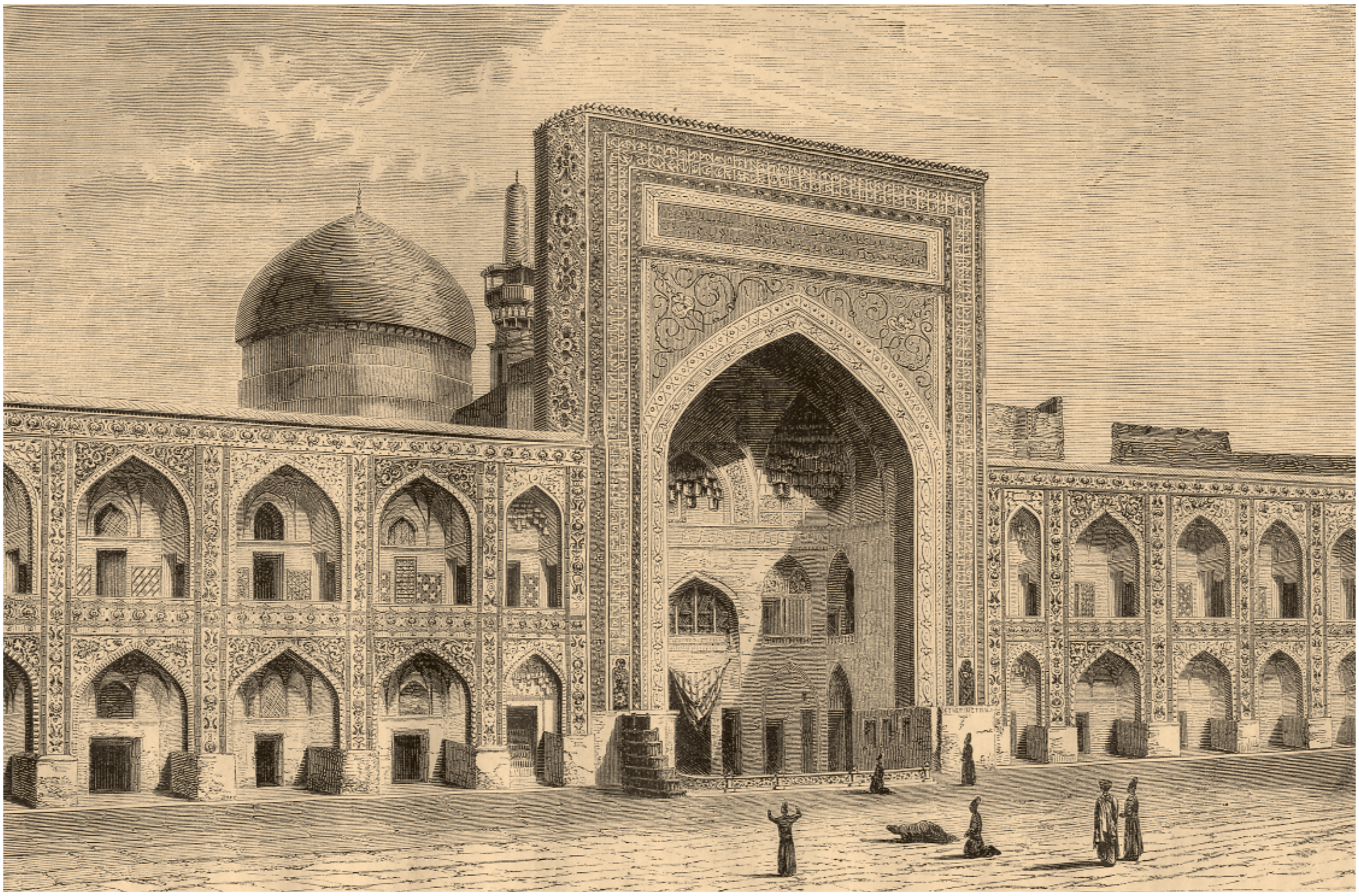


Fig. 10: "The interior court in the mosque of Imam Ali Risa"; Globus 1862b, 101.

After World War II, English became the most studied and most spoken foreign language in Iran and it offered an alternative way of making German literature to be known in Persia. Still today, German literature in most cases is not translated directly from the German language although meanwhile German has become the second most important language in Iran (after English and before French).

German literature from the 20th century is rather popular in Iran. It owes its spread throughout Iran to the literary journal Sokoan where numerous German authors and their works were introduced to the Persian public, e.g. Franz Kafka's "Vor dem Gesetz" (In the Eyes of the Law) and the "Verwandlung" (The Change). Among further works which have become very famous and popular there count Hermann Hesse's "Steppenwolf" and "Siddharta", Heinrich Böll's "Ansichten eines Clowns" (Opinions of a Clown), Günther Grass's "Katz und Maus" (Cat and Mouse), Max Frisch's "Andorra" and Friedrich Dürrenmatt's "Besuch der alten Dame" (The Old Lady's Visit). Particular popular are Franz Kafka and especially (before the revolution) Bertolt Brecht. Also a definite success were the works by Stefan Zweig: one third of all prose literature which was translated from Western languages between 1945 and 1955 was written by this author. But it must be noted that the total share of German literature of the Iranian cultural life is rather insignificant and taking notice of many works is (has been) restricted to a small cultural elite.

Still today, the influence of German literature is rather insignificant. Persian poetry hardly took over any European influence; modern Iranian novelty has been mostly influenced by French novelists. Authors of Iranian short stories follow British and American examples. The German drama was popular in Iran and was often performed before the revolution but also in this sector the main influence for Iranian dramatists came from French works for a long time.

But still: some prominent representatives of Iranian literature who had been living in Germany and thus had close contact to the German culture were lastingly influenced. Thus, Bozorg Alavi (1904-1977), who had been studying in Germany in the 1920s, was

Fig. 12: Johann Wolfgang von Goethe: West-oestlicher Divan, Frontpage; First edition, gift to Sulpiz Boisserée. Frontispiece was painted by Johann Heinrich Meyer. Original: Goethe-Museum Düsseldorf, Anton-und-Katharina-Kippenberg-Stiftung; Photo: Walter Klein.

living in Germany from 1953 until his death: until 1975 he was a professor for Persian language and literature at the East Berlin Humboldt University and in his foreword to his "Geschichte der persischen Literatur" (A History of Persian Literature) confessed that he owed his personal intellectual development to the German culture. The same is true for his friend Mohammad-Al Jamalzada (1892-1997), the father of modern Persian short stories, who from 1916 to 1930 worked at the Persian embassy in Berlin: he was a member of the committee of Persian nationalists which was founded in Berlin in 1915 with Hassan Taqzada being chairman and he wrote for the magazine "Kava" which he was later publishing and which played an outstanding role with spreading scientific methods and with the development of modern Iranian intellectual history. The influence of German culture and literature on Alavi and Jamalzada can indirectly be found also at other Iranian authors like Hushanng Golshir (1937-2000).

In the field of philosophy the influence of German thinking is particularly felt. Ahamad Fardad (1912-1994), one of the most influential contemporary Iranian philosophers, had been studying in Germany and France and brought Iranian intellectuals into contact to a. o. Friedrich Nietzsche, Friedrich Hegel, Emmanuel Kant,

Fig. 13: "The mausoleum of Rabir Shah"; Globus 1862b, 103.

and Martin Heidegger. After the 1950s there developed a circle of leading intellectuals, philosophers, and translators around Fardad (Catanzaro; Alavi 1965; Gelpke 1961; 1962; Chehabi 1981; Rahnema 1981).

Archaeology

The first news by German speaking travellers before the early 19th century about archaeological monuments on Persian soil are from travellers like Johannes Schiltberger (s. a.) Heinrich von Poser (s. a.), Adam Olearius (s. a.), Johann Albrecht von Mandelslo (s. a.), Engelbert Kaempfer (s. a.), or Carsten Niebuhr (s. a.). It was Carsten Niebuhr's copies of Achaemenide inscriptions from Persepolis which laid the foundations for Friedrich Grotefend to decipher texts in cuneiform writing at Göttingen in the year 1802.

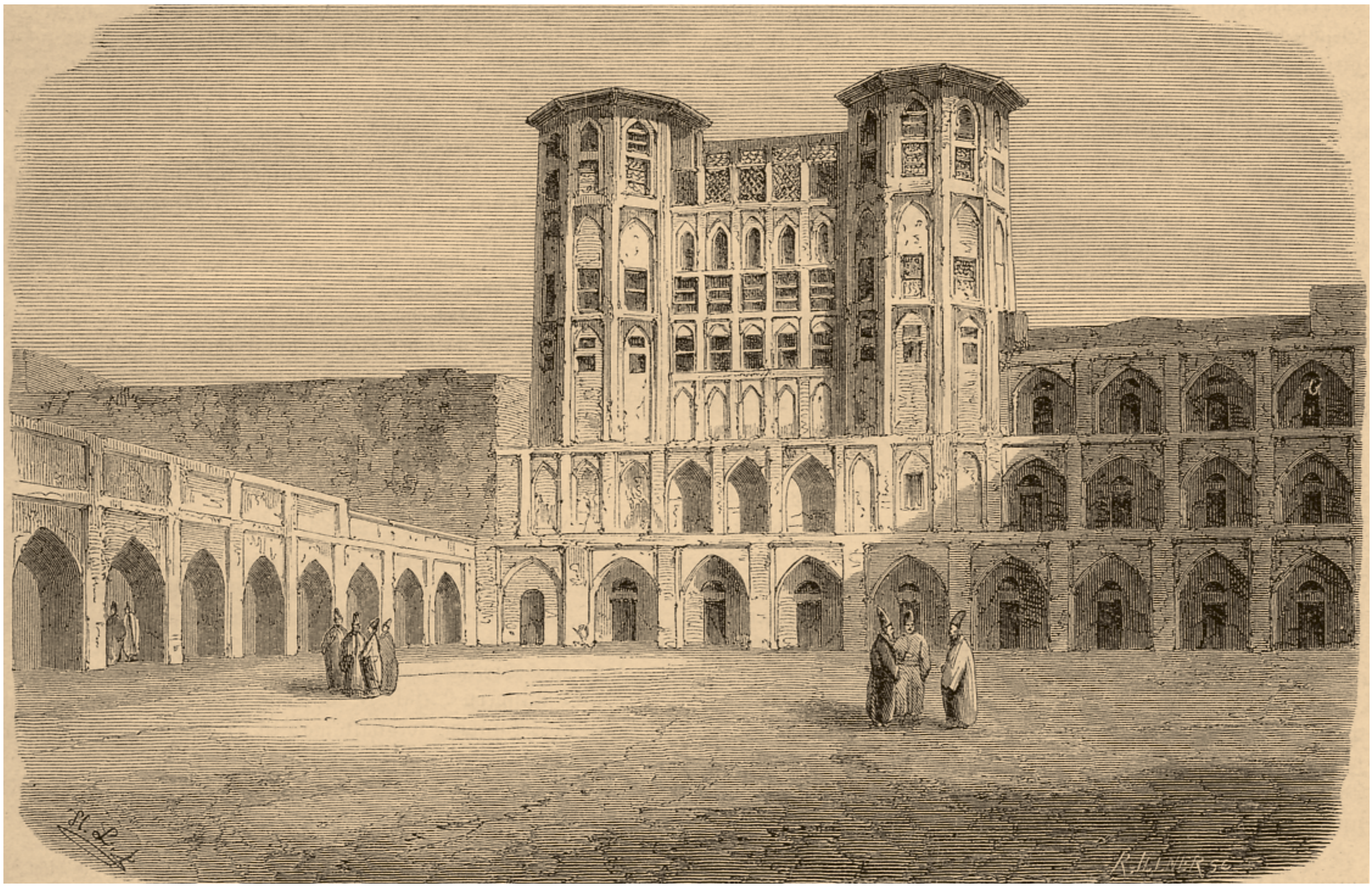
In the following years there happened a brilliant search for texts in cuneiform writing in the Near and Middle East, in 1828/1829 the orientalist Friedrich Eduard Schulz travelled through the region around Lake Urmia, supported by the French Academy of Sciences, and a. o. visited Ujan, Qalat-e Zohahaak, and Takht-I Suleiman where he copied the inscriptions on the meanwhile collapsed walls of the Ilkhanide palace. Just as well, Schulz discovered the Urartean stele at the Kelioshin pass. His copies and notes were partly lost when in 1829 he was robbed and murdered by Kurdish tribesmen (Gabriel 1952, 144; Willock 1834, 134-136). R. Rosch was also murdered by natives during his fieldwork of casting the Kelishin stele (Lehmann-Haupt 1910, 245).

Around 1857, Otto Blau (Blau 1858) travelled through the regions South and West of Lake Urmia and made copies of the Urartean inscriptions at Tappeh Tash (West of Miandoab) which proved the place to have been a Urartean outpost on the Mannean frontier, and he made casts of the Kelishan inscription which broke to pieces on his way back, however (Lehmann-Haupt 1910, 219-222). In the years 1898 and 1899, Waldemar Belck and Carl Friedrich Lehmann-Haupt extended their archaeological survey on Urartean evidence to the Urmia region and examined the preceding investigations and research results: on their journeys they did not find the inscription at Tash Tappeh to be *in situ* anymore; fragments of it later came into the possession of the British Museum (Lehmann-Haupt 1910, 219-222). Both also carried out excavations at Tappeh Goek. In 1884 and 1885, the German geologists H. Pohlig, Alfred Rodler, and Theodor Strauss carried out palaeontologic analyses in the Maraga region while being in the service of Austrian companies (Weithofer 1890, 756).

Though during the 19th century the focus was on the Northwest of Persia, which was so rich in inscriptions, there were also investigations of the historic centres of Fars and Persepolis. In 1874, the Prussian Ministry of Sciences and Education sent out an astronomical expedition to Isfahān to watch the planet Venus passing by. The photographer of the expedition, Friedrich Stolze, professor at the Technical College in Berlin, had developed the technique of photogrammetric measurement even before Albrecht Meydenbauer: when the astronomical work was finished, Stolze together with the orientalist Friedrich Carl Andreas carried out a photographic and photogrammetric survey on archaeologic monuments and inscriptions at Persepolis and in the Southern region of Fars which lasted until 1878. Later, Friedrich Carl Andreas was to be the leading teacher of Persian language at Göttingen University where a. o. also Arthur Christensen, Kaj Barr, and Walter B. Hennig were studying. This survey in the region between Darab, Tasuj, and Busheir resulted a. o. in discovering the Sasanian reliefs at Busheir. Besides this, the two researchers were committed in architectural, ethnographic, and zoologic research. At Persepolis both happened to take part in the large scale excavations by the governor of Fars, Farhad Mrza Motamed-al-Dawla: there, Stolze researched part of the mudbrick fortifications and made a photogrammetric ground-plan of the location which was to be of great importance for the later excavations. Only a small part of Stolze's and Andreas's material was published in two volumes (Stolze & Andreas 1882; Stolze 1883).

A number of German publications from the 19th and the early 20th century offered information and illustrations of archaeological and historic sites in Persia to the German public. Heinrich Brugsch described the results of the Prussian embassy's expedition from Tiflis to Tehrān, Hamadan, Isfahān, and Shiraz under Baron Julius von Minutoli in the years 1860 and 1861 (s. a.). The Austrian physicist Jacob Eduard Polak published a detailed report on Qajar Persia and explained the origin of gold deposits (Polak 1865; 1888, 141-142). The Hungarian Armin Vambery travelled through Persia, Afghanistan, and Central Asia in disguise and between 1901 and 1903 the orientalist Oscar Mann crossed Persia from Busheir to the Northwest: he made photographies and casts of the Pahlavi inscriptions at Hajabad and of the Elamite reliefs at Malamir, he studied and documented the archaeologic monuments in the

Fig. 14: "Residency of the gouvernor of Kermanshah in Persia (Following an original drawing by Major Krziz)"; Globus 1864, 52.



regions of Kermanshah-Harsin, Qaleh Yazdegerd, and Lake Urmia (Mann 1903; 1904/1905). Other travellers and researchers in then still dangerous North-western Persia were the Austrian Ida Pfeiffer (Pfeiffer 1850), also Moritz Wagner (Wagner 1852), Max von Thielmann (Thielmann 1875), G. Pauli (Pauli 1887), Hugo Grothe (Grothe 1910), and E.-J. Westarp (Westarp 1913). By the end of the 19th century, scientific interest in Islamic fine arts and Persian culture was growing in the German Reich. Since 1897 Friedrich Sarre as an expert of the Islamic history of arts had been to Persia several times and had been studying Sasanian and Islamic monuments, his main interest having been in the period of transition from pre-Islamic to Islamic culture (Sarre 1899; 1902; 1910); by his student Ernst Herzfeld Sarre found an excellent partner.

Ernst Herzfeld was an architect and also an educated archaeologist, historian of arts, and orientalist. He had taken part in the excavations at Assur in the years 1903 to 1905 and from there started researching the Western provinces of Persia. His view and interpretation of Persian culture was dominating research for half a century. One of his early journeys (1905-1907) took him to Pasargadae and Persepolis, in Berlin he was awarded a doctorate for a study on Pasargadae in 1907 (Herzfeld 1908). In 1917 he qualified as a university lecturer in Berlin and lectured there until 1935 as a professor of Oriental archaeology, spending most of his time with fieldwork, however.

Herzfeld was a "gifted" excavator. His main interest was in researching historic and archaeological sites and monuments in Persia. His first publication, together with Sarre, was on rock paintings (Sarre & Herzfeld 1910), a second volume was on the archaeologic monuments on the connecting road from Mesopotamia to Media. The latter publication was done in cooperation with the leader of the French archaeological mission at Hamadan and Sar-e pol-Zohab, Charles Fossy (Herzfeld 1920).

Together with Sarre, Herzfeld published on the remnants of the Sasanian palaces at Ktesiphon and Dastagerd, following an archaeological survey in Northern Mesopotamia (1907-1908) (Sarre & Herzfeld 1911-1920). Between 1911 and 1923 he three times travelled to the border region of Iraq/Persia near Suleimanija: after this, the publication on the mysterious tower of Paikuli with a long Pahlavi inscription by the Sasanian king Narseh was written (Herzfeld 1914; 1924); a new edition of this inscription was published by Helmut Humbach and Prods O. Skjoervö in 1978-1983 (Humbach & Skjoervö 1978-1983). Herzfelds longest journey was from 1923 to 1925 and took him from Baghdad to Tehrān via Ktesiphon, Qasr-i Shirin, Kermanshah, Hamadan, and from there to Busheir via Korha, Isfahān, Persepolis, Shiraz, Firuzabad, Farrashband, Kazerun, Fahlan, and the island of Karg. Then he went back to Tehrān. His travel account from 1926 only informed rather superficially and shortly, e.g. about the Zoroastric sanctuary at Kuh-e Kuaja and about identifying Ahr-e Qames as the Parthian Hekatompylos (Herzfeld 1926).

After 1929, Herzfeld researched at Pasargadae, Persepolis, and Esatakor. After 1934 his work at Persepolis was continued by Erich Friedrich Schmidt who – just like Herzfeld – had to emigrate. But still, until 1938 Herzfeld published his results in the "Archäologische Mitteilungen aus dem Iran"(Archaeolological News from Iran) (since 1929), in the "Ergänzungsbände" (Supplementary Volumes) (since 1938), and in the "Iranische Denkmäler" (Iranian Monuments) (after 1932). His London lectures (1934) and his Lowell lectures at Harvard were published under the title of "Archaeological History of Persia" (Herzfeld 1935) and under the title "Persia in the Ancient East" (Herzfeld 1941). But Herzfeld's finishing publications on his research in the region of Fars and in Sistan have never been published. There is no doubt that Herzfeld must be considered one of the great researchers and interpreters of Persian fine arts and history (Herzfeld 1938a; 1938b; Erdmann 1937; 1954).

Herzfeld's excavations at Ktesiphon were continued under Oskar Reuther and Ernst Kühnel from 1928 to 1929 and from 1931 to 1932; mostly the latter campaign, with American contribution, produced fundamental knowledge of topography, architecture, and history of this Sasanian capital. (Reuther 1930; Kühnel 1933).

Following Sarre's early investigations of Islamic archaeology, more German and Austrian activities started in Persia and Central Asia in the late 19th century. The founder of the Berlin Ethnologic Museum, Adolf Bastian, had been collecting pottery and archaeological material at Afras and Toi Tappeh (near Tashkent) since 1899 (Grünwedel 1890; Erdmann 1942). Between 1912 and 1914, Ernst Diez and Oskar von Niedermeyer from Vienna tried to carry out excavations at Nishapur; when their licence was revoked they documented numerous monuments from the Islamic period (Diez 1918); von Niedermeyer collected rich photographic material during a military mission to Afghanistan (1916/1917) (Niedermeyer 1924).

The establishment of the German Institute in Isfahān in the year 1938 under the Iranist Wilhelm Eilers, who had also been taking part in the excavations at Persepolis for a short time, was a milestone for the development of German-Iranian scientific relations. But after 1939 the main interest of this institute was in the fields of philology and linguistics. Due to the political situation, the institute had to be closed down in 1941, Eilers was deported to Australia. However, in 1957 he returned to Iran together with Kurt Erdmann and Ernst Kühnel to prepare future activities. On an expedition under the archaeologist Hans Henning von der Osten and Swedish Bertil Almgren in the year 1958 the Sasanian fire sanctuary on Takht-i Suleiman and the neighbouring Iron Age ruins at Zendan-i Suleiman were chosen for future excavations, after Hans Henning von der Osten's sudden death in the year 1960 Rudolf Naumann until 1976 and Dietrich Huff until 1978 led the investigations there (Damm 1968; Naumann 1961; 1962; 1964; 1965; 1974; 1975; 1977; Huff 1969; 1977; 1987).

In the year 1961 the Tehrān department of the German Archaeological Institute could be opened. Its first director was Heinz Luschey (until 1971), he was followed by Wolfram Kleiss until 1995. Right from the beginning the institute continued its publications: "Archäologische Mitteilungen aus Iran", Ergänzungsbände", and Iranische Denkmäler" were continued, they were joined by "Teheraner Forschungen" (Tehran Research) (since 1960), "Beiträge zur Archäologie und Geologie des Zendan-i Suleiman" (Essays

Fig. 13): "The inscripted rock of Bisotun"; Globus 1864, 241.

on Archaeology and Geology of Zendan-i Suleiman) (after 1968), "Tacht-e Suleiman" (since 1976), "Führer zu archäologischen Plätzen in Iran" (Guide to Archaeologic Sites in Iran) (since 1977), "Bastam" (since 1979), and "Materialien zur iranischen Archäologie" (Materials on Iranian Archaeology) (since 1993). The first German excavations and surveys after the end of World War II were carried out at Bisotun (Luschey 1968; Kleiss 1970; 1972; 1974; Trümpelmann 1968; Salzmann 1976; Huff 1985; 1998; Kleiss & Calmeyer 1996).

After intensive fieldwork in Azarbaidjan, research on the Urartean empire came into the focus after 1968. In 1968, Kleiss excavated the fortified place of Sangar with its rock graves (Kleiss 1969; 1970), in 1969 there followed excavations in the Urartean fortress of Bastam in the North of Koyn (Kleiss 1970; 1972; Kleiss (publ.) 1979; 1988; Kleiss & Kroll 1979; Kroll 1977; von Schuler 1972).

Improving the knowledge of the early Sasanian period was now one of the main interests of German archaeological research in Iran. Investigations around Firuzabad, Farrashband, and Nurabad, in the circular town of Ardashir Kura (1972) and the excavations in the two palaces at Firuzabad, which were done in cooperation with the National Organization for the Conservation of Historic Monuments, must be mentioned here.

Between 1971 and 1975 a research program, directed by H. J. Nissen, was carried out in the region of Behbahan-Lordagan and in cooperation with the Oriental Institute of Chicago and the Berlin University. In the course of this work it was possible to excavate the settlement of Tappeh Sohz near Behbahan from the 5th millennium BC (Nissen 1973; Bernbeck 1989). From 1971 to 1978, excavations at the prince's seat of Kordlar Tappeh (near Urmia) from the early Iron Age were carried out by an Austrian expedition (Lippen 1979).

Besides excavations, the German archaeological Institute and other archaeological institutions did a lot of surveys and investigations in the following time. Particularly in the focus was the Luristan culture (Calmeyer 1964; 1969; 1973a; and b). Persepolis and Pasargadae were also subject to investigations: Herzfeld's and Sarre's studies on Achaemenid sculpture and Persian fine arts in rock could be continued (Calmeyer 1973 a; 1973b; 1981; 1992; Gall 1974b; 1990; Gropp 1971b; Herrmann 1977; 1980-1983; Herrmann & MacKenzie 1989; Huff 1984; Hrouda & Trümpelmann 1976; Kleiss & Calmeyer 1975; Krefter 1971; 1973; Trümpelmann 1975a; 1975b; Walser 1966). Just as well there was research on the so called Medish and Southern Persian rock graves and fire sanctuaries (Calmeyer 1978; Gall 1966; 1974a; 1988; Gropp 1970, 203-208; Huff 1971a; 1975e; 1988; 1992; 1999b; Kleiss 1972, 199-204). The investigations of the Zoroastric fire temples were continued both by the Tehrān institute and by the university institutes of Hamburg and Göttingen (Grop 1969; 1971a; Schippmann 1971), architectural studies on Persian palaces were published by a. o. Huff (Huff 1993; 1999a) and Kleiss (Kleiss 1989). Dams, bridges, the network of roads and caravanserais from the Achaemenide and the Islamic period were also subject to research journeys (Kleiss 1991; 1992; 1996-1997). Investigations of the Elamite culture were carried out by the University of Göttingen (Hinz 1964; Hinz & Koch 1987; Seidl 1986) while the University of Tübingen and other universities carried out surveys in different regions of Iran (Carls 1982; Gaube 1973a; 1980; Gropp 1995; Hinz 1969; Pohanka 1986; Schippmann 1970; Schweizer 1972). The Universities of Bamberg and Tübingen were intensively committed in Islamic archaeology (Finster 1994; Leisten 1998), the Universities of Vienna and Tübingen were committed in ancient numismatology and sphragistics (Gaube 1973b; Göbl 1971; 1973; 1976; 1984; 1993). The University of Munich developed to a centre of archaeologic research. (Boessneck 1973; Boessneck & Krauss 1973).

After 1978 it was impossible at first to carry out either excavations or large scale fieldwork. Due to this, after 1989 the activities of the Tehrān department of the German Archaeological Institute were extended towards Central Asia (Götzelt 1996): In 1993 excavations in the Uzbek province of Surkhandaria were started, at first at Tappeh Dzhandaulat, after 1994 at Dzharkutan (Huff 1997). This was a cooperation with the Uzbek Archaeological Institute.

With the German Archaeological Institute being newly organised, the Tehrān department was integrated into the newly built "Department of Eurasia". Besides other activities, excavations and research on the question of raw materials in the Uzbek Karnab region and in the Tajik region of Pendzikent (mostly in Mushiston) were started in 1997, directed by Hermann Parzinger: this research was done in cooperation with the Deutsches Bergbau-Museum Bochum, the TU Bergakademie Freiberg, and the Uzbek and Tajik Archaeological Institute (Alimov *et al.* 1998; Parzinger & Boroffka 2003). Another research program in Tadjikistan in 1997 was on the Kuljab region.

The magazines of the Tehrān department were partly continued by the Department of Eurasia: "Archäologische Mitteilungen aus Iran (AMI)" have been called "Archäologische Mitteilungen aus Iran und Turan (AMIT)" (Archaeologic News from Iran and Turan) since 1997, the "Ergänzungsbände" were renamed "Archäologie in Iran und Turan" (Archaeology in Iran and Turan). A new periodical ("Eurasia Antiqua") and a series of monographies ("Archäologie in Eurasien") (Archaeology in Eurasia) have been existing since 1995 or rather 1996.

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The 5612 m high mount Damavand northeast of Teheran; Photo: G. Gerster.

Stone Raw Material Sources in Iran: Some Case Studies

Saman Heydari

Introduction

Geoarchaeological researches conducted during recent years in various regions of Iran have shown that geological features have played one of an important role in choice of settlement locations by prehistoric communities. The objective of this study is therefore to locate the sources of mineral raw materials, in particular cherts and siliceous tuff, as well as to evaluate the relationship between these resources and prehistoric settlement patterns. Radiolarian cherts and siliceous tuff raw materials occur in large amounts in some regions in Iran.

The most common artefact-material of prehistory is stone-rock and/or minerals. Stone was the most durable material available to early human and, in most environmental settings, the most readily available. Among stones, chert/flint is one of the raw materials most appreciated. Chert is a stone that contains a lot of silica and therefore is both very compact and breaks in a conchoidal pattern. This makes chert an ideal raw material for the production of cutting tools by chipping.

Chert's importance to man throughout history is based primarily on the way it breaks. It is one of a relatively few rock types that can be broken in controlled manner to form a sharp, yet durable edge. This fracturing process, called flaking, chipping, or knapping, is the principal way in which chert was worked into useful items, although chert can also be ground or abraded into desired shape (Luedtke 1992, 79).

Silica can occur in three forms: amorphous, such as opal, cryptocrystalline and microcrystalline. All three of these forms are found in different varieties of chert. The most common varieties are flint, jasper, and novaculite. There exists also a variety of chert that is composed largely of fibrous chalcedony and that is called by that name. Generally, cherts are a mixture of all or some of these varieties. "Flint", in most English-speaking contexts, is the other

Fig. 1: Thin sections of Do Ashkaft (a) and Gakia chert (b) in comparison with tuff (c).

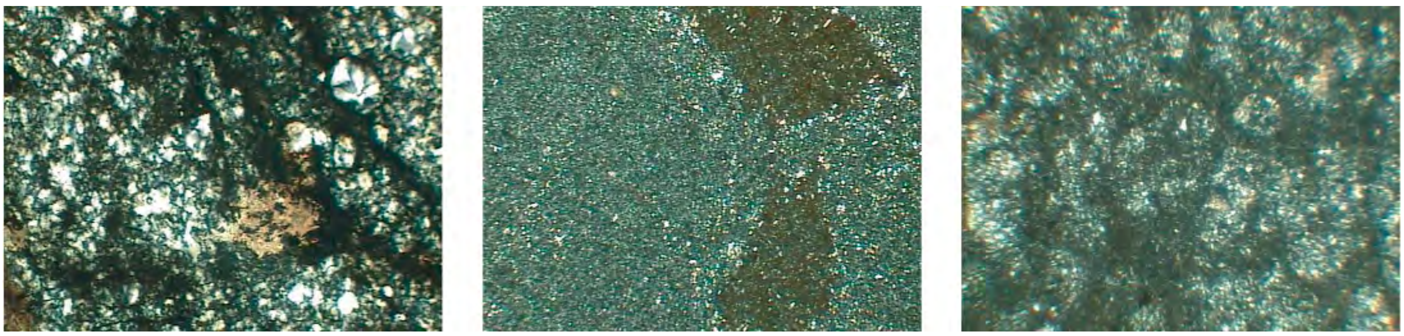

Fig. 2: Flaked piece of brownish Gakia chert, Photo: DBM; Th. Stöllner.

Fig. 3: Raw piece of greyish-brownish Beshahr chert; Photo: DBM, M. Schicht.

common name for chert. In a strict sense, the term "flint" refers to grey-to-black cherts composed mostly of chalcedony and/or cryptocrystalline quartz (Garrison 2003).

Chert occurs in several regions of Iran in large quantities. For the purpose of this study, chert deposits from three different regions in Iran have been investigated (Fig. 1). Those are:

Fig. 4: Flakes of reddish, radiolarian Gakia chert from Do Ashkaft; Photo: DBM, M. Schicht.

1. The Kermanshah region in the western central Zagros Mountains in Cretaceous Radiolarite (chert limestone) sources; where the Gakia and Do-Ashkaft chert are found.
2. The Behshar region in the northern and north-eastern foothills of the Alborz Mountains, where the Behshar chert is embedded in Jurassic limestone formations
3. The Kāshān region in the Karkas Mountain chain on the southern edge of the Dasht-e Kavir on the Central Iranian Plateau where a siliceous tuff occurs.

On the basis of geological and morphological observations and the source locality (including access and elevation) the stone raw materials found in these regions have been classified into the following four categories:

a) Radiolarite as tabular chert is located in the centre of the Kermanshah plain (Fig. 2).
b) Radiolarite as nodular chert occurs in limestone deposits in the Behshar region (Fig. 3).
c) Chert resources exposed in the form of nodular radiolarites mixed with limestone in the Kermanshah region (Fig. 4).
d) Deposited or exposed lithic material occurring as non cemented, rounded water worn pebbles and cobbles on alluvial fans in the Kāshān region (Fig. 5).

Based on geological and geomorphological observations, the setting of the chert sources can be investigated. The three regions that I focus were chosen because they provide information on the two related aspects that will be discussed here: the location of siliceous stone resources and settlement choices of prehistoric sites. It will become evident that one reason for the selection of prehistoric settlement places is the close proximity to raw material sources.

Fig. 5: Flakes and pieces of greyish tuff from Karkas region; Photo: DBM, M. Schicht.

Kermanshah region (radiolarite of Kermanshah)

The Kermanshah region is located in the western central Zagros, near the Iran-Iraq border. The Zagros Mountain arc is an independent highland zone that stretches over about 1500 km from the south-east of Turkey and north-eastern Iraq to the southwest of Iran near the Persian Gulf. Archaeological surveys and excavations of Palaeolithic and Neolithic sites in the Zagros since the 1950's have shown that the intermontaneous valleys (Mortensen 1974) – for example that of Kermanshah – were among the most densely settled areas in Iran (Braidwood & Howe 1960; Levine 1977).

Geologically, the Zagros Mountains in the Kermanshah region embrace three large-scale tectonic zones of the Zagros Orogen. These are east to west, the Rezaiye-Esfandagheh Orogenic Belt, the Zagros Crush Zone (coloured mélange and radiolarites) and the Zagros Folded Belt.

The Zagros Crush Zone is divided into three sub zones: (a) a south-western zone of thrust-bounded slices of Late Cretaceous limestone; (b) a north-eastern zone of infolded masses of Coloured Mélange, consisting of ophiolites and radiolarian chert, tectonically emplaced during the Late Cretaceous thrusting of the Rezaiye-Esfandagheh Orogenic Belt; (c) a middle zone of radiolarian chert and detrital limestone (Brookes 1989). The ophiolites and the radiolarian chert in the Kermanshah region have been known since a long time. The radiolarite belt of Kermanshah exists in a more or less regular, 15 km wide band that runs from the Borujerd area in the south up to Paveh in the north-west (Heydari 2000). It is especially well visible in the Kermanshah plain, framed by the north-eastern mountains and the south-western mountain chain, and consists of thick thrust sheets of massive limestone. The permanent river of Qara Su incised into the Gakia hills and in those locations as well as on the small plains beyond a dendritic drainage pattern is formed. There the Neolithic villages were founded.

Radiolarian chert occurrences are present in the plain and on the highland slopes. In the plain, which we named it here, “Gakia chert” forms a series of dome-shaped outcrops (Fig. 2). The chert, originally in tabular formations, is often fragmented by weathering into smaller blocks, consisting of fine- to coarse-grained milky chert of white, grey or cream colour. The visible attributes of most typical variety of Gakia chert include mottled, streaked, banded and laminated.

Gakia is one of the most important chert sources of this type in the Kermanshah region. It is situated at 1400 m above sea level, 9 km east of the modern city of Kermanshah. This is also the locality where the first Acheulian hand-axe was found by Robert Braidwood and his team in the 1950s (Braidwood 1960; Smith 1986). The big outcrop at Gakia is associated with chert workshop and knapping areas. A collection of chipped stones and tools has been gathered in the recent years by F. Biglari and the author from the surface of Gakia.

In the mountain slopes, the chert resources which here we name it “Do-Ashkaft Radiolarite” (or chert) are exposed in the form of nodular radiolarites mixed with limestone (Fig. 4).

Palaeolithic communities used both sources, while Neolithic societies exploited only the higher quality sources that were located closer to their settlements in the plain. Indeed, at the Mousterian cave site of Do-Ashkaft, located on a slope of the Maivaleh Mountains in Kermanshah region, local chert sources that are located next to the site were used (Biglari & Heydari 2000; Biglari forthcoming). They often mined vertical and horizontal joints, which occur naturally in the rock.

On the contrary the numerous Neolithic inhabitants in the plain which were specialized in the production of stone tools, such as Sarab, Asiab, Murian and Ban Asiab (Bernbeck et al. in press), used only raw material from the local radiolarite sources in the plain. We can see the large cores, blanks and flakes in these sites; it is evident that these sites are close to the chert sources. This idea is confirmed by the presence of large cores in Ban Asiab and flakes in Murian (personal observations).

Behshahr region

The northern highlands comprise the Alborz massif that includes Iran's highest peak, the Damavand. The Behshahr region is in the

Fig. 6: Natural quarry in the Behshar region as outcrop of Behshar chert; Photo: S. Heydari.

province of Mazandaran in the north of Iran. The region provides one of the great natural varieties, the luxuriant green vegetation of the high-rainfall Caspian littoral.

Carlton Coon (1952) was the first person that pointed to cherts of Behshahr in his report on the excavations in the Hotu cave. For example, he stated interestingly: "This limestone contains nodules of flint usually pressed between the layers like raised biscuits".

The chert from the Behshahr region is found in thick continuous sheets, lenses ranging from 5 to 50 cm thick, alternating with limestone layers. In the Hotokash Mountain between the cities of Neka and Galugah, it consists of a thrust massive and of Cretaceous limestone, stretching over 46 km and with average width 12 km from west to east at an elevation of about 800 to 1200 m sealevel. The lithic material is identified as chert or flint nodules embedded in limestone deposits. Nodules usually occur in rounded ellipsoid shapes, several centimetres in size and flattened in the plane of the bedding. They are found both as tabular layers and in nodular form and belong to various geological periods.

The tabular layer is found in a succession of cliff formations which are more or less 20 m high and 100 m long and present vertical and horizontal faults and joints (Fig. 6). This cliff formation extends along the Hotokash Mountain. Small vertical cavities in these formations constitute natural quarries where the extraction of chert is rendered easier. The heavy weathering of these cliffs causes the separation of boulders which fall down the slopes and,

Fig. 7: Behshar chert in situ; Photo: S. Heydari.

after further fragmentation, are found as chert nodules in seasonal or permanent streams in the valley-bottoms (Fig. 7). This lithic material also occurs as non-cemented, rounded, water worn pebbles and cobbles on the mountain slopes in deposits resulting from the operations of streams and carried to the lowland by seasonal flooding far into the plains, near to the lowland settlements. This material was frequently exploited by ancient humans as is shown by the presence of flakes and cores in the riverbeds.

Unfortunately, most of the chert sources in the Behshar area have been destroyed in recent years by inconsiderate exploitation of dolomite immediately next to the cliff formations described above. It seems certain that many ancient mining sites must have been destroyed in this way.

The chert of tabular origin shows a splintery fracture and a resinous lustre on freshly-broken surfaces (Fig. 3). The nodular cherts are spheroid, ellipsoidal or discoidal, although many attain odd or fantastic shapes, sometimes mimicking turtle shells, bones or other fossil material. Both types are homogeneous; present an opaque white cortex and a reticulate pattern on the surface. The cores of these cherts are also homogeneous but translucent and milky white to pale yellow. They can also be opaque, white, brown or pale red.

The study of the Epipalaeolithic and Neolithic sites stone tools of Komishan cave and Sang Tappeh in Behshahr region, specially blade cores show that ancient people used both tabular and nodular chert resources (E. Ghasidian, pers. comm.). The people extracted raw material either from their primary context or gathered them in the riverbeds. In the numerous Neolithic sites identified in the Behshar plain (Mahfrozi 2002), chert boulders were sometimes used as grinding stones, for example at Gohar Tappeh.

Kāshān region (Karkas Tuff)

In contrast to chert, tuff is a raw material of volcanic origin. Tuff is an extrusive felsic to intermediate pyroclastic igneous rock composed of volcanic ash and a variety of mineral grains and rock fragments. Its colour ranges from dull earth tones of light brown-pink to grey. Crystals and inclusions of sedimentary rock lava fragments and other pyroclasts are common within tuffs. Tuff appears to have been rarely used in construction in antiquity (Garrison 2003). This particular material was used by prehistoric communities on the Central Plateau from the Palaeolithic to the Chalcolithic period (Biglari 2004; Heydari 2004).

The Kāshān region comprises the foothills, alluvial fans and alluvial lowland of the Karkas Mountains on the Central Plateau. The Karkas Mountain is of volcanic origin, and lithic materials were produced as a result of specific volcanic eruptions. Basalt, rhyolite, andesite and especially tuff in general are various kinds of stones in this region.

Along the northern slopes of the Karkas chains, typical cone-shaped alluvial gravel fans have built up in the Kāshān region. Those are not steep, but result from the high topographic relief. They are nested in groups in which small fans from small ravines above, and are deformed by larger ones from larger ravines. Different varieties and sizes of stone raw materials, distinguished by the kind and the size of the stone, are found on these fans (Heydari 2004).

One variety shows desert varnish that occurs when loose material containing pebbles or larger stones is exposed to wind erosion. The finer dust and sand are blown away and the pebbles that gradually accumulate on the surface display a strong shiny patina, resulting from the combination of wind and sun exposure (Fig. 5). The desert varnish allows distinguishing Palaeolithic from the younger material by the degree of patination.

Most probably, the easy accessibility of the raw material that is found over a wide area in the shape of cobbles and pebbles and is hence easy to collect was one of the major reasons for the choice of this material. From the Palaeolithic period onwards, tuff has been widely used by the human communities living in this region (Biglari 2003; 2004). The assemblage from the Upper Palaeolithic open air site of Sefid Ab, where tuff is used for the production of flakes, scrapers and other tools is a good example of this kind of stone. During the Neolithic period, the use of tuff changed and the material was then largely used for hammer stones and flakes, while chert was by then the most important raw material. An example of this is found at the famous Tappeh Sialk situated on the alluvial lowland just in front of an alluvial fan at the foot of the Karkas Mountain, where settlement activity began around 5800 BC.

Conclusion and discussion

Our investigations show that everywhere a great amount of raw stone materials can be found; the prehistoric sites are situated just close to them. Only the approach of getting the stones was different in these periods. During the Palaeolithic periods, human used both low and high quality raw materials which they had been found near and far from their sites. But we know many Neolithic sites which are located just close to the outcrops. This favoured the extraction of raw material and helped the development of higher quality production. Primarily investigations around the Gakia region have shown that there are several Neolithic sites which chert raw materials have been used extensively (Bernbeck et al. in press).

In this paper we present three places where outcrop of chert and tuff were exploited. There are most probably many other places in the Iranian plateau that need to be investigated. I will end this discussion by stressing prehistory settlements are related to stone raw material.

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The Preliminary Observations on Middle Palaeolithic Raw Material Procurement and Usage in the Kermanshah Plain, the Case of Do-Ashkaft Cave

Fereidoun Biglari

Background

The study of raw material as a way to understand landscape use by Palaeolithic hunter-gatherer has been a main focus among researcher during the last few decades (Dibble 1991; Kuhn 1995). While these studies provided insight into Palaeolithic way of life in other regions, there were almost no similar attempts to look at Palaeolithic assemblages in Iran. Henry Wright was the first archaeologist to pay close attention to the prehistoric use of chert in the south-western slopes of Zagros in the Deh Luran Plain (Wright 1981). He distinguished three different types of chert by texture and colour, basing his analysis on archaeological samples from the fourth millennium site of Tappeh Farukhabad. Also there are more recent studies on lithic raw material use and trade in the Zagros region (see Abdi *et al.* 2002; Bernbeck *et al.* in press; Biglari & Abdi 1999; Heydari 2000).

This short paper is merely an introduction to lithic raw material resources in the Kermanshah plain and Middle Palaeolithic raw material usage in the cave site of Do-Ashkaft and in a broader sense a starting point to this kind of studies in the field of Palaeolithic archaeology in Iran. The collection analysed is a surface assemblage, which was collected by the author and S. Heydari at Do-Ashkaft during the late 1990s (Biglari & Heydari 2001).

In this study raw material types were identified by means of macroscopic characteristics. Then they were ranked by frequency and in one case by weight to measure relative abundance within the assemblage.

Introduction

The research on Middle Palaeolithic of the Kermanshah region started more than seven decades ago by pioneering excavation of Carlton Coon at Bisotun rock shelter (Coon 1951). This site has produced one fragment of a hominid bone in association with a rich Mousterian industry. The nearby site of Ghar-e Khar was tested by Philip Smith in 1965. Smith's test revealed a sequence from at least the late Middle Palaeolithic, through Upper and Epipalaeolithic and later times (Young & Smith 1966). During the Iranian Prehistoric Project, directed by R. Braidwood in the Kermanshah region, two Mousterian sites of Warwasi and Kobeh were tested by Howe (Braidwood 1960). In addition to these sheltered sites, a large workshop with Levallois elements was discovered by Mortensen and Smith near Harsin in 1977 (Smith 1986; Mortensen & Smith 1977).

Archaeological surveys, which have been done by the author and S. Heydari in the 1980s and 1990s, increased the number of Middle Palaeolithic sites known in the region. During these surveys at least six caves and open air sites with Mousterian assem-

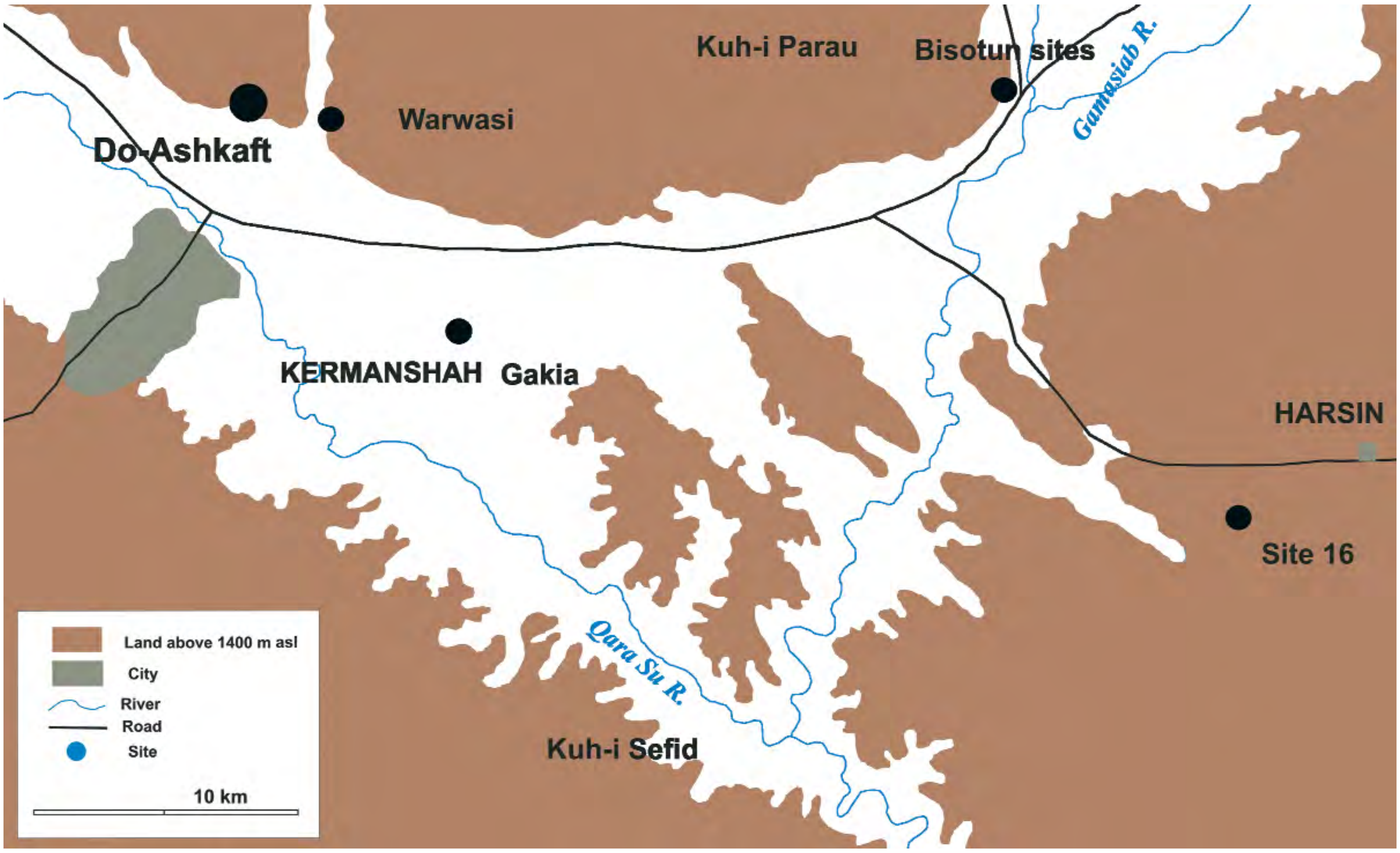


Fig.1: Map of the Kermanshah Plain and the locations of Do-Ashkaft, and other sites mentioned in the text.

blages were discovered (Biglari 2001; Biglari & Abdi 1999, 6; Biglari & Heydari 2001). Among these, Do-Ashkaft Cave yielded the largest assemblage, which allows us to start a detailed study and to compare it with other known Mousterian assemblages from the Zagros region.

Regional context and raw material sources

Kermanshah plain is a broad intermontane through in the Zagros Mountain in West Central Iran, with a general elevation of about 1350 m asl (Fig. 1). Two important drainages in this intermontane plain are Qara Su, Gamasiab, and their tributaries. This large plain is bounded to the northeast and southwest by two NW/SE trending mountain chains. Geologically the plain is located in the tectonic zone of the Zagros Crush Zone, between two other tectonic zones, the Zagros thrust zone and the Zagros fault zone (Brookes 1989; Heydari 2000; Waltham & Ede 1973).

Although, there have been no formal surveys of chert outcrops in the region. But our previous surveys in the region resulted in locating a number of major and minor sources, which have been used by Palaeolithic occupants of the region (Heydari 2000).

Among these outcrops, there is one outstanding raw material source, Gakia-Harsin, where radiolarian chert occurs in nodules and tabular forms on a hilly area to the southeast of Kermanshah. This hilly area is part of the so-called Radiolarit Belt of Kermanshah, extending from Borujerd at the southeast to Paveh at the northwest (see Heydari, this volume). The hilly area is approximately 25 km long and 16 km wide, which stretches along the northern slopes of Kuh-i Sefid. Its width at the eastern part is about 10 km, which decrease to 5 km in the western end, close to the eastern suburb of Kermanshah (Fig. 2). The area is surrounded on northern and north-western sides by the alluvial plain of the Qara Su River. On the southern side the Qara Su River separates it from the northern slopes of Kuh-i Sefid. Numerous chert nodules and cobbles have eroded from the outcrops owing to natural weathering processes.

Until today within this area three major types of radiolarian chert are known. The Harsin type is typically homogenous reddish

Fig. 2: Arial view of the western part of the Gakia area, Do-Ashkaft located in the cliff at centre (Source: Schmidt 1940).

brown opaque material, which occurs in two textures, fine and medium. The fine texture material has a darker colour with glossy appearance (2.5 YR 2.5/4 dark reddish brown), while the medium texture is light (2.5 YR 6/4 light reddish brown) or medium (5 YR 4/3 reddish brown) in colour. They could be variants of "Fine Red and Green chert" as described by H. Wright (1981). The outcrops of this material were located at the south-eastern part of the hilly area (west and southwest of Harsin). Also it is present at the western part of the hilly area along two other types at Gakia. These are very fine purple to light red and brown chert with glossy appearance (10 YR 6/3, 2.5 YR 4/4, 5 YR 6/3) that H. Wright suggested to call "Fine Opaque White Red or Brown Chert" (H. Wright, p.c.). It has superior flaking qualities. The other type, a greyish chert, occurs mainly in the medium texture, and a smaller number in fine and coarse texture (10 YR 7/2). This material was more exploited during Neolithic and Chalcolithic periods for blade production (Bernbeck *et al.* in press, and personal observations).The hilltops covered by huge and continuous workshops and chipping floors are related to the manufacture of flint artefacts during different periods of prehistory. A large Mousterian workshop (site 16) discovered by Mortensen and Smith at west of Harsin (Mortensen & Smith 1977) indicates that the eastern part of the area was exploited since the Middle Palaeolithic, which continued even to Neolithic time as it is documented in chipped stone assemblages from Ganj Dareh (personal observations).

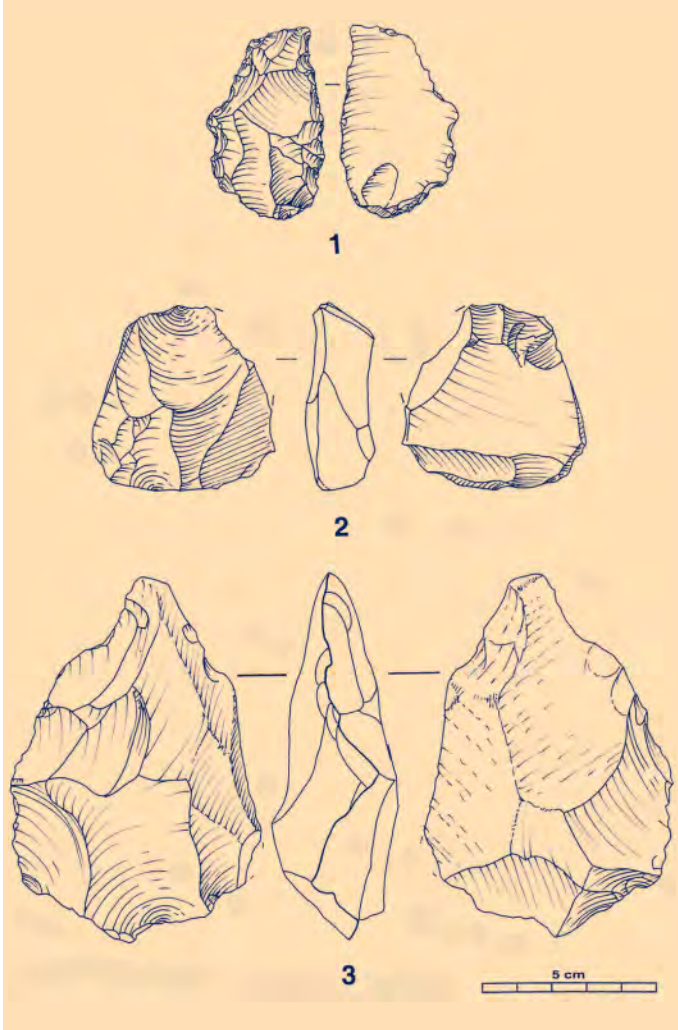


Fig. 4: Lithic artefacts from Gakia.

Fig. 3: Cores and a flake from Gakia; Photo: DBM, M. Schicht.

It seems that the western part (Gakia) was known to hominid groups even earlier. In the course of the Iranian Prehistoric Project in 1959-1960, an Acheulian biface and some flakes and cores were found about 30 m to the north of Qara Su River at Gakia area (Braidwood 1960; Singer & Wymer 1978, 15). During a survey of a hilltop located about 5 km to the north of this locality, undertaken by the author and S. Heydari in 1997, some core-choppers, Levallois cores and flakes and more later lithic artefacts were found on a hilltop scatter west of Gakia village (Fig. 3 & 4). These finds indicate that Gakia outcrops were exploited by hominids during Lower and Middle Palaeolithic. Two known Chalcolithic mound sites of Tappeh Murian and Ban Asiab specialised in lithic production indicate that this chert source kept its importance even during later prehistoric periods (Bernbeck *et al.* in press; Braidwood 1960).

Prehistoric hunter-gatherer through this area would have had easy access to these raw materials. The presence of Acheulian and Mousterian artefacts on this hilly area indicates that there was no dramatic change in distribution of lithic raw material outcrops since the Middle Pleistocene in Gakia-Harsin hilly area. Thus we might expect to trace at least some of these raw material types in Mousterian assemblages from cave sites located along the northern margins of the plain. The Middle Palaeolithic site of Do-Ashkaft located about 13 km to the northwest of Gakia yielded some evidence for such exploitations (Fig. 2).

The site

Do-Ashkaft is located on the north outskirts of Kermanshah, at the southern face of Maiwaleh Mountain at about 1.5 km to northwest of the Taq-i Bostan Spring and the famous Sasanian rock reliefs. The cave faces south and is situated about 190 m above the plain floor at an altitude of 1600 m asl (Fig. 5). The strategic position of the site high above plain floor with easy

Fig. 5: Do-Ashkaft, the location of the nearest outcrop of local raw material is shown by an arrow; Photo: S. Heydari.

Fig. 6: The outcrop of radiolarian chert adjacent to Do-Ashkaft.

access to diversified biotops for the game, the presence of a spring located immediately above the entrance with a continuous flow and radiolarian chert outcrops close to the site (Fig. 6 & 7), have attracted local hunter-gatherers to occupy it repeatedly during the Middle Palaeolithic period.

More than 4000 flint artefacts have been collected from the entrance area and the talus slope of the cave during a period of five years (1996-2001). The lithic assemblage comprises tools, flakes, trimming flakes, shatters and cores. The single and convergent scrapers (including Mousterian points) constitute the largest percentage of the tools, followed by other scraper types, retouched pieces, notches/denticulates, burins and miscellaneous artefacts. As it is typical for the Zagros Mousterian, the retouch on these tools is heavy and extensive (Biglari & Heydari 2001).

Fig. 7: Close view of the outcrop.

Raw material procurement zones

Two main procurement zones can be suggested on the basis of distances from the site to the nearest raw material sources and geographical distribution of raw material occurrences in the area.

1. The Maiwaleh Zone: raw material sources found at immediate vicinity of the site up to 4 km to west, and 2.5 km to east along southern slopes of the Maiwaleh Mountain. Raw material types in this zone mostly consist of radiolarian chert outcrops in Middle Cretaceous crystalline limestone. Our foot survey along the southern slope of the Maiwaleh Mountain confirmed the presence of many exposures of the material. Those exposures located in vicinity to the cave submitted to tectonic pressures resulting in many fissures make it tend to be fractured. This opaque material has a waxy appearance and reddish-brown, brown and green colour. The cave occupants could recover it from the outcrop themselves or would collect it as chunks on slopes around the site. Other outcrops of this raw material type in the Maiwaleh Zone, in contrary to outcrops adjacent to Do-Ashkaft, are not tectonised. Other types of raw material at Maiwaleh Zone, which are present as small nodules in limestone bedrock, are opal and chalcedony. Most sources in this zone would fall within the category of "local".

2. The Radiolarit Belt Zone: raw material sources along radiolarit belt, which at nearest point (in south direction) are about 8 km far from the site. Raw material types in this zone where described earlier. Do-Ashkaft occupants may have some difficulties in procurement of nearer sources of this zone, because they had to cross the Qara Su River, which flows about 5 km from the site. While for procurement of Gakia sources they could walk along the river that may took less than two hours to get those sources. Although this study shows that Do-Ashkaft occupants had an opportunistic use of these sources. All sources in this zone would fall within the category of "non-local" or regional.

It should be mentioned since our knowledge about raw material sources in the Kermanshah plain is still in a primary state, some specimen considered as non-local, could come from a nearer source at the Maiwaleh Zone. Thus the frequency of non-local raw materials may be lower in the assemblage. A precise provenience determination of most raw material types of non-local or regional groups appears not to be possible until an extensive raw material survey is done in the region. For minimising the problem of source assignment confusion, we plan to conduct chemical analysis on samples of raw material from various outcrops both in the hilly area of Gakia-Harsin and the mountain slopes.

Patterns of raw material procurement and usage

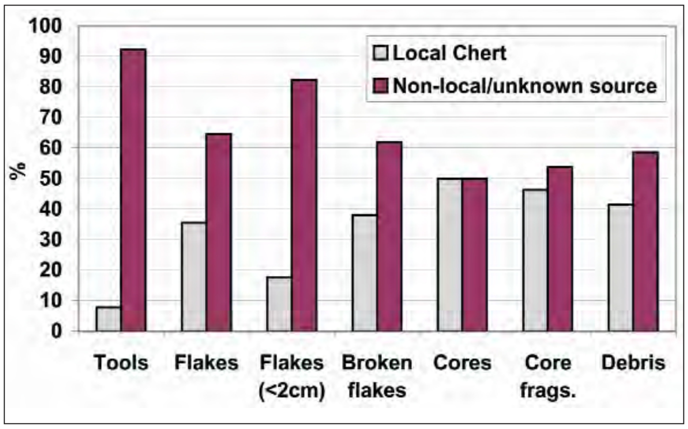
A high frequency of regional material consists of reddish-brown opaque chert, which is plentiful in the eastern part of Gakia-Harsin hilly area and also occurs in some quantity at the western part. Since no close source for this raw material has been determined in the Maiwaleh zone, except scattered pieces on mountain slopes, it is possible that it derives from Gakia area or a nearer source west of Kermanshah in the same Radiolarit Belt Zone. Although the possibility of nearer sources in the side valleys of Tang-e Kenesht and Malaverd located at eastern and western ends of the Maiwaleh Mountain can't be excluded. The Mousterian assemblages from Bisotun sites contained a relatively high frequency of this material which may procure from eastern part of the Gakia-Harsin area (Biglari 2001).

Fig. 8: A large lump of local chert.

Fig. 10: Cores and tools made of local chert; Photo: DBM, M. Schicht.

There is a non-local chert type in the assemblage that can be identified almost precisely. This very high quality chert which has purple to light red and brown colour as mentioned earlier is present at the western part of the Gakia hilly area in the Radiolarit Zone. Its nearest source located about 13 km to the south east of the site. This chert type makes up less than 3% of the total assemblage. The low representation of this material suggests that the use of this high quality material at Do-Ashkaft appears to have been rather opportunistic. Its presence at Do-Ashkaft has some implications for the mobility patterns of the local Middle Palaeo-lithic hunter-gatherers. The procurement of this chert type for Do-Ashkaft occupants may have involved less than two hours walk from the cave (Fig. 8). Since the time and energy expense for logistical trips to the western Gakia area would not have been great, the very low representation of this material in the assemblage may indicate a very restricted procurement territory. There are some other types of stone, their source is unknown and they may come from the Radiolarit Belt Zone or a nearer source at the Mawaleh Zone.

Fig. 9: Comparison of the distribution of local vs. non-local raw material types by artefact class at Do-Ashkaft.



When the technological and typological structure of local and non-local material components of the Do-Ashkaft assemblage are compared, certain differences in reduction and tool production strategies can be observed (Fig. 9). Local material accounts for about 34% of the assemblage by frequency. Its knapping would seem to have been more wasteful as the resource was locally plentiful. For these local raw material types, especially on-site material (tectonised), the chain operation took place almost entirely at the site as shown by the high percentages found there of cortical flakes, flakes, cores and other waste products associated with debitage (Fig. 10). The percentage of waste pieces significantly exceed the percentages of finished tools and reaches to 97% of all artefacts made of local raw material. The total number of local tools is 39 or only about 8% of the tool collection. The very low ratio of tools to cores (1.25 tools per core) and tools to flakes (one tool per 14 flakes) suggests that local flakes are rarely used for formal tool production. Tool-flake ratio increases significantly in the regional raw materials (one tool per two flakes).

Among artefacts made on non-local raw materials cortical and semi-cortical flakes are not abundant (47%). This can be interpreted as evidence for initial off-site processing of raw material. Trimming flakes (<2cm) and debris are much more common for non-local material than local radiolarit suggesting the tools made on non-local material were subject of more resharpening to maximise their lifetime (Fig. 11).

The cores are principally small, exhausted and consist of radial or subradial cores, parallel cores, amorphous cores and Levallois cores. The mean of maximum dimension of the cores is 38.04 mm. Core types are not significantly different in size, but radial

Fig. 11: Cores and tools made of non- local chert; Photo: DBM, M. Schicht.

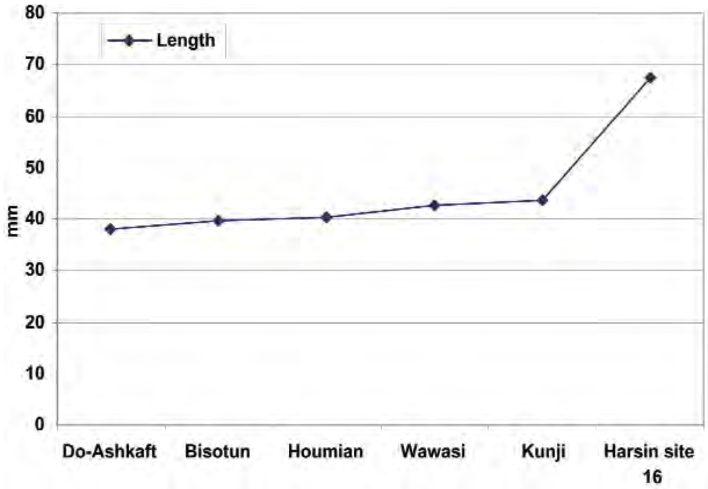
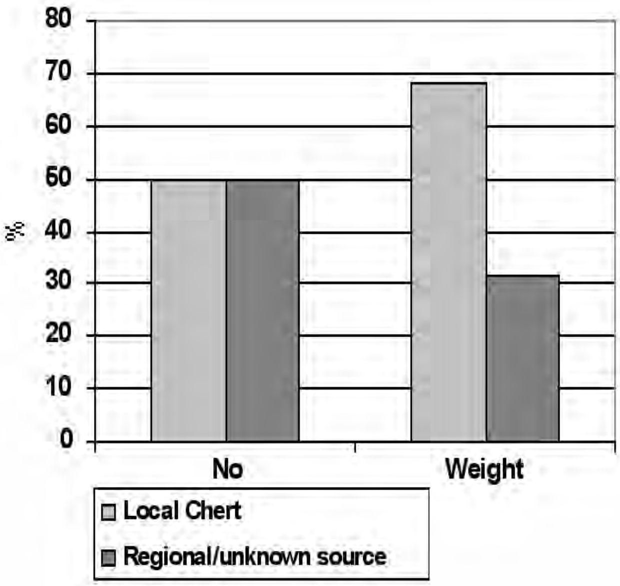


Fig. 13: Comparison of the means of maximum dimension of complete cores from Do-Ashkaft and some other Mousterian sites in the Zagros region.

type shows a much larger average size (39.76 mm), followed by parallel and amorphous types. Frequencies of cores made on local and non-local chert are equal. But local material is dominated by weight and account for 68% of the core sample (Fig. 12). The mean weight is 36.77 g for local cores and 17.10 g for regional cores. This difference is also visible in the size of the cores. Local cores are larger than non-local cores, and their mean of 33.7 mm. An interesting aspect of the non-local cores is the production of very small specimens. Almost 38% of the non-local complete cores are less than 30 mm in maximum length, while all local cores are larger than this size. Such small cores also reported from some Mousterian sites in the Zagros region and one site at the Iranian Central Plateau (Biglari 2004; Dibble 1984; Lindly 1997; Shidrang in prep.). These fully exploited cores made of non-local cherts suggest that non-local raw material was exploited in such a way that the core produced the maximum possible number of blanks until flaking surfaces would become very small.

Fig. 12: Frequencies and weights of cores for local vs. non-local raw material types.



In general, cores are significantly smaller statistically in length, width, and thickness than cores in other Mousterian assemblages from the Zagros region (Fig. 13). This could indicate more stress on raw material and greater reduction in Do-Ashkaft assemblage. Bisotun is closest to Do-Ashkaft in its mean maximum size of cores. Except that cores at Do-Ashkaft are thicker.

Cortex is present on 33 of the cores or about 53% of the total. Only 35% of the cores made of non-local material are cortical while near 71% of the local cores have a cortex. The low frequency of cortical pieces made of non-local material (35%) could indicate that the material which has been brought to the site was already partially prepared.

Conclusion

Do-Ashkaft lithic industry is characterised by more stress on raw material and greater reduction as indicated by small and exhausted cores, especially non-local cores, and heavily resharpened tools. The difference in core dimensions between the local and non-local raw material suggests a more economical exploitation of the regional raw material brought to the site. This indicates that Do-Ashkaft occupants did not have easy access to high quality raw material sources in the region. The production of tools, however, presents a much higher preference for using non-local better quality chert. The populations of hunter-gatherer which occupied Do-Ashkaft seem to have limited the procurement territory since the exploitation of resources may not exceed more than 15 km, as it is indicated by the very low frequency of western Gakia chert in the assemblage (Fig. 14).

The results of this study indicate that Do-Ashkaft occupants obtained better quality raw material from sources in the Radiolarit Belt Zone or other unknown sources in the Kermanshah region prior to the occupation at Do-Ashkaft, and subsequently local sources of the Maiwaleh Zone were used. Since the local low-quality material had low procurement cost, tools made of it were used without secondary modification for simple daily tasks, while better quality raw material types were maximised and used to produce formal tools.

Further investigation of this cave site and workshop sites in the Gakia-Harsin hilly area will permit a better understanding of raw material procurement strategies and land use pattern during Middle Palaeolithic time, in the high intermontane valley of Kermanshah.

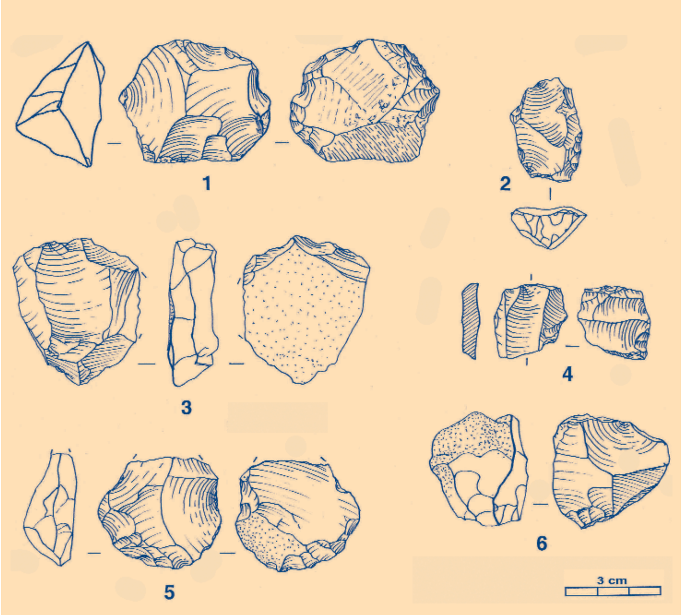


Fig. 15: Lithic artefacts from Do-Ashkaft Cave: 1. centripetal core (local chert); 2. bipolar Levallois core (chalcedony); 3. unipolar Levallois core (local chert); 4. small Levallois core (non-local chert); 5. centripetal core (local chert); 6. centripetal core (Levallois?).

Fig. 14: Core and tools made of Gakia chert; Photo: DBM, M. Schicht.

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Traditional agriculture in northwestern Iran (1978); Photo: G. Weisgerber.

Iran in the Neolithic

Reinhard Bernbeck

Introduction

Until about 60 years ago the period between 20,000 and 5000 BC in Iran and the Middle East was a wide knowledge gap. Before this time Palaeolithic hunter-gatherers were living there, then sedentary village dwellers. Robert Braidwood of the Oriental Institute in Chicago, by his excavation projects, was the first to bring on research on this period (Braidwood 1960; 1962). One of his major fields of work was Western Iran, particularly the area around Kermanshah in the Zagros Mountains. After his works there followed field research by younger archaeologists in the lowlands of Khuzestan, in Iranian Azarbaidjan, in the plain of Qazvin, and in the Marv Dasht between 1960 and 1980.

Today we are supplied with a much more dense framework of excavations and knowledge from surveys. But concerning the Neolithic, still huge parts of Iran are not marked on the map and we may excitedly wait for the results of future research.

Time and Geography

For summing up the present knowledge of the Neolithic it is at first necessary to define the basic dimensions of all archaeological knowledge, which are time and space. If in this case space, i. e. Iran, is easy to define, the definition of time meets difficulties as, though we are provided with radiocarbon dating, which is a scientifically solid and more and more reliable source, many older radiocarbon datings are unclear and often contradictory. Even today archaeologists see no other possibility than additionally using criteria for dating which do not belong to a scientific discipline.

Thus two approaches are employed. One compares the material cultures of certain places or their strata, a method of "relative chronology" which causes some problems particularly when early periods are concerned. On the one hand, the style of the artefacts – e.g. stone blades in the Early Neolithic – did not change fast enough. On the other hand, particularly conspicuous turning points of the development of material culture, e.g. the development of pottery, are supposed to have happened in wide regions at the same time. This approach does not take into the account that in one region the technology of pottery might have been developed much earlier or later than in another one.

A second way of dating causes similar problems. Ecologically orientated archaeologists used to study how wild animals and plants were gradually domesticated. Then from these observations complex theories were developed. We are talking about "broad spectrum revolution", "incipient agriculture", "food resource management" etc. Many scientists assume a timely succession of steps for taking over natural resources. But also in this case, like in the case of pottery, there are indications for the idea that hunting and collecting was not given up at all places at the same time.

With these reservations in mind I will try to sum up the time of the Neolithic in Iran. The end of the Palaeolithic, called "Epipalaeolithic", is in a period of about 7000 years from c. 18,000 to 11,000 BC. In those days groups of hunter-gatherers were mostly living in the caves of the Zagros Mountains. Compared to earlier groups of game hunters, a tendency towards increasing the number of the kinds of plants and animals, which were collected and hunted, can be observed. Not only smaller vertebrates were hunted but also pistachios and wild fruit were collected. Finally, consuming snails and smaller aquatic animals like crabs is new (Flannery 1973). We know almost nothing about the 2500 years which followed the Epipalaeolithic after 11,000 BC. Only when discovering the place of Asiab (c. 8500-8000) in the Kermanshah area we are in better known periods. Asiab was a small camp of hunter-gatherers, only seasonally inhabited. Besides the fact that wild goats and sheep were hunted, great numbers of snail shells were found. These finds were interpreted in the way that from time to time the hunting activities of the inhabitants of Asiab were

Fig. 1: The Epipalaeolithic cave of Pa Sangar, at the edge of town above Khorramabad, Iran; Photo: R. Bernbeck.

unsuccessful and that then they were forced to consume food which they usually did not like.

Some nearby and more constantly occupied settlements in the Zagros date from a short time after Asiab, from the time between 8000 and 6800 BC. Still the material culture of Tappeh Ganj Dareh and Tappeh Abdul Hosein does not include any pottery. Thus this period is often called “aceramic Neolithic”. This is also true for the oldest levels of Tappeh Guran, located in Luristan, as well as for the sites of Ali Kosh and Chogha Sefid in the plain of Deh Luran, west of the Zagros Mountains. There, flocks of sheep and herds of goats were kept for the first time. Managing animals meant a fundamentally new orientation of the Neolithic inhabitants of Iran and must be understood to be connected with a whole number of other innovations, particularly the architecture of houses. We do not definitely know if in those days there was any cultivation of cereals. Tools for harvesting and for making cereal products are there, but remnants of burned grain are extremely rare.

Fig. 2: Map, showing the most important places mentioned in the essay.

After this first Neolithic period, for which there is doubtless evidence only in Western Iran, there is the next period at 6800 BC which is known almost from the entire country. This Late Neolithic is characterised by the introduction of pottery. There are finds from the Bakhtiari Mountains near Isfahān, from the plains of Marv Dasht, from Hajji Firuz near Urmia, and from the South-East near Tappeh Yahya. Also from the Iranian highlands similar materials are known from the oldest levels at Tappeh Sialk, Zagheh near Qazvin, and from Cheshme Ali, South of Tehrān. Finally the just recently excavated Aq Tappeh and the site of Tappeh Sang-i Chakhmaq – both located North of the Alborz in the plains of Gorgan – are to be counted among the ceramic Neolithic. Traditionally archaeologists date the end of Neolithic in Iran to the time of a further development of the technology of pottery. At about 5500 BC some ware appears in many valleys of the Zagros and in the lowlands of Khuzestan which is burned at high temperature, mixed with fine minerals, and usually painted in black colour. They replace the earlier straw-tempered pottery and are characteristic for the era of Chalcolithic which follows Neolithic.

Fig. 3: Arrowheads made from small flint blades, found at Toll-e Bashi, province of Fars; Photo: R. Bernbeck.

Technology

With getting sedentary, agriculture and livestock breeding changed societies in such a fundamental way that at the same time people created a completely new material environment. Technologies were either decisively developed further or completely new productions appeared.

Stone Tool Industry

The industry of stone tools can only be roughly outlined here. As metal appeared only very late at the end of Neolithic (s. b.), the necessary tools for cutting, scraping, and drilling in their majority were made of flint. Some tools, belonging to agriculture, are especially typical for the Neolithic, among them long, narrow blades with so called sickle gloss, which is a silicate deposit on flint, if it is used for cutting grass or similar plants. Also typical are those cylindrical, tapered cores of flint, from which these blades were flaked. Many other tools were secondarily made from blades. In the Early Neolithic, arrowheads were produced from blades which were sloped at one end. Later, smaller points were produced in the shape of half-moons or trapeziums which are also known as “geometric microliths” (Fig. 3).

Not only flint was used as raw material for the blade industry. In small amounts there was also obsidian, a black, very hard, volcanic rock which is almost glass-like. As it is found only at very few places in the Middle East – in the area of Lake Van in Eastern Turkey and a bit farther away to the Southwest in the crater of a dormant volcano – the presence of obsidian suggests far reaching trade as early as in the Neolithic. But it is definitely wrong to imagine wandering traders. Instead, small amounts of obsidian was handed from settlement to settlement, rather a curiosity than a raw material for daily needs.

Rubbing Stones

Huge round or oval grinding stones from basalt or other coarse grained rock have already been known from cave-dwellings in the Epipalaeolithic. They are of significance mostly because they were later used for making meal. But it looks as if until some time in the aceramic Neolithic they were used for crushing pigments like ochre and only secondarily for making flour from wild grain. Grinding stones are also of interest as they could not be transported, due to their weight. The existence of such tools indicates that groups of humans were no longer roaming across greater distances but were staying at one place for longer times.

Pottery

The oldest ceramic products in Iran are hand-moulded vessels from Ganj Dareh, which shows no other kind of pottery (Fig. 4). These were not burned before use and are only preserved due to a fire that destroyed the settlement. Only in later times people started to burn the clay vessels on purpose. In the entire Iran there is only one place, Tappeh Guran, where there is evidence for the transition from aceramic to ceramic containing levels. Thus, for the time being it is not possible to say all too much about the introduction of this technology (Vandiver 1987).

Clay vessels were moulded by hand, quite often from two separately moulded parts. At first the base and the lower part of the side were made. After this half had dried a bit and was stabilised the cylindrical upper part was put on top. From this in most cases a bend of the side resulted where the two parts were put together. This was superficially painted over. Vessels showing this feature are known from extended parts of Iran, from Khuzestan to the higher parts of the Zagros. Often pots were coated with a layer of watery barbotine on the outside, so that they could be used for liquids. Sometimes an additional layer of red colour was applied to this layer, by which the vessel was even better sealed (Fig. 5). The more delicate vessels had some painted decoration in black colour at the upper part and at the inner side of the brim (Bernbeck 1989). All Neolithic pottery is burned at relatively low heat (around 600° C max.). For doing this it was probably laid out on the open surface and covered with long-burning material like dung or branches.

Though we are quite well informed about the technical process of producing pottery we know little about its use. Until recently the use was roughly deduced from general features like size (e.g. very big vessels were for storage), shape, or the way the surface was treated (sealing is for liquids). Only during the past 15 years a completely new orientation of the research on pottery came up which identifies the remnants of food by help of chemical analyses and reconstructs the ways of use by help of systematically recording microscopically small traces of use. Only in a few cases this method was applied to Neolithic pottery from Iran and we may excitedly wait for new results in this field.

Painted pottery does not appear right after the appearance of pottery but very fast it is taken over everywhere in Iran. It is conspicuous how geographically restricted the motifs were. Almost every valley of the Zagros and every plateau had its own repertoire (Hole 1987). In some regions the painting is exclusively abstract (Fig. 6), in others we find highly complex structures of decoration, including figurative depictions (Fig. 7). Today it is the common opinion that the symbols had two functions: distinguishing oneself from other small regions by clearly different motifs, and working as an integrative factor within a settlement by employing a world of signs known to all members of the community.

Fig. 4: The settlement mound of Ganj Dareh from the aceramic Neolithic, region of Kermanshah; Photo: R. Bernbeck.

Fig. 6: Abstract motifs of painted pottery from Toll-e Bashi, province of Fars; Photo: R. Bernbeck.

Fig. 5: Red polished pottery from Qaleh Rostam, high parts of the Zagros Mountains; Photo: Hans J. Nissen.

Fig. 7: Painted pottery from Qaleh Rostam, Zagros; Photo: Hans J. Nissen.

Layout of the Settlements and Geography

We are quite well informed about the details of building in Neolithic Iran. But for the time being, maps of the settlement structure, which might tell something about neighbourhood, routes, and the process of growth and fall of settlements, are only insufficiently known.

From the few evidence we are able to deduce two things. First, the houses in the Neolithic villages stood wide apart from each other (Voigt 1983). Public areas were much bigger than the small rooms in the interior which were hardly bigger than 2 x 2 m. Second, in public areas there were facilities like ovens and hearths which were used by several households at the same time. For the time being, there are hardly any exact data concerning the distribution of objects inside and outside the houses. In case they are at hand, much more things were found in the public area. Thus we may conclude that people spent most of their time outside the houses.

The building plans are the same, in so far as almost all excavated places show rectangular architecture (e.g. Smith 1990). The houses mostly have two rooms and sometimes small siderooms (Fig. 8). The building materials were either tamped clay or hand moulded, long mudbricks, whose surface was sometimes roughened in order to increase stability. We may presume that mudbricks were made right at the site, for the long, thin, and heavy components would have broken on transport, even if only on a short way. As far as we can recognise, the roofs were flat. They consisted of thin wooden rods with a cover of brushwood and a layer of clay on it. Like it is done in Western Asia still today, they had to be rebuilt every year. Insufficient stability is known from at least one place, which is Tappeh Abdul Hosein. There, under the collapsed wall of one house three skeletons were found. It remains unclear if the house collapsed because of dilapidation or because of other reason, e.g. an earthquake.

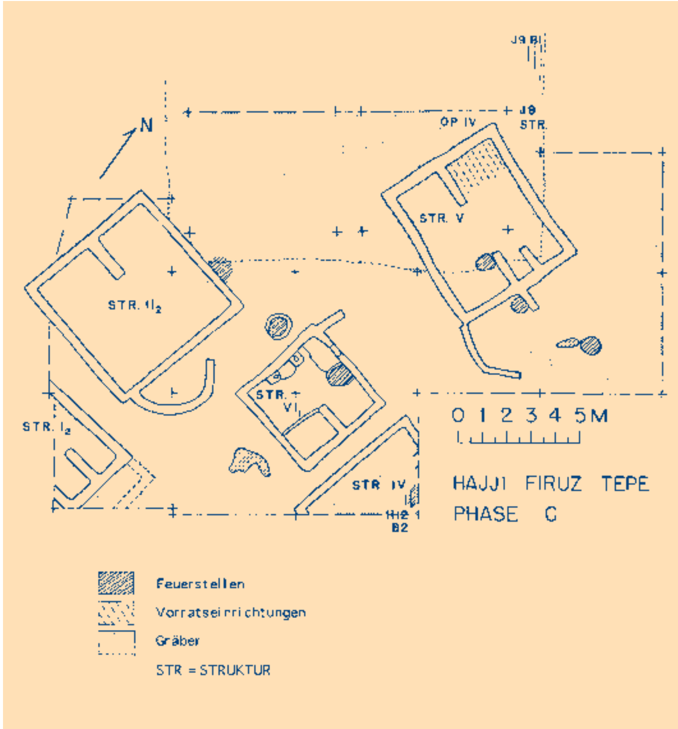

Fig. 8: Map of settlement structure of Phase C at Hajji Firuz, North-Western Iran; acc. to Voigt 1983, fig. 138.

Metal Production

As early as in the Neolithic, considerable amounts of copper were manufactured to artefacts. As far as we know, this was not melted copper but cold hammered metal. Most of the copper was found during excavations in the highland. Some single finds in the lowlands, far away from any deposit, are surprising. At Ali Kosh and Chogha Sefid one small copper artefact each was found, which indicates connections to the North-East, probably as indirect connections as in the case of obsidian trade.

While many copper objects seem to be jewellery, rings or beads, one artefact from Tall-i Mushki could be identified as a fishhook, due to its bent shape and the still preserved string which was around it. In Sialk, besides copper jewellery there are needles and bodkins.

Clay Figurines

At some of the Neolithic places, particularly at Tappeh Sarab, a lot of small clay figurines were found, depicting various animals and humans. Interestingly enough, the animal-figurines are mostly in a realistic style (Fig. 10a-b) while the depictions of humans (mostly women) are abstract and often are without head or limbs (Fig. 10c) (Broman-Morales 1990). Also, almost everywhere, but particularly in Fars, abstract, small clay artefacts are found whose basic form is skittle-like, cylindrical, or button-like (Fig. 9). There are also stone versions of these objects. Probably they were used as memory aids, each specific form maybe marking a specific thing or being, e.g. a gregarious animal.

The "Neolithic Revolution"

The transition from Palaeolithic to Neolithic, which V. Gordon Childe called the "Neolithic Revolution" while referring to the "industrial revolution", holds its important position in the history of the world, as it marks a process without which our present way of life would be unimaginable. Today the term "Neolithic Revolution" has mostly been abandoned, as it was proven that in the Middle East, including Iran, this development took thousands of years. It makes more sense to speak of a "process of Neolithisation".

60 years ago, when these historically unique processes got to be a central issue of research, work at first was concentrated on disco-

vering the oldest places where evidence for domesticated plants and animals could be found. Doing this, researchers like Kathleen Kenyon and Robert Braidwood thought it to be a matter of fact that with the domestication of grain there came sedentism. But the lack of interest in sedentism went when there was a closer look at the earliest predecessors of Neolithic at the coasts of the Mediterranean, where there is evidence for sedentism long before any kind of domestication (Bar-Yosef & Meadow 1995). After having looked through the finds from Epipalaeolithic Zagros, Kent Flannery claimed that in this period there was a "broadband revolution", when groups tended to stay at one place as long as possible (Flannery 1973). To do so, they had to reach back to natural resources like snails, other molluscs and small vertebrates, e.g. hares, which in earlier times had not been among their diet. But this thesis has not yet been proven for Zagros. The groups of hunter-gatherers kept living in caves, and concerning the question how long they were used, we are still dependent on speculations, despite more recent research.

But in other respects the analyses of bone finds makes methodical progress. E.g. archaeologists started to deal with the age at which animals were slaughtered and found out that before the domestication of gregarious animals, particularly sheep and goat, these animals had been hunted selectively. Instead of indiscriminately killing sheep, goats, and other cloven-hoofed animals (pigs, gazelles, and cows), particularly young, male animals among the herds were aimed at. This kind of selective hunting, sometimes called "management", was analysed in detail by Melindas Zeder (1999; 2000). After her opinion especially young, male animals were hunted, as for the biological reproduction of the herds only a few male animals were necessary. Other researchers think that this increasingly selective hunting led to such familiarity with the habits of the animals that domestication happened almost automatically.

But Hans-Peter Uerpmann (1996) points out that for domestication it was definitely necessary to make the animals free from their fear against humans, and this could not happen in the context of hunting, may it have been selective or not. He claims that raising newborn animals, like wolves, wild goats and wild sheep, is the only possibility to explain the oncoming symbiosis of human and animal. If this is the case, the dogs, which are evident in Zagros and around the Mediterranean as early as in the Epipalaeolithic, are an important argument. But the domestication of the wolf as the prototype of the domestication of animals does not answer the question why this idea was used for only very few other species and – if imitating mothering is a human instinct – why this was not done much earlier in the progress of mankind.

Concerning wild grain, the idea is that domestication happened without purpose. The heads of wild grain fall apart fast so that they are difficult to harvest. But among the wild grain, still existing in the Zagros, there are always mutants whose stands do not fall apart, and which thus with great probability reached the settlement or camp areas of the humans after the time of harvest. If year after year some of this corn fell to the ground near the settlements, germinated and was harvested together with the wild grain, the number of mutants could slowly rise. This theory is based on the idea of a large extent of sedentism.

Concerning the Iranian Zagros it is presumed that grain was not domesticated at the place but that it was brought from the Mediterranean area, already in the form of a mutant (Miller 1992). Goats, on the other hand, might well have been domesticated in the high parts of the Zagros; concerning sheep, we still do not know enough about the process. Focusing on the biological analyses of plants, animals, and ecologic factors for quite a long time was one-sided in so far as the motivation of humans only played a minor role.

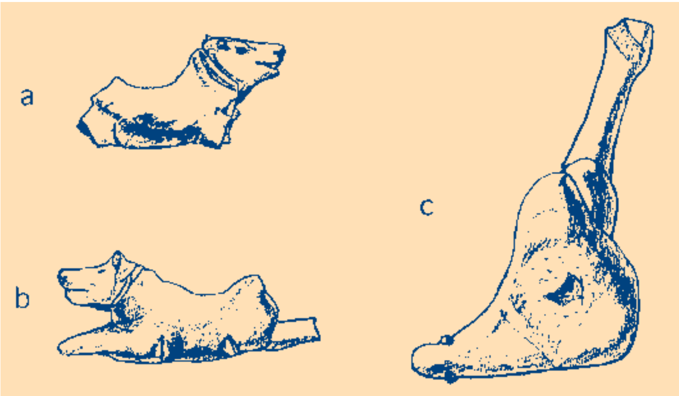

Fig. 9: Animal figurines and abstract anthropomorphic figurines from Tappeh Sarab, region of Kermanshah; acc. to Broman-Morales 1990; a: tab. 4c; b: tab. 4e; c: tab. 12i.

Fig. 10: Abstract clay artefacts from Toll-e Bashi, province of Fars.

Only a new orientation of archaeology brought some change, when the attempt was given up to understand human behaviour only from the outside and by help of natural science and the past was understood to be a process of reasonable human behaviour. E.g. Ian Hodder, leader of the excavations at the famous settlement of Çatal Höyük (Turkey), said that neolithisation had less been a process of domesticating plant and animal but much more a kind of human self-taming (Hodder 1990; see Watkins 1990). He interprets Neolithic symbolism as trying to separate a "home area" from a "wild" outside area and making oneself a part of the former. Only in the course of this process humans are able to understand themselves as being different from nature – as being a bearer of civilization. Jaques Cauvin (1996) sees the emergence of a religion with a female principle in the Neolithic, which became material by help of female clay figurines, and a male principle which he finds in depictions of bulls´ horns. These more recent theories show their own weak spots as they are based on the idea that the Neolithic human had a basic need for symbolism. But especially in early Neolithic Iran we have a situation when groups turn to agriculture and livestock breeding, and from archaeological finds it is not possible to find any symbolic-ideological frame for this. Thus we may say that at the moment those theories which ask about the meaning of the course of neolithisation are only able to offer sufficient answers for the western part of the Middle East.

Even more recent ideas approach the emergence of the Neolithic way of life from a completely different perspective. Which inner problems had to be solved by groups of hunter-gatherers during the process of sedentism and of the transition to agriculture and livestock breeding? Ethnographic investigation of present societies of hunter-gatherers suggest that in those societies there is no intellectual separation between human world and nature (Ingold 2000). Thus the idea of a shortage of resources is not well-founded and because of this, sharing collected fruit and hunted animals is a matter of principle which is not analysed. Today we consider private property a form of meanness. Of course from time to time there might be bottlenecks. But as that what we today call "natural" resources, being an external reality, is rather considered a kind of feeding unit, almost "parent-like", by groups of hunter-gatherers, individual acquisition at the expense of the other members of the society would mean serious damage to the group.

Even if in pre-Neolithic times "nature" was a general "breadwinner" and unconditional sharing counted among social basics, the question must strongly be raised if the process of neolithisation, i.e. the acquisition of resources which now were considered an external reality, did not create ideological resistance. Why did humans start to imitate their "breadwinner" – nature – by help of domestication? Were these developments followed by societal fractures? In the year 2003 Susan Pollock, Kamyar Abdi, and the author himself started a project in the plain of Ramjerd in the province of Fars which is supposed to answer these questions (Abdi et al. 2003).

Only from retrospective view the consequences of neolithisation are known to us. Village life developed, then towns with social hierarchies, empires and differences between rich and poor, war and peace. Writing finally enabled to remember glorious history and to withhold defeats and crimes. Today genetic engineering leaves us at the threshold of another dimension of imitating nature, as far-reaching as neolithisation was. Just like any Palaeolithic game hunter in Iran, today we are not able to estimate to which extend our social reality will be changed by this development.

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Obsidian in Iran from the Epipalaeolithic Period to the Bronze Age

Kamyar Abdi

Introduction

Obsidian is a predominantly greenish-grey to black (but also sometimes brown and red), naturally occurring volcanic glass formed by rapid cooling of viscous lava of rhyolithic composition (Gourgaud 1998). Obsidian registers around six on the Mohs hardness scale. Obsidian is easily chipped, breaking with a conchoidal fracture to produce extremely sharp edges. For this important physical property, obsidian was a much-desired raw material for making tools before the introduction of metal blades.

Two main dating techniques have been applied to obsidian: obsidian hydration dating and fission-track dating. Obsidian hydration dating (Friedman, Trembour & Hughes 1997; Stevenson, Mazer & Scheetz 1998) rests upon the principle that exposed surface of obsidian absorbs water at a steady rate for the same chemical composition, forming a hydration layer. By measuring the thickness of the hydration layer and comparing that to known local hydration rate an approximate date for flaking can be estimated. Fission-track dating (Westgate, Sandhu & Shane 1997; Poupeau *et al.* 1998) rests upon the principle that the spontaneous fission of uranium atoms causes radiation damage in natural dielectric solids including minerals such as obsidian. The damage – called fission-tracks – accumulates and sustains in the environmental conditions in the earth's surface and can be measured for chronological purposes. However, known rate of spontaneous fission is often on the order of millions of years, that is useful for geological, but seldom for archaeological dating.

Obsidian finds from archaeological contexts can be traced back to identifiable sources using obsidian sourcing, a chemical method to fingerprint unprovenanced obsidian samples and comparing them with chemical composition of known flows in order to determine their geological source (Glascock, Braswell & Cobean 1998). Obsidian can be grouped into three broad types based on its chemical composition and the petrography of the geological structures within which it occurs. These three types are alkaline, calc-alkaline, and per-alkaline. These three types are determined by their major element composition – ratios of alkali and alkaline elements. But thereare the minor trace elements that allow one to make fine distinctions among several potential sources. However, since various flows in the same volcanic locality could be rather different in their chemistry, careful sampling at each source and minute laboratory analyses is required for making accurate fingerprinting and attribution to a specific source.

Near Eastern Sources of Obsidian

The most important sources of obsidian in the Near East are located in Anatolia and Caucasus. There are also smaller sources in southern Yemen, possibly in southwest Arabia and the Red Sea islands (Zarins 1989; Francaviglia 1990), and perhaps some localities in Iran, yet to be explored. The major Anatolian and Caucasian sources are grouped into four distinct geographical clusters (Fig. 1): central Anatolia (Cappadocia), northeast Anatolia, south eastern Anatolia (the Lake Van region), and Caucasus (Armenia, Azarbaidjan, and Georgia) (Poidevin 1998).

I The central Anatolian (Cappadocian) obsidian sources are predominantly located to the southeast of Tuz Gölü (the Salt Lake). Obsidian from central Anatolia is of calc-alkaline type. These sources provided obsidian for a large region extending from western Anatolia and the Levant to Syria and Mesopotamia as far east as Deh Luran Plain in south western Iran (Renfrew, Dixon & Cann 1968; Wright 1969; Chataigner 1998, 277-293), but there is still no evidence to suggest that obsidian from central Anatolia reached into the Zagros and further east into the Iranian Plateau.

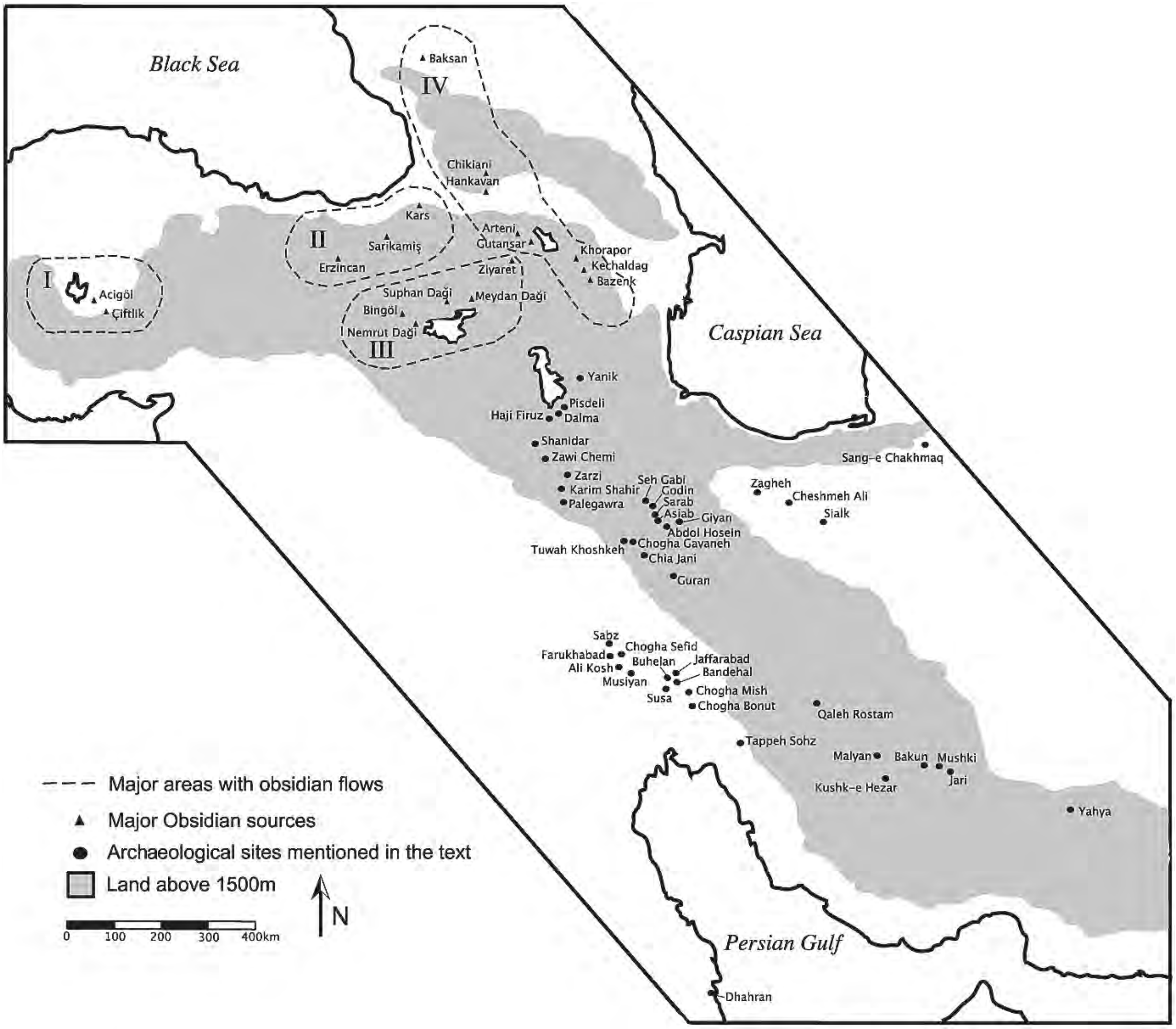

Fig. 1: Location of major obsidian sources and the archaeological sites mentioned in the text; after K. Abdi.

II The northeast Anatolian sources are located to the southeast of the Black Sea in the area from Erzincan to Mount Ararat (Poidevin 1998, 125-134). The chemical composition of these sources is also calc-alkaline.

III The southeast Anatolian (Lake Van region) sources of obsidian include a number of major flows around Lake Van, but also sources to the east around Lake Urmia in Iran (Wright 1969; Wright & Gordus 1969; Dixon 1976; Renfrew & Dixon 1977; Poidevin 1998, 135-150). The Lake Van sources are of both per-alkaline and calc-alkaline types.

IV The Caucasian sources are predominantly located in the mountains to the northwest and southeast of Lake Sevan in Armenia and Azarbaidjan, but there are also isolated sources in Georgia and northern Caucasus along the Baksan River on the Russian side of the Caucasus mountains. These sources are clustered into 14 distinct chemical groups, predominantly of calc-alkaline type (Blackman *et al.* 1998).

Obsidian Finds from Iran

Obsidian was exploited and used in eastern Anatolia as early as the Middle Palaeolithic period (Yalçinkaya 1998), but obsidian artefacts appear in archaeological contexts in the Central Zagros only by the late Upper Palaeolithic period at Shanidar (Level C) and Zarzi, and only then in small quantities. By the Early Epipalaeolithic period obsidian occurs in higher quantities at sites such as Zarzi and Palegawra, continuing through the Late Epipalaeolithic period at Shanidar and Zawi Chemi. Most of these obsidian finds seem to have come from Lake Van region (Renfrew, Dixon & Cann 1968).

A drop in obsidian finds in the Early Aceramic Neolithic can be attributed to the small number of sites of this period explored; finds from Palegawra, Karim Shahir, and Asiab are notable exceptions.

Obsidian finds from the Central Zagros continue throughout the Neolithic period at Guran and Chia Jani (Late Aceramic Neolithic), Sarab and Abdul Hosein (Early and Middle Neolithic), Chogha Gavaneh (Early Chalcolithic), Godin, Seh Gabi, and Giyan (Middle and Late Chalcolithic). At Seh Gabi obsidian from Nemrut Dağ just to the north of Van, and two Caucasian sources are present. At Chogha Gavaneh only three pieces of obsidian have been discovered in Layers IX-VIII (dated to Early Chalcolithic period) (Wright 2005). These three pieces are opaque or slightly translucent and black in colour, thus probably not from the Lake Van region. But, the one piece of obsidian from the nearby Tuwah Khoshkeh, dated to Late Middle Chalcolithic has the greenish hue typical of the Lake Van region (Abdi *et al.* 2002, 61), thus suggesting a possible shift in the sources of the Central Zagros obsidian.

Further to the southeast in the Central Zagros at Qaleh Rostam in the Bakhtiari region, of a total number of 280 lithic artefacts from Late Neolithic period only four retouched blades (1.4%) were made from obsidian (Gebel 1994).

In the southwestern foothills of the Zagros in the Deh Luran plain obsidian appears as early as the Late Aceramic Neolithic period with the beginning of sedentism at Tappeh Ali Kosh (Boz Mordeh phase) continuing through Early Neolithic phase at Tappeh Ali Kosh (Ali Kosh phase) and Chogha Sefid, Late Neolithic phase at Tappeh Ali Kosh (Mohammad Jafar phase), Chogha Sefid, and Chogha Sabz, and by Chalcolithic period at Chogha Sabz, Musiyan, and Farukhabad (Renfrew 1969; 1977).

At Tappeh Ali Kosh, in the Boz Mordeh phase there are a total of 347 pieces of obsidian (0.9% of the lithic assemblage), increasing to 474 pieces (2%) during the Ali Kosh phase, and dropping to 417 pieces (1.7%) by Mohammad Jafar phase (Hole, Flannery & Neely 1969, 173). Obsidian continued to be used in Deh Luran throughout the Neolithic and Chalcolithic periods, usually forming one percent or less of the total lithic assemblage, except a surge during Mohammad Jafar (156 pieces = 8%) and Sefid (2042 pieces = 5%) phases at Chogha Sefid (Hole 1977, Tab. 38; Renfrew 1977). By the Uruk period there is a decline in the quantity of obsidian in the lithic assemblage (Wright 1981, 275). Obsidian from Deh Luran came almost entirely from northeast Anatolian and especially Lake Van sources (Renfrew 1969; 1977), except a small quantity from Bayat Phase at Tappeh Sabz that seems to have come from central Anatolia (Renfrew, Dixon & Cann 1968, 325; Chataigner 1998, 292, Figs. 7a-b).

Further to the southeast obsidian has been reported from Neolithic and Chalcolithic contexts at Chogha Bonut, Chogha Mish, Bandebal, Buhelan, Jafarabad, and Susa on Susiana Plain and Tappeh Sohz on Behbahan plain. At Aceramic and Formative phases at Chogha Bonut obsidian finds include 26 pieces (2.18%) of the total 1190 pieces of lithic material (Alizadeh 2003, 91-113). Obsidian from Chogha Mish came from various Lake Van sources (Blackman 1984, 36).

In the northern Zagros in Azarbaidjan obsidian appears during the Middle Neolithic period at Hajji Firuz and Yanik and continues through Chalcolithic period at Yanik, Pisdeli, and Dalma (Renfrew & Dixon 1977, Tab. 1).

On the Central Plateau obsidian finds occur at Neolithic and Chalcolithic contexts at Zagheh, Cheshmeh Ali, and Sialk, as far east as Sang-i Chakhmaq, also in very small quantities.

In the southern Zagros, especially in Kur River Basin, obsidian finds are present as early as the earliest phase of settled occupation during Mushki period, although in small quantities. From a total of 2951 lithic artefacts from Tall-i Mushki, only 12 (0.4%) are obsidian (Furuyama 1983). Following the Mushki period, there is a drop in obsidian finds; there is no obsidian from the Mushki-Jari transitional period at Toll-e Bashi and only one in 50 surface finds from Kushk-e Hezar (Alden *et al.* 2004, Tab. 5). By Jari B period there is no obsidian (Hori 1988-89), perhaps indicating a hiatus during which the inhabitants of Kur River Basin lacked access to the material. A few pieces of obsidian are found on the surface of Shamsabad/Bakūn sites (Mahdavi & Bovington 1972, Tab. 1) and excavated Bakūn deposits. While there is no data on obsidian from Lapui phase, it does occur in Banesh and Kaftari contexts. Analysis of obsidian finds from Banesh contexts at Malyan (Operation ABC and TUV) suggest that over 80% of finds can be traced back to the Lake Van sources (Blackman 1984). In the following Kaftari phase obsidian from Lake Van sources drop to 29% in favour of obsidian from other sources, including 30% from Caucasian sources (Blackman *et al.* 1998, 222).

Further to the east, obsidian has been reported in small quantities from Chalcolithic deposits at Tappeh Yahya (periods VA-IVB) in Kerman, also from the Lake Van region (Blackman 1984).

The farthest find of the Lake Van obsidian has been reported from a number of localities around Dhahran on the southern coast of the Persian Gulf (Renfrew & Dixon 1977, Tab. 1).

Mechanism of Exploitation and Exchange

The wide distribution of obsidian in the Near East from a relatively small number of sources has lead to much speculation on the nature and mechanism of exchange networks involving obsidian.

The credit for first systematic characterisation and exploration of obsidian exchange in the Near East goes to Colin Renfrew and his colleagues (Cann & Renfrew 1964; Renfrew, Dixon & Cann 1966; 1968;

Dixon, Cann & Renfrew 1968; Renfrew 1969; 1977; Dixon 1971; Renfrew & Dixon 1977). These early studies not only provided an initial classification of obsidian types through trace-element analysis, but also proposed a spatial model in the form of a fall-off curve to explain the distribution of obsidian in the Near East. This model postulated an exchange network along what Renfrew and his colleagues called the "Zagros Interaction Zone" that carried obsidian from Lake Van sources as far south as Susiana during the Neolithic period (*c.* 7500-5500 BC). In what Renfrew and his colleagues labelled "Law of Monotonic Decrement" they noted that the proportion of obsidian in the total excavated lithic assemblage decreased in a regular exponential fashion with the distance from the source (Renfrew, Dixon & Cann 1968, Fig. 2). They also noted that plotting the percentage of obsidian in total lithic assemblage to distance from source shows a curve suggesting two zones: a "supply zone" of up to 300 km from the source where as much as 80% of the total lithic assemblage might be obsidian, and a "contact zone" that procured obsidian through "down-the-line-trade" (Renfrew & Dixon 1977, 147-9).

Renfrew and his colleagues further argued that for later Neolithic and Chalcolithic periods (*c.* 5000-3000 BC), due to small quantitative data on excavated obsidian, their model did not hold beyond the supply zone for each source. They therefore introduced a "Tigris-Iranian Plateau Zone" that covered western Iran and extending all the way to Dhahran on the southern shore of the Persian Gulf, the farthest south obsidian from Lake Van sources was reported. But the quantity-against-distance curve (above) no longer seemed to be decreasing in a monotonic fashion, but the opposite, *e.g.*, local clusters seemed to be the case. For example, certain important settlements, such as Susa, seem to have been receiving unusually high supplies of obsidian. Renfrew and his colleagues interpreted this as a shift from reciprocal to central place exchange, presumably suggesting the emergence of traders, a postulate supported by observation that by this time obsidian was used not much for utilitarian tools, but for items such as seals and personal ornaments signifying prestige and social status (Renfrew & Dixon 1977).

The above model has been criticised on a number of grounds. For example, Warren (1981) argues that the fall-off pattern observed by Renfrew and Dixon has to be explained as a difference in mechanisms for exploitation and distribution at the source, not in the supply zone. Blackman (1984, 22), on the other hand, argues that the function, and not the material type, defined the exchange mechanism, so various items could have been included in the same exchange system. But, most importantly, Gary Wright (1969, 47-52) pointed out some flaws in the model by Renfrew and his colleagues: first, there seems to be minor deviations in the straight line predicted by Renfrew and his colleagues. Second, Wright stressed that weight as opposed to proportion of obsidian to the total lithic assemblage should have been calculated, because in the Neolithic period, man and not pack animals were used for transportation. Third, Wright argued that obsidian should be measured in the context of the function of the site in which they are discovered, *i.e.,* permanent settlements. Fourth, Wright pointed out that the local availability of local chert and flint should be considered in how much obsidian was imported.

Despite some criticisms, the model proposed by Renfrew and his colleagues still seems to be widely accepted as a working hypothesis for the distribution of obsidian in the ancient Near East. The geological, petrological and chemical analysis of obsidian, however, has progressed by leaps and bounds in the past two decades. For example, a recent collection of essays on obsidian in the Near East (Cauvin *et al.* 1998) has raised the bar on interdisciplinary studies of archaeological obsidian. Various papers in this volume (see especially, Gourgaud 1998; Bigazi *et al.* 1998; Poidevin 1998; Blackman *et al.* 1998) present in-depth analysis of a wide range of sources and specimens, in some cases tracing finds to exact flows in specific localities.

Conclusion

With the introduction of metals from the late fourth millennium onwards, obsidian gradually lost its utilitarian function, but it was still valued for its physical appeal as a material of luxury for the production of personal ornaments, vessels, and seals, among others (for a later history of obsidian use see Moorey 1994, 70-71).

As more in-depth studies of obsidian exploitation and exchange elsewhere in the Old World (*cf.* Torrence 1986) and the New World (*cf.* Hirth 2003) indicate, a wide range of techniques and tactics were applied for procurement and distribution of obsidian. As archaeological studies of obsidian in the Near East shift from broad regional synthesis to highly localised analysis, we can expect to see more refined studies emerging in the years to come.

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Early Towns in Iran

Barbara Helwing

Iran is a country extraordinarily rich in natural resources of copper, lead and silver, as well as metamorphic rocks and semi-precious stone. Thus, it is not surprising that people in this region developed an early interest in these resources and started developing new technologies to exploit them, focusing especially on copper and silver. These new materials quickly turned out to be coveted trade goods that were distributed even to distant areas by means of an emerging trade network. These long-distance contacts constitute one of the most important factors in Iranian history, since they established contact to the peoples of the Central-Asian steppes and the Afghan Mountains, as well as the inhabitants of the oasis cultures along the Indus, Euphrates and Tigris, and the newly discovered culture on the Halil Rud. The emergence of a series of trade centres marks the beginning of a new international era, the "Era of Exchange", as the French archaeologist Pierre Amiet termed it (Amiet 1986).

The origin of the famous historic trade routes, the Silk Road and the King's Road, stems from this network of trade routes that developed during the 3rd to 4th millennium BC "Era of Exchange" (Herrmann 1964; Majidzadeh 1982). These roads connected the emerging urban centres of South-western Iran and Mesopotamia with the raw material deposits on the plateau and further east. They followed the winding valleys of the Zagros into the highlands and to the edge of the big desert Dasht-e Kavir and then went along its fringe or crossed it. Thus, the carnelian sources in Eastern Iran and Pakistan, the lapis lazuli mines in Badakhshan/Afghanistan, Tajikistan and the Chagai mountains of Pakistan, and the rich copper and silver deposits of the Central Iranian Plateau and especially the Kerman Province could be reached. Since the 4th millennium BC, the Persian Gulf had also become accessible through maritime trade (Potts 1994).

This „Era of Exchange" had a significant impact on the Iranian cultures. The processing of the new materials required specialists and completely new professions emerged. The new technologies were improved successively and the long-distance trade called for new methods of information management. Small villages evolved into towns and cities with craftsmen's quarters, central markets, trade stations, an administration and temples. The consequences of these changes were so dramatic, that the famous prehistorian Gordon Childe coined the term "Urban Revolution" to describe them (Childe 1950). This evolution reached its first culmination at the beginning of the 3rd millennium BC with the emergence of the Proto-Elamite culture (3100-2600 BC). The term "Proto-Elamite" can be traced back to the epigrapher A. Scheil (Scheil 1905; 1923; 1932), who used it to describe the glyphs of an archaic writing system, which is thought to be the precursor of the later Elamite script. Today, in following McCown (1949), an entire archaeological cultural complex is referred to as "Proto-Elamite".

Archaeological Sites

Sedentary villages existed in Iran since Neolithic times. As a rule, they were situated along the fringes of the limited fertile land and tended to be inhabited over a long period of time. When the mudbrick houses of a settlement were abandoned, new buildings were erected over the ruins of the old houses. That way – layer by layer – small mounds were formed, which are known under their Persian name tappeh. Important sites consist of a cluster of these mounds, rather than a single one.

The archaeological investigation of the succession of layers in these tappehs allows the definition of local and regional cultural sequences, that each bear the name of the excavated settlement and its corresponding building phase (Ghirshman 1978; Vanden Berghe 1966).

Fig. 1 & 2: Two vessels of so called Cheshmeh-Ali/Sialk III-Stile from Iranian Central Plateau of Tappeh Ghabrestan (1) and Ismailabad (2); Photos: DBM, M. Schicht.

Geography, Pottery and Chronology

The natural formation of the Iranian landscape – the steep mountain ranges of the Zagros and Albourz, the coast of the Caspian Sea, the tableland with the big desert, the lowlands in the West and the elevated plain in the East beyond the Lut desert – has favoured the development of different cultures that are all embedded in their specific environment. At this time, six main geographical regions can be distinguished. The desert margin regions on the central plateau surround the desert. Iranian Azarbaidjan mirrors the development in Eastern Anatolia and Transcaucasia. The lowlands of Khuzestan in South-western Iran, the ancient Susiana and adjacent plains were closely connected to Mesopotamia. The high valleys of the Zagros in Fars constituted an independent region, and South-eastern Iran – Sistan-Baluchistan – had connections to Afghanistan and Pakistan. Finally, the recently discovered oasis culture on the Halil Rud (Pittman 2003) maintained long-distance relations with Arabia and Mesopotamia across the Persian Gulf (Figs. 1 & 2).

The definition of cultural traditions and their regional and chronological variants in Iranian prehistory relies mainly on pottery classification (Dyson 1992). In the 5th and 4th millennia BC, pottery with dark painted decoration over a beige or red surface was widely spread. The designs show geometrical or naturalistic patterns, which certainly were not only used as decoration, but also acted as symbols within a value system that has not come down to us. For that reason, similar motifs can be found over vast distances and only disappear towards the end of the 4th millennium, when the introduction of writing in Proto-Elamite times procured new tools to retain information.

The development of the painted pottery of the 5th and early 4th millennium BC can best be assessed on the Iranian plateau. Here, on the south-eastern fringe of the great desert, the brown on beige painted pottery of the Sialk III style is to be found. It features geometric and zoomorphic designs that were arranged in circular bands and panels (Ghirshman 1938). North of the desert, the inhabitants of Tappeh Hesār decorated a reddish pottery with similar patterns (Schmidt 1937), and again similar designs, but with a different execution, adorn the pottery of Tureng Tappeh (Deshayes 1967) and Shah Tappeh (Arne & Burton 1945) in the plain of Gurgan, close to the coast of the Caspian Sea.

In the utmost West of the highlands, the painted pottery of Pisdeli shows a much simpler composition (Dyson & Young Jr. 1960). The Susa I pottery in Southwestern Iran reveals some influence from the Mesopotamian Ubaid culture (Le Breton 1957) (Fig. 3),

Fig. 1 & 2: Two vessels of so called Cheshmeh-Ali/Sialk III-Stile from Iranian Central Plateau of Tappeh Ghabrestan (1) and Ismailabad (2); Photos: DBM, M. Schicht.

but unlike Mesopotamia, painted pottery stays common in this region until well into the 4th millennium BC.

It is only in the late 4th millennium BC, and probably due to the influence of new technologies, especially the introduction of the fast potter's wheel, that a new trend toward the production of a monochrome mass-produced ware emerges. This ware is occasionally decorated with horizontal circular bands and can be found throughout Western Iran and the plateau. Examples of this new style are documented in late Susa II, as well as in early Sialk IV (Ghirshman 1938) and in the Banesh period in Fars (Nicholas 1990). In the North, grey polished wares, already attested in small quantities in the ceramic assemblages since the 5th millennium BC, increase continually in ratio. Only in the South-eastern part of the country, on the other side of the Lut desert and along the Halil Rud, and therefore beyond Proto-Elamite influence, a characteristic style of painted pottery survives into the middle of the 3rd millennium BC.

Fig. 3: Beaker Period Susa I/II from Susa. Photo: DBM, M. Schicht.

Settlements

The southern Zagros highlands reveal a radical reorganization of settlement structures during the late 4th millennium BC. After decreasing steadily in size and number since the end of the 5th millennium BC, a process possibly due to the appearance of alternative ways of life, like for example nomadism (Sumner 1988; Alizadeh 1988 and contribution in this volume; Zagarell 1982), some settlements in favoured locations now started to grow to an unprecedented size. Fortification systems, administrative buildings and craftsmen's quarters portray a truly urban character. These big settlements are usually surrounded by an array of smaller sites that comprise farming villages, nomadic camps or even specialised production areas. A good example for such an early city is Tal-i Malyan in Fars, later to become the capital of Anshan (Sumner 1975; 1985; 1986). During the Banesh period of the late 4th millennium BC, its urban area, which covers several small mounds, increased noticeably in size. A city wall encircled some of the mounds. An administrative complex formed the centre of the settlement, while workshops producing stone tools and shell beads, as well as processing areas for arsenic copper and lead, were located on the smaller outer mounds. A similar process of development can be assumed in other settlement areas of the southern Zagros, like Tal-i Ghazir in Behbahan (Caldwell 1968).

Tappeh Sialk (Ghirshman 1938) (Fig. 4) and Tappeh Hesār (Schmidt 1937; Dyson & Howard 1989) (Fig. 5), the two best-known settlements on the plateau, have so far been investigated only to a much lesser extent. Nevertheless, they too certainly represent regional centres with specialised economic areas that can be characterised as proto-urban as early as the early 4th millennium BC, during the Sialk III and Hesār IC-II periods, respectively. Looking at a wider geographical context, the surveys and excavations at Arisman (Chegini *et al*. 2000) now also indicate the existence of contemporary specialized industrial settlements that supplied the market in Sialk. More specialised settlements can be found on the plateau at Tappeh Ghabristan (Majidzadeh 1979; 1989) and at the just recently excavated settlement of Tappeh Ozbaki (Majidzadeh 2001).

The settlements in Iranian Azarbaidjan, on the other hand, certainly did not attain urban dimensions during the Late Chalcolithic and Early Bronze Ages. The large settlement mound at Geoy Tappeh (Burton Brown 1951) mostly originates from later times, and the sparse occupation remains of the Late Chalcolithic are by no

Fig. 4: The south mound of Tappeh Sialk, seen from north mound, in the back the Karkas-mountains.

means representative. In Yanik Tappeh, an enclosure wall made of stone was erected at the beginning of the Early Bronze Age. At the same time, a completely new style of architecture was introduced and the houses now show a circular ground plan (Burney 1961; Burney & Lang 1971). The emergence of fortification walls can be traced over a wide geographical area that ranges from Sos Höyük in Anatolia (Sagona 2000) to Yanik Tappeh in Azarbaidjan. More evidence also stems from numerous settlement sites that are only known through surface surveys. Fortification walls are often considered as a typical indicator for urban settlements, though in this case they rather seem to suggest a persistent need of protection by the inhabitants. This might indicate the imminent presence of the same groups that eventually brought about the cultural break between the Late Chalcolithic and the Early Bronze Age. In the East, archaeological evidence for Chalcolithic settlements so far still remains elusive. However, by the end of the 4th millennium, in the oases along the fringe of the desert, large cities with extended craftsmen's quarters begin to emerge. The best-known are Shahr-i Sokhta in Sistan (Tosi 1973; 1983) and Shahdad in Kerman (Hakemi 1997). As on the Iranian plateau further east, the existence of specialised industrial settlements can also be detected here, for example at Tappeh Yahya, where a workshop for chlorite vessels has been discovered (Lamberg-Karlovsky & Beale 1986; Lamberg-Karlovsky & Potts 2001; Kohl 2001). Jiroft on the Halil Rud (Pittman 2003; Majidzadeh 2003a; 2003b), a recent addition to the archaeological map of this period, is another large settlement with extended cemeteries. Research in this newly established cultural region is still at the very beginning, but it is already obvious that another highly differentiated urban society existed here.

The lowland of Khuzestan is the most comprehensively researched area, where, similar to the situation in Fars, settlements had been on the decline throughout the 5th millennium BC (Johnson 1973). But with the late 5th millennium Susa and Abu Fanduweh started to expand into regional centres, and at the middle of the 4th millennium BC a third centre emerged at Chogha Mish, larger than the other two (Alizadeh in press; see this catalogue). This settlement consists of a systematically planned Upper and Lower Town, and incorporates monumental architecture and craftsmen's quarters. At the same time, the concentration of settlements along the western edge of the plain suggests that the eastern half of the Susiana was largely under the control of nomadic groups. Whether the three urban centres were in economical or political competition with each other, is a question that cannot be answered at this time.

Fig. 5: The mound of Tappeh Hesār.

Economy

The rise of a society that operated on the division of labour and specialist craftsmen is a characteristic feature of the Late Chalcolithic and the "Urban Revolution" (Childe 1950). The necessary redistribution of work gave rise to a complete reorganisation of all fields of work, including the agricultural sector. The production of staple foods became a specialised branch of the economy, as did pottery production, blacksmithing and trade.

Subsistence

Organising the food supply for the population of a whole town or city is an enormous logistic challenge (Zeder 1991; Miller 1982). The towns in Southern and South-eastern Iran had enough arable land at their disposal to assure self-sufficiency. Various irrigation methods had been developed since the 6th millennium BC. Inundation periods were utilised, and the construction of canals and terraces allowed the retention of water over a longer period of time, so that both the water and the silt could be used. Such terraces are known from Dowlatabad near Tappeh Yahya (Lamberg-Karlovsky & Tosi 1989). These irrigation methods raised the yield of the fields in the direct hinterland of the cities, where mainly wheat and barley, but also millet, grapes and dates were cultivated. The crops were used in a variety of ways; the production of fermented beverages like beer and wine has been proven at Godin Tappeh for the 4th millennium BC (Badler, McGovern & Michel 1990).

Analyses of animal bone assemblages show that controlled husbandry and culling of herds of sheep and goats took place at a distance from the cities. It is quite possible that this economic branch was in the hands of nomadic groups, who in this case would have supplied the inhabitants of the cities with animal products. Cattle, however, was kept only in close proximity of the settlements, and their meat and dairy products were probably consumed by just a small fraction of the urban population. Another branch of animal husbandry specialised in the breeding of draft and pack animals. There are only a few and still controversial records for the use of horses, donkeys and camels in the long-distance trade of this time.

In other regions of the Near East, donkeys are known since the 4th millennium BC, but the archaeological evidence for Iran is – except for the onager, that was hunted – still lacking. Domesticated horses, possibly originating in East Anatolia or Transcaucasia, appear in Iran not before the later 3rd millennium BC. Secure evidence for camels dates as late as the 2nd millennium BC, and so far the terracotta figurines of dromedaries from Shahr-i Sokhta (Bökönyi & Bartosiewiecz 2000, 132) are the only indication of a possibly earlier use of these animals in transportation.

Metallurgy

The extraordinarily rich metallic ore deposits in Iran have favoured the early development of specialised crafts, especially metallurgy, since Chalcolithic times (Pigott 1999; Pernicka 1990). Poly-metallic ore deposits are found in abundance throughout the plateau. Among the best known are the copper and silver deposits of Anarak-Talmessi in the Dasht-e Kavir desert, which were systematically exploited since Sasanian times and probably already much earlier. Pyrotechnology – the use of fire to alter the physical properties of a material – was used since the 5th millennium BC to transform oxidic copper ores, such as malachite, into malleable metallic materials. The use of sulphidic ores, which are somewhat more difficult to process, as they require an additional procedure in the reduction of the ore, dates only slightly later. Arsenic copper is the most widely used metal in this time and was probably made from arsenical copper ore. A more uncommon procedure was the systematic extraction of silver from silver-lead ore by means of a refinement process known as cupellation, which first appeared on the Iranian Plateau in the 4th millennium BC (Pernicka, Rehren & Schmitt-Strecker 1998).

Fig. 6: Crucible with a base, type Ghabrestan, within melted remnants of copper at the reaction-surface; Photo: DBM, M. Schicht.

Some of the best-known archaeological evidence for the processing of copper comes from a small workshop area in Layer 9 of Tappeh Ghabristan in the Qazvin Plain (Majidzadeh 1979). It consists of a two-room house in the centre of the settlement, whose larger room was furnished with two hearths. A crucible with a pierced foot – a type now known as Type Ghabristan – was standing next to the larger hearth (Figs. 6 & 7). On the other side, a workbench or platform made of mudbrick had been set up. Pieces of copper ore were found inside a large bowl within the same building, and several casting moulds for tools were scattered across the floor. The copper workshop of Ghabristan is a textbook example of the so-called

Fig. 7: Open hearth-mould of a shaft-hole axe with core-holder in clay; Photo: DBM, M. Schicht.

"cottage industry", where all production steps, from the smelting of the ore to the final reworking of the finished artefact, are completed within one area.

The industrial settlement of Arisman (Chegini *et al.* 2000) is a good example for the systematic processing of copper towards the end of the 4th millennium BC. The smelting of the ore now took place outside the actual settlement, and the construction of draft furnaces that utilised the locally prevalent winds to process enormous amounts of ore led to the accumulation of large slag heaps in the vicinity. During this time, only the casting and finishing processes took place within residential buildings.

Bead Industry

Workshops for lapis lazuli have been found at several sites from the early 3rd millennium BC, like Tappeh Hesār, Susa, Shahdad, Tal-i Malyan and Shahr-i Sokhta (Fig. 8). At the latter, carnelian and turquoise were used in addition to lapis lazuli (Foglini & Vidale 2000; Casanova 1995). Although no corresponding architectural layers were preserved, the work process could be approximatively reconstructed. The raw material was divided into blocks with flint

Fig. 8: *Chain of lazurite-, carneol-, chalcedony- and gold-beads from Tappeh Hesār; Photo: DBM, M. Schicht.*

tools using a specific technique of carving and pressure. Those blocks were then divided up further into smaller pieces, depending on the intended dimension of the product. Sanding and polishing produced the final shape of the beads, and flint drills were used to create the perforations. The same techniques were also used on other semi-precious stones, such as chalcedony and turquoise. Carnelian and agate were additionally subjected to strong heat to enhance their colour effect. Bead-makers were professional craftsmen, and some of them carried the tools of their trade with them at all times, even into the grave, as some burials from Shahdad demonstrate (Hakemi 1997).

Steatite Carving

The simple procedures of sanding, cutting, drilling and polishing are sufficient to shape the soft steatite or chlorite, which is found in the Kerman region. Since the 3rd millennium BC, this special material had been carved into richly decorated vessels. Tappeh Yahya was one of the centres of steatite vessel manufacture (Kohl 2001), and its products were traded as far as Mesopotamia, the Arabian Peninsula and the Indus Valley. The findings from Tappeh Yahya are to this day the best illustration of the vast distances that were crossed regularly in the trade of prestige objects. After the end of the 3rd millennium BC, steatite workshops also appeared in the cities along the desert fringe, for example in Shahdad.

Just recently, Jiroft has been added to the list of known production centres for steatite vessels (Majidzadeh 2003a). Its products are characterised by their complex and inventive iconography Figs. 9 & 10).

Administration

The growing subdivision of individual economic branches and the craft specialisation that are the hallmark of the "Era of Exchange", required new methods and tools to document, manage and control the flow of goods and labour. Stamp seals had been in use as ear-

Fig. 9 & 10: Two steatite vessels, cemeteries of Shahdad and Jiroft; Photo: DBM, M. Schicht.

Fig. 9 & 10: Two steatite vessels, cemeteries of Shahdad and Jiroft; Photo: DBM, M. Schicht.

ly as the Neolithic, but it was the 4th millennium BC that saw the introduction of tokens, bullae and cylinder seals in order to label and authenticate documents. Since the Late Uruk period, when the introduction of standardised accounting systems and – slightly later – the invention of writing took place, Mesopotamia had efficient documentation tools at its disposal. It is in this time and under the palpable influence of the Uruk culture that the earliest numeric tablets are also found in Iran, in layer 17B on the acropolis at Susa. The seal impressions on these bullae and tablets are stylistically indistinguishable from the ones found in Uruk itself, and demonstrate just how close the link between Susa and the Uruk culture was in this time.

However, real writing did not appear until the beginning of the Proto-Elamite Period, which coincides with Susa III, at about 3100 BC. The first Proto-Elamite tablets are to be found in layer 16C at Susa, while a set of numeric tablets with single and possibly Proto-Elamite glyphs came to light between layers 17B and 16C (Vallat 1971; 1978). The particular and unique Proto-Elamite writing system was used to record a non-semitic language – the Proto-Elamite. This term reflects the assumption that the language might be a predecessor of the later Elamite, which was spoken in Elam in the 2nd millennium BC. Both the Proto-Elamite script and the glyptic demonstrate a new development that is completely detached from Mesopotamia (Pittman 1997). Two distinctive types of seals can be distinguished, each belonging to a particular group of users. The first, called "common style", is characterised by cylinder seals made of annealed steatite that are decorated with schematic, mostly geometrical and floral patterns. The second group shows a more refined style that certainly has affinities to the earlier Uruk seals, although their stylistical expression is distinctively Proto-Elamite. Heraldic scenes and animal groups are depicted, and movement is illustrated for the first time. Human representations are rare; the iconography is centred on heroes with animal aspects and hybrid figures like griffins. Another specifically Proto-Elamite characteristic is the depiction of wild animals, like lions or bulls, in human posture and acting like humans, for example feeding animals.

Social and Political Organization

The profound changes in society in Late Chalcolithic and Early Bronze Age Iran have to be deduced from predominantly indirect information. Conclusions can be drawn from the spatial organisation of settlements, the overall picture of settlement dynamics and – in the 3rd millennium BC – from burial data. It is obvious that urbanisation brought about growing craft specialisation. The conversion of self-sufficient rural settlements, as they had existed since Neolithic and Early Chalcolithic times, into urban societies that relied on craftsmanship and the division of labour called for a complete reorganization, in order to free up manpower for such specialised industries as metallurgy. In addition, intermediaries that ensured the exchange of goods and raw materials were needed – thus the new occupation area of commerce emerged. The discovery of entire potter's quarters and industrial areas in the excavations of Chogha Mish and Tappeh Ghabristan, of Tappeh Sialk and Arisman, as well as the burials of craftsmen, still equipped with the tools of their trade, in the cemeteries at Shahdad and Shahr-i Sokhta, all corroborate the growing differentiation of society. Private initiative certainly was a driving force behind the emergence of this new economy, and the varying use of seals since the 4th millennium BC allows the distinction of different groups of users within a universally accepted system (Pittman 1997). In the wake of this economic reorganisation individuals soon were able to accumulate personal wealth and status, as can be seen in the rich burials of the 3rd millennium BC, for example at Shahdad.

Beyond the cities, the nomadic groups led a completely different life and most probably also formed independent political units. It seems reasonable to assume the existence of an interwoven system of mobile tribes and sedentary city residents that depended on each other in numerous ways and exchanged goods on a regular basis.

The analysis of settlement patterns in some of the favourable settlement areas, like the Susiana and Fars, shows an at least three-tiered settlement hierarchy since the 4^{th} millennium BC. A network of smaller and partially specialised satellite settlements surrounded central settlements with administrative centres and monumental architecture. This visible institutionalization of economic and political power bears all the traits of early state formation (Johnson 1973; Wright 1998). Whether this model also might apply to other regions of Iran, such as the tableland and the oasis cultures in the East, will have to be determined by further research.

Conclusion

The cultural history of Iran from the Late Chalcolithic to the Early Bronze Age (5^{th}-3^{rd} mill. BC) was certainly influenced by its geographical location between Central Asia and Mesopotamia, the Caucasus Mountains and the Persian Gulf, and the contacts that resulted consequently. The abundant natural resources that could be exploited, due to an early development of adequate technologies, transformed Iran quickly into a principal supplier of various raw materials and prestige objects for the neighbouring regions. The ensuing new economy eventually led to the emergence of the first cities in ecologically favoured areas. These cities acted as market places and trade centres and soon developed into religious and political focal points as well. They were supplied by specialised industrial settlements and farming and nomadic communities in the hinterland. Towards the end of the 4th millennium BC, all these developments resulted in the distinctively Iranian cultural identity that is archaeologically known as the Proto-Elamite Civilization.

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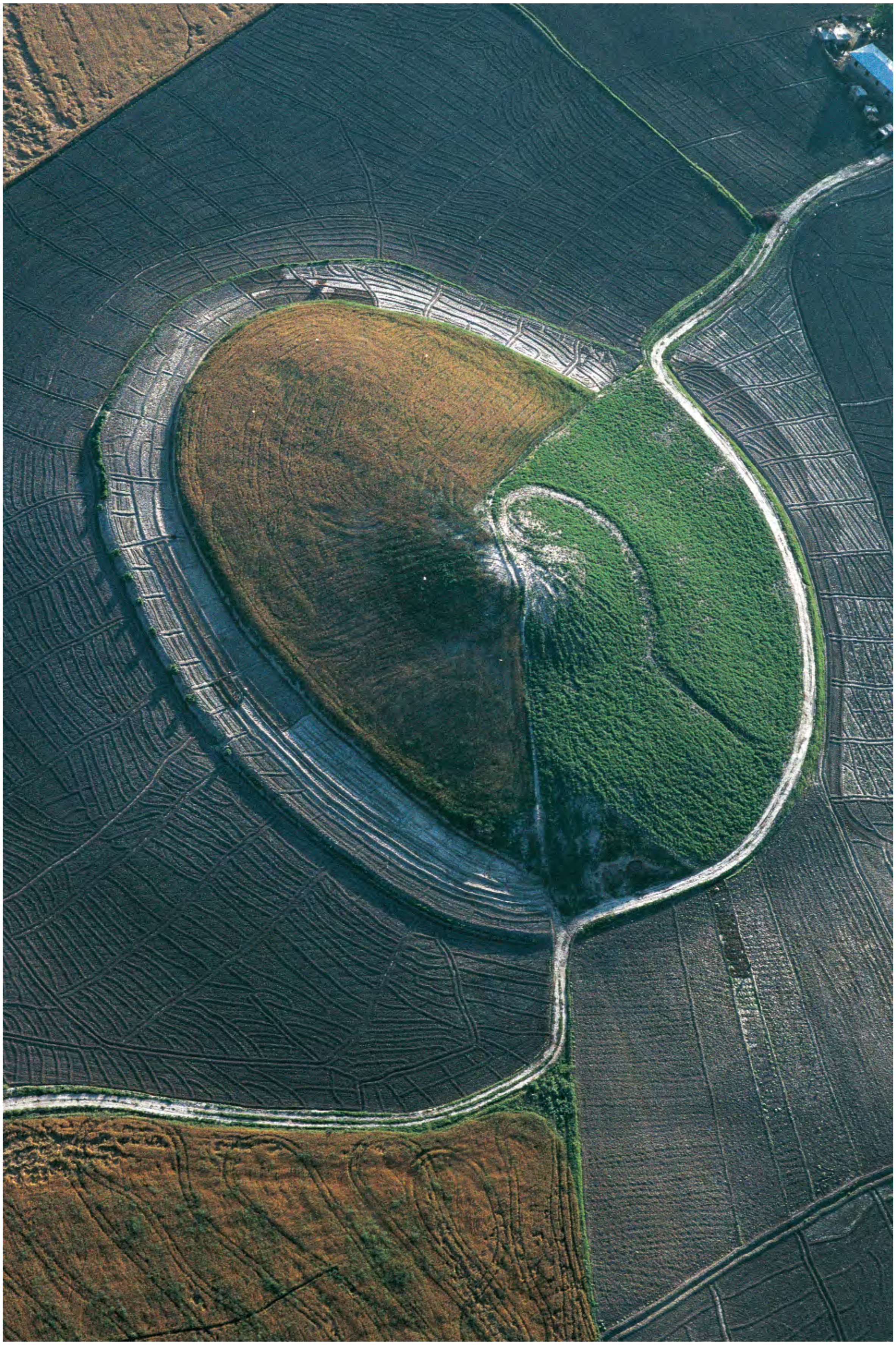
Mound of a prehistoric settlement (Tappeh) in the plain of Gorgan. The mixed vegetation is caused by the cultivation of the acreages; photo: G. Gerster



Chogha Mish

Abbas Alizadeh

Fig. 1: Map showing the location of Chogha Mish and other major sites in south-western Iran and Mesopotamia.

Introduction

Chogha Mish (KS-01), 32° 13' north, 48° 33' east, in lowland Susiana (in modern-day Khuzestan Province), is the largest pre-Sasanian settlement in north-eastern Susiana, and is strategically located between the outlets of the large perennial rivers of Dez and Karun in the plain. Closer to the site are two important tributaries of the Dez River, the Siah Mansur, some 10 km to the west, just west of Jundi Shapur, and the Shur, slightly less than 1 km to the east Mish (Figs. 1 & 2).

The mound of Chogha Mish consists of a truncated cone-shaped high mound to the north overlooking a large terrace to the south Fig. 3). The summit of the High Mound is at elevation 100.54 m above sea level. It is about 27 m above the surrounding plain and over 30 m above the riverbed of the Shur, to the east (el. 70.30 m). The High Mound, measuring *c.* 200 x 150 m, is steepest toward the north and north-west, where it slopes *c.* 23 m in 60 m., *i.e.*, an incline of nearly 1 in 3 m. Its western edge is fairly regular, but on its north-east, east and south-east sides it has four irregularly shaped lobes separated by deeply eroded gullies. The terrace, about 400 x 300 m, has four less prominent peaks (Fig. 4).

Eleven seasons of excavations at the site provided a long, uninterrupted prehistoric sequence of cultural development in south-west Asia. Chogha Mish is therefore uniquely qualified to demonstrate at a single locus a series of major developments that took place during the entire Neolithic period in south-western Asia. These developments include the gradual appearance of central places, increasing specialisation and improvement in the production of material culture, changes in subsistence economy, and the emergence of chiefdom and proto-state societies.

Archaic Susiana 1 Phase

The earliest cultural phase discovered at Chogha Mish, the Archaic Susiana 1 phase, dates to *c.* 6800 BC (Delougaz & Kantor 1996). Cultural phases much earlier than the basal levels of Chogha Mish were accidentally discovered in the nearby mound of Chogha Bonut (Alizadeh 2003). The continuation of the Archaic period thus will have to be sought at Chogha Mish. The initial occupation of Chogha Mish is marked by the presence of the earlier Painted-burnished Variant and its developed version, the standard Painted-burnished Ware. Sometime during the Archaic Susiana 1 phase, the Painted-burnished Variant completely disappeared. The standard Painted-burnished Ware was associated with other artefacts, for example, the tiny T-shaped figurines, which occur both in Susiana and Deh Luran to the north. As mentioned above, striking parallels can be found in the pottery and figurines from the distant sites in the Iranian central plateau. The T-shaped figurines are frequently interpreted as belonging to a Zagros complex but they have a wider distribution since we have closely similar material far to the north-east of Iran.

Architectural remains of this phase at Chogha Mish were inconclusive. They consist of poorly preserved pisé and mud brick wall fragments, beaten earth surfaces and several cooking installations. The use of long bricks continued into this phase. As in the earlier and later phases, the floors of the cooking installations were covered with fire-cracked rocks. No change in the subsistence economy was noted from the previous phase.

Subsistence Economy

The earliest inhabitants of Chogha Mish subsisted on domesticated goats and sheep and hunted gazelle, onager, and aurochs. During the Archaic 3 phase and Early Susiana period, cattle and pigs became important, comprising almost half of the assemblages at Chogha Mish and Jafarabad levels 6-4, with 40% sheep and goats. Later, during the Middle Susiana period, sheep and goats became dominant accounting for *c.* 65% at Jafarabad, with sheep becoming more dominant in later phase. This last development can be taken as an indication of the increasing importance of wool in Susiana.

Cereal remains recovered from Chogha Mish include barley, bread wheat, and oat. In addition, the wild grasses such as goat face grass, rye grass, as well as canary grass and fescue also occurred with the domestic ones. Wild and domestic types of legume species accounted for the majority of seeds recovered from the site, indicating that such plants were more cultivated/exploited by the Chogha Mish farmers. The recovered seeds include milk vetch, clover, as well as screw beans, vetch, pea, and lentil, the latter two showing morphological signs of domestication. Other carbonised seeds besides legumes, grasses and flax were also present in the Archaic levels. The most frequent were Lolium, Aegilops, and Plantago (plantain). Less frequent seeds include rush, bed straw, and sea blite, caper, members of mint family, shepherd's purse, as well as seeds from borage family, goosefoot family, lily family, mallow family, poppy family, and nettle family.

The available evidence of carbonised seeds from the Archaic levels at Chogha Mish does not support the importance of cereals (primarily emmer and einkorn wheats and barleys) in the early stages of domestication. Rather, during the entire Archaic period, legume crops seem to have been more significant in the subsistence economy. In fact, legumes comprise the largest portion of total seeds counted from Archaic through the end of the Susiana sequence. This picture changes in the Protoliterate period when cereals become dominant in the records.

Archaic Susiana 2 Phase

The size of the small, initial settlement of the previous phase at Chogha Mish increased. Thus, a settlement of approximately 90 x 100 m can be established for the Archaic Susiana 2 village, but it may well have been larger. Taken together, the Archaic Susiana vil-

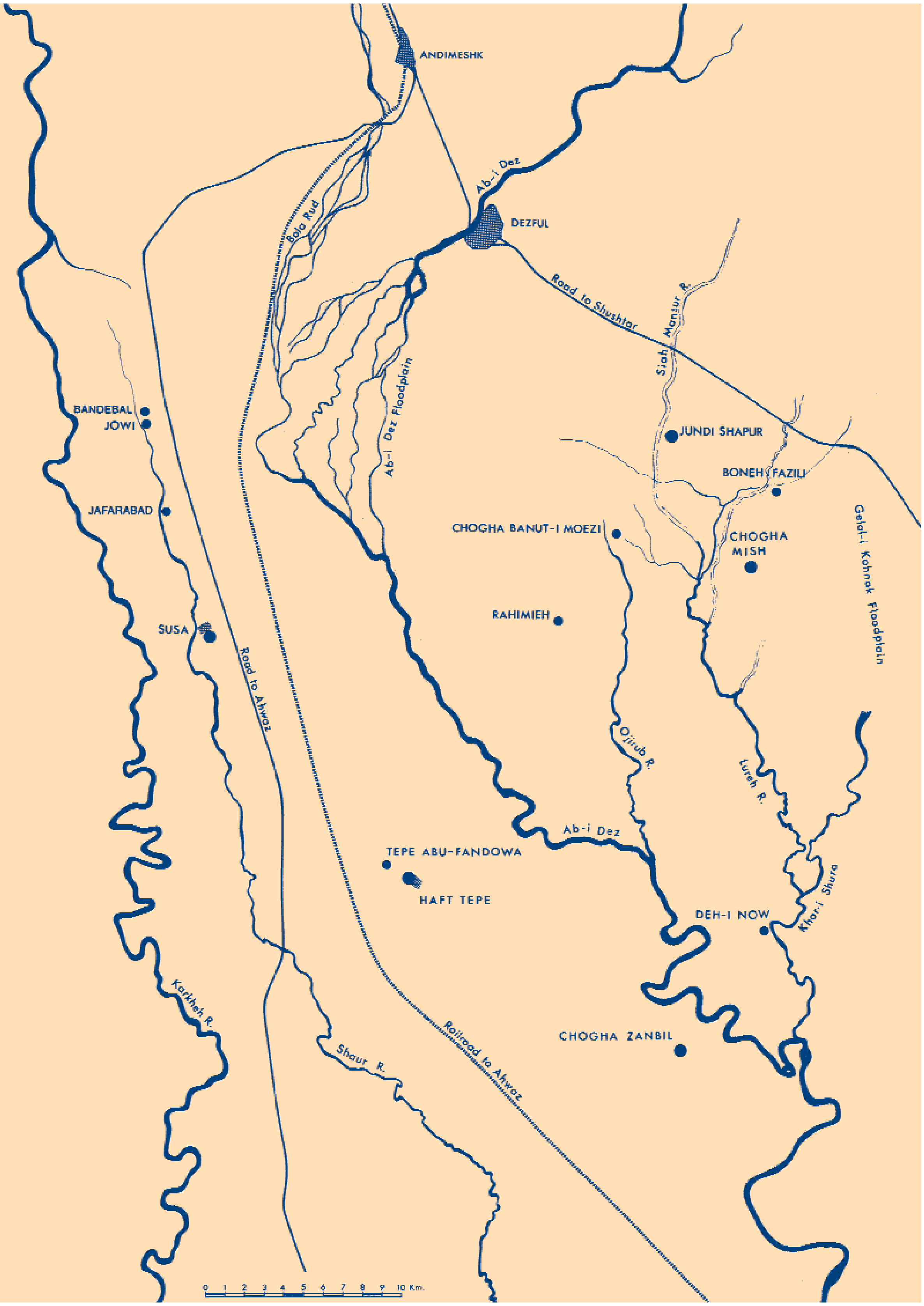


Fig. 2: Map of upper Khuzestan showing the location of major sites.

Fig. 3: Mound of Chogha Mish, from the south.

lage at Chogha Mish may have been some 2 ha with about 200 inhabitants.

The Archaic Susiana 2 phase at Chogha Mish is also poorly known. Based on the fragmentary architectural evidence, building materials and general plan of the earlier Archaic Susiana 1 phase continued. The use of long mud bricks, bond together with an ashy mortar, continued. Enough of a single incomplete architectural plan was preserved to indicate the general layout of the building. It consisted of at least three rectangular rooms with a storage bin. No hearth or kiln was found in the excavated area, but the presence of ashy patches protruding from under the unexcavated portion suggests cooking activities. Here we have a clear evidence of mud plaster that covered the long bricks used in the walls.

The technique of chipped stone industry continued from the preceding phase without much change. Other artefacts such as T-shaped figurines, bone and stone tools also continued into this phase. New was a class of highly stylised clay figurines that appeared in this phase. They are generally cylindrical in shape and were decorated with punctuation and incised marks. The distinct standard Painted-burnished Ware was replaced by the Red-line Ware, but other types continued from the preceding phase.

The domesticated species, *i.e.*, sheep, goat, wheat and barley, had fully developed morphologically and the emphasis on hunted animals decreased. Stone foundations for mud brick walls were found in this phase. Contact with the Samarra/Hassuna tradition of northern Iraq was perhaps established during this phase.

Archaic Susiana 3 Phase

Major changes took place in this phase: A new class of pottery, the Close-line Ware, appeared; stone pavement in front of rooms and doorways was first used; cattle was introduced; non-domestic

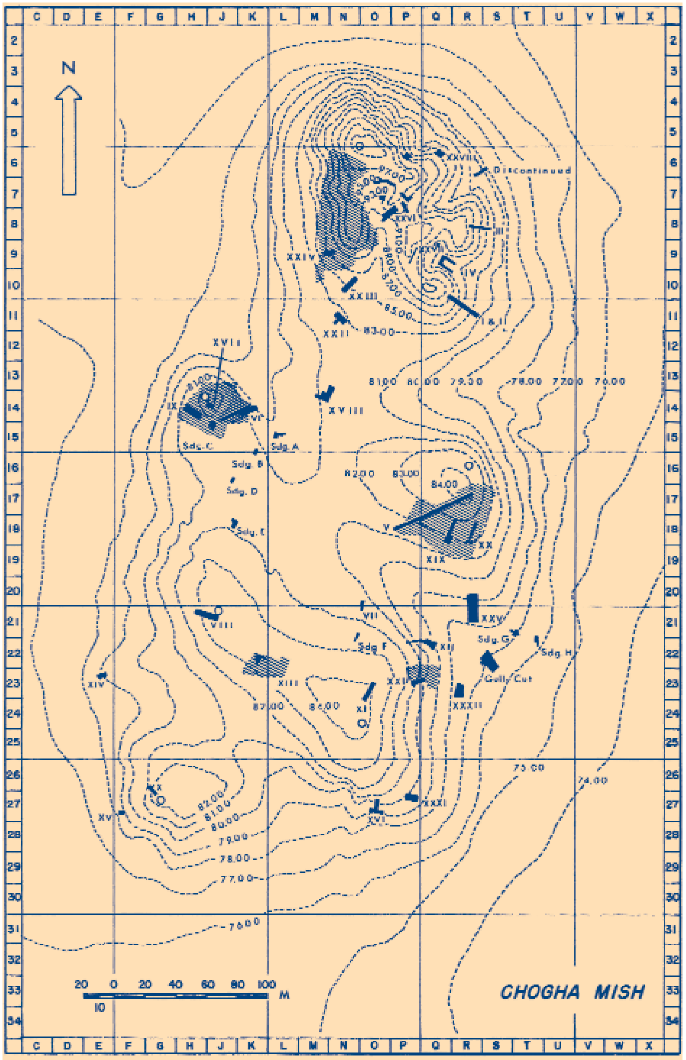


Fig. 4: Contour Map of Chogha Mish.

architecture appeared; and the settlement expanded to a minimum of *c.* 2.5 ha. In addition, the inter-regional similarities in material culture of the preceding phase now include southern Mesopotamia as well.

If the new pottery represents an innovation that was brought to south-western Iran as a result of outside cultural or technological influence or migration, the new immigrants did not replace the indigenous population. The interface between the Archaic Susiana 2 and 3 levels at Chogha Mish indicates no violence and except for the introduction of the new pottery, other material objects of the Archaic Susiana 2 phase continued into the new phase and developed. The Close-line Ware also occurred in Deh Luran and the Mandali region of central Mesopotamia, where it is known as Chogha Mami Transitional (CMT), after the type-site. Although the Close-line Ware, CMT, and Ubaid 0 have close affinities with the

Samarra; they also exhibit considerable differences in style and the grammar of design.

No complete architectural plan of Archaic Susiana 3 domestic residences was discovered at Chogha Mish. Nevertheless, the plan of the remnants of the buildings dated to the Archaic Susiana 3 phase indicates no substantial change from the preceding residential houses. People lived in multi-room houses with shared open yards in between. Some walls, presumably those exposed to the elements, had stone foundation. Long, cigar-shaped mud bricks were still in use, but the walls of at least one building were comparatively thick enough to suggest an upper level, but this is by no means certain.

A large building provides evidence for a possible non-domestic architecture in this early phase. The preserved and excavated parts consist of at least two long halls with no traces of domestic installations such as hearth, fireplace and bins on its beaten earth floor. Similarly, no burial was found associated with this building, unlike other domestic buildings of this phase. The southern wall of this building has four buttresses made of headers and the wall itself made of stretchers using long bricks, a building technique remarkably close to that found in the contemporary Tell el-Oueili in southern Mesopotamia. The unusually thick western wing of the building suggests an upper story or perhaps landing area or foundation for a staircase. The general layout of this structure was already anticipated in the Archaic Susiana 0 phase architecture at Chogha Bonut.

The dead were buried under the floor of houses and possibly in open areas adjacent to them. Most graves were devoid of funerary gifts, even though they were found undisturbed. The possibility that perishable gifts had accompanied them should not be ruled out, however. The graves, as preserved here, were of simple pit with no special features. Both extended and flexed positions were common. Similar burials were also found at Chogha Sefid, near Ali Kosh. Bones of the skeletons at both sites were covered with red ochre. Some of the skeletons had artificially elongated skulls, a tradition that continued until the Middle Susiana period in lowland Susiana. But the practice was by no means common, suggesting that it was limited to certain members (elite?) of the society.

The Early Susiana Period

The cultural contact among several regions in south-west Asia that was suggested above increased in the following Early Susiana period in south-western Iran and the Ubaid 1/Eridu phase in southern Mesopotamia. Although the ceramic of each region exhibits local characteristics, on the whole the pottery repertoires and other utilitarian objects share many common features in both regions. The one significant difference, however, is the total absence of any structure in Iran that can be considered a temple, while in Mesopotamia such buildings become the focal point at a number of sites.

A number of small test areas between the west side and the southern part of the Terrace at Chogha Mish showed that the size of the settlement more than doubled to a minimum of *c.* 3.6 ha during the Early Susiana period. Bread wheat, emmer, and six-row barley became the main staple as were cattle, sheep, and goats. As supplement to their diet, the inhabitants of Susiana in this period continued the practice of hunting, gathering and fishing.

Early Susiana pottery tradition was a direct continuation of the preceding phase; in both technology and decorative style Susiana was in a lockstep development with southern Mesopotamia. In fact, the close similarities between the material cultures of the two regions prefigure the shared inter-regional development in the second half of the 4th millennium BC. While in the preceding Archaic Susiana 3 phase the potteries of southern Mesopotamia and Susiana show general similarities, the two traditions show closer and specific parallels during the Early Susiana period. Whether the regional as well as inter-regional homogeneous character of the pottery of this period is an indication of socio-economic transformations in the production of pottery in terms of specialisation and close contact among the prehistoric potters of the region is difficult to say. It should be noted, however, that no pottery kilns were found in this period.

A change both in the quality and technique of flint tools and stone industry occurred in the Early Susiana period. Flint blades were shaped less carefully and the fine bladelets of the archaic period were absent. A new type of stone tool, considered to be a hoe, appeared in this period both in Susiana and Deh Luran and continued throughout the prehistoric sequence. Such hoes have a crescent-shaped sharp tip with an elongated narrow handle usually smeared with bitumen; in a few specimens the rope wrapped around the handle for a better grip was still preserved. Whether such tools were used to break the ground or to cut weeds, the task must have been a backbreaking job. Saddle-shaped stone mills continued from the previous phase.

If the Early Susiana period was a time of the development of local chiefdoms, the architecture provides the best evidence. The most coherent architectural plan of the Early Susiana period was found in Trench XXI (Fig. 5). Here, a series of comparatively large multiple-room structures was excavated. The ubiquitous long mud bricks continued to be used along with smaller rectangular bricks. The technique of paving with cobbles the open spaces in front of rooms and entrances also continued from the Archaic Susiana 3 phase.

At least two structures seem to have been residences of extended or chiefly families, while a third with a series of long, parallel chambers with an open area in front may have been used both as a residence and a warehouse. The large mud brick platform in the south-western part of an open court is difficult to interpret, particularly in the absence of detailed information on the materials found there. The platform measures *c.* 7 x 5 m and is only one course high. On the south and east, walls surround it. Thus, it may have been another residential unit with paved floors; such floors are found in two other rooms. The fact that no traces of walls were found that would have stood on the west and north

Fig. 5: Top plan of Trench XXI with architectural remains of the Archaic 3 through Middle Susiana phases.

sides of this platform, argues against its reconstruction as an enclosed unit. Taken together with the other architectural features, this platform may has served as a preparation or a loading "dock". The Early Susiana architectural layout with an open central area and perhaps a warehouse surrounded by residential units provides antecedent for the much later administrative quarters in Iran, particularly in Fars (Tall-e Bakūn A) and Sistan (Shahr-i Sokhta).

The Middle Susiana Period

The transition from the Early to Middle Susiana period was smooth and gradual. The areas of the village that were occupied during the preceding phase, continued to be occupied in this phase as well. If pottery is any indication, contact (emulation, imitation, or movement of potters) between lowland Mesopotamia and Susiana reached its maximum during the early phase of the Middle Susiana period. Houses were still made of mud bricks with occasional stone foundation. The Archaic long bricks were no longer used in this phase. House floors were either of beaten earth or covered with a layer of twilled mat; pierced stones were used as door sockets. The architectural plan of the preceding Early Susiana period seems to have been preserved. The only Middle Susiana building that was excavated in this area is similar in plan to the Early Susiana architecture with rectangular multiple rooms, long storage magazines, and evidence of both domestic and industrial activities.

The dead, as before, were still buried under the floor of residential units and in open space (Fig. 5). Similarly, the orientation of the body seems to have depended on the availability of space rather than on any fixed cultural practice. As in the previous periods, most of the graves of the Middle Susiana period were devoid of funerary objects. It seems that the practice of burying the dead within the residential areas was abandoned by the end of the early Middle Susiana phase. That this situation may be an accident of discovery is indicated by the intramural graves found at other Middle Susiana sites in the region. No burial was found dating to the late Middle Susiana phase.

The diet did not change much from the previous phase. Wheat, six-row barley, lentils, vetch and flax were the main cereals. Sheep and goats were common and cattle were also present. This diet was supplemented by fishing and hunting of onager and gazelle, though not necessarily as important as it was in the preceding phase. The pattern of spatial distribution of the bones of the hunted animals would have been helpful in speculating on the type of residence and associated objects, but that information is not available.

Microlithic and obsidian blades were absent in this phase, and the types of ground stone tools were limited, presumably because of the naked grains varieties that had been developed. The prominent Early Susiana star-shaped spindle whorls continued into the early Middle Susiana phase along with a variety of new painted shapes.

The following late Middle Susiana phase is pivotal in the socio-economic life of lowland Susiana. This phase corresponds to the Ubaid 3 and possibly the early stages of Ubaid 4. Whereas in the early Middle Susiana phase the pottery closely resembles that of Haji Mohammad/Ubaid 2, the ceramic of the late Middle Susiana attains its own characteristics and shares a number of features with the contemporary cultures of Bakūn B2 and Gap 1 in highland Fars and Giyan V in central Zagros, a dramatic shift of attention from lowland Mesopotamia to highland Iran, a trend that continued until the beginning of the Protoliterate period.

The late Middle Susiana phase at Chogha Mish is the most extensive occupation of the prehistoric period. Almost the entire 15 ha of the mound show sign of occupation, though it is not absolutely certain whether the whole mound had been occupied at the same time. The archaeological materials and architectural remains from Chogha Mish that are dated to this phase may be taken as a reflection of the changing organisation of the society in this phase. A major difference in the architecture from the previous phases is marked by the appearance of a large monumental building (Fig. 6). Almost in the middle of the settlement, towards the eastern edge of the mound, a substantial building was found. The excavated portion consists of four parallel large halls. The outer walls are furnished with buttresses. The substantial walls of this building, some 1.50 m thick, its plan of regularly aligned rooms, and the façade with symmetrical buttresses indicate its monumental and formal character. A back room on the north side of the building still contained numerous storage jars; another room had a stack of 18 complete thin-walled bowls typical of the late Middle Susiana phase. On the floors of this building were found numerous flint nodules for the manufacture of flint blades, some of which were also found in the rooms. The presence of this building indicates that by the late Middle Susiana phase a level of social differentiation was achieved in the settlement. At the same time at the nearby site of Chogha Bonut a comparatively large building in the middle of the site dominated the settlement.

The Late Susiana 1 Phase

There seems to be a chronological gap between the time Chogha Mish and a number of its satellites were deserted and the time when Susa was founded, though the available data make it difficult to estimate the time lag. "Late Susiana 1 phase" has been proposed to designate this phase in lowland Susiana (Alizadeh 1992). This is the time when Chogha Mish remained abandoned. During the following phase, Late Susiana 2/Susa 1, Chogha Mish was reoccupied.

The Late Susiana 2 Phase

This phase is poorly known at Chogha Mish. According to MASCA-corrected weighted average (Weiss 1977, 357) this phase spans 4350 to 4190 BC. The following phase, Terminal Susa, not attested at Chogha Mish, lasted for 100 to 150 years. If we accept the 150-year duration estimate for this phase that is suggested (Wright 2001, Tab. 4.1), given the thin archaeological deposits dated to this phase at Susa (Dyson 1966; Le Brun 1971), then the entire prehistoric sequence at Susa spans 4350 to *c.* 4000 BC.

The available data from Chogha Mish are not sufficient to suggest an absolute date for the reoccupation of Chogha Mish during this phase. But the total absence at Chogha Mish of any ceramic carry-overs from the preceding phase suggests that the site may have

Fig. 6: Top plan of Late Middle Susiana Burnt Building.

been reoccupied sometime during the Late Susiana 2 phase. The architectural remains of the Late Susiana 2 phase at Chogha Mish were fragmentary and are limited to the High Mound. Nevertheless, the presence in parts of the main terrace of sherds dating to this phase suggests that this area, too, may have either contained Late Susiana 2 architecture or was used to manufacture pottery. No direct evidence is available to support this inference, however.

Prior to the 6th season of excavations, a series of kilns and ashy floors mixed with stone blades, potsherds and wasters were found on the High Mound. When excavations in the 10th season continued in the area, two superimposed architectural levels were found. The Late Susiana 2 architecture on the High Mound reveals only a partial plan of the building. The surviving and excavated portions exhibit multi-room structures with rectangular and square rooms. The open areas surrounding the rooms were filled with ashy and clayish layers. The millennia-old practice of paving open areas with cobbles continued into this phase.

The limited area of Late Susiana 2 occupation at Chogha Mish and the abundance of associated kilns and ashy deposits suggest that, as at Jafarabad, Chogha Mish may have been reoccupied during this phase as a small industrial centre, rather than strictly a residential one. Nevertheless, one has to bear in mind the degree of destruction and levelling that Protoliterate building activities had caused the Late Susiana 2 remains on the High Mound.

The Protoliterate (Late Uruk) Period

Prior to the excavations at Chogha Mish in 1961, the pottery of the earlier part of the Protoliterate period (Late Uruk/Protoliterate a-b) was known primarily from Uruk-Warka. The latter part of the Protoliterate period (c-d/Jemdet Nasr) was best known from the Diyala sites as well as from Jemdet Nasr, Kish, Tell Uqair, and to a lesser extent by material from other sites in both southern and northern Mesopotamia. Susa had also produced a considerable number of Protoliterate pottery types, which, on the basis of Mesopotamian comparisons, Le Breton attributed to phases termed Susa B and C, or the Proto-Elamite period, as the latter is also known.

The pottery types of the Jemdet Nasr phase of the Protoliterate period (c-d) are well known from the Diyala region and other central Mesopotamian sites. Despite extensive excavations at Chogha Mish, no pottery definitely datable to this phase has been found. Among the most noticeable is the total absence of the typical polychrome wares, the monochrome four-lugged jars, the slender red-washed spouted vessels, and the solid pottery stands. Thus, Chogha Mish does not seem to have been occupied during the latter part of the Protoliterate period, and lay deserted again until the Old Elamite (Sukkalmah) period.

Chogha Mish Urban Development

Eleven seasons of excavations at Chogha Mish revealed a planned Protoliterate town with streets, side alleys, sewer and irrigation drains, water wells and cesspools, workshops, and public and private buildings. From the beginning, the town was divided into an upper and lower quarter. The upper town was located on the High Mound and the lower town on the Terrace.

Occupational remains of periods later than the Protoliterate (particularly the Old Elamite) had substantially damaged the remains of the upper town; nevertheless, enough survived to provide hints of its once glorious days. Most of the architectural remains of the period either is destroyed or covered by the massive Old Elamite fortification walls and other buildings. What remained shows an incomplete plan of a large structure with rectangular rooms, cisterns, and a substantial drainage system. The presence of several pottery kilns, huge amount of broken sherds and wasters, layers of ash, as well as mosaic cones, clay tokens and sealings suggest that this area was the locus of administration and industrial activities. No fortification wall was found associated with the town, or anywhere in lowland Susiana in this period. But the presence of a substantial rectangular structure in front of this quarter can be interpreted as a watchtower on the highest point of the settlement.

The lower town on the Terrace was much better preserved (Fig. 7). Baked bricks were used almost exclusively for pavements, drains, wells and cesspools. Mud bricks were used in domestic and public buildings. The residential units have usually mud brick walls 30-50 cm thick. The mud bricks contained ash and sherds of earlier peri-

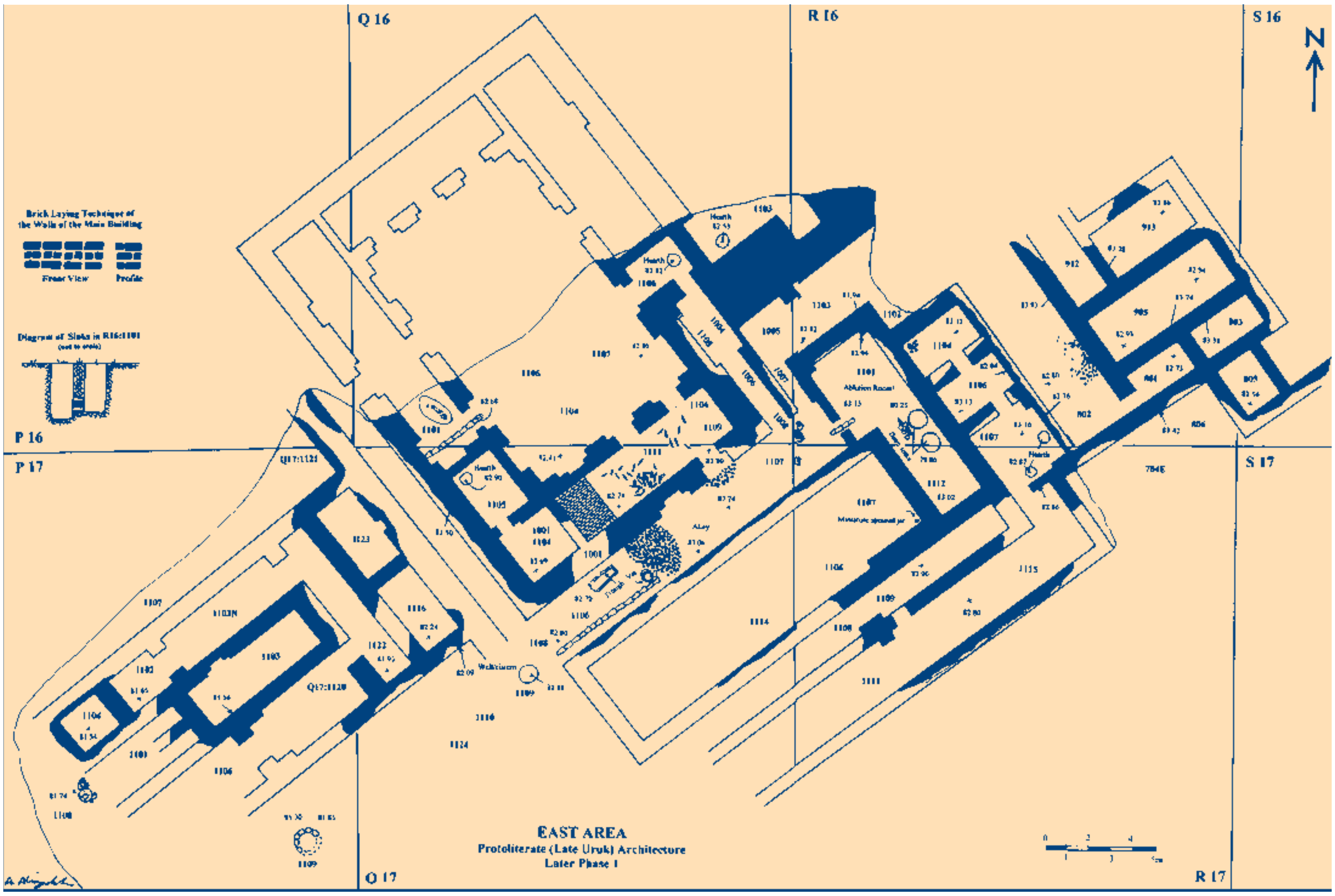


Fig. 7: Top plan of the Protoliterate (Late Uruk) Monumental Building at Chogha Mish.

ods and thus the clay may have been taken from the numerous pits (some dug to Archaic levels) that dot the settlement. Frequently stumps of earlier walls (primarily Middle Susiana) were used as foundation for the Protoliterate Phase 1 walls. Rooms vary greatly in size and shape from square to rather oblong rectangle. Sometimes, the shape of the available space and the position and orientation of earlier or contemporary walls may have been the reason for some trapezoidal rooms or storage bins. But on the whole, the entire town has a general NE-SW orientation that it retained throughout the two phases of occupation.

Some residential buildings have relatively large rectangular areas that can be interpreted as courtyard based on fragmentary cobble pavements found in them. It is difficult to say with certainty, however, if all residential buildings had their own open courts. The evidence suggests that the available open spaces were shared by several buildings. Some rooms were provided with a fireplace and a bench on which were placed (some still *in situ*) a number of beveled-rim bowls and small spouted jars. In contrast to the Diyala region, no burials were found under house floors, with the sole exception of a simple burial in the East Area. Numerous kilns and fireplaces were found throughout the settlement. During the Protoliterate period, as in the earlier phases, Chogha Mish was a major centre for manufacturing pottery, as the numerous simple and complex pottery kilns found on the Terrace attest. Large number of clay sealings, impressed tablets, clay balls and bullae, and tokens indicate the administrative nature of Chogha Mish during the Protoliterate period as well.

The entire Protoliterate town at Chogha Mish was criss-crossed by both open and covered water and sewage channels. Such drains were made of both baked bricks and baked pottery pipes that nicely fitted together. The perpendicular angle at which buildings and drains cross one another is another indication of the planned architecture throughout the Protoliterate period. Subsidiary drains from narrow side alleys and even from some individual houses joined the main ones at right angle.

The available evidence does not allow us to make distinction between the drains that were used to supply the town with fresh water and those that were used to lead sewage and wastewater to cesspools or out of the settlement. The closest fresh water source to Chogha Mish is the Shur River, *c.* 1 km to the east. However, the presence of a number of deep brick-lined wells that were often connected to the drainage system offers a more likely candidate for the source of fresh water at Chogha Mish. It must be noted, though, that none of these features was completely excavated.

The Protoliterate settlement at Chogha Mish was established as an administrative and production centre with a number of secular and possibly religious monumental buildings, or a combination of both. A large complex of buildings was partially excavated in the East Area. To the west of this major complex, a substantial polygonal mud brick platform was erected, the function of which is not known to us. Measuring *c.* 350 m^2, this platform was surrounded by subsidiary structures abutting it. If the platform supported a building, no traces of it were left. The surface of the platform was littered, even imbedded, with potsherds of the Parthian period, however.

The monumental building that was found in East Area dominated the settlement. It consists of a central court with recessed niches and square and rectangular chambers surrounding it from two sides. The main entrance of the building leads to a long, brick-paved antechamber, at one end of which a heap of gazelle bones was found.

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The Persian Gulf near Bandar-i Deylam. A river, swollen by winter rains, seeks its way through the coastal sediments; Photo: G. Gerster.

Susa

Agnès Benoit

The city of Susa is the main key site for ancient Iran (Fig. 1). The only one to have an occupation span of 6000 years – from the foundation in 4200 BC to the 13th century AD – it brought to light the Elamite Civilization that flourished in Iran long before the Persians built their universal empire. Susa goes into the historical period at the end of the 4th millennium BC by inventing an original writing system, the proto-elamite script, which was soon replaced by Sumerian cuneiform signs. The city was founded on a small plain – aptly named Susiana and irrigated by the Karun and Kerkha rivers (modern Khuzestan) – that forms an eastern extension of the great Mesopotamian plain. This geographical setting plays a defining role in the identity of the site: all through its history, Susa alternately shows a certain vulnerability towards Mesopotamian influences and an autonomy that has its roots in the mountainous part of the country. In fact, Susa is the lowlands capital of the political entity that is Elam, the double country extending from the Susiana to Fars, while Tal-i Malyan, founded around 3000 BC, governed the highlands. The seasonal movements of transhumant populations assured permanent contact between these two worlds.

Metallurgy was the principal craft in Susa, especially during the 3rd millennium BC, when the trans-elamite world took possession of the processing of alabaster, chlorite, semi-precious stone and shell. Excavations at Susa have predominantly been led by French archaeologists and encompass all three mounds of the settlement (Chevalier 1997; Mecquenem 1980): the Apadana in the north, named after the Persian palace built here around 521 BC by Darius the Great, the Acropolis (or Acropole) in the west, which dominated the plain with its 38 m of archaeological deposits, and finally the large mound of the Royal City (or Ville Royale) in the east, jutting out to the south at the so-called Donjon.

The Archaeology of Susa

The Discovery of the Apadana (1851-1852)

One of the first renowned visitors to Susa was Austen-Henry Layard, who soon after would come to fame through the British excavations at the Assyrian cities of Nimrud and Nineveh. During a stay with the Bakhtiari tribes in 1841-1842, he also briefly visited the Susiana. Archaeology as such does not begin at Susa until the appearance of British geologist-archaeologist W. K. Loftus (1820-1858). Initially hired to mark out the Turkish-Persian border, he was later won by O. K. Rawlinson, famous decipherer of Old Persian and director of all British excavations in Mesopotamia, for the rather unrealistic task of uncovering the entire site. Accompanied by the artist Henry A. Churchill, whose role it was to draw everything that there was, Loftus bravely went to work in two campaigns between 1851 and 1852 (Curtis 1993; Chevalier 1997, 36-45). His discovery of four column bases on the Apadana tell, bearing a trilingual inscription revealing the names of the builders of the palace[1] and the term "Apadana" designating its hypostyle part, is of historic importance. A topographical map, tracing the exact elevation lines of the site, was also established. But the

Fig. 1: Aerial view of Susa (1977). In the front the modern place of Shush with David's grave and the fort of the French archaeological mission. In the background the excavation of the palace of Darius; Photo: G. Gerster.

region was dangerous, the results not very spectacular compared to contemporary excavations in Assyria, and so Loftus had to leave off his work. Thirty years later, the French, namely Marcel Dieulafoy and his wife Jane, had no reason to complain of this decision.

The Excavations of Marcel and Jane Dieulafoy (1884-1886)

Marcel Dieulafoy (1844-1920) was an Engeneer des Ponts et Chaussées. He came to Mesopotamia and Persia in 1881 for a round trip of 16 months, during which his wife took pictures and kept a travel journal (Dieulafoy 1887; 1989; 1990). Back in France, he kept on dreaming about the Persian capitals. After having obtained funds from the director of the National Museums and the indispensable excavation permit, he finally returned to Susa in 1884, where he took interest in the same tell as Loftus, the Apadana. During the course of two campaigns, in 1885 and 1886, he discovered the Lion Frieze[2], remnants of the staircase, a double-protome capital with volutes that belonged to the columns of the inner hall of the Apadana, and moulded and colour-glazed bricks representing archers (Tallon 1997).

But the excavator, misled by his knowledge of palatial architecture in Pasargadae and Persepolis, where columns constitute the principal architectural elements, failed to recognise the residential part of the palace, built in unbaked brick with large central courtyards. In the plans – drawn by Charles Babin after Dieulafoy's directions – he replaced them with a "paradise", or garden, and a vast terrace (Dieulafoy 1893, pl. II).

In March of 1886, the Shah Nasr-ed Din, fearing local insurrection, ordered the definitive stop of the excavations. Barely returned to France, Dieulafoy reconstructed with great insight two panels of the famous Archer Frieze, the lions of the Lion Frieze and the large capital with bull protomes. These works of art are exhibited in the Louvre on the first floor of the Colonnade[3]. The Dieulafoy mission forms the basis of the Iranian collection of the Museum, which went on to become one of the most prestigious in the world.

The Delegation to Persia under the Direction of Jacques de Morgan (1897-1912)

Grown cautious through its misadventures with Assyrian excavations, France was trying to obtain archaeological priority rights in the Susiana and even through all Persia, especially since a strong foreign competition began to emerge (Chevalier 2002, 127). This venture took ten years of negotiations, but in the end the convention of 1895 was signed with Nasr-ed Din Shah, granting France the entire archaeological research in Persia and stipulating the equal division of finds. A special provision allowed the acquisition of gold and silver objects by France «at an appropriate price» (Chevalier 2002, 131-136). This first accord was followed by a second convention, signed in 1900 with Mozzafer-ed Din Shah, son of the former ruler, which granted France the benefit of all excavated objects in the Susiana (Chevalier 2002, 141-152). The latter set all out for the Louvre Museum classed as an excavation storeroom. The convention of 1900 was not denounced until 1927, when Reza Shah, the first sovereign of the Pahlavi Dynasty, ended the agreement (Chevalier 1997, 76-77).

Fig. 2: Jacques de Morgan and Father Vincent Scheil opening the cases of the French archaeological delegation in the year 1902; from Chevalier 1997a, fig. 113.

Privileges such as these had to be met by a genuine commitment of finances and personnel. The Delegation to Persia (or Délégation en Perse), created in 1897, focused before all on Susa and hardly went beyond the Susiana, except for the excavations at Rey and Talish, and a few surveys. It ran on a considerable budget for the period, and allowed itself a Delegate General of French Excavations in Persia, Jacques de Morgan (1857-1924), who led it during the fifteen years of its existence (Chevalier 1997, 78-82). Aged 40 years at his appointment, this graduate of the Ecole des Mines was a geology, prehistory, ethnology and natural sciences enthusiast. In 1898, he called in a great epigrapher, the Father Vincent Scheil (Fig. 2).

Not very eager to follow in his predecessor's footsteps, because, as he said, «it is the history of Elam that I am looking for,» Morgan initially favoured excavations on the Acropolis tell, which he considered the most important and ancient part of the site (Chevalier 1997, 81). From the first campaigns on, he uncovered the great monuments that the Middle Elamite king Shutruk-Nahhunte had brought back from his raids to Babylonia in the 12th century BC: the Naram-Sîn Stela, the Code of Hammurabi, the obelisk of Manishtusu, and the Kassite kudurrus. Following this first yield, proper Elamite discoveries soon came to light: for the 3rd millennium BC, numerous inscribed bricks, the "Vase à la Cachette" (found in 1907; Cat. no. 43-47, 476 & 492) the foundation deposits of Shulgi, and the monuments of king Puzur-Inshushinak; for the Middle Elamite period, the metalworkers' masterpieces, such as the statue of queen Napir-Asu, the serpent table, the model of the *Sit-Shamshi*, as well as the «Find of the gold statuette» and the depot of the temple of Inshushinak (found in 1904); for the Achaemenid period, the princely sarcophagus tomb with its cloisonné jewellery.

Hardly had they been discovered, all these objects were published, translated, if they bore inscriptions[4], and exhibited at the Louvre (Chevalier 1997).

A new book series, entitled "*Les Mémoires de la Délégation en Perse*", was set up on this occasion; its first volume appeared in 1900. If all these points give credit to J. de Morgan, indefatigable worker that he was, the way he ran his archaeological excavations as a public works project – he permanently employed 800 to 1200 workmen at Susa – has to be kept in perspective. He worked on an artificial grid to dig first sounding tunnels[5] and then trenches of 5 m width and depth[6], without precise measurements and elevations, and always at the risk of misinterpreting the nature of the encountered structures. In order to get to the lowest levels as quickly as possible, Morgan opened the «Great Trench» or «Morgan Trench», which he excavated in steps: dug out of the south-eastern edge of the Acropolis, this trench measures 80 m in length at a variable width (11.80 to 35 m), depending on the number of opened parallel trenches. At its end, «Morgan's witness» is situated, where Alain le Brun worked during the last French mission to Iran.

Fig. 3: Massive double axe made of arsenic copper, Susa I/II, c. middle of the 4th millennium BC, Louvre; Photo: DBM, M. Schicht.

Fig. 4: Golden pendant in the shape of a jackal-like dog, Susa II, c. 3300-3100 BC; the soldered loop is one of the oldest proofs for this technique, Louvre; Photo: DBM, M. Schicht.

In 1906-1908, Morgan reached virgin soil, exposing the necropolis and what he thought to be a rampart, but which actually is the "Funerary Massif" (or Massif Funéraire). Here, the pottery of Susa I and the first evidences of metalworking were encountered.

Despite the already made reservations, the work of the Délégation has advanced our knowledge of the Ancient Orient in giant steps (Amiet 1997). The painted pottery of the Susa I period, for example, constituted an absolute novelty at the beginning of the 20th century, since nothing this old had been found in Mesopotamia yet. In addition, Elam was brought to light as well.

However, growing tensions with his associates led to Morgan's waning interest in Susa, and after 1908 he no longer set foot there, turning over the reins to his confidant, R. de Mecquenem. During the years 1908-1909, he only casually announced discoveries as important as those of the two «archaic deposits» (Susa II and Susa III) or the royal head often attributed to Hammurabi and published only 30 years later. Nevertheless, he sponsored the resumption of the study of Darius' palace, entrusting it to Mecquenem, who, between 1909 and 1911, uncovered the large central and western courtyards of the residential area. The latter also brought in, in 1912, Maurice Pillet, a young architect, to carry out a general survey of the building.

Fig. 5: Susa/Shush: Bivalved casting moulds to produce arrowheads, chlorite and sandstone, 3rd millennium BC, Louvre; Photo: DBM, M. Schicht.

Fig. 6: Two fittings for wheel rims, tomb A of the Apadana hill, Susa/Shush, 20th century BC, Louvre; Photo: DBM, M. Schicht.

The Susiana Archaeological Mission under the joint Direction of Roland de Mecquenem and Father Scheil (1918-1946)

In 1903, J. de Morgan had welcomed at Susa Roland de Mecquenem, a graduate of the Ecole des mines like him, and soon considered him to be his «worthy successor». Which he unfortunately proved to be also in his choice of excavation technique.

With the end of the World War I, work resumed in Susa under the control of Father Scheil (1868-1940), who continued publishing the texts, and Roland de Mecquenem (1877-1957) as «Field Director». This joint direction of the «Susiana Archaeological Mission» would last until the outbreak of World War II. Albeit financial means had somewhat decreased, still hundreds of workers could be employed. The majority of finds was funerary, the burials located within houses. Mecquenem worked on the two already known tells, the Apadana and the Acropolis. In 1924 he enlarged his sphere of action to the tell of the Royal City, and finally, in 1929, to the Donjon. In addition, he turned to the small prehistoric sites in the Susiana plain that predated the foundation of Susa: Tappeh Djaffarabad, Tappeh Djowi and Tappeh Bendebal.

On the Apadana mound, the basement of Darius' palace yielded sarcophagi, shaped like inversed bathtubs and dating to the Simashki dynasty at about 2000 BC, which were rich in finds of jewellery and bitumen vessels.

On the Acropolis, two soundings led to a refined chronology of the older periods. In sounding no. 1, which was begun in 1920 in the north of the tell, close to the Castle[7], Mecquenem found Susa I pottery and, in 1927, the double-edged copper axe (Fig. 3, Cat. no. 30). Sounding no. 2 in the south of the Acropolis, perpendicular to Morgan's trench, yielded numerous finds of the Uruk period, such as pins with animal heads, beads from a children's burial and the small golden dog (Fig. 4, Cat. no. 31). The Simashki burials were found in the same sounding.

On the vast tell of Ville Royale, in arched vaults, constructed from diagonally placed bricks, rested effigies made out of unbaked clay. The three excavation places that were opened along the south-western edge of the tell were named no. 1, no. 2 and Donjon. The Donjon held the tombs of the 3rd millennium and the sarcophagus burials, several of which yielded casting-moulds in 1934 (Fig. 5, Cat. no. 41 & 42; Mecquenem 1943, 135-136). Rim bandings of wheels were also found here (Fig. 6, Cat. no. 48).

In short, the Donjon and the Royal City are characterised by a rich yield of objects from the 3rd and 2nd millennia BC, such as bitumen vessels and metal objects, among them a silver breast cover (Fig. 7, Cat. no. 508).

Fig. 7: Two objects shaped like female breasts, decorated with silver, "tombe à sarcophage", a child's tomb, late 3rd millennium BC. Louvre; Photo: DBM, M. Schicht.

On both Apadana and Ville Royale, moulded, unglazed bricks were discovered in bulk. These had once adorned the façade of the temple of Inshushinak in the Shutrukid period, during the 12th century BC. Their reconstruction revealed panels of Lama goddesses, alternating with bull men and palm trees.

In 1936-1937, Mecquenem resumed excavations at the necropolis, which had been dug in 1907-1909 by Morgan's crew, and identified the «rampart» adjacent to it as a «Funerary Massif».

Although the plans produced by the Susiana Archaeological Mission are hardly more satisfying than the ones from the Délégation, the uncovered remains were published in a more detailed manner in two volumes of Mémoires (Mecquenem 1934; 1943).

A new way of dividing the finds was instituted. Until 1928, they had all been brought to the Louvre, now the finds that had stayed at Susa and the new discoveries were to be part of the division. This arrangement remained valid until 1969, when J. Perrot put a stop to it.

Fig.8: The French delegation in Susa 1974; from Chevalier 1997a, fig. 148.

The Roman Ghirshman period (1946-1967)

Shortly after World War II, R. de Mecquenem retired from the mission to give his seat to an archaeologist of Russian origin, Roman Ghirshman (1895-1979), who during the Thirties had already excavated in Iran at sites such as Giyan, Sialk and Bishapur. Instituted in 1946 as the new director of the Mission at Susa, he was interested in the historical periods that so far had been hardly studied, and he introduced a new approach to stratigraphy, choosing to explore only one level per year. One of his first actions was to excavate an area of half a hectare in the north of the tell of Ville Royale, Ville Royale A, which he would close only 20 years later, having reached virgin soil after the excavation of 15 successive city layers (Ville Royale I-XV). Then he dug a much smaller area along the south-western edge, which was called Ville Royale B. The thus recovered material and epigraphical finds covered a period stretching from the middle of the 3rd millennium BC to the 13th century AD.

Ghirshman also resumed work in the palace of Darius on the Apadana. From 1951 to 1962 he temporarily left off work at Susa for Choga Zanbil, another city in the Susiana plain[8], built by the Middle Elamite king Untash-Napirisha in the 14th century BC. Louis Le Breton, an associate of Mecquenem, endeavoured to chronologically classify all previously excavated material, and put forward an alphabetical sequence of four periods, from A, the time of the foundation of the city, to D, the Akkadian period (Le Breton 1957).

At last, between 1965 and 1968, Father Steve and the architect and archaeologist Hermann Gasche investigated the oldest levels of the Acropolis and found an enormous artificial terrace in the centre of the mound, built from unbaked brick at the time of the city's foundation. They assessed the height of this platform at 10 m and its sides at the dimensions at 70 x 65 m, including the Funerary Massif. The discovery of this terrace marks a milestone in oriental archaeology, since it effectively links Susa to Southern Mesopotamia, to Eridu, Tell Uqair and especially to Uruk.

The Jean Perrot period (1968-1979)

In 1968, the prehistorian Jean Perrot (born 1920), already known for his excavations of the Chalcolithic Beersheba Period in the Negev desert and the Natufian site of Ain Mallaha, relieved Ghirshman as director and headed the Mission at Susa until the Islamic Revolution in 1979. Determined to clarify the chronological ambiguities that had obstructed a full understanding of the site since the beginning, and which the periodization of Ghirshman had attempted to eliminate, he gathered an international, interdisciplinary team and charged them to provide a reliable stratigraphical sequence for the entire site. Every person responsible was to establish a sequence by level, which then would substitute the mainly typological classification of Le Breton (Perrot *et al.* 1989).

Alain Le Brun and Denis Canal worked on the old periods of the Acropolis: Le Brun on Acropolis I – north wall of sounding no. 2 and western side of «Morgan's witness» in the south-eastern part of the tell –, studied layers 27 to 14B, which comprised the time from Susa I to Susa III (4200 to 2800 BC, from the establishment of the city to the Proto-Elamite period); Denis Canal, working on the operation called Acropolis II, had to understand the history of the High Terrace (Susa I to Susa II): he worked out its orientation and its assumed length, and discovered the course of its southern façade with a recess on one side and an offset corresponding to its floor level. Thus, the Terrace appeared to be clearly separated from the Funerary Massif, contrary to Steve's opinion.

In dig Ville Royale I, Elizabeth Carter studied the stratigraphy of the 3rd millennium BC – Susa III to Susa V, the latter ending with the *sukkalmah* dynasty – in a sequence of layers numbered from 18 to 3. Pierre de Miroschedji in dig Ville Royale II was charged with the clarification of the period spanning from the Late Middle Elamite, in the last centuries of the 2nd millennium BC, to the end of the Neo-Elamite, in the middle of the 6th century BC.

Geneviève Dollfus investigated sites in the Susiana plan that predated the foundation of Susa. At the conference on Susa in 1977, a synchronization between the different trenches was put forward[9].

Furthermore, the excavations at Darius' palace on the Apadana resumed in 1969. They led to the discovery of the Palace Gate and, in 1972, of the statue of Darius that decorated one of its sides. On the right bank of the Chaour River, Rémy Boucharlat uncovered another Persian palace that was attributed to Artaxerxes II.

All excavation reports were published in a new series established in 1971. The "*Cahiers de la Délégation archéologique française en Iran"* are open to all French archaeological missions in Iran.

Finally, J. Perrot decided to end the agreement on the division of finds that had been in place since 1929. Therefore, the Louvre does not possess a single object that stems from this mission.

The Development of Metallurgy in Susa

The history of metallurgy begins with copper[10]. It is in large parts a random outcome, although the proximity to mining sources played a decisive role, as its three pioneering regions Anatolia, Iran and Palestine demonstrate. However, the road from the exploitation of a material to the understanding of its properties can be quite long. If native copper was used in Çayönü (Anatolia) since the 8th millennium BC to manufacture about forty various small objects, and later, in the 7th millennium BC, for rolled beads, such as the bead from Ali Kosh (Iran), or the bracelet of eight beads from Mehrgahr in Pakistan (Moulherat *et al*. 2002), it was first due to its beautiful colour and metallic sparkle, and copper was certainly considered before all as a stone[11].

From the 5th millennium on, the use of copper increased markedly and the spectrum of objects broadened. In Sialk, pins, awls and spirals, probably cold-hammered (Smith 1965), were found in the two layers that precede the establishment of Susa[12]. Real metallurgy, which uses casting in addition to hammering to shape objects, and which also transforms the copper mineral to metal through smelting, only developed in the second half of the 5th millennium BC, and its impulse seems to have come from the Iranian plateau. Here in the highlands, Tal-i Iblis and especially Tappeh Ghabristan provide our main sources of information as to the treatment of the raw material. For typological variety and the manufacturing techniques of objects, Susa in the lowlands is our reference.

For a better understanding of the following paragraphs, we need to remember that numerous metals exist in two forms: a native form, when they are already metallic in their natural state – as is the case for gold, electrum, copper, platinum, silver, and native and meteoric iron –, and an oxidized form, when they are in a mineral state from which the metal has to be extracted by smelting.

The Emergence of Metallurgy in the Susa I Period (4200-3800 BC)

Typology of Production

Right from the foundation of the city, the inhabitants of Susa displayed a great talent for metalworking, far superior in number and quality of manufactured objects to the production at other contemporary sites. The most prolific area is the Susa I Necropolis, contemporary to layers 27-25 of Acropole I: flat axes, awls, needles and mirrors, all made of copper, had been deposited in 70 of the 2000 graves that J. de Morgan excavated. The ductility of copper was cleverly exploited to draw the metal into needles, its reflecting properties were displayed by the mirrors, its melting point at around 1100° C allowed the casting of solid objects, and its malleability permitted their reworking after they were taken from the mould.

Some shapes were rather conservative, since the metalworkers simply converted lithic objects into metal. Although no casting-mould has been found, we know that they were single-valved[13], because the objects always display a flat face.

In levels 24-23, the shapes became more complex: the double axe (Fig. 3, Cat. No. 30) and the hoe were still cast in open moulds, but they already had a hole for the shaft, like the type found at Tappeh Ghabristan. The two small vertical projections at the extremities of the double axe were hammered (Tallon 1987, 97).

The objects were now more massive and with their socket shafts more functional than the large, rectangular, flat axes from the Necropolis. Notable progress can also be registered at Sialk (pins with rather massive conical or pyramid-shaped heads), at Tappeh Hesār and at Tappeh Yahya.

Still very rare, but occurring occasionally, are tin bronzes – a needle in Tappeh Sialk III, a flat axe in Susa I (Sb 11278; 2.3% tin) and a small axe at Mundigak (Casal 1961, 244, 249) –, the existence of which can be explained after V. Pigott with trade relations towards the East, where Afghanistan possessed notably abundant deposits of copper and tin (Pigott 1999a, 79).

Fig. 9: Cross shaped pendant, silver with inlays of gold and hematite, late 4th millennium BC, tomb of a child, sondage 2 of the acropolis, Louvre; Photo: DBM, M. Schicht.

The Processing of Raw Materials

Ancient metallurgy at Susa is only known through its finished products, since no workshops have been discovered at the site, or any material proof of their existence, such as hearths, crucibles or moulds.

The analyses carried out by the *Laboratoire de Recherche des Musées de France* show that two thirds of the objects from the Necropolis consist of very pure copper, the only notable impurities being arsenic[14] and nickel. Finding out whether this alloy from the Susa I period was intended or not, is not easy, since analysis cannot distinguish between the casting of native copper and the casting of copper obtained through smelting. Information about the composition of available sources and contemporary metallurgical practices at the sites on the Iranian Plateau, however, can shed more light on the manner in which the metallurgists of the 5th and 4th millennia dealt with raw materials.

The Deposits

Two copper deposits in Iran, Talmessi and Meskani, have most probably been exploited from the Neolithic to the Early Bronze Age. They are in the Anarak district, in the north of the Lut Desert and 200 km east of Tappeh Sialk. These deposits bear native copper with arsenic impurities, geologically associated with two copper arsenides, Algodonite and Domeykite, which will dissolve like sugar and release their arsenic when combined with native copper in a crucible (Pigott 1999a, 78-79). The copper from Anarak also contains cobalt and nickel impurities. At present, Talmessi is considered the probable supplier of Sialk, Susa and Mesopotamia during their earliest periods.

Crucible Metallurgy

Crucibles are known from a number of sites on the plateau, such as Tal-i Iblis, Shahr-i Sokhta (Hauptmann *et al.* 2003, 206, 211) and Tappeh Ghabristan. However, just one smelting hearth has been found, in a 3rd millennium context at Shahdad, south of the Lut Desert (Hakemi 1972; 1997, 87-88, figs. 50-51). Crucibles are typical for Iranian metallurgy in Chalcolithic and Bronze Age times. Their characteristic is their use not only in the melting of native copper for casting, but also in the melting of native copper mixed with copper arsenides in order to achieve an efficient alloy, as well as in the smelting of oxides and the co-smelting of oxides and sulphides.

In Tal-i Iblis near Kerman, the analysis of 300 crucible fragments indicated their use in smelting process, since they still held traces of slag and had not been exposed to temperatures higher than 1000° C[15]. Thus, as an experimental reconstruction confirmed, the charge had been filled directly into the crucible, which had been covered, and the fireplaces had been simple pits in the ground.

But the first irrefutable proof of smelting and casting processes comes from Tappeh Ghabristan near Qazvin, at the end of the 5th millennium BC: 20 kg of malachite[16], crushed into small, nut-sized pieces, ideal for smelting, were found, along with two hearths, a crucible with slag residue, four open casting moulds for tools with shaft-holes, and a rectangular mould for five rod-shaped ingots (Majidzadeh 1979, 83, figs. 1-2). Additionally, a cylindrical object made of clay that can be interpreted either as a mould or as a tuyère (blowpipe) was uncovered. If it was in fact a tuyère, it would be the only prehistoric example from the Plateau and one of the very few found in Western Asia as a whole.

The workshops at Tappeh Ghabristan and the significant quantities of metal at Tappeh Hesār, Sialk and Shahdad suggest the existence of professional metallurgists, whose efforts were more directed towards the manufacture of objects through casting and hammering than towards the modification of raw material processing techniques, which would not show significant improvement for two millennia. V. Pigott explains this conservatism with the abundance of the Anarak deposits and the ease with which an alloy with good mechanical properties could be achieved, namely by mixing native copper with copper arsenides, in order to release their arsenic into the crucible[17].

The Spectacular Developments during the Susa II and Susa III Periods (3500-2800 BC)

Metallurgy at Susa during the proto-urban period does not follow the periodisation suggested by the excavators, since the political rupture at the end of Susa II does not affect this branch of economy. The continuity of production is attested on the Acropolis – in

Fig. 10: Necklace of silver pendants with inlays of gold and hematite, late 4th millennium BC, tomb of a child, Tehran, NMI; Photo: DBM, M. Schicht.

Fig. 11: Necklace of beads with a silver pendant, decorated with polychrome inlays, Tappeh Sialk, late 4th millennium BC, Louver; Photo: DBM, M. Schicht.

Mecquenem's sounding no. 2 and Le Brun's work on Acropolis I – where, between layers 17 and 14B, needles continue to occur. The main novelty, however, is the emergence of metallurgy in Mesopotamia. In Iran, the impulse still seems to come from the Iranian Plateau. The significant features of this period are the development of polymetallic products, the emergence of new techniques, such as lost-wax casting, soldering, hammering, the hammering of copper, lead and silver into sheets, the occurrence of bivalve moulds, and finally the increase of intended alloys.

The Development of Polymetallism

In the course of the 4th millennium BC, new metals attracted interest: gold, silver and lead, a phenomenon visible at Susa and Tappeh Hesār. The gold most probably came from Muteh, near Kāshān, one of the richest mines worldwide (Tallon 1987, 263). Its treatment is illustrated in the little dog with pendant loop (Fig. 4, Cat. No. 31), treatment of silver in the cruciform pendant[18] (Fig. 9, Cat. No. 246) and the triangular chased pendants with hematite inlays (Fig. 10, Cat. No. 245), all of them coming from two children's tombs. Obviously, a play of colour effect between the silver and the new materials was sought. This phenomenon is not inherent to Susa. As Françoise Tallon emphasises, «this extremely refined jewellery, consisting of precious materials previously unknown at Susa, have to be compared to objects from a contemporary burial at Sialk, namely two circular silver medallions with lapis lazuli and bone inlays (Tallon 1987, 320),» (Fig. 11, Cat. no. 134). Actually, the burial where the triangular pendants had been found, also held an intricate piece of jewellery made of lapis lazuli, quartz, shell, carnelian and rock crystal beads.

Lead appears in Susa and Sialk in the Late Uruk period, but is rare elsewhere. It is used to fashion vessels like the beak-spouted jar (Fig. 12, Cat. no. 507), bowls and cups. At the end of the 4th millennium BC, the material was mined in the same district of Anarak that already provided copper. The simultaneous appearance of lead and silver at Susa is certainly not accidental. In fact, no silver-bearing mineral deposit in the Middle East seems to exist; silver emerges as a by-product of copper and lead following the cupellation process[19].

The Emergence of New Techniques

Lost-wax casting – already known for several centuries in Palestine and magnificently showcased in the Nahal Mishmar Hoard – allows the production of metal sculptures at the same time as the stone sculpturing which develops rapidly. The objects are in the round, like the small golden dog mentioned earlier (Cat. no. 31) or its even smaller counterpart in silver (Tallon 1987, no. 1162), or adorn the heads of pins (Fig. 13, Cat. nos. 34 & 35). The bird sitting on a closed fist nicely demonstrates the original and sometimes humorous approach to art in Susa.

Soldering is used for the first time in the manufacture of the golden dog that, as small as it may be, definitely synthesizes the important innovations of the period (Duval *et al.* 1987; Eluère 1998). In the Proto-Elamite period, soldering was used on several joints of the silver bull in the Metropolitan Museum (Lefferts 1970). In both cases, the solder is an alloy – gold and copper, silver and copper – to reduce the risk of overheating and thus deforming the objects.

The champlevé of silver pendants allowed inlays of the already mentioned rare materials and simplified their fixation.

Metal hammered into sheets was used in the manufacture of statuettes, such as the bull from the Metropolitan Museum mentioned above (of unknown provenance), or vessels like Sb 10213 (Susa II) (Fig. 12, Cat. no. 507) and Sb 6821 (Susa IIIB). Equipped with a beaked spout, they reproduce ceramic models and demonstrate the

Fig. 12: Vessel with a beaker shaped muzzle embossed of lead sheet, Susa/Shush, late 4th millennium BC, Louvre; Foto: DBM, M. Schicht.

Fig. 13: Two cast figurative copper needles, Susa/Shush; Uruk period, Susa II, late 4th millennium BC, Louvre; Photo: DBM, M. Schicht.

Fig. 14: Hoard "Vase à la cachette", shaft-hole axe, Susa/Shush, middle of the 3rd millennium BC, Louvre; Photo: DBM, M. Schicht.

Fig. 15: Hoard "Vase à la cachette", toilet articles in a copper sheath, Susa/Shush, middle of the 3rd millennium BC, Louvre; Photo: DBM, M. Schicht.

virtuosity of the metalworkers, since the entire vessel was made out of a single sheet by hammering and annealing. X-rays and microscopic studies indicate that the transition from the spout to the body of the vessel is continuous and not soldered (Tallon 1987, 216).

The Increase of Intended Alloys

Analyses of copper objects show a more heterogeneous composition of raw materials with the presence of arsenic, silver, antimony and bismuth, suggesting the exploitation of sulphidic copper as chalcopyrite (Pigott 1999a, 80).

The two main alloys of the period are copper-arsenic and copper-lead, with the latter very limited in time.

Fig. 16: Hoard "Vase à la cachette", cylindrical double-vase made of chlorite, Susa/Shush, middle of the 3rd millennium BC, Louvre; Photo: DBM, M. Schicht.

Bivalve Moulds

These appeared at the beginning of the 3rd millennium BC and allowed the casting of real socket or muff, which greatly facilitated the shafting of axes. This feature is illustrated by a later example of Sumerian type (Fig. 14, Cat. no. 47).

The Widespread Use of Copper in the Susa IV Period (2600-2200 BC)

Fig. 17: Hoard "Vase à la cachette", one of five plano-convex shaped ingots, Susa/Shush, middle of the 3rd millennium BC, Louvre; Photo: DBM, M. Schicht.

The big developments of metallurgy in Susa mainly date from the Early Dynastic III period, which corresponds to Susa IV A (2600-2340 BC), and from the Akkadian period, which is Susa IV B (2340-2200 BC). The use of copper became more widespread and the typology diversified increasingly: weapons, tools, vessels, jewellery and toiletry objects (Fig. 15, Cat. no. 43) were now common. Still, the city had lost its dynamic and did not remain the centre of great technological innovations in metallurgy that it had been at the end of the 4th millennium BC. It became, to cite P. Amiet, «a modest city of Sumerian characteristic,» that could not bear comparison to the contemporary city-states of Mesopotamia. Gold, lapis lazuli and carnelian did not pass through anymore; the Persian Gulf became the principal exchange route for precious and semi-precious raw materials to Sumer: gold and lapis lazuli from Bactria and luxury objects produced in the workshops of the trans-elamite world, like chlorite vessels (*cf.* Fig. 16, Cat. no. 492), turquoise, carnelian or lapis lazuli beads, striped alabaster vessels, shell bracelets and much more.

Tin bronze (more than 5% Sn) made its appearance at Susa in the middle of the 3rd millennium, but its use remained confined to only a few objects, like the axe with concave shaft hole and moulded ridge[20] (Tallon 1987, Vol. 2, no. 41; Fig. 14, Cat. no. 47) or the «Vase à la Cachette». This alloy has the advantage of a lower melting point, a minimum gas release during casting, and greater hardness, which significantly improves the efficiency of tools and weapons. However, tin bronze remained a luxury item, and pure or arsenical copper still was most commonly used at Susa, and even more so in the trans-elamite world. The best example for all these points is the «Vase à la Cachette».

The network of Susa's relations changed: its orientation now shifted towards Luristan and Mesopotamia, from where it obtained metallurgical models that were copied in a simplified manner; it also turned towards the Gulf, possibly changing its supply sources.

The «Vase à la Cachette»

This hoard, found in 1907 on the Acropolis, provides through its variety the principal evidence for the diversity of crafts practiced in Iran towards the middle of the 3rd millennium BC (Morgan 1912, fig. 117; Mecquenem 1912, 144, no. 287; 1934, 189-190, fig. 21; Le Breton 1957, 117-120; Amiet 1986, 125-127; Tallon 1987, vol. 1, 328-333; vol. 2, nos. 103, 781, 794, 1075, 1086, 1107-1110, 1165-1169). It included, distributed between two ceramic vessels, 48 copper or bronze objects, five plano-convex copper ingots with faint traces of arsenic and nickel (Fig. 17, Cat. no. 44), three gold rings, a ring made of three twisted circles of gold, silver and copper, seven beads and two tips of gold, a tiny frog made of lapis lazuli, eleven vessels of striped alabaster, a glazed sherd, 13 small pebbles or *calculi* (tokens), and six cylinders, which suggest a date of around 2450 BC. The homogenous composition of the copper in all objects, including the ingots, indicates that this is a coherent assemblage from the same period (Tallon 1987, 330).

The typology of metal objects from the «treasure» is very varied and, although some shapes show influences from Luristan and Mesopotamia, without comparison: less rich than in the Royal Cemetery at Ur[21] and less exuberant than in Luristan. Affinities with the vessels from Shahdad can be noted. The tools, vessels, jewellery and weapons[22] were now frequently made of pure copper and illustrated the end of arsenic copper alloys, which had been so characteristic for the preceding periods (Menu & Tallon 1998).

The use of tin bronze for the strainer (Fig. 18, Cat. no. 46) and three other objects[23] represents the main technological innovation. Precious materials decreased to a minimum and fine pieces of jewellery were of gold highly alloyed with silver. The small glazed sherd is mainly of interest for its original bright blue-green glaze, almost perfectly preserved, due to its sheltered deposition inside the «Vase à la Cachette».

Supply Sources: Iran or Oman?

Analyses of the «Vase à la Cachette» metal objects and their trace elements have led T. Berthoud to conclude that their copper source can be found on the Arabian Peninsula, and more specifically in Oman, equated with the country of Magan (Berthoud 1979, 111). Several scholars have refuted this claim, stating that trace elements do not allow a clear distinction between the mining sources of the Iranian Plateau and those of Oman (Pigott 1999a, 80-81).

Metal Storage

What to think about the objects cast in the rod-shaped moulds from Tappeh Ghabristan? Were they already ingots? Specimens from the 3rd millennium BC are much easier to identify. They were of plano-convex shape and mirrored, or so it was thought, the shape of the bottom of the hearth where they were produced. Today we know that they were cast in flat pits outside the hearths and left to cool there. The five ingots found in the «Vase à la Cachette» (Fig. 17, Cat. no. 44) vary in weight between about 1.5 to 3 kg. The plano-convex shape was to remain the only known form for a long time. Examples have been found in several sites in Oman.

Fig. 18: Hoard "Vase à la cachette", strainer made of tin-bronze, middle of the 3rd millennium BC, Louvre; Photo: DBM, M. Schicht.

The Susa V Period (2100-18th Century BC)

This period encompassed the Neo-Sumerian Renaissance, brought about by the conquest of the region by Shulgi, the Simashki dynasty and the beginning of the *sukkalmah* dynasty. The city of Susa returned to prosperity, especially around the turn from the 3rd to 2nd millennium BC (Tallon 1987, 354). Metallurgy prospered remarkably: new types of objects appeared, expressing contacts with Luristan (hammer of Shulgi with plumage), Mesopotamia (foundation nails of Shulgi) and Bactria (hammers with diagonal socket). Thus, Susa found itself once more in the centre of exchange between East and West. The use of tin became more systematic and frequent, leading to technological progress. Weapons, adzes and chariot fittings were now made of real bronze with 5% tin content (Tallon 1987, 351). The two unanalysed wheel rim bandings (Fig. 6, Cat. no. 48) belong to solid wooden disc-wheels in the tradition of the 3rd millennium BC. Iron and nickel remained the main impurities in copper.

Gold became more abundant. It was used to sheathe statues, like the one of the «god with the golden hand» (Tallon 1987, Vol. 2, no. 1337), or in the manufacture of jewellery, although in a more unostentatious manner. The use of filigree, granulation and cloisonné, as known in the Sumerian world, was rare. Silver was hammered into chest ornaments, which undoubtedly had been sewn onto clothing through two opposing holes. These breast-covers (Fig. 7, Cat. no. 508), possibly predating the Susa V period[24], were heavily alloyed with copper to heighten their stability. A great amount of the jewellery made from precious materials came from the Simashki sarcophagus tombs. Finally, the earliest casting moulds found in Susa stem from this period: they are bivalves made from stone and multifunctional for spearheads or arrow points, with runners and sprues (Fig. 5, Cat. nos. 41 & 42). Sb 9611 is the only mould displaying a closing system with tenons and mortises; the others had to be tied together.

Thus, all the great metallurgical innovations had been achieved and there were no more inventions to speak of before the appearance of iron. The mastery of metal, however, was continuing, and the Middle Elamite period (14th-12th cent. BC) would be one of the most prolific in Susa. Let's not forget that the most extraordinary pieces of metalwork in the entire Orient were realised on the Susiana plain: the statue of queen Napir-Asu from the 14th century BC has still not rendered all its secrets of manufacture, but it remains an unquestionable masterpiece (Meyers 2000).

Notes

1 The palace was built under Darius (522-486 BC), burned under Artaxerxes I (465-425 BC) and rebuilt under Artaxerxes II (405-359 BC).

2 The only large frieze that was found in place, north of the first courtyard in the residential area of Darius' palace.

3 The inauguration of the exhibition halls by the President of the Republic, Sadi Carnot, took place on June 6, 1888.

4 This was especially true in the case of the Code of Hammurabi: the main part of the stela was found in 1900 and published by Father Scheil in 1902 (Scheil 1902). An exhibition featuring it was held in May 2002 at the Grand Palais des Champs-Elysées, including an important fragment of the Code that was found at Susa just in time to make its way to Paris.

5 The tell had an estimated height of 35 m. In order to obtain a relative chronology of the site, Morgan divided these 35 m into seven completely artificial levels of 5 m each, and had a series of tunnels dug into the steep face of the southeastern corner of the tell at highly varying heights.

6 Ambitious to systematically explore the tell, Morgan divided it into two equal parts along a Northwest–Southeast axis. Perpendicular to this axis, 5 m wide trenches cut through the entire length of the tell.

7 The Castle is a small fort, built in 1898 by J. de Morgan to house the *Délégation*. It is situated high on the Acropolis, on its easily defendable northern top.

8 Choga Zanbil lies about 40 km to the southeast of Susa. Its vocation was the accumulation of all cults from the ensemble of deities of the Susa and Anshan kingdoms.

9 The stratigraphy of Susa has been published in the *Cahiers de la DAFI*, I, 1971 and following, as well as in «La séquence archéologique de Suse et du Sud-Ouest de l'Iran antérieurement à la période achéménide», *Paléorient* 4, 1978, 133-228.

10 Sincere thanks are given to Benoît Mille, in charge of metallurgical studies at the Centre de Recherche et de Restauration des Musées de France (UMR 171 of the CNRS), for his review of this part of the article.

11 Nevertheless, five out of 18 analyzed objects from Çayönü displayed a microstructure that attested to annealing (Maddin *et al.* 1991).

12 The stratigraphy of the older layers of Sialk is divided into four periods, Tappeh Sialk I-IV. Sialk II corresponds to the 5th millennium BC, before Susa was founded; Tappeh Sialk III, layers 1-3, is contemporary with the necropolis of Susa I (layers 27-25 of Alain Le Brun's Acropolis I work; end of the 5th millennium), and layers 4-7 are contemporary with the second part of Susa I (layers 24-23 in Acropolis I; beginning of the 4th millennium). Tappeh Sialk IV1 corresponds to Susa II, which is the Uruk period from 3500 to 3100 BC, and IV2 belongs to the Proto-Elamite period between 3100 and 2800 BC.

13 Very probably with a lid, since their surface is quite even.

14 The proportions are still very modest: only half of the 68 analyzed objects show traces of arsenic, at a mean percentage of 0.48%. The occurrence of arsenic considerably improves the mechanical properties of the metal by hardening it (very much like tin does) and by improving its flow for casting. However, almost 4% arsenic are needed to record a noticeable improvement.

15 1000° C are sufficient for smelting, but not for casting (Dougherty & Caldwell 1966, 17-18).

16 Malachite is a rich copper oxide that can be easily smelted in a crucible and leaves very little slag.

17 Metallurgy at Tappeh Hesār went along the same lines, since arsenic copper metallurgy was practiced there for two and a half millennia (Pigott

1999b, 113).

18 This plaque has the shape of a Greek cross and its edges have been bent up to hold the inlays. The central square bears a rosette executed in repoussée and its four arms received hematite inlays. The plate is of unalloyed silver, but with impurities that seem to indicate minerals of at least two different provenances. The small pendant loop has been fixed to an indentation of the edge without soldering (Tallon 1987, 263).

19 Silver is separated from lead through an oxidizing melting process in a porous crucible. The silver settles on the bottom of the crucible, while the lead oxide is progressively drawn into the cupel.

20 3.7% Pb, 7.6% Sn after LRMF; 8.2% Sn after Laboratory Dr. Junghans.

21 The jewellery from the Royal Cemetery displays new inventions in embossing, filigree decoration, proto-granulation and cloisonné.

22 Tools: adzes, cross-cut and flat chisel, a unique shovel, saw, pruning knife, sieve, scale and bolt; Vessels: cups, bowls and carinated vessels; Jewellery: hand-mirror, bracelets, rings and beads; Weapons: flat or winged axes, and daggers.

23 Only four objects contained more than 7% tin: the sieve, two vessels and a flat adze.

24 R. de Mecquenem placed them in the «25th century».

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Susa, watercolour of Maurice Pillet from the 1920s; in front the Achaemenid palace of Darius, in the background the French fort; after Chevalier 1997, 62.

Chalcolithic Archaeology of the Qazvin Plain

Hassan N. Fazeli

Cultural Summary

Qazvin plain is defined as a region by the interaction of people in different sub-regions over a long period starting by the sixth millennium BC (Fig. 1). Archaeological evidences of the Qazvin plain present important information about the development of cultural complexity, rising of craft specialisation and long distance trade during the fifth and fourth millennium BC.

Geography and Settlements

The plain of Qazvin is a geographically well-bounded region located some 150 km west of Tehran in central north Iran, receiving an average annual rainfall of more than 300 mm. To the north lie the Alborz mountains and the Caspian sea, and through the region runs a major route of communication connecting the western and eastern segments of northern Iran. The Qazvin plain is an important section of the route ultimately linking the highlands of Iran and Afghanistan, via the Zagros mountain passes, with the lowland plains of Mesopotamia.

Since the 1970s archaeological studies of the Qazvin plain have been based on the investigation of the sites of Zagheh, Ghabristan and Sagzabad in the Qazvin plain. The sites of Zagheh, Ghabristan and Sagzabad are located approximately 60 km south of the modern town of Qazvin in the Zanjan province and 140 km west of Tehrān. The three sites are in close proximity with Zagheh lying 2 km to the east of Sagzabad and Ghabristan about 300 m to the west of the latter. Recent re-excavations of Zagheh in 2001 and Qabristan in 2002 and systematic settlement survey of 2003 have supplemented earlier findings and provided new interpretations of

Fig. 1: The Relative Chronology of the Qazvin plain.

Period	Surveyed sites data	Excavated sites data
Late Chalcolithic 3700-3000 BC	Ismailabad (Qazvin), Zagheh 2, Mian Palan, Mansorabad1, Ebrahim Abad,	Qabristan III & IV
Middle Chalcolithic 4000-3700 BC		Qabristan II & III
Early Chalcolithic 4300-4000 BC	A68, Mahmodian	Qabristan I
Transitional Chalcolithic 5300-4300 BC	Cheshm-Bolbol, Kamal-Abad, Chehar Boneh, Ebrahim Abad, Bahrami, Zafaran Tape, Qara Qobad, Zahir Tape, Mahmoodian, Zagheh 2	Zagheh
Late Neolithic 6000-5300 BC	Chehar Boneh, Zagheh 2*, A68, Ebrahim Abad * During survey of 2003 some sites within the plain have same names such as Zagheh. So, we add some numbers for the sites have same names.	

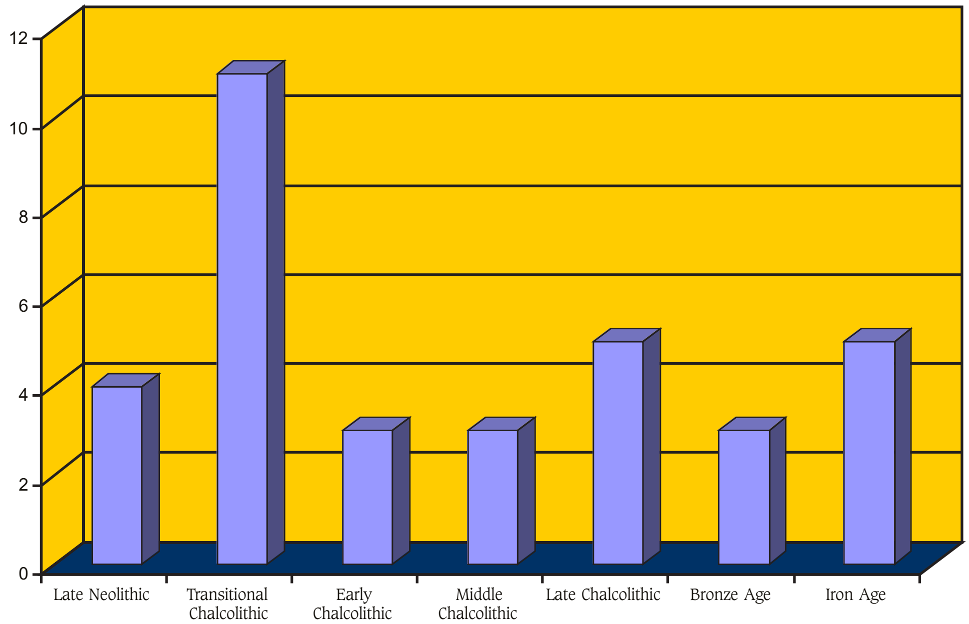

Fig. 2: Prehistoric archaeological site distribution of the Qazvin plain (based upon the settlement survey of 2003).

the cultural sequence in this region of Iran. Figure 1 indicates the settlement pattern and distribution of sites from 6th-1st millennium BC. The settlement system of the Qazvin plain has two important characteristics. First, there is highly shifting of settlement and inconsistency of site occupation. Settlement population gradually grew and then suddenly decreased. Secondly, the largest settlement sizes are less than 10 ha and there is not a high archaeological visibility of settlement hierarchy. In fact, within the region there is an extremely increasing of site number in each period.

Economy and Social Organisation during the 5th Millennium BC

Based upon the Zagheh result the economic life of the Qazvin plain during this period was dominated by agriculture and husbandry of animals such as sheep, goat, pig and cattle (Mashkour et al. 1999). The results of the radiocarbon determinations taken from Zagheh excavation 2001 indicate that Zagheh was settled around 5370-5070 BC and abandoned around 4460-4240 BC. Dominating the settlement at Zagheh there is a large and well-appointed 'Painted Building' [or shrine] with internal features (Fig. 3) such as a large circular hearth and painted panels of wall plaster, as well as associated burials (Fig. 4) with red ochre and grave goods in the form of ceramics, beads, and ornaments of turquoise, agate, and lapis lazuli, and tools of copper, all support the interpretation of this building as having a non-domestic nature (Fazeli 2001). Other structures and burials at Zagheh are of a less ostentatious character, arguing for a marked degree of social hierarchy at this early stage in the settlement of the Iranian highlands. Additionally, evidence for large-scale production of pottery has been recovered in recent years from trench K at Zagheh, including deeply stratified ash deposits, remains of pottery kilns, piles of prepared clay and crushed stone (for temper), lumps of red ochre, and production tools. Hundreds of spindle whorls indicate a highly developed textile industry and the presence of tokens may suggest a form of administration (Fazeli & Djamali 2003).

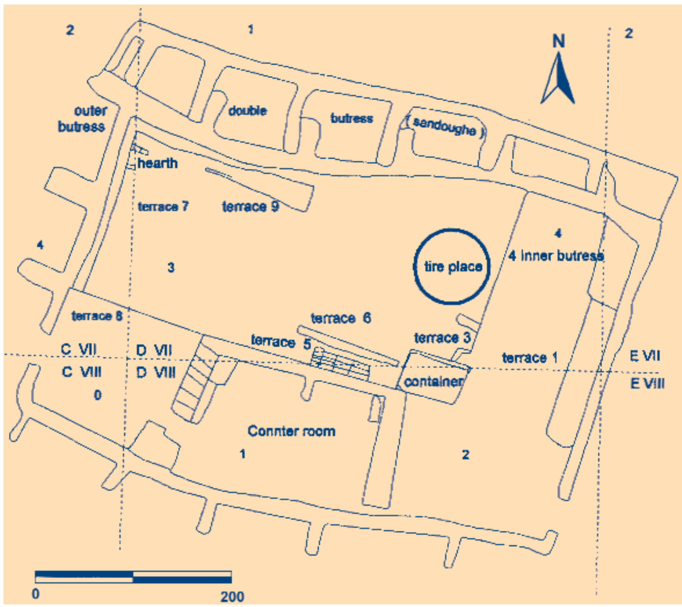

Fig. 3: Plan of Zagheh Shrine.

Fig. 4: One individual grave of Zagheh buried with grave goods close to the shrine.

The present data indicate uses of ceramic vessels during the Transitional Chalcolithic period ranging from utilitarian purposes such as storage, food preparation, and cooking, through socio-political and ideological or ritual ones. The Qazvin Plain sites present four distinct types of ceramics: Cheshmeh-Ali ceramic type (red fine ceramics), Zagheh Crusted ceramic type, Zagheh Simple ceramic type and Zagheh Painted ceramic type.

The degree of labour investment, quality, texture, kind of temper, and methods of surface finishing are different in each of the four types mentioned above. Red polished ceramics (Cheshmeh-Ali ceramic type) are the predominant pottery of this period and are distributed within the most sites on the Iranian central plateau. The Cheshmeh-Ali ceramics painted with numerous animals motifs, both naturalistic and stylised of flying birds, goats, gazelle, dogs, fish, ibex, geometric designs, parallel bands, vertical strips, chevrons, dots, and dashes, floral or tree patterns. The walls of the vessels have often been highly burnished outside; inside they have been overworked with a bone or a wooden stick.

Economy and Social Organisation during the 4th Millennium BC

From 4200 BC there is an increasing scale of political and economic organisation with greater cultural complexity with specialisation of ceramic and metal artefacts. The craft goods indicate a higher degree of differentiation between settlements, which is a reflection of greater local exchange and higher economic integration. At Ghabristan excavation of 1970s and 2002 several trenches were investigated, yielding three cultural periods of Early, Middle and Late Chalcolithic. Occupation at Ghabristan spans 4200 to 3000 BC (Fig. 5). As at Zagheh much of the settlement is today buried under several metres of modern alluvium, and recent test trenching has established its extent as about 2 ha. Convincing evidence for an early coppersmith's workshop was excavated in level II at Ghabristan, which can be chronologically linked, via ceramic similarities, with Sialk III 4-5 and Hesār IB. The copper workshop comprises a suite of two rooms, their doorway later blocked, situated amongst a complex of potters' workshops and other buildings (Majidzadeh 1979). The larger of the two rooms has a range of features indicating copper ore processing, including two small hearths, complete and fragmented crucibles, baked bricks for supporting the crucibles over the hearths, moulds for the production of copper objects including bar ingots, a ceramic pipe used for bloomery, a large bowl containing 20 kg of copper ore in small pieces, and water storage facilities. In the 2002 excavations at Ghabristan pieces of copper ore (raw material) were recovered in the southern part of the site, suggesting that metal workshop activity was not restricted to the central area of the site. In addition to the evidence for a copper workshop, in the 1970s a range of copper objects, including daggers, axes, chisels, awls, needles, pins, and bracelets, was recovered from level II at Ghabristan, and their similarity to artefacts from contemporary levels at Sialk and Hesār is striking (Majidzadeh 1979, 86; Moorey 1982, 85). It has been suggested that the Ghabristan evidence can more probably be interpreted as remains of melting and casting in moulds of native copper rather than smelting of copper ore (Muhly 1980-83, 352; 1988, 7), but this reinterpretation does not account for the large quantities of copper ore found at the site, both in the 1970s and in more recent excavations.

In addition to this exceptionally vivid evidence for craft specialisation in copper smelting and casting from early fourth-millennium Ghabristan, it is clear that the production of pottery was also undertaken in an intensive and highly organised manner by the community living at the site (Majidzadeh 1976; Fazeli 2001). Indeed, given the site's relatively small area extent, and the major

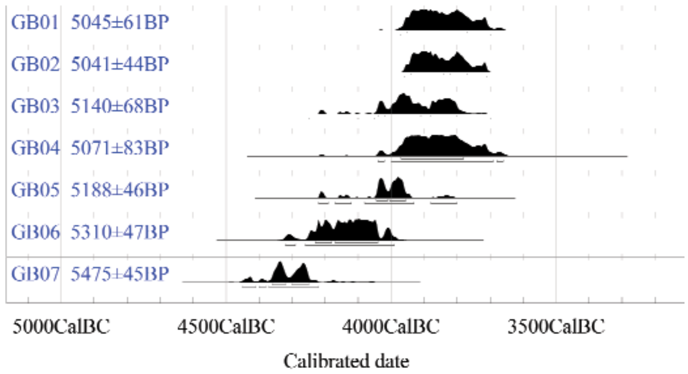

Fig. 5: Radiocarbon dates from the excavation of trench L34 at Ghabristan, 2002 (after Fazeli et al. forthcoming).

evidence for pottery and copper processing and production, it could be argued that the site constitutes a workers' settlement, largely devoted to specialist craft activity, although further excavations are needed to clarify this point. A so-called 'Main Building' in level II has been posited as a residence for the ruler of the settlement or a communal structure for public gatherings (Majidzadeh 1976, 128).

During later occupation at Ghabristan, in level IV dated to the late fourth millennium BC, sherds of about 50 bevelled-rim bowls were found (Majidzadeh 1977, 61). The possible means by which these vessels reached, or were made at, Ghabristan are numerous, but they undeniably connect the site, however tenuously, with the world of Late Uruk Mesopotamia. In some way the interest of the lowlanders in access to nearby copper sources or rather to means of exchange with long-established local communities who controlled copper extraction, smelting, and casting may well be materialised in the form of the recovered bevelled-rim bowls (Fazeli 2001). Occupation at Ghabristan is dramatically brought to an end at around 3000 BC with evidence for extensive burning, including a burnt human skeleton on a floor, clay sling shots, and complete but broken pottery in situ, suggesting a violent and sudden end to settlement at the site (Negahban 1977, 37).

Conclusion

The Qazvin plain, then, hosts considerable evidence for Chalcolithic social complexity in the form of architecture, burial, artefacts, and modes and means of production of pottery and copper items. Such complexity is visible in the placing of the dead and the quantity and quality of the grave goods of Zagheh. Material objects in graves reinforce the role of ideology and how people legitimate their power. The mortuary evidence from the 'Painted Building' at Zagheh indicates that elites played a major active role in the material culture patterning (Fazeli 2001). Attempts at increasing craft specialisation and differential wealth were based on long distance trade, which stimulated the basic cohesion of this political structure. These attributes, and others, have been argued as indicating that by the later Chalcolithic period the major settlements of the Iranian central highland had already reached the threshold of urban civilization, to a degree that "one could consider them as small cities or towns rather than simple village areas" (Majidzadeh 1976, 159).

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House with a patio in a village of eastern Sistan (1976);G. Weisgerber.

Sialk and its Culture at a Glance

Von Sadegh Malek Shahmirzadi

The prehistoric site of Sialk incorporates two hills, north and south, and two cemeteries, A and B (Fig. 1). This was the case at least in 1931 when the site was patented as number 38 of the Iranian national relics. The site was until recently located in a vast and remote area, 4 km south-west of the town of Kāshān, beside the Kāshān-Finn road. Today, due to the urban expansion of the last two decades, Sialk is located inside the town of Kāshān. The village of Dizjeh was once several hundred metres from the site and a small village, but today has grown up into a town which has also intruded on the prehistoric site – on the southern and eastern parts of the site's southern hill. Only about 50 m separates the remains of the ancient world's oldest ziggurat, located at the pinnacle of the southern hill, from the pomegranate gardens on the hill's south side. 200 m south of the southern hill are the remains of the 3500 year-old Cemetery A, which is now covered by a 24 m wide boulevard constructed for the town of Amir-Almoemenin's automobile traffic. The remains of the 3000 year-old Cemetery B has not fared any better, the only difference being that the pomegranate garden was converted in the autumn of 2002 into a rose garden.

Roman Ghirshman[1], the famous Ukrainian-born French archaeologist and Iranologist, began the excavation of Sialk's southern hill in 1933 and continued this work into 1934. After a three years hiatus, he went back to Kāshān and extended his excavation to the northern hill and Cemeteries A and B. The publication of his 1938 and 1939 excavation reports was perhaps one of the most important contributions of early archaeological work; these reports have been reliable references for establishing the chronology of the prehistory of Iran's central plateau. In 2001-2002, the Sialk Reconsideration Project began its own research and a review of previous archaeological studies. A second and a third field season of research continued in 2003 and 2004[2]. The preliminary report of the first season of the "Sialk Reconsideration Project" was published under the title of "The Ziggurat of Sialk" in 2002, the preliminary report of the second season, entitled "The Silversmiths of Sialk" was published in 2003. The following is an abstract of Sialk's archaeology based on Ghirshman's studies and the Sialk Reconsideration Project.

Before the discovery of the new site of Tappeh Shourabeh on the piedmont of the Karkas mountains, it was believed that the first inhabitants of the Sialk settled on the northern hill around 7500 years ago, while the last group of immigrants entered the Sialk 3000 years ago and buried their dead in the cemetery B. Ghirshman concluded that there were six distinct cultural periods recognisable at the Sialk site between these two events (Fig. 2): 1) a first and second period with remains on the northern hill, 2) a third and fourth period with some remains on the southern hill, 3) a fifth period with remains in Cemetery A, and 4) a sixth period with remains in Cemetery B. Each of these six cultural periods had its own characteristics which distinguished one period from another; in the following paragraphs the cultural characteristics of each period will be described.

First cultural period (Sialk I 1)

According to Ghirshman's excavations, the remains of the first period were found on the northern hill in layers 1-5 (Fig. 3). In this period, the inhabitants of the Sialk made hand-formed pottery which was baked in simple kilns with little temperature control. The potters decorated the vessels with geometrical designs in black on a buff or pale red surface. People lived in small huts or hamlets with clay walls, The roofs were covered with a mixture of twigs, leaves and then coated with a layer of mud plaster. Subsistence was a combination of hunting, gathering, and probably limited (dry) farming and animal husbandry of small herds of goats and sheep. The people were obviously familiar with the local mineral resources; during the middle part of the period they exploited local copper veins to produce small copper ornaments via hammering techniques. Marble was also used to make small implements such as bowls and adornments such as bangles, bracelets and decorative beads. The dead were buried with a thin layer of red ochre and some grave gifts underneath the floors of houses.

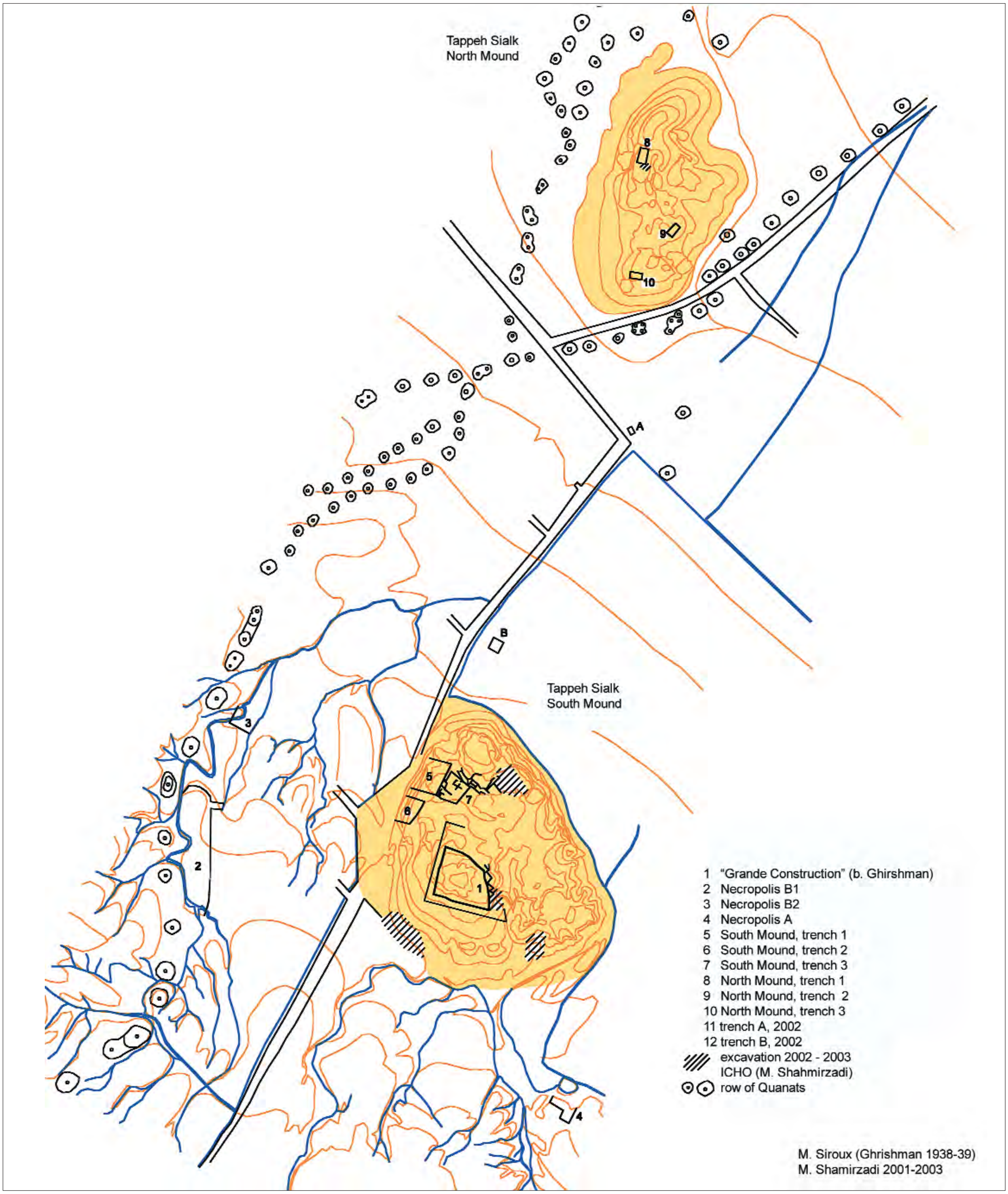

Fig. 1: Simplified map of the investigations of R. Ghirshman and S. Malek Shahmirzadi between 2001 and 2003 at the northern and the southern mound; after Ghirshman and Shahmirzadi.

Years B.P.	Period		Cultur	Kind of Pottery	Name of Pottery	Sites on the Central Iranian Plateau	Sialk
ca. 2600	Iron Age	III	Mede & Achaemenid	wheel made	grey, red and orange burnished	Sagzabad level XV Ozbaki Sagzabad level XIII-XIV Ozbaki Sagzabad level XVI-XII Ozbaki	Achaemenid gap
ca. 3000		II	post late plateau		zoomorphic vessels	Sagzabad level XVI-XII Ozbaki	Sialk VI (cemetery B) gap
ca. 3500		I			gray and gray-black	Kahrizak Mamorin Sagzabad level V-VI Ghaytarich Khorvin Ozbaki Hissar Ic Agh Tepe	Sialk V (cemetery A)
	proto-elamite		late plateau		proto-elamite (late Uruk & Jamdat Nasr)	Sialk IV (Ziggurat) Ghabrestan Mamorin Veshnaveh ? Arisman	gap Sialk IV (Ziggurat)
ca. 4900	transitional					Veshnaveh? Sialk III 6-7&7a Arisman	Sialk III 6-7 &7a
ca. 6100	proto urbanism		middle plateau		Sialk Ware	Cheshumeh Ali B western Mahmoudieh Ghabrestan 1 (levels 19-11) Hissar 1 Ghareh Tepe Qom Ghomrud Ghareh Tepe Shahryar Gabrestan II-IV Morteza Gerd Ozbaki (Matal Tepe)	late Sialk III 4-5 early Sialk III 4-5
ca. 7000	neolithic	pottery neolithic	old plateau	hand made	Cheshmeh Ali ware	Agh Tepe 11&1 Golestan Palace? Qumes Barlekin Belt Cave Hotu Cave Ismaeil Abad Cheshmeh Ali A Shah Tepe Sheikh Tepe Yarim Tepe Cheshmeh Bolbol Shir Ashian Sohanak? eastern Mahmoudieh Ozbaki Puinak Ganj Tepe Qaleh Dokhtar Tepe Shoghali Ghareh Tepe Shahryar Khurian Merseh Ghomrud Tureng Tepe Mohammad Abad Zagheh (levels VIII-I)	Sialk I 2-5 & II 1-3
ca. 8000			archaic plateau		Zagheh ware	Agh Tepe III Sang-e Chakhmagh Cheshmeh Ali? Sialk I 1 Cheshmeh Bolbol Deh Kheir Mehran Abad? Yarim Tepe Ozbaki Zagheh (levels XII-IX) Pokerdwaul	Sialk I 1
ca. 9000			formative		Soft ware	Belt cave (from level 6 up) Tepe Shurabeh Hoto cave (from 4.6 m up) Mehran Abad	Tepe Shurabeh
ca. 10500		acera-mic				Hotu cave (from 4.6 m to 7.15 m) Belt cave (levels 11-7)	?
ca. 12000	Epi-palaeolithic		Ali Tepe Cave Belt cave (levels 27-11)				?
	upper late palaeolithic		upper				Sefid Ab
ca. 45000			middle	Masileh Basin (with monsterian tools) Tehran?			
ca. 60000			lower				

Fig. 2: Cultural development at the Central Plateau in prehistoric times; chronological chart.

Fig. 3: General view to the northern mound in 2003; Photo: Sialk Reconsideration Project.

Second Cultural Period (Sialk I 2-5 – II 1-3)

While the same basic manner of life described above appears to have continued into the second cultural period, a major difference between the periods can be found in the type of pottery that was produced. The pottery of the second period was decorated not only with geometric patterns, but also with symbolic and stylised animals and plants (Fig. 4); a better kiln was also being used to bake the pottery. People continued to build the walls of their houses with straw and clay and hand-made mud-bricks. The roofs were covered with twigs, leaves and mud. Burial practices were carried out as they had been in the previous period.

Fig. 4: Footed bowl with black geometrical painting on a red slip from period II of the northern mound, excavations R. Ghirshman; Photo: M. Schicht, DBM.

This second period appears to be a cultural continuation of the first cultural period, starting in the second layer of excavation – for example, there were only a few changes in the pottery technology. This change of the ceramic traditions had been started since Sialk I 2-5 and lasted to the end of the second period; The author therefore considers the cultural remains dating from the first period's second level through to the end of settlement on the northern hill as a single culture; this single culture is identified as the Cheshmeh Ali cultural period, because of its close resemblance to the Cheshmeh Ali culture in Rey.

Third Cultural Period (Sialk III 1-6)

The third period of the Sialk site began around 6100 years ago, when the inhabitants of the northern hill abandoned their settlement. Some of the inhabitants moved to the south side of the "Sialk Rud" (Sialk river) settling on a naturally hilltop which is presently called the south mound (Fig. 5). Studies by the Sialk Reconsideration Project in 2001-2002 have shown that the southern hill was located beside a river-stream that was running about 6500 years ago. The old bed of this river was identified during the first season of the new project in 2002 at a depth of 6 meters from the surrounding areas. Archaeobotanical studies carried out in 2002 revealed that this river ran from Northwest to Southeast through a wooded corridor of spruce, pine, willow and other species. These facts illustrate that the Sialk inhabitants lived in an area which provided a beneficial climate, not to mention a ready supply of fuel and raw materials. The diversity of animals and plants depicted on the vessels made by potters on the southern hill not only implies the inspiration of the natural environment for decoration, but also that the Kāshān area had a temperate climate during this period which was able to host diverse flora and fauna – spruce pine, willow, tamarisk, almond, fig; goat, sheep, deer, gazelle, cow, cheetah, fish, frog, tortoise, duck, heron, stork, and vulture.

Fig. 5: General view to the southern mound in 2003; Photo: Sialk Reconsideration Project.

The first inhabitants of the southern hill lived in houses built from mud-bricks shaped in rectangular frames. The rooms had right angles and used the bond method for walling in order to strengthen the building; after coating the surface of the walls, some inner surfaces may have been coloured with a solution of ochre. The economy of the period was still based on farming and animal husbandry, though now on a larger scale – agriculture was done in both the normal and dry farming method, and goats, sheep and cows were kept. A significant amount of progress was made during this period regarding technology: starting in the middle of the period, pottery was made using the wheel and baked in more sophisticated kilns with controllable temperatures. The pottery that was most in demand was made plain, while decorative pottery depicted compound geometrical designs and stylised depictions of flora, fauna, and human figures; goats, cows, deer, gazelles and cheetahs were the most popular motifs (Fig. 6). The great skill and accuracy of the Sialk artists in drawing the details of nature can be seen by the fact that the goats and cows have been drawn with different forms. Organic colours, soot, minerals and animal fat were used for coloration; in some cases potters may have used more than one colour on a vessel, as evidence from the end of this period suggests. During the third period the inhabitants of Sialk were also skilful metallurgists; they knew how to extract silver from the local ore and used this to make ornaments and jewellery, and additionally made their everyday tools from copper. During the second research season of the Sialk Reconsideration Project, a metallic knife recovered from the remains of the last settlement level of this period was found to be composed of copper with 95% purity made by the open casting method.

Some information about the social situation of the third period was obtained during the second season of the Sialk Reconsideration Project. In addition to artisans, farmers and animal husbandmen, the presence of a well-off rank has been recognised, primarily through differences in the type and size of residences. In the excavation of a habitation area dating to the end of this period, parts of three rooms of a large house were uncovered. The wall of the northern room was found to have been coloured with an ochre solution. In the middle room, the skeletal remains of a ten-year old girl and a middle-aged man were buried under debris. In the southern room were the remains of approximately ten medium- and large-sized vats, which had been broken by the collapse of the ceiling. One of the vats was 1.2 m in height with a 70 cm diameter mouth; the outer surface of some of the vats was decorated with stylised animals and plants in two colours.

Fig. 6: Goblet from Sialk, period III,5-6 with a painted row of horned goats or Capricorns; Photo: M. Schicht, DBM.

Fourth Cultural Period (Sialk IV 7-7a)

Ghirshman believed that there was a gap between the third and the fourth cultural periods of the Sialk, which was a result of a fire. However, excavation during the second season of the Sialk Reconsideration Project showed that this fire was not comprehensive and had affected only a part of the industrial section of the town. Cultural continuation between the third and fourth periods was visible not only in the inhabited sections, but also in an experimental sounding which was dug south of main relief of the southern hill in order to reach the virgin soil. The fourth cultural period of the Sialk began 5000 years ago and lasted some 500 years. In this period, writing using symbols and letters (the "beginning of Elamite") had become common practice in the Sialk. Additionally, gigantic buildings were constructed in the now huge city of Sialk (Fig. 7 & 8). In 2001, the Sialk Reconsideration Project identified parts of the oldest-known ziggurat of the ancient world, which was built about 4750 years ago beside the main temple. According to approximate calculations, more than 1,250,000 mud-bricks with the dimensions 35x35x15 cm were used to construct this ziggurat, which had at least three floors. The base platform is 56 meters from east to west and 45 meters from south to north. The second platform, judging by the horizontal adit made through its core from east to west by Ghirshman, was 35 x 35 meters. There was a smaller platform on top of the second one, yet only remains of the first two rows of mud bricks are distinguishable. The height of the first platform is four meters and it seems that the height of the other two platforms were almost the same. On the south side of the first platform is a four meters wide mud brick pavement about 1.5 meters high. Two semi-conical half-towers were added to the southern and northern corners of the eastern facade of the second platform. In addition of these two semi-conical half-towers a small

Fig. 7: View to north to the southern hill with the mud-brick construction after its cleaning in 2002; Foto: M. Schicht, DBM.

Fig. 8: Fragments of head and horns of a fully sculptural Terracotta-Capricorn from the new excavations of the Sialk Reconsideration Project.

alcove with an ogee arch was constructed on this façade near to the southern half-tower and a mud-brick bench of 1.5 m wide and about on meter height was constructed in front of the alcove, which was extended from the southern to northern semi-conical half-towers. The interior surface of the alcove and the top of the bench were plastered with a thin layer of white plaster, possibly with a mixture of lime or gypsum. The space between the eastern façade of the second platform to the upper eastern edge of the first platform to the upper eastern edge of the first platform is 11 meters while the space on the west is only 5 meters. At the present, the only rational and logical reason for this 6 meter extension seems to have had something to do with some type of morning ceremonial cultic function, since in the morning the first ray of the sun would shed light on this façade. Based on some reliable archaeological evidence it seems that the ziggurat of Sialk was constructed some time during the Proto-Elamite period, *i.e.* between 2900 to 2500 BCE[3].

Fifth Cultural Period (Sialk V)

About 3500 years ago, tribes from central Asia began to immigrate west; they entered the Sialk site, which was abandoned and uninhabited for ages, and temporarily settled there around 3200 years ago. There is not much information about these newly arrived immigrants, other than what has remained is their cemetery – cemetery A – which is located 200 m south of the southern hill. In 1937 Ghirshman excavated twelve of the graves; the pottery found in the graves was wheel-made and dark grey to black in colour, indicating affiliation with the Iron Age I period.

Sixth Cultural Period (Sialk VI)

After a gap between 2900 to 2800 years ago, during the Iron Age II period, a group of northern tribes entered the area and buried their dead in a cemetery 150 m west of the southern hill, cemetery B. Ghirshman excavated over 200 graves during his 1937 investigation. The graves of this group were ridge-shaped, with beautiful pottery vessels of diverse forms (some in the shape of animals and birds) and personal ornaments included with the dead. Many of the burial vessels – skilfully decorated with beautiful red ochre depictions inspired from nature – are now in museums and private collections, such as the Louvre Museum, famed as “Sialk vessels”. It was recognised during the second season of the Sialk Reconsideration Project that the people who created cemeteries A and B also settled temporarily on the southern hill.

Seventh Cultural Period (Sialk VII)

During this 220 year period the Kāshān area was part of the vast Achaemenid Empire, but for unknown reasons the area was not settled. However, some typical pottery sherds of that period are visible in the artefact collection from the two seasons of excavation by the Sialk Reconsideration Project.

Where did the first Inhabitants of the Sialk come from?

A fundamental question for the archaeology of this region is: Where did the first inhabitants of the Sialk (those who entered the

Fig. 9: The site Tappeh Shourabeh at the piedmont of the Karkass-Mountains; in eastern direction the Bagh-e Fin can be seen; Photo: S. Malek Shahmirzadi.

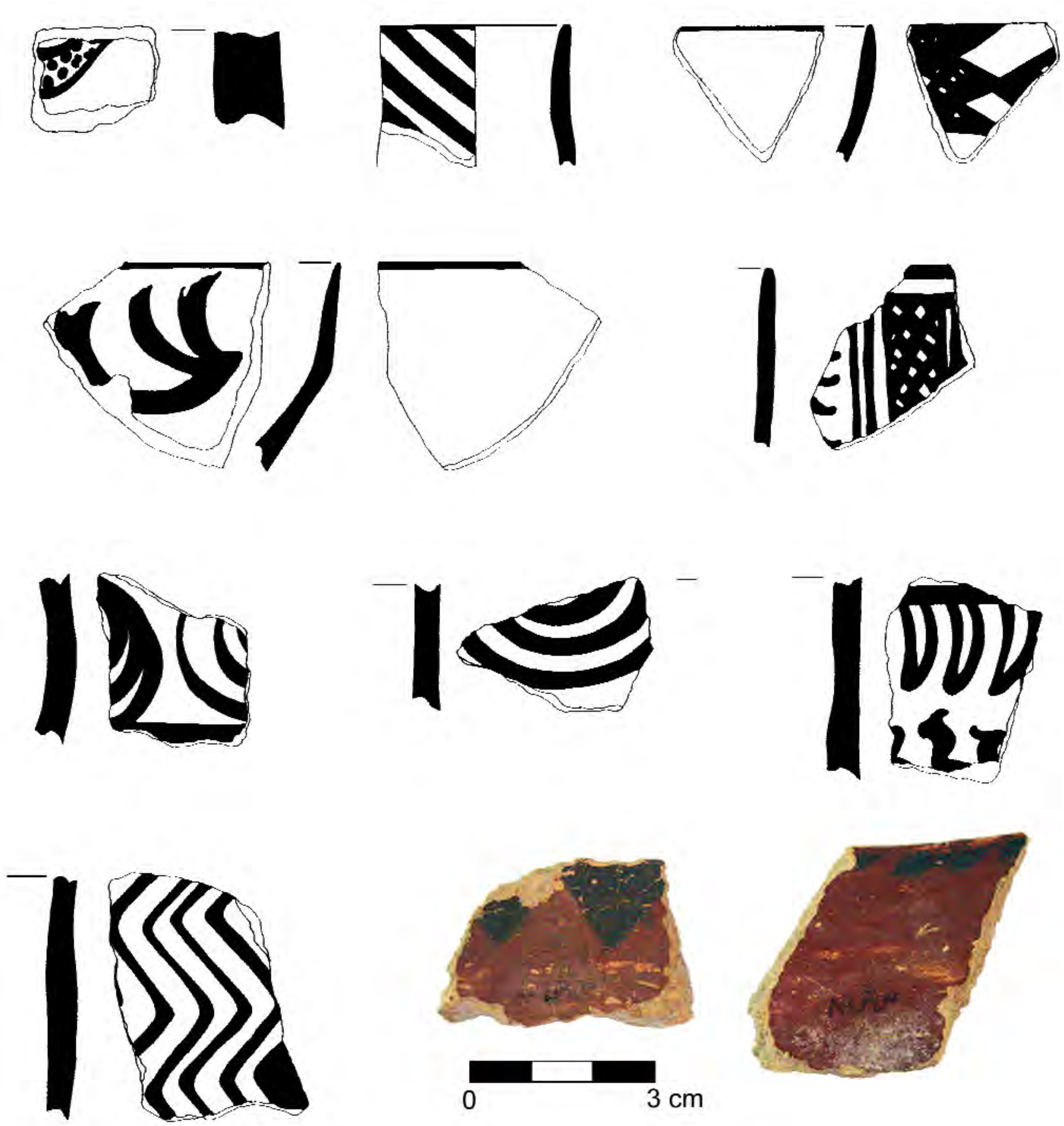

Fig. 10: Pottery sherds from Tappeh Shourabeh; after Shahmirzadi 2003.

area and settled the northern hill) come from? The Sialk Reconsideration Project succeeded in answering this question by the end of the second season of excavation. In the foothills of the Karkas Mountains, about 5 km south-west of the Sialk site, the remains of small settlement known as Tappeh Shourabeh give intriguing clues (Fig. 9). The pottery of this hillock site, which is one of the more important indicators for the dating of finds, is much older and more primitive than the oldest pottery found in the first cultural period of the Sialk (Fig. 10). Now there is some evidence that the first inhabitants of the North mound of Sialk were those who were living on the piedmont of Karkas and moved to the plain and settled there around 7500 years ago.

Notes

1 Roman Ghirshman (1895-1979), famous archaeologist, worked in many sites in Persia and Afghanistan. 1935-1941 excavations in Bishapur; 1936 discovery of the Ziggurat at Chogha Zanbil. Excavation of the prehistoric site of Nad-i Ali in Afghanistan. Director of the "Delegation Archeologique Française" in Afghanistan from 1941, from 1946 director of the French Archaeological Mission in Persia. Survey of the prehistoric sites of the Iranian plateau, *e.g.* excavations at Tappeh Giyan near Nihavand, and Tappeh Sialk near Kāshān.

2 The project was founded by the Iranian Cultural Heritage Organization (ICHO who finances and supports the project. The project is headed by the author of this article.

3 R. Ghirshman has dated this mud-brick architecture (his "grande construction") to period VI and resulting from this to the Early Iron Age: Ghirshman 1939.

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Bagh-i Shahzadeh, „King's Garden", Mahan near Kerman. In the arid zones of Iran it is impossible to survive without artificial water supply. Gardens and irrigated groves are oases of vitality; Photo: G. Gerster.

A Prehistoric Industrial Settlement on the Iranian Plateau – Research at Arisman

Nasr N. Chegini, Barbara Helwing, Hermann Parzinger & Abdulrasool Vatandoust

The Iranian Plateau is surrounded by two mountain ranges, the Zagros and the Alborz. These high rising mountain chains form wide highlands on their inner side and in the centre there is the big desert of Dasht-e Kavir.

At the foot of the mountains, where the highlands start, there are numerous springs supplying a narrow strip of fertile ground. Thus today there is a green band of irrigated fields and gardens around the desert, often only a few kilometres wide. This zone of transition from the mountain range to the highlands presented itself as a preferred settlement area for the people after the beginning of the 7th millennium BC. Today there is a circle of prehistoric settlements around the desert.

One of these places is the prehistoric metalworking settlement of Arisman. It is located at the southern rim of the desert, at the northern foothills of the Karkas Mountains, 960 m above sea level. The closest known prehistoric site is Tappeh Sialk, 60 km to the Northwest in the municipal area of Kāshān. As we know from surveys in the surrounding area, Arisman is the biggest but by far not the only metalworking place in this region.

In the area of the prehistoric settlement of Arisman, on more than 1 km^2, there are artefacts on the surface, like pottery fragments, stone tools, and copper slags from the 4th to the early 3rd millennium BC. But a clearly indicated settlement mound, as it is typical for other places in the Middle East, is not to be seen. The concentration of copper slags, which at three places are piled up to real heaps of more than 25 m in diameter, is especially conspicuous. They show that in the antiquity Arisman must have played an important role as a producer of copper. But how old the copper industry at Arisman really is, became clear only in 1997 when a piece of charcoal from one of the three slag heaps showed to be from the early 3rd millennium BC. This encouraged the archaeological investigations which were started in the year 2000.

Since then there have been three excavation-campaigns at Arisman and a survey in the hinterland of the prehistoric settlement[1], and a picture of a complex prehistoric industrial settlement starts taking shape which intensively contributed to build a network of far distance trade in the 4th millennium BC.

Excavations at Arisman

In contrast to many known archaeological sites in Iran, the prehistoric settlement of Arisman extends horizontally instead of vertically. Obviously this horizontal extension is the result of moving the settlement continuously, while the layer containing building structures reaches a maximum of 1.60 m. Today the excavations have concentrated on four different areas: the oldest levels from the mid of the 4th millennium BC were recorded in the southern excavation area B, while younger levels from the end of the 4th millennium BC were recovered in area C. Excavation areas A and D aimed for investigating two slag heaps which are from the same time as the settlement finds in area C.

Sialk III-Period

House and Pottery Quarters in Area B

In the mid of the 4th millennium BC a single, one room residential house with clay walls was erected in area B (Fig. 1). This house is the oldest archaeological finding recorded for the time being. In the

Fig. 1: Arisman, area B, ground-plan of house from Sialk III-period (mid of 4th millennium BC).

interior of the building there is a hearth at the short side, next to it there were two cooking pots *in situ*. These are handmade, and the underside of the bottom of the pots is structured by finger-imprints, obviously to make the surface bigger and thus reach better absorption of the heat.

After this house had been abandoned, craftsmen's quarters were established in this area. Big kilns were erected, five of which could be investigated in the excavation area. These kilns are of three different types (Boroffka & Becker in this volume). Obviously in these kilns big amounts of pottery were produced. A layer of rubble, being almost one metre thick, is around the kilns. It contained thousands of pottery fragments, pieces from the walls of the kilns, and – surprisingly – numerous waste from manufacturing copper and silver, probably from craft shops which must have been nearby. After the pottery quarters had been abandoned, this area was only used from time to time. Still rubble was dumped, and there is also a burial which was dug into the layer of rubble in later times.

Metallurgic Finds from Area B

The layer of rubble around the kilns contained numerous metallurgic wastes: fragments of melting pots and moulds (Cat. no. 206-212), fragments of litharge (Cat. no. 227-229), slags (Cat. no. 218) and small pieces of copper ore, hammer- and anvil-stones, and finally some copper artefacts (Cat. no. 214-217, 221-225) and a bit of gold sheet and gold wire (Cat. no. 231).

The melting pots are roughly made dishes with thick walls and about 30 cm in diameter, made of straw-tempered clay and a stand which was pierced in the longitudinal direction. Probably this kind of piercing made it possible to put a stick through it in order to move the hot pot. Usually the inner sides of the pots are covered by copper slag. This type of melting pot is typical for the 4th millennium BC and is called the Ghabristan Type Melting Pot, after the site where its first evidence is documented (Majidzadeh 1989, pl. 27, b *in situ*, pl. 28, a). Besides Ghabristan it is also found at other sites on the plateau, at Tappeh Sialk (Nokandeh 1382 [=2003], pl. 2, 1-4) and at Tappeh Mamourian (information by J. Mehrkian). But meanwhile we know from surveys in the hinterland of Arisman that this type was not the only one being used in the 4th millennium BC during the late Sialk III-period: there some isolated melting places from the late Sialk III-period could be recorded at the rim of the desert, where a different kind of melting pot with a massive handle was used. Also the moulds are made of clay but contain much more sand than straw. Mostly moulds for bars and flat axes are found, but also two moulds for casting big double axes. Also small clay-cylinders were found which were probably used for the shaft-holes while casting the double axes. Heavy copper tools are known in the 4th millennium BC and double axes are found *e.g.* at Susa (Tallon 1987, 96-97, no. 74, refering to another double axe from older excavations). More types of double axes are from contemporaneous Ghabristan (Majidzadeh 1989, pl. 28, c). Clay-models of double axes are known from Telloh (Genouillac 1934, 6, pl. 44, c; Sarzec & Heuzey 1884-1912, pl. 42, 2, 45,5) and again from Susa (Tallon 1987, 97, annotation 84, referring to Sb 11205, as yet unpublished).

For the time being, among the copper artefacts from Arisman there are no such heavy tools and it must be presumed that they were only made for trade and did not remain at Arisman. The only metal tools are small tools like chisels and bodkins, as known from Sialk (Ghirshman 1938, pl. 84, S.1698) and Hesār (Schmidt 1937, pl. 16, H.3743).

For processing the copper – ore, slag, and metal – hammer tools play an important role. Ore was beaten to small handy pieces before it was put into the furnace. The remaining slag still contained a high amount of copper and thus it was again hammered to pieces and the drops of copper were picked out. Finally hammers were used for forging and moulding the copper. Stones were used as tools, some of them in their original shape, others were partly shaped. Granite, basalt, granodiorite, but also sandstone was often used, as well as flint. For hammering, oblong pestles or round hammerstones were used, quite often also natural, nearly round pieces of flint. Flat plates or hollowed mortars served as pads.

Pottery from Area B

The pottery from the layer of rubble is made in the typical way of the late Sialk III-period, some handmade, some made on the potter's wheel. Usually the clay is bright, and many vessels are painted in dark colours. With firing the sherd turned to be yellowish, beige, or red, and the painting turned to be dark brown. Beakers with softly curved S-like vessel walls (Cat. no. 235) count among the most common types, next to bowls on high stands and big kettles, as well as small bellied beakers with inverted rims. The painted patterns are mostly geometric and restricted to the upper parts of the vessels. Especially typical are narrow hatchings which make a flame-like pattern, going around the rims of the beakers. Also typical are fire branch patterns or grill patterns, also running around the beakers. Other patterns are arranged to metopes, and in these metopes there are also single motifs like depictions of the sun or of plants, occasionally there are zoomorphic or anthropomorphe motifs. Among these, rows of horned animals (Cat. no. 235) – bulls, goats, ibex, and deer – appear most often, next to depictions of aquatic birds or leopards. Humans are extremely rare. The pottery from Arisman is parallel mostly to the finds from levels III, 6-7 at nearby Tappeh Sialk (Ghirshman 1938), where there is evidence for almost all the motifs. Zoomorphic and anthropomorphe depictions are found at Sialk in much greater numbers than at Arisman and thus allow to conclude on the rich population of animals in those days.

Y. Majidzadeh counted Sialk III, 6-7 among his horizon of "Late Plateau A", dating it to the 2nd and 3rd quarter of the 4th millennium BC (Majidzadeh 1976, 204 tabl. 5). Malek Shamirzadeh goes along with this and also dates Sialk III, 6-7 around the mid of the 4th millennium BC (Malek Shamirzadeh 1382 [=2003], fig. p. 208). This approach is now confirmed by the radiocarbon datings from Arisman (Görsdorf 2003, 361).

Besides the typical Sialk III-types there is a small amount of handmade coarse wares among the pottery collection from Arisman, coming from a completely different cultural background. These are model-shaped conical bowls, so called bevelled rim bowls, and flat plates with thick rims. Such types are typical for the Uruk-culture which develops in the Mesopotamian alluvial lowlands in the 4th millennium BC. There the first towns are built, with walls and temples, with craftsmen's quarters and a society based on the division of labour, and at the end of this development there is the introduction of a complex administrative system and of writing (Nissen 1988). After about 3800 BC the thus significantly rising demand for raw materials leads to increasing contact to the mountainous

Fig. 2: Arisman, area C, residential area and craftsmen's quarters from Sialk IV-period (c. 3000 BC).

regions of Iran and Syria – Anatolia, which are rich in raw materials. As early as around the mid of the 4th millennium BC there is evidence – by pottery types – for contact between the Uruk-culture and Arisman which probably was the result of increasing trade between the highlands and the lowlands.

Area B – Conclusion

As the pottery quarters at Arisman impressively show, in the Iranian highlands there were specialised craft shops as early as around the mid of the 4th millennium BC, where objects of everyday use – in this case dishes, but also metal – were produced on a large scale and by standardised methods. These products were made for customers outside the settlement and were traded via a network of far-distance-trade. Thus very early some contact between the highland settlements and the early towns in the Mesopotamian lowlands was established.

Sialk IV-Period

Half a millennium later, at about 3000 BC, the work routine in metal trade is much more distinguished. The original smelting process happens outside the residential areas and is done in open space next to the settlement. There we find the furnaces, and copper is produced on a large scale, the slag heaps A and D being evidence for this. Also the inner structure of the settlement has changed deeply, as the arrangement of houses in area C shows.

Residential Area and Craftsmen's Quarters in Area C

In contrast to the older settlement in area B, which is proven by the existence of a single house, in area C now houses with several rooms and inner courtyards are arranged at both sides of a street (Fig. 2). These houses are right next door to each other and only occasionally they are separated by a narrow space – maybe a sewer. The houses were accessible from the street by help of narrow doors which then led into a corridor. The bigger rooms were farther inside. The inner rooms show floors and walls which were plastered with clay. In the open spaces there are some installations, mostly ovens. These ovens are supplied with a floor made of mixed clay and gravel and their upper parts were covered by a cupola made of clay.

In some rooms there were a lot of finds. Thus we know that in these houses there was room for everyday life and there were areas where the metal, which had been produced in the furnaces in areas D and A, was further manufactured. In one small room there were several hammer stones and anvil stones, and concentrations of copper slag were found, which had been hammered to small pieces in order to obtain the remaining copper. Probably the slag had originally been stored in a container made of some organic material, maybe a leather sack or a basket. Also copper artefacts,

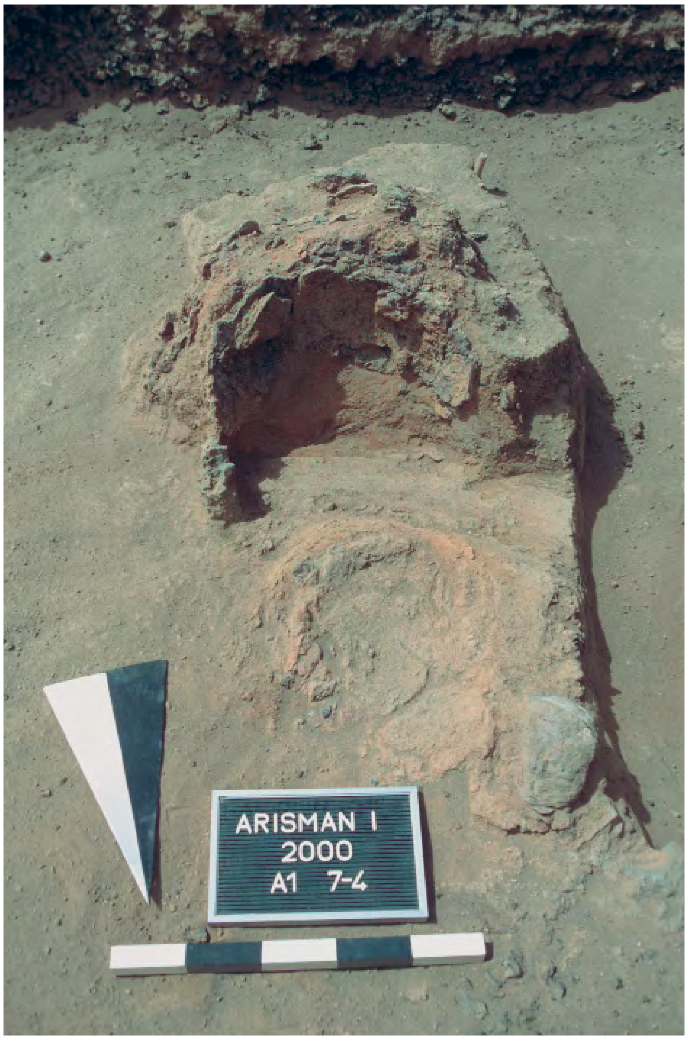

Fig. 3: Arisman, area A, furnace from Sialk IV-period (c. 3000 BC).

among them bodkins and a small chisel, were found in the settlement. And finally the inhabitants had obviously started to take the copper and silver trade into their own hands. In one small room two cylinder seals were found, together with a silver pendant with polychrome inlets.

At some later time, but still during the first half of the 3rd millennium BC, the settlement was abandoned and then used as a burial place where several children were buried in big storage vessels. Some of them wear copper jewellery, *e.g.* copper spirals around their arms.

Slag-heaps and a Furnace in Areas A and D

The two bigger ones, A and D, of the three slag-heaps at Arisman, had yet been investigated archaeologically. Both are 25 m in dia-

Fig. 4: Arisman, area D, open pits, probably for preparing charcoal, Sialk IV-period (c. 3000 BC).

meter and are more than 1 m high. Every smelting brings innumerable kinds of waste – slags, fragments of the crushed furnace wall, ashes and charcoal, broken melting pots and moulds. Thus these heaps were made by successively piling this waste of copper-smelting.

In area A it was indeed possible to excavate the furnace which had been central to the heap (Fig. 3). But in area D the furnace seems to have been outside the excavated area. Instead here – 40 m away from the heap at a place which had shown strong anomalies during the geo-magnetic investigation – a total of seven pits with plastered walls and traces of fire were investigated whose filling contained ashes, charcoal, slags, and other smelting-waste (Fig. 4).

The melting point of pure copper is 1083° C. Thus for smelting copper ore a temperature is needed which is even a bit higher – about 1200° C must be reached. For doing this, high quality fuel is needed, probably ready prepared charcoal. It is possible that the plastered and burned pits in area D were used for the production of charcoal.

For the time being, only the excavation of a furnace in area A offers information about the furnaces at Arisman. The furnace consisted of a small rostrum made of mud-bricks which stood directly on the old surface. A round oven – 70 cm in diameter with plastered walls, they were thickly covered by slags as a result of the heat – was set into this rostrum. In the lower part of this oven there was a U-shaped furrow and a depression where probably the melting pots stood. The upper end may be reconstructed as a clay-plastered cupola. For every smelting this cupola was newly erected and after that it was crushed to get the copper out. Thus every smelting required a renovation of the oven. This was always done at the same place, the new oven being set into the remnants of the older one. Thus the oven slowly moved into a south-eastern direction. The number of 33 renovations of the cupola shows that in this furnace at least 33 smeltings must have been done.

In the slag-heaps there are found many broken melting pots and fragments of furnace walls. Especially the rims of melting pots were informative, where fragments of furnace wall with a negative print of the pot rim could be adjusted. They show that a clay hood was directly set upon the pots so that the pot was sealed hermetically.

The Seals

The use of cylinder seals was introduced in the 4th millennium BC. Though stamp seals had been known for some time, it was the cylinder seal which made possible a continuous impression of picture-cylinders across a bigger surface. Originally, cylinder seals were used for the first time probably in the conurbation of the Uruk-culture in the southern foothills of the Zagros and Taurus mountains, in Khuzestan, Northern Syria, and in Mesopotamia, for documenting business transactions (Boehmer 1999). The two cylinder seals from Arisman show that also the people at Arisman were part of a widely spanned trade network and that they themselves controlled the distribution of their products – copper and silver.

The two cylinder seals from Arisman belong to two completely different types. One is made of some transparent greenish stone which was incompletely cut into a cylindrical shape, obviously by hand. The seal shows the depiction of a horned four-legged animal in front of a small triangle. The way it is done shows that the seal cutter's hand was rather clumsy, as the depiction is put together by straight carved lines. Due to this the animal shows one eye which fills the entire inner surface of the head. Also the cylinder seals from Tappeh Sialk show animals which are done in a similar way. The only difference is that here small drill holes were applied to mark the corners (Ghirshman 1938, 48, pl. 94). Thus it is very likely to interpret the seal from Arisman as having been done by a local seal cutter. The depiction, on the other hand, shows borrowings from the repertoire of the cylinder seals of late Uruk time, when the depiction of the "holy herd" in front of a pen was a popular motif.

In contrast to these unique local seals, the second piece belongs to a widely used standard pattern. These seals in "Piedmont Jemdet Nasr Style" were used in the entire Zagros and also in the Iranian highlands (Pittman 1994). They are made of fired soapstone and show canonised geometric patterns. Thus at Arisman we find both seals, which were cut at the place, and also standardised seals, as they are evident for the entire Zagros.

Pottery

Not only in metallurgy but also in the technology of pottery-production there are deep changes. Now all the vessels are produced on the fast-turning potter's wheel. This is only possible if the clay is prepared in a different way: To prevent the clay from tearing when it is moved so fast, now bigger amounts of sand are added. Again the clay itself is of local origin and also the material for tempering probably comes from a nearby riverbed. When fired, the pottery turns red. Only in a few cases it is painted, mostly with simple stripes running around the vessel and occasionally with more complex geometric patterns. Now big bowls with fine rims count among the standard types, also supply containers with oval bodies and various variants of pots and jars. Biconical vessels with long, open beaks are particularly typical (Cat. no. 240).

Like in the collection from the Sialk III-period, now in Sialk IV there is a small number of types, which were produced at the place but whose prototypes are found in the Mesopotamian Uruk-culture. Among them there count bevelled rim bowls, whose walls are much steeper now than in case of the older examples, and also the handmade rough plates are still found. Now additionally there are vessels with four perforated lugs on the shoulder, a type which is evident in the entire coverage of the late Uruk- and Jemdet Nasr-cultures.

But this element from Uruk is only a minor contribution. Much more important are the strong connections – of standard pottery from Arisman and particularly the stripe-painted pottery – to material of the early Proto-Elamite-culture, as it is known best from Tal-i Malyan (detailed discourse on cultural relations in: Helwing in press). There we find both the bowls with fine rims and the vessels with four perforated lugs, and also the types that were borrowed from Uruk. The same types are also found in other highland sites from the same period, *e.g.* at Tappeh Yahya in Kerman. Here – again due to the pottery collection – the existence of a cultural koiné outlines at the beginning of the Proto-Elamite period, which centres in the Iranian highlands and which is an autonomous unit, having contact to the Mesopotamian Uruk-culture.

Conclusion

Meanwhile research at and around Arisman has decisively improved our knowledge of early copper and silver production on the Iranian plateau. We are now able to sketch the technologic development in the 4th millennium BC in detail, while the records on a furnace from area A may serve as a basis for future reconstructions. At the same time surveys around Arisman led to discovering further sites with metallurgic remnants which show that Arisman was the biggest copper-producing site known for the time being, but not at all the only one in this region. But most of all the significance of the Iranian plateau as a cultural koiné of its own has become visible, which was part of a widely stretched network of far distance contacts but at the same time showing individual features. There is hope that future research will shed more light on this – just dimly visible – aspect of the autonomous cultural development on the Iranian plateau.

Notes

1 This work is part of the interdisciplinary research-project "Früher Bergbau und Metallurgie auf dem westlichen iranischen Plateau" which since the year 2000 has been done in cooperation with the Iranian Cultural Heritage Organisation and the Geologic Servey of Iran on one hand, and with the Deutsches Archäologisches Institut, Eurasienabteilung, Deutsches Bergbau-Museum Bochum, and TU Bergakademie Freiberg on the other hand.

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Traditional working smith near Astarre, north-west Iran; Photo: G. Weisgerber 1978.

Pottery Kilns in Arisman

Nikolaus Boroffka & Jörg Becker

The development of early fire-techniques in the Middle-East has been sketched by various scholars (*e.g.* Ghirshman 1938, 38ff.; Delcroix & Huot 1972; Majidzadeh 1975-1977; Alizadeh 1985; Hansen Streily 2000). The easiest way, which is to fire pottery in open fire (Ghirshman 1938, fig. 6, 1; Majidzadeh 1975-1977, 218) has hardly been worked on. The discourse was mostly on kilns with one or two chambers. The latter is a construction with one fire chamber and a second chamber above or next to where the pottery is placed. This means that the prepared vessels did not have any direct contact to the fire and thus the process of firing was more under control. Delcroix and Huot (1972) suggested a subdivision into six types (incl. variations) according to the way of firing, while Alizadeh (1985) drew four major lines of development according to the shape of the ground plan. The latter system fits better to archaeologic features (see Hansen Streily 2000, 70) though it must be completed, especially if today's knowledge is taken into consideration. Direct firing in the open fire, which may be supposed to have been prior to kilns, is difficult to prove archaeologically (see *e.g.* Audouze & Jarrige 1977) and will not be discussed further in this essay. To Alizadeh's four major evolutions (1985, fig. 8) there should be added kilns with two chambers and a single central pillar (for example as line no. V) (Fig. 1) which can be derived from his type IV (the central pillar is connected to the wall). They are considered the technically best developed kilns, as this construction allows the most effective circulation of hot air.

In Area B of the Arisman-settlement, which is contemporary to Sialk III (4th millenium BC), a total of five kilns have been identified, up to today, that belong to lines II and V.

Three constructions, situated closely to each other, belong to line II following Alizadeh (Fig. 1-4). Showing a diameter of c. 80 cm in the interior they are small if compared to the other two kilns. They consisted of a circular fire chamber which was separated from the fire chamber above by a grate with holes (Fig. 4). Obviously no pillar in the chamber was necessary. The upper part of the chamber was dome-shaped and collapsed in later times; its remnants were found on the grate (Fig. 2), or, at places where the grate itself had collapsed, in the fire chamber. The base of one upper smoke outlet was found in the lintel. One of these kilns had collapsed together with the stock inside, so that it was possible to uncover the vessels together with the remnants of the threshing floor in the fire chamber (Fig. 3). These kilns were charged through an opening to the South-East. Similar kilns are known *e.g.* from level III/1 at Tappeh Sialk (single) (Ghirshman 1938, 36f., fig. 5) or in groups of three to five from level I at Tell Abada (Hansen Streily 2000, 77, fig. 14-15).

The two kilns of Line V are significantly larger. Besides that, we can distinguish between a variation with one opening to charge them and another variation with an additional smoke outlet. At one kiln with a diameter of 150 cm in the interior (Fig. 5) the fire chamber, which had to be spanned by the grate, was so big that a central pillar was built, made of vertical, loaf-shaped mud-bricks. Its height of *c.* 80 cm allows a complete reconstruction of the size of the fire chamber. According to the fragments the upper part was also dome-shaped. To the South-East the kiln had an opening to charge it with fuel. Similar constructions are known only from later periods, such as period IV/1 (3rd millennium BC) at Mundigak (Delcroix & Huot 1972, 40f., fig. 1, A.3) or from the Early Bronze Age (2850-2600 BC) at Tell el Far´ah (Delcroix & Huot 1972, 71ff., fig. 7, E.2) or the late Bronze Age-period V (late 3rd/ first half of 2nd millennium BC) at the Namazga-Depe settlement (Delcroix & Huot 1972, 43, fig. 2, B.1).

The biggest kiln of line V, with a diameter of c. 200 cm in the interior, had a pillar made of vertically and horizontally built mud-bricks (Fig. 6-7). Its height was c. 80 cm. Despite the pillar the grate was additionally reinforced by a grill. Long narrow mud-bricks were built from the sides to the pillar and then rendered to form a grate with holes in it. This kiln was also provided with an opening in the south-eastern wall to supply the fire-chamber with fuel. Probably in order to control the air supply this longish praefurnium was covered by rectangular mud-bricks, which were found fallen into the channel when the site was excavated. Diagonally opposite to the fuel opening, in the North-West, a smoke outlet

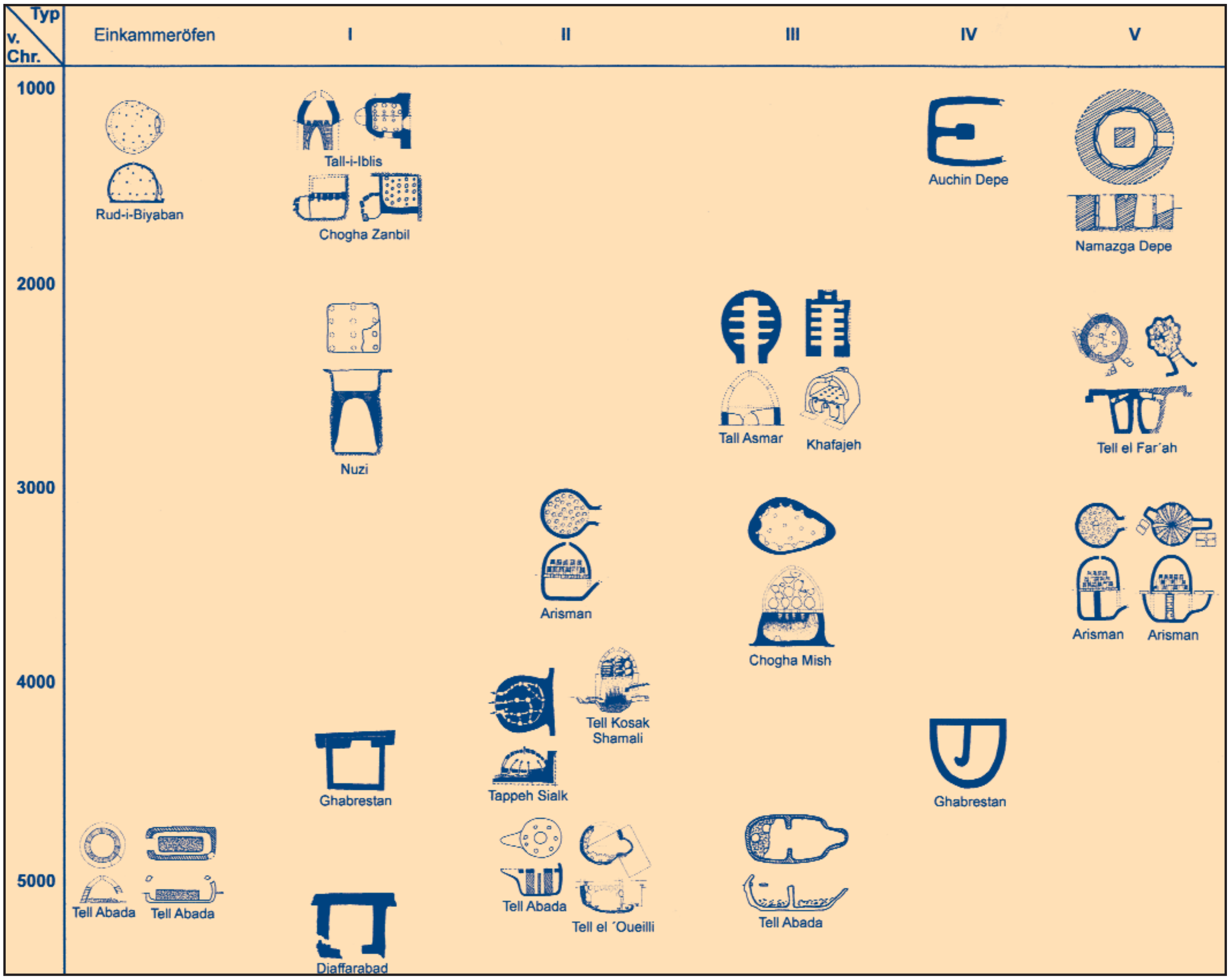


Fig. 1: Development of pottery kilns in the Middle East (see references).

Fig. 2: Arisman, Iran. Features of a kiln of development-line II. The grate can be recognised easily.

Fig. 3: Arisman, Iran. Features of a kiln of development-line II. The grate collapsed into the fire chamber, together with the vessels.

had been built (Fig. 6). Constructions with air supply and smoke outlets were also found in level II (5th millennium BC) at Tell Abada (Hansen Streily 2000, 74, fig. 7), though this is a kiln with only one chamber, and a kiln with two chambers in level 6 in sector B (5th/4th millennium BC) at Tell Kosak Shamali (Koizumi & Sudo 2001). In both cases – like at Arisman – the smoke outlet was not aligned with the fuel opening. The construction of the grate with a grill of longish mud-bricks is similar to the later kiln at Tell el Faráh (Delcroix & Huot 1972, 71ff., fig. 7, E.2).

All the fire chambers of the kilns at Arisman dug into the ground. The fact that the fuel openings of all kilns, which have been found so far, were located to the South-East is also conspicuous. If the fire chamber is dug out, an isolating effect is created and loss of energy is reduced. The orientation might be explained by the fact that (today) the wind comes mostly from the North-West. To achieve better control of air supply it was better not to expose the fuel opening to direct wind but to place it in the lee and a bit below ground level.

The relatively close group of kilns in area B at Arisman probably indicates a specialisation of craftsmanship and the oncoming of pottery-quarters. Though the fact that these five kilns were located in a relatively close area within the settlement gives evidence to the existence of specialised potters, there are only very few defective products among the finds. Maybe such waste was dumped far away from the settlement. On the other hand there are mighty deposits of ashes around the kilns, which obviously were not dumped at a greater distance. Most probably the craftsmen were so good at controlling the heat that there were only very few defective products. The complex construction of the kilns themselves also shows advanced technical knowledge.

Fig. 4: Arisman, Iran. Reconstruction of a kiln of development-line II; drawing: R. Boroffka.

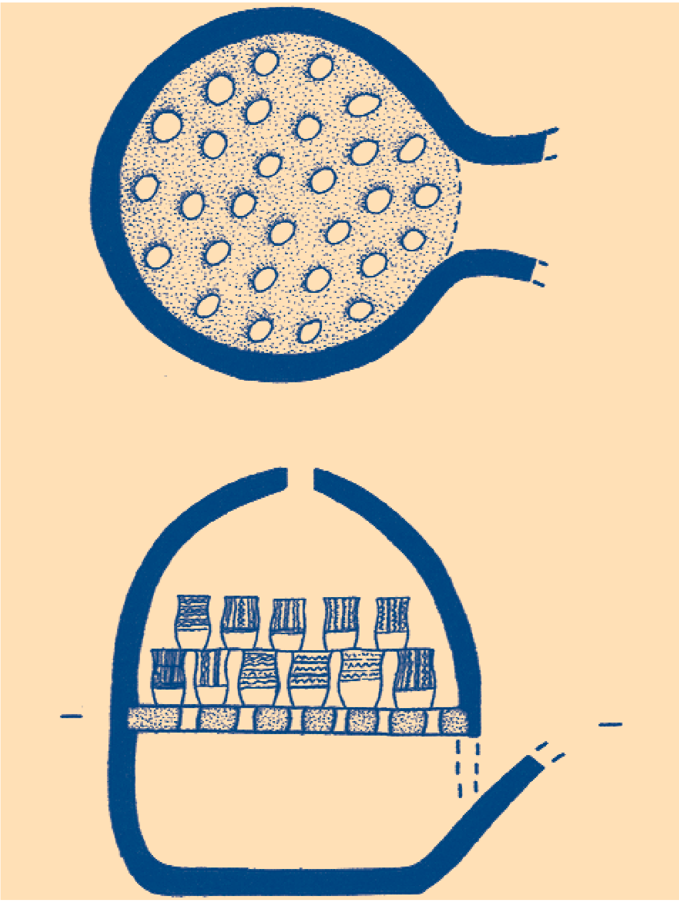


Fig. 5: Arisman, Iran. Reconstruction of a kiln of development-line V without smoke outlet at the side.

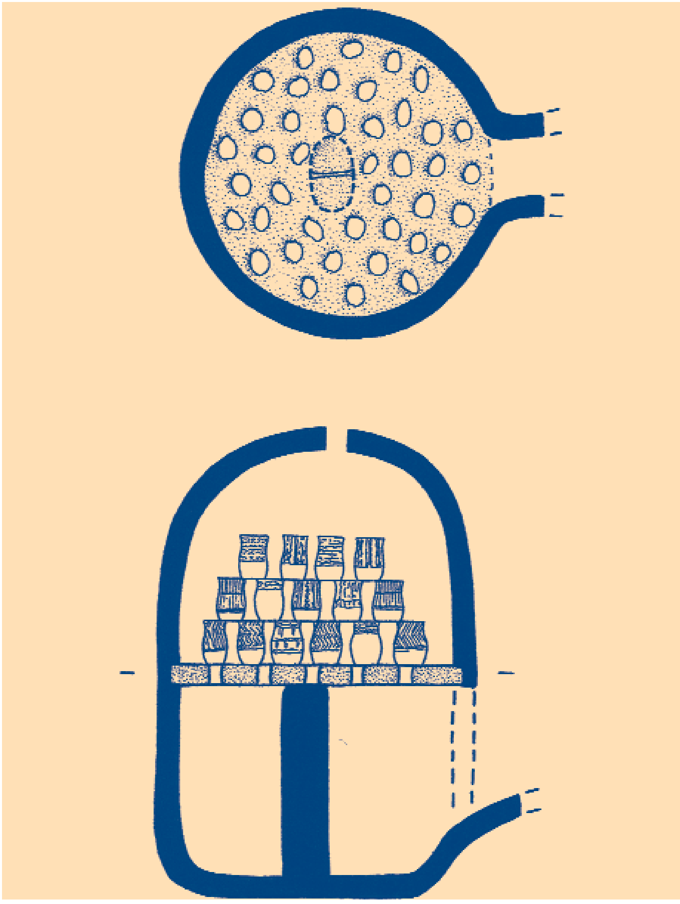
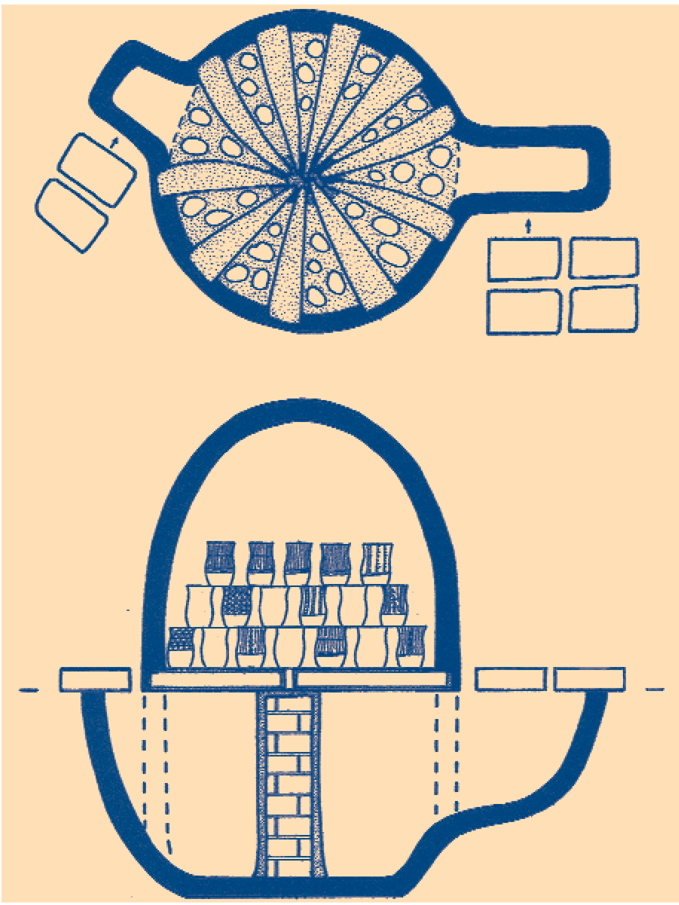


Fig. 6: Arisman, Iran. Features of a kiln of development-line V with fuel opening and smoke outlet.

Fig. 7: Arisman, Iran. Reconstruction of a kiln of development-line V with smoke outlet at the side; drawing: R. Boroffka.



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Tappeh Hesār: A Major Manufacturing Centre at the Central Plateau

Kourosh Roustaei

Introduction

During the fourth and third millennia BC a number of sites began to develop into regional centres and small towns (Fig. 1). This development had inherent consequences which characterised this period as the most dynamic period in cultural history of human societies. Formation of state institutions, residential segregation and functionally different quarters, well-established far-distance trade, and highly developed metalworking are some of the manifestations of this new era, which we archaeologically call "Bronze Age".

As its name implies, introduction of specialised metalworking was one of the crucial aspects of the Bronze Age, which presumably had much influence on the interactions of cultural spheres. In this regard it would be worth to keep in mind the technological and economical importance of developed metalworking which could highlight the role of such capable regions in the cultural interaction. Some of the major Bronze Age centres of eastern Iran and Central Asia are Shahr-i Sokhta, Tappeh Yahya, Shahdad, Namazga Tappeh, Altyn Tappeh, Harappa, and Tappeh Hesār. Tappeh Hesār – situated on a well-established important route between east and west, and its supposed central position among the Bronze Age settlements of the region has an effective role for a better understanding of interactions between cultures and civilizations of the Iranian Central Plateau, Central Asia, South-Western Iran and Mesopotamia.

Environmental Considerations

The Iranian Central Plateau lies in the central northern part of Iran. Its exact borders are far to be defined clearly, but from archaeological point of view it can be defined as the region between the southern slopes of the Alborz Mountains in the north, the edge of the vast Dasht-e Kavir Desert in the east, the alluvial highland plains of Isfahan in the south, and the eastern hilly flanks of the Zagros Mountains in the west. As such, the Central Plateau is part of the great interior basins of Iran that is surrounded on three sides by several mountain ranges.

The Central Plateau, as part of the Volcanic Belt of Iran, is rich in metal deposits. In spite of lack of systematic archaeological investigations to locate the possible ancient mines in the Central Plateau, we have some information on some ancient mining districts like Veshnāveh (Holzer & Momenzadeh 1971) and Anarak, and also several "old working" (Bazin & Hübner 1969) (see this volume). The most important archaeometallurgical sites known in Iran lie in the Central Plateau, such as Arisman (Chegini et al. 2000) and Tappeh Hesār (Dyson & Howard 1989), or in southern part of the Volcanic Belt of Iran, such as Shahdad (Hakemi 1992) and Tal-I Iblis (Caldwell 1967; 1968).

As definite northern border of the Central Plateau of Iran, Alborz Mountains is one of the most obvious geomorphologic features of this vast region, which stretches curvy in east-west direction just south of the Caspian Sea. This mountain range is flanked by Koppeh Dagh range to the east and the Talesh range to the west. In this way these mountain ranges are a natural barrier which separates the Iranian Plateau from the northern lands. With numerous peaks above 4000 m, the highest point of Alborz Mountains is Mount Damavand with an elevation of 5670 m. Due to its high elevation, Alborz Mountains enjoys high precipitations which feed several streams and rivers flowing both northward to the Caspian Sea and southward to the northern part of the Central Plateau.

The modern climate of the Central Plateau is, in general, arid to semi-arid; nevertheless, there are several different climatic niches, too. The existence of several mountains and highlands in northern, western, and southern parts causes immediate areas in favour of more moderate climatic conditions than in the inner parts of the Central Plateau. These areas usually are extending in stripes along

Fig. 1: Major Bronze Age sites of the Iranian Plateau and nearby regions.

the mountain ranges. In addition to milder climate, these areas enjoy favourable conditions due to neighbourhood of the mountains. They also benefit from several streams and small rivers flowed down from the mountains before fading out in further, drier lands. According to current archaeological data the majority of the sites located in or near these favourable zones. One of the best known parts of the Central Plateau are the immediate southern flanks and plains of the Alborz Mountains comprising one of the most favourable and fertile land-stripes of the Central Plateau. Some of the better known and published sites are situated here – from west to east Tappeh Zagheh, Tappeh Ghabristan, Khurvin, Tappeh Ozbaki, Qare Tappeh, Cheshmeh Ali, and Tappeh Hesār.

The Site and its Environment

Tappeh Hesār, about 2 km south of Damghan city, is located in the semi-arid, north-north-eastern part of the Central Plateau of Iran. It lies at the foot of an alluvial fan which pours out of the Alborz Mountains. The main surface water of the Damghan Plain is Damghan River which originats from the Cheshmeh Ali spring, about 35 km north-west of Tappeh Hesār. After entering the Damghan Plain this river branches into several streams, one of them passes near Tappeh Hesār.

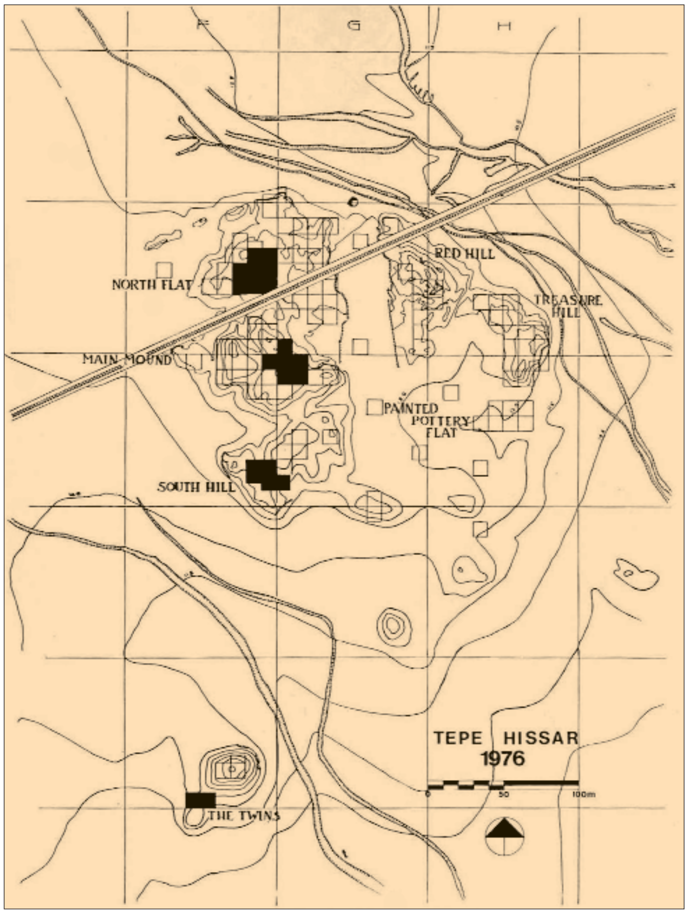

Fig. 2: Topographic map of Tappeh Hesār (Dyson & Howard 1989).

The site of Tappeh Hesār comprises some disconnected hillocks with flat areas among them which totally measured about 12 ha. Original excavators gave different names to different parts of the site according to their topographies: North Flat, Main Mound, Painted Pottery Flat, Red Hill, Treasure Hill, South Hill, The Twins and Sasanian Mound (Fig. 2). Although the present area of the site is about 12 hectares, some geomorphologic observations suggest that some parts of the site have been eroded away by human and natural agents as well (Dyson & Tosi 1989, 5-6).

History of the Researches

Tappeh Hesār was excavated for the first time in 1931 and 1932, for some eleven months during two seasons, by a team from The University Museum of the University of Pennsylvania directed by Erich F. Schmidt (1933; 1937) (Fig. 3). So far, Schmidt's excavation at Hesār is the most extensive one carried out among the sites of the Central Plateau of Iran. During his excavations, Schmidt opened more than 11000 m^2 on all parts of the site. In 1956 a brief examination of the site was carried out by Robert H. Dyson Jr. in search of the plain wares which should have occurred with the painted pottery. The results were unrecorded in the publication (Dyson & Howard 1989). In 1972 Grazia M. Bulgarelli made a limited survey of surface materials (1974). Then, in 1976 a joint team of The University Museum of the University of Pennsylvania, Turin University, and the Iranian Centre for Archaeological Research conducted a multiple fieldwork of re-examination of Schmidt's trenches, limited excavation, surface survey of the site, and a regional survey of the Damghan Plain (Dyson & Howard 1989). During the Restudy Project more than 2000 m^2 on the North Flat, Main Mound, South Hill, and Twins were opened. At any rate, they

Fig. 3: Work in the Hesār I settlements (Schmidt 1937, 21, Abb. 20).

Fig. 4: North Flat of Tappeh Hesār and newly constructed railroad passing through it.

could not reach the earliest deposits of the site. Finally, a rescue excavation (due to Tehran-Mashhad railroad constructions) directed by Esmaiil Yaghmaii of the Iranian Centre for Archaeological Research was made at the site in 1998 (Fig. 4).

Cultural Sequence

For several decades the known cultural sequence of Tappeh Hesār was, and in fact still is, relied on Schmidt's works on the site (Schmidt 1937). His extensive excavations at this site revealed three major strata or periods of I, II, and III, which divided into eight phases from down to top: IA, IB, IC, IIA, IIB, IIIA, IIIB, and IIIC. Schmidt identified two of these phases as transitional: IIA transition between Period I and II, and IIIA transition between Period II and III. The main criterion for this subdivision was a stylistic analysis of grave goods, especially pottery, rather than stratigraphy, whose rules were not yet understood sufficiently. It is interesting to note that much of Schmidt's efforts on excavations at Tappeh Hesār dedicated to dig out more than 780 graves of all periods.

During the Restudy Project directed by Dyson and Tosi in 1976, areas on the Main Mound, North Flat, South Hill, and Twins were examined; a major building with six stages, A to F from the top down, have been identified to clear the Hesār sequence. According to the new phasing the two lowest phases (F and E) belong to Terminal I, which is equivalent with Schmidt's IC/IIA phases. The Hesār II period is defined by phases C-D in the 1976 sequence, which includes buildings 1-3 on the Main Mound assigned by Schmidt as Period III (1937, fig. 86) and graves assigned by Schmidt as Hesār IIB (Dyson & Howard 1989). The Hesār III period (Middle Bronze Age) is defined by phases B-A of 1976. Based on stratigraphy the stage Hesār III can be divided into two phases. Early Hesār III consists of the Burned Building, which is roughly equivalent in time to Schmidt's IIIB graves. Late Hesār III is documented by levels overlying the Burned Building which contain clusters of artefacts, including a large number made of alabaster. This material is augmented by graves and hoards elsewhere in the upper levels of the site assigned by Schmidt to IIIC (Voigt & Dyson 1992, 170-171). As they could not reach to Schmidt's IA/B phases (the deepest layers of Hesār), they adopted Hesār I for Schmidt's Hesār IA/B.

The results of clustered and averaged radiocarbon determinations for Hesār Sequence according to samples collected during Restudy Project, are as follow (Voigt & Dyson 1992, Table 1):

Hesār III	2400-2170 BC (5 samples)
Hesār II	3365-3030 BC (20 samples)
Hesār IC/IIA	3980-3865 BC (6 samples)

As the main body of information about Hesār comes from Schmidt's extensive excavation at this site, in dealing with describing Hesār materials we follow the terminology established by Schmidt for cultural sequence of the site. In the following, the main aspects of three strata or periods of Hesār will be outlined.

Hesār I Period

The earliest deposits of the site (Period I) were reached at 18 plots, i.e. 1800 m2, mainly in the Main Mound and North Flat (Schmidt 1937, 22, Fig. 21). According to ceramic variations, three phases are identified in this period, from down to up A, B, and C. The architecture of Period I consists of unorganised clusters of houses, built of chineh or mud bricks.

Period I is the era of Painted pottery. Pottery of IA phase is handmade. The colour of the ground is reddish-brown with dark grey simple geometric designs. The common form of this ware is that of chalice vessels, in the shape of jars, bowls and goblets. Although the technique, designs, and ground colour of this ware changed during time, hence means for defining the sequence of Period I ceramic phases, the vessel forms, with minor elaborations only, persists as late as phase IIIA.

During phase IB, wheel-made pottery appears for the first time in the Hesār sequence. The ground colour of this ware is buff or light brown. In addition to the increased variety of geometric patterns, the motives of conventionalised birds, human beings, and ibexes appear in this phase. The most common motif of this ware is floral scrolls. The vessel forms of Hesār IB are almost identical to IA ones, which implies the continuation in cultural trend of the site.

The most sophisticated painted pottery of Hesār I appears in period IC. Pottery of this phase has a light greyish brown, often almost greyish white, ground colour with dark paintings. It is interesting to note that the ground colour of painted Hesār ware from phase IA to phase IC became increasingly lighter. The characteristic decorative patterns of this ware are ibexes and feline, while floral scrolls, human "dancers", and "birds' parades" have been disappeared. The forms of the vessels, though fundamentally still Hesār IA shapes, have become more varied and elegant, and geometrical patterns of a type not previously encountered increase the scope of the ornamentations.

Many stone objects and tools are found in the Hesār IC deposits: flakes and cores, flint arrowheads, axes, whetstones, pestles, polishers, weights, and miscellaneous objects. From the Hesār I and II strata only clay figurines found, while in the Hesār III Period figurines of metal, bone, and stone occurred as well. Painted clay figurines restricted only to IC and IIA phases. Simple button seals occurred mainly in Hesār IA, while great numbers of stemmed stamp seals were found in the graves of Hesār IB and particularly IC. Only simple geometric designs were applied on these seals. Cylindrical seals did not occur at Tappeh Hesār prior to Hesār IIIB. A large number of stamp-seal-shaped objects were found in the Hesār I graves, but for their high frequency in the same graves and considering the fact that in several cases seals, particularly spool-shaped button seals, were found graded in size, it seems they were used as ornaments rather than real seals (Schmidt 1937).

In earliest deposits of Hesār IA only simple copper points and some corroded copper lumps were found. But in later phases of

Period I more sophisticated items such as pins (IB), and daggers, knives and axes (IC) occurred. One of the best samples of Hesār I workmanship in copper is an axe (H 4176) found on the floor of a Hesār IC room.

In sum, 209 burials were excavated from the Hesār I deposits. Forty-one of them belong to IA, twelve to IB, and 91 to IC. The dead of all Hesār Periods were buried in the mound area. With few exceptions, the Hesār I dead lay on the right side.

Hesār II Period

Schmidt reached this period in 34 plots, i.e. 3400 m^2. The excavations were mainly focused on the area of Painted Pottery Flat, South Hill, and Red Hill (Schmidt 1937, 103, Fig. 61). The appearance of Grey Ware was the main criterion for defining this period. Period II of Tappeh Hesār divided into two phases from down to up, A and B, again on the basis of stylistic variations of pottery. Deposits of Period II are thinner than the preceding and succeeding periods, hence indicating shorter occupations. In terms of architecture there is no major difference between Period I and II: rows of rectangular rooms with use of mud bricks or chineh constructed in a haphazard manner, although chineh is used much less than Period I.

The predominant pottery of Period II is grey ware. Although the paste and ground colour of this ware differ from painted ware of Period I, some forms such as bowls, jars, and goblets are exactly than before. Forms like neckless jars, tall-stemmed bowls or goblets, and un-stemmed bowls and jars are newly introduced. Painted ware continues to its existence alongside with grey ware during phase IIA. While some motives of this ware are identical with motives of different phases of Period I, some suggest being characteristic of Period II, such as long-necked gazelles. Schmidt classified all the graves with both painted ware and Grey ware to Hesār IIA, and presence or absence of painted ware was the sole criterion for identifying phases IIA and IIB.

In phase IIA, clay human figurines as well as painted animal figurines appeared for the first time. Seals or seal shape ornaments collection of Period II show no major difference with Period I, though the typical seal of this period is made of copper. In Hesār IIB exceptionally large copper seals appear.

Period II shows great advances in both quantity and quality of copper objects. The copper mace heads and ring-shaped ornaments such as bracelets, finger rings, and earrings occur during this time for the first time and pins with elaborate coiled heads are frequent. There are only a few blades of Hesār II in the collection. They closely resemble the blades of Hesār I. The mace heads of Hesār IIB are the most attractive metal objects of their time. In some cases, the remains of wooden handles were still found in those. While in Period I no objects of silver were found, Hesār II produced several items, all ornaments. Silver objects include "double scroll" pendants, earrings, a finger ring, an oblong bead, and a curious ladle-shaped pendant. Most of these items have copper parallels, too. Silver objects of Hesār are among the earliest occurrences of this metal in the Central Plateau of Iran.

Hesār III Period

Deposits of Hesār III period were excavated in 85 plots, i.e. 8500 m^2. It is astonishing that the rather associated humble architecture of this period stands in clear contrast to its rich grave goods. The deposit's thickness of this period is much more than in preceding periods and could be divided into three phases by Schmidt, from down to top A, B, C. The most elaborate and the best preserved building of Period III is the "Burned Building", attributed to Phase B by Schmidt (1937) (Fig. 5). It is a complex measured about 23 x 10 m with a main living room, several storerooms, a kitchen, and several other installations such as staircases, chambers, a fireplace, and a latrine. Skeletal remains of several killed people and many precious artefacts in situ suggest that the building and its residents had been attacked by an enemy. Also, the large dimension of the building, its several spaces with various functions, large number of high value objects found in it, and its unique plan indicate that it should be considered as an unusual building of some particular functions. In apparent absence of religious aspects of the Burned Building, Schmidt inclined to attribute it to the most high-ranked person of the Hesār IIIB society (1937, 164).

While the appearance of plain grey ware, followed by the disappearance of painted pottery (except for sporadic surviving types), marked the arrival of Hesār II, characteristic form changes distinguish Hesār II and III. The stemmed vessel disappears except of braziers, and new shapes define the last ceramic epoch of Tappeh Hesār. Bottle-pitchers, vase-cups, and, toward the end, attractive canteens are the principle forms of Hesār III. In terms of time, Hesār IIIA is the phase of transition from Hesār II to III. In terms of space, it is a layer deposited during that phase and containing material with both Hesār II and III characteristics. The stemmed vessels of Hesār II type were found in the transitional layer of Hesār IIIA.

The characteristic vessel of Hesār IIIB is the "bottle-pitcher". In several instances incised or burnished patterns of parallel cross-hatched lines or herringbone designs ornament parts of the vessel. The surface colour is dark grey or grey, usually with faint grey-brown shades. The paste is grey or grey-brown, and medium to fine, as a rule. The majority of the bowls are conic or roughly hemispherical, resembling the stemmed forms of Hesār II.

The last phase of Hesār III contains some new pot forms in addition to other features, such as alabaster vessels, copper wands, and the like, unknown during the preceding phases. It is a significant fact that in the uppermost burials of the mound, in phase IIIC, a few plain red vessels were found mingled with the prevailing grey ware and the alabaster vessels typical of this period. These red vessels may indicate the beginning of a new era characterised by red ware. The principle guide vessel of Hesār IIIC is the canteen

Fig. 5: Hypothetical reconstruction of the Burned Building (Schmidt 1937, 170, Fig. 94).

with an oval, oblong, or at times almost globular body, and a bottle neck. Two suspension handles with narrow perforations are on opposite sides of the shoulder or upper body. The bodies of some specimens are partly or totally covered with burnished herringbone patterns. The surface of these vessels is grey, usually with brownish tints, and somewhat polished. The paste is grey, medium to fine. Spouted pitchers are frequent in Hesār IIIC. The globular vessel with burnished herringbone pattern and long beak-spout is typical for this phase (H 3511). Bi-conic jars, at times supplied with neck ridges, still occur in Hesār IIIC, though they are more frequent in the preceding phases (Schmidt 1937).

During the second season of excavation at Hesār two assemblages of objects were found in the plots DH 05, CH 95, and DH 07. These assemblages, called Hoards by Schmidt, include several items of various materials: alabaster objects, weapons, tools, and vessels of copper, and ornaments of gold, silver, and other materials (Schmidt 1937, Figs. 96-99) (Fig. 6). These hoards, dated to Phase IIIC, have been deposited in the late Hesār II and early Hesār III layers.

In Hesār III deposits several different types of figurines of various materials were found: human figurines of backed clay, alabaster and bone, animal figurines of backed clay, stone and copper, mouflon heads of gold, animal effigy vessel of pottery, effigy lid of copper, human effigy vessel of pottery and copper wands or symbols. Wands occur during all sub-phases of Hesār III. The more elaborate symbols were found in phase IIIC. The wands are usually found in graves, but several plain specimens occurred in loose refuse.

The characteristic seal of Hesār III is made of copper. Stamp seals occur in phases IIIB and IIIC. Medallion seals were found in the best equipped graves of phase IIIC only. There are, however, stamp seals of lead, alabaster, serpentine and backed clay, and seal impressions in clay.

Metallurgy in Period III far surpasses the preceding eras. There are a large number of various copper objects, and objects of other metals as well, of high craftsmanship in Hesār III deposits which imply the flourish of metallurgy in this period. Of copper objects we could mention daggers, lances, spearheads, knives, mace heads, arrowheads, axes, mattocks, chisels, pins, tacks, needles, points, bracelets, finger rings, earrings, double-scroll pendants, tubes, diadems, mirrors and vessels. In addition to copper objects, several items of lead, silver, and gold were found in the Hesār III deposits. Lead does not occur at Tappeh Hesār prior to period III. All the lead vessels are confined to the last phase of Hesār III. While in period II only a few silver ornaments were found, the series of Hesār III silver objects is large: pendants, tacks, bracelets, buttons, earrings and a diadem. Also silver vessels, such as pitchers and jars, were found in the Hesār III deposits. Gold items found in

Fig. 6: Ornaments from Hoard I on the Treasure Hill (Schmidt 1937, 228).

Hesār III consist of a long plain diadem, beads, ear pendants, a finger ring, and a cup. But the most beautiful objects of gold are five mouflon heads, which occurred in the Hesār IIIC hoard I in the Treasure Hill.

Stone vessels occurred at Tappeh Hesār solely in the uppermost phase (IIIC). They are guide specimens of their time, and some of them belong to the most attractive group of objects obtained at the site. The most striking alabaster vessels are plates with short or tall stems, and the most frequent alabaster and common vessels are cups of various shapes. The usual forms are slightly varied inverted truncated cones and hemispheres.

Variety of form and attractiveness of the raw materials carefully selected for their ornamental effect are distinctive features of the Hesār III beads. Banded chalcedony and amber (only found in Hesār IIIC) are the most important new materials. Ivory and lead were not found in the strata preceding Hesār III.

Tappeh Hesār still stands as the most important excavated site of the Bronze Age in the Central Plateau of Iran. Cultural sequence of the 5th to 2nd millennia BC of the Central Plateau relies heavily on the excavated materials of this site. Ceramic comparisons of Hesār sequence with Sialk, Cheshmeh Ali, and Ghabristan suggest the correlations between Hesār IA phase with Sialk III1-3, Cheshmeh Ali IB, and Ghabristan I. Hesār IB is comparable with Sialk III4-5 and Ghabristan II. The ceramic tradition of Hesār IC/IIA has close affinities with Sialk III6-7b, and to a lesser extent with Ghabristan III and IV. The ceramic of Hesār II and III has been compared with Sialk IV and Sagzabad, respectively (Dyson 1991, Table 34). Nevertheless, there is no single excavated site with comparable phases with Hesār II and III in the Central Plateau, and the reasonable parallels wait to be established in the future.

One of the main aspects of Tappeh Hesār has been clarified due to the results of the Restudy Project to a reasonable extent. It is the role in production of several items found there, most of them yet to be documented on the other sites of the Central Plateau. The 1976 surface survey of Tappeh Hesār showed that industrial activities such as metal working, manufacturing items of lapis lazuli and semiprecious stones, limestone and soapstone bead-making, and pottery making were actively in progress at certain areas of the site at different periods (Tosi 1989) (Fig. 7). Although according to geology of Hesār/Damghan region most of the raw materials for industrial activities mentioned above are accessible locally, we have not yet solid data on the possible types and extent of the available raw materials in the region. Nevertheless, this deficiency can not affect the importance of Tappeh Hesār as the major manufacturing centre of various items in the Central Plateau during Bronze Age. In addition to Hesār's strategic position on a well-known important route between east and west this aspect highlights the role of Tappeh Hesār as a possible major trading centre too. Part of this latter aspect of the site had been suggested previously by Bulgarelli's surface survey on the site: This work succeeded in defining the role of Tappeh Hesār in the ancient lapis lazuli trade from east to west (Bulgarelli 1974).

Although Schmidt published a large number of metal objects of the Tappeh Hesār (1937), the importance of this site to the study of ancient metallurgy remained somewhat obscure until the investigations carried out by the Restudy Project. The importance of the Hesār in the Bronze Age archaeometallurgical technology in the Central Plateau is greatly enhanced by the fact that excavations in 1931-1932, and especially those in the 1976, have revealed a small but important collection of artifacts directly associated with metal smelting and casting. The Hesar metal finds comprise in one of the largest collections of artefacts from an excavated context on the Central Plateau of Iran (Pigott 1989; 1999). The discovery of pieces of mould (Fig. 8) and furnaces, and also large extent of scattered slag on this site which cover more than 9% or 11,000 m^2 of the preserved site, indicate the intensity of archaeometallurgical activities in the antiquity at Hesār. The slag analyses suggest the smelting of arsenical ores of copper as well as perhaps lead-silver ores (Pigott 1999). One of the astonishing aspects of the Hesār metallurgy is the remarkable technological conservatism in using arsenical ores of copper during the entire existence of the site from later fifth to early second millennium BC, which may typify the character of copper production on the Central Plateau of Iran before the Iron Age. The discovery of certain quantity of litharge and

Fig. 7: Pearl necklet of lazurite, chalcedony und carneol, early 3rd. Mill. BC.; Photo: DBM, M. Schicht.

other by-products of lead-silver ore smelting at South Hill and the Twins, highlight the role of Hesār in manufacturing such items. So far, remains of litharge have been found on Sialk (Roustaei 2002, 121, Pl. 3:7; Nokandeh & Nezafati 2003, Pl. 1), and Arisman (Stöllner, pers. comm.). $ Abb. 8

Our current knowledge on the possible ore resources used by Hesā r metalworkers is limited. This is caused to a large extent in a lack of systematic survey aimed to find the ancient mining sites in North-Eastern Iran. Nevertheless, according to a number of geological surveys, two sites of Taknar, about 22 km north-west of Bardeskan, and Gooshe, in Torood district about 100 km south of Shahrood, show evidence of ancient mining, which are among the nearest copper deposits to the Tappeh Hesār (Bazin & Hübner 1969). In this regard we may mention two further far distance mining districts of Veshnāveh, in southern mountains of Qom, and Anarak, about 320 km south of Hesār, on the southern edge of Dasht-e Kavir Desert.

Fig. 8: Fragments of a mould from Tappeh Hes_r, South Hill, DF 88 (2) 5/1, late 4th. – 3rd. Mill. BC.; Photo: DBM, M. Schicht.

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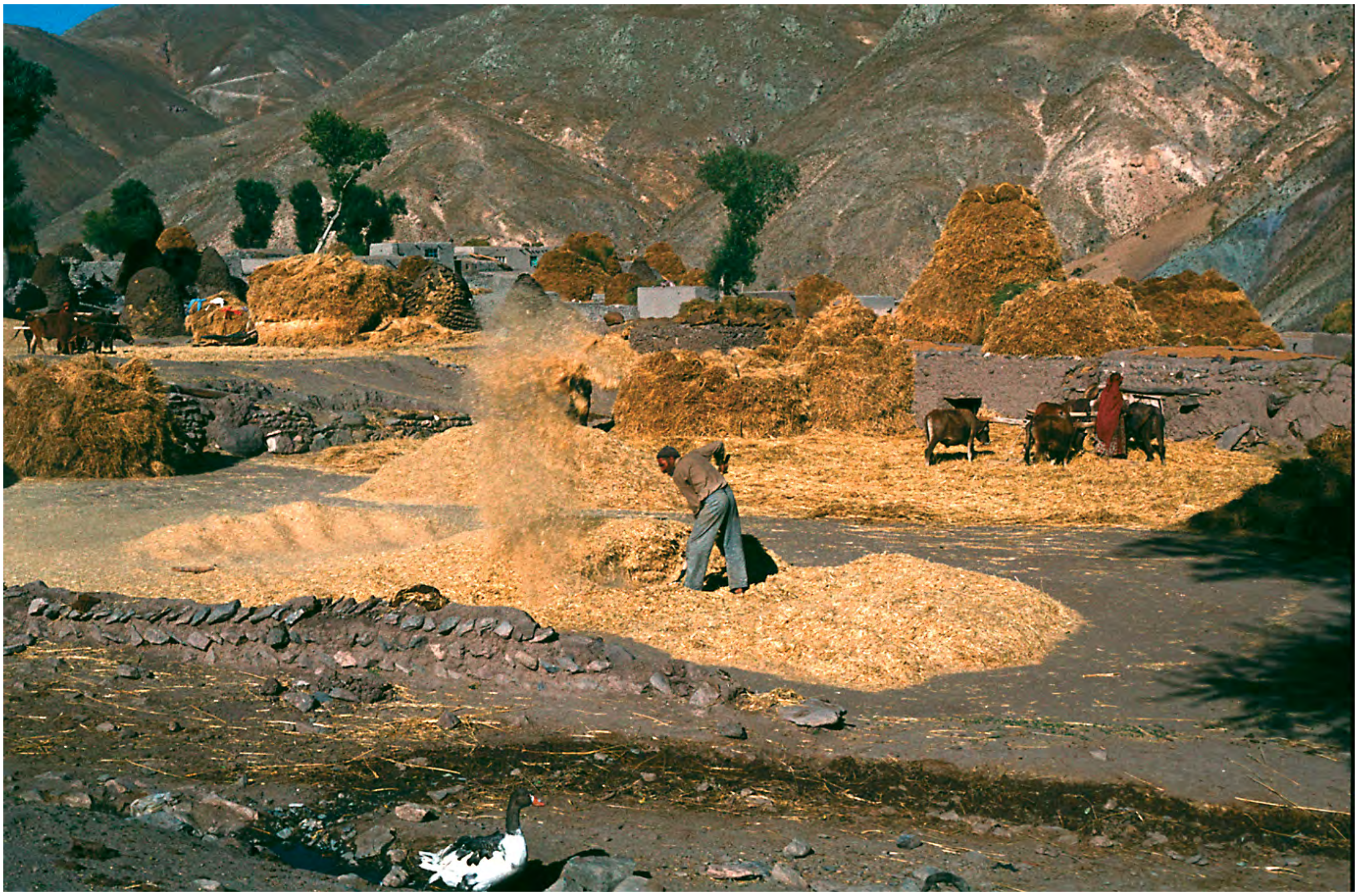

Threshing-area in a village in Northwestern Iran; Photo: G. Weisgerber 1978.

Copper and Silver in Arisman and Tappeh Sialk and the Early Metallurgy in Iran

Ernst Pernicka

Introduction

Copper is the first metal that was used by man. According to present evidence this began in the late ninth millennium BC with the most abundant finds at Çayönü and Aşıklı Höyük in Anatolia, but Iran was most likely part of this early development, as copper finds from Ali Kosh, Tappeh Zaqeh, and Chogha Sefid dating from the mid-eighth to the mid-sixth millennia BC seem to suggest (for a more complete listing of early metal finds see Pernicka 1990). Analyses of several of these metal objects have revealed that all were made of native copper albeit with the application of fire for annealing the metal between various deformation steps in order to avoid cracking (Yalçın & Pernicka 1999).

The reason for the beginning of the use of metals is unclear but its roots may be sought in a change of preference for colours. In the Palaeolithic all shades of yellow to brown colours were used including white and black pigments as demonstrated in many cave paintings. Red as the colour of blood and thus of life seems to have been especially appreciated as indicated by hematite finds (Schmandt-Besserat 1980) and even an underground mine for hematite on the Greek island of Thasos (Koukouli-Chrysanthaki & Weisgerber 1999). Green and blue pigments never appear in palaeolithic cave paintings nor do any green or blue materials in palaeolithic contexts. This situation changes in the early Neolithic. An early forerunner may be the pendant from Zawi Chemi in the Zagros Mountains in northwest Iraq that was initially was interpreted as corroded metal. Muhly (1989), however, pointed out that it would be exceedingly difficult to drill a hole into copper metal with some sort of a bow drill. Since the pendant originally had two holes, it is now generally accepted that it must have been a mineral from the beginning. Nevertheless, it is a green mineral (malachite) that was used as an ornament and thus marks the beginning of a significant change that becomes widespread throughout the early Neolithic, namely the use of green stones, not only malachite, for ornamental purposes. This has even been designated as hallmark of the early, pre-pottery Neolithic in the Near East.

Once green materials were sought, it is easy to imagine that at some stages native copper metal was also found and collected, because on corrosion it also turns green and thus malachite and native copper certainly occur together. People who collect stones for various purposes are bound to test their usefulness and so the special properties of metal, especially its ductility, would soon be discovered. It would also have been discovered that the metal would crack, if it was too heavily deformed by hammering. One further test that can be envisaged is the behaviour of stones on heating in fire so that it may not be surprising that the earliest metal finds often show cracking from excessive cold-working but also show evidence of annealing. The use of heat may well have arisen from previous experience with the heat treatment of flint and other materials to improve flaking.

Another property of malachite must have been observed on heating (partially) corroded native copper: The colour changes from green to black in fire and may sometimes result in a red material (cuprous oxide, Cu_2O). This would certainly have aroused the curiosity and interest of the early craftsman and may eventually have led to the intentional transformation of copper ores to copper metal by the use of fire, i.e. smelting. However, at present the details of this step remain obscure due to the lack of relevant finds. It is not even known, if smelting or melting of copper came as the next stage. However, since the discovery that the mace-head of Çan Hasan of the early sixth millennium BC, that was long thought to represent the earliest cast metal, was really made of native copper by hammering and annealing (Yalçın 1998), it seems more likely that smelting preceded melting and casting. The clearest indication of smelting is the occurrence of copper slag and it may be no coincidence that the earliest appearances of such slags so far were reported only from Iran, namely from Tal-i Iblis, Tappeh Sialk, Tappeh Ghabristan and Tappeh Zaqeh, all dated to the late fifth millennium

Fig. 1: Map of Iran with the most important places mentioned in the text.

BC. These sites show that smelting of copper ores seems to have been practised regularly suggesting that the first steps must have been even earlier. The technology seems to have spread quickly, because in the fourth millennium copper slags are found in a large area ranging from the Aegean to the Middle East. Isolated finds have also been reported from Spain and south-eastern Europe but their contexts have yet to be confirmed.

It has already been mentioned that the first metal objects appear in Iran in the southwest, in the Deh Luran plain at the base of the Zagros Mountains which lies on a traditional route between Mesopotamia and the Susiana plain. This region is climatically extreme with extremely hot and dry summers and cold north winds during winter. Rain falls only in the winter months and is highly variable from year to year. It is, however, sufficient to allow dry farming in an average year but the crop is always in danger if the timing of the rains does not accord with the agricultural cycle. Thus the earliest settlements known from the ninth millennium BC are located near the few permanent rivers. They seem to have been semi-permanent, as wild steppe grasses still dominate the food remains although domesticated emmer has been found. It is here that the earliest metal find in Iran, a bead of rolled copper sheet, was found at Ali Kosh. It dates roughly to the middle of the eighth millennium BC. A few more finds from this period were recovered in the so-called Early Village period which is contemporary with the late Pre-Pottery Neolithic in Iraq from Chogha Sefid and Tappeh Sabz.

The latter find already marks the beginning of a development that is characterised by a significant increase of copper usage indicated by the rise of the number of metal finds. In the sixth millennium BC copper objects were found at Tappeh Giyan in northeast Luristan, Tappeh Sialk near Kāshān, Tappeh Yahya in the south as well as Tal-i Iblis in the Kerman province, and at Tappeh Zaqeh in the Qazvin plain west of Teheran.

Fig. 2a: Present view of part of the Meskani mine which is out of operation.

Fig. 2b: Meskani mine; remains of an older gallery that was blast open. This is one of the few indications of an earlier mining period than the present one.

Most of these early objects, as far as they have been analysed, consist of native copper. The repertoire of shapes is limited to beads and awls. It is during the Chalcolithic, mainly in the fifth millennium BC that the use of copper expanded significantly. Copper frequently contains arsenic in varying concentrations and it has been suggested that this represented deliberate alloying or, at least, selection of certain ores in order to obtain a harder metal. Thus needles, pins, tanged dagger blades, chisels, as well as shaft-hole and flat axes were made which clearly served utilitarian purposes in contrast to the predominantly ornamental usage in the preceding period. Towards the end of the Chalcolithic daggers with midrib, shaft-hole maceheads, bracelets, ear rings and finger rings round up the repertoire.

Despite these promising findings, the investigation of the early metallurgy of Iran is still far from satisfactory. Contrary to other regions of the Old World, e.g. Anatolia, where most ore deposits were archaeometallurgically investigated in the field and in the laboratory for their chemical compositions and lead isotope ratios, few ore deposits in Iran have been thoroughly investigated up to date. There is little known about the composition of the chalcolithic and Bronze Age metal finds and almost nothing about Bronze Age mining. The only site in Iran where ancient mining was attested and investigated is Veshnāveh 60 km from Qom and 45 km from Tappeh Sialk (Holzer & Momenzadeh 1971; Chegini *et al.* 2000; see also the contribution by Th. Stöllner in this volume).

Since Veshnāveh is comparatively close to Tappeh Sialk it has been considered as a possible ore source for the copper metallurgy at that site. However, the ores from Veshnāveh are low in arsenic while most analysed chalcolithic copper objects from the Iranian plateau including Tappeh Sialk contain arsenic in variable but higher concentrations. Therefore, another region was usually thought to have supplied most of the early copper on the Iranian Plateau, namely the ore deposits of Anarak, in particular the copper deposits of Meskani (Fig. 2a & 2b) and Talmessi (Fig. 3). The richness of both deposits was described in an early report (Maczek *et al.* 1952) and it was emphasised that they produced mainly native copper with significant quantities of natural copper-arsenic minerals. This led other researchers to the conclusion that this copper also reached Tappeh Sialk in prehistoric periods (Smith 1968), although no traces of ancient mining or the presence of ancient mining tools such as grooved stone hammer were ever reported. Berthoud (1979) even suggested that this region was the major supplier of copper for Mesopotamia in the fourth millennium BC.

Both deposits are located in geologically young volcanic rocks. The mineralization occurs in small veins (up to 0.5 m thick at Talmessi), veinlets, nest-like and irregularly shaped bodies of massive ore as well as impregnations. On the whole, over fifty ore minerals have been detected in the deposit. Among the secondary minerals Cu sulfides (especially chalcocite at Meskani) and Cu, Ni, Co arsenides prevail, native metals, pitchblende, galena, etc. were also noted. Typical is the absence of Ni and Co sulfides. Sulfarsenides are rare. The native copper usually contains several percents of arsenic (up to 20%) and nickel (up to 10%). The ore is also relatively rich in uranium which results in highly radiogenic lead isotope ratios (see below) which distinguish these deposits from the

Fig. 3: Present view of part of the Talmessi mine.

ones in the Karkas Mountains and Veshnāveh. So far such lead isotope ratios have not been observed in chalcolithic metal artefacts from central Iran. It seems that the importance of Meskani and Talmessi for the early metallurgy of central Iran may have been grossly overestimated in the past. It is even possible that both deposits were originally not exposed at the surface and therefore not even known to prehistoric metallurgists.

It is still unclear, if both deposits were already mined in ancient times. Pottery sherds are rare and do not indicate any prehistoric activities, although some diggings with rounded surfaces which are suspicious for early mining are present. In the 1960s the exploitation of the deposit ceased; it was resumed for a short period in the 1970s and then both mines were finally abandoned.

More promising in this respect seems to be the Baqoroq copper mine, which is located 4 km northwest of Nakhlak and forms an island of hills surrounded by the sand dunes of the Dasht-e Kavir desert; presently it is slowly being covered by those. The mineralization consists of impregnations, masses and sinters of malachite, azurite, chrysocolla, cuprite, and locally chalcocite in Upper Cretaceous limestone. The mine was active from 1935 to the Second World War, but several old pits and one adit are visible. In the largest pit some diggings which are suspected to be old workings are present. Near the mine are remains of buildings and of a copper smelter including roasting furnaces and slag sites. No traces of ancient smelting activities were found in the area. The oldest pottery sherds, which are rare, date to the Safavid period (1501-1736).

In this context the discovery of a chalcolithic settlement with extensive metallurgical remains at Arisman, some 60 km southeast of Kāshān is of special interest (Chegini *et al.* 2000) (Fig. 4). The site is rather large but flat with no settlement mound. It extends over several hectares and comprises several slag heaps and scattered pieces of copper slag. After three excavation seasons in an area with slag concentrations designated Arisman I it is clear that extensive copper smelting took place at the site during the Sialk III and IV periods, i.e. from the late fifth to the early third millennium BC.

One slag pile (trench A) was excavated and revealed a smelting furnace with more than thirty layers in the furnace wall (Fig. 5). The

Fig. 4: Overview of the chalcolithic smelting site of Arisman in front of the Karkas Mountains; Photo: DBM.

Fig. 5: *Copper smelting furnace at Arisman with interior of the furnace wall that is built up of more than thirty layers of burnt and partly slagged clay. The front of the furnace was probably removed after each smelt and afterwards re-built for the next smelt; Photo: DBM, Th. Stöllner.*

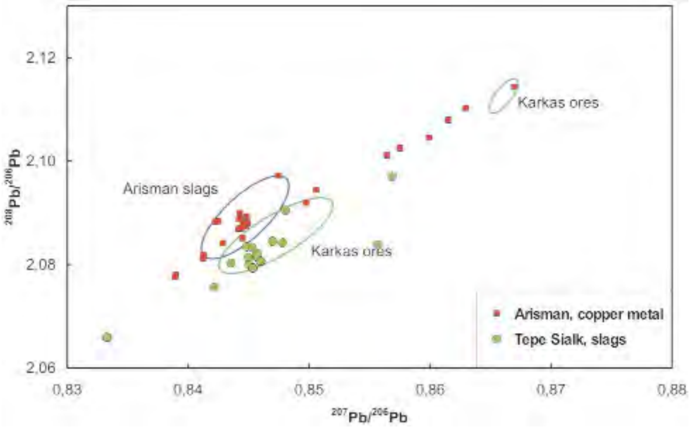

Fig. 6: Lead isotope ratios in slags and copper metal from Arisman and in copper slags from Tappeh Sialk as well as in ore samples from the Karkas Mountains near Arisman, including the prehistoric mining region of Veshn_veh. The variation of lead isotope ratios in copper metal from Arisman is larger than in the slags suggesting that not all the metal found at Arisman was produced there. In addition, it is unlikely that the ore derived from the Karkas mountains, while the majority (but not all) of the copper slags from Tappeh Sialk would fit the regional ores isotopically. The data for the slags from Tappeh Sialk were taken from Schreiner et al. (2003).

smelting process has yet to be fully reconstructed but it seems to resemble the one with similar furnace constructions found at Fenan in the Wadi Arabah, Jordan (Hauptmann 2000). The furnace was built on and into a platform of mudbricks. It is a round structure with an outer diameter of about 70 cm and the opening facing northeast. In the lower part the furnace formed a hemispherical bottom with about 30 cm inner diameter. Only the upper part of the furnace walls were slagged. It seems that what can be seen now is the reaction vessel for the charge and the charcoal and that the smelting product (presumably copper metal and liquid slag) was drained into a crucible below this reaction zone. Fragments of such crucibles were found, partly covered with slag which was mostly inside the crucible but was occasionally running down the outside as well. One complete clay mould for a flat axe and pieces of some others attest not only to smelting but also to melting and casting at the site. Little pottery was found within the slags but all fragments were attributed to the Sialk IV period, so that the furnace installation can be dated roughly to 3000 BC. It is thus later than the bulk of the settlement which is contemporary with Sialk III. Nevertheless, copper slag was also found within settlement layers so that copper must have been produced at Arisman over a period of several centuries.

Since 2001 Tappeh Sialk has been re-investigated by the "Sialk Reconsideration Project" under the direction of Dr. S. Malek Shamirzadeh. On the south mound a metallurgical workshop was discovered that dates to the Sialk III period and is thus contemporary with the earlier phases of Arisman. Close to the workshop area two small lenses of slag accumulation with much charcoal were sampled and subjected to radiocarbon measurements. The results yielded dates around 3700 BC (calibrated). The slag generally resembles in composition the one from Arisman but is less homogenous and contains more copper on average (Schreiner *et al.* 2003).

Considering that Arisman is nowadays located in a region that can be characterised as semi-desert which can only be cultivated by irrigation, the question arises, why so much copper was produced at this particular site. At first one would think that there could have been copper ores in its surrounding. Accordingly, a geological field survey was conducted but the outcome was rather poor. There are several small copper mineralizations in the Karkas Mountains (altogether 46 locations were visited and sampled, Nezafati 2000), but there is no sign of ancient exploitation. Moreover, the lead isotope ratios of those mineralizations do not match the slags of Arisman (Fig. 6).

This is conclusive evidence that these ores were not smelted at Arisman, because the isotope composition of lead is often more or less constant within an ore body and is not changed at all by chemical reactions during smelting or corrosion. The principle of those methods is rather simple: Over geologic time spans the average lead isotope composition of the Earth's crust has continuously changed due to the radioactive decay of uranium and thorium which results in different isotopes of the element lead. The newly formed so-called radiogenic lead mixes with the lead already present. When a lead ore deposit is formed then the U/Pb and Th/Pb ratios are drastically changed so that the influx of radiogenic lead stops within the deposit. One can visualise this situation as a fixation of a certain lead isotope composition due to ore formation. The abundance ratios of the lead isotopes in the ore deposit depend on its geological age and the U/Pb and Th/Pb ratios of the source region from which it formed. Therefore, lead ore deposits can often be differentiated by their lead isotope abundance ratios which can thus be regarded as a geochemical fingerprint like the trace element pattern. In contrast to the trace element concentrations this fingerprint will not be changed on the way from the ore deposit to the finished artefact.

The results of the isotope analyses of lead in various samples of metal, slags and ores show that there is no match in lead isotope ratios between either slags from Arisman and Tappeh Sialk and copper ores from Veshnāveh. Although the Veshnāveh mines are rather close by and the only prehistoric mines known in the region it was already suspected from the beginning that it is unlikely that they supplied the raw material for the smelters of Arisman and Tappeh Sialk since the slags and also copper fragments from both sites contain much arsenic in contrast to the ores from Veshnāveh. But the difference between the two archaeological sites comes as a surprise and suggests that they did not draw on the same ore sources. At least for Arisman the copper deposit of Baqoroq provides arsenic-rich ores that would also fit in their lead isotope ratios. However, only the rejection of an assumed relationship between ore deposit and slag site or metal artefact is conclusive. The argument cannot be reversed, because it is in principle possible that other ore deposits exist with similar lead isotope ratios. Only when a certain region has been more or less exhaustively investigated such a relationship could be postulated in case that only a single deposit with the region yields matching lead isotope ratios.

So far no mention was made of the most important alloy of this period, namely bronze, a mixture of copper and tin. This material appears in quantity in the first half of the third millennium BC in a large area between the Aegean and the Persian Gulf and, last not least, has given the name to a whole period in cultural history, the Bronze Age. It has long been considered to be an enigma that this alloy was first used in a region that is devoid of any geological tin deposit (for details see Muhly 1985; Pernicka 1998). According to present knowledge the most likely sources for tin in the Early Bronze Age of the Near East are to be sought in central Asia. However, the two earliest known tin mines in Uzbekistan and Tadjikistan cannot be securely dated before 2000 BC (Alimov *et al.* 1998; Parzinger & Boroffka 2003; Weisgerber & Cierny 2002). In any case, tin is geologically well attested from Afghanistan to Kazakhstan and Mongolia and could conceivably have come from there. This assumption is corroborated by the contemporaneous appearance of gold and lapislazuli in Near Eastern contexts of the late fourth millennium BC. It is generally held that the latter, a semi-precious blue stone derives from Afghanistan where there is one of the very few occurrences of this mineral. However, the only site whose metal inventory was well studied from the archaeometallurgical point of view (about 20% of the total metal inventory) is Tappeh Hesār in the north of Iran. No tin bronze was used there in the whole cultural sequence from the Chalcolithic to the Bronze Age. Instead, arsenical copper prevails. However, at Tappeh Sialk a dagger was recently excavated from Sialk III strata, i.e. dating to the fourth millennium BC, which on inspection could consist of tin bronze. It seems that we need a much broader analytical investigation of the prehistoric metal finds in Iran. At present the evidence is too scanty to draw a consistent picture from the available evidence.

Finally, a particularly interesting aspect of the early metallurgy in Iran needs to be mentioned. Chronologically the second metal to be used and produced by man is lead. This has been found in Pre-Pottery Neolithic context at Yarim Tappeh in northern Iraq but as yet not in Iran. However, this may only represent the present state of knowledge and future research may well turn up Neolithic lead objects in Iran also. The reason for this assumption is that at Arisman and also at Tappeh Sialk large pieces of litharge cakes were found dating to the fourth millennium BC (Fig. 7). Litharge (chemically lead oxide, PbO) is not found in nature but is produced from argentiferous lead metal on oxidation. This process is called cupellation and is the dominant process for the production of silver in the Old World. The individual size and the number of litharge finds at Arisman and Tappeh Sialk is so large that lead mining for silver production must have had a long tradition already in the fourth millennium BC on the Iranian plateau.

It is certainly no coincidence that the earliest silver object presently known was found at Tappeh Sialk (Ghirshman 1939) in Sialk III contexts. In the fourth millennium silver becomes widespread within a relatively short period which suggests a rapid diffusion of a very special technology (Kohlmeyer 1994). Since no lead slags were found either at Arisman or at Tappeh Sialk the argentiferous lead must have been smelted somewhere else. It has always been assumed that the most likely source for this is the large lead mine of Nakhlak, also in the Anarak area. This can now be confirmed by the determination of lead isotope ratios (see below). At Nakhlak lead mineralization is observed over an area of about four km2. The ore bodies occur as steeply dipping quartz-calcite-barite veins with galena, or clusters of such veins, occasionally with zones of veinlet-impregnated ores accompanying them. The thickness of the

***Fig. 7:** Litharge cakes from Arisman; Photo: DBM, M. Schicht.*

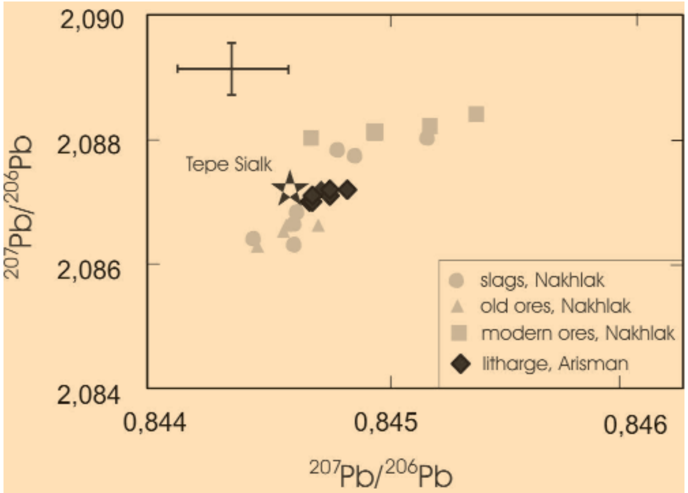

Fig. 8: Lead isotope ratios in lead slags and lead-silver ores from Nakhlak and in litharge samples from Arisman and Tappeh Sialk, the latter indicated by a star. The "modern ores" derive from modern deep mining at Nakhlak at a depth of 50 to 200 m. The "old ores" are scattered pieces of ore from the surface in the vicinity of old structures and from the ancient mines near the surface. The cross indicates the standard error of a single measurement (two sigma) in the Freiberg laboratory. Note that the total variation of the data is only about 0.1% in this plot.

ore bodies varies from 0.25 to 25 m (on average 2.8 m), the extension reaches 500 m; they are traceable along the dip for up to 400 m. Ores are practically monomineralic consisting only of galena. Cerussite which forms veinlets, nests, impregnation, sinters and crusts is widespread in the oxidised ores. Today the silver content is not very high, namely 35-247 g/t Ag, but it is likely that it was much higher in the oxidised zones of the ore body.

It has long been known that the Nakhlak mine was exploited since ancient times. According to archaeological investigations, the oldest recognisable mining activities date back at least to the Sassanid period (224-642 CE). The ancient diggings reach up to a depth of about 80 m. Mining tools, including picks, hammers, wooden shoes, lamps, etc. were recovered in the diggings. In spite of intensive modern mining the ancient galleries are still visible at some localities, especially at Gombadeh as well as in shaft no.1. In addition to direct ancient mining traces of some living and settlement relics related to ancient mining are still present in the area including ruins of two fire temples, a fortification (Qaleh Bozorg) and a small water dam (Stöllner *et al.* 2004).

Indirect but strong evidence for chalcolithic mining at Nakhlak is provided by lead isotope ratios. All litharge samples analysed so far from Arisman and one litharge sample from Tappeh Sialk show an exceedingly small spread of lead isotope ratios that overlaps perfectly with a similar small spread in lead ores from Nakhlak (Fig. 8). Although this is not conclusive evidence, it is nevertheless a strong hint that Nakhlak may have provided the raw material for the silver production at Arisman and Tappeh Sialk. It is conceivable that the lead was brought there, because Nakhlak is located much closer to the interior of the Dasht-e Kavir desert. It would certainly have been difficult to provide the fuel needed for the sumptuous cupellation of the lead for the production of silver.

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Bronze Age Copper Mining at Veshnāveh

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The excavations done by R Girshman at Tappeh Sialk during the 1930s were the first to draw the attention of archaeology to the area along the Dasht-e Kavir desert, stretching from the holy city of Qom in the Northwest to Kāshān, Natanz, and Naïn and finally to Yazd in the Southeast. Also Ghirshman´s excavation showed an early use of copper (Ghirshman 1938; 1939): In the northern hill copper devices were found in layers which today we know to be from the 6th and the 5th millennium (Sialk, Period I/II: Ghirshman 1938, 16, 30). Out of a sudden the significance of the Central Plateau as a distributor of metal raw materials came into the view of archaeology, even more as the evidences from Tappeh Sialk showed an extremely close relationship to Mesopotamia since the 4th millennium (Ghirshman 1938/39; Lamberg-Karlovsky 1978). Later the copper from this region was thought to have played a decisive role as a part of the economic background of these early contacts. Thus trading raw materials seemed to have been a driving force of the numerous cultural relations which lead on the plateau to the complex forms of settlement and society, similar to those in the lowlands. The slogan "Uruk expansion" meant the expansion of trading posts focused on raw materials which led to the periphery of Mesopotamia. These occurrences were understood to be a major reason for this social and economic change[1]. Today the view is quite different and the contacts of the plateau and Mesopotamia are seen more discriminately; obviously nomadic ways of life and forms of economy play a major communicating role (*e.g.* Alizadeh 1998; also see Alizadeh and Helwing in this volume). But still the question of where those metal raw materials came from stays unanswered.

As early as 1894/95 Finnish explorer A. F. v. Stahl described the "Weshnave" copper seam. At this time v. Stahl was president of the Persian post: "About three kilometres north of Weshnave, between Kum and Kashan, out of dark brown volcanic rock of aphanitic structure there comes up a vein of calcite, dipping vertically and copper pyrite and black copper ore mingled within" (von Stahl, 1894, 3f.) (Fig. 1). Von Stahl described the copper mines of those days as being very small and so we may be allowed to think that the Veshnāveh copper deposit was only used by locals. Some slag that was found as early as 1978, looking rather ancient, confirms the imagination of an uncontrolled smelting process going along with rather sporadic exploit: charcoal from the place could be dated to come from some time between 1811 and 1927 by help of radiocarbon dating[2]. It is only due to a UN supported survey of the Iranian copper deposits that the Veshnāveh seam has found attention again. In 1969 the geologists Herwig Holzer and Morteza Momenzadeh again travelled the area and for the first time described the ancient mining, dating it to be prehistoric due to their findings of pottery and of a bigger number of grooved hammers (Holzer & Momenzadeh 1971; Holzer 1974). This marked the beginning of a series of further investigations which from then on again and again brought researchers to this copper field. E.g. as early as 1975 a French group featuring Thierry Berthoud (Berthoud et al. 1976; 1982), then in 1976 and 1978 the Deutsches Bergbau-Museum featuring Gerd Weisgerber also came. Weisgerber for the first time described the mines explicitly and prepared a further script on the matter (Weisgerber, pers. comm., as yet unpublished). But these hopeful beginnings were interrupted by the outbreak of Islamic Revolution and then by the war between Iran and Iraq. Only due to preparing the "Ancient Mining and Metallurgy in West Central Iran"-project (since 2000) the Veshnāveh field was again taken into the account (Chegini et al. 2000). Similar to older ideas, the major question was if and in what way Veshnāveh had to be dealt with as having been part of that regional "copper trust" of the Sialk III/IV-levels. Especially the dumps of slag from the 3rd millennium, which had been discovered in the Arisman settlement, again lead to the question where the copper ore had come from, as the Arisman slag dumps suggest a considerable capacity of this early smelting activities. But before dealing more closely with this question, it is back to the Veshnāveh investigations: By the year 2000 it was possible for the first time to start systematic work in this area and the researchers succeeded with going on continuously until 2002. The question of how the Sialk and Arisman settlements had been supplied with copper was not of major interest with this research on the archaeology of mining. The idea was rather to study systematically and completely a Bronze Age mining-field, whose state of preservation was unique, and to find answers to the

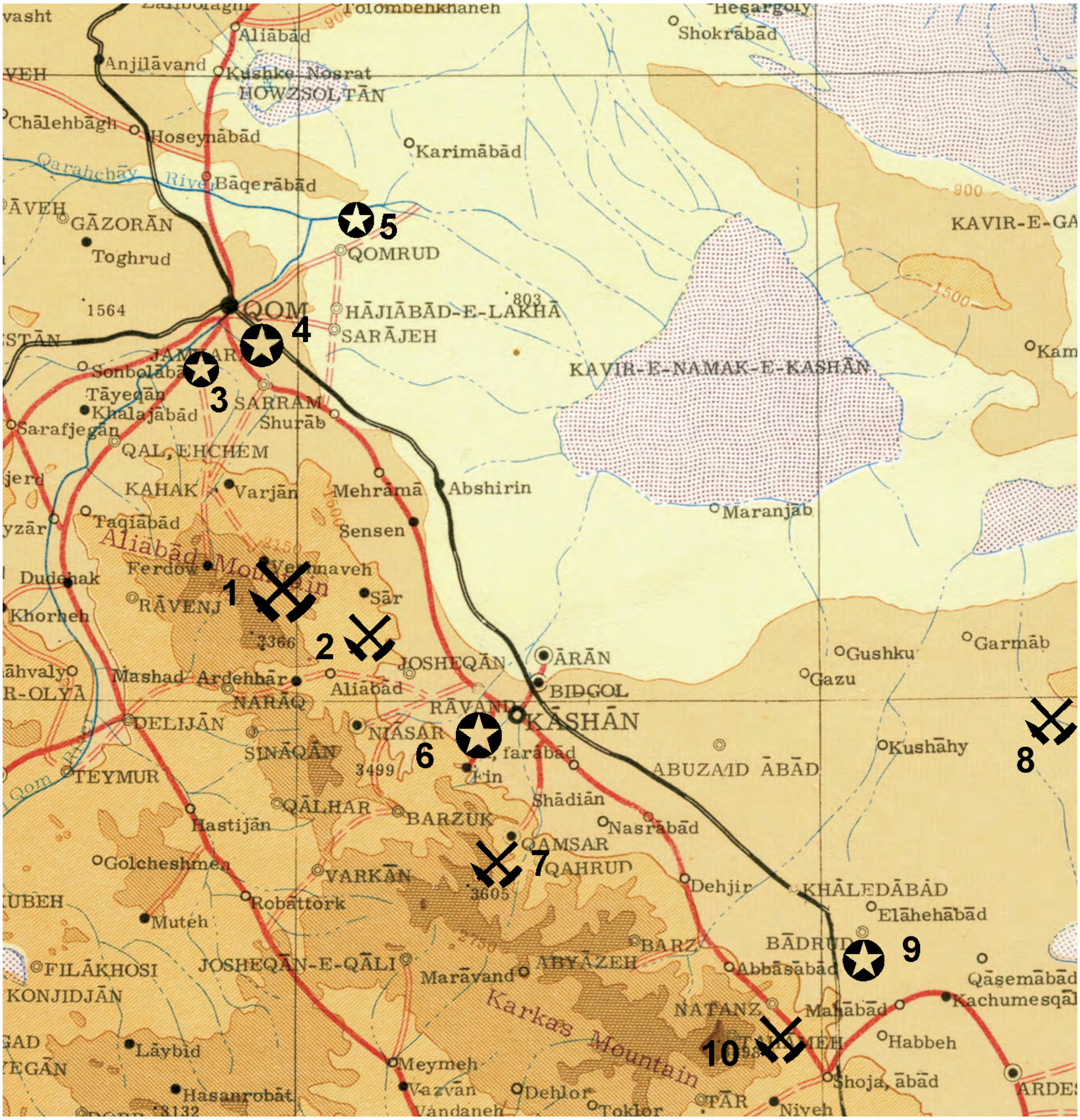


Fig. 1 Regional map with most important archaeological sites and copper mines from Chalcolithic period to early Iron Age. 1 Veshnāveh (3rd to 2nd mill.), 2 Nigh bei Mashkan (prehistoric), 3 Sarm, graveyard (Iron II-III), 4 Jamkaran, settlement (Iron II-III); 5 Qomrud, Tell and area of settlement (5th to 3rd mill.), 6 Tappeh Sialk, settlement and graveyard (5th to 1st mill.), 7 Kohrud-Qāmsar, prehistoric copper mining (?); 8. Gorgāb (prehistoric ore mining), 9. Arisman (4th to 3rd mill.), 10. Milajerd (2nd to 1st mill.; smelting, ore-exploitation).

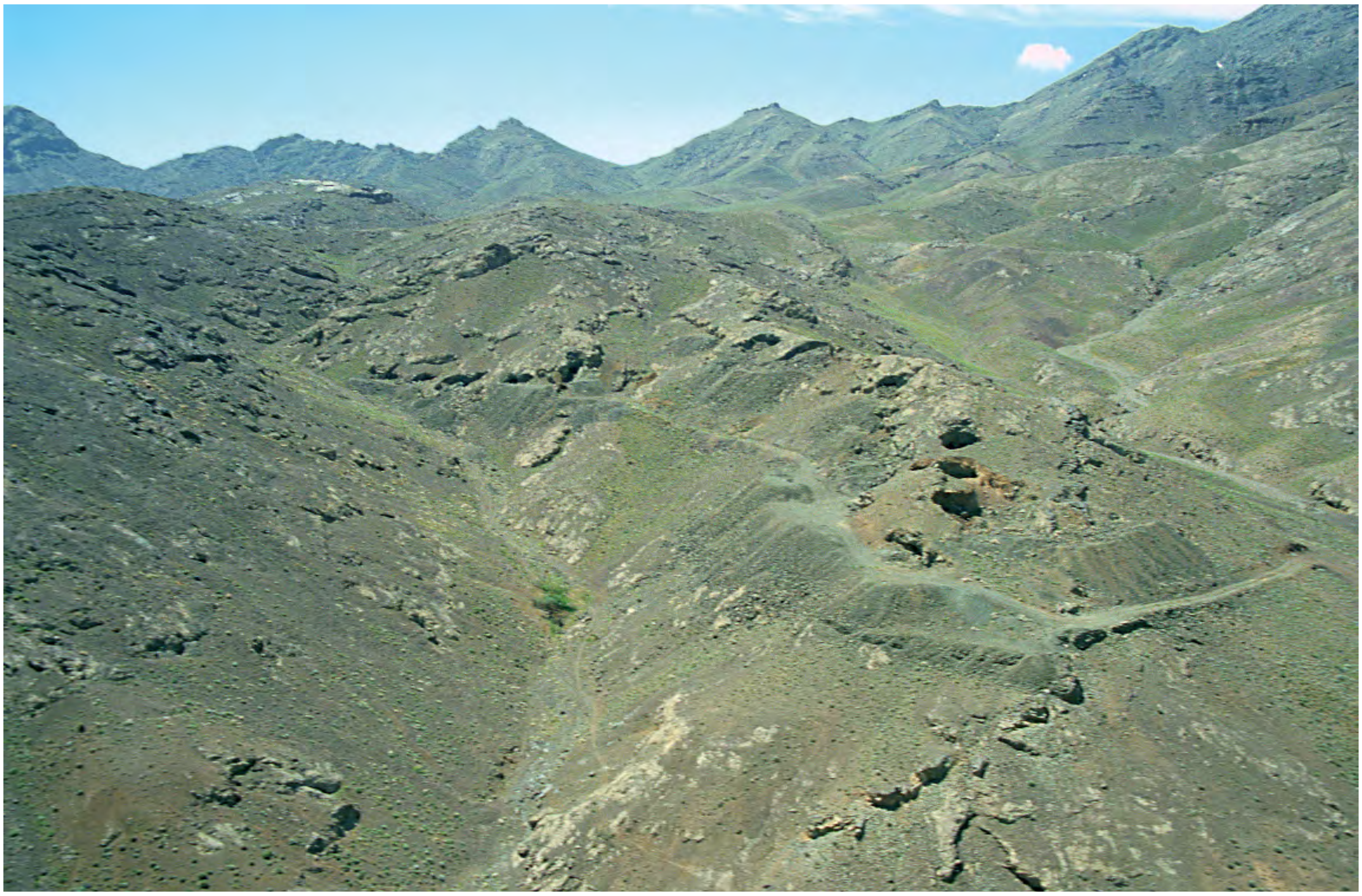
question of the technical and logistic process of early copper exploit: In what way were the single steps of work co-ordinated, where did the raw material come from for the stone hammers in use, what supplies had to be organised from the outside, and much more. But most of all: who were these early miners and where did they come from? Beyond this the outstanding state of preservation of the mines allowed to expect detailed insights concerning the progress of extraction and output. These are questions which today can be answered only partly. While at the beginning the question of size and extend of the mines played a major role, from 2002 on it was possible to pursue more complex goals, like researching subsistency and vegetation around the mining areas in question. To finally achieve a research of work-techniques providing sufficient results a detailed analysis of deposit structures (hewing waste, fragments of tools aso.) within and around the mines had to be done.

Work at Veshnāveh was often characterised by the hardships of simple life in a mountain-village community and by long and work-intensive days in the camp and the field[3] – quite often several excavation- and survey-teams were working at cross purposes and often enough communication between the sites was difficult as they were several kilometres apart from each other. Usually each excavation took about five to eight weeks[4].

Geology and Deposit

The Kuhestan-e Qom area is a part of the Uroumieh-Dokhtar belt, the so called copper belt of Iran, dating from the upper and lower Eocene, which on the other hand belongs to the genetically strongly connected metallogenic zone between the Alps and the Himalayas. Thus it is not surprising that the middle-Iranian mountains provide Iran's biggest and richest ore fields (copper, gold, lead, zinc). The mountain chains and geologic units around Veshnāveh with Mount Alwand (3000 m) and Kuh-e Qo-Qo to the East all behind them form a line stretching roughly from North-Northwest to South-Southeast and show strong brittle tectonics. The petrographic structure is dominated by volcanic rock and pyroclastic rock (Holzer 1974; Momenzadeh & Haghnazar 2001). The coverings of volcanic rock consist of andesite breccia, basaltic agglomerations, and basaltic and andesite eruptive rock showing dykes. This stratification may be understood to be the result of submarine or surface volcanism. The impregnation-copper-deposit of Veshnāveh itself is embedded in Eocene andesite, submarine basaltic lava (unit "ab" according to Momenzadeh´s & Haghnazar's classification 2001). It consists of just one stratigraphic

Fig. 2 Aerial photography of the mining district Mazrayeh, photo: DBM, Th. Stöllner.



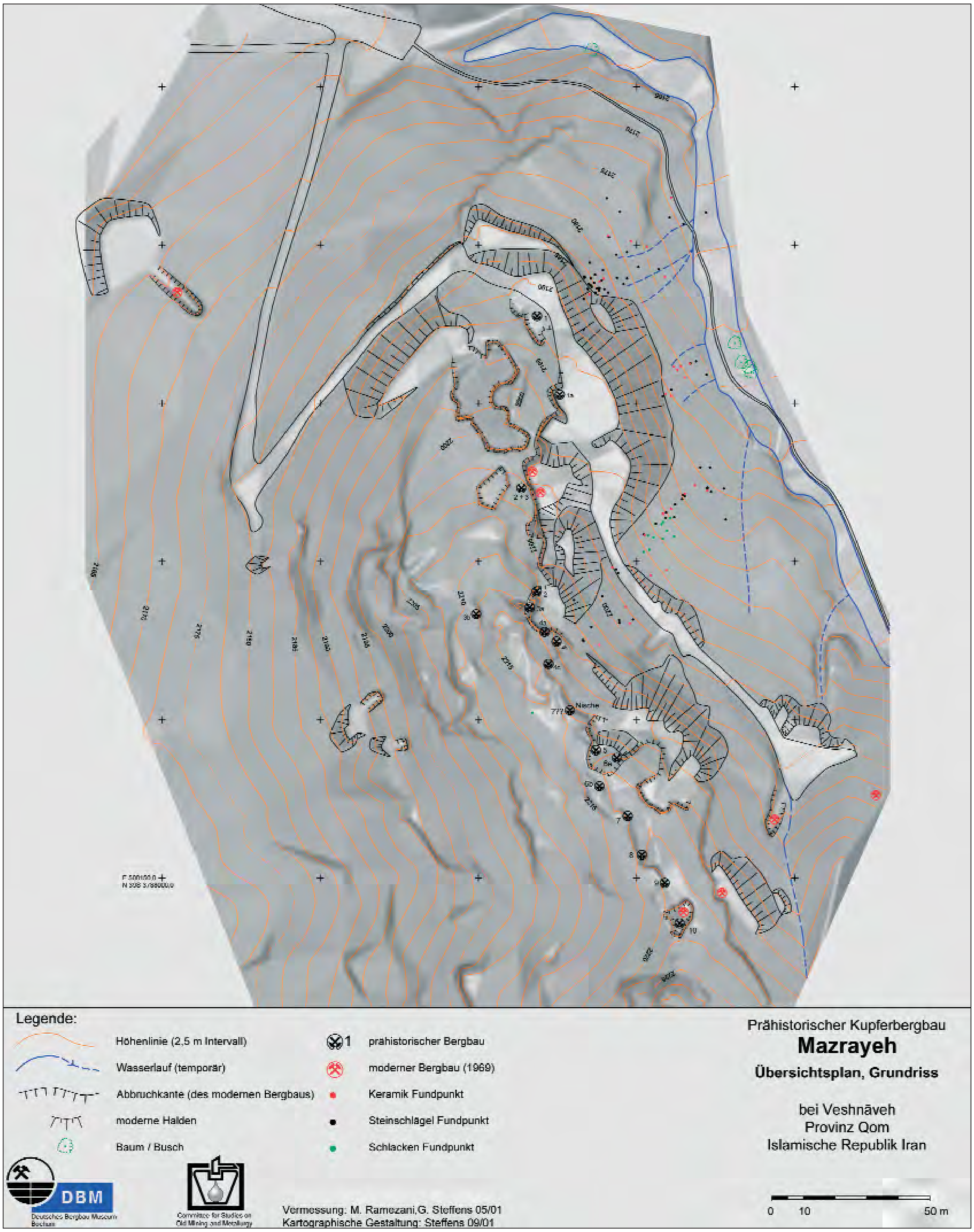


Fig. 3 Map of the mining district of Mazrayeh including prehistoric and modern mining places, acc. to DMB.

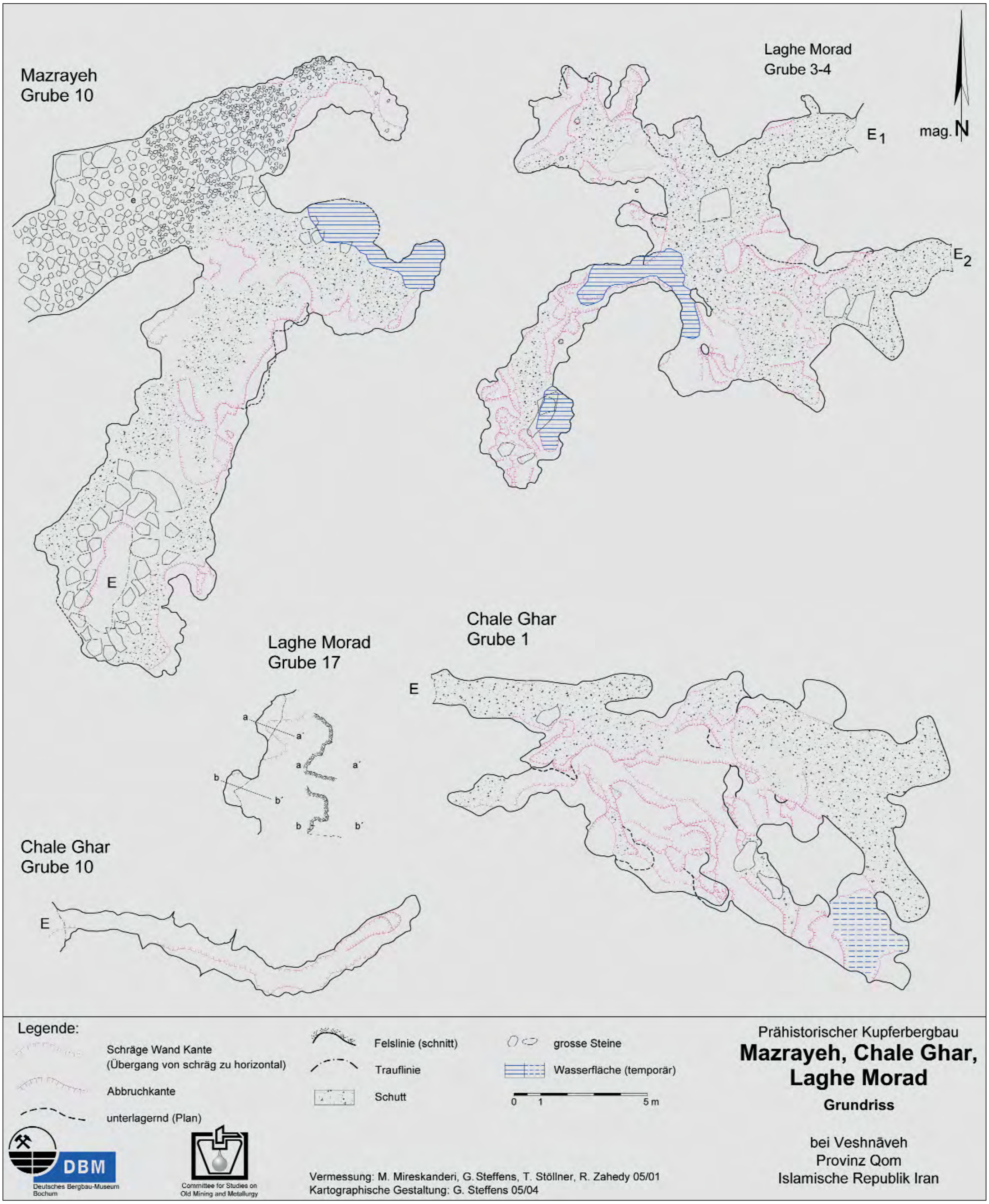


Fig. 4: Schematic maps of prehistoric mines: nishes (CG 19), tunnel mining (CG 10) tub-shaped, following the load mines (M10), mines with two entrances (LM 2/4), complex stope-mining with halls (CG 1, LM 2/18), acc. DBM.

complex among the upper part of the basaltic lava where the latter starts to be replaced by covering, Oligocene sediments. The latter is a conglomerate/sandstone-sediment being covered by layered, close-grained tuff which is of green or reddish-violet colour. The surrounding rock of copper-mineralisation shows a characteristic bubble-like amygdoloidal texture. Quite often there are minerals like epidote, chlorite, calcite, or silicate inclusions.

Some of these bubbles are filled with malachite, also the mineralisations appear in the form of vein-like fillings and also in the form of nests and pouches. In some places these mineralisations provide a high concentration of copper. The veins and pouches are but strongly step-structured and growing lesser in concentration towards the basement rock. Typical copper minerals are chalcosite (copper glance), malachite, and azurite, also smaller amounts of native copper and a bit of chalcopyrite (copper pyrite). Especially chalcosite and malachite were economically interesting.

A view at the extraction done by the Puyesh Mining Company during the 1960s leads to interesting insights: In 1969 in the mining field of Mazrayeh/Mezrayeh, which is easier to reach, about 1000 tons of concentrated ore with 7-8% of copper-content were exploited. In those days the rough ore was hand-picked and enriched at the place. The basic ore did not have more than about 1% of Cu (Holzer & Momenzadeh 1971, 4; Holzer 1974, 144) but we will have to start out from the idea that the content of ore was at certain times much higher during the Bronze Age, the exploit having been only selective and happening in small areas. If we compare other areas we will be allowed to start out from the idea of a copper content of about 4-10%.

Actual Research – General View at the Mining Areas

The actual investigations at Veshnāveh started with a mining-archaeological survey: the three mining areas which are known from literature (Holzer & Momenzadeh 1971; Berthoud et al. 1976, 3-8) – the one at Laghe Morad (Lagh-e Morad= Murad's valley), the mining area at Mazrayeh which still was exploited (copper place), or the one at Chale Ghar (Chehel-e Ghar=fourty caves) – were intensively studied and measured. Soon the investigations showed that there were far more mines and mining places than those that had been known.

According to today's knowledge the Mazrayeh mining area consists of at least twelve prehistoric mining places (Fig. 2 & 3) – from pouch-sized small mines to bigger mine complexes. Unfortunately the area has been heavily affected by mining in modern times. As copper mineralisation is only found in a certain seam with a thickness of only 1-2 m, modern exploit destroyed especially the area of the prehistoric mines by heavily using explosives. Thus it is not always clear if the nucleus of these mining places is really old. A drift that was tunnelled deeper did not prove to be successful as it did not reach a formation containing any copper. The prehistoric look of the mining area has completely been changed by modern exploit. Today the picture is characterised by roads and by the complexes of mines which have grown to huge caverns. Especially at the eastern side of the ore-containing mountain ridge the dead rock and that rock containing only a small percentage of ore has been dumped by machine to huge heaps. There the modern dumps also cover prehistoric structures, e.g. prehistoric dumps which can be recognised by certain finds like hammers, fractional hewing waste, or pottery. Essentially the map shows three mining fields (mines 1, 2-3, 4a-c/12) in the lower, northern part of the area. Also at the western side we know dump-like structures, mostly below mines 5-6 and about the place where there is a boldly flat spot. Berthoud et al. (1976, 6ff, map 2) called this an "installation" (Fig. 3). On the other hand several dug-outs at this side showing small and recently piled dumps are to be interpreted as coming from modern geological prospection – we also find them at the other mining places.

If we look at how the mines were laid out, it is especially significant how thin the natural covering was. Quite often it is less than 1-2 m – also the traces of mining, which have currently been investigated, show that mining was done mostly towards the roof and the wall faces, just where the content of ore was better and richer. Concerning this also the mine complex 9-10 (Fig. 4) is of interest: the oblong workings, which are done in a rather modern way in their upper part, changes its direction in the deeper parts and now stretches from SW to NE with two more chamber-like headings in NW. This shows that obviously the direction of the work was changed here – probably to follow an especially rich vein. This kind of mining at the Veshnāveh mines is classical pillar or irregular stope mining (Weisgerber 1989, esp. 201-203 offers a classification). In principle this kind of mining used to follow the ore bed and in case of rich ore beds extensions to the sides were made. Due to this the deeper parts are younger than those being closer to the surface around the so called "openings". At the same time the shape of the mine shows about where the exploited, rich ore was, thus allowing to expect certain indications concerning the amount of exploited rough ore. Calculations (see below) show that Mazrayeh was perhaps even the biggest of the three mining fields at Veshnāveh (Fig. 14)[5].

The situation at the Chale Ghar mining field is completely different: it is accessible via Karnovoon and Yek Gerdouneh, where also some smaller mining fields are known. The Chale Ghar field is part of a zone of mineralisation being similar to that of Mazrayeh, as it is situated north-eastern and to the West of a ridge that slopes from SE towards NW (Fig. 5 & 6). Two groups of mines are known[6]: nine mines and pouch-sized mines are in the Northwest, another eight or nine mines are in the Northeast. More mining places are known, being in the south-western part of the ridge. The area is mostly characterised by a deep, canyon-like small valley which is situated to the West of the ridge. It also marks a tectonic fault line which leads to a significant displacement of the strata East and West of it. This topographic feature probably contributed to intensive erosion around the steeply sloping mining field. So in contrast to Laghe Morad and Mazrayeh the characteristic dumps at

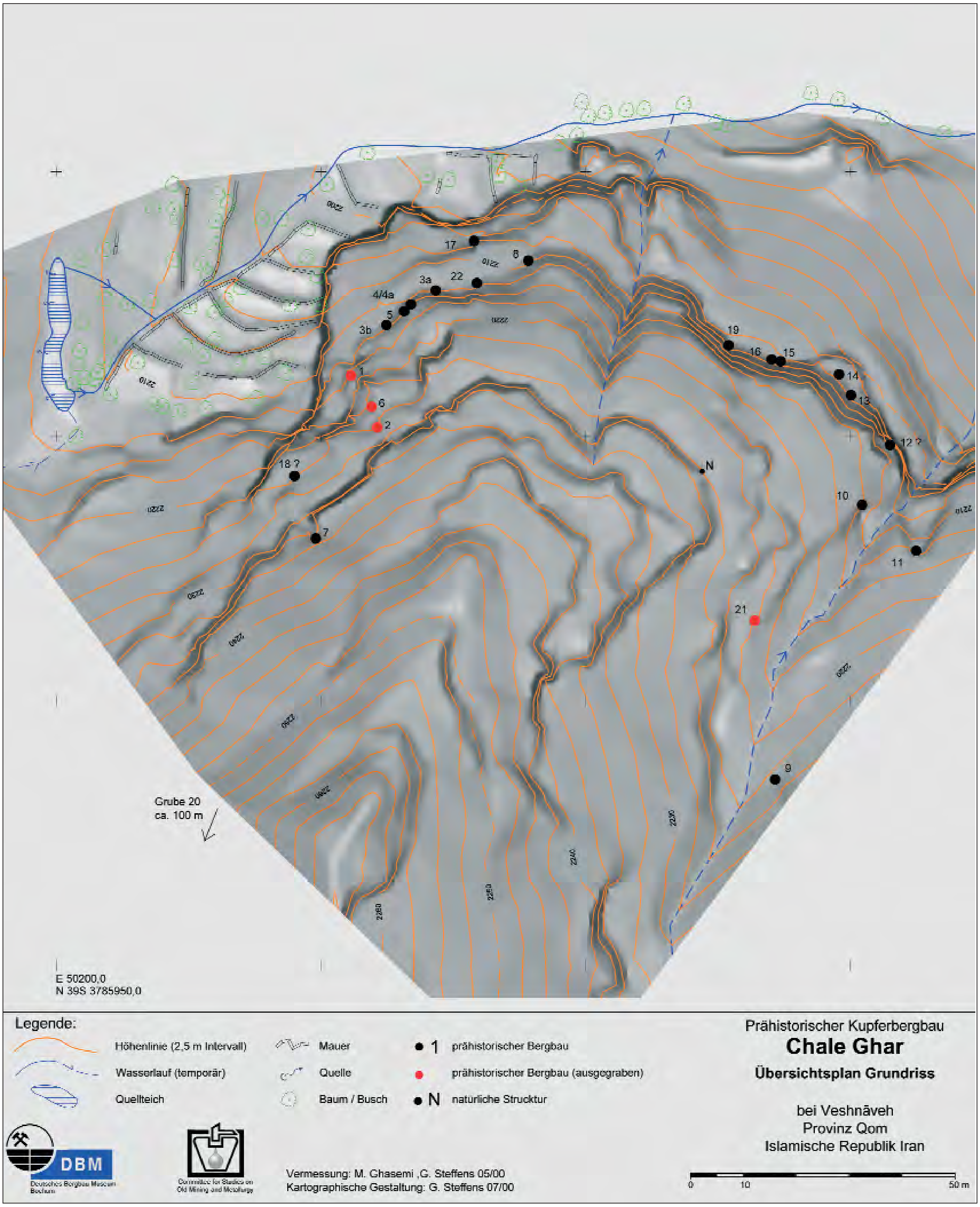


Fig. 5: Map of the mining district in Chale Ghar with prehistoric workings, after DBM.

Fig. 6: Aerial photography of the mining district Chale Ghar, 2001, Photo: DBM, G. Steffens.

the openings and also the easily visible finds of grooved hammers, as known from the other fields, are missing here.

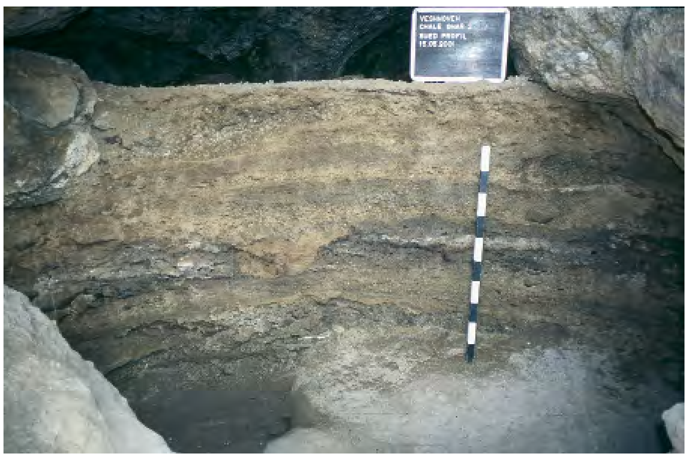
The special tectonic situation near the fault line also lead to steep bedding and to secondary mineralisations alongside single shearing planes. Due to this some mines (especially mine 1, 10, 21) are steeper or built drift-like (Fig. 4). Both here and at Mazrayeh in principle the drifting was done in a stope-mining way. The real mining process was prepared by extensive fire-setting (on fire-setting see recently Weisgerber & Willies 2000), then the copper-containing rock was hammered from the barrier pillar by use of heavy hammers. Finally the rock was further selected and concentrated outside the mines.

The excavations were supposed to produce further insights. At first there were sondage-investigations to get material for radiocarbon-dating. But very soon work was extended to regular mine-excavation. To give an example: Only after the investigations had been going on for some time it was recognised that the openings known as mines 2 and 6 actually were just one small complex of mines, both openings being connected by a forecourt which is open today. It is not clear if it has ever been covered completely, but if it was, the covering must have been extremely thin. More than anything else the structures of the floor offer further insights. The floor is scattered with round or oval traces of fire-setting from the exploit-works. In deeper parts of the floor there are still parts of the Bronze Age mining waste to be found. This is especially interesting as the remnants of charcoal and tools, that were found there, offer indications concerning the way of exploit. As an example, for fire-setting there was also employed the tamarisk, which is used to dry sites; grooved hammers and fragments of separating and crushing plates prove that the rock was worked at and that ore was dressed at the place. But the rich sediment packet at the entrance of mine 2/6 also showed younger phases of exploit (Fig. 7): Within the 55 layers of sediment there was also proof for anthropogenic settlement. The later use of the mine was clearly indicated by fireplaces and packets of ashes; most probably they are from the Iron Age or from even younger periods – a feature that is also true for other mines we saw.

In contrast to rather hall-like mine 2/6, mine 21, having been discovered as late as 2001, was something special: being 33 m long it is the longest of all and was obviously built after a rich, aisle-like mineralisation. As it has been almost completely closed since ancient times, we stepped into a nearly untouched mine complex. The unchanged and exceptionally well preserved traces of exploit clearly indicate that work was done in sections. Probably each time a fire was lit that weakened the rock after some days, until after sufficient ventilation rock and copper ore could be crushed. In the interior of the mine just at the breast there still were the plates peeled off in a bowl-like shape that had been used for exploit (exfoliation: on this term see Weisgerber & Willies 2000, 144f.; Chegini et al. 2000, 314). Due to its narrowness in this mine only a small number of miners, maybe two or three persons, may have been working. The clearly visible step by step drifting shows how small-dimensioned the exploit must have been originally.

In contrast to that mine 1 is much bigger and more differentiated (Fig. 4): obviously this complex mining field was intensively extended during a number of years – many drifts, chamber-like rooms and recesses, and also landings were built during the years.

Fig. 7: Chale Ghar, mine 2, profile with layers; Photo: DBM; Th. Stöllner.



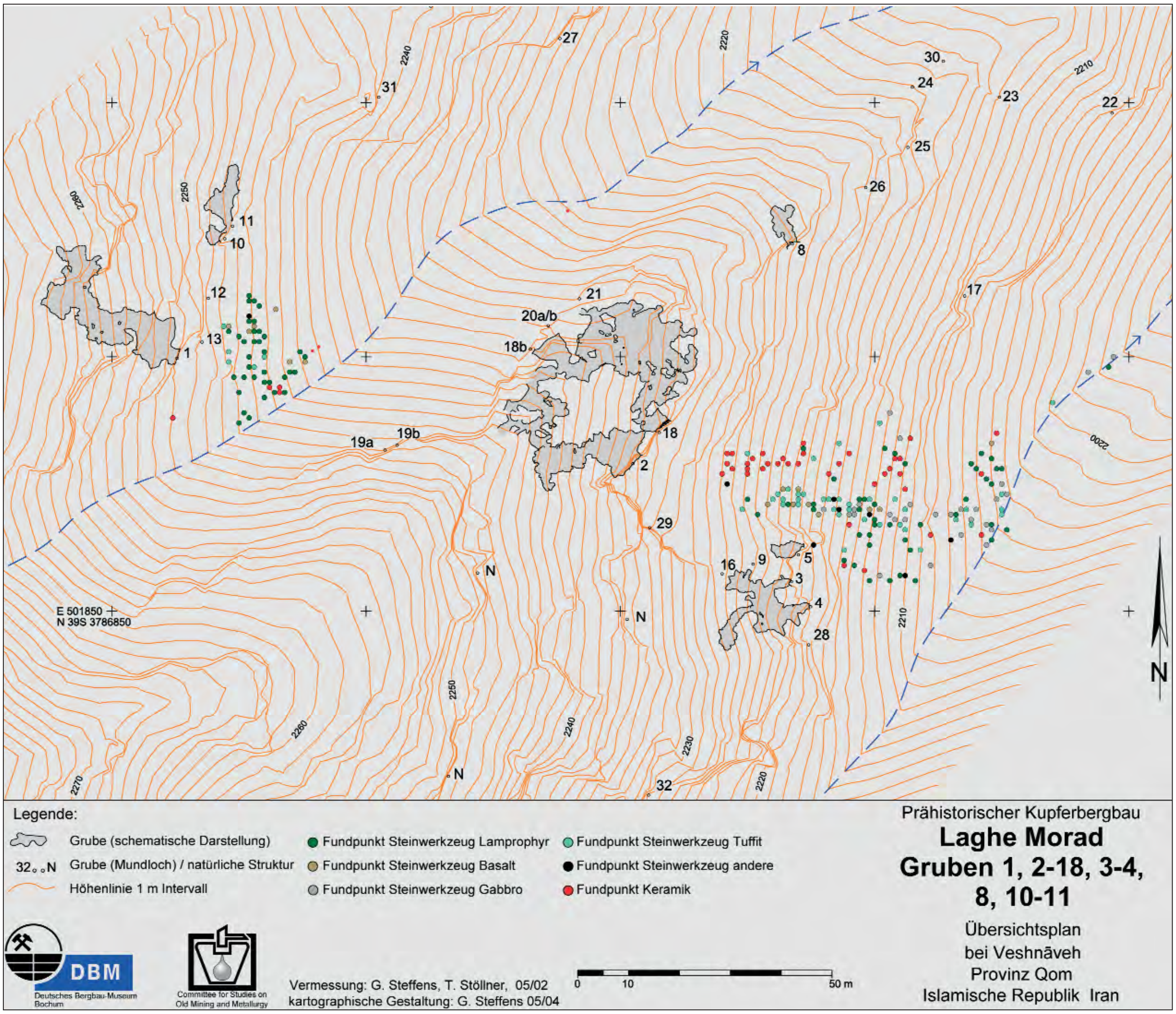


Fig. 8: Detail of the mining district Laghe Morad mining field. For the bigger mines grey was used to form the background. Also the finds of stone hammers from the dumps are shown, differentiated according to types of rock; after DBM.

So we hoped for further insights by help of excavations in the deeper parts of the mine which were covered by water: but to our big surprise among the supposed waste we discovered a lot of offerings of a cave shrine, being of more recent times. Next to animal and vegetal offerings there were hundreds of ornaments, finger rings, pearls, and dressing ornaments, also some coins and wooden vessels. The previous excavations showed a unique site, where from Parthian times on at the latest probably women and children had been praying and offering. These rituals probably lasted until the 8th century AD, i.e. until early Islamic time and belong to the sphere of older Persian, Median religious practise (Stöllner & Mireskanderi 2003)[7]. Together with stones the offerings were sunk into water, that was already there in those days, and so were deposited upon older layers of Bronze Age mining. Not only due to these exciting archaeological finds this mine counts among the outstanding archaeological evidences at Veshnāveh – also the preservation of this most individually built mine can be called excellent.

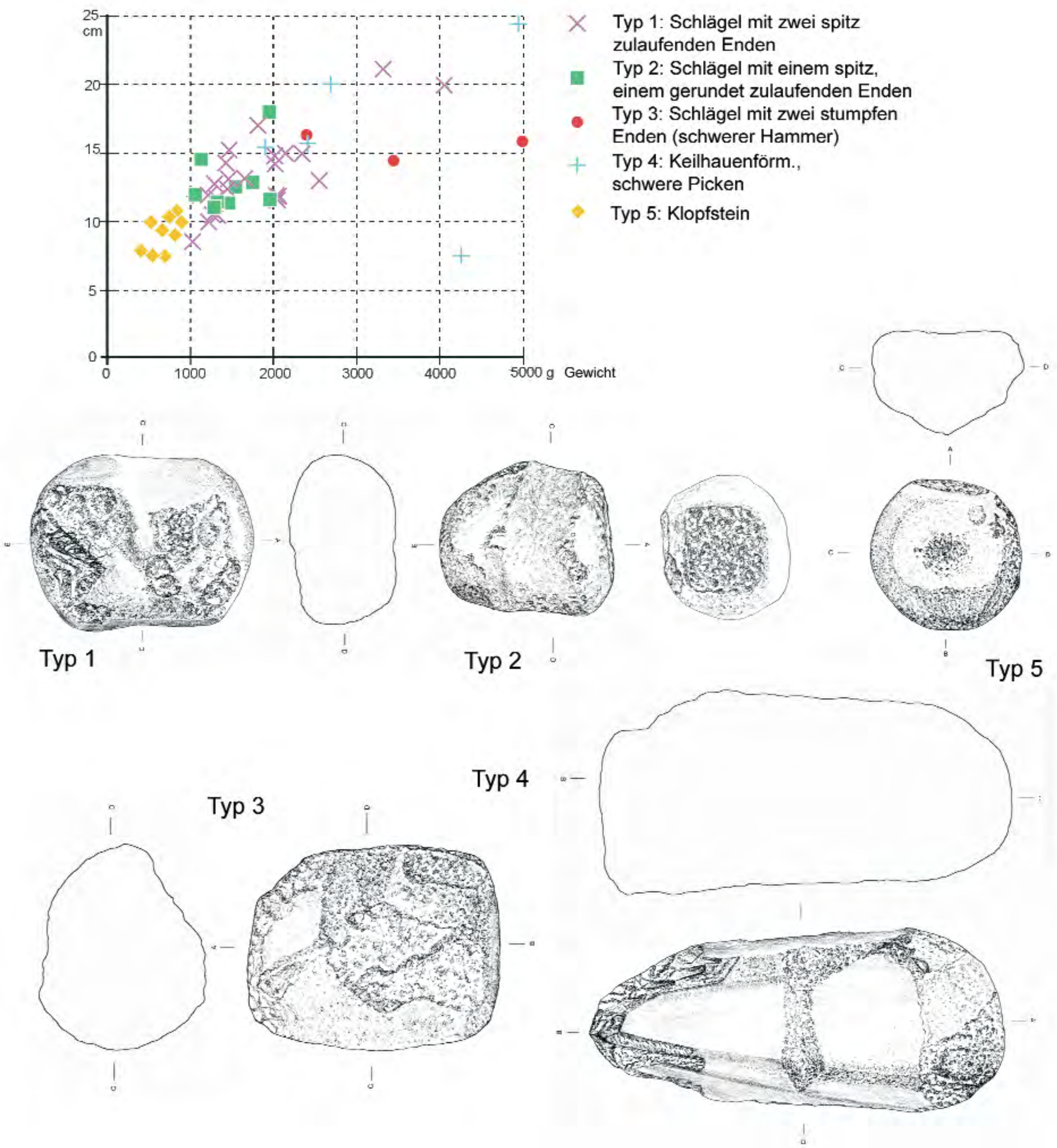


Fig. 9: Types of hammer-stones, found in Veshnāveh; hammers on a scale of S 1:4.

Other than Chale Ghar the place of Laghe Morad, being 2 km away to the North as the crow flies, is situated at two softly sloped small dry valleys (Fig. 8) – here water is only existent in early spring and flows away into the deeply cut canyons which drain towards the Kavir of Kāshān in the East. From this direction there might have been the access to the mining area, if we take into the account that the great arterial roads went along the Central-Persian mountain chain from Northwest to Southeast as far as Yazd and Kerman. The

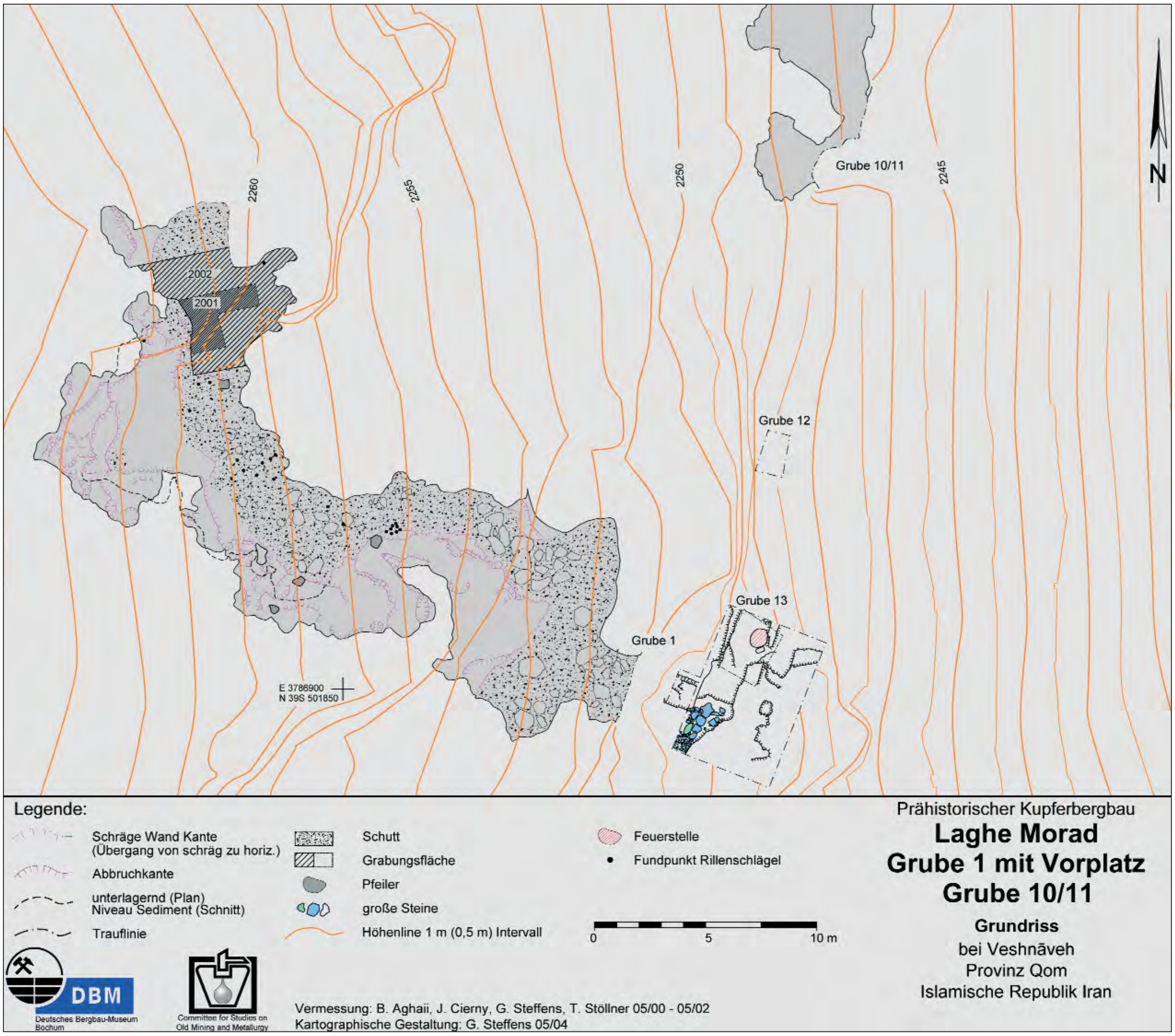


Fig. 10: Map of the excavations in mine 1 incl. forecourt and the fireplace which was uncovered there. Also the traces of Copper Age (?) mining; after DBM.

area, which slopes towards the East, shows only sparse vegetation and may have been rather hostile to settlement also in the Bronze Age. From the beginning our survey made clear the differences to Chale Ghar and Mazrayeh (Chegini et al. 2000, 311f.). The bed of the mineralised basalt is mostly sub-horizontal and reaches the surface mostly at both sides of the above mentioned valleys at two ridges. There are also the mine heads to be found which today are estimated to be about 30, including some places of exploit at the surface. Both number and size of some mines show that this field is the biggest of all mining areas that were found at Veshnāveh (see above). Especially important is the outstanding state of preservation of the mine complexes: dumps, mine heads, and the mines themselves do not seem to have been used in more recent times. Also erosion seems to be insignificant in the valleys, due to their soft sloping, so that the old surface are all in all well preserved. For example the dump areas are still easily recognisable and it is especially there where hammers and fragments of hammers are to be found in interesting numbers. These fragments of grooved hammers allow some more precise statements – like on the way the pieces are fragmented, which shows that also the raw materials for the hammers were hewed into shape and made into tools. A simple classification shows – dependent on weight – several types of tools. Along with grooved hammers and heavy hammers, wedge-shaped picks and hammerstones must be mentioned, all of them making a highly developed set of tools (Fig. 9). Also the numerous splinters and fragments make clear how much the hammers were used up due to the crushing way of working. Concerning this also the differences in choosing the raw materials for the hammers are interesting: Though generally those easily recognisable tools made of greenish or black amphibolite lampro-porphyry are predominant, also basalt, gabbro-porphyry, or greenish, lithic tuff was used during single periods of time or by single groups. This is explicitly shown if the dumps at mine 1/13 and 2/18 are compared, both being completely different from each other concerning this matter. This clearly indicates chronological or group factors.

At Laghe Morad the mines themselves show broad variations. Along with tube-like drifts showing irregular abandoned pillar method (mine 1, mine 2) there is a number of smaller places being nothing more than recesses close to the surface or small chambers (mines 10-12, 5). Mine 3-4 shows a special way of building – it consists of two openings being of different height, showing bord and pillar system with single roadway drivages and being wider in the interior. Mine 3 at Chale Ghar is quite similar to this, which allows to suggest that this was a rather common way of building at this place. The two openings make regular ventilation possible, thus solving a problem which requires additional openings in case of deeper mines. Also the very big and widely structured complex of mine 2/18 shows similar efforts[8]: despite massive back stowing of gravel, debris, and prehistoric rock fill at some places, four or five openings can be recognised; two bigger chambers, which later were probably connected by ventilation holes, had been developed to be hall like during a longer period of mining. Probably in that place there was a very rich vein. We may suggest that mine 18 was started from NW and mine 2 from SE (see Fig. 4). The extended but partly very low mine shows some quite developed knowledge of mining: like at Chale Ghar the interior structures show roadway-like drifting at the beginning, but soon being widened. Though a detailed view at the mostly untouched mine was possible, excavations were indispensable, as only in this way dating, the history of exploitation, and details of the employed technology could be determined.

It looked promising to concentrate on a convincing complex, which was mine 1 (Holzer & Momenzadeh 1971, supplement 2), the so called Soragh-e Div (monster cave), and also mines 12 and 13 (Fig. 10). There in addition to the interior some dump and forecourt areas are existent which allow to say something about work in the inner and outer parts of the mines.

The excavations started as early as in 2001 but have not yet been finished: like at Chale Ghar the idea was to uncover greater parts of the prehistoric waste. By looking at structure and deposit of the overburden further insights concerning the prehistoric work routine were possible. Though the upper parts of the layer had been rather mixed up by bio-disturbance some tools were found "in situ". Especially the great amount of pottery was noticeable which was found in the farthest part of the mine in various layers (Fig. 11). It might as well be that these fragments of vessels come from younger settlement activities. But significantly hammerstones and crushing-plates for processing the ore were missing[9]. In the forecourt of the opening oft mine 1/13 further insights were gained into how the ore was processed, as there an especially prepared place for processing could be found. A furrow, which had been created by mining close to the surface, later was graded by help of rough

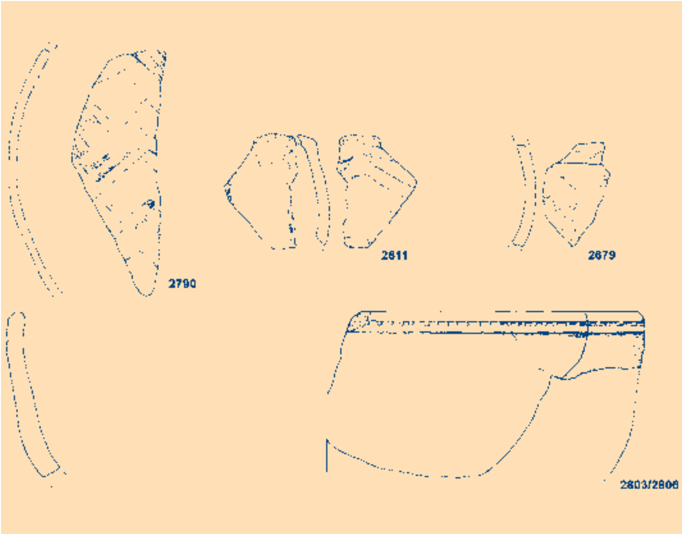


Fig. 11: Finds of pottery (painted and grey ware) from the excavations in mine 1/13 of Laghe Morad. M = 1:5 (top); 1:7 (bottom).

stones and crushing-plates (Fig. 12). Radiocarbon dating from the waste at this place gave the 3rd millennium BC as a result, which indicates one of the earliest period of exploiting copper ore. Also the traces of fire setting in the above mentioned furrow and in mine 13, which probably was nothing more than a recess close to the surface, are thought to come from this period. The crushing plates, which were found there together with hammerstones and huge grinding plates, prove that ore was processed by crumbling and crushing. Probably it was made into concentrated ore of highest possible purity and then taken to the smelting places. If a fireplace nearby was really connected with ore processing, as indicated by small pieces of ore, cannot yet be determined[10]. Nevertheless in the forecourt of the mine a specially prepared place was found which maybe had been intentionally established in the older mining furrows. It is not yet clear if the steps, which were roughly hewed into the rock, and the horizontally established fireplace come from the time of mining activity or if they are much younger.

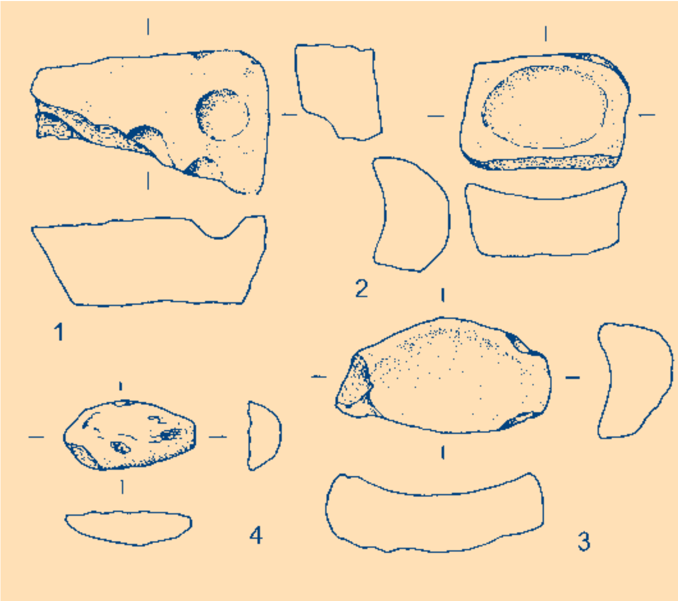


Fig. 12: Crushing and grinding-stones belonging to ore dressing in the forecourt of mine 1/13 in Laghe Morad; M.= 1:20.

Landscape and economy in the Bronze Age

If we look at the mines, being close together in single groups, of course the question is of interest, what vegetation was like in the surroundings of the mines in the time of bronze age mining – as sufficient resources of firewood are absolutely necessary to do this kind of mining which was mostly based on firesetting. Comparing the results of recent archaebotanical investigations offer some insights: though for the time being only some species of wood have been identified, a comparison to the investigations at the younger Parthian or Sasanian place of sacrifice at Chale Ghar shows that there was an essentially open stand of deciduous trees, situated very close to streaming waters. Tamarisks indicate that next to the place there were also extremely dry places, like those still to be found on the mountain slopes of the area. In how far this was also true for the oldest periods of mining cannot yet be determined.

But still there are some evidences suggesting that mining activities did not lead to deforestation but that the situation had lastingly changed in even older times due to extensive cattle husbandry and the climatic change during early Holocene. Locally existing woods were surely exploited for firesetting, the miners not being able to employ wood that kept the heat for a long time, like oakwood, but had to be satisfied with wood that burned down rather fast, like tamarisk or pistacia.

Livestock

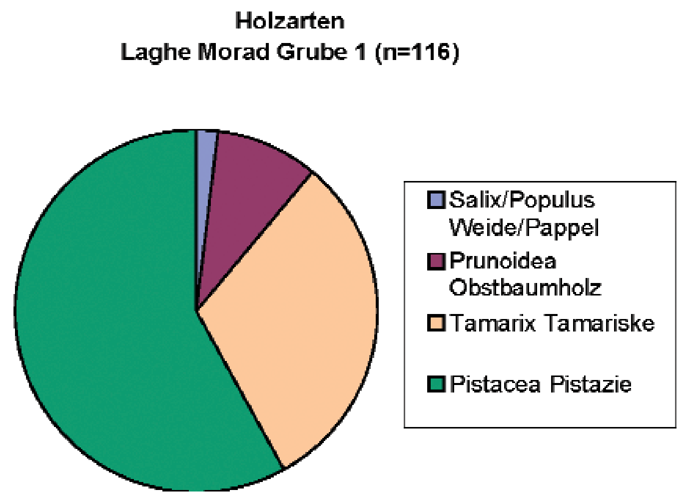
Around 980 bone fragments were discovered in the Bronze Age mine Laghe Morad 1. They allow the reconstruction of the subsistence and animal husbandry of the Bronze Age miners. Most of the bones are from sheep and goats, with the goats constituting the bigger part. Besides the small ruminants a limited number of cattle were kept. Donkeys were used for riding and transport. Bones of dogs, mankind's oldest companion were also found.

The ritual site of Chale Ghar 1, dating in Parthian to early Islamic times, yielded around 800 bone fragments. They show almost the same species distribution as Laghe Morad 1 with the small ruminants again forming the majority. The spectrum is completed by cattle, donkey and horse. Very important is the high occurrence of chicken bones which constitute 40% of the material. Young chicken were obviously preferred, a circumstance that leads to difficulties in determining the sex of the animals. Concurring with this age pattern, very young goats were selected for the ceremonial acts.

Thoughts concerning the output of ore and on the economic integration of copper mining at Veshnāveh

Though for the time being many questions cannot be answered, some results are showing through: According to radiocarbon dating the Veshnāveh fields were probably run from the first half of the 2nd millennium BC to the middle of that millennium, which means during middle and late Bronze Age. An older period may have been

Fig. 13: Diagram of distribution of wooden sorts in Laghe Morad, mine 1.



Lab-nummber	Site	Context	Artefact-nummber	Absolute Date (BP)	Calibration im Confidenz-Intervall (2σ, 95,4%)
ETH 25914	Veshnāveh	LM 1	2992	3090±50	BC 1446-1201 (99,4 %)
ETH 26659	Veshnāveh	LM 12	2315	3355±60	BC 1770-1507 (99 %)
ETH 26660	Veshnāveh	LM 12	2315	3475±65	BC 1946-1618 (100 %)
ETH-27234	Veshnāveh	LM 13, 31000	2403	2730±55	BC 946-803 (92,2 %)
ETH-27235	Veshnāveh	CG 1, 10007	1283	2390±60	BC 764-617 (27,6 %), 605-371 (72,4 %)
ETH-27236	Veshnāveh	CG 1, 10009	1284	2845±55	BC 1134-843 (98,7 %)
ETH-27237	Veshnāveh	LM 13, 31001	2419	4240±60	BC 2925-2617 (99,6 %)
ETH-27238	Veshnāveh	CG 21	4092	3255±45	BC 1624-1420 (100 %)
ETH-27239	Veshnāveh	CG 1, 10013	4165c	2655±45	BC 900-781 (100 %)
ETH-27240	Veshnāveh	Mezrayeh, alte Aufsammlung		40±45	AD 1688-1735 (19,6 %), 1811-1927 (78,7 %)

Fig. 14: Table of chronology of the ^{14}C-datings of Veshnāveh.

during the first half of the 3rd millennium BC, i.e. during the transition from Copper Age to early Bronze Age (Sialk IV). At this time probably exploitation near the surface started (Fig. 14). This is similar to the situation known from Fenan in Jordan, where at this time early mining started in the so called massive-brown-sandstone-formation (MBS), showing stop mining close to the surface (Weisgerber 1996; Hauptmann 2000). But the amount of data presently at hand must be improved if the single periods shall be defined more clearly, especially if the question of continuous mining shall be answered. At any case it is conspicuous that the mining period of the early and middle 2nd millennium does not seem to have been connected to appropriate settlement activities in the region. For the time being settlements, especially those dating from the early 2nd millennium, are extremely rare in the area between Qom and Natanz, which is also the case for the rest of the Central Plateau[11]. Only as late as the second half of the millennium settlement starts again, like those at Jamkaran near Qom (e.g. Kleiss 1983) or at Tappeh Sialk (burial site B)[12]. Exactly in the northern approaches there is the Sarm burial site, which must be dated to be from Iron II and III (excavations ICHO Qom 2001/2002). The chronology of the widely known Grey Ware is very important for a chronology of the Central Plateau during the 2nd millennium (most recently see Piller 2004, in press). The question if there was any copper mining at Veshnāveh during this period must be left to further geo-chemical investigations[13].

Finally there is the question of where the Veshnāveh ore was transported to and where it was processed into final products. For the time being only the results of the geo-chemical investigations done by the current Iranian-German project will be able to say something about this. Earlier studies always underlined the significance of Veshnāveh for supplying places like Tappeh Sialk with raw materials (Holzer & Momenzadeh 1971; Algaze 1993). But the more recent investigations show a much more differentiated picture[14] (also see Pernicka et al. in this volume). Provenance studies exclude the idea of only one, very rich source of raw materials for supplying the early metal-processing settlement of Arisman: combinations of trace elements and also the relation of Pb-isotopes allow to suggest also the use of copper ore from the Kāshān/Qom area along with that from the huge copper seams in the Talmessi/Anarak area – though probably only in small amounts. If we look at the chronologic approaches up to now, Veshnāveh must be understood to have produced mainly later than Arisman and the metal-workshops at Tappeh Sialk. Maybe they were overlapping only during the youngest periods of Sialk IV, when the huge dumps of slag were piled up at Arisman: when during this period the "almost industrialised" production was obviously intensified, it was perhaps necessary to reach back also to seams like at Veshnāveh, which were more difficult to reach and whose ore was more complicated to smelt due to its content of sulphide.

To achieve a widely convincing picture it is also necessary to think about the general copper exploitation at Veshnāveh – as we have seen, the rough ore was separated and concentrated by hand and at the place. So which amounts do we have to take into the account? This is not easy to calculate, but the average of modern production may serve as a basis, in so far as also in those days separation was mostly done by hand and barren material went to the dumps. More difficult on the other hand is it to calculate the amount of ore which was taken out, though a rough calculation shows a certain tendency[16] (Fig. 15): In all of the three fields together at least 1848 cubic metres of hollow space were exploited (which is about 4620 t of mineralised rock); estimating at least 1% of copper in the rough ore we may suggest the production of at least 46 t of raw copper (which is less than it actually was, of course). Even if in prehistoric times the content of copper may easily have been ten or twenty times bigger, this is not all too much if we look at other areas: as calculated by C. Eibner at the Mitterberg main lode there was a production of about 7000 t of copper, which is almost twenty times more than at Veshnāveh, if an average, untouched deposit with about 10% of copper is estimated (Eibner 1989, 32). Now Mitterberg was one of Central Europe's main producers, but during the 2nd millennium it is far behind the production at the gigantic Kargaly area, were an amount of 55000 or even 120000 t of copper is estimated (average content of copper: 4.5-20%: Chernykh 2003, 81). More examples could be mentioned, which makes clear that in the early 2nd millennium Veshnāveh was far from being a major producer but rather a regional supplier. If this is also true for the early period depends on insights concerning the size of the early mining works – but for this further research is necessary.

We may suggest that the copper supply of Arisman, as sketched by Hezarkhani et al. (2003, see annotation 14), came from different deposits. This might be typical for the whole region, as indicated by recent investigations of slags and finished products. The results so far do perfectly fit to the idea of sporadic and small-dimensioned exploitation of copper deposits like at Veshnāveh – the more as the next big deposits, like those of Talmessi and Meskani, do not show up explicitly enough in the analyses. Due to the lack of prehistoric settlement in the surroundings of the mines we are allowed to suggest that expeditions for raw materials – probably small groups – exploited the various regional deposits seasonally. Do we have to take nomadic groups into the account, doing that work from time to time? This is a likely solution, if we think of the great significance of this economic system in Iran and probably especially during a period of restricted settlement activities around the Central Plateau at about the beginning of the 2nd millennium (a. o. see A. Alizadeh in this volume). Thus Veshnāveh might serve as a characteristic example of copper mining, as frequent in Central Iran during the Bronze Age. Especially its outstanding state of preservation is unique and makes this mining area stand out from other mining of its time: thus its archaeological evidences on mining also allow detailed thoughts concerning mining techniques and the course of sporadic and seasonal mining.

Mine	Volume of space mined (m^3)
Mezrayeh, Mine 1	30
Mezrayeh, Mine 2	70
Mezrayeh, Mine 3	68
Mezrayeh, Mine 4	42
Mezrayeh, Mine 5	72
Mezrayeh, Mine 9	10
Mezrayeh, Mine 10	270
Mezrayeh, Small Mines	40
Total Mezrayeh	**602**
Chale Ghar, Mine 1	110
Chale Ghar, Mine 2/6	62
Chale Ghar, Mine 3	35
Chale Ghar, Mine 4	2
Chale Ghar, Mine 10	16
Chale Ghar, Mine 19	3
Chale Ghar, Mine 20	5
Chale Ghar, Mine 21	40
Chale Ghar, Small Mines	20
Total Chale Ghar	**293**
Laghe Morad, Mine 1	160
Laghe Morad, Mine 2/18	552
Laghe Morad, Mine 3/4	120
Laghe Morad, Mine 5	4
Laghe Morad, Mine 8	20
Laghe Morad, Mine 10-11	55
Laghe Morad, Mine 12	7
Laghe Morad, Kleingruben	25
Total Laghe Morad	**943**

Fig. 15: Table of mines' sizes in the Veshnāveh mining field.

Anmerkungen

1 Head of this Iranian-German project were M. Mir Eskanderi, Teheran, and Th. Stöllner, Bochum. M. Momenzadeh and Sh. Haghnazar worked on the geological aspects of the deposit; R. Pasternak, Kiel, was in charge of archaeobotany; G. Steffens, Bochum, was in charge of measuring. First investigations of animal bones were done by M. Doll, Tübingen.

2 Generally very early: Lamberg-Karlovsky 1978; e.g. G. Algaze (1993, 69 pp. fig. 35) explicitely called Veshnāveh a supplier of raw materials for the nearby settlement of Sialk. He supposed the latter to have been an "Uruk outpost" or something like that; on the Uruk expansion and previous models and concepts see: Kümmel 2001; Stein 1999; most recently D. T. Potts interpreted the concentration of protoelamic finds in an architectural complex of period IVC2 of Tappeh Yahya not only with renewed settlement activities but also with direct influence from the Susian; Lamberg-Karlovsky & Potts 2001, esp. 198. I like to thank B. Helwing, Berlin/Tehran for advice.

3 AMS ^{14}C-measuring was undertaken by the group of Prof. Dr. Bonani, ETH Zürich: ETH 27270: 40±45, calibrated in 2σ-intervall: AD 1688-1735 (19,6%), 1811-1927 (78,7%).

4 We were looked after by the drivers of the Geological Survey of Iran, the cook Hassan Moradpour, the Bagheri and Javodi families, who offered the hospitality of their house. From 2000 to 2002 the following people took part in the excavations: K. Mückenberger, A. Müller, T. Riese, K. Roustaie, B. Schroth, A. Weisgerber, G. Weisberger, R. Zahedi, M. Zeiler, and workers from Veshnāveh. Especially Prof. Dr. G. Weisgerber contributed inspiration and help to the work, especially at the beginning.

5 For 2004 there is the plan of another five weeks excavation and then for a final investigation in 2005.

6 Purely arithmetically the mostly undisturbed Laghe Morad field is bigger, but at Mezrayeh vast parts simply cannot be estimated and so the calculations concerning the place are automatically reduced.

7 In contrast to Laghe Morad and Mezrayeh, the Chale Ghar mining field has not yet been described sufficiently.

8 The site is being excavated by a supplementing project: investigations on parthian and early sassanidian hoards at Veshnāveh, Iran: DFG STO 458/2.

9 Older photographies by Holzer & Momenzadeh 1971, supplement 2.

10 Grinding stones, that were collected on the surface, definitely do not come from that period, which is also true for those that were found in the covering and strongly mixed layers. Still it may be that some pre-selecting separation did also take place in the mine. Unfortunately the location of most of the finds on the surface, if they are in the mine or in the forecourt, cannot be determined. In the course of time they have been moved or piled up to heapes.

11 At least there exists one radiocarbon dating, indicating that as late as during early Iron Age there were activities in the surroundings of these mines.

12 Mir Abedin Kaboli´s survey in the Qomrud area showed that these periods are missing in the alluvial area of Qomrud-basin; a breakage of settling in some parts is shown by huge infertile colluvial packets which can be found between Sialk IV and early Iron Age in the 2nd millennium: Kaboli 2000. An appropriate observation was made near the big Jamkaran settlement.

13 On the chonology of the Sialk burial sites see: Ghirshman 1938, 26-65; Tourovetz 1965.

14 The Central Grey Ware with buttons ("Knöpfchenware") might indicate this, but as surprisingly it appears in large numbers always in open mines like Laghe Morad, mine 1, it may as well be evidence of later sporadic or seasonal settlement.

15 The results of the archaeometallurgical team of the Arisman project show this: Z. Hezarkhani, M. Momenzadeh, N. Nezafati, R. Vatandoust, R. B. Heimann, E. Pernicka, M. Schreiner & B. Winterholler, Archaeometallurgical researches in central Iran. Script as yet unpublished 2003, esp. 53-58.

16 We like to express our sincere thanks to Gero Steffens, Dipl. Ing., DMB, for the calculation.

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Craft Activities in Banesh Period Kur River Basin

Kamyar Abdi

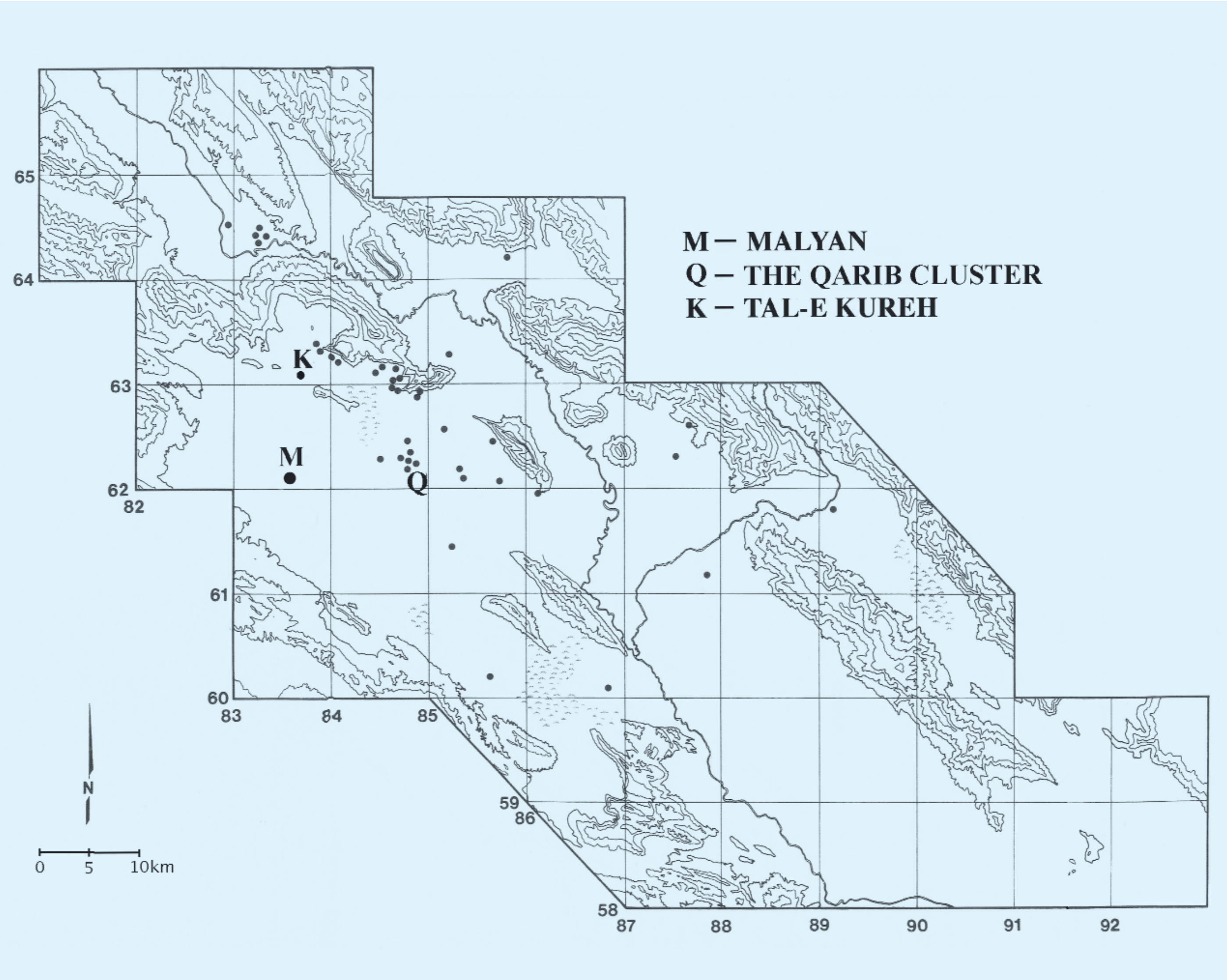

Fig. 1: Map of Kur River Basin with the distribution of Banesh sites (marked with small dots) and important sites mentioned in the text.

Introduction

Banesh culture emerged in Kur River Basin (hereafter KRB) in central Fars in southern Iran (Fig. 1) around 3400 BC. By about 3200 BC Banesh-related material appeared in late Susa II levels (Acropole I: 18-17) and continued through Susa III (Acropole I: 16C-14B, Ville Royale I: 18-10). By about 3000 BC non-ceramic Banesh-related material (*e.g.*, seals, sealings, and tablets) reached Sialk (IV), Yahya (IVC), Shahr-i Sokhta (I:10), and Hessār II (Alden 1982a; Dyson 1987).

The KRB is a semi-arid region located at the south eastern limit of the Zagros oak forest zone. Archaeobotanical studies (*cf.* Miller 1982) indicate that the region was more wooded in the Banesh period, with juniper, oak, almond, pistachio, and poplar trees in close proximity to Malyan. The increasing use of forest woods during the Banesh period as fuel for craft activities apparently triggered a process of deforestation which has continued until now (*cf.* Miller 1985; 1990).

The Banesh period in the KRB is divided into Early, Middle, and Late phases (Sumner 1986), characterised by two major families of pottery: Banesh Grit-Tempered Ware which may be slipped and decorated with black, white, and/or red paint; and Banesh Chaff-Tempered Ware, predominant throughout the period. Lowland-related ceramics, including Bevelled-Rim Bowls, were also used. Besides pottery, Middle and Late Banesh phases are characterised by typically small cushion-shaped clay tablets inscribed with Proto-Elamite script. Other administrative devices including cylinder seals and sealings also occur in Banesh contexts.

Settlement Pattern

Twenty-six sites in KRB are dated to the Early Banesh phase (Sumner 1986). These sites are characterised by their small size and unusual location near the high hills in the middle or scattered around the edges of the plain. These settlements had easy access to springs at the foot of mountains. The Middle Banesh settlement system consists of Malyan – with an area of at least 40 ha at the end of the phase – as the dominant centre, the Qarib cluster, and 17 villages scattered across the plain. In the Late Banesh phase, Malyan occupied over 40 ha with a surrounding city wall, encompassing about 200 ha. The Qarib cluster and 15 small villages across the plain comprise the rural settlements of the Late Banesh phase.

There are two important clusters of sites in KRB during the Banesh period: Kuh-e Kuruni and Tall-e Qarib. The former cluster includes 16 unmounded or very low sites situated on the rocky southern talus of Kuh-e Kuruni. The two largest sites in this cluster are between 2.5 to 4.5 ha, and the rest around 1 ha or less. This part of the plain is today commonly used by pastoral nomadic people. The presence of stone alignments of undetermined date and Banesh sherds as the major component in some of these sites raises the possibility that this area was used by pastoral nomads during Banesh times as well (Alden 1979; Sumner 1986).

Evidence for Craft Activities

Important evidence for craft activities in KRB during the Banesh period comes from the Qarib cluster, a group of eight small and one large villages situated almost exactly in the centre of the plain (Fig. 1). Sites of the Qarib cluster are located within a few hundred meters of each other, and a nearest neighbour analysis of this cluster shows a tendency towards uniform spacing (Alden 1979). The closest source of irrigation water to the Qarib cluster is about 10 km to the north. It is possible that these villages were engaged in dry farming and animal husbandry, but the survey evidence, including the large Chaff-Tempered pottery dumps at locations 8G35 and 8G37, suggest that the Qarib cluster was primarily a centre for pottery production (Alden 1979; Sumner 2003, 203). Further, studies of stone fragments from Tall-e Qarib (Blackman 1981) support the interpretation of the cluster as a production centre, as a characteristic type of inlaid plaster vessel (Alden 1979, Fig. 55) is found only here.

Evidence from the Qarib cluster suggests centralised pottery production in the Early Banesh phase (Alden 1982b). The central site of this cluster (8G38), located on a low natural rise about a meter higher than the plain, consists of a collection of sherd clusters covering a rectangular area of 180 x 150 m. These sherd clusters may represent individual households across the site, but they are not distinct enough to allow an estimate of the number of dwellings on the site. A concentration of stone vessel fragments was found on the eastern edge of 8G38, suggesting a dump area for vessels broken during manufacture or shipping to other parts of the plain. Alden (1979, 204) suggests that 8G38 may have been occupied by people who manufactured Chaff-Tempered pottery at the nearby site of 8G35. This latter site consists of about 0.7 ha (140 x 100 m) of very dense sherd cover. There is a large salt-crusted depression just west of this site which may have been the clay source for Chaff-Tempered pottery production. 8G37, a small 0.1 ha site, also has surface deposits like those of 8G35. Another site in the Qarib cluster, 8G40 is defined by a light, uneven sherd scatter on a low natural rise. Alden (1979, 205) suspects that the latter was similar to 8G38 before recent plowing broke up larger sherds and scattered them over the settled area.

More evidence for craft activities in KRB during the Banesh period comes from Tal-e Kureh in the northernmost corner of the Baiza plain, about 12 km north of Malyan and 15 km northwest of the Qarib cluster. While the Qarib cluster seems to have served as a centre for production of Chaff-Tempered pottery and stone vessels, the surface survey and test excavations at Tal-e Kureh indicate the production of the other major type of Banesh pottery, *i.e.*, the Banesh Grit-Tempered ware (Alden 2003). The location of Tal-e Kureh would make sense considering its close proximity to wooded hillsides and low carbonate clay deposits of shale beds above the talus slopes (Blackman 1981) used for production of Banesh Grit-Tempered ware (Sumner 2003, 111).

Fig. 2: Map of Malyan.

It should be noted that the frequency of Grit-Tempered pinched-rim bowls – a characteristic pottery of the Banesh period made at Tal-e Kureh and distributed from the Qarib cluster – varies with the distance from the Qarib cluster with closer sites having higher frequencies and farther sites lower frequencies (Alden 1982b). This pattern implies that a market-type distribution system was responsible for manufacturing and bulk transportation of pottery from production sites at Tall-e Qarib to distribution centres in the plain. According to Alden (1982b, 98), the radius of the area served by Tall-e Qarib was between 14 and 18 km, roughly the maximum distance a person on foot could go and return if he carried a reasonably sized burden. In support of this hypothesis, it should be noted that no site more than 20 km from Tall-e Qarib yielded any pinched-rim bowls.

Craft Activities at Malyan

Some insight into craft activities during the Middle Banesh phase comes from areas ABC and TUV at Malyan (Fig. 2). Operation

TUV, in an isolated area of Banesh occupation in the southeast corner of the site, is characterised by domestic buildings (Nicholas 1990), whereas Operation ABC, roughly in the centre of the site, has yielded a series of four buildings of increasingly monumental scale (Sumner 2003). ABC 2, the uppermost building, is described as a large warehouse, while ABC 3 was an elaborately decorated building with a formal arrangement of rooms and doorways, and ABC 4 a large structure with evidence for both domestic activities and craft production. Walls of ABC buildings and a number of other structures at TUV were faced with lime plaster, suggesting an industry of lime production at the site (Blackman 1982).

Operations ABC and TUV produced a wide variety of raw material from local and distant sources, as well as semi-worked and finished products, and production debris. This evidence points to various craft activities including flint-knapping, bead making, stone vessel production, and shell-working (Nicholas 1990; Vidale 2003). So far no evidence for pottery production during Banesh period has been excavated at Malyan; therefore, it is conceivable that the Qarib cluster served as pottery supplier for Malyan as well. While pottery came from the nearby Qarib cluster, copper came all the way from Anarak, lapis lazuli from Afghanistan, turquoise from Khorasan, shell from the Persian Gulf, obsidian from Lake Van region, and a faience bead from Baluchestan.

Evidence for copper smelting comes primarily from Operation TUV, Levels 2-3, where slag, bits of metal, and furnace fragments were discovered in domestic contexts, while ABC buildings 2 to I4 also yielded some evidence for copper smelting (Pigott, Rogers & Nash 2003).

It seems that during the Middle Banesh phase Malyan was a small city with part-time craftsmen engaged in craft activities on both household and institutional levels (Sumner 2003, 116). The extent of craft activities and the range of material used, whether imported or locally procured, seems to have been beyond the immediate needs of the local population and the products may have been distributed among sedentary and mobile population in KRB for consumption or trade. The still less than perfectly understood Proto-Elamite texts (Stolper 1985) as well as other administrative devices from both ABC and TUV operations may partially record these craft and marketing activities.

Conclusion

The archaeological evidence from Banesh period KRB suggests extensive craft activities and a significant level of craft specialisation. The Qarib cluster and Tal-e Kureh seem to have been occupied by specialised craftsmen, responsible for production of the two major families of Banesh pottery: Banesh Chaff-Tempered Ware at the Qarib cluster and Banesh Grit-Tempered Ware at Tal-e Kureh. Spatial analysis by Alden (1982b) shows that the Qarib cluster flourished in a central locale in the Early Banesh settlement system where resources to manufacture Chaff-Tempered pottery were easily available. This locale later became the nexus of regional distribution system for Banesh society. It seems that the Qarib cluster also served as a distribution point for stone vessels from unidentified production sites.

So far no direct evidence has been discovered to determine whether Malyan had direct control on craft activities at the Qarib cluster or Tal-e Kureh, but the pattern of specialised production and regional distribution is suggestive of some sort of centralised control mechanism that may have operated out of Malyan (only 12 km to east of the Qarib cluster and 12 km south of Tal-e Kureh). This sort of spatial relationship between the regional centre and area of craft activities can also be observed in the later third millennium urban centres on the Iranian Plateau such as Hesār, Shahdad, and Shahr-i Sokhta (Tosi 1984; Mariani 1989) where the evidence for small-scale craft activities was discovered in residential areas, while large-scale activities, especially those with considerable debris and pollution (most importantly pottery production) are found in specialist workshop areas, usually a distance from the settlement.

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Cultivation of rice between Meymand and Jahrom in the centre of Persis. The reticulated irrigation canals part the paddy field in numerous modules. Rice is the most important staple food in Iran and comes in varying preparations with nearly all dishes; Photo: G. Gerster.

Tappeh Yahya and the Prehistoric Metallurgy of South-eastern Iran

C. P. Thornton & C. C. Lamberg-Karlovsky

Fig. 1: Sites mentioned in the text.

Introduction

In his important English summary of decades of Soviet work on ancient metallurgy, E. N. Chernykh (1992) proposed a new heuristic device for the study of archaeometallurgy known as the "metallurgical province" , which he defined as a system of interrelated metallurgical and metalworking foci. There are a number of such 'provinces' in Western Asia that date back to the very beginnings of copper utilisation, including the Southern Levant, the Anatolian highlands, the Iranian plateau, and the Balkans (see Schoop 1995). Of these, the one that has received the least scholarly attention is South-eastern Iran, despite the fact that this area provides some of the best evidence for the evolution of metallurgy in prehistory from the precocious crucible smelting at Tal-i Iblis in the 5th millennium BC to the well-preserved metallurgical and metalworking facilities of 3rd millennium Shahdad. Early experimental and ethnographical work by Cyril Stanley Smith, Theodore Wertime, and Radomir Pleiner (1967) notwithstanding, the study of South-eastern Iranian metallurgy has been mostly limited to small-scale analyses of copper-base artefacts (*e.g.*, Curtis 1988) or metallurgical remains (*e.g.*, Hauptmann & Weisgerber 1980).

Fig: 2: Timetable of the major areas discussed.

DATE (BCE)	Mesopotamia	Khuzistan	Fars	Soghun	Kerman	Sistan	Central Asia
5500				*Tepe Yahya*			
				?			
		(Jaffarabad)					Djeitun
5000				VII			
					Tal-i Iblis		
	Ubaid				?		Pre-Anau IA
					(0)		
4500		(Chogha Mish)	(Bakun)				
					I-II		
				VI			
	Uruk						Anau IA
		Susa					
4000	Early						
		I					
				VC	III		
			(Lapui)			(Mundigak I)	Namazga I
	Middle				IV		
3500							
				VB-VA	V-VI		
	Late	II	*Tal-e Malyan*			(Mundigak II)	Namazga II
						Shahr-i Sokhta	
3000	Jemdet Nasr		Banesh				
		III		IVC		I	Namazga III
	Early Dynastic						
	I						
						II	Namazga IV
2500	II	IV					
	III	Old Elamite			?		
				?		III	
	Akkadian	Akkadian		IVB			Namazga V
					Shahdad	IV	
2000	Ur III	Ur III				?	
		Shimashki	Kaftari				
	Isin-Larsa	Sukkalmah		IVA	*Khinaman*		Namazga VI
				?	?		?
	Old						
1500	Babylonian	Mid Elamite					

An exception to this trend was the work of Dennis L. Heskel (1982), whose dissertation provided the first comprehensive analysis of the metallurgy and metalworking techniques of this important region (see also Heskel & Lamberg-Karlovsky 1980, 1986). Heskel's work was significant for a number of reasons. First, he argued convincingly against the Marxist models for a linear evolution of metallurgy in which one metal type replaces its 'inferior' predecessor (à la Childe 1944), preferring instead a cumulative model in which the metalworker's repertoire expanded as new materials and technologies were discovered. Second, he made metallographic analysis the focus of his research, thereby providing much-needed information on the metalworking techniques of this region from the Chalcolithic through the Bronze Age. Third, and most significantly, Heskel provided one of the first anthropological syntheses of ancient metallurgy; *i.e.*, he explored the interaction between the material and the socio-cultural realms of human existence.

It is at this level of analysis, which Chernykh (1992, 8) unfairly dismisses as "inferior" to more typological and technological studies, that we will attempt to summarise the metallurgical sequence of South-eastern Iran. Over the past few years, new data on metallurgical collections have come forth from sites in this 'province' such as Shahr-i Sokhta (Hauptmann *et al.* 2003), Shahdad (Hakemi & Sajjadi 1997; Vatandoust 1999), Tappeh Yahya (Thornton *et al.* 2002), Tal-i Iblis (Pigott & Lechtman 2003), and Tal-i Malyan[1] (Pigott et al. 2003a, b). That these recent works have highlighted the importance of this region to the greater understanding of ancient metallurgy in toto is most fortuitous, because the new era of collaboration between Iranian and foreign scholars, as exemplified by this splendid exhibition, has only just begun.

The Beginnings of Metallurgy

The earliest metal objects from South-eastern Iran were found at the small (4 ha) site of Tappeh Yahya (Fig. 3), which is located in the Soghun Valley about 220 km south of the modern city of Kerman. Although little more than a village for most of its existence, the C^{14}-dated levels of nearly unbroken prehistoric occupation (*c.* 5500-1700 BC) and decades of scientific analysis of the excavated materials have made Yahya one of the most important archaeological sites in Iran (see Lamberg-Karlovsky & Beale 1986; Lamberg-Karlovsky & Potts 2001). The metal artefacts from the Neolithic/Chalcolithic levels of the site (*c.* 5500-3600 BC) are almost exclusively of high-purity native copper and the three that have been analysed metallographically, including the intricately-made tack from *c.* 4800 BC (Thornton et al. 2002, 1456), demon-

Fig. 3: The northern step trench of Tappeh Yahya in 1973.

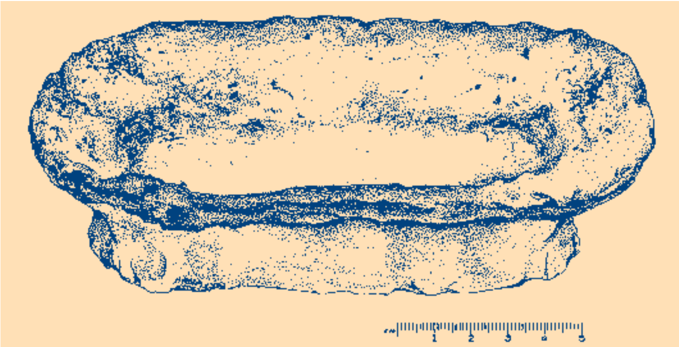


Fig. 4: Ceramic crucible from Tal-i Iblis as reconstructed from a large fragment; from Caldwell 1967, 185.

The early practice of smelting in South-eastern Iran at Tal-i Iblis is most surprising given the relative lack of metallurgical pyrotechnology or its products at contemporary sites such as Tappeh Yahya. Far from an immediate replacement of the local native copper tradition, the introduction of arsenical copper in the late 5th millennium BC does not become widespread at Yahya until the Chalcolithic-Bronze Age transition (Periods VB-VA; *c.* 3600-3200 BC). Even then, the use of high-purity copper (either smelted from oxide ores or melted native copper) for finished objects continues well into the Bronze Age, which may suggest that unalloyed copper was valued for aesthetic properties such as its colour (à la Hosler 1994).

strate a level of sophistication in native copper metalworking that is unparalleled at this early date.

One noteworthy object from this collection of early metal artefacts is a pin/awl from Period VIA (*c.* 4200 BC) that is distinguished from similar pieces by having a rectangular cross section (others are circular) and containing significant impurities (1.43 wt% As and trace amounts of Pb, Sn, and Ag; see Thornton *et al.* 2002, fig. 3b). More importantly, preliminary metallographic analysis suggests that this piece has been cast to shape and probably smelted, although future in-depth study of this object is needed before anything conclusive can be posited. It is undoubtedly not coincidental that this artefact, which was probably imported to Yahya, is contemporary with the increased contact between South-eastern Iran and the Chalcolithic centres to the west as evidenced by three late Ubaid sherds and Lapui ware from Fars (Lamberg-Karlovsky & Beale 1986, 266).

Period VIA at Yahya is also marked by a decrease in the use of local chlorite for bead making and a significant increase in the use of turquoise, the closest source of which lies ~170 km to the north near the important site of Tal-i Iblis (Beale 1973). This shift is noteworthy for the purposes of this paper because of the overwhelming evidence for early crucible smelting (*c.* 4500-3500 BC[2]) of copper oxide ores found at Iblis (see Caldwell 1967, 1968; Pigott 1999b, 74-7). This evidence for early metallurgical pyrotechnology in conjunction with the copper arsenate ores from this site identified by Heskel (1982, 421-2) make Iblis a probable source for the arsenical copper pin from Yahya VIA. It is worth mentioning that the arsenic utilized by South-eastern Iranian metalworkers is often considered to derive from the famous Anarak-Talmessi mine region, a theory first proposed by Heskel & Lamberg-Karlovsky (1980) following the seminal work of Cyril Stanley Smith (1965). However, it should be noted that not a single iota of archaeometric or archaeological evidence exists to support the hypothesis, which is oft-repeated in the literature on arsenical copper in Iran and beyond, that the Anarak-Talmessi ore sources were being exploited in prehistory. Only future studies in Iran can provide much-needed scientific corroboration.

The Bronze Age

Although 'Bronze Age' metalworking techniques (*e.g.*, intentional alloying) are known at Iranian sites before the 3rd millennium BC[3], it is the expansion of Proto-Elamite culture from Khuzistan in the late 4th/early 3rd millennium BC that signals the beginning of the archaeological 'Bronze Age' in South-eastern Iran. At Yahya Period IVC, this expansion takes the form of a Proto-Elamite 'colony' or administrative building containing Proto-Elamite tablets (such as those on display in this exhibit), seals/sealing, and ceramics (see Lamberg-Karlovsky & Potts 2001), a collection directly paralleled in similar colonies at Tappeh Sialk and Tal-i Malyan and in isolated finds from Godin Tappeh, Shahr-i Sokhta, and Tappeh Hesār (Lamberg-Karlovsky 1978). While the nature of this 'colonization' remains unclear, it was undoubtedly related to the rise of the great Bronze Age trade networks that crisscrossed the Iranian plateau in the 3rd millennium BC.

In relation to metallurgy, the transition from Period V to Period IV at Yahya is marked by new object forms (*e.g.*, the stylus), greater amounts of arsenic (up to 5wt% As), and, most significantly, a shift to casting artefacts instead of working them to shape. This new 'technological style' (à la Lechtman 1977)[4] signifies a decrease in the 'value' (qua reflection of the amount of labour invested in an object) of copper-base objects, which is probably related to the increase in metal production and metalworking at sites across the Iranian plateau in the 3rd millennium BC (Pigott 1999a, b). One such site that deserves mention is Tal-i Malyan ("Anshan") in Fars, where evidence for small-scale metal production and processing has been found by excavations in both the ABC and TUV areas of the site (Nicholas 1990; Sumner 2003). Recent metallographic work by Rogers and Nash (in Pigott *et al.* 2003a) on metal artefacts and metallurgical by-products (*e.g.*, ores and prills) from the Banesh period of this site (*c.* 3400-2600 BCE) has identified copper-base alloys containing arsenic, lead, and, in one case, 28.2wt% antimony, and copper oxide ores[5] (see Abdi in this volume).

Shahr-i Sokhta in Sistan is another Bronze Age site whose flourishing metallurgical technology undoubtedly influenced the shift in technological style witnessed at Yahya Period IVC. A recent re-analysis of the ores and slags from this site by Hauptmann *et al.* (2003) has confirmed Heskel's (1982, 30-1) observation that oxide and sulfide ores were being utilised from the earliest levels of Period I (*c.* 3200-2800 BC) and with great abundance in Period II (*c.* 2700-2500 BC), most likely in crucible-based co-smelting operations. One of the most intriguing new discoveries from this site is a single example of speiss (with 41 wt% Fe, 18 wt% As, 0.5 wt% Sb, 0.15 wt% Cu), which the authors describes as the product of the "erroneous heat treatment of an odd piece of arsenopyrite" (Hauptmann et al. 2003, 201). However, there are other possibilities: this material may be the accidental by-product of an over-heated co-smelting operation between copper oxide and arsenopyrite, or it may have been refined from arsenopyrite (FeAsS) or leucopyrite (Fe_3As_4) for the simple reason that arsenic can be sublimated into copper in a closed crucible (see Rostoker & Dvorak 1991, 11-13).

Although there are many stylistic parallels in the copper-base trinkets from Shahr-i Sokhta and Tappeh Yahya, the complete lack of sulfide inclusions in the artefacts that have been analysed by electron microprobe from 3^{rd} millennium contexts at the latter site would seem to dismiss the possibility of Shahr-i Sokhta being Yahya's main copper supplier. Indeed, the diagnostic shaft-hole axe from Yahya Period IVB2 displayed in this exhibition (see also Lamberg-Karlovsky & Potts 2001, 143) has no parallels at Shahr-i Sokhta, but is closest in form to axes from Damin, Shahdad, and far-away Susa (ibid., 115). The other significant difference between the metal being utilised at these two sites is the presence of minor amounts of tin (0.38-0.75 wt% Sn) in four artefacts from one area of Yahya IVB (*i.e.*, 'B' and 'BW' contexts), including the piece of 'splash' or casting spillage analysed by Heskel (1982, 93-4)[6]. This contrasts sharply with the collection from Shahr-i Sokhta, which, despite its proximity to the cassiterite sources of Afghanistan and the presence of tin in artefacts from Mundigak (Cleuziou & Berthoud 1982), is entirely devoid of tin[7] (Hauptmann *et al.* 2003, 208).

We have argued previously (Thornton *et al.* in press) that the presence of tin in artefacts from Yahya Period IVB and the expansion of alloy types to include tin bronze, leaded tin bronze, proto-pewter (Pb-Sn), and low-zinc brass (16.9-19.4 wt% Zn) in the following Period IVA (*c.* 1900-1700 BC) are undoubtedly related to the increasing influx of Central Asian material culture throughout the 3^{rd} millennium that is first witnessed in the unanalysed compartmented stamp seal[8] and two pins with elaborate heads from Yahya IVC (see Lamberg-Karlovsky & Potts 2001, 36, 47, 64) and by the compartmented seal from Bampur IV made of tin-bronze (de Cardi 1970, 328). This assertion was based on two lines of evidence from the Yahya collection. First, the only arsenical copper artefacts that were not found in 'X' contexts of the site (where the standard Yahya-style arsenical copper 'trinkets' remain ubiquitous) both contain minor amounts of tin (0.5-1.25 wt%)[9]. Second, the new metal alloys mentioned above are almost entirely found in 'A' and 'B' contexts at the site, which is an area of Period IVA that shows numerous cultural parallels to the Bactrian-Margiana Archaeological Complex (BMAC) of Central Asia (see Hiebert & Lamberg-Karlovsky 1992; Hiebert 1998).

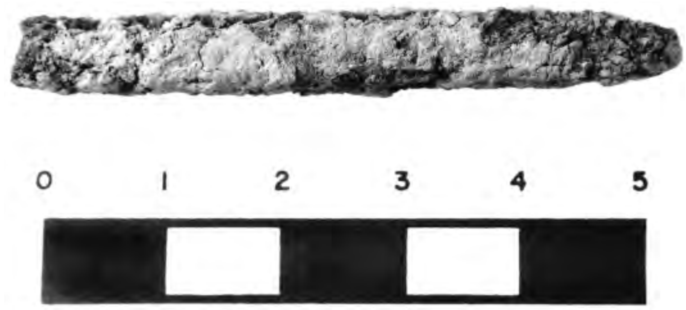


Fig. 5: A standard arsenical copper 'trinket' from Period IVC at Tappeh Yahya. Beginning in the late Chalcolithic of the 4th millennium BC, these 'trinkets' continue to be made and used during the Bronze Age and throughout the Iron Age.

The BMAC of the Namazga VI period (*c.* 2000-1700 BC) is noted for a significant increase in the use of tin-bronze (>50% of artefacts analysed) relative to the earlier Namazga V cultures of Southern Turkmenistan and South-eastern Iran (*c.* 8-12% of artefacts analysed) (Ruzanov 1999). This trend may be a result of the first exploitation of the tin-rich ores of Karnab (Uzbekistan) and Mushiston (Tajikistan) by the 'Andronovo' culture in the early 2^{nd} millennium (see Boroffka et al. 2002; Weisgerber & Cierny 2002; Parzinger & Boroffka 2003). Indeed, recent archaeological work in the Murghab Delta of Turkmenistan (Gubaev *et al.* 1998) has provided evidence for cultural interaction in and simultaneous occupation of the region by both the urbanized BMAC culture and the steppe-nomadic 'Andronovo' culture, which is noted for using tin-bronze (*c.* 3-10% Sn) in more than 90% of their metal objects (Chernykh 1992, 213). The possibility of an 'Andronovo'-BMAC-South-eastern Iranian connection in the use of tin-bronze is a topic that demands further research.

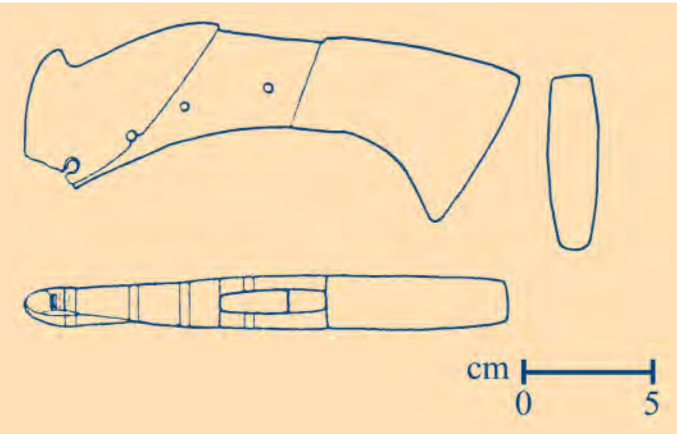
It is with this pattern in mind that we suggest that the three objects from the more local 'X' contexts of Yahya Period IVA that are tin-bronze (*i.e.*, two pins and a bangle) may also be imports from Central Asia. This claim can be made based on the presence of high levels of tin (7.62-8.66 wt% Sn) in addition to relatively significant traces of iron and sulfur (~0.2 wt% Fe, 0.1-0.19 wt% S; see Thornton 2001, 72); *i.e.*, two elements that were not detected by microprobe analysis[10] in the standard arsenical copper trinkets from this site, but which are prevalent in the metal artefacts from Margiana analyzed by Hiebert and Killick (1993) and in most of the tin-bearing artefacts from Yahya IVA. One of these artefacts, a pin with a fluted, globular head, is stylistically comparable to two pins from the BMAC-related cemetery at Khinaman (see Curtis 1988, 110).

It is probably not coincidental that minor amounts of tin (0.26-0.78 wt%) were also found in two of the three brass pieces from this period that have been discussed in depth elsewhere (Thornton *et al.* 2002, 1457-1459; Thornton & Ehlers 2003). The full metallographic analyses of the two brass bracelet fragments, which are stylistically similar to contemporary bracelets from Margiana (Hiebert & Killick 1993, 189-190) and Khinaman (Curtis 1988, 110), will not be repeated here, but it is interesting to note that they were made in two very different styles of metalworking. While the chemical composition of these objects (notably the presence of zinc sulfide (ZnS) inclusions) suggests that the brass itself was produced elsewhere[11], the metalworking techniques used to produce these objects is comparable to those used to make arsenical copper artefacts from this collection, which may suggest that copper-base alloys were imported to Yahya and then worked locally.

It should be noted, however, that five of the eight tin-bearing artefacts (0.36-16.8 wt% Sn) from the Kaftari period at Tal-i Malyan (c. 2200-1600 BC) were also manufactured via the same metalworking techniques (see Pigott et al. 2003b, 170-173). Although their technological styles in metallurgy are similar, Dan Potts (1980, 579-580) has noted that only a single painted buff ware sherd with parallels to Kaftari Ware found in Yahya Period IVA demonstrates evidence of contact between Malyan and South-eastern Iran. This may suggest the presence of a 'middleman' through which these metalworking techniques and tin-bearing metals may have spread. While no evidence of contact with the BMAC has ever been noted at Malyan itself (Sumner pers. comm.), the tin-bearing copper artefacts from nearby Tal-i Nokhodi analysed by Cyril Stanley Smith (in Goff 1964) were found in association with a shaft-hole axe-hammer (Fig. 6) unquestionably related in general form to the 'ceremonial' axes from Margiana (see Sarianidi 2002, 103) that have also been found in great numbers in the Shahdad cemeteries (including those displayed in this exhibition).

Although the expansion of the BMAC to the Iranian Plateau in the late 3rd/early 2nd millennia undoubtedly played a part in the increase of tin-bronze usage at Susa VB (Malfoy & Menu 1987), Kaftari-period Malyan (Pigott et al. 2003b), and Yahya IVA (Thornton et al. 2002), it seems unlikely that the base metal for these stylistic artefacts could have come from Central Asia itself given the

Fig. 6: BMAC-style axe-hammer from Tal-i Nokhodi; from Goff 1964, 50.



scarcity of BMAC sites with evidence of actual metal production besides the single copper oxide crucible smelt uncovered at Dashly-3 (Sarianidi et al. 1977). A strong contender for the source of copper-base metals in South-eastern Iran is the complex of metallurgical workshops at Shahdad (Khabis) (see Hakemi 1992; Hakemi & Sajjadi 1997; Pigott 1999b, 89-90), which remains poorly understood both archaeologically and metallurgically. What seems clear, however, is that from the late 3rd millennium to the mid 2nd millennium BC, Shahdad was a major urban centre with convincing evidence for the large-scale production and manufacture of metal, pottery, and semi-precious stones (Asthana 1984) as well as significant contact with the cultures of Central Asia (Lamberg-Karlovsky & Hiebert 1992).

Although the large collection of metal artefacts remains mostly unexplored, Abdolrasool Vatandoust's (1999) analysis of sixteen artefacts from the site has revealed the presence of minor amounts of tin (0.12-0.54 wt%) in over two-thirds of the corpus. With this in mind, it is probably safe to suggest that by the late 3rd millennium, Shahdad was supplying metal to many of the sites in South-eastern Iran including Tappeh Yahya and probably Jiroft, where classic Shahdad-style pins (Fig. 7), metallic vessels, and a metal "basin"[12] with a repousse eagle have been found (see Majidzadeh 2003, 208-9). More tenuous is the suggestion that Shahdad served as the conduit through which Central Asian culture and styles, such as the use of tin-bronze and the BMAC material found throughout the region, reached small sites such as Yahya and the cemetery of Khinaman. Only future studies of the Shahdad collection and collections from Central Asian sites will be able to answer what role the BMAC played in the adoption of tin-bronze across the Iranian Plateau in the early 2nd millennium BC.

Concluding Remarks

In this paper on the prehistoric metallurgy of South-eastern Iran, we have attempted to look for larger diachronic and synchronic patterns related to Tappeh Yahya, which, despite its diminutive size, remains the best studied collection of metal artefacts in the region. From the skilled working of native copper in the late 6th/early 5th millennia to the introduction of copper-base alloys such as tin bronze and brass in the late 3rd/early 2nd millennia, this important region of Iran continues to redefine our understanding of the prehistoric metallurgical sequence of the Middle East, exactly as it did twenty years ago. With an era of international collaboration just dawning, it behoves us to encourage new archaeometallurgical research in this area so that South-eastern Iran can join the ranks of other comparable metallurgical 'provinces' in importance and depth of knowledge.

Although we have chosen to highlight Chernykh's conception of the metallurgical 'province' in our discussion, it is our contention that the future of archaeometallurgical studies in Iran and beyond lies in more anthropological models of socio-technic interaction. Notable among these are Lechtman's (1977) theory of 'technological style' discussed above, Lemonnier's (1986) conception of

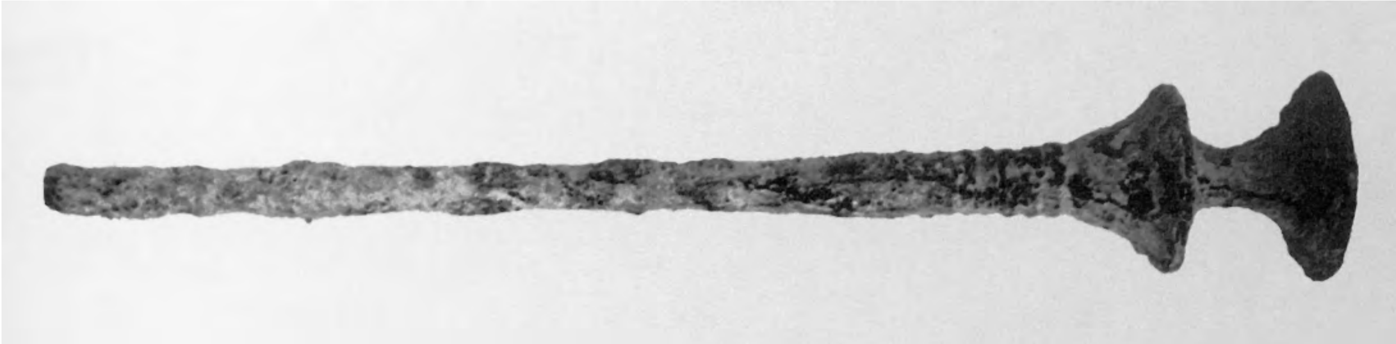


Fig. 7: A pin from the clandestine excavations at Jiroft that is identical to pins from Shahdad such as the one analyzed by Vatandoust (1999, 131); from Majidzadeh 2003, 155.

'technological systems',[13] and Rita Wright's (2002) discussion of 'social boundaries' within a shared technological interaction sphere or, in this case, within a 'metallurgical province' (see Stark 1998). Only by applying these important theoretical constructs to our interpretation of rigorous scientific analyses can we begin to understand metallurgy as a "human experience" (à la Smith 1977) and thereby usher in this new century of archaeological research in Iran with a concern for its people, both present and past.

Notes

1 Although outside of the region generally classified as Southeastern Iran, Tal-i Malyan and other sites in the Fars region were undoubtedly in contact with the 'metallurgical province' to the east (to what extent is unclear); thus, they will be included in this paper.

2 Following Voigt & Dyson (1992, 143-5), although the exact chronology of Iblis and its intercultural comparanda are not entirely clear.

3 *E.g.*, the 4th millennium artefacts from Susa with up to 19 wt% Pb, 8 wt% As, and 5.3 wt% Sn analyzed by Thierry Berthoud (1979).

4 *I.e.*, a culturally-specific way of making an object that is structured by the ideological 'world-view' of the craftsperson within his or her society.

5 Little can be said about the types of ores actually smelted at Malyan until a detailed microprobe analysis of the inclusions in the metal artefacts is undertaken.

6 This artefact was incorrectly labelled as Period III in Thornton et al. 2002.

7 Although the entire corpus of metal artefacts from Shahr-i Sokhta has yet to be analysed.

8 This artefact, although stylistically part of the late 3rd and early 2nd millennia corpus of compartmented stamp seals found throughout Central Asia and South-eastern Iran (see Baghestani 1997), was found inside a Jemdet Nasr pot from the Period IVC Proto-Elamite building complex (see Lamberg-Karlovsky 1984).

9 Heskel (1982, 96) reports finding 2.4 wt% Sn and not 1.25 wt% Sn in the pin from B.69.2.1, which may indicate uneven distribution of the tin in different parts of the artefact.

10 Due to isobaric interference with the argon carrier gas used in the ICP-MS analysis of the Yahya collection, sulfur and iron were not detectable except in those artefacts also analysed by electron microprobe analysis (see Thornton et al. 2002).

11 Perhaps in Central Asia, where copper-zinc alloys are occasionally reported from Namazga V (i.e., late 3rd millennium) contexts, including a seal (14.8 wt% Zn) and a needle (24.7wt% Zn) from unstratified contexts at Namazga Tappeh (see Egor'kov 2001, 87), a ring (25 wt% Zn, 10 wt% Ni) and a pin (15-18 wt% Zn, 5 wt% Pb, 3 wt% Sn) from Dal'verzin (Bogdanova-Berezovskaja 1962), and a blade fragment (16 wt% Zn, 12 wt% Pb, 6.6 wt% Sn, 2.2 wt% As, 1.6 wt% Fe) from Altyn depe (Egor'kov 2001). Of course, the spectral analyses performed in the 1950s and 1960s on the Namazga Tappeh and Dal'verzin material must remain suspect, and an analysis of the same Altyn-depe blade fragment by a second laboratory reported less than 6wt% Zn, but only future analyses of Central Asian materials will confirm or deny the presence of brass in 3rd millennium contexts.

12 The only excavated examples of these "plates" (pot lids?) with raised relief animals, which have been discussed in a number of publications (see Moorey 1993; Hakemi 2000; Bellelli 2002), are from Hesār (1) and Shahdad (5), although an early possible proto-type of this type of object is the ceramic "pot lid" with a repousse stag from early 3rd millennium Level C at Kvatskhelebi in Georgia (see Sagona 1984, 39, Fig. 105-226.A1; also Kavtaradze 1999, 82).

13 I.e., the combination of choices (or "chaines opératoire") made by craftspeople within a particular socio-cultural context during the production and use of material culture (see Dobres & Hoffman 1999).

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Chlorite and Other Stone Vessels and their Exchange on the Iranian Plateau and Beyond

Philip Kohl

Connections that linked different regions of the ancient Near East assumed different forms, including the movements or migrations of peoples and the exchange of goods. Although often difficult to distinguish archaeologically, the circulation of materials also took diverse forms, including gift exchanges, movements of materials via marriage alliances, tributary demands, merchant-directed market trade driven by principles of supply and demand, and war booty brought back from successful military campaigns. Via all these processes, materials moved around and were deposited in other places than where they were initially produced, and all have been attested archaeologically and in early cuneiform sources during the Bronze Age. It is often analytically useful or even essential to distinguish an exchange of luxury items from a trade in utilitarian goods or necessities and to separate the exchange of finished commodities from a trade in raw materials or semi-processed goods, such as metal ingots. Nevertheless, these different types of the circulation of materials do not necessarily operate in distinct spheres of exchange, but often overlap or occur together and even change their character over time. That is, luxury goods can be exchanged for utilitarian items, and raw materials can be traded for finished commodities. Similarly, materials that can be considered luxuries in one period can become necessities at a later time, as happened with copper and bronze materials during the later 3rd millennium BC. This essay selectively reviews evidence for the production and complex circulation of undecorated and carved soft-stone vessels on the Iranian plateau along the Persian/Arabian Gulf to south-western Iran and southern Mesopotamia in the middle to late 3rd millennium BC. It also briefly considers other evidence suggestive of the circulation of finished vessels and other luxury goods produced on the Iranian plateau and lands even farther east during this period.

Scholars of the ancient Near East have long recognised that the Iranian plateau was a source for valuable materials unavailable within Mesopotamia proper (*e.g.,* Moorey 1993), though typically the system of exchange that was envisioned was one of unfinished or semi-processed materials arriving in the urban centres of Mesopotamia, Syria, and south-western Iran where they were further worked into highly crafted tools, weapons, containers, and ornaments. It became clear, however, that such a picture was incomplete, and that there was also an exchange of finished products between these regions, a system of exchange most clearly seen in a corpus of widely distributed and elaborately carved soft stone vessels (Aruz 2003). It was also most significant that these carved vessels had a distinct, recognisable iconography with a highly specific symbolic content that was shared by different cultures, suggesting that ideas and possibly belief systems, were also exchanged or diffused over large parts of western Asia during the middle to late 3rd millennium BC.

Fig. 1A: Cylindrical vessel with 'hut'/architectural façade motif. Halil Rud valley, south of Jiroft, south-eastern Iran, height 10.5 cm, diameter 15 cm; adapted from Madjidzadeh 2003, 67.

This trade in these finished commodities is well documented at the workshop of Tappeh Yahya in south-eastern Iran, which produced some of these vessels, and at the trading or redistribution centre on the small island of Tarut just off the Arabian mainland north of Bahrain (Zarins 1978; Lamberg-Karlovsky 1988; Kohl 2001). Moreover hundreds of complete vessels in this style have recently been recovered from pillaged tombs in the Halil Rud valley south of Jiroft or *c.* 80-95 km. east, north-east of Tappeh Yahya, and their very abundance underscores their local production and utilisation in south-eastern Iran (Majidzadeh 2003). The soft green stone chlorite is a commonly available resource in the Iranian Zagros that is found in accessible, easily worked outcrops in the mountains surrounding the small town (*c.* 4 ha) of Tappeh Yahya. It was exploited in all periods of the occupation at the site from Neolithic through Classical times. There is a very sharp peak in the

Fig. 1C: Cylindrical vessel with 'hut'/architectural façade motif, Baghdad National Museum purchased vessel , height c. 10 cm, diameter c. 12 cm; adapted from Kohl 1974, 180, pl. XLVIIIa

Fig. 1B: Cylindrical vessel with 'hut'/architectural façade motif, Saar, Bahrain Island height 7.7 cm, diameter 12.2 cm; adapted from Muscarella 2003, 341, fig. 239.

Fig. 2A: Cylindrical vessel with feline combating eared serpent, Halil Rud valley, south of Jiroft, south-eastern Iran, height 7.4 cm, diameter 11 cm; adapted from Madjidzadeh 2003, 83.

Fig. 2B: Cylindrical vessel with procession of inlaid felines, from Nasiriya, southern Iraq, Baghdad National Museum, height, c. 10 cm, diameter c. 14 cm; adapted from Kohl 1974, 156, pl. XXXIXa.

utilisation of this local resource during the late IVB period at Tappeh Yahya, which is now well dated to the last centuries of the 3rd millennium (on the basis of nine new calibrated ^{14}C determinations, *cf.* Lamberg-Karlovsky 2001, 276, tab. A.1). During this period, the lapidaries at the site began to carve chlorite vessels in a distinctive style, sometimes referred to as the Intercultural Style, which is now well recognised on sites stretching across south-western Asia from Syria and Mesopotamia in the west to the Indus Valley in the east (for the latest discussion with a partial distribution map, *cf.* Aruz 2003c, 325).

Objects in this style consist principally of cylindrical and tapering narrow-mouthed conical vessels and small bowls, some of which possibly contained valuable perfumes or ointments, and enigmatic padlock-shaped handles or weights, including one found far to the north-east in Uzbekistan (Aruz 2003c, 339, fig. 236). A limited number of geometric and naturalistic raised designs sometimes appear alone or occur together on these objects and include architectural façades often with columns and characteristic sagging lintels (the so-called 'hut' motif), fantastic animals, such as serpents, eagles, and scorpions, and stylised human representations. A few of the vessels in this style found in Mesopotamia contain inscriptions (Kohl 2001, 226, fig. 9.13; Aruz 2003c, 336, fig. 233), though these seem to have been incised into the vessel sometime after its original production; that is, such inscriptions only provide *termini ante quem* for dating the vessels. Here we illustrate three vessels carved with the hut or architectural façade motif (Fig. 1A-C) and three carved with figured representations of felines and feli-

Fig. 2C: Truncated conical vessel with feline combating eared serpent, Mari, Ishtar temple, Syria, height 14.5 cm, diameter at base 13 cm; adapted from Aruz 2003, 335, fig. 232.

Fig. 3: Uncarved, bell-shaped chlorite bowl from Ur, Royal Cemetery, PG 800, diameter at rim 31 cm; adapted from Zettler & Horne 1998, 159, fig. 134.

nes confronting or combating serpents (Fig. 2A-C). The motives or, better, sets of motives are highly standardised, if not canonical: the sagging lintels or huts occurring with what appear to be architectural columns; and the felines with curved tails and bodies with round holes for inlays with mouths agape combating eared serpents whose twisted bodies are covered with oval holes for inlays. This broadly distributed style is highly distinctive and immediately recognisable and clearly supportive of some form of contact between highland Iran and the urban centres of greater Mesopotamia.

Physical and chemical analyses (Kohl, Harbottle & Sayre 1979; Kohl 2003) were conducted on carved and uncarved samples of chlorite from Tappeh Yahya and from outcrops or source samples collected in the Zagros mountains immediately north and west of the site, and from artefacts, particularly from these Intercultural Style vessels, found on sites stretching from Mesopotamia into south-western Iran (Susa) and across the Iranian plateau. This study initially demonstrated that most of the vessels carved in this distinctive style were indeed made of chlorite and not the related soft stone steatite to which they had been mistakenly attributed. More significantly, it was possible to break down the corpus according to their simple mineral identification – various non-chlorites, chlorites, and chlorite mixtures or compounds – and tentatively distinguish between at least four separate sources of chlorite.

The archaeological implications of this analytical study were significant and, to some extent, unexpected. Certain, though not all, Sumerian sites seemed to obtain their material from separate sources and not from the single documented production workshop at Tappeh Yahya. The Mesopotamian site of Bismaya (or Adab) was particularly distinctive since most of its analysed samples were actually made from steatite. The clustering of the Intercultural Style 'pure' chlorites broke down into four groups: 1) a Sumerian (southern Mesopotamian and Diyala Valley) group; 2) a Susa-Mari-Yahya group, the source presumably being the chlorite found in the Yahya area; 3) a group with samples dominantly from Susa and Mari; and 4) a final group with samples from Susa, Adab, and the Persian/Arabian gulf (containing some of the tested samples from Tarut and Failaka islands). The analytical work clearly demonstrated that there had been *multiple* production centres, carving complicated, iconographically identical designs on vessels which were destined for the temples and wealthy graves in urban centres far removed from where the stone was quarried and, at least for some of the vessels, worked.

Even more strikingly, the soft stone artefacts analysed from the small island of Tarut just off the Arabian coast north of Dhahran and north of Bahrain also proved to be highly distinctive, suggesting that Tarut was an emporium or transhipment centre for these vessels and/or for the semi-processed and unworked raw materials (partially worked fragments having also been found at Tarut, *cf.* Zarins 1978, pl. 75 b, 605, including those with combatant snake designs, *ibid.*, pl. 72b, nos. 110 and 251). The stone vessels from Tarut were made from several distinctive minerals and different chlorites, suggesting that the tiny island was receiving its soft stones – in unfinished and/or finished forms – from several different source areas. Lathe-turned vessels (*ibid.*, pl. 72b, no. 501) were also found at Tarut, a production technique never used in the late period IVB workshop at Yahya. The presence of this method of production at Tarut corroborates the analytical study in that it shows that at least some of the vessels at Tarut came from workshop(s) other than Yahya.

Undecorated soft stone vessels were also recovered at Tarut, including the so-called bell-shaped bowls with raised circular bases (Fig. 3), which are also found at Yahya, Shahdad, and, most notably, at Ur (compare, for example, stone vessel types 49-51 from the Royal Cemetery at Ur (Woolley 1934, pl. 245) with those found at Shahdad (Hakemi 1997, 605)). The association between these uncarved bell-shaped bowls and the decorated Intercultural Style vessels is clear: seven bell-shaped bowls were recovered from Puabi's tomb (PG 800), and this tomb also contained two of the Intercultural Style vessels found at Ur. The uncarved bowls, like the carved Intercultural Style vessels, are characteristically found in wealthy elite or 'royal' contexts at Ur. Some of these bell-shaped bowls from Ur are quite large; one from Pu-abi's tomb, for example, stood 40 cm high with a rim diameter of 53 cm. This vessel must have weighed several kilograms, and it would have been difficult to import such a heavy and fragile vessel into Mesopotamia as a finished object other than by sea (T.F. Potts 1989). Their presence at Tarut suggests in fact that this was the case, and such maritime-directed movement of materials also is supported by the analytical data of the soft-stone vessels from Tarut.

It is, of course, much easier to record the broad distribution of the elaborately carved vessels than it is of these less striking, undecorated bell-shaped bowls, and this problem of recognition must be acknowledged when trying to assess the scale and intensity of the exchange of materials during the third millennium BC. It has become increasingly clear that there was an extensive overland exchange across both the Anatolian and Iranian plateaux and maritime exchange from the Indus Valley to the Arabian peninsula and the Gulf of other finished goods, such as alabaster vessels (Ciarla 1979; Casanova 1991), and types of jewellery, including circular and heart-shaped gold beads with raised and perforated mid-ribs, etched carnelian beads, and gold and copper quadruple-spiral beads (cf. distribution maps in Aruz 2003b, 240-242). What is less clear is to what extent this exchange of finished luxury goods accompanied a more fundamental trade of metals north to south from Anatolia and the Caucasus and east to west from Afghanistan, Central Asia and Oman into Mesopotamia (D.T. Potts 2000, 48).

It is also probable that materials were not only exchanged but brought by peoples as they moved from one area to another, a pattern that may explain the connections between the Bactrian Archaeological Complex (BMAC) of southern Turkmenistan and northern Afghanistan and the major metallurgical centre of Shahdad north-east of Kerman (Thornton & Lamberg-Karlovsky this volume). Chronological relations here need to be precisely defined. The new series of calibrated ^{14}C determinations from late period IVB contexts at Yahya clearly supports the lower chronology initially proposed by Amiet (1986, 133-134) for dating the chlorite workshop levels at Yahya to Akkadian, if not post-Akkadian times or to the last centuries of the 3rd millennium BC. Since many of the well-stratified Intercultural Style vessels from Mesopotamia date to the end of the Early Dynastic period or more towards the middle of the 3rd millennium, it is clear that objects in this style were produced for several hundred years, presumably being quarried and carved in different areas and in different workshops at different times. Chlorite artefacts occur quite frequently at Shahdad, but few actually can be listed as examples of the elaborately carved Intercultural Style vessels; the greater and more convincing parallels to the Yahya chlorite corpus are to undecorated vessels, such as the bell-shaped bowls and the flat-based cups with slightly flaring or concave sides (Hakemi 1997, 605-607), or to tall goblets decorated with bands of triangles, chevrons, oblique lines or with incised schematic hut designs and open bowls with flat rims, and alternating incised annular and zigzag lines (Hakemi 1997, 609-611). Most of the chlorite artefacts from Shahdad, such as compartment boxes with lids, 'hut' models, and small vials or perfume jars typically decorated with a simple drilled concentric or dot-in-circle motifs, either only rarely occur or are not found at Yahya, while the last, in particular, also appear regularly now on BMAC sites to the north-east. The simplest explanation to account for the differences between the chlorite artefacts from Yahya and those from Shahdad is chronological; viz., the Shahdad cemeteries largely post-date the period of the peak production of the Intercultural Style vessels at Yahya, and the emergence of this centre and its evidence for large-scale metallurgical production, which is also reflected in the changed technology of Yahya IVA metals, is somehow connected with the emergence and development of BMAC sites (and the movement of settlers from there into eastern Iran? (Hiebert & Lamberg-Karlovsky 1992)).

Despite the abundance of chlorite at Shahdad, no raised relief figured representations, such as occur in the pillaged Jiroft cemeteries and at Yahya and on Tarut Island and which are characteristic of some of the most famous examples from Mesopotamia and south-western Iran, were found in the nearly 400 graves excavated at the site. The few classic Intercultural Style occur in graves that are difficult to interpret or that are not terribly distinguished in terms of the number of objects found. The Shahdad graves are, at best, weakly bimodal ("rich"/"poor") in terms of number of objects found/burial. Some burials contain more than twenty ceramic vessels in addition to stone and copper/bronze artefacts, but many of the most spectacular objects found at Shahdad are found in graves containing little else (*e.g.,* graves 47, 114, and 165). The chlorite vessels from Shahdad are not uniquely found in elite graves. In fact, it is essentially impossible to distinguish elite from non-elite grave contexts at Shahdad, suggesting a relatively equal or shared distribution of wealth in their society.

The ongoing Iranian excavations in the Halil Rud valley south of Jiroft are certain to clarify the contexts of the wealth of carved stone vessels and other luxury exotica plundered from there and only todate summarily described by Madjidzadeh (2003, 6) in his catalogue of the recovered objects. Indeed, given their lack of archaeological provenience, it is possible that some, if not all, of these materials may not be genuine. Although that possibility must remain open, the incredible richness of this corpus deserves preliminary comment here – based on the assumption of their authenticity. Many of the chlorite vessels, both in forms and carved motives, constitute classic examples of the Intercultural Style. They could easily have been produced in the Yahya workshop. Other objects, such as flattened zoomorphic statues (*ibid.*, 131-136), footed goblets, some of which are carved and inlaid (*ibid.*, 11-12, 18-33, 49-50), and double-sided lapis lazuli 'stamp seals', some of which have copper/bronze handles (*ibid.*, 169-174), are unique or have less certain parallels. The relative abundance of lapis lazuli suggests connections farther east, possibly with the mines of Badakhshan, and the footed goblets recall BMAC ceramic forms, as well as more remotely a footed carved steatite/chlorite goblet from the necropolis at Gonur-depe in Turkmenistan (Aruz 2003c, 340, fig. 237a). The reportedly dense concentration of early cemeteries and large settlements suggests a regional florescence of a complex Bronze Age polity stretched along the Halil Rud south of Jiroft that flows towards the Jaz Murian basin from the north and that is, thus, located in the same catchment area with the documented 3rd millennium cemeteries and settlements that are found along the Bampur river that flows into this basin from the east (De Cardi 1970, 260, fig. 13). It may be premature to speculate too broadly, but the workshop at Yahya, which is located at the terminal south-eastern extension of the Zagros *c.* 95 km west, south-west of Jiroft, seems to represent a highland component to this Halil Rud centred complex. In other words, it would appear that many of the vessels carved at Yahya were produced for the local consumption of peoples living in the Jaz Murian basin, though it is impossible to determine on current evidence whether they were destined for the local elite or interred in the more egalitarian pattern exhibited at Shahdad.

The Shahdad pattern of consumption certainly contrasts with the context of the securely stratified examples of Intercultural Style vessels from the Mesopotamian sites of Khafajah, Mari, Ur, and Nippur that are found almost exclusively in temples and wealthy or 'royal' burials. Were these carved vessels and other exotica from the east traded as part of an extensive commercial network that was directed by profit-seeking Mesopotamian merchants? Unfortunately, the distributional and analytical data on this point remain moot. Mercantile trade represents only one means by which these materials may have been distributed. Other mechanisms, such as gift exchanges, marriage alliances, tribute, and the like, also may have been means by which the materials were distributed. Some vessels undoubtedly made their way to Mesopotamia as war booty (Klengel & Klengel 1980), suggesting possibly their symbolic value and relative scarcity. The illustrated vessel from the Ishtar Temple at Mari (Fig. 2C) had been broken and apparently its rim had then been reformed, smoothed down, and subsequently utilised. Such a pattern of secondary utilisation does not suggest continuous, uninterrupted access to such carved vessels and again may illustrate both the relative scarcity and high value of these finished vessels. An argument supportive of a competitive, merchant-driven trading network is that there were demonstrably multiple centres for the production of specific types of prestige goods, such as the Intercultural Style vessels. If the vessels themselves were produced over a period of several hundred years, as now is suggested by calibrated radiocarbon determinations, then some of these centres, like the Yahya workshop, were not functioning simultaneously, but sequentially. One production centre simply replaced another for some unknown reason (*e.g.*, the abandonment of old or the occupation of new areas due to shifting political alliances, movements of peoples, climatic/environmental changes or whatever).

The analytical evidence from Tarut can be reasonably interpreted as demonstrating that multiple workshops and/or soft-stone source areas were engaged in the production and shipment of these objects to Tarut at the same time. The fact that the carved vessels so suddenly appear in the stratified sequence at Yahya suggests that they were produced to answer a demand. Someone wanted them – either local elites or distant urban institutions. Different workshops – functioning simultaneously, sequentially, or both – fulfilled the needs of different centres or markets. Such evidence readily lends itself to a commercial exchange model, though qualified by the necessary caveats against anachronisms. The data is consistent with merchants competing to meet their orders or requests for such goods and consistent with the cuneiform evidence from Ebla and with what is known for the slightly later Old Assyrian trading network. Undoubtedly, the rise and fall of production centres, like Yahya, or even secondary states, like Shahdad and now possibly Jiroft, are related to shifting political alliances in the trans-Elamite world, formations that can only be dimly discerned archaeologically.

The 'elites' in eastern Iran or in the trans-Elamite world were hardly the peers of their urban contemporaries to the west; rather, there is little evidence for social differentiation at Shahdad and, as far as is known, at other sites in eastern Iran, the Indus borderlands, and Central Asia. Of course, when it is to their advantage to do so, royal elites can overlook status distinctions and treat their inferiors as equals; thus, the Mesopotamian references to the 'kings' of Magan and of other areas east of Sumer. The exchange of gifts among such 'royal' personages also remains a viable alternative explanation for the distribution of some of the Intercultural Style vessels and of other such finished commodities and prestige goods. If gift exchange was the preferred mechanism and if the 'elites' of the trans-Elamite world were broadly distributed throughout their societies, then there must have been considerable gifts given in return. In either case – commercial or gift exchange – Mesopotamia must have produced its own commodities or surplus goods to participate in the exchange network, though, unfortunately, most of the evidence for Mesopotamian surplus production, above all of woollen textiles, remains, archaeologically invisible.

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A Cylindrical Double-Vase with Basketwork- and House-Decoration

Agnès Benoit

When the delegation in Persia directed by J. de Morgan discovered a chlorite double-vase[1] at Susa at the beginning of the 20th century nobody knew anything about the real origin of this particular crafts product (Fig. 1). Very few examples with this kind of designs were at hand and the fact that a double vase was an extremely rare form was completely ignored. Near East Archaeology was still a young discipline and Nippur (end of 19th century) and Telloh (1903)[2] excavations were the only ones that already had published on similar objects or fragments, all made from this green, but also grey and black rock, that authors called indistinctly chlorite, steatite or serpentine. The important discoveries at Bismaya[3], the old Adab (1903-1904), were still unpublished[4]. Between the two wars, excavations at Ur, Khafadjé, Tell Agrab, and Mari, bringing to light some examples of this production for the 3rd millennium, revealed their wide distribution and their aim at being exported from one or several centres of production, that remained to be localized. Nevertheless, around 1960, P. Delougaz was able to give a general account of the architectural decorations and the titles of the two essays, published in 1964 by F. A. Durrani, for the first time, bore witness that the scholars began to understand the network of exchange between Mesopotamia and the Indus valley (1964a; 1964b). But the real starting point of the knowledge about chlorite is 1968, when the excavations in South-Eastern Iran started: at Tappeh Yahya (Lamberg-Karlovsky 1970; Tosi 1973, 21-53) the existence of craftshops could be proven and at Shahdad (Hakemi 1972) evidence of many different shapes of vessels were given. These new finds encouraged Pierre de Miroschedji to start a study on the mostly unpublished collection at the Louvre, which includes about 100 steatite-vases and artefacts from Susa. He divided them into two groups: an "ancient series" and a "recent series", chronologically overlapping each other for about 100 years[5]. This study from the year 1973 is considered basic even today (Miroschedji 1973).

Fig. 1: The cylindrical double-vase from Susa; Photo: DBM, M. Schicht.

The vase, on display here, belongs to the "ancient series". Its double-cylindrical shape shows one of the two major shapes, the second one being conical. These simple, open shapes were due to the bow-drill technique, as used in Egypt and at Sistan (there for beads) during this period. The wheel was used for horizontal lines and then the motifs were carved. These vases were not manufactured occasionnally but in special craftshops where craftsmen used proven methods and had a mass production. That is why the repertoire of motifs was not wide.

The two types of decoration, which appear on the double-vase from Susa, are well known: plaits and basketwork motifs are among the most favourite themes of the chlorite-carvers: their best known variant, the wickerwork of rather big reed stems, has been selected here. Architectural motif is also very frequent with fasades stretching on one, two, or even three registers. Doors with curved lintel are divided into two parts by a horizontal line, isolating checked patterns in the lower one.

But the double-vase from Susa shows unique features in some details: the house is not only provided with a door in the centre but also with symmetrical windows, all of them with curved lintels. The whole building seems to be made from plant material, particularly the bundles of reed, which remind to the big *mudhifs*[6] from Southern Mesopotamia, whereas, on the already mentioned fragment from Telloh mudbricks or puddled clay adorned with herringbone patterns have been used. At last, the posts and the lintels are doubled, while in other examples they are also tripled[7]. In brief, the depiction of the Susa house is more realistic than in other known vases.

If the motifs are easy to identify, the double-shape of the vase is still unusual[8]. Did it play the same role as the boxes divided into compartments which will appear during the «recent series» (Miroschedji 1973, 59, fig. 9)? At the same period, the small biconical "flacons", on top of a house-shaped base with curved or straight lintel, multiply especially at Shahdad[9].

What of these architectural motifs is conventional and what is realistic? P. de Miroschedji suggests that in the case of clay and mudbrick buildings the soft wood of door and window lintels bends under the weight of the material (1973, 17). To support this idea he presents photographs of such deformations (ibid. 18, fig. 1). But the lintels are bent in such an exaggerated way in the chlorite craft that a mostly decorative function may be suggested. Surely an answer could be found by trying to reconstruct these stylized models.

Notes

1 It is not possible to define neither the year nor the context of this find. It is known that the artefact comes from Tell Akropolis, from the place of the Inshushinak temple: Mecquenem 1911, 6.

2 On the central Tell, in an sounding shaft, 6 m deep, Cros 1910, 40. This artefact is in the Louvre, AO 4115.

3 A fragment of the vase with inscription by King of Kish Mésilim, the famous fragment of the Musicians´ Vase, and small pieces belonging to a vase with architectural decoration.

4 The book titled «Bismaya oder die verlorene Stadt Abad», edited by the head of the mission, Edgar James Banks, Professor for Ancient History in Istanbul, was published as late as 1912.

5 Today it is thought that the "ancient series" dates from a period between 2600-2200 BC and the "recent series" between 2300-1700 BC.

6 This is the huge building in the marshland area which is built from wood and reed in the form of a long rectangular hall and provided with a vaulted roof. These halls are for meetings.

7 This is the case at Telloh, where the door showed a triple post, framed with zig zag patterns which are interrupted by four poles or pillars, and towered by small bricks, see annotation No. 2

8 Another vase of this type was borrowed from Pakistan for an Indus exhibition, cat. of Indus Civilization, Metropolitan Art Museum, Tokyo, 2000, n° 732. On both vases there is the same decoration of small bricks with big zig zag patterns.

9 Hakemi 1972; the complete publication by the same author: Hakemi 1997, 621-624.

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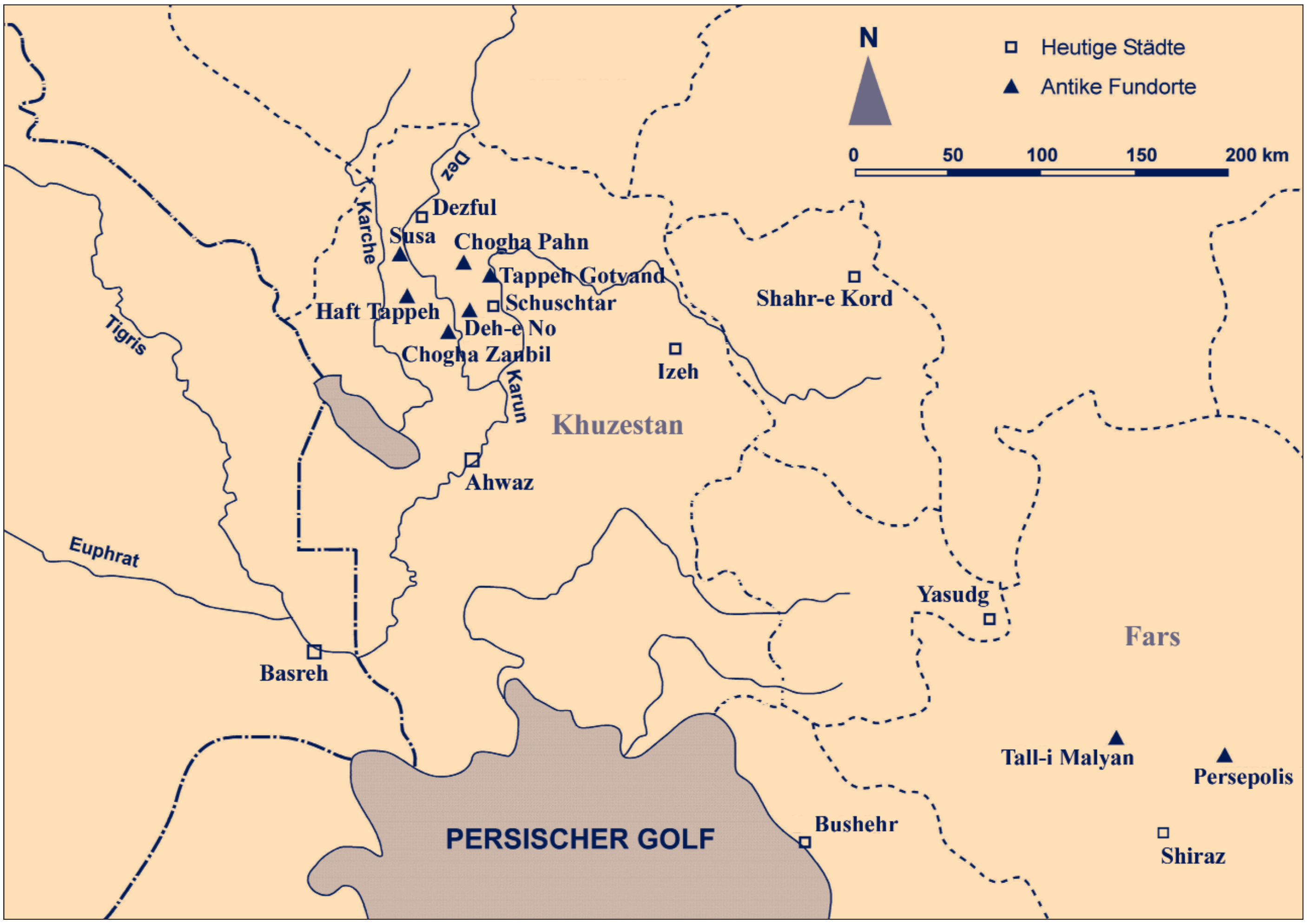
Elam: Archaeology and History

Behzad Mofidi Nasrabadi

Fig. 1: Map of South-western Iran.



Besides Mesopotamia, the plains of Khuzestan in the Southwest of what is Iran today played a major role with the origin of urban societies in the Middle East (Fig. 1). The climatic and geographic features of this region with its three main rivers Karkhe, Dez, and Karun offered favourable conditions for building and developing channels and irrigation systems which led to intensive agricultural activities during the 4th millennium BC. By building channels it was possible to use wide areas of the lowlands for agriculture and to achieve an enormous increase of harvest. Naturally, such a development was related to a polarisation of wealth. Some members of the community succeeded with controlling the riches or rather the related factors like landed property, distribution of work, and trade. By the end of the 4th millennium BC, some settlement centres in Southern Mesopotamia and Khuzestan, like Uruk and Susa, developed into towns with centralised administration (McC Adams & Nissen 1972; Pollock 1989). Writing was invented in both centres for administrative purposes. These were pictographs or logograms which were mostly used for reporting the amount of cattle and other agricultural goods (Friberg 1978; Damerow & Englund 1989). In Mesopotamia the pictographs gradually changed into cuneiform writing in the course of the 3rd millennium BC. Now it was also used for reporting historic matters. Though at first there was an independent writing at Susa, the so called proto-Elamite writing, later the Mesopotamian cuneiform writing was taken over.

The earliest evidence mentioning the country of Elam is from Mesopotamia and belongs to the 3rd millennium BC. In Sumerian sources the sumerogram NIM, meaning "high" and the determinative KI (i.e. "country") are used to describe the neighbour region Susiana, which is the northern part of today's Khuzestan as well as the more eastern situated highland. The Akkadian equivalence was KUR *elammatum* which is "the country of Elam". Within research it is often suggested that the inhabitants of the Mesopotamian plains called the neighbouring region to their East NIM ("high"), due to its high mountains. Thus, the Akkadian term *elammatum* was related to the verb *elûm* ("to be high") (Hinz 1964, 18; Damerow & Englund 1989, 1; Quintana 1996, 50). But the Elamites themselves called their country *Hal Hatamti* or Haltamti which according to W. Hinz means "Country of the Lord" or "God's Country" (Hinz 1964, 18). Contemporary scholars rather conclude that the Akkadion term *elammatum* is the same word as Elamite *Haltamti*, only the pronunciation being Akkadian (Valat 1996, 89).

The Elamite territory was not restricted to the plains of what is Khuzestan today but included wide parts of the Zagros Mountains to the North and East, as well as the region of Fars. Besides Susa, also the city of Anzan or Anshan (today's Tal-i Malyan) in the region of Fars was one of the more important centres of the Elamite kingdom. Further Elamite regions are also mentioned by written sources. Most of all, the regions of Awan and Simash are said to have played an important role in the early history of Elam.

Our present knowledge of the Elamite culture is mainly based on the excavations which were done by the French for long years. Their systematic work started in 1897, when France was granted a privilege for excavations by the Iranian king. Besides Susa, only a few Elamite centres like Chogha Zanbil, about 45 km East of Susa, and Tal-i Malyan, the ancient Anshan (in the region of Fars) were investigated. As the goal of the early excavations was to find ancient monuments for the Musée de Louvre, in those days no scientific method was employed. The result was that the sequence of the different layers was not defined and the constructions of the buildings were not documented. Thus, up to these days there is no exact information about the architectural structures of wide excavated areas at Susa. This is particularly true for the area which is called "Acropolis" (Fig. 2). Only in the course of the last decades excavations were done for which stratigraphic methods were employed and which thus offer information concerning some of the building structures at Susa from the different periods. Thus, it was possible to recognise *e.g.* a terrace from the end of the 4th millennium where the remnants of temples were found (Fig. 3). This complex is said to have been one of the early forms of temple-towers (Ziqqurrat) which are known from Uruk and Eridu in Mesopotamia. That such high temples, which were built on terraces, did exist in the early period of Elamite history is known from depictions on the numerous seal impressions. A good example is the impression of a cylinder seal from the beginning of the 3rd millennium BC (Fig. 4) (Amiet 1972, No. 695) which was found on the Acropolis. A "temple" can be recognised provided with horns at both sides and built on a terrace. The high temples in Elam were probably decorated by horns, as from the Neo-Assyrian period in the 1st millennium BC we know another depiction showing horns at an Elamite Ziqqurrat. The inscriptions by the Assyrian king Assurbanipal also offer indications for the fact that the Ziqqurrat at Susa was decorated by horns, as it is reported that the Assyrian troops carried away these horns.

Besides the insights from archaeological finds, also written sources offer important information about the history of Elam. The inscriptions mostly come from Mesopotamia. According to the Sumerian list of kings, at about the middle of the 3rd millennium BC the town of Ur was defeated and its kingdom was taken to Awan (Jacobsen 1939, Col. Inv. Iv., 5-6). It seems as if from then on the kingdom of Awan was controlling wide parts of Mesopotamia for a longer period until a king of Kish succeeded with putting an end to the Elamite rule over Mesopotamia (Jacobsen 1939, Col. Iv., 17-19). According to an Oldbabylonian list of kings, the dynasty of Awan began at the beginning of the 3rd millennium BC and included twelve kings (Glassner 1996). We do not know very much about this period. But there must have been several struggles between Elam and Mesopotamia in the middle of the 3rd millennium (Potts 1999, 88-90).

With Sargon of Akkad seizing power in Mesopotamia in the year 2334 BC, a new era in the history of the Middle East began. After having secured his kingdom in Mesopotamia he led a campaign towards the East. According to his inscriptions, Luhishan, son of Hishibrashini, is said to have ruled Elam at this time (Gelb & Kienast 1990, 188). Sargon succeeded with conquering Elam and taking rich booty to Mesopotamia (Gelb & Kienast 1990, 178-181). Probably, Sargon accepted the rule of the Elamite king Luhishan over Elam, but as his vassal. After Luhishan's death Hishepratep, ninth king of the Awan dynasty, seized the throne of Elam. When Sargon died, Hishepratep together with Abalgamash, the

Fig. 2: Air photography of Susa.

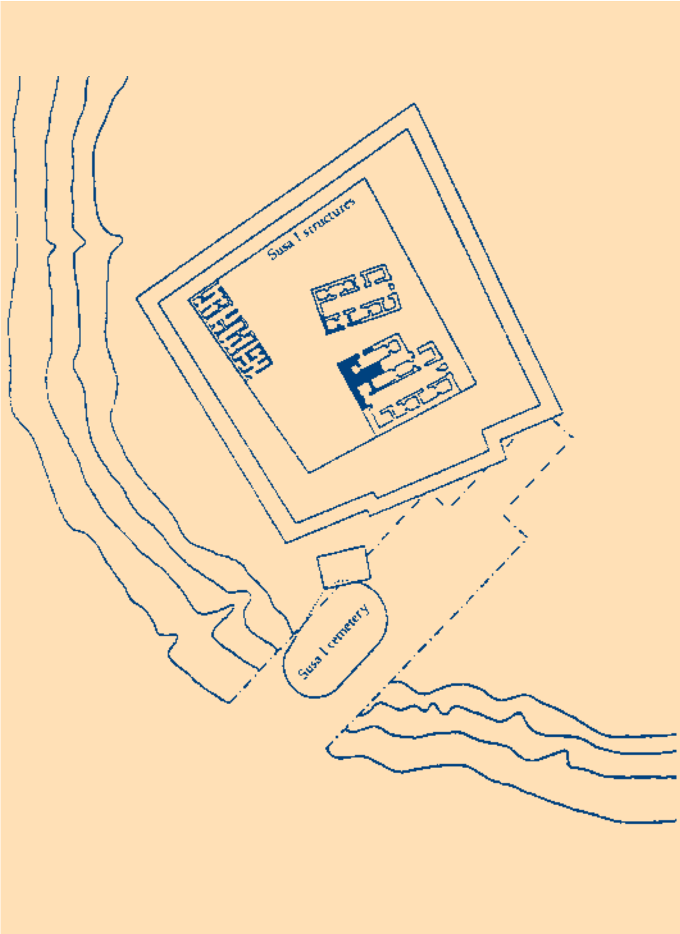


Fig. 3: Temple complex at Susa from the end of the 4th millennium BC, erected on a terrace; following Harper et al. 1992, fig. 23.

king of the region of Warahshi North of Susa, took the opportunity of rebelling against Mesopotamian rule. But in the end his efforts were without success as Rimush, Sargon's son and successor, conquered Elam again and brought numerous pieces of booty to Mesopotamia. Several items, like stone vessels, which Rimush had taken from Elam and dedicated to the Mesopotamian gods, were discovered by excavations at Ur and Nippur (Gelb & Kienast 1990, 66-70).

Sargon and Rimush had only conquered the Western parts of the Elamite kingdom. Up to then, the Eastern provinces and Anshan had escaped the campaigns of the Akkadian rulers. This changed when Manishtusu murdered his brother Rimush and seized power. By a large-scale campaign he intruded deep into the Eastern part of the Elamite kingdom. While a part of his army was marching over land towards Anshan in what is the region of Fars today via Susa, he himself with the rest of his troops crossed the Persian Gulf by ship to get far into the interior of the country of Elam. The reason for this campaign is explained by an inscription:
"Manishtu, King of the world, after having conquered Anshan and Sherihum had ships cross the Lower Sea ... The cities across the sea, 32 (in number), had been allied for fighting but he defeated (them) and captured their cities, slaughtered their rulers. And from the river ... to the mines of precious metals he seized (the country). The mountains across the Lower Sea: their black rocks he broke and loaded onto ships and had (them) anchor at the quay of Akkad. His statue he fashioned and dedicated it to the god Enlil. By the gods Shamash and Aba I swear: (these are) no lies, truly! As for the one who destroys this inscription, may the gods Shamash and Ishtar tear out his roots and destroy his progeny." (Gelb & Kienast 1990, 75-77).

Fig. 4: Seal from Susa, depicting a high temple; following Harper et al. 1992, fig. 28.

Fig. 5: The rock relief at Kurangan, showing the god sitting on a snake; following Vanden Berghe 1986, fig. 2.

Manishtusu had his vassals rule over various parts of Elam. Eshpum was the governor of Susa and Ilshu-rabi ruled over the region of Pashime at the Persian Gulf (Potts 1999, tabl. 4,7). The Akkadian language and writing was introduced into administration and for official purpose in Elam.

The Mesopotamian rule over Elam continued during the long reign of Manishtusu's son Naram-sin. But due to the troubled situation in the regions of the Zagros Mountains, Naram-sin preferred to make an alliance with Elam (Hinz 1967). The struggles between the Akkadians and the mountain peoples, particularly the Guteans, had weakened the Akkadian kingdom. When Naram-sin's son Sharkalisharri came to the throne, the situation changed so that now the Akkadians had to defend themselves against attacks by the Guteans and the Elamites (Gelb & Kienast 1990, 54).

At the end of the Akkadian period, Elam had won back its independence under Kutik-inshushinak (Akkadian: Puzur-inshushinak). Kutik-inshushinak succeeded with gaining control of various parts of the country and even with extending his influence as far as to the region of Diyala and to the Eastern areas of Mesopotamia (Potts 1999, 124). One of his inscriptions gives the names of about 80 places which he had conquered. It is even reported that the King of Simashki had come to him to surrender (Gelb & Kienast 1990, 321-324). Under Kutik-inshushinak Elam gained renewed self-confidence. Many official inscriptions by the king were written in the Linear Elamite writing. How exactly this writing was developed is not known. All evidence comes from Kulik-inshushinak's reign (Hinz 1969; Vallat 1986). Similar signs were also found on sherds in the East of Iran, like at Shahdad in the province of Kerman, but they are partly different from the Elamite writing.

The inscriptions by Kutik-inshushinak mention building activities and many donations which he had given to the main god of Susa, Inshushinak. At Susa a stone made foundation document with relief depictions was found (Gelb & Kienast 1990, 328-329; Harper *et al.* 1992, 88, fig. 54). The depiction shows a male person on his knees, wearing a crown of horns and holding a so called foundation-nail in his hands. A praying goddess is standing behind him. On the backside a lion was depicted. The upper part of the foundation monument is heavily damaged. But in the relief the remnants of a snake can be recognised. In the religion of the Elamites the snake played an important role. Religious scenes from various periods show snakes which are depicted together with the Elamite gods. Often the snake was even depicted as the throne of certain gods (Fig. 5) (see De Miroschedji 1981).

After Kutik-inshushinak's time Elam again seems to have got under control of the Mesopotamian rulers. With the foundation of the third dynasty of Ur in the year 2112 BC by Urnamma, Mesopotamia rose again to be a world power. Particularly during the long reign of Urnamma's son Shulgi, wide regions of the Middle East were conquered. Elam was conquered, too. The region of Susiana counted among the 40 districts of the empire and for some time it was governed by Sumerian governors. Shulgi tried to gain the Susianians' goodwill by respecting their religion and their gods. He had the temple of Inshushinak at Susa rebuilt and sacrificed several offerings to the Elamite gods. His inscripted bricks, which had been

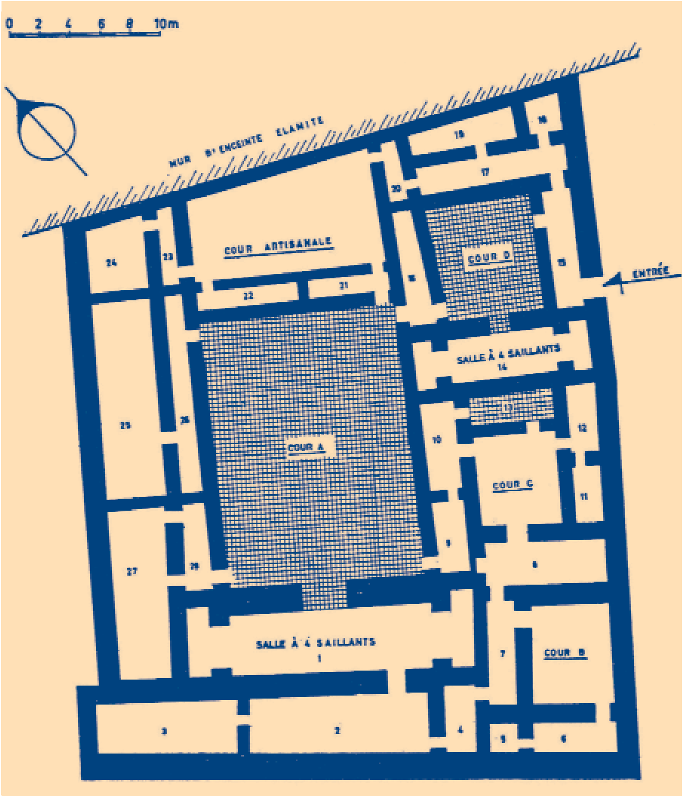


Fig. 6: House at Susa from the Sukkalmakh period, following the Babylonian pattern; following Miglus 1999, fig. 240.

used for building the temple, were found during the French excavations at Susa (Malbran-Labat 1995, 22). A bronze statue, which Shulgi had dedicated to the Elamite god Inshushinak at Susa, also bears an inscription (Potts 1999, pl. 5.1). The statue shows Mesopotamian features but is supposed to have been made at Susa.

Subjugating the peoples of the Zagros Mountains was not an easy task for the Mesopotamian ruler. To keep the different regions of Elam under control, Shulgi tried to bind the Elamite ruling families to himself by political marriages. Thus, he married his daughters to the rulers of Marhashi, Anshan, and Pashime. But this policy does not seem to have been always successful. Thus, *e.g.* Anshan was conquered and destroyed four years after Shulgi's daughter had married the governor of Anshan.

Despite several risings of the Elamite towns, Shulgi and his successors were able to keep up their rule over the Elamite territories. Only during Ibbi-sin's reign, Shusin's son, the Elamites under the Kings of Simashki succeeded not only with liberating Elam after some tries but they even conquered Mesopotamia and the town of Ur in the year 2004 BC. Ibbi-sin is taken to Elam as a prisoner, together with the statue of Nanna, the main god of Ur (Potts 1999, tab. 5, 2).

The struggles between Elam and Mesopotamia also mark the beginning of the 2nd millennium BC. After the dynasty of the Kings of Simashki a period began which in literature is called the Sukkalmakh period. The title of Sukkalmakh is a Sumerian word and means something like "Grand Vizier". During the time of the third dynasty of Ur, in every region of the empire a Sukkalmakh was appointed. Under the influence of the Mesopotamian tradition, the Elamite rulers at Susa took over this title at the beginning of the 2nd millennium BC and called themselves Sukkalmakh of Elam. Several centuries of Mesopotamian rule in the Susiana had led to the fact that several Mesopotamian cultural aspects like writing and language had become traditional at Susa. Even the architecture shows typical features of Babylonian planning and floor plan. The big residential buildings from this period at Susa, which were excavated by Ghirshman, follow the concept of the so called Babylonian court house, according to which at one side of the central court there was the big "entrance room". It was accessible through a door on the central axis of the "excessive" front of the court. Together with the side rooms, the "entrance room" is the main part of the house (Fig. 6) (Miglus 1999, 98, tab. 49, fig. 240).

Numerous texts and inscribed bricks from different parts of Elam give evidence to building activities in the Sukkalmakh period. At Susa, several rulers had rebuilt the temple complex of the god Inshushinak. Kukkirmash even claims to have built a new temple for Inshushinak by the name of Ekikuanna (Malbran-Labat 1995, 18). Also at Tal-i Malyan, the ancient Anshan, an inscribed brick of another ruler from this period, named Siwepalarhuppak, was found which reports the building of a temple (Stolper 1982, 60).

In the course of the 2nd millennium BC Elam developed to be one of the most important political centres in the Middle East. Elam's political and economic independence was mirrored by a kind of cultural self-confidence. In the 16th century BC the Elamite rulers did not call themselves Sukkalmakh any more but "King of Susa and Anshan". Specialist literature speaks of a new era of the Elamite history which is called the Middle Elamite period. The first king of this period is said to have been Kidinu of whom only a seal impression was found (Amiet 1980, 139, No. 11). About the other kings during this early phase of the Middle Elamite period we also do not know very much. But about the reign of Tepti-ahar, who had monumental buildings erected at Haft Tappeh, about 20 km south of Susa, we have more information.

The excavations at Haft Tappeh were done from 1965 to 1978 and brought interesting information about the Middle Elamite period (Negahban 1991). The excavations recovered a building consisting of two tombs made of bricks and wings of two complexes. They were called "Terrace Complex I and II" by the excavators. Remnants of wall paintings were found on the clay plaster of some of the rooms. At some places the walls were still preserved up to a height of 9 m. In a side room, several clay tablets were found which seem to have come from an archive. Southwest to the first terrace there were three small rooms belonging to a craft workshop, where raw materials but also ivory and metal products were found. In one of the rooms the skeleton of an elephant was discovered. Obviously, the bones and ivory of the elephant were used as raw materials. A huge kiln consisting of two parts, which was used for processing metal, was in the court in front of the craft shop.

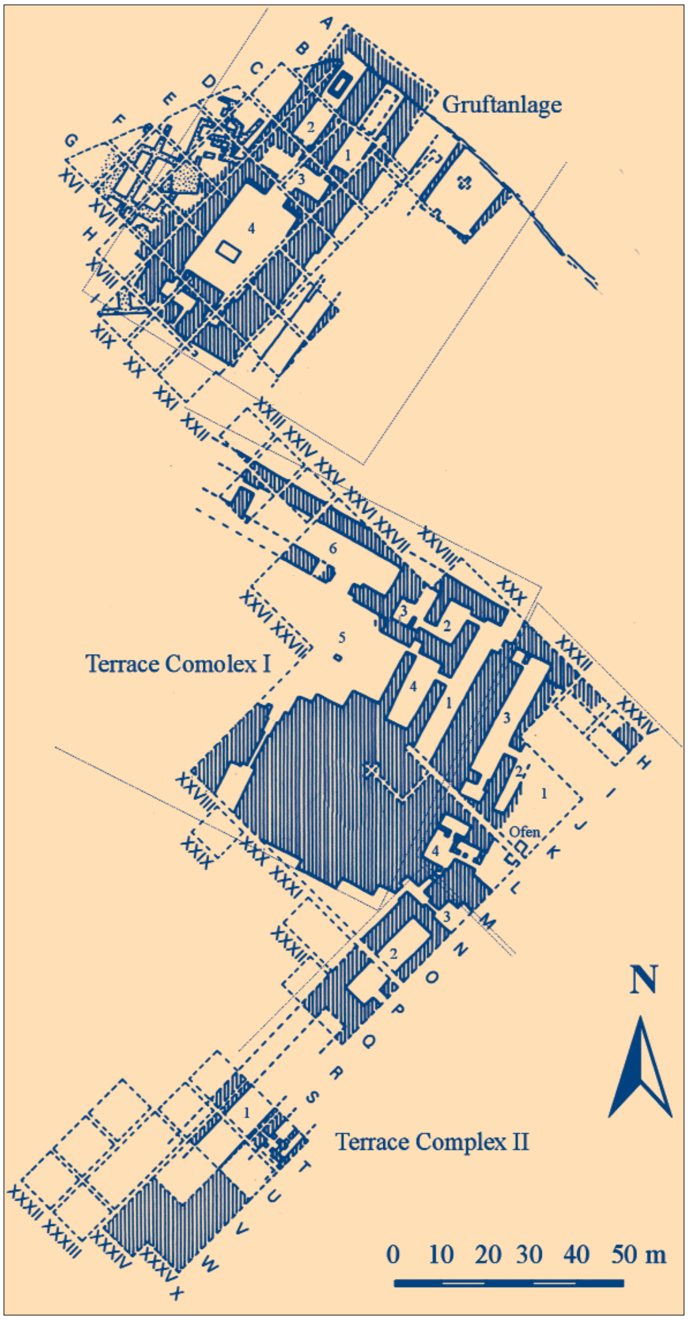


Fig. 7: Map of excavation at Haft Tappeh; following Negahban 1991, pl. 2. The northern direction was corrected by the author. Also, the numbers of the rooms were changed.

Recent geo-physical investigations at Haft Tappeh produced a complete picture of the structure of the building complexes. After completing the excavation plan by the results of the geo-magnetic survey, a monumental complex consisting of several units, each of which was provided with a wide court, can be recognised south of the excavated tombs (Figs. 8 & 9). The two excavated mud brick terraces were in the Northern and in the Southern corners of a wide, rhombus-shaped court (court D). In the northern and western corners there seem to have been two smaller mud brick terraces. Court D was connected to court A and to the excavated area ("Terrace Complex I") by a narrow corridor. Another wide court (C) was northwest of court D. In the Northern part of this court, a complex of several parallel rooms can be recognized. In this area, more tombs are suspected, southeast of which there were two small courts. Due to the strong, positive anomalies on the magnetogram, these two small courts are probably paved with bricks (Mofidi Nasrabadi 2003-2004a).

East of the described building complex there was court B which must have belonged to another complex. The excavated rooms of the already described craft workshop were at the South-western side of this court. Also, documents concerning the delivery of precious metals and other materials were found in this area. Farther to the south there was a monumental, square building with a very wide court (E). The court was surrounded by long rooms. Southeast to court E there seems to have been some more, rectangular courts. The structure of this complex is similar to the palaces from the Middle Elamite period as we know them from Chogha Zanbil (Dur Untash) (Fig. 10). Like the palaces at Chogha Zanbil, this complex must have consisted of several rectangular courts which were surrounded by long rooms. But their dimensions and the thickness of their walls are much more gigantic than those of the palaces at Chogha Zanbil.

The mud brick massifs, which flanked the building complexes, might have been terraces on which there were temples of the various gods. As far as they have been published, the inscriptions from Haft Tappeh mention two temples being surrounded by a mud brick wall. One of them was that of a previously unknown Elamite god *Padi* (Reiner 1973, 90, l. 39-40, 50, 53; Negahban 1991, 123-124). The other one was called "Great Temple" and had the name É.KUR (Herrero 1976, 108-111). Besides the temples, also a palace (É.GAL) is mentioned by a stone inscription. Thus, concluding from the inscriptions we may say that there were several temple complexes and a palace at Haft Tappeh. The different, monumental building complexes which were identified by the geomagnetic survey are appropriate to the buildings mentioned by the inscriptions.

The building complex at Haft Tappeh is said to have been erected by Tepti-ahar but it has not yet been possible to date his reign exactly. On a clay tablet the year is mentioned when the king drove away a person by the name of Kadashman- ^{d}KUR.GAL (Herrero 1976, 102). This indicates a war between Tepti-ahar and one of the Babylonian kings. As the second part of the person mentioned is written in sumerogram it is not possible to be sure about which king is meant. At first it was thought that it had been Kadashman-enlil I (c. 1374-1360 BC). More recent research rather says that ^{d}KUR.GAL here means the god Kharbe and that thus the person had been the Babylonian king Kadashman-kharbe I (c. end of 15th century BC) who was driven away (Cole & De Meyer 1999).

After Tepti-ahar, another king is said to have ruled over Susa who is called Inshushinak-shar-ilani, King of Susa, by the inscriptions (Glassner 1991, 111; Malbran-Labat 1995, 56; Amiet 1996, 140).

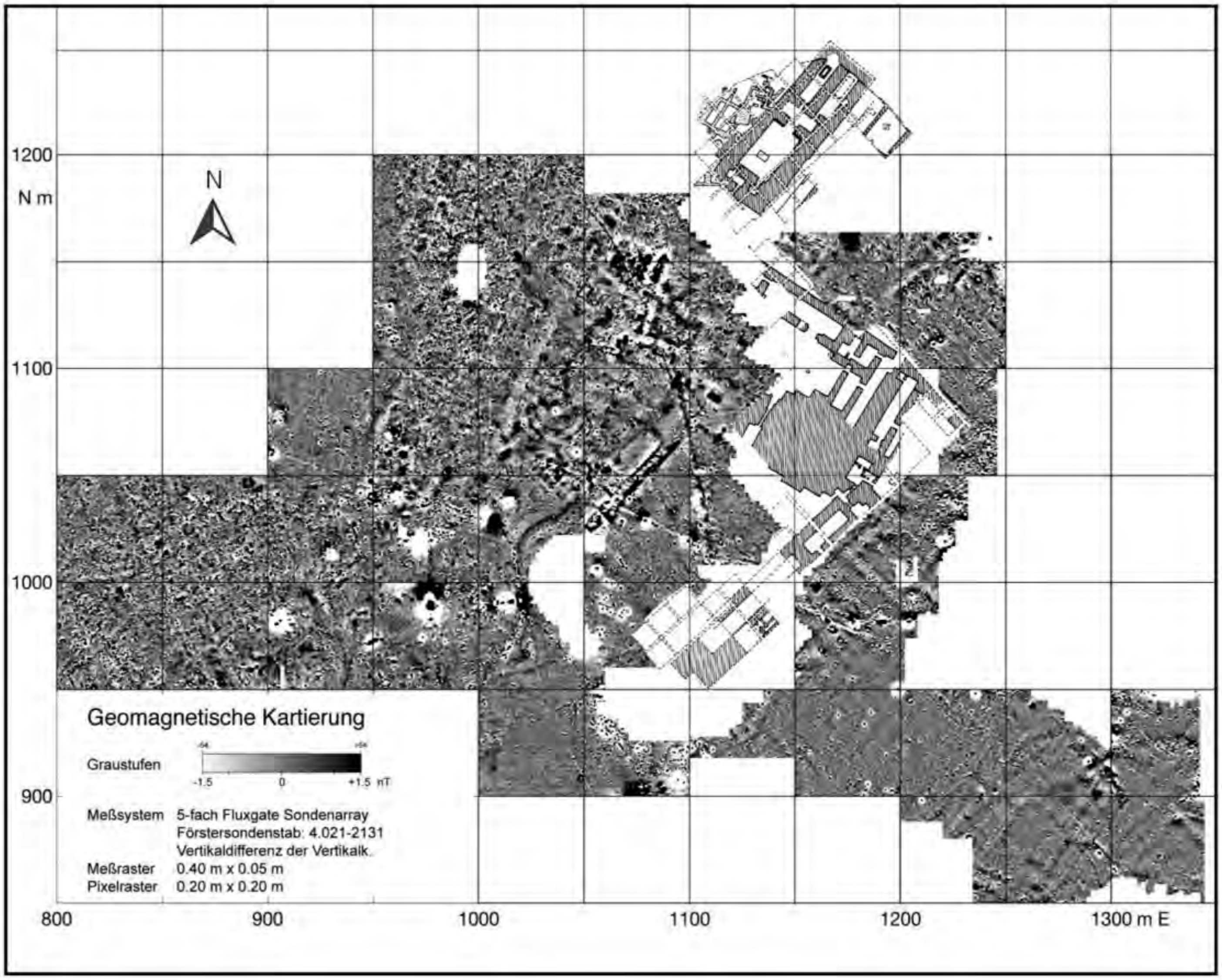
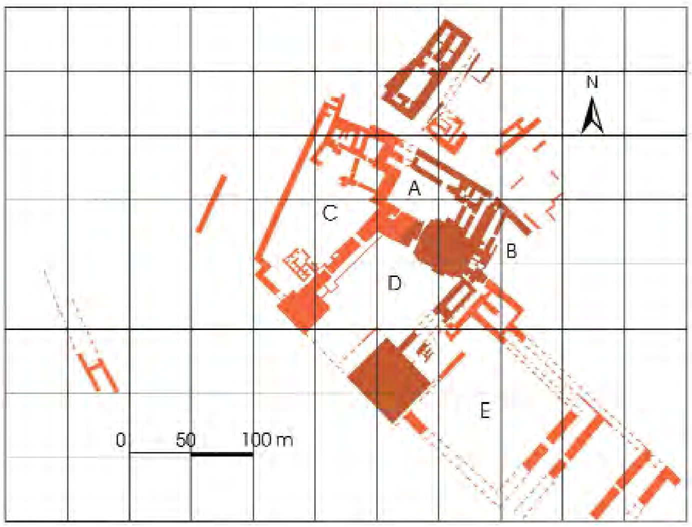


Fig. 8: Magnetogram of Haft Tappeh; following Mofidi Nasrabadi 2003-2004a, fig. 7.

Fig. 9: Reconstruction of the building complexes at Haft Tappeh according to the geo-magnetic survey.



Due to lacking written and archaeological sources, the end of the first phase of the Middle Elamite period stays shrouded in mystery. The burned timbers, which were found in the excavated rooms of the buildings at Haft Tappeh, suggest that the building complexes were destroyed in the course of wars. Pottery finds, which also indicate the time of occupation, are mainly from the first phase of the Middle Elamite period (c. 1500-1300 BC)[1]. Remnants of pottery from the second phase of this period were not found. Thus, Haft Tappeh was probably destroyed in the 14th century BC and after that lost its importance.

It did not take long until a new dynasty established in Elam whose political power reached its peak under King Untash-napirisha. Untash-napirisha, son of Humban-numena, ruled at about the end of the 14th century BC. From the time of his reign thousands of inscribed bricks are left which indicate his systematic building acti-

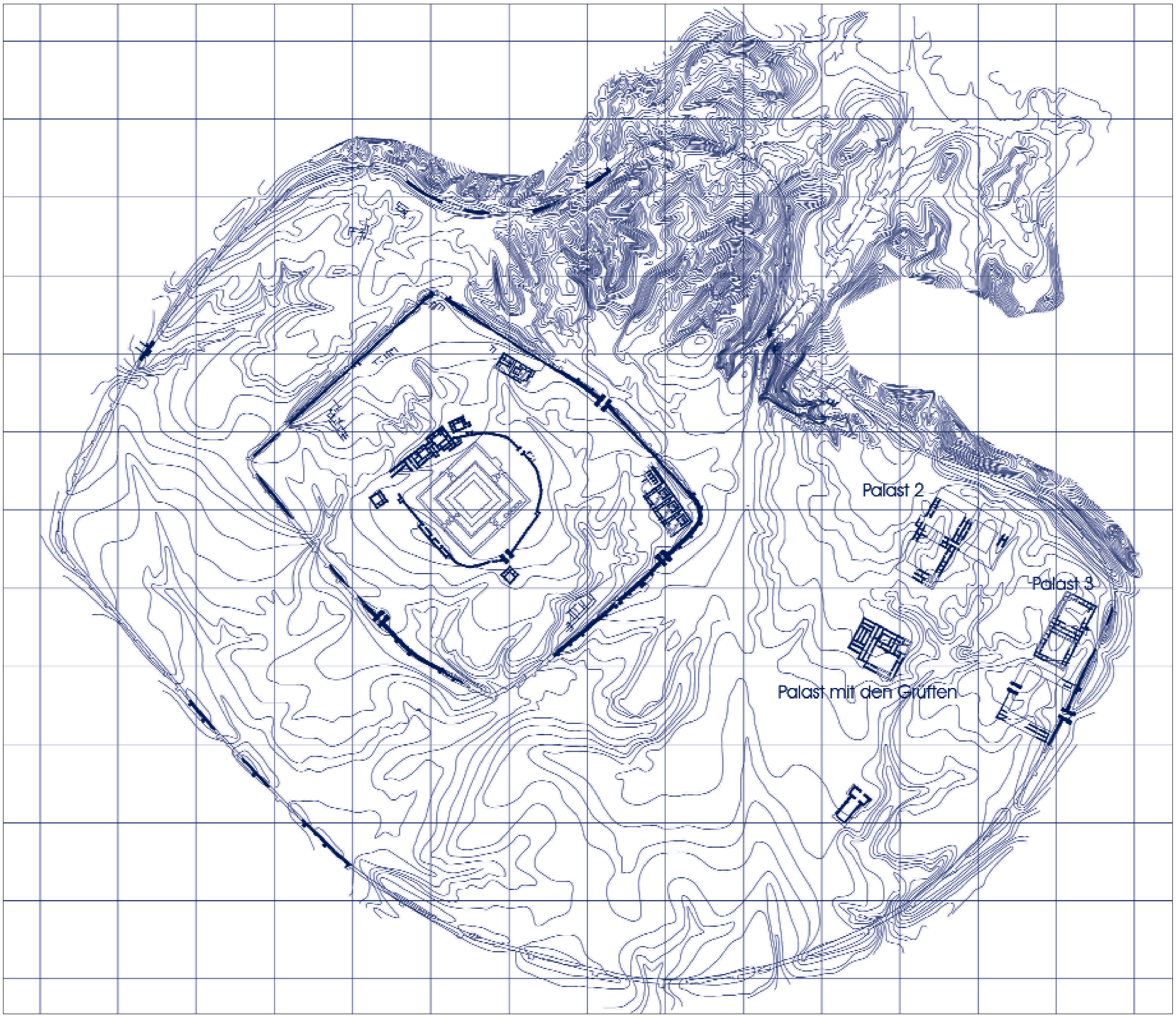


Fig. 10: Map of the ancient city of Dur Untash at modern Chogha Zanbil (every square is 100 m wide).

vity in Elam. He had even a new residency erected at a place about 45 km southeast of Susa, which today is Chogha Zanbil, and which was called Dur Untash ("Untash's Castle") or rather Al Untash ("Untash's Town") after his name. Due to its monumental temple-tower (Ziqqurrat) and the numerous temple complexes, this town is well known in literature (Fig. 10).

The French excavations during the 50s of the 20^{th} century directed by Roman Ghirshman recovered wide areas of the town (Ghirshman 1966; 1968; Steve 1967; Porada 1970). The Ziqqurrat or temple-tower of the Elamite main gods Inshushinak and Napirisha was located in the centre of the town and measured 105 x 105 m (Fig. 11 & 12). It was surrounded by a wall. Outside this wall at the north-western and north-eastern sides of the Ziqqurrat there were the temple complexes of other gods which themselves were surrounded by a second wall and formed a kind of holy district (Elamite: *siyan kuk*). A third wall of about 4 km length was erected around the entire area of the town. Usually, mud bricks were the material for building. The mud brick massif of the ziqqurrat was supported by a baked brick package to protect it from rain. The

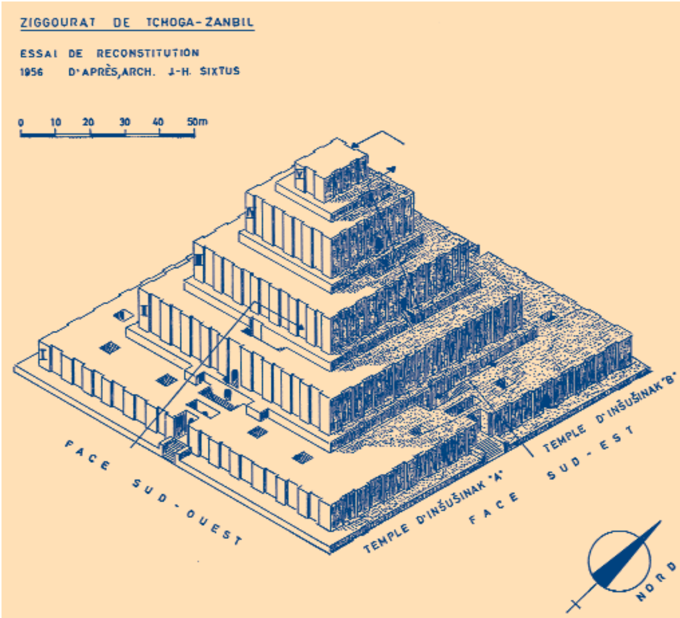


Fig. 11: Reconstruction of the ziqqurrat at Chogha Zanbil; following R. Ghirshman 1966, fig. 40.

Fig. 12: Computer based reconstruction of the ziqqurrat at Chogha Zanbil by B. Mofidi Nasrabadi.

fronts of the ziqqurrat were decorated by numerous enamelled bricks. Additionally, between every ten rows of bricks there was one row of inscribed bricks (Fig. 13). The huge wooden doors of the temple complexes were decorated by glass tubes showing spiral-like ornaments (Cat. no. 477). At all four sides of the ziqqurrat there were stairways to reach the first floor. Only at the south-western side there were stairways leading up to the second floor (Fig. 14). It was not possible to find out exactly where the stairways up to the high temple had been. The entrances of the stairways at the foot of the ziqqurrat were flanked by bulls or griffins made of terracotta.

Inside the middle wall broad paths paved with fragments of bricks had been built which connected the gates of the middle wall to the main gates of the inner wall. About 500 m east of the ziqqurrat and near the eastern gate there were three building complexes which were called palaces. One of these palaces was provided with five subterranean, vaulted tombs which maybe were supposed to be used for the burials of the members of the royal family. But indications of royal funerals were not found.

To get further information concerning the structure of the town and the various functional units like residential area, streets, sewerage system, market squares aso., further investigations and excavations at Chogha Zanbil and around have been done since 1999

Fig. 13: Inscribed brick from Chogha Zanbil.

Fig. 14: The stairways at the south-western side of the ziqqurrat at Chogha Zanbil.

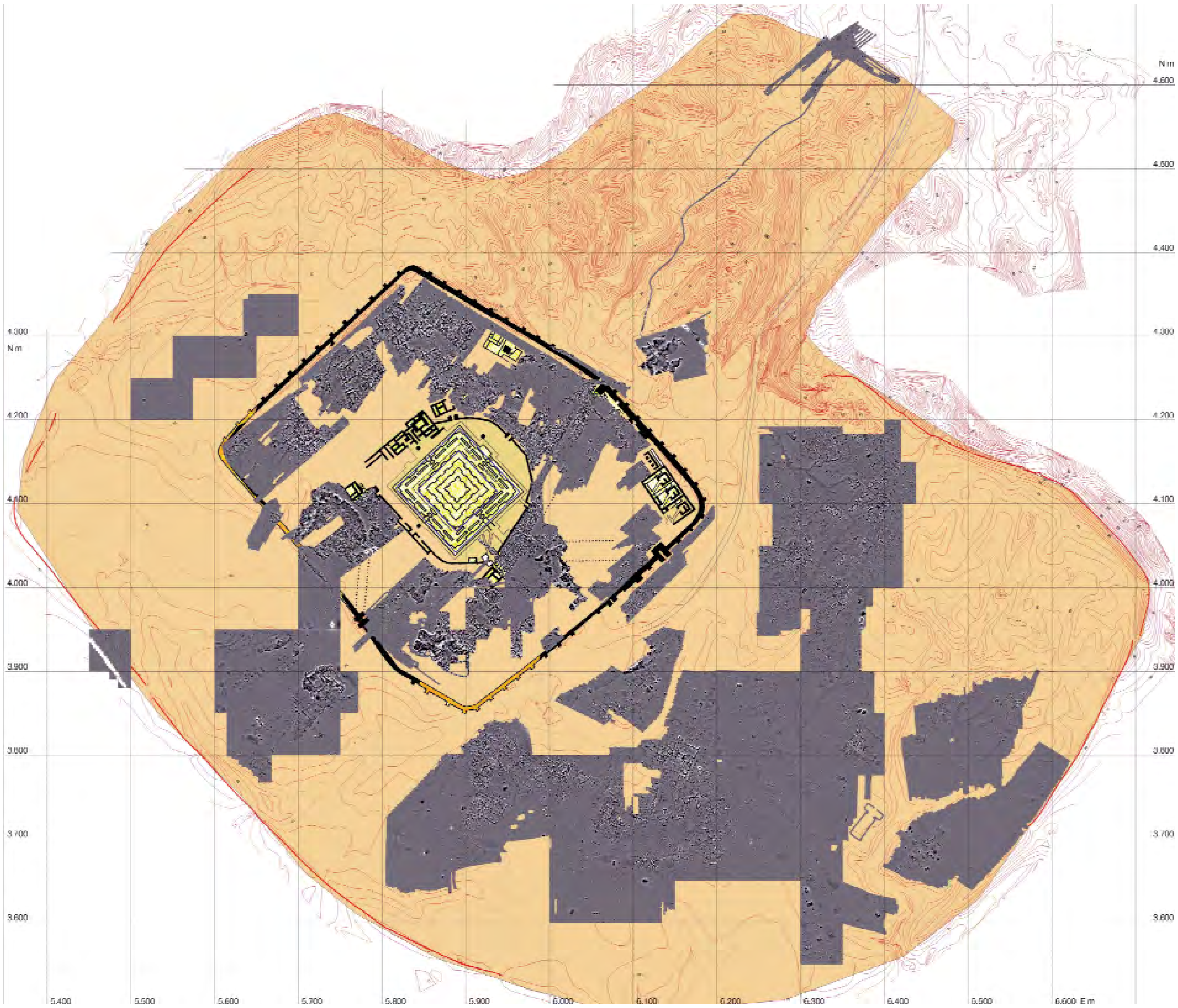


Fig. 15: Magnetogram of Chogha Zanbil (every square is 100 m wide).

under the author's direction (Mofidi Nasrabadi 2003-2004b). Besides the excavations, the area of the town was investigated by help of the geo-magnetic method. It was possible to recognise numerous buildings whose structures are similar to those of residential buildings (Fig. 15). Particularly within the middle wall there was a dense development. Mainly, the houses are in the northern, north-western, and southern areas. Outside the middle wall the buildings are concentrated in the south-eastern part of the area of the city[2]. According to the pottery assemblage, Dur Untash must have been occupied from about the 13th century to the 7th century though the houses inside the middle wall were not built when the town was founded but probably some time later.

Untash-napirisha had thousands of inscribed bricks made which tell about the building of various complexes. Besides at Chogha Zanbil, also at other places of the Elamite kingdom like at Susa, Tappeh Gotvand, Tappeh Deylam, and at Chogha Pahan his inscribed bricks were found which belonged to different temple complexes (Steve et al. 1980, 81-82; Stolper & Wright 1990). Fragments of steles and life-sized stone and bronze statues from the time of his reign were found at Susa which indicate progressive working methods in stone and metal during this period (Fig. 16 & 17).

After the time of Untash-napirisha the written sources are silent again. We have very little knowledge about the period of his successors. Only with a new dynasty seizing power, which in literature is called the dynasty of the Shutrukides after the name of its first king Shutruk-nahhunte I, the situation changes. The new ruler called himself "King of Susa and Anshan". He is known by numerous inscribed bricks which he used for building different temples. Such inscriptions were not only found at Susa but also at Deh-e No, Chogha Pahan West, and at Lihan near the modern place of Busheir (Malbran-Labat 1995, 79-83; Steve 1987, 29). Under Shutruk-nahhunte I Elam developed to be one of the most important political centres of the Middle East. About 1158 BC he conquered Babylonia and brought rich booty from the Babylonian towns to Elam. Particularly, several statues and steles like the stele of Naram-sin and the statue of Manishtusu as well as Hammurabi's codex were brought to Susa. Shutruk-nahhunte seems to have been especially fond of antiques as in his capital of Susa he was collecting not only Mesopotamian monuments in the form of booty but also monuments from other Elamite places. Shutruk-nahhunte left the rule over Babylonia to his son Kutir-nahhunte who on his side placed Enlil-nadin-akhkhi, a Babylonian, on the throne as his vassal. Only a short time after, Enlil-nadin-akhkhi rebelled against Elamite rule. Kutir-nahhunte conquered Babylonia a second time and destroyed several towns. He took the statue of Marduk, the Babylonian main god, to Elam and appointed a new governor in Babylonia. After Shutruk-nahhunte's death, Kutir-nahhunte came on the throne of the Elamite kingdom. Of Kutir-nahhunte there were also found several inscribed bricks which give evidence to his building activities at Susa and at other Elamite towns (Malbran-Labat 1995, 83.87).

More than Kutir-nahhunte, his brother and successor Shilhak-inshushinak left monuments with inscriptions to posterity. He had numerous temple complexes rebuilt in different parts of the country. For the front of the Inshushinak temple at Susa bricks were used which depict reliefs of hybrids of bull and man and female, praying figures (Fig. 18) (De Mequenem 1947, 14, fig. 18 and pl. I, 2). A very interesting and unique bronze model showing the practise of a religious ritual also comes from his period (Harper et al. 1992, 137-141). It shows two bald-headed, male persons cowering in front of a rostrum with several steps. While one of them is holding a small vessel in his hand, the palms of the other person's hands reach out to the vessel. It was suggested that the rostrum might be a ziqqurrat, especially as beside the rostrum two rows of small cone-shaped rostrums are depicted which show similarities to two rows of small rostrums at the entrance of the south-eastern stairway of the ziqqurrat at Chogha Zanbil. The inscription

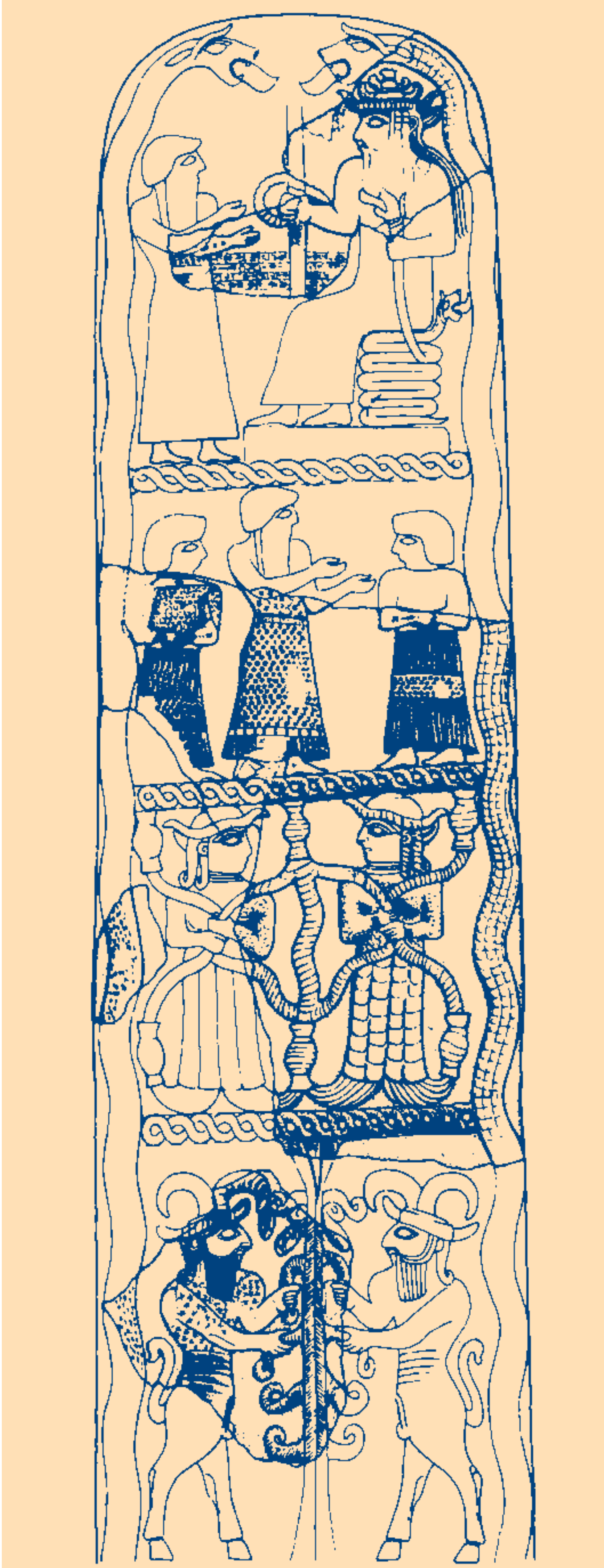


Fig. 16: Stele of Untash-napirisha; following Harper et al. 1992, fig. 42.

Fig. 17: Fragment of a statue of Untash-napirisha; following Spycket 1981, fig. 75.

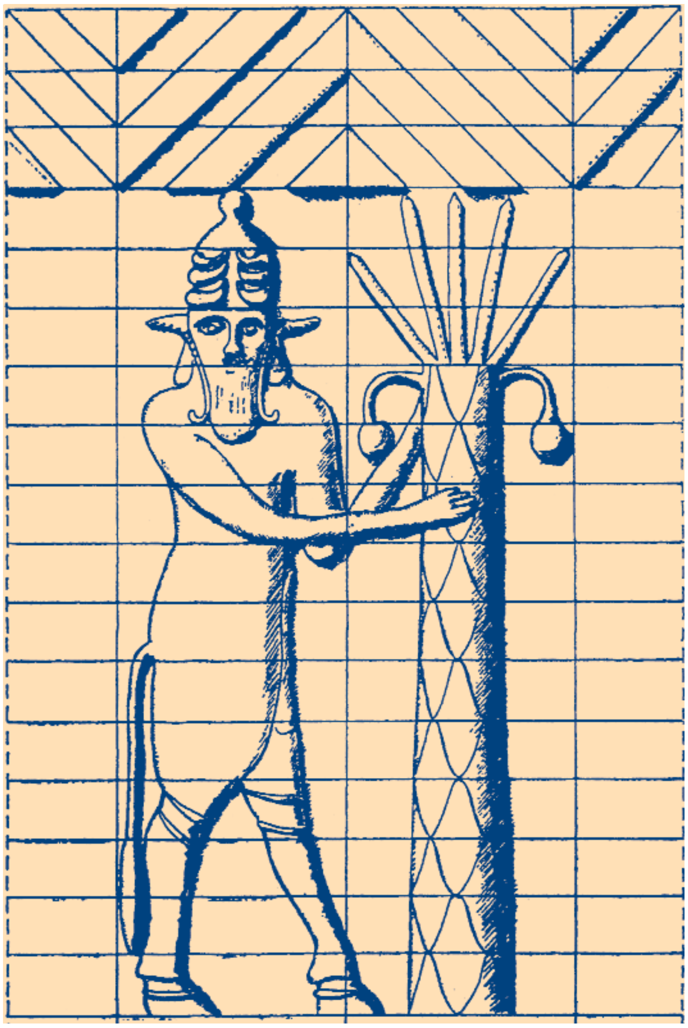
calls the ritual a *sit shamshi* ("sunrise") (König 1965, § 56). Thus it is suggested to interpret the scene as a ritual happening at the time of sunrise.

In the course of the Middle Elamite period, the political power of Elam was rising in region. In the third phase of this period, i.e. in the time of the Shutrukide dynasty, even Babylonia was under the political influence of the Elamite rulers. This resulted in increasing Elamite self-confidence. Thus, the Elamite language was used more often for writing down historic events. E.g. the inscriptions by Shutruk-nahhunte and his successors were mainly written in the Elamite language which due to today's lack of knowledge is not always easy to understand.

Hutelutush-inshushinak, Kutir-nahhunte's son, is known as the last king of the Shutrukide dynasty. The Mespotamian sources offer more detailed information about the time of his reign. In his inscriptions, Nebukadnezzar I (1125-1104 BC) describes how by order of Marduk he liberated the Marduk statue, which had been taken to Elam by Kutir-nahhunte, from Elamite imprisonment. While his first try was not successful, at a second try he succeeded with conquering Elam and he took the statue of Marduk back to Babylon (Foster 1993/I, 298). Probably, Hutelutush-inshushinak fled to the eastern mountains to Anshan but his fate stays unknown.

After the Shutrukide dynasty the sources are silent for several centuries until the texts from the New Assyrian period again tell about Elamite history. Particularly, the inscriptions by Assurbanipal (668-627 BC) report more exact details of the political situation at this time. In the course of the Assyrian policy of expansion Elam was conquered and looted by Assurbanipal's troops. The kingdom of Elam did not recover from this strike and was integrated into the Persian Empire in the 6th century BC. Though Elam was not a political power in the region, Elamite cultural features still existed. E.g. the centralised administration of the Persian Empire was run by Elamite writers. Thus, the Elamite language was used next to Babylonian and ancient Persian both for administrative documents and for royal inscriptions.

Fig. 18: Part of a relief from Susa, depicting Shilhak-inshushinak; following De Mequenem 1947, 14 fig. 8.



Notes

1 For the different phases of the Middle Elamite period see Potts 1999, 188-258.
2 The reports on the excavations and surveys are being prepared.
3 For the abbreviations see Reallexikon der Assyriologie und Vorderasiatischen Archäologie.

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The „holy" city of Inshushinak near Chogha Zanbil in Khuzestan; in the centre the 90 m high Ziggurat; Photo: G. Gerster.

The Iranian Highlands in the 2nd and 3rd Millennium BC: the Period of Early History

Christian Konrad Piller

Introduction

The period of early history is the last phase before the start of history in the Iranian highlands. It includes the time from the beginning of the Middle Bronze Age in the early 2nd millennium BC until the end of the Middle Iron Age in the 7th/6th century BC (Fig. 1).

In the period of early history there live only cultures without writing in the Iranian highlands. Written sources exist only from the end of this period and even then they only come from neighbouring regions but not from the Iranian highlands themselves. After the 9th century BC there are first Assyrian, later also Urartean texts at hand which mostly refer to the political situation in Northwest and West Iran. Thus, for judging the situation we have to be satisfied with the results of archaeological field research. But if the

Fig. 1: Comparative chronology of the Iranian highlands in the 1st and 2nd millennia; draft by the author.

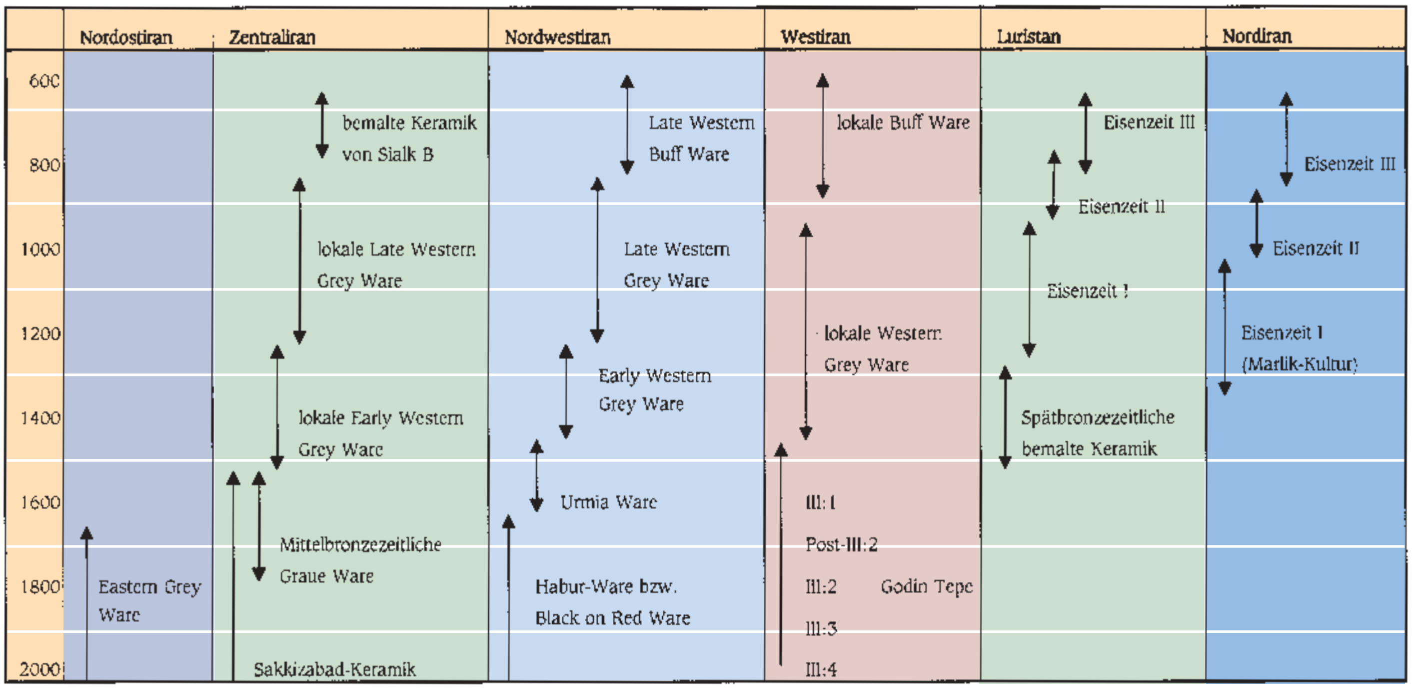


Fig. 2: Map of the major sites, discussed in this article.

size of the area and the geographic structure of the region are taken into consideration, they will even only provide us with a general overview (Fig. 2).

Middle and Late Bronze Age

In the first half of the 2nd millennium BC the Iranian highlands are populated by several regional cultural groups which are mostly characterised by their different traditions of pottery. Usually, metal artefacts only play a minor role among the archaeological finds. Something which is shared by these Bronze Age cultures is their settled way of life in Tell-settlements; burials are carried out inside the settlements. Besides single burials in simple pits there are also bigger cists which are used for several burials one after each other (e.g. Rubinson 1991).

The above mentioned regionalising is most significant in North-western Iran where influence from several regions can be seen. By way of the Black on Red Ware, a reddish pottery with black painting, the area North of Lake Urmia is part of a bigger cultural complex which stretches across the Trans-Caucasus and Anatolia.[1] In contrast to the Trans Caucasus and East Anatolia, where this culture is almost exclusively known by burial mounds for the time being, in the Southern part of the area there are Tell-settlements like Kültepe II in Nachitchevan and Haftavan Tappeh in North-western Iran.[2] The spread of Habur Ware in the Southern part of the Urmia region suggests that this region, being comparably accessible from Mesopotamia, was under Mesopotamian influence

Fig. 3: Polychrome Urmia Ware from Haftavan VIB; according to Edwards 1983, 351.

Fig. 4: Middle Bronze Age Pottery from Central Iran. Left: painted vessels of Sakkizabad pottery; right: appropriate vessel types of Middle Bronze Age grey ware (so called Central Grey Ware). The grey pottery is decorated with carved lines or small clay balls; according to Piller 2003, fig. 11.

during the early 2nd millennium BC.[3] Finds of clay-nails and tiles at Dinkha Tappeh, which are made in Mesopotamian tradition, confirm the impression of close contacts between both regions, something which up to then was only due to pottery finds. Metal objects like jewellery and parts of clothing partly show parallels to artefacts from as far as the Southern Levant. Due to this archaeological evidence, it was suspected that sites like Dinkha Tappeh were part of a widespread Mesopotamian trade network.[4]

In the late Bronze Age the contacts to Mesopotamia come to an end; Habur Ware disappears from among the finds. Instead, in the entire Urmia region as well as in Nachitchevan and in parts of East Anatolia there is the spread of the multi-coloured Urmia Ware which was developed from the middle Bronze Age Black on Red Ware (Fig. 3).[5]

Also, the situation in Central Western Iran is relatively well explored. Here, the painted pottery from Tappeh Giyan and Godin Tappeh develops also during the early 2nd millennium BC.[6] A look at neighbouring Lurestan shows how different the state of research in the Iranian highlands may be, where the only evidence from the Late Bronze Age, which is known for the time being, is a burial containing painted pottery at Sarab Bagh.

In the Northern part of Central Iran the Sakkizabad-Pottery is widely spread which at first got famous due to art trade. Because of the lack of convincing archaeological evidence it is difficult to judge this kind of pottery. It is a yellow to orange-reddish ware with dark painting which may be monochrome and as well polychrome (Fig. 4, 1,3,5; Fig. 5, 1,3,5,7). During the Middle Bronze Age an unpainted grey pottery developed from the Sakkizabad-Pottery which partly shows the same shapes and decorations (Fig. 4, 2,4,6; Fig. 5, 2,4,6,8).

In North-eastern Iran, grey pottery looks back to a much longer tradition. Here, the so called Eastern Grey Ware appears as early as the late 4th millennium BC and soon pushes away painted pottery (Dyson & Voigt 1992, 169-174). With the level which is represented by Hesār III, this culture reaches its peak before all the sites, which have yet been investigated, are abandoned. The reasons for the end of this culture remain to be unknown but climatic change might have played a major role.[7]

The Early Iron Age

The period between the 15th and the early 8th century BC is called Early Iron Age. The beginning of this phase marks a significant cut in the development. Among the finds, this radical change of culture can at first be seen with pottery. In wide parts of the Iranian highlands the regionally influenced Bronze Age groups of pottery are replaced by a relatively uniform looking culture which is characterised by an unpainted pottery with sanded down or polished surface. Due to the grey colour of some of the vessels, this pottery was called Western Grey Ware.[8] Also, the shapes of the vessels are different from those of the preceding period. Along with the introduction of this new kind of pottery there is increasing fortifying of settlements and a change of burial customs. Now, burials happen in single graves outside the settlements (Fig. 6). Necropolises are built extra muros which may be considered a characteristic feature of the Iranian Iron Age. Metal objects like weapons, jewellery, or horse harnesses gain increasing importance as grave gifts and prove the higher social status of the buried individuals. In the late 2nd and early 1st millennium BC there is an intensification of metal crafts, especially working in bronze. In the beginning, iron artefacts are rare and only in later phases of the Early Iron Age they appear more often among the finds.

The area around Lake Urmia and the Northern part of Central Iran must be considered the central region of Western Grey Ware.[9] Later, a variant of this grey pottery spreads even beyond the glens of the Zagros Mountains as far as Central Western Iran.[10] Within the Alborz Mountains in Northern Iran an Iron Age culture comes into existence which shows loose relations to Western Grey Ware but looks completely independent as far as other aspects are concerned.

The Southernmost parts of the Iranian highlands as well as Luristan are not included in the distribution area of the grey pottery. While there is only very few information about Southern Iran, Luri-

Fig. 5: Sequence of pottery from the Middle Bronze Age until the end of the Early Iron Age, according to the finds from Hasanlu level VI-IV. Comparison of chronological systems acc. to Young and Dyson. Below: painted Habur Ware; centre: Early Western Grey Ware or rather Iron Age I; above: Late Western Grey Ware or rather Iron Age II; according to Dyson 199, 136, fig. 12; with author's remarks.

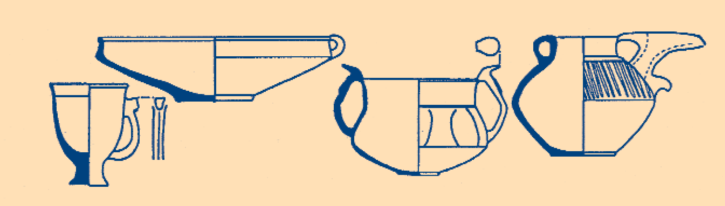
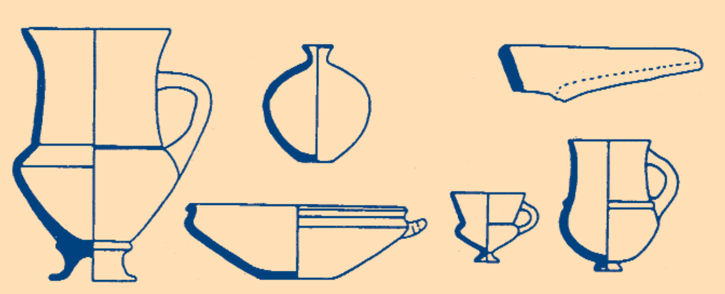
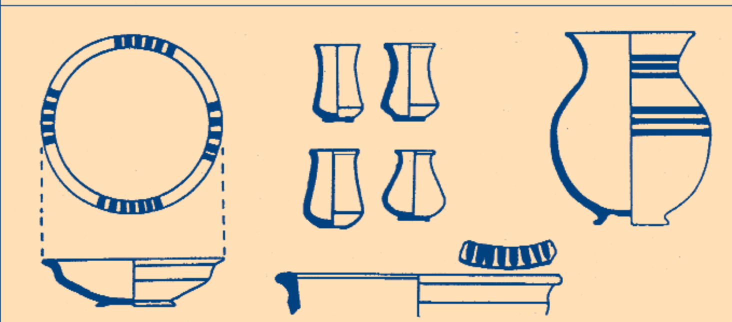
absolute Daten v.Chr.	Hasanlu Schichten		T.C. Young	R.H. Dyson
ca. 800	IV		Late Western Grey Ware	Eisenzeit II (Iron II)
ca. 13. Jh. ca. 15. Jh.	V		Early Western Grey Ware	Eisenzeit I (Iron I)
ca. 17. Jh.	VI		Habur-Ware	Habur-Ware

Fig. 6: Grave from Iron Age II from the extra muros cemetery on Low Mound at Hasanlu. The vessels may be considered typical key forms of Late Western Grey Ware; according to Dyson 1989b, 109, fig. 3.

Fig. 7: Type forms of Early Western Grey Ware from a grave at Dinkha Tappeh: beaked flagon, handled beaker, and so called "worm bowl"; according to Muscarella 1994, 153, table 12.1.2.

stan is one of the great centres of the Iranian Iron Age. Already since the twenties the so called Luristan Bronzes have attracted the interest of archaeology and history of arts (see essay by Overlaet).

History of Research and Terminology

The Urmia region may be considered the best researched region of the Iranian highlands. Mainly during the 60s and 70s, the Urmia basin and its neighbouring regions were the aim of numerous expeditions. During excavation campaigns stretching over some years, not only graveyards but also and mostly settlements like Hasanlu, Kordlar Tappeh, or Bastam were investigated. The insights concerning the development of architecture, metal crafts, and pottery, which were achieved there, were the main basis for chronological and historico-cultural classifying of the period of early history.

The term Western Grey Ware was introduced by T. C. Young who worked out a chronological division for the late 2nd and the early 1st millennium BC which is based on the investigation of pottery (Young 1962; 1965). For doing this, mainly the evidence from Hasanlu was evaluated and compared to sites like Tappeh Sialk and Khurvin in Central Iran. Young was able to work out several chronological phases of pottery and for this defined a number of characteristic shapes of vessels. He distinguished Early Western Grey Ware and Late Western Grey Ware, the latter developing from the first. In the Middle Iron Age, grey pottery is followed by Late Western Buff Ware (Fig. 7).

Only a short time after this, R. H. Dyson introduced a chronological system for the same period, which as well consisted of three phases, and introduced the terms Iron (Iron Age) I, II, and III. The phases Iron Age I and II are mostly appropriate to the pottery phases of Early and Late Western Grey Ware and are put together as Early Iron Age. Iron Age III is the same as the Middle Iron Age.[11] Basically, both chronologies are valid still today but meanwhile some modifications had to be done. By correcting the ^{14}C-dates from Hasanlu and Dinkha Tappeh, the time levels of Iron I and II have significantly shifted upwards since they were published for the first time. Meanwhile, Iron I must be considered to have been from the early 15th century to the 13th/12th century BC (Dyson 1989b, 107-108; Dyson & Muscarella 1989, 8-15). Thus, according to Iranian terminology the beginning of the Iron Age is in a period which is commonly called Late Bronze Age. Additionally, there is almost no iron among the archaeological finds from Iron Age I. Only after Iron Age II this kind of metal gains wide acceptance for producing weapons and tools in contrast to bronze (see essay by Pigott). The term Early Iron Age for the period between 1500 and 800 BC was kept nevertheless, to underline both the difference to the earlier Late Bronze Age and the continuous development during this period.

On the Ethnologic Interpretation of the Archaeological Finds

In the following time it was tried to find a historic and ethnologic interpretation of the archaeological evidence. The obvious break with Bronze Age traditions, the appearance of a new kind of pottery, and the change of burial customs were considered to be indications for the arrival of a new population in the Iranian highlands. Concerning this, a relation to the Bronze Age Eastern Grey Ware was indicated due to the possibility of comparing technology and also partly typology. Soon, production and spread of the grey pottery was ascribed to peoples who had – coming from the North-eastern Iran – immigrated to the Western parts of the Iranian highlands during the 2nd millennium BC (Young 1963, 229-249; Deshayes 1969, 160-163; Vanden Berghe 1981, 75-77). The bearers of the grey pottery were addressed as Indo-European or rather Iranian, so that the spread of Iron Age culture seemed to be a manifestation of Indo-European tribes immigrating to the Iranian highlands. At first, this theory was widely accepted within archaeological literature.

The progress of research showed that the situation may be considered much more complex than originally thought. The statement that with the beginning of Iron Age I there was a considerable cultural break did not stay unchallenged (Medvedskaya 1982; opposing: Muscarella 1994). Indeed, the archaeological evidence from the Urmia region is not to be considered representative for the entire distribution area of Western Grey Ware. In Central Iran and Western Iran, clearly overlapping horizons can be seen which give evidence to a gradual change from painted pottery to grey pottery. Concerning the Northern parts of central Iran there is even proof for a local development of grey pottery from the native painted Sakkizabad-Pottery.[12] Also the method of relating archeologically known cultural phenomena to historically known peoples was increasingly and critically debated.[13] Neither could any evidence be found for relating grey pottery to Indo-European peoples nor was there evidence for the supposed migrations (Young 1985, 368-377 summarises the state of research as far as the Mid-80s). A closer look shows that the possibilities for a comparison between Eastern and Western Grey Ware were rather superficial und do not give evidence for any direct genetic connection (Dittmann 1990, 134-135).

The few written sources, which offer indications concerning the population of the Iranian highlands, mostly contradict the idea of equating Indo-European tribes with the population of the Early Iron Age.[14] According to Assyrian texts, North-western Iran in the 8th and 9th century BC is inhabited by groups showing relations to the Hurritic language.[15] According to Urartean and Assyrian sources, one of the most important peoples are the Manneans who most probably also belong to the Hurritic environment.

Recently, there were suggestions to look for the Indo-European migrations at the change from Early Iron Age to Middle Iron Age, *i.e.* after the disappearing of Grey Ware (with full explanation: Young 1985, 375-377). Future research will have to prove if this theory will last. Thus, we should give up on any ethnological interpretation of the archaeological evidence from the Iranian highlands until there is further information.

Hasanlu: Early Iron Age in North-western Iran

Hasanlu is one of the biggest settlement mounds in the Southern parts of the Urmia region. The oldest cultural layers reach back to the Neolithic. Shortly after the middle of the 2nd millennium BC, the Iron Age starts with the layer Hasanlu V. The real settlement is located on the so called High Mound and is only slightly fortified in the beginning. Low Mound, which is a plateau North of the mound, stays uninhabited during the Early Iron Age and is used as a burial area extra muros. The distribution of public and private buildings on High Mound already anticipates the development of later periods. Young used the pottery finds from Hasanlu V as his major foundation for defining Early Western Grey Ware. As leitmotif of the pottery phase, handled beakers, beaked flagons without bridge, and the so called Worm Bowl must be mentioned (Fig. 7).[16]

In level IV a continuous development of architecture and material culture can be seen. While level IVA is a less well known phase of transition, the then following layer IVB (*c.* 1100 to 800 BC) represents the peak of the North-western Iranian Iron Age. In the Southern part of High Mound there are several huge buildings, assembling around two open courts (Fig. 8). Due to the layer of

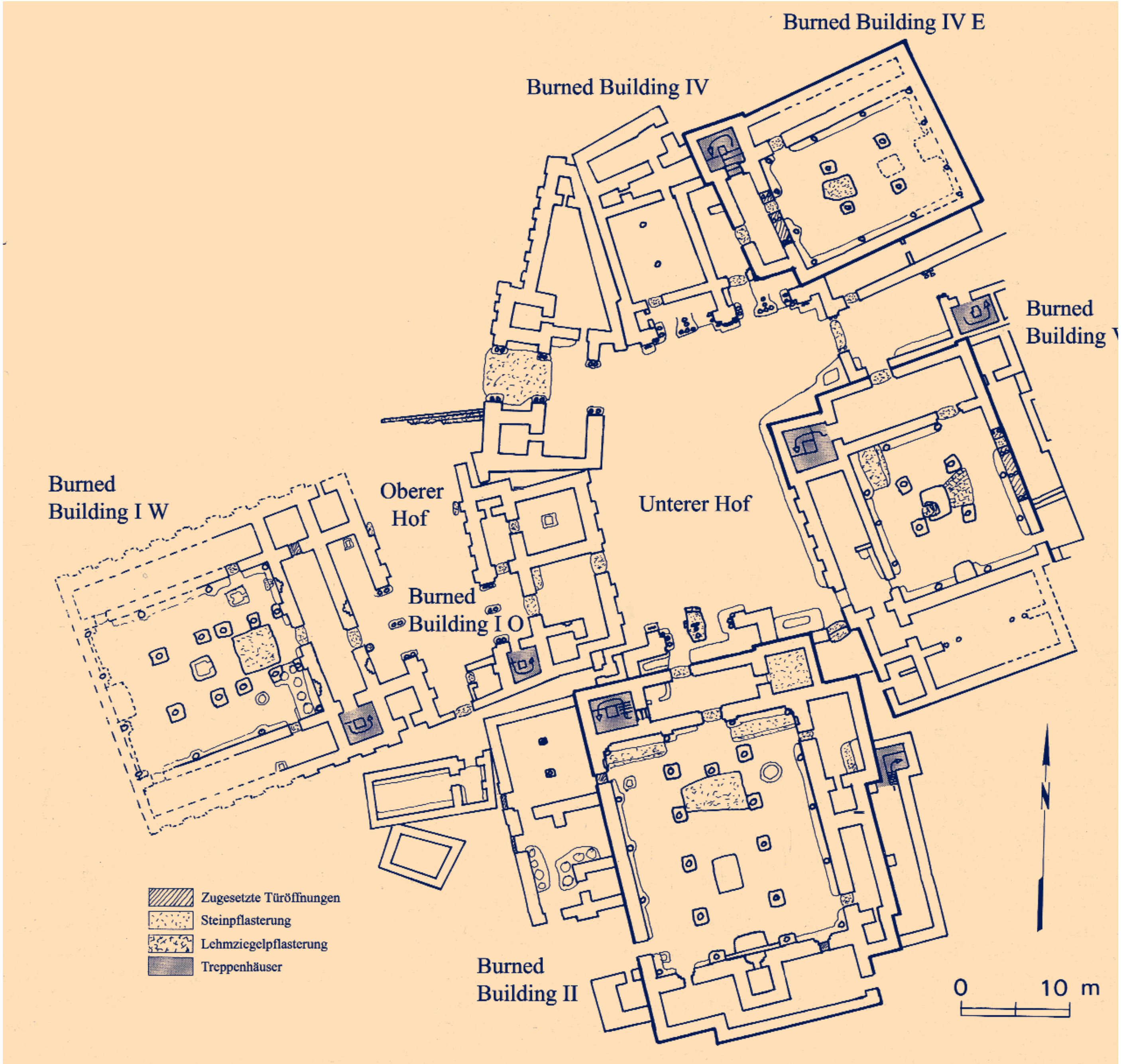


Fig. 8: Hasanlu IVB. Map of public buildings (Burned Buildings) which are located around two open courts in the Southern part of the hill; according to Dyson 1989b, 115, fig. 10; with author's remarks.

ashes, which marks the end of Hasanlu IVB, the buildings were called Burned Buildings by the excavators.

The conflagration, which destroyed the settlement, is definitely due to an enemy attack. This attack seems to have hit the inhabitants of Hasanlu completely unprepared. Signs of a longer fight could not be found. Many inhabitants were neither able to save their belongings nor themselves. Numerous skeletons of those killed by violence kept lying in the streets and buildings after the place had been looted and burned (Fig. 9). In the course of the raid, fires broke out which soon were out of control. Obviously, under these circumstances it was impossible even for the attackers to systematically loot the settlement so that the horizon of destruction in level IVB contained an unusual amount of interesting and partly unique artefacts.

The Burned Buildings showed an outstanding number of finds. As the evidence shows, the buildings were party built with two storeys

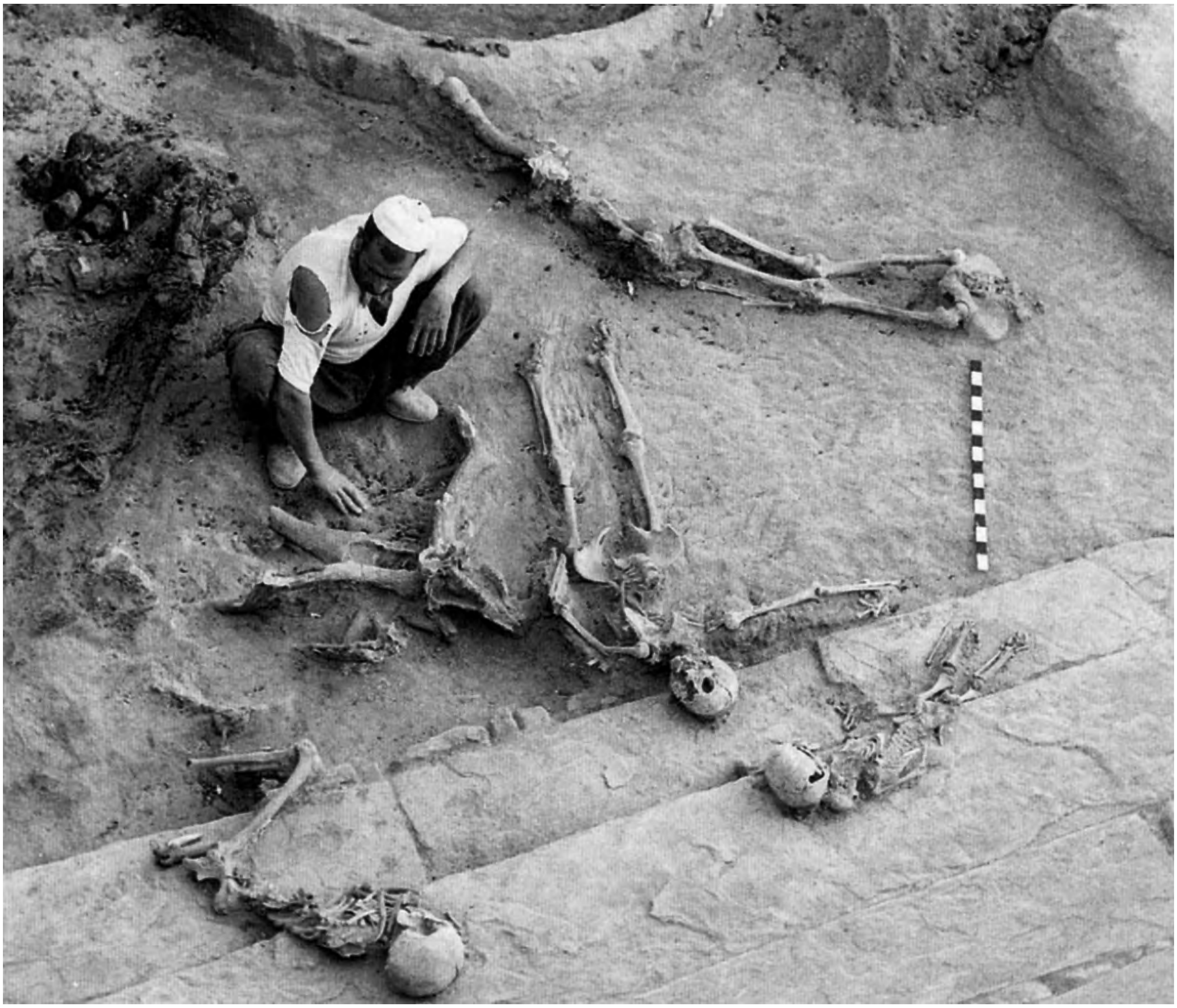


Fig. 9: Victims of the attack on Hasanlu at about 800 BC which was responsible for the destruction at level IVB; according to Muscarella 1989, 35, fig. 20.

and had a central hall which was supplied with wooden columns on stone bases. Many rooms, especially on the upper floors, were used as magazines for weapons, ivory carvings, small vessels for cosmetics etc. The public character of these buildings is debated but it has not yet been possible to make clear their exact function. Due to various reasons, the excavators spoke out in favour of cult.[17]

From this layer of destruction there comes the probably best known artefact, the so called Hasanlu Gold Bowl.[18] This is a vessel made of gold sheet, showing numerous exceptional depictions which probably belong to mythology or cult (Fig. 10). The vessel was found in Room 9 of Burned Building I West. In the same room there were the corpses of three armed men, obviously one of them had been carrying the vessel. It has not yet been possible to understand if these individuals were inhabitants of Hasanlu who had been trying to save the precious vessel, or if they had been attackers who had not been able to complete their looting. Also the origin of this vessel is debated. It is safe to say that the bowl is much older than the archaeological environment in which it was found. It should to be dated to the late 2nd millennium BC. While at first there was the idea that the vessel was a precious heirloom from the level Hasanlu V, today it is not considered impossible that it might be an import from Northern Iran (summarising the arguments: Löw 1998, 268-272).

Fig. 10: Drawing of the depictions on the so called Hasanlu Gold Bowl. The bowl was found in the rubble of level IVB; according to Löw 1998, 86, fig. 14a.

Due to its favourable location, Hasanlu had numerous contacts to neighbouring regions also during the Early Iron Age.[19] The finds from the destruction horizon in level IVB show that in the 9th century BC there existed close connections to Assyria. Due to this, among others cylinder seals and ivory came to the Urmia region from the Mesopotamian, Northern Syrian, and even Phoenician region. At the same time, an independent style of arts developed at Hasanlu which for the time being could be proven only at this place and which is called Hasanlu Local Style.[20] In addition to the imports, cylinder seals, ivory carving, and metal objects were produced locally in this style.

Inside the settlement, there was evidence for various areas where metal was manufactured. The so called Artisan's House may be supposed to have been the craftshop of a bronze-craftsman;[21] also in Burned Building III there obviously happened the manufacturing of bronze. The lack of ore or slags suggests that the production of bronze in the form of ingots happened outside the settlement. Also, the areas where iron was produced may be supposed to have been outside the settlement (Pigott 1989, 71).

The raid on Hasanlu put an end to the development of this place which had been continuously going on after the middle of the 2nd millennium BC. With the destruction in level IVB, Western Grey Ware and Hasanlu Local Style disappear. The public buildings in the centre of the settlement were not reconstructed again. In the following level, IVA, newcomers or survivors seem to have built simple accommodations within the ruins.

Until today, it was not possible to find out who the attackers were. According to the ^{14}C-dates, the violent end at level IVB may be supposed to have happened at about 800 BC (Dyson & Muscarella 1989; De Schauensee 1988, 57, annot. 2). Thus, the assumption that the Urarteans were responsible for the destruction of the place gains probability. The stela, which was erected by the Urartean kings Ispuini and Menua, clearly shows that Urartean armies were in the region. Near Hasanlu it was possible to find evidence for a number of newly founded settlements, among which the fortress of Qalatgah is the most important one.[22] The Urarteans were active at Hasanlu itself and erected a fortress wall in typical Urartean style on the ruins of the destroyed town.

Early Iron Age in Northern Iran: The Marlik Culture

Northern Iran more or less includes the area of the modern Iranian provinces of Gilan and Mazanderan within the Alborz Mountains. In historic times, this region was an area of retreat, which was difficult to reach, and only partly or with some delay was taking part in the developments in the Iranian highlands. The situation may be supposed to have been similar in pre-historic times. In contrast to Hasanlu, where strong influence from the outside world

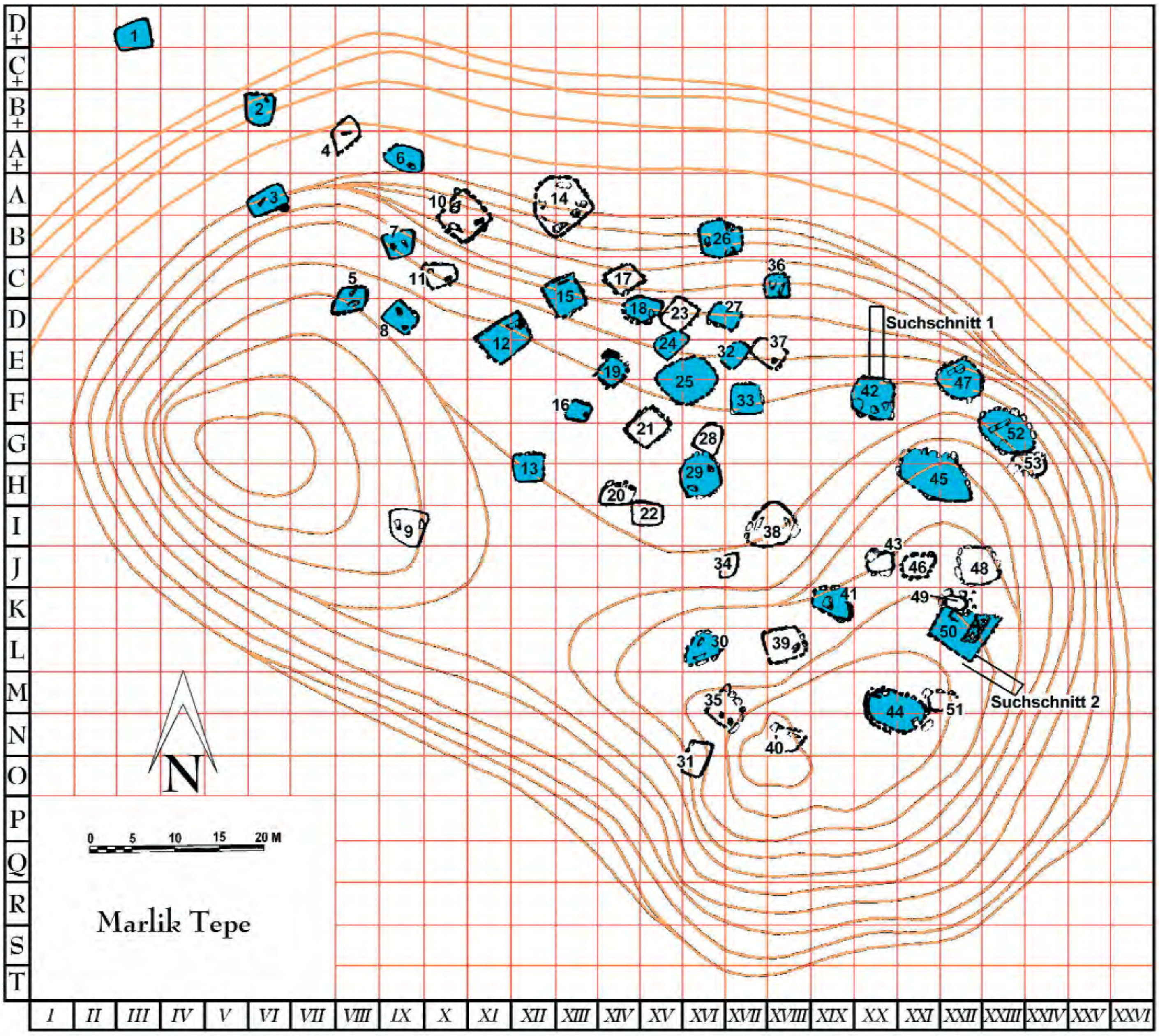


Fig. 11: Map of the necropolis at Marlik. Some of these stone-built graves may have considerable size but still were made for only one person of the rich Iron Age upper class. Graves containing weapons are marked in blue on the map; according to Negahban 1996, 12, with author's remarks.

contributed to the development of the local culture, the Iron Age culture in the Alborz Mountains developed mostly independently. Sites from the Middle or Late Bronze Age are practically unknown for the time being. In the second half of the 2nd millennium BC, a culture occurs which is to be understood as the third great complex of the Iranian Iron Age, next to North-western Iran and Lurestan.

Only relatively late the region within the Alborz Mountains gained the attention of research. As early as in the 30s, gold finds, which were discovered while building a palace for the Shah, had caused great sensation and are known in literature as the Kalar Dasht Treasure (Samadi 1959, 3-12). But still archaeological research was not intensified before the early 60s. At this time objects increasingly appeared in the arts trade, which supposedly came from the region of the Alborz Mountains. Following the famous Luristan Bronzes, the term Amlash Bronzes was introduced.[23]

The most important site in Northern Iran is the necropolis of Marlik. There, excavations were done in the years 1961 and 1962, directed by E. O. Negahban (Negahban 1996). At first, the place had been estimated to be a Tappeh, which is an artificially grown settlement mound. Soon it was found out that it was a natural hill with 53 graves which had been made during the Iron Age (Fig. 11). Soon the rich finds made clear that here there was the cemetery of a higher social class.[24] Only a short time after this, finds which were similar in style and quality were discovered at the nearby place of Kaluraz (Hakemi 1968).

Due to the literally confusing variety of finds, the dating of the necropolis of Marlik was at first debated. Meanwhile, it seems to be clear that the graves were made in the time between the 13th and the 11th century BC. It may be supposed that the hill was given up as a cemetery at about 1000 BC.[25] By analysing the present finds, E. Haerinck succeeded with dividing the Iron Age in the Alborz Mountains into three parts, being slightly different from the periods in the Urmia region (Haerinck 1988, 67-73). The most important phase is doubtlessly Iron Age I which lasted from about 14th/13th century to about 1000 BC. For this phase, the necropolis of Marlik is the key site. For the time being, there is only very few evidence from Iron Age II, so that there is the impression of a transitional phase. Together, Iron Age I and II are Early Iron Age. The 8th and 7th century BC is called Iron Age III (Fig. 1).

During entire Iron Age I the Alborz Mountains had many contacts to the outside world. This is evident from a. o. imported cylinder seals from the Assyrian, Mitannic, and Elamite regions, as well as from glass-mosaic vessels, as known from Middle-Assyrian connections. Special among the finds are metal vessels ornamented with figures which at first were believed to be Mesopotamien products, due to their depictions.[26] But recently it could be proven that these vessels were manufactured locally (Löw 1998, 242-246).

The metal vessels from Marlik, Kaluraz, and Kalar Dasht are captivating due to their stilistic variety, the remarkable quality of manufacturing, and the successful inclusion of Assyrian, Babylonian, and Elamite examples into the native motifs, and thus they count among the outstanding products of the Iranian Iron Age. Probably these outside influence came to the remote Alborz Mountains as a result of trade. The regional deposits of gold, copper, and iron might have played a major role with this.

In Iron Age I, an increasing differentiation of society can be seen. An upper class comes into existence which cares for being provided with great riches in their graves and which also tries to deduct from the rest of the population by choosing a separate cemetery. Among the status symbols of this upper class there are mostly weapons, next to jewellery and metal vessels; in almost any case especially rich graves show bigger amounts of daggers, lances, and mace heads (Fig. 12). The manufacturing of weapons in Northern Iran is surprisingly varied and in the Early Iron Age shows a significant development of types and technology. By the end of Iron Age I, bimetallic and iron weapons occur for the first time (see essay by Pigott).

In the early 1st millennium BC, the contacts to regions outside the Alborz Mountains mostly come to a sudden end. During Iron Age II and III, Northern Iran again is an isolated region within the Iranian highlands.

Fig. 12: Goblet of gold and silver of Kaluraz; h. 12,5 cm; Tehrān, National Museum, Inv.-Nr. 6395; photo: DBM, M. Schicht.

Fig. 13: Grave No. 47 of the Marlik necropolis during excavation. The dead was buried in the form of a crouched burial on left side and upon a layer of daggers and spearheads. In front of the hip, a gold vessel was found which was decorated with figures. C. 12th/11th century BC; according to Negahban 1996, Colour PL XIA.

The Economic Basis of the Early Historic Period

For a long time the theory of an immigrated, nomadic population influenced our idea of the economic basis of the Early Iron Age (e.g. Ghirshman 1964, 3-8; Porada 1964, 31; Vanden Berghe 1981, 75-77). Surely a transhumant pastoral economy, as there is evidence for in the Urartean period, was part of the basis of the early historic period (Wartke 1993, 82). But it is hardly possible to prove this archaeologically. If we conclude the information at hand, there arises the picture of a mostly settled society which is based on agriculture, crafts, and trade.[27]

Due to archaeobotanical investigations it was possible to get an idea of the prehistoric flora in North-western Iran and to conclude agriculture and diet of the Iron Age population (Harris 1989, 14-23). Besides many kinds of grain, lentils, beans, and chick-peas were grown among others. Dried wineberries might suggest that in this region the tradition of growing wine reaches at least as far back as to the Early Iron Age. In contrast to that, the figs, which were found at Hasanlu, most probably were imported.

Usually, depictions of agricultural activities are not among the repertoire of early historic art. A rare example are figures of cattle from Northern Iran which are combined with a miniature plough (Negahban 1996, 128-129; tabl. 43, 129; tabl. 44, 131, 132). In how far hunting contributed to the diet of the population is also unclear. The known depictions of hunting might be realistic scenes or they might as well be mythological scenes. Concerning this question, investigations of finds of animal bones may be supposed to bring interesting insights in the future.

Trade with neighbouring regions, especially Mesopotamia, counts among the most important economic bases in the early historic time. In the Early Iron Age, import goods from Assyria, Babylonia, and Elam increasingly appear in the Iranian highlands and give evidence to the increasing significance of trade as an economic factor. But information on structure and organization of the Iron Age trade network is difficult to find, as written sources on this field are lacking. Important sites like Hasanlu or Tappeh Sialk are located at strategically favourable places along natural roads through the Iranian highlands and probably also served as far distance trade stations.

Surely, also natural resources like salt (see essay by Schachner) or metal counted among the trade goods of the Iranian highlands. Deposits of copper, gold, and iron are frequent in the mountain areas of the Iranian highlands. Recent investigations by the Deutsches Archäologisches Institut at Arisman and by the Deutsches Bergbau-Museum at Veshnāveh give evidence to the fact that large scale copper mining was done there as early as in the Chalcolithic (a preliminary report by Chegini et al. 2000). The bronze industry of the Iron Age cultures demanded bigger amounts of copper and tin. Appropriate finds from Hasanlu suggest that bronze was pre-produced in the form of ingots before it was further processed inside the settlement.

While in the Iranian highlands enough copper was at hand, the tin needed for the production of bronze had to be imported. Still it is completely unclear where the ancient cultures in the Middle East had their tin from. Recently, it was possible to prove the existence of pre-historic tin deposits in Central Asia.[28] If the Central Asian deposits were worthy of consideration for the origin of Middle East tin, the shortest connection between both regions would lead through the Northern part of the Iranian highlands.

A similar trade route may be imagined for lapis lazuli. This stone, which was also found in the graves at Marlik, comes from North-eastern Afghanistan and was traded as far as to Egypt in the Bronze Age. There is also evidence from historic times for this probable trade route through the Northern part of the Iranian highlands. Exactly there ran an important part of the Silk Road in the Middle Ages (Kleiss 1993, 387-388).

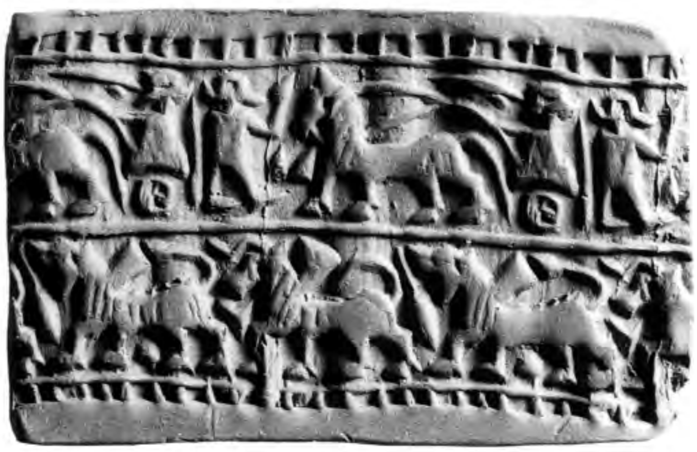
The increasing exchange with the advanced civilizations of the lowlands can also be seen at the development of crafts and art of the Iranian highlands. At Hasanlu, thousands of shells were found which were partly processed into jewellery at the place. The majority of these finds comes from the Persian Gulf and may be supposed to have come to North-western Iran via the glens of the Zagros Mountains (Reese 1989, 81). Shells from the Mediterranean give evidence to trade also in that direction. The raw material for the ivory, which was produced at Hasanlu, was also imported via Mesopotamia (Fig. 13).[29]

The products of art and crafts, which were imported from Mesopotamia and Elam, surely represented a significant value for

Fig. 14: Ivory with the depiction of a warrior in the so called Hasanlu Local Style. From the rubble of level IVB. Late 9th century BC; according to Muscarella 1989, 33, fig. 16.

the inhabitants of the highlands though they are partly old pieces or damaged objects.[30] Those prestigious luxury goods encouraged an independent production which was adjusted to the native idea of style. The best example is the already mentioned Hasanlu Local Style, in which both native elements and typical Assyrian motifs may be combined (Fig. 14). Also, the figuratively decorated metal vessels from Northern Iran and North-western Iran are hardly imaginable without Mesopotamian and Elamite influence. The examples for some of the depictions are many centuries older than the vessels themselves, though. This makes clear how powerful the Mesopotamian pictural language could be in the Iranian highlands.

Fig. 15: Rolled out depictions of a seal made in Hasanlu Local Style. Hasanlu IVB, late 9th century BC. A strong orientation towards geometric depictions is typical for this style; according to Marcus 1989, 55, fig. 5a.



Middle Iron Age

The destruction of Hasanlu IVB stands for the end of the Early Iron Age. In the following period there is a deep change of material culture in the entire region. Western Grey Ware disappears and in the course of time is replaced by other kinds of pottery.

In this time, parts of North-western Iran come under Urartean rule. We are able to mostly reconstruct the campaigns of the Urartean kings by inscriptions on rock faces and stone steles (Salvini 1995, 18-98). In the permanently occupied area the typical Urartean utility ware and fine wares dominate the finds (on Urartean pottery in North-western Iran see Kroll 1976). Due to its reddish polish, the latter is exported as a high-value luxury good far beyond the borders of the empire. The Urarteans tried to secure their territory by building fortresses. The best explored building of this type in Iran is the fortress of Bastam (see essay by Kroll).

In the same period, the tradition of grey pottery ends also in Central Iran. The most important site in this region is the necropolis B at Tappeh Sialk, which with its 218 graves counts among the biggest cemeteries which were investigated in the Iranian highlands (Ghirshman 1938, 26-68) (Fig. 15). Probably, the use of this cemetery starts in the 9th/8th century BC in the transitional phase from the Early Iron Age to the Middle Iron Age (Fig. 1). Concerning type and shape, the pottery is completely in the tradition of Western Grey Ware (on the phases of use inside necropolis B see Tourovetz 1989). In the later phases of use at this necropolis, a characteristic ochre-coloured ware with reddish-brown painting develops, the shapes of the vessels being partly taken over from grey pottery. Bimetallic and iron weapons and tools increasingly replace bronze. Though there are indications of certain relations to Middle Iron Age cultures in Western Iran, the painted pottery from Sialk B still is a unique phenomenon in the Iranian highlands.[31] We have no information about the end of this culture. Only three three-winged arrowheads of horse-nomadic type suggest that the burial place was abandoned in the course of the 7th century BC.

In the second half of the 7th century BC, the Urartean empire falls victim to the onslaught of horse-nomadic intruders.[33] Assyrian sources report that at that time Scythians and other tribes had been in the Middle East. The existence of bronze three-winged arrowheads with attachment, which were found in the destroyed fortresses and settlements in North-western Iran and in Eastern Anatolia, might be considered archaeological evidence for the presence of Eurasian horse-nomads in the Iranian highlands.

Fig. 16: Cist with saddle roof in the necropolis of Tappeh Sialk. C. 8th/7th century BC; according to Ghirshman 1963, 8.

According to historic sources, in the course of the 7th century BC bigger parts of the Iranian highlands came under Medish rule. Among others, the founding of the Medish empire may be supposed to have been a reaction to Assyrian campaigns in the Western Iranian region. But for the time being, it has been difficult to prove this political-historical founding of an empire by archaeological evidence. Similar to the Urarteans, the Medes are able to join forces and to rise to be a dangerous competitor of the Assyrian empire. Together with the Babylonians, they finally succeed with destroying the Assyrian capitals. With the political unification of the Iranian highlands, which was started by the Medes, the road is clear for the Achaemenid empire, the first true empire of history.

Conclusion

In the Middle and Late Bronze Age, the Iranian highlands are not a region with one uniform culture. Mostly, the regional cultures have their own painted pottery which around the middle of the 2nd millennium BC – the beginning of the Iron Age – is replaced by unpainted pottery. The cultural break is also shown by the change of burial customs and the rise of metal crafts, particularly working in bronze reaching industrial size. Only after the early 1st millennium BC, iron is increasingly accepted as the raw material for weapons and tools. Inside the Iranian highlands three great Iron Age cultural complexes may be distinguished: the so called Western Grey Ware in North-western Iran and Central Iran, the Marlik Culture in Northern Iran and the Lurestan Culture in Western Iran. Hasanlu, located Southeast of Lake Urmia, and Marlik Tappeh in the Alborz Mountains may be considered important sites. Here, due to increasing contacts to Mesopotamia, independent styles of art are developed. In the course of Middle Iron Age, in the 8th and 7th centuries BC, the first historically recorded states come into existence in the Iranian highlands.

Notes

1 Already the Trans-Caucasian Kura-Araxes pottery had a similar distribution area in this region during the Early Bronze Age. Concerning the Middle Bronze Age, the highland of Trialeti must be mentioned as the best known site in Trans-Caucasia. Here, several kurgans with appropriate pottery and rich metal finds were excavated. Concluding on Trans-Caucasia see Kushnareva 1997, 81-150. A view at the just beginning research is offered by Özfirat 2001.

2 On the Middle Bronze Age in Nachitchevan see Bahşaliyev 1997, 105-110; on Haftavan Tappeh level VI see Edwards 1983.

3 On the pottery finds from Dinkha Tappeh see Hamlin 1971; 1974. Kroll 1994, 163-166 records seven sites in the regions South and North of Lake Urmia, where there exists Habur Ware from excavations or surface finds. On the possibilities of an ethnologic definition of Habur Ware see Kramer 1977.

4 Rubinson 1991, 389. According to the present state of research it is not possible to say if there were real branches in Iran, like those which the Assyrians had in Anatolia in the early 2nd millennium BC.

5 This term goes back to Edwards who used this expression for the polychrome pottery from Haftavan VIB. See Edwards 1981, 109-111. On the chronologic position of the Urmia Ware see Rubinson 1994, 199-201. On the recent finds of Urmia Ware in Eastern Anatolia see Özfirat 2002.

6 Henrickson 1987, 51-60. Using the finds from Godin Tappeh, Henrickson worked out a phased system for the painted Bronze Age pottery in Central Western Iran, in which he was able to include also older excavations like Tappeh Giyan, Bad Hora, or Tappeh Djamshidi.

7 On the effects of even short climatic changes in historic time see Overlaet 2003, 8.

8 This term is misleading in so far as vessels of this type may also show black, reddish, or brown colour. Among certain finds grey vessels are even a minority. See Muscarella 1974, 59. At Dinkha Tappeh III, only 27% of the burial pottery is grey. The term Grey Ware is a general term for the Iron Age culture of the Iranian highlands.

9 Muscarella 1994, 140, emphasises that the finds from Central Western Iran may be clearly distinguished from this.

10 Tappeh Giyan must be mentioned as the most important site in Western

Iran, where the settlement mound was mostly used as a burial area during the Iron Age. See Contenau & Ghirshman 1935.

11 A similar three phased chronological system giving the terms Iron Age I, II, and III is also used for Northern Iran and Lurestan, though with different phases. See Haerink 1988, 67-73; Overlaet 2003, 6-10.

12 The Middle Bronze Age grey pottery was called Central Grey Pottery after Young's terminology; see Piller 2003. Also in Nachitchevan there is a longer transitional phase at the transition from Bronze Age to Iron Age. Besides a new, grey pottery, here some painted pottery is still produced, even typical key forms of Western Grey Ware such as beaked flagons with painting were produced. See Bahşaliyev 1997, 111-115, fig. 18-20.

13 Kramer 1977, 99-108 offers a view at the inpredictabilities of ethnologic interpretations.

14 Concerning North-western Iran, the Assyrian sources of the 9th century do not give any names of people or regions which could clearly be identified as Indo-European. On the other hand, in those regions of Western Iran, where Indo-European tribes like the Medes can be localised, there is no grey pottery. See Winter 1989, 99-103.

15 Important monuments of the fine arts such as the gold bowl from Hasanlu are rather related to Hurritic ideas than to Indo-European ideas.

16 The worm bowl is a flat bowl which is decorated with a bent rib; e.g. Muscarella 1994, tabl. 12.1.2, below right.

17 Dyson 1989b, 118-119. On the floors of some rooms there were almost no finds. It is thought that these rooms were cleaned regularly to prepare them for certain activities. Fixed installations inside the Burned Buildings like rostrums and steles also indicate the use of these buildings for cult.

18 It is not a bowl but a big beaker or rather a small dish with steep wall and a bulged bottom. On the shape see Winter 1989, 88, fig. 3.

19 Due to the importance of the place during the 9th century, the questions occurrs if Hasanlu might be called by its original name in Assyrian or Urartean texts. While Reade 1979, 175-181, suggests to consider Hasanlu as the land of Gilzanu of the Assyrian texts, Salvini 1995, 42, is of the opinion that it might be the town of Mesta which is mentioned on Urartean steles.

20 The term "Local Style" was first used by Porada 1965, 114-116 and was later used for other groups of artefacts like ivory carvings and cylinder seals. See Muscarella 1980, 161-189; Marcus 1996, 19-34.

21 Besides several fireplaces, here there were also melting pots, a metal bar, moulds for various objects, and a ball of hematite which was probably used for smoothing bronze. See De Schauensee 1988, 46.

22 A view at the evidence from the neighbouring area of Hasanlu is offered by De Schauensee 1988, 45.

23 Named after the small place of Amlash at the Northern slopes of the Alborz Mountains which is named as the place of origin in the art trade.

24 At Marlik there are hardly any poorer graves. Some graves were completely empty. The excavator is of the opinion that they were robbed as early as in ancient times. The cemeteries of the common population were in the valleys below the Marlik Hill.

25 Löw 1998, 33-61. The finds from the latest graves already indicate Iron Age II which in Northern Iran started at about 1000 BC. But typical finds from the Iron Age II is not found at Marlik. Some younger finds may be judged as being intrusive and probably are from later burials which were done on the hill in the course of the 1st millennium BC. See Haerink 1988, 65.

26 Calmeyer 1982, 341-343, thinks that the metal vessels were payed by bypassing traders as a kind of toll.

27On the discourse on the way of living of the Iron Age population in Lurestan see Porada 1964, 9-31, together with Overlaet 2003, 233-234.

28 On recent field research in Central Asia including an introductory discourse on the present state of research see Alimov et al. 1998.

29 It still remains unclear where the raw material for the Middle East ivories comes from. The Syrian elephant is not mentioned anymore in the early 1st century BC and at that time had probably died out. At any case, the trade route for African or Indian ivory will have been via Mesopotamia to North-western Iran.

30 Dyson 1989b, 120-123. In the rubble of Hasanlu IVB, Elamite objects were found which are to be dated to the late 3rd millennium BC according to their inscription.

31 A compilation of extremely different opinions on this matter is offered by Dittmann 1990, annot. 107.

32 The earlier opinion, that Urartu was destroyed by the Medes as late as in the early 6th century BC, cannot be accepted anymore. See Hellwag 1998.

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Luristan metalwork in the Iron Age

Bruno Overlaet

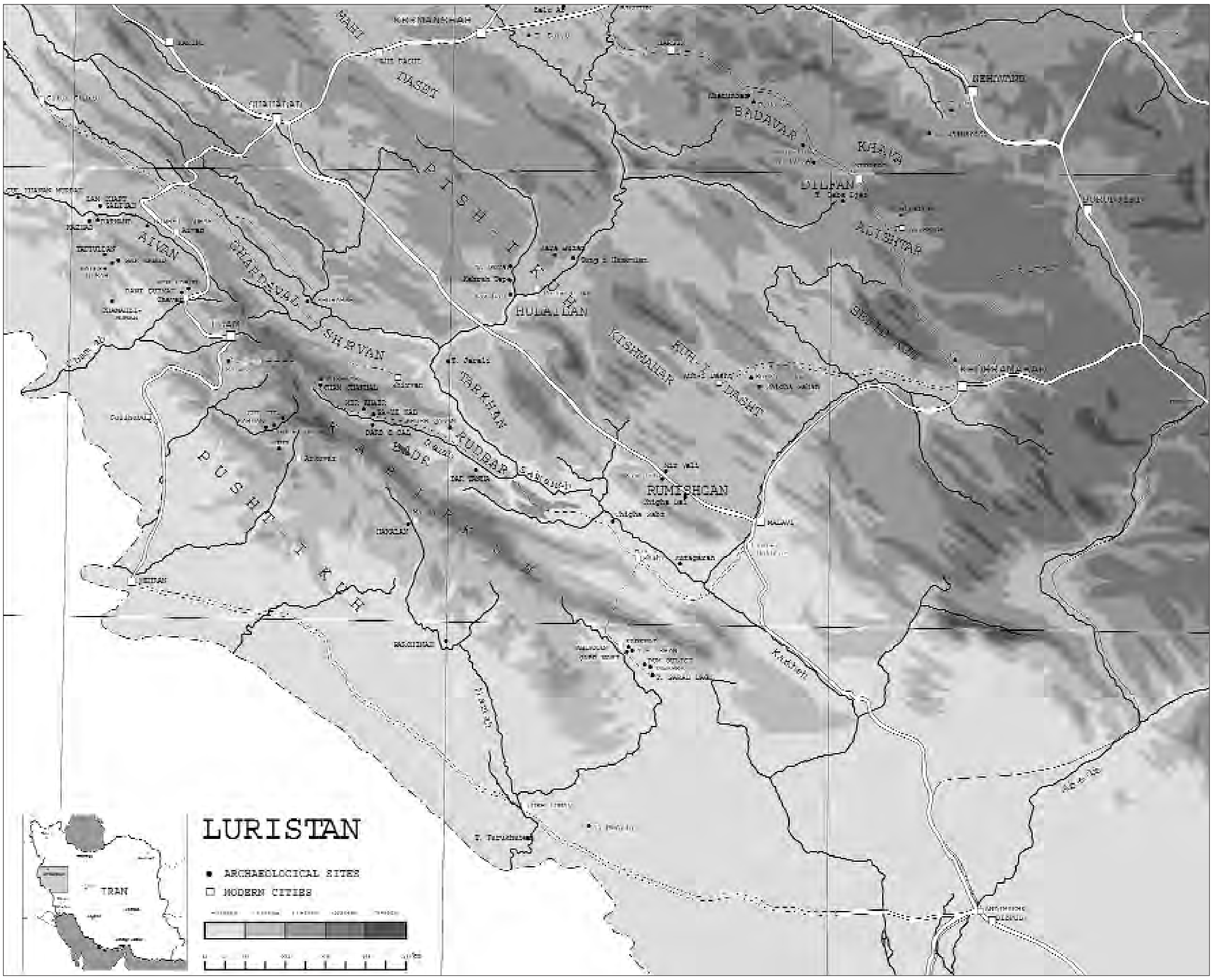


Fig. 1: Map of Luristan.

Fig. 2: View of the Iron Age III graveyard at War Kabud in 1966. Trench of the Belgian team surrounded by pits of earlier illegal excavations.

The "Luristan bronzes" are among the most enigmatic and appealing creations of ancient Iran (fig. 3). There are hammered and engraved sheet metal objects such as large disc headed pins and quiver plaques and cire perdue cast objects, such as spike butted axeheads, horsebits with decorated cheek-pieces, idols, etc. Less well known but as impressive, however, are the decorated iron swords, bracelets and pins. These metal objects are decorated in a very distinctive style with animals, humans and fantastic creatures, combining human as well as animal traits. This decorative style culminates in the “master of animals finials” (Cat. no. 333), in which two confronted felines and a central human figure, often with several Janus-heads on top of each other, are fused into one. Some Luristan bronzes were already acquired by European museums in the second half of the 19^{th} century, but their origin and significance long time remained a mystery. It was only in the late 1920s when suddenly large numbers of these bronzes appeared on the art markets that it became apparent that they came from graveyards and sanctuaries in Luristan.

Geography

Luristan is situated in the western part of the Zagros chain which separates the Iranian plateau from the Mesopotamian plain (Fig. 1). In an archaeological context, “Luristan” denotes the mountainous part of the Zagros between the Iraqi border, the “Great Khorasan Route” across the Zagros, the roads connecting Kermanshah, Sahneh, Nihavand, Borudjird and Dorud and then the Ab-e Diz river to the plain of Dezful. In modern terms this includes the provinces Ilam and Luristan.

The area is dominated by three more or less parallel mountain chains, the Kabir Kuh, Kuh-i Sefid and Kuh-i Garin, which run from NW to SE. These ridges reach heights of around 3000 m asl. In reference to the Kabir Kuh, Luristan is divided into the Pusht-i Kuh (literally "over the mountain", seen from the Iranian plateau) and the Pish-i Kuh (literally "before the mountain"). In general, one could say that Luristan is characterised by rainy winters and dry summers. However, the mountainous character of Luristan causes a multitude of micro-climates (Potts 1999, 12-15). These regional differences explain the seasonal migration of semi-nomadic groups in Luristan. The Kuh-i Sefid divides the Pish-i Kuh in two climate zones. The north-eastern high valleys, referred to as the sardsir or summer quarters, provide a cooler climate in summer while the lower valleys in the south-west (garmsir or winter quarters) provide a milder climate in winter.

Archaeological research

The geography explains why access to the region was always difficult. Until the first half of the 20th century, Luristan had kept much of its tribal autonomy and the central Persian government had little control on the nomadic Lur population. For a long time, clandestine excavations in Luristan continued on a massive scale and escaped all control of the official archaeological services. Many thousands of tombs were looted and the finds were rapidly dispersed among museums and private collections.

As a result, scientific studies on Luristan were limited to the cataloguing of unprovenanced collections (Godard 1931; Calmeyer 1969; Amiet 1976; Moorey 1971). Attempts to place them in an historical context, could only be based on stylistic comparisons with neighbouring regions and on the often inaccurate or even intentionally misleading information obtained from art dealers. The first major scientific breakthrough came in 1938 when an American expedition was able to excavate a sanctuary at Surkh Dum-e Luri in the Pish-i Kuh (Schmidt, van Loon & Curvers 1989). Although the building had already been partially looted, it was still possible to make important discoveries. Stacks of ex-voto objects were found underneath floors and in walls. These included seals and bronze objects such as disc headed pins (Cat. no. 324-326). Since then, the excavations of Danish, British and Iranian archaeologists in the northern Pish-i Kuh valleys of Luristan and the Belgian excavations in the southern Pusht-i Kuh, have completed the picture. The Luristan graveyards with stone build tombs, excavated by the Belgian team, were found to belong to different periods, ranging from the Middle Chalcolithic era (second half of the 5th - first half of the 4th millennium BC) to the Iron Age (Haerinck & Overlaet 2002: survey Chalcolithic and Bronze Age; Overlaet 2003; 2005: survey Iron Age). They contain mostly pottery, weapons and personal ornaments. During the Bronze Age (c. 3000/2900-1300/1250 BC), the bronze objects are related to those of neighbouring regions in Mesopotamia and on the Iranian plateau. The characteristic "Luristan" style objects all belong to the Iron Age (c. 1300/1250-650 BC).

The Iron Age chronology

Although much research has now been done on Luristan, our knowledge about the Iron Age population and its culture is still very fragmentary. We still lack information on specific regions and chronological phases. Nevertheless, the Belgian excavations in the Pusht-i Kuh, directed by the late Louis Vanden Berghe, have made it possible to propose a general chronology for at least this part of Luristan. There seem to be important regional variations, however, between mainly the Pusht-i Kuh and the Pish-i Kuh.

When discussing the Iranian "Iron Age", one has to keep in mind that this label does not mark – as one would expect – the first general appearance of iron in Iran. It was linked to a cultural change in North-western Iran which was associated with the arrival of the Indo-Europeans. There were changes in the ceramics and the weapons, there was the appearance of "extra muros" cemeteries etc. The developments within this culture lead to a subdivision into three phases, called Iron Age I, II and III (Young 1965; 1967; 1985; Dyson 1965; Levine 1987, 233). It is evident, however, that such changes did not occur identically and simultaneously on a vast territory such as Iran. As a result, the "Iron Age" terminology and its tripartite division can not be applied on the whole of Iran. Nevertheless, it is conventionally used in Luristan, as in other parts of Iran (See e.g. Haerinck 1988, 64-65: Gilan), as a rough chronological marker and a general reference system.

The end of the Late Bronze Age and the beginning of the Iron Age in Luristan is marked by a sudden change in lifestyle. C. 1300/1250 BC, settlements throughout Luristan, such as Tappeh Baba Jan, are deserted (Goff 1968, 127; 1971, 150-151; Schmidt, van Loon & Curvers 1989, 486-487). Although some sites did remain settled, this was, however, on a limited scale (see Tappeh Guran, see Thrane 2001; Overlaet 2003, 25-28, fig. 14-16). What precisely happened is not known. There are no indications for a military destruction from any of these Bronze Age sites. It was probably related to climatological factors as the desertion of these settlements coincides with a peak of increased rainfall in the Near East between 1350 and 1250 BC (Neumann & Parpola 1987, 164). It is thought that this resulted in a period with repetitive floodings and failing crops, something which could easily cause a collapse of the economic system. The vacuum which was thus created was filled by the "Iron Age Luristan population" who were to produce the canonical Luristan bronzes. Who these people were remains a mystery. They may have moved into Luristan at this time or they may have been a remaining group of the sedentary Bronze Age population which adapted to new circumstances and adopted a new lifestyle. They may also have been local minorities, possibly semi-nomadic, that were already present in the region. Such groups could in fact expand after the collapse of an agriculturally oriented sedentary society, which would have occupied up to then the most fertile lands.

One of the recurrent questions about the Luristan population is that of their way of living. When the first Luristan bronzes appeared on the art markets in the late 1920s, archaeologists stated that the

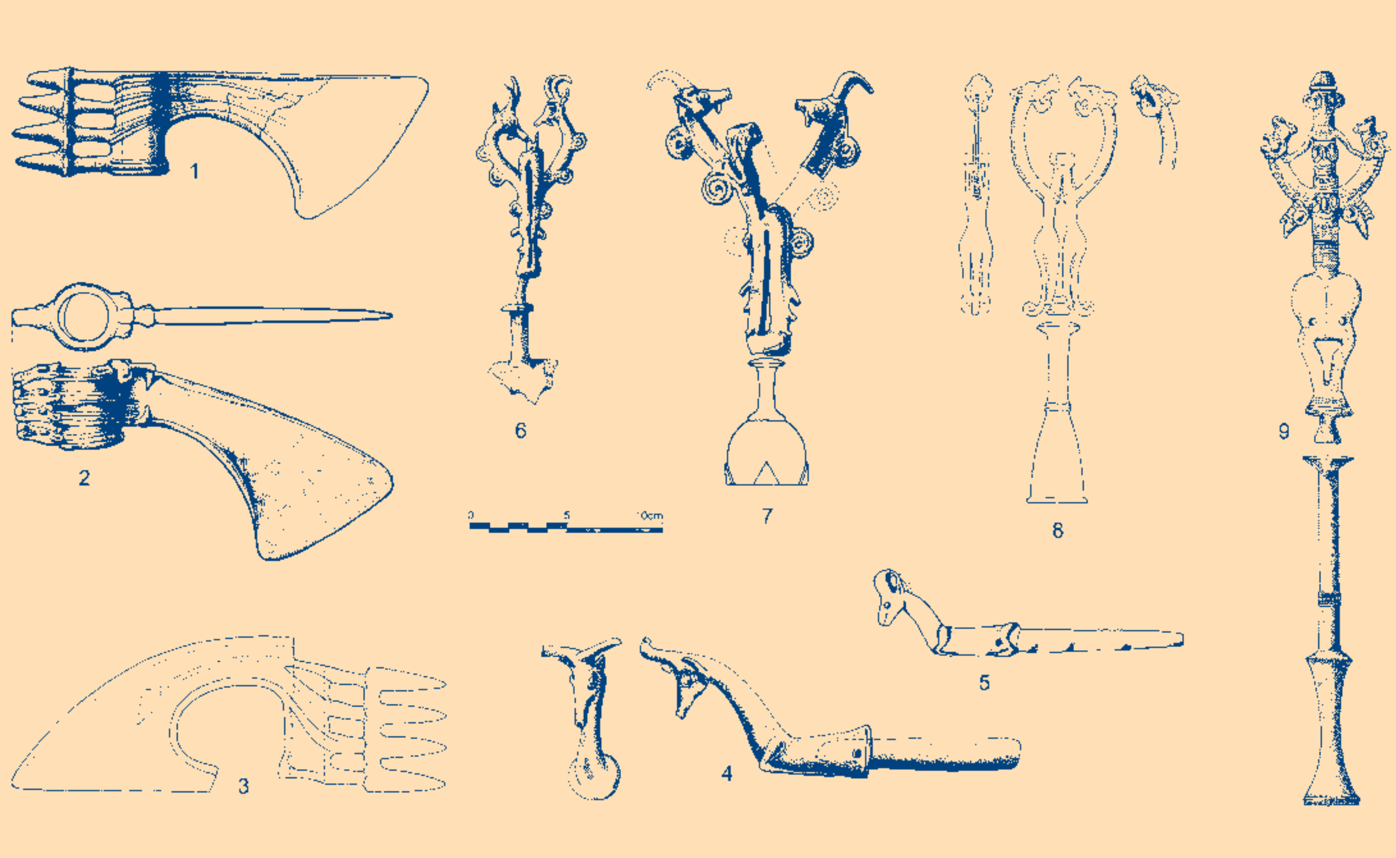


Fig. 3: 1, 4-7 Canonical cast bronzes found during controlled excavations at Bard-i Bal, 2 Kutal-i Gulgul, 9 Tattulban and 3, 8 Khatunban.

people who had made them had to be nomadic (Godard 1931, 21). Luristan was at that time hardly explored and it was thought that the region could never have been suited for sedentary habitation, an idea which later had to be abandoned. The situation during the Iron Age must have been much more complex. There probably were semi-nomadic as well as small settled groups in the region. Depending on climatic, political and economic changes, one or the other lifestyle may have been the dominant one. A similar symbiosis of lifestyles still exists nowadays in Luristan.

The first phase of the Luristan Iron Age, called Iron Age IA in the Pusht-i Kuh, can be dated between c. 1300/1250 and c. 1150 BC "Extra-muros" graveyards with cist tombs were excavated at Duruyeh, Kutal-i Gulgul and Bard-i Bal in the Pusht-i Kuh (Fig. 4 top). The earliest tombs were individual but it rapidly became customery to re-open the tombs and use them over and over again. Since these tombs were relatively small, however, the burial-goods were stacked at the back of the tombs and the remains of the deceased had to be pushed to the side to make room for every - reuse. Most were build with stone slabs or boulders and were rectangular to horseshoe shaped. One of the small sides was used as an entrance and was often closed with one or two large stone slabs. The flat roof of the tomb chamber usually consisted of large stones. Some of the tombs at Kutal-i Gulgul were used for at least four people. However, as human remains are usually not preserved or only fragmentary, the exact numbers may be much higher. Among the burial-goods occur pottery shapes and objects which indicate that the population had contacts with Kassite Mesopotamia. Good chronological markers are imported decorated shell fingerrings and faience buckets which are known from Kassite burials in the nearby Hamrin region and from elsewhere in Mesopotamia (Beyer 1982; Boehmer 1982, 40; Boehmer & Dämmer 1985, 80; Clayden 1998; Overlaet 2003, 74-76, 138-141, 219-220, Abb. 50-51, 108-109, 185). At the same time, the first objects in canonical Luristan style are present. There are e.g. spike butted axeheads and simple finials which consist of a tubular bronze support mounted by two confronted animals (Fig. 3). There is no proof yet that iron was used in Luristan at this stage. Bronze was the common material for weapons and utensils as well as for jewellery.

Around the middle of the 12th century BC came an end to the presence of Mesopotamian objects among the burial-goods. This can be explained by the destruction of the nearby Kassite settlements in the Hamrin by the Elamite army of Shutruk-Nahhunte around 1160 BC. This event must have cut off the Pusht-i Kuh from its suppliers. As a result, the deposition of Kassite objects in tombs would have ended shortly afterwards. This military Elamite campaign was part of general upheavals in the Near East, linked to a distinctive dry period which had caused widespread crop failures, famines and epidemics, something which in turn gave rise

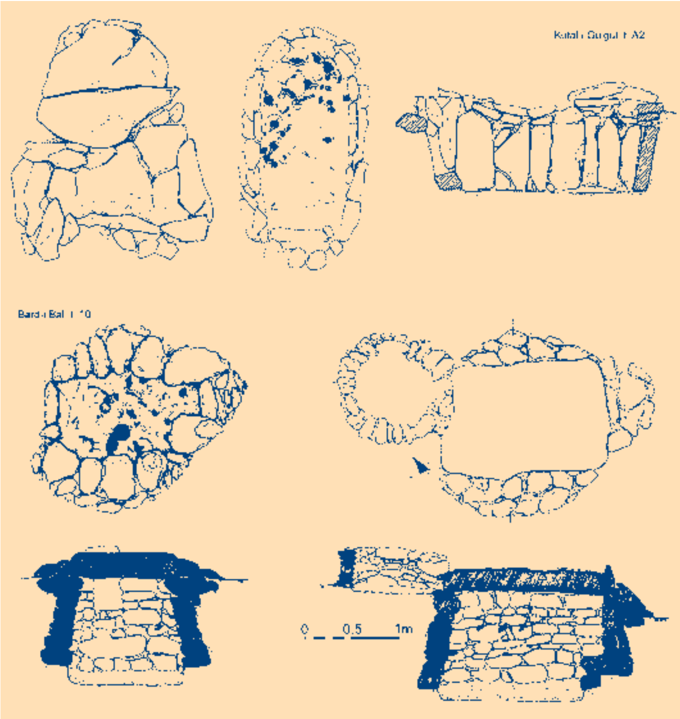


Fig. 4: Plan of an Iron Age IA tomb from Kutal-i Gulgul and an Iron Age IB-IIA tomb from Bard-i Bal in the Pusht-i Kuh.

to migrations and military conflicts (Neumann & Parpola 1987, 161-162).

During the following phase, called Iron Age IB-IIA in the Pusht-i Kuh (c. 1150 - c. 900 BC), the same graveyards remained in use but new tomb shapes appeared which were better suited for re-use. Some tombs at Bard-i Bal are made larger and have an easy stepped entrance (Fig. 4 bottom). Iron occurs and gradually became more common. It was an expensive and prestigious material, however, and was therefore mainly reserved for jewellery, such as pins, fingerrings, bracelets and anklets. The canonical bronzes, which include axes, whetstone handles, horsebits with decorated cheekpieces and finials, evolved into more elaborate and complicated shapes (Figs. 3 and 5).

Important changes took place in Luristan in the course of the 9th century BC. From about 950/900 BC a new cooler period started in the Near East causing a slight increase in precipitation (Neumann & Parpola 1987, 175). It seems that this created again the necessary circumstances for agriculture on a larger scale, something which in turn allows the support of a larger population. In the course of the 9th century BC, some of the larger tappeh's in the Pish-i Kuh, deserted at the end of the Bronze Age, were resettled and new small settlements were appearing (Goff 1968, 127-128). At Baba Jan, an important complex with a stronghold and what seems to have been a temple, was build by settlers who are characterised by their painted "Baba Jan III" ware (Henrickson 1988; Overlaet 2003, 38-41, fig. 25-27). Its heydays are in the 8th century BC. No canonical bronzes were found at the Baba Jan III settlement or in tombs with Baba Jan III ceramics, an indication that either the heydays of these bronzes were over or that they are not to be associated with these specific groups of settlers. In the 9th century, the sanctuary at Surkh Dum-e Luri, probably dedicated to a female deity, stands at the beginning of a prosperous period with regular renovations and the deposition of hoards of *ex-voto* objects (Schmidt, Van Loon & Curvers 1989; Overlaet 2003, 34-37, fig. 22-24). Among these are many heirlooms. An important group are the pins with large decorated heads (Cat. no. 324-326), many of which may predate the Iron Age III phase (Moorey 1999, 151). Female deities, human figures with horns, animals and floral motives occur on them. A large graveyard on a hilltop above the sanctuary was unfortunately plundered but Baba Jan III related sherds, left by the plunderers, indicated that at least part of it was contemporary to the main occupation of the sanctuary[1].

Also in the Pusht-i Kuh, changes are observed in the 9th century (Iron Age IIB: c. 900-800/750 BC). People are again buried in small individual tombs. What incited the population to abandon their traditional re-use of (family?) tombs and to build individual tombs again, remains a mystery. We do not have any excavated settlements sites in the Pusht-i Kuh, although some tappehs are present in the larger valleys. Iron was still widely used for jewellery, but it seems that the material became more common as it was also used for daggers (Cat. no. 329). Expendable weapons such as arrowheads were still made of bronze, however, a clear indication of the value of iron.

The following phase in the Pusht-i Kuh, the Iron Age III, seems to have been a very prosperous period (c. 800/750-650 BC). A large number of graveyards is known (Vanden Berghe 1987; Haerinck & Overlaet 1998; 1999; 2004) which may indicate an important increase in population density. The burial-goods are generally more diverse and valuable. The tombs are usually individual and among the burial-goods are bronze vessels, iron armament and new shapes and types of ceramics (Fig. 7). A group of fine grey and fine buff ware is decorated with incised geometric designs (Cat. no. 337), which are related to the painted designs of the Baba Jan III ware in the Pish-i Kuh. Iron had become a very common material and its status had consequently changed. Although iron anklets are still occasionally encountered at the beginning of the Iron Age III (Cat. no. 331), it is clear that iron jewellery is no longer in vogue. Iron fingerings no longer occur. Swords and daggers, arrowheads, axes and adzes were now made of iron. Bronze was used for decorative elements on arms, for jewellery and for some more complex shaped weapons such as mace-heads and axe-adzes. A mace-head from War Kabud (Cat. no. 341) combines a bronze tube with an iron ball and is of a type which also occurs in Mesopotamia. Assyrian imports in the Pusht-i Kuh, such as glazed vases, occasionally occur among the burial-goods, indicating that the area became more integrated again in the general political events of the Near East. The discovery of an Assyrian rock sculpture at Shikaft-i Gulgul in the Pusht-i Kuh, illustrates the occasional military incursions of Neo-Assyrian armies into Luristan (Reade 1977). Neo-Assyrian sources mention the existence of a confederate state,

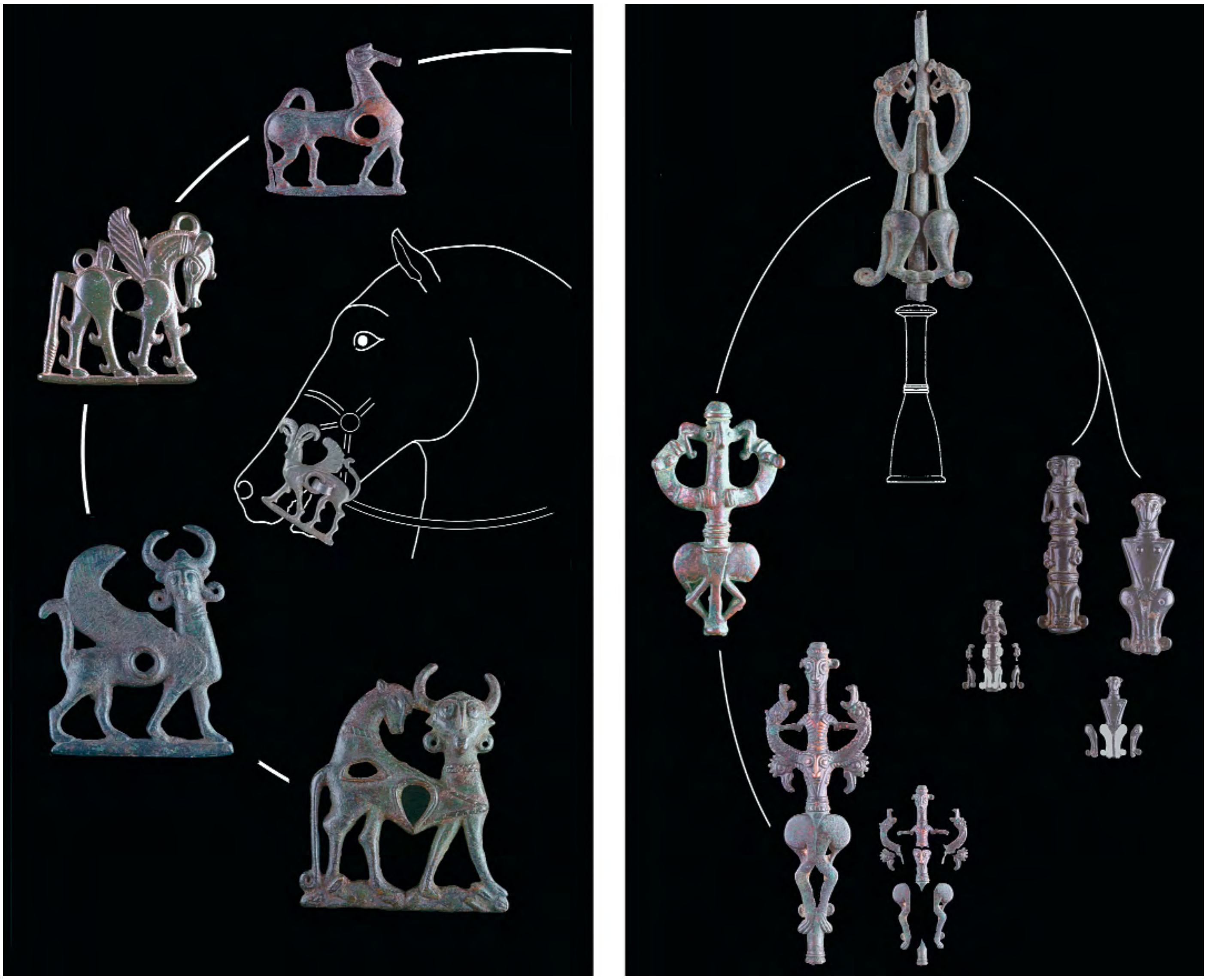


Fig. 5: Evolution from simple to complex compound images: finials and cheekpieces of horsebits (collection: Royal Museums of Art and History, Brussels).

called Ellipi, in Luristan. The people of the Pusht-i Kuh may have been the Parnakians, mentioned by the Assyrians as fierce enemies (Zadok 1981-82, 135). Ellipi was probably confined to a large part of the Pish-i Kuh (Medvedskaya 1999, 63-64). It was a territory where Iranian/Median influence from the north may have met with a strong Elamite influence in southern Luristan (see Henkelman 2003, 196-198). We have no written records from Iron Age Luristan itself which could shed light on the political and tribal organisation of the area, or on the extent of the Elamite influence. In view of the presence of Elamite faience pottery and seals, however, it has been proposed to see the last expansion of the Surkh Dum-e Luri sanctuary in the first half of the 7th century, as under direct Elamite influence. The end of this religious centre must be around the middle of the 7th century (Schmidt, van Loon & Curvers 1989, 448, 487-491). We have little or no information about the transitional phase from the Iron Age III to the rise of the Persian Achaemenian empire. The treasure from the Kalmakarreh cave in Luristan (Cat. no. 512-515), which was unfortunately looted and is now widely dispersed, must have been hidden at the end of the 7th or at beginning of the 6th century BC. It contained several vessels with Elamite cuneiform inscriptions mentioning private individuals as well the rulers of a local “kingdom of Samati”, probably situated somewhere in southern Luristan (Henkelman 2003, 214-227, pl. 9-15).

Fig. 6: Pins with heads in the shape of felines in bronze (top), bronze and iron (middle) and iron (bottom) (collection: Royal Museums of Art and History, Brussels).

The canonical Luristan style

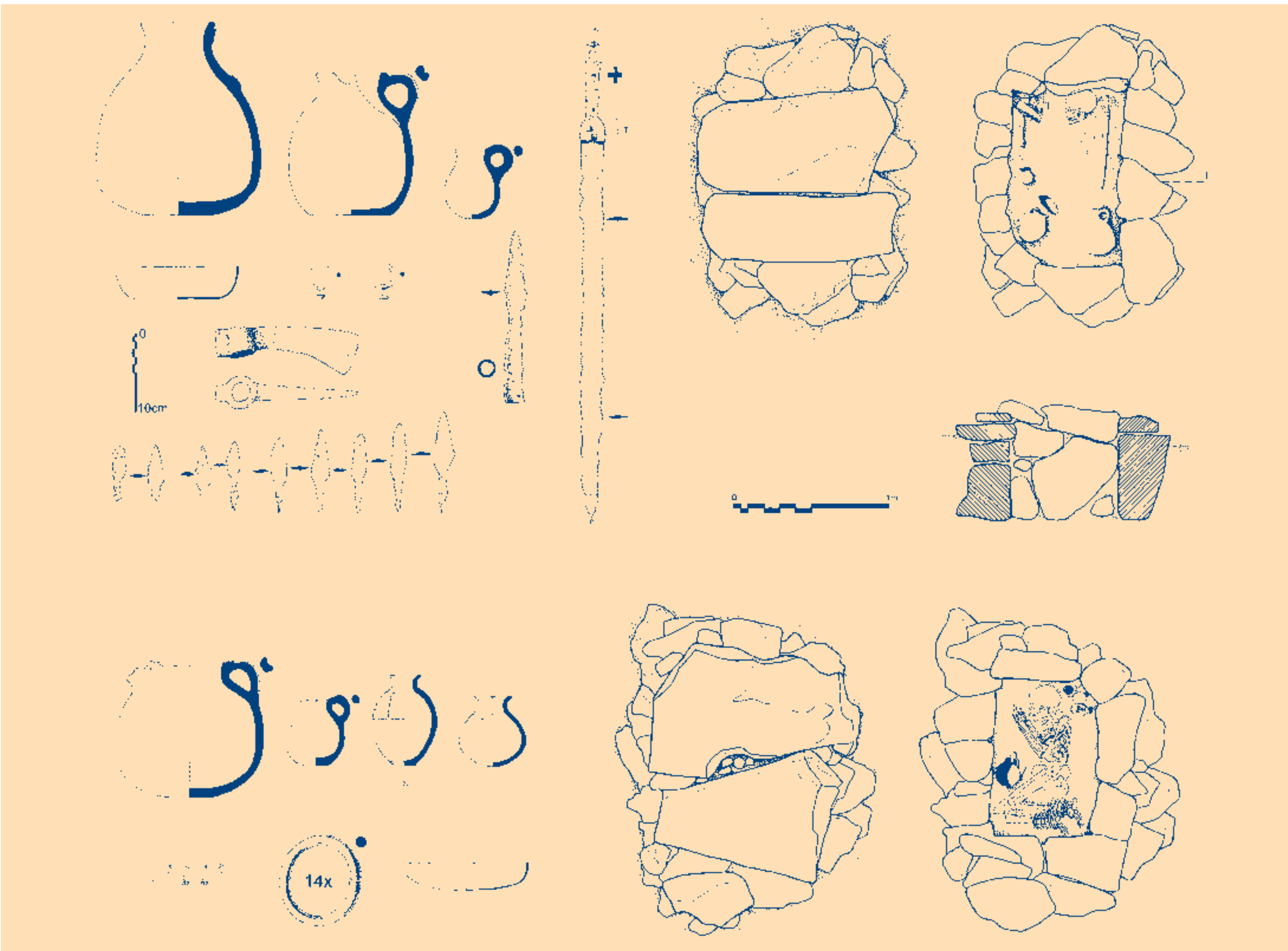
Although literally thousands of canonical Luristan style objects are present in musea and private collections, only a very small number has been discovered during controlled excavations. There are also many forgeries among the unprovenanced objects. Some forgeries are very crude and easy to detect, others, however, are made by excellent craftsmen and a good knowledge of both techniques and iconography combined with metal analyses is needed to detect them. Thus, many questions remain concerning the precise date, the stylistic development, function and regional distribution. Technically, one can distinguish between cast bronzes and hammered sheet metal bronze. A separate category are the decorated iron objects.

The cast bronzes are mainly lost wax casts which combine animal, human and fantastic decorative elements. Among these, there are idols or finials, weapons, horse trappings and jewellery (Figs. 3, 5, 6).

The finials or idols (Fig. 3, 5) occur from the Iron Age IA onwards[2]. The earliest examples consist of a pair of rampant predators or goats on a tubular bottle shaped support. They are symmetrical and the front and back is identical. They are either arranged around a sheet metal tube or hold rings between their paws or hoofs. It may be that a branch was once mounted in the middle as to create the image of a tree of life flanked by animals, a common subject which was widespread in the ancient Near East. There seems to be an evolution from more or less naturalistic animals to more stylised ones. One group, often referred to as "master of animals" finials, combines the image of two rampant felines with a central human figure (Fig. 3: 9, 5). Again it is created around a central tube and has an identical front and back. The human figure is bifacial indicating that the image is designed to be seen from all sides. Whereas the two felines and the human torso are easily recognised on the earlier types (Cat. no. 333), it becomes more difficult when parts become fused and human heads and birds are added to the image. The latest variant is a complex one: the lower part shows the confronted hips and hind legs of the predator, above it is a tube with two or three human heads and the arms of a human who grasps the long curving necks of the predators. Small birds or bird heads are sometimes added to the felines hips or at the base of the necks. Only one such "master of animals" finial was up to now discovered during controlled excavations. It was found in an early Iron Age III tomb of a warrior at Tattulban in the Pusht-i Kuh (Fig. 3: 9) (Vanden Berghe 1971, 264-268; Overlaet 2003, 188-189, fig. 155-156). As it was the only finial ever discovered in an Iron Age III tomb and since it represents the end of the stylistic evolution, it seems that by this time the heydays of these finials were over. A small group of tubular figurines are related to these late finials and may thus belong to the same phase. They are small human figurines which often have no longer an identical front and back. The lower part may consist of the hindpart of the predators or small predators are simply placed against the legs (Fig. 5). The precise significance of these finials is still unknown. The few specimens from controlled excavations indicate that they were placed in male tombs. Those of the Iron Age I-II usually also contained other canonical bronzes such as spiked butted axeheads and whetstone handles.

From warrior tombs also comes decorated armament (swords and daggers, axes, halberds, shields and quiver plaques), utensils (whetstones) and horse harness (bits and rings). One type of axe with a downwards curved blade has several spikes on the butt (Fig. 3: 1-3 / Cat. no. 315)[3]. On the earliest examples which date from the Iron Age IA, these spikes are still modest in size and the axe seems to be an efficient weapon. The blade of later specimens, however, is sometimes curved to such an extent that the cutting edge stands in an almost straight angle to the shaft of the axe. This cutting edge was rarely sharpened and suggests that only the tip of the blade and the spikes were of importance. Spike butted axeheads can be decorated with geometric or figurative designs on the blade, and sometimes small predators or birds were placed on the top rim of the blade. On more elaborate specimens, the blade emerges from a predators mouth and the spikes can be animal shaped. This type of axehead was no longer found in the Iron Age III tombs. At that time a simpler type of iron axe had become the standard (Cat. no. 339). A group of halberds with comparable decorations is contemporary with the spike butted axe heads (Cat. no. 316) (Moorey 1971, 58-59, fig. 7, pl. 3; 1991, 4, fig. 1). Some combine an iron blade with a cast-on bronze decorated socket and thus illustrate the transition from bronze to iron armament which is completed by the beginning of the 8th century BC. Associated with the use of bronze daggers in the Early Iron Age (Cat. no. 318, 319) is the occurrence of whetstones (Fig. 3: 4-5). Bronze cutting edges had to be sharpened regularly and a whetstone was a much needed tool. Elaborately cast bronze handles were sometimes fitted to them (Cat. no. 330) and again there seems to be a stylistic and chronological evolution from rather simple naturalistic specimens to more complex ones[4].

Fig. 7: Iron Age III tomb and burial-goods of a man (top) and woman (bottom) at War Kabud in the Pusht-i Kuh.



A rare group of iron swords may be one of the first local attempts to produce more complex iron objects in Luristan. The hilts are decorated with lions, lions heads and human heads (Cat. no. 328). Two bearded human heads are set on the disk of the hilt. The back of each head has the shape of a lions protome. Two small predators, either lions or panthers, are placed at the base of the hilt. About 90 of such swords are known but unfortunately, none comes from controlled excavations (Muscarella 1989 (with extensive references)). These short swords consist of a series of separately forged parts of low-carbon wrought iron. Technical evidence indicates that the iron was not produced by those who created the decorated swords. The craftsmen who produced these weapons appear to have had relatively little knowledge of iron working techniques and may instead have been more familiar with bronze working (Moorey 1991, 3; Rehder 1991). This should not surprise. Since iron ore was apparently not available in Luristan, it must have been imported as forged bars or ingots. The area of Hamadan is one of the potential sources (Pigott 1989, 69, fig. 4). It is almost self-evident that the bronze workers were the first to experiment with the working of a new metal such as iron. The rarity of the metal and its novelty appeal explains its value as a status symbol in the Early Iron Age. One way for the craftsmen to include the prestigious iron into his production was to combine bronze and iron. Simple shapes were produced in iron and the decorative parts were cast-on in bronze. The casting-on technique widely occurs in the Iron Age II in western Iran and is common at sites such as Hasanlu IV (Pigott 1989). Much more difficult, and thus more costly and prestigious, must have been the complete translation of the current bronze decorations into iron. These swords are not the only examples of Luristan decorative ironwork. Massive and heavy wrought iron bracelets which are decorated with human faces and lion-masks are identical to bronze cast specimens[5]. Fig. 6 shows three pins with a head in the shape of a crouching lion. The first is entirely cast in bronze, the second has a cast-on bronze head on the iron pin while the third is completely made of wrought iron. The iron, squarish shaped lion is identical to the small lions on the hilt of the iron swords. Although it is clear that the iron swords and the other decorative ironwork belong to the formative stage of the ironworking technology in Luristan, it is difficult to date them precisely. In view of their uniformity, they may belong to a limited period within the 10th to early 8th century BC time range. However, arguments for a much earlier as well as for a later date have been advanced[6].

Horse trappings such as harness rings (Cat. no. 327) and horsebits with decorative cheekpieces (Fig. 5 / Cat. no. 321) are also characteristic for Luristan[7]. Again, none of them was ever found during controlled excavations. A few simple bronze horsebits were found at Khatunban B (Haerinck, Mohammadi-Jaffar & Overlaet 2004, pl. 5, 14-15) in an Iron Age II context and some iron horsebits were found in Iron Age III tombs (Cat. no. 335) (Haerinck & Overlaet 2004, fig. 19, pl. 128). In view of these discoveries and in view of their stylistic association with other lost wax cast bronzes, however, those with decorated cheekpieces must predate the Iron Age III. The cheekpieces also evolved from simple naturalistic images to very complex ones (Fig. 5). The simplest cheekpieces depict animals running on a horizontal baseline. Bits with simple cheekpieces shaped as horses are also known from an Early Iron Age tomb at Marlik in northern Iran (Negahban 1996, 305-306, pl. 135) and others are depicted on Neo-Assyrian sculptures (Muscarella 1988, 156), but it is only in Luristan that this type of object is developed into a cultural statement. In the more complex images, animals can have wings, horns or even human faces. Wings sometimes end in animal heads and small animals can be added to the scene. Some cheekpieces display predators with their prey or even a horse drawn chariot. Some of these cheekpieces can be extremely heavy which suggests that they were not meant for daily use. On the other hand, traces of wear are often visible which indicates that they must have been used, either intensively or over a long period.

Among the sheet metalwork from Luristan, there are bronze vessels (Cat. no. 334 / KMKG AW.67-4), disc-headed clothing pins with hammered and engraved decorations (Cat. no. 324-326) and plaques which were mounted on for example shields, quivers, horse harness or clothing. The iconography includes male and female deities, hunting and banqueting scenes, animals and floral motives. One group of decorated vessels, the so-called nipple beakers, is decorated in a uniform style and can be dated to the 10th century BC. They are either made by a Babylonian workshop or under strong Babylonian influence (Cat. no. 317) (Calmeyer 1965; Muscarella 1974; 1988, 244-248). One was excavated at Zalu Ab and several fragments were found at the Surkh Dum-e Luri sanctuary (Schmidt, van Loon & Curvers 1989, 322, 330, pl. 190), which confirms their occurrence in Luristan. Like the majority of the seals, they thus predate the main use of this sanctuary (Schmidt, van Loon & Curvers 1989, 413; Moorey 1999, 148). It seems as if many of the votive offerings were only deposited at the temple either after they had fallen out of fashion, or once they were considered of special value precisely because of their great age. Whatever the explanation, it supports the idea that the above mentioned disk headed pins from Surkh Dum-e Luri (Cat. no. 324-326) also predate the Iron Age III (Moorey 1999).

Final remarks

The combination of research on the many unprovenanced Luristan bronzes with field research in Luristan by a limited number of teams, has made it possible to propose a general chronological context. Nevertheless, it is obvious that many aspects of the cultural setting are still enigmatic. Hardly anything can be said about the Iron Age population, their way of subsistence, beliefs or political structure. More field research is urgently needed as many archaeological remains in the region are inevitably endangered by the ongoing expansion of towns and villages and by widespread mechanised agriculture. The systematic surveys and excavations by MIRAS, the Iranian Archaeological Service, and eventual future joined Iranian and foreign field work which is now in its planning stage, will hopefully allow to obtain a more complete picture of the culture and history of Luristan.

Notes

1 Personal observation September 2003 (survey by E. Haerinck & B. Overlaet in association with MIRAS).
2 Moorey 1971, 140-168, pl. 30-39; Muscarella 1988, 136-154, nr. 215-149; Overlaet 2003, 185-193, fig. 153-159.
3 Moorey 1971, 49-54, fig. 5-7, pl. 2-3; Muscarella 1988, 189-190, nr. 304-305; Overlaet 2003, 166-172, fig. 134-137.
4 Moorey 1971, 98-100, pl. 11-12; Muscarella 1988, 182-183, nr. 298-301; Overlaet 2003, 180-185, fig. 146-152.
5 Muscarella 1989, 166-167, 171-172, nr. 264, 272, fig. 13-14; Moorey 1991, 9, fig. 4.
6 Muscarella 1989, 354-355: c. 750-650 BC; Moorey 1991 and Rehder 1991: 11th century BC.
7 Potratz 1966; Moorey 1971, 101-139, pl. 13-26; Muscarella 1988, 158-166, fig. 9.

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The early iron age fortress of Ziwiye in Khordestan; in 1947 here was found the famous gold hoard; Photo: G. Gerster.

Luristan Disc-headed Bronze Pins

Souri Ayazi

Iran was an important centre of metalworking in the ancient world for a very long time, with the Luristan region considered by scholars as one of the most prominent locations of such activity. Luristan bronzes comprise a wide range of categories: functional and objects like tools and weapons and horse harnesses, ceremonial and ritual objects, personal decorations and ornaments, and various types of vessels; these bronzes were unique in their technique and innovation, and had a great impact on Iranian metalworking in later periods. Following the 1929-30 spread in the world antique markets of numerous bronze objects ascribed to the Luristan region, and their increased presence in western museums, the Luristan region attracted several Iranian and foreign researchers for excavation. Official and clandestine excavations recovered various artefacts; in particular, the diverse bronze-wares enjoyed great world renown.

Prominent among bronze artefacts found in Luristan are pins, characteristic in their diversity, quantity and various decorations. These pins can be divided into three main groups according to their head decorations (Fig. 1):

1. Pins with cast heads in various floral, animal, geometric, domed and conic designs.
2. Pins with openwork cast heads, usually in a crescent, circular or rectangular frame, some with iron shakes.
3. Pins with flat, mostly circular heads of wrought sheets, the surface decorated with various floral, zoomorphic, geometric, human and semi-human motifs. These motifs range from the plain to composite, from very realistic to very abstract forms, and are created by casting or hammering.

The first thing that attracts an observer attention is the use of surface to express themes and concepts derived from the craftsmen's beliefs and mental convictions. The craftsmen's mental power and innovation, the pictorial knowledge and clever use and arrangement of suitable spaces for casting various motifs are quite interesting aspects to consider.

Only a few of the pin-heads now preserved in the museum were found during systematic excavation in Sorkh-Dum, Luristan; many derive from illegal excavations and smuggled goods, and therefore lack precise information as to their provenance and recovery history. Of course, this is a circumstance common to many bronze objects of Luristan. One of the vast plains of Luristan region is Kuhdasht; Sorkh-Dum is located 74 km west of Kuhdasht, on the foot hills of a mountain of the same name, being thus called after the ochre colour of the foot hill.

Survey and excavation of the Sorkh-Dum site took place in 1938 by an American mission headed by Erich Schmidt, in continuation of excavations carried out in 1934-35. A major temple was discovered along with numerous bronze finds, including mirrors, whetstone handles, small engraved plaques, figurines (scattered in the rooms), and sheet and cast disc-headed pins with religious themes (mostly situated in wall crevices).

The architectural remains, artefacts and graves of Sorkh-Dum are usually ascribed to the Middle Bronze Age; however, various levels of settlement remains continue from 1200 BC to the 7th century BC (Iron I/II). The present paper is a survey and concise presentation of more than 80 bronze sheet disc-headed pins, which are preserved in the National Museum of Iran.

The disc-headed pins surveyed are divided into three main groups according to their appearance, each group being divided further into subgroups:

Bosses are normally manufactured by using moulding techniques and have a diameter between 1 to 6.7 cm, usually 1 to 2 cm. The diameter of disc-headed pins is between 1.9 to 14 cm leading to a slender sharp pointed shank. The length of the whole shank is between 3.5 to 30 cm and their diameter is between 1.5 to 5 mm. The discs are very slender with a thickness around 1 mm and in very rare cases a little thicker, mostly visible in conic pin-heads. The backs of disc-headed pins are plain and hollow, patterned only on

First group (Circular sheet pin heads with central boss)	A. Convex boss	Plain	
		Patterned	Rosette
			Human Face
			Lion Face
	B. Conic boss		
Second group (Sheet pin heads without central boss)	A. Plain		
	B. Patterned		
Third group (Square sheet pin heads without central boss)			

Fig. 1: Classification of pin heads according to their appearance.

one side and in some cases cast in one-sided moulds. The pin wires are mostly round and shank-like. The shanks in some pins have a rectangular shape; in these examples, the patterned head is also rectangular and without a central boss. In most cases, the disc and shank have been cast in separate moulds and joined later, with the joint being flattened by hammering. In some discs with a conic central boss, the joint has a hand-shaped ornamental appendage or is decorated with circular bands in relief. In these examples the main part of the shank is missing and only the appendage remains; the shanks were probably made of iron and destroyed by corrosion.

A survey of pin-heads revealed great diversity in decorative scenes and pattern arrangements; three main groups with further sub-divisions were specified (Fig. 2).

First Group:

Pin-heads with plain bosses (A) may have plain (A.1) or patterned margins (A.2). The patterned margins may have one of the following forms:

A.2.1 *Floral designs*, such as a scallop-like band terminating in a pomegranate and pine cone, or as petals encircling the central boss.

A.2.2 *Animal figures* encircling the central boss.

A.2.3 *Composite patterned margin*, comprising zoomorphic figures and flora around the central boss.

A.2.4 *Miscellaneous geometric designs*, as small spheres, scattered or concentrated, polygon stellar and concentric embossed bands.

Pin-heads with floral bosses (B) usually combine a rosette rendered in linear form with several or limited petals on the boss and the encircling margin in three main groups.

Plain (B.1), floral (B.2) or animal (B-3).
Pin-heads with central bosses depicting a full human face (C), usually female, include the following:
Pin-heads with discs showing a single female face; most examples of this were unearthed in Sorkh-Dum excavations and resembling each other (C.1). Central faces are sometimes accompanied by floral designs (C.2) or animal-plant or animal-human combinations (C.3).

The last group comprises circular pin-heads with a central boss in the form of a lion mask (D). The lion's face covers the whole central boss and there is a plain margin (D.1); alternatively, the face can be accompanied by floral (D.2) or composite designs of humans, animals and plants (D.3) (Fig. 3).

Second Group:

The second group are sheet disc heads without central bosses, comprising two groups: plain (A) and patterned (B) – it should be noted that most are of this second type, and plain pin-heads without any decoration are the smallest pin-heads regarding size (A).

Patterned pin-heads (B) are divided into five groups according to their designs:

B.1 Floral designs
B.2 Animal figures (mostly unearthed in Sorkh-Dum)
B.3 Human figures
B.4 Composite designs

First group (Circular sheet pin heads with central boss)	A. Plain boss	A.1 – Plain boss – Plain margin	
		A.2 – Plain boss – patterned margin	A.2.1 – Floral design
			A.2.2 – Animal design
			A.2.3 – Composite design (Floral & Animal)
			A.2.4 – Miscellaneous geometric design
	B. Floral boss	B.1 – Plain margin	
		B.2 – Floral margin	
		B.3 – Animal margin	
	C. Boss with Human face	C.1 – Plain margin	
		C.2 – Floral margin	
		C.3 – Composite margin (floral, animal & human)	
	D. Boss with Lion face	D.1 – Plain margin	
		D.2 – Floral margin	
		D.3 – Composite margin (floral, animal & human)	
Second group (Sheet pin heads without central boss)	A. Plain		
	B. Patterned	B.1 – Floral design	
		B.2 – Animal design	
		B.3 – Human design	
		B.4 – Composite design	B.4.1 – Human & animal
			B.4.2 – Human & plant
			B.4.3 – Animal & plant
			B.4.4 – Imaginary creatures
		B.5 – Miscellaneous geometric design	
Third group (Square sheet pin-heads with zoomorphic or miscellaneous geometric designs)			

Fig. 2: Classification of pin heads according to their decorations and their concept of design.

B.5 Miscellaneous geometric designs.
Composite designs include both human and animal (B.4.1), often depicting the Master of the Animals accompanied by other animals. Man and plant (B.4.2) or animal and plant (B.4.3), where animals like lion and goat are depicted by the sacred tree, the last category in composite design, comprise pin-heads with imaginary creatures (B.4.4), for example a monster with human body and dual lion heads and four wings. Disc-headed pins with miscellaneous geometric designs (B.5), such as dotted lines and hexagonal stars with points terminating in tiny spheres, have no central boss.

Third group:

The third group comprises square sheet pin-heads with zoomorphic or miscellaneous geometric designs.

Fig. 3: Sheet disc-headed pins with long shank. In the centre a small boss with two bands is visible, decorated with chased chequered lines, tiny dots and oblique lines. This is encircled by small flower of embossed dots. The middle margin is composed of a band of scallops whose joints shape triangles, and the middle branch is decorated with chased oblique lines. In this middle of each scallop, a pine cone is visible. This floral band is simple in design compared with others. The filling designs are as flowers composed of embossed and chased dots. On the outer margin two rows of tiny embossed dots are visible. Tehrān National Museum No: 1299, 1300-1100 BC, diameter: 13,7 cm.

To facilitate a more detailed study of pin-head designs and to gain a better understanding of the concepts arising from the craftsmen's imagination, instincts, mental attitudes and beliefs, a general classification with minor sub-divisions might be conceived.

These decorations and designs can be divided into four groups: human, animals, floral and miscellaneous geometric designs.

Human figures include in common Master of the Animal or more unusual a man with imaginary human beings. They are generally seen on most pin-heads and are in the form of a central face, figure, or a combination of the two.

In *central faces*, the hair is usually divided in the middle and collected on the forehead by a ribbon; eyebrows are thick and joined, eyes are oval and protruded, lips are slender and chin is pointed. This style of dressing the hair up the forehead is reminiscent of Sumer and Akkad figures (Majidzadeh 1370, 89). Female heads are depicted with hats in some cases; faces are mostly womanish

Fig. 4: Fraction of a bronze sheet disc-headed pin with the embossed face of a woman. Eyebrows are thick and joined, chased with short parallel lines. Eyes are protruding and oval, the protruding nose is long and the lips are slender. Cheeks are shown by two delicate lines, and hair is shown above the head with slender lines. Tehrān National Museum No: 7097, 1300-1100 BC, size: 8.6 x 6 cm.

and found in Sorkh-Dum. Some scholars (such as Moorey, Ghirshman and Dussaud) have considered these faces as depictions of a fertility goddess or guardian-goddess of waters, while other scholars (Godard and Clerg-Fobe) have regarded them as strictly mortal faces. The latter view seems more realistic and tangible in regard to what is normally expected in Middle Eastern art (Muscarella 1988, 123). Goldman, taking into consideration the New Assyrian iconography, considers the central female face as a symbol of Ishtar (Moorey 1971, 215). Majidzadeh believes that the origin of all full faces and frontal humans was Mitannic iconography.

Fig. 5: Bronze pin head, Luristan. Sheet with a long square shank in the middle of pin-head. Gilgamesh is depicted as a bull-man in profile; he has a trunk like nose, large eyes, oval chequered hat with a tail behind the head and zoomorphic ears, and is seizing two fierce animals (lions) standing on their hind legs. Decorative designs are chased on two sides of the pin-head as embossing of sun disc or a quarter rosette and vertical lines above the head. The central pattern is encircled by small and large embossed rosettes; on the margin, a row of tiny embossed dots are visible; Tehrān National Museum, No. 864, 1300-1100 BC; diameter: 10,4 cm.

The mural paintings of the Nuzi palace on the west bank of the Xabur river, built for a local prince in Mitanni-territory in 1450 BC, depict bull heads and a full human face in frames which are comparable with central full faces seen on pin-heads (Majidzadeh 1367, 10). Moorey believes that they date to the first millennium BC; he thinks that using single heads as a decorative design was common practice (Moorey 1971, 214) (Fig. 4).

Pin-heads, with *human figures* on the disc may stand alone or be depicted with animal designs. Sometimes the human figures depicted on disc-headed pins depart from normal human figure and are represented as Master of the Animals.

In Mesopotamian mythology and in the art of the Middle East and south-west Asia, the Master of the Animals is shown as a human figure flanked by two animals. Many archaeologists consider this figure to be Gilgamesh, the legendary half-god half-human hero and king of the Sumerians at Ereck (Majidzadeh 1367, 14).

The motif of a nude hero (or Gilgamesh) is also met in the seal-making art of Susa. Taking into consideration the cultural influence of Babylon and Elam, this motif joins other Elamite motifs and it appears on the Untash Gall stele as Bull-Man (Majidzadeh 1370, 61).

On some pin-heads the Master of the Animals is carrying a snake. The snake is of Elamite origin; the motif of a snake coiling around the Tree of Life appeared in Elam at an unknown point, with the image of two mating snakes as the symbol of Elamite reproduction penetrating as far as Egypt (Hinz 1371, 47). Godard believes that the snake was an ancient motif used as a margin on ancient vessels, later it was determined to be a symbol of vice or virtue, affluence, water or Angra Mainyu (god of darkness). Being seated on a throne of a coiling snake and/or holding a snake's neck is common in Elamite art; for example, on the Gurangan Rock a deity is sitting on a coiled snake and holding its head in his hand (Godard 1358, 43). Gilgamesh's figure is sometimes seen on pin-heads, fighting a fierce animal such as a lion or accompanied by animals such as goats (Fig. 5).

Animal motifs on pin-heads show great diversity: lions, goats, fowl, fish, and composite imaginary animals are all common depictions.

One of the most common motifs on many ancient monuments is the lion, depicted in two ways on sheet pin heads: as a mask (full face) on the central boss, and in a standing position facing a Master of the Animals or sometimes the sacred tree.

Another animal motif used on pin-heads is the goat, which is sometimes suspended in the air with a back-turned head. This style of depicting animals prevailed throughout the Near East between the 14^{th} century BC up to the 11^{th} century BC among Mitannies, Middle Assyrians, an Syrians (Majidzadeh 1367, 10). The goat motif is sometimes related to a plant, usually flanking the sacred tree (being one of the oldest religious motifs in the Middle East). A goat can appear alone, with a man, or with other animals. Ibex motifs are mostly represented in scenes related to the second and particularly the first millennium BC.

Fig. 6: Sheet disc-headed pin with broken shank. A woman face with large protruding eyes, joined eyebrows, long nose and two cheek lines comprises the central boss. The middle margin design is depicted as two pairs of winged animals at the top and bottom of the disc, flanking the sacred tree; rosette motifs are visible between these. The margin is decorated with a band and a row of tiny embossed dots; Tehrān National Museum No: 1389, 1300-1100 BC, diameter: 13 cm.

Motifs of other animals like fish, birds, and snakes are also found on disc-headed pins.

The fish motif was used for a long time in various periods from the rising of Elam to its end. Seals unearthed during the Susa excavation reveal this motif, ascribed by Amiet to the early Elamite period, middle of the second millennium BC; the middle Elamite period and the early first millennium BC (Negahban 1372, 31).

The bird motif on disc-headed pins closely resembles the birds seen on the ceramic vessels of Gian, Nihavand, and Kamtarlan II (Luristan). Another example of a common bird motif is the vulture, which is reminiscent of the vultures on the margin of Luristan metal coatings and those on the legendary Marlik rhyton.

Composite imaginary animals appear as winged animals with two heads. Using wings in depictions of common animals such as ibex,

Fig. 7: Sheet disc-headed pin with a long shank. Two rows of embossed lines decorate the margin and a group of small embossed spheres in the middle comprise a flower. Tehrān National Museum No: 850, 1300-1100 BC, diameter: 10.1 cm.

bulls and horses reached its zenith in the Babylonian, Kassid and Middle Assyrian periods in late 13th and 12th centuries. Luristan craftsmen of this period made use of winged animals in decorating pin-heads; the winged bull and ibex motif probably originated from Elamite art – like the griffin motif, it has spread from its place of origin to other places (Majidzadeh 1367, 11). On one pin-head a creature with two lion heads, a scaled neck, open mouth, four wings and a human-like body is seen (Fig. 6).

Floral pin-head motifs include palm trees, floral bands or margins, rosettes and scattered petals in various designs.

In many instances the animal motif comes together with the palm tree motif, usually as a pair of animals flanking the tree; this round motif of symmetrical animals flanking the tree was a traditional motif prevailing throughout the Near and Middle East. In Luristan, the sacred tree is represented in various styles and shapes, in complete contrast with the formal style of Assyrian and Babylonian art (Charles Martin 1980, 32), which represented the sacred tree in its natural form; in the middle Assyrian period, between the 14th to the 12th centuries in Mesopotamia, Assyrian artists saw the tree as being different from natural ones and began to represent it in a decorative and latticed design. This differentiation was recognised by all artists of the region and was imitated all over west, north-west and south-west Iran, in Khuzistan, Luristan, Ziwiye, Hasanlu and Marlik (Majidzadeh 1370, 91).

Floral band or margin is a corona in the shape of a lobed like band ending in pine cone or palm leaves and pomegranate, arranged alternately; sometimes with simple and stylized designs and mostly encircling the central boss. The pomegranate was considered a sacred tree; the sharp green colour of the leaves, the shape of the bud resembling a brazier and its fruit resembling a women's breast in child birth, caused the tree to always be sanctified (Farahvashi 1355, 65). In the late 2nd millennium BC, using a special kind of margin to decorate artistic monuments was common in Marlik workshops, and these floral margins are visible on the bottom of most Marlik rhytons and cups.

The rosette is also among the decorative motifs of the pin-heads; it may form the central boss or be used along with animal and human motifs. This motif is used on seals and other monuments of the middle Assyrian period, such as the Ogarit Goblet and the cylindrical Mittani seal impressions of the middle 14th century BC.

Fig. 8: Bronze sheet of disc-headed pin with broken shank. At the joint of shank with the disc, which is levelled by hammering, delicate chequered and hatched lines are visible. In the centre lays an embossed sphere surrounded by tiny embossed dots, resembling a flower. This motif is encircled by a pentacle chased linearly, with each point ending in an embossed sphere. Angles are filled with tiny embossed dots. Tehrān National Museum No: 1291, 1300-1100 BC, diameter: 7,5 cm.

Rosettes are reminiscent of the middle Assyrian period, where they were first used in the decoration of Tukulti-Ninurta II's palace in Kar-Tukulti-Ninurta. In some of the surviving mural paintings of this palace, and also in decorating some ivory objects (combs, vessels and inlay work), the rosette motif is clearly visible (Negahban 1372, 65).

Miscellaneous geometric designs on pin-heads are divided into four groups: embossed spheres and dots, embossed chain (helical) and circular bands, tiny dotted lines as well as stars. Large and small spheres and dots are embossed all over the pin-heads or are worked out as leading to the pin-head margin (Fig. 7).

On many pin-heads, helical margins or embossed bands with zigzag lines are interlaced to decorate around the central boss or the middle margin; this type of ornamental margin was common in the late 2nd millennium BC and used in later Near and Middle Eastern civilisations for a long time. Examples of this kind of margin can be seen on the cylindrical seals classified by Frankfort as Mittanian, on the Assyrian seals of the 12th to 13th centuries BC, and on the first and second groups of Syrian and Palestinian seals of the middle to late 2nd millennium BC. Similarly, this margin type can be seen on the bronze vessels of western Iran and Marlik gold vessels. This decorative margin is visible (Negahban 1368, 62, 67).

On some pin-heads the geometric design is a linear six-pointed star, worked out in the disc centre with a sphere at every point; sometimes the inner surface is filled with dots. In the Levant and Mesopotamia, an eight-pointed star was a common and prevailing design, being the main sign of Ishtar; craftsmen who made Luristan disc-headed pins made use of this mighty and robust symbol on their artefacts, but it is doubtful whether it represented Ishtar or the local counterpart. Round bronze decorative pendants with rings or holes for wearing (instead of shanks) closely resemble the pin-heads in regards to form and decoration. Some of these pendants are decorated with star designs (Fig. 8); they were produced on a large scale all along the eastern Mediterranean shore and in Mesopotamia in 2nd millennium BC (Moorey 1971, 210 f.).

Origin and Usage

Luristan disc-headed pins may have evolved from the circular bronze pendants, which were common and long-used as personal ornaments in some regions of Iran and south-western Asia (Moorey 1971, 208). The presence of rings attached to the upper part of the pendants suggest several methods for using them; they may have been sewn on clothing, or used as necklaces, as belt decorations or votives inserted in the shrine walls. Some of these pendants reported from north-west Iran had a central embossed cone encircled by decorative floral or animal margins very similar to the pin-heads. These pendants have such a high degree of similarity with the disc-headed pins that one might conclude they were all made in one workshop; the same conclusion is reached on quiver cover decorations, suggesting that they could not have been made without the craftsmen informing each other. Some of the other possible uses for the pins include oblation, personal ornaments, and fixing idol heads onto their pedestals. Pins of various shapes were found as oblations in Sorkh-Dum temple wall rifts, and many display symbols of reproduction like the pomegranate, rosette, goat and snake; they may well have been donations to a fertility goddess. In a group of pins with simple cast heads (pins of the first type), the presence of a hole on the shank may prove their use for fastening clothing; on a sheet disc-headed pin introduced by Potratz, the central female figure is using a pair of pins on her dress (Moorey 1971, 208). On a pin-head, preserved in the Iranian National Museum, this method of wearing pins is seen on the attire of the depicted figure. Pins were manufactured like most bronze-wares, by casting or hammering. Whenever the full face of a human or animal was needed in the sheet centre, open moulds were used. After moulding, the objects were heated and hammered to work out details like eyes, beard and hair, using a linear method as well as chasing the surface; in cases of a flat pin-head surface with no central boss the desired designs were worked out using a linear method and chasing (Moorey 1971, 295; Majidzadeh 1367, 10). There is not enough positive evidence on the provenance of the metals used by Luristan metal workers; to a large extent, evidence is based on the location of modern mines in Iran. Iran was one of the oldest copper producing regions in the ancient world. Thus, from the late 7th millennium BC spherical beads were recovered in Ali-Kosh in the Deh-Loran plain (6750-6000 BC) which were made from cold-wrought natural copper – far away from the main copper deposits on the Central plateau; other copper objects were unearthed in many parts of Iran dating to later periods, especially in the 4th millennium (Majidzadeh 1364, 215, 217).

At first, the alloy of copper and arsenic was commonly used; ancient metal workers later made alloys of copper and tin in order to get a harder metal. Sheet bronze became common in around 2000 BC. Luristan metalworkers procured their metal from central or northern Iran, from the Zagros mountain to the north of Hamadan, or even from places further to the East (*e.g.* Towhidi 1366, 63, 64), such as the Khorasan and Anarak regions in Isfahān (Moorey 1379, 37). There is evidence of metal export from eastern Anatolia to Assyria, and of Assyrian monarchs transferring metals as loot back to their country (Moorey 1974, 24). However, a paucity of written evidence turns any investigation of Luristan metalworkers into a painstaking enterprise.

Many researchers consider the Kassite and Cimmerian people as the creators of the Luristan bronze pins. Others believe that most objects ascribed to Luristan were in fact manufactured in Elam or Mesopotamia, reaching the Zagros region as trade goods or war booty – Luristan bronzes, with their sophisticated technique and wealth of decorations, could not have been made by nomadic artisans or metal workers. Nomadic people were mostly engaged in the manufacture and repair of simple implements and utensils of daily life; the main metalworkers of Luristan who created the more sophisticated and artistic monuments comprised small groups settled in urban centres like Hulailan, Tarhan and South Kurdistan, and their customers were mostly warriors with permanent settlements on the south-western or north-eastern plains. Thus, metalworking was mostly patronized by this small minority of ruling elites; the Kassite and Cimmerian people are named among these mighty patrons (Moorey 1974, 19f.).

In regard to the dating of these pins, different opinions abound. Godard relates them to late 2nd and early 1st millennium BC, Moorey to 1000-650 BC (Iron Age 2, 3), Vanden Berghe and Hertzfeld to the late 2nd millennium BC, Pope and Dussaud and Clerg-Fobe to the late 2nd to early 1st millennium BC, and Pierre Amiet and Cantor to the Achaemenid era. Van Loon found them reasonably dated to the 8th and 7th centuries BC and Muscarella suggested the 8th century BC (Muscarella 1988, 203;). For proper dating of these pins, Elamite artefact dating must be used as a reference, since Mittani designs indirectly influenced Elam and Luristan via Assyria. Luristan bronzes most strongly resemble artefacts from the mid-Elamite period and the zenith of that Empire, namely artefacts from the 13th to 11th centuries BC. This argument is supported by the neighbouring location of these kingdoms and their communication; one could alternatively take into consideration the spread of designs from the country of origin to neighbouring territories during a specific period (Majidzadeh 1367, 9-11).

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View from the citadel of Ziwiye to the surroundings (1978). In front the remnants of a peristyle of an official building. In the 7th century BC the settlement was burnt down by a warlike operation; Photo: G. Weisgerber.

Hasanlu and the Emergence of Iron in Early 1st Millennium BC Western Iran

Vincent C. Pigott

Introduction

While the origins of iron metallurgy remain subject to much debate, current arguments would suggest that its development and initial sporadic usage occurred in Anatolia and Transcaucasia (*e.g.*, Colchis) during the 2nd millennium BC, although that has never been proven (Pleiner 2000; Pigott 1989, 69). What is clear is that by the closing centuries of this millennium, the transition to iron was underway in the eastern Mediterranean (*i.e.*, from Greece and Anatolia south into the Levant).[1] Iron was rapidly becoming the metal of choice for tools and weapons, but the popularity of bronze by no means waned and certain tools and weapons continued to be made with this alloy of copper and tin. However, tin-bronze was gradually being pigeonholed as a decorative material appropriate only for personal ornaments and items worked, for example, in *repoussé*.

In the period prior to iron's wide-spread appearance (*c.* mid-late 2nd millennium BC), the archaeological record of north-western Iran yields evidence of a dramatic cultural shift that classically has been attributed to the invasion of Indo-Iranian-speaking tribes (Young 1967, 24; Burney & Lang 1972, 117; Ghirshman 1979). However, this shift did not occur overnight, but rather indicates an extended phase of cultural transition that lasted over several centuries. Bronze Age metalworkers in Iran may well have had a rudimentary knowledge of metallic iron as a possible by-product of copper/bronze smelting[2]. Even if true, they apparently had little need or inclination to pursue iron-making during the Iron I period (*c.* 1450/1350-1100 BC). During this time, the bronze-making skills of the indigenous population seem to have served all stylistic and functional needs of the population.

During the early Iron Age of western Iran, tin-bronze was certainly the copper alloy of choice for ornaments as well as tools and weapons (*e.g.*, Moorey 1982, 94-95; see also Moorey 1994, 263-265). Some arsenical copper continued to be produced and was excavated at sites in Dailaman (*e.g.*, Egami *et al.* 1965; 1966) and in Gilan at Marlik (Negahban 1996). It is possible that tin-bronze was somewhat harder to come by in these regions, although it is important to note that few of the 'utilitarian' artefacts from other sites in the region have been analysed, thus adding the caveat that perhaps this discrepancy is a product of different types of assemblages being analysed. Interestingly, only modest amounts of iron were found at Marlik and other sites in Gilan (Pigott 1980, 424-425, 429). Despite the proximity of Iran to the supposed core area of iron's early development, widespread and continuous use of the metal did not occur until the 10th/9th centuries BC (Iron II period) of north-western Iran at sites such as Hasanlu, Dinkha, and Haftavan and at a significant distance to the southeast at Sialk in central Iran (*Ibid.*).

Before looking at the evidence for early iron in western Iran, it is important to address why iron may have been adopted in this region in the first place.

Iron is the fourth most common element in the earth's crust and its ore minerals are as close to being ubiquitous in Southwest Asia as such minerals can be. It is widely available, for example, on the Anatolian and Iranian Plateaux (Fig. 1). As a result, the production of iron had certain economic advantages over bronze-making, which, for example, was dependent upon the long-distance trade in tin metal and/or ores. It should be noted, however, that iron's ubiquity was offset by the time and manpower needed to smelt and forge it (Smith 1971, 51). While true steel (*i.e.*, iron with a high and uniformly-distributed carbon content) has mechanical properties superior to those of a cold-worked 10% tin-bronze, published analyses of ancient Near Eastern iron artefacts show that they were made most often made of a low-carbon, heterogeneously-carburised wrought iron that was on par with the best tin-bronzes of the early Iron Age (Fig. 2). In other words, there is little current evidence to suggest that iron was a technological innovation initially adopted as a result of its superior mechanical properties.

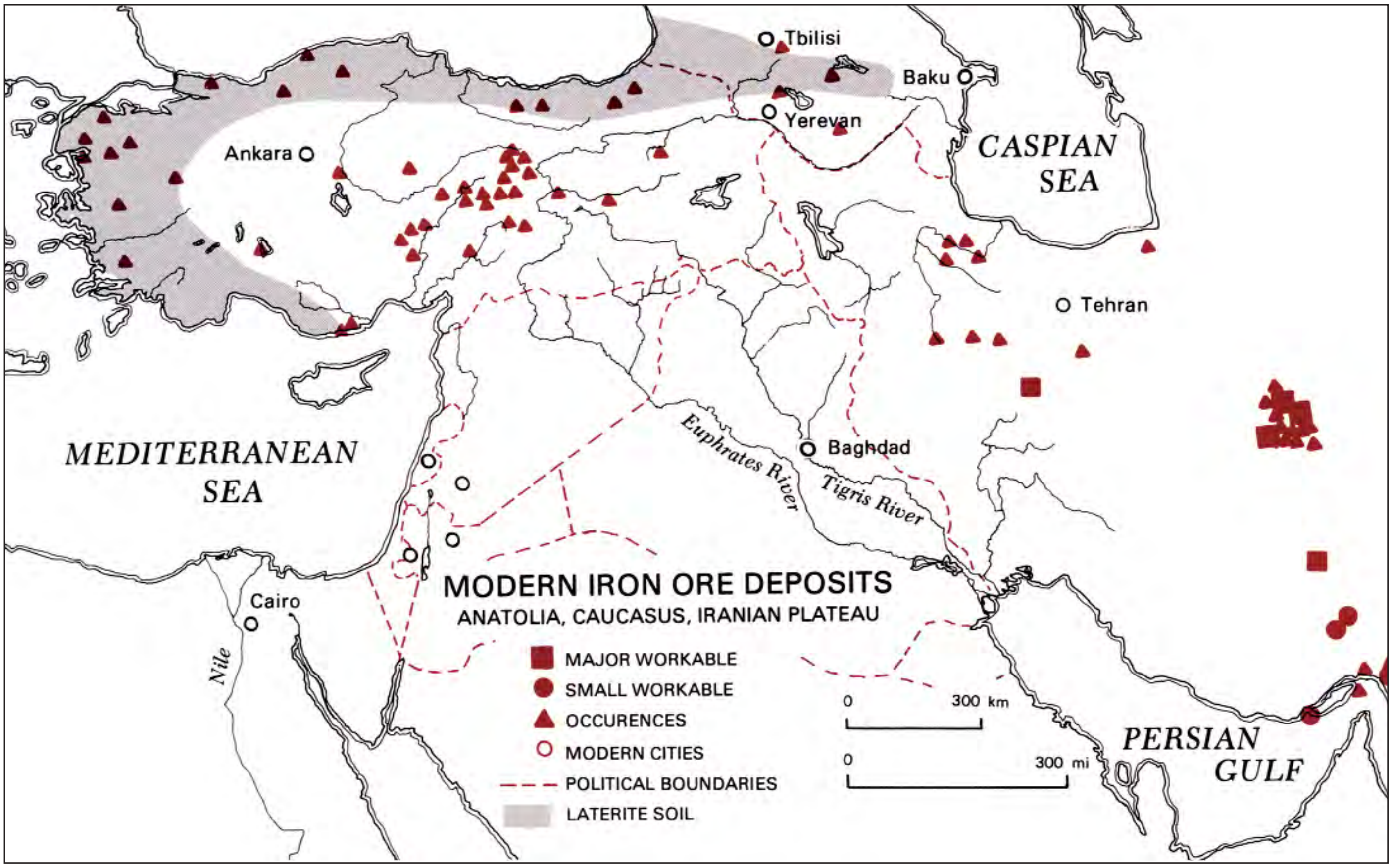

Fig. 1: Locations of modern iron ore deposits in Anatolia, Iran and the Caucasus; (Pigott 1989, 69, Fig. 4).

Therefore, we seek answers elsewhere as to why iron was accepted relatively rapidly in western Iran. The impetus for acceptance in this region may have come from its iron-using neighbours to the west, most notably the Assyrian Empire. It is in the Iron II Period, when the Assyrians began to mount significant military campaigns into western Iran, that iron first occurs *en masse* in the area. We know from Assyrian texts that iron was held in high esteem among its elites, both military and royal (Pleiner & Bjorkman 1974, 286-288)[3]. Peoples in western Iran undoubtedly had the opportunity to visit Assyria and witness first-hand its grandeur and/or felt Assyria's power as its armies regularly intruded deeply into their homelands. The desire to emulate Assyrian might and strength, symbolised in Assyria by the iron dagger (Pleiner & Bjorkman 1974), may have facilitated the acceptance of a new technology that would not have been difficult to master by people steeped in millennia-old traditions of metalworking. Indeed, iron seems to have been worked first as a decorative material by Iranian bronze-workers, who then moved on to producing a whole repertoire of tools, weapons, and decorative artefacts utilising the unique properties of the new metal (Pigott 1980; 1981). Although local innovation is theoretically possible, it is hard to imagine that the synchronic arrival of iron with the coming of the Assyrians was merely a coincidence.

North-western Iran: Iron at Hasanlu Tappeh

The Iron Age citadel of Hasanlu, likely destroyed by the Urartians[4] around 800 BC, provides one of the points of reference for understanding iron in elite settlement contexts in western Iran (*e.g.*, Dyson & Voigt 1989). The site and the role that iron played there can be seen as a microcosm of what was transpiring in similar contexts across much of the Ancient Near East.

Almost 2000 iron artefacts were excavated from the late 9th century BC destruction level of the Hasanlu Period IVB citadel. Of these, some 65% were weaponry. It is important to note that a similar amount of tin-bronze, which was most frequently used for equestrian trappings, architectural decoration, personal ornaments, and certain weapons and armor, was also excavated at the site (de Schauensee 1988). The metallographic analyses of several of the iron artefacts from the destruction level indicate that the metal is best termed a low-carbon, heterogeneously-carburiszed wrought steel (Pigott 1981, 229-267; see also Knox 1963) (Fig. 3). In this

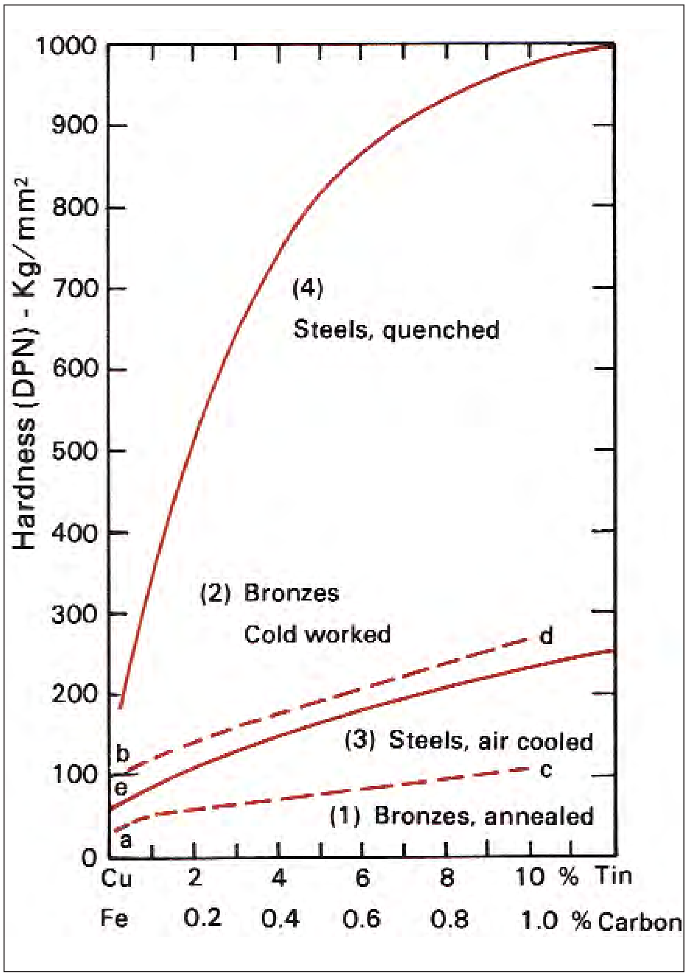

Fig. 2: Graph comparing the hardness of different forms of iron and copper. Pure copper that has been annealed has the lowest efficiency (point a); it increases in hardness with the addition of tin (up to 10 percent, point c), and with cold-working (point d). Pure iron (point e) is hardened by the addition of carbon, thereby making it into steel. "If steels are heated and allowed to cool naturally, the range of their hardness (curve 3) is slightly below that of worked bronzes, but they become spectacularly superior if quenched (curve 4). The curves are approximate and the hardness varies considerably with impurity content, details of casting technique, prior annealing, and other factors. The brittleness of an alloy generally increases with its hardness." (Pigott 1989, 68, Fig. 2).

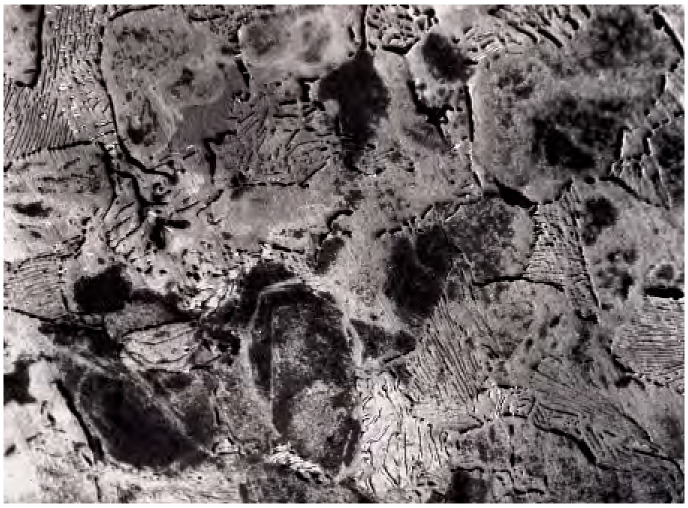

Fig. 3: Photomicrograph of iron sword UM 65-31-220, showing pseudomorphic pearlite colonies (note their lamellar structure) preserved in the oxidized matrix of the sword. The light coloured, elongate lamellae are probably uncorroded carbides. This artefact had evidence of evenly distributed carburization (in the form of pearlite colonies) in the central portion of the blade, as well as at the blade's edge. Thus it would qualify as a "mild" steel and most probably was an effective weapon of war. Along one edge of the blade distorted structures in the oxide suggest some evidence of cold-working deformation of the metal. Grain size, when apparent, is seen to be coarse, and there is some indication of the artefact having been cooled fairly slowly (Pigott 1989, 76, Fig. 15).

period, iron was one of a variety of materials being experimented with for decorative effect, and it often occurs as part of bimetallic artefacts such as spears with iron sockets and tin-bronze blades, iron daggers with tin-bronze cast-on hilts, and *repoussé* tin-bronze belt plaques with iron rivets. Certain iron artefacts, such as *repoussé* iron plaques, were obviously worked as if they were made of tin-bronze. By the Iron III period (*c.* 800-550 BC), however, bimetallism had waned and the two metals were increasingly differentiated in use: tin-bronze for decorative items and iron for tools and weapons.

Hasanlu was a major regional settlement of considerable size and significance during the Iron Age until its destruction in the late 9th century BC. It was located along a major route through north-western Iran between Assyria and points further east. In this strategic location, the site likely controlled local as well as long-distance travel and trade and may have acted as a regional processing, production, and/or distribution centre for all kinds of materials, both imported and locally procured. Furthermore, by controlling the hinterland around it and the long-distance resources, Hasanlu would have had ready access to the fuel, ores, and labour necessary for the production of iron on a substantial scale.

However, if iron was being produced on a large scale at Hasanlu, one would expect substantial residues of production including slag and furnace remains. At Hasanlu, as with most sites in the Ancient Near East, the remains of iron production proved to be elusive. No direct evidence of iron smelting or smithing was found other than some large boulders of the iron ore magnetite, which were built into walls and used as floor paving in Citadel buildings. It is possible that the industrial process of smelting was conducted away from the Citadel, but some level of iron working had to have been taking place at the site for three reasons. First, there is the large quantity of militarily-oriented iron artefacts found at the site that would have required the services of blacksmiths to repair, resharpen, and reforge. Second, there are a few iron artefact types unique to Hasanlu, including equestrian shoulder 'rondels' (plaques) in *repoussé*

Fig. 4: Iron artefacts unique to Hasanlu include two types of hoarse gear: sidebar cheek pieces with three holes (a) and decorative plaques (b). The plaque or rondel is decorated with a winged horse in relief, made by hammering on the reverse side of the plaque. (a: UM 73-5-369, L. 5,8 cm; b: HAS 60-876, Diam. 19,5 cm) (Pigott 1989, 71, Figs. 6a, b).

and iron sidebar cheekpieces with three holes for attachment to bridles (Fig. 4), which were probably produced locally. Both of these equestrian artefacts are north-western Iranian in style and are not known on Assyrian reliefs (Dyson & Muscarella 1989). Finally, the standardised size and shape of a certain type of iron knife is also suggestive of local smithing practices. Only the repetitious efforts of a skilled blacksmith familiar with the properties of iron could result in the consistency of form found in this class of small, tanged iron knives with a single cutting edge and an upturned point (Fig. 5). Some 86 such knives were excavated at Hasanlu (Pigott 1980, 426, Tab. 12.3) and more examples were found in contemporary individual burials at nearby Dinkha Tappeh (Muscarella 1974).

The Role of Assyrian Influence in Western Iran

The most important question that remains unanswered concerns the actual source of the iron metal being forged into tools and weapons at sites like Hasanlu and elsewhere in western Iran. If iron ores were not being mined and smelted by western Iranian peoples from *c.* 1000 BC onwards, then the most likely source for the raw metal was the Assyrian Empire which exercised a profound influence in the region over several centuries. At Hasanlu, for example, there are various possible sources for the iron found in Period IVB contexts, including the possibility of an Assyrian garrison occupying the Citadel before the Urartians invaded. The iron artefacts, much of them weaponry and/or related to the military could have been imported from Assyria in finished form. Or, perhaps as iron bloom were imported and subsequently forged to desired shapes by blacksmiths accompanying the troops. Local bronze-workers may have been enlisted as well, thus explaining the iron artefacts worked like tin-bronze. One also cannot discount a trade in iron coming from Assyria in return for produce, timber and horses from the fertile valleys of western Iran. Some iron might even have been given by local Iranian polities as a sign of allegiance to Assyria.

Fig. 5: Small iron knives with a single cutting edge and upturned point were apparently mass-produced at Hasanlu. (HAS 74-286, L. 10,8 cm) (Pigott 1989, 74, Fig. 12).

Nor can one ignore the possibility that iron was taken as booty or tribute by the Citadel elite who sent raiding parties to loot regional settlements of their stores of iron. Overall, it is clear that the influence of Assyria was pervasive in the region and local smiths may have depended upon Assyrian blacksmiths to teach them about the unique characteristics of the metal iron and how to work it under the smith's hammer.

Therefore, the cultural changes occurring at Hasanlu from the mid-2nd millennium BC onwards – including the emergence of a highly-stratified society with a powerful military presence – would have fostered in many ways an atmosphere of both local creativity but also emulation of all things Assyrian (see Winter 1977, 379). In Assyria, iron was a metal of special status associated with the military elite and imbued with religious significance. For the local western Iranian elite, owning items in iron (either Assyrian in origin or local imitations) would have conferred a certain status on them, thereby enhancing their prestige and political power (ibid., 381). In this light, it is not so surprising that the emergence of the widespread use of this relatively new material at Hasanlu and across western Iran generally occurred in a period of emerging affluence, social stratification, and military might and in a context of artistic and technological innovation.

Central Western Iran: Luristan

This brief overview of iron in the Iron Age of western Iran would not be complete without mention of the finds from the province of Luristan. There is little question that new insights into the role of iron in mortuary contexts will be revealed as scholars begin analysing the newly-published results of the excavations by the Belgian Archaeological Mission in Iran (BAMI) directed by the late Louis Vanden Berghe. Two scholars, Drs. Ernie Haerinck and Bruno Overlaet at the University of Ghent, are undertaking the daunting task of publishing the masses of data from the numerous excavated Iron Age cemeteries that yielded great quantities of iron artefacts (see, for example, Overlaet 2003). Future assessments of the published archaeological data on Luristan iron, combined with analytical initiatives (*e.g.*, metallography, AMS dating, Pb-isotope analysis) that focus on some of the best-preserved iron artefacts, are guaranteed to rewrite our understanding of not only iron's role in the region, but across the entire Ancient Near East.

The Iron Daggers from Luristan

Of significance to future studies is the well-known and unique class of iron daggers that are thought to hail from the cemeteries of Luristan and are found in museum collections around the world (Fig. 6). These unusual daggers, which bear both zoomorphic and anthropomorphic images on their pommels, have been much discussed in the literature (*e.g.*, France-Lanord 1969, 75-126; Moorey 1991; Muscarella 1989; Pleiner 1969a; b; Rehder 1991; Smith 1971). Among the almost 90 daggers known there are no excavated examples; all were acquired by various museums and collectors in the 1920s, 1930s, or later as Luristan's ancient cemeteries were being heavily looted for their remarkable ornate bronzes. This naturally raises the question of their validity as artefacts as opposed to modern forgeries. For example, among the many unusual characteristics of these daggers is their marked degree of similarity, undoubtedly the result of their having been manufactured in one workshop or by one group of smiths (*e.g.*, Moorey 1991, 2) or perhaps by modern metalworkers copying ancient prototypes. Furthermore, most of the daggers are well-preserved for iron of such antiquity, although this could be a product of their deposition in the protective environment of tombs and the low temperature working of the iron (*i.e.*, being air cooled below 750oC), which makes the metal more corrosion-resistant (Smith 1971, 51) as well as soft and ductile (Rehder 1991, 16, 19; Pigott 1999, 93-94).

Fortunately, two of the daggers (from the Royal Ontario Museum and Massachusetts Institute of Technology) have been radiocarbon dated by accelerator mass spectrometry (AMS) to the period 1094+60 years BC (Rehder 1991, 14; Moorey 1991). Not only was it a relief to discover that at least two of the daggers were authentic, but it came as a surprise because they were previously thought to date to the Iron III period (*c.* 800-550 BC) (Moorey 1971, 128). Of course, these two radiocarbon dates merely reflect when the iron was smelted, so the daggers could have been made from recycled metal at a later date (see below). If it is found that other daggers date to a similar time period, it would place this class of daggers among the very earliest iron artefacts in western Iran. Moreover, they would join an exclusive group of pre-1000 BC iron artefacts known from across the Ancient Near East (see Waldbaum 1999).

Their Manufacture

The way in which the daggers were manufactured is also intriguing (see, *e.g.*, Smith 1971). Rehder (1991) has suggested that the iron was smelted by metalworkers who understood forge-welding, but that the daggers were later manufactured by smiths who did not have this knowledge (Moorey 1991, 6-7). In iron smelting, if the furnace producing the iron yielded a single large bloom then the forging of the single bloom to extrude slag and coalesce the metal would not necessarily teach the smiths the benefits of forge wel-

Fig. 6: Iron sword from Luristan, unknown provenance. (Tehran, National Museum Inv.-No. 988, L. 54 cm); Photo: DBM, M. Schicht.

ding. However, Rehder suggests that the producers of the daggers' iron were smelting small 'mini' blooms that had to be forge-welded together into large pieces of iron stock. Quite possibly, from wherever these blooms were being made, they were traded away to smiths in places such as Luristan, who then used the stock to assemble the daggers. However, the daggers were not shaped by forge-welding multiple pieces of iron together. Rather, they were crimped and riveted together from 8-15 individual parts, possibly by bronzesmiths who "were improvising brilliantly in ignorance of iron's special qualities" (Moorey 1991, 6-7; see also Maxwell-Hyslop & Hodges 1966, 169; Rehder 1991; Smith 1971, 52). Thus, if we accept Rehder's suggestion, the possibility exists that the blooms were being manufactured in one place (perhaps from workshops in neighbouring Assyria[5]) and then traded to smiths in Luristan – a model for early iron production that could be extended to all of western Iran.

Concluding Remarks

Iconographic arguments proposed by Roger Moorey (1991, 7-8) suggest that dagger imagery could have been linked to an underworld deity such as Nergal, who is in turn associated with both Assyro-Babylonian, Hittite, and Hurrian cult as well as the sword. This underworld association would be appropriate for a weapon that was perhaps manufactured exclusively as a mortuary offering (*cf.* Moorey 1991, 8). The daggers' curious unwieldiness fits well with the idea that they were not intended for battle. In addition, the iron used in the blades tends to be a low-carbon heterogeneously-carburised wrought iron that is fairly weak to start with and only becomes weaker with annealing. They were, therefore, soft and ductile daggers (Rehder 1991, 16). Thus, the general sense is that they were being manufactured as prestigious grave goods to be interred with deceased individuals, perhaps those of a certain elite status or rank such as a class of warriors (see Muscarella 1989, 351; Rehder 1991, 18).

Of course, given the acontextual status of the Luristan iron daggers, they will be plagued by controversy until each one has been subjected to radiocarbon analysis. It is extremely difficult to argue with the radiocarbon dates for the smelting of the iron used in the two Luristan daggers, but it remains to be seen what an art historical approach can tell us about the date of their actual manufacture. As a result of our recent MASCA analytical program on the bronzes from Luristan excavated by the Belgian Mission (see Fleming *et al.* in press), a note on the iconography of the daggers can be raised that, in turn, might reflect on their chronology. On a number of the Luristan daggers there is depicted in forged and chiselled metal the image of a bearded human face. A very similar bearded human visage is found on tin-bronze axe-adzes from the excavated Luristan cemetery at Bard-i Bal, which is dated to the Iron III period (*c.* 800-550 BC) by Haerinck and Overlaet (in press). Whether this image is part of a long-lived Luristan iconographic tradition or supportive of the later date for the actual manufacture of the daggers, which both Smith (1971) and Rehder (1991, 16) deemed particularly remarkable examples of the early blacksmith's craft, remains to be seen. Only continued scholarly research into the archaeology and ancient technology of iron metallurgy in western Iran will shed new light on this and a myriad of other intriguing questions.

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Notes

1 Among the numerous references that can be consulted on the coming of iron in the Ancient Near East, the following are particularly informative: Curtis et al. 1979; Maddin 2003; Moorey 1994, 278-292; Muhly 1982; Pleiner 2000; Pleiner & Bjorkman 1974; Waldbaum 1999; Wertime & Muhly 1980. The discussion in this chapter of the catalogue is based on my previous publications (Pigott 1980; 1981; 1982a; b; 1989; 1999, 6-7, 90-96).

2 The possibility that the initial encounters with metallic iron (other than meteoritic) were the result of iron produced during the smelting of copper ores has been discussed by a number of scholars (*e.g.*, Cooke & Aschenbrenner 1975; Gale et al. 1990; Maddin 2003, 310; Merkel & Barrett 2000; Pigott 1982a, 21; 1999, 6; Smith 1966; Tylecote 1970, 290; Tylecote & Boydell 1978; van der Merwe & Avery 1982; Wertime 1964, 1262; 1973). Despite the fact that iron can be produced during copper smelting, neither archaeology nor the laboratory has been able to provide any well substantiated early examples of such iron.

3 What remains curious about iron in the Assyrian Empire is that despite the enormous amount of iron used by the Assyrians, archaeology has yet to identify significant evidence for the mining and smelting of this important metal. It is difficult to imagine that Assyria acquired all of its iron from outside the empire by means such as conquest, trade, treaties, and tribute.

4 The potential influence and role of Urartian iron and ironworking in western Iran has not been examined in detail nor discussed herein. Those

interested in this topic can consult the following sources: Kellner 1979; McConchie 1998; Merhav 1991.

5 There is strong evidence to suggest that Assyria was an empire conversant with iron technology by the later 2nd millennium BC (Curtis et al. 1979; Pleiner & Bjorkman 1974).

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Memories of Hasanlu 1958 – the discovery of the golden beaker

Robert H. Dyson, Jr., 46 years after the discovery

In the summer of 1958 the excavation of the newly discovered burned building I at Tappeh Hasanlu in north-western Iran had progressed though rooms 1 (portico), 2 (anteroom), and 3 (stairway). The content of these rooms provided clear evidence for a collapsed second floor overlain by quantities of artefacts. The task remained to clear the adjacent south-east corner of the building (room 9). Here the brick walls which stood on meter-high free-standing stone foundations were badly destroyed. We therefore began with a small exploratory test trench along the north side of the room to locate the upper edge of that foundation. Our best pickman, Iman, was set to this task and soon he found the stonework and penetrated the debris in the room along its south face. He came upon a layer of round bronze buttons and human arm bones at which point I took over.

Elsewhere in the excavations we had found quantities of these buttons each with rounded edges and a single loop for attachment at the back. We had not, however, found them *in situ* and thus did not know how they were used. Here they proved to be in place and formed the outside protective of a gauntlet being worn on the right arm of a fallen soldier. I was brushing this carefully along with the arm bones which lay with the wrist just in front of the wall. Suddenly there appeared a large edge of something gold lying just beyond the hand bones. What was it I wondered, thinking possible of a large bracelet. My friend, the English archaeologist Charles Burney was watching. Impatiently he asked „Well, is it decorated?" „I don't know", I replied and took a couple of swipes at it with my small brush. The soft earth fell away to reveal large surface of shining gold covered with repoussee figures. The twin bulls pulling the weather god's chariot reared their heads in the sunlight for the first time in over 2700 years (Cat.no. 357)!

In the end the complete excavation of room 9 showed that three armed men had been crushed by the collapse of the building's second floor and fell into the room below where they lay above a thick floor deposit of rich black soil containing sheep/goat bones and broken pottery saucers. One man carried a star-shaped bronze

Fig. 1.: R. H. Dyson Jr. 1958 with the golden beaker; from: I. J. Winter, The "Hassanlu Gold Bowl"; Thirty Years later. Expedition 31, 2-3, 1989, 87 Fig. 1.

The mound of Hasanlu in north-western Iran. American excavations took place from 1957 to 1978 under the direction of R. H. Dyson jr.; poto: G. Gerster.

mace, another iron dagger with gold handle. The third carried the beaker. The upper end of his femora had been lodged in his jaw by the force of the collapse which also crushed the beaker into the shape it now has

Bastam and Iron Age in North-western Iran

Stephan Kroll

As in prehistoric times, in the entire region still today agriculture and livestock breeding is dominant. On the plains and in the valleys around Lake Urmia there is mostly agriculture. In the higher regions, in Kurdistan, Eastern Azarbaidjan, or in the Northern part of Western Azarbaidjan, there is more breeding sheep and goats while agriculture is less important. In the entire North-western Iran, being 1000 to about 1300 m above sea level, farming without artificial irrigation is possible. Obviously, artificial irrigation was used to a larger extent only after the Urartean period (8^{th}-7^{th} century BC). Only in Eastern Azarbaidjan around Ahar copper mining played a certain, not yet investigated role, probably after the late Bronze Age. Further raw materials worth mentioning do not exist (Weisgerber et al. 1990).

Lake Urmia itself does not freeze, due to its high content of salt. Thus, despite the high sea level, the plains around stay free from snow even in winter. But the nearby mountains are covered with snow, often also in summer. This may explain why the earliest settlements are around the lake but not in the hinterland or in the mountainous regions. On the other hand, the mountain chains, often rising to more than 3000 m, explain why the single regions often have little contact to each other, mostly less than half of the year. But it is almost impossible to use modern dates for the ancient situation. This is particularly true for the density of the population and for the economic strength of each region. Furthermore, modern irrigation and new settlements have completely changed the ancient landscape.

Early Settlement

Probably due to their high and northern location, Kurdistan and Azarbaidjan are inhabited much later than e.g. the Hamadan-Kermanshah region, probably as late as at the beginning of the 6^{th} millennium BC. The first sites, like e.g. Hajji Firuz, Hasanlu X, or Ahrendjan Tappeh and Yanik Tappeh are around Lake Urmia. From the East and the North of Azarbaidjan there are no sites known. Sites are lacking also in the South, e.g. in the region around Miandoab or in Kurdistan. All in all, it seems that first settlement happened only in very few regions which were ecologically favourable. In the 5^{th} and 4^{th} millennium BC, settlement grows to be more intensive, also partly in higher regions. Here it is striking that, compared to other regions of Iran, in the North, on the Eastern shore of Lake Urmia, and in Kurdistan the number of sites is very small. In the regions of Ahar, Meshkinshahr, and up to Ardebil, only one site is known so far. Particularly by pottery tradition, contacts to Northern Mesopotamia and Central Iran can be proven.

Finds of Northern Mesopotamian Ubaid pottery from the middle of the 4^{th} millennium, which were found during excavations and expeditions, are unique. These sites stretch from South to North on the Western shore of Lake Urmia, from Ushnu to Maku. South and East of the lake there is no evidence for any finds. It seems to be likely that the finds of Ubaid pottery in Iranian Western Azarbaidjan are related to the Mesopotamian interest in being supplied with raw materials, in this case with obsidian from Trans-Caucasus. This might also explain why there is no appropriate evidence from other regions of North-western Iran.

All in all, concerning this early period from the 6^{th} to the middle of the 4^{th} millennium we may say that in the beginning there were only a few settlements but then more than 80 small and medium sized ones. In contrast to that, there is no evidence for settlements on higher or mountainous terrain. As far as we know, all these small settlements were not fortified. Obsidian, flint, and bone played an outstanding role as raw materials. In contrast to other regions of Iran there is hardly any evidence for the use of metal (copper). Agriculture and breeding small animals was the predominant form of economy. Foreign trade contacts are rare.

Early and Middle Bronze Age

All excavations prove that at the end of the Chalcolithic there was a clear hiatus. This is supported by an analysis of settlement structure. In the entire region, only a few Chalcolithic sites are still inhabited in the Early Bronze Age. Now, all regions of North-western Iran show a dense settlement. Altogether, there are surely more than 120 settlements.

There is evidence for Early Bronze Age settlements especially due to the spread of the "Kura-Araxes Culture" which had its centre between Kura and Araxes, as the name says. At the end of the 4th millennium it vehemently spreads towards Anatolia and Iran from its original region in the Trans-Caucasus. For some time, settlements of the Kura-Araxes Culture even exist in the region of Qazvin, Hamadan, Nihavand, and Kangavar. The best known site of such a Kura-Araxes settlement is Godin IV, where a preceding settlement of the Uruk Culture was replaced. In this period, for the first time we are able to observe a number of deep changes. The sites are of very different size, and as far as there is evidence they are fortified by walls, *e.g.* large settlements like Yanik or Ravaz. In the case of Ravaz, far in the North of the country near Maku, additionally there is evidence for round towers like they are built in Mesopotamia and Palestine at the same time. Now, cattle breeding is especially developed. In this period, in the neighbouring regions there is fast development of copper and bronze metallurgy; unfortunately there is only little evidence for this in North-western Iran. In the Middle Bronze Age, in North-western Iran single areas can be distinguished which have hardly any relationship to each other. All in all, a significant reduction of settlement can be seen. The most important site in the North is Haftavan VIB near Salmas, with clear cultural contact to Eastern Anatolia and the Trans-Caucasus. Finds from Dinkha IV on the South-western shore of Lake Urmia indicate that the entire South-western region of Lake Urmia was under Mesopotamian influence. *E.g.* sikkatu and clay nails were found. Together with "Habur Ware", they give evidence for the intensive, close contact of this region to Northern Mesopotamia in the older Assyrian period. Thus, one must presume that it was the region and not only single bigger sites which were in direct contact to Northern Mesopotamia for a certain time in the 1st half of the 2nd millennium. We may suppose that a route along the Small Zab and the Kelishin Pass was the throughway to Northern Mesopotamia, as it had been in the Chalcolithic. Between the springs of the Small Zab and the river system of the Gadar there are only smaller mountain chains.

Early Iron Age (Iron I–II)

In the entire North-western Iran and in the Araxes region North of it, after the middle of the 2nd millennium a new culture obviously slowly develops, which was called "Grey Ware Horizon" or rather Iron I and II by Young and Dyson (Dyson 1965; Young 1965).

While during the Early Bronze Age the contacts to the Trans-Caucasus and to Eastern Anatolia are close, North-western Iran falls apart into different independent traditions during the Middle Bronze Age. But in the Early Iron Age we are able to state that the culture is generally very uniform. This uniform tradition advances from the South (Central and Northern Iran) to the North and ends in the Trans-Caucasus on the one hand (Kashkay & Aslanov 1982), on the other hand at the modern border between Turkey and Iran (Bartl 1994). Originally, Young related this tradition with the Iranian immigration but meanwhile has partly modified this view (Young 1985). But it is unquestioned that here as a broad wave a new pottery tradition intrudes North-western Iran – and the bearers of this tradition with it.

Due to surveys, about 200 sites in North-western Iran may be dated to the Early Iron Age, particularly to the second part of the Early Iron Age (Iron II: about 1100-800 BC). In the first part of Early Iron Age (Iron I: about 1450-1100 BC), there are fewer settlements, especially cemeteries are found whose accompanying settlements have not yet been found, *e.g.* at Tabriz, at Ziwiye, or at Dinkha Tappeh. But there are only a few excavated sites; Haftavan, Kordlar, Geoy, Hasanlu, Dinkha, Ziwiye should be mentioned. As proven by Pigott for Hasanlu (1977), there is hardly any iron metallurgy during Iron I but to a large extent after Iron II. This can also be seen especially well at the cemetery of Dinkha Tappeh (Muscarella 1974). Though in North-western Iran various places of ancient mining are known they have not been scientifically investigated. Only in the Ahar region Weisgerber was able to prove the existence of an ancient mining district from the Early Iron Age at Sunghun (Weisgerber et al. 1990).

Particularly in Iron II it is especially conspicuous that in the entire country we find not only small, fortified settlements but also works which we may consider larger fortified places, due to the maps of their development. Hasanlu V and IV should be mentioned first. The town was fortified by a wall, and due to its size and its public buildings, it was surely a central place of the Ushnu-Naqadeh region (Dyson & Voigt 1989).

Kuh-i Corblah on the South-western shore of Lake Urmia and the strong fortress of Aslan Qal'eh West of Miandoab are other huge fortresses besides Hasanlu. Near Bukan, there is the fortress of Girdahrar Qal'eh (Kroll 2004). And by the end of the Early Iron Age, the fortress at Zendan-i Suleiman was erected which maybe must be considered a sanctuary (Boehmer 1964).

All in all, this evidence from the Lake Urmia region are mirrored in Eastern Azarbaidjan. In this period, especially due to graves, for the first time there is evidence for settlement in all regions. Also, fortresses are known. Similar to the Lake Urmia region, none of them may be called large, with the exception of Hasanlu. As far as we know, all of them are to be dated to the period of Iron II. The fortresses of Nashteban, Qiz Qal´eh Ruyan Duyah, Ak Kale, and Seqindel should be mentioned (Kroll 1984a, SB 11; MKSR 69. 71; AH 26). These fortresses in all parts of the country give the impression that the entire region was ruled by single, minor rulers. Somehow, this situation is mirrored in the Assyrian sources from the same time, which concerning the mountain countries speak of a number of small territorial units (Salvini 1967). But it is not possible to identify one of these regions with a definite ancient name. There are good reasons for localising Gilzanu Southwest of the Lake Urmia region, maybe in the Ushnu-Naqadeh region with Hasanlu as its centre, as suggested by Reade (1979).

The several destruction layers at Hasanlu and particularly the disaster of Hasanlu IVB not only archaeologically mark a decisive turning point for Hasanlu but for the entire North-western Iran, concerning the history of settlement. Due to several similar destruction layers at Kordlar Tappeh, we may presume that by the end of the Early Iron Age, *i.e.* during the 9th century, such disasters happened more often. If we follow the historic sources, particularly from Assyria, we must presume that a great deal of this destruction is due to the Assyrian expansion to North-western Iran and Eastern Anatolia. Obtaining raw materials in the widest sense was the goal of this expansion, including metal and even horses (Salvini 1995, 18-24). But the kingdom of Urartu, which was rising and expanding at about the middle of the 9th century and which was centred around Lake Van and West and Northwest of Lake Urmia, may have been responsible for this (Salvini 1995, 14-17). A short time later, the empire of the Manneans rises in Kurdistan (Postgate 1989). For the time being, research has not been able to find out if these states were rising due to independent interests or if they are to be considered a reaction to Assyrian aggression. In this period, in the 2nd half of the 9th century BC, the first fortresses in the Lake Urmia region are built which show a completely typical way of building that can already be identified as Urartean.

Early Urartu (end of 9th century BC)

After the Urartean king Ishpuini (*c.* 820 BC) it is the custom not only to provide royal buildings with inscriptions but also to build up inscriptions of victories at home and in the conquered regions (Salvini 1995, 38-47). Even if we cannot presume that we will find all of such inscriptions, the view is clear. In the Western regions of Azarbaidjan there are two building-inscriptions by King Menua (*c.* 800 BC) and as well building- and consecration-inscriptions by later rulers. South of Lake Urmia, on the other hand, there are inscriptions by Ishpuini and Menua at the Kelishin and in Qalatgah, but at the Tashtepe in the Miandoab region there is the inscription of a campaign (Salvini 1984). The oldest inscriptions of campaigns in the North of Armenia, in the Ararat plain, were made as late as by King Argishti I (*c.* 770 BC) (König 1955, No. 85-93). On the other hand, in the Northeast, in Nakhitçevan, we know the inscription of a campaign by Ishpuini (Salvini 1998). In Eastern Azarbaidjan, in the region of Ahar, the oldest inscription in Seqindel dates from Sarduri II. at about 750 BC (Salvini 1982). This distribution of campaign- and building-inscriptions means that probably the entire Western Azarbaidjan had always been Urartean territory and had not to be conquered; Eastern Azarbaidjan and the regions beyond the Araxes were included in the course of the 9th-8th century.

The most important Urartean place at this time is the double-fortress of Ismail Agha Qal´eh in the Urmia region, which probably was erected in the beginning of Urartu in the middle of the 9th century BC. Similar to Bastam, it is located at the edge of the Urmia Plain, high on a protruding mountain above a river and thus controls the entire plain around. Unfortunately, the research at this important old Urartean fortress by an Italian expedition has been interrupted for some decades, so that we have no information about the plan of such an old fortress except what was produced by a short, first excavation (Pecorella & Salvini 1984). Only the excavation of the fortress of Bastam, which was erected in the 7th century BC, then produced further information. All other known fortresses from the early Urartean period must be considered medium sized or small (Kleiss 1976).

Middle Iron Age (Iron III): Urartu – Manneans – Assyria (8th-7th century BC)

The important development in the history of metallurgy happened during Iron II, which is proven by the example of Hasanlu IVB, when for the first time there was large scale manufacturing of iron products, particularly offensive weapons and tools. Also unique is the existence of bimetallic composite-products which were partly made of iron, partly of bronze, *e.g.* swords or needles. For Middle Iron Age there is no evidence for the latter tradition. Offensive weapons (spears, arrowheads, swords, daggers) and partly protective weapons (helmets) and almost all tools for daily use, like hoes or knives, were made of iron. Furniture decorations, equipment for horses and wagons, belts and sacrificial gifts like oversized shields or helmets were still made of bronze. There is evidence for these finds from the excavations at Urartean sites like Haftavan III (8th century BC) or Bastam (7th century BC).

In North-western Iran, surveys produced evidence for about 80 definite Urartean sites. Concerning this, it is difficult to distinguish the 8th from the 7th century by surface finds. There is evidence for Urartean places in the regions of Maku, Khoy, Marand, Ahar, Salmas, Urmia, and Ushnu-Naqadeh. At Tabriz we know only two sites at the Northern edge of the Tabriz Plain. No sites are evident at Mahabad, Miandoab, Maragheh, and in almost all regions of Iranian Eastern Azarbaidjan, i.e. these regions have never been controlled permanently by Urartu, just as Kurdistan South of Lake Urmia. On the other hand, more than 200 places in the entire North-western Iran may be called Iron Age.

The criterion for Urartean constructions is the architectural evidence. All buildings show carefully made foundations of unitised stone walls, on which walls of mudbricks are erected. Fortress walls show rectangular projections and towers (Kleiss 1976). Another criterion for Urartean sites is the share of "Urartean Palace Pottery" – which may be small – and the existence of cloverleaf jugs with their typical handles (Cat. no. 385). There is no predecessor for this shape in the Early Iron Age. If these jugs have carved measures on their handles, this indicates central distribution of food (Kroll 1979). Another important criterion is central storage in gigantic storage vessels, pithoi, whose volumes are given (Cat. no. 387). Such pithoi were taken away as booty as early as by the Assyrian king Salmanassar III after his victory over the Urartean king Aramu (Barnett 1974, fig. 167). At the same time, this depiction gives evidence to the fact that storage and central planning started in Urartu as early as in the middle of the 9th century.

The building of fortresses in the Urartean period is nothing new, as there are fortresses as early as in Early Iron Age in all of Azarbaidjan. But what is new is the evidence for the fact that each region does not only have one or two huge or rather central fortresses but is surrounded by a network of medium sized and much smaller fortresses. As far as there is evidence for, all these constructions within one region had eye contact to each other. Also new is the size of the constructions. Fortresses of the size of those at Qalatgah, Ismail Agha, Bastam, Verahram, Livar, or Gavur Qal'eh on the Araxes – occupying an area of 8-30 ha – had not been existing in earlier periods. Also new is the construction of extravagant rock graves for the upper class, partly within reach of the fortresses, e.g. at Sangar, Verahram, or Ismail Agha. At two fortresses, at Djiq Qal'eh and at Khezerlu, even without excavations it was possible to find tunnels of steps which had been made in order to secure water supply by help of tunnels inside the fortresses. Finds of magazines with storage vessels in the huge fortresses, ready to contain thousands of litres, prove that central storage was built up. On the other hand, the jugs with measures prove the central distribution of food for workers and officials.

The building of all these fortresses gives evidence to the fact that this must have been a period of intensive military struggle. This is mainly confirmed by Assyrian sources. These inscriptional sources supply us with some important territorial information, which is that the territory of the Urarteans and that of the Manneans had a common border (Boehmer 1964), that there were constant struggles about border and territory. We also know that frontier areas or single places were constant war zones and again and again changed their possessor (Postgate 1989). More than one time, Assyrian kings felt the need to massively interfere with these struggles. Archaeologically, it is difficult to trace such historic evidence.

The only foreign campaign of this period into North-western Iran, for which there is more sufficient evidence, was Sargon's II of Assyria 8th campaign in the year 714 BC. Based on his profound topographic knowledge of the Lake Urmia region, Zimansky was the first to reconstruct this campaign around Lake Urmia and to identify single Urartean provinces, which are mentioned by Assyrian texts, with modern regions (Zimansky 1990). Zimansky suggested to identify the huge Urartean fortress of Livar in the region of Marand with Ushqaja (Zimansky 1990, 15) which is destroyed and burned down by Sargon on his 8th campaign. The location of this fortress by Sargon goes as follows: "From Uishdish I went and came to Ushqaja, the huge fortress at the farthest border of Urartu, which like a gate blocks the entrance to the territory of Zaranda ..." (Mayer 1983, 85). Zimansky's suggestion is supported by his own observations. From the South, the Marand Plain can be reached via two passes, one via the place of Sufian, where both the old and the new route go, or farer to the East via the place of Alandjaq, where an old route leads to Marand via a pass. If one reaches the height of the two passes, one sees the wide plain of Marand and as a gigantic block of rock the fortress mountain of Livar lies in one's view. Such a geographic constellation has not been observed elsewhere in North-western Iran. Independently from thought on the Sargon campaign, also the older travel literature mentions this wide view on the plain of Marand.

Also, one other suggestion is important, which is to identify Qalatgah (East of Ushnu) with Uajais (Zimansky 1990, 17). According to Sargon, Uajais is located at the lower end of Urartu, not far away from which the King of Hubushkia pays tribute. Within the dense network or Urartean fortresses which stretches from Armenia to the South-western shore of Lake Urmia, Qalatgah indeed is located at the Southern end of this network of fortresses. As at the same time it is the biggest fortress in the entire region (Muscarella 1971), it might well be the centre as which it is described by the Assyrians. In contrast to that, no important role may be ascribed to Hasanlu IIIB and its mighty Urartean wall. Rather, the excavated inside buildings give the impression as if the wall had been finished but as if after that Hasanlu had not been used anymore as a military stronghold. The architectural evidence rather indicates a squatter settlement which does not at all fit to the gigantic wall (Dyson & Voigt 1989, 3-11). All in all, we may try to distinguish two territorial units in Iron Age III. First, there are the regions in the West and the North where there is archaeological evidence for Urartean presence. Then there are the regions in the South and the East where typical Urartean evidence is lacking. Concerning the South, the evidence indicates that this region may be identified with the Mannean empire.

Bastam

It stays debated if Sargon's campaign of 714 BC did weaken Urartu for a longer time. From the region around Lake Van (Toprakkale, Adilcevaz, Ayanis) and from the North and Northeast of Iranian Azarbaidjan there are reports of activities of Urartean kings of the 7th century like Argishti II and Rusa II (Salvini 1995, 99-109), e.g. building the huge fortress of Bastam (Fig. 1), while Haftavan III, which had been destroyed by conflagrance (by Sargon), is not rebuilt again (Burney 1973). This suggests that in the 7th century Urartean influence was maybe restricted to the Northern and North-eastern regions of North-western Iran.

But due to the excavations of the seventies at Bastam (Khoy region) and at Ayanis after 1989 (on the Eastern shore of Lake Van), the view on Urartu's last period during the 7th century has

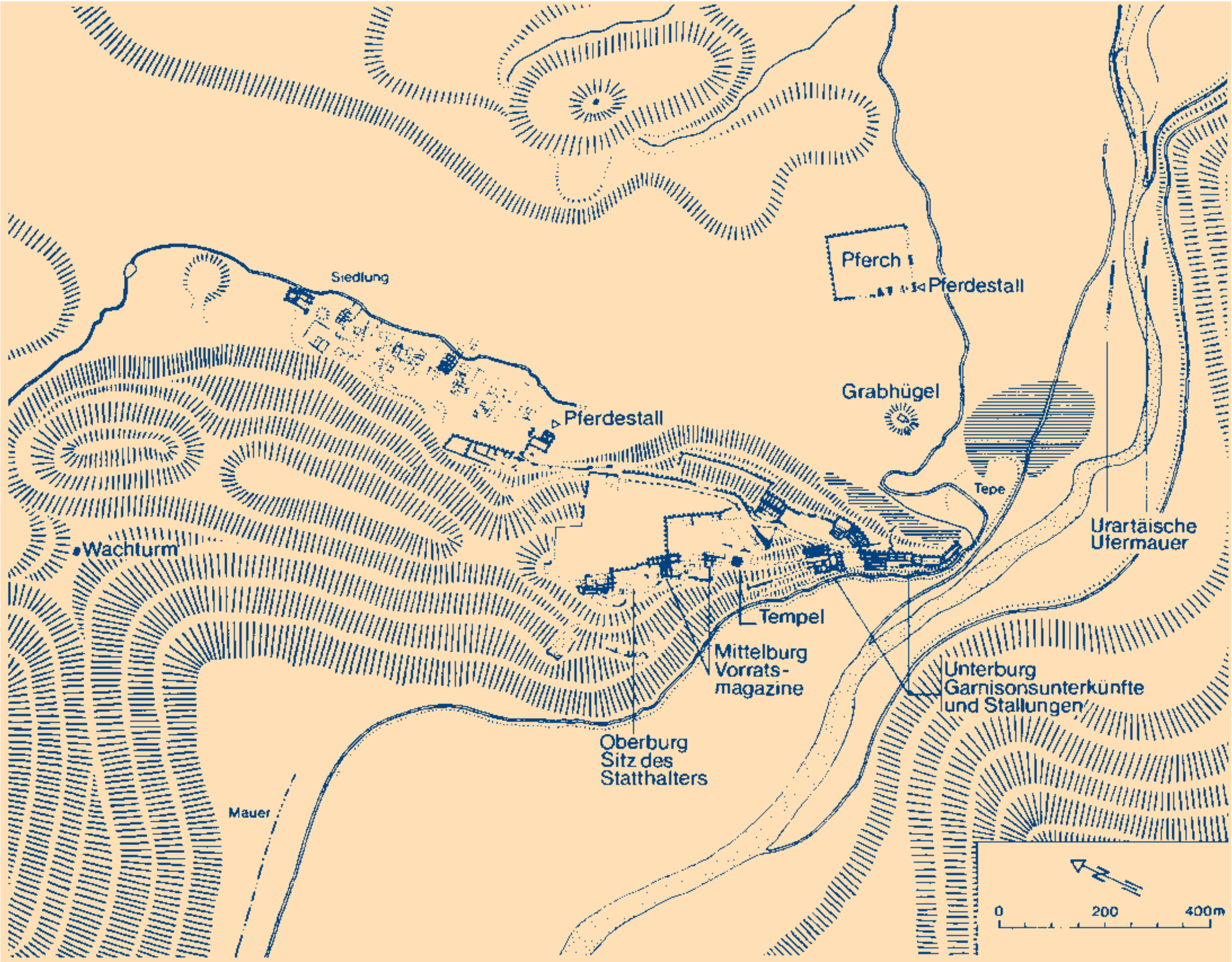

Fig. 1: Map of the Urartean fortress of Bastam in the Aqcay valley, built by King Rusa II (7th century BC), including garrison buildings, stables, and extensive magazines; by S. Kroll.

significantly changed. Today it is clear that the Urartean king Rusan II (c. 680-655) was one of the most successful and mightiest kings of his time, before the Empire of Urartu – maybe even during his reign – went to flames at the onslaught of horse nomads. In Iran, he founded the fortress of Bastam (ancient name Rusai.URU.TUR=Rusa's town) as a new military and agricultural centre. Between 1969 and 1978, the German Archaeologic Institute, Tehrān Dept., directed by W. Kleiss, excavated this biggest Urartean fortress in Iran (Kleiss 1978; 1988).

At the edge of a wide plain, which had not been especially cultivated before, Rusa II erected a fortress of c. 800 to 200 m, stretching almost 150 m up the mountain, on a protruding rock where the river Aqcay comes from the mountains. Channels and embankments were built along the river. Bastam is located at a once strategically important connection from Lake Van to the East into Iran, about 1300 m above sea level. In the lowest, southernmost part of the fortress, the so called lower acropolis, the military garrison was stationed, as there is evidence for by iron arrow- and spearheads (Cat. no. 379) and two iron "heraldic" lance heads (Cat. no. 381). The guards at the gate may be supposed to have been armed with these "heraldic" lances, as the place of both the pieces just at the Southern gate suggests. Here but outside the wall, also several of the two- and three-winged bronze arrowheads of the attackers were found (Cat. no. 380). A bakery was also excavated. A path led through the Southern gate, which was heavily fortified by towers, and into the central and the upper acropolis which were higher, i.e. farer to the North. In order to build stabile foundations for the walls, the rocky ground was worked down into horizontal "stairways" by help of iron hoes or picks (Cat. no. 257). From the small area of the upper acropolis, probably the residency, where also the temple must have been, there come finds like the fragment of a bronze lionhead (Cat. no. 390) and architectural elements decorated in the shape of leaves (Cat. no. 377).

That part of the fortress which occupied most of the area, the so called central acropolis, was reserved to the storage of food in gigantic storage vessels: grain, wine, oil. At Bastam, probably some millions of litres were stored thus in magazines. In that way they were supposed to be safe from enemy attacks, e.g. Assyrian attempts. In other rooms there were stored thousands of dried and salted butchered animals, each of it with a sealed clay bulla. Probably these animals were sealed with such a clay bulla as a receipt by tax officials when the tributes were collected. The seals on these clay bullae are numerous, mostly they come from higher officials (members of the royal family?) but there were also many seals of King Rusa II (Cat. no. 384). Pithoi and a bulla with an identical impression of a seal of Rusa II in the rubble of Ziwiye (Seidl 1988, 150) in Kurdistan prove that Urartean influence in North-western Iran must have been really strong under Rusa II.

In the North and the South of the fortress, stables for some hundreds of horses were found, evident by chemical analysis (Kroll 1989); another stable with a pen of 100 to 100 m next to it was found Eastwards on the plain. A settlement below the fortress could only partly be recognised in outline, as meanwhile it has mostly been buried by the arm of a river. Industrial sites like *e.g.* kilns, iron and bronze forges, and other craftshops have not yet been found. It may be supposed that they were outside the fortress and were also buried. This burying is not only due to natural causes but definitely man-made. While all of the Urartean buildings are just on that ground, which was left by the last glacial epoch, with the beginning of the Urartean period obviously over-exploitation started, most likely by cutting down the trees on the surrounding slopes. Thus, erosion started which until today has covered the Urartean settlement below the fortress with up to 6 m of erosional scree.

As far as there is evidence for, in the entire North-western Iran Middle Iron Age settlement – may it be Mannean, Urartean or of any other name – ends with a gigantic disaster in the 2nd half of the 7th century BC. At all the sites mentioned, there are indications for the attackers in the form of two or three winged arrowheads (Cleuziou 1977), as they are typical for horse nomads (Rolle 1977): in Armenia at Karmir-Blur, in Iran both at Ziwiye and at Bastam (Cat. no. 380), in Turkey recently proven at Ayanis (Derin & Muscarella). Based on written evidence, particularly Salvini pointed out

Fig. 2: View from the fortress of Bastam to the West and into Aqcay valley. An old road from the Urartean capital of Tushpa at Lake Van to Bastam leads through this valley.

Fig. 3: View from the fortress mountain of Bastam to the Southern, lower part of the fortress. In the centre there is the Southern gate, fortified by towers. To the left there is a columned hall. To the right of the gate there are the remnants of a long, three-aisled building: a stable for horses. Above it there are the foundations of a garrison building with a number of smaller rooms.

Fig. 4: View from the East to the fortress mountain of Bastam in the winter of 1975. Two parallel fortress walls are clearly visible which diagonally stretch up the mountain from the right.

Fig. 5: Impression of the cylinder seal of the Urartean King Rusa II on a clay bulla. A servant holds a parasole above the king's head, in front of the king there goes a lion. At the upper and the lower edge there are remnants of the inscription in cuneiform writing: This is the seal of Rusa, Son of Argishti.

to the possibility of the presence of horse nomads in Urartean and Mannean territory during the time of Rusa II (Salvini 1988, 131-138). Archaeologic evidence for the area farer to the North was recently compiled by Motzenbäcker (2000).

But the decline of sites in North-western Iran by the end of Middle Iron Age (end of the 7th century BC) is dramatic. There are only 20 sites known which we find difficult to call Medish or Achaemenid. Bastam burned down, and only at one place inside the old area it was possible to prove insignificant settlement from the Medish-Achaemenid period (Cat. no. 386).

The entire period after the decline of Urartu until the Islam must be called an archaeologically dark age. Traditionally it is presumed that North-western Iran was part of the empire of the Medes and Achaemenides. But today this is judged much more differentiated (Lafranchi et al. 2003). Later, Northern Iran was a part of Armenia, the rest of Azarbaidjan was a part of Atropatene. There are records for struggles among Parthians, Armenians, and Atropatene, the latter more and more getting under Parthian rule. Later, Roman campaigns went as far as to North-western Iran (Schottky 1989). But all in all it is not possible to identify single archaeologic evidence with these great empires.

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The palace of Kyros the Great in Pasargadae (6th century BC); in front a fishlike human creature (1976); Photo: G. Weisgerber.

Medes and Persians

Heidemarie Koch

Since the second half of the 2nd millennium BC, Indo-German horse nomads settled in the northern areas of what is today Iran – Medes and Persians. Probably due to climatic changes they had been forced to leave their homes in Central Asia and they had reached the South, moving east of the Caspian Sea. Thus e.g. the settlement mounds of Yarim Tappeh and Tappeh Hesār give testimony to their presence. An unusual kind of grey pottery seems to have been particularly typical for these peoples; this colour does not exist in nature but was made by mixing ashes and other natural materials into the clay. The reason for such an effort only to get a grey colour, which is “unspectacular” at first sight, is shown by the highly polished surface. Obviously the impression should be given that these vessels were made of silver. Also the bold and erect shapes, which are difficult to make from clay, point to the fact, that obviously metal vessels served as examples (Fig. 1).

Ceramic vessels made of grey clay and of similar shape were also found South-West of the Caspian Sea, in the province of Gilan. They were excavated *e.g.* in the tombs at Marlik, dating from the end of the 2nd millennium. Among them are spherical vessels with striking long beaks (Fig. 2). To make them from clay, also great skill was needed. At the same time they give an impression of metal art, of which relatively much less was preserved, due to the material. The tombs, which are – like at Marlik – in separated burial grounds outside the towns, also indicate Indo-European settlers, for usually in the Middle East the deads were buried below the houses. In the tombs of Marlik and Amlash there were also found several valuable vessels made of precious metal and some pieces of jewellery, all of them made of silver and gold (see Cat. no. 436-439). Typical is the shape of the beakers, which are growing a bit narrow towards the middle and then become wider again towards the top (see Cat. no. 440, 441). Quite often they are decorated with animals in relief, the heads of which are sometimes completely protruding. A popular motif are e.g. winged bulls (Cat.

Fig. 1: Vessel made of grey clay with polished surface and scratched decoration (height 40.9 cm), Tappeh Hesār (Mazanderan), about 2400-2200 BC; Seipel 2000, 148 nr. 74.

Fig. 2: Spherical vessel with a long muzzle (beak?) made of grey clay with polished surface (height 18 cm), Tappeh Marlik (Gilan), about 1200-1100 BC; Seipel 2000, 161 nr. 87.

no. 436) which also appear in later periods of Persian art (see Fig. 9).

From the existence of typical kinds of pottery we are able to deduce where the Iranian tribes went and where they stayed for some time. It seems as if the Medes went directly to the Central-Iranian highlands and settled in the area of their later capital Ekbatana (Hamadan today). Also the settlement mound of Sialk (near today's Kāshān), where also vessels with long beaks were found, was part of their territory. But in this case the vessels are made of bright clay and are richly decorated with dark red patterns (see Cat. no. 355). This kind of painting is typical for Sialk. The Persians, instead, had at first gone farther to the West, past the Southern shores of the Caspian Sea, and settled in the area south-west of the Caspian Sea, which is suggested by the finds from Amlash and Marlik. At Hasanlu, not far from the southern shores of Lake Urmia, remnants of buildings were found in the course of excavations. These remnants are conspicuous, due to their architectural features; prestigious buildings with huge columned halls are especially unusual. They seem to be typical for the Persians, for the preference for such halls can also be seen in the following periods, for instance at the Achaemenid palace buildings at Pasargadae and Persepolis.

In this area between Lake Urmia and the Caspian Sea the Persians must have been living when they were mentioned by a historical source for the first time. In the year 843 BC the Assyrian king Salmanassar III in his reports of his campaigns mentions a people unknown so far which called itself "Parsa" (he writes Parsumasch), that means the Persians. A short time later, in 836 BC, he also reports an encounter with the Medes. The further military conflicts show that the latter had already achieved a position which was not to be underestimated. According to an Assyrian inscription, in 834 BC the Assyrian king received tributes from 27 Median kings. Here the expression "king" rather means chieftains. Between 745 and 705 BC the Persians are mentioned several times in close connection to the Medes. In 714 BC the latter are mentioned among the subjects of the Assyrian king Sargon II, and in 713 BC 45 minor Median submit to the Assyrian king. At this time the expression "Mada" for the territory appears.

To escape the pressure and the constant threat of being conquered by the Assyrians, after Sargon's II death in 705 BC, the Babylonian king Marduk-apla-iddina joined forces with Elam, Juda, and the Phoenician towns Tyrus, Arad, and Askalon. Also the Persians must have joined this alliance. For King Sanherib's annals from 692/91 BC report that the people of "Parsuasch", together with the

Ellipi and the kingdom of Anshan had fought against the Assyrians. The Ellipi were a small buffer state between Assyria and Elam. Anshan is the highland of Elam which later became the Persis. For centuries the Elamite kings bore the title "King of Susa and Anshan". From excavations, which were done by the Oriental Institute of Chicago at Tal-i Malyan about 50 km west of Persepolis from 1975 to 1978, we know that this was the ancient Anshan. Thus, the kingdom of Anshan must have contained approximately the territory of the later Persis, the Persian homeland, which today is the province of Fars.

In recognition of the military help against the Assyrians, the Elamites obviously allowed the Persians to settle in their territory. Elamite administrative tablets from Susa, presumably dating from the first half of the 7th century BC, corroborate this. They record allocations by the public clothing store at Susa, but also taxes for it. There are several Persians mentioned. Thus at this time there must have existed already a certain amount of Persian fiefs in Elamite territory.

This Persian advance further to the South seems to have happened quite peacefully. At all excavations, which were done in the entire area, no break in pottery or settlement structures could be stated for the time between 1250 and the 7th century BC. Thus the way to the South must have been made without any military conflicts. But the Elamite king Kutir-Nahhunte II (693-92 BC) is the last to bear the title "King of Anshan and Susa". From then on the territory seems to have been completely in the hands of the Persians. Thus they had reached the territory from where they would conquer a complete world empire.

But before this we want to have a look at the Medes again. Not only the Assyrians were a constant threat to their neighbours but also from the North there was the danger of repeated invasions. Here – obviously following the Medes and the Persians – Kimmerians and Scythians were pressing after. These tribes were related, they spoke Iranian languages and were used to a tough nomadic existence. All of these Iranian tribes brought a decisive invention with them: they knew how to breed horses. Not only delicately made bridles suggest this (see Cat. no. 321-323) but also depictions of horses were very popular, like on the precious silver beaker from Amlash. Thus, horses were the most important booty for the Assyrians, when in 744 BC they succeeded in advancing far into the territory of the Medes, as far as to Mount Bikni, which probably is Mount Damavand near Tehrān. Additionally, they took numerous small farm animals, 300 talents (about 9 t) of lapis lazuli, and 500 talents (about 15 t) of bronze artefacts. As lapis lazuli is found only far in the East, in Badakhshan (todays Northern Afghanistan), these distant countries must have been in a close trading relationship with the Medes, if this highly desired and extremely precious stone was found in their possession in such amounts.

In 672 BC the Medes, supported by Kimmerians and Scythians, rose against the Assyrians. As the Assyrian annals report, they were led by a man called Kaschtariti; this may well be the Assyrian spelling of the Median name Chschathrita (correct spelling: Xwaxštra which means something like "the Grand"; 674-653 BC). He seems to have succeeded in uniting under his leadership the various Median tribes. But during the fight the Scythians left their allies, because the Assyrian king, who obviously was a clever tactician, had married one of his daughters to the Scythian king. But still the Medes succeeded in regaining their independence. The following decades were filled with far reaching struggles which affected the whole of Asia Minor and Egypt. Various kingdoms and peoples formed alliances, sometimes broke their treaties again and formed new alliances with their former enemies. In 653 BC the Median king Chschathrita (Xwaxštra) lead another campaign against the Assyrians but was attacked by the Scythians on his other flank and died in battle. After this, from 653 to 624 BC, Media was under Scythian rule for 29 years.

During this time (in the years 646, 642, and 639 BC) the Assyrians conquered Susa and thus made an end to Elamite independence. The Elamite king fled to the mountains and the Assyrian troops went after him.

In 625 Kyaxares (Median Chwachschtra [Xwaxštra] "autocratic ruler") succeeded in reuniting the Median tribes and in beating the Scythians. He was able to gain this victory mostly because he had completely reorganised his army, for Kyaxares organised his fighters according to types of arms and not according to tribes, as it had been usual before. After his victory Kyaxares had built a big, strongly fortified town, which according to Herodot was circular and surrounded by a wall: Ekbatana, which today is Hamadan, from then on was capital of the Medes.

In 614 BC the Medes besieged Ninive, capital of the Assyrians, but without success. So they marched on and conquered Assur. After this great victory the Babylonians entered into an agreement with the Medes. It was sealed by the Babylonian king Nebuchadnezzar wedding Amytis, Kyaxares' daughter. It is for her that Nebuchadnezzar was said to have built the famous Hanging Gardens, which the Greek counted among the Seven Wonders of the World, as his wife was said to have missed the green gardens of her native country so dearly. In the following year, in 613 BC, Ninive was taken by the Medes and completely destroyed in 612 BC. Thus things had happened which the biblical prophets Nahum (2,2-3, 1,7) and Zephanja (2,13-15) had prophesized by their impressive words. One result of these wars was that at about 600 BC there were only three powerful states in the Middle East: Media, Babylonia, and Egypt.

On March, 16th, 597 BC Nebuchadnezzar's troops besieged Jerusalem. King Jojachin surrendered. Together with his family, all of his treasures, and thousands of craftsmen and warriors he was taken into captivity at Babylon (2. kings 24, 10-16). Ten years later, in 587 BC, Nebuchadnezzar took action against Jerusalem a second time, which again was renegade, and the rest of the population – except some men of low social status – was taken away into the famous "Babylonian Captivity", of which the Bible reports in details (2. kings 25,1-12). Only the Persian king Cyrus the Great would set the Jews free again (Ezra 1,1-5ff.).

The Median king Kyaxares also extended his territory, and at about 624 BC the Persians were under his rule. Then probably Parthians, Hyrkanians, and Armenians followed. At about 590 BC the territories of the Manneans and Urarteans must have been conquered. Only if these regions were under his command, Kyaxares was able to turn against the great kingdom of the Lydians in the West of Asia Minor. The Greek historian Herodot, living in the 5^{th} century BC, tells about the war between Kyaxares and Alyattes, king of the Lydians (Historia I 73-74). Just when the two armies were about

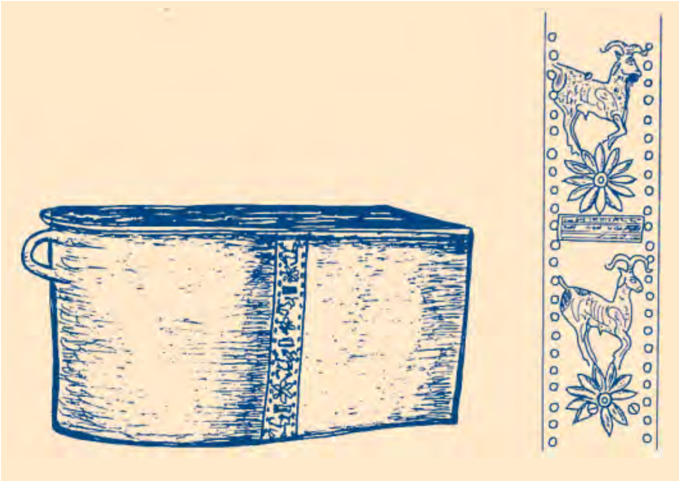

Fig. 3: Golden bracelet (diameter 9.5 cm), Ziwiye, $8^{th}/7^{th}$ century BC; Seipel 2000, 182 nr. 108.0

to meet in Kappadocia, there was a solar eclipse. Due to this, the participants were horrified in such a way that they gave up fighting. As this eclipse is mentioned, we are able to date the fight exactly: it happened on May, 28th (or 29th), 585 BC. Six years later Astyages, son of Kyaxares, married Aryenis, daughter of Alyattes, king of the Lydians. Thus both kingdoms were living together peacefully.

All in all, historical news about the Medes are very scarce, and we know even less about their culture. There were very few scientific and systematic excavations. Various artefacts, which are considered Median, came on the art market, due to illegal excavations. The most famous complex, which again and again is mentioned as an example of Median art, is the "Ziwiye hoard". It was found in 1947 near a high hill east of the town of Saqqiz, close to Hasanlu, in the course of illegal excavations. Those were troubled times, and thus in the course of distributing the booty many of the artefacts made of precious metal were melted down, others, which seemed to be less precious, were broken and thrown away. Due to the engagement of antiques dealers, the remaining artefacts were distributed to various private collections and museums in USA, France, Canada, England, and Japan. Today a great part of it is in the archaeologic museum in Tehrān[1]. Only some years after news about the finds had been spread, archaeologists came to Ziwiye. They found a strong fortress from the 7^{th} century BC, made of mudbricks. Partly the walls were still standing up to a height of 7.5 m. But the entire area was full of holes, due to illegal excavations. Probably the fortress was the residence of a local ruler, and in it there was a palace-like building with a columned entrance hall. The palace was decorated with enamelled tiles like in the Assyrian palaces at Assur and Kalkhu.

Maybe this hoard belonged to a grave. The artefacts had all been put into a sarcophagus, a huge bronze tub with one curved end (Fig. 4). This shape was usual also with the Persians until the end of the 5^{th} century BC. But it is conspicuous that the artefacts of the hoard were rather different and had obviously been collected during a longer period. They may be dated to the time since the second half of the 8^{th} century BC, which means that some of them had already been 100 years old when they were buried. Thus it might also be the case that only the hoard was buried in the bronze coffin, in order to protect it, e.g. from advancing enemies. The gold-jewellery is particularly impressive: for instance there is a heavy bracelet, ending in lion heads. In the middle part of the curve there are two small lions on each side, which are lying down and looking at each other (Fig. 3). Also the lion head, which is presented on the exhibition (Cat. No. 443) might originally have been fixed to a piece of jewellery. Pieces like the two mentioned ones may be considered predecessors of the later Achaemenid royal art. The same is true for the vessels of precious metal which were manufactured by the Medes. Some examples were found in the Kalmakareh-Cave near Pol-i Dokhtar (Cat. no. 512). The skillfulness of the Median craftsmen was famous even more than one hundred years later, as an inscription by the Persian king Darius the Great (522-486 BC) clearly shows. In the so called "inscription on building the fortress" (Burgbau-Inschrift), which tells about building his palace at Susa, he names the materials which were brought from all parts of the Persian empire and which craftsmen did the work. He clearly says: "The goldsmiths, who manufactured the gold, they were Medes and Egyptians." Thus, they must have been especially experienced and famous for their skill.

The settlement mound of Nush-i Jan may serve as an example of Median buildings. It is the only Median site, which has until now been excavated almost completely (750-660 BC, fig. 5). The hill with its buildings rises about 30 m above the plain. The mudbrick buildings are preserved up to the height of 8 m, partly even remnants of roofs are there. An unusual building in the centre, with niches and a big platform, obviously served as a sanctuary. But unfortunately we are not able to say who was adored and maybe given sacrifices here. The room is very well preserved as it was carefully filled, probably to protect particularly this place from advancing enemies. A huge reception hall next to it is again characterised by columns.

The centuries of fighting, with Babylon and Susa being destroyed again and again, had also exhausted the powers of Elam and Babylonia. After Ninive had been destroyed, first the Medes ruled the Susiana and the territories farther to the East. Probably also the Persian king numbered among their vassals, who meanwhile was residing in the old Elamite royal town of Anshan. Thus the Persians had reached the heartland of their new home territory, the

Fig. 4: Sketch of the bronze sarcophagus, wherein the hoard of Ziwiye (Kurdistan) was found, 8th/7th century BC; Koch 1992, Fig. 195; drawing: H. Koch.

"Persis". This is the Greek name for it, based on the ancient Persian word "Parsa", the expression the Persians used for their people, their home country, and their language.

In 550 BC the Persian king Cyrus, who later was called "the Great" (555-532 BC), succeeded in beating the Median armies. The decisive battle was fought at the fortress of Pathragada which was called Pasagadae by the Greeks. At this place Cyrus built his capital, providing it with great palaces and gardens (Fig. 6). There he had erected his grave, too, a simple house, rising above ist environment on a stepped base. But both the grave-building and the base are made of huge stone ashlars, a technology which had not been known before in the Middle East. Probably Cyrus saw it during his campaign against the incredibly rich Lydian king Croesus

Fig. 5: The Median fortress Nush-i Jan; Photo: G. Koch.

Fig. 6: The palace of Cyrus the Great (555-532 BC), founder of the Persian Empire, at Pasargadae; Photo: G. Koch.

in the West of Asia Minor. From there he also had sent for Greek masons who built his palace and the huge terrace. It is just the simple monumentalism of Cyrus' mausoleum what makes it so impressive.

By conquering Lydia and extended parts of Asia Minor and by taking Babylon in the year 539 BC, Cyrus had laid the foundations of the Persian empire. In it, all the preceding kingdoms of the Middle East were included. It was further extended by his son Kambyses (530-522 BC), who won Egypt but died on his way back to Persia. The Persian empire was then decisively extended by Darius the Great (522-486 BC), who was one of Cyrus' nephews, so that finally it reached from the Black Sea and the Caspian Sea in the North to Egypt and Nubia in the South, from the coast of Asia Minor in the West to the waters of the Punjab in India in the East. But first Darius had to fight fiercely for one year, until his rule was secured. To symbolize his victory, he had a relief made at the rock of Bisotun, high above the trade route and military road which led from Babylon to the old Median capital of Ekbatana (Hamadan today). There King Darius is depicted, towering above all other persons (Fig. 7). In his left hand he is holding a bow, with his right hand he is greeting the symbol of the god Ahuramazda which is hovering above the whole scene. The god is turning to King Darius, handing over the "ring of power" to him. Such a ring can be found on depictions, at least since the 3rd millennium BC, whenever a god is handing over sovereignty to a king. It shows that the king is acting on behalf of the god. This is also said by Darius in his inscription: "According to the will of Ahuramazda I am king". This is the first time that a king clearly declares himself for Ahuramazda, the "wise lord" who was proclaimed by the prophet Zarathustra.

On the Bisotun relief, his bow and his lance bearer are standing behind the king. Darius is setting one foot on a man who is lying on the ground, arms raised pleadingly. This is the magician Gaumata who had seized power in Persia during Kambyses' absence and who then had been overwhelmed by Darius. In front of the king, nine men are standing in a row whose hands are fettered on their backs and who are tied together by a rope around their necks. These men had started revolts in various parts of the

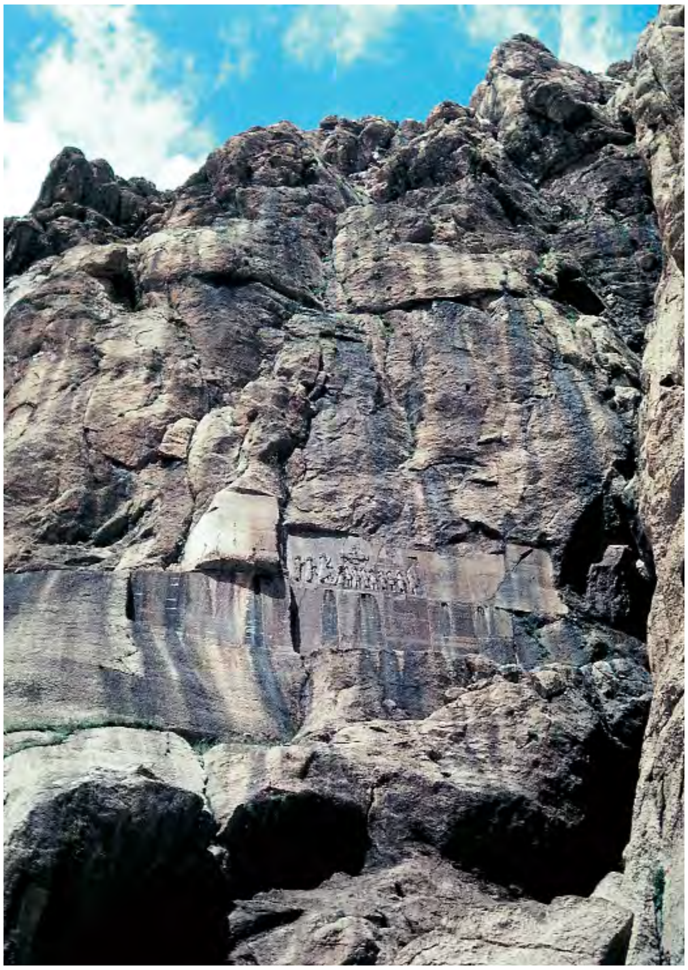

Fig. 7: The relief of Dareios the Great (522-486 BC) at the rock of Bisotun symbolising his victory; Photo: W. Hinz.

empire. Darius himself calls them "liar kings". A detailed report tells to the posterity, which incidents exactly led to making the relief. The report is written in three languages, Elamite, Babylonian, and Ancient Persian. Here it is striking that the first version was written in Elamite. The explanation is, that the Persians at first did not know a writing of their own. They were a people of horse nomads and did not need any kind of writing. But now, having become masters of an empire, the Persians needed writing and a carefully organised administration. For the latter they employed the Elamites who already had the experience of some millennia in this field. Thus, e.g. thousands of clay tablets from Darius' administrative archive, which were found at Persepolis, are all written in Elamite script and language. This explains, too, why the relief at Bisotun was at first provided with an Elamite inscription. As now the Babylonians, also being an ancient civilized nation, were part of the Persian empire, King Darius had a Babylonian version added the left of the relief. Doing this, it must have annoyed the king that the Persians, being the ruling people, did not have a writing of their own. Thus, around the year 520 BC he instructed his secretaries to immediately invent a script for the Persian language. In this writing the report was written down once again, this time in the Persian language and below the relief. Darius added a further paragraph, where he clearly insists on having invented this new script.

This newly invented cuneiform writing had some advantage over the older Elamite and Akkadian cuneiform writings which had developed over the centuries and thus were rather complicated. Against the about 600 Akkadian cuneiform signs and the about 200 Elamite signs now there are only 37 Ancient Persian signs, being a mixture of alphabetical and syllable writing. Only by help of these much simpler signs it was possible to decipher cuneiform writing at all. As King Darius had written the inscriptions in three languages and went on doing so with all of his later inscriptions, it was possible to decipher Elamite, Akkadian, and Babylonian cuneiform writing, starting from Ancient Persian. Thus the Bisotun relief is not only highly important for history but also it was the starting point of the research on all cuneiform writings.

After King Darius had secured peace in the country he had to make sure that the administration kept on working well and was appropriate to the growing demands. Thus he further extended Cyrus' seat of government at Pasargadae and finished the buildings which his predecessor Cyrus had begun. Besides, he had a completely new palace built in the old Elamite capital of Susa. In contrast to the Elamite brick buildings he had the foundations of the walls and the gigantic columns of the reception hall, called "Apadana" by the Persians, erected in stone. For this a solid foundation had to be made, for which – depending on the ground – 10 to 20 m of gravel were piled up. Building inscriptions are preserved – again in three languages – in which Darius reports from which countries of the empire the craftsmen and artists had come and from where the precious building materials for this palace at Susa had been brought. Unfortunately, only small remnants of this magnificent building are preserved, telling from its former beauty (see Cat. no. 483-486).

But most important for the king was another project, a completely new residence which was planned by him alone and was supposed to be the new centre of the Persian empire: Persepolis. Still today, the ruins of this unique construction rise on the mostly artificial terrace on the slopes of the Kuh-i Rahmat, the "Mountain of Mercy". Despite the destruction, done by Alexander the Great's soldiers in the year 330 BC and the looting of following centuries, the remnants of the buildings, created by Darius the Great and his successors, are still an impressive sight for every visitor. Darius himself was responsible for the huge reception hall, the Apadana, whose columns shine brightly towards anyone approaching from far across the plain (Fig. 8), for the palace with its door-frames and windows, some of which are cut from one single stone block, and for parts of the treasury. The latter was not only the seat of the highest ranks of the administration but also precious objects were stored there. Nearly nothing remained of them, but even the fragments give an idea of what pieces were once stored in it, may they have been precious due to materials or to the elaborate way in which they had been manufactured. Thus, parts of the so called "royal table ware" were found, plates, bowls, trays etc., made of differently coloured marble or granite. Fragments of bronze work or goldplated copper inlays were spread everywhere. Gold threads, pearls still hanging on them, told of noble embroideries which once were stored there. Only the finds from the satrapy of Lydia or from the old Median capital of Ekbatana give us an idea of the silver bowls with gold inlays or of the gold bowls and rhyta. But there were pieces which were considered even more precious than gold vessels: those made of glass (see Cat. no. 543). Being objects of special luxury, they were exported to far away countries, which is testified by an example which was found in Germany (see Cat. no. 480). They were mostly used for drinking wine. In his comedy "The Acharnai" the Greek poet Aristophanes vividly tells about the incredible luxury. In his play, envoys, having come back from the Persian king, tell about what they had to "suffer" during their journey: "We were hospitably entertained and had to drink unmixed, sweet wine from glass tumblers and gold vessels, no matter if we liked it or not." Indeed, those poor Greeks deserve our sympathy, such drinking vessels and then unmixed wine!

Still today, in the treasury at Persepolis there is the so called treasury relief which once decorated the centre of the gigantic stairway at the main front of the reception hall, the Apadana. There King Darius sat on his throne, accompanied by the crown prince, Xerxes, and welcomed the representatives of all the peoples of his

Fig. 8: The terrace of Persepolis, centre of the Persian Empire; Photo: G. Koch.

Fig. 9: Monumental relief of a bull with its head made completely three-dimensionally from the hundred-columns-hall, Persepolis; Photo: G. Koch.

empire, who brought their best gifts (Fig. 10). Behind him, his guards, the noblemen, and the dignitaries of the Persian empire had assembled.

The later Achaemenid kings changed a lot and added many buildings, so that finally the whole terrace was filled with buildings. But doing so, they always fell back on examples and motifs which had been created by Darius the Great. The last Achaemenid kings even had their tombs chiselled into the rocks of Kuh-i Rahmat. Also then they repeated the prototype of Darius. But he had had worked his tomb into a steep cliff in some distance from Persepolis, where also his immediate successors added their tombs to his – all of which are copies of his example (Fig. 11). Even as late as in Sasanian times this place was particularly worshipped and the kings of the 3rd century AD added their own reliefs. Today the place is called Naqsh-i Rostam, because the people thought that the gigantic reliefs recorded the deeds of the great Iranian hero Rostam.

Fig. 10: The so called treasury relief once situated in the middle of the eastern stairway of the reception hall, the Apadana. It shows Dareios the Great (522-486 BC) receiving delegations of all peoples of his empire; Photo: G. Koch.

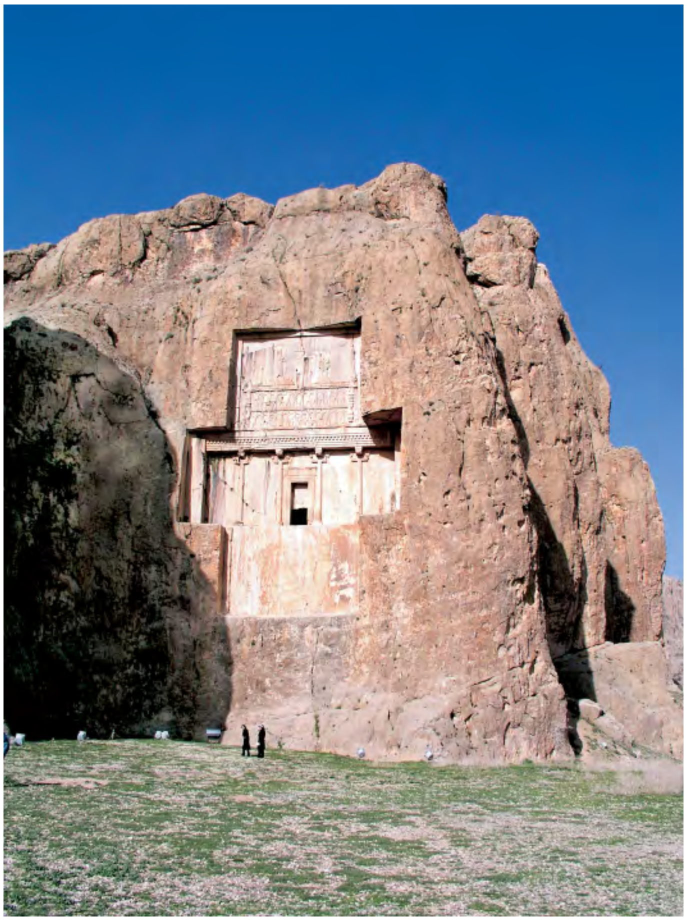

Fig. 11: The tomb of one of the Achaemenid kings, presumably of Xerxes (486-465 BC), in the cliffs of Naqsh-i Rostam; Photo: G. Koch.

Notes

1 R. Ghirshman (JNES 32, 1973, 445-52) made a list of the pieces, including measurements and short descriptions. Altogether, his list contains 341 pieces, 43 of gold, 71 of silver, 103 of ivory.

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Glazed Bricks in the Achaemenid Period

Shahrohk Razmjou
With contributions by Mike S. Tite & A. J. Shortland and Marion Jung & Andreas Hauptmann

Glazed bricks are an important element in Achaemenid royal art and architecture. According archaeological evidence this technique was widely used from the beginning of the reign of Darius the Great, about late 6th century BC.

The main centres of Achaemenid period like Susa, Persepolis and Babylon started to use glazed bricks for new structures and buildings. Nowadays we may suggest that producing glazed bricks in Achaemenid period begun at Susa and then spread to Persepolis. Susa received the main concentration for creating glazed panels to adorn walls with polychrome glazed bricks.

Basically Darius re-activated Susa, the ancient Elamite capital by rebuilding the city that was damaged by Assyrian soldiers under Assurbanipal in the 7th century BC. The ancient royal city was not only revived by Darius, but after erecting the royal centre it acquired more than its lost glory and became one of the main centres of the Achaemenid vast empire.

With a strong governmental and financial support, a large number of the best known artisans from all corners of the Persian domain including different countries under the Achaemenid Empire, gathered in Susa and started to use their skills in an universal collaboration[1]. When a certain amount of the work was finished at Susa, some of the artists might have moved shortly afterwards from Susa to Persepolis and used their skills to create the most glorious structures of the empire bearing glazed friezes.

The first archaeological excavations at Susa were started by Jean and Marcel Dieulafoy in the late 19th century in which a large number of glazed bricks were found (Potts 1999, 330).

The recovery and study of Susa glazed bricks continued until today. Unfortunately almost the great amount of the collection was not found in their original location but they have been reused in other structures in later periods (Caubet 1992, 224). But some other fragments were found in the area where they have been fallen, like the courtyard or the north wall of the eastern court (Caubet 1992, 224). Later the excavations by Erich Schmidt at Persepolis gave another clear evidence for the beauty of the Achaemenid palaces in which the glazed bricks had decorated the walls (Fig. 1).

The Wall Decorations

Darius has left a foundation inscription at Susa and he has described his architectural activities in that text. In this inscription after he mentions Babylonians who wrought the baked brick, he refers to the Medes and Egyptians who adorned the wall which means they made wall decorations (Kent 1953, 144; Potts 1999, 328). If Darius did not mean the glazed bricks which were a masterpiece in his royal palaces, therefore there would be a missing part in Darius text for the important decoration of the walls (Fig. 2). On the other hand the glazed bricks actually are to adorn walls and they are a wall decoration in its complete meaning.

In his inscription first Darius refers to Babylonians who made (baked) brick and just after that he speaks about those who adorned the wall. To show the procedure in his inscription he mentions every work in turn and what he refers to, likely is the process of making wall decoration with glazed bricks. Also we have to remember that the glazed bricks are the only architectural element that needed to be baked and the rest of the buildings and palaces were made of mud-brick.

Another proof for supporting this idea can be found by the study of artistic styles of the images on the glazed bricks. Darius speaks about Egyptian artists who adorned the wall, we can clearly find some elements, which have been drawn in Egyptian style. Basically the images in glazed bricks, especially human figures are designed by the order and instructions of Persian royal designers as a basic model. In general the whole design seems to be melted in a unique style, but in some cases by analysing details we can come across specific artistic elements. In the drawing of some motives, although they look very much Persian, the Egyptian drawing style can be recognised. For example a winged disc is very much like the representation of the Egyptian god Horus as a winged disc[2]. This artistic style is amalgamated with another artistic element that perhaps could be Median, as mentioned by Darius. These different styles together represent a Persian royal fashion design.

Susa friezes are also parallel to Achaemenid stone reliefs at Persepolis. Stone reliefs are actually decorating the walls of the palaces and thus they can be recognised as wall decorations. At Persepolis some images were chosen to decorate the walls of the palaces but in stone, and in Susa the images are parallel to those at Persepolis.

Historical Background

During archaeological excavations at Dur-Untashi, modern Chogha Zanbil, some examples of glazed bricks from Middle Elamite period were found by R. Ghirshman (1966, 110-111). They are decorated and painted on one peripheral surface and being glazed and used on the walls. These bricks, like inscribed bricks, could make a continuous chain of circles like a belt around architectural features at Chogha Zanbil. There were also other examples like glazed decorative pegs with inlays made of glass paste in the shape of a round eye[3]. The pegs usually were glazed with a green-blue colour glaze. At the same time in Chogha Zanbil, a similar glaze was also applied for statues like the statue of a sacred bull (Ghirshman 1966, 49-50, pl. XXXIII-XXXIV).

In the Middle Elamite period at Susa, moulded un-glazed bricks are more common, but very much like the Achaemenid period, each brick is a part of a complete scene. After that period, the same tradition re-appeared in Neo-Elamite period (Heim 1992, 206), but still no archaeological evidence has yet been found to confirm the continuity of the old manufacturing technique to Neo-Elamite period and then to Achaemenid period (Haerinck 1973, 118 f.). Perhaps the same tradition was followed in other parts of Elamite territory after the fall of the centres, such as Susa and Chogha Zanbil. But main reason is the lack of excavations to confirm the exact situation. Some examples found in Susa, including a polychrome glazed plaque, which was found with coloured rosette knob as an attachment of these plaques to the wall (Heim 1992, 207).

There is evidence from the Iron Age for use of painted bricks that can also be recognised as tiles. From the Median site of Baba Jan a number of monochrome painted tile-shape bricks were found (Goff 1969, 128f.). Other examples have been discovered from other Iron Age sites such as Ziwiye, Hasanlu and Bukan (Malekzadeh 2001, 138). In Bukan they represent polychrome designs including images of animals and mythical creatures.

Fig. 1: Susa; the palace of Darius. Water colour by Maurice Pillet (1881-1904; Chevalier 1997, Pl. VIII).

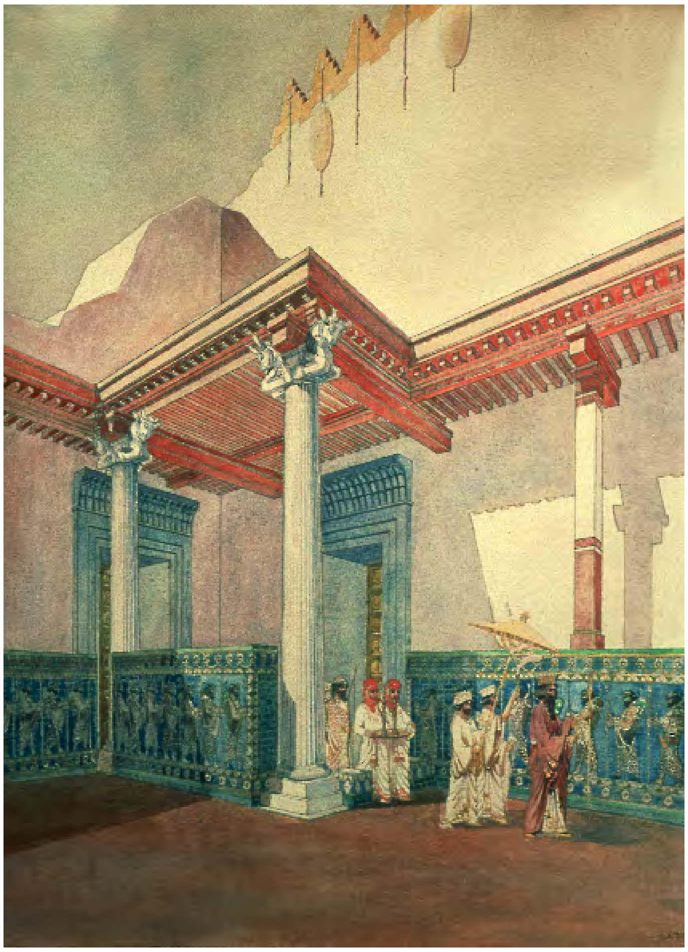

Fig. 2: Susa the palace of Darius: reconstruction of the base with the frieze of the guards at the forecourt. Water colour by Maurice Pillet (1881-1904); Chevalier 1997, Pl. XII.

In Neo-Babylonian period many glazed bricks were produced to adorn walls. The Babylonian glazed bricks were found at the Ishtar Gate and the palatial structures with the images of walking animals.

In Achaemenid period the usage of glazed bricks reached to its peak, both in technique and the design. The glazed friezes first appeared at Susa, perhaps by the instructions of designers and engineers of Darius as a decorating element for new royal palaces.

Comparison of Susa and Persepolis

Basically Susa is located in an area without stone resources. For constructing the royal buildings of Susa, Darius has imported stone for the columns from a village called Abiradush (DSf: Kent 1953, 144). Therefore stone was not an economical and reasonable material to be used for decorating the walls and representing the royal reliefs at Susa. Therefore Achaemenid designers at the royal palaces of Susa preferred to use glazed and un-glazed bricks to decorate the walls.

But unlike Susa, Persepolis was built on a rocky bed and laid back to a limestone mountain with access to many stone resources in the region. Therefore the designers could use plenty of stone carvings instead of glazed bricks. At Persepolis glazed bricks were also used but in lesser extent. Susa was built with more glazed bricks and lesser stones, and Persepolis was made with stone and lesser-used glazed bricks. After receiving paint the stone reliefs could become like the glazed bricks with a similar function (Frankfort 1954, 267). But of course they were probably not as shiny as the glazed bricks.

The glazed bricks are also different in style. At Susa there are many fragments that represent human and animal figures.

The human figures include the images of the so-called Susian soldiers and of course Royal images (Canby 1979, 315-320, Plate 50). There are also images of individuals carrying things ascending the staircase of the palaces. There are also some other miscellaneous fragments showing other individuals like a wreathed man (Muscarella 1992, 238, fig.166).

At Susa many other fragments were found representing animals and mythological or symbolic beings. At Persepolis there is no evidence of a human or animal representation on glazed bricks. But the same iconography can be found on stone.

Material, Shapes and Variations

A huge number of glazed bricks at Susa and all the glazed bricks from Persepolis are siliceous bricks with a mixture of sand and lime that have been fired up to three times for making the brick, its painting and glaze (Caubet 1992, 223; Haerinck 1997, 30). Achaemenid bricks from Babylon are also made from the same material (Haerinck 1973, 118) and other bricks from Borsippa (more seem to be Achaemenid than Neo-Babylonian) are clay baked bricks (Reade 1986, 110, pl. 15a-b). Usually the designs on the glazed bricks are outlined with a black paste and then they received the rest of the paint and the glaze. Probably the bricks had a preliminary coating on their surface.

They were produced in different shapes due to their function. For forming a panel with a number of bricks, the architects needed to use mortar and sometimes asphalt, to join the bricks. Because each brick is a part of a scene and the fragments had to join together closely, if mortar was applied then a gap was made between the bricks and the scene would stretch. Also without mortar, the wall could not be erected. For solving this problem, the upper surface of each brick was made in a wedged shape with a slipped surface

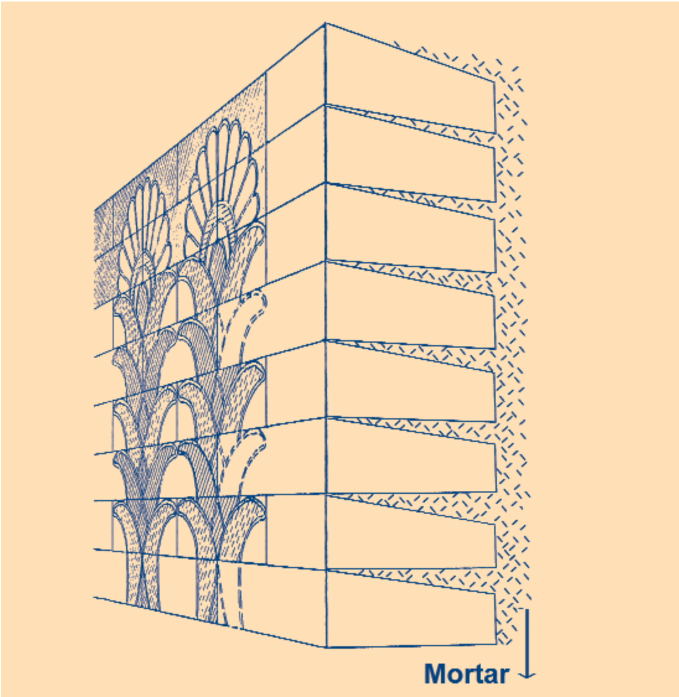

Fig. 3: A section of a glazed brick frieze with a provided space for mortar; drawing by Sh. Razmjou.

on the top. Then the outside edges of each brick could join to other brick and in behind there was enough space, provided for the mortar (Fig. 3). But in the case of other bricks like some inscribed bricks, there was no need to do so. Because each of those was a separate register and they could have a thin layer of mortar in between and also on the facade. Therefore they were made in a normal rectangular shape of a brick.

Some other forms of glazed bricks were produced as a pavement or as top of stepped-shape parapets that had four decorated lateral sides. These types of bricks were attached only with their lower surface.

Place of Their Usage

Because the glazed bricks at Susa might have been used in a lower level on the palace walls, they have to be designed from the beginning of designing the palace. They are not ornaments but they are clearly bricks that were placed in the wall.

According to excavators at Persepolis, such as Schmidt, the broken fragments of glazed bricks were found in the area between the southeast tower of the Apadana palace and the northwest of the Tripylon Gate (Schmidt 1953, 77-78). Scholars thought they might be the decorating façade of the Apadana towers at the top and they were scattered in that area after the collapse of the tower (Schmidt 1953, 78). Persepolis is located in a mountain region and still receives huge amount of rain and snow every year starting from the autumn. The size of the water channels of the Persepolis palaces shows that they have been designed to flow away a huge amount of water from the roof. But some would think if glazed bricks were used outside a building on the façade, they would apparently have received damage after few times of raining. Because they are decorative architectural elements and were designed to be used in the structure, they could easily damage the whole building and could not resist much against the water. This is caused by a different climate comparing to Babylon. But mud-bricks were also used for the walls and they could have the same problem. Therefore we should think about a strong mortar or a strong covering material for mud-brick façade, which could resist such condition. But the glazed bricks could stand with their glaze against the rain and protect the colours and the wall.

From the other point of view glazed bricks were not used for an internal space of towers, since they could have a minimum view. The size of drawing lines shows that they were designed to be visible from a distance. By considering all these facts we may suggest that possibly the glazed bricks might have been used on the façade of the towers, both outside and under the portico which was a roofed and covered area and was also more protected from the rain and snow.

To compare this with Susa, we have no evidence to prove the same situation for the Susian glazed bricks, which are also iconographical different from Persepolis.

At Susa, because of some problems like reusing the glazed bricks in later periods, many of them have not been found in their archaeological context. A few remnants of the friezes were found at their original site, but their location is still problematic. Some fragments have a smaller size and due to this we may suggest that they might have been used closer to the ground level or even used at the sides of the walls above the floor.

There are different suggestions about positions of the glazed bricks at Susa. Some of those belong to staircases. The famous sphinxes might have been used in between of two window frames, on pilasters or lunettes above windows or doors (Caubet 1992, 224), or even inside niches (Fig. 4). The Susian guards were found in an area near the entrance of the palace in the West Side of the cour est (Mecquenem 1938, 323-324) and the cour ouest with griffins and winged bulls (Muscarella 1992, 217).

Dating

The exact date for starting major architectural projects at Susa is not clear enough, but it must have started after the second year of

Darius the Great, when he had gained the control of the whole Empire. A fragment of a glazed brick can be a piece belonging to another Bisotun relief that was made for Susa in glazed bricks (Canby 1979, 315-320, Tab. 50). This fragment can be dated to 521-520 BC (Muscarella 1992, 218, No. 2) or even 519 BC because preparing a building until its finishing, designing its decorations and inviting artists needed a longer procedure.

Before completion of the palaces at Susa, Darius decided to start a new project at his ancestral homeland Pars (Ghirshman 1964, 147). Then perhaps the artists, who worked on the Susian workshops for producing glazed bricks, were moved to Persepolis to start a new project. This can be understood from hundreds of fragments of glazed bricks found at Persepolis, which are made exactly in the same style like Susa. The sizes, shapes, methods and techniques are the same, even the architectural signs for positioning the bricks. Unlike the stone sculptors of Susa were not the same people working at Persepolis, because their style and techniques are entirely different.

But for glazed bricks, this is a good evidence for dating parallel bricks. Artaxerxes II informs us that the royal palaces were burned in a fire in the reign of his grandfather Artaxerxes I and he has rebuilt the palaces again (Kent 1953, 154). Therefore the glazed bricks may be recognised as the products of the time of Artaxerxes II and not Darius, because the bricks had been destroyed in the fire (Ghirshman 1964, 140, 142).

At Persepolis we know that the glazed bricks belong to the time of Darius (Muscarella 1992, 218) and Xerxes, there is no evidence for such activity of Artaxerxes II at Persepolis. By comparing different aspects of the glazed bricks we can see how close and parallel they are. It is unlikely that the whole friezes were reproduced after such a long time, exactly as it was before.

It is now widely accepted that the famous glazed bricks of Susa are probably made at the time of Darius the Great and belong to the 6th to early 5th century BC. A number of the glazed brick fragments must have been made at the time of Artaxerxes II. His palace at Shaur had stone reliefs and painted walls (Labrouse & Boucharlat 1972, 83; Boucharlat 1997, pl. 14-15), this shows that he had used other ways for decorating his royal palaces. After the reign of Artaxerxes II we have no evidence for using glazed bricks in Achaemenid buildings. Probably the Achaemenids could make more bricks in the same way, time to time to repair the damaged bricks.

Babylon

In Babylon many Achaemenid glazed bricks were found by R. Koldeway (1914, 104 f.). The exterior walls of a columned palace probably made by Darius at Babylon, was decorated with the glazed bricks and had images of the so-called "Immortal" (Susian) guards (Koldeway 1931, pl. 39; Haerinck 1997, 29). They represent two types of glazed bricks: relief and flat (*Ibid*) and they show guards, cuneiform inscriptions, floral and geometrical designs (Haerinck 1997, 29-30, also Haerinck 1973, 118f.). Some of the guards are made in life-size and some are made half life-size (Haerinck 1997, 29).

Fig. 4: Frieze showing winged sphinxes and a winged disc, Susa, late 6th century BC, Louvre; Photo: DBM, M. Schicht.

The glazed bricks from Borsippa (Reade 1986, pl. 15a) have parallel designs with Susa and more likely were produced in the Persian Period.

Images and Iconography

Susa has the most varied images of the glazed bricks. They are made in relief and flat bricks. The images at Susa include floral patterns, geometrical designs, human figures and mythological creatures. Few designs look like Babylonian images on glazed bricks, but details are totally different. Also some designs are new images with no iconographical background in Mesopotamian art.

There is a fragment showing heads of roaring lions, repeated on the margin of a brick (Fig. 5). This motive is an Iranian motive and is more related to a northern origin (Muscarella 1992, 230). Parallel examples from Ur in Mesopotamia are dated back to Achaemenid period as well (Kantor 1957, 8-9). They appear in Achaemenid period on textile work, ornaments, seal impressions, coins and reliefs[4]. The polychrome bricks of the so-called Susian archers (or the Immortals) are another example for repeating motives. They are represented in a row or a repeating procession, now believed toward a central panel with royal inscriptions (Caubet 1992, 224) (Fig. 6). Some fragments with the hands of the "Immortals" join to an inscribed frame (Koldeway 1931, pl. 39a-I). Their dresses are shown in whole details, with patterns, designs and colours. Some designs are floral and some other represents three towers or a fortification on a hill in a square frame. Their skin is painted in dark brown. It is still not clear if they represent Susian guards with a darker skin, or the paint has been changed to brown by some reasons. But there are also other fragments that show faces in pink (Muscarella 1992, 233-234, pl. 161-162).

Perhaps during this time some trainees were also joined to the group of artisans in Susa and moved later with them to Persepolis. But it is hard to suggest why they did not produced human and animal figures at Persepolis. Perhaps in Persepolis it was easier to represent these images in stone reliefs.

In general the glazed bricks have an independent style with some inventions in iconography and style that is typical Achaemenid.

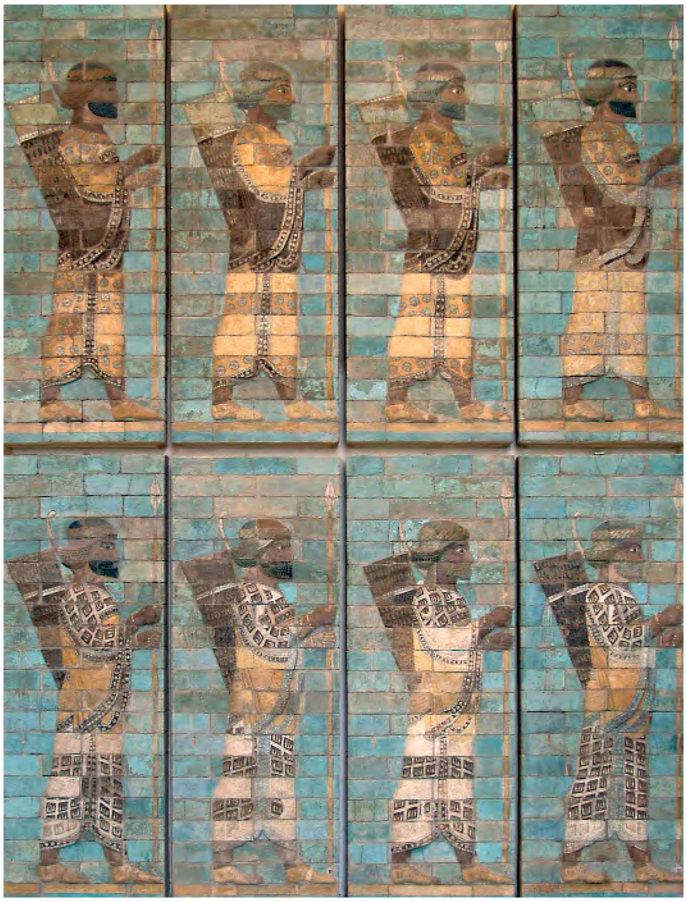

Fig. 6: A frieze of Susian guards, Susa, late 6th century BC, Louvre; Photo: DBM: M. Schicht.

Fig. 5: A glazed tile with lion heads, Susa, late 6th to early 5th century BC, Louvre; Photo: DBM, M. Schicht.

Signs

Achaemenid artisans used signs and markings on each brick in order to organise various fragments correctly and to create a complete panel. These signs are different and they are a kind of architectural sign. In Achaemenid architecture architects adjust each piece correctly with the other used some similar signs (Fig. 7). In Babylon, like Susa and Persepolis such markings are reported by Koldeway for the glazed bricks (Koldeway 1914, 104-105, Fig. 65). The signs in all places include linear signs with a combination of circles and lines. They are drawn on the upper surface of each brick with black ink or glaze or blue and greenish paint.

Colours

Achaemenid glazed bricks have a range of colours both on flat and relief bricksand are protected under the layer of glaze. The colours that can be found on the bricks from Susa and Persepolis are white, yellow, green, brown, blue, greenish blue, lapis-lazuli blue, pink and black. But surprisingly there is no red colour. In Babylon the colours used for the glazed bricks are white, blue, yellow, green, brown and black, but no red colour again (Haerinck 1997, 30). Red colour was widely used for stone reliefs, floors and some columns in the palaces and was made of cinnabar[5]. But it was not common to use it in glazed bricks. According Koldeway there is also a pink colour on the bricks from Babylon that was applied as skin colour that reminds those at Susa (Koldeway 1914, Fig. 64).

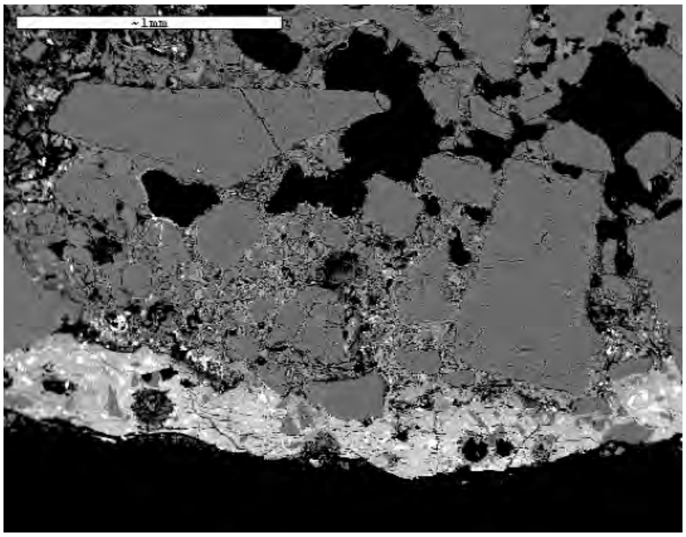

Fig. 8: SEM photomicrograph of glazed Susa brick fragment showing, from bottom to top, glaze layer (light grey) containing a scatter of lead antimonite particles (white) and body consisting of coarse quartz particles (dark grey) bonded together by partially fused feldspar and clay phases (mottled grey).

Report on the scientific examination of a glazed brick from Susa: Glazes[6]

Mike S. Tite & A. J Shortland

Introduction

Four fragments from a single glazed brick from Susa dating to the Achaemenid period were available for scientific examination. These fragments provided two areas of yellow glaze, two of white glaze and one of green glaze.

Fig. 7: An architectural sign on the upper part of a glazed brick from Susa; Photo: National Museum of Iran.

Polished sections through the glaze and body were prepared and were examined in a scanning electron microscope (SEM) with attached energy dispersive spectrometer (EDS) for x-ray analysis. The SEM was operated in backscatter mode so that the different phases present could be identified on the basis of their atomic number contrast, higher atomic number phases appearing brighter in the SEM image. The bulk chemical compositions of the glazes and bodies were estimated from EDS analyses of areas, respectively, some 150x150 μm^2 and 1x1 mm^2 (Fig. 8). For individual phases within the glazes and bodies, the area of analysis was reduced as appropriate. The small areas of unweathered glaze located in the green glaze sample were also analysed using wavelength dispersive spectrometry (WDS) using a 15 µm diameter spot size. In addition to the SEM examination, a small sample was removed from the white glaze for x-ray diffraction analysis (XRD).

Results

The bodies of the Susa bricks consist mainly of coarse, angular particles of quartz, up to about 1 mm across, that are bonded together by partially fused feldspar and clay phases (Fig. 9 & 10). In addition, adjacent to the yellow and green glazes, the bodies contain occasional lead-rich and soda+lead-rich regions respecti-

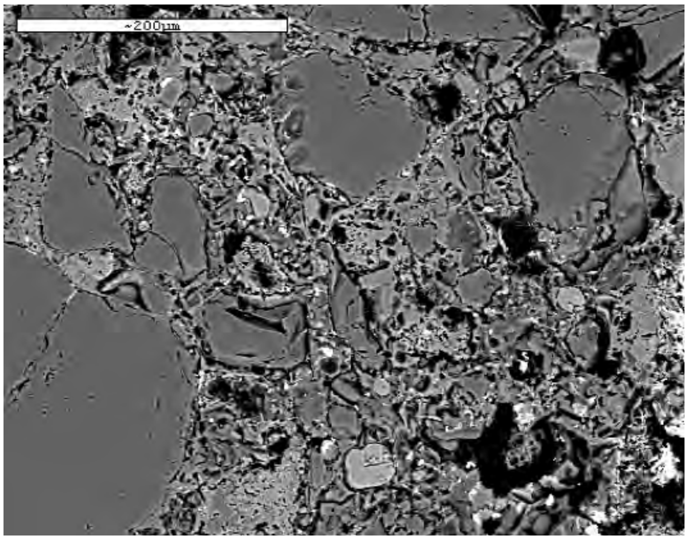

Fig. 9: SEM photomicrograph of glazed Susa brick fragment showing body with partially fused feldspar and clay phases (light grey) bonding together quartz particles (dark grey).

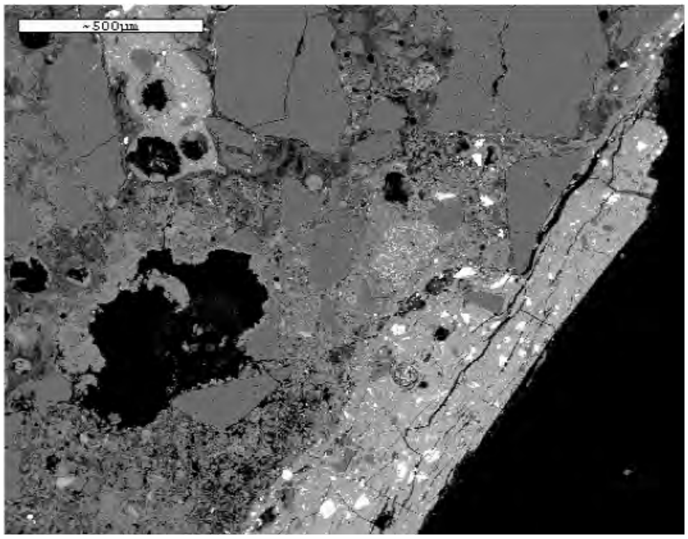

Fig. 10: SEM photomicrograph of glazed Susa brick fragment showing, from right to left, glaze layer (light grey) containing a scatter of lead antimonite particles (white) and body consisting of coarse quartz particles (dark grey) with fragment derived from the applied glazing mixture (light grey with white particles) at top left.

vely which probably represent fragments derived from the applied glazing mixture (Fig. 11).

Both the cracked appearance of the glazes in the SEM and the low alkali contents obtained for their bulk compositions indicate that the Susa glazes are all highly weathered. However, analyses of the small areas of unweathered glaze located in the green glaze sample indicated a soda-rich glaze containing only low concentrations of lime and magnesia, but a high lead oxide content. The green colour of this glaze was achieved through a combination of copper oxide which, by itself, would have produced a turquoise blue glaze and yellow lead antimonite particles which also acted to opacify the glaze. The yellow glaze was similarly opacified by lead antimonite particles (Fig. 9 & 11). XRD analysis indicated that the white glaze was opacified by sodium antimonite ($NaSbO_3$) particles (Fig. 12).

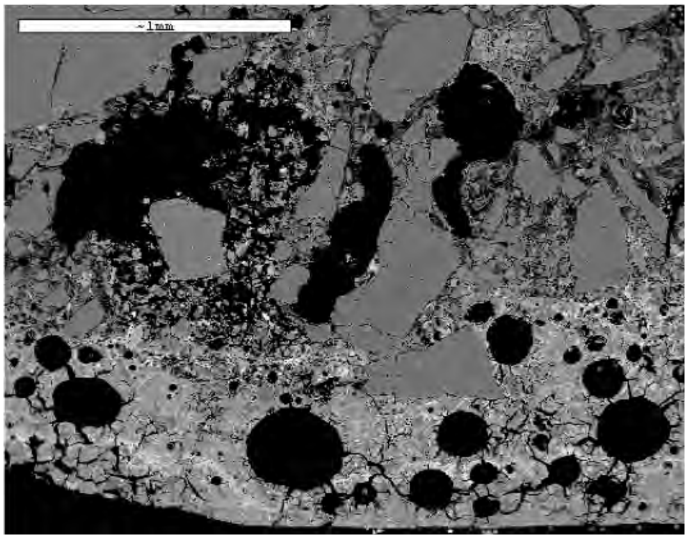

Fig. 11: SEM photomicrograph of glazed Susa brick fragment showing, from bottom to top, glaze layer (light grey) containing a scatter of sodium antimonite particles (white) and body consisting of coarse quartz particles (dark grey) bonded together by partially fused feldspar and clay phases (mottled grey).

Discussion

Caubert & Kaczmarczyk (1998) also found that glazed bricks from the palace of Darius 1st (522-486 BC) at Susa consisted mainly of coarse, angular quartz particles, their bulk compositions, as determined by inductively coupled plasma spectrometry (ICP), being similar to those observed in the present study (Fig. 8). This contrasts with earlier glazed wall plaques from the Neo-Assyrian sites of Nimrud, Ba'shiqa and Arban (Freestone 1991) and glazed bricks from the Ishtar Gate and Processional Way at Babylon (Matson 1986), all of which were produced using calcareous clays, typically containing 15-20% CaO.

Caubert & Kaczmarczyk (1998) do not provide quantitative analyses for their Susa glazes. However, Matson (1986) analysed the glazes from Babylon using an electron microprobe with WDS, and established, on the basis of their high analytical totals, that they were essentially unweathered. These Babylonian glazes are of the soda-lime type and contain significantly higher concentrations of

Iranproben 3359/04-3366/04 Glasuren
REM-EDX, Elementanalyse

measurement	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19									
sample	3359/04 (IR 6/1)			3360/04 (IR 6/2)				3361/04 (IR 6/3)			3362/0 (IR 6/4)			3363/04 (IR-6/5)												R-6/8)		
formula		black			yellow			pale green				brown			dark blue													
Na2O	5	5	5	1		1		1	1	1	1	1	1	2	2	1	1		1									
MgO	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2												
Al2O3	1	1	1	1	1	1	1	4	4	4	1	2	3	2	1	1	1	1	1									
SiO2	76	79	75	70	70	78	74	56	54	49	78	81	80	69	70	67	6											
P2O5	0																			1				1			1	1
SO2	1	1	1	1							1	1	2	1	2	1												
Cl	1			1							1		1	1														
K2O	3	3	3	2	1	2	2	4	3	3	1	1	1	3	2	3												
CaO	4	4	4	3	3	3	2	3	3	4	12	8	7	6	6	8												
MnO											2	2	2															
FeO	6	6	7	6	9	6	4	3	4	3	1	2	2	10	9	11	1											
CoO														3	2	2	3	1	1	1	1							
CuO	2		2					3	2	2				3	3	3												
Sb2O3					3		4	9	11	14															4	4	3	3
PbO				16	13	8	12	15	17	19																		

Fig. 12: Semiquantitative analyses of eight glazes from Susa. 3 to 4 single measurements were taken from one sample. Tin was not detected in any of the samples. All values in wt. %. IR-6/1 etc. are inventory numbers of the Deutsches Bergbau-Museum; 3359/04 etc. are archaeological inventory numbers.

lime and magnesia than those of the unweathered green glaze from Susa (Fig. 8). Thus, the Babylonian glazes fall firmly within the Near Eastern tradition of soda-lime glazes produced from crushed quartz pebbles and soda-rich plant ash derived from saline plants. This type of glaze was first introduced with the beginnings of glass production around 1500 BC (Paynter & Tite 2001) and continued in use through into the Islamic period. The Susa glaze therefore appears to differ slightly from this tradition in using a plant ash with significantly lower lime and magnesia contents, a difference that would have been a factor in increasing its susceptibility to weathering. Further, although glazes opacified with lead antimonite are expected to contain lead oxide in excess of that required to produce lead antimonite, the lead content of the Susa glaze appears to be higher than normally observed, and is certainly significantly higher than that in the yellow Babylonian glazes.

The identification of sodium antimonite as the white opacifier in the Susa glazes was initially unexpected. Without having access to XRD, Caubet & Kaczmarcyzk (1998) had suggested that the white opacifier used in their Susa glazes was calcium antimonite. In addition, using XRD, Fitz (1983) identified calcium antimonite as the white opacifier in the glazes from the Ishtar Gate and Processional Way at Babylon. However, in view of the very low lime content of the Susa glazes (typically less than 2% CaO), the formation of sodium antimonite, rather than calcium antimonite, when antimony oxide is included in the glaze mixture is perhaps not surprising.

Conclusions

The glazed bricks from Susa represent a development from the established technology for glazed brick production in the Near East in a number of different ways. First, a high quartz body has replaced the earlier calcareous clay bodies. Second, the glazes, although within the soda-lime glaze tradition, appear to have used a plant ash with lower lime and magnesia contents, and to have increased the excess of lead oxide over that required for the production of the lead antimonite. Third, probably because of their low lime content, the white glazes were opacified using sodium antimonite rather than the expected calcium antimonite.

Report on the Scientific Examination of a glazed brick from Susa: Colours

Marion Jung & Andreas Hauptmann

Introduction

We received eight additional samples of glazes. These were taken from several bricks from the palace of Darius in Susa, dated to the beginning of the 5th century BC. They showed eight different colours: black, white, yellow, brown, azure, dark blue, light green and turquoise.

As the samples were very crumbly and fine grained they were not suitable for making thin section for detailed analyses under the scanning electron microscope (SEM) as performed by Tite & Shortland (see above). Hence, we decided to analyse the samples by X-ray diffraction and to present semi quantitative spot analyses made under the SEM by EDS.

Results

According to the results found by Tite & Shortland the X-ray diffraction analyses revealed that all the samples contain quartz (SiO_2) as a main component. Additionally, calcite ($CaCO_3$), gypsum ($CaSO_4 \bullet 2 H_2O$), and in one case (3366/04; IR-6/8) trona ($Na_3(HCO_3)_2 \bullet 2 H_2O$) was found. Naturally, any proportions of glass were not detected with this method. Gypsum and trona are considered to have been formed by decomposition of the glaze by weathering processes ("Wetterstein"). As it is known that this, in general, leads to a leaching of alkalis, we may not exclude that also concentrations of K_2O are incorporated in the calcite, in the gypsum and in the trona.

The SEM analyses of the glazes are pretty homogeneous. Note, that no tin was detected in the samples which is well known as an opacifier of glass. It seems not to have been used at Susa in this period.

3359/04 (IR-6/1): black glaze

Main components are SiO_2 (75-80 wt. %), Na_2O (5 wt. %), CaO (4 wt. %), K_2O (3 wt. %) and indicate the glaze to be made up of a soda-potash-lime-glass. In addition, it contains 6-7 wt. % of Fe-oxide, most probably as magnetite (Fe_3O_4) which caused the black colour and masked a blue tint caused by Cu-oxide (2 wt. %). No antimony was detected in this sample. Hence, no sodium antimonite has to be expected as a white opacifier as observed by Tite & Shortland.

3360/04 (IR-6/2): yellow glaze (four analyses)

The glaze is predominantly made up by 8-16 wt. % PbO, 70-78 wt. % SiO_2 and 4-9 wt. % Fe-oxide. This is a typical lead glaze. Such glazes are characterised by low melting points and low viscosities that cause a glossy smooth and well fused surface. As the glaze is yellow we suggest that the colouring agent was lead antimonite ($Pb_2Sb_2O_7$) which also acted as an opacifier.

3361/04 (IR-6/3): turquoise green (three analyses)

Again, the glaze consists of a lead glass with 15-19 wt. % PbO. In contrast to sample 6/2 it is considerably higher in Sb_2O_3 (9-14 wt. %) but, nevertheless, is not of a yellow colour. Probably it is marked by Cu-oxide (2-3 wt. %), and most of the lead antimonite acted to opacify the glass.

3362/04 (IR-6/4): brown (three analyses)

The glassy matrix is made up by SiO_2 (78-81 wt. %) and CaO (7-12 wt. %). MgO is like in the other samples 1 wt. %. It is the only sample that contains Mn-oxide (2 wt. %) which, along with some iron-oxide (1-2 wt. %) detected, is the reason for the brownish stain of the glaze by $(Mn, Fe)_2O_3$.

3363/04 (IR-6/5): dark blue (four analyses)

The glass is a Ca-silicate with 2-3 wt. % potash and 1-2 wt. % sodium while MgO is only slightly higher than in the first four samples. Fe-oxide is around 10 wt.%. Colouring agents are Cu-oxide (3-4 wt. %) and Co-oxide (2-3 wt. %), probably as a Co-spinel ($CoAl_2O_4$).

3364/04 (IR-6/6): turquoise (four analyses)

The composition of the glass is almost identical to sample 6/5. Colouring agents are again Cu- and Co-oxide, but with lower concentrations of Co.

3365/04 (IR-6/7): blue (three analyses)

The glaze consists of a Ca-silicate (SiO_2 76-78 wt. %, CaO 6-8 wt. %) with a little MgO (1-2 wt. %) and K_2O (1 wt. %). The blue colour of the glaze is caused by Cu-oxide which reaches 8 wt. %. No Co was detected in the sample.

3366/04 (IR-6/8): white (four analyses)

The sample contains the highest SiO_2 concentration of all samples (83-85 wt. %), followed by CaO (5-7 wt. %). K_2O is at 1 wt. %, Na_2O partly below 1 wt. %. Sb-oxide is between 3 and 4 wt. %. The white colour most probably was caused by sodium antimonite ($NaSbO_3$) and confirms the observation made by Tite & Shortland (see above) which, according to X-ray diffraction was partly decomposed to Na-carbonate by weathering.

Discussion

The analyses of the glazes from the bricks in Susa performed by the scanning electron microscope do not reflect the original composition. Due to considerable leaching most of the alkalis (Na_2O, K_2O) are removed from the silicate and are replaced by water (hydratisation). "Wetterstein" was formed by corrosion.

According to Wedepohl (2003), most of the glass (and glazes) were manufactured until the late 1st millennium BC by mixing quartz and ashes from plants. Main components of such ashes are calcium carbonate ($CaCO_3$) und potash carbonate (K_2CO_3) if plants from terrestrial vegetation is utilised. If ashes from halophytes are used then sodium carbonate (Na_2CO_3) is a predominating oxide. In any case, $MgCO_3$ is a minor constituent. If heated, carbonates from the ashes are reacting with quartz and are forming silicates while carbon dioxide evaporates. Glasses or glazes made in such a way are high in SiO_2 and contain oxides of Ca, Na, K and Mg. We observe a slightly higher level of K_2O compared to sodium Na_2O, but this does not qualify to decide if the glazes were made from halyphytes or not. What concerns CaO, it is comparable to the analyses by Tite & Shortland. Two of the glazes, a yellow and a green one, were made of lead silicate (3360, 3361).

In the glazes, the following colouring agents were identified: antimony, lead, copper, manganese, iron and cobalt. The yellow colour is caused by Sb-compounds with Ca and Pb, while Na-antimonite leads to a white colour. The light blue and greenish colour is most probably caused by Cu_2+-ions. Perhaps some spots may be coloured by a crystallisation of Egyptian Blue ($CaCuSi_3O_{10}$), but this would need high Cu-concentrations and would opacify the glaze.

The dark blue and light blue coloured samples are of special interest due to their cobalt contents which are based on the addition of special ores. Co-deposits are much rarer than those of copper or even antimony. Also in Iran cobalt ores are rare. Possible sources could be traced at the mines at Qamsar near Kāshān (Th. Stöllner in Pernicka, this volume) or perhaps in Azarbaidjan (Moorey 1994, 191).

Notes

1 For the date see: Potts 1999, 328.
2 For this fragment see: Muscarella 1992, Fig. 164.
3 Ibid: 73-75, pls: XVIII-XIX; Razmjou 2004, forthcoming: Decorative Glazed Pegs with Eye Symbol from Chogha Zanbil. Images from Chogha-Zanbil.
4 Kantor 1957, 8-11, Fig. 6, pl. 6B-C, for coins see: Meshorer & Qedar 1999, 112, No. 156-159.
5 Based on test results from the Smithsonian, a forthcoming paper by the author and Janet Douglas.
6 While preparing the exhibition in Bochum the question arose why not to analyse some of the colours and glazes from the Susa bricks. In collaboration with the National Museum of Iran, Tehrān, and the Deutsches Bergbau-Museum, Bochum, colour and brick samples where collected. While the bricks were analysed in Oxford to provide more information about glazing techniques, the DBM carried out work for a better understanding of the colouring devices.

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Pre-Islamic Quarry- and Stone-Technology in Iran

Dietrich Huff

In the course of history quarries have always been of greater significance only where stone-architecture and big sculptures were widely common. This is mostly true for Egypt and the ancient Mediterranean cultures. For Iran, instead, the older Oriental way of building with mud-bricks was predominant, since the younger antiquity replenished walls with mortar – and partly this has not changed until recently. Only by way of building rock-reliefs, which probably was influenced by Mesopotamian examples, handling stone partly found its way into the Western borderlands of Iran.

But there are two periods in the Iranian history, when – without any preceeding development – stone dominated the Iranian prestigious architecture. These periods, from when some technologically remarkable quarries are preserved, are: the Achaemenid and the Sasanian period, *i.e.* the time from 559 to 330 BC and the time from 224 to 651 AD. But only the West of the Iranian highlands, with the residencies of the kings, is concerned, and surely it is not coincidental that it was in these periods when the Iranian rulers were most intensively trying to prove their military but also their cultural superiority to their Western neighbours. Doing this, both architecture and fine arts created much more than copies. It is true that the techniques, which had been developed in the Western cultures, were used – partly by employing hired specialists or those who had become prisoners of war. But the definitely Iranian setting of work and the guidelines for the design always created results which were distinctively Iranian.

The outstanding stone-building-projects, for which also quarries can be proved, are Pasargadae, the residency of the first great king, Cyrus II, and Persepolis, Achaemenid residency since Darius I (522-486 BC). In the time of the Sasanian dynasty there were stone-projects in the early period, particularly under Shapur I (240-272 AD) in the Southwest, i.e. in Khuzestan and Fars, in the late period under Khosrow I (531-579 AD) and Khosrow II (591-628 AD) in the Northwest of the empire, in Kurdistan, Azarbaidjan, and in the Caucasus.

Cuneiform scripts give evidence to the fact that for building the Achaemenid kings' residencies craftsmen from all parts of the multiracial state worked there, among them also inhabitants of the Greek provinces. Economic experts name Ionians, Karians, and Syrians as employees (Cameron 1948, 11, 14; Kent 1953, 144 § 45-49). Additionally, the short but self-confident inscriptions by a certain Pytharchos and a certain Nikon in the quarry-region of Kuh-e Rahmat above the terrace of the palace of Persepolis show that their position was not at all inferior, compared to other workers. It is not clear, if also the allegedly four thousand lamentable Greek prisoners of war had been sentenced to hard labour who, according to Curtius Rufus' (V, 17-19) dramatic tale, they came out of Persepolis to meet Alexander the Great and therefore were mutilated and branded. As the majority of them rejected Alexander's offer to take them back home, not only because of shame but also because of the families they had founded abroad, it is likely that they also had been integrated at least into the lowest part of Persian society.

For the basic work in the quarries and for basic masons' work probably mostly native workers were employed. Though the highly developed Urartean techniques of handling stone were not continued by the early Medes and Persians it is well likely that basic skills of handling rock had always been available in a mountainous country like Iran, and we may presume that in case of demand also native skilled workers were trained in a short time. It is not likely that Greek masons were needed for clearing away the huge masses of rock in the Tang-e Bulaghi, when the road connection between Pasargadae and Persepolis was built (Stronach 1978, 166-167, pl. 142-144). In contrast to that many of the mason's signs at those buildings, which are ascribed to Cyrus, are very close to symbols on Anatolian and Eastern Greek coins and seals and to Lydian mason's signs at Sardes. Thus we may conclude that the earliest Achaemenid building activities were decisively influenced by craftsmen from Ionia and from the Hellenistic Western provinces of the Cyrus-empire in Anatolia (Stronach

Fig. 1: Pasargadae, Terrace of the palace Tall-i Takht, Greek technique of stonework; Photo: D. Huff.

1978, 121-123). Many of these mason's signs were used in Iran until Safawidian times.

Also the method of building during Cyrus' era is very close to Western methods. The terrace of the palace at Tall-Takht, the Zendan-Suleiman, and Cyrus' mausoleum at Pasargadae, as well as the copies of the latter two buildings at Naqsh-i Rostam show pseudo-isodome masonry and straight layers of equally high ashlars (Nylander 1970, 58-99; Stronach 1978, 11-43) (Fig. 1). But building Cyrus' halls at Pasargadae, and at the buildings at Persepolis since the time of Darius I, the typical Achaemenid method of building developed with almost no exception: gigantic, partly monolithic components were individually cut and then used as frames of windows and niches. Columns were not put together by standardised short parts but by shaft-parts which sometimes were more than 8 m long. When at Pasargadae steps and other parts are worked separately as units of the same kind, according to their function (Stronach 1966, 15-20), then at Persepolis they were cut and laid from huge blocks or plates like from natural rock (Herzfeld 1941, 238, pl. 49-50) (Fig. 2). Even the terrace of the palace at Persepolis is – in contrast to Pasargadae – provided with an almost gigantic wall made of individually cut blocks of various size and shape (Herzfeld 1941, 238-242, pl. 49-50) (Fig. 3). It is a surprising phenomenon that the rationalization of work by help of using standardised components was abandoned in favour of an

Fig. 2: Hussein Kuh at Naqsh-i Rostam; Achaemenid surface quarry; Photo: D. Huff.

Fig.3: Persepolis, stairway to the terrace of the palace with stone columns, lintels and frames. Mud brick walls are vanished. The wall of the terrace is made of irregular Achaemenid ashlars; Photo: D. Huff.

archaic-looking and megalithic method of building which Herzfeld (1941, 238) compared to sculpturing. He thought that the production of especially huge and long components was due to avoiding as much as possible the laborious precision work of making absolutely fitting surfaces (Herzfeld 1942, 237). But we should also take into consideration the clients' and constructors' general attitude, which was influenced by the deeply rooted tradition of building with mud-bricks, so that complete stone walls were obviously out of the question. We must not forget that the overwhelming majority of the walls at Pasargadae and Persepolis – even in the case of most prestigious buildings – consisted of mud-bricks. Away from supporting walls, stone was used only for doors, windows, and steps, which were decorated with reliefs and other decorations, and for extremely high columns which could not longer be made of trunks (Fig. 4). There was no necessity for the mass production of standardised components like stones for walls.

But in the field of craftsmanship, those techniques, which under Cyrus had been imported from the masons in the Eastern Mediter-

Fig. 4: Persepolis, quarry underneath Kuh-Rahmat, uncompleted bullhead capital; Photo: D. Huff.

Fig. 5: Persepolis, in lead encapsulated iron staples, located in swallowtail-shaped holes; different techniques of visible and covered stone-surfaces; Photo: D. Huff.

Fig. 6: Persepolis, chiselling of a damaged spot to integrate a work piece; Photo: D. Huff.

Fig. 7: Bishapur, quarry underneath the Sasanian fortress. Making of blocks by using wedges for splitting with wedge-furrows and wedge-holes. Above later Zoroastrian platforms to expose the bodies; Photo: D. Huff.

ranean countries and which had reached its peak in those days, were not given up. At Persepolis, the methods of handling stone and of preparing surfaces, the polishing and the setting of the stones, including anathyrosis, bracing by help of iron staples which were swallowtail-shaped or parallel and supported by lead, is of outstanding quality which even in later times was never outdone (Tilia 1968, pl. 6-17, 40-65) (Fig. 5). The tool-marks on the workpieces, though they are not always clear, basically show those variants of pickhammers, flathammers, and chisels which are still used today and whose most simple types had been used locally, while the rest had been brought by the hired master craftsmen (Wulff 1966, 127-130) (Fig. 6). Particularly one tool – the hammer tooth ("Zahnhammer") – which had been developed in Greece as late as around the mid of the 6th century and whose traces are rare at Pasargadae, was increasingly used at Persepolis. Together with the pay-rolls, the Greek autographs at the quarries, and Greek letters as mason's signs, the traces of hammer teeth clearly indicate the activities of Western masons during Darius' I rule and after, or at least of those who had been trained in the West (Tilia 1968, 68ff.; 1969, 33-35; Nylander 1970, 23-35).

The fact that Greek craftsmen or those from the West introduced methods of quarrying at Achaemenid quarries and that Pytharchos and Nikon were working there later – whatever their function was – becomes evident from the methods of clearing the rock from sideways and of breaking it from the ground, which have been known for a long time from the ancient Western world and which have now been found to have been done perfectly in Iran. Breaking off and cutting huge blocks was done by wedging, which is evident from wedge-furrows or from rows of wedge-holes and their traces (Fig. 7). Obviously it is not possible to clearly decide how the wedging was done. The general opinion is that the breaking off was done by setting wooden wedges into the wedge-holes and letting them swell by pouring in water (Nylander 1968, 6-9). But others think of a faster and more effective method: metal wedges, which are supposed to have been driven in all at the same time (Röder 1965, 515-516). A third method – pushing the workpiece to the side by driving in tilted timber – would have been especially useful in this case, as will be shown below. But for the time being there is no evidence for this (Röder 1965, 515 fig. 28).

In the Achaemenid quarries the raster-shaped traces of equally-sized big ashlars of the same pattern, which are quarried on the whole surface, are completely missing. The limited need for smaller stones was unsystematically covered from rock-benches and isolated blocks of rock. The typical Achaemenid type of quarry was created by a method of quarrying which was perfectly adjusted to the need for large, high and wide blanks. Vertical slices of rock were cleared at all sides and then at the bottom they were broken

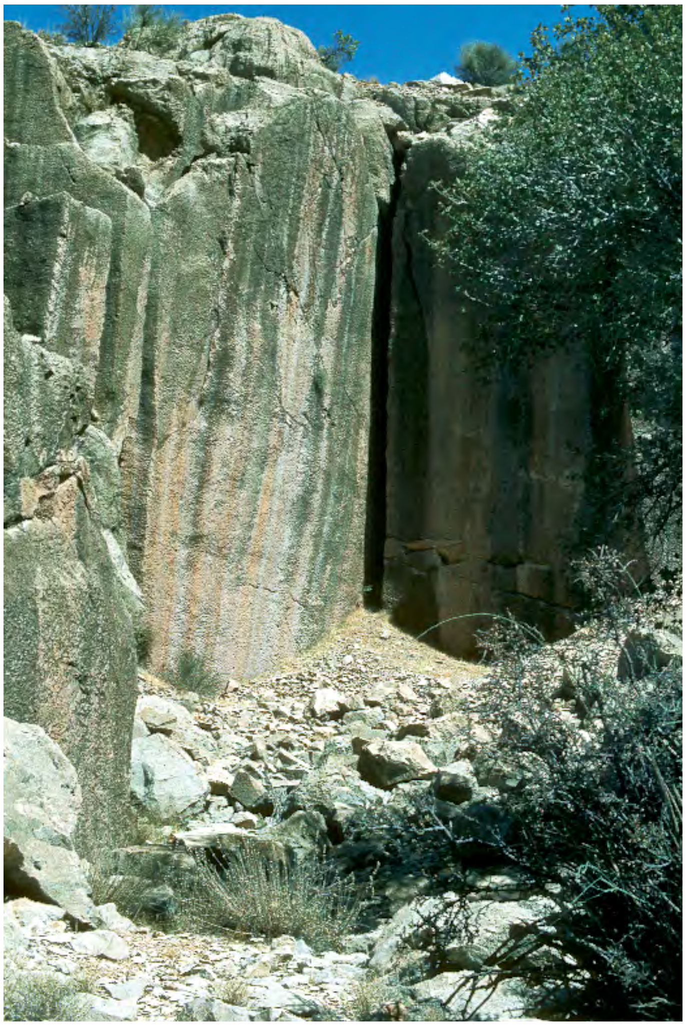

Fig. 8: Sivand, cut of the quarry into the rock; in order to get large monolithic blocks; photo: D. Huff.

that was in front of the façade, was quarried by way of several horizontal segments, of which only the highest, at the adoration-relief, was finished. The overburden-bench was used as a working platform for chiselling the relief. At the second segment – on the level of the entrance-front, on which work was never started – the rock is partly quarried but also part of it is still there in the form of slices of rock standing parallel to the front of the grave like a wood of steles. Obviously at first some gravel-trenches were hoed, being 40 to 60 cm wide and 1 to 2.5 m away from each other, which ran parallel to the front of the grave and were 4 to 5 m deep. Then the slices of rock in between were cut into the necessary length. After some slices had been taken out, work was stopped (Tilia 1968, fig. 35-36; Kleiss & Calmeyer 1975, fig. 2-3 tabl. 14-15).

Much bigger and more impressive quarries of a similar chamber-like type are up in the mountains between Persepolis and Pasargadae, near Sivand. Here also, like at the rock-grave, at first a cut was driven into the rising slope, but then it was widened to the right and to the left inside the mountain (Fig. 8). Due to this, monumental, hall-like chambers were accidentally created, the original cut being a central gate, through which the roughly hewed workpieces were taken away. One slice of rock, which was cleared at the side panel, shows that the gravel-trench, which again is only c. 60 cm wide, was hewed out to the bottom of the quarry, i.e. c. 10 m, and that the complete slice was supposed to be torn down as one piece. As the floor of the quarry is filled with rubble, the horizontal wedge-holes, which were needed for breaking off, can only be presumed. If the cramped and dangerous conditions in the trench are taken into consideration, here the use of swelling wooden wedges or the already mentioned method of pressing away the slice by help of driving horizontally tilted timber into the upper zone of the trench seems likely (Röder 1965, 515, fig. 28).

Two shafts of columns in one chamber of the quarry, which are lying alongside each other and are roughly hewn but not broken off alongside the strata of the bed of rock by help of wedge-holes. This method was the best possible way concerning work-techniques, but it led to the fact that the strata-structure of the components, which were quarried in this way – mostly high components, like the shafts of columns, door panels, or wall plates with cut out windows – was not any longer alongside the bed but vertical, after they had been built in. This was the reason for higher proneness to weathering, i.e. vertical cracks and pieces breaking away on the whole surface (Krefter 1967, 432).

A special case of an Achaemenid quarry, which besides the typical method of quarrying also demonstrates the pragmatic connection of quarrying stone and rock-architecture, being typical for later periods of Iranian history, is the unfinished royal grave south of the terrace of the palace at Persepolis (Kleiss & Calmeyer 1975, 83-85). Here, like in the case of other royal graves at Persepolis, for building a vertical front it had been necessary to drive a deep and wide cut into the side of a diagonally sloping foothill. The rock,

Fig. 9: Sivand; blanks of columns in the quarry, prepared while lying; Photo: D. Huff.

Fig. 10: Bishapur, "Valerian's prison", stonework with ashlars done in Roman technique. The lead was stolen to make bullets; Photo: D. Huff.

off from the ground, demonstrate how long components in particular were cleared out of the rock, while lying down (Fig. 9). Compared to making and moving short, vertical parts, this doubtlessly is the easier way. The damage, resulting from the fact that the structure of the strata was wrong after the component had been built in and which today causes serious problems with the conservation particularly of the fluted columns at Persepolis, could either not be foreseen in those days or maybe nobody cared.

The most striking type of quarry, which characterises the view of Achaemenid quarries in the most definite way and which may be called a surface quarry, basically shows the same principle of quarrying, but it has no defined side-marks and is less deep. Parallel ploughshares from gravel-trenches and slices of rock between them, mostly being 1 to 2 m thick, cover the whole surface of profitable rock benches, or they form blocks on them. They are especially well preserved above the two rock-ossuaries at Naqsh-i Rostam, which were wrongly interpreted as fire-altars, and between the other rock-grave monuments of this biggest Zoroastric necropolis of the Sasanian period (Schmidt 1940, pl. 11A; Calmeyer 1990, 187, fig. 2). Necropolises in the areas of abandoned quarries are a phenomenon which is also seen in other cultures. Here on the Hussein Kuh, the rock-graves of the Achaemenid kings at the South-Eastern cliff doubtlessly were the focal point of this mostly misunderstood necropolis (Trümpelmann 1984; Huff 1988, 152; 2004, 209-210).

Surface quarries are also further to the West, at the Northern rim of the Persepolis-lowlands, where they supplied the Achaemenid dam-buildings on the river Kur with stones (Bergner 1937, 1-3, fig. 2, tabl. 1-8). They are also found at Madjdabad (Calmeyer 1990, tabl. 14, 1, col. Tabl. A) and, if only some traces, in the quarry-area which of all was exploited most extensively, the environment of the terrace of the palace at Persepolis, where every kind of quarrying is found (Herzfeld 1942, pl. 46, 50; Schmidt 1953, fig. 25, pl. 2B, 4, 5, 18B).

To get stones of special quality, obviously long ways were accepted. Especially dark limestone, as it was used for special components at Persepolis, Naqsh-i Rostam, and Pasargadae, seems to have come from quarries at the Kuh-e Sabz, near Madjdabad, a ridge in the midst of the Persepolis-lowlands (Tilia 1968, 77, fig. 27, 28; Calmeyer 1990, 186). Concerning the conspicuously bright stone, which was used for the columns and ashlars at Pasargadae, it is presumed that the material came from the 50 km away quarries at Sivand (Sami 1971, 49-50; Tilia 1968, 68-69).

It looks paradoxical that just during the Seleucian-Parthian period, when Hellenistic influence was strong, stone architecture was restricted to a few columns and barbarized capitals, and that it had its revival only under the then following Sasanian dynasty which saw itself as the revivalist of the traditions of the old Iran that had been destroyed by Alexander. The Takht-i Nishin throne, in the round town of Ardashir Khurreh/Firuzabad – probably the ruin of the first fire-temple which was built by Ardashir I, the founder of his dynasty (224-240 AD) – is a building made of ashlars, solidly done layer upon layer and showing a perfect version of the Hellenistic-Roman method of building, with iron staples which were supported by lead. As also the system of measurement, which was used for the ground plan, seems to be the Roman foot instead of the Oriental cubit used for others of Ardashir's buildings, in this case a Western master craftsman may be presumed. The mason's signs on the other hand indicate a mostly native group of craftsmen. The quarry, which supplied this single building, is not known (Huff 1972, 525-540).

Under Ardashir's son Shapur I extensive programmes for building with natural stone were started after his repeated victories over Roman armies, when big numbers of Roman prisoners of war – trained engineers among them – were at hand for ambitious building projects. The huge buildings of canals, dams, and bridges in Khuzestan, some of them still in use today, are dated into this period. The name Band-e Qaisar, emperor's dam, reminds to the emperor Valerian who is supposed to have been captured by Shapur I himself in 260 AD. At Shushtar there are some quarries on the right banks of the river, next to the bridge-dam, where rock-benches on the steep banks, which were covered by soft conglomerate, were also quarried underground in big caves (Roggen 1905, 176). On the left banks, outside the city, there are extensive quarries which were exploited on the whole surface and are easy to see. But it seems as if especially here small sized ashlars for the foundations of the town houses have been quarried until recently. One cube of rock, c. 4 m high, was left standing in the centre of the area, showing a rectangular room in the interior and reminding to a command centre. If its upper margin shows the original level of the area, it is as uncertain as its function and the time of its construction. More quarries are at the road from Shushtar to Ahwaz (Kleiss 1981, 197-198). Also at Shushtar the quarries were used as a necropolis in later times; the cliffs of the small valleys, which criss-cross the area, hide innumerous burial chambers.

The quarries at Bishapur – Shapur's royal seat – are less disfigured by later settlement than Shushtar. They are located on the rocky slopes of the mountains, which make the North-Eastern border of the town, below the walls of the fortress and stretch on both sides of the gorge which is famous for the reliefs of Shapur and his successors. They show the typical rational, raster-like quarrying of blocks, which were c. 70 cm high and c. 75 to 100 cm wide, and which – starting from the edge of a steep slope – were broken off from the ground by help of horizontal wedge holes or rather wedges, in this case probably made of metal wedges. On the surface the outlines of the blocks were defined by gravel trenches, which were only 20 cm wide and varying in depth, in a way that the deeper ones are parallel to the front working edge. Vertical wedge holes for dividing the next block are driven into the bottom of those gravel trenches which run rectangular to the working edge and are only 15 cm deep (Huff 1994, 34, fig. 3-4).

The necropolises, which are also found in the quarries at Bishapur, are of special interest as obviously they offer a view on the Zoroastric custom of abandoning corpses. On blocks of rock and on rock benches, flat, sarcophagus-like graves were chiselled out where probably the dead stayed in the open until wild animals had eaten the transient tissue. Fragments of lids, which were found at Bishapur, and other technical details of the graves allow to presume that they were then closed. Embossed platforms, which are only a few centimetres above the rocky ground, seem to have been a more simple version of such places of abandoning, where the dead were laid down for decarnation. Also in this case we cannot rule out the possibility that later the platforms were covered by a hollowed lid-stone (Ghirshman 1971, pl. 7, 34; Huff 1988, 167, fig. 12; 2004, 595-596, tabl. 9, 16).

Like the quarries, also some of the buildings at Bishapur – among them the hall which is called "Valerian's prison", though without any real evidence – show perfect Roman craftsmanship (Fig. 10): stonework made of ashlars with well integrated casting cores and finely trimmed edges (Ghirshman 1971, 133-141, pl. 40,1). The bridge piers of the numerous Sassanidian river-bridges in the West of Iran are made in the same way.

But as early as at Bishapur there are signs for the differences from the standard of Western methods of building with stone, which are typical for late Sasanian architecture. Huge pieces of columns, though used secondarily in Islamic times, are provided with pedestals which are massively mortised (Fig. 12). The outer walls of the

Fig. 11: Derbent, Sasanian quarry in Dagestan at the Caspian-Sea; today partly under water; Photo: D. Huff.

Fig.12: Bishapur, Sasanian pieces of columns bearing traces of mortice dowel joints; reused in early Islamic buildings; Photo: D. Huff.

square, so called Anahita-temple are made of excellent ashlar stonework, but the walls of the surrounding, vaulted corridors are made of hewn stone and mortar (Ghirshman 1962, 149, fig. 189-191). C. 30 years after Shapur, his son Narseh (293-302 AD) erected the tower-like monument of Paikuli, which on the outside must have been similar to the still well preserved tower of Nurabad near Bishapur from Shapur's time, but whose formwork has completely fallen off due to the fact that it was not integrated into the core (Herzfeld 1924; Huff 1975, 179-192).

This approach of not using the formwork as an integrated part of the construction but of using it as a prestigious surface gets more and more typical – with very few exceptions – for the few building programs during the late golden age of the Sasanian empire, for which stone was used. The comparison of two fortifications shows typical features, as for both the constant succession of headers and stretchers is used to create a decorative effect. Both are Sasanian "official buildings" but belong to different cultures. The stone walls of Derbent, probably erected by Khosrow I (531-579 AD) on the Western shores of the Caspian Sea to fortify the North-Western frontier, was doubtlessly built from huge, well dovetailed and mortared blocks by native craftsmen from the Caucasus and master craftsmen from the Armenian-Georgian-Dagestan or Roman-Minor Asian building tradition. The big quarries can be seen on the shores and in the waters of the Caspian Sea which today are higher than they once were (Kudrjavcev & Gadziev 2001, 340-341) (Fig. 11). Under Khosrow II (591-628 AD) at the latest, and obviously following this optical example, the Gushnasp fire-sanctuary, which is Takht-i Suleiman today and which was especially

Fig.13: Takht-i Suleiman, Sasanian southeast gate, medieval repair of the towers; Photo: Th. Stöllner.

Fig. 14: Kangavar/Qasr al-Luslus, staircase to the terrace of the late Sasanian palace; in front a column with capital, remnant of the arcades of the terrace; Photo: D. Huff.

connected to the Sasanian royal family, was provided with a surrounding stone wall, on the outside looking like the one at Derbent but built in the now fashionable Persian building tradition: for the formwork, stone plates, which are only 20-30 cm thick, are successively set as stretchers and headers, the stretchers partly held by slight notches at the heads of the headers (Fig. 13). Behind this there is a package of hewn stone with plaster mortar. This very rational method was disadvantageous, as the plates of the stretchers, which were only insufficiently held by the heads of the headers, have mostly fallen off. Traces of a quarry similar to those at Bishapur where found on the plateau of a travertine cone right south of the sanctuary (Osten & Naumann 1961, fig. 3, 39-53).

The originally most impressive stone building in Iran, the ruin at Kangavar, the medieval Qasr al-Luslus, castle of the thieves, which for a long time was misunderstood to have been a Seleucian-Parthian Anahita-temple, is also provided with a terrace-wall which was set at a core of hewn stone and mortar to form a façade. Today there is no doubt that medieval chronicles were right when calling this building, which was famous for being almost without joins, one of the Khosrow's or of Khosrow's II palaces (Schwarz 1969, 494-497). Here the core of the wall is a self-stabilizing, steep embankment of massive hewn stone and mortar. In front of this, the façade was built from smaller blocks of stone at the bottom and more and more bigger blocks upwards (Fig. 14). The wedge-shaped upside down construction looks risky but at least parts of it are completely preserved, including the shafts of the columns which were standing on it.

Like at Persepolis, parallel to the façade there are opposed flights of stairs whose ends are made in the form of monolithic blocks with 2 to 5 steps. Also the joins of the façade, which is not consequently layered and shows projections and individually set ashlars, is appropriate to the Achaemenid predecessor. Also the round pillars, which due to their diameter of c. 1.40 m and their shaft-length of 2.35 m cannot be called columns, were not produced according to a standardised pattern but individually. If the demanded length could not be achieved when making the shaft, the missing piece was added to the pedestal or the capital. Though, according to the chronicles, the palace was not finished, obviously no workpieces have yet been found. The quarries in the nearby Chehel Maran-massif are known but not yet investigated (Kambakhsh-Fard 1971, 22; Azarnoush 1981, 71-94).

Fig.: 15: The quarry Tarash-e Farhad near Bisotun with its 200 m long and 40 m high smoothed rock above the trees; Photo: D. Huff.

A comparison of early and latest Sasanian stone-techniques, as they are best preserved at Bishapur and at Kangavar, shows a course of development which is surprisingly similar to that of the Achaemenid period. In both cases, doubtlessly in the beginning there is an import of techniques from the Western neighbouring regions, mostly from Eastern Mediterranean countries which were influenced by Greek and Roman culture. Then follows a fast and thorough rejection of economic and analytic ways of production and manufacturing, the Sasanian craftsmen's conscious or unconscious recourse to the basically megalithic way of working with stone, as it had been typical for the Achaemenid period, being characteristic for the strong traditional ties of Iranian culture in general. The formal changes are similarly drastic. If some of the capitals and pedestals at Bishapur could almost be taken for Roman style, then the columns or rather pillars at Kangavar, which were obviously derived from Doric, Ionian, and Corinthian order, caused a century of confusion within the research on the history of arts (Schippmann 1971, 300-308).

The fact that at the same time, together with transforming older Western influence, also during the late Sasanian period new ideas from the West were taken over again and again, is shown by the capitals at Kermanshah and Bisotun (Herzfeld 1920, 104-121, tabl. 55-60) which are decorated with Iranian motifs but whose contours remind to the basket-capitals ("Korbkapitell") of the late antiquity. Obviously for the small monument of Taq-e Girre even an imported Syrian horseshoe-arch ("Hufeisenbogen") was used. But all in all, stone only played a marginal role also in Sasanian architecture. It was not without reason that the stone-architecture at Kangavar is so deeply admired by the old chronicles. The common material, also for prestigious buildings, was mortar-masonry of brick or hewn stone with a decoratively styled stucco surface. The buildings on the terrace at Kangavar were made of brick.

Thus on first sight it is surprising that just during the last period of Sasanian rule the biggest and most impressive quarry in Iran was started. It is known as Tarash-e Farhad, and mythology says that it was the unsuccessful attempt of Khosrow's II builder, Farhad, to tunnel the mountain of Bisotun in order to gain Shirin's hand (Fig. 15). But the quarry, located c. 300 m West of Darius' relief at Bisotun, was not primarily started for quarrying blocks of stone, similar to the unfinished royal grave at Persepolis. Here,

Fig. 16: Taq-i Bustan near Kermanshah, reliefs and iwan-grots; Photo: D. Huff.

probably under Khosrow II, the idea was to smooth out the rock for almost 200 m of length and 40 m of height and to build a terrace in front of it, which was supposed to be 140 m below. We may well presume that here the last great Sasanian ruler intended to exceed the relief and inscription of his predecessor Darius who in those days had already become a myth. We may only speculate about what was to be made here – reliefs, inscriptions, caves like at nearby Taq-i Bustan.

Due to the numerous traces of work this half-finished dismantling attracted the attention of research as early as in the 19th century (Morgan 1896, 287f.). The quarrying of rock-slices, rising step by step, is demonstrated by the graduation of gravel trenches which are behind each other on different levels. Even more difficult than making a vertically even surface was making a horizontally even surface, due to the extension of the project and the uneven cross-profile of the cliff. Partly the work had to be driven forward deeply into the rock. Even in the present state, far from achieving an upright and even back wall, there are undercuts of up to 5 m at the upper edge, almost 40 m high. The vertically quarried rock-slices are usually about 1.20 m thick. C. 60 cm of this was the stone, which was needed as building material, and another 60 cm was due to the gravel trench behind, being up to 1.70 m deep. Where it was necessary to straighten the edge, mostly the gravel trench was widened. Obviously a certain norm was demanded. In what way the material was broken off, which was standing in front of the trench like a parapet when the trench was deep enough, cannot be clearly recognised from the traces of work. The situation is similar to the huge Achaemenid chamber-quarries at Sivand. Breaking off by help of horizontally set metal wedges looks difficult in narrow trenches; it seems possible by help of swelling wooden wedges but there is no evidence for this. Thus also here pressing off by help of slightly tilted timber is taken into consideration (Salzmann 1976, 122).

The stone material was partly used for the supporting wall of the terrace below the surface, in the form of roughly hewn stone. Works premises on the scree slope in front of the cliff are evident from damps of stone chippings and from stones which are roughly hewn to ashlars. Single ashlars are used for the supporting wall which had to reach a height of 37 m – 15 m wide at the bottom – if it was supposed to be built up to surface level without landings. It is not clear if also other projects – e.g. the piers of the bridge over the river Gamasiab which is just opposite and at least was finished, and other traces of Sasanian building activities in the lowlands – were supplied with ashlars. Other quarries were found 15 km South of Bisotun which perhaps supplied the capitals at Bisotun with bright limestone. At any case a big part of the ashlars, which were quarried at the place, were re-used for the so called Old Caravanserai, an early Islamic robat, or military camp, which is evident from the same mason's signs at the various sites at Bisotun (Kleiss & Calmeyer 1996, 131-145). There are also similarities to masons' signs at Kangavar, Takht-i Suleiman, and Derbent.

At Harsin, 34 km South-East of Bisotun, there is an also unfinished but much smaller quarry (Huff 1985, 19-37). Below the foothill of a mountain, which was inhabited as early as in prehistoric times, there comes out a spring which is abundant in water and has several outlets. Above this and following the contours of the rock, a terrace was built partly by building a wall, partly by quarrying. The bigger part of the surface – 50 m long and up to 10 m deep – was finished and a uniform level was reached. In the smaller, Western area work was stopped on two horizontal steps. The quarrying was done on the whole surface by hoeing out flat gravel-trenches and breaking out the rock between them. Neatly chiselled wedge holes cannot be seen, obviously in the end only hewn stone was quarried which was easily broken off from the rugged cliff. The cleared cliff was revised hand in hand with the quarrying by using chisels and hammers, so that a somewhat even surface was made, though the horizontal steps are still there.

This place was obviously part of a huge park. Right in front of the terrace a round water basin with a central pedestal was hewed into the rock. Huge parts of stones and blocks of ashlars show that not only hewn stone was quarried. A three-stepped block is done like the step blocks at Kangavar, and a stone table, which is 4.80 long and 2.55 m wide with an arched door-hole of 2.55 m height, remind to the monolithic windows at Persepolis. Fragments of monolithic channels confirm Rawlinson's description (1839, 110f.) from the first half of the 19th century, who in his days still saw the remnants of workstones, the columns and capitals of a palace *c.* 500 m away. An aqueduct from the springs led to it. Concerning the moderately sized surface it may well be presumed that it was supposed to serve for reliefs and insciptions. The reliefs of the early Sasanian period had been built before at springs or watercourses. The nearby Taq-i Bustan offers the picture of a finished rock-construction, combining reliefs and iwan-caves (Fig. 16). It is likely that also the Taq-i Bustan was a quarry when work on it was started (Herzfeld 1920, 57-139).

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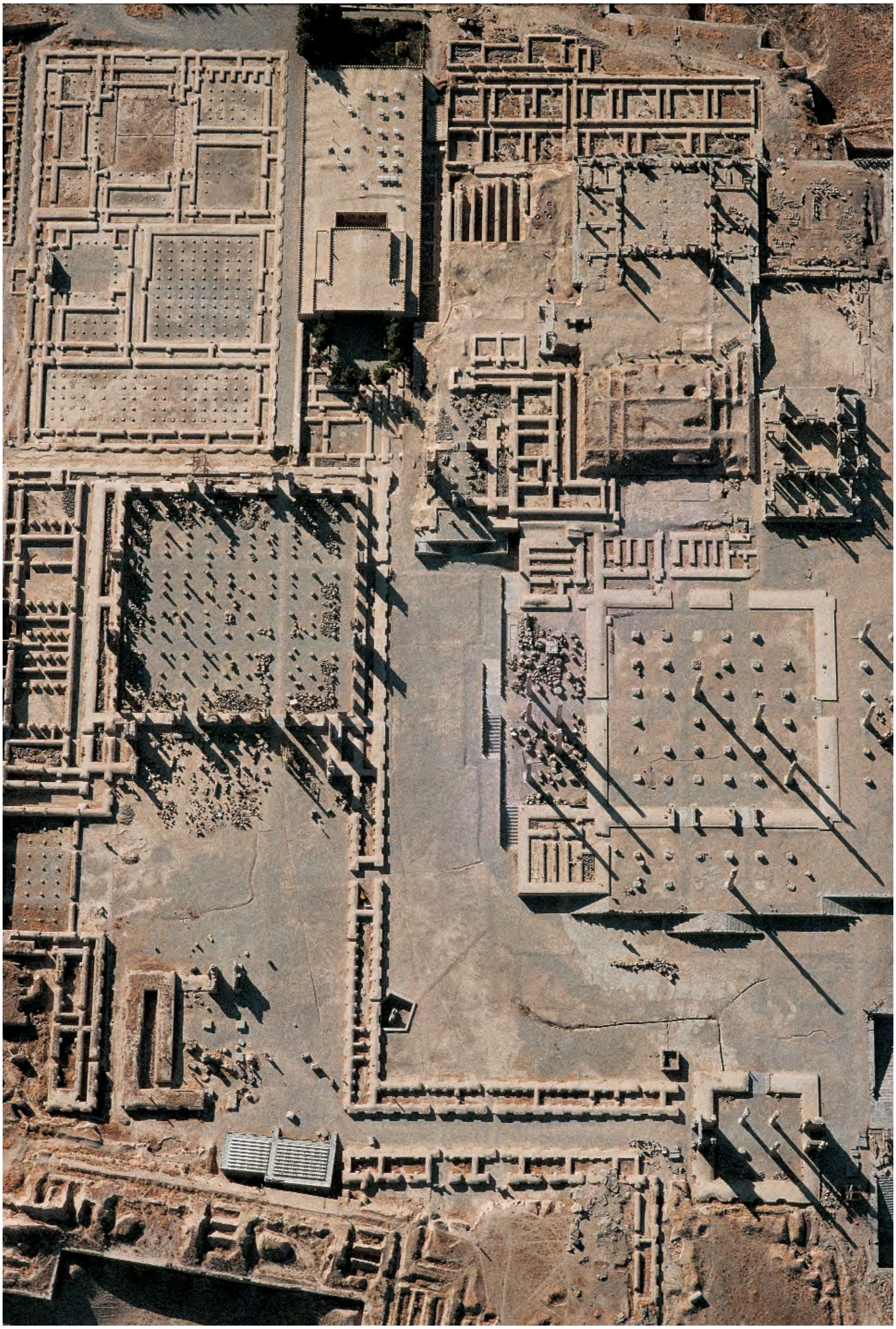
Takht-e Jamshid, the ancient Persepolis, residence of the Achaemenidian great kings in the plain of Marv Dasht near Shiraz. The photo from Gerster shows perfectly the layout of the ensemble.



Communicators between East and West: The Parthians

Josef Wiesehöfer

The Evidence on the Parthian Empire

Though there is numerous evidence on the Parthian empire, its meaningfulness varies (Boucharlat (publ.) 2002a; Wiesehöfer (publ. 1998). Concerning the written sources, the indigenous evidence from that time have priority, most of all: a) the more than 2000 Parthian ostraca (inscribed clay sherds) from Nisa (in modern Turkmenistan), notes of the provisional registration of deliveries to the palace which are important both for the science of onomastic and for the history of administration; b) the parchment documents and papyrus from Avroman (SW-Iranian Kurdistan) (in Greek and Parthian languages) and from Dura-Europos in Syria; c) the Parthian inscriptions from the Elymais (Southwest Iran), from Southern Kurdistan, Susa, and Eastern Iran; d) the Aramaic inscriptions from the Elymais as well as from Hatra and Assur in Northern Mesopotamia; e) the Greek inscriptions from Bisotun near Kermanshah in Iranian Kurdistan and from Susa as well as from the Parthian-Greek bilingual inscription on a Herakles statue from Seleucia on the Tigris (on the re-conquest of Charakene/Mesene 151 AD); f) the Babylonian documents in cuneiform writing, and g) the literary evidence in Greek language from the Parthian empire (Apollodoros from Artemita, Isidoros from Charax) (Fig. 1). To Western authors like Pompeius Trogus (1st century BC), Strabo (Augustus period), Tacitus (1st/2nd century AD) a. o. as well as to the Chinese historic works from the Han period we owe the (partly topic and `ideologic') view from the outside at the Parthian empire. In the Sasanian dominated Iranian tradition, information on the Parthians has only basically been preserved (there, the Parthians are depicted as powerless "minor kings" (Yarshater 1983)). Archaeological and numismatological tradition is at least as important as literary and inscripted tradition: Among the sites from the Parthian period in Iran, Nisa (near today's Turkmenian capital Ashchabad), Bisotun, and Tang-i Sarvak (Parthian reliefs) as well as Shami (sculptures, s. b.) are outstanding (Boucharlat 2002b; Colledge 1977; Curtis 1999; V. S. Curtis et al. 1998; Herrmann 1975; Seipel (publ.) 2000/2001). Concerning their depictions (e.g. portraits, diadem) and their Greek, later Parthian legends (titles, rulers' epitheta), coins (imperial, provincial, and local mintings) are as important (Sellwood 1980; Alram 1998). Roman official monuments (*e.g.* from the Augustean and Severean periods) express Parthian inferiority as well as Rome's seizure of the Oriental "counterworld".

History of the Parthians from Arsakes I to Artabanes IV (*c.* 250 BC to 224 AD) (Fig. 2)

When the Seleucians, Alexander the Great's successors in the territories between Western Anatolia and Eastern Iran, are weakened due to struggles with Ptolemeans and to struggles about the line of succession, Andragoras, the Satrap (provincial governor) of Parthia (in modern Turkmenistan/North-eastern Iran) renounces his sovereign, though without claiming the title of a king. But soon he dies fighting the semi-nomad Parni who after occupying the Northern parts of Parthia now gain control of further regions of this province.

Under their leader Arsakes, the new masters – soon they are called Parthians after their new home, their rulers are called Arsakides after the founder of the dynasty – also conquer Hyrkania and are able to hold their territories even when fighting Seleukos II. Also the so called `Parthian Era' refers to the phase of building the empire, counting from the 1st of Nisan (=April 14th), 247 BC. After having been forced to accept Seleucian rule for some time in the course of Antiochos's III, the Great (210-105 BC), eastern campaign, the Parthians renounce a second time and during the following decades – most of all under Mithridates I (171-139/8 BC) – they expand their rule as far as to Western Iran and Mesopotamia; at the same time they annex the so called Greek-Bactrian Empire

Fig. 1: Map of the most important sites and regions.

DATE	NAME
c. 247/238 – c. 217 v.Chr.	Arsakes I.
c. 217 – c. 191 v.Chr.	Arsakes II.
c. 191 – 176 v.Chr.	Phriapatios
176 – 171 v.Chr.	Phraates I.
171 – 139/8 v.Chr.	Mithradates I.
139/8 – 128 v.Chr.	Phraates II.
128 – 124/3 v.Chr.	Artabanos I.
124/3 – 88/7 v.Chr.	Mithradates II.
91/0 – 81/0 v.Chr.	Gotarzes I.
81/0 – 76/5 v.Chr.	Orodes I.
c. 78/7 – c. 71/0 v.Chr.	Sinatrukes
71/0 – c. 58/7 v.Chr.	Phraates III.
58/7 v.Chr.	Mithradates III.
58/7 – 38 v.Chr.	Orodes II.
38 – 2 v.Chr.	Phraates IV.
2 v. – 2 n.Chr.	Phraates V.
4 – 6 n.Chr.	Orodes III.
8/9 n.Chr.	Vonones I.
10/1 – 38 n.Chr.	Artabanos II.
38 – 45 n.Chr.	Vardanes
43/4 – 51 n.Chr.	Gotarzes II.
51 n.Chr.	Vonones II.
51 – 76/80 n.Chr.	Vologaises I.
77/8 – 108/9 n.Chr.	Pakoros
77/8 n.Chr.	Vologaises II.
79 – 81 n.Chr.	Artabanos III.
108/9 – 127/8 n.Chr.	Osroes
111/2 – 147/8 n.Chr.	Vologaises III.
147/8 – 191/2 n.Chr.	Vologaises IV.
191/2 – 207/8 n.Chr.	Vologaises V.
207/8 – 221/2 oder 227/8 n.Chr.	Vologaises VI.
213 – 224 n.Chr.	Artabanos IV.

which is centred in today's Northern Afghanistan. Mithridates II (124/3-88/7 BC) overcomes setbacks and once and for all secures the empire's supremacy in Iran and Mesopotamia. Due to their struggle with Armenia, now the Parthians come into the Romans' field of view: treaties with Lucullus (69 BC) and Pompeius (66 BC) define the common border to be on the Euphrates. Breaking the treaties by Crassus results in the devastating defeat at Karrhai (53 BC). After a planned campaign by Caesar was not carried out due to his murder and also the Parthian retaliation failed after short living success in Syria and Asia Minor (41-38 BC), Marcus Antonius tries his luck but has to retreat from Armenia and Media Atropatene in disgrace. Only Augustus is more lucky (20 BC): dynastic problems within the Arsakide House and Roman threats force the Parthian king, Phraates IV, to give back the Roman standards and to accept Roman supremacy over Armenia; the emperor, giving up on offensive Eastern policy on the other hand, has this treaty appropriately celebrated by word and picture like a great victory.

In the following decades, mostly Armenia's political status is the disputed point between Rome and the Parthian empire, as Armenia is desired by both powers due to its particular geopolitical location; several times the Roman emperors employ Phraates's IV descendants for their political goals, as they are in Rome (Fig. 3). Only the treaty of Rhandeia (63 AD), negotiated by Nero's and Vologaises's I envoys, solves the Armenian problem for some time: the kingdom there becomes a primogeniture under Roman supremacy;

Fig. 2: Parthian list of rulers.

Fig. 3: Parthian relief from Sar Pul-i Zuhab near Kermanshah; probably the investiture of the Parthian king Gotarzes II (43/4-51 AD); photo: R. Bartelmus.

Vologaises's brother Tiridates in an elaborated ceremony receives the insignia of the Armenian kingdom from Nero's hands in Rome. After another period of instable interior and foreign policy, the illegal action of the Arsakide Osroes in Armenia gives the Roman emperor Traian grounds for his great Eastern campaign (114-117 AD); though risings in Mesopotamia and elsewhere soon force the Princeps, who has pushed forward as far as to the Persian Gulf, on a retreat during which he dies. With great foresight, his successor Hadrian gives up on his predecessors new acquisitions and restricts his ambitions to securing the border on the Euphrates and his influence in Armenia. However, in Mesene (Southern Mesopotamia) a ruler of Arsakide descent, who is independent from the Parthian kings, holds out until 151 AD. Under Hadrian and his successor Antoninus Pius the Romans have intensive economic contacts to the neighbour in the East (s. b.). A Parthian attack on Armenia and Syria under Vologaises IV, which is at first successful, is answered by retaliation under Avidius Cassius (161-165 AD): the Parthian residency at Ktesiphon (near today's Baghdad) is captured, Northern Mesopotamia comes to Rome; however, an epidemic, which later will infect the whole empire, forces the Romans to retreat, involving heavy losses. Also the campaigns by the emperors Septimius Severus and Caracalla (after 195 AD) do not change the status quo ante of foreign policy despite temporary success; however, they seem to have enabled ambitious Parthian minor kings from the Persis to follow their own goals: during the first decades of the 3rd century AD, the Sasanians Pabag and Ardashir expand their territory to the entire Southwestern Iran; the latter finally succeeds with beating the last Arsakide Artabanos IV in battle on April 28th, 224. He kills him in this battle and himself seizes the throne of entire Iran (Schippmann 1980; Wolski 1993).

Parthian Monarchy and Parthian Aristocracy

The Arsakide monarchy shows an interesting mixture of older Parni, adapted Achaemenid, and adopted Hellenistic-Seleucian elements. *E.g.* the special relation between the royal house and the former Parni tribe or rather clan leaders (s. b.), which not always had positive effects on the empire as a whole, were pre-Parthian heritage. The idea of the power of the royal `brightness of luck' is owed to Iranian tradition; coronation and honouring the memory of the founder of the empire by donating an eternal flame and by taking on his name as official royal name, all these aspects express the idea of the power of inherited charisma. But the Arsakides also adopt – probably under Mithidates II – the Achaemenid title of "King of the Kings" and emphasize the genealogical closeness to their Iranian royal predecessors. After the first half of the 2nd century BC they are also inceasingly influenced by Hellenistic royal traditions: thus, they adopt e.g. for the legends of their coins and for their inscriptions the well known Hellenistic royal epitheta (for example: "the Just", "the Victorious" etc.), at first purposefully chosen and arranged, later rather formally listed. They even imitate the institution of the "Friends of the King" at court though without the Arsakide monarchy as a whole – in the sense of ideology – becoming the king's `personal power' like in the case of the Ptolemeans or the Seleucians; this is already prevented by the old privileges and the influence of the land owning aristocracy which is divided into ranks and is able to pursue independent policy in their territories by employing the "royal council", the privilege of coronation, and most of all their actual economic independence. The conflicts between the king and the aristocracy which is based on their followers and their estates, are each decided in favour of the one or the other side due to the king's personality, to the instruments of power (like mercenaries) at hand, to the ambitions of single chiefs or members of the royal house, and especially due to the situation of foreign policy. Often enough, also the king's and the aristocracy's interests are the same, often enough rivalries among the clan leaders offer new possibilities to the kings (Wiesehöfer 2003, 179-197, 360-363).

It is difficult to reconstruct from the evidence the ways of royal behaviour and appearance, at least we know that there were certain royal regalia and certain insignia of a ruler (such as the double-diadem), that – like in the case of the Achaemenides – hunting parties, banquets, and audiences offered the opportunity to the king to show his generosity. As far as the religious aspect of the ruler's legitimation is concerned, the ancient Iranian idea of the ruler enjoying the gods' grace continues to exist; but at the same time the Arsakide kings introduce themselves – probably under the influence of the Hellenistic royal tradition – as being material beings with divine features. It happens in their time that due to their attractiveness regarding the subject matter and their particular religious colour the Eastern Iranian heroic topics push away or superimpose almost all other traditions, something that results in genuine historic memory disappearing e.g. in South-western Iran, the home of their Achaemenid predecessors; at the same time in the Parthian period oral epic tradition expands, Arsakide princes and "vassals" and their glorious deeds are included. Bards make these topics popular at the kings' courts but also among the people (Yarshater 1983).

Especially the Romans occasionally experienced the fighting power of Parthian armies which was based on the well-rehearsed collective action of armoured Kataphract- (horse and rider both armored, the publishers) and light bowmen-cavalry. Famous but notorious is also the "Parthian shot", a hailstorm of arrows from mounted bowmen shooting backwards while pretending to flee (Wiesehöfer 2003, 197-204, 363-365)

Administration, Economy, and Military Organisation in the Parthian Empire

For the Roman author Plinius senior the Parthian empire seems to be an ensemble of "kingdoms". This description is a mixture of the correct observation of minor kingdoms which are financially and militarily dependent on the "King of Kings" but also enjoy considerable autonomy, and of the hint that these structures were responsible for the weakness of the empire as a whole. As a matter of fact, the "minor kings" now and then pursue their own policy but it is also true that the independence which is granted to them does not only help with saving the cultural variety of the single regions but that on the whole it definitely proves to be politically effective. Besides the "kingdoms", there were territories directly subjected to the empire, which according to Achaemenid-Seleucian tradition are administrated by "satraps" or "strategoi", as well as border territories protected by "margraves". As already mentioned, also the Parthian noblemen own gigantic estates in Iran; if, and if they were in what way, these estates had to pay taxes is something we do not know, however.

Of particular importance for the social and economic development of the empire are the towns, both the ancient, native ones – such as in Mesopotamia – and the Hellenistic and Parthian new foundations; usually, under the Arsakides they happen to experience a period of economic and cultural height. At some of them (most of all Seleucia-Ktesiphon and Ekbatana (today: Hamadan in South-western Iran)) also coins are struck for imperial and partly for local demand.

While we have only insufficient information about the agriculture of the Parthian empire, there is some information about East-West trade, transporting via Parthian territory goods from India and China on the Silk Road or via the Persian Gulf as far as to the great trade centres on the Eastern Mediterranean. Chinese annals from the Han period and other, not at last archaeological, evidence tell about the Romans importing mainly spices, flavourings, and precious stones as well as the famous silk from China by help of Parthian, Mesenian, and Palmyrian merchants; themselves supplying the East with most of all silver vessels, gold, and wine as well as linen. The Parthians import from China the famous "Serian iron" (steel) as well as apricots and peaches and export to her the "Parthian fruit", the pomegranate, additionally grapevines, lucerne, and probably horses, the latter together with the famous horses from Ferghana becoming famous in China as "heavenly".

Cults and Cultures in the Parthian Empire

If the Arsakide kings and the Iranian elite of their empire are personally followers of the Zoroastric faith, whatever the confession (Strausberg 2002, 192-204), all other cults are legal, indeed they often enjoy royal support. The Jews at their ancient places in Mesopotamia, which after the failure of the Bar Kochba rising becomes a centre of Jewish wisdom, enjoy particular appreciation. In the "vassal kingdom" of Adiabene, even the local king, Izates, together with his family converts to the Jewish faith. Beyond this, clay tables from Mesopotamia as well as early inscriptions by the Sasanians, being the Parthians' successors on Iranian soil after the 3rd century AD, and the Manichean tradition show the Arsakide empire as an empire where there lives a wealth of traditional or newly created religious communities: in the West Christian, Gnostic, and Baptist communities as well as followers of Babylonian, Arabian, and Iranian cults, in the East Hindus, Buddhists, Jainas. A well known "wanderer between the religious worlds" is An Shigao who in the year 148 AD appears at the court of the Chinese Han-emperor Huandi (146-168 AD) in Luoyang. His Chinese family name already indicates that he came to China from the Parthian empire (Chinese: Anxi) – maybe as a refugee. According to Chinese evidence he was a Parthian crown prince who had given up on the throne and dedicated his life to studying religion. This An Shigao became famous in China as the first known translator of Buddhist manuscripts into the Chinese language; those texts which can definitely be ascribed to him are all from the older Hinayana-school of Buddhism and are on techniques of meditation or on various numeric category theories. As translations they are not of high quality but they prove to be extraordinarily important for the history of research as they help with understanding the look of Buddhism in the 2nd century and as their language is rather close to colloquial than to literary Chinese of those years. It does not seem that An Shigao was – as has been thought for a long time – a prince of the Arsakide royal house in Ktesiphon but a member of a Parthian "vassal kingdom" in Eastern Iran, possibly at Merv or Buchara. From the fact that other Buddhist missionaries of those days came to China mostly from the kingdom of the Kushan, the Eastern neighbours of the Parthians, and that the texts which in those days were translated into Chinese by An Shigao and others had originally been written in the then frequent language of the Kushan kingdom, we may suggest that his home was near the Kushan territory.

Just like in the Achaemenid empire, also in the territory of the Arsakides many different languages are accepted to be spoken, many

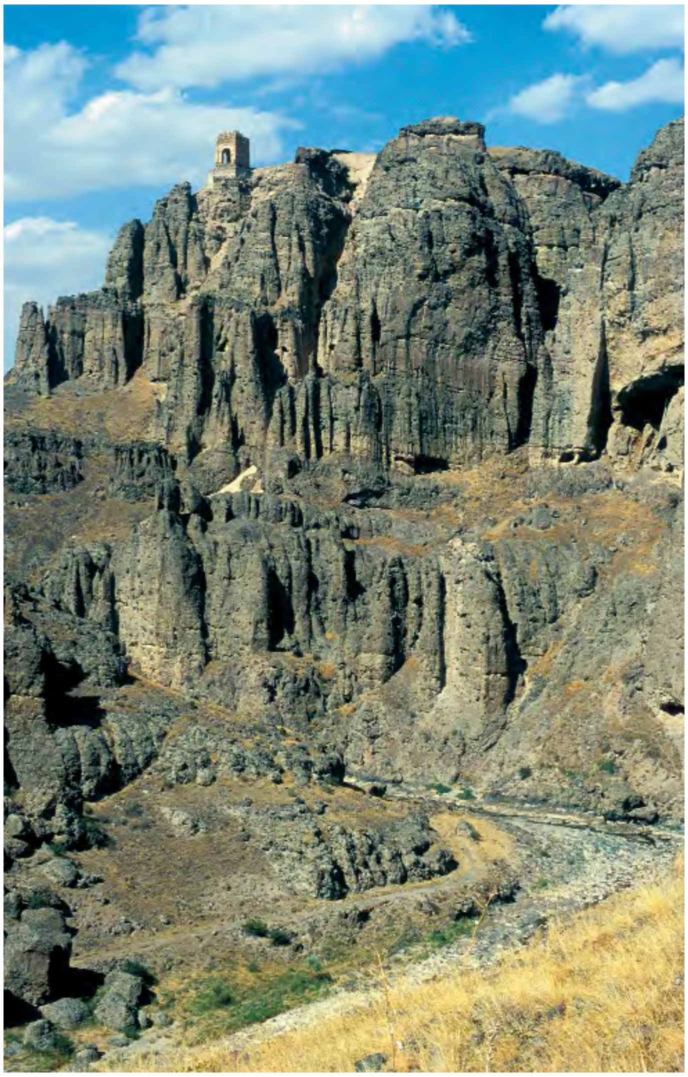


Fig. 4: Late Parthian pavilion Qalah-I Zuhhak in Iranian-Azarbaidjan, possibly a pavilion for hunting; photo: R. Bartelmus.

different writing systems are used and many cultural traditions are followed; this multi-culturality is also one reason for the Parthians' success. It is remarkable how open-minded they face even strange ideas, how they employ it, and how they design – *e.g.* in the field of the fine arts – their own ideas and foreign ideas to be something new in such a way that the original Parthian contribution is not easy to recognise. Most likely, this attribute may be deserved by the principle of frontality in three-dimensional fine arts, wear and jewellery, and by the iwans, brick buildings with rectangular rooms and sometimes gigantic vaulted constructions which – often covered by three-dimensional stucco decorations – mostly open at one side towards a central court (von Gall 1998).

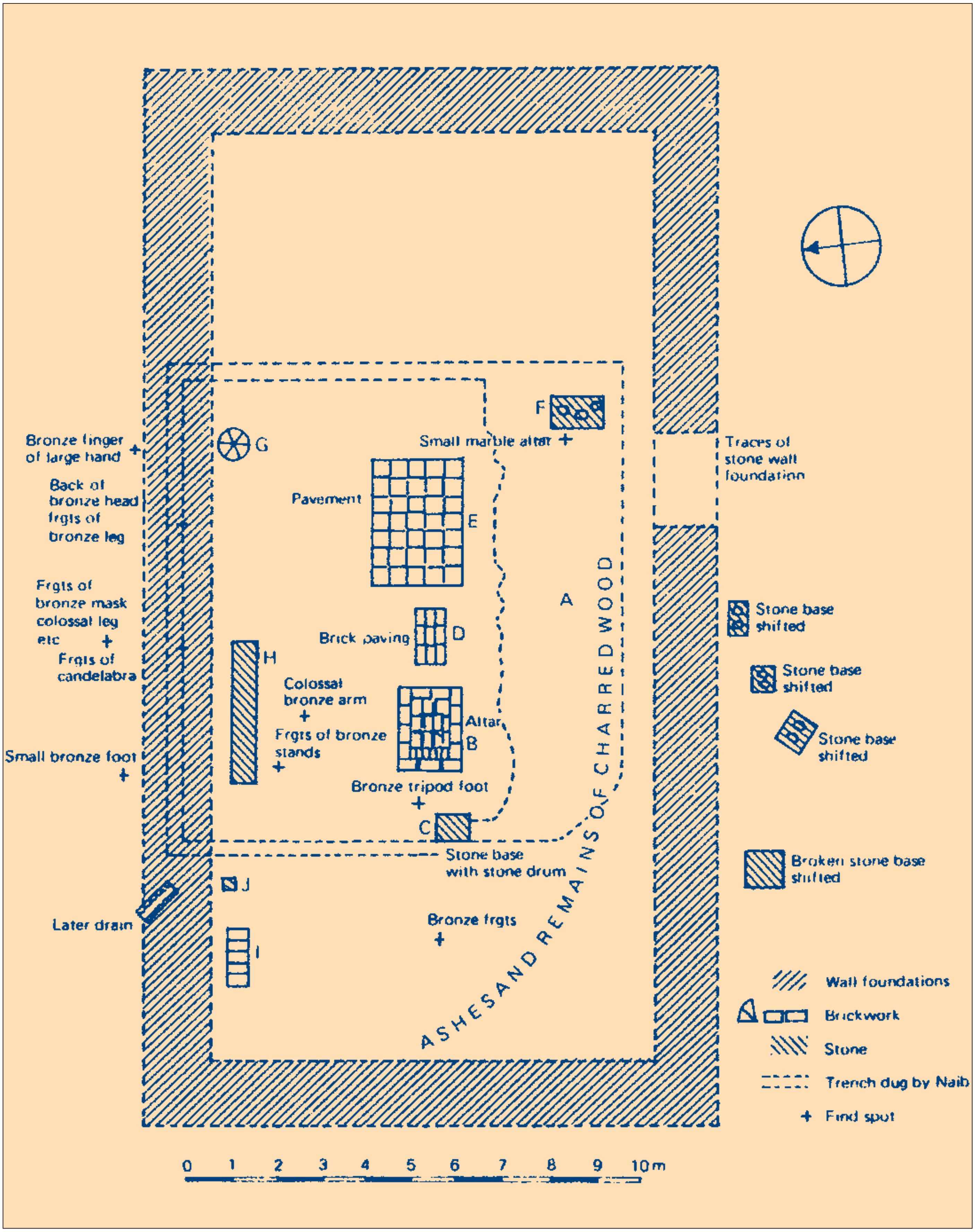
As proven by the example of the early Arsakide residency of Nisa – excavated by Turkmenian and Italian archaeologists – near the modern Turkmenian capital Aschchabad (Invernizzi 1998), there are Greek artists at the Parthian court besides native artists and they create works of high quality. Literarily and ideologically ambitious subjects explain the traditions of their people to the kings, the rulers themselves familiarised with language and content and occasionally tried their hands at writing; however, it seems as if the Arsakides of the later period increasingly turned towards the Iranian part of their cultural heritage. But despite all `tolerance' towards cults and cultures: guide-line of the Arsakides' p o l i t i c a l attitude towards their subjects were always the principles of the subject's loyalty and the ruler's supremacy; just like in the case of the Achaemenides, also with the Parthians, considerable local autonomy and strict control by the centre were combined in such a way that the existence of the empire was guaranteed for almost 500 years.

Parthian Sites in Western Iran

In the Bachtiari Mountains in Western Iran, which still today are difficult to access, in the ancient region of Elymais, we have not found any big settlements from the Parthian period but still there were three impressive sanctuaries. That of Shami, deep in the mountains and located *c.* 25 km north of the town of Izeh (Malamir), surely goes back to the Seleucian period (Fig. 5). There, during the last decades numerous Hellenistic fragments of marble and bronze sculptures have been found, a woman's head, made of stone, and an incomplete bronze head of a ruler standing out among them. Some try to recognise the ruler's head as a depiction of either the Seleucian king Antiochos III or IV, i.e. those kings who both at the beginning of the 2nd century BC without success tried to loot rich Elymean sanctuaries in order of being able to pay the war contributions to Rome. Although the sanctuary itself has not yet sufficiently been excavated, it is a matter of fact that it was active during the Parthian period. This is not at last suggested by the maybe most spectacular find from Shami, a bit more than life-sized (1.94 m), almost completely preserved bronze statue from the 1st century BC or the 1st century AD, for the time being the only preserved big three-dimensioned depiction of an Arsakide dignitary (or prince?) (Fig. 6). Hairstyle and and clothing refer to the fashion of the Parthian period which at that time was common in the area (Curtis 1998; Vogelsang-Eastwood 2000) (Cat. no. 567).

Further to the West, French excavators found two more terrace-sanctuaries from the Parthian period, Masdshid-i Sulaiman and Bard-i Nishandah. The terrace-sanctuaries, which were built from hewed stones, show a ground-plan rather unusual in the Parthian empire, and the gods worshipped in them indicate a syncretism of a local Semitic (not Zoroastric) religious variant and Hellenicised

Fig. 5: Plan of the sanctuary at Shami, Western Iran (Colledge 1977, 42 fig. 14).


F
Small marble altar
G
Bronze finger of large hand
Back of bronze head frgts of bronze leg
Pavement
E
Traces of stone wall foundation
Frgts of bronze mask colossal leg etc
Frgts of candelabra
A
Brick paving
D
Stone base shifted
Stone base shifted
H
Colossal bronze arm
Frgts of bronze stands
Altar
B
Stone base shifted
Small bronze foot
Bronze tripod foot
C
Stone base with stone drum
J
Broken stone base shifted
Later drain
Bronze frgts
I
ASHES AND REMAINS OF CHARRED WOOD
Wall foundations
Brickwork
Stone
Trench dug by Naib
Find spot
0 1 2 3 4 5 6 7 8 9 10 m

cults. Even more than the architecture, the stone monumental sculptures prove Greek iconography having intruded these geographic spaces (Mathiesen 1994). The best known, though not the only example is a Herakles defeating the Nemean Lion. On the terrace of Bard-i Nishandah, numerous stone capitals with volutes were found which were designed following the Greek example, the volutes are framing figures showing Parthian hairstyle and clothing. The local style of art also shows with the Elymean rock and high reliefs of that time.

Fig. 6: Parthian bronze statue, 1.94 m height, from Shami, Western Iran; photo: DBM, M. Schicht.

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Iran in Sasanian and Medieval-Islamic Periods

Dietrich Huff

Sasanian Period

For the Eurocentric historic conscience of the Western world the Persian empire of the Sasanians is an almost unknown quantity. This is not at all justified, as the Sasanian dynasty was ruling the Orient from India to Syria for about four centuries, from 224 to 651 AD, and was a constant competitor of the Byzantine empire whose fate it shared in the end. The two powers were called the eyes of the world. Finally, both fell victim to the onslaught of the Arabian tribes which were spurred by the new Islamic doctrine of salvation, the Sasanian empire completely and forever, Byzantium at first only concerning her Levantine and Northern African territories. But concerning its culture, Sasanian Persia did not at all disappear from history. Just as medieval Europe was deeply influenced by the civilization of the Roman empire, which had been destroyed by the migration of peoples, the Sasanian heritage influenced the culture of the Eastern Islamic countries.

Iran under Sasanian rule

The Sasanian empire was not the result of the impetus of a new religion or the penetration of a fresh and efficient society of conquerors. Instead, the driving force was the charisma of an usurper, Ardashir Papakans, who brought together both a sense of mission and unscrupulousness and who succeeded in showing and enforcing the idea of an orderly world to the late Parthian society which had been ruined by constant wars and the inner fights and

Fig. 1: Air photography of the circular city of Ardashir Khurreh/Gur, today Firuzabad in Fars, South-Iran; Photo: Georg Gerster.

Fig. 2: Plan of the plain of Firuzabad with the radial system of land distribution around the circular city of Ardashir Khurreh (short form: Gur). Built by Ardashir Papakan at about 220 AD, renamed Firuzabad in the 10th century; following D. Huff.

rivalries of minor kings. Medieval Oriental literature offers numerous legends and fairy tales on Ardashir's origin and life which are not to be understood literally but give some tendencies which are close to reality. According to Tabri's chronicle (c. 900 AD), Ardashir was the governor of Darabgerd in the province of Fars when in a dream an angel told him "that God was giving to him the power over all countries … When waking up … he felt power and boldness like never before. His first deed was to go to a place … Gopanan … and to kill its king Pasir" (Nöldeke 1879). After further annections, which were done in similar cold blood, he incited his father Papakan, who was at the provincial capital of Istakhr near Persepolis, to murder the king of Fars, Gozihr, and to take over the power over the entire province. By a number of bloody deeds, he then got rid of his brothers – his father died of natural reasons – and put down the rising of the citizens of Darabgerd. Being the unchallenged ruler of Fars, though not legally accepted by the Parthian Great King Artaban V, he started to build a city and a palace on the plains of modern Firuzabad, which in those days was boggy. The fact that he did not choose the capital of Istakhr or the also important Darabgerd for a residency might have been due to the cruelties which he had done there. But probably it was mainly due to the almost uninhabited and strategically favourable plain which was abundant in water and surrounded by mountains and thus offered protection from enemy attacks and the best possibilities for realising his demonstrative building and land reclamation projects.

Fig. 3: Firuzabad, view at the town towards the square stair tower in the centre whose core still shows a heighth of 30 m; Photo: D. Tangen.

By draining the plain and irrigating dry areas he created the image of being a colonisator who gained new lands for his followers. By his sensational buildings he clearly claimed to take over the leading role, not only in Fars but in all of Iran.

In contrast to the hippodamic system, i.e. a raster of rectangular crossing streets, which was easy to measure and had been used since ancient times, Ardashir's city shows a radial-concentric plan, dividing not only the perfectly circular city (diam. c. 8 km) and a polygonal ring of suburbs (diam. c. 8 km) but also the entire plain as far as to the mountains 10 km away into a geometrically perfect cobweb of 20 sectors (Huff 1999a, 633-636) (Fig. 1 & 2). At the ends of the orthogonal main axis there was a round fort at the Eastern entrance of the plain, a garden around a spring in the West, probably a Zoroastric necropolis on the Northern mountain slope, and an aqueduct at the Southern exit of the drainage system whose main channel went along the North-South main axis and through the ditch which surrounded the city. The 20 sectors of the extraordinarily layed out radial-concentric plan meet at a separately walled inner circle (diam. c. 450 m) in the city centre. In the centre of this inner circle, exactly at the point of intersection, there was a fortress-like, square stairtower which was about 20 m broad and

Fig. 4: Firuzabad, reconstruction drawing of the tower in the centre of the town, called "Tirbal"; following D. Huff.

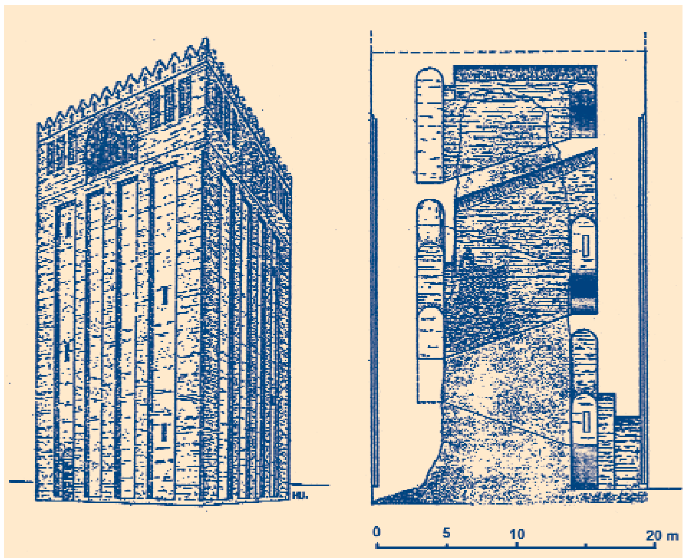

Fig. 5: The palace fortress of Qaleh Dukhtar near Firuzabad from the North; Photo: D. Huff.

Fig. 6: Ardashir Papakan, detail of the huge cavalry fight-relief of the battle between Sassanides and Parthians in the gorge of Tang-i Ab below the mountain fortress of Qaleh Dukhtar; Photo: D. Huff.

probably 40 m high. Still, the slim spiral staircase towers are about 30 m high (Fig. 3 & 4).

The medieval reports make it difficult to interpret the tower, called Tirbal, as they mix it up with the ruin of the cross-cupola building Takht-i Nishin (Huff 1972, 517-540) next to it, probably Ardashir's first fire-temple (Le Strange 1912, 13-16). Doubtlessly, the tower also had a practical function; the lay-out of the radial plan would have hardly been possible without it. Additionally, it provides a visibility connection to Ardashir's palace-fortress on a plateau above the gorge of Tang-i Ab, which controls the most important entrance to the plain (Huff 1969/70, 319-338). But the real function of the tower was probably that of a symbol of royal power. Though it is not possible to reconstruct exactly Ardashir's ideas, his plan of the city and its environments can hardly be interpreted to have been anything other than a model picture of his ideal state. In its centre there was the God-chosen Great King who arranges, supports, and protects his kingdom as an absolute ruler. Doubtlessly, this was an alternative program to the dissolving federal Parthian state, where the great King was mostly dependant on the voluntary support of the minor kings and the great noble families.

Fig. 7: Relief of Ardashir's investiture by the highest god, Ahura Mazda in the rocky gorge of Tang-i Ab near Firuzabad; left Ahura Mazda, right the king and cortege; Photo: D. Huff.

The fact that Ardashir was particularly interested in the circle as a symbol of the protective, centralist kingdom he also showed by his palace-fortress of Qaleh Dukhtar which not only blocked the entrance-gorge to the plain but in which he also built a palace of unusual monumentality (Fig. 5). Taking the risk of a difficult construction, he had the square throne hall built as the core of a donjon-like round tower, which as a gigantic bastion protrudes from the main defending wall. Thus, his huge relief of a cavalry fight at the cliff opposite the fortress in the entrance-gorge of Firuzabad shows the king as champion of the battle (Gall 1990, 20-29) (Fig. 6).

According to Tabari, an exchange of letters, which probably is the invention of historic writers at the court but very correctly characterises the development of the conflict, led to the final break between Ardashir and the Parthian Great King. Artaban is said to have written to Ardashir: "you exceeded your powers beyond all measure and sealed your fate yourself, oh you Kurd, having been brought up in the tents of the Kurds. Who did allow you to crown yourself, to seize all the countries, to subdue their kings and inhabitants? Who told you to build the city … on the plain?" Ardashir's answer was unmistakeable: "God gave the crown to me …made me King of the Countries … and helped me against the rulers and the kings who I have killed. Now concerning the city … I hope to have you in my power soon and to send your head and your possessions to the fire-temple which I made in Ardashir-Khurra" (Nöldeke 1879, 11-12). The fact that the building of a city made Ardashir´s unruliness inexcusable can only be understood taking into the account that founding a city was a royal privilege. Beyond that, the name must have been a really outrageous provocation. Khurreh or Khvarnah is a term of the old Iranian ideology of power, a divine charisma which is only insufficiently translated by "gleam of good luck", "glory", or "majesty", without which any royal rule was impossible. By calling his city his own Khvarnah, Ardashir boasted about already possessing the Khvarnah, *i.e.* he publicly announced to claim the title of Great King of Iran. In the decisive battle, which now was inevitable, Ardashir killed the Great King by his own hands, as Tabari reports;

Fig. 8: Rock relief of Ardashir's investiture by Ahura Mazda, Naqsh-i Rostam (near Persepolis). Under the hooves of the king's horse (left) and the god's horse (right) there are the defeated Parthian king Artaban V and Ahiram, the Satan of the Zoroastric pantheon; Photo: D. Huff.

then he is said to have dismounted his horse "and kicked Artaban's head with his feet. On this day he received the title of Shah-en Shah, King of the Kings" (Tabari 1879, 15).

The decisive moment of the battle is shown by the already mentioned relief in the gorge of Firuzabad (Fig. 6): it shows the Sasanian cavalry in light coats of chain mail, who were also superior in arms, after the fleeing Parthians in their heavy mail and plate armour. Ardashir, with his lance held straight and with waving plume has made Artaban and his horse fall; the Parthian falls down from the saddle head first with his eyes closed, i.e. dead. Behind this, Ardashir's son Shapur runs his lance through the body of the fleeing and falling follower who is said to be Dadhbundadh, Grand Vizier and author of the insulting letter.

The second relief in the gorge shows Ardashir's investiture by Ahura Mazda, the highest god (Fig. 7): man and god are facing each other at eye level, and across a small fire altar the god gives the ring of the ruler, which is decorated with ribbons, to his deputy. Ardashir had his prestigious relief of the investiture built at the cliff of Naqsh-i Rostam, at the Achaemenide royal graves near the town of Istakhr (Fig. 8). Here, the handing over of the ring of the ruler happens on horses. Under their hooves there lie the representatives of the evil, Ahiram, the Satan of the Zoroastric pantheon and Artaban, the epitome of the Evil on Earth.

Also Ardashir's new, centralist organised coinage, which did not allow cities and minor kings to mint their own coins any longer, was Zoroastrically featured. The usual silver coins, drachmas, always show a fire altar on their backsides instead of the still Hellenistic motifs of Parthian coins. From now on, the frontside shows the profile of each king, looking to the right, with his individual crown (Fig. 9). On his earliest mintings Ardashir wears a Parthian helmet crown or rather a tiara, later a diadem, i.e. a headband with ribbons flying behind. The plume on the head, already depicted on the cavalry fight relief, is typical, which in the form of the corymbus became a part of the increasingly phantastically designed crowns of the later kings. The coinage, which stayed to be

Fig. 9: One of Ardashir's silver drachmas, showing the bust of the king looking to his right on the front side and a fire altar with Pahlavi-inscription on the back side. Early coinage of the new type of Sasanian coins.

well organised until the end of the Sasanian empire, is the most important guide for the Sasanian chronology. The different crowns of the kings, who are named by the inscriptions, make it possible to date other depictions, though in reality the crowns were different not only in shape and attributes but also in their colours which are not given by the coins so that mistakes are possible (Göbl 1968).

The strong religious ties, which are shown by all of Ardashir's works and which is emphasised in all written sources, may well have been more than political calculation. But doubtlessly he very effectively employed the Zoroastric religion and its clerics for his political goals. The letter by the priest Tansar, whose known form is from the late Sasanian period, tells how the wise priest tries to convince the minor king Gushnasp of Tabaristan, the unspoiled and traditional mountainous and woody region at the Caspian Sea, to accept Ardashir's rule and to subdue the fire temples of his country to the new clerical organisation (Boyce 1968).

Very fast the clerics became a support of the throne. Major parts of the civil administration were entrusted to it. Writing the imperial chronicles was also mostly in the hands of the priests and thus it was exposed to clerical manipulation. The priest Kartir, whose career had already started under Ardashir and who reached higher and higher honours during his 70 years of service under six kings, decisively influenced the politics of the kings, mostly under Bahram I (273-276) and Bahram II (276-293). Being the only one who was not a member of the dynasty, he succeeded in leaving his mark by picture and writing next to the reliefs and inscriptions of Sasanian kings.

Even after his victory over Artaban and the Parthian army Ardashir had to wage war for years until he had enforced Sasanian superiority over those territories, who were considered Iranian, *i.e.* the regions from Central Asia to Armenia and Syria. At first he seems to have planned to keep Ardashir Khurreh as his residency, as he built a second, bigger palace on the plain. But obviously even during his time it became clear that the area of the Parthian city Ktesiphon and the old Hellenistic Seleukia on the Tigris would stay to be the political and economic centre of the kingdom. Opposite of Ktesiphon, on the Western banks of the Tigris he installed the town of Veh Ardashir, obviously by surrounding an already existing settlement, Kokhe, with a circular wall and populating it with inhabitants of neighbouring Seleukia which was abandoned due to a change of the course of the Tigris (Fiey 1967, 17-21).

Under Ardashir's son and successor Shapur I (240-272 AD), the Sasanian empire reached a peak which was hardly reached again. During the struggles with Rome, which had already been started by Ardashir, after some favourable treaties with the emperors Gordian (238-244 AD) and Philippus Arabs (244-249 AD), Shapur won a glorious victory at Edessa in the year 260 AD when not only a huge part of the Roman army but also the emperor Valerian (253-260 AD) himself was taken prisoners by the Persians. Their forced settlement in various towns of Iran, particularly in Khuzestan, lead to an enormous economic rise. At Shushtar, Roman engineers and craftsmen built dams and bridges for extensive irrigation projects. Near neighbouring Dezful the town of Jundishapur was built, where many prisoners settled but which also was provided with a royal palace, probably including manufactures belonging to it. As a place of science and scholarship, Jundishapur

Fig. 10: Air photography of the town of Bishapur on the Kazerun plain with its orthogonal network of roads, following Roman examples. At the entrance of the rocky gorge in the Northeast, rock reliefs tell about the victories of the Sasanian kings over the Romans; Photo: Georg Gerster.

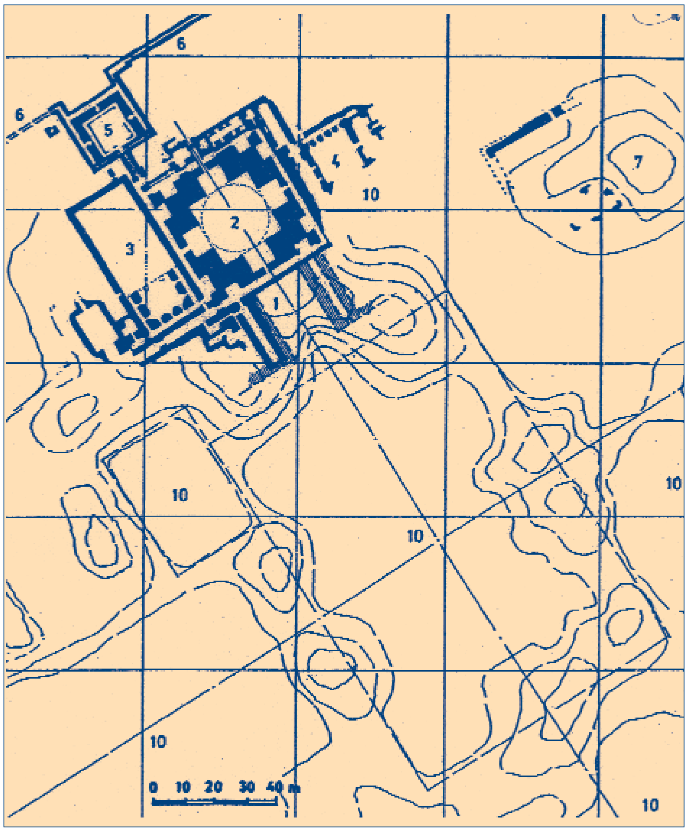

Fig. 11: Plan of the huge complex of buildings in the North of the town which was interpreted to have been one of Shapur's palaces but which must have been the monumental complex of a fire temple; following A. A. Sarfaraz & D. Huff.

would be famous everywhere in the Orient until late Islamic times. Particularly the Faculty of Medicine at the University, which was founded here and where Greek doctors are said to have introduced Hippocratic medicine, was said to be the best educating place of all the caliphate. There was an observatory and an honoured academy. In the early 6th century, Khosrow I tried to win over the pagan philosophers, who were emigrating from Athens due to Christianisation, to teach there.

Also, Shapur built a famous palace at Veh Ardashir/Ktesiphon. But for his home residency he chose the conveniently situated and richer plain of Kazarun instead of the remotely located Ardashir Khurreh. Exactly like Jundishapur, his city of Bishapur shows the simple hippodamic plan with cardo and decumanus, the rectangular layed out main streets (Fig. 10). The map of the city and more than that the walls of hewn stone of some buildings are doubtlessly due to the employment of Roman imprisoned builders. A monument of double columns with Corinthian capitals and a statue of Shapur, which has now disappeared and which a governor of the city had erected at a crossroad to honour the king, also follow Syrian-Roman examples (Ghirshman 1971; 1956).

The Northern part of the town consists of one huge complex of buildings which at first was called a palace but which can only have been a fire temple (Fig. 11). Its plan shows a further development of Takht-i Nishin (Huff 1972, 517-540), Ardashir's fire temple at Ardashir Khurreh: here, the square cross cupola hall is even surrounded by a corridor. With its span of more than 20 m the cupola at Bishapur had not only double the size than its predecessor but probably it was the biggest one which was built in the Sasanian period. In front of the core building, in which the holy fire was burning, there was an iwan, a deep, vaulted entrance hall which opened into a gigantic court which itself was axial-symmetrically surrounded by three more iwans and probably also by arcade halls (Huff 1993, 53-54, fig. 31). In the siderooms and smaller courts of the core building, floor mosaics were excavated which are unique in Iran insofar as they show Roman technique but figurative depictions being definitely Sasanian style. Also, a building made of hewn stone was excavated, which was built into the ground with one half and was considered a sanctuary of Anahita due to surrounding underground corridors for water supply, but which more likely served for cleaning ceremonies (Ghirshman 1962, 135-168).

With the religious buildings at Ardashir Khurreh and Bishapur, the development of the prestigious Sasanian fire temple basically comes to its end. The plan of Bishapur is based on the huge sanctuary on the Kuh-i Khwadja in Sistan and is also visible in the special case of the temple of Atur Gushnasp on the Takht-i Suleiman and as well in the case of the huge sanctuary which is likely to be the latest one, the temple of Khosrow II (591-628 AD) at Qasr-i Shirin, despite a more simplified altar room (Reuther 1931; Schippmann 1971; Naumann 1977). In the case of smaller temples, like Ardashir's original building, the surrounding corridors may be missing. The most important part of all ancient and surviving Zoroastric fire temples is always the completely closed, mostly cupolated altar room; the here constantly gleaming and in the course of ceremonies flaming log fire must be protected from every kind of pollution, so the priests even wear breathing protection. Sunlight, the biggest of all fires, may not touch a sacred fire, as then it would be humiliated. The widespread idea that in Sasanian temples the fire was carried from a remote fire chamber to an open canopy, the chahartaq, and there was exhibited to the believers during the ceremonies, is in contrast to the most important ritual rules of the Zoroastric canon. Additionally, archaeologic excavations and surveys showed that all the alleged open chahartaqs, which might have been fire temples, were completely closed by surrounding rooms, corridors or walls (Huff 1982, 197-212; 1993, 53-56).

Shapur's now completely destroyed palace at Bishapur was on a heavily fortified, projecting part of the chain of rocks just above the city (Fig 10). The slopes show the traces of quarries from the time of erecting Shapur's hewn stone buildings and the pits of graves and platforms for exposing the dead of the Zoroastric necropolis from a time when probably the palace was not used anymore. In the gorge next to the fortress, where a river breaks through the

Fig. 12: Naqsh-i Rostam. Among the graves of the Achaemenide kings Shapur I had his relief of victory over two Roman emperors made: Philippus Arabs, on his knees and begging for peace and Valerian who Shapur takes prisoner by "his own hands". In the corner on the right the bust of the High Priest Kartir; Photo: D. Huff.

chain of rocks, Shapur had his victories over the Romans celebrated by several reliefs. Besides Shapur, the main characters are always the defeated Roman emperors: Gordian killed under the hooves of Shapur's horse, Philippus Arabs on his knees in front of the Sasanian and begging for peace, the latter himself grasping Valerian´s outstretched arms who, according to the tradition, was captured by Shapur's "own hands" (Ghirshman 1956; Schmidt 1970, 122-141; Hermann 1977, 87-100; Vanden Berghe 1983).

But his most impressive sculpture is an 8 m high statue which was chiselled out of a stalactite in a huge cavern high at a cliff, about 5 km up the river from Bishapur (Ghirshman 1962, 162-165). It is suggested that Shapur, who is said to have died at Bishapur, was buried in the cave. Shapur left his testament on the walls of the Achaemenide tower building of Naqsh-i Rostam, the Ka´aba-ye Zardusht (Fig. 12), diagonally opposite to his oversized victory relief: an account of his deeds and pious donations in three versions: in Greek, and both in Parthian and Sasanian Pahlavi (Schmidt 1970, 13.34-49, tab. 1-17). Because of this it was suggested that the Achaemenide tower served second hand as Shapur's astodan.

Though under Shapur the importance of the Zoroastric clerics increased significantly – the size of the fire temple of Bishapur and the reported promotion of the high priest Kartir speak for themselves – there was no suppression of other religions during his reign. The founder of the religion, Mani, who propagated the syncretistic, manichean global religion, succeeded with gaining Shapur's special favour and freedom of mission in the whole empire. The apostle, who was also famous as a great painter, dedicated a summary of his teachings, the Shapurakan, to the king. But after the early death of Shapur's successor Hormizd I Mani fell out of favour and was executed at about 276 AD, probably still under Bahram I. His straw-stuffed body, according to other sources his head, was hung at one of the gates of Jundishapur, which from then on was called Mani gate. During the few decades after Shapur's I death, his successors not only squandered the splendid position of the Sasanian empire but also allowed the Zoroastric clerics to establish a fundamentalist, intolerant religious regime. In the inscription, which he placed next to Shapur's at the Ka´aba-ye Zardusht, the priest Kardir tells: "he (Bahram II) ... awarded me with the rank and the honour of the mighty of the empire (the higher nobility) and concerning the pious works destined to the gods he made me more independent and more liberate than I had ever been before. He made me High Priest and judge of the entire empire and Highest Priest of the Cult … and gave me the name Kartir, the saviour of Bahram (II), the High Priest of Ahura Mazda … the teachings of Ahiram and the devils were banned from the empire … Jews, Buddhists, Mandeans, Christians, Gnostics, and Manicheans were … persecuted, idols were destroyed …". The many times repeated sentence is telling: "… many superior magicians experienced happiness and wealth. Appointments to many magicians and Bahram-Fires were sealed." Among the divinely ordained deeds, Karti prides himself on – like founding Bahram-Fires and converting unbelievers – there counts a certain social practice in the Sasanian empire whose interpretation is not undebated: brother-sister marriage. Kartir writes: "Many marriages between relatives were created" (Hinz 1970, 259-262).

Besides territorial losses both to the Romans and to the Hephtalites in the East of the empire, struggles about the line of succession and the interests of noble families and clerics must have lead to a serious crises in the early 4th century AD. When Hormizd II (302-309) died, apparently without descendants, the unborne child of one of his wives is said to have been crowned in her womb, so that the clique at the court, together with the queen, was able to rule for at least two more decades. But the heir, Shapur II (309-379 AD), grew up to be a surprisingly able ruler (Fig. 13). By a ruthless campaign, which is said to have led as far as to the interior of the Arabian peninsula, he put an end to the raids of Arabian pirates who had looted the Persian coasts and the hinterland. In the West he won back territory, which had been lost to the Romans, and stabilized the border by a system of fortresses, the Khandak-i Shapur. Also Armenia, which had mostly become Christian, came back under Persion control. The same is true for the kingdom of Kushan in the East, which now struck its own coins under the Kushan Shahs who were mostly Sasanian princes.

During the reign of Shapur II, Constantine the Great (325-337 AD) declared Christianity to be the national religion of the Eastern Roman Empire. Thus, the situation of the Christians in Iran got alarmingly worse. Considered potential collaborators of the Roman arch-enemy, they were excluded from military service; instead, their tax burden was doubled. Concerning this, one of Shapur's instructions says: "… We have to suffer from all the hardships of war while they, the Christians, have nothing but peace and pleasure. They are living on our soil and share the Caesar's, our enemy's, emotions" (Osten 1956, 138). It was not only raising the taxes. In the big cities of Mesopotamia with their big Christian sections of the population, Shapur's persecution was especially severe after Roman troops had advanced as far as to Ktesiphon. When a rising at Susa was put down, there happened massacres among the Christian inhabitants; the city is said to have been trampled to dust by war-elephants. The fact that other religious minorities, e.g. Jews, were not at all persecuted, proves that Shapur's persecution of Christians was not due to religious but to political reasons.

The early Sasanian kings had their reliefs made only in their home province of Fars – with the exception of one Ardashir-relief in

Fig. 13: Silver drachma by Shapur II; Photo: B. Grunewald.

Azarbaidjan. Here, mostly around Bishapur and Istakhr, there are also the ruins of lavish buildings made in the Roman technique of hewn stones which was only used for official buildings. Thus, we may suppose that in the early Sasanian period the Persis/Fars was the spiritual centre of the empire. But the economic and political centre of the state had increasingly shifted to the rich, densely populated conglomerate of cities around Ktesiphon/Mada´in in Mesopotamia. Obviously, Shapur II had also been growing up there; here he is said – according to the historic legend – to have solved the traffic problems between the two cities of Ktesiphon and Veh Ardashir, which were located opposite to each other, by erecting one-way bridges across the Tigris, being only a boy. As early as under Shapur II, the climatically favoured and agriculturally rich mountainous regions of Kurdistan may be supposed to have drawn the attention of the king's court, just as they were near to al-Mada´in. Here, at the old East-West artery from Mesopotamia to the Iranian plateau and to Central Asia via the rich cities of Hamadan/Ekbatana, Ray, Merv, there is also Bisotun/Bagistan, the Mountain of the Gods, where already Darius and the Parthian kings had chiselled their inscriptions and reliefs, a place which at all times had been of significance for Northern Iranian Media similar to Naqsh-i Rostam near Istakhr for the Southern Iranian province of Fars; and to this area the prestigious summer residencies and monuments of the dynasty, which up to then had been kept in Fars, were now shifted. Shapur II, who finishes the line of Southern Iranian rock-depictions, died in 379 AD, after a reign of 72 years.

His successor, Ardashir II (379-383), had his investiture by the gods Ahura Mazda and Mithras depicted in the massive of Kermanshah, near Bisotun. Here, Shapur II himself together with his son Shapur III (383-388) is depicted in a relief which for the first time is located in a small, iwan-like rocky cave. Later, right next to this the most magnificent of all the Sasanian rock-monuments, the Taq-i Bustan, would be built.

Under Shapur's II successors the priests again seem to have gained decisive influence at the court. This is suggested by the judgement of the royal reports, which were supervised by the clerics, on one of the most interesting Great Kings, Yazdegerd I (399-421 AD), who was given the second name "the sinner". No other king's reputation was spoiled in such a detailed way. But the reports are so obviously manipulated, the single accusations are so hypocritical, that they easily show a maybe rude and cynical but definitely prudent, tolerant, and most of all incorruptible ruler who in his efforts to untie the network of corruption, nepotism, and bigotry at his court finally failed because of the clerics and the nobility whose selfish interests were threatened. As obviously one did not dare to confess his murder openly, it was reported that he had been abducted by a mysterious white horse or that he had been killed by the kicks of hooves. A part of the Syrian reports on the prosecution against Christians, which increasingly started again, shed some light on the situation at the court, which led to the coronation of his son and successor Bahram V (421-439 AD): "As he (Bahram V) was owing the unclean magicians a debt of gratitude for having bound the crown of the kingdom around his head out of all his father's sons, that was why he obeyed the order of the damned Mihrshapur, the head of the magicians, dragged the dead, who had been buried since the days of his fathers, out of their tombs and spread them out to the sun, and this order was valid for five years" (Hoffmann 1880, 39).

This part doubtlessly shows that mostly the priests decided about heirdom to the throne and that satisfying the clerics was the most important feature of any candidate. It also shows that Yazdegerd had been hated by the priest not at least because of his tolerance towards the Christians. Additionally, Bahram's obeying action against burials, by which the Christians inevitably came into conflict with Persian authorities, points out to the Zoroastric commandment of exposing the dead which should prevent the element of earth from being polluted by decomposing human substance. The rules for funerals, which are very exactly fixed in the Vendidad and in other religious texts of the Avesta, the collection of religious Zoroastric books, demand the corpse to be laid down on rocky

Fig. 14: The two so called fire altars of Naqsh-i Rostam, in fact they are Zoroastric bone graves, astodanes. Following a drawing by E. Flandins from the 19th century including completed cupola-like roofs; Photo: D. Huff.

mountains away from the agricultural land until, after animals and decomposition have done their work, there are only the ritually clean bones left over which either stay to completely fall apart or may be kept in bone containers, the so called astodanes. In the steppe regions of Central Asia the astodanes often are richly decorated ceramics, ossuaries, in Iran they are mostly chambers or niches hewn into the rocky walls, often with inscriptions which call the grave a dakhma, or they are pits in the rock whose lids have disappeared in almost all cases. Also the two rock monuments at Naqsh-i Rostam, which incorrectly were called fire altars, were such bone containers which remind to reliquaries (Fig. 14). The fact that we do not know a single Sasanian royal grave is doubtlessly due to this Zoroastric funeral practice which prevented any kind of monumentalism (Huff 2004).

Bahram V, whose second name was "Gur", the onagre, grew to be one of the most popular characters of Persian literature. He grew up at Hira, which was a mostly Christian place, at the court of the Arabian vassal dynasty of the Lakhmides who were famous for their warriors and poets and who ruled a buffer state at the Western rim of the Mesopotamian lowlands against the Arabian desert tribes and the Ghassanides of Syria who were dependent from the Eastern Roman Empire. Bahram V was famous for being a great hunter, particularly of the fast and persistent desert donkeys, and for living the good life who brought the first Gypsy families from India to Iran to play their music at his feasts. The fact that still successful defensive actions happened against the Hephtalites, who were advancing from the North-eastern steppes, and that it was possible to negotiate financial subsidiaries for securing the Caucasian border with the Eastern Roman Empire, may have been his brother Narseh's credit, who often acted as his deputy, and the credit of Mihr Narseh who under him, under his father, and under his successors had the function of Grand Vizier. Under Bahram V, for the first time there are reports on visits by the king and gifts to the fire temple of Azarbaidjan. No matter if by this the sanctuary of Atur Gushnasp on the modern Takht-i Suleiman was meant or any other temple, this mentioning shows that now the religious interest of the court was not any longer directed to Fars in the South but to the North-western part of the empire. Also, Bahram V is said to have died in Azarbaidjan; while hunting an onagre he sank into a pit of mud, his corpse was never found.

Bahram's grandson Peroz (459-484 AD) died similarly though it was on the battlefield. After the death of Bahram´s son and successor Yazdegerd II he had been crowned, probably again with the help of the clerics and Hephtalite support, after he had killed the rightful heir to the throne, his brother Hormuzd III (457-459). Summarising, this was said about him: "Peroz was a man of bad luck and mishap for his people, and most of what he spoke and did was of damage and disadvantage for himself and his subjects" (Nöldeke 1879, 121). He was not responsible for a seven years drought and famine which he is said to have made more bearable by prudent supply measures. But concerning his wars against the now powerfully established Central Asian Hephtalites, which sometimes he started by breaking contracts, he was unsuccessful in the end; he was taken prisoner and money had to be paid for his release; his son Kavad spent two years at the court of the Hephtalites as a hostage, one daughter got into the Hephtalite ruler's harem. His last campaign against the Hephtalites ended with the complete destruction of his army, he himself is said to have been killed together with many others by falling into pitfalls which had been prepared by the enemy.

Even more dramatic was his son's Kavad (484-531 AD) period of office. Having been dethroned twice by high nobility and priests, he fled to the Hephtalite court which he knew from his time as a hostage and with whose help he both times won back the Sasanian crown. The most important event of his reign, which was unique in Sasanian history, was the rise of the Mazdakites, a social-religious revolution by which the Zoroastric reformer Mazdak wanted to break up the clerical numbness of the Zoroastric state church and the caste-like, socially unfair Sasanian social system. The basis of his pre-communist ideology was equality of all men before God and in society. By this he mobilised not only the impoverished masses but also he won, probably unexpectedly, the king's support. During the 25 years of his movement he succeeded with enforcing radical social changes like community of property and community of women at least in some parts of the country. It may be supposed that Kavad by accepting this radical social change saw a possibility of restricting the overwhelming influence of high nobility and clerics and of regaining the king´s freedom of decision. When in the course of the revolution both the legal system and the economic basis of the state were beginning to break down, in the year 528 AD the rising was rigorously put to an end. After a disputation had been ordered between Mazdak and 3000 of his followers and representatives of the Zoroastric and Christian churches, Mazdak was declared a sorcerer and hanged after he had been forced to watch his followers being buried head first in a garden as "blossoms of his teachings". The driving force behind the extinction of Mazdacism was Kavad's son and successor Khosrow I who on this day got his second name Anushirwan, "The One with Immortal Soul". In the course of nationwide persecutions all of Mazdak's followers were killed, if possible, their property was confiscated, and their churches were given to the Nestorian Christians who after their official resignation from the Eastern Roman church on the synod of Beth Lapat/ Jundishapur were not longer considered enemies of the state and, for some time, enjoyed religious freedom.

Khosrow I Anushirvan (531-579 AD) went down in Iranian history as the most important and highest honoured king and also due to his justice. By treaties with the Eastern Roman Empire and by tributes to the Hephtalites he secured himself against outside attacks and in the course of ten years of inner reorganisation he built up a satisfying social and economic organisation. By help of orphanages and womencare he tried to ease the consequences of the complete ruin of family ties which was due to the Mazdakite movement. By supporting the desolate agriculture and by enhancing the lower gentry, the dekhanes, village leaders, he won loyal followers as a counterweight against the anyway weakened high nobility. By help of new agricultural surveys – already started under Kavad – and a modernised tax system he filled the treasury and made the financing of loyal troops possible. The Zoroastric clerics were again appointed to their old functions and thus they were – at least for the time being – more loyal to the royal house than ever before.

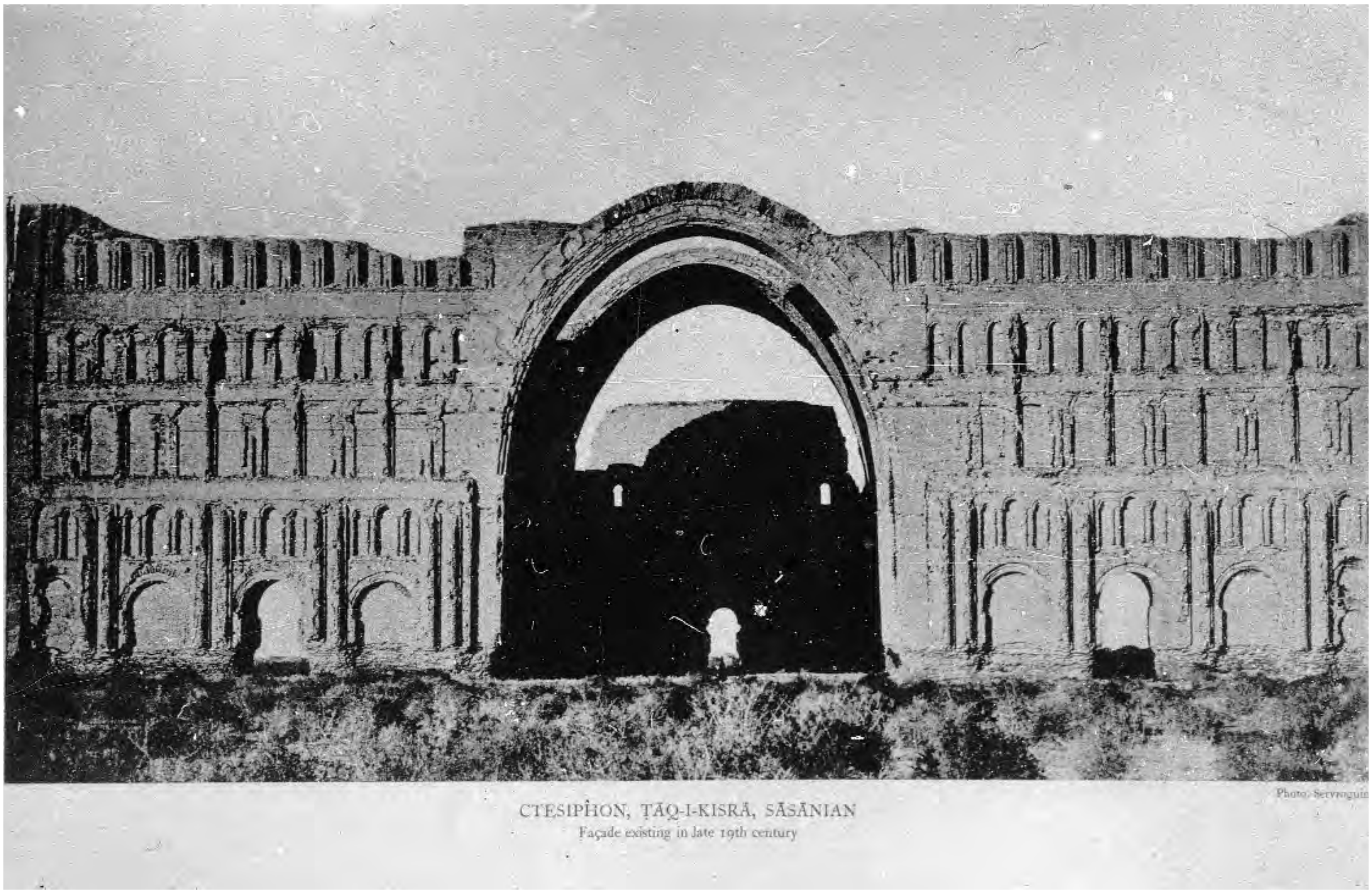

Fig. 15: Taq-i Kisra, audience hall of the Late Sasanian royal palace near Ktesiphon.

After consolidating the empire, Khosrow I again took up the campaigns in the West and East. As the result of an intervention against the Ethiopians he seized control over the Yemen, won parts of Syria and conquered the rich Antiochia whose inhabitants he replanted into a city near Ktesiphon, Rumija or Veh Antiokh Khosro, "Khosrow's Better Antiochia" which had only been built for this purpose. Being allied with the Turkish tribes, who were now advancing to the West in Central Asia, he destroyed the kingdom of the Hephtalites but by this established a new neighbour at his North-eastern border who in future would become more dangerous than the one both had just defeated together.

From the entire Middle-Sasanian period after Ardashir II there are neither rock reliefs nor monumental palaces or temples of the quality of the Early-Sasanian monuments known or preserved. Doubtlessly, there were royal buildings but they were made of mudbricks and, like the buildings of common architecture, have completely vanished. Due to their Theodosian II- (408-450 AD) and Peroz-coinage, the finds of coins from the early mudbrick period of the fire temple on the Takht-i Suleiman in Azarbaidjan prove that this sanctuary, which was especially important for the Sasanian royal house, was founded in the 5th century AD. The replacement of the mudbrick buildings by temple and palace buildings made of stone and bricks can be dated to Kavad´s last years and to Khosrow's I early years in the period after the suppressing of the Mazdakite rising, due to appropriate coins (Naumann 1977, 68-69). In a similar sequence, Khosrow replaced the first barrage walls of Derbent from the 5th century AD by the partly still standing, impressive stone fortresses which here secured the Sasanian Northern frontier (Kudrjavcev & Gadžiev 2001, 333-356). Khosrow I is probably also the builder of the biggest Sasanian - palace at Ktesiphon whose partly preserved throne hall, the Taq-i Kisra, only insufficiently gives an idea of the former complex of buildings (Huff 1971, 150-154) (Fig. 15). The fact that no rock relief can be definitely subscribed to Khosrow I may be typical for this successful ruler who obviously found his satisfaction by reaching his political and military goals.

One decade after Khosrow's I death in 579 AD the Sasanian throne again got into difficulties, due to his son's and successor's Hormuzd IV (579-590 AD) clumsiness. Hormuzd was dethroned when he demoted and dishonoured his renowned general Bahram

Fig. 16a: Taq-i Bustan, hunting relief at the side wall of the grot; Photo: D. Huff.

Chobin, who had successfully fought against Turks and Byzantines, because of an unimportant defeat and only out of jealousy. Now, Bahram Chobin crowned himself at Ktesiphon (590-591). The real heir to the throne, Hormuzd's son Khosrow, fled to Byzantium, won the favour of the Byzantine emperor Mauricius and from him, for giving back the Syrian territories conquered by Khosrow I, he was given an army with which he campaigned against Bahram Chobin. As the latter was not of royal blood, i.e. he did not possess the Khvarnah, he was left by his troops and followers and himself had to flee to the court of the Turkish Khagan where he later was murdered at Khosrow's instigation. Khosrow II, whose second name was Parviz, "the Victorious" (591-628 AD), as the most magnificent, richest, and thus, according to Oriental values, happiest ruler, was the example of the ideal of power, glory, and greatness but also of the decline of the Sasanian dynasty. His extreme prodigality, his ruthless exploiting the country and his lack of justice lead to financial and moral erosion of the state which two decades after his death resulted in the destruction of the Sasanian empire. The huge royal buildings, whose ruins are all along or near the old road from Ktesiphon in the heart of the Mesopotamian lowlands up to the centre of the Iranian highlands, are all subscribed to him. Allegedly because of a prophecy, according to which he was to die in Ktesiphon, he had the strongly fortified residency of

Fig. 16b: Taq-i Bustan, Khosrow's II investiture by the gods Anahita and Ahura Mazda; Photo: D. Huff.

Fig. 16c: Taq-i Bustan, high relief Khosrow's II, as an armoured horseman, at the back side of the grot; Photo: D. Huff.

Dastagerd/Daskara built north of the capital, of whose 16 m thick brick walls some parts are preserved (Sarre & Herzfeld 1920, 89-93). At Qasr-i Shirin, in the foothills, there are still the remnants of a gigantic palace and a huge fire sanctuary (Reuther 1931, 493-587). Another palace, Haush Quri, is located in the hills farther to the Northwest. The palace of Kangavar, the medieval Qasr Luslus, "Castle of the Thieves", with the hewn stone masonry of its terraced foundations and its columned arcades is the only one to be compared to early Sasanian buildings around Bishapur. Of the allegedly unfinished brick superstructures nothing is left (Azarnoush 1981, 69-94).

The most fascinating structure from the late Sasanian period is the Taq-i Bustan, the arcade hall in the garden, near Kermanshah (Herzfeld 1920, 57-103; Ghirshman 1962, 192-199; Fukai et al. 1969-1984; Vanden Berghe 1993, 78-93). Besides the two Middle Sasanian rock reliefs – the already mentioned relief of Shapur III, located in a niche inside the arcades, was perhaps included into the later completed structure – a wide and deep iwan-hall was hewed into the cliff, its three walls are completely covered by reliefs (Fig. 16). On the side walls sometimes dramatic compositions of hunting scenes in preserves are depicted, each of them showing the king as a bowman standing in a small boat or as a horseman, surrounded by female musicians, beaters, and elephant riders who take away the hunted animals (Fig. 16a). Together with the so called hunting-bowls, big silver plates which were mostly found in Southern Russia and probably were presents for princes of nomad tribes – mostly their motif is the hunting king – the hunting reliefs at Taq-i Bustan give the impression that hunting was a major part of the daily lives of Late Sasanian kings. A gigantic area in front of the Taq-i Bustan, enclosed by rectangular walls, was probably a hunting park, a paradeison.

At the back wall of the Taq-i Rustam there is a double-life-sized armoured horseman, chiselled out of the rock as an almost completely three-dimensional sculpture (Fig. 16c). Above it, there is a frontal scene of investiture where the goddess Anahita and the highest god Ahura Mazda each are giving a ring of investiture to the king who is standing between them on a rostrum and is looking like being uninvolved (Fig. 16b). The motif of the two scenes is basically the same like that of the two rock reliefs of Ardashir I at Firuzabad: warriors on horseback and divine investiture of the king. But the differences of the way in which this is depicted is significant for the different ideal of monarchy in the beginning and at the end of the four hundred years of Sasanian history. Ardashir is without a helmet, with a light coat of chain mail at full gallop and a victorious fighter, Khosrow II instead heavily armoured with a helmet, which only leaves the eyes unprotected, his lance shouldered in resting position he is sitting on Shabdiz, his battle horse which is famous from literature; no enemy seems to exist. The relief of Ardashir's investiture shows a personal relationship between king and god. Both are standing face to face and equally sized; inscriptions call Ardashir also a god. But while he is receiving the ring of investiture with one hand, he honours Ahura Mazda with his other hand which is raised forgreeting. Instead, the scene of investiture at the Taq-i Bustan gives the impression of the gods paying homage to the king.

The dating of the Taq-i Bustan is a little debated; the king's crown in the scene of investiture may also be interpreted as Peroz's (Fig. 16b). But the majority follows the opinion that it was Khosrow II who had this monument built and which impressingly characterises the last period of the Sasanian era. It would even be overruled by the almost 200 m long and almost 40 m high smoothing of a cliff at Tarash-i Farhad at neighbouring Bisotun, whose purpose we do not know but which doubtlessly was meant not only to overshadow the Taq-i Bustan but also the rock relief and the inscriptions by Darius I at Bisotun.

The dethrowning and murdering of the Byzantine emperor Mauricius, in whose debt he was for his thrown, was the reason for Khosrow II to start new campaigns against the Eastern Roman Empire in 604 AD which were successful only in the beginning. After raids far into Anatolia and after conquering Syrian cities – in 614 AD Jerusalem surrendered – Persian troops even occupied parts of Egypt. Two times, in 615 and in 626 AD, Persian armies reached Constantinople. While Khosrow II was not accepting the far reaching peace proposals by the Byzantine emperor Heraklius, who was not involved in Mauricius' murder, the latter advanced to Armenia and North-western Iran with Anatolian contingents, several times defeated the Persian army which was after him, pillaged the fire sanctuary of Atur Gushnasp from where Khosrow, who had fled there, escaped with great difficulty, conquered Dastagerd and Ktesiphon in the winter of 627 AD after a bold advance to the South, and retreated with rich booty. In the spring of 628 AD, the demoralised Persian generals together with the heir to the thrown declared Khosrow II dethrowned and proclaimed Sheroe king under the name of Kavad II Khosrow II shared the fate which he had inflicted on his father. With his son's consent he was executed by the rebels. As Sheroe/Kavad II also had his 17 brothers killed, besides his father, the Sasanian dynasty was almost extincted when he died after a reign of about seven months. The successors, his underaged son, two of his sisters, generals, and obscure, far related pretendents, were at the mercy of cliques, provincial rulers, and officials of the court. Some of them lost the crown after a few days, only few of them after only one year. There were simultaneously appearing rival claimants to the thrown, hardly one of them died of natural causes. In 632 AD, at Istakhr, the original home of the Sassanides, a surviving grandson of Khosrow II, Jazdegerd III (632-651 AD) was crowned as a youth and his fraction succeeded with having him accepted nationwide after long internal fights. After a lasting peace had been made with Byzantium as early as under Sheroe/Kavad II, the regions West of the Euphrates and the Holy Cross of Christ, which had been taken away when Jerusalem was conquered, had been given back, for a last period a Sasanian Great King resided in the Taq-i Kisra of Ktesiphon. But the state's will of self-assertion had long been gone. In 602 AD, Khosrow II by a fatal wrong decision had eliminated the Arabian dynasty of the Lakhmides of Hira and had killed Nu´man, the king of this loyal dependent state. For 300 years the Lakhmides had defended the Southern and Western borders of the Sasanian empire against the nomadic tribes of the Arabian peninsular and the coast of the gulf and also against the Ghassanidians from Syria who served the Eastern Roman Empire. Only half a decade after installing a Sasanian governor in the place of the Lakhmide princes, Arabian nomads defeated the Sasanian's troops in the battle of Dhu Qar near Hira and thus in the eyes of the Arabians destroyed the aura of Persian invincibility.

Between the Hedjra of 622 AD, the prophet Mohammed´s move from Mekka to Midina, and after his death in 632, the nomads of the Arabian peninsula had been converted to Islam and at Midina the foundations of an Islamic state had been built. The new religion demanded from its followers to lead the whole mankind towards this Holy Doctrine. As a reward, the inhabitants of the desert, who were suffering from hunger, were promised material profit or, in case of death as a hero or martyr, paradise. As early as in 632 AD, Arabian sailors again occupied parts of the Persian gulf coast and invaded the highlands of Fars. In 633 AD Hira was conquered, in 636 AD the Sasanian imperial army was defeated at Qadisiya, with the battle of Djalula the capital Ktesiphon/Veh Ardashir and thus Mesopotamia were lost. In 642 AD, the last Sasanian army was destroyed at Nihavand in the Iranian highlands, South of Hamadan. The Persian foot soldiers are said to have been chained to each other to prevent them from running. At this time there was no organised resistance left, but it took a full decade until the resistance of single fortresses, cities, and areas of retreat was broken; only the woodlands of Tabaristan at the Caspian Sea could not be overwhelmed for the time being. Jazdegerd III had at first retreated to his home region of Fars, where even Ardashir's I old mountain fortress near Firuzabad was again made ready for resistance, as there is evidence for by finds of coins (Huff 1978, 140). In a dramatic last act, Jazdegerd tried to win troops in the North-eastern frontier areas, in Merv, Balkh, from the Turkish rulers of Sogdia, and by a message to the Chinese court but without sufficient success. Finally it were the Dekhanes of Khorasan, who had decided to surrender to the Arabians, who robbed him of his last finances. In 521 AD he was murdered by his host while being asleep in a mill near Merv. Many Persian noblemen, Jazdegerd's son and successor Peroz among them, fled to China, where they found new homes as officers or officials. Only one century later, when the Arabian advance was threatening the Chinese sphere of influence, a Chinese army campaigned against the Muslims at the Northern rim of the Central Asian mountains but was defeated by them in 751 AD near Talas. The most important booty for the Arabians were Chinese prisoners who in Samarkand introduced the production of paper, an invention which was very much welcomed by the Arabian society which was extremely fond of writing, just the opposite of the ancient Persian culture.

Medieval Islamic Periods

With the decline of the Sasanian empire Iran disappeared from the world-wide map for more than half a millennium. The Sasanian provinces became part of the caliphate, of the world-wide empire which was to be erected by Mohammed's order. Mohammed's successors, the caliphs, were both its religious and worldly head. The Qur´an, the divine revelation, which had been written down by Mohammed, was the religious and worldly law. It was completed by the collection of Mohammed's sayings and decisions, Hadith (tradition). The rules for dealing with conquered non-Muslims guaranteed their faith if it was one of the book-religions like Christianity or Jewry. By referring to the Avesta, the Zoroastric Persians succeeded in being counted among the book-religions. As wards, dhimmi, they had to pay poll tax, those who surrendered voluntarily were even allowed to keep their estates. There were restrictions: non-Muslims were not allowed to build new temples, to celebrate their rites in public, they were allowed to ride donkeys at the most, and they had to wear special clothing. But on the lower level the administration of the conquered countries was kept unchanged, even the Sasanian coins were used until the end of the 7th century, sometimes they were overstruck. In the big cities like Hira, Ray, Hamadan, and Istakhr there were – sometimes repeated – risings after the first surrender; in the end, Hamadan and Istakhr were destroyed to such an extend that the Arabian camp of Shiraz rose to be provincial capital. Obviously, the rationally acceptable and easily to follow teachings of Mohammed, to which everyone was allowed to convert to without difficulties, very fast lead to the conversion of a big part of the Iranian population to Islam. Though the hope of thus avoiding poll tax was not always fulfilled, belonging to the religion of the victorious was of advantage in any case. Thus, particularly the dekhanes were able to keep their lands and their social ranks. Forced conversions of book-possessing unbelievers were not demanded and were not in the Arabian's interest as poll tax payed a major part of the treasury. Not at all there was a fast mingling of victorious and conquered, though; the division of the Arabian troops according to their tribes was an ideal, efficient system during campaigns, and tribal consciousness would be typical for Iranianised Arabs for some centuries. But the high share of Islamic Persians who started to play a role in administration and economy unavoidingly lead to deep Irianian influence on the culture of the Eastern provinces of the caliphate. Though the priority of the Arabian language was unchallenged not only in the field of religion but at first also in philosophy, literature, in all fields of sciences, in administration and jurisprudence, already the architecture of the Umayyads´ residencies, who had moved the seat of the caliphate from Midina to Damaskus, show Iranian influence besides the understandably predominant Syrian-Roman heritage. The Persian influence becomes obvious when under the Abbaside caliphs (779-1258) the seat of the caliphate was moved to Baghdad near the former Sasanian capital of Ktesiphon/Veh Ardashir.

Had Persian influence become visible in the case of architectural details of some of the Umayyad desert castles, Abbaside architecture may be considered a real continuation of Sasanian architecture (Creswell 1958, 161-290). The contemporary descriptions of the caliph´s Al-Mansur circular city of Baghdad emphasize that the plan had been an invention by the caliph which had never been before. But in fact it is impossible that the Sasanian circular city of Ardashir Khurreh/Firuzabad, which was perfectly known in the entire educated Oriental world, was not the example for the residency of the Abbasides. The desert palace of Ukhaidir from the Abbaside period obviously follows the tradition of Sasanian palaces like the one of Qasr-i Shirin, architecture and stucco decorations of the Abbaside residential city of Samarra are unimaginable without Sasanian predecessors.

Mainly, the Abbasides had gained power due to the political agitation and the strategic ability of Abu Muslim who was a Persian, probably from Isfahān, and who at Kufa in Southern Iraq, for some time the centre of the Shi´a and of other anti-Umayyad fractions, had learned about the political disunity of the Arabian society. Particularly the Shi´a, the party which demanded the title of caliph back from the Umayyads for the descendants of Ali, the prophet's son in law, would later be of decisive significance for the Islamic history of Iran. Around 746 AD Abu Muslim, being only 19 years old, went to Khorasan to propagate the claim of the Abbasides, a noble family from Mecca related to Mohammed and competing with the Umayyads. At this time, Khorasan was the most important province of Iran to which also belonged Trans-Oxania, *i.e.* Central Asia. By combining the inner-Arabian, religiously and socially motivated resistance against the Umayyad regime with the dissatisfaction of the Persians with the continuing privileges of the Arabian part of the population, Abu Muslim gained followers from Arabian and Persian side, recruited troops, drove the Arabian governor away and was able to conquer all important cities in Northern Iran, later also in the South of the country. In January 750 AD, his troops destroyed the army of the last Umayyad caliph, Marvan II (744-750 AD) in a ten-days-battle on the Great Zab in Iraq; already two months before Abu´l-Abbas, whose second name was "As-Saffah", "He, Who Sheds Blood", had proclaimed the Abbaside caliphate at Kufa, which would exist until 1258 AD. Abu Muslim, the creator of the caliph, was murdered on a pilgrimage to Mecca in 755 AD by order of the second Abbaside caliph, Al-Mansur; his high prestige among the Persians had made him suspected to be a potential rebel or rival. Also for Ali's party, the Shi´a, his political efficiency brought no great success at first.

With the Abbaside revolution the population of the Iranian provinces, as far as it had converted to Islam, had reached almost complete equality with the Arabian Muslims; now they were allowed to leading functions of administration and armed forces. The earliest and most famous viziers of the Abbasides, the highest officials of the caliphate, came from the Khorasan family of the Barmakides. Then, in the 9th century, Persian families like the Tahirides (821-873 AD) and for some time the Saffarides (867-1495 AD) succeeded with establishing principalities, which were in fact independent under the caliphs´ superiority, while at first having the function of governors; i.e. they had to pay tax to Baghdad and the name of each caliph had to be mentioned during Friday-Prayer and on coins. The most magnificent of these dynasties was the one of the Samanides (819-1005 AD) which from Bukhara ruled Eastern Iran and Trans-Oxania. Its founder, a dekhane from the Balkh area

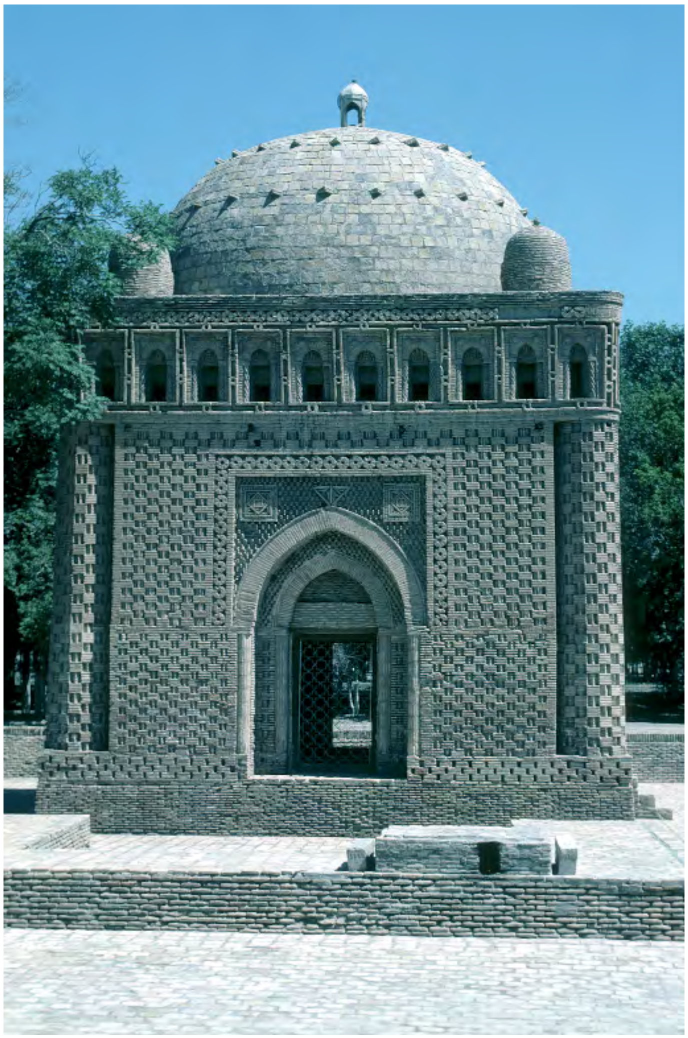

Fig. 17: The Samanide mausoleum at Bukhara; Photo: D. Huff.

who had converted to Islam, traced his descendance back to Bahram Chobin or even the Sasanian royal family itself. Under the Samanides, recollecting the Iranian history became a public matter. The vizier Bal´ami published a Persian translation and adaptation of Tabari's Arabian chronicle which is a compilation of the history of the Sasanian state. Daqiqi wrote the Khudainamak and Firdausi at Tus started to work the same topic into the Shahnameh (Book of the Kings), the Persian national epic, in a dialect which became the Persian standard language. The Samanide mausoleum in Bukhara, which was mistakenly considered the basic type of the Sasanian fire temple, became the example for generations of Islamic mausoleums (Huff 1999b, 151-160) (Fig. 17).

During the 10th and 11th century, the history not only of the Iranian provinces West of Khorasan but of the entire Eastern caliphate was made by the many branches of the dynasty of the Buyides (932-1062 AD). As members of the warlike Dailamite tribes from the Caspian Mountains they served in the armies of other local princes and of the caliph and used their positions in the armed forces at Isfahān, Kerman, and Khuzestan to seize almost all of Iran and Iraq. In 945 AD Baghdad was occupied, in 977 the Buyide Adud Ad-Daula had himself crowned a king by the caliph. Though the caliph's function as the religious head was not put to the question, the political decisions were not longer in his hands. The ruler of all believers had now become a ward of a Persian dynasty which did not try to hide its close and traditional connection to the pre-Islamic Iranian kingdom. The Buyides tried to revive the ceremonial of the Sasanian court. Adud Al-Daula made the old Sasanian place of Ardashir Khurreh a highly frequented second residency besides his main seat at Shiraz and changed its name, which meanwhile had been shortened to be "Gur", to Firuzabad, "City of Victory". Probably as a calculated contrast to the Sunnite confession, which was considered specifically Arabian and which enjoyed the favour of the Abbaside caliphs but which was also the confession of most of the Persian-Islamic dynasties, the Buyides confessed the moderate fraction of the Twelve-Shi´a and were tolerant towards the followers of the old Zoroastric religion. Their position had increasingly worsened under the converted and thus especially strict Persian-Sunnite princes. Particularly in Khorasan and the other Northern Iranian provinces, the number of Zoroastrics was declining significantly due to resignation and emigration. Due to emigration to India, in those days the still existing Persian communities, the Parsians, came into existence there. In Southern Iran, in the regions of Kerman, Yazd, and especially in the Buyidic Fars, conditions were more favourable, many Zoroastrics from Northern Iran sought refuge there. At Shiraz, where Zoroastrics were allowed to move freely without the special clothing which was demanded elsewhere, Mobad Manuchihr was residing who was authoritative throughout the entire country concerning religious questions. Religious manuscripts were written and letters to other communities were exchanged; this is also called a "Zoroastric rennaissance". At Kazerun, the Zoroastric population tried to prevent the erection of an Islamic religious building; in the valleys near Kazerun, particularly in the old part of the town of Girreh, which is now mostly in ruins, with its fire temple being famous in wide areas in those days, still today there are several so called Chahataqs, mostly the remnants of fire temples which probably were built as late as in the Buyide period despite the ban on building them. One of the most interesting buildings of the Iranian architectural history, the so called Sasanian palace of Sarvistan East of Shiraz might be from the same period. According to details of its construction it cannot have been Sasanian and according to its ground plan it cannot have been a palace. Maybe here, in the wasteland, people dared building a fire temple in which, as the ground plan suggests, not only one fire was burning, e.g. the famous Atur Farnbagh of Fars, but more fires were or were supposed to be accomodated which had been driven away from their regular places (Bier 1979).

Buyides and Samanides had been significantly weakened in the late 11th century due to internal struggles and constant wars. During the first decades of the century both of them lost great parts of their territories to the kingdom of the Ghaznawides which had been founded by the leader of Turkish Samanide mercenaries in Eastern Afghanistan and which was fast spreading from India to

Western Iran; Firdausi had dedicated his Shahmaneh to the most important ruler of this dynasty, Mahmud of Ghazna (998-1030 AD). Turkish mercenaries or slaves had been playing a significant role in the armies of the caliphate and its dependent principalities since the beginning of the Abbaside era. In the first half of the 11th century, the Seldchukes, a tribe of the Turkish Oghuses under Toghril Beg, who had been advancing from what is Kazakhstan today to the West, overran the entire Iranian highlands – now not longer as weak-willed mercenaries but as conquerors – destroyed what was left of the Samanide and Buyide kingdoms, reduced the principality of the Ghaznawides to its Easternmost Indian provinces, invaded the lowlands of Iraq, and in 1055 AD took Baghdad.

The Seldchukes confessed the Sunnite confession of Islam and justified their conquest as liberating the caliph from the Shiite Buyides' treating him as a child. In fact, treating the caliph as a child moved on to the Turkish ruler of the Seldchukes whom the caliph gave the title of "Sultan of the East and the West".

The 100 years rule of the Seldchukes meant a peaceful period of economic recovering and a golden age of culture for the country which had been shaken by constant fights and changing rule. After the victorious battle of Malazgird, North of Lake Van, in 1071 AD, which put an end to Byzantine rule over Asia Minor, the Great Seldchukes left the further Turkisation and Islamisation of Anatolia to the Rum-Seldchuke offset and the numerous Turkmen tribes following them and restricted themselves to securing and building the Great-Seldchuke sultanate which reached from Afghanistan to the Mediterranean coast of Syria. Like before, the administration was in the hands of Persian officials, supervised by Seldchuke governors. The economic prosperity also showed up in fine arts and crafts: fine metal craftwork as well as striking, colourfully enamelled sgraffitto-pottery and the highly refined lustre- and minai-pottery, which like in book-painting depicted humans despite the ban on pictures, is typical for the Seldchuke period. In the Seldchuke period also the impressive mosque cupolas which still today form the core of the prominent mosques of big cities. Particularly the Koran schools, the medresses, which until then had been accommodated in mosques or private homes, received their own monumental buildings.

Establishing great, stately payed medresses in all provincial capitals, of which the Nizamiyes in Baghdad and Nishapur were the most famous ones, goes back to Nizam Al-Mulk, Grand Vizier under the Sultans Alp Arslan (1063-1072 AD) and Malik Shah (1072-1092 AD). Nizam Al-Mulk, one of the greatest statesmen not only of his time and under Malik Shah the true ruler of the kingdom, was a convinced supporter of Sunnite Islam. He wrote the Siasatnameh, the book on the rules of government for kings, which offers important insights not only into the ideology of the state but into all aspects of life of the period. E.g. his report on a wealthy Zoroastric from Ray in the late 10th century, whose just finished Dakhma (mausoleum) had been seized by help of a religiously disguised trick, shows that especially at this time the legal position of the members of other religions was increasingly denied. Dismissal of all non-Sunnites from official positions and banning them from public life is expressively demanded in the Siasatnameh by referring to collections of appropriate arguments and judgements by orthodox theologians (Nizam Al-Mulk 1978, 167-170). This happened not only to Zoroastrics, Christians, and Jews but also to Dailamites or rather to all Shiite sects, particularly to the Ismaelites whose sect of the Assassines with their head Hasan-e Sabah indeed was a threat to the ruling class of the state. Their assassinations made them feared not only by the crusaders of the Holy Land, also Nizam Al-Mulk was stabbed to death by one of the "Old Man's of the Mountain" envoys. The destruction of the Assassines was only possible after the next wave of conquerors which swept over Iran, the one of the Mongols, who in 1250 AD conquered Alamut near Qazvin, the main seat of the "Old Man of the Mountain", and the natural fortress of Girdkuh near Damghan which had been besieged for 27 years. Already after 1220 AD, the first Mongol storms had devastated Trans-Caucasia, Khorasan, and the rest of Northern Iran. Between 1255 and 1260 AD, after Djingis Khan's death (1227 AD) and the renewed organisation of the kingdom, his grandson's Hulagu (1256-1265 AD) army, who was the newly elected Ilkhan of the Western Mongolian empire, conquered the whole of Iran. In 1258 AD Baghdad was captured, the caliph, after having told about all his secret treasure, was wrapped into a carpet to prevent his blood from being shed and beaten to death. The Mongolian conquest was much more cruel and destructive than that of the Seldchukes. Particularly the North-eastern provinces, where complete cities and their inhabitants were extincted and the irrigation system was destroyed, never again reached their economic and cultural level. But the other parts of the country – like after the Turkish conquest – recovered surprisingly fast. Concerning fine arts and crafts, the development, which had begun under the Seldchukes, was continued without a break. Particularly the art of making books as well as enamelled pottery reached an unmatched quality due to the introduction of new techniques and fusing of Seldchuke Iconography and Chinese elements (Fig. 18).

Fig. 18: Tile in the Ladjvardina-technique from the Ilkhanide summer palace on the Takht-i Suleiman; Photo: B. Grunewald.

Fig. 19: Sultaniye, the burial mosque of the Mongolian Ilkhan Uldjeytu; Photo: D. Huff.

The same is true for architecture and its decorational forms. The early Ilkhanide palace on modern Takht-i Suleiman in Azarbaidjan is the only medieval palace of Iran which is preserved (Naumann 1977, 74-115); the burial-mosque of Uldjeytu in Sultaniyeh is the peak of mausoleums, which began with the Samanide mausoleum in Bukhara, and the greatest creation of interiors of all Iranian architecture (Fig. 19). Sa´di and Hafiz at Shiraz are only the most famous representatives of the poetry of their time. The Ilkhanide imperial centre had been established in Azarbaidjan which was rich in water and thus especially favourable for nomad warriors and their herds. At Maragheh, the first capital, there worked Nasir Al-Din Tusi, the most famous philosopher and scientist of his time, for whom Hulagu had built an observatory. Later, Tabriz and Sultaniye were major residencies, Baghdad also stayed to be a seat of the ruler although it had lost its position of being the centre of the Islamic world. As half of the Mongolian armies consisted of Turkish tribes and as the Turkish language had become second national language in Iran especially since the Seldchuke period, the Azeri-Turkish language became the dominating language of the province under the Ilkhanes. Originally, the Mongols had been of Shamanist religion – but partly also Nestorian Christians; mostly their elite, and thus the Ilkhanes themselves, were tending towards Buddhism. Hulagu's (1256-1265 AD) wife Doquz Khatun was Nestorian, Abaqa Khan's (1265-1282 AD) wife was a Byzantine princess who after his death went back to Constantinople under the name of Maria Mughliotissa and founded a monastery which is still existent. But Mongols and Christians were mostly connected by a common enemy, the Mamelukes, who had put an end to the Mongols' advance towards the Mediterranean with their victory in the battle of Ayn Djalut (1260 AD) near Damascus and who had driven the Christian crusaders out of the Holy Land. Despite several diplomatic missions between the Ilkhanes, the Pope, and the French king, a military alliance was not established. In those days, in Europe there rose the unrealistic illusion of the far-eastern Christian kingdom of a mysterious "Priest John" which was hoped to liberate the Holy Land after the destruction of the Crusaders' rule. Under pressure of the competing khanate of the Golden Horde in the North, which had long before converted to Islam, and of the Mamelukes in the West, who were allies of the Golden Horde, the most able among the Ilkhanes, Ghazan Mahmud (1295-1304) converted to Sunnite Islam. Thus, the de facto equality of religions in the Ilkhanide empire came to an end though there was no persecution of other religions, the Buddhist monks were expelled from the country.

Just as in the times of earlier foreign rule over Iran, also under the Ilkhanes the administration was in the hands of Persian officials and viziers. Among the most able and most famous there counted members of the Djuwaini family. But during the years before Ghazan´s rule, the corrupt and oppressive tax policy of the vizier Sa´ad Ad-Daula and, after his execution, the interesting but insuccessful attempt of introducing paper money following the Chinese example had lead to riots among the population and to a financial crises. Together with the viziers Ali Shah, of whose gigantic mosque, even surpassing the Taq-i Kisra, remnants are still preserved at Tabriz as ark, fortress (Wilber 1955), and Rashid Al-Din, who was not only an outstanding statesman but also the greatest historian of the Ilkhanide period, Ghazan outlined a reform of administration, justice, and tax which included all fields of life, social care and even protection of animals and which stabilised the situation of domestic policy in the entire country within very short time.

In 1304, Ghazan died at the age of 31 after a reign of only nine years. Under his brother and successor Uldjeytu Khodabende (1304-1216 AD), Rashid Al-Din and Ali Shah continued Ghazan's policy of reform though without support by the new Ilkhan who was not interested in economy and politics. Uldjeytu, baptised under the Christian name of Nicholas, then a Buddhist and a Sunnite, became a strict Shiite in 1310, with disadvantageous results for domestic policy. In the residential city of Sultaniye, which had been founded by his father Arghun (1284-1291 AD), he built the already mentioned burial mosque (Wilber 1955, 139-141) (Fig. 19) for the mortal remains of the Shiite saints Ali and Husein, who had been buried at Kerbela, South of Baghdad, but the citizens refused to deliver them.

Uldjeytu's son Abu Sa´id (1316-1335 AD) seized the throne as a youth. After Rashi Al-Din, accused of having poisoned Uldjeytu by scheming rivals had been executed and Abu Sa´id did not gain any authority, the final decline of the Ilkhanide state began. In 1335 AD Abu Sa´id died without leaving an heir to the throne, probably poisoned by one of his wives whose relatives had been killed before by his orders. Under the successing pretendents and competing groups the state dissolved again into local, feuding territories. With the Ilkhanide empire, Iran had been an independent state for the first time in 600 years. Within borders which were appropriate to those of the Sasanian empire, during its peak there were mostly inner peace, safe roads, and economic prosperity. Only very seldom before and thereafter there was such an amount of religious tolerance and liberal-mindedness. Not without reason the first medieval missions and journeys from Europe to Eastern Asia happen in the Mongolian period; at Tabriz there was an Italian trade post until far into the 14th century. With the Ilkhanes converting to Islam there was a peaceful separation from the anyway dissolving Mongolian empire; the Great Khan's name disappeared from the Ilkhanide coins without worsening the good relationship towards each other. Though the preconditions for continuing a united Iranian state were there, firstly these possibilities was not used. Only about two centuries later the Safawids established a permanent consistent Iranian state.

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Coinage of the Preislamic and Islamic Period

Elaheh Askari & Mehdi Daryaei

Introduction

Coin, a flat piece of metal minted by the state as money, is a valuable archaeological record. It is a living historic document for dating archaeological contexts. Coins as an ancient visual media have always been considered by archaeologists and numismatists. Thus, their contribution is not only in dating the contexts, but also in reflecting the political, economic, social, religious and artistic aspects of the era or site concerned. Although rare in archaeological contexts, coins serve as a valuable resource for archaeological interpretations.

There is no doubt that due to the richness of Iran's culture and history, both in ancient and Islamic times, the high amount of minting and producing coins seems us a direct result of economical prosperity and trade exchanges. Thus, various types of coins from different dynasties were brought into circulation. Two main factors contributed to this:

1 Iran's access to rich mineral sources for useful production.
2 Iran's pioneering role in metallurgy and metal working, enabling the designing of coin dies, based on the prehistoric experience with engraving seals, resulting in the foundation of mints.

The need for setting a standard for payments, establishing a common measure of value and to facilitate the exchanges in the market, led to the striking of coins in the late 6th century BC in Iran. Since then, the royal monopoly of minting was held by the state as the absolute authority in controlling the coinage.

The method of minting was that pieces of gold, silver or copper with a specific weight were placed between dies and the impression was conveyed to the metal with a hammer. Those dies were made from a hard metal like copper or iron and the desired motifs or inscriptions were carved in inverse. Normally all the major cities and centres of the country had mints. On occasions of victories, or different celebrations, special coins were minted as medals or commemorative pieces.
(M.D. & E.A.)

Iran, the early coinage

Achaemenid coinage

From a political, economic and artistic point of view, Cyrus the Great and his successors, especially Darius the Great, changed the Mediterranean world by not only bringing Greek territory under Persian rule and administration, but also familiarising this region with the prosperity of an intercultural Persian culture. The historic event of the conquest of Lydia by Cyrus the Great, the founder of the Achaemenid dynasty, is also numismatically an important event, making Iranians acquainted with the usage of coinage. Many numismatists believe that the gold Croseids, struck by the Lydian king, Croseus, in the mid 6th century BC, can be grouped into two types: Early and Late, and after the conquest of Lydia by Persians they re-opened the Sardis mint by striking the late gold Croseids weighing around 8 g. Archaeological evidence for this comes from the Apadana palace in Persepolis where archaeologists found eight pieces of late gold Croseids predating the royal archer currency (Schmidt 1957, 111) (Fig. 1).

Numismatists believe that Darius the Great, the Achaemenid king, introduced the striking of Persian coins in ancient Iran. His regal coinage, numismatically known as 'royal archer', consisted of two main denominations: Daric, the gold currency and Sigloi (Shekel) the silver one. Contrary to many numismatists belief, there is no terminological connection between 'daric' and 'Darius'.

Fig. 1: Light Gold Croseid, 8,07 g, Apadana Palace, 520 BC, NMI.

The 'daric', the first Persian coin was minted with the contribution of Iranian metal workers and gem designers which had a history of about five millennia of cutting stone and seals. Indeed, the technique and artistry is similar. The daric is made of pure gold, of a weight of ca. 8.40 g and had a priority to the late Croseid gold coins which were 8.08 g (Fig. 2).

Indeed, striking darics strengthened the power of the Achaemanids in territories ruled by them, and also caused great reformations and regulations in terms of economy and trade exchanges.

The silver currency, sigloi weight is c. 5.40 g (Fig. 3). In circulation, as was the case with the light Croseids, 20 silver sigloi equalled one daric in value (Bivar 1985, 617). Therefore, the value ratio between silver and gold was 13.3: 1.

Fig. 3: Sigloi (Type III), silver coin, Achaemenid Period, 5,3 g, NMI 0011.

According to the coin hoard finds, the daric was struck mainly in Asia Minor as a widespread currency for the payment of the Achaemenid army and Greek mercenaries as a part of their military expenses. Besides, it was used as a valid currency in international exchanges through the Mediterranean world from Asia Minor to Italy. Thus, several locations inside and outside the Empire were reported containing daric coin hoards: Oxus in the north-eastern Satrapy in Bactria (Dalton 1964), Susa, Babylonia, Egypt, Cyprus, Macedonia, Greece and Italy (Carradice 1987, 87-89). But most of the hoards came from Asia Minor, which is believed to be the main location of the Persian mints. Achaemenid coinage can be interpreted in two aspects:

1. As a political and military issue for the payment of Persian army, as a political instrument for hiring Greek mercenaries, and to light the fire of war between the Greek city states, Sparta and Athena (Plutarch, 76).
2. The ease of trade throughout the Mediterranean region especially with Greek merchants as part of their economic relations.

Daric and sigloi typology is one of the main issues in Achaemenid numismatics. In terms of their iconography, it would be impossible to attribute the royal archers to a specific Achaemenid king,

Fig. 2: Daric (Type III) 8,38 g, early 5th cent BC, Kestner-Museum Hannover, see Cat. no. 446.

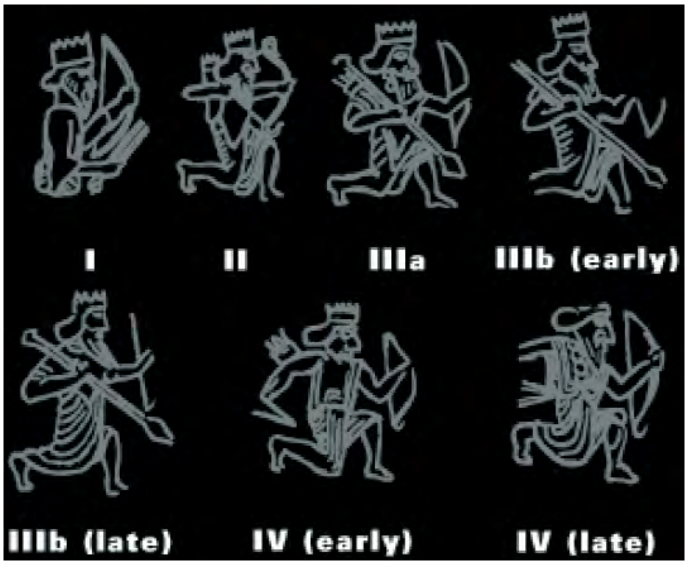

Fig. 4: Types of coin-pictures Achaemenid gold- and silver-coins, after Carradice 1987.

according to their facial characteristics (Daryaei 2004, 20). However, by studying coin hoards, found in various locations across Mediterranean region, Asia Minor, Italy, Greece, Macedonia and ancient Persia a new typology has been developed (Carradice 1988, 78).

Four types can be seen on the obverse of both daric (gold), and sigloi (silver) (Fig. 4):

- I The king, facing right, is represented from his waist upward with the special type of Achaemenid crown and a long beard, bearing Persian drapery in his left hand holding a bow and two arrows in his right.
- II Facing right kneeling and drawing the bow from quiver at his waist (the type of the bow is different with all other types)
- III The main distinguishable element is the presence of a long downward spear in the right hand of the king, while holding the bow in the left. This type has two sub-groups, III a, and III b, according to the pellets.
- IV The presence of ‘Akinakes’, the Persian dagger, at the right hand of the king, while having the bow in the left.

All the above-mentioned Royal Archer types have a single punch-mark on the reverse.
In fact, the obverse of royal Achaemenid coins combines two symbols:

1. A religious message which shows that the king is in battle against the devilish power, a battle which is also represented at Persepolis reliefs.
2. A political message that the Achaemenids conquer their enemies, especially the Greeks, an interpretation based on its circulation mainly in Asia Minor and the satraps of the Mediterranean region; this also illustrates the Persian king as a hero and conqueror for his reputation of wealth and power.

It would be impossible to recognise in the iconography the Persian kings, because all are the same in terms of their face characteristics. Conspicuous bravery was depicted on the coins what led to the circulation of coins as a powerful media in those days. A hoard containing 300 gold darics, uncovered at the Athos canal in Macedonia in 1839 (Kray 1969, 49) where Xerxes ordered to build a canal as part of his military campaign in Europe is a numismatical and archaeological evidence for this historic event which can be interpreted as the military function of the coinage.

Satrapal Coinage

The word satrap is derived from Old Persian, “khshathrapāvā”, the protector of the realm or land. The satrap was appointed by the Great King of Kings. This kind of administration was a powerful and well organised system for safeguarding and managing the territories of the satrap Empire. In general, the Persian kings had a policy of tolerance toward their subjugated nations. They respected the conquered people’s culture and religious traditions. This tolerance can be seen in the behaviour of Cyrus the Great, who did not destroy or burn any of his captured cities.

Even more he constituted the first charter of human rights, which was extended to all ancient nations. This universal innovation has become the basis of a universal declaration of human rights. Practically, this policy led to the independence of satrap coinage, on the basis, that the King granted the individual satrapies to mint their own coins, but of lesser values like silver and bronze. Most of the satrap coinage bears Aramaic legends.

Fig. 5: Datames, Silver stater, NMI.

Fig. 6: Silver coin, Mazaios, NMI.

In this regard, only a few examples will be presented:

1 Tissaphernes (412 BC)
This satrap was one of the most important characters, ruling in Sardis over Lydia, Ionia and Caria. He struck silver drachms and tetradrachms which on the obverse represented him with a Persian hair dress and beard; on the reverse, the Athenian owl with BAE (Basileos) is carved. This sort of cultural exchanges between the Greeks and Persians can be found in several cases.

2 Datames (386-372 BC) (Fig. 5)
Datames, the satrap of Cappadocia, minted silver coins for the payment of his troops. On a silver stator weighing c. 10.8 g the following elements can be seen:
Obv. A female head with flowing hair, nearly facing.
Rev. A bearded and helmeted male head to the right with an Aramaic inscription (Mitchiner 1978, 51).

3 Mazaios (361-334 BC) (Fig. 6)
Mazaios ruled as a satrap over Cilicia, Ebarnahara and Babylonia. His silver coinage shows the Ba'al of Tarsus seated while holding a sceptre and an eagle in his left hand with an Aramaic inscription: 'Ba'al tarz' on the obverse. The reverse shows a lion attacking a bull.

Fig. 7: Sidon Silver coin, 28 g. NMI.

4 Coinage of Sidon (Fig. 7)
Under the authority of the Persians, the city of Sidon in ancient Phoenicia issued one of the 'largest silver denominations in the ancient world' (Mitchiner 1976). This festive or commemorative coin weighs c. 28 g. On the obverse the Phoenician galley is presented, while on the reverse the Persian King on a chariot, riding by a charioteer on left profile, can be seen. The king of Sidon is walking behind.

Alexander and Seleucid coinage

Although the occupation of Persia by Alexander the Macedon and his successors lasted only a short period, the Macedonian ruler recognised the necessity of coinage in the Persian territories and satrapies. The capture of Sardis enabled him to receive the 'rich Persian treasury' (Price 1991, 25), and again in Damascus, Egypt, Babylonia, Susa, Ekbatana and finally Persepolis all the wealth of Persia were looted (Plutarch, 17:1). Persepolis was burnt and destroyed. After all these years of bloodshed he died at Babylonia in 323 BC. In terms of Alexander's coinage all types of coins were struck on the attic standard. For the gold stators, weighing around 8.5 g, we can observe Athena wearing a crested helmet decorated with a serpent on the obverse, and Nike standing facing left while holding a wreath in her extended right hand, and a vertical legend ALEXANDROU on the reverse. In contrast, his silver denominations were more varied. Normally the tetradrachms (around 17 g) and drachms (4 grams) have the following characteristics (Fig. 8):

On the obverse the head of Heracles (Greek Hero) facing right and wearing a lion skin is represented. On the reverse, Zeus sitting on the throne, holding an eagle in his right hand and a sceptre in his left can be seen. On the right hand of the reverse there is a vertical legend: ALEXANDROU, like on his gold stators. At excavations at Pasargadae three types of coin hoards have been discovered, which archaeologically are connected to the destruction of the site, as follows found in rooms: 82, 187, 86a (Jenkins 1978, 185-186) all belonged to Alexander and his successor Seleucus I.

The types contain both drachms and tetradrachms and were struck in the following mints: Ake, Amathus, Amphipolis, Aradus, Babylonon, Byblos, Ekbatana, Kition, Marathus, Myriandros, Persepolis and Susa.

Parthian Coins

Arsaces, the first Parthian ruler, with his brother Tiridates expelled the Seleucids from Persia around 250 BC and re-established the glory of Persia for another 500 years.

Fig. 8: Alexander silver tetradrachm, 16 g, NMI.

Fig. 9: Silver tetradrachm, Artabanus II, 16 g, NMI 136.

The standard currencies in this era were silver denominations, drachms and tetradrachms (Fig. 9 & 10). The drachms weighing c. 4 g bearing on the obverse the portrait of the Arsaces (King) at a left profile is represented with a bashlik (tiara). The silver coinage exhibits an enthroned archer holding a bow on the reverse. Some scholars believe this image might represent Arsaces, the founder of the Parthian Empire (Sellwood 1970, 11).

Three types of legends were employed on the reverse by the Iranian Parthian craftsmen during 500 years of coinage: Greek, Aramaic and Middle Persian (Parthian Pahlavi). Mint names were shown by monograms, which indicate that several mints were operating in coin production: Abarshar, Apamea, Areia, Artemita, Charax, Ktesiphon, Ekbatana, Edessa, Epardus, Hecatompilos, Kangavar, Laodicea, Margiana, Ninive, Nisa-Mithradatkart, Rhagae, Saramana, Seleucia, Susa, Syrnyx, Tambrax and Traxiana.

Sasanian Empire

After Ardashir Babakan, the king of Persis, defeated Artabanos IV, the last Arsacid king, he crowned himself in Ktesiphon, beginning a new era in Iran. His successors, especially Shapur the Great, brought back all Persian territories from the Romans. The rock relieves in Naqsh-i Rostam in Persis, engraving the capture of the Roman Emperor Valerianus, kneeling for Shapur I, present an archaeological record of this historic event. Sasanians were proud of their Achaemenid descendance and applied many Achaemenids elements in their art to raise their credibility. After Ardashir I came into throne he unified Iran under two main issues: Iranian (Aryan) nationality and Zoroastrianism. From this time everything was under the service of the above-mentioned elements. Coinage was no exception. Politics and religion were strongly intertwined together and the extreme insistence on these two elements by the

Fig. 10: Silver drachm, Darius, 4,15 g, NMI 139.

Fig. 11: Gold dinar, Shapur II, 7,82 g, NMI 244.

Fig. 12: Gold half-dinar, Khosrow II, 4,56 g, NMI 1064.

Fig. 13: Silver drachm, Ardashir I, 4,1 g, NMI 1301.

King and the Zoroastrian priests for more than 400 hundred years, eventually led to the collapse of the Empire under the attack by the Arab nomads.

In their coinage, the Sasanian court applied symbolical, national and religious iconography and legends, where they engraved fire alters, the symbol of Zoroastrianism.

From a numismatic point of view, Sasanian coins can be divided into two main groups: Festive issues and normal currency (Göbl 1971). The festive coins, called dinar, were issued in gold to commemorate or celebrate special occasions such as the Iranian victory over the Romans, Kushans, Hepitalites and others, which are exactly parallel to Sasanian rock relieves. They were also used to commemorate the king's coronation. From the beginning Ardashir introduced his own gold coinage. According to Alram (2003, 23) 'the Roman and Kushan gold coinage of his western and eastern neighbours may well have served as a model, but Ardashir went his own way with regard to the standard of coinage'. His new dinar had at 8.5 g a higher weight than the Roman and Kushan dinars, although after him the weight was reduced to c. 7 g.

Fig. 14: Silver drachm, Shapur I, 3,44 g, NMI 2349.

Several dinar denominations were issued in Sasanian Iran: Double-dinar, one and a half dinar, half-dinar, 1/3 and 1/6 dinar (Fig. 11 & 12).

The main currency in this period was the silver money, the drachm, called in Middle Persian drahm, are the thinnest and largest drachms ever produced in ancient times. There was a fluctuation in terms of its weight but in general they are c. 4 g and like the dinar it has several denominations: half-drachm and 1/6 unit.The iconography of Sasanian coins is marvellous; the King (or Queen in late period) is represented with the royal crown and ornaments on the obverse in a right profile.

On the reverse, the Zoroastrian fire-altar is engraved, later on with attendants on each side of the altar. The image of which varied between different issues (Alram 2003). The coin legend is written in Middle Persian (Sasanian Pahlavi) script. The typology of the King's crown is an interesting subject in numismatics. Each King had its own crown therefore in the first glance they are identifiable according to their special crowns (Göbl 1971, 7) (Fig. 13 & 14).

From the time of Varhran IV, mint abbreviations become common on the reverse. The study of these mint abbreviations is a major new aspect of numismatic research, and until be crucial to ones understanding of Sasanian coinage and history (Fig. 15 & 16).
(M. D.)

Islamic coins

After the advent of Islam and its spread throughout the region, the influence of Islam affected the coinage. After the collapse of the imperial kingdom of the Sasanids and after Yazdegerd III the Arab rulers minted coins like those of the Sasanid period in Islamic Iran. These were the first Islamic coins minted. The Muslim rulers

vig. 15: Silver drachm, Khosrow II, 4,06 g, NMI 267.

did not use their portraits on these coins, but used the portraits of the Sasanid rulers as they had been used in the past. These coins are named Arab-Sasanid. The first four caliphs used the names of the Sasanid rulers on the Arab-Sasanid coins. These coins generally bear the portrait of the Sasanid Khosrow II and the names of early Islamic rulers with inscriptions in Pahlavi or Kufic script on the obverse and the name of the mint and date in Yazdegerdi or Hejira years on the reverse. Generally the names of God, the prophet Mohammad and other holy invocations were added to the borders. The metal of most of these coins is silver (Dirham) and sometimes copper (Fels). The first time Islamic Dirham-coins were minted by order of Omar Ibn-e Khattab in the 8th year of his reign, i.e. 641 AD. On the obverse there were the portraits of a Sasanid monarch and inscriptions in Pahlavi script appeared on the reverse. This was continued until the reign of the Umayyads. The minting of Arab-Sasanid coins during the first four caliphates and the early rule of Abdul Malek Ibn-i Marvan in 700 AD. After this date Islamic coins without portraits were minted.

The first golden coin without a portrait was the Dinar, minted in 700 AD during the reign of Abdul Malek Ibn-i Marvan, the Umayyad caliph. A verse inscription from the Holy Koran can be seen

Fig. 16: Silver drachm, Queen Buran.

Fig. 17: Tabarestan coin, avers: Tabarestan ruler in style of a Sasanian king with the name Said Ibn Ta'latj in Kufic writing; revers: Fire-alter with two guardians and Pahlavi-inscription: Farrāh afzut; May the glory of the king increase; mint: Tabarestan (Tapurestan), around AD 700; NMI 293.

Fig. 18: Abbasid gold coin, Al Mokhtader, avers/revers: Kufic incription with coranic text, Minting year: AD 926; mint: Al-Rafegheh/Irak; NMI 1157.

Fig. 19: Bujidic gold dinar with Kufic inscription, minted by Gouverneur Ahmad Ibn Ali, Mint: Mohammadiye/Ray, NMI 1173, see Cat. no. 448.

on one side of these coins. From the year 700 AD silver coins were officially minted and thereafter Arab-Sasanid coins went out of circulation.

Although Islamic coins with scripts and without portraits were in circulation from the second half of the 1st century AH (700 AD) coins in the style of Sasanid coins with portraits still were minted in Tabarestan until the 2nd century AH (about 800 AD). These coins, which are smaller than the Arab-Sasanid coins, are named Tabarestan coins (Fig. 17). The coins of Arab-Tabarestan rulers are similar to those minted by the Espahbodans. The difference is that the name of each ruler is in Kufic script and the name of Tabarestan and the year of minting are in Pahlavi script on the reverse side of the coin. The Espahbodan family of Tabarestan descended from the Sasanid dynasty and ruled in the Tabarestan area. They used a special local calendar with years named Tabari.

As mentioned before the first Umayyad coins with scripts (in gold) were minted during the reign of Abdul Malek Ibn-i Marvan and

Fig. 20: Samanid coin, Nassr-Ibn Ahmad (AD 914-943) with Kufic inscription, AD 934, Mint: Nishapur; weight: 4,96 g.

replaced the Arab-Sasanid Dirhams. During the Umayyad caliphate the name of the caliph does not appear on the coins. Only the date and place of minting appears on the silver coins and the date of minting on the gold coins. On Umayyad coins, the phrase "God is One" appears in Arabic language, along with the place and date of minting, and on the reverse side, the Holy Surah Al-Ekhlas without the word "Qol" appears.

From the year 744 AD, when the revolt against the Umayyads under the leadership of Abu-Moslem Khorassani took place, until the end of the Umayyad Caliphate in 749 AD and the reign of As-Saffah, the first Abbasid caliph, coins with political scripts against the Umayyads were minted. These coins are known as Abu-Moslem coins. They still did not bear the name of the caliph and thus were similar to those of the Umayyads. They were minted in Jebal, Khorasan, Khuzestan and Fars. The difference between the coins minted by the revolutionists and Umayyad coins lies in their different transcription of Verse 23 from the Sura 42 of the Holy Koran. On none of the silver coins does appear the name of Abu-Moslem, but on copper coins between the years 744 to 749 AD the name of Abu-Moslem is seen. On the borders on the reverse side of Umayyad and Abbasid coins part of Verse 33 from Sura 9 (At-Towbeh) is visible. On the reverse side, by order of As-Saffah, the first Abbasid caliph from the years 749 to 753 AD who was the descendant of the uncle of the Prophet Mohammad, an Arabic statement appears instead of Surat-Al-Ekhlas. On the border of Abbasid coins, Verses Nos. 3 and 4 from the Sura 30 (Ar-Rum) can be seen.

The rule of the Abbasid caliphs lasted from 749 to 1256 AD. The various rulers in different parts of Iran used their titles along with the name of the caliph on their coins (Fig. 18). From the middle of the 9th century AD, when the local rulers of Iran like the Saffarids and the Dailamites became powerful, they began to weaken the rule of the caliphs. Thus, when Mo'ezz-od-Dowleh entered Baghdad in 944 AD, he was personally greeted by Mostakfi, the Abbasid caliph. The power of these local rulers was such that they could change even the caliphs. However, reasoned in religious reasons, the respect for the caliphs has maintained and their

Fig. 21: Ghaznavid coin, Sultan Mahmood (only title and date of mint are mentioned), with Kufic inscription, AD 1025; mint: Nishapur; weight: 4,5 g; NMI 390.

Fig. 22: Khorasmshahid (local King of Khorasan/Khorasm) Alaedin Mohammad (AD 1217-1238), Gold; Mint: Nishapur, Kufic inscription; NMI 12686.

names continued to appear on the coins. In the 10th century AD, for the first time after the Sasanid dynasty, the title of "King of Kings" appeared on the coins minted by the Buyids (Fig. 19). The Suras from the Holy Koran which were minted on the border of Abbasid coins also appear on the coins minted by the Samanids (Fig. 20), Ghaznavids (Fig. 21), Buyids (Fig. 19) and the following dynasties (Fig. 22).

On Ilkhanid coins, the Name of the Mongol Khans in Uighur script appeared (Fig. 23). After the death of Abu Sayed Bahādor Khan in the year 1333 AD various families came to power, like the Jalayerids, the Mozaffarids, the Sarbedaran, the Timurids and other families. Each of them ruled in a different part of Iran. Coins from this period are valuable from a historic point of view. Most of the coins of these rulers are copies of Ilkhanid coins. In addition to the titles and names of the rulers, the names of the first four caliphs also are designed on these coins. Up to the rule of the Seljuqs the face of humans and animals did not appear on the obverse of the Islamic coins of Iran. The only visible designs are the sword, the crescent of the moon and stars. However, on the coins minted by the "Rum Seljuqes", designs like lion and sun, and on those minted by Toghrol Seljuq, a doom and minarets can be seen. The great Ilkhans used an honorific title but those in Iran preferred the title of king of kings of Islam, sultan and other titles of the Iranian kings. Sometimes their names also were inscribed in Uighur script on the coins. On the coins minted by Ghazan, the name Ghazan Mahmoud is visible in Kufic, Uighur and Chinese.

In general, over six centuries, from Arab-Sasanid, Umayyad, Abasid, the kings of Iran and the Turkish Sultans until the Mongol invasion, the designs on coins were normally in old Kufic scripts and without dots. Only on the copper coins of the Atabegs and Khwarezm-Shahs the design did show changes due to calligraphy. After the Mongol invasion, the Kufic scripts were gradually replaced by Naskh and Nasta'liq, used until Safavid dynasty. The changes of scripts on coins developed much slower than changes in normal writing. The portraits of animals on copper coins were used for a special reason: The lion and sun motif showed changes with the passage of time. Toghra signatures from the Mongol and Turkmen sultans also became prevalent and persist until the 19th century. The most readable forms of these signatures are those of Nasr-ed-Din Shah.
(E. A.)

Fig. 23: Ilkhanid gold dinar with Kufic inscription, minted in Gorgarm by the Gouverneur Abu Said Bah_dor, AD 1319; NMI 1196, see Cat. no. 449.

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A Late Sasanian helmet and a sella castrensis from NW-Iran

Bruno Overlaet

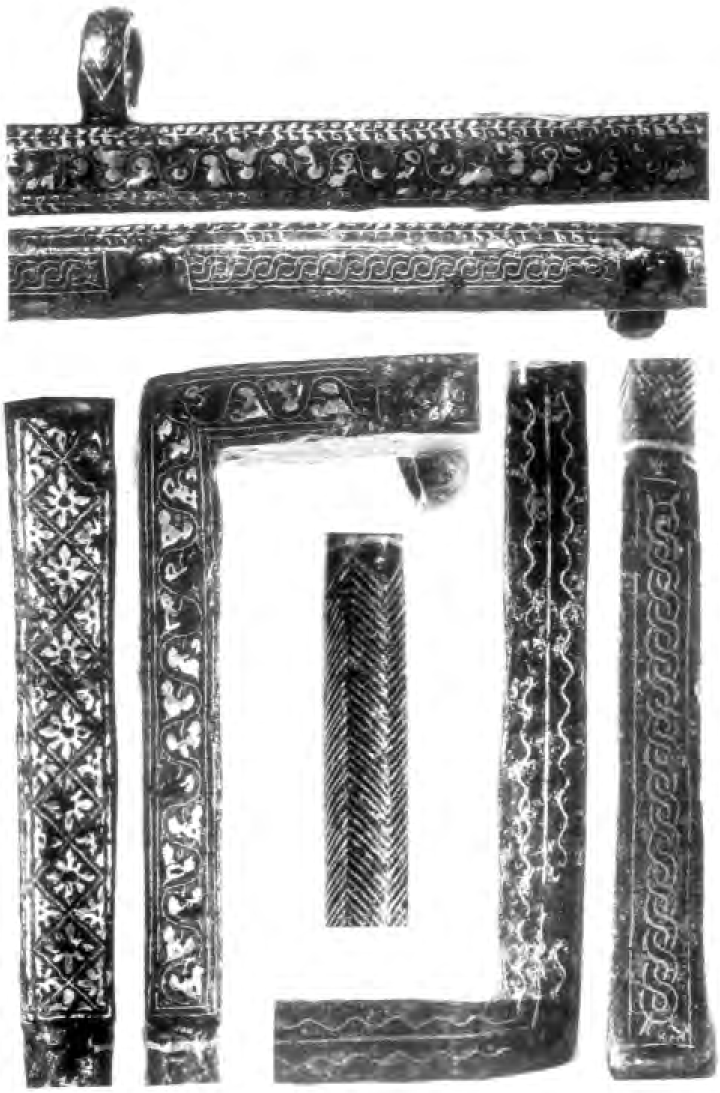
In the mid sixties, "The Royal Museum of Art and History" acquired some antiquities which were said to come from Cheragh Ali Tappeh in NW Iran (Overlaet 1982; 1995). This site, also known as Marlik Tappeh, was renowned for its Iron Age cemetery and like "Gilan", "Amlash" or "Rudbar", its name was often mis-used in the art trade as the alleged provenience for Iranian finds. Although its exact provenience is thus not known, a NW Iranian origin was nevertheless convincing in view of the tracked commercial history of the pieces and since the region was at that time the source of many finds surfacing on the antiquity markets.

Among the finds, which were said to come from a single tomb, were iron swords and daggers, a heavily corroded iron folding chair (Fig. 1-2) and an iron Spangenhelmet covered with bronze and silver. The character of these finds makes it probable that they did come from one (or several contemporary) tombs. Sasanian tombs are extremely rare in Iran, since the official Zoroastrian faith specifically forbade the interment of bodies. Historic sources mention, for example, a treatise between the Sasanian king Khosrow I and the Byzantine emperor Justin II to secure the Christians living within the Sasanian empire the right to bury their dead. Sasanian tombs are attested in Dailaman, however, and the Zoroastrian faith does not seem to have been firmly established in this area. Early Islamic sources even mention the existence of people in Dailaman who did not adhere to any known religion. Politically, the Dailamites preserved much of their autonomy until the beginning of the 6th century AD when the area was incorporated into the Sasanian dominions (on the Dailamites and their religion, see Minorsky 1932; 1965).

The helmet and the folding chair are both out of the ordinary items, which must have belonged to an important, high-ranking individual. They are regalia, which reflected widely understood values, known and recognised from the Mediterranean Roman and Byzantine world to Central Asia and the Far East.

The shape of the folding chair is simple. Two rectangular frames, respectively 66.5 x 41 and 66.5 x 38 cm, pivot on an iron pin in the centre of the long sides. The long sides of one of the rectangles are curved to fit around the other. An iron rod, which passes

Fig. 1: Details of the iron sella castrensis with brass and silver inlay. Royal Museums of Art and History, Brussels, Inv. IR.1316.



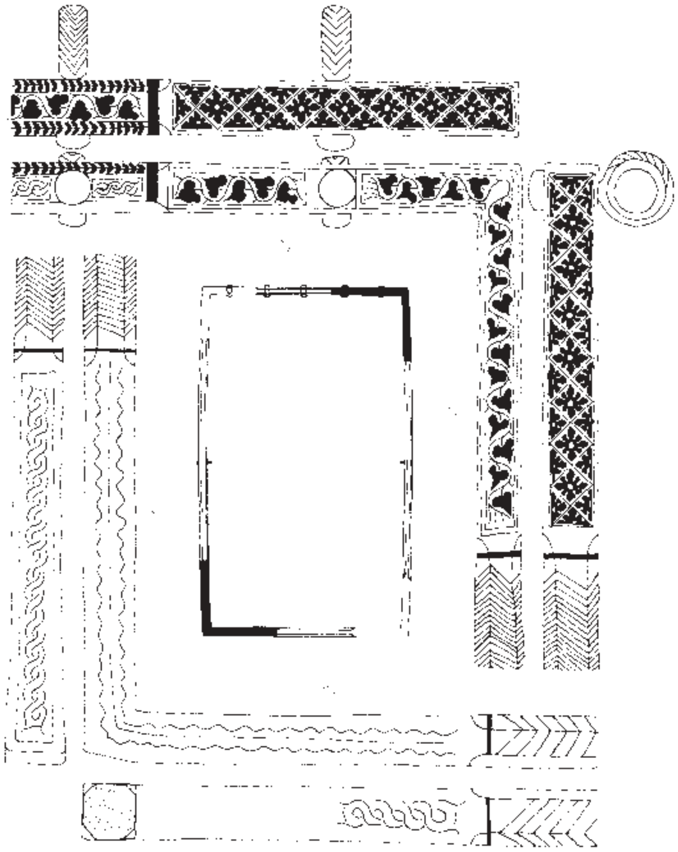


Fig. 2: Analytical drawing of the sella castrensis.

through five rings on the top horizontal bars, held the textile seat. The iron bars of the frame have a square section (14 x 14 mm) at the corners and are octagonal in the middle. All visible parts of the stool were elaborately damasquinated with brass and silver underneath the rusty surface. Careful cleaning revealed intricate geometric and floral patterns. The upper part is decorated with silver floral and geometric inlay, the middle and lower part with brass geometric inlay. The lower bar, which rests on the ground, is decorated on the two visible sides only. Similarly, the upper horizontal bars with the five rings are only inlaid on the top and outer side. It indicates that they were to be seen and were not covered by the textile seat or by cushions.

This stool, shaped as two crossed rectangles with the bottom transversals functioning as a base, is of a simple, yet not very common type. Similar iron stools were excavated in 5th-6th century royal Nubian tombs at Ballana, in 6th century Avar tombs at Kölked-Feketekapu in Hungary and in late 6th/7th century Langobardic graves at Nocera Umbra in Italy (see Wanscher 1980, 146, 210-214, 323; Overlaet 1995, 101-103). The Italian folding chairs are identical in shape and so similar in decoration that if not a common workshop, at least a common cultural background must be suggested.

The prestige, associated with such folding chairs, originates in the Roman world (for an extensive discussion see Wanscher 1980). This straight-legged type of folding chair or campstool, referred to as the “sella castrensis”, is the military counterpart of the “sella curulis”, the seat of office of high Roman magistrates from early Republican times onwards. The sella curulis was propagated as the ultimate symbol of power. It was carried with the fasces in front of Roman senators and the chair was depicted as a symbol of his office on, for example, coinage and funerary monuments. The Roman emperor Trajan depicted himself on a bronze coin seated on the military version, the sella castrensis, while he crowns the Parthian Parthamaspates as king of Armenia (Fig. 3). Submissively kneeling in front of the podium is the allegorical figure of Parthia. Imagery like this propagated the association of power and folding chairs and also explains the appearance of a sella curulis on Kushan coins and on Central Asian wall paintings at Panjikent. The association of power and folding chairs also survived in the late antique and mediaeval western world. Folding chairs became the seat of office of both worldly and religious leaders. The use of, for example, the faldistorium or episcopal seat is still precisely regulated in Roman-Catholic ceremonies.

Where the damasquinated folding stools were made remains to be established. This decorative technique was widely used in barbarian workshops but they may also have been made in a Late Roman or Byzantine workshop. Byzantium had close contacts with the Langobards as well as with Iran. The emperor Justinian, for example, is known to have used Langobardic mercenaries in his military expedition against the Sasanians in 553 AD. How a folding stool of Barbarian or Byzantine origin eventually arrived in Iran

Fig. 3: Roman coin of Trajan: the emperor, seated on his sella castrensis, crowns the Parthian king (after Kurz 1972, 300).

Fig. 4: Silver sheeted sword. Abegg-Stiftung, Riggisberg , Switzerland (Photo: Abegg-Stiftung, Chr. von Viràg).

cannot be said. It may have been as booty, as a present or even as a tradegood.

The Sasanian helmet is formally related to the European "Baldenheimer helmets", a type of Spangenhelmet which is usually decorated with an amalgam of late classical and barbarian elements and which was produced in Byzantine or Ostrogothic workshops. Their occurrence in chieftain's graves indicates that they were clearly seen as "Rangabzeichen" (Werner 1988). The material, decoration and refined workmanship of the arms and of the suit of armour have in all cultures and all times reflected the social position of a warrior. Its elaborate decoration classifies the Sasanian helmet amongst the regalia of an important Iranian chieftain.

The helmet consists of four plates placed between a horizontal browband, a vertical band from the front to the back and two short bands on both sides. These iron bands are all sheeted with bronze, whereas the four iron plates are covered with a silver sheet. Bronze rivets hold the construction together. Perforations along the lower rim probably served to attach mail. The silver plates are decorated with a pattern of feathers, small embossed scales with incised lines within each scale. The same scale pattern is dotted on the bronze sheeting of the bands. A circular motif is present on the apex of the helmet. On the front of the browband there is a lunar crescent placed on a pedestal. This crescent has minuscule crescents placed on both extremities.

Silver and gold sheets with feather or scale decoration also occur on three more helmets, on a dagger and on a series of swords (Fig. 4), all of which are claimed to come from northern Iran (for a complete list with bibliography, see Overlaet 1998). Two of these helmets also have a crescent on the front. Since few Sasanian helmets have survived it is difficult to date them. However, the swords, which have an identical feather decoration, do provide some dating criteria. They have straight double-edged blades, no guards and a slightly curved grip with two indentations, one for the index finger and one for the three lower fingers. These swords were attached to the belt with straps of different length that ran from the belt to two mounts on the side of the scabbard. The sword was thus held in an oblique position. The advantages of this two-point suspension system (Trousdale 1975) are obvious and explain why it is still used by the modern cavalry. The tip of the long sword did not drag on the floor and the weapon could also be drawn much faster. The scabbard could be moved backwards with one hand while the sword was drawn with the other. The first time that this suspension is depicted in an Iranian context is on the early 7th century rock sculptures of Khosrow II at Taq-i Bustan (Fig. 5). Earlier representations all show long straight swords with broad guards that are carried in a vertical position and are attached to the belt with a scabbard slide, a kind of hook on the back of the scabbard. The use of this new suspension combined with an asymmetrical hilt, suggests that the swords, and the helmets, are to be dated in the late 6th or 7th century AD, *i.e.* at the end or shortly after the Sasanian rule.

Although decorative scale patterns are not uncommon in Sasanian art and occur on stucco, architectural elements and silverware, such patterns are found on horsegear and armament in a much wider cultural area. This suggests that the feather pattern may have been more than purely decorative. It may have had another more symbolic significance. Scale decorated gold or guild bronze and silver sheets already occur on early 5th century Hun armament and equipment (see Werner 1956). It can be seen on Hun saddles, daggers and swords. In this context, it indicated a high social rank and the possession of a gold sheeted bow was, for example, the privilege of a Hun warlord. The scale decoration is found throughout Eurasia, however. It is found in South Korea from the 5th to 7th century on arms and horsegear in early Silla tumuli. Various types of imbrication patterns even occur on Japanese swords in the same period and are thought to be a south Chinese influence (Anazawa & Manome 1979). In Europe, the pattern is well known on the 6th century Bal-

Fig. 5: Rock sculpture of Khosrow II at Taq-i Bustan.

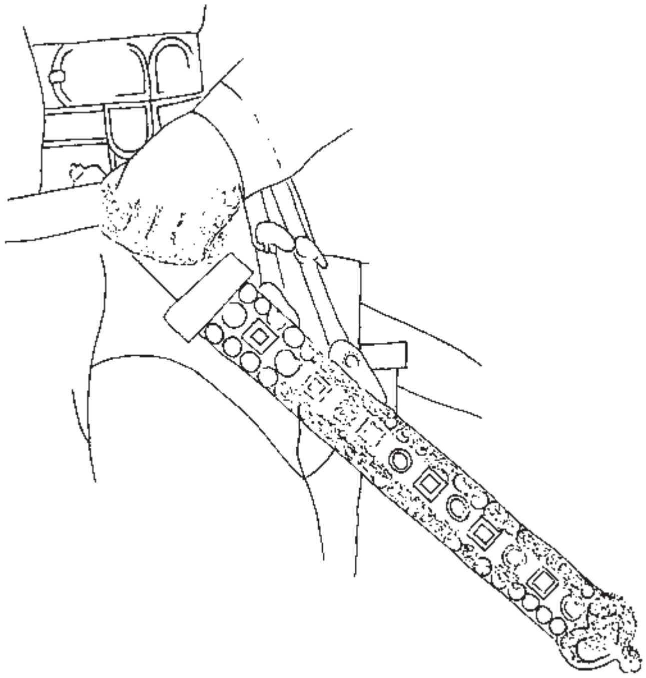


Fig. 6: Detail sword attachment Khosrow II. Drawing B. Overlaet.

denheimer type helmets, which are related to the above mentioned Sasanian helmets. Unique to the Sasanian objects, however, is the incised pattern within each scale, which supports the interpretation as a feather pattern. It has been suggested (Ghirshman 1963, 310) that it refers to the mythical Varagna bird, one of the incarnations of the Zoroastrian god of victory Verethragna. In the Bahram Yasht, protective powers are ascribed to its feathers.

This richly decorated military equipment, which includes helmets, swords and a sella castrensis, must have belonged to members of a ruling nobility or to local chieftains. They are claimed to come from tombs in Dailaman or northern Iran, but since none comes from controlled excavations, it is impossible to assess their precise cultural context. The available data all suggest a late 6th or 7th century date, but in the end, only finds from controlled excavations can provide a reliable and more complete understanding of their proper cultural context.

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The circular shape of the ancient Ekbatana (today: Hamedan) is supposed to come from the Sasanian times.

Technical Examination and Provenance Studies on Sasanian Silver Vessels from Quri Qaleh

Fereshteh Rahimi

Introduction

Silver vessels are among the many outstanding works of art produced by the Sasanians. Study of these vessels can potentially help to elucidate the culture, social customs, political establishments and technological progress of the Sasanian Empire, which lasted 400 years (224-627 AD) and covered a vast geographical area stretching from the Black Sea to the Persian Gulf and from Syria's Mediterranean coast to central Asia – this huge area included Iran, Iraq (Iranshahr), and parts of Armenia, Georgia, and Afghanistan. The study and analysis of Sasanian silver vessels is beneficial from a chronological point of view because the vessels' decoration reflects the conditions and events that were occurring simultaneously.

Many studies have already been carried out on the silver vessels housed in museums and galleries around the world, and various classification and divisions have been devised by researchers. Some of these vessels were found during archaeological excavations in Iran and Iraq (the heart of the Sasanian Empire); many are from Perm, west of the Ural Mountains, far from their place of manufacture and the areas where these objects may have been sent as royal gifts. While Iranian Sasanian silver vessels are common museum items all over the world, most were unfortunately found during unauthorised excavations, and therefore does not exist information associated about their provenance.

Another point which should be made about Sasanian silver vessels pertain to those with royal images on them; it was common to imitate these images, which illustrates the extent of Sasanian influence on neighbouring cultures during the empire's domination and the time after its fall.

The objects of this study include eight silver vessels, which were found by workers of the governor's office in Paveh town during the 1997 grading process of the entrance to Quri Qaleh cave (Fig. 1-8). The cave is located near the village of Quri Qaleh, in the Kermanshah Province, on the side of Shahoo Mountain. Some Arab and Arab-Sasanian coins were found with the silver vessels, which play an important role in determining the dates of the vessels; two ceramic jars were also found. The finds were transferred to the Kermanshah Cultural Heritage Centre; these objects are important because they were found in an area whose reputation is closely linked to the presence of Sasanian works, an area that was also notably the bridge between Mesopotamia and Pars.

The figural and decorative motifs of the silver vessels, as well as other evidence, relate them to the late Sasanian and early Islamic period; however, this period of art is hardly understood historically and metallurgically. This is in part because the Sasanian style continued to be produced in the art of Iran and Mesopotamia for several centuries after the decline of the Sasanian dynasty itself to the early Islamic period, which clearly confuses matters.

Sasanian Silver Vessels

Silver vessels are the most famous Sasanian artefacts. These objects have their own special style and method of manufacture, and can be classified into stylistic groups. Many Sasanian figures and motifs were adaptations of people with various cultural backgrounds. The penetration of the Sasanian Empire eastward into Central Asia and its temporary control on large parts of the Silk Road resulted in Iranian designs influencing the art of the Far East. The precise relationship between the Sasanian East and the Romano-Byzantine West is less well-understood.

During the last ten years, studies on Sasanian silver vessels have resulted in typologies based on theme, decoration style, and relation to specific areas, cultures, and periods.

Historical art and technical studies can provide reliable evidence pertaining to customary styles and authenticity.

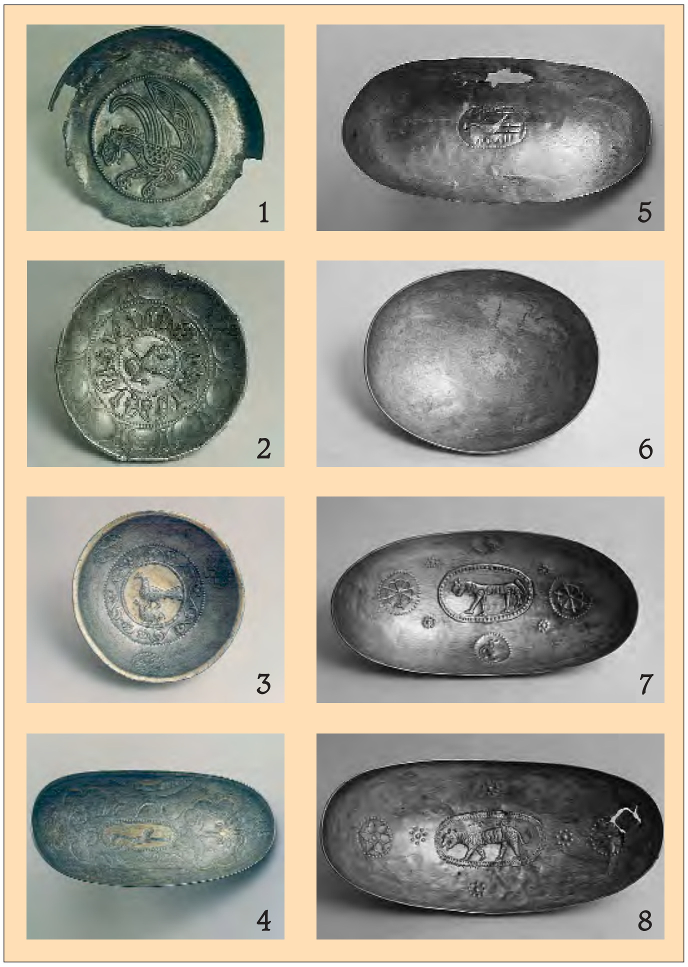

Fig. 1-8: Silver vessels found in the Quri Qaleh cave.

Recent studies by Pieter Meyers on methods of manufacture indicate that different techniques and levels of craftsmanship were involved in manufacturing the silver vessels – none were produced by simple molding. Decorative techniques were varied and intricate: bowls and plates with lots of ornamentation could have separate silver pieces added to provide even more relief decoration, vases and ewers could be decorated by hammering and chasing.

Many of the vessels were gilt by an amalgam of gold and mercury. Sometimes small objects, such as small circular bowls, were made of silver with high percentage of copper. Royal court silvers are qualitatively more pure and additionally have a more uniform metallurgical composition. Analyses have shown that there are some differences between the courtly productions and provincial productions – this indicates that while workshops were not centrally controlled and different mines were exploited, the courtly vessels were made of silver from one mine.

The silver vessels which were found at the Quri Qaleh cave site can be divided in three groups. Vessels of the first group are the most numerous, and include elliptic or boat bowls; they are light-weight and relatively simple compared to other Sasanian silver vessels. The second group includes two small circle bowls, which are related to late Sasanian period according to Harper's chronology. The third group includes only one object, a circle cup with a right angle and a sidewise as the following figure: اــــل There are some objects like this figure with larger dimension among silver and bronze vessels attributed to the late Sasanian period.

Technical Study on Silver Vessels of Quri Qaleh Cave

In order to identify the technology of the Sasanian silver vessels, many studies on royal vessels have been done. As mentioned above, these objects are attributed to the late Sasanian era based on archaeological evidence. There are many unknown factors in this case: what kind of ore, the location of the mines, the smelting methods, the place of smelting, the methods for producing alloy, the shaping methods, the decoration methods, and the development process of metallurgical methods.

Technical studies on these vessels have been done in order to:

1. determine the method of manufacture
2. determine the origin
3. analyse the composition
4. determine the decorative methods.

Usage Methods

Radiography

X-ray radiography is often used to study archaeological objects. In this study, x-ray radiography was used to study over 100 Sasanian silver vessels and an equal number of related silver objects, and

Fig. 9: Radiograph of the silver vessel Quri Qaleh No. 871.

Lab-No.	Sample	Cu	Zn	Sn	Pb	Bi	Au	Fe	Ni	As	Sb
FG-011932	QC 871	24	2,6	0,045	1,1	0,038	0,6	0,3	N D	N D	0,01
FG-011933	QC 872	24	3,7	0,19	0,72	0,045	0,19	2,3	0,08	N D	0,09
FG-011934	QC 873	19	0,32	0,015	1,06	0,03	0,62	0,18	0,02	N D	0,003
FG-011935	QC 874	17	N D	0,4	1,65	0,094	0,6	0,62	0,05	0,01	0,03
FG-011936	QC 875	7,2	0,6	0,35	1,22	0,028	0,7	0,6	N D	N D	0,008
FG-011937	QC 876	52	4,3	0,11	1,15	0,036	0,46	0,56	0,1	0,06	0,016
FG-011938	QC 877	29	1,3	0,086	0,97	0,033	0,6	0,26	0,07	N D	N D
FG-011939	QC 238	6	0,003	N D	0,25	0,032	0,7	0,28	N D	N D	0,005

Fig. 10: Chemical analysis of Quri-Qaleh silver vessels (in percent).

results indicate that Sasanian silver objects were shaped by hammering.

Radiographs were obtained with x-ray energy of 54 kV and 60 mA. The radiographs had high quality and the characteristics of the objects were clearly demonstrated; only the image of object No. 871 was not clear, because the centre of the vessel was very thick. A second image was obtained for this object, with x-ray energy of 64 kV and 80 mA, which provided a sharper image of the centre (Fig. 9).

The results of the radiographic study of the objects are as follows: density variations in all of the radiographs can be observed, the thickness is less in the area of curvature, none of the objects contain trapped gas, and they were made by hammering moulded sheets.

Object No. 871, which needed a greater amount of x-ray radiation penetration in order to produce its radiograph, shows a tape around the central design. This tape indicates the presence of another layer in the centre of the vessel – in fact this is one of the decorative methods used in production of Sasanian silver vessels. To produce certain decorations, pre-cast and pre-hammered pieces were attached to the objects; in order to fix these additional prefabricated pieces into place, a simple pattern was carved on the metal and the sides of the hollow areas and the resulting edges were curved back. The pre-cast piece was fixed and a curved edge was secured on the added edge by hammering. Then decorations were completed by chasing, carving and/or gilding. The amalgam gilding method was used for object No. 871.

Metallurgical Structure

Metallographic study is another of the methods used to study old metals. Four samples were examined using this method; the results indicate that the corrosion rate was considerable, the presence of silver-copper eutectic of silver-rich phase was shown. The presence of typical cast dendritic structure and a considerable amount of their deformation in object No. 875 show that these objects were shaped by cold hammering.

Results of elemental analysis

Most objects were made of silver-alloy with high impurities. A copper with a large amount of zinc or brass was most likely used to make the alloy (Fig. 10).

The metal cores of some damaged vessels were used for examination. For other objects, such as vessels No. 871, 873, 876, and 877, samples were taken from the surface; however, this causes the amount of the secondary element (used to produce the alloy – copper in this case) to increase.

Because of the large quantity of zinc in samples No. 871, 872, and 876 it is possible that brass was used to produce the alloy. Only in two samples, No. 238 and 875, the copper percent was low in comparison with other vessels; the gold quantity in these two samples was an equivalent 0.7%. All the objects had equivalent quantities of copper, arsenic, tin, zinc and antimony; therefore they all underwent the same smelting process.

The Results of the Isotopic Analysis

Lead isotope analysis was performed with a multiple-collector inductively-coupled plasma mass spectrometer (MC-ICP-MS). The results of the isotopic analysis (Fig. 11), show the ratio of the lead isotopes to be approximately equal. The evidence therefore indi-

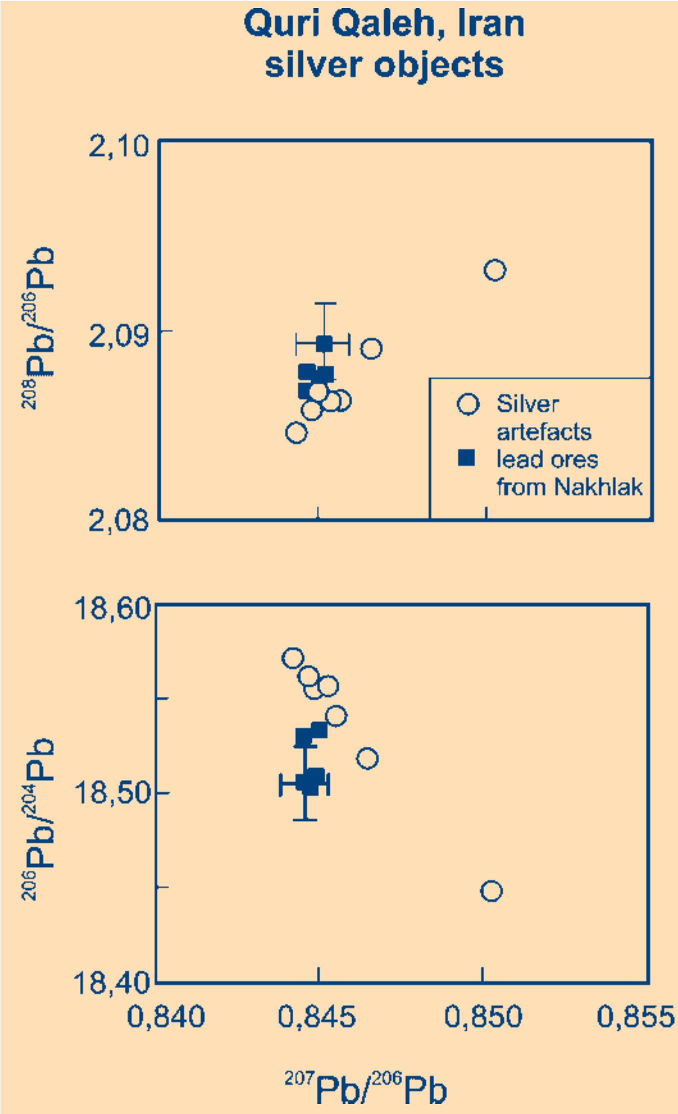

Fig. 11: Lead-isotope-ratios of the silver vessels of Quri-Qaleh in relation to lead-silver ores of Nakhlak.

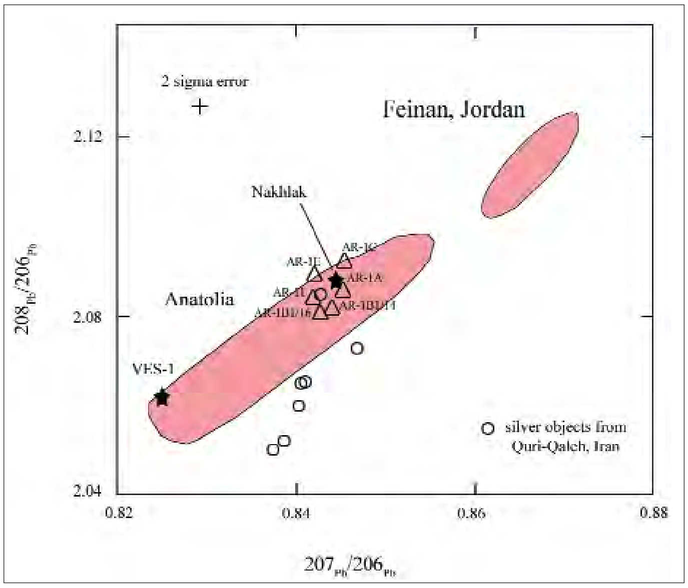

Fig. 12: Lead-isotope-ratios of litharge from Arisman, of lead-silver-ores from Nakhlak as well as of the silver objects from Quri-Qaleh in relation to the isotopic field of Anatolia Feinan (after Pernicka).

cates that the silver ore used in the two vessels was from the same source.

The isotopic ratios were compared to ores from Middle East, including Nakhlak and Veshnāveh in Iran, and some slag from Arisman (Fig. 12). Only in sample No. 873, the lead isotope ratios were approximately equal to the ore sample from the Nakhlak mine. After separating the lead from the silver matrix to improve on the precision of the data, the conclusion is that all the samples are rather similar and they are all consistent with having derived from Nakhlak. For further study and identification of the mines used, it is necessary to study and examine the silver mines of Iran as well as more silver objects.

Acknowledgement

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Copper smith in the bazaar of Isfahan, driving a beak shaped workpiece (2000); Photo: Th. Stöllner.

Takht-i Suleiman. Sasanian Fire Sanctuary and Mongolian Palace

Dietrich Huff

In the middle of the 10th century AD, the far travelling poet Abu Dulaf (1955, 31-33) wrote about that place in North-western Iran which today is known as Takht-i Suleiman: "Shiz is a town ... within the mountains where there are gold, mercury, ... and amethyst mines. ... The walls of this town surround an unmeasurably deep lake. I measured a depth of about 14000 cubits (7-8000 m) without the piece of lead touching the ground, ...whenever the water moistens the earth, the ground changes to stone at once. Up there, there is a highly worshipped fire temple where the magicians light the fires in the East and the West. Up on its cupola there is a silver crescent moon ... Another miracle of this temple is that the fire has been burning for 700 years without a break and that it does not leave any ashes. This town was built by King Hurmuz ... of stone and mortar. At the temple there are high columned halls and awe-inspiring buildings."

Obviously, Abu Dulaf was a many-sided character who was accused of being unreliable and telling phantastic tales even by medieval scholars. Also, his report on Shiz tells untruths and absurd things, a. o. what he says about how deep the lake is and his anyway vague statement that the fire, whose name he does not know in contrast to other chroniclers, was still burning at the time of his visit looks as little possible as the name of the royal founder. However, his description of Shiz is not only the most detailed one but to this extend the earliest which we know. Thus, it is not surprising that later geographers again and again quoted it, though giving critical or nasty comments.

The deep, mysterious, always 21° C warm lake on the peak of Takht-i Suleiman was doubtlessly the reason for building temple and palace buildings here in later times (Fig. 1).

At first it was the lake itself, which is fed by a thermal spring containing high amounts of lime, which built up a peak of about 60 m due to the limescale of its water running over the shore. Mountains which came into existence in the same way are typical for the landscape of the surrounding highlands being between 2000 and 3000 m above sea level; most striking is Zendan-i Suleiman, which is 3 km away and mistakenly was often considered a volcano, with its, now dry, about 100 m deep crater. The growing of Takht-i Suleiman came to an end when early settlers in the highlands began to divert the water through channels for irrigating their fields. Now and again, longer breaks in the settlement and dilapidation of the channels led to the lake growing again. The oldest remnants of settlements in the area go back as far as to the 4th millennium BC. But they are located near non-thermal springs in the glens.

The water of the lake of Takht-i Suleiman does not only contain lime but also sulphur and can hardly be used as drinking water. However, around the middle of the 1st millennium BC there was a small settlement with simple houses made of stone and clay on the northern side of the lake whose most significant evidence are burials of humans and dogs i*ntra muros* (Fig. 2). Just here, in the heartland of Media, burials of complete bodies are not really to be expected because, as already reported by Herodot, particularly among the Median "magicians" the Zoroastric custom of exposing the bodies was predominant. The settlement was only existent for a few generations. After the dilapidation of the houses and the channels, the water of the lake, which now was running out without regulation, covered anything with a layer of limestone.

Several centuries later in the Parthian period, on the northern shore of the lake a small polygonal fortress was built of which the stone foundations of a massive, round bastion and parts of a wall, which was connected in an obtuse angle, were excavated. The few

Fig. 1: Air photography of Takht-i Suleiman from the North; Photo: G. Gerster.

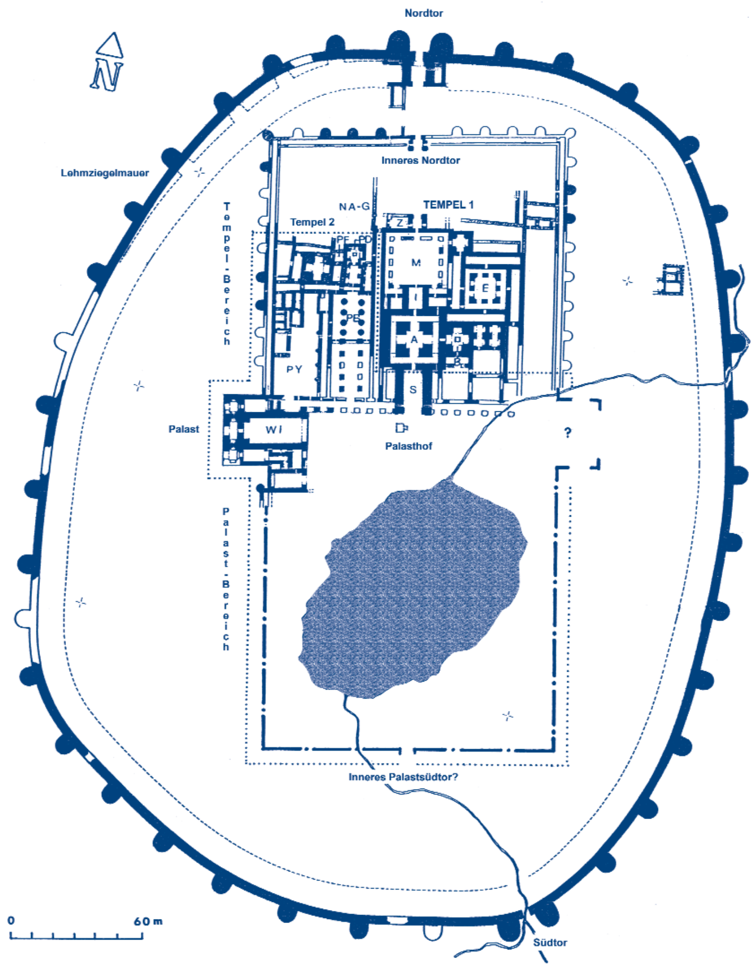
Fig. 2: Burials intra muros from the Achaemenid period on Takht-i Suleiman; Photo: D. Huff.

pottery fragments from the Parthian period suggest a not very intensive use. A thin alluvial layer of lime and sand above the walls give evidence to another break of settlement.

According to the earliest finds of coins, the period of importance beyond the region hardly began before the middle of the 5th century BC when the peak of the mountain was surrounded by a 12 m thick wall of mudbricks and in the interior extended mudbrick buildings were built. Only little remnants of these mudbrick buildings are preserved in between the stone buildings from later periods. But they clearly show that the basic plan of the first complex was kept when, probably during the last years of King Kavad's (488-531 AD) reign, the clay buildings were replaced by stone and brick buildings step by step (Fig. 3). The complex is identified as the temple of Atur Gushnasp ("Fire of the Stallion") due to Zoroastric texts and to some of the clay bullae, seals of documents, which were titled "Priest of the House of the Fire of Gushnasp". Atur Gushnasp was one of the three most important Bahram fires of Iran and must have had a particularly close connection to the royal house especially in the late Sasanian period. It is described as the fire of knights and warriors. The two other Bahram fires which were especially worshipped, Atur Farnbagh, the Fire of the Priests, and Atur Burzin Mihr, the Fire of the Peasants, are said to have been burning in Fars and Khorasan; they have not yet been found. Bahram fires made the first class of the holy fires which were put together from a number of other fires by help of especially extensive ceremonies and were maintained by priests by help of especially extensive rituals.

The Atur Gushnasp on what is Takht-i Suleiman today was doubtlessly burning in cupola room A, which had massive corner posts and surrounding corridors and which was the centre not only of the rectangular inner wall but also of the entire complex. Other than the standard type of ancient and contemporary fire temples, this room is directed towards two strictly separated areas in the North and the South by help of two iwans, i.e. deep entrance halls. Also, the two gates in the surrounding wall must be considered belonging to them. The reason for this complex and thought-out ground plan was obviously the double function of the sanctuary: in the North it was a pilgrim's destination for the common people, in the South it was a palace-temple for the king and his court.

Fig. 3: Plan of the Sasanian fire sanctuary of Atur Gushnasp on Takht-i Suleiman (6th-7th century AD); following D. Huff.



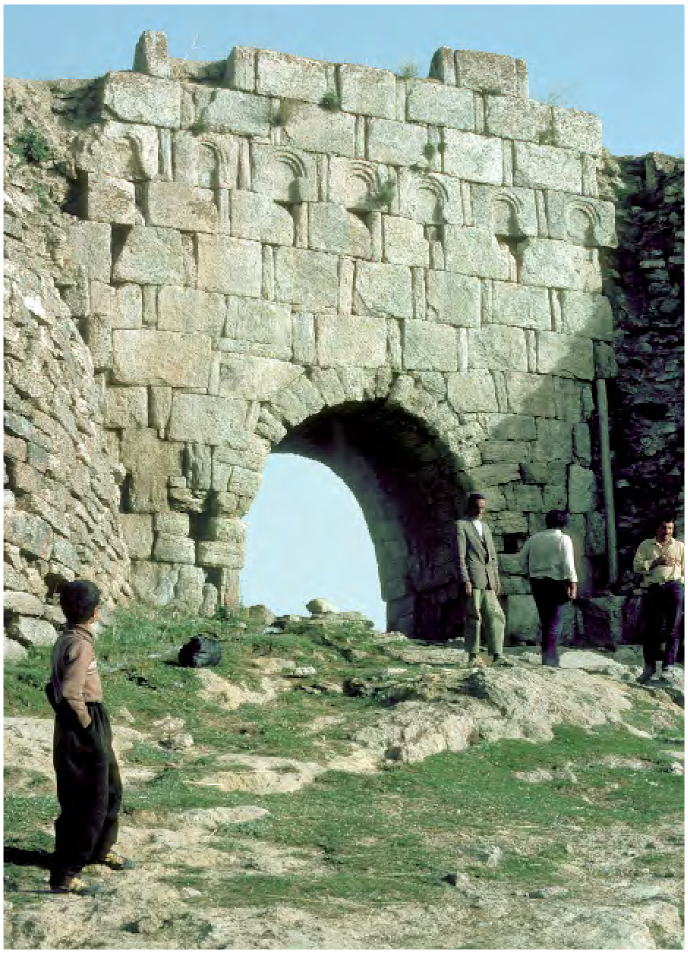


Fig. 4: The Sasanian southern gate of Takht-i Suleiman, half blocked by calcification of a flowing rivulet; Photo: D. Huff.

After climbing the steep, 60 m high northern slope of the mountain, the common pilgrim stepped through the northern gate and some more inner gates and forecourts, next to which the remnants of simple clay buildings, day rooms and latrines were found (NA-G), came into the court of the temple which was surrounded by arcades (M), and finally reached the northern temple-iwan, the real place of devotion.

Maybe he was also allowed to walk around cupola-room (A), which was isolated by thin walls, through the surrounding corridors. Most probably, the chancel itself, whose centre was devastated by medieval treasure hunters, was – like it is still usual in modern fire temples – reserved for the priest whose ceremonies are indicated by traces of pedestals and rostrums in the construction of the brick floor. Among the rooms and courts, which were used for running the temple, the small cross-cupola room (B) east of the main building is particularly interesting and its function is debated. A brick basin in its centre cannot have been a water basin due to an opening which could not be blocked. Maybe it was a container basin for the ashes of the holy fire so that the latter could be distributed among the believers, as it is partly done in fire temples still today.

The fact that fire temples were not only places of pilgrimage and worshipping but also centres of civil administration is shown by a hoard find of clay bullae, seals, i.e. official certifications of all kinds of contracts and certificates by official authorities, which was found in room Z and which proves that this place next to the gate to the court of the temple, i.e. the link between citizens and governmental authority, was a governmental office.

Fig. 5: Ruins of the Sasanian palace (left) and the fire temple (right) at the northwest bank of the sea, rebuilt by the Mongolian Ilkhane Abaqa as summer and hunting palace; Photo: Th. Stöllner.

Fig. 6: Ilkhanide northern iwan with a stairway leading up to the Ilkhanide throne hall which was built on the Sasanian fire temple; in the lower third the remains of the smaller Sasanian iwan are seen, in front below left, on a lower level, the Sasanian platform of the throne; Photo: Th. Stöllner.

In the southern, royal part of the sanctuary the structure of the Northern part is basically repeated, though appropriately adjusted. The southern gate was shifted from the main axis to the East as far as to the highest part of the saddle which links the mountain to the next high ground (Fig. 4); here, the royal pilgrim was able to ride in almost at ground level without any significant slope. As remnants of walls in the Northwest suggest, the lake was surrounded by a wall similar to that of the part in the North, though here the part of the wall which was built onto the stone foundations was always made of mudbricks. During the periods after this settlement it was dug away and in the course of later breaks of settlement the water of the lake left a several meters thick layer of lime sediment on the entire southern half of the plateau which made regular excavations impossible. Thus, we do not know if an inner southern gate at the main axis or at any other place led into the forecourt of the royal palace and temple.

The lake within the enclosing wall served as the water basin which was compulsory for every Oriental court (Fig. 5). For the time being, it may only be suggested that the square, which was gigantic compared to the northern court of the temple, was surrounded by arcades of pillows like the latter, as there is a row of arcades at the northern side in front of the temple. The iwan in the centre of this row of arcades, the royal hall of worshipping, shows double the length of its common counterpart at the northern side. The palace at the north-western corner of the southern court is somehow appropriate to the poor clay accomodations in the northern area of the temple, as it shows a *c.* 11.50 m broad and almost 30 m long throne hall, small sidehalls, corridors, and bedrooms as well as a row of rooms which opened to the West through wide gates. Being a high cube, the palace projected far into the centre of the western, inner surrounding wall, which was fortified by towers, and with its triumphal arch-like openings it must have made an impressive front from the outside view.

Axial to the throne hall, which is open towards the interior, in front of the southern iwan of the temple there is a rostrum with a monolithic stair at the eastern side. The blocks of hewn stone are worked in such a careful manner which is not found at any of the other buildings, so that most probably this must be considered a takht, a throne (Fig. 6). Who is sitting on the throne is right outside the alignment of the wall of the temple iwan, who is standing in front of the rostrum immediately faces the Bahram fire which is burning in the background, an arrangement which surely was not

Fig. 7: Sasanian votive made of gold sheet with a depiction of a man; found in the fire sanctuary on Takht-i Suleiman; Photo: B. Grunewald.

coincidental. We know that in case of establishment of truth, *e.g.* decisions of a court, administrations of oaths etc. the presence of a holy fire was important.

Next to the Atur Gushnasp temple, separated only by a corridor and only accessible from the palace court there was a second and smaller fire temple of the standard type: ceremonial halls and those for worshipping as well as anterooms lead to a cross-cupola fire-room where still there is the three-step pedestal of a fire altar with a 60 cm wide shaft made of bricks. The square plate of the altar may be supposed to have had a side length of c. 1 m. Next to the altar room to the West and maybe connected by an opening to look through there is a room plus anteroom, a niche for sleeping and doors which were located in a way to prevent anyone from looking in. Possibly, this was a meditation room for the king or other pilgrims of high rank. Accessible by common corridors, there follows a cross-cupola hall with side rooms which due to kitchen courts and great amounts of pottery fragments as well as latrines is proven to have been a complex of banquet halls. This is an absolutely usual combination also at contemporary fire temples.

Even today it is not unusual to have several fires in one common temple complex. However, the fires may not burn next to each other or within sight, each of them must have its own cella. Mostly, such a double accomodation is due to the situation. But on Takht-i Suleiman it seems to have been planned right from the beginning to build two fire temples next to each other. Also, the completely different ground plans show that each of the fires was related to different ceremonies. Obviously, the Atur Gushnasp temple was laid out as a place of worshipping by king and people and of course also for the ritual ceremonies of the priests. But the second fire temple, which was only accessible from the palace court, was reserved only for the king and his court. Thus, we might consider it a temple for the personal fire, which according to tradition was lit for every king, but such thoughts are sheer speculation. The big number of various rooms in the second temple indicates several ceremonies happening here besides the fire rituals and this fire having been closely integrated into the daily life of the court.

Only very few finds from the Sasanian period have survived the long and intensive settlement of the Islamic period; even Sasanian pottery fragments are rare. The clay bullae have already been mentioned, differently sized, potato-shaped lumps of clay which were fixed to a leather cord through the document or were fixed to the knot of a bundle of documents and then were marked by the print of a stamp seal (Cat. no. 556f.). Also, plugs which were pressed into the openings of vessels and then plastered, were sealed. The function of these bullae was appropriate to European wax-seals or to contemporary official stamp seals. Small votive tablets made of gold and silver sheet with depictions of human figures, limbs or symbols which are difficult to interprete are the religious leftovers of pius pilgrims (Fig. 7).

From one of the building periods of the temple there comes a glass-blower's craftshop where round bullion point sheets were made from blocks of glass. It was not possible to find out where these window panes were built in. Of the original stucco decorations of the temple buildings only fragments were left. Besides floral and heraldic ornaments, there were reliefs of animals and life-sized figures which indicate a rich and magnificent range of depictions.

The fragments had been "buried" in the protecting clay filling of a raising of the floor in the second fire temple and probably give evidence to a destruction of the sanctuary, which is historically reported, and ensuing rebuilding without decorations. During the campaigns of the Byzantine emperor Heraclius in North-western Iran between 624 and 630 AD, the Persian king Khosrow II had retreated to the remote sanctuary of Atur Gushnasp and, being followed by the Byzantine army to this place, had fled on to Dastagerd while taking with him "Croesus's treasure" i.e. the treasury and the "fire fraud" i.e. the Gushnasp Fire. Byzantine and Armenian sources describe that the Roman soldiers tore the statues of the false gods from the walls of the temple, burned everything

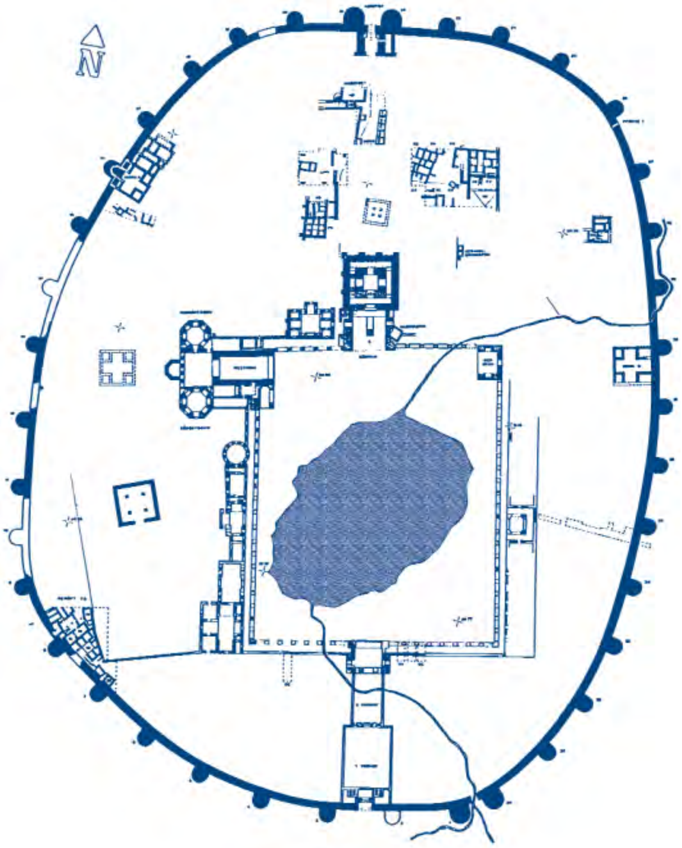


Fig. 8: Plan of the Ilkhanide summer palace Suqurluq (1265-1270 AD) on Takht-i Suleiman; following W. Kleiss in D. Huff.

to the ground, and filled the lake in front of the temple with the corpses of the slain enemies (Minorsky 1964, 91-94; Thomson & Howard-Johnston 1999, 214-215). After Heraclius had left, the temple was rebuilt and obviously the Gushnasp Fire was brought back. It even survived the Arabian conquest of Iran 20 years later. In the peace treaty between the Arabs and the Persian margrave of Azarbaidjan there was an agreement “not to hinder the people of Shiz, particularly not in dancing at their feasts and in publicly celebrating their traditional customs” (Schwarz 1969, 1116). It is not sure if this situation survived for 300 years until Abu Dulaf’s visit (c. 943 AD) who described the fire as still burning.

In any case, with the decline of the Sasanian royal house the royal area of the complex will have lost its significance. At first, the inhabitants of the small settlement, which was outside at the western slope of the mountain of the temple between the two gates, will have moved into the walls. At the time of the middle of the 13th century, the place had developed into the densely inhabited Islamic town of Shiz about which almost all chronicles tell (Schwarz 1969, 1111-1120).

Abaqa Khan’s (1265-1282 AD) coming to power, who was the second ruler of the Mongolian dynasty of the Ilkhanides, the rulers of Djengis Khan’s vice-kingdom of Iran, brought a temporary end to the town of Shiz. He chose the extraordinary place for building a palace. After the inhabitants had been sent away and their farms had been torn down, basically the plan of the old Sasanian palace area was perfected. Along the main axis a new southern gate was broken into the surrounding wall from where forecourts and inner gates led into an entrance iwan at the southern side of the palace court. On the Sasanian enclosing wall, which had long disappeared, arcade halls were erected at all four sides, behind them there were pavilions, halls, and small palaces (Fig. 8). The Atur-Gushnasp temple was used as the sub-construction of a gigantic throne hall which was erected on the reconstructed cupola. An open stairway in the extended and newly vaulted iwan led upstairs to it. The iwan hall of the Sasanian royal palace got a new and higher vault and was extended by side buildings with several storeys and octogonal pavilions with big windows at the backside. The two main buildings were decorated by stalactite-cupolas and -niches, stucco-reliefs, frescoes, and, most of all, by coloured enamelled tiles (Fig. 9, Cat. no. 562-564). But only prints, fragments, and sherds are left. Particularly the tiles were systematically hewed off as early as in the Middle Ages and except some fragments they were used elsewhere. At the north-western corner of the palace court, on the buried second fire temple, there is a compact building with a wide, square court, a type of building which at other Mongolian building projects is interpreted to have been a library, e.g. at the Ilkhanide observatory of Maragheh. At the north-eastern corner of the court, opposite to the big palace iwan, a fourth iwan completed the symmetry of the palace court. Along the transverse axis, which was defined by these iwans, there are cross-shaped pavilions outside the palace court which possibly were integrated into garden complexes. The function of a four-columned square hall to the West and outside the palace court stays unclear, for whose columns, torus-foundations, and reliefed

Fig. 9: Fragment of a reliefed tile with lustre-enamel, hunting scene. Decoration of a wall of the Ilkhanide palace on Takht-i Suleiman; Photo: B. Grunewald.

Fig. 10: Northern side of Takht-i Suleiman, view from the Northern gate across the pilgrims´ path to the (restaurated) remnants of the inner gate, to the inner, vaulted corridor wall leading to the ruins of the fire temple and to the high ruin of the palace hall (Western iwan). In the foreground there is the Eastern sideroom of the gate and the recovered accomodation buildings from the period after the Sasanians, the Middle Ages, a. o. bazaar-shops; Photo: Th. Stöllner.

door settings red sandstone was used and which is suspicious due to the fact that its orientation is different from the main axis.

The Northern side of the peak, i.e. the former area of the common pilgrims which had been opened up by the northern gate, was the area of economy and servants also with the new Mongolian plan. Here there were pottery craftshops, smalls chambers for accomodation, but also bigger farms, some of which along the western wall were built at the same time as the palace building (Fig. 10). This area may be supposed to have been the nucleus of the recapture of the place by a civilian population as early as in the late Mongolian period in the early 14^{th} century. Abaqa Khan and his successors did not use the remote palace as a permanent residency; it was inhabited by members of his family. His grandson Mahmud Ghazan was raised here, who, being one of the most important Ilkhanes, later (1295-1304 AD) accepted Islam for the dynasty. After 1335 the empire of the Ilkhanides fell apart and soon after the destruction of some parts of the palace may have begun. Columns and decorated blocks of stone were used for new buildings, *e.g.* for a small mosque at the northern gate and for a hammam. A bazaar alley at the way to the northern gate probably came into existence even earlier. At about the end of the Ilkhanide period, at about 1340, the tax official and chronicler Hamd-Allah Mustawfi (1919, 69) wrote: “in the district of Andjarud there is a capital, the Mongols call it Saturiq (Suqurluq). The Kajanian Kaikhusro built it. In there, there is a huge castle and in the court of the castle there is a ... lake. Its bottom is unmeasurable. ... The Mongolian khane Abaqa had this castle rebuilt right after he had come to the throne. Everywhere around, there are good meadows.”

Obviously, the peasant inhabitants of Suqurluq unrestrictedly went on with the prospering economy of their predecessors at Shiz. Selling the decorations of the palace may have been useful for them. Great amounts of tile fragments, which could not be sold, fill waste pits and abandoned kilns or they decorate the frames of open fireplaces in their living rooms (Fig. 9). According to the finds of pottery, this late flourishing did not last much longer than for one century. Maybe it were Timur’s (1370-1405) campaigns or the nomad tribes, which immigrated to Iran while following him, which did not only put an end to life at Suqurluq but to the entire region.

Like the name of Shiz, now also the name of Suqurluq was forgotten. Instead, the Azeri-Turkish population, which was now dominating Azarbaidjan, identified the gigantic ruins and the natural scenes around with the oriental-mythologic ensemble of Takht-i Zendan and Tawileh-i Suleiman, throne, prison and horse stable of Solomon and Takht-i Bilqis, throne of Bilqis, the Queen of Saba. Ker Porter (1822, II, 556-562), who in the early 19th century gave the first modern description of the place, did not find any village around, only a camp of Shasevan nomads who at this time were notorious for being robbers and bandits and from who his small companion of horsemen hurried away on back ways. An increasing number of accounts of journeys on Takht-i Suleiman woke the interest of Western research on Iran. In 1937 A. U. Pope (1937, 71-105) and members of the American Institute for Iranian Arts and Archaeology shortly surveyed the hill of ruins. Between 1959 and 1978 excavations were done by the Deutsches Archäologisches Institut together with Iranian and Swedish archaeologists. Recently, investigations and restaurations were done by the Iranian Antiques Organisation.

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The palace of the Sasanian great king Ardashir in Firuzabad, the ancient Gur (1978); Photo: G. Weisgerber.

Gold- and Metal Working on Takht-i Suleiman in the Late Antiquity and the Middle Ages

Dietrich Huff

Though Azarbaidjan is not the province of Iran which is richest in mineral resources, the mountains around modern Takht-i Suleiman were known for their important deposits of ore and minerals as early as in the middle ages. That enterprising world traveller *Abu Dulaf*, whom we have to thank for the earliest eye-witness report on the ancient monuments at the place called *Shiz* in those days, travelled through the region in the middle of the 10th century AD, mostly for the purpose of finding and trading precious metals and stones as well as minerals for chemical and medical purpose. He names deposits of various kinds of gold as well as silver, lead, mercury, arsenic, and amethyst in the mountains between Shiz and Zenjan (Abu Dulaf 1955, 30-33).

Indeed, the name of the village of Zarhuran (place for washing out gold) as well as gigantic dumps of scree at old gold washing places at a tributary of the river Saruq and old galleries of mines North-west of Takht-i Suleiman give evidence to former production of gold, silver, and lead. An old fashioned arsenic mine is still working here and in the mountains near Anguran East of Takht-i Suleiman particularly zinc mining is done industrially these days (Osten & Naumann 1961, fig. 2, 19-20; Damm 1968, 41-44; Weisgerber 1990, 75-77; see also essay by Stöllner on ore mining in Iran).

In how far and in what way the inhabitants of Takht-i Suleiman or rather the small town of Shiz or those of the fire sanctuary of Atur Gushnasp were engaged in mining and washing out gold during different periods of time is something which can hardly be proven archaeologically at the site itself. Metal crafts are not only to be presumed but there is evidence for them by archaeologic finds. A cast blank made of bronze or lead alloy, which was found in the layer of waste in one of the Northern, public courts (Na), dates from the late Sasanian period of the fire sanctuary. The filling of the channels still connects three small figurines to the plate-shaped cast of the funnel in the former mould which now is knocked off (Fig. 1). The figurines, sized 2-2.5 cm, are a four-legged friend, goat or dog, as well as a hooklike object, maybe a foot with the tip of the shoe being bent up, and an object which reminds to a reel or a drum. A round bar of copper seems to have lead through the first two objects. It cannot be definitely stated for what these small, completely three-dimensional objects were meant to be used, as a talisman, an amulet, or as a piece of decoration. But probably they belonged to a kind of production of and trade in devotional articles in the widest sense of the word, just like it existed and still exists at all places of pilgrimage.

A number of votive plates made of gold sheet, sometimes of silver, which mostly were also found in the public area for the pilgrims but as well in the side court (PY) of the second fire temple which was a part of the palace area, give clear evidence to pilgrimage at

Fig. 1: Raw bronze cast of three small votive figures, see cat. No 558; Photo: DBM, M. Schicht.

the Gushnasp fire temple (Naumann et al. 1975, 172-174). The 3-4 cm high, oval, a bit more lavishly worked plates show human figures which are three-dimensionally worked out or only engraved (see article Huff, Takht-i Suleiman, Fig. 7). Smaller, rectangular sheets show panicle-shaped, circular, or sunbeamlike symbols, there is also the contour of a leg. Votive plates of this kind are also known from other sites (Cat. no. 283, 285). Most famous are the gold sheets of the Oxus-Treasure which go back as far as to the Achaemenid period and probably come from the Oxus temple at Takht-i Sangin in Southern Tadshikistan (Dalton 1964). It could not be proven by the excavations that the votive plates from Takht-i Suleiman had been manufactured at the place. The piece of the highest quality, three-dimensionally showing the front of a man with a sword, which significantly was not found in the pilgrims´ area but in the court of the palace/temple PY, may be supposed to have belonged to a member of the royal court and to have been brought from some other places. But the plates from the pilgrims´ area – provided with primitive symbolic signs and in some cases even showing inaccurate angles – were most probably manufactured on special demand of each pilgrim by goldsmiths or traders in the forecourts of the temple who needed only a few hews with the chisel.

Local manufacturing of gold leaf may definitely be presumed during the building of the Ilkhanide palace on Takht-i Suleiman (around 1270 AD). Gold leaf was needed as a decorative plating for the so called Ladjvardina-Tiles which were the most luxurious type of wall covering. These were lapis lazuli-blue and turquoise-green enamelled relief tiles with a gold leaf plating in the form of tendrils, blossoms, animals, and other ornaments. The fact that gold leaf was used is shown by the straight and angular cuts of the contours which additionally were painted over by white, red, and black lines (see article Huff, Sasanians, Fig. 18). Manufacturing of most of the types of tiles at the building site has been archaeologically proven. As gold leaf decorations are highly sensitive to abrasion and thus transport from the far away great pottery centres like Kāshān was surely avoided, it is the more likely that the Ladjvardina-Tiles were manufactured at the place.

However, one gold- or silversmith left an unmistakeable trace of his presence on Takht-i Suleiman, if rather accidentally: his toolbox including content (Huff 1977, 220-222; generally Wulff 1966, 1-73).

In the decayed corner room of a Sasanian house, which is partly preserved even today including its vaults (OG4), to the East outside the rectangular enclosing wall near the Eastern outer wall, in the decay of the collapsed sidewall there was a compact find complex of agglomerated objects of ceramics, bronze, and most of all iron objects being corroded beyond recognition (Fig. 2). Soon it was clear that this was the content of a completely rotten wooden case, still showing the remnants of iron fittings and hinges, some with fibres of wood on them (Fig. 3). The case must have had a size of about 20 x 35 cm with a height of about 15 cm and must have been divided by drawers, trays, and special shelves.

The purpose of this case was clearly explained by a great number of differently sized, conical ceramic bowls with a diameter of 1.5

Fig. 2: Findspot of the toolbox; photography: DAI, D. Huff.

Fig. 3: Toolbox and its content after recovering; Photo: DAI, D. Huff.

to 5 cm: they are small melting pots and on their bottoms there were still the remnants of various molten metals (Cat. no. 451). These melting pots, which were easy to make, were kept even in the case of damage, mostly to melt out the contents of precious metals from the remnants. A later analysis of some of the melting pots showed traces of gold, silver, zirconium, lead, tin, zinc, copper, iron, spronzyin, and arsenic.[1] Next to the small melting pots there were several long bones which had partly turned to charcoal and which may be supposed to have served as blowpipes for kindling the glowing charcoal in the little furnace below the melting pots (Huff 1977, 221, annot. 21).

After the at first completely unrecognisable iron tools had been cleaned, for which we have to thank an archaeologist with many talents, also a small hammer and big, tweezer-like pairs of pliers turned up, by help of which the melting pots were held into the fire, as well as seven different pairs of scissors of different length, whose sometimes extremely short blades proved them to be plate shears for materials of different strength (Cat. no. 471-473). There were also appropriate remnants of sheet, but mostly jewellery like earrings and other rings, various semi-precious stones, most of them carneoles, among it a Sasanian stone seal, depicting a bird (Cat. no. 469c), and two Islamic stone seals with inscriptions (Cat. no. 467). The Kufic inscription on a carneole-seal proves its possessor (Cat. no. 467) to be a follower of Muhammad and Ali, *i. e.* a member of the Shiite minority which in those days was not really liked by the authorities in most parts of Iran. The second seal bears the name Sharhalat Ben be Ja'far, probably the possessor (reading by Emad el Din Sheikh el Hokemāi, University of Tehrān). As the seals are to be dated from periods which are far from each other, they are not of significance for dating the find complex, except of offering a date *post quem*. The fact that they are together in a goldsmith's toolbox is something that may be observed in the gold-shops and goldsmiths´ craft shops of oriental bazaars even today.

Fig. 4: Eight-sided decorated weight from the toolbox; back side see Cat. no. 456; Photo: DBM, M. Schicht.

Fig. 5: Two small bronze boxes from the toolbox. On the bottom side of the lid of the smaller vessel adhere wooden remains; see Cat. no. 454; Photo: DBM, M. Schicht.

Typically, weights are part of the stock in a goldsmith's toolbox, as proven by examples from later periods (Ward 1993, 24, fig. 13). A particularly concise bronze weight from Takht-i Suleiman is of the often found eight-sided prisms type (Bivar 2000, 92-94, tab. 56 c-d) but is outstanding due to its especially rich decorations (Fig. 4). On its eight facets, kufic inscriptions were placed between decorative bands, as well as on the upper and bottom sides between risp-ornaments. Conspicuously, one of the bottom fields was destroyed beyond recognition by wedge-shaped chisel marks. The blurred inscriptions, which are difficult to read, partly seem to be invocations to Allah; for the time being there stays the question if someone tried to erase one of the inscriptions.

Also some pyramid- or rather cupola-shaped bronze objects with a hexagon outline are probably weights (Cat. no. 459-461). Obviously, the stock of shapes of medieval weights included a great variety (Allan 1982, 90-91, fig. 120-130). But it might also be that these bronze objects served for manufacturing metal decorations. This must be presumed for a variety of smaller objects in the form of animals and plants. Maybe they were used for impressing thin metal sheets or as punches for the mass-production of moulds for appropriate bronze applications (Allan 1982, 61-66, No. 6-35). Three halfs of four-legged friends belong to the same group of finds and remind to those popular animal-shaped padlocks, though heads and feet are missing (Cat. no. 462). Particularly mysterious is a small bronze plate showing the contours of a crown or, if seen from the other side, of a beaked flagon. Its surface is decorated by a wave pattern within a frame of beaded bands (Cat. no. 458). A flat depression filled with stain at the bottom line reminds to a

Fig. 6: Carved, hollow bronze object from the toolbox; see Cat. no. 470; Photo: DBM, M. Schicht.

stencil or a punch for manufacturing fittings to fix straps or broad hooks to their suspension rings (maybe part of a belt buckle).

A complete padlock, consisting of two parts, also belongs to the stock of the toolbox (Cat. no. 455). A metal rod with expansion bolts to its sides is most probably the locking mechanism of a similar padlock (Tanavoli & Wertime 1976, 30ff.). The purpose of several big iron rods with three- and four-edged ends is unclear (Cat. no. 474); in one case there were notches like those of a file. Furthermore, the box contained several bronze boxes, some of them with a lid (Fig. 5), the remnants of a small wooden box, a turned bronze handle or stand (Fig. 6), a lump of some asphalt-like mass, probably used as a pad for chisel-work, a bent needle, fragments of lead plates, countless remnants of bronze and silver wire, various fragments of glass, and even small scraps of textiles.

For dating the toolbox, a bronze bowl and a ceramic bowl are important. The interior of the flat Omphalos-bowl made of bright bronze is divided by six axis of symmetry, as two arrangements of three axis of symmetry each are placed one on top of the other, the spaces in between filled out with risps and birds (Fig. 7). The bowl made of quartz-frit shows a blue lustre-enamel, its interior pattern of simplified risps is divided into four sectors by two deep blue cross-bands (Fig. 8). Both bowls can be dated to the 13th century AD and completely follow the tradition of the pre-Ilkhanide style. Thus, the toolbox must be dated to the time of the building of the Ilkhanide palace, which is estimated to have been short after 1265 AD. This is also suggested by the archaeological finds. The box must have belonged to a master craftsman whose home was maybe the country town of Shiz which was flourishing at this place until it was removed for some time to help the palace being built and which is not supposed to have changed much since Abu Dulaf´s description from the middle of the 10th century AD. Certainly, the place where the box was found was not a craft shop. Obviously, the box is the complete professional property of a gold- and silversmith who was used to move from one workplace to the other. Obviously, the box had been deposited in the side room of the halfly decayed Sasanian house (OG), the side room having been prepared in a makeshift manner. When the sidewalls, which had been repaired without mortar, collapsed, it was buried for good. The presumption that this destruction was connected to sending away the inhabitants at the beginning of building the palace cannot be proven but is likely. When a bit later, in the late Ilkhanide period, the palace was abandoned and demolished and the place turned to be a country town again, the new inhabitants of the ancient Sasanian house settled on a ground level which was above the decay. Of the various fire pits, which were dug out in the following times for the Tandur ovens and which reached down as far as 80 cm, none met the buried toolbox.

Fig. 7: Omphalos-bowl made of non-ferrous heavy metal from the toolbox; see Cat. no. 453; Photo: DBM, M. Schicht.

Fig. 8: Blue enamelled footed bowl from the toolbox; see Cat. no. 452; Photo: DBM, M. Schicht.

Notes

1 The analysis was carried out by Prof. Dr. H. Knoll, Institut für Anorganische Chemie, Freie Universität Berlin.

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A row of often renewed qanats and the agriculture near Firuzabad, province of Fars. For the Iranian arid zones the subterraneous qanats are important lifelines. They bring water under the earth's surface many kilometres to the settlements; Photo: G. Gerster.

The Significance of the Lead-/Silver Mines at Nakhlak in Antiquity

Thomas Stöllner, Gerd Weisgerber, Morteza Momenzadeh & Ernst Pernicka[1]

Introduction

In the metallurgy of the Middle East after the 4th millennium BC silver plays an increasing important role as a metal for jewellery and as a valuable metal. Later its increasing economic importance is shown by the striking of silver coins since the Achaemenid period (middle of 1st millennium BC). Since then, the use of this metal is generally increasing, as shown e.g. by the treasure-find from the Kalmakareh-cave in Lurestan: the silver weight of the metal vessels, which were found there, is remarkable[2] and suggests professional production of this metal from ores containing silver. Almost at the same time, de-silvered lead is increasingly used as constructing material in Persian architecture, as e.g. the buildings of Persepolis in the Fars show. The economic importance of both metals continues until the early Islamic period and is appropriately expressed by silver dishes and coins (Harper 1993; Sperber 1971).

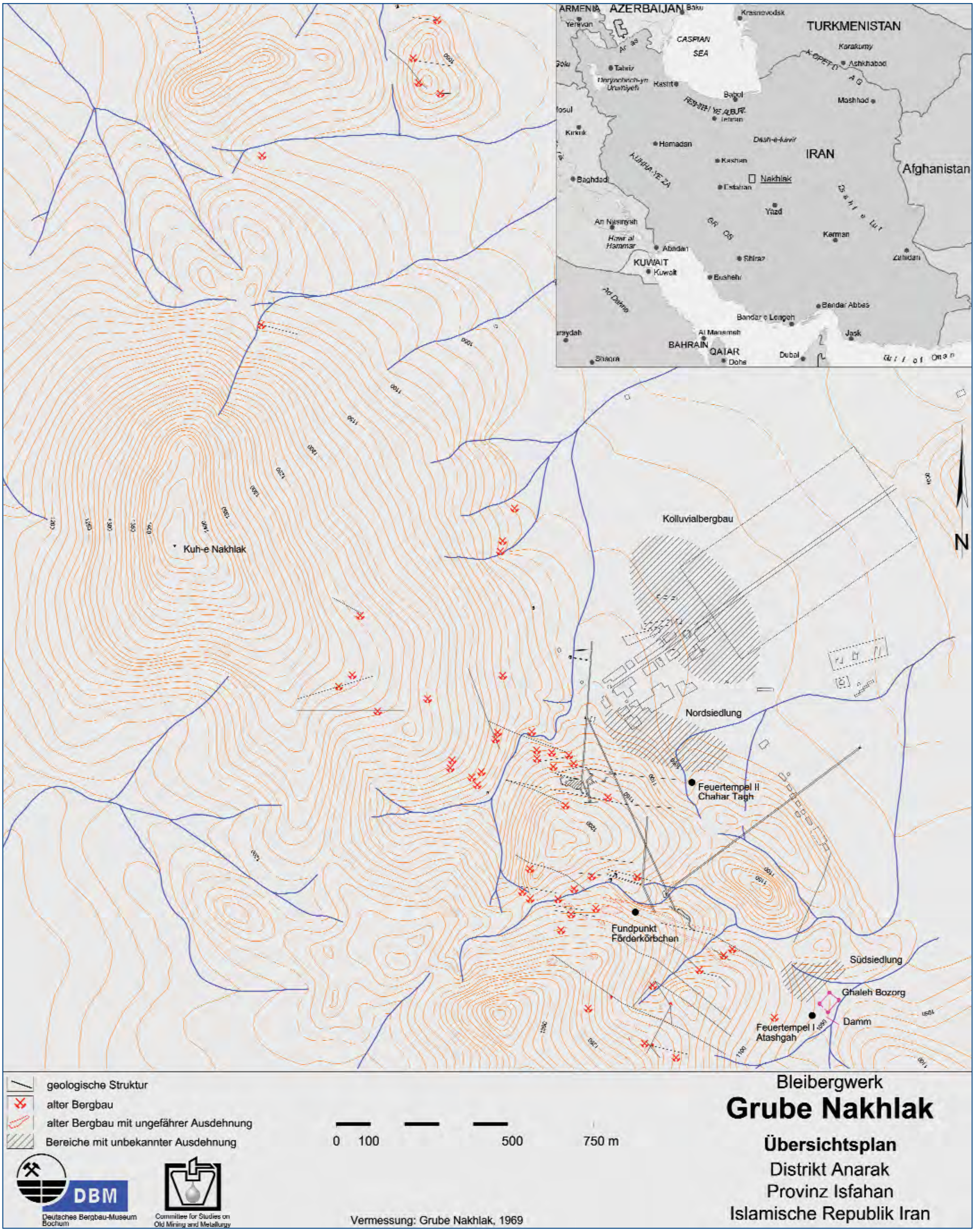
Usually, silver is produced from silver containing lead ores, as in nature there are hardly bigger amounts of its native form. The process of the cupellation (an oxidizing process) of silver from reduced silver containing lead has been known in the Middle East since the 4th millennium and appears on the Iranian Plateau since this technology was started (see below). Among the archaeological finds from the Near East, Egypt, and the Aegean from this period, silver finds often appear together with lead and litharge, something which very early was considered an indication of silver production from silver containing lead ores (Kohlmeyer 1994; Moorey 1994).

An early peak of this kind of silver production is finally reached in the 1st millennium. The precondition for this is "proto-industrial" prospecting of huge lead-silver deposits e.g. in Anatolia (Trabzon, Taurus), or in Attica (Laurion), in Southern Spain (Huelva, Cartagena), or on the Iranian Plateau (Craddock 1995, part. 205ff.; Meier 1995). There, ancient mining of Pb/Zn/Ag-ores in a belt of mountains between the Anarak region in the NW and Buhabagh/Darhand in the SO of the Dasht-e Kavir can be proven.[3] A second belt of deposits stretches from Arak to Isfahān and Shahreza – also showing extended traces of ancient mining.

One of the most important and biggest deposit areas is the district of Anarak/Nakhlak, a region where galenite and cerussite lead ores accumulate. This central and important deposit is located at the Eastern rim of the Kavir desert, about 120 km away from Naïn and is best accessible via Anarak and the mining place of Tschah Kharbuzeh ("melon well") (Fig. 1, 3). Due to its well, the settlement was the resting place before crossing the sand desert East of it (the so called "sand of ghosts") and repeatedly was the aim of explorers who already in early times left descriptions of the production at Nakhlak (Vaughan 1896; Gabriel 1935). After the end of the 19th century, there is a lot of evidence for the presence of European researchers, such as the Finn A. F. von Stahl in the 1890s as well as the German and Austrian engineers and geologists E. Fischer, E. Böhne, and M. Mazcek (1936-1940) as well as v. Websky (1951/52) in the first half of the 20th century, later followed by French and British scientists like G. Ladame (1940s), P. Bariand, or G. Burniol (1960s).[4] By a geologic study, the geologists H. Holzer and R. Ghasemipour finally presented the still fundamental lithologic and tectonic structuring which later was improved and completed by I. Rasa (Holzer & Ghasemipour 1973; Rasa 1987).

The first mining-archaeological expeditions were started in 1966 by a visit of C. S. Smith, Th. A. Wertime, J. R. Caldwell, and R. Pleiner when doing their first archaeometallurgical journey (Pleiner 1967, 347-353). Together with the older reports, particularly by A.

Fig. 1: Overview of the mining district of Nakhlak (detail); the mining-archaeological evidence and its location in the Islamic Republic of Iran; G. Steffens, DBM.


ARMENIA
AZERBAIJAN
CASPIAN SEA
TURKMENISTAN
IRAN
Nakhlak
Afghanistan
KUWAIT
BAHRAIN
QATAR
Kuh-e Nakhlak
Kolluvialbergbau
Nordsiedlung
Feuertempel II Chahar Tagh
Fundpunkt Förderkörbchen
Südsiedlung
Ghaleh Bozorg
Damm
Feuertempel I Atashgah
N
geologische Struktur
alter Bergbau
alter Bergbau mit ungefährer Ausdehnung
Bereiche mit unbekannter Ausdehnung
0 100 500 750 m
DBM
Deutsches Bergbau-Museum Bochum
Committee for Studies on Old Mining and Metallurgy
Vermessung: Grube Nakhlak, 1969
Bleibergwerk
Grube Nakhlak
Übersichtsplan
Distrikt Anarak
Provinz Isfahan
Islamische Republik Iran

v. Stahl, M. Mazcek, and G. Ladame they mainly documented older, traditional methods of production and thus are of inestimable value. Following a travel account by British H. B. Vaughan, U. Hallier finally documented the preserved buildings and the mining complex (Hallier 1972; Vaughan 1896, 33f.). Finally, the results of two mining-archaeological expeditions done by the DBM and directed by G. Weisgerber in 1976 and 1978, just before the Islamic Revolution, have stayed mostly unpublished. As late as in the Nineties there were again increased efforts of re-starting mining-archaeological research in Iran. This also lead to a renewed consideration of Nakhlak.

Remarks on Traditional, Persian Pb-Production at Nakhlak

Like at many mining plants in Iran, also at Nakhlak German engineers worked as advisors in the 1930s and supplied us with some highly important records and reports. Besides Anarak and Nakhlak, this also concerned the neighbouring copper mining at Baqeroq. Until some time in the 19th century the district of Anar-

Fig. 2: Nakhlak, typical lead-furnace with steps at Nakhlak in the Thirties (1936) during the smelting process: left: tapping through the front side of the furnace; right: filling the furnace through the shaft; following M. Maczek, Salzburg.

ak had anyway been a centre of copper processing, the transition to lead production happened later. This may be considered an indication that only then there was a clear revival and modern reopening of the Nakhlak mines (Pleiner 1967, 347). Indeed, as late as 1894 the pits of Nakhlak are described as being "abandoned".[5] Shafts were sank for the first time in the 1930s, before that there was following the veins in the sense of uncontrolled exploitation.

From 1936 to 1940, the Salzburg engineer Max Mazcek documented the traditional processing techniques.[6] In those days, Nakhlak was in private hands (Movalet Society) and was working with traditional methods only.[7] The ore which was used consisted of cerussite ($PbCO_3$) and galenite (PbS) together with small amounts of zinc blende (ZnS) or rather its oxidation products and traces of copper sulphides. The ore came mostly from pillows which were still standing after the preceding, very old mining and from stowing. Blasting was not necessary. Thus, the ore, which was carried up in leather bags (Fig. 11), consisted of small pieces. A hewer's capacity is reported to have been 300-350 kg per man and shift, the output 600 kg.

By washing the ore it was cleared from clay – the residue from the metasomatosis of the mineralized zone – to a certain degree and then formed by hand to about apple-sized balls which were dried in the sun. After this, the ore showed a content of about 20-30% of lead. The insignificant loss from washing is said to have still contained 4-5% of lead. At Nakhlak, the furnace was filled with about 2 t of lead ore, 1 t of limonite, porous aggregate and 2 t of charcoal (probably produced of tamarisk wood). After about 20 hours in the furnace this resulted in 480 kg of lead with a metal content of about 95%.

Before the European influence during the 1930s furnaces were much smaller, they were run by help of simple goat skin bellows, so men doing the blasting job were very close to furnace and lead smoke. The shape of the furnace can be recognized in Maczek's photographies (Fig. 2a-b): they were low shaft furnaces, supported at the sides by a kind of steps and made of clay with a fireproof lining in the melting zone. The latter was available in the area and thus cheap to get. Behind the furnace there was the blower house with an area of about 3 x 3 m. Inside there were the two-winged

Fig. 3: Nakhlak, view from the East to the mining place with the flanks of the mountains, which are covered by lode mining, and the terrain chummed up by colluvial mining in the foreground (1976). The arrows indicate the thick veins of Palan-e Gavi (right) and Nahr-e Tahar (left). On the slope to the left, Southern frame of the picture there is the smaller one of the two fire temples, Chahar Tagh; Photo: G. Weisgerber, DBM.

bellows which worked similarly to an accordeon and were run by two strong men.[8] According to R. Pleiner, these older furnaces were charged with 100 kg of lead ore, 30 kg of iron ore, 35 kg of charcoal; about 15 kg of lead were finally produced after twelve hours of melting.

R. Pleiner´s travel accounts as well as Holzer's and Ghasemipour's studies offer a view at the situation in the pits which were nationalised after 1954; according to them, 570 workers were employed in 1969, among them 200 miners underground. The output was about 5500 to 6000 t a month, about 770 t of concentrated or ore separated by hand were produced out of this.

Wulff (1966, 16) tells us that as late as during the 1960s the poor and extremely unhealthy conditions of working and living were changing (on this see in detail: Stöllner & Weisgerber 2004) when due to mine-drainage there was water for small gardens. A new, bigger settlement with a small hospital could be built. Since then, the children have been going to school instead of going to work which meant concentrating the ore by hand-separating. The parks, palm trees, and small gardens with cotton and vegetables give a false impression of the real water supply. This vegetation completely depends on the water which is pumped out of the mine. It is rather salty and cannot be used for drinking but only for irrigation and washing. Thus, the company runs two tankers which without a break bring water from up to 70 km away.

Deposit and Geology

The deposit is situated at the Western side of the Central-Iranian Kavir desert. The Nakhlak Mountains are an isolated mountain chain, 11 km long, up to 5 km wide, and stretch from NW-SE. The highest peak is about 1440 m above sea level and thus about 400 to 500 m higher than the surrounding plains. The Pb-Ag deposit is one of the numerous lead, zinc, silver, barium, and iron deposits in Iran and beyond in the Eastern Mediterranean which are embedded in cretaceous carbonate formations. It is part of a zone of mineralization which reaches much farther from SE to NW along the Lut and Kavir deserts as far as to the Alborz Mountains in the North. These lead-/zinc deposits are considered the richest in the entire Middle East. The Central-Iranian ore formations like Nakhlak, Mehdiabad, Mansurabad, Ranvanj, and Darreh Zanjir were judged by several authors to be syngenetic to the surrounding mountains.[9]

The Pb-Ad-mineralization belongs to the Upper Cretaceous carbonates. Geo-chemical and statistic analyses show high concentrations of ore in the surrounding rock, mainly lead. The ore-bodies themselves are vein-deposits but besides there are also karst fillings and pouch fillings as well as fillings of joints and fissures (Fig. 4). The sub-vertical veins stretch from East to West while the deposits slightly go down to the North (the general direction is North to South). About 28 veins are to be distinguished (Holzer & Ghasemipour 1973), the longest having about 500 m. The thickness of the veins changes from a few decimetres to about 20 m. The average thickness of the profitable veins measures about one to five metres. Many of the mineralized vein-crevices only reach the 50 m level of the modern pit; but especially thick and economically interesting mineralizations reach deeper, far beyond the 200 m level, below ground-water level which is deeper (127 m) than the 125 m level. This ground-water level also marks the end of ancient to Islamic mining. Altogether, within the range of the drilling area (c. 0.4 km^2) about 7 million tons of ore are estimated. The average content of ore is about 8.33% of lead, 0.38% of zinc, and at least 70g/t of silver.

Fig. 4: Thick ore vein of galena, zinc blende and vein stuff in the pit of Nakhlak; width of the vein c. 1. 5 to 2 m (2000); Photo: G. Weisgerber, DBM.

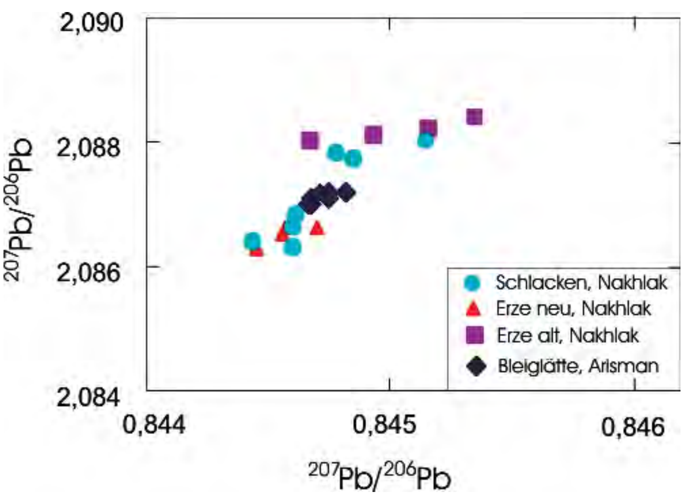
Nakhlak as a Supplier of Silver in the 4th and 3rd Millennium

The fact that the first silver objects appear together with lead has already been mentioned. This leads to the suggestion that from the beginning silver was produced from silver containing lead ores though in nature it also appears in metal form. From antiquity to the early Modern Age, the most usual method of producing silver was the two step process from silver containing lead ores. For this it is unimportant if cerussite was used, as suggested by Wertime and Meyers (Wertime 1973; Meyers 1988), or galenite (lead sulphite, PbS). It would have been easy to reduce both to some silver containing lead from which silver could be produced by selective oxidation, the so called cupellation. As lead usually contains less than 1% of silver, it is indeed surprising that this small content was discovered as early as in the 4th millennium BC and had been systematically exploited. However, this is suggested by all analyses of early silver objects, as silver from the process of cupellation still contains a bit of remaining lead and also can be distinguished from native silver by its trace elements (Pernicka 1987).

Only just a few years ago there have been further and even clearer indications of the knowledge of the cupellation process in the 4th millennium BC, i.e. dated finds of litharge (lead oxide, PbO) from stratigraphically secured archaeological contexts in Eastern Anatolia and at Habuba Kabira in Northern Syria (Hess et al. 1998; Pernicka et al. 1998; Lloyd & Mellart 1962). Litharge does not exist in nature. It only appears with the production of silver by oxidizing lead and often it was not further processed, as in the prehistoric period metal lead could hardly be practically used. Thus, the appearance of litharge is a definite proof of cupellation. By now, numerous finds of litharge at Arisman and Tappeh Sialk (Ghirshman 1938) have proven that also in the Iranian highlands silver was produced from lead ores by cupellation already in the 4th and in the first half of the 3rd millennium BC.[10]

But until recently the origin of the lead and thus of the silver was unclear. Lead isotope-analyses of the litharge-finds from Habuba Kabira did not show any similarities to the big lead-silver deposits of Turkey in the Taurus and in the region of Trabzon (Seeliger et al. 1985; Yener et al. 1991). However, the situation concerning the origin of the silver in the Iranian highlands is different. For a long time it was suggested that the deposit of Nakhlak was an important producer of silver in antiquity. Due to the great similarities of the lead isotopes in the dated litharge-finds from Arisman to the ores and slags from Nakhlak (diagram 1), it is now possible to deduce that this deposit was exploited as early as the 4th millennium. Similarity of lead isotopes in ores and artefacts is a necessary though not sufficient precondition for this interpretation. But at the deposit of Nakhlak the spread of lead isotopes is so unusually low that in this case because of such a great similarity the assigning seems to be legitimate.

Diagram 1: relations of lead-isotopes in slags and lead ores from Nakhlak and in litharge from Arisman. The "old" ore analyses are unpublished data by F. Begemann and S. Schmitt-Strecker, MPI for Chemistry, Mainz. Please note the scale of the coordinates. The complete data-variation is only about 0.1% in this diagram.



The Peak of Mining and its Monuments

Ancient Mining

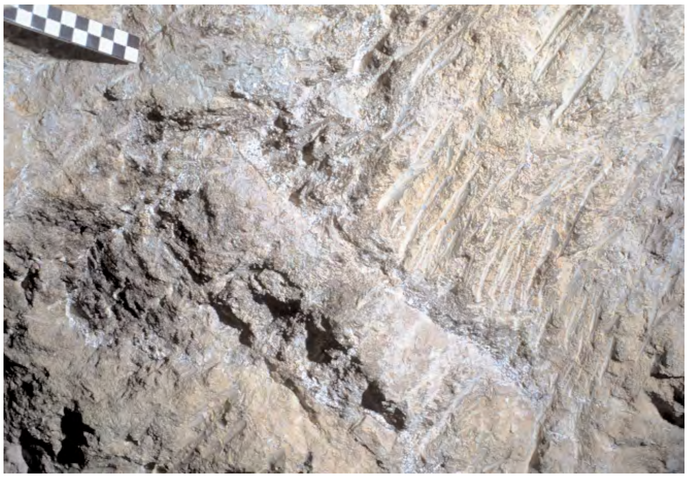
While early phases of mining can only be proven indirectly, the mining-archaeological evidence, as visible and known today, may be roughly related to the first millennium AD (Berthoud et al. 1976, 15). Most probably, this period is also a first peak of lead and silver production. It stays unknown when it started or if it was even done continuously after the earliest exploitation of the deposits in the 4th and 3rd millennium BC.[11] E.g. the vast evidence concerning ancient mining has not yet been investigated properly: many of the steep and today worked out drifts cannot be visited without appropriate spelaeologic equipment.

At first, ancient mining concentrated on the veins showing up at the surface. Thus, here the oldest mining must be awaited. Mainly in the South of the district, small funnel-shaped surface depressions or inclined shafts are conspicuous next to the long surface depressions (Holzer & Ghasemipour 1973, fig. 4) – they might indicate ancient mining close to the surface, mostly aiming for the cerussite-rich parts at the outcrop of the deposit.

The highest openings are at the central part of the deposit. A winding donkey-path, which was made more convenient by help of supporting walls, leads to them. At its end, two drifts are crossing (one of them very narrow). As a great exception, a nearly rectangular (2.5 x 2.5 m) shaft was sank, which can be overlooked

Fig. 5: Pit of Nakhlak, 50 m level; long lode mining with platform, a view up to the drift; Photo: G. Weisgerber, DBM 1978.

Fig. 6: Nakhlak, mine, typical pick traces at the salbands of a drift; Photo: G. Weisgerber, DBM 1976.



for only about 5 m, due to a rock which fell in, but which reaches much deeper. The platform around the shaft is even paved. Obviously, the shaft does not count among the very ancient mines.

In principle, most of the surface veins are exploited and show traces of ancient workings. In the underground, the traces of exploitation only rarely go beyond the 80 m or 50 m level of the modern mine.[12] Only in one case, the ground water depth is reached at 127 m (drift No. 5). Some of the ancient mining areas (so called Pirman = Old Man) got names, such as Palan-e Gavi, which goes as deep as 145 m, or the drift of Nahr-e Tahar with a depth of about 150 m which today looks like a small valley (Fig. 3). Many of the pits are mines which are opened by inclined shafts at both sides of the mountain. Some of the dips show ladders in the shape of stairs but they are so steep that with increasing depth they cannot be used without help. In front of the openings there are platforms which were built either by help of terraced walls or of recesses in the rock.

In the pits there are hall-like mines besides narrow, mineral bearing fissures which seem to be completely exploited. The mining area near the shaft of Qaleh Bozorg, a so called *Kar-e qadimi* ("old working") almost vertically reaches a depth of 32 m, a width of 10 m, and a length of about 20 m (Stöllner & Weisgerber 2004, fig. 12). Here, the ore body must have been especially thick and profitable – probably, it was exploited downwards by horizontal bench stoping. In contrast to that, the long lode minings, which stretch up to 300 m, are only imaginable by a combination of inclined horizontal bench stoping and then back stoping. Probably, the exploitation originally started on the peak but then was done from the sides and from the bottom of the valley as well.

This is suggested by the often existing platforms made of fallen blocks and backfilled rocks or wooden platforms in the drifts (Fig. 5). Besides platforms, single horizontal props are often observed which here have hardly any supporting function. They rather seem to be remnants of transport- and climbing-aids (or rather for supporting the mining-work). Real timbering hardly exists.

As the mineral was separated from the limy rock by a kind of clay-salband, the traces of the mining tools are often clearly to see in this soft material (Fig. 6).

In most cases the mining tools were pointed, probably picks. There was the work with hammer and wedges or chisel but the classical, systematically "hammer and chisel" work does not exist. Appropriate to this are the finds or fragments of picks and chisels or rather strong iron wedges as they are at the museum of the Geological Survey of Iran (GSI) in Tehrān or at Nakhlak (Fig. 7).

Besides iron mining tools, in the collection of the mining school at Nakhlak there are more finds which give an impression of working underground: while a Sasanian or Parthian bottle with a narrow neck is not definitely to be interpreted as a vessel for water or lamp-oil, the latter is most probably true for a beaked leather sack which is soaked with lead oxide. A lamp made of sheet (with an uneven edge) might come from the most recent period of mining – such a lamp is mentioned by the already quoted Alfons Gabriel still in 1935. Also so called soles, sole-shaped wooden boards with

Fig. 7: Nakhlak, tool finds of picks and hafted wedge as well as chisel-shaped small wedge, 1-2, museum of the Geological Survey of Iran, 3-4, collection of Nakhlak Mining School; drawings by J. Garner/Th. Stöllner.

holes probably for fixing leather strings, were found inside the mines. These sandal-like, strong shoes may have made walking easier while mining underground.[13] Furthermore, R. Pleiner reported more objects which are not there any more (Pleiner 1967, 348f., fig. 4, 3): while a huge iron hammer may be supposed to have been used for crushing already mined rock, a wooden saddle suggests the transport of ore from the mine to the processing-places by the help of donkeys. Thus, its use at the already mentioned, paved donkey-path until recent times is imaginable.

Especially interesting was the find of a small bucket in the ancient part of the pit in the year 2000: it was recovered at the lower end of an exploited vein in the sink-hole area west of the mine at the Qaleh Bozorg shaft (Fig. 9-10). There, several completely exploited but relatively narrow drifts being 1 to 2 m wide are visible, partly filled with layered stowing, showing single platforms inside. Some of these stages were supported by wood. The gallery at the findspot was only insignificantly wider than the bucket itself, about 0.5 m at the bottom – obviously the small bucket was used here or at a similar place and was given up (Fig. 8).

The bucket was still filled with several pieces of rock with low or no content of ore, which had the size of a child's fist. Possibly, it was fallen down into the narrow drift during the course of work. The bucket, which had been repaired several times, must have been used for a longer period prior it was lost. It is a small vessel,

Fig. 8: Exploited drift in the sink-hole area with small bucket at the findspot (2000); drawings by J. Garner/Th. Stöllner.

Fig. 9: Nakhlak, caving in, small hawling bag in the condition when found; the bulk material has been taken out; drawing by J. Garner/Th. Stöllner.

Fig 10: Nakhlak, caving in, small bucket in present, unrestored condition, showing the weaving schemes of wickerwork and textiles; drawing by M. Hadadi, RCCCR, ICHO Tehrān).

sewed of textile patches or rather of several reed and raffa wickerwork and then strengthened (Fig. 9-10).

Certain indications concerning the use of the small bucket come from findspot and appearance. The relatively long carrying strap suggests that it was used for taking up small, hanging loads in the narrow fissures. Probably, there were only a few ladders built in so that the load had to be taken up through the narrow fissures by climbing. Also, the small bucket does not definitely suggest very organised, output-orientated work (e.g. a longer row of people handing buckets to each other) but rather that small loads were carried up by single workers possibly children. This might have well been done during some mining which was concentrated on picking afterwards. If this is the case, the bucket does not mark the beginning of mining at this place. Maybe it can be dated to the late Sasanian but probably to the early Islamic period by AMS-radiocarbonate dating. The date which was offered by the ETH Zurich is within the 2-Sigma intercept between the late 7th and the 10th century AD.[14]

For the time being, haulage and ventilation shafts have not been proven for the Sasanian and early Islamic mining at Nakhlak. Insofar, the long carrying strap and the low capacity of the small bucket are typical for a rather unsystematic way of hauling. A leather

Fig. 11: Nakhlak, mine, patched leather bag from the collection of Nakhlak Mining School (2000); drawing by J. Garner/Th. Stöllner.

sack, which is part of the collection at the mining school of Nakhlak (Fig. 11), shows several patches and irregular, partly torn bulges – possibly it was also used for hauling rich ore. With its short handles, also this object might have been used in combination with transport by help of ropes.

Colluvial Mining

At the softly inclining slope below the new village and below the ore veins of the mountain there were once thousands of small shafts dug into the gravel of the colluvium with a diameter of 0.8-1 m or also bigger, about 2-3 m from each other in an area of more than 2-3 km^2 (Fig. 3). In some cases the ring-shaped heaps are well visible but mostly they are disturbed by the heap of the neighbouring shaft so that in many cases only piles are left. Wind and water have eroded the fine material on the surface and thus have almost re-shaped the original landscape. These small shafts were only discovered due to the fact that when the foundation-trenches for new houses were dug, the loose filling material was conspicuous or after irrigating a garden the filling of a shaft occasionally disappeared into the ground. Today, the original field of gravel pits is almost destroyed, as the area was graded and the gardens were dug out 0.6 m deep.

In 1976 and 1978, a former dynamite-depot, which had been dug into the ground like a cellar and was broken, allowed a look under the surface. After a 5 m deep stairway, a side wall which had fallen towards the interior offered a revealing profile. On the level of the chamber bottom, at the lower end of a more than 5 m thick layer of pebbles there was an opening through which it was possible to look into the surprisingly wide space of the former mines. The cavity was only interrupted by some remaining pillars for support and by the gravel cones of the backfilled shafts (Fig. 12). Thus, the secondarily sedimented and deposited ore in the gravel of the mountains had been exploited by 4-5 m deep shafts with small mining chambers at the bottom mostly connecting each other. It seems as if the spoil of each new shaft was filled into the neighbouring preceding shaft.

Thus at Nakhlak, besides the exploitation of those veins which were visible on the surface there was also the use of those ores which had gone into the colluvium due to weathering, besides galena mostly cerussite. These activities are so old that there is no local oral tradition. In 1884, Houtum-Schindler describes the turquoise-mining at Nishapur and says that the miners' women and children dig for turquoise also in the colluvium of the moun-

Fig. 12: Nakhlak, colluvial mining 1976, underground cavity with debris funnel of a shaft (left); Photo: G. Weisgerber, DBM.

Fig. 13: Nakhlak, Southern settlement, the fire temple (Atashgah) and the fort (Qaleh Bozorg) from the West (1978); Photo: G. Weisgerber, DBM.

tain there (Houtum-Schindler 1884). Due to the above mentioned hard living conditions without families at Nakhlak still in the last century, this way of organising work cannot be applied without problems. But now this way of producing sofar is evident for Iran twice.

The Environment of the Big Fort of Qaleh Bozorg: Ātashgāh, Settlements and Dam

After H. B. Vaughan's descriptions from 1890, the Sasanian fort and the nearby, well preserved fire sanctuary are the best known and striking buildings of the ancient mining settlements at Nakhlak (Fig. 13). Particularly Qaleh Bozorg (Big Fortress) has been described several times and is one of the two former fortifications in the area of the mining settlements at Nakhlak: the smaller Qaleh Kuček (Small Fortress) was in the area of the modern mining settlement and was destroyed when the latter was built. It is interesting that the constructions North (in the area of today's settlement) and South of the main mining area seem to be repeating (in the following: Northern and Southern settlement, see Fig. 1). In both areas, besides a military building and a topographically close fire temple, also traces of settlement and mining are situated close to each other. Topographically, the mining area is located south of Kuh-e Nakhlak (1439 m above sea level) in a mostly cretaceous formation of lime, just behind a geologically younger but not mineralized mountain ridge which partly covers it. In between there is the already mentioned main break.

Today, from the settlement area to the North there are visible only the remnants of the Chahar Tagh, a typical building of four arches with central cupola. U. Hallier, who described both buildings in detail and investigated them, provisionally identified the smaller Chahar Tagh as a "public" fire sanctuary and the better preserved Ātashgāh as the holy place for keeping the flame.[15]

But for the time being it is not even definite if both buildings are really from the same period: at least the Southern ensemble round Qaleh Bozorg seems to have been erected as early as in the Parthian period: this is suggested by common grounds concerning the technique of building and by the radiocarbonate dating of a timber from the fort (see Fig. 14). The fort itself is about 40 x 45 m wide and besides four round towers at the corners it shows a bastion-like gate building. Today it is without any recognizable

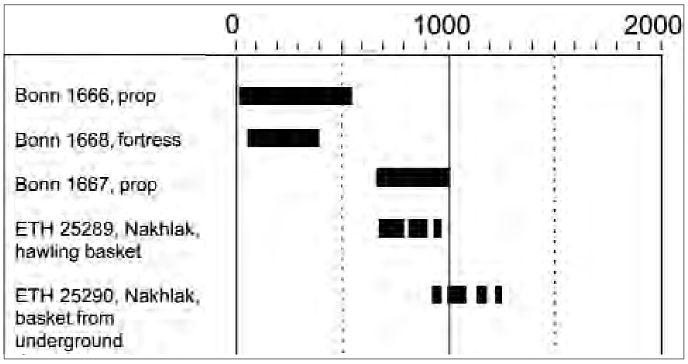


Fig. 14: Radiocarbonate-data of the mining area of Nakhlak; following Hallier 1972 with additional data (2002).

inner buildings, the question stays unanswered if it was inhabited – e.g. by a military unit. About Qaleh Kuček it is reported that a ramp inside leads underground and that it was the home of the miners (Hallier 1972, 301).

Qaleh Bozorg is located on the terrace of two dry valleys which meet further to the Southeast and is about 6-8 m above their bottom. The terrain at the point between these two wadis is very disturbed on the surface, thus suggesting mining activities. The surface depressions are up to 1.50 m deep with a diameter of 4 m at the bottom and of 10 m at ground level. The heaps reach a height of 2 m. Thus, we might think of gravel- pit-mining in the colluvium similar to the Northern settlement but for the time being the classifying of the material (benefication) also allows to interprete it as a refuse tip.

Fig. 15: Dam South of Qaleh Bozorg or rather of the Southern settlement in the year 2000; Photo: Th. Stöllner, DBM.

To the East, between the fort and the fire temple of Ātashgāh there is a medium-sized slag heap of conspicuously small pieces of slag on the red sandstone. In 1976, some remnants of a furnace were still recognizable. More slag heaps are farther to the North between the two wadis which make the terrace where the fort rises.

Between the Western one of the two wadis and cut by the track leading to the fort there is again some terrain with strongly disturbed surface. Here, bigger rocks and the conspicuously big amount of pottery might indicate a former burial field which maybe fell victim to the gravel-pit-mining or to looting. But up the slope there are walls which are still clearly visible, maybe they are from a settlement which perhaps belonged to the fort.

North of the fort – between the Northern ridge, the mining area, and the fort – there is an area which is also rather disturbed and covered with rocks. Single dry walls are shadowy visible. There, pottery (Stöllner & Weisgerber 2004, fig. 17) and slag finds, mostly crown-shaped slags from forges, were picked up. The latter may be accepted as indicating the manufacturing of iron in the settlement, something which is not surprising given the big number of iron tools which are necessary for mining.

This suggests a more or less extended settlement area around Qaleh Bozorg and Ātashgāh. It also seems as if there was small-scale processing at the place although for the time being it stays unclear if this was at the same time as the Parthian-Sasanian activities.

To the South, not far away from the fort, at the two embankments of a wadi there are still the ruins of a dam which in former times dammed the winter-water from the valley to the Southwest of the fort (Fig. 15). Doubtlessly, this was organisationally and chronologically related to the fort and thus to the peak of mining there. Also here, it seems to be important that in later times never again such great investment was done, with the exception of most recent times. At the bottom, the dam was more than 6 m wide and it was more than 4 m high. Some time or other it was washed away all across the wadi.

Besides this huge dam there were also smaller irrigation dams and dams as well as other constructions for water supply. About 100 m east of the fire temple of Chahar Tagh, in the course of road-building at a foothill of the mountain a big, low cave with a cover of only 1 m and a shaft mouth-like opening was cut. The cavity is more than a man's height and more than 8 m wide. In the Levantine such openings are typical for cisterns. Already Hallier interpreted in this way (Hallier 1972, 301). A probably not very old clay vessel, which had been elaborately repaired by help of an outer wickerwork of wire, comes from this cavity. At last and for a long time the cavity was used as a latrine.

Processing and Cupellation

Like in historic times, also at the peak of ancient mining – maybe also in the neighbouring desert zones to the East – there was processing. There, the shifting dunes again and again reveal slag fields and remnants of furnaces. In those days there was probably still enough fuel in the form of bushes (tamarisks, saxaul). But we also found remnants of furnaces and lead slag in the environment of the settlement zones. Already in 1966, Pleiner et al. reported nothing less than six slag places (glassy, black slag) in close vicinity of Nakhlak, more at the neighbouring mining place of Tschah Kharbuzeh.

Concerning cupellation, in 1976 and 1978 we only saw litharge waste. In each case it is a flat cake of 8 or more cm in diameter with a convex bottom (Stöllner & Weisgerber 2004, fig. 19). The upper side was irregularly sunk and occasionally showed bulges. Thus, the cupel, where lead and silver were separated by oxidation, had the shape of a bowl. The cupellation was not done in the environment of mining and the related settlements but farther out in the desert, the bushes there probably being used as fuel. Gabriel reports several times that the poor population of the places in the area earned some small extra income by collecting wood.[16] Occasionally, the sand reveals the flat cakes of litharge.

Conclusion

The significance of mining at Nakhlak for the history of economy is obvious: most probably, in the region of Anarak and Nakhlak ores were produced as early as in the 4th and 3rd millennium. But without further geo-chemical analyses of other cretaceous Pb-Ag deposits of similar type in Central Iran it will not be possible to be definitely sure: at least theoretically, the probable syngenetic formation makes many deposits look possible to have been the origin of the ores at Arisman. In those days, silver was finally separated from lead by help of the cupellation process at settlements to which the ore (concentrated ore?) was taken.[17] This was done far away from the deposits. This suggests sporadic and seasonal access, which may be the reason why so few traces were left at the ore sites. While these early activities are at least indirectly proven by help of provenance-analyses, we have not yet succeeded in definitely proving the use of regional copper ores, e.g. the native copper from the famous Talmessi deposit.

With the introduction of gold and silver currency in the Eastern Mediterranean region and in the Near and Middle East, also the preconditions for exploiting the lead-/silver/(zinc) deposits on the Iranian Plateau change. Even if at Nakhlak evidence from the Achaemenid period and from the second half of the 1st millennium BC are still lacking, they are to be awaited.

Only for the younger Parthian, the Sasanian as well as from the early Islamic period, the intensive exploitation of the deposit is safe due to mining-archaeological evidence and a number of radiocarbonate-datings (Fig. 14/tabl. 1). Most of all, the two fortresses show control by the state and protection of the deposit and fit to a concept of intensive exploitation at the place:[18] settlement, mining, and smelting activities may be supposed to have reached large scale, and it must be suggested that the big number of people working at the place were supplied from the outside. But how and when this mining declined, if there was sporadic after-use e.g. in the form of picking up loose material from older mining, and when new exploitation started, stays completely unclear for the time being. For this, new and systematic field research is needed. The significance of this ensemble for the archaeology of mining can hardly be estimated high enough: the quality of tradition and the complexity of the evidence are unique for Iran and in the case of renewed research there outstanding results are to be expected.

laboratory No.	place	data
Bonn 1666[19]	pit, support	1790±100; 2σ: 0-AD 550 (95,4%)
Bonn 1667	pit, legs	1190±80; 2σ: AD 680-1000 (95,4%)
Bonn 1668	Qaleh Bozorg	1820±80; 2σ: AD 20-400 (95,4%)
ETH 25289	Surface, caving in, small bucket	BP 1215±40; -28,3±1.1; 2σ 699-749 (10,1%), 751-894 (85,4%), 919-952 (4,5%)
ETH 25290	pit, bucket	BP 1030±40, -28,4±1.1 2σ: AD 894-918 (3.7%), 951-1056 (86,2%), 1082-1157 (6,7%), 1137-1157 (3,3%).

Tabl. 1: Nakhlak, Iran: The radiocarbonate datings, as existent for the time being (following Hallier 1972 and unpublished DBM; one modern date from 1978 was not mentioned: HAM 1167).

Notes

1 Shortened version of an article which was published in the periodical "Der Anschnitt": Stöllner & Weisgerber 2004.

2 E. Bleibtreu in: Seipel 2001, 200ff. (more than 200 silver vessels); on silver in the Sasanian period a. o. Sperber 1971. On lead as metal for daily use: Meier 1995. On lead in the metallurgy of Iran also Pleiner 1967, 363-371.

3 The ancient mining already is described by Pleiner 1967 (e.g. Naiband, Chubanan/Tars, She Changi); Berthoud et al. 1976, 15-17.

4 Stahl 1894; Böhne 1929; Baier 1940; Ladame 1945; Bariand 1962/63; Burniol 1968.

5 Stahl 1894. He says the same about the copper pits at „Bage Guruk" (=Baqeroq), 10 km Northwest of Nakhlak.

6 Commendable letters by Bergdirektor a. D. Max Maczek from July 21st and August 2nd , 1977.

7 Some of M. Maczek's photographies are also depicted in: Wulff 1966, 16.

8 Concerning their construction and their way of working, these blowers were similar to Roman bellows (e.g. Weisgerber & Roden 1985, fig. 14). Until recently, they were also spread in other parts of the Near East, e.g. in Jordan (1990).

9 Momenzadeh 1976; Rasa 1987. On the problems of provenance-analyses see the completed version: Stöllner & Weisgerber 2004).

10 The finds from Arisman are mostly from Sialk IV-strata or they are from section B above the late Sialk III 5 to 7b building structures; at Sialk, new investigations by S. Malek Shahmirzadi lead to definite finds of litharge in contexts of late Sialk III. Oral information by Prof. S. Malek Shamirzadi and Dr. B. Helwing.

11 Pleiner 1967, 348, a. o. mentions an Achaemenid inscription plate which today is missing.

12 Of course, due to the sloping the vertical depth below the surface varies strongly and in single cases reaches 150 m. Very instructive: Holzer & Ghasemipour 1973, fig. 5 below.

13 In the collection of the GSI there is a similar example from the smithsonite pit at Dashtan (Kerman).

14 The AMS-radiocarbonate-data as introduced here were calculated by help of the particle accelerator at the Insitute for Particle Physics at the ETH Zurich: 25289, BP 1215±40; -28,3±1.1; 2s 699-749 (10,1%), 751-894 (85,4%), 919-952 (4,5%). We like to thank Prof. Dr. Georges Bonani for his fast work. The calibrating was done with the program calibETH (radiocarbonate 34/3, 1992, 483-492). According to the Oxford calibration curve in the program OxCal, the 2-Sigma intervall is 680-900 (93.2%) and 920-940 (2.2 %).

15 Hallier 1972; in general see also: Schippmann 1971, note 116.

16 Gabriel 1935, 57: *" Some more poor people from Anarek or Ardistan live at Ashin now and again if they want to produce charcoal in the environment of the place or want to graze goats; 67: "Sometimes with great effort a well is dug by the charcoal burners in common work which is used only now and again, as long as the wood in the environment has not all been collected; 71: "...something like a path is outlined. It was made by wood collectors who far in the Rid-e Djinn collect the saxaul-trunks to burn charcoal from them for the furnaces of Nekhlek."*

17 Concerning the processing of copper, the situation is similar. Earliest smelting was done at the settlements and not at the mines.

18 Military installations for protecting mining areas are often reported from the 1st millennium: Qaleh Zari in Sistan: Hallier 1973, 189ff.; the copper deposit at Sheikh Ali in Kerman: Berthoud et al. 1976, 15ff.

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Ancient Mining in the Hindukush According to Ancient and Medieval Sources

Gerd Weisgerber

As there are only few reports on ancient mining in what is Iran today, and as on the other hand the various empires of the past 2500 years in this region reached far beyond this modern state, ancient news about modern Afghanistan, which is located to the East, shall be introduced in this catalogue (in detail: Weisgerber 2004). This country is determined by the Hindukush Mountains in the Northeast and its foothills towards the Southwest. The biggest stream of the Southern slopes with its 1300 km of length is the Hilmand-Rud which ends in the outletless marshy lakes of Sistan and seeps away in the wide lakes of the delta. Today, this desert region of Sistan is divided among Iran, Afghanistan, and Pakistan. The two former countries are rich in metal ores as well as ornamental and precious stones. From recently, a detailed list of mineral deposits of Afghanistan including coordinates is at hand (Bowersox 2004, 446-472).

The most intensive medieval period of mining was in the time of the Saffarides (866 to *c.* 900) and the Ghasnawides (977-1187), *i.e.* about 1000 years ago. Most of the reports date from this period and thereafter. Despite repeated Mongol destruction the production of raw materials revived at some places during quiet periods in the High and Late Middle Ages but the peak of the High Middle Ages was never reached again.

It is typical for written sources that spectacular raw materials like precious stones, gold, and silver drew more attention than *e.g.* iron or copper although mostly the latter were of much more importance for a country's economy.

Geology/Deposits

Generally, mineralizations in Afghanistan are connected to intrusions of tertiary granites into the metamorph limestone of the Central Hindukush. As the country is located at the Western end of a pegmatite belt, stretching from Pakistan, Nepal, India as far as to Burma, its mountains contain many deposits of precious stones. Two kinds of precious stones, lapis lazuli and ruby, have been exploited for millennia. What makes Afghanistan special is the fact that from no other Islamic country there are so many good reports by various Arabian, Persian, and even European authors from periods that early, for besides some Roman mentionings we owe many informative indications to the Venecian Marco Polo (1254-1324).

Garnet

The Persian born cosmographer Zarkariya' b. Muhammad al-Qaswini (1203-1283) mentions garnet as one of the precious stones from Badakhshan[1], Ibn Hauqal even speaks of "wonderful garnets" (Ibn Nauqal 1964, vol. II, 434). Muqaddasi (after 985) offers the most details: *"From Badakhshan you get wonderful garnets, they are wonderful precious stones being equal to rubies due to their beauty and their astonishing shine in pink colour, the colour of pomegrenade, purple, or with a shade of wine. Here, there is digging for lapis lazuli due to its many deposits in the surrounding mountains"* (Muqqadasi 1963, 434).

Lapis Lazuli

Lapis lazuli from Afghanistan was already exported to Neolithic Egypt, to Naqadah. But the peak of its use was in Bronze Age Mesopotamia, to which it evidently came via the Iranian Plateau (Tosi 1974). Its deposit exists on River Koktscha, a tributary of the Panj/Amu Darja in the high mountains of Badakhshan (Fig. 1). Its cornflower-blue colour is mainly due to the mineral lasurite. The mines are at about 2630 m above sea level, there are mines of different size, from 30 m of width and 40 m of height to narrow spots. Extremely steep spoil heaps reach down to the river (Kulke 1976).

Fig. 1: Sar-e Sang, view at the spur with the openings of the mines; Photo: Kulke 1973.

Marco Polo (1254-1324) was the first European to localize the place where this blue decorative stone was exploited to be in Badakhshan: *"In the same country there is another mountain where stones are found, from which they make azure of the finest quality in the world. Like silver, these stones come from veins"* (Polo 1958, 76ff.). His use of the word "azure" refers to pigment, as during the High and Late Middle Ages varnish-stone played an outstanding role. Blue pigment was definitely necessary if a lasting and most of all intensive blue for miniature painting or frescos was wanted. *E.g.* the dark blue coat of a Madonna could hardly be depicted without lapis lazuli! At Dürer's time, customers or painters got their ultramarine (= oltre mare = from beyond the sea) from the pharmacy, in Germany it was literally worth its weight in gold (Krekel & Burmester 2000; Kurella & Strauß 1983, 36). Although it was called "from beyond the sea", nobody had any idea

Fig. 2: Sar-e Sang, view at the spur with the marble hollow on the Northern slope of Kohe Madan. About in the centre of the picture mines 2 and 4, above right in the hollow white slate. Bright cone of rubble in the centre stands for the heaps of the mentioned lapis lazuli mines; Photo: Kulke 1973.

Already Ibn Hauqal, one of the most important geographers of the Balch school (943-988) knows about the location of the precious stone-mines in Badakhshan (Fig. 2 & 3) and the journey from Balkh to Badakhshan via Tayiqan [Taloqan] "7 days, ...Badakhshan produces rubies and lapis lazuli, the pits are in the mountains" (Ibn Hauqal 1992, 225).

Muhammad ibn Mansur (died in 1313) described the different qualities but sometimes mistakes lapis lazuli for turquoise: *"Lagward is a well known soft stone and is divided into four kinds: Badaxsi, Keregi, Dirmari, and Kirmani. Again, there are two kinds of Badaxsi: on one kind there are spots in the colour of gold but not on the other kind. Sometimes it is also the case that Lagward is mixed with earth or white stone. From Lagward there are made bowls, jugs, ring stones, belt trimmings, and finger rings, and other things of that kind. ... The most famous source of Lagward is in a mountain which is known as Mount Lagward, in Xutlan near the town of Badaxsan. Around Kereg Kirman and elsewhere there are less famous sources. The beautifully coloured, pure Badaxs with golden spots is better than the other kinds of Lagward"* (Ritter *et al.* 1935, 51f.). The golden spots refer to pyrite in real lapis lazuli, the mixture with white stone refers to the worse qualities with a lot of marble, the best example for this being the famous axe from Troy. The reference to Kirman may be supposed to mean the turquoise there.

In the Islamic Middle Ages, this stone had also the function of an amulet. Al-Qazwini (1203-1283) reports on this, a Persian natural scientist and cosmographer: [Pseudo]-*"Aristotle says: this a famous stone; it inherits softnes, it is used as a seal-stone and in the people's opinion it is of great value. If used for rubbing in under eye-make-up it makes the eye look more beautiful. Ibn Sina [=Avicenna] says: it makes warts fall off and makes the eyelashes more beautiful and bigger. – Somebody else says: the varnish-stone helps against sleepnessless and is good for melancholic people."* Qazwini 1994, 233). Obviously, the use as strong pigment (eye shadow) was common in the Orient.

where exactly it came from. Not at last due this Marco Polo thought it worth mentioning.

Ruby

Colour and light gained the bright red ruby from Badakhshan, which is called spinel today, its place in Oriental poetry. The ruby mines of Badakhshan were East of the Panj, in what is Tadjikistan today, at the mountain of Kuh-e Lal, North of Ishkashim (Fig. 4). But in the past, the province of Badakhshan strechted far beyond that stream, and the district of Ishkashim, bordering Xinjiang – Marco Polo's "Sighinan" – was a part of it, as already al-Biruni (973-*c.* 1059) knew in his "Mineralogy" from the first half of the 11th century: *"The ruby mines are ... three days travel away from Badakhshan, bordering Wachan, in the state of the Shainshah whose capital is Shikism [Ishkashim] near the mines.* From there they have got their name of "ballas-rubies": *Badakshan itself has got nothing to do with it (the name), the ruby is called Badakhshan as this is the place where it is transported to, where it is cut and polished ..."*

Fig. 4: "Badakhshan-ruby" mine at Kuh-e Lal; Photo: G. Bowersox, Gem-Industries, Hawai.

Al-Biruni writes on the technique of mining: *"There are two ways of exploiting ruby: the first is based on mines, the second on picking it up from between stones and lumps of earth which are washed down due to the mountain getting destroyed by earthquakes and by the streams of mud coming down from the slopes. This kind of exploitation is called `tartari´ there (= soap mining) ... When they (the miners) meet some white stone, called `pick´which due to its colour is similar to marble [probably magnesite, forsterite] but soft and crumbling and covered on two sides either by flint or any other stone, ... itself being white and with a light blue shade, then they continue their work as this is the first sign of success with their efforts and hopes. Then they dig until they meet what is called `shirista´. That is some loose rock and when put out it crumbles, it is useless, but for them it is a sign of the demanded. Then they come to some rock which is not loose but dense and from what bead necklaces are made: it can be pierced ... After having passed this rock the spot is reached were precious stones are ... and this ruby is found within a cover of white stone looking like mountain crystal. Together with what is in it, this cover is called `migal´. Its size may vary ... After the cover has been put away, the precious stone itself is seen – either as a complete piece, this seldomly happens, or in the form of regularly layed out small pieces [saponite grains], similar to the grains of a pomegranade in their skin"* (al-Biruni, quoted after Bubnova 1971).

From the geographer al-Idrisi (*c.* 1100-1165) there comes an enthusiastic indication of the exploitation of ruby: *"From Balkh to Badakhshan you count 13 days. ... let us return to the description of Badakhshan ... From these mountains they also get very precious coloured stones, like the ruby of a lively red, the ruby with the colour of pomegranade pulp, and others, as well as a lot of lapis lazuli. These stones are exported to all the countries in the world, it is impossible to see any which are more beautiful"* (Idrisi 1975, 478f.).

Also later, ruby is often mentioned in connection with lapis lazuli, *e.g.* by Marco Polo (Fig. 5): *"Badakhshan or Balashan "is a Province inhabited by people who worship Mahommet, and have a peculiar language. It forms a very great kingdom ... It is in this province that those fine and valuable gems the Balas Rubies are found. They are got in certain rocks among the mountains, and in the search for them the people dig great caves underground, just as is done by miners for silver. There is but one special mountain that produces them, and it is called Syghinan [Shignan]. The stones are dug on the king's account, and no one else dares dig in that mountain on pain of forfeiture of life as well as goods; nor may any one carry the stones out of the kingdom. But the king amasses them all, and sends them to other kings when he has tribute to render, or when he desires to offer a friendly present; and such only as he pleases he causes to be sold. Thus he acts in order to keep the Balas at a high value; for if he were to allow everybody to dig, they would extract so many that the world would be glutted with them, and they would cease to bear any value. Hence it is that he allows so few to be taken out, and is so strict in the matter* (Polo, Yule & Cordier 1992, 157).

In more recent times, the ruby deposit of Jegdalek, about 50 km east of Kabul, came to the fore. The quality of the stones can definitely be compared to those from Mogok in Burma (Bowersox 1985, 202; Bowersox *et al.* 2000; Hughes 1997; 2001).

Emerald

In Afghanistan, emeralds exist in the Hindukush, Eastnortheast of Paranden in palaeozoic marble and crystalline slate tectonic zones of 10-12 km length. If Plinius (N. H. XXXVII, 65) is talking about them, *"There are 12 kinds of emerald. The Scythian are the most noble ones. ... Second glory enjoy, also due to the place where they are found, those from Baktria"*, the latter must have been emeralds from Afghanistan.

Sapphire

Marco Polo also mentions sapphires (Al_2O_3) in our region: *There is also a mountain with sapphires"* (Polo 1958, 77). This result has been recently confirmed (Bowersox et al. 2000).

Salt

Salt is and was produced from deposits of rock salt and salt lakes for the country´s own needs, the reserves are said to be huge. As late as in 1935, Karl Brückl saw caravans of camels and donkeys from the entire country coming to Katagan via the Khawak pass to cover the tribes´ need of salt in the biggest and most important opencast mine, the one of Namakau (Brückl 1935), 378f.). The salt mountains mentioned by Marco Polo in the following are salt deposits of grey or red clay: *"After those twelve days' journey you come to a fortified place called Taican [Taloqan, between Balh and Pamir], where there is a great corn market. It is a fine place, and the mountains that you see towards the south are all composed of salt. People from all the countries round, to some thirty days' journey, come to fetch this salt, which is the best in the world, and is so hard that it can only be broken with iron picks. 'Tis in such abundance that it would supply the whole world to the end of time"* (Polo, Yule & Cordier 1992, 153).

Asbestos

Called Hajar-al-Fatilah (= wick stone) by the Arabs, asbestos was popular as a long-lasting material for the wicks in oil lamps: *"In Badakshan, in the country of the Turks, you find some white,*

Fig. 5: From a medieval edition of "Marco Polo's Book of Wonders": depiction of an Oriental queen, accompanied by a lady-in-waiting, with merchants in the background. In the centre, miners are digging for the precious stone ruby, each of them carries a deep red ruby in his hand. On the right, dragons and a griffin defend the treasures of the earth; Photo: Bibliotèque Nationale, Paris.

flexible stone which is used both for fabric and for wickerwork. Thus, also the wicks of lamps are made from it. The oil penetrates into it but they are not burned away by the fire" (Shems ed-Din 1994, 95). Muqaddasi adds that also mats as pads for meals were woven from it. And if they were dirtied by fat, they only needed to be baked in the oven for some time to be absolutely clean again (Muqaddasi 1963, 303).

Metals

Besides precious stones, in the Middle Ages mostly silver from Central Asia and Afghanistan played a major role, something which not at least was known due to the gigantic amounts of silver coins which were traded as far as to Scandinavia (Steuer 1998). Thus, Marco Polo's statement following his praise of lapis lazuli is not really surprising: *"The silver, copper, and lead mines are also very profitable"* (Guignard 2003, 65f.). But unfortunately there is no historic evidence of gold, lead, and copper mines beyond some namings.

Tin

In the early 70s, Soviet geologists found more than one hundred deposits of tin in Afghanistan.[2] It is mostly kassiterite. In a Roman description of the Earth tin is mentioned in the Drangiana, for Strabo says: *"The inhabitants of Drangiana (Drangae), who concerning their way of life copy the Persians, have only small supply of wine but they have got tin in their country"* (Strabo XV. 2. 10). In antiquity, Drangiana was the country at the Hilmand, *i.e.* Sistan in the wider sense. This might at least indicate that kassiterite, *e.g.* on River Harud Rod, was used in Roman times.

Iron

Muqaddasi reports on frequent deposits of iron ore in Khorasan (Muqaddasi 1963, 419, 436, 447) and Ibn Hauqal gives further details: *"In the country there are deposits of iron ore whose exploitation is extraordinary and surpasses the demand"* (Inb Hauqal 1964, 447).

Lead

At Sim Kuh in the Western part of the Hindukush, almost near Persia, ancient silver mines were found. This confirms older literature saying that along the road from Herat to Sarakhs there was a mountain called Sim-Kuh (=silver mountain).[3] We may suggest that this is "Jabal al-fidda" [=silver mountain], marked North of Herat on the Small Idrisi Map (Fig. 6) from 1192 AD (Miller 1926). But this is not the oldest reference. That is owed to Hudud a,´Alam from the year 982: *"Kuh-I Sim, a small village at the slope of a mountain with a silver mine; the latter has been abandoned due to lack of fuel"* (Hudud al-Alam 1070, 104, No. 27).

Ibn Hauqal writes: *"Maweralnahr [Trans-Oxania, today Uzbekistan and Tadshikistan] supplies raw silk, wool and fur in great amounts. Her mines supply sufficient amounts of silver, tin, or lead, and they are better than the other mines except those of Panjhir; but Maweralnahr supplies the best copper and mercury and other mining products. And the mines of ammonium salt for soldering in entire Chorasan are here"* (Ibn Hauqal 1992, 233).

The following will be on this famous mining site of Pandshir (= Five Hills). The location of Pandshir in the network of caravan trails is often described: if one wanted to go from the Baktrian capital Balkh to the district of Badakhshan, where there were the mining places of Pandshir and Jarianeh [Jarbaya], one had to cross Anderaba, where there was a mint: *"From Anderaba to Jarianeh 3 days, from Jarianeh to Panjhir one day"* says Ibn Hauqal (943-988) who several times mentions Pandshir and the importance of mining there (Ibn Hauqal 1992, 231).

Only about one hundred years later there follows the Arabian-Maghrebian geographer Al-Idrisi (100-1165): *"From Semendjan to Anderaba 5 days travel. The latter town was built at the foot of a mountain. Here, the silver coming from Hariana* [Jarbaya] *and Bendjehir [=Panjhir] is stored. Located at the confluence of two rivers, one of them called Anderaba and the other one Kiasan, it is surrounded by gardens, orchards, and fenced estates with wineberries and fruit trees. ... The inhabitants of Hariana* [Jarbaya] *own neither trees nor orchards. They only grow some kinds of vegetable; but they are committed in mining. Indeed it is impossible to see something more perfect than the metal which is extracted here and than that which is got out of the mines of Bendjehir* (=Panjhir). *That is a small town on a hill, one day´s travel away from the former. Its inhabitants attract attention as being of violent and aggressive character. The river, which comes out of the Bendjehir mountains, runs towards Hariana, as we have just stated. The workers in one or another mine with great tenacity, industriousness, and skill are committed in producing, melting, extracting the metal from the slags and generally in everything concerning their trade. ...From here to Farwan two days to the South"* (Idrisi 1975, 475f.).

The most detailed medieval description of mining – not only from the Islamic Middle Ages – is owed to the Arabian geographer Jakut (1179-1229), 200 years after Ibn Hauqal. He writes on mining at Pandshir, the richest mine of Islam, North of Kabul: *"Panjhir is a town in the Balkh region where there is a silver mountain. The inhabitants there are halfbreeds and they bear anger and evil, and among them there happens murder and manslaughter.* There were 10,000 digging for silver *"being always engaged in quarrel and vice." ... "There, pieces of silver are that common that almost*

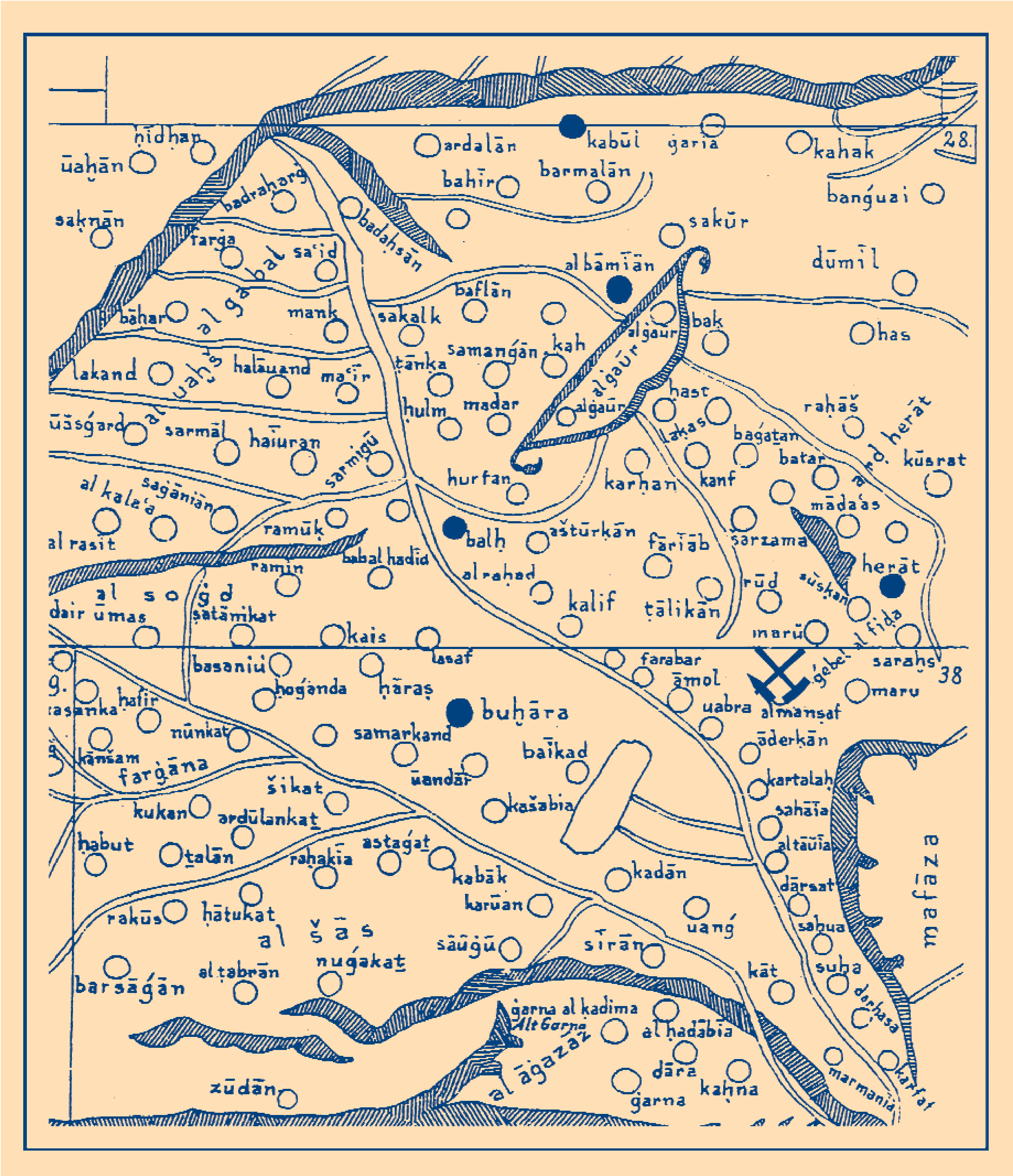

Fig. 5: Detail from the Small Idrisi Map, orientated towards the South. Some modern places are marked as black spots, the silver mountain of "gebel al-fida" was marked by the author with the hammer and chisel-symbol; following Miller 1926b.

everything is one whole silver Dirhem, if it was only a piece of vegetable. The silver is in the peak of the mountain which towers over the town and which looks like a sieve due to all the mines. The miners only follow those veins which indicate containing silver. If they find such a vein, they constantly dig until they find the silver. It happens that someone gains about 300,000 Dirhems from digging; often he finds what makes him and his descendants wealthy, often he gets at least the amount of his investion, but on the other hand he often is reduced to beggary, which is the case if water and other adversities are stronger. Sometimes someone is digging after a vein, another one is digging just the same one from a different crevice and they start digging at the same time. In this case it is the custom that he who is first and steps into his rival´s way is entitled to the mine and its product. With this digging contest they work like no devil, as if one is first the other one´s entire investion is gone. If they arrive at the same time, they go halves. They dig only as long as the lights and lanterns are burning; if they reach that far that the lights go out, they do not go any further. Who goes further will die in the shortest time. It happens that someone is rich in the morning and poor in the evening, or poor in the morning and rich in the evening."[4]

These reports offer indications of early Islamic mining law. In Islam, mineral resources were considered common property of the community, controlled by the government. The people were entitled to exploit them directly or to leave them to private people for exploitation, under the condition that the treasury received 20% (following Duri 1979, 103). Obviously, innumerable private owners had their claim at the Panjhir Mountain. The figures giving the number of miners differ widely from six to ten thousand men, obviously according to the manuscripts. The example mentioned is likely to mean: if when following his vein someone met the already existing drift of somebody else, *i.e.* if the veins were meeting, the other one had priority. If they met like roadhead to roadhead, they could go on together. Concerning the technique of mining, Jakut´s report shows that people were definitely able to interprete the signals from the lamps and in case were able to understand them to be a warning. But it also shows that drainage was an unsolvable problem and that hardly any measures for artificial ventilation were carried out. Instead, the people relied on natural ventilation, just like it was the case in our region in the early Middle Ages. Amazingly, the first medieval rules of mining law in Europe date from about the same time.

Notes

1 Brückl 1935, 366f., upper course of Darja-e Shatsur, a tributary of the Pandshir, pegmatite granite with garnets.

2 Wolfart & Wittekind 1980, 410; Penhalluric 1986, 28-31. Bowersox 2004, 470-472 lists about 75 deposits, mineralisations, or placers with coordinates.

3 Holdich 1910, quoted after Herbordt 1925, 195.

4 Jakut, following Mez 1922, 416.

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The Turquoise Mines at Nishapur

Gerd Weisgerber

"Kerman is the land of turquoise; everywhere in the mountains these stones are found, they are broken and hewed out of the rocks." By these words Marco Polo (1254-1324) mentions this mineral which is so typical for Persia (Polo 1992, 90; 2003, 48) (Fig. 1). In the 13th century turquoise made the wealth of this Central-Iranian kingdom, besides iron of outstanding quality. But already the Roman natural scientist Plinius (1st cent. AD) probably knew these deposits in "Carmania" (= Kerman) (Nat.Hist. XXXVII.33.110). In the 19th century geologists report that until recently there had been turquoise-mining a. o. near Parez. But they also mention that these stones from Kerman were of pale blue colour, easily loosing it and thus not being highly appreciated.

Completely different is the turquoise from Maden, a mining place 54 km Northwest of Nishapur in Khorasan in the North of Iran (Bazin & Hübner 1969, 95f., map and elevation fig. 43). And it seems as if Albertus Magnus (1200-1280) is talking about them: "Turqoise is a stone of bright blue colour, as if milk has intruded into the blue and got through to the surface." (Albertus Magnus 1967, 123). Still today, turquoise is mined there, its bright blue is not reached by any turquoise in the world if they are compared *e.g.* to that from the Sinai (Weisgerber 1976; 1991), from Tibet, or from Northern and Southern America (Pogue 1915), which mostly differs by dark veins and inclusions ("turquoise-matrix") and often

Fig. 1: Turquoise-mining, from Marco Polo's book "The Wonders of the World" in the manuscript of the so called Master Boucicaut (around 1390-1430), written after 1410. The picture shows the Great Khan, sitting enthroned under a canopy. Pearls, turquoise, and rubies are shown to him which were washed out of the lake or were mined in the mountains by his miners (Bibliothèque Nationale, Paris).

Fig. 2: Nishapur, big opencast mine, probably the result of a caving in (1976).

by nodular shape, but most of all by the fact that in the past it lost its colour very fast or changed it to be green, due to drying out. To avoid this loss of value, today almost all traded turquoise is protected by impregnation. In recent times, the town of Mashad was the one trade centre, in the past the export was mostly to Russia and India.

Due to the beauty and quality of the turquoise from Maden, both the stones and the town of Nishapur or the land of Khorasan are often mentioned as one by many medieval geographers and cosmographers, *e.g.* by Ibn Hauqal (943-988)[1], in the Hudhud (982/83) (Hudhud 1970, 102, 103) or by Muqaddasi (985) (Muqaddasi 1963, 419). Also the first detailed description by Al Biruni (973-1050) comes from the 10th century. He lived in Persia, India, and Afghanistan and thus was close enough to the famous origin of our stone of jewellery to be provided with further insights:

"On firuzaq (turquoise).
It is a blue stone. It is brought from the Ansar mountain, one of the Riwand mountains at Nishapur. [with cutting] it takes water

when polished on a hard, beautiful stone; then it is polished with oil by using a file. The wetter it is, the better is its quality.The best quality comes from the deposits at Azhari and Bushaqi. The most beautiful kind is of dark colour, the shiny kind, al labni, then the kind which is known by the name of Schirfam (?). One drachma [the weight of one stone] is 10 dinars. – The people from Iraq prefer the ones which are smoother, those from India love the round ones with bulged surface. The biggest pieces of turquoise found weigh 100 drachmas; of pure ones with nothing mixed in there are only pieces of 5 drachmas. They reach a value of 100 dinars" (Wiedemann 1984, 509).

Some time later, Al-Qazwini (died in 1283) in his paper on mineralogy is talking about the same deposit: *"Turquoise is a nice looking, green stone mixed with blue. Its pits are in the country of Khorasan. Its colour is pure, like the purity of the air, as when the atmosphere gets dull it gets also dull. It is useful for the eyes if crushed together with make-up powder and then rubbed in. It is not used for the clothes of kings as it diminishes their majesty, and according to Ga´far, Muhammad´s son – may God have mercy with both of them – the hand which seals with a turquoise will never be poor"* (Qazwini 1994, 30).

Or fifty years later al-Damasqi (died in 1327): *"Among the less precious stones there is the turquoise, which comes from the vapour of copper, it comes from mines. There are two kinds: the Bushaqi, which is best, blue colour, pure, shiny with intensive clearness, the Khalendji. ... Oils spoils them and changes their colour, their fire goes out if they are exposed to sweat or perfume. ...Twenty or ten years after having come from the pit they start loosing their colour. ...The turquoise mines are found around Chorasan and in other copper mines"* (Damasqi 1974, 78).

At least it becomes clear from the written sources that turquoise mining was done in the districts of Kerman and Nishapur as early as more than one thousand years ago. It also becomes clear that besides their material value the stones were said to bear medical powers and powers to protect from the evil. People liked to wear them at their turbans, set in pearls, to protect themselves from the "evil look". As talismans they decorated daggers, sabres, or harnesses.

But the most detailed description we thank to the Persian Muhammad ibn Mansur who wrote in his own language at about 1300 (Houtum-Schindler 1886, 309f. using modern measures and values):

"According to different deposits, turquoise is distinguished into different kinds and when seeing a turquoise, experts know at once from which pit it has come. There are five kinds: Nishapuri; Ghaznewi (Afghanistan), Ilagi (Trans-Oxania), Kermani, and Charezmi (Chiwa). Only the Nishapuris are of value, the other kinds are soft, not pure, and they soon loose their colour. The Nishapuris are hard, beautiful, and pure and they do not change their colours; there are 7 kinds of them: Abu Ishagi, showing a beautiful, dark colour and being shiny and pure; Azheri, similar to Abu Ishagi but not as good; Soleimani, showing a bit of a milky colour; Zarbumi with golden spots (pyrite) which are not as shiny as the first kinds; Chaki, sky-blue; Abdul Medjidi, dark blue but not pure; Andelibi, showing the colour of milk. If the weather is clear, the turquoise is bright and shiny, if the sky is cloudy, it is murky and dim. Some turquoise is soft, and if butter is put on it, its colour gets darker; but this will soon disappear. Jewellers call this quality Sedja (also Mescha and Messiha). Two-coloured turquoise is called Abresch (patched).

Hard turquoise is drilled by using diamond, the softer quality by steel. There are three kinds of fake turquoise: 1° fayence 2° some hard, green stones composed of copper and other minerals; 3° Madjun I Tschini, also called Boreizeh (Chinese paste). It is very easy to distinguish real turquoise from fake one. Turquoise is also divided into old and new, according to its age. Shine and colour of old turquoise do not change, new turquoise will soon loose its colour. They say that never a beautiful, perfect turquoise of more than 23 g has been found though big pieces of turqoise are not rare at all. Jewellers tell about an Ilagi-turquoise, having weighed more than 920 g and having been fifty (thousand?) dinars worth (850 Francs, or 850,000). In the history of the Selchukes it is written that King Alparslan, when taking Fars, was brought a turquoise bowl from the castle of Istachr which contained 6 kg of musk and amber, and that Djamschid´s name

Fig. 3: Nishapur, view from below into an abandoned shaft (1976).

was engraved on it. Sultan Sandjar is said to have possessed a piece of turquoise being as big as an apple. In the treasure-house of (the Salmanide) King Nob ibn Mansur there was a turquoise pot big enough for six bottles, each of them containing 4.5 litres of rose water.

Turquoise is cut on the wheel, then it is polished by using a soft stone and willow. The best kind of turquoise is Nishapuri, and the best kind of Nishapuri is Abu Ishagi; then follows Azheri-turquoise, then Soleimani, then Zarbumi, then Chaki and Abdul Medjidi, and finally there is Andelibi which is the worst quality. The best colour is dark green (sic!), the second best colour is the milky colour (white), then there follows sky-blue. The shape which is most popular in Chorassan and Trans-Oxania is peikani (pointed) while the Arabs and Syrians prefer the mussateh (flat) turquoise. The Chinese love Taymaleh (?), turquoise which is criss-crossed by other stone (matrix?) and they use it for decorating their idols and their wives."

"Good turquoise feels soft, it is pure and shiny. Abu Ishagi or Azheri is of beautiful, dark colour without any mistake, it weighs 2.3 g and it is worth 119-170 Francs; 4.6 g is worth 340-510 Francs; 9.2 g is 850-1190 Francs. Milk-coloured turquoise of 4.6 g are 14 Francs; average qualities are 3 Francs for one stone of 4.6 g; poorer qualities are less valuable. Turquoise is some copper ore which was changed by heat."

"Looking at turquoise makes the eye stronger. If you look at a piece of turquoise in the morning you will have a lucky day. When the moon is new you should look at a piece of turquoise. Turquoise helps its possessor to defeat his enemies, it protects him from being injured, and makes him popular with all people.

Wetness, oil, and strong smell weaken the shine of the stone; wether-fat makes the colour stronger, thus the pieces of turquoise which are on the hands of the slaughterers are always of beautiful colour."

There are turquoise mines at Ilag, Ghazni, Chaarezm, in the mountains between Yazd and Kerman and in the mountains between Tus and Nishapur near the village of Paschan (the ancient name of the village of Maden). The best mines are at Nishapur; there, there are seven pits from which the above mentioned seven kinds of Nishapuri-turquoise come. The best mine is the one which was discovered by Isaac, father of Israel, and which therefore is called Isaac's pit; the worst pit is the one of Andelibi.

Fig. 4: Nishapur, mining district with traces of mining.

Fig. 5: Nishapur, only one half of each of two former shaft-like pits is preserved.

Fig. 6: Nishapur, big opening of a turquoise-mine at about 1908 (Will's cigarette-picture following Scalisi & Cook 1983, 71).

Today, in the district of Maden near Nishapur there are three valleys and their flanks marked by ancient mining. In medieval scripts the place is also called Pashan or Fishan.[2] The turquoise district is marked by andesite and trachyte rock with local porphyrs and breccia. Descendend copper-solutions reacted with phosphates and feldspar and changed into turquoise in the form of flat crevice or nodular intrusions. Thus, there are intrusions in the form of plates being 2-6 or 13 mm thick at the most or there are small masses of the size of peas or beans. The pits are located about 2000 m above sea level.

At about the end of the 19th century, almost the entire village of Maden with its about 1500 inhabitants was occupied with mining in 266 small or big pits and with working the decorative stone in their houses. They were able to make a living from that, however, none of them got really wealthy. As always, the miners were the last to profit.

The mines of Abdurrezagi (Abu Ishagi) in the North of the district were famous, one of them reached a vertical depth of 50 m. Obviously, water seeping in caused some difficulties. But here the best turquoise was found. The pits of Maleki, Zaki, and Mirza Ahmedi had been run prudently for a long time (Safawide period) but then they were run by private possessors which unfortunately lead to uncontrolled over-exploitation. Because of this, the supporting pillars were lost which left the mines to completely collapse (Fig. 2). But even in the debris of these cavingins, being more than 40 m deep, there was still found turquoise of good quality. Some of the ancient sink-holes are said to have been caused by the earthquakes of 1271 and 1273 (Pogue 1915, 35). Also in the valley of Dar-i-Kuh, where there were both galleries and shafts (particularly for ventilation), there was profitable mining (Fig. 3-5). The turquoise from the Ardelani pits was not as famous. But nevertheless there were twelve shafts which were plugged in 1884. The name "chiragh-kush" tells that there, in a depth of 30 m, the air was so bad that the flames of the lamps extinguished. New in those days were the pits of Anjiri which produced turquoise of good quality and in sufficient quantity. All pits were worked by using picks and crowbars as mining tools. Only seldomly, gunpowder was used, as the decorative stone was suffering too much from that.

Of particular importance was producing turquoise from the debris from the pits and, most of all, from the colluvial debris at the slopes of the mountains and from the alluvium of the valleys, where turquoise had been washed to due to weathering. Without any system, funnels were dug at the surface and the material from the hollows and fault pits was brought up. Sieving and separating was done by children. These mines close to the surface were called Khaki-mines, at about 1884 they provided the best stones.

Already at the mines the stones were sortet according to their quality: 1. Angushtari (ring-stones), 2. Barkhaneh, 3. Arabi. In those days, sanding was done by using emerald-coated[3] discs or on sandstone. Polishing on leather was done by children (Fig. 6).

When the author payed a very short visit in the year 1976, only at one place there was mining for turquoise. The mine was accessible via two openings of an almost 1 km long, tunnel-like drift, which were situated opposite to each other. Several times on its rather straight way, the drift cuts older pits (Fig. 7). Sink holes, opencast mines, collapsed shafts, and drift-openings in the environment gave evidence to the extended work of the past. If this was only the work of the past centuries, numerous archaeological finds from Central Asia, Mesopotamia and as far as Egypt give evidence to the fact that turquoise has been a demanded decorative stone for millennia, particularly in the Bronze Age 3rd and 2nd millennia BC (Moorey 1994, 101f.). As none of the Iranian turquoise-mines has yet been investigated in terms of mining-archaeology, the question stays unanswered in how far Iranian deposits were exploited in these early periods. Also concerning the Maden deposit, unfortunately there is no evidence for this, at least for the time being.

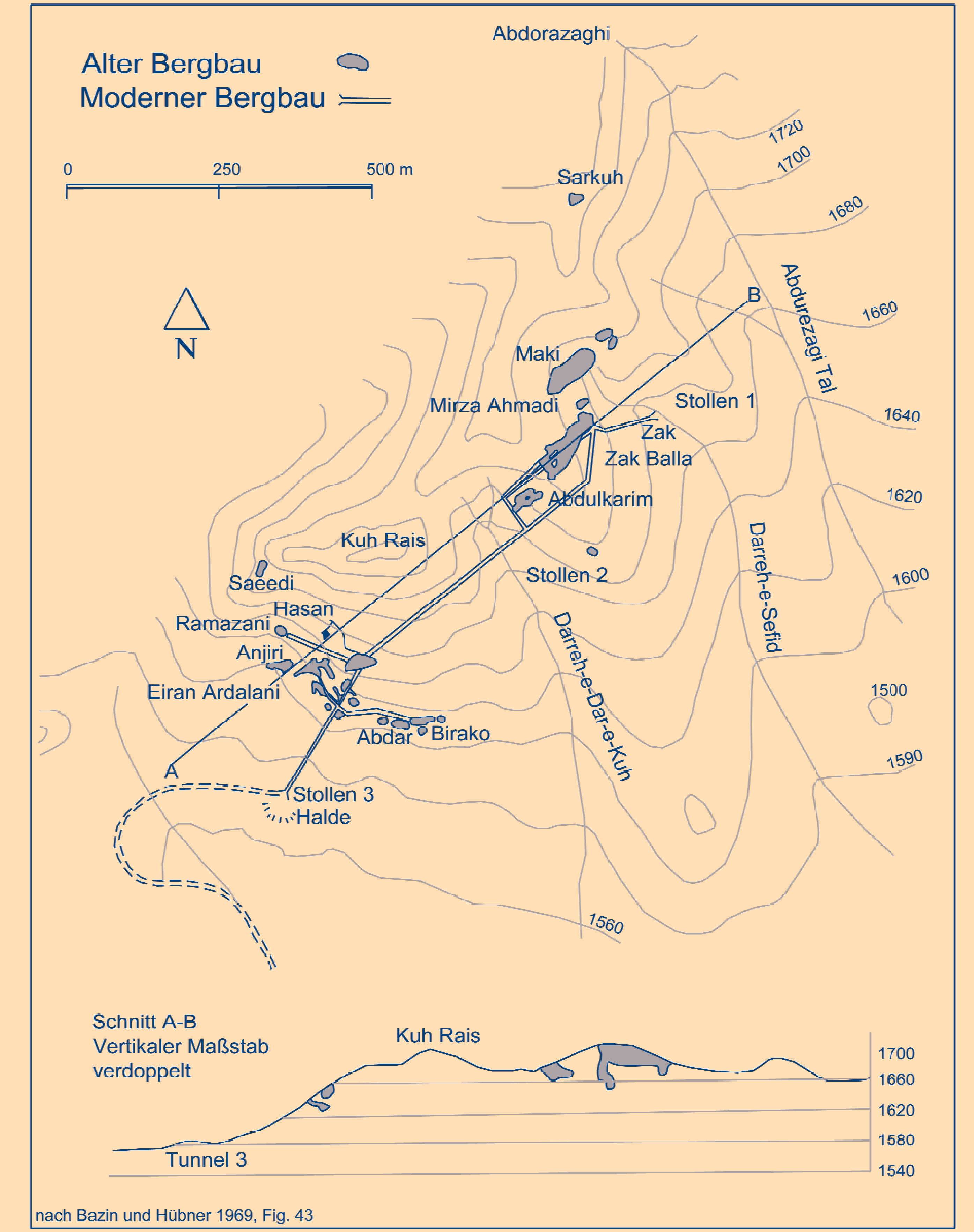
Notes

1 Ibn Hauqal 1992, 215: "In the mountains of Nishapur and Tous they find turquoise."

2 Houtum-Schindler 1884 offered a description of the mines which for the time being is the most detailed one; the same 1881; Kunz 1897; Gubelin 1966; 1977.

3 Emeralds from Badakhshan in Afghanistan.

Fig. 7: Nishapur, plan of the mine working (Bazin & Hübner 1969).


Alter Bergbau
Moderner Bergbau
0
250
500 m
N
Abdorazaghi
Sarkuh
1720
1700
1680
1660
1640
1620
1600
1500
1590
1560
Abdurezagi Tal
Darreh-e-Sefid
Darreh-e-Dar-e-Kuh
B
A
Maki
Mirza Ahmadi
Stollen 1
Zak
Zak Balla
Abdulkarim
Kuh Rais
Stollen 2
Saeedi
Hasan
Ramazani
Anjiri
Eiran Ardalani
Abdar
Birako
Stollen 3
Halde
Schnitt A-B
Vertikaler Maßstab
verdoppelt
Kuh Rais
1700
1660
1620
1580
1540
Tunnel 3
nach Bazin und Hübner 1969, Fig. 43

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The medieval fortified village of Qaleh-e Gird (Sistan) will be covered by sickle shaped dunes; Photo: G. Gerster.

Medieval Islamic Pottery and a "Cookbook" from Kāshān

Ernst Pernicka
including an essay on the cobalt mine at Qamsar by Thomas Stöllner

Enamelled pottery is an important and characteristic part of craftwork in the medieval Islamic world. Its greatest time was between the 9th and the 13th century, a time when in Europe there was hardly any pottery in the sense of fine arts. Though during the heyday of medieval civilization a highly valued kind of pottery was created in the form of the ceramics from the Rhine or the Waldenburg ceramics, the enamel was usually colourless and without artistic design. Only as late as during the Renaissance the manufacturing of coloured enamelled pottery was started in the form of the so called "Majolika". But this kind of pottery has its roots in Islamic Spain and can be traced back to Mesopotamia in the 9th century. By using enamel, various effects are to be created. First, it seals the originally porous piece of ceramics and prevents liquid from getting in. Especially in the case of dishes this is a desired feature. Additionally, it stabilizes the piece of ceramics and protects it from corrosion. But most desired at all times was the decorative effect of enamel, which is pleasantly smooth and is captivating due to its glossiness, may it be shiny or matt, thus being an element of style of its own. But enamel achieves special attractiveness due to its lasting colour and the pattern which in the case of some Islamic pottery may reach the artistic quality of medieval book illumination.

The origin of enamel might be in trying to imitate natural minerals like turquoise and lapis lazuli which were demanded as decorative stones. The origins can be traced back as far as to the 4th millennium BC. It does not appear on clay pottery, as we might think, but on a piece of ceramics which is almost completely made from pulverised quartz. Together with the bright enamel of mostly blue or green colour, a first glance makes it look similar to enamelled clay pottery with white, non-transparent primary coat. Because of this, researchers in the 19th century introduced the term "fayence" for this kind of pottery, after the Italian town of Faenza, where in the Middle Ages pottery was manufactured which was coated with white tin-oxide and then painted with colours. It should be mentioned that this ware comes from the earlier "Majolika" ware from Spain. As this early, enamelled pottery was at first found mostly in Egypt, the term "Egyptian Fayence" became common. But similar material also appeared in Mesopotamia. But due to the much worse conditions of preservation it had completely lost its colour in most cases, so that the similarities to "Egyptian" fayence were not recognised at first. Thus the Mesopotamian tradition of research calls these artefacts "Fritte" or enamelled "Fritte" or glass "Fritte". In all cases this pottery is rich in quartz, containing more than 90% of SiO_2 (one could also speak of "quartz pottery"), which in most cases was enamelled. For only enamel stabilizes such a piece of ceramics, as when fired the pulverised quartz sinters only slightly due to its high melting point. The earliest definite finds of this material from Mesopotamia date from the 5th millennium (Obed period and early Uruk period).

In all cases the enamel is a lime-alkali enamel. On a piece of ceramics, which is rich in quartz, this kind of enamel adheres better, and by help of it the colours are made brighter than in the case of lead enamel, though the latter is easier to handle but was introduced in Mesopotamia only in the 1st millennium BC. Due to the different expansion-coefficient, the lime-alkali enamel only insufficiently adheres at clay pottery. In most cases stress-cracks appear which even lead to peeling off. For this reason also the enamel on ceramics, which were used for building, like at Babylon, are often badly preserved. That's the reason why also for ceramics of this kind the basic material for enamelled bricks was rich in quartz again.

On roman pottery, instead, the enamel is usually lead enamel. Probably it comes from the Eastern Mediterranean, maybe since the Hellenistic period; at least it was used there after the 1st millennium BC. It is easier to handle in so far, as it can be applied to normal clay ceramics and melts with low temperature. It is enough if a layer of lead-oxide, which is a mass waste-product from processing silver from lead, is applied to the piece of ceramics before firing. When fired, the lead-oxide melts and releases an amount of silicon-oxide from the material itself which is big enough to produce, at a temperature of about 700° C, liquid lead-silicate which, when cooling down, makes a beautiful and well adhering enamel. A disadvantage of this technique is the fact that lead gets into liquids, particularly acid liquids like vinegar, and that the colour under the enamel tends to running. Due to this, most of the Roman enamelled ware is one- or two-coloured, honey-yellow or light green. This colour is mostly due to the iron oxide which colours light yellow in the case of oxidising firing and light green in case of reduced firing. Many vessels show both colours, as often it was not possible to sufficiently control the temperature. A dark green colour could be reached by adding copper oxide. Such enamels were used in the Roman Empire and also by its Eastern neighbours, the Parthians, and were still made until the Sasanidian period and even until the Islamic period.

This tradition of lead enamel was carried on by the Islamic potters, though also lime-alkali enamel was used in Egypt and Syria in the 9th century, when Islamic enamelled pottery rose. We may not say that the Sasanidian tradition of enamel was directly taken over, as

Fig. 1: Fragment of enamelled pottery from Fustat near Cairo in Egypt (Victoria & Albert Museum, London). Such pottery with botanic design in blue and white is typical for the period between the 12th and the 14th century.

the early Islamic pottery of the period between 661 and 750, centring at Damascus, was mostly un-enamelled. Under the Abbasides the caliphate was transferred to Bagdad. Thus Mesopotamia was the heartland of the Islamic world. It is widely accepted that this period was the heyday of Islamic culture, which is also shown by the manufacturing of pottery. The native potters still knew the monochrome lead enamels which mostly were applied in very thick layers. Also whitish enamels were known which, due to cristallised colourless calcium-silicate, looked opaque. Probably this knowledge was reactivated when the first Chinese pottery and porcelain of the T´ang period (618-906) came to the Islamic world, as shown by excavations at Samarra, North of Bagdad. There, a short living town came into existence, centring around a palace in the 9th century. The Chinese imports were white and unpainted and were always considered a luxury, the demand being bigger than the supply, as it is evident from contemporary texts. It is generally suggested that these imports first encouraged the native potters to imitate them and later led to independent creations. For the lack of appropriate raw materials made it impossible in Mesopotamia to really reproduce the hard Chinese ceramics. Thus the outer appearance was produced by applying the already mentioned white, opaque enamel.

The native potters were not only satisfied with imitating Chinese porcelain. Furthermore, they developed new techniques which are unique in the art of pottery. First, the white ground was painted with local designs, in the beginning with blue or green colour and later by using the so called lustre-technique. This consists of a metallic glance on the enamel which is achieved by applying a thin layer of copper oxide and silver oxide on the ready fired enamel and then a second, reducing firing. The idea of manufacturing such pottery, whose golden glance obviously was supposed to imitate the appropriate precious metal, probably comes from the Islamic religious ban of using gold for dishes. Under the Fatimids the production of this ware was mostly moved to Fustat in what today is Cairo. But it had its heyday in Iran in the 12th century.

The background was the rise of the Turkish Seldshukes who rose to be the ruling dynasty during the 11th century. During their conquest of Mesopotamia and Anatolia via Iran they converted to the Islam. The new central power again stimulated political and cultural life after a certain decline. A new, less formal style of fine arts gained acceptance, which also influenced pottery. But for this genre a second influence seems to have been decisive, i.e. the appearance of a new kind of porcelain from China where under the Sung dynasty (960-1279) there was a renaissance of manufacturing porcelain. At Kuan and Ju new manufactures were founded whose products are known as Ting ware and ying-ching ware. To this porcelain, coloured enamels in ivory-colour, pale green, pale blue, and black were applied. The most important pieces had greenish enamel (seladone).

While in the 9th century the first (white) porcelain was imitated by applying opaque, white enamel to a piece of ceramics, at the same time two other techniques were developed. On the one hand, the piece of ceramics was covered by a ceramic stain of quartz powder and white clay, which thus made a white ground, to which transparent enamel could be applied. This might even be lime-alkali

Fig. 2: Bowl in the Kāshān style, dated to 1100-1200 AD (St. Louis Art Museum No. 282:1951).

enamel, as the ceramic stain served as an intermediate layer which made the enamel stay better. On the other hand, the piece of ceramics itself was kept to be white and the enamel was transparent. This is quartz pottery, taking over a very old tradition from Mesopotamia and Egypt. Though looking almost transparent in the

Fig. 3: Lustre-pottery (Seldshukes) from Iran, dated to 1150-1250 AD (St. Louis Art Museum No. 19:1937).

Fig. 4: Bowl from Kashan (12th/13th century AD) with painting under the enamel and pressed in decoration, showing the wickerwork of a basket. The Arts of Islam, The Arts Council 1976.

case of thin pieces of ceramics, the material was softer and more likely to crack than real porcelain. This new technique seems to have been developed in specialised craftshops, at first at Basra in Southern Mesopotamia, while in the beginning the clay was mixed with a relatively small amount of quartz and even glass. From Basra obviously some potters emigrated to Egypt, to further develop this technology under the Fatimid rulers at Fustat (Old Cairo) in the 10th century AD. Obviously due to lack of appropriate clay, like that from Basra, real quartz-pottery with a minimum of clay was created. In these two centres also the lustre-technique was developed which at Fustat at first was used for pieces of ceramics made from local clay. But this needed much effort to reach the demanded quality, so that later lustres always appear on a piece of quartz ceramics. This was the more necessary, as more and more transparent enamel was the fashion which needed a white piece of ceramics.

In the second half of the 11th century at least some potters went back to the centre of power under the Seldshukes in Iran, as their products were luxury goods, probably for the upper classes only. The most important craftshops in Iran were at Rhages, near Tehrān, and at Kāshān. For this pottery the Chinese method of applying the design under the enamel was taken over, but of course the design was typical for the Islamic world. As such painting under the enamel tends to running; the enamel on the quartz-pottery from this period is mostly lime-alkali enamel. The transparency of the material was occasionally improved by piercing the unfired piece of ceramics, the holes being filled by the enamel when fired. Later this technique was also used in China by putting grains of rice into the piece of ceramics.

From this heyday of the production of pottery at Kāshān there exists a manuscript in which the common technique of manufacturing quartz pottery is described in detail. It was written by Abu'l Qasim `Abdallah ben Ali ben Muhammad ben Abi Tahir al-Qasani at Tabriz around the year 1301 AD and it gives an appropriate image of the composition and the use of this ware. The author comes from a family of potters at Kāshān. Though some expressions and single materials cannot be definitely interpreted, the manuscript is of inestimable value, as it tells about secrets which were carefully kept by the craftshops.

For making quartz pottery, various materials were needed, of which Abu´Qasim names twelve which were at hand for the potters at Kāshān:

- Quartz or "sugar stone", as the miners called it. Rock crystal could be used to the same effect but was more difficult to find.

- "rod breakage", some rock which was very similar to quartz. It was not found in big pieces, "less clearer and less substantial than sugar stone" which was widely common. It is interpreted as calcite ($CaCO_3$) both by Wunderlich (Ritter et al. 1935) and Allan (1973).

- Some kind of white sandstone, called "fodder" by the workers which come from the mountains near the village of Fin in the district of Kāshān. These two substances are mentioned again elsewhere: "The for tiles and writing is made from fodder and rod breakage and is stirred together with glass-fritte and clay." Analysis of quartz-pottery from Iran – among it there are tiles which may be dated to around 1300 AD due to their style (Allan et al. 1973) – showed that pieces of ceramics usually contain 90% of SiO_2 and only very seldom more than 3% of Ca. Thus both substances must be quartz rock.

- Qamsari, a rock which is named after a village of this name. It is fired and crushed to a sandlike substance. Also this material cannot be exactly identified. The firing reminds to the firing of lime but elsewhere the texts shows that it cannot be lime. The making of a glass-fritte for an opaque tin-enamel is described, metallic lead and tin being melted in a melting pot and being completely oxidised so that tin containing yellow litharge is made. The fritte is made by roasting one share of Qamsari and one share of ashes from plants, then letting it cool down. Then two to three shares of this mixture and one share of yellow litharge are heated again in a kiln for twelve hours until a non-transparent is made. It must be crushed and then stored. From this mixture it is only possible to make glass if Qamsari contains either silicon or boron. As boron does not exist in the area around Qamsar, it must be quartz again which gets friable when "fired" and can be crushed more easily. It might be e.g. some sandstone which mostly consists of quartz, with lime as a binder. When fired, the lime might dissolve to unblock the quartz.

- Ashes from plants, produced by burning plants which are rich in salt. These ashes give the alkali oxydes Na_2O and K_2O which are needed for lime-alkali enamel.

- Lagward, some rock which is found at Qamsar in the mountains around Kāshān. "It shines like silver coated by black (or hard) rock." ... "A red coloured kind of it sweats out from the outer surface of the rocks at the place where it is found, similar to the red shell of pistachio. This kind is of extreme power but is a pernicious and deadly poison." From the description, this material can be clearly identified as cobalt ore, probably cobalt glance ($CoAsS$). The red kind is definitely cobalt bloom ($Co_3As_2O_8.8H_2O$), which comes from oxidising cobalt glance. Due to containing arsenic, this mineral is poisonous. At Qamsar there was cobalt mining probably until the mid of the 20th century. At the end of the 19th century it was described as follows by the British general A. Houtum-Schindler: "Two miles below Kamsar some thin lodes of copper ore crop out in shales which dip 80° west, and strike north 22° west to south 22° east. One mile or less north of the copper lodes are the celebrated cobalt mines which have been worked in ancient times, and belong to some sayyids of Kamsar and Kashan. The rocks there are dolomites broken through by serpentines with an immense load of iron ore, copper pyrites, sulphuret of nickel, cobalt bloom, and earthly cobalt (peroxide). The lode strikes north 7° west to south 7° east, and dips 80° west. Only the earthy cobalt is at present of any practical value; it contains about five per cent of metal. It is collected by the proprietors and washed with water, and the heavy sediment is made into cakes. The washing process is called saravabuna i.e. ab va bun I ab (top water and bottom water). The cakes, under the name of lajverd I Kashi, are exported, principally to Kashan, Qum, and Isfahan, where they are sold at a rate of about one shilling and sixpence per pound. All the proprietors receive equal shares of the proceeds, and they have an agent (bonek-dar) who looks after the sale and keeps account for them for a commission. In order not to lower the price only a certain quantity, sufficient for the actual demand, about 1300 lbs. per annum, is put on the market, and should there not be a demand for this quantity, the mine is closed and carefully guarded." In those days the ore was reduced to metal. To use it for coloured enamel, it was mixed with quartz powder at equal shares and together with a rubber solution it was applied to the ceramic stain for paintings under the enamel. For paintings on the enamel, the metal was mixed with fourty times of its weight of quartz powder or glass powder while adding two times of its weight of borax. This mixture was heated in a clay pot until enamel was made which was scraped off and pulverised. In a mixture of rubber solution it was painted onto the enamel and fixed by a second firing.

- Muzzarad, some black rock, similar to antimony glance, which is still black and shining even when coming out of fire. It is found in the mountains of Gagarn in the Chorassan region. This material is chromite (Fe, Mg) (Cr, Al, $Fe)_2O_4$, as identified for the first time by Pernicka et al. (1976) on the basis of Islamic pottery from Seistan. In the East of Iran, in what today is the province of Khorassan, bigger deposits of chromite are known. This mineral indeed is fire-resistant and does dissolve in enamel. Thus it is used in the form of powder for paintings under the enamel.

- Gold- and silver-markasite, "male and female magnesia" (hard and soft manganiferous ore), yellow vitriole (probably pyrite, FeS_2), arsenic (probably arsenic sulphide), lead oxide (PbO), antimony glance, Tutia (mostly zinc-oxide from the smoke of smelting lead), and lead. Some white, sticky, fat clay, the one from Kāshān being white.

- Substances made from the seven metals. One of them is tin. In the country of the Franks (Europe) it is melted into "snakes"; some of it is brought from China in big pieces and some of it is brought from the territory of the Bulgarians, thin as leaves with pages of paper put between.

- Lead, which is found at many places, like Kerman, Jazd, and Rum. The Bulgarian lead is said to be the best as "its substance" (probably the product of oxidation) is extremely white.

- Burnt copper and copper oxide: "The red, green coloured kind of soft nature is the best, from which comes the green colour, and also copper oxide made from burnt iron, from which the yellow colour comes in the fire."

From these substances the potters made either the substance or the enamel, depending on how they were mixed and used. Both lead enamel and alkali enamel are at first transparent and colourless. Both can be coloured by help of metal oxides, copper and cobalt being most important in those days. Copper colours light blue (turquoise) with alkali enamel, in case of lead enamel it colours dark green. Cobalt always colours dark blue. Red or brown was achieved by adding iron or by oxidising firing. With reducing firing, copper could also colour red. Opaque enamel was made by adding tin oxide which does not dissolve in the enamel. The delicately spread crystals make the enamel non-transparent. It is comparatively easy to make monochrome enamel. But if several colours and drawings shall be applied, lead enamel causes difficulties, as the colours tend to running. Thus the polychrome Islamic pottery in Iran from the 12th and 13th centuries is mostly combined with alkali-enamel. There are two different techniques of making polychrome enamelled pottery, i.e. painting under the enamel and painting on the enamel. The latter needs at least a second firing, but the advantage is that there is the possibility of using more colours. For the technical problem of polychrome enamel is in the fact that the pigments change their colours after the firing, something that cannot be controlled. Thus the number of colours is very restricted in the case of painting under the enamel in the Middle Ages: only black and two shades of blue, made by copper and cobalt, which can be used for the necessary temperature of 1000-1100° C. In the case of lower temperature, however, a bigger number of colours is possible, with coloured glass – melting at lower temperature – is applied to the basic enamel, made at higher temperature during a first firing.

This so called "Minai-technique" was invented in Iran in the 12th century but was already out of fashion in Abu'l Qasim´s days. At the end of his description of manufacturing pottery at Kāshān he remarks: "All gold-plated pieces, like writing and other things, are made by using this method, and also if pieces of seven colours are wanted, something which is out of fashion these days." Obviously the "seven colours" mean Minai-pottery. It is named after the Arab word for enamel, which is not absolutely correct in the technical sense. But in the field of the history of fine arts the term has become common as a terminus technicus. Investigations by Mason et al. (2001) showed that the melting point both for the basic enamel as for the colours which are used for painting on the enamel is between 890 and 920°C. This means that the firing had to be controlled very strictly to prevent the painting on the enamel from dissolving. These statements are based on estimations concerning the chemical composition of basic enamel and second enamel. It is possible, however, that borax was added to the second enamel, something which would significantly reduce the temperature of the melting point. At least in the 19th century borax was known and was used for such purposes, as Houton-Schindler reported. Borax can only very seldom be recognised by the usual methods of analysis and thus might have been overlooked.

The already mentioned lustre-pottery also needs two firings. For this also there are exact statements in Abu'l Qasim's records. He calls it "enamel of the two fires" and describes the way of making it as follows: "You take yellow or red arsenic 11/2 shares, silver markasite or gold markasite 1 share, yellow vitriole from Tabas half a share, burnt copper a quarter and stirred to a dough, crushed and crumbled. A quarter of it is crumbled on a grinding stone two times, each time for 24 hours, together with burned and crushed silver, until it has become extremely fine-grained. Then you dissolve in a bit of wine berry-syrup (or vinegar) and with it you paint the pieces in the way you like, and then you put them into a second kiln, which is made ready for this, and you give three times of (firing with little) smoke, each 24 hours long, to let it get the "colour of the two fires" (like gold). And when they have cooled down you take them out and rub them with wet clay, then a colour like gold is the effect, but instead of all this, simple (bloodstone) with burnt silver is of the same effect. And that what has been fired steadily shines like gold and like the light of the sun."

The metal glance is made by the copper being reduced to a thin metal coating, which is created by burning the wine berry syrup and the reducing firing (fire with smoke). The golden colour, which gets to be rather brownish in the course of time, is typical for this age, when silver was rare (Caiger-Smith 1985). The lustres from the time before about 1100 AD usually contain more silver and today look olive green.

Notes on Mining Archaeological Structures at the Cobalt Mine of Qamsar

Thomas Stöllner

During the 13th century AD the famous "Kāshi" writer Abu'l Qasim described in his "book of the stones" the stone "Lāğward" which was exploited near the village of Qāmsar. Abul'Qasim reported its importance for the blue colouring of glass and glaze and until recently it was widely accepted that this mineral was cobaltite (CoSAs) (Ritter et al. 1935, see above). Following A. Houtum Schindler's description, especially the earthy peroxides of this ore have been used economically, perhaps formed into cakes or pellets to be transported to Kāshān (Houtum-Schindler 1896, 114 ff., see above). As Qamsar is one of the very rare deposits for this mineral in the Middle East it always came into discussion as raw material since blue coloured material occurred in the Bronze Age (*e.g.* Abu Shahrein/Eridu: Moorey 1994, 191).

As the mountains east of Kāshān, the Kuh-e Gargesh, also bear considerable copper deposits, this region seems promising to look for prehistoric ore use; near Qamsar the French expedition reported a small mining site, extracting a chalcopyrite ore body embedded in Oligo-Miocene lime stones as country-rock (Berthoud *et al.* 1976, 9 f.).

This mining site of Qamsar is situated apparently 4 km north of the village and can be reached only on foot while passing a high ridge within a narrow valley. So it never was accessible for vehicles. The modern mining ensemble consists of a large underground gallery just above the valley-bed and miners' lodgings up the valley (Fig. 5). The mine itself has been exploited by opencast working until the second half of the 20th century, and so rapid blasting work seriously damaged older underground mining. Large dumps of debris are enclosed and supported by rock walls towards the northern slope; bunkers for storing the separated ores are situated just beneath the older underground workings. The main lode is embedded sub-vertically in fractures of the Oligocene/Miocene limestone (Qom) formation and roughly follows the general NW to SW drift; besides cobalt-enrichment it contains iron (iron-oxides) and copper ores. Some smaller underground workings are visible in the main lode on the northern slope of the valley which indicates the original use of fire-setting technique.

Towards north, mine 1 is badly damaged by modern blasting work, but remaining underground structures indicate the use of fire-setting; today's opencast area provides some idea of an original underground structure of about 30 m in length.

Mine 2 represents the best preserved of these mines, but it remains unclear if an opencast area of apparently 15 m in length and 10 m in height was worked in this way by original mining or by modern after-use (Fig. 6). Large fire-setting structures followed a considerable lode (2 up to 7 m thick) into the depth; parts are filled by mining debris and are not yet visible. A steep, diagonal shaft of about 15 m in length is covered by coarse rock debris on the floor and was also driven in fire-setting technique; a side-gallery (a diagonal shaft with 40° decline towards SW) can be observed 8 m before the working end of the main gallery. Other parts, e.g. mining rooms towards west, are filled as well.

Cobalt-mine 3 also shows fire-setting technique, but is visible only in parts and filled by coarse rocks of the modern blasting work; two ceiling parts are still preserved. At the dump in front of mine 3 a concentration of blue and green enamelled Islamic pottery is remarkable.

Fig. 5: Qamsar mine from the West; photo Th. Stöllner 2002.

The type of large scale mining by using fire-setting technique, perhaps additionally to iron tools like picks and sledge hammers (e.g. no stone hammers were detected anyway), is a strong argument to date the activities to some time of the medieval and even younger Islamic period. But it is not unlikely that older traces will be detected if the place is more carefully investigated. In general, the traces strongly indicate mainly a medieval exploitation period – the technique of following the load by fire-setting and pick-work was widely distributed in Iran.

Fig. 6: Qamsar, mine 2, open-cast and underground mining in diagonal shafts; photo Th. Stöllner 2002.

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Salt Deposits and Their Exploitation in Historic Iran

Andreas Schachner

"Civilised life is unimaginable without salt." By this concise statement Plinius concludes the omnipresent significance of salt (Natriumchloride, NaCl). While big amounts of salt endanger the agricultural use of land, small amounts of "white gold" are vital, as it controls the water balance of each organism. Besides its importance as remedy, basic food, and luxury food, especially the preserving effect of salt consequently makes it a part of almost all aspects of human life, for salt dehydrates organic materials to the effect that bacterial decomposition is not possible. This not only makes the salting of meat possible but also the production and preserving of a variety of foods (e.g. dairies) and even e.g. the tanning of leather. Thus salt – besides its natural necessity – is the starting point of an incalculable number of production processes and products and due to this was one of the most important raw materials of pre-industrial societies. Thus the cultural-historic significance of the development of salt-technologies is similar to that of agriculture and metallurgy (Bloch 1970, 12). This essential necessity is the basis of political systems and empires whose precondition was both controlling this raw material and the ways it went from production to the consumer. Its great significance for human life is the reason why salt was an important symbol with contract-making in the Islamic world (Fahd 1993, 958-959) and was considered a sign of hospitality[1]. Despite this varied and enormous significance, up to today salt has been widely neglected, as far as the research on the historic oriental cultures in general and on Iran in particular is concerned – maybe because of its daily familiarity.

The Deposits in Iran

Within this essay it is not possible to name all known salt deposits in Iran, but the greater regions and the kinds of deposits will be described exemplarily. In Iran the latter can be defined by two types: rock salt and salt which is obtained by evaporation at the big lakes.

The mountains, in which rocksalt is embedded, are to be distinguished geologically from the overlying strata and occur in connection with crystalline-metamorph massive rock. In the West and the North of the country there are numerous deposits in the Zagros Mountains. These salt formations are the direct continuation of geologically similar structures in the Caucasus, North of the Araxes in Armenia (salt mines at Kolpi), Azarbaidjan (Nahçıvan) and in North-East Anatolia.

In the South of Iran in Baluchistan, in the coastal mountains, and on the offshore islands there are numerous and relatively big salt deposits which often are connected to volcanic rock. At some places they come out of the overlying strata and run out as so-called salt-glaciers or they characterise the landscape in the form of salt-domes (Ehlers 1980, 37). Maybe they are part of a salt-formation which reaches as far as to the Punjab[2]. In the North salt deposits are only to be found at the Southern side of the Alborz[3] and in the East they go along the Southern side of Kopet Dagh up to Afghanistan.

The salt deposits in Iran are distinguished by a geologic speciality. The relatively young formation of the mountains in connection with a climate of low rainfall prevent the salt from being washed out. In contrast to the deposits in Central Europe, they are preserved on the surface. In most cases they are only covered by clay and at steep slopes or cliffs they partly outcrop. Thus mining is much easier. Today both drift mining (e.g. at Zanjan) and opencast mining (*e.g.* North of Nishapur or on the islands of Kism or Hormuz[4]) are common.

A second, inexhaustible reservoir of salt are the inland waters and kavirs of Central Iran. The central basins without an outlet, in which the rivers and wadis of the peripheral mountains seasonally drain

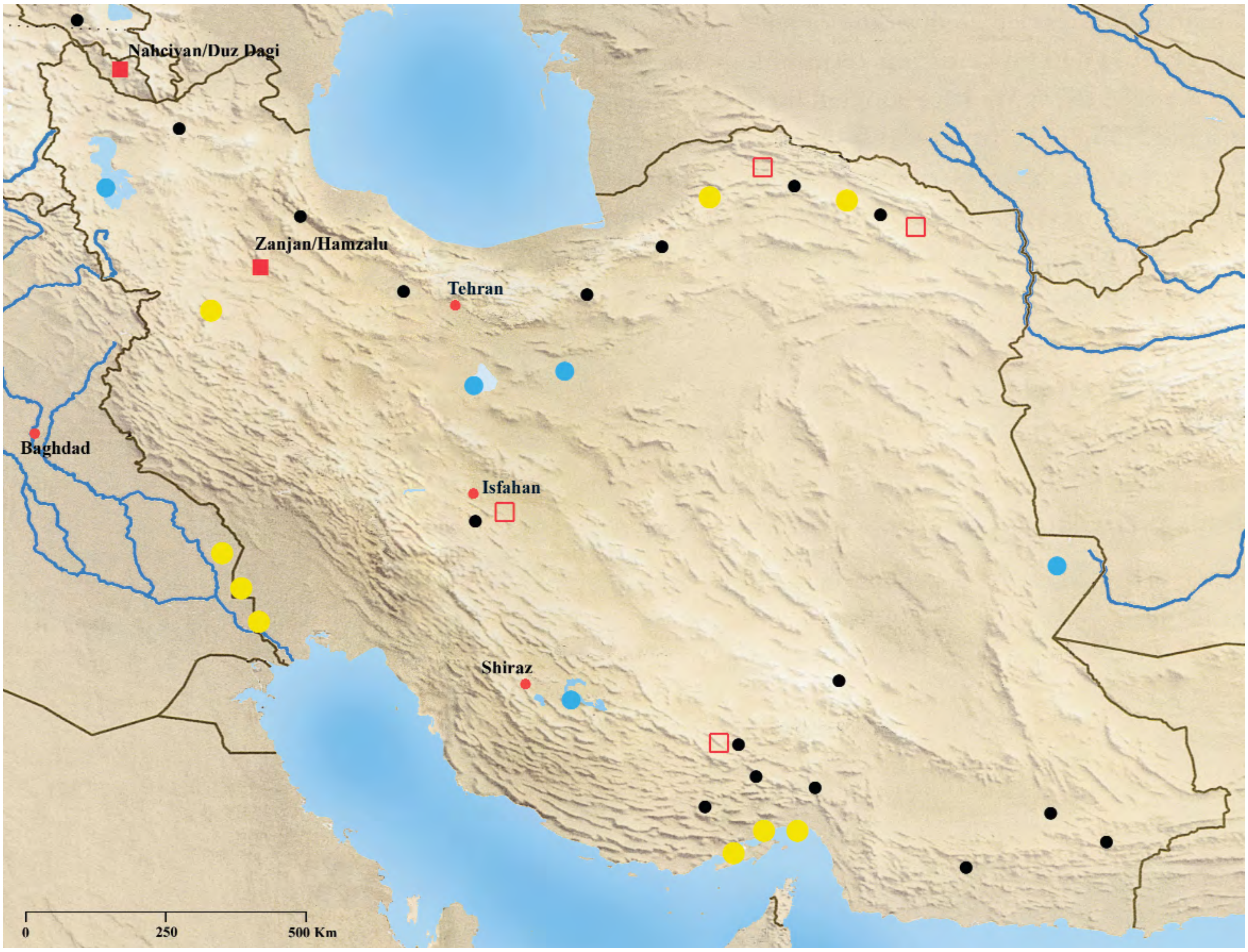

Fig. 1: Map of salt deposits in Iran and in known mining-areas (selection). ■ – archaeological analysed mines, □ – presumed mining in historical periods; ● – salt lake with salt working; ● – surface salt mining; ● –miners deposits.

their waters, are characteristic features of the landscape in Central Iran. At the ends of the waters small seasonal lakes occur. Though they often dry out completely during the summer months, the clay soil is strongly compressed. During the extremely hot summer months the salt and gypsum minerals in the water crystallise on the surface above the clay sediments and form puddles or even gigantic crusts of salt. When the rivers dry out completely the salt crust rips open polygonlike to form so called structured soil, due to increasing volume. According to the colour of the surface the salt is called white salt or black salt (*namak sefid* bzw. *Namak siyah*). This landscape, which is typical for Central Iran, was mentioned the first time by the Assyrian king Assarhadon (680-669 BC) who led a campaign to the Northern parts of the salt deserts at the mountain of Bikni, which probably was the Damavand[5].

While the salt from the kavirs is less pure and thus can only be used for crafts, some of the lakes still today are of great importance for salt production. Similar to the kavirs they occur in basins without outlets. Concerning the content of salt, which is extremely high, Lake Urmia holds second position of all inland waters in the world. North of Qom Lake Derya-ye Namak and South-East of Shiraz in Fars the lakes of Bahtigan, Maharlu (also called Lake Shiraz), and Lake Djankan (Sadan 1993, 57) should be mentioned. Still today salt is produced industrially on the shores of these lakes by making

Fig. 2: Crystallization of salt at Lake Maharlu in Fars (photography by Georg Gerster).

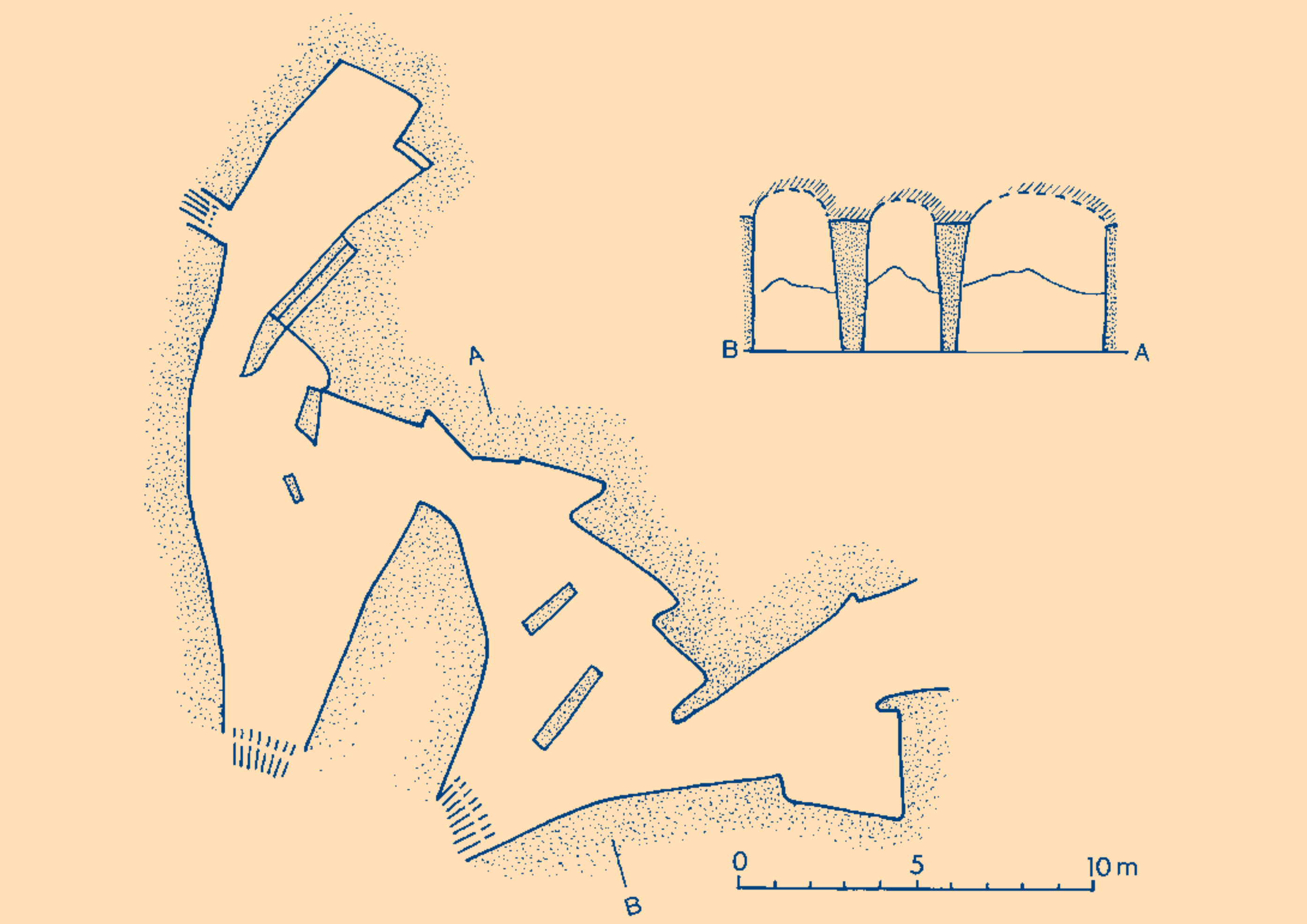

Fig. 3: The salt mine at the Duz Daği in Nahçıvan; following Aliyev 1983, 83.

small basins by help of dam-building, where the water evaporates during the summer months.

Historic Salt Production in Iran

Although salt is important for all aspects of life and a daily part of man's whole life, archaeological and ethnographic evidence of historic production and use of "white gold" is almost unknown for Iran and its neighbouring countries. Only some coincidental finds and remarks allow a shadowy reconstruction.

Due to the kinds of natural deposits and their frequency in Iran, salt seems to be a raw material which is easily accessible. It is of great significance that salt production by evaporation is possible almost everywhere, in contrast to Europe. In Iran this raw material could simply be collected without much effort. Compared to mining, this way is much more economic, as about double the amount can be produced (Bloch 1970, 12). At the same time and due to its general availability, direct administrative control of salt production is impossible, and monopolies cannot exist. But purity and quality of salt, which is produced by evaporation, can hardly be controlled, especially by pre-industrial methods.

Still today this way of producing salt is common in some places, and in various parts of the country it can be traced back to the times of early Islam by help of written records. Thus there are reports on salt production by help of evaporation from Fars (Schwarz 1969, 10), from Hamadan, Seistan, from Horasan and the fens of the South, and from the area around Basra (Spuler 1952, 399). The salt from the fens of the Eastern parts of the lowlands of Mesopotamia and Susiana was traded at Abbadan since medieval times (Lockhart 1960, 5).

From ancient times there are no records concerning this way of producing in Iran. Collecting salt, which was produced by evaporation, is known from Mari on the Euphrat in Syria in the early 2nd millennium BC (Durand 1987, 199-205; 1990, 629-634). It seems to be justified to presume this way of producing salt also in pre-Islamic times in Iran. In this connection we should ask if the obvious wealth of Hasanlu and other big trading places in close vicinity of Lake Urmia, the saltiest lake in Iran, are not due to producing and trading salt?

Historic evidence from Northern Mesopotamia, which is ecologically similar to Iran, show that salt production and trade were controlled by the state since early historic times but was mostly in the hands of nomads (Potts 1997, 103-106; Guichard 1997, 167-200; Durand 1990, 634). Despite the lack of sources, also in Iran the importance of the nomads for supplying the urban centres with salt should not be underestimated. Most of the salt deposits are in regions where settled and agriculture-based life is hardly possible and which are used by nomads only from time to time. Wool-woven saddlebags, called *namakdan*, are still today used by the nomads of Iran exclusively for transporting salt.

Despite the relatively easy availability of salt, produced by evaporation, rock salt from mines still today is considered the better quality in Iran and is the kind of salt exclusively used in the kitchen. As it is not possible to mine the same amount, it is also much more expensive than salt produced by evaporation. Although in Iran still today salt is mined by underground mining and opencast mining, also for this way of producing archaeological evidence is rare. Only two salt mines can definitely be proven, but they have not yet been investigated in detail.

The oldest known salt mine in the cultural area of Iran is located north of the Araxes in Nahçıvan, which today is a part of Azerbaijan. The deposits at the Duz Dagi (salt mountain) are about 12 km North-East of the capital of Nahçıvan, on the Eastern banks of the River Nahçıvan near the village of Büyükduz. They are the direct northern extension of the deposits in Northern Iran. Surveys showed the existence of drifts which go as far as 70 m into the mountain and reaching a maximum width of 6 to 20 m, while the ten big chambers reach a height of up to 10 m (Fig. 3) (Aliyev 1983, 82). Similar to European salt mines, mining was done in these big chambers. In some drifts and chambers pillars of salt were left as support pillars during mining activities. Calculations by the explorers showed that during the entire time of exploitation about 5760 m^3 of

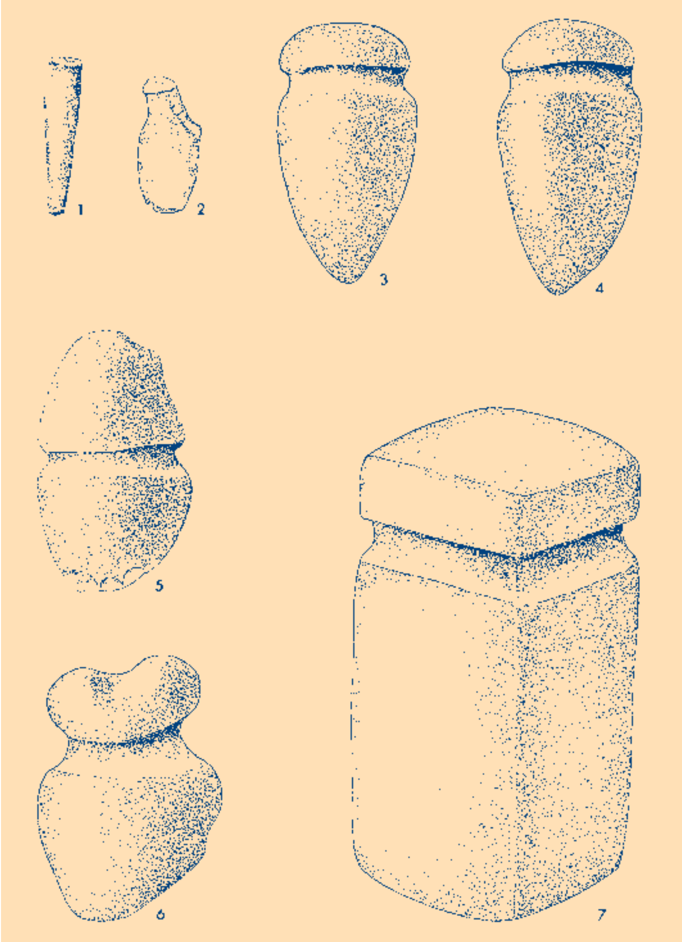

Fig. 4: Big stone tools from the salt mine at the Duz Da_i in Nahçıvan (following Aliyev 1983, 81; no scale).

material were mined, which is about 11500 t. Also the explorers report that at one of the walls incised signs were found which are to be interpreted as a system for counting the output (Aliyev 1983, 84-85; Bahşaliyev & Novruzlu 1995, 78).

The most important indication of salt production by mining are numerous stone tools which were found in the drifts and on the overburden dumps in front of the entrances (Fig. 4) (Aliyev 1983, 83-84). They are big, only roughly worked hammers, reaching a weight of up to 30 kg (Bahşaliyev & Novruzlu 1995, 78). At some places the impressions of timber were found in the salt, and in the rubble reed-made baskets were preserved which had been used for transport. On some bench-like rostrums in the drifts the remnants of reed-made mats were found (Aliyev 1983, 85; Bahşaliyev & Novruzlu 1995, 78).

Besides monochrome fragments, dating from the Kura-Araxes period, according to the finders, also polychrome fragments from the 2nd millennium are supposed to have been found in the drifts, so that a general use of this mine from the Early to the Late Bronze Age seems possible[6]. Few, as yet unpublished fragments, which were found outside the drifts, might indicate the processing of salt at the place.

Only a few kilometres west of the prehistoric mine there are the settlements of Kültepe I and II in the Nahçıvan valley. Here also numerous big stone tools were found whose types are appropriate to those from the salt mine (Bahşaliyev & Novruzlu 1995, Sekil 17; Алиев 1991, Taf. 10; Абибуллаев 82, tab. XIV.6-8; Aliyev 1977, 93-95 tab. 18.1-3) and which indicate a general concurrence of and direct connection between the sites, as the fragments do. Kültepe I and II count among the most important excavation sites in Southern Trans-Caucasus, as here one of the few complete sequences of cultural development from the Aeneolithic to the Iron Age was excavated (Абибуллаев 1982; Schachner 2001). Especially remarkable is the fact that the Kültepe II settlement deeply changed in the Middle Bronze Age and develops from a small roundhouse-village in the Early Bronze Age to a kind of greater settlement which is almost unknown from other places of the region (Алиев 1991; Schachner 2001, 291 fig. 22, 29). The reasons for this development are as yet unknown, but the close vicinity to the salt mine at the Duz Dağı, which dated from about the same time, due to pottery finds, might be an explanation. Other raw materials, which might have been able to bring such increasing wealth, are not known from the surroundings of the settlements. Maybe this is a way to see a connection between the settlement and both production and trade of raw materials.

Another evidence for ancient salt mining in the highland of Iran is the coincidental find of a mummified male corpus in a salt mine at Hamzalu in the Western part of the province of Zanjan, which is even used in modern times (RCCCR 1998, 3, 16; یتوبد ۱۳۷۶). While no tools for mining could be found at this place, a leg, the head and parts of the torso, clothing, and some pieces of equipment

Fig. 5: The salt mine at Zanjan.

could be saved. The outstanding preservation of the organic finds, due to the salt, is remarkable. The man wore trousers made of bright cloth which, like the preserved boot, can easily be compared to depictions of appropriate wear[7]. Besides the wear, a golden earring, a silver needle, and three iron knives indicate that this man probably was no worker[8]. The preservation of the organic remnants made a radiocarbon dating possible, dating them from the 3rd century AD, i.e. late Parthian or Sasanian times (RCCCR 1998, 17).

Archaeological investigations of the mine showed that several deep drifts reach up to 45 m into the mountain in several directions, following the salt deposit (RCCCR 1998, 16). As the mine is located in a region that has intensively been used during all periods of cultural history, it is likely that the mining activities are much older than the discovered corpus. But it is of major significance that the mine was in relatively close vicinity to one of the most important Sasanian works on the Takht-i Suleiman.

Though further archaeological research has not yet been done, we know from historic records from Islamic times that during the entire Middle Ages there were costly mining activities, driving drifts deeply into the mountain (al-Hassan & Hill 1986, 235-244). Several authors report on a deposit near Darabgerd, where especially good salt was mined during Islamic times that was not only processed to table salt but also cut into plates and other shapes and was traded to a. o. Shiraz[9]. More mines were a. o. in Horasan (al-Hassan & Hill 1986, 235), at Isfahān (Schwarz 1969, 868), or in the region of Zanjan.

In addition to the already mentioned general and nationwide ways of exploitation there are other ways, dependent on local conditions. The highly outcropping salt deposits on the Southern coast of Iran are criss-crossed by natural caves and tunnels. Creeks drain the natural drifts and flush out the salt which accumulates on the surface as a kind of foam and is used due to its high quality (Fulda 1931, 4).

All indications show that in Iran and the neighbouring countries salt was a regional raw material that could be used without difficulties. This general availability is probably the reason that in Iran and the neighbouring regions there were never any economic structures which could be compared to the medieval salt-cartels or to the kingdom of Timbuktu in Central-Africa which was based on far-distance salt-trade[10]. But still, more detailed research of further salt mines in Iran and the neighbouring regions should be demanded. The few results show that especially organic finds are to be expected and might allow insights into aspects of life which traditional excavations do not offer.

Notes

1 Described in the Shah-nameh from Firdowsi (Levy 1985, 310).
2 Fulda 1931, 2; the salt deposits at Kohat and in the Pakistan Salt Range are probably parts which are farthest to the East.
3 The best known ones are those at Kuh-e Namak.
4 The deposits on Hormuz and on other islands in the Eastern part of the Persian Gulf were also used by Portuguese sailors for replenishing their stocks.
5 Borger 1956, 55 Nin. A-F episode 16.46-52; for location see Radner 2003, 59.
6 Aliyev 1983, 83-86; a second mine at the Duz Dağı was probably used in the Middle Ages: Bahşaliyev & Novruzlu 1995, 78.
7 On the finds see the coloured depictions in RCCCR 1998.
8 RCCCR 1998, 17-18, 20-21 (incl. Fig.); also see ی‌نوبة ۱۳۷۶.
9 Sadan 1993, 57; Schwarz 1969, 95, 97. As Darabgerd was important in Sasanidian times, we may presume that these deposits were exploited as early as then.
10 Only the tax, which was common for crafts-products, was demanded (Spuler 1952, 466).

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Salt in Afghanistan: Significance, Geology, and Traditional Rocksalt-Mining

Holger Kulke

Introduction: Significance of the Afghanistan Deposits

Due to its location at the interface of tectonic plates the Central-Asian multiracial state of Afghanistan does not only show vast areas of high mountains but is also provided with a number of various deposits (see essay by Weisgerber). Its precious stones, especially lapis lazuli from the world's biggest deposit in the north-eastern Hindukush (Kulke 1976), and various kinds of ore were partly mined as early as in early historic times (Weisgerber).

As a result of the heavy, bloody fights for independence against Russian occupation since the early 1980s and the then following guerrilla-wars and power struggles, the country – poor anyway – has completely bled to death. The traditional structures fell apart and millions of refugees were driven away, especially to Pakistan and Iran. Wild over-exploitation of lapis lazuli, which had been a state-owned monopoly, and also of the precious stones aquamarine, tourmaline, ruby, and kunzite (pink purple spodumene $LiA_1Si_2O_6$) from the high mountains in the east of the country contributed decisively to financing the struggles which went on for more than two decades. The deposits of natural gas in northern Afghanistan, which have been discovered since the 1960s (Samsonow 1994), grew decisively in regional significance during the years of war and crises. Selling gas enabled the warlords of the North to gain wide independence from the main parts of the country; at the same time they helped to increase the standard of living in the northern provinces, compared to the situation in Kabul.

Salt in Afghanistan

Rocksalt[1] on the other hand did not seem to have had any outstanding economic significance among the deposits of the country as it is to be found in great amounts at many places in the Central-Asian area and is easily to mine there. As here – in contrast to pre-industrial Europe – salt was never used for salting meat and fish, it was and still is used only as table salt, while the consumption per head is conspicuously low (2.6 kg/year in Afghanistan, according BPG-study 1968; for comparison: 8.0 in France, 10.0 in Austria, kg table salt/year for the year 1965). Up to these days in Afghanistan there has been neither technical procession nor industrial use of this mineral resource.

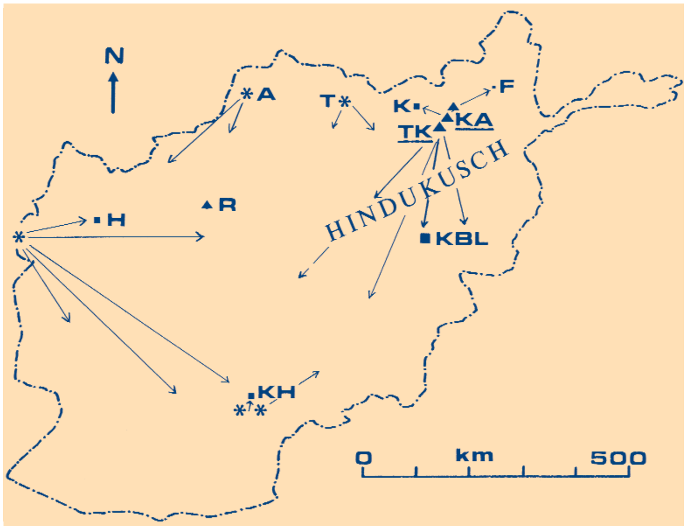

Fig. 1: Sketch of the most important salt-deposits in Afghanistan (according to BPG 1968). ▲: rocksalt-openings, stars: production from salt-lakes, : ■ towns a. cities. Abbreviations: A: Andkhoy, F: Faizabad, H: Herat, K: Kunduz, KA: KALAFGAN, KBL: Kabul, KH: Kandahar, R: Rukh, T: Tashkurgan, TK: TAQČA KHANA. The arrows connect places of production and consuming.

This essay is on the two biggest mining places of rocksalt in the country, Taqča Khana and Kalafgan, from where vast parts of the country – including the capital Kabul – were mainly supplied, which is supposed to still be the case. The following explanations

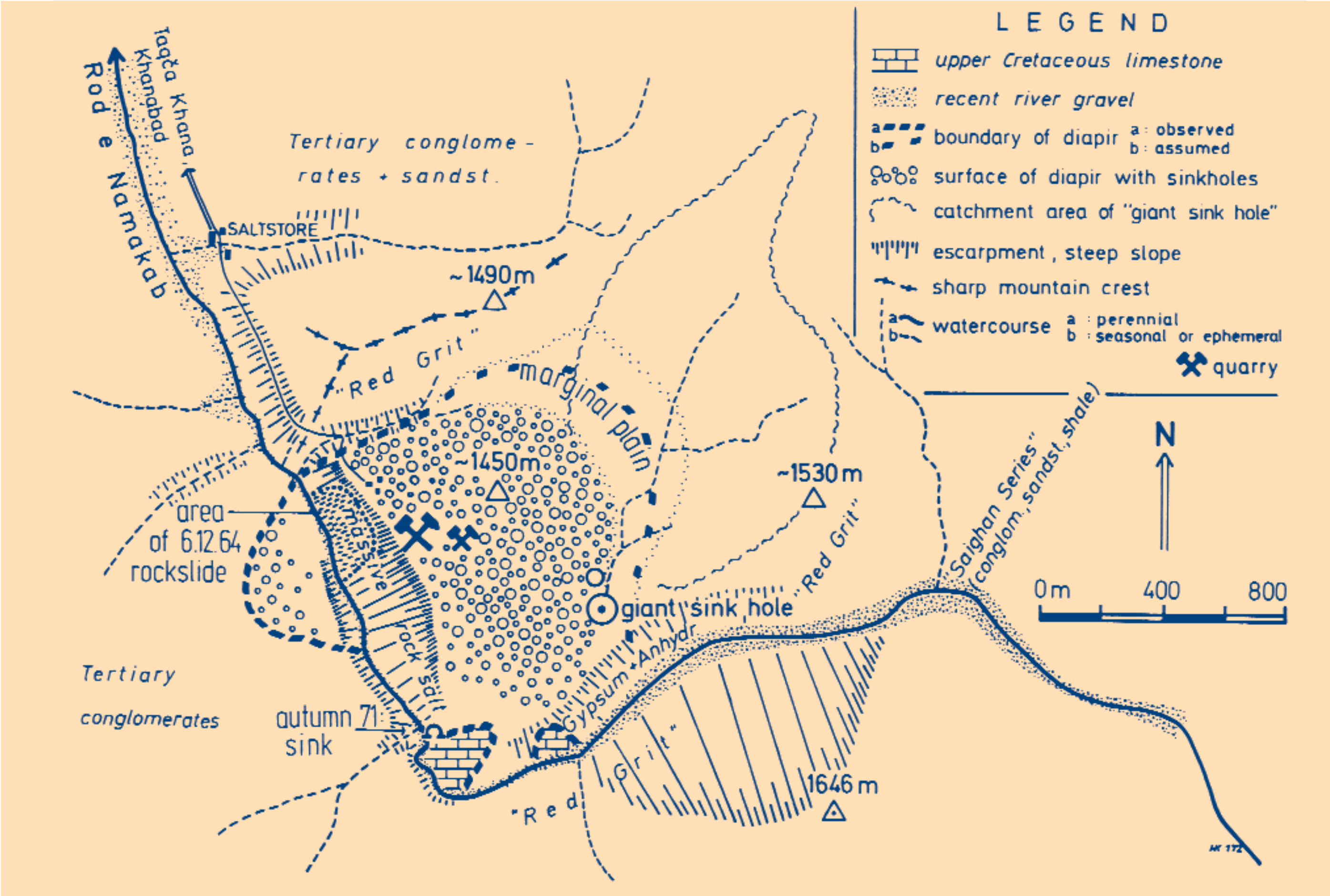

Fig. 2: Geo-morphology and geology of the salt-mountain at Taqca Khana (from: Kulke, 1971). ; - - - solution funnels, schematic: ○. The bigger funnel ⊙ drains the north-eastern area of the diapir dividing line and parts of the neighbouring slope, its catchment area is outlined by the wavy line. The steep salt slope towards the river, the landslide from December, 6th, 1964, and the short-time vanishing of the river in the autumn of 1971 through the SW-edge of the diapir are written in.

refer to the situation during the early 1970s when Afghanistan was still a peaceful country, following her own traditions. Presumably the situation of mining and supplying has not significantly changed since then.

There are two types of rocksalt-deposits in the country:

1. At the north-eastern rim of the Hindukush there are several smaller salt deposits pressed upwards by diapirism and one or two bigger bodies of hallite (see Hinze 1964, 41f.). Due to its geologically fast exposing the easily soluble rocksalt is partly uncovered there or below some minor overlying. Among the at least five hallite-openings, the mining places of Taqča Khana (c. 19,000 t/y) and Kalafgan (*c.* 2,200 t/y) are of economic significance; the first supplies half of the country's demand (BPG 1968).

2. Around the high mountain chains there are numerous salt lakes without outlets. If they fall dry in summer there is access to salt layers of various thickness. In favourable cases – before they have dried out completely – the amounts of salt crystals can be shoveled away or whole plates can be carried away. From the salt pan of Andkhoy (province of Faryab in the north-western lowlands) there were mined about 10,000 t a year around 1965. This young and loose salt is less popular in the country than rocksalt, as sometimes it is dirtied while being mined, transported, or traded.

The Rocksalt-Bodies of Taqca Khana and Kalafgan

Location (Fig. 1): The big amount of hallite at Taqča Khan is at about the centre of the province of Takhar in north-eastern Afghanistan, *c.* 20 km ESE of the provincial capital of Taloqan. The salt mountain (*c.* 1450 m) is about 4 km south of the village of the same name, above the narrow valley of Rod e Namakab (= saltwater river) which comes out of the Hindukush at this place. The co-ordinates of the deposit are: 36°35´N/69°48´E.

Fig. 3: Salt-quarrying at the Taqča Khana-diapir. A new bank is opened up after the residual clay (on the right) has been removed. The view is WSW across the Rod e Namakab-canyon and to the small western part of the salt-deposit. Photo: August 1970 (slides-archive H. K. 2422).

The salt mine at Kalafgan (*c.* 1650 m) is hidden in a short valley c. 13 km WSW of the village of Kalafgan, in the crested mountain country of the Eastern part of the province of Takhar. The mine (36°43´N/69°48´E) is 2.5 km north-west of the Kunduz-Faizabad highway, which was still untarred in 1970.

Geology (according to Kulke 1971): The rocksalt of both deposits is set among the continental red grit of the local chalk rock (Hinze 1964). During the upfolding and rising of the Hindukush after the end of the Older Tertiary (c. 25 millions of years ago) it was pressed upwards within the latter's steep stratigraphic unit and compressed to form bigger masses. Tectonically they are probably gigantic salt lenses or rather untypical pre-phases of salt deposits. The salt masses of Taqca Khana (Fig. 2) are deeply cut by the narrow valley of the wild Namakab river. From this steep salt slope sometimes landslides come down from cliffs and dam the river for short periods. Due to rainfall (probably about 600 mm/y) the dome-shaped surface of the 1 km^2-sized salt deposit is structured pockmark-like. The salty water runs through cliffs, which are widened into caves, into the Namakab, which is 260 m below, and oversalts its clean mountain water. The funnels are close together and usually are 2-5 m deep with a diameter of 5-20 m; one gigantic funnel (c. 30-40 m deep, c. 100 m in diameter) at the rim of the massif drains outlying parts of the salt deposit into the nearby river through a broken, steep slope of gypsum and anhydrite.

Where the surface is less structured, a covering of residual clay of grey-red solution remains of the coarse-grained rocksalt. The latter shows coloured bands from white-grey (the most demanded quality) and reddish to rare chocolate-brown tones. The NaCl-content of the rocksalt is from 88 to 98.5 w.-%; the main contamination is due to colouring clay and small crystals of anhydrite (Kulke 1972).

Fig. 4: Rocksalt-quarrying in the big quarry at Kalafgan. The blocks are laboriously hewed out. Photo: from August 1970 (slides-archive H.K. 2440).

Though the yearly losses by solution are supposed to be between 50,000 and 150,000 t NaCl because of its exposed location, from the geologic point of view the deposit still shows big amounts of salt which are easily to mine. Following a rough estimate there are more than 300 millions of tons, only above the level of the Namakab river. Thus Marco Polo's assessment (see Weisgerber in this volume) from the point of view of the late 13th century is understandable. He writes: "...In the South there rise gigantic salt mountains. From everywhere, from the distance of 30 days, people take the salt, for it is the best in the world. Only by using iron picks it is possible to knock it off, as it is so hard. The amount is unmeasurable, all mankind could be supplied until the end of all time."

The deposit of Kalafgan shows an inconspicuous morphology. It forms a hill of about 10 ha whose rocksalt also shows up through solution funnels below a rather thick covering of purple-red clay. Only at the steep southern flank hallite is above ground.

Fig. 5: A group of donkeys carries two blocks of salt each from the mining places down to the salt collecting point (in the background) in the northern approaches to the salt-mountain at Taqča Khana (location: see Fig. 2). Photo: August 1970 (slides-archive H. K. 2420).

Rocksalt-Mining

On the Taqča Khana-salt deposit several minor quarries were run; on the Kalafgan-deposit in those days there was a mine of about 80 m in diameter which was open to the south and showed vertical walls in the almost horizontally striped salt rock. Mining was done by hand while steep slopes were preferred and sometimes also mining was done at the walls of bigger solution funnels. In the Kalafgan-quarry (Fig. 3) salt pillars of some 10 m^2 are cut down to the floor in the form of even and well done miniature banks whose thickness varies; at the Taqča Khana mountain the mining is done less systematically (Fig. 4). The salt mine at Kalafgan was opened about 1947, according to the foreman´s information; in the summer of 1970 15 workers were toiling there, producing about 7 t of salt blocks a day.

For making the salt blocks, at first long, deep furrows, being about 30 cm away from each other, are hewed into the tough rocksalt. This method of mining is similar to the traditional quarrying of stones. But due to widely spaced cliffs and lack of gaps within the stratification the oblong blocks must also be hewed out at the sides and at the bottom, which means a lot of additional work. The size of the blocks is about 50 cm of length with a cross-section of almost 25 x 25 cm, so that a donkey is able to carry two of them (45-60 kg each) on paths down to the collecting point (Fig. 5). If possible, there the blocks are handed over directly to lorry drivers who play the role of wholesalers. Even far into the 20th century the basic distribution of salt blocks, at least in areas with less developed infrastructure, was done by help of caravans, mostly donkeys.

Old and abandoned mining places do not come to everybody's notice on the terrain, may it be that they were filled up again by overburden from mines above or that they have been restored to their “natural state” over a longer period by dissolving of the salt. Probably the method of mining has not or only slightly changed during the centuries. But due to road-building during the early 20th century, and by help of transport by lorries, the production may have multiplied. Uncrushed, the rocksalt gets to the bazaars, as far as Kabul, which today is 400 km to drive, and beyond[2]. Only there it is crushed to lumps and sold to the households. At home it is ground for daily use by help of mortars and stone mills which are worked by hand (Fig. 6).

Conclusion

Such manual but professional salt-mining without processing may be considered unique in the world. There are salt-mountains of similar or even bigger volume in several countries. In NW-Pakistan the one at Kalabagh is exploited in a semi-industrial way, as well as there is mining of varying intensity at some of the Iranian salt-massifs. At the salt-mountain of Cardona (NW of Barcelona, Spain) and at the one at Tissa (north-east of Fes, Morocco) there has been mining for a long time, in Algeria a bigger salt-factory at Djebel Melah (= salt-mountain) d´El Outaya (near Biskra) has been run for only about 15 years. At all these mining places the salt is dissolved to clean it and then crystallised, before it is used. In principle, improving the product by re-crystallisation should also be welcomed in Afghanistan; at the Taqča Khana-mountain there are favourable conditions for doing this. This would also offer a possibility to use the fine salt which for the time being is rejected. Another problem, which has not yet been solved, is the strong salt-contamination of the Namakab-river (about 1.3-7 g/l according to season: BPG 1968; Kathuria 1972) which makes the use of its water for irrigating the foothills impossible. But for many years Afghanistan will have to solve problems of much different kind.

I like to express my thanks to Mr. Paul Bucherer, head of the Afghanistan-Institut, Bubendorf, Switzerland, and to Dr. Azizullah

Fig. 6: Salt is ground for use in a handmill made of stone. Photography from the 1970s, taken in north-eastern Afghanistan, by courtesy of P. Bucherer, Stiftung Bibliotheca Afghanica, Bubendorf, Switzerland).

Qureischie, Geol. Inst. Univ. Bonn, for reading the manuscript and for comments, and to Mrs. Gabriele Unger, Dresden, for typing.

Notes

1 Rocksalt: the term here means massive, compact rocksalt in the geologic sense (NaCl), in contrast to the younger, less hardened rocksalt from salt-lakes and salines.

2 Until the Salang-Pass tunnel was built through the main chain of the Hindukush in the early 1960s, the route was about 180 km longer and much more exhausting.

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Mining for Water – Kaeris and Qanat

Iran's Most Important Traditional Method of Water Production

Gerd Weisgerber

As everywhere, also in Iran the usual exploitation of natural or artificial water resources plays and played an important role, like sources, streams of water and rivers, or wells and roofed cisterns. Still today the latter´s ruins are found mostly in desert-like regions where people tried to save the water of the rare rainfalls for man and animal. Open reservoirs, sometimes dammed, do exist just like the so called Gabarband-dams which are only supposed to prevent the rain from running away too fast and the soil from eroding, without being able to dam water in the strict sense. For Arabian-Islamic travellers, geo- or cosmographers in the Middle Ages it is almost in every case worth mentioning if a village or a town with its gardens and fields is supplied by running or still waters, running waters being definitely more appreciated. But "running waters" meant much more than creeks and rivers common in Central Europe, it meant also water from Qanats. In the Hudud al-Alam, a Persian geography from 982 AD, it is said about Nishapur, for example: "Nishapur is the biggest and richest town of Korassan ... The biggest part of its spring water runs underground" or it says: "Khur and Khush, two towns at the rims of the desert. Their water comes from underground canals" (Minorsky 1970, 102f.).

Fig. 1: On desert terrain, several generations of ring-shaped heaps from qanat-shafts are visible. Several lines mean several periods of construction. Like in the case of the two long lines this may be a new construction or, like the two shorter lines, they may be extensions or only repairs of broken drifts; Photo: Georg Gerster.

Fig. 2: Seemingly endless, the ring-shaped heaps of various periods of constructing qanat-shafts run from the environments of Yazd to the next settlement; Photo: G. Weisgerber 1978.

Qanats/Kaerises

In the following, a very old method of water supply shall (simplified) be described, without which most parts of Iran would have stayed to be deserts and would have remained uninhabited. This is done by underground drifts of which still today ten thousands of settlements are dependent, both concerning drinking, washing and bath water and the irrigation of the vital oasis plantations. In Persian this system is called “Kaeris”. A nearly horizontal drift (only 1-2 mm gradient per metre) serves as water supplier which in its upper course in the debris of rainy mountains collects ground water (“drainage drift”) and then leads it to the lower plain and to the settlement through an extension (“transport drift”). As it is not possible to take more water from it than provided by nature and weather, there is hardly any damage to the environment, quite in contrast to the modern pumps of deep wells. Traditionally, Persia is considered the origin of the costly Qanat-technique but this has not yet been historically proven. For the purpose of science, the Arabian term “Kanat” or “Qanat”, meaning a canal, has gained wide acceptance (qanat as-Suwais = Suez-Canal). In Northern Africa these constructions are called “foggara”, in Oman “aflaj”. On the surface, qanats are easily recognisable by lines of shaft dumps which often run many kilometres long (Fig. 1 & 2).

Hydrology

The hydrologic condition of Iranian qanats are the enormously thick sedimentations of debris along the high pre-mountains (colluvium and alluvium). Colluvial layers being some hundred metres thick are not a rarity. Above water-resistant ground they collect gigantic amounts of water, *e.g.* meltwater after wintertime (Fig. 3). In contrast to regions where only the delicate groundwater in the alluvium of the deepest terrace of a valley is exploited (*e.g.* in Oman), over the millennia the Persian deposits look almost inexhaustible. But even in Iran a series of several dry winters may cause problems.

How long the water supply of a qanat will be sufficient does not only depend on the amount of water which is taken from it but also from the speed of this water. At first this influences the settling of sediments in and outside the drift and thus the costs of maintenance. Drainage water which runs towards the drift exploits the porosity of the sediments. The faster the water is running – depending on gradient – the faster it drains in from the sides and thus washes fine sediments into the drift. In the case of careful extraction the drift might keep its original state but if the water is running fast, base and side walls erode. Of course, qanat-builders and oasis farmers are well aware of this, thus they very carefully regulate water level and flow by help of small stone walls across.

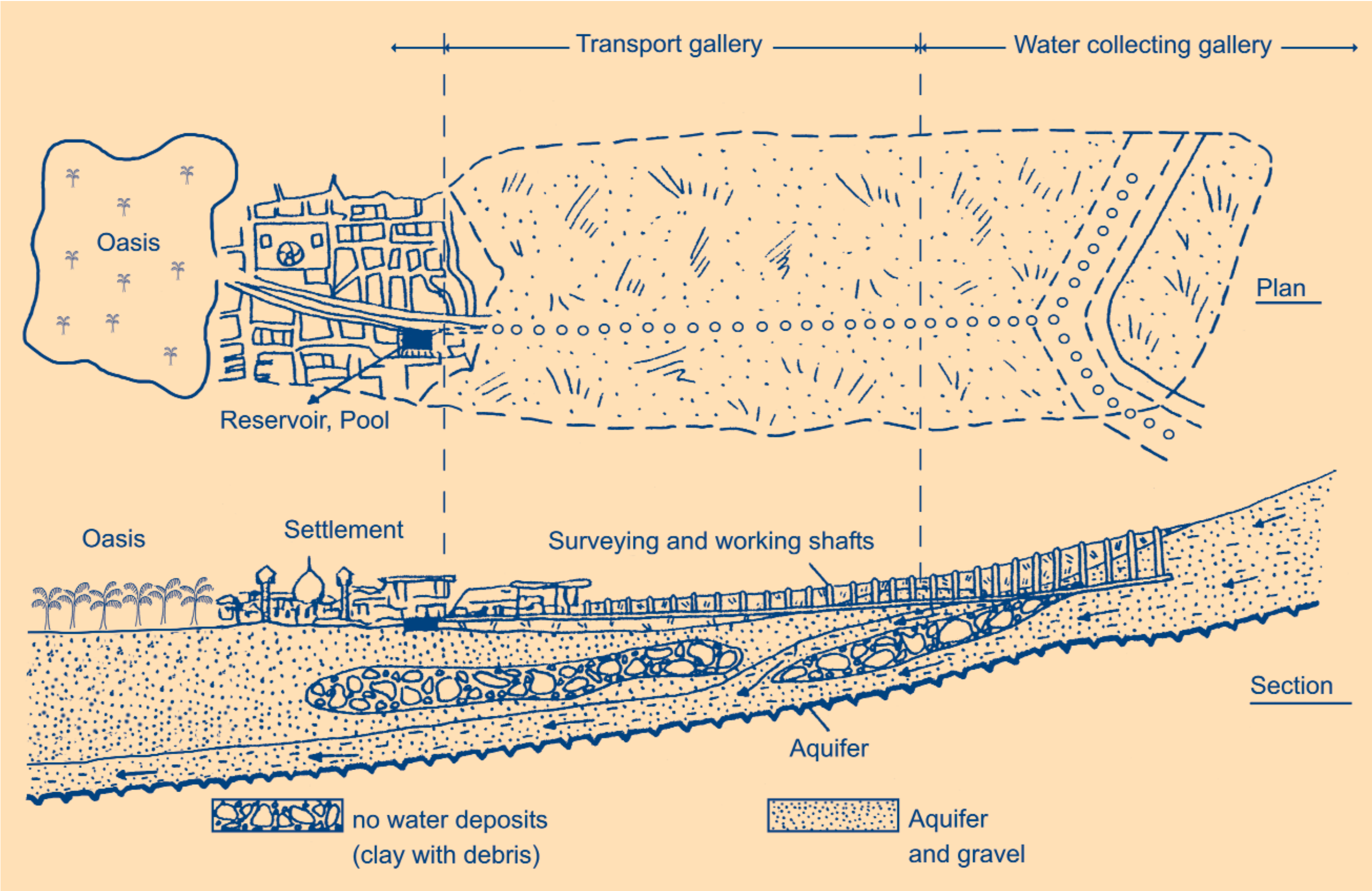


Fig. 3: Scheme of a qanat; the numerous shafts are typical, on the bottom work was directed towards each other, thus being able to finally create a long underground drift for collecting and transporting water; following Kuros 1981, fig. 1.

Historic Introduction

Incomprehensibly, research on the age of the qanat-system in Iran, its supposed country of origin, is just starting, there are no archaeological investigations on it. For the time being, only more or less useful historical news have been collected (Forbes 1964, 156-163), of which a remark by Polybios seems to be the relatively most reliable one. An often quoted report by the Assyrian king Sargon II (722-702 BC) of his war against Rusa I of Urartu from the year 714 BC mentions water sources but means something completely different; there are no qanats in Urartu (Gall 1967). Achaemenide ostraca refer to the distribution of qanat-water in Egypt (Chauveau 2001) but if Polybios (200-123 BC) talks about the time of the Parthian king Arsaces II, about the year 209 BC (Drexler 1961, X.28), he seems to be referring to qanats: "In this part of Media there is no water at the surface but there are many underground canals (*hyponomoi*) to which there reach down the shafts of wells, at places in the desert unknown to anyone who is not familiar with the region". But as Polybios is writing decades after the events and was not there himself, it does not make much sense to take his explanations literally (Brinat 2001b). Also in the Middle Persian language there are preserved texts (Menasce 1966). From the perspective of mining archaeology we may state that in the Near and Middle East there are costly constructions with numerous and deep shafts only since the Iron Age. Probably the new iron tools contributed to this, besides new leading elites. Not at last because of such inventions even in the Book of Hiob in the Bible the building of shafts is excitedly emphasized. Thus, it is well possible that the qanat-system was invented as early as in the 1. half of the 1st millennium BC while the Bronze Age can probably be excluded.

In the Sultanate of Oman, archaeological investigations showed that there the system was known at least in the second half of the 1st millennium BC. Indeed the increasing settlement and flourishing of the country during the so called Lizq/Rumeilah period (1100-300 BC) would not have happened without the qanat-system (Weisgerber 1981, 247f.; 2004). If today there is evidence for Oman's "aflaj" being older than Persia's kaerises, this does not mean they are actually older. For the time being this does only mean that they have been researched more intensively.

But Iran's kaerises are not only mentioned by medieval travellers, there is even basic scientific literature on their building by al-Karadji (Kargi 1966; 1973), particularly on their measurement (s. b.) and on distributing their water; it is called: "The Tapping of Invisible Water". One thousand years ago, this scientist wrote at the beginning of his book: "Despite its mountains, plains, and valleys, the earth is ball-shaped. God made it the centre of universe ... To the worlds, the stars, the fire, the air, the water, and the ground he gave their appropriate space each ... Due to this, all heavy elements like water and ground tend to moving towards the centre of the earth. The more heavy the thing, the more it is forced towards the centre." Though this is not our way to express it, thus here is definite reference to the theory of gravity, and a little later the running of water is clearly explained by the theory of gravity. Karadji also mentions the different kinds of ground water which we easily interprete as today's ideas of seeping away, of condensation, and of juvenile ground waters (following Kuros 1981).

At first by the extending Persian empire, then by the Arabian conquests in the course of spreading Islam the qanat system was widely spread in the Old World. Thus, today there are qanats from Afghanistan (Balland 1992; Humlum 1959; Jentsch 1970) to Egypt (Wuttmann 2001), Northern Africa (Bisson 1992; Cornet 1952), and on the Iberian peninsular. Spanish conquistadores exported the system to the New World from New Mexico to Chile (Troll 1963), indeed, it was even employed in North-western China (oasis of Turfan). Already the Romans built qanats at home or in the Gaule and German provinces (Kayser & Waringo 2000) or they used the appropriate building-technique. In the High Middle Ages, under Abbot Fulbert (1152-1177) the level of Lake Laach was lowered by help of this system (Grewe 1979), and still in the late Middle Ages such a system was built for the water supplies of Blankenstein Castle in the Eifel (Grewe 2000). Since the early 19th century, in the town of Selb in Franken and around it there are qanat-constructions though today they do not have to fulfill their original function as water suppliers (Klaubert 1973).

Quanat

Among engineers the term "qanat" means a special system to find water "hidden" in the underground, to collect it, and to make it run to the surface by help of light gradient, *i.e.* without employing artificial energy. For building such constructions some special, very costly building technique is employed. This is a drift (most times mistakenly called a "tunnel") cutting groundwater-horizons and through which the water is conducted to the surface (similar to drainage galleries with mining). For building the often several kilometres long drift, many shafts are necessary, from where work progresses towards each other in order to build the drift (Fig. 3). Because of the water supply being very reliable and of the often gigantic amount of work, the system and its builders were not only admired by countless western geographers during the past 200 years[1] but already by Islamic scientists one thousand years ago. Four fifths of all the water being used on the Iranian Plateau are exploited from the underground by help of this method, having made necessary the building of underground water-drifts of some thousands of kilometres length.

Henri Goblot strikingly described the employed technique: "Qanats are a mining-technique for exploiting underground water deposits by the help of drainage galleries" (Goblot 1979, 27). Indeed, the opening of such a water-drift is similar to the opening of an ore mine. A kaeris/qanat/aflaj/foggara is a mining-technically drifted underground infiltration gallery conducting water seeping in from aquifer layers in the highlands or from sedimentary terraces to lower areas, it is employed mostly in arid or semi-arid zones.

With doing this, in the case of new settlements there often was a reversal of the "ordinary" situation, when first a settlement was built and then water supplies were built for it. When people wanted to build a qanat, *i.e.* they finally succeeded with finding underground water and conducting it down to the valley and to the surface, then the place of the water coming out determined the location of the settlement, indeed of the mosque, and mostly the location of the oasis orchards. If the settlement was already there, like in the case of today towns, then *e.g.* for additional qanat-buildings the level had to be adjusted, something which in some cases caused extreme work and costs.

If the construction of a new qanat is planned than firstly, there has to be research on where and in which depth enough water occurs. An experienced qanat-master chooses a spot where a promising exploratory shaft or "mother shaft" shall be sunk. If the result is positive, a spot for the water to come out is determined, *i.e.* where settlement and oasis shall be located. Now the problem is to make a connecting drift between the supposed water exit and the water level in the mother shaft. As these spots are often many kilometres away from each other and often it is not possible to look from one to the other, it is obvious that this connection is difficult to establish and cannot be done without measurement, so that altogether this demands an enormous effort. Just working from the opening of the drift towards the mother shaft would first take several years as every basket of earth would have to be transported all the way out of the drift (as it is the case *e.g.* with every ancient mine). Second, the try would fail as one would not know underground which direction to take and how to keep it. Therefore without marking the route and measurement at the surface this task cannot be accomplished. Just this was a serious problem not only some thousand years ago.

Because of this the ingenious system of shafts distributed along the entire length of the line was invented which were to be connected to each other underground, just the qanat-system. Though due to measurement reasons the shafts had definitely to be built within short distances. They offered additional advantages:

Rationalization:

it was possible to work at several places simultaneously, something which made the progress of work enormously faster.
The workers (*muqanni*) could enter and get out fast.
If needed, there was an escape route for the workers in case the hanging wall was about to collapse.

The spoil could be dumped at each shaft and in form of a ring-shaped heap offered additional protection against surface water intruding into the underground system.

Ventilation:
fresh air could circulate through the part between the shafts.

Light:
some light came through the shafts, thus improving the view, at least near the shaft.

Maintenance:
via the shafts, after completion it was easily possible to control, to look after, and if necessary to repair the single sections of the drift. Occasionally there were irruptions or constrictions in the drifts which often were very long. In those days, constrictions in danger of collapse were secured by wooden posts or bricked up with stones, today narrow rings of burned clay or of concrete are built in. In some cases they are also used for supporting the wall of the shaft (Fig. 4).

Now, how are kaerises practically built?

Prospection for Water

To let the water run to the surface, the exploitable area must always show more gradient than the future ground of the qanat. At first the kaeris-master (*muqanni-bashi*) chooses a certain spot where because of his experience he suggests "invisible water" to be in the underground. There, for the search for water up to three "mother shafts", being 200 to 500 m from each other, are sunk. In the ideal case there is water on different levels. If water is found, *i.e.* if water accumulates in the underground above a water-resistant layer, water is taken from the shaft during a defined period of time to be able to estimate the available amount of infiltrating water. Like all the others, these shafts are 0.70 to 1.10 m in diameter. Their depth varies, some are said to show a depth of 100 m or more. Of course, in the downwards direction the shafts get more and more shorter, except a mountain must be cut across.

Measurement/Mine surveying

If the result of the test is positive, the next step is to make the discovered water run to a contemplated settlement area. For this, the route of the future conducting drift must be marked at the surface and the complete difference in altitude of water level and future opening must be calculated. This is not possible without costly measurement. The bigger the distance between mother-shaft and settlement area, the more costly and lengthy is the measurement and the more time takes the mining work. One thousand years ago Karadji, our informant, knew four methods of identifying the difference in altitude (Fig. 5), *i.e.*:

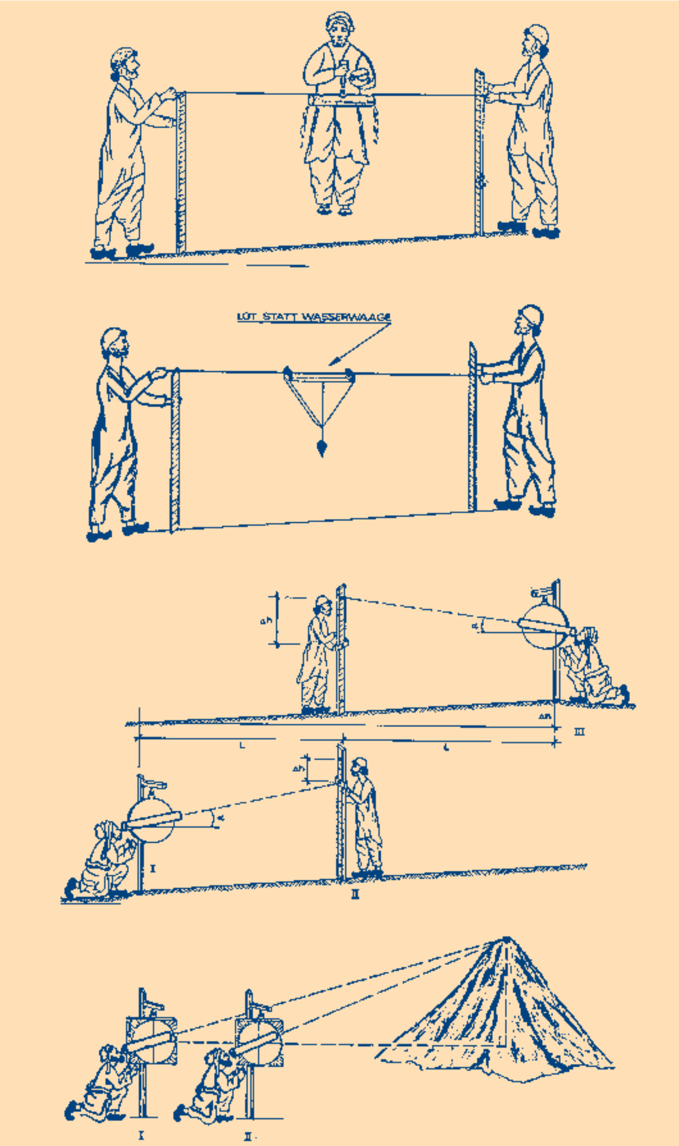
1. By spirit-level.
2. By lot.
3. By the "spyglass"-principle.
4. Karadji himself developed the method of the pseudo-theodolite which worked faster than all the others. It was about tangents with known distance (Kuros 1981).

When the course of the route is marked it must be applied to the underground, something which in the past was only possible by help of numerous shafts if these were connected underground, *i.e.* from each bottom of a pit to the two neighbouring shafts were aimed at. The distance between the shafts varies from 20 to 200

Fig. 4: Near Neiriz, ceramic rings are lying ready for supporting a maybe instable part of the drift or, like in the foreground, for securing a shaft; Photo: G. Weisgerber 1978.

m, depending on the terrain. To take the correct direction from shaft to shaft and to keep it, two lots are hung into each shaft in a way that vice versa the upper ends of the lots in the neighbouring shafts can be sighted correctly. The sight at the lower ends of the two lots in the shaft gives the direction in which the drifts are to be advanced. In the case of long distances the direction is kept by burning a light at the beginning of the drift-section. As long as it is visible, the direction is correct. The depth of the shafts was determined by measurement. Very deep shafts were stepped. The distance between the shafts varies according to subsoil and location. The longer the qanat, the more probable are ever deeper shafts towards the mountains.

Fig. 5: The four methods of measuring the altitude, as described by Karadji in his book on the "Invisible Waters" about 1000 years ago; from: Kuros 1981, fig. 11-14.



Drifting

While heading from two directions, the qanat-workers always dig from two shafts towards each other until the cut-through. The height of the drift-sections is only enough for the muqanni to be able to walk bent down, *i.e.* about 1.60 m. Bigger heights may come from the benches of the drift-sections being adjusted due to the gradient. Often enough children had to help. One-sided picks serve as tools (pick-work) and also hammer and chisel as well as simple shovels. As mostly it is sediment, the material which must be hewed is not very hard. Due to stability, the roofs of the drifts are parabolic. Only bigger rocks in the soil may make the work considerably more difficult as in this case they must be bypassed, something which may easily end in mistakes of direction. Within the transport part of the gallery or drift, from every shaft it is possible to work towards both directions. However, if the water level is met, it is only possible to work upwards so that the drained water can run downwards.

Light

In the past, small oil lamps were used like for mining, which also warn if the content of oxygen gets too low, but today battery lamps are used.

Ventilation

In the past, for ventilation fresh air was pumped through leather pipes by help of shin-bellows if the shaft was deep. But still toxication and casualties were possible. Thus, the shaft-master was obliged to carry vinegar with him, which in connection with earth produces oxygen which could be inhaled (Kuros 1981).

Haulage

The winches by help of which the debris was hauled to the surface are particularly interesting. Still today, the so called Oriental winches with turning cross construction are in use, though these days motor-driven winches are increasingly employed, mostly because they can haul bigger loads. Depending on size, the turning-cross construction needs one or two men to work it, as the transmission is rather direct (Fig. 6 & 7). To provide better rope guiding, often a small pulley is placed at the opening of the shaft. In the past, leather baskets or bags were used for haulage, today huge, stabile vessels are made from lorry-tyres. In the past, the rope was hemp, today for the motor-winches steel-rope is used.

Entering the Shafts

Usually the men climb up and down the shaft on bare feet, like alpinists in a chimney, while pressing their feet onto the rough and uneven shaftface or placing them into stepholes. This kind of entering and leaving the shaft determines the shaft's diameter, for if the shaft is too wide, this is not possible. Occasionally, the rope of the winch serves as support and safety. Today the men often enter and leave the shaft while standing in the haulage-vessels of the motor-winch.

Water Transport

Each qanat-drift is divided into two sections, *i.e.* in the upper part the infiltration gallery into which the water penetrates from the groundwater-level and where it is collected. The lower part is the adjoining transport-gallery. Often, the latter is much longer,

Fig. 6 & 7: Oriental turning-cross winch above a qanat-shaft near Rafsandjan. Each turn brings up as much as 4 m of rope. The winch can easily be taken apart for transport; Photo: G. Weisgerber 1978.

Fig. 8: Modern winch-scaffold with petrol-driven engine and a hoisting bucket made of old lorry-tyres near Rafsandjan; Photo: G. Weisgerber 1978.

through it the water runs to the future or already existing oasis. For the continuation of drifting it is a great help that in the lower part work is possible without being considerably obstructed by seeping water, until finally there is the cut-through in the groundwater area and the water runs through the drift. Like the entire underground work, this moment may well be dangerous. Several groundwater-levels may cause particular danger while drifting.

Despite all skills of measurement and all experience, it will often be necessary to smooth the ground or to deepen it to make the water run, not too slow and not too fast. The gradient must be just enough to make the water run but not steep enough for any erosion of the ground or the walls of the drift. If measurement had been inaccurate, it could be necessary to decisively increase the gradient of the ground. Like Roman aqueducts, qanats do not show steep gradient, only 1-2 per mill (=1-2 mm per 1 m). As it might be that the water gets over major differences in altitude, it is often possible to build in turbines for grain-mills on its way.

The water which finally comes to the surface may be collected in reservoirs before being distributed among the oasis-orchards after having passed the mosque and the place for the people to get water. This distribution to certain owners is organised according to time management and traditionally is strictly controlled. In towns, such as Yazd, the water runs into a big reservoir. At Yazd, this is a monumental cupola-building whose six wind-towers provide cooling and ventilation. Since a long time ago one goes to the water down a seemingly endless stairway.

Due to their specialised work, their diligence, their stamina, and their courage, qanat-builders are highly respected in Iran, for it is obvious that with these building activities there happened thousands of deadly accidents. In Antiquity and in the Middle Ages the muqannis enjoyed special privileges.

The Significance of Qanats for Iran

It is estimated that in Iran there are about 60000 villages and about as many qanats. Given an average length of 6 km, all qanats together reach a length of 360000 km. The water-output is between 5 and 1000 litres per second. If the average amount of water is estimated to be 12-15 l/s, all systems together supply about 750 m^3 per second (following Kuros 1981). These figures alone emphasize the significance of the qanat-system for Iran's economy.

Unfortunately, more or less modern, motor-driven pumps have competed this traditional water supply for oases, replaced it or even destroyed it by drying it out (Bonine 1982, 148) though it is obvious that the exploitation of groundwater by help of qanats is much more careful than over-exploitatingly producing water by help of ever deeper reaching pumps. Thus, qanats guarantee long-time supply, on the other hand they are considerably more expensive and more dangerous.

Dynamics of the Qanats

We are used to understand qanats as being one-phased and static: once they are built, they work for a long time or rather forever? This is not the case: even if visiting Iran as tourists, we can observe that often several lines of qanats run alongside each other (fig. 1 & 2). Definitely, they are not from the same time. Already this observation offers a historic dimension, qanats are not static but they underly dynamic change.

This does not mean repairs of broken spots or of breaking-zones or even of whole unsafe constructions but it means new constructions in reaction to changes of the groundwater-level resulting from constant exploitation of water. If the following example is not typical for Iran – just as there has not been any research of this – comparable constructions in the Sultanate of Oman on the Arabian peninsular (Al-Ghafri *et al.* 2000; Boucharlat 2001; 2003; Wilkinson 1977) show that also careful exploitation of water by help of qanats may change the groundwater conditions. This happens faster in Oman than in Iran, as in Oman there is only the groundwater from river-terraces whose amount is significantly smaller, of course, than in the huge alluvial and colluvial sediments of Iran. If there have been no winter-rains for several years or if they have been only meagre, *i.e.*, if the reserves of water have not been refilled, this results in the qanat producing no water or not enough. This may have considerable results as the users, being dependent on water, must react (in detail in: Weisgerber 2004).

Seldomly, settlement and oasis had to be completely abandoned. Instead, there was a certain choice of far reaching measures for the case of emergency:

1. The area of the seeping-drift could be made longer towards the mountains and/or it could be branched out to make the seeping-area wider. Such intricate networks at the end can be seen on aerial photographies both from Oman and Iran.

2a. The ground of the drift could be lowered to get water from some previously untouched levels. In the course of the more than two thousand years of history of the aflaj in Oman this measure was several times employed at almost all qanats.

2.b By help of new shafts it was possible to dig a completely new, deeper drift into untouched or neighbouring areas. In Oman, today at almost every modern falaj-building site older drifts on higher levels can be observed (Fig. 9).

Fig. 9: A recent trench dug by an excavator for securing the transport-section of an Oman qanat near Shareeah revealed several older and long abandoned qanat-drifts which were closer to the surface; Photo: G. Weisgerber 1982.

Effects of Emergency Activities

Always, the latter two measures had the effect that afterwards the water came out or was at hand at a deeper place than before, *i.e.* deeper than settlement and oasis. This again led to consequences: either both village and oasis had to be moved down the valley or the oasis itself had to be lowered by digging and transporting away thousands of cubic metres of earth. For the comparably small amount of drinking water for the people and their cattle it was enough to build wells down to the water-drift. For Oman there is archaeological evidence of both measures but lowering the oasis was the preferred method. Almost every oasis in Oman is surrounded by a high wall of dug-away earth. If the oasis was too big and thus the distance was too far, gigantic heaps of earth were piled (*e.g.* at Ibri; Nizwa: Costa 1983). As the old paths in the orchards were not lowered, often these are much higher today than the present level of the oasis which in such cases has been made accessible by stairs leading down from the path. Lowering the ground of the oasis was an exhausting and expensive enterprise but in order of survival every oasis-farmer had to contribute. Of course, besides the demanded knowledge and technical skill, all this requested well organised planning, financing, and leadership (see Scarborough 1991).

It is the question if the considerably bigger reserves of water in the Iranian colluvial fans of mountain debris made measures similar to those in Oman unnecessary. However, if one looks at aerial photographies often showing parallel, partly dead and abandoned qanat-lines (Fig. 1), one is tempted to doubt this. The sometimes extremely long qanats – up to 75 km are mentioned – are hardly supposed to have been of this length at the time of their construction; we may suppose that here quite often measures of emergency were taken and the ends of the drifts were continued towards the mountains, in one case there is even talking of qanats on different levels (Bonine 1982). Probably, such qanat-lines, running more or less alongside each other, are also on different levels so that in the course of the millennia it is appropriate to suggest conditions similar to Oman. The long stairway down to the municipal reservoir at Yazd might also be such an indication.

From this perspective, history and dynamics of Iranian qanat-systems are still a wide, open field of research.

Anmerkung

1 Beckett 1952; Beaumont *et al.* 1989; Bemont 1961; Briant 2001a; Butler 1933; Cressey 1958; English 1968; Feylessoufi 1959; Fischer 1928; Gharahman 1958; Hartl 1979; Hartung 1935; Honari 1989; Kuros 1943; 1981; Lambton 1989; Neely & Wright 1994; Neumann 1953; Rahimi-Laridjani 1988; Safi-Nezad 1992; Stratil-Sauer 1937; Wulff 1966, 249-254; 1968.

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The Blue-Glazed Donkey-Beads from Qom, Iran – Observations Concerning an Almost Forgotten Crafts-Technique

Ulrike Rothenhäusler

Introduction

Who does not know them, those shining, blue- and green-glazed figures of animals, amulets, and pendants from ancient Egypt? When they were discovered in the 19th century, due to their colourful enamel these artefacts reminded to modern faiences from Italy, so that they were called "Egyptian Faiance" (Schlick-Nolte 1999, 12). As early as in 1912/13 the composition of "Egyptian Faience" was analysed and it was found out that they were not made of clay but of quartz-sand (Brandt 1999, 170). Also, the enamel does not – as usual with faiences – consist of tin-oxide enamel but was made of alkali[1] and copper- or iron-oxide (Brandt 1999, 170). Because of this, the term "Egyptian Faience" is not used anymore, they are called glazed siliceous ware.

In Egypt, the first quartz-silica-pottery appears with the beginning of the pre-dynastic period (5500-3050 BC). Besides faience-beads, also smaller steatite-objects were enamelled (Nicholson 1993, 18). In the Middle East, the earliest finds are known from the 2nd half of the 5th millennium (Wartke 1999, 56). With the beginning of the 3rd millennium, quartz-silica-pottery appears in Greece (Scheunert 1999, 66). For the time being, there is little evidence for them from the early periods of Iran but with the beginning of the Islamic period high-quality quartz-enamel on pottery-tiles were produced as front decorations of mosques (Helmecke 1999, 90).

For a long time there was the question of how the enamel on quartz-silica-pottery was produced. Today we know three methods: self- or efflorence-enamelling, application-enamelling, and the process of cementation (Schlick-Nolte 1999, 13; Busz & Sengle 1999, 192-219). Being one of those ancient techniques, the process of cementation has survived up to these days in a craftshop at Qom, Iran; in 1968 it was analysed and described for the first time by Wulf et al. For using this method, beads are made of quartz-

Fig. 1: Page 1 of the brochure.

Fig. 2: Workers while kneading the quartz dough.

Fig. 3: Workbench with just finished basic shapes of quartz-sand.

powder, then they are dried and finally they are embedded into a powder containing the components for enamelling. When fired, the components of the enamel get gaseous, crystallise again within the beads and enamel them in blue. Probably, this technique was used as early as in the beginning of the 3rd millennium in Egypt (Nicholson 1993, 8) but it was archaeologically proven only by a find from Fusat in Egypt from the 1st or 2nd century AD. Here, enamelled beads still embedded in powder were found (Brandt 1999, 184).

The Production of Quartz-Silica-Pottery in Iran

In 1999 an exhibition titled "Turquoise and Azure – Quartz-Silica-pottery from the Orient and the Occident" was planned by the Universität Gesamthochschule Kassel and the Staatliche Museen Kassel. This exhibition was on production and history of quartz-silica-pottery. Also mainly emphasised was decoding the recipes as they were used e.g. at the Qom craftshop. The idea was to make them useable for modern artists. This exhibition attracted my interest and during a journey to Iran in the summer of 2003 I was able to visit the craftshop at Qom and to learn about the production of blue-enamelled beads. These days, the craftshop and shop of the Kashipaz brothers[2] are along an arterial road from Qom, it is accessible from a court. Besides glazed siliceous-pottery, also ceramic-vessels are sold. These days, not only the already mentioned blue donkey-beads are produced but also a variety of other motifs (stars, hearts, flowers, animals ...) about which a special brochure offers information (Fig. 1). A common feature of all the motifs is that very few of them are bigger than 30-40 cm.

At first sight, the way of production does not seem to have changed after 1968 (Wulf et al. 1968, 98-107). On a wooden table

Fig. 4: In the court the wet basic shapes are laid out for drying.

Fig. 6: Empty kiln, 2.5 m deep. The vessels are stacked in between the ceramic spacers.

Fig. 5: Workers while embedding beads into the vessels. The beads must not lie too close to each other and are completely covered by powder.

the dough of quartz-powder and gum tragacanth which has been dissolved in water, is kneaded by using a piece of wood and then pressed into metal moulds (Fig. 2 & 3). These basic shapes are then layed out for drying on cloths in the court (Fig. 4 & 5).

For the enamel, a grey powder consisting of three shares of fine-grained "sintered" plant ashes, three shares of moisturised lime, two shares of quartz-powder, 0.5 shares of charcoal, and a share of copper-oxide are mixed together (Brandt 1999, 172). In 1968 the quartz-powder was grinded from pebbles in a handmill and the copper-oxide was delivered by a copper smith who collected the hammerscale from his manufacturing new vessels (Wulf et al. 1968, 100). The plant ash is made from the plant Salsola soda or rather Salsola kali, which is a desert plant belonging to the Chenopodiaceae family and containing a lot of alkali, the Iranian name is Ashnon (Brandt 1999, 172). This plant is under conservation in Iran but to be able to produce quartz-silica-pottery traditionally and not to be forced to use synthetic materials, it is grown on a farm since 1999 (Edalatian 1999, 190). The dried quartz-beads are embedded in layers into ceramic vessels (Fig. 5). The craftsmen take care that the beads are completely surrounded by the powder. One kiln takes 50 vessels with a diameter of 33 cm and a height

Fig. 7: Opening the vessels after cooling down. The blue beads are clearly visible in the grey powder.

of 18 cm each (Brandt 1999, 172). Wulf calculated that up to 40,000 beads can be enamelled during one firing (Wulf 1968, 101). From heating the kiln until it has completely cooled down again, the firing takes three days and a temperature of c. 1000° C is reached which may be kept for 12 hours (Fig. 6 & 7).

Fig. 8: Bead, made following Brandt's recipe.

Blue Beads – Made by Your Own?

For interested people who would like to produce the famous Egyptian blue hippopotamus by themselves I recommend the essay "Khar Mohre – die Entschlüsselung einer iranischen Glasurtechnik und Bezüge zur Ägyptischen Fayence" by Brandt (Brandt 1999, 175). Following his investigations, I was able to enamel a Roman mellon-bead by myself (Fig. 8). For making the basic shapes, a syrup-like liquid was made of gum tragacanth and water. This was used for kneading the quartz-powder into a dough and then -formed to be beads by using a wooden rod. After several days of dry-

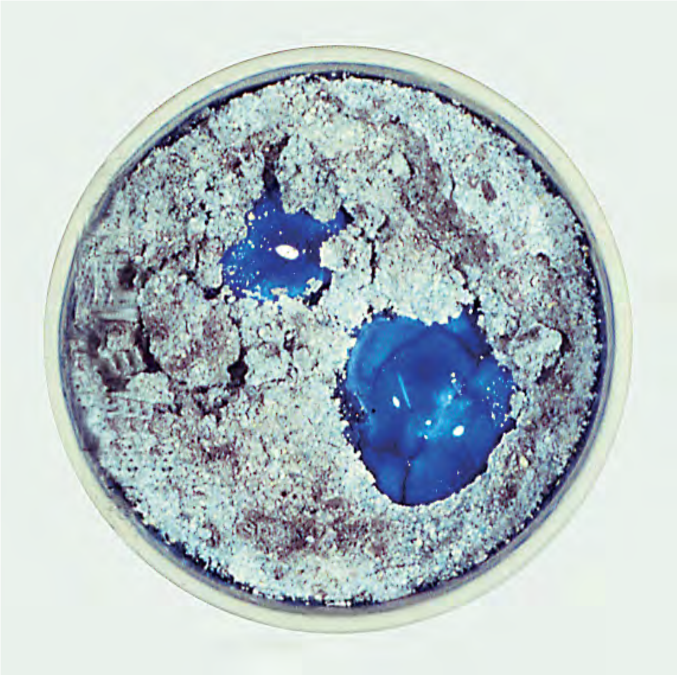

Fig. 9: Opening the vessel after the firing. The blue-enamelled beads are still embedded in the powder.

ing the wooden rod could be taken away and the shape could be carved with a knife. To achieve a black decoration after the firing, the beads may also be painted with a dough of manganese- or iron-oxide (Schlick-Nolte 1999, 18).

For the pre-enamel, 19.5 g of sodium carbonate, 1 g of sodium chloride, 35.5 g of silicon dioxide, and 44 g of calcium carbonate are mixed. To every 100 g of pre-enamel 1-2 g of copper-oxide are given. The dried beads were embedded into the powder in a porcelain vessel, covered with a lid and then fired at 900-1000° C for 240 minutes. After cooling down, now it is the exciting moment: taking the shining, blue beads out of the white-greyish powder (Fig. 9).

Notes

1 Various kinds of plant ash or soda were used.

2 I like to express my thanks to Mr. Kashipaz for showing me through the craftshop and for his detailed explanations on the methods of production, and to Mr. Arab, director of the regional ICHO board at Qom for arranging my visit.

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The traditional Zoroastric village Abyaneh in the Karkas mountains, today protected by measures of the Iranian Cultural Heritage Organization (1999); Photo: G. Weisgerber.

The Pyrotechnological Expedition of 1968

Roya Arab & Thilo Rehren

Introduction

The 1960s saw a major increase in interest in technological issues in archaeology, particularly in metal and ceramic production, the origin of raw materials, and the development and spread of technologies. In this academic climate, Theodore Wertime set out to explore the beginnings of the use of fire in Western Asia and Central Asia with a series of expeditions, culminating in the survey of 1968, covering Afghanistan, Iran and Turkey. These countries were already known for their prominent role in the early development of high-temperature technology, from plaster to ceramic and metals. Wertime wrote in 1968, "Forty years ago a number of European countries were vying to be known as the original home of the blast furnace – today the competition has moved in space to the Middle East and in time to the much earlier beginnings of the smelting of ores and metals." (Wertime 1968, 927). In effect, archaeology was becoming more scientific and down-to-earth, starting to look beyond the palaces and grander people, in an attempt to find out more about the lives of ordinary people and addressing question of early farming, urbanisation and the various technologies that gave rise to civilisations.

Fig. 1: Ancient kiln at Maghiz, 28.08.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

Before the 1968 Expedition

Wertime had already been active in the region for several years, both in his professional capacity as Cultural Attaché at the embassies of the USA in Iran and Greece, and in his very own quest for the birth place of pyrotechnology, as he called it.

In 1961, along with the Iran Ministry of Mines, he had made a metallurgical reconnaissance of archaeological sites in the North, followed by a trip in 1962, together with Cyril Stanley Smith (Wertime, A2)[1]. In 1966, a survey covering 'The Great Persian Desert' was carried out as an adjunct to the excavations by Caldwell at Tal-i Iblis (Smith *et al.* 1967). They did a rapid and wide-ranging survey of old mining and smelting sites in Iran, with the intention of looking for archaeological evidence, traditional lore and pattern of settlement (Smith *et al.* 1967; Wertime A1). A further reconnaissance in 1967 was not attached to any particular excavations, but was coordinated with Lamberg-Karlowsky's field survey of 1967 (Wertime A1). Thus, Wertime had already gained some experience

Fig. 2: Persepolis, 31.08.1968; photo: Beno Rothenberg/IAMS (Tel Aviv/London).

in the region, and visited many archaeological sites. The 1968 survey, however, was going to be the largest and most ambitious of them all.

The Team

Formal planning for this survey began in 1967, when Wertime started to approach various specialists to build his team. Having secured funding from the Smithsonian Institution, he went about inviting a carefully selected group of specialists. In a letter to a colleague he mentions the planned survey and names of seven people he was sounding out for the survey (Wertime 1967, B1). Not all of those mentioned did eventually travel, and other scholars were included in the expedition. The final team then included, in alphabetical order, Robert Brill, interested in ancient glass, glazes and metals, from Corning, New York; Sam Bingham as the team's photographer; Fred Klinger as the geologist; Fred Matson, an archaeologist from Philadelphia, Pennsylvania, specializing in ceramics; Ezat Negahban, an eminent Iranian archaeologist; three archaeo-metallurgists, Radomir Pleiner from Prague, Beno Rothenberg from Tel Aviv, and Ronald Tylecote from Newcastle-upon-Tyne; and finally John Wertime, one of Theodore's sons. Even allowing for a degree of independence, it would seem that with ten specialists travelling there was cause for some interesting dynamics. Not all members felt that their needs were met in terms of choice of sites, "the various expertises of our expedition members were beyond mutual reconciliation", as Wertime himself put it (Wertime 1976, 491). Not all the sites were visited by all the members and some members visited other sites alone; for instance, Beno Rothenberg was not present in Afghanistan, and Radomir Pleiner did not go on to Turkey.

Theodore Wertime was clearly the facilitator and leader in this team. He was a powerful character who achieved most of his goals in life (Wertime 2000). During his time as Cultural Attaché to the US embassies in Iran and Greece in the 1960s and 70s, he had managed to carve out a "parallel career as a serious historian of metallurgy" (Wertime 2000, 35). This he managed probably not just due to his love of ancient technology, but also for his excellent choice of fellow travellers on all his expeditions. He was, it seems, a travelling student choosing those who had lessons to offer he wanted to learn, and whose wisdom he sought to explain the pla-

Fig. 3: Ancient and modern mining at Anarak, 03.09.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

Fig. 4: Slag heaps and furnace remains at Meskani, 03.09.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

ces he, in his capacity as a diplomat, was able to arrange for them to go. According to Rothenberg (pers. comm. 2004), Wertime never took an active part in professional discussions of the team, at the sites as well as whilst travelling; he did, however, take notes during discussions of sites visited. Some years later, Cyril Smith told Beno Rothenberg that whatever Wertime published after the 1968 trip were indeed views voiced by the professionals during their trip (Rothenberg pers. comm. 2004).

Sites and Sampling

The survey began in Afghanistan in August 1968, covering the following sites: Kara Murad Beg, Estalif, Bamian, Farinjal, Panjhir Valley, Sar Kāshān, Mirzaka, Karystu Valley, Askar Kot, Tappeh Mundigak, and Herat. By August 12th , the members had reached Tehrān/Iran, from where they went on to visit Uzbeg Kuh, Deyhook, Tappeh Yahya, Deh-i Sard, Sechah, Tall-i Iblis, Qatru, Kuh-e Sorkh, Istebanat, Persepolis, Sar Cheshmeh, Pasargadae, Hanneshk, Talmessi, Meskani; these site names have been taken from Pleiner's notes (1968, A11). After Meskani further visits were made to Talmessi, before moving on to Sialk and finally Ahaer in Iran. The expedition then moved on to Turkey on September 16th, covering Trabzon, Tirebolu, Ergani-Maden, Geyduk, Kültepe, Çatal Höyük and Acem Höyük (Tylecote 1968, A3). The majority of sites visited were archaeological in nature; however, some represent modern cities, local bazaars, museums and modern production centres. Two published maps exist from the survey, one in the geological report (Domenico *et al.* 1978), and one in a short piece written by Tylecote (1970). With no decision being made as to the name and spelling of the site names, Beno Rothenberg suggested to use consecutive site numbers, at least for the archaeo-metallurgical material.

Despite the clear pyrotechnological aims of the expedition, no coordinated sampling was conducted by the group; as far as we could establish from the participants, several members of the group collected material according to their own briefs and interests. Klinger accumulated a systematic collection of rock and soil samples (Domenico *et al.* 1978); Matson (pers. comm. 2003) collected sherds of archaeological ceramics which are now at the Matson Museum in Philadelphia; and the three archaeo-metallurgists collected slags, ores, furnace remains and other metallurgy-related material. Wertime himself did not take any samples.

The lack of coordination between the members made it difficult to associate the site numbers on the archaeo-metallurgical samples with their proper names when cataloguing the artefacts from the survey, some 35 years later, were it not for the reports collected by Pleiner which could be used in association with Rothenberg's and Tylecote's note books to establish provenance (Arab 2003). This

Fig. 5: Ancient furnace remains at Tamarish, 03.09.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

felt that Wertime as a diplomat should have sorted the problem out (Rothenberg pers. comm. 2004). Wertime though was apparently not interested in finds which only the professional team could handle and publish (for this reason there was no budget for analytical or other work on these samples). Rothenberg finally managed to meet the Turkish minister of mining who gave him an export permit to Tel Aviv (ibid). Tylecote took some samples with him to England, and the rest were left in Rothenberg's store for safe keeping. When Tylecote had asked for funding to work on the samples, Wertime had not been interested. Rothenberg waited for a long time to hear from Wertime, as he had taken lots of photographs and kept a record of the site numbers and the collection, expecting Wertime to want to publish a report together with the team members (ibid). In fact, nothing happened. "We never took any useful decisions regarding publication and Ted said do it if you want to", Tylecote later writes in a letter to Klinger (Tylecote B8).

It seems quite clear that Theodore Wertime, who was the instigator of this expedition, lost interest in the work and was not being supportive enough after the expedition. We may assume that he was aware of this issue, as Wertime says in a letter to some of the expedition members of 1968, when speaking of another project in the region, that "This time we should institutionalise relationships in the area...As a beginner what are the chances Beno would invite some Iranian, Turkish and Greek archaeologists at his digs in Negev or Sinai?" (Wertime 1969, B7). However, no further expedition followed from this one, and its participants went on with their individual lives. Very few publications ever referred to it.

confusion was already felt by members themselves; Tylecote and Pleiner discuss this in personal correspondence after the survey. They discuss their eagerness to start analysis, and the issue of site names, with Tylecote finally suggesting that Wertime should decide what site names to use (Pleiner & Tylecote 1968, B6).

Clearly, the tight schedule did not allow the group to survey the vast lands they travelled in any detail; however, they tried to tap into the knowledge of the local people. Sam Bingham mentions visits to markets, and wherever an audience could be found, for whom there was a display put on of the kind of material the team was interested in, with the curious invited to comment and mention where they had seen any of the materials being displayed (Bingham F4). These approaches were modern for their time and show a real effort to address questions of past technologies, though in this instance there seem to have been too many questions.

After the Expedition

Both Klinger and Matson took their collections to the United States. The archaeo-metallurgical collection first remained in Turkey, due to antiquity laws of the country. The samples should have been recorded on entry to the country to avoid this; Rothenberg

Fig. 6: Slag heap in Isfahan, 04.09.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

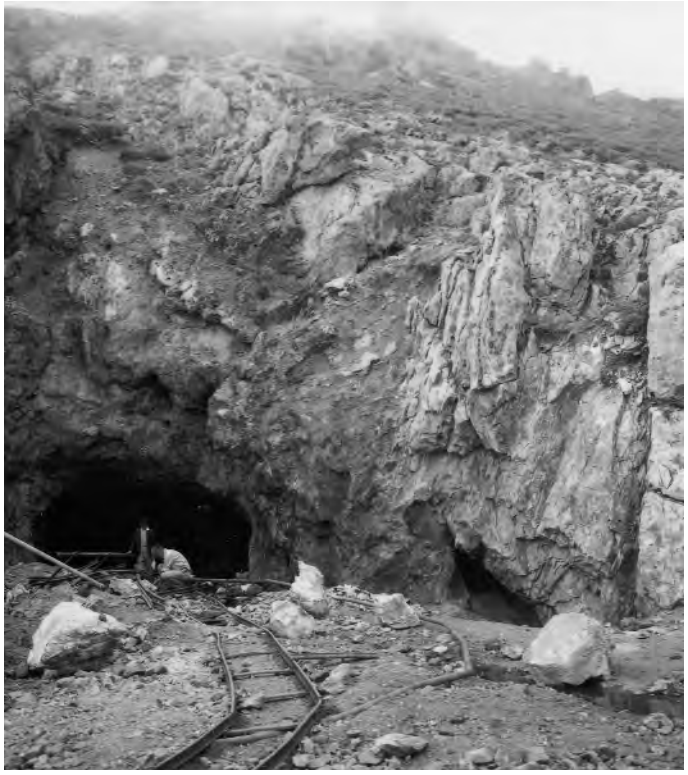

Fig. 7: Old mine entrance in Tabriz-Ahar, 13.09.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

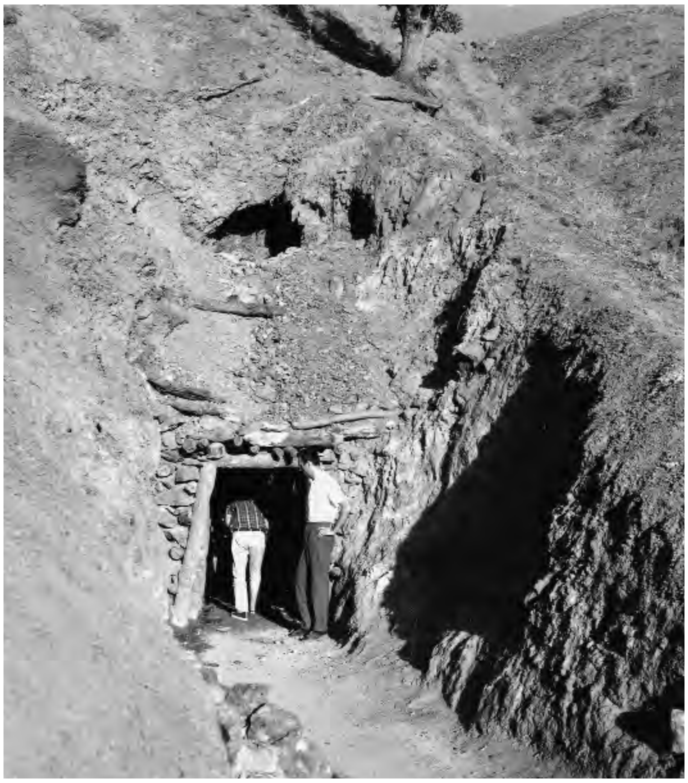

Fig. 8: Mines and waste heaps in Ergani Maden, 21.09.1968; Photo: Beno Rothenberg/IAMS (Tel Aviv/London).

Finally, a chance meeting between Beno Rothenberg and a student in 2002 led to the decision to transfer the archaeo-metallurgical collection to the Institute of Archaeology UCL for future curation and use in teaching and research. The collection is now fully catalogued, documented and archived at the IoA (Arab 2003).

Collection and Documentation

The bulk of the archaeo-metallurgical collection was transferred to the IoA in 2002. It has since been repacked, re-labelled and catalogued, and given a full photographic documentation and an appendix of supporting texts, field notes and field photographs for future research (Arab 2003). The majority of the physical material is ferrous and non-ferrous slags and ores from Iran and Turkey, and technical ceramics such as tuyere, crucible and furnace fragments; remains of a few metallic artefacts are also present. The collection is accessible on request for study and analysis, governed by the IoA's procedures for access to its collections. The related documentation includes copies of:

- Unpublished reports and results of analyses.
- Professor Tylecote's field note book, letters and documents of interest.
- Professor Rothenberg's field note book and photographs from the 1968 survey, and a taped conversation with him in 2002.
- Klinger's geological report of the 1968 survey, and correspondence in 2003.
- Published reports and articles relating to the survey of 1968.
- Correspondence relating to the survey of 1968, with varied people in 2002/2003.

Acknowledgements

Our thanks go first and foremost to Beno Rothenberg for looking after the collection for more than thirty years, and to Radomir Pleiner for his impeccable collection and curation of unpublished reports and his generosity in sharing these with us. Robert Brill, Fred Klinger and Sam Bingham kindly provided information and shared some of their personal memories with us, for which we are very grateful. Paul Craddock of the British Museum is thanked for allowing us to photocopy Ronald Tylecote's original notes. The transferral of the collection to the Institute of Archaeology UCL was generously sponsored by IAMS. The curation of the collection and the research into its history were done in partial fulfilment of the requirements of the degree of BA in Archaeology of the University of London.

Notes

1 The use of letters and numbers in references refers to the appendix containing documentary evidence, attached to the artefactual collection at the IoA (Institute of Archaeology). Where a letter and number, e.g. A1, is added in this article the data has not been published (reports, notebooks, photographs, letters, emails and personal communication), and is archived at the IoA.

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Memories of the Archaeometallurgic Expeditions to Iran and Afghanistan in the Years 1966 and 1968

Radomír Pleiner

It was in Warsaw in the year 1965 when I had the opportunity to meet personally the American gentlemen Theodore A. Wertime and Professor Cyril Stanley Smith, on the occasion of a congress on technology history. At that time they were taking part in organising

Fig. 1: Map of the travelling Route of 1965 in Iran (after Smith et al. 1967, 319 Map 1).

Fig. 2: Travelling at the fringes of the Dash-e Kavir, Nahklak 1965 (Foto Pleiner).

a scientific project: For the first time some of those known sites in Iran were to be visited, surveyed, and documented, that were connected with ore mining, processing, and manufacturing of non-ferrous heavy metals and iron. In those days I was in my thirties, and being an archaeologist at the Prague Archaeological Institute I specialised on the oldest history of Iron. Thus I was invited to join the expedition, being the only European and – what was more – being from a country of the then Eastern Block. Of course this caused some difficulties. At last I received permission to take part in the project and to leave the country. On September, 9th, I was on the plain to Tehrān via Rome, supplied with a seabag. Among others in this seabag there were some primitive thermopairs, to be ready for some melting-experiments. In a hotel in Teheran I met the other members of the expedition: Theodore A. Wertime, Cyril S. Smith, and Dr. Joseph Caldwell who then was in charge of the excavations at Tal-i Iblis. Later also Mr. Vossoughzadeh took part, a geologist from the Ministry of Agriculture. We were provided with two Landrovers plus drivers, and so in the afternoon of September, 11th, started to the South, direction Kāshān (Fig. 1).

At Kāshān, a small town, we spent the night in a small hotel for the first time. Just this was an experience of its own: in the rather empty house we could not fall asleep – the heat was unbearable. But we were told that all the guests had taken their beds onto the flat rooftop. There they were now resting in the fresh air. After having visited the famous Tappeh Sialk the following day, we had our rest in the same way the next night. After this satisfying experience we always used to sleep outside, both on various rooftops and, if in the deserts, on mattresses and camp beds. From Kāshān we went South and then westward along the rim of the Dasht-e Kavir salt-desert (Fig. 2).

These lines do not intend to publish reports on finds or research, they were published as early as in the year 1967. On the contrary, some experiences and episodes shall be brought back to mind which illustrate this first archaeometallurgical journey across the Iranian Plateau.

But I think it is necessary to mention our route and the most important places and sites. In most cases they were mining places, which in those days were still used, and which promised to give important information concerning traditional, medieval, or ancient ways of work: gold mining, lead-processing of silver containing cerussites, metallurgy of copper, the production of zinc oxide (the so called Tutia), and finally, making iron. The route led South to the gold mines of Muteh, then to the East into the areas of Naïn and Anarak (Cu) and of Nakhlak and Jandagh-un Khur (Pb) (Fig. 3). Even farther to the East there was Tabas, and the road turned South again, a. o. to the heaps of lead-slags of Seh Changi, Naiband, Tars, and Chubanan, until we reached the Kerman area. This route went along the Dasht-e Lut salt-desert, it was particularly exhausting. South of Kerman we visited the excavations of the residential mound of Tal-i Iblis, where Prof. Caldwell had been able to prove traces of copper processing from the 7th to the 5th millennium B. C. There we made some experiments with copper ore (malachite) and on the production of lead with the addition of iron ore. For this my thermopairs were used. In the Southern parts we focused on iron and lead mining at Baft. Then we continued our journey in the northward direction to Yazd – an important centre of lead processing. The last part of our journey through Iran took us to the West, including the unforgettable tour of achaemenide centres of Pasargadae and Persepolis. I got the task of excavating a medieval islamic foundry (11th century) in the Hannasqh mountains. The

Fig. 3: Nakhlak mine with mining installations and living buildings in 1965 (Foto Pleiner).

complex was completed by three iron mines. At this time the expedition was divided and I stayed at Hannasqh together with the geologist Mr. Vossoughzadeh. After the excavation had been finished I reached Tehrān again, via Isfahan. At the Iran Bastan Museum I sorted and packed all the samples. There I had the opportunity to study the oldest Iron Age in Iran. The result was a book which was published in 1969. So far some short information concerning our route.

Now I would like to tell about some experiences which of course could not be mentioned in the archaeological publication. As already mentioned, the most mournful part of the journey was in the East, along the Dasht-e Lut desert. The Landrovers drove on a two-lane track in the sand. On our way we overtook a wrecked lorry whose driver was walking to the next police station. We helped him and supplied him with food and melons. Well, by the way, police and melons! In Iran we were constantly checked by the police. But it must be mentioned that the policemen were rather willing to help. At Naiband we even spent the night at the police station. Concerning the melons, we consumed them without a break. They supplied us with liquid, they tasted good and their skin seemed to offer some protection against infection: until we reached a village near Kerman, where we saw on the bazaar that those melons, which had not been sold, were kept damp in dirty water over the night to make them look fresh the next day. Fortunately we always took our medicine, so nothing happened. Since those days, for almost forty years, I have not been able to look at a melon again. Travelling through the desert we reached the small town of Tabas on September, 8th, a flourishing oasis which was visited by Marco Polo as early as in the 13th century. This time our place of refuge was the porch of the governor's palace, which is located at the end of a beautiful Persian garden, watered by long streams of water. There, there also lived a pelican which had been ended up at this place by a storm. Tired and sweaty we lay outside on our mattresses. Good grief! Nights on the Iranian Plateau may as well be cold. The next morning I suffered from lumbago and could not get up. Though I was able to lie down, to stand up, or to walk slowly, I was not able to sit up. Thus dear old Professor Cyril Smith fed me all the day long in a lying position. At Tabas we enjoyed a two days rest. But for me it was a problem to go on. It was not easy to sit up but I was given a privileged position in the front, next to the driver. But still driving on the track was terrible. Despite this I took part in surveying and documenting. At Naiband I sat on a heap of lead-slags in the heat and was drawing. Suddenly somebody called my name, forgetting about my pain I ran down the slope – and was all right again. All right during the journey, but after a rainy and foggy october in Prague I had another half a year trouble with the lumbago.

All in all we went more than 3000 km. The overnight stays were different: in the desert, at caravanserais, in mining plants, on porches and rooftops (Fig. 4). The food consisted of tins – besides

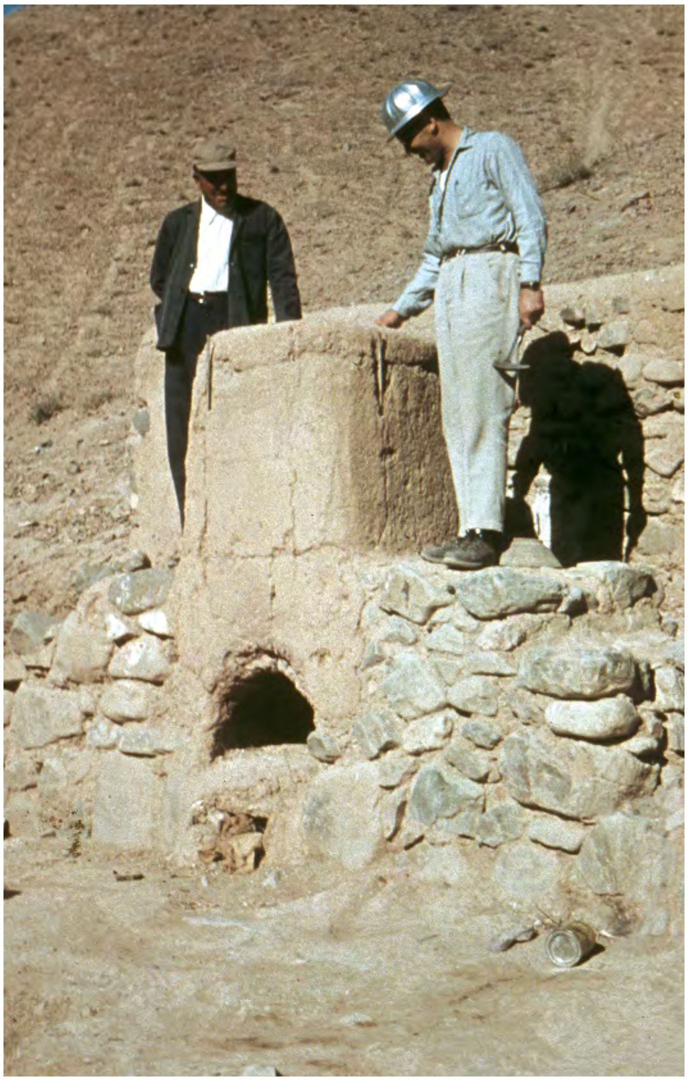

Fig. 4: Nakhlak 1965; discussing the traditional lead smelting furnaces with local workers (Foto Pleiner).

the melons. In villages, several times we were invited to a meal of roasted sheep, cucumbers, and tea. Even on the country there was electricity, produced by mobile petroleum-generators. During day-time we drank juice, in the evenings there was a glass of Bourbon each, for relaxing. That was good but a bit too warm.

Due to Professor Caldwell´s care the scientific results were published as early as in the year 1967 and they contributed to the understanding of traditional mining and processing. Work was continued during the second expedition in 1968 and thus many things were completed.

As already mentioned, the second expedition was in 1968. Again I was invited but no longer I was the only European. Besides some young American researchers (Mr. Madson, pottery, Dr. Brill, glass) also Professor Ronnie Tylecote (England) and Dr. Beno Rothenberg (Tel Aviv, London) were members of the group. I remember this expedition to have been adventurous. Unfortunately today I have not got any information concerning our route and our finds. Everything was sent to Washington, and what was left was destroyed in my laboratory on the ground-floor of the institute by the flood of the year 2002 (the water reached the ceiling).

This time the program included Afghanistan, in those days still under royal government, a poor but not a starving country where the Americans ran several institutions. The ethnologic examinations were on pottery, *e.g.* a workshop near Kabul, and on producing glass (Herat). The archaeometallurgical surveys were to be done at *e.g.* the gigantic medieval heaps of slag at Askar Kot and also at the residential mound of Tappeh Mundigak, where prehistoric traces of copper processing were found. A striking experience was to see Bamian with the then still undamaged clay-figures of Buddha leaning against the rock. Another experience was a terrible bus-disaster on the Pandshir – there we paid a visit to the old gold placer. Or gunfights far away in the mountains, while we were going on the road which had been built by Americans and Russians. After having passed Herat we crossed the border to Iran. By way of diplomatic help we succeeded in escaping the terrible vaccination-procedure against cholera and typhoid.

Our route in Iran was similar to that in the year 1966. From the town of Mashdad we went South and thus escaped the gigantic earthquake which caused 42,000 deaths one day later. Schah Reza Pahlevi visited the ruins by helicopter but then only bulldozers were necessary. For me the further course of the journey was mournful. In Mashdad we heard on the radio that Czechoslovakia was being occupied by Soviet and other troops of the Warsaw Treaty states. At that time my wife was doing a big archaeological excavation in North-west Bohemia (Brezno site) and was having our little daughter with her, and I did not know what had happened to them.

This insecurity haunted me for four weeks. The entire expedition felt with me and especially Beno Rothenberg encouraged me. Finally I was sent by bus from Isfahan to Tehran, where we were supposed to stay at the British School. And there the incredible happened: I was told that my family – though the excavation took place in the midst of a military camp – was all right, including the dog, that was barking at the soldiers. And this is the way this message reached me: There was a network of well-organised radio-amateurs and one of these good people radioed the message. It was recorded in Uppsala, Sweden, and then officially transmitted by telegraph to Tehrān. The message even included the advice to carry on my journey. I was supposed to go from Tehran to a conference near Phoenix, Arizona, via Tel Aviv and London. This was done successfully but that is another story. In the end everything turned out well.

These two expeditions brought some information concerning old technologies and methods of processing raw materials – there is no doubt about that. At this place I like to honour the late Theodore Wertime, Cyril Stanley Smith, and Ronald Frank Tylecote, all of whom were laid to rest a long time ago. Beno Rothenberg is still alive and the last time we met at the congress in Milan (2003) and chatted happily about the old days. Participation in this project is something which I regard as a part of the history of my life.

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