

Reconnaissance Survey of Ancient Mining and Metallurgy in the Mersa Alam Region Eastern Desert of Egypt

Introduction

1. Following the International Conference on Archaeo-metallurgy held in Cairo in April 1995, initiated and co-sponsored by IAMS London, the first steps were taken to set up an Egyptian Centre of Archaeo-metallurgy. It was decided to centre this organisation around a major, long-term archaeo-metallurgical field research project, which will also become a 'training ground' for students in field research methodology and the scientific processing and conservation of metal-related archaeological finds. For this purpose, the Egyptian authorities, represented by the Supreme Council of Antiquities (SCA) Egypt and the Egyptian Geological Survey and Mining Authority (EGSMA), in collaboration with the Tabbin Institute for Metallurgical Studies Helwan, (Tabbin), the Institute of Archaeology (IA), University College London, the Institute for Archaeo-Metallurgical Studies (IAMS), University College London and The Royal School of Mines (RSM), Imperial College of Science, Technology and Medicine, London, formed an international working group consisting of Professor C. Tim Shaw (RSM), Professor Beno Rothenberg (IAMS), Professor Fekri A. Hassan (IA), Dr Abdel Aziz A. Hussein (EGSMA), Professor Dr Sayid Khalil (Tabbin), Dr Kamal Barakat (SCA), Professor Dr Kamal Hussein (Tabbin), Dr Mohammed el Huwari (EGSMA), Mr Attiya Makhoulf (EGSMA).



Fig. 1. The iron and copper smelting site at Hamash.

In March 1996 the working group made a reconnaissance survey in the Mersa Alam region of the Eastern Desert (Fig. 1) with the objective of identifying archaeological sites in this region with evident potential for systematic archaeo-metallurgical field research and associated interdisciplinary scientific studies. Although copper mining and smelting sites, with interrelated mine workings and smelting installations, workshops and metallurgical debris, workers' camps and archaeological artefacts, were obviously considered the most likely candidates for such a long-range interdisciplinary

archaeo-metallurgical undertaking, the study group decided to inspect several major sites where mining of copper, gold, tin and emeralds had been previously identified.

The reconnaissance party travelled on the first day from Mersa Alam to the Wadi Mueilha to visit a tin mining region with strong indications of ancient workings. From there the party continued to the Hamash area to investigate reported copper workings. On the next day the party visited the emerald mines in the Wadi Sikeit and on the following day inspected the large scale Bakari gold workings. On the road from Mersa Alam to Idfu the party inspected the Kanayis Temple and its surrounding.

2. The ancient Egyptians are known to have exploited a variety of mineral resources since prehistoric times. Copper and gold in particular were already used during Predynastic times, before 4000 BC, and were in wide use since the Old Kingdom. Gold mines, dating to the Predynastic and the Pharaonic periods and up to medieval times, have been located in a variety of areas of the Eastern Desert. Since the early years of this century and especially since the 80s, a fair number of geological reports have been written by the Egyptian Geological Survey and others about gold deposits and mining in the Eastern Desert (e.g. Jenkins 1925; Kochin and Bassiuni 1986; Gabra 1986)¹ but only in recent years was systematic field research of ancient gold extraction in the Eastern Desert undertaken as a collaborate project of the Geological and Egyptological Institutes of Munich University and the Egyptian Geological Survey and Mining Authorities (EGSMA), with due emphasis on the geological, mining technological and – of particular significance – archaeological aspects. During the years 1989-93, about 150 ancient gold mines were identified (Klemm 1995; 1994; also recently Cairo Conference reports 1995; Hawary; Takia and Hussein; Osman; Tawab; Klemm).

However, many very early, Predynastic gold mining sites showed quite extensive copper mineralisation – believed to have been the means of identifying the associate gold by the earliest miners (Klemm 1994:194) – which therefore represent for the archaeo-metallurgists a so far unsolved 'enigma': What was actually mined at these sites in Predynastic times – gold or copper or both? What were the mining techniques of these copper-gold mines and what is their chronology and culture-historical context? Recent excavations at such a site, Wadi Dara in the northern part of the Eastern Desert (Tawab et al. 1990), showed that copper was the mineral mined and smelted at this site in Predynastic times and that gold was only mined in Early Islamic times (9th century AD). Yet, although this may be correct at Dara, according to the evidence available so far, this is certainly not the whole story of gold – and copper – in the Eastern Desert and will need much further detailed investigations.

Extensive copper mineralisation in several regions of the Sinai peninsula, with about 100,000 tons of Middle to New Kingdom smelting slag of a very advanced metallurgical

character alone in one huge slag heap at Bir Nasib, was a major source of copper of Pharaonic Egypt (Rothenberg 1979, 1987). In the Timna Valley (Wadi Meneiyeh) of the southern Arabah, on the eastern fringe of Sinai, operated large-scale Pharaonic, New Kingdom (19th-20th Dynasties) copper industries (Rothenberg 1990; 1988; 1972; Conrad and Rothenberg 1980) with sophisticated mining and smelting technologies as well as a highly organised industrial organisation. These provided convincing evidence for the exceptionally high standard of development of ancient Egyptian extractive metallurgy. Although there was also earlier, evidently indigenous, pre- and early-dynastic (Late Pottery Neolithic to the end of the Early Bronze Age (Rothenberg and Merkel 1995; Rothenberg and Shaw 1990) copper smelting in Sinai and in the Timna Valley – and presumably also in the Eastern Desert – the ultimate origin of the Egyptian New Kingdom (Late Bronze Age-Early Iron Age) peak of extractive metallurgy has not yet been traced; indeed, it is one of the unresolved riddles of early metal-related history.

Again, during the 22nd Dynasty, probably during the campaign by Pharaoh Sheshonk I in post-Solomonic Palestine (c.920 BC), the Egyptian copper industry at Timna was revived for a short period of time. The copper smelting technique of this time, using a still more advanced furnace and tuyere type, unique slag tapping arrangements, with the sole use of manganese as (a much more efficient) flux, produced the most advanced tapped slag (containing almost no metallic copper) found so far anywhere (except also in the New Kingdom smelters of Sinai) before modern times (Rothenberg 1990: 44-57). The metallic copper produced here was of extraordinary quality and contained no iron and very little other impurities – quite exceptional for this period. A very similar smelting technology was again found at the later copper smelting sites of Edomite (Jordan, 8th to 6th centuries BC), Feinan, south-east of the Dead Sea (Bachmann and Hauptmann 1984), and seems to have reached this region from Sinai, perhaps by way of Egyptian 22nd Dynasty Timna. But where was this advanced Pharaonic metallurgy developed? It is also for this reason that it is so vital for the history of metallurgy to search for these steps in the development of Egyptian extractive metallurgy 'closer at home', i.e. in the mines of the Eastern Desert.

3. Tin, that vital ingredient of proper bronze, had never been found in the Near East but the presence of cassiterite deposits in the area of Wadi Mueilha in the Eastern Desert (noted following a visit to the area in 1976 by Wertime, Muhly and Rapp) was unfortunately not followed up by mining experts and has only recently been brought to the attention of archaeo-metallurgists (Rothe 1995). The cassiterite deposits were mined during the first half of this century, which most probably destroyed most of the evidence of any ancient mining. In any case, if the ancients ever worked the tin deposits of Wadi Mueilha, it is most likely that they would have picked their ore from the wadi alluvium, instead of working the difficult granite, and this 'mining' would have left very few traces. The tin mining region was included in the survey by our group in order to establish its potential for future mining research. It should, however, be noted that a great deal of archaeo-metallurgical work has already been done in the area by a team from Minnesota University, directed by Professor R. Rapp (Rothe 1995; Rothe and Rapp 1995), including field surveys and analytical and experimental studies, and the study of the numerous hieroglyphic inscriptions of the region and beyond.

Mueilha

Travelling along the Wadi Mueilha, we turned into an unnamed tributary of that wadi where tin mineralisation had

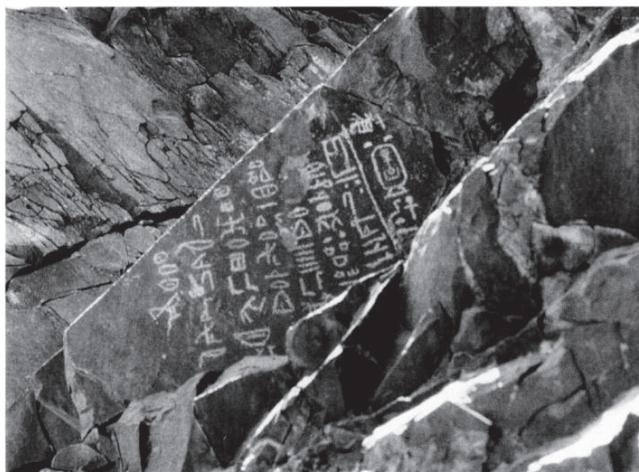


Fig. 2. Sixth Dynasty hieroglyphic inscription with the cartouche of Pepi II Neferkare (2278-2184 BC) near the ancient mining area of Mueilha.

been exploited up to recent times. About one km from the wadi junction we came first to some Bedouin petroglyphs of camels and, more important, *wasm* (traditional Bedouin symbols) indicating that water could be dug there. A little further on the same outcrop of dolerite we found to a group of hieroglyphic inscriptions (recently published in a PhD thesis by R. D. Rothe, Minnesota, 1995). These inscriptions are dated to the Old Kingdom, especially to Pharaoh Neferkare Pepi II (2278-2184 BC, Sixth Dynasty), and imply that during his reign water wells were dug in this wadi (Fig. 2). The inscriptions mention several high ranking functionaries, like the 'King's Noble, overseer of the foreign gang', the 'Sealbearer', the 'Chamberlain and overseer of the scribes of the crew' and several inscriptions mentioning a 'Ship Captain'. These inscriptions clearly indicate the presence nearby of a large working force, for which water was naturally a basic requirement. Water may also have been a basic requirement for the gold extraction process. These Old Kingdom inscriptions fit very well the assumption of large scale mining operations – the tin mines of Mueilha – as early as Old Kingdom times. The actual mining area is located about three km north of the inscriptions. Obviously the ancient miners would have exploited the placer deposits in the area. The tin weathering from the quartz veins in the area produces coarse cassiterite grains while the granites produce fine grained cassiterite. We assume that these were mined in antiquity, but since it was alluvial it was not possible during our short visit to identify any old mine workings.

Upon returning from the tin mining area down the Wadi Mueilha, about 2-3 km from the wadi junction, in a small side arm of the wadi, a group of ring-shaped, stone-built tombs, with standing slabs surrounding the base, were identified. There were at least seven tombs, approximately 4m in diameter, 80cm high, with walls ranging in thickness from a metre to 60cm. Our preliminary observations suggest that these are Predynastic tombs and require further archaeological investigation.

About 4 to 5km from the wadi junction leading to the Mueilha mine, we encountered an archaeological site referred to by the local Bedouins as the 'Roman City'. This is a large area of rectangular stone-built houses or workshops, now in a state of disrepair. There were a lot of Roman potsherds, but some sherds seemed to be as early as Pharaonic. One of the buildings was on top of a small knoll and was probably a lookout or defensive building of some kind. At some distance from the main group of Roman buildings, along the foot of an adjacent hill, were some rougher stone structures which appeared to be earlier than the Roman buildings. We also found many grinding stones, some obviously *in situ*, so either they were grinding some ore, or they were making grinding stones for use elsewhere. There are no known mines of any sort in the immediate vicinity.

Hamash

Hamash is mainly known as an ancient gold mine and is recorded as such on the latest official map 1:50,000, Bir Umm Qubur sheet (see also Klemm 1994: 221), but copper mining has also been mentioned (Rothe 1995: 174-6). In the Hamash area are several locations with ancient mine workings and building remains (Area W, Area E, Um Hagalik, Um Tundub).² We visited Hamash-West, the site with the largest known complex of ancient buildings. These building remains are situated along the foot of a hill where mine workings are located.

At the north end of the site are several simple stone enclosures, probably remains of workers' huts. Further south stands a group of rectangular, uniform buildings, similar to Early Islamic army stations in the South Arabah and Sinai. Right next to these buildings, a large, multi-room structure showed several phases of construction (or re-construction), some even relatively recent. In what appeared to be a forecourt of this building, heavily burnt, ashy 'installations' indicated metallurgical activities. Similar 'ash heaps' are also to be found in the other sections of the site, perhaps from roasting of ores.

Dispersed among the buildings were pieces of broken slag 'cakes' as well as lumps of rough, viscous furnace slag and many slagged stone furnace fragments. Obviously, smelting had taken place all over the site. A heap of several tons³ of particularly dense and homogeneous tapped slag was located right next to the large multi-room building, indicating that major smelting activities must have taken place there.

As much as could be established by visual inspection of the metallurgical debris, there seemed to be evidence for various extractive processes having taken place at Hamash, perhaps also at different times. Much of the slag was very dense, dark black and very homogenous, and showed no metallic inclusions; other pieces of tapped slag showed corroded copper prills on their surface. Furthermore, some of the slag was rough and viscous, obviously not tapped, and seemed to have been raked out of the furnace at the end of the smelt. However, most of the slag was tapped slag, showing on the surface the typical ripples of such a slag, and had obviously been tapped into a pre-prepared roundish tapping pit. The diameter of such a complete slag 'cake' was 40-50cm. and its maximum thickness 4 to 5cm. The smelting furnace fragments, found together with this slag but also at other sections of the site, indicated a furnace diameter of about 35-40cm.

No clay tuyeres of any kind were found at the site, a fact of considerable significance taken in consideration that at all Pharaonic smelting sites in the Arabah and the Sinai, numerous clay tuyeres were found – but none in the smelters of the Roman, the Early Islamic and later periods (Rothenberg 1990). We assume that during these later periods the bellows tube was made of iron. The same applies to stone working tools. No such tools were found at Hamash-West – the same as at the Roman-Early Islamic smelting sites in the Southern Arabah and Sinai (Rothenberg 1972: 212-23; see corrected date Rothenberg 1988).

Some plain pottery was collected on the site, seemingly later than Roman.⁴ However, we shall have to rely on C14

dating of charcoal entrapped in the slag, before we cannot say anything definitive about the chronology of the slag and the extractive operations of Hamash. However, tentatively, we suggest an Early Islamic and or later date for the Hamash-West smelting operations.

It was quite unexpected that the analysis of the slag established that at Hamash-West iron as well as copper was produced. Several slag samples from the slag heaps of Hamash have been analysed by the Tabbin Institute for Metallurgical Studies, Cairo, and were found to be iron smelting slag. Since this is the first time that ancient iron slag has been identified in the Eastern Desert, we publish these results in Table 1, below. The slag was of the fayalite-rich olivine type with a spinel phase, sometimes also with small amounts of pyroxene.

The fact that no stone tools of any kind were found at Hamash-West – neither at the site of the buildings or the smelting operation, nor at the mine on top of the adjacent hill – seems to indicate that no gold was extracted at this site in ancient times, though traces of gold may be present in the mine workings on top of the hill. Gold may have been extracted here in modern times.⁵ Copper minerals were identified both at the smelting site and within the mine up on the hill, though the main mineralisation at this mine was, according to Abdel Aziz Hussein (EGSMA), arsenopyrite and haematite. There are, however, several copper-rich mines in the vicinity and these would have provided the ore for the copper smelter. The haematite of the mine above would of course provide the ore for the iron smelter.

On top of the hill there were a number of possible 'plates' (the surface evidence of filled ancient mine shafts) associated with some very old looking spoil heaps. There was also access to the ancient mines, but as these had been made by modern prospecting and had been left in an unsafe state, we did not go far into these workings. Furthermore, whatever traces and tool marks the original miners had left had been destroyed. We searched for mining tools but failed to find any. We are therefore unable to say anything other than that this is apparently an ancient mining site but further research on the mining activities in the area is required before any opinion as to technology and date could be developed.

Sikeit Emerald Mines

Up the Wadi Nugrus, a tributary of Wadi Gimal, is the Wadi Sikeit, where emerald mines are located. We visited one of the several 'mining towns' of the area, which is located where the wadi widens out to form a large, oval-shaped valley. At its southern entrance, the mining temple of Sikeit is located (Fig. 3), whilst all around the valley stand the ruins of a huge complex of workers' habitations and other very large buildings, with buildings also climbing the steep slopes of the enclosing hills. The mining temple was cut into the rock face and had numerous inscriptions in Greek on it. The whole temple was carved, like Abu Simbel, into the rock but, unlike the latter, this one is falling apart. There is another small rock-carved shrine on the hill above and to the right of the main temple.

The site was littered with large quantities of Roman, perhaps also Ptolemaic, pottery and the number of amphora fragments was astonishing considering the location of the

Table 1 (%):

	SiO ₂	Cu	CaO	MnO	Al ₂ O ₃	Pb	Zn	K ₂ O	Na ₂ O	FeO	Ni	Cr	TiO ₂	V	S
1/1	32.0	0.011	4.7	0.70	4.5	0.03	0.01	0.60	0.30	50.9	0.03	0.02	0.21	0.03	1.17
1/2	30.9	0.013	7.2	0.50	4.5	0.01	0.01	0.90	0.43	53.9	0.02	0.02	0.18	0.05	0.63
1/3	27.9	0.010	4.7	1.10	3.3	0.03	0.01	0.63	0.30	59.3	0.015	0.02	0.15	0.02	-
1/4	32.2	0.012	8.1	0.83	5.1	0.04	0.01	0.82	0.40	47.1	-	0.01	0.18	0.03	9.29
1/5	36.2	0.011	5.2	0.98	2.7	0.01	0.01	0.74	0.35	50.3	0.01	0.01	0.04	0.01	1.19



Fig. 3. The partly rock-cut temple at the Sikeit emerald mines.

site. Nevertheless, the complete range of the date of the activities at the site will have to await the proper study of the site and its pottery.

Further up the wadi lie the mines. There is an old workers' path, dry stone built, all the way up to the mines, but at one point a later mining dump lies right across it. Up the mountain, near the top, was another workers' village. There are old open pit mines and enterable underground ones. The tool marks seemed to indicate relatively late, Roman or even Early Islamic mining activities. The surface pottery at the mines is consistent with the age indicated by the mining technology. However, some pottery recovered from a stratified section of tailings near the mines requires further investigation to establish if emerald workings go back earlier than the Roman period. No mining tools were found.

There were mine openings and mine dumps everywhere. The ore bodies themselves are randomly distributed along a contact and so the mines are rather random affairs, with no real planning of the operations. Most of the underground mines were also filled up with detritus of the ages and could not be investigated.

Bakari

The Bakari gold mine is an extensive composite archaeological site⁶ with at least four main components consisting of a Predynastic and Old Kingdom mining and workshop area at its north-eastern corner, a large New Kingdom settlement to the south of it, and a very complex and widespread Ptolemaic and Early Islamic mining, workshop and habitation area in its southern part. There are also other New Kingdom habitations in the western area of the site, and apparently also Predynastic remains.

Our preliminary survey of the Bakari mining workshops and settlements produced a sequence of different types of stone tools (Fig. 4) used in the gold extraction process,⁷ clearly reflecting the development of the extraction technology of gold throughout history. This complete sequence

Fig. 4. Grooved hammer stones from the Predynastic gold mine at Bakari.



makes Bakari a unique site for the history of gold mining world-wide.

At the northern end of the site, there was a group of primitive, semi-detached, round, stone fences, seemingly of the Old Kingdom (Site 1), with numerous small stone hammers and stone anvils dispersed inside the structures, many of which were still in situ. According to the shallow dent marks, these were simple crushing tools, used as locally found, others showed striation marks and were obviously used as grinding tools.

On the hill to the west, at a mining site (Site 2), we found grooved hammer stones, none of which were found in any of the working camps of any period. On the slope below the mine (Site 2) we found a workshop for the preparation of such grooved hammers from dolerite pebbles of various sizes, brought here from somewhere in the vicinity. These grooved hammers represent the earliest ore mining tools anywhere in the world and have been found at fifth and fourth millennium BC mines in Timna (Arabah), at Rudna Glava (Yugoslavia), in the ancient 'copper belt' of south-west Spain, at Mt Gabriel in Ireland, in fact everywhere where mining at a prehistoric, Late Neolithic-Chalcolithic, technical horizon has been identified. There is a very strong likelihood that these grooved hammers identify Bakari as an early Predynastic mining site.

The mine on top of the hill was found more or less undisturbed. It could be entered and a few hammer pock marks could be identified as the typical mining tool marks. Next to it there was another open mine, but this was a vertical opening with smooth sides and very deep, and it was decided not to enter it without climbing equipment. The find of the grooved hammers next to mine workings certainly makes this site important for further investigation into early mining methods.

Further south, a large group of New Kingdom architectural remains were located (Site 3). The New Kingdom architecture as found here, represents a very flimsy building of irregular stone fences, which seems rather unusual for New Kingdom working camps in view of the rather well-built Egyptian miners camps in Sinai and in Timna (Petrie 1906; Rothenberg 1972). It therefore seems most likely, that the structures found by us are what was left after the Ptolemaic and/or Early Islamic miners dismantled the New Kingdom buildings and removed the stones for the building of their own settlements further to the south.

In the New Kingdom workshops there were essentially four types of stone tools, the functional interrelation of which is a matter for further detailed research. The size of the stone tools were from 30 to 100cm and there was a very large number of tools spread right through all the New Kingdom buildings. One tool type is a squarish, unworked rock with a flat anvil-type upper surface, which shows shallow cup marks from rough mineral crushing activities. The second tool type is an oblong rock which shows a long groove and striation traces created by a grinding tool moving up and down. The third tool type, which clearly represents the final stage of the gold extraction, shows evidence for a concentric movement, grinding the ore to fines. This type of tool has a large cup mark in the centre showing striation of concentric working around it. The fourth type of New Kingdom tool was a crescent-shaped, heavy, trough-like stone grinder of large size (up to one metre long), which was found together with a unique, heavy, grinding or rubbing tool with outcropping 'handles' for moving it back and forth along the lower trough-like part of this grinding installation. Some of the New Kingdom (and also Ptolemaic/Early Islamic – see below) tools showed two or more of the above types of working, often on top of each other, indicating a change of function or secondary use of a tool which had become

unserviceable for its original purpose, or was taken from an earlier workshop.

On the hill above this site there are a number of mine openings. They were not enterable having been largely filled with sand over time. It was not possible to identify the mining techniques used in these mines and further clearing and investigation will be needed to establish the methods used.

Further south, there was a large complex of a Ptolemaic and Early Islamic mining settlement (Site 4). Here one can distinguish between multi-room habitations, solid, monumental stone buildings and low, fence-like workshop structures. One of the typical workshops within a low fence was 10 x 7 metres and contained in situ ten rotary mills of granitic rock, their diameter about 50cm. This is a typical tool for finishing the crushing and grinding process, as it will result in very finely ground mineral. In the Ptolemaic-Early Islamic workshops were also other types of crushing and grinding tools the function of which, and their interrelations, will be a very interesting subject for detailed study related to the reconstruction of the extraction technique of these periods of major mining activities at Bakari.

We also identified water-laid fine-grained tailings below a stone-built platform suggesting that water was used for separating the gold from the fines produced at the workshops.

It is interesting to notice that within the habitation areas, a number of small granitic 'saddle-backed' querns were found, used perhaps for grinding grain and not for ore dressing. However, in the courtyards of the big buildings were also crushing tools and it was quite obvious that a large number of people had been constantly working on this part of the extractive process.

Once again the mines were up the hill above the working and habitation area, but here most of the openings had been disturbed by recent (British) prospecting. However, there is part of an old open pit left up on top of the hill worth further investigation. There were also sites at the top of the hill to which ore had been taken for preliminary crushing. The reason why this ore was taken there for crushing requires further study.

A mining component in the western part of the site (Site 5) consists of several New Kingdom houses and, at some distance from them, a mining area of quartz veins and a crushing site, as well as an elaborate water collecting system. There are also rock mortars developed in the bedrock. Grooved hammers were found at this site, as was an extremely weathered quern. Klemm reported from here the rock drawing of a ship (Klemm 1994: Abb.11).

According to our observations, the progress from a primitive stone hammer and anvil to really sophisticated specialised stone tools designed for each stage of the gold extraction process can be followed at Bakari. This makes Bakari unique and therefore most important for the study of the history of gold mining in Egypt from earliest times to the Early Islamic Period.

Kanayis Temple

A temple on the Mersa Alam-Idfu road known as the Kanayis (Churches) Temple was visited on the return trip to Luxor. The temple was excavated in part in the rock with an outside built facade. Rock carvings, mostly ships, were identified on the cliff face above the temple. It is suspected that the temple, which may have been a mining temple, was built next to a Pre-historic rock shelter.

Discussion and Conclusions

1. Although important field surveys have recently been undertaken by the Munich University (R. and D.D. Klemm) and Minnesota University (R. Rapp and R.D. Rothe), in collaboration with EGSM, their main objective was the identification and surface investigation of gold and tin mining

sites in the Eastern Desert. Copper mining and smelting sites in the Eastern Desert have not yet been systematically investigated, in fact no survey concerned especially with ancient copper has yet been undertaken.

So far we know only about some small scale, Predynastic copper mining sites because of their coincidence with gold mining, but even these sites have not been excavated and their archaeological stratigraphy, i.e. culture-historical chronology, is so far unclear. The only exception are the sites of G. Mongul-South and Wadi Dara in the northern Eastern Desert the excavation of which produced evidence for Predynastic copper smelting as the earliest metal extraction at these sites, with gold mining only in the Early Islamic (9th century AD) period (Tawab et al. 1990). Although a number of copper deposits and copper mining sites have been identified in the south as well as in the north of the Eastern Desert – like Hamash – these sites still await systematical archaeo-metallurgical study. So far not a single Pharaonic copper production site has been identified in the Eastern Desert and it seems imperative for Egypt's metal-history, and archaeo-metallurgy in general, to give priority to a proper survey of copper mining and smelting as the first part of a major archaeo-metallurgical research project in the Eastern Desert

However, it should be remembered that surface surveys, even if done very meticulously, will only provide tentative results, pending proper archaeological excavations (see note 7). We would like to point out in this connection the systematic survey of the copper mining region of the Southern Arabah (Rothenberg 1962), the results of which had to be fundamentally changed after a series of systematic archaeological excavations in the copper mines and smelting camps (Rothenberg 1972; 1988: 1-18; 1993: 1475-86; Conrad and Rothenberg ed. 1980; Rothenberg and Shaw 1990). It was only due to proper archaeological excavations of sites found during the initial surface survey that the chronology and culture-historical context of the Arabah sites could be established – identifying in the Timna (Wadi Meneiyeh) Valley the largest Egyptian New Kingdom copper industries known to date – and only by meticulous scientific follow up of the excavations could the complete picture of the origin and development of copper metallurgy throughout the ages be worked out (Rothenberg 1990; Rothenberg and Merkel 1995).

2. In the light of these consideration we shall shortly discuss the four key sites visited during our reconnaissance survey.

Mueilha: The source of tin has been for long one of the fundamental problems of the ancient Near East and the tin mine at Mueilha is for that reason a very significant discovery. Mueilha is the core of an ongoing field and laboratory research project in the Eastern Desert by R. Rapp and R. D. Rothe, Minnesota University. We tend to agree with Rothe (1995: 171-4) that modern mining operations have most probably destroyed whatever traces of ancient mining had been preserved at Mueilha, especially as the ancients probably simply collected the tin nuggets from the natural placering in the wadis, which would have left very little recognisable traces.

From the find of metallic tin droplets in the small casting workshop of the New Kingdom mining temple at Timna (Rothenberg 1988: 202; Craddock 1988: 180, Table 4) we learned that metallic tin was indeed carried by the Egyptians to their workshops and it would be most interesting to prove that this tin originated from the Mueilha mine.⁸ Perhaps this approach could be widened out to a search for tin in Egyptian excavations and museums, and their systematic analytical study.

Hamash: According to the prospectus of our survey and other sources,⁹ there are several copper mines in the Hamash region, seemingly also of different times. We would recommend a special visit to the Hamash area to properly survey all its ancient sites, since the Hamash region could be a good place for systematic excavations which would also take care of the (perhaps first) appearance of iron smelting in the Eastern Desert. However, we would strongly recommend a season of archaeological surveying in other parts of the Eastern Desert, where other sites are known as copper mining and smelting sites, such as Semiuki, in the south, or Abu Seyal in Wadi Allaki, before the final decision is made where to start a long-range archaeo-metallurgical research project. There are of course also other considerations, like logistics and communication, to be taken in account.

Bakari: The survey of Bakari has shown this site to provide a unique opportunity for a systematic archaeological and mining-historical study of gold extraction technology from Predynastic times to Early Islam with the exception of the Roman-Byzantine period.¹⁰ Since all aspects of gold extraction are reasonably well-preserved, including the mines, installations for the separation of the gold with the help of water, the whole range of working tools and the architecture of workshops and habitations, there is no doubt that the systematic excavation of Bakari would be of great importance for mining history.

Sikeit: From the archaeo-metallurgical point of view, the emerald mines – though highly interesting also because of the huge size of this operation and the fine state of preservation of its buildings – are not considered a priority for archaeo-metallurgy.

To sum up: There are unique research potentials for archaeo-metallurgy and culture-history in the Eastern Desert and we would suggest priority be given to a copper region, Hamash or another suitable site, and also excavate the site of Bakari. These sites, properly excavated and partly reconstructed, could also serve as a unique 'Mining Park', a rare attraction for 'alternative tourism'.

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Notes

¹ Quoted from Klemm 1994:189

² According to the guide prepared for our survey by EGSMA.

³ Without excavation it was not possible to establish the quantity of slag at the site and the quantity mentioned is only a rough approximation. However, compared with the large slag heaps seen in Sinai, the slag heap of Hamash indicates a relatively medium scale operation.

⁴ Rothe (1995: 174) reported having found Roman pottery at Hamash. The sherds we found at the site seemed much later but will have to be re-investigated in the light of Rothe's identification. This issue is of some importance because Rothe builds his identification of the architecture and the chronology and the kind of metal extracted at different times at Hamash, on the Roman date of the pottery.

⁵ If the British extracted gold at Hamash-West, as suggested by Klemm (1994) and Rothe (1995), surely there must be records available also concerning extraction methods and processing. No clear evidence of gold mining was discernible at the mine up on the hill.

⁶ Bakari was mapped, and its components dated, by Klemm (1994), but the

pottery and working tools found at the site remain so far unpublished

⁷ The sequence of stone tools, as recorded in our survey, should be considered still tentative until confirmed by excavation. It is quite possible that stone tools of one period, left behind in a workshop, will be found in a workshop of another period in secondary use. The definitive typology of the stone tools will have to await proper stratigraphic excavations (see below).

⁸ We have already put our Timna samples at the disposal of Rip Rapp and Russell Rothe, including some high tin bronze samples from the same Egyptian workshop.

⁹ We wish to thank Rosemarie Klemm for passing on to us valuable information on copper in the Eastern Desert and for her valuable observations on this subject.

¹⁰ The Klemms' map of Bakari (1994: Abb. 11) was very helpful in dating the different miners, settlements and workshops. Unfortunately, the Klemms' survey report of Bakari is still unpublished. We accepted Klemm's exclusion of Roman-Byzantine from the long history of Bakari gold mining (1994: 217) as based on the study of the pottery of the site.

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