Sicán Elite Tombs and Their Broader Implications

The Central Andean country of Peru has a rich and prominent prehispanic cultural heritage and has adopted unique ancient icons as symbols of its modern nation and institutions. Two of the most striking and commonly seen icons are the gold tumi ceremonial knife and the funerary mask which often appears on book covers (Fig. 1). The tremendous public outrage is understandable when the famous Tumi de Illimo was stolen from the National Museum of Anthropology and Archaeology in Lima and found sometime later cut up and partially melted down. Yet, in contrast, little concern has ever been expressed in regard to the lack of information about the cultural significance of the tumi knife or masks.

As correctly inferred around the turn of the century by Max Uhle, the father of scientific archaeology in the Central Andes, the distinct art style exemplified by these masks and tumi knives was known to have flourished in the Lambayeque region of the North Coast of Peru long before the emergence of the mighty Inca Empire in the fourteenth century AD. The region, endowed with large perennial rivers and extensive, fertile plains, has by far the most productive agricultural land of the entire Peruvian coast. At the time of the apogee of prehispanic cultural development some 1,000 years ago, historian Paul Kosok estimates that the region represented about one-third of the total cultivated area and population of the Peruvian coast. In other words, the Lambayeque region is one of the two major bread baskets of the Central Andes, along with the southern high plateau region around Lake Titicaca, the home of Tiwanaku and Inca cultures. The Lambayeque region also boasts most of the largest irrigation systems and monumental architecture of South America.

Curiously, however, the region received little in-depth archaeological attention until the mid-1970’s. The pioneering works of American scholars such as A. L. Kroeber, Paul Kosok and Richard Schaedel were limited to surface surveys and mapping without any excavations. Ironically, while these works were being carried out, systematic grave plundering was taking place, most notably in the Batán Grande hacienda (large estate) in the middle of the small La Leche valley, about one hour’s ride from the city of Chichlayo (c. 800km north of Lima).

Modern looting fervour in Batán Grande began in the mid-1930’s with the discovery of quantities of gold funerary offerings from deep tombs at the site of Sicán.

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Fig. 1. Cinnabar covered gold mask from the principal burial of the Huaca Loro tomb. Note the pair of ear spools, nose ornament, and algarrobo resin and emerald beads.
within what is now the Poma National Archaeological Reserve. Hacienda peasants in groups of 10–15 were taken away from their work in agricultural fields and assigned to looting activities under the direction of maestros or masters who excelled in locating tombs. The grave looting technique of systematically placed vertical prospecting pits with radiating horizontal tunnels developed and subsequently spread over a wide geographic area. The extent and intensity of looting continued to increase, culminating in the late 1960's when a bulldozer was employed for a year to remove surface soil and facilitate identification of tomb pit outlines. Intense looting lasted until 1969 when the Agrarian Reform forced the hacienda owners out of Batán Grande. Sporadic looting continued until the mid-1970's; when the author began his fieldwork in 1978, some 100,000 holes and numerous long bulldozer trenches within the Poma National Archaeological Reserve were evident.

Here the first scientifically excavated Middle Sicán shaft tombs are described and the nature of their socio-political organization and elite considered. Over the past fourteen years, the Sicán Archaeological Project centred in the Batán Grande region has clarified varied material and organizational features of the pre-Incaic Sicán culture, such as its bronze and ceramic production and monumental pyramid constructions. One topic that has awaited in-depth investigation has been the nature of Sicán socio-political organization and elite, particularly the basis and nature of their evident power and wealth.

One of the approaches to this task involves multidimensional analysis of mortuary practices and grave goods. During the past 14 years, the Project encountered and excavated some twenty relatively small, simple Sicán burials in diverse settings in and outside of the inferred Middle Sicán capital of Sicán. The resultant sample hardly reflected the degree and nature of social differentiation inferred from the artistic depictions and published and unpublished information on looted tombs. J. C. Tello, L. Valcárcel and, more recently, A. Pedersen have reported impressive quantities and diversity of gold and other costly objects looted from Sicán shaft tombs in Batán Grande as large as 15 x 15m at the top and 15m deep. An estimated 85% of the authentic Sicán-style gold objects in the Gold of Peru Museum in Lima is thought to have been derived from Sicán shaft tombs in Poma. However, given their looted origin, little can be said with any certainty of their socio-political, religious and economic correlates and significance.

The focus of the 1991–2 fieldwork (which ended in March) was the excavation of two inferred Middle Sicán elite tombs: a large 15 x 15m tomb in a stabilized sand dune some 120m due south of the Huaca Las Ventanas pyramid and a 3 x 3m tomb at the north base of the Huaca Loro pyramid, some 350m to the west (Fig. 2). These tombs, with their relatively large size and proximity to the main pyramids within the inferred capital, are seen as indicative of the social importance of the deceased interred there and augment the extant burial sample. Funerary treatment and contents were expected to verify this supposition and to provide important clues to the nature of the Sicán elite and their power and wealth. At the same time, this highly contrasting pair of tombs was selected to test the model of differential sacred value of tomb location, i.e. that symbolic value inversely relates to the distance from the pyramid and thus the higher the status of the deceased, the closer to the pyramid that individual would be buried.

The 1991–2 fieldwork involved the participation of professionals and students from five countries and the expected complexity and size of the tombs to be excavated required much careful planning and preparation. For example, the excavation of large, deep and complex tombs requires a sizeable, well-trained crew, as well as ample time and good funding (Fig. 3). Most of the workers had from five to twelve years experience in archaeological excavation. Through ten years of prior research into various aspects of the Sicán culture, we were also well versed with its chronology, technology and other relevant facts and issues. The nine-month long season was supported by a generous grant from the Shibusawo Ethnological Foundation and the Tokyo Broadcasting System of Tokyo, Japan. In addition, working in the area with such a long and infamous looting history as Batán Grande meant that the local population had to be educated as to the aims and value of scientific excavation by means of public lectures and field trips. Specialists in metals, geology, artefact conservation, organic remains, and human osteology willing to work in the field had to be brought together. Our prior research experience with Sicán bronze production was quite valuable in these respects. We established a long-term collaborative agreement with the Museo de la Nación (National Museum) in Lima with these objectives and our Peruvian co-director, Carlos Elera and conservator, Victor Chang are from the Museum. Also, for the past nine years, John F. Merkel of the Institute of Archaeology, UCLA, has collaborated in the analysis and conservation of metal objects. Students from the archaeology programme at the Catholic University and the San Marcos National University, both in Lima, also assisted. Last, and by no means least, with some tombs said to reach as deep as 15 to 20 metres below the surface, we had to wait for a prolonged drought that would lower the ground water level. The area has suffered a drought since the major flood of 1983 and the water table was c. 16m below the surface during the excavation.

The Huaca Las Ventanas tomb excavation took nearly six months, largely due to its size and the technical problems stemming from the unstable sand matrix of the tomb. Much of the eastern half of the tomb had been looted sometime in the past. However, the intact portion revealed much about the tomb construction and internal organization. Essentially, the tomb had an inverted step-pyramid shape, the top measuring 15 x 15m. About 4m below the tomb opening, terraces with adobe brick buttressing walls on the north and south sides were identified. The south terrace preserved an offering consisting of a set of intentionally broken ceramic vessels, a sheet metal covered, double-spout ceramic bottle; and a 2.5 x 1.5m metal sheet with an elongated painting at the centre. The last displays what appears to be a cosmos vision of the Sicán religion with a red (cinnabar) sun and pale crescent moon on the east and west ends, respectively, and the Sicán Deity with a tumi-knife and trophy head at the centre flanked on both sides by a series of stylized ocean waves, fish and feathered 'serpents'. The painting was done on a thin plaster layer applied over a cotton cloth pasted on standardized copper alloy sheet metal panels (each 25 x 12.5cm) laid out side by side.

This previously undocumented use of sheet metal proved to be a major feature of the tomb; in essence, over 20 distinct layers of paper thin sheet metal, mostly
depletion-gilded and painted, lined the interior of the tomb and served to separate groups of offerings, as well as burials. This feature was quite evident on the west side of the tomb, where offerings began from a terrace at c. 8m depth. Through a series of descending 'terraces', offerings that included painted sheet metal panels, at least five sheet metal-covered double-spout ceramic bottles, shell beads, numerous packages of *naipes*, cast bronze implements, llama heads and limbs, continued to the centre and bottom of the tomb, c. 12m below the top of the pit. *Naipes* are sheet metal objects in standardized sizes and shapes that may have served as primitive currencies. At the bottom, the offerings covered an area of only 3 x 3m. Whole and partial remains of at least nine individuals, mostly young adult females, were found on the north and south edges of the lowest level offerings. Other than some traces of cloth that once wrapped the bodies, there were few or no offerings directly associated with them. We did not find a centrally placed individual that could be regarded as the principal burial.

The six-month Huaca Loro tomb excavation that ended in mid-March, 1992 was, technically speaking, straightforward and revealed a totally different content and internal organization. This is a good example of a Sican shaft tomb in having an essentially square (2.5–3.0m to a side) cross-section and vertical shaft over 10m in depth. Fortunately, this tomb was dug in an area of consolidated clay, silt and sand flood deposits lessening the risk of cave-ins that occurred at Las Ventanas. The tomb fill was a heterogenous, stable mass of fine sand and clay lumps.

The internal organization and content of the burial chamber at the bottom of the shaft may be described in terms of six levels of artefacts and human burials spanning about 11 to 12.7m below the surface. The first and

Fig. 2. Map of the Middle Sican capital of Sican with a dozen major adobe brick mounds and indications of the location of the two elite tombs excavated in 1991–92.

Fig. 3. Panoramic view of the Huaca Loro tomb excavation, looking west. Note the vertical shaft of the tomb. Gold Cache 1 is just emerging in the back right corner.
top level consisted of a juvenile burial (10-12 years old, of indeterminate sex) in a seated position on top of a truncated pyramid-shape 'box' placed at the centre of the chamber. The box resembles a miniature version of the nearby Huaca Loro truncated pyramid. The face of the juvenile was painted with bright red cinnabar and had a shell bead necklace.

The second level corresponded to the aforementioned 'box' built of wood and cane frames and lined with gilded sheet metal and woven mats. It measured roughly 1.5m to a side at the base and stood c. 0.8m high.

Along the walls of the chamber surrounding the base of the central box (and representing the third level) were 15 bundles of cast bronze implements. Each bundle contained an average of 30 pieces, each weighing 0.4 to 0.9kg. These implements had blunt ends, apparently had no use-wear, and probably did not serve as weapons. Some of these bundles were associated with what are popularly known as *virutas metálicas* — large piles of depletion-gilded sheet metal fragments. It appears that scraps or even imperfect products of sheet metal were simply piled up with these implements.

Clearly the most notable feature of the third level was a rectangular 1.2 x 0.6 metre 'box' nearly 30cm high lined with organic mats and sheet metal and placed at the north-west corner of the chamber (Figs 4, 6). It contained, at the centre, some two dozen packed layers of gold, *tumbaga* (gold-copper alloys) and silver objects, including five cylindrical crowns, four rattles, over a dozen *tumi*-shaped head ornaments, at least eight sets of 'feathers', and four head-bands. The majority of the objects appear to have been personal ornaments and ritual paraphernalia. When these flattened and corroded together objects are properly stabilized and detached, it is likely the total number of artefacts from this cache will exceed sixty or seventy. Most gold objects are over 18 carat. Like most known Middle Sican objects, these newly found pieces are fashioned out of sheet metal and decorated by means of repoussé technique and cut-out designs. Joining is most commonly done by means of staples.

The central box proved to be empty and had beneath it five intersecting, wooden poles that were originally covered by depletion-gilded sheet metal. Most of the poles had carved 'mythical feline' heads at the ends. It is thought that these poles once formed the frame of a litter, as depicted on Sican ceramics and gold ear spools. In the south-east corner of the chamber, placed along the side of one pole, was a cluster of six pairs of large golden ear spools, some with elegant filigree ornamentation (Fig. 5).

The fourth level immediately below the poles revealed large piles of whole *Spondylus princeps* and *Conus fergussoni* shells weighing nearly a kilogram each, as well as a large cluster of shell, turquoise and other beads (c. 20kg in weight), and a wide range of ceramic vessels, including plates, jars, double-spout and single-spout bottles.

Occupying the centre of the fourth and fifth levels was the principal burial of the tomb, a seated, cross-legged...
adult male, 40-50 years in age and estimated 160cm in height (Fig. 7). The body was covered with cinnabar and wrapped in a textile with nearly 2,000 gold-alloy foil (1.5 x 1.5cm) squares originally sewn on. The upper chest area was bedecked by at least four layers of blue stone (sodalite?), quartz, agate, amethyst, chrysocolla, shell and other beads. The head was ornamented with silver ear spools and a large mask masterfully fashioned out of a single gold alloy sheet (Fig. 1). The mask was largely covered by cinnabar and had eyes represented by pierced algarrobo resin and emerald beads. Eye sockets and ears were covered by badly corroded silver (?) sheets.

Flanking the body and extending to the west were two 90cm long tumbaga (gold-copper alloy) gloves, which ended with wires and copper rods for support. It is unlikely that they were actually worn. The hand of one glove held a gold cup, as if to salute or offer a drink to someone buried farther to the west. In fact, it is highly likely that there is another major shaft tomb symmetrically situated on the west side of the long adobe platform. The other hand overlaid the top of a wooden staff with gold and tumbaga ornaments. For reasons still unknown, the body was seated cross-legged but upside down. Most of the gold, wooden and ceramic pieces associated with the burials were similarly found in inverted positions.

Below the body was the fifth level, containing additional items, including a tumbaga crown with an animal head, perhaps a boar, and a standard decorated with a tumi-shaped ornament. This level also contained two young adult female burials in the north-west corner of the chamber. Apparently they wore clothes with gold and tumbaga foil squares sewn on (Fig. 8).

Finally, the sixth level was represented by a nearly square pit (c. 1.8 x 1.5m) dug some 70-80cm below the floor of the burial chamber. The pit was situated at the bottom of the largest niche (Niche 1) dug into the east wall of the chamber. It was literally packed full with over 300 kilograms of virutas metalicas, three large clusters of beads (shell, sodalite(?), quartz and amethyst crystals, etc.), cinnabar and limonite deposits, numerous bundles of nasipes, at least two dozen masks and tumi-shaped head ornaments fashioned out of copper-silver alloy sheets, among others. Given the quality of the metal used, abundance, and lack of ornaments, these masks and head ornaments may have served as architectural decorations along with polychrome murals.

In reality, the burial chamber was surrounded by seven niches of varying shape and size. One niche was nothing...
more than an incised outline. All others had a depth of only about 50 to 80cm. One had the burial of a child, perhaps 5–6 years of age, at its mouth. Three of the remaining niches contained only small fragments of depletion-gilded sheet metal and Niche 5 had a rectangular, mat-lined box containing some dozen gold objects such as ‘feathers’ and a rattle. The gold feathers of this cache still preserved a coating of cinnabar and fine impressions of actual bird feathers.

Without doubt the most important aspect of this tomb excavation is that; for the first time, an intact Middle Sicán elite tomb has been scientifically documented, opening the door to a wide range and various levels of artefactual and contextual analyses. Reflecting upon the power and wealth commanded by this Middle Sicán lord, the overall quantity and diversity of funerary goods found within this 3 x 3m burial chamber are remarkable for the New World: 489 cast bronze implements with a total weight of some 300kg; 141 Conus shells; 179 Spondylus shells; an estimated 600kg of virutas metalicas or sheet metal scraps, c. 70kg of beads; 19 ceramic vessels, and at least 80 major gold objects, among other items. Altogether, the burial chamber was packed with over 1.2 tons of varied goods.

The political power of the Sicán elite at the Huaca Loro may be gauged by his command over material resources and labour. For example, consider the quantity of bronze and gilded metal objects found in the tomb. Just to smell some 300g or so of bronze would have taken a full day for several metalworkers, as indicated by our replicative smelting experiments. Similarly, 600kg of uniformly thin (c. 0.1mm) gilded sheet metal, though mostly scraps, represents an enormous outlay of manpower and materials. Each sheet would have been carefully produced with stone hammers.

Clearly, the Middle Sicán polity had established an extensive economic network that brought a wide range of exotic, costly goods from all over western South America. The emerald that decorated the mask probably came from the Muzo region in southeastern Colombia. This is not surprising given that local imitations of diagnostic Sicán pedestaled bottles have been found at La Tolita at the border of Ecuador and the Colombian coast. The presence of so many Spondylus shells in a single elite tomb was expected from their frequent depiction in Sicán art, including harvesting of the shells by divers, and large-scale offerings documented on top of monumental temples such as Huacas Rodillona and Las Ventanas. The network probably extended to the Marañon River, a major tributary of the Amazon River, on the eastern side of the Peruvian Andes (less than 140km east of Batán Grande). Though practically all Andean rivers carry some gold, the best known historical and modern sources of placer-mined gold are rivers on the eastern escarpment of the Peruvian Andes. In her survey of the Jaén-San Ignacio region, Ruth Shady found an appreciable quantity of Sicán ceramics. Villagers near the major modern gold mine of Poderosa overlooking the Marañon River also report finding Sicán ceramics from local, prehispanic cemeteries.

The southern limit of the network is still not clear. The notable quantity of intensely red cinnabar (c. 3.5kg) may have come from a well-known mercury mine in Huancavelica some 900km south of Batán Grande.

It would seem that underlying the impressive power and wealth of the Middle Sicán was their successful integration of a regional economy based on large scale bronze production and irrigation agriculture with inter-regional trade that had brought exotic goods, such as tropical shells imbued with religious significance, since the first millennium B.C.

In regard to Sicán social organization, the tombs described offer important insights. The Sicán tombs excavated so far clearly fall into four groups: those with (1) high carat gold objects; (2) plated and/or gilded objects; (3) bronze objects; and (4) no metal objects. This differentiation is similar to that of the Mochica tombs from Sipán and the later Inca state use of metals. The Huaca Las Ventanas tomb, in spite of its gigantic size, had only gilded and bronze objects. The Huaca Loro tomb contained all types of metal objects. There are some indications that certain shaft tombs might contain only high carat gold objects. It is thus quite possible that the Huaca Loro tomb did not represent the highest echelon of Middle Sicán society; such a tomb is probably to be found below the monumental pyramids, like the situation in Maya temples. Tentatively, we may suggest the presence of at least four social strata. Coincidentally, in terms of human labour costs and necessary skill, as well as iconographic contents, four distinct production spheres in the Middle Sicán ceramic and metal objects have been identified.

The new data from the 1991–2 excavation are quite suggestive, but the tomb sample is still inadequate to test properly the concentric model of sacred land value suggested earlier. The observed differences in shape and size between the Huaca Loro and Las Ventanas tombs appear to be in part due to the notable differences in their soil matrix. In the loose sandy area of the latter, it would be nearly impossible to excavate a vertical shaft-tomb like the former. Given the composition and number of burials found at Las Ventanas, the possibility is that this tomb contained only the bodies of court attendants of an important personage who was buried apart in a 'companion tomb'.
Monte Romero, a Silver Producing Workshop of the 7th Century BC in South-West Spain

This paper presents the main conclusions of archaeometallurgical research on the excavated material of Monte Romero. The site was first described by Professor Beno Rothenberg in IAMS Newsletter Number 9 (1986) p. 1–4. The ancient workshop was dated, on the basis of the archaeological ceramics, to the 7th–6th centuries BC. This corresponds to the time when the Phoenicians founded colonies along the south coast of the Iberian Peninsula and established trading links with the local people. Silver was the commodity that was at the centre of the trade from the Iberian Peninsula to the eastern Mediterranean.

The site of Monte Romero, Site 56, was first discovered in 1975 during the IAMS archaeometallurgical survey of south-west Spain directed by Professor B. Rothenberg. It is situated in the precinct of the modern mine of Monte Romero, located in the Sierra Aracena.

The lode of Monte Romero is part of the Iberian Pyrite Belt and as such it is composed of lenses of pyrite and chalcopyrite whose extremities are composed of sphalerite and galena (Fernández Alvarez, 1975: 80). It has to be emphasised that the deposit is extremely complex and ore types tend to overlap in characteristics. However, six principal types of ore have been defined (Fernández Alvarez, 1975: 81). The ore that is believed to have been processed in the ancient workshop is what is called the ‘massive complex mineralization’ and is composed of coarse crystals of galena and sphalerite with a small quantity of pyrite and quartz. Copper is also present in the form of freibergite (\((\text{Ag,Cu})_n(\text{Sb,As})_n\)S\(_n\)) which may be present at 0.2–0.6%. It is due to the presence of this mineral that both silver and arsenic levels in this type of ore are higher (Fernández Alvarez, 1974: 252). Although this type of mineralization is usually found in deep deposits, at Monte Romero it outcrops to the surface and would have been easily accessible to ancient prospectors and miners.

During the archaeometallurgical survey in this area by Rothenberg and Blanco Freijero (1981: 84–7), a scatter of slag, tuyeres, fragments of cupellation dishes and so forth were found at Monte Romero in association with pottery which was initially dated to the 7th–5th centuries B.C. This wide variety of metallurgical finds, the early date of the site and the complexity of the typical ores at Monte Romero convinced the IAMS research group that the site should be excavated.

Two squares labelled A2 and A3 of a total area of c. 50m\(^2\) were excavated in 1986 under the direction of Professor Rothenberg. Differences in the types of metallurgical debris from each excavated square were readily apparent. In Square A2, small slag heaps, discarded furnace wall fragments and straight, slagged tuyeres were uncovered. No furnaces were found in situ. The location of these waste heaps, however, suggest that the smelting area was situated directly to the south of the excavation.

Along a low wall in Square A3, a stack of complete, used cupels was discovered (Fig. 1). Furthermore, in Square A3 bent tuyeres that are not slagged were also found which are believed to have been used in the refining rather than smelting step. It is, therefore, concluded that this area was used for cupellation (Fig. 3). Once again it is believed that what has been excavated is more likely to have been a storage area, while the actual cupellation would have taken place just north of the excavation. A more detailed description of the excavation results and some preliminary ideas on a possible metallurgical process model for the production of silver at the ancient workshop have been published in a previous IAMS Newsletter (Rothenberg et al., 1986).

The material recovered during the excavation has since been the subject of the writer’s PhD research undertaken at the Institute of Archaeology, University College London. In this paper, some of the results of the materials investigations and final conclusions are presented.

The excavation of the site has produced two types of slag: tapped slag and ‘free-silica’ slag. The tapped slag, which had clearly been fluid, is dense and homogeneous. It does not contain any metallic prills visible to the naked eye. In contrast, the second type is extremely inhomogeneous and contains metallic lead visible on a freshly cut surface as well as many large rock inclusions. It does not seem to have ever reached a fully fluid state. This type has usually been called either ‘free-silica’ slags or ‘slag balls’. The names derive from the fact that they contain a large amount of unreacted siliceous rock fragments, as well as having the shape of a ball or a bun.

‘Free silica’ slag has also been found at other sites located in the south-western part of the Iberian peninsula.

Fig. 1. Stack of cupellation dishes as discovered during the excavation of Monte Romero.
which are connected with the extraction of silver (Rothenberg and Blanco Freiheix, 1981: 99; Fernández Jurado, 1988–1989b: 192). It has been interpreted as a mistake in the smelt (Ruiz Mata and Fernández Jurado, 1986: 260), but this interpretation is unlikely because ‘free-silica’ slag is now known from many different sites over a wide span of time. Obviously, the same mistake could not have been repeated at all of these sites. Also included among the archaeometallurgical finds from the site was speiss, which is a waste product formed as a separate phase in the presence of an excess of arsenic and/or antimony in the charge. Any process model, therefore, that may be suggested will have to be able to offer an explanation of how and why these slags and speiss were produced.

Used culps found in the excavation are clear evidence of the cupeulation process. The excavation also revealed a quantity of metallic lead whose presence is very significant as part of the process, as it could be either an intermediate product of primary smelting and, therefore, silver rich, or a by-product of the cupeulation process and, therefore, de-silvered.

A series of analytic methods were employed for the investigation of these finds. X-ray fluorescence spectrometry (XRF) and inductively coupled plasma (ICP) emission spectrometry were used for the bulk chemical analysis of samples of each of these groups of samples. Since many of the finds were quite inhomogeneous, micro-analysis was deemed to be necessary. A microprobe was used to analyse not only the metallic prills trapped in the slag matrix of both the tapped slag and the slag balls but also the different minerals of which the slag is composed. The mineralogical investigation of the slags was supplemented by X-ray diffraction (XRD) analysis. Finally, atomic absorption spectrometry (AAS) was employed for the analysis of the many finds of metallic lead in order to ascertain silver concentrations.

In the survey publication which included Monte Romero, several surface samples of slag from the site were identified as copper smelting tap slags (Rothenberg and Blanco Freiheix, 1981: 86–7). From the excavation, however, analytical results on tapped slag samples show that the lead concentration is consistently higher than that of the copper concentration (Pb ranging from 2.9% to 5.6% compared to Cu 0.0% to 0.30%). Thus, these new excavated tapped slag samples have been interpreted as lead smelting slags.

The XRF analysis of the tap slags also revealed a relatively high level of barium, averaging 10%. Furthermore, X-ray diffraction analysis of the slag samples indicated celsian (BaAl₂Si₂O₇) as the main constituent, not fayalite (Fe₅SiO₄), one of the most common minerals found in ferrous slags (Bachmann, 1982: 14), as initially expected.

Barite, the barium sulphate mineral, serves as an excellent flux for lead smelting, as it facilitates the desulphurizing of galena during the roasting process, while in smelting it reacts with any lead silicates formed, releasing metallic lead (Maréchal, 1985: 30–31). As barite is not commonly found in the argentiferous ores of Monte Romero it is argued here that this property of barite was identified by the ancient metallurgists working at the site and it was deliberately added as a flux to the charge.

As expected, the bulk chemical analysis of the ‘free-silica’ slag showed a great range in compositions. Some were silica rich, with SiO₂ concentrations reaching as high as 50%, some were barium rich with barium concentrations reaching 18%. One sample was found to be manganese rich. Microanalysis of the rock inclusions revealed that the different compositions are mainly due to the presence of different unreacted rock fragments. Thus the silica rich slag balls contained significant amounts of unreacted quartz while the barium rich slag balls contained unreacted barite.

The mineralogy of the slag matrix is regulated by the flux charged. Thus in the barite rich slag balls, celsian (BaAl₂Si₂O₇) was the main crystalline phase. In contrast, in the silica rich slag balls, hedenbergite (CaFeSiO₄) and anorthite (CaAl₂Si₂O₈) were the main minerals. It seems, therefore, reaction had taken place between the ore and the flux which led to the formation of these silicates. This was then followed by the introduction of excess flux which did not have the opportunity to react fully and is, therefore, found in the form of these large inclusions.

In general, this ‘free-silica’ slag has a very high lead concentration averaging c. 10% Pb, but sometimes reaching as high as 25%. Microanalysis of a number of samples showed that the lead is in the form of entrapped metallic prills as well as lead silicate glass which is the matrix component of the slag. The prills can often be observed with the naked eye in a fresh break.

A number of hypotheses have been proposed for the ‘free-silica’ slags. In the IAMS Newsletter (1986) publication of Monte Romero, it was suggested that the free-silica slags were the product of the recycling of the culps and furnace linings and that the rock inclusions acted as a ‘sieve’ which facilitated the separation of the lead metal from the slag. Professor Tylecote, on the other hand, had suggested that the quartz crystals were used as a means of solidifying the slag and absorbing it as a sponge thus enabling the separation of the metal from the slag (Tylecote, 1987: 306–7).

Historically, metallurgical activities from the middle of the last century added another perspective to possible interpretations of the free-silica slag. Percy describes a lead smelting process where lime is added to the molten charge of the furnace in order to stiffen the molten charge which is subsequently cooled and remelted with more lime. According to Percy (1870: 230) in the final stages of the smelt, ‘the lime is again added, the slag is pushed back from the surface of the lead and left to drain a little, the lead is tapped out and the slag is then raked out of the furnace in pasty lumps termed ‘grey slag’.

The use of the lime, Percy argued, is purely mechanical, in other words to cool and solidify the slag. The removal of the slag as a solid enabled the lead metal to be exposed to the atmosphere of the furnace and thus further reactions took place. Furthermore, any lead trapped in the slag has the time to drain off and to be collected (op. cit. 236–8).

It is suggested for the archaeometallurgical remains from Monte Romero that the free-silica type of slag was the result of a similar process, where silica and barite were used in a similar way. The charge was saturated with an excess of flux in the form of quartz and barite. As a result the slag cooled and solidified, thus enabling its separation from the lead metal. The presence of a large amount of glass as well as the quenched form of the crystals in the matrix support the idea that the slag was rapidly cooled.
The fact that the slag balls contain so much lead, combined with the fact that a large group of complete balls was found stored in a pit in Square A3 (Locus 16) together, suggests that the free-silica slags were to be retreated at a subsequent step in the overall process. The tapped slags in contrast to the slag balls do not contain lead silicates. This suggests that the 'free silica' slag was charged back into the furnace mixed with more barite flux which has reacted with the lead silicates, releasing the lead and forming a more fluid slag: the tapped slag.

The furnace wall fragments from the site commonly consisted of a layer of slag adhering to a layer of clay which was smeared over the furnace wall construction: slate plates alternating with clay. Based upon the curvature of the largest furnace wall fragment, the approximate diameter of the furnaces was only 24cm. XRF analysis of the furnace lining found this to have a higher SiO₂ content than the tapped slag and a very high lead content (ranging between 16.2 to 22.4%). The compositional results of the furnace lining agree with observations drawn from the study of examples produced during experimental smelting work (Merkel, 1990: 119, note 15; Hetherington, 1978: 203). Microanalysis of the furnace lining found the lead to be present in the form of lead silicate within which some celsian crystals were formed. This detail clearly matches the furnace fragments from where the sample was taken to the production of the tapped slag or perhaps the barium rich-slag balls.

Microanalysis of a slagged tuyere also detected barium in the slagging which was mainly composed of lead silicate. This matches the straight tuyere fragments to smelting operations through the presence of barium rich slag. The analysis of a drop attached to a bent tuyere, which was not slagged, found this to be composed predominantly of lead oxide. This indicates that the bent tuyere had once been in contact with litharge or metallic lead, and as such would connect this find to the cupellation process.

The XRF analysis of the speiss found this to be mainly composed of copper (average = 31%), antimony (average = 17%) lead (average = 26.36%) iron (average = 9%) and arsenic (average = 4%). The speiss was also found to contain 0.5% of silver. Although, a model for the desilvering of speiss has been suggested by Craddock et al. (1987: 10), such a process does not seem to have been undertaken at Monte Romero. The presence of speiss at Monte Romero is not surprising considering the mineralogy of the complex ore used. An excess of antimony and arsenic would have existed in the charge due to the presence of freibergite in the ore.

Metallic lead was found at Monte Romero in the form of large flows with a ropy surface as well as small droplets. Analysis of all of the lead finds by AAS revealed that some of the lead samples were silver-rich, while others have a silver concentration lower than 1,000ppm. The analytical results showed that, indeed, there existed specimens of silver-rich lead (with silver concentrations of 5,000ppm) as well as desilvered lead (with silver contents as low as 100ppm) at the site. The desilvered lead probably derives from recycled litharge and used cupels. In terms of silver concentration and size, most of the finds which had a concentration of silver between 3,000 and 5,000ppm are small droplets, while the majority of large pieces contain about 1,000ppm of silver.

Most of the lead samples, complete cupellation dishes and the fragments of the cupellation dishes came from a single pit located near the low wall in Square A3. Analysis of the cupels showed that these were almost completely composed of lead oxide (PbO c. 80%). It is therefore assumed that these were stored there awaiting to be reprocessed. As the lead was stored in the same pit, it seems likely that the lead and the cupels were meant to be reprocessed together. As both silver-rich and desilvered lead were found mixed together, and as it seems to have been impossible to readily distinguish between the two by eye, it is suggested here that all of the contents of
the pit were meant to be added to the smelting charge in order to assist in the formation of the silver-rich lead bullion.

The model (Fig. 2) proposed for the Monte Romero finds may seem rather complex for such an early archaeological period. Nevertheless, it does agree best with the archaeometallurgical evidence from the site. The polymetallic ore would have initially been roasted to drive off a portion of the sulphur. Next it was mixed with quartz and barite flux and charcoal, then charged into the smelting furnace. The products of this smelting step would have been slag, speiss and lead, probably present in three superimposed layers in the furnace. However, separation of these three distinct layers would have been difficult at this step of the process. Thus, rather than being tapped, the slag was cooled and solidified by the addition of large inclusions of crushed rock and removed in the form of these slag balls.

The speiss and lead would have been left in the furnace, where upon cooling, speiss having a higher melting point than lead, would have solidified and could be removed in the form of plates. The primary lead could then be tapped out. The lead produced would have been silver-rich and would subsequently undergo cupellation.

The slag balls, however, still contain a large amount of lead and, therefore, would have been re-treated. They could be crushed and mixed with more barite flux and charged back into the smelting furnace. The barite would react with the lead silicates releasing metallic lead and forming a fluid tap slag. Any trapped metallic prills would also be released and liquate to the bottom of the furnace. Thus this cycle would produce a tap slag and more metallic lead.

The presence of slagged crucible fragments from the site, whose analysis revealed that the slag was in fact layers of lead metal with a mixture of copper and antimony, may be evidence of a dressing step previous to cupellation. In ‘dressing’ the lead metal is melted, due to the low solubility of the other impurities in molten lead and their lower specific gravity, they float to the surface from where they can be removed. This produces a more refined, silver-rich, lead which would then be cupelled.

Cupellation took place in cupels with an average diameter of 12cm. Although the best material for the manufacture of cupels and cupellation hearths is traditionally known to be bone ash, this was not used in the preparation of the cupels from Monte Romero. XRF analysis of the cupels does not detect any phosphorus. The products would be silver, which has not been found in the site, and litharge, the lead oxide. The cupels found at Monte Romero are completely saturated with litharge.

The fact that much of the lead that does not contain much silver indicates that the litharge was reduced in a final step to produce metallic lead. It seems likely that this was again recycled into the smelting furnace where it would again act as a collector of the silver from the polymetallic ore.

The site of Monte Romero offers a unique opportunity to investigate a silver workshop of this period. Unlike other workshops that have been excavated, such as that at San Bartolomé de Almonte (Ruiz Mata and Fernández Jurado, 1986), Monte Romero is located in close proximity to the mine and shows all the various steps of the process, from the ore to the cupellation. Also, unlike larger sites, such as Rio Tinto, Monte Romero was occupied only during a single period, which avoids the complex stratigraphic problems of mixed finds belonging to different processes of different periods.

The sophisticated process established by our archaeometallurgical investigation, shows that the people working in the 7th century B.C. workshop of Monte Romero were competent metallurgists who were able to process even highly complex ores to produce silver.

Vasiliki Kassianidou

References


Bronze and Iron Age Metallurgy from the Oman Peninsula

Most research concerning collections of ancient metalwork is approached from either a purely analytical or typological viewpoint. In this work, an attempt has been made to combine both approaches. The copper alloy weapons have been investigated using atomic absorption spectroscopy, standard metallographic techniques and scanning electron microscopy with energy dispersive microanalysis. Typological comparisons are made to other metal object finds at sites in the region. The material that forms the corpus of the study, on loan for analysis and conservation from the Al Ain Museum in Abu Dhabi, comprise grave finds from three sites in the
U.A.E., namely Umm an-Nar, Qattarah and Qidfa. The three sites represent different archaeological periods and, consequently, different technological horizons.

The earliest group of artefacts are representative of the second half of the third millennium B.C. from the island of Umm an-Nar. The group consists of five simple objects, mostly pins and awls. These objects were very basic forms and not sufficient for typological study. The metal compositions had some characteristics similar to other Umm an-Nar objects, for example with 1-2% of nickel and arsenic. However, the concentrations of tin at 1.5%, 0.6% and 0.2%, respectively, in three of the analyzed objects represents a significant discovery. Although, one object alloyed with tin may seem early for the Umm an-Nar period in the area, the actual alloying with tin and the implied organized trade routes to tin sources would not be unexpected in comparison to what was previously known about the Umm an-Nar acquisition of other materials, such as gold, lapis lazuli and cornelian (Weisgerber, 1985).

The second group of artefacts come from a grave at Qattarah, in the Al Ain oasis. The finds form a representative collection of weapons from a classical Wadi Suq context, c. 2000 B.C. Except for one example with about 5% tin, the other short daggers and triangular blades are unalloyed with tin. The concentrations of arsenic and nickel are below about 1%. Socketed spearheads have similar compositions.

The latest group is from Qidfa, a site on the east coast of the Oman peninsula. The collection is tentatively dated to the latter part of the second millennium, B.C., in an early Iron Age context. From the collection of 26 analyzed arrowheads from Qidfa, the tin concentrations seem random, with no correlation between tin concentration, shape or incised decoration. In contrast, four examples of swords/daggers (32-40cm in overall length; Fig. 1) from Qidfa have between 7-9% tin with the inferred deliberate control of composition. Three heavy rings (each 530-1,220gms.) were analyzed as well showing tin concentrations between 8-13%. A shaft-hole axe and an adze were also alloyed with tin.

From the objects studied, there appears to be a good understanding of the advantages of cold-working and annealing copper for the material from both Qattarah and Qidfa. The utilization of copper-tin alloys was much more prevalent at Qidfa and seems comparable to alloying practices at later dates (Weisgerber, 1988). A preliminary typological investigation of this material revealed many parallels with other finds from Oman and the U.A.E., both in composition and form. Wider parallels were identified, with the material displaying similarities to material from western Iran, the Talysh region of Iran and from Syria/Palestine. The triangular dagger blades from Qattarah and the heavy rings from Qidfa, however, seem unique to the Oman peninsula. From the results, the introduction of tin to allow widespread use of bronze for weapons and other objects at Qidfa can be documented and manifest characteristics of both imported as well as local metalworking traditions.

The excavator and curator of the material from Qidfa and Qattarah is Dr Walid Yasin of the Al-Ain Museum. Loan of the objects to the Institute of Archaeology, University College London, for archæo-metallurgical analysis and conservation (Fig. 2) was arranged by Dr J. Merkel through the Tourism and Antiquities Directorate, Al-Ain, Emirate of Abu Dhabi. The archæo-metallurgical investigation of the material is now complete. It was undertaken as a M.Sc. report by the author under the supervision of Mr C. Phillips and Dr J. Merkel in the IAMS Archæo-Metallurgy programme at the Institute of Archaeology, UCL. Presently, the metal objects are undergoing conservation treatment by students under the supervision of Dr J. Merkel and Ms K. Tubb as part of their teaching in the course 'Conservation of Archæological Artefacts'. The loan of the objects is gratefully acknowledged. It is a splendid opportunity to work on such interesting, high-quality objects in preparation for their display at the Al-Ain Museum.

Jason Ryan

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New Archæo-Metallurgical Evidence for the Beginnings of Metallurgy in the Southern Levant. Excavations at Tell Abu Matar, Beersheba (Israel) 1990/1

In IAMS Newsletter No. 17, 1991, the Chalcolithic (4th millennium B.C.) Ghassulian-Beersheba enigma was reviewed as one of the most significant unanswered questions in the early history of the southern Levant intimately connected with metallurgy. This enigma, which was impressively emphasized by the sensational discovery by P. Bar-Adon, a member of Yigael Yadin's famous Judaean Desert Expedition (1960), of hundreds
of sophisticated prestige metal objects in the Nahal Mishmar cave, has its focal point at Tel Abu Matar, near the town of Beersheba, in the Negev of Israel. Here, similar sophisticated prestige objects, as well as remains of more primitive, local copper working, were uncovered by J. Perrot in the early 1950's. However, because of the sparsity of metallurgical process debris in these excavations, it had hitherto not been possible to reliably reconstruct the ancient copper smelting and working technology of this early, prehistoric phase of metallurgy, or to establish the source of the sophisticated prestige objects and their manufacturing technology. The following preliminary report on the recently renewed excavation at Tel Abu Matar reviews the unique find of technologically comprehensive groups of metallurgical production and working remains, from the ores to the finished object, and their significance for the reconstruction of the beginnings of copper technology in the Chalcolithic Period. This unique find is now providing the material base for a new research programme, which will follow the trail of archaeo-metallurgy towards the solution of the Ghassullian-Beersheba enigma.

Tell Abu Matar was originally excavated by Jean Perrot in the early 1950's, who revealed a group of underground structures and stone walling on the surface above, related to the Ghassullian Chalcolithic culture (Perrot 1955; 1984). Between January 1990 and March 1991 salvage excavations were carried out at Tell Abu Matar by the Archaeological Division of Ben-Gurion University of the Negev, Beersheba, under the auspices of the Israel Antiquities Authority, and directed by Isaac Gilead, Steve Rosen and Peter Fabian. Beno Rothenberg was called in to take charge of the archaeo-metallurgical investigations. The immediate goal of these excavations was to establish the extent of the ancient site in connection with development plans in the area. Due to the huge size of the site (in the order of 1.5 hectares) it was only possible to excavate systematically a number of key points, supplemented by trenches in places where no surface remains were evident.

Area A: A metallurgical workshop

Adjacent to the habitation area excavated by Perrot, Trench 1 (Fig. 1), was cut in order to provide a deep section for the study of the environmental and geomorphological history of the site, an aspect unknown from the previous excavations. Trench 1 proved to be a most informative stratigraphic section and led to the discovery of a metallurgical workshop. The section showed a series of tilted thin ash layers, which contained more stones than anywhere else in the section and here were numerous pockets of charcoal, pottery sherds, including a slagged rim of a small crucible, and many little lumps of copper slag and bits of copper. Since the stratigraphy and finds in the section suggested copper production or working, a 5m square was excavated in this area.

In the centre of this square was a shallow pit of about 0.5m diameter, with hard-baked walls indicative of high temperatures, which we considered to be a metallurgical installation (Fig. 2). Above its floor were lenses of charcoal, brick fragments, and vitrified lumps of silt. The same type of material, including also a spread of dark ashes, was found in the immediate vicinity of the installation in a circle of about 2m diameter, indicating pyrotechnical activities related to metallurgy. Evidence for this assumption can be seen in the numerous pieces of slag and fragments of crucibles, several pieces of slagger 'furnace lining' and lumps of copper ore. There was also a ceramic fragment which seems to be part of a tuyere. The small crucibles, about 6cm in diameter and 6-8cm deep, were made of the local loess, tempered with straw, and showed on their rim a thin layer of slagggy encrustation with traces of corroded copper, sometimes also
"spilling over" to the outside. Their inside had a smooth, vitrified surface. The crucibles were obviously heated from the top (not from below and outside) - typical for melting/casting crucibles. This was recently confirmed by a preliminary petrographic study of crucible fragments from Abu Matar by J. Goren (Goren 1992, unpublished ms).

Although there were fragments of bricks and vitrified brick material inside and in the immediate vicinity of the furnace-like installation, its original contours could not be established with certainty. However, the overall character of the finds related to this installation, especially the dark wood ashes close to the installation, not normally found in or near a smelting furnace, would indicate casting operations at this location. There remains of course the question of the presence of ore lumps and fragments of slagged 'furnace lining' at this location, but these could well be stray finds from a nearby copper smelting furnace, not yet uncovered. The damaging effect of flood water (indicated by lamina in the section) above the installation caused, in some cases by puddling, could well have been the cause also of the dispersion of 'intrusive' metallurgical debris over the site.

About 3m west of this installation, in another shallow, pit-like depression, and embedded in a layer of ash, was a concentration of stone implements, probably connected with the metallurgical activities in this area: large cobbles, split in the centre and used as anvils and smaller pebbles with flaking and pecking marks indicating their use as hammerstones. Some of these implements showed green copper stains. There were also pieces of slag, charcoal, crucible fragments, pottery sherds and flint artefacts.

Area M: A habitation quarter – with metallurgical activities (Fig. 3)

Area M, about 100m from Perrot's excavations, was essentially a densely build up habitation quarter, where the excavation uncovered several strata of stone and brick walls and more underground structures, thereby providing a much improved picture of the nature and history of Chalcolithic Abu Matar (Gilead et al. 1991).

Dispersed between the structural remains were ore lumps, slagged furnace parts, small pieces of crushed slag and a few crucible fragments. Many more metallurgical process remains of the same kind, including a fragment of furnace wall covered by a 5mm thick layer of solid slag, were found inside a large and deep pit, located underneath a stone wall. The preserved curvature of this slagged furnace fragment indicated a furnace diameter of about 35cm.

Although most of the metallurgical remains, found between the structures of Area M, seemed to be stray finds, these appeared to represent somewhat different metallurgical activities than the finds in Area A. Considering the character of the slagged furnace wall fragment and the small, crushed slag lumps, as well as the fact that far less crucible fragments were found here than in Area A, we would, tentatively, suggest that somewhere near or in Area M copper smelting took place in furnaces very much the type of the Chalcolithic furnace at Timna Site 39 (Rothenberg 1990, 4-6).

Area B: Chalcolithic remains underneath a farmhouse of the Arab Period

In a 1.5m thick debris layer underneath the Arab farmhouse, located about 80m west of Area A, numerous metallurgical finds were made, consisting of ore and/or slag nodules, copper prills, some larger lumps of copper ore and slag, and several corroded copper objects. This find clearly shows the wide extent of metalworking at Chalcolithic Tell Abu Matar. It appears that metalworking of one kind or other took place almost everywhere in the area of this Chalcolithic settlement, inside and outside the actual habitation quarters.

Summary

The excavations at Tell Abu Matar provided a uniquely comprehensive assemblage of metallurgical process debris, from the copper ore and metal extraction to the casting operation and their product, the finished metal object. The scientific processing of these finds is planned to commence early in 1993 and we hope to be able to establish a comprehensive model of Ghassulian-Beersheba Chalcolithic copper metallurgy. This investigation should also establish whether, besides (unalloyed) copper metallurgy, there was also working with arsenical copper, the alloy used for the manufacture of the 'prestige objects' found at the Ghassul-Beersheba sites, including Tell Abu Matar.

One of the major aims of the archaeological and material-science investigations of the finds of Abu Matar will be to establish the stratigraphy of the commencement of metallurgical activities at the site and 'the stratigraphic moment' of the appearance of the prestige objects in the settlement. It will also be highly important to establish the character of the seemingly different metallurgical processes in the different quarters of the site, which will show the degree of craft specialisation already at this early stage of metallurgy.

Preliminary comparative studies have shown that the copper ore fragments found at Tell Abu Matar originate, most probably, from the mining area of Feinan, on the north-west of the Arabah, as already suggested by J. Perrot (1957, 38, 87, see now also Hauptmann 1989, 126-8). The evidence of widespread Chalcolithic ore trading, based on the copper mines of the Arabah - where no sites of Ghassulian-Beersheba culture have been located - represents a highly significant new parameter in the culture-history of the southern Levant.

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Fig. 3. A typical habitation of Chalcolithic Abu Matar.
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IAMS Workshop Series:
Archaeo-metallurgy in the Ancient Near East

In the Arabah, the geological rift valley from the Dead Sea south to the Gulf of Aqaba/Elat, copper mining and smelting has taken place since early prehistoric times. The two most investigated archaeo-metallurgical areas in the region are Timna and Feinan. The remains at Timna have been the focus of interdisciplinary study for almost thirty years under the direction of Professor Beno Rothenberg. Feinan, to the north-east, has large scale remains of prehistoric mining and smelting which have been intensively investigated since 1984 by a team of archaeologists and scientists from the Jordanian Department of Antiquities and the Deutsches Bergbau-Museum directed by Dr Andreas Hauptmann.

The role of copper production at Timna and Feinan for the ancient history of the southern Levant, however, is not yet fully understood. Recent publications of the results of these investigations have caused lively debate in scholarly journals, especially relating to the chronology of the sites and proposed reconstructions of the metallurgical processes and installations. There are a number of other critical issues which have not yet been resolved concerning trade in ores and copper for different archaeological periods. Unfortunately, since the modern border between Jordan and Israel separates these two ancient metallurgical centres in the Arabah, it has not been possible before to approach the problems by detailed comparative studies.

Therefore, this first in a planned series of specialist workshops addressed *Archaeo-Metallurgy in the Arabah, The Negev and Sinai.* The main purpose for this workshop was to provide an informal forum for discussion of the archaeo-metallurgical evidence from these contiguous regions. It was co-organized by the authors and took place on 23-24 October 1992 at the Institute of Archaeology, University College London. Archaeologists and scientists actively engaged in archaeo-metallurgical research in the Wadi Arabah attended from Germany, Great Britain, Jordan and Israel.

The workshop was divided into three parts. The first was dedicated to dating archaeo-metallurgical activities and culture historical problems in the Arabah. B. Rothenberg and J. Glass proposed a developmental sequence for copper metallurgy based upon three technological stages. Evidence for this division was extensive study of the mineralogical and chemical composition of pottery both from Timna and Sinai. Rothenberg especially stressed the enigma of the Ghassulian and Beer Sheba cultures relative to the developments in the Chaleolithic of the Arabah and Sinai. He proposed a Late Neolithic date for the earliest copper smelting site (F2) at Timna. The development of mining technology at Feinan from the Chalcolithic up to the Roman period was explained by G. Weisgerber. He was able to set up a chronology both by archaeological evidence and 41 radiocarbon dates derived from charcoal samples from different archaeo-metallurgical sites. At Feinan it was not possible, even by extensive archaeological excavation at Tell Feinan by M. Al-Najjar, to find evidence of smelting activities earlier than the middle of the fourth millennium B.C. During the fourth millennium, the copper ore itself was traded to settlements in the Negev and had been smelted there. Very interesting are changes presented by S. Shalev in copper metallurgy from the Chalcolithic period to the Early Bronze Age. During the EBA, copper ore was smelted near the mines and the metal traded. Early Bronze Age smelting sites have been reported from both Timna (EB IV) and Feinan (EB II). W. Fritz reported on the excavation of an EB II and Iron Age site at Barqa al-Hetiye in Feinan. Midianite pottery is present at this site.

The second major topic dealt with the evaluation of provenance studies based upon lead isotope analyses and geochemical data from Timna and Feinan. Z. Sios-Gale voiced concern regarding sample numbers used for characterization of ores and slags. It was agreed that it is necessary to compare artefacts with both the ore deposit itself and slags at the smelting sites. This contribution was followed by a lecture on the most recent measurements on lead isotope composition of ores from Timna by N. Gale in comparison with the data available from Feinan. So far, more than 50 ore samples have led isotope results at Timna. Generally, the Timna ores have a similar pattern as the ores from the Dolomite-Limestone-Shale Unit at Feinan, but overall reveal a larger range. As emphasized by E. Pernicka, not only lead isotope analyses, but also the geochemical characteristics of the ores, slags and metal are necessary to study provenance. Slags are particularly important to provide a direct link between ores and metals. The increasing number of isotope and chemical data for Timna and Feinan provide an excellent basis for future research on the provenance of metal artefacts from the region.

In the third session, aspects of extractive metallurgy were discussed. It could be demonstrated by the investigation of slags and metals from Feinan (A. Hauptmann) that very pure copper ores have been smelted during the
middle of the fourth millennium B.C. Only very small amounts of slag have been discovered from this period. The smelting during the Early Bronze Age was done on a larger scale and under relatively low reducing conditions. These models could be supported by results of recent smelting experiments by J. Merkel with pure malachite ore to produce a plano-convex ingot in a primitive bowl furnace. A lively discussion among the participants focused on the reconstruction of EBA smelting furnaces from Feinan that were proposed to have been natural draught furnaces. The contribution by G. Philip compared stylistic and technical characterisations between metal artefacts from Jericho and Tell el-Dab’a. H.-G. Bachmann outlined the recognition and smelting of high-grade copper ores and presented the concept of a ‘reaction vessel’ relative to increasing scales of production. In particular, he emphasised the importance of distinguishing between small-scale ‘workshop metallurgy’ for artefact manufacture versus ‘plant metallurgy’, i.e. production centres, where metals (ingots, etc.) for trading were the essential output. In his closing remarks for the workshop, he considered the abilities and organization of the metalworkers as well as variations in the archaeometallurgical evidence between Timna and Feinan.

This workshop offered a fruitful opportunity to discuss problems and new finds from the region. Materials and metallurgical processes were discussed and still outstanding problems of dating could be clarified and defined. The discussions will be of great value for future research. At the end of the workshop it was suggested to organize, perhaps in Bochum, a larger international archaeo-metallurgical symposium, leading to a comprehensive publication.

Andreas Hauptmann and John Merkel

From the Director’s Desk

Welcome to two new Trustees and new members of The Scientific Committee

The Trustees of IAMS and its Director are very pleased to welcome Milton H. Ward, Chairman, President, and Chief Executive Officer of Cyprus Minerals Company, as a new USA trustee of IAMS.

The Director is particularly pleased to announce that Dr John Merkel, our first IAMS sponsored American PhD research student (1978–82), has now been invited to join the Board of Trustees of IAMS. Dr Merkel, whose archaeo-metallurgical investigations – Experimental Reconstruction of Bronze Age Copper Smelting, based on the IAMS excavations in the Timna Valley, Israel, published in B. Rothenberg (ed.) The Ancient Metallurgy of Copper, Vol. 2 of Researches in the Arabah, IAMS 1990 – created a landmark in our understanding of the ancient extractive processes, was invited in 1988 to take up a teaching and researching post at the Institute of Archaeology, University College London and became a member of IAMS’ Scientific Committee. In 1991 he was appointed chairman of this central IAMS Research Committee.

The Director also welcomes four new members to the IAMS’ Scientific Committee: Dr J. A. Charles (Cambridge University), Dr R. Harrison (Bristol University), Professor I. Shimada (Harvard University), and Ms Z. Stos-Gale (University of Oxford).

IAMS sponsored first report in Europe on the discovery of a Sicán Lord’s tomb in Peru

On May 11, 1992, Professor Izumi Shimada, Peabody Museum, Harvard University, delivered a IAMS invited lecture on the important discovery of a Sicán Lord’s
tomb, belonging to the pre-Incan (c. 900–1000 A.D.) culture, at the site of Batán Grande, Peru. In this tomb a large treasure of the Sicán Lord’s grave goods of highest artistic accomplishment were uncovered, revealing new insights into the mysteries of Sicán culture. Dr John Merkel is the metallurgist and conservator attached to the expedition to Batán Grande, directed by Professor Shimada.

The lecture and reception at the Institute of Archaeology was very well attended, including Mr Gilbert Channy, Chargé d’affaires of Peru, Sir Sigmund Sternberg and some 140 invited guests. The Director and Dr Merkel are especially grateful to Sir Alistair Frame and Sir Sigmund Sternberg for their support of this event.

First publications of IAMS-supported post-graduate research

The present issue of IAMS Newsletter (No. 18) carries papers written by some of our students, Ms Vasiliki Kassianidou and Mr Jason Ryan, as first reports about their research work in the frame of IAMS’ and the Institute of Archaeology’s teaching programme. It is our policy to involve and support post-graduate students as partners in our own research projects and these papers show some of the important results of this approach. I would like to take this opportunity to thank Tom Kennedy, President of The Copper Club, New York, and G. F. Joklik, President and Chief Executive Officer of Kennecott Corporation, USA, for their generous support of this research projects which made it possible for IAMS to offer scholarships to several specially gifted students.

Conference on Bronze Age copper and tin at the Camborne School of Mines

In July 1992 a one day conference, ‘Prehistoric Extractive Metallurgy in Cornwall’, was held at Camborne School of Mines, Redruth, Cornwall, organized by a consortium of the Ancient Metallurgy Research Group, Bradford University, the Camborne School of Mines and IAMS. Although the Cornish peninsula combines rich mineral resources with some of the best preserved Bronze Age landscapes in the United Kingdom, comparatively little attention has been paid to the possibility of recovering traces of prehistoric mining. The conference reviewed the existing geological and archaeological evidence for extractive metallurgy in Cornwall, especially of copper and tin, and the participants discussed methods and plans for future research in the region. IAMS has for some years been involved with ‘the search for tin’ in Cornwall and plans to become involved in a Cornish major research project. We would welcome any support from individuals and institutions concerned with the ancient mining past of Cornwall as a major partner in the study of culture-history in south-west Britain.

Thanks to Andreas Hauptmann and John Merkel for the efficient organization at short notice of a very successful workshop on the archaeo-metallurgy in the Arabah at the Institute of Archaeology, Gordon Square, University College London. This direct meeting of archaeologists and scientists, reported above, dealing with the same range of problems in adjacent areas separated by geopolitical borders was an impressive event which may serve as a model of friendly, unbiased communication – imperative for scientific progress – in spite of difficult political situations.

Special thanks are due to John Merkel and his wife Cynthia Carpenter for hosting at their home a very pleasant reception for the participants in the workshop.

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