

The Chalcolithic Copper Smelting Furnace in the Timna Valley – its discovery and the strange argument surrounding its dating

Early in 1960, during our first exploration of the Timna Valley, Moshe Preis, the geologist of the modern Timna Copper Mines Company handed me a handful of early flint tools (see photos in Rothenberg 1962, Pl. XV), which he had found together with some small pieces of copper slag on top of a hill at the fringe of the Arabah, near the entrance to the modern mine. This 'gift' was rather exciting because until then we had only seen much later smelting sites, dated (now) to the Egyptian New Kingdom, 14th–12th centuries BC, and the Roman–Early Islamic period, where no flint tools were ever found. These flint implements were the first indication of prehistoric copper smelting in the Timna area.

During the following weeks of fieldwork we therefore investigated the area just *outside* the Timna Valley and located, besides the site seen by the geologists (later excavated and called Site 39 – see below), a large cluster of prehistoric settlements, many of them with remains of copper smelting, e.g. pieces of slag dispersed over a small working area (several square metres) near the houses or on a low hillock nearby. Amongst the slag and the houses we found flint tools as well as sherds of handmade early pottery (quite different from the handmade Iron Age pottery of the Negeb).

During a later survey we also discovered evidence of prehistoric mining and copper smelting *inside* the Timna Valley, although it became obvious that the prehistoric, rather small scale, 'cottage industry' type of copper production which was generally attached to settlements, took place mainly in the Arabah, outside Timna, and near the sources of drinking water and firewood.

The most significant result of our extensive surveys during the years 1959–84 was the conclusion that in prehistoric times the Arabah, part of the large, semi-arid region comprising the Sinai Peninsula from the borders of Egypt to the Mountains of Arabia and the Southern Negeb, was inhabited by indigenous pastoral nomads, copper (and turquoise) miners and smelters (for first reviews see Rothenberg 1979;1979a). We located several hundred prehistoric sites in the Arabah and adjacent Sinai, many of which could be dated by flint industries and pottery and recently also by radiocarbon measurements (Dr H. Haas, S.M.U. Radiocarbon Laboratory, Dallas, Texas – see Rothenberg, B. ed. *New Researches in Sinai*, Vol. 1, in press) to the era from the 6th millennium BC (Pottery Neolithic), through the 5th–4th (Chalcolithic) to the beginning of the 3rd (Early Bronze Age).

Typological as well as petrographic investigations of the flint industries and pottery of this indigenous prehistoric population established the existence in Sinai, the Arabah and adjacent areas, of a well-defined autochthonous prehistoric culture which could be traced through three phases of cultural development – accompanied by three, parallel developing, distinct phases of copper smelting technologies: from the primitive 'hole-in-the-ground' smelting hearth of the Chalcolithic Periods, through the first stone-built bowl-furnace and first slag tapping of the Early Bronze Age, to the sophisticated, well-ventilated, clay-lined shaft-furnace with perfect tapping facilities of the Late Bronze Age and later (Rothenberg, 1985). The scale of production at the individual smelting sites of these technological, and chronological, phases is also highly significant. A Chalcolithic 'cottage industry' produced only a few kilograms of copper whilst during the Early Bronze Age production increased to hundreds of kilograms, and the major smelting camps of the New Kingdom (Late Bronze Age) produced many hundred tons of copper, i.e. they achieved copper production on a really industrial scale. It is against the background of these basic facts that we have to try and understand the appearance of prehistoric

Fig. 1. Site 39.



copper mining and smelting in the Arabah – and the significance of the Chalcolithic smelting furnace at Site 39, the first prehistoric copper smelting installation ever found anywhere.

Site 39 : Chalcolithic Copper Smelting

Site 39 is located in the Nahal (wadi) Nehustan (one of the four main wadis of the Timna Valley), alongside the modern road to the Timna Mines Co. (Fig. 1). It consisted (after its excavation in 1965) of a circular enclosure, Site 39A, used for habitation and as a workshop for the preparation of the smelting charge, at the bottom of the hill on top of which the geologists had found the flint tools and peculiar small slag (Site 39B). The slag looked rather rough and viscous and showed numerous inclusions of copper pellets, quite different from the solid slag lumps we had previously seen at the New Kingdom smelting camps of Timna. During our subsequent survey we found more flint tools and also a few sherds among the slag on top of the hill and these appeared to be the same as found around and (during its excavation) within the circular enclosure below. The archaeological finds at Site 39 were studied at the time by Professor M. Stekelis, Director of the Department of Prehistory, Hebrew University, Jerusalem, and dated to the Chalcolithic Period (Rothenberg 1962, 8 and Chapter III).

In 1965 we excavated Site 39 (Rothenberg, B. 1966; 1972, 26–51). In the centre of the slag dispersal on top of the hill we found a hole-in-the-ground smelting hearth. It was originally dug into the ground to bedrock and had a low substructure of small stones (Fig. 2). The excavation proved that, at the conclusion of the smelting operation the content of the hearth was raked out in order to mechanically extract the metallic copper pellets entrapped in the very viscous slag. Obviously, the Chalcolithic smelter in his primitive hole-in-the-ground ‘fur-

nace’ did not achieve the separation of the metallic copper from the viscous slag. Many of the slag pieces found scattered around the furnace had sandy furnace wall material still sticking to them, and most contained quite a lot of copper prills (Fig. 3).

Excavating the furnace site, 39B, in 1965 (Rothenberg 1966, 86–93; 1978, 4–11, Plan and section Fig. 12), we found a hard-trodden working floor underneath the shallow Present Surface and this was stratigraphically the surface into which the hearth had been dug. On this floor we found some handmade early potsherds and a good number of flint tools (Rothenberg 1978, Fig. 17–9). The prehistorian A. Bercovici, Tel Aviv University, studied these flint tools and wrote: ‘Other implements, especially the axes family, are almost exclusively of Chalcolithic type and, therefore, important for the determination of the latest possible date of this group’. Bercovici compared the flint implements and the potsherds of Site 39 with the similar Chalcolithic finds from below the Egyptian Mining Temple of Timna (Rothenberg 1988) and reached the conclusion that this group of flint objects and potsherds indicates ‘a Chalcolithic culture which existed towards the end of the Chalcolithic Period ... the late 4th millennium BC’ (Bercovici, A. 1978, 16–20).

During the excavation in 1965 we collected several bags of soil containing traces of charcoal for radiocarbon dating but, to our great disappointment, there was not enough carbon in the samples for the C14 dating techniques available at the time. However, the archaeological evidence found at Site 39, especially as seen in the context of the extensive Chalcolithic occupation of the region and documented at hundreds of sites all over Sinai and the Arabah, made up for this lack of radiocarbon dates for Site 39.

The discovery and excavation of the first Chalcolithic smelting site and furnace was received with considerable

Fig. 2. Chalcolithic copper smelting furnace, Site 39A.



Fig. 3. Typical Chalcolithic slag (actual size) from Site 39A.



interest by archaeo-metallurgists and archaeologists alike and many of our colleagues came to see the site, taking metallurgical samples and archaeological finds for further studies. Site 39 quickly became the key site for the study of *Chalcolithic Copper Smelting* (Tylecote, R. F. and Boydell, P. J. (1978) and, indeed, appears in the archaeological and archaeo-metallurgical literature as the model-site for Chalcolithic archaeo-metallurgy. Site 39 with its distinct primitive copper smelting technology (and because of its location near many Late Bronze Age to Early Islamic smelting sites, the archaeological evidence and sophisticated archaeo-metallurgical installations as products of which could be easily compared *in situ*) became the obvious type-site for the early beginnings of copper smelting (for lack of space we quote here only some of the most important references: Tylecote, R. F. 1976, 7; 1986, 19).

Strange arguments surrounding the dating of Site 39

There was, however, one odd exception: James David Muhly. Already in the Supplement (1976) to the publication of his doctoral dissertation of 1973, he wrote: 'While little of the early material has been published thus far, it seems doubtful that anything at Timna is really earlier than EB II' (Early Bronze II = 2850–2650 BC – P.C.). Since I have always found it difficult to argue with people possessing supernatural powers like clairvoyance, which enables them to know things hidden from ordinary man (like unpublished archaeological finds or archaeological sites never seen), it seemed at the time of little use to react to Muhly's 'views'.

Muhly, however, did not let go. In 1984 he published in *Bibliotheca Orientalis* (XLI, No. 3–4) a very extensive review of our work in Timna. Concerning Site 39 he stated: 'I know of nothing found at any of the mining or smelting sites at Timna that need to be dated earlier than the latter part of the Egyptian New Kingdom'. Although Muhly is a well-established expert on ancient history, but he is not a metallurgist nor an archaeologist, and neither has he ever seen any of the archaeological evidence nor the sites themselves, yet he took it upon himself to evaluate and criticise the results of many years of systematic and very large-scale professional investigations by a group of well-known metallurgists and prehistorians. Here is a typical argument: 'Rothenberg has never published any hard evidence in support of the Chalcolithic dating of Site 39'. I wonder what could possibly be such hard evidence in the eyes of an ancient historian – obviously not the detailed comparative study of the flint implements (Bercovici, A. above; Ronen, A. 1970; Kozloff, B. 1974) from Site 39, nor the hundreds of similar settlements and smelting sites in Sinai and the Arabah (Rothenberg, B. 1968; 1970; 1972; 1974, see survey map in 1988) where only prehistoric flint and pottery finds were ever recorded – now C14 dated to prehistoric times.

As his only 'factual' argument against the Chalcolithic date of Site 39, Muhly signed up two rather extraordinary Late Bronze C14 dates published some time ago in *Radiocarbon* (Muhly 1984, 288). Regarding these C14 samples and their implication, I have already pointed out

in *IAMS Newsletter* No. 12 (1987) the damage to scientific research by the publication of C14 results of stratigraphically unreliable samples, sent to Radiocarbon Laboratories without confirmation of the context by the excavator. In our case, one of the samples was picked out of the soil brought several years after the excavation from a nearby location as fill for the excavated hearth 39B, in order to prevent its collapse. Muhly ignored the warning by the author of this C14 report, that this sample is 'invalidated by misassociation'. The second sample came from an intrusive Late Bronze Age fireplace of another site altogether (Site F2 in Timna) which was cleared long after the original excavation of the prehistoric site itself and has since been recalled as mistaken (Leese, M. N., in Craddock 1986, 117–8).

If such is all the 'hard evidence' Muhly can provide against our Chalcolithic date for Site 39, and of hundreds of similar prehistoric sites in Sinai and the Arabah, it should be difficult for any informed reader to relate to him seriously.

However, the story – and the damage – goes on: From amongst several recent publications following in Muhly's footsteps, we quote here as typical Hanburg-Tenison, J. W. (1986, 160): 'Much discussion has centred on the claim for Chalcolithic mining and smelting at Timna (Rothenberg 1966; 1978; etc.). Very little corroborative evidence has been produced to support the argument, and most scholars now reject any claim for metallurgy at Timna before the Bronze Age (Muhly 1984, 287)'. Perhaps many of the uninformed readers really were convinced by the overwhelming barrage of arguments produced in such an authoritarian fashion in Muhly's giant Timna review (16 double column folio pages), but scholars who actually studied the sites and finds *in situ*, do not seem to share his 'view'. A team from the German Mining Museum, Bochum, who worked in Timna in 1974–6, and are now active in the ancient mining area of Fenan (Jordan), wrote in a recent reply to Muhly's argument: 'The obvious exploitation of the mineral deposits at Timna and smelting of its ores already in the Chalcolithic Period, as repeatedly postulated by B. Rothenberg, has been disputed recently (Muhly 1984). However, we have to accept as certain the existence of [metallurgical] activities in the Timna Valley during the Chalcolithic period' (transl. B.R.).

Oddly enough, and actually amusing, there are 'Muhly waves' even in recent publications by the same Bochum scholars: '... in fact, the smelting furnace, site 39 ... cannot be dated (Muhly 1984), but the immediate proximity of a dwelling ruin (site 39A) where excavations have produced Chalcolithic flint material, ensures at least the presence of humans at the site in the Chalcolithic Period.' (Weisgerber, G. and Hauptmann, A. 1988, 53).

Rather odd. We quote from the original excavation report of Site 39 (Rothenberg, B. 1978, 7–8): 'An area of 4 × 3m. around the furnace was excavated down to a hard surface, which must have been the working floor, connected with the smelting operations. Charcoal, slag fragments, flint tools and some pottery were found on this floor, right up to the kerb of the furnace' ... 'At 39B,

around the smelting furnace, only one working floor was found, close to bedrock, and **on this ancient surface, flint implements and sherds were found *in situ*, and dated to the Chalcolithic Period**’.

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Exploring the Ancient Copper Mines of the Wadi Amram (South Arabah)

Wadi Amram is one of the southern tributaries of the Wadi Arabah, about 11km. from the shore of the Red Sea. This report describes an archaeological survey of its ancient copper mines (Rothenberg 1962), carried out by a small team from the Peak District Mining Museum, Derbyshire, England, in conjunction with IAMS, in October and December 1989. It compliments earlier archaeo-metallurgical work by Beno Rothenberg and the Bergbau Museum Bochum, at the nearby Timna Valley (Conrad and Rothenberg 1980; Rothenberg 1988).

Geology

The wadi near the mines is very steep-sided, with many near vertical cliffs, and there is no vegetation or natural source of water in the area. The mines are kaolinitic sandstone of probably Lower Cretaceous age, which is so unusually weak in compressive strength that it can be crushed in the hand. It is part of a thick sequence of white, yellowish and red slits and sandstones, which can be seen to overlie basic and ultrabasic rocks, and are unconformably overlain by an Upper Cretaceous (Cenomanian) limestone sequence, which forms a high escarpment.

The mineral seems mainly to be a copper silicate, probably chrysocolla, occurring irregularly in a band some three to five metres thick, though malachite or

related copper carbonate mineralisation is also present. The grade of ore was low, perhaps below 1% where it was mined extensively rather than selectively. It occurs occasionally as substantial nodules, but more generally it was in disseminated form as small wheat-sized nodules. The breccia also contains iron/manganese rich clasts which may have been used as flux in smelting.

Two mining Complexes: Sites 33 and 38 (on the Arabah Survey map, Rothenberg 1962, 1972, 1988).

There are two main mining complexes in the Wadi Amram and both were examined by our team. Site 33 is about one kilometre from the head of the Wadi and consists of two main areas, (a) a long scarp foot which slopes up to the skyline, and (b) an area of wadi-floor, beneath the cliff of area (a), where ‘plates’ were found. These are very shallow depressions, three to five metres across, which stand out from their surroundings because of their finer washed-in material. Similar ‘plates’ were excavated by an IAMS team in the Timna Valley in 1976 (Rothenberg 1988, Introd.) and turned out to be alluvially infilled mine shafts or pits. Site 33 has a scatter of Chalcolithic and New Kingdom (14th–12th centuries B.C.) pottery sherds and stone tools.

Site 38 is near the head of the wadi, adjacent to a rock formation called the ‘Amram Pillars’, a much frequented