Number 12
June 1988
ISSN 0261-068X
Institute for Archaeo-Metallurgical Studies

Institute of Archaeology, University College London, 31–34 Gordon Square, London WC1H 0PY. Telephone: 01-387 7050 ext. 4721

Early Islamic Copper Smelting – and Worship – at Beer Ora, Southern Arabah (Israel)

Fig. 1. View of the smelting camp at Beer Ora.

The smelting site at Beer Ora (Site 28 on our Survey map) was discovered by the author in 1959 during his archaeological exploration of the Arabah Valley from the Dead Sea to the Red Sea.[1] It is located about 25km. north of modern Eilat, one km. from an ancient well, still used today by a small settlement, and consists of two very large slag heaps surrounded by smaller heaps (Fig. 1).

Most of the slag pieces were broken off large circular slag plates, 50–80cm. in diameter and *c.* 7cm. thick. There were also complete slag plates, most of which had a small 'cast in' hole in the centre. This ring-shaped slag was obviously tapped, very heavy, solid and black, with very few copper inclusions, and obviously the product of an advanced smelting technique (Fig. 2).

Unlike all the other smelting sites of the Arabah, it was surprising that at Site 28 no stone-built structures were visible anywhere; indeed, there were no structures whatsoever. We assumed at the time that the workers' habitation may have been somewhere near the ancient well or in a nearby wadi, where some structural remains and Roman sherds had been found by our Survey.

Only a handful of apparently Roman sherds were found during our surface survey of the slag heaps, most

Fig. 2. Ring-shaped slag found in the excavations.

of which could be dated to the second century A.D., while some others remained difficult to define.

In 1969 we excavated at Beer Ora.[2] The most important find was a group of smelting furnaces in a fairly good stage of preservation. The smelting hearth was a mortar-lined pit, dug into the ground without any stone support and with a slag-pit attached to it. There were tuyère fragments but none as found *in situ*. One of the smelting furnaces had been refettled with mortar lining after a previous run – and abandoned unused (Fig. 3).

Although the furnaces at Beer Ora seemed to be of much less sophisticated construction than the earlier Egyptian New Kingdom smelters of the Timna Valley, the smelting technique appeared to be rather similar. There were, however, characteristic differences which only became apparent during the subsequent metallurgical study of the slag – Pyroxene type of slag instead of Fayalite and Knebelite types[3] – but these were basically connected with the fluxes used and not the result of a different smelting technology.

Upon excavation, the smaller slag heaps turned out to be collapsed buildings constructed of slag plates

Fig. 3. A smelting furnace of the Early Islamic period. Note that the used furnace was refettled for additional use, but subsequently abandoned.

standing on edge. Most of these rather small structures were used as stores but some were also habitations. One had a small kitchen attached to it, where remains of cooking utensils were found (Fig. 4).

Right in the centre of the smelting site we noticed a curious arrangement of slag plates which had been inserted into the ground, standing on edge, to form a rectangular ground plan, 7.5 × 5.5m. with an 'apse' at its south side (Fig. 5). Excavation showed that these slag plates had been carefully set into narrow, triangular foundation trenches and the 'apse' was constructed with particular care by using a double row of smaller slag pieces. The method of construction suggested that the lines of slag could only have been intended as the demarcation of a plot by a kind of symbolic fence. Clearing the inside down to a hard trodden surface, *c.* 10cm. below the present surface, some sherds and traces of a fireplace or two were found, but nothing to indicate the function of the structure.

In the first publication of Beer Ora in 1972,[4] based on the dating at that time of the pottery found to the Roman period, it was suggested that this enigmatic structure could be a 'symbolic' early Christian church. Reference was made to the observations in Sinai of Bedouin 'mosques', which are, in fact, only segregated plots, marked out simply by a line of stones or shells, with an 'apse' indicated as the *mihrab*.

In 1982 we excavated a rock-cut smelting furnace at Site 2 in the Timna Valley, reported in IAMS *Newsletter* No. 5.[5] This furnace (Fu Z) was dated by pottery and the general context of the site to the Egyptian New Kingdom, like most of the smelting camps of Timna. It therefore came as a great surprise that a charcoal sample taken from the very bottom of this furnace at the end of our excavation, produced a radiocarbon date of A.D. 740, i.e. Early Islamic. The implications of such a late date for Fu Z, which was of the same type as most of the New Kingdom smelting furnaces at Site 2, and also showed the same ring-shaped tapped slag, made it imperative to systematically re-investigate many of the Arabah and Timna sites and installations. This renewed investigation included the systematic collection of a large series of charcoal samples from all slag heaps in Timna and the Arabah which contained mainly ring-shaped slag, including the large slag heap of Beer Ora.

The radiocarbon dating of these samples proved that the Timna furnaces in question were indeed of a New Kingdom date, but at several sites there was also evidence for a later, secondary use of New Kingdom installations.[6]

The large slag heap of Beer Ora had already been sectioned in our previous excavation and we could therefore obtain well-stratified charcoal samples from the top of the heap to its bottom. All these turned out to date to the Early Islamic Period, the bottom sample to A.D. 640.[7]

Parallel to these scientific investigations there were also new developments on the archaeological front. As part of our preparations for the final publication of our Arabah and Timna research – the first two volumes of

Fig. 4. Slag-built store and kitchen of the Early Islamic period.

which are due for publication in 1988 – Professor M. Gichon re-investigated the pottery of the Classical periods found at our Arabah sites in order to update the reports prepared many years ago. Since a number of Early Islamic sites have been excavated within the last ten years, in the Arabah as well as in Arabia, much new comparative material became available. One of the important results of these recent ceramic studies was the re-dating to Early Islamic of a number of sherds which had previously been considered 'Late Byzantine or later'.

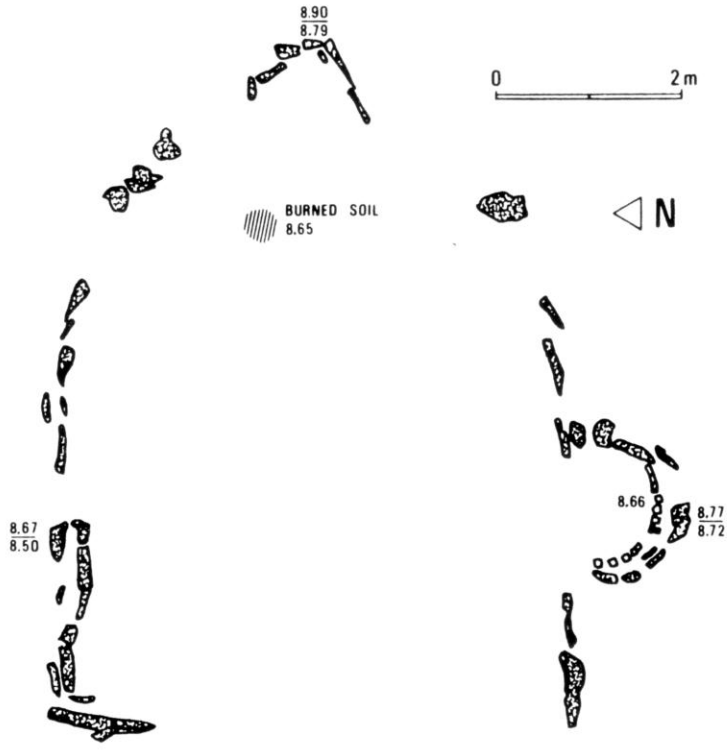
C14 dating, as well as the new pottery identification and dating of Beer Ora, established that the history of this site was rather more complicated than has been assumed so far. At the beginning, during the Roman Period, it was a copper smelter close to a Roman well and station. During the Early Islamic Period, when the southern Arabah was occupied by Muslim invaders, copper mining and smelting was restarted in the whole area. Beer Ora, probably because of its rich water source, and the proximity of a rich copper mining area at the nearby southern fringe of Timna, became the major Early Islamic smelter of the Southern Arabah.

Tracing each of the Early Islamic sherds to its exact stratigraphic context made it evident that the smelting furnaces of Beer Ora, previously published as Roman installations, and the related characteristic Pyroxene-type ring slag, must now be re-dated to the Early Islamic Period. This re-dating may also explain the fact that the Beer Ora slag showed fluxing with limestone, a fact which was quite difficult to accept for the Roman Period in the Arabah. Although the use of limestone as flux in a smelting charge in the Early Islamic Period still seems rather early, it appears now to be well established by Bachmann's phase studies of the Beer Ora slag.[3]

We now have the first reliably identified Early Islamic copper industry in the Arabah, using quite advanced extractive metallurgical production methods, and this new information adds a further chapter to the long history of copper mining and smelting in the Arabah.

In the light of these new and important re-interpretations, we can now ascertain the function of the

Fig. 5. 'Mosque' outlined in slag with the mihrab *orientated south towards Mecca.*



enigmatic slag structure among the slag heaps of Beer Ora. It is not a 'symbolic church' but a mosque built by the seventh century A.D. Islamic metallurgists of the Arabah. This, of course, also explains why the 'apse', i.e. the *mihrab*, was orientated south, towards Mecca.

The age-old tradition of erecting places of worship in the centre of mining and smelting regions, still adhered to in modern times, and well documented by our Arabah expeditions from the fifth millennium B.C. beginnings of metallurgy to the fourteenth–twelfth centuries B.C. Egyptian mining temple of Timna,[8] can now be followed through to the seventh century A.D. at Beer Ora – a total of about 6000 years of mining and metallurgy and metal-related worship.

Beno Rothenberg

References

1 Rothenberg, B. Ancient Copper Industries in the Western Arabah, *Palestine Exploration Quarterly*, 1962, 5–71; idem, *Negeb: Archaeology in the Negeb and the Arabah*. Tel Aviv, 1969.
2 Rothenberg, B. *Timna*. London, 1972, 214–23.
3 See Bachmann, H. G. Early copper smelting techniques in Sinai and in the Negeb as deduced from slag investigation, in Craddock, P. T. *ed. Scientific Studies in Early Mining and Extractive Metallurgy*, British Museum Occasional Paper 20. London, 1987.
4 Rothenberg, B. *Timna*. London, 1972, 221.
5 See also Rothenberg, B. A. rock-cut copper smelting furnace in the Timna Valley, *Historical Metallurgy*, No. 17, 1983, 116–19.
6 Rothenberg, B. I.A.M.S. Newletter, No. 9, 1986, 7.
7 Pta 4117, bottom of slag heap: 1390 ± 50 b.p.; cal. date 640 A.D. (Courtesy Dr. J. Vogel, Pretoria).
8 See reference Note 2, and now Rothenberg, B. *The Egyptian Mining Temple at Timna, Researches in the Arabah*, Vol. 1. London, 1988.

Arsenical Copper Smelting at Batán Grande, Peru

The Sicán Archaeological Project, under the direction of Professor Izumi Shimada (Harvad University), is a long-term interdisciplinary study carried out to date over nine seasons (1978–86). A primary research aim is an understanding of both cultural and technological aspects of Sicán copper production. John Merkel, who recently took a doctoral degree in archaeo-metallurgy on an IAMS Fellowship at London University, is collaborating with Dr. Stuart Fleming (MASCA, University of Pennsylvania) on the analytical programme of the Sicán Archaeological Project. Dr. Merkel (currently at Harvard, but shortly to join the staff of the Institute of Archaeology, University College London) is on the Scientific Committee of IAMS. The project is supported by grants from the National Geographic Society, the National Science Foundation and Harvard University.

Starting with the Middle Sicán Period, A.D. 900–1100, copper-arsenic alloys definitely replace unalloyed copper to become the mainstay of the North Peruvian metallurgical tradition. At the sites around Batán Grande (Fig. 1), indigenous copper production ended with the Spanish conquest at A.D. 1532–5. This brief report will discuss new evidence from technical investigations of the ores, slag, speiss, copper and furnaces, including copper smelting experiments conducted on site.

Based on work to date, it appears that Batán Grande represents part of an extensive, regional network of copper production sites. Six prehistoric mines and three smelting sites have been identified and, in part excavated in the Batán Grande area. The earliest remains of copper smelting furnaces date from *c.* A.D. 900–1000. At the site of Huaca del Pueblo, Batán Grande, five rows of small bowl-shaped furnaces have been excavated (Fig. 2). More than fifty examples of such furnaces have been examined altogether in the three

Fig. 1. Relevant archaeological sites in the Batán Grande region of North Coast Peru.