Recent Research in Chalcolithic Metallurgy: Investigation of Abu Matar, Israel

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The research being undertaken by the present writer consists in technical studies of metallurgical materials found in the course of the archaeological rescue excavation at Abu Matar, Israel, which was carried out under the auspices of Professors Itzac Gilead and Beno Rothenberg in 1991 for the Israeli Antiquities Authority (1),(2). Abu Matar is widely recognized as the most important Near East Chalcolithic (middle fourth millennium BC) site, having remains of the earliest copper smelting (3)-(6).

EXCAVATIONS

Abu Matar is a large, well-developed Chalcolithic settlement in the Beersheba Valley, north Negev, Israel. Initially excavated in the 1950s by Jean Perrot (7), the settlement was found to be contemporary with other Ghassulian cultures found in the southern Levant. In his excavations Perrot discovered remains of a metallurgical industry; the metallurgical materials then unearthed have been extensively analysed, documented and discussed (8),(9),(10).

ORE SAMPLES

The collection of metallurgical material at the Institute of Archaeology, London, is an assemblage of subsamples made by Professor Rothenberg from the originally excavated materials, which are preserved at Ben-Gurion University of the Negev, Beersheba, Israel. Initial analysis of the subsampled metallurgical material began with the examination of the copper and iron ores (Figure 2). In deciding which ores to analyse, a systematic sampling strategy (11),(12) was employed, which resulted in selection and analysis of 11 different ore samples.

The purpose of analysing the ores was to determine the numbers and types of minerals present and to attempt to ascertain the provenance of the ores. Examination of copper ores from Perrot’s excavations by Tylecote and colleagues (8) and Hauptmann (9) showed them to consist mainly of malachite, cuprite, chrysocolla and chalcocite. One of the major debates about metal production during the Chalcolithic period in Palestine is concerned with the source(s) of copper ores. There are two main copper ore sources in the region-Timna (13) and Feinan (9)-both of which are more than 100 km from Abu Matar and thus pose the question as to how these ores arrived at the production site. Were they mined by the metalworkers of Abu Matar themselves, were they traded or was there an established socio-political-economic system that ensured that the ores were brought to the production sites? In previous work comprising studies of mineral content, textural analysis, host rock, lead isotope analysis and comparison of chemical composition with present-day samples taken from Timna and Feinan, it was determined that ores smelted at Abu Matar derived from Feinan.

The metallurgical material excavated in 1991 (see Figure 1) is far better preserved and more complete than that excavated by Perrot. The range of finds is remarkable, comprising copper and iron ores, slags, furnace fragments, crucibles, copper and finished copper objects. The vast amount of metallurgical material far exceeds the amounts of material found at any other contemporary site in the Levant and therefore provides the greatest potential source of information on the technical abilities and, possibly, the cultural attitudes of the Chalcolithic peoples.
approximately 125 km away. These analyses were based, however, on only a few samples. More extensive analyses of new samples could either confirm those past findings or suggest an alternative ore source for the copper industry in the northern Negev.

ARSENICAL COPPER

Another important facet of the subject is represented by high-arsenic/antimony copper alloys. Initial analysis of prestigious items (eg crowns and mace heads) (14), such as those found in the Nahal Mishmar hoard, revealed highly arsenical copper alloys (15). More recent investigation of the Nahal Mishmar copper artefacts has established that a combination of antimony and arsenic, in high concentrations, identifies this as a very rare type of alloy in the Near East (16),(17). This spectacular assemblage of copper artefacts, which is on display at the Israel Museum, Jerusalem, is chronologically related to the material at Abu Matar, dating from the Chalcolithic period. The amount of metallurgical material found at Abu Matar leads to the suggestion that it could have been the major metal production centre for the Ghassulian culture and, as such, could well have produced such elaborate alloyed items. In view of this it was important to identify whether any of the ores discovered at Abu Matar were arsenical.

PRESENT STUDY AND INITIAL RESULTS

The present study employed several of the analytical techniques used in previous examinations of Abu Matar ores and introduced some new methods of investigation. Samples were mounted in epoxy resin and also thin-sectioned to 30 mm in preparation for analysis. First, microscopic and petrographic examinations were performed to gain a general impression of the complexity of the ores and to confirm mineralogy. Individual phases, minerals and host rock were analysed for chemical composition under a scanning electron microscope (Figure 3). Further, more detailed compositional analysis was performed with an electron-probe microanalyser. Samples were also powdered for X-ray diffraction analysis (XRD), which was used to identify minerals in the ores. Optical microscopy was then again used to complement the results obtained through XRD.

The results of these further analyses show the ores to be extremely complex, comprising many mineral phases mostly copper sulphides, such as chalcocite, chalcopyrite and covellite, but also including some carbonate ores, such as malachite and cuprite. XRD analysis indicated at least five major minerals in each sample with a number of minor, still unidentifiable lines. The iron ores were found to be carbonate (Ca(Mg,Fe) (CO3)2), which fits nicely with the postulation that the ores derive from the dolomite lime shale formations at Feinan (9). No significant concentrations of arsenic have been detected as yet in the ore samples and more samples are required to resolve the arsenic source problem.

On the basis of the information gathered so far, it can be stated that there are indeed some similarities between ores found at Abu Matar and the ore source of Feinan. The ores have a sandstone base, which matches the massive brown sandstone in Feinan. However, some of the minerals detected have not been reported as formed in the Feinan deposits. Further investigation with lead isotope analysis is recommended to help overcome the uncertainty as to the origin of the copper ores at Abu Matar. More ore samples were selected from the Abu Matar archaeometallurgical materials at Ben-Gurion University of the Negev during a field trip in December, 1997, which was funded by the Institute of Archaeology, the University of London Central Research Fund, and the University College London Graduate School. Analyses of these materials are to be completed during 1998.

The collection of metallurgical remains from Abu Matar represents a unique opportunity to study ancient mastery of metal production and the selective use of alloys. It is quite possible that ritual activity was associated with metal.
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procurement and this will be investigated and related to Chalcolithic temples found at Teleilat Ghassul and En Gedi and the Chalcolithic copper hoard found at the Nahal Mishmar cave. Early indications from preliminary analysis of the copper prills suggest that at least some of the copper artefacts produced at Abu Matar were made of the more prestigious arsenical alloyed copper, indicating an established site for specific production of these artefacts in the Chalcolithic period.

REFERENCES
