doi:10.18866/biaa2018.19

Metallurgical technology and metal exchange networks: a case study from the western Anatolian Late Chalcolithic and Bronze Ages

Michele Massa | British Institute at Ankara

From Mines to Graves (FMTG) is a four-year project sponsored by the British Institute at Ankara and dedicated to shedding light on the early stages of metallurgy in western Anatolia. Commencing in 2016, the research aims to investigate patterns of extraction, raw-material procurement and the manufacture and circulation of metal in western Anatolia between the Late Chalcolithic and the Late Bronze Age (c. 4000–1200 BC). The study area, which is rich in metal deposits and evidence of pre-modern mining, has also been extensively investigated archaeologically through numerous excavated sites and survey projects. This research corpus thus allows a seamless integration of the metallurgical and archaeological evidence, something that has not been possible so far for other Anatolian contexts.

FMTG's main research foci are: to understand the organisation of metal extraction, refinement and production and its diachronic changes; to identify episodes of metallurgical technology transfer; and to understand the mechanisms of metal exchange and the importance of metal for western Anatolian societies.

Methodology

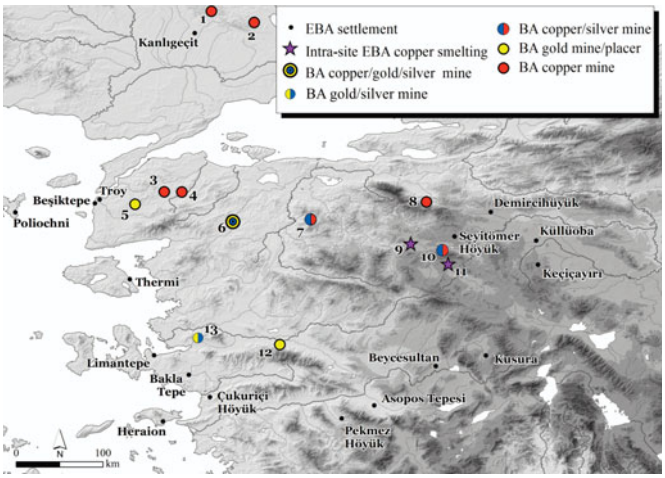
Previous research has suggested an increasingly sophisticated division of labour at major Anatolian mining sites already in the late fourth and early third millennia BC. Göltepe/Kestel and Derekutuğun in particular seem to reveal a spatial separation between different activities such as extraction, refinement, production of metal ingots/blanks and artefact manufacture. A field survey led by Erkan Fidan (an FMTG collaborator), investigating inland northwestern Anatolia (Kütahya province) in order to identify prehistoric mining sites and metallurgical workshops, provides the arena to test this hypothesis in the field.

Another focus of investigation is the development of metallurgical technology between the mid-fourth and late second millennia BC across the whole of western Anatolia, looking at extraction (mining), refinement (smelting/roasting) and production technologies (for example alloying practices, but also manufacturing techniques). In order to explore these issues, we have launched an extensive programme of chemical-composition analysis using non-destructive portable X-ray fluorescence spectrometry (pXRF), as well as destructive inducted coupled plasma mass spectrometry (ICP-MS) and metallographic analysis of ores, slags and artefacts.

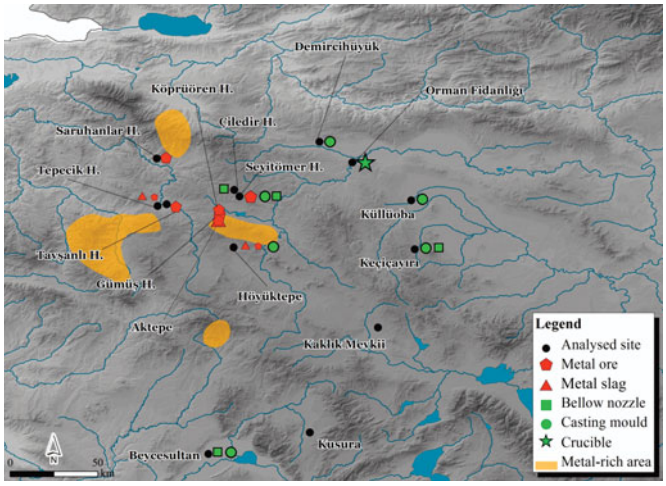
The last major focus of the project is the analysis of metal exchange networks and their organisation; this is being tackled through a range of different perspectives. Employing contextual analysis, we are trying to understand how much of the metal production may have been exported, by looking at, for instance, the presence and frequency of tools to create blanks and ingots, as well as the circulation of actual blanks in the study area. In addition, investigation of the metallurgical workshops themselves allows an understanding of whether they are 'wealthier' or more connected with distant communities (witnessed, for example, by the presence of exotic materials) than the average domestic context in the same site/area. Furthermore, a GIS platform allows us to visualise the analytical results in a spatial framework and to contextualise them within their ancient natural and human landscapes. It also provides the opportunity to plot the distribution of different artefact types in order to sketch broad patterns of exchange. Lastly, a programme of lead isotope analysis is allowing us to assess directly the origins of raw materials and finished products.

Results from the 2018 season

The first component of fieldwork in 2018 entailed an archaeometallurgical survey in the Kütahya province. An important result was the discovery of three mounded settlements (Saruhanlar Höyük, Tepecik Höyük and Tavşanlı Höyük) that yielded copper slags (debris from metal refinement) most likely dateable to the Early and/or Middle Bronze Ages.



Evidence for Bronze Age mining in northwestern Anatolia.



Evidence for metallurgical smelting and casting in north-western Anatolia during the Late Chalcolithic and Bronze Age.

The locations of these slag-yielding sites are between 5km and 10km from known copper deposits. While more research is needed (particularly in order to explore these potential metal sources), this indicates that primary smelting of copper-rich minerals could have taken place relatively far away from the mines. This new evidence adds up to extensive traces for contemporary intra-site metallurgical workshops in the region. Several excavated Bronze Age sites in Kütahya (Seyitömer Höyük and Höyüktepe in particular) have also yielded copper ore and slags. Furthermore, all Early and Middle Bronze Age settlements within a 100km radius from known copper sources have evidence of small-scale metal manufacturing activities in the form of bellow nozzles, casting moulds and/or crucibles (see the map above). Even though large metallurgical workshops have so far not been identified, the widespread evidence of metallurgy in the region certainly hints at its importance for local economies.

Part of the survey season was also dedicated to investigation of the multi-period silver mine of Gümüşköy/Aktepe, already known through research conducted in the 1980s. At that time, the Turkish-German team was able to identify evidence of extensive exploitation of the silver-rich lead minerals (galena) during the Roman, late antique and Ottoman periods. In addition, radiocarbon samples from several narrow tunnels yielded three dates between c. 2500 and 1700 BC, dating the earliest exploitation to the Early and Middle Bronze Ages. During our investigation we were hampered by the significant destruction of the archaeological levels as a consequence of recent (post-1980s) mining, and, unfortunately, we were unable to find any evidence of prehistoric occupation. We did, however, document in detail the large extraction operations (Roman to Ottoman in date) on the hills surrounding Aktepe, including numerous open-air pits pockmarking the area for at least 3km^2. Within a 5km radius from Gümüşköy/Aktepe, two roughly contemporary mounded settlements yielded numerous silver-lead slags, indicating an intensive use of the mine during the first millennium AD.

The second component of the 2018 fieldwork entailed the pXRF analysis of metal objects from Late Chalcolithic and Bronze Age sites along the Büyük Menderes valley and the central Aegean coast (Denizli, Aydın and Izmir provinces). This assemblage includes 135 samples from Beycesultan, Çine-Tepecik, Yassıtepe, Yeşilova, Bakla Tepe and Çeşme-Bağlararası. Together with the new dataset, we have now collected over 500 samples from 27 sites collectively spanning over two millennia.

Even though analysis of individual assemblages is ongoing, some general trends are readily detectable. Across western Anatolia, artefacts made of unalloyed or arsenical copper comprise the lion's share of the metal assemblages dateable between the Late Chalcolithic and Early Bronze Age II, and continue to be a significant (often dominant) component until the Late Bronze Age. In contrast, while the first tin bronzes start to appear in northwestern Anatolia relatively early (c. 2900–2800 BC), they remain uncommon throughout the whole Bronze Age. This pattern suggests the continuation of traditional alloying practices (with arsenic) and possibly the exploitation of local copper sources. The only exception is represented by sites with good access to major trade routes; these have considerably higher proportions of tin bronzes from at least the mid-third millennium BC.

Intriguingly, the large dataset at our disposal has allowed us to detect several rarer alloys that suggest an intensive process of experimentation particularly during the Early Bronze Age. These include copper with intentional addition of lead, nickel, antimony and/or silver. Particularly in the Middle and Late Bronze Ages, we detect an increase of 'dirty' alloys, with inclusions of metals not normally found together in earlier periods (for example tin and arsenic). This possibly suggests a higher rate of metal recycling from different sources.

Further work

The remainder of the 2018/2019 period of research will be dedicated to laboratory-based work on metal artefacts, slags and ores. Geochemical composition analysis (ICP-MS) will be employed to confirm and strengthen the results obtained with faster, non-destructive but less accurate pXRF. Metallography on slags will allow understanding of issues related to smelting technology and its diachronic changes. Lead isotope analysis on finished metal artefacts, slags and ores will allow us to propose potential copper and silver sources for our dataset and for already published assemblages, leading to a better understanding of the broader dynamics of metal exchange.