“Eastern Mediterranean Metallurgy and Metalwork in the Second Millennium BC”

A conference in honour of James D. Muhly

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Department of History and Archaeology and Archaeological Research Unit
On the cover: Copper ox-hide ingot from Enkomi now in the Cyprus Museum. Drawn by Clara Vasitsek.

Organizing Committee: Vasiliki Kassianidou and Giorgos Papasavvas.
During the last ten years, an increasing body of archaeological, mining and metallurgical evidence for copper production utilizing local mineral resources and dating to the 3rd millennium BC, has been recorded on a number of Aegean islands. The present status of our knowledge totally validates the pioneering suggestion of some vanguard archaeologists who, in the early seventies, based on indirect indications, wrote that in the Aegean Early Bronze Age there may have been local developments in metallurgy, allowing the production of metals by the exploitation of indigenous ore-sources. However, the flourishing copper production in the Aegean of the 3rd millennium does not seem to be followed by a respectively prosperous one during the consecutive 2nd millennium. Several sites in various islands of the Archipelagos such as Thassos, Kythnos, Seriphos, Siphnos, Parapola and others, proven (archaeologically and technologically) to be 3rd millennium copper production centres based on local ore-sources, appear to be inoperative, with scant exceptions, during the second millennium.

The possible reason(s) for the decline of copper production in the Aegean during the 2nd millennium, a period indelibly marked by the flush of copper production in Cyprus, are investigated in this paper, both from an archaeological and a metallogenetic viewpoint.

In recent years, the gradually accumulating archaeological knowledge increasingly convinces prehistorians to set aside the old view that the Aegean underwent a kind of lapse in the Middle Bronze Age (or even a few centuries later) in comparison to the Early Bronze Age. Not only in Crete but also in the Cyclades and in the north Aegean islands, Middle- and Late Bronze Age installations mark out their welfare, as well as socio-economic developments and interactions. Moreover, recent and ongoing studies on finds related to metal-technology from thriving Aegean 2nd millennium settlements indicate considerable metalworking activities, albeit oriented to alloying, casting, hammering, transforming, refining, recycling, and ornamentation. In almost all studied cases there are no remains indicating copper production from cupriferous ores, i.e. smelting slag etc. Thus the archaeological investigation, though it exhaustively examines and thoroughly
explains a large number of important issues, it leaves unanswered the crucial question of why the inhabitants of the flourishing 2nd millennium settlements were not engaged in copper production, as was done in the Aegean during the 3rd millennium.

On the contrary, the same region when seen from a metallogenetic and archaeometallurgical viewpoint provides some plausible features, which seem to shed some light on the above paradox. The following points are stressed in this study: a) the exploitable copper ores were never rich in the Aegean islands and in the Greek mainland (in comparison with adjacent regions), even if examined from the prehistoric point of view, b) the early Aegean copper production was always based on ‘oxidised’ (secondary) copper ores such as malachite, azurite, chrysocolla etc, not on primary copper sulphides, as it can be deduced from archaeometallurgical studies, c) the iron-sulphides existing in the Greek mainland and the Aegean usually contain low copper-sulphides (<5%); therefore it seems rather unattainable for the prehistoric metalworkers to have succeeded to extract any copper from such sulphidic ores, and d) exhaustion of oxidized copper ore is quite obvious at two early sites of open-air copper mining, found on Kythnos, an island considered to be the most important copper source in the Aegean during the Early Bronze Age.

In this study we support the position that copper production in the Aegean ceased in the 2nd millennium BC because the existing oxidized copper ores had been exhausted. We believe that this happened around the end of the 3rd millennium BC.
Pyrgos/Mavrorachi in Cyprus metallurgy

In the history of Cyprus metallurgy the site of Pyrgos / Mavrorachi offers evidence ranging in date from the Philia facies to the Middle Bronze Age II. Excavations have brought to light an architectural complex of Early-Middle Bronze Age dedicated to different industries, including the production and processing of copper. The industrial complex was built in the Middle Bronze Age on the ruins of Early Bronze Age houses. In addition to copper working, the most important industry was the production of olive oil which was used in copper smelting as well as in the production of perfumes and textiles. The evidence suggests that metal processing was carried out with different techniques. The stratified remains suggest that the craft had developed at the time of the first occupation of the site. The different forms and sizes of the furnaces, stone anvils and tools, moulds, crucibles, nozzles and bronze objects are the remains of this long lost activity. However, the absence of tuyères, coupled with the large quantity of mineral fragments not completely melted (reduced to copper slag granules), suggests that the smelting procedure had not been mastered. The chemical-physical study of crucibles and the furnace environment yields indications on the intentional use of specific work areas for processing specific metals and contributes to tentative reconstructions of the working processes, those in turn tested through experimental archaeology. The characteristic stone anvils and clay moulds for axes, which have no comparison abroad, testify to an indigenous background of long experience, suggesting that Cyprus had started to produce copper and bronze long before the second millennium BC.
The merchants of Ugarit: Oligarchs of the Late Bronze Age trade in metals?

Ugarit’s location at the nexus of land based routes that delivered tin from Central Asia and Eastern Mediterranean maritime trade circuits, together with its close proximity to Cyprus, from which it received abundant supplies of copper, make it a unique vantage point from which to study trade in the components of bronze in the Late Bronze Age. Added to this, we are indeed fortunate that, at the close of the Late Bronze Age, the merchants of Ugarit were literate and recorded their business dealings on tablets that have been excavated in their hundreds since the 1950s. This extraordinary survival means that we have more knowledge of the activities of Ugarit’s merchants than, for example, those of Europe in the early Middle Ages. This paper will explore the role the merchants of Ugarit played in supplying metals to the Eastern Mediterranean world in the closing years of the Late Bronze Age, drawing on recent philological work and attempting to integrate this with archaeological and scientific data. It will also consider how a business oligarchy comprised of powerful merchants, functioning alongside Ugarit’s Palace, may have provided the foundation for the development of entrepreneurial trade.
Between the beginning of the Middle Bronze Age and the beginning of the Late Bronze Age, Crete experienced a number of fundamental changes in its social, political, and economic situation. One of the most important of these changes involved an enormous intensification of its craftwork and manufacturing production, especially in the making of objects from bronze. That this production should have made such an impact on the island might be seen as surprising, because Crete has neither copper nor tin in sufficient quantities to support any large manufacturing industry. Both metals had to be imported, and Cyprus emerged as the dominant source for Cretan copper. The new relationship between the two islands benefited both of them, and it resulted in major developments in Crete and Cyprus that reached a peak during the latter part of the Late Bronze Age.
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Standing on ceremony? Copper metallurgy at Maroni-Vournes

The evidence for copper metallurgy at Maroni-Vournes is an appropriate subject for us to address here as it was Jim Muhly who, having inspected the material, provided the excavators with the first authoritative commentary on the identification and significance of the metallurgical assemblage. Professor Muhly was quick to note the fragments of oxhide ingots and the many fragments of slag that occur across the site, and it was with this correct assessment of the assemblage that Maroni-Vournes joined the list of Cypriot centres involved in copper production.

At that time, despite the increasing number of Cypriot sites associated with copper metallurgy, very little appeared clear about the precise nature of the technology used for copper production in Late Bronze Age Cyprus. Without such insights it is virtually impossible to build models of how communities organised copper production or assess whether Cypriot practices were a truly Cypriot innovation or whether they might be related to practice overseas. Evidence for copper production in Late Bronze Age Cyprus has proven to be complex and often surprising. For instance, in discussing archaeometallurgical finds from Enkomi, Kition and Hala Sultan Teke, Tylecote found it difficult to envisage primary smelting taking place at those settlements, despite evidence for what appeared to be matte smelting slags.

It is against this background of material being difficult to reconcile with context that the more recent excavations at Politiko-Phorades can be understood to be so significant. It now seems that we can, for the first time, appreciate what a Late Bronze Age production unit looked like with its furnace remains and significant slag deposit. However, the issue remains that slag deposits that occur at settlements are an interpretative challenge. Recent work on the material from Maroni-Vournes builds on Professor Muhly’s original assessment but offers fresh insights into the nature of the practices at such sites. In this paper we report the results of these recent studies and highlight the issues they raise and the implications for our understanding of Late Bronze Age metallurgy in Cyprus. Particular attention is paid to the context, scale and organisation of practice, which are of considerable importance for understanding the economic, social and political geography of Late Bronze Age Cyprus.
The evidence for metallurgical workshops of the 2nd millennium in Ugarit and the Levant

Our goal is to consider the pertinence of evidence of 2nd millennium workshops in the Levant, mainly at Ugarit, by comparing them with archaeological data from Cyprus (Enkomi, etc.), with data collected from experiments on ores and with the evidence collected from an «ethnoarchaeological» survey of actual workshops (smiths, tinkers, etc.) in Syria.

The study focuses on the different types of by-products (slag, fragmentary ingots, scrap metal etc.) and their context, on techniques which will not leave any traces («fonte au sable»), on perishable tools (like the ones made of wood), and finally on «multi-functional» materials which can be used in several activities or whose function can be mistaken with another one (ground stone tools, ceramics used as pot bellows, etc).

It will be argued that the evidence which seems to be the most pertinent (e.g. the mould from Ras Ibn Hani: production or recycling in a sanctuary?) is not necessarily evidence of metallurgical activity.

The question which will be addressed is whether there is evidence for smelting, melting and/or recycling in the workshops of the Levant, taking into consideration the role of itinerant craftsmen, as well as, the areas from where the ores came.
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**Bronzeworking in the harbour-town of Knossos at Poros-Katsambas**

The Minoan coastal settlement at Poros-Katsambas, already identified by A. Evans as the harbour town of Knossos, presents concrete evidence of intense commercial and industrial activities. Following a parallel way with the processing of obsidian in a mass-scale, metalworking develops already from the outset of the Prepalatial period, in Early Minoan I-II, as attested by a full array of metallurgical implements related to melting and casting of copper. This technological tradition has expanded further in the following Middle and Late Bronze Age, when also the trading activity of the prime Knossian harbour at Poros reached its peak.

The results of rescue excavations conducted at Poros suggest that metalsmithing was practiced extensively throughout the settlement during the Middle Minoan period. In Middle Minoan IIB-IIIA, in particular, when the Minoan palatial system was consolidated, copper/bronze workshops active at Poros seem to have operated with considerable quantities of metal. Metalworking further increases in the next, Neopalatial period, as evinced by finds including full series of permanent installations, equipment and waste material of bronzesmithing. In the Final Palatial period, after the destruction of the Minoan palaces and other urban centres, bronzeworking continues at Poros, all over the settlement, though now recycling seems to predominate as opposed to the use of imported raw material.

The available evidence permits an overall evaluation of the significance of metalworking activities at Poros during the 2nd millennium BC, in association with the function of the settlement as the main port of Knossos. This is further examined within the spectrum of the emergence and decline of the palatial societies in the first half of the 2nd millennium BC and the range of overseas trade, with reference to the function of the metal workshops and the existence (or not) of a central control pattern. Is the situation observed at Poros responsive (and in what degree?) to the structures of the bureaucratic administration of the nearby Knossos palace, as mirrored in the Linear B tablets? Do they have any relation with the strategies of the so-called “Mycenaean dynasty” being installed at Knossos in the years after the catastrophe of 1450 BC? Is the disintegration of the palatial system the reason for the decline and gradual eclipse of the industrial activity at Poros in the Post Palatial period?
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The role of the Apliki mine region in the post 1500 BC copper production and trade networks in Cyprus and in the wider Mediterranean

The role of Cyprus as a copper source in the 2nd millennium BC Eastern Mediterranean region cannot be underestimated. The importance of this role has received strong scientific support from lead isotope analyses (LIA) obtained for Cypriot, Minoan and Mycenaean artefacts, especially since the availability of comprehensive lead isotope analyses of Cypriot ores, published by Oxford in 1997 (Stos-Gale et al. 1997), with subsequent confirmation of LIA data for Apliki ores by Pernicka at Freiberg.

The comparison of the lead isotope data for Cypriot ores with that for the copper based artefacts with Cypriot LIA shows that it is possible to state that the great majority of these analysed copper based artefacts have the lead isotope ‘fingerprints’ of various copper mines situated around the Troodos mountain range. This accords with, and extends, the more limited direct archaeological evidence that copper was mined in the Bronze Age at Ambelikou and was smelted at Phorades and Apliki-Karamallos, together with smaller scale evidence from sites such as Enkomi, Ayios Dhimitrios and Hala Sultan Tekke. However, all analysed oxhide ingots dated post 1400 BC, found on sites ranging from Sardinia to Central Anatolia, including Egypt, Greece, Crete and Cyprus itself, have unmistakably uniform LIA ‘fingerprints’ that so far have been identified as consistent exclusively with the ores from the mining region of Apliki in the Northern part of the Troodos (Stos-Gale et al. 1997; Gale 1999). The most puzzling aspect of this research is the comparative scarcity of copper with the Apliki ‘fingerprint’ amongst the metal artefacts, other than ingots, from all Bronze Age sites in the Mediterranean analysed so far.

In this paper we conduct a detailed analysis of the presence of metal or slags with the Apliki LIA signature in various archaeological sites in the light of new analyses of ores from the Apliki mine region and new archaeometallurgical evidence from this mining area conducted in the past and in recent years. Additionally an analysis of the approximate relative copper production of different Cypriot mines will be attempted, using the lead isotope data accumulated during the 25 years of research into lead isotope provenance studies in Oxford.


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Niello versus kuwanna, the examination of the Enkomi cup

This paper presents the results of recent studies carried out on the famous silver cup, found in Enkomi, now in the collections of the Cyprus Museum in Nicosia (inv. nr. 4207). The piece was first published by Cl. Schaeffer (1940-1950) and was later discussed by several scholars, notably by R. Laffineur (1974). In the early '50s the Enkomi cup was cleaned and restored in the British Museum by M. Penderleith.

For this study the materials have been analysed, the object has been examined with different magnification devices and under the microscope. The manufacturing techniques employed for the silver cup and for the polychrome decorations have been determined.


A broken miniature oxhide ingot found at Allassa Pano Mandilaris during the 1984 excavation season put under dispute, at least in my mind, all earlier interpretations related to the ritual character or the symbolic values of the artefacts. Was that a signal of the collapse of the complex society in Cyprus, or merely a demonstration of the lack of copper during the final phase of the Late Cypriot period, which lead the owners to re-melt even the weights, as Zwicker has interpreted the miniature ingots? This question and others related to the bronzes from Allassa will be discussed in this paper, always within the broader context of metallurgy on the island of Cyprus.
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Cyprus beyond the East Mediterranean in the 2nd millennium: developments and perspectives

Jim Muhly’s many contributions to the study of Cypriot Bronze Age metalwork and metallurgy have included important contributions on the question of the European trade in bronzes and other material. The Mediterranean metals trade might seem irrelevant to what was going on in lands far to the north, even allowing for the piece of ox-hide ingot in the Oberwilflingen hoard in Baden-Württemberg; but the increasing evidence for north-south and east-west contact in the Late Bronze Age means that we should consider Europe and the East Mediterranean as a dynamic whole rather than as separate entities. The connections of Cyprus and the Uluburun wreck with Italy and Sardinia have been much discussed, but the connections north to the Black Sea and beyond remain to be fully explored. In this, the finds of anchors off Bulgaria, double-axes in Ukraine, and most recently the Hordeevka amber beads and Sarköy hoard are important pointers to a set of interconnections that show that the Black Sea was part of the East Mediterranean trade system just as the western and central Mediterranean was.

The paper will set these developments in the context of the much-discussed core-periphery debate, and suggest alternative models for understanding the unfolding evidence.
It is generally agreed that new coastal settlements, which appeared in Cyprus at the beginning of the Late Bronze Age (e.g. Enkomi and Hala Sultan Tekke), were not founded in the name of an agrarian economy. They were meant to function as gateway settlements that provided harbour facilities. During their foundation horizon each would have been little more than a terminal site in a regional settlement pattern engaged in the production and export of mineral wealth. By the 13th century BC, however, they had grown into primary urban centres and prominent East Mediterranean emporia.

The foundation of Paphos (Palaepaphos) on the south-west coast which, like Enkomi and Hala Sultan Tekke, was virtually a non site before the Late Bronze Age, should also be interpreted in the context of those processes that replaced the village-based agricultural economy of Early and Middle Cypriote with a complex economy based on the procurement and export of a metallic product. Strangely enough, the decisive role that the exploitation of copper sources must have played in the establishment of Paphos and its subsequent development into a state capital has not been sufficiently acknowledged.

Despite the limited visibility of the actual mines from where copper would have reached the Paphos harbour facilities, drastic changes observed in settlement number and settlement location in the wider Paphian region may not be unrelated to copper sources and copper routes. One of the key targets of the Palaepaphos Urban Landscape Project, which was initiated in 2006, is to try to understand, through landscape analysis and the use of GIS, the relation of the Paphian polity to its chora and how it may have affected its particular urban structure.
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Metallurgy and metalwork in Enkomi: the early phases

Enkomi justifiably is considered to be the most important Late Bronze Age settlement on Cyprus. First of all, it stands apart from most Late Cypriot sites in having a long habitation history that spans the whole of the Late Bronze Age. Second it is the most extensively excavated of this period, having been first excavated at the end of the nineteenth century by a team from the British Museum and subsequently in the middle of the 20th century by two teams under the direction of Claude Schaeffer and Porphyrios Dikaios. The excavations brought to light a well organized town with impressive architectural remains, where rich finds both local and imported were uncovered. Among them is the largest number of written documents, which appear already in the earliest phase of occupation. Furthermore, the only three complete oxhide ingots known from Cyprus, as well as, a significant number of fragments, come from Enkomi. Situated on the east coast, where throughout Cypriot history the island’s most important commercial harbour is located, Enkomi, probably the main port of export of Cypriot copper, is believed to have played a key role in the Late Bronze Age maritime trade network.

The excavations, especially those of Dikaios in the northern edge of the town, revealed evidence of a buzzing metallurgical industry dating already from the earliest phases of occupation. Over the years scholars have wondered about the metallurgical processes that were taking place in these workshops. The fact that the workshops are within an urban centre which is located at a significant distance from the rich ore deposits of the Troodos Mountains led to the reconstruction of a chaine opératoire for the production of copper ingots that started in the mining districts and was completed at this site. Jim Muhly was of course one of the scholars to address this issue. In his 1989 article entitled “The organization of the copper industry in Late Bronze Age Cyprus” he discussed the plethora of archaeometallurgical finds from the earliest phases of Enkomi and stated: “What is now needed, what is absolutely essential in order to understand the development of copper smelting technology at a site such as Enkomi, is a careful study of the stratified slags coming from all the major periods of activity at the site.”

As a tribute to him, I decided to take up the challenge and take a closer look at the archaeometallurgy of Enkomi. For the purposes of this presentation, I will focus on the earliest phases of occupation which correspond to the MCIII and
the LCI. The recent discovery and excavation of a LCI primary smelting workshop at the site of Politiko-Phorades, enables us to know much more about the smelting technology of this period, the form of the installations and the waste products. Thus the finds from Enkomi will be compared and contrasted with those from Phorades and an effort will be made to identify the metallurgical processes that were taking place in the numerous workshops of this important urban centre.
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Metallurgical production and exchange on Bronze Age Cyprus

This paper presents an overview of the archaeological and archaeometallurgical evidence for the production and exchange of copper, from its earliest emergence in the Prehistoric Bronze Age, through its development and fluorescence in the Protohistoric Bronze Age. Over a long period of nearly 2000 years, the production and exchange of copper transformed Cyprus’s role and position in the eastern Mediterranean from a localised producer to an international provider of the Bronze Age’s most crucial metal. In this paper, I consider the social and economic implications of this transformation, and discuss how metallurgical production and trade impacted on broader developments taking place within and beyond the island of Cyprus.
It is thanks to the pioneering studies of Robert Maddin, James D. Muhly and Tamara Stech on metal trade in the Mediterranean in the seventies, that Sardinia (where the first discoveries of oxhide ingots took place in 1857) was brought to the specialists’ attention. Following these studies, two subsequent research projects were developed: the first one, entitled *Cypriot metal trade in the Mediterranean and its interaction with the central Mediterranean and Nuragic Sardinia: the oxhide ingots* (2002), is aiming to the careful collection and recording of all the archaeological data related to the oxhide ingots in Nuragic Sardinia, through the systematic mapping of the findspots, the establishment of the provenance of the relevant finds and of their archaeological contexts; to the study of the typology and chronology of the associated metal and pottery materials; to the collection of all the drawings and photographs of the oxhide ingots with the addition of new and yet unpublished discoveries; to the recording of the weight of each oxhide ingot fragment, with reference to the metrological systems in the Bronze Age Mediterranean.

The second project, entitled *Metal trade in the Mediterranean from Cyprus and the Aegean to Sicily: the oxhide ingots* (2003) completed the research on the oxhide ingots from Sicily and the Aeolian islands, and included the ingots of different shapes and also scrap metal. The two oxhide ingots found in Corsica and South France were also taken into consideration.

The third and final enterprise was the publication of a volume presenting the updated results on the metal trade and Cypriot oxhide ingots in the central Mediterranean, from an archaeological, analytical and historical point of view.

In this paper, the story of these researches and projects will be traced.
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Profusion of Cypriot copper abroad and dearth of bronzes at home: reflections on a paradox in Late Bronze Age Cyprus

During the course of the Late Bronze Age, Cyprus had established herself as a major participant in the international relations and commercial enterprises between the Great Powers of the Eastern Mediterranean. Cypriots used the island’s abundant copper resources as a vehicle to penetrate in the wide geopolitical network that was maintained by empires, states and other polities, in order to regulate the circulation of immense quantities of raw materials and finished products. Both the archaeological finds and written evidence from various areas testify to the growing importance of Cypriot copper for the maintenance of several bronzeworking industries around the Eastern Mediterranean and beyond. This successful venture not only gave Cyprus a prominent role in the Eastern Mediterranean, but it also affected the developments back home, since the significant changes discernible in the patterns of settlements and burial practices from the Late Cypriot I onwards are usually ascribed to the intensification of copper production and of long distance trade.

Despite this dependence of many cultures to Cyprus for the acquisition of copper already by the Middle Bronze Age, Cyprus herself appears to have had a rather restricted bronzeworking industry in the larger part of the Late Bronze Age. Before Late Cypriot IIC, bronzes from tombs, sanctuaries or settlements are rare on the island, and never of a quantity or quality that could be compared with the products of the areas that were importing Cypriot copper, let us say Minoan Crete. In other words, there are simply not enough Cypriot bronzes from this period, which would account for a correspondingly extensive use of this metal by Cypriots as well. Bronzes are lacking even in flourishing towns, such as Enkomi, where rich evidence for metallurgical activities since its foundation has been unearthed, or even in rich tombs in the period from Late Cypriot I-Late Cypriot IIB. On the other hand, a large array of imported, prestige items found in several of these tombs testify not only to the high levels of social complexity but also to the interaction with the foreign countries that Cyprus was supplying copper to. This is a reversal of the situation observed in the previous period, when large numbers of bronzes were a major component of mortuary assemblages, whereas foreign imports were rather limited.

How is it possible to account for this paucity of bronze items at exactly the
period where both the exploitation of copper and the contacts of Cyprus to her neighbours had expanded at an unprecedented scale? Conventional explanations, such as differences between Cyprus and other areas, such as, let us again say Minoan Crete, in the uses of bronzes in ritual, mortuary or habitation contexts, or the extent of excavated sites on Cyprus in comparison to other regions do not seem to account for this state of affairs. Moreover, Cypriot smiths were in the position to develop their own bronzeworking tradition by at least Late Cypriot IIC, as demonstrated by the manufacture of highly sophisticated and technologically complex, bronze works. What was happening in this respect between this period and the earlier part of the Late Bronze Age?
The emergence of tin-bronze metallurgy across the Asian Old World – a question of sources and societal impact

Since, and as a direct result of, the 1973/1976 publication of James D. Muhly’s seminal volume, Copper and Tin, new research has done much to demonstrate that the emergence of tin-bronze is a pan-Asiatic technological phenomenon. Muhly’s own research and publications over the past three decades have proven to be a motivating force in the subsequent characterization of this emergence and its societal impact.

For purposes of discussion, I focus upon two of Muhly’s formative statements on the rise of tin-bronze to assess where our research is today. First, in his “Supplement” to Copper and Tin (1976:97), he suggests, “The Near Eastern texts dealing with the tin trade, both in the Old Assyrian and in the Old Babylonian periods, still seem to make best sense in terms of a source of tin coming from the east…” Just what do we know at present about such ‘eastern’ sources and their role in the metals trade of Southwest Asia?

Second, in his 1988 article entitled, “The Beginnings of Metallurgy in the Old World”, Muhly wrote: “In all other corners of the Bronze Age world….we find the introduction of bronze technology associated with a complex social, political and economic developments that mark the rise of the state. Only in Southeast Asia…do these developments seem to be missing.” Today, this one statement lies at the heart of a region-wide controversy in Southeast Asia involving archaeological, technological and chronological data. One school of thought maintains that tin-bronze appears in this region in the very early 2nd millennium BC within a heterarchical societal context. In distinct contrast, a second school of thought argues for the appearance of tin-bronze ca. 1000 BC in a socially-complex hierarchical context which only centuries later led to the rise of the state in Southeast Asia. This controversy will be briefly reviewed and the question asked: “Can tin-bronze metallurgy be used as a marker for the development of more socially-complex societal constructs such as the state?”
“Reconstructing” the Enkomi tombs (British Excavations):
An instructive exercise

The project (The artifacts of the Enkomi Tombs (British Excavations) in Cyprus: Digitisation Programme) began as a continuation of the digitisation project carried out by the British Museum of the contents of the tombs of Enkomi excavated by the British in 1896. The proposal, aiming at the digital “restitution” of the tombs was submitted to the Research Promotion Foundation and was approved in 2008.

Had the statement in Murray, Smith and Walters 1900 been adhered to in the so-called “share” process, that the division [of the objects] was made in such a manner as not to separate the contents of any one tomb, the Cyprus Museum would have had the contents of one third of the 100 tombs excavated, that is 33 or 34 tombs and the British Museum would have had the contents of the rest, that is 66 or 67 tombs. The fact that it was possibly the first excavation in Cyprus of its time to have left behind some records was not underestimated, but at the same time some degree of inaccuracy was expected. It was not, however, before the objects were re-registered in the British Museum catalogues that the discrepancies began to become apparent and are now becoming real difficulties. Not only are the total number of objects in the tombs different from what was originally recorded, but tombs that were recorded to have been allocated to the Cyprus Museum are now “invisible”. It appears at present that the Cyprus Museum only has objects from 22 tombs. In addition objects from the same tombs that consistently appear in both museums, clearly indicate that the tomb contexts were not kept intact.

A further problem is the actual identification of objects in the Cyprus Museum which is due to a number of factors:

Objects regarded to be “duplicates” and therefore not worthy of being preserved, may have been discarded in the past, sometimes by agreement or individually.

Secondly, the objects from the 1896 excavations, initially stored in the old Cyprus Museum on Victoria Street were, on their transfer to the new Cyprus Museum in 1909 given Museum accession numbers and a number of them have in that process lost their tomb provenance. To make things worse, the objects were catalogued according to material and in the case of gold, bronze and other non-ceramic objects, the loss of the original tomb number is much more common.
Ironically it has only been possible to identify only one bronze artifact in the Cyprus Museum to complement the inventory already published by the British Museum.

Further, the overwhelming majority of the tombs were found disturbed and it is thus difficult to claim that this restitution or re-unification of the contents is representative of the actual original wealth of the tombs. The possibility of practising secondary interments or emptying in antiquity may have also affected the number of objects in each tomb. But even with all these problems of the past and the present, their wealth in precious materials and exotica is still striking and indicative of the status of the deceased.

It is hoped that after every object is recorded, a complete verified inventory and the final allocation of the tombs- and possibly its reasoning- will be available. Further study of the contents and composition of the tombs may eventually result in the re-assessment of the tomb assemblages excavated in 1896 with respect to their social and political implications.
QANTIR-PIRAMESSE - Bronze workshops of industrial dimensions

The city of Pi-Ramesse in the eastern Nile Delta was Egypt’s capital for much of the 19th and 20th dynasty. Within the overall city-area, covering about 30 square kilometres, a limited section of approximately 30,000 square metres can be identified as high-temperature workshops. The archaeological evidence in situ enabled reconstructions of a huge early Ramesside bronze factory, proving an industrial scale of bronze production and casting.

“Melting Batteries” of more than 14 metres length are arranged parallel to each other and orientated towards “Cross Furnaces” of about 9 by 9 metres. The melting batteries carried large numbers of bronze melting crucibles, while the cross furnaces are tentatively identified as heating devices for large moulds until the cast is accomplished. Attached to this foundry is an extensive workshop area, most probably for further processing of semi-finished products into “objects”. Whilst their kind and function remains somewhat obscure, it is most likely that they were connected to the needs for the basic equipment of the city of Pi-Ramesse as well as to needs beyond.

The sheer size of the installations connected with bronze production and attached workshops for further processing forced us to re-interpret the traditional concept of ancient Egyptian reliefs and paintings known from tombs and other sources: To the “Suq-concept” – small workshops working alongside to each other, no matter what their affiliation – the “Industrial-concept” has to be added, as known since the earliest times of Egyptology from stone-handling (see Pyramid-construction) and import of timber (see ship and temple building) and even the import of copper.

The findings of the “factory” shall be presented and the reconstructed technology shall be exemplified. They will be set into the frame of the site’s stratigraphy, international relationships and an overall high-temperature context.
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The metallurgy of bronze production at Qantir – Pi-Ramesse

Long-term scientific excavations at the Ramesside site of Qantir – Pi-Ramesse in the eastern Nile Delta (see paper by E.B. Pusch) yielded overwhelming evidence for bronze melting and casting. This paper looks at the metallurgical aspects of this industry, studying the technical ceramic and the metallic remains. The first part presents the technical ceramics used in the crucibles and the possibly related cross furnaces, pointing to clear material and design differences and attempting a functional interpretation of these differences. The second part looks at the evidence from metallic remains within the crucibles, containing regularly phases very rich in tin, well beyond the normal range of compositions encountered in ordinary bronze. These tin-rich phases and regions within the crucibles are interpreted as an indication for the regular and planned alloying of tin and copper metal, rather than the *ad-hoc* re-melting of existing low-quality bronze. This is linked back to the well-known evidence for organised long-distance trade in copper and metal during the Late Bronze Age, suggesting future research in this aspect to better understand the relative role of the various copper-producing regions active at the time.
The Vasilikos Valley in southern Cyprus is a location of important copper sources (mined in recent times). Archaeological survey and excavation, especially at the large Late Bronze Age town of Kalavasos-Ayios Dhimitrios, have revealed much evidence concerning metallurgical activity and the role of metals in the Bronze Age economy of the area. Little is yet known about the earlier phases during the Early or Middle Cypriot periods, although large numbers of copper or bronze objects have been found in MC tombs. At Ayios Dhimitrios in Late Cypriot IIC, finds of slag and other metallurgical materials are widespread in almost all parts of the site, although not in very great quantity. Furnaces have not been found, with the exception of a few fragments and one incomplete possible small installation. One building seems to have been used for small-scale coppersmithing to repair or re-use copper/bronze items and scrap. Copper or bronze objects occur frequently, mostly of the usual Cypriot types, including ingot fragments, with a few more unusual examples. While metallurgy clearly had a significant role in the economy, a prominent place was also given to highly organised agricultural production, especially of olive oil. Not all of the planned metallurgical studies have been completed, but the evidence so far will be summarized.
Just a few rusty bits: the innovation of iron in the Eastern Mediterranean in the 2nd and 1st Millennia BC

The Eastern Mediterranean is widely credited with the ‘innovation’ of the metal iron. It is beyond doubt that iron, after its arrival, had a profound influence on many aspects of ancient societies. These range from the quality and nature of tools, weapons, and building materials that now became available, through the nature and scale of agriculture that the new tools allowed, to environmental impact on many levels. However, early finds (pre 500 BC) of actual smelting and smithing of iron are extremely scarce in the entire region. As a result, historical as well as technological reconstructions of the invention and development of early iron production, and thus its role in society, are largely formed by the presence of iron artefacts in the archaeological record rather than actual production remains.

This paper will explore how just a handful of small and heavily corroded artefacts from the second millennium BC, predominantly from Anatolia, has led to wide ranging and influential theories that still colour our understanding of the past in this region. From just some 30 fragments, in combination with a few, often debated, literary indications of the presence of iron in antiquity have sprung, for example, the many stories about a state monopoly on iron (by Hittites, Philistines, Assyrians), about the way that this metal gave those who possessed this secret knowledge the ‘edge’ in battle, or about the role of this innovation for the political changes in the Eastern Mediterranean states and also about the way that this metal spread out from there.

However, it is only at the turn of the 2nd and 1st Millennium BC that we are in the position to extract some information on actual production of iron. And, besides a wealth of technological information this evidence surprisingly shows a very different view about the social and economic place of iron in society. Drawing from the unique 930 CalBC iron smelting finds from Tell Hammeh in Jordan (including the smelting furnaces discovered there about a month ago), and the 900 CalBC smithing finds at Tel Beth-Shemesh in Israel, this paper will discuss how iron was made and how it was embedded in the culture, economy, and society of the Eastern Mediterranean at that time.
Late Bronze Age Alalakh and Cyprus: A relationship of metals?

The excavations at Tell Atchana (ancient Alalakh) brought to light the capital of a small Bronze Age regional state called Mukish dating from 2200-1300 BC. The archaeological finds represent aspects of its lively international discourse, if not shared artistic styles with far-flung areas such as Cyprus, Crete, Mesopotamia, Hittite Anatolia and Egypt. This paper aims at sparking a dialogue on the notion that objects and the technical knowledge of making them elucidate relationships deeply embedded in the social order. The production of fine artifacts such as metalwork, glass, faience, and ivories was under palace patronage. At the same time, trade, diplomacy, warfare, and interregional networks facilitated the transport of materials across great distances in the ancient Near East. Several analytical techniques have aided in the reconstruction of these trans-regional activities. In particular, Lead Isotope Analysis, ICP-MS, the use of Scanning Electron Microscopy (SEM) and polarizing light microscopy, have highlighted the artistic expression of Alalakh and the production of artifacts of power and prestige. Within this frame, new information is presented about the sources of raw materials in the Amanus and Taurus Mountains.
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