Mediterranean Archaeology and Archaeometry, Vol. 18, No 1, (2018), pp. 11-25

DOI: 10.5281/zenodo.1069514

METAL ARTEFACTS IN CHALCOLITHIC CYPRUS: NEW DATA FROM WESTERN CYPRUS

Bleda S. Düring[1], Victor Klinkenberg[1], Charalambos Paraskeva[2], Vasiliki Kassianidou[2], Ellon Souter[3], Paul Croft[2], and Andreas Charalambous[2]

[1]Faculty of Archaeology, Leiden University, PO Box 9514, 2300 RA Leiden, The Netherlands
[2]Department of History and Archaeology, The University of Cyprus, PO Box 20537, Nicosia CY-1678 Republic of Cyprus
[3]Department of Archaeology, The University of Manchester, Oxford Road, Manchester M13 9PL United Kingdom

Received: 05/08/2017
Accepted: 24/10/2017
Corresponding author: Bleda S. Düring (b.s.during@arch.leidenuniv.nl)

ABSTRACT

The origins of copper-based metallurgy on the island of Cyprus, which became the main supplier of the metal in the Late Bronze Age in the Mediterranean and whose name became associated with the metal, is relatively obscure. While metal extraction and metal artefacts became increasingly important in the broader Near East, early metallurgy on Cyprus remains poorly known, and it is often postulated that metals were of limited importance on the island prior to the Philia phase. Here we present a unique context from the Late Chalcolithic (ca. 2800-2400 BC) from the excavations at Chlorakas-*Palloures* that has considerable ramifications for this debate.

KEYWORDS: Chalcolithic Cyprus; Chlorakas-Palloures; early metallurgy; copper; exchange networks

1. INTRODUCTION

To most archaeologists and ancient historians the link between Cyprus and copper metallurgy appears self-evident; the island was a major producer in antiquity, and the metal and the island toponym became synonymous (Kassianidou, 2014). However, in prehistory this link was far from obvious, as copper metallurgy took off much earlier in regions such as Anatolia, the southern Levant, Iran and Arabia, than it did in Cyprus (Yener, 2000; Weeks, 2003; Philip et al., 2003; Vatandoust et al., 2011). By contrast, in Cyprus, there is relatively limited evidence for copper metallurgy, or indeed copper-based artefacts, prior to the so-called Philia phase (ca. 2450-2250 BC, Peltenburg et al., 2013: 338). This late start of metallurgy on the island has puzzled scholars, especially because artefacts that are held to have been made of Cypriot copper ore have been found at Pella, in Jordan, (Philip et al., 2003), and at Aghia Photia on Crete (Day et al., 1998; Stos-Gale and Gale, 2003), both dating to the early third millennium BC. It has even been suggested on this basis that the chronology of prehistoric Cyprus needs to be shifted several hundreds of year earlier than is conventional (Bourke, 2014), a hypothesis that seems untenable in the light of recent work on absolute chronology on Cyprus (Peltenburg et al., 2013; Manning, 2014a; 2014b; Paraskeva, in press).

In this paper we present a context from the Late Chalcolithic in which a metal axe/adze was retrieved from the excavations of Chlorakas-*Palloures*, located near Paphos in the southwest of Cyprus, which can provide a significant contribution in understanding this problem of how and when the emergence of copper-based metallurgy on Cyprus occurred.

2. EXCAVATIONS AT CHLORAKAS-PALLOURES

The site of Chlorakas-*Palloures* (also known as *Vrysoudhia*) was first identified in the 1950s (Karageorghis, 1967: 302; Hadjisavvas, 1977; Stanley Price, 1979: 143, see also Bolger et al., 2004; Peltenburg, 1979: 79). It is one of a series of Chalcolithic sites situated in the Ktima lowlands (Christodoulou, 1959: 9-18), in the Paphos District of western Cyprus (Figure 1). A series of Chalcolithic settlements have been found in this region which are about 1.5 km apart and are located on raised terrain overlooking the coastal plain. *Palloures* is one of these settlements, situated on the western edge of the village of Chlorakas and due north of the city of Paphos.

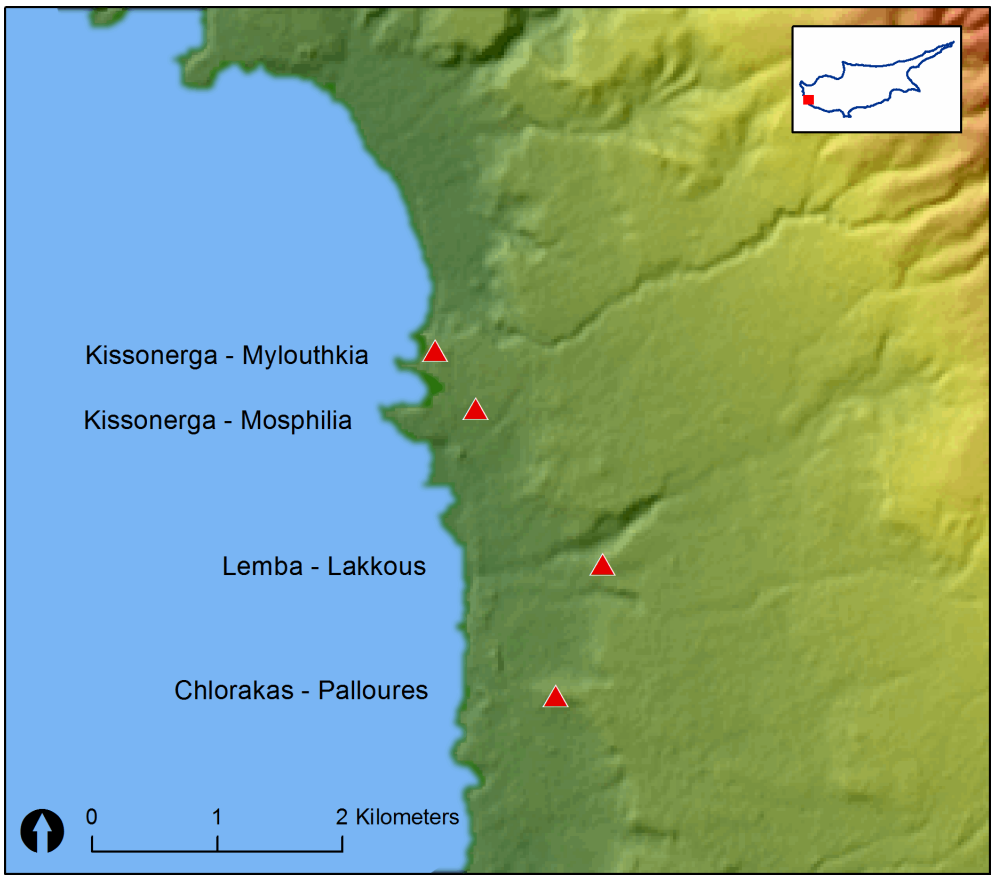

Figure 1. Map of Chalcolithic sites in the northern Ktima, western Cyprus (produced by V. Klinkenberg).

The site has been badly disturbed by a mid-1970s land consolidation program; several roads were cut through the site and buildings were constructed on top. One of the central plots of the site was scheduled for development in 2015. Due to this, a three year rescue excavation was initiated from 2015 onwards to investigate the archaeological deposits. Given the risk of imminent destruction and limited time frame, the excavation strategy at Chlorakas-*Palloures* has been to excavate as much of this part of the settlement as possible. To date, 13 trenches of 5 by 10 metres have been opened in order to establish the distribution of archaeological strata across the site and locate well preserved buildings and contexts. Two clusters of buildings were defined (Figure 2). In the north is a group of mainly large and well-built buildings, which contained some extraordinary features, such as very large hearth platform and a large mortar installation. In the southern cluster a series of smaller domestic structures was excavated, measuring some 4 to 6 metres in diameter.

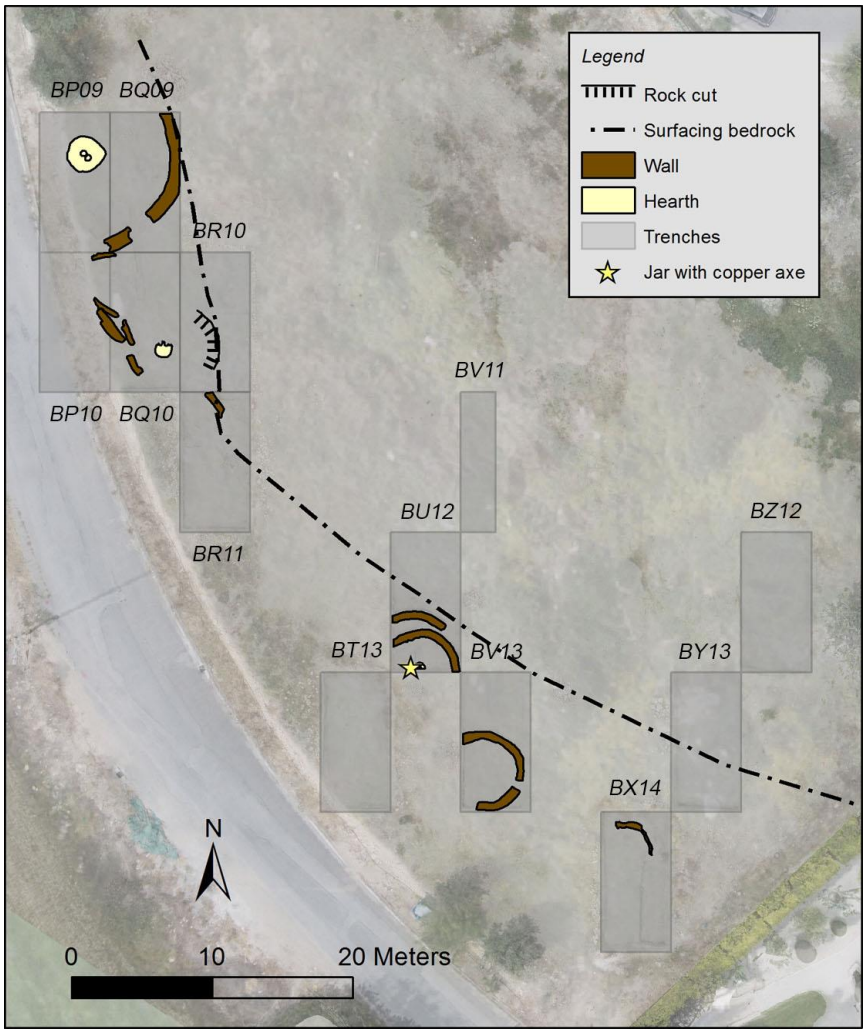

Figure 2. Plan of the Palloures showing trenches and the main architectural features encountered (produced by V. Klinkenberg).

3. A REMARKABLE CONTEXT

In this paper the focus is on trench BU12 where a sequence of two buildings was uncovered (Figure 3). Building 5 is the earlier of these two structures and is approximately 8m in diameter. The bedrock has been cut to create a level surface on which this building has been constructed. The wall is well built and stands four courses high. The wall ends in the east, possibly because its stones have been robbed. Probably associated with this building is a plastered raised hearth found in the south of BU12, and a compact earth floor surrounding it, however, we need to work further on this to establish the relationship. Most likely in association with this floor surface was a collection of six ground stone tools, including a very large pestle, measuring 47 cm in length.

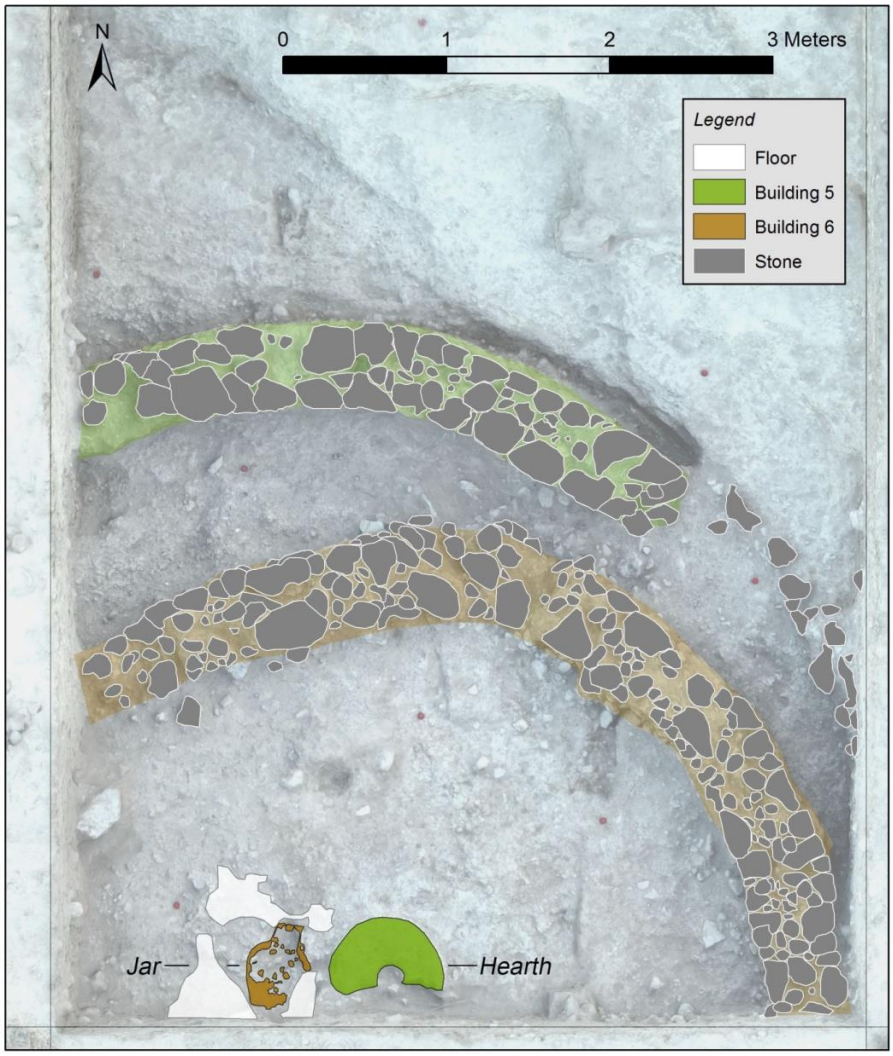

Figure 3. Plan of southern half of trench BU12 showing building 5 and its successor, building 6, the central hearth and the jar (produced by V. Klinkenberg).

Overlying this floor was a collapse deposit covered in turn by a midden deposit. Significant quantities of finds were obtained from the latter. On top of these a second building (building 6) was built, which would have measured about 5.6 metres in diameter. The wall is not as well constructed as that of its predecessor, and it is plausible that some stones were taken from the older building for its construction. No clearly associated floor surface was preserved, but fragments of plaster were found at a relatively high level. Significant to this discussion is an almost complete, large jar, which in all likelihood belongs to this later building.

This large jar (571_DC1) was found lying on its side. Although mostly intact, ploughing has shaved off part of the vessel. Intriguingly the jar contained a remarkable collection of artefacts, which include four hooks made of pig tusks (Lots 567_M1 and 571_M2/M3/M4), a large and flat stone axe/adze (571_G1) and a metal axe/adze (571_M1). This is a significant set of artefacts (Figure 4), given that all the artefacts are either unique or rare in Chalcolithic Cyprus.

Jar 571_DC1 was located very close to the surface which makes it difficult to determine its precise context. It is apparent, however, that the jar was lying in a depression or a cut in a lime plaster surface. This surface (Unit 18) seemed to be sloping down at its sides which could indicate that it originally was a raised platform or hearth. Due to later truncation of the plaster surface no original edges could be defined on its sides. The lime plaster ran up to the ceramic sherds, indicating that the cut or depression was probably created in relation with the deposition of the jar. A probable scenario is that the jar was originally set upright on this surface, functioning as a dug-in storage jar.

The abandonment of the jar and its content could be explained as the result of a hasty departure following a local catastrophe such as a major conflagration. In the present context, no burning traces or other indicators have survived, however, to substantiate

such a hypothesis. In line with the examples of similar contexts described below, it is conceivable that the jar deposition is part of a tradition of deliberate caching. Two conventional interpretations are available for these contexts: first, that of a banking cache, that is a collection that was stored / hidden temporarily; or, second, a ritual cache, that is a collection that was deposited as part of a ritual and not meant to be retrieved (Klinkenberg, 2016: 21-2). Considering the uniqueness of the jar assemblage and the probable high economic value of the metal axe, the deposit could be interpreted as a banking cache. The assemblage is however rather varied in nature which makes an interpretation in the ritual sphere more likely.

The practice of caching objects other than liquid and solid consumables in storage vessels as banking or ritual caches has a number of possible parallels at Chalcolithic sites in the region. For the Middle Chalcolithic period, the best known instance of object caching was discovered in the Ceremonial Area at Kissonerga-*Mosphilia* period 3B in pit 1015 under building 994, where the well-known RW building model (KM 1446), was located which was tightly packed with ten stone and nine pottery figurines, a triton shell, a four-legged model stool, a terracotta pierced cone, pestles, pounders, rubbing stones, a polisher, a flint blade and pebbles (Peltenburg, 1988: 289-90, Fig. 1-2; Peltenburg and Thomas, 1991: 5-6).

The closest parallels for the caching practice observed in our jar 571_DC1 come from Lemba-*Lakkous*. At the latter site, a close parallel is reported from context M32d.2a equated to the uppermost floor of Building 21.1 that dates to period 2 of Area II. A stone axe (LL 776) and a stone adze (LL 777) were found inside storage jar F100 (Peltenburg, 1985: 112-3, Pl. 24.4). This example should probably be dated to the transition to or even early within the Late Chalcolithic. Additional evidence for the Late Chalcolithic period comes from Kissonerga-*Mosphilia*, where stone tools were found in certain vessels of the Pithos House (Peltenburg, ed. 1998b: 203): and barrel jar KM 5558, contained a triangular bowl (KM 1248), and nests of other small bowls (KM 1246; 1249; 1254; 1255; and 1257) (Peltenburg, ed. 1998a: Pl. 11.6; Peltenburg ed. 1998b: 8). Of course, whether or not these contexts from the Pithos House are regarded as (ritual) caches, depends on whether one regards the conflagration of the building as a ritual event or an act of violence (Peltenburg 1998: 252-5), in the latter case we would be dealing with storage rather than caching.

All the above cases highlight the fact that objects caching within storage vessels was not an unknown practice, and occurs both in the Middle and the Late Chalcolithic. Therefore, jar 571_DC1 from Chlorakas-*Palloures* is part of an existing tradition. What the precise motivation was for the deposition of this cache remains unclear but an interpretation as a votive hoard, perhaps as a part of a house-closing ritual as is suggested for the large assemblages which were left behind on the floor of the Pithos house at Kissonerga-*Mosphilia* (Peltenburg, ed. 1998a: 253), remains plausible.

Figure 4. Collection of artefacts found in the jar. Photos by Ian J. Cohn and Andreas Charalambous (copper axe/adze).

3.1 The Jar

The pottery vessel 572_DC1 was recovered broken, but *in situ* on a surface that can be associated with Building 6 in trench BU12. The jar has been classified in terms of shape as a rather rare variant of the collared storage jar (Figure 5; Kissonerga-Mosphilia Type 20 in Bolger, 1998a: 98; ARCANE Type 26 in Bolger and Webb, 2013: 44).

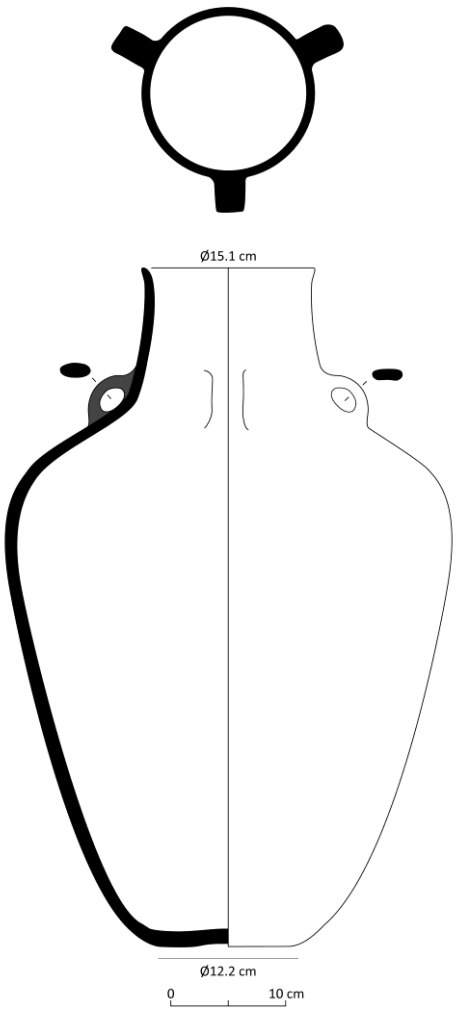

Figure 5. Drawing of Jar 572_DC1. Produced by Victor Klinkenberg and Charalambos Paraskeva.

Nevertheless, the jar stands apart from established descriptions, as it features an obovoid body with convex walls resting on a slightly concave base and supporting a short cylindrical neck with a slightly flaring, thinning pointed rim that is considerably smaller than the maximum body and roughly equivalent to the base diameter. Moreover, three d-shaped loop handles (Stewart 1985: 257; Kissonerga-Mosphilia Pierced Lugs (Types A-C) in: Bolger 1998a: 100) with a flattened oval or kidney-shaped section begin from the lower neck and end at or a little below the neck/body join, where they are roughly equidistantly placed at c.120º one from the other. In terms of size, this is considered to be a medium-sized closed vessel with a maximum capacity of 33 litres.

The 572_DC1 jar has been attributed to our Fabric Group D, a relatively minor fabric, the production of which probably began in the later Middle Chalcolithic and continued throughout the Late Chalcolithic. The fabric is characterized by strong to dark brown clay with dark laminated core, while inclusions comprise of medium to dense vegetal filler, and sparse limestone and igneous tempers. It is almost exclusively used for monochromes and is usually reserved for larger storage vessels. A variant with better levigated clay and fewer inclusions occurs in the second half of the Late Chalcolithic and continues after the onset of the Philia phase (Paraskeva, 2015: 1: 262, 645, Fig. 4.70).

Similar fabrics reported in the literature include the CPW-mono, CPW-tartan, RL, and partly RMP-B fabrics from Kissonerga-*Mosphilia* Periods 3B and 4, (Bolger, 1998a: 95-96; Bolger, 1998b: 118; Bolger, 1998c: 156), the CPW and partly DM ECY 2 fabrics in the ARCANE typology (Bolger and Webb, 2013: 42), and the CPW and partly the RL fabrics from Lemba-*Lakkous* Periods 2 and 3 (Stewart, 1978: 13-15; Peltenburg, 1983: 27; Stewart, 1985: 262). Based on the above association, the absolute dating of the context and the fabric description, it is argued that 572_DC1 can be assigned to the better levigated variant in Fabric Group D that appears in the second half of the Late Chalcolithic and is considered to be coeval to Kissonerga-*Mosphilia* 4B.

Some comparanda exist for the shape of jar 572_DC1, with most of them coming from nearby sites investigated by the Lemba Archaeological Project. To begin with, the ancestry of the shape may be sought in simpler Middle Chalcolithic types, such as KMyl 2016, a partially surviving RM-b holemouth storage jar (Type 24) with a short neck, slightly concave base, and ovoid body from Phase 3, Occupation II of B200, Potspread 200.227 at Kissonerga-*Mylouthkia* (Peltenburg, 2003: Fig. 51.4; Bolger, 2003: 138); and KM2281, an RMP-B baggy holemouth jar with an ovoid body, indication for a lug below neck, and restricted neck with everted rim from KM3B, Unit 938 at Kissonerga-*Mosphilia* (Peltenburg, 1998a: Fig. 62.1; Bolger 1998c: 152).

Contemporary Late Chalcolithic parallels to 572_DC1 include a few jars from Periods 4 and 5 Kissonerga-*Mosphilia*, Periods 2 and 3 Lemba-*Lakkous* (Middle and Late Chalcolithic), and Late Chalcolithic Kalavasos-*Pamboules*. At Kissonerga-*Mosphilia,* KM1946 was found at KM4, Unit 391, and is a CPW holemouth storage jar exemplifying the use of multiple vertical handles on a storage vessel (Peltenburg, 1998a: Fig. 72.2; Bolger, 1998c: 159), while KM3300 found in KM4 (Late Chalcolithic), Unit 217 is one of the closest parallels in terms of fabric and shape, as this CPW holemouth storage jar features a short neck, slightly obovoid body, pierced lugs at the neck to body join and an omphalos base (Peltenburg, 1998a: Fig. 73.2; Bolger, 1998c: 159). One last jar from

Kissonerga-*Mosphilia*, namely KM 559.02 from KM5?, Unit 504 is tentatively dated to Period 5, and is a CPW holemouth storage jar with a similar obovoid body, but flat base that indicates continued production of this shape throughout the Late Chalcolithic (Peltenburg, ed. 1998a: Fig, 75.6; Bolger, 1998c: 163).

Moving to Lemba-*Lakkous*, two storage jars probably from Area II of Periods 2 and 3 (Middle and Late Chalcolithic) are reported. Although the contextual information is unclear, both the incomplete vessels illustrated have short necks, slightly flaring rims and vertical loop handles from mid- or lower-neck to neck-body join with flattened oval or 'ridged back' sections, and constitute good contemporary parallels for 572_DC1 (Peltenburg, 1985: Fig. 52: 1-2; Stewart, 1985: 255, 257).

Finally, at Kalavasos-*Pamboules*, two Red Lustrous Type II jars present stark similarities to 572_DC1. Although the contextual information for both jars is missing, their ascription to Type II that is not represented at Middle Chalcolithic Erimi-*Pamboula* (Dikaios, 1962: 135-136), and their distinct features like the short collar neck, the multiple vertical or horizontal loop handles at the rim to body join or lower shoulder, the ovoid body and the slightly concave base, render them contemporary and near exact parallels to 572_DC1 under consideration (Dikaios, 1962: Fig. 64: 2-3, Fig. XLIII: 2-3).

To sum up, it appears that 572_DC1 is a rather rare occurrence in the repertoire of Chalcolithic potters, but it is consistently associated with storage vessels manufactured up to the end of the Late Chalcolithic, while it appears to draw its ancestry from certain later Middle Chalcolithic types. Moreover, the strong similarities with the Kalavasos-*Pamboules* jars, the better levigated fabric and the relatively low percentage of Fabric Group D sherds at Chlorakas-*Palloures*, may indicate that this jar was imported to the site sometime in the second half of the Late Chalcolithic.

3.2 The Jar Deposit

Sherdage from contexts associated with jar 572_DC1 are minimally affected by post-depositional processes, such as the regular ploughing of the area in the recent past. Specifically, 3% are unclassifiable, 8% belong to Middle Chalcolithic and 89% to Late Chalcolithic wares. Also, abrasion analysis demonstrates that nearly two thirds of Middle Chalcolithic sherds are worn, while over 90% are medium to thick. Lastly, Lot 567, viz. the context below 572_DC1, presents a mixed profile with 47% unclassifiable sherds, 21% Middle and 32% Late Chalcolithic. Per the above, the contexts associated with 572_DC1 can be securely dated to the Late Chalcolithic, while the few Middle Chalcolithic sherds are probably residual.

The soil in the jar was sampled for micro morphological and botanical analysis. From the flotation of the soil a charred seed of *Hordeum vulgare ssp. vulgare* (hulled barley) was retrieved (determination by Professor René Cappers of the Groningen Institute of Archaeology), which was send to the Groningen ^{14}C laboratories (571.S1). This yielded a date 4065 ± 35 BP (GrA68670), which calibrates to 2853-2812 BC (11% probability); 2744-2726 BC (2% probability); and 2696-2487 (82% probability). Thus, the charred seed dates to approximately 2600 BC, and all the other objects and the jar are at least of the same date, and possibly older. The result also demonstrates that the jar filled up during the Late Chalcolithic. In order to assess the manner in which the jar was filled up with soil a block sample of the jar content was taken for thin section micromorphological analysis. The thin section preparation is, however, ongoing and the results will be published in the near future.

3.3 The Pig Tusk Hooks

A clutch of four quite delicate hooks, presumably fish hooks, came from within the jar that also contained the metal and the stone cutting tools. These hooks come from lots 567 (567_M1) and 571 (571_M2/M3/M4), and all are neatly manufactured on segments of lower canine teeth (tusks) of pigs that retain the thin enamel layer on one side, but consist mainly of dentine. The hooks appear all to have been of comparable size, but 567_M1 is the only hook to preserve its full length of 37.1mm, and to retain the perforated upper part of its shank. This hook has a maximum thickness of 3.2mm, and the top of its shank is fined off from side to side and possesses a v-shaped notch. Its hourglass perforation is asymmetric, cutting more deeply into the soft dentine than it does into the harder enamel side, and the 0.8mm minimum diameter of the perforation suggests the use of a fine fishing line (broken perforations on two of the three hooks from lot 571 have minimum diameters around 1.0mm and 1.5mm).

The lot 567 hook has new damage to its sharp tip, while two of the hooks from lot 571 (571_M2/M3) have new damage to both their tips and their shanks. By contrast, 571_M4 has only old breaks to its tip and to its shank, across the perforation, so it seems that whilst the three other hooks may well have been complete and functional, 571_M4 appears to have been deposited in a damaged and unusable state, albeit nearly complete.

Contemporary and similar hooks made from pig tusk and of bone occurred occasionally at nearby

Kissonerga-*Mosphilia* in Chalcolithic times (Croft, 1998: 246). Another local example of earlier date is a small hook made of pig tusk from the earliest (9th millennium BC) of the Neolithic wells at Kissonerga-*Mylouthkia* (Croft, 2003: 41, Pl. 8.5, Fig. 71.3), and hooks that would have been used for fishing and possibly for other purposes also occur on other Cypriot Neolithic sites (Croft, 2003: 41).

3.4 The Stone Axe/Adze

The ground stone cutting tool, CP 571_G1, is subrectangular in plan with straight, flattened facets. The cutting edge is slightly curved and, though it has been bifacially sharpened to an edge, it is asymmetrical in lateral section. This perhaps suggests that it was crafted to be used as an adze. It is of a medium size for an axe of this period and is large for an adze (L = 12.7cm), is fairly wide (W = 7.8cm) and has a thin section (Th = 1.5cm).

CP 571_G1 is made from a very fine-grained, bluish-grey igneous rock usually labelled as basalt and deriving from the chilled margin of dykes of the Sheeted Diabase Complex (Elliott, 1981: 15; 1991: 95). This object has been finely ground over most of its surface during manufacture. Notably, CP 571_G1's blade is very sharp and had no striations, polishes, notches or chips related to use. Thus, neither axe- nor adze-specific wear could be identified (For criteria see Semenov, 1964: 123, 125; Elliott, 1981: 19; Bolger, 1988: 83). In addition, the body of the tool bore no evidence of hafting (For criteria see Elliott, 1981: 19; 1998: 169-70), breakage or reworking. This lack of evidence for use is in contrast to the majority of cutting tools of this time period, which often show multi-stage modification sequences.

As discussed elsewhere in this paper, CP 571_G1 was found beside metal axe CP 571_M1 in Unit 19. The close association of these objects is supported by the presence of copper corrosion adhering to the surface of CP 571_G1. Furthermore, this stone cutting tool bears a closer resemblance in form to the metal cutting tool than the other 62 adzes and axes recovered from Chlorakas thus far. CP 571_G1 does have parallels in contemporary stone assemblages elsewhere, however. Given the frequency of ground stone cutting tools recovered from Chalcolithic sites of the Lemba region, it belongs to a relatively rare sub-group of objects, whose shapes have been previously recognized as bearing a resemblance in shape to – so far absent – metal axe types (See LL 131-133, 207; LL 492m; LL 584 in Elliott, 1985: 166-7; and KM 1012 and KM 1085.18 in Elliott, 1998: 208, 210). Notably, Peltenburg suggested that Chalcolithic stoneworkers were emulating metal styles when crafting these straight-sided, flat and thin cutting tools (Croft et al., 1998: 188). This was perhaps a bold assertion at the time, given that, prior to the retrieval of the Chlorakas-*Palloures* copper axe, the earliest confirmed objects of this type on Cyprus came from Philia phase assemblages (Kassianidou, 2013: 241). It is remarkable, however, that this particular stone axe/adze resembles the associated copper axe/adze in its thickness (1 versus 1.5 cm), in its trapezoidal body tapering towards the butt end, in its more or less rectangular butt, and in its slightly asymmetrical blade. The discovery of this assemblage (Unit 19) at Chlorakas therefore seems to support the hypothesis that Chalcolithic stoneworkers in southwest Cyprus were aware of and were influenced by metal axe styles by at least 2600BC.

3.5 The Copper Axe/Adze

The metal axe/adze found in the jar (571_M1) is a small but heavy object. It is about 7.5 cm long and weighs 119 grams, and flares out at the bit (Figure 6). The main body of the axe has a more or less flat trapezoidal shape, tapering towards the rear and is about a centimeter high. The butt of the axe/adze is rectangular in shape. Seen from the side the cutting edge is asymmetrical and the object could therefore be classified as an adze. However, only usewear could establish whether it was in fact an adze, so here we will call it an axe/adze. This type of axe/adze, does not have clear comparanda on Cyprus in the Chalcolithic, Philia phase, or Early Cypriot periods, although an axe butt fragment from Kissonerga-*Mosphilia* (KM 457, Peltenburg, ed. 1998: 188-9) fits in terms of dimensions and shape. Flat axes of roughly similar shape are known from Anatolia and the Aegean. A flat axe from Horoztepe, a site that is traditionally dated towards the end of the third millennium BC but whose chronology is not well understood, is similar in overall shape, but is both longer and thinner (Anlağan and Bilgi 1989: 46). A flat axe from the Demiricihüyük-Sarıket cemetery, to be dated ca. 2700-2500 BC, is broadly similar in dimensions, shape, and weight, although the butt is more rounded (Seeher 2000: 86, fig 28, grave 171). An axe of level IIIB at Thermi, ca. 2900-2700 BC, seems to be of similar dimensions and shape to ours (Branigan 1974: 166 ; plate 13, n. 602). By contrast, the flat axes of the Levant have tapered butts or are more elongated, resembling chisels (Gernez 2008; Montanari 2015: 67, 69).

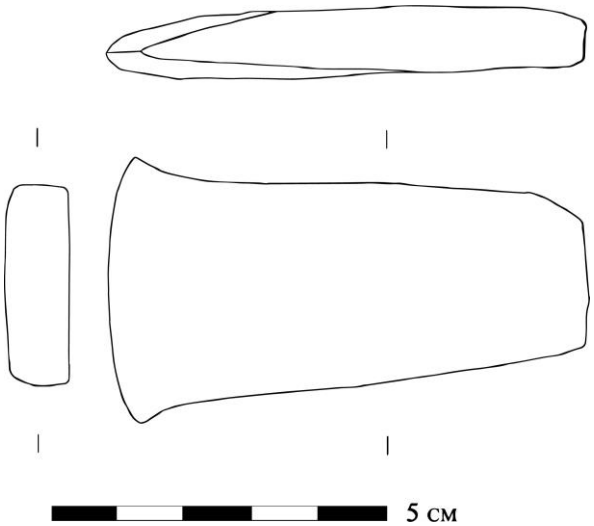

Figure 6. Drawing of copper axe / adze 571_M1. Produced by Victor Klinkenberg.

The find of this axe/adze at Palloures contrasts markedly with other metal artefacts known from Chalcolithic Cyprus. First of all it is larger and heavier than any of the other Chalcolithic artifacts known to us to date. Apart from a few chisels, these consist without exception of small and mostly ornamental artefacts as well as utilitarian objects such as needles (Peltenburg, 2011; Kassianidou, 2013). At Palloures we have also found such artefacts, including a copper spiral of about 4 cm long (partially unrolled) and 0.5 cm wide, which has a clear parallel from Souskiou-*Laona* (Kassianidou, 2013: 248-9: no. 1). Further, we retrieved part of a snake / spiraliform pendant (700_M1). Like the spiral already mentioned, this object has clear parallels at Souskiou-*Laona* (ibid: no. 2). These parallels suggest that, like the picrolite objects which circulated in Chalcolithic Cyprus, these metal artefacts might have been produced by specific workshops and exchanged between communities who shared a common appetite for these things.

One of the questions that we wanted to address for the metal artefacts found at Palloures is what their composition was, and whether they were made of local native or smelted copper, or produced from imported materials. It is well known that the best way to differentiate between native and smelted copper is through metallography (Maddin et al., 1980) but to do this one needs to take a sample. Considering the unique nature of the axe, this was not possible. Furthermore, it is also well known that a simple chemical composition cannot specify provenance (Pollard and Bray, 2014: 229). Lead Isotope Analysis (LIA) is currently the best technique for this, although it is not without problems (Pollard and Bray, 2014: 231). Again LIA was not an option as a sample could not be removed, so we resorted to an alternative knowing very well the limitation of the technique we used. The artefacts were chemically analysed by Andreas Charalambous and Vasiliki Kassianidou from the University of Cyprus using a handheld portable X-ray fluorescence spectrometer (HHpXRF): a 2010 DP-6500C Delta analyser from Innov-X Systems (now Olympus). The analytical mode which was employed is Alloy Plus. In the specific mode, Beam 1(40kV) determines the concentration of the elements Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Hf, Ta, W, Re, Pt, Au, Pb, Bi, Zr, Mo, LE, Pd, Ag, Sn and Sb, while Beam 2 (10kV) is used for the determination of Si, P and S. Mining mode was used for the determination of arsenic (As). Similarly with Two-Beam Mining mode, Alloy Plus mode utilises a Fundamental Parameters algorithm to determine elemental concentration without the requirement of stored fingerprints, as the specific instrument is calibrated from the manufacturer for the analysis of metals. However, for checking the accuracy and reliability of the specific mode and of Mining mode for the determination of As, certified reference materials like CRM-875 (bronze standard) and BCR-691 (set of five copper alloys) were used.

In the spiral object (857_M1) and the snake (700_M1), no arsenic or sulphur was detected (Table 1). Remarkably, however, the axe/adze (571_M1), has a small amount of tin as one of its components. The percentage of tin is minute (just 0,1%) but is nevertheless significant as tin is not present in Cypriot copper ores, not even as a trace element (Constantinou, 1982: 15; Muhly, 1985: 277; Gale, 1991: 47). Tin is also not usually associated with native copper (Gale, 1991: Fig. 13; Pernicka, et al. 1997: 120-1) and therefore its presence indicates the use of smelted copper. There are three ways of interpreting the traces of tin: first, either the object was made by recycling/mixing local copper with imported metal which contained tin; second, the artefact was locally made entirely of imported raw material; or, third, the artefact was imported as a finished object. Given that there are comparanda for our axe / adze in Anatolia and the Aegean, it is possible that we are dealing with an imported artefact. Importantly, at least part of the metal of which the axe/adze was produced is therefore of non-local origin, and came from outside the island. In this respect, our axe/adze is not unique. Kassianidou and Charalambous have also analysed sixteen other Chalcolithic artefacts and the results will soon be published in the monograph on Souskiou-*Laona* (Kassianidou and Charalambous, in prep). Within the analysed assemblage there are another two objects which bear traces of tin one from the Late Chalcolithic site of Lemba-*Lakkous* (LL 209) and another from the Late Chalcolithic site of Kis-

sonerga-*Mosphilia* (KM 694). More importantly there is an object (KM 2174) from this latter site which can be identified as made of bronze because it was found to contain 3.3% tin (Sn). Following Stech (1999: 62) a copper alloy is defined as bronze when the concentration of tin is at least 2%. Further examples of metal artefacts with (small but significant amounts) of tin have been reported for Middle Chalcolithic Erimi-*Pamboules* (Erimi 7 & 388; Zwicker, 1981). Gale (1991: 48) also reported that object LL 134frp, Lemba-*Lakkous* had traces of tin (<0.04) but no tin was detected in the new set of analysis. So the object from Chlorakas-Palloures is not a *unicum*. The question of course is how we can explain copper objects with traces of tin in this period.

Table 1. Compositional analysis of three metal artefacts found in the 2016 campaign at Chlorakas-Palloures.

Composition (wt% ± std)								
Object	Weight (g)	Cu	Pb	Sn	Fe	Zn	As	S
571_M1	119	99.5 ± 0.1	0.02 ± 0.002	0.1 ± 0.01	0.3 ± 0.02	0.05 ± 0.005	n.d	n.d
857_M1	0,967	99.2 ± 0.1	n.d	n.d	0.8 ± 0.05	n.d	n.d	n.d
700_M1	1.960	99.3 ± 0.1	0.01 ± 0.001	n.d	0.7 ± 0.05	n.d	n.d	n.d

4. DISCUSSION AND CONCLUSION

As mentioned in the introduction it appears that copper-based metallurgy starts relatively late on Cyprus in comparison to adjacent regions such as Anatolia and the Levant. Based on data at hand, there is relatively limited evidence for copper metallurgy, or indeed copper-based artefacts, prior to the so-called Philia phase (Peltenburg, 2011; Kassianidou, 2013). Metal artefacts that date to the Middle Chalcolithic are relatively few and mostly very small in size, and are most probably made of native copper which has been mechanically treated. They are, in other words, the product of a primitive stage of metallurgy which uses low temperatures and, therefore, has been defined as a cold technology, not too dissimilar from that used in the processing of other rocks and minerals such as chert and picrolite in the case of Cyprus (Kassianidou, 2013: 234). By the Late Chalcolithic artefacts occur which can be identified as tools, namely the awl from Kissonerga-*Mosphilia* (KM416), the chisels from the same site (KM 694 and KM986) and the chisel from Lemba-*Lakkous* (LL134) (Peltenburg, 2011: 7; Kassianidou, 2013: 238). These are larger and heavier and must have been cast in very simple moulds. The assemblage increases substantially in the Philia period both in terms of sheer number of artefacts and in terms of types of artefacts (Kassianidou, 2013: 238). Analyses of Chalcolithic artefacts do not suggest that they were made of either native Cypriot copper or Cypriot copper ores (Gale, 1991: 50, 53). On the other hand, the metalworking evidence from Kissonerga-*Mosphilia* presented by Peltenburg (2011: 7), in the form of ore fragments and crucibles, demonstrates the possible existence of Chalcolithic copper metallurgy. However, at present, it appears that the introduction of casting of larger and more complex objects in moulds starts in the Philia phase, when copper-based artefacts increase substantially (Manning, 2014a). It has been argued that the copper processing data from Kissonerga-*Mosphilia* in fact dates to the final part of the Late Chalcolithic overlapping with the Philia, and that there is no evidence for Late Chalcolithic copper metallurgy predating the Philia (Webb and Frankel 2011).

The find of artefacts possibly made of Cypriot copper, at Pella in Jordan in a context dated by the excavator to the end of the EB II, ca. 2900-2800 BC (Philip et al., 2003: 87) and at Aghia Photia on Crete dating to the EM I, ca. 3100-2700 BC (Day et al., 1998; Stos-Gale and Gale, 2003; Davaras and Betancourt 2004; Muhly and Kassianidou 2012) complicates this picture, however. While the suggestion that the sequence of Cypriot prehistory needs to be shifted (Bourke, 2014) does not seem credible in the light of recent evaluations of third millennium Cypriot chronology (Manning, 2017: 476-9), the occurrence of artefacts apparently dating to the earlier third millennium BC that are possibly made of Cypriot ore does raise the possibility of a developed Cypriot Chalcolithic copper metallurgy that has so far eluded us.

On the other hand, a number of studies on the elemental composition of Chalcolithic artefacts have suggested that metals were at least in part imported into the island in this period. Gale (1991: 57) argued that Chalcolithic metal artefacts were not made of native copper nor of Cypriot ores. In response, Peltenburg (2011) argued that one of the artefacts analyzed by Gale was from an unreliable context, and the second, an axe probably made of Anatolian ores (Gale, 1991: 45-6), most plausibly dates to the Philia phase. Likewise, Webb et al. (2006: 271) also found that some Philia phase artefacts were made of imported, Anatolian and Cycladic, copper ores, and

that Cypriot ores were also exploited at this time. Thus, in our current understanding, by the Philia phase, objects of substantial size were made on Cyprus from Cypriot copper ores, but metal artefacts from other regions are also present. Complicating this discussion is the fact that there is a likely chronological overlap between the Late Chalcolithic and the Philia, as for example at Kissonerga-*Mosphilia*. Here, it is of interest that at Chlorakas-*Palloures* we do not have any Philia materials, and the site most likely either predates the Philia / Late Chalcolithic co-existence, or did not engage with Philia groups in a way that is archaeologically detectable.

The Chlorakas-*Palloures* axe/adze, taken together with the evidence of Pella and Aghia Photia, suggest that this configuration – of indigenous metallurgy co-existing with the importation of metal artefacts – might already have existed in the Late Chalcolithic. Support for this idea is also provided by the common occurrence of (small but significant) amounts of tin in objects from Middle Chalcolithic Erimi-*Pamboules* and Souskiou-*Laona,* and Late Chalcolithic Lemba-*Lakkous* (Zwicker, 1981; Gale, 1991: 48; Kassianidou and Charalambous, in prep). Even if the tin is found at the level of a trace element it may be indicative of the source of the metal. Bronze is usually believed to be a technological innovation of the third millennium (Muhly, 1985: 283-5; Helwing, 2009: 215; Piggott, 2011: 273), but recent excavations and analytical studies have detected some, admittedly rare, occurrences of bronze in the Balkans predating the third millennium BC (Radivojević et al., 2013), in the Caucasus region (Thornton, 2007: 129-30), in the Iranian Plateau (Thornton, 2009: 317) and in the southern Levant (Garfinkel et al., 2014). Some tin bearing copper metal or metal objects from one of these areas must have reached the island at some point during the Late Chalcolithic, where it may have been mixed with locally produced metal or recast on the island: it has become clear in recent years that much more mixing of ores and alloys took place in prehistory than so far acknowledged (Pollard and Bray, 2015). It remains possible to interpret the Late Chalcolithic artefacts on Cyprus made from non-Cypriote copper as imported objects. Likewise, the copper used in the Pella and Aghia Potia objects dating to the early third millenium BC are 'consistent with Cypriote ores' but this does not prove that they were indeed made of Cypriote copper. Finally, the Aghia Potia and Pella metal objects might predate the Chlorakas-Palloures axe /adze by some centuries, and it is possible to associate the Palloures axe / adze to the Philia in chronological terms. However, we think that as the evidence for Cypriote Late Chalcolithic artefacts made in part of non-Cypriote metals, and artefacts possibly made of Cypriote ores in the surrounding regions increases, the idea that Cypriot extractive metallurgy developed significantly during the Late Chalcolithic is becoming more plausible, if far from proven.

However one weighs the evidence, the data presented here certainly supports the view in which Late Chalcolithic Cyprus, that is prior to the Philia phase, became increasingly involved in broad exchange networks, an argument put forward by Peltenburg (2007) and Bolger (2013). This can be documented in the ceramic assemblages as well as in the faience beads found in Middle Chalcolithic tombs on Cyprus. How exactly metallurgy and trade in metal objects and ores fitted into in the context of rising connectivity within the broader Eastern Mediterranean will hopefully be clarified in the future.

ACKNOWLEDGEMENTS

We are grateful for the reviews and comments of the two reviewers, who helped to improve this paper. We would like to thank the staff of the Department of Antiquities, and in particular the director Marina Solomidou-Ieronymidou, Despina Pilides, and Stathis Raptou. Our thanks also go out to Margarita Kouali of the Paphos Museum. We would also like to thank the Byvanck Fonds for financing our campaign and Leiden University for logistical support. The facilities provided by the Edgar Peltenburg Archaeological Research Centre (formerly the Lemba Archaeological Research Centre) are of key importance to our research. Finally we would like to thank the Chlorakas-*Palloures* 2015 and 2016 field teams for all their hard work.

REFERENCES

Anlağan, Ç., and Bilgi, Ö (1998*). Protohistorik Çağ Silahları / Weapons of the Protohistoric Age*. Istanbul: Sadberk Hanım Müzesi.

Bolger, D. (1988) *Erimi-Pamboula: A Chalcolithic settlement in Cyprus*, Oxford: British Archaeological Reports.

Bolger D. (1998a) Ceramic structures and analytical methods. In *Excavations at Kissonerga-Mosphilia 1977-1995*, E. Peltenburg, (ed.), Jonsered, Paul Åströms Förlag, pp. 93-102.

Bolger D. (1998b) The evolution of ceramic types. In *Excavations at Kissonerga-Mosphilia 1977-1995*, E. Peltenburg, (ed.), Jonsered, Paul Åströms Förlag, pp. 102-123.

Bolger D., (1998c) The evolution of ceramic types. In *Excavations at Kissonerga-Mosphilia 1977-1995,* E. Peltenburg, (ed.), Edinburgh, University of Edinburgh, pp. 126-164. http://www.shca.ed.ac.uk/projects/lemba/publications/kissonerga/chap17.pdf - last accessed: 08/05/2017.

Bolger D. (2003). Catalogue of vessels and miscellaneous pottery. In *The Colonisation and Settlement of Cyprus: Investigations at Kissonerga-Mylouthkia,1976-1996*, E. Peltenburg, (ed.), Sävedalen, Paul Åströms Förlag, pp. 137-140.

Bolger, D. 2013. A matter of choice: Cypriot interactions with the Levantine mainland during the Late 4th–3rd Millennium BC. *Levant* Vol. 45, pp. 1-18.

Bolger D. and Webb J. M. (2013) Ceramics. In *Cyprus, Associated Regional Chronologies for the Ancient Near East 2,* E. Peltenburg, (ed.), Brussels, Brepols, pp. 39-127.

Bolger, D., McCartney, C., and Peltenburg, E. (2004) Regional interaction in the prehistoric west: Lemba Archaeological Project Western Cyprus Survey. In *Archaeological Field Survey in Cyprus. Past History, Future Potentials*, M. Iacovou, (ed.), London: British School at Athens, pp. 105-123.

Bourke, S. J. (2014) Taking an Axe to Cypriot Prehistory: Jordan and Cyprus in the Early Bronze Age. *Akkadica Supplementum* Vol. 12, pp. 71–94.

Branigan, K. (1974). *Aegean Metalwork of the Early and Middle Bronze Age*. Oxford: Clarendon Press.

Christodoulou, D. (1959) *The Evolution of the Rural Land Use Pattern in Cyprus*. London, Geographical Publications Limited.

Constantinou, G. (1982) Geological features and ancient exploitation of the cupriferous sulphide orebodies of Cyprus. In *Early Metallurgy in Cyprus 4000-500 BC*, J. D. Muhly, R. Maddin and V. Karageorghis, (eds.), Nicosia, Pierides Foundation, pp. 13-23.

Croft, P. (1998) The bone and antler industry. In *Excavations at Kissonerga-Mosphilia 1979-1992,* E. Peltenburg, (ed.), Jonsered, Paul Åströms Förlag, pp. 199-200.

Croft, P. (2003) Worked bone. In *The Colonisation and Settlement of Cyprus. Investigations at Kissonerga-Mylouthkia, 1977- 1996,* E. Peltenburg, (ed.), Sävedalen, Paul Åströms Förlag, pp. 41.

Croft, P., Peltenburg, E., and Tite, M. (1998) Other artefacts. In *Excavations at Kissonerga-Mosphilia 1979-1992*, E. Peltenburg, (ed.), Jonsered, Paul Åströms Förlag, pp. 188-201.

Davaras, C., and P. P. Betancourt (2004) *The Hagia Photia Cemetery I: The Tomb Groups and Architecture*. Philadelphia, INSTAP.

Day, P., Wilson, D., and Kiriatzi, E. (1998) Pots, labels and people: Burying ethnicity in the cemetery of Aghia Photia, Siteias. In *Cemetery and Society in the Aegean Bronze Age*, K. Branigan, (ed.), Sheffield, Sheffield University Press, pp. 133-149.

Dikaios P. (1962) The stone age. In *Swedish Cyprus Expedition 4/1A*, E. Gjerstad, O. Vessberg, and J. Lindros, (eds.), Lund, The Swedish Cyprus Expedition, pp. 1-204.

Düring, B. S., Klinkenberg, V., Pareskeva, C., Croft, P., Souter, E., and Sonnemann, T. (2016) Excavations at Chlorakas-Palloures, New Light on Chalcolithic Cyprus. *Report of the Department of Antiquities, Cyprus*, in press.

Elliott, C. (1981) Observations on ground stone adzes and axes from Lemba-Lakkous. *Report of the Department of Antiquities,* pp. 1-23.

Elliott, C. (1985) The ground stone industry. In *Excavations at Lemba-Lakkous 1976-1983,* E. Peltenburg, (ed.), Göteborg: Paul Åströms Förlag, pp. 70-93, and pp. 161-95.

Elliott, C. (1991). Rock sources of ground stone tools of the Chalcolithic period in Cyprus. *Bulletin of the American Schools of Oriental Research* Vol. 282/3, pp. 95-106.

Elliot, C. (1998) Ground stone tools. In *Excavations at Kissonerga-Mosphilia 1979-1992.* E. Peltenburg, (ed.), Jonsered, Paul Åströms Förlag, pp. 168-87, 193-230.

Gale, N. (1991) Metals and metallurgy in the chalcolithic period. *Bulletin of the American Society of Oriental Research,* Vol. 282, pp. 37-62.

Garfinkel, Y., Klimscha, F. Shalev S., and Rosenberg, D. (2014) The beginning of metallurgy in the southern Levant: A late 6th millennium cal BC copper awl from Tel Tsaf, Israel. *PloS One* Vol. 9/3: e92591.

Gernez, G. (2008) *L'armement en metal au Proche et Moyen-Orient: des origines a 1750 av. J.-C.* Paris: unpublished PhD Sorbonne.

Hadjisavvas, S. (1977) The archaeological survey of Paphos. A preliminary report. *Report of the Department of Antiquities, Cyprus*, pp. 222-231.

Helwing, B. (2009). Rethinking the tin mountains: Patterns of usage and circulation of tin in greater Iran from the 4th to the 1st millennium BC. *Türkiye Bilimer Akademisi Arkeoloji Dergisi,* Vol. 12: 209-221.

Karageorghis V., (1967) Chronique des Fouilles et des Découvertes Archéologiques à Chypre en 1966, *Bulletin de Correspondance Hellénique,* Vol. 91/1, pp. 275-370.

Kassianidou, V. (2013) Metals. In *Associated Regional Chronologies for the Ancient Near East and the Eastern Mediterranean* 2, E. Peltenburg, (ed.), Turnhout, Brepols, pp. 231–249.

Kassianidou, V. (2014) Cypriot copper for the Iron Age world of the Eastern Mediterranean. In *Structure, Measurement and Meaning. Studies on Prehistoric Cyprus in Honour of David Frankel*, J. M. Webb, (ed.), Uppsala, Åströms Förlag, pp. 261-271.

Kassianidou, V., and Charalambous A. (in prep). Chemical analyses of copper objects and faience beads using portable x-ray fluorescence. In *Figurine Makers of Prehistoric Cyprus. Settlement and Cemeteries at Souskiou*, E. Peltenburg, (ed.), Oxford, Oxbow.

Klinkenberg, V. (2016) *Reading Rubbish. Using Object Assemblages to Reconstruct Activities, Modes of Deposition and Abandonment at the Late Bronze Age Dunnu of Tell Sabi Abyad, Syria.* Leiden: Netherlands Institute for the Near East.

Maddin, R., Stech Wheeler, T., Muhly, J. D. (1980) Distinguishing artifacts made of native copper. *Journal of Archaeological Science,* Vol. 7, pp. 211-225.

Manning, S. W. (2014a) Timing and gaps in the early history of Cyprus and its copper trade what these might tell us. In *Structure, Measurement and Meaning. Studies on Prehistoric Cyprus in Honour of David Frankel*, J. M. Webb, (ed.), Uppsala, Åströms Förlag, pp. 23-41.

Manning S. W. (2014b) A radiocarbon-based chronology for the Chalcolithic through the Middle Bronze Age of Cyprus (as of AD 2012). In *Egypt and the Southern Levant during the Early Bronze Age: C14, Chronology and Connections*, F. Höflmayer and R. Eichmann, (eds.), Berlin, Deutsches Archäologisches Institut, pp. 207-240.

Manning S. W. (2017) Comments on climate, intra-regional variations, chronology, the 2200 B.C. horizon of change in the East Mediterranean region, and socio-political change on Crete. In *The Late Third Millennium in the Ancient Near East: Chronology, C14, and Climate Change*, F. Höflmayer, (ed.), Chicago, The Oriental Institute of the University of Chicago, pp. 451-90.

Montanari, D. (2015) Metal Weapons in the Southern Levant during the Early Bronze Age: An Overview. In *Copper and Trade in the South-East Mediterranean. Trade Routes of the Near East in Antiquity*, K. Rosinska-Balik, A. Ochal-Czarnowicz, M. Czarnowicz, and J. Debowska-Ludwin, (eds.), Oxford: Archaeopress, pp. 67-76.

Muhly, J. D. (1985) Sources of tin and the beginnings of bronze metallurgy. *American Journal of Archaeology,* Vol. 89, pp. 275-291.

Muhly, J. D. and Kassianodou, V. (2012) Parallels and Diversities in the Production, Trade and Use of Copper and Iron in Crete and Cyprus from the Bronze Age to the Iron Age. In *Parallel Lives. Ancient Island Societies in Crete and Cyprus,* G. Cadogan, M. Iacovou, K. Kopaka and J. Whitley, (eds.), London, British School at Athens, pp. 119-140.

Paraskeva C. (2015) *Chronology, Topography and Social Change: A Multi-Linear Perspective on the Chalcolithic to Bronze Age Transition in Cyprus.* University of Edinburgh: unpublished PhD dissertation.

Paraskeva C. (in press). The Middle Chalcolithic to Middle Bronze Age chronology of Cyprus: Refinements and reconstructions. In *New Directions in Cypriot Archaeology*, S. Manning, (ed.), Cornell, IT, Cornell University Press.

Peltenburg, E. (1979) The prehistory of West Cyprus: Ktima lowlands. Investigations of 1976-1978. *Report of the Department of Antiquities, Cyprus,* pp. 69-99.

Peltenburg, E. (1983) The prehistory of West Cyprus: Ktima lowlands investigations 1979-82. *Report of the Department of Antiquities Cyprus*, pp. 9-55.

Peltenburg, E. (1988) A Cypriot model for prehistoric ritual. *Antiquity,* Vol. 62/235, pp. 289-293.

Peltenburg, E. and Thomas, G. (1991) The Context and Content of the Ceremonial Area. In *A Ceremonial Area at Kissonerga,* E. Peltenburg, (ed.), Göteborg, Paul Åströms Förlag, pp. 1-11.

Peltenburg, E. (1998) The character and evolution of settlement at Kissonerga. In *Excavations at Kissonerga-Mosphilia, 1979-1992*, E. Peltenburg, (ed.), Jonsered, Paul Åströms Förlag, pp. 233-60.

Peltenburg, E. (2007) East Mediterranean Interactions in the 3rd Millennium BC. In *Mediterranean Crossroads*. S. Antoniadou and A. Pace, (eds.), Athens, Poreides Foundation, pp. 141-161.

Peltenburg, E. (2011) Cypriot chalcolithic metalwork. In *Metallurgy: Understanding How, Learning Why. Studies in Honor of James D. Muhly*, P. P. Betancourt and S. C. Ferrence (eds.), Philadelphia, INSTAP, pp. 3-10.

Peltenburg E., (ed.) (1985) *Excavations at Lemba-Lakkous, 1976-1983*, *Lemba Archaeological Project I.* Göteborg, Paul Åströms Förlag.

Peltenburg, E., (ed.) (1991) *A Ceremonial Area at Kissonerga. Lemba Archaeological Project II.2.* Göteborg, Paul Åströms För lag.

Peltenburg, E., (ed.) (1998a) *Excavations at Kissonerga-Mosphilia, 1979-1992. Lemba Archaeological Project II.1A.* Jonsered, Paul Åströms Förlag.

Peltenburg, E., (ed.) (1998b) *Excavations at Kissonerga-Mosphilia, 1979-1992. Lemba Archaeological Project II.1B.* Jonsered, Paul Åströms Förlag.

Peltenburg E., (ed.) (2003) *The Colonisation and Settlement of Cyprus: Investigations at Kissonerga-Mylouthkia, 1976-1996*, *Lemba Archaeological Project* III/1. Sävedalen, Paul Åströms Förlag.

Peltenburg, E., Frankel, D., and Paraskeva, C. (2013) Radiocarbon. In *Cyprus, Associated Regional Chronologies for the Ancient Near East and the Eastern Mediterranean 2*, E. Peltenburg, (ed.), Turnhout, Brepols, pp. 313-338.

Pernicka, E., Begemann, F., Schmitt-Strecker, S., Todorova, H. and Kuleff, I., (1997) Prehistoric copper in Bulgaria: its composition and provenance. *Eurasia Antiqua,* Vol. 3, pp. 41-180.

Philip, G., Clogg, P. W., Dungworth, D., and Stos, S. (2003) Copper metallurgy in the Jordan Valley from the third to the first millenia BC: Chemical metallographic and lead isotope analyses of artefacts from Pella. *Levant,* Vol. 35, pp. 71–100.

Pigott, V. C. (2011) Sources of tin and the tin trade in southwest Asia: Recent research and its relevance to current understanding. In *Metallurgy: Understanding How, Learning Why. Studies in Honor of James D. Muhly*, P. P. Betancourt and S. C. Ferrence, (eds.), Philadelphia, INSTAP, pp. 273-291.

Pollard A. M., and Bray P. J. (2014). Chemical and isotopic studies of ancient metals. In *Archaeometallurgy in Global Perspective. Methods and Syntheses,* B. W. Roberts and C. P. Thornton, (eds.), New York, Springer, pp. 217-238.

Pollard, A. M. and Bray, P. J. (2015). A new method for combining lead isotope and lead abundance data to characterize archaeological copper alloys. *Archaeometry,* Vol. 57: 996-1008.

Radivojević, M., Rehren, T. Kuzmanović-Cvetković, J. Jovanović, M., and Northover, J. P. (2013) Tainted ores and the rise of tin bronzes in Eurasia, c. 6500 years ago. *Antiquity,* Vol.87/338, pp. 1030-1045.

Seeher, J. (2000). *Die bronzezeitlichen Nekropole von Demircihöyük - Sariket*. Tübingen: Ernst Wasmuth Verlag.

Semenov, S.A. (1964) *Prehistoric Technology*. London: Adams & Mackay

Stanley Price, N. P. (1979) *Early Prehistoric Settlement in Cyprus 6500-3000 BC*. Oxford, British Archaeological Reports.

Stech, T. (1999) Aspects of early metallurgy in Mesopotamia and Anatolia. In *The Archaeometallurgy of the Asian Old World*, V. C. Pigott, (ed.), Philadelphia, The University Museum, University of Pennsylvania, pp 59-72.

Stewart J. D. (1978) Preliminary remarks on the Chalcolithic pottery wares from Lemba-Lakkous. *Report of the Department of Antiquities Cyprus*, pp. 8-20.

Stewart J. D. (1985) Discussion of areas I and II ceramics. In *Excavations at Lemba-Lakkous,1976-1983*, E. Peltenburg, (ed.), Göteborg, Paul Åströms Förlag, pp. 249-270.

Stos-Gale, Z., and Gale, N. (2003) Lead isotopic and other isotopic research in the Aegean. In, *Metron. Measuring the Aegean Bronze Age,* K. Foster and R. Laffineur, (eds.), Liege: Liege University Press, pp. 83-100.

Thornton, C. P. (2007) Of brass and bronze in prehistoric southwest Asia. In *Metals and Mines: Studies in Archaeometallurgy*, S. La Niece, D. R. Hook, and P. T. Craddock, (eds.), London, Archetype Publications, pp. 123-135.

Thornton, C. P. (2009) The emergence of complex metallurgy on the Iranian Plateau: Escaping the Levantine paradigm. *Journal of World Prehistory,* Vol. 22/3, pp. 301-327.

Vatandoust, A., Parzinger, H., and Helwing, B. (2011) *Early Mining and Metallurgy on the Western Central Iranian Plateau: The First Five Years of Work*. Mainz am Rhein, Philipp Von Zabern.

Webb, J. M. and Frankel, D. (2011) Hearth and Home as Identities of Community in Mid-Third Millennium Cyprus. In *On Cooking Pots, Drinking Cups, Loomweights and Ethnicity in Bronze Age Cyprus and*

Neighbouring Regions. V. Karageoghis and O. Kouka, (eds.), Nicosia, The A. G. Leventis Foundation, pp. 29-42.

Webb, J. M., Frankel, D., Stos, Z., and Gale, N. (2006) Early Bronze Age metal trade in the Eastern Mediterranean. New compositional and lead isotope evidence from Cyprus. *Oxford Journal of Archaeology,* Vol. 25, pp. 261-288.

Weeks, L. (2003) *Early Metallurgy of the Persian Gulf. Technology, Trade and the Bronze Age World.* Leiden, Brill.

Yener, K. A. (2000) *The Domestication of Metals. The Rise of Complex Metal Industries in Anatolia*. Leiden: Brill.

Zwicker, U. (1981) Qualitative Untersuchung von Metallfunden aus Zypern mit unbekanntem Fundort aus verschiedenen Sammlungen (Teilweise Patina-Schabproben), *Untersuchungsbericht* UB 328/81. (unpublished internal report)