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OXHIDE INGOTS IN THE CENTRAL MEDITERRANEAN

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TABLE OF CONTENTS

INTRODUCTION - <i>F. Lo Schiavo, J.D. Mubly, R. Maddin, A. Giumlia-Mair</i>	9
I. <i>EX ORIENTE LUX</i>	
Oxhide ingots in the Aegean and in Egypt - <i>J.D. Mubly</i>	17
Oxhide ingots in Cyprus - <i>V. Kassianidou</i>	41
The iconography of the oxhide ingots - <i>G. Papasavvas</i>	83
II. THE CENTRAL MEDITERRANEAN: SICILY	
Oxhide ingots in Sicily - <i>F. Lo Schiavo, R.M. Albanese Procelli, A. Giumlia-Mair</i>	
Introduction - <i>F. Lo Schiavo</i>	135
1. Cannatello (Agrigento) - <i>F. Lo Schiavo</i>	135
2. Thapsos (Siracusa) - <i>F. Lo Schiavo</i>	139
3. The oxhide ingot fragment from Thapsos and objects from Tomb 7. A metallurgical study - <i>A. Giumlia-Mair</i>	145
4. Lipari (Messina) - <i>F. Lo Schiavo</i>	147
5. Artefacts from the Lipari hoard - <i>R.M. Albanese Procelli</i>	151
6. Objects from the settlement - <i>R.M. Albanese Procelli</i>	156
7. The bronze fibulae of the <i>alpha</i> II hut area - <i>F. Lo Schiavo</i>	158
8. The hoard under the <i>alpha</i> II hut on the Acropolis of Lipari: a metallurgical study - <i>A. Giumlia-Mair</i>	166
Catalogue of analysed finds from the Lipari hoard - <i>A. Giumlia-Mair</i>	178
Conclusions	215
III. THE CENTRAL MEDITERRANEAN: SARDINIA	
Introduction - <i>F. Lo Schiavo</i>	225
Oxhide ingots in Nuragic Sardinia - <i>F. Lo Schiavo</i>	
1. Arzachena (Sassari), nuraghe Albucciu	229
2a. Olbia (Sassari), nuragic village of Serra Elveghe	235
Appendix I The discovery of the hoard at Serra Elveghe, Olbia - <i>R. D'Oriano</i>	239
2b. Olbia (Sassari), Trambuccone	241
3. Oschiri (Sassari), nuraghe S. Giorgio	243
4. Ossi (Sassari), nuragic village of Sa Mandra 'e Sa Giua	246

Appendix II	Hoardings and metallurgy in the nuragic village of Sa Mandra 'e Sa Giua, Ossi <i>F. Lo Schiavo</i>	249
5.	Alghero (Sassari), Porticciolo	268
6.	Ozieri (Sassari), S. Antioco di Bisarcio	270
Appendix III	The nuragic bronze workshop at S. Luca, Ozieri - <i>F. Lo Schiavo</i>	272
7a.	Ittireddu (Sassari), nuraghe Funtana - Hoard I	287
7b.	Ittireddu (Sassari), nuraghe Funtana - Hoard II	290
8.	Pattada (Sassari), Sedda Ottinnera - Hoard	296
9.	Siniscola (Nuoro), Ghiramonte	302
10.	Nuoro: unknown locality: perhaps Urzulei, Monte Gruttas	304
11.	Dorgali (Nuoro), in the Isalle Valley	306
12.	Teti (Nuoro), Abini	308
13.	Fonni (Nuoro), Gremanu o Madau	313
14.	Ortueri (Nuoro), Funtana 'e Cresia	318
15.	Belvì (Nuoro), Ocile	321
16.	Talana (Nuoro)	323
17.	Triei (Nuoro), Bau Nuraxi	325
Appendix IV	The archaeological excavations at nuraghe Bau Nuraxi, Triei (Nuoro) Preliminary report: 1984-1985 campaigns - <i>M. Sanges</i>	327
18a.	Villagrande Strisaili (Nuoro), Corte Macceddos	329
18b.	Villagrande Strisaili (Nuoro), S'Arcu 'e is Forros	332
18c.	Villagrande Strisaili (Nuoro), Sa Carcaredda I - II	336
19.	Lanusei (Nuoro), Perda 'e Floris	338
20.	Seulo (Nuoro), Is Fossus	340
21.	Nurallao (Nuoro), Nieddiu	342
22.	Nuragus (Nuoro), Serra Ilixi ("Valenza")	345
23.	Tertenia (Nuoro), Nastasi	350
24.	Baradili (Oristano), Santa Maria	354
25.	Villanovaforru (Cagliari), Baccus Simeone	358
26.	Sàrdara (Cagliari), nuragic village of S. Anastasia	362
27.	Villasor (Cagliari), Giva 'e Molas	367
Appendix V	Documents of ancient metallurgy in the territory of Villasor (Cagliari) and nuraghe Su Sonadori - <i>A. Usai</i>	371
28.	Monastir (Cagliari), Monte Zara (the site)	377
29.	Soleminis (Cagliari), S'Arenagiu	379
30.	Assemini (Cagliari)	381
31.	Capoterra (Cagliari)	382
	Oxhide ingots hoarding and offering in Nuragic Sardinia - <i>F. Lo Schiavo</i>	391

IV. THE CENTRAL MEDITERRANEAN: CORSICA

The oxhide ingot from Sant'Anastasia, Borgo (Corsica) - *F. Lo Schiavo* 411

V. THE CENTRAL MEDITERRANEAN: SOUTH FRANCE

The oxhide ingot from Sète, Hérault (France) - *F. Lo Schiavo* 421

VI. SPECIAL TOPICS

Marks on Central Mediterranean copper ingots - *M.G. Amadasi Guzzo* 431

The weights of Sardinian oxhide ingot fragments - *F. Lo Schiavo* 437

A threefold ill-posed problem - *M. Lo Schiavo* 449

VII. METALLURGY

Archaeometallurgy in Sardinia: a general metallurgical evaluation - *R. Maddin* 491

Lead isotope analysis and the origin of sardinian metal objects - *A. Hauptmann* 499

A digital archive for the metallurgy of oxhide ingots - *E. Farinetti* 515

CONCLUSION AND OPEN PERSPECTIVES

517

F. Lo Schiavo, J.D. Mubly, R. Maddin, A. Giunlia-Mair

CD-Rom: OXHIDE INGOTS ANALYSES DATABASE - *E. Farinetti, F. Lo Schiavo, R. Maddin*

TO GIOVANNI SPANO

(Ploaghe, March 8th, 1803 - Cagliari, April 3rd, 1878)

*Canon, Senator of the Kingdom of Italy, and
Director of the National Archeological Museum in Cagliari.*

*Most important of all for this volume, he is credited with reporting the first discovery of
oxide ingots, at Serra Ilixi in central Sardinia in 1857,
and acquiring three of them for the National Archeological Museum Collection.*

OXHIDE INGOTS IN CYPRUS

Vasiliki Kassianidou

Introduction

It is well known that the first oxhide ingots were discovered at the site of Serra Ilixi on the island of Sardinia in 1857 (Lo Schiavo 2005: 305). It was not long after that a similar ingot was uncovered on Cyprus (*Fig. 1*). This was found at Enkomi (*Fig. 2*) in 1897 during excavations by a team from the British Museum (*Fig. 3*) and was described in the excavation report published in 1900 as follows:

“Among the bronzes from the foundry site (*Fig. 25*, no. 1535) is a thick, heavy slab of copper, having the Cypriote letter *si* stamped on the surface, apparently when the metal was in a spongy state. Its weight is 81lb 10oz. An analysis kindly made by Prof Church shows 98.05 per cent of copper. In Sardinia similar slabs of copper bearing ‘letters’ or sigla have been found, from which it may be inferred that the metal ready for melting was usually sent out in this form” (Murray *et al.* 1900: 17).

In 1904 Luigi Pigorini published the ingots from Agia Triada and in 1906 Svoronos published examples from Phaistos and Mycenae (Lo Schiavo 2005: 305). The study of oxhide ingots, therefore, began between the end of the 19th century and the beginning of the 20th century. From the very beginning it was observed that ingots made of practically pure copper, of standardised shape and weight, and bearing inscribed symbols, which were found on the islands of Sardinia, Cyprus and Crete, seemed to be the form in which metallic copper was traded in the Mediterranean area during the Late Bronze Age.

Buchholz in an article published in 1959 was the first to try and compile all the available evidence regarding oxhide ingots, as well as offering a typology of the known varieties of oxhide ingot shapes (Buchholz 1959: 7). In the opening paragraph of his article he pinpoints another key issue that is hotly discussed to this day, and that is the origin of these oxhide ingots. From the very beginning Cyprus, Crete, Sardinia and even Egypt were suggested as possible places of origin for the ingots. In 1962, Hector Catling published his book entitled “*Cypriot Bronze Work in the Mycenaean World*” in which he dedicated a section to the oxhide ingots found on Cyprus and in Greece, while in 1967 George Bass published the report on the Cape Gelidonya shipwreck, where the then largest concentration of oxhide ingots had been found. In his publication, Bass (1967: 52-78) presented not only the ingots from Cape Gelidonya but also a detailed list of ingots as well as illustrations of ingots from various localities (mainly in Egyptian wall-paintings).

Since then, there have been many more publications discussing the copper oxhide ingots and the issues that had been raised from the very beginning. Many of these will be quoted in this paper. It is not surprising that the questions of the origin of the metal, the shape of the ingots, and indeed the more general issue of the metals trade during the Late Bronze Age, have been the most debated aspects of the study of oxhide ingots. The purpose of this paper, however, is to discuss the oxhide ingots found in Cyprus.

Unlike Sardinia where, according the latest publication of Lo Schiavo (2005, 317-326) oxhide ingots either complete or in fragments have been found at 31 sites all over the island, in Cyprus oxhide ingots have been found only in the following eight sites: Enkomi, Maroni-*Vournes*, Maroni-*Tsaroukkas*, Kalavassos-*Ayios Dhimitrios*, Maa-Palaeokastro, Pyla-Kokkinokremos, Mathiatis and perhaps Skouriotissa (see below) (*Fig. 1*). Furthermore, unlike Sardinia and Crete, in Cyprus only three complete oxhide ingots have been found to date and of these, only one comes from an archaeological excavation. Unfortunately, it is from the British Museum’s excavation at Enkomi that took place in 1896-7, which was less than entirely systematic. The contrast in both

the number of find-spots and the number of complete ingots in Cyprus, with the numbers of each of those in Sardinia and Crete, is acute and is one of the issues that will be discussed in this paper.

In the following paragraphs, information regarding the archaeological and chronological contexts of the oxhide ingot fragments found at each of these sites is presented. All the ingot fragments are listed for easy reference in a catalogue at the end of this paper. Where available, the results of chemical analyses are also presented. As the analyses were done at different times, by different laboratories, using a variety of analytical techniques, it was deemed unsuitable to compile them into a single table. Therefore, they are briefly discussed under each entry, together with any available information regarding provenance gained through Lead Isotope Analysis. The Lead Isotope Analysis results are not reproduced but can be easily found in the publications referred to. Then this paper will focus on the chronology of the Cypriot ingots, and the available evidence, both archaeological and archaeometric, regarding the workshops where they may have been manufactured.

Ingots from Cyprus

Enkomi

Archaeological and Chronological Context

As stated above the first oxhide ingot to be found on Cyprus came from Enkomi, where a team from the British Museum undertook excavations at the end of the nineteenth century. They were primarily seeking Late Bronze Age tombs and their rich grave offerings. It is now known that in the Late Bronze Age tombs were located under the buildings and streets of the city. So while sinking trial trenches in their search for tombs, they actually went through the habitation levels of Enkomi (Catling 1964: 278). The city was later systematically excavated by two other teams. A French team under the direction of Claude Schaeffer (1952, 1971) excavated an area which extended mainly in the centre of the city, while a team from the Department of Antiquities of Cyprus under the direction of Porphyrios Dikaïos (1969: 71), excavated an area in the northern sector of the city (Area III or Quartier 1W in Fig. 2) as well as an area in the centre of the city (Area I or Quartier 4W). As a result, Enkomi remains to this day the most extensively excavated Late Cypriot site (Karageorghis 2002: 57).

It was clearly also one of the most important, if not the most important, settlement on the island, as witnessed by both the architectural remains and the rich finds from the habitation levels and the tombs. Enkomi is located on the eastern coast of the island, on Famagusta Bay where until recent times Cyprus' most important commercial harbour was located. Clearly the choice of location had much to do with the fact that this is an ideal location for a harbour involved with the Eastern Mediterranean sea-borne trade. The excavations revealed that Enkomi was founded between the end of the Middle Cypriot (MC) and the beginning of the Late Cypriot (LC) periods, in other words around the end of the 17th century BC, and it was abandoned at the end of the LCIIIA (ca. 1200-1100 BC). It therefore, stands apart from most other Late Cypriot sites in having a long habitation history that spans the whole of the Late Bronze Age. During its peak Enkomi was fortified and had a well-organised city plan with parallel streets intersecting at right angles the avenues which ran from the city's gates (Fig. 2). Its monumental architecture, evidence for the use of writing (Enkomi has produced the largest number of Cypro-Minoan texts to date (Karageorghis 2002: 17)), and the very rich burial offerings bear witness to the importance of the city. Although little is still known about the political organisation of the island at this period, it is believed that if the island was united under one ruler, then his seat of power would most probably have been at Enkomi (Muhly 1989: 299).

Dikaïos' (1971: 500) excavations revealed evidence of metallurgical activity in Enkomi dating from the earliest phases of occupation. In the northern edge of the town he uncovered a building, the so-called Fortress, in which there were objects and waste material clearly associated with copper workshops. These included tuyères, ceramic and stone bellows, quantities of slag, a variety of stone moulds and scrap metal (Dikaïos 1971: 505). Metallurgical workshops were also excavated in various other parts of the city by the French team (Courtois 1982; Lagarce and Lagarce 1986).

It is, therefore, not surprising that the only three complete ingots known from Cyprus, as well as a significant number of fragments, come from Enkomi. The settlement was clearly involved in overseas trade, it encompassed several metallurgical workshops, it has a long occupation history and last but not least, it is this site that has been excavated to the greatest extent among its contemporaries.

The British Museum's team found the first complete oxhide ingot together with ingot fragments, bronze tools, including smithing tools, weapons, vessels, and scrap metal. The finds formed what has come down in the literature as the "Foundry Hoard" from Enkomi (Catling 1964: 278-281). Because many of the artefacts were not damaged or used, Catling (1964: 281) suggested that the hoard consisted of the contents of a metalworking workshop, in other words the tools of the smith, his raw material in the form of ingots and scrap metal, and finally the products of the workshop. The publication of the British Museum's excavation does not specify where exactly they found the ingot (Murray *et al.* 1900: 16-17) and since the city's layout was revealed many decades later when Enkomi was systematically excavated, it is not easy to pinpoint the exact location of the Foundry Hoard within the city. Nevertheless, Schaeffer (1952: 28) who interviewed some of the local villagers believed that the hoard came from the north-western section of the city.

The ingot which is now in the British Museum (Inv. no. 1897/4-1/1535) weighs 36.92 kg and measures 70 cm in length, 40.5 cm in width and is on average 5.5 cm thick (Catling 1964: 267; Muhly *et al.* 1980: 90). It bears an impressed mark, created shortly after the metal was cast. The hoard also included ingot fragments. According to Catling (1964: 267) there were four ingot fragments but according to Crewe (pers. comm.) who has been systematically cataloguing the British Museum's finds from Enkomi there are in fact six ingot fragments (Inv. no. 1897,0401.1520.12, Inv. no. 1897,0401.1520.13, Inv. no. 1897,0401.1520.14, Inv. no. 1897,0401.1520.15, Inv. no. 1897,0401.1520.33, Inv. no. 1897,0401.1520.36)¹.

The archaeological context of the other two complete ingots is even less certain as they came from the antiquities market: one was purchased in Nicosia and the other in Famagusta (Muhly *et al.* 1980: 91). The first one is in the Cyprus Museum (Inv. no. 1939/VI-20/4) (Catling 1964: 268). It weighs 39.18 kg and measures 72 cm in length, 42 in width and is 3.9-5.5 cm thick. It bears an impressed mark (*Fig. 4*). The second was purchased by H. Mudd and exported to California together with many other Cypriot antiquities, including a significant proportion of the ingot fragments from the Mathiatis Hoard discussed below (Muhly *et al.* 1980: 91). The ingot is now in the Cypriot collection of Harvey Mudd College, Claremont, California (Muhly 2005: 139). It weighs 32.10 kg, and measures 65 cm in length, 35 cm in width and is 3.75-5.6 cm thick. A quatrefoil mark is impressed on its surface (Muhly *et al.* 1980: 92) (*Fig. 5*).

According to information gathered by Schaeffer, the two ingots came from the north-western part of the city, where local villagers discovered several oxhide ingots. Schaeffer (1952: 28) was shown the field where this "Ingot hoard" probably came from and proceeded to some trial excavations. The area according to Courtois (1982: 160) corresponds to the French Mission's Quartier 6W, where several seasons of excavations uncovered abundant metallurgical remains including crucible fragments, charcoal, sulphide ore pieces, miniature ingots and a variety of stone tools such as pestles and grinding stones, indicating intense metallurgical activity (*Fig. 2*).

Although there is no proper archaeological context that would enable the accurate dating of either of these hoards, Catling (1964: 281) argued that they could not be of a date earlier than 1200 BC. He based this statement on the fragments of bronze stands that were included in the Foundry hoard, which he believed to have been produced in Cyprus only after the arrival of Mycenaean settlers on the island in the 12th century, as well as on the shape of the ingots. Following the typology of Buchholz (1959: 7), the ingot in the British Museum is of Type III, which according to Catling (1967: 267) is not known in contexts earlier than 1200 BC. Both arguments have been contested. The study of the thirty-four oxhide ingots from the Cape Gelidonya shipwreck led Bass (1967: 69) to the conclusion that it was not possible to differentiate between the three types of ingots chronologically. Therefore a date of 1200 BC cannot be substantiated solely on the shape of the ingot. Furthermore, the presence of fragments from a bronze stand cannot be used as an argument for

1 I would like to thank Lindy Crewe for the help in tracking down the ingot fragments from Enkomi now in the British Museum. These are now published in the British Museum online catalogue of the finds from the excavations from Enkomi (Crewe *et al.* 2009).

a 12th century date for the whole hoard: after a thorough study of the Cypriot tripod and four-sided stands, the bronze artefacts which best illustrate the technological capabilities of Cypriot smiths, Papasavvas (2001: 214-216), has shown that many of them date to the LCIIC period, which corresponds to ca. 1320-1200 BC or according Manning *et al.* (2001: 339), who used radiocarbon to define the absolute date of this period, 1340-1315 BC to ca. 1220-1990 BC. In fact according to Knapp, Muhly and Muhly (1988: 246):

“Still there is nothing in the Gunnis or Stylianou Hoards, the Mathiati Hoard or even the Foundry Hoard that would be out of place in the LCIIC period. The abundance of copper oxhide ingot fragments from recent excavations at Maroni-*Vournes* Pyla-*Kokkinokremos*, Maa-Palaeokastro, and Kalavassos all dated to the LCIIC period, may even suggest that the intact ingots from Enkomi’s Foundry and Ingot Hoards were of the same date.”

Apart from the three complete oxhide ingots, fragments of ingots have also been discovered in several locations in the excavated part of the city. As stated above, six fragments were part of the Enkomi Foundry Hoard which came from the north-western part of the city.

Excavations in Quartier 6W which took place in 1966, brought to light almost half of an oxhide ingot, the largest fragment to come out of any excavation in Cyprus (Lagarce 1971: 397) (*Fig. 6*). According to Lagarce J. and Lagarce E. (1986: 66), the fragment came from Point Topographique 1495, a few metres to the east of the initial trial excavations. It was found at the bottom of a pit excavated by tomb-robbers, which he believes to have been where the “Ingot hoard” actually came from (Lagarce 1971: 397). As stated above, the French Mission brought to light abundant evidence of metallurgical activity within the area of Quartier 6W, where this ingot was found. The fragment is illustrated (plate XVII in Lagarce J., Lagarce E. 1986) but there is no information regarding its dimensions or weight. It bears an impressed circular mark between the two handles. Unfortunately, according to the legend of the plate, this find was stored in the French Mission’s storerooms in Enkomi, which were abandoned in 1974 when the Turks invaded Cyprus and occupied 38 % of the island including Enkomi. Its present location is, therefore, unknown and it is impossible to study it further. Furthermore, the fragment came from a disturbed area and, therefore it cannot be securely dated, nor can it be used to date the ingots from the “Ingot Hoard” (Lagarce J., Lagarce E. 1986: 66).

Lagarce J. and Lagarce E. (1986: 66) refer to another oxhide ingot fragment found during the 1949 mission at Enkomi and mentioned in Schaeffer’s diary. Catling (1964: 268) also illustrates (Pl. 49e) an ingot fragment from the French Mission’s excavations of 1949 which presumably is the same object. According to information given in the diary, this came from a metallurgical workshop located somewhere within the Quartier 5W and dating to the LCII or the 14th century BC. Quartier 5W is a central area of Enkomi where the Bâtiment 18 is located (Courtois 1982: 158). A casting workshop, established on Floor IV, was found over the burned ruins of this impressive building. This fragment is one of the earliest dated examples from Cyprus and, therefore, it is very important. Unfortunately, no more information is available regarding the inventory number, the dimensions or weight of the fragment, and an effort to relocate it in the Cyprus Museum’s store rooms was fruitless.

Another ingot fragment (Inv. no. 19) was among the objects that made up the bronze hoard found in Well 212 (Point Topographique 1670) in Quartier 5E. The fragment has one well-defined edge, which presumably corresponds to the edge of the ingot (Lagarce 1971: 415). The hoard consisted of a number of weapons, tools and other bronze artefacts (including four swords and balance plates), as well as scrap metal (Lagarce 1971: 405-417). Among the pieces of scrap metal is another ingot fragment which has no inventory number and is not described in the text but is illustrated in the same photograph, as Inv. no. 19 (Lagarce 1971: 424; *Fig. 25a*). The high concentration of copper slag and other finds, such as crucible and tuyère fragments, found in the adjacent rooms, wells, and open areas, shows that Well 212 was within a metallurgical workshop (Lagarce 1971: 383-393). According to Lagarce (1971: 425) the hoard can be dated to between 1200 and 1150 BC and more probably closer to 1200 BC, based on the ceramics that were found in the filling of the well.

From Quartier 5E also come three fragments (Inv. no. 99 a-c) which were excavated in 1960 and are said to date to the LCIIC or the beginning of the LCIII (Courtois 1984: 22). One of them is very large and the top surface has a texture similar to that of the oxhide ingots (*Fig. 7*). The lower surface, however, is different and no edge is preserved, so it is not certain that it is part of an oxhide ingot. The other two objects are not in fact fragments of oxhide ingots.

Two ingot fragments (Inv. 80a and 80b) came from Well 343 in Quartier 3W, which was excavated in 1960 (Fig. 8). According to Courtois (1984: 22) they date to the Late Cypriot III. Both fragments come from the edge of an oxhide ingot. Unfortunately there is no further information regarding the context of these finds.

From the same Quartier come two more ingot fragments which were found during the 1962 excavations in Point Topographique 783 (Courtois 1982: 166-167; Courtois 1984: 37). They were found together with fragments of a variety of bronze objects including a tripod leg and also slag. The first piece (121 B) does not preserve any edge but has the typical texture of oxhide ingots (Fig. 9) while the second (121 G) is an unusually thick handle fragment (Fig. 10). According to Courtois (1982: 158) this deposit dates to the end of the 12th century BC. If this is the case, then the ingot fragments from Point Topographique 783 are the most recent examples from Cyprus.

The excavations have also produced small fragments which cannot be positively identified as oxhide ingot fragments. Four such fragments (Inv. no. 82) come from Locus 59, Point Topographique 708 in Quartier 3W and date to the LC III (Courtois 1984: 22). Similarly a small fragment (Fragment J) was among the finds from the bronze hoard found in Point Topographique 1458 in Quartier 6W excavated in 1966 (Courtois 1984: 40).

Chemical Analysis

The very first ingot to be found on Cyprus was also the first to be analysed. The publication by Murray *et al.* (1900: 17) gives the results of a chemical analysis which ascertained that the ingot consisted of 98.05% copper, 0.31% lead, 0.05 % zinc and had traces of silver, bismuth, iron, and sulphur. No tin or nickel were detected.

A sample from the same ingot was analysed in the 1970's both by Craddock who used Atomic Absorption Spectroscopy (AAS) and by Muhly, Maddin and Stech who used Optical Emission Spectroscopy (OES) (Muhly *et al.* 1980: 91). The results of these analyses are reproduced in Table 1. The same ingot was analysed by George Rapp who used Neutron Activation Analysis to determine the concentration of some trace elements (Muhly *et al.* 1988: 285). His results are reproduced in Table 2.

Table 1. Chemical Analysis (AAS and OES) of oxhide ingot from Enkomi now at the British Museum. Concentration given in weight % (Table I in Muhly *et al.* 1980: 91).

	Cu	Al	Sb	As	Ca	Co	Fe	Pb	Mg	Mn	Ni	Si	Ag	Sn	Ti	Zn
AAS	98,5	Nd	-	0,40	Nd	0,09	0,14	0,015	Nd	Nd	0,07	Nd	0,01	-	Nd	nd
OES	98,8	0,03	0,1	0,3	0,09	0,1	0,3	0,03	0,09	0,003	0,1	0,3	0,009	0,01	0,03	-

Table 2. Chemical Analysis (NAA) of oxhide ingot from Enkomi now at the British Museum. Concentration given in weight % (Table 2 in Muhly *et al.* 1988: 286).

	As	Sb	Ag	Au	Co	Se	Te
Enkomi BM	0,37	0,0080	0,025	0,0013	0,1	0,0018	0,0084

Microscopic analysis of the ingot revealed a dendritic structure typical of a cast object. A second phase, visible between the dendrites, was found to consist of copper sulphides, some of which contained traces of arsenic, tin and cobalt (Muhly *et al.* 1980: 91).

Muhly, Maddin and Stech (1980: 92) also analysed the oxhide ingot, which is now in California. The results of that analysis are reproduced in Table 3.

Table 3. Chemical Analysis (OES) of oxhide ingot from Enkomi now in the Cypriot collection of Harvey Mudd College, Claremont California (Table II in Muhly *et al.* 1980: 91).

Al	Sb	As	Ca	Co	Fe	Pb	Mg	Mn	Ni	Si	Ag	Sn	Ti	Zn
0,05	0,01	0,3	-	-	0,3	0,03	0,1	<0,001	-	0,3	0,01	-	-	-

Microanalysis revealed a similar structure to the other ingot from Enkomi: dendrites typical of a cast object and copper sulphide inclusions between the grains (Muhly *et al.* 1980: 92-93).

Provenance

Lead Isotope Analysis was carried out on samples from the complete ingot from Enkomi, as well as from the ingot fragments which were part of the Foundry hoard and are now in the British Museum (for the analytical data the reader is referred to *Table 6*, in Stos-Gale *et al.* 1997: 110). According to the analysis, they coincide with the ores from the so-called Solea Axis in the North-West of Cyprus and in particular with the ores from the mine of Apliki (Gale 1999: 116). This is an interesting result as, save for those of the Limni Axis, the ore deposits of the Solea Axis are those to be found at the farthest possible distance from Enkomi (*Fig. 2f*). This raises many questions regarding the organization of the Cypriot copper industry in the Late Bronze Age, which will be addressed below.

Maroni-Vournes

Archaeological and Chronological Context

The site of Maroni-Vournes, on the south-eastern coast of Cyprus, is a low hillock 500 metres from the sea where another Late Bronze Age coastal site, that of Maroni-Tsaroukkas is located (Manning *et al.* 2002), and it is approximately 12 km from the copper mines of Kalavassos (*Fig. 1*). It consists of a series of buildings, which have been excavated by a team under the direction of Gerald Cadogan (Cadogan 1983, 1984, 1986, 1987, 1988, 1989, 1992, 1998; Cadogan *et al.* 2001). A study of the pottery found has revealed that an important settlement existed at Vournes already in the LCI period (ca. 1600-1450 BC) (Cadogan *et al.* 2001: 77) but it is during the LCIIIC period that the site reached its peak and then was eventually abandoned. At that time a large building was constructed with ashlar masonry. The so-called Ashlar Building is believed to have been an administrative centre where, according to the archaeological evidence, olive oil was produced and stored together with cereals. Apart from food storage, textile production and metalworking are activities which seem to have taken place in this building (Cadogan 1998: 8).

The evidence for metalworking from the area of the Ashlar Building (particularly from Trenches J19, K19 and L19) consists of pieces of slag, furnace conglomerate, broken artifacts, pieces of bronze scrap, and casting spillage (Cadogan 1986: 43; Muhly *et al.* 1988: 292). Among them were identified fragments of oxhide ingots. The fact that these finds come from below the floor of the Ashlar Building indicates that the metalworking activities in this area of the site antedate its construction and therefore, belong to an earlier phase (Cadogan 1984: 8). According to the records of the excavation, kindly provided by its director Gerald Cadogan, three possible oxhide ingot fragments were found in the area of the Ashlar building: MV/M201, MV/M210, and MV/M216. All three came from Room 20, and one of them (MV/M216) was found below the gypsum paving of the room.

More oxhide ingot fragments were found in association with the smaller buildings that lie to the south-east of the Ashlar Building. The most intriguing of these is the so-called Basin Building which consists of a roughly square room with a paved floor in which there is a rectangular basin (Cadogan 1984: 6-7). The use of this building is unclear, although it is presumed that water was somehow involved. The Basin Building was constructed during the LCIIA –LCIIB (ca. 1450-1320 BC) and predates the Ashlar Building, (Cadogan *et al.* 2001: 84). At some point, the walls of the basin partially collapsed and an earth floor was laid over it and eventually all of the building was sealed by a layer of ashlar chips.

One of the oxhide ingot fragments (MV/M183), identified as such by Jim Muhly, was found on the floor of the Basin Building together with lumps of furnace conglomerate (Cadogan 1987: 83). As it is believed that the Basin building was constructed and used in the 14th century BC and was then abandoned and sealed before the subsequent LCIIIC, during which the Ashlar Building was constructed (Cadogan 1986: 42; Cadogan *et al.* 2001: 84), then the same date should be assigned to the oxhide ingot fragment.

Two more oxhide ingot fragments (MV/M181 and MV/M260) were found in Trench M17 (Area 29). In this trench, which is adjacent to the Basin Building, another small rectangular building with a series of plaster floors was excavated (Cadogan 1986: 40). The exact dating and function of this building, however, is also

unclear, although it is believed that it is contemporary to the Basin Building and that their use was somehow connected (Cadogan 1992: 53). According to the excavator, the ingot fragments were found on levels which date to the LCIIB or even the LCIIC period.

In sum, seven oxhide ingot fragments have been collected during the excavations at the site of Maroni-Vournes. Most of the fragments come from levels and buildings which antedate the construction of the Ashlar Building, which is believed to have taken place during the 13th century BC. Therefore the ingot fragments from Maroni-Vournes, are some of the earliest examples from Cyprus.

Chemical Analysis

There are as yet no published chemical or microscopic analyses of the ingot fragments from Maroni-Vournes. The study of the archaeometallurgical material has recently been assigned to Roger Doonan and should be published in the near future.

Provenance

Lead Isotope Analysis of samples taken from the oxhide ingot fragments from Maroni undertaken by the Isotrace Laboratory at Oxford (for the analytical data the reader is referred to *Table 6*, in Stos-Gale *et al.* 1997: 110), indicates that they coincide with ores from the Solea Axis in the North-West of Cyprus and in particular with those from the mine of Apliki (Gale 1999: 116). One of the samples (it is not specified which) falls within an area where the field for the Apliki mine overlaps with that of Skouriotissa and Mavrovouni and therefore it is possible that it was made out of copper coming from one of these mines. Gale (1999: 116), however, believes that although Skouriotissa and Mavrovouni cannot be excluded, this fragment, like 27 out of the 29 ingot fragments from Cyprus so far analysed, was also made out of copper from Apliki.

Maroni-Tsaroukkas

Archaeological and Chronological Context

The site of Maroni-Tsaroukkas is located right on the coast at a distance of just 500 metres from Maroni-Vournes, and has been known since 1897 when the British Museum team excavated a number of Late Bronze Age tombs which were rich in Mycenaean ceramics and other interesting finds such as ceramic boat models (Manning *et al.* 1994: 83). Its position indicated that this could very well have been a port or anchorage and therefore a project under the direction of Sturt Manning was initiated in order to investigate the settlement and any possible remains of the port still surviving on the sea-bed (Manning *et al.* 2002: 111). An archaeological survey of the area, test excavations, systematic excavations at some of the more promising places and an underwater survey of the coast revealed important remains dating from the LCI to the LCIIC (Manning 1998; Manning, De Mita 1997; Manning *et al.* 2001; Manning *et al.* 1994). Based on the survey results the excavator came to the conclusion that *Tsaroukkas* and *Vournes* were part of the same large but dispersed settlement dating to the Late Bronze Age (Manning, De Mita 1997: 126-128). The underwater survey of the seabed off the site of Maroni-Tsaroukkas produced some very interesting results. Thirty five stone anchors, of the Cypriot Late Bronze Age type were recorded, indicating that this must indeed have been an anchorage during this period (Manning *et al.* 2002: 114). More importantly several well preserved ceramic sherds dating to Late Bronze Age were also collected. Among them was a variety of LCIA wares, as well as imported ceramics such as Canaanite jars (Manning *et al.* 2002: 126-146) indicating that this anchorage was already used for long distance trade from the 17th century BC (Manning *et al.* 2002: 159).

At *Tsaroukkas*, excavations revealed the remains of a settlement dating to the LCIIC period overlaying a cemetery dating from the LCI-LCIIC (Manning 1998: 42). One of the buildings investigated, Building 1, is believed to have been a textile workshop as among the finds were several spindle whorls (Manning 1998: 42). Small pieces of slag and a few bronze artefacts were also recovered from this building. Several pieces of slag were also found in Building 2 which was located closer to the coast (Manning 1998: 45). However, the presence

of a room with a paved floor, which is sloping towards a pithoid jar set in the floor, and collection of small Plain White jugs suggests to the excavator that some kind of liquid was being processed in this room. The discovery of numerous carbonised olive seeds on this floor indicates that very probably the liquid was olive oil (Manning 1998: 46).

The single small piece of oxhide ingot was found in Building 1, where slag and other bronze artefacts indicate that as well as the production of textiles, some metallurgical activity was also taking place in this building². The ingot fragment comes from a LCIIC deposit and therefore is contemporary with the majority of oxhide ingot fragments from Cyprus. It is however a particularly interesting find, as it comes from a settlement clearly involved in sea-borne trade.

Chemical Analysis

The ingot fragment from Maroni-*Tsaroukkas* has not yet been analysed.

Provenance

The provenance of the oxhide ingot fragment from Maroni-*Tsaroukkas* is unknown, as its Lead Isotope profile has not yet been determined.

Kalavassos - Ayios Dhimitrios

Archaeological and Chronological Context

The site of Kalavassos-*Ayios Dhimitrios* is located in the Vasilikos Valley on the southern coast of the island, some 7 km to the north-west of Maroni-*Vournes* (Fig. 2). It lies 3.6 km from the sea and 8 km south of the Kalavassos copper mines (South 1995: 192). The location is believed to have been chosen, on the one hand because of its proximity to the copper mines and the coast and on the other because it lies on the east-west route along the south coast of the island (South 1995: 192). Although there is evidence, namely tombs and remains of buildings, that occupation of the site started at the beginning of the LC period, like Maroni-*Vournes*, Kalavassos-*Ayios Dhimitrios* reached its peak during the LCIIC period and was abandoned at the end of this period (ca. 1200 BC) (South 1989a: 319). The settlement extended over an area of approximately eleven hectares and it was characterised by well constructed buildings, and streets provided with drains (South 2002: 60). The burial gifts indicate that the inhabitants of *Ayios Dhimitrios* had access to valuable and imported goods (South 1989a: 318; South 2002: 62). The NE sector of the settlement stands apart from the rest because of the concentration of large well constructed buildings (South 1995: 194). The largest and most impressive is Building X, which is built with ashlar masonry. A large monolithic stone basin, where presumably the pressed oil was initially stored and numerous large pithoi were found in the buildings, which according to gas chromatography contained olive oil. Clearly this was an administrative building, one of whose main functions was olive oil production and storage: the storage capacity of the building is estimated at 50,000 litres (South 1995: 194).

Although the excavations have not yet revealed large quantities of metallurgical debris that would indicate the presence of metallurgical workshops, small quantities of slag have been found throughout the excavated area, and it is entirely possible that the “industrial” part of the settlement has yet to be discovered (South 1989a: 320). As argued above, because of the proximity of the settlement to the copper deposits of Kalavassos, where unfortunately no evidence for Late Bronze Age mining has yet been discovered, it is believed that this administrative centre would also have controlled the production of copper and that the wealth of the elite attested in the rich burial goods was partly due to the trade of this metal (South 1995: 195; South 2002: 62).

Indications for the presence of some kind of metallurgical workshop have been found in the south-east area of the excavation where Building IX is located. The building (initially named the Rectangular Building) consists of seven rooms that form two wings, which do not communicate directly with each other and has

2 The oxhide ingot fragment from Maroni-*Tsaroukkas* is unpublished and I would like to thank the director of the excavation, Sturt Manning, for allowing me to publish it here.

produced the highest number of bronze artefacts from the whole of the excavated area (South 1982: 64-65). Most came from room A45 in the western wing. There 23 different tools and other artefacts, such as bowls, were found together with smaller pieces of metal (South 1983: 113-114), while in the adjacent room, A44, fragments of crucibles, tuyères, slag and a feature which may be a furnace were uncovered (South 1982: 65). The excavator, Alison South, suggested that, room A45 may have been a storage room for metallic artefacts which were produced or repaired in room A44. In the eastern wing of the building, rooms of similar shape and layout were filled with fragments of large pithoi, which must have taken most of the available space. In room A50 a pithos was found sunken on the floor (South 1982: 65). It is in this same room that three fragments of oxhide ingot were recovered during the removal of a baulk in its centre (South 1983: 104) (*Fig. 11*).

Weights, a very rare bronze cylinder seal (South 1982: 65), and a recently identified bronze stylus (Papasavvas 2003: 84), indicate that some sort of recording was taking place in Building IX, which according to South (1989a: 320) may have been a coppersmith's residence and workshop. The presence of copper ingots among the finds, therefore, is not surprising. It can be interpreted in two ways: either that this is the raw material that was used by the smith to produce the metal objects, examples of which were stored in Room A45 or the ingots were themselves products of this workshop. The absence of ingot mould fragments and the fact that they were found in pieces rather than complete, supports the first hypothesis.

According to the ceramic analysis of sherds collected from Building IX the occupation of this building dates to the LCIIIC and, therefore, the ingots can be dated to the same period (Russel 1983: 111).

Chemical Analysis

One of the ingot fragments from *Ayios Dhimitrios* (K-AD 588) as well as some of the other metallic finds were sampled and analysed by Robert Maddin and Jim Muhly. The report has not yet been published but was kindly made available to the author by Alison South. As the results have not been published they cannot be reproduced here. Suffice to say that in general the ingot was found to consist almost entirely of metallic copper.

Provenance

Lead Isotope Analysis of samples taken from some of the oxhide ingot fragments from Kalavassos-*Ayios Dhimitrios* undertaken by the Isotrace Laboratory at Oxford (for the analytical data the reader is referred to *Table 6*, in Stos-Gale *et al.* 1997: 110), indicates that they coincide with ores from the so-called Solea Axis in the North-West of Cyprus and in particular with those from the mine of Apliki (Gale 1999: 116). This is an intriguing result as one would presume that the ingots as well as the artefacts found at *Ayios Dhimitrios* would be made of copper metal coming from the Kalavassos copper mines. In fact, according to Gale (1999: 115) none of the objects from this site were made of copper coming from the Kalavassos mines. Furthermore, the isotopic ratios of the slag of *Ayios Dhimitrios*, which are consistent with those of the Uluburun ingots, have not yet been matched with any known mineralization in Cyprus (Gale, Stos-Gale 2002: 290). All this, of course, raises many questions and seems to oppose the idea that one of the reasons behind the choice of location for the settlement was its proximity to the copper mines, as well as the idea that the wealth of *Ayios Dhimitrios*' elite was due to the production of the local copper. The question of oxhide ingot production will be discussed below.

Pyla - Kokkinokremos

Archaeological and Chronological Context

Pyla-Kokkinokremos is a relatively large, fortified settlement, built on a plateau located 800 metres from the south-eastern coast of the island (*Fig. 1*) (Karageorghis 2002: 74). It was established during the LCIIIC and was abandoned by 1200 BC. But unlike Enkomi, Maroni and Kalavassos, this settlement had a short life span. According to the excavators it was occupied only for 25-30 years (Karageorghis, Demas 1984: 70). It is argued that like Maa-Palaeokastro, it was a settlement established by Achaean refugees who came to Cyprus after the destruction of the Mycenaean palaces and chose initially to live in isolation from the local population (Karageorghis 2002: 76).

The excavations revealed a series of buildings consisting of small rooms and courtyards which form “complexes”. In Complex B, an external courtyard, Room 22, was excavated, in which were found two pits (Karageorghis, Demas 1984: 12). In the first, a natural hollow utilised as a pit, small pieces of copper slag were found while in the second, which had been purposely dug in the hard packed filling, a bronze hoard was found (Fig. 12). The hoard consisted of a variety of bronze artefacts, including a scale from an armour, an unfinished weight, a small bronze figurine, bronze cymbals, scrap metal and five oxhide ingot fragments (Inv. no. 65), including two handles, one of which is fairly large (Karageorghis, Demas 1984: 55-57) (Fig. 13). One of the handles bears traces of the chisel used to break it off (Muhly, Maddin 1988: 472). The composition of the hoard indicates that it was a founder’s hoard (Karageorghis, Demas 1984: 63). The presence of slag in one pit and this founder’s hoard in the other suggested to the excavators that beyond the courtyard there used to be a metallurgical workshop (Karageorghis, Demas 1984: 12).

Because of the short occupation of the site the date of this hoard and subsequently of the oxhide ingot fragments from Pyla-Kokkinokremos can be estimated with some accuracy. As stated above the site was abandoned ca. 1200 BC and was only occupied for 25-30 years (Karageorghis, Demas 1984: 63). Presumably the hoard was deposited during the abandonment of the site, in other words sometime around 1200 BC.

Chemical Analysis

The chemical composition of one of the fragments was determined using X-Ray Fluorescence analysis and that of another by Electron Microprobe analysis (Gale, Stos-Gale 1984: 100). Although not stated, the two fragments, which were given the numbers 65S and 65L, are presumably the two handles. The analysis found the ingots to consist of fairly pure copper, with significant traces of arsenic. The results of the analysis are reproduced in Table 4.

Table 4. Microprobe Analysis of oxhide ingot fragments Inv. no. 65S and XRF analysis of oxhide ingot fragment Inv. no. 65L from Pyla-Kokkinokremos. Results given in weight % (Table 7 in Gale, Stos-Gale 1984: 103).

Sample	Cu	As	Fe	Pb	Ni	Co	Sb	Bi	Sn	Zn	Ag	S
Inv. 65S	98.45	0.26	0.04	0.00	0.09	0.05	0.05	0.00	0.00	0.00	0.04	0.01
Inv. 65L	99.3	0.45	0.14	0.12	-	-	-	-	-	-	-	-

One of the handle fragments (Inv. no. 65S) was also analysed by Muhly and Maddin (1988: 471). Their analytical results agree with those of the Gales. In other words the ingot is made of very pure copper with arsenic being the main impurity (Muhly, Maddin 1988: 472). Their results are reproduced in Table 5.

Table 5. Electronbeam microanalysis of oxhide ingot fragment (Inv. no. 65S) from Pyla-Kokkinokremos. (Table 1 in Muhly, Maddin 1988: 471).

	Cu	Sn	As	Fe	Pb	Co	Ni	Zn	Sb	Ag	Bi	Au
P1	99.99	0.01	0.12	0.1	0.00	0.05	0.05	0.01	0.01	0.00	0.00	0.03

Provenance

The provenance of two of the oxhide ingot fragments from Pyla-Kokkinokremos was determined using Lead Isotope Analysis (for the analytical data the reader is referred to Table 6, in Stos-Gale *et al.* 1997: 110). According to the analysis, they coincide with ores from the so-called Solea Axis in the North-West of Cyprus and in particular with those from the mine of Apliki (Gale 1999: 116).

Maa - Palaeokastro

Archaeological and Chronological Context

The fortified settlement of Maa-Palaeokastro is located on the western coast of the island (Fig. 1). It is built on a long promontory which rises abruptly above two small bays. Cyclopean walls were built on both ends of

the promontory protecting the settlement from potential invaders coming either from the sea or from the land. The choice of the location together with a number of novelties that were not known from other Cypriot Late Bronze Age sites, such as bathtubs and large hearths, led the excavators to the conclusion that the settlement of *Maa-Palaeokastro*, like the one at *Pyla-Kokkinokremos* discussed above, was established by Mycenaean refugees who came to Cyprus shortly after the destruction of the Mycenaean centres on the mainland (Karageorghis, Demas 1988: 264-5). The settlement was founded at the end of the LCIIIC and the occupation does not seem to continue beyond the LCIIIA:1. In other words, the settlement had a rather short life spanning fifty years, between 1200 and 1150 BC (Karageorghis, Demas 1988: 260). Unlike *Pyla-Kokkinokremos* which was abandoned, this settlement was violently destroyed.

Although limited, the excavations revealed evidence of small-scale metallurgical activity at the site (Karageorghis, Demas 1988: 262). This included tuyère fragments, coming from the initial excavations of Porphyrios Dikaïos in 1954 (Karageorghis, Demas 1988: 214), ceramic pot bellows (Zwicker 1988: 430), pieces of copper slag (Zwicker 1988: 428), scrap metal and, last but not least, fragments of copper oxhide ingots. One of the pieces was discovered during the excavations of Dikaïos and identified as such by Zwicker (1988: 429). There is no information regarding exactly where it was found nor about its size. Two small fragments (Inv. no. 189) came from Room 64 in Building II, which was interpreted as a storeroom (Karageorghis, Demas 1988: 22). These fragments were re-examined for the present study. Their small size and texture does not conform to the oxhide type and strictly speaking they should not be included in the present catalogue. The slag and the fragmentary, ceramic pot bellows came from the same building (Muhly, Maddin 1988: 471). Finally, another small fragment came from below Floor II in Rooms 1 and 2 of Area I (Karageorghis, Demas 1988: 100).

Due to the short life span of the settlement of *Maa-Palaeokastro*, the ingot fragments can be easily dated. At the earliest they would date to the end of the LCIIIC, in other words around 1200 BC, when the settlement was founded and at the latest they would date to 1150 BC when the settlement was destroyed. These are, therefore, a little later in date than the ones coming from other sites like Maroni and Kalavassos.

Chemical Analysis

Samples taken from the oxhide ingot fragments from *Maa-Palaeokastro* were studied by Zwicker (1988: 429) by Electron Microprobe analysis. The microanalysis detected copper sulphide inclusions rich in tellurium, cobalt and iron, as well as copper-copper oxide eutectic phases along the grain boundaries. Traces of arsenic, sulphur, antimony and selenium were also detected.

One of the fragments (Inv. no. 189) was also analysed by Muhly and Maddin. The chemical analysis found the ingot to consist of fairly pure copper with arsenic as one of the main impurities (Muhly, Maddin 1988: 471). The analytical results are reproduced in *Table 6*.

Table 6. Electron Beam microanalysis of oxhide ingot (Inv. no. 189) from Maa-Palaeokastro (Table 1 in Muhly, Maddin 1988: 471).

	Cu	Sn	As	Fe	Pb	Co	Ni	Zn	Sb	Ag	Bi	Au
M1	97,87	0,00	0,24	0,00	0,03	0,01	0,02	0,00	0,00	0,03	0,00	0,02

The microanalysis also revealed the presence of copper sulphide inclusions. The relatively large size of the grains indicates that the molten metal solidified slowly (Muhly, Maddin 1988: 471). According to Muhly and Maddin (1988: 472) such a microstructure would be consistent with the use of a clay or limestone mould for the casting of the ingot.

Provenance

The provenance of one of the oxhide ingot fragments from *Maa-Palaeokastro* was determined using Lead Isotope Analysis (for the analytical data the reader is referred to *Table 6*, in Stos-Gale *et al.* 1997: 110). According to the analysis, they coincide with ores from the so-called Solea Axis in the North-West of Cyprus and in particular with those from the mine of Apliki (Gale 1999: 116).

Mathiatis

Archaeological and Chronological Context

The first and still the most detailed publication of ancient remains from the copper mines of the Troodos was published in 1937 by J.L. Bruce, Resident Director of the Cyprus Mines Corporation, the company which owned the concession for exploiting most of the Cypriot deposits including those of Skouriotissa, Mavrovouni, Apliki and, of course, Mathiatis. It is in this publication that a photograph of 16 oxhide ingot fragments said to be from Mathiatis was first published, but without any comment or reference to it in the text (Bruce 1937: 641) (*Fig. 14*). The photograph was reproduced by Buchholz (1959: 29), who listed the fragments from Mathiatis in his catalogue of oxhide ingots. Again no further information was offered. It is Catling (1964: 283) who managed to find a little more about the origin of these finds.

The ingot fragments formed part of the so-called Mathiatis hoard, which consisted of a variety of bronze artefacts and twenty-seven fragments of oxhide ingots. It was accidentally discovered some time in the 1930s during the beginning of mining operations in the orebody of North Mathiatis, located on the north-eastern foothills of the Troodos mountains (*Fig. 1*). The objects were found in a circular depression 90-120 cm in diameter lying 60 cm from the surface (Catling 1964: 283). Unfortunately this is the only information regarding their context.

The finds then came to the possession of H.S. Mudd, owner of the Cyprus Copper Corporation, who submitted them for export, together with other antiquities which he had in his collection. The permit was issued but one sixth of the finds were kept by the Cyprus Museum. This is probably the reason why there are two entries for the Mathiatis hoard in Catling's catalogue (Catling 1964: 268). The first entry concerns the sixteen fragments, including four handles, illustrated in the photograph first published by Bruce (*Fig. 14*). Catling (1964: 268) stated that their whereabouts were then unknown, but presumably they are the fragments whose export was permitted and are now part of the Cypriot collection of Harvey Mudd College, Claremont, California. The second entry concerns eleven fragments which are stored in the Cyprus Museum under the inventory number Nicosia 1936/VII-17/9 (*Fig. 15*).

During the course of the present study, I had the opportunity to study the fragments in the Cyprus Museum, a detailed description of which is given in the catalogue below. The study had some interesting results. As a single inventory number was used for the whole group of the ingot fragments, I asked the permission of the Department of Antiquities to give each of the fragments a letter by which it can be distinguished. This immediately made it clear that there are in fact twelve rather than eleven fragments under the same inventory number. And indeed twelve fragments are illustrated in the photograph published by Catling (1964: Pl. 49g). However, not all twelve are in fact fragments of oxhide ingots! One of the larger fragments (1936/VII-17/9c) is part of a bun or plano-convex ingot, the first of this type to be identified in a LC context (*Fig. 16*). The smaller fragment 1936/VII-17/9l, which is thinner, has a smoother surface and is homogeneous in section, is clearly different than the rest. Upon close examination it was clear that this is a fragmentary miniature oxhide ingot (*Fig. 17*). Catling (1964: 269) mentions a fragmentary miniature oxhide ingot among the finds from the Mathiatis hoard whose whereabouts were unknown. Presumably this is among the finds that are now part of the Cypriot collection of Harvey Mudd College, Claremont California. This fragment is illustrated (Pl. 52b:37) in Catling's publication and is clearly a different object to the one now in the Cyprus Museum. In other words the Mathiatis hoard included two fragmentary miniature oxhide ingots!

The fact that the hoard also included many broken or damaged bronzes and pieces of scrap metal, as well as the ingot fragments, led Catling (1964: 284-285) to the conclusion that this was a "melting" hoard or what Knapp, Muhly and Muhly (1988: 237) defined as a "founder's" hoard. As the hoard was not found during a systematic nor even a rescue excavation, there is no information as to its context available, and therefore it is rather difficult to date it. However, the ingot fragments were found together with other bronze artefacts. Based on the typology of these bronze weapons and tools, and their similarity with objects found in the "*Trésor des Bronzes*" from Enkomi, Catling (1964: 283) suggested a 12th century date for the hoard and subsequently for the ingot fragments from Mathiatis. This date was challenged by Knapp, Muhly and Muhly (1988: 244-246) who argued that the Mathiatis hoard as well as other hoards from Cyprus, which Catling dated to the 12th century, could very well be of a LCIIIC date. In other words they could date to the 13th century instead.

As no systematic excavations were ever conducted in this area, there was very little archaeological evidence regarding Late Bronze Age occupation in Mathiatis, apart from the hoard, until the accidental discovery and subsequent rescue excavation of a tomb from this period (Hadjicosti 1991: 75). The tomb, located within the village and, therefore, at a distance of a few kilometres from the find-spot of the hoard, was partially looted. Nevertheless the excavation recovered a significant quantity of ceramic and other finds which date the tomb to the LCIIA period (ca. 1425-1360 BC). Furthermore, according to local villagers it was part of an extensive cemetery now under the houses of the modern village (Hadjicosti 1991: 87). Clearly the cemetery would have been associated with a settlement but this has yet to be excavated.

It is a shame that the hoard was not found during a proper archaeological excavation, as it is very important for many reasons. First of all, this is the largest concentration of oxhide ingot fragments found to date in Cyprus. Second, together with the ingots said to be from Skouriotissa, these are the only examples which come from a site, whether a settlement or a workshop, located in one of the mining districts of the Troodos. Third, they were part of a founder's hoard, in other words this is the raw material that was used by the founder to produce a variety of objects. This topic will be discussed further below.

Chemical Analysis

Samples from three of the Mathiatis ingot fragments were analysed using Optical Emission Spectroscopy by the team of Muhly, Maddin and Wheeler (1980: 93). The results are reproduced below in *Table 7*. The copper content, calculated by difference, is in the order of 98%.

Table 7. Optical Emission Spectroscopy analysis of oxhide ingot fragments from Mathiatis. Results given in weight % (Table III in Muhly et al. 1980: 103).

	Cu	Al	Mo	Cr	Ca	Co	Fe	Mg	Mn	Ni	Si	Ag	Sn	Ti
MAT 1	98*	0,001	-	-	0,01	0,1	0,001	0,01	-	0,01	-	0,01	-	0,001
MAT2	98*	-	-	-	0,1	0,1	-	0,1	0,01	0,1	0,1	0,01	-	-
MAT 3	98*	-	-	0,001	0,01	0,1	-	0,1	-	0,01	0,01	0,1	-	-

Microscopic analysis of the samples revealed the presence of copper sulphide inclusions, as well as some copper oxides. In Mathiatis 3, some inclusions were identified as possibly being entrapped particles of slag. The similarities in chemical composition and microscopic structure of the analysed samples led to the suggestion that they are perhaps fragments from the same ingot.

A few years later the same team re-analysed two of the samples using Proton Induced X-Ray Emission Spectroscopy (PIXE), because the results of the Optical Emission Spectroscopy were not deemed accurate enough. The results are reproduced in *Table 8*.

Table 8. PIXE analysis of oxhide ingot fragments from Mathiatis. Results given in weight % (Table 2 in Muhly et al. 1988: 286).

<i>Sample</i>	<i>Cu</i>	<i>Sn</i>	<i>As</i>	<i>Ni</i>	<i>Pb</i>	<i>Sb</i>	<i>Fe</i>	<i>Cl</i>	<i>Ag</i>	<i>S</i>	<i>Si</i>	<i>Ca</i>	<i>nM</i>
<i>MAT1</i>	98.4	<0.012	0.66	0.018	0.053	0.043	0.083	0.013	0.062	0.40	0.020	0.009	0.007
<i>MAT1A</i>	98.6	<0.011	0.85	<0.012	0.064	0.039	0.024	0.042	0.13	0.037	0.055	0.023	0.014
<i>MAT2</i>	99.1	<0.009	0.16	0.029	0.030	0.020	0.044	0.15	0.030	0.11	0.098	0.097	0.008

Gale and Stos-Gale also took samples from four of the Mathiatis ingots, both for chemical and isotopic analysis. It is unclear whether they sampled the same three fragments that were analysed by the other team. The results were initially published in 1984 together with the analysis of the ingots from Pyla (Gale, Stos-Gale 1984: 100) and again in 1986 (Gale, Stos-Gale 1986: 93; Stos-Gale *et al.* 1986: 139). In the first publication, the analytical results come from microprobe analysis and are reproduced in *Table 9*, while in the other two the trace element composition of the samples was determined using Neutron Activation Analysis. The results are reproduced in *Table 10*. In general, the ingots were found to be of pure copper with arsenic being the most significant impurity (arsenic was not one of the analysed elements in the previous set of analysis). One of the samples was also found to contain significant, although within the trace element level, amounts of iron, cobalt and nickel (Gale, Stos-Gale 1984: 100). It is also stated that one of the samples had abundant sulphide inclusions.

Table 9. Microprobe Analysis of oxhide ingot fragments from Mathiatis. Results given in weight % (Table 7 in Gale, Stos-Gale 1984: 103).

Sample	Cu	As	Fe	Pb	Ni	Co	Sb	Bi	Sn	Zn	Ag	S
MAT1	98.31	0.35	0.32	0.00	0.10	0.20	0.05	0.00	0.00	0.00	0.02	0.61
MAT2	99.31	0.52	0.01	0.00	0.06	0.01	0.08	0.00	0.00	0.00	0.03	0.05
MAT3	99.40	0.46	0.01	0.00	0.07	0.02	0.05	0.00	0.00	0.00	0.01	0.15
MAT4	99.41	0.60	0.00	0.00	0.03	0.01	0.07	0.00	0.00	0.00	0.03	0.01

Table 10. Neutron Activation Analysis of Oxhide ingot fragments from Mathiatis. Results given in ppm (Table 3 in Gale, Stos-Gale 1986: 93; Table 4 in Stos-Gale et al. 1986:139).

Ingot	Sn	Pb	As	Sb	Co	Ni	Cr	Fe	Au	Ag	Bi	Zn	Se	In	Ir
MA1	<2750	166	6860	177	1762	550	<25	500	25.8	140	<50	340	50	<43	.012
MA2	<1657	155	4730	190	297	310	<57	300	17.1	186	<50	191	114	<66	.03
MA3	<1500	207	5874	170	720	410	<48	210	27.0	142	<50	140	78	<58	.01
MA4	<1429	64	2196	89	40	120	<43	310	10.7	80	<60	64	440	<100	<.01

Provenance

Lead Isotope Analysis of samples taken from some of the oxhide ingot fragments from Mathiatis undertaken by the Isotrace Laboratory at Oxford (for the analytical data the reader is referred to Table 6, in Stos-Gale *et al.* 1997: 110), indicates that they coincide with ores from the so-called Solea Axis in the North-West of Cyprus and in particular with those from the mine of Apliki (Gale 1999: 116). Like the ingots from Kalavassos-Ayios Dhimitrios, this is again a rather surprising result considering that the site is located within one of the Troodos mining districts.

Although the orebody of North Mathiatis itself is not cupriferous (Bear 1963: 85), a few kilometres to the south is the orebody of South Mathiatis, which was exploited in Antiquity, as evidenced by the presence of ancient mine galleries and slag heaps, as well as the discovery of a smelting workshop dating to the Archaic period, which is currently being excavated (Fasnacht *et al.* 1997; Fasnacht 2002). One would expect that a smith active in this area would be using “local” copper and yet the Lead Isotope Analysis indicates that he was provided with copper from the north-western foothills of the Troodos, which lie at a distance of more than sixty kilometres from Mathiatis. This question will be discussed in more detail below.

Said to be from Skouriotissa

Archaeological and Chronological Context

In a paper published in 1986, Gale and Stos-Gale mention four fragments of oxhide ingot (Inv. no. 1976-I-20/7a–7d), which had been found in Skouriotissa (Fig. 1) together with fragments of crucibles and tuyères and were stored in the Cyprus Museum in Nicosia (Gale, Stos-Gale 1986: 89). In another paper, they stated that there were at least seven fragments from Skouriotissa and that:

“The fragments of oxhide ingot said to be from Skouriotissa are kept in the Nicosia Museum, in a box with a large tuyère with adhering slag, fragments of three others, a large piece of black slag and another of reddish slag, and two stones with adhering slag, but the records do not prove that all these were found together” (Stos-Gale *et al.* 1997: 107).

During the course of this study these fragments were examined in the Cyprus Museum. A detailed description of them, as well as photographs, are published here for the first time (Figs. 18, 19). The fragments clearly derive from copper ingots, most of which are clearly of the oxhide type (for example the larger of the group Inv. no. 1976-I-20/6 or the handle fragment Inv. no. 1976-I-20/7f). Presumably the others, although they are missing tell-tale characteristics such as finished edges or the typical texture, are also of this type, although it is not even certain that they came from the same deposit.

Skouriotissa, which is located at the north-western foothills of the Troodos (*Fig. 20*), is one of the largest copper ore deposits of the island, and the only mine that is still operated today. There have been no systematic excavations in the area, apart from those of Menelaos Markides for the Department of Antiquities, who in 1915 excavated tombs ranging from the Middle Bronze Age down to the Iron Age (Åström 1989: 7). Within the village of Katydata, which is at a distance of less than a kilometre from the mine, Markides excavated nine tombs dating to the Late Cypriot Period (Åström 1989: 9). More recently the Department of Antiquities has also undertaken rescue excavations of tombs dating to the Middle-Late Bronze Age which should be published in the near future. Furthermore, the area of Skouriotissa was systematically surveyed during the Troodos Archaeological and Environmental Survey Project. One of the areas of interest was that of Katydata village where an effort was made to identify both the location of the Bronze Age cemetery excavated by Markides and the settlement that would have been associated with it. The preliminary report published discusses the evidence for the possible location of the Early – Middle Cypriot settlement (2500-1700 BC) associated with the earlier tombs (Boutin *et al.* 2003). Unfortunately the location of the Late Bronze Age settlement still remains unknown.

However, this should not come as a surprise, when one considers how extensively the original landscape has been disturbed, as a result of both ancient and modern mining operations. The area is dominated by ancient slag heaps, estimated to consist of approximately 2 million tons of slag, which date predominantly to the Roman period. The heaps have been systematically recorded and sampled during the Troodos Archaeological and Environmental Survey Project and although C14 dating analysis has not yet been carried out, pottery collected within the slag layers is almost exclusively Roman in date. Furthermore, the fact that the modern mine is an open cast mine means that most of the ore deposit, and with it the hill within which it once lay, has been removed. In its place there is now a substantial crater measuring hundreds of metres in depth and diameter, while the surrounding area is covered by the modern mine's spoil heaps. It is entirely possible that a Late Bronze Age settlement and/or copper smelting workshop did once exist on the hill of Skouriotissa. Unfortunately no archaeological survey was undertaken at Skouriotissa prior to the formation of the open cast mine and therefore this can never be verified.

An effort to find out more about the provenance of ingots in the Cyprus Museum's archives proved fruitless. The entry just states that the fragments are from "the area of Skouriotissa" and that they were turned into the Department of Antiquities by an employee of the Hellenic Mining Company by the name of "Andreas". Had the last name of this man been recorded, there might have been a chance to find him and ask him to pinpoint where exactly the ingots were found. So it seemed that these very important finds would remain without any context and this would have been a great shame, as the Skouriotissa fragments and those from Mathiatis would have been the only Late Bronze Age ingots from the mining regions of the Troodos. Furthermore the ones from Skouriotissa would have been the only examples found in the mining area which according to the Lead Isotope Analysis has produced all known, analysed oxhide ingots.

However, as a result of this study a rather startling discovery was made. A closer look at the photograph published by Bruce (1937: 641) (*Fig. 14*) of the ingot fragments which are said to be from Mathiatis and which Catling identified as the fragments which were exported by Mudd, revealed that it in fact includes six of the seven fragments thought to be from Skouriotissa (1976-I-20/6, 1976-I-20/7a, 1976-I-20/7b, 1976-I-20/7c, 1976-I-20/7d, and 1976-I-20/7e) as well as one of those fragments from Mathiatis which are in the Cyprus Museum (Inv. no. 1936/VII-17/9e). This, therefore, suggests that at least six of the seven fragments are in fact not from Skouriotissa but rather they are part of the Mathiatis hoard! One wonders why they were not exported together with the rest of the objects which Mudd was permitted to take (apparently to California), and how they ended up in the possession of the Hellenic Mining Company (which took over the concession for exploitation of Skouriotissa and other mines previously licensed to the Cyprus Mining Company owned by the Mudd family)? This is an issue that still needs to be clarified. A more detailed study by the author of the ingot fragments from Mathiatis and those which are said to be from Skouriotissa, including chemical analyses, is already underway and should be published in the near future.

As there is no information regarding the archaeological context of those ingot fragments said to be from Skouriotissa, there is no information regarding their date. Nevertheless, when they were first published they were given the same date, in other words the 12th century BC, given by Catling (1964: 267-268) to the

other oxhide ingots found in Cyprus (note 16 in Stos-Gale *et al* 1986: 128), while in later publications their date is given as post 1250 BC (Gale 1999: 116). This question of the date of the Cypriot oxhide ingots will be discussed below.

Chemical Analysis

Samples taken from four of the oxhide ingots fragments said to be from Skouriotissa (1976-I-20/6 (SK6), 1976-I-20/7a (SK7a), 1976-I-20/7b (SK7b), (SK7c), 1976-I-20/7d (SK7d)) were analysed using Neutron Activation Analysis (Gale and Stos-Gale 1986: 89; Stos-Gale *et al.* 1986: 128). The analysis found that the copper concentration was above 99% and that the major impurity was arsenic. The full analyses are reproduced in *Table 11* below.

*Table 11. Neutron Activation Analysis of Oxhide ingot fragments from Skouriotissa. Results given in ppm (Table 3 in Gale, Stos-Gale 1986: 93; Table 4 in Stos-Gale *et al.* 1986: 139).*

<i>Ingot</i>	<i>Sn</i>	<i>Pb</i>	<i>As</i>	<i>Sb</i>	<i>Co</i>	<i>Ni</i>	<i>Cr</i>	<i>Fe</i>	<i>Au</i>	<i>Ag</i>	<i>Bi</i>	<i>Zn</i>	<i>Se</i>	<i>In</i>	<i>Ir</i>
<i>SK6</i>	<232	<i>nm</i>	5030	158	1215	<i>Nm</i>	<41	<i>Nm</i>	20.7	128	<i>nm</i>	355	82	<49	<.01
<i>SK7a</i>	<355	98	5012	133	296	330	<52	280	24.9	170	<60	103	90	<68	01
<i>SK7b</i>	<1851	<i>nm</i>	3758	118	<i>nm</i>	470	<60	280	23.9	143	<50	<i>nm</i>	<i>Nm</i>	<45	01
<i>SK7d</i>	<815	26	2218	59	22	160	<30	250	4.2	40	<50	90	242	<43	<.01

Provenance

Lead Isotope Analysis of samples taken from the oxhide ingot fragments said to be from Skouriotissa undertaken by the Isotrace Laboratory at Oxford (for the analytical data the reader is referred to *Table 6*, in Stos-Gale *et al.* 1997: 110), indicates that they coincide with ores from the so-called Solea Axis in the North-West of Cyprus and in particular with those from the mine of Apliki (Gale 1999: 116). One of the samples (it is not specified which) falls within an area where the field for the Apliki mine overlaps with that of Skouriotissa and Mavrovouni and, therefore, it is possible that it was made out of copper coming from the latter mines. Gale (1999: 116), however, believes that, like the vast majority (27 out of 29) of the analysed ingot fragments from Cyprus, it was made out of copper from Apliki, although Skouriotissa and Mavrovouni cannot be excluded.

Discussion on the oxhide ingots from Cyprus

Having presented the archaeological and archaeometric data concerning the oxhide ingots and fragments found in Cyprus, general issues may be discussed such as the distribution of the ingots, their archaeological and chronological context, the chemical composition and provenance of the metal, and the possible areas of production.

Typology

Although the typology of oxhide ingots by Buchholz (1959: 7) has been challenged as a reliable dating system (Bass 1967: 69), it is nevertheless useful as a way to describe an ingot and compare it to others. Unfortunately, the majority of finds in Cyprus are fragments and therefore not easy to classify. This can only be done with the three complete ingots, the half ingot from Enkomi and some of the larger pieces from the Mathiatis hoard which preserve the handle as well as a substantial part of the body. The British Museum and the Cyprus Museum ingots are very similar in shape and were both assigned to Type 3 (Buchholz 1959: 28-9). The third complete ingot, now in California, is different, having much thicker handles than the other two and a more elongated and narrow shape. This is probably why Buchholz (1959: 29) assigned it to Type 2/3. In fact it is much closer to his Type 2. This is also the case with the half ingot from Enkomi from Schaeffer's excavation. The larger fragments from the Mathiatis hoard (both those now in the US and the one in the Cyprus Museum (Inv. no. 1936/VII-17/9a) belong to Type 3.

The three complete Cypriot ingots are similar in that they all have a weight of over 30 kg. In fact the one in the Cyprus Museum weighs just over 39 kg, almost double the weight of complete ingots found outside Cyprus which are usually in the range of 20-30 kg. For example the ingots from Agia Triada range in weight from 27 to 32 kg (Buchholz 1959: 32), the ingots from Uluburun all weigh around 25 kg (Pulak 1997: 235), while the ingots from Cape Gelidonya seem to be a little lighter ranging in weight from just below 20 to almost 25 kg (Bass 1967: 57). In the latter two groups one should take into consideration a possible reduction in the original weight due to the corrosion of the metal in sea water for over three thousand years. Ingots of similar weight to those in Cyprus have been found in Sardinia, for example those from Serra Ilixi (Buchholz 1959: 38).

The three complete and the one half ingot from Enkomi all bear impressed marks on the upper rough surface. The mark on the ingot which is now in California is located on centre of the surface while in all the other examples it is on one of the narrower sides, between the handles. As pointed out by Bass (1967: 72-74) this type of marking, which he called "primary" must have been done when the metal was still soft. In other words, the ingots were marked at the workshop where they were produced. The marks on the ingots now in the British Museum and in the Cyprus Museum could very well be characters from the Cypro-Minoan Script. In the case of the other two the marks are simple shapes. In the example now in California the mark is a quatrefoil shape and on the half ingot from Enkomi it is a spherical mark. I have argued elsewhere that the marking of metal ingots, whether they are copper oxhide ingots, copper bun ingots, tin oxhide ingots or tin plano-convex ingots, indeed even lead ingots, seems to be a specifically Cypriot practice, parallel to the practise of marking pottery (Hirschfeld 1993: 313) and that this implies that the ingots have either been traded via Cyprus or that they have been handled by people familiar with the Cypriot marking system (Kassianidou 2001: 116). What is needed is of course a systematic study of all the marks on oxhide ingots by someone who is familiar with the Late Bronze Age scripts, not only of Cyprus but also of the Aegean.

Chemical composition

Most of the oxhide ingots and fragments from Cyprus have been analysed. The fact that the analyses were done with a variety of analytical techniques (Optical Emission Spectroscopy, Atomic Absorption Spectroscopy, Neutron Activation Analysis, Microprobe Analysis etc.) means that it is not easy to compare the results. First of all, each of these techniques has different detection limits and different capabilities, especially when it comes to the trace elements. Second, the samples are not always analysed for the same range of elements.

In any case, what the available analytical data clearly shows is that the oxhide ingots are made of very pure copper. Other elements are present only as traces. Out of these, arsenic, iron, and selenium are some that are found in noteworthy concentrations. In all the ingot fragments that have been studied microscopically, sulphide inclusions were detected, indicating that the metal was extracted from sulphide ores. These results agree with the recent chemical and microscopic analysis of a number of oxhide and bun ingots from the Uluburun ship. According to Hauptmann, Maddin and Prange (2002: 13):

"We, therefore, conclude that the ingots reflect the composition of "pure" copper ores that were smelted to produce the metal and with but few exceptions we see few indications that bronze scrap could have been added as has been suggested."

This fits very well with the composition of Cypriot ores, which are almost exclusively sulphidic and consist mainly of sulphur and iron with small amounts of copper and zinc and trace amounts of cobalt and nickel (Constantinou 1992: 336-337). Modern geological surveys have not detected any copper carbonates or copper silicates in any of the Cypriot ore deposits (Constantinou 1982: 15).

As the ingot fragments from Cyprus are few, ideally they should all be re-analysed using the same technique. It would be even more desirable to initiate a wider analytical program for all the oxhide ingots found in the Mediterranean, so that a truly reliable database could be constructed which would enable meaningful comparisons to be made.

Chronology

When Catling (1964: 267-272) discussed the oxhide ingots of Cyprus, he proposed a date in the 12th century for them, although none of the examples he listed had come from a truly systematic excavation or had a secure archaeological context. The date was based on the typology of the other bronze objects which together with the ingot fragments made up the hoards. However, the British Museum's excavation records did not clearly list the objects that were part of the Enkomi Foundry hoard, and he had to "reconstruct" the hoard based on a variety of documents and inventory numbers which were kept at the British Museum (Catling 1964: 279). Similarly, the Mathiatis hoard lacked a proper archaeological context. It had come to the Cyprus Museum in order to be exported together with other antiquities which constituted part of the private collection of Harvey Mudd. In fact, Catling (1964: 282-285) noted that among these bronzes were some which were clearly of a later date, which he called "intrusions" and he carefully picked them out. By comparing the contents of these hoards with other hoards mainly from Enkomi, such as the Trésor des Bronzes, which did have a secure date within the twelfth century, he came to the conclusion that all three hoards containing oxhide ingots (the Enkomi Foundry Hoard, the Enkomi Ingot Hoard and the Mathiatis Hoard) were of the same date and subsequently that all the ingots from Cyprus dated solely to the 12th century (Catling 1964: 289-291).

There was another reason why Catling dated the ingots to the 12th century BC and this had nothing to do with the actual archaeological evidence. It was his belief that the Cypriot copper industry only really developed after the arrival of Mycenaean settlers on the island, who took over the production and trade of Cypriot copper, cast in the shape of oxhide ingots (Catling 1964: 271). Therefore the ingots in Cyprus could not be earlier than the arrival of the Mycenaeans.

For many years, this 12th century date of oxhide ingots in Cyprus was accepted and used by all those who studied them (e.g. Stos-Gale *et al.* 1986: 128; Muhly *et al.* 1980: 90). As a result Cyprus' role in the metals trade during the Late Bronze Age could not be properly appreciated or even accepted. If oxhide ingots appeared in Cyprus only after the 12th century BC, then those oxhide ingots found elsewhere in the Eastern Mediterranean could not have been made in Cyprus. Furthermore, the archaeological evidence seemed to contradict the textual evidence. According to the ancient sources, copper from Alashiya, widely accepted to be Cyprus, had been exported since the 18th century BC (Muhly 1972: 204). By the 14th century BC, Cypriot copper was exported in truly great quantities: in the letters sent by the king of Alashiya to the Pharaoh of Egypt, found in the archive of Amarna, a total of 897 talents of copper, corresponding to 26 tons of metal, are said to have been sent to Egypt (Knapp 1985: 238; Knapp 1996: 8; Muhly 1972: 21; Muhly 2005: 139-140). As the copper was traded in the form of oxhide ingots, and no ingots had been found in Cyprus from before the 12th century, then, some have argued, perhaps Alashiya should not be identified with Cyprus.

As more Late Cypriot sites were excavated and more ingot fragments were found it became clear that the date of oxhide ingots from Cyprus should be pushed back, at least to the middle of the 13th century: most of the ingots listed and discussed above came from LCIIIC levels. Furthermore, a re-appraisal of Late Bronze Age Cypriot and Aegean hoards by Knapp, Muhly and Muhly (1988: 244-248) showed that many of the Cypriot hoards, including those which contained ingots, dated to the 13th rather than the 12th century BC.

Two Late Cypriot sites have, however, produced ingot fragments of an even earlier date. The first is Enkomi where according to Lagarce and Lagarce (1986: 66) Schaeffer found an oxhide ingot fragment in a metallurgical workshop located somewhere within the Quartier 5W and dating to the LCII period or the 14th century BC. A similar date is assigned to the oxhide ingot fragments from Maroni-Vournes, found below the Ashlar building, which was constructed in the LCIIIC period and on the floor of the Basin building, which was built and used during the LCIIA-B period.

For the moment, no ingot fragments dating prior to the 14th century have been found on Cyprus. This may have to do with the fact that the early part of the Late Bronze Age, in other words the LCI-LCIIB periods, is not very well known, as most of the excavated settlements date to the LCIIIC. Although it is now becoming clear that there are earlier habitation levels in a number of them (for example Kalavassos-Ayios Dhimitrios, Maroni-Vournes and of course Enkomi), these have not been extensively studied or uncovered. Although not a strong argument, it is possible that the absence of earlier oxhide ingots from Cyprus may have to do with the fact that no workshops, or storerooms dating to this period where such finds might be expected, have yet been excavated to any great extent.

The excavation of the smelting workshop at Politiko-*Phorades*, dating to the beginning of the Late Bronze Age (16th-15th century BC) (Knapp *et al.* 2001: 205) showed that copper was produced at this period and that the technology was very advanced (Kassianidou 1999: 95-96). Furthermore, the copper workshops excavated by Dikaïos in Enkomi were already active from the Middle Cypriot III period. Describing the excavated remains dating to the LCI he stated:

“In many of these (rooms) we found remnants on successive floors of furnaces littered with masses of tuyères and broken crucibles, together with much copper oxidation and other debris from copper smelting establishments.” (Dikaïos 1971: 505)

What is extremely interesting is the fact that, among the finds from these rooms, was also a fragmentary clay tablet of Cypro-Minoan script (Dikaïos 1971: 503). Dating to the 15th century BC, this is one of the earliest written texts from the island and its discovery within a metallurgical workshop is significant. The Cypriot copper industry was already well established and there is no reason why some of the copper produced could not have been exported in the shape of oxhide ingots. In fact, if we accept the lead isotope data, the oxhide ingots from Gournia (Stos-Gale *et al.* 1997: 112-113) and more recently from Mochlos (Stos-Gale 2004: 58), dating to the Late Minoan IB (1500-1450 BC) were made of copper coming from the mine of Apliki. What this means is that Cypriot copper was already being cast into oxhide ingots by the 15th century BC.

The most recent oxhide ingots come from Enkomi. They are the two fragments from Point Topographique 783 in Quartier 3W, which according to the excavator date to the end of the 12th century BC. So the use of the oxhide ingot on the island of Cyprus can be confirmed from the 14th down to the end of the 12th century BC. It is to be hoped that future excavations will expand these chronological boundaries.

Distribution within the island

It is true that in Sardinia oxhide ingots have been found in 31 different sites all over the island (Lo Schiavo 2005: 317) while in Cyprus they have only been found in eight. However, one has to take into consideration how many Nuraghi have been excavated (even if many of these excavations have not been published) and by contrast how few Late Cypriot sites have been excavated. Although archaeological surveys over the last fifty years have identified around 350 sites dating to the Late Cypriot period (Knapp 1997: 47), only about twenty of them have been excavated to any extent. In other words, the difference may simply have to do with the fact that there are many more excavated Nuraghi than Late Cypriot settlements.

When Catling published the oxhide ingots and fragments from Cyprus in 1964, he listed only two sites: Enkomi and Mathiatis (where, as observed above, neither systematic nor rescue excavation had ever taken place). Six more sites have now been added to the list, five of which were excavated after the publication of his book. The sixth is Skouriotissa, although the seven ingot fragments said to be from Skouriotissa may in fact have been found in Mathiatis. It is indicative that the latest find came from Maroni-*Tsaroukkas*, the most recently excavated site in the group. Of course, in the last thirty years other important Late Cypriot settlements such as Toumba tou Skourou, Kition, Hala Sultan Tekke and Alassa have also been excavated, but have not produced any oxhide ingot fragments. However, none of these (with the exception of Hala Sultan Tekke) have been extensively excavated and, therefore, the absence of oxhide ingots may simply be due to the fact that those parts of the settlement, where one would expect to find oxhide ingots (i.e. copper workshops and/or storerooms) have not yet been uncovered. Furthermore, many settlements were abandoned at the end of the LC IIC period and they were usually thoroughly cleared of all valuables, including metal. The absence of oxhide ingots from Late Cypriot sites may therefore only be circumstantial.

As shown in *Fig. 1*, oxhide ingots have been found in sites on the east coast, on the south coast, on the south-west coast and inland. The absence of ingot fragments from the northern coast of Cyprus most probably has to do with the fact that apart from the site of Phlamoudi (Smith 2005: 32-65), no Late Bronze Age settlement had been excavated in that area before 1974. Since 1974 that part of the island is under Turkish occupation and therefore, protected by UNESCO's guidelines, which prohibit excavations in occupied territories. This means that over the last 30 years archaeological research has focused on the southern part of the island, about which we now know much more than about the occupied part of the island.

Ingots have been found in coastal settlements, which were clearly involved in long-distance trade, such as Enkomi and Maroni-*Tsaroukkas*, as well as in inland settlements, which were involved both in the control of the production of olive oil and grain and possibly of copper such as Kalavassos-*Agios Dhimitrios* and Maroni-*Vournes*, and presumably in a settlement involved in the production of copper such as Mathiatis. Furthermore, there were found in fortified settlements believed to have been founded by Achaean refugees, such as Pyla-*Kokkinokremos* and Maa-*Palaeokastro*, which were also involved in metal production. It was Catling (1962: 144) who first suggested that the Late Cypriot sites can be divided into three categories: inland settlements which were involved in agriculture, inland settlements which were involved in the exploitation of the copper orebodies and finally, large urban centres located on the coast and involved in sea-borne trade. Keswani (1993) suggested instead that the sites should be divided into four groups, urban centres, inland-sanctuary centres, agricultural villages and mining sites. Knapp (1997: 48) also suggested a four tiered classification of Late Cypriot sites but his categories are the following: Primary ('urban' centres), secondary ('town' centres), tertiary sanctuary sites and finally peripheral agricultural and mining villages. Using Knapp's classification, oxhide ingots have been found in primary sites (Enkomi, Kalavassos, Maroni), secondary sites (Pyla and Maa) and peripheral sites (Mathiatis). They seem to be absent from the tertiary sites, in other words the sanctuaries. This, in a way, is surprising for Cyprus. Not because of the suggestion that copper production was temple-based and under religious control, as has been suggested in the past by Catling (1971: 30), against which I have recently argued (Kassianidou 2005), but because metallurgical workshops have been found in association with sanctuaries, at both Kition (Karageorghis, Demas 1985: 81; Karageorghis, Kassianidou 1999) and Athienou *Bamboulari tis Koukouninas* (Dothan, Ben Tor 1983: 140). Neither of these sites has produced a single fragment of oxhide ingot. Nevertheless, the fact that the ingots are found not only in primary sites, but also in secondary and peripheral sites is important, because it shows that they are not only associated with settlements that were involved in sea borne trade. This is a conclusion to be discussed below.

Context

In all cases, where the archaeological context is preserved, and even in the one (Mathiatis) where it is not, the oxhide ingots have been found either in areas where there was clear evidence of metallurgical activity (namely at Kalavassos-*Agios Dhimitrios*, Maroni-*Vournes* and *Tsaroukkas*, Maa-*Palaeokastro*), or as part of a hoard. All the hoards that contained ingot fragments also contained broken or damaged bronze artefacts, scrap metal and in some places even slag. They can, therefore, be classified as "founders' hoards", defined as (Knapp *et al.* 1988: 237).

"Founders hoards should be represented by materials collected together for their value as metal not for the intrinsic value of the original objects. They may be characterised particularly by broken objects or scrap metal, by castings, and slag, and by ingot fragments, all items lacking special significance and all being reduced to their lowest common metal denominator."

The only possible exception might be the Enkomi Ingot Hoard, although one should bear in mind that its existence is only based on information gathered by Schaeffer many years after its discovery. If his informants were correct and the two complete ingots were indeed found together with many more ingots, whose whereabouts are now unknown, it is possible that what the clandestine excavators found was in fact a warehouse full of ingots, not unlike those found at Aghia Triadha (Buchholz 1959: 32-34) and Zakros (Platon 1974: 100). The ingots may have either been intended for export or for local use, as according to Courtois (1982: 160), they are believed to have been found within an area of Enkomi, where there is ample evidence for metallurgical activity. In the former case, they could very well have been the products of those workshops, rather than the raw material they used. Unfortunately, however, there is absolutely no evidence, such as mould fragments, that would indicate the existence of a workshop dedicated to the production of ingots in Enkomi.

Whatever the case may be regarding the complete ingots, the fact is that in all the other cases the ingot fragments represented raw material for the use of the Cypriot metalsmiths. I therefore disagree with Gale's (1999: 117) assertion, which in my opinion contradicts the evidence:

“Although surprisingly there is evidence for the breaking up of copper oxhide ingots within Cyprus (fragments have been found at Enkomi, Mathiati, Maroni, Ayios Dhimitrios and Pyla), this seems not to have been a common event. The oxhide ingots were not within Cyprus a normal source of copper for Late Bronze Age Cypriot people; rather these ingots were produced chiefly to supply a foreign market. It would have been perverse indeed to go to the considerable trouble of casting large oxhide ingots, only to break them up again in order to make weapons and tools within Cyprus itself.”

As surprising and “perverse” as it may seem the fact is that in all Late Cypriot sites, except Enkomi where complete examples have been found, oxhide ingots were found in pieces, usually as part of founders’ hoards or within metallurgical workshops, and, as I have argued before for Sardinia (Kassianidou 2001: 105), this is clear evidence that copper oxhide ingots in Cyprus were being used and were not only intended for export.

The Uluburun shipwreck has shown that in the Late Bronze Age, a variety of shapes of ingots were in circulation. Although the main bulk of the copper carried by the ship was in the form of oxhide ingots, there were also a significant number of plano-concave (or bun) ingots as well as a smaller number of slab ingots (Pulak 2001: 18; Pulak 2000: 140-5). Although up to now other shapes of ingots seemed to have been absent from the archaeological record of Cyprus, during the present study a fragment of a plano-concave ingot (Inv. no. 1976-I-20/7c) was identified among the ingot fragments from Mathiatis (*Fig. 16*). This find suggests that plano-concave ingots were also being used in Cyprus (although, according to the evidence so far, most of the copper metal circulating on the island for local use was in the standardised form of the oxhide ingot).

If this proposition is correct, it has significant connotations regarding the organization of the Cypriot copper industry, about which we know very little. It is not within the scope of this paper to discuss this hotly debated issue, which is linked with the wider question of the political organization of the island, and therefore the reader is referred to other publications dedicated to this topic (Knapp 1993, 1986; Merrillies 1992; Muhly 1989, 1996; Peltenburg 1996; Stech 1982). What I would like to suggest is that the use of oxhide ingots within Cyprus indicates that the production and circulation of metal within the island was regulated. In other words the metal produced was cast into standardised ingots not just for export but also for use within the internal market. Presumably, whoever controlled the export of Cypriot copper also controlled the distribution and circulation of copper within Cyprus.

Production

The recent and thorough study of the Uluburun ingots by Hauptmann, Maddin and Prange (2002: 12) has confirmed that earlier suggestions about the ingots having been made of copper tapped directly from the smelting furnace were incorrect. Their analyses showed that, the oxhide ingots were produced by batches of copper that were melted together to form a single oxhide ingot weighing 25-39 kg. In other words, there are at least two stages in the production of an ingot: first is the extraction of the metal from its ores, which in the case of sulphide ores is itself a multi-stage process, and second is the melting and casting of enough metal to produce an ingot. The two stages need not be carried out at the same place.

In Cyprus, all the copper ore deposits are located within the Pillow Lavas which form a ring around the Troodos mountains (*Fig. 20*) and logically, this is where first stage, the extraction of the metal, would have taken place. The discovery and excavation of a smelting workshop, that of Politiko-*Phorades* (Knapp *et al.* 2001, 1999, 1998; Kassianidou 1999), dating to the LCI period and a miners’ village involved in the production of metal, that of Apliki-*Karamallos* dating to the LCIIIC (Du Plat Taylor 1952; Muhly, 1989), which are both located within the Pillow Lavas of the Troodos, indicates that indeed copper was smelted near the ore source. However, the analysis of the slag from *Phorades* showed that, the workshop did not produce metallic copper, but an intermediate product, matte. In order for matte to be turned into copper metal, further smelting steps would have been necessary. According to the available evidence these were not taking place at the same workshop.

Archaeologists and archaeometallurgists alike have long been trying to understand why smelting slag and furnace conglomerate is often found in the urban centres of the Late Cypriot period (Muhly 1989: 302; Stech 1982: 105). Dikaïos (1969: 46), for example, reported on a significant slag heap which he found in association

with the copper workshops in his Area III. Enkomi is probably the site that is located at the farthest distance away from the copper deposits, as well as from the forests of Troodos, which would have provided the furnaces with the necessary large quantities of fuel (Stech 1985: 103). Furthermore, one of the products of the initial stages of the smelting process is sulphur dioxide, a poisonous gas, which would not be welcome inside the confines of an urban environment (Stech 1985: 103). Thus the suggestion that primary smelting of copper ores was taking place at Enkomi, or any of the other coastal urban centres, was questioned (Stech 1982: 102). Rather it was suggested that the slag and the furnace conglomerate represented a primitive technology. The conglomerate was produced somewhere near the mining districts, and then transported to the urban centres. There it was smelted in small furnaces forming a pool of copper at the bottom of a mass of slag, which also contained prills of copper. It was then argued that copper was recovered largely through the crushing of the slag, and the removal of the copper prills trapped within it, which were then melted together to form a copper ingot (Stech *et al.* 1985: 399; Muhly 1989: 303).

The study of the archaeometallurgical material from Politiko-*Phorades*, the only primary smelting workshop dating to the Late Bronze Age to be excavated until recently, has shown that even from the beginning of the Late Bronze Age the smelting technology was anything but primitive (Kassianidou 1999: 95-96). Well-designed and standardised smelting installations resulted in two well-separated products, slag and matte, which had to be processed further in order to produce copper (Knapp *et al.* 2001: 207). This step in the process was not performed at the same workshop and it is therefore very likely that the matte was transported to an urban centre for secondary smelting. The slag found in urban centres could very well be a product of this stage in the production of copper, although we must bear in mind that there is a chronological difference between *Phorades*, which dates to the LCI, and the archaeometallurgical finds from the urban settlements most of which date to the LCIIIC.

According to the Lead Isotope Analysis the copper used for making all the oxhide ingots dating after 1250 BC not just from Cyprus but also from all the other areas around the Mediterranean came from only one mine, that of Apliki (Gale 1999: 116; Gale, Stos-Gale 1999: 271-273). Needless to say, many archaeologists have found this suggestion hard to accept (e.g. Muhly 2003: 144). One of the scholars who opposed this idea more strongly than others is Knapp (1999: 106) who stated:

“The cultural and economic model proposed - namely that a single site and a single ore deposit was producing all or most of the copper oxhide ingots found in the Bronze Age Mediterranean – whilst bold and provocative, and coherent in analytical terms, makes little sense in economic, social, spatial or even mineralogical terms, contradicts the model we can now propose on the basis of our work at *Phorades*, and represents a marked change from earlier interpretations that proposed exploitation of multiple ore deposits around the Troodos.”

Although it is a fact that the ore deposits of the so-called Solea Axis (Apliki, Skouriotissa and Mavrovouni) are among the largest copper deposits in the whole Mediterranean area and in modern times were the source of 85% of all the copper produced on the island (bearing in mind that the modern industry is based on a completely different set of parameters) (Constantinou 1982: 15), nevertheless I also am sceptical of this proposition (Kassianidou 2001: 110). Apliki is the smallest of the three deposits and the one that is highest up on the foothills of the Troodos, in other words the one farthest from the sea and the Mesaoria plain. It is of course the only mine clearly associated with an excavated Late Cypriot settlement, that of Apliki *Karamallos*, which dates to the LCIIIC period (Du Plat Taylor, 1952; Muhly 1989). So there is no doubt that this ore deposit was indeed exploited in this period.

What I, and others, find very surprising is that none of the numerous other ore deposits, scattered all around the periphery of the Troodos mountains, seem to have been exploited, although many of them, such as those of Kalavassos, are clearly within the hinterland of a major Late Cypriot settlement or administrative centre (South 2002: 62-63). There does not seem to be any particular reason why only the Apliki mine would have been preferred over the others. The ore deposit is neither at a more favourable location nor at a level closer to the surface than the others, and fuel would have been just as plentiful in any of the other mines, as they are all located within the forested foothills of the Troodos mountains. On the contrary, Apliki, and the other mines of the Solea Axis together with those of the area of Limni are the mines which are farthest away from Enkomi, and the other sites which have produced oxhide ingots.

Furthermore, according to the available evidence it seems that the final stages of the production of copper were taking place at workshops within the urban settlements such as Enkomi, where presumably matte or perhaps black copper from various smelting workshops was transported. In order to have enough metal to cast an ingot, the product of several smelting charges would need to be melted together. According to the Lead Isotope Analysis the metal from a single mine was exclusively used for casting ingots, while metal coming from other mines was used for casting artefacts (although it is never clarified which are the other mines which have been identified as sources for contemporary bronze objects) (Gale 2001: 115; Gale, Stos-Gale 2002: 290). It just does not make sense: if we assume that the final stage in the extraction of copper was taking place in an urban settlement then what the Lead Isotope Analysis seems to imply is that although matte or some other form of semi-processed material arrived at a settlement (for example Enkomi) from different mines, only the material coming from Apliki was used to produce copper ingots, while that from the other mines was used to produce copper artefacts. And yet according to the archaeological evidence many of the smiths around the island were supplied with copper in the form of oxhide ingots coming from Apliki!

What it comes down to, I think, is whether we accept the analytical data as “objective” and, therefore, correct, or whether we question the ability of this analytical technique to detect provenance correctly, even for unalloyed copper metal. These issues have been extensively discussed over the last decade and it is beyond the scope of this paper to present all the points of view (for more information the reader is referred to the following publications: Budd *et al.* 1995; Gale 1991, 1999, 2001; Gale, Stos-Gale 1987, 1999; Knapp 2000; Muhly, 1983, 1985, 1995; Stos-Gale, Gale 1994; Stos-Gale *et al.* 1997). There is definitely scope for more analytical work to be done, especially with regard to the slag coming from the urban centres. A systematic Lead Isotope Analysis of slag from Enkomi for example, might show whether copper was produced there through the processing of material coming from a single ore deposit or from a multitude of ore deposits.

However the extraction of the metal is but the first stage in the production of an ingot. One still needs to find out where the metal was cast into an ingot of standardised shape and weight. Although practically all excavated Late Cypriot sites have produced evidence of some metallurgical activity (Muhly 1989: 301-302), no ingot moulds have been found in any of them and to this date the only mould for casting an oxhide ingot was found in Ras Ibn Hani in Syria (Lagarce 1986; Lagarce J., Lagarce E. 1997: 75-7). This might be because the ingots were not always cast in a stone mould but were also cast in sand, which would leave no traces behind. Merkel's (1986: 259) and Van Lokeren's (2000: 275) casting experiments have shown that this was possible. Unfortunately, the study of the Uluburun ingots was not able to clarify this question (Hauptmann *et al.* 2002: 18), and for the moment this remains open.

In the absence of evidence such as ingot moulds, the question of where the ingots were produced is even harder to answer than the question of where the metal was produced. It is further hindered by the fact that we know very little about the political organization of the island, in other words whether it was divided into city-kingdoms as it was in the Iron Age or whether it was a single political entity centrally governed. In the former case, each city-kingdom would control the ore deposits within its territory and produce copper both for its own use and for export, which seems to have been the instance in the Iron Age (Muhly 1989: 303), while in the latter case the production, local distribution and trade of oxhide ingots made of Cypriot copper would have been controlled by one settlement, the capital. The fact that throughout the island the same type of ingot is used, and accepting the suggestion (from lead isotope analysis) that all the metal came from one mine, might be arguments in support of this latter scenario. The wealth of metallurgical material from Enkomi led Muhly (1989: 299) to suggest that:

“It is entirely possible that Enkomi actually controlled the copper industry of the entire island by virtue of its status as the capital of the kingdom of Alashiya. I would even venture to suggest that the city was probably called Alashiya; the name served both as designation of the capital and of the kingdom, exactly as at nearby Ugarit.”

It is indeed very likely that one of the main products of the extensive metallurgical workshops of Enkomi were copper oxhide ingots. However, whether oxhide ingots were only produced in Enkomi or were also produced in other settlements remains an open question, as there is no archaeological evidence for or against this idea.

What can be definitely be refuted are earlier suggestions that the copper industry was not controlled by the Cypriots. In the past Catling (1964: 271) had suggested that the production of copper only started after the arrival of the Mycenaeans, who also controlled the export of the metal in the shape of oxhide ingots, while Bass (1991: 73) still maintains that it was the Syrians who were the driving force behind the trade in Cypriot copper, and they were the ones who had the Cypriots cast the metal into ingots with forms of their choice. However in his review of Cyprus in the 13th century, the period during in which oxhide ingots are found practically all over the Mediterranean, Cadogan (1998: 12) categorically stated that: “Nothing suggests that foreigners were in charge in Cyprus or living in resident enclaves, let alone governors’ houses.” There is no question therefore, that the copper industry was under the control of anyone else but the indigenous population. Furthermore, new discoveries such as those at the site of Pyrgos *Mavrorakhi* from the Middle Cypriot period (Belgiorno 1999: 2000) and Politiko-*Phorades* from the beginning of the Late Cypriot period (Knapp *et al.* 2001: 205), as well as the evidence from Enkomi (Dikaïos 1971: 500) clearly show that by the 13th century the Cypriot copper industry had already had a long history (Kassianidou 2008).

Finally, as I have argued elsewhere, the Cypriots were not only in charge of their own copper industry but they were also major players, rather than passive spectators, in the metals trade within the Mediterranean area (Kassianidou 2001: 110; 2003: 116).

Conclusions

The fact that, over the last few years, excavations of Late Cypriot sites have been limited, means that the present publication has had to restrict itself to the presentation and discussion of those oxhide ingots finds from Cyprus already published. Nevertheless, it is the first time since Catling’s 1964 publication that all the information regarding these finds is compiled into a single paper. Clearly there is much that still needs to be done. We are still lacking a primary smelting workshop contemporary with the majority of the oxhide ingots; we are still lacking the workshops where the ingots would have been produced and we are still lacking ingots dating to periods earlier than the LC II. It is only through new systematic surveys and excavations that we may hope to resolve some of the issues raised within this publication.

Acknowledgments

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Catalogue of oxhide ingots and ingot fragments found in Cyprus

The following catalogue consists of the published oxhide ingot and ingot fragments, with the exception of the find from Maroni *Tsaroukkas* which is presented here for the first time. Furthermore, a detailed description of the ingot fragments from the Mathiatis hoard and those said to be from Skouriotissa is published here for the first time. This is also the case for some of the ingot fragments from Enkomi, Maa and Pyla which have been published in the past but were never fully described and were therefore re-examined for the present study. The preserved shape and texture of some of the ingot fragments do not conform to the oxhide type. They are, therefore, solely described as “ingot fragment” rather than “oxhide ingot fragment” a term which is reserved for those fragments which can definitely be identified as such.

Enkomi

1. Inv. no. 1897,0401.1535. Complete oxhide ingot now in the British Museum. Weight: 36.92 kg. Length: 70.5 cm. Width: 41.5 cm. Average thickness: 5.2 cm. It bears a stamped mark on its top rougher side. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. (Murray *et al.* 1900: 17; Catling 1964: 267; Muhly *et al.* 1980: 90; Courtois 1982: 160).
2. Inv. no. 1939/VI-20/4. Complete oxhide ingot now in the Cyprus Museum. Weight: 39.18 kg. Length: 72 cm. Width: 42 cm. Thickness: 3.9-5.5 cm. It has a stamped mark on the top rougher side. Believed to be part of the so-called “Ingot Hoard” which was probably found in Enkomi’s Quartier 6W (Catling 1964: 267).
3. Complete oxhide ingot now in the Cypriot Collection of Harvey Mudd College, Claremont California. Weight: 32.1 kg. Length: 65 cm. Width: 35 cm. Thickness: 3.75-5.6 cm. A quatrefoil mark is impressed on its surface. Believed to be part of the so-called “Ingot Hoard” which was probably found in Enkomi’s Quartier 6W (Muhly *et al.* 1980: 92; Muhly 2005: 139).
4. Inv. no. 1897,0401.1520.12. Ingot fragment. Weight: not given. Length: 10 cm. Width: 6.3 cm. Thickness: 3.4 cm. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. The fragment has been sampled in the past. Now in the British Museum. (Catling 1964: 267; Crewe *et al.* 2009).
5. Inv. no. 1897,0401.1520.13. Ingot fragment. Weight: not given. Length: 9 cm. Width: 6.1 cm. Thickness: 3.3 cm. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. The fragment has been sampled in the past. Now in the British Museum. (Catling 1964: 267; Crewe *et al.* 2009).
6. Inv. no. 1897,0401.1520.14. Ingot fragment. Weight: not given. Length: 6.2 cm. Width: 5.5 cm. Thickness: 3.5 cm. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. The fragment has been sampled in the past. Now in the British Museum. (Catling 1964: 267; Crewe *et al.* 2009).
7. Inv. no. 1897,0401.1520.15. Ingot fragment. Weight: not given. Length: 6.1 cm. Width: 5.8 cm. Thickness: 3.5 cm. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. The fragment has been sampled in the past. Now in the British Museum. (Catling 1964: 267; Crewe *et al.* 2009).
8. Inv. no. 1897,0401.1520.33. Ingot fragments, scrap metal and perhaps slag, cemented together. Weight: not given. Length: 10.8 cm. Width: 7.1 cm. Thickness: 4.5 cm. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. Now in the British Museum. (Catling 1964: 267; Crewe *et al.* 2009).
9. Inv. no. 1897,0401.1520.36. Ingot fragments and what looks like slag cemented together. Weight: not given. Length: 9.2 cm. Width: 5.7 cm. Thickness: 4.6 cm. Part of the “Foundry Hoard” which was probably found in Enkomi’s Quartier 6W. Now in the British Museum. (Catling 1964: 267; Crewe *et al.* 2009).

10. Half an oxhide ingot. It bears an impressed circular sign on the rough side. No information regarding its size or weight. Enkomi 1966. Found in Enkomi's Quartier 6W and is believed to have been part of the "Ingot Hoard". The fragment is now lost as it was kept in the French Missions storerooms in Enkomi which were looted after the 1974 Turkish invasion of the island. (Lagarce 1971: 397; Lagarce J., Lagarce E. 1986: 66).
11. Oxhide ingot corner fragment, the handle is not preserved. Enkomi 1949. From Quartier 5W. No information regarding its size or weight. Excavated in 1949 (Lagarce J., Lagarce E. 1986: 66). It is also mentioned and illustrated by Catling (1964: 268, Pl. 49e). The fragment could not be traced among the bronze finds of the French Mission in the Cyprus Museum.
12. Inv. no. 19. Oxhide ingot edge fragment. Part of the Bronze Hoard from Well 212. Weight: not given. Length: 8.25 cm. Width: 7.25 cm. Thickness: 3.45-4.2 cm. Found at Point Topographique 1670, in Quartier 5E. Enkomi 1967 (Lagarce 1971: 415). The fragment could not be traced among the bronze finds of the French Mission in the Cyprus Museum.
13. Inv. no. 99a. Large ingot fragment. Perhaps not of the oxhide type. Weight: 1850 g. Length: 20.6 cm. Width: 11.2 cm. Thickness: 3.3 cm. Found at Point Topographique 352, in Quartier 5E. Enkomi 1960 (Courtois 1984: 22).
14. Inv. no. 99b. Ingot fragment. Perhaps not of the oxhide type. Weight: 925 g. Length: 10.6 cm. Width: 7.6 cm. Thickness: 3.5 cm. Found at Point Topographique 352, in Quartier 5E. Enkomi 1960 (Courtois 1984: 22).
15. Inv. no. 80a. Oxhide ingot edge fragment. Weight: 945.2 g. Length: 8.7 cm. Width: 10.1 cm. Thickness: 2.5-3.7 cm. Found at Point Topographique 343, in Quartier 3W. Enkomi 1960 (Courtois 1984: 22).
16. Inv. no. 80c. Oxhide ingot edge fragment. Weight: 912.4 g. Length: 6.2 cm. Width: 8 cm. Thickness: 3.7-4.6 cm. Found at Point Topographique 343, in Quartier 3W. Enkomi 1960 (Courtois 1984: 22).
17. Inv. no. 121B. Oxhide ingot fragment. Weight: 1500 g. Length: 12.5 cm. Width: 9 cm. Thickness: 3.7 cm. Found at Point Topographique 783, Locus 59 in Quartier 3W. Enkomi 1962 (Courtois 1982: 166-167; Courtois 1984: 37).
18. Inv. no. 121G. Oxhide ingot handle fragment. The handle is very thick and one side is much wider than the other. Weight: 1.31 kg. Length: 12.2 cm. Width: 3.7 cm. Thickness: 5.5 cm. Found at Point Topographique 783, in Quartier 3W (Courtois 1982: 166-167).
19. Inv. no. 82a. Small ingot fragment. Perhaps not of the oxhide type. Weight: 120 g. Length: 4.2 cm. Width: 3.3 cm. Thickness: 1.8 cm. Found at Point Topographique 708, in Quartier 5E. Enkomi 1960 (Courtois 1984: 22).
20. Inv. no. 82b. Small ingot fragment. Perhaps not of the oxhide type. Weight: 70 g. Length: 4.9 cm. Width: 3.4 cm. Thickness: 1.9 cm. Found at Point Topographique 708, in Quartier 5E. Enkomi 1960 (Courtois 1984: 22).
21. Inv. no. 82c. Small ingot fragment. Perhaps not of the oxhide type. Weight: 80 g. Length: 5.3 cm. Width: 2.6 cm. Thickness: 1.5 cm. Found at Point Topographique 708, in Quartier 5E. Enkomi 1960 (Courtois 1984: 22).
22. Fragment J. Small ingot fragment. Weight: 180 g. Length: 5 cm. Width: 3.3 cm. Thickness: 2.3 cm. Part of the bronze hoard found at Point Topographique 1458. Enkomi 1966 (Courtois 1984: 39).

Maroni - Vournes¹

23. MV/M181. Small ingot fragment. Length: 4 cm. Width: 2 cm. Thickness: 2.5 cm. Weight: not given. Found on the floor of the Basin Building (Cadogan 1987: 83).
24. MV/M181. Ingot fragment. Length: 6.5 cm. Width: 4 cm. Thickness: 2.5 cm. Weight: not given. From M17, Level 13, Small find 2, basket 5647.
25. MV/M201. Ingot fragment. Length: 5.6 cm. Width: 3.4 cm. Thickness: not given. Weight: not given. From J19, Level 24, Small find 38, basket 2391.
26. MV/M210. Ingot fragment. Length: 3.5. Width: 3 cm. Thickness: not given. Weight: not given. From J19, Level 21, sample 4, basket 2385.
27. MV/M216. Two ingot fragments. a) Length: 2.2 cm. Width: 2 cm. Thickness: not given. Weight: not given. b) Length: 2.6 cm. Width: 2 cm. Thickness: not given. Weight: not given. From K19, Level 12, sample 9, “spring cleaning”.
28. MV/M260. Ingot fragment from Trench M17, Context 18. No information regarding its shape, size or weight.

Maroni - Tsaroukkas²

29. MT 449. Ingot fragment. Weight: not given. Length: 2.9 cm. Width: 2.3 cm. Thickness: 1.2 cm. Found in Building 1. Context ZW/15, 2.3.

Kalavassos - Ayios Dhimitrios

30. K-AD 468. Oxhide ingot fragment. A corner piece broken on both extremities. Weight: 1280 g. Length: 10.0 cm; Width: 9.7cm; Thickness: 4.4 cm. Found during the excavation of the baulk, in Room A.50 of Building IX in the South-East Area (South 1989b: 123).
31. K-AD 471. Oxhide ingot fragment. An oxhide ingot handle. Weight: 356 g. Length: 6.7 cm. Width: 4.35 cm. Thickness: 4.2-2.7cm. Found during the excavation of the baulk, in Room A.50 of Building IX in the South-East Area (South 1989b: 123).
32. K-AD 588. Oxhide ingot fragment. Weight: 403.9 g. Length: 7.4 cm. Width: 6.4 cm. Thickness: 3.1 cm. Found during the excavation of the baulk, in Room A.50 of Building IX in the South-East Area (South 1989b: 123).

Pyla - Kokkinokremos

33. Inv. no. 65a. Oxhide ingot handle fragment. Weight: 1625 g. Length: 13.9 cm. Width: 3.6-7.8 cm. Thickness: 4.1-5.9 cm. Part of the Bronze Hoard from Pyla. Found in Room 22 of Complex B. (Karageorghis, Demas 1984: 55-57; Muhly, Maddin 1988: 472).

1 The inventory numbers and context information of the oxhide ingots from Maroni-Vournes are not published and were kindly provided by the director of the excavation Gerald Cadogan, whom I would like to thank.

2 The oxhide ingot fragment from Maroni-Tsaroukkas is unpublished and I would like to thank the director of the excavation, Sturt Manning, for allowing me to publish it here.

34. Inv. no. 65b. Oxhide ingot handle fragment. Weight: 410 g. Length: 6.2 cm. Width: 3.2-3.6 cm. Thickness: 4.3 cm. Part of the Bronze Hoard from Pyla. Found in Room 22 of Complex B. (Karageorghis, Demas 1984: 55-57; Muhly, Maddin 1988: 472).
35. Inv. no. 65c-e. Three ingot fragments. No information regarding their shape, size or weight. Part of the Bronze Hoard. Found in Room 22 of Complex B. (Karageorghis, Demas 1984: 55-57; Muhly, Maddin 1988: 472).

Maa - Palaeokastro

36. Inv. no. 189. Two small ingot fragments. The size and texture of these fragments indicates that they are probably not of the oxhide type. Dimensions of larger fragment: Weight: 70 g. Length: 4.6 cm. Width: 2.8 cm. Thickness: 2 cm. Found in Room 64 in Building II (Karageorghis, Demas 1988: 22; Muhly, Maddin 1988: 471).
37. Ingot fragment from Porphyrios Dikaïos excavations. No information regarding where it was found nor about its shape, size or weight (Zwicker 1988: 429).
38. Ingot fragment. Weight: 28.2g. Other dimensions not given. Tray 5. From below Floor II in Rooms 1 and 2 of Area I (Karageorghis, Demas 1988: 100; Zwicker 1988: 429).

Mathiatis

39. Inv. no. 1936/VII-17/9a. Oxhide ingot quarter fragment. The handle is rather narrow and short. Weight: 5000 g. Maximum length (at handle): 24 cm. Length at centre: 14 cm. Width: 19.9 cm. Handle width: 2.7. Thickness: 4.7 cm. Handle thickness: 5.2 cm. Part of the Mathiatis hoard stored at the Cyprus Museum. The fragment has been sampled in the past.
40. Inv. no. 1936/VII-17/9b. Oxhide ingot corner fragment but handle is broken. Weight: 4200 g. Length: 16.2 cm. Width: 11.2 cm. Thickness of body: 4.5 cm. Thickness of handle: 5 cm. Part of the Mathiatis hoard stored at the Cyprus Museum. The fragment has been sampled in the past.
41. Inv. no. 1936/VII-17/9c. Bun ingot fragment. Weight: 2075 g. Length: 12.4 cm. Width: 10.3 cm. Thickness: 4.6 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
42. Inv. no. 1936/VII-17/9d. Oxhide ingot corner fragment but handle is broken. Weight: 1975 g. Length: 12.1cm. Width: 9.5cm. Thickness: 4.3 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
43. Inv. no. 1936/VII-17/9e. Oxhide ingot handle fragment. Weight: 1350 g. Length: 11.5 cm. Width: 7 cm. Thickness: 4 cm. Part of the Mathiatis hoard stored at the Cyprus Museum. The fragment has been sampled in the past.
44. Inv. no. 1936/VII-17/9f. Oxhide ingot edge fragment. Weight: 1700 g. Length: 9.9 cm. Width: 9.5 cm. Thickness: 4.4 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
45. Inv. no. 1936/VII-17/9g. Oxhide ingot fragment. Weight: 850 g. Length: 9 cm. Width: 6.6 cm. Thickness: 3.3 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
46. Inv. no. 1936/VII-17/9h. Oxhide ingot edge fragment. Weight: 1100 g. Length: 8.1 cm. Width: 6.3 cm. Thickness: 4.2 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.

47. Inv. no. 1936/VII-17/9i. Oxhide ingot edge fragment. Weight: 600g. Length: 6.6 cm. Width: 6.2 cm. Thickness: 3.2 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
48. Inv. no. 1936/VII-17/9j. Oxhide ingot fragment. Weight: 240 g. Length: 4.8 cm. Width: 4.6 cm. Thickness: 2.4 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
49. Inv. no. 1936/VII-17/9k. Oxhide ingot fragment. Weight: 160 g. Length: 3.7 cm. Width: 4.6 cm. Thickness: 2.6 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
50. Inv. no. 1936/VII-17/9l. Miniature oxhide ingot fragment. Broken along the long axis of the body, as well as, the handle. Weight: 120 g. Length: 5.5 cm. Width: 2.8 cm. Thickness: 1.4 cm. Part of the Mathiatis hoard stored at the Cyprus Museum.
51. Sixteen fragments of oxhide ingots. Part of the Mathiatis hoard. Exported out of Cyprus in the 1930's. Now probably in the Cypriot Collection of Harvey Mudd College, Claremont California. No information regarding their size or weight. (Catling 1964: 268).

Said to come from Skouriotissa

52. Inv. no. 1976-I-20/6. Oxhide ingot corner fragment but handle has broken off. Weight: 3325 g. Length: 17.4 cm. Width: 12.1 cm. Thickness: 4 cm. The fragment has been sampled in the past with a large drill which has left behind four rather large drill holes. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.
53. Inv. no. 1976-I-20/7a. Ingot fragment Top surface similar to that of the oxhide type but lower surface is unusually flat. The ingot is also thinner than other examples. Weight: 2250 g. Length: 16.2 cm. Width: 13.1 cm. Thickness: 2.8 cm. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.
54. Inv. no. 1976-I-20/7b. Oxhide ingot fragment. Weight: 1175 g. Length: 15.8 cm. Width: 6.8 cm. Thickness: 3.2 cm. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.
55. Inv. no. 1976-I-20/7c. Oxhide ingot fragment. Weight: 525 g. Length: 8.7 cm. Width: 5.7 cm. Thickness: 3.4 cm. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.
56. Inv. no. 1976-I-20/7d. Oxhide ingot fragment. Weight: 420 g. Length: 9.3 cm. Width: 7.1 cm. Thickness: cm. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.
57. Inv. no. 1976-I-20/7e. Oxhide ingot edge fragment. Weight: 6.3 g. Length: 8.6 cm. Width: 6.3 cm. Thickness: 2.6 cm. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.
58. Inv. no. 1976-I-20/7f. Oxhide ingot handle fragment. The handle is rather small and thin. Weight: 230 g. Length: 6.5 cm. Width: 2.6 cm. Thickness: 3.6 cm. Said to be from Skouriotissa but most probably it is actually part of the Mathiatis hoard.

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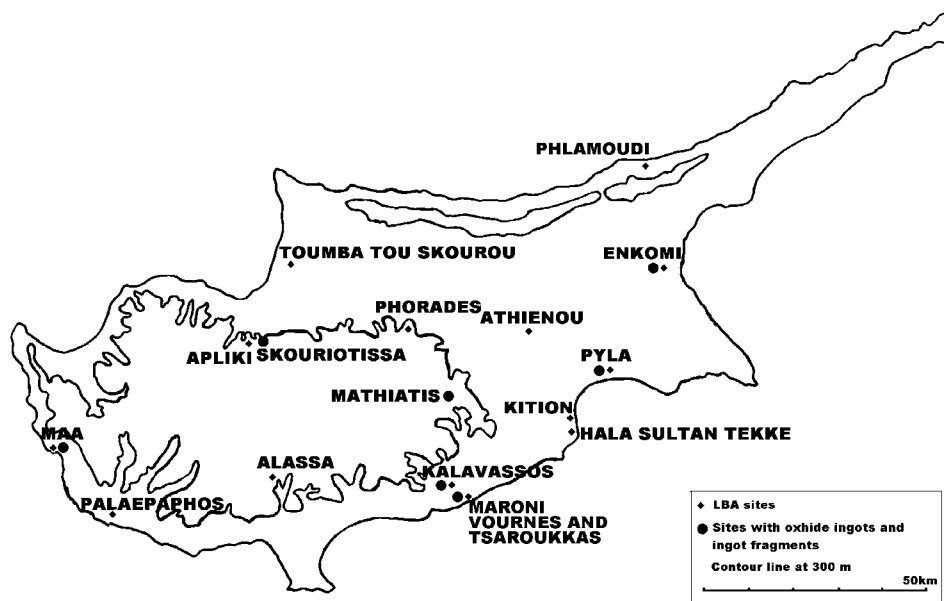


Fig. 1

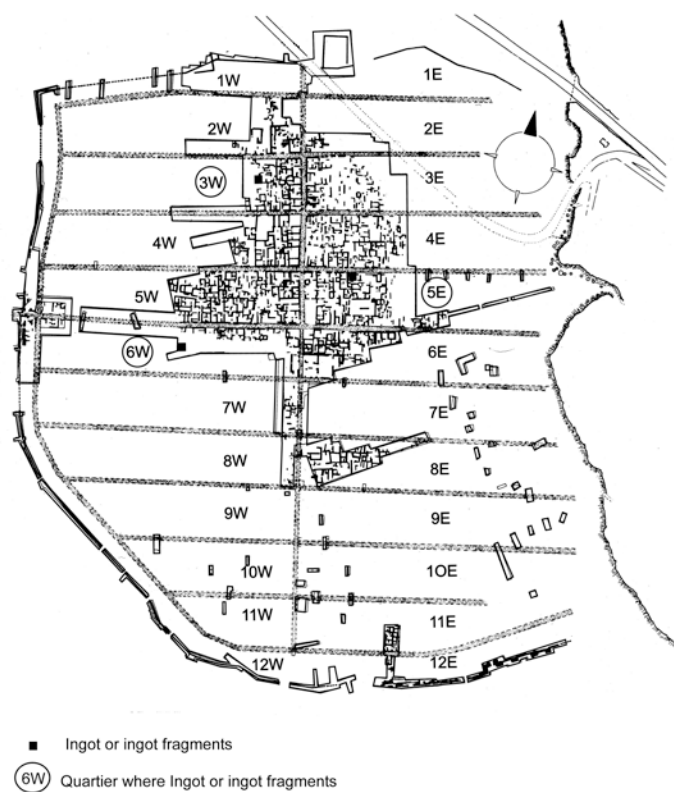


Fig. 2

Fig. 1. Map of Cyprus with sites mentioned in the text.

Fig. 2. Plan of Enkomi showing the different areas excavated by the French Mission and the locations where complete oxhide ingots and fragments were found.



0 10 cm

Fig. 3



0 10 cm

Fig. 4



0 10 cm

Fig. 5

Fig. 3. Oxhide ingot said to be from Enkomi, now in the British Museum (Inv. no. 1897/4-1/1535).

Fig. 4. Oxhide ingot said to be from Enkomi, now in the Cyprus Museum (Inv. no. 1939/VI-20/4).

Fig. 5. Oxhide ingot said to be from Enkomi, now in the Cypriot Collection of Harvey Mudd College, Claremont California.

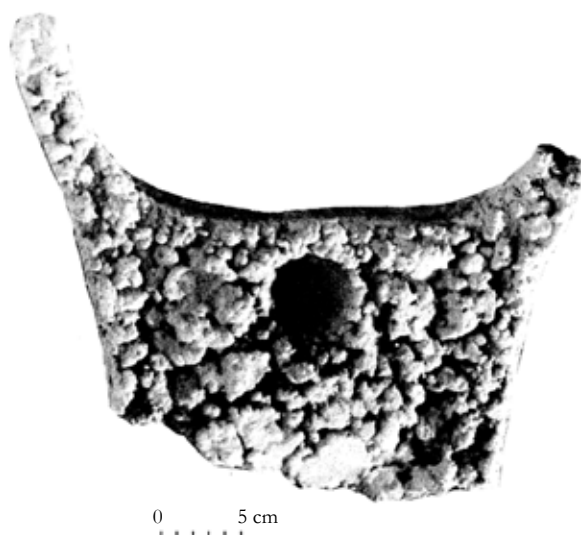


Fig. 6



Fig. 7

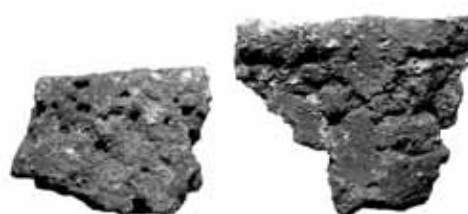


Fig. 8



Fig. 9



Fig. 10

- Fig. 6. Half an ingot found in Enkomi's Quartier 6W.
 Fig. 7. Ingot fragment (Inv. no. 99a) from Enkomi.
 Fig. 8. Ingot fragments (Inv. no. 80) from Enkomi.
 Fig. 9. Ingot Fragment (Inv. no. 121B) from Enkomi.
 Fig. 10. Ingot Fragment (Inv. no. 121G) from Enkomi.

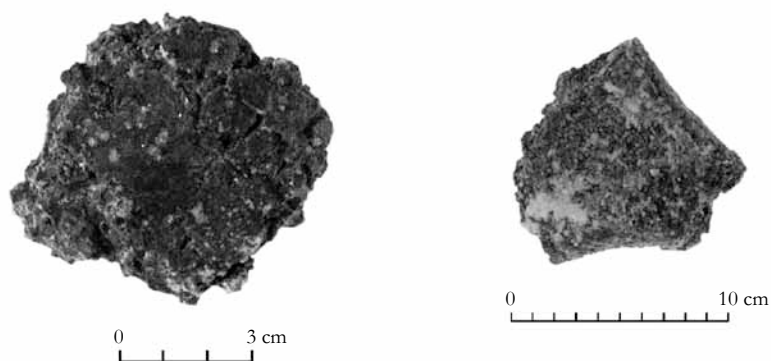


Fig. 11



Fig. 12

Fig. 13

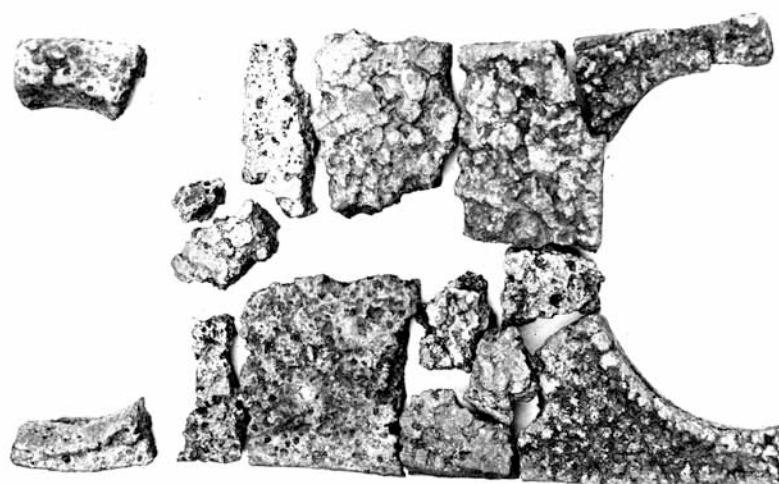


Fig. 14

Fig. 11. Ingot fragments from Kalavassos-Ayios Dhimitrios (Inv. nos. 468, 471, 588).

Fig. 12. Bronze board from Pyla.

Fig. 13. Two of the ingot fragments from Pyla-Kokkinokremos (Inv. no. 65).

Fig. 14. Ingot fragments from the Matthiatis Hoard part of the H. Mudd collection.

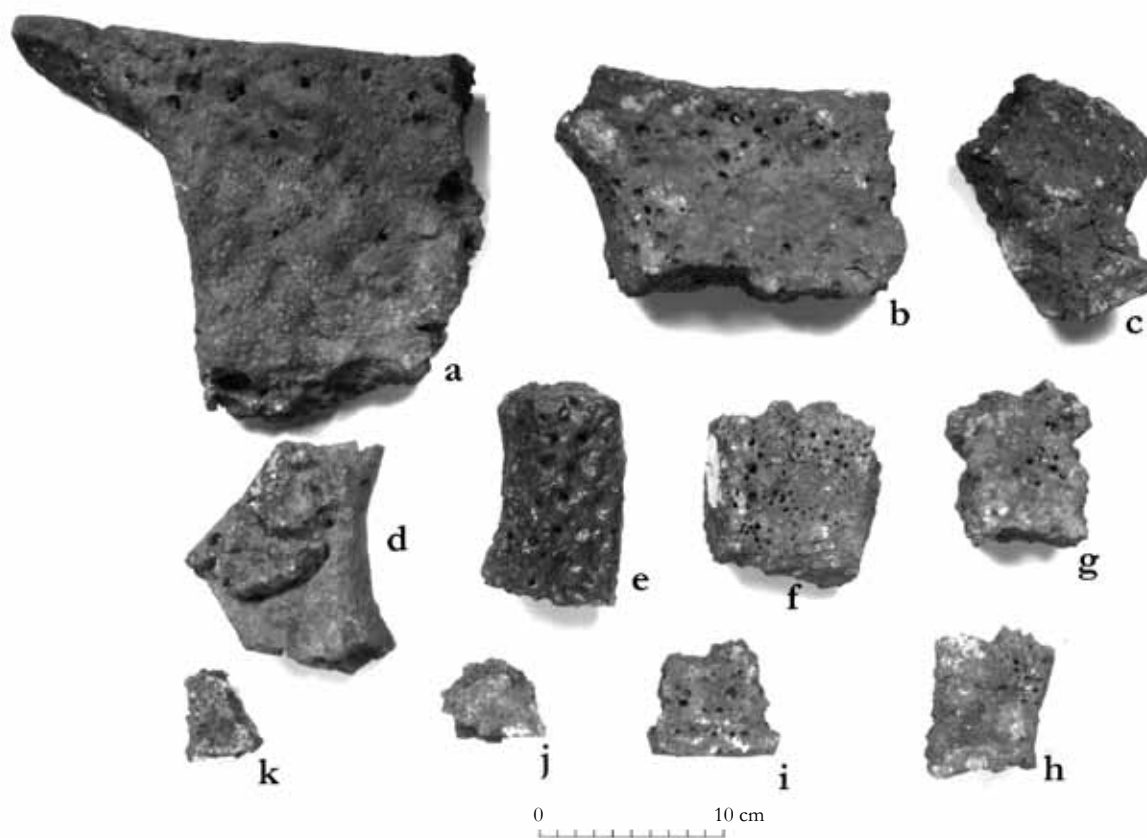


Fig. 15

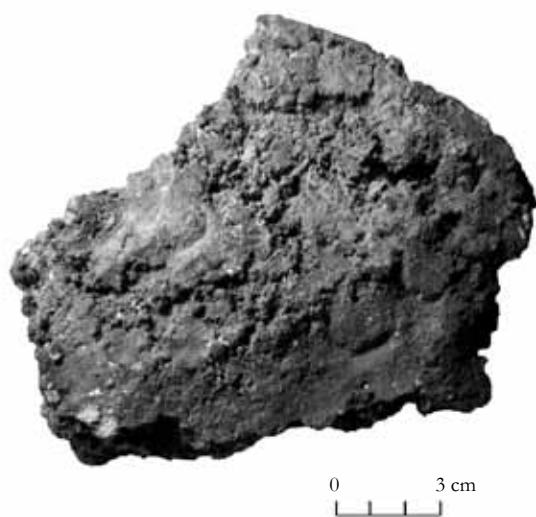


Fig. 16

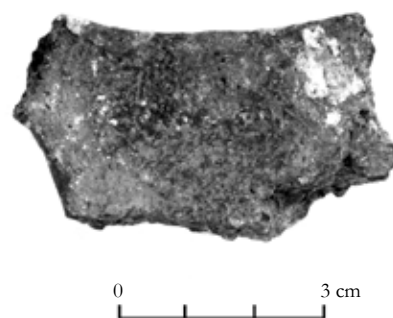


Fig. 17

Fig. 15. Ingot fragments (Inv. no. 1936/VII-17/9a-k). Part of the Matbiatis Hoard, in the Cyprus Museum.

Fig. 16. Plano convex ingot (Inv. no. 1936/VII-17/9c). Part of the Matbiatis Hoard, in the Cyprus Museum.

Fig. 17. Miniature Ingot fragment (Inv. no. 1936/VII-17/9l). Part of the Matbiatis Hoard, in the Cyprus Museum.

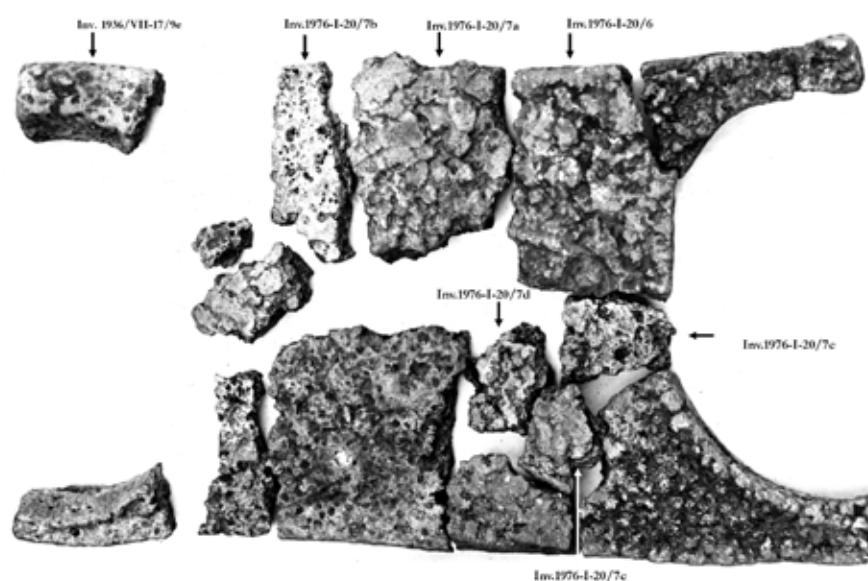
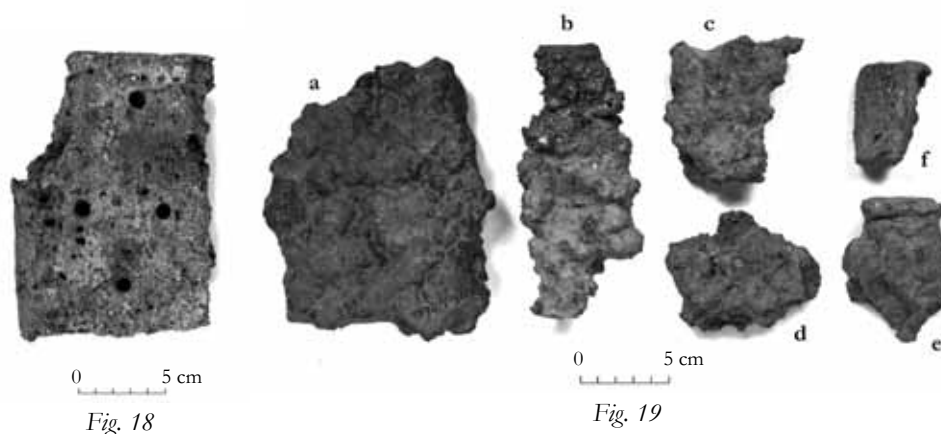


Fig. 20



Fig. 21

Fig. 18. Oxhide ingot fragment (Inv. no. 1976-I-20/6). Said to be from Skouriotissa.

Fig. 19. Ingot fragments (Inv. no. 1976-I-20/7a-f). Said to be from Skouriotissa.

Fig. 20. Ingot fragments (Inv. no. 1976-I-20/6 and Inv. no. 1976-I-20/7a-f), among those from Mathiatis Hoard.

Fig. 21. Map of Troodos showing the location of some of the most important copper ore deposits. Outlined area corresponds to the pillow lava formation.

THE ICONOGRAPHY OF THE OXHIDE INGOTS

George Papasavas

Introduction

A keen interest in copper oxhide ingots began in the 1950s (Buchholz 1959), and was fueled in the 1960s and 1980s by the excavations of the Cape Gelidonya and the Uluburun shipwrecks (Bass 1967; 1991; Pulak 1998). This interest is still very much alive among many researchers of the Ancient Mediterranean, who continue to collect, analyze and publish the evidence. Despite the large number of oxhide ingots excavated up to now, which has been considerably enlarged by the finds of these two shipwrecks, any new find of an oxhide ingot or even small fragments of one, is still considered as an important discovery, and attracts the attention of experts worldwide, whether archaeologists, ancient historians, or archaeometallurgists and geologists. Besides discussions on their chronology and the organization of ancient international trade networks, there are also lively debates on the analytical methods used to establish the provenance of the raw material of the ingots. A large corpus of bibliographical references to oxhide ingots has been assembled over the years. Much less attention has been devoted, however, to the representations of ingots in various media, although some scholars, (Knapp 1986; Webb 1999) have examined some of them and stressed their importance for assessing social and economic issues, particularly in relation with the possible links between metallurgy, religious ideology and political control on Late Bronze Age Cyprus.

The work of numerous scholars over the past thirty or forty years has given Cyprus a prominent role in the ancient Mediterranean, especially in the production and distribution of metals. The excavation, publication and scientific analyses of the many relevant finds show that, despite the fact that oxhide ingots, or fragments of them, have been found only in fairly small numbers on the island up to now, especially when compared with the exceptional finds from Crete and Sardinia (see the contributions of Muhly, and Lo Schiavo in this volume), Cyprus was the primary producer and exporter of copper in the entire Mediterranean (Kassianidou 2003; 2004; Muhly 2003; 2005). This evidence is complemented by the representations of ingots in various Cypriot artefacts, which, to some extent, counterbalance the absence of the ingots themselves.

Ancient Cypriot art, especially that of the Bronze and Early Iron Ages, lacks a long tradition in iconography. Cypriot iconography in general is not only very restricted in its repertory, but also much later in its evolution, in comparison with the island's neighboring cultures. Pictures were for some reason relatively unappealing to ancient Cypriot craftsmen for a long time, and even when they started using them, they did so in a restrained way and predominantly on luxury items of the Late Bronze Age.

Because of this late development, Cypriots eventually had to adopt foreign iconographic schemes, which in some cases are traceable back to their sources of inspiration, including Egypt, the Near East and the Aegean (Knapp 1986: 77-83, 116; Webb 1999: 271-2). However, they only chose very selectively, despite the richness of the iconographic resources they were exploiting, and at the same time adapted the foreign images to their indigenous culture. Not all of their subjects, however, were foreign, and in some cases they themselves contributed new ideas, and expressed their own experiences. This seems to be the case with the introduction of ingots in the Cypriot iconographic repertory. As regards the type of the Ingot Bearer, in particular, whether borrowed from a foreign source or not (see below), it was given a completely new meaning and used in totally different contexts.