

UNIVERSITÄTSFORSCHUNGEN ZUR PRÄHISTORISCHEN ARCHÄOLOGIE

Aus dem Institut für Archäologische Wissenschaften der Universität Bochum
Fach Ur- und Frühgeschichte

Band 169

Metals and Societies

Studies in honour of Barbara S. Ottaway

edited

by

Tobias L. Kienlin
Ben W. Roberts

2009

VERLAG DR. RUDOLF HABELT GMBH, BONN

Contents

Ben Roberts – Tobias L. Kienlin

Foreword 9

Caroline Jackson

Of Barbara 11

Christian Strahm

Die Begegnung mit Barbara Ottaway:

Erinnerungen an die Impulse für die frühen akademischen Studien 16

Publications of Barbara S. Ottaway 18

I. Metals and Societies

Christopher P. Thornton

Archaeometallurgy: Evidence of a Paradigm Shift? 25

Martin Bartelheim

Elites and Metals in the Central European Early Bronze Age 34

Rüdiger Krause

Bronze Age Copper Production in the Alps:

Organisation and Social Hierarchies in Mining Communities 47

Tobias L. Kienlin – Thomas Stöllner

Singen Copper, Alpine Settlement and Early Bronze Age Mining:

Is There a Need for Elites and Strongholds? 67

Emma C. Wager

Mining Ore and Making People:

Re-thinking Notions of Gender and Age in Bronze Age Mining Communities 105

Christian Strahm – Andreas Hauptmann

The Metallurgical Developmental Phases in the Old World 116

Ben Roberts

Origins, Transmission and Traditions: Analysing Early Metal in Western Europe 129

Benoît Mille – Laurent Carozza

Moving into the Metal Ages:

The Social Importance of Metal at the End of the Neolithic Period in France 143

Dirk Brandherm

The Social Context of Early Bronze Age Metalworking in Iberia:

Evidence from the Burial Record 172

John Bintliff

Is the Essence of Innovative Archaeology a Technology for the Unconscious? 181

II. Aspects of Copper and Bronze Age Metallurgy

Dušan Borić

Absolute Dating of Metallurgical Innovations in the Vinča Culture of the Balkans 191

Nikolaus Boroffka

Simple Technology: Casting Moulds for Axe-adzes 246

Tobias L. Kienlin – Ernst Pernicka

Aspects of the Production of Copper Age Jászladány Type Axes 258

Mark Pearce

How Much Metal was there in Circulation in Copper Age Italy? 277

Paul Ambert – Valentina Figueroa-Larre – Jean-Louis Guendon –

Veronika Klemm – Marie Laroche – Salvador Rovira – Christian Strahm

The Copper Mines of Cabrières (Hérault) in Southern France

and the Chalcolithic Metallurgy 285

Roland Müller – Ernst Pernicka

Chemical Analyses in Archaeometallurgy: A View on the Iberian Peninsula 296

Susan La Niece – Caroline Cartwright

Bronze Age Gold Lock-rings with Cores of Wax and Wood 307

Trevor Cowie – Brendan O'Connor

Some Early Bronze Age Stone Moulds from Scotland 313

Viktoria Kiss

The Life Cycle of Middle Bronze Age Bronze Artefacts

from the Western Part of the Carpathian Basin 328

Elka Duberow – Ernst Pernicka – Alexandra Krenn-Leeb

Eastern Alps or Western Carpathians: Early Bronze Age Metal within the Wieselburg Culture 336

Marianne Mödler – Gerhard Trnka

Herstellungstechnische Untersuchungen an Riegseeschwertern aus Ostösterreich 350

Barbara Horejs

Metalworkers at the Çukuriçi Höyük?

An Early Bronze Age Mould and a “Near Eastern Weight” from Western Anatolia 358

Vincent C. Pigott

“Luristan Bronzes” and the Development of Metallurgy in the West-Central Zagros, Iran. 369

Quanyu Wang – Jianjun Mei

Some Observations on Recent Studies of Bronze Casting Technology in Ancient China 383

III. Approaches to Early Metallurgy

Walter Fasnacht

7000 Years of Trial and Error in Copper Metallurgy – in One Experimental Life. 395

Caroline Jackson

Experimental Archaeology and Education:

Theory without Practice is Empty; Practice without Theory is Blind 400

Salvador Rovira – Ignacio Montero-Ruiz – Martina Renzi

Experimental Co-smelting to Copper-tin Alloys 407

Julia Heeb

Thinking Through Technology – An Experimental Approach to the Copper Axes

from Southeastern Europe 415

Colin Merrony – Bryan Hanks – Roger Doonan

Seeking the Process: The Application of Geophysical Survey

on some Early Mining and Metalworking Sites 421

IV. Studies in Historical Metallurgy

Alessandra Giumlia-Mair – Péter Gaboda – Hedvig Györy – Irén Vozil

Two Statuettes with *ḥmty km* Inlays in the Fine Arts Museum Budapest 433

Nerantzis Nerantzis

Using Mills to Refine Metals: Iron Smelting Technology

of the Transitional Byzantine to Ottoman Period in Macedonia, Greece 443

Paul T. Craddock

Perceptions and Reality: The Fall and Rise of the Indian Mining and Metal Industry 453

List of Contributors 465

Metalworkers at the Çukuriçi Höyük? An Early Bronze Age Mould and a “Near Eastern Weight” from Western Anatolia*

Abstract

Excavations at Çukuriçi Höyük on the west Anatolian coast have revealed a settlement that dates from the early 6th to the 3rd millennium BC. The attention of this contribution is focussed on the latest two phases of this settlement that date to the first half of the 3rd millennium BC. The existence of a craftsmen's quarter as well as evidence of metalworking will be illustrated with the various find contexts. The significance of and parallels for a mould for rod ingots will be discussed in more detail. The discovery of a weight attests the use of Near Eastern system of measurement at Çukuriçi Höyük, which in its temporally early appearance as well as in view of its measured values is unique thus far in the Aegean-Anatolian sphere.

Introduction

The first steps in copper and bronze metallurgy are one of the most discussed topics in Aegean Prehistory during recent decades.¹ The role of the northeast Aegean, particularly of Troy and the Aegean islands of Lemnos (Poliochni) and Lesbos (Thermi) was the focus of scientific analyses.² As N. Gale recently pointed out, a local independent development of bronze metallurgy in the northern Aegean seems implausible, because – as it seems today – the alloy components came from far away, maybe from Afghanistan or Central Asia (Gale 2008: 211–212). Further, besides the questions of metal sources and chemical analyses, the development and significance of metalwork and its role in Early Bronze Age (EBA) societies were part of archaeological investigations. In her substantial study of the EBA settlements of Poliochni, Thermi,

Emporio and Heraion, O. Kouka could define convincingly some characteristic elements of these societies concerning metallurgy, which represents only one among other existing specialised crafts (Kouka 2002; Kouka 2008a).

Oppositely, the role that the craft of metalworking played at the beginning of the EBA development on the west Anatolian coast – with the exception of the Troad – still remains mostly undefined.

The state of research in western Anatolia during the Early Bronze Age

While the northeast Aegean, including Troy has been the constant core and starting point for research on early metallurgy in the Aegean (e.g. Pernicka et al. 1984; Muhly et al. 1991; Pernicka et al. 2003; Bege-mann et al. 2003), the entire coastal region of west Anatolia is still largely a ‘terra incognita’. Although the number of known settlements dated to the EBA has increased during the past two decades, only a few have been excavated; and if these were published at all, then it has been only in the form of preliminary reports. Thus, knowledge about cultural developments that occurred in this area during the early 3rd millennium BC (EBA I) is still quite limited (Kouka 2008b).

It can be stated that no settlements dated to this chronological horizon and located in the entire coastal zone between Troy, Beşiktepe and Izmir have been excavated and published that are crucial for the question of early metalworking.³

Comparably more is known about the region around Izmir, owing to the years-long research of H. Erkanal. In all some 12 settlements dated to the EBA have been discovered (Erkanal 1999: 237; Erkanal

* I would like to thank M. Mehofer, who is carrying out part of the archaeometallurgical analyses on the Çukuriçi Höyük material, for fruitful discussions and for the possibility to use some of his initial results in this article and Emily Schalk for translating the German text.

1 For a summary overview including the most important literature on questions of early metallurgy in Anatolia, the Aegean and southeastern Europe, see Renfrew (in: Elster/Renfrew 2003: 314–318) and Day/Doonan (2007).

2 See, for example, Branigan (1974), Pernicka et al. (1984), Gale/Stos-Gale (1986), Pernicka et al. (1990), Muhly et al. (1991), Bege-mann et al. (1992), Stos-Gale (1992) and Pernicka et al. (2003); summarised by Gale (2008).

3 Although numerous sites have become known through various surveys (for example, Bittel 1950; Driehaus 1957), large-scale excavated settlements are lacking in this region. More recent investigations in the area of Pergamon (director F. Pirson, German Archaeological Institute) at Yeni Yeldegirmen-tepe by the author of this contribution have confirmed that larger settlements were already present at the beginning of the EBA (Horejs, forthcoming).

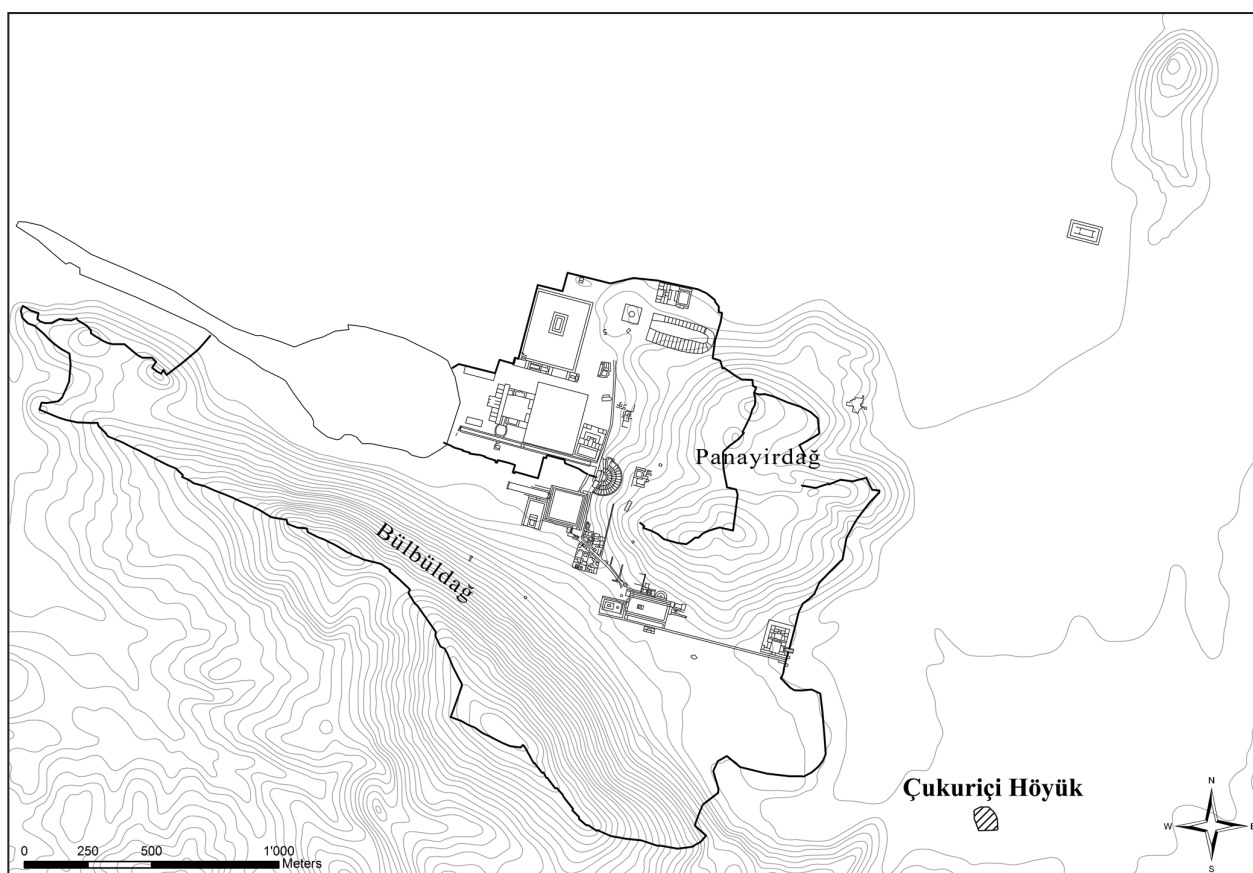


Fig. 1: The area of the ancient city of Ephesos with the location of the tell Çukuriçi Höyük (map by Ch. Kurtze).

2008b: 190 fig. 10). Of these the sites of Liman Tepe, Bakla Tepe and Panaztepe have also been excavated and/or are still being investigated.⁴ Further excavated sites in the hinterland and sites on the coast south of İzmir have yielded scarcely any conclusive information for early metalworking.⁵

Liman Tepe and Bakla Tepe, however, have provided the first clues, which will be briefly summarised. Both settlements were enclosed by a fortification wall as early as EBA I (Erkanal 1999: fig. 52c.d), which means the first half of the 3rd millennium BC. The form and structure of the settlement's architecture within the wall has not been published conclusively as yet. Yet, according to the preliminary reports, the proto-urban character of a maritime trading centre, as distinct in the following period EBA II (Kouka 2008; Erkanal 2008b: 181), cannot be recognised at either site (Erkanal 2008a; Erkanal 2008b).⁶ Nevertheless, from a cultural point of view in the EBA I this region appears to have already been integrated in a “north-

ern and an eastern Aegean koine”, which extended from Thasos and Troy in the north to the area of İzmir in the south (Kouka 2008a: 291).

Aside from textile production and crop cultivation, in EBA I a “developed metallurgy” seems to have been present in Liman Tepe, “with goods of all kind being produced by moulds and forging” (Erkanal 2008b: 180). A square ore dressing device has been published which was used for ore beneficiation (Kaptan 2008: 245, photo 2). All of the published pieces of copper slag date apparently to the EBA II (level V) (Kaptan 2008: 245–246). In this regard further publications can likely be anticipated on metallurgy.

Bakla Tepe has been designated by its excavator as a “centre of metal industry” (Erkanal 2008a: 168). Several metallurgical artefacts such as crucibles, moulds, fragments of tuyeres as well as copper slag were found in the late Chalcolithic and Early Bronze Age settlement layers (Erkanal 2008a: 168; Kaptan 1998). The presence of silver, lead, zinc, copper and gold in the immediate surroundings has been confirmed, but evidence of the exploitation of these ores in prehistoric times is still lacking (Erkanal 2008a: 168; Lengeranli 2008; Kaptan 2008).

Through the recent excavations at Çukuriçi Höyük a further settlement has now been disclosed, where a metal production is attested that dates to the early part of the 3rd millennium BC. This important evi-

4 E.g. Erkanal/Erkanal (1983), Erkanal/Günel (1995), Erkanal/Günel (1996), Erkanal/Günel (1997) and Erkanal (2008a). For further information with all bibliographic references see http://www.geocities.com/irerp_tr/.

5 For example, no signs of metallurgical activities in the settlement of Ulucak; the few metal objects that were found mainly from the cemetery (Çilingiroğlu et al. 2004).

6 My sincere thanks are extended to O. Kouka for showing me Liman Tepe at length and for our in-depth discussion about the settlement.

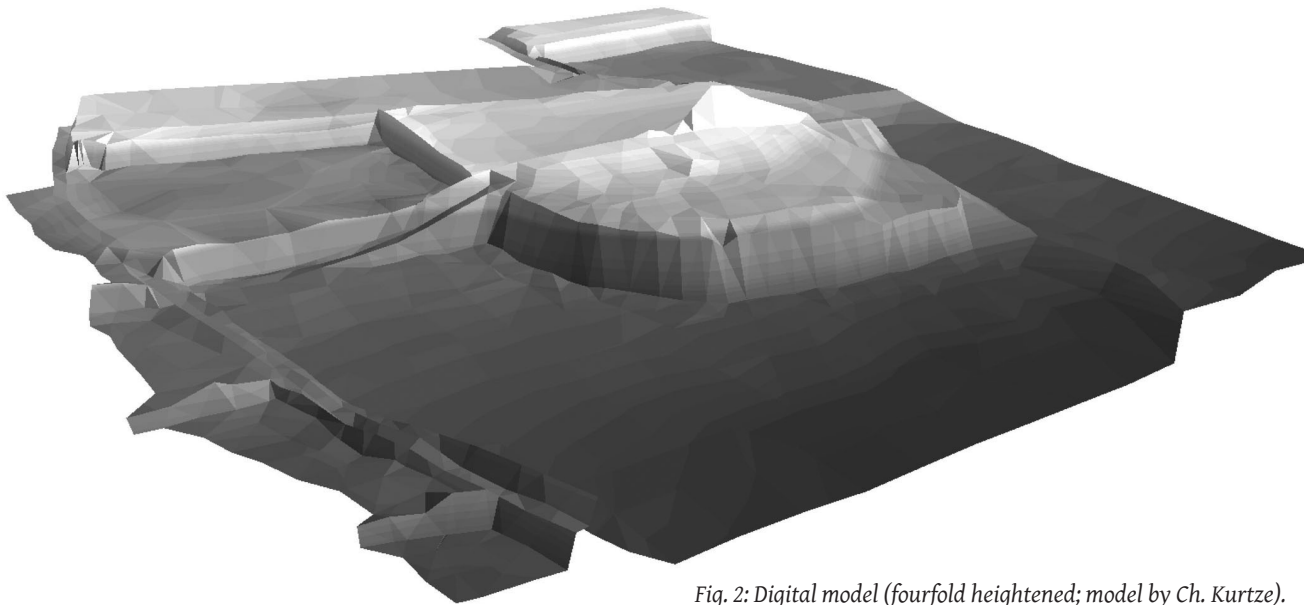


Fig. 2: Digital model (fourfold heightened; model by Ch. Kurtze).

dence will be presented here for the first time in the context with settlement remains.

The Çukuriçi Höyük

Çukuriçi Höyük is a tell site, situated southeast of the famous ancient city of Ephesos (fig. 1). It was first investigated in 1995 in a brief excavation, which was in the form of two small test trenches and was conducted by a team from the Ephesos Museum in Selçuk (Evren/İçten 1997). However, during the following years a large part of the settlement hill, which today is encircled by bountiful fruit-tree plantations, was gradually dug away, levelled, planted and irrigated. These massively destructive methods ultimately had the result, amongst other consequences, that Çukuriçi Höyük became the centre of the first perennial research project that is devoted especially to the pre-history of the Ephesos-region. The initial trial excavation, funded by the Austrian Archaeological Institute, took place in 2006, which led to the first systematic excavation in 2007. Investigations should continue in the following years until 2010 and will be financed by the Austrian Science Fund (Project no. P 19859-G02).⁷

As far as can be currently determined, Çukuriçi Höyük comprises at least five architectural phases, which are preserved to a height of at least five metres above the ground level of the surrounding cultivated area (fig. 2). The extent to which the cultural layers reach in depth and the thickness of the alluvial sedimentation covering the original horizon of the surrounding fields are unknown thus far.⁸ Çukuriçi

Höyük embraces a minimum of five settlement horizons and, hence, can be defined as a tell site.

Two separate areas of the tell have been excavated since 2006: one in the middle of the northern bulldozed boundary, the other at the present-day southern end of the tell. These two sectors have not been linked stratigraphically so far (fig. 3). Nonetheless, the settlement phases that could be distinguished with certainty in both areas and securely defined are designated Çuk VIII–VI and IV–III. They can be dated preliminarily to the Late Neolithic/Early Chalcolithic, the Late Chalcolithic and the Early Bronze Age periods (Horejs in press), which means the early 6th millennium, the second half of 4th millennium and the first half of 3rd millennium BC.

The two latest settlement phases (Çuk IV–III), which can be preliminarily dated to EBA I, are the focus of this contribution.⁹ They were excavated in two trenches (S1, S2) at the present-day southern border of the tell and cover an area of 28 x 3 m (S1) and 17 x 8 m (S2).

The spectrum of archaeological contexts and information is – not surprisingly – very broad and manifold; thus, here the essential elements of the architecture will be summarily presented (fig. 4). Today the latest phase of settlement, Çuk III, is preserved only in the excavated area, as the architecture that originally covered the entire surface of the tell was razed and removed during the aforementioned modern expansion of the fruit-tree plantations.

⁷ For details about the programme of investigations see Horejs (2008; in press).

⁸ Initial drillings carried out by H. Brückner and Ch. Kraft in the summer of 2008 allow the presumption that there are a few metres of cultural layers below the present-day base

of the tell; these will be investigated in the next excavation seasons. I extend my thanks to the director H. Brückner (University of Marburg) and members of his staff for their great teamwork.

⁹ The study of the ceramic material has not been completed yet, but the state of our research – which also includes radiocarbon dates – suggests a date in the first half of the 3rd millennium BC, which corresponds to EBA I.

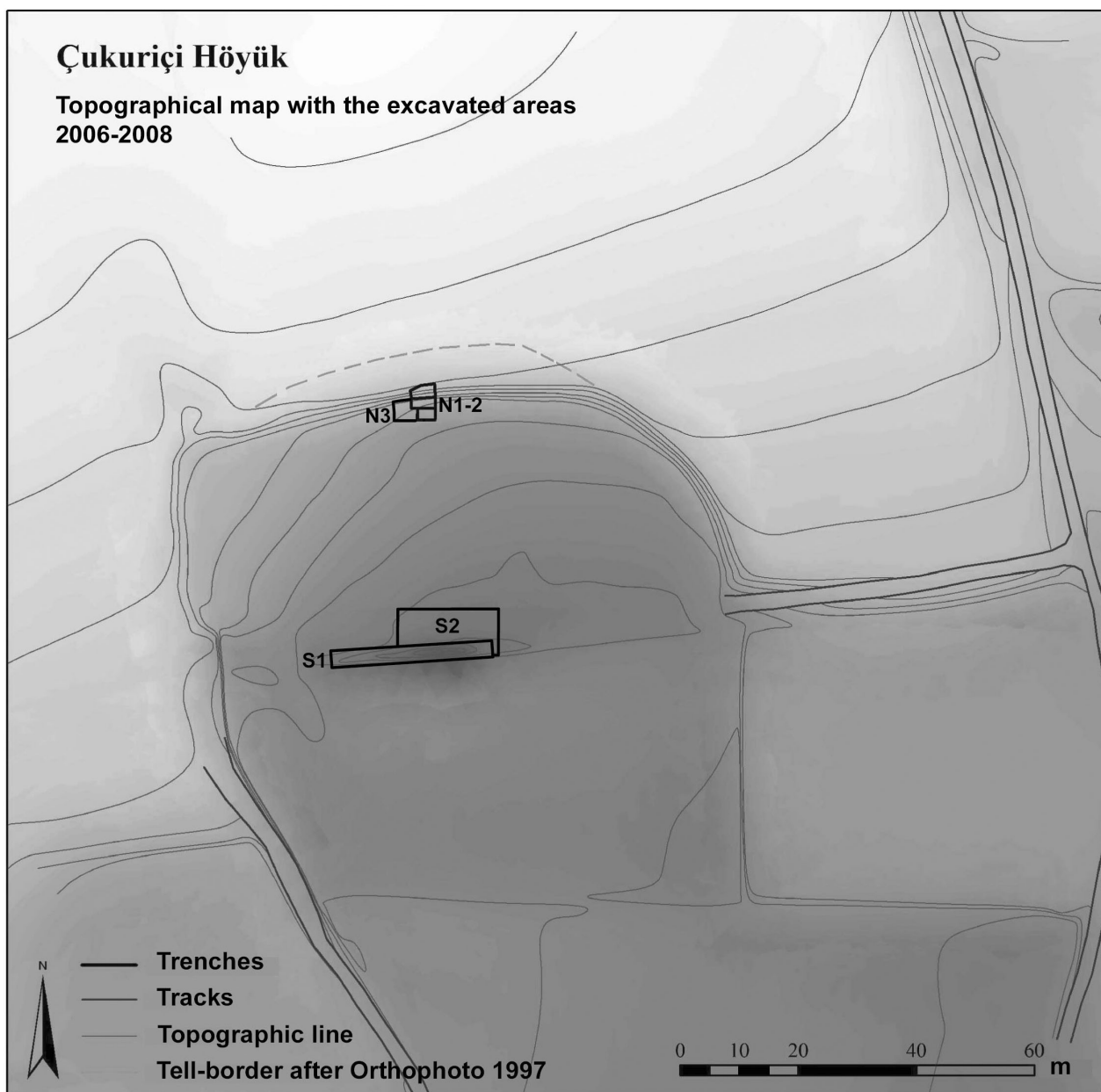


Fig. 3: Topographical map of the tell with the excavated areas from 2006 to 2008 (Ch. Kurtze/B. Horejs).

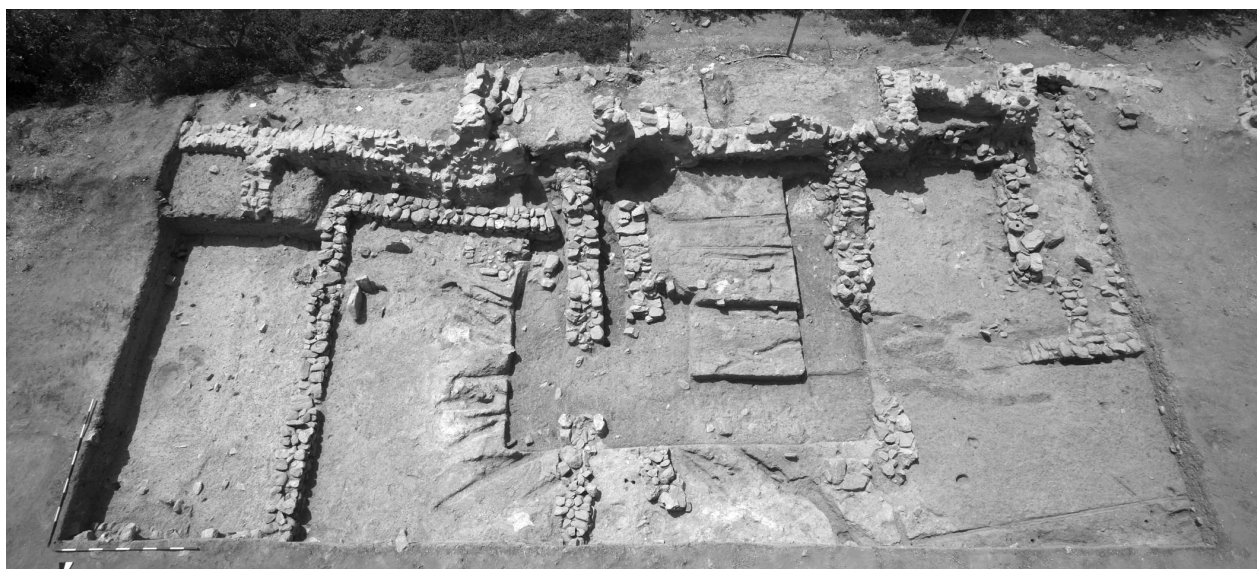


Fig. 4: Excavated area of 2008 (trench S2) with architectural remains of phases Çuk IV-III (photograph by N. Gail).

Fig. 5: Architectural remains of settlement phases Çuk IV-III in trenches S1 and S2 (plan by M. Börner/B. Horejs).



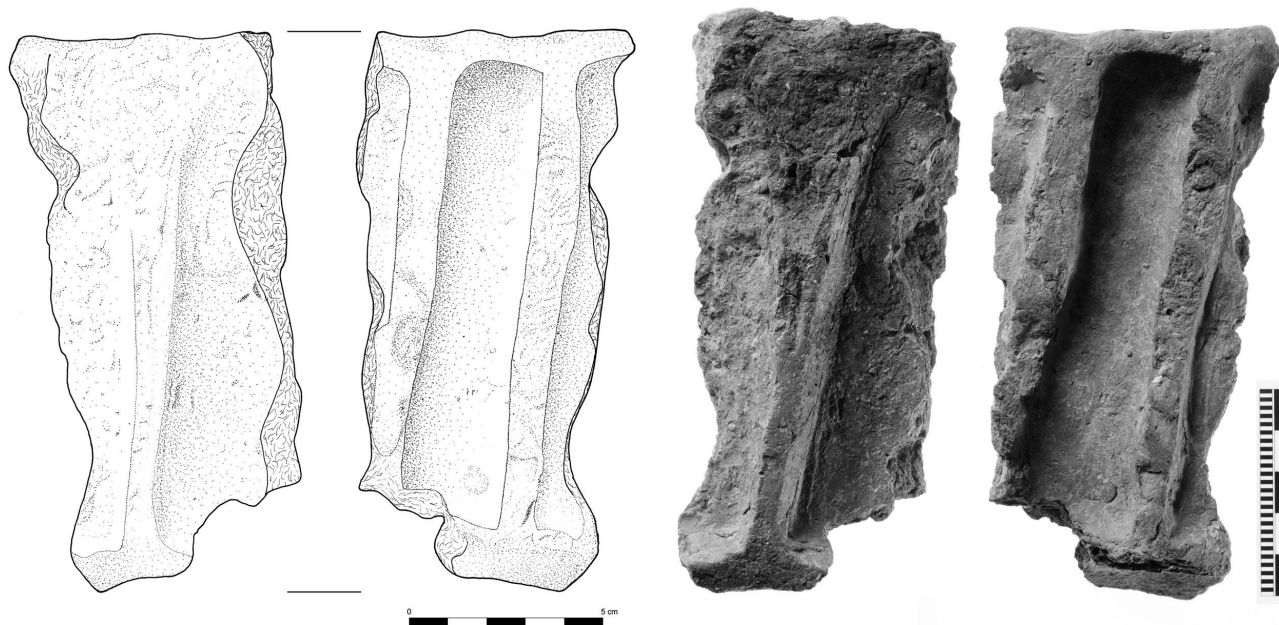


Fig. 6: a) Drawing of both sides of a ceramic mould for rod ingots found in Çukuriçi Höyük, no. Cuk 07/431/3/11 (drawings by S. Mattova/J. Traumüller). b) Photograph of both sides of the ceramic mould for rod ingots from Çukuriçi Höyük, no. Cuk 07/431/3/11 (photograph by N. Gail).

The buildings that were still preserved were arranged on an east-west axis; in the course of plantations' expansion they had been severed along the north and south boundary of the present-day lots. For this reason none of the preserved house remains from this phase, Çuk III, could be excavated completely (fig. 5).

A deep, U-shaped pit in the centre of trench S2 is also attributable to recent intrusions; it also destroyed several walls from the underlying phase Çuk IV, most of whose original course can nevertheless be reconstructed. At present there are three identifiable buildings from this phase (Çuk IV), which are aligned roughly north-south. They have a rectangular ground plan and vary in size, whereby the house located in the centre of the excavated surface consists of only one room. The size of the other two houses, clearly with several rooms, has not been determined yet.

The architecture of phase Çuk III follows upon a massive layer that was levelled extensively. It presumably represents a large building, which appears to comprise at least eight rooms. Due to the recent destruction the course of individual walls cannot be traced; however, in all likelihood they are associated with this building.

The question as to the kind of roof construction employed in both settlement phases, Çuk III and IV, is still unanswered, so that some of the so-called 'rooms' could have been open courtyards. Although the manner of construction differs in detail, it does concur in its general features: a stone socle without a foundation carries several courses of brick walls, a few bricks were found heavily destroyed upon the floors. The floors themselves are predominantly of simple stamped clay without a plaster covering.

There is an astonishingly large number of ovens in this area, which points to intensive craft activities. Of the total of ten ovens (fig. 5), four have been excavated thus far (ovens 1–3, 7). Whereas oven 7 was for normal household use, presumably for baking and roasting, the other ovens had specialised purposes. These ovens are open at the top, semicircular to round in plan, and built of mud and mudbricks that are burnt red probably from high temperatures. Varying amounts of the remains of a white material were found in the interior of these three ovens; analysis of the material has not been concluded yet. According to an initial assessment, however, it could be limestone.¹⁰ The exact purpose of the ovens cannot be stated with certainty now. The results of the analyses of their contents are needed and six more ovens must be excavated.

Metal craftsmen at the Çukuriçi Höyük?

Numerous finds were made in the entire area of both Early Bronze Age phases, Çuk III and IV, that attest metallurgical activities in the settlement: slag, mud mixed with slag, crucible ladles, casting debris, semi-finished objects and various tools and artefacts.

The investigations that commenced in 2008 on these metallurgical complexes by M. Mehofer¹¹ und E. Pernicka¹² have not been completed yet. However,

¹⁰ I wish to thank E. Pernicka and M. Mehofer for their valuable comments and suggestions during the excavation.

¹¹ Archaeometallurgy – Vienna Institute for Archaeological Science, University Vienna/Austria.

¹² Curt-Engelhorn-Zentrum für Archäometrie, Mannheim/Germany.

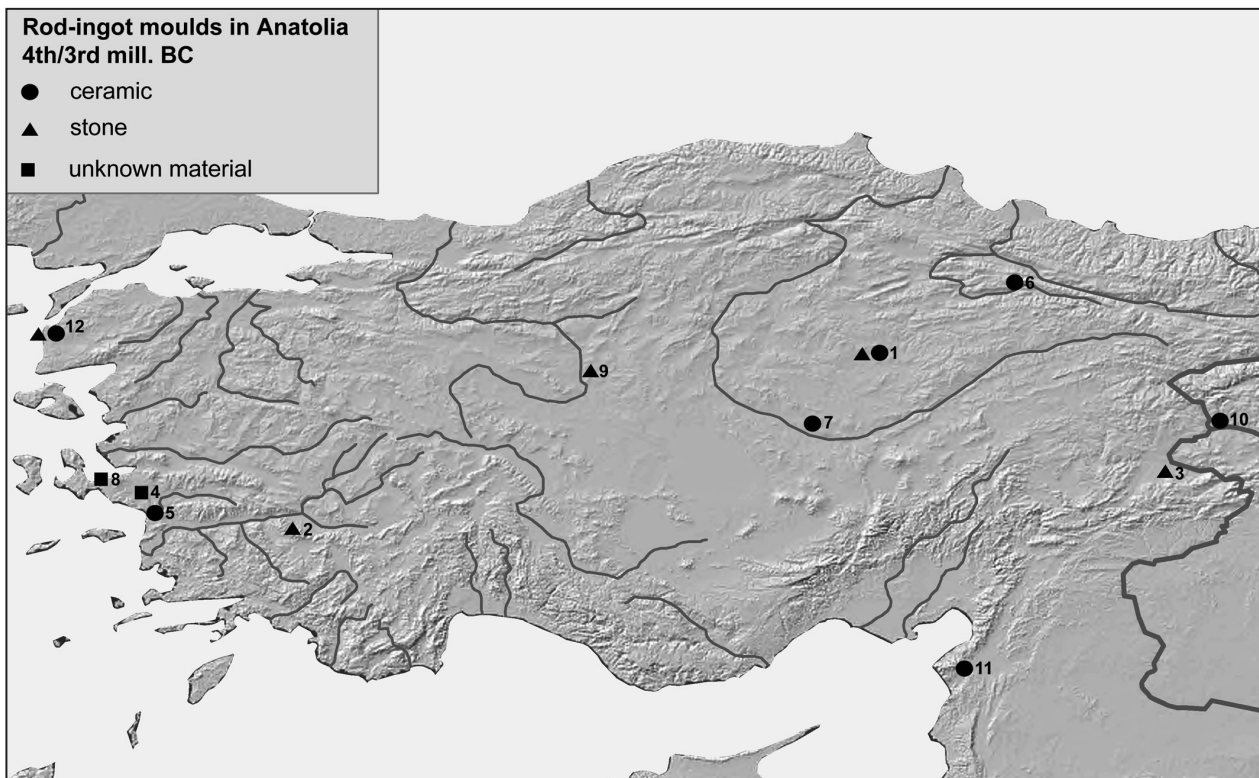


Fig. 7: Distribution of rod ingot moulds in Anatolia in the 4th and 3rd millennium BC according to A. Müller-Karpe (1994: 135 fig. 89) with additions. 1. Alişar 2. Aphrodisias 3. Arslantepe 4. Bakla Tepe 5. Çukuriçi Höyük 6. Gevrek 7. Hacibektaş 8. Liman Tepe 9. Polatlı 10. Sakyol 11. Taynat 12. Troy.

it can already be stated that there is clear evidence of metalworking. In this reference, an object that was found in 2007 should be singled out and will be presented for the first time here.

A ceramic mould

Made of fired clay, the ceramic mould is one of the most extraordinary objects discovered in Çukuriçi Höyük so far (fig. 6a–b).¹³ It was found in context with numerous other objects on the penultimate use-horizon of Room 1 in settlement phase Çuk III (fig. 5). All objects kept in Room 1 at the time of destruction as well as the overlying latest floor were ultimately sealed by a massive layer of debris, stones of the stone socle and clay from the presumed roof construction. This destruction was apparently violent and rapid, yet did not lead to a widespread conflagration, factors which imply a severe but brief earthquake. Thereafter the settlement was abandoned and never inhabited again.¹⁴

The inventory of Room 1 found in the same use-horizon as the mould embraces a broad spectrum of cooking pottery and tableware, various tools and utensils made of stone and antler, spindle whorls

and food refuse.¹⁵ A similar picture is presented by the overlying floor, which also contained all kinds of artefacts,¹⁶ a large number of cooking pots and tableware and ornaments. In both phases of the room's use the interior walls were covered with white plaster, and no massive effects from fire were visible. All of these factors imply that the objects had been primarily stored in this large room and that work with the use of fire did not take place there. This is further supported by the presence of corresponding ovens, traces of fire and production debris (slag, ash) in the direct vicinity. Hence, the mould was not found in the context of its use, but in a secondary position: in its place of storage.

The ceramic mould is made of coarse, scarcely levigated clay; its outer surface is roughly smoothed and the negative forms show distinct traces of burnishing (fig. 6b). Approximately rectangular in form, the one-piece mould is severely damaged on three sides (preserved size: L. 14.3 cm; W. 6.1 cm; H. 4.3 cm; weight 355 g). There are negative forms on two sides, with forms for three and two rod ingots respectively, and one that is almost completely preserved (L. 11.5 cm; W. 2.4–2.6 cm; D. 1.3 cm). Due to the broken edges,

¹³ Find no. Cuk 07/431/3/11.

¹⁴ This conclusion is supported by the lack of repairs or rebuilding of houses in the area as well as the fact that no finds of later date were found on the entire tell nor in the immediate surroundings.

¹⁵ The identification of the silices was carried out by M. Bergner, and that of objects of antler and bone and of the molluscs by A. Galik. My thanks to both individuals for providing me with this information.

¹⁶ Among these were objects that clearly served in metalworking, such as an anvil, hammer stones and another mould.

however, the original number of ingot negatives can no longer be determined. The slightly blackened surface of the negatives confirms that the mould was actually used.

Metallurgical analyses

The mould with negatives was secured by conservators immediately upon its discovery, so that the preserved surface was not contaminated. Initial technological and metallurgical investigations were undertaken at the site by M. Mehofer. By means of scanning electron microscopic examination (Vienna Institute for Archaeological Science/VIAS), the samples taken from the mould’s surface revealed the following (Mehofer 2008): No metal remains adhered to the surface of the negatives. Measurements were made on samples of the ceramic surface, whereby foremost lead and minor traces of copper could be determined. Analyses by means of mass spectrometry are still in progress; their results will provide final clarity.¹⁷

Definition and comparisons

This form of mould can be assigned to the group of open hearth moulds with negatives of forms on several sides, which according to A. Müller-Karpe (1994: 131) represent the most common type of moulds in Anatolia. The length and width of the example from Çukuriçi Höyük correspond approximately with the measurements noted by Müller-Karpe (1994: 132). By contrast, the majority of comparable moulds (80 %) are made of stone (Müller-Karpe 1994: 133).

At present Early Bronze Age hearth moulds are known from a minimum 14 sites in Anatolia, including Troy, Aphrodisias, Liman Tepe and Bakla Tepe in western Anatolia. Moulds of this type, which were formed in clay and fired, appear much more seldomly (fig. 7). Early Bronze Age clay moulds found in Troy are usually made from secondarily used pithos sherds (cf. Müller-Karpe 1994: pls. 15.1.3.7, 16.3, 18.1), and all date to Troy II at the earliest. The single exception is a mould made of ceramic, which was found in Troy I and is thus the oldest evidence of metalworking in Troy. The mould published by C. Blegen stems from a later excavation in the so-called “Schliemann Trench” and is dated to Troy I Middle (Blegen et al. 1950: 150 nos. 38–100; pl. 221).

This type of mould was used most frequently during the 3rd millennium BC for making ingots (rod-shaped and round ingots) and flat axes – often in combination. The negative of a completely preserved rod ingot on the Çukuriçi Höyük mould (L. 11.5 cm; W. 2.4–2.6 cm; D. 1.3 cm) corresponds roughly with the measurements supplied by Müller-Karpe.



Fig. 8: Stone weight found in Çukuriçi Höyük, no. Cuk 08/520/3/7 (photograph by N. Gail).

Even if the distorting aspect of moulds being filled to different levels is excluded, the differences in length and breadth of rod-shaped ingot negatives of the Early Bronze Age are still too great to recognise any standardised system of weight at first glance. Despite this fact, in my opinion it seems more likely that the objects functioned as ingots and thus for trade or exchange, and that they are not semi-finished products still being reworked. A. Müller-Karpe argues convincingly for this probability in view of the statistical irregularity in weight among moulds for rod ingots in relation to flat axes. Found under the same conditions at discovery, these objects appear four times as often as chisels, for example, which are a possible end product of reworked rod ingots (Müller-Karpe 1994: 136).¹⁸ If one defines rod-shaped ingots as a common form of metal used for trading purposes, then the question unavoidably arises as to a system of standardised weights. In this regard, a further discovery in Çukuriçi Höyük will prove helpful.

The weight found in Çukuriçi Höyük

The elongated weight¹⁹ (L. 3.9 cm; W. 1.35 cm; weight 15.67 g) consists of basic volcanic basalt and has a carefully polished surface (fig. 8). It is approximately rectangular to oval in cross section, the broad sides are slightly convex, and both small ends are flat. The weight was found in the above-mentioned levelling layer between settlement phases Çuk IV and III, which represents a distinct hiatus and currently can be followed throughout the entire excavated area of construction. Thus, the weight cannot be assigned to

17 Analyses are being carried out at the Curt-Engelhorn-Zentrum für Archäometrie in Mannheim/Germany.

18 It should be noted here as a caveat that Müller-Karpe’s statistics also include all objects dated to the 2nd millennium BC; in comparison exceedingly fewer finished products (chisels and axes) dated to the 3rd millennium BC are known in Anatolia.

19 Find no. Cuk 08/520/3/7 was procured by the Museum Selçuk and is now stored in the Museum’s depository.

an architectural context: Nonetheless, this find does support the idea that at the time of the beginning of phase Çuk III the system for weighing by means of weights was indeed already known.

Thanks to the latest investigations by L. Rahmstorf, it has now been recognised that in the course of intensive long-distance exchange a uniform metric system emerged, extending from the Near East to the Aegean. So far, however, evidence of this system appears only after the middle of the 3rd millennium BC (Rahmstorf 2006a; 2006b: 67–79). As of the advanced Early Bronze Age Rahmstorf can distinguish types of weights, with which the new find from Çukuriçi Höyük can be correlated perfectly.

Definition and interpretation

The weight from Çukuriçi Höyük belongs to the group of sphenoidal objects, which due to their initial interpretation as sling projectiles by H. Schliemann were named as such (Rahmstorf 2006b: 68). Comparable types of weights have been found in Troy, Poliochni, Tarsus and Bozüyük (Rahmstorf 2006b: 69 fig. 10, 1–13), the oldest of which date to Early Bronze Age II.

Rahmstorf has reconstructed a system of weights that is based upon the Syrian 'mine', weighing 470 g, also designated in literature as Egyptian or Ugaritan (Rahmstorf 2006b: 70). Weights with markings as well as written sources confirm that this unit of weight was employed in Syria as early as the 3rd millennium BC (Rahmstorf 2006a: 21–22). The Syrian mine can be subdivided into different units, so-called 'shekels', which weight 7.8 g, 9.4 g and 11.75 g respectively. Until now only the unit of 9.4 g could be attested with certainty in the Early Bronze Age; Rahmstorf since has been able to confirm it outside of Syria, namely in weights discovered in Troy and other Greek sites (Rahmstorf 2006a: 24–28; Rahmstorf 2006b: 78 fig. 14). This supra-regional and apparently long-used system is exhibited by weights found in the Late Bronze Age shipwreck of Ulu Burun and in finds from Egypt of the 2nd millennium BC (Rahmstorf 2006a: 13–18; Rahmstorf 2006b: 70).

Due to the state of publication, the association of Anatolia with supra-regional standards for weights is absolutely unclear. Solely the weights found in Tarsus and Troy are published together with their measurement in grams (Rahmstorf 2006a: 22–24). Nevertheless, the discovery of an Early Bronze Age beam from a balance scale in Troy, in Bozüyük as well as in Külüoba shows that measuring objects at that time was accomplished by means of weighing them (Rahmstorf 2006a: 24).

Aside from Syria, the unit of 7.83 g is also found in Susa in the late 3rd and early 2nd millennium BC; it has not been attested thus far in Anatolia and the Aegean (Rahmstorf 2006b: 72). Interestingly, the weight from Çukuriçi Höyük amounts to exactly double this unit

of weight: $7.835 \times 2 = 15.67$.²⁰ Despite the enormous geographic distance of regions on the Tigris and Euphrates rivers to the central Anatolia west coast, this context astonishingly fits into the picture proposed by Rahmstorf. The development of a standardised system of weights during the 3rd millennium BC reflects the need for a precise calculation of value. The weight from Çukuriçi Höyük proves that standardised weights were already in use during the first half of the 3rd millennium BC. Moreover, together with finds from Troy, this weight shows that two of the known Near Eastern units of weight, namely 7.83 g and 9.4 g, were utilised in the Aegean and on the west Anatolian coast respectively.

Conclusions

The two latest phases of settlement at Çukuriçi Höyük (Çuk IV–III) yielded abundant evidence of metalworking, which includes aside from production debris, artefacts, tools, semi-finished and finished products, a ceramic mould for rod-shaped ingots. The majority of the 3rd millennium BC known rod-shaped ingots and/or moulds for such ingots date to the developed Early Bronze Age (second half of the 3rd millennium BC), while isolated examples from Arslantepe, Polatlı and Sakyol attest that they were used even earlier (Müller-Karpe 1994: cat. nos. 22.4.6, 23.1, 25.1, 26.1, 28.1).

The date of the settlement phases at Çukuriçi Höyük is based upon closed ceramic contexts, in which until now only characteristic pieces of middle to late Early Bronze Age I could be identified. As it has not been possible to undertake comparative studies within the region of Izmir yet, due to the lack of publications on coeval closed find contexts there, stratigraphies from sites located farther away must suffice for our present research. This situation does not take the differences to be expected in the development of the material culture in the region of Çukuriçi Höyük into consideration, which must still be defined for this temporal horizon.

There are notable similarities with Middle to Late Troy I, and the absence of wheel-turned pottery and *depata amphikypella* as well as individual ¹⁴C dates are very strong implications that justify a preliminary date to the period Early Bronze Age I. The finds from this period presented here are indicative of two basic aspects of the settlement at Çukuriçi Höyük. On the one hand, metallurgical activities with the production of rod-shaped ingots strongly suggest the settlement's participation in an exchange system of goods. Analysis of comparable finds contradicts a wide-

²⁰ My sincere thanks go to L. Rahmstorf for his helpful information and for the evaluation of the weight presented here.

spread standardisation of ingots at that time; they were probably traded according to their general form and size. On the other hand, the adoption at the same time of Near Eastern system of weights demonstrates the use of standardised values for measuring within the area from the Tigris as far as the Aegean.

In order to substantiate these indications further metallurgical analyses as well as new excavations are necessary: They would allow the two thus far unique finds from Çukuriçi Höyük to be integrated into a line of argument that contains a larger number of finds.

References

- Begemann et al. 1992
F. Begemann/S. Schmitt-Strecker/E. Pernicka, The Metal Finds from Thermi III-V: A Chemical and Lead-Isotope Study. *Studia Troica* 2, 1992, 219–239.
- Begemann et al. 2003
F. Begemann/S. Schmitt-Strecker/E. Pernicka, On the Composition and Provenance of Metal Finds from Beşiktepe (Troia). In: G. A. Wagner/E. Pernicka/H.-P. Uerpmann (eds.), *Troia and the Troad (Natural Science in Archaeology)*. Berlin: Springer 2003, 173–203.
- Bittel 1950
K. Bittel, Zur ältesten Besiedlungsgeschichte der unteren Kaikosebene. *Istanbuler Forschungen* 17, 1950, 10–29.
- Branigan 1974
K. Branigan, *Aegean Metalwork of the Early and Middle Bronze Age*. Oxford: Clarendon Press 1974.
- Çilingiroğlu et al. 2004
A. Çilingiroğlu/Z. Derin/E. Abay/H. Sağlamtimur/İ. Kayan, Ulucak Höyük. Excavations conducted between 1995 and 2002. Louvain: Peeters 2004.
- Day/Doonan 2007
P. M. Day/R. C. P. Doonan (eds.), *Metallurgy in the Early Bronze Age Aegean*. Sheffield Studies in Aegean Archaeology. Oxford: Oxbow 2007.
- Driehaus 1957
J. Driehaus, Prähistorische Siedlungsfunde in der unteren Kaikosebene und an dem Golfe von Çandarlı. *Istanbuler Mitteilungen* 7, 1957, 76–101.
- Elster/Renfrew 2003
E. S. Elster/C. Renfrew (eds.), *Prehistoric Sitagroi. Excavations in Northeast Greece, 1968–1970. Volume 2. The Final Report*. *Monumenta Archaeologica* 20. Los Angeles: 2003.
- Erkanal 1999
H. Erkanal, Early Bronze Age Fortification Systems in Izmir Region. In: P. P. Betancourt/V. Karageorghis/R. Laffineur/W.-D. Niemeier (eds.), *MELETEMATA. Studies in Aegean Archaeology Presented to Malcolm H. Wiener as he enters his 65th Year*. *Aegaeum* 20. Eupen: Kliemo 1999, 237–242.
- Erkanal 2008a
H. Erkanal, Die neuen Forschungen in Bakla Tepe bei Izmir. In: H. Erkanal/H. Hauptmann/V. Şahoğlu/R. Tuncel (eds.), *The Aegean in the Neolithic, Chalcolithic and the Early Bronze Age. Proceedings of the International Symposium in Urla, October 13th–19th 1997*. Ankara: Ankara University Press 2008, 165–177.
- Erkanal 2008b
H. Erkanal, Liman Tepe: New Lights on Prehistoric Aegean Cultures. In: H. Erkanal/H. Hauptmann/V. Şahoğlu/R. Tuncel (eds.), *The Aegean in the Neolithic, Chalcolithic and the Early Bronze Age. Proceedings of the International Symposium in Urla, October 13th–19th 1997*. Ankara: Ankara University Press 2008, 179–190.
- Erkanal/Erkanal 1983
A. Erkanal/H. Erkanal, Vorbericht über die Grabungen 1979 im prähistorischen Klazomenai/Limantepe. *Hacattepe Üniversitesi Edebiyat Fakültesi Dergisi* 1983, 163–178.
- Erkanal/Günel 1995
H. Erkanal/S. Günel, 1993 Liman Tepe Kazısı. XVI. Kazı Sonuçları Toplantısı I, 1995, 263–279.
- Erkanal/Günel 1996
H. Erkanal/S. Günel, 1994 Liman Tepe Kazısı. XVII. Kazı Sonuçları Toplantısı I, 1996, 305–328.
- Erkanal/Günel 1997
H. Erkanal/S. Günel, 1995 Liman Tepe Kazısı. XVIII. Kazı Sonuçları Toplantısı I, 1997, 231–260.
- Evren/İçten 1997
A. Evren/C. İçten, Efes Çukuriçi ve Arvalya (Gül Hanım) Höyükleri. *Müze Kurtarma Kazıları Semineri* 8, 1997, 111–133.
- Gale 2008
N. H. Gale, Metal Sources for Early Bronze Age Troy and the Aegean. In: H. Erkanal/H. Hauptmann/V. Şahoğlu/R. Tuncel (eds.), *The Aegean in the Neolithic, Chalcolithic and the Early Bronze Age. Proceedings of the International Symposium in Urla, October 13th–19th 1997*. Ankara: Ankara University Press 2008, 203–222.
- Gale/Stos-Gale 1986
N. H. Gale/Z. A. Stos-Gale, Anatolian and Cycladic Metal Sources. In: *Proceedings of the First Conference on Southern European Archaeometry*. Delphi 1984. *PACT Journal* 15, 1986, 13–32.
- Horejs 2008
B. Horejs, Çukuriçi Höyük. A New Excavation Project in the Eastern Aegean. *Aegeo-Balkan Prehistory*. http://www.aegeobalkanprehistory.net/article.php?id_art=9
- Horejs forthcoming
B. Horejs, Yeni Yeldeğirmenitepe. In: F. Pirson, *Pergamon – Bericht über die Arbeiten in der Kampagne 2008*. *Archäologischer Anzeiger* 2009/2.
- Horejs in press
B. Horejs mit Beiträgen von F. Galik und U. Thanheiser, Erster Grabungsbericht zu den Kampagnen 2006–2007 am Çukuriçi Höyük. *Österreichische Jahreshefte* 77, 2008 (in press).
- Kaptan 1998
E. Kaptan, Bakla Tepe’de eski metalurjiye ait buluntular. *Arkeometri Sonuçları Toplantısı* 13, 1998, 103–114.
- Kaptan 2008
E. Kaptan, Metallurgical Residues from Late Chalcolithic and Early Bronze Age Liman Tepe. In: H. Erkanal/H. Hauptmann/V. Şahoğlu/R. Tuncel (eds.), *The Aegean in the Neolithic, Chalcolithic and the Early Bronze Age. Proceedings of the International Symposium in Urla, October 13th–19th 1997*. Ankara: Ankara University Press 2008, 243–250.
- Kouka 2002
O. Kouka, Siedlungsorganisation in der Nord- und Ostägäis während der Frühbronzezeit (3. Jt. v. Chr.). *Internationale Archäologie* 58. Rahden/Westfalen: Marie Leidorf 2002.
- Kouka 2008a
O. Kouka, Zur Struktur der frühbronzezeitlichen insularen Gesellschaften der Nord- und Ostägäis: Ein neues Bild der sogenannten „Trojanischen Kultur“. In: H. Erkanal/H. Hauptmann/V. Şahoğlu/R. Tuncel (eds.), *The Aegean in the Neolithic, Chalcolithic and the Early Bronze Age. Proceedings of the International Symposium in Urla, October 13th–19th 1997*. Ankara: Ankara University Press 2008, 285–300.
- Kouka 2008b
O. Kouka, Diaspora, Presence or Interaction? The Cyclades and the Greek Mainland from the Final Neolithic to Early Bronze II. In: N. J. Brodie/J. Doole/G. Gavalas/C. Renfrew (eds.), *Horizon – Όρίζων: A Colloquium on the prehistory of the Cyclades*, Cambridge, 25th–28th March 2004. McDon-

- ald Institute Monograph Series. Cambridge: McDonald Institute for Archaeological Research 2008, 271–279.
- Lengermanlı 2008
Y. Lengermanlı, Metallic Mineral Deposits and Occurrences of the Izmir District. In: H. Erkanal/H. Hauptmann/V. Şahoğlu/R. Tuncel (eds.), *The Aegean in the Neolithic, Chalcolithic and the Early Bronze Age. Proceedings of the International Symposium in Urla, October 13th–19th 1997*. Ankara: Ankara University Press 2008, 355–367.
- Mehofer 2008
M. Mehofer, Çukuriçi Höyük – Vorläufiger Untersuchungsbericht (unpublished). Wien 2008.
- Muhly et al. 1991
J. D. Muhly/F. Begemann/Ö. Öztunalı/E. Pernicka/S. Schmitt-Strecker/G. A. Wagner, The Bronze Age Metallurgy of Anatolia and the Question of Local Tin Sources. In: E. Pernicka/G. A. Wagner (eds.), *Archaeometry '90. International Symposium on Archaeometry, Heidelberg 1990*. Basel: Birkhäuser 1991, 209–220.
- Müller-Karpe 1994
A. Müller-Karpe, *Altanatolisches Metallhandwerk. Offa-Bücher 75*. Neumünster: Wachholtz 1994.
- Pernicka et al. 1984
E. Pernicka/T. C. Seeliger/G. A. Wagner/F. Begemann, Archäometallurgische Untersuchungen in Nordwestanatolien. *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 31, 1984, 533–599.
- Pernicka et al. 1990
E. Pernicka/F. Begemann/S. Schmitt-Strecker/A. P. Grimanis, On the Composition and Provenance of Metal Artefacts from Poliochni on Lemnos. *Oxford Journal of Archaeology* 9, 1990, 263–298.
- Pernicka et al. 2003
E. Pernicka/C. Eibner/Ö. Öztunalı/G. A. Wagner, Early Bronze Age Metallurgy in the Northeast Aegean. In: G. A. Wagner/E. Pernicka/H.-P. Uerpmann (eds.), *Troia and the Troad (Natural Science in Archaeology)*. Berlin: Springer 2003, 143–172.
- Rahmstorf 2006a
L. Rahmstorf, In Search of the Earliest Balance Weights, Scales and Weighting Systems from the East Mediterranean, the Near and Middle East. In: *Weights in Context. Bronze Age Weighting Systems of Eastern Mediterranean. Chronology, Typology, Material and Archaeological Contexts. Proceedings of the International Colloquium Rome 22–24 November 2004. Studi e Materiali 13*. Roma 2006, 9–45.
- Rahmstorf 2006b
L. Rahmstorf, Zur Ausbreitung vorderasiatischer Innovationen in die frühbronzezeitliche Ägäis. *Prähistorische Zeitschrift* 81, 2006, 49–96.
- Stos-Gale 1992
Z. A. Stos-Gale, The Origins of Metal Objects from the Early Bronze Age site of Thermi on the islands of Lesbos. *Oxford Journal of Archaeology* 11, 1992, 155–177.