Abhandlung

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Early Bronze Age metalwork in Central Anatolia – An archaeometric view from the hamlet

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Zusammenfassung: Folgender Beitrag diskutiert die Ergebnisse von an Metallfunden der frühbronzezeitlichen Nekropole Kalınkaya-Toptaştepe in Zentralanatolien vorgenommenen Spektralanalysen. Da archäometrische Daten für Zentralanatolien im 3. Jahrtausend immer noch lückenhaft sind und bevorzugt Fundkomplexe früher Zentralorte berücksichtigt, Assemblagen aus dörflichen Ansiedlung jedoch bislang weitgehend unerschlossen sind, ist diese Studie in erster Linie als dringend benötigte Verbreiterung der Quellenbasis zu verstehen. Arsen-Kupferlegierungen bestehen neben „echten" Bronzen (Kupfer-Zinn), Kontaminationen wie Nickel mögen Rückschlüsse auf bestimmte Lagerstätten zulassen. Die erzielten Resultate ergeben somit einen guten Einblick in Metallverwendung und Legierungstraditionen einer Kleinsiedlung in der jüngeren anatolischen Frühbronzezeit

Schlüsselworte: Frühbronzezeit; Anatolien; Siedlung; Gräberfeld; Metallurgie; Archaeometrie

Résumé: L'article ci-dessous présente les résultats d'analyses spectroscopiques menées sur un ensemble d'objets de l'âge du Bronze Ancien provenant de la nécropole de Kalınkaya-Toptaştepe en Anatolie centrale. Vu que les données archéométriques concernant le 3e millénaire av. J.-C. en Anatolie centrale sont encore fort rares, qu'elles proviennent surtout de grands centres occupés précédemment et que les ensembles provenant d'établissements ruraux n'ont presque pas fait l'objet de recherches, l'intention primaire de l'étude que nous présentons ici est d'attirer l'attention sur les données qui sont à notre disposition. Les alliages de cuivre et d'arsenic existent à côté de 'vrais' bronzes (alliages de cuivre et d'étain), et la contamination, par exemple par le nickel, peut fournir de nombreux indices sur la présence de dépôts spécifiques. Les résultats permettent de se faire une bonne idée de l'emploi des métaux et des techniques traditionnelles d'alliage utilisés dans un habitat mineur d'Anatolie vers la fin de l'âge du Bronze Ancien.

Mots-clefs: Age du Bronze Ancien; Anatolie; habitat rural; nécropole; métallurgie; archéométrie

Abstract: The following contribution discusses the results of spectroscopic analyses carried out on metal artefacts from the Early Bronze Age cemetery of Kalınkaya-Toptaştepe in central Anatolia. Given that archaeometric data from 3rd- millennium BCE Central Anatolia are still quite sparse, tend to stem mainly from earlier central places, and the assemblages from village sites have so far remained largely unexplored, the study we present here is primarily intended to draw much needed attention to the data that are available. Copper-arsenic alloys exist alongside 'true' bronzes (copper-tin alloys), and contamination, for example by nickel, can yield much information about specific deposits. The results obtained provide good insights into the use of metals and traditional alloying techniques on a minor settlement at the end of the Anatolian Early Bronze Age.

Keywords: Early Bronze Age; Anatolia; Settlement; Necropolis; Metallurgy; Archaeometry

Whenever a seminar, scientific discussion or scholarly work raises the issue of significant 3rd millennium BCE Central Anatolian finds and features, the contributions will inevitably contain references to sites like Eskiyapar and especially Alaca Höyük. The latter, whose first campaigns of excavations were conducted by a young, Republican generation of Turkish archaeologists in the 1930s, revealed a stunning array of splendidly equipped cist graves predating the Hittite occupation horizon of the 2nd millennium BCE. The versatile metalwork from these burials represents one of the finest hours of ancient Anatolian

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craftsmanship[1]. The basis for this accumulated wealth so lavishly displayed might be rooted in the control of crucial mineral resources like copper, lead, silver, gold and even tin, and the management of the growing network of caravan trade routes in the advanced 3rd millennium BCE which may well have also affected the northern Central Anatolian plateau[2]. Indeed, together with other early 'central places' like Eskiyapar, sites such as Küllüoba in the Eskişehir plain or Karataş-Semayük in the south-west – although different in size and structure – appear to form part of a growing 'pre-urban' phenomenon in rural Anatolia, with new architectural approaches to underline the status and economic power of the local ruler[3].

In stark contrast to these, we still know very little about the size, organisation and technical facilities of the 'commoners' living in small dispersed villages in Anatolia proper, the 'Hatti heartland' of the Hittite overlords of the 2nd millennium BCE. Setting aside the uncertainties still overshadowing the overall chronological sequence of 3rd-millennium Central Anatolia, with seemingly (?) a void 'Early Bronze Age I'[4], it is still largely unknown how far the splendid alloying, casting and forging know-how illustrated at Alaca Höyük had any repercussions in rural areas, or even whether it was further nurtured there. Without a proper idea of metal production and consumption in rural Anatolia, the picture remains much distorted.

Thanks to a project targeting the Early Bronze Age metalwork of Central Anatolia as a whole, involving researchers from Bilkent University, the Museum of Anatolian Civilizations, Ankara University, and the Sarayköy Nuclear Research and Training Centre (SANAEM), we are now able to add to the evidence available with a new series of metal analyses. This project focused on the semi-quantitative, non-destructive analysis of metal objects from the Early Bronze Age rural settlement and cemetery of Kalınkaya, a stone's throw from Alaca Höyük. As will become apparent, this material is in an ideal position to add fresh data to a still largely incomplete jigsaw puzzle.

Setting the scene

The prehistoric settlement and cemetery of Kalınkaya-Toptaştepe, with Toptaştepe itself being a natural rise with traces of ancient occupation, is located to the north-east of the modern village of Kalınkaya, district of Alaca, Çorum province in Turkey[5] (Fig. 1). The site is located at approximately 1300 m asl and 3 km north-east, as the crow flies, of Alaca Höyük. The area was first investigated in 1948 by Raci Temizer, but that expedition focused exclusively on an ancient tumulus (known to local people as 'Dedenin Sivrisi') located to the north-west of Kalınkaya; the findings made there allegedly dated to the Late Hellenistic/Roman period[6]. Hence, because of this short campaign in 1948 which ran for just one season, the vicinity of Kalınkaya was initially thought to yield only classical remains and no further archaeological survey and/or excavation campaign was undertaken there. But in 1971 the museum authorities were alerted to the fact that local inhabitants had illegally started to dig and loot the cemetery on the slope of Toptaştepe (sometimes also referred to as 'Taştoptepe'). A rescue excavation was carried out to prevent further damage and looting (Fig. 2). The team included Raci Temizer (then director of the Museum of Anatolian Civilizations) as field director, Mahmut Akok as architect and illustrator, and Aliye Öztan, Ahmet Tırpan, Levent Zoroğlu, who were then archaeology students and are now all senior scholars in the fields of Prehistory and Classical Archaeology[7]. The same team was once again in the field in 1973, from 10 to 25 July. This short expedition extending over two brief field seasons revealed the prehistoric phases of Kalınkaya, and brought to light the finds and features which form the subject of this study.

Unfortunately, the results of the Kalınkaya excavations were never published in the following decades, with the exception of three consecutive mentions in the 'Archaeology in Asia Minor' section of the *American Journal of Archaeology*[8]. Indeed, it is only in the last decade that the original excavation diaries, plans, documents and objects, all stored in the Museum of Anatolian Civilization in Ankara, have been archaeologically scrutinised, and their initial results published in a series of articles[9]. The documentation and findings of the 1971 and 1973 campaigns revealed a prehistoric presence from the Chalco-

1 Arık 1937; Koşay 1938; Koşay 1951; see especially. Zimmermann 2008b for recent literature.
2 *Contra* Efe 2007; see Zimmermann 2009; Zimmermann/Geniş 2011.
3 Çevik 2007.
4 Bertram 2008; see Yalçın 2011 for new, very high radiocarbon datasets for selected Alaca Höyük objects.
5 Zimmermann 2007a.
6 Temizer 1949.
7 Zimmermann 2007a, 8–11.
8 Mellink 1972, 169; Mellink 1973, 173; Mellink 1974, 109
9 Zimmermann 2006; Yıldırım/ Zimmermann 2006; Zimmermann 2007a; Zimmermann 2008a.

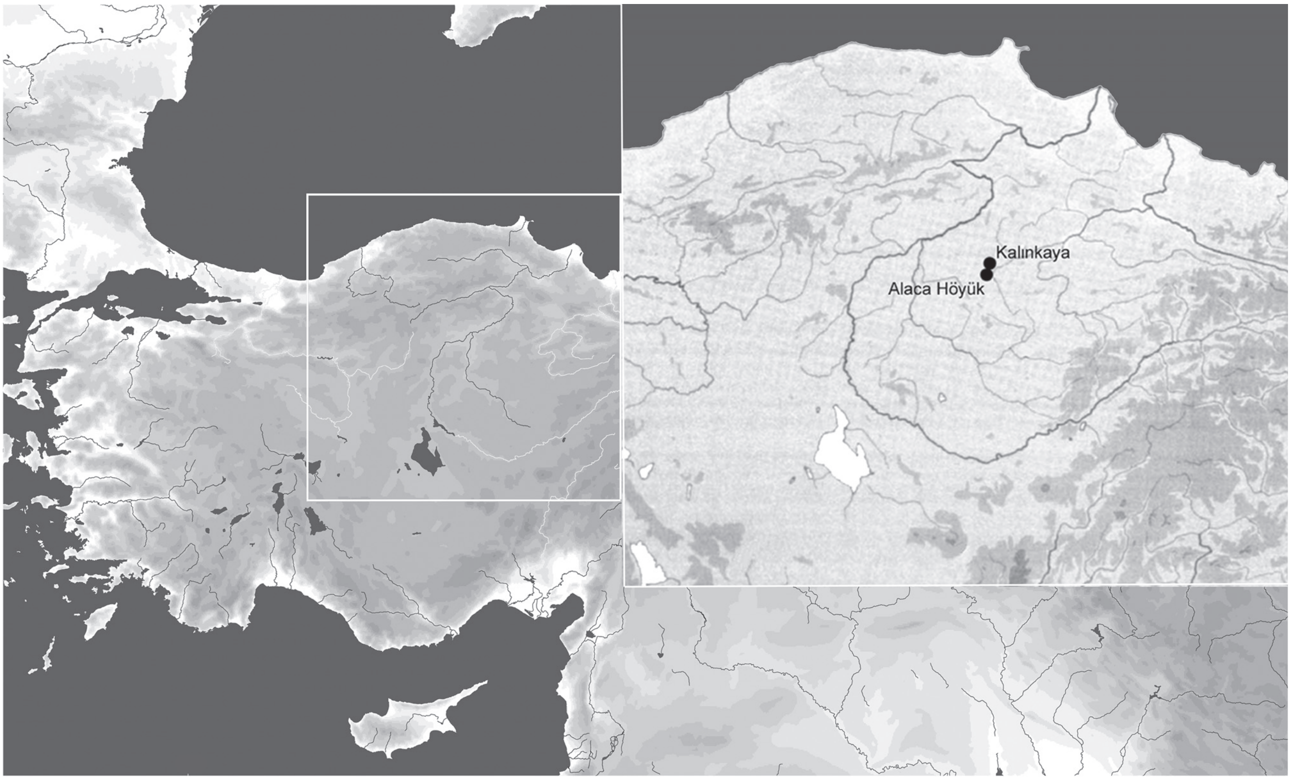

Fig. 1: Map showing the location of Alaca Höyük and Kalınkaya

lithic to the Middle Bronze Age (4th to early 2nd millennium BCE), the major occupation phase being limited to the Early Bronze Age (3rd millennium BCE). Scattered surface material also attests to limited human activity during the Old Hittite period, namely the 17th century BCE[10]. The archaeological objects considered in this article, come exclusively from the Early Bronze Age occupation horizon, more precisely the cemetery on the southern slope of Toptaştepe which was severely damaged in parts. Here, pithos burials in regular Anatolian tradition were accompanied by a few stone cists and simple pit burials[11]. Since no radiometric dating was applied at the time of the excavations, they are categorised according to conventional archaeological methods, i.e. through typological comparison.

The range of metal objects retrieved from the burials consist of jewellery or accessories (two rings and 16 bracelets) (Fig. 3), weapons (Fig. 5), and tools, all of them sharing typological and technical attributes with artefacts from neighbouring sites like Resuloğlu[12]. Regional coincidence in terms of typological traits is also visible among the weapons. For example, the broad triangular flange and bevelled edges, together with a combined technique of tongue-and-rivet hafting observed on the Toptaştepe daggers represent a regional phenomenon that is frequently found in the Central, as well as the Western Anatolian Early Bronze Age[13].

Three outstanding cultic items, though cast with rather modest means, comprise one crude and one more carefully modelled bull statuette (Fig. 4,1–2), and one abstract standard. These artefacts indicate that the site of Toptaştepe was embedded in the ritual network of later Early Bronze Age Central Anatolia, with theriomorphic and abstract standards and *sistra* as characteristic, emblematic features of a rather small entity that included Alaca Höyük, Eskiyapar, Balıbağı and Horoztepe[14].

10 Zimmermann 2006, 276.
11 Zimmermann 2007a, 11–14.
12 Ibid. 16–21.
13 Ibid. 16–18.
14 Zimmermann 2008b.

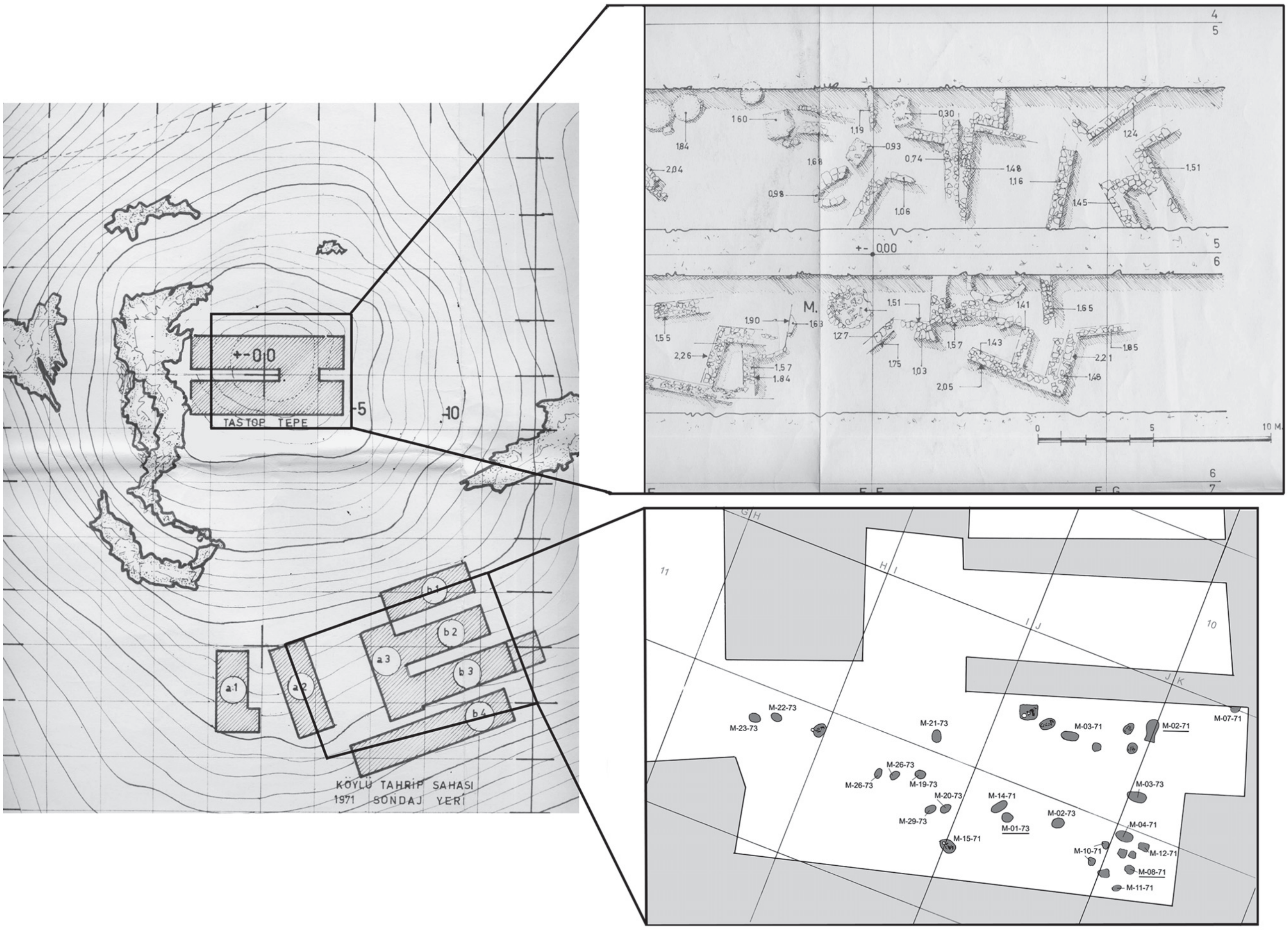

Fig. 2: Trenches dug on the top and the southeastern slope of Toptaştepe in 1971, with architectural remains from the parallel trenches on top and so far identified Early Bronze Age burials from the slope (original documentation from the archives of the Museum of Anatolian Civilizations, Ankara; burial map after Zimmermann 2007a)

Archaeometric studies of Bronze Age metal objects from Central Anatolia – the story so far

Early, pioneering studies include an analysis of selected metal artefacts from Alaca Höyük by E. Meyer (1937), a study on metal production and consumption in Anatolia by S. Przeworski (1939), and culminate in U. Esin's spectrographic analysis of Anatolian metal artefacts[15]. The following decades saw the appearance of only a few major contributions dealing with issues of metal production and consumption in Central Anatolia that included the Pre-Classical period, such as P. De Jesus' 1978 doctoral dissertation, with some further analysis of Early Bronze Age metal items[16]. In 2000 A. Yener's in-depth account of the technical and social dimensions of the 'domestication of metals' (hence her title) appeared, albeit mainly focusing on her own research in the Taurus region[17]. In recent years archaeometric analyses targeting the metallurgy of Central Anatolia in the Bronze Age have been pursued at a much reduced pace, and no larger studies have been conducted or published. Thus, the production and alloying traditions in large parts of Bronze Age Anatolia, especially the rural foci in the vicinity of early urban centres like Alaca Höyük, remain largely obscure. Although vast amounts of metal objects from Central Anatolian Bronze Age findspots are stored in the museums of Çorum, Çankırı and Yozgat, very little, if anything is known about their elemental composition, in terms of what raw materials the communities used and combined to produce metal tools, weapons, vessels and jewellery items. A recent re-evaluation of metal objects from Tarsus, previously analysed in U. Esin's com-

15 Koşay 1938; Przeworski 1939; Esin 1969.
16 De Jesus 1980.
17 Yener 2000.

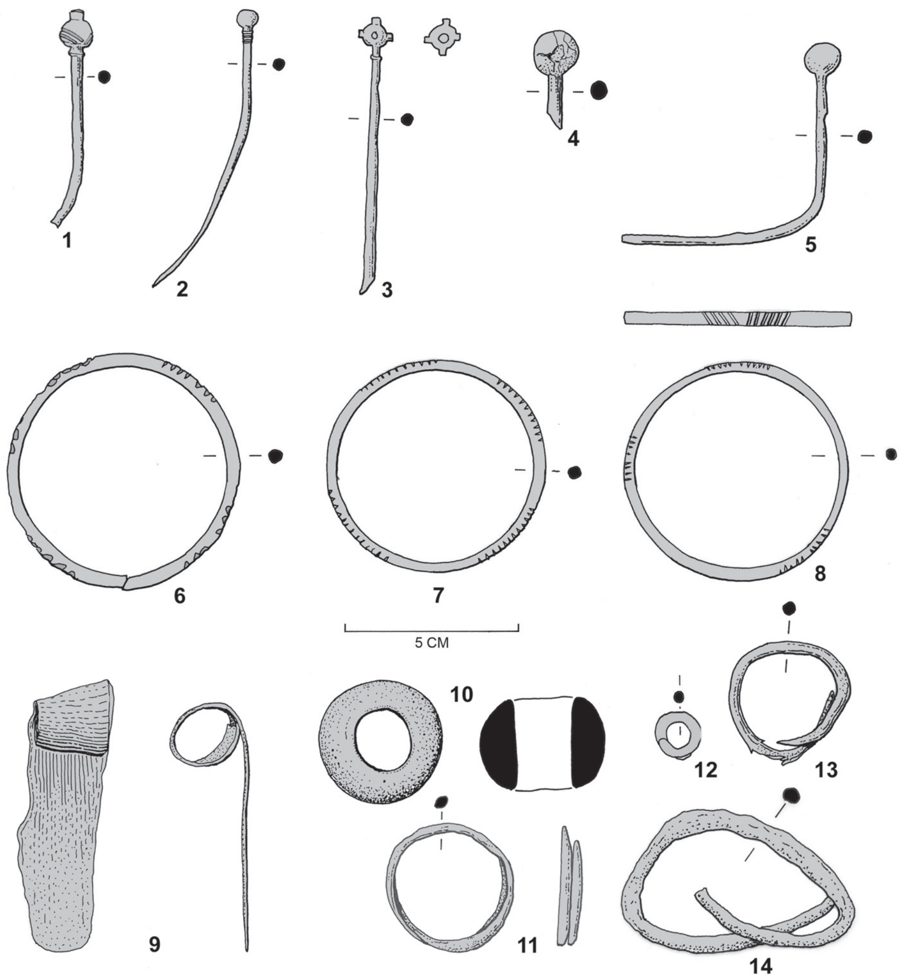

Fig. 3: Selection of metal objects from Kalınkaya – 1) pin (KK 112–71) – 2) pin (KK 49–73) – 3) pin (KK 109–71) – 4) pin (KK 105–71) – 5) pin (KK 106–71) – 6) bracelet (KK 101–71) – 7) bracelet (KK 114–71) – 8) bracelet (KK 121–71) – 9) rolled sheet (KK 70–71) – 10) macehead (KK 56–71) – 11) bracelet (KK 97–71) – 12) ring (61–73) – 13) bracelet (KK 117–71) – 14) bracelet (KK 64–73) (Drawings by B. C. Coockson)

prehensive study[18], has revealed serious inconsistencies between the old and new datasets, reinforcing the need for a new series of analyses; it has highlighted the necessity to undertake spectrographic investigations in particular, to refocus on developments in metal consumption and alloying traditions in the 3rd millennium BCE[19]. Moreover, a recent joint project involving scientists from the universities of Bilkent and Ankara has targeted Early Bronze Age metal production and consumption in the Central Anatolian countryside[20].

18 Esin 1969.
19 Kuruçayırlı/Özbal 2005.
20 Zimmermann/Yıldırım 2008; Zimmermann *et al.* 2009; Zimmermann/İpek 2010.

Archaeometric analysis of metal objects from Kalınkaya-Toptaştepe: then and now

Initial semi-quantitative, non-destructive X-ray Fluorescence (XRF) analyses of the metal objects from Kalınkaya-Toptaştepe, using a P-XRF (handheld XRF) device, were carried out in 2006. After a few scans, a puzzling, yet substantial amount of zinc (Zn) was observed on a growing number of copper-based objects. This suggested the study should be put on hold, since no zinc could be expected in metal-based objects from a 3rd-millennium BCE Central Anatolian context, considering the alloying technologies available at the time[21]. Although the occasional occurrence of exceptional, unmatchable results is a known phenomenon in modern archaeology, it seemed too presumptuous to rewrite the history of brass solely on the basis of a small assemblage of provincial Anatolian metal objects.

21 See Pernicka 1990, 55–56.

Thus a working hypothesis – that modern Zn contamination was the unwanted side-effect of an electrochemical cleaning procedure thought to have been carried out on the objects recovered in 1971 – was suggested, especially since the XRF-device penetrates the surface to only a depth of 2 microns, which may well correspond to a potential bias caused by a tainted surface. In this reduction method, nascent hydrogen, Zn and caustic soda lead to an electrochemical reaction. An enamelled container is heated to hasten the process and obtain the results more quickly. The last step consists of applying an electrical DC current inside the container that diffracts the patina off the surface of the metals[22]. The object now reveals its original, unpatinated surface, rendering it more eye-catching in museum display cases. However, a certain quantity of Zn sticks to the surface as a thin residual film[23]. This thin layer of Zn cannot be seen by the naked eye but becomes clearly evident when spectrometry is applied; spectrometric analysis was quite certainly not undertaken by the Kalınkaya expedition of the early 1970s. Moreover, an object with an exposed 'original' surface is extremely sensitive to modern contaminants, which may result in slow but continuous damage to the object's surface, and, at worst, an irreversible loss of material. As it was, all the metal artefacts from the 1971 rescue campaign had a suspicious blank, patina-free surface; by contrast, the small quantity of items retrieved in 1973 all had a thick, crystalline patina.

In the second analysis of these 'over-conserved' objects the major objective was to minimise – or ideally completely remove– the presumed surface zinc contamination. To achieve this, removal of the contamination with a micro sandblasting device operating with oxidized aluminium, followed by an additional surface cleaning with formic acid seemed to be the most promising approach. Prior to this specific surface treatment, i.e. before applying any measures to remove the contaminant, XRF tests on the objects were carried out. The results were almost entirely the same as those obtained in 2006, with similar or identical amounts of elements, including the notorious Zn ratios peaking at up to 5 % by weight. After applying the two cleaning procedures sketched above, the entire Zn contamination was successfully removed from all the objects, and the former ratio of the Zn contaminant was equally distributed among the elementary composition of the ancient, original material matrix. Hence it could clearly be demonstrated that zinc was not an integral element of the initial casting procedure, but merely the result of an overzealous cleaning procedure back in the 1970s. Moreover, this suggests that electrochemical cleaning measures might well explain why other prehistoric metal items exhibit 'exotic' amounts of zinc. A macehead, tentatively dated to the Early Bronze Age and containing a substantial amount of Zn, from the Sadberk Hanım Museum collection with an otherwise obscure provenance history[24], could well be such a victim of a well-meant but – at least from a contemporary point of view – decidedly wrong cleaning procedure.

A total of 45 metal objects from the museum store and from permanent display cases could be re-analysed. For the measurements, a handheld XRF device[25] was used. The 300 µm Peltier-cooled PIN detector allows for a non-destructive surface scanning that reveals the object's chemical composition. For calibration, the AISI standard was used. To obtain a secure statistical average, up to five surface measurements were taken depending on the size of the object, to take account of inhomogenous elementary distributions that could be expected from the original casting procedure. The distribution of elements is given in the chart illustrated on Tab. 1.

A view from the hamlet

The small assemblage of metal artefacts from a funerary context analysed here represents a good cross-section of the kind of Early Bronze Age Central Anatolian metalwork that can be found on a small rural settlement. The largest group of items by far consists of simple jewellery items like plain and crudely decorated bracelets and pins, used as decorative dress fasteners; they were most probably the personal belongings of the deceased, and not specially manufactured for the funeral ceremony. These are accompanied by a few tools and weapons and, given their modest stylistic appearance and technological attainment, could all have been produced by a local metalsmith.

The two bull statuettes are more remarkable, and they differ profoundly from each other in style and working technique. The rather crude statuette (KK 100–71) (Fig. 4,2) seems to be an abject failure, desperately trying to copy the masterfully executed large zoomorphic statuettes of neighbouring Alaca Höyük. Casting defects were not repaired or removed, and the whole object appears to be unfinished, or abandoned by a perhaps insufficiently skilled

22 Plenderleith/Werner 1979, 194–197; 245–252.
23 Ibid. 194–197.
24 Anlağan/Bilgi 1989, 98; 110.
25 P-XRF, Innov-X A 2000 Rhino model.

Tab. 1: Results of non-destructive XRF elementary analysis. Figures given in weight %

Object	Cu	Sn	As	Pb	Fe	Ni
KK 19–71 (standart)	97.2	–	2.4	0.23	–	–
KK 37–71 (pin)	97,5	–	1.2	0.84	0.14	–
KK 48–71 (bracelet)	89.4	10.2	0.32	0.11	–	–
KK 56–71 (macehead) **(Fig. 3.10)**	93.6	–	4.9	1.43	–	–
KK 57–71 (dagger) **(Fig. 5.1)**	97.2	–	2.7	0.11	–	–
KK 70–71 (sheet) **(Fig. 3.9)**	97.3	–	2.4	0.35	–	–
KK 71–71 (dagger) **(Fig. 5.2)**	93.3	0.76	1.6	0.30	0.81	3.2
KK 73–71 (pin)	98.4	–	1.3	0.23	0.11	–
KK 77–71 (bracelet)	91.2	8.7	0.14	–	–	–
KK 78–71 (pin)	92.3	7.2	0.81	0.13	0.52	–
KK 82–71 (pin)	97.6	2.3	–	0.12	–	–
KK 84–71 (pin)	82.6	10.7	–	3.8	3	–
KK 87–71 (dagger) **(Fig. 5.3)**	96.7	–	3.1	0.14	0.1	–
KK 96–71 (bracelet)	99.8	–	–	0.19	–	–
KK 97–71 (bracelet) **(Fig. 3.11)**	97.9	–	0.82	0.36	0.14	–
KK 100–71 (figurine) **(Fig. 4.2)**	96.0	–	3.9	0.10	–	–
KK 101–71 (bracelet) **(Fig. 3.6)**	91.8	8.2	–	–	–	–
KK 103–71 (bracelet)	96.2	–	3.8	–	–	–
KK 104–71 (bracelet)	87.1	12.3	0.57	0.13	–	–
KK 105–71 (pin) **(Fig. 3.4)**	87.5	12.1	–	0.17	–	–
KK 106–71 (pin) **(Fig. 3.5)**	91.2	7.9	0.34	0.57	–	–
KK 107–71 (pin)	87.7	11.3	0.61	0.22	0.19	–
KK 109–71 (pin) **(Fig. 2.3)**	90.1	8.3	0.89	0.48	0.15	–
KK 111–71 (pin)	93.2	2.8	0.89	0.48	0.15	–
KK 112–71 (pin) **(Fig. 3.1)**	89	9.8	1.9	0.23	–	–
KK 114–71 (bracelet) **(Fig. 3.7)**	99.2	–	0.2	0.2	–	–
KK 115–71 (dagger) **(Fig. 5.4)**	91	7.6	1.3	0.23	–	–
KK 116–71 (pin)	88.8	–	9.6	0.21	0.35	–
KK 117–71 (bracelet) **(Fig. 3.13)**	85.4	–	14.3	0.07	–	0.24
KK 121–71 (bracelet) **(Fig. 3.8)**	93.3	–	6.5	0.19	–	–

Tab. 1 (continuation)

Object	Cu	Sn	As	Pb	Fe	Ni
KK 122–71 (bracelet)	90.9	9	–	0.09	–	–
KK 123–71 (bracelet)	93.5	–	4.9	1.4	–	–
KK 124–71 (bracelet)	93.1	–	6.8	–	–	–
KK 125–71 (bracelet)	99.7	–	0.14	0.16	0.1	–
KK 126–71 (pin)	97.5	–	2.3	0.16	–	–
KK 147–71 (pin)	96.2	–	3.4	0.25	–	–
KK 33–1–72 (figurine) **(Fig. 4.1)**	90.1	7.7	–	1.27	0.93	–
KK 12–73 (axe)	95.1	–	4.8	–	0.15	–
KK 22–73 (pin)	96.2	–	3.4	–	0.41	–
KK 49–73 (pin) **(Fig. 3.2)**	96.6	–	0.83	0.24	2.83	–
KK 60–73 (pin)	98.5	–	0.99	0.28	–	–
KK 61–73 (ring) **(Fig. 3.12)**	96.9	–	1.9	–	1.2	–
KK 63–73 (bracelet)	91.4	–	8.6	–	–	–
KK 64–73 (bracelet) **(Fig. 3.14)**	98.2	–	1	–	0.74	–
KK 65–73 (pin)	98	1.8	0.11	–	0.11	–

metalworker[26]. Its counterpart, KK 33–1–72 (Fig. 4,1), was confiscated by the local police from a group of looters; although rather small, it is worked in the tradition of the technologically much more advanced bull figurines of Alaca Höyük. The suspicion arises that this statuette (which could unfortunately not be investigated more thoroughly because it is again on permanent display) was either produced by an experienced senior metalsmith at neighbouring Alaca Höyük or – an unlikely but still reasonable possibility – looted from a grave in the immediate vicinity of Alaca Höyük's famous 'royal tombs'. By contrast, the crude statuette might then be understood to be the work of an apprentice working at Kalınkaya.

What separates the two figurines further (and probably supports the hypothesis of their place of production) is their chemical composition. The crude bull statuette (KK 100–71) is made of arsenic-rich copper, with an As amount of 3.89 %, and no tin (Sn) peak seen in the spectrometric test; the far better figurine (KK 33–1-72) is 'real' bronze (the classical Cu and Sn combination) with a fairly high Sn content of 7.69 %.

In conclusion, two major groups can be distinguished in the 45 items analysed: Cu+As alloys and Cu+Sn alloys, in nearly even proportions within the assemblage of Kalınkaya metal objects. Unalloyed Cu items[27] (which however contain traces of other metals as natural, unintentional contaminants) are the minority. Within these groups, some noteworthy deviations require discussion: arsenic-rich copper might be the result of processing polymetallic ores, since As used as an alloying agent is highly toxic, especially when smelted. It cannot however be excluded that minerals like arsenopyrite were deliberately added to the Cu, as metalsmiths may not have been aware of the fatal illnesses frequent exposure to such a substance can cause. A high As content might also be a consequence of arsenic enriching of an object's surface during cooling, and not necessarily the result of adding a high amount of As[28].

The unexpectedly high content of an alloying agent must be evaluated differently for bronze. Here, amounts that go beyond 7 % by weight or even beyond 10 % by weight do not improve the technical quality of the bronze. Since tin was a rare and highly valued alloying agent, it seems unlikely that even modestly skilled metalsmiths wasted such a valuable substance without good reason. The answer probably lies not in the technical qualities of the finished product such as strength and durability, but in the object's final colour, as already suggested for Early

26 Zimmermann 2006.

27 KK 96–71, KK 114–71, KK 125–71.

28 Pernicka 1990, 50–52; Lechtman 1996.

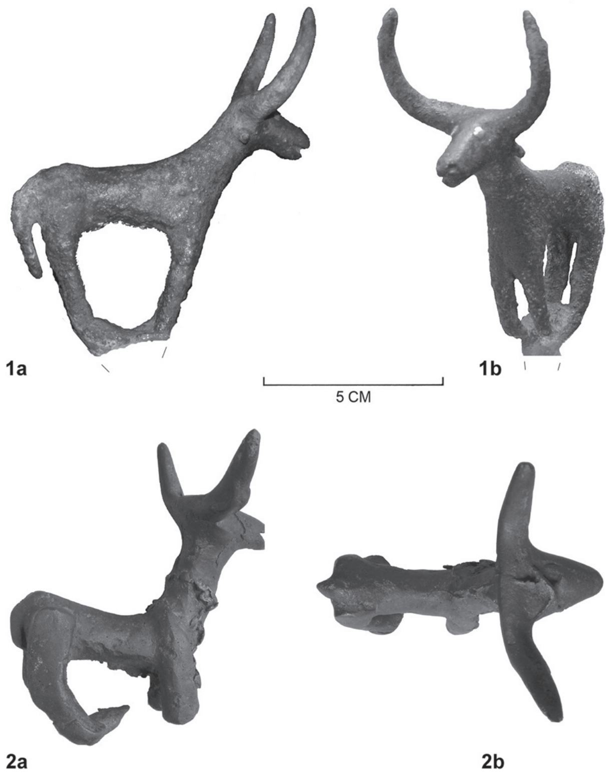

Fig. 4: Bull figurines – 1a.b) KK 33–1-72–2a.b) KK 100–71 (Drawings and photograph by B. C. Coockson)

Bronze Age metal items from neighbouring sites[29]. Here, with an ever-increasing amount of tin, the object's colour tends towards a silvery sheen, which makes perfects sense for giving jewellery items, for example, and it is a hue that is in accord with the dominant fashion of the period.

Lead occurs in quite tiny amounts, which can be explained as occurring with natural contaminants of the copper ore; if the amount goes beyond 1 %, as attested in a few items (see Tab. 1), recycling of Pb-rich scrap-metal could be an explanation, since the addition of Pb to drop the smelting temperature was not carried out on a regular basis at the time[30].

The presence of nickel (Ni) in two objects (see Tab. 1) is possibly related to the processing of Cu ores from ultrabasic, ophiolithic rocks, known for example from the Taurus mountains[31]. However, recycling of scrap-metal produced from an ophiolithic rock source is a very reasonable hypothesis in these specific cases.

A preliminary look at the cemetery's finds and features suggests a tentative dating in the second half of the 3rd millennium BCE. However, Central Anatolia still lacks an agreed absolute chronology, as alluded to at the beginning of this article. An awkward lacuna seems to exist in the first half of the 3rd millennium BCE, with extremely scarce, if any, evidence for human activity in the Early Bronze Age I phase[32]. All material uncovered seems to correspond to the traditional definition of Early Bronze Age III pottery styles. Furthermore, new ^{14}C data obtained from artefacts belonging to the 1930s campaign at Alaca Höyük drag the date of several 'Royal tombs' well into the early (!) second millennium BCE[33]. What looks like a long awaited filling up of the void in the early 3rd millennium actually further complicates the situation, since the stratigraphic context, technology and stylistic connections of the associated material would rather put it into the last quarter of the 3rd millennium. Without a statistically safe and sound portfolio of crosschecked radiocarbon dates, there is very little chance to resolve these pressing issues in the immediate future.

If we adopt a 'conservative' chronological estimate until something better becomes available, it is important to note that a small rural site like Kalınkaya has an obvious and secure supply of precious tin in the later 3rd millennium BCE. This does indeed deserve attention, since some regions, especially the Black Sea littoral, seem to have been cut off from the supply of tin, or were, for reasons yet unknown, not manufacturing tin-copper (bronze) items until the 2nd millennium BCE[34]. Recent analyses of metal assemblages from the northern Central Anatolian plateau, however, show that this very region was an arena for competing alloying traditions, with arsenic-rich copper objects in 'Pontic fashion' extending much further south than had previously been thought. Furthermore, the phenomenon of adding copious amounts of tin to the copper, exceeding by far the necessary 2–3 % by weight to create a decent, durable bronze, as attested in numerous objects from Resuloğlu[35], can also be documented in several items from the Kalınkaya cemetery. A possible explanation for this does not necessarily imply that the local coppersmiths were unaware that they were being heavy-handed, but rather that they attempted to manipulate the colour of an object to obtain a more silvery sheen.

Philology has clearly shown that the Hittites, rising to prominence and power in the 2nd millennium BCE, adopted substantial aspects of the culture, customs and belief systems of the Hatti, to be merged with their own

29 Zimmermann/Yıldırım 2008.
30 Pernicka 1990.
31 Hauptmann/Palmieri 2000, 79–80.
32 Bertram 2008, 73–74; Düring 2011, 266.
33 Yalçın 2011, 61–62; 64.
34 Özbal *et al.* 2002.
35 Zimmermann 2007b; Zimmermann/Yıldırım 2007; 2008.

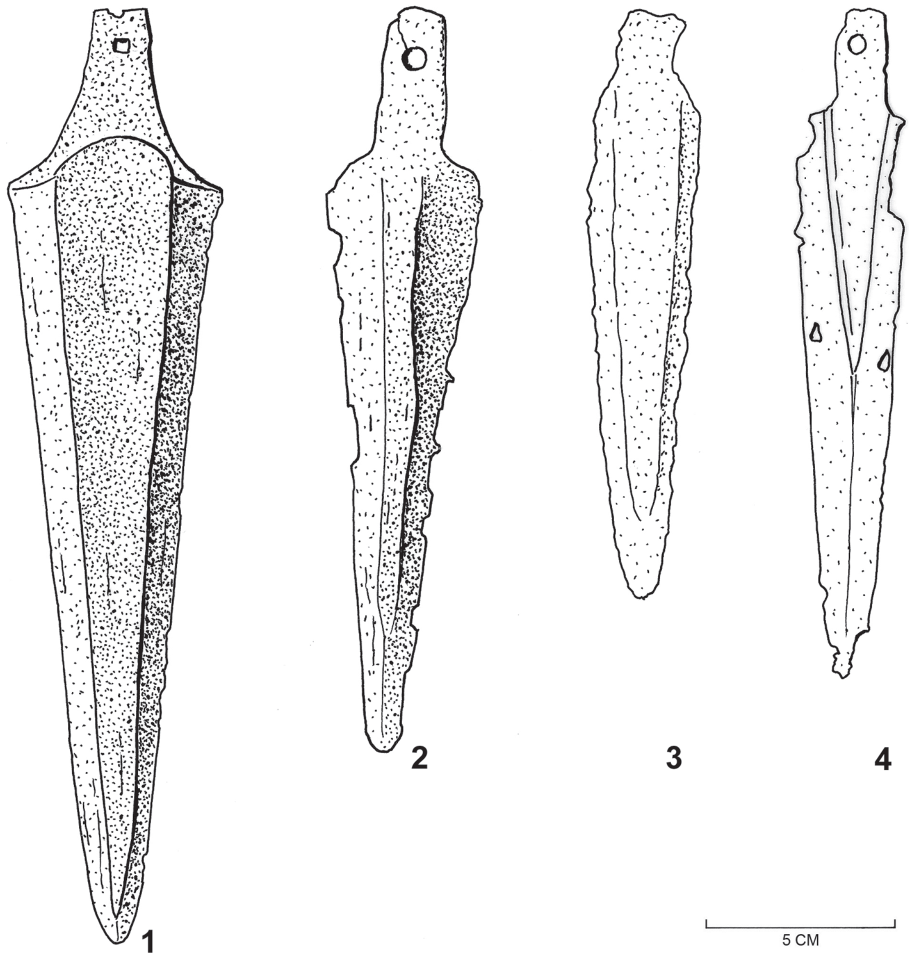

Fig. 5: Kalınkaya daggers – 1) KK 57–71 – 2) KK 71–71 – 3) KK 87–71 – 4) KK 115–71 (Drawings by B. C. Coockson)

social identity[36]. It seems therefore legitimate to assume that Hittite artisans similarly incorporated technological know-how from the indigenous Central Anatolian populations. A recent archaeometric investigation of the famous metal tablet known as the Kurunta Treaty has shown that excessive amounts of tin (evidently for coating the tablet) were used to give it a fake silver appearance[37].

By way of conclusion, our archaeometric study of a metal assemblage from a small village settlement and cemetery can only be the first step towards a more holistic picture of metalworking traditions in 3rd-millennium BCE Central Anatolia, prior to its cultural overprint by the emerging Hittite Empire. Looking at the presumed early (pre)urban centres certainly does not suffice. A thorough (re)evaluation of metal products from the rural periphery is essential to prevent the view from the hamlet being just a single piece of the jigsaw.

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36 Soysal 2004, 1–39.
37 Zimmermann *et al.* 2010.

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