

EVIDENCE FOR EARLY USE OF TIN AT TÜLİNTEPE IN EASTERN ANATOLIA

DOĞU ANADOLU/TÜLİNTEPE'DE KALAYIN İLK KULLANIMINA DAİR VERİLER

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ÖZET

Elazığ Altınova'nın Keban Baraj gölünün su kaplama alanı içinde kalması, eski Elazığ-Bingöl demiryolunun geçiş yolunun değiştirilmesini gerektirmiş ve yeni tren hattının yakınında bulunan Tülintepe 1966 yılında kamulaştırılarak, bir kısım toprağı alınmış ve bu toprak demiryolu düzleminin ovidan yükseltilmesi için dolgu malzemesi olarak kullanılmıştır. İlk Tunç Çağı ve Son Kalkolitik Çağ için önemli veriler içeren höyüğün üst katları böylece tahrip olurken, kaldırılan toprakta tümüyle rastlantısal olarak bir kılıç ve beş mızrak ucundan oluşan bir toplu maden buluntusu açığa çıkmıştır. Daha sonra Tülintepe'de yapılan sistematik kazılar sonucunda ve diğer tarihöncesi yerleşimlerden bilinen benzer buluntu grupları ile karşılaştırılarak adı geçen maden topluluğunun Son Kalkolitik-İlk Tunç Çağı I'e tarihlendirilmesi öngörülmüştür.

Buluntu topluluğunun ortaya çıkmasından yaklaşık 30 yıl sonra, modern yöntemlerle yapılan arkeometalürjik araştırmalar sonucunda söz konusu kılıç ve mızrak uçlarının arsenik ve nikel içerikli bakırdan üretildiği ve yüzeylerinin kalayla kaplı olduğu anlaşılmıştır. Böylece kalayın günümüzden 5000 yıl önce Anadolu'da kullanıldığı belgelenmektedir. Aşağıdaki yazımızda, arkeolojik yayınlara Tülintepe "Hazine Buluntusu" olarak geçen bu maden topluluğunun yapım tekniklerine, yüzey kullanım izleriyle ilgili veriler ve üretilmiş oldukları metallerin kompozisyonlarına ağırlık verilmektedir. Ele aldığımız buluntu topluluğunun yakın çevredeki yaklaşık eş zamanlı benzerleriyle karşılaştırılmasının ve görelî olarak tarihlendirilme önerilerinin yanı sıra, buluntuların yapımında kullanılan metallerin kökeni de ele alınmakta, tüm bu somut bilgiler Eski Dünya'da kalayın bilinen tarihçesi de göz önünde bulundurularak, deneysel bir yaklaşımla belli bir sosyo-ekonomik çerçeveye oturtulmağa çalışılmaktadır.

INTRODUCTION

The leading role of Anatolia in the development of metallurgy has been mentioned in archaeological publications several times¹. The first settlers of Anatolia already knew about ores. They collected minerals like hematite, malachite or semi-precious stones in striking colours and worked small beads out of them. In some regions they also gathered native copper and worked small beads out of it or formed objects like pins, fishing hooks or awls. In order to optimize the forming process the new raw material was heated (Yalçın 2000a; 2003; 2008). Pyrotechnology copper working was thus evident long before the firing of ceramics. Thus the craft of metal working started in Anatolia almost 10.000 years ago and turned into one of the most important economic branches in human history. For a long time native copper remained the only metal people used. About 7.000 years ago they succeeded in obtaining copper from its ores. Rolled head pins, chisels and axes from Mersin XVI made of smelted copper are dated to 5.000 BC (Yalçın 2006). By this time the Anatolian settlers were able to gain copper from different ores and to manufacture different tools out of it.

The number of copper artefacts increases in the 4th millennium BC. In this stage of development, workshops with ore pieces, fractures of crucibles, casting moulds and a series of metal finds give us hints about vivid metallurgical activities in the settlements. Examples for these activities have been found all over Anatolia, such as in Eastern Altınova, in the Plain of Antioch in Southeastern Anatolia, as well as in Central and Western Anatolia. Special attention should be paid to Altınova where many prehistoric settlements were found. These settlements maintained flourishing economic and cultural contacts with the Levant, Mesopotamia and Transcaucasia (Hauptmann and Palmieri 2000; Frangipane 2001). In this time of cultural boom the very complex compositions of copper ores were used for metallurgical process (Cu-Pb-Zn-As.Sb-Ni-mineralization, "Fahlerz", massive sulphide ores). Almost across the whole of Anatolia, a specific metal that appears with frequency can be observed within the territory of the Kura-Araxes-/Karaz-Culture. It consists of a copper-arsenic alloy and contains different amounts of nickel. In this connection it makes sense to ask whether this special kind of

copper was responsible for the different qualities of certain metal objects like jewellery, weapons and tools (Yalçın and Yalçın 2008).

Smelting experiments with several ores led to the discovery of new metals. As a result the dominion of copper ended in the 4th millennium BC. Silver, gold and lead were discovered. The first massive objects of silver were found e. g. in Korucutepe in Altınova (van Loon 1978). In this stage of development throughout the Near East the extraction was still done in the settlements. If needed the copper was melted in crucibles and was worked directly on spot. We call this kind of production "household-metallurgy" (Hauptmann 2000). At the beginning of the 3rd millennium BC copper seems to be alloyed with tin. Thus bronze was born. Some rare early examples come from Tell el-Judaidah, Alişar I, Troy I and Thermi I, though the suggested early date is not safe enough (Mellink 1992).

In Malatya-Arslantepe in Eastern Anatolia almost 100 metal objects were found both in a palace and a royal tomb that were dated to 3400-2900 BC. These finds are of great importance for the metallurgy of this period in the Near East. They consist of weapons and ceremonial objects made from arsenical copper and partly from nickel. Among them there is jewellery made from a silver-copper alloy that provides some of the earliest evidence for intentional alloying techniques (Hauptmann *et al.* 2003).

In the Early Bronze Age II-III (in the 3rd millennium BC) the first big change in metallurgical development occurs. As a kind of a first "industrial process" the ores were extracted in the vicinity of the mines (Strahm 1994). From now on the evidence of further working steps like hearths, melting pots, casting moulds, ingots and final products were found in the settlements (Müller-Karpe 1994). Well organized mining, metallurgy and metal trade led to a society with the hierarchical structures and task distribution. With the beginning of the 2nd millennium BC the first regional kingdoms with central organized social structures and an impressive metal culture came into being.

With the beginning of the Early Bronze Age II, the use of tin bronze expanded in Mesopotamia and in

Central Anatolia and reached Troy, while some parts of the Near East and Anatolia were still using arsenical copper. While most of the high-status objects of Alacahöyük, Horoztepe and Troy were made from bronze, arsenical copper was still in use e. g. in İkiztepe in the Black-Sea Region and in Tarsus at the Mediterranean coast of Southern Anatolia (Esin 1969; Özbal *et al.* 2002).

With the discovery of bronze, the golden age of metal trade began. Tin probably to be imported over large distances. In the main distribution regions of bronze, tin mines are rare (Yener *et al.* 1989. Consult also the contributions in this book). Only one mine like Kestel would not be capable of delivering tin to the whole Near East in the 3rd millennium BC. The next known tin deposits are in Central Asian countries like Afghanistan, Uzbekistan, Tajikistan and Kazakhstan. From the early 2nd millennium on tin production has been proven to have occurred in all the aforementioned countries (Weisgerber and Cierny 2002; Parzinger 2002; Cierny *et al.* 2005). Yet we cannot associate the original tin mines with tin used for the objects found in the Near East. At the latest the “bronze industry” was established in the Middle Bronze Age in the 2nd millennium BC. Weapons, tools and pieces of furniture were all ideally made from bronze. A wide range of types as well as serial production supported a flourishing metal economy. It is in this phase of industrialisation that iron production starts. Apart from rare finds of meteor iron known from the Near East, the first terrestrial iron finds identified with complete certainty had already appeared in Anatolia in the first half of the 3rd millennium BC. But it took a long time until iron and steel pushed bronze aside and were preferred for the mass production of the weapons and tools. This happens at the beginning of the last millennium BC first (Yalçın 1998 b).

Already mentioned is the spectacular metal finds from Arslantepe VI A-B1 (3400-2900 BC) that were published by Frangipane *et al.* (2002) and Hauptmann *et al.* (2003). The analytic investigations have shown that the jewellery was produced from a silver-copper alloy. Furthermore a kind of arsenic enriched copper, partly nickel-bearing, was used in order to produce high-status objects, weapons (also swords and spearheads) and tools. Some swords were dec-

orated with silver stripes afterwards (Palmieri 1981; Frangipane *et al.* 2002). The source of As-Ni-enriched copper is not yet known, as the present investigations do not establish the provenance with certainty as being from any of the known metal mines of Eastern Anatolia (Hauptmann *et al.* 2003). A similar dated hoard of metal objects from Tülin-tepe in Altınova, lying about 80 km to the north-east of Arslantepe, has not yet been investigated. This completely unknown metal hoard was unearthed by chance during rail-road construction works in 1966. It consists of one short sword and five spearheads. They belong to the same typological class as the metal finds from Arslantepe VI A-B and are dated to about the same range (Harmankaya 1993; oral communication with M. Frangipane)². At this point we may ask some questions about the chemical composition and the provenance of the metals used. Further questions consider the relations between the metal hoard from Tülin-tepe and the metal finds from Arslantepe VI A-B. Samples from Tülin-tepe finds were taken at the archaeological Museum of Elazığ³. Afterwards they were analyzed. Special attention was paid to the following questions:

1. From which material were the objects produced?
2. Which traces of production and use can be recognized?
3. Which compositional and production similarities do the spearheads from Tülin-tepe and the metal finds from Arslantepe VI A-B show?
4. Where do the metals come from?

During the check of the metal finds in the archaeological Museum of Elazığ two further metal objects from Tülin-tepe and three more from Tepecik were discovered. According to the publications of Esin (1986) these metal finds were dated to the Late Chalcolithic and the EBA I like those from Arslantepe VI A-B. The results of the investigations will be briefly presented here⁴.

THE ARCHAEOLOGICAL DATA AND THE DESCRIPTION OF THE FINDS

Tülin-tepe is situated in Altınova about 21 km to the east of Elazığ. Today the site is flooded by the waters of Keban Dam. It was discovered in the early 1940s (Kökten 1947) and was mentioned in many later archaeological reports (Meriggi 1967; Burney 1958; Whallon and Kantman 1970).

During the construction of the Keban Dam the course of the railroad had to be raised or relocated. The needed earth was unfortunately taken from nearby Tülintepe, thus destroyed an essential part of it (Fig. 2). During this work a metal hoard was found by chance in 1966.

In 1967 the topographic plan of the site was drawn by Whallon and Kantman during the survey that preceded the start of the Keban Dam Rescue Project. Between 1971-1974 Ufuk Esin and Güven Arsebük from the University of Istanbul excavated here. Due to the destruction, the excavations were restricted to the Chalcolithic Period and the Early Bronze Age (Esin 2000a: 87). Besides the widespread ceramics of this region and different stone artefacts some copper slags were found in a stone well. These slags indicated metallurgical activities that could be dated to the Chalcolithic Period and the Early Bronze Age I (Esin and Arsebük 1974: 142; Esin 2000a: 88).

The metal hoard of Tülintepe consists of a short sword and five spearheads. Yet the exact find spot could not be named (Fig.3; Table1). Nothing is known about other metal finds and ceramics that belonged to this hoard since they disappeared during the delivery of the earth taken from this spot of Tülintepe. Such accompanying finds would certainly be of a great help for a close dating (Harmankaya 1993: 372).

The short sword has a length of 44.6 cm, a width of 5.3 cm. It weighs 324 gr.⁵ It rather reminds of a dagger with a pointed triangular hilt-tongue that does not have rivet holes (Yalçın and Yalçın 2008). The sword has a narrowing, well shaped blade that terminates in a to the point. It does not include an exact middle rib. The tip of the blade is broken. The cut shows partial traces of hammering and is a little corroded at the shoulder. Because of the absence of a rivet hole at the hilt-tongue, the form of the hilt cannot be defined exactly. Silvery shining metal rests can be observed on the surface of the sword.

The spearheads were cast in two sided moulds and have leaf-shaped blades with a well-formed middle rib. The sockets are rounded, sometimes rather octagonal. They show a thickening spot which extends to a spine-like point at the lower end. The length of this spine-like end alternates from piece to piece and it is not only pointed but also angular in shape. It helped to fasten the spearhead at the spear.

Silvery shining metal rests can be also seen on the surface of the spearheads.

Though the spearheads form a closed typological group together, they show different lengths (38-51 cm) and widths (3.7-6.0 cm), thus the sizes are not constant. The leaf-shaped blades, sockets and spine-like ends also have various sizes. So we can talk about unique pieces here (compare Fig.3).

All six objects are well preserved, though one of the spearheads is broken. They were all restored, necessary samples were taken, and finally they were exhibited in the Archaeological Museum of Elazığ (Fig.4). During the restoration work valuable information about the production techniques was obtained.

During and after the exposure of the surfaces the objects were investigated under a (binocular) microscope. In part the corrosion layer was up to 2 mm thick. It primarily consisted of malachite ($\text{Cu}_2(\text{OH})_2/\text{CO}_3$) and atacamit ($\text{Cu}_2(\text{OH})_2\text{Cl}$). They formed a hard and firmed layer together with calcareous sediment. Below this greenish layer a black soft layer of corrosion was obvious. It contained partially a silvery shining metal (Fig.6a, b). At close observation under the binocular we could state that the objects were originally completely covered with this “silvery” metal. On one of the spearheads even two of these “silvery” metal layers were observed. We already know that among the comparable metal finds from Arslantepe VI A-B1 there is at least one spearhead with a partially silver decorated surface (Palmieri 1981; Frangipane 2001; Hauptmann *et al.* 2003). Thus we can also speak about a silver decoration or a silver cover in case of Tülintepe. In order to check this hypothesis scientifically, samples were taken from some of these “silvery” fragments.

During the restoration some traces of working were obvious. According to these observations the objects seem to have been cast in two-sided moulds. They were finally formed by hammering. None of the objects showed traces of having been used. We can presume that these metal objects were either not used or that they were not regular weapons. Thus they were probably ceremonial. The “silver” cover confirms this hypothesis and attest to their function as ceremonial objects.

In addition to these weapons a rolled head pin and a metal awl from Tülintepe, two further awls from Tepecik (mentioned above) were also restored and conserved (Table1; Fig.4).

DATING SUGGESTION

The spearheads belong to a wide-ranged typological class in the Near East. The earliest examples come from Arslantepe VI A-B1 (Late Chalcolithic-EBA I; Palmieri 1981; Frangipane 2001), Hassek Höyük (EBA I/II; Behm-Blancke 1981; 1984) and Birecik (EBA I/II; Squadrone *et al.* 2008). Further finds come from Norşuntepe (EBA III; Schmidt 2002), İkiztepe (EBA II; Bilgi *et al.* 2004), Horoztepe (EBA II/III; Özgüç and Akok 1958), Kültepe (EBA; Özgüç 1986) and Karahasan Höyük (EBA III; Harmankaya and Erdoğan 2002). They can closely be compared with the spearheads of Arslantepe. In this way a date similar to Arslantepe VI A-B1 can be suggested.

Both typologically and technologically the sword and the five spearheads discussed above show almost the same features as similar finds from the royal tomb of Arslantepe. In this tomb were found, in addition to the spectacular metal finds, hand-made red-black burnished pottery (Karaz Ware), wheel-made light Syrian-Mesopotamian pottery and reserved slipped ware of the same Syrian-Mesopotamian pottery group (Frangipane 2001:7, fig.21). These ceramic finds are also recorded within the layers of the Early Bronze Age I in Tepecik. Further they were found in the stone well in Tülintepe which is linked to the Early Bronze Age (I/II) defence wall of the settlement (Esin 2000; Yalçın and Yalçın 2008). In this way the finds from the royal tomb of Arslantepe and those from the metal hoard from Tülintepe can be compared. We can even suppose that the sword and the spearheads from Tülintepe originally belonged to a cist grave that was destroyed and lost during railroad-excavation (Harmankaya and Erdoğan 2002). If we consider the well-known cist graves both of Arslantepe and Hassek Höyük with similar finds that are dated almost to the same period, we can assume nearly the same origin for the metal hoard from Tülintepe as well. This funeral tradition can be understood as a connecting link that holds the social structure of the Early Bronze Age I together. Within this common tradition we can consider the wide-spread defence walls of this early phase too that were meant to protect the valuable possessions like metals or

metal objects from the alien threat of the invaders. Special attention should be paid to another fact: The valuable weapons or high-status objects from Arslantepe, Tülintepe and Hassek Höyük emphasize a Late Chalcolithic / Late Uruk tradition in the Eastern and Southeastern part of Anatolia. Beyond this they underline further connections between these Anatolian regions and Transcaucasia at the same period.

The royal cist tomb of Arslantepe is dated to Period VI B1 (Frangipane 2001:13; fig.4). In addition, a silver-decorated spearhead of this royal tomb can be compared with three similar decorated swords from the temple of Period VI A (Frangipane 2001:7; fig.17).

Based on this data the sword and the spearheads from Tülintepe can be correlated with the similar metal finds from Arslantepe VI A-B1. This suggests an extended date from the end of Chalcolithic to the beginning of the Early Bronze Age I.

ARCHAOMETALLURGICAL INVESTIGATIONS

CHEMICAL COMPOSITION

Five spearheads, one sword and two more metal finds from Tülintepe were analysed. Further analyses were done on three metal objects from Tepecik. The results are summarized at Table 3. In this table some analyses of the swords and spearheads from Arslantepe VI A-B1, as well as further analyses of an ingot from Tepecik are comparatively listed. We can obviously see that, apart from one exception, tin as an alloy does not play a part in the samples that were analysed (Table 3).

They consist entirely of copper and always contain some arsenic. In all of the objects the amount of arsenic lies between 0.5 and 3.1 %. Only one sample (Tr-19/7) has 0.2 % As. We can assume that arsenic comes from the extracted ores; thus it is not consciously alloyed with major copper⁶. This is also valid for nickel with an amount up to 2.5 %. Figure 7 provides striking evidence for a positive correlation of As- and Ni-values. Some iron, zinc, antimony, bismuth, silver and some sub-classified lead as further trace elements are always represented. Special attention should be paid to two spearheads (Tr-19/5 and 6) that show 10 times increased Sb- and Ag-values. These two objects showing the highest As- and Ni-

amounts, are good candidates giving the very first hints about their provenance.

Comparative samples, e.g. the rolled head pin with a tin amount of 5 % can be clearly differed from the rest finds of Tülintepe. This can obviously considered as a tin copper alloy. Special attention should be drawn to the early date of this find (compare below).

The metal finds of Tepecik are heterogeneously composed. The first two objects of Tepecik contain barely any nickel or a very small amount of it (comp. Table 3). But they show 1 or 2 % arsenic. The third sample (an awl) contains 2.8 % arsenic and 4.4 % nickel. Both of the typologically similar awls from Tülintepe (Tr-19/10) and Tepecik (Tr-21/53) illustrate a similar composition. Esin (1976) dated this find from Tepecik to the Late Chalcolithic Period. The awl and the rolled head pin of Tülintepe are dated to the same period as well.

The Early Bronze Age I ingot from Tepecik contains the highest amounts of As and Ni of all objects available from Tepecik und Tülintepe. In this case we can also presume an extraction of the As-Ni enriched copper ores.

From the finds of Arslantepe (spearheads and swords), except for one sample have traces of nickel. They consist of copper with an arsenic amount of 2-5 %. In addition we observe that the finds from Arslantepe barely contain Fe, Zn, Pb and other trace elements. Only four spearheads from the royal tomb show obvious silver values between 0.04 and 0.3 %. The finds from the palace contain no silver at all (Table 3).

Figures 7 and 8 show As/Ni and As/Sb diagrams of the finds from Arslantepe, Tepecik, and Tülintepe. It becomes obvious, that generally the analyses from Arslantepe show cluster with low amounts of Ni and Sb compared with those from Tülintepe and Tepecik. However it is important to note, that in rare cases some analyses of the Tepecik objects fall into this "Arslantepe cluster" and one analysis of the Arslantepe objects falls into the area where the Tepecik and Tülintepe analyses are plotted. Thus, although generally these diagrams are quite helpful in distinguishing Arslantepe objects from those of Tülintepe and Tepecik, an unequivocal classification is not possible. Nevertheless based on these results it becomes obvious, that the source material for the

objects from Arslantepe probably comes from a different ore deposit than that of Tülintepe and Tepecik.

THE SURFACE COAT OF THE OBJECTS

The samples taken from the "silvery" metal coat were investigated by the aid of scanning electron microscope (SEM). All the samples consist homogeneously of tin (fig. 9a-c). The tin layers are uniformly 8-10 μm thin. On the corroded metal surface only small amounts of them were preserved. On one of the spearheads a further fine coat of tin was observed immediately under the first tin layer. Because of the uneven distribution of this former tin coat on the metal objects, we presume that the metal hoard of Tülintepe was completely covered with tin. In case of one spearhead we can even consider a possible double tin coating. Thus the tinning of copper as a new metallurgical technique has been proven to have occurred in Tülintepe.

LEAD ISOTOPIY

Lead isotope analyses of the objects from the metal hoards of Tülintepe were also carried out. Table 4 shows the $^{208}\text{Pb}/^{206}\text{Pb}$, $^{207}\text{Pb}/^{206}\text{Pb}$, and $^{204}\text{Pb}/^{206}\text{Pb}$ -ratios of the metal objects investigated. In Fig.10 the isotope ratios of the objects from Tülintepe are displayed; for comparative reasons those of the spearheads and the swords from Arslantepe (palace-Arslantepe VI A; royal tomb VI B1) are also shown. From both, the $^{208}\text{Pb}/^{206}\text{Pb}$ versus $^{204}\text{Pb}/^{206}\text{Pb}$ - (Fig.10a) and the $^{207}\text{Pb}/^{206}\text{Pb}$ versus $^{204}\text{Pb}/^{206}\text{Pb}$ - (Fig. 10b) diagrams it becomes obvious, that the objects from the two different localities can be clearly distinguished due to their isotopic compositions. Whereas the analyses of the Tülintepe objects are characterized by low $^{208}\text{Pb}/^{206}\text{Pb}$ -, $^{204}\text{Pb}/^{206}\text{Pb}$, and $^{207}\text{Pb}/^{206}\text{Pb}$ -ratios, those from Arslantepe behave the opposite way around. Even the finds from Tülintepe can be grouped in two categories: while the three spearheads, Tr-19/5, 6, and 7, exhibit low $^{207}\text{Pb}/^{206}\text{Pb}$ -ratios (at about 0.831) and also low $^{208}\text{Pb}/^{206}\text{Pb}$ - (2.07) and $^{204}\text{Pb}/^{206}\text{Pb}$ - (0.053) ratios, a second group of objects (two spearheads (Tr-19/2, 8) and one sword Tr-19/4) shows considerably higher ratios (see Fig. 10a, b).

We can not talk in terms of real groups here, as only six artefacts were analysed. There are rather trends that point out different provenances for the metals.

The finds from Arslantepe do not show homogenous isotopic relations either. Furthermore there is no overlap at all with the finds from Tülin-tepe.

DISCUSSION OF THE RESULTS

The proof of the early use of tin in Tülin-tepe is an important development in Near Eastern archaeology. But it also reveals some new questions. If we do not consider the fact that the rolled head pin from Tülin-tepe with 5 % tin was dated to the Late Chalcolithic Period by Esin (1986), we can ask whether tinning was discovered earlier than the bronze alloy. But if the dating of this pin is in fact correct, it would be the oldest bronze find in the whole Near East. Till now the EBA I finds from Alishar I, Troy I and Tell el-Judaïdah have been believed to embody the earliest evidence for the use of bronze, whereby Mellink (2002: 173) correlates the chronology of Alishar I and Troy I with the Early Bronze Age II (approximately. 2900 BC) of Eastern Anatolia. Yet this date should also be discussed according to new comparative studies based on the ceramics that suggest relations between Central and Eastern Anatolia already at the End of the Late Chalcolithic Period going into the Early Bronze I (Yalçın in press). If we consider the dating and the find context of the rolled head pin from Tülin-tepe relatively safe, this artefact will probably be the earliest tin bronze in the whole Near East.

The metal hoard of Tülin-tepe is even more interesting. We can date these metal finds by the aid of typology and compare them with the finds from Arslantepe that probably belong to a time span between 3400-2900 BC. Thus there is evidence for copper tinning in Tülin-tepe for the first time in this period. This fact is in opposition to the theory that tinning was discovered by the Gauls. We refer to a special section in *Gaius Plinius Secundus*: “*A Gallic invention tin is used to colour the bronze objects, thus one can hardly differ them from silver. They call these bronze articles “incocita” (coloured by cooking). Later silver was used for colouring either, especially for decorating the harnesses of pack-animals or the cattle; that was in the city of Alesia. The honour of the first mentioned invention is due to Biturigs (inhabitants in Aquitanic Gallia, today Département du Chèr et de L’Indre)*” (Naturalis Historiae Libri XXXVII, Cap.48 in Rackham 1952: 242-243).

According to Babst (1883) the Gauls should be rejected as the inventors of this method. He supports the view that transient Bronze Age smiths brought tinning from Asia. This method was applied everywhere you can find and melt tin. In the Late Bronze Age even in Bactria people knew how either to produce bronze or tinning (Lenormant 1875)⁷. In the tin-prosperous grasslands of Central Asia, e. g. in Bactria, bronze objects first arrived in the Middle and Late Bronze Age that is the 2nd millennium BC (Parzinger 2002; Cierny *et al.* 2005). However tin had been used in Mesopotamia and Anatolia since the 3rd millennium BC (EBA II) and even sporadically since the Early Bronze Age I. Since there is no evidence about the origin of Central Asian tin in the 3rd millennium BC, we can accept the regional sources of and around Anatolia as the possible origin (Weisgerber and Cierny 2002). The controversial tin mine discussed in Kestel could have served as the supplier of Anatolia. Thus it is not astonishing if we hit upon the use of tin in Tülin-tepe in the 4th millennium BC. If we consider, the rolled head pin of Tülin-tepe and the metal hoard are dated to almost the same period; then tinning and alloying interestingly start at the same time.

The finds from Tülin-tepe yielded some new questions. Are the spearheads and the sword the only tinned copper objects of this period? What about the “silver” decorated swords of Arslantepe? As far as we know the silver plated swords from Arslantepe have not been analyzed. Thus we must ask whether we are dealing with tin plating in part or completely. Our attention is especially drawn to one silver decorated spearhead from the royal tomb. This find was compared either with the similar finds from the palace or with the finds of the metal hoard from Tülin-tepe (Frangipane 2001). Could the silver decoration of this spearhead consist of tin? If not, did the metallurgists of Tülin-tepe want to imitate the silver plating from Arslantepe and use tin instead of silver, or vice versa? A new aspect of the beginning of the tin utilization in the Near East must now be discussed.

Through tinning, the surface of an object gains a reflective brightness. This effect surely impressed observers. This trait was probably the reason for this new technique. In this case it was for about high-status objects that were produced for the privileged persons of a new rural society in Tülin-tepe or in the other settlements like Tepecik, Norşuntepe and

Korucutepe in the Altınova region. These objects could also be used for cult ceremonies. The missing traces of utilization build an additional foundation for this assumption. This is not a surprising result, if we consider the innovative metallurgy of this region. In the 4th millennium BC Anatolia, especially South-Eastern Anatolia, seems to gain importance and advantage over Mesopotamia where there are no ore deposits. Anatolia is not only a supplier of metals but it also gets a full portion in the cultural development of this vast region.

In prehistoric times Altınova was an extraordinarily fertile plain that offered good conditions for farming, which permitted agriculture to flourish. On the other hand the forested mountains, the grazing lands with rich stocks of wild animal as well as the meadows offered pleasant living conditions (Müller-Karpe 1994). The rich ores of this region and the favourable road connections further promoted development. Metal work and the metal trade were especially responsible for cultural growth. About the end of the 4th millennium BC, within the Late Uruk Period, metal work flourished (Müller-Karpe 1994). In the excavated settlements in the Plain of Altınova, in Clicia and the Plain of Antioch the amount of metal finds and relics increase as rural centres were developed. Principalities or small dynasties like Arslantepe and some others in the Plain of Altınova reached interregional importance for the centralized reloading of goods and for demonstrating new technologies from other cultural regions (Frangipane 2002). Though formerly there had been no major distinctions within domestic architecture, from this period on we notice a clear social hierarchy, as for example with the complex plan of the palace in Arslantepe. Traders from Mesopotamia and Northern Syria or nomadic tribes from the northern and eastern regions offered the elites of these centres their goods; they maintained trade links and even settled down there. Certainly it is not accidental that certain pottery groups like the “Karaz-Ware”, “Uruk-Wares” or certain sorts of metal gradually appear in the vast area between Caucasus and the Southern Levant. Copper with arsenic and nickel emerges in the Near East from the beginning of the 3rd millennium BC on (Fig.11). The diffusion of metals and the one of Kura-Araxes / Karaz Pottery seems to be closely linked (Fig.12). Could it be that the nomadic tribes of the Orient were trading metal products and a tradition of cer-

tain pottery groups? Was it these same nomads that invented tinning in Tülintepe?

Profiting from the flourishing economy, the elites began to live in palaces in the new rural centres and control the trade (comp. Frangipane 2002). The increased circulation of metal for producing weapons, tools and jewellery implies the option of hoarding. Thus the accumulation of wealth was possible and with it, the establishment of an upper class (Müller-Karpe 1994). The need for high status products increased and encouraged further innovation. New discoveries and techniques followed in consequence. The attention now focused on new metals like silver, lead and gold, which were alloyed with each other for the first time. In Korucutepe silver was extracted for the first time (van Loon 1978). In Arslantepe silver was alloyed with copper (Hauptmann *et al.* 2003), and in Tülintepe high status objects made from arsenic and nickel containing copper were tinned. The rich funeral gifts in Korucutepe and Arslantepe are evidence of this privileged wealth. These tombs of the Late Uruk Period form the beginning of a gift tradition for the afterlife in the 3rd millennium BC that reaches its peak in Alacahöyük, Horoztepe, İkiztepe and Troy.

If we think about the finds both of Tülintepe and Arslantepe, we recognize that they basically consist of similar kinds of metal. From the metallurgical point of view it is important to ask whether a classification Cu-As and Cu-As-Ni makes sense. These questions were already faced in several recent publications (comp. Pernicka 1995; Hauptmann 2008; Begemann and Schmidt-Strecker 2008). If we follow the appearance of these metals in the Near East, it is remarkable that they always appear together and that arsenic enriched copper always predominates. Thereby the amount of nickel fluctuates from traces to lower ranges as expressed in percentage. Besides the nickel, enriched metal finds occur in the Late Chalcolithic contexts from time to time, but more and more in those of the Early Bronze Age I-II.

The isotopic analyses from Tülintepe presumably point towards two different provenances. We cannot exclude the occurrence of different type of ore mineralisation within the same locality that has deviating or even different lead isotopes. The best examples of this come from the copper deposits of Cyprus. In Cyprus the isotope plots of the particular ore dis-

tracts like Kalawassos or Apliki do not show close relations, though they belong to the same geological type of ore deposit, and the distance between these two locations is less than twenty kilometres (Gale and Stos-Gale 2005, fig.2-6)⁸. Yener *et al.* (1991) got a similar image from Bolkardağ in Central Taurus. In Bolkardağ four different isotope plots with various poly metallic ore occurrences were defined. Some of them are prehistoric and some were exploited in antiquity (comp. Lehner *et al.*, this book).

Evaluating the present available lead isotope data from the well known ore deposits of Anatolia like Keban, Elazığ-Maden, Siirt and Artvin-Murgul we observe that these deposits stress dissimilar plots/fields (Fig.13a, b). In fact only Siirt and Murgul are overlapping. We certainly emphasize that this evaluation should be taken with caution, as until now there are only a few isotope analyses available from these ore deposits⁹. No data from Tülin-tepe coincide with the data available from the ore deposits of Eastern Anatolia. Only one part of the Arslantepe data presented for the finds from the palace and the royal tomb shows a correspondence with the data from Murgul and Siirt. Some minor coincidence of a few data from Arslantepe can be considered with the deposit of Maden, however only from the $^{204}\text{Pb}/^{206}\text{Pb}$ - versus $^{207}\text{Pb}/^{206}\text{Pb}$ diagram (Fig. 13a). According the available isotopic data the provenance of the finds from Tülin-tepe and most of the finds from Arslantepe is tentative.

If we compare the hoard finds from Tülin-tepe with the finds in the whole Near East, we can state that a certain kind of arsenic copper and nickel containing copper appears in many of the prehistoric sites (comp. Fig. 11). In numerous Late Chalcolithic an Early Bronze Age sites, in the Southern Levant, in Mesopotamia and in Maikop in Northern Caucasia, we can find metal objects with a similar composition (comp. Pernicka 1995: 85-89, fig. 34; Hauptmann and Palmieri 2000: 79, fig.7). The provenance of this kind of metal was not previously evident. Now let us reflect on the distribution of the different sites in connection with possible ore deposits which may have served as sources. Starting from a high amount of nickel in copper, only certain ore deposits can be regarded as dispersive sources. A possible origin for nickel enriched ore deposits in context with ophiolites exists in the

Alpine mountain chains of Anatolia, in Cyprus, in Iran and in Oman (Fig.11). Because of the geographic closeness and cultural historic background, the ore deposits of Oman can be regarded as the origin of the Southern Mesopotamian metal finds. The origin of the Anatolian finds should be initially searched for in the Anatolian ophiolitic zone that gave way to the corresponding ore deposits. But perhaps the origin should be investigated in the deposits of North-Western Iran. Some scholars suggest Caucasian ore deposits as the source of the delivery (Pernicka 1995; Hauptmann and Palmieri 2000; Hauptmann 2008).

If we focus our attention on the vicinity of Altınova, we should realize that this area emerged from the collision of the Arabian and Anatolian micro platforms as a part of the great Eurasian plate. Altınova and the vicinity belong to the Anatolide-Tauride terrane (for details see Okay 2008). This suture is featured by the ophiolitic zone described above. The heights in the vicinity of Elazığ consist of a narrow zone in the South that is stuck between the Arabian platform and the northern nappe zone (Yılmaz 1993). This zone is characterized by upper Cretaceous to early Miocene sequences of marine sediments, ophiolites, and volcanics that experienced intense tectonic shearing. The lower units in the northern part of area are composed of upper Cretaceous polymetamorphic ophiolitic sequences (lower beds) which are mainly overlain by clastic sediments rocks of the middle Miocene "Maden Group". The upper unit comprise Palaeozoic and Mesozoic metasediments and metavolcanics. Cover sequences essentially are Pliocene to Quaternary sediments and volcanics (Yılmaz 1993).

Due to these geological formations in Eastern Anatolia, many ore deposits were generated. Some of the Anatolian massive sulphide ore deposits e.g. are closely related to the ophiolites in Cyprus. There in the root zones of massive sulphide ore bodies the so called stockwork ores were found that are enriched in Fe-Ni-As-Co (Constantinou 1999; Panayitou 1980). Similar ore deposits are also described for Eastern Anatolia, e. g. near Pancarlı (to the North of Siirt) and in Kakbil near Ovacık (Tunceli), also related to ophiolites. According to an interim report of MTA and an oral communication with Tandoğan Engin, nickel sulphides occur in Pancarlı. They contain about 2 % copper. According to

Seeliger *et al.* (1985) the sulphide deposits in Kedak, near Palu and Haçan and to the West of Maden hang together with serpentinites. Tylecote (1970) described the existence of “Fahlerz” in the cementation zone at Maden (known as Ergani-Maden). Analyses of these ores do not appear in the lists of Seeliger *et al.* (1985) and Wagner *et al.* (1989). In Maden the serpentinites acting as supporter for Cu-Ni-As are in a close context with serpentine rocks (Bamba 1976). U. Esin (1987) mentioned small Ni-deposit in Şehkatili and Havri in the vicinity of Maden. Principally the Cu-Ni-Co-As-S mineralization occur in the ophiolite sequences together with the chromites. Such ore deposits are found near Guleman in Elazığ and further north in the vicinity of Kop Mountains (to the Northeast of Erzincan) (Engin *et al.* 2000).

We can also consider a couple of further small copper deposits between Malatya and Siirt that are partly connected with the ophiolites as a possible origin of the As-Ni containing copper objects (Seeliger *et al.* 1985). For this purpose detailed fieldwork at the ore deposits of the Anatolian ophiolite zones is needed. Moreover a big database for the geochemical access of the ore deposits is necessary. This should be done as well for the major ore deposits like in Maden, Keban, Murgul or Küre.

FINAL REMARKS

This paper provides evidence for the tinning in Tülintepe about 5000 years ago. Almost at the same time the first tin-bronze objects were produced there. With the research contribution presented in this paper the investigations can be focused on the beginning of the Near Eastern tin technology once again and the archaeological data may be reinvestigated from another point of view now.

Our work was financed by the German Research Society (Deutsche Forschungsgemeinschaft). The finds were investigated by the stimulus of late Prof. Dr. Ufuk Esin, with the aid of the Elazığ Museum and the permission of the Ministry of Culture and Tourism of the Turkish Republic. The finds were restaured and drawn by two members of the Restoration School of the University of Ankara, Mrs. Ayşe Ebru Gültekin and Mrs. Ezgi Özpamir. We want to express our warmest thanks to all contributors of this study. Special thanks go to Prof. Dr. Kathleen James-Chakraborty (School of Art History and Cultural Policy – University College Dublin) for editing the English of the manuscript.

NOTES

1. The development of metallurgy in Anatolia has been discussed by the first author in several other papers.
2. The spearheads are compared with Arslantepe from the typological point of view. M. Frangipane, H. Hauptmann and U. Esin regard the same date range with Arslantepe VI-B1 as possible.
3. The finds are stored in the museum of Elazığ. Their preparation and sampling were approved by the Turkish General Directory for Antiquities. The restoration of the finds was undertaken by Mrs. Ayşe Ebru Gültekin and Mrs. Ezgi Özpamir (School for the Restoration and Conservation of the University of Ankara). Mr. Haydar Aksen, the director of the museum, has supported our work. With the help of inventory lists we had the possibility to check through some further metal finds from the Chalcolithic Period and the Early Bronze Age and to sample them. By this way we could check all the metal objects in the depots of the museum. After counting we recognized the huge number of the metal finds almost 4700 pieces. These objects have not been
- studied neither archeologically nor scientifically yet, demonstrating the urgent need of scientific investigations on the subject “Early Metallurgy in Eastern Anatolia”.
4. Parts of the results presented here have been intensely discussed in the last issue of Anatolian Metal (Yalçın and Yalçın 2008). The current contribution of this special issue contains some of the previous results which are updated by new data. In this connection a reiterant publication is intended.
5. The measurements indicate the conditions after their restoration.
6. Similar results were obtained from the Early Bronze Age metal finds from Hassek Höyük. Also hereby the authors presume an “unintended” contamination (Schmitt-Streckler *et al.* 1992): Here it is not about arsenic bronze but arsenic containing copper or arsenic copper.
7. As a part of the Iranian population the Bactrians lived in the terrain of the present Afghanistan and had access to tin deposits there. The Assyrian merchants got tin probably from these people and brought it to Mesopotamia and Anatolia.

8. Troodos-Ophiolithe, part of the Eastern Mediterranean ophiolite zone, has rich copper deposits. The massive copper sulphide layers are restricted to the pillow lavas of the ophiolite series where they consist of four or more ore bodies in five main ore zones around the Troodos Mountains (comp. Constantinou 1999: 38-42, Abb.1). Gale and Stos-Gale (2005) used hundreds of isotope analyses in order to differentiate these ore bodies from each other. Thus it was possible to classify different isotopic fields within the Troodos complex and to associate the archaeological finds with the particular pits.
9. Until now a few samples have been analyzed: From Maden (in the most of the publication: Ergani or Ergani-Maden) and Murgul 6 examples and from Siirt only 3 (Seeliger et al. 1985; own sources). In the other large ore regions of Anatolia we observed the same situation.

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TÜLİNTEPE

Finds of the hoard

lab. no. inv. nr. object dating type of metal

Tr-19/2 66.TMKC.11-13 spearhead LC/EBA I Cu
Tr-19/4 66.TMKC.11-11 sword LC/EBA I Cu-As-Ni
Tr-19/5 66.TMKC.11-12 spearhead LC/EBA I Cu-As-Ni
Tr-19/6 66.TMKC.11-14 spearhead LC/EBA I Cu-As-Ni
Tr-19/7 66.TMKC.11-15 spearhead LC/EBA I Cu
Tr-19/8 66.TMKC.11-16 spearhead LC/EBA I Cu-As

Finds of the excavation

Tr-19/9 71.TMKC.9-28 rolled head pin LC Cu-Sn
Tr-19/10 71.TMKC.9-30 awl LC/EBA I Cu-As-Ni

TEPECİK

Tr-21/51 69.TMKC.1021.3-34 awl LC/EBA I Cu-As
Tr-21/52 69.TMKC.1033.3-46 needle LC/EBA I Cu-As
Tr-21/53 79.TMKC.12-80 awl LC/EBA I Cu-Ni-As
BÜ-33/82 ingot EBA I Cu-As-Ni

Table 1: Metal finds from Tülintepe and Tepecik. LC: Late Chalcolithic, EBA I: Early Bronze Age I.

ARSLANTEPE (palace: 3400-3000 BC)

lab. no. inv. nr. object dating type of metal

Tr-8/4 AR2 2316A sword LC Cu-As
Tr-8/8 AR2 2318B sword LC Cu-As
Tr-8/9 AR2 2319A spearhead LC Cu-As
Tr-8/18 AR1 2320A spearhead LC Cu-As
Tr-8/21 AR1 2329A spearhead LC Cu-As
Tr-8/28 AR1 2334A sword LC Cu-As
Tr-8/31 AR1 2331A spearhead LC Cu-As

ARSLANTEPE (royal tomb: 3000-2900 BC)

lab. no. inv. no. object dating type of metal

Arsl 15 T1 2, y19 sword EBA I Cu-As
Arsl 26 T1 2, y42 spearhead EBA I Cu-As
Arsl 27 T1 2, y39 spearhead EBA I Cu-As
Arsl 28 T1 2, y41 spearhead EBA I Cu-As-Ni
Arsl 29 T1 2, y9 spearhead EBA I Cu-As
Arsl 30 T1 2, y5 spearhead EBA I Cu-As
Arsl 31 T1 2, y37 spearhead EBA I Cu-As
Arsl 32 T1 2, y40 spearhead EBA I Cu-As
Arsl 33 T1 2, y36 spearhead EBA I Cu-As
Arsl 34 T1 2, y43 spearhead EBA I Cu-As
Arsl 35 T1 2, y24 sword EBA I Cu-As

Table 2: The swords and spearheads from Arslantepe discussed in that paper.

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TÜLİNTEPE1											
Sample		Cu	Fe	Ni	Zn	Pb	As	Sb	Sn	Bi	Ag
Tr-19/2	spearhead*	98.2	0.35	0.13	0.023	0.006	0.51	0.012	0.002	0.012	0.030
Tr-19/3	spearhead*	98.7	0.36	0.11	0.022	0.004	0.52	0.012	0.001	0.009	0.030
Tr-19/4	sword	96.0	0.44	0.70	0.029	0.020	2.11	0.057	0.016	0.020	0.039
Tr-19/5	spearhead	93.6	0.74	1.98	0.031	0.003	2.59	0.200	0.001	0.046	0.259
Tr-19/6	spearhead	94.4	0.02	0.63	0.025	0.001	2.17	0.320	0.001	0.023	0.234
Tr-19/7	spearhead	97.7	0.29	0.01	0.022	0.002	0.27	0.008	0.001	0.009	0.005
Tr-19/8	spearhead	97.2	1.04	0.06	0.029	0.006	1.16	0.034	0.001	0.013	0.050
Tr-19/9	rolledheadpin	94.3	0.28	0.21	0.053	0.043	0.55	0.029	5.270	0.014	0.039
Tr-19/10	awl	93.8	0.02	2.55	0.032	0.220	3.16	0.210	0.006	0.062	0.041
TEPECİK1											
Tr-21/51	awl	97.1	0.34	0.001	0.017	0.140	2.00	0.038	0.049	0.019	0.025
Tr-21/52	needle	93.2	0.61	0.046	0.016	0.570	0.93	0.360	0.037	0.031	0.036
Tr-21/53	awl	92.7	0.06	4.430	0.040	0.038	1.84	0.270	0.001	0.083	0.036
BÜ-33/82	ingot3	91.1	<0.01	2.68	0.002	4.82	<0.01	0.02			
ARSLANTEPE (palace: 3400-3000 BC)2											
Tr-8/4	sword	93.0	0.012	0.001	0.001		4.93	0.003			0.001
Tr-8/8	sword	95.0	0.084	0.003	0.001		4.05	0.002			0.003
Tr-8/9	spearhead	96.0	0.004	0.001	0.002		3.77	0.005			0.003
Tr-8/18	spearhead	96.0	0.005	0.002	0.002		3.53	0.002			0.001
Tr-8/21	spearhead	98.0	<0.01	0.001	0.003		2.57	0.004			0.001
Tr-8/28	sword	96.0	<0.01	0.001	0.002		4.31	0.001			0.004
Tr-8/31	spearhead	95.0	<0.01	0.002	0.002		4.05	0.001			0.001
ARSLANTEPE (royal tomb: 3000-2900 BC)2											
Arsl15	sword	96.0	0.008	0.002	<0.001	<0.001	3.15	0.007	<0.001	0.007	0.001
Arsl26	spearhead	98.0	0.018	0.010	0.003	0.021	2.18	0.008	<0.001	0.019	0.043
Arsl27	spearhead	97.0	0.006	0.003	<0.001	<0.001	2.59	0.007	<0.001	0.005	0.001
Arsl28	spearhead	96.0	0.005	1.690	<0.001	0.030	1.15	0.072	<0.001	0.008	0.310
Arsl29	spearhead	97.0	0.004	0.003	<0.001	<0.001	2.43	0.006	<0.001	0.005	0.001
Arsl30	spearhead	98.0	0.004	0.003	<0.001	<0.001	2.92	0.007	<0.001	0.005	0.001
Arsl31	spearhead**	97.0	0.006	0.002	<0.001	<0.001	3.17	0.007	<0.001	0.008	0.002
Arsl32	spearhead	97.0	0.008	0.003	0.001	<0.001	2.86	0.007	<0.001	0.007	<0.001
Arsl33	spearhead	96.0	0.004	0.003	0.001	0.029	2.17	<0.01	0.008	0.020	0.081
Arsl34	spearhead	93.0	0.010	0.010	0.005	0.021	2.68	0.036	0.017	n.d.	0.113
Arsl35	sword	88.0	0.002	0.009	0.003	0.021	3.80	<0.01	0.003	n.d.	0.016

Table 3: The chemical composition of the metal finds from Tülin-tepe and Tepecik. For comparative reasons the analyses of the swords and spearheads from Arslantepe are also given.

1: own research; 2: Hauptmann et al. 2002; 3: Özbal 1983: 216; *: same object (from the head (2) and the shaft (3));

** : mean value of two analysis.

lab. nr.	object	type of metal	208Pb/206Pb	207Pb/206Pb	204Pb/206Pb
Tr-19/2	spearhead	Cu	2.0785	0.8368	0.05339
Tr-19/4	sword	Cu-As-Ni	2.0792	0.8355	0.05320
Tr-19/5	spearhead	Cu-As-Ni	2.0681	0.8307	0.05303
Tr-19/6	spearhead	Cu-As-Ni	2.0687	0.8312	0.05305
Tr-19/7	spearhead	Cu	2.0719	0.8320	0.05309
Tr-19/8	spearhead	Cu-As	2.0779	0.8358	0.05335

Table 4: Lead isotopic ratios of the finds from Tülin-tepe.



Fig. 1: Morphological map of Anatolia with the selected prehistoric sites of the 4th / 3rd millennia BC and showing the old mining locations. Tülintepe and Tepecik are located in Altınova, only 80 km north-eastern of Arslantepe. In the vicinity there are also some prehistoric mining locations.



Fig. 2: The prehistoric mound of Tülintepe in autumn 1966. a) An important part of the site which is destroyed; b) Big trucks are loaded at the mound.

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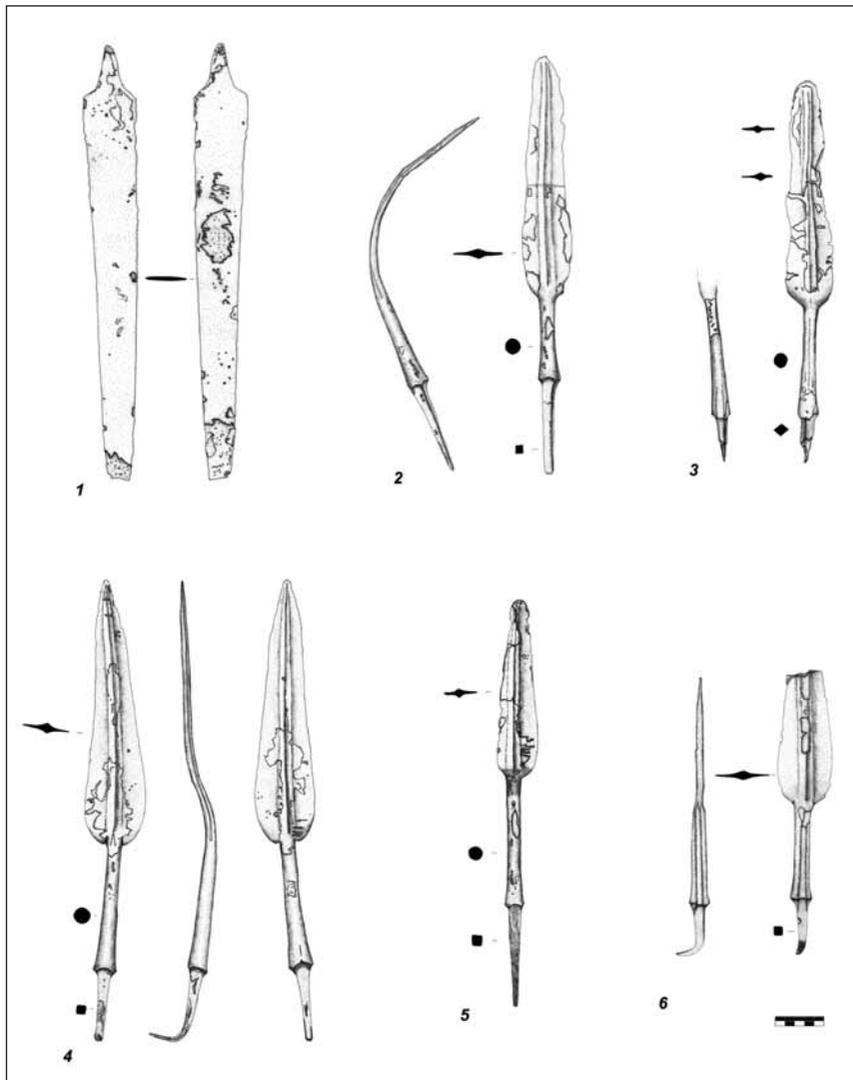


Fig. 3: The hoard finds of Tülin-tepe consisting of a short sword and five spearheads. 1. Short sword (Tr-19/4; 66.TMKC.11-11), 2. Spearhead (Tr-19/8; 66.TMKC.11-16), 3. Spearhead (Tr-19/7; TMKC.11-15), 4. Spearhead (Tr-19/2; 66.TMKC.11-13), 5. Spearhead (Tr-19/5; 66.TMKC.11-12), 6. Spearhead (Tr-19/6; 66.TMKC.11-14) (Drawings by A. E. Gültekin and E. Özpamir).

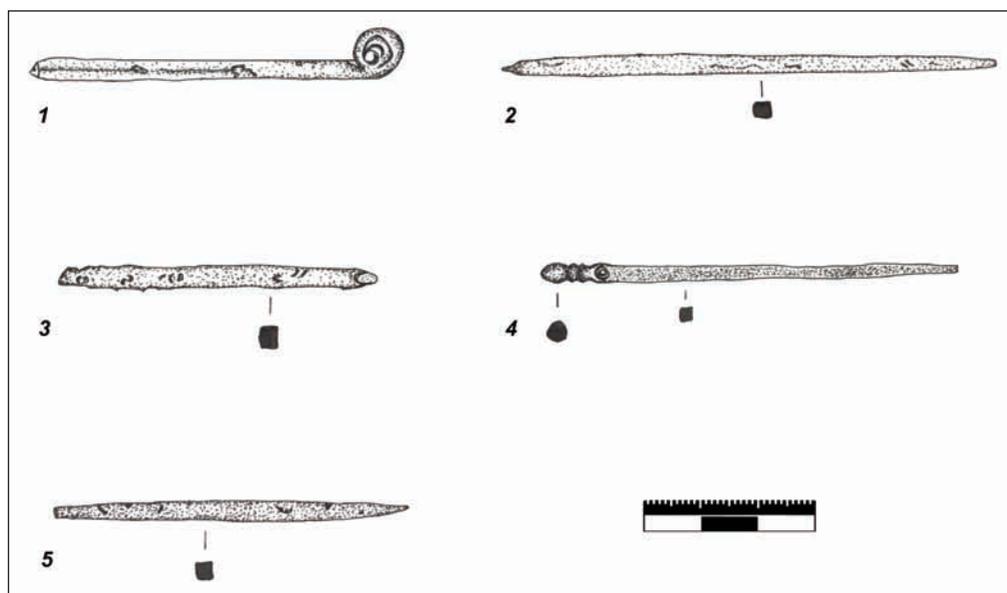


Fig. 4: Further metal finds from Tülin-tepe and Tepecik. 1. Tülin-tepe, rolled head pin (Tr-19/9; 71. TMKC.9-28; Tl.71.246), 2. Tülin-tepe, awl (Tr-19/10; 71.TMKC.9-30; Tl.71.144), 3. Tepecik, awl (Tr-21/51; 69.TMKC.1021.3-34; T.69.940), 4. Tepecik, pin (Tr-21/52; 69.TMKC.1033.3-46; T.69-54), 5. Tepecik, awl (Tr-21/53; 79.TMKC.12-80; T.74.233, VII 12) (Drawings by A. E. Gültekin and E. Özpamir).



Fig. 5: The finds from the hoard of Tülintepe were exhibited after the restoration at the Archaeological Museum of Elazığ.



Fig. 6: Relics of tin (white) on the former spearhead surfaces released from the corrosion

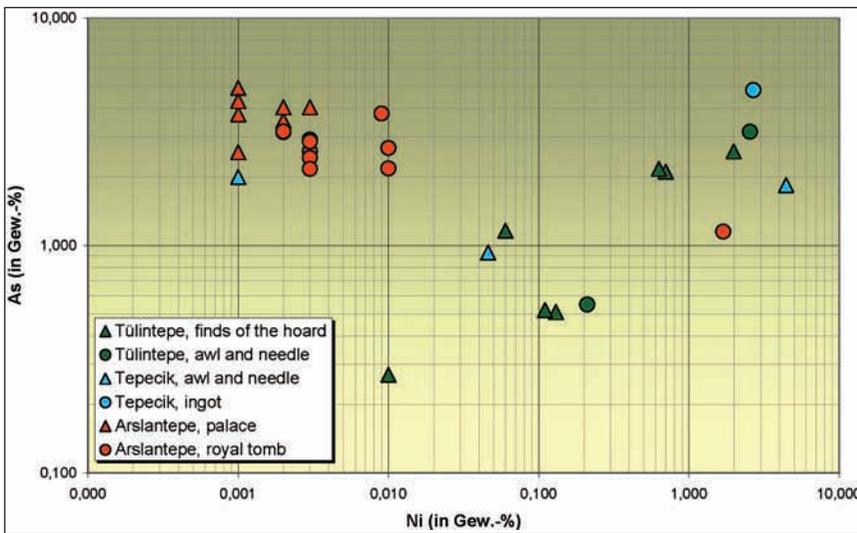


Fig. 7: Distribution of the As and Ni-values (in wt. %) of the finds from Tülintepe. For a comparison the contemporary metal finds from Tepecik and Arslantepe were evaluated here. The data for the ingot from Tepecik are taken from Özbal (1983), and the one for Arslantepe from Hauptmann et al. 2003.

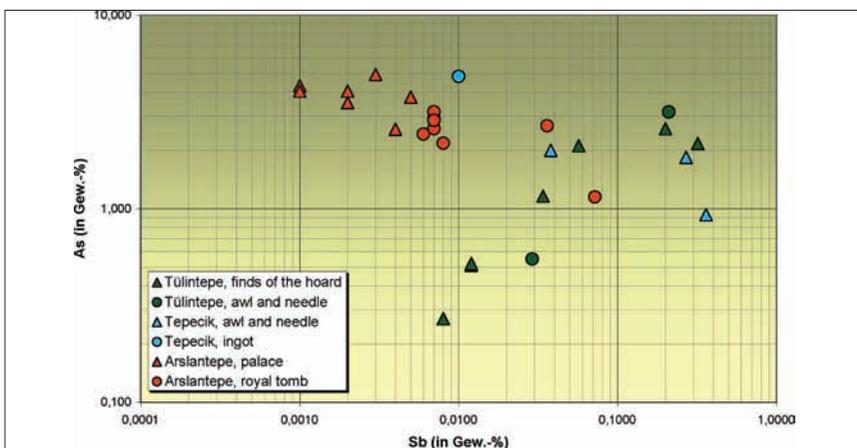


Fig. 8: Distribution of the As and Sb-values (in wt. %) of the finds from Tülintepe. For a comparison the contemporary metal finds from Tepecik and Arslantepe were evaluated here. The data for the ingot from Tepecik are taken from Özbal 1983, and the one for Arslantepe from Hauptmann et al. (2003).

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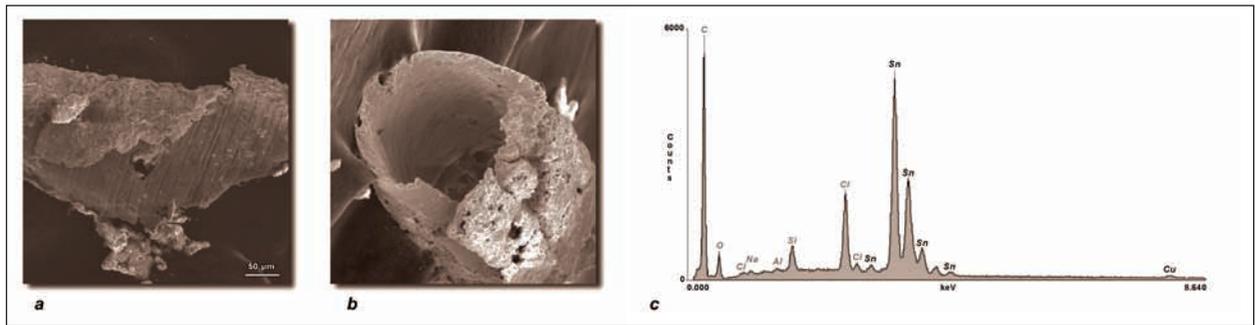


Fig. 9: Tin cover from the short sword (a) and from one of the spearheads (b) under the SEM and its SEM-spectrum (c).

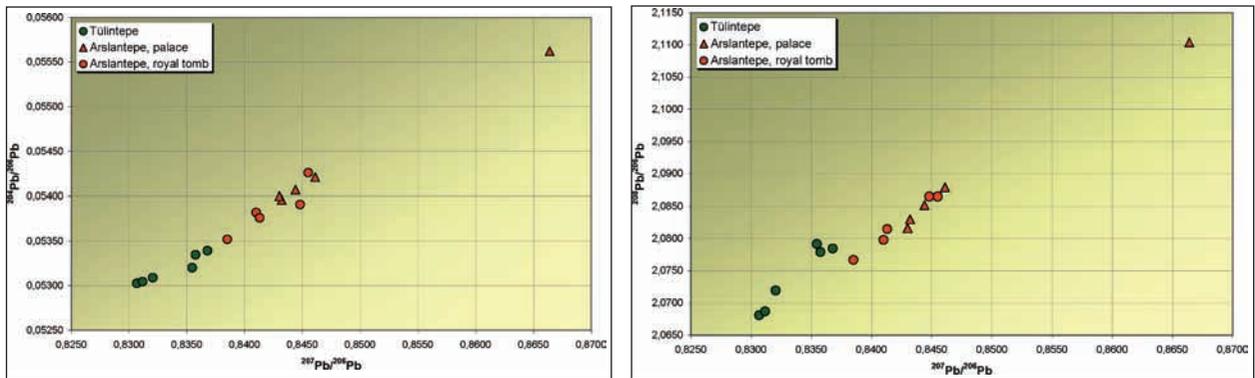


Fig. 10: The lead isotopic ratios of the hoard finds from Tülin-tepe compared with the contemporary spearheads and swords from Arslantepe.



Fig. 11: The distribution of the arsenic and nickel-containing copper objects in the Near East that are closely connected to the “ophiolithic zones” (expanded after an outline from Pernicka 1995; Hauptmann and Palmieri 2000).

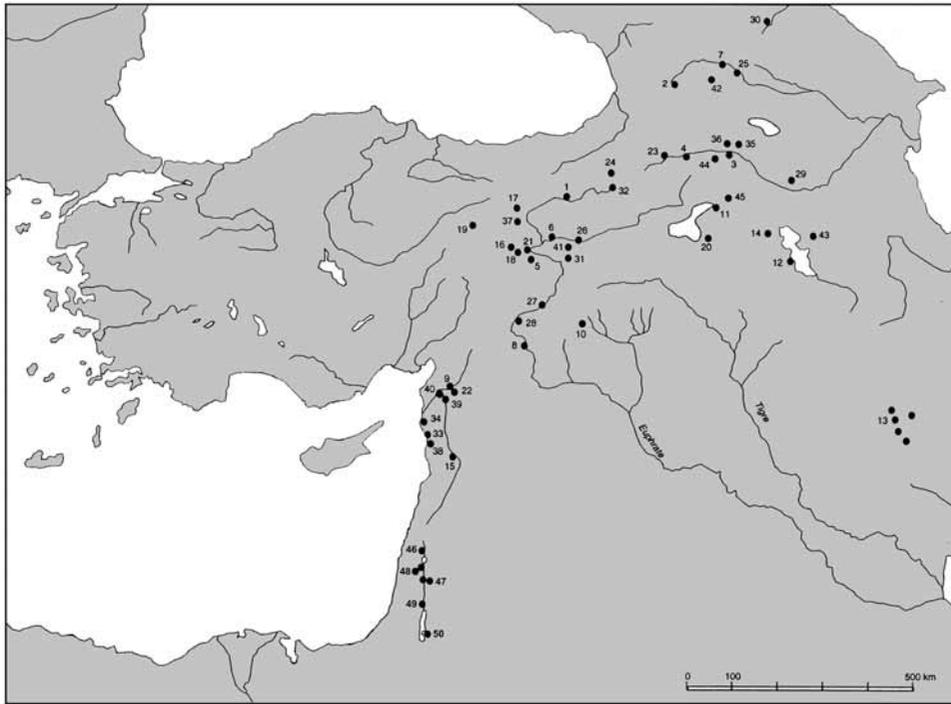


Fig. 12: The distribution of the Karaz / Kura-Araxes / Khirbet Kerak Pottery and the comparable contemporary pottery from the Near East (from Yalçın and Yalçın 2003: Abb.1). 1. Altintepe, 2. Amiranis Gora, 3. Ararat, 4. Armavir Blur, 5. Arslantepe, 6. Aşvan, 7. Beshtasheni, 8. Kargamış, 9. Amuq-Çatal Höyük, 10. Tell Chuera, 11. Ernis, 12. Geoy Tepe, 13. Godin Tepe, 14. Haftavan Tepe, 15. Hama, 16. Harsatepe, 17. Hornavil, 18. Horomhan, 19. Değirmende Höyük, 20. İremir, 21. İsaköy, 22. Amuq-Tell el-Judaidah, 23. Karakuri, 24. Karaz & Güzelova & Sos Höyük, 25. Kiketi, 26. Korucu Tepe, 27. Hayaz & Hassek Höyük, 28. Kurban Höyük, 29. Kültepe, 30. Lugove, 31. Norşuntepe, 32. Pulur-Sakyol, 33. Qal'at er-Russ, 34. Ras Shamra, 35. Shengavit, 36. Shresh Blur, 37. Sivrikaya, 38. Tell Sukas, 39. Tabara el-Akrad, 40. Amuq-Tell Ta'yinat, 41. Tepecik, 42. Trialeti, 43. Yanık Tepe, 44. Yayı Tepe, 45. Zülfübulak, 46. Tell Qadesh, 47. Tell es-Shuna, 48. Affula & Khirbet Kerak/Beth Yerah, 49. Jericho, 50. Bad edh-Dhra.

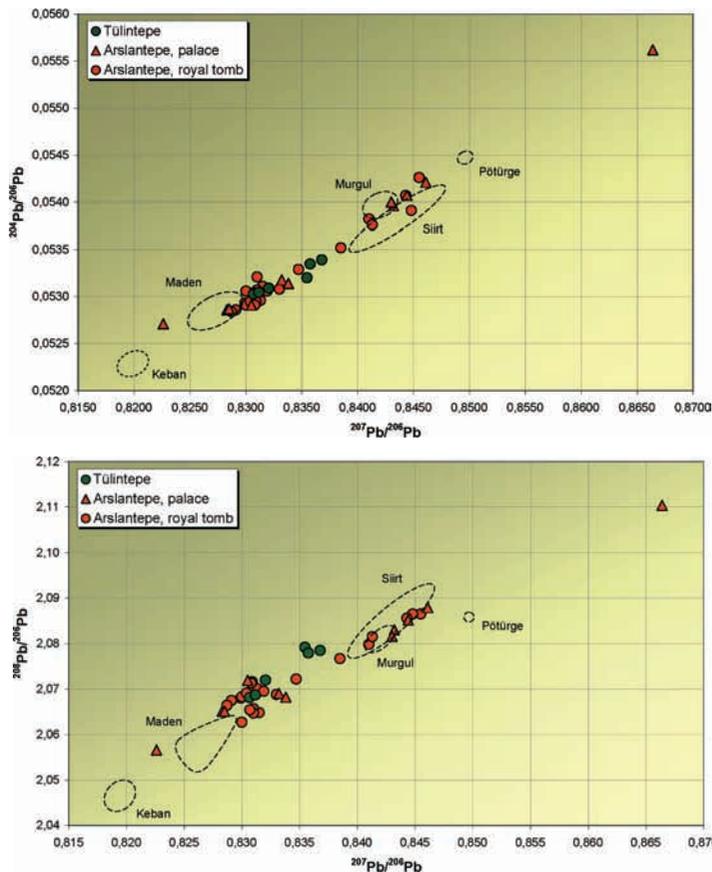


Fig. 13: The lead isotopic ratios of the hoard finds from Tülintepe and the contemporary finds from Arslantepe compared with the data from the metal mines of Eastern Anatolia (the data for Arslantepe are taken from Hauptmann et al. (2003); the data for the mines are from Seeliger et al. (1985) and from own sources of the authors.