Archaeol Anthropol Sci
DOI 10.1007/s12520-015-0297-5

ORIGINAL PAPER

The new Late Bronze Age hoard find from Kobbelbude (former Eastern Prussia, district Fischhausen) and the first results of its archaeometallurgical investigations

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Received: 31 July 2014 / Accepted: 8 October 2015

Abstract This article deals with a new discovered Late Bronze Age hoard find from former Kobbelbude (district Fischhausen, Eastern Prussia, now district Kaliningrad, Russian Federation). The hoard find is of special importance because it is the first time that metallurgical investigations were carried out on its artefacts. Archaeometallurgical analysis is, apart from few exceptions, still a desideratum of research in the eastern Baltic region. Also, for the first time, lead isotope ratios were determined. The results of the isotopic composition of the lead show a first hint towards a possible Eastern Alpine origin of the used ores. Former archaeometallurgical research of Bronze Age metal finds from the eastern Baltic region suggested a more abstract assumption about the origin of the ores from Middle Europe. Moreover, with the analysis of the chemical composition of the artefacts from Kobbelbude, a material classification to the type "dilute" fahlore copper with nickel, which we know from Late Bronze Age Middle Europe, was drawn. The results presented in this paper are a first step in the field of archaeometallurgical research in the eastern Baltic region and open a new perspective on Bronze Age metallurgy in relation to cultural history.

Keywords Late Bronze Age · Deposition · Copper ores · Chemical composition · Lead isotopes

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Introduction/materials and methods

The Kobbelbude hoard was found in 2009 by local people in the forest in Kobbelbude (former Eastern Prussia, now Bobrovo, Kaliningrad District, Russian Federation), north of the small town of Svetly (former Zimmerbude)[1] (Figs. 1(12) and 2).

Compactly placed artefacts lay at a depth of 0.5 m in sandy soil. Twelve bronze objects were found altogether. At the bottom of the hoard was a spiral pin and above it a wide bracelet comprised of five ribbon-shaped arm spirals (Fig. 3).

This group of artefacts lay in the centre of four neck rings and a ring. The former lay on top of one another. The find situation clearly shows that the items were carefully placed in the hoard. Several studies of hoard finds from northern and central Europe (Hansen 1994; Sommerfeld 1994; Maraszek 2006; Soroceanu 2012) have demonstrated that bronze artefacts were chosen intentionally and treated specially before they were finally deposited in the ground. The very large number of hoards and their distribution illustrate extensive communication relations, which resulted in a common hoarding practice that differed only slightly across time and space. The hoard from Kobbelbude belongs to the category of homogeneous hoards with ornaments. Due to the fact that neck and foot rings or bracelets were put together only, the hoard find of Kobbelbude can, following the classification of Regine Marazsek, be assigned to the category of *Ringschmuckhort* (Maraszek 2006). The composition of the Kobbelbude hoard find is a typical example of the Late Bronze Age find repertoire of north and central Europe although twisted neck rings with eye- or hook-shaped terminals occur more frequently in Poland. Generally, neck rings are the dominant form

[1] That same year, the Kaliningrad Museum of History and Art purchased the items found in the hoard and they are now held by that institution, Inv. Nr. КГОМ 1/50-18048. 1–12. A detailed study of this hoard is being prepared for publication (Skvortzov, Čivilytė, in press).

Published online: 16 November 2015

in the category of ring ornaments within such hoard finds (Maraszek 2006).

All artefacts are well preserved except for a few slight defects. A repair mark can be seen on one of the ribbon-shaped arm spirals. Such repairs reflect the high professional know-how of the metal workers and also indicate that the production of new ornament types, technically complicated as they are, must have been quite a lengthy process.[2]

According to the types found in the hoard, it can be dated to Montelius periods V and VI.

There are two massive neck rings twisted into loops with overlapping terminals (Fig. 4(2 and 3)). Two other torqued neck rings are made of thinner wire and their terminals form a hook (Fig. 4(1)). One terminal of each neck ring is broken. The five ribbon-shaped bracelets have spiral-like ends. The open wide bracelet is slightly damaged (Fig. 4(6)). It is decorated with nine small rolls and each of its terminals ends in two vertical rows of dots. A closed ring with a round cross section was also found in the hoard (Fig. 4(5)). The spiral pin is typical for various periods, including Montelius periods V and VI (Fig. 4(4)).

The Kobbelbude hoard is an important find for the knowledge of the Late Bronze Age in the Baltic region. In the Montelius periods V and VI, an increased number of hoards were found on the Sambian peninsula compared with earlier periods. We know about 30 of such Late Bronze Age hoards from a small area (Gaerte 1929; Engel 1935; Hoffmann 2000). This reflects the dominant rite of depositing artefacts in Bronze Age Europe, which intensified particularly during Period V (Hundt 1955; Sprockhoff 1956; Maraszek 2006). Most hoards were found on the Sambian peninsula in an area of the so-called Sambian Barrow Culture in the Kaliningrad District and extending north along the coast of Lithuania (Sidrys and Luchtanas 1999). A great number of these are concentrated in the north-western part of the peninsula where amber sources were richest (Fig. 1). It is important to note that in many Late Bronze Age hoards, we find imported objects from the neighbouring Lusatian Culture and especially from Scandinavia rather than locally made artefacts. This illustrates the long tradition of close cultural contacts between the eastern Baltic region and intensive metal-working centres. It should be taken into account that in the relevant literature Baltic amber is idealised, e.g. that Baltic amber played the most important economic role for the eastern Baltic societies in the Bronze Age because of its role as exchanging material for metal. The idealised image of the Baltic amber prevails in literature, which is often related namely with the Eastern Baltic region, as allegedly the early Mycenaean culture received amber specifically from the eastern region of the Baltic Sea. Historiography argues that the Sambian peninsula, Lithuania and other Baltic countries were the main suppliers of amber.[3] However, the traditions of amber use here after the Neolithic were highly limited, particularly in the Bronze and Iron Age. In Jutland, which is a region of amber resources, the occurrence of bronze objects does not differ significantly from those of other regions of Denmark (Jensen 1965). In contrast to Jutland, the situation on the eastern coast of the Baltic Sea is quite different: here, a clear preponderance of bronze objects along the coastline occurs. This fact reflects a different approach to amber on both coasts of the Baltic Sea. It is also important that in the Late Bronze Age cremation burials in Denmark contain an increased amount of amber as grave goods, which cannot be said about the east coast. Besides, in Denmark, amber is used not only for amber jewellery but also for the decoration of tools, such as handles of bronze awls (Jensen 1965). This reflects a wider range of application of amber than in the eastern Baltic Sea region. The exchange contact model "amber for metal", which became a paradigm, is hard to prove. Any factual data and archaeological evidence to assume the constitution of exchange and trade networks in the Bronze Age Baltic milieu are still missing. Certainly, we should take into account that besides amber, local products such as furs, dried fish, agricultural products and stock could be used as well(Sperling 2014) Anyway, the economic relevance of amber in the region of the Blue Earth for the circulation and use of metal seems to be plausible. The concentration of bronze objects on the coastline combined with stylistic similarities shows the influence coming from north and west-central Europe in the Bronze Age into the eastern Baltic region. Of special importance are maritime contacts. The distribution of bronze objects in the Baltic from the mouth of the river Vistula in the south to the Gulf of Finland in the north shows a decrease of finds from south to north. When moving from the Baltic Sea coast further inland, the number of finds reduces also. However, no pieces of raw metal were found in hoards in the eastern Baltic region, with one exception.[4] Damaged, highly fragmented hoards (German: *Brucherzhorte*)[5] are also very rare in this region, but it is possible that archaeologists will find more in the future.

[2] We know another example from the eastern Baltic region, where repaired jewellery objects occurred in one hoard, from Staldzene, Latvia, which was found on the coastline of the Baltic Sea and dates to Montelius period V–VI. It consists of Scandinavian import objects, most likely from Gotland, only (Vasks and Vijups 2004).

[3] For the most exhaustive historiography, see Bliujienė 2007.

[4] Former Littausdorf, Kr. Fischhausen (today Zorino, about 5 km north-west of Primorsk). It included 119 bronze artefacts: 64 sickles, 36 arm rings, 11 spearheads, 7 socketed axes and 1 large piece of copper scrap (Bezzenberger 1904).

[5] The term *Brucherzhorte* is used in literature for mostly damaged and fragmented objects, which are considered as metal waste or material supply for re-melting. This interpretation has become accepted since the study of Frauke Stein (Stein 1976). The purely profane interpretation has been dropped in the last decades because of more indications that the broken objects were connected to certain rites (detailed information can be found in Maraszek 1998; 2006 with further literature). Besides this predominant interpretation of those hoard finds, they are classified as *Brucherzhorte* furthermore. In the eastern Baltic regions, the hoard find of Tehumardi (Estonia) represents such an example of depositing fragmented objects. Within this find, which was interpreted as a hidden depot of a bronze caster in the past, selected bronze objects are deposited, which were broken following a certain rite (Sperling 2013).

Fig. 1 Amber deposits and Late Bronze Age hoards in Sambia. *a* Amber deposit area (after Schlicht 1922 with additions of K. Skvortzov); *b* crops of blue amber-bearing clay (after Schlicht 1922); *c* the most important amber deposits (after Schlicht 1922); *d* basic regions of collecting amber at the end of the sixteenth century (after Schlicht 1922 with additions of K. Skvortzov). *1* Zorino, distr. Zelenogradsk (former Littausdorf, distr. Fischhausen); *2* Molotschnoje, distr. Zelenogradsk (former Klein Drebnau, distr. Fischhausen); *3* distr. Zelenogradsk (former Willkau, distr. Fischhausen); *4* Kotelnikovo, distr. Zelenogradsk (former Wargen, distr. Fischhausen); *5* Svetlogorsk (former Rauschen, distr. Fischhausen); *6* Kaliningrad (city) (former Moditten, distr. Konigsberg); *7* Pribreschnoje (former Waldburg, distr. Konigsberg); *8* Ozerki, distr. Gvardejski (former Groß Lindenau, distr. Konigsberg); *9* distr. Bagrationovskij (former Domnieksruh, distr. Heiligenbeil); *10* Peskovo, distr. Pravdinskij (former Groß Schönau, distr. Gerdauen); *11* Suchodolje, distr. Gvardejski (former Klein Nuhr, distr. Wehlau); *12 Bobrovo, Svetlogorsk (former Kobbelbude, distr. Fischhausen)*; *13* Smolnoje, distr. Pravdinksij (former Charlottenburg, distr. Insterburg); *14* Zalivnoje, distr. Gurjevskij (former Grünwalde, distr. Fischhausen); *15* Paraschiutnoje, distr. Zelenogradsk (former Saltnicken, distr. Fischhausen); *16* Zaostrovje, distr. Zelenogradsk (former Schlakalken, distr. Fischhausen); *17* Golovenskoje, distr. Gvardejevsk (former Willkühnen, distr. Königsberg)

The Kobbelbude artefacts are very similar to northern European types, but they are not exact copies. It should be stressed that after axes, neck rings are the second most common form in northern European hoards of this period. Most have been found on Danish islands and in north-eastern Jutland and Sweden; many come from northern Poland as well (Maraszek 2006; Blajer 1999). The ribbon-shaped arm spirals, albeit undecorated, along with the wide bracelets are similar to typical northern European variants too (Sprockhoff 1956).

No archaeometallurgical research of such artefacts has been carried out so far, with the exception of A. Bezzenberger's 1904 publication which provides chemical analyses of a few Late Bronze Age finds (Bezzenberger 1904). New research of only some objects was published in 2010 (Mödlinger 2010). However, until now, no lead isotope analysis was carried out. Therefore, this new investigation marks a new step in our understanding of Bronze Age metallurgy and local metal production.

From the Kobbelbude hoard, six objects were sampled for determination of their chemical composition and lead isotope ratios. The sample description can be found in Table 1.

The chemical composition was determined by energy-dispersive X-ray fluorescence analysis (ARL Quant'X). Two measurements were made with different excitation voltages at 28 and 50 kV and 1000 s measuring time each. Quantification was achieved by a modified and improved version of the procedure described by Lutz and Pernicka (1996).

Four elements are most suitable for establishing material classification on account of their behaviour in the smelting processes, namely silver, nickel, arsenic and antimony (Pernicka 1990). The ratios of silver and nickel to copper

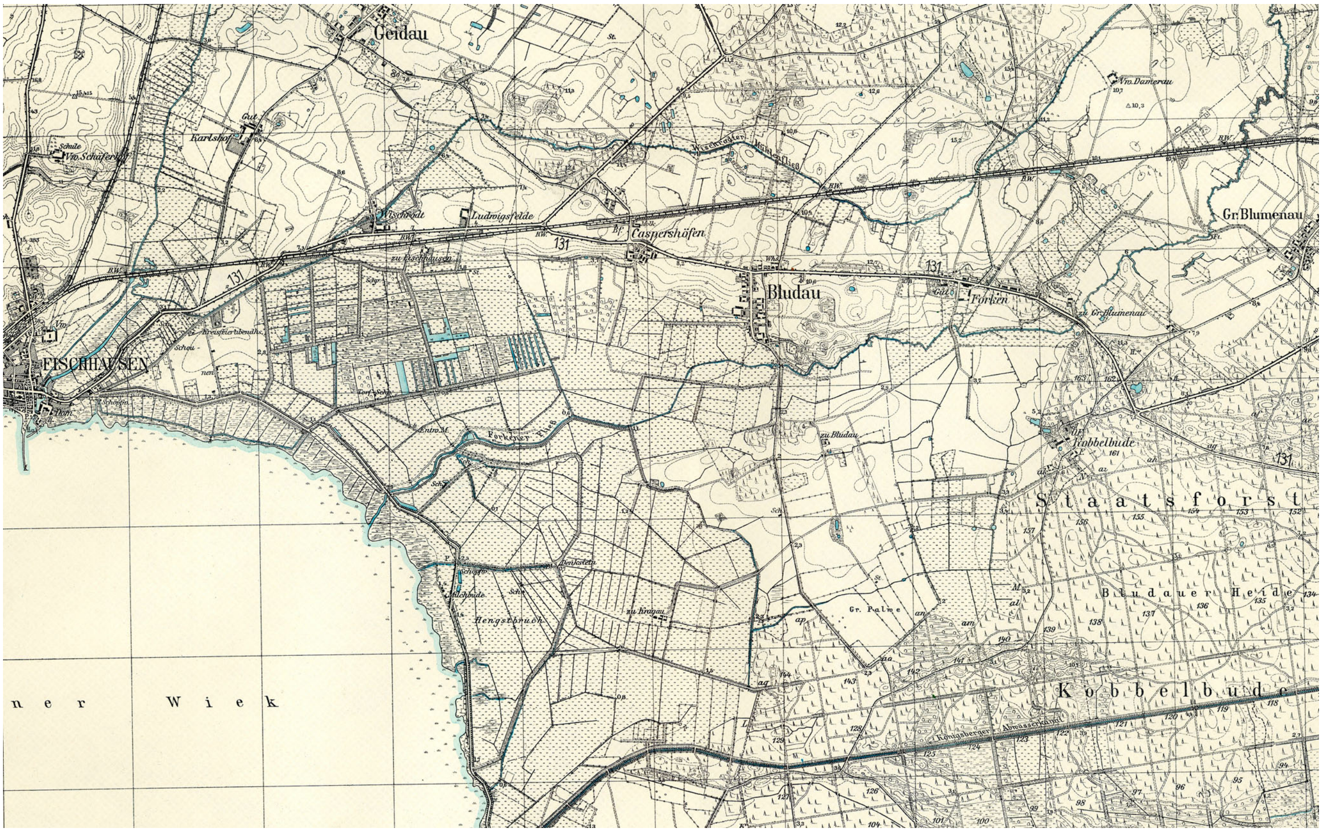


Fig. 2 Find spot of the Kobbelbude hoard on the map of 1935

remain quite stable during smelting and subsequent metal treatment. Therefore, they can provide information about the ore used. Arsenic and antimony concentrations are prone to substantial changes during the smelting of sulphide ores. However, they provide general information on the ore type used, such as fahlores (Krause 1988).

The results are evaluated by employing two double logarithmic diagrams silver vs. nickel and arsenic vs. antimony. To distinguish unalloyed copper from bronze, a further double logarithmic diagram, showing tin vs. arsenic, can be used.

By the determination of the stable lead isotope ratios and the comparison of the results with lead isotope signatures from copper ore deposits, possible regions of origin of the used raw materials can in principle be identified. The analysis was performed with a multi-collector inductively coupled plasma mass spectrometer following the procedure

Fig. 3 The position of the bracelets in situ (photo K. Skvortzov)

Table 1 Sample description

Lab. ID	Sample ID	Invent. no.	Object
MA-112888	KA29	18048.12	Twisted neck ring with looped terminal (Fig. 4(2))
MA-112889	KA30	18048.08	Thin twisted neck ring (Fig. 4(1))
MA-112890	KA31	18048.10	Closed ring with round cross section (Fig. 4(5))
MA-112891	KA32	18048.9	Twisted neck ring with looped terminal (Fig. 4(3))
MA-112892	KA33	18048.2	Wide bracelet (Fig. 4(6))
MA-112893	KA34	18048.3	Spiral-headed pin (Fig. 4(4))

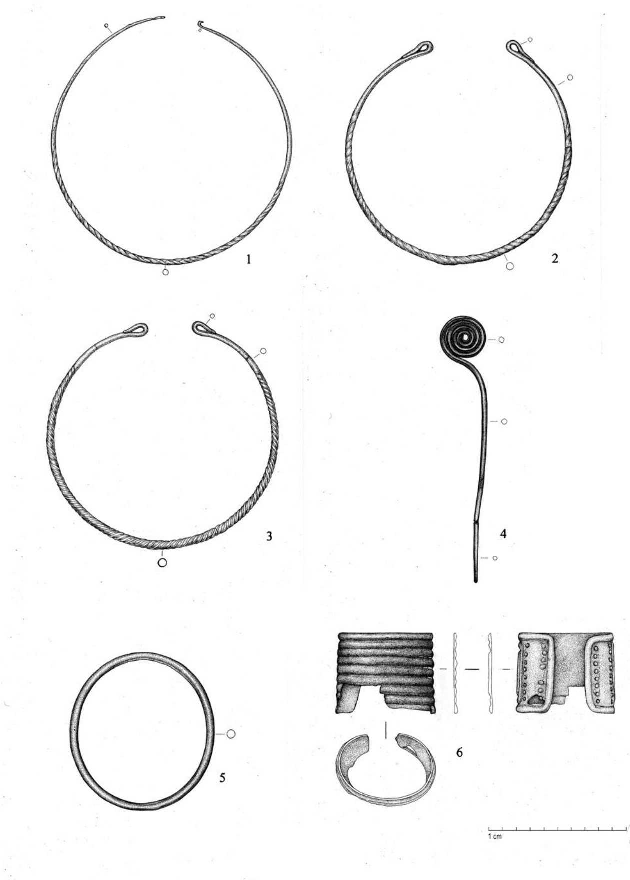


Fig. 4 The investigated metallurgical objects from the Kobbelbude hoard (drawing R. Shirouchov)

described by Niederschlag et al. (2003). The use of lead isotope ratios is well established for provenance studies, because the isotopic compositions do not change during the smelting of ores. This geochemical fingerprint is therefore the same in ores from a specific deposit and in the artefacts that were produced from them. Since in nature lead isotope ratios depend on the geological age of a deposit and its geological environment, different deposits may have different lead isotope ratios and can therefore be distinguished (Stos-Gale and Gale 2009). However, isotopic compositions are not unique and may be similar in different ore deposits. Therefore, a good knowledge of the possible ore sources in the region under investigation is mandatory.

Results and discussion

All the objects consist of tin bronze (Table 2). Furthermore, two samples (MA-112891, KA32, and MA-112892, KA33) contain more than 1 % arsenic. Lead between 2 and 7 % was detected in five samples. From Fig. 5, it is obvious that most of the objects form a quite homogenous group. Only one sample (MA-112889, KA30) is slightly different. All samples contain significant concentrations of silver, nickel, arsenic and antimony and can therefore be classified as “dilute” fahlore copper with nickel, which frequently occurs in central Europe in the Middle and Late Bronze Age.

Regarding the determination of the stable lead isotope ratios, only two of the six samples were taken into account. The remaining four contain more than 2 % lead and are unsuitable for further analysis because the results refer to the lead isotope signature of the lead and not the copper ore.

Therefore, no statement regarding the origin of the copper of these four samples can be made. Furthermore, one must consider that during the Late Bronze Age recycling may have occurred, which would have altered the lead isotope signature. More precisely, if the lead isotope signatures of different deposits are mixed, it is virtually impossible to identify the deposit or origin.

Table 2 Chemical compositions of the analysed samples; all data are given in mass percent. Fe, Zn and Te were sought but were below their detection limits of 0.02, 0.2, and 0.005 % respectively

Lab. ID	Co	Ni	Cu	As	Se	Ag	Sn	Sb	Au	Pb	Bi
MA-112888	0.11	0.53	84	0.81	0.01	0.39	8.8	0.89	<0.01	4.2	0.05
MA-112889	0.06	0.12	90	0.20	<0.01	0.04	9.3	0.27	0.02	0.10	0.01
MA-112890	0.06	0.74	81	0.83	0.01	0.61	8.3	1.47	<0.01	7.1	0.04
MA-112891	0.13	0.48	89	1.20	<0.01	0.33	6.0	1.04	<0.01	1.93	0.04
MA-112892	0.12	0.31	78	1.40	0.02	0.40	15.6	0.65	0.06	3.8	0.06
MA-112893	0.06	0.28	91	0.28	<0.01	0.23	1.97	0.59	<0.01	5.8	0.03

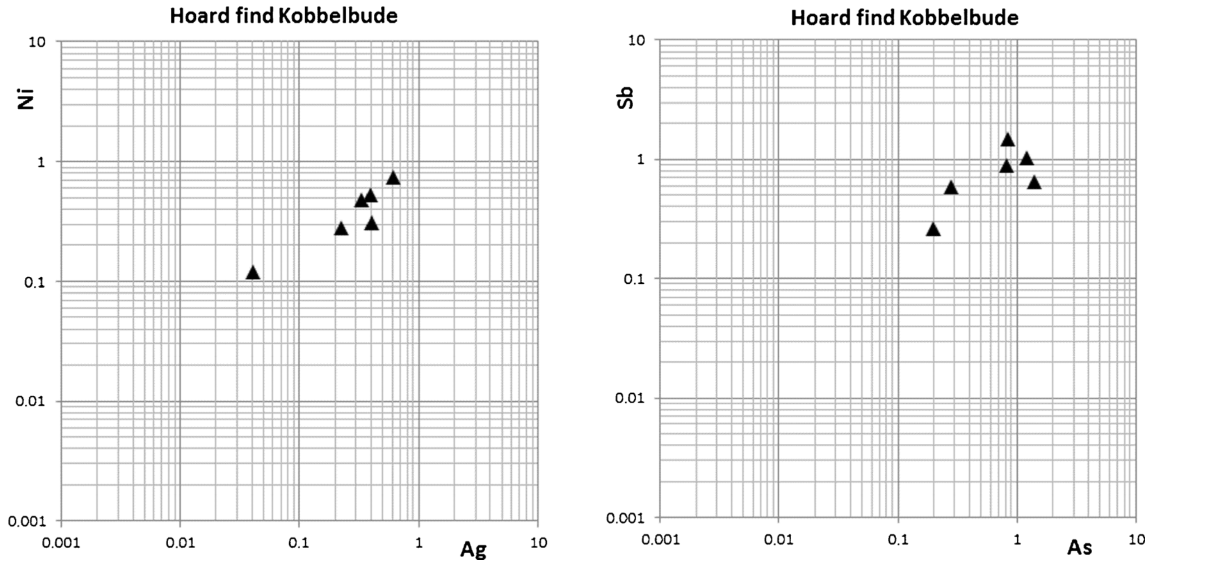


Fig. 5 Double logarithmic diagram for the trace elements silver vs. nickel (*on the left*) and arsenic vs. antimony (*on the right*); all data given in mass percent

Due to the fact that the eastern Baltic region lacks any copper ore deposits, the results from Kobbelbude were compared with different copper ore deposits in Europe. Matches were found with Slovakian copper ore deposits of the Western Carpathians (Schreiner 2007) as well as Alpine ore deposits in the Lower Inn Valley (Höppner et al. 2005) (Figs. 6 and 7) only.

The fahlores in the Unterinn valley are not associated with nickel so that this possible source region can be excluded for the Kobbelbude hoard. Although some Slovakian deposits would match the lead isotope ratios of the objects, it is nevertheless not very likely that the copper derives from there. Fahlores with nickel can be found there, but the analysed ore samples (Schreiner 2007) generally contain less nickel.

When having a look at the results of the study by Johan Ling et al. (Ling 2014) for Scandinavian Late Bronze Age objects dating in the period Montelius V, it can be seen that he suggests for 8 of 20 analysed objects from this period an origin of the ores in Austria, Tyrol. However, this hypothesis does relate to lead isotope ratios only; no geochemical and trace element data are taken into account, and therefore, this hypothesis needs to be checked.

To sum up, the best guess at present for the ore origin of the metal used for the Kobbelbude hoard find is some other copper mineralisation in the Eastern Alps, where nickel is often

Fig. 6 $^{207}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ for two objects from the Kobbelbude hoard and copper ores from Slovakian copper ore deposits of the Western Carpathians (Schreiner 2007)

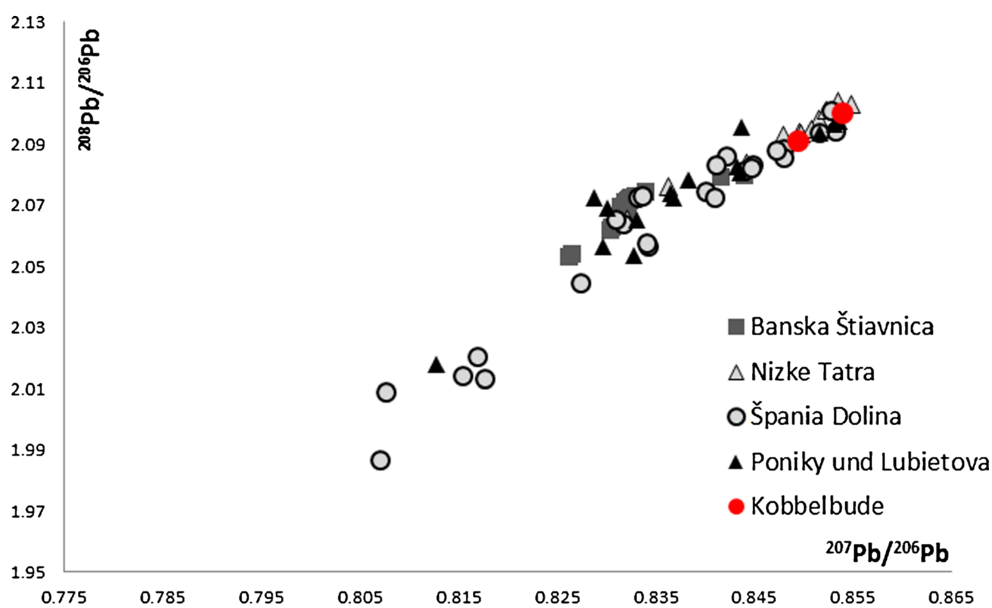
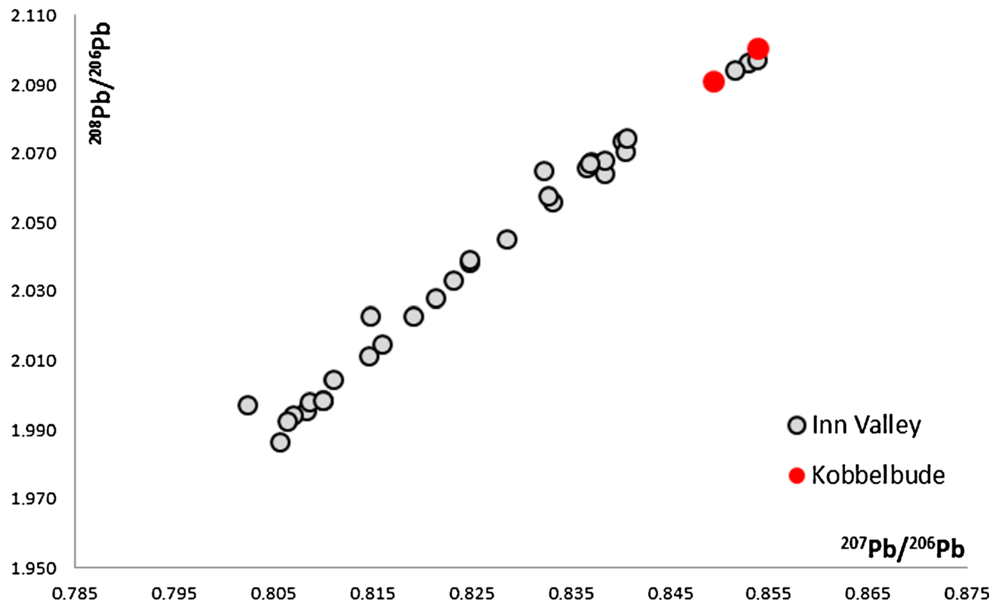


Fig. 7 $^{207}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ for two objects from the Kobbelbude hoard and copper ores from Inn Valley copper ore deposits (Höppner et al. 2005)



associated with copper ores. Further research, especially on similar artefacts from the Baltic region, is necessary to widen the analytical basis. Moreover, the origin of the fahlore copper with nickel is still unknown; hopefully, this unsolved question can be answered soon.

Acknowledgments This research is funded by the European Social Fund under the Global Grant measure VP1-3.1-ŠMM-07-K-01-101.

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