Abhandlung

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Touchstones and mercury at Hedeby

Abstract: Im Beitrag werden wikingerzeitliche, als Grabbeigaben überlieferte Steinartefakte – Probiersteine – aus Haithabu behandelt. Chemische Mikroanalysen der Steinoberflächen wurden durchgeführt und Spuren von Metall entdeckt. Dabei handelt es sich um auch andernorts auf Probiersteinen identifizierte Metalle, es fanden sich jedoch auch Hinweise, die auf Amalgamierung des Messings deuten, was als Fingerzeig für die Verwendung von Quecksilber gewertet wird.

Keywords: Haithabu; Wikingerzeit; Grabbeigaben; Probiersteine; Edelmetalle; Quecksilber; chemische Mikroanalysen; Archäometallurgie

Résumé: Dans cet article nous considérons une sélection d'objets de pierre provenant de sépultures du site de Hedeby, datant de l'époque viking. Nous présentons les résultats d'analyses microchimiques effectuées sur les traces de métal retrouvées à la surface de ces objets. Mis à part les métaux qui ont régulièrement été identifiés sur les pierres de touche, un objet a également révélé des indices d'un amalgame de laiton. Ainsi nous nous penchons aussi sur la question de la présence du mercure à Hedeby.

Mots-clefs: Hedeby, époque viking, mobilier funéraire, pierre de touche, métal précieux, mercure, micro-analyse chimique, archéometallurgie

Abstract: This article considers selected stone artefacts from graves at the Viking Age site of Hedeby. It aims to present the results of chemical microanalyses of metal traces preserved on their surface. Besides the metals that were regularly identified on touchstones, one artefact showed signs of a brass amalgam. For this reason the authors also examine the question of the occurrence of mercury at Hedeby.

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Keywords: Hedeby, Viking Age, grave goods, touchstone, precious metal, mercury, chemical microanalysis, archaeometallurgy

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Introduction

Balance scales and/or weights have been recovered from numerous early medieval burials. And even more medieval as well as prehistoric burials have produced stone artefacts carefully worked into an oblong shape, with a quadrangular cross-section, flat and smooth sides and made of a hard raw material. Archaeologists usually interpret them as 'whetstones': their occurrence is linked with another artefact frequently seen among grave goods, i.e. a knife. However, chemical microanalyses of the surface of a number of these stone artefacts have yielded traces of non-ferrous metals, including precious metals, instead of iron: These artefacts served in fact as tools for determining the value of a metal[1].

Touchstones have been recorded in great quantities at early medieval trade centres, at elite sites and in metal workshops in Northern Europe, or the bullion economy (*Gewichtsgeldwirtschaft*) zone, as have numerous balance scales, weights and hacked silver, including dirhams[2]. The huge number of damaged, discarded or lost touchstones from early medieval settlement and production contexts testifies to their low value. However, as is also the case of weights or balance scales, their importance changed fundamentally when used in a funerary ritual: the common tool became a symbol.

The origin of the symbolic role of tools intended for determining the value of metal, which was brought into play during burial rituals from the Eneolithic (in Germany, the elegant Early Bronze Age stone artefact from Leubingen may serve as an illustrative example), can be regarded as an expression of access to precious metal, or simply of social standing. Early medieval society however under-

1 Ježek/Zavřel 2011; Ježek 2013b.
2 See Steuer 1987.

stood the role that these artefacts played in the ritual of bidding a final farewell to adults and children in a much wider sense. There is no doubt as to their positive animation, which did not address the afterlife of the deceased as such, but referred to the world they left behind. However, the presence of balance scales, weights or touchstones in children's graves does not allow us to decide whether it involved the expression of an unattained destiny, or a demonstration of the inheritance ambitions of the surviving family members, or a communication of wishes in general[3].

The stone artefacts from Hedeby

Approximately 20 % of burials unearthed at Hedeby (Haithabu, Schleswig-Holstein, Germany) were furnished with grave goods. After knives and beads, the most common items in furnished graves were stone artefacts assumed to be whetstones[4]. Approximately half of this category's thirty finds come from coffin burials. However, the characteristic stone artefacts were found in both modestly and richly furnished graves. Some of these stone artefacts were in burials with cremated remains (nos. 320 and 325)[5], others were found in chamber graves (nos. 4 and 5). Coffin burial no. 32 is one example of a richly furnished female grave that also contained a 'whetstone'. A "whetstone or touchstone" was also found in 1836 in a context, not recorded in detail, along with a sword, tongs, a hammer and other items[6]. It is reasonable to assume that this was a male grave with forging tools (so called – erroneously – smith's burial)[7].

Ten stones which H. G. Resi identified as possible touchstones or polishing stones[8] were extracted from an assemblage of 10,470 worked stones from Hedeby, in particular from the settlement layers. H. G. Resi recorded traces of gold on one of these artefacts[9]. This stone is a massive, rather 'primitive' object, and, were it not for author's rigorous work, one might never have guessed its function as a touchstone. The local settlement and burials in fact revealed dozens of elegantly ground stones likely to be touchstones[10]. One end of one such specimen was gold-plated, similarly as were several elegant 'whetstones' from Early Iron Age prestigious burials in Ukraine[11]. Nevertheless, the assemblage of stone artefacts from Hedeby contains far more frequently items that were not worked into elegant forms.

On the strength of her thorough examination of the Hedeby stone artefact assemblage, H. G. Resi considered the possibility of interpreting a number of specimens made of imported banded schist as touchstones, though she found local stone to be a more suitable material. Instead, she believed that artefacts made of banded schist were jewellery or game-related pendants (*Spielanhänger*), with an explanation as "symbolically-charged miniature pendants in the shape of an emblem of power" (*symbolgeladene Miniaturanhänger in der Form von Herrschaftszeichen*)[12]. Resi points out the high number of dark schist 'whetstones' in Hedeby's cemetery A and the concentration of similar artefacts made of light schist in cemetery 4, while also highlighting the "impressive polishing" of these specimens[13].

Aims, methods and problems of the research

Nearly all of the thirty stone artefacts from the Hedeby graves are oblong, with a rectangular cross-section and a hole at one end. A total of 18 stone artefacts from local graves were selected using a binocular microscope for chemical microanalysis as the next step (see Fig. 1). The goal was to determine whether streaks of iron had survived on the stones, which would confirm their function as whetstones, or whether traces of non-ferrous metals were present. We used chemical microanalysis combined with surface observations of the objects using a Scanning Electron Microscope (SEM hereafter) using EDS–BSE (Energy-Dispersive X-Ray Spectroscopy–*Back Scatter Electrons*) analysis. It provided data on the content of individual oxides, or on the chemical elements of the alloys that were investigated. The findings are calculated at 100 % in Tables; these data are semi-quantitative.

We are not the first to use this method: twenty years ago Frank Wietrzichowski used SEM to identify traces of gold with a small amount of silver and copper on a touchstone from the 8th-century or early-9th-century Baltic coast settlement of Groß Strömkendorf (Germany) – prob-

3 Ježek 2013b.
4 Resi 1990, with refs.; Arents/Eisenschmidt 2010a, 164–165; 300.
5 Grave numbers follow Arents/Eisenschmidt 2010b.
6 Arents/Eisenschmidt 2010b, 18–19.
7 See Ježek 2015.
8 Resi 1990, 39–40.
9 Resi 1990, 40; 62 table 28,1.
10 E.g. Resi 1990, tables 5–13; 16; 20.
11 Resi 1990, 35, table 10,1; Burghardt 2012, plate 1.
12 Resi 1990, 36.
13 Resi 1990, 33–34; 55–58.

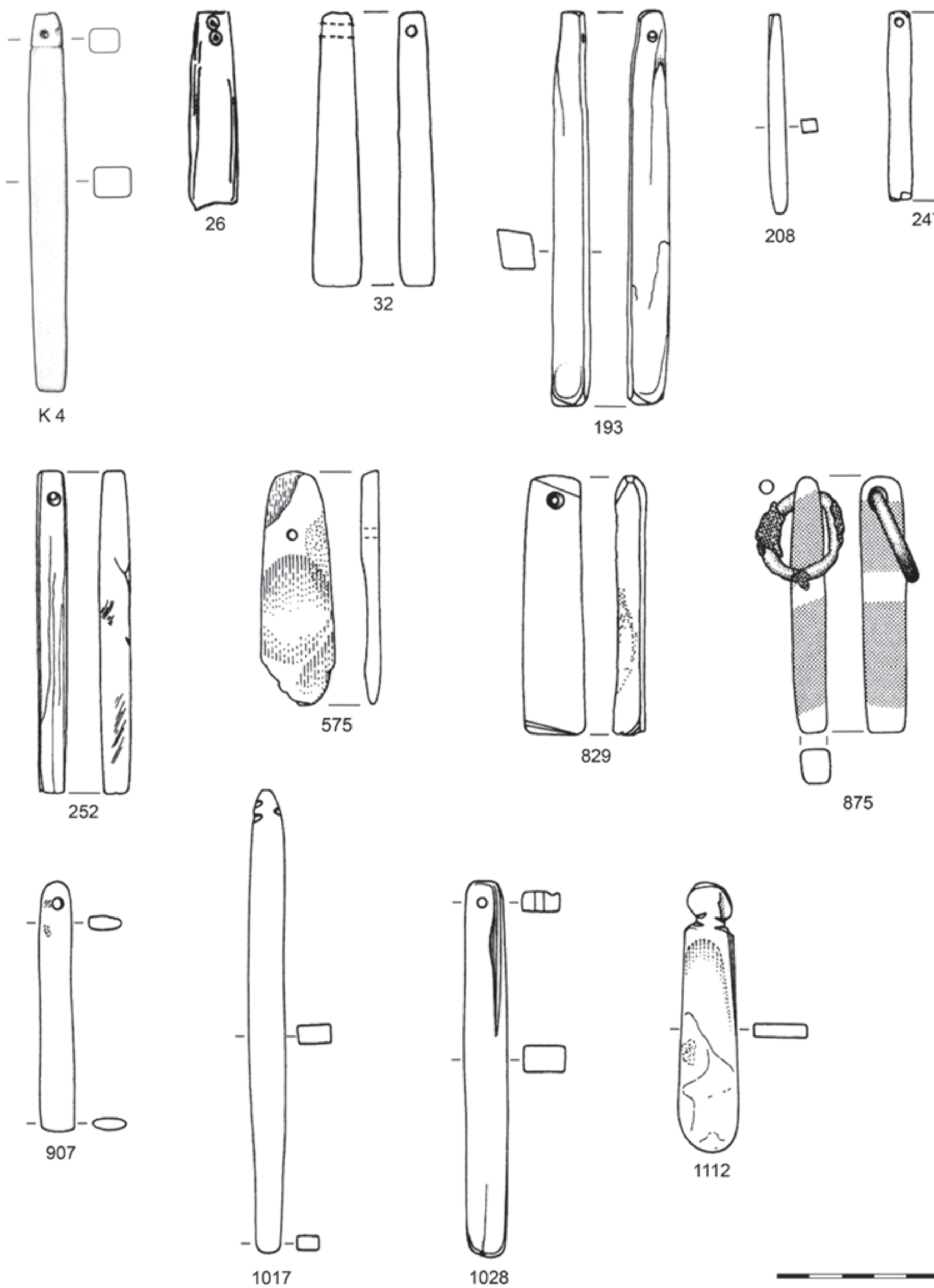


Fig. 1: Stone artefacts from the Hedeby burials selected for analysis (after Arents/Eisenschmidt 2010b). The authors apologise to the readers: they have been unable to obtain photographs of the objects from the Archäologisches Landesmuseum, Schloss Gottorf, Schleswig.

ably the legendary site of Reric[14]. After the ground-breaking studies of V. Zedelius and A. Oddy, the number of touchstones increased in the archaeological literature[15]. However, it is now clear that this no longer involves dark stone, or even only black stone, which was anticipated recently[16].

When making a positive identification of a touchstone among archaeological finds the main complication relates to its actual use in the past. Before a touchstone could be used, it was necessary to remove the remnants of the test it performed previously. However, we can set aside the question of whether certain touchstones were cleaned prior to being placed in the grave, since it is virtually impossible to reconstruct the method used to clean the artefacts following an excavation. Under the circumstances, there is something of greater importance for establishing whether these artefacts were whetstones or touchstones. Unlike touchstones, it is difficult to imagine that whetstones were thoroughly cleaned after use. Sharpening clearly leaves far heavier traces than those left by the tests to determine the quality of a potentially valuable object.

Analytical results

SEM observations did not reveal traces of metals on four of the 18 artefacts studied from the Hedeby burials (Gr. nos. 513, 562, 913 and 967). This does not mean that traces of metal were not preserved on the stones or that they never existed: none of the artefacts was viewed with the SEM on all four sides. Only selected places on the stones could be viewed, and it is possible that certain traces of only a few micrometres in size have been overlooked on the observed side too. The same is true for stones on which streaks of metal were found (Table 1).

Although traces of iron were found on several stone artefacts, with a single exception (Gr. no. 32: iron with a small admixture of lead), these same stones also carried traces of non-ferrous metals. 'Pure' iron was recorded in one case (Gr. no. 907); another two stones had traces of an alloy of iron with copper (Gr. nos. 26 and 208). In several cases we found traces of iron with an admixture of chromium (Gr. nos. 907, 1028, 1112 and Chamber Gr. no. 4); as we ascribe these traces to tools used in the archaeological excavation, they are not listed in Table 1. It is difficult to determine whether other traces of iron also have the same origin or not. It should also be pointed out that some stones bear a visible ferric crust caused either by geochemical processes that occurred in the ground over the course of a millennium or by contact between the stone and iron objects buried in the grave; when conducting our chemical microanalyses we attempted to avoid these places on the stones.

Traces of non-ferrous metals (for examples, see Fig. 2) were recorded on 13 artefacts from the set that we examined. Linear streaks from objects made of non-ferrous metals were found preserved on stones from seven burials (Gr. nos. 208, 247, 875, 907, 1028, 1112 and Chamber Gr. no. 4). In addition to distinct streaks, these stones and others also revealed grains of non-ferrous metals ranging in size from a few micrometres to several dozen micrometres, including repeated occurrences on several observed specimens.

The most numerous traces of metal were those of lead and its alloys. Lead, the metal most frequently found on touchstones[17], was essential for the work of every jeweller; however, its use was definitely much wider. Copper, tin and/or their alloys were also frequent. A 35–40 % share of zinc in early medieval brass is no longer surprising today[18]. In the 16th century, Lazarus Ercker describes weight ratios of copper and calamine in the charge for the calcination of brass and weight yields of the obtained alloy: in his examples the zinc content is up to 40 % in calcined brass[19]. Brass of this kind was recorded on three stones from Hedeby (as well as from other early medieval sites). Zinc gives a golden hue to brass, and an increase in zinc content makes the colour of the object more golden. The question remains whether the aim of producing alloys with a zinc content higher than 30 % was to obtain a refined imitation of gold.

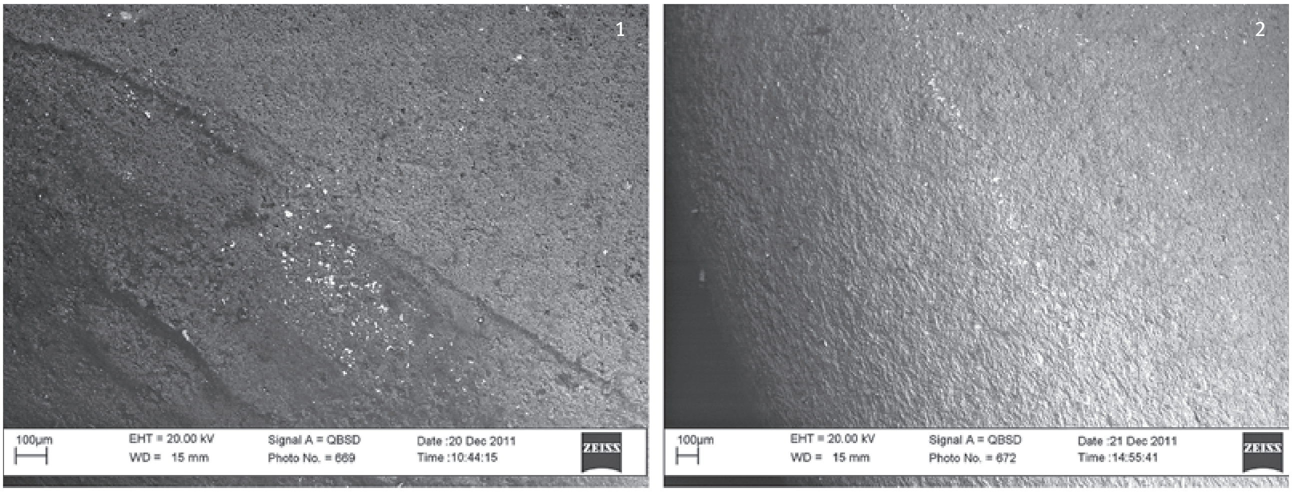
Only two of the artefacts studied (from Gr. nos. 575 and 875) showed traces of silver; both cases involved grains of only micrometres. The raw material of the second of these stones is identical to the banded schist of touchstones typical for Birka, which are found in a zone ranging from Iceland to Northern Russia[20]. Linear streaks of tin as well as 'large' (in terms of micrometre dimensions) areas of brass were preserved on this stone, and an analysis of one of the traces of tin showed a low admixture of arsenic and lead and a negligible amount of silver.

Represented twice in small amounts, we regard arsenic as an unintentional admixture or as part of an ore

14 Wietrzichowski 1993, 38. See also Eluère 1986.
15 E.g. Zedelius 1981; Oddy 1983 and 1993; Moore/Oddy 1985; Schemainda 1988.
16 See Ježek/Zavřel 2011 and 2013; Ježek 2013a and 2013b.
17 Ježek/Zavřel 2011 and 2013.
18 Ježek/Zavřel 2011, 150; 2013; Ježek 2013b.
19 Ercker 1574, f. 118.
20 Johansen *et al.* 2003; Hansen 2009, 76.

Table 1: Identified traces of metal on selected stone artefacts from the Hedeby burials (An. No = analysis number). The data acquired by the SEM-EDS method are given in weight percent (wt. %) and calculated at 100 %; the data are semi-quantitative. Grave numbers (Gr. no.) according to Arents/Eisenschmidt 2010b (Kagr. = chamber grave). Four of the 18 artefacts studied from the Hedeby burials (Gr. Nos. 513, 562, 913 and 967) did not reveal traces of metal on the observed sides, and they are not included in the table; however, none of the artefacts were viewed with SEM on all four sides.

Gr. No.	An. No.	Ag	As	Cu	Fe	Hg	Ni	Pb	Sn	Tl	Zn	Σ
26	1			79	21							100
	2							100				100
32	1				95			5				100
193	1			64					36			100
	2			59				4			37	100
	3							100				100
208	1			100								100
	2			29	71							100
	3							100				100
247	1		7					93				100
252	1			11				89				100
	2							20	80			100
	3							67			33	100
	4							100				100
575	1	100										100
829	1								100			100
	2							100				100
	3			10				16	74			100
875	1	100										100
	2	100										100
	3								100			100
	4			1					99			100
	5			65							35	100
	6	1	4	1				4	90			100
907	1			60							40	100
	2				100							100
	3								100			100
1017	1							100				100
	2								100			100
1028	1			100								100
	2							100				100
1112	1			22		36	6			23	13	100
	2			35		42	8				15	100
	3			3			4	70	21		2	100
	4							100				100
Kagr. 4	1								100			100



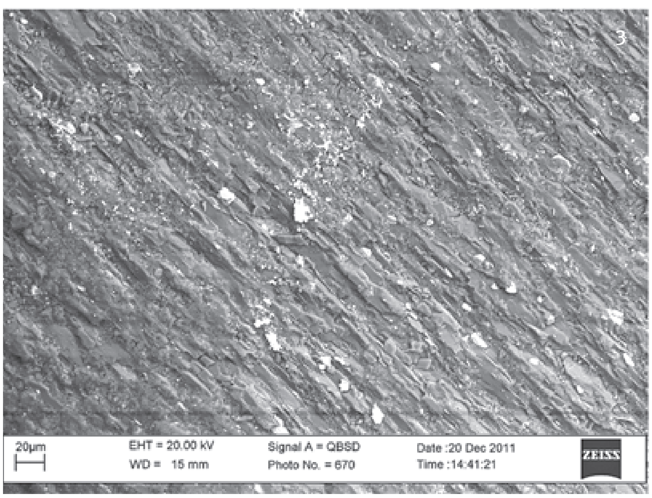


Fig. 2: Examples of metal traces on the surface of stone artefacts from the Hedeby burials. 1: Grave no. 875: tin with copper admixture; 2: Grave no. 907: brass; 3: Grave no. 1017: lead (photos: Marc Theodor).

of a different metal. This element is a common component of certain magmatic and hydrothermal deposits of copper, lead and tin. The same is true for the occurrence of arsenic in alloys recorded on the touchstones from Hedeby: one case involves a minor admixture of lead, the second a small admixture of tin accompanied by a similarly low content of lead.

The majority of metals and alloys recorded on the stone artefacts from the Hedeby graves have counterparts at other sites in Northern and Central Europe. However, the archaeometallurgist's attention is drawn to the stone from Grave no. 1112 at Hedeby: its shape does not differ from the majority of similar stone artefacts found at the site but, instead of a hole, one end of the stone has a notch for the purpose of attachment (as with other specimens from Hedeby)[21]. In addition to streaks of lead, two grains around ten micrometres in size are unique, and not only in the context of Hedeby.

Mercury at Hedeby

An analysis of one of the grains revealed a material dominated by mercury, followed by copper, zinc and nickel. In addition to these elements, the second grain also contained thallium (23 wt. %). Mercury was again the dominant component; the proportion of thallium was similar to that of copper. Although the earth's crust has a relatively high share of thallium[22], this element is disinclined to enter independent crystalline phases. Natural thallium minerals are associated in nature with arsenic (realgar AsS, orpiment As_2S_3), antimony (stibnite Sb_2S_3) and

21 See Resi 1990, table 11; similar adaptation is known also from other sites.

22 See Rösler/Lange 1972; Polanski/Smulikowski 1969, 496–498.

Table 2: Analysis of one of the metal traces with mercury on the surface of the stone artefact from Burial no. 1112 at Hedeby. The data are given in weight percent (wt. %) and atomic percent (at. %) and calculated at 100 %; the data are semi-quantitative.

Elmt	Cu	Hg	Ni	Tl	Zn	Σ
wt.%	22	36	6	23	13	100
at.%	38	19	11	12	20	100

mercury. This mineralisation is typical for certain epithermal veins in late andesitic volcanic zones. The well-known occurrence of this mineralisation is at Allchar (Alshar) on the border of Macedonia and Greece[23]; however, other occurrences are also recorded in Europe[24]. The combination of copper, zinc and nickel suggests that trace from test of alloy instead of natural ore was preserved on this touchstone. A substantial amount of mercury is present in both of the analysed grains (36 and 42 wt. %). The alloy can therefore be designated as an amalgam.

A fundamental question is which metal or alloy was amalgamated. If we convert the weight percentages of Cu, Zn and Ni to 100 %, the heterogeneous content of these metals is apparent. Similar alloys are designated as nickel brass, or α´ phase of the Cu-Ni-Zn system[25] in the modern period (this alloy is better known under the names of nickel silver or *Neusilber*, *alpacca* or *pakfong*). The presumed alloy, which was amalgamated, had a copper content in the range of 50–85 wt. %, nickel 10–20 wt. % and zinc 5–30 wt. %. The variability in the measured values is most likely to have been caused by the existence of specific phases in the amalgam residue. Generally, the higher content of Ni gives modern nickel brass a lustrous silvery colour. The analysed alloy could have had a yellowish or golden colour prior to amalgamation[26]. The nickel in this alloy was probably already a component of the copper used during the calcination of the brass (Table 2).

Mercury forms amalgams with certain metals (Ag, Au, Cu, Zn, Pb, Sn and Cd) easily; alloys are formed with iron, cobalt and nickel only with great difficulty. The phase nature of the analysed grains is not known. Under normal conditions copper and mercury form a solid phase in a ratio of approximately 1:1 (Cu_7Hg_8)[27]. The Cu-Hg mixture is liquid when there is a higher content of mercury. The preparation of a small amount of amalgam probably used fire assaying methods for the preparation of amalgam samples – hammering into thin sheets, cutting them into narrow strips and rolling these pieces into spirals. The strips were mixed with mercury, and the excess mercury was removed from the resulting amalgam by forcing it through fine leather[28].

Zinc forms a stoichiometrically undefined phase with mercury. This phase is liquid or plastic when there is a predominance of Hg; as the content of Zn increases, the phase becomes solid. Crystalline zinc and a solid Zn-Hg solution are present in a solid alloy. Although nickel with copper forms a solid solution, it is very reluctant to form an amalgam on its own. Due to the fact that the amount of mercury identified is enough to create an amalgam only with part of the copper and zinc present in the grains, it is likely that a binary phase of Cu-Zn (brass) and Cu-Ni (copper nickel) or a ternary phase of these metals is present. Although experimental data is missing for a discussion of the binding of thallium, it is likely that the mercury used in the amalgamation already contained a low amount of thallium and that a phase rich in thallium was created locally during amalgamation. For the sake of interest, we can add that the presence of several percentage points of thallium in mercury reduces its freezing point to -58° C. Again, the second grain, composed of mercury, copper, zinc and nickel, did not contain an admixture of thallium.

Hedeby is not the only early medieval site in Europe where finds of mercury are documented[29]. A container for mercury was found in Burial no. 10 at Hérouvillette in Normandy dated to the first half of the 6th century and furnished with forging tools, weapons, coins, balance scales, etc. – and also with three stone artefacts with the characteristic shape of touchstones[30]. However, probably only in Hedeby were small drops of mercury found repeatedly in an early medieval settlement context[31] – everywhere in situations dated to the 9th century[32]. We should recall that dirhams often contain a small amount of mercury[33]; during re-smelting mercury distils and can condense. However, in none of the three cases in Hedeby was mercury found in the irrefutable context of a metallurgical workshop. In fact, although the mercury detected on the touchstone

23 See Volkov *et al.* 2006.
24 E.g. Kondela *et al.* 1996.
25 Jianga *et al.* 2005.
26 Korbař/Stránský 1963, 48–50; 252–253.
27 Chakrabarti/Laughlin 1985.
28 See Georgius Agricola: Hoover/Hoover 1950, 297–298; 426–428; Ercker 1574, f. 44–46.
29 See Bayley 1992, 789; 795; Bayley/Andrews 1997, 220.
30 Decaens 1971, 12–21 fig. 10.
31 Schietzel 2002.
32 Schietzel 2002.
33 Ilisch *et al.* (eds) 2003.

from Burial no. 1112 was part of a brass amalgam[34] and the various kinds of metalworking were processed in Hedeby, we cannot be sure the amalgamation was carried out just in this site. In any case, we still lack a reason for conjecture on the amalgamation of precious metals at Hedeby[35].

H. Steuer *et al.* assume that the mercury found at Hedeby came from Central Asia, not from closer deposits on the Iberian Peninsula[36] (however, there are also other deposits of cinnabar known in Europe, including Moschellandsberg in Germany). They base their claim on quite sparse evidence of contact between Northern Europe and the Western Caliphate on the one hand, and, on the other hand, on a large quantity of Samanid dirhams known from the northeastern part of Europe. Be that as it may, the arrival of these coins across Eastern Europe can hardly be regarded as evidence of contact between Hedeby and the Samanid Empire. The focus of H. Steuer and colleagues is on several small sherds of thick-walled pottery discovered at Hedeby: the authors offer an interpretation as the remnants of vessels used to transport mercury. R. Ettinghausen in particular defended this use of sphero-conical vessels known in numerous exemplars from the eastern part of the Arab world[37]; their appearance, however, dates to the 10^{th}–14^{th} centuries. To date, no analyses have confirmed the anticipated traces of mercury on the walls of these vessels. Despite the small dimensions of the relevant sherds from Hedeby, which makes any classification more complicated[38], it is clear that they do not correspond to the shape of the Arab vessels in question. In any case, this is irrelevant in the light of the inscription on the sphero-conical vessels from Persia, which urge their users to “Drink to your good health,” and which are therefore justifiably interpreted as vessels for beer[39].

Discussion of social aspects

It would be a mistake to try to deduce how frequently tests on precious metals were carried out from randomly preserved and recorded streaks on touchstones. Furthermore, we could only analyse a small number of the items from Hedeby that have the potential to be touchstones. Nevertheless, in comparison with cemeteries at comparable sites (e.g. Birka in Sweden or Dziekanowice in Poland; of course, any type of comparison is imprecise), it is impossible to ignore the absence of traces of tests on gold and the rarity of traces of silver on the touchstones analysed at Hedeby. Both these precious metals and their alloys are found relatively often on touchstones, even at sites of far lesser importance, including rural cemeteries. Resi’s discovery of gold (not confirmed by a chemical microanalysis?) on one of the stones from a settlement context at Hedeby[40] is another reason not to doubt that objects made from this metal were actually tested at the site. At any rate, as is the case at other Viking Age sites in Northern Europe and in Slavic agglomerations between the German Elbe and North-Russian Volga[41], hundreds of touchstones at least can be expected in the settlement context of Hedeby. However, prior to the analysis of a far greater number of stone artefacts likely to be touchstones from Hedeby, we shall focus our interest on the question of the social standing of the individuals buried with touchstones.

We should reiterate that the identification of traces of streaks from non-ferrous metal objects on touchstones is the result of the convergence of numerous known and unknown circumstances; moreover, uncleaned or imperfectly cleaned streaks cannot attest to the range of metals tested in the past, not to mention the methods used to clean archaeological finds. Still, one of two stones in the assemblage of 18 specimens on which traces of silver have been recorded comes from a grave furnished with, among other artefacts, a silver amulet case (Gr. no. 875). This stone belongs to a group of artefacts made from banded schist, a raw material used for touchstones in Northern Europe[42]. Several such characteristically-shaped stones were also found in settlement contexts at Hedeby[43]. Unfinished products discovered there document the import of this raw material and its local working[44].

Although the high social status of individuals buried in chamber graves is beyond doubt, the touchstone from Chamber Grave no. 4 only revealed numerous linear streaks of tin. The remaining graves from which the stones provided the traces of non-ferrous metals either had no other grave goods that could be identified using archaeological methods or were furnished very modestly[45]. These also include the second recorded specimen in the sample studied that had traces of silver; the stone from Grave

34 Streaks of an amalgamated metal are preserved also on the touchstone from Grave no. 56 in Birka.
35 See Armbruster 2002, 177, with refs.
36 Steuer *et al.* 2002, 159–162.
37 Ettinghausen 1965.
38 See Steuer *et al.* 2002, fig. 19.
39 Qūčānī 1987; Ghouchani/Adle 1992.
40 Resi 1990, 40; 62 table 28,1.
41 See Ježek 2013b.
42 Aside from Birka, e.g. Ježek 2013b, fig. 4; 2014, fig. 1; 2015, fig. 6.
43 See Resi 1990, 34–36 table 20.
44 Resi 1990, 35 table 21.
45 Arents/Eisenschmidt 2010b.

no. 575 was accompanied by a knife only. Touchstones or candidates for this classification are recorded in three of the 23 graves at Hedeby designated as elite burials[46]. This variability shows that the tools used for determining metal found in burials cannot be used as a reliable social indicator. The presence of this type of artefact in graves is nothing more than a reflection of the choice of the survivors from a range of symbols used at the moment of bidding their final farewell; attempts at a grave good-based social differentiation of burials using such artefacts would be pointless in the case of Hedeby.

At Hedeby the touchstones found in graves were recovered in the area of the waist, hips or calves, more often on the right side of the skeleton. They do, however, also occur by the right knee (Gr. no. 193), the left elbow (Gr. no. 203), the right shoulder (Gr. no. 26), or the chest (Gr. no. 1028). These four touchstones have a hole for hanging; Grave no. 1112 yielded an exemplar featuring a notch for hanging on the right forearm. Further, cases of children's graves with touchstones (often laid at the waist) confirm that the placement of such artefacts in the grave did not reflect the reality of the deceased individual's life[47]. As a symbol, the touchstone fulfilled a function in the burial rite whichever position it was laid in, regardless it was visibly placed or put in a bag, as can be assumed for the specimens without a hole for hanging and which were found in the area of the waist or hips.

Making assumptions about the differences in the position of touchstones in a burial would be as erroneous as drawing conclusions about social standing of deceased on the basis of presence or absence of traces of precious metals. Finally, as numerous children's graves furnished with weights or touchstones demonstrate, many individuals met with these objects only after their passing.

Conclusions

Touchstones were placed in graves as an object of intimate dialogue (better, monologue) between the survivors and the deceased from the Eneolithic[48]. The same role is later played by balance scales, weights and other, often far more valuable, objects in graves. However, the social testimony of touchstones or weights in a grave without any other distinct furnishings must be considered separately for each site. In contrast to extraordinary sites (Hedeby being one such site), tools used for determining the value of metal play an important role in establishing a social identity especially in rural cemeteries. In the case of Hedeby, an analysis of the spatial distribution of touchstones in the settlement layers in particular offers better insights into the production, social, or even 'professional' structure of this site. Both trade and goldsmithing took place at Hedeby[49]. It can be assumed that hundreds or even thousands of touchstones will be identified in the local finds assemblage.

At Hedeby, there is a conspicuously low representation of streaks of precious metals in comparison to touchstones from other European early medieval sites analysed to date. Birka and Dziekanowice have been mentioned; further (analytically confirmed) examples come from Valsgärde, Tuna in Alsike, Vendel (Sweden), Starigard/Oldenburg, Thumby-Bienebek (Germany), Pokrzywnica Wielka, Łączyno Stare, and Końskie (Poland) as well as from other sites[50]. However, there is a difference between these occurrences and Hedeby: the examples cited are linked with the social elite. Despite all its wealth, the trade centre of Hedeby is not such a place: its social profile is much more diverse. Due to the standing of Hedeby in Viking Age trade, there is no doubt that dozens or even hundreds of unanalysed typical stone artefacts from local settlements carry traces of precious metal. But these objects are considered of lesser importance than touchstones with traces of metals that attest to ancient metal technology. The evidence for the amalgamation of brass from Hedeby is one such case.

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46 Arents/Eisenschmidt 2010a, 301.
47 Cf. Ježek 2013a, 150–151.
48 Ježek 2013b, 726–727; 2015.
49 Armbruster 2002 and 2012.
50 Ježek 2013a; 2013b and 2014; Ježek/Zavřel 2013.

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Appendix

Description of the stone artefacts from the Hedeby graves in this study

All the artefacts are made of grey, greyish-brown, greyish-green or greyish-ochre schist, mostly with a large proportion of mica. The artefact made of banded schist from grave no. 875 is an exception.

Gr. no. – grave number[51]; L. – length; w. – width; h. – height; max. – maximal.

Gr. no. 26. An oblong artefact with a rectangular cross-section; one end bears traces of the incomplete perforation of two holes; the artefact slightly narrows in both lengthwise sections towards the part-perforated end. L. 6.5 cm, max. w. 1.5 cm, max. h. 0.9 cm.

Gr. no. 28. An oblong four-sided artefact; one end has a perforated hole; the artefact slightly narrows in both lengthwise sections towards the perforated end. A ferric crust is present on the sides (probably the remains of contact with an iron object in the grave). L. 8.5 cm, max. w. 1.6 cm, max. h. 1.1 cm.

Gr. no. 193. An oblong, irregular, four-sided artefact; one end has a perforated hole; the artefact slightly narrows toward the perforated end. L. 12.3 cm, w. 1.2 cm, h. 1.1 cm.

Gr. no. 208. A small, oblong artefact with a square cross-section; both ends narrow slightly. L. 6.4 cm, max. w. 0.6 cm, max. h. 0.5 cm.

Gr. no. 247. A small, oblong artefact with a square cross-section; one end has a perforated hole. L. 5.9 cm, w. 0.7 cm, h. 0.6 cm.

Gr. no. 252. An oblong artefact with a square cross-section; one end has a perforated hole; the artefact slightly narrows in one of the lengthwise sections. L. 10.0 cm, w. 0.9 cm, max. h. 1.0 cm.

Gr. no. 513. An oblong, slim artefact with a rectangular cross-section; one end has a perforated hole; the artefact slightly narrows in both lengthwise sections towards both ends. L. 10.3 cm, max. w. 1.2 cm, max. h. 0.8 cm.

Gr. no. 562. A small, oblong artefact with a rectangular cross-section; one end has a perforated hole, the opposite end is damaged. The extant length is 6.2 cm, w. 0.7 cm, max. h. 0.5 cm.

Gr. no. 575. A flat, oblong artefact which narrows towards one end with a perforated hole. Although the opposite end is damaged, the original length can be ascertained. L. 7.3 cm, max. w. 2.3 cm, max. h. 0.6 cm.

Gr. no. 829. An oblong artefact with a rectangular cross-section; one end has a perforated hole; the artefact slightly narrows towards this end. L. 8.0 cm, max. w. 1.9 cm, max. h. 1.0 cm.

Gr. no. 875. Banded schist. An oblong artefact with a nearly square cross-section. One end (with rounded corners) features a perforated hole in which a ring for hanging has survived. In one of the lengthwise sections the artefact narrows slightly toward the perforated end. L. 8.0 cm, max. w. 1.3 cm, max. h. 1.1 cm.

Gr. no. 907. A flat artefact with a nearly oval cross-section; one (rounded) end has a perforated hole. L. 7.8 cm, w. 1.1 cm, max. h. 0.5 cm.

Gr. no. 913. An oblong artefact with a rectangular cross-section; one end has a perforated hole. L. 8.5 cm, max. w. 1.3 cm, h. 0.7 cm.

Gr. no. 967. An oblong artefact with a rectangular cross-section and with rounded ends; one end has a perforated hole. L. 8.0 cm, max. w. 1.1 cm, max. h. 0.7 cm.

Gr. no. 1017. An oblong artefact with a rectangular cross-section; one rounded end features notches for winding a cord or wire; the artefact narrows slightly toward the opposite end. L. 14.4 cm, max. w. 1.0 cm, max. h. 0.6 cm.

Gr. no. 1028. An oblong artefact with a rectangular cross-section and with rounded corners; one end has a perforated hole. L. 11.7 cm, max. w. 1.3 cm, max. h. 0.9 cm.

Gr. no. 1112. A flat, oblong artefact, with a rectangular cross-section, that narrows toward one end. The wider end is rounded, while the narrower end is shaped in a spherical head that is separated from the body of the artefact by distinct notching (for winding a cord or wire). L. 8.3 cm, max. w. 1.8 cm, max. h. 0.6 cm.

51 According to Arents/Eisenschmidt 2010b.

Kagr. (Chamber Grave) 4. An elegant, rectangular artefact, with a slightly rectangular cross-section, that narrows slightly toward both ends. One end is separated from the body of the artefact by a fine notch, which was probably intended as a decorative element. A perforated hole appears above the notch. A ferric crust is present on three sides of the artefact (probably the remains of contact with an iron object in the grave). L. 11.8 cm, max. w. 1.2 cm, max. h. 1.0 cm.