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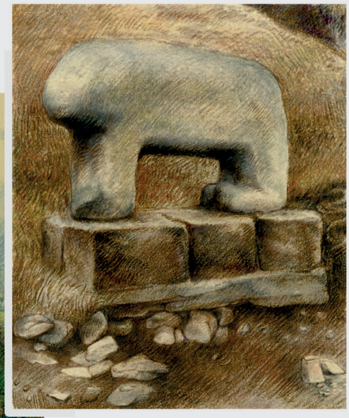

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A UNIQUE DEPOSIT OF THE ÚNĚTICE CULTURE HALBERDS FOUND IN MARKOSICE

Abstract: In 2010, an accidental discovery of two Únětice culture halberds was made.in the village of Markosice They were later donated to the Museum Chamber of the Society of Friends of Gubin Region, whose board subsequently decided to commission the Institute of Archaeology of Wrocław University to carry out further research on the Early Bronze Age finds and the site where they were found. In this study you will find a detailed description of the halberds, an initial site survey and the results of a physicochemical analysis of the aforementioned artefacts.
Keywords: physicochemical analysis, magnetometer survey, halberds, Únětice culture, bronze metallurgy, hoard, early Bronze Age

INTRODUCTION

In the Autumn of 2010 Police Officers from Gubin found out about an accidental discovery of two metal objects dating back most likely to the prehistoric time. The discovery was made by Mr Marek Gawlik, a farmer from Sadzarzewice, who pointed them to the discovery site and described the positioning of the objects at the time of discovery. He also agreed that the artefacts would be donated to the Museum Chamber of the Society of Friends of Gubin Region. Among the persons informed of this discovery was Prof. Grzegorz Domański, who has been carrying out systematic archaeological analyses of the Gubin microregion for decades. He, in turn, informed Prof. Irena Lasak, who expressed interest in evaluating the newly found hoard. After

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an initial analysis, we concluded that this find of two Únětice culture halberds made entirely of bronze is a unique find of European importance.

Based on the description of the discovery circumstances, it was established that the moment of discovery, one of the halberds was visible above the ground surface. After the removal of the first halberd, a second one appeared at the same depth. Both halberds were placed opposing each other– with shifts facing to the inside and blades facing outwards in unspecified direction (Fig. 2). Despite heavy corrosion, the halberds survived in quite a good condition (Fig. 6).

A surface survey and magnetic prospection[1] of the discovery site was done in 2010. This survey included the geomagnetic prospection of an area of 2400 sq metres surrounding the discovery site using the Bartington Grad 601–2 gradiometer (Fig. 3). Although the type of subsoil found on the site was not very susceptible, researchers hoped to register regularities in geomagnetic anomalies and use the patterns to understand the wider picture of circumstances and context of the discovery (e.g. a bank of a lake for example). Unfortunately, the test results did not show any clearly interpretable patterns in the geomagnetic anomalies of the terrain, although several dipole anomalies were identified among them, which could be useful, should a wider terrain analysis be carried out in the future.

The Laboratory for Archaeological Conservation and Archaeometry of Wrocław University took it upon itself to carry out specialist analyses of the artefacts leased to them by the Society of Friends of the Gubin Region.

ENVIRONMENTAL AND NATURAL CONTEXT

The Markosice village is situated roughly 13 km southwest of Gubin, which, according to J. Kondracki's regionalisation of Poland places them within the Gubin Heights mesoregion (315.71), an area belonging to Zielona Góra Heights (315.7) of South Baltic Lakeland (314–316). This is a marginal zone of the late Polish glaciation. The erosion accumulative relief character of this area is an outcome of various processes that occurred here during the glacial meltdown. The southernmost part of this terrain extends to the Brody-Drewitz ridge with a glacial trough on the ridge's northern side. A vast glaciofluvial plain with singular kelm hills and sand-gravel eskers with loam lenses extends north of this ridge. The relative height of these formations reaches 20 meters. It is a sparsely populated woodland terrain dotted with small lakes (Kondracki 1988, 299; Głowacki 2006).

The site of the halberds' discovery is situated on the eastern edges of the glacial trough set on the northern part of the Brody-Drewitz Ridge, which spreads from Brody to the Nysa Łużycka Valley not far from Markosice. It is likely that these

[1] This survey was carried out by: Irena Lasak, Grzegorz Domański, Mirosław Furmanek, Radosław Kuźbik and Bartosz Augul.

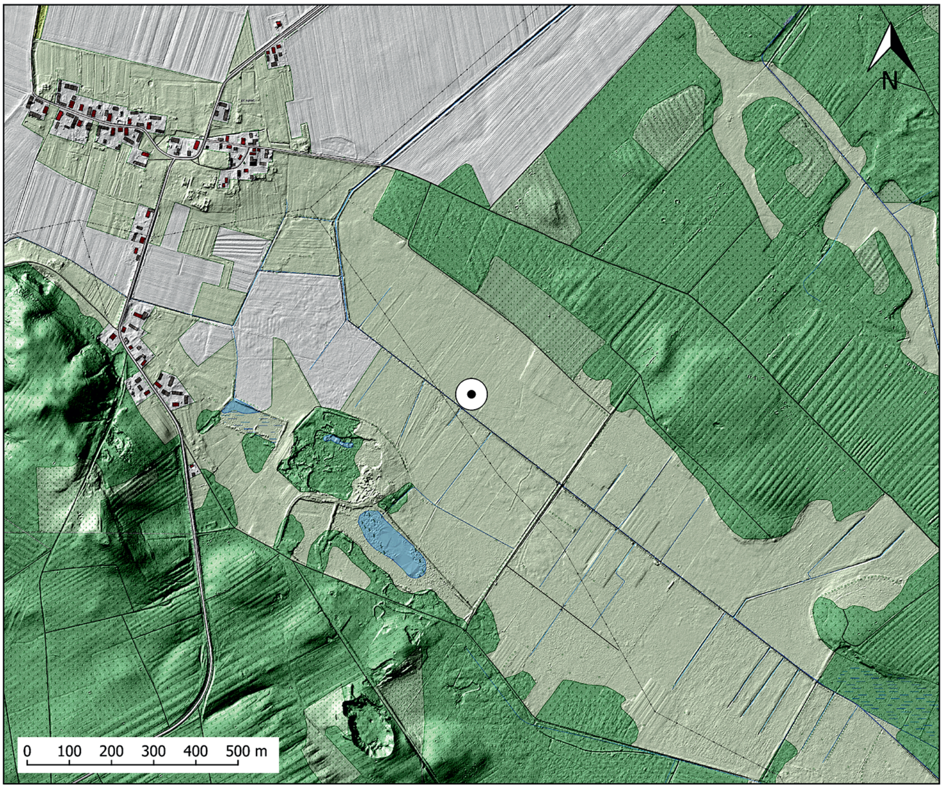


Fig. 1. Markosice. Localisation of the site (prepared by M. Furmanek)

artefacts had once been deposited within the biogenic deposits reservoir, now filled with peat and gyttija. Two such reservoirs clearly existed in the eastern parts of the trough, and Brodzkie and Suchodół lakes are set partly within their area. These lakes formed during the Bølling-Allerød period, and during late Subboreal period transformed into aqua-terrestrial environment (most likely due to biogenic sedimentation) (Głowacki 2006). In recent times, this microregion that has been anthropogenically transformed by drainage canals and ditches.

SETTLEMENT CONTEXT

While there are traces of human activity in this region going back to the Palaeolithic and Mesolithic periods, first firm evidence for human settlements begin in the Neolithic. The Early Bronze Age is most commonly represented by cemeteries and hoards. Settlements are far less numerous in this region, and apart from the hypothetical Únětice culture settlement in Gubin itself (Butent-Stefaniak 1997, 166), we are left only with faint traces of their existence at the sites of Grabice 5, Biecz

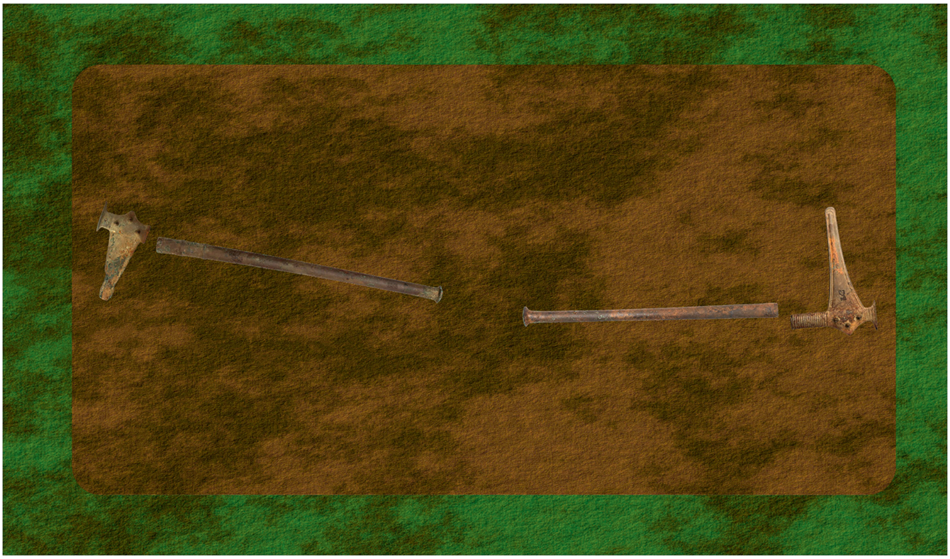


Fig. 2. The reconstruction of halberds' positioning at the time of the discovery (prepared by M. Furmanek)

Fig. 3. The results of magnetic survey (prepared by M. Furmanek)

1 and Gębice 1 (Domański 1992, 68–70). Settlements were most commonly found around the lower course of Nysa Łużycka river, in the south of the so-called "Old Country", and were enclosed within a triangle boardered by Gubin, Brody and Biecz. In general, the settlement zone lies on the edges of Lubsza, Wodra and Nysa Łużycka

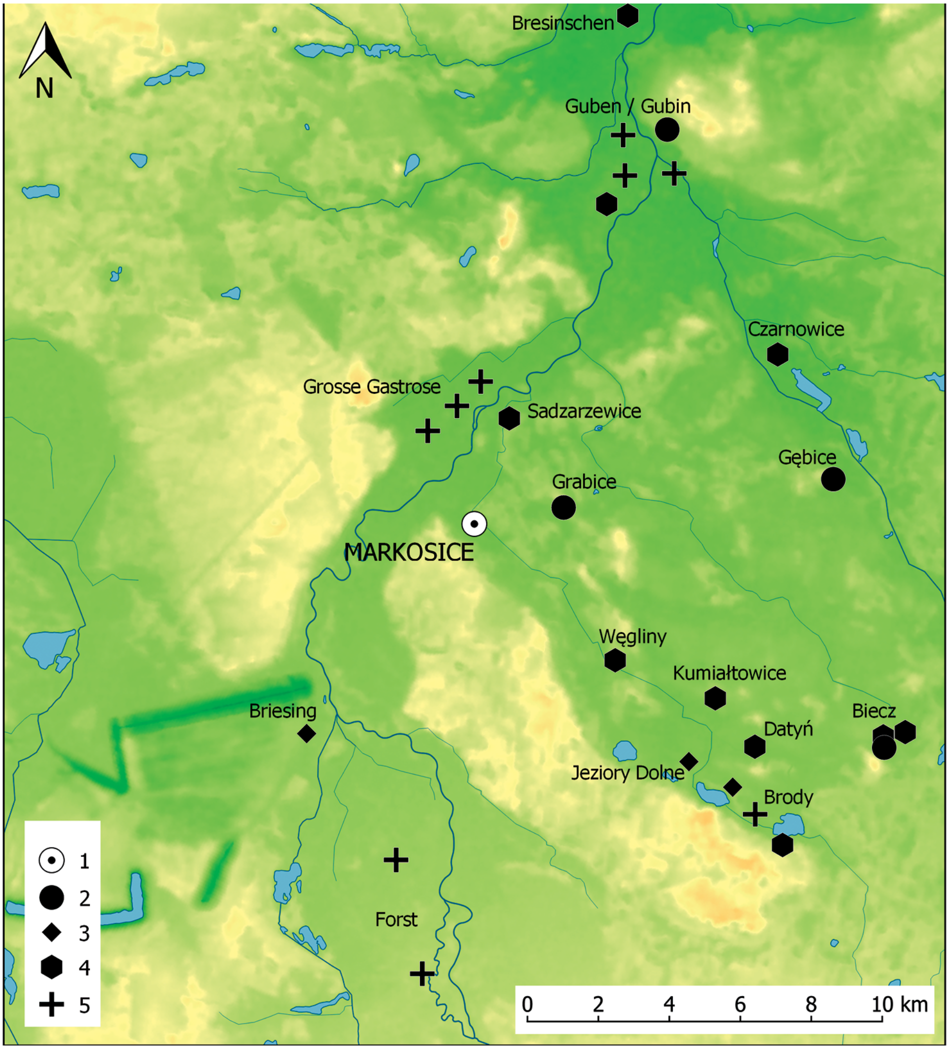


Fig. 4. The map of Early Bronze Age sites: 1 – Markosice site, 2 – settlement, 3 – single bronze finds, 4 – hoards, 5 – cemetery or grave (prepared by M. Furmanek)

river basins, along what are now vast meadow areas, which were originally riparian scrubs (Domański 1992, 70).

The microregion in questions has a larger accumulation of early Bronze Age hoards located across the Nysa Łużycka Valley, all the way to Lubsza in the West. The so-called Gubin aggregation saw 10 such hoards, with the biggest of them found in Bresinchen (Butent-Stefaniak 1997, 212; Breddin 1969, 41). The hoard in question, deposited in 2 large vessels, comprised of 146 bronze items weighing 30.381 kg in total. It included 103 flanged axes and a double axe, 8 daggers, 10 eyelet rings (*Ösenringe*), 22 bracelets, and 2 halberds (Breddin 1969, 15, Abb. 4–18). Although raw bronze material is found in some of the sites of the Gubin aggregation, the vast majority of hoards are of an ornamental character. Most of them may be connected to the classic period of the Únětice culture, with the exception of the Węgliny grouping, which seems to derive from a slightly later period (Butent-Stefaniak 1997, 212, 214, 217). The hoards of Odra basin comprise one of four groups of this kind of the Únětice culture findings. This group, associated with the banks of Odra River is represented mostly by axes and necklaces, and less numerous shoulder guards with composition similar to that of findings from Saale river basin (Butent-Stefaniak 1997, 213). Due to the presence of raw material pieces, unfinished items and similar kinds of products appearing frequently, it is suspected that most of these hoards had been hidden by metallurgist-merchants travelling the "Odra Trail", which traditionally connected the South and the North allowing cultural and material exchange throughout many prehistoric periods. Cult-related deposits have also been found, but are less numerous and best represented by these found in peat bogs (e.g. Biecz peat lands) (Butent-Stefaniak 1967, 213, 217).

There is a well-pronounced accumulation of the Únětice culture sites near Gubin, especially to the south of this town, on both sides of Nysa Łużycka river. Along the right bank of the river hoards were discovered in Biecz, Brody, Czarnowice, Datyń, Kumiałtowice, Sadzarzewice and Węgliny. The left bank saw discoveries in Bresinchen and Forst (Breddin 1969, 42–46). The majority of these hoards were characterized by ornaments, although a few bronze axes were also found (Sadzarzewice, Węgliny) and the only dagger in the region was discovered in Biecz 2.

The deposit from Bresinchen was the only hoard from the Gubin region that included blades of two halberds, which, in the past, would also have had wooden shafts representing two types: a so-called Northern Greater Polish ('Northern Poznań type' according to G. Kossina, or "Polish type" according to W. A.v. Brunn) and a Brandenburg type ('South-West-Brandenburg-Meklemburg type' according to G. Kossinna, or 'North-German type' according to W. A. v. Brunn) (Breddin 1969, 16, 20, Abb. 13, Taf. 5: 4–5).

CHARACTERISTICS OF THE HALBERDS FROM MARKOSICE

The macroscopic assessment we carried out at the beginning indicated that one of the halberd blades (No.2) with a shorter and partly damaged blade fitted the longer shaft (No.3), but there is no certainty whether the other, better preserved head with a longer blade (No. 1), and the shorter shaft (No.4) also served as integral parts of another halberd (Fig 5–6). In theory, we could have two possibilities: both the blade and the shaft were integral parts of a halberd deposited in its entirety, or both fragments came from different artefacts and were randomly put together as a symbolic deposit. The true scenario seems impossible to establish, even if we take into account the results of the physicochemical tests of alloys used to create the halberds, which will be discussed below.

It seems sensible to take into account a possibility of the halberds being a forgery. Detailed analysis of X-ray imagery of the artefacts seemed to reveal an iron rivet in one of the shafts (No. 3). It was agreed that a physicochemical analysis of the artefacts and comparative analysis of other Early Bronze Age items, especially those connected to the Únětice metallurgy workshops were necessary to answer all the questions related to the halberds and establish what technologies might have been used in their making.

HALBERD I

This quite massive halberd blade (No. 2) comprising of a socket and a blade is thought to have been cast as one piece, although a rivet located in the upper part of the blade is visible with the naked eye and appears in the X-ray pictures as well (Fig. 7). The positioning of the rivet is difficult to explain in the constructional context of a possible two-part blade as it sits too high above the possible connecting point between the shaft and the blade of the halberd blade. Considering the sleeve in the bottom part of the head poll is quite short, it is possible that this rivet, and possibly another, non-visible one, were used to secure the hilt in the halberd's blade. There is considerable corrosion related damage to the blade of the halberd and the blade in particular, which can be observed macroscopically. The blade, whose edges and end are chipped has a triangular shape with flat and wide ribbing, and sits in a triangle-ended socket. It is finished with a flat, oval disc at the top, whilst the bottom part is thicker and reinforced, probably to make the shaft fastening more secure. Grooves are running around the base of the disc and around the bottom and top parts of the blade's socket, both sides of which are further embellished with large, triple pseudo-studs with sharp tips. The total length of the blade is 20.6 cm (19.4 cm in the surviving state), the shaft's length is 10.4 cm and the blade's length is 14.8 cm (surviving length is 13.8 cm). The maximum blade width is 6.6 cm, the diameter of the base of the sleeve measures 3 × 1.4 cm, the disc diameter and thickness are 6.4 × 2.2 cm and 0.2 cm respectively, the pseudo-studs height is ca. 1.6 cm, and their diameter at the base measures roughly 1 cm. The total weight of the blade is 308 g.

The shaft of the halberd in question (No.3) is long and hollow (sleeve shape) with lens-like cross-section. There are two ring-like thickenings at the top with grooves running all the way around, very similar to those at the base of the blade's socket. The bottom part of the sleeve hilt is well pronounced and finished with a semi-sphere. X-ray imagery revealed a small rivet hole between the afore-mentioned rings corresponding to a small thickening of the surface, which indicates the presence of a rivet (sample 3a). A rivet-like structure (sample 3b) was recovered from the inside of the shaft's sleeve while inside surface scrapings (at the depth of ca. 8.5 cm from

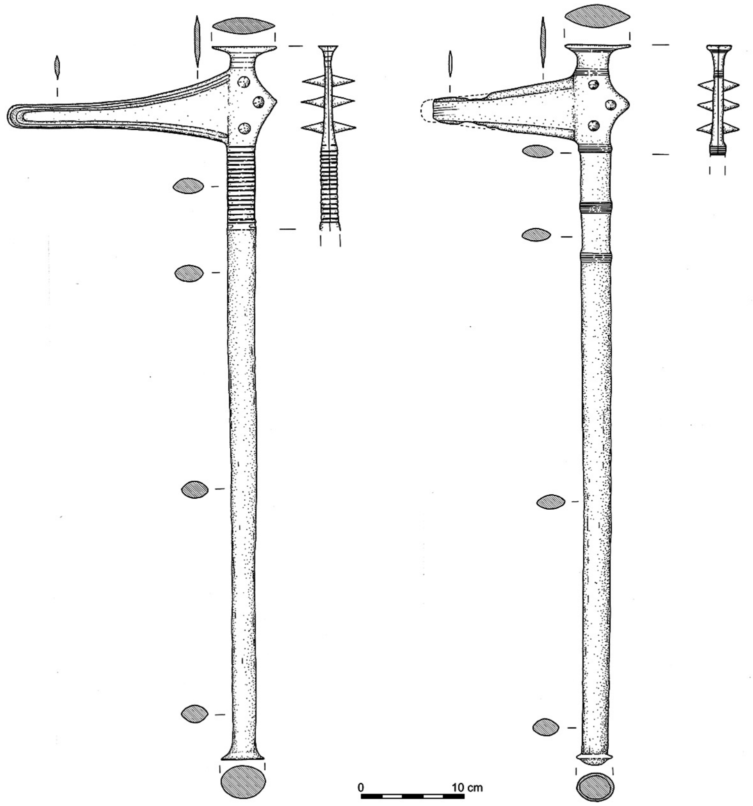


Fig. 5. Halberds from the Markosice deposit (drawing by N. Lenkow)

its base by the blade) were being collected for analysis. The shaft measures 60 cm in length, about 3 × 1.4 – 2.6 × 1.6 cm in diameter and weights 848 g. The diameter of the semi-spherical pommel is 3.6 × 3 cm.

HALBERD II

The blade and the shaft of this halberd do not fit together. Although this leads us to the assumption that they were put together randomly (or perhaps for ritual reasons?), there are also signs of some fragments of the top part of the shaft are missing, which suggests a possibility that they indeed were once parts of the same artefact. The bottom part of the shaft also shows signs of damage, and the surface of the entire halberd is covered with layers of corrosion.

Fig. 6. Halberds from the Markosice deposit (photo by M. Mackiewicz)

The blade of this halberd (No.1), most likely also cast as one piece, is larger and thinner than that of the other halberd. Its blade is longer and triangular in shape with slightly thinner edges and a wide, rounded tip, reminiscent of a duck's beak. There is also a wide central rib on the blade outlined by a double groove. The back of the shaft is triangular in shape with three sharp pseudo-studs on each side. Above it, from the tip of the blade emerges a convex lens – shaped plate with rows of a circular grooves running around its base. Several more (around 20) rows of such grooves run around the base of the blade, where the shaft would be secured. The length of the blade of the halberd, its shaft and blade is 26 cm, 17 cm and 21.2 cm respectively. The blade's width is 7.4 cm in its widest point, the bush measures 3 cm × 1.6 cm in diameter at its base, the top plate is 6 cm × 1.6 cm in diameter and 0.5 cm thick. The pseudo-studs protrude 2.2 cm above the surface and are about 1.2 cm in diameter at the base. The blade weights 494 g.

The shaft (No. 4) is chipped at one end, but a fragment of a circular groove is still visible there. The shaft's knob is thicker and topped with a convex lens – shaped plate. The shaft's cross-section is also lens-like in shape. In the present condition the shaft is 52.5 cm long, the diameter of the lens-shaped sleeve is 2.8 cm × 1.8 cm, the diameter of the plate equals 4.2 cm × 3.4 cm, and it weighs 720 g.

SPECIALIST ANALYSIS

The chemical composition was determined using the Spectro Midex X-ray fluorescence spectrometer, which allows for a virtually non-invasive analysis of small objects. In this case, because of the artefacts' size and poor state of preservation, the spectral analysis was performed in two stages. The first stage involved the cleaning of the artefacts and their surface analysis. During the second stage, micro boreholes 0.5 cm in diameter, and 4–5 cm deep were drilled (using Hss-Super, Heller Germany drill bits) in the surface, and the shavings were then analysed.

The results showed that the alloy of which the artefacts were made is mostly copper (Cu) with other metal additives, mostly tin (Sn), antimony (Sb), arsenic (As) and silver (Ag). It is unlikely that lead (Pb) and bismuth (Bi) were actual ingredients of the fragments tested. Determining the exact concentration of lead and arsenic using the Spectro-Midex spectrometers is quite problematic due to the proximity of the major analytical signals of these elements (K_αAs 10.50 keV, L_αPb 10.55 keV) and the algorithm used in this device, which only shows the concentration of lead. The presence of lead in the sample taken from the halberd's blade was excluded after comparing the sample's spectrum signals to the typical spectrum signal pattern of lead with further lines also taken into account. The presence of K_βAs (11.58 keV) lines, and the lack of the L_βPb (12.61 keV) signal indicates the presence of arsenic, but excluded lead.

The results varied widely during the first stage of the analytical assessment (table 1), and surprisingly showed a high concentration of iron in some samples of halberds' parts (e.g. 1–2, 2–3), but particularly in the samples taken from bottom parts of halberds' blades (parts 1–1 and 2–2), most likely due to the artefacts' corroding in an iron-rich environment.

The presence of rivets in the blade and shaft of halberd I raised many doubts from the beginning of the analysis. The analysis of the blade's rivet showed it was a copper structure with some other metal additives. In a sample taken from the blade of a highly corroded rivet located on the shaft, the analysis showed iron as the most common ingredient. At the same time, a sample taken from the other blade of the same rivet (sample 3b) showed copper as its main component. The comparison of the results of analysis of the rivets and other parts of the halberds shows that the level of iron concentration in samples increases with the amount of corrosion, and its presence in the samples is most likely linked to its presence in the soil in which they were deposited.

The results of the second stage of the analysis were much more precise and consisted of a series of tests performed on shavings derived from micro boreholes drilled in the artefacts' surface. This approach can be justified by the fact that the surface of both artefacts was highly corroded, which would contaminate the metal sourced for analysis. Between four and ten analyses were performed on each sample (Fig. 8, table 2). In both of the bushes, at the base of the blades a residue of mixed organic matter and fine-grained, bronze in colour substance was also found. In the bushes

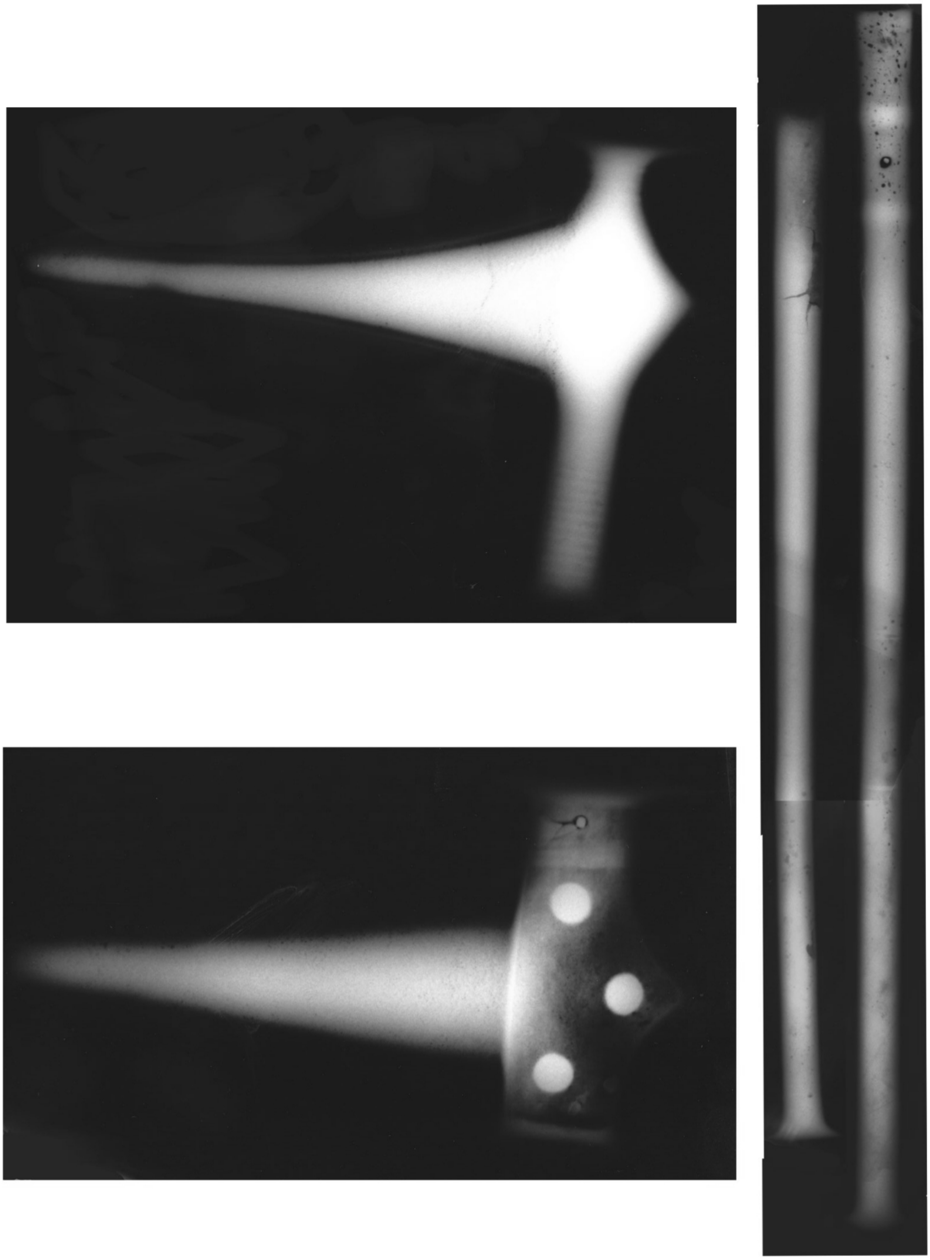


Fig. 7. X-ray image of the halberds (prepared by B. Miazga)

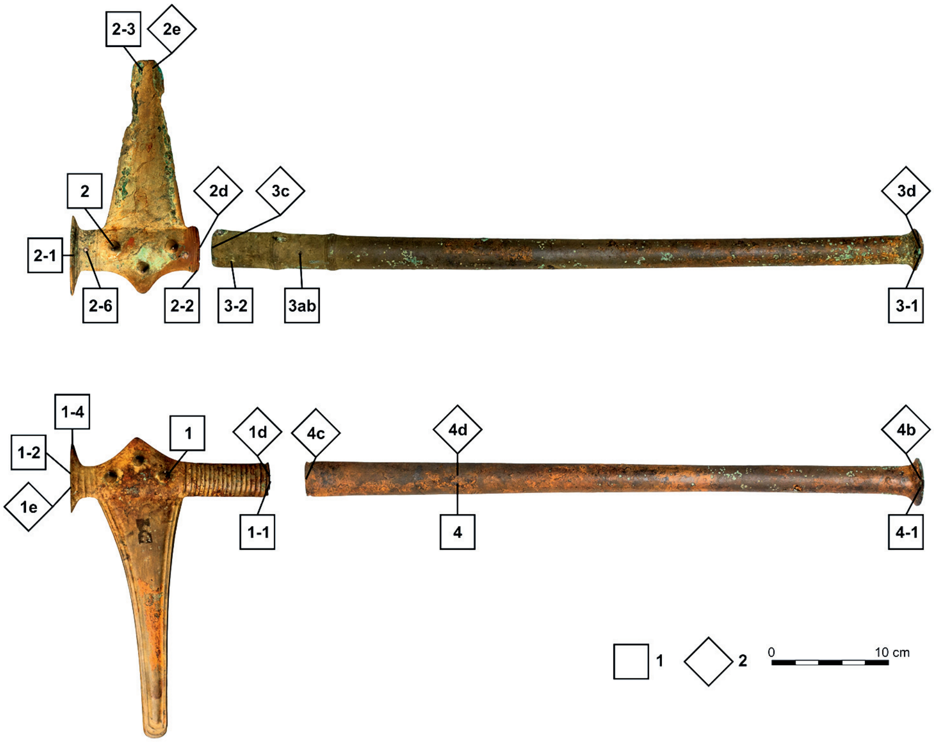


Fig. 8. Sampling points for XRF analysis (prepared by M. Furmanek, photo by M. Mackiewicz)

of the shafts on the other hand, only rusty – brown, highly oxidised, powder-like substance was discovered, which, according to XRF analysis, is rich in iron. A small metal fragment was also recovered, which is most likely the rivet found during sample taking.

These analyses show certain similarities and differences between the shafts and their various parts. The concentration of copper in the samples we analysed is between 75.8% and 89.2%, and was the lowest in the samples taken from blade No.1 (79.4% and 80.4% on average in samples analysed), and the edge of blade No.2 (80.7%). The copper content was higher in all other samples from both of the shafts (84.0% to 87.1% on average), the base of the blade No.2 (84.7%), and the rivet found in the shaft (86.5%). The tin concentration also varied and was higher in the blade No.1 (11.6% and13.2% on average), and much lower (4.3%–6.8%) in all the other parts of both halberds. The silver content was quite similar across all samples (0.8% – 1.0% on average) except for the samples taken from the blade No.2, which showed a slightly higher silver concentration (ca. 1.2%). The percentage of arsenic in the samples differed from that of copper and tin and was higher in the samples taken from blade No.2 (4.1% and 4.06% on average) compared to other samples, which comprised of between 1.9% and 3.1% of arsenic. Similar pattern emerges when analysing the sum of trace elements

Table 1. Results of chemical composition analyses carried out during the first stage research

description	element / sample	Fe %	Ni %	Cu %	Ag %	Sn %	Sb %	As %
Halberd II-blade	1	0.3	0.1	75.8	1.0	17.3	1.5	2.9
	1a	0.8	0.1	72.3	1.1	19.8	1.7	3.1
	1–1	9.3	0.1	52.0	1.4	30.2	2.4	3.2
	1–2	5.2	0.1	56.5	1.6	27.0	2.3	6.2
	1–2a	1.5	<	5.2	0.2	2.9	0.2	0.3
	1–3	0.2	0.1	68.9	1.3	23.2	2.1	3.3
Halberd I- blade	2	0.2	<	74.9	1.7	14.5	1.8	5.5
	2–1	0.9	<	66.0	2.7	21.6	2.4	5.0
	2–2a	8.6	<	77.2	1.1	8.2	0.8	2.6
	2–2b	13.5	<	65.4	1.6	12.7	1.5	4.0
	2–2c	7.7	<	59.6	2.7	22.3	2.2	3.8
	2–2d	9.7	<	68.5	1.7	13.5	1.5	3.8
	2–3	9.3	<	61.2	2.4	19.4	1.8	4.3
	2–3a	12.8	<	52. 8	2.9	23.2	2.2	4.6
	2–4	1.8	<	48. 9	4.2	33.8	3.0	6.8
	2–5 (rivet)	0.5	<	86.4	1.6	6.1	0.8	1.3
	2–6 (rivet)	2.0	<	13.9	<	0.3	<	0.4
Halberd I-shaft	3 (rivet)	27.7	–	3.1	<	0.1	<	0.2
	3a (rivet)	32.4	–	4.1	0.1	0.1	<	0.2
	3b (rivet)	0.4	<	90.2	0.6	5.3	0.4	0.1
	3–1	1.1	<	83.6	1.5	7.7	0.8	3.7
	3–2	0.8	<	81.8	0.8	11.9	0.7	2. 6
	3–3	4.4	<	10.5	0.2	1.0	<	0.5
Halberd II- shaft	4	<	–	8.4	<	0.4	0.1	0.2
	4–1	1.4	–	16.1	0.3	2.8	0.2	0.6
	4–2	<	–	2.7	0.2	1.3	0.2	0.5
	4a	1.0	–	6.1	0.1	0.8	0.1	0.1

< – below 0.1%

Table 2. Statistic characteristics of halberds' chemical composition

		Fe	Ni	Cu	Ag	Sn	Sb	As (Pb)
1d	N	10	10	10	10	10	10	10
	Mean	0.89406	0.11772	80.43706	0.77841	11.58765	1.05641	2.89147
	Min	0.00470	0.11150	75.82000	0.57100	7.73600	0.70400	2.48900
	Max	9.85700	0.12560	82.59000	0.88900	13.65000	1.23400	3.31600
	OS	2.361945	0.004357	1.765413	0.084204	1.687015	0.153380	0.270453
1e	N	7	7	7	7	7	7	7
	Mean	0.02496	0.11557	79.40000	0.85771	13.18143	1.19086	3.03629
	Min	0.00470	0.11150	78.89000	0.79700	12.48000	1.08300	2.48900
	Max	0.08440	0.12560	80.43000	0.88900	13.65000	1.23400	3.31600
	OS	0.029685	0.004954	0.579598	0.029227	0.366626	0.053602	0.353889
2d	N	6	6	6	6	6	6	6
	Mean	0.57577	0.03612	84.69167	0.90783	6.52317	0.88283	4.06533
	Min	0.00420	0.03440	83.76000	0.80900	5.31900	0.69900	3.84700
	Max	1.94200	0.03870	85.65000	1.00300	7.32600	1.04100	4.48800
	OS	0.895708	0.001481	0.701011	0.079851	0.798733	0.125013	0.245388

		Fe	Ni	Cu	Ag	Sn	Sb	As (Pb)
2e	N	5	5	5	5	5	5	5
	Mean	0.46420	0.04054	80.72600	1.19720	6.55520	0.88160	3.96960
	Min	0.05940	0.03750	78.58000	1.17200	5.75400	0.79000	3.81900
	Max	1.59000	0.04420	82.08000	1.22600	7.25800	1.01000	4.07000
	OS.	0.643536	0.002599	1.473764	0.024191	0.602752	0.089313	0.109029
3c	N	10	10	10	10	10	10	10
	Mean	1.67540	0.12634	85.45500	0.91040	6.38900	0.82480	2.49440
	Min	0.02007	0.12100	83.53000	0.57600	3.66500	0.49000	2.06600
	Max	4.48000	0.13710	86.80000	1.11300	7.95500	1.01600	2.76500
	OS	1.577077	0.004288	0.950664	0.183867	1.509530	0.185763	0.196646
3d	N	5	5	5	5	5	5	5
	Mean	1.19828	0.12330	85.54000	0.95120	6.61500	0.85840	2.46800
	Min	0.80230	0.11870	84.36000	0.57400	3.88000	0.51900	2.02400
	Max	2.03200	0.13570	88.45000	1.10400	7.70400	1.00800	2.63500
	OS	0.501263	0.007089	1.707703	0.213750	1.552680	0.194765	0.254856
3 rivet	N	6	6	6	6	6	6	6
	Mean	2.54738	0.15163	86.52667	0.87967	4.28233	0.92850	1.89883
	Min	0.27630	0.12450	77.84000	0.44440	2.08000	0.51900	1.08400
	Max	8.15100	0.17660	92.18000	1.39500	6.86500	1.30800	2.62200
	OS	2.900188	0.017310	5.056495	0.327485	1.676215	0.264591	0.524214
4b	N	8	8	8	8	8	8	8
	Mean	0.10136	0.08045	87.13375	0.84200	5.60838	0.85163	2.93413
	Min	0.00470	0.07610	86.18000	0.56200	3.47200	0.51900	2.35500
	Max	0.38640	0.08690	89.22000	1.02400	7.20000	1.08300	3.36900
	OS.	0.129991	0.004267	0.906105	0.176320	1.381597	0.215570	0.335019
4c	N	9	9	9	9	9	9	9
	Mean	0.74516	0.08096	86.62000	0.83433	5.56256	0.82367	2.82956
	Min	0.00537	0.07470	84.51000	0.59000	3.73100	0.52900	2.40100
	Max	3.05000	0.08960	89.25000	1.04800	7.33600	1.09200	3.12800
	OS	1.018747	0.004939	1.413427	0.175434	1.398717	0.207784	0.250197
4d	N	4	4	4	4	4	4	4
	Mean	1.58448	0.07600	84.01000	1.01875	6.82375	0.99775	3.14175
	Min	0.30410	0.07470	81.38000	0.98500	6.16300	0.90300	3.09600
	Max	4.48100	0.07930	85.63000	1.08800	7.64700	1.12400	3.22400
	O.	1.958337	0.002206	1.939399	0.047035	0.615534	0.098219	0.059264

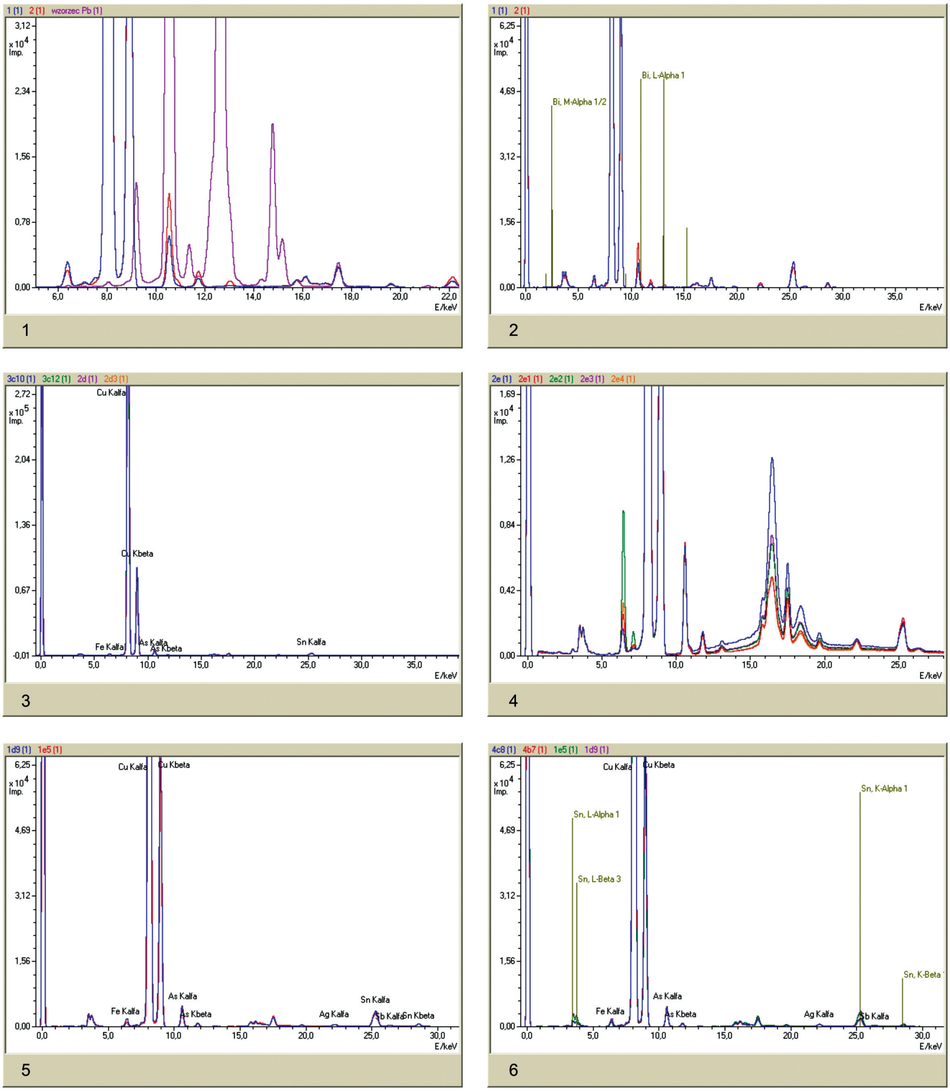


Fig. 9. XRF energy spectrums (1 – spectrum of the analysed halberds and that of typical lead sample (pink line), 2 – spectrum of the analysed halberds with super-imposed bismuth lines dismissing its presence in the samples, 3 – comparison of spectrums of samples from the head (sample 2) and the hilt (sample 3), 4 – spectrum of samples taken from the highly corroded blade of head No. 2, 5 – results for samples from the head No. 1, 6 – comparison of spectrums of samples taken from the head No. 1 (1e5, 1d9) and hilt No. 4 (4c8, 4b7). Prepared by B. Miazga

(arsenic, silver, nickel, and antimony) content in the samples, which is also higher in the samples from the blade No.2 (5.9%–6.1% on average) than in the other samples (3.9%–5.2% on average).

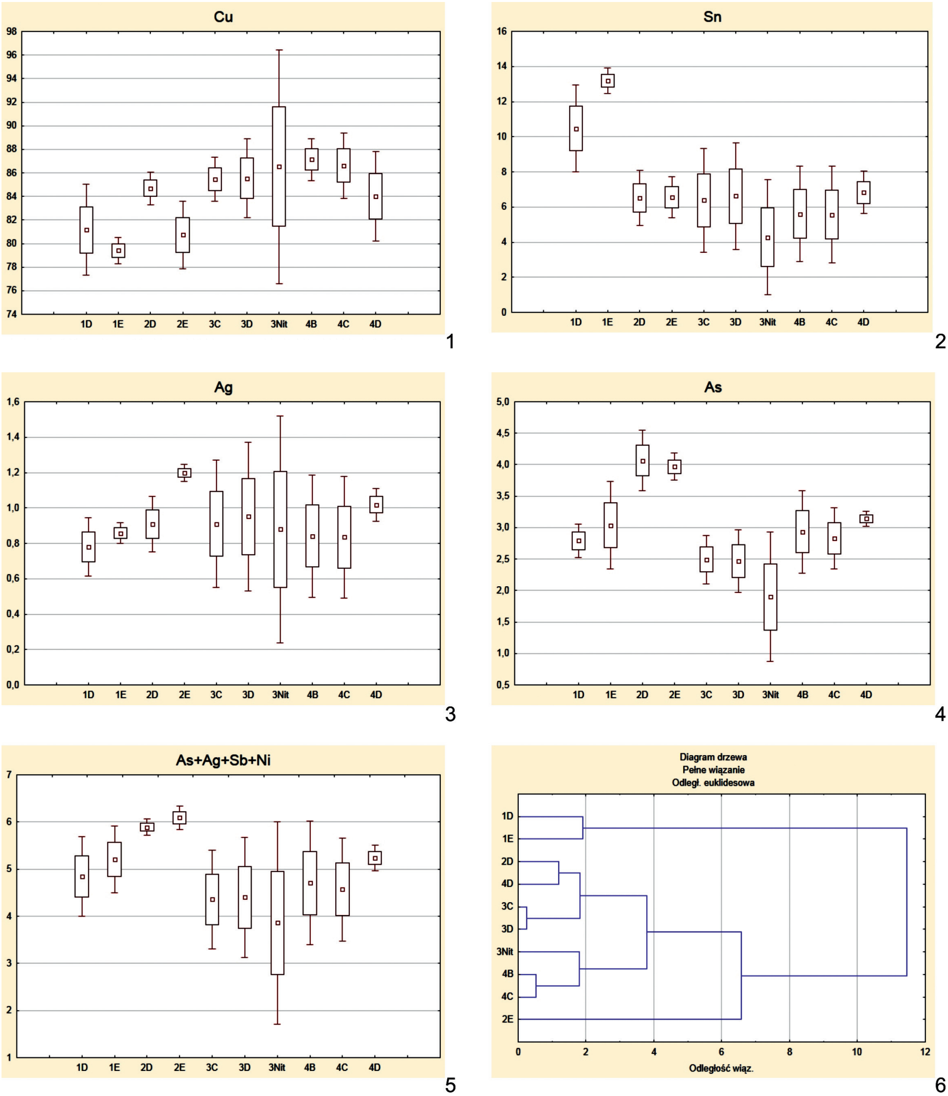
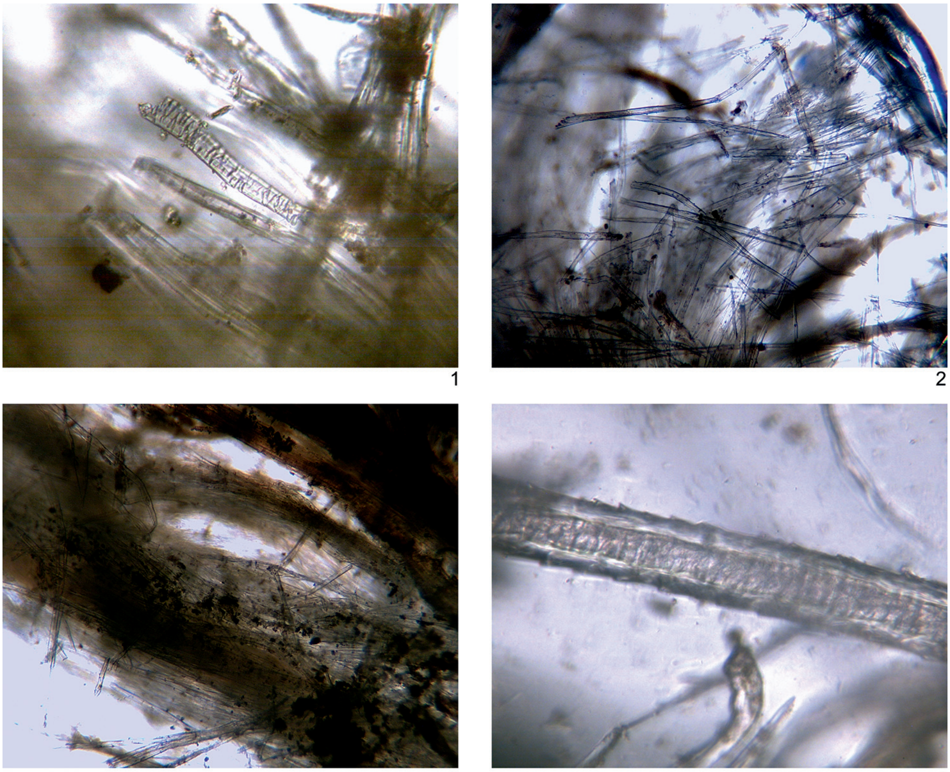


Fig. 10. Diagrams of variations in chemical content of raw material used in the production of halberds (1 – copper, 2 – tin, 3 – silver, 4 – arsenic, 5 – trace elements, 6 – data clustering dendrogram). Prepared by M. Furmanek

To compare the results of these tests, a cluster analysis was performed (Fig. 10: 6). As a result, a dendogram showing similarities between the samples was produced. It showed that the chemical composition of blade No.1 differed the most when compared with samples from other parts of both halberds. Blade No. 2 also showed some differences (indicated earlier by the arsenic and trace elements concentration), but not as pronounced as in the case of blade 1.



1 2 3 4

Fig. 11. Photographs of the macro-residue extracted from inside of the halberds (1–3 – unmarked residue, 4 – hair). Photo by A. Sady-Bugajska

The analysis conducted showed undoubtedly that the blade No. 2 and shaft No. 3 formed an integral part of halberd I. On the other hand, based on the chemical and statistical analysis, the blade and shaft of the other halberd were confirmed to have come from two different artefacts (as suspected after the macroscopic analysis) assembled together to create a new item, or simply deposited together, possibly for ritual reasons. Taking into account the fact that the alloy used in the making of blade No.1 is quite different to those in both shafts sharing similar composition, one could assume it came into the possession of the person or a group of people depositing it later than the halberd I and shaft No.4, which could have happened for various reasons that are difficult to establish at the present moment. Slight differences in the composition of the blade No.2 and both shafts might be due to different ingredients used for their production, which might have been intentional considering each part of the halberd had a different function.

Archeobotanical analysis was also attempted, prompted by the apparent presence of organic matter inside the halberds. Subsequently, seven samples of between 1 cm^3 and 3 cm^3 in volume of fine-grained, rusty coloured mineral sediment, along with botanical residue it carried were taken for analysis from blades and shafts of the halberds. The samples were then soaked and washed on a geological sieve (0.2 mm), to eliminate mineral fraction masking. The residue remaining on the sieve was then placed on Petri dishes and magnified with the use of a stereoscopic microscope. Very thin fragments of organic matter, most likely wood, were identified in four of the samples. Microscopic sections of this matter were then observed under Delta Optical ME 1000 microscope under magnification of between 64x and 1600x. Observations revealed the particles to be composed of fibres sometimes single and separated (?), but unfortunately, they lacked any characteristics that could definitely confirm them to be those of wood. Apart from a botanical residue a presence of a hair was also confirmed in one of the samples (Fig. 11).

THE DISCUSSION

Halberds are some of the most impressive metal objects of the European Early Bronze Age, and despite a long history of research of this category of artefacts which commenced at the brake of the 19th and 20th century, many questions relating to their genesis, function, production sites and even classification, remain unanswered (e.g. Needham 1996; Schuhmacher 2002; Sarnowska 1969a; Czebreszuk 2001), but the most advanced forms, especially those with metal shafts can be undoubtedly considered unique phenomena of Únětice metallurgical workshops (Sarnowska 1969b: 87, 90; Fogel 1983: 142, 149; Kaczmarek 2012: 97).

Due to their triangular shape, the Markosice halberds belong to the Meklemburg type (known also under other names; e.g. Breddin 1969, 28; Gedl 1980, 33, 35–37; Blajer 1990, 33; Kaczmarek 2012, 99–100), and particularly the complete halberd I bares morphological resemblance to similar artefacts from Pomerania (Jelenino, Mierzeszyn), Great Poland (one example from Granów near Łąki Małe – the tomb A in tumulus I), and one found in Silesia discovered in a suspected tumulus grave near Kotla (Gedl 1980, 35–36, Taf. 9–10). The halberd in question is analogically most similar to that found in the Bresinchen hoard discovered about 10 km away from the village of Markosice. That particular halberd has a triangular shaft connected to the blade by two rivets (visible on the X-ray pictures) and a single 'pseudo- rivet', and according to W.A. v. Brunn should be connected to the third variant of Brandenburg (Meklemburg) type of so-called North German halberds (Breddin 1969, 28). The Bresinchen assemblage further proves that two kinds of halberds – with flat and triangular shafts – were being produced and used simultaneously. This is not a unique example as the Granów (Greater Poland) hoard also included halberds of both North Great Polish and Brandenburg types (Sarnowska 1969a, 10, 12, ryc. 3a–b).

Quite a strong uniformity of halberds found in Poland (under 20 examples in total) and the presence and locations of examples of the so-called Greater Poland type in particular suggest they were produced in a metallurgical workshop located in the Greater Poland region (Sarnowska 1969a, 39–40). It is highly unlikely that these complex and impressive weapons were cast in local workshops, which lacked ore resources and experienced metallurgists (Kaczmarek 2012, 99).

Both halberds from Markosice, and other Polish examples have characteristics that link them to the eastern distribution of North German Meklemburg form, generally associated with the classical stage of the Únětice culture (Kaczmarek 2012, 99–100, ryc. 23). A relatively early origin, of the halberd, reaching back to 2100 BC has been indicated by series of radiocarbon dates taken from halberd shafts from the Melz (Meklemburg) hoard, with results showing they could be connected to the BA_{1b} phase (according to H. Vandkilde; Kadrow 2001, 41–42). It has been correctly emphasized that just because the hoard was deposited in to certain location, does not necessary mean it was also produced there, and could be connected to the Harz metallurgy centre rather than a classical Únětice one as the former region had rich copper and tin lodes at that time (Krause 1998, 186; Kadrow 2001, 42; Kaczmarek 2012, 100).

Many contributions trying to interpret these items' functions have appeared in recent times, and some halberds are thought to have been used as weapons in both battles, and in unspecified magical rituals, as the Ligurian petroglyphs seem to indicate (Sarnowska 1969a, 19). Their function most likely changed with time, and they later became symbols of power and prestige (Sarnowska 1969b, 83).

Scholarship increasingly argues for the use of halberds from the Iberian Peninsula in battle, and it has been suggested that some halberds from other regions will have had a similar function (Brandherm 2011). In fact, traseological analyses show only 10% of Iberian examples have signs of battle-related wear, while as much as 40% of Irish examples had damaged edges. Some scientists argue that the deposition context of these artefacts might have had a huge impact on the state they survived in (Brandherm 2011: 24; O'Flaherty *et al.* 2011). The assumption that these halberds were too heavy and awkward to handle and thus be used in battle has been dropped in favour of the battle use thesis further supported by the hardness analyses of the blades and experiments carried out on their replicas trying to establish how successful these items could have been as weapons (O'Flaherty *et al.* 2011, 39, 45–48).

The issue of circumstances in which these items were deposited is quite interesting, as for example these of Iberian Peninsula and Italy were usually discovered in tombs, in France only 3 halberds were uncovered in a cemetery while all the others were single finds, similarly to Irish artefacts of which only 4 were discovered as parts of a hoard (the hoards of Hillswood and Cotton included only halberds), while all the others were uncovered without any apparent cultural context. The Irish, British and French halberds are usually found in wet environments, particularly rivers and peat bogs (Schuhmacher 2002, 264–274). The vast majority of halberds found in Poland were individual finds, fewer of them appeared as a part of a hoard, and only two were discovered in lavishly stocked tombs (Sarnowska 1969a, 40). The halberds found in Juncewo and in the hoard from Biecz were discovered in a peat bogs, with the former uncovered at the depth of 2 m, while the Ptusza halberd was discover during drainage works. The halberds found in Germany were discovered in similar circumstances, with two of them found in a swamp in Tierplatz near Neustadt Dosse, a shaft of a halberd was found in peat in Hansdorf (Meklemburg), and another halberd fished out of the Odra River. The hoard sites containing such objects were sometimes covered with a huge boulder (Sarnowska 1969a, 9, 12, 16, 26, 36–37, 42, 44).

Chemical analyses of various objects such as coins, axes and glass were carried out as early as the 18th century, and from the early 19th century onwards, trace elements in antique objects deposited at museums were systematically reported (Haustein, Pernicka 2008, 391). Fundamental questions relating to the origin and dating of European halberds were poised by S.P. O'Ríórrdaín in the 1930s, but it wasn't until later that the first results of chemical analyses of bronze objects including halberds were published by W. Witter (Rassmann 2010: 808), who, later together with H. Otto and S. Junghans made an important contribution to the differentiation of the so-called metal groups/bronze types (marked with a capital letter and a number) in connection with certain Central European regions. Apart from the basic copper and tin content, they also took into account the concentration of trace elements, which was attributed, at least to some degree, to the impurities in the natural ore. The results of metallurgy analysis of the Bresinchen hoard fall under this typological trend (Breddin 1969: 32).

With relation to early Bronze Age metal objects found in Poland, in the 1970s, at the Laboratory of the Material Culture Institute of Polish Academy of Sciences, a series of analyses of Early Bronze Age metal objects were carried out by Tadeusz Dziekoński. Seventy-five items were analysed and divided into 4 groups: objects made of copper with no tin added (group I), copper objects with up to 3% of tin content (group II), copper objects with high silver, arsenic and antimony content (group III), and copper objects with over 6% of tin content (group IV). The tin condensation in tin alloys varied from 3% to 5%, although quite often these values were between 7.15% and 14%. Bronze alloys with 6% to 12% of tin content have the strongest mechanical properties according to the author of aforementioned analyses, however, copper alloys of over 6% tin content are virtually impossible to forge (Sarnowska 1975, 82–83, 92). The analysed halberds were also classified according to the amount of tin content. The halberd from Środa had the lowest tin concentration (0.46%–0.80%, thehighest content in the blade), a medium tin concentration was established in the halberds from Inowrocław (2.70–3.40%), one example from Granowo (3.05% and 8% in the blade) and the halberd from Ptysza (8.9%). The halberd found in the tomb in Łęki Małe had the highest tin concentration (8.4% in the blade and 14.25% in the shaft). Not only did it show the results to be in line with the formal and technical analyses of the artefacts, but also confirmed that Únětice metallurgy was characterised by a wide diversity of techniques (Sarnowska 1969a, 43–45). High tin content in the alloy, of which the halberd from Łęki Małe is made, makes it similar in that respect to the artefacts from Central Germany (Hansdorf, Helmsdorf, Leubingen). According to H. Grössler's old concept, all artefacts made of alloys with high tin content originated in the British

Isles (Sarnowska 1969a, 44). Having said that, metallurgy studies in Poland at that time were not developed yet and left a lot to be desired (Fogel 1983, 150).

After analysing a series of groups of impurities present in metal artefacts from Britain and North-West Europe, in the 1980s P. Northover singled out particular lodes of non-ferrous metals, which lead him to the assumption that most of early metal objects originated in Ireland (e.g. axes) and far fewer were produced on the European continent (e.g. daggers and halberds) (Harding 2000, 204). Bronze Age metals used in metallurgy are generally thought to have evolved from pure copper, through copper-arsenic alloys and tin-copper alloys to copper, tin and lead alloys with a small percentage of tin and lead, which were added in higher amounts during the late Bronze Age (Harding 2000, 202).

K. Rassmann summarised the latest results of the analyses of halberds from western parts of Central Europe in his writings and emphasized that it has become possible to establish the origins of particular types of halberds by taking into account their proposed typological classification, dating and results of the so-called archeometallurgical method (Rassmann 2010). The author also emphasized the importance of other leading researchers in the field of Early Bronze metallurgy, particularly the works of R. Krause, E. Pernicka and St. Schwenzer (Rassmann 2010, 813). H. Wüstemann carried out relatively thorough analysis and classification of halberds. As a result, he established that those belonging to types 1–3 in his classification contain no tin, although arsenic concentration is that of between 4% and 7%. All the halberds belonging to types 4–7 on the other hand showed high tin concentration which lead to a conclusion that production of halberds with arsenic added to the alloy chronologically precluded production of tin-rich halberds (Rassmann 2010, 812–813).

The results of chemical analyses of Early Bronze Age hoards found in East Germany showed that they could be arranged alongside three horizons (I-III). This chronological model was mentioned in R. Krause's writings in the context of the development of metallurgy of that time (Krause 2003). The lines separating the horizons were subsequently moved in respect to the eastern part of Central Europe (Rassmann 2010, 258–260). The chronological succession of small and large axes with increasing concentration of tin in their alloys that correlated with the presence of trace elements was also pointed out. The presence of trace elements in both axes and hoop shaped ornaments from these hoards lead to the separation of the so-called material groups (Rassmann 2010, 813–814, Abb. 4a-4b, Abb. 5). Variations in the proportions of different material groups within the treasures of horizons II and III were also spotted allowing the scientists to arrange them into groups. The elder group (variant 1) with the majority of arsenic copper in the alloy (e.g. Dieskau 2), the later group (variant 2) associated with the appearance of "fake" ore with large amounts of Nickel added (Melz 1, Erenburg, Dettum, Dederstedt, Kyhna), the third group (variant 3) was dominated by the so-called Bresinchen type of copper (eponymic site, Stubendorf, Marwedel) and 'hoop copper' (so- called Ösenringkupfer: Nieder Neundorf, Schleinitz) and other type, similar to the latter (Trebbichau, Melz 2, Göda-Birkau).

The latest of the groups (variant 4) was dominated by the Bennewitz type of copper (Gröbers-Bennewitz, Pegau-Carsdorf, Veltheim) (Rassmann 2010, 814–815, Abb. 7).

Material groups containing arsenic copper and "hoop copper" are crucial for dating blades and halberds. Most of the blades in halberds belonging to variants 1–3 contain arsenic copper, although nickel-rich ore was used to produce some of their other parts. After comparing the results of all chemical analyses carried out on East German metal artefacts one could conclude that the arsenic rich copper is mostly associated with a Neolithic context (mostly with so-called horizon II). With time, nickel was being added to the arsenic copper (variant 2), which was noticed in the later hoards of the horizon II, excluding most of the halberds. The Leubingen and Apeldoorn halberds were made using ore of Bresinchen type of along with raw materials from the latest group (variant 4). Considering similarities between chemical properties of alloy additives, trace elements and tin content it is advisable to date all halberds containing tin as belonging to horizon III. The tin content in halberds varied already during late horizon II, and examples from North German type of variant 1 and 2 were regularly made using tin rich alloys. Therefore it is postulated that more extensive tests are carried out (Rassmann 2010, 816–817, Abb. 3c, 6, 8: 1–2, 9).

Among variants 1 and 2 of North German type halberds, a separate group with different production techniques can be distinguished; halberds of Polish, Saxon and North German variant 2 types, characterised by variations in chemical content and tin concentration (the highest tin concentration was discovered in the North German type of halberds, most likely related to the fact that they are chronologically younger). These types, according to Ch. Strahm, represent the 'consolidation phase' (Aufbauphase) in Early Bronze Age tin bronze metallurgy. Radio carbon datings from Meltz 2 and cemetery in Łęki Małe used in the development of this chronological model allowed to establish that the discussed halberds can be dated to 21st-20th Century BC, which in relative chronology places them in the late horizon II. Artefacts high in tin (e.g. hoard from Meltz 2) can be connected to highly developed bronze production of North East parts of Central Europe on the brink of horizon II and III (Rassmann 2010, 818–819, Abb. 10–11, note 22).

A statistical analysis of typological characteristics of European halberds allows us to pinpoint the European provinces in which they would be produced according to K. Rassman, who further suggests there were three provinces where halberds were produced – Únětice, Atlantic parts of Western Europe, and western Mediterranean. The Únětice region is quite unique in the sense that artefacts produced there bare resemblance to the western Mediterranean type (imports?), but at the same type their development is connected to local metallurgic workshops. Many of these artefacts have quite unique characteristics, probably due to specific technical or technological experiments (e.g. adding tin and arsenic to the alloy). Considering the results of halberds' analyses one could argue that the Únětice culture had much stronger ties with Western Europe than with South East Europe (Rossmann 2010: 818–819, Abb 10–11, note 24).

When comparing the result of the analysis of halberds from Markosice with the aforementioned model of Early Bronze Age metallurgy development, their special position can be noticed regarding the unusually high content of trace elements in their alloys reaching 4%–5% or even 6% in case of blade No. 2, which is mostly due to high arsenic concentration (2.5%–3% or even 4% in blade No. 2). These values are characteristic to products from horizon II, but on the other hand the high concentration of tin (usually around 5%–7% and even 10%–13% in head No. 2) shows characteristics similar to artefacts from horizon III or even IV.

These observations, along with the trends presented in the development of Early Bronze Age metallurgy could indicate a relative chronology between different parts of the Markosice halberds. The halberd blade No. 1 showing a different chemical composition and apparently not being an original part of the halberd it was deposited as a part of could actually be younger in origin than the other parts of the halberds. Higher concentration of arsenic in this particular blade might be due to the metallurgists reusing alloys from earlier artefacts, or could be intentional, as higher concentration of arsenic in artefacts with cutting surfaces is quite characteristic for that era (Harding 2000, 202–203).

Their high tin content is also thought-provoking, as it is a characteristic typical of later metallurgy horizons, and might mean that the entire chronological model of halberds' occurrence within these horizons should be reassessed. If we assume that the halberds in question are characteristic of the classical Únětice era, then the proposed chronology that places them within Horizon II between 2150 BC – 1950 BC (or the transition period between horizons II and III) cannot be sustained, especially as recent, numerous carbon datings show that the classical phase of Únětice culture should actually be dated as occurring between 1950 BC and 1700 BC (compare e.g. with Silesia: Furmanek, Lasak 2013). Wide socio-cultural changes were occurring at that time having many effects on the society, such as creation of rulers' burials, fortified settlements and general increased demand for prestigious items such as halberds, which the artefacts in question are a good example of.

The archeobotanical analyses of the residue found inside the shafts did not bring any meaningful results. Similar analyses were done on other objects of that type. Inside both of the Bresinchen halberds, for example, fragments of wooden shafts were found made of a deciduous tree wood, most likely from the birch family (Betulaceae), although anatomically resembling central European trees of willow (*Salix*) and poplar (*Populus*) species belonging to the willow family (Salicaceae). There are not many cases of fragments of wooden halberd shafts that have been found and only some survived in conditions that would allow for the species of the tree they were made of to be established. The shaft of the halberd found in the Leubingen tomb is known for example to have been made of hawthorn (*Crataeugus*) wood that came from a shrub or low tree (Breddin 1969, 20; Sarnowska 1969, 30). Inside the shafts of halberds found in the Melz (in Meklemburg) hoard (8 halberds in total), remnants of wooden cotters used to secure the shaft inside the halberd's blade were also found. It was established that they were made from a tree belonging to the ash family, and the radiocarbon datings performed on their samples showed that the halberds were relatively old, dating back to around 2100 BC. This bronze production of that time most likely preceded the increased productivity of classic Únětice Period metallurgical workshops of northern Germany, and was probably connected to the beginnings of the Harz (Saale) metallurgy centre (Kadrow 2001, 42; Kaczmarek 2012, 100). Parts of wooden casings for blades secured to the shafts at a right angle were also preserved amongst the examples from the Iberian Peninsula. Unfortunately, in most cases these halberds were incomplete and it is difficult to establish their shafts were made of bronze or wood (Sarnowska 1969, 34, 40). When it comes to halberds found on the territory of Poland, the northern Greater Poland type example found 2 meters under the surface of a peat bog near Juncewo (Great Poland) has brought many questions (Sarnowska 1969, 12, ryc. 5b; Kaczmarek 2012, 99). It is thought to have had a wooden shaft with brown ribbon wrapped around it, and a bronze pommel furnished with a loop, which isn't typical of halberds made entirely of bronze. Such halberds would usually have a bronze shaft and blade connected with a wooden shaft, as seen in the example found in a suspected burial (?) site near Inowrocław in Greater Poland (Sarnowska 1969, 12; Kaczmarek 2012, 99). The shaft of a halberd found in the central tomb A in Łęki Małe barrow 1 was metal and hollow with a wooden core that would connect it with the blade. Interestingly, an imprint of some kind of fabric was found on the entire length of one side of the shaft (Kowiańska-Piaszykowa 2008, 40, 203, tabl. IV: 1c).

There is no doubt there is a votive context when it comes to the items found in Markosice, which is supported by the conditions they were deposited in. In the Early Bronze Age, the peat bog they were found in would most likely be a slowly overgrown reservoir. Moreover, the positioning of the artefacts, as described by the person who discovered them, is unlikely to have been accidental and probably also had a symbolic meaning. The act of throwing high ranking, valuable objects into a pool of water was probably an ostentatious way of showing high social position by the person performing this kind of sacrifice (Bradley 1999). This double deposition which started with the dawn of Bronze Age and occurred more and more often as it progressed is also quite important, as there are other, numerous examples of pairs of objects being laid together, particularly weapons and objects indicative of status or prestige (e.g. pair of swords from Rørba, two daggers from the Nebra hoard, but also two halberds from the Bresinchen hoard and many others). This duality of these kinds of deposits, especially these with ritual context relates to the duality of the (proto) Indo-European religion represented by the pair of divine twins. These deities were not only connected to the Sun cult, but also acted as the protectors of sailors and warriors, divine healers or masters of the dance (Kristiansen 2010). Vedic Ashvins and Greek Dioscuri are their best known representations. The presence of this type of myth during the Bronze Age in Europe is also confirmed by the iconography of Nordic rock art and figurines (Kristiansen 2010).

CONCLUSION

The pair of halberds from Markosice is, undoubtedly, unparalleled amongst other finds of this type. Thanks to the specialist analyses of the chemical composition of the alloy the halberds were made of it became possible to make sense of some confusing elements of this deposit, and analyse these objects in the context of the current state of research on Early Bronze Age metallurgy. Some inaccuracies in the chronology of halberds' appearance and in the so-called horizons of metallurgy development were noticed as a result. Further specialist research is needed to fully clarify these issues, and these conclusions are only to act as a trigger.

Votive deposits of artefacts quite often included numerous groups of objects, which could indicate they were remnants of cyclical ceremonies repeated over long periods of time. It is therefore possible that further findings of this type could be made on the site of the Markosice halberds discovery. This site should be therefore protected and appropriate steps undertaken with relation to large-scale investments in open-pit lignite mining which is planned in this region.

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