RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Hoard with a miner's pick from Krtely in South Bohemia: On the question of the relations of hoards, imports and burial mounds of the Urnfield period

Depot s hornickým špičákem z Krtel v jižních Čechách: K otázce vztahů depotů, importů a mohylových pohřbů v období popelnicových polí

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This article presents a hoard of 27 metal artefacts and fragments of one ceramic vessel from the South Bohemian site of Krtely, dated to the earlier phase of the Late Bronze Age (Br D – Ha A1). Two exceptional phenomena are associated with the hoard. The first is its placement in a burial mound, and the second is the presence of two fragments of a broken miner's pick, analogous to those found in the salt mines of Hallstatt. In addition to typological-chronological analyses, the article also includes elemental composition and use-wear analyses of the pick. Unique to this find is the reutilization of the pick as a chisel. The hoard also contained a fragment of a cast sword hilt with embedded fragments of other artefacts, examined by X-ray and tomographic analyses. The hoard from Krtely significantly contributes to the ongoing discussion on the role of Bronze Age metal hoards and their potential connections to ritualized behaviour and the spiritual world of that era.

South Bohemia – Late Bronze Age – hoard – pick – burial mound – XRF analyses – use-wear analyses

V článku je publikován depot 27 kovových artefaktů a zlomků jedné keramické nádoby z jihočeské lokality Krtely, který lze datovat do starší fáze mladší doby bronzové (Br D – Ha A1). S depotem jsou spojeny dva výjimečné fenomény, na něž je tento článek zaměřen. Prvním je uložení depotu do mohyly, druhým pak přítomnost do dvou fragmentů rozlomeného hornického špičáku s analogiemi v solných dolech v Hallstattu. Vedle typologicko-chronologické analýzy je v článku tento artefakt podroben i analýze prvkového složení a traseologické analýze. Zatím bez analogií je jeho reutilizace na dláto. Depot obsahoval i zlomek lité rukojeti meče, do níž jsou vloženy zlomky dalších artefaktů, které byly zkoumány pomocí rentgenové a tomografické analýzy. Depot z Krtel významně přispívá do bohaté diskuse o roli kovových depotů doby bronzové a o jejich možných souvislostech s ritualizovaným chováním a duchovním světem tehdejších lidí.

jižní Čechy – mladší doba bronzová – depot – špičák – mohyla – XRF analýzy – traseologická analýza

Introduction

In archaeological terminology, graves and hoards are typically distinguished as separate entities (*Neustupný 2010*, 154–156). A straightforward definition of a hoard implies that it is a collection of at least two artefacts intentionally and simultaneously deposited outside grave goods (e.g., *Salaš 2005*, 12, with earlier literature). This usually leads to the spatial exclusion of hoards and graves. However, there are exceptions, as evidenced by the recently discovered hoard from Krtely in South Bohemia, which was embedded at the top of a burial

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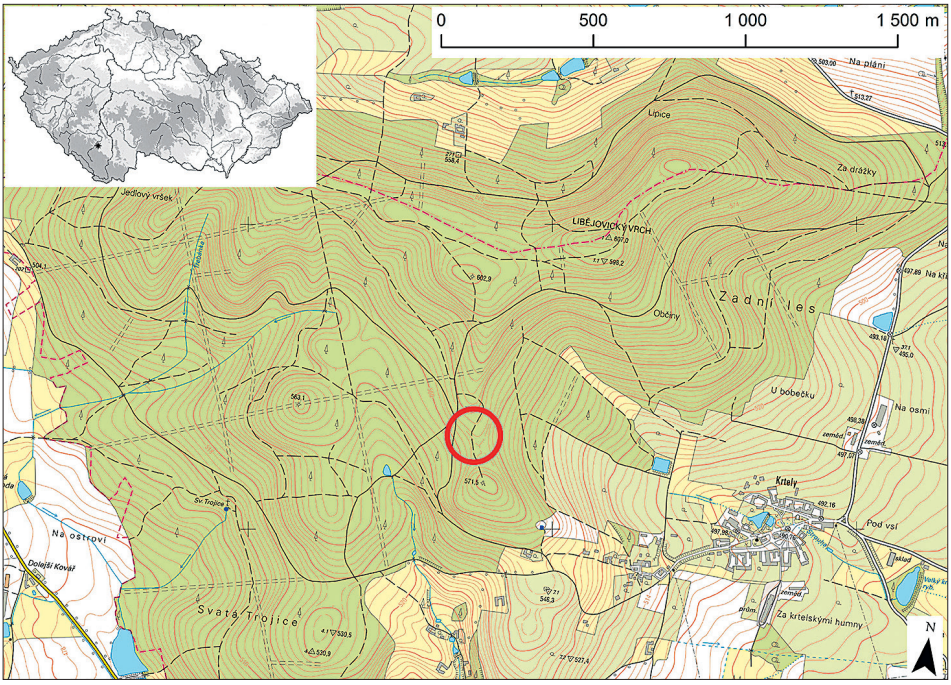

Fig. 1. Krtely. Location of the site on the map of the Czech Republic and topographic position on the 1:10,000 ground map (modified by J. John).

mound. In the following text, we will discuss not only the archaeological analyses of the hoard itself, distinguished by a unique miner's pick, but also the phenomenon of placing metal hoards in or near graves during the Bronze Age.

Find circumstances and natural conditions of the hoard from Krtely

In November 2017, Aleš Hutter found a set of metal artefacts, which he removed from the ground and then handed over to the archaeological collection of the South Bohemian Museum in České Budějovice. On 29 August 2018, O. Chvojka, J. John, J. Fröhlich, and J. Michálek conducted site documentation and a survey of the find and surrounding burial mounds.

The hoard was found in the 'Na Překážce' forest on the southern spur of the Libějovický Hill, 1000 m WNW from the chapel in the village. The altitude of the find is 567 m and WGS-84 coordinates 49.0861128N, 14.1549303E (*Fig. 1*). This is the northeastern edge of the burial mound cemetery, dated to the Hallstatt period and the early Middle Ages (*Michálek 2017*, 180; *Lutovský et al. 2023*, 269–270). At least 35 burial mounds in two groups were identified during the surface survey (*Fig. 2*). Based on their formal and spatial characteristics, some mounds can be dated to the early Middle Ages (arrangement in rows, rectangular shape, shallow ditches around the mounds), while others (probably older prehistoric mounds) are manifested only by surface accumulations of stones.

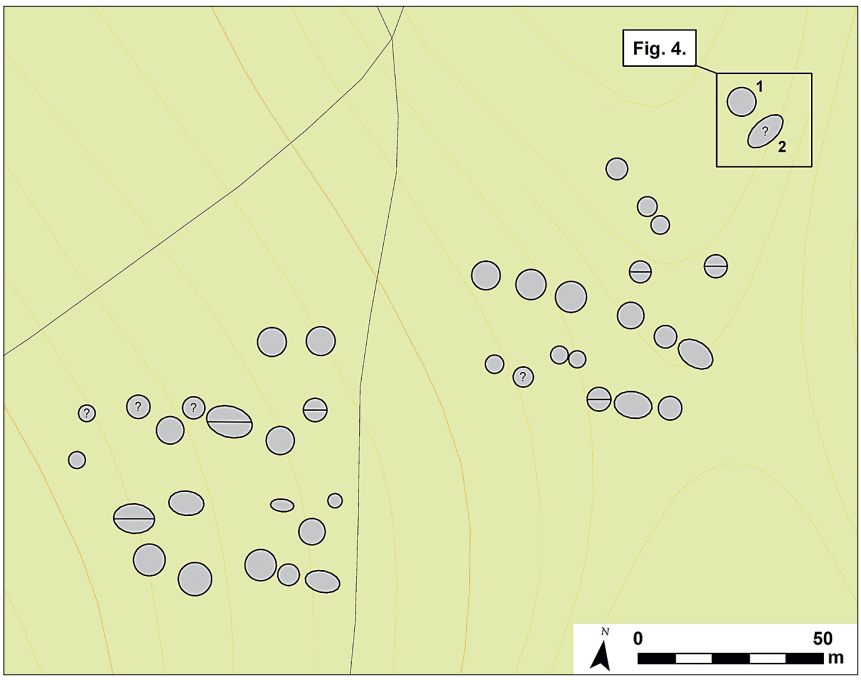

Fig. 2. Krtely. Plan of the barrow cemetery with the location of the hoard (box) (made by J. John).

The massif of the Libějovický Hill (607 m above sea level) forms part of the Bavorovská Highlands, which is the largest of the Šumava foothills, separating the middle course of the Blanice River from the Českobudějovická Basin (*Chábera et al. 1985*, 15–16). In the wider vicinity of the site, there are gold deposits that were mined in the Middle Ages and modern era; the remains of historical shafts are preserved on Libějovický Hill (*Fröhlich 2006*, 77; *Mašlová 2017*, 44–45). A mining trench was located close to the hoard, but it is uncertain whether it is related to the exploitation of gold or quartz (*Mašlová 2017*, 38–39). However, there is no way to prove a possible connection between the hoard analysed here and the burial mound cemetery with the mentioned gold deposits.

According to the finder, the metal artefacts were found clustered in a pit approximately 20 × 30 cm and up to 45 cm deep. The objects were located in a cavity between quarry stones up to several tens of centimetres in size, evidently part of the mound embankment construction. One large ingot was reportedly placed shallow below the surface, with other objects found without any arrangement beneath it. Unfortunately, the finder did not take any photographic or other documentation, nor was detailed information about the position of individual artefacts recorded. The pit also contained several dozen ceramic fragments from one vessel (see no. 28 in the *Online Supplementary Material 1*), which were also collected by the finder. No further findings were made in the excavated pit during the subsequent expert survey. Excavation outside the pit was not carried out, as it was determined that the hoard was deposited in a yet unrecognized burial mound (marked as Mound No. 1), the detailed examination of which could not be conducted. Mound No. 1 is covered by a mature spruce forest, and the pit with the hoard was located directly at the foot of one spruce (*Fig. 3*).

Fig. 3. Krtely. Mound 1, the place of the hoard discovery (photo by O. Chvojka).

Description of the archaeological situation and artefacts from the hoard

Mound No. 1, into the top of which the hoard was placed, appears as a relatively inconspicuous elevation today (*Fig. 4*). Nearby is a second, probably prehistoric burial mound. Although both of elevations have not yet been archaeologically investigated, we assume that they are burial mounds. In addition to the mounds themselves, which clearly stand out from the surrounding terrain (*Fig. 4*), this interpretation is also supported by the finding of a bronze three-edged arrowhead from the Hallstatt period which was found at the Mound No. 2 (see *Michálek et al. 2022*, 116, Fig. 4: 4).

The recovered assemblage from Mound No. 1 contained 27 metal artefacts (one in 2 fragments) with a total weight of 7257.2 g, as well as fragments from one ceramic vessel that likely served as a container for some of the metal artefacts. All finds are now stored in the archaeological collection of the South Bohemian Museum in České Budějovice under inventory numbers A 36.419–36.446.

For a description of both mounds and artefacts (*Fig. 5–9*), see *Online Supplementary Material 1*.

Analyses

Archaeological analysis and chronological classification of the hoard

Miner's pick

The most interesting artefact in the hoard is a miner's pick with butt wings and a hexagonal cross-section body, which was later ground into a chisel and then deliberately broken

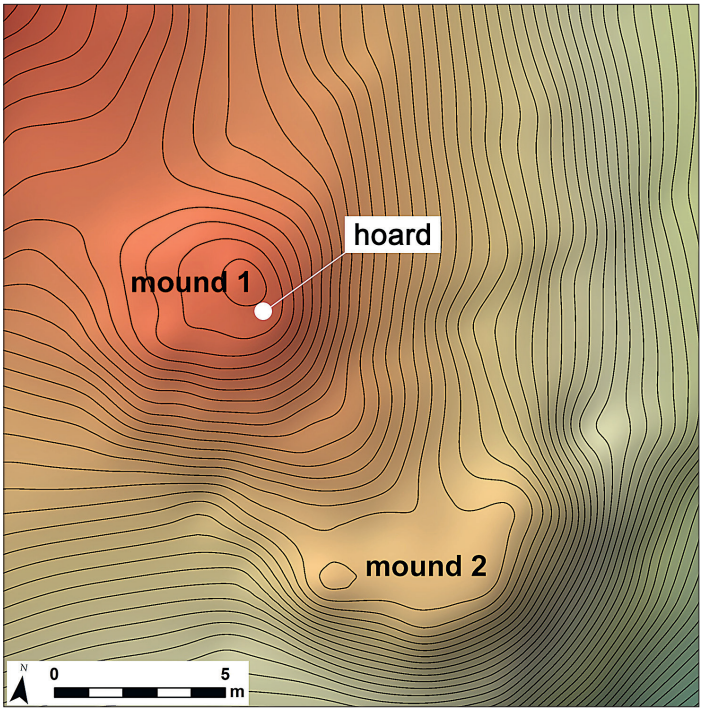

Fig. 4. Krtely. Contour plan of mound 1 (made by J. John).

(*Fig. 5*). It is only the third such find in the Czech Republic (*Fig. 10*), with all three picks coming from hoards of fragments dating to the early phases of the Late Bronze Age (*Tab. 1*). While the specimens from Holašovice in South Bohemia (*Kytlicová 2007*, Taf. 21: 22) and from the South Moravian hoard from Réna u Ivančic (*Salaš 2018*, 50–52, Tab. 3: 75) are small fragments of hexagonal bodies with tips, the pick from Krtely is preserved whole. The closest analogy can be found in the Upper Austrian hoard from Sipbachzell, which contains six picks with wings in various states of preservation, as well as two socketed picks associated with the copper exploitation centre at Mitterberg (*Höglinger 1996*, 40–45). Notably, one almost completely preserved pick with wings from Sipbachzell was already broken in prehistoric times in the same manner as the specimen from Krtely (*Höglinger 1996*, Taf. 20: 349).

A significant number of bronze picks with butt wings and bodies of hexagonal cross-section, along with their fragments, have been found in the Hallstatt salt mines and the nearby burial site (both in several graves and as solitary scattered finds within the burial site). In the mid-1970s, 34 specimens were documented (*Mayer 1977*, 228–233), but many more have been added since then (*Barth 1993–1994*, 29, 31). However, no comprehensive list has been published since Mayer's work. The chronological classification of these picks is more complicated, ranging from the Urnfield period to the later phases of the Hallstatt period (*Mayer 1977*, 230). Nevertheless, some years ago, it was established that Bronze Age miner's picks differ from those of the Hallstatt period in both shape and size; Bronze Age picks are more robust, while Hallstatt period specimens are more delicate (*Barth 1993–1994*, 31; *Kowarik et al. 2019*, 65–67). This reflects the development of salt extraction techniques,

	Country	Site	Context	Dating	Number of pieces	Preservation condition	Length (mm)	Weight (g)	References
1	CR	Holašovice	hoard	Br D – Ha A1	1	Fragment	57	78	*Kytlicová 2007*, Taf. 21: 22
2	CR	Krtely	hoard	Br D – Ha A1	1	Broken	308	1643	current paper
3	CR	Ivančice	hoard	Br D – Ha A1	1	Fragment	21	9	*Salaš 2018*, 50–52
4	A	Hallstatt	mines, burial site	Br D – Ha D	34	Complete – 3 Fragments – 31	a/ 382 b/ 283 c/ 255*	a/ 1750, b/ undeterm. c/ 1300*	*Mayer 1977*, 228–233
5	A	Koppental	sacrificial site	Br D	2	Fragments	a/ 18 b/ ?	a/ 4,4 b/ ?	*Modl 2008*, 188–189
6	A	Obertraun	hoard?	Urnfield?	1	Broken	348	1730	*Windholz-Konrad 2018*, 181, 183
7	A	Sipbachzell	hoard	Br D – Ha A1	6	Complete – 2 Fragments – 4	a/ 338 b/ 324*	a/ 1742, b/ 1485	*Höglinger 1996*, 129
8	A	Straßen	isolated find	Urnfield?	1	Complete	289	549	*Windholz-Konrad 2003*, 41–42
9	RO	Guşteriţa	hoard	Ha A1	2	Complete – 1 Undetermined – 1	?	?	*Vulpe 1975*, Taf. 46: 464
10	RO	Uioara de Sus	hoard	Br D – Ha A1	7	Nearly complete – 3 Fragments – 4	?	?	*Vulpe 1975*, Taf. 45: 457–459, 46: 460–463
Total					**56**	**Complete/nearly complete – 12 pcs, fragments – 43 pcs, undetermined – 1 pc**			

Tab. 1. Overview of European finds of miner's picks with a hexagonal cross-section body and butt wings. Asterisk (*) indicates cases where only complete or nearly complete pieces are listed. For the Hallstatt site, the minimum number is according to the latest inventory (*Mayer 1977*); later finds that have not yet been comprehensively published are not reflected.

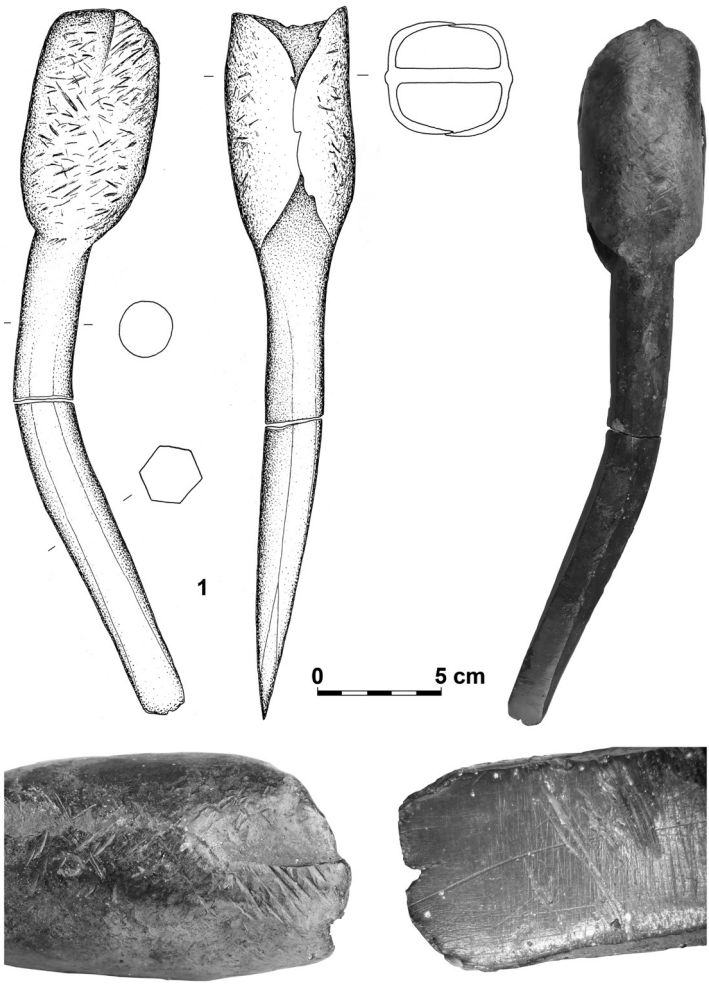

Fig. 5. Krtely. Bronze pick from the hoard (drawing by T. Kolegar, photo by L. Törökvá).

as seen in the varying lengths of preserved wooden handles, of which over 1400 have been found in Hallstatt (*Kowarik et al. 2019*, 50, Abb. 23). Radiocarbon dating of these handles has significantly refined the chronology of the picks, dating them from approximately 1400 to 1000 cal BC (*Barth 1993–1994*, 29–31, Tab. 1; *Thomas 2014*, 183).

Two recently found picks analogous to those mentioned above have been recorded near Hallstatt. The first is a whole specimen from the 'middle Koppental' valley near the village of Straßen, about 8 km east of the prehistoric salt mines (*Windholz-Konrad 2003*, 41–42, Taf. 25: 352). This is, however, an isolated find without further context. The second find, discovered in 2007 near the village of Obertraun at the southern edge of Hallstatt Lake, has no clear finding context, although a fragment of a cake-shaped ingot was found about 10 m away. Notably, the tip of this artefact was broken off and subsequently pushed between the butt wings (*Windholz-Konrad 2018*, 181, 183, Abb. 96). Two further fragments of pick tips come from the Koppental sacrificial site near Bad Aussee, dated by ^{14}C between 1420 and 1260 cal BC (*Modl 2008*, 86–88, 188–189).

Other finds of bronze hexagonal picks come from the eastern part of the Carpathian Basin. Two large hoards from the beginning of the Late Bronze Age were found in Transylvania, containing analogous picks to the Czech and Austrian specimens mentioned. The Guşteriţa II hoard included one complete pick and one undescribed fragment (*Vulpe 1975*, 80, Taf. 46: 464; *Petrescu-Dîmboviţa 1977*, 95, Pl. 155: 1),[1] while the Uioara de Sus hoard contained three large and four smaller fragments (*Vulpe 1975*, 80, Taf. 45: 457–459, 46: 460–463; *Petrescu-Dîmboviţa 1977*, 115, Pl. 220: 17–19, 221: 1, 5). Unfortunately, none of these Transylvanian specimens have been described in detail in the literature.

An artefact from an unknown site (Velikaya Began, Zmeevka, or Orosievo near Berehovo) in Transcarpathian Ukraine (*Kobaľ 2000*, 98, Taf. 94B: 5), sometimes referred to as a miner's pick (e.g., *Salaš 2018*, 50), has been excluded from the analysis after a revision by the authors. It is an artefact of a different type and likely served a different function.

From the point of view of the primary function of these picks, there is no doubt that they served as tools (diggers) for salt extraction, while no evidence for their possible use for copper extraction has yet been provided. Most recently, this question has been addressed in the case of the Romanian specimens by P. Thomas, who opines that the aforementioned finds from both hoards cannot be linked to mining in Romanian copper or salt deposits, as no similar picks have been found in any of the Bronze Age mining areas, despite relatively intensive modern archaeological excavations (*Thomas 2014*, 181).

The origin of these picks is often sought in the Alpine region, as recent research suggests the oldest Austrian specimens predate the Transylvanian ones (*Thomas 2014*, 183, 185). However, their place of production has not yet been identified (*Kowarik et al. 2019*, 67). Some picks, including some pieces from Transylvania, have carved marks on the bodies at the junction of the wings (*Mayer 1977*, 232–233, Abb. 2; *Höglinger 1996*, Taf. 20: 349–351; *Thomas 2014*, 184), but no mark is visible on the specimen from Krtely.

The specimen from Krtely is unique in its reutilization from a pick to a chisel, with no other documented pick showing this secondary modification. Speculatively, we may consider the reworking of this originally mining tool after its transfer to South Bohemia, where it could then have been used, for example, as a woodworking tool.

Other artefacts

Sword

A fragment of a sword with a cast hilt (*Fig. 6*: 2) is exceptional in South Bohemia, representing only the third specimen of this type of weapon from the Urnfield period in this region. No sword with a cast hilt from this epoch was known here until recently (*Chvojka 2009*, 102). Two swords have been recovered since then: one complete specimen of the Liptov type, found in 2010 at Písecká Smoleč (*Jiřík – Pták 2013*, 163), and another fragmented with a heavily damaged hilt (typologically indeterminate) from Předčice (*Chvojka et al. 2021a*, 60–61, Fig. 15: 4).

[1] M. Petrescu-Dîmboviţa mentions two additional pick tips from this hoard, which were lost at the beginning of the 20th century (*Petrescu-Dîmboviţa 1977*, 95); since it is impossible to verify these findings, they are not further considered and are not included in *Table 1*.

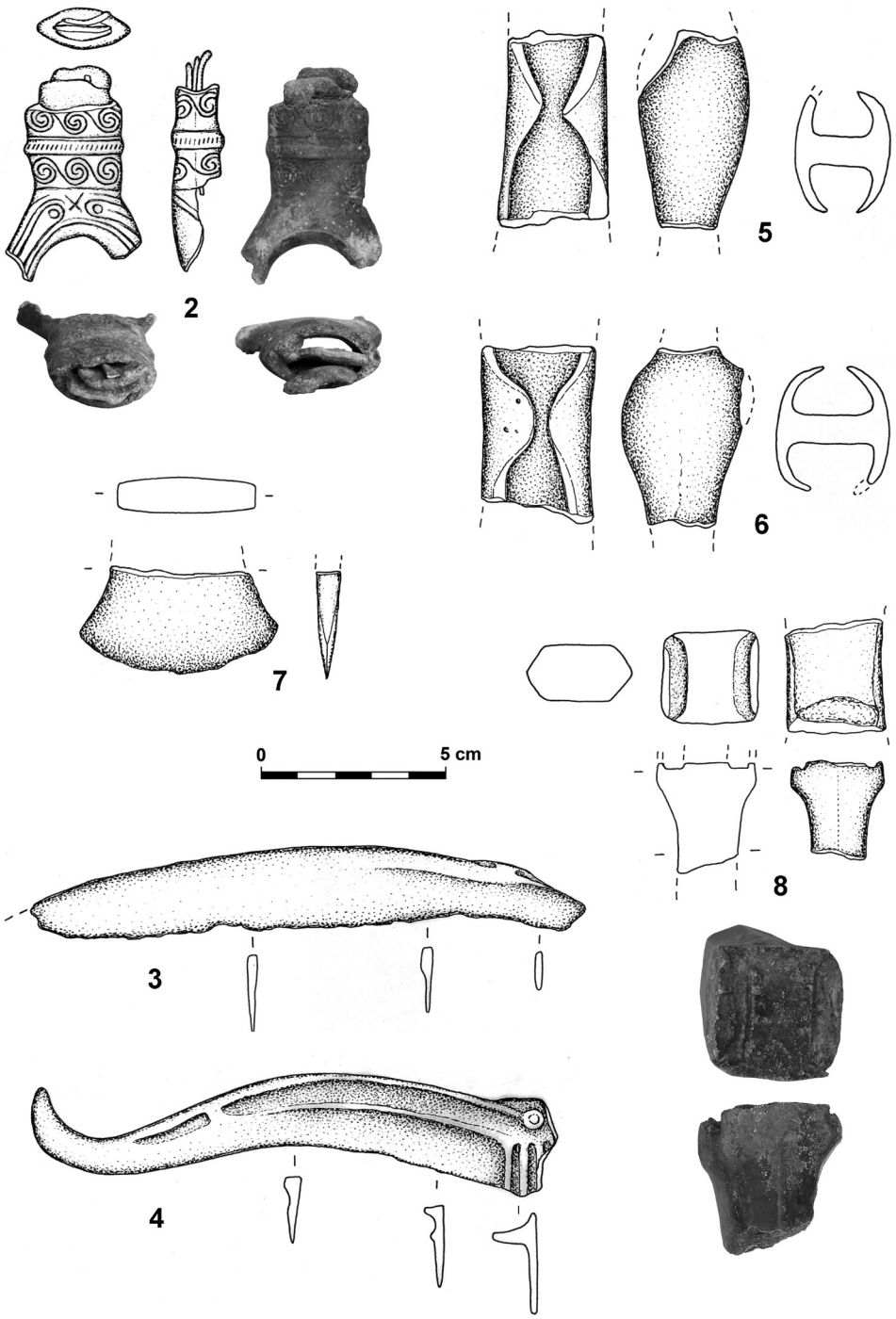

Fig. 6. Krtely. Bronze artefacts from the hoard. The numbers of artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar, photo by L. Töröková).

The typological determination of the sword from Krtely does not present any serious difficulties. It can be classified into the group of Liptov type swords (see *Hrala 1954*). The full-hilt of oval cross-section, with continuous spiral decoration in the tang areas formed by a single line, places the fragment among the swords of the Erding type, sometimes referred to as Erlach type. These swords are widespread throughout Europe (*Stockhammer 2004*, 177–178, Karte 21). It is the overall composition of the tang in which the Krtely specimen shows an only significant discrepancy from the existing classification. Unlike other swords of this type found so far, which have a tang fitted with three embossed horizontal ribs (Dreiwulstschwerter), the lowest of which separates the tang from the guard, the guard on our fragment is separated from the sword by only one groove, with the usual horizontal rib missing.

If we exclude the specimens from watercourses, the fragment from Krtely is the first evidence of the deposition of a Liptov type sword in Czech hoards of fragments, not considering the solitary deposited sword with a full hilt of the Aldrans type from Jezeří in northern Bohemia (*Jiráň et al. 2023*).

The fragment of the sword from Krtely is only the second find of an Erding-type sword in Bohemia. The only earlier find of the same type is a sword drawn from the Vltava River below Prague's Vyšehrad in 1900. The decoration of the hilt and guard differs somewhat between the two swords. While the Vyšehrad sword has clearly recognizable two bird protomes on the guard and the ribs on the hilt are diagonally incised on both sides from the outside, the Krtely specimen has the incisions applied to the body of the rib, and the guard features a more abstract motif of two kidney-shaped loops set in the largest extension with small circles.

These decorative elements are also found on other Erding type swords. The decoration on the tang of the Krtely sword closely resembles that of South Bavarian swords from the eponymous Erding and especially from Erlach, where the decorative scheme coincides with the unusual motif of an oblique cross in the centre of the sword's guard (*Quillfeldt 1995*, Taf. 45: 135–136).

The Krtely sword fragment is also notable for containing three other fragments of bronze objects inserted into the hilt's inner space. To further typologically identify these artefacts, the hilt was subjected to X-ray and tomographic imaging (see chapter X-ray and tomographic analysis of a sword fragment). The images reveal one rod-shaped chisel or burin, and two fragments of rounded, undecorated, heavily burnt metal sheets of indeterminate typological classification.

Knife

Among the several complete or nearly complete artefacts in the Krtely hoard is a knife (*Fig. 6*: 3), an older form with a plate-like hilt of the Riegsee type. The knife from Krtely fulfils its basic morphological signs, especially the straight, not arched, edge of the blade. However, the shape of the knife in the transition between the blade and hilt is unusual. Typically, the contour of the butt straightens at the hilt's point, while the contour of the hilts's lower part rises in relation to the blade's contour (e.g., *Jiráň 2002*, 21–23). In the case of the Krtely knife, both the upper and lower contours of the hilt symmetrically curve downwards in relation to the contours of the butt and blade. The only similarly profiled knife is a specimen found in 1870 at Schöngeisinger Forst (*Hohlbein 2016*, Taf. 25: 269).

Sickle

The typological analysis of the sickle from Krtely (*Fig. 6*: 4) focuses on its overall construction and applied technological elements. The distinctly S-shaped blade with an upward-pointing tip is less common among Upper Danube Urnfields finds, where arched blades predominate even in lateral thorn sickles. Sickles are mostly found as fragments in hoards, so the overall shape of the blade cannot be reconstructed in most cases. However, the occurrence of S-shaped sickles in such assemblages in the oldest time horizon is demonstrated by a fragment from the Plzeň-Jíkalka hoard and a sickle from the St. Matěj cemetery in Prague-Šárka (*Kytlicová 2007*, Taf. 10: 17, 40: D3). Similar S-shaped sickles appear in younger hoards from Lažany, Prague-Vinoř, Rýdeč, Radětice, and potentially Kamýk nad Vltavou (*Kytlicová 2007*, Taf. 25: 31, 27: 68, 49: 104, 50: 105, 107, 110, 69: 88, 91, 76: 260, 262, 267, 78: 40, 92: 220, 225, 226).

The additional parallel reinforcing rib on the side of the blade's upper part, accompanying the butt rib, lacks chronological sensitivity and is common in sickles with a lateral thorn dated to the Plzeň-Jíkalka horizon and slightly later ones. Small perpendicular ribs at the heel of the sickle under the knob are minimally represented in Knovíz culture sickles. In Bohemia, this element appears on sickles from hoards in thirteen cases only, with varying forms. All sickles with similar ribs on the heel are found in hoards from the Lažany and Suchdol horizons from the early period of the Knovíz culture (Kamýk nad Vltavou, Lhotka, Pětipsy, Vinoř, and Rýdeč: *Kytlicová 2007*, 146; Rataje u Bechyně: *Chvojka et al. 2018*, Fig. 16: 18). However, the technological execution of these ribs mostly differs, whether it is just their schematic indication or the resulting ornamentation. Closer analogies to the form and execution of the perpendicular ribs on the sickle from Krtely are shown only by the ribs on the sickle from Kamýk nad Vltavou and one sickle from Rýdeč (*Kytlicová 2007*, Taf. 25: 28, 93: 228). In the case of the above-mentioned two hoards, it should be noted that both contain artefacts that demonstrate their connection with territories outside the Bohemian Basin (*Hrala 1966*; *Kytlicová 2007*, 9, 22, 224, 232, 239, and others).

Based on the comparison of the morphological elements used, which characterize the specimen from Krtely, with other sickles with a lateral thorn found in hoards of the Knovíz culture, it can be stated that the sickle from the hoard in Krtely is a distinct solitaire on Czech territory. However, we reach a similar conclusion if we search for similarly shaped sickles in the neighbouring European area. Several closer or more distant analogies can be found in the eastern regions, particularly in Moravia, quite frequently in Slovakia, and even in Vojvodina (*Říhovský 1989*, Taf. 4: 39, 44, 52; *Vasić 1994*, Taf. 2: 32, 34–36; *Furmánek – Novotná 2006*, Taf. 8: 133–149, 9: 150–156). West of the Bohemian Basin, one can mention the German specimens in the Niedernberg hoard or the river find from the Rhine near Mainz (*Müller-Karpe 1959*, Taf. 161: A11, 12; *Primas 1986*, 70, Taf. 16: 254, 256, 257). If we focus solely on the exceptional profile of the blade with two longitudinal ribs and a markedly extended tip, it is noteworthy that the closest to the sickle from Krtely is the sickle from Bavarian Affalterthal, which was part of a hoard dated to stage Br D, where it cannot be ruled out that it was also deposited in the context of a burial mound (*Müller-Karpe 1959*, Taf. 152: A11; *Primas 1986*, 63, Taf. 7: 122).

Axes

Three artefacts can undoubtedly be identified as fragments of axes – in two cases with medial wings (*Fig. 6*: 5–6) and in one case as a fragment of the blade of an indetermined

type of axe (*Fig. 6*: 7). Axes with medial wings are typical artefacts of the Late Bronze Age, which are abundantly represented especially in hoards from this epoch (*Kytlicová 2007*, 122–130; *Chvojka et al. 2017b*, 174), including in South Bohemia.

The classification of the fragment of the central part of the tool (*Fig. 6*: 8) is problematic, which we tentatively classify with reservations as a fragment of the central part of an axe with a stepped ridge. This type of axe is relatively rare in Bohemia, found from the end of the middle to the later phases of the Late Bronze Age (*Kytlicová 1959*). However, the above-mentioned classification is complicated by the fact that the groove separating the edge ridges from the body of the tool comes to the surface. Therefore, the precise original shape of this artefact is unknown. It is also possible that this fragment could be classified as some type of hammer with a central hole (see *Nessel 2019*, 67, Abb. 67).

Chisel

The flat rod-shaped chisel, which is damaged by burning (*Fig. 7*: 15), represents a chronologically insensitive shape, appearing throughout the entire Bronze Age (*Mayer 1977*, 218–219, Taf. 87: 1279–1280; *Říhovský 1992*, 274–276, Taf. 76: 1219–1226). In South Bohemia, there are many rod-shaped chisels from the Bronze Age, though most are more delicate. In shape, the chisel from Krtely is closest to the broader chisel from Lišov (*Chvojka et al. 2017a*, Fig. 16: 25).

Twisted rod

The fragment of a twisted rod with one preserved straight end (*Fig. 7*: 10) could be interpreted as a working tool – a burin or punch? This hypothesis is suggested by similar artefacts from other Central European sites, which are often interpreted as rod-shaped chisels secondarily remade from objects originally of a different function, including twisted rods (see *Nessel 2019*, 99–100, Abb. 112e; for Bohemian examples see *Kytlicová 1961*). The closest analogy in South Bohemia is a rod-shaped twisted object from the Paseky 3 hoard, which was labelled as a chisel or punch (*Chvojka et al. 2017b*, 174, Tab. 128: 19). Similar shaped chisels can also be found in other Czech hoards, such as those from Kundratice and Velké Žernoseky (*Kytlicová 2007*, Taf. 116: 67, 118: A10). To confirm the interpretation of the mentioned artefacts as working tools, it would be advisable to carry out use-wear analyses in the future.

Neckring

The hoard from Krtely contained several complete and fragmented examples of circular jewellery. These include a fragment of a massive twisted neckring with engraved decoration at the seal-like end (*Fig. 7*: 9), which belongs to typical forms of the Late Bronze Age (*Kytlicová 2007*, 56–62). Similar twisted rings were found in several hoards of the Br D/Ha A1 stages in South Bohemia (e.g., Staré Sedlo: *Kytlicová 2007*, Taf. 23: 11–16; Olešná 2: *Chvojka et al. 2017b*, Tab. 117:10; Paseky 1: *Chvojka 2009*, Tab. 20: 9–14) and Ha A2/B1 (Albrechtice nad Vltavou: *Kytlicová 2007*, Taf. 131A).

Bracelets

Three artefacts belong to bracelets or general arm ornaments, each belonging to a different type. From the end of the Middle and especially in the following Late Bronze Age, massive cast bracelets with fine engraved decoration are common (in South Bohemia, e.g.,

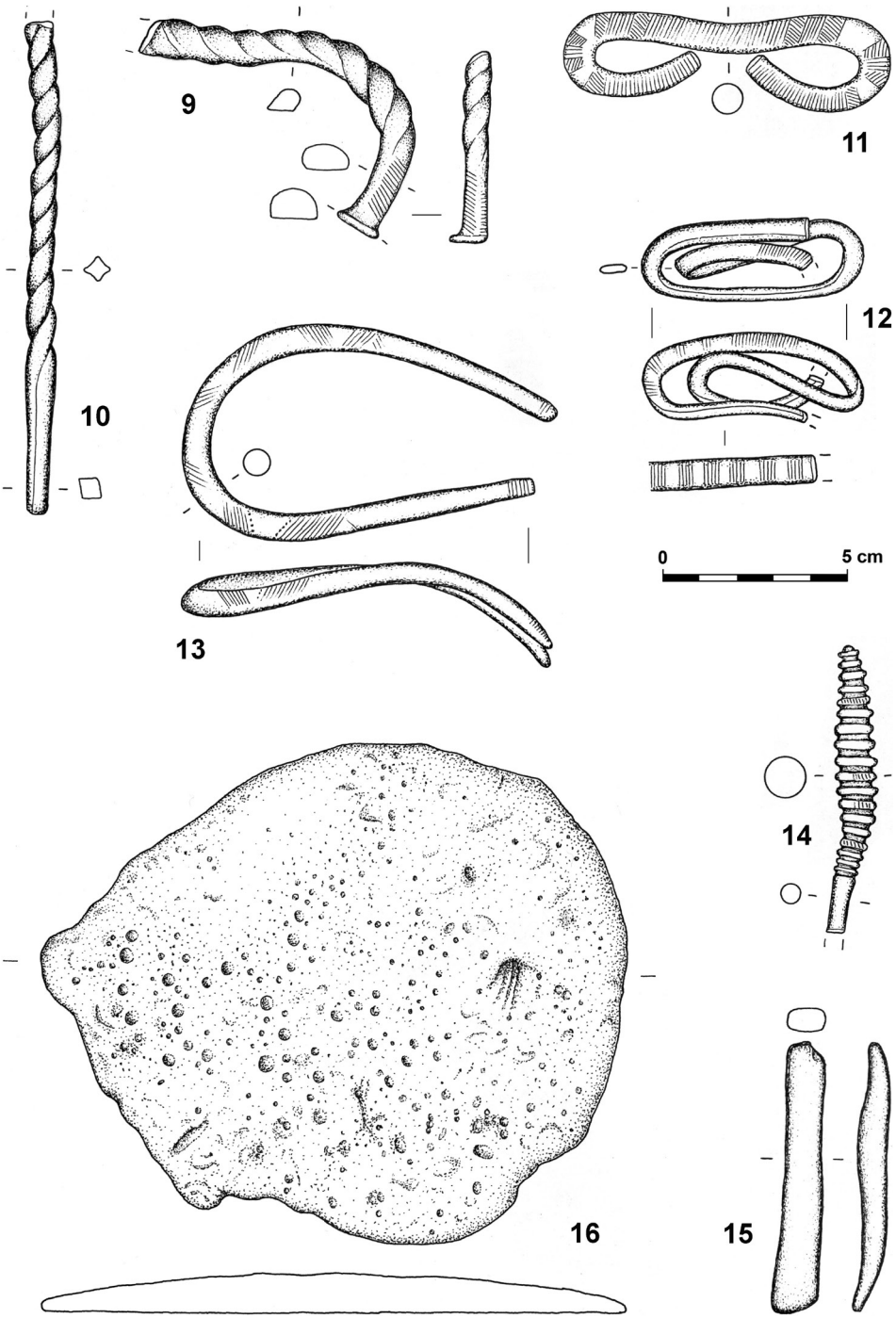

Fig. 7. Krtely. Bronze artefacts from the hoard. The numbers of artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar).

Beneš – Kytlicová 1991; *Chvojka et al. 2017b*, 170–171), one example of which is represented in the hoard discussed here (*Fig. 7*: 11). This massive object, however, was deformed into the shape of a figure eight before being deposited in the hoard, with the closest geographic and chronological analogy found in the hoard from Staré Sedlo (*Kytlicová 2007*, Taf. 23: 10).

The second fragment from Krtely is more delicate, made from a flat band, and is also significantly deformed (*Fig. 7*: 12). Given its decoration and band profile, we interpret it as a fragment of a spiral armring, with close analogies found, for example, in the South Bohemian hoard from Olešná 1 (*Chvojka et al. 2017b*, Tab. 110: 1–2). Similar examples can also be found in other regions (e.g., *Salaš 2005*, Tab. 242: 62).

The fully preserved bracelet was probably slightly saddle-shaped secondarily (*Fig. 7*: 13). Bracelets with similar shapes and decorations can be found in several other South Bohemian hoards (e.g., *Kytlicová 2007*, Taf. 23: 7–8; *Chvojka et al. 2017b*, Tab. 117: 7), though none are curved in the same way as the bracelet from Krtely. Similarly shaped, undecorated rods are found in the Moravian hoard from Přestavlky, but these cannot be classified as circular jewellery (*Salaš 2005*, 386, Tab. 265: 158).

Pin

The only representative of pins in the Krtely collection is a fragment probably with a long-knobbed head (*Fig. 7*: 14). Although it cannot be entirely ruled out that the top of the head is broken off and the pin originally had a differently shaped head (e.g., *Kytlicová 2007*, Taf. 60: D3, 66: B5), we assume this is not the case and that it is a pin with a long and distinctly knobbed head, as known from many hoards from the Br D – Ha A1 stages (*Kytlicová 2007*, Taf. 60: A3, 66: B1). Similar pins are documented in South Bohemia from the horizon of the Plzeň-Jíkalka hoards (*Kytlicová 2007*, Taf. 5: A1, 6: B4, 6: C4), but they are also common in hoards and graves from the following early phases of the Urnfield period (*Chvojka 2009*, 87; *Chvojka et al. 2017b*, Tab. 110: 16).

Cake-shaped ingots

Although raw material ingots are very common in hoards of metal artefacts from the Late Bronze Age, they are mostly present as larger or smaller fragments of original cake-shaped ingots (cf. most recently *Kmošek et al. 2020*). Whole examples are scarcely documented in Czech hoards from the area of Upper Danubian Urnfield culture. The report of a large ingot found in 1876 at Plešivec, along with other artefacts in a burnt pit containing ash, is problematic (*Richly 1893*, 125; *Jelínek 1896*, 216). The mentioned artefact has not been preserved, and its identification as a cake-shaped ingot is certainly questionable.

The oldest and largest documented whole cake-shaped ingot is from the hoard from Malé Nepodřice (*Kytlicová 2007*, 283, Taf. 11: B), which was deposited together with an axe and a pin, dating the set to the very beginning of the Urnfield period in the Plzeň-Jíkalka hoard horizon.

In terms of size and time frame, the ingot from Krtely is closest to the whole cake-shaped ingot from the Velvary hoard (*Kytlicová 2007*, Taf. 56: A82). This set belongs to the Lažany horizon and contains, among other things, a metal sheet fragment with typical decoration, linking it to the Upper Bavarian area of the Riegsee horizon (*Kytlicová 2007*, 175, 208). Similarly, the whole cake-shaped ingot from the Prague-Butovice hoard and a smaller ingot from the hoard from Zahájí are dated to the Lažany horizon (*Kytlicová 2007*,

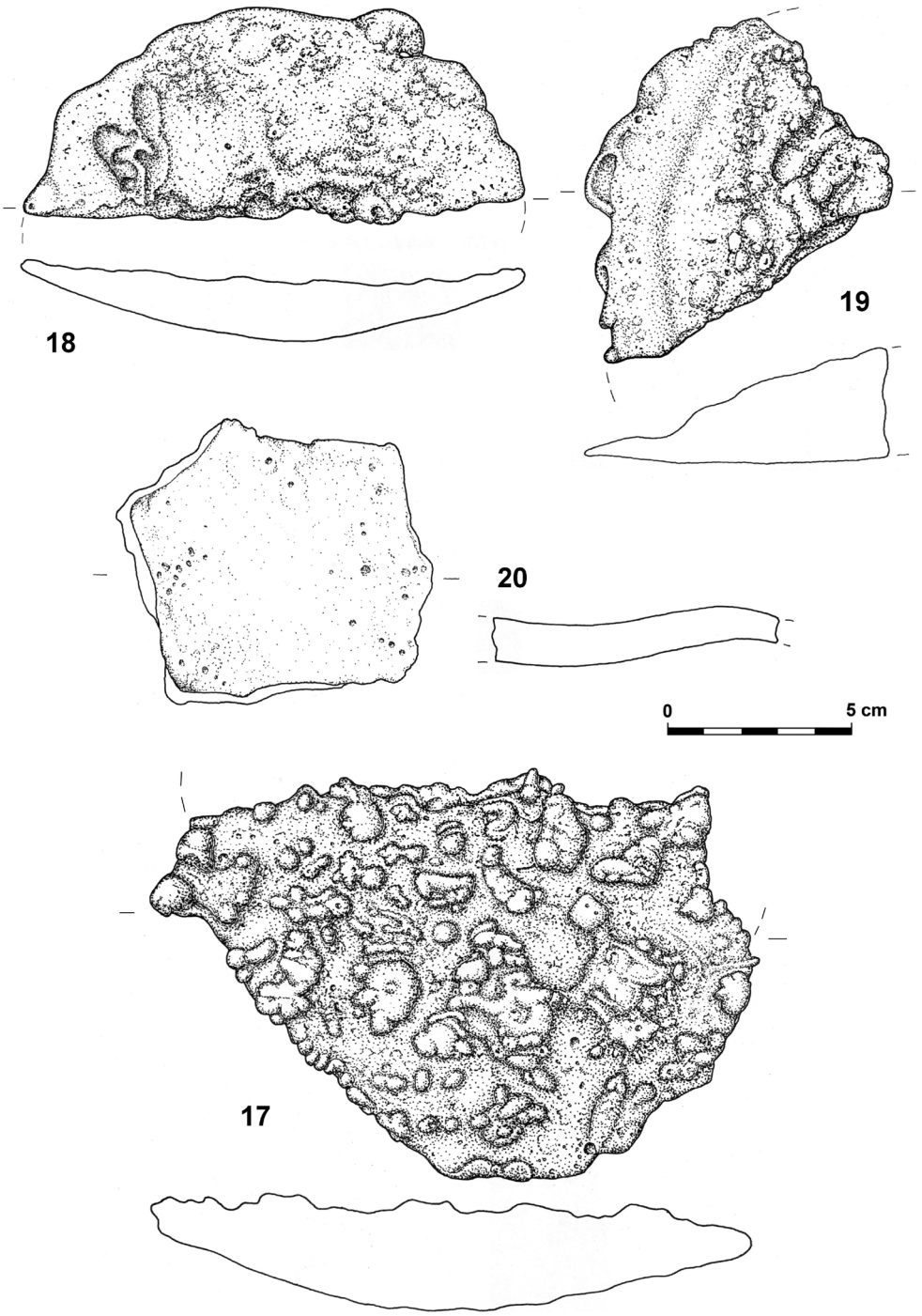

Fig. 8. Krtely. Copper artefacts from the hoard. The numbers of artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar).

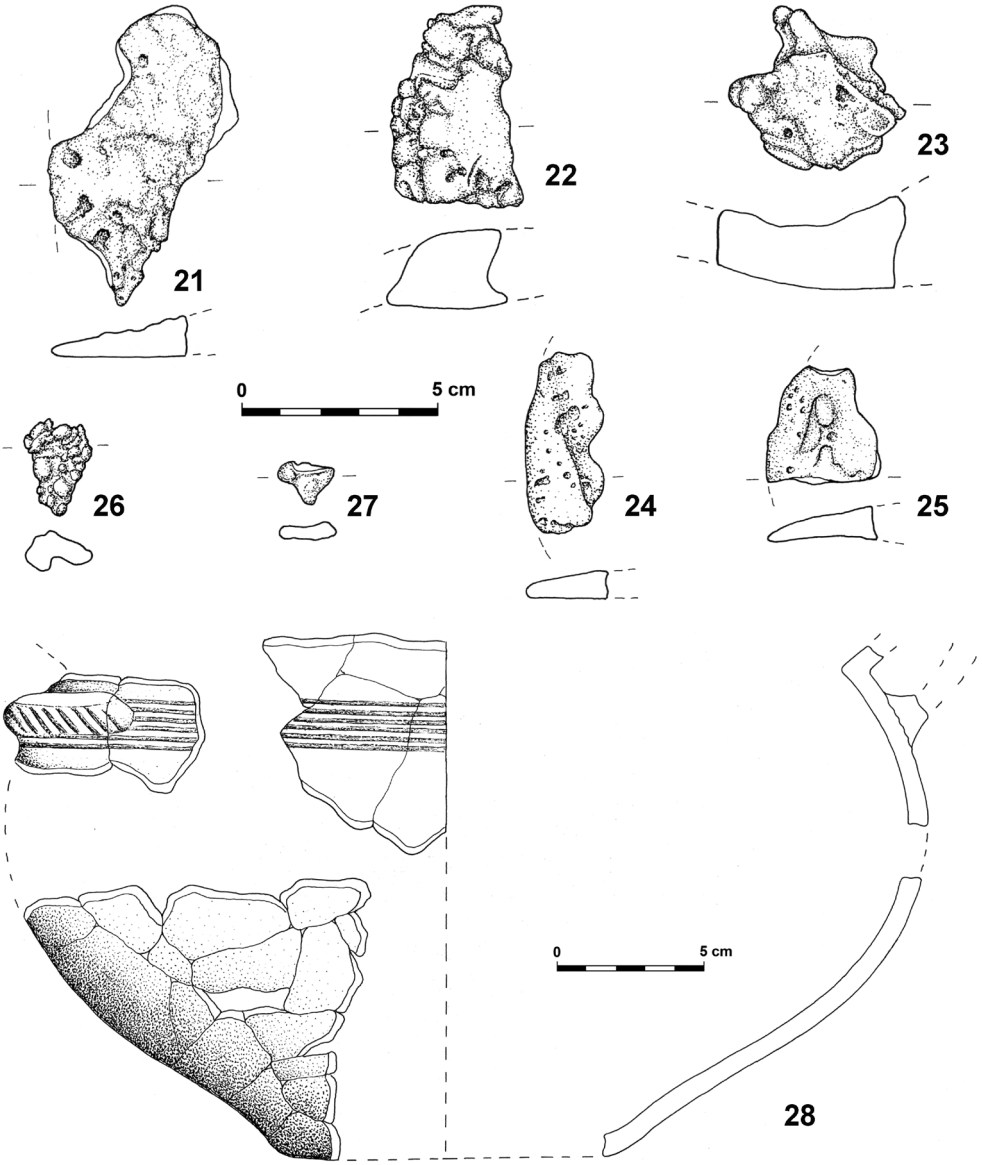

Fig. 9. Krtely. Copper artefacts and the torso of a ceramic vessel from the hoard. The numbers of the artefacts correspond to their list in the *Online Supplementary Material 1* (drawing by T. Kolegar).

295, Taf. 22: B8, 45: 54 – as Prague-Jinonice). A more recent find from the same period is a smaller cake-shaped ingot found with a larger number of incomplete ingots in the Olešná 2 hoard (*Chvojka et al. 2017b*, 117, Tab. 121: 34).

The cake-shaped ingot from Krtely (*Fig. 7*: 16) is thus the sixth verifiable complete example found in hoards from the Upper Danubian Urnfield culture in Bohemia. All previous cases can be associated solely with the early phases of the development of this cultural

complex. The remaining 11 ingots from the hoard in Krtely are variously sized fragments and pieces (*Fig. 8–9*), which cannot be typologically evaluated in detail.

The presence of cake-shaped ingots and their fragments is also a significant argument for classifying the assemblage as a hoard, since they do not appear in graves with a few exceptions (e.g., *Hennig 1993*, Taf. 45: 20–21).

Ceramic vessel

Similar to several other South Bohemian hoards from the Late Bronze Age, the assemblage of metal artefacts found near Krtely was accompanied by a ceramic vessel, unfortunately without a clear relationship. The vessel was preserved only fragmentarily, with its upper part completely missing (*Fig. 9*: 28). Therefore, its typological classification is problematic; however, we consider the classification of the vessel as an amphora or jug to be the most likely. Numerous analogies for both types of vessels with decorations in the form of a bundle of narrow grooves on the neck can be found directly in South Bohemia. Similarly decorated large jugs formed the container for the hoard from Holašovice (*Kytlicová 2007*, Taf. 22: A37), and other examples of jugs with grooved decorations come from settlement areas and grave complexes (e.g., *Chvojka 2009*, Tab. 33: 2, 44:6, 54: 19; *Hlásek et al. 2016*, 151, Fig. 8: 1). However, similar grooved decorations on the neck are also documented on some South Bohemian amphorae from the earlier phase of the Late Bronze Age (*Chvojka 2009*, Tab. 61: 5).

Chronological classification of the hoard from Krtely

The typological analysis of the artefacts clearly indicates the chronological classification of the hoard from Krtely. All datable metal products and the torso of the ceramic vessel belong to the earlier phases of the Late Bronze Age, i.e., to the Reinecke stages Br D – Ha A1, although some have a broader chronological range. Due to the absence of organic materials, this date was not supported by radiocarbon dating, but the typological analysis of most artefacts provides a clear classification into the stated period. This is also confirmed by the chronological classification of the most interesting metal product from the hoard – the pick, which is based on analogies mainly from the salt mine environment in Hallstatt. Although bronze picks with butt wings were used throughout the Urnfield period and into the Early Iron Age, as already mentioned, there was a certain evolution in shape and size of the picks during these epochs, reflecting a functional shift in salt mining techniques (*Barth 1993–1994*). The specimen from Krtely in its shape, dimensions, and weight corresponds to the picks from the Late Bronze Age, as shown by similar complete picks from the hoards in Sipbachzell (*Höglinger 1996*), Guşteriţa II, and Uioara de Sus (*Vulpe 1975*, 79–80, Taf. 45: 457–459, 46: 460–464). Based on these analogies, the pick from Krtely can be clearly dated to the Late Bronze Age. The above typological classification of the sword, knife, sickle, circular jewellery, and pin safely confirms the dating of the entire hoard to the period Br D – Ha A1.

Analysis of the elemental composition of metal artefacts from the hoard

Small samples of metal shavings were taken by drilling from all artefacts from the Krtely hoard and then subjected to pXRF elemental analysis using a handheld Niton XL2 GOLDD

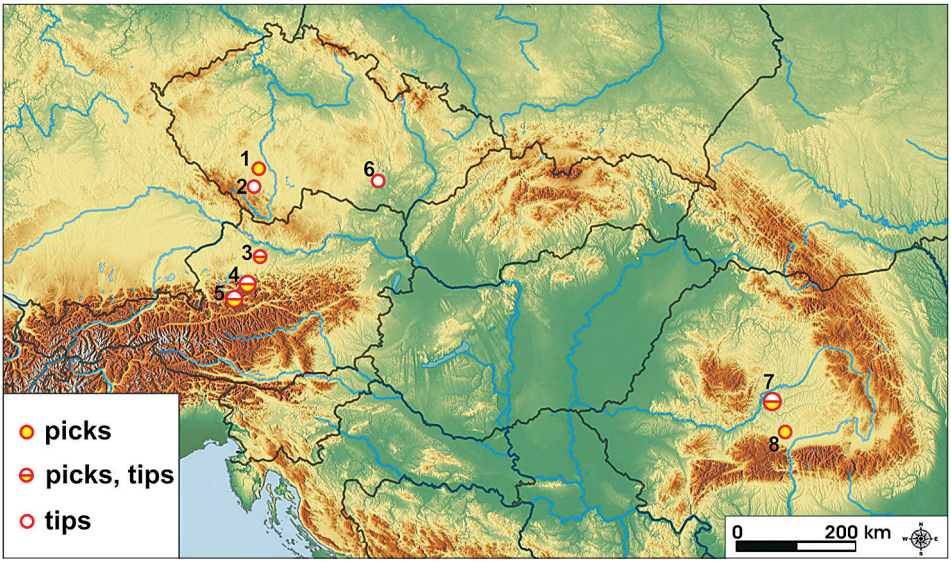

Fig. 10. Map of the distribution of Hallstatt-type picks in Central Europe. 1 – Krtely, 2 – Holašovice, 3 – Sipbachzell, 4 – region of Bad Aussee, 5 – Hallstatt, 6 – Ivančice, 7 – Ocna Mureş-Uioara de Sus, 8 – Sibiu-Guşteriţa (background www.stepmap.com, modified by T. Zachar).

spectrometer and a low-power X-ray lamp (45 kV/2W). The measured values clearly indicate that tools, weapons, and ornaments were made of tin bronze, while the ingot fragments are copper (*Tab. 2*). Unlike the copper ingots, the fragments of products often also contain small amounts of lead. Among the bronze artefacts, the highest tin content was found in the miner's pick (9.48%), but it should be noted that the sampling and measurement procedure typically leads to a slight underestimation of the tin content in the alloy (see *Malý et al. 2019*), and the actual content of this element is probably slightly higher (see ED-XRF analysis results below).

The Hallstatt-type winged pick from the find assemblage from Krtely (*Fig. 5*), as well as a fragment of an identical type of pick in the hoard from Holašovice (*Kytlicová 2007*, Taf. 21: 22), were subjected to elemental analysis using the ED-XRF method (*Nørgaard et al. 2019*, 3–4). After removing the surface layer of patina, we drilled out a small amount of metal (30 mg). The analyses were performed by the CEZA Mannheim laboratory (using the EDRFA Spectro Xepos HE instrument). Given the function of the picks as mining tools (*Reschreiter et al. 2018*), the aim of the analyses was to obtain more detailed information on the tin content in the bronze alloy. The pick from Krtely contained 12% tin, the specimen from Holašovice 10.6% tin (*Tab. 3*: ID1, ID3). The analysis of the artefact from Krtely using the XRF method indicated a value of 9.48% tin (see above), while in the case of the pick from Holašovice, the NAA method measured a value of 12.96% tin (*Tab. 3*: ID2, ID4; *Salaš 2018*, 51, Fig. 20). The differences found in the measurements, in the case of the Krtely specimen up to 2.52%, represent a common deviation resulting from the use of different methods (e.g., *Salaš 2014*, 73, Fig. 21; *Zachar – Salaš 2019*, 619, Tab. 1). The content of other elements in the bronze alloy of the monitored miner's picks (<0.33%, ED-XRF method) represents natural contamination of the primary copper raw material.

ARTEFACT	Cu	Sn	Fe	Co	Ni	As	Sb	Pb
1	89.93	9.48	0.05	< LOD	0.27	0.03	< LOD	< LOD
2	89.89	8.10	0.04	< LOD	0.77	0.48	0.14	0.25
3	94.82	2.96	< LOD	0.04	0.30	0.98	0.19	0.36
4	94.32	4.82	< LOD	0.05	0.11	0.17	< LOD	0.18
5	92.22	6.80	< LOD	< LOD	0.26	0.12	< LOD	0.14
6	93.34	5.93	0.04	< LOD	0.27	0.12	0.03	0.08
7	92.93	6.16	< LOD	< LOD	0.32	0.13	0.04	0.12
8	94.92	4.26	0.06	< LOD	0.35	0.11	0.02	< LOD
9	91.38	7.93	< LOD	< LOD	0.15	0.09	< LOD	< LOD
10	92.93	6.16	< LOD	< LOD	0.29	0.13	0.04	0.09
11	93.89	4.85	0.25	0.04	0.31	0.20	0.04	0.09
12	92.64	6.43	< LOD	0.03	0.29	0.14	0.03	0.07
13	93.42	5.41	0.06	< LOD	0.24	0.25	0.04	0.13
14	91.30	8.12	0.23	< LOD	0.04	< LOD	< LOD	< LOD
15	92.20	7.25	< LOD	< LOD	0.17	0.13	< LOD	0.04
16	98.94	< LOD	0.59	0.07	1.21	0.04	< LOD	< LOD
17	99.80	< LOD	0.26	< LOD	0.61	0.09	< LOD	< LOD
18	97.35	0.15	0.81	< LOD	0.06	1.24	0.30	< LOD
19	99.57	< LOD	0.05	< LOD	0.28	0.05	< LOD	< LOD
20	98.04	< LOD	2.12	0.05	0.30	0.31	< LOD	< LOD
21	78.78	< LOD	19.85	< LOD	0.85	0.35	0.05	< LOD
22	97.91	< LOD	1.92	< LOD	0.08	0.03	< LOD	< LOD
23	98.53	< LOD	0.66	0.14	0.50	0.19	< LOD	< LOD
24	98.66	< LOD	0.79	0.13	0.15	0.06	< LOD	0.16
25	97.04	< LOD	1.91	0.15	1.23	0.49	< LOD	< LOD

Tab. 2. Results of elemental analysis (pXRF) of all metal artefacts from the Krtely hoard. LOD – below detection limit (prepared by J. John).

ID	Locality	Analysis	Fe	Co	Ni	Cu	Zn	As	Ag	Sn	Sb	Pb	Bi	Au	Se	References
1	Krtely	ED-XRF	<0.05	0.02	0.26	88	<0.05	0.02	0.009	12	<0.005	<0.005	<0.01	n	n	MA-223762
2	Krtely	XRF	0.05	n	0.27	89.93	n	0.03	n	9.48	n	n	n	n	n	in this article
3	Holašovice	ED-XRF	<0.05	0.01	0.27	89	<0.05	0.05	0.018	10.6	0.008	0.064	<0.01	n	n	MA-223761
4	Holašovice	NAA	0.185	0.012	0.329	86.43	n	0.052	0.017	12.96	0.008	n	n	0	n	*Salaš 2018*
5	Ivančice 4	NAA	0	0.047	0.611	87.39	n	0.323	0.038	11.34	0.219	n	n	0.001	0.001	*Salaš 2018*
6	Sipbachzell Nr. 349	XRF	0.19	n	0.11	84.24	n	n	n	15.42	0.04	n	n	n	n	*Frána – Jiráň 1996*
7	Sipbachzell Nr. 353	XRF	0.11	n	0.36	87.28	n	0.37	n	11.52	0.25	0.11	n	n	n	*Frána – Jiráň 1996*
8	Sipbachzell. unknown	NAA	0.139	0.013	0.122	82.644	0.0058	0.0465	0.0091	13.44	0.045	0	n	0.00033	0.0026	*Frána – Jiráň 1996*
9	Hallstatt	OES	n	n	0.36	90.6	n	0.34	0.56	6	1.45	0.69	n	n	n	*Junghans – Sangmeister – Schröder 1974*

Tab. 3. Results (%) of elemental analysis (ED-XRF, NAA, XRF, OES) of Hallstatt-type picks. n – not analysed (according to *Junghans et al. 1974*; *Frána – Jiráň 1996*; *Salaš 2018*; CEZA Mannheim MA-223761-62; prepared by T. Zachar).

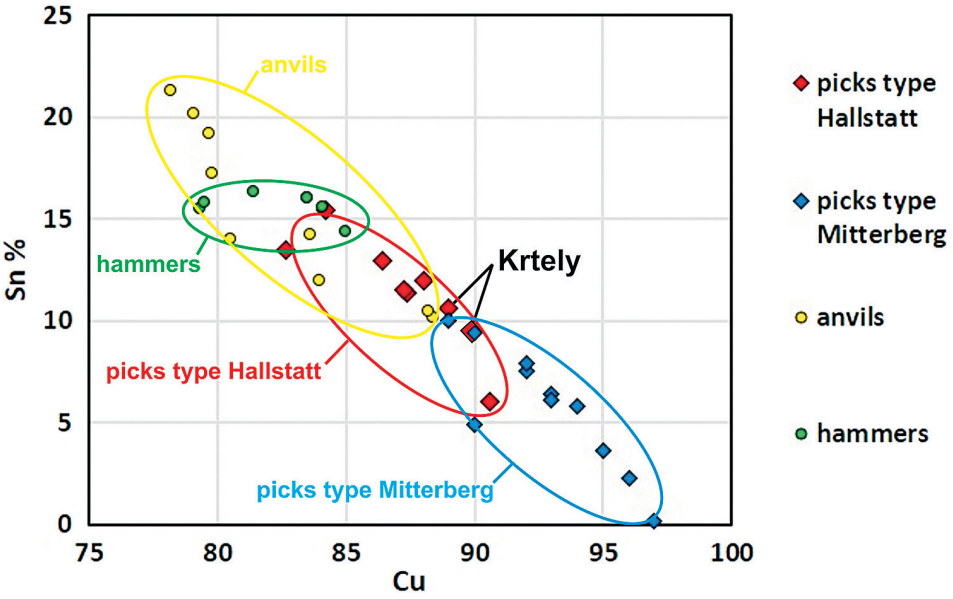

Fig. 11. Graph comparing Sn contents (ED-XRF, NAA, XRF, OES) of Hallstatt and Mitterberg type picks with anvils and hammers from the Late Bronze Age (according to *Junghans et al. 1974*; *Frána – Jiráň 1996*; *Stöllner – Schwab 2009*; *Salaš 2014*; *2018*; *Chvojka et al. 2022*; prepared by T. Zachar).

We compared the amount of tin in the bronze alloy of two Hallstatt-type winged picks from South Bohemia with available elemental analyses (methods NAA, XRF, OES) of other miner's picks from Central Europe. The tin values in the bronze alloy of the Hallstatt-type picks, or their fragments from the hoards in Sipbachzell (*Frána – Jiráň 1996*, 107, Tab. D: 349, 353; *Höglinger 1996*, 129, Taf. 20: 349, 353) and Ivančice (*Salaš 2018*, 51, Fig. 20, Tab. 3: 75), range between 11.34 and 15.42% (*Tab. 3*: ID5–8). An exception is the specimen from the eponymous site Hallstatt (*Mayer 1977*, 228, 229, Taf. 1370–1375), where spectral analysis indicated a tin content of only 6% (*Tab. 3*: ID9; *Junghans et al. 1974*, 306, Nr. 20103). The measured amount of Sn (OES method) corresponds more to the tin content of Mitterberg-type socketed picks, whose values range mostly from unalloyed copper to 10% (*Fig. 11*; *Frána – Jiráň 1996*, 107, Tab. D; *Stöllner – Schwab 2009*, 162, Tab. 6). So far, in no case have we found significantly increased tin contents between 12 and 21.3% (lowest value 10.13% Sn), as we observe in the majority of anvils and small hammers (*Fig. 11*; *Salaš 2014*, 74, Fig. 23; *Chvojka et al. 2022*, 86, Tab. 1). The tin contents found in the Hallstatt-type miner's picks suggest slightly increased tin contents compared to other bronze artefacts (e.g., *Frána et al. 1997*, 152–160), which form the ideal hard tin bronze (for more details, e.g., *Salaš 2014*, 73).

The amount of tin in the alloy of the picks probably did not need to match the hardness of the hammers and anvils, as mining rock salt did not require the hardness of metallurgical tools used for working metal. At the same time, this minimized the brittleness of the bronze picks, which was a problem and led to the breaking off of tips (*Reschreiter – Kowarik 2019*, 115), because rock salt can be very hard. In this context, the significantly lower tin content in the Mitterberg-type picks, intended for mining copper ore, is surprising. However, hard-

ness was increased here by forging and annealing (*Stöllner – Schwab 2009*, 163–165). Comparing the amount of tin in two different types of picks (Hallstatt and Mitterberg) with metallurgical tools confirms that the amount of tin in the bronze alloy in the Late Bronze Age was not accidental but closely related to the function of the artefact (*Reschreiter et al. 2018*).

Use-wear analysis of the pick

The spectacular find of the pick from Krtely was subjected to thorough analysis aimed at identifying and interpreting the manufacturing and use-wear traces on the artefact. It underwent detailed microscopic examination, photographic documentation using RTI, visual inspection, and elemental composition analysis via pXRF. The artefact exhibited a progressive sequence of evidence of its life, from the identification of the material used, through the manufacturing process, usage, reutilization, deposition, and post-depositional processes (*Fig. 12*).

Manufacturing of the artefact

The pick was manufactured by casting molten tin bronze into a stable two-part mould. Subsequently, the sprue channel was cut off at the butt, and the surface was ground down. Post-casting marks are visible on the sides of the artefact's butt in the form of incompletely ground seams at the parting line of the mould. To achieve a perfect grind would have required removing a presumably excessive amount of material, hence this was abandoned. The entire butt of the artefact bears irregular break marks likely resulting from the rough removal of the sprue channel. The flanges were originally cast perpendicular to the body of the pick and then hammered and bent at their ends, creating a closed space for attaching a handle on each side through partial overlap. Consequently, the material of the wings is thicker at the body than at the ends. Additionally, the edges of the wings are irregular, likely due to their imperfect casting. A similar method of wing creation was used in winged axes, as evidenced by comparing the wings of preserved casting moulds with the finished products. The body beneath the wings transitions from a slightly irregular circular cross-section to a regular hexagon, originally extending to the tip of the artefact.

Usage of the pick

The outer surface of the upper part of the artefact shows a considerable number of linear depressions (*Fig. 13*: A). These are primarily located on the sides of the item and to a lesser extent at the point where the wings meet. The depressions cluster into bundles of roughly parallel grooves, which in the butt area intersect at angles of 90° ± 3°. Given the function of analogous finds, these marks can be linked to the intensive use of the artefact in mining activities, specifically mechanical disruption of rock. Based on their character and placement, the linear depressions likely resulted from abrasion against the mine walls or the present rock. Numerous impact marks on the sides of the pick may also indicate its use as an anvil, as similarly documented on the sides of some axes and other artefacts from Moravian hoards (*Malach et al. 2016*, Fig. 17, 54, 67: A, 93–94, 105) or on the hammer from Zlatna in Romania with similar marks, which suggest the interpretation of the secondary use of this object as an anvil (*Nessel 2019*, 69, Abb. 69).

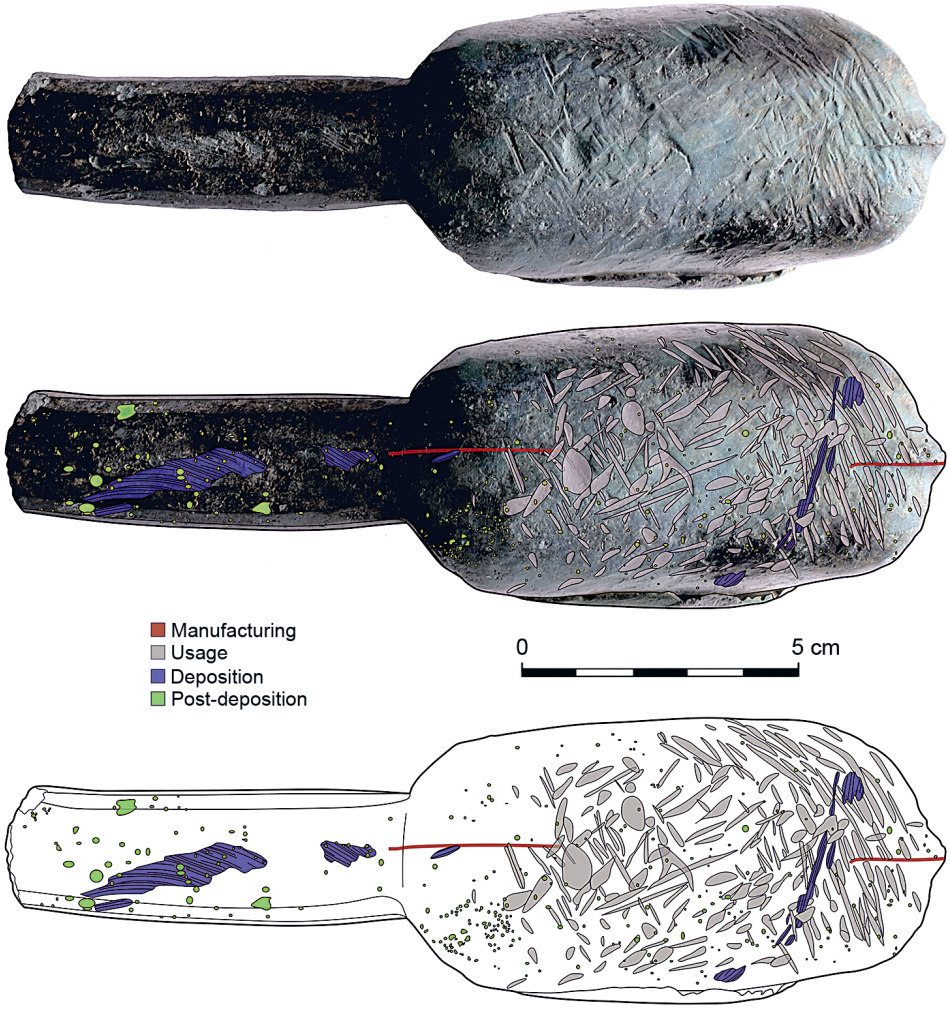

Fig. 12. Krtely, pick. RTI documentation and interpretation of surface traces (photo and drawing by M. Kmošek).

The placement of use-wear marks mainly on the sides of the pick raises questions about its fixation to the handle. Comparing it with analogous finds from Hallstatt (*Kowarik et al. 2019*), where wooden handles were preserved, the placement of work marks on the sides rather than at the point where the wings meet does not correspond. According to the wear marks, the pick from Krtely would have been fixed to a handle perpendicular to all analogous finds of handles.

Reutilization of the artefact

The functional end of the artefact was modified in relation to a change in its use. The original conical/pyramidal tip was reshaped into a chisel-like form. The modification affected the terminal 15 cm of the artefact (*Fig. 5*). Two parallel planes were further flattened,

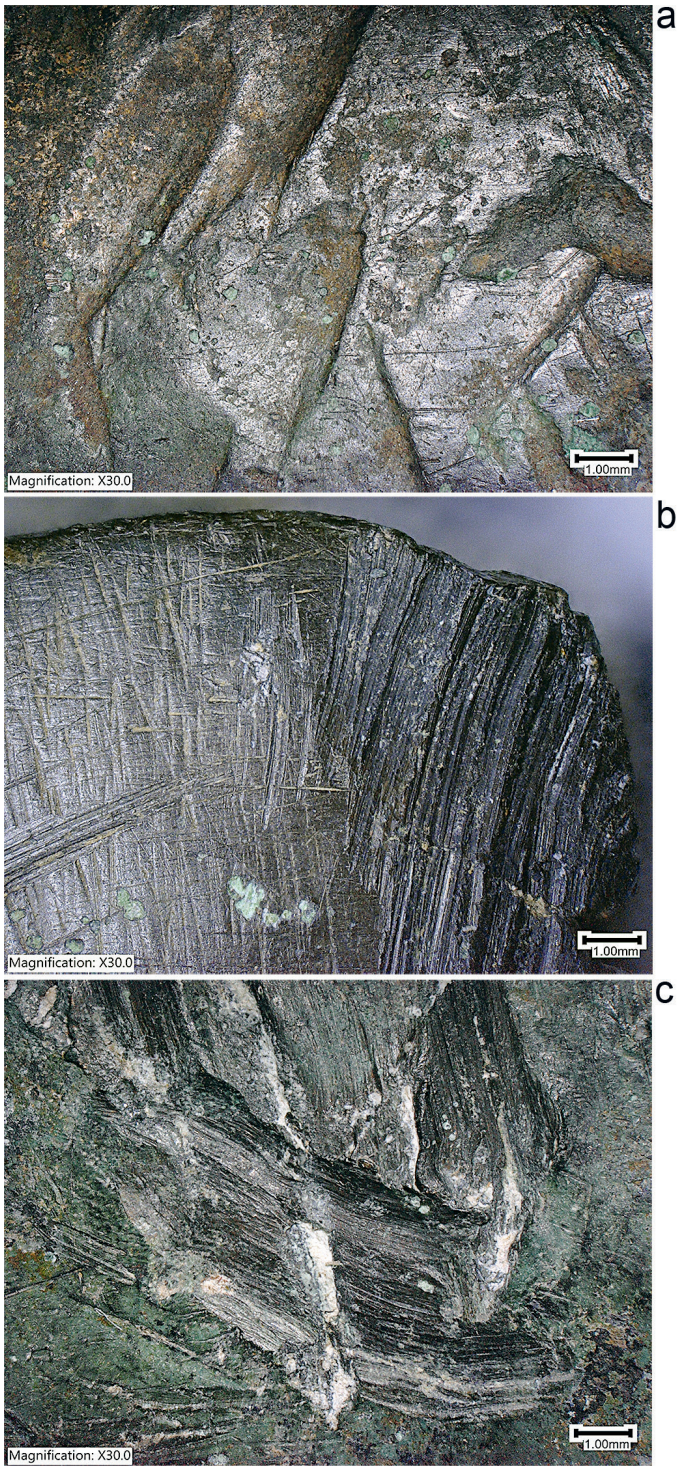

Fig. 13. Krtely, pick. A – microscopic photo of traces of use on the upper part of the artefact. B – microscopic photo of the traces of grinding (left) and damage on the blade. C – microscopic photo of damage marks on the body of the artefact (photo by M. Kmošek).

forming a chisel edge. This adjustment is marked by a noticeable break in the artefact's structure, surface texture, and different and compact coloration of the corrosion products compared to the rest of the surface. The side edges were also slightly flattened to narrow the width of the artefact's end. Such a modified functional end would have hardly served for mining anymore, suggesting the modification was due to a change in the artefact's use. The created edge could have functioned as a chisel, with lesser probability as an axe, adze, weapon, or another tool. A possible function related to cutting cake-like ingots into pieces, also found in the hoard, is feasible but remains a somewhat constructed interpretive solution. The reutilized function again raises the question of how the artefact was fixed to a handle, which is challenging to resolve without assigning a specific interpretation from those mentioned. Reutilization and modification of the functional end might also have occurred in the context of the tip breaking off, as there are a considerable number of broken tips compared to other parts of picks (*Mayer 1977*; *Kowarik et al. 2019*, 65, Abb. 42). Instead of re-forging the pick into its original shape, it may have been modified to its current form. The edge shows grinding marks parallel to the cutting edge, contrasting with all other parts of the artefact (*Fig. 13*: B).

Deposition

The artefact was found in a hoard with numerous other copper alloy items. Its lower part was broken off from the rest of the body by the application of significant mechanical force, causing bending leading to the artefact's breakage. Whether the cause was an accident during use or intentional action to remove the artefact's primary function cannot be determined, leaving both possibilities, or other unknown ones, relevant. The surface of the artefact bears irregular deep abrasion marks randomly distributed (*Fig. 13*: B–C). These damage marks overlay both usage and reutilization marks. The cause of these marks remains undetermined but may be connected to one of the above-mentioned deposition methods. Unfortunately, there is no way to determine how long before its deposition the artefact broke and got abraded, and thus how long it might have circulated in society after these events.

Post-deposition

After the hoard was deposited in the ground, post-depositional processes began, primarily evidenced by soil corrosion forming a compact layer of corrosion products on the artefact's surface, ranging from light green to dark brown. Likely after being removed from the ground and disturbing the stable burial conditions, localized corrosion damage in the form of pitting corrosion occurred, creating small depressions in the previously formed corrosion products.

X-ray and tomographic analysis of a sword fragment

The aim of the CT reconstruction and its visual analysis was to determine the shape and composition of the metal fragments embedded in the sword's hilt. Acquisition images for CT reconstruction were taken with the Explorer X test 200 – 120/400 from Testima. The device is equipped with two X-ray sources. The first source, with a maximum voltage of 200 kV, is more suitable for imaging more massive metal samples, but due to the longer

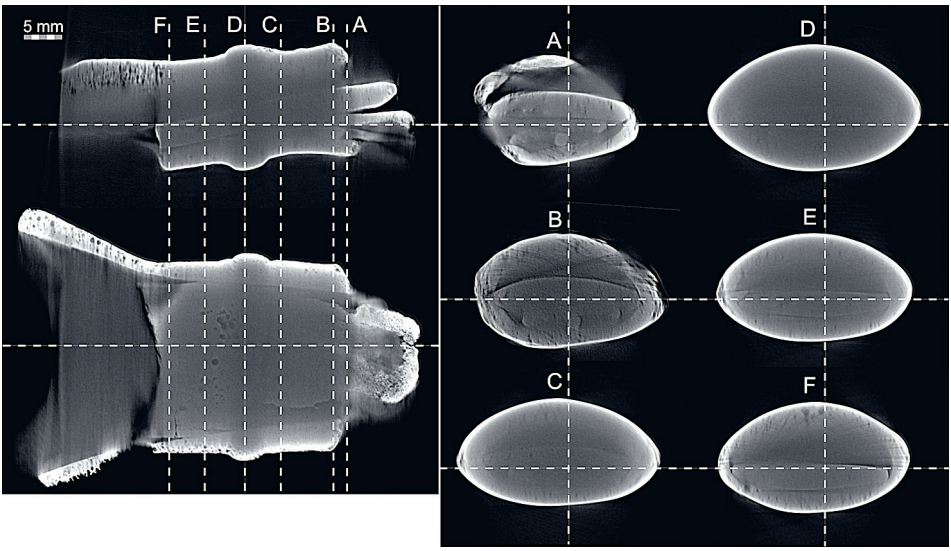

Fig. 14. CT reconstruction of the sword hilt: selected hilt cuts (photo by R. Thér).

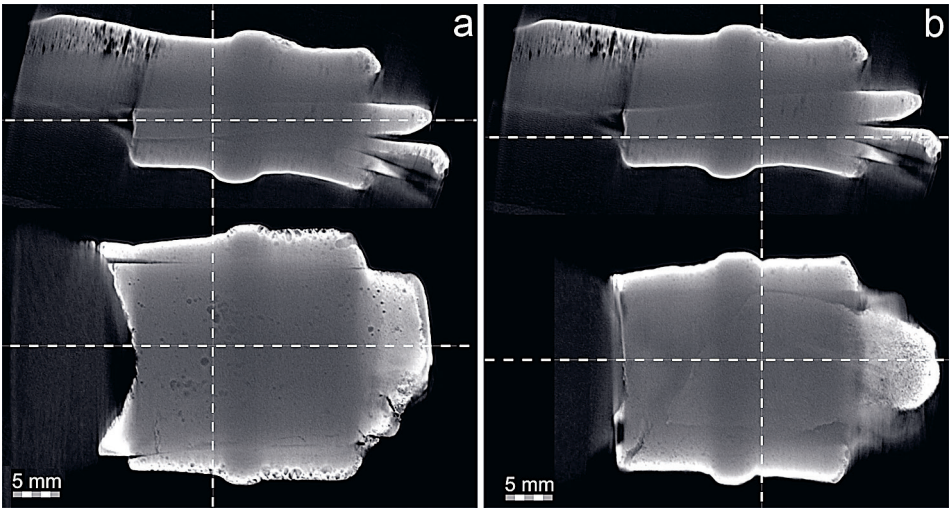

Fig. 15. CT reconstruction of the hilt of the sword. a – captured shape of the thicker upper plate inserted into the hilt, b – captured shape of the weaker lower plate inserted into the hilt (photo by R. Thér).

focal length (0.8 mm), it is not suitable for imaging smaller objects in higher resolution. The second source, with a maximum voltage of 120 kV, is suitable for detailed imaging (focal length 0.05 mm) but has limited power, insufficient for penetrating larger objects with high radiodensities. Thus, the setup used did not provide optimal imaging parameters for the task. Better results were obtained with the second source, but it is evident from the reconstruction that its power was insufficient for optimal penetration of the hilt, and

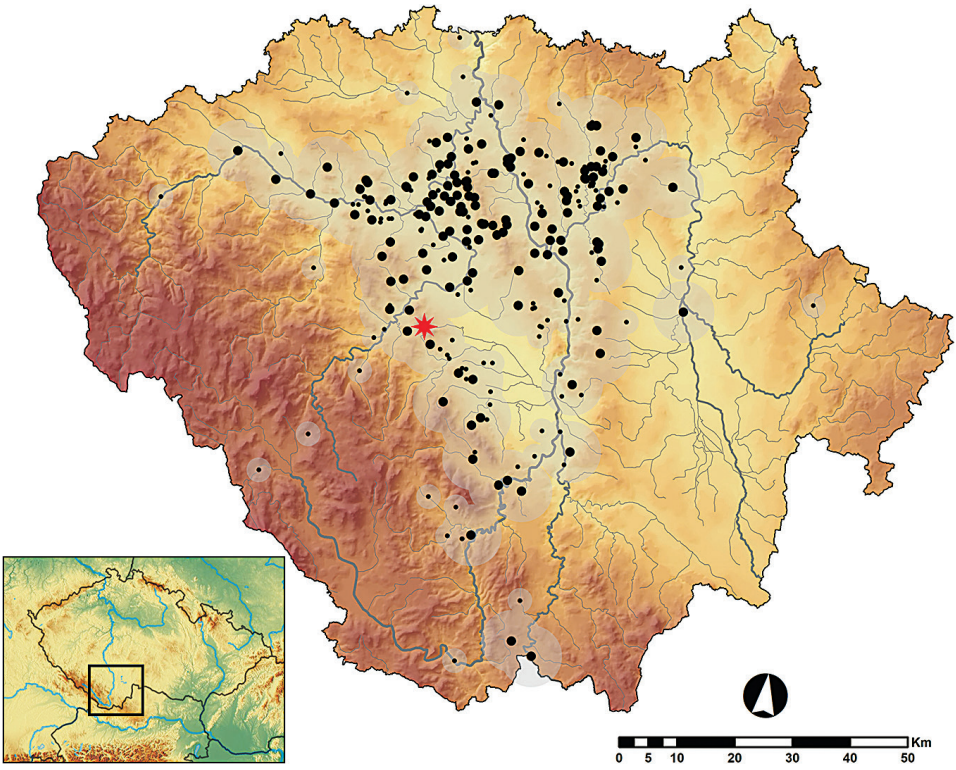

Fig. 16. South Bohemia in the earlier phases of the Late Bronze Age (Br D – Ha A1; according to *Chvojka et al. 2021b*, Fig. 6.21). Red star – location of the hoard from Krtely; larger points – certain dating; smaller points – probable dating.

in places with the greatest thickness of the metal fragment assembly (at the rib reinforcement of the hilt; *Fig. 14*: D) the X-ray photons were completely absorbed.

For the CT reconstruction, 400 acquisition images were taken at 120 kV and 260 μA. The reconstruction was performed using LometomArk software developed for Testima X-ray imaging systems. Despite the mentioned limitations, the primary goal of the analysis was met. The shape of the embedded fragments (two plates and one rod-like object; *Fig. 15*) can be observed in the defined sections, allowing documentation of the entire composite. It was also possible to verify that no decoration or other morphological features remained on the surface of the inserted fragments, which would have allowed identification of the artefacts from which these fragments originated. We can see the deformation of the inner profile of the hilt by the thicker plate, indicating its forcible insertion into the hilt (*Fig. 14*: B).

Settlement-topographical analysis of the hoard

The hoard from Krtely was deposited in a landscape that was inhabited during the Late Bronze Age, though it was not part of the core areas of the South Bohemian region (*Fig. 16*; *Chvojka et al. 2021b*, 127–130, Fig. 6.21). Sporadic settlement from the Late

Bronze Age is known directly from the Krtely cadaster (*Chvojka 2009*, 253). In the Krtelský forest, located in the Netolice cadaster south of Krtely, are several prehistoric burial mounds, at least two of which can be dated to the beginning of the Late Bronze Age (*Chvojka 2009*, 255 and new, as yet unpublished finds). The nearest proved settlement from the Late Bronze Age is located at the Rábín court in the Malovice cadaster, 3.7 km from the hoard (unpublished research by the Prachatice Museum in 2014).

The hoard's deposition site itself represents a relatively prominent location elevated about 60 m from the surrounding terrain, which, if deforested, would provide a view south and east into the western part of the Českobudějovická Basin and the Netolická Highlands. Depositing hoards in similarly conspicuous locations is also documented elsewhere in the Late Bronze Age in South Bohemia, such as in the Písek Mountains, where several hoards from the Br D to Ha A stages were found at peaks or on ridges (*Fröhlich et al. 2015*).

Discussion

Bronze Age hoards in the context of burial mounds

The deposition of hoards of bronze artefacts within the context of burial mounds is a completely unique phenomenon in the Czech territory. No similar cases have been convincingly proved for the Urnfield Culture period (see *Šteffl 2014*, 28). In the past, some sets of bronze artefacts were considered to be hoards deposited within the context of burial mounds (e.g., finds from Albrechtice nad Vltavou or Vrcovice in South Bohemia: *Fröhlich 1997*, 6–8, 218–219; *Kytlicová 2007*, 254, 315), but this has not been proved for any of them. In the case of Albrechtice, the only indication of a connection between the set of five twisted anklets and the funerary component is the fact that they were part of a large collection of bronze artefacts gathered at Ohrada Castle, most of which came from the local burial mound site, which was destroyed by the end of the 19th century. There are no specific details available regarding the discovery circumstances of these anklets from the Ha B1 stage. There is no evidence to suggest that this is a hoard deposited within the context of a burial mound. In Vrcovice, according to initial information, two shield fibulae were found along with 'two boxes resembling shells' (phalerae?) and many bronze rings among the stones while removing a mound at the edge of a meadow. No skeletal remains or containers or ashes were found. Therefore, the existence of a burial mound is highly uncertain (see the latest discussion: *Chvojka et al. 2023*, 194).

From the perspective of the investigated issue, it is also not relevant to consider finds deposited near burial mound sites but outside their areas – for example, a sword from Písecká Smoleč, found about 50 meters from the edge of an undated burial mound site (*Jiřík – Pták 2013*).

Even within the broader Central European Urnfield Culture settlement area, the deposition of hoards within the context of burial mounds can be considered extremely rare (*Tab. 4*). Specifically, such a context cannot be ruled out for eight other hoards in Germany (*Wahle 1925*; *Falkenstein 2011*, 89–90). However, these hoards display many different characteristics from one another.

The closest site to Krtely, where the deposition of a hoard in the context of a burial mound can be considered, is Affalterthal in Upper Franconia, located 220 km away. Here,

Site	Position	Tools	Ornaments	Raw Material	Dating	Problem
Zeublitz	at the foot of the mound	x	0	0	Br C	hoard?
Wekheim	near the edge of the mound	x	0	0	Br C	moulds: hoard?
Krtely	to the top of the mound	x	x	x	Br D/Ha A1	–
Affalterthal	western part of the stone pile	x	x	0	Br D	hoard near mound?
Ederheim	in the grave chamber	x	0	x	Br D/Ha A1	hoard in grave chamber?
Jüchsen	outer edge of the stone circle	x	0	x	Br D/Ha A1	–
Marburg-Lahnberge	outside the stone circle	0	x	0	Br D/Ha A1	only one pin
Bad Friedrichshall-Jagstfeld 1	in the mound	0	x	0	Ha A2	unclear information
Bad Friedrichshall-Jagstfeld 2	inner side of the ditch around the mound	0	x	0	Ha A2	–

Tab. 4. Overview of Bronze Age metal hoards from burial mound areas. Selected examples from Central Europe. The hoards from the same period as the Krtely hoard are highlighted in grey.

a collection of bronze artefacts consisting of three sickles, eight pins, and an armband was found in the late 19th century. The hoard was found in the western part of a stone pile, which was interpreted as a mound, although no traces were found to confirm its funerary use. P. Reinecke interpreted the elevation rather as a heap of prominent stones after subsequent inspection (*Reinecke 1937*). On the other hand, *K. Schwarz* (*1955*) again connected the deposition of the hoard with a mound. Later, some authors avoided the connection with a mound, referring to it only as a hoard (*Müller-Karpe 1959*, 286; *Stein 1979*, 122–123), however, others accepted the association of the ensemble with the mound (*Hennig 1970*, 67; *Hansen 1994*, 443; *Falkenstein 2011*, 89).

The nearest undisputed mound site, from which the hoard in a burial mound is also mentioned, lies at the western border of Bavaria, 270 km from Krtely in Ederheim (*Ludwig-Lukanow 1983*, 24–26). Here, 20 mounds were heavily damaged during deforestation in the 1920s. During the excavation of mound No. 8, a collection of two complete sickles and two fragments of sickles, along with a small piece of an ingot, was found at the right knee of the buried skeleton. The collection was designated as a hoard based on the functional nature of the artefacts. For the same reason, the tweezers found together were assigned to the grave goods of the buried.

A small hoard deposited within the context of a burial mound comes from Jüchsen in Thuringia, where 10 mounds were investigated. The hoard was discovered during a proper excavation in 1959. It was deposited under two stone slabs at the outer edge of the stone circle of a large burial mound No. 1 from the Middle Bronze Age. It contained two axes and two small ingots (*Feustel 1993*, 62–66, Taf. 31: 14–16).

Regarding the hoard from the Lahnberge-Lichter Kuppel position in Marburg, there is a question. During the research in 1897, Mound No. 2 was investigated. On its western side, outside the stone circle, a peculiar semicircular structure made of small stones was uncovered, at the centre of which a broken pin was found (*Dobiat 1994*, 260, Taf. 70: 1–2). It is likely impossible to determine whether this is a solitary hoard or a symbolic burial.

The collection of two sickles and an axe, supposedly found in 1929 at the foot of a mound near the village of Zeublitz in Upper Franconia (*Stein 1979*, 172), has been preserved only in drawing form (*Radunz 1969*, Taf. 9: 5–7). The discovery circumstances are not known, nor can the completeness of the original find be confirmed. The find can most likely be classified as a hoard, although there are doubts (*Radunz 1969*, 129; *Hennig 1970*, 88).

Another one or possibly two hoards originate from the site of Bad Friedrichshall-Jagstfeld in Baden-Württemberg (*Biel 1977*). Around the year 1862, one mound was excavated, in which, besides burials, two stone axes were said to have been found in the central part and at the edge of the mound. Additionally, a hoard of 19 bronze rings and many small rings was reportedly placed higher up in the mound. The situation in this case is unclear as the artefacts have not been preserved. However, it is possible that some of the circular ornaments published by *R. Dehn* (*1972*, 84, Taf. 7: A) originate from this find. If this is the case, it offers a parallel with the hoard of nine bracelets that was later found at this site. During a rescue excavation in 1974, another significantly damaged mound was examined, and this hoard was placed north of the central burial, by the inner side of the ditch surrounding the mound.

A somewhat different deposit is the find of two casting moulds found near the southwest edge of one of the four burial mounds in the cadastral area of Wenkheim in Baden-Württemberg (*Wahle 1925*). Since these artefacts were deposited outside the central funerary space, this find can likely be interpreted as a hoard. The products from these moulds belong among the representative artefacts of the later phase of the Middle Bronze Age, with no direct analogies yet found for the knife cast from the second mould (*Hohlbein 2016*, 33).

The mentioned possible cases of hoards deposited in the context of burial mounds represent a time span from the Middle to the Late Bronze Age. The find from Zeublitz and the moulds from Wenkheim should be classified into the Middle Bronze Age, where it is relevant to consider the different symbolic meanings of depositing actual bronze artefacts versus depositing the means of their production.

Most of the possible identified analogies fall within the chronological interval Br D – Ha A1. These assemblages regularly contain tools and raw materials, some also include ornaments. More detailed conclusions based on a comparison of the find circumstances are practically impossible with such a small sample. Besides Krtely, we record only four other sites from this period, although in the case of Affalterthal it is not entirely certain that the structure to which the hoard was deposited is a burial mound, and in Ederheim, doubt arises from the fact that the assemblage was deposited directly by the body of the buried. Another question is whether a single fragment of a pin deposited by the mound in Lahnberge can be viewed as a hoard. Thus, only the assemblage of artefacts from Jüchsen, whose find circumstances are documented by proper research, can be unequivocally considered a hoard deposited in the context of a burial mound. Unlike the situation in Krtely, however, it was deposited outside the actual mound body. At this point, we must admit that even in the case of the Krtely hoard, it is not possible, due to the absence of professional research on the actual mound structure, to unequivocally consider this structure a burial mound.

In the subsequent chronological interval Ha A2, we record the last traces of the observed behaviour in the case of finds from Bad Friedrichshall. Here, one or perhaps two hoards deposited in the context of burial mounds consist exclusively of circular ornaments.

As can be seen, the deposition of hoards of bronze products in the context of burial mounds is a very rare phenomenon. Such deposits do occur over a very wide area, but only

sporadically. One notable observation is that, similar to the case in Krtely, other studied assemblages also contain atypical artefacts. This is true for one sickle from Affalterthal, which is very close to the unusual example from Krtely, or in the case of the negative of a unique type of knife from Wenkheim.

The conducted analysis clearly shows that the deposition of hoards in the context of funerary components can be considered a special, unconventional form of ritual behaviour. The situation identified in Krtely is therefore unique, and the origin or initiator of such a ritual must be sought outside the Czech basin.

Notes on the fragmentation and secondary modifications of deposited artefacts

In recent years, especially in connection with Bronze Age hoards, the deliberate damage and fragmentation of deposited artefacts has been a widely discussed issue (e.g., *Nebelsick 1997*; *Rezi 2011*; *Brück 2016*; *Bradley 2017*, 124–141; *Knight 2020*). A fundamental question is the intentionality of this phenomenon, which can be determined or at least suggested by use-wear analysis. This, in turn, has a decisive influence on the interpretation of the entire hoard: while unintentionally damaged artefacts may have been collected for the purpose of remelting and reutilization, deliberately devalued artefacts suggest interpretations such as size and weight standardization in connection with potential (pre)monetary use of the artefacts, or as a means of removing the artefact from active use, thus interpreting the hoard as a permanent deposit (*Rezi 2011*, 303–305).

In the case of the Krtely hoard, we can distinguish five groups of metal artefacts based on their state of preservation:

1. Completely or almost completely (more than 80% of the item) preserved undeformed artefact: knife (No. 3), sickle (No. 4), ingot (No. 16).
2. Completely preserved artefact, broken: pick (No. 1).
3. Completely preserved artefact, deformed: bracelets (No. 11, 13), chisel (No. 15).
4. Large fragment of an artefact (50–80% of the item): twisted rod (No. 10), pin (No. 14), ingot (No. 17).
5. Fragment of an artefact (up to 50% of the item): sword (No. 2), axes (No. 5–8), neckring (No. 9), armring (No. 12), ingots (No. 18–27).

From this overview, it is evident that out of a total of 27 metal artefacts in the Krtely hoard, only three were preserved in a complete or almost complete and undeformed state (*Fig. 6*: 3–4; *Fig. 7*: 16). The pick is also preserved in its entirety (*Fig. 5*), but it was (intentionally?) broken into two parts. Therefore, it cannot be ruled out that in this case, deliberate removal from active use occurred. It is interesting to note that a similar pick from the Sipbachzell hoard was broken in the same way (*Höglinger 1996*, Taf. 20: 349), while another was deposited whole. For other fragments of products from the Krtely hoard, the intentionality of their fragmentation cannot be proved, nor can it be excluded. In the case of fragments of cake-shaped ingots, the incomplete parts could have been removed for the practical use of copper raw material for smelting.

Two bracelets were deposited whole but secondarily deformed. While we do not know precise analogies for the saddle-shaped rod bracelet (*Fig. 7*: 13) in Czech hoards, deformation of cast massive bracelets is relatively common in hoards from the Urnfield Culture period (e.g., *Salaš 2005*, Tab. 131: 417; *Lauermann – Rammer 2013*, Taf. 32: 2–3), as shown

by several South Bohemian examples (*Chvojka 2009*, Tab. 77: 2; *Chvojka et al. 2017b*, Tab. 110: 15, 117: 12). A similar 'figure eight' crushing of a bracelet, as documented in Krtely (*Fig. 7*: 11), is also documented in the hoard from Staré Sedlo (*Kytlicová 2007*, Taf. 23: 10). Similar to the aforementioned intentional breaking of the pointed tool, the deformation of the cast bracelet can be seen as clear evidence of the item's devaluation and deliberate removal from active use.

Four fragments show signs of fire. While this could have led to the warping of the chisel (*Fig. 7*: 15), it did not lead to visible deformation of the pin (*Fig. 7*: 14), twisted rod (*Fig. 7*: 10), or sword (*Fig. 6*: 2). Unfortunately, it is not possible to determine whether the burning was intentional.

In the case of the mentioned sword hilt fragment, it is necessary to point out an interesting phenomenon: the use of the cavity in the cast hilt fragment as an opening for inserting three other artefact fragments (*Fig. 14–15*). The combination of several objects into one by inserting them into each other is occasionally documented during the Urnfield period. A good example is the Blučina 6 hoard, consisting of an axe, with a dagger placed between its medial wings on one side and a spearhead on the other, all tied together with three bracelets (*Salaš 2005*, 292, Tab. 65, 482: 1–2). Similarly, in the Blučina 17 hoard, an axe blade fragment was placed between the wings on one side and a sickle fragment on the other (*Salaš 2005*, 306, Tab. 89: A). A very interesting analogy is offered by hoard no. 3 from the Kladky site, where an axe was found with an axe blade and a fragment of a circular ornament inserted into its socket (*Vích 2012*, 260, Fig. 28). However, the insertion of other artefacts or their fragments into the cavity of a sword hilt has not yet been documented in Czech hoards. Therefore, the meaning of this phenomenon in the case of the sword fragment from Krtely eludes us.

We can thus conclude that at least the pick and two bracelets in the Krtely hoard might have been intentionally damaged, i.e., taken out of everyday use. Therefore, it is probably not a collection of material intended for remelting, but rather a reflection of the deeper spiritual beliefs of the people who gathered and placed this collection at the top of an already existing mound.

Conclusion: Interpretation and significance of the Krtely hoard

Given its composition and the circumstances of its discovery, the Krtely hoard can be considered an example of a votive deposit (*Hansen 1994*, 381–384), containing several artefacts that are exceptional in South Bohemia, some of which may have been intentionally damaged. Considering the placement of the collection at the top of the mound, we can consider the following possibilities for its interpretation: 1) the hoard as a memorial/offering to deceased ancestors, 2) a so-called 'burial of bronzes', or 3) the hoard as a remnant of the deceased (cf. *Hansen 1994*, 388–390; *Šteffl 2014*, 94–96, 106–112). The exact explanation of the original meaning of the Krtely hoard is not possible, but its relationship to the mound is evident. However, we must also consider the possibility that the people who placed the hoard on the mound's surface may not have been aware that it was a burial monument. This naturally takes us into the realm of speculation; however, given the aforementioned examples from other regions in our text, we hypothesize that it was a conscious placement of the hoard into a burial monument.

The relationship between hoards of fragments with intentionally damaged artefacts and contemporary cremation burials with also damaged (by fire) human remains and grave goods has already been noted in the past (*Nebelsick 1997*, 40). In the case of the discussed hoard with a predominance of fragments from Krtely, which has a clear spatial connection to a burial monument, this connection to burial can undoubtedly be assumed. Indeed, some of the metal artefacts in Krtely were damaged by fire, and it can be assumed that the bronzes were placed in a ceramic vessel, similarly to how cremated human remains with their grave goods were commonly deposited during this era.

The Krtely hoard thus significantly contributes to the rich discussion on the role of metal hoards in the Bronze Age and their possible connections to ritualized behaviour and the spiritual world of the people of that time. It also serves as evidence of long-distance contacts of the inhabitants of South Bohemia during the Late Bronze Age. Notably, the miner's pick unequivocally indicates a connection to the salt mines in Hallstatt, which, together with a previously found fragment of another pick from Holašovice (*Kytlicová 2007*, Taf. 21: 22), suggests a possible distribution of salt to South Bohemia. Along with many other pieces of evidence (e.g., the bracelets of the Riegsee horizon: *Chvojka 2006*; copper distribution: *Kmošek et al. 2020*), the Krtely collection confirms the strong orientation of the inhabitants of South Bohemia (not only) in the Late Bronze Age towards the south, into the present-day Bavarian and Austrian Danube regions and the Alpine areas.

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