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SWORDS UNCOVERED AT THE BURIAL GROUND OF THE STARÁ KOUŘIM STRONGHOLD (9TH CENTURY) FROM THE PERSPECTIVE OF ARCHAEOLOGY AND METALLOGRAPHY[1]

INTRODUCTION

The Early Medieval Stará Kouřim stronghold (Kouřim, Kolín District), built in central-eastern Bohemia above a meander in the River Kouřimka – a left tributary of the Elbe (Fig. 1) – was one of the most important strongholds in Bohemia (Šolle 1966; 1981; Bartošková 2000). It was expanded twice from the first half of the 9th century until the end of the 9th century until, with an area of 44 ha, it became the largest stronghold in Old Slavonic Bohemia. The Stará Kouřim stronghold was the seat of a powerful ruling family. We know from the *Legend of Christian* about St. Wenceslaus that the duke of Kouřim accepted the Přemyslid sovereignty during the reign of Prince Wenceslaus (921/925–935) (Kristián 1978, pp. 100–102; Třeštík 1997, pp. 117–137, 419–420). The Stará Kouřim stronghold was abandoned sometime after the mid–10th century, apparently in connection with the annihilation of the old ruling family by the Přemyslids. Nevertheless, the microregion continued to be of key importance. Before the end of the 10th century, a Přemyslid administrative castle was founded on the opposite bank of the Kouřimka, at the site of "U sv. Jiří" (Šolle 1969; 1989; 1993; 2000, pp. 23–53, 86–108). Finally, during the 13th century, local settlement shifted to the High Medieval town of Kouřim, which lies to the north of the Přemyslid administrative castle (Šolle 2000, pp. 109–110). Due to the fact that it has not been disrupted by modern construction, the entire area offers one of the best preserved and representative records of the relocation of the site of a regional fortified central place during the Middle Ages. The Stará Kouřim stronghold is known primarily from the systematic archaeological excavations done by M. Šolle between 1948 and 1958. Among other important discoveries, Šolle uncovered the burial grounds that members of the Stará Kouřim elite (including several generations of local rulers) had chosen as their final resting place (Fig. 2). The burial grounds were located alongside a natural pond – traditionally referred to as "Libuše" – located just in front of the inner line of fortifications (Šolle 1959; 1966, pp. 33–53, 69–229, 255–273; Profantová 2001, pp. 329–335; 2006). The pond was probably an important site for pre-Christian cult rituals. The oldest graves date from the time when only the inner wall of the stronghold existed. This means that the area around the pond, including the burial grounds, was separated by a ditch. Over the course of the 9th century, following the construction of the central fortifications, the burial grounds were fully incorporated into the stronghold compound.

Archaeological excavations of the burial grounds took place from 1956 to 1958 during the final stage of excavations at Stará Kouřim. The excavations uncovered a major part of the burial grounds consisting of 152 graves and at least 163 individuals. The burial grounds by the "Libuše" pond were in

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[2] This upper terrace can be interpreted as the remnants of a shallower grave from the burial grounds' later phase, which was not sufficiently differentiated during excavations (Šolle

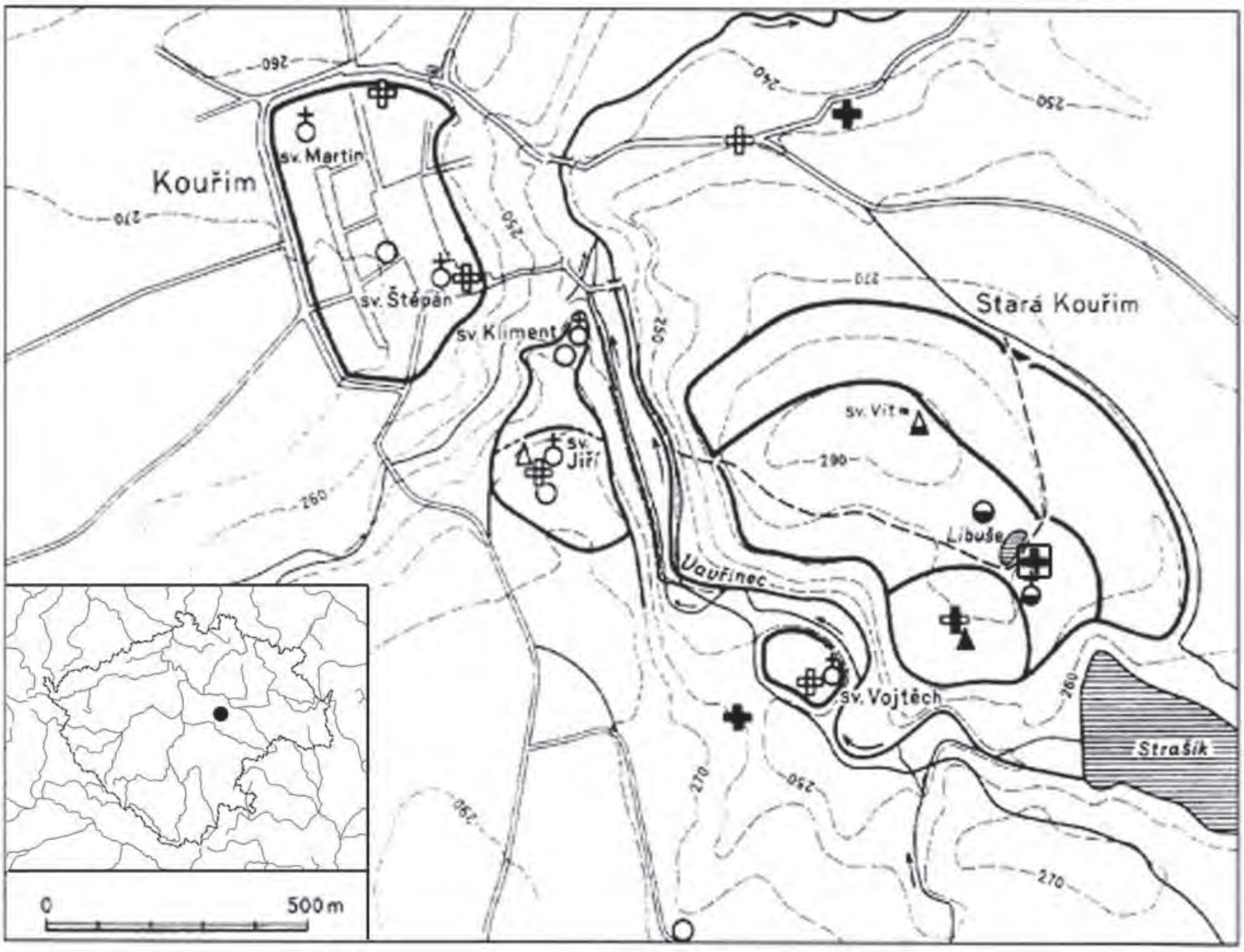

Fig. 1. Kouřim (okr. Kolín), location of the strongholds of Stará Kouřim, Kouřim-"U sv. Jiří" and Kouřim (high and late medieval town). Position of the burial ground by the "Libuše" pond is marked by cross in square (after Lutovský 2001, p. 135; amended)

use from the first half of the 9th century until the second half of the 10th century. Based on grave goods, the individual graves can be classified as belonging to the early as well as the late Great Moravian period, the post-Great Moravian period, and the beginnings of the Late Hillfort Period. The necropolis contains probably the oldest Early Medieval inhumation graves in Bohemia, and also contains the signs of the transition from cremation to inhumation burials. Based on the wealth of the grave-goods, the nature of the grave pits, traces of funerary rites, and the presence of items that can be interpreted as attributes of power, various authors have identified from four to nine burials of mrs of the strongembehold's highest social elite (Šolle 1959, p. 372; Sasse 1982, pp. 170–179, 317–318; Profantová 2001, pp. 332–334; 2006, pp. 232–243; Košta 2010). Only two of them, buried during the earlier period of burials, contained goods intended for males (Šolle 1966, pp. 260–261, 269–270). These exceptionally opulent burials, which have often been called "princely" burials, were also the only ones at the burial grounds to contain a sword.

METHODOLOGY OF METALLOGRAPHIC EXAMINATION OF THE SWORDS

Samples for metallographic examination were taken from the sword blades using a circular diamond-blade saw, then prepared using standard methods (mounted in resin, wet ground and polished with diamond paste) and examined firstly in unetched condition (to observe the slag content of the metal and weld lines), then after 3%-Nital etching (to observe the matrix structure and its distribution) and finally after etching using Oberhoffer's reagent (to observe white weld lines and the distribution of phosphorus-rich and -poor parts). The slag content of the metal was evaluated, in accordance with laboratory tradition, using the Jernkontoret scale, and grain size by ASTM E112 standard. The structure was observed

Fig. 2. Plan of the burial ground by the "Libuše" pond at Stará Kouřim (Šolle 1966, p. 36; amended): A – position of Grave 55; B – position of Grave 120

and documented by Olympus microscope BX 60 with digital video recording using Olympus Camedia 5050ZOOM camera. The matrix hardness was measured based on the Vickers method at an applied load of 200 g using the Wilson Wolpert 401MVD hardness-tester.

A small control sample was taken from Sword H55; the sample mounted in clay was annealed at 930°C for 1 hour and cooled to room temperature for 12 hours in a metallurgical oven. The annealed sample was used for determination of carbon content (using metallography and image analysis) in the cutting edge of the blade.

1. SWORD FROM GRAVE 55 (NATIONAL MUSEUM, INV. NO. H1–96664)

Archaeological contexts

Grave 55 (Fig. 3:A) is located on the southern edge of the central part of the burial grounds (Fig. 2; Šolle 1959; 1966, pp. 41, 260–261). The burial pit is of an elongated oval shape, with a SW-NE orientation, 4.4 m long, 1.6 m wide, and 1.18 m deep as measured from the lower level of the topsoil. The determination of the pit's length is not without ambiguity. While the actual grave, including grave goods, was within the deeper south-western of the grave (length: 2.7 m), the shallower terrace extending in the north-easterly direction (which would give the burial pit a length of 4.4 m) cannot be definitively considered to be part of portion the burial pit[2] of Grave 55. The pit's vertical walls were quarried into the weathered gneiss bedrock; in the lower part of the grave, the stones lining the coffin were partially preserved. Isolated remnants of the coffin were preserved in the form of a dark layer. The grave was covered with stone infill. Because of groundwater, none of the remains were preserved, but the position of the body – outstretched, with head facing to the southwest – can be determined on the basis of the position of the funerary gifts. The distribution of gifts indicates that the deceased was apparently taller than 1.60 m, i.e., in all likelihood an adult individual.

Located near the head of the deceased, there was a wood-and-metal bucket (Fig. 4:4), whose outer surface was decorated with hammered bronze plating. Along the upper left side of the deceased's body was a sword (Fig. 4:7; 6:a) with cast bronze set of fittings for a sword belt strap (Fig. 4:5; Wamers 2005, p. 169) consisting of a trefoil metalwork fitting, oval metalwork fitting with two rivets on the underside, a fragment of oval metalwork fitting with a sleeve on the underside and an elongated strap-end with two rivets near the end of the upper rim. The entire set is decorated with rough notching, representing a simplified or geometrised plant motif; it is the result of a synchresis of the Frankish manner of wearing a sword (Košta, Hošek 2008, pp. 17–25; Ungerman 2011a) with the production techniques of declining late Avar tradition (Šolle 1959, pp. 412–416; 1966, p. 41; Košta 2010, pp. 137–138). In view of the low quality of the set, we may presume that it was produced by a local craftsman who was familiar with the basics of Avar technology and inspired by Frankish art. Located near

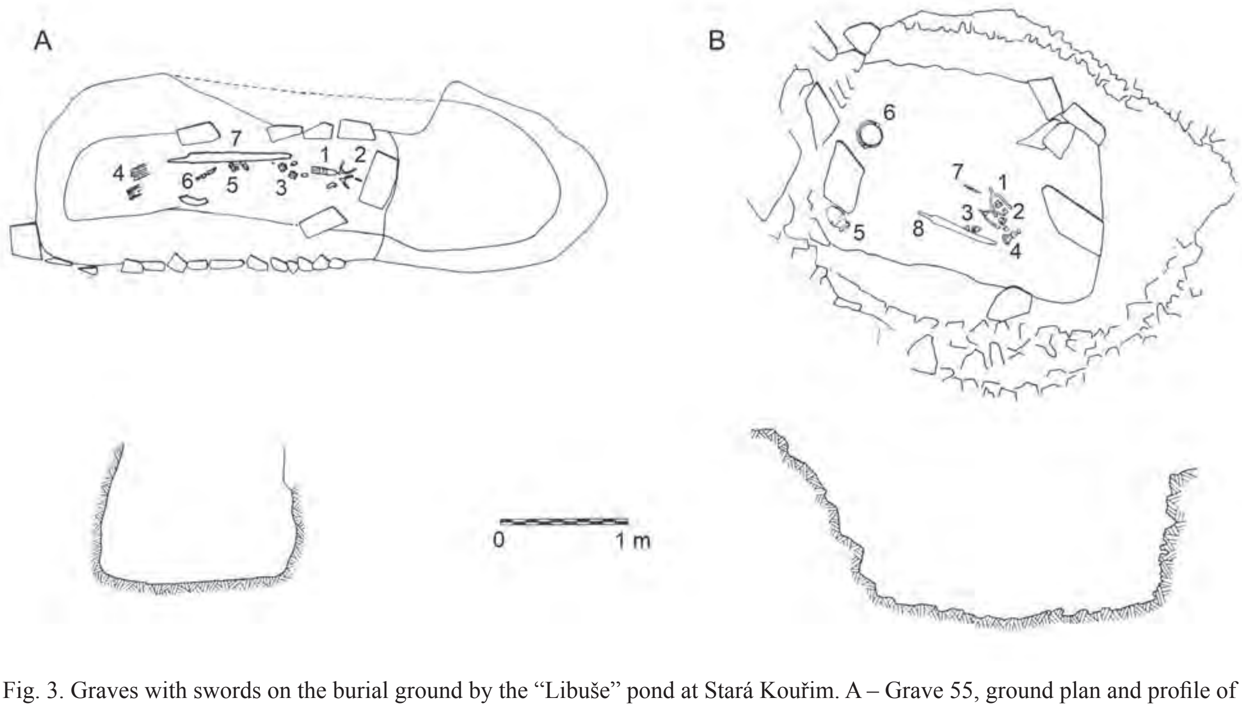

Fig. 3. Graves with swords on the burial ground by the "Libuše" pond at Stará Kouřim. A – Grave 55, ground plan and profile of the grave pit: 1 – ferrule; 2 – spurs with fittings for spur straps; 3 – set of fittings for calf straps; 4 – bucket; 5 – set of fittings for a sword belt strap; 6 – knife; 7 – sword. B – Grave 120, ground plan and profile of the grave pit: 1 – spurs; 2 – set of fittings for spurs straps; 3 – set of gilt silver fittings (of calf straps?); 4 – axe-hammer; 5 – ceramic bottle; 6 – bucket; 7 – knife; 8 – sword (after Šolle 1966, p. 71; amended)

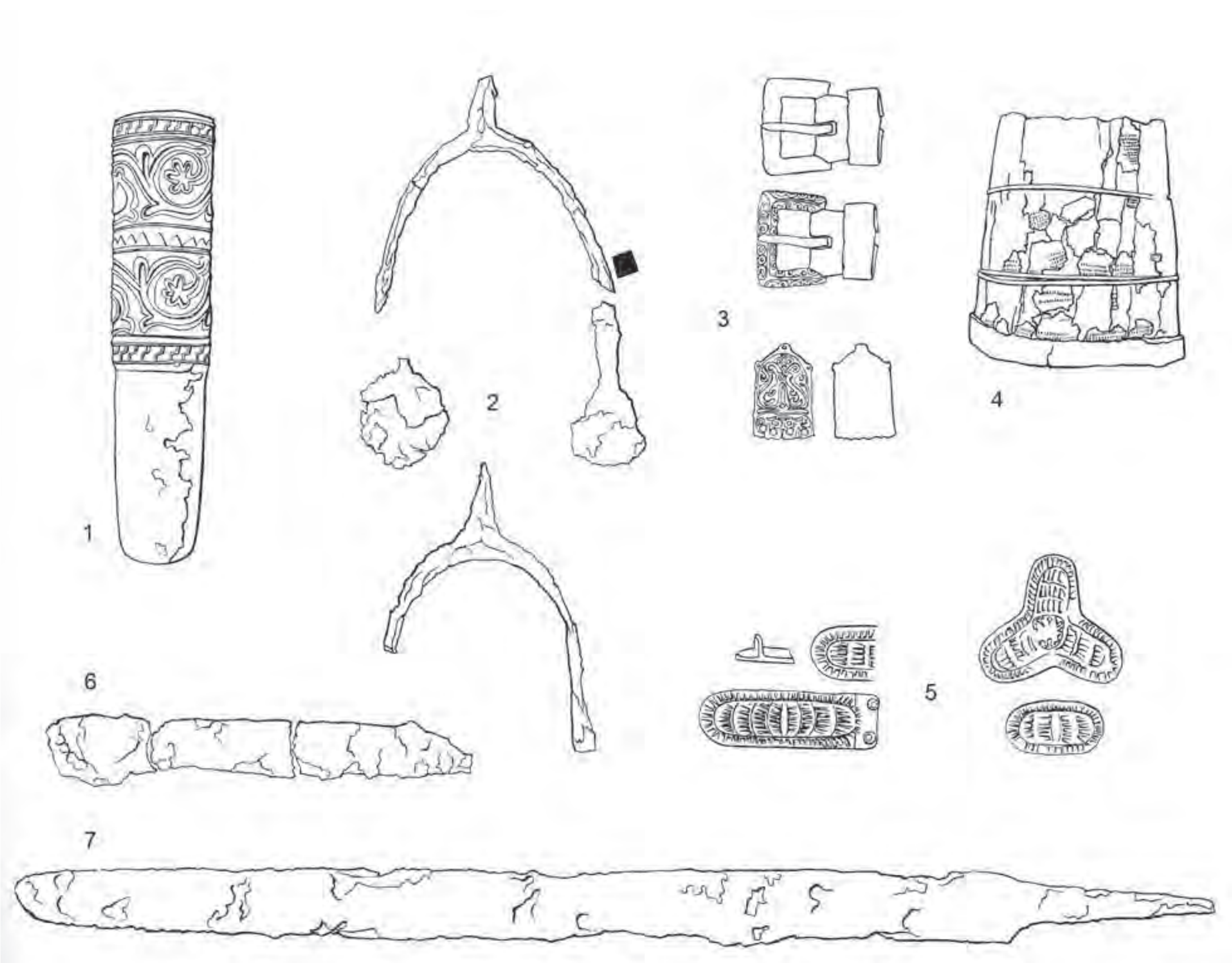

Fig. 4. Stara Kourim. Inventory of Grave 55 (various sizes): 1 – ferrule; 2 – spurs with fittings for spur straps; 3 – set of fittings for calf straps; 4 – bucket; 5 – set of fittings for a sword belt strap; 6 – knife; 7 – sword (after Šolle 1966, p. 73; amended)

the leg area, there was a pair of sturdy iron spurs (Fig. 4:2) with terminal plates and a short spike, outfitted with a set of iron fittings made of fastening bands. The spurs from Grave 55 are part of a group of items modelled after Frankish designs. In view of the rough handiwork on the terminals, we can consider them to be domestic imitations. The paired cast bronze gilded buckles and strap-ends decorated with a plant relief (Fig. 4:3; Wamers 2005, pp. 169–170) – whose position within the grave indicates that they were part of the calf straps (Ungerman, forthcoming) – are, if we are to respect the definition by K. Wachowski (1989), part of the group of the so-called "Blatnica type" items. Such items can, as a rule, be interpreted as resulting from the combination of late Avar traditions and Frankish influences in social groups formed during or after the disintegration of the Avar Khaganate within the territory that was in contact with the Frankish Empire (Benda 1963; Bialeková 1977; 1980; Wachowski 1989; Profantová 1997; Ungerman 2011b). The sets' origin can thus be placed within the north-western part of the Carpathian Basin or (most likely) in Moravia. Located by the legs was a massive ferrule (Fig. 4:1; 5) consisting of a silver-plated bronze grip affixed on a copper-plated stone tip. The grip is divided by three horizontal geometric niello bands into two fields and is covered with a gilded plant ornament. The ornamentation, which is characteristic for early Carolingian plant ornamental style, allows us to place the ferrule's manufacture within a Carolingian environment, most likely around the turn of the 9th century (Wieczorek, Hinz, eds. 2000, pp. 162–163; Wamers 2005, pp. 48–50, 170). A similar opulent Carolingian ferrule, decorated with acanthus decoration inlaid into arches, is kept in the collection of the Germanisches Nationalmuseum in Nuremberg; unfortunately, its archaeological context is not known (Wamers 2005, pp. 48–50). Apparently placed on the deceased's chest, there was a long, significantly damaged knife (Fig. 4:6) with the fragmentary remains of the scabbard's bronze metalwork.

Fig. 5. Stara Kourim. Opulent ferrule from a leader's stick or standard from Grave 55. Photo M. Stecker

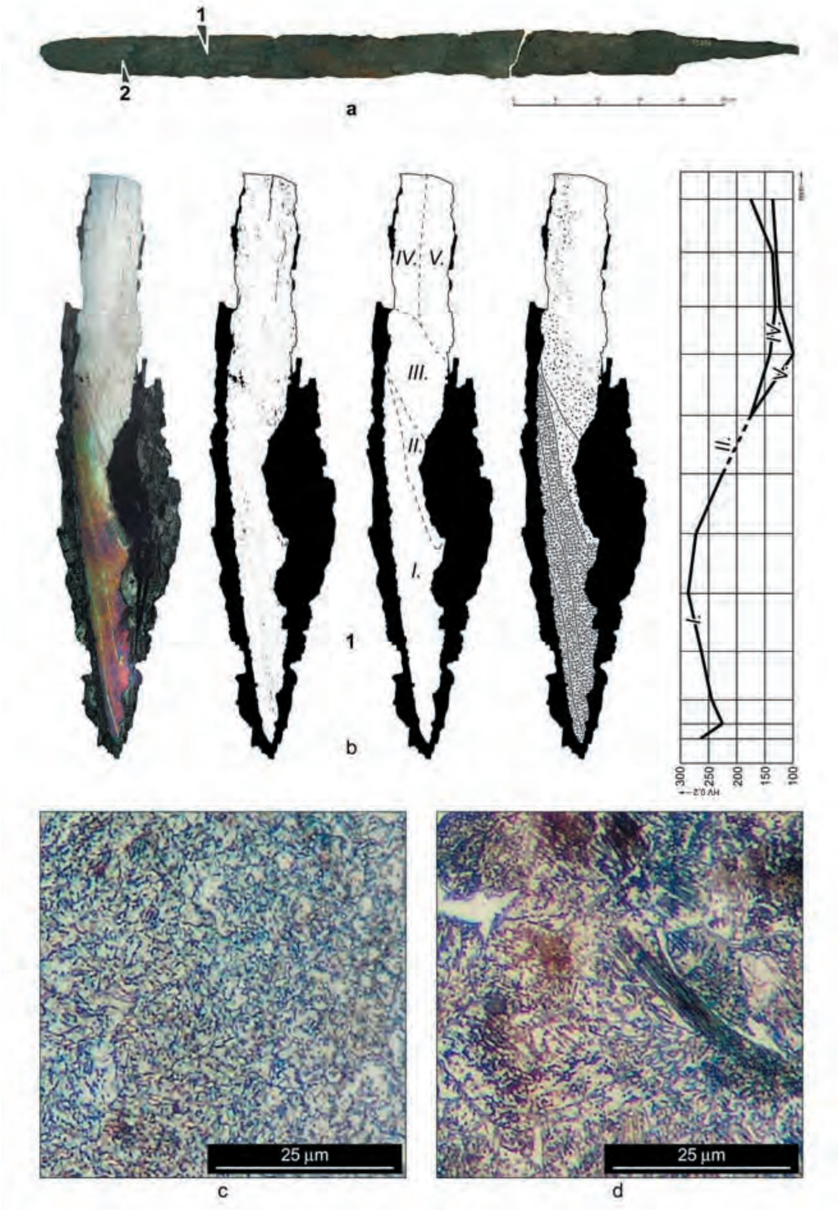

Fig. 6. Stará Kouřim. Sword H55 (dating of the grave: 1^{st} third of the 9^{th} century): a – the weapon studied and the sampling method used; b – Specimen 1(from the left: the specimen after Nital etching, unetched state, layout of described areas, schematic drawing of the specimen indicating used materials and their mutual combination as revealed by etching); c – ferrite-cementite structure in the cutting edge (Area I); d – pearlitic structure with partially globularised cementite (Area II); etched with Nital (c, d). Photo and drawing J. Hošek

Grave 55 was located in the older horizon of the "Libuše" pond burial grounds in Stará Kouřim, which also includes other extensive stone chamber tomb-graves, in many cases layered with more recent graves (Šolle 1966, pp. 33–53). The same horizon also features the transition from cremation to inhumation burials. Based on the grave goods – whose nature is clearly associated with the early Great Moravian horizon, with numerous elements still reflecting pre-Great Moravian traditions – Grave 55 can be dated to the first third or the first half of the 9^{th} century. Grave 55 is thus the oldest Early Medieval inhumation grave in Bohemia that can be dated on the basis of grave goods. Based on the nature of the goods, the grave contained a male who held an extremely high social position, including the exercise of power, as demonstrated by the ostentatious gifts with a high semiotic status.

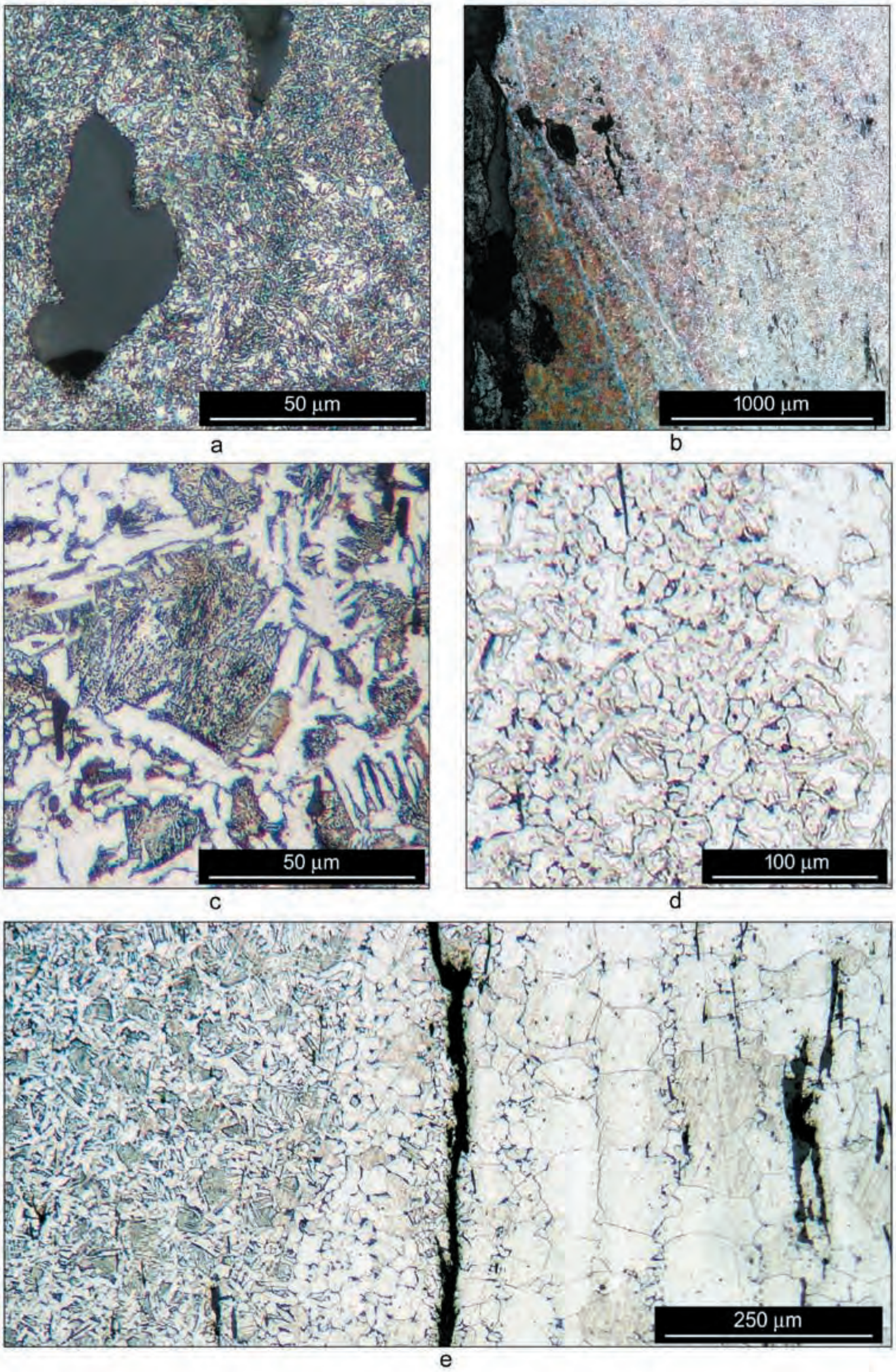

Fig. 7. Stará Kouřim. Sword H55. Specimen 1: a – an example of vitreous slag inclusion that appears in the structure of the cuting edge; b – attachment of the cutting edge on the central blade portion (Areas I and III); c – ferritic-pearlitic structure (pearlite with partailly globularized cementite); d – ghosting structure of ferrite with traces of pearlite; e – distribution of structures in the central part of the blade (Areas IV and V); etched with Nital (all). Photo J. Hošek

Description of the sword

The sword from Grave 55 (length: 901 mm) was found without a pommel or cross-guard (Fig. 4:7; 6: a), no traces of which were preserved on the bottom of the grave pit (Šolle 1959, pp. 377–378). In view of the fact that no remains of the deceased were preserved within the grave pit, it is possible that the pommel and cross-guard were made of bone or antler,

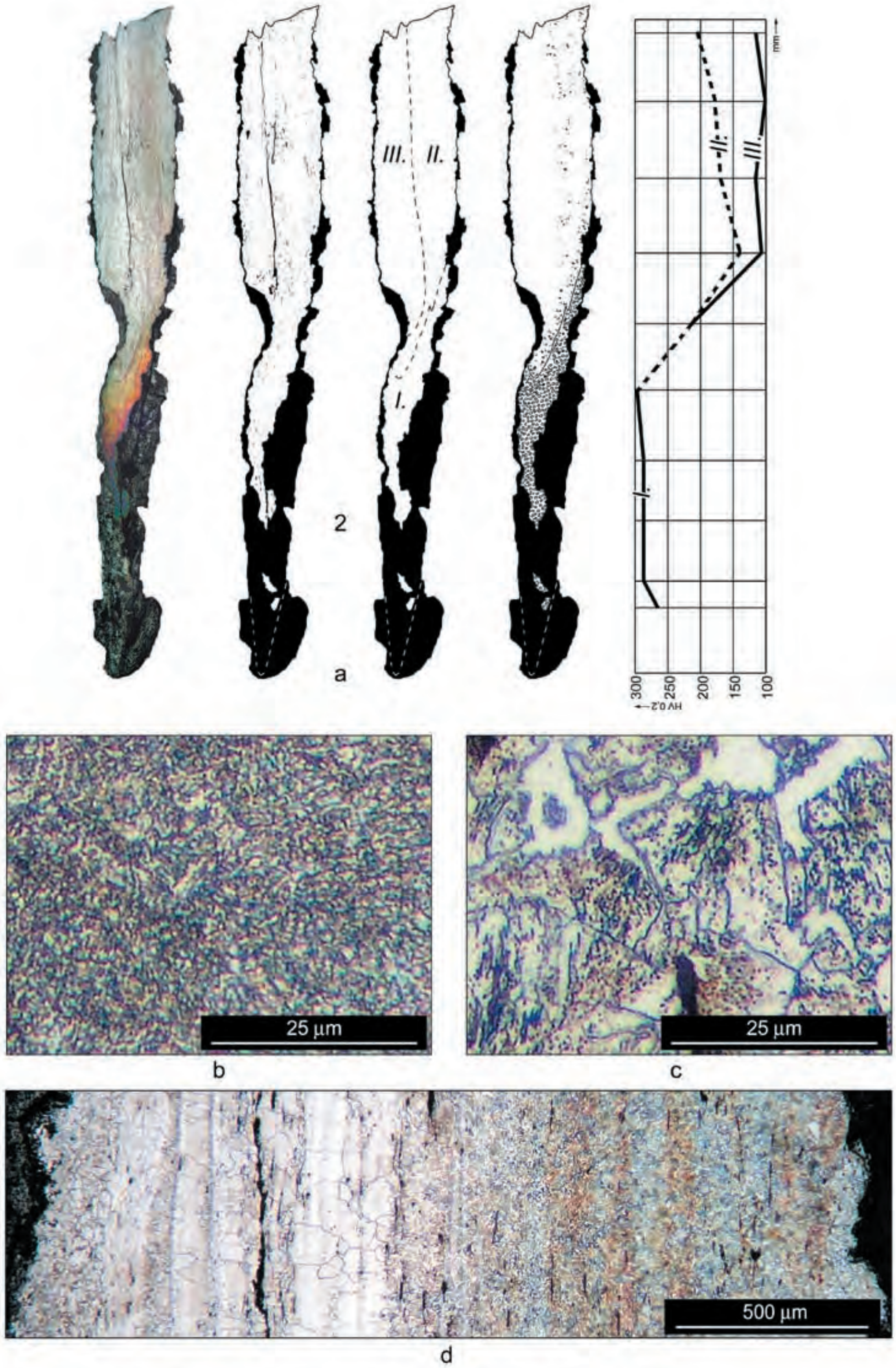

Fig. 8. Stará Kouřim. Sword H55: a – Specimen 2, (from the left: the specimen after Nital etching, unetched state, layout of described areas, schematic drawing of the specimen indicating used materials and their mutual combination as revealed by etching); b – ferrite-pearlite structure in the cutting edge (Area I); c – ferrite-cementite structure in the central portion of the blade (Area II); d – distribution of structures in the central partion of the blade (Areas IV and V); etched with Nital (all). Photo and drawing by J. Hošek

but we cannot rule out a possibility that the hilt was removed from the sword before its deposition into the burial chamber. The sword's blade is 761 mm long and the tang, which widens from 10 mm to 37 mm from tip to blade, is 140 mm long. The blade is sturdy, and despite significant damage its width below the tang is 52 mm. The central fuller was significantly damaged by corrosion and is visible only in several places on X-ray photos; its width could not be determined. Considering the sword's current state of preservation, it appears that the tang was affixed to the blade slightly asymmetrically and that the point of the blade was slightly off-centre, but we cannot rule out the possibility that these irregularities are the result of the weapon's degradation. Because of its asymmetrical nature, the sword was usually considered to be single-edged. The blade's double-edged nature was finally proven by metallographic analysis performed as part of this study (see below).

The sword is impossible to classify by type. The shape of the blade can only be roughly classified, because the shape of the fuller is impossible to define; it most closely corresponds to Geibig's Type 2c or 3, which were manufactured from the second half of the 8th until the first half of the 10th century (Geibig 1991, pp. 83–88, 153). "Ante quem" dating can be performed only via a comparison with other finds from the grave inventory.

The sword was placed inside a wooden scabbard, whose body was preserved, fused by corrosion to the blade. Along the middle of one side of the blade, iron circles measuring c. 15mm were preserved at a distance of 435 mm and 460 mm from the point (i.e., roughly at 2/5 of the blade's length). The circles would appear to be related to the manner of attaching the sword strap with the set of decorated bronze fittings to the scabbard.

Metallography of the sword

Samples for metallographic examination were taken from both sides of the blade, the first at a distance of 199 mm, the other 97 mm from the point (Fig. 6:a).

Specimen 1 (Fig. 6:b-d; 7):

Rather coarse single-vitreous-phase inclusions prevail in the cutting-edge (their amount corresponds to Level 2 on the Jernkontoret scale), and rather small single- as well as multi-phase inclusions, together with defective welding lines, appear in the revealed central portion of the blade (Level 4 on the Jernkontoret scale). The structure of the cutting edge (Area I) consists of fine cementite particles and veins scattered in a ferrite matrix (hardness 254 ± 23 HV0.2); it is of steel with about 0.45% C, judging by the annealed control sample. Farther from the edge (near Area II) the structure takes the form of fine lamellar pearlite. There are white (light etched) welding lines passing through the cutting edge. The central portion of the blade can be determined by Areas III-V and most likely also by Area II. Areas II, III and IV are a fine-grained to medium-coarse-grained mixture of pearlite (cementite partially globularised) and ferrite (pearlite usually prevails in Areas II and III, ferrite usually prevails in Area IV). Area V consists of ferrite (ASTM 5, tertiary cementite and traces of pearlite also sporadically appear in the structure) to ferrite-pearlite (ASTM 8; often with ghosting structure). The measured hardness was 174 HV0.2 in Area II, 149±17 HV0.2 in Area IV and 125±20 HV0.2 in Area V.

Specimen 2 (Fig. 8):

The appearance and amount of inclusions are as in Specimen 1. The cutting edge is determined by Area I and consists of a ferrite-pearlite structure (cementite in the form of fine particles and veins) with a hardness of 287±16 HV0.2. The central portion of the blade is determined by Areas III and IV. Area III is a mixture of ferrite (which prevails in the structure) and pearlite (cementite partially globularised) with the total hardness of 173±24 HV0.2. Area IV features a banded ferritic structure (ASTM 6–8), sporadically with tertiary cementite or some pearlite; the hardness reaches 108±6 HV0.2.

Assessment:

The blade was made either as shown in fig. 9:a, or as shown in fig. 9:b. In both cases steel cutting edges were welded onto a central portion of iron and steel. Unfortunately, the studied specimens do not allow us to assess clearly whether the middle part is a single non-homogenised piece without a deliberate attempt to combine iron and steel (this is indicated by Specimen 1) or the portion was made of rods of iron and steel welded together (Specimen 2 indicates rather this possibility). Although the blade was quenched and tempered, the applied heat treatment or accidental reheating softened the cutting edges made of steel with 0.45 to 0.8% C. As a result, this is nowadays considered a weapon with a blade of approximately mediocre quality.

2. SWORD FROM GRAVE 120 (NATIONAL MUSEUM, INV. NO. H1–96683)

Archaeological contexts

Grave 120 (Fig. 3:B) was uncovered in the south-eastern margins of the burial grounds (Fig 2; Šolle 1959; 1966, pp. 69–72, 269–270). This large grave, with an irregular rectangular shape, was quarried into the bedrock with a SW-NE orientation. The top of the pit measures 3.3 m by 2.65 m; the weathered bedrock walls narrow down funnel-like at various

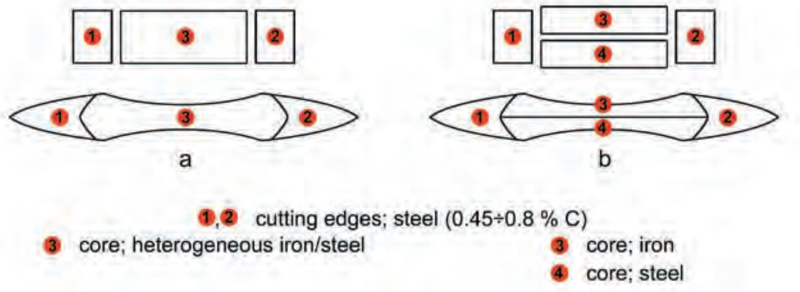

Fig. 9. Stara Kourim. Two possible methods of welding semi-finished pieces together to make Blade H55. Drawing J. Hošek

angles to the bottom measuring 2.25 m by 1.6 m. The depth of the pit probably significantly exceeded 1 m.[3] The grave pit of Grave 120 was covered by Graves 84 and 119 (Šolle 1959, p. 491), which contained no gifts and which, based on the superposition and the orientation of their grave pits, M. Šolle classified as part of the earlier horizon of the late burial phase (B1; Šolle 1966, pp. 35–53).

Because of the action of groundwater, the remains were completely decomposed. The position of the funerary gifts leads us to infer that the head of the deceased pointed towards the west. The distribution of the gifts within the grave indicates that the person buried was no taller than 1.4 m, meaning that he probably was not an adult. Also contributing to this conjecture is the fact that the grave contained a ceramic vessel. At Stará Kouřim, ceramic vessels were found – wherever this could be determined – exclusively in children's graves. Nevertheless, we cannot rule out other alternatives, for instance the possibility that the deceased was interred in a hunched position.

The grave goods consisted of two vessels – a wood-and-iron bucket (Fig. 10:6) and a egg-shaped ceramic bottle decorated with horizontal sinuous and straight bands produced by combing (Fig. 10:5). The original location of the legs was defined by a pair of sturdy iron spurs whose terminal plates contain two rows of rivets decorated with an imitation of

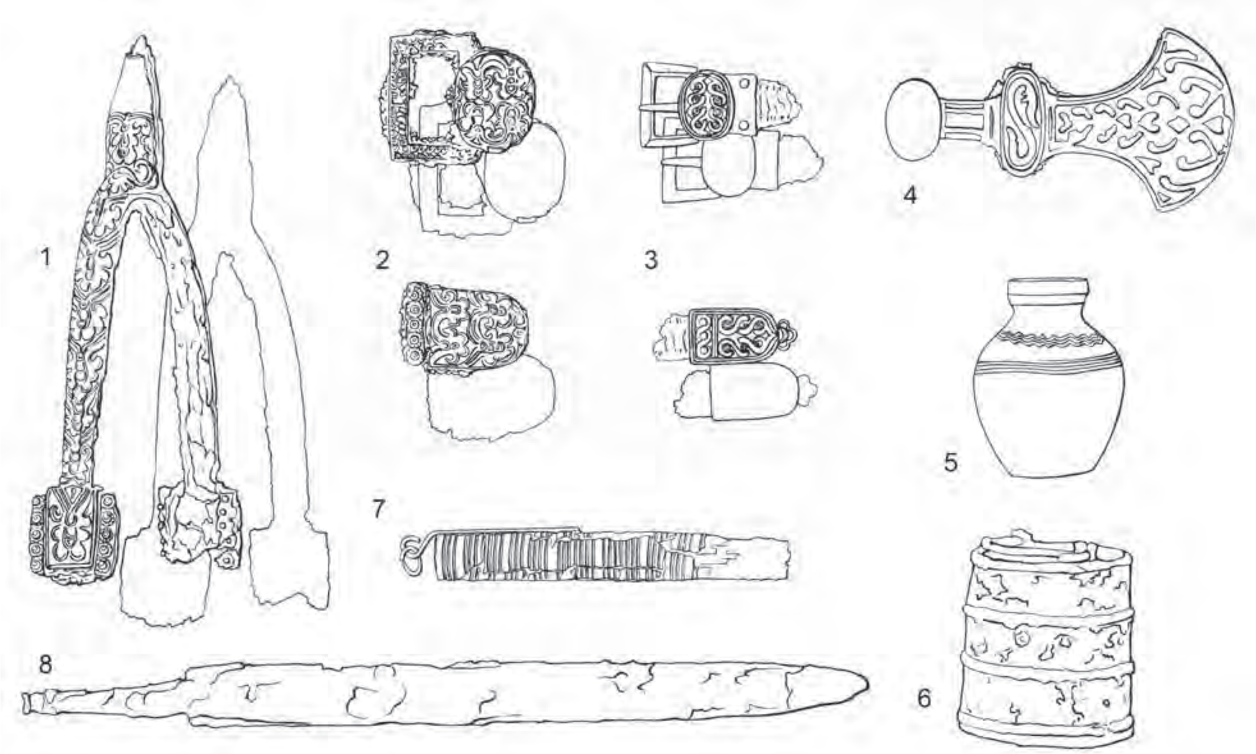

Fig. 10. Stara Kourim. Inventory of Grave 120 (various sizes): 1 – spurs; 2 – set of fittings for spurs straps; 3 – set of gilt silver fittings (of calf straps?); 4 – axe-hammer; 5 – ceramic bottle; 6 – bucket; 7 – knife; 8 – sword (after Šolle 1966, p. 75)

astragal (Fig. 10:1; 11); the spurs can be unambiguously classified as "Type Biskupija-Crkvina" (Vinski 1983; Jelovina 1986; Kouřil 2005; Petrinec 2009, pp. 184–202), which for the most part includes Carolingian imports that entered the Carpathian Basin and central-eastern Europe mainly in the first half of the 9th century. The Kouřim spurs are covered with gilded metal sheet with a palmette design worked into the stamped background in the style found on the decoration of hammered Great Moravian *gombík* buttons. These would appear to be products of Great Moravia inspired by Frankish designs, although we cannot rule out the possibility that they originated on the eastern fringes of the Frankish Empire. The spurs' straps were decorated with silver-gilt-plated metalwork (strap-ends and buckles with sleeves) decorated with the same motif as the spurs (Fig. 10:2). Located near the lower part of the deceased's body, there was a short iron sword (Fig. 10:8; 13:a; 18). The paired silver gilded buckles with sleeves and strap-ends (Fig. 10:3) are decorated with a precisely worked geometric notched braid-like motif; the strap-ends have a trefoil projection on the top (Košta 2008, p. 23). They are typical of the decoration found with Type Biskupja-Crkvina spurs (Jelovina 1986) and can be considered to be Frankish imports. According to the grave's documentation, at least one set was found under the sword. Based on their location within the grave, Šolle inferred that they "apparently served to hold the sword" (Šolle 1966, pp. 42, 269–270; 1959, p. 378). However, such a sword belt decoration would be entirely unique within the European context. A more likely interpretation is that the decorations were part of the calf straps. Calf straps were a typical fashion accessory in the 9th century which had been adopted by west Slavonic elites from the Franks. The remnants of calf straps are a common find in Great Moravian graves (Ungerman, forthcoming), and a similar set was found in Kouřim's Grave 55. Their location along the inner side of the sword's blade probably corresponds to the location of calf strap fittings. Located near the deceased's waist, there was an iron knife with a silver-gilt grip made of transverse ribbed bands (Fig. 10:7). The rear of the grip is fitted with a loop. Found underneath the spurs, there was an iron axe-hammer with a fan-like cutting edge overlaid with silver plates with die-cut ornamentation (Fig. 10:4; 12). This opulent artefact with rounded silver rear and a cutting edge covered in a silver band did not serve as a weapon but as a

Fig. 11. Stara Kourim. Terminal plate and part of one arm of the spur from Grave 120. Photo M. Stecker

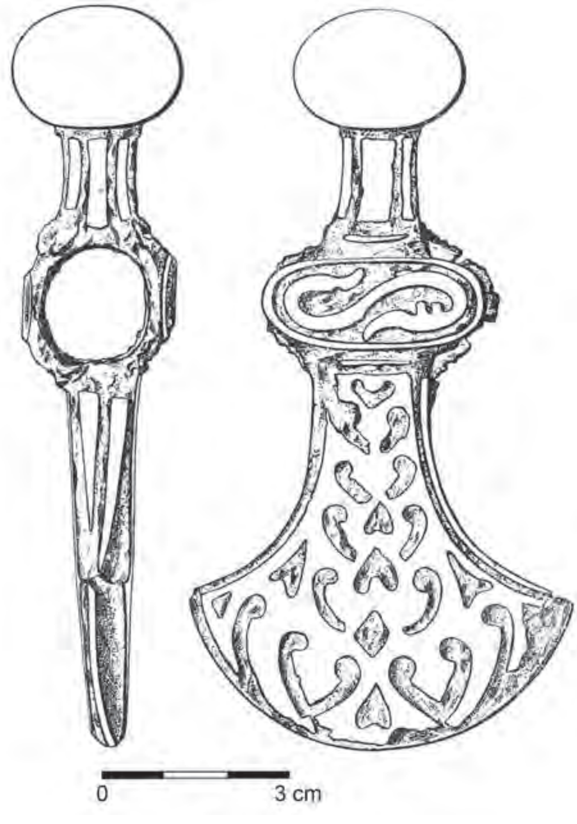

Fig. 12. Stara Kourim. Axe-hammer from Grave 120 (after Šolle 1959, p. 392).

sign of its bearer's power. It is a unique find within the whole central Europe, and there exist only scant and partial analogies in the rest of Europe (Niederle 1921, pp. 294–295; Paulsen 1939, pp. 34–46, 102–128, 140–148, 258; Šolle 1959). We here name at least one relatively nearby example – the faintly similar axe with a fan-like cutting edge found in the warrior grave of a Great Moravian character in Burial Mound XVI at Veľké Hostie in Slovakia (Porubský 1955, pp. 225–226, p. 234). The nearest forms of battle-axes are found in the greater Volga region and are usually associated with the culture of the Volga Bulgars (Paulsen 1939). The literature dates most of these artefacts to a more recent period than Grave 120, although the archaeological context of most of these is unclear, meaning that there is no exact support for their chronological determination. The ornamentation used on the axe-hammer is reminiscent of the decorative style associated with the 9th century artefacts coming from the Northern Black Sea area (Saltovo-Mayaki Culture; the earliest Old Hungarian artefacts etc.; see for instance Fodor 1977; 1982, pp. 250–272). This study cannot provide a precise assessment of the axe-hammer, but we can at least state that it is of eastern European provenance, most probably from the Volga region or the Black Sea steppes.

Grave 120 dates from the older phase of the "Libuše" pond burial grounds in Stará Kouřim, as testified by the stratigraphic situation, the features of the graves, and the grave goods found inside (Šolle 1966, pp. 33–53; Profantová 2001, p. 330). Based on the grave goods, we can state that it belongs among the graves dated to the older Great Moravian horizon. The absence of items based immediately on late Avar traditions and the decoration on the spurs, which corresponds to the incidence of hammered flower decoration on stamped background on the *gombík* buttons, allow us to state that the burial took place somewhat later than in Grave 55. In absolute terms, we place it chronologically within the second quarter or around the mid–9th century. The individual buried in Grave 120 was probably a male and was a member of the highest elite at the Stará Kouřim stronghold. Although there exist certain indications that he may have died before reaching adulthood, he was given a number of costly items for his final journey that clearly defined his social status and that of his family.

Description of the sword

Grave 120 contained a short double-edged sword with a total length of 576 mm (Fig. 10:8; 13:a; 18; Šolle 1959, pp. 378–380). The only part of the sword's hilt to be preserved was the 108mm-long tang, with a button-like termination in the shape of a rectangle with rounded corners. It would appear to be formed by clinching the tang. Below the termination, the tang is slightly narrowed at a distance of ca. 9 mm. The narrowing corresponds to the height of the upper cross-guard (or the base of a two-piece pommel). One may assume that the various parts of the former hilt were made using organic material, such as bone or antler (Šolle 1959, p. 378), because disintegrated and corroded remains of the sword tang and its surroundings were enriched in phosphorus, the upper "button" of the sword tang was not damaged and because the skeletal remains were also not preserved.

The sword's 468 mm blade is sturdy, with a width of 43 mm below the tang. Its edges run almost in parallel, and do not begin to come together until near the point. The central fuller is roughly 20 mm wide and terminates 40 mm before the tip. X-ray photos show the use of pattern-welded lineation, requiring four rods of Damascene steel. The rods were twisted in sections of 50 mm to 70 mm in order to create a double dendritic (chevron-like) left-right-left-right pattern, with similarly long segments of alternating rods left straight.

The body of the scabbard was made of wood; traces of wood were preserved at several places on the blade. Traces of an unidentified material were found along a length of c. 100 mm below the tang – which may have been inlaid on the scabbard. The remains of a right-angled structure were preserved on one side of the blade, 115 mm from the cross-guard, which can be interpreted as hammered metal. Metalwork measuring 35 mm x 29 mm is located in the middle of the blade; transversally to the blade's axis, it was fitted with two rivets in the centre of its width. Indications of two similar hammered metal objects can be found towards the point of the blade in regular intervals of 115 mm, although their shape and size cannot be reconstructed. The final metalwork was located roughly 115 to 120 mm from the point of the blade.

Metallography of the sword

Samples for metallographic examination were taken from both sides of the blade; the first sample (s) at a distance of 118 mm, the second at a distance of 103 mm from the point (see fig. 13:a). As the first sample (labelled as Specimen 1A) broke in two pieces after the first blade-sampling, another sample (labelled as Specimen 1B) was taken from the same place.

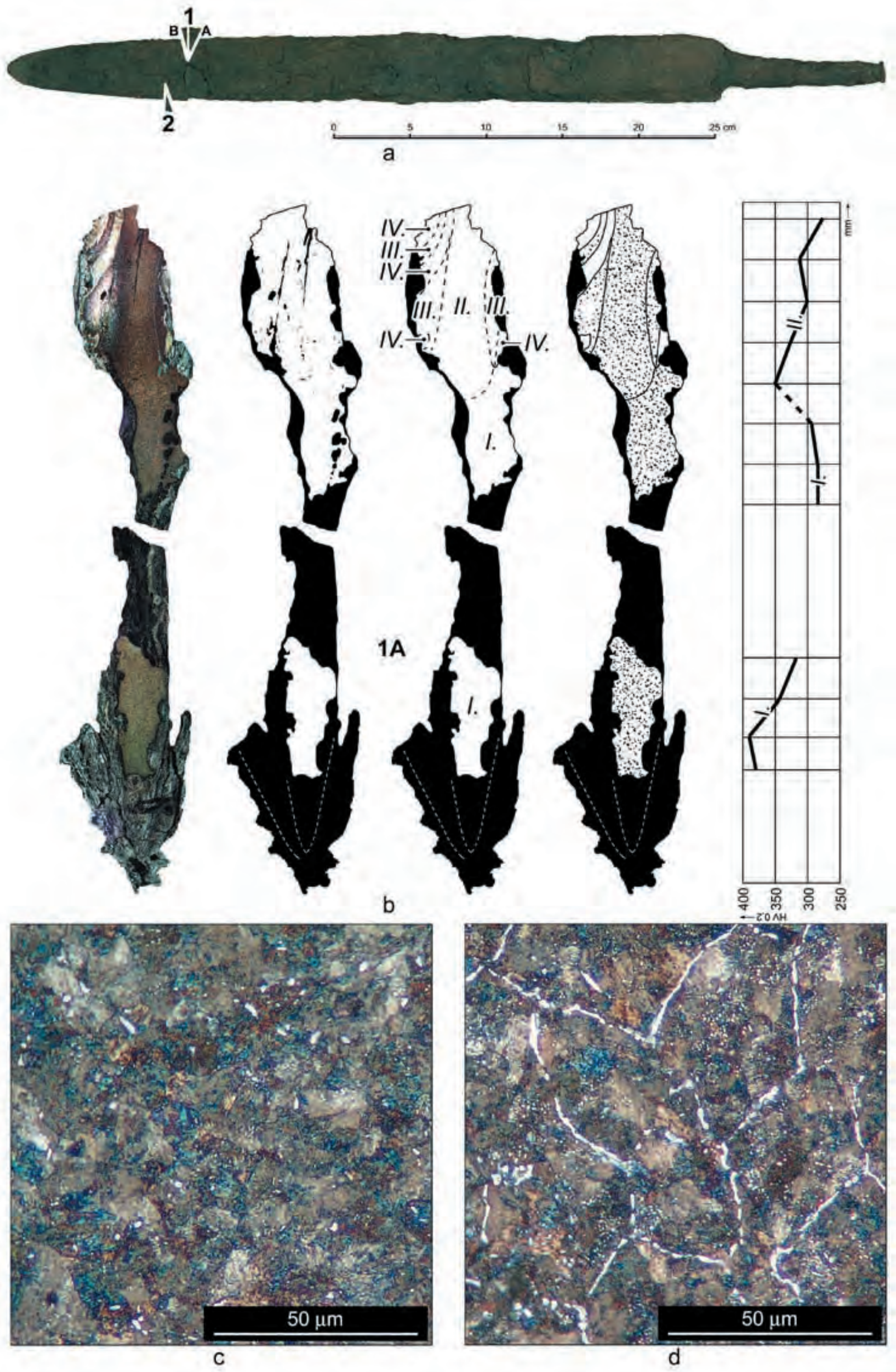

Fig. 13. Stará Kouřim. Sword H120 (dating of the grave: 1st to 2nd third of the 9th century) : a – the weapon studied and the sampling method used ; b – Specimen 1A (from the left: the specimen after Nital etching, unetched state, layout of described areas, schematic drawing of the specimen indicating used materials and their mutual combination as revealed by etching); c – fine pearlite with occasional occurrence of cementite particles (Area I); d – fine pearlite with a cementite network (Area I); etched with Nital (c, d). Photo and drawing J. Hošek

Specimen 1A (Fig. 13:b-d; 14:a-b):

The matrix of the specimen contains an average amount of inclusions (Level 2–3 on the Jernkontoret scale), more inclusions and corroded areas (welds) are situated in the blade core. The inclusions are formed by a single phase of glassy appearance. When etched with Nital, the revealed structure can be divided into four basic areas. Area I consists of a hypereutectoid

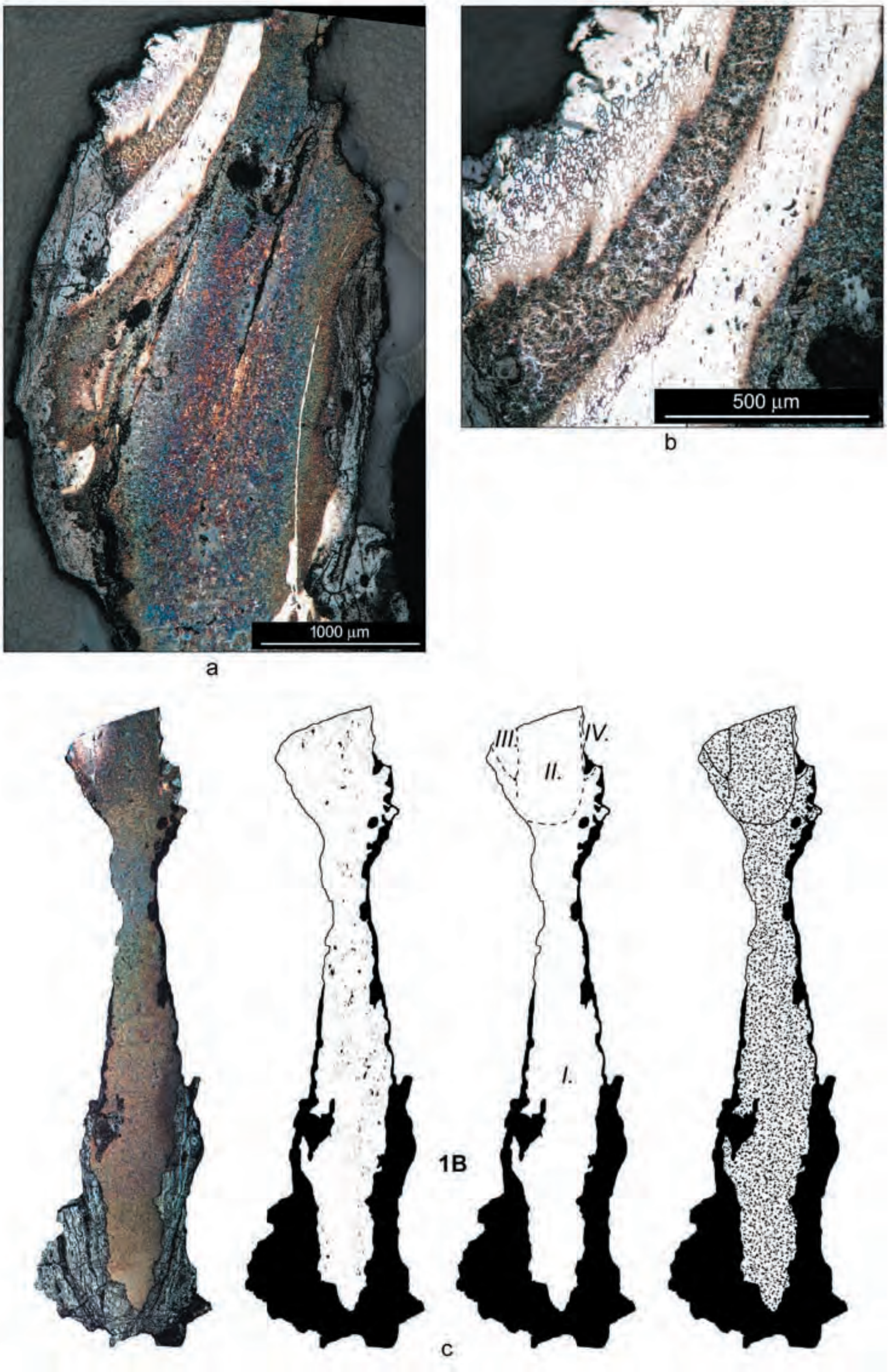

Fig.14. Stará Kouřim. Sword H120. Specimen 1A: a – macro photo of the attachment of the pattern--welded panels on the blade core; b – detail of the pattern-welding; c – Specimen 1B (from the left: the specimen after Nital etching, unetched state, layout of described areas, schematic drawing of the specimen indicating used materials and their mutual combination as revealed by etching); etched with Oberhoffer's reagent (a, b). Photo and drawing J. Hošek

pearlite-cementite structure with carbon content up to 1.2%. In some places, e.g. near the cutting edge, the cementite appears in small quantities in the form of fine particles (in this area the hardness reaches 390 HV0.2), in other parts the cementite creates a network corresponding to the original austenite grains (Fig. 13:c, d); only pearlite appears near the border with Area II. The pearlite in Area I is very fine, having a hardness of 327±45 HV0.2. Area II, corresponding to the blade core, appears beyond a welding line; the

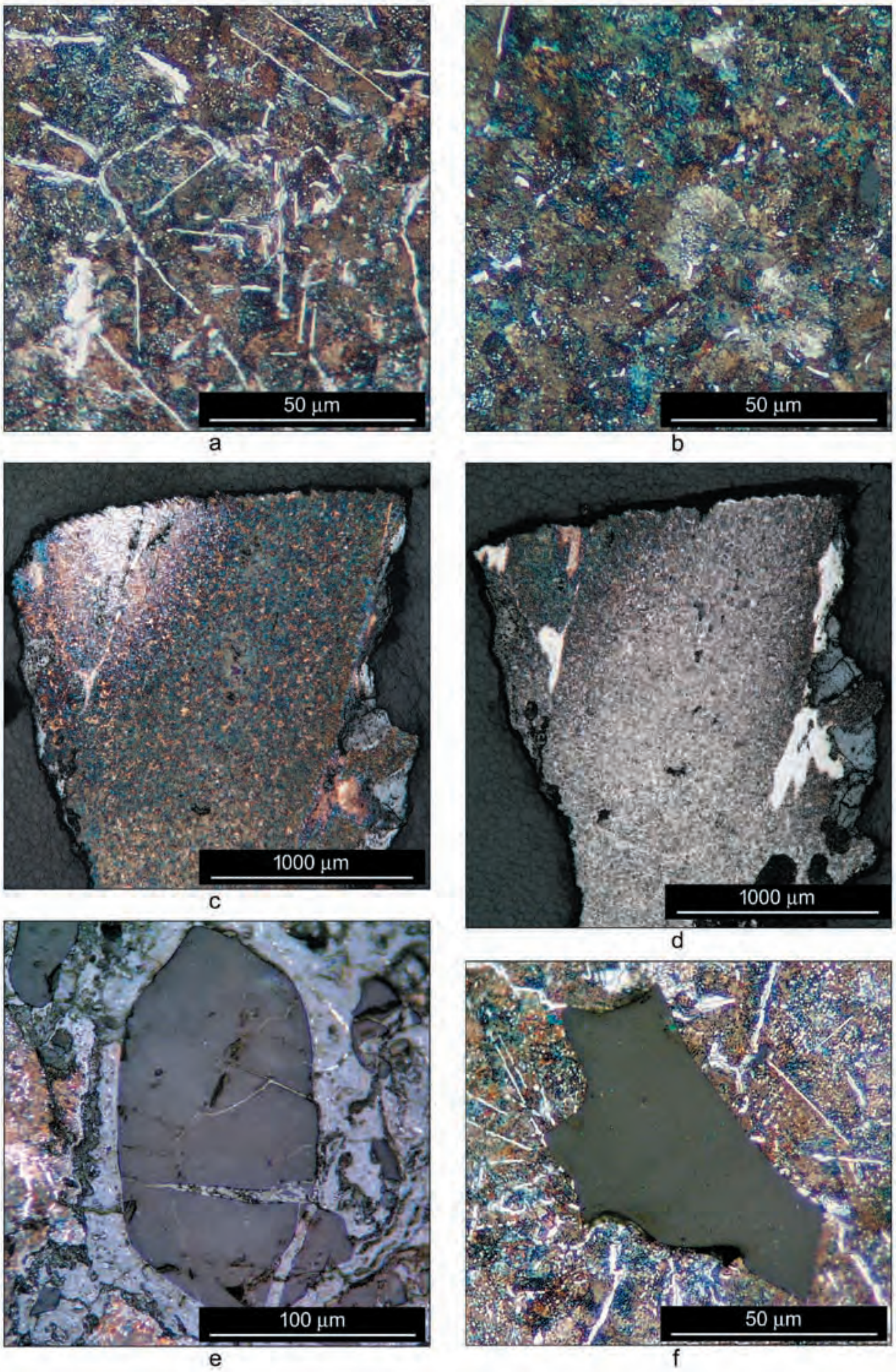

Fig.15.Stará Kouřim. Sword H120. Specimen 1B: a – fine pearlite with laths of secondary cementite (Area I); b – pearlitic structure with occasional appearance of particles of secondary cementite (Area I); c – photo of the central portion of the blade with attachment of a pattern-welded panel (Areas II and III); d – an attachment of the cutting edge and patterned panels on the blade core (Areas I and II); e, f – examples of inclusions consisting of single vitreous phase; etched with Nital (a, b, c, e, f) and Oberhoffer's reagent (d). Photo and drawing J. Hošek

weld can be distinguished by a fine-inclusion chain and by lighter etching (on application of Oberhoffer's reagent). It consists of a fine pearlitic structure with a hardness of 313±29 HV0.2. Finally, pattern-welded panels are attached to the blade core; the panels consist of ferritic-pearlitic layers (about 0.5% C; ASTM 6; 170±6 HV0.2) to a pearlitic structure (Area III), and of layers of ferrite with the hardness of 254 ± 13 HV0.2 (Area IV), see fig. 14:a, b).

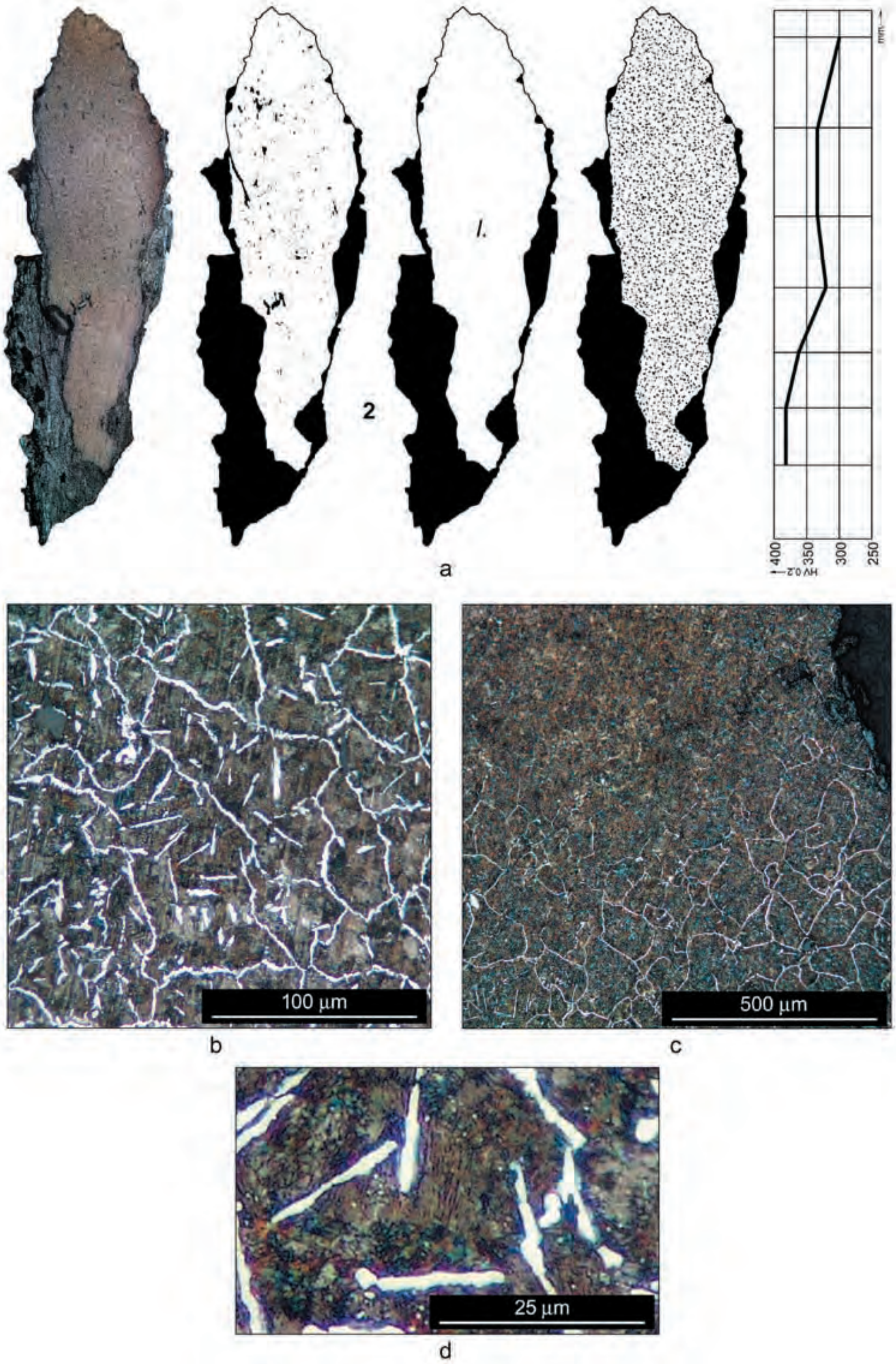

Fig.16. Stará Kouřim. Sword H120. a – Specimen 2, (from the left: the specimen after Nital etching, unetched state, layout of described areas, schematic drawing of the specimen indicating used materials and their mutual combination as revealed by etching); b, d – structure of fine pearlite with secondary cementite in form of network and laths; c – changeover of the structure from pearlite-cementite to pearlite (near the central part of the blade); etched with Nital (b-d). Photo and drawing J. Hošek

Specimen 1B (Fig. 14:c, 15):

The central part of the specimen features a few slag inclusions (Level 2), and the cutting edge part has more inclusions (Level 3 on the Jernkontoret scale). The inclusions consist of a single phase (Fig. 15:e, f). Some of the welding lines are accompanied by chains of very fine inclusions.

After etching with Nital, a hypereutectoid cementite-pearlite structure with carbon content up to 1.2% appears in the cutting edge (Area I). As in Specimen

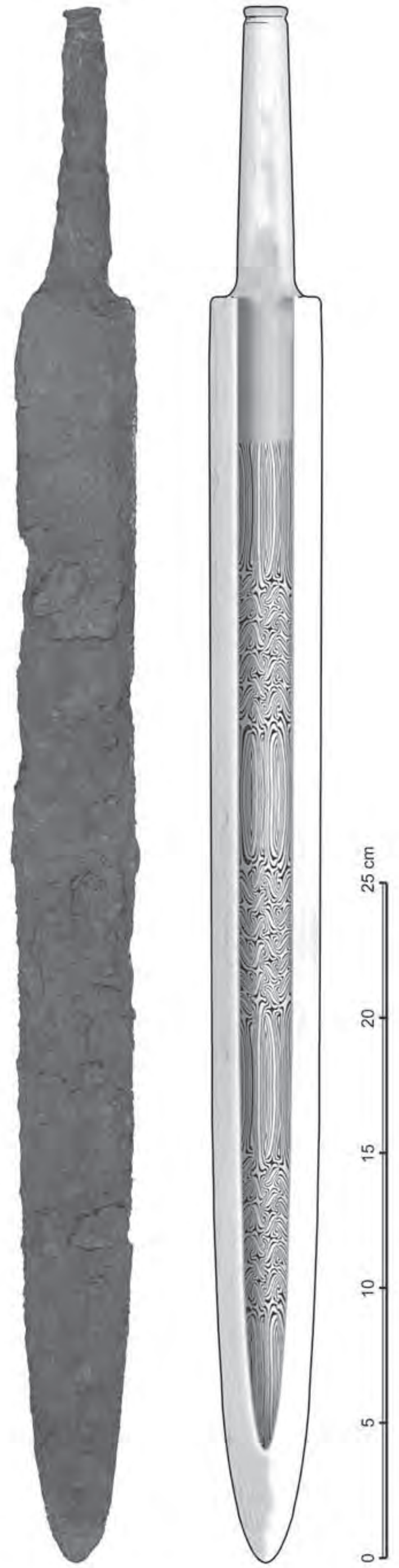

Fig. 17. Method of welding semi-finished pieces together to make Blade H120. Photo and drawing J. Hošek

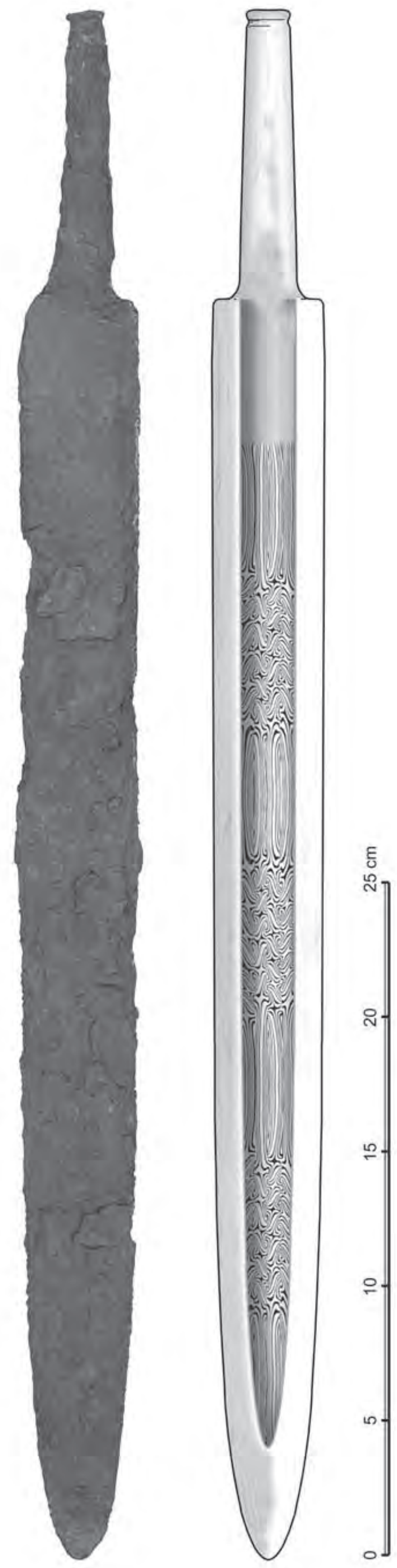

Fig. 18. Photo and drawing reconstruction of Sword H120 (Stará Kouřim, dating of the grave: 1st to 2nd third of the 9th century). Photo and drawing J. Hošek

1A, the structure consists of a very fine pearlite with scattered fine cementite particles near the very cutting edge, a network and laths of cementite appear in the middle part of the edge. The central portion of the blade (the core and pattern-welding, see fig. 15:c, d) was revealed only partially. A fine pearlite is visible in Area II, a slightly hypoeutectoid pearlitic-ferritic structure appears in Area III, and a ferritic-pearlitic structure, which indicates an enrichment in phosphorus, is featured in Area IV.

Specimen 2 (Fig. 16):

The central portion of the blade has a high amount of inclusions (Level 4 to 5) while the other parts have only a few inclusions (Level 2 on the Jernkontoret scale). The structure is fine-grained pearlite and cementite with a carbon content up to 1.4% (Fig. 16:b, d). The pearlite is very fine, the cementite is in the form of a network and laths corresponding to the original austenite grains. Hardness reaches 353 ± 24 HV0.2 (about 380 HV0.2 in the cutting edge). There is a very fine lamellar pearlite with a hardness of about 300 HV0.2 near the presumed attachment of the core (Fig. 16:c).

Assessment:

The blade was made as shown in fig. 17, i.e. cutting edges of steel with a carbon content of 0.8 to 1.4% were welded onto an eutectoid steel core, which featured surface pattern-welded panels consisting of layers of steel and phosphoric iron. The blade was cooled down rather quickly, but was not hardened.

DISCUSSION

The blade of the sword from Grave 55 was of standard construction, with cutting edges of steel welded onto a middle part combining (but it is unclear whether intentionally) iron and steel. In the case that the central part consists of iron and steel, then the 11th century sword blade No.1 from Lutomiersk, Łask District (Piaskowski 1959, p.166, figs. 112, 133 and 122:7) would be an exact analogy. A blade with a central portion made of two pieces longitudinally welded together was also described by Tylecote and Gilmour (1986, 235), but this blade (from the 11th century sword No. S44 from the River Thames at Brentford) was all steel. Obviously, when iron and steel were mutually combined, it was more common to place one rod of iron between two rods of steel (see, for example, Košta, Hošek 2009, pp. 112–115; Kolchin 1953, pp.132–134, fig. 106:8, 9). In the event that the central part was made of one heterogeneous material, the blade would belong to the group of blades with rather simple central portions (some of them made largely of iron (Košta, Hošek 2009, pp.118–119; Kolchin 1953, pp.132–134, fig. 106:1, 3), some of them made predominantly of steel (Kolchin 1953, pp.132–134, fig. 106:11). From this point of view, the conceivable heterogeneity of the central rod (of Sword H55) was not incorrect if the rod was not intended as all-steel. Regardless of the construction of the central portion, the material and heat treatment of the cutting edges are particularly important for the interpretation of the weapon. The cutting edges were made of good-quality steel, but they are nowadays soft and they reveal their overheating after quenching. The sword may have been accidentally exposed to fire, but incorrect blade tempering seems to be, in this case, more likely. One of the permissible interpretations is the possibility that the sword was made by someone who knew how to forge a standard blade, but was not yet fully familiar with sword-blade hardening.

The sword from Grave 120 was undoubtedly a very valuable weapon as it combined both attractive appearance (surface pattern-welding, see fig. 18) and good material construction (blade core and cutting edges are steel). The cutting edges, rich in carbon, were not quenched because rather rapid cooling was sufficient enough to achieve sufficient hardness at the very edges. Concerning the combination of material used, heat treatment and blade construction, there is no analogical blade known to the authors.

Remarkable is the hypereutectoid carbon content of the steel used and the absence of quenching as these could indicate usage of crucible steel, which was produced as entirely (in such case, homogeneous and almost free of slag inclusions) or partially molten (then potentially rather heterogeneous and with some slag inclusions) steel in heated crucibles. The most common traditional method of crucible steel production involved the carburisation of wrought iron in crucibles filled with charcoal (diffusion process); another method consisted of the fusion of wrought and cast iron. It is presumed that hypereutectoid steel (usually free of slag inclusion) observed in some of the medieval swords may have been a kind of crucible steel produced in the Middle East or Central Asia (as far as we know, Europeans did not use this cast-steel making process at that time). This

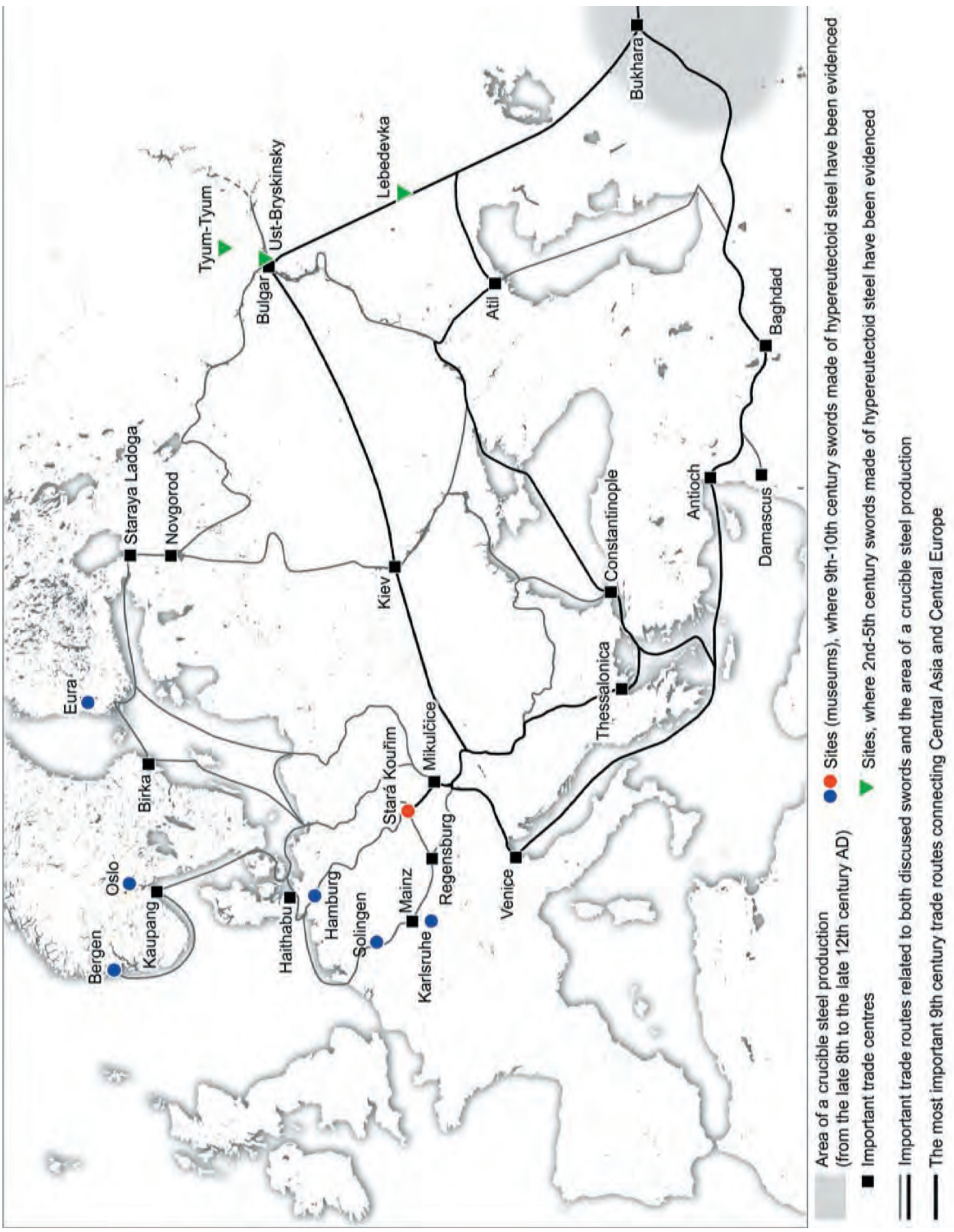

Fig. 19. Map showing a relation among sites (museums) which have revealed swords made of hypereutectoid steel, related 9th century trade routes and trade centres and the area in which contemporary crucible steel production have been archaeologically evidenced. By J. Hošek and J. Košťa.

idea is very interesting and especially crucial for the interpretation of Sword 120 from Kouřim that the supposed relationship between European swords and crucible steel of the Middle East or Central Asia has to be discussed here in more detail.

There are several swords made of hypereutectoid steel, which are mentioned in literature and which could be useful in the attempts to determine the possible origin of the Kouřim sword steel. Hypereutectoid steel (in non-quenched state) was observed in several swords from the Volga-Kama region (Russian Federation); namely in two Migration Period swords (3rd to 5th century AD – Azelino culture (Азелинская культура)) – one coming from the tumulus burial grounds of Tyum-Tyum (могильник Тюм-Тюм) the other from Ust-Bryskinskiy (Усть-Брыскинский могильник) cemetery, in one the 4th to 5th century sword from Kudash (Кудаш) burial ground (Zav'yalov, Rozanova, Terechova 2009, pp.108–109) and in two swords from the Tarasovskiy (Тарасовский) burial ground (Goldina, Berts 2010, p. 154). Similar sword blades of hypereutectoid steel were furthermore found on the late Sarmatian necropolis (2nd to 3rd century AD) of Lebedevka VI (Лебедевка VI) in the South Ural region (Kazakhstan). It is assumed that all these swords were made of crucible steel produced in distant territories such as Persia, Central Asia or India,[4] and that the occurrence of such swords in the Volga-Kama region demonstrates evidence of long-distance trade relations, in which the leading role was played, at the time, by the Sarmatians (Zav'yalov, Rozanova, Terechova 2009, pp.108–110).

Concerning later finds that could be contemporary with the sword from Kouřim, a particular group of Ulfberht swords of (at least in part) hypereutectoid steel (sometimes rather heterogeneous) was recently determined by Williams (2007a; 2007b; 2009; 2012). Williams discovered that hypereutectoid steel had usually been employed in the manufacture of swords bearing the inscription +VLFBERH+ T, which is one of the known variants of the inscription.[5] Using the list of examined (most of them by A. Williams) Ulfberht swords published by Williams (2007a; 2009; 2012, pp. 122–134) we are able to mention the following +VLFBERH+T swords made entirely, or in part, of such steels: 1) one sword from the Alster River, nowadays deposited in the *Museum für Hamburgische Geschichte* (Jankuhn 1951, p. 224); 2) a sword from the Elbe River, also in the *Museum für Hamburgische Geschichte* (Williams 2007, p. 236); 3) a sword from the River Rhine in Karlsruhe, nowadays in the *Württemburg Landesmuseum Suttgard* (Williams 1977a); 4) one sword from the *Oslo Historisk Museum*; 5) three swords from the *Bergen Historisk Museum*; 6) a sword from the *Deutsche Klingenmuseum* in Solingen (Williams 2007a, p. 236); 7) a sword from Eura, now in the *Helsinki Kansali Museum* (Williams 2009, p.127–128); 8) a sword from a *Private Collection* (Williams 2009, p. 129–130). Furthermore, according to results of chemical (WDX) analyses carried out on Ulfberht sword blades, it seems that two other blades from the *Bergen Historisk Museum* were made of partially hypereutectoid steel – one of them bears the inscription H ┌ X I N T ┼, the other the inscription ….B R T (Williams 2009, pp.135–136, 144).

Williams assumes (2012, p. 120), in the same way as Terekhova and Rozanova do (Zav'yalov, Rozanova, Terechova 2009, pp.108–110), that the used hypereutectoid steel may have been a kind of a crucible steel imported from the Middle East, this time by Vikings to the Baltic area via the River Volga trade route.

Hence it seems that hypereutectoid steel produced in the Middle East or Central Asia may have been the subject of long-distance trade for many centuries. The traditional centres of crucible steel production thus might have been the likely places from which the steel, used for Sword H120, may have originated. Naturally, there were trade routes connecting Central Asia with 9th century Bohemia (Fig. 19)

On the other hand, certainly not all medieval hypereutectoid steel came from the Middle East or Central Asia. Also European bloomery steel can be of eutectoid and/or hypereutectoid composition. Highly carburised areas are regularly observed in experimentally as well as archaeologically yielded blooms and Crew (Crew, Charlton 2007, p. 222), for instance, obtained by experimental smelting a block of cast iron. In fact, pieces of cast iron are being discovered along with bloomery slag all over Europe (Crew 2004). The question is whether European medieval smelters and blacksmiths were capable of (or used to) intentionally exploiting carbon-rich blooms or parts thereof to make utilizable pieces of hypereutectoid steel. Besides this, blacksmiths of medieval Europe were most likely familiar with the technique of carburising iron in closed crucibles; tools can be carburised in this way in their functional parts (if not whole) and/or pieces of iron can be transformed into pieces of steel (Pleiner 2006, p. 67). Steel obtained in such a manner could easily reach hypereutectoid carbon content, but it is very possible that Europeans did not heat the crucibles so intensively to achieve compact ingots of cast steel. Hypereutectoid steel of local origin was therefore potentially available in Europe, nevertheless, it is certain that hypereutectoid steel with a carbon content of 1.2% and higher was not a common material in medieval European forgings.

In concluding, we should also mention two Early Medieval swords from Moravia (one from Nemilany and one from Mikulčice, both in the Czech Republic) that also revealed, in their cutting edges, small areas of steel with a hypereutectoid carbon content. A blade from an "+ULFBERHT+" sword, lifted from Grave H41 in Nemilany (near Olomouc) and dated to the end of the 9th to the 10th century (Kalábek 2009, p.150), is composed of hypoeutectoid steel in the middle part (alternating strips of ferritic-pearlitic structure with the carbon content varying between 0.4 and 0.6%) and welded-on cutting edges of steel. The cutting edge examined near the point was hardened eutectoid to slightly hypereutectoid steel (bainitic type structure with small cementite grains), and the edge situated near the tang was of non-hardened eutectoid steel (Selucká, Richtrová, Hložek 2002, p. 29). The sword from Mikulčice, a late 9th to early 10th century weapon lifted from Grave 805, has a blade with the central portion consisting of alternating bands of low carbon (0.2 to 0.3%) and eutectoid steel; welded-on hardened steel cutting edges consist mainly of bainite and very fine pearlite, which are accompanied by scattered martensitic grains. Martensite and troostite prevail in the very cutting edge of a specimen from near the grip, whilst bainite with small grains of cementite prevails in the very cutting edge of the specimen, near the point (Košta, Hošek 2009, p.117). Although steel used in both these swords (Nemilany; Mikulčice, grave 805) was locally hypereutectoid (but the carbon content most likely did not exceed 1%), they are not considered as weapons with cutting edges made deliberately of crucible steel of non-European origin. Both seem to be heat treated in a sophisticated manner and at least the sword from Mikulčice does not significantly differ, except in the small area with cementite grains, from some other swords from the site.

CONCLUSION

Both examined swords come from princely graves (rock chamber tombs) with rich grave goods, which were uncovered at the burial grounds at the "Libuše" pond near the Early Medieval stronghold of Stará Kouřim (Czech Republic), and which can be dated to the course of the 9th century. A more detailed classification of these weapons is impossible due to the lack of hilts, which were originally most likely of organic material, such as bone or wood, as skeletons of the buried princes were also not preserved. Carried out metallographic examination and the review of the archaeological contexts has allowed us to arrive at the following statements and hypotheses.

Sword 55 (dating of the grave: 1st third of the 9th century)

The blade of the sword had an ordinary structure – cutting edges are of good quality steel, the middle part (core) varies between iron and steel; the blade was quenched, but afterwards underwent a high degree of overheating, which could be associated either with incorrect heat treatment or with accidental fire, which decreased the cutting edge quality.

The sword, nowadays considered a medium quality weapon (because of its relatively soft edges), was accompanied by a sword-belt garniture that reveals a fusion of the Avar and the Frankish traditions; the garniture is also of an average, or even substandard, quality. It is conceivable that sometime at the time of the extinction of the Avar Khaganate, or shortly afterwards (1st third of the 9th century?), the sword-belt garniture and the sword itself were made in a local workshop, situated somewhere in the area where the Avar and the Frankish traditions merged.

Sword 120 (dating of the grave: 1st to 2nd third of the 9th century)

The sword was undoubtedly of high quality and a valuable weapon. Its blade was made of rods of steel with the carbon content up to 1.4% in the cutting edges and the steel-cored middle part featured pattern-welded surface panels (consisting of strips of steel and phosphoric iron). Despite the high amount of inclusions, we do not rule out the possibility that the cutting edges might be a kind of crucible steel, which was produced in Central Asia or the Middle East and which was a rare and desired material in European sword manufacturing at that time. There is no clear support to determine the provenance of the weapon. The design is more European in nature, although the short length and the use of hypereutectoid steel are rather atypical. In the context of the possible origin of the hypereutectoid steel, the probable provenance of the silver-plated axe-hammer is interesting because it is assumed to be in the East European environment.

Although the results of the metallographic examinations opened new possibilities for interpretation of the swords from the Stará Kouřim princely graves, we recall that the findings are at this stage of research considered rather as working hypotheses, which must be further verified and tested.

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