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Technological and provenance insights into La Tène pottery: An analysis of the settlement assemblage from Křinec (Czech Republic)

Jan Volf – Karel Slavíček – Richard Thér – Kristýna Trnová

Ceramic technology evolution at the beginning of the Roman Period: Case study of the Mlékojedy settlement site (Central Bohemia)

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Celtic migrations and the spread of La Tène Culture: A consideration of possible explanatory models

Martin Schönfelder

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CONTENT – OBSAH

EDITORIAL

In this issue of *Archeologické rozhledy*, we present readers a set of three research articles and one discussion paper. The first two articles share much in their methodological approach, as they apply petrography and X-ray fluorescence analyses on excavated pottery. Jan Volf and colleagues examined finds from the Křinec site to seek potential technological changes in pottery production at the end of the La Tène period. The analysis thus operates within the context marked by the decline of oppida and Celtic culture in Central Europe (bearing in mind all the issues that the terms 'Celtic' as well as 'culture' may be affected by). The paper by Zdeněk Beneš and his colleagues expands on this topic and, based on a case study from the Mlékojedy site, they explore the (dis)continuity in pottery production during the transition from the La Tène to the Roman periods.

With the following paper, we are moving beyond the usual chronological scope of archaeological research. Jan Hasil and colleagues present their analysis of the waste dump excavated in the World War II POW camp in Sauersack/Rolava to illustrate how modern artefacts can enrich our knowledge of the intricate history of the 20th century. With Martin Schönfelder's discussion paper on Celtic migrations, we return to Iron Age archaeology, but even here historical sources play an important role. Livening up the archaeological inquiry with the names of tribes, their leaders, and precise dates for major events, it may, on the other hand, blindfold us from seeing the true testimony of the archaeological record. Links between historical accounts and artefacts will never be straightforward. Moreover, research in protohistoric and historic periods is and will always be inevitably burdened by current political, and mostly nationalist, connotations, as Jiří Macháček noted in his review of two volumes dedicated to medieval lead seals in Central and Eastern Europe.

Although it may not be apparent at first glance, all four papers in this issue are linked by a common theme. They address, more or less directly, past migration, as their authors try to identify different social groups behind the archaeological record – groups that probably migrated to the area the excavated objects come from. While Jan Volf and his colleagues address the processes that preceded and set the ground for the migration on which Zdeněk Beneš and his team focus, the discussion paper by Martin Schönfelder examines migrations more directly; in the case of POW camps, forced migration and relocation were key aspects. Fortunately for most of the inmates, it was a reversible act. Thus, whether it is a prehistoric ceramic vessel or a glass bottle for medicaments, these objects can reveal much about the identity and behaviour of their users. The problem is – as is always the case with archaeological finds – that such objects are mute and it is left to archaeologists to employ all their ingenuity to decipher their stories.

By studying past migrations, archaeologists have entangled themselves, quite paradoxically, in the same process. Mobility constituted medieval university communities the same way it is an essential, virtually mandatory part of academic careers today. To sketch some scholarly classification, which is so enjoyed by archaeologists, such academic migration is structured by the subject of study itself (i.e. by specialisations in archaeology) as well as the age cohorts of the participants (younger members are usually more involved in migration than older high-ranking individuals). Academic migration is mostly short-term. It would probably leave no detectable traces for isotopic analysis of the travelling scholars' bodies,

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with the exception of academic expats who set out for migration with no return. Based on these principles, an intricate community of shared practice with translocal connections is woven. Writing these lines at Christian-Albrechts-Universität zu Kiel during my postdoc fellowship, I am living proof of these words.

Václav Vondrovský

RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Technological and provenance insights into La Tène pottery: An analysis of the settlement assemblage from Křinec (Czech Republic)

Vhled do technologie výroby a provenience laténské keramiky: Analýza sídlištního souboru z Křince (Česká republika)

Jan Volf – Karel Slavíček – Richard Thér – Kristýna Trnová

During the Late La Tène period in the first century BC, Central Europe witnessed significant shifts in settlement structures and material culture. Understanding these changes necessitates an examination of LT D1b phase settlements, particularly in Bohemia, where such sites are rare. This study extends beyond conventional stylistic analysis of pottery, incorporating material and manufacturing perspectives to reveal production organisation, distribution, and community interactions. Through a comprehensive examination of the settlement pottery from the feature 27/1986 from Křinec using X-ray fluorescence, thin section analysis, and computed tomography, we have gained a better understanding of the settlement's position in the regional socio-economic network within which ceramic vessels or raw materials were transported over distances of more than 20 km. The presented approach offers a deeper comprehension of the La Tène period's end in Bohemia and underscores the value of multifaceted pottery research in archaeological studies.

Late La Tène period – production of pottery – socio-economic network – X-ray fluorescence – ceramic petrography – computed tomography

Během pozdní doby laténské v prvním století před Kristem došlo ve střední Evropě k zásadní proměně sídlištní struktury a materiální kultury. Pochopení této transformace vyžaduje studium sídlištních souborů z fáze LT D1b předcházející této proměně, a to obzvláště v Čechách, kde jsou takovéto soubory vzácné. Tato studie jde nad rámec konvenční stylistické analýzy tvarů a výzdoby keramiky a zahrnuje rozbor použitého materiálu a technologie výroby s cílem poodhalit organizaci výroby, distribuci a interakce mezi komunitami. Komplexní zkoumání sídlištní keramiky z objektu 27/1986 z Křince pomocí rentgen-fluorescenční analýzy, analýzy výbrusů a výpočetní tomografie dovolilo lépe porozumět pozici, kterou toto sídliště zaujímalo v regionální socio-ekonomické struktuře, uvnitř níž byly transportovány nádoby nebo suroviny k jejich výrobě na vzdálenosti větší než 20 km. Představený přístup umožňuje získat hlubší vhled do závěru doby laténské a ukazuje potenciál vícefázové analýzy keramiky jako součásti archeologického výzkumu.

pozdní doba laténská – výroba keramiky – socioekonomická síť – rentgenová fluorescence – keramická petrografie – počítačová tomografie

Introduction

Analyses of the properties of pottery enable to study not only its manufacturing process but also the contacts between the regions and past societies that produced and used these vessels. The production chain of ceramic vessels was influenced by multiple factors, such as the raw material used, their function in society, organisation of their manufacturing, and cultural conventions (*Orton – Hughes 2013*, 23–35; *Hunt 2017*, 135–136; *Eramo 2020*, 2, 4; *Montana 2020*, 2). In general, forms of ceramic production resulted from interactions

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between people and their environment (*Hunt 2017*, 135–136). Pottery was also a part of the everyday reality of past communities, as it was essential for multiple activities, and therefore factors influencing its properties and production included customs and traditions (*Santacreu 2017*).

The social role of pottery was reinforced by relations between generations of potters who shared conceptions of correct manufacturing procedures and ideal final products (*Nicklin 1971*; *Arnold 2005*; *Spataro – Meadows 2013*, 60; *Roux et al. 2017*; *Berg 2018*, 97). Consequently, potters could disregard manufacturing techniques of other communities with distinct pottery production traditions (*Roux et al. 2017*; *Spataro – Meadows 2013*, 72). In addition, the pottery production process was often adapted to certain types of raw materials (*Nicklin 1971*). The spread and preservation of the same pottery tradition between different communities required a stable system of contacts and the sharing of information about manufacturing practices among potters (*Jeffra 2011*, 27–28, 207–208; *Santacreu 2017*).

In individual communities, all households could manufacture pottery solely for their own use. Alternatively, some households might have produced pottery for other households as a secondary means of subsistence. Investments in production, including time and resources, grew with the importance of pottery production for a household's subsistence (*Peacock 1982*, 8–9, 13–24; *Rice 2015*, 189; *Thér et al. 2015*, 40–41). In general, specialisation of the production of any commodity increases with the lower availability of necessary resources, the higher complexity of the manufacturing process, or the demand of consumers for products with certain attributes (*Thér et al. 2015*, 38–40). Higher specialisation of production may be likewise connected to the demographic development of society (*Thér – Mangel 2014*, 5) and is not necessarily related to sociopolitical complexity (*Hunt 2017*, 117). Thus, the transportation of products (including pottery) between regions primarily depends on suitable conditions, such as the proximity of travelling routes (*Nicklin 1971*; *Peacock 1982*, 79–80; *Clark – Parry 1990*, 297).

The characteristics of pottery manufacturing often varied between regions. Likewise, in such cases, the attributes of ceramic vessels also differed. Therefore, it is possible to study contacts between regions with distinct pottery production traditions (*Orton – Hughes 2013*, 23–35). Contacts could involve the transportation of vessels, imitation of the visual properties of pottery from other areas, or the spread of different manufacturing techniques. Forms of contact may be investigated by comparing styles, ceramic fabrics, and manufacturing processes of the vessels (*Meyer 2013*; *Stapfer 2017*). An examination of ceramic fabrics includes analyses of their elemental and mineralogical composition (*Orton – Hughes 2013*, 140–146; *Rice 2015*, 379–382, 393–400; *Gliozzo 2020a*; *Repka 2020*, 22–23).

The manufacturing process can be reconstructed by examining the attributes of pottery. It consists of multiple stages, including the collection of a raw material and its modifications, the shaping of a vessel, adjustments to its appearance, and firing (*Hunt 2017*, 102–105). The choice of raw material is limited by available resources (*Rice 2015*, 52). In the case of pre-industrial societies, potters usually gather raw material (both clay and inclusions) within one kilometres of the household. Only rarely inclusions are collected from a distance greater than seven kilometres (*Arnold 2005*; *Hein – Kilikoglou 2020*, 10). However, some materials may be more suitable for the manufacture of specific products, such as wheel-made pottery (*Hunt 2017*, 95–98), or vessels with distinct functions (*Orton – Hughes 2013*, 117). In addition, potters might prefer a certain source of clay or type of inclusions based on their traditions (*Schiffer – Skibo 1987*).

The shaping of a vessel involves various operations, which can be divided into primary (forming of a roughout) and secondary techniques (*Thér et al. 2015*, 47; *Hunt 2017*, 104). A vessel may be shaped completely with the hands or with the help of a rotational device. Its rotational energy might be used to create a primary shape, to finish a shape made with the hands (for example by coiling), or during another part of ceramic manufacturing. An advantage of the first possible application of rotational energy is the speed of shaping. However, this method requires a longer learning period than the rest of the techniques (*Thér et al. 2015*, 28–29; *Běhounková 2018*, 8; *Thér 2020*, 7). Individual shaping techniques leave specific traces (*Jeffra 2011*, 56, 115–123, 126–128; *Thér et al. 2015*, 47, 63; *Thér 2020*, 2, 8–10). Pottery featuring a surface without irregularities, with uniformly thick walls, and parallel striations on the inner wall can be classified as wheel-made. When rotational energy is applied only to finish a vessel, it may also be possible to observe traces characteristic of hand-made pottery (*Jeffra 2011*, 56, 122–123, 148–149; *Choleva 2012*; *Běhounková 2018*, 13–17, 20–21), such as irregularly oriented striations, relicts left from joints of coils or separate parts, and unevenly thick walls (*Jeffra 2011*, 116–128; *Běhounková 2018*, 8, 13–15, 18).

Most of the visible traces are removed by potters before firing. Nevertheless, the shaping of a vessel can also be studied based on the orientation of particles in a ceramic fabric, which can be examined, for instance, by micro-petrographic analysis or computed tomography (*Thér et al. 2015*, 47, 63; *Hunt 2017*, 544–549). The attention to surface treatment then potentially indicates the importance of the pottery's visual attributes and other functions. For example, the surfaces of vessels may vary in the level of polishing. In addition to specific appearance, polishing also leads to the lower permeability of fluids and deposition of dirt (*Jeffra 2011*, 56, 137; *Corina Ionescu – Hoeck 2020*). Alternatively, the outer surface might be roughened, often to facilitate the manipulation and transportation of a vessel (*Rice 2015*, 138, 140).

Structures used to fire pottery can be divided into open and closed variants. Additionally, the structures differ in whether the fuel is in contact with the pottery or not. However, all structures allow potters to adjust the process of firing (*Mangel 2016*, 48–49; *Roux 2019*, 111–116). The specifics of firing affect the colours of the final products. Their colouring depends on a combination of temperature, level of oxidation and composition of the fabric. In this regard, the colouring of pottery can be influenced by a potter (*Thér et al. 2015*, 47, 66–72; *Roux 2019*, 111; *Gliozzo 2020b*; *Repka 2020*, 24) and may differ even between vessels made of the same material (*Hunt 2017*, 203). Depending on the firing process, cross-sections of fired vessels will have homogeneous colouring or colouring composed of more than one layer (*Orton – Hughes 2013*, 133–135). For instance, a potter can create thin light or dark surface layers by adjusting the final phase of firing (*Thér et al. 2015*, 71; *Roux 2019*, 101).

In this paper, the research on pottery production serves as a source of information about society at the end of the La Tène period (1st century BC) in Central Europe. At this time, material culture and the settlement network underwent a significant transformation associated with social changes (*Venclová 2008a*; 147; *Salač 2010*). The end of the La Tène period in Bohemia can be defined by stage LT D1 (130/100 – ca. 50 BC) and LT D2, which is synchronous with stage A of the Roman period (*Kysela 2013*, 131). In the phase LT D1a (130/100–80/70 BC), the social, economic, and settlement development of the Late La Tène period reached its peak. However, in phase LT D1b (80/70–50/40 BC), the population began to decrease, and settlements started to be abandoned. This process ended with the collapse of the settlement network and gradual replacement of existing material culture by new elements (*Waldhauser 1983*; *2001*, 41, 130–132; *Beneš et al. 2018*, 89–90; *Danielisová 2020*, 136–145). The transformation included fundamental changes in pottery production, such as the end of the use of potter's wheels and double chamber kilns, and alterations in the shapes and decoration of the vessels (*Thér et al. 2015*, 16; *Beneš et al. 2017*). Analogous changes can also be observed in other regions of Central Europe (*Beneš et al. 2018*, 90), for example, in Central Germany (*Daszkiewicz – Meyer 2003*; *Meyer 2013*) or Bavaria (*Tappert 2005*).

Pottery production of the La Tène period in Bohemia reached its peak in the stages LT C2–D1 (*Beneš et al. 2018*, 208). Coarse and fine ware were clearly separated, both in terms of their properties and in regional variability/homogeneity. Attributes of coarse pottery varied between regions, while fine pottery was highly uniform (*Venclová et al. 1998*, 150–151, 166–167; *2008a*, 98–101). During the research of pottery production in Eastern Bohemia, fine and coarse ware did not differ in clay sources, but in the subsequent preparation of material (*Thér et al. 2015*, 103). The preparation of material for the production of coarse pottery, including types of inclusions, was related to regional traditions (*Venclová et al. 1998*, 150–151; *2008b*, 186–187; *Danielisová 2010*, 67; *Thér et al. 2015*, 133; *Joštová 2020*, 57–58).

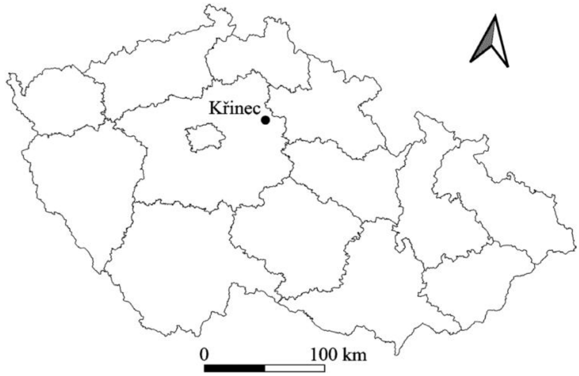
Depending on the region, fine and coarse ware also frequently differed in terms of the shaping process. In Central and Eastern Bohemia, fine ware was always formed with the help of a wheel. Likewise, rotational energy was sometimes used during the shaping of graphite pottery and, especially in Central Bohemia, other coarse pottery. The rest of the coarse pottery was most often shaped by coiling (*Mangel et al. 2013*, 103; *Thér et al. 2015*, 101–102, 120; *Thér – Mangel 2024*, 16, 22). In Western and Northwestern Bohemia, differences between fine and coarse pottery were less pronounced and their shaping process was more variable (*Thér – Mangel 2024*, 16, 22, 15–16). The frequency of wheel-made fine ware varied between regions and even between individual settlements (*Motyková et al. 1990*, 351–362; *Venclová 2008a*, 98; *2008b*, 186–187, 191; *Salač – Kubálek 2015*, 90; *Danielisová 2010*, 65–66).

A smooth or polished surface was characteristic for fine ware in all regions of Bohemia. The types of roughened surfaces of coarse pottery then varied across regions (*Venclová 2008a*, 98–100). For example, grated surfaces predominated in Central and Eastern Bohemia (*Venclová et al. 1998*, 151; *2008b*, 188, Tab. 33; *Danielisová 2010*, 76; *Joštová 2020*, 78–82), while the most common variants of the roughened surface in Northwestern Bohemia were 'marble' and 'crumb' types (*Salač – Kubálek 2015*, 62).

Pottery was fired in various open and closed structures including double chamber kilns, which were used to fire wheel-made ceramics (*Mangel 2016*, 69, 272; *Beneš et al. 2018*, 204–205). Simultaneously, wheel-made fine ware mostly had uniform colouring, while the colouring of coarse pottery made by hand varied. Wheel-made coarse pottery differed in colouring (to some extent) from both previous groups (*Thér et al. 2015*, 120–121).

The high uniformity of fine ware indicates that it could be produced by specialised potters (*Venclová 2008a*, 58–59, 81–82; *2008b*, 185). These producers used potter's wheels and firing kilns to intensify ceramic production or to create specific types of pottery (*Thér – Mangel 2014*, 12). Especially in Central Bohemia, specialised potters also produced wheel-made coarse pottery. On the other hand, coarse pottery in Eastern Bohemia was usually made by hand in individual households (*Thér et al. 2015*, 14, 132). The specialised

Fig. 1. Position of the Křinec site at the map of the Czech Republic.



production of wheel-made pottery was conducted by numerous independent workshops with a short range of distribution (*Thér – Mangel 2024*, 24–25).

Understanding the changes in pottery production during the Late La Tène period in Bohemia is, however, complicated by the fact that the analysed pottery often comes from oppida or settlements that were abandoned before the phase LT D1b. One of the sporadic examples of the LT D1b assemblage represents pottery from the settlement in Křinec (*Fig. 1*) in the eastern part of Central Bohemia (*Beneš et al. 2018*, 302; *Danielisová et al. 2018*, 164). The La Tène settlement in this part of Bohemia was primarily concentrated around the rivers Labe (Elbe), Jizera, Cidlina, and Mrlina (*Venclová 2008a*, 26). Křinec is located about 10 km northeast of the Labe. In its cadastral territory, three settlement areas from the stages LT B–D could be recognised around the river Mrlina. The settlement was formed by small groups of houses or individual unfenced homesteads (*Motyková-Šneidrová 1957*; *Rybová 1968*, 22; *Waldhauser 2001*, 284). This form of settlement was also common in other parts of Bohemia during the LT B–D period (*Venclová 2008a*, 31; *2008b*, 176).

In the eastern part of Central Bohemia, the most prominent settlements in the Late La Tène period were situated at the sites of Žehuň and Týnec nad Labem and a settlement agglomeration also most likely existed near Kolín (*Fig. 2*). All these sites were connected to other regions by the communication route along the Labe (*Mangel et al. 2013*, 92–93; *Beneš et al. 2018*, 86; *Thér – Mangel 2024*, 7). The site of Týnec nad Labem is located 28 km southeast of Křinec (*Fig. 2*: 1) on the hill Kolo (225 m.a.s.l.) overlooking the Labe (*Fig. 2*: 2). It was inhabited in the Hallstatt period and also in the Late La Tène period. The site has been known to archaeologists since the first half of the 20th century and was partially excavated between 1974 and 1977. A metal detector survey was then conducted south of the site between the hill and the river. Finds included fragments of metal vessels, mirrors, rings, and 68 coins dated to stages LT D1–D2 having origin in Bohemia as well as in other regions of Europe (*Beneš 2015*; *2020*).

The site of Žehuň takes position between Křinec and Týnec nad Labem (*Fig. 2*: 3). It was inhabited in the Bronze Age as well as in the La Tène and Roman periods. Finds from the La Tène period include 143 coins (74 from LT C1–C2, 56 from phase LT D1a and 13 from phase LT D1b), 164 other metal artefacts, and pottery fragments. Pottery was typical for the eastern part of Central Bohemia, while types of metal artefacts pointed to the contacts with other regions, for example with the central Danube area. The La Tène settlement in Žehuň was probably abandoned in phase LT D1b, and therefore it was contemporary with the Křinec settlement (*Danielisová et al. 2018*).

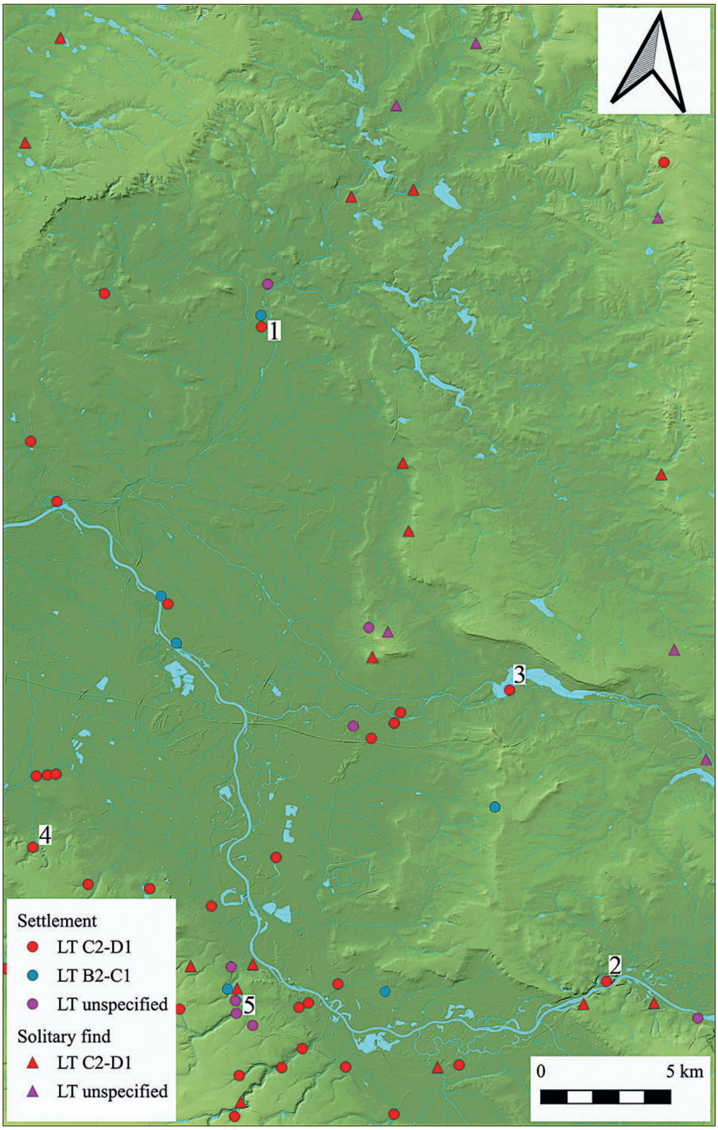


Fig. 2. La Tène settlement structure in the vicinity of Křinec: 1 – Křinec, 2 – Týnec nad Labem, 3 – Žehuň, 4 – Cerhýnky, 5 – Štítary u Kolína.

The assemblage from Křinec can be used as an example of pottery from the end of the La Tène period before subsequent changes of the stage LT D2 appeared. Its attributes can be compared with characteristics of pottery from the previous phases of the Late La Tène period in order to determine whether it has a similar character or whether it differs. Chemical composition analysis and thin section analysis also allow to study ceramic fabrics. Their distinctions might point to the choice of a specific material for the production of certain categories of ceramic vessels or to a different provenance of pottery. Based on this, we can obtain new data regarding the organisation of pottery production and distribution and contacts between local settlements at the end of the La Tène period.

Geological setting

Křinec is located on the fluvial deposits of the Mrlina River, primarily consisting of loam, sand, and gravel, which are part of the southern Bohemian Cretaceous Basin, notably the Teplice formation. The Teplice formation, dated from the Upper Turonian to Lower Coniacian, ranges from 30–110 m in thickness. It often begins with the 'Upper Turonian transgressive horizon' overlaying siltstone with glauconite and nodules of phosphates, including phosphatised fauna relics and coprolites. In the Křinec vicinity, these marine sediments mainly include calcareous claystone, marlite, and siltstone with clay limestone. Downstream, near the Březno formation, sediment composition shifts to primarily marlite and limestone (*Fig. 3*).

The Mrlina River, which is situated about 300 m east of the site of Křinec, originates around 20 km north in Příchvoj and flows mostly through the Březno formation of calcic claystone, marlite, and calcic siltstone. Approaching Křinec, it traverses the Rohatec layers of the Teplice formation, which is characterised by silicified calcic claystone and marlite.

The broader region encompasses geological units from the Teplá-Barrandien area, Moldanubian Zone, Kutná Hora – Svratka area, and the Permocarbon of the Blanice furrow. The Moldanubian Zone, situated to the southwest, features the two-mica, medium- to coarse-grained porphyritic Říčany granite of the Central Bohemian pluton. Nearby, the Barrandien area presents Neoproterozoic slate, greywackes, and conglomerates, along with Ordovician rocks including slate, siltstone, sandstone, and quartzite.

Southeast from Křinec, the area of the Podhořany Crystalline Complex in the Iron Mountains is predominantly composed of fine-grained paragneiss and mica schist, with the Chvaletice-Sovolusky Proterozoic and Chrudim Paleozoic not far away. The Chvaletice Group includes phyllitised clay shale and greywacke schist, tuffitic rocks, volcanic basic rocks, and bodies of amphibole to amphibole-pyroxene gabbro, while the Sovolusky Group contains clayey shale and spilitic rocks. The Chvaletice massif is located between the Podhořany Crystalline Complex and the Chvaletice-Sovolusky Proterozoic and consists of two-mica granite, granodiorites, and amphibolic gabbro to metagabbro with a transition to amphibolites.

Southwards, the Kutná Hora Crystalline Complex is delineated into Šternberk-Čáslav, Kutná Hora, and Malín Groups featuring a diverse array of rocks including two-mica gneiss, amphibolite, and quartzite. The metamorphosis took place in kyanite-staurolite, or sillimanite-almandine subfacies with muscovite (*Mísař et al. 1983*).

Material

The assemblage analysed in the article comes from feature no. 27/1986 in Křinec. The site is situated on a small elevation over the left bank of the river Mrlina (197 m.a.s.l.) in the south part of the cadastral area of Křinec. During the excavation in 1986 and 1987, around 60 archaeological features were found, including nine from the La Tène period. However, only the sunken feature 27/1986 could be dated to stage LT D1b. Its chronology is based particularly on the find of an iron spoon-type brooch. The feature had a size of 550×330×40 cm and was oriented to east-west axis. It contained two rows of cone-shaped loom weights in the western corners and three rows of loom weights in the northeast

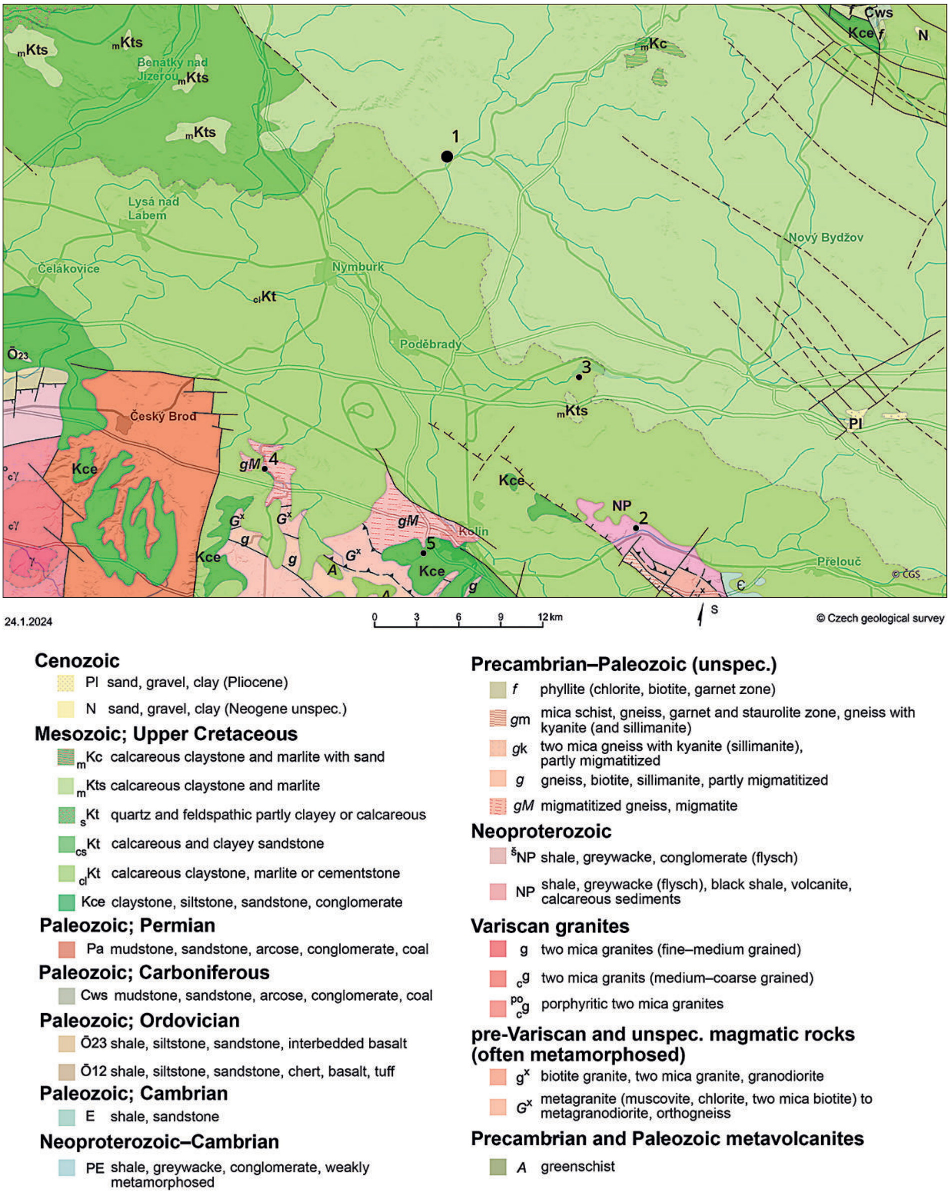


Fig. 3. Geological map of the region: 1 – Křinec, 2 – Týnec nad Labem, 3 – Žehuň, 4 – Cerhýnky, 5 – Štítary u Kolína (after Czech geological survey 2024, modified).

corner. In addition, a shallow hole with a layer of ash interpreted as a hearth was found in the western part. Other finds from the feature included eight spindle whorls, an iron hook, part of an iron chain, a fragment of a bracelet from a silver sheet, and pottery fragments. The finds are deposited in the Polabské Museum in Poděbrady (P 34158–34197, 34232–34434, 34474–34509).

Tab. 1. Values of the variables Po, Mat, Vy, and traces left from the shaping process.

Surface treatment (Po)	
Po1	polished
Po2	smoothed
Po3	roughly smoothed
Po4	matt
Po5	grainy
Po6	grated
Po7	uneven coating of fine clay, so-called 'marble' type
Po8	coarse coating, so-called 'crumb' type
Po9	combing
Material category (Mat)	
Mat1	size of inclusions up to one mm, sorting high
Mat2	size of inclusions up to one mm, sorting medium
Mat3	size of inclusions up to three mm, sorting medium
Mat4	size of inclusions up to three mm, sorting low
Mat5	size of inclusions above three mm
Colouring of a cross-section (Vy)	
Vy1	homogeneous dark
Vy2	homogeneous light
Vy3	light–dark
Vy4	dark–light
Vy5	dark–light–dark or dark–light–dark–light–dark
Vy6	light–dark– light or light–dark–light–dark–light
Vy7	asymmetrical multicolored
Traces left from the shaping process	
Hand	traces associated with hand-made pottery
Wheel	traces associated with wheel-made pottery
Comb	traces associated with a combination of both methods

The majority of pottery from the feature was identified as being wheel-made and created from similar material (*Sedláčková 1991*). Based on the stylistic assessment, the assemblage does not contain pottery from the Roman period or from other regions (*Droberjar 2006*, 16). In terms of vessel shapes, the assemblage is very uniform and can be dated to the stage LT D. It is supported by the dating of the silver bracelet, which comes from the same period. The studied assemblage of pottery consists of 541 ceramic specimens, of which 30 were selected for archaeometric analyses (*Fig. 4–5*; *Tab. 2*) based on their attributes.

Methods

Macroscopic analysis

As an initial step, the assemblage was analysed macroscopically to gather data about its main characteristics and to select representative samples for further analyses. Examined attributes of pottery included weight, wall thickness, level of fragmentation, preserved part, shape, surface treatment (Po), material category (Mat), proportion of inclusions (InMn), variability of inclusions (InVar), traces left from the shaping process (*Tab. 1*), and the colouring of a cross-section (Vy).

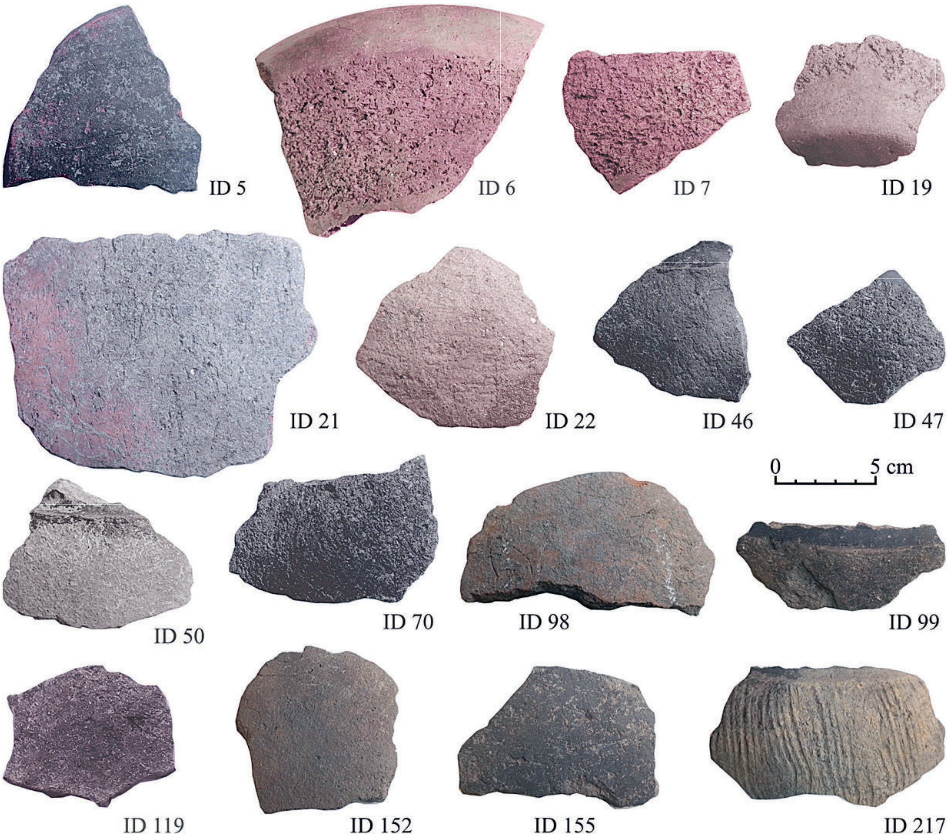


Fig. 4. Samples selected for X-ray fluorescence spectrometry (ID 5–217).

ID	Fabric	XRF	OM
5	A1	+	
6	C	+	+
7	C	+	
19	A4	+	
21	A3	+	
22	A2	+	
46	B	+	
47	A4	+	+
50	A3	+	+
70	A4	+	
98	D	+	+
99	A2	+	+
119	A1	+	
152	D	+	
155	B	+	+
217	B	+	+
228	A2	+	
257	C	+	+
258	C	+	
313	A3	+	+
339	B	+	
416	A1	+	
493	A3	+	
494	A3	+	
534	C	+	
536	A4	+	
576	A1	+	+
577	A3	+	
587	B	+	
594	A1	+	

Tab. 2. List of samples, fabrics, and analytical methods (XRF – energy-dispersive X-ray fluorescence spectrometry, OM – optical microscopy).

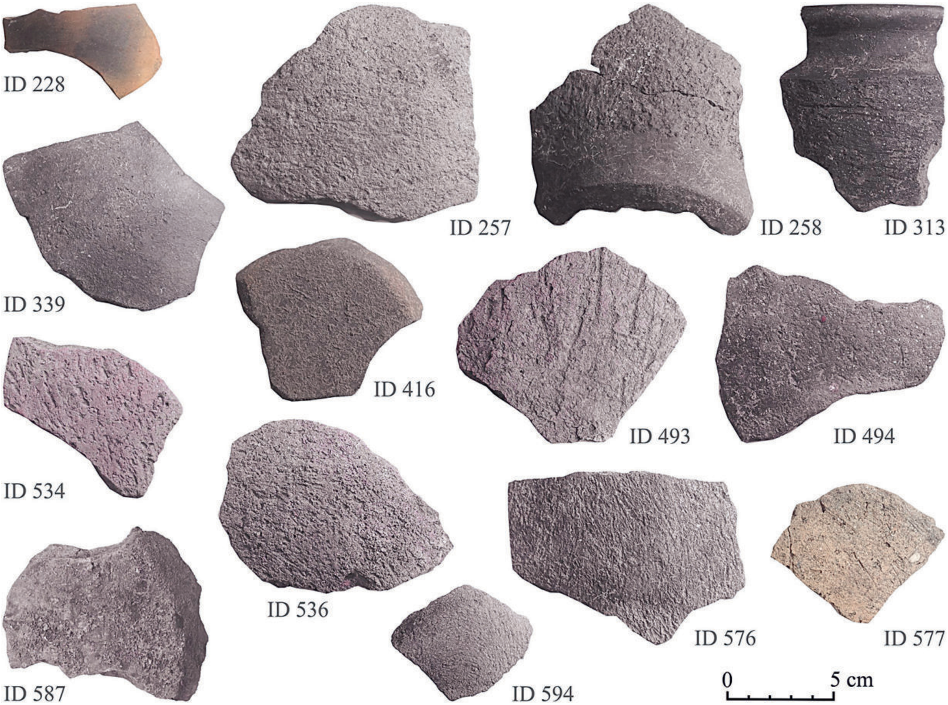


Fig. 5. Samples selected for X-ray fluorescence spectrometry (ID 257–594).

Surface treatment (Po) was divided into nine potential variants based on the typology created by *Venclová* (*1998*, 90–91; *2008a*, Fig. 50) for the La Tène pottery in Bohemia. The five subcategories of ceramic material (Mat1–Mat5) were defined according to size and the sorting of inclusions. The proportion of inclusions (InMn) was categorised into three groups: less than 5 % (InMn1), 5–20 % (InMn2) or more than 20 % (InMn3) (after *Orton – Hughes 2013*, 238–240). Inclusions in the ceramic fabric also differed in their shapes, colours, and other attributes. For this reason, the descriptor for variability of inclusions (InVar) was defined. Ceramic fabric might have contained one type or none (InVar1), two types (InVar2), or more types (InVar3) of the visually determinable inclusion.

Finally, seven variants of colouring visible on the cross-section (Vy) were distinguished based on the alternation of light and dark layers. Colours were described from the outer wall to the inner one and determined using the Munsell Book of Soil Colour Charts. The assessment of layers also involved an examination of their thickness and regularity (see *Orton – Hughes 2013*, 133–135, Fig. 11.1).

Computed tomography

Computed tomography (CT) was used as a non-destructive alternative to petrographic analysis. It helped to investigate the microstructure of the ceramic fabric and identify the forming process of six ceramic vessels (ID 135, 258, 313, 328, and 567; *Fig. 6*). Samples were selected during the macroscopic analysis based on traces linked with different forming

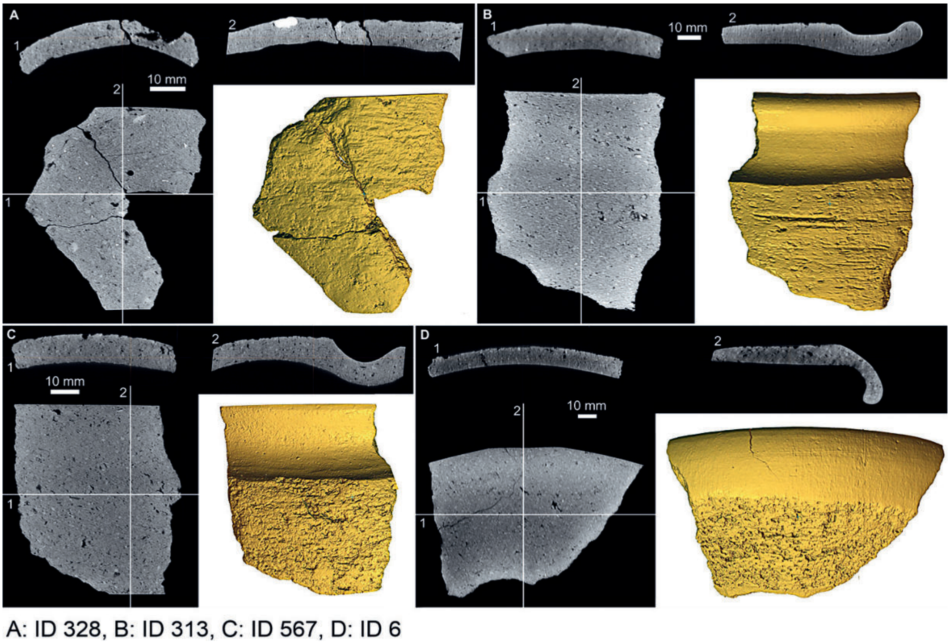


Fig. 6. Samples ID 6, 313, 328, and 567 selected for computed tomography.

methods. Three samples (ID 6, 313, 567) had traces characteristic for wheel-made pottery and two samples (ID 135, 328) had traces typical both for hand-made and wheel-made pottery. During the CT, the shaping process of the vessels was determined based on the orientation of components in the ceramic fabric and discontinuities in the structure of the walls. The main factor affecting the orientation of components is the direction of a force applied during the forming. The forming forces cause compressive and shear stress in the material. The compression rotates elongated particles and deforms the shape of voids. Deformation by compression stress results in the diagonal orientation of particles relative to the forming force. In the case of shear stress, the particles are aligned along the direction of the forming force (*Rye 1981*; *Vyalov 1986*; *Carr 1990*; *Courty – Roux 1995*; *Middleton 2005*; *Livingstone Smith 2007*; *Berg 2008*).

X-ray images were acquired by an X-ray generator using a lamp with a focal spot of 0.05 mm at a voltage of 120 kV and a current of 160 μA (obtained on the Explorer X test 200-120/400 X-ray device by Testima). Each CT reconstruction was based on 400 RTG images acquired with the same settings as single X-ray images. CT reconstructions were created using LometomArk software equipped with the X-ray device mentioned above. The resolution of the resulting CT reconstructions varied depending on the size (ranging between 55 and 120 μm).

In the next step of the analysis, radial, tangential, and horizontal sections were extracted from the 3D reconstructions. Components identified in the 3D reconstructions were classified based on their orientation, shape, and position. Structures of tangential, radial, and horizontal sections were also evaluated. The evaluation recognised regulated, omnidirectional, and fluid structures of components (*Thér 2020*). The interpretation of collected data was based on theoretical assumptions regarding the connection between applied shaping techniques as well as the resulting structures of the ceramic fabric and on the reference pottery assemblage.

Ceramic petrography

Chemical composition analysis was conducted using a Rigaku NexCG energy dispersive fluorescence spectrometer (ED-XRF) equipped with a 50 W Pd tube and a silicon drift detector (SDD) with a resolution capability of up to 145 eV. Element quantification errors due to matrix-based discrepancies were mitigated through the application of a calibration library, which was specifically designed for ceramics and soils using standard reference materials of the National Institute of Standards and Technology (NIST), the China National Analysis Centre for Iron and Steel, the National Research Centre for Certified Reference Materials in China, the National Institute of Advanced Industrial Science and Technology in Japan, and MINTEK. The 30 samples were analysed in the form of pressed powder pellets.

Concentrations of selected elements (Al, Si, K, Ca, Ti, V, Mn, Fe, Ni, Cu, As, Rb, Sr, Ba, Pb) were statistically analysed. Hierarchical clustering of the first four components of PCA yielded a classification of samples, allowing for the selection of 10 samples for thin section analysis. Standard thin sections (30 μm) were examined by an Olympus BX 51 polarising optical microscope. The methodology of thin section analysis followed the procedures described by *Quinn* (*2013*). Inclusion abundance was expressed as a semiquantitative score using the adjusted guidelines of *Sauer* and *Waksman* (*2005*).

Statistical data analysis

Data collected during macroscopic analysis were evaluated using RStudio statistical software (R version 4.2.2). An initial exploratory data analysis examined the distribution of individual variables and their potential relationships, which were visualised by bar plots and boxplots. Subsequently, the contingency tables were created to study relationships between categorical variables, and the Kendall rank correlation coefficient was applied to estimate the association between numeric variables. The first part of the data analysis in RStudio used dplyr packages for the organisation (*Wickham et al. 2023*), skimr for the summarisation (*Waring et al. 2022*), and ggplot2 for the visualisation of data (*Wickham 2016*).

In the next step, relationships between categorical variables were further examined using the chi-square test of independence, Cramér's *V*, and correspondence analysis (CA). The chi-square test was used to confirm whether categorical variables in the contingency tables were independent or associated in some way (*Baxter 2015*, 203; *Carlson 2017*, 190–193). Values of Cramér's *V* obtained through the rstatix package (*Kassambara 2023*) helped to estimate the strength of the associations (*Carlson 2017*, 195–198). CA was performed in RStudio through the FactoMineR package (*Lê et al. 2008*) to summarise and visualise the relationships between categorical variables (*Carlson 2017*, 279). The conclusions of macroscopic analysis were compared with the results of interdisciplinary analyses. The comparison made it possible to investigate, for example, whether pottery made from ceramic fabrics of different compositions also varied similarly in other attributes.

Results

Macroscopic analysis

The most numerous material category (Mat) was represented by Mat3 (47.1 %), followed by Mat1 (32.4 %), Mat5 (14 %), Mat2 (3.7 %), and Mat4 (2.8 %). The proportion of inclusions (InMn) in ceramic fabrics ranged between 5–20 % (InMn2) in 57 % of the assemblage; it was higher than 20 % (InMn3) in 29.5 %, and lower than 5 % (InMn1) in 13.5 % of the assemblage. The fabric contained two types of visually distinguishable inclusions (InVar2) in 46.4 % of the assemblage, one or none (InVar1) in 45.5 %, and more than two (InVar3) in 8.1 %. Fabric did not contain visible inclusions in 2.4 % of the assemblage.

The variable Mat was positively correlated ($r^2 = 0.456$) with the variable InVar. Between Mat1 and Mat5, the frequency of the value InVar1 decreased, while the frequency of the values InVar2 and InVar3 increased (*Tab. 3*). The correlation between variables Mat and InMn was less significant ($r^2 = 0.297$). All material categories regularly appeared together with the value InMn2. In contrast, the value InMn1 occurred predominantly with values Mat1 and Mat2, while the value InMn3 was most characteristic of Mat5. The variables InMn and InVar were positively correlated ($r^2 = 0.368$). Frequency of the value InVar1 decreased with a higher proportion of inclusions, while the frequency of values InVar2 and InVar3 increased (*Tab. 4*). Based on the chi-square test and Cramér's *V* (*Tab. 5*), relatively strong relationships existed between the variables Mat, InMn, and InVar. Similarities and differences between material categories were confirmed by CA, particularly the distinction between Mat1 (mainly associated with the variables InMn1, Po1, and Po2) and Mat5 (InVar3). CA dimensions were also defined by the opposition of wheel-made and hand-made pottery (*Fig. 7*).

Wall thickness mostly varied between five and eight mm (46 %). Less frequently, pottery had walls thinner than five mm (22 %) or thicker than 10 mm (6 %). Wall thickness was not significantly correlated with material category ($r^2 = 0.194$) or with proportion ($r^2 = 0.208$) and variability of inclusions ($r^2 = 0.18$). Nevertheless, the value InMn1 was characteristic mainly of pottery with walls thinner than 6 mm.

Traces characteristic of hand-made or wheel-made pottery did not occur on 58 % of samples. The rest of the assemblage featured traces specific for hand-made (22.9 %) and wheel-made pottery (15 %) or traces linked with a combination of both methods (4.1 %). Pottery in all three groups was predominantly made from Mat3 but differed in the ratio of Mat1 and Mat5. The value Mat1 occurred more frequently in the second group and the value Mat5 in the first group. In the third group, the ratio was balanced (*Tab. 3*). Pottery in all three groups also usually contained 5–20 % of inclusions (InMn2). However, compared to the other two groups, the value InMn1 appeared less frequently in the first group (*Tab. 6*). The group of pottery with traces specific for wheel-made pottery then varied from the other two groups by higher frequency of the value InVar1 and lesser frequency of the values InVar2 and InVar3. Simultaneously, pottery with walls thinner than 6 mm belonged almost exclusively to the group of pottery with these traces.

The chi-square test and Cramér's *V* confirmed the existence of relationships between the pottery-forming traces and other variables. However, the general strength of the associations was only minimal (*Tab. 5*). Based on CA, the group of pottery with traces typical

Tab. 3. Relations between material categories and the variables InMn, InVar, Po, Vy, and traces left from the shaping process.

	Mat1	Mat2	Mat3	Mat4	Mat5	Total
InMn1	58	3	8	0	4	**73**
InMn2	85	11	165	11	35	**307**
InMn3	32	5	81	4	37	**159**
InVar1	124	13	108	0	1	**246**
InVar2	50	7	130	13	51	**251**
InVar3	1	0	17	2	24	**44**
Comb	6	0	9	1	6	**22**
Wheel	35	1	38	2	5	**81**
Hand	24	2	66	1	31	**124**
Po1	11	0	2	1	0	**14**
Po2	33	2	11	2	5	**53**
Po3	39	6	66	4	19	**134**
Po4	37	3	65	3	25	**133**
Po5	7	0	8	0	5	**20**
Po6	26	8	57	3	9	**103**
Po7	4	0	16	0	5	**25**
Po8	12	1	19	2	7	**41**
Po9	2	0	4	0	0	**6**
Vy1	78	7	118	6	24	**233**
Vy2	10	1	11	0	10	**32**
Vy3	32	5	63	6	22	**128**
Vy4	8	0	7	0	1	**16**
Vy5	34	6	40	2	12	**94**
Vy6	8	1	10	1	6	**26**
Vy7	1	0	1	0	1	**3**

Tab. 4. Relations between the variables InMn and InVar.

	InMn1	InMn2	InMn3	Total
InVar1	64	145	35	**244**
InVar2	9	141	101	**251**
InVar3	0	21	23	**44**
Total	**73**	**307**	**159**	**539**

Tab. 5. Chi-square test: Relations between properties of pottery.

Variables	$\chi 2$	df	p-value	Cramér's V
Mat-InMn	100.7	8	<0.001	0.3056347
Mat-InVar	158.87	8	<0.001	0.3831842
InMn-InVar	90.823	4	<0.001	0.2902614
Traces-Mat	23.144	8	0.003184	0.2257826
Traces-InMn	15.355	4	0.004019	0.1839069
Traces-InVar	10.864	4	0.02814	0.1546903
Po-Mat	65.645	32	0.0004165	0.1761339
Po-InMn	132.54	16	<0.001	0.3546179
Po-InVar	28.525	16	0.02734	0.1641997
Po-Traces	49.616	16	<0.001	0.3335376
Vy-Mat	25.042	20	**0.1998**	0.1087862
Vy-InMn	20.028	10	0.02899	0.1378462
Vy-InVar	12.127	10	**0.2767**	0.1070598
Vy-Traces	13.895	10	**0.1778**	0.1757228
Vy-Po	62.594	40	0.01269	0.155309

	Comb	Wheel	Hand	Total
InMn1	4	19	7	**30**
InMn2	14	43	76	**133**
InMn3	4	19	41	**64**
InVar1	5	43	42	**90**
InVar2	15	34	70	**119**
InVar3	2	4	12	**18**
Po1	1	11	0	**12**
Po2	2	19	7	**28**
Po3	5	12	37	**54**
Po4	4	12	38	**54**
Po5	2	3	4	**9**
Po6	5	17	17	**39**
Po7	0	2	7	**9**
Po8	3	3	9	**15**
Po9	0	2	1	**3**
Vy1	6	36	50	**92**
Vy2	4	4	5	**13**
Vy3	6	11	30	**47**
Vy4	0	2	2	**4**
Vy5	3	21	29	**53**
Vy6	2	7	7	**16**
Vy7	1	0	1	**2**

Tab. 6. Relations between traces left from the shaping process and the variables InMn, InVar, Po, and Vy.

for hand-made pottery differed significantly from the group with traces characteristic of wheel-made vessels both in material and surface treatment (*Fig. 7*). The group of pottery with traces linked with a combination of both methods varied from the other two groups as it was associated most prominently with the value Vy2. Dimensions were defined primarily by the opposition of the values Mat5, InMn3, InVar3, Po3, and Po4 (hand-made pottery), and the values Mat1, InMn1, InVar1, Po1, and Po2 (wheel-made pottery).

Types of surface treatment (Po) occurred in the following order: Po3 (25.3 %), Po4 (25.1 %), Po6 (19.5 %), Po2 (10 %), Po8 (7.8 %), Po7 (4.7 %), Po5 (3.9 %), Po1 (2.6 %) and Po9 (1.1 %). Only three ceramic fragments featured a surface coated with graphite. The surface Po1 appeared almost exclusively on pottery from Mat1. The type Po2 was also most characteristic for ceramics from Mat1 but occurred on pottery from other materials as well, including Mat5. In comparison, types Po3 and Po4 represented common surface treatments of pottery from all material categories. Likewise, types Po5 and Po6 were not specific for a single material category, while types Po7 and Po8 appeared slightly more often on pottery from Mat3–Mat5 (*Tab. 3*). The frequency of surfaces Po1 and Po2 significantly decreased with a higher proportion of inclusions. In contrast, the occurrence of type Po3 changed only minimally, and the frequency of type Po4 increased. Other types of surface treatment were mostly identified on pottery containing more than 5 % of inclusions. Pottery with distinct types of surface treatment did not differ significantly in the variability of inclusions (*Tab. 7*).

Pottery with traces specific for wheel-made vessels predominantly featured surface treatments Po2, Po6, Po3, Po4, and Po1. Pottery identified as hand-made typically had surface treatments Po4, Po3, Po6, and Po8. In the case of the last defined group, the most

	Po1	Po2	Po3	Po4	Po5	Po6	Po7	Po8	Po9	Total
InMn1	9	26	21	9	1	1	0	2	1	**70**
InMn2	5	15	80	76	7	69	16	28	4	**300**
InMn3	0	11	32	48	12	33	9	11	1	**157**
InVar1	10	34	62	49	6	45	9	18	6	**239**
InVar2	3	17	62	72	13	46	14	20	0	**247**
InVar3	1	2	10	12	1	12	2	3	0	**43**
Vy1	6	19	61	54	9	54	12	13	0	**228**
Vy2	1	1	9	7	3	3	1	6	0	**31**
Vy3	0	10	33	39	2	19	7	16	2	**128**
Vy4	0	1	2	3	1	6	0	0	1	**14**
Vy5	6	16	20	21	4	14	5	4	3	**93**
Vy6	1	3	8	6	1	5	0	1	0	**25**
Vy7	0	1	1	0	0	1	0	0	0	**3**

Tab. 7. Relations between surface treatment and the variables InMn, InVar, and Vy.

frequent surface treatments were represented by types Po3, Po6, Po4, and Po8 (*Tab. 6*). In comparison, the wall thickness of pottery with distinct types of surface treatments did not vary significantly, with the exception of type Po1, which was characteristic of vessels with walls thinner than 5 mm. The chi-square test and Cramér's *V* confirmed an association between the variable Po and other variables, particularly InMn and traces connectable with a shaping process (*Tab. 5*). During CA, types of surfaces Po7, Po4, Po8, Po5, and (less notably) Po3 were associated with different values than types Po2 and Po1. The type Po6 then varied from other types of surface treatment. In the first two dimensions, both groups were defined (in addition to properties of inclusions) by the opposition of hand-made and wheel-made pottery. This opposition was visible even on the biplot of the second and third dimension (*Fig. 8*).

Variants of the cross-section colouring (Vy) occurred in the following order: Vy1 (43.8 %), Vy3 (24.1 %), Vy5 (17.7 %), Vy2 (6 %), Vy6 (4.9 %), Vy4 (3 %), and Vy7 (0.6 %). Homogeneous types (Vy1 and Vy2) represented 49.9 % of the assemblage, double layered types (Vy3 and Vy4) 26.7 %, and multilayered symmetrical types (Vy5 and Vy6) 22.6 %. Simultaneously, types with a dark surface (Vy1, Vy4, and Vy5) were more frequent (64.5 %) than types with a light surface layer (Vy2, Vy4, and Vy6). The uneven transition of layers was visible on more than a third (33.6 % – 38.5 %) of pottery with colouring types Vy3, Vy5, and Vy6 and half of ceramics with the type Vy4. In comparison, uniformly thick layers were most characteristic of the type Vy3 (46.1 %), less for the types Vy6 (26.9 %) and Vy4 (25 %), and the least for the type Vy5 (16 %). At the same time, thick core and thin surface layers occurred more frequently with the type Vy5 (46.8 %) than the type Vy6 (23.1 %).

Frequency of colouring types with a dark surface (Vy1, Vy4, and Vy5) slightly decreased with higher material categories (*Tab. 3*). Differences in occurrence of these types (*Tab. 6*) were also found between pottery with traces connectable with wheel-made ceramics (72.8 %), hand-made ones (65.3 %), and a combination of both methods (40,9 %). In the case of surface treatments (*Tab. 7*), the frequency of types with a dark surface was as follows: 85.8 % (Po1), 72.5 % (Po6), 70.7 % (Po2), 70 % (Po5), 68 % (Po7), 66.7 % (Po9), 61.9 % (Po3), 60 % (Po4), and 42.5 % (Po8). Multilayered symmetrical types were then

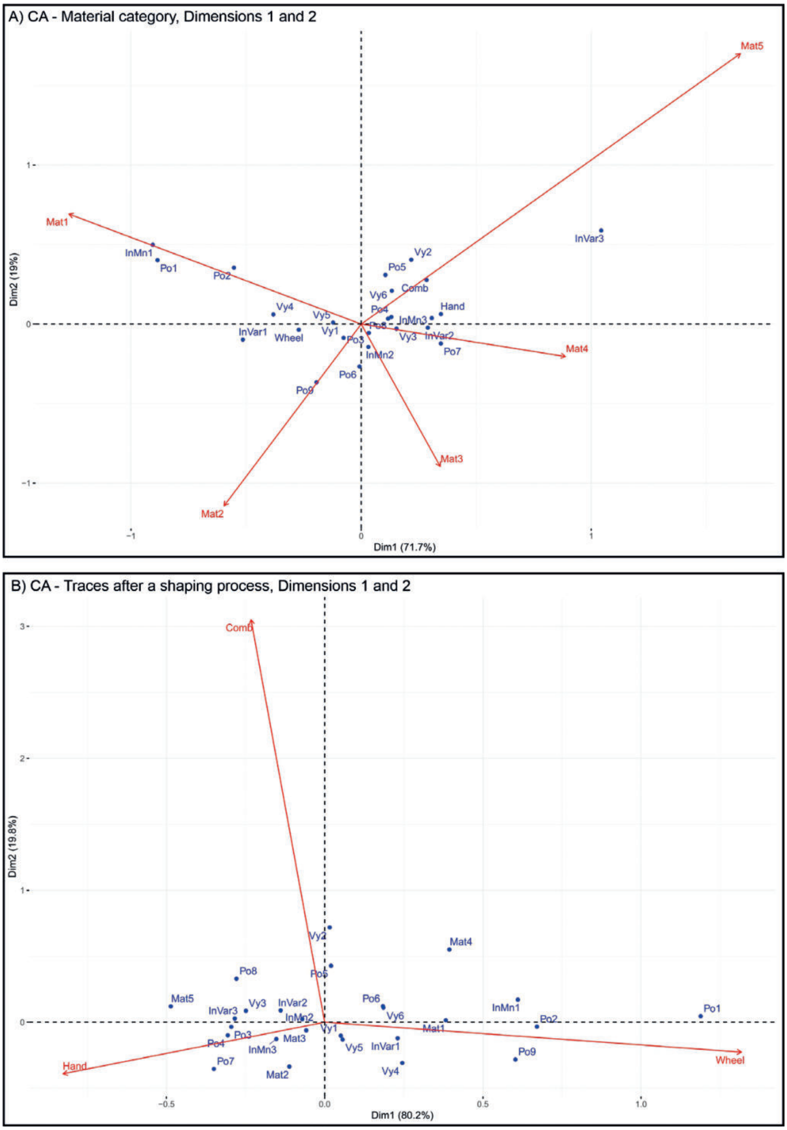


Fig. 7. Correspondence analysis: A – Relations between material categories and other attributes of pottery; B – Relations between traces of shaping process and other attributes of pottery.

characteristic for pottery with surfaces Po1 (50.3 %) and Po9 (50 %) and occurred only rarely together with type Po8 (12.5 %). Based on the chi-square test, the null hypothesis of independence between the variable Vy and other variables could be rejected only in the case of InMn and Po. The values of Cramér's *V* did not indicate strong relationships between the variables (*Tab. 5*). CA showed that differences primarily existed between groups of colouring with dark (Vy1, Vy4, Vy5) and light surfaces (Vy2, Vy3, Vy6). On the biplot of the second and third dimension, it was possible to observe differences between symmetrical multilayered types of colouring (Vy5, Vy6) and the type Vy3. Simultaneously, there was a similarity between homogeneous types of colouring (Vy1 and Vy2). (*Fig. 9*).

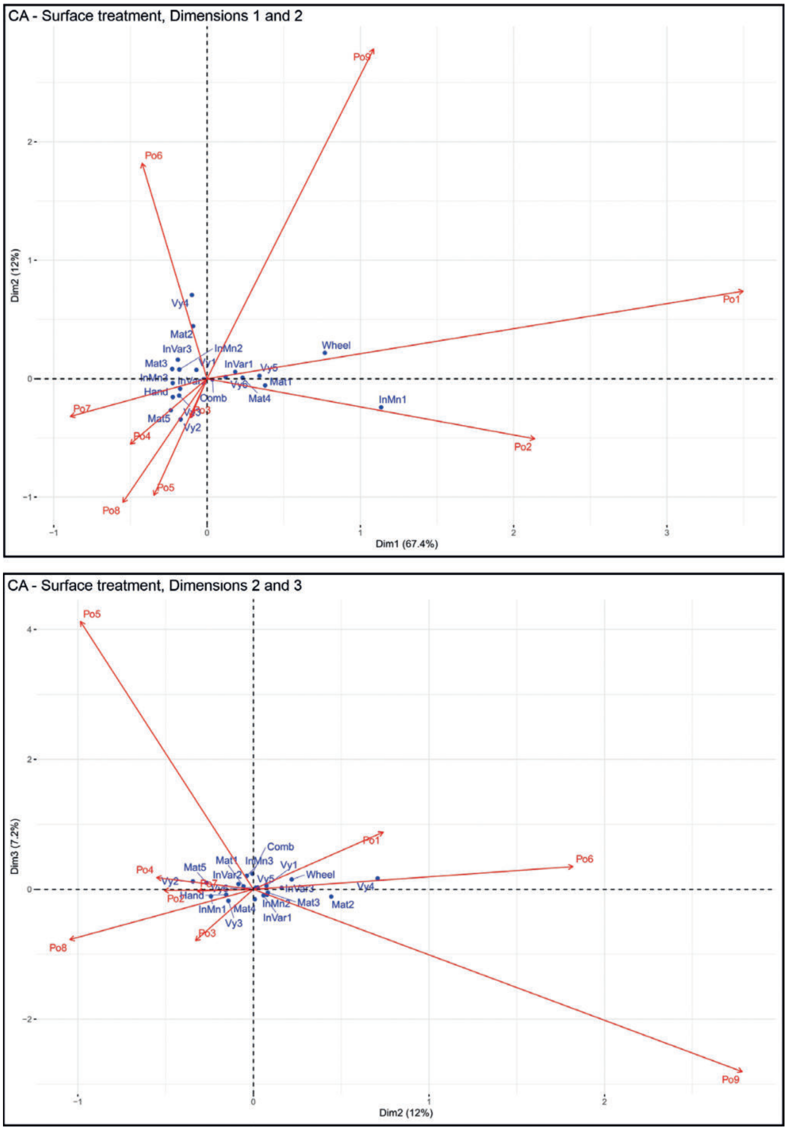


Fig. 8. Correspondence analysis: Relations between surface treatment and other attributes of pottery.

Attributes of fabric groups

Four groups of fabrics could be identified based on the chemical composition and thin section analysis (*Online Supplementary Material 1*). Pottery in group A was made from fabric with a high content of mica and could be divided into four subgroups. The subgroup A1 (ID 5, 119, 416, 576, 594) was represented by pottery from different materials and with various surface treatments (Po2, Po7, Po9). Samples in the subgroup A2 varied in most of the attributes (ID 22, 99, 228). The subgroup A3 (ID 21, 50, 313, 493, 494, 577) consisted, with one exception (ID 313), of pottery made from the material category Mat5 with

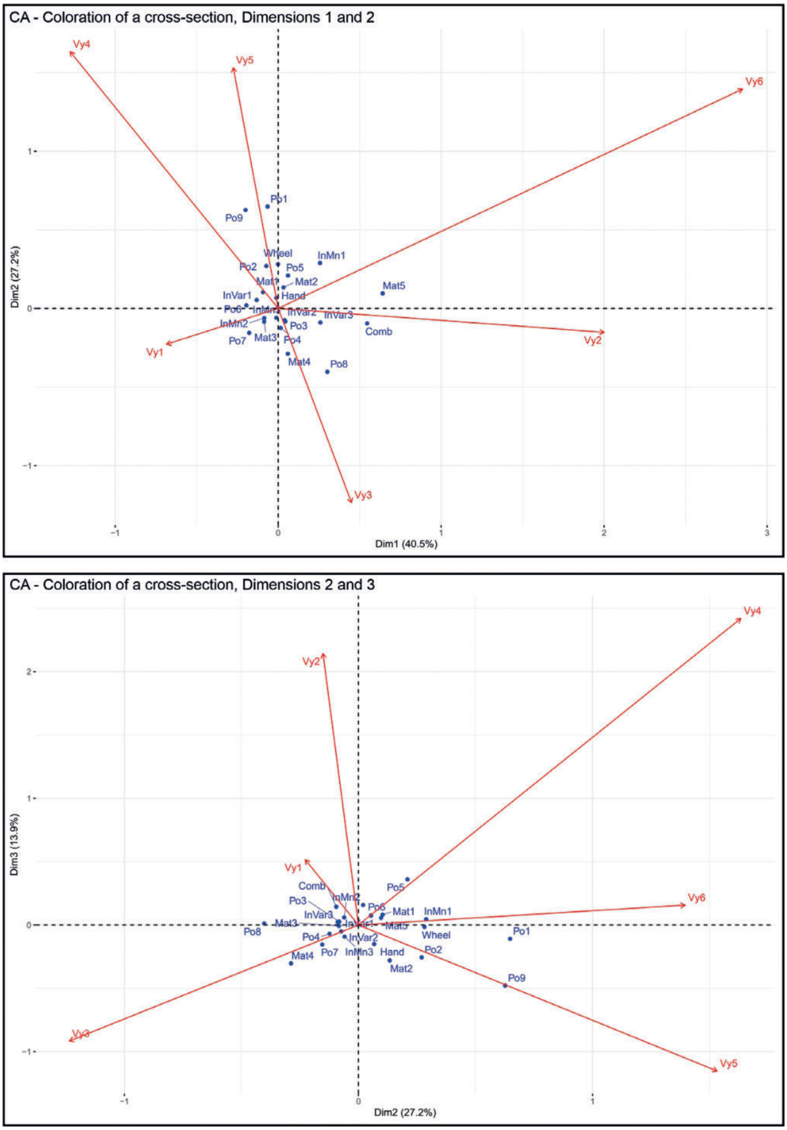


Fig. 9. Correspondence analysis: Relations between the colouration of a cross-section and other attributes of pottery.

surface treatments Po3, Po4, and Po8. The subgroup A4 (ID 19, 47, 70, 536) then contained only pottery with surface treatments Po6 (3x) and Po7 (1x). The group B (ID 46, 155, 217, 339, 587) was less variable than other groups and included one ceramic fragment with a surface coated with graphite (ID 339). Most pottery in the group featured surface treatments Po3 and Po4. Pottery in the group C (ID 6, 7, 257, 258, 534) had the identical surface treatment (Po6) but differed in other attributes. The group D (ID 98, 152) consisted of pottery with a high content of inclusions (InMn3), traces typical for hand-made pottery, and with the surface Po7. The chi-square test confirmed the existence of an association between fabric groups and the variable Po ($\chi^2 = 72.231$, df = 42, p = 0.002553, *V = 0.6443008*).

Computed tomography

Sample ID 6

The sample comes from the torso of a bowl. On the tangential section, the orientation of the components was omnidirectional with irregularly shaped voids. On the radial section, the structure was oriented obliquely, rising from the inner to the outer surface. The vessel was probably constructed from thick coils transformed in the wall by pinching and drawing, which were attached asymmetrically to the outer upper edge of the constructed vessel.

Sample ID 135

The rim, neck, and upper body parts were preserved. On the tangential section, horizontal orientation in the neck area and omnidirectional in the body area were observed. On the radial section, the structure was oriented obliquely, rising from the inner to the outer surface. The neck of the vessel was made from a separate segment. The segment terminating the vessel body could be either a slab or a thicker coil transformed in the vessel wall. Oblique orientation on the radial section corresponded to asymmetric segment placement. Segments were joined to the outer part of the upper edge of the constructed vessel.

Sample ID 258

The lower body part of the vessel was preserved. Irregular voids prevailed in the tangential section. The segments could be a slab or a transformed thick coil. Omnidirectional irregular pores corresponded to the drawing technique. Drawing exerts shear stress on the wall and the intended consequence of this stress is plastic deformation. However, if this stress is excessive, it can cause the formation of cracks manifested as irregular voids, especially around aplastic inclusions.

Sample ID 313

The rim, neck, and upper body parts were preserved. The tangential section showed an alternation of omnidirectional and horizontally directed voids. The radial section showed an omnidirectional structure. Alternation of omnidirectional and horizontally directed structures corresponded to the use of thick transformed coils. A horizontal structure marked the area where the coils were joined. The omnidirectional structure represented the cores of the coils transformed by pinching and drawing.

Sample ID 328

The rim, neck, and body of the vessel were preserved. In both sections, a fluid structure with predominantly horizontal orientation on the TR could be observed. Joints between segments were detected and the vertical distance between them was about 15–20 mm.

Sample ID 567

The rim, neck, and upper body parts were preserved. Alternating horizontal and omnidirectional orientation on tangential sections and omnidirectional orientation on radial sections were observed along with the remnants of horizontal joints of perpendicularly attached segments. This undoubtedly pointed to the use of transformed thick coils; in this case, however, the coils were attached perpendicularly to the edge of the formed vessel.

Ceramic petrography

Statistical analysis allowed to categorise the ceramics into four fabrics, labelled A–D (*Fig. 10*). Fabric A was the most extensive, and its chemical composition did not exhibit any significant specificity within the dataset. Fabric B exhibited the highest concentrations of Si and Ca. Fabric C was characterised by elevated levels of Al, K, Rb, Sr, As, and Pb. Fabric D displayed the highest metal contents, specifically Ti, Mn, Fe, and Ni. Subsequently, we presented petrographic descriptions of selected representatives for each fabric (*Online Supplementary Material 2*).

Fabric A

It was characterised based on five samples (ID 47, 50, 99, 313, 576). This type of ceramic featured a very fine matrix (with aleuritic particle content ranging from 1 to 5 %). The matrix exhibited a lenticular microstructure. Non-plastic inclusions were very poorly sorted, with a bimodal size distribution. Larger inclusions accounted for 20–30 % of the volume and were typically single or double-spaced. Their predominant shape was elongated-equant and mostly subangular. In sample 313, some sandy grains were even round. The average porosity reached 5 % in all samples, with pores primarily taking the form of vughs.

Petrographically, fabric A was distinguished by its high content of mica flakes (*Fig. 11*: A). Muscovite was frequently to abundantly present, while biotite was common to abundant. The most prevalent mineral after mica was quartz (common to abundant). Feldspars occur occasionally, with both plagioclase and alkali feldspars having equal representation. Calcite was rare in samples 47 and 50. All samples contained trace amounts of amphibole and tourmaline. Other accessory minerals identified include glauconite (present in varying amounts from rare to common in samples 99, 313, 50, 47), garnet (traces in samples 99, 576; *Fig. 12*: A), pyroxene (traces in samples 50, 576), kyanite (rare in sample 576; *Fig. 12*: B), and epidote (traces in sample 99). Sample 50 contained trace amounts of microfossils.

Fragments of rocks were predominantly composed of gneiss and, except for sample 576, all samples included frequent to dominant two-mica gneiss grains (*Fig. 12*: C). This specific sample was distinctive for its inclusion of metaquartzite instead of gneiss, although these may represent quartz-rich portions of gneiss. Some gneiss fragments in other samples contained sillimanite (sample 99; *Fig. 12*: D) and kyanite (sample 576). Two samples (47, 50) contained occasional mica schist grains, which could be attributed to mica-rich portions of gneiss. Sample 47 included graphite metaquartzite in rare volume, and chert was identified in trace to scarce amount in two samples (samples 313, 50).

Fabric B

It has been characterised based on two samples (ID 155, 217). Similar to fabric A, this group represented ceramics with a notably clay-rich matrix. The microstructure was unparallel. Non-plastic inclusions were very poorly sorted, exhibiting a bimodal size distribution. The psamitic fraction was less abundant, ranging from 10 to 20 % and resulting in the double or open spacing of grains. The predominant shape of these grains was nearly exclusively equant and varies from subrounded to rounded (*Fig. 11*: B). Pores appeared as vughs and planar features with varying volumes (5–15 %). The firing temperature was

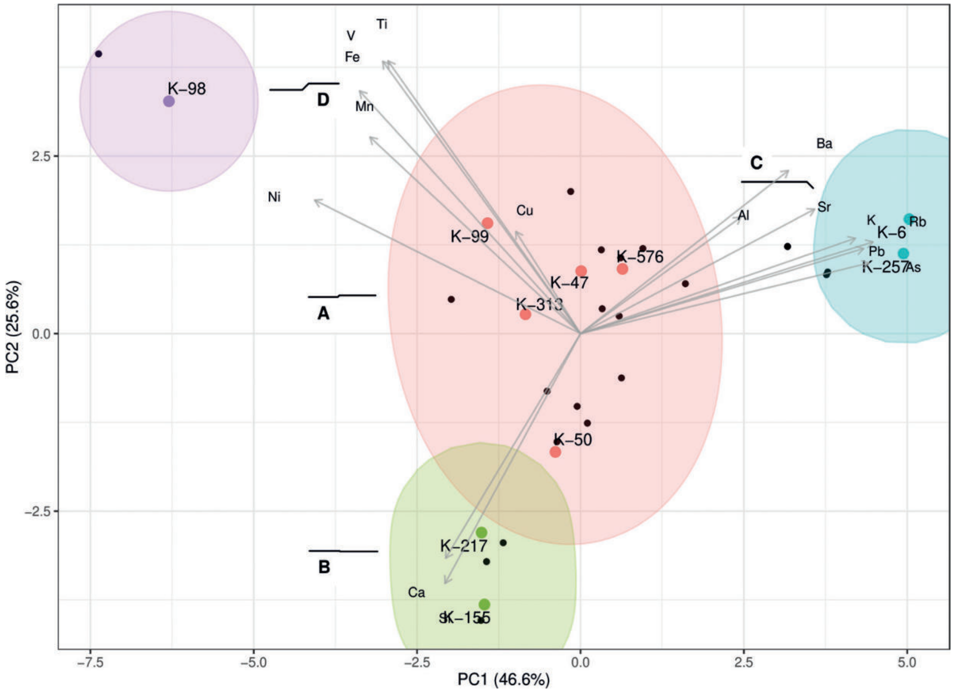


Fig. 10. Principal component analysis showing the relation of fabrics based on their chemical composition.

similar to fabric A, i.e., lower than 700 °C. However, in sample 217, green amphiboles were light brown-green, indicating a slightly higher temperature, possibly around 750 °C. It is considered a threshold after which green amphiboles start transitioning to brown and red hues (*Kiriatzi et al. 2011*; *Quinn 2013*). The matrix of sample 155 contained foraminifera microfossils.

Among the present mineral grains, quartz predominated as frequent to abundant, followed by common muscovite. Muscovite was significantly more abundant than biotite, which was found only in rare amounts. Calcite occurred in occasional to common volumes. Feldspars, both alkali and plagioclases, were present only in rare amounts. However, sample 155 contained common alkali feldspars. Accessory minerals were represented by amphiboles in trace amounts, as well as tourmaline and chlorite (*Fig. 12*: E). Fragments of rocks were not very common. Both samples contained metamorphic rocks in the form of gneiss (occasional in 155, rare in 217) and mica schist (rare in 155). Sample 217 contained chert in rare amounts.

Fabric C

It was represented by samples ID 6 and 257. The group was characterised by a comparable representation of alkali feldspars to quartz, with both minerals being frequent to abundant (*Fig. 11*: C). Another distinctive feature was the presence of frequent biotite flakes. Plagioclases were occasional to common, while muscovite was rare to occasional. In sample 257, common amphibole grains were present, while sample 6 contained only

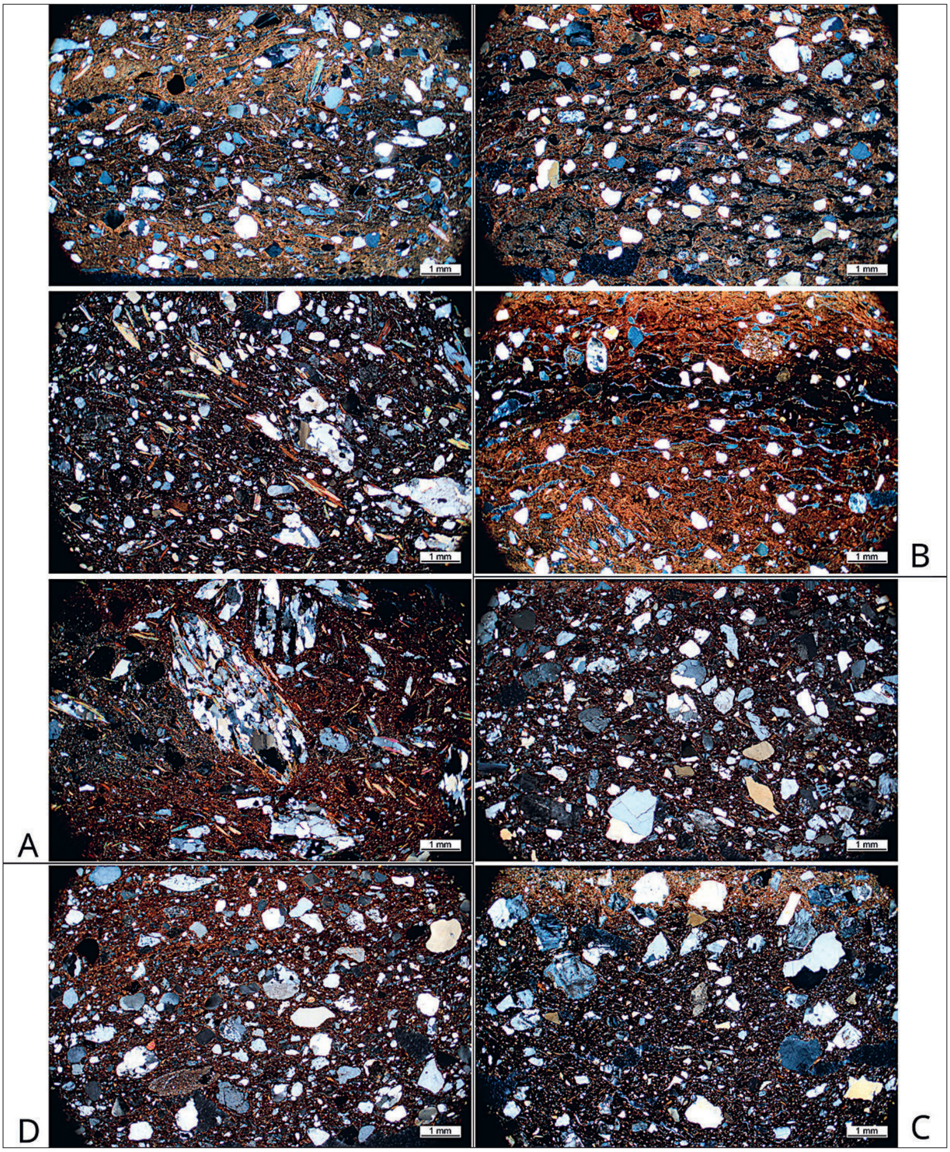


Fig. 11. Photomicrographs of samples demonstrating basic characteristics of each fabric: A – abundance of mica flakes and large fragments of metamorphic rocks in fabric A (IDs from top to bottom: 50, 313, 99); B – rounded quartz grains in fine-grained matrix of fabric B (155, 217); C – alkali-feldspar and quartz dominated temper in fabric C (257, 6); D – sand-tempered (quartz, feldspars among other various rock types) fabric D (98).

rare amounts. Pyroxene was identified in rare quantities only in sample 257 along with trace amounts of tourmaline.

Another specific attribute of this fabric was the abundance of granitoid rock fragments (*Fig. 12*: F). In sample 257, the predominant minerals in these granitoids were quartz,

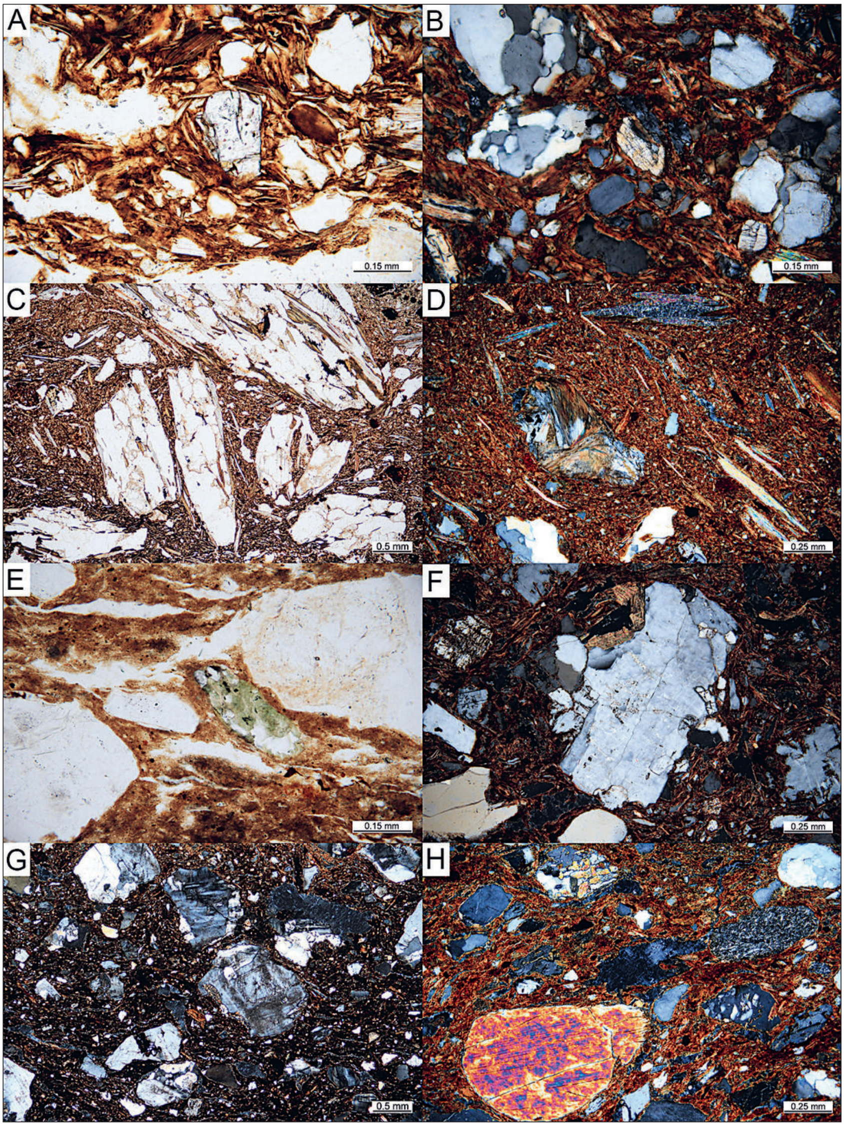


Fig. 12. Photomicrographs of important inclusions: A – colourless garnet grain in mica-rich matrix (ID 576, fabric A); B – kyanite next to polycrystalline quartz, alkali feldspars, and micas (ID 576, fabric A); C – large fragments of two mica gneiss (ID 99, fabric A); D – sillimanite gneiss next to muscovite and biotite flakes (ID 99, fabric A); E – detail of chlorite (ID 155, fabric B); F – biotite granite fragment (ID 6, fabric C); G – alkali feldspar grains (ID 6, fabric C); H – amphibole grain (bottom left) next to accumulation of epidotes (top) and an elongated fragment of unspecified volcanic rock (top right; ID 98, fabric D).

followed by alkali feldspars (*Fig. 12*: G), biotite, and plagioclases in order of their abundance. In contrast, in sample 6, alkali feldspars predominated in these fragments, with quartz being less common, and muscovite was also present. Sample 257 also contained unspecified weathered grain of clastic sedimentary rock.

Fabric D

It was described based on a single sample (ID 98). This sample exhibited a weakly parallel microstructure. Non-plastic inclusions were very poorly sorted, with a bimodal grain size distribution. Aleuritic particles made up 5 % of the volume, while psamitic grains constituted 20 %. These grains were spaced at double intervals and were elongated to equant with a subrounded shape. Pores were predominantly vughs and planar, accounting for 10 % of the sample. Biotite flakes exhibited a medium degree of pleochroism. Green amphibole pleochroism ranged from light green to brownish-green, thus the estimated firing temperature is in the range of 700–800 °C.

The minerals present in the sample included abundant quartz grains, frequent alkali feldspars, common biotite, and rare muscovite (*Fig. 11*: D). Accessory minerals were represented by common amphiboles, occasional epidote, and trace amounts of tourmaline (*Fig. 12*: H). Fragments of various rock types were present in the sample, including clastic sediments, granitoids, metamorphic rocks, and volcanic rocks. Clastic sediments were represented by sandstone with iron-rich cement in occasional amounts. Occasional granitoid fragments consisted of granite, with minerals quartz, alkali feldspars, and plagioclases being the most abundant. Occasional metamorphic rocks included phyllites and an unspecified rock composed of amphiboles, quartz, and pyroxenes. Fragments of unspecified volcanic rocks were rare in the sample.

Discussion

Ceramic fabrics identified in the assemblage varied in percentage and the sorting of inclusions. Certain types of materials were preferred for the production of pottery with traces typical for wheel-made or hand-made ceramics, while other types could be seen as universal variants. Likewise, these categories of pottery differed in surface treatment. For example, wheel-made pottery from fine material often had a highly smoothed (Po2) or polished surface (Po1), while the surface of hand-made pottery was usually just unevenly smoothed (Po3) or roughened. Pottery formed by a combination of both methods evinced similar surface treatment to hand-made pottery but varied in properties of material. The variability of the firing process was also connected with the properties of pottery, including surface treatment.

One of the ceramic categories was particularly pronounced: pottery made from Mat1 with a low proportion (InMn1) and variability of inclusions (InVar1) and with traces typical for wheel-made ceramics, walls thinner than 6 mm, and a dark surface. Its surface was often polished (Po1) or smoothed (Po2). However, none of these attributes were specific only for this group. Furthermore, the assemblage also contained solitary fragments of pottery with traits which were otherwise mutually exclusive. An example of the high variability of the assemblage could be found in the firing process. Certain types of pottery featured the dark surface more frequently and differed in the occurrence of homogeneous, two-layered, and multilayered variants of colouring. However, even the firing of wheel-made pottery from fine material and with a polished or smoothed surface was not completely identical. Likewise, variability existed in the transition of layers of individual colouring types (Vy). This could point to differences in the process of firing.

Results of the macroscopic analysis showed preferences for certain ceramic fabrics and techniques for the production of specific groups of vessels, but it was possible to observe various irregularities. Based on this, we may conclude that the production of pottery was not completely consistent and not always uniformly repeated; not only samples with traces typical for hand-made pottery, but also samples with traces characteristic of wheel-made pottery varied in its attributes. A relatively uniform group was represented by pottery without visible inclusions, which always had a wall thickness up to 6 mm and evinced only traces linked with wheel-made pottery. Still, ceramic specimens in this group differed in surface treatment (4x Po1, 5x Po2, 2x Po3, 2x Po4) and also in the firing process (5x Vy1, 1x Vy2, 1x Vy3, 1x Vy4, 2x Vy5, 2x Vy6).

Compared to ceramics from the previous phases of the Late La Tène period (*Venclová et al. 1998*, 150–151, 166–167; *2008a*, 98–101), fine pottery from Křinec was not uniform in its attributes. Simultaneously, the frequency of pottery made of material without visible inclusions was significantly lower (2.4 %) than, for example, in the assemblage from the oppidum in České Lhotice (32 %) or the settlement in Slepotice (14.8 %) in Eastern Bohemia (*Danielisová 2010*, 67; *Joštová 2020*, 57). The occurrence of pottery with traces characteristic of wheel-made vessels in Křinec did not differ from other settlements from the Late La Tène period in Bohemia (*Venclová 2008b*, 186–187; *Danielisová 2010*, 65–66; *Salač – Kubálek 2015*, 90). However, in the assemblage from Křinec, traces linked with hand-made vessels could be found even on pottery from Mat1 and Mat2. This contrasts with other assemblages from Central and Eastern Bohemia, including the assemblage from Týnec nad Labem, which did not contain hand-made fine pottery (*Thér et al. 2015*, 14; *Thér – Mangel 2024*, 16, 22).

Additional information regarding shaping techniques was obtained by computed tomography. During the macroscopic analysis, three (ID 6, 313, 567) out of six samples had traces typical for wheel-made pottery and two samples (ID 135, 328) had traces linked to a combination of both methods. Nevertheless, computed tomography showed that all six samples were formed by hand, mostly from thick coils transformed by pinching and drawing. This conclusion was supported by optical microscopy as none of the samples exhibited features typical for wheel-thrown pottery and the microstructure was mostly unparallel or lenticular. Also, the mica flakes, a good indicator of particle orientation, showed no systematic orientation. Consequently, it could be assumed that the majority of pottery from Křinec was formed by hand. In general, the computed tomography revealed that macroscopic analysis has only indicative information value for the reconstruction of the shaping process. Nevertheless, statistical analysis showed differences between groups of pottery with distinct traces, which can still be considered as signs of differences in the shaping process.

Similar to various other ceramic assemblages from the Late La Tène period in Central and Eastern Bohemia, the most common type of roughened surface of pottery from Křinec was the grated surface (Po6). Unlike these assemblages, Křinec revealed mainly the pottery with a minimally treated surface (Po3 and Po4), while the polished surface (Po1) was almost absent (*Venclová et al. 1998*, 151, 153; *2008b*, 188, 190; *Danielisová 2010*, 76). In terms of the high frequency of the untreated and low frequency of the polished surface, the assemblage from Křinec was similar to, for example, the pottery from the settlement in Slepotice (*Joštová 2020*, 78–82). Compared to other sites from the Late La Tène period in Central and Eastern Bohemia, pottery from Křinec also differed in the variability of its colouring. Even the group of fine pottery (Mat1, Mat2) did not feature identical colouring (*Beneš et al. 2018*, 204–205; *Thér et al. 2015*, 120; *Joštová 2020*, 58–61).

Comparison of the results of macroscopic analysis and X-ray fluorescence analysis did not show a significant connection between the chemical composition of the ceramic fabric and other attributes of pottery. Differently formed and fired vessels did not necessarily vary in the sources of clay used. The clay source did not differ even between fine (Mat1–Mat2) and coarse pottery (Mat3–Mat5). A similar situation was observed in Eastern Bohemia. However, unlike there, the clay of the pottery from Křinec came from multiple sources (*Thér et al. 2015*, 102–103). Fabric groups varied mainly in the occurrences of surface treatments, specifically the roughened types Po6 and Po7. Observed variance might be related to the distinct provenance of pottery (*Venclová 2008a*, 99–102). Likewise, characteristics of inclusions could be connected with local traditions of pottery production (*Thér et al. 2015*, 133). Fabric groups did not differ in estimated firing temperature. In comparison, pottery from the settlement from the stages LT B2/C1 – D2 in Nitra – Mikov Dvor in Slovakia varied in the firing temperature independently on fabric groups (*Gregor – Březinová 2012*).

Provenance

None of the identified fabrics appear to correspond to the geological setting of the Křinec site located in the Bohemian Cretaceous Basin. The expected petrographic composition of locally produced pottery would primarily include sandstone, siltstone, or marlite grains with quartz as the dominant mineral. Other minerals would be less common, with a significant presence of glauconite among the accessory minerals. It is worth noting that glauconite was exclusively identified in fabric A, but the rest of the petrographic description does not align with local origin. The bimodal distribution of non-plastic components suggests intentional tampering of the ceramic clay. The presence of subrounded grains (except for fabric B, where grains are equant and subrounded-rounded) indicates some degree of transport by natural agents. This could potentially be associated with alluvial sediments.

The samples of fabric A were found to be rich in micas and contained fragments of gneiss, some of which included minerals like kyanite and sillimanite. These minerals are not common and can be diagnostic in terms of provenance. Glauconite, calcite, and microfossils contained in the pottery do not provide any additional aid in the search for material provenance given the fact that they occur naturally in the large region of the Bohemian Cretaceous Basin. However, kyanite and sillimanite are minerals typical for metamorphosed aluminum-rich pelitic rocks such as gneiss. They can also occur in pegmatites. Regarding the possible sources of these rocks, the two closest regions can be considered. The first is the Kutná Hora Crystalline Complex situated 25 km to the south and southwest. The second are the metamorphosed Proterozoic rocks of the Iron Mountains approximately 30 km to the southeast.

The Kutná Hora Crystalline Complex forms the bedrock in the strip from Plaňany in the northwest to Kolín in the southeast. Migmatites belonging to this complex contain muscovite, biotite, sillimanite, garnet, and kyanite. Unconsolidated sediments of river terraces in the form of sand and gravel from the lower Pleistocene in the vicinity of Dobřichov and Cerhenice and it has been confirmed that they contain a significant proportion of gneiss, phyllites, and granitoids. The heavy mineral fraction in these sediments includes not only common minerals but also garnet and green amphiboles (*Adamovič et al. 1993*). Several settlements from the Late La Tène period are known from this area and its surroundings, including the site in Cerhýnky (*Fig. 2*: 4; *Fig. 3*: 4), where a pottery kiln was found

(*Rybová 1968*, 9–10; *Waldhauser 2001*, 173). La Tène pottery kilns were also excavated west of Kolín (*Malyková 2014*) in Štítary u Kolína (*Fig. 2*: 5; *Fig. 3*: 5).

As mentioned above, the second possible source could be the metamorphosed rocks of the Chvaletice Proterozoic in the Iron Mountains region. These rocks have a similar mica content, and they also include garnet and kyanite (*Fediuk 1981*). However, there is no documented occurrence of sillimanite in them. Sillimanite could have been part of the fluvial sands of the Doubrava River and its tributaries. The site of Týnec nad Labem represents a prominent settlement within the area (*Fig. 2*: 2; *Fig. 3*: 2).

The petrography of fabric B is less specific compared to the previous group, but it can be generally characterised as similar to fabric A in terms of the increased content of muscovite and the presence of metamorphic rocks. Additionally, it contains chlorite and slightly more calcite. Nevertheless, the origin of the raw material, especially the temper, could be associated with the suggested sources.

Fabric C is defined by a significant content of alkali feldspars and biotite, which are derived from granitoids where these two rock-forming minerals (along with quartz) prevail over others. This description aligns with the granites of the Chvaletice Massif, which constitute the magmatic core of the Iron Mountains region (*Beneš et al. 1963*). The nearest occurrence of these granites is located less than 30 km southeast of the studied site. Another possible source could be the Říčany Granite of the Central Bohemian Pluton, which is situated 35 km to the southeast (*Janoušek et al. 2014*).

Fabric D differs from the others in its higher content of epidote and amphiboles. It is characterised by a notable frequency of alkali feldspar grains and an increased portion of plagioclases. Biotite predominates over muscovite. This mineral assemblage could also correspond to the magmatic rocks of the Chvaletice Massif, which include not only granites but also gabbro. The presence of epidote indicates a certain degree of metamorphism. Therefore, the source rocks for this fabric could combine gabbro, possibly granites, and metamorphic rocks of the Chvaletice Proterozoic.

Distribution of materials used as a temper over greater distances was also documented in Eastern Bohemia (*Thér et al. 2015*, 103–111). In comparison, the ceramic clay used in Nitra – Mikov Dvor mostly originated in the area surrounding the settlement (*Gregor – Březinová 2012*).

Conclusions

In general, pottery from Křinec was partially similar (for example in surface treatment) to assemblages from the previous phases of the Late La Tène period in Central and Eastern Bohemia. However, it differed in the higher variability of its properties. Even the group of pottery made from fine material was not homogeneous and varied, for example, in the process of firing. Considering these results, pottery in the assemblage from Křinec could originate from several sites, which differed in the production of pottery. Simultaneously, none of the fabrics were specific only for a certain category of ceramic vessels. The acquired data point to the possibility that at the end of the La Tène period contacts between settlements in the region included the transportation of ceramic vessels or raw material, but potters from different communities did not share knowledge about pottery production. However, to confirm or reject this hypothesis, it would be necessary to examine more local assemblages from the Late La Tène period.

The ceramic materials from the Křinec settlement, embedded in the Bohemian Cretaceous Basin, show no geological alignment with the local setting, hinting at a non-local origin. The study reveals distinct characteristics in the ceramic fabrics (A, B, C, and D). Fabric A, with gneiss containing kyanite and sillimanite, likely originates from the Kutná Hora Crystalline Complex or the metamorphosed Proterozoic rocks of the Iron Mountains. Fabric B is similar to A but varies in mineral mix. Fabric C is composed of alkali feldspars and biotite, which suggests a source in the granites of the Chvaletice Massif or the Říčany Granite. Fabric D, with content of epidote and amphibole, points to a composite origin from gabbro, granites, and metamorphic rocks of the Chvaletice Proterozoic. All proposed sources located no closer than 25 km from the studied site are indicators of a socio-economic network with a potential centre in Týnec nad Labem or near Kolín.

The pottery from Křinec should be compared with Late La Tène assemblages from other parts of Bohemia in order to obtain data on regional differences in production and distribution of pottery during this period.

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RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Ceramic technology evolution at the beginning of the Roman Period: Case study of the Mlékojedy settlement site (Central Bohemia)

Vývoj technologie výroby keramiky na počátku doby římské: Případová studie ze sídliště v Mlékojedech (střední Čechy)

Zdeněk Beneš – Karel Slavíček – Dalibor Všianský

This exploratory archaeometric study investigates pottery from a Großromstedt culture associated with a significant migratory wave from the north into the Bohemian Basin at the transition from the Late La Tène to the Roman periods. The analysis of ceramics from the Mlékojedy settlement reveals evidence of technological discontinuity in two key chronological transitions. The first and more significant transition between the Late La Tène period and the Early Roman period (LT D/R A) is characterised by a change in the pottery forming method, with a turn away from the use of the potter's wheel. New pottery shapes and a new range of ornamentation are also introduced in this period, potentially indicating cultural import or/and population migration. However, the technological changes in pottery production were not absolute, as certain processes persisted. The second technological discontinuity was found between phases R A and R B1 of the Roman period. It appears as a natural evolution of the ceramic technology, which was accelerated by the social changes. The findings suggest that the vast majority of pottery could have been produced from local sources.

Early Roman period – Late La Tène period – XRF – XRD – ceramic petrography

Tato průzkumná archeometrická studie zkoumá keramiku spojenou s významnou migrační vlnou ze severu do české kotliny na přelomu pozdní doby laténské a doby římské. Analýza keramiky ze sídliště Mlékojedy odhaluje doklady technologické diskontinuity ve dvou klíčových chronologických přechodech. K prvnímu a významnějšímu dochází mezi pozdní dobou laténskou a mladší dobou římskou (LT D/R A). Vyznačuje se změnou způsobu formování keramiky a odklonem od používání hrnčířského kruhu. V tomto období se také prosazují nové tvary keramiky a nová škála ornamentů, které mohou naznačovat kulturní import či/a migraci obyvatelstva. Technologické změny v hrnčířské výrobě však nebyly absolutní, neboť určité procesy přetrvávaly z předcházejícího období. Druhá technologická diskontinuita byla zjištěna mezi fázemi R A a R B1 doby římské. Vyznačuje se přirozeným vývojem keramické technologie, který byl pravděpodobně urychlen společenskými změnami ovlivněnými kontaktem s římsko-provinciální kulturou. Nálezy naznačují, že naprostá většina keramiky mohla být vyrobena z místních zdrojů.

mladší doba římská – pozdní doba laténská – XRF – XRD – keramická petrografie

Introduction

During the 1st century BC and at the beginning of the Christian era, Central Europe underwent significant changes. In Bohemia, they were manifested by the abandonment of the Celtic oppida and a distinctive modification of the cultural environment. This is traditionally explained by the arrival of a new population – the *Germani*, represented by the remnants of the Großromstedt culture. The study of this complex phenomenon, which affected

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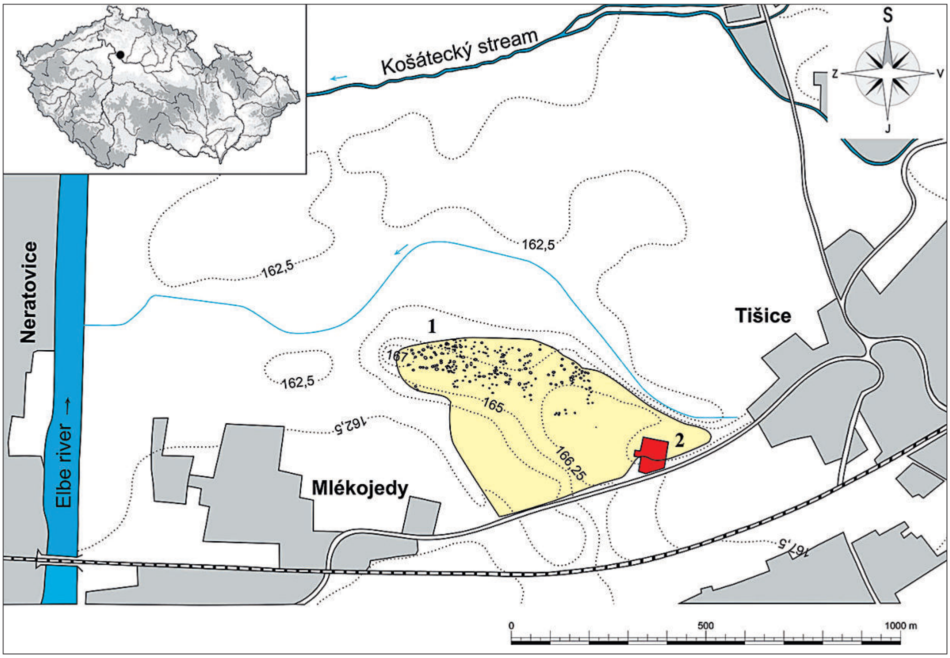

Fig. 1. Location of Mlékojedy site on the map of the Czech Republic and position of the settlement in Mlékojedy (no. 1) and burial ground in Tišice (no. 2). Yellow colouring indicates an area excavated by a sand pit.

ethnic changes, settlement structure, burial rites, and economy, has a long tradition and can be addressed in different ways. One possible approach is to follow a particular economic aspect in a given territory at a given period, such as agriculture (*Kreuz 2005*) or metallurgy of non-ferrous metals (*Bursák et al. 2022*). In this text, we will focus on pottery production.

Our source of information is the extensive material record of the Early Roman period settlement site at Mlékojedy, Central Bohemia (*Fig. 1*). It was excavated in the years 1972–1976 by K. Motyková and it was uncovered almost in the full extent due to a gradually expanding sand quarry at the site. Settlement size and dating from roughly the mid- 1st century BC (R A) to the mid-1st century AD (R B1) is a good illustration of the beginning of the culture of the Roman period (for the most recent information about the site, see *Beneš 2021*). The dating of the Mlékojedy settlement site is based on small metal finds, mainly brooches and pins, as well as on pottery (*Droberjar 2008*, 100–102; *Beneš 2021*, 15–21). However, small amount of the Late La Tène period pottery were found as intrusions in R A and R B1 features.

Just 150 m away from the settlement, burial ground of Tišice was excavated in 1953 and 1954. It was dated into the same time (*Motyková-Šneidrová 1963*) and apparently belonged to the settlement. Mlékojedy together with Tišice thus represent a unique situation where both settlement and burial ground belonging to the same community were explored.

This paper addresses socio-economic development in Bohemia at the beginning of the Roman Period using a case study of pottery from the Mlékojedy site and employing a combination of the traditional archaeological type-chronological and archaeometric analyses. At the beginning of the research, four specific questions were developed.

1) What was the typological and technological relationship between pottery fragments of the Late La Tène cultural tradition (wheel-made pottery fragments, graphite pottery, etc.) and pottery of the Großromstedt culture of the Roman Period?

2) Did domestic pottery from phases A and B1 of the Early Roman period undergo any technological development that is generally reflected in the typological development of pottery shapes and decoration?

3) Would it be possible to identify such pieces among the analysed pottery from the Early Roman Period which were not produced on the same site as the rest?

4) Can pottery shapes that seem to be typologically alien be designated as imports?

Archaeological and historical context

At the beginning of the 1st century BC, i.e. during the Late La Tène Period, specifically LT D1 relative chronological phase[1], the vast majority of Bohemia (except for its northernmost parts) was occupied by the people of the La Tène culture (*Danielisová 2020*, Fig. 18). At that time, the La Tène 'civilization' was already going through its final, so-called oppida phase. It was characterised by the emergence of large, fortified settlements that gradually took on the features of primitive urban agglomerations. The latest finds associated with the existence of oppida in Bohemia can be placed at the turn of the 3rd and 4th quarter of the 1st century BC (*Rybová – Drda 1994*, 130–132; *Militký 2015*, 168–169). The potential presence of individuals or groups of Germanic origin (i.e. those with a cultural background corresponding to the Jastorf, Przeworsk, and Oksywie cultures) in the Bohemian oppida environment in LT D1 phase has so far only been discussed in the case of northern peripheral regions (*Droberjar 2006a*, 16–22; *Beneš et al. 2017*, 41–45). However, from the growing evidence of contacts with the cultures in the northern half of Central Europe (e.g. *Vích 2017*, 658, Fig. 18), we can hypothesise that long-term contacts (commercial, political, even some sort of peripheral colonisation) between the bearers of these so-called 'Germanic' cultures and the population of La Tène Bohemia existed.

The cultural situation in Bohemia only changed significantly around the middle of the 1st BC with a new wave of settlers who represented the Elbe-Germanic Großromstedt culture. Its material record has already been sufficiently described (e.g. *Peschel 1978*, 72–118; *Droberjar 2006a*). Without any doubt, there was a strong cultural connection between Bohemia and the Main River region (*Steidl 2004*; *Frank 2009*). This Elbe-Germanic Großromstedt culture is assumed to have spread from the German Central Uplands and reached Bohemia during the late oppida phase at the earliest (*Droberjar 2006a*; *Danielisová 2020*, 142–144). The relationship between the Großromstedt culture and the Late La Tène population of Bohemia is attested by several pieces of evidence, including intrusions of La Tène pottery in later contexts, and even imitations of La Tène pottery with the 'new Großromstedt' technology, i.e. without the use of the potter's wheel or graphite (*Beneš et al. 2017*).

[1] According to a concept of periodisation which was used by *Danielisová* (*2020*, Table 2, Fig. 2).

Bearers of the Großromstedt culture established unfortified flatland settlements in Bohemia, especially in the fertile northern half of the country in the traditionally settled regions (*Droberjar 2006a*, 28, 64–76). These 'first Germanic people' also brought a change in the burial rite by establishing necropolises consisting of cremation graves. The ashes were placed either in urns or pit graves. At several continuously investigated sites, such graves represent the initial phase of burials that lasted until the end of the 2nd century AD (e.g. *Droberjar 1999*). The incorporation of Bohemia into the large Elbe-Germanic circle of the Großromstedt culture created a new, large cultural block in the middle of Europe which was considered 'Germanic' by Roman authors writing at the turn of the Christian era (*Burmeister 2020*).

Shortly before the turn of the Christian era, the material culture of the entire Großromstedt area developed into the R B1 phase of the Roman Period, which is usually dated to ca. 10 BC to 50 AD (*Droberjar 2006b*). In spite of contemporary efforts to free archaeological analysis from the influence of written sources, these changes are traditionally interpreted as a consequence of historical events, which are well-documented in the works of authors such as Strabo (*Geografika* VII 1,3: *Radt ed. 2003*), Velleius Paterculus (*Historia Romana* II, 108–110: *Mouchová ed. 2013*), P. C. Tacitus (*Annalen* II, 26, 44–46, 62–63: *Minařík – Hartmann eds. 1975*). According to them, Bohemia can be considered the centre of the so-called Maroboduus Empire (e.g. *Salač 2021*). The rapid development of the social structure of the population inhabiting Bohemia during the first decades of the first century AD is proven by rich burials excavated in cemeteries established during the previous chronological phase R A (e.g. Stehelčeves, Tišice, Třebusice, Tvršice), the cemeteries newly founded in R B1 (Dobřichov-Pičhora), but also from isolated burials (*Droberjar 2006b*, 682–695). In addition to cremation graves, inhumations also began to appear in Bohemia (as well as in the Elbe-Germanic circle, see *Lichardus 1984*). Archaeological and historical sources show that this short period lasting roughly two to three decades marked a cultural and political upswing for the territory of Bohemia. It is archaeologically detectable thanks to an influx of cultural elements from various parts of Europe. The significant number of Roman objects, particularly Italian bronze and silver toreutics, imported in Bohemia mainly during the R B1a phase stands out compared to the rest of Central Europe where such imports are sparse (e.g. *Droberjar 2007*, 55–56). There is also evidence of a significant influx of antique brass, probably originating from the Massif Central in today's France, demonstrating increased contact with the Roman Empire (*Bursák et al. 2022*). From a historical point of view, this is also supported by the attention paid to mutual Romano-barbarian relations by Roman written sources (e.g. *Kehne 2009*).

The settlement site of Mlékojedy (and the adjacent burial ground in Tišice), from which all the samples examined in this study originate, are a good representation of the beginning of the Roman period in Bohemia. Although few the Late La Tène potsherds have been found in some of the later features, no permanent component of this culture has been documented and excavated there. Two cultural reversals could be observed at the site and thus reflect the usual situation in Central Bohemia. At the time of its foundation in LT D2/R A (i.e. in ca. 50–30 BC), there was the first important reversal – the arrival of the Großromstedt culture. This change is supposed to have been caused by the collapse of the economy of the La Tène culture and the immigration of a new, technologically less advanced population. The second turning point is the social transition taking place between phases R A and R B1 (i.e. around ca. 10 BC). In Bohemia, this is mainly apparent in the funerary con-

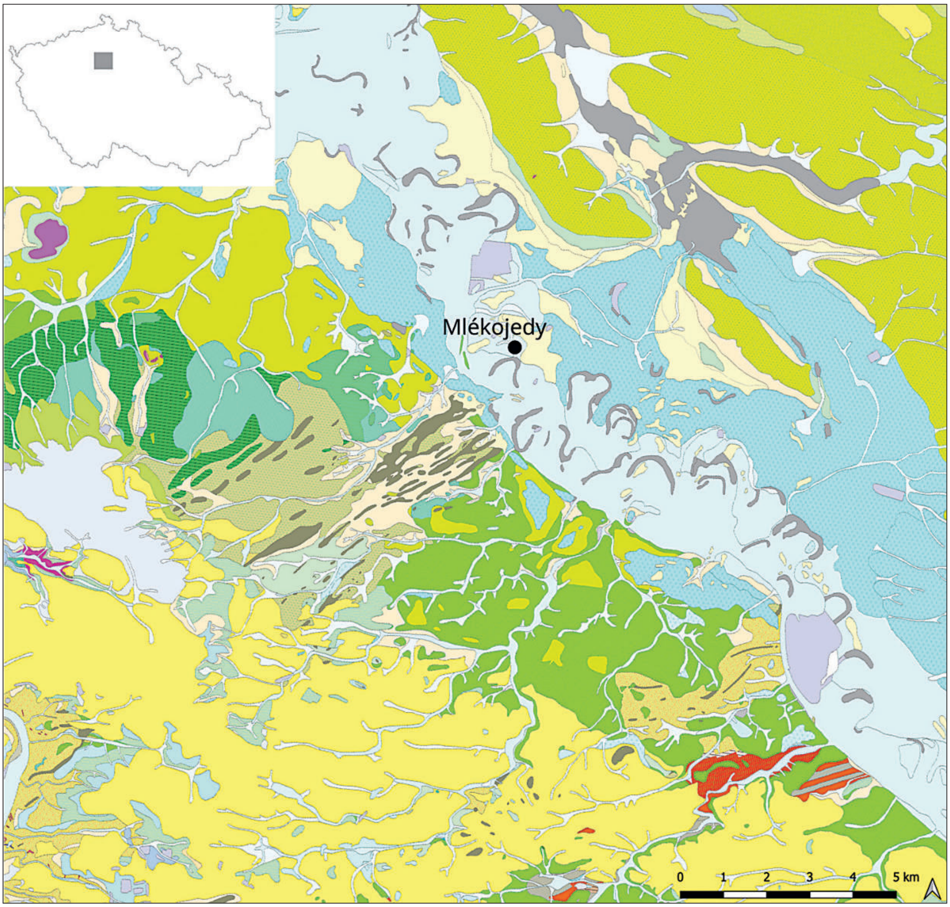

Fig. 2A. Location of Mlékojedy settlement on the geological map of the vicinity (after Czech geological survey 2023, modified).

text by the emergence of truly rich burials of both women and men equipped with a considerable number of Roman imports. It is usually explained by the arrival of a new group of settlers of the *Marcomanni* tribe under the leadership of Maroboduus from the west (*Droberjar 2006a*, 602–604). It remains a question to what extent this change was also manifested in the settlements of this culture, as topic has not been studied yet.

Geological setting

The geological setting of the study site was described in a geological report created by *Losert* (*1993*) as an annexe to the excavation report. The Mlékojedy settlement site is located on a former alluvial terrace of the Elbe River (*Fig. 2*) formed of sand and gravel. According to the pebbles analysis, the terrace consists dominantly of quartz with metamorphic, intrusive, and sedimentary rocks. The metamorphic rocks, principally gneiss,

Fig. 2B. Legend of geological map (after Czech geological survey 2023, modified).

orthogneiss, migmatite, and metabasite, come from the Krkonoše-Jizera and Kutná Hora crystalline complexes, and partly also from the region of the Iron Mountains. The intrusive rocks, namely granitised basalt, come from the nearby Neratovice complex, and the sedimentary rocks are siltstones, sandstones, and agglomerates of Permian and Mesozoic.

The bedrock of the Quaternary alluvium outcrops in the close vicinity of the settlement in several places; the closest outcrops are located in the riverbed of the Elbe River. They are formed of intermediate and basic igneous rocks, such as granodiorite, monzonite, diorite to gabbro, and granites. Igneous rocks are part of the Neratovice complex which outcrops in the town of Neratovice (located across the Elbe River from Mlékojedy) and further to the southwest.

However, the major part of the bedrock is formed by the Barrandian Proterozoic flinty shale, greywacke, and graphitic shales which outcrop up to seven kilometres to the southwest. Volcanic rocks are present in this series as spilites and veins of diorites. Coatings of iron-bearing minerals (hematite and limonite) are abundant on dislocations of disrupted

Proterozoic rocks. Ordovician shales and quartzites outcrop ca. 13 km to the south up the stream at Brandýs nad Labem or even little further to the west in the profile of the Vltava River where named sediments are accompanied with carboniferous clastic sedimentary rocks.

The largest part of the surroundings of the site of Mlékojedy is formed by Cretaceous sediments, which are covered by Quaternary alluvium of the Elbe River in the settlement's vicinity. The closest outcrops used to be located in the riverbed of the Elbe River right between Mlékojedy and Neratovice, but these have been removed along with the modern river flow regulation works. Given the fact that Mlékojedy is located in the Bohemian Cretaceous Platform, the Mesozoic sediments span tens of kilometres from the site. The sediments are represented by sandstone with a variable content of calcite, agglomerates, sandy limestones, shales, claystone, and marlite.

Tertiary rocks in the area are present only as small and isolated volcanic funnels, which are related to the Central Bohemian Uplands volcanic complex located ca. 40 km northwest. Local development of thermally altered rocks in contact with active volcanism is typical for Tertiary volcanic activity in the Bohemian Massif (forming hardened rocks such as porcelanite). Volcanic rocks are represented mostly by nephelinite and basaltoid.

Material and chronology

A total of 321 settlement features have been examined during the rescue excavations in Mlékojedy. Of these, 28 were dated to the Eneolithic, and one feature (a sunken hut) was dated to the Early La Tène period. The rest belongs to the Early Roman period. With approximately 20 thousand potsherds, it is among the largest settlement sites from the Roman period excavated in Bohemia. The burial ground in Tišice, which is believed to have served as the final resting place of the inhabitants, was key to the dating of the settlement in Mlékojedy. K. Motyková divided this burial ground into two chronological groups, primarily on the basis of brooches (*Motyková-Šneidrová 1963*, 429, Fig. 48). Later, other researchers succeeded in distinguishing a total of three phases (*Lichardus 1984*, Abb. 2–3; *Völling 2005*, 16–17), which are synchronous with general phases of Roman period: A, B1a, and B1b. A comparison of the settlement in Mlékojedy and the burial ground in Tišice will always be a comparison of two qualitatively different components. For chronological comparison, it was appropriate to use brooches at the beginning of processing. Compared to 51 specimens from Tišice, only six pieces were found in the settlement site Mlékojedy. If we were to arrange ourselves according to relative chronology, then two pieces come from phase A and the remaining four fibulae belong to phase B1 (*Beneš 2021*).

From the processed and evaluated sets of potsherds from the Mlékojedy settlement, 60 pottery samples were chosen (*Tab. 1*). They usually come from features rich in finds – usually sunken huts – which enable more reliable dating. The fragments were already visually described, analysed, and dated. Only the fragments dated indisputably were used in this study: 48 samples come from the early (R A) or later (R B1) phases of the Roman period, and 12 samples from the Late La Tène culture. The latter were visually identified by marks of rotational movement during vessel forming or typological attributes.

A subdivision was further made within the Roman period group. Two subgroups were defined, namely the tableware (fine) and cookware (coarse). The definition was based on the fineness of the ceramic matter visible in the fracture (the real or apparent absence of

Sample ID	Inv. no.	Feature	Chronology	Tech Group	XRF	Petrography	XRD
1	497.179	57	Late LT		+		
2	469.853	89	Late LT		+	+	+
3	469.854	89	Late LT		+	+	+
4	496.463	105	Late LT		+	+	
5	LT01	164	Late LT		+	+	+
6	LT02	167	Late LT		+		
7	ML63/6/1	I/63	Late LT		+		
8	LT03	200	Late LT		+		
9	469.874	102	Late LT		+		
10	469.832	50	Late LT		+	+	
11	LT05	174	Late LT		+	+	
12	LT04	170	Late LT		+		
13	497.181	57	R A	tableware	+		
14	466.668	76	R A	tableware	+	+	
15	466.683	76	R A	tableware	+		
16	467.684	84	R A	tableware	+	+	
17	497.825	141	R A	tableware	+		
18	497.901	141	R A	tableware	+	+	+
19	499.096	157	R A	tableware	+		
20	499.312	157	R A	tableware	+	+	+
21	500.427	172	R A	tableware	+	+	+
22	500.456	172	R A	tableware	+	+	
23	501.650	203	R A	tableware	+		
24	501.581	203	R A	tableware	+		
25	497.176	57	R A	cookware	+		
26	467.016	76	R A	cookware	+		
27	467.771	84	R A	cookware	+	+	
28	469.423	99	R A	cookware	+	+	+
29	497.816	141	R A	cookware	+	+	
30	498.172	141	R A	cookware	+		
31	499.217	152	R A	cookware	+		
32	499.227	152	R A	cookware	+	+	
33	499.132	157	R A	cookware	+	+	
34	500.473	172	R A	cookware	+		
35	501.569	203	R A	cookware	+	+	
36	501.599	203	R A	cookware	+		
37	63/1/1,11,12	I/63	R B1	tableware	+	+	
38	464.725	8	R B1	tableware	+		
39	465.097	32	R B1	tableware	+	+	
40	496.722	38	R B1	tableware	+	+	
41	465.716	43	R B1	tableware	+		
42	497.110	50	R A	tableware	+		
43	466.572	75	R B1	tableware	+	+	+
44	468.884a	87	R B1	tableware	+		
45	495.530	105	R B1	tableware	+	+	
46	496.195	117	R B1	tableware	+		
47	500.802	174	R B1	tableware	+		
48	501.339	200	R B1	tableware	+	+	
49	63/1/13	I/63	R B1	cookware	+	+	
50	464.932b	8	R B1	cookware	+	+	
51	465.098	32	R B1	cookware	+		
52	465.557	38	R B1	cookware	+		
53	465.597	43	R B1	cookware	+		
54	466.011	50	R B1	cookware	+	+	
55	467.072	75	R B1	cookware	+	+	
56	496.442	105	R B1	cookware	+		
57	496.140	117	R B1	cookware	+		
58	498.391	140	R B1	cookware	+		
59	500.506	171	R B1	cookware	+	+	+
60	500.758	174	R B1	cookware	+	+	+

Tab. 1. List of analysed samples including inventory number, feature number, cultural/chronological affiliation, typological determination of shape/decoration.

a temper), the surface treatment, and the sherd's thickness. Tableware is mostly distinguished from cookware by thorough surface treatment, which often includes polishing to achieve a metallic lustre and firing in a reducing atmosphere. Another attribute, although not primary and not always observed, is the use of finer temper or its (seeming?) absence. Tableware usually consists of more gracile thin-walled shapes. Some selected potsherds are relatively easy to date typologically, especially the characteristic tableware. On the contrary, dating of certain cookware shapes is limited. In such cases, a link to a well-dated feature was important.

Pottery fragments of La Tène tradition

La Tène fragments represent a cultural intrusion at the settlement site, since no Late La Tène features have been excavated at the site and it is not probable that there had been any. Fragments of the Late La Tène pottery occur relatively often at other sites dated to the R A phase. The main hypothesis explaining their presence in later assemblages is generally that the site might have been used for various (but mostly residential) purposes during earlier periods (not necessarily continuously). In the case of Mlékojedy, this can be ruled out. The area of the gentle hillside was thoroughly investigated, except for its eastern edge, and no Late La Tène settlement activity was detected (*Beneš 2021*, 21–27). The revision of the archaeological material from the site has not been completed yet, but 62 wheel-thrown or wheel-finished potsherds are already known from the site and seem to be scattered evenly throughout the entire settlement area. These sherds represent only 0.4% of the total number of recorded pottery fragments; such amount is considered negligible. Actually, similar percentages were observed at other Early Roman sites (e.g. Zwenkau-Nord: *Kretschmer 2019*, 104–105).

Not all such fragments from Mlékojedy can be reliably dated to the La Tène Period, as they are often small atypical pieces. A Late La Tène date and cultural affiliation can only be considered unquestionable in a few cases (*Fig. 3*). However, other atypical fragments can perhaps be dated to the same period, i.e. to LT C–D, based on the structure of the ceramic material and the characteristic firing pattern. Fragments of wheel-made pottery were found in features dated both to the earlier (R A) and later phase (R B1) of the Mlékojedy settlement. They thus represent either intrusions that got into the objects of the Roman period by accident (such as intrusions from the topsoil), or they were part of the material culture both in phase R A as well as in the later phase R B1. However, this would mean a serious rethinking of our perception of the so-called legacy of the Late La Tène culture in the Roman period (cf. *Salač 2011a*) meaning that at least in some regions and perhaps even individual settlements, the wheel-made pottery of the Late La Tène tradition could still be produced even in the R A phase.

Due to a high degree of fragmentation, only a few pieces from the Mlékojedy wheel-made pottery assemblage can be identified more closely. First, there is the remnant of a vase-shaped vessel from feature 57 (*Fig. 3*: 1). It is a type often encountered in major cemeteries of the Early Roman Period of phase R B1 (e.g. Großromstedt, Schkopau, Třebusice or Dobřichov-Pičhora), but also in graves of the South Bavarian group, which was strongly influenced by the Central German environment (*Droberjar 1999*, 3–40; *2006a*, 42–45, Fig. 17–18; *Salač 2011b*). Based on these wheel-made models, handmade imitations may have been produced in a purely 'Germanic' fashion (*Rieckhoff 1995*, 163; *Salač 2011b*,

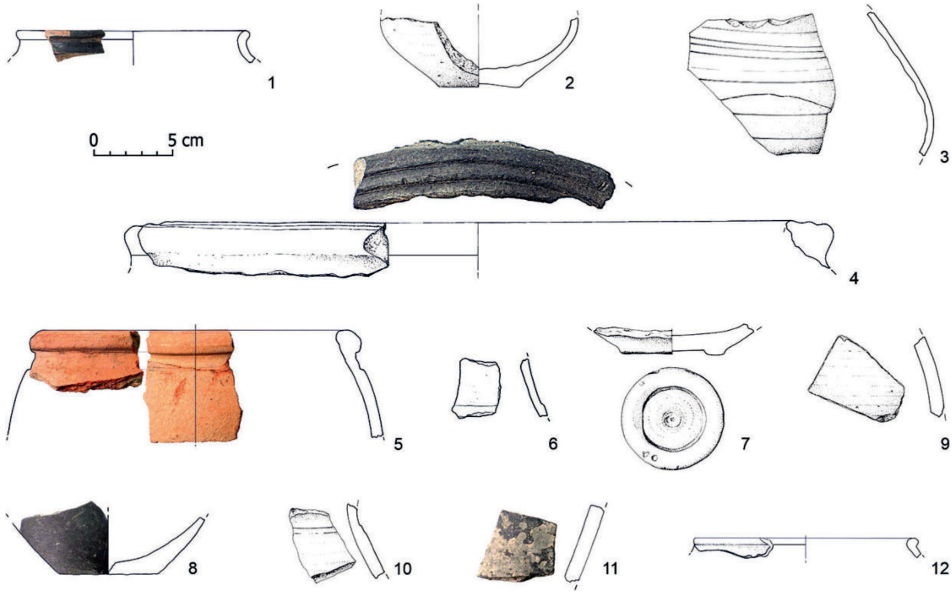

Fig. 3. Fragments of analysed La Tène vessels. Descriptive numbers match with the numbers in *Tab. 1*.

Abb. 1). A large fragment of shoulders and a bottom of a fine clay vessel is decorated with regularly spaced horizontal grooves (*Fig. 3*: 3). Coarse pottery is represented by the rim and shoulders of a barrel-shaped vessel with a finely roughened bulge from feature 164 (*Fig. 3*: 5), which can be dated to the LT C2–D1 horizon (*Venclová 1998*, 161–167). The rim of a storage vessel (ruff collar) with horizontal circumferential grooves on the outer side, which was excavated in the feature 105 (*Fig. 3*: 4), also differs from the common assortment of local pottery at Mlékojedy. It probably does not come from a wheel-thrown vessel, although it is not clear whether technological traces of wheel-throwing or wheel-finishing would be visible on a rim. However, analogous wheel-made finds are known from Bratislava-Devín hilltop and belong to the final phase of the Late La Tène occupation of the site, which was dated by a fragment of an A 18 type fibula (*Pieta 2008*, 182, Fig. 88: 9–11).

Pottery fragments from phase R A

Pottery fragments from vessels originate from features dating back to an earlier phase of the Mlékojedy settlement (n=25). Petrographic thin sections were made from six tableware and six cookware samples. XRD analysis was always carried out on a pair of samples from the first and second group.

Tableware

A typical vessel shape of the R A phase (Großromstedt culture) is the so-called Plaňany beaker (*scharfkantige Situle*; *Droberjar 2006a*, 25; *Peschel 2017*, 28–34; *Kretschmer 2019*, 68–75). According to preliminary typological observations, the occurrence of this vessel type can be mainly associated with the Saxon-Thuringian area, Bohemia, and the Main

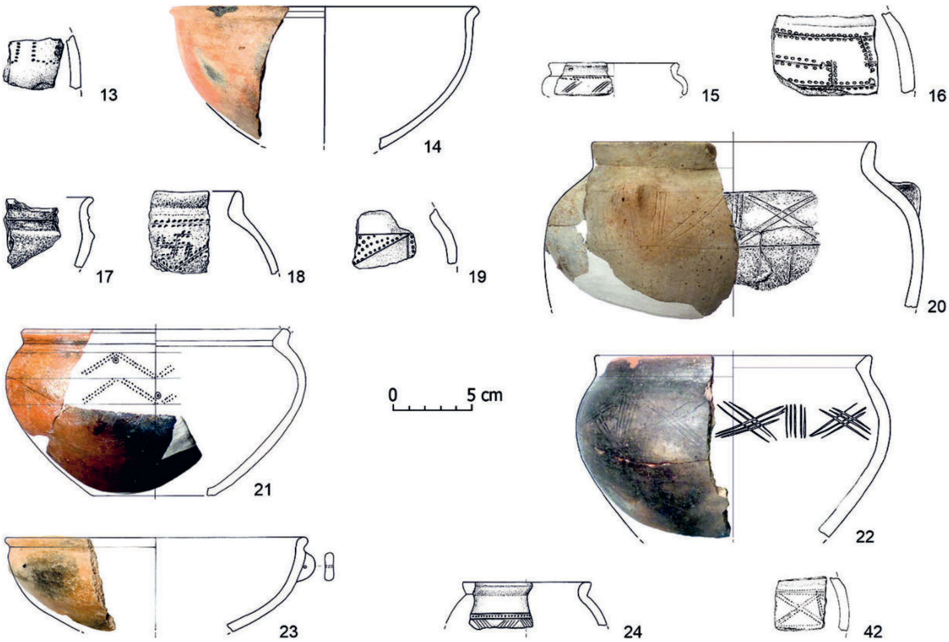

Fig. 4. Fragments of analysed R A tableware vessels. Descriptive numbers match with the numbers in *Tab. 1*.

River region (e.g. *Peschel 1978*, 74–77). A good example illustrating the representation of these beakers is the Schkopau burial ground, where they constitute up to 60% of all ceramic vessels (*Schmidt – Nitzschke 1989*, 23–25). A Plaňany beaker from Mlékojedy was decorated with a thin groove and oval puncture marks (*Fig. 4*: 15). Another shapes represented among the samples (*Fig. 4*: 21, 22) are the so-called unsegmented terrines, i.e. deep bowls with a short, sharply turned-out rim, which is often faceted (*Droberjar 2006b*, 617, Fig. 11). Chronologically speaking, this is a long-lasting shape used from phase R A to the 1st century AD (*Leube 1978*, 24–26; *Droberjar 1999*, 46–48; *Lenz-Bernhard 2002*, 65, Abb. 41–42; *Kretschmer 2019*, 86–87). A typical attribute, present both on tableware and, in a coarser form, also on cookware, is the faceting of rims (*Fig. 4:* 21, 22, 25, 26, 29, 33). Actually, pottery from this horizon of the Großromstedt culture is most easily recognisable on the basis of tableware decoration. These are simple geometric motifs which were often used during later stages and feature characteristic elements (e.g. *Jílek et al. 2015*, 49–51, Figs. 3–4; *Kretschmer 2019*, Abb. 54): fine grooves (*Fig. 4*: 15, 20, 22, 24), a band filled with puncture marks (*Fig. 4*: 24), lines of puncture marks along a fine groove (*Fig. 4*: 16, 18), fields filled with puncture marks (*Fig. 4*: 19), and also loosely executed lines of puncture marks (*Fig. 4*: 13, 21). As early as during this period, the first use of the so-called tracing wheels (cogged-wheel decoration) or stamps (*Fig. 4*: 42) is assumed (*Schmidt – Nitzschke 1989*, 23–25; *Droberjar 2008*, 104–106). The fact that this kind of decoration also occurred in features dated to the later phase (R B1) causes a problem. It cannot be distinguished whether it testifies to an intrusion (since such decoration on fine pottery is, generally speaking, quite rare even in features dating from phase R A) or a longer use of this element in the pottery production.

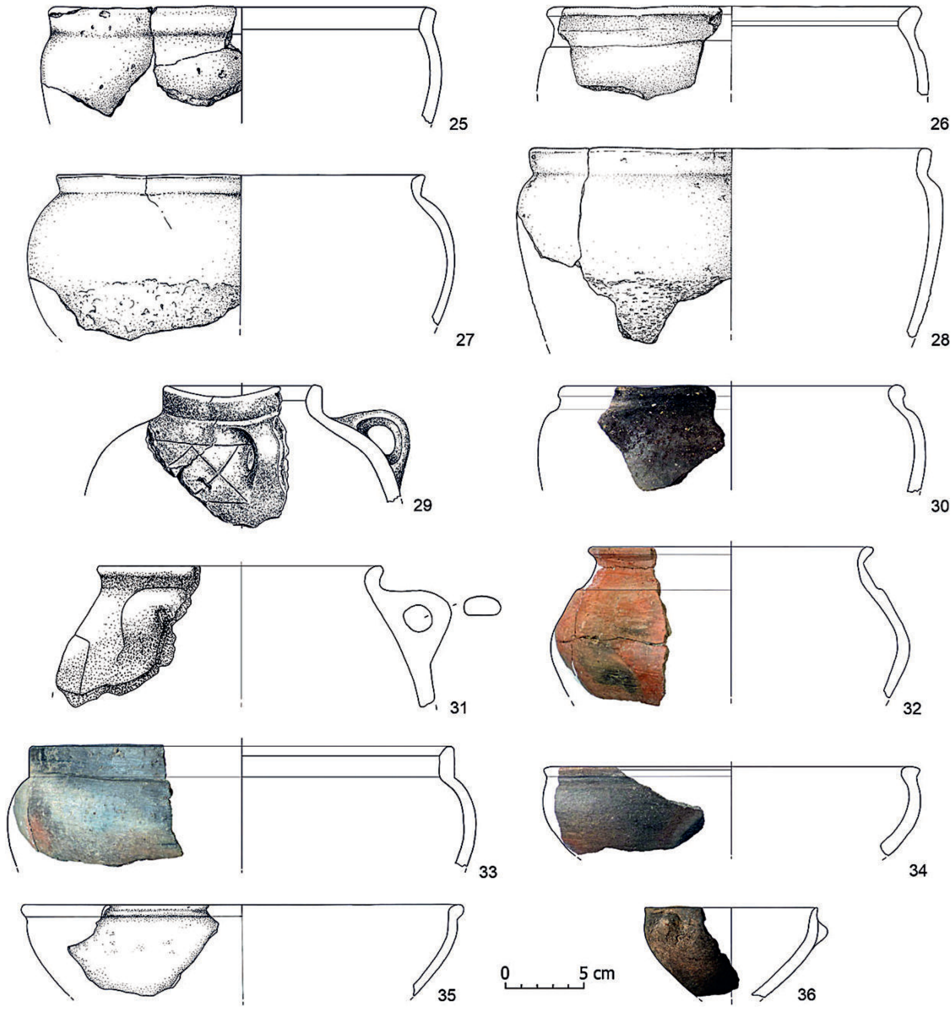

Fig. 5. Fragments of analysed R A cookware vessels. Descriptive numbers match with the numbers in *Tab. 1*.

Cookware

Coarse cookware from phase R A is mostly chronologically insensitive. It is rarely decorated (*Fig. 5*: 29), and the rims are sometimes faceted (*Fig. 5*: 25, 26, 29, 33). Pots and deeper bowls are often roughened in their lower parts (*Fig. 5*: 27, 28). There are also some exceptional shapes which are still reminiscent of the Late La Tène types, despite the fact that they are not wheel-made and their execution no longer corresponds to Late La Tène models (*Fig. 5*: 30). Similar evidence can also be found at other sites with finds of this horizon (e.g. Prague-Podbaba: *Kostka – Jiřík 2009*, Figs. 14–17; Horoměřice: *Šulová 2006*, Figs. 4: 1, 5, 13, 14; 5: 5; 6). The occurrence of coarse shapes with off-set shoulders is also quite remarkable. They may be indicative of development into the R B1 phase, of which this form is typical (*Fig. 5*: 26, 32).

Pottery fragments from phase R B1

Potsherds from vessels originate from features dating to the R B1 phase of the Mlékojedy settlement site (n=23). Petrographic thin sections were made from six samples of tableware, as well as from six samples of coarse cookware. XRD analysis was always carried out on a pair of samples from the first and second group.

Tableware

Fine pottery underwent rapid development during the R B1 phase. Perfectly polished thin-walled vessels were still fired in a reduction atmosphere, but the occurrence of faceted rims was noticeably declining. A characteristic vessel type representing tableware of the R B1 phase is the so-called segmented terrine with a conical (concave) neck (*Fig. 6*: 37, 40, 41, 46) and several derived shapes (vase-shaped terrines or low terrine-shaped bowls, e.g. *Fig. 6*: 45). These also included types 1, 6, 8 and 9 (so-called classic terrines) according to E. Droberjar (*Droberjar 1999*, 40–48, Abb. 12; *Lenz-Bernhard 2002*, 68–69, Abb. 48–52; *Droberjar 2006b*, 616–617, Fig. 10), or possibly certain types of vase-shaped terrines according to the same author (*Droberjar 2006b*, 610–616, Fig. 4–5). It is therefore a kind of 'leitmotif' of the later phase, although isolated occurrence of these types during the earlier period is not ruled out either, as demonstrated above. The segmented terrine with a conical neck also occurred in the adjacent burials ground of Tišice, where it was found in a total of four graves (no. 12, 34, 43, and 82), all of which are dated by fibulae to R B1, or more precisely to both of its subphases. Another group of vessels that almost exclusively belong to the settlement's later phase are bowls with a rounded profile and a distinctly short, rounded, and sometimes even spherical rim (*Lenz-Bernhard 2002*, 53, Abb. 32; *Fig. 6*: 39, 43, 44). The technology of cogged-wheel decoration has come into prominence, although the decorative motifs seem to build on previous development (*Fig. 6*: 37, 40). Combing can also be noted on finer vessels (*Fig. 6*: 39). For the first time, we also encounter embossed horizontal bands and grooves on the shoulders (*Fig. 6*: 37, 43). They generally act as an element separating the vessel's shoulder from the below-neck area, which is normally the function of an offset. An earlier theory argues that terrines with horizontal ribs might have been influenced by vase-shaped vessels made in the Late La Tène style on the potter's wheel, as discussed above (*von Müller 1957*, 8; *Salač 2011b*, 57).

Cookware

Coarser cookware seems slightly more varied than during the previous phase. Terrine-shaped vessels with a turned-in neck and shoulders, which are divided either by an offset (*Fig. 7*: 51, 56, 59) or an embossed band (*Fig. 7*: 54) were popular. We also encounter deep bowls, formally corresponding to unsegmented terrines (*Fig. 7*: 50, 58, 60). Unusual shapes include sharply profiled vessels, which are formally reminiscent of the von Uslar I type typical of the Rhine-Weser area (*Schulterknickgefäße*, see *Meyer 2008*, 114–117, 221–225; *Fig. 7*: 49). Such indications of a relationship to the early Rhine-Weser cultural circle are supported by the observations made during the analysis of burial rite at the necropolis in Tišice (*Motyková-Šneidrová 1963*, 420–429). There are also other shapes in the Mlékojedy assemblage that make a slightly alien impression (*Fig. 6*: 45). Faceting of rims is relatively rare and occurs usually only in the form of a single edge (*Fig. 7*: 51, 52, 54).

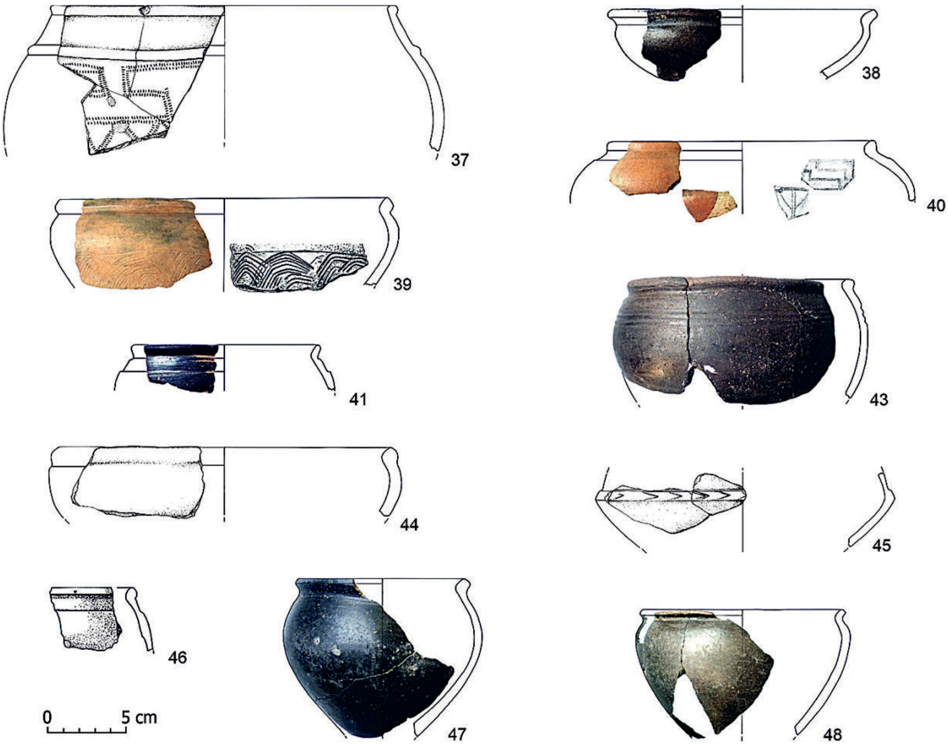

Fig. 6. Fragments of analysed R B1 tableware vessels. Descriptive numbers match with the numbers in *Tab. 1*.

Decoration also occurred on cookware in the form of a single embossed band on the shoulders (*Fig. 7*: 54). When it comes to engraved elements, disorderly spaced incisions were sometimes used (*Fig. 7*: 50). The technique of combing was, of course, also known during the earlier phase, but the termination in high arches did not appear before the phase B1 (*Fig. 7*: 55, 57). The lower parts of cookware vessels were often roughened, either in the form of so-called tangle-like (*Fig. 7*: 56) or fine roughening (*Fig. 7*: 54). It can be generally stated that combed decoration also fulfils the function of surface roughening, so that it can be considered partly as a decorative element, partly as a technological element. The same can probably be said of densely applied incisions (*Fig. 7*: 50).

Methodology

Samples for chemical composition analysis (60 pieces in total; *Tab. 1*) were prepared using a Retsch PM 100 agate planetary ball mill. The chemical composition was determined by a Rigaku NexCG energy-dispersive fluorescence (ED-XRF) spectrometer with a 50 W Pd tube and a silicon drift detector (SSD). The samples were analysed in the form of pressed powder pellets (1 g). Matrix-based error in element quantification was minimised by using a calibration library specialised for soils and ceramics.

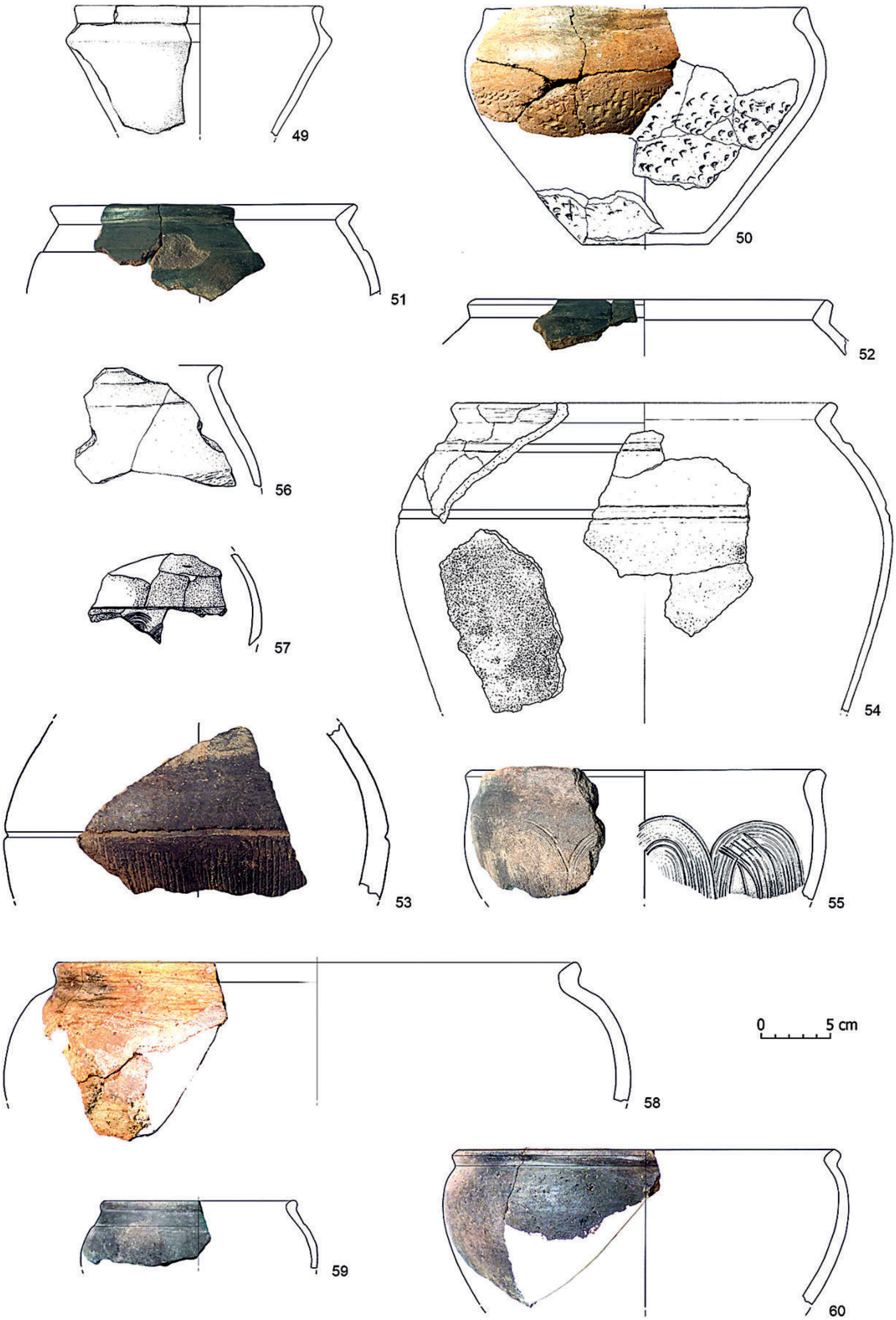

Fig. 7. Fragments of analysed R B1 cookware vessels. Descriptive numbers match with the numbers in *Tab. 1*.

Concentrations of Al, Si, K, Ca, Ti, V, Mn, Fe, Ni, Cu, As, Rb, Sr, Ba, and Pb were chosen for principal component analysis (PCA) using the FactoMiner package in R (*Lê et al. 2008*). The PCA results were further used for hierarchical clustering (*Husson et al. 2010*), which helped selecting samples for petrographic analysis.

Based on statistical evaluation of element concentration, 30 samples were chosen for petrographic analysis (*Tab. 1*). Standard thin sections (30 µm) were analysed by an Olympus BX 51 polarising optical microscope. This analysis focused on structure description (*Quinn 2013*), non-plastic inclusion identification, and quantification. The inclusion abundance was estimated using a semiquantitative scale similar to *Sauer* and *Waksman* (*2005*). Distinguishing between temper and natural inclusions was based on empirical assessment of grain size distribution. Larger-sized grains whose count was beyond natural distribution were classified as temper (similar to *Quinn 2013*, 103). Coarse/fine/void ratio (c/f/v) was estimated according to *Whitbread* (*1995*, 383) with the boundary between coarse and fine set to 10 µm.

Powder X-ray diffraction (XRD) analysis was used as a supplementary method on 10 samples in order to support mineralogical composition revealed by petrography and to determine the firing temperature (*Heimann 2017*). XRD was performed on a Panalytical X'Pert apparatus with a Co-anode and an RMTS detector (X'Celerator) in conventional Bragg-Brentano parafocusing Θ – Θ reflection geometry (step: 0.033 °2Θ, time per step: 160 s, measured angular range: 4–100 °2Θ). The obtained data were processed using Bruker Diffrac plus EVA 2 and Topas 4 software. Quantitative phase analysis was performed using the Rietveld method. The degree of crystallinity of the samples was determined comparing the integral intensities of the diffraction lines of the crystalline phases and the diffuse background.

A similar combination of methods has been employed in earlier studies (e.g. *Nösler – Stilborg 2010*, 105–106) and can be considered a good practice to study the technology of prehistoric pottery.

Results

ED-XRF

The bulk chemical composition of all 60 samples (*Supplementary material 1*) made it possible to get an idea of the variability of the set. The former dataset was divided according to the chronology of samples, forming distinctive datasets of the Late La Tène, R A and R B1 phases. Each group was examined by statistical analysis using principal component analysis. Scree plots of PCA analysis of 12 La Tène samples, 25 R A, and 23 R B1 samples (*Supplementary material 2*) have shown that the first four components, for each chronological stage, expressed a sufficient amount of variance (86.1%, 76.7%, and 76% respectively) to be used for hierarchical clustering. The weight of each element for every component can be examined in scatter plots. The hierarchical clustering method has revealed clusters based on the first four components. Samples for petrographic analysis were chosen in order to represent each cluster sufficiently (*Tab. 1*). Based on the results, 30 samples for ceramic petrography were chosen in order to cover the maximum variability of the assemblage.

Ceramic petrography

Despite the sample selection was based on chemical clusters of each separate chronological stage, the classification, which is an outcome of petrographic analysis, was performed on all chosen samples regardless of their dating. Dependent on the character of the matrix and presence of mineral grains and rock fragments (*Supplementary material 3*, technological aspect of each sample was described individually in *Supplementary material 4*), samples were divided into four main petrofabrics groups labelled A–D. In order to avoid over-simplification and data loss, these groups were further divided into several subgroups. Samples that could not be merged based on the selected features were marked as loners and will be described individually. Petrofabrics and loners are described not only in terms of petrography (*Tab. 2*; *Tab. 3*), but also according to their distinct chemical composition (*Tab. 4*).

Petrofabric A (10 samples)

The group comprises pottery made from a very fine lenticular structure matrix with various amount of fine silt. Aplastic distribution is bimodal and the division into subgroups is based on the character of the largest fraction of sand-sized aplastics. Subgroup A1 (3 samples) is characterised by abundant subrounded to rounded equant psamitic quartz grains, as well as frequent polycrystalline quartz of similar fashion (*Fig. 8*: A). Other mineral or rock fragments are not so abundant. Alkali feldspars are common and plagioclases occasional. Biotite, muscovite, and amphiboles are rare. Rock fragments of various genetic types are present in very low volumes. Granitoid rocks, clastic sedimentary rocks, and even carbonatic rocks are rare. Few aplastic grains of anthropogenic nature (slag) were present in one sample (28). Subgroup A2 (3 samples) includes frequent angular and subangular granitoid rock fragments and plagioclases (*Fig. 8*: B). Quartz grains and alkali feldspars are common, as well as polycrystalline quartz. High amount of amphibole and biotite, which both occur commonly, are significant for this subgroup. Muscovite, on the other hand, is rare, similarly to tourmaline which was identified in two samples. Subgroup A3 (4 samples) differs in the presence of frequent grog and common slag (*Fig. 8*: C, D). Among the identified minerals, quartz is the most common. Alkali feldspars and plagioclase are occasional. Micas and accessory minerals, such as amphiboles and tourmalines are rare. Rock fragments are represented by rare fragments of granitoid and clastic sedimentary rocks.

Petrofabric B (5 samples)

The pottery has a matrix of unparallel structure. Non-plastic inclusions are of smaller grain size compared to petrofabric A. Yet, the size distribution of grains is also bimodal. The most abundant mineral is quartz, followed by polycrystalline quartz (*Fig. 8*: E). Alkali feldspars are common and outnumber occasional plagioclases. Micas, amphiboles, and tourmalines are rare. Among rock fragments, granitoid rocks are the most abundant as they occur occasionally. Clastic sedimentary rocks are rare, as well as metamorphic rocks. Some samples include slag (39) or remains of plant tissues (45, 59).

Petrofabric C (6 samples)

It represents variably grained pottery with a distinguishing unimodal distribution of plastics, an increased amount of micas, and the presence of sillimanite. Subgroup C1

Petrography/ Fabric subgroup	A1	A2	A3	B	C1	C2	D
Quartz	++++	++	++	++++	+++	+++	++++
Alkali feldspar	++	++	+	++	+/-	+	++
Plagioclase	+	+++	+	+	+	++	++
Biotite	+/-	++	+/-	+/-	+	+	+
Muscovite	+/-	+/-	+/-	+/-	++	+	++
Amphibole	+/-	++	+/-	+/-	+/-	+	+/-
Garnet	-	-	-	-	-	-	+/-
Sillimanite	-	-	-	-	+/-	+/-	-
Tourmaline	-	+/-	+/-	-	+/-	-	-
Calcite	-	-	-	-	-	-	+
Polycrystalline quartz	+++	++	++	+++	+++	+	++
Granitoid	+/-	+++	+/-	+	+/-	+/-	++++
Clastic sedimentary rock	+/-	-	+/-	+/-	-	-	-
Cabronatic clasts	+/-	-	-	-	-	-	+
Metamorphic rock	-	-	-	+/-	-	+/-	-
Grog	-	-	+++	-	-	-	-
Slag	+/-	-	++	+/-	-	-	++
Organics	-	-	-	+/-	-	-	-
c/f/v ratio	10/85/5–20/70/10	5/90/5–15/80/5	5/94/1–10/85/5	10/89/1–20/75/5	10/85/5	5/94/1–10/85/5	10/89/1–20/70/10

Tab. 2. Petrofabrics – summarisation of petrography.

Petrography/Sample	3	14	18	22	40	43	54
Quartz	+/-	++++	++	+++	+++	+++	++++
Alkali feldspar	+/-	+	+	+/-	+	++	+
Plagioclase	-	++	+	+	++	++	+
Biotite	+/-	++	+	+/-	+	+/-	+/-
Muscovite	+/-	++++	+/-	+/-	+	+/-	+++
Amphibole	+/-	-	-	+/-	+/-	++	-
Calcite	+/-	+	-	-	-	-	-
Tourmaline	-	-	-	-	-	-	+
Polycrystalline quartz	+/-	++	+	+	+++	++	++++
Granitoid	-	+++	+++	-	+/-	++	++
Clastic sedimentary rock	-	-	-	-	++++	++	+/-
Chert	-	-	-	+/-	+/-	-	-
Limestone	-	+	++++	-	-	++++	-
Metamorphic rock	-	-	-	-	-	-	+
Bone	-	-	+++++	-	-	-	-
Grog	-	-	+/-	-	-	-	-
Organics	-	-	+/-	-	-	-	-
Slag	-	-	-	-	-	-	+
Microfossils	-	++	-	-	-	-	-
Mollusc shell	-	-	-	-	-	-	+
c/f/v ratio	0/99/1	10/89/1	10/89/1	5/94/1	15/84/1	30/69/1	20/79/1

Tab. 3. Summarisation of petrography of loners.

Petrofabrics		Si*	Al*	Fe*	K*	Ca*	Ti*	V	Mn	Ni	Cu	As	Rb	Sr	Ba	Pb
A1	mean	32.7	7.0	3.7	1.6	1.3	0.4	100	482	35	34	12	132	214	1035	30
	sd	1.8	0.6	0.1	0.1	0.3	0.1	31	162	4	1	1	7	58	426	2
	min	31.2	6.4	3.6	1.5	1.0	0.3	77	305	30	34	11	125	149	545	28
	max	34.7	7.4	3.8	1.7	1.6	0.4	135	621	38	36	13	139	260	1320	32
A2	mean	31.1	8.2	3.1	2.0	1.4	0.4	122	351	35	37	9	160	230	814	23
	sd	0.4	0.3	0.1	0.3	0.1	0.0	14	19	2	2	1	24	42	113	1
	min	30.8	7.9	3.1	1.8	1.3	0.4	106	332	33	35	9	135	190	686	22
	max	31.5	8.4	3.3	2.4	1.4	0.4	130	369	36	39	10	182	274	900	24
A3	mean	31.1	7.5	3.5	1.9	1.2	0.4	115	376	36	38	11	161	218	904	27
	sd	1.9	0.8	0.3	0.1	0.1	0.0	19	62	1	7	1	13	44	214	3
	min	29.0	6.8	3.2	1.7	1.0	0.4	89	304	35	32	10	152	159	691	24
	max	33.1	8.5	4.0	2.0	1.3	0.5	136	433	37	46	12	180	263	1130	30
B	mean	40.2	8.9	2.3	1.6	1.0	0.3	82	262	32	35	10	134	180	738	24
	sd	8.3	3.2	0.4	0.2	0.1	0.0	19	47	2	6	1	7	22	102	2
	min	33.6	6.5	1.9	1.3	0.9	0.3	54	221	29	29	9	126	161	626	22
	max	53.9	14.5	3.0	1.8	1.2	0.4	102	322	35	46	11	140	214	867	27
C1	mean	32.2	7.4	3.5	1.8	1.1	0.5	131	432	36	34	11	132	198	1109	26
	sd	2.8	1.0	1.1	0.4	0.1	0.1	20	169	4	8	1	2	8	253	3
	min	30.3	6.3	2.3	1.4	1.0	0.4	110	247	31	27	9	130	191	846	23
	max	35.4	8.2	4.4	2.1	1.1	0.5	149	579	39	42	12	133	207	1350	29
C2	mean	30.6	8.1	4.0	1.9	1.1	0.5	158	789	40	40	12	131	175	1023	29
	sd	1.8	0.5	1.1	0.4	0.1	0.1	23	193	10	11	0	13	40	168	1
	min	29.0	7.7	3.1	1.5	1.0	0.5	140	651	31	33	12	118	142	883	28
	max	32.5	8.6	5.2	2.1	1.2	0.6	184	1010	50	53	12	144	219	1210	30
D	mean	30.4	8.9	4.0	2.3	1.1	0.5	152	498	33	26	10	234	166	918	25
	sd	0.5	0.6	0.0	0.2	0.2	0.1	14	186	3	2	1	60	18	399	2
	min	30.0	8.5	4.0	2.2	1.0	0.5	142	366	30	25	10	191	153	636	24
	max	30.7	9.3	4.0	2.5	1.2	0.6	162	629	35	28	11	276	178	1200	27
Loners	mean	29.5	7.0	2.8	2.1	3.4	0.3	73	372	35	29	9	151	271	739	22
	sd	4.0	1.3	0.5	0.4	2.4	0.0	18	71	9	3	1	51	99	259	2
	min	24.5	5.2	2.1	1.6	0.8	0.3	50	276	25	23	7	98	107	490	20
	max	35.2	9.1	3.6	2.5	6.9	0.4	105	505	53	33	10	238	377	1250	24

Tab. 4. Summarisation of general chemical composition of each petrofabric and loners (elements marked with * in wt %, other elements in ppm).

(3 samples) matrix is heterogeneous in the case of all three samples. Connecting attributes represent common muscovite and rarely occurring alkali feldspars (*Fig. 8*: F). Quartz and polycrystalline grains are frequent, while plagioclases and biotite are occasional and amphibole rare. The identification of sillimanite in sample 5 is significant. No metamorphic rock fragments were noticed. Granitoid rocks are rare. Subgroup C2 (3 samples) differs from the previous one by only occasional presence of polycrystalline quartz, lower abundance of muscovite, and higher volume of feldspars, both alkali and plagioclases (*Fig. 8*: G). Sillimanite is present in sample 21. Besides granitoid rocks, several rock fragments of metamorphic origin were identified.

Petrofabric D (2 samples)

This group includes pottery with a bimodal distribution of aplastics including abundant sand-sized grains. The distinguishing attributes are abundant quartz and granitoid rock fragments, common alkali feldspars and plagioclase, occasional biotite, and common muscovite and occasional calcite (*Fig. 8*: H). Accessory minerals are represented with rare amphibole and garnet. The abundance of slag in the matrix is also important for petrofabric D.

Loners (7 samples)

These samples were different from the main petrofabrics as well as one from another. Therefore, these seven samples were labelled loners and will be described individually.

Sample 3 was made of very fine calcareous raw material (loam or loess) which was very well sorted (*Fig. 9*: A). All aplastics were below fine sand fraction and the largest grains were scarce, which limited petrographic identification. Apart from quartz, alkali feldspar, calcite, amphibole, and micas were distinguished; all were present in very low amounts.

Sample 14 is distinctive, due to the presence of microfossils in the raw material and abundant muscovite (*Fig. 9*: B). The content of biotite is also increased compared to the rest of the assemblage. Sand-sized grains of temper are composed of abundant quartz and muscovite, which is present as stacked flakes. Frequent granitoids, common plagioclases, occasional alkali feldspars, calcite, and limestone were also observed.

Sample 18 is very special within the studied assemblage for it includes a plenty of bone fragments (*Fig. 9*: C). Besides bones, the aplastics are composed of abundant limestone fragments and frequent granitoid rocks (*Fig. 9*: D). Quartz is common, while feldspars and biotite are occasional, and muscovite is rare. The sample also includes rare plant tissue remains and grog.

Sample 22 stands out among the loners with the unimodality of the aplastics consisting mostly of silt and fine sand. This characteristic makes it comparable to petrofabric C, however, its petrography is very simple and straightforward when confronted with the named group (*Fig. 9*: E). Most aplastic particles are quartz, which is frequent. The rest belong to occasional plagioclase and rare alkali feldspar, micas, amphiboles, and chert.

For sample 40, the high amount of clastic sedimentary rock fragments, namely shale, is typical (*Fig. 9*: F). Among detected minerals, quartz is frequent and dominates the spectrum. Plagioclases are more abundant than alkali feldspars. Micas are occasional. Accessory minerals are represented by rare amphiboles. Granitoid rock fragments are also rare.

Significant for sample 43 is the abundance of limestone fragments of psamitic and aleuritic fraction, as well as the common occurrence of sandstone fragments (*Fig. 9*: G). The aplastics are further composed of frequent quartz, common alkali feldspars, plagioclase, and amphibole. Micas are rare. Granitoid rock fragments occur commonly.

Sample 54 is made of fine-grained homogeneous material. An important feature that distinguishes this loner is the presence of mollusc shales and slag (*Fig. 9*: H). The sample includes abundant sand-sized grains of quartz and polycrystalline quartz. The second most abundant mineral is muscovite, which was classified as occurring frequently; biotite, on the contrary, is rare. Feldspars of both types are occasional, as well as tourmaline. Among the distinguishable rock types, granitoid is common, metamorphic rock occasional, and sedimentary rock rare.

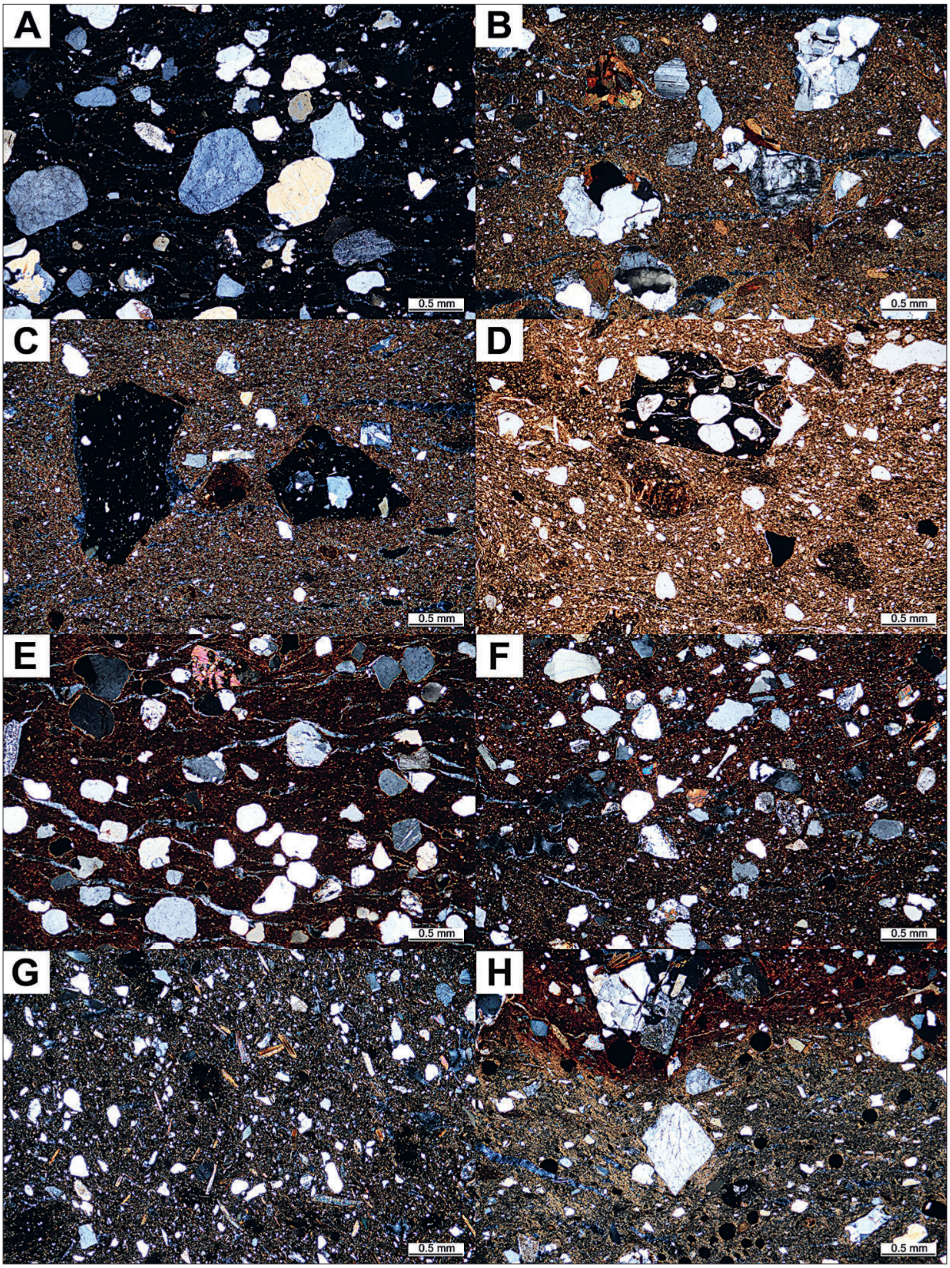

Fig. 8. Photomicrographs of samples representing petrofabrics: A – petrofabric A1: fine grained matrix tempered with rounded quartz sand (sample 55, XPL); B – petrofabric A2: dominant temper subangular fragments of granitoid rocks, high content of feldspars and amphiboles (sample 20, XPL); C – petrofabric A3: grog tempered (sample 33, XPL); D – petrofabric A3: grog tempered matrix containing particles of slag (sample 35, PPL); E – petrofabric B: quartz sand tempered, occasionally occurring granitoid rocks (sample 50, XPL); F – petrofabric C1: unimodal distributed aplastics of igneous, magmatic and sedimentary origin (sample 5, XPL); G – petrofabric C2: micaceous non tempered pottery (sample 2); H – petrofabric D: granitoid rock fragments used as temper, matrix rich in round particles – blacksmith slag (sample 60, XPL).

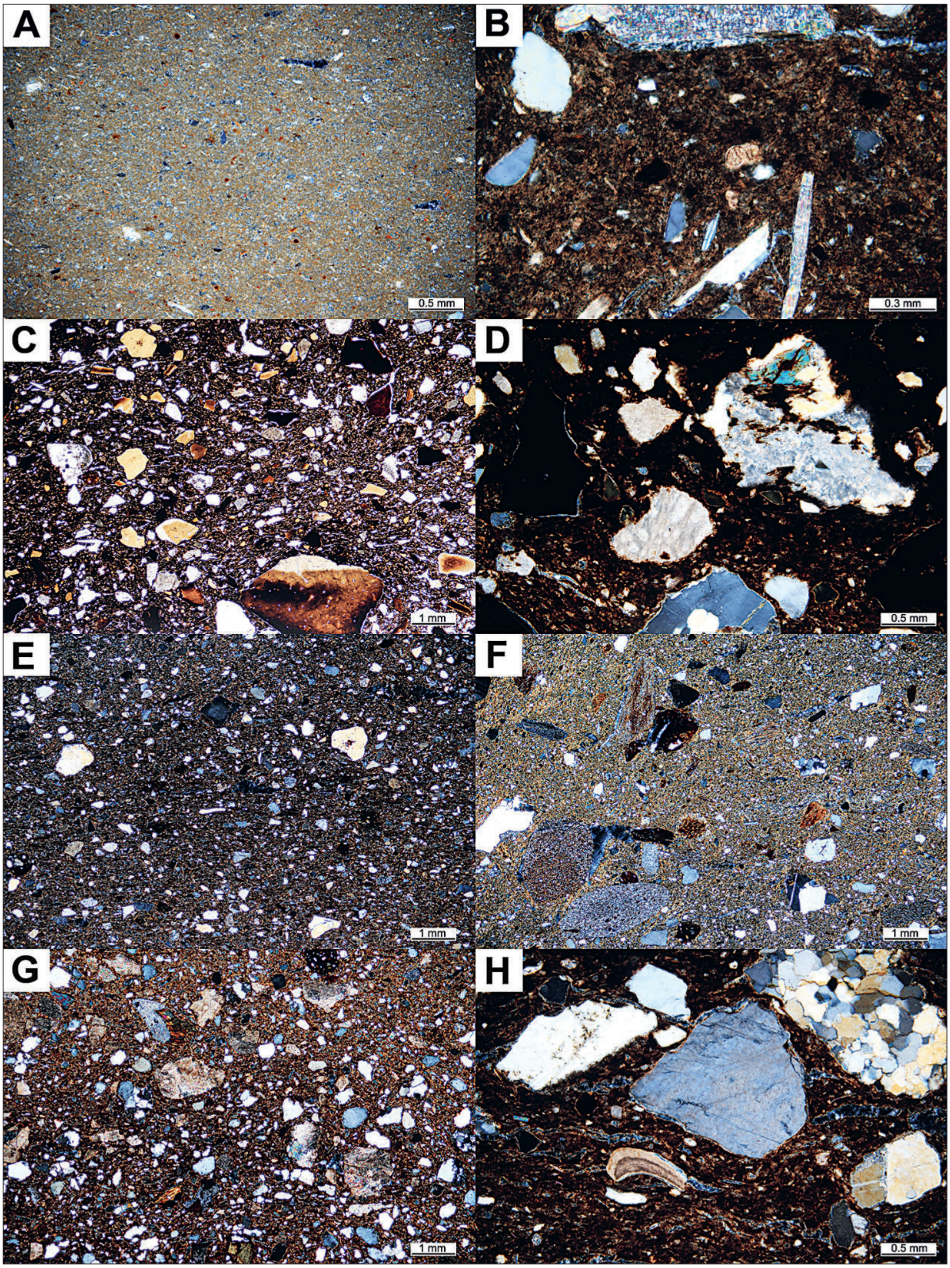

Fig. 9. Photomicrographs of loners: A – non-tempered calcareous matrix (sample 3, XPL); B – muscovite rich temper (sample 14, XPL); C – abundant bone fragments used as temper (sample 18, PPL); D – detail on a granitoid rock and limestone fragment (sample 18, XPL); E – fine-grained aleuritic matrix (sample 22, XPL); F – temper consisting of subrounded fine-grained clastic sedimentary rock fragments (sample 40, XPL); G – limestone rich temper (sample 43, XPL) ; H – detail on a mollusc shell (sample 54, XPL).

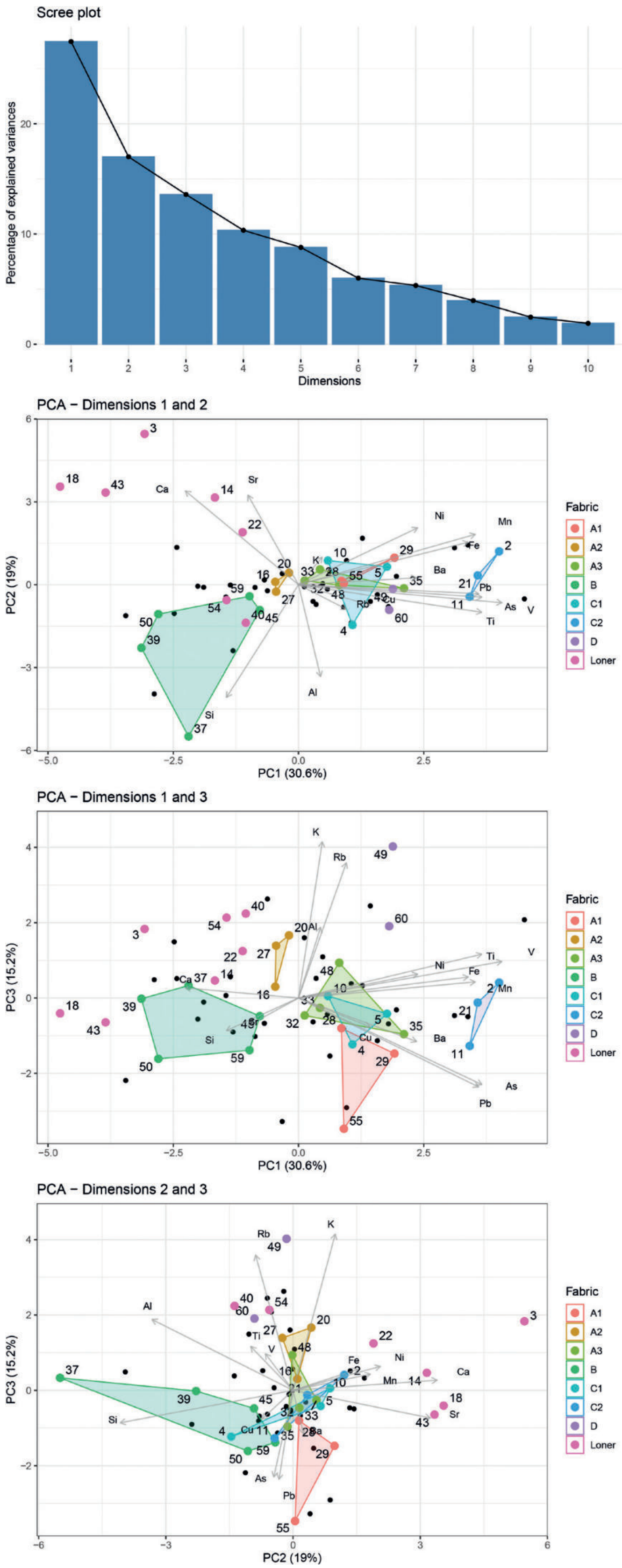

Fig. 10. Principal component analysis showing relations among petrofabrics based on their chemical composition.

Bulk chemical composition of petrofabrics

The principal component analysis was performed again on a whole dataset (*Fig. 10*). The same chemical elements were chosen as variables for the statistical analysis as in ED-XRF (Al, Si, K, Ca, Ti, V, Mn, Fe, Ni, Cu, As, Rb, Sr, Ba, Pb). The first component explains 31.2% of variance, which is the lowest value compared to the previous PCA analysis (see above in ED-XRF section). The reason may be that when comparing the more heterogeneous part of the assemblage (across all three chronological stages), the variance is caused by more factors unlike when comparing a limited dataset (e.g. assuming the pottery was made with one technological approach in the given chronological stage, the variance would be caused by provenance differences only, while the technology could have varied according to dating).

The first component is strongly defined by the presence of Ca and Sr with the lowest score and Mn, Fe, Pb, As, and Ba with the highest score. The first component allows to differentiate loners (*Fig. 10*), which have the highest concentrations of Ca and Sr, and also the petrofabric C2 with the highest values of Fe, Pb, As, Mn, and Ba. The second component shows the negative correlation of Si and Al against K and Ni. The scatter plot of the first two components reveals a distinct divergence of the petrofabric B having the highest concentration of Si. Petrofabrics A1, A2, A3, C1, and D seem to be close, and some of them are even overlapping in terms of their chemical composition. Distinction of A2 and D can be explored using the third component which shows high scores for increased concentrations of K, Rb, and Al, of which petrofabric D has the highest scores. The summary of bulk chemical composition underlines the result of PCA (*Tab. 4*).

XRD

Quartz was a predominant mineral in all analysed samples, followed by feldspars and mica minerals (*Tab. 5*). These constituents are common in the examined clays. Samples 3, 18, and 48 displayed relatively elevated concentrations of calcite, ranging from approximately 4 to 14%. Iron oxides, specifically magnetite and hematite, were observed as minor phases in all samples. Sample 20 was characterised by a high amphibole content (4%). Minor amounts of amphibole were detected in the remaining samples except for sample 3, where it was absent. Anatase, a common minor phase in clays, was identified in samples 43 and 60. Samples 18 and 43 contained smectite, while sample 18 also exhibited the presence of apatite (15.7%; *Fig. 11*).

The only unequivocally newly-formed crystalline phases, or ceramic phases, were gehlenite and pyroxene in sample 3, as well as a phase with a composition approximating $Al_{1.2}(Mg,Fe)_{0.6}Si_{1.8}O_6$ in samples 2 and 28 (quantified using ICSD pattern no. 31105). The content of X-ray amorphous phases ranged between approximately 7 and 31 mass percent. Gypsum in sample 21 and anhydrite in sample 43 were of secondary origin. A partially secondary origin cannot be ruled out for calcite, particularly in samples with lower concentrations (samples 28 and 60).

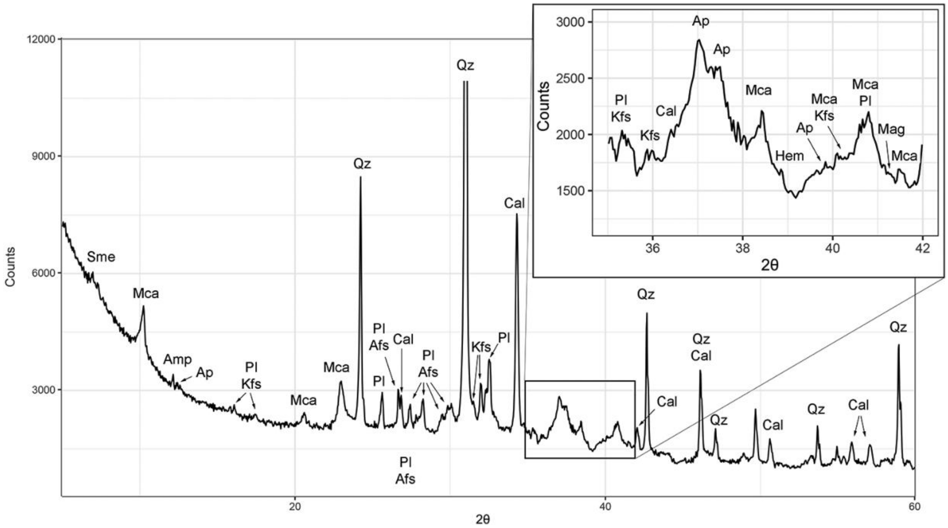

Fig. 11. Diffractogram of bone tempered pottery (sample 18). Sme – smectite, Mca – mica structure minerals, Amp – amphibole, Ap – apatite, Pl – plagioclase, Kfs – alkali feldspars, Qz – quartz, Cal – calcite, Hem – hematite, Mag – magnetite.

Discussion

The petrographic analysis of aplastics enabled to divide pottery into four main groups (petrofabrics). Some of them were further subdivided into subgroups. However, these are predominantly subgroups of petrofabrics A (3 subgroups) and C (2 subgroups). Positive results achieved by this method suggest that this division correlates with the cultural-chronological determination of the samples according to their archaeological contexts (*Tab. 6*). Petrofabrics also correlate with a formal division into tableware and cookware. In addition, the so-called isolated specimens (loners) yielded interesting results. In the following paragraphs, we discuss and interpret our results from a cultural-historical viewpoint.

Technological change between LT D and R A

Wheel-made pottery fragments of the Late La Tène tradition, numbering six samples, mainly belong to group C and its subgroups C1 and C2, where material is free of added temper. This correlates with the technology used for the production of pottery on a rapidly rotating potter's wheel since the rougher temper would significantly abrade the hands and damage the surface of the produced vessel. However, the thin sections of these samples did not show significant unified grain orientation, typical for wheel-thrown pottery (see *Thér – Toms 2021*). The fine-grained character of pottery was a limiting factor however not even the elongated grains of quartz evinced the orientation specific for tangential sections. It is therefore possible that this pottery could have been formed by hand and just finished on the potter's wheel. Only one Late La Tène sample (no. 3) stands out and can be designated as a 'loner'. It also shows signs typical for ceramics made on a fast potter's wheel. Clay without additional temper facilitated the formation of fine shapes on the potter's

Sample	2	3	5	18	20	21	28	43	59	60
Dating	**LT**	**Lt**	**LT**	**RA**	**RA**	**RA**	**RA**	**RB1**	**RB1**	**RB1**
Quartz	53.2	31.3	57.8	38.3	48.2	56.9	67.3	61.5	71.7	61.1
K – feldspar	10.5	7.2	12.3	7.5	15.0	11.7	9.5	4.9	7.3	15.2
Plagioclase + albite	13.2	9.9	10.6	8.0	18.6	12.5	6.7	2.9	6.1	4.7
Amphibole	0.8	0.0	0.7	0.8	4.0	1.4	0.4	1.0	0.5	0.4
Apatite	0.0	0.0	0.0	15.7	0.0	0.0	0.0	0.0	0.0	0.0
Anatase	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	1.3
Magnetite	1.4	2.3	2.2	0.8	1.4	2.2	1.2	1.1	0.6	3.0
Hematite	0.0	0.8	1.0	0.2	0.2	0.3	0.3	0.0	0.1	0.5
Gehlenite	0.0	13.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pyroxene with stucture close to diopside	0.0	20.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Calcite	0.0	3.9	0.0	11.1	0.0	0.0	0.8	13.8	0.0	0.4
Gypsum	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
Anhydrite	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
$Al_{1.2}(Mg,Fe)_{0.6}Si_{1.8}O_6$	7.1	0.0	1.8	0.0	0.0	0.0	7.0	0.0	0.0	0.0
Mica minerals (incl. illite)	13.8	10.8	13.7	15.5	12.8	14.3	6.9	9.9	13.6	13.4
Smectite	0.0	0.0	0.0	2.1	0.0	0.0	0.0	4.3	0.0	0.0
Total	100.0	100.0	100.1	100.0	100.2	100.0	100.1	100.1	99.9	100.0
Degree of crystallinity	77.6	76.6	77.5	74.9	73.3	62.8	76.0	92.3	81.0	69.5
Firing temperature [°C]	<650	<700	>850	<750	<700	<650	<800	<750	<650	<700

Tab. 5. Quantification of phase composition calculated by the Rietveld method.

Petrofabric	Subgroup/Samples	Datation			Total
		Late LT	**R A**	**R B1**	
A	A1		2	1	3
	A2		3		3
	A3		3	1	4
	Total		8	2	**10**
B				5	**5**
C	C1	3			3
	C2	2	1		3
	Total	5	1		**6**
D				2	**2**
Loners	Sample 3	1			1
	Sample 14		1		1
	Sample 18		1		1
	Sample 22		1		1
	Sample 40			1	1
	Sample 43			1	1
	Sample 54			1	1
	Total	1	3	3	**7**
Total		**6**	**12**	**12**	**30**

Tab. 6. Petrofabrics pivot table showing sample count belonging to each petrofabric.

wheel, as well as the final treatment of their surfaces (polishing). On the other hand, it also reduced the material's resistance to thermal shocks during firing. Firing of Late La Tène fine tableware is usually assumed to have been carried out in two-chamber kilns with a grate (*Thér et al. 2017*). However, statistically evaluated experimental firings in different types of firing devices (from open bonfires to clamp kilns to two-chamber kilns) show that similar technological properties of pottery can be achieved in open firings provided that craftsmen are skilled enough (*Thér 2014*). Regarding the firing temperatures, XRD findings demonstrated that the La Tène samples were exposed to higher temperatures than later pottery; it surpassed 850 °C. Sample 3, in particular, was subjected to the highest temperature, as indicated by the presence of newly-formed gehlenite and pyroxene.

A significant change is represented by the next chronological phase R A. Eight of the 12 samples can be assigned to the petrographic group A, which was tempered. The nature of the matrix is the unifying element of petrofabric A, which had to be divided into three subgroups. Subgroup A1 is represented by two samples, subgroups A2 and A3 are represented by three samples each. Subgroups A1 and A3 formally correspond to coarser cookware, but they both represent quite different manufacturing processes. While A1 was tempered with quartz sand, A3 was tempered with grog. Subgroup A2 contains two samples of fine tableware and a single sample of coarser pottery. The use of subangular granitoid rock as a temper is characteristic. Generally speaking, petrofabric A mainly corresponds to coarser cookware. One sample (no. 21) of finer tableware from chronological level R A belongs to subgroup C2, i.e. non-tempered material typical for samples of the Late La Tène period, and sample no. 22 is also very close, possibly representing a certain continuity between LT and R A phase in pottery technology. It is interesting that both samples come from the same archaeological feature.

An exception is the sample no. 18, which belongs to fine tableware. It has a black polished surface decorated with a swastika motif. This vessel was tempered with crushed bones (confirmed by XRD, the sample contains 15.7% apatite). Although the use of bone temper has been employed since the Neolithic, it has never been a widespread practice (*Mariotti Lippi – Pallecchi 2017*, 570–571; *Kowalski et al. 2020*). During the Iron Age in Northern Europe (500–300 BC and 180–400 AD), fine pottery with an admixture of bones was used. Despite the fact that bone temper may have had certain technological advantages, such as good incorporation of crushed bones into the clay or the vessel's increased resistance to thermal shocks, it is assumed that this tempering method had a more symbolic and perhaps even associative meaning (*Stilborg 2001*, 400–402). In some regions, it could have been a local tradition (e.g. *Taayke 2006*, 203–204).

The pottery of phase R A appears to be characterised by a variety of tempering. Similarly to the use of crushed bones, tempering with grinded pieces of older pottery (grog) is usually given a more symbolic significance, although it is actually very suitable for temper (*Holmquist 2021*). Tempering with grog has rarely been observed at other, similarly dated sites in Europe (e.g. *Daszkiewicz et al. 2017*; *Bajnok et al. 2022*). In this context, it is interesting to mention an archaeoceramological study summarising results from several sites in Central Germany dating from the pre-Roman Iron Age to the Roman Period (ca. 5th century BC to 3rd century AD) whose cultural background is comparable with Mlékojedy. The authors state that pieces of older pottery were used as temper mainly in the centuries before the beginning of the Christian era, whereas in the Roman Period itself, quartz grains and to a lesser extent also other types of rocks or organic particles were used

(*Daszkiewicz – Meyer 2008*, 317, Abb. 10). It still remains a question for further research, whether this finding, repeatedly observed especially on pottery of the earlier R A phase from Mlékojedy, is a generalisable phenomenon.[2]

Although the differences between the ceramics of the Late La Tène tradition and the R A phase of the Roman period are quite large, there are also certain connections. Interpreting this difference as proof of the migration of a new population is therefore not entirely without problems. Now let us put aside the option that all potsherds of Late La Tène character are mere intrusions having no relationship with settlement features from the Roman period – on the basis of constantly recurring cases not only from Bohemia but also from Central Germany, it can be judged that their presence is not a coincidence. We are left with two hypotheses then. First, they might got into the features of the Großromstedt culture (traditionally considered to be 'Germanic') because the pottery had some function in the living culture, for example it was traded with a still-surviving workshop in the vicinity, which produced pottery according to the old tradition, or as a kind of family heritage. The second hypothesis assumes the existence of a pottery workshop operating directly on the investigated site. After the initial production of pottery according to the old recipes, this workshop could very soon reorient itself to a new (possibly simpler) production technology. As a result of this shift, some procedures can still be observed in typologically younger vessels. However, the idea that specialised potters producing wheel-made pottery would switch to a completely different technological chain is unlikely. Such a chain is tied to a particular organisational form of craft that lost its grounding during the changes in the socio-economic structure at the beginning of the Roman Period. Therefore, it is far more likely that the technological phenomenon has a certain inertia and disappears with the last potters born into it. Moreover, discontinuous technological changes are usually linked to social changes (cf. *Thér – Mangel 2023*, 3–4). This change could take some time (one generation?), which offers a certain interpretation space enabling to explain the surviving fragments of the Late La Tène pottery on the settlement in Mlékojedy.

Technological change between phases R A and R B1

The analysed pottery of phase R B1 is mainly characterised by petrofabric B. Petrofabric A1 and B are very similar in terms of petrography; both are made of fine-grained loam tempered with sandy quartz. The difference is in the microstructure, which for A1 is slightly lenticular and for B mostly unparallel. A more important difference was observed in the chemical composition, with Si, Al, and Fe being the most dividing factors. Petrofabric B has significantly higher contents of Si (~ 8 percentage points) and Al (~2 pp), while Fe is lower (~1.5 pp). It is important to bear in mind that this is a comparison of bulk chemical composition. It does not necessarily mean that the pottery clay originated

[2] *Holmquist* (*2021*, 10) commented on the significance of grog tempering in the Corded Ware culture, expressing the opinion that if vessels, which people took with them when migrating to new settlements, broke, they were symbolically used as a tempering agent to make new vessels. This is an interesting analogy for mobile communities, such as those who were the bearers of the Großromstedt culture during the LT D2/R A period. An analogous interpretation can also be found among indigenous populations of North America, who used grog tempering along with new technology of shell tempering during a time of cultural change after the advent of the Mississippian culture (*Weinstein – Dumas 2008*).

from a different source. The element concentrations could have been shifted by tempering meaning that petrofabric B was more tempered than petrofabric A, but it was not conclusively demonstrated by petrographic analysis. The reason for the discrepancy is probably a combination of both – differences in clays and tempering. The raw material for B included more alleuritic and pellitic quartz and it was slightly more tempered. Nonetheless, this similarity proves the continuation of pottery making tradition on the site between phases R A and R B1.

Petrofabric D (samples 49 and 60) differs from the other samples by the use of iron slag as a tempering agent. It is not clear to what extent this was the potter's intention and to what extent a result of 'contamination' of the raw material, for example due to the proximity of metallurgical facilities usually located at the settlement's edge. However, such cases are also known from northern Europe, and thus probably no coincidences (*Stilborg 2001*, 399–400). It should be mentioned in this context that sample 49 comes from a vessel close in shape to Uslar I type pottery from the Rhine-Weser cultural zone. The rest of the assemblage consists of three samples designated as 'loners'. Each was tempered with a specific material: sample 40 with shale fragments, sample 43 with pieces of limestone, and sample 54 with quartz, granitoids (including amphiboles) and mollusc shells. They do not stand out from the rest of the assemblage regarding their shape.

In terms of firing technology, which can be discussed based on mineral composition, there is no discernible difference between the R A and R B1 phases. All analysed samples suggest a lower firing temperature (less than 800 °C). For the majority of the samples, it is not possible to determine the firing temperature due to the absence of indicators, which are phases formed during firing at temperatures exceeding 850 °C. A certain indicator is the amount of detected X-ray amorphous phase, however in the case of the examined samples, this is not a result of melting, but rather the dehydroxylation of clay minerals. Two samples with distinct dating (sample 18 from R A and sample 43 from R B1) contain minerals that demonstrate very low temperatures, specifically smectite, and a relatively high content of calcite, which otherwise decompose at higher temperatures.

Provenance

The provenance of pottery will be discussed based on the ceramic petrography. It is necessary to bear in mind that each individual component of pottery – clay and temper – may be of separate origin. It is also necessary to take into account that imports may not be distinguishable if pottery was transported over short distances due to the similar petrographic and chemical composition of clays and tempers (*Daszkiewicz et al. 2019*, 38). All samples of petrofabric A have a very similar matrix, it is likely that the raw material came from a single source. The matrix was described as a very fine-grained material, most probably loam, which could have originated from alluvial sediment. The site is located in the alluvium of the Elbe River, therefore, it is feasible to place its origin in its close surroundings (see the 7 km radius around the site in *Fig. 2*) according to the hypothesis on the resource area by *Arnold* (*2005*, 17). Looking at the temper, which differs for each subgroup, it is necessary to interpret their provenance separately. Subgroup A1 was tempered with quartz sand. The site was built on a river terrace composed dominantly of quartz sand and gravel. It is therefore very likely that the sand originates either from the area of the settlement or from its close surroundings.

Subgroup A2 temper is dominantly sand of granitoid rocks. Even though the terrace is formed from this rock type as well, it is minor and mixed with other rock types, such as metamorphites. However, the igneous Neratovice complex forms the bedrock of the terrace on which the site was built. It used to outcrop in the riverbed, and the outcrops can still be found on the left riverbank in modern days. When comparing feldspar type volume in the granitoid temper, plagioclases are more abundant than alkali feldspars, which correlates well with local granodiorites. They could have been either collected in the form of sand, which was naturally formed by the erosion force of the river or picked up in bigger form and crushed before being added to pottery clay. The shape of grains (mostly equant, subangular to angular) testifies the formation by natural processes and thus supports the former interpretation.

Subgroup A3 shares similar mineralogy with A1, nevertheless the amount of quartz is significantly lower. Apart from quartz, only rare rock grains, namely granitoids and clastic sedimentary rocks, were identified, both of which commonly occur in the area. Since the pottery was tempered with grog, there is not a sufficient base for provenance discussion based on petrography only. However, the morphological, as well as decorative types, are common on the site and since the matrix is similar to the other subgroups, it can be concluded that A3 is also of local origin.

Petrography of petrofabric B is very similar to subgroup A1. The discussion on its provenance can, therefore, reach the same conclusion. It is very likely that it was made from local raw materials.

The matrix of both subgroups of petrofabric C differs from A and B. It is more silty and more abundant in micas. Still, the clay body resembles loam and could have originated from alluvium as well. The presence of sillimanite refers to metamorphic rocks which are not natural to the area. Nonetheless, such rocks are present, even though not abundant, among the alluvial sand of the Elbe River. The raw material was most probably taken from a different source than for A and B and this source was also likely located close to the site.

Petrography of group D is comparable to A2 with an even higher abundance of granitoid rocks and admixture of occasional calcite and carbonate clasts. The provenance discussion needs to be extended by finding the origin of carbonates. Calcareous claystone and marlite form a bedrock on both banks of the Elbe River. Biodetritic limestone is located on the left bank close to the site. It is very likely that these eroded rocks form part of the sand and alluvium around the site. Even though the petrofabric D is very probably of local origin, the raw materials could have been taken from a slightly different source than the petrofabrics described above.

The provenance of loners will be discussed individually. Sample 3 was made of very fine calcareous clay and does not include particles coarse enough, which could help interpret its provenance. The calcareous clay could have developed on a base of limestone or calcareous claystone forming the bedrock on the left riverbank close to the site. The raw material obviously comes from a source unsimilar to all the other studied samples. The potter most probably had to cross the river to obtain the clay. Sample 14 is unique in two attributes – the microfossils included in the ceramic matrix and the abundance of muscovite. Loam with microfossils could have developed on a limestone base, similarly as the calcareous clay of sample 3. Moreover, stacks of muscovite sheets are abundant. The presence of rounded equant sandy quartz indicates fluvial transport of the temper. One of the grains is a granitoid rock (more angular compared to quartz) with a high volume of muscovite.

It seems that the muscovite is derived from granitoid rocks, possibly from the Neratovice complex. According to the shape of granitoid rocks, no long-distance river transport was involved. The sand used as temper most probably originated from a river sediment close to the site.

Sample 18 with bone temper was also heavily tempered with sand, which includes quartz, subangular limestone, and granitoids. All the mentioned rock types are to be found on the left riverbank. Given the fact that they are not very rounded, they were not transported on a long distance. Therefore, we conclude that such sand could be of diluvial origin from the area around Neratovice. Sample 22 is quite fine grained, so petrography did not bring any specific information which could have been used for provenance discussion. The majority of aplastics are formed by fine subangular quartz sand. Sample 40 was tempered with elongated subrounded psamitic fragments of shales and equant rounded quartz sand. Shales outcrop ca. 13 km upstream on the left bank of the Elbe River near Brandýs nad Labem. The shape of shale fragments hints that water transport played a role in their abrasion. It is possible that the sand used as temper for the sample originates from the area between Brandýs nad Labem and Mlékojedy, because there are no traces of granitoids which are to be expected in the river sediment from Mlékojedy and Neratovice down the stream. Sample 43 shows a temper of sand formed by a combination of quartz, limestone, sandstone, granitoids, and amphibole fragments. All the above rocks occur locally. Petrography of the sample 54 temper is similar to sample 14 and so are the arguments for its provenance. The temper consists of granitoid rocks, an abundant muscovite and quartz. However, the sample 54 differs in having no microfossils in the ceramic body.

Conclusions

This study is the first step toward archaeometric investigation of the pottery associated with a significant migration wave from the north to the Bohemian Basin at the turn of the La Tène and Roman periods (cf. *Droberjar 2006a*). The analysis of pottery from the settlement of Mlékojedy shows signs of discontinuity in both major chronological transitional periods (LT D/R A and R A/B1), while the former change was more pronounced taking place between the Late La Tène period and the Early Roman period (LT D/R A). It manifests itself primarily in the way the vessels were shaped. The use of the potter's wheel was abandoned not only in the case of classic wheel-throwing but also as a finishing with the help of kinetic energy Another change consists in shaping the new pottery shapes of the Roman period, which can be explained as evidence of human migrations more than just a cultural imports. These new morphological vessel types bear a completely new range of decorative motifs. However, the similar absolute change cannot be observed in technology since not all aspects of pottery making changed. General adoption of new technology was accompanied by a few exceptions, which demonstrate that certain procedures (e.g. the selection and processing of pottery clay) may have continued to some extent. Some evidence of nostalgia for a bygone time or evidence of a transition phase of a certain kind may also be the reason why samples from the earliest phase of the Roman period (R A) were tempered with crushed bones or grog.

The second, less noticeable technological discontinuity was revealed at the transition between phases R A and R B1. It rather represents a natural development in the pottery making technology accelerated by social changes or internal development of technology. This change was reflected in the homogenisation of temper spectrum and the processes for manufacturing tableware and cookware probably also became unified. During phase R B1, finer clay was no longer strictly used for the production of tableware.

The achieved results show that the vast majority of the pottery could have been produced from local resources available either in the immediate vicinity of the settlement or not far from it (e.g. on the other side of the Elbe River). Only one of the analysed samples can be most probably interpreted as an import, as the deposits of materials which were used as temper are located at least 13 km away upstream of the Elbe River in the vicinity of Brandýs nad Labem. Also, the pottery shapes, which seem to be based on other cultural circles, were manufactured locally.

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RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Archaeology of the main waste dump of the Sauersack/Rolava POW camp in the Ore Mountains (NW Bohemia)

Archeologie hlavní skládky odpadu zajateckého tábora Sauersack/Rolava v Krušných horách (SZ Čechy)

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The Sauersack/Rolava POW camp from World War II is the first archaeologically investigated site of its kind in Bohemia, and thanks to its highly authentic state of preservation it can be considered one of the best archaeologically known internment facilities in Europe. Nevertheless, new findings continue to emerge, including information from illegal treasure hunters. In 2022, the main settlement waste dump was identified and due to the threat to the site from illegal excavations, pre-emptive archaeological testing was immediately undertaken. The research has resulted in the documentation of a remarkable structure suited to waste disposal and the recovery of an assemblage of artefacts and ecofacts that complement and extend our knowledge of the communities that inhabited the POW camp.

World War II – forced labour – POW camp – settlement waste – Dark Modernities – Bohemia – ore mining

Zajatecký tábor Sauersack/Rolava z období druhé světové války je první archeologicky zkoumanou lokalitou svého druhu v České republice a zejména díky vysoce autentickému stavu zachování je možno jej pokládat za jedno z nejlépe archeologicky poznaných internačních zařízení v Evropě. Přesto i zde nadále dochází k získávání nových poznatků, například na základě informací pocházejících z prostředí nelegálních hledačů s detektory kovů. V roce 2022 se tak podařilo rozpoznat hlavní skládku sídlištního odpadu a vzhledem k ohrožení lokality nelegálními výkopy bylo obratem přistoupeno k preemptivnímu archeologickému výzkumu. Výsledkem je dokumentace pozoruhodné struktury sloužící k odstraňování odpadu a získání souboru artefaktů a ekofaktů, které doplňují a rozšiřují naše poznatky o komunitách obývajících zajatecký tábor.

druhá světová válka – nucená práce – zajatecký tábor – sídlištní odpad – Dark Modernities – Čechy – rudné hornictví

'The actions of Napoleon and Alexander, on whose words the event seemed to hang, were as little voluntary as the actions of any soldier who was drawn into the campaign by lot or by conscription. This could not be otherwise, for in order that the will of Napoleon and Alexander (on whom the event seemed to depend) should be carried out, the concurrence of innumerable circumstances was needed without any one of which the event could not have taken place. It was necessary that millions of men in whose hands lay the real power – the soldiers who fired, or transported provisions and guns – should consent to carry out the will of these weak individuals, and should have been induced to do so by an infinite number of diverse and complex causes.

L. N. Tolstoy, War and Peace (book IX, chapter 1, translation by Aylmer and Louise Maude)

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Introduction: People and things as actors in global conflict

When L. N. Tolstoy included in his epic *War and Peace* a general reflection on whether the role of the individual, without distinguishing his social position and thus 'place in history', is equal, he broke the thousand-year-old stranglehold on thinking and writing about the past. Naturally, even today it is possible to encounter approaches within history (including the historiography of modern conflict) based on the thematisation of heroic or demonic figures. His approach is often carried over – here in a truly distorting way – into the treatment of historical materiality. While in the case of Jean Moulin, Jan Kubiš and Reinhard Heydrich we can to a certain extent meaningfully consider their prominent role in history, in the case of the iconic blue scarf and hat on display in Les Invalides in Paris, the modified anti-tank No. 73 grenade, or the cabriolet Mercedes-Benz 320 B 'SS-3' damaged by an explosion, it is generally impossible to reach a deeper quality of insight than a certain form of adoring or fascinated fetishism. However, if we accept the inclusive conception of all, even marginal, figures in human history, which can be traced back to Tolstoy, and if we apply the symmetrical principle of the study of (historical) materiality (essentially *Shanks 2007*; *Witmore 2007*; *2014*; *Pauknerová 2014*), we can easily arrive at the theoretical reflection that just as there are no banal human participants in history, none of the material actors can be considered irrelevant. The impression of banality is nonetheless created here by the absence of an obvious line to a section of the historical narrative.[1]

A safe (and perhaps the only possible) solution is the formulation of separate discourses, semi-independent of the historical master narrative, within which the study of certain sections of historical materiality takes on clearly defined meanings. As a model, we can mention art history, individual regional schools of medieval archaeology, or the discourse of the so-called *Dark Modernities* in the archaeology of the 20th century. Within this framework, the archaeology of internment and persecution facilities and the archaeology of forced labour was established and already adopted within Czech archaeology. One of the key findings of this research is the recognition that it was the sum of material and human actors removed from their original contexts and meanings that constituted the reality of life behind barbed wire.

The Sauersack World War II labour camp (today Rolava, Sokolov district) in NW Bohemia was the first archaeologically investigated internment camp in Bohemia (the first site of this type investigated in the Czech Republic was the Roma concentration camp in Hodonín u Kunštátu in Moravia; *Kos 2013*). The camp was built mainly for Soviet and French POWs from Arbeitkommandos des StALAG XIIIB and was an integral part of the industrial complex of a mining and tin processing plant, the construction of which began in 1941 (*Fig. 1*). In the last decade, it has become the object of systematic multidisciplinary research and one of the key sites of 20th-century archaeology in the Czech Republic (*Rojík 2000*, esp. 100–105; *Weber 2001*; *Hasil et al. 2015*). An integral part of this industrial facility was the labour camp, designed in 1940 using the model of the Roman military

[1] Narrative as the predominant mode of communication about the past has been characterised by *Vašíček* (*2006*). The implications of this fact in the field of historical archaeology are analysed by *Hasil* and *Novák* (*2020*) using the example of the residences of medieval elites.

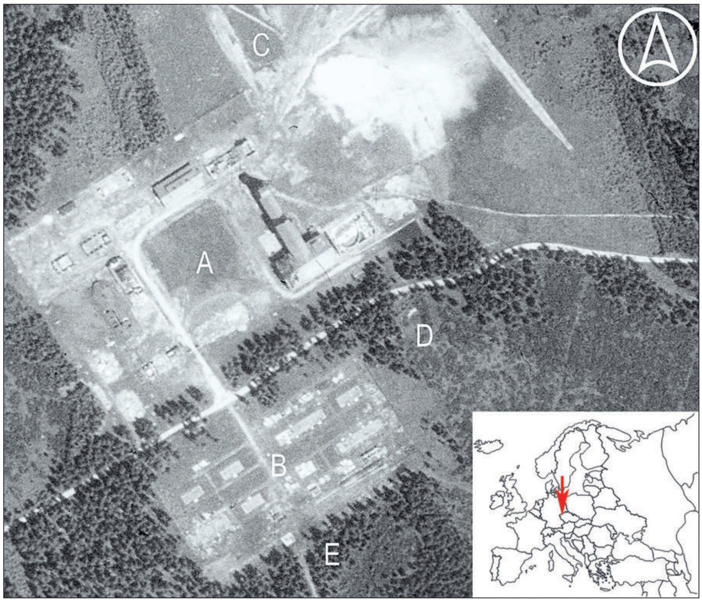

Fig. 1. Sauersack/Rolava. Historical orthophoto of the deserted mining and processing plant and dismantled POW camp (1953, source: Military Geographical and Hydrometeorological Office of the CR, LMSA08.1953.KRAS54.03365). A – mining and processing plant; B – POW camp; C – spoil tip; D – mine sinkhole from 1942, later used as landfill; E – position of another landfill of the POW camp tested by excavation in 2019.

Castra by Berlin architects C. Th. Brodführer and F. Krefter, both of whom took part in the German archaeological expeditions to the Near East (*Vařeka et al. 2023*, 43–51). In 1941, the site of Sauersack temporarily housed the administration of the constructed mining plant and Italian concrete workers were quartered here. The first contingent of prisoners of war arrived this same year (239 French and Soviet prisoners). Their number grew during the war and was further supplemented by marginal numbers of other nationalities (Czechs, Greeks, Dutch, Belgians – according to *Rojík 2000*, Tab. p. 100). Due to the increase in the number of inhabitants, the camp was expanded during the war (*Hasil et al. 2015*, Fig. 8: 9) and the development was expanded by buildings that were clearly of a lower quality standard than the original buildings. The camp was evacuated at the end of April 1945. It was not used again after the war and the prefabricated houses were sold to Czechoslovak Railways as warehouses (*Hasil et al. 2015*. esp. 198–199). Since then, the abandoned site has undergone natural transformations without any significant non-authentic interventions.

2022 research campaign: the main landfill of the POW camp

Research aims, issues, and methods

An important output of the systematic topographic survey of the defunct industrial complex carried out in 2013–2017, which was based on field survey, the study of historical plans, and the use of airborne laser scanning data, was the identification of several landfills of settlement waste. They can be hypothetically assigned to the residential areas of the various communities that were housed within the industrial complex. On one side of the spectrum, we can anticipate civilian mining specialists and camp administrative

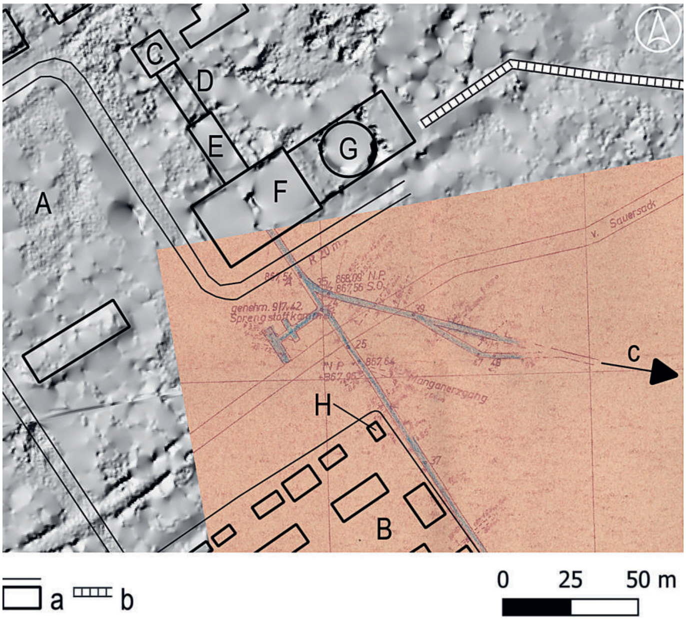

Fig. 2. Sauersack/Rolava. Area of the mine sinkhole east of the POW camp at the German mine plant created shortly before the accident (second half of 1942). A – tin mining and processing plant (Facility No. 1); B – POW camp; C – headframe; D – ore mine; E – ore magazine; F – ore treatment; G – sludge thickener; H – presumed guardhouse (Building No. 7); a – surface buildings and linear structures of the industrial area and POW camp; b – narrow-gauge rail for ore transport connecting Facility No. 1 and Facility No. 2 on the surface; c – planned underground interconnection of Facility No. 1 and Facility No. 2 at a depth of 60 m.

staff accompanied by their families as well as the well-supplied, barracks-style living community that was later identified as (mostly?) French or Francophone POWs. On the other side, there was the poorly supplied community of others, especially Soviet prisoners. Archaeological testing of these dumps was the subject of a 2019 research campaign (*Hasil et al. 2021*; *Hasil et al. 2023*, 50–53).

However, during site reconnaissance, another waste dump was overlooked, which was even connected by a specially constructed narrow-gauge railway with the POW camp. Due to its technical design and the estimated volume of waste deposited, it can be described as the likely main dumping ground for the waste produced by the inhabitants of the internment facility. The feature was omitted from previous surveys because it was not part of the originally projected components of the camp, but an unintentional mine sinkhole was re-used as a dump site. This sinkhole appeared in late 1942 / early 1943 because of intense mining activity 60 m east of the northeast corner of the POW camp. The research team obtained information about the existence of a sunken feature containing WWII artefacts indirectly from unauthorised prospectors with metal detectors, according to whom there were to be finds of militaria – an early (German?) type of Stahlhelm and allegedly even a magazine of a German submachine gun around the mine sinkhole. This substantial information generated the need for a field excavation for two reasons. From the perspective of cultural research management, it was the rescue of at least a sample of research data clearly threatened by illegal activities. From an academic point of view, it was desirable to verify the information about the discovery of the militaria, since in the several thousand artefacts from the 2019 campaign, not even one (*sic*) could be categorised as military material. The excavation in the 2022 campaign thus addressed the question of which community or communities produced the waste deposited in the sinkhole (the search for material

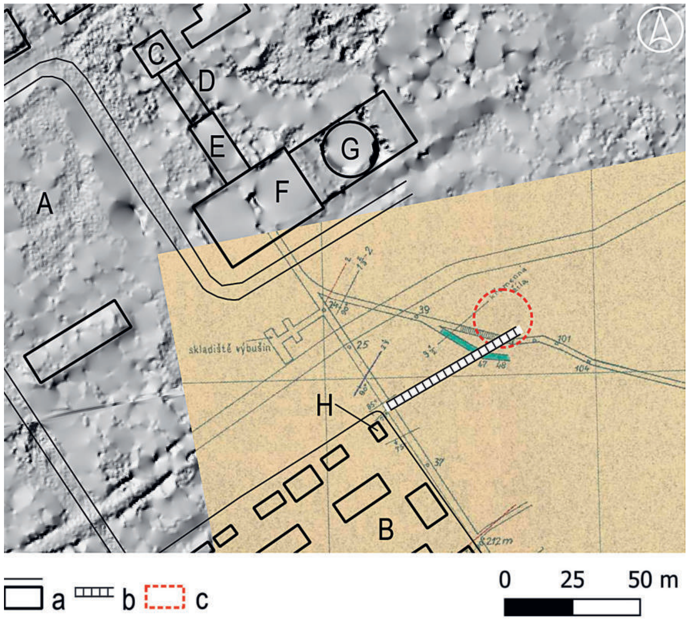

Fig. 3. Sauersack/Rolava. Area of the mine sinkhole east of the POW camp at the postwar mine plant (early 1950s). A – tin mining and processing plant (Facility No. 1); B – POW camp; C – headframe; D – ore mine; E – ore magazine; F – ore treatment; G – sludge thickener; H – presumed guardhouse (Building No. 7); a – surface buildings and linear structures of the industrial area and POW camp; b – narrow-gauge rail for transport of waste into the sinkhole; c – mine sinkhole.

traces of a Wehrmacht guard that had previously remained archaeologically invisible was crucial), to explore an unusually designed and clearly very large waste area, and to place the new data in the context of the previous results. The method chosen, i.e. manual selection and partial sieving of a sample of deposited waste in volume of c. 1 m^3 was therefore fully in line with the 2019 campaign. Only the archaeobotanical evaluation, which would provide rather predictable information about the surrounding environment identical to the present one and the presence of ruderal plant species (*Hasil et al. 2021*, esp. Table 5), was omitted. Instead, a pre-emptive detector prospection of the entire surface of the landfill was undertaken.

Archaeological features

Mine sinkhole

The archaeological feature investigated in 2022 emerged in direct connection with the start of mining at Sauersack/Rolava, which is dated to August 1, 1942 (*Hasil et al. 2015*, 181; cf. *Weber 2001*, 2). The mine map from November 5, 1942, (*Fig. 2*) shows that a pair of parallel horizontal mine workings at the 60 m level was intended to be built in the area of the future mine sinkhole. The first working was connected with Facility No. 2, which should have served for the underground transport of mined material by carts (in the early days of mine operation provided by a surface narrow-gauge railway, *Fig. 2*: b), transport of men, ventilation, and dewatering. The second of the parallel tunnels with a total length of 60 m was to serve as an underground switching station; hypothetically its function could be related to the nearby explosives store. However, as seen on the post-war mining map (*Fig. 3*), which shows the final extent of the tunnels at the 60 m level, the 1942 project

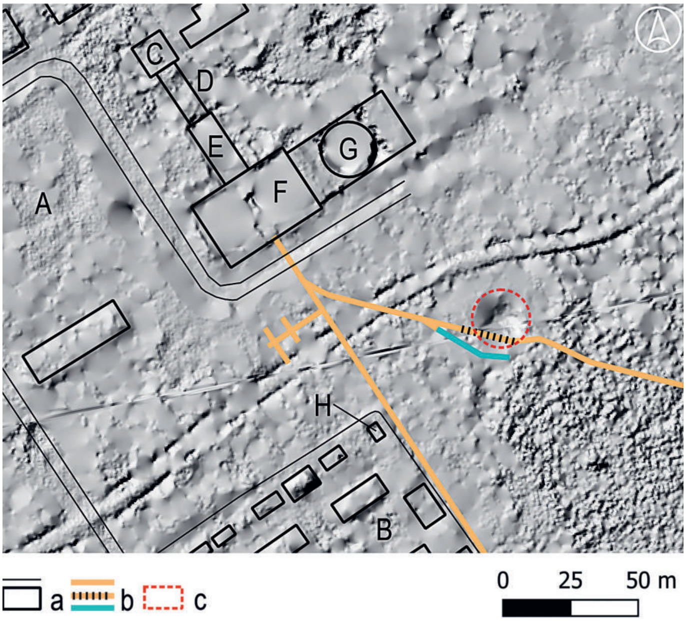

Fig. 4. Sauersack/Rolava. Area of the mine sinkhole east of the POW camp in the contemporary DEM (DMR 5G background data provided by ČÚZK). A – tin mining and processing plant (Facility No. 1); B – POW camp; C – headframe; D – ore mine; E – ore magazine; F – ore treatment; G – sludge thickener; H – presumed guardhouse (Building No. 7); a – surface buildings and linear structures of the industrial area and POW camp; b – mine adit, bricked-up adit, inaccessible adit; c – mine sinkhole.

obviously could not have been completed because of the presence of a geological anomaly (manganite vein) at the location of the proposed parallel tunnels. This anomaly was probably the reason for the collapse during the construction of the parallel galleries. The mine designers responded to the new situation by abandoning the vision of the parallel switching line, the unfinished section of which remained inaccessible (presumably collapsed), and by constructing reinforcement (presumably by bricking) in the threatened section of the interconnection of Facilities No. 1 and No. 2 (*Fig. 4*: b). Their courses were also slightly corrected.

The mine sinkhole was manifested on the surface by a funnel-shaped depression with a diameter of 20 m and a depth of at least 5.5 m (*Fig. 5*). It is located immediately above the planned parallel tunnels (the negligible offset is probably caused by the inclination of the geological layers, *Fig. 4*: c). Since the underground connection between Facility No. 1 and Facility No. 2 was put into operation in 1943, this geological event can be dated precisely to the turn of 1942 and 1943.

Waste dump

Roughly at the same time (mid-1943), a significant increase in the number of interned forced labourers began (*Rojík 2000*, Tab. on p. 100), which was archaeologically indicated by the extension of the POW camp to the south (*Hasil et al. 2015*, esp. obr. 8: 9) and the continuous development of accommodation buildings, auxiliary structures, and facilities. The higher number of inhabitants in the POW camp (prisoners and consequently the guards) was undoubtedly reflected in the increased need for the deposition of generated settlement waste. The use of a large mine sinkhole situated 50 m from the northeast corner of the camp seemed to be an ingenious solution. On a general level, this is a remarkable

Fig. 5. Sauersack/Rolava. The mine sinkhole east of the POW camp, seen from the northeast. The red arrow points to the location of the test trench from autumn 2022 (photo by J. Hasil).

Fig. 6. Sauersack/Rolava. Test trench on the southern edge of the mine sinkhole (autumn 2022, photo by J. Hasil).

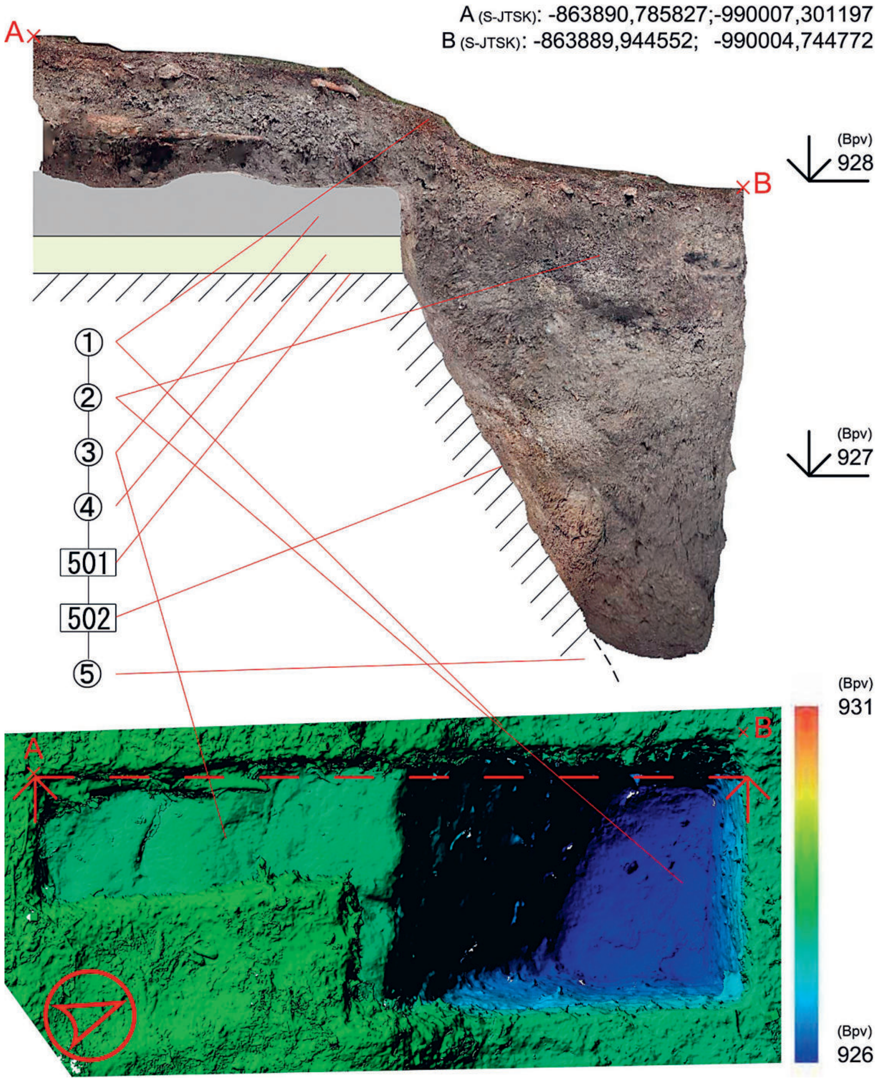

Fig. 7. Sauersack/Rolava. Test trench on the southern edge of the mine sinkhole. Layers: 1 – forest soil; 2 – landfill of settlement waste; 3 – concrete platform for the narrow-gauge railway; 4 – sandy subbase; 5 – subsoil. Features: 501 – cut-off for concrete foundation; 502 – mine sinkhole (autumn 2022, photogrammetry by P. Hasil).

chain of interactions between humans and the environment (initiation of mining), the environment and humans (mine accident), humans and the environment again (reutilisation of the sinkhole as a dump), and finally the environment to humans (natural archaeological transformation of the abandoned landfill).

After surface recognition of the sinkhole/landfill, it was obvious that waste was deposited here from a single point, creating a stratigraphically younger, conical formation in the funnel-shaped sinkhole – a waste mound. On this highest point of the waste cone,

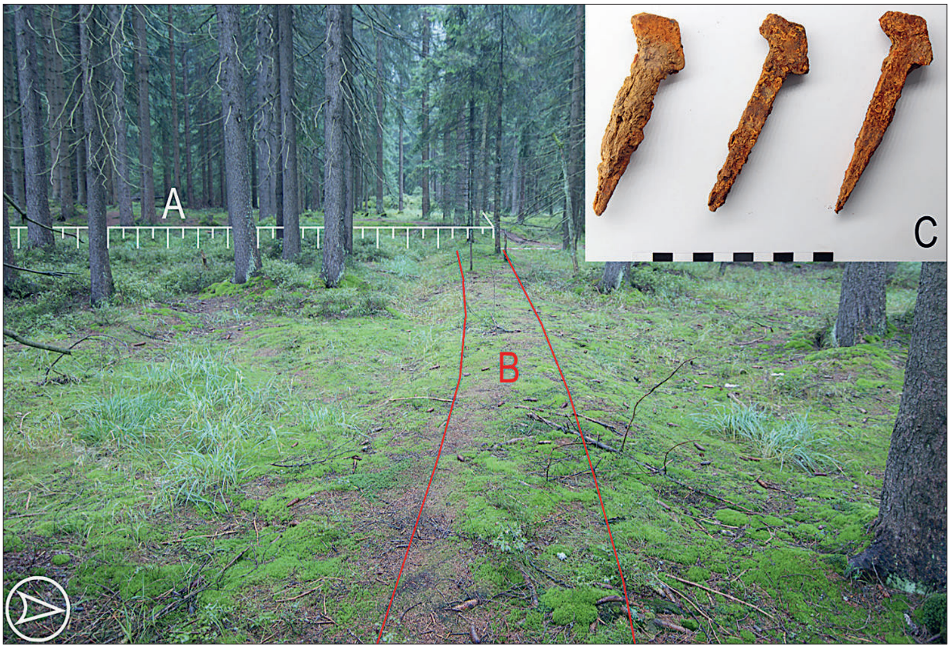

Fig. 8. Sauersack/Rolava. The body of the narrow-gauge railway seen from the mine sinkhole/waste dump, i.e., from the east (photo by J. Hasil). A – surface edge of the northeastern corner of the POW camp; B – body of the railway; C – characteristic railroad spikes collected on the body of the railway (photo by I. Hrušková).

a small test pit measuring 1×1 m was dug. Subsequently, it was extended in the southern direction (*Fig. 6*), after it became apparent that the edge of the mine sinkhole had been artificially reinforced with a concrete platform, thus explaining why waste was dumped into the pit from a single point. The stratigraphic situation in the trench was trivial and consistent with the initial hypotheses (see *Fig. 7*).

Relic of narrow-gauge railway

The concrete platform indicates that the use of the mine sinkhole as a landfill was not spontaneous, and the foundations are clear material evidence of intentional and organised activity. A relatively faint and indistinctive (cf. *Fig. 3: b* and *Fig. 4*) linear concave feature linking the reinforced rim of the mine sinkhole to the northeast corner of the POW camp (*Fig. 8*: B) helped clarify their purpose. The structure has been hypothetically interpreted (based on analogies from other parts of the industrial site) as the embankment of a narrow-gauge railway. This hypothesis was subsequently supported by the recovery of a trio of typical rail spikes from the surface of the concave feature using a metal detector (*Fig. 8*: C).

The existence of a narrow-gauge railway between the POW camp and the mine sinkhole/waste dump retrospectively helped refine the interpretation of the excavated concrete platform. Most probably, it was used for the installation of a tipping device for mine carts (cf. *Fig. 9*).

Fig. 9. A – Sauersack/Rolava. Mining carts on the ramp south of the processing plant. The design of this type allows the hull to swivel and the load to be discharged to both sides (*StA Sachsen, BA Freiberg*, Best. StB, Nr. 3-2847); B – analogy to swivel tipper (photo by A. Schwarz, source https://hellertal.startbilder.de); C – mining cart, one of the types used according to written evidence at the Rolava mining plant (source https://www.vvm-museumsbahn.de/ix/ix-start/ix-start.php?id=12&env=au&pname=/fz/C6/C64-Muldenk/C683-16/120916-IMG_2243-w1200m.jpg&pwidth=1200).

Presumed guard house

The existence of the landfill and associated narrow-gauge railway is not reflected in any known archival plan of the POW camp. Thus, it remains unclear how the internal area of the camp was connected to the rail embankment. Even detailed surface reconnaissance of the area of the northeast corner of the fenced site failed to reveal any evidence of the existence of a gate (*Fig. 8*: A). It is conceivable that there may not have been direct access to the track bed from the camp area and waste was dumped into the mine carts over the camp enclosure.

Considering this question and the alleged discovery of militaria, a regular rectangular surface relic of a house measuring 4 × 6.5 m in the northeast corner of the camp is remark-

Fig. 10. Sauersack/Rolava. Relics of presumed guardhouse in the northeast corner of the POW camp (Building No. 7, after *Hasil et al. 2015*, 188). A – view from the south; B – detail of the northwest corner of Building No. 7 showing the remains of roofing material (terry paper) and water supply connection (red arrow) (photo by J. Hasil).

able (*Fig. 10*; *Hasil et al. 2015*, 188, Building No. 7). According to the building plan of the camp dated June 2, 1942 (*SOA Plzeň*, *CDR*, box 11), this area was to be the location of a guard post. We have so far considered this functional interpretation of the building rather less likely, as its construction standard was clearly very low (absence of a concrete foundation, no evidence of a heating system, roofing with tar paper). The building was considered rather as some kind of technical facility (evidence of water supply pipe in the building, see *Fig. 10*: B). However, the discovery of the narrow-gauge railway, which must necessarily affect the level of security of the camp perimeter (a gate or platform for throwing waste over the fencing), brings the original interpretation back into play. Namely, the narrow-gauge railway, which was built later than Building No. 7, was intentionally located at the site of the presumed guardhouse.

Artefacts

By manual selection under partial sieving, approximately 1.25 m^3 of accumulated settlement waste was excavated. As explained above, it was deposited intensively, based on established rules for the disposal of waste from the settlement used by groups of prisoners and guards (cf. *Fig. 11*). The formation of settlement waste represents a complex process of transformation that allows archaeology to consider the social identities of its producers (*Květina – Řídký 2017*). In the specific case of the Rolava POW camp, a system of hypotheses and research questions can be based on prior archaeological knowledge (the results of the 2019 field research, which distinguished the settlement waste of two differently supplied communities), as well as knowledge obtained from written, i.e., non-archaeological evidence. According to the municipal chronicle of the village of Vysoká Pec, we know that while the POWs – naturally – resided in the POW camp, the Wehrmacht guards were quartered outside the camp area, which probably narrows considerably the spectrum of settlement activities that can be manifested in the local waste. An important aspect is also the disproportion in the numbers of both groups.

	POW Camp				Facility No. 3		Facility No. 1: loging of specialists
	southern landfill (excavated 2019)		northeast landfill (excavated 2022)		(excavated 2019)		(surface collection 2019)
	surface collection	stratified finds	surface collection	stratified finds	surface collection	stratified finds	surface collection
artefacts/ecofacts [g]							
container glass	100	252	0	439	3793	5502	
table glass	0	10	0	62	269	563	
table porcelain	0	293	0	37	2890	1589	
metal can	40	100	0	0	115	12190	
animal bones	3	60	0	121	882	1602	
artefacts (not quantifiable)							
militaria			Stahlhelm (?), magazine of submachine gun (?)				
tools				grinding disk			
personal items	comb (fragment); parts of shoes	razor; parts of shoes; soft textile		severs (2x), spoon (2x), fork, mirror, parts of shoes; textile	clasp-knife; parts of shoes; soft textile	domino tile (ivory); fragments of zip with slider; fragments of textile; plastic buttons	
building material	building ceramic; plate glass; tar paper; fasteners	building ceramic; plate glass; tar paper; fasteners; wiring material		building ceramic, fasteners, table glas, components of electroinstalation, metal components of buildings, wire	bricks; tiles; plate glass; wiring material; bulding fittings; fasteners	bricks; plate glass; wiring material; bulding fittings; fasteners; rebar; mortar with issolation imprints	slate rooftile
plastic	rubber gasket	rubber hose; fragment of cellophane		rubber	rubber hose	rubber hose	
other metal objects		aluminium foil; enamelled vessel; galvanic cell; tube of toothpaste		enamelled pot	iron ball (diameter cca 4 cm – for pétanque?); components of iron stove	enamelled vessels; metal boxes for cosmetic/medicament; tubes for cosmetic/medicament; aluminium foil	fastening component of wooden headframe construction

Tab. 1. Characteristics and summarisation of finds.

Fig. 11. Trash can lid illegally excavated and dumped on POW camp site (2023, photo by M. Pavlíková).

The basic categories of finds were compared with the results of the 2019 campaign (*Tab. 1*; *Fig. 12*). It is obvious that the settlement waste in the northeast landfill excavated during the 2022 campaign stands much closer in characteristics to the settlement waste linked with the Soviet POW community in the southern landfill while differing significantly from the waste recorded at Facility No. 3.

The absence of metal cans is notable, although this fact is not easy to interpret. A direct explanation could be that the inhabitants of the POW camp were practically not supplied with commodities for which this type of packaging was used. This interpretation is unlikely, however, as it would be based on the long-obsolete assumption that settlement waste directly reflects settlement activities without further transformation (cf. *Binford 1981*). A much more likely explanation is that the metal cans in the POW camp were subject to a system of selection and separate treatment. Its organisers could have been the camp administration (collecting the secondary raw material), but also the prisoners themselves, as the memoir literature mentions a variety of ways in which the involuntary residents of the internment facilities reused these containers (for example, making improvised heating and cooking devices or even ventilating escape tunnels).[2]

There is also congruence between the two landfills at the POW camp in the case of another important packaging material – glass. Again, there is a significantly lower share compared to the community stationed at Facility No. 3, where the high representation of glass packages is caused particularly by non-returnable alcoholic beverage bottles. Depending on container volume, the disposal pattern for glass packaging appears to be the same in both landfills of the POW camp. If we observe the degree of fragmentation of individual containers according to their volume, we find that the trend already evident in the data from the 2019 research campaign is confirmed (see *Hasil et al. 2021*, Tab. 2).

[2] The manufacturing of stove and kitchen equipment from empty cans in Miranda de Ebro, the internment facility in the fascist Spanish, in 1942 was described by the Czechoslovak air officer *František Fajtl* (*1991*, 146, 152). The use of cans for the construction of the ventilation of the escape tunnel was recalled by another Czechoslovak airman Ivo Tonder (*Tonder – Sitenský 1997*, 68), a participant of the so-called Great Escape from Stalag Luft III in Zagan in March 1944 (cf. *Pringle et al. 2007*).

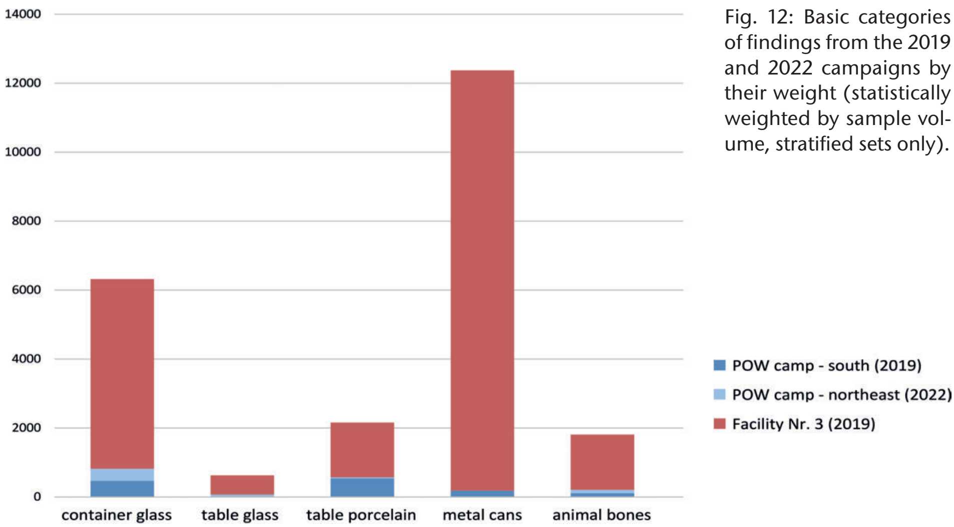

Fig. 12: Basic categories of findings from the 2019 and 2022 campaigns by their weight (statistically weighted by sample volume, stratified sets only).

The community inhabiting the POW camp discarded glass containers of higher volumes (above 250 ml) exclusively in a highly fragmented form.

To determine the fragmentation of glass and porcelain vessels, the analysis used the so-called Dimension Ratio Model (DRM, *Hasil et al. 2021*, esp. Table 2; *Hasil – Pilař in print*), which was previously developed by our team. Unlike the Fragmentation Index (FI, *Květina 2005*; *Kuna 2015*), which works with an estimate of the number of individuals based on sherd thickness, the DMR determines categories of vessel damage, which is a more efficient and rapid procedure in the case of type-uniform modern assemblages (category I: undamaged vessels or vessels on which three major dimensions can be measured; category II: vessels on which two major dimensions can be measured, excluding bottom; category III: vessels on which one major dimension can be measured including bottom; category IV: most fragmented material). Finally, DRM can also be determined for other categories of objects (building ceramics, fillings of building openings) even on the basis of mere photographs of the material. This is useful in the case of modern assemblages, as particularly the larger artefacts had to be shredded on-site.

Thus, we can hypothesise that there was usually some form of secondary use for the glass packaging, or that secondary material collection was again practised. The only undamaged (or minimally damaged DRM category I) packaging that was discarded is small-volume pharmaceutical and cosmetic products for which there was no use or which offered only a small amount of recyclable material. This principle was fully confirmed in the find spectrum of the 2022 campaign, as only a *Thymodrosin* medicine bottle and a narrow glass pill tube came into the sampled settlement waste without damage due to the consumption of their contents (*Fig. 14*). On the contrary, at Facility No. 3, undamaged (or with 'perimortem' damage, which could have occurred after deposition or even during excavation) wine bottles of common volumes around 750 ml were most often discarded (*Hasil et al. 2021*, Table 2), as well as wide spectrum of glass containers for food.

The low representation of fragments of various types of table glass and porcelain points to one of the possible schemes of providing the internment community with dining equip-

Fig. 13. Sauersack/Rolava. Trademarks: A – ewer from the production of the První českobudějovická továrna na smaltované nádobí; B – detail of the mark; C – mark of the První českobudějovická továrna na smaltované nádobí (after *Vondra n. d.*); D – bottle of Tymodrosin (photo by I. Hrušková).

Fig. 14. Sauersack/Rolava. Packaging of medicinal products recovered during the 2019 and 2022 campaigns at the landfills of POW camp and Facility No. 3. The high representation of products of French origin is notable (photo by I. Hrušková).

ment, which in the case of the POW camp was made of metal or enamel. It is often imperceptible in the archaeological record, as objects of this type are not subject to normal damage or deterioration (see *Fig. 13*: a). Also, this factor is identical to the image of settlement waste collected in 2019 and 2022 in the context of the POW camp. On the contrary, the community inhabiting Facility No. 3 was equipped with large batches of identical types of table glass and porcelain, and both ways of shaping the settlement's waste point to the barracks life of the community that produced it. The same provisioning conditions are known, e.g. from the work camp in Prague at Letná on the site of the J. V. Stalin monument (early 1950s), where the inhabitants were supplied with large sets of identical table porcelain and glass types (*Hasil et al. 2022*, 21–24). Another model of the 'provisioning' of the internment community is represented by a set of drinking tableware from the Roma and Sinti concentration camp at Lety u Písku (South Bohemia), where no identical types were found among several dozen mugs (*Vařeka et al. 2022*, 64–109), demonstrating that the internees used equipment they brought from their households.

The interpretation of finds that cannot be statistically grasped due to their singularity or partiality is difficult. In practice, these objects (parts of repaired or newly constructed buildings, personal objects such as cutlery or ewers, scraps of textiles and parts of shoes, a fragment of a mirror, etc.) can be regarded as random evidence of everyday camp life, for which, unfortunately, it is not possible to reconstruct the transformative processes they underwent before entering the context of intentionally collected and deposited settlement waste. It is remarkable that among the finds documented by regular archaeological excavation, militaria are still absent. Only a part of an ewer of the Austro-Hungarian model, but in a post-war, probably civilian enamelled version (*Fig. 13*: a) was recognised as military material. Alleged finds of militaria reportedly made by unauthorised metal detectorists from the investigated dump could not be linked to other objects whose find situation would have been indisputable. This is a significant loss, since with knowledge of the details, it would have been possible to decide whether the finds were from the inside of the dump, i.e. from the period of the camp's operation, or rather from its surface, which would have argued for their deposition in the final days of the war or even in the post-war period, when it is easy to imagine that the practice of selecting artefacts to be taken out of use had radically changed.

Provenance of artefacts

Only two artefacts with an identifiable manufacturer's trademark come from the 2022 research campaign. The everyday objects are represented by the top part of an enamelled ewer, which can be identified as a product of the *První českobudějovická továrna na smaltované nádobí* (*First Enamelware Factory in České Budějovice*) according to the blue lion logo on the bottom (*Fig. 13*: a, *Vondra n. d.*). The type of the ewer is derived from the Austro-Hungarian army model known as M.1899. The blue-grey enamelling could not be dated more closely and it remains unclear whether it is a product for the civilian market or a series intended for the army.

The find of a *Thymodrosin* medicinal syrup bottle (*Fig. 13*: d) is notable because it enlarges the already-known spectrum of drug packaging. *Thymodrosin* is an expectorant used for a range of respiratory ailments, from cough to bronchitis, whooping cough and pneumonia. The drug was initially manufactured by pharmacist Otto Schröder in Göppingen, later by the *Thymodrosin-Gesellschaft* in Bad Godesberg am Rhein (now a district of Bonn, Germany). An identical type of packaging is in the collections of the *Deutsches Hygiene Museum* in Dresden (Inventarnummer DHMD 2020/185 – *Die Sammlung des Deutschen Hygiene-Museums Dresden 2023*). The excavated artefact is missing the Bakelite cap of Boehringer Ingelheim found on the Dresden specimen.

A larger number of drug containers were recovered from previous campaigns at POW camp and Facility No. 3, but only three of them could be identified in more detail (*Tab. 2*). It is noteworthy that all these identified medicines were manufactured in France. A round-bottomed reddish-yellow tin jar with the name *Formocarbine Naphtolee* contained charcoal granules. It was made famous by the *Laboratoire de Medicine Experimentale Georges Tetard* in Beuvais, north of Paris. The product has been manufactured since 1925 and was intended for the treatment of gastrointestinal infections (*Frogerais 2019*). A similar indication can be noted for *Lysarthrol*, produced by the *Laboratoires du Docteur Roussel* in Paris (*Vidal 1935*, 975). Nevertheless, the most notorious substance used in the POW camp community was undoubtedly *Pipérazine*. It was developed as a psychic and sexual stimulant and was produced and promoted as a gout remedy by the Parisian pharmacist Léon Midy (1847–1928). By the 1940s, however, *Pipérazine* was already obsolete in this role, and a similar designation is unlikely even in the POW camp context. In this case, the much more likely is the deployment of *Pipérazine* as an antiparasitic, since its composition paralyses the locomotor system of worms, which then leave the human digestive tract alive (*Museum Sybodo* n.d.). The preponderance (albeit statistically inconclusive) of French preparations can be hypothesised as evidence of the supply of Red Cross packets to the community at the Sauersack mine site. The indication of the recognised preparations then gives insight into the nature of the internees' health problems: indigestion, respiratory problems, and parasites.

Excursion: Recollections of eyewitness Franz Achtner and the medical practices at the POW camp

The most comprehensive memoir of the living conditions at the Sauersack/Rolava POW camp was written by Franz Achtner, who worked there as a payroll accountant in the early years of the mine (*Achtner 2004*). Although his contribution is only limited to a few printed pages and lacks any internal structure, the two passages from the memoir makes it possible to link the historical narrative with the relatively numerous finds of medicine containers.

In the first case, *Achtner* (*2004*, 38) remembers the commander of the Wehrmacht guard: '*The Wehrmacht officer was already a unique individual. In his civilian profession, he was a dentist and he took pleasure in performing dental treatments. And his business was booming! For his "praxis" he had various pliers at the ready and even a sealing device, which he had to kick like a spinning wheel, however – what for a nostalgic joke! With the drill he fiddled around in the patient's mouth and with his right foot he tapped the flywheel so that the drill reached the correct speed. He mainly treated his French prisoners or his Wehrmacht corporals who were assigned to him to "guard" the French. But from time to time, a private person strayed into his "practice", because it was a long way to a dentist in Neudek, and the "company dentist" was much closer and more convenient.*'

Further on in his text, *Achtner* (*2004*, 39) mentions the activity of a doctor from the POW circle: '*(…) Russian prisoners of war also came to the mine in 1942. Among them was the Belarussian Dr. med. Viktor Suska, who looked after the health of his fellow prisoners. But he was also often called to the sick inhabitants of the surrounding villages to provide medical treatment, and in a very short time he was the darling and blessing of the Frühbusser and Sauersacker area. (…) It may have looked strange when this highly*

area	campaign	item	number	country	city	brand	produced
POW Camp	2019	galvanic cell	1	Germany?	?	?	?
POW Camp	2019	shaving gel	1	France	Paris of Montreuil	Vibert Fréres	?
POW Camp	2019	jar of body créme	1	Germany	Hamburg	NIVEA	after 1925
POW Camp	2022	bottle of Thymolin	1	Germany/ Czechoslovakia	Prague/Ústí nad Labem	Thymolin D.R.G.M.	1920's–1940's
POW Camp	2022	Mess kit	1	Austria-Hungary/ Czechoslovakia	České Budějovice	První českobudějovická továrna na smaltované plechové nádobí, s. r. o.	1910–1930s
Facility No. 3	2019	porcelain bowl	3	Denmark	Copenhagen	Kobenhavns Porcellains Maleri	after 1924
Facility No. 3	2019	porcelain flat plate	1	Germany/ Czechoslovakia	Chodov*	Haas & Czjzek	1920's–1960's
Facility No. 3	2019	bottle of Becherovka-liqueur	1	Germany/ Czechoslovakia	Karlovy Vary*	Johannes/Jan Becher	1920's–1940's
Facility No. 3	2019	bottle of spirit solution	1	Germany/ Czechoslovakia	Brno	ALPA	after 1930
Facility No. 3	2019	tube of toothpaste	1	Germany	Mainz or Gera	BLENDAX	after 1932
Facility No. 3	2019	alumnium cap of dehydrated milk	1	France	?	Grande compagnie latiére industrielle de Normandie	?
Facility No. 3	2019	aluminium cap of malt flour	1	France	Paris	Pouillard et Fils, Docteurs en medicine et pharmaciens	?
Facility No. 3	2019	metal dose of Formocambine	1	France	Beauvais	Laboratoire de medicine expéri-mentale (G. Têtard), S. A. R. L.	1920's–1960's
Facility No. 3	2019	bottle with gram/spoon scale	1	France	?	?	?
Facility No. 3	2019	bottle of Piperazine (drug)	1	France	Paris	Léon Midy et Fils	1910s–1950s
Facility No. 3	2019	electrical fuse	1	Germany	?	Träga	?
Facility No. 3	2019	fragment of printed paper (found in dose of digestive agent)	1	France?	?	?	?
Facility No. 3	2021	metal dose of Lysarthrol	1	France	Paris	Laboratoires du Docteur Roussel	since 1930s

Tab. 2. Provenance of artefacts. * regional product.

revered doctor, trained with above-average knowledge, was accompanied to the patients by a Wehrmacht corporal with an overhanging carbine. What might have been going on in the mind of the German corporal and in the mind of the Russian doctor? God knows, those were devastating times. We were so young then and people didn't take it so hard.'

The evidence of Asklepios followers working during WWII at the Sauersack/Rolava mining and processing plant could be hypothetically expanded by archaeology through finds from Facility No. 3 (1.3 km west of Facility No. 1), which yielded medicine packages of French provenance, that may have been supplied in Red Cross packets. It can thus be considered that the French POW contingent may also have been accompanied by their own doctor or medic (*Hasil et al. 2021*, esp. Fig. 13 and Tab. 3). This hypothesis could be contradicted by the fact that findings of medicinal and healing substances are relatively common in the context of labour camps, as their inhabitants suffered from strenuous labour (cf. findings from Stalinist labour camps of the 1950s at the uranium mines in the Jáchymov region, *Vařeka 2020*), but the new finds of medical packaging made in 2022 extend the representation of this category well above the usual level (*Fig. 14*).

Archaeozoological analysis of animal bones

A small assemblage containing 11 fragments of animal bones was excavated from 20 cm to the bottom layer during the 2022 campaign. Nine fragments come from ribs (*Fig. 15*: top and left) and two are fragments of burnt diaphyses (*Fig. 15*: bottom right).

From a taphonomic point of view, the finds show a higher degree of degradation; soil conditions caused the disintegration of the ribs, so the collection may not represent all of the originally deposited material. However, since most of the finds are particularly fragile elements of the skeleton (ribs), we do not assume that durable elements such as teeth, long bones of the limbs, finger joints, skull and others were originally part of the deposition, except for the mentioned small fragments of burnt bone diaphysis.

Fragments of wider ribs with a maximum recorded width of 3.6 cm belong to a large mammal. Although the fragments do not bear unequivocal taxonomically diagnostic features, we can completely rule out that they belonged to humans and non-ungulates. Since horse was excluded based on the morphology of some fragments, we can assume the second large farm animal in our region, the domestic cow (*Bos taurus*), which fits the observed morphology well. The morphological observation does also not allow a determination of whether the rib fragments formed one continuous piece of the body, or even to say that they belong to the same individual. The diagram therefore illustrates the volume of material rather than the exact position (*Fig. 15*: centre). However, as the diagram suggests, the back of the thorax was not recorded and the front ribs appeared only exceptionally, if at all. However, the excavated ribs represent the fleshy part of the body, albeit with a lower meat content. At least two rib fragments were cut diagonally with a saw, which evidences portioning outside the joints (*Fig. 15*: photo on the left). The longest preserved rib fragment (24 cm in length) does not correspond to cooking in a small pot.

One burnt fragment of the diaphysis belongs to a large and the other to a medium-sized mammal, thus testifying to the presence of at least two animal species in the given context. The burning of the bones is perfect, to a white colour, so we can speculate they were disposed of in a fire after consumption.

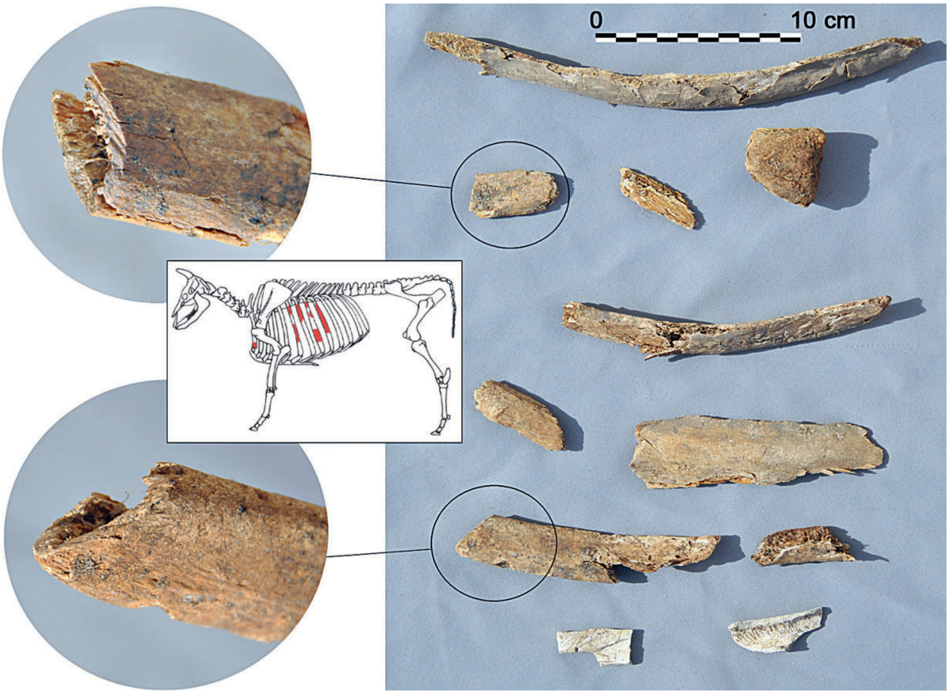

Fig. 15. Sauersack/Rolava. Bone finds from the layer 20 cm–bottom. Right – complete assemblage of excavated bones (bottom two burnt fragments, above ribs). Left – details of diagonal sawing on two rib fragments. Centre – diagram of the cattle skeleton with the approximate anatomical position of the excavated rib (photo by R. Kyselý).

Cattle ribs were also identified in the assemblage excavated in 2019. Some of the cattle ribs in Facility Nr. 3 were also cut with a saw, but they are far from the dominant component there. Although the assemblage from 2019 found at the POW camp is more variable in terms of anatomical and taxonomic composition and includes more meaty parts of animal bodies (proximal parts of the limbs, vertebrae), they provide the same basic information. In both cases, they represent fleshy, commonly consumed body parts. Also, burnt bones were detected in both excavations. The obvious prevalent consumption of beef over, for example, less prestigious and cheaper pork is interpretationally challenging. A possible starting point here is the higher durability of beef during transport and storage in suboptimal conditions, as illustrated by traditional bans on pork in Middle Eastern (Islamic, Jewish) cultures.

Conclusion: things, peoples, and identities behind the barbed wire

The archaeological study of the settlement waste of specific communities formed by the historical circumstances of World War II is now a highly frequent and globally expanding research topic. Interest in these issues was sparked in the context of Holocaust commemoration (*Theune 2006*; *2010*), but soon expanded to include various groups of internees (e.g. US citizens of Japanese origin, *Camp 2016*), forced labourers (*Vařeka 2024*), and naturally also combatants (e. g. Luftwaffe personnel in Finland, *Väisänen et al. 2023*). Only in quite exceptional cases, however, can archaeological interest in World War II camps be considered comprehensive on the level of evidence and preservation, of (academic) research, and on the level of presentation to the public (the situation in the State of Brandenburg is exceptional in this respect, cf. *Kersting 2022*).

The involvement of semi-professional researchers and often mere collectors of World War II artefacts is currently very high and unfortunately not always positive. On the one hand, it brings, especially through the deployment of metal detectors, knowledge about unique artefacts (post-processual 'biographies of things', e.g. *Alsdorf 2001*), but at the same time threatens the contexts that should be investigated in their entirety (complex analysis of artefacts and ecofacts, study of processes of selection and formation of settlement waste).

On the contrary, so far less common academic, processual-oriented research, which focuses mainly on the mutual contextualisation of individual categories of artefacts and ecofacts (e.g. *Olsen – Witmore 2014*; *Hausmair 2017*; *Seitsonen et al. 2021*; cf. *Baloun – Kypta 2023*, 43, who dismiss it as an 'archaeological children's game'), has yielded the most significant results for understanding group identities, social status, and everyday life of recent and only apparently well-known specific communities. We have addressed its principles in the case of the Sauersack/Rolava POW camp excavations.

Research on the newly identified main settlement waste dump in 2022 provided new information and confirmed existing knowledge on the transformations related to the formation of the settlement waste community inhabiting this specific settlement. The nature of the immovable features (an intentional landfill connected to the camp site by a narrow-gauge railway) showed that waste management was significantly regulated. Thus, complex patterns of settlement waste transformations need to be rethought, which is a major interpretive shift from the results of the 2019 campaign. More organised waste management was considered only in the settlement area of the civil mining specialists (*Hasil et al. 2021*, 8).

The excavated artefacts and ecofacts confirmed very close patterns and identical trends to the POW camp waste from the 2019 campaign. It was possible to demonstrate that a sample as small as approximately 1 m^3 is sufficient for identify the community that produced it. On the other hand, it is now clear that the material world of the community inhabiting the camp was much more complex than could be described by artefacts and ecofacts coming from the context of intentional waste disposal alone. Thus, even a comprehensive image of life at the settlement would not be complete if it depended solely on the archaeological record. Most glaring in this respect is the absence of material evidence of the two antagonistic groups, the prisoners and the guards, as well as the utterly meagre number of finds that could be associated with the equipment of modern armies. Although military gear components are not a category of items that would enter settlement waste on a daily basis, it is still surprising that the rotation of many hundreds of men (POWs were not deprived of their own equipment, on the contrary, they were re-supplied with loot or German gear elements, if needed), including at least dozens of fully equipped Wehrmacht guards, caused practically no contamination of the regularly discarded waste. In the future, research interest will therefore need to be directed towards the recognition of other find contexts such as lost objects we might expect, e.g. in the camp's sewers, latrines, and the remains of residential buildings. In contrast, the discovery of a large number of medicine containers points in an incredibly straightforward direction to the memories of eyewitnesses about German and Belarussian doctors – and above all both in a semi-formal status – at the site. We regard all of these observations as substantial methodological insight, especially for the archaeology of societies and cultures whose internal structure lacks a non-archaeological key to being understood.

Waste management has been repeatedly described in other contexts as a material manifestation of claiming group identity (*Birch 2012*; *Burgert et al. 2014*; *Květina – Řídký 2017*). In the case of a specific settlement such as the POW camp, we can reformulate this view in the way that the instrumentalisation of human and material actors (*Hasil et al. 2021*, 24) led to the imposition of this identity. It is remarkable that groups which, based on the historical narrative, we will always consider antagonistic within the community of inhabitants (captives vs. guards) respected this social reality at least to the extent that they acted in unity at the level of waste management.

Finally, let us return to Tolstoy's thesis that the role of the individual in history cannot be seen as central or peripheral. This paper, then, has sought to demonstrate that a collection of (sub)recent, seemingly banal artefacts and ecofacts can, perhaps as a single source, preserve the trace of nameless men '*who fired, or transported provisions and guns*' or co-formed the community of Sauersack/Rolava POW camp residents. As such, they are significant material relics of World War II alongside iconic artefacts attracting tens of thousands of visitors each year, i.e. the *USS Arizona*, the Boeing B-17F of Ser. No. 41-24485 called *Memphis Belle*, and U-Boat Type VIIC *U-995*, which represent the imaginary role of Emperor Napoleon or Tsar Alexander in Tolstoy's parable. We believe that we have succeeded in demonstrating that modern settlement waste provides a space for the full application of archaeological theory and methods, and that it provides more than mere props for the actors of the historical narrative, offering equally valuable, authentic, and immanent testimony.

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DISCUSSION – DISKUZE

Celtic migrations and the spread of La Tène Culture: A consideration of possible explanatory models

Keltské migrace a šíření laténské kultury: úvaha nad možnými vysvětlujícími modely

Martin Schönfelder

Migrations and mobility are key issues within archaeological research. The La Tène culture of Central Europe (450–20 BC) underwent deep transformative processes in the 4th and 3rd century BC, traditionally named as the 'Celtic migrations' and attested by written sources, and the spread of La Tène culture across Europe, which is explicitly conceived here as a phenomenon in its own right. Is it possible to corroborate one with another? In this article, I propose three models which may help to explain the main processes behind the archaeological phenomena of the 'Celtic migrations'. These explanatory models and new results are based on long-term research of the La Tène societies of the 4th/3rd century BC, which were deeply rooted in the ideals and behavioural norms of the 'princely' elites of the 5th century BC.

Iron Age – La Tène – mobility – migration – mercenaries

Migrace a mobilita jsou klíčová témata archeologického výzkumu. Laténská kultura ve střední Evropě (450–20 př. n. l.) prošla ve 4. a 3. století př. n. l. hlubokými transformačními procesy, které se projevily dvojím způsobem. Jeden z projevů, doložený v písemných pramenech, tradičně označujeme jako „keltské migrace“. Za další projev považujeme soudobé šíření laténské kultury po Evropě, které je v tomto textu explicitně pojato jako samostatný fenomén. Je možné potvrdit jedno druhým? V tomto článku navrhuji tři modely, které mohou pomoci vysvětlit hlavní procesy stojící za archeologickými fenomény „keltských migrací“. Tyto interpretační modely a nové výsledky vycházejí z dlouhodobých výzkumů laténských společností 4./3. století př. n. l., které byly hluboce zakořeněny v idejích a behaviorálních normách „knížecích“ elit 5. století př. n. l.

doba železná – laténská kultura – mobilita – migrace – žoldnéři

Introduction

By way of the 'Celtic migrations', Central Europe and La Tène culture entered history (for definitions and research overview see *Kaenel 2007*; *Fitzpatrick 2018*). The material culture of the 'Celts' was identified fairly early on (*de Mortillet 1870/1871*; *Collis 2003*) and the characterisation of these people as wild warriors was attributed, at least in the press, by popular illustrations and museum exhibitions. The chariot with two furious warriors in the entrance hall of the Keltenmuseum Hallein is a good example. In the early years of research 'Celtic migrations' were tracked by archaeologists using a simple historical model: they took Greek and Roman written sources at face value and assumed the accounts of these writers to be the historical truth, or close to it (e.g. *Kruta 1978*; *1981*; *Frey 1996*). The topics of mobility and migration are now a fundamental focus of current archaeological research (*Fernández-Götz et al. 2023*).

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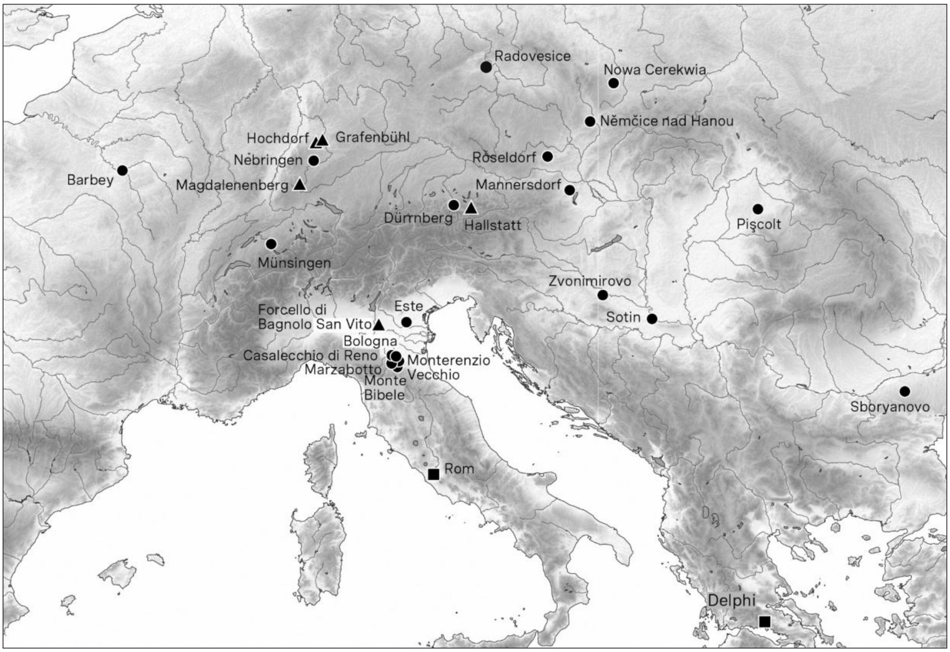

Fig. 1. Sites mentioned in the text and other selected key sites of the 'Celtic migrations' (map M. Ober, LEIZA).

Until today, little work has been done on the background of the migrations and cultural spreads in the Iron Age. They have been stated and described but not questioned. Individual keywords were mentioned but not put to the test on the archaeological find material for the areas with 'Celtic' influence in Italy and the Danube region (*Fig. 1*). In the following text, migrations and cultural spreads will be taken up here and further deepened.

The traditional views

Over the last decades, archaeology has considered how La Tène culture (supraregionally defined by the relevant fibulae, weapons, and art) was spread over the eastern part of Central Europe. Informative results have been obtained for the Carpathian Basin, where a leapfrog movement of La Tène groups or 'colonists' is assumed along the northern border of the Carpathian Basin, from Slovakia to Romania, as described by Aurel Rustoiu (*Fig. 2*; *Rustoiu 2012*, 362, Fig. 3). These groups spread further south, to Serbia and into Croatia (*Popović 1996*; *Ljuština 2013*; *Drnić 2020*). La Tène finds have been identified in even greater numbers as far south as Bulgaria (*Megaw et al. 2000*; *Anastassov 2011*) and Moldavia (*Munteanu et al. 2020*), fibulae even further afield (*Hellström 2018*).

Bands and fraternities of young warriors have been suggested as the main protagonists of the 'Celtic migrations' (*Wendling 2013*). The model of the *ver sacrum* ('sacred spring' – a generation of young adults earlier determined by religion had to leave the community) is currently the preferred explanation (e.g. *López Sánchez 2018*, 185; for its origins see:

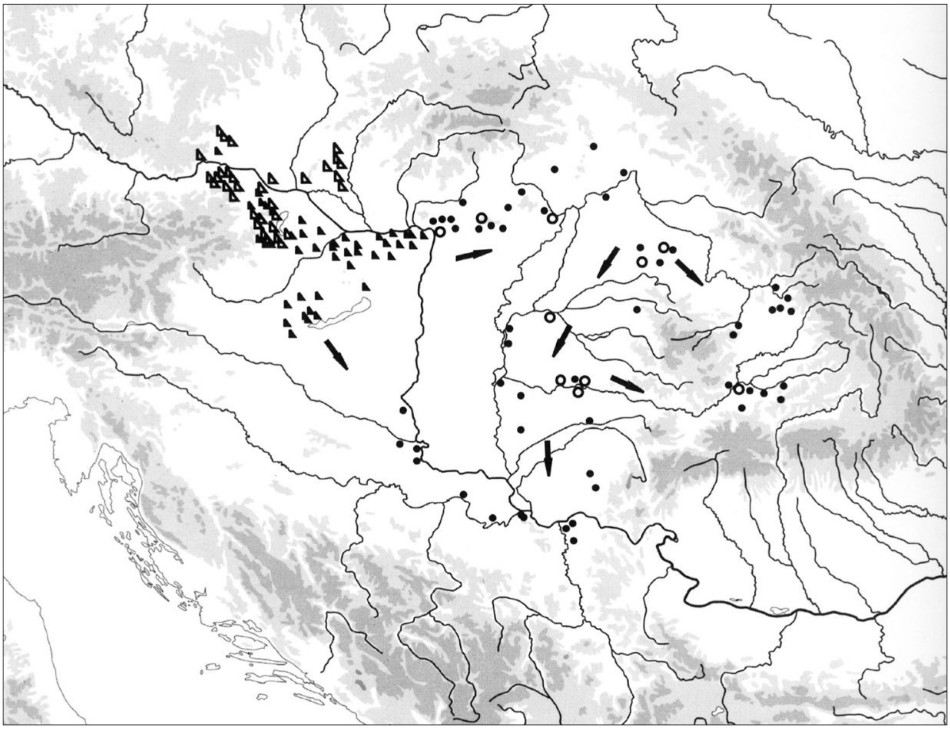

Fig. 2. Distribution map of early La Tène burials from the Carpathian Basin and directions of 'Celtic colonisation' following the ideas of Aurel Rustoiu. White triangles – cemeteries LT A; black triangles – cemeteries LT B1; white dots – cemeteries beginning in LT B1/B2; black dots – cemeteries beginning in LT B2 (after *Rustoiu 2012*, 362, Fig. 3; reproduced with kind permission of A. Rustoiu).

de Cazanove 2000). In contrast to the conventional view of whole groups of 'colonists' (*Rustoiu 2012*) or warriors (*Wendling 2013*), a rather supplemental model will be proposed here; the prevailing views regarding the general directions of these movements and their chronology are, however, accepted.

Continental European Iron Age archaeology has, so far, participated little in more theoretical debates regarding the 'entanglements', which might have occurred within migrations in general (see *Pollex et al. 2005*; *Ulf 2014*), and in the 'period of the Celtic migrations' in particular. Manuel Fernández-Götz has illustrated the current challenges quite clearly stating that long-distance movements of populations should not be excluded in our considerations on cultural change (*Fernández-Götz 2016*; *2019*; see also *Fernández-Götz et al. 2023*).

The written sources available for the 'Celtic migrations' tell us about push and pull strategies as recounted in legends (see *Tomaschitz 2002*; *Urban 2007*). In the story of Ambigatus, king of the Bituriges, overpopulation is the reason for migration to the East and South (*Livius, Ab urbe condita* V, 34; *Foster 1967*), whereas the legend of Arrun tells about imported wine, olive oil, and figs, luring the Celts to warmer climes (*Livius, Ab urbe condita* V, 33; *Foster 1967*; *Plutarch*, *Camillus* 15, 3–6; *Perrin 1968*; *Dionysius of Halicarnassus, Antiquitates Romanae* 13, 10–11; *Spelmann 1963*). Similar to this story is that told about

Helicon the Helvetian; a craftsman, who had visited Italy and who attracted his fellow tribesmen south with local fruits (*Plinius, Naturalis historia* XII, 2, 5; *Rackham 1960*). All these legends explain the motivation(s) of the Celts to Mediterranean readers, similar to the well known legends about Greek colonisation in the Classical Period. Today, few believe these legends have any connection with the reality in antiquity, and are now recounted solely as anecdotal models.

A decline of the climate and the associated crop failures around 400 BC, attested by ice cores and other climate proxies (*Maise 1998*), were a potential trigger for the 'Celtic migrations' to Italy (even if the details are hard to prove: *Nortmann – Schönfelder 2009*; *Schneider 2012*, 221–222). The Italian migrations climaxed in the conquest of Rome in 390/387 by Brennus following the battle of the Allia (*Plutarch*, *Camillus* 22, 4; *Perrin 1968*). In the following years, La Tène culture (and the 'Celts'?) spread to the East, the Carpathian Basin, to Greece (Delphi 279 BC), and finally to Galatia (*Jovanović 2014*); though these later movements cannot be connected to the climatic evidence.

The generally high degree of mobility within the La Tène society (cf. *Woolf 2016*; *Fitzpatrick 2018*) is attested by research on strontium isotopes and other methods of a statistically relevant number of burials from several cemeteries. Analyses focused both on the core area of the La Tène culture and on the new areas which are supposed to have received settlers (*Hauschild et al. 2013*; *Scheeres et al. 2013*; *2014*; *Alt – Schönfelder 2017*). New scientific data from promising projects (*Sorrentino et al. 2018*; *Laffranchi 2019*; *2022*) must be further correlated with archaeology.

But how did La Tène really spread?

A major question remains unasked (for the wrong questions on this subject see *Anthony 1990*, 897–899) and unresolved: How did the La Tène culture spread? No real answers had been presented until now, as the historical texts had been in the focus.

The 'migrations' to Italy should be the primary focus of study, as they are, at present, the only ones which can be accepted as involving a genuine movement of large groups of people to a distant location. The model presented here can be called the *baggage train model*. Additionally, two other models – *marriages with long-distance partners* and *fostering of children* – provide further potential explanations for the reasons how La Tène culture spread over large areas of Europe.

These models are based on systematic observations of La Tène finds in eastern and southern Europe: first, these are individual weapons or rarely entire panoplies, which spread quickly and set standards, and second, clothing accessories and women's jewellery, which are found also as individual objects, occasionally as entire sets. Trade goods (tin, amber and others) and diplomatic gifts (bronze vessels, textiles and others) existed but in this period we are not yet moving in an economically shaped coinage economy. The mobility of objects in a proto-market economy was therefore always connected with the personal relationships of people (*Brück 2015*).

Concerning the mobility of goods and the people involved, we should imagine a system of long-established networks between the South and North, in which mainly western alpine groups (chiefly the Golasecca culture: *Cicolani 2017*; *Cicolani – Zamboni 2023*) played a major role. A range of goods had been crossing the Alps since the Hallstatt Iron

Age – bronze vessels (*Naso 2017*; *2019*), brooches (*Ettel 2005*; *vice versa*: *Frey 1971*; *De Marinis 1987*), and raw materials like coral and others (*Fürst et al. 2016*). The Alps may have hindered transport, but never prevented contacts existing.

The models proposed here are intended to enrich the discussion on the spread of La Tène culture; the mobility of warrior groups to Italy or Greece is not to be denied.

Crossing the Alps with a baggage train

For some time it has been evident that no Celtic tribe crossed the Alps in its entirety. Central Europe was not emptied around 400 BC. Although the levels of human activity appear to decrease in the LT B1b/B2 phase (around 350/300 BC), this is mainly due to the change in burial rite from tumuli in LT A to flat burials in LT B. Furthermore, we can observe rather de-centralised settlement patterns with even more scattered burials (see *Mennessier-Jouannet et al. 2007*; e.g. Dornach, Lkr. München, Germany: *Irlinger – Winghart 1999*, 76–78, 91–92). The large proto-urban and fortified settlements, known in LT A, such as in Bohemia (*Chytráček et al. 2010*) or northern Bavaria (*Pare 2009*; *Schußmann 2010*, 149–151), are no longer occupied in LT B2. The archaeological traces of 'Celtic tribes' in northern Italy do not correspond to an entire population with women and men in equal portions, as can be seen in the Bologna cemeteries, at Monte Bibele and in Monterenzio Veccio (prov. Bologna, Italy; *Vitali 1992*; *2003*; *Vitali – Verger 2008*). A significant mixing of populations at the latter two sites can be documented by strontium isotopes (*Sorrentino et al. 2018*), even though the local geology is changing fast and like this restricts any strong statements (see *Scheeres et al. 2013*, 3617–3618). Small children and seniors might never have been part of such a demanding adventure. Evidence for Celtic women, in the form of LT A/B1a female jewellery from the time of the 'real migrations', is likewise rare.

If the *Senones*, the latest 'tribe' which arrived in Italy, had been attacking Rome in 387 BC, the largest population movements would presumably have occurred in the years before. According to the current absolute chronology (*Sormaz – Stöllner 2005*), this would have taken place at the end of the LT A phase. During LT A there are no substantial La Tène traces in Italy (see *Vitali 1992*; *2003*). The only potential site assigned to the *Boii* is Casalecchio di Reno on the southwestern outskirts of Bologna (*Ortalli 2008*). Rare examples of Celtic female bronze jewellery, mainly in the form of *Hohlbuckelringe* in Marzabotto (prov. Bologna; *Kruta Poppi 1975*), are typical of LT B2, i.e. the second half of the 3rd century BC (*Fig. 3*; see *Fábry 2008*, 129, Fig. 2 and 3; *Geschwind 2020*).

In sum, the Alps appear to have been rather crossed by bands of young Celtic warriors in more or less organised tracks, perhaps starting in some central European regions under the initiative of leaders, to whom they gave tribal names to the travelling warriors. The small number of women could be explained by female companions in the baggage train of these expeditions, which passed through those parts of the Alps under control of the communities of the Golasecca culture (*Schönfelder 2010*).

Such a model of the 'Celtic migrations' is a good possibility for explaining the spread of La Tène weapons considered as victorious weapons, and some other accompanying finds in a short period of time in this one part of the Mediterranean world. Weapons with a perceived or real feeling of superiority crossed the Alps in large numbers, thereby creating local demands for such weapons across a broad area of northern Italy (*Reinecke 1940*; *Dore 1995*). This in turn would have stimulated local production and imitation of such weapons

Fig. 3. Hollow boss rings (*Hohlbuckelringe*) from Marzabotto (prov. Bologna, Italy; photos and drawings with kind permission of H. Geschwind).

(*Vitali 1996*). The distribution of La Tène objects in Greece might have followed other mechanisms, as discussed in more detail below.

The baggage train model also helps to explain the distribution of Celtic names for tribes and individuals in Northern Italy. Any attempt to explain the spread of La Tène culture, however, would appear to require an additional model. How did female jewellery and other parts of the La Tène cultural package spread, especially in the Carpathian basin, and over the great distance from the far West to the East, and *vice versa*? Some forms, like *Hohlbuckelringe* or pseudo-filigrane decoration on bronzes, inspired or said to be inspired by the Eastern Celts, have also been found in the west e.g. in France (cf. *Duval 1977*; *Kruta 1985*).

These interpretations are not new but at the same time, they lead to a dead end if we want to examine generally the spread of La Tène culture into its margins. Especially in the Carpathian Basin, La Tène women's jewellery is more numerous than weapons. So here we need complementary or other proposals.

Adopting habits of the elite: marriages with long-distance partners

The 5th century BC was still a time of princely graves (*Fürstengräber*) and princely sites (*Fürstensitze*) in some parts of Central Europe. Impressive burial barrows and opulent gold jewellery reflect a society with significant social divisions (*Haffner 1991*; *Hunter – Joy 2015*). These princely elites or aristocracy followed, at least for a few generations, a seemingly homogenous lifestyle, judging by the burial rite used to identify them. For example, imported bronze vessels were used for over two to three centuries in a specific way (*Naso 2017*; *2019*). The same can be said for weapons, gold jewellery, and the use of exotic raw materials, like glass, amber, and coral. By contrast, the criteria for distinguishing between 'minor nobles' and 'normal people' is not well-defined. Based on the evidence for upper societal echelons, a pronounced elite funerary style evolved over time, involving a whole range of prestige accessories, undergoing different changes in different parts of Europe (see recently *Bardelli 2017* for the upper Rhine region; *Schönfelder 2016* for Champagne region).

Personal connections and heroic narratives are likely reasons for such a dynamic periphery, though in the core area, a mainly homogenous elite behaviour seems to have existed. Personal contacts may have taken place in private and public spaces and probably also at funerals (for the performative character, see *Wendling 2018*). The funeral ceremonies were likely oriented not only to the needs of grieving locals, but also to other elite persons, as they would have better understood the numerous ornate grave goods. The distribution of similar types of gold jewellery in princely graves, such as gold torques, but also in the graves of 'princesses', like gold beads (*Wendling 2019*, 173–181) and ear/hair rings, show that women were also involved in these elite networks (*Metzner-Nebelsick 2009*; *Trémaud 2017*; *Winger 2017*). The basis for this phenomenon is probably exogenous elite marriages.

Isotopic studies of inhumations from the Magdalenenberg–Tumulus (Schwarzwald-Baar-Kreis, Germany) show that at least some women interred with foreign objects may have had non-local origins based on their isotopic values (*Oelze et al. 2012*; *Koch 2017*). Preliminary studies of the aDNA from 6th century BC late Hallstatt princely graves are beginning to show genetic relations between elites over some distance. For example between the Hochdorf and Asperg 'Grafenbühl' (both Lkr. Ludwigsburg, Germany; a distance of some 11–12 km; *Krausse 2005*). These studies are still in their early stages, and it is hoped that further analyses will provide more satisfactory results.

Concerning the circumstances of this time, it seems that *exogenous marriages* were one of the most important expressions of elite behaviour: they demonstrated bonds to other communities by marriages, by a foreign tongue, and maybe even by the use of foreign jewellery. Such displays of elite behaviour must have been important for the local nobility and were likely recompensed for by a *vice-versa* exchange of marriage partners. Elite marriages enabled personal networks to develop in the Early Iron Age. Such networks probably did not reach beyond the Alps, but rather to neighbouring regions, including the key sites at the salt mines of Hallstatt and Dürrnberg. Here, we also find foreign objects (*Schumann 2015*, 120–123; *Pauli 1978*, 443–455), for example the Upper Rhine *Einknotenring* golden bracelet from Dürrnberg grave 200 (*Zeller 1992*; *Guggisberg 2000*, 112–113, Fig. 120) and the aforementioned gold beads (*Wendling 2019*, 173–181). From Hallstatt and Dürrnberg, the contacts extended further south (*Wendling 2014*).

Following the transition to LT B around 380 BC, a different La Tène society emerged. The princely elites represented in Ha D and LT A are less visible. Rather, many more men sought to express themselves, or were expressed, as warriors resulting in imports and banqueting becoming less prevalent in the burial record. Instead of being buried with elaborate 'princely' objects, many men received a full panoply of weapons (shield, spear and sword). Grave enclosures, as signs of separation from others, became popular for these 'modest' elites in many parts of Europe (*Becker 1995*; cf. *Repka 2020*). It appears that from LT B2 onwards there was some sort of a levelling of the elites.

Traditionally, archaeologists concentrated on imports and on the warriors when discussing social developments within the La Tène society, especially as 'rich' female elites are far less visible beyond more or less heavy bronze jewellery (for a new focus on women in the southern Carpathian Basin see *Dizdar 2018*; *2020*). But if we accept that there was a fundamental change in society, we must consider the role women or families played, not solely those males who sought to portray themselves as warriors and followed aristocratic habits.

It seems that an elite burial was a perceived necessity for large sections of La Tène society; nevertheless, much more in demand was an aristocratic lifestyle. It is also likely that, compared to the Hallstatt period, a larger part of society got involved in long-distance marriages. These marriages were arranged, confirmed, and renewed. This model is better able to explain the greater number of La Tène objects in former non-La Tène environments. La Tène weapons were adopted and LT B ring jewellery and fibulae spread in all directions: to western and southern France, the Alpine regions, and the Carpathian Basin. A fascinating case study is some of the heavy and enamel decorated bronze torques with discs (e.g. *Scheibenhalsringe*, type D according to Felix Müller), which are typical of the southern Upper Rhine valley, but individual examples of which are known from Champagne, Ticino, and the northern Carpathian Basin (*Fig. 4*; *Müller 1989*, 85–88). Fibulae of the Münsingen group can also be added to these objects exchanged over long distances (see *Bujna 1998*; *Guštin 1998* for subtypes in detail). Although these artefacts rarely appear as sets of objects, collectively they give an image of distribution. Its core was in Central Europe (albeit with gaps, due to restricted numbers of discoveries depending on the local topography) and isolated finds come from female graves in the periphery. They need not be direct evidence of individual female mobility, indeed they could already have belonged to a second generation. Within the Carpathian Basin, locally made female La Tène jewellery also spread and some specific regional distribution patterns can be observed (*Dizdar 2018*; *2020*). Therefore, this is a period when Central European connections existed and imports from the Mediterranean played a much-reduced role than in the preceding period of the 'princes' – even though this was the time of 'Celtic' raids into Hellenistic Greece. Booty did not pay – but this is a different story (*Schönfelder 2007*). This rise in individual mobility is, therefore, a key development for understanding the spread of La Tène culture.

Affirmation of family ties: fostering of children

Children buried with rich funerary equipment represent a new phenomenon in the Early Iron Age (*Schumann 2015*, 295–303). The puzzle of its origins is yet to be solved. Robert Schumann has questioned the interpretation of these burials as indicators of inherited social status since they are not frequent. In any case, these burials show that children could have had an important meaning in the minds of local communities. If these well-equipped infant burials do not represent the heirs of early La Tène elites, we must search for other explanatory models. Here, we have to agree with Schumann, even if it leaves well-trodden paths.

Fig. 4. *Scheibenhalsringe* from the southern Upper Rhine valley discovered in the Carpathian Basin: A – Pişcolt grave 108, jud. Satu Mare, Romania; B – Distribution map of Müller's group D *Scheibenhalsringe* (after *Müller 1989*, Pl. 52. Suppl. 3; reproduced with kind permission of F. Müller).

Fostering children of allied families was a widespread phenomenon on the continent during the Middle Ages and in the Celtic-speaking areas of the Atlantic (*Parkes 2006*). It helped to generate a spirit of noble community in the Middle Ages over a long distance. Children were forced to leave home, but in doing so they learned to understand a little bit more about the world and the social systems of their parents and the foster parents.

Raimund Karl has proposed a system of fostering children, at least for young boys, for the late Pre-Roman Iron Age based on the written sources of the British Isles and by transferring ideas from the 'Celtic' Middle Ages to the past (*Karl 2005*). The giving of children as hostages is a well-known model of Roman cultural propagation for the late Republic

(*Creigthon 2000*). Therefore, it seems legitimate to reflect on such phenomena in the societies of La Tène culture as well. The idea of fostering children had been neglected for a long time in archaeology, but with modern isotope studies, it may become increasingly relevant for the Pre-Roman Iron Age.

Isotopic studies in larger La Tène cemeteries, like Nebringen (Lkr. Böblingen, Germany; grave 20, 14–15 years) and Radovesice II 'Na Vyhlídce' (okr. Litoměřice, Czech Republic; grave 6, child, >6 years), show that also children could have foreign origins (*Scheeres et al 2013*, 3620; *2014*, 507). In light of their rather normal grave equipments, these observations require an explanation. Some rare graves with special children's weapons can be cited here: for girls with simple small ring jewellery, the numbers are relatively high; for boys it looks different. A grave dated to this LT B2 phase is known from Barbey (dép. Seine-et-Marne, France) at the Seine and Yonne rivers confluence. It contained a 12–14 years old boy with a bronze torque and equipped with a child-size sword (*Rapin 2002*). Another example of such a short weapon comes from Este 'Campodaglio' grave 38 (prov. Padua, Italy; *Vitali 1996*, 588–592). This is remarkable, as weapons for little 'princes' were not produced for 'princely burials' in the LT A phase, but for elite warrior burials in the LT B phase. A similar weapon of short size (only 46.9 cm) from Grave 15 in Radovesice was deposited – for whatever reasons – in a normal adult grave (*Waldhauser 1987*, 119–120, Pl. 21).

A proposal of foster children brought up in a foreign land, as evidenced by the strontium evidence, seems plausible, if we accept, that elite behaviour was emulated by a large part of the population.

Further raids

Further raids of 'Celtic' armies reached Greece in 280–277 BC, and large groups of warriors were hired as mercenaries (*Jovanović 2014*; *López Sánchez 2018*). In these cases, the baggage train model can be applied again. It is important in these instances to discuss the potential origin of these armies. 'Celtic' armies and mercenaries did not necessarily need to have originated in Central Europe and travelled to the southernmost parts of the Balkans. What is meant by the label 'Celtic' in the Greek? Language? Armament? A way of fighting? Tribal structures? Or simply their 'barbarian' character?

We can be sure that some warriors were recruited in the large, unenclosed middle La Tène settlement of Němčice nad Hanou in Moravia on account of the numismatic evidence. Coins found here came from the very areas of the Mediterranean where mercenaries were recruited (*Kolníková 2012*). Further examples of such potential recruitment sites include Roseldorf in Lower Austria (*Holzer 2014*) and Nowa Cerekwia in Upper Silesia, even north of the Carpathians (*Rudnicki 2014*). At present, however, we do not know how Celtic, how La Tène these armies may have been, which individuals and ethnicities installed themselves in Bulgaria according to written sources, who raided Greece and who became mercenaries. It might be that large parts of these armies had been coming together in the newly latènised regions in the Carpathian Basin – or that they may have had some 'Illyrian' origin (*López Sánchez 2018*, 190–191). La Tène relics in Greece are very scarce and do not seem to be connected with the key date of the 279 BC raid (cf. *Kysela – Kimmey 2020*).

Conclusions

The spread of a new cultural phenomenon to another region is one of the key questions in prehistory. Models of migration of tribes and warrior groups in the 'period of Celtic migrations' have evolved over the last 100 years following the prevailing theoretical and political opinion of the time. None of these models have been detailed enough. None have been fully persuasive, as the historic 'Celtic migrations' do not explain the spread of the Celtic La Tène culture; up to now, no consistent picture has been achieved. Within this perspective, Italy and the Balkans do not follow the same scheme and both have previously been contradicted by former tendencies towards a diffusionist vision of development in Europe. Perhaps for these reasons, European Iron Age archaeology has displayed an aversion to the topic of contact and mobility in modern edited volumes on the topic of contacts and mobility (*Lehoërff – Talon 2017*; *Boivin – Frachetti 2018*).

We have presented here three specific models to explain the large-scale occurrence of La Tène objects and the spread of the La Tène culture, which are coherent with the picture of the archaeological finds in the southern and eastern margins of the La Tène culture. They are supported by strontium isotopes analyses at key sites. The *baggage train model* explains what people had seen in the past: tribes on the move, even if it had only been a large band of warriors with a baggage train in the 'Celtic way', including some women.

Families with an open mind and aspirations of upward mobility within the warrior elite of the 4th and 3rd century BC finally spread La Tène culture all over Europe. This phenomenon is based on the evolving social structures. Societies, which needed 'princely tombs' to keep up continuity, developed later into societies, which needed elite behaviour in the form of *elite marriages* and *fostered children* on a much bigger scale. This rise in tight-knit personal networks helped to spread La Tène culture.

The ideas presented in this paper have developed over some time. The research was initiated by a DFG financed project on Iron Age mobility 'Mobilität und Migration in der Eisenzeit (4./3. Jh. v. Chr.). Archäologische und bioarchäometrische Ansätze zum Nachweis von Einheimischen und Zuwanderern'. Further discussions with Kurt W. Alt (Krems), Markus Egg (Mainz), Andrew Fitzpatrick (Leicester), Sebastian Fürst (Saarbrücken), Heidi Geschwind (Niederweimar), Raimon Graells y Fabregat (Alicante), Corina Knipper (Mannheim), Andrew Lamb (Hradec Králové), Pavel Sankot (Prague) and others have helped to develop these ideas. I am grateful to Heidi Geschwind (Niederweimar), Felix Müller (Bern), and Aurel Rustoiu (Cluj-Napoca) for the possibility to use their illustrations (digitally revised by Vera Kassühlke, RGZM), and Andrew Lamb for revising the English language.

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BOOK REVIEW – RECENZE

Michal Hlavica: Fragmenty Velké Moravy. Hrnčířské značky jako nástroj výzkumu společenské a politické komplexity Moravy 9. století. Spisy Archeologického ústavu AV ČR Brno 75, Archeologický ústav AV ČR, Brno, *Brno 2023*. ISSN 1804-1345. 179 str., 44 obr., 4 tab., katalog.

Snahou autora bylo přispět nejen k diskusi o tom, jak nazývat mocenský útvar západních Slovanů v 9. stol., ale pomocí značek na dnech některých nádob charakterizovat distribuci tohoto běžného spotřebního artefaktu a tím osvětlit i organizační strukturu Velké Moravy. K tématu přistoupil tak, že nejdříve shrnul závěry diskuse týkající se charakteru a názvu Velké Moravy označované někdy jako stát, feudální stát, cyklické náčelnictví či raný stát. Do diskuse přispěl i aplikací pojmu „zrcadlová říše“, která představuje „*…periferní společenství organizující se v reakci na interakce s mnohem vyspělejší říší ve svém sousedství…*“ (str. 8). Se znalostí různých modelů se pokusil „*…ukázat, jaké mechanizmy vedly ke vzniku konfederačního uspořádání Velké Moravy…*“ (str. 9). Jako vhodný model autor zvolil organizační strukturu náčelnické konfederace, na jejímž vrcholu stál vůdce konfederace, o něco níže regionální náčelníci, kterým byli podřízeni komunitní náčelníci s lokální komunitou.

Za území, které bylo možné z centra efektivně spravovat, považuje kruh o poloměru 25–30 km. Tato vzdálenost podle autora odpovídá půldennímu pochodu. Znamenalo by to, že během jednoho dne je možno pěšky urazit 50 až 60 km, což by výjimečně trénovaný jedinec mohl zvládnout, ale pro běžný provoz to není pravděpodobná představa. Podobně příliš optimistický je i autorův předpoklad, že trasu od břehů Dunaje na Pohansko u Břeclavi bylo možné zvládnout pěšky za jeden den, tj. 16 hodin (str. 83). Vzhledem k tomu, že na tehdejších cestách se zvláště při transportu zboží cestovalo pomaleji, jeví se jako reálnější odhad, že 25 až 30 km byla vzdálenost dosažitelná pěšky za jeden celý den.

Jako politický model se pro Velkou Moravu hodí podle autora decentralizované společenství zrcadlové říše, které aplikuje na konkrétní situaci. Napsat, že politické ekonomii velkomoravských vládnoucích elit dominoval „*mobilně-predátorský produkční mód*“ (str. 27), zní uším dnešního Středoevropana tvrdě. Vzhledem k tomu, že termín predátor se užívá především v souvislosti s označením jiných živočichů než člověka, hodilo by se lépe místo predátorský použít výraz kořistnický.

Okrajově se autor dotkl koncentrace mohylových pohřebišť u Rudimova, které zřejmě souvisí s výskytem pelosideritických rud. Zatím není prokázáno, že by zde byla doložena „*…dislokace monumentálních pohřbů a ceremoniálních shromažďovacích míst…*“, které by dokazovaly nároky velkomoravských elit žijících v osmadvacet kilometrů vzdáleném Starém Městě u Uherského Hradiště (str. 28). Produkce železa a jeho zpracování v tomto období je také prokázána v Moravském krasu a Boskovické brázdě, kde se uvažuje o rozdílném charakteru organizace ve vztahu k mocenskému centru na Starých Zámcích u Líšně (*Mikulec et al. 2022*). Speciálně zaměřený výzkum by zde mohl ledacos prokázat. Jen necelých 20 km od Rudimova leží vrch Klášťov označený jako „*…centrum s předpokládanou ceremoniální funkcí…*“ (str. 29). K tomu lze dodat, že by se dobře hodilo označení tohoto místa jako „*hrdla, které se materializovalo do podoby exkluzivní kontroly nad uzlovým bodem dálkového a regionálního obchodu či kontroly nad přepravou importovaného zboží*“ (str. 27). V přeneseném slova smyslu bychom mohli hovořit o celnici kontrolující transport zboží mezi Nitranským knížectvím a Moravou. Co se týká směny, autor počítá s tím, že „*podstatná část ekonomické i politické moci (byla) v rukou regionálních elit*“ (str. 36) a velkomoravští vladaři měli „*jen omezenou ekonomickou a politickou moc*“ (str. 37). Nejednalo se tedy podle něj o stát feudálního typu, ale o mocensky decentralizovanou náčelnickou konfederaci.

Za velmi důležitou obchodní komoditu je třeba považovat sůl, transportovanou od Dunaje do nadregionálního tržního centra na Pohansku a odtud do regionálních center (Znojmo, Brno-Líšeň,

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Staré Město u Uh. Hradiště) vzdálených okolo 60 km. Tento tržní systém je prezentován na dvou mapách (obr. 16, 17), kde jsou tržní centra a další významná sídliště zasazena do šestiúhelníkové sítě a predikovaných komunikací. Při pohledu na mapu na obr. 17 není jasné, proč Staré Brno bylo zařazeno do kategorie významných sídlišť této doby. Pozoruhodné je rozčlenění komunikace mezi Pohanskem a Brnem-Líšní na menší úseky, kde opevněná sídliště byla od sebe vzdálena kolem 15 km. Predikovat taková sídliště by bylo možno i na trase mezi Mikulčicemi a Starým Městem, nebo Strachotínem a Znojmem. Rozdělení důležité komunikace na menší, zhruba patnáctikilometrové úseky by jistě z hlediska kontroly trasy i provozu prospělo. Jádro Velké Moravy bylo tedy oblastí integrovanou do regionálního tržního systému a regionální tržní centra byla zároveň mocenskými centry.

Tržní systém autor testoval na značkách na dnech nádob z Mikulčic, Starých Zámků, Starého Města a Pohanska. Technikou frotáže sejmul značky na stovkách nádob, roztřídil je a vzájemně porovnal tak, že se z celého souboru vytřídil soubor 41 jistých a 18 pravděpodobných identických značek. Není překvapující, že identické značky se vyskytovaly především na jednotlivých lokalitách, ale značky identifikované na Pohansku a Mikulčicích jsou odrazem blízkých, nejen geografických, vazeb těchto lokalit. Identické značky z Pohanska a Starých Zámků, nebo rakouského Pellendorfu, ležícího zhruba na polovině cesty k Dunaji, je možno považovat za projev dálkového obchodu. Každopádně velikým překvapením je zjištění identické mikulčické značky na nádobě ze Staré Boleslavi vzdálené vzdušnou čarou 230 km. Oba fragmenty mají v keramice grafit, což prý rámcově datuje tyto kusy do období po zániku Velké Moravy. Grafitová keramika se však v Mikulčicích vyskytuje již ve velkomoravském období (*Poláček 1998*). Podrobnější rozbor materiálu, z něhož byly obě nádoby zhotoveny, by snad určil, zda se do Staré Boleslavi dostala celá nádoba z Mikulčic, nebo se tam vyskytoval hrnčíř, který opustil mikulčické centrum i s nářadím, respektive matricí. Názor, že po zániku Velké Moravy odcházeli řemeslníci do Čech, se potvrzuje například u šperkařů pracujících pro elitu pohřbenou na Pražském hradu (*Frolík – Smetánka 1997*, 70–71).

Autor svůj názor, že Velká Morava byla decentralizované společenství konfederačního uspořádání ekonomicky i politicky charakterizované z velké části jako autonomní náčelnictví (str. 87), testoval analýzou identických značek na keramice a dostatečně podložil dalšími relevantními argumenty. Jistě by bylo zajímavé stejnou metodou charakterizovat hospodářskou a politickou situaci na Moravě po připojení k přemyslovskému státu ve dvacátých nebo třicátých letech 11. století, kdy jsou známa tři údělná knížectví a další opevněná sídliště. Jaké označení z hlediska ekonomického a politického by se pro tuto situaci hodilo? Jisté je, že kniha Michala Hlavici naznačila nejen možná řešení, ale otevřela i další otázky.

Josef Unger

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BOOK REVIEW – RECENZE

Aleksandr Musin – Marcin Wołoszyn (eds.): The Sphinx of Slavic sigillography – small lead seals of "Drohiczyn type" from Czermno in their East European context. U Źródel Europy Środkowo-Wschodniej/Frühzeit Ostmitteleuropa. Tom 6/1. Leibniz-Institut für Geschichte und Kultur des östlichen Europa – Instytut Archeologii i Etnologii Polskiej Akademii Nauk – Instytut Archeologii Uniwersytetu Rzeszowkiego, *Kraków – Leipzig – Rzeszów – Saint Petersburg – Warszawa 2019*. ISBN 978-3-96023-289-6, 978-83-66463-00-4, 978-83-7996-693-6. 1128 str. a 1 vložená mapa.

Iwona Florkiewicz – Adrian Jusupović – Aleksandr Musin (eds.): The Sphinx of Slavic sigillography – small lead seals of "Drohiczyn type" from Czermno: material evidence. U Źródel Europy Środkowo-Wschodniej/Frühzeit Ostmitteleuropa. Tom 6/2. Leibniz-Institut für Geschichte und Kultur des östlichen Europa – Instytut Archeologii i Etnologii Polskiej Akademii Nauk – Instytut Archeologii Uniwersytetu Rzeszowkiego, *Kraków – Leipzig – Rzeszów – Saint Petersburg – Warszawa 2020*. ISBN 978-3-96023-362-6, 978-83-66463-28-8, 978-83-7996-809-1. 626 str. a 2 vložené mapy.

Pro archeology je důležité studovat i zahraniční odbornou literaturu pojednávající o artefaktech či jiných fenoménech, které se nevyskytují v jejich zájmové oblasti, a to přesto, že jsou běžně přítomné v sousedních regionech. Takové nálezy sice nemůžou použít jako zdroj přímých analogií ke svému materiálu, motivují je však přemýšlet o tom, proč se do jejich zájmové oblasti tyto artefakty nedostaly či zda tam přece jenom nejsou přítomny, ale zatím nebyly správně klasifikovány. Do této kategorie patří z perspektivy středoevropského badatele bezpochyby i malé olověné plomby či pečeti drohiczynského typu z 11. až 14. století, které ve střední Evropě dosud chybí, přestože se ve značných počtech objevují na území Kyjevské Rusi a jejích nástupnických knížectví, a dokonce i na východním okraji piastovského panství – v Podlesí. Jejich největší koncentrace, konkrétně 14 000 kusů, byla zjištěna na eponymní lokalitě Drohiczyn nad Bugem, která je považována za důležitou celnici na hranici mezi Kyjevskou Rusí a Polskem, resp. východní a střední Evropou.

Olovo samo o sobě představuje důležitou surovinu raného středověku, které se i u nás dostává v poslední době zasloužené, bohužel však stále ještě nedostatečné pozornosti (*Bláha et al. 2013*; *Macháček – Měchura 2013*; *Pták et al. 2018*). Teprve postupně si začínáme uvědomovat, že středověk necharakterizovala pouze „moc stříbra", ale i „moc olova" (*Musin 2022*). Jedním z mimořádně významných druhů olověných artefaktů byly pečeti a plomby, které sloužily nejen k pečetění listin a korespondence, ale také k označení převáženého zboží. Zatímco pečeti mohly být vyrobeny i z jiných materiálů, především vosku, plomby, jak naznačuje jejich etymologie, byly vyráběny dominantně (nikoli však výhradně) z olova (lat. *plumbum*). V českých archeologických nálezech se olověné plomby objevují poměrně sporadicky, a to až v kontextech 14. století či mladších (*Fröhlich – Chvojka 2016*). Označovaly se jimi nejen štůčky tkanin, ale i převážené koření, drahé kovy a některé potraviny (*Březinová 2007*, 93).

V jiných částech slovansky mluvící Evropy se středověké olověné pečeti a plomby vyskytují mnohem dříve a v podstatně větším množství. Příkladem jsou obě hlavní města Bulharské říše – Pliska a Preslav (*Jordanov 2003*), které stejně jako Kyjevská Rus patřily do sféry kulturního a politického vlivu Byzance, kde se olověné pečeti běžně používaly až do 13. stol.

Recenzovaná publikace, pojednávající o nálezech olověných plomb a pečetí ze střední a východní Evropy, je rozdělena do dvou dílů. V prvním jsou shromážděny příspěvky, které zčásti zazněly na mezinárodní konferenci v Krakově (2018), jejíž název se dostal i do titulu knihy „The Sphinx of Slavic sigillography". Druhý díl shrnuje nálezy olověných plomb získaných v okolí obcí Czermno

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a Gródek, ležících asi 200 km jižně od Drohiczyna. Zde byl v raném středověku vybudován na hranici Kyjevské Rusi důležitý pevnostní komplex, hypoteticky spojovaný s historicky známými Červeňskými hrady.

Komplexní analýzy plomb drohiczynského typu, konference i knihy jsou výstupem několika projektů podporovaných prestižní harvardskou institucí Dumbarton Oaks Center, polským ministerstvem kultury a národní výzkumnou agenturou i německým Leibniz-Institut für Geschichte und Kultur des östlichen Europa (GWZO), který je spolu s polskými institucemi i spoluvydavatelem knih. Oba recenzované svazky spojuje postava editora Aleksandra Musina, kterého doplnil Marcin Wołoszyn v prvním dílu a Iwona Florkiewicz a Adrian Jusupović v druhém dílu. Oba díly jsou psány dvojjazyčně – polsko-anglicky.

Téma recenzovaných knih je vysoce aktuální. Jestliže v 90. letech 20. století bylo známo asi 15 000 kusů plomb drohiczynského typu, dnes je to již dvojnásobek pocházející z více než 900 lokalit. Enormní nárůst jejich počtu souvisí s masivním rozšířením detektorů kovů, jejichž použití ve východní Evropě je široce diskutováno v úvodním příspěvku prvního dílu z pera obou editorů. Jsou zde srovnávány aktuální podmínky a praxe používání detektorů v různých zemích, a to včetně právních výkladů této činnosti – speciálně je v této souvislosti zmiňována Česká republika a práce publikované J. Maříkem o tomto tématu.

Z historiografického hlediska je nutno upozornit i na „politickou" dimenzi výzkumu plomb a pečetí drohiczynského typu. Velkou pozornost jim doposud věnovala především ruská, ukrajinská a běloruská věda, která tento fenomén spojovala s kyjevskými knížaty, zvláště Rurikovci, přičemž plombami se specifickou symbolikou měl být označován knížecí majetek. Geografické rozšíření plomb tak mělo delimitovat rozsah rurikovské panovnické moci. Asi nepřekvapí, že ve středoevropských zemích včetně Polska, kde jsou nálezy plomb drohiczynského typu také poměrně hojné, se jim dosud věnovala spíše menší pozornost, což mají recenzované publikace za úkol napravit. Stojí však za připomenutí, že olověné „ruské plomby" zmiňuje ve svém monumentálním díle již L. Niederle, který ovšem ještě nevěděl, jak je správně datovat (*Niederle 1925*, 409).

V prvním dílu je publikováno přes 20 textů z pera více než 30 autorů. Příspěvky jsou rozděleny do čtyř hlavních částí. První část je laděna historiograficky a muzeologicky. Jsou v ní popsány výsledky výzkumu hradiště v Drohiczynu a písemné zprávy o něm. Dále jsou zde prezentovány největší sbírky olověných plomb v petrohradské Ermitáži, Státním archeologickému muzeu ve Varšavě a Numismatickém kabinetu v Krakově. Analyzován je i ojedinělý písemný pramen – arabský cestopis z 12. století, v němž lze najít zmínku o diskutovaných plombách.

Druhou část knihy tvoří jediný, zato v celé knize nejdelší příspěvek, kterým je topografické zpracování a katalog plomb drohiczynského typu ve střední a východní Evropě, sestavený P. Gaydukovem. Kromě Ruska, Ukrajiny, Běloruska a Polska se plomby v menším počtu našly i na území Litvy a Lotyšska. Samostatnou přílohou knihy je mapa s lokalizací všech dosud známých nalezišť. Jsou nerovnoměrně rozptýleny na rozsáhlém území mezi Vislou a Volhou. K nám nejbližší je Sandomierz, která leží asi 350 km od Olomouce. Nejvýraznější koncentrace je patrná na dněperském levobřeží, mezi Dněprem a Desnou, dále mezi horním tokem Pripjati a řekou Styr či v okolí Smolenska.

Třetí část je věnována ikonografické analýze vyobrazení na plombách. Předpokládá se, že jde o dynastické či heraldické symboly Rurikovců, objevují se však i kříže, trojúhelníky jakožto symboly trojjedinosti boží, vyobrazení svatých, jednotlivá písmena cyrilice apod. Speciální pozornost je v knize věnována dynastickým symbolům, z nichž některé bývají srovnávány se znaky tamga euroasijských nomádů, které měly v raném středověku převzít i východoevropské elity. Do této skupiny patří také všeobecně známý a do dnešních dnů používaný ukrajinský „trojzubec" a jeho různé odvozeniny. Dynastickými symboly ovšem mohly být i jednotlivá písmena. Celkově je známo okolo 360 různých variant těchto symbolů. Kromě pečetí se objevují i na mincích, zbraních, jako graffiti na stěnách budov, dále na keramice, cihlách, speciálních heraldických závěscích apod.

Čtvrtá část je složena z 12 příspěvků, v nichž autoři popisují, diskutují a interpretují výskyt plomb drohiczynského typu v archeologických kontextech na různých významných lokalitách v Rusku (Novgorod, Staraja Ladoga, Kursk), Bělorusku (Minsk), Polsku (Nasielsk, Połtusk a okolí, Płock) a na Ukrajině (Kyjev).

Na území dnešního Polska se, kromě eponymní lokality, našel větší počet plomb drohiczynského typu jen na lokalitě Czermno, která je hypoteticky, ale poměrně přesvědčivě, spojována s historicky známými Červeňskými hrady. Olověných plomb (nejen drohiczynského typu) se zde našlo přes tisíc. Tomuto početnému soubor, jeho komplexnímu interdisciplinárnímu vyhodnocení, i popisu širšího nálezového kontextu je věnován samostatný druhý díl knihy, který vyšel v roce 2020.

Druhý svazek je rozdělen do 10 kapitol, které jsou doplněny jmenným a geografickým rejstříkem. Po obligatorním úvodu z pera hlavního iniciátora celého výzkumu Marcina Wołoszyna, následují kapitoly kolektivu autorů o sídlištním komplexu prozkoumaném v okolí městečka Czermno a olověných pečetích a plombách nalezených na této lokalitě. Jsou publikovány formou katalogu nálezů s kompletní fotografickou dokumentací. Speciální pozornost i speciální kapitola sepsaná Aleksandrem Musinem, Sergeiem Toporovem a Annou Lozhkinou je věnována nálezu olověné plomby, kterou byl původně asi označen štůček textilu dovozeného do východní Evropy z francouzského (nyní belgického) Tournai. Podle provedené analýzy plomby se toto zboží dostalo do Czermna nejpozději ve druhé polovině 13. století. Součástí kapitoly je i syntetické zhodnocení cca 300 západoevropských olověných pečetí nalezených v prostoru východní Evropy. Dvě třetiny z nich pochází z ruského Novgorodu.

Poslední část druhého svazku sestává ze šesti příspěvků věnovaných metalografickým analýzám plomb drohiczynského typu z Czermna, Drohiczyne a sbírek muzeí v Białostoku, Varšavě a Krakově. Tato část knihy je převážně dílem Aldony Garbacz-Klempka z Akademie Górniczo-Hutniczne v Krakově a jejích spolupracovníků. Použitá metoda je založena především na vyhodnocení poměrů izotopů olova a určení stopových prvků v plombách i analyzovaných olověných rudách. Použita byla i optická a elektronová mikroskopie. Analyzováno bylo 168 olověných artefaktů nejenom z Polska, Ukrajiny a Ruska, ale pro srovnání i z České republiky (Libice nad Cidlinou), Maďarska a historické Byzance. Přínos těchto náročných analýz k celkové intepretaci diskutované nálezové skupiny ovšem není z textu příliš zřejmý.

Shrneme-li celkové dojmy z obsáhlé dvoudílné práce, lze konstatovat, že se jedná o mimořádně komplexní a úctyhodné zpracování početné skupiny důležitých artefaktů, které se na konci raného středověku používaly ve východní části Evropy. Plomby a pečeti jsou díky své povaze nositeli specifické informace, a mají proto velký interpretační potenciál, který se autoři knih snažili maximálně využít. Objektivní, resp. správný výklad těchto nálezů je ovšem, zvláště v dnešní době, velmi komplikovaný. Distribuce plomb a pečetí se symboly Rurikovců totiž v raném středověku zřejmě vymezovala to, co se dnes označuje jako „russkij mir" (*Khomenko 2022*). Bylo by samozřejmě zcela ahistorické spojovat situaci raného středověku s dneškem. Bohužel novodobí ideologové panovníků „vší Rusi", kteří se postupně přesunuli z Kyjeva do Vladimiru a za časů Zlaté hordy dále do Moskvy, s historickými reminiscencemi aktivně pracují, aby odůvodnili probíhající vojenskou expanzi na cizí území (*Wikipedia* n.d.). I tento aktuální kontext si musíme při intepretaci raně středověkých nálezů z této oblasti uvědomovat.

Přestože se v českých zemích importy či imitace artefaktů z prostředí Kyjevské Rusi a obecně z Východu ojediněle objevují, např. v podobě glazovaných písanek, chřestítek a snad i přeslenů z ovručské břidlice (*Bláha 1998*), olověné plomby drohiczynského typu od nás dosud neznáme. Je zřejmé, že politická ani ekonomická moc Rurikovců tak daleko na Západ nesahala. A zřejmě ani obchodní výměna mezi oběma regiony v té době nebyla nějak intenzivní, přestože se uvažuje o napojení našich zemí na panevropskou obchodní magistrálu Řezno – Praha – Olomouc – Krakov – Kyjev (*Sláma 1990*).

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