

# FINDS OF PREHISTORIC HAMMERS WITH GROOVES AND NOTCHES FROM THE TERRITORY OF SLOVAKIA<sup>1</sup>

## Contribution to the Beginnings of Mining and Exploitation of Non-ferrous Metals

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The study discusses finds of prehistoric stone hammers with grooves and notches from the territory of Slovakia, which are associated mostly with mining and exploitation of non-ferrous metals. More than 400 exemplars from 17 sites come from the territory of Slovakia. They can be classified into several basic types. Most of the above-mentioned hammers (almost 400 exemplars) come directly from Špania Dolina, Piesky site, in central Slovakia. Another rather rich group comes from its nearby surroundings in the region of Banská Bystrica (Banská Bystrica, Banská Bystrica-Kremnička and Horné Pršany). As for the remaining 13 sites, mostly located in SW Slovakia, away from the areas of non-ferrous metals exploitation, only 14 hammers were obtained from them. To identify the function of hammers in this area, four of them were submitted for X-ray fluorescence spectroscopy. It confirmed presence of traces of copper (Cu) on percussion ends on three exemplars. Obviously, some hammers – also outside the main area of copper ore exploitation in the central Slovak volcanic mountains – were used in metallurgy. With regard to the fact that hammers were primarily designed for striking, it can be assumed that some of them were used as multifunctional tools. The petrographic analysis of the hammers from Špania Dolina-Piesky showed that they were mostly made from silicite, less frequently from andesite, granodiorite, amphibolite and migmatite. The raw materials used for making hammers in other parts of Slovakia were only slightly different. Use of hammers for copper exploitation in Slovakia as early as the Early Eneolithic, the Epi-Lengyel period, was confirmed by the discovery of a hammer with a groove and notch in a Ludanice group settlement feature in Banská Bystrica-Kremnička. Use of hammers in the Early Bronze Age is documented by the hammer in the Nitra culture male burial in Čachtice in the central Váh river basin and the exemplar uncovered in a Hatvan culture settlement feature in Šahy in the lower Ipel' river basin.

## INTRODUCTION

Despite the fact that in the territory of Slovakia, we encounter rare finds of stone hammers with grooves and notches associated with prehistoric mining as early as the first half of the 20<sup>th</sup> c. (Pečenice – beginning of the 20<sup>th</sup> c., Španie Pole – in 1937, Lontov – in 1938, Šurany-Nitriansky Hrádok – in 1949), the expert public started to pay attention to them in its second half. The discovery of 11 stone hammers found by Geologický prieskum company in 1964 was the impulse. The hammers were uncovered during processing of medieval piles of tailings carried out by Rudné bane company in Špania Dolina-Piesky (Liptáková 1973, 72). This fact considerably contributed to the subsequent archaeological excavation in 1971 and 1972 by A. Točík in Špania Dolina-Piesky and in the saddle between the sites of Piesky and Richtárová. The excavation resulted in discovery and localization of approx. 200 stone hammers in the area. Some hammers were found on the surface of the piles and some were uncovered in regular trenches in the layers of tailings. With regard to this, the excavation did not bring the expected result, i. e. specified chronological classification of the stone hammers. Nevertheless, it was detected from their distribution along a section of approx. 650 m that the assumed prehistoric exploitation in Piesky was concentrated mostly on the northern slope (Točík/Bublová 1985, 83, 84).

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With regard to the fact, that the excavation in Špania Dolina-Piesky did not chronologically fix the hammers with grooves or notches, results of the rescue excavation of the burial ground from the Early Bronze Age in Čachtice in the central Váh river basin seem to be extremely important. The excavation carried out by J. Batora in 1975 uncovered a burial of an adult male (burial 1) from the end of the Nitra culture and the beginning of the Únětice culture. It contained a stone hammer with a groove preserved in fragments. This discovery of the hammer represented not only the first, but also the only – for some decades – stratified find of such artifact in the territory of Slovakia (Batora 1976, 22).

P. Žebrák followed from the above-described activities of A. Točík in Špania Dolina-Piesky in 1985. He carried out a detailed surface survey at the site (Žebrák 1986, 256). The survey was initiated – apart from the recent deep hillwash grooves in loose arkoses caused by summer rain – mainly by new finds of stone hammers from the site of Piesky (Trgiňa 1986, 227, fig. 98: 1a, 1b). The survey repeatedly confirmed the largest concentration of fragments from prehistoric pottery and polished as well as chipped stone industry on the northern slopes of the piles in Piesky (Žebrák 1986, 256).

The results of the excavations and survey in Špania Dolina-Piesky were represented by A. Točík and P. Žebrák in 1989 in their synthetic study published in the then West Germany (Točík/Žebrák 1989, 71–78). Later, P. Žebrák presented them at an international conference on prehistoric metallurgy in southeastern Europe which took place in Donji Milanovac in Serbia in 1990 (Žebrák 1995, 13–19).

More than ten years later, in 2002, V. Furmánek and L. Illášová published a hammer with a groove discovered in 1937 in Stará Bystrica in the region of Kysuce, in northwest Slovakia. In their study, they pointed to an important fact that the hammer was discovered in the territory of the Kysucká Magura Mountains, where occurrence – even local – of copper is not assumed in terms of geology (Furmánek 2005, 16; Furmánek/Illášová 2002, 105–119).

In the same year, K. Marková was dealing with the topic of hammers with grooves in association with finds documenting metallurgic production at the fortified settlement from the Early Bronze Age in Malé Kosihy, Törökdomb site. She was following from the discovery of such hammer in the area of acropolis of the fortified settlement, in the Hatvan culture layer (horizon IIIA; Marková 2002, 205, 207, fig. 1: 5). She also pointed to the different situation in relation to occurrence of hammers with grooves in the Hatvan culture in the territory of Hungary, where – unlike in Slovakia – their finds are still absent (Marková 2002, 208).

After several years, studies dealing with grooved hammers occurred in Slovak archaeological literature again. T. Kolon published a new find of a hammer from Špačince in 2015. The site is located in the northern part of the Trnavská pahorkatina hills, i. e. outside the places of occurrence of copper deposits, similarly to the find of the hammer from Stará Bystrica. In spite of this, the author does not deny that the local prospectors and metallurgists might have travelled to the metalliferous areas of the nearby Little Carpathians (Kolon 2015, 14).

In the same year, the interdisciplinary work group around archaeologist M. Kvietok from Banská Bystrica was dealing with hammers in association with the topic of hammered-out copper in Slovak prehistory (Kvietok et al. 2015, 37–42). Then, in 2017, the team members focused on new, previously unpublished, 124 exemplars from Špania Dolina-Piesky. The new hammers were mostly collected on the surface of the local eroded piles and a few of them were found outside Špania Dolina, in the nearby villages, where they were imported as construction material. It is important that from the above-mentioned number of hammers, the authors were able to obtain basic data on the raw material, weight and dimensions of as many as 111 exemplars (Sitár/Kvietok/Jeleň 2017, 8–29).

An article by M. Solivajs, a member of the Mineralogical Society of Slovakia in Banská Bystrica, was added to the above-mentioned studies in 2021. It deals with about 60 exemplars of stone hammers and their fragments collected by amateurs in the area of Kremenica natural monument in the cadastral area of Horné Pršany, near Banská Bystrica. The hammers do not have grooves or there are only partial grooves, sometimes encircling grooves (Solivajs 2021, 1–3, fig. 1A).

The latest find of a hammer with a groove comes from Banská Bystrica-Kremnička, where it was uncovered in 2021, during the rescue excavation of the Midland Adventure company in the area of Logistický park company. Unlike the above-mentioned hammers from Horné Pršany, this exemplar was found in a settlement feature previously dated to the Piliny culture period on the basis of pottery (Fratričová/Miňo 2022, 1–5). After the following detailed evaluation of the pottery, it was found out that the feature can be dated to the Epi-Lengyel period and associated probably with the Ludanice group bearers.<sup>2</sup>

<sup>2</sup> I would like to thank M. Kvietok for the information.

## TYPOLOGICAL ANALYSIS OF HAMMERS WITH GROOVES AND NOTCHES FROM THE TERRITORY OF SLOVAKIA

The first typology of stone hammers from the territory of Slovakia was elaborated by A. Točík and H. Bublová on the basis of results of the excavation in Špania Dolina-Piesky in 1985. In terms of typology, they divided the hammers into flat (*Točík/Bublová 1985*, fig. 26: 5, 6; 14: 6) and thick (*Točík/Bublová 1985*, fig. 28: 6; 29: 4; 36: 2). According to their shapes, they are divided into prismatic, cylindrical, conical and hoe-shaped. Prismatic hammers are most frequent (Fig. 1; *Točík/Bublová 1985*, fig. 18: 17; 19: 9, 19; 22: 4; 23: 15; 25: 1, 3; 34: 2), followed by cylindrical (Fig. 2; *Točík/Bublová 1985*, fig. 19: 18; 20: 6; 21: 2), conical (Fig. 3; *Točík/Bublová 1985*, fig. 20: 1; 22: 7; 23: 3, 13; 25: 6) and hoe-shaped (Fig. 4; *Točík/Bublová 1985*, fig. 18: 4; 20: 8; 26: 5). Among the cylindrical exemplars, ovoid hammers were recognized (Fig. 5; *Točík/Bublová 1985*, fig. 23: 4, 6, 12). A large group consists of transitional shapes of hammers which were hard to classify into any of the groups. It is noteworthy that all types of hammers from Špania Dolina-Piesky are more or less battered, which documents their use (*Točík/Bublová 1985*, 85, fig. 23: 4).

After a several decades lasting break, the typology of hammers was dealt with again in 2017 by *Sitár/Kvietok/Jeleň* (2017, 8–29). They followed from the typology elaborated by A. Točík and H. Bublová (*Točík/Bublová 1985*, 47–135) and they also developed it, using the potential of the many new finds of hammers from Špania Dolina-Piesky. From 107 exemplars, 60 were classified among hoe-shaped hammers, flat from both sides, often only 30 mm thick, with a distinct shallow or partial groove. According to the authors, this frequent type of hammers might have been well used in Špania Dolina-Piesky in the surface part of the copper deposit to exploit the metal from the sandy subsoil (*Sitár/Kvietok/Jeleň 2017*, 21). The authors distinguished other types of hammers – ovoid type (18 exemplars), spherical-globular (17 exemplars), prismatic (7 exemplars) and cylindrical (5 exemplars), which were much less frequently represented (*Sitár/Kvietok/Jeleň 2017*, 24). It must be noted that these four types of hammers do not represent their other new types, different from the types defined by A. Točík and H. Bublová (1985, 85), as the authors used modern terminology instead of their original names.

80% of the 107 stone hammers from Špania Dolina-Piesky had visible grooves, which allowed their attachment to hafts and 20% did not have grooves; it is an interesting finding. Among the above-mentioned 80% of hammers, 63 exemplars had distinct grooves, 20 exemplars had shallow grooves and 3 exemplars had incomplete grooves (*Sitár/Kvietok/Jeleň 2017*, 21, 24). Here, it should be mentioned that the typology of hammers with grooves from the area of exploitation of copper ore in Schwaz-Brixlegg in northern Tyrol is based mainly on the location and number of attachment grooves (*Rieser/Schrattenthaler 1998–1999*, 153, fig. 14).

Information on the weight of individual hammers can be considered important, as it was associated with the method and purpose of their use. A. Točík and H. Bublová classified the hammers from Špania Dolina into three categories depending on their weight: heavy – large (2500 g and more), medium (1000–2500 g) and light – small (max. 1000 g; *Točík/Bublová 1985*, 85). A. Sitár, M. Kvietok and S. Jeleň identified with this classification of hammers by weight in their analysis of the 108 exemplars from Špania Dolina and 2 exemplars from Banská Bystrica, Fortnička/Bystrica stream site. It is remarkable that most exemplars, i. e. 50, weighed between 1000 and 2500 g, 44 exemplars weighed less than 1000 g and 17 exemplars were heavier than 2500 g (*Sitár/Kvietok/Jeleň 2017*, tab. 1). If we compare the presented weights of the large number of hammers from Špania Dolina-Piesky with the area of prehistoric copper exploitation in Schwaz-Brixlegg, we find out that they are very similar. Weight of hammers with grooves in Špania Dolina-Piesky varied between 180 and 7300 g; in Schwaz-Brixlegg, it was between 200 and 7000 g (*Rieser/Schrattenthaler 1998–1999*, 152). Naturally, the weight of the hammers was closely connected with the raw material used for their production at a specific site. This fact – apart from the size and character of the surface – had a great influence on the general shape and location of the encircling groove. According to the findings of A. Točík and H. Bublová, the small and medium hammers from Špania Dolina-Piesky had relatively wide and deep grooves, located in the middle and well-balanced, which allowed good attachment to wooden hafts. For this reason, the authors agreed that such hammers were used for crushing the exploited ore and the strong hit was related to the flexibility of the wooden haft (Fig. 6; *Rieser/Schrattenthaler 1998–1999*, fig. 33). According to them, this function is also suggested by the considerably high number of fragments from small hammers (*Točík/Bublová 1985*, fig. 18: 11, 12, 15; 19: 7; 21: 3, 10, 17, 19). Similar information was confirmed by the analysis of the above-mentioned 107 hammers from Špania Dolina-Piesky; 43% of them bear traces of chipped-off parts (*Sitár/Kvietok/Jeleň 2017*, 21).

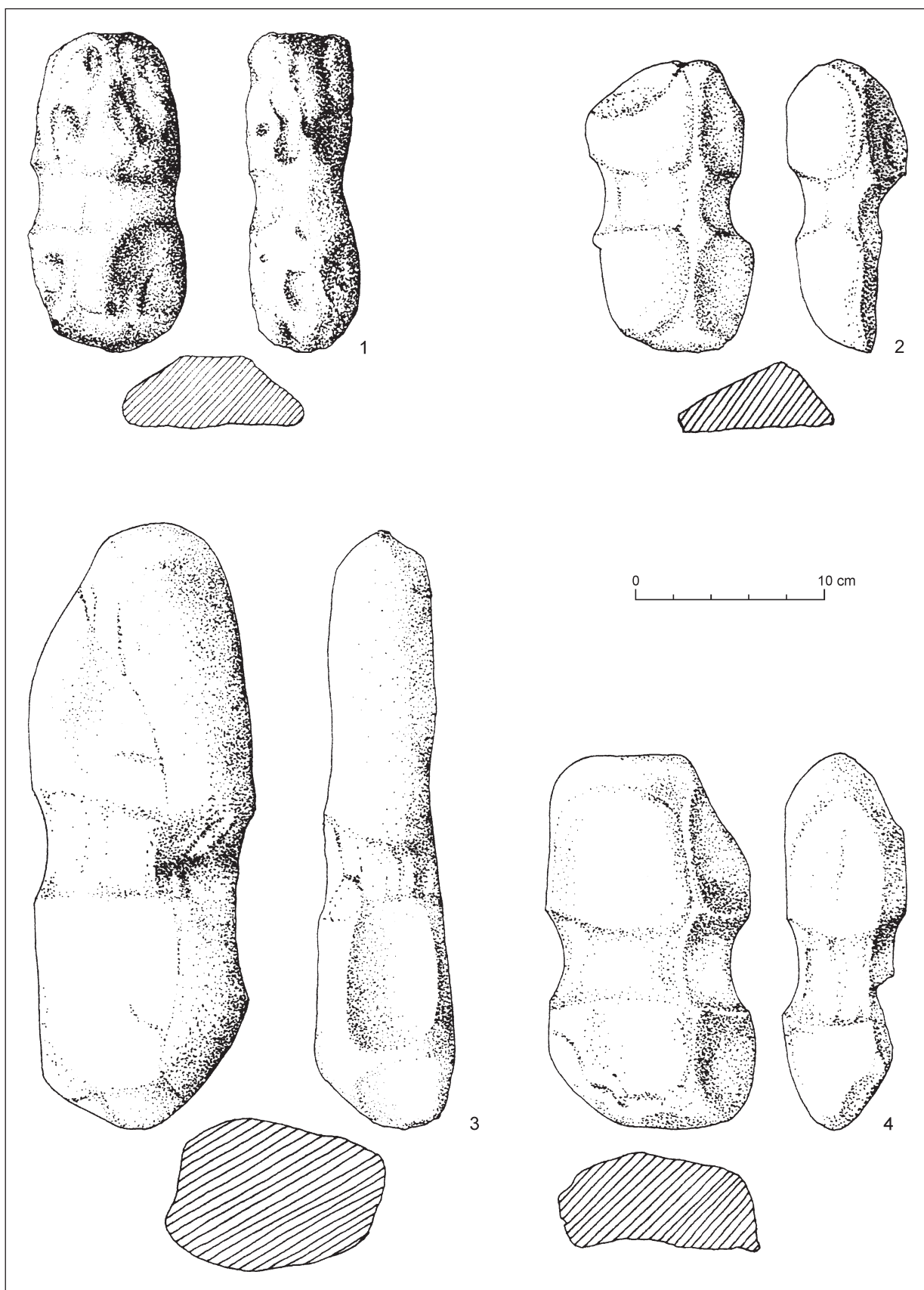


Fig. 1. Špania Dolina-Piesky, Banská Bystrica dist. Prismatic stone hammers with grooves (after *Točík/Bublová* 1985).

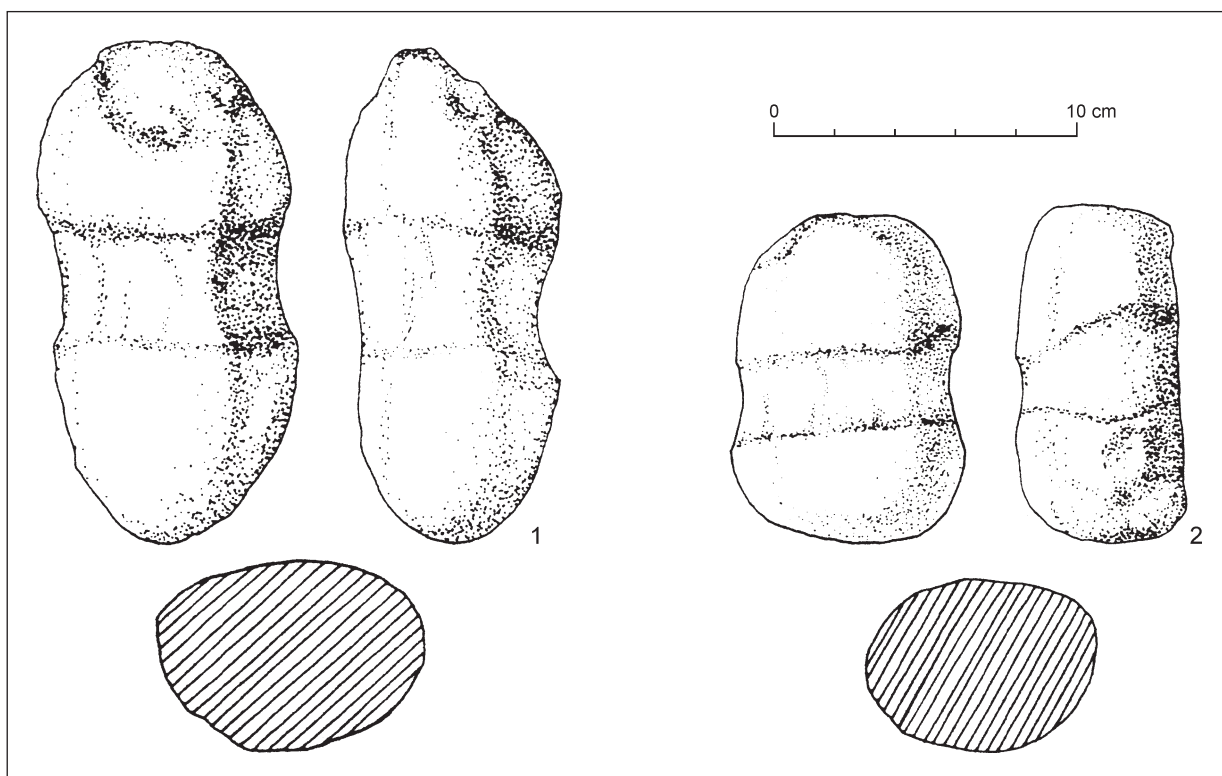


Fig. 2. Špania Dolina-Piesky, Banská Bystrica dist. Cylindrical stone hammers with grooves (after Točík/Bublová 1985).

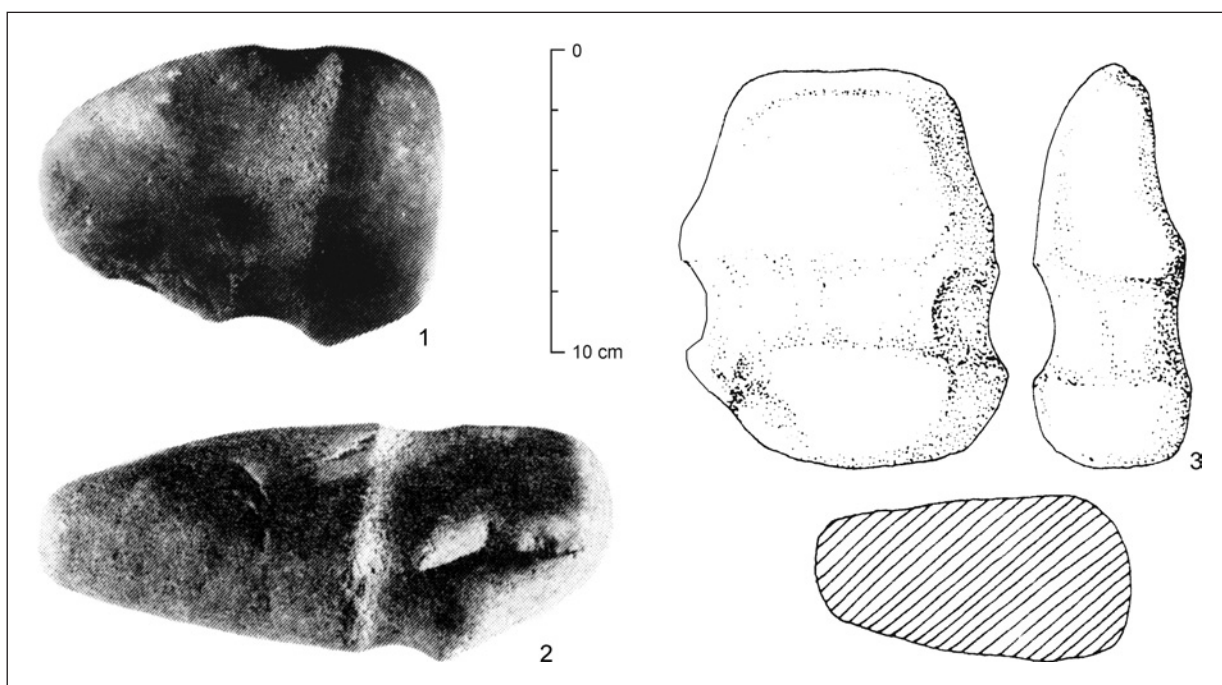


Fig. 3. Špania Dolina-Piesky, Banská Bystrica dist. Conical stone hammers with grooves. 1, 2 – without scale (after Točík/Bublová 1985).

As for the large and heavy hammers from Špania Dolina-Piesky with traces of battering, the encircling grooves are rather shallow and asymmetrical, which suggests that these exemplars were used for better grip in both hands (Šitár/Kvietok/Jeleň 2017, fig. 8; Točík/Bublová 1985, fig. 22: 7; 29: 4; 36: 3). Some large and heavy hammers with smooth surface even had exceptionally two encircling grooves (Fig. 5: 3; Točík/Bublová 1985, fig. 36: 3).

Exemplars from 16 sites in the territory of Slovakia which were found outside the main area of their occurrence in Špania Dolina also fall to the above-described typology to a great extent. It occurred that most of them are cylindrical hammers (10 exemplars) in two variants – short (Fig. 7) and elongated (Fig. 8), followed by ovoid/spherical-globular (3 exemplars, Fig. 9) and prismatic (3 exemplars, Fig. 10). It is noteworthy that massive heavy hammers only occurred in central Slovakia, in Horné Pršany (Fig. 10: 2) located at the SW periphery of Banská Bystrica and in Španie Pole (Fig. 7: 5) situated on the southern foothills of Slovenské rudohorie hills, i. e. in areas with deposits of oxidation copper ores in the immediate vicinity. Thus, we can assume that they were used for exploitation or hammering of copper ore. In Horné Pršany, the hammers were

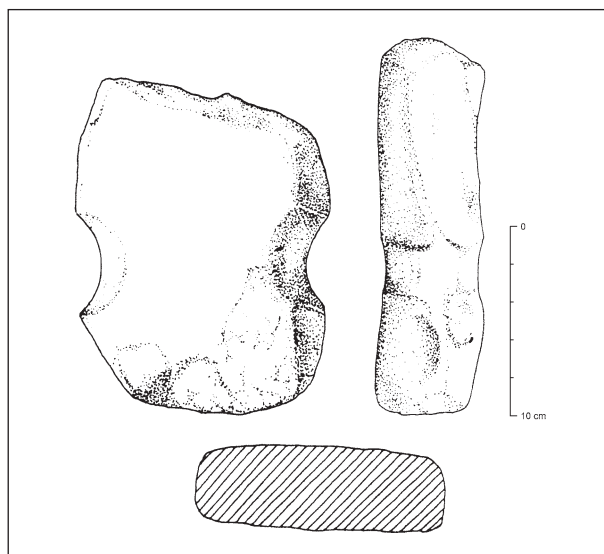


Fig. 4. Špania Dolina-Piesky, Banská Bystrica dist. Hoe-shaped stone hammer with notches (after Točík/Bublová 1985).

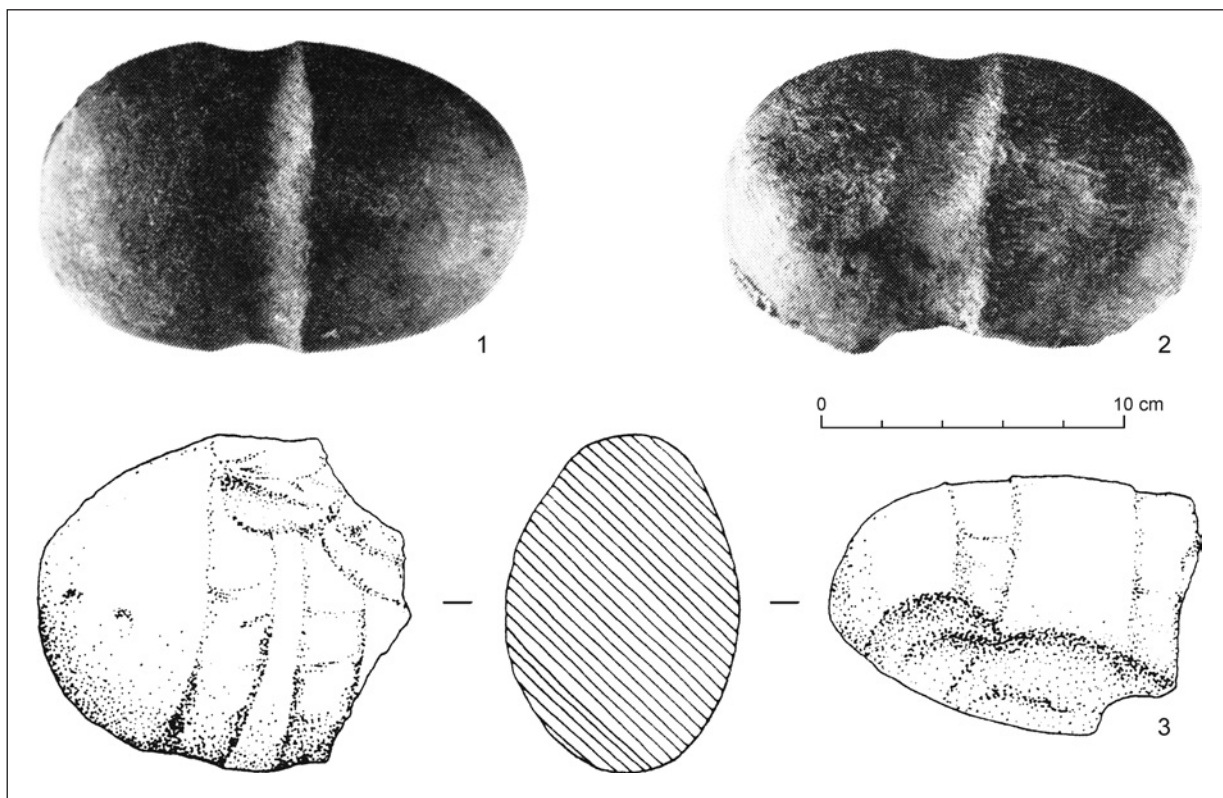


Fig. 5. Špania Dolina-Piesky, Banská Bystrica dist. Ovoid/spherical-globular stone hammers with grooves (after Točík/Bublová 1985). 1, 2 – without scale.

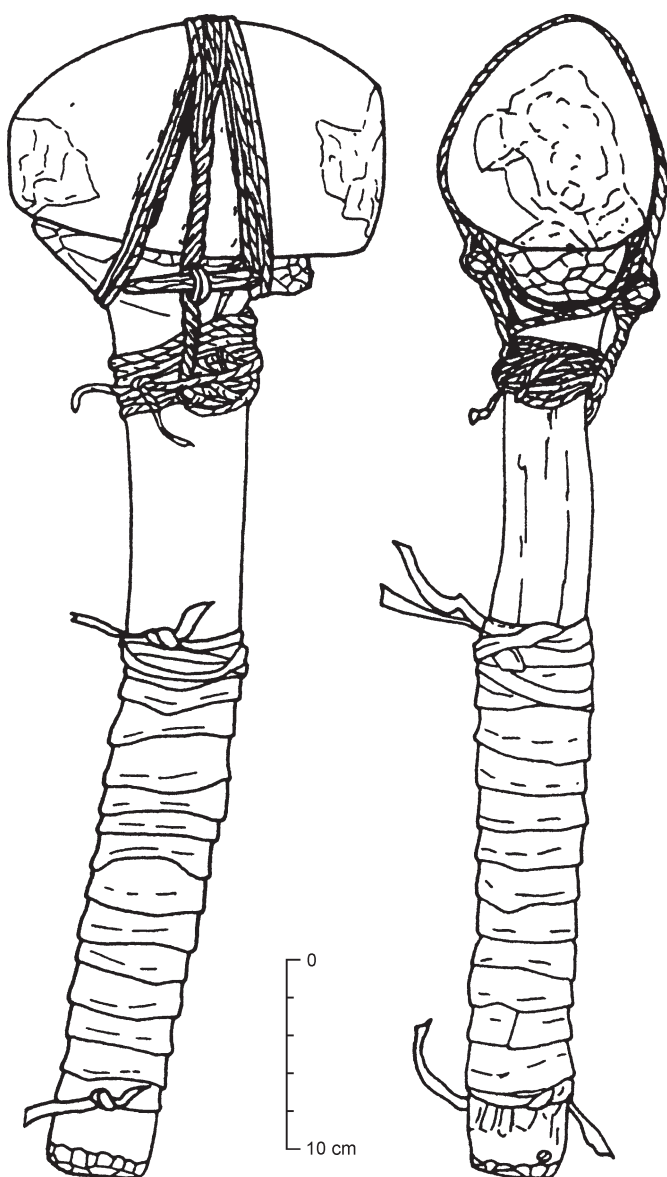


Fig. 6. Reconstruction of attachment of a stone hammer with a groove to a wooden shaft. Fixation of the hammer by a hemp cord and a shaft wrapped in a leather strap (after *Rieser/Schratenthaler 1998–1999*).

weighing 1556 g, represents hammers of medium weight (*Kolon 2015, 13*). Only the exemplar from Španie Pole in the south of central Slovakia, which weighs 3024 g, can be associated with heavy massive hammers (*Furmánek 2004, 28*).

A. Točík and H. Bublová assumed that exploitation at the site of Piesky in the Early Bronze Age was connected with processing of the ore, i. e. crushing and roasting, at the site. They followed from a small number of stone slabs with depressions for ore crushing which were found on terraces 7, 8 and 9 (*Točík/Bublová 1985, 85*). The depressions on the slabs had various sizes, which suggests that stone hammers of various sizes were used for crushing (*Sitár/Kvietok/Jeleň 2017, 22*). The increased number of stone slabs recorded meanwhile in the gossan area in Špania Dolina-Piesky together with the considerable increase of the number of hammers suggest that pure copper was hammered at the site, which allowed its easier transportation (*Sitár/Kvietok/Jeleň 2017, 23*).

obviously used for exploitation of silicite material with regard to the presence of its deposits at the site of Kremenica (*Solivajš 2021, 1*).

The typological analysis confirmed that hoe-shaped hammers with notches on both sides did not occur in the territory of Slovakia outside the area of Špania Dolina-Piesky. This might confirm the assumption that they were used only for exploitation of copper ore by digging in the sandy subsoil in the upper part of the deposit (gossan) at the site of Piesky (*Sitár/Kvietok/Jeleň 2017, 21*). In association with hoe-shaped hammers, it can be said that similar artifacts with two opposing notches were discovered at the Late Eneolithic settlement of the Kostolac group in Iža in southern Slovakia, which spreads on the left bank of the Danube river. However, these are interpreted as weights for fishing nets (*Němejcová-Pavúková 1968, 361, 380, fig. 21: 9*). Finally, we encounter similar interpretation of some grooved hammers in the territory of Sweden (*Indreko 1956, 21, fig. 4*).

Apart from grooved hammers, two hammers with notches also occurred outside Špania Dolina. There is a miniature exemplar from Šahy (Fig. 11: 1) with an ovoid shape, and a hammer from Vráble, Fidvár site (Fig. 11: 2), with a prismatic shape.

Comparison of weight of hammers from Špania Dolina-Piesky and its nearby surroundings (see this text above) with other exemplars from the territory of Slovakia brought interesting information. With the exception of the only exemplar from Špačince, other finds outside Špania Dolina weigh between 565.0 g and 738.6 g, so they are classified as light exemplars. The hammer from Špačince,

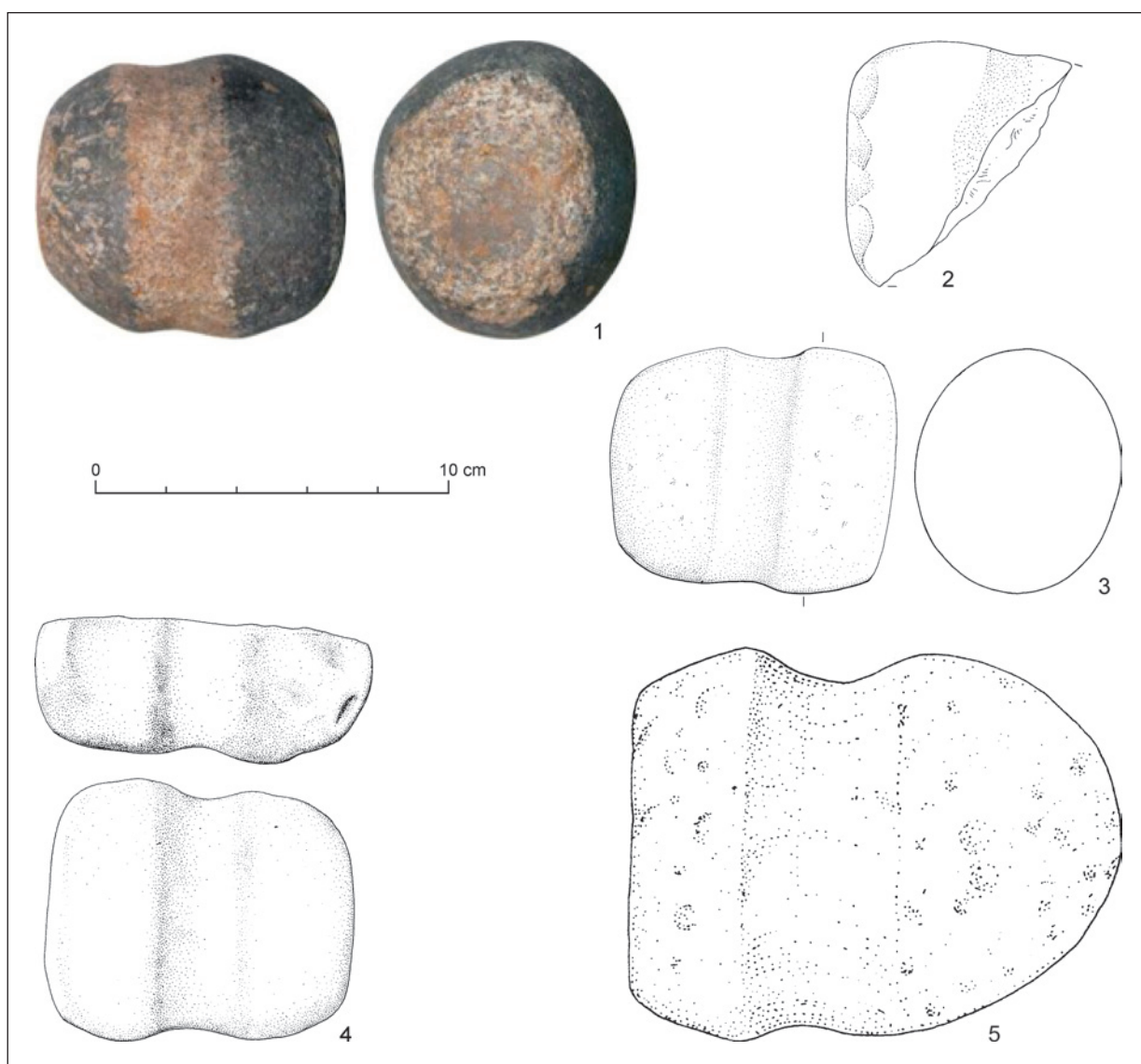


Fig. 7. Short cylindrical hammers. 1 – Banská Bystrica, part Kremnička, Banská Bystrica dist. (after *Fratričová/Mišo* 2022); 2 – Čachtice, Nové Mesto nad Váhom dist. (after *Bátora* 1976); 3 – Brhlovce, Levice dist.; 4 – Pečenice, Levice dist.; 5 – Španie Pole, Rimavská Sobota dist. (after *Furmánek* 2004).

#### MATERIAL FROM WHICH THE HAMMERS WERE MADE (RESULTS OF PETROGRAPHIC ANALYSES)

The petrographic analysis of the hammers discovered during the excavation in Špania Dolina-Piesky in 1971 and 1972, which was executed by L. Illášová, showed that they were made mostly from quartzite; this raw material was followed by andesite, granodiorite, amphibolite and migmatite. These rocks come from the territory of the Nízke Tatry Mountains and volcanic rocks from the Kremnické pohorie hills (*Illášová* 1986, 106). These results were later confirmed by the petrographic analysis of the 111 hammers obtained by the surface collection in Špania Dolina and its surroundings in 1982–2012 (*Sitár/Kvietok/Jeleň* 2017, 13).

Pebbles modified as hammers used in Špania Dolina came from the nearby surroundings, where they had been imported mostly from the Hron river bed or from the Starohorský potok stream and the Bystrica river (*Točík/Bublová* 1985, 85).

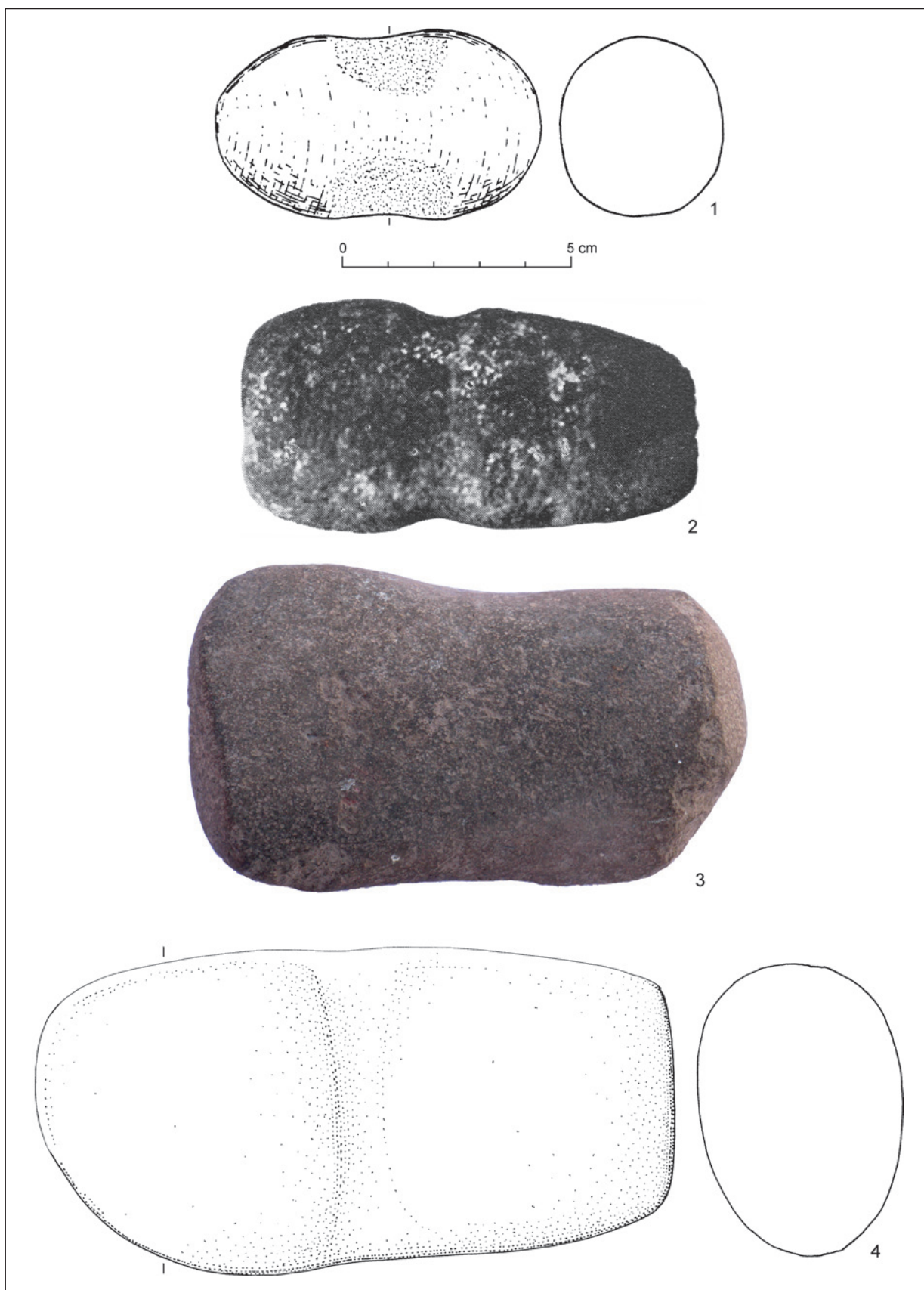


Fig. 8. Elongated cylindrical hammers. 1 – Šurany-Nitriansky Hrádok, Nové Zámky dist. (after *Hovorká/Illášová* 1999); 2 – Lontov, Levice dist. (after *Janšák* 1938); 3 – Pečenice, Levice dist.; 4 – Jur nad Hronom, Levice dist.

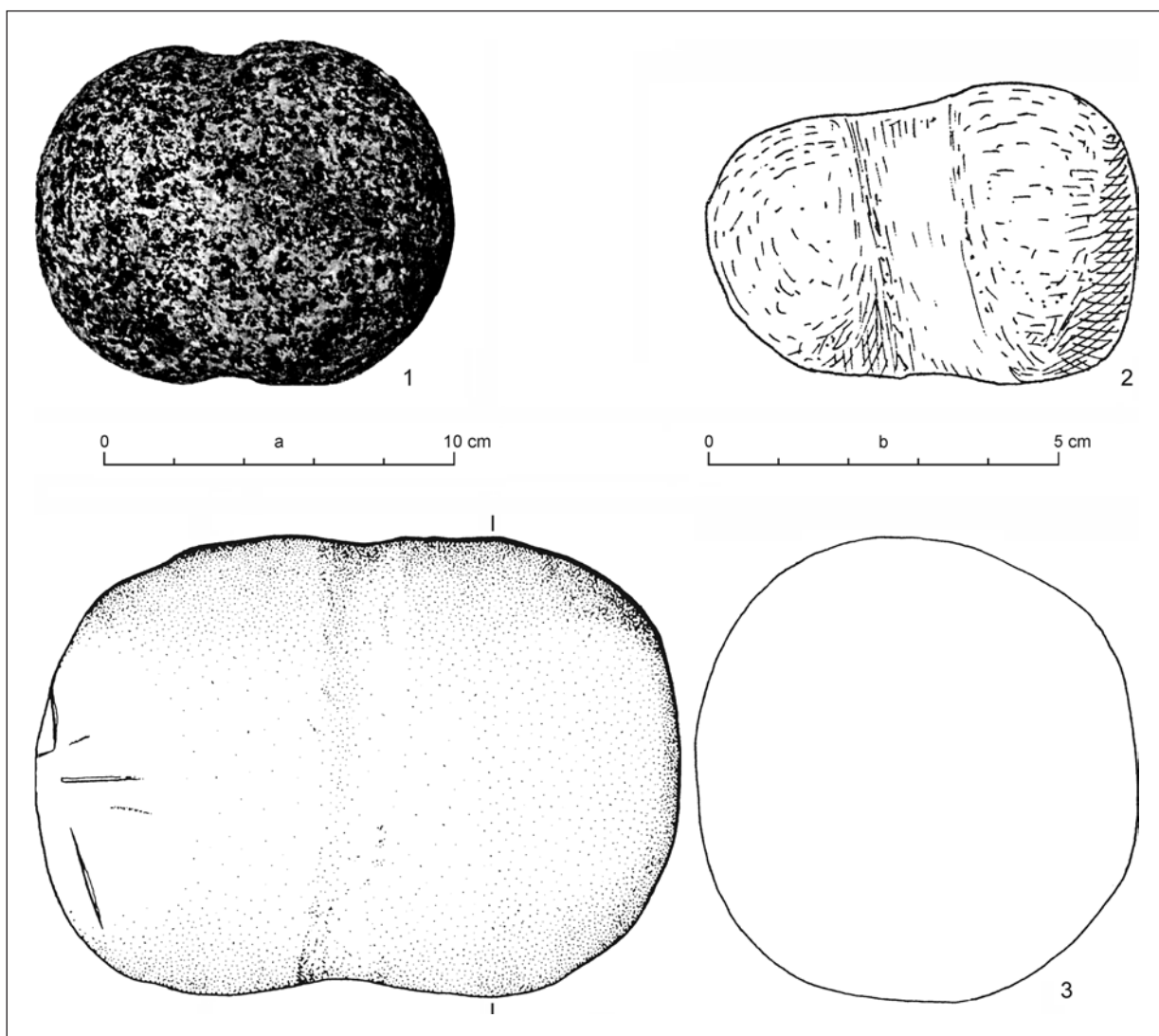


Fig. 9. Ovoid/spherical-globular hammers. 1 – Špačince, Trnava dist. (after Kolon 2015); 2 – Ipeľský Sokolec, Levice dist. (after Paulík 1982); 3 – Stará Bystrica, Čadca dist. (after Furmánek/Illášová 2002). Scale: a – 1; b – 3; without scale – 2.

A slightly different situation in terms of raw materials used for production of hammers was detected with the exemplars from other regions of Slovakia. Silicified sandstone was the considerably predominant raw material (7 exemplars; Banská Bystrica-Kremnička, Brhlovce, Čachtice, Jur nad Hronom, Pečenice – 2 exemplars, Stará Bystrica). It was followed by quartzite (3 exemplars; Horné Pršany – 2 exemplars, Vráble) and andesite (3 exemplars; Banská Bystrica-Fortnička/Bystrica river, Lontov, Malé Kosihy). Diorite (Špačince), limnic quartzite (Banská Bystrica-Fortnička/Bystrica river) and metaquartzite (Šurany-Nitriansky Hrádok) were represented by one exemplar each. The hammer from Špačince was made from diorite, whose deposits are probably located near Bratislava (Kolon 1995, 14).

#### DISTRIBUTION OF HAMMERS IN THE TERRITORY OF SLOVAKIA

As stated above, the highest number of hammers comes from the territory of central Slovakia, Špania Dolina, Piesky site (Fig. 12: 14). Almost 400 exemplars have been recorded from the site so far – complete or in fragments (Kvietok 2017, 160). Three new sites in the region of Banská Bystrica have been added in the last few years – Banská Bystrica-Fortnička/Bystrica river (Fig. 12: 1), Banská Bystrica-Kremnička (Fig.

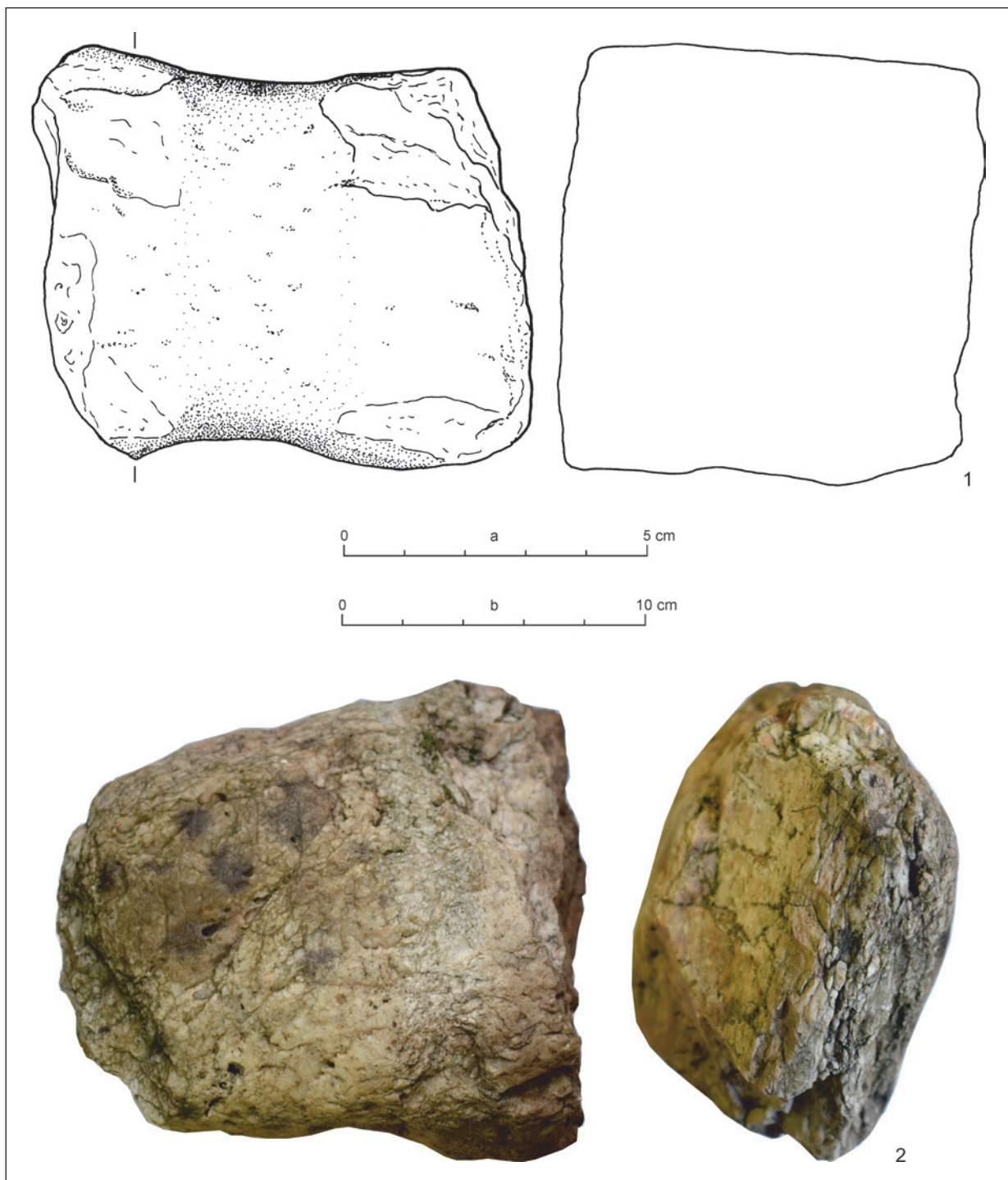


Fig. 10. Prismatic hammers. 1 – Malé Kosihy, Nové Zámky dist.; 2 – Horné Pršany, Banská Bystrica dist. (after Marková 2002; Solivajs 2021). Scale: a – 1; b – 2.

12: 2; Fratričová/Mišo 2022, fig. on p. 1) and Horné Pršany (Fig. 12: 5; Fratričová/Mišo 2022, 4, 5; Solivajs 2021, 1; Ušiak/Hrončiak 2000, 179, 180).

Apart from the region of Banská Bystrica, we find sites with hammers concentrated also in the regions of the lower Hron river basin and the Ipel river basin. It is remarkable that an X-ray fluorescence spectrometry showed presence of copper traces on the percussion ends of the hammers (see below), which suggests their possible use in activities associated with metallurgy. It is actually not very surprising,

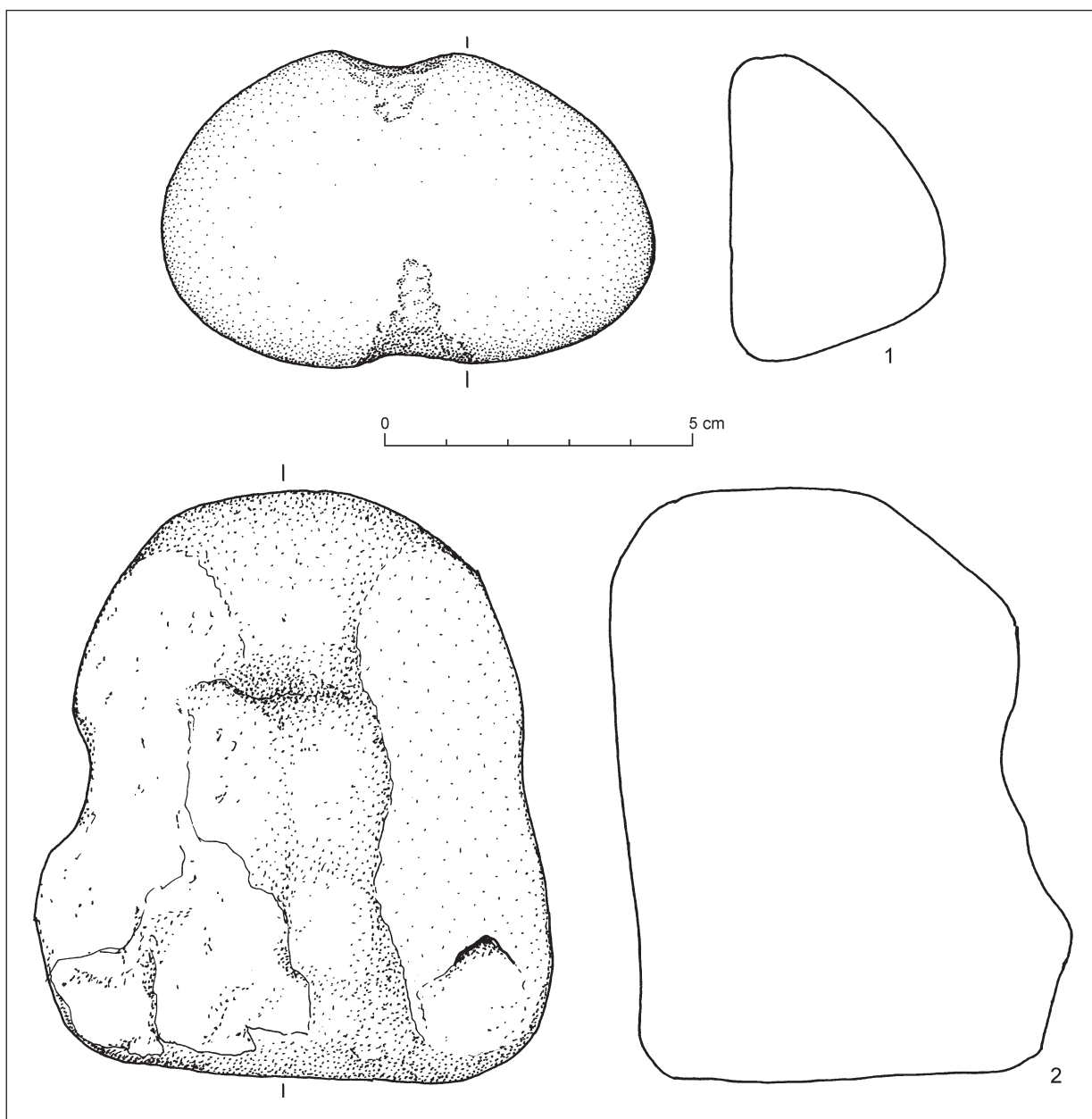


Fig. 11. Hammers with notches. 1 – Šahy, Levice dist. (after Bátor/Neumann/Pálinskás 2023); 2 – Vrable, Nitra dist.

as one part of sites with hammers is located on the foothills of the Štiavnické vrchy hills (Pečenice, Fig. 12: 10; Brhlovce, Fig. 12: 3) or in the forefield of their southern promontories (Jur nad Hronom, Fig. 12: 7) and another part of the sites with hammers is in the immediate northern vicinity of the Börzsöny hills (Ipeľský Sokolec, Fig. 12: 6; Lontov, Fig. 12: 8; Malé Kosihy, Fig. 12: 9; Šahy, Fig. 12: 12), situated in the territory of Hungary. As we know, both mountain ranges are of volcanic origin and are rich in deposits of non-ferrous metals (Schalk 1998, fig. 3).

Other sites with hammers are scattered mainly in southwestern Slovakia in the Dolnonitrianska (Šurany-Nitriansky Hrádok, Fig. 12: 16) and Žitavská niva floodplains (Vrable, Fig. 12: 17) and in the Trnavská (Špačince, Fig. 12: 13) and Podmalokarpatská pahorkatina hills (Čachtice, Fig. 12: 4).

One exemplar of a hammer is known from the Kysucká vrchovina hills in northwestern Slovakia (Stará Bystrica, Fig. 12: 11) and south of central Slovakia, in the southwestern part of the Slovenské rudohorie hills (Španie Pole, Fig. 12: 15) each. It is noteworthy that finds of grooved or notched hammers are still absent in the territory of eastern Slovakia.

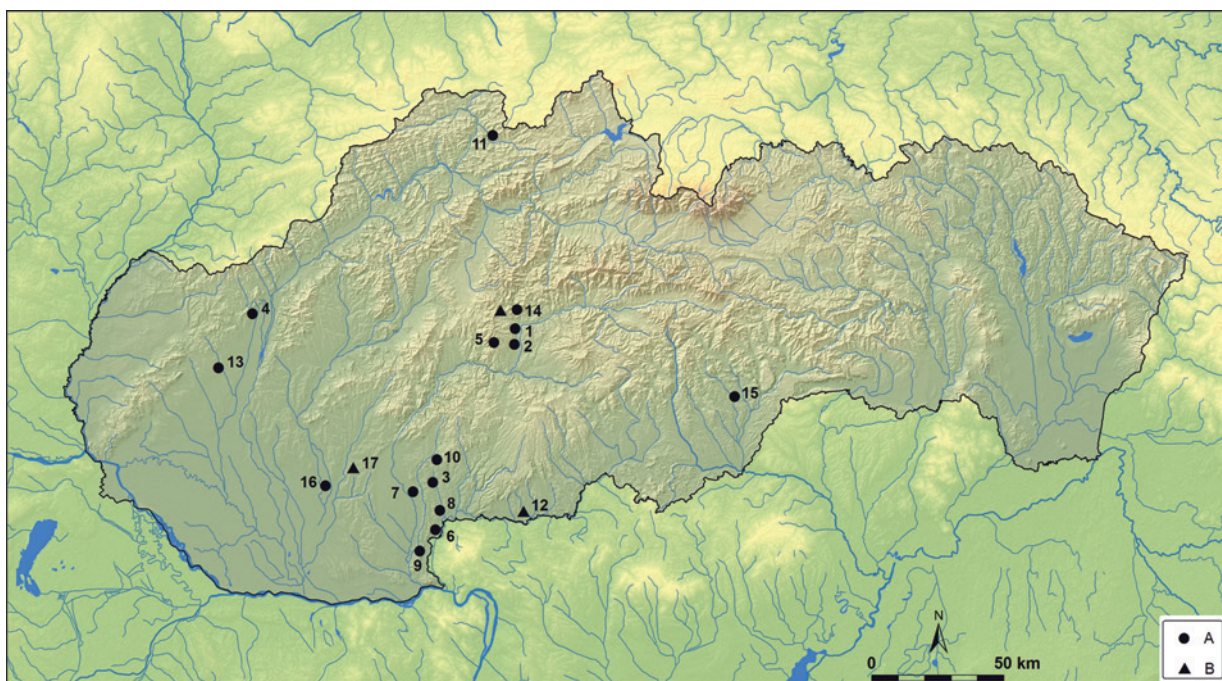


Fig. 12. Map of sites in the territory of Slovakia where prehistoric stone hammers with grooves and notches were discovered. Legend: A – hammers with grooves; B – hammers with notches. 1 – Banská Bystrica, Banská Bystrica dist.; 2 – Banská Bystrica, part Kremnička, Banská Bystrica dist.; 3 – Brhlovce, Levice dist.; 4 – Čachtice, Nové Mesto nad Váhom dist.; 5 – Horné Pršany, Banská Bystrica dist.; 6 – Ipeľský Sokolec, Levice dist.; 7 – Jur nad Hronom, Levice dist.; 8 – Lontov, Levice dist.; 9 – Malé Kosihy, Nové Zámky dist.; 10 – Pečenice, Levice dist.; 11 – Stará Bystrica, Čadca dist.; 12 – Šahy, Levice dist.; 13 – Špačince, Trnava dist.; 14 – Špania Dolina-Piesky, Banská Bystrica dist.; 15 – Španie Pole, Rimavská Sobota dist.; 16 – Šurany, part Nitriansky Hrádok, Nové Zámky dist.; 17 – Vráble, Nitra dist. (map created by M. Bartík based on materials by J. Bátora.)

## HAMMERS AND DEPOSITS OF COPPER ORES IN SLOVAKIA

The excavation in Špania Dolina-Piesky has confirmed the connection between hammers and the areas of copper ore deposits (Fig. 13: 4, 5). However, their direct use for exploitation or processing the ore at the site (crushing and roasting) in prehistory has not been definitely confirmed. A lot has been suggested by the collected finds of stone polished industry, stone slabs and pottery of the Epi-Lengyel character (Točík/Bublová 1985, 83–87).

Certain progress in this aspect was brought by the trial excavation of the Early Eneolithic settlement in Slovenské Pravno, Prášnica site, in 1976. A considerably large volume of Epi-Lengyel pottery, which is similar to the pottery in Špania Dolina-Piesky, was found in three settlement features (Šalkovský 1977, 261, fig. 169: 10–15; Točík/Bublová 1985, 86). Moreover, destroyed remains of a roasting furnace with remains of copper slag and copper grains were probably uncovered in feature 1; in feature 4, a large volume of slag and fragments of a lingulate copper artifact were found (Točík/Bublová 1985, 86). The finds from Slovenské Pravno document not only spreading of the bearers of the Lengyel culture final stage to the higher-located mountain areas of central Slovakia, but also documents processing of tetrahedral copper ores exploited in the region of Špania Dolina, which is only 27 km ESE from the settlement in Nitrianske Pravno (Nevizánsky/Šalkovský/Zachar 2017, 44).

In association with the finds in Slovenské Pravno, it was rightly pointed out by A. Točík and H. Bublová that analogous Lengyel pottery was also discovered in the area of studios producing chipped industry in the upper Nitra river basin, e. g. in the cadastral areas of Brusno-Chrenovec, Ráztočno and Handlová, which are – with the exception of stream terraces – located in altitude of 700 m a. s. l., e. g. at the sites of Dlhovina, Pod Bralom, Horenovo, Zábava and Remata (Točík/Bublová 1985, 86). Obviously, exploitation of copper ore and silicite raw materials were associated with and carried out by prospecting groups mainly in the late Lengyel period (Točík/Bublová 1985, 87). The above stated is confirmed by the situation observed in the neighbouring central Hron river basin (see the text below).

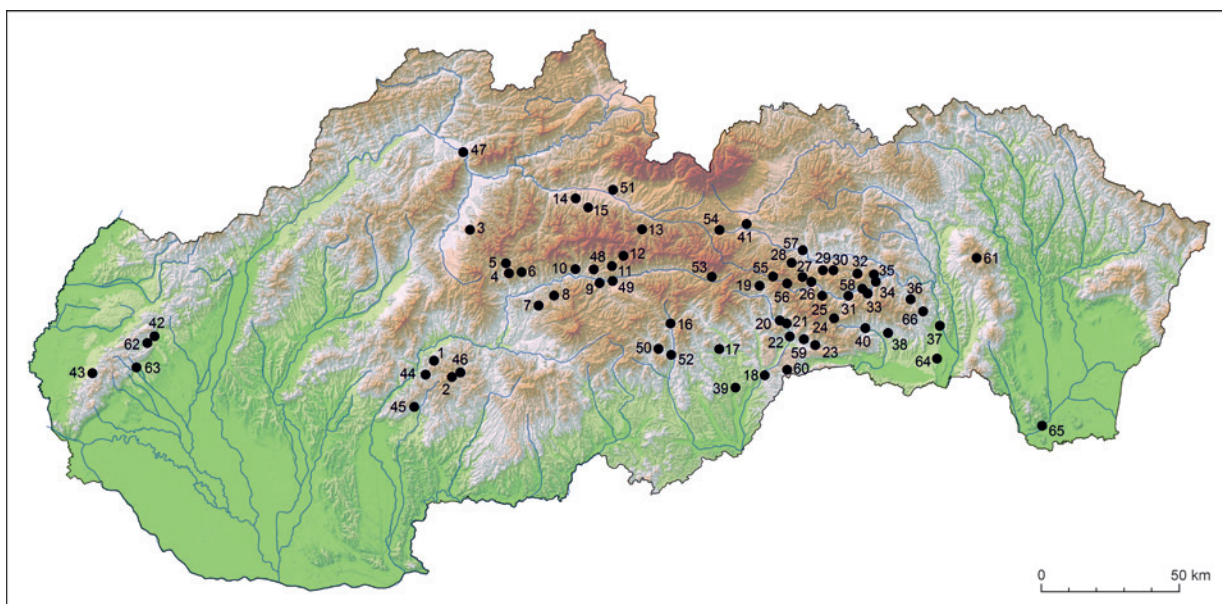


Fig. 13. Map of occurrence of oxide copper ores in Slovakia. 1 – Vyhne, Žiar nad Hronom dist.; 2 – Banská Štiavnica, Banská Štiavnica dist.; 3 – Blatnica, Martin dist.; 4 – Špania Dolina, Banská Bystrica dist.; 5 – Staré Hory, Banská Bystrica dist.; 6 – Baláže, Banská Bystrica dist.; 7 – Poniky, Banská Bystrica dist.; 8 – Ľubietová, Banská Bystrica dist.; 9 – Hronec, Brezno dist.; 10 – Jasenie, Brezno dist.; 11 – Mýto pod Ďumbierom, Brezno dist.; 12 – Jarabá, Brezno dist.; 13 – Malužiná, Liptovský Mikuláš dist.; 14 – Partizánska Ľupča, Liptovský Mikuláš dist.; 15 – Dúbrava, Liptovský Mikuláš dist.; 16 – Tisovec, Rimavská Sobota dist.; 17 – Nandráž, Revúca dist.; 18 – Ardovo, Rožňava dist.; 19 – Dobšiná, Rožňava dist.; 20 – Gemerská Poloma, Rožňava dist.; 21 – Betliar, Rožňava dist.; 22 – Rožňava, Rožňava dist.; 23 – Drnava, Rožňava dist.; 24 – Smolník, Gelnica dist.; 25 – Stará Voda, Gelnica dist.; 26 – Nálepko, Spišská Nová Ves dist.; 27 – Hnilčík, Spišská Nová Ves dist.; 28 – Spišská Nová Ves, part Novoveská Huta, Spišská Nová Ves dist.; 29 – Rudňany, Spišská Nová Ves dist.; 30 – Poráč, Spišská Nová Ves dist.; 31 – Mníšek nad Hnilcom, Gelnica dist.; 32 – Slovinky, Spišská Nová Ves dist.; 33 – Prakovce, Gelnica dist.; 34 – Gelnica, Gelnica dist.; 35 – Žakarovce, Gelnica dist.; 36 – Košická Belá, Košice-okolie dist.; 37 – Košice, Košice dist.; 38 – Rudník, Košice-okolie dist.; 39 – Gemerská Ves, part Šankovce, Revúca dist.; 40 – Medzev, Košice-okolie dist.; 41 – Poprad, part Kvetnica, Poprad dist.; 42 – Smolenice, Trnava dist.; 43 – Pernek, Malacky dist.; 44 – Hodruša-Hámre, Žarnovica dist.; 45 – Pukanec, Levice dist.; 46 – Banská Belá, Banská Štiavnica dist.; 47 – Strečno, Žilina dist.; 48 – Horná Lehota, Brezno dist.; 49 – Brezno, Brezno dist.; 50 – Klenovec, Rimavská Sobota dist.; 51 – Liptovský Mikuláš, part Mútnik, Liptovský Mikuláš dist.; 52 – Hnúšťa, Rimavská Sobota dist.; 53 – Šumiac, Brezno dist.; 54 – Vikartovce, Poprad dist.; 55 – Mlynky, Spišská Nová Ves dist.; 56 – Hnilec, Spišská Nová Ves dist.; 57 – Spišská Nová Ves, Spišská Nová Ves dist.; 58 – Helcmanovce, Gelnica dist.; 59 – Krásnohorské Podhradie, Rožňava dist.; 60 – Silica, Rožňava dist.; 61 – Zlatá Baňa, Prešov dist.; 62 – Lošonec, Trnava dist.; 63 – Častá, Pezinok dist.; 64 – Haniska, Košice-okolie dist.; 65 – Ladmovce, Trebišov dist.; 66 – Silica, Rožňava dist.; 67 – Košice-Bankov, Košice dist. (after Bátora 2018, fig. 267; Sedliak 2005, pl. III).

Much closer to Špania Dolina than Slovenské Pravno is located, on the NW periphery of Banská Bystrica, Moskovská ulica street, a feature with a thin cultural layer was uncovered. The layer contained fragments of Epi-Lengyel pottery as well as clusters of copper slag of malachite ore (Kvietok 2017, 165). Even more significant evidence of metallurgic activity was documented in Horná Mičíná, Hájny diel site, where the investigated settlement stretches on the interface of the Zvolenská pahorkatina hills and the Bystrická vrchovina hills, in the altitude around 542 m a. s. l. (Zachar et al. 2023, fig. 1). Excavations uncovered two extremely important features which were dated by  $^{14}\text{C}$  method between 3968 and 3708 cal. BC and can be culturally associated with the bearers of the late stage of the Ludanice group (Zachar et al. 2023, fig. 7–9; tab. 2; 3). First feature was shaped like a storage pit sunken in the dolomite bedrock and contained pottery of the Epi-Lengyel character, polished and chipped industry, daub, animal bones and charcoals as well as a fragment of a metallurgic crucible and copper ore (Zachar et al. 2023, fig. 3; 4). The second feature was a furnace consisting of an oval metallurgic pit and a loading pit. The fill of the metallurgical pit consisted of smelted copper ore of approx. 10 kg, a fragment of a metallurgic crucible and charcoals (Zachar et al. 2023, fig. 5; 6). Spectral analysis of the copper ore, slag and smelted copper showed that tetrahedral copper was produced at the site; it is identical with the copper artifacts from the Early Eneolithic in the territory of today's Slovakia. It is

important that copper of this type is known also from the nearby deposits e. g. in Poniky (Fig. 13: 7; Zachar *et al.* 2023, 23).

The presented evidences of settlement by the bearers of the Epi-Lengyel groups in the territory of the Zvolenská kotlina basin can be considered a result of their migration from the south to the north along the Hron river, mainly through the Slovenská brána geomorphological unit in the area of Rybník and Tlmače. The shift of settlement to higher-located mountainous areas of the Hron river basin in the Early Eneolithic had been documented earlier in the territory of Žarnovica. There, on a high right-bank Hron river terrace, near the remote settlement of Zliechovci, southwest of Revište castle ruins, coarse-grained pottery was detected together with chipped tools from limnic silicite (Bárta 1986, 27). The shift of settlement northwards was obviously connected with the interest in the above-mentioned deposits of copper ore in central Slovakia, mainly in the region of Špania Dolina-Piesky (Fig. 13: 4), as well as the sources of silicites in the Žiarska kotlina basin. It can be supposed that mainly the inhabitants of the many Epi-Lengyel settlements were interested in them. The settlements were located in the corridor of the Slovenská brána unit (Tlmače-Hrádze, Kozárovce, Čaradice, Tekovské Nemce, Hronský Beňadik-Psiare) or its forefield (Rybník-village area, Čajkov-Osúchov kameňolom, Čajkov-Baranec-Kruhy, Čajkov-Deberča, Podlužany-Areál JRD, Hronské Kľačany, Nová Dedina-Gondovo, Tlmače-Lipník, Nový Tekov-EMO kanál, Nový Tekov-Marušová; Bátora 2009, fig. 8; 12).

Populations from several tens of the known Epi-Lengyel settlements from the neighbouring upper Žitava river basin most probably participated in exploitation of the above-mentioned raw materials (Bátora 1989, fig. 1). It is suggested by many finds of copper artifacts in the territory of the Slovenská brána unit and its forefield in the lower Hron river basin (Čajkov, Nový Tekov-Šándorhalma, Nová Dedina-Tekovská Nová Ves) and the upper Žitava river basin (Volkovce, Veľké Vozokany, Nevidzany, Tajná, Dolné Obdokovce, Koliňany, Neverice); the finds include massive axehammers of the Székely-Nádudvar, Jászladány and Szendrő types (Bátora 1989, fig. 12; 13; 2002, fig. 2; 3; 2009, fig. 12; 13). The assumption that copper artifacts from the upper Žitava river basin might have been made from the copper ore obtained in central Slovakia is supported by the spectral analysis of the copper axehammer of the Székely-Nádudvar type from Volkovce. The chemical composition of the axehammer showed that it was made of pure copper (Cu) with a minor share of nickel (Ni) and trace amounts of silver (Ag), iron (Fe), tin (Sn) and zinc (Zn; Págo 1989, 14, fig. 1). Such composition is close to the composition of Slovak copper (Págo 1968, 250–253; Schreiner 2007, 173, 174). Besides the spectral analysis, the local production of the axehammer is suggested by the fact that it is a raw cast – semi-finished product, which is documented by the distinct traces of casting on the surface (Bátora 1989, fig. 4; 7: 1; Págo 1989, 14). Local production is also suggested by the untreated surface of another axehammer of the Székely-Nádudvar type from Tajná in the upper Žitava river basin (Bátora 2002, fig. 2).

The fact that metallurgic production took place in the upper Žitava river basin in the Early Eneolithic is documented by the situation observed at the settlement of the Ludanice group of the Lengyel culture in Čierne Kľačany, where fragments of copper ore were discovered in foundation trenches of two houses and in a storage pit. They represented Cu minerals – malachite and azurite (Cheben I./Cheben M. 2015, 27). Moreover, miniature solids of copper in form of little balls or drops were found, confirming copper metallurgy and further processing (Cheben I./Cheben M./Chebenová 2019, 75, 76).

It can be supposed that a certain amount of raw material for the metallurgy in the territory of the lower Hron and upper Žitava river basins might have been provided for the Ludanice group bearers not only by the above-mentioned region of Špania Dolina-Piesky (Fig. 13: 4) but also the nearer situated polymetallic deposits in the Štiavnické vrchy hills with the largest concentration detected around Hodruša-Hámre, Banská Štiavnica, Vyhne, Banská Belá and Sklené Teplice (Fig. 13: 1, 2, 44, 46). It is also possible that the immediately located deposits in the southern periphery of the Štiavnické vrchy hills were used as well, e. g. near Voznica, Rudno nad Hronom, Brehy near Nová Baňa, Uhliská, Pukanec and Žemberovce (Bernard 1981, 353). Here, Pečenice can be mentioned. It is situated in the same region. At the local upland settlement at the site of Vtáčnik, two stone hammers with grooves were found together with Early Eneolithic pottery of the Epi-Lengyel character and fragments from the Late Eneolithic Kosihiy-Čaka-Makó culture (Novotný 1955, 20; pl. VII: 2). Thus, it is very probable that the bearers of both Eneolithic cultures participated in exploitation of the nearby deposits of copper ore as well as in its further processing in this region.

The association with the bearers of the Kosihiy-Čaka-Makó culture is greatly suggested by finds of copper axes with single blades of the Baniabíc and Fajsz types from the upper Žitava river basin (Žitavany-Opatovce; Bátora 2023, fig. 6: 2; 7: 2) and the Baniabíc type from the lower Hron river basin

(Dolný Pial; Bátora 2023, fig. 2: 1). Spectral analyses of both axes from Žitavany-Opatovce confirmed that they were made from arsenical copper (Cu content varied between 96, 610% and 99,187%) contained in oxidation ores – malachite and pseudo-malachite. Their deposits in central Slovakia occur in the regions of Ľubietová and Špania Dolina (Schreiner 2007, tab. on p. 238).

Finally, the poly-quantitative evaluation of the content of individual trace elements in the axe from Dolný Pial showed that it was made from copper of eastern provenance, which includes the territory of Slovakia with its deposits (Žebrák 1995, 18, 19). The accordance of its chemical composition with the composition of the Slovak copper ore allows an assumption that the axe from Dolný Pial was made of copper obtained in this territory (Págo 1970, 20, 21).

It is noteworthy that we must consider a new actor – the Yamnaya culture bearers – in association with metallurgy in the territory of the lower Hron river basin in the Late Eneolithic. Their presence in the lower Hron river basin is suggested by several tens of tumuli located mostly in the inundation area on the right bank of the Hron river (Bátora et al. 2023, fig. 31). It is also suggested by the spectral analysis of the axehammer from burial 7, uncovered under a tumulus of the Yamnaya culture in Sárrétudvar in the upper Tisza river basin in Hungary. The analysis confirmed that it was made from the copper raw material from the deposits located in the territory of today's Slovakia (Dani/Kulcsár 2021, 337). This find clearly shows that the Yamnaya culture bearers were attracted to the flat terrain of southwestern Slovakia and the Hronská tabuľa table in particular not only by pastures but also by deposits of non-ferrous metals, i. e. copper, gold and silver, which were located in the nearby mountain ranges of central Slovakia (Fig. 13).

The assumption of A. Točík and H. Bublová that the continuity in exploitation of copper ore in Špania Dolina-Piesky associated with further processing of the ore (local crushing and roasting) is more than probable in the Early Bronze Age (Točík/Bublová 1985, 87) was later confirmed by analyses of the stable lead isotopes ratio in the ore and in metal artifacts (Duberow/Pernicka/Krenn-Leeb 2009, 343–345, fig. 10–13).

The discovery of a bronze dagger with a lingulate handle (Peschiera type) on the dominant hill of Glezúr in the immediate vicinity of the assumed exploitation in prehistory documents that this area of copper exploitation was also known in the following period of the Middle and in the beginning of the Late Bronze Age. Based on the method of depositing, i. e. blade stabbed perpendicularly in the earth, the dagger can be culturally associated with the Pily culture bearers and dated to the interface of stags BC2–BD1 (Zachar/Struhár 2017, 53; 65, fig. 3; 4).

## FUNCTION OF THE HAMMERS OUTSIDE THE MAIN EXPLOITATION AREAS OF NON-FERROUS METALS

The function of the few hammers with grooves or notches discovered in the territory of Slovakia outside the exploitation areas of non-ferrous metals in central and partly eastern Slovakia remains a question (Fig. 13). With the ambition to answer the question at least partially, four hammers were analysed by X-ray fluorescence spectrometry, which was executed by Niton XL3 XRF Analyzer device (I would like to thank Mgr. V. Mezey from IA SAS in Nitra for the analysis). The analysis on the percussion ends of two hammers with grooves with cylindrical shapes which were made from silicified sandstone confirmed presence of trace amounts of copper (Cu) with the same value of 0.003%. One hammer comes from the territory of the lower Hron river basin (Jur nad Hronom, Fig. 8: 4), another one comes from the lower Ipeľ river basin (Brhlovce, Fig. 7: 3). The analysis of the third exemplar with ovoid shape and notches

Tab. 1. Results of the analysis of stone hammers performed by the X-ray fluorescence spectroscopy method with the Niton XL3 XRF Analyser (author of the analysis V. Mezey from the Archaeological Institute of the SAS in Nitra).

| Site           | Roch [%] | Fe [%] | Cu [%] | Zn [%] | Pl [%] |
|----------------|----------|--------|--------|--------|--------|
| Brhlovce       | 99.59    | 0.32   | 0.003  | 0.007  | –      |
| Šahy           | 93.14    | 6.00   | 0.005  | 0.012  | 0.003  |
| Jur nad Hronom | 98.53    | 1.43   | 0.003  | 0.007  | –      |
| Vráble         | 99.69    | 0.30   | –      | 0.005  | –      |

from Šahy in the lower Ipel' river basin (Fig. 11: 1) showed trace amounts of copper (Cu) – 0.005% (Tab. 1). These analyses suggest that some hammers – even outside the main area of copper ore exploitation in the volcanic mountain ranges of central Slovakia – might have been used in activities associated with metallurgy. With regard to the fact that the hammer from Jur nad Hronom as well as the one from Brhlovce had a regular flat or slightly concave smoothed surface on one of their ends, it cannot be denied that they were secondarily used as anvils for treatment of metals. The exemplar from Kiel-Wik, Forsteck in the northern German Schleswig-Holstein is an example of such use of a grooved hammer (Freudenberg 2009, fig. 4).

As for the hammers from Šurany-Nitriansky Hrádok (Fig. 8: 1) and Vráble-Fidvár (Fig. 11: 2) found in the areas of fortified settlements from the Early Bronze Age, their possible use in metallurgy – e. g. crushing of the metal ore – is supported by several finds as well as terrain observations. In Šurany-Nitriansky Hrádok, there are many casting moulds, clay nozzles and small solids of bronze material, which were concentrated mainly in the middle of the southern edge of the Maďarovce culture settlement, where metallurgic workshops were obviously located (Bartík 1999, 190, fig. 8). Besides several exemplars of casting moulds and clay nozzles, the site of Vráble-Fidvár provided fragments of roughly shaped pottery crucibles with remains of bronze material, which indicate presence of metallurgic workshops in several parts of the settlement (Bátora/Tóth/Rassmann 2015, 132, fig. 10: 1, 2; Sýkorjaková 2010, pl. II: 28; XV: 6, 7–10; XVI: 1, 2; 2012, pl. XXXIV: 190pk\_1–4; XXXV: 108\_73). The X-ray fluorescence spectrometry of the percussion ends of the hammer from Vráble-Fidvár – despite the above-mentioned evidence related to metallurgy – did not confirm presence of trace elements of copper. Thus, the local hammer with notches was clearly used for different purposes (see the text below).

Use of the hammer with a groove from Čachtice in association with metallurgy can be hypothetically considered, similarly to the hammers from Šurany-Nitriansky Hrádok and Vráble-Fidvár (Fig. 7: 2; Bátora 2018, fig. 272). Such use is supported by the local deposits of copper ore in the nearby Little Carpathians (Farkaš/Gregor 2013, 63). As for the unique find of the hammer from Špačince (Fig. 9: 1), its use in metallurgy is questionable despite the fact that it was found in the forefield of the Little Carpathians, since distinct traces of use are absent on both its percussion ends (Kolon 2015, 14).

Since hammers with grooves and notches were primarily used for percussion and they are also called mining hammers (Delgado-Raack/Risch 2017, 8), it can be assumed that mainly their exemplars from Slovakia discovered in areas far from deposits of non-ferrous metals were used as multifunctional tools for various activities. These might include so-called rough works e. g. during construction of fortifications, breaking stone, construction or destruction of unused construction features, etc. The settlement of Akrotiri on Thera in the eastern Mediterranean, which was destroyed around 1600 BC due to a volcanic eruption, is a good example; hammers with grooves were used there for demolition of damaged buildings (Michailidou 2013, fig. 4; 140). Finally, such multi-purpose use of stone hammers is assumed in the Únětice culture period in the neighbouring Moravia (Kamarád/Fojtík/Přichystal 2024, 63, 64).

## DATING OF HAMMERS WITH GROOVES AND NOTCHES FROM THE TERRITORY OF SLOVAKIA

Although a high number of exemplars of stone hammers with grooves or notches was discovered during the excavation in Špania Dolina-Piesky in 1970–1972, the question of their precise dating and exact cultural classification remained open, despite the finds of fragments of Epi-Lengyel pottery from collections (Točík/Bublová 1985, 86). The assumption of A. Točík and H. Bublová that hammers were used for copper exploitation as early as the Early Eneolithic, the Epi-Lengyel period, has recently been proved right. It happened thanks to the results of the excavation in Banská Bystrica-Kremnička, where a hammer with a groove was found in a settlement feature dated to the Ludanice group period (Fig. 7: 1). This dating is also supported by the results of previous excavations with evidence of metallurgic activity in Slovenské Pravno (Šalkovský 1977, 261, fig. 169: 10–15), Banská Bystrica, Moskovská ulica street (Kvietok 2014, 8, 9), Čierne Kľačany (Cheben I./Cheben M. 2015, 27) and Horná Mičiná (Zachar et al. 2023, fig. 7–9; tab. 2; 3).

Using hammers in the Early Bronze Age has been documented by several stratified finds. Firstly, we can mention the discovery of the grooved hammer fragment from Čachtice in the central Váh river basin again. It was uncovered at the burial ground from the Early Bronze Age in a male burial (burial 1) dated to the end of the Nitra culture (Fig. 7: 2; Bátora 1976, 22; 2018, fig. 272). Another find is a notched hammer

from Šahy, which was uncovered in the area of a fortified settlement (feature 2) of the Hatvan culture (Fig. 11: 1; *Bátora/Neumann/Pálinkás 2023*, 18, 19).

In association with precise chronological classification of the discovered hammers, we can mention the exemplar from Malé Kosihy in the lower Ipeľ river basin, which was also found in the area of a Hatvan culture fortified settlement, at the site of Törökdomb (Fig. 10: 1). It was uncovered in the Hatvan culture layer (horizon IIIA) located 180–160 cm deep (*Marková 2002*, 205, 207, fig. 1: 5; *Točík 1981*, 9, 236–245).

The massive hammer with a groove from Španie Pole located in the south of central Slovakia can be roughly dated to the Middle/beginning of the Late Bronze Age (Fig. 7: 5). Such dating is supported by the nearby settlement and burial ground of the Pily culture (*Furmánek 2004*, 27).

## CONCLUSION

Stone hammers with grooves and notches belong to remarkable prehistoric artifacts which are associated mainly with mining and exploitation of non-ferrous metals. More than 400 exemplars from 17 sites are known from the territory of Slovakia. They can be classified into several basic types. Most of the above-mentioned hammers (almost 400 exemplars) come directly from Špania Dolina, Piesky site, in central Slovakia and another large group comes from its nearby surroundings in the region of Banská Bystrica (Banská Bystrica, Banská Bystrica-Kremnička and Horné Pršany). 14 exemplars of hammers come from 13 other sites, mostly located in SW Slovakia (Fig. 12), outside the non-ferrous metals mining areas. They include cylindrical hammers of two variants: short (Fig. 7) and elongated (Fig. 8). There are also ovoid/spherical-globular (Fig. 9) and prismatic (Fig. 10) hammers. Massive, heavy hammers occurred only in central Slovakia, in the areas with deposits of copper ores in the immediate vicinity. Thus, it can be assumed that they were used mainly to exploit or hammer out copper ore.

The petrographic analysis of the hammers discovered in Špania Dolina-Piesky showed that most of them were made from quartzite, some exemplars were made from andesite, granodiorite, amphibolite and migmatite. A partly different situation was detected with the exemplars from other parts of Slovakia, where silicified sandstone was predominant, followed by quartzite and andesite. Rarely, hammers were made from diorite, limnic quartzite and metaquartzite.

In the territory of Slovakia, we find a concentration of hammers not only in the region of Banská Bystrica, but also in the regions of the lower Hron and Ipeľ river basins (Fig. 12). Other sites with occurrence of hammers are scattered mainly in the southwest of Slovakia, in the floodplains of the lower Nitra (Šurany-Nitriansky Hrádok, Fig. 12: 16) and Žitava rivers (Vráble, Fig. 12: 17), in the Trnavská pahorkatina hills (Špačince, Fig. 12: 13) and the Podmalokarpatská pahorkatina hills (Čachtice, Fig. 12: 4). Single exemplars of hammers are known from northwestern Slovakia – Kysucká vrchovina hills (Stará Bystrica, Fig. 12: 11) and the south of central Slovakia, from the southeastern part of the Slovenské rudohorie hills (Španie Pole, Fig. 12: 15). It is noteworthy that finds of hammers with grooves or notches are still absent in the territory of eastern Slovakia.

The excavations, mainly in Špania Dolina-Piesky and its nearby surroundings, showed a close connection between the stone hammers and the areas with deposits of copper ores. The fact that the hammers were used for exploitation of silicite raw materials as well was suggested by the survey of the deposit and exploitation site of limnic silicite in Horné Pršany, Kremenia site, near Banská Bystrica, where approx. 60 exemplars were obtained by a surface collection. The assumption that exploitation was also carried out in the Early Eneolithic is suggested by older finds of Epi-Lengyel pottery in the area of studios for production of chipped industry in the neighbouring upper Nitra river basin, e. g. in the cadastral areas of Brusno-Chrenovec, Ráztočno and Handlová.

The shift of the Epi-Lengyel groups bearers from SW Slovakia northwards was obviously associated mainly with their interest in the above-mentioned deposits of copper ore in central Slovakia, mainly the area of Špania Dolina-Piesky (Fig. 13: 4) as well as silicite deposits in the Žiarska kotlina basin and probably also the Zvolenská kotlina basin. It can be assumed that primarily the bearers of the Ludanice group were interested in the above-mentioned deposits. Their settlements were located in the lower Hron river basin as well as the corridor of the Slovenská brána geographical unit (Rybník, Kozárovce, Tlmače, Hronský Beňadik-Psiare) and its southern forefield. The population of the Ludanice

group from the nearby region of the upper Žitava river probably participated in exploitation of the raw materials as well. It is suggested – in addition to the spectral analyses of copper artifacts found at its settlements – by frequently occurring chipped industry from limnic quartzite which comes mostly from the Žiarska kotlina basin.

It is possible that a certain volume of the raw material necessary for metallurgic activity in the lower Hron and upper Žitava river basins was provided to the Ludanice group bearers by the nearer-located polymetallic deposits in the Štiavnické vrchy hills, where the highest concentration of them was detected near Hodruša-Hámre, Banská Štiavnica, Vyhne, Banská Belá and Sklené Teplice (Fig. 13: 1, 2, 44, 46). Finally, the deposits located in the immediate vicinity, in the southern peripheral part of the Štiavnické vrchy hill, e. g. near Voznica, Rudno nad Hronom, Brehy near Nová Baňa, Uhľiská, Pukanec and Žemberovce. In this context, we could mention the upland settlement of Vtáčnik in Pečenice, which is situated right in this territory. Apart from the Early Eneolithic pottery of the Epi-Lengyel character and pottery fragments of the Late Eneolithic culture of Kosihy-Čaka-Makó, two stone hammers with grooves were found in the settlement area. Thus, it is very likely that bearers of both Eneolithic cultures participated in exploitation of the nearby deposits of copper ore and its processing in this region. It is remarkable that in the Late Eneolithic, we must consider a new actor in association with metallurgy in the lower Hron river basin – probably bearers of the Yamnaya culture. Their presence in the lower Hron river basin is suggested by several tens of tumuli which are located mainly in the inundation area on the right bank of the Hron river. Results of the spectral analysis of the copper axehammer uncovered in a burial under a tumulus of the Yamnaya culture in Sárrétudvar, in the upper Tisza river basin in Hungary, pointed to the fact that the bearers of the Yamnaya culture were – apart from potential pastures – attracted to the flat terrain of southwestern Slovakia and the Hronská tabuľa table in particular also by deposits of non-ferrous metals located in the nearby central Slovak mountain ranges (Fig. 13).

Thanks to the X-ray fluorescence spectrometry of four hammers from southwestern Slovakia, the study brings new information on the function of the hammers also outside the main areas of exploitation of non-ferrous metals. In three cases, presence of trace elements of copper (Cu) on the percussion surfaces of the hammers was confirmed (Brhlovce, Jur nad Hronom and Šahy). Obviously, some hammers in the territories of the lower Hron river and the Ipel' river basins were used in activities associated with metallurgy. With regard to the fact that hammers were primarily used for percussing, we can assume that some of them were used as multifunctional tools. They might have been used mostly for rough works, e. g. in construction of fortification, cracking stones, building or destructing unused structures, etc.

The important question of dating and specified cultural classification of the prehistoric hammers with grooves and notches from the territory of Slovakia remained open for a long time, despite the finds of fragments from Epi-Lengyel pottery during the excavation in Špania Dolina-Piesky in 1970–1972. It was the recent excavation in Banská Bystrica-Kremnička revealing a hammer with a groove in a settlement feature dated to the Ludanice group period (Fig. 7: 1) which confirmed the previous assumption that hammers were used for copper exploitation as early as the Early Eneolithic. Such dating is supported by the results of previous excavations in Slovenské Pravno, Banská Bystrica-Moskovská ulica street, Čierne Kľačany and Horná Mičiná, which had brought significant evidence of metallurgic activity at Epi-Lengyel settlements.

In the following period of the Early Bronze Age, use of hammers is documented by several old as well as new stratified finds. First, we can mention the discovered fragment of a hammer with a groove in Čachtice, in the central Váh river basin, which was uncovered at the burial ground of the Early Bronze Age, in a male burial (burial 1) dated to the end of the Nitra culture (Fig. 7: 2). Another hammer with notches from Šahy in the lower Ipel' river basin was uncovered in a feature of the Hatvan culture (feature 2) in the area of a fortified settlement (Fig. 11: 1). Another exemplar of a hammer also discovered in the area of a fortified settlement comes from the lower Ipel' river basin, Malé Kosihy in particular. It was found in the layer of the Hatvan culture (horizon IIIA, Fig. 10: 1).

The massive hammer with a groove from Španie Pole in the south of central Slovakia (Fig. 7: 5) can be roughly dated to the period of the Middle/beginning of the Late Bronze Age. Such dating is supported by the settlement and burial ground of the Piliny culture located near the site of the hammer discovery.

## CATALOGUE OF THE SITES WITH HAMMERS WITH GROOVES AND NOTCHES FROM THE TERRITORY OF SLOVAKIA

### 1. Banská Bystrica, Banská Bystrica dist.

In the urban area of the town, in the borough of Fortnička, a stone hammer with a groove – 1 (inv. no. 281/31) was found in the river of Bystrička in 2005. In 2012, another exemplar of a hammer with a groove – 2 (inv. no. 610/31) was found at the same site.

Description:

1. Axe-shaped hammer with a groove. Dimensions: L 160 mm, thickness 100 mm, groove W 100 mm. Weight: 2790 g. Material: andesite.
2. Square-shaped hammer with a groove, unfinished. Dimensions: L 132 mm, thickness 65 mm, groove W 85 mm. Weight: 1096 g. Material: limnic quartzite.

Deposited at: Naše múzeum medi (Our Museum of Copper), Herrengrund Miners Fraternity, Špania Dolina.

Bibliography: *Sitár/Kvietok/Jeleň 2017*, tab. 1: 11; 18.

### 2. Banská Bystrica-Kremnička, Banská Bystrica dist.

During the rescue excavation by the Midland Adventure company, a shallow feature – a refuse pit – was uncovered in the area of the Logistické centrum company. Its fill contained fragments of pottery as well as a hammer with a groove. The feature was originally dated to the Piliny culture period. Revision of the pottery material showed that the feature could be dated to the Epi-Lengyel period (I would like to thank Martin Kvietok from the Midland Adventure company in Banská Bystrica for the information).

Description: The hammer has a cylindrical shape, rounding towards both ends with distinct percussion ends. An encircling groove made by gradual percussing is located in its central part. Dimensions: L 87 mm, W 72 mm, H 79 mm, groove W 26 mm. Weight: unknown. Material: silicified sandstone? (Fig. 7: 1).

Deposited at: Spoločnosť Midland Adventure Banská Bystrica company.

Bibliography: *Fratričová/Mišo 2022*, fig. on p. 1.

### 3. Brhlovce, Levice dist.

The assemblage of finds provided by the Tekovské múzeum in Levice to the Institute of Archaeology SAS in Nitra for processing and documenting included a stone hammer with a groove. The hammer had been brought to the museum by local pupil Slaný, who had found it in a farm building on his grandfather's property in Brhlovce. The exact site of discovery of the hammer has not been identified, in spite of the personal meeting of J. Batora and Mr Slaný – currently living in Levice-Kalinčiakovo – in 2017.

Description: The hammer has a cylindrical shape, slightly narrowing and rounding towards both ends with percussion ends. In its central part, there is a continuous encircling groove created by gradual percussing. Dimensions: L 80 mm, width 57 mm, H 70 mm, groove W 20 mm. Weight: 565.0 g. Material: silicified sandstone (Fig. 7: 3).

Deposited at: Institute of Archaeology SAS in Nitra.

Bibliography: *Habovštiak 1962*, 2

### 4. Čachtice, Nové Mesto nad Váhom dist.

During the rescue excavation carried out in 1975 by J. Batora from IA SAS in Nitra in the cadastral area of the village, part of a burial ground from the end of the Nitra culture and the beginning of the Únětice culture was investigated at the site of Močiar. In burial 1, where a man was buried, crouched on the right side, a fragment of a hammer with a groove was found in front of his bent right leg.

Description: Fragment of a half of a hammer with cylindrical shape with one preserved percussion end bearing distinct traces of use and with remains of a groove, which was probably located in its middle part. Dimensions: preserved L 62 mm, preserved W 70 mm. Material: silicified sandstone (Fig. 7: 2).

Deposited at: Institute of Archaeology SAS in Nitra.

Bibliography: *Batora 1976*, 22; *2018*, fig. 272.

### 5. Horné Pršany, Banská Bystrica dist.

During the surface survey at the deposit and exploitation area of limnic silicite, P. Ušiak and R. Hrončiak discovered a fragment of a hammer with an encircling groove (1) in the cadastral area of the village, at the site of Kremená, in 1998. Later, in the beginning of the 21<sup>st</sup> c., a surface collection carried out by amateurs from the Slovak Mineralogic Association from Banská Bystrica obtained approx. 60 exemplars of stone hammers and their fragments – some of them had no encircling grooves, some of them had partial grooves and some of them had complete encircling grooves (2).

Description:

1. Fragment of a large prismatic hammer with a preserved encircling groove in the middle part (?) has an almost diamond-shaped cross-section. The front part of the hammer fragment is gradually narrowing. Dimensions: preserved L 162 mm, W 98 mm, H 155 mm. Weight: unknown. Material: quartzite (Fig. 10: 2).

Bibliography: *Fratričová/Mišo 2022*, 4, 5; *Ušiak/Hrončiak 2000*, 179, 180.

2. A massive cylindrical hammer with narrowed and rounded ends, clearly made from a smooth pebble. Approx. in the middle, there is a rather shallow encircling groove. Dimensions and weight: unknown. Material: quartzite?

Deposited at: Stredoslovenské múzeum Banská Bystrica.

Bibliography: *Solivaĵs 2021*, 1, fig. 1: A.

#### 6. Ipeľský Sokolec, Levice dist.

During the trial excavation carried out by J. Paulík in 1981, a part of a fortified Hatvan and Čaka culture settlement was examined at the site of Staré pieskovisko (Staré vinohrady). A hammer with a groove was discovered; its classification into one of the cultures is unclear.

Description: Both percussion ends of the small ovoid hammer with a centrally located groove are rounded. Dimensions, weight and material: unknown (Fig. 9: 2).

Deposited at: Archaeological Museum SNM in Bratislava.

Bibliography: *Paulík 1982*, 218, fig. 121: 6.

#### 7. Jur nad Hronom, Levice dist.

Doctoral student P. Tóth submitted a hammer with a groove obtained from a local inhabitant during a surface collection in the cadastral area of the village to the Institute of Archaeology in 2014.

Description: The hammer has a long cylindrical shape and oval cross-section. One end is rounded, without traces of percussing, the other is narrowed and bears a flat percussion surface of 40 × 30 mm. The 15 mm wide encircling groove is not in the exact middle of the hammer – it is slightly shifted to the wider rounded part. Dimensions: L 145 mm, W 40–50 mm, H 65–70 mm. Material: silicified sandstone. Weight: 738.6 g (Fig. 8: 4).

Deposited at: Institute of Archaeology SAS in Nitra.

Bibliography: unpublished.

#### 8. Lontov, Levice dist.

1.5 km east of Lontov, right of the road from Kubáňovo to Ipeľský Sokolec and the river of Ipeľ, a stone hammer with a groove was discovered at a polycultural prehistoric site in the 1930s. The site can be most probably identified with the site of U Litaša, where a fortified settlement of the Hatvan culture was detected by a geophysical survey in the end of the second decade of the 21<sup>st</sup> c.

Description: The long cylindrical hammer has an approx. elliptical cross-section. It is slightly narrowing and rounding towards both ends with flat percussion surfaces. The circumferential groove is not located in the middle; it is shifted to the wider part of the tool. Dimensions: L 100 mm, W 35 mm, H 50 mm. Weight: unknown. Material: andesite (Fig. 8: 2).

Deposited at: Ethnographic Museum SNM in Martin.

Bibliography: *Cheben/Chebenová 2019*, 202–204, fig. 2; pl. V; *Janšák 1938*, 77–79, pl. XXIX: 1.

#### 9. Malé Kosihy, Nové Zámky dist.

In the course of the archaeological excavation at the fortified settlement from the Early Bronze Age, which was carried out by A. Točík in 1956 in the cadastral area of the village, at the site of Törökdom, a fragment of a hammer with a groove was discovered in the area of the acropolis of the fortified settlement, in trench I/8, in the Hatvan culture layer (horizon IIIA).

Description: The fragment of an angular hammer with both ends considerably damaged (chipped-off). The cross-section of the hammer is almost square. There is an encircling groove in the middle part of the hammer. Preserved dimensions: L. 86 mm, max. W. 67 mm. Weight: 580 g. Material: fine-grained amphibolic andesite (Fig. 10: 1).

Deposited at: Institute of Archaeology SAS in Nitra.

Bibliography: *Marková 2002*, 205, 207, fig. 1: 5; *Točík 1981*.

#### 10. Pečenice, Levice dist.

In the beginning of the 20<sup>th</sup> c., Mr Michal Kočíš, inhabitant of Pečenice and colleague of A. Kmeť, discovered two hammers with grooves (1 and 2) in the cadastral area of the village, Vtáčnik site. Together with these hammers, M. Kočíš found sherds from the Epi-Lengyel period and a fragment of a bowl on stem (square-shaped) which can be dated to the Kosihy-Čaka-Makó culture. It is noteworthy that several decades later, at the same site, V. Budinský-Krička obtained a fragment of another bowl on stem with engraved checker decoration on the interior surface filled with white incrustation.

Description:

1. Fragment of about a half of a cylindrical hammer with slightly rounded percussion surfaces on its ends. In the middle part, there is a continuous encircling groove made by gradual percussing (groove W 20–25 mm). Dimensions: L 83 mm, preserved W 35 mm, H 63–70 mm. Weight: unknown. Material: silicified sandstone (Fig. 7: 4).
2. Long cylindrical hammer with oval cross-section and percussion surfaces with distinct traces of workwear on both ends. A wide shallow groove is situated in the middle. Dimensions: L 122 mm, W 63–70 mm. Weight: unknown. Material: Silicified sandstone (Fig. 8: 3).

Deposited at: property of Mr. Beňa, heir of Michal Kočíš, a long-standing co-worker of A. Kmeť, in Pečenice.

Bibliography: *Bátovská 2012*, 2, 18; *Budinský-Krička 1947*, pl. VII, 2; *Novotný 1953*, pl. VII: 2.

### 11. Stará Bystrica, Čadca dist.

According to the information from a letter from Karol Andel sent to the Institute of Archaeology SAS in Nitra in 1953 (letter deposited with the Department of Documentation of IA SAS under no. 178/53), a stone hammer with a groove was found in the cadastral area of the village, at the site of Blato.

Description: An ovoid/spherical-globular stone hammer has a circular cross-section and rounded percussion surfaces on both ends. The encircling fixation groove is located in its middle part. Dimensions: L 91 mm, W 68 × 65 mm.

Weight: 565.0 g. Material: sandstone strongly saturated with iron oxide (Fig. 9: 3).

Deposited at: Ethnographic Museum SNM in Martin (inventory no. 4302).

Bibliography: *Furmánek/Illášová 2002*, 105, 106, fig. 1, 2.

### 12. Šahy, Levice dist.

In the course of the excavation by the Institute of Archaeology SAS in Nitra and the Hontianske múzeum a Galéria F. Simonyiho in Šahy in 2017, a hammer with a groove was uncovered in trench G, feature 2. The feature contained typical pottery of the Hatvan culture and a sherd with incised decoration of the Kisapostag culture.

Description: Fragment of a stone hammer with approx. ovoid shape, partly damaged by a split-off in the upper half. Dimensions: L 80 mm, preserved W 35 mm, H 50 mm. Approximately in the middle part of the hammer (perpendicular with its longitudinal axis), a 5 mm deep and 16 mm wide notch is situated; in the lower part, there is a shallow depression – 16 mm long and 2–3 mm deep. The space between the notch in the upper part and the depression in the lower part was not connected by a continuous encircling groove. Weight: 140 g. Material: unknown (Fig. 11: 1).

Deposited at: Hontianske múzeum a Galéria F. Simonyiho in Šahy.

Bibliography: *Bátora/Neumann/Pálinkás 2023*, 18–20.

### 13. Špačince, Trnava dist.

V. Zachar discovered a stone hammer with a groove north of the village, at the site of Peňažité, in 2014. He submitted it to the Archaeological Museum SNM in Bratislava.

Description: A completely preserved ovoid/spherical-globular stone hammer with a groove. There is a shallow encircling groove approx. in the middle. The hammer is slightly narrowing from the rounded head part. No distinct traces of damage are visible on the surface. Dimensions: L 117 mm, diameter at the groove 93–83 mm, groove W 18 mm, diameter of the front part 95 × 78 mm, head diameter 98 × 91 mm. Weight: 1556.6 g. Material: diorite, probably from the surroundings of Bratislava (Fig. 9: 1).

Deposited at: Archaeological Museum SNM in Bratislava.

Bibliography: *Kolon 2015*, 11–13, fig. 3.

### 14. Špania Dolina-Piesky, Banská Bystrica dist.

Almost 400 hammers come directly from Špania Dolina. Most of them were discovered in the course of the archaeological excavations by A. Točík in 1971 and 1972 in the saddle between the sites of Piesky and Richtárová. In 2017, 124 exemplars were added to them. In terms of shapes, prismatic, cylindrical, conical, ovoid and hoe-shaped exemplars are most frequently represented. A large group consists of transitional hammer shapes which can hardly be classified into any of the above-mentioned types. In terms of weight, they can be classified into three categories: heavy – large (2500 g and more), medium (1000–2500 g) and light – small (up to 1000 g). The petrographic analysis showed that they were made mostly from quartzite; fewer exemplars were made from andesite, granodiorite, amphibolite and migmatite. These rocks come from the territory of the Low Tatras and from the volcanic rocks of the Kremnické pohorie mountains. Pebbles modified into hammers were brought to Špania Dolina-Piesky from the nearby surroundings, mainly from the Starohorský potok stream, the Bystrica river and the Hron riverbed (Fig. 1–5).

Deposited at: Institute of Archaeology SAS in Nitra; Naše múzeum medi (Our Museum of Copper), Herrengrund Miners Fraternity, Špania Dolina.

Bibliography: *Sitár/Kvietok/Jeleň 2017*, tab. 1: 11; 18; *Točík/Bublová 1985*, 47–135.

### 15. Španie Pole, Rimavská Sobota dist.

A stone hammer with a groove was found in 1937 in the cadastral area of the village, at the site of Rézbanya (from the Hungarian expression for copper mine).

Description: A short massive cylindrical hammer with an oval cross-section, has one rounded end and one slightly narrowed end with a large flat percussion surface. The encircling fixation groove with W 40 mm is not in the middle of the hammer; it is slightly shifted towards the flat percussion surface. Dimensions: H 156 mm, max. diameter 132 mm. Weight: 3.24 kg. Material: amphibolic-pyroxene andesite (Fig. 7: 5).

Deposited at: Ethnographic Museum SNM in Martin.

Bibliography: *Furmánek 1987*, 48, fig. 12; *2004*, 28: kat. no. 11.

### 16. Šurany-Nitriansky Hrádok, Nové Zámky dist.

A stone hammer of a collection character was discovered by A. Točík during the excavation in the area of the fortified settlement of the Lengyel and Maďarovce cultures in 1949.

Description: An elongated cylindrical hammer with a circular cross-section, one rounded and one slightly pointed end. In the middle, there are indistinct depressions on both sides but they do not make up a continuous encircling groove. Dimensions: H 75 × 42 × 40 mm. Colour: grey. Material: metaquartzite (Fig. 8: 1).

Deposited at: Institute of Archaeology SAS in Nitra.

Bibliography: *Hovorka/Illášová* 1999, fig. 8. 1.

### 17. Vrábľe, Nitra dist.

During the raster surface survey carried out by experts from the IA SAS in Nitra, RGK DAI Frankfurt am Main, University in Bamberg and the Institute of Geography of Heidelberg University, a hammer with fixation notches was discovered in sector × – O 10.

Description: The hammer has prismatic shape and triangular cross-section. In the middle of each of the three rounded sides of the triangle, there is a fixation notch (depth of notches varied from 4 to 8 mm, their width was between 20 and 30 mm). One part is flat and the second is rounded with distinct traces of percussing. Dimensions: L 95 mm, flat part W 70 × 77 mm, rounded part W 65 × 65 × 65 mm. Weight: 796.5 g. Material: quartzite (Fig. 11: 2).

Deposited at: Institute of Archaeology SAS in Nitra.

Bibliography: *Falkenstein et al.* 2008, 39–50.

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## Nálezy pravekých kamenných mlatov so žliabkom a s vrubmi z územia Slovenska

### Príspevok k počiatkom baníctva a ťažby farebných kovov

J o z e f B á t o r a

#### Súhrn

Kamenné mlaty so žliabkom a s vrubmi patria k pozoruhodným artefaktom v praveku, ktoré sú spájané najmä s baníctvom a ťažbou farebných kovov. Z územia Slovenska je známych viac ako 400 exemplárov, ktoré pochádzajú zo 17 nálezísk a možno ich zaradiť do niekoľkých základných typov. Z uvedeného počtu prevažná väčšina mlatov (takmer 400 ks) pochádza priamo zo Španej-Doliny, z polohy Piesky, na strednom Slovensku a ďalšia početnejšia časť z jej blízkeho okolia v bansko-bystrickej oblasti (Banská Bystrica, Banská Bystrica-Kremnička a Horné Pršany). Zo zvyšných 13 nálezísk, ktoré sa prevažne nachádzajú na juhozápadnom Slovensku (obr. 12), mimo ťažobných oblastí farebných kovov, pochádza iba 14 kusov mlatov a sú medzi nimi taktiež zastúpené exempláre cylindrické v dvoch variantoch: krátke (obr. 7) a pozdĺžne (obr. 8), ďalej mlaty ovoidné až sféricko-gulovité (obr. 9) a prizmatické (obr. 10). Masívne, ťažké mlaty sa vyskytli iba na strednom Slovensku, v oblastiach, v ktorých sa v bezprostrednej blízkosti nachádzajú ložiská medených rúd a tak oprávnené možno predpokladať, že slúžili najmä na ťažbu, resp. na vytĺkanie medenej rudy.

Petrografická analýza mlatov nájdených v Španej Doline-Pieskoch ukázala, že boli zhotovené prevažne z kremenca, potom nasledovali exempláre vyrobené z andezitu, granodioritu, amfibolitu a migmatitu. Čiastočne odlišná situácia v tomto smere bola zistená u exemplárov pochádzajúcich z ostatných oblastí Slovenska, kde dominoval silicifikovaný pieskovec, potom nasledoval kremenec a andezit. Iba výnimočne boli mlaty zhotovené z dioritu limnokvarcitu a metakvarcitu.

S koncentráciou výskytu mlatov na území Slovenska sa okrem Banskobystrickej oblasti stretávame aj v regióne dolného Pohronia a Poiplia (obr. 12). Ich ďalšie náleziská sú roztrúsené najmä na juhozápadnom Slovensku v Dolnonitrianskej (Šurany-Nitriansky Hrádok, obr. 12: 16) a Žitavskej nive (Vráble, obr. 12: 17), v Trnavskej (Špačince, obr. 12: 13) a v Podmalokarpatskej pahorkatine (Čachtice, obr. 12: 4). Po jednom exemplári sú mlaty známe zo severozápadného Slovenska z Kysuckej vrchoviny (Stará Bystrica, obr. 12: 11) a z juhu stredného Slovenska, z juhovýchodnej časti Slovenského rudohoria (Španie Pole, obr. 12: 15). Pozoruhodné je, že doteraz absentujú nálezy mlatov so žliabkom, resp. s vrubmi z oblasti východného Slovenska.

Výskumy najmä v Španej doline-Pieskoch a v blízkom okolí preukázali úzku väzbu kamenných mlatov na priestor ložísk medených rúd. To, že mlaty boli využívané aj na exploatáciu silicitových surovín naznačil prieskum ložiska a miesta ťažby limnosilicitu v Horných Pršanoch, v polohe Kremenia, neďaleko Banskej Bystrice, kde sa podarilo pri povrchovom zbere získať približne 60 exemplárov. Na predpoklad, že aj táto exploatácia bola uskutočňovaná v staršom eneolite, poukazovali už dávnejšie nálezy epilengyelskej keramiky v priestore ateliérov na výrobu štiepanej industrie v susednom hornom Ponitří, napr. v katastroch Brusna (časť Chrenovec), Ráztočna a Handlovej.

Aj posun osídlenia nositeľov epilengyelských skupín z juhozápadného Slovenska severným smerom zrejme súvisel najmä so záujmom o uvedené ložiská medenej rudy na strednom Slovensku, predovšetkým v oblasti Španej doliny-Pieskov (obr. 13: 4), ako aj o ložiská silicitov v Žiarskej kotline a pravdepodobne aj vo Zvolenskej kotline. Možno oprávnené predpokladať, že záujem o uvedené ložiská mali v prvom rade nositelia ludanickej skupiny, ktorých sídliská sa v pomerne veľkom počte rozprestierali na dolnom Pohroní v koridore Slovenskej brány (Rybník, Kozárovce, Tlmače, Hronský Beňadik, miestna časť Psiare), ako aj v jej južnom predpolí. Na exploatácii uvedených surovín sa s veľkou pravdepodobnosťou podieľala aj populácia ludanickej skupiny z blízkeho horného Požitavia. Na to poukazujú nielen spektrálne analýzy medených predmetov nájdených na jej sídliskách, ale aj početne zastúpená štiepaná industria z limnokvarcitu, ktorá pochádza najmä zo Žiarskej kotliny.

Nie je vylúčené, že nositeľom ludanickej skupiny mohli určité množstvo suroviny na metalurgickú činnosť v oblasti dolného Pohronia a horného Požitavia poskytovať aj bližšie ležiace polymetalické ložiská v Štiavnických vrchoch, kde ich najväčšia koncentrácia bola zistená v okolí Hodruše-Hámrov, Banskej Štiavnice, Vyhiň, Banskej Belej a Sklených Teplíc (obr. 13: 1, 2, 44, 46). Napokon mohli byť využívané aj bezprostredne ležiace ložiská v južných okrajových častiach Štiavnických vrchov, napr. v okolí Voznice, Rudna nad Hronom, Brehov pri Novej Bani, Uhlísk, Pukanca a Žemberoviec. V tejto súvislosti možno spomenúť výšinné sídlisko Vtáčnik v Pečeniciach, ktoré sa nachádza priamo v tejto oblasti. V areáli sídliska sa okrem staroeneolitického keramického materiálu epilengyelského charakteru a zlomkov keramiky neskoroeneolitickej kultúry Kosihy-Čaka-Makó našli aj dva kamenné mlaty so žliabkom. Je preto veľmi pravdepodobné, že nositelia oboch eneolitických kultúr sa podieľali aj v tomto regióne na exploatácii neďalekých ložísk medenej rudy, ako aj na jej následnom spracovaní. Pozoruhodné je, že v období mladého až neskorého eneolitu v súvislosti s metalurgiou v oblasti dolného Pohronia je potrebné počítať aj s novým aktérom, ktorým zrejme boli nositelia jamovej kultúry. Ich prítomnosť na dolnom Pohroní naznačuje niekoľko desiatok mohylových násypov, ktoré sa nachádzajú prevažne v inundačnom území, na pravom brehu rieky Hron. Výsledky spektrálnej analýzy medeneho

sekeromlatu, ktorý bol odkrytý, v hrobe pod mohylou jamovej kultúry v Sárrétudvare, v hornom Potísi v Maďarsku poukázali na to, že nositeľov jamovej kultúry popri potenciálnych pastviskách, do rovinatého terénu juhozápadného Slovenska a špeciálne na Hronskú tabuľu, priťahovali aj ložiská farebných kovov nachádzajúce sa v neďalekých stredo-slovenských pohoriach (obr. 13).

Štúdia vďaka röntgen fluorescenčnej spektrometrickej analýze, ktorej boli podrobené štyri mlaty z juhozápadného Slovenska prináša nové poznatky týkajúce sa funkcie mlatov aj mimo hlavných ťažobných oblastí farebných kovov. Tá v troch prípadoch potvrdila prítomnosť stopových prvkov medi (Cu) na úderových plochách mlatov (Brhlavce, Jur nad Hronom a Šahy; tabeľa 1). Evidentne tak časť mlatov, aj v oblasti dolného Pohronia a Poiplia, bola využívaná pri činnostiach spojených s metalúrgiou. Vzhľadom na to, že mlaty boli primárne určené na udieranie možno predpokladať, že niektoré z nich slúžili ako multifunkčné nástroje. Mohli byť využívané najmä pri tzv. hrubých prácach, ako napr. pri stavbe opevnení, lámaní kameňa, budovaní, alebo deštrukcii nefunkčných stavebných objektov a pod.

Dôležitá otázka datovania a bližšieho kultúrneho zaradenia pravekých mlatov so žliabkom a s vrubmi z územia Slovenska zostávala, napriek nálezom zlomkov epilengyelskej keramiky počas výskumu v Španej Doline-Pieskoch, v rokoch 1970–1972, dlhšiu dobu otvorená. Až nedávny výskum v Banskej Bystrici-Kremničke, kde sa našiel mlat so žliabkom v sídliskovom objekte datovanom do obdobia ludanickej skupiny (obr. 7: 1), potvrdil správnosť dávnejšieho predpokladu, že mlaty boli využívané na ťažbu medi už v staršom eneolite. Uvedené datovanie podporujú aj výsledky predchádzajúcich výskumov v Slovenskom Pravne, v Banskej Bystrici na Moskovskej ulici, v Čiernych Kľačanoch a v Hornej Mičinej, ktoré priniesli výrazné doklady metalurgickej činnosti na epilengyelských sídliskách.

V nasledujúcom období staršej doby bronzovej je používanie mlatov doložené viacerými staršími i novšími stratifikovanými nálezmi. Ako prvý možno uviesť nález fragmentu mlatu so žliabkom z Čachtíc, na strednom Považí, ktorý bol odkrytý na pohrebisku zo staršej doby bronzovej, v hrobe muža (hrob 1), datovanom do záveru nitrianskej kultúry (obr. 7: 2). Ďalší mlat s vrubmi zo Šiah na dolnom Poipli bol odkrytý v objekte hatvanskej kultúry (objekt 2) v areáli opevneného sídliska (obr. 11: 1). Z dolného Poiplia, z Malých Kosiň, pochádza aj ďalší exemplár mlatu, ktorý bol nájdený taktiež v priestore opevneného sídliska, vo vrstve hatvanskej kultúry (horizont IIIA, obr. 10: 1).

Iba rámcovo možno do obdobia strednej až počiatku mladšej doby bronzovej datovať masívny mlat so žliabkom zo Španieho Poľa na juhu stredného Slovenska (obr. 7: 5). Za takéto datovanie hovorí aj skutočnosť, že neďaleko nálezu mlatu sa rozprestiera sídlisko a pohrebisko pilinskej kultúry.

Obr. 1. Špania Dolina-Piesky, okr. Banská Bystrica. Kamenné mlaty so žliabkom hranolovitého/prizmatického tvaru (podľa Točík/Bublová 1985).

Obr. 2. Špania Dolina-Piesky, okr. Banská Bystrica. Kamenné mlaty so žliabkom valcovitého/cylindrického tvaru (podľa Točík/Bublová 1985).

Obr. 3. Špania Dolina-Piesky, okr. Banská Bystrica. Kamenné mlaty so žliabkom kužeľovitého tvaru. 1, 2 – bez mierky (podľa Točík/Bublová 1985).

Obr. 4. Špania Dolina-Piesky, okr. Banská Bystrica. Kamenný mlat s vrubmi motykovitého tvaru (podľa Točík/Bublová 1985).

Obr. 5. Špania Dolina-Piesky, okr. Banská Bystrica. Kamenné mlaty so žliabkom vajcovitého/sféricko-guľovitého tvaru (podľa Točík/Bublová 1985). 1, 2 – bez mierky.

Obr. 6. Rekonštrukcia pripevnenia kamenného mlatu so žliabkom na drevenú rukoväť. Fixácia mlatu konopnou šnúrkou a rukoväť ovinutá koženou páskou (podľa Rieser/Schrattenthaler 1998–1999).

Obr. 7. Krátke mlaty cylindrického tvaru. 1 – Banská Bystrica-Kremnička, okr. Banská Bystrica (podľa Fratričová/Mišo 2022); 2 – Čachtice, okr. Nové Mesto nad Váhom (podľa Batora 1976); 3 – Brhlavce, okr. Levice; 4 – Pečenice, okr. Levice; 5 – Španie Pole, okr. Rimavská Sobota (podľa Furmánek 2004).

Obr. 8. Pozdĺžne mlaty cylindrického tvaru. 1 – Šurany-Nitriansky Hrádok (podľa Hovorka/Illášová 1999); 2 – Lontov, okr. Levice (podľa Janšák 1938); 3 – Pečenice, okr. Levice; 4 – Jur nad Hronom, okr. Levice.

Obr. 9. Mlaty vajcovitého/sféricko-guľovitého tvaru. 1 – Špačince, okr. Trnava (podľa Kolon 2015); 2 – Ipel'ský Sokolec, okr. Levice (podľa Paulík 1982); 3 – Stará Bystrica, okr. Čadca (podľa Furmánek/Illášová 2002). Mierka: a – 1; b – 3; bez mierky – 2.

Obr. 10. Mlaty hranolovitého/prizmatického tvaru. 1 – Malé Kosiň, okr. Nové Zámky; 2 – Horné Pršany, okr. Banská Bystrica (podľa Marková 2002; Solivajs 2021). Mierka: a – 1; b – 2.

Obr. 11. Mlaty s vrubmi. 1 – Šahy, okr. Levice (podľa Batora/Neumann/Pálinkás 2023); 2 – Vrable, okr. Nitra.

Obr. 12. Mapa nálezísk pravekých kamenných mlatov so žliabkom a s vrubmi na území Slovenska. Legenda: A – mlaty so žliabkom; B – mlaty s vrubmi. 1 – Banská Bystrica, okr. Banská Bystrica; 2 – Banská Bystrica, časť Kremnička, okr. Banská Bystrica; 3 – Brhlavce, okr. Levice; 4 – Čachtice, okr. Nové Mesto nad Váhom; 5 – Horné Pršany, okr. Banská Bystrica; 6 – Ipel'ský Sokolec, okr. Levice; 7 – Jur nad Hronom, okr. Levice; 8 – Lontov, okr. Levice; 9 – Malé Kosiň, okr. Nové Zámky; 10 – Pečenice, okr. Levice; 11 – Stará Bystrica, okr. Čadca; 12 – Šahy, okr. Levice; 13 – Špačince, okr. Trnava; 14 – Špania Dolina-Piesky, okr. Banská Bystrica; 15 – Španie Pole, okr. Rimavská Sobota; 16 – Šurany, časť Nitriansky Hrádok, okr. Nové Zámky; 17 – Vrable, okr. Nitra (mapu vyhotovil M. Bartík podľa podkladov J. Batora).

Obr. 13. Mapa výskytu oxidačných rúd medi na Slovensku. 1 – Vyhne, okr. Žiar nad Hronom; 2 – Banská Štiavnica, okr. Banská Štiavnica; 3 – Blatnica, okr. Martin; 4 – Špania Dolina, okr. Banská Bystrica; 5 – Staré Hory, okr. Banská Bystrica; 6 – Baláže, okr. Banská Bystrica; 7 – Poniky, okr. Banská Bystrica; 8 – Ľubietová, okr. Banská Bystrica; 9 – Hronec, okr. Brezno; 10 – Jasenie, okr. Brezno; 11 – Mýto pod Ďumbierom, okr. Brezno; 12 – Jarabá, okr. Brezno; 13 – Malužiná, okr. Liptovský Mikuláš; 14 – Partizánska Ľupča, okr. Liptovský Mikuláš; 15 – Dúbrava, okr. Liptovský

Mikuláš; 16 – Tisovec, okr. Rimavská Sobota; 17 – Nandráž, okr. Revúca; 18 – Ardovo, okr. Rožňava; 19 – Dobšiná, okr. Rožňava; 20 – Gemerská Poloma, okr. Rožňava; 21 – Betliar, okr. Rožňava; 22 – Rožňava, okr. Rožňava; 23 – Drnava, okr. Rožňava; 24 – Smolník, okr. Gelnica; 25 – Stará Voda, okr. Gelnica; 26 – Nálepko, okr. Spišská Nová Ves; 27 – Hnilčík, okr. Spišská Nová Ves; 28 – Spišská Nová Ves, časť Novoveská Huta, okr. Spišská Nová Ves; 29 – Rudňany, okr. Spišská Nová Ves; 30 – Poráč, okr. Spišská Nová Ves; 31 – Mníšek nad Hnilcom, okr. Gelnica; 32 – Slovinky, okr. Spišská Nová Ves; 33 – Prakovce, okr. Gelnica; 34 – Gelnica, okr. Gelnica; 35 – Žakarovce, okr. Gelnica; 36 – Košická Belá, okr. Košice-okolie; 37 – Košice, okr. Košice; 38 – Rudník, okr. Košice-okolie; 39 – Gemerská Ves, časť Šankovce, okr. Revúca; 40 – Medzev, okr. Košice-okolie; 41 – Poprad, časť Kvetnica, okr. Poprad; 42 – Smolenice, okr. Trnava; 43 – Pernek, okr. Malacky; 44 – Hodruša-Hámre, okr. Žarnovica; 45 – Pukanec, okr. Levice; 46 – Banská Belá, okr. Banská Štiavnica; 47 – Strečno, okr. Žilina; 48 – Horná Lehota, okr. Brezno; 49 – Brezno, okr. Brezno; 50 – Klenovec, okr. Rimavská Sobota; 51 – Litovský Mikuláš, časť Mútnik, okr. Litovský Mikuláš; 52 – Hnúšťa, okr. Rimavská Sobota; 53 – Šumiac, okr. Brezno; 54 – Vikartovce, okr. Poprad; 55 – Mlynky, okr. Spišská Nová Ves; 56 – Hnilec, okr. Spišská Nová Ves; 57 – Spišská Nová Ves, okr. Spišská Nová Ves; 58 – Helcmanovce, okr. Gelnica; 59 – Krásnohorské Podhradie, okr. Rožňava; 60 – Silica, okr. Rožňava; 61 – Zlatá Baňa, okr. Prešov; 62 – Lošonec, okr. Trnava; 63 – Častá, okr. Pezinok; 64 – Haniska, okr. Košice-okolie; 65 – Ladmovce, okr. Trebišov; 66 – Silica, okr. Rožňava; 67 – Košice-Bankov, okr. Košice (podľa *Bátora 2018*, obr. 267; *Sedliak 2005*, pl. III).

Tabela 1. Výsledky analýzy kamenných mlatov uskutočnenou metódou röntgen fluorescenčnej spektroskopie prístrojom Niton XL3 XRF Analyser (autor analýzy V. Mezey z Archeologického ústavu SAV, v. v. i.).

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