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Petroarchaeological investigation of three nephrite axes from Moravia and Czech Silesia

Petroarcheologický výzkum tří nefritových seker z Moravy a českého Slezska

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KEYWORDS

Nephrite axes – Eneolithic – Moravia and Czech Silesia – natural sources – Jordanów Śląski

ABSTRACT

In 1989, 2002 and 2021, three axes were found in Moravia and Czech Silesia, which share a similar appearance and typology. Two of these axes (Bolatice near Opava, Hlinsko near Lipník nad Bečvou) can be dated to the Early Eneolithic (Funnel Beaker Culture), while the third (Archlebov near Ždánice) was a surface find in an area with pottery fragments corresponding to the Moravian Painted Ware Culture. The raw material used in the axes is almost macroscopically identical and has a striking mottled colour. Mineralogical methods (determination of magnetic susceptibility and density, X-ray diffraction record) were used for classification. The methods proved the raw material was nephrite with a significant presence of clinopyroxene. Our comparison with nephrite occurrences in Central Europe has shown the nephrite source at Jordanów Śląski in Polish Silesia to be the most probable source.

1. Introduction

The impulse for writing this article was the discovery of a macroscopically noticeable stone axe in Bolatice (Opava District). During its examination, A. Přichystal realised that he had already seen two very similar axes at the Hlinsko near Lipník nad Bečvou (Přerov District) and Archlebov (Hodonín District) sites. Although attention was mainly focused on the axe from Bolatice, analogous analyses were also added for the other two axes. These confirmed that all three axes are made from the same unique raw material – nephrite. In the second part of this article, we determine the provenance of these axes in relation to three important sources of nephrite in Central Europe – the nephrite deposit at Jordanów Śląski in Polish Silesia, nephrite cobbles in the River Mur between the cities of Leoben and Graz (Styria, Austria), occurrences of nephrite in southeast Switzerland (Canton of Graubünden/Grisons) and the adjacent Province of Sondrio (Lombardy, Italy) – see Fig. 1.

2. The axe from Bolatice (Opava District)

The axe was found during a development-led excavation at the construction site of the Kaplan family house on building plot No. 2977/23 in the cadastral area of Bolatice village (Opava District). The excavation was carried out by P. Rataj from the

Fig. 1. Locations of the studied nephrite axes (4 – Bolatice, 5 – Hlinsko, 6 – Archlebov) and potential nephrite sources (1– Jordanów Śląski, 2 – Poschiavo-Scortaseo / Val Malenco, 3 – Mur River in Styria).

Obr. 1. *Lokalizace studovaných nefritových seker (4 – Bolatice, 5 – Hlinsko, 6 – Archlebov) a potenciálních nefritových zdrojů (1 – Jordanów Śląski, 2 – Poschiavo-Scortaseo / Val Malenco, 3 – řeka Mur ve Štýrsku).*

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Institute of Archaeology in Brno from 15 July to 12 August 2021. The investigated site is located at the eastern edge of the inner built-up area of the village of Bolatice, at the boundary between the 'Ruždina' and 'Za Větřákem' land plots in an area with a raised plateau extending from Bolatice as far as the local district of Bolatice-Borová. The area is located at an altitude of 272–273 metres above sea level.

A number of archaeological finds originate from the cadastral municipality of Bolatice. The oldest find, a stone axe-hammer, was made at the end of the 19th century on the southwestern edge of the village (Juchelka 2007, 413). The local teacher Karl Sczodrok was the first to take an interest in the archaeological settlement of the village and he summarised his findings from surface surveys of the village area in the article 'Steinhämmerfunde aus Bolatik im Kreise Ratibor'. He created a well-arranged map with occurrences of polished stone industry in the cadastral district of Bolatice and its surroundings and assigned most of these finds to the Linear Pottery Culture (Sczodrok 1913, 12–15). However, this thesis can no longer be unequivocally verified today, as the artefacts have been lost over the years. The number of individual finds has increased over time. Almost all of these were found by chance or during systematic surface surveys. The finds of chipped stone artefacts confirm that the land in the cadastral district of Bolatice was already settled from the Old to the Middle Palaeolithic (Svoboda 2001, 114). The continuity of settlement during the Neolithic period is evidenced by the artefacts made by the peoples of the Linear Pottery Culture and Lengyel Culture (Janák 2001, 8; Juchelka 2007, 413). The presence of the Late Eneolithic population with cord-ornamented pottery is confirmed by typical stone axe-hammers (Šebela 1999, 33). A small-scale Bronze Age settlement is evidenced by a perforated spherical mace head (Arndt 1926, 55) and a bronze axe from Chuchelenský les (forest) (Jisl 1950, 2).

However, none of these objects was found near the Kaplan family house where the archaeological rescue excavation was carried out. A total of eleven archaeological features were identified during this research, all of which were evidently disturbed due to agricultural activity.

Of the investigated features, only features 503 and 509 contained archaeological finds (17 objects in total). The ceramic inventory is very poor and includes only ten pieces of pottery, of which eight are atypical. In one case, decoration is visible on a pottery fragment from feature 509. This is an engraved line at the boundary between the neck and belly of the vessel, supplemented by two vertical engraved lines. However, the state of preservation of the fragment does not allow a more precise interpretation of the decoration motif. The last pottery fragment (feature 503) belongs to a collared bottle (Fig. 2).

The chipped stone industry is as similarly scarce and unremarkable as the ceramic inventory. Only two pieces from feature 503 and two pieces from feature 509 were captured. Feature 503 contained a flake and a broken retouched blade. The chipped stone industry from feature 509 comprises two blades, the first preserved in its entirety with a visible saw-like retouch. The second is the proximal part of a broken blade, perhaps with a retouch. All four pieces are made from the Baltic erratic flint. Feature 509 also contained a smoothed quartzite fragment and a ground hematite cobble.

A small axe (Inv. No. AUB 22/21-9) with a rectangular cross-section, symmetrical blade and ground-off lateral sides was recovered from feature 503. This form is characteristic of the Eneolithic polished stone industry (e.g. Buchvaldek 1964). The artefact has a length of 3.7 cm, the width decreases from 3 cm at the cutting edge to 2.1 cm at the butt, and the height reaches a maximum of 0.9 cm. The axe is perfectly polished except for the butt. The weight of the axe is 18.9 g.

According to the typology by M. Zápotocký, the axe can be identified as type C 3: variant C 3–2 (Zápotocký 2002, 173–175). The author dates this type to the Early and Middle Eneolithic. M. Vokáč mentions trapezoidal and rectangular axes with a rectangular or oval cross-section as a common form in the Funnel Beaker Culture (Vokáč 2008, 216).

Based on the modest ceramic inventory and the axe type, we can probably assign this assemblage to the Funnel Beaker Culture.

2.1 Results of analysis of the axe from Bolatice

The axe has a striking mottled colour. The darker green spots, usually up to 1 cm in size, are frayed and show signs of unidirectional elongation, probably parallel to the indistinct metamorphic foliation. They stand out against a lighter background, whose colour corresponds to very pale orange (10YR 8/2) in the Munsell Color System – see Fig. 3.

Magnetic susceptibility could be measured only indicatively due to the small dimensions of the artefact. The measurement was taken using a portable SM-30 magnetic susceptibility meter and the value obtained is around 0.11×10^{-3} SI units. Further, the density of the raw material used was determined by the double weighing method: 2.995 g/cm^3. The last method used was non-destructive X-ray diffraction, which was performed on the smoothed surface of the artefact in a specially adapted device

Fig. 2. Fragment of a collared bottle from Bolatice, Inv. No. AUB 22/21-1. Photo by I. Vondroušová, drawing by J. Fritsch.

Obr. 2. *Zlomek láhve s límcem z Bolatic, inv. č. AUB 22/21-1. Foto I. Vondroušová, kresba J. Fritsch.*

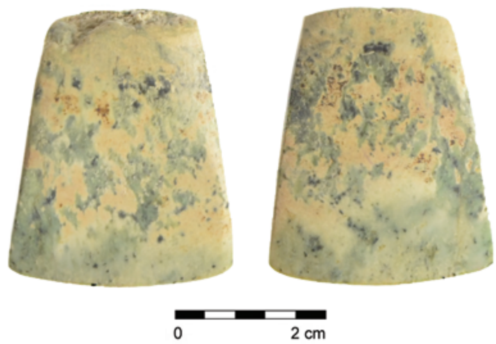
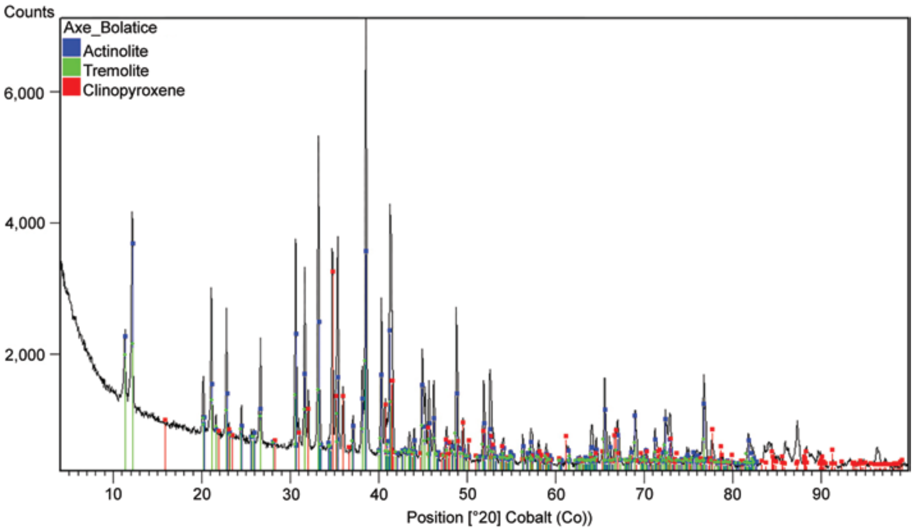


Fig. 3. Nephrite axe from Bolatice (Opava District). Photo by T. Malá.

Obr. 3. *Nefritová sekera z Bolatic (okres Opava). Foto T. Malá.*



Graph 1. X-ray diffraction record of the nephrite axe from Bolatice. In addition to the dominant amphiboles of the tremolite-actinolite series (80% in total), the axe also contains 20% clinopyroxene. All X-ray diffraction records have been evaluated by D. Všianský.

Graf 1. *Rentgenový difrakční záznam nefritové sekery z Bolatic. Vedle dominujících amfibolů ze skupiny tremolit–aktinolit (celkem 80 %), surovina sekery rovněž obsahuje 20 % klinopyroxenů. Všechny rentgenové difrakční záznamy vyhodnotil D. Všianský.*

with the mineral representation estimated using the Rietveld method. The analysis confirmed the absolute predominance of fibrous amphiboles of the tremolite-actinolite series (around 80%) and together with the determination of density, the X-ray diffraction results identify the raw material as nephrite (Graph 1).

3. The axe from Hlinsko near Lipník nad Bečvou (Přerov District)

A comparison with the previously described nephrite axes from the territory of Moravia (Přichystal et al. 2019) has shown that an axe with very similar typological characteristics and the same appearance was previously described from the Eneolithic hillfort in Hlinsko near Lipník nad Bečvou (Přerov District). In addition, one more fragment of another nephrite axe was found there. This well-known archaeological site has been thoroughly researched several times (Pavelčík 2001, Šebela et al. 2007). The Eneolithic settlement of this site has been associated with the Funnel Beaker Culture and Baden Culture. The axe under study comes from a pit investigated during archaeological excavations directed by J. Pavelčík in 1989 (Fig. 4).

The axe from Hlinsko has the dimensions of 4.5 × 3.1 × 1.0 cm and a weight of 26.95 g is stored in the Komenského Museum in Přerov (Inv. No. 03940-173/89). Its structure is again mottled, consisting of green spots on a whitish-grey background. Magnetic susceptibility measured with the SM-30 portable kappameter reaches 0.22×10^{-3} SI units so is somewhat higher than that of the axe from Bolatice. Density was not determined. The non-destructive X-ray diffraction analysis showed almost the same composition as with the axe from Bolatice (Graph 1). This estimate was again made by D. Všianský based on the Rietveld method: around 82% of fibrous amphiboles from the tremolite-actinolite series and 18% clinopyroxene (Graph 2).

4. The axe from Archlebov (Hodonín District)

The artefact is kept in the museum at Žarošice village and was found by R. Muroň during a surface survey on the 'Archlebské maliny' land plot in 2002. His report states there are pottery fragments corresponding to the Moravian Painted Ware Culture in the area of the site. The locality had already been registered by E. Kazdová (1984) as the older stage of the Moravian Painted Ware Culture. The dimensions of the axe are 8.0 × 4.5 × 2.0 cm, and the weight is 148.3 g (Fig. 5).

Fig. 4. Nephrite axe from Hlinsko near Lipník nad Bečvou (Přerov District). Photo by L. Plchová.

Obr. 4. *Nefritová sekera z Hlinska u Lipníka nad Bečvou (okres Přerov). Foto L. Plchová.*

Fig. 5. Nephrite axe from Archlebov (Hodonín District). Photo by L. Plchová.

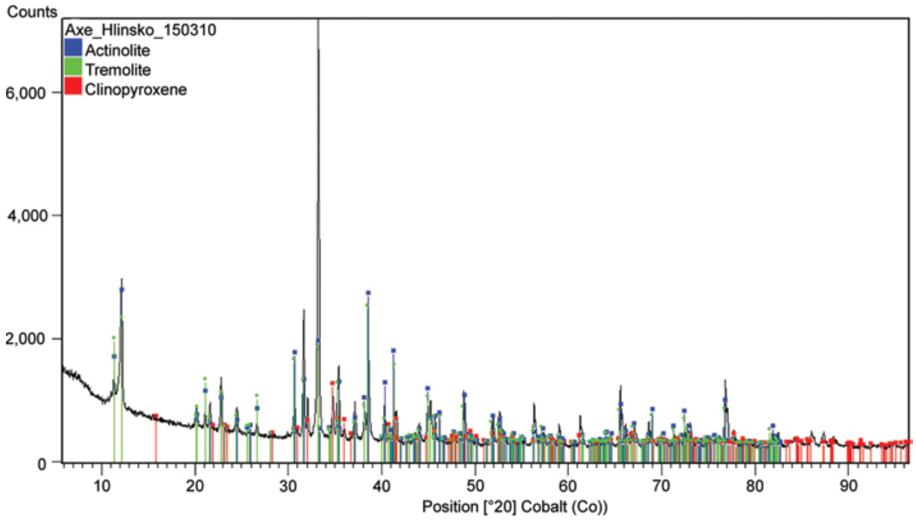
Obr. 5. *Nefritová sekera z Archlebova (okres Hodonín). Foto L. Plchová.*

Magnetic susceptibility is the same as that of the axe from Hlinsko, which is 0.22×10^{-3} SI units, and the mottled appearance is also identical to this axe. Density reaches a value of 3.09 g/cm^3. The mineral composition of the axe was again determined by non-destructive X-ray diffraction with an estimate based on the Rietveld method (Graph 3) – 57% fibrous amphiboles and 43% clinopyroxene (Graph 3).

From a typological aspect, we can classify all three axes according to the classification by M. Zápotocký, who created a typological series of the development of axes based on finds from the Čáslav Basin. This classification assigns the axes to groups B and C, and these groups together fall within the time interval from the Early to the Late Eneolithic (Zápotocký 2002, 180–182). The axes were also dated in the same way by M. Šmíd in Moravia (Šmíd 2017, 194–195). A typological analysis of axe forms for individual Neolithic and Eneolithic cultures was also published in a work by M. Vokáč. According to his description, none of the axes deviates from the typological forms that occurred in settlements corresponding to their cultural classification (Vokáč 2008, 54–58, 206–217).

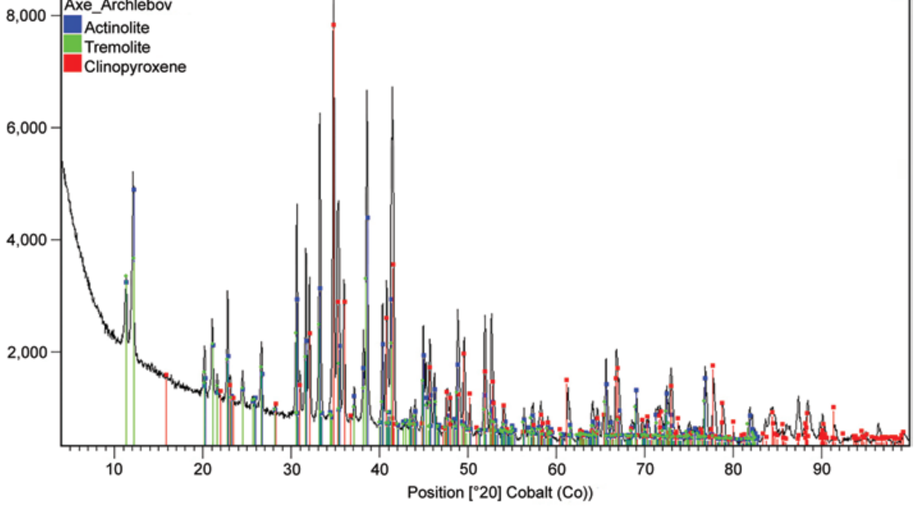
5. Sources of nephrite in Central Europe

The name of the rock, nephrite, is derived from the Greek word 'nefros', which means kidney and is related to the belief that the stone protects its wearer from kidney diseases. In medieval pharmacies, it was listed as 'lapis nephriticus'. The rock has an almost monomineral composition, as it is mainly formed by fibrous actinolite – tremolite minerals from the amphibole group. This means nephrite has excellent mechanical properties and is strong and tough – its strength is almost double compared to jadeitite, another similar rock. Due to their similar appearance, both the lay public and collectors combine the two rocks into one group designated by the English term 'jade', and even experts have been known to confuse them. For example, J. Skutil (1946) in his summarising article on Neolithic jadeite and nephrite products from Moravia had only jadeite (more correctly jadeitite) axes in his collection. According to Skutil, not one specimen was made of nephrite, and therefore, of course, he incorrectly looked for their origin in Polish Silesia. Jadeitite rock is formed by a different mineral – jadeite from the pyroxene group, and its sources are found in other places than the nephrite



Graph 2. X-ray diffraction record of the nephrite axe from Hlinsko. The amphibole (tremolite, actinolite) content is around 82%, clinopyroxene represents 18%.

Graf 2. *Rentgenový difrakční záznam nefritové sekery z Hlinska. Amfiboly (tremolit, aktinolit) tvoří kolem 82 %, klinopyroxeny reprezentují 18 %.*



Graph 3. X-ray diffraction record of the nephrite axe from Archlebov. Amphibole content (tremolite, actinolite) reaches 57%, clinopyroxene 43%.

Graf 3. *Rentgenový difrakční záznam nefritové sekery z Archlebova. Obsah amfibolů (tremolit, aktinolit) dosahuje 57 %, klinopyroxenů 43 %.*

deposits. All jadeitite or nephrite axes found to date in the Czech Republic come exclusively from Moravia; not a single axe has yet been found in Bohemia. Central European jadeitite axes also differ from nephrite axes in their typology (provided that they were not reground in later prehistoric periods), and their raw material comes from northwest Italy (Biró et al. 2017).

In the history of research into raw materials of polished stone tools, nephrite was one of the rocks that had already been discussed in Europe and our territory in the second half of the 19th century. This was related to the abundant finds of Neolithic nephrite axes along the shores of some Swiss lakes. The first reliably identified nephrite axe from our territory was described by J. Štelcl (1967) in the assemblage of Neolithic polished stone tools from Plaveč near Znojmo. Another nephrite axe was reportedly found by the archaeologist L. Meduna near Jemnice (Košťuřík et al. 1986, 195), but it is not known who made the determination and how was it made. Three nephrite Neolithic objects are mentioned by I. Mrázek (1996, 44–46): a trapezoidal axe and a hoe from Prštice and a discoid mace head from Popůvky (both villages are located in the Brno-Country District), but was only determined macroscopically. The latest evaluation of nephrite finds from Moravia, carried out by Přichystal et al. (2019), includes eight items.

As far as the origin of the nephrite raw material is concerned, the opinion that nephrite tools were brought to Europe from Asia had considerable support in the last quarter of the 19th century, even though, for example, the literature says that around 30,000 axes with a total weight of around 6,000 kg were found in the vicinity of pile dwellings along the shores of Lake Constance in Switzerland. This was because the sources of nephrite in Europe were not known at that time, and in the Middle Ages it was imported to Europe from Asia. Only the erratic material transported onto the territory of Germany and Poland by the continental glacier has yielded eight pieces of nephrite, which were assumed to be of Scandinavian (Finnish) origin (e.g. Linstow 1911). The discovery of natural occurrences of nephrite near Jordanów Śląski (Jordansmühl) in Polish Silesia (Traube 1884) or the finds of nephrite cobbles in the Mur River in Austrian Styria and the Sann/Savinja River on the border between Austria and Slovenia brought a new perspective to the discussion. Extensive nephrite deposits were then described at the beginning of the 20th century from Switzerland and later from nearby Italy. Currently, the best sources of nephrite are probably known in Switzerland at the Scurtaseu/Scortaseo site near the village of Poschiavo, Canton of Graubünden/Grisons, Bernina Region. The valley along the River Poschiavino (Val di Poschiavo) is wedged like a spur into northern Italy. A lens of light green nephrite can be found there surrounded by talc in a layer of dolomite marble. There are two other deposits near the village of Poschiavo (Alpe d'Ur, Piatte di Canciano) and on the Italian side is a known occurrence of nephrite at Alpe Mastabio in the Val Malenco valley, less than 20 km west of the Swiss site of Scortaseo. Italian nephrite is also situated on a talc deposit. The next three Swiss nephrite deposits are found about 15 km to the west and another group of eight deposits is located about 40 km to the north between the villages of Bivio and Mulegns. In this latter group of natural deposits, a group of French researchers (Pétrequin et al. 2022) managed to find places of Neolithic nephrite mining (Marmorera, Lajets, Furschella). Therefore, the Swiss nephrite must also be taken into consideration when searching for the origin of nephrite axes in our part of Central Europe.

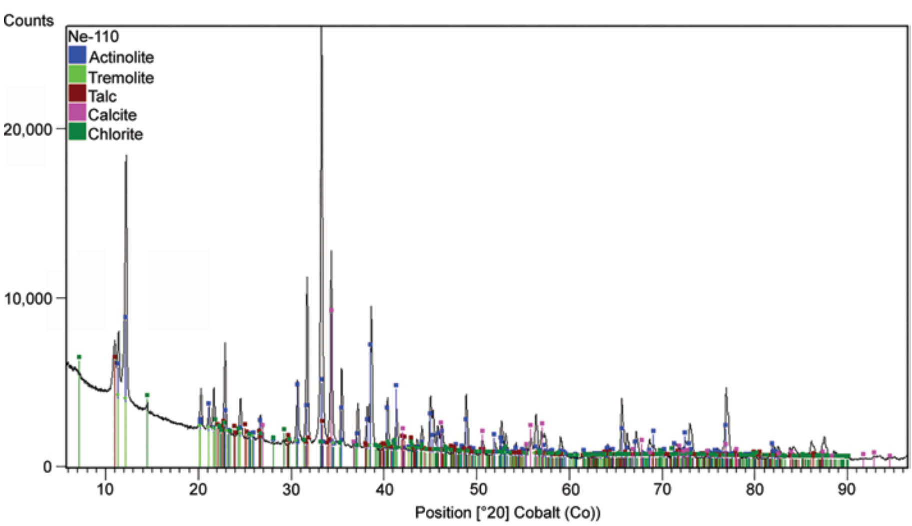
5.1 Provenance of nephrite axes from Bolatice, Hlinsko and Archlebov

When identifying the provenance, we start from the macroscopic appearance, determination of densities and mineral composition determined based on X-ray diffraction. D. Všianský analysed the records and tried to distinguish tremolite and actinolite as well as various pyroxenes (diopside and augite). However, this turned out to be unreliable, so it is necessary to class amphiboles together as a tremolite-actinolite group, similar to the case with the clinopyroxene group.

Regarding the provenance of our nephrite axes, we can rule out an origin from the chance find of a piece of nephrite in glacial erratic material (such finds are, in addition, extremely rare), since it is highly unlikely that axes with identical raw materials from three different archaeological sites would come from a single chance find. Furthermore, we can reject the origin from the River Mur in Austrian Styria, because at first sight, our axes already no longer correspond to these grass-green nephrite cobbles with a homogeneous colour. Therefore, it is necessary to consider the origin from the Polish site of Jordanów Śląski or Swiss deposits.

5.2 Comparison with Swiss and Italian nephrite sources

Swiss nephrites were studied earlier as part of the JADE-2 project; samples were taken by the principal investigator of the project, P. Pétrequin from France, and petrographic research was carried out by N. Juranová (2015) and A. Přichystal



Graph 4. X-ray diffraction record of Ne-110 nephrite from Poschiavo–Scortaseo, Switzerland. Amphiboles (tremolite, actinolite) represent a total of about 82%, chlorite is 1%, talc 11%, calcite 6 %.

Graf 4. *Rentgenový difrakční záznam nefritu Ne-110 z naleziště Poschiavo–Scortaseo, Švýcarsko. Amfiboly (tremolite, aktinolit) představují kolem 82 %, chlorit 1 %, mastek 11 % a kalcit 6 %.*

(in Errera et al. 2017). The results have now been supplemented in several cases with the determination of density, control measurement of magnetic susceptibility and a new evaluation of X-ray diffraction records. The Mulegns CH-10 site has amphibole represented by tremolite according to our microprobe analyses. At the Les Hauderes CH-181 site, it was actinolite lying on the border with tremolite (Juranová 2015). In Swiss nephrites, the relics of pyroxenes or pseudomorphs after them were not found; on the contrary, according to our X-ray diffraction analyses, they commonly contain calcite (up to 31%), talc (up to 11%) or chlorite (up to 21.5%) – see Graph 4.

A characteristic feature is often light to whitish colours (Munsell 5GY 7/2 greyish yellow-green to 5GY 8/1 light greenish grey) caused precisely by the presence of talc and calcite. Swiss nephrites almost always have a distinct metamorphic foliation and sometimes have distinct folds. Their densities are lower (2.87–2.92 g/cm^3) than the densities of our axes. Similarly, the nearby analogous source of nephrite in the Italian Val Malenco valley can contain up to 30% calcite, and therefore its average density calculated from thirteen samples is lower – 2.891 ± 0.072 g/cm^3 (Adamo, Bocchio 2013).

With high probability, we can exclude that the raw material of our axes originates from Switzerland or a nearby source in Val Malenco, Italy. Both the Swiss raw materials and the Italian nephrite differ from the Bolatice axe by their appearance (they usually have distinct foliation and light colours) and the absence of pyroxenes, and, on the other hand, by a significant calcite and talc content and by lower densities.

5.3 Comparison with the nephrite source near the village of Jordanów Śląski in Lower Silesia, Poland

The nephrite deposit at Jordanów Śląski may be currently exhausted, but at the end of the 19th century, a block weighing 2,140 kg was exported from there to the USA, so there must have been sufficient raw material at that time. In the 1970s, nephrite blocks 2.5 m long and 0.4 m thick were obtained there during mining (Sachanbiński 1979). The local nephrite was petrographically studied in detail by Gil (2013), who distinguished nephrite *sensu stricto* and nephrite schist. He stated that true nephrite contains around 87–90% tremolite, 5–6% pyroxene (diopside) and 4–8% chlorite, while spinel and garnet (grossular) may be present in tenths of a per cent. Nephrite schist has both a developed foliation and a more varied composition: in addition to 34–80% tremolite, it can have 7–55% pyroxene (diopside), 5–39% chlorite, up to 4% spinel, up to 11% garnet (grossular), prehnite and titanite in tenths of a per cent and clay minerals with oxide aggregates up to 10%.

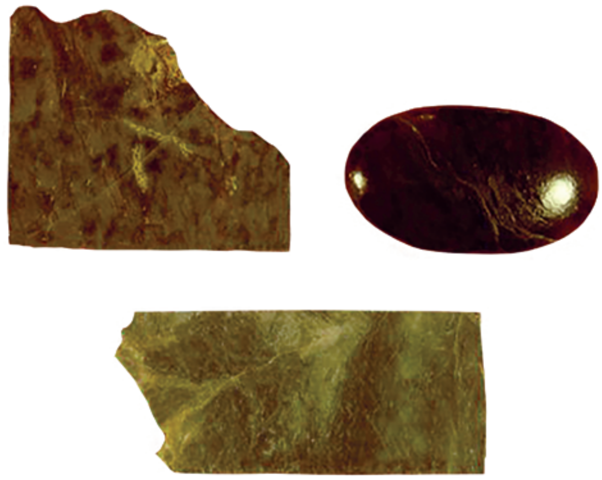


Fig. 6. Varieties of nephrite sensu stricto from the quarry at Jordanów Śląski in 1971. Photo by A. Přichystal.

Obr. 6. *Variety nefritu sensu stricto z lomu u obce Jordanów Śląski v roce 1971. Foto A. Přichystal.*

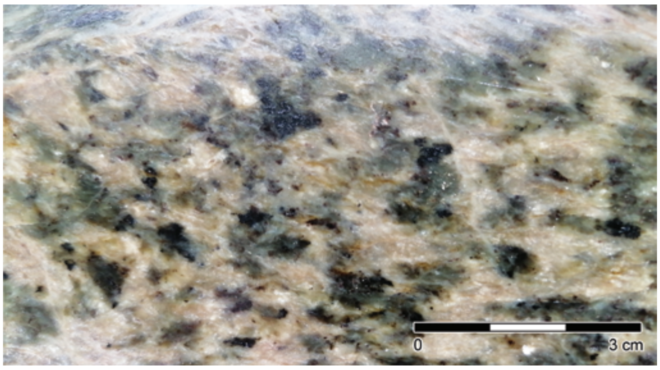
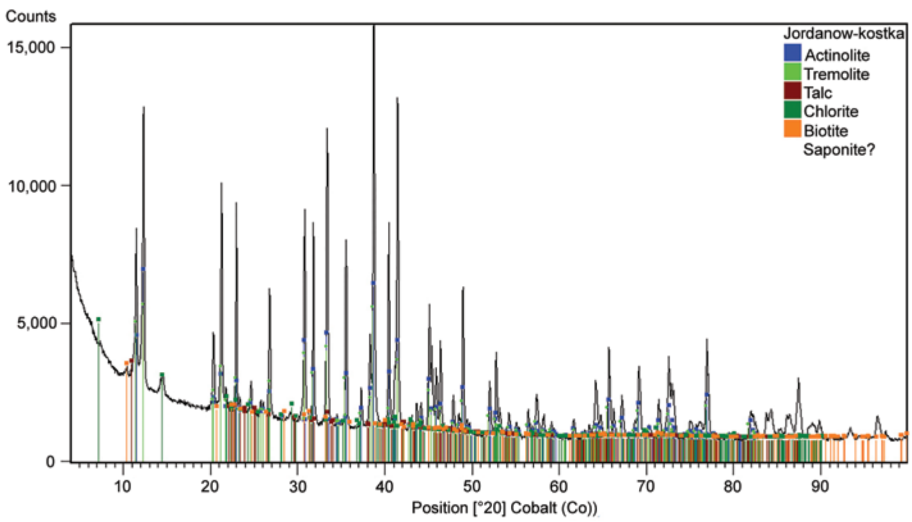


Fig. 7. Mottled variety of nephrite (nephrite schist) from the quarry at Jordanów Śląski. Sample from 1971. Photo by A. Přichystal.

Obr. 7. *Skvrnitá varieta nefritu (nefritové břidlice) z lomu u obce Jordanów Śląski. Vzorek z roku 1971. Foto A. Přichystal.*



Graph 5. X-ray diffraction record of a polished piece of nephrite from the quarry at Jordanów Śląski.

Graf 5. *Rentgenový difrakční záznam leštěného kusu nefritu z lomu u obce Jordanów Śląski.*

The author of this report visited the quarry at Jordanów Śląski as early as 1971 when it was still being exploited and nephrite was being processed into small ornaments. In addition to the massive deep green variety (Fig. 6), also frequent at that time was a mottled variety with dark green blurry spots on a lighter yellowish-green background (Fig. 7).

The density determined from these samples varies between 2.990–2.995 g/cm^3, so it is almost identical to the density of the studied nephrite axes. According to the X-ray diffraction record, the axes from Bolatice, Hlinsko and Archlebov always contain clinopyroxene in addition to the dominant amphibole (tremolite/actinolite). Clinopyroxene should be a characteristic mineral of the nephrite from Jordanów Śląski. However, the X-ray diffraction record of a piece of nephrite raw material from the quarry at Jordanów Śląski clearly shows that the presence of pyroxene could not be proved in this sample (Graph 5), i.e. there are varieties in which pyroxene is contained at less than 2% or is completely absent.

6. Conclusion

Based on the determination of density and mineral composition, the macroscopically similar axes from Bolatice, Hlinsko and Archlebov were made from nephrite. The raw material was compared with natural nephrite sources in Switzerland/Italy and at Jordanów Śląski in Polish Silesia. Due to the mottled structure of the raw material, the density and especially the mineralogical composition, where all three studied axes contain a significant amount of clinopyroxene, we assume the origin of their raw material to be Jordanów Śląski in Lower Silesia, Poland. The axe from Bolatice represents the nearest occurrence from the natural source (about 130 km), the distance between Hlinsko u Lipníka nad Bečvou and Jordanów is 175 km and between Archlebov and Jordanów 210 km as the crow flies.

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References

Adamo, I., Bocchio, R. 2013: Nephrite Jade from Val Malenco, Italy: Review and Update. *Gems & Gemology* 49(2), 98–106. Available also from: https://www.gia.edu/gems-gemology/summer-2013-adamo-nephrite-italy.

Arndt, A. 1926: Vorgeschichtliche Bodenfunde im Kreise Ratibor. *Ratibor Heimatbote für das Jahr* 1926, 54–56. Available also from: https://sbc.org.pl/publication/337225.

Biró, K., Pétrequin, P., Errera, M., Přichystal, A., Trnka, G., Zalai-Gaál, I., Osztás, A. 2017: Des Alpes à l'Europe centrale (Autriche, République tchèque, Slovaquie et Hongrie). In: P. Pétrequin, E. Gauthier, A.-M. Pétrequin (eds.): *JADE. Objets-signes et interprétations sociales des jades alpins dans l´Europe néolithique*. Les Cahiers de la MSHE Ledoux no. 27. Tome 3. Besançon: Presses universitaires de Franche-Comté, 431–466.

Buchvaldek, M. 1964: Základní tvarosloví eneolitické kamenné industrie. *Zprávy Čs. společnosti archeologické při Čs. akademii věd* VI(3), 25–26.

Errera, M., Přichystal, A., Pétrequin, A. M., Pétrequin, P., Vaquer, J. 2017: Analyses des énchantillons naturels de néphrite. In: P. Pétrequin, E. Gauthier, A.-M. Pétrequin (eds): *JADE. Objets-signes et interprétations sociales des jades alpins dans l´Europe néolithique*. Les Cahiers de la MSHE Ledoux no. 27. Tome 4. Besançon: Presses universitaires de Franche-Comté, 1227–1237.

Gil, G. 2013: Petrographic and microprobe study of nephrites from Lower Silesia (SW Poland). *Geological Quarterly* 57(3), 395–404. DOI: 10.7306/gq.1101. Available also from: https://gq.pgi.gov.pl/article/view/8060.

Janák, V. 2001: *Nejstarší dějiny Hlučínska*. Kravaře: Kulturní středisko zámek Kravaře.

Jisl, L. 1950: Hlučínsko v pravěku. *Český lid* 5, 1–4.

Juchelka, J. 2007: Pravěké osídlení Hlučínska – přehled stavu výzkumu. *Pravěk. Nová řada* 17, 411–434.

Juranová, N. 2015: *Nefrity Švýcarska a jejich využívání v pravěku*. Manuscript of the bachelor thesis. Masarykova univerzita. Přírodovědecká fakulta. Ústav geologických věd. Stored in: Ústřední knihovna Přírodovědecké fakulty Masarykovy univerzity. Available also from: https://is.muni.cz/th/j7gmm/?lang=cs.

Kazdová, E. 1984: *Těšetice-Kyjovice. 1/ Starší stupeň kultury s moravskou malovanou keramikou*. Spisy Filozofické fakulty 260. Brno: Universita J. E. Purkyně. Available also from: https://digilib.phil.muni.cz/cs/handle/11222.digilib/103871.

Koštuřík, P., Kovárník, J., Měřínský, Z., Oliva, M. 1986: *Pravěk Třebíčska*. Prameny k dějinám a kultuře Moravy 2. Brno, Třebíč: Muzejní a vlastivědná společnost, Západomoravské muzeum.

Linstow, O. v. 1911: Über Nephritgeschiebe. *Zeitschrift für Naturwissenschaften* 83, 437–444.

Mrázek, I. 1996: *Drahé kameny v pravěku Moravy a Slezska*. Brno: Moravské zemské muzeum, Litera.

Pavelčík, J. 2001: *Hlinsko. Hradisko lidu bádenské kultury*. Archeologické památky střední Moravy 2. Olomouc: Vlastivědné muzeum v Olomouci.

Pétrequin, P., Pétrequin, A. M., Errera, M. 2022: *Projet Jade. L' exploitation néolithique de la néphrite en Oberhalbstein*. Raport de prospection 2022, Surses (Grisons, Suisse). Besançon: MSHE C.N. Ledoux.

Přichystal, A., Kovář, J. J., Kuča, M., Fridrichová, K. 2019: The jadeitite-omphacitite and nephrite axeheads in Europe. The case of the Czech Republic. In: R. Glesser, D. Hofmann (eds): *Contacts, boundaries & innovation in the fifth millennium. Exploring developed Neolithic societies in central Europe and beyond*. Leiden: Sidestone Press, 289–304.

Sachanbiński, M. 1979: *Kamienie szlachetne i ozdobne Śląska*. Wrocław: Wydawnictwo Ossolineum.

Sczodrok, K. 1913: Steinhämmerfunde aus Bolatik im Kreise Ratibor. *Oberschlesische Heimat* 9, 12–15. Available also from: https://sbc.org.pl/dlibra/publication/74974/edition/79561/oberschlesische-heimat-1913-bd-9?language=de.

Šebela, L. 1999: *The Corded Ware Culture in Moravia and in the Adjacent Part of Silesia* (*Catalogue*). Fontes Archaeologiae Moravicae, Tomus XXIII. Brno: Archeologický ústav AV ČR, Brno. Available also from: https://arub.cz/wp-content/uploads/The_Corded-_Ware_Culture_in_Moravia.pdf.

Šebela, L. et al. 2007: *Hlinsko. Výšinná osada lidu badenské kultury*. Spisy Archeologického ústavu AV ČR Brno 32. Brno: Archeologický ústav AV ČR, Brno, v. v. i. Available also from: https://arub.cz/wp-content/uploads/2020/11/Hlinsko_2007.pdf.

Skutil, J. 1946: Moravské nálezy jadeitových a nefritových neolitických výrobků, slezské importy. *Slezský sborník* 44(6), 145–156.

Šmíd, M. 2017: *Nálevkovité poháry na Moravě*. Pravěk. Supplementum 33. Brno: Ústav archeologické památkové péče Brno, v. v. i.

Štelcl, J. 1967: K petrografii kamenných nástrojů z některých nalezišť moravského mladšího neolitu. *Acta Musei Silesiae*, A, XVI, 143–157.

Svoboda, J. 2001: Bolatice (okr. Opava). *Přehled výzkumů* 42, 114. Available also from: https://arub.cz/wp-content/uploads/01_pv_42_2000_paleolit_a_mezolit.pdf.

Traube, H. 1884: Über den Nephrit von Jordansmühl in Schlesien. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*, Beilagen Band 3, 412–427.

Vokáč, M. 2008: *Broušená a ostatní kamenná industrie z neolitu a eneolitu na jižní Moravě se zvláštním zřetelem na lokalitu Těšetice--Kyjovice*. Manuscript of the thesis. Masarykova univerzita. Filozofická fakulta. Ústav archeologie a muzeologie. Stored in: Ústřední knihovna Filozofické fakulty Masarykovy univerzity. Available also from: https://is.muni.cz/th/co134/.

Zápotocký, M. 2002: *Eneolitická broušená industrie a osídlení v regionu Čáslav – Kutná Hora*. In: I. Pavlů (ed.): *Bylany. Varia 2*. Praha: Archeologický ústav AV ČR, 159–227.

Resumé

Článek referuje o detailním studiu tří seker velmi podobného vzhledu, použité suroviny i typologie. První sekera byla získána v Bolaticích (okr. Opava) a pochází z výzkumu Archeologického ústavu AV ČR v Brně, v. v. i. Na základě skromného keramického inventáře a typu sekery ji můžeme nejspíš přiřadit ke kultuře nálevkovitých pohárů. Druhá sekera pochází z výzkumu J. Pavelčíka na výšinném hradisku Hlinsko u Lipníka nad Bečvou (okr. Přerov). Jeho eneolitické osídlení je spojováno s kulturou nálevkovitých pohárů a badenskou kulturou. Třetí sekera byla nalezena při povrchovém průzkumu u Archlebova (okr. Hodonín) v trati, odkud je známo osídlení kultury s moravskou malovanou keramikou.

U všech seker byla změřena magnetická susceptibilita a určeno minerální složení pomocí nedestruktivní rentgenové difrakce, u dvou stanovena hustota. Tyto hodnoty byly srovnány s výsledky měření vzorků nefritu z potenciálních evropských zdrojů – Jordanów Śląski v jižním Polsku a Poschiavo-Scortaseo a Valmalenco při švýcarsko-italských hranicích. Valouny nefritu z řeky Mur v rakouském Štýrsku mohly být vyloučeny, neboť se zřetelně odlišují již makroskopicky. Studované sekery mají kromě převládajícího tremolitu a aktinolitu ze skupiny amfibolů významně zastoupen také klinopyroxen (18, 20 a 43 %), což je minerál charakteristický podle G. Gila (2013) pro jordanovský nefrit (5–6 %), a ještě více pro zdejší nefritovou břidlici (7–55 % pyroxenu). Rovněž hustotami se naše sekery více blíží hodnotám z Jordanowa než hustotám nefritů ze Švýcarska/Itálie. Na základě těchto výsledků proto považujeme původ studovaných seker ze slezského Jordanowa za vysoce pravděpodobný.

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