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A UNIQUE RAW MATERIAL FROM EARLY UPPER PALAEOLITHIC LAYERS IN THE POD HRADEM CAVE (MORAVIAN KARST, CZECH REPUBLIC) – INTERPRETATIVE PROBLEMS

ABSTRACT: The Pod hradem Cave in the Moravian Karst is a very significant Palaeolithic site because of the way in which the preserved stratigraphic sequence documents both the geological and cultural development of the karstic area during the Weichselian Interpleniglacial. Research of the cave has yielded a small but interesting collection of lithic chipped artefacts, which fall within the period from the Middle/Upper Palaeolithic transition to the Gravettian. In the Moravian Karst archaeological relics from this period are rather sporadic, and the Pod hradem Cave is the only one cave where modern interdisciplinary research can be applied. The lithic chipped industry has been classified over time, as Szeletian, Aurignacian and Gravettian. Petrographic analysis of the stone implements performed by the authors during a revision of the finds has brought some unexpected results. They proved that finds from stratigraphically separated horizons were made of the same kind of porcelanite coming from the Kunětická hora Hill near Pardubice, the use of which in the Moravian Palaeolithic had not been determined before, except for the youngest (Epigravettian) occupation in Stránská skála IV near Brno. This corroborates a connection between populations living in the Moravian Karst and the region of Eastern Bohemia, but the nature of the contact cannot be specified for now. The fact that the same phenomenon appears in different cultural horizons is also difficult to explain.

KEY WORDS: Pod hradem Cave – Moravian Karst – Czech Republic – Raw material distribution

INTRODUCTION

Lithic raw materials were one of the key factors that had a bearing on the life of the primeval populations. The humans of the Stone Age were capable of utilising a wide range of minerals and rocks for the production of the tools they required for survival in various ecosystems. An interdisciplinary approach that combines the findings of archaeology, mineralogy, geology and/or other fields of knowledge, currently allows us to determine the stone

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raw materials used to a relatively high standard (e.g. Bertran *et al.* 2006, Biró 2009, Fernandes *et al.* 2007, Kasztovszky *et al.* 2008, Přichystal 2009, Turq 2000). This multidisciplinary cooperation leads to important methodological shifting in raw material distribution studies (Féblot-Augustins 2009, Markó 2009, Miller, Papagianni 2003, Oliva 1998, Perles 1991, Surmely *et al.* 2008).

The underlying trend in prehistoric research of stone raw materials has become the creation of distribution maps that show the locations of the possible sources of the raw materials used and their distances from the studied site (Féblot-Augustin 1993, 1997, Rensik *et al.* 1991, Siman 1991). However, in this way we are only able to determine, whether the local population preferred to focus on local and regional raw materials, or whether those imported from greater distances were in use more frequently. For a more precise determination of the distribution model, and thereby the economic behaviour of humans we have to confront the results of the determination of raw materials with technological analysis. The advantage of such an approach can be seen in many examples (e.g. Duke, Steele 2010, Féblot-Augustins 2009, Neruda 2011, Oliva 2007, Roebroeks *et al.* 1987, Tsobgou 2009 etc.) and it is obvious that such a methodological approach is becoming more and more elaborate.

Although, in general terms the determination of stone raw material can help us to reconstruct the behaviour of Palaeolithic people (distribution models, economic models or mobility), there are still issues that are difficult to explain. They concern the serious interpretation problems within the processes of distribution. Especially in cases of unique raw materials from long distances it is hard to explain how they appeared on a site under the study. One of the examples may be the identification of porcelanite – a hitherto unique raw material for the Moravian Palaeolithic – that was discovered in two different stratigraphic horizons in the Pod hradem Cave.

THE POD HRADEM CAVE

The Pod hradem Cave is situated in the Pustý žleb Dry Valley in the Moravian Karst, approximately 4 km SSW of the Kůlna Cave (*Figure 1*). Beyond a rather small portal that opens to the north there is a narrow corridor leading into a wider space, from which several other corridors lead. The cave was systematically explored between 1956 and 1958 by means of a lengthwise section through the cave from the entrance through to the rear part of the main hall. During the excavations, R. Musil and K. Valoch differentiated a complex stratigraphic sequence. Apart from animal skeletal remains this contained a limited number of lithic artefacts (newly Nerudová *et al.* 2012); K. Valoch originally divided it into three cultural (chronological) units, which were separated from one another both in terms of stratigraphy and space (Valoch 1965).

A vast situation with a concentration of charcoals (a fireplace?), which yielded several indistinctive lithic artefacts (first group of finds, after Valoch 1965) and a date falling within the Gravettian period, was located in an expanded area in the middle section of the cave, at a distance of 14–18 metres (the finds are localised within the cave using two systems: the distance from the cave entrance and/or the square metres; cf. *Figure 2*). Further industry attributed to Aurignacian (second group of finds, after Valoch 1965) was found scattered in several layers at an interval of 21–25 metres. The absolute data from trench 2 (*Figure 2*), which set the chronological position of the so-called horizon W1/2 and referred to the finds on the grounds of the resemblance of the sediments, tends to be related to these finds. In roughly the same place as the first group of finds but one metre deeper, a solitary leaf point was found in layer 15; K. Valoch has correlated the leaf point with Szeletian (third group of finds, after Valoch 1965). Below this layer another spongolite blade was discovered of unclear age and cultural classification (in detail Nerudová *et al.* 2012, Valoch 1965).

MATERIAL AND METHODS

Sample

We have carried out an analysis of artefacts manufactured from a peculiar raw material, which was originally determined by J. Uhrová as fine-grained chert from the Devonian limestones in the vicinity (Valoch 1965). This raw material was identified in two stratigraphic units – with the second group of finds that K. Valoch linked to Aurignacian (*Figure 3:1–11*) and with the leaf points (*Figure 3:12*).

Petrological analysis

Due to the archaeological character of finds non-destructive methods of petrographic analyses were preferred. All artefacts and reference samples were determined by stereomicroscoping of the surface using the method of water immersion that modifies the refraction and allows the inner structure to be observed (Přichystal 2009).

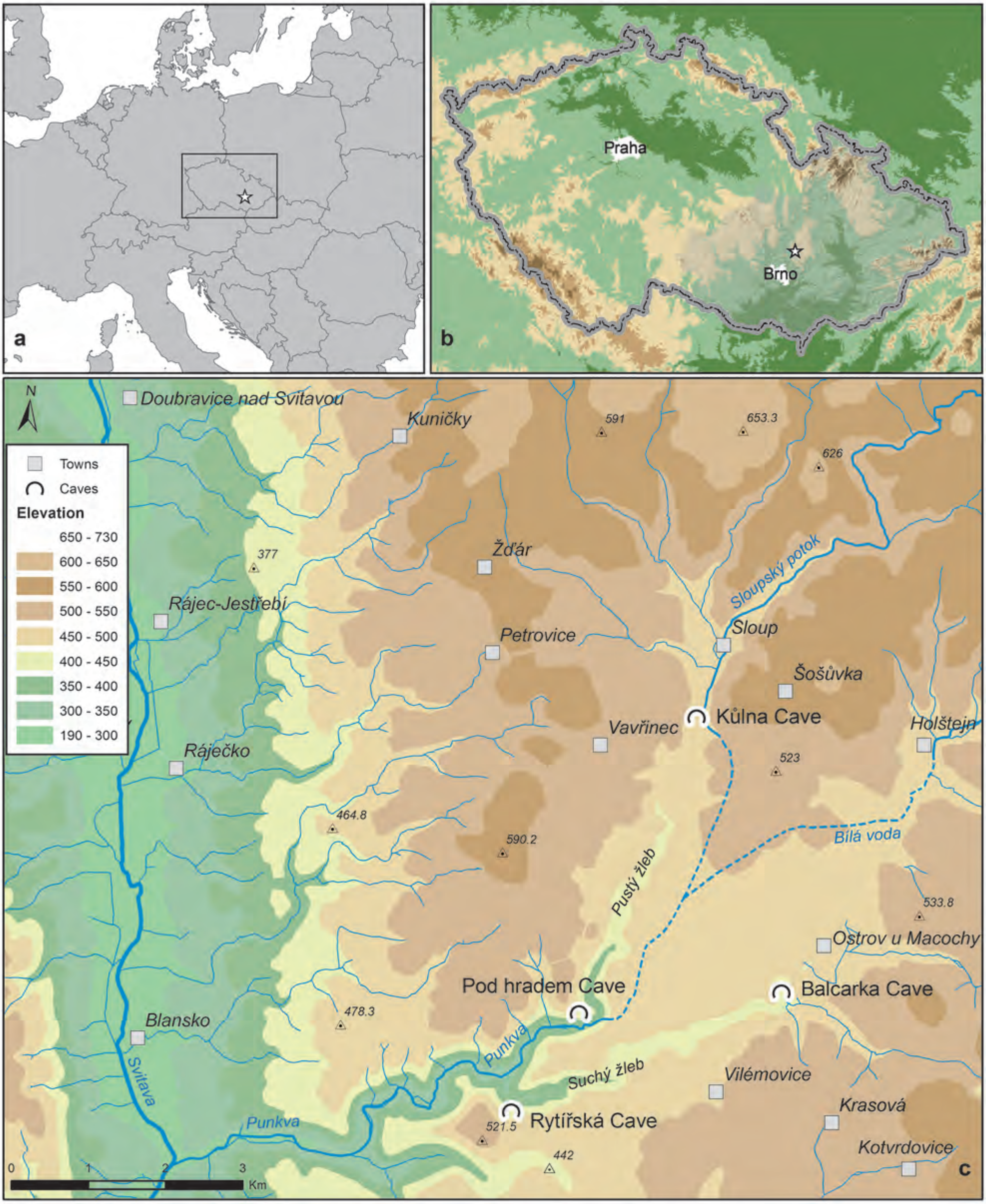

FIGURE 1. Location of the Pod hradem Cave; a, position in Central Europe; b, position in Czech Republic; c, relation of Pod hradem Cave to other important cave sites in Moravian Karst.

The colour of samples was described by comparing it to the Munsell colour system, and the magnetic susceptibility values were measured by a KT-6 hand-held kappameter. Since neither the thickness nor the dimensions of any of the items was good enough for a reliable determination of values, the measured data have to be regarded as orientational, since in reality the values will be somewhat higher.

To verify results of non-destructive methods thin sections from one artefact and reference samples were studied under the stereomicroscope and they served also for X-ray diffraction measurement (Nerudová *et al.* 2012).

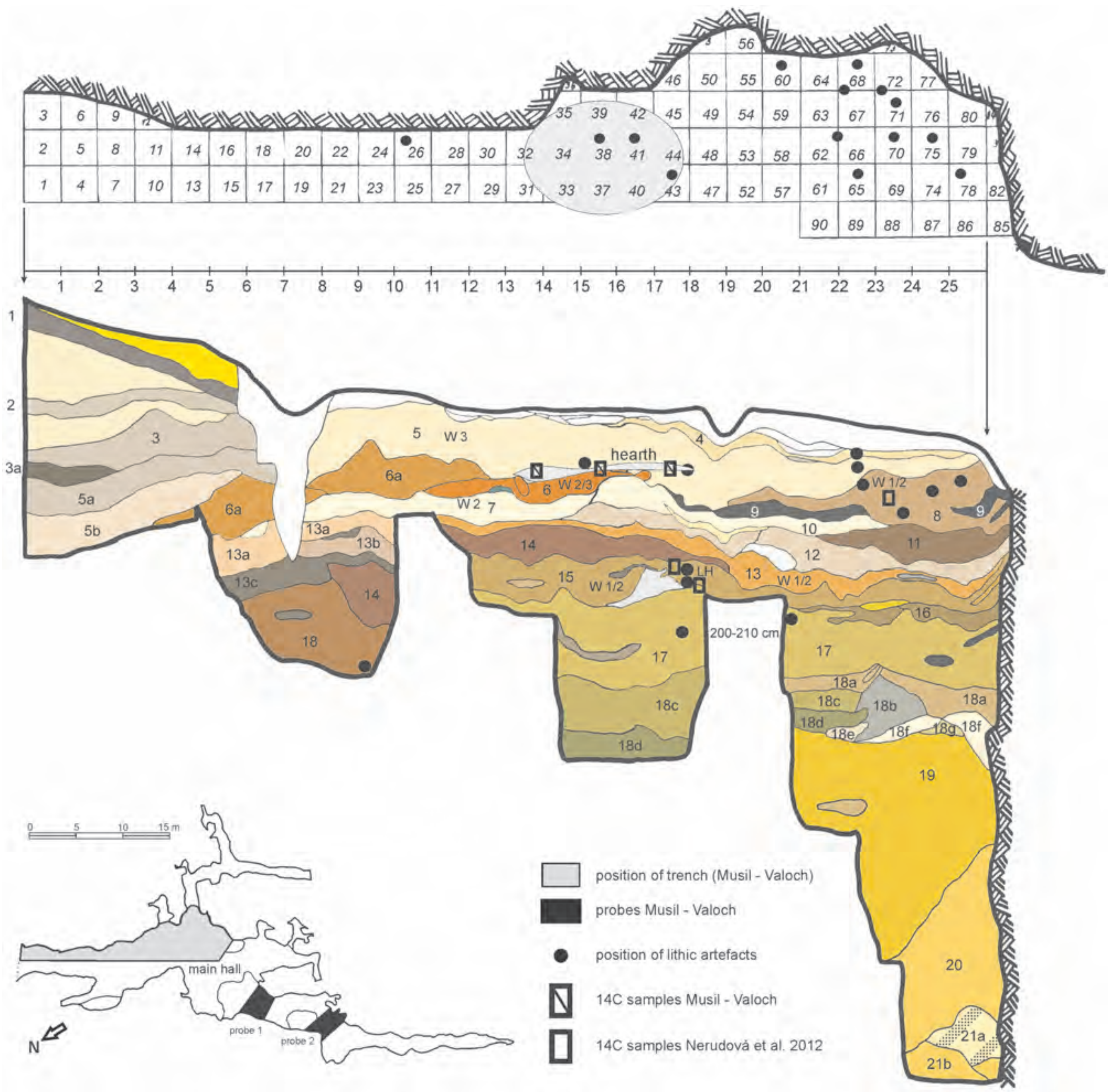

FIGURE 2. Spatial and vertical distribution of artefacts. The profile representation is higher than in reality so that its length corresponds to the grid squares. Digital reconstruction based on Valoch (1965) done by Z. Nerudová.

Archaeology

All archaeological finds obtained during the excavation of the cave by R. Musil and K. Valoch were checked by their positions in both the square and stratigraphic systems. Artefacts stored at the Anthropos Institute of the Moravian Museum in Brno were compared with the originally published data (Valoch 1965).

In the context of the new petroarchaeological results, we have attempted to make the chronostratigraphic position of the horizons with the finds more precise. Our attention has been focused on the find of the leaf point and the blade, which was situated in the layer below, and also on the second group of finds linked to Aurignacian, since this has been dated indirectly using the correlation of the sediments between the main profile and trench 2.

Bones originating from the same square and the same layer as the finds of chipped stone industry were used as samples for dating in Oxford Lab and compared with previously obtained values (Nerudová *et al.* 2012). The bones have no traces of human manipulation but they provide only one material that can be dated. It must be taken into account the bone assemblages are created and affected mostly by carnivores (in this case by cave bears) and therefore the relation of data from bones to the archaeological finds is based only on the stratigraphic rules.

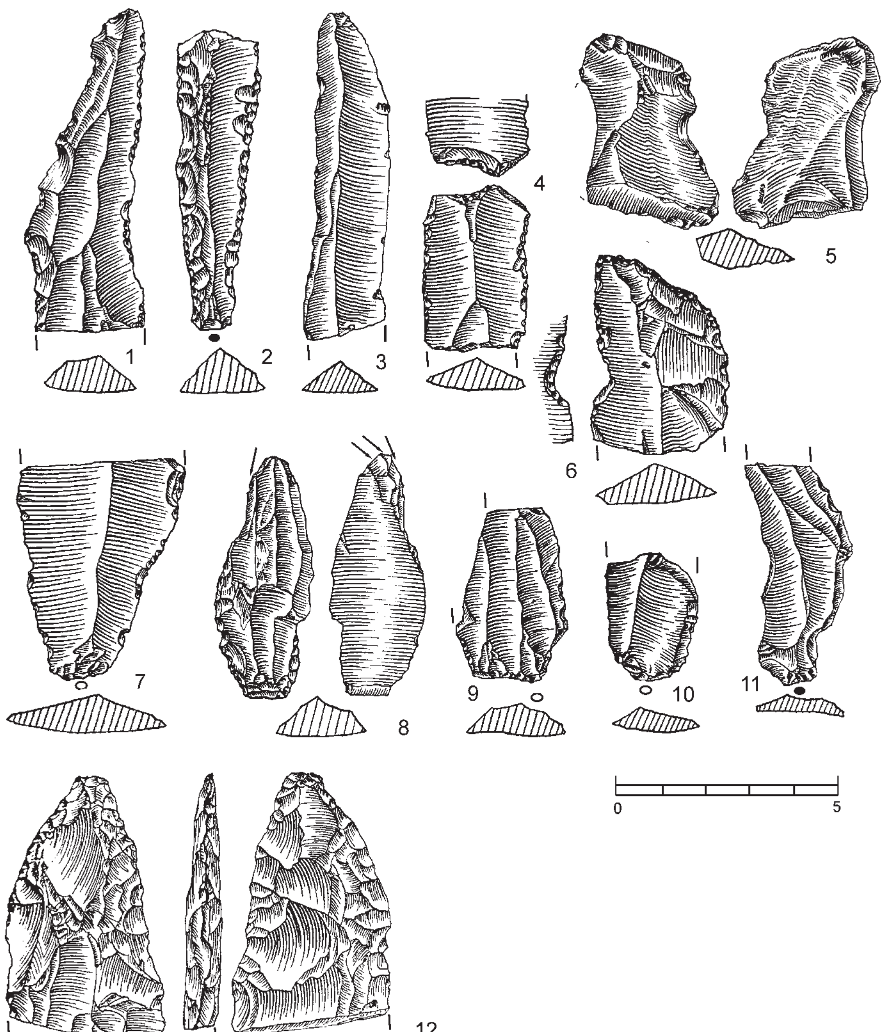

FIGURE 3. Lithic artefacts from the Pod hradem Cave made from the porcelanite. 1–11, finds asociate with Aurignacian; 12, Szeletian leaf point. After Valoch (1965).

RESULTS

Petrography

Petroarchaeological analysis separate 13 artefacts that appear to be very similar by their raw material structure (*Figures 3, 4:1* and Valoch 1965: Taf. IV:2). Macroscopically the studied rock appeared to be very fine-grained to aphanitic, exceptionally bigger clasts of clear quartz could be distinguished; in all cases it is very light to greyish-white coloured raw material (*Figure 4:2*). The higher magnetic susceptibility has proven it was not a chert or some other silicite (*Table 1*). There are also tiny accumulations of weathered (limonitised) pyrite visible in the rock. Because of intense weathering and patination of the surface of artefacts it was not possible to reliably determine the rock by viewing under stereomicroscope, therefore a petrographic thin section was prepared from artefact No. 8358 (*Figures 3:5, 4:1–3*). The section through the artefact has shown that the raw material was intensely lightly patinated to the depth of up to 2 mm, and its colour was in fact greyish-yellow green (5GY 7/2). As can be seen from the thin section, it is a very fine-grained rock, the prevailing part of which consists of a mix of minerals indiscernible under polarisation microscope. In this base matter, there are authigene tiny wavelike veinlets filled with xenomorphic quartz, or this quartz forms only tiny schlier-like or isometric structures. We can also observe accumulations of brown, opaque pigment consisting of iron oxides and hydroxides that in places fill the sections of what probably are micro-fossils. The rock also contains egg-shaped accumulations of finely crystallised opaque pyrite.

The character of the original non-patinated appearance, the presence of brown coatings, the occurrence of fine sulphide accumulations, the slightly increased magnetic susceptibility on the biggest artefact amounting to 0.16×10^{-3} SI (the other lower values are due to the fact these are small artefacts), the presence of glittery dust-like component and darker streaks or schliers clearly indicate an absolute conformity of properties with the porcelanites from the Kunětická hora Hill near Pardubice (Přichystal 2009). The thin section carried out from artefact No. 8358 also shows identical properties as this source (compare *Figure 4:3–4*).

To verify this provenance we applied the X-ray diffraction method, and we compared samples of porcelanite emerged at the contact of fine-grained sediments with a more recent volcanic rock (e.g. the Kunětická hora Hill near Pardubice, Bučnik near Komňa) and those from the sources around naturally burnt banks of coal (Medlovice near Uherské Hradiště, the surroundings of Most).

Porcelanites emerged around burnt banks of coal in the Most region have been characterised in detail

TABLE 1. Overview of petrographic features of the studied porcelanites.

Artefact ID	Raw material colour	Magnetic susceptibility ($\times 10^{-3}$ SI)	Notes
8350*	5Y 5/2	0.16	Silty quartz grains; a cavity after weathered out accumulation of pyrite
8356	10YR 8/2	0.02	Small limonite spots and smudges on the surface
8357	Yellowish grey	0.04	Relict silty texture made of quartz grains; cavities after weathered out aggregates of pyrite
8358**	10Y 6/2–5GY 7/2	0.04	Smudges on the surface; silty quartz grains; a cavity after weathered out pyrite
8359	Yellowish grey	0.02	
8360	Yellowish grey	0.03	Very fine-grained glossy quartz silt
8361	Yellowish grey	0.03	A cavity with aggregate of sulphide (3 mm)
8362	Yellowish grey	0.11	Indication of smudge structure
8363	Yellowish grey	0.08	Glossy silty quartz grains and small accumulations of pyrite
8364	Yellowish grey	0.04	The same characterization as ID 8362 a 8363
8365	Yellowish grey	0.06	The same characterization as ID 8362 a 8363
8366	Yellowish grey	0.04	The same characterization as ID 8362 a 8363
8367	Yellowish grey		The same characterization as ID 8362 a 8363

* Previously determined as chert (Nerudová *et al.* 2012: 137).
** Artefact used to the thin section.

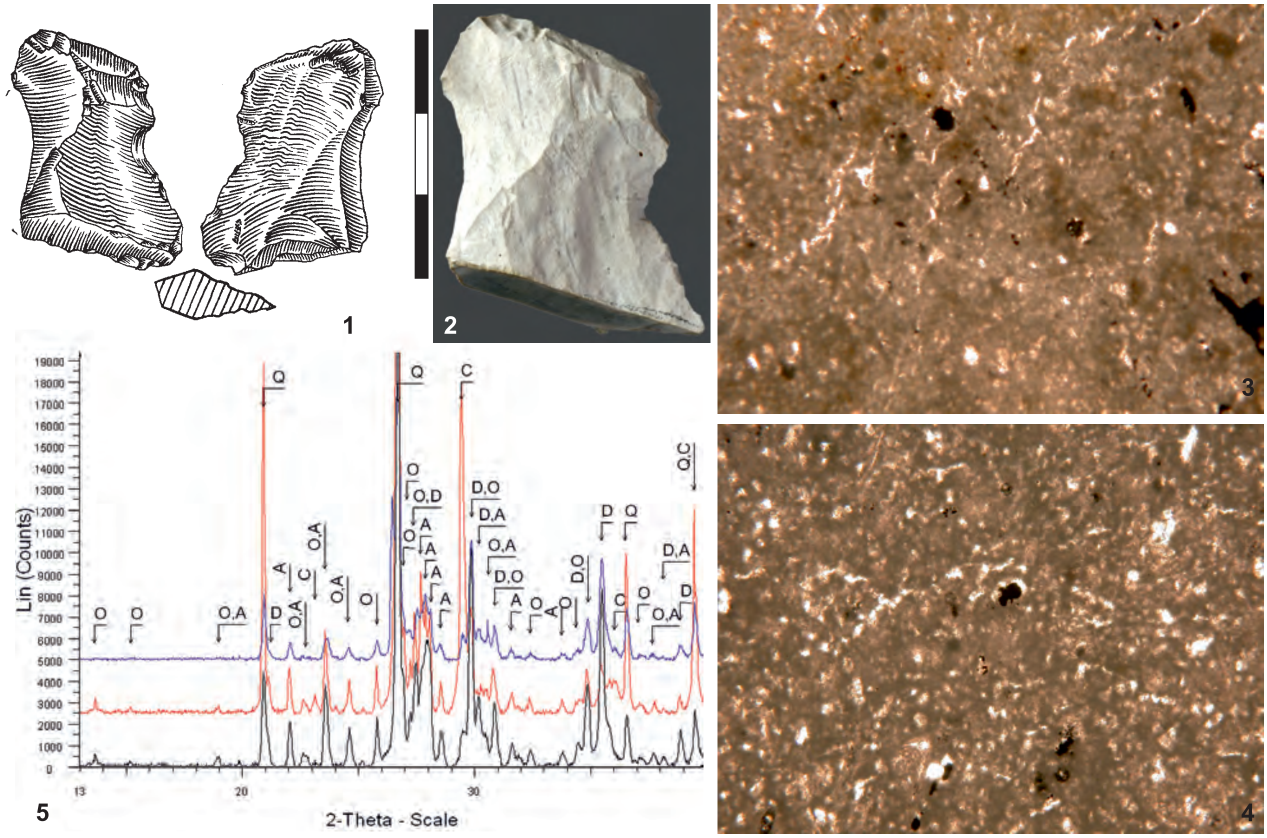

FIGURE 4. 1, artefact ID 8358 (Valoch 1965: Taf. II:2). 2, artefact ID 8358, photo by P. Neruda. 3, petrographic thin section of porcelanite, artefact no. 8358 from the Pod hradem Cave. The rock substance is fine-grained (aphanitic) with indiscernible minerals. Newly formed xenomorphic quartz with homogenous extinction can only be discerned in light schlier forms. Opaque metalliferous mineral represented by fine-grained pyrite is also present. Picture length 1.5 mm, 1 nicol. Photo by A. Přichystal. 4, petrographic thin section of porcelanite from the Kunětická hora Hill. It gives an analogical picture as the previous sample. Picture length 1.5 mm, 1 nicol. Photo by A. Přichystal. 5, comparison of X-ray diffraction record of artefact no. 8358 from the cave Pod hradem (black horizontal line above X axis) with the powdered porcelanite from the Kunětická hora Hill (central red horizontal line) and stone porcelanite from the Kunětická hora Hill (highest blue horizontal line). The vertical lines show position of the main lines of the individual minerals, computer interpreted. All three samples show identical mineral composition of quartz (Q), diopside (D), anorthite (A) and orthoclase (O). The powdered porcelanite from the Kunětická hora Hill (red horizontal line) contained in addition a considerable amount of calcite (C), i.e. it was an imperfectly fired porcelanite. Black curve, Pod hradem 8358; red curve, Kunětická hora 2008 (powder); blue curve, Kunětická Hora stone porcelanite 2010. Recorded and interpreted by D. Všianský.

recently (Žáček *et al.* 2010). From the description of the authors of the research, as well as from our experience it is obvious these porcelanites usually feature striking yellow or red colours with a clinker structure, or they are rocks of porcelain appearance and lightly purple or bluish colour (5PB 7/2–5P 6/2); hence even macroscopically these differ from the studied artefacts originating from the Pod hradem Cave.

Porcelanites emerged from burning sediments nearby volcanic rocks are macroscopically closest to those from the Pod hradem Cave. We are aware of a similar looking porcelanite from Bučnik near Komňa (The Uherský Brod region); according to X-ray analysis this contains authigene feldspars and pyroxenes, but differs from our artefacts by the presence of clay minerals, vermiculite and chlorite. For this reason the X-ray diffraction analysis of artefact No. 8358 from the Pod hradem Cave has been compared with the X-ray record of porcelanite from the Kunětická hora Hill, both in lump form and reduced to powder (*Figure 4:5*). Both samples contained quartz, ferrous diopside, anorthite and feldspar, and thus were identical with the studied artefact of the third group.

The leaf point ref. No. 89192 from the Kůlna Cave, also considered to be made of porcelanite, underwent the same analysis for comparison. Apart from quartz it was found to contain feldspar, ferrous diopside and albite. Therefore, its mineral composition is analogous, the difference being only in alkalinity of plagioclas.

Chronostratigraphic position of archaeological horizons

The horizon with the leaf point has been dated using three samples from 2008 altogether. Despite the relatively large temporal scatter of the three dates, all of them fall within the timeframe of the Lower Szeletian that we had defined on the grounds of the finds from Vedrovice V (Valoch *et al.* 1993) and Moravský Krumlov IV (*Table 2*; Davies, Nerudová 2009, Neruda, Nerudová 2013).

The dataset for the second group of finds is much less consistent. Admittedly, the older data series show a minimal scatter, and are in conformity with the assumed cultural classification of the discovered blades as Aurignacian. The new series of data from 2010 allowed the dating of layer 8 directly in the square, where the mentioned blades and other blanks were found. The acquired file limits the time span from 28.9 to 42.3 kyr uncal BP, i.e. 33.4 to 45.6 cal BP (*Table 2*). Such significant differences in the results of radiometric dating could have been caused either by freezing of the sediments that causes changes in the vertical positions of finds by up to 25 cm (in the current conditions; Mihevc 2009), or the secondary redeposition was caused by bears. More precise chronostratigraphic classification of the finds cannot be based on typology or technology either. For the time being we only have samples from the original excavations available for the first group of data; chronologically these samples fall within the Gravettian period (21.5–26.8 kyr ^{14}C BP). It will be interesting to compare the results of radiocarbon dating with the new data from the excavations of L. Nejman that were managed in 2011–2012 (Nejman *et al.* in press).

DISCUSSION

The outcome of the petrographic analysis of the lithic industry from the Pod hradem Cave was very surprising, especially as regards the chronostratigraphic position of the studied finds. From the angle of distribution, it is not only the distance of the raw material source, more than 100 km (*Figure 5*) that is of interest, but that this also applies to the location of the proper source, which is situated in East Bohemia. In the early Upper Palaeolithic cultures distant imports appear quite often, but evidence of the contact of the Moravian population with Bohemia is virtually missing. Obviously, we cannot rule out these contacts and we even anticipate them, but on the other hand, it is surprising to have them appearing in three different chronostratigraphic units, in addition on a locality the most likely functional interpretation of which is

TABLE 2. Radiometric ^{14}C dates from the Pod hradem Cave. Calibrated by IntCal2009.

Lab. Number	^{14}C-Age [BP ± SD]	CalAge p(95%) [cal BC]	CalAge p(95%) [cal BP]	CalAge p(68%) [cal BC]	CalAge p(68%) [cal BP]
GrN-848	33,300 ± 1100	39,920–32,600	41,870–34,550	36,260 ± 1830	38,210 ± 1830
GrN-1724	33,100 ± 530	37,390–33,590	39,340–35,540	35,490 ± 950	37,440 ± 950
GrN-1735	29,400 ± 230	32,440–31,240	34,390–33,190	31,840 ± 300	33,790 ± 300
GrN-1743	21,500 ± 100	24,060–23,100	26,010–25,050	23,580 ± 240	25,530 ± 240
GrN-1751	28,200 ± 220	31,270–30,110	33,220–32,060	30,690 ± 290	32,640 ± 290
GRN-1918	26,830 ± 300	30,120–29,200	32,070–31,150	29,660 ± 230	31,610 ± 230
OxA-19774	40,050 ± 550	42,850–40,570	44,800–42,520	41,710 ± 570	43,660 ± 570
OxA-19775	34,930 ± 290	39,840–36,400	41,790–38,350	38,120 ± 860	40,070 ± 860
OxA-19776	33,000 ± 500	37,180–33,580	39,130–35,530	35,380 ± 900	37,330 ± 900
OxA-19777	35,220 ± 240	40,070–36,590	42,020–38,540	38,330 ± 870	40,280 ± 870
OxA-22233	37,900 ± 650	41,290–39,530	43,240–41,480	40,410 ± 440	42,360 ± 440
OxA-22234	28,900 ± 300	32,200–30,680	34,150–32,630	31,440 ± 380	33,390 ± 380
OxA-22235	42,300 ± 1500	46,640–40,720	48,590–42,670	43,680 ± 1480	45,630 ± 1480

a killing site specialising in bears. If these were common Moravian raw materials, the solution of this question would not be so essential, but the import of an exceptional, specific raw material from the territory of Bohemia can have far-reaching consequences for the interpretation of human behaviour or for the solution of methodological issues relating to stratigraphy and research as such.

There are three basic interpretations to be taken into account for the analysis of this phenomenon:

1. Import of this raw material occurred repeatedly in various periods and cultures.
2. The horizons of the individual groups of finds are basically contemporaneous, and the existing situation of the finds resulted from post-deposition processes.
3. Utilisation of porcelanite in the horizon containing the blades was secondary, i.e. humans have made use of a raw material found in older layers.

Unfortunately none of the interpretations is without problems and fully satisfactory. In the first instance, the same model of behaviour would have to be repeated by various populations, and even with different industries (both Szeletian and Aurignacian). Moreover, the identification of Szeletian in the Bohemian environment is rather problematic (Nerudová, Přichystal 2001); we are aware from the analysis of distribution models that the hunters were more likely oriented towards different, local raw materials. There is no direct evidence of the utilisation of Bohemian porcelanite in the Moravian Aurignacian, for which imported raw materials are far from being unusual. The issue of repeating of the same or similar specific distribution strategy would also be interesting because both industries were created by different humans, since the linking of Szeletian to Neanderthals is regarded as being highly probable (e.g. Neruda, Nerudová 2013, Oliva 2005, Svoboda 2004), albeit without a concrete osteological find for the time being, and Aurignacian had been created by anatomically modern humans (cf. Mladeč; Teschler-Nicola 2006). The

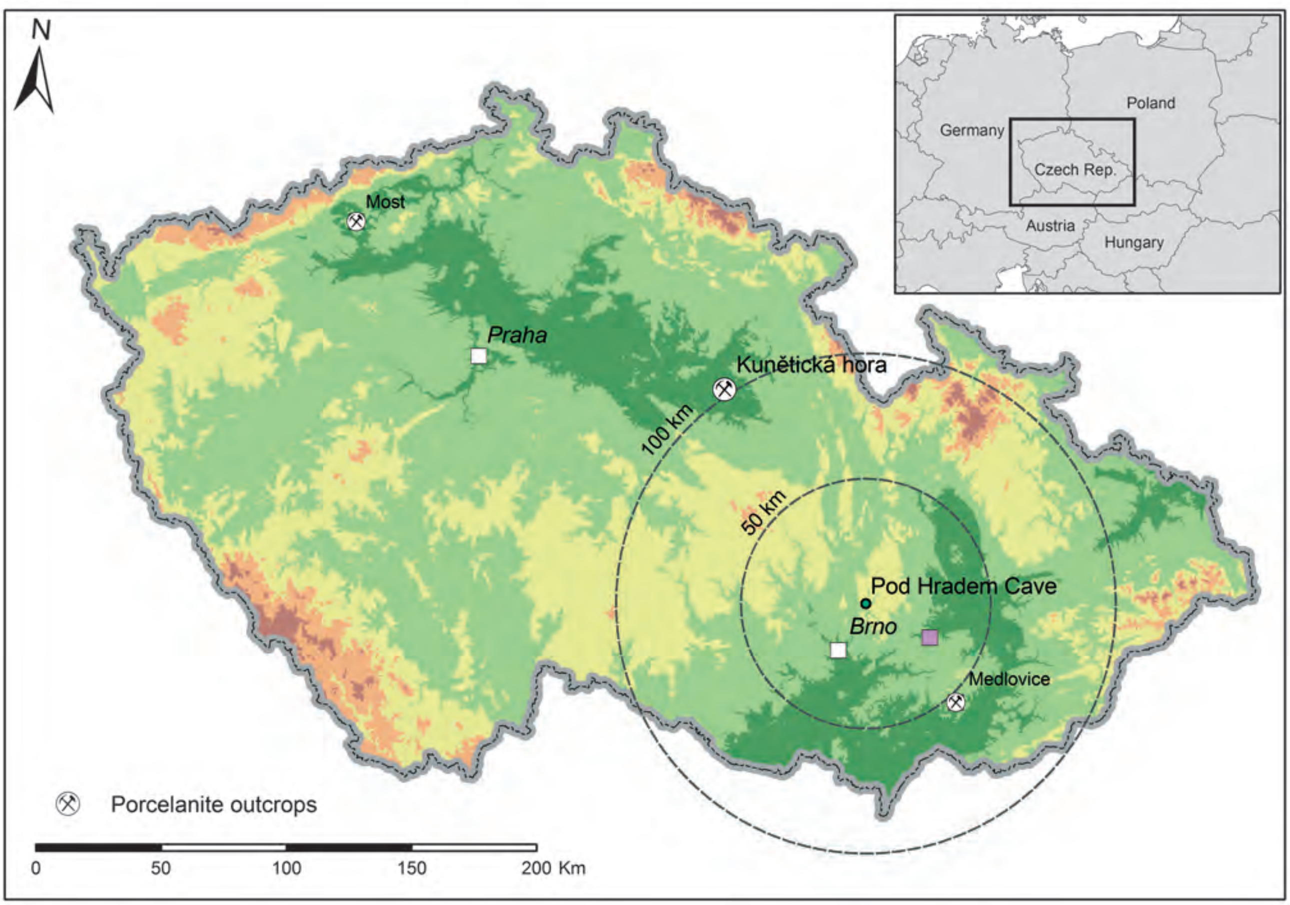

FIGURE 5. Raw material distribution from Kunětická hora Hill source (east Bohemia) to the Pod hradem Cave (Moravian Karst).

reason why both groups of humans sought out the same raw material could not be related to its specific quality, because from the technological point of view the described porcelanite can be compared to other Czech and Moravian raw materials.

The second model could resolve the issue of recurrence of this phenomenon in different cultures, but it is problematic especially from the stratigraphic point of view. The position of the individual archaeological horizons in the sequence of layers is still the most reliable way of establishing the relative chronology. Even if we admit that sedimentation in the Pod hradem Cave could have been quite rapid (at least in some periods), it is still rather unlikely that temporally coincident horizons could lay in different sediments with 1 m difference in levels (cf. *Figure 2*). Redeposition within post-deposition processes probably does not provide an explanation either. Such a disturbance of layers would have to be recorded in the documented stratigraphy, which is otherwise described in a great detail (Musil 1965). At the theoretical level, we could deliberate on the finds from the first and the second group as representing in fact one cultural unit, which has only been separated on the grounds of indirect dating, but the merger of these two groups with the horizon containing the leaf point is highly unlikely.

The third model ensues from the assumption that the humans, who left behind the blade industry in the cave, could have found porcelanite in older, disturbed sediments. Obviously such explanation would imply that the import had to happen in relation with the activity of the creators of the leaf point, i.e. probably Neanderthals. Again, we clash with the stratigraphic issue, since one metre is a relatively significant thickness of intact sediments, moreover there is no fault appearing on the profile that would explain the uncovering of layer 15, from the Szeletian, during a more recent phase of occupation. It is also of interest that the discovered industry of porcelanite is very heterogeneous from the viewpoint of technology, but it is not possible to determine from the items, whether porcelanite had been chipped directly on the site, or the raw material had been brought in already final forms, albeit of greatly differing morphology. A core, which we would expect in relation to blades, is totally missing.

A separate question relating to the above findings is linked to the identification of the mechanisms, through which distant raw materials got to a certain locality, although in this respect our options are significantly limited. It could be a simple linear model based on the transport of these raw materials during a displacement of an entire group from one site to another, or alternatively a targeted expedition – that are primarily taken into consideration. In the Palaeolithic materials the second option is apparently quite reliably sustained through imports of rock crystal and smoky quartz from the Czech-Moravian Highlands during Middle Palaeolithic (Neruda 2011). However ethnological studies clearly suggest that spreading of some raw materials could have been a rather complicated process linked with handing of gifts or bartering within intergroup interactions (e.g. Mauss 1954).

CONCLUSION

Petrographic revision of lithic artefacts from the Pod hradem Cave has brought surprising findings for the Moravian Palaeolithic. Non-destructive analyses identified using of porcelanite. X-ray diffraction of thin section from one artefact was used to verify the determination and provenance. The outcomes of the analyses were in accordance with the values for porcelanite from the Kunětická hora Hill.

The presented instance reveals that in some cases, raw material analysis can also be utilised e.g. for the resolution of cultural and chronological or stratigraphical issues. Without the identification of a specific sort of raw material from an unusual region we could regard the question of the chronostratigraphic division of the Pod hradem Cave as resolved. The identification of porcelanite in two horizons however alerts us to a possible error hidden in our existing interpretation.

We can also make use of identification of raw materials and their sources in the prediction of territories, which were occupied by the primeval humans although we are unaware of adequate evidence. Regardless of the way (i.e. premeditated distribution, gift, or barter) a very distant raw material reached a locality, within the region of its occurrence there must have existed a group of humans, who exploited the raw material at least for some time. This premise makes it possible for us to move from the study of human behaviour at one point (a site) to a larger area, and thus to acquire findings of new quality.

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