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Lithic raw material procurement in the Moravian Neolithic: the search for extra-regional networks

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ABSTRACT – *The study of lithic raw material procurement can contribute to the study of ancient networks. Petrographic analysis combined with systematic mapping of raw material outcrops has been conducted in Moravia and adjacent territories by A. Přichystal over a period of more than three decades. Combined with well excavated (including wet-screening) and ^{14}C (radiometric) dated sites, allows us to study changes in the distribution networks of raw materials during the Mesolithic and Neolithic periods.*

IZVLEČEK – *Študij oskrbe s surovinami lahko prispeva k razumevanju povezav v prazgodovini. A. Přichystal je petrografske analize v povezavi s sistematičnim kartiranjem najdišč na Moravskem vodil več kot trideset let. Dobro izkopana in ^{14}C datirana najdišča omogočajo študij sprememb v mezolitskih in neolitskih surovinskih distribucijskih mrežah.*

KEY WORDS – *Moravia; Neolithic; raw materials; networks; ^{14}C chronology*

Introduction

Since Neolithic cultures were first defined (*Palliardi 1914*) within the Middle Danube area, the main focus has been on pottery at the expense of other forms of material culture. The same trend may be documented during the entire 20th century; however in its last decades several researchers changed their focus to the study of stone tools, both from the viewpoint of raw material utilized for their production and their typology (*e.g.* Přichystal, Mateiciucová). Since the year 2000, stone industries have attracted greater attention within the Moravian archaeological community (I. Mateiciucová, M. Vokáč, M. Kuča). This paper continues this trend by looking at the Moravian Neolithic mainly in terms of the stone industry – combined with ^{14}C chronology and the palaeoclimatic record – while attempting to summarize contemporary research questions and preliminary results. In recent studies, the role of pottery has declined. Although the authors acknowledge the important role of pottery analyses, this study aims to take an innovative approach to Neolithic development in the region.

Methodology

The analysis of raw material networks, particularly the distribution of specific varieties of raw material on the eastern Central European scale, has been the subject of several publications. While Lech (*2003*) studied the distribution of many types of siliceous rocks, Groneborn (*2003a*) focused on the distribution of several specific raw materials (Szentgál-type radiolarite, obsidian, Maas valley silicite, and Wittlingen chert). It is fruitful to study these raw material networks and compare them with hypothetical and radiocarbon record based models (*Bocquet-Appel et*

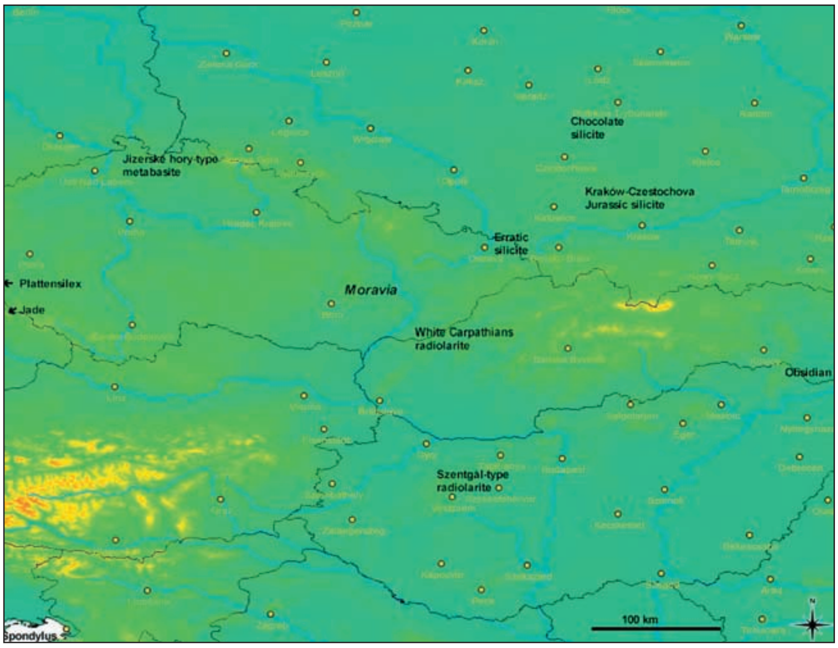

Fig. 1. Map showing raw materials imported into Moravia.

al. 2009) of diffusion of the LBK and other Neolithic cultures across the European continent. Recently, Mateiciucová (*2002*) analyzed LBK raw materials from the Middle Danube area (Ph.D. thesis) and Kuča (*2008*) focused on the supply of Neolithic raw materials in a particular micro-region of the Brno Basin. One set of limitations regarding the methods used in Moravia is posed by the necessity of working with assemblages excavated and collected over a long period, by different people using different excavation methods, and often lacking in information concerning possible contamination by older or younger material (the majority of sites are poly-cultural). The lack of (or inconclusive) radiocarbon dating results is also a problem. Therefore, we have selected a set of reference-sites that we deem representative of each culture and cultural phase. The selected reference sites were excavated using modern field techniques (including wet-sieving and precisely fixing the provenance of all items) and dated using absolute dating methods. It will be necessary to excavate more such reference sites in Moravia in the near future.

An important innovation in lithic raw material studies has been the development of a non-destructive method of sourcing raw materials. Using this method, it has been possible to determine the source of many (hundreds to thousands) chipped artefacts. The method involves matching chipped silicic artefacts with raw materials from geological sources using a stereomicroscope with water as an immersion liquid (*Přichystal 2002b*). This research has resulted in the sourcing of thousands of Neolithic chipped artefacts which, in turn, has made it possible to reconstruct raw material distribution networks.

The geographical and geological setting of Moravia

Moravia is a historical geographic unit (land) currently constituting the eastern half of the Czech Republic. From a geographical and geological point of view, Moravia lies on the boundary between the Western Carpathians in the east and the Bohemian Massif in the west, and also on the Black Sea (Danube, southern Moravia), and the Baltic Sea watershed (Oder River, northern Moravia). The relief of Moravia consists of river valleys surrounded by highlands. The river valleys are connected by gates which form a system of passages – communication routes which connect eastern and western, northern and southern Europe (*Svoboda et al. 1996*).

During the last glaciation Moravia was a periglacial zone between the Alpine and Fenoscandinavian ice sheets and allowed movements (migrating animal herds, hunter-gatherers, raw materials) in both of the above-mentioned directions. After the LGM, people penetrated Moravia from both western and eastern refuges (*cf. Semino et al. 2000*), and the Morava River served as an arbitrary boundary between the western Magdalenian and eastern Epigravettian culture complexes. The north-south became part of the (later period) so-called amber route. These main communication routes are now being utilized for a network of motorways.

The relief, slope erosion and intensive agricultural use of the lowland fields in the past (ploughing has caused erosion and the disturbance of archaeological material located near the surface) has had a negative impact on the preservation of ancient sites.

Local raw materials

The area has highly diverse geology, with many geological units in a relatively small area. This is reflected in the number of local and very often unusual raw materials (of different origin) suitable for both knapped and polished stone working.

The knapped stone industry

The most important locally available raw material is the Krumlovský Les-type chert. The main outcrops are in the Krumlovský Les Highland in southwestern Moravia (*Oliva 1990; Oliva, Neruda, Přichystal 1999*), where the nodules occur as pebbles with a characteristic black cortex (desert varnish) in Miocene gravel deposits. M. Oliva has documented the mining of this resource since the Mesolithic period (*Oliva 2008*). Isolated outcrops of this material, often of low-quality, are also known from another part of Moravia.

Other raw materials have been locally documented and include Olomučany-type chert, Stránská Skála-type chert, rock crystal, and Cretaceous spongolitic chert.

Isolated outcrops of Jurassic Olomučany-type chert are known only from the central part of the Moravian Karst (*Přichystal 1999a*).

The Jurassic Stránská Skála-type chert is present as nodules in organodetritic limestones at Stránská Skála hill on the eastern periphery of Brno (*Přichystal 1994*).

Primary sources of Cretaceous spongolitic chert occur in the general area of Boskovice Furrow (northwest of Brno) and secondary deposits can be found in the gravel terraces of south Moravian rivers (*Přichystal 2002*).

Rock crystal (respectively, smoky quartz, citrine and rose quartz) originates from pegmatites or quartz veins in the strongly metamorphosed crystalline rocks of the Bohemian-Moravian Highlands. This raw material is known to occur in colluvial deposits adjacent to the primary outcrops, as well as in (reworked) river gravels (*Vokáč 2004*); however, Alpine or Polish (Jeglowa) lithic sources may also have been used.

Various kinds of opal and chalcedony masses, which are the siliceous weathering products of various metamorphic rocks (especially of serpentinite), often called 'plasma, chalcedony, or opal', are known mainly from southwestern Moravia (*Vokáč 2004*); however there are less frequently utilized sources in other parts of Moravia and southern Bohemia (*Přichystal 2004*). Because of the nature of this group of raw materials, sources are very difficult to identify unambiguously.

Apart from obsidian originating in the Carpathian region, the use of a very unique and unusual local raw material, moldavite (tektite, natural glass), has also been documented (*e.g. Vokáč 2004*).

The polished stone industry

The sources of hornblende diorite of the Rokle-type, first described by A. Přichystal (*1988*), are in the Svratka River valley and its surroundings (northwestern outskirts of Brno). However, there is currently no direct evidence that it was mined (*cf. Vokáč, Kuča, Přichystal 2005; Kuča, Vokáč 2008; Kuča, Kirchner, Kallabová in print*).

The outcrops of diorite porphyry (porphyric microdiorite) are located to the west of Brno. Dykes of diorite porphyry intrude into both the granitoids and metabasites of the Brno Massif. They have a characteristically low magnetic susceptibility (*Vokáč, Kuča, Přichystal 2005; Kuča, Vokáč 2008*).

Outcrops of the chlorite-actinolite greenschist of the Želešice-type (see *Přichystal 1999b; 2000a; 2000b; Kuča, Vokáč 2008*) occur in the southeastern part of the Brno Massif. This raw material is characterized by a high magnetic susceptibility (1.5–55 x 10^{-3} SI units).

Both primary and secondary outcrops of amphibolites with banded structures are known in the Moldanubicum and Moravicum – geological units forming a strongly metamorphosed core of the Bohemian Massif in southeastern Moravia. Other possible sources are known to exist in the Hrubý Jeseník Mts. (northern Moravia) and the Malé Karpaty Mts. in western Slovakia.

Another important rock type for polished artefacts is eclogite, which is rock typically composed of garnet and pyroxene. There are local sources in the Moldanubicum; however, there are sources of eclogites in the Western Alps that were exploited in the Neolithic (*e.g. D'Amico, Starnini 2000*), and we cannot exclude the possibility that they were also imported from north-western Italy, as has been documented for jadeitites.

Culmian siltstones and silty shales are dark grey, fine-grained rocks from Lower Carboniferous formations in northern Moravia (Nízký Jeseník Mts.) and central Moravia (Drahany Highland, Maleník block). Greywackes used for polished hammer-axes occur in the same geological units (*Janák, Přichystal 2007*).

Cenozoic volcanics (basalts, phonolites, andesites) are known from several outcrops within the Middle Danube area, *e.g.* in northern Moravia, Silesia, northern and central Hungary, southern Slovakia (*Illášová 2001*), as well as northern and western Bohemia. The location of their sources is still being investigated.

Imported raw materials

Imported raw materials are defined as those coming from sources over 30–40km from the site (*i.e.* approximately a one-day walk). These distances are measured from the city of Brno, in southern Moravia.

The knapped stone industry

The radiolarites originating in the Balaton Lake area (*Biró, Regenye 2007*) were imported from the Bakony Mts. in Hungary. Local geologists distinguish several types of radiolarites (*e.g.* Szentgál, Sümeg, Harskút, Úrkút-Eplény). This raw material was imported in the form of whole nodules or blocks. It is approx. 220km as the crow flies from Brno to the sources of the Balaton radiolarites.

Obsidians were transported from Zemplínské Vrchy Upland, currently divided by the Slovak-Hungarian border. The only known obsidian source in Central Europe occurs in this area (*Biró 1981; Illášová, Spišiak, Toronyiová, Turnovec 2004; Přichystal 2004*). This is supported by all the currently available trace elements analyses of archeological finds.

The primary outcrops of the Kraków-Czestochova Jurassic silicite are located within the limestone area between Kraków and Czestochova in southern Poland. These outcrops are approx. 300km from Brno.

The outcrops of so-called chocolate silicite are located in the northern foothills of the Holy Cross Mts. in Central Poland (*Schild 1976*). These outcrops are approx. 420km from Brno.

The outcrops of a tabular banded Plattensilex (Arnhofen- and Baiersdorf type) are located in Bavaria, some 350km from Brno.

The most important Bohemian raw materials are Tertiary quartzites from north-western Bohemia – Skršín- type, Tušimice-type, Bečov-type (*Neustupný 1966; Malkovský, Vencl 1995; Přichystal 2004*). These outcrops are located approx. 260km from Brno.

We define erratic silicite as siliceous raw materials (silicites) collected from glacial and glacifluvial deposits in southern Poland and northern Moravia. The nearest such outcrops are approx. 110km from Brno. While in the northern Moravian sites, this raw material would be classified as local (*i.e.* it is not possible to separate the Polish from the Moravian sources), in central, western, eastern, and southern Moravia, it is an imported raw material.

Jurassic Carpathian or Alpine radiolarites were occasionally used in south-eastern Moravia. They were sourced in the White Carpathians on the Moravian-Slovakian border, or at Mauern, Vienna. These outcrops are approx. 110km from Brno.

The polished stone industry

A group of raw materials called metabasites of Jizerské hory-type comprise the most important raw material frequently utilized for polished artefact production in central Europe. It has low magnetic susceptibility values (0.30–0.80 x 10^{-3} of SI units). The primary outcrops were discovered in northern Bohemia: Jistebsko (*Šrein et al 2002*) and Velké Hamry (*Přichystal 2002a*). The latest characterization of the whole mining area was carried out by Šída (*2007*). The metabasite of Jizerské Hory-type has had a complicated geological history, and from a petrological point of view, it can be described as a thermally metamorphosed greenschist. Some authors prefer to identify this material as hornblende-plagioclase hornfels. These outcrops are some 200km from Brno.

The serpentinites originate from the Moldanubicum, and are characterized by high magnetic susceptibility values reaching dozens of SI units (*Přichystal, Gunia 2001*). Although this material is known from various sites in the Bohemian Massif, the most important source is probably in south-west Moravia (*Weiss 1966*). However, we cannot exclude the utilization of non-Moravian sources, such as those in southern Poland (*Wojciechowski 1983*). The distance of these outcrops from Brno is approx. 210km (in Poland).

Gabbro is a rock used for the production of perforated tools, known sources of which occur in several areas, including the Orlické and Železné Mts. and in Lower Silesia (*Ślęża Hill; Přichystal 1999a.222*). The distance of these outcrops from Brno is around 200km (in Poland).

The commercial term 'jade' often includes one of two very different materials – nephrite or jadeitite. While the only nephrite source in Central Europe has been found near the village of Jordanów in Lower Silesia (*Gunia 2000*), for jadeitite there are sources in the western Alps (*D'Amico, Starnini 2000*). The distance of these outcrops from Brno is around 200km (nephrite) and about 800km (jadeitite).

Neolithic mining of white marble was described at Bílý Kámen hill near Sázava (*Žebera 1939; Přichystal 2000a; 2000b*). The distance of the outcrops from Brno is approx. 140km.

The shells of the mollusc *Spondylus gaedoropus* L., in the central European LBK of anticipated Mediterranean origin (*Lenneis et al. 1995*), were utilized for the production of personal adornments (*Vencl 1959; Podborský 2002*). However, in Moravia the presence of this raw material has been documented not in the earliest LBK, but in later phases of LBK, most frequently as grave goods (*e.g.* in the Vedrovice burial ground, *Podborský et al. 2002*). In Moravia, the importation of this raw material ceased towards the end of LBK, probably as a sequel to changes in interregional distribution networks.

On the other hand, there is evidence that the raw material distribution networks operated in both directions, *i.e.* Moravian raw materials were being exported. Due to their inexperience, lithic analysts and geologists in neighbouring countries often do not identify these materials as Moravian; for example, we were recently able to identify Moravian raw materials (diorites from the Brno area were found in eastern Slovakia, Krumlovský Les breccia in southern Poland, metabasite of the Jizerské hory-type in Austria and Hungary, etc.).

The Late Paleolithic and Mesolithic background

The number of excavated Late Paleolithic sites is very limited because of the lack of sunken features from this period, the absence of loess sedimentation, and intensive erosion during later periods (up to the present). The Late Paleolithic is represented by a local variety – Tišnovian (a local variant of Federmesser-Gruppen), and there are no absolute dates. Only one excavated site (Tišnov-Dřínová site) and several surface collections have been reported. While the local raw materials, often poor in quality, were used in the Czech-Moravian Highland, the erratic silicite and Kraków-Czestochova silicite were used in the Morava River valley, which is located on the main communication route and closer to the sources.

Sandy dunes were the preferred locations during the Mesolithic period. Such sites often poorly preserve organic material, and were intensively disturbed by rodents (*cf. Škrdla, Poláček, Škojec 1999*). Several Mesolithic sites have been excavated and several more surface sites have been reported. The absolute chronology of the Mesolithic period (by 'absolute chronology' we mean calibrated radiometric dates – ^{14}C or AMS) indicates an age range of 9 to 6 millennia BC (*e.g. Valoch 1978; Svoboda 2003*). Mesolithic people used local raw materials, often collected from river gravels; however, Oliva (*2008*) recently documented extraction pits dating back to the Mesolithic in the Krumlovský Les mining area.

The Earliest Linear Band Pottery Culture (LBK) in Moravia

The earliest LBK in Moravia has links to the western branch of this culture and is represented in Moravia by phase Ia, based on the relative chronology developed by Tichý (*1962*), and expanded by Čižmář (*1998*), Pavúk (*2004*), and Pavlů (*2005*). The dating of the occupation discovered recently in Spytihněv has shown that the already well-documented earliest presence of this phase in Moravia dates back to 5420–5220 calBC (*cf. Schenk et al. 2008*). This does not necessarily mean that this was the earliest presence of LBK in Moravia. Another absolute date (5580–5220 calBC, p95%) is available from an earlier excavation at Žopy (*Quitta 1967; Mateiciucová 2002*). Another important site is at Brno-Ivanovice (*Čižmář* 1998), which yielded a date of 5570–5450 calBC (*Stadler et al. 2000*). Similar or identical absolute dates for the earliest LBK have been obtained for the broader region, including Lower Austria, Moravia, Bohemia, and southern Poland. Unfortunately, other examples of important Moravian LBK sites, often still lacking appropriate absolute dating, include Kladníky (*Mateiciucová 2000*), Vedrovice-Za Dvorem (*Mateiciucová 2001*), and Mohelnice (*Tichý 1998*, a Neolithic dendrochronology date exists for this site – 5450 BC).

The earliest Moravian LBK sites are generally located along the main rivers (*e.g.* Morava River) and follow the main natural geographic corridors connecting the Danube and Oder valleys. They are sometimes located on the margins of surrounding highlands, *i.e.* at strategic locations above the main river valleys (on hilltops).

A significant change in raw material procurement in the form of much more extensive raw material networks is observed when compared to the preceding period of the last hunter-gatherers. The raw materials were imported from all directions, often from hundreds of kilometers away. The raw materials that were not imported, or not utilized to a great extent during the previous periods, began to assume greater importance (in the polished stone industry). The raw materials identified at the sites indicate more extensive networks than during the Mesolithic period, and similar or more extensive networks compared to the Upper Paleolithic period. The extra-regional contacts are represented by marine shells imported from the Mediterranean, Krakow-Czestochova Jurassic silicite, northwest Bohemian metabasites, Szentgál-type radiolarite from the Balaton Lake area, and obsidians from eastern Slovakia.

Although we currently have a number of the earliest LBK assemblages in Moravia, we prefer to use the recently excavated site at Spytihněv as a reference site (*Schenk et al. 2008*). This site was excavated to modern archaeological field-work standards (recording the provenance of all artefacts, wet-sieving all excavated sediments), and yielded a collection of characteristic pottery and a representative collection of knapped stone artefacts and several polished stone artefacts. Absolute dates have also been obtained. Another reference site is Žopy, where Pavelčík excavated a sunken feature in the 1950s which yielded a date and a collection of 71 stone artefacts (*Gronenborn 1997.169, Mateiciucová 2002*).

The site at Spytihněv (49°9'42.07"N, 17°29'25.83"E – WGS–84) is located on a southerly ridge extending from Maková Hill. The site reaches an altitude of 322.1m above sea level and rises to 135 meters above the Morava River. The site is in a strategic position that allows control of the lower Morava River valley. The collection of knapped stone from Spytihněv consists of 442 items, surprisingly dominated by erratic silicite (49%), followed by Kraków-Czestochova Jurassic silicite (32%). Contacts with the southeast Transdanubian region are indicated by the presence of Szentgál-type radiolarite (13%). The polished stone artefacts from Spytihněv were made from Jizerské Hory-type metabasite and Želešice-type greenschist (*Schenk et al. 2008*). The raw material spectrum is surprisingly rich and indicates intensive contacts with northern Bohemia (metabasites), the Brno area (Želešice-type greenschist), the Kraków-Czestochova area in Poland, the Balaton area (the Szentgál-type radiolarite) in Hungary, and eastern Slovakia (obsidian). The contacts with southern and eastern territories were expected to be similar to the LBK core area; however, the intensive contacts with northern regions from the earliest phase of LBK are important for creating and testing the hypothesis of the spread of LBK further to the north.

The site of Žopy (49°20'11.54"N; 17°35'44.25"E – WGS–84) is located in a brickyard, near the modern town of Holešov. The site is located in the Rusava River valley, a left-bank tributary of the Morava River, in the western foothills of the Hostýn Mountains, at an elevation of 250–255m (the relative altitude above the Rusava River is 12–17m).

According to Mateiciucová (*2002*), Kraków-Czestochova Jurassic silicite prevails (63.1%), supplemented by Szentgál-type radiolarite (10.5%) and erratic silicite (6.6%). Isolated artefacts were made from Úrkút/Eplény-type and Hárskút-type radiolarites, Krumlovský Les-type chert (variety I), and quartz. Details on polished stone raw materials are not available.

The third important site – Brno-Ivanovice – is located on the northern outskirts of the modern city of Brno (49°15'38.001"N, 16°34'47.256"E, WGS–84), in the valley of the Ponávka River. The site reaches an altitude of 255–260m and the relative altitude above the Ponávka is 10–20m. According to Mateiciucová (*2001*), the knapped stone industry was made on Olomučany-type chert (68%), Moravian Jurassic chert (10%), Krumlovský Les-type chert (variety II, 2%), and isolated artefacts were made from Krumlovský Les-type chert (variety I), Kraków-Czestochova Jurassic silicite, Bakony radiolarite and quartz (*Mateiciucová 2000.229*). Details on polished stone raw materials are not available.

The Vedrovice-Za Dvorem site (49°0'59.75"N, 16°22' 16.203"E, WGS–84) is located on the south-eastern slopes of the Krumlovský Les upland and reaches an altitude of 250m. Based on a relative chronology, the earliest phase of LBK is present (Ia, information by Z. Čižmář). Mateiciucová (*2001*) described a collection of 255 artefacts from two sunken features (176 and 179). The collection is characterized by a prevalence of Krumlovský Les-type chert (variety I, 63.5%), Olomučany-type chert (17.5%), Krumlovský Les-type chert (variety II, 9%). Only isolated artefacts were produced from Szentgál-type radiolarite, Kraków-Czestochova Jurassic silicite, and erratic silicite (*Mateiciucová 2001.10*). Relevant details on polished stone raw materials are not available.

This brief introduction to the major earliest LBK lithic collections demonstrates the importance of imported raw materials and contrasts with the limited use of locally obtained raw materials. The radiolarites of Hungarian origin and obsidian from eastern Slovakia (or northeastern Hungary) indicate contacts to the south and east, *i.e.* to the LBK core area, and are traditionally accepted as documenting the spread of the earliest LBK from Transdanubia to Moravia and further north (*cf. Groneborn 2003b; Mateiciucová 2002*). These raw materials constitute around 10–15% of the raw material spectra; the majority of raw materials were imported from northern territories, *i.e.* the opposite direction to the currently suggested Neolithisation. The Kraków-Czestochova Jurassic silicite dominates such early LBK sites in northern Poland, which are dated to the same period (*Boguszewo, Mateiciucová 2000; Malecka-Kukawka 1992*). The similarity in raw material supply patterns over a large area documents the significance of the Kraków-Czestochova Jurassic silicite for the earliest LBK in Moravia and Poland and documents a rapid diffusion of the earliest LBK in the region. The prevalence of the Kraków-Czestochova Jurassic silicite over the Hungarian radiolarites at the earliest Moravian LBK sites enables us to posit an alternative hypothetical route for the Neolithisation of Moravia – from the northern Kraków area (there are several mountain passes through the Carpathians from Slovakia to the Kraków area). Obsidian had been imported into Poland since the Mesolithic period (*Kozłowski 1989.202*). The presence of other imported raw materials such as erratic silicite and northern Bohemian metabasites support this 'provocative' hypothesis.

The end of phase I and middle phase of LBK

During the middle to late LBK (phases Ib to III are based on relative chronology), the occupation continues to penetrate deeply into the highlands and further from the main rivers; however, raw material procurement strategies are still similar to those of phase Ia.

The burial site at Vedrovice-Široká u Lesa, dated to phase Ib based on relative chronology, is one of the most important eastern Central European such sites (*Podborský et al. 2002*). The grave-goods were produced primarily from Kraków-Czestochova Jurassic silicite (37.3%), the local Krumlovský Les-type chert (25.4%), Szentgál-type radiolarite (7.5%), and included isolated artefacts made from Úrkút/Eplény-type radiolarite, reddish-brown radiolarite, erratic silicite and quartz (*Mateiciucová 2002*). Valuable grave goods are represented by a collection of artefacts made from Spondylus shells (*Podborský et al. 2002*).

In the middle phase of the LBK (phase II based on relative chronology, or the Musical Note Pottery phase of the LBK), density of occupation increased. The raw material networks were more extended and the quality of the raw material quality was a significant factor affecting choice. The Kraków-Czestochova Jurassic silicite dominate in the raw material spectra, supplemented in southern Moravia by locally available Krumlovský Les-type chert and Olomučany-type chert. Erratic silicite was almost ignored (*cf. Mateiciucová 2001*). While during this phase the importation of the Szentgál-type of radiolarite was limited (Vedrovice-Za dvorem, Přáslavice-Kocourovec; *Mateiciucová 1997*) to the end of middle phase, and in connection with increasing influences from the east (Želiezovce from south-eastern Slovakia), this raw material again increased in importance (*Mateiciucová 2001*).

The late phase of LBK

Occupation density decreased during the late phase of LBK, and distribution networks changed (*Mateiciucová 2001*). While eastern (Želiezovce) influences disappeared, western influences (Šárka) increased.

Stroke Ornamented Pottery Culture (SPC)

Moravia can be divided into a northern region, where the Stroked Pottery Culture is present, and a south-western, with Early MPWC and the episodic presence of Stroked Pottery Culture (SPC).

With the exception of several graves from Těšetice-Kyjovice – 5915 ± 30 BP, 5920 ± 30 BP, 5960 ± 30 BP, 5970 ± 30 BP, 5915 ± 30 BP, we currently have no radiocarbon dated SPC collections, and only preliminary results based on inadequately excavated collections are available. While northern and central Moravia are characterized by the predominance of erratic silicite (Olomouc-Slavonín, Určice), southern Moravia is characterized by local Krumlovský Les-type chert (Modřice, Křižanovice u Vyškova, Blučina) with imported erratic silicite present in small amounts. The local Olomučany-type chert, imported Bavarian plattensilex, north-west Bohemian quartzite, white marbles, Kraków-Czestochova Jurassic silicite, Szentgál-type radiolarite, and obsidian were documented only in small amounts (*Oliva 1996;*

Kazdová et al. 1997; 1999; Čižmář, Oliva 2001). Due to the lack of well excavated and absolutely dated SPC sites, a detailed raw material analysis (compared to LBK or Lengyel culture analysis) is not available.

Lengyel Culture (Moravian Painted Ware Culture, MPWC) in Moravia and Mährisch-Österreichische Gruppe (MOG) in Austria

The Lengyel Culture (in absolute chronology 4800–4000 calBC) is the most important upper Neolithic culture in the Middle Danube Region. In Moravia, two phases – I and II – were identified based on relative chronology (*Kazdová, Koštuřík, Rakovský 1994; Čižmář et al. 2004; Pavúk 2007*). MPWC sites have yielded the majority of the Neolithic radiocarbon dates from Moravia.

Currently, we have one of the earliest MPWC sites (phase Ia) reference sites in Moravia: Těšetice-Kyjovice – 'Sutny' (48°53'55.019"N, 16°7'57.925"E, WGS 84) in the south-west (*Kazdová 1984; Podborský 1988; Kuča, Kazdová in print*, etc.). A series of radiocarbon dates is available: 5450 ± 90 BP, 5625 ± 40 BP, 5870 ± 40 BP (*Podborský 1975/76; Kazdová, Dočkalová in print*). A collection of 1629 stone artefacts from selected sunken features was analyzed. The most commonly utilized material was the locally available Krumlovský Les-type chert (65%), supplemented by local siliceous weathering products of serpentinites (6%). Imported raw materials mainly include obsidian (14%), and isolated artefacts were made from occasional silicite, Kraków-Czestochova Jurassic silicite, and radiolarite (*Přichystal 1984*). Polished stone items were produced from metabasite of the Jizerské hory-type, and there were significantly fewer artefacts of greenschist of the Želešice-type.

There are two reference sites from phase Ib for MPWC culture. Březník-Zadní Hon is located in the Czech-Moravian Highlands (49°10'30.478"N, 16°12' 43.765"E, WGS 84). A single ^{14}C date is available for this site; 5780 ± 40 BP (Poz–22398; *Kuča, Nývltová Fišáková, Škrdla, Vokáč in print*). The dominant raw material is Krumlovský Les-type chert (95%). Only isolated artefacts were made from imported chocolate silicite (1.4%) and Kraków-Czestochova Jurassic silicite (1.0%). The majority of raw materials used for polished artefacts were imported from the Brno area (greenschist of the Želešice-type, amphibolitic diorite of the Rokle-type, and diorite porphyry/porphyric microdiorite). Amphibolite and metabasite of the Jizerské hory-type were also occasionally used.

Šebkovice is the second important site of the Ib phase of MPWC, also located in the Czech-Moravian Highlands (49°6'35.42"N a 15°49'57.16"E, WGS 84). It is dated by ^{14}C to 5845 ± 45 BP (GrA–34102, *Kuča, Vokáč, Nývltová Fišáková in print*). As in the previously described site, the Krumlovský Les-type chert prevails, supplemented by isolated artefacts made from local or regional origin (siliceous weathering products of serpentinites, opal, rock crystal, and chalcedony). More distant imports are comprised of isolated artefacts from chocolate silicite, obsidian, Kraków-Czestochova Jurassic silicite, erratic silicite, Bavarian plattensilex, and radiolarite. Polished tools were produced from greenschist of the Želešice-type, amphibolitic diorite of the Rokle-type, and diorite porphyry/porphyric microdiorite.

Three reference sites are available for phase Ic of MPWC. The first is Jezeřany-Maršovice-Na Kocourkách (49°2'37.05"N, 16°24'59.873"E, WGS 84), located directly on outcrops of Krumlovský Les-type cherts and dated to 5325 ± 50 BP (Bln–2067, *Rakovský 1985*). The assemblage numbers 2097 knapped artefacts, with Krumlovský Les-type cherts predominant. Other raw materials are represented only by isolated items and include radiolarite, Kraków-Czestochova Jurassic silicite, Bavarian plattensilex, erratic silicite, and chocolate silicite (*Rakovský 1985; Přichystal, Svoboda 1997; Oliva 2001*). Polished artefacts have not been published yet.

The second site from this period (phase Ic, MPWC) is Brno-Bystrc (49°13'12.516"N, 16°31'11.014"E, WGS 84), which yielded a date of 5570 ± 60 BP (Bln–2424, *Rakovský 1985*). The Krumlovský Les-type chert is again the most commonly used raw material, supplemented by Kraków-Czestochova Jurassic silicite, Olomučany-type chert, and Stránská Skála-type chert. Polished tools were produced from greenschist of the Želešice-type, amphibolitic diorite of the Rokle-type and diorite porphyry/porphyric microdiorite (*Přichystal 1988; Čižmářová, Rakovský 1988*).

The third reference site from this period was excavated in Mokrá near Brno (49°14'2.189"N, 16°44' 59.606"E, WGS 84) on the southern margin of the Moravian Karst. Two dates are available; 5645 ± 35 BP (VERA 760, *Šebela, Kuča 2004*) and 5640 ± 45 BP (GrA–34088, *Kuča 2008*). Imported raw materials are present in significant proportions – erratic silicite and Kraków-Czestochova Jurassic silicite are followed by Krumlovský Les-type chert, Olomučany-type chert, Crecateous spongolitic chert, obsidian and chocolate silicite. Polished tools were produced from raw materials obtained in the Brno area (greenschist of the Želešice-type, amphibolitic diorite of the Rokle-type and diorite porphyry/porphyric microdiorite).

The only reference site for phase IIa of MPWC is Dluhonice (49°27'47.311"N, 17°25'8.528"E, WGS 84) in the Moravian Gate, which yielded a ^{14}C date of 5675 ± 45 BP (GrA-34089). Knapped artefacts were produced only from erratic silicite and Kraków-Czestochova Jurassic silicite. Polished tools were produced from greenschists of the Želešice-type.

A radiometrically dated site from phase IIb of MPWC is not currently available. Two dates are available from phase IIc of the MPWC from Jezeřany-Maršovice (*Košturík et al. 1984; Oliva 2001*); 5040 ± 50 BP (Bln-2068) and 5120 ± 50 BP (Bln-2142). The only identified raw material present is the local Krumlovský Les-type chert and chert breccia. Imported raw materials have not been identified. Polished tools were produced from greenschist of the Želešice-type, amphibolitic diorite of the Rokle-type and diorite porphyry/porphyric microdiorite, amphibolite, and greenschist of undetermined origin.

Except for the earliest phase (Ia) of the MPWC, southern Moravia was characterized by the exploitation of several local raw materials (see below), while the area far to the east and to the north-east of Brno is characterized by significant amounts of erratic silicite and Kraków-Czestochova Jurassic silicite (*cf.* Mokrá; *Šebela, Kuča 2004; Kuča 2008a*). On the other hand, southwestern Moravia is a typical refuge area, with many local raw materials which were exploited at different rates (the Krumlovský Les-type cherts, siliceous geests, crystalline varieties of quartz, chalcedony, etc.; *cf.* Březník, Jezeřany-Maršovice, Šebkovice; *Kuča, Nývltová Fišáková, Škrdla, Vokáč in print; Přichystal, Svoboda 1997; Oliva 2001; Kuča, Vokáč, Nývltová Fišáková in print*). The situation in the Brno area relates to south-western Moravia and is characterized by a predominance of Krumlovský Les-type chert; however, the area is rich in local raw materials suitable for polished stone production (amphibolitic diorite of the Rokle-type, diorite porphyry/porphyric microdiorite, chlorite-actinolite greenschist of the Želešice-type; *cf.* Brno-Bystrc (*Rakovský 1986; Čižmářová, Rakovský 1988*). The lower Morava River valley and the Dyje-Svratka River valleys are regions influenced both by the nearby outcrops of the Krumlovský Les-type cherts and by the imported Kraków-Czestochova Jurassic silicite and erratic silicite from the north. The upper Morava River valley, North Moravia or Moravian Gate, through the Vyškov Gate, served as corridors used for transporting raw material to southern and south-western Moravia (*cf.* Dluhonice) during the MPWC.

Generally, the earliest (phase Ia) MPWC is characterized by a continuing tendency to use the local raw material, as is documented in the later phases of the LBK. During later phases (Ib-II) of the MPWC, the importation of rocks from the Brno area increases (greenschist of the Želešice-type, amphibolitic diorite of the Rokle-type, diorite porphyry/porphyric microdiorite). Polished stone items may have been valuable commodities traded for high-quality raw materials mainly from the north (the Kraków-Czestochova Jurassic silicite, chocolate silicite, erratic silicite?). During the later phases (Ib-II) of MPWC, imports are usually less numerous. Based on preliminary analyses, we can conclude that the Krumlovský Les-type silicite, erratic silicite and Kraków-Czestochova Jurassic silicite played a major role in the later phase (II) of the MPWC.

Conclusion

During the earliest LBK, raw materials were imported from all directions, often over distances of hundreds of kilometers. The extra-regional contacts are attested by the Krakow-Czestochova Jurassic silicite, north-west Bohemian metabasite, Szentgál-type radiolarite from the Balaton Lake area, and obsidian from eastern Slovakia (the obsidian demonstrates contacts with the region occupied by the eastern branch of the LBK). This raw material spectrum documents the extended raw materials networks which were connected to Moravia from all points of the compass, which is a contrast to the preceding Late Paleolithic and Mesolithic occupation, where the economy was based on the utilization of local raw materials. The extent to which the hunter-gatherer way of life survived until the Early Neolithic penetrated the main river valleys remains an open question. Taking into account the significant differences in the raw materials of the economy (and other aspects of social life) between the Mesolithic (Mikulčice, Smolín) and the earliest LBK (reference sites), contact between the two cultural complexes appears to have been very limited. However, in order to test interaction hypotheses, more radiometric dates are needed.

During the later phases of the LBK, the imported raw material (Krakow-Czestochova Jurassic silicite, northwest Bohemian metabasite, and Szentgál-type radiolarite) continued to be significant; however, the amount of local raw materials increase, and this is clearly visible, especially in southern and south-western Moravia (an area rich in quality local raw material sources). The valuable grave goods and the most distant contacts are represented by a collection of artefacts made from Spondylus shells.

The western influences (from Germany) led to a significant difference in raw material spectra during the SPC. This is demonstrated by the presence of western raw materials not previously imported to Moravia (Bavarian plattensilex, north-west Bohemian quartzite, and white marble). The Kraków-Czestochova Jurassic silicite, Szentgál-type radiolarite, and obsidian imports continue to be significant, but they are present in smaller quantities. The use of local raw materials is similar to the later phases of the LBK and continues in similar proportions until the end of the Neolithic. The main extra-regional contacts are indicated by the presence of Bavarian plattensilex, Kraków-Czestochova Jurassic silicite, Szentgál-type radiolarite, and obsidian. The area of the obsidian outcrops was occupied by the Bükk culture people, and the Lake Balaton area was occupied by bearers of the earliest Lengyel Culture.

The earliest phase of MPWC (Ia) is characterized by similarities with the later phases of the LBK, both in artefact typology and raw materials (*e.g.* north-west Bohemian metabasites). A significant change begins with phase Ib, which is characterized by increasing regionalization and utilization of local raw materials (especially for polished stone). While the Kraków-Czestochova Jurassic silicite maintains its importance, obsidian began to play a more important role than before. Chocolate silicite from central Poland occurs for the first time. The extensive raw material networks present highly exotic and high-quality raw materials such as nephrite and jadeitite, documented in the early phase of MPWC (*Vokáč 2008*). Beginning from phase Ic, and during phase II of MPWC, raw material supply is characterized by the prevailing

Lab. Number	Site	Culture/ Phase	^{14}C–Age [BP±STD]	CalAge p(95%) calBC	CalAge p(68%) calBC	Reference
Bln–57	Žopy	LBK Ia	6430±100	5580–5220	5400±90	*Felber, Ruttkay 1983*
Poz–21786	Spytihněv	LBK Ia	6340±40	5420–5220	5320±50	*Schenk, Kuča, Škrdla, Roszková 2008*
1272	Těšetice	LBK II	6150±35	5260–4980	5120±70	*Kazdová, Dočkalová in print*
1275	Těšetice	LBK II	6210±35	5300–5020	5160±70	*Kazdová, Dočkalová in print*
1276	Těšetice	LBK II	6210±35	5300–5020	5160±70	*Kazdová, Dočkalová in print*
VERA–4591	Těšetice	LBK II	6225±35	5350–5030	5190±80	*Kazdová, Dočkalová in print*
VERA–4590	Těšetice	LBK II	6210±35	5300–5020	5160±70	*Kazdová, Dočkalová in print*
Poz–22715	Těšetice	LBK II	6200±30	5270–5030	5150±60	*Kazdová, Dočkalová in print*
Těšetice	Těšetice	MPWC Ia	5450±90	4490–4050	4270±110	*Podborský 1975/76*
Těšetice	Těšetice	MPWC Ia	5800±60	4790–4510	4650±70	*Podborský 1975/76*
GrA–34102	Šebkovice	MPWC Ib	5845±45	4850–4570	4710±70	*Kuča, Vokáč, Nývltová Fišáková 2009*
Poz–22398	Březník	MPWC Ib	5780±40	4750–4510	4630±60	*Kuča, Nývltová Fišáková, Škrdla, Vokáč in print*
Poz–22525	Pavlov	MPWC Ic	5780±35	4730–4530	4630±50	*Kuča in preparation*
GrA–34088	Mokrá	MPWC Ic	5640±45	4590–4350	4470±60	*Kuča 2008a*
VERA–760	Mokrá-lom	MPWC Ic	5645±35	4560–4400	4480±40	*Šebela, Kuča 2004*
Bln–2067	Jezeřany-Maršovice	MPWC Ic	5325±50	4320–4000	4160±80	*Rakovský 1985*
GrA–34089	Dluhonice	MPWC IIa	5675±45	4620–4420	4520±50	*Kuča in preparation*
Bln–2068	Jezeřany-Maršovice	MPWC IIc	5040±50	4010–3690	3850±80	*Košťuřík, Rakovský, Peške, Přichystal, Salaš, Svoboda 1984*
Bln–2142	Jezeřany-Maršovice	MPWC IIc	5120±50	4040–3760	3900±70	*Košťuřík, Rakovský, Peške, Přichystal, Salaš, Svoboda 1984*
Bln–2424	Brno-Bystrc	MPWC Ic	5570±60	4520–4320	4420±50	*Rakovský 1985*
Vera–2596	Brno-Ivanovice (Globus)	LBK I	6545±40	5570–5450	5510±30	*Stadler et al. 2000*

Tab. 1. List of available radiometric dates from Moravia, calibrated using CaPal, ver. 07.

use of local raw materials. Extra-regional contacts are limited and can be demonstrated only along the main communication corridors which played a more important role (imports of obsidian or Kraków-Czestochova Jurassic silicite). However, 'prestigious' imports of high quality raw materials from more distant areas (chocolate silicite, jadeitite, nephrite) are also occasionally present, but the tools made from these materials may have had a symbolic or prestigious function and consequently may not reflect regular raw material networks.

We can conclude that Moravia, rich in local raw materials derived from its complicated geological structure, was an important communication corridor (and also a node at the junction of several corridors) not only during the Neolithic, and this is reflected in the diverse and extensive raw material networks.

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