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## 5. STONE RAW MATERIAL USED BY THE EARLY FARMING COMMUNITIES OF MORAVIA AND LOWER AUSTRIA AND ITS PROVENANCE

In this work I, try to apply only petrologically correct terms; the terms commonly used in archaeological literature are quoted in parentheses. I intentionally avoid the term “flint” as a general designation of stone raw materials used in chipped stone industry. According to A. Přichystal, and in line with the majority of American, English and Czech sedimentary petrologists, “flint” is only a variety of chert which occurs commonly in form of nodules, but also forms layers in the Cretaceous chalk of southern England and western and central Europe (Fairbridge & Bourgeois 1978, 120; Allaby & Allaby 1991, 141; Přichystal 1997b, 351). All varieties of siliceous rocks originating in limestones of various ages are subsequently called cherts.

The raw materials (**map 4**) have been divided into five basic groups (Přichystal 1991; 1994, 43; 1997b, 354):

**5.1. Silicites** (synonymous with *siliceous rocks, siliceous sediments*) – very fine-grained non-clastic sedimentary rocks rich in SiO<sub>2</sub>, originating through chemical, biochemical or diagenetical precipitation. This group comprises all types of cherts, including flint, radiolarite, lydite and spongolite, as well as freshwater limnosilicites and hydrosilicites.

**5.2. SiO<sub>2</sub> minerals** – these are the result of magmatic or hydrothermal processes, or of the weathering of certain rocks. In contrast to silicites, they contain no fossils, but some silicate minerals (chlorites, micas, tourmalines, amphiboles, biotites) may be present (Přichystal 1999, 29). This group includes quartz, rock crystal, chalcedony and their varieties (agate, smoky quartz, citrine), siliceous weathering products of serpentinites and jasper.

**5.3. Natural glasses** – this group includes volcanic glasses, created by the rapid solidifying of lava flowing across the Earth's surface (Bouška & Kouřimský

1979, 35), as well as other natural glasses (fulgurites, impact glass and tektites). The most popular natural glass in prehistoric times was obsidian.

**5.4. Clastic silicic rocks** – this group includes non-metamorphic sediments predominantly composed of quartzose grains or chert fragments, which were again cemented by SiO<sub>2</sub> (e.g. quartzites, chert breccias; Přichystal 1999, 30);

**5.5. Other rocks** (e.g. porcelainites, silicified woods)

### 5.1. Silicites

**5.1.1. Krumlovský Les chert** (abbreviated to *KL*; synonymous with Moravský Krumlov chert; Cz. *rohovec typu Krumlovský Les*)

This was the most important local raw material in southern Moravia throughout the whole stone age and was also used in later periods (Oliva 1997).

The greatest concentrations of this chert occur in the Miocene sandy gravel on the south-eastern slopes of the Krumlovský Les upland (Cz. *Krumlovský Les* abbreviated to *KL*), in the Brno-Country (Brno-venkov) and Znojmo districts. The Krumlovský Les upland lies some 19–28 km south-west of Brno and geographically is part of the Bobrava Highlands, which form an extended, wooded ridge running north-south. Geologically, the Krumlovský Les upland lies at the eastern edge of the Bohemian Massif, at the interface with the Carpathian Foredeep. At present, it reaches altitudes of up to around 400m.

The biggest concentration of this chert is linked to Ottnang sediments of Lower Miocene age and to the ‘Rzehaki’ layers (Cícha & Paulík 1963, 145).

Krumlovský Les cherts are relics of marine calciferous sediments of Jurassic and perhaps Cretaceous

age, which originally covered the greater part of the Bohemian Massif. At the end of the Cretaceous, the sea receded and intensive weathering of the sediments began. Chert concretions were released from their parent rock. In the early Tertiary, there was intensive weathering in an arid climate, which left a 'black desert varnish' on the surface of the cherts. In the Ottnang, these were flushed into foreshore sediments that were broken on the rocky coast of the massif, surfaces being systematically affected by marine surf (Přichystal 1984, 207; 1997b, 353; Škoda 1986, 6, 72).

Attention was first paid to chert from the Krumlovský Les upland region in the 1970s (Valoch 1975a). Just a few years later it was termed Moravský Krumlov chert (Lech 1981, 12). Its current name and a detailed description are owed to A. Přichystal, who divided it into two varieties on the basis of the quality, or rather granularity, of the silicite mass (1984, 208).

Krumlovský Les I chert (KL I) is a chert of coarse-grained, silicite structure, which occurs in the form of perfect pebbles to semi-rounded fragments. A black coating is characteristic of all forms. It ranges from several millimetres thick to an inconspicuous black varnish. The pebble surface is covered with a large number of nail-shaped indentations. The silicite mass is grey predominantly a bluish to purplish grey, sometimes with a ruddy tint. There is often an alternation of more and less translucent, irregularly defined parts.

The fine-grained variety known as Krumlovský Les II chert (KL II) occurs in the same forms as type I, but fragments are more frequent. The black coating is, however, very thin. The colour of the silicite mass ranges from grey to pure brown. In the majority of samples, large, rounded, non-homogeneous inclusions can be observed. These are formed of differentially silicified masses, particularly quartz, and are sometimes referred to as 'petrosilexes' in the archaeological literature.

Under the microscope: Under the microscope, KL I chert (**fig. 1: 1**) is characterised by whitish-grey, cloud-like turbidity changing to streaky formations containing large numbers of microfossils. These alternate with pellucid parts that have a bluer tint and are formed of chalcedony. In the pellucid parts, individual microfossils are clearly distinguishable; they are mainly sponge spiculas (*Porifera*), which form complex structures in the coarse-grained variety (Přichystal 1984, 208; Mateiciucová 1992, 15; Oliva, Neruda & Přichystal 1999, 237).

KL II chert (**fig. 1: 2**) generally has a brownish background under the microscope. Again, whitish-grey to beige cloudy or granular turbidity occurs, but not in such concentrations as in the first type. Sponge spiculas generally have only a simple shape, and do

not occur in such quantities as in the KL I variety (Přichystal 1984, 208; Mateiciucová 1992, 16).

In 1997, the Krumlovský Les III variety was distinguished on the basis of studies at the Upper Palaeolithic station of Alberndorf in Lower Austria (Přichystal 1997a). This is a fine-grained chert with dark grey silicite mass often containing macroscopically visible, lighter fossil fragments.

The outcrops of Krumlovský Les III chert have not yet been found. It appears only rarely in the Krumlovský Les area itself. As KL III variety we can designate cherts occurring above all in the Brno Basin, although they are rare even here. Because of the processing characteristics observed at the Upper Palaeolithic site in Alberndorf, I personally think that the original sources of this variety lie in Lower Austria and it is possible that the gravels in which the raw material had been found are now exhausted (Bachner, Mateiciucová & Trnka 1996).

Munsell colour: *KL I* – medium light grey N6, medium grey N5, light grey N7, greyish blue 5 PB 5/2, pale purple 5P 6/2, pale red purple 5RP 6/2.

*KL II* – light brownish grey 5YR 6/1, pale yellowish brown 10YR 6/2, light olive grey 5Y 6/1.

*KL III* – dark grey N3, medium dark grey N4, medium grey N5.

Possible confusions: KL II chert may be difficult to distinguish from erratic silicites or Krakow Jurassic silicites.

Usage: both the KL I and the KL II varieties were used throughout prehistory. At Mesolithic sites and sites of the Stroke-Ornamented Ware and early Austrian/Moravian Painted Ware cultures the KL II variety is more common, while the KL I variety was used more often at LBK sites.

Evidence of extraction: in the late phase of the Moravian Painted Ware culture (on the basis of ceramic finds), the Early Bronze Age (dated by ceramics, disc cores; Oliva 1999, 8, 66; Oliva, Neruda & Přichystal 1999, 271, 287–289).

### **5.1.2. Moravian Jurassic chert (abbreviated to MJC; Cz. moravské jurské rohovce)**

'Moravian Jurassic chert' is a term used to describe chert from denudation relicts of Jurassic limestone at the eastern edge of the Brno Basin, e.g. from Stránská skála, Bílá hora, Švédské šance and Hádý. Geologically, it belongs to the lower stage of the Upper Jurassic – the Oxfordian.

### 5.1.2.1. *Stránská skála chert* (Cz. *rohovec typu Stránská skála*)

This term is applied to a grey-to-beige chert with alternating dark grey and whitish-grey stripes 1–2mm thick. It occurs in the upper layers of the eponymous site. Cherts of a bluish hue or with reddish-brown and yellow shades have also been found. The stripes are most visible beneath the cortex of the chert, trailing off towards the middle.

The lower layers contain unstriped grey to bluish grey cherts also known from other Jurassic relicts.

The cherts occur in the form of globular to round concretions with conspicuous, unequally coarse, rough white cortex 0.5 to 1cm thick. There is no clear border between the cortex and the silicite mass. The size of the concretions does not exceed 10–15cm (Přichystal 1987, 28; 1991, 74; 1997b, 352; 1999, 27–28).

Cherts with a black surface, similar in appearance to chert from the Krumlovský Les upland, are known from the eastern periphery of the Brno Basin, e.g. from beneath Hády. Their surface is highly broken, and it does not seem to attain so high a quality as the Krumlovský Les cherts (according to A. Přichystal, this is a Krumlovský Les III chert).

Under the microscope: Moravian Jurassic cherts contain relatively few well preserved microfossils. A mosaic structure is a common phenomenon in the silicite mass, with a more translucent grey alternating with whiter parts. By contrast, Krumlovský Les cherts are far richer in microfossils, particularly sponge spiculae, which may indicate that they are rather of Cretaceous age.

For *Stránská skála* chert, the occurrence of *Crinoidae* (sea-lily) fragments is characteristic, these being identifiable only by their eyes, which appear as small round or oval white inclusions (**fig. 1: 3**). Sponge spiculae are not nearly as common as in Krumlovský Les chert.

Munsell colour: medium light grey N6, medium grey N5, light grey N7, light olive grey 5Y 6/1, yellowish grey 5Y 7/2, light brownish grey 10YR 6/1.

Possible confusions: Krumlovský Les cherts, erratic silicites.

Usage: *Stránská skála* chert was used in particular during the Palaeolithic and in the Eneolithic (Moravian Painted Ware II, Funnel Beaker cultures; Přichystal 1994, 44; Svoboda 1995). It only appears very rarely on LBK sites.

Evidence of extraction: Funnel Beaker culture? (Svoboda 1995; Oliva 1999, 66).

### 5.1.2.2. *Olomučany chert* (Cz. *rohovec typu Olomučany*)

Other Moravian Jurassic cherts come from the central part of the Moravian Karst; in the Neolithic, the most important of these was Olomučany chert.

Olomučany chert forms strata up to 2m thick in Jurassic silicified limestone not far from Olomučany (Přichystal 1994, 44; 1999, 28). The silicite mass is dark grey to grainy greyish-black. The cortex is usually a rough, dirty white colour. The boundary between the cortex and the silicite mass is often poorly visible.

Under the microscope: At first sight, the colourfulness of this material is startling (**fig. 1: 4**). The greyish-brown and dark grey silicite mass is interrupted by white, lacy segments, which in places become light, translucent, cloudy masses. A red pigment appears regularly. Among the fossils there is a clear predominance of sponge spiculae (*Porifera*), although *Radiolaria* and *Foraminifera* are also present. Grass green silicate clay minerals – glauconites – are a characteristic feature of Olomučany chert, concentrating less on the dark and more on the edge of the light, poorly silicified mass. In weathered pieces, small yellow to brown lumps – limonites – are visible.

Munsell colour: brownish grey 5YR 4/1, olive grey 5Y 4/1, dark grey N3, greyish black N2, dark yellowish brown 10YR 4/2.

Possible confusions: dark grey varieties of chocolate silicites

Usage: Olomučany chert was used at Upper Palaeolithic stations in the Moravian Karst (Přichystal 1994, 44). During the Mesolithic, it appears in small quantities at most stations in south Moravia (Hudec 1996; Mateiciucová 2001a, 286–287). In the LBK and Stroke-Ornamented Ware cultures, it was used at sites up to 15 km from its primary source (Čižmář 1995; Oliva 1996, 103; Kazdová, Peška & Mateiciucová 1999, 143–144; Mateiciucová 2000, 229). In the Moravian Painted Ware culture, it is replaced by other cherts even in settlements close to its sources (e.g. *Stránská skála* chert).

**Evidence of extraction:** Given the volume of the good quality raw material used at LBK sites, extraction may be presumed<sup>4</sup>.

**5.1.3. Erratic silicites** (synonymous with *Baltic erratic flint*, *Nordic flint*, *erratic flint*; Cz. *silicity z glacienních sedimentů eratické silicity*, abbreviated to SGS, Pol.: *krzemień narzutowy baltycki*; Ger.: *baltischer Feuerstein*)

These are Cretaceous and Early Tertiary silicites from the western shores of the Baltic Sea, from where they were moved south by the continental glacier. Their limit is defined by the glacial extent in the Holstein and Saale areas (Mindel and Riss; Ginter & Kozłowski 1990, 28).

Erratic silicites are a source that covers an extensive area. Within the Czech Republic, they occur in glaciogenic, glaciolacustrine and glaciofluvial sediments in north Moravia, Silesia and northern Bohemia. The most southerly glacier extended as far as about 10 km north of the town of Hranice na Moravě in the Moravian Gate. As it melted, erratic silicites exceptionally travelled even further south with the meltwater, as far as the rivers Bečva and Morava (Gába 1988, 86–87).

Flints, as these silicites are called, form only a small part of this group. Z. Gába (1977) divided the erratic silicites occurring in Moravia into two basic types. The predominant type comes from Bryozoan limestone of Danian (early Tertiary) age; it has a generally flat shape and a silicite mass that is brownish-grey to grey in colour. It contains opaque light grey to whitish inclusions up to a centimetre in diameter and numerous fossils, especially of *Bryozoa*. The second type is flint of Maastrichtian (Cretaceous) age originating from Cretaceous chalk of the Baltic coast; it occurs in the form of jagged concretions with hollows filled with a white substance containing fragments of sponge spiculas and *Foraminifera* tests. The colour of the silicite mass is dark grey to black (Přichystal 1991, 72).

An erratic origin is recognisable at first sight by the glossy, very smooth surface that stems from the long transport from the Baltic, during which most of the original cortex was completely stripped away.

**Under the microscope:** Silicites of Danian age are marked by a large quantity of microfossils, in particular of *Bryozoa* (fig. 1: 5), which are often visible to the naked eye. Beneath the microscope, they take the

form of perforated plaques or tubes, depending on the section observed. In addition to *Bryozoa*, sponges and *Foraminifera* tests commonly appear (Přichystal 1994, 43).

Maastrichtian flints (fig. 1: 6) contain far fewer microfossils than silicites of Danian age; most often these are *Foraminifera*, sponges (*Porifera*), hystrichospheres and coccoliths (Přichystal 1994, 43–44).

**Munsell colour:** *silicites of Danian age* – pale yellowish brown 10YR 6/2 to dark yellowish brown 10YR/4/2. *Maastrichtian flints* – dark grey N3 to greish black N2.

**Possible confusions:** Krumlovský Les II cherts, Krakow Jurassic silicites, limnosilicites, Volhynian silicites.

**Usage:** throughout prehistory. At most LBK sites in north Moravia, there was a preference for Krakow Jurassic silicites.

**5.1.4. Krakow Jurassic silicites** (synonymous with *the Krakow Jurassic flint*; Cz. *silicit krakovské jury*, *silicit krakovsko-čenstochovské jury*, abbreviated to SKJ or SKČJ; Pol. *krzemień jurajski podkrakowski*; Ger. *Krakauer Jura-Feuerstein*)

The primary source lies in the Upper Jurassic limestone sediments of the southern part of the Krakow-Czestochowa highlands. There are secondary occurrences in Cretaceous conglomerates and clays, as well as in glaciofluvial and alluvial sediments (Lech 1981, Tab. 1, 18–26; Přichystal 1985, 481).

These silicites occur in large concretions, which were particularly well-suited to the production of Eneolithic chipped stone artefacts.

Krakow Jurassic silicites have been described by M. Kaczanowska and J. K. Kozłowski (1976) and by J. Lech (1980a). Kaczanowska and J. K. Kozłowski distinguish seven varieties, of which the reddish brown type A in particular is known from the Czech Republic – it is typical of the LBK settlement at Olszanica in Little Poland. In Moravia, the Neolithic also saw the importation of the greyish-brown variety, typical of an extraction area at Sąspów (Dzieduszycka-Machnikowa & Lech 1976; Lech 1981). The division of Krakow Jurassic silicites into varieties has been sharply criticised in detail (Morawski 1976).

The surface of the concretion is formed by a rough, greyish-white to beige cortex, which is not divided from the silicite mass by a clear boundary.

**Under the microscope:** a red pigmentation (compounds of Fe<sup>+III</sup>), evenly spread through the silicite mass, is characteristic of Krakow Jurassic silicites (fig. 1: 7).

<sup>4</sup> In 2003 and 2004 some depressions were detected near Olomučany. They contained a huge amount of chipped stone industry of workshop character and have been preliminarily interpreted as prehistoric mining pits (Přichystal & Přichystal 2005).

Microfossils are larger and relatively few in number; these are *Crinoidea* (sea-lily) fragments and other fossils that, if seen under a binocular microscope, look like potato crisps (Přichystal, pers. comm.).

Munsell colour: greyish brown 5YR 3/2, dark yellowish brown 10YR 4/2, moderate brown 5YR 4/4, brownish grey 5YR 4/1, dark reddish brown 10R 3/4, pale brown 5YR 5/2.

Possible confusions: Krumlovský Les II cherts, erratic silicites, chocolate silicites, limnosilicites, Volynian silicites.

Usage: used throughout prehistory. Preferred over erratic silicites in the LBK of northern Moravia, eastern Bohemia and Silesia.

Evidence of extraction: Magdalenian? Late Palaeolithic? LBK? The Lengyel-Polgár complex (Lech 1980b; 1981; Oliva 1999, 67–68).

#### 5.1.5. *Chocolate silicites* (Cz. *čokoládový silicit*, Pol. *krzemień czekoladowy*; Ger. *Schokoladen-Feuerstein*)

Jurassic silicites are light brown, dark chocolate brown or dark grey-brown in colour, with a waxy gloss. The primary sources are in the Holy Cross hills (Góry Świątokrzyskie) of Poland, in the area stretching from Iłża via Wierzbica and Tomaszów to south-west of Orońsko. The material occurs in the form of concretions and plates. The cortex is dirty white, rough, and 0.5cm to several centimetres thick; it is conspicuously divided from the silicite mass. Beneath the cortex, the silicite mass has a darker shade. R. Schild has divided the coloured varieties into 11 main groups (1976, 147–177). Macroscopically, the chocolate silicites differ from similar silicites in the granular cloudiness of the silicite mass, which is best observable against the light.

Munsell colour: dark yellowish brown 10YR 4/2, dusky yellowish brown 10YR 2/2, dusky brown 5YR 2/2, brownish black 5YR 2/1, greyish brown 5YR 3/2, pale brown 5YR 5/2.

Possible confusions: Krakow Jurassic silicites, brown varieties of erratic silicites, Transdanubian radiolarites (of the Úrkút-Eplény and Hárskút types), dark varieties of limnosilicites, Olomučany chert.

Usage: throughout prehistory. In Moravia in the Mesolithic and Austrian/Moravian Painted Ware I.

Evidence of extraction: Orońsko II (Radom district, Poland) – Late Palaeolithic?; Tomaszów I (Radom district) – Mesolithic (Janisławice culture), Neolithic (LBK? Lengyel culture) to Middle Bronze Age (Trziniec culture); Wierzbica-Zele (Radom district) – Bronze Age, Urnfield period, La Tène?; Polany Kolonie II (Radom district) – Eneolithic (Corded Ware?) to Early Bronze Age (Mierzanowice culture); Polany II (Radom district) – Early Bronze Age (Mierzanowice culture). Sources: Schild 1980; 1995a; 1995b; Schild, Królik & Marczak 1985; Herbich & Lech 1995; Lech & Lech 1995; Oliva 1999, 17–23, 67.

#### 5.1.6. *Spotted Świeciechów silicite* (synonymous with *grey white-spotted chert*; Cz. *świeciechowski silicit*, *puntikovaný rohovec*; Pol. *krzemień świeciechowski*, *krzemień szary-biało nakrapiany*)

The primary source is in Poland in the Holy Cross hills (Góry Świątokrzyskie), on the middle course of the Vistula to the south-east of the chocolate silicite sources. This is a Cretaceous (Turonian) silicite, grey to dark grey in colour, with white spots formed of calcite or chalcedony. It occurs in the form of flat nodules up to 50 x 20cm in size (Samsonowicz 1925; Balcer 1976, 179–186; Oliva 1999, 29–30, 67).

Munsell colour: light olive grey 5Y 6/1, olive grey, 5Y 4/1, medium light grey N6, medium grey N5, medium dark grey N4, dark grey N3.

Possible confusions: theoretically confusable with flints from western Europe (the Maas Basin), Rijckholt flint (*Rijckholt Feuerstein*) and Valkenburg flint (*Valkenburg Feuerstein*).

Usage: throughout prehistory.

Evidence of extraction: Świeciechów-Lasek (Tarnobrzeg district, Poland) – Eneolithic (Funnel Beaker culture?), Bronze Age? (Balcer 1971; 1975, 149–157; Lech 1983b, 117; Oliva 1999, 29–30, 67)

#### 5.1.7. *Radiolarites*

These are brownish red, brown, orange-brown, yellow, green, grey and black silicites comprising more than 50 % *Radiolaria* tests. The *Radiolaria* are in various stages of preservation, from the perfectly preserved to the hardly discernible phantoms, recognisable only because they contain no pigment. The *Radiolaria* are generally filled with chalcedony, but occasionally may be formed of calcite or chlorite. The basic mass is

most commonly coloured by brownish-red haematite or green chlorite. Admixtures of silty, clastic quartz, muscovite, biotite, rutile and tourmaline also occur (Mišík 1969, 125–126). Radiolarites appear in stratified, thick beds or in the form of concretions.

#### 5.1.7.1. Slovakian and Polish radiolarites

These are tied to the Carpathian Jurassic (Callow/Oxford) limestones of the Carpathian Flysch belt in Slovakia and Poland (Pieniny). For Moravian sites, provenance is considered to be in the north-eastern part of the Vlára Pass – the Chmelová elevation (925 m a.s.l.) near Vršatské Podhradie (4 km from the Moravian, i.e. Czech, border), where there is also evidence for pit mining (Bolešov and Pruské, Povážská Bystrica district, Slovakia). Radiolarites were secondarily moved into the fluvial sediments of the Váh (Přichystal 1994, 46; Cheben *et al.* 1995; Oliva 1999, 11).

Slovak and Polish radiolarites are most often brownish-red to reddish-brown in colour. Green, greyish yellow-green, dark yellowish-brown, yellow and almost black (Vlára, Pieniny) shades also occur. All of the tints have a mainly brown cast. The raw material is often shot through with white and green veins of quartz, chalcedony or carbonates. The cortex is a dirty whitish-green, sometimes ruddy, and penetrates fully into the silicite mass with no conspicuous boundary.

Munsell colour: dark reddish brown 10R 3/4, dusky red, dusky red 5R 3/4, greyish red 10R 4/2, moderate brown 5YR 3/4, dark greenish grey 5GY 4/1 and 5G 4/1, olive grey 5Y 4/1, medium light grey N6, medium grey N5, dark yellowish orange 10YR 6/6, yellow 2.5Y 7/8 to 2.5Y 8/8.

Possible confusions: with radiolarites in general (fig. 1: 8), particularly those from Danubian gravels and the Tertiary gravels of south Moravia, with Mauer radiolarites and with Gerecse radiolarites.

Usage: Slovakian and Polish radiolarites were used throughout prehistory.

Evidence of extraction: Neolithic? Eneolithic? (Cheben *et al.* 1995; Oliva 1999, 66).

#### 5.1.7.2. South Moravian radiolarites

According to A. Přichystal, radiolarite pebbles also occur in the coarsely clastic Miocene sediments of the Carpathian Foredeep in south Moravia, between Troskoto-

vice, Novosedly and Mušov (Přichystal 1994, 46). These probably played only a minor role in prehistory.

#### 5.1.7.3. Mauer radiolarites

The source of these radiolarites lies in the weathered Jurassic limestone near Mauer, close to Vienna at the edge of the Vienna Woods at a location known as ‘Antonshöhe’ (356m a.s.l.). Another outcrop is known in the vicinity of Mauer in Gießhübl (P. Stadler, pers. comm.).

Dark ruddy violet to red shades, shot through with chalcedony, quartz or carbonate veins, are characteristic. Greyish-green to greyish yellow-green and brownish-yellow shades also occur. Unlike the brownish-yellow varieties of Hungarian radiolarite from the Bakony mountains, which in most cases have an orange or rosy pastel tinge, the red varieties of Mauer radiolarite are more violet. At the same time, the brown and yellow varieties may have not only a grey tinge, but also an unclear violet tint. The coloration of the silicite mass reaches as far as the dirty white, rugged cortex.

Under the microscope: *Radiolaria* are for the most part highly visible (fig. 2: 1). They are larger than the *Radiolaria* of Bakony radiolarites and are filled with bluish-violet chalcedony or translucent micro-crystalline quartz, occurring in relatively large quantities. Very occasionally, black (Mn-compound) and green (chlorite?) pigments and white (calcite) spots appear.

Munsell colour: dusky red 5R 3/4, very dark red 5R 2/6, dark reddish brown 10R 3/4, olive grey 5Y 3/2 and 5Y 4/1, light olive grey 5Y 5/2, medium grey N5, medium dark grey N4, dark greenish grey 5GY 4/1 and 5G 4/1.

Possible confusions: with radiolarites in general, particularly Slovakian and Polish radiolarites and Gerecse radiolarites.

Usage: Mauer radiolarites were used throughout prehistory (particularly in the Upper Palaeolithic, the Neolithic and the Eneolithic).

Evidence of extraction: Eneolithic (Austrian/Moravian Painted Ware; Kirnbauer 1958; Ruttkay 1970; 1980)

#### 5.1.7.4. Szentgál, Hárskút and Űrkút-Eplény radiolarites (synonymous with Transdanubian radiolarites, Bakony radiolarites)

The primary sources lie in the Jurassic limestone Bakony mountains north of Lake Balaton in north-

-western Hungary. These radiolarites are characterised by fine granularity, pastel colours and creamy white to whitish-yellow parts of the silicite mass, and in particular by the way it extends to just below the cortex. These white to whitish-yellow parts contain no pigment and are referred to by Hungarian scholars as 'porcelainites' (Biró & Dobosi 1991).

Under the microscope: The *Radiolaria* are small and inconspicuous, as if dissolved. A black pigment (Mn-compound) often appears in the Szentgál and Úrkút-Eplény radiolarites (fig. 2: 2).

#### *Szentgál radiolarite*

An orange-brown to orange-red coloration with pastel shades is typical. Rosy brown tints are also known.

#### *Úrkút-Eplény radiolarite*

Yellowish-brown, mustard to caramel pastel shades are characteristic, with pink or orange tints. Both in the silicite mass and in the cortex, a black pigment (Mn-compound) is visible to the naked eye.

#### *Hárskút radiolarite*

A brown to dark brown, sometimes brownish-grey radiolarite with pastel orange or rosy tints. No black pigment is visible.

Munsell colour: *Szentgál radiolarite* – moderate reddish brown 10R 4/6, dark reddish brown 10R 3/4, moderate red 5R 4/6.

*Úrkút-Eplény radiolarite* – dark yellowish orange 10YR 6/6, light olive brown 5Y 5/6.

*Hárskút radiolarite* – moderate brown 5YR 3/4 to 4/4, pale reddish brown 10R 5/4, dusky brown 5YR 2/2.

Possible confusions: with radiolarites in general, with Gerecse radiolarite and with several light varieties of chocolate silicite.

Usage: used throughout prehistory (Biró 1998, 35–36).

Evidence of extraction: Neolithic? Eneolithic? (Lengyel culture: Biró & Regenye 1991; Bacskay 1995; Biró 1995).

#### **5.1.8. Spongolites** (synonymous with *Cretaceous spongolite chert*; Cz. *spongolity* or *křídové spongiové rohovce*)

The primary sources lie in Moravia in the northern part of the Boskovice furrow, which forms the eastern part of the Bohemian Cretaceous Basin, in an

area roughly delimited by Bořitov, Boskovice, Letovice and Kunštát. The cherts form strata in the denudation relicts of sandstone and sandy conglomerates of Lower Turonian age. They are light grey, bluish-grey or honey coloured. Groups of sponge spiculas (*Spongolia*) may form lighter bands in the silicite mass. Spongolites secondarily reached the gravel terraces of the Svitava and occasionally the Svratka.

Cretaceous spongolites have also been found in the Tertiary gravels on the Culmian sediments of the Maleník block (between Lipník and Hranice na Moravě) and in gravels on the palaeogene rocks of the Kelčská pahorkatina hills (Přichystal 1994, 45; 1999, 28).

Under the microscope: full of sponge spiculas (fig. 2: 3).

Munsell colour: medium light grey N6, medium grey N5, light grey 2.5Y 7/2 to pale yellow 2.5Y 7/3, light brownish grey 2.5Y 6/2, moderate yellowish brown 10YR 5/4, pale yellowish brown 10YR 6/2, dark yellowish orange 10YR 6/6 to 7/6.

Possible confusions: with several varieties of Krumlovský Les chert.

Usage: primarily in the Palaeolithic and Mesolithic, occasionally in the Moravian Painted Ware culture.

#### **5.1.9. Limnosilicites** (synonymous with *limnoquartzites*, *limnic quartzite*)

This raw material is generally described as limno-quartzite, but this is a misleading term, as it has nothing to do with either metaquartzite (metamorphic rock) or orthoquartzite (clastic sedimentary rock). Limnosilicites originated in still, fresh water; therefore it is imperative to use this denomination (Přichystal 2004, 11). The primary sources are in the neo-volcanic region of the Žiar Basin in central Slovakia, while there are secondary occurrences in the gravels of the lower Hron. Other rich primary sources are known from the eastern slopes of the Slánské vrchy upland in south-east Slovakia, as well as from north-eastern Hungary – the Tokay mountains, the Mád mountains, the Bükk mountains and the Mátra mountains. The majority occur together with hydrosilicites (synonymous with hydroquartzites), which originated in flowing fresh water (Mišík 1975, 94; Kaminská 1991, 19–20, Obr. 5; Biró 1998, 34–35).

Slovakian limnosilicites are most often white, brown or grey to black in colour. Limnosilicites from the Tokay mountains are generally white, beige, light brown or honey to dark brown in colour. By contrast,

limnosilicites from the Mátra mountains appear more homogenous, with red and purple shades predominating (Biró & Dobosi 1991; Biró *et al.* 2000).

Under the microscope: Characteristically, the material shows fragments of vascular plant tissue, mainly grasses, with easily visible cellular structure, embedded in a fine-grained chalcedony or micro-crystalline quartz (**fig. 2: 4**). Fibrous chalcedony makes a smaller contribution, filling cavities within which thin layers of alternating coloured tones are visible. Pollen is also plentiful. Rutile (edisonite) commonly occurs as a pigment (most often in the form of brownish-red spikes), as do anatase (cubic to rhombic), calcite and siderite (Mišík 1969, 122; 1975, 93–94).

Possible confusions: with hydrosilicites (originating in flowing fresh water), siliceous weathering products of serpentinites, jaspers, erratic silicites.

Munsell colour: *slovakian limnosilicites* – pale blue 5PB 7/2, very light grey N8 to medium light grey N6, yellowish grey 5Y 8/1, moderate brown 5YR 4/4, light brown 5YR 5/6, pale yellowish brown 10YR 6/2, dark yellowish orange 10YR 6/6 to greyish orange 10YR 7/4, pale reddish brown 10R 5/4, light bluish grey 5B 7/1.

*Limnosilicites from the Tokay mountains* – greyish orange 10YR 7/4 to dark yellowish orange 5YR 5/6, pale brown 5YR 5/2, pinkish grey 5YR 8/1, moderate reddish orange 10R 6/6, medium grey N5.

*Limnosilicites from the Mátra mountains* – light red 5R 6/6 to very pale orange 10YR 8/2, moderate red 5R 4/6 to 5/4, moderate orange pink 10R 7/4, pale yellowish orange 10YR 8/6 to pale yellowish brown 10YR 6/2, greyish orange 10YR 7/4.

Usage: used throughout prehistory (Mišík 1969; Biró 1998, 34–35).

Evidence of extraction: Neolithic and Eneolithic (hydrosilicite in Miskolc-Avas; Siman 1995).

**5.1.10. Abensberg-Arnhofen striped tabular chert** (Kelheim district, Bavaria, Germany; synonymous with Bavarian Plattensilex, Bavarian striped tabular chert; Cz. *proužkované deskovité rohovce typu Abensberg-Arnhofen, bavorský Plattensilex, bavorský proužkovaný deskovitý rohovec*)

The primary sources lie in stratified, thick beds of Jurassic limestone (malm zeta 1+2). Light grey to grey fine-grained tabular cherts with white, light grey and light brown stripes are typical. Striped chert also oc-

curs in the form of irregular to globular nodules. The cortex is greyish-white and is conspicuously divided from the silicite mass (Binsteiner & Engelhardt 1987; Engelhardt & Binsteiner 1988; de Grooth 1994).

Possible confusions: some of the patinated erratic silicites, other cherts from the middle Danube.

Munsell colour: very light grey N8 to dark grey N3, light olive grey 6/1, moderate olive brown 5Y 4/4, light olive grey 5Y 5/2, grey 10YR 6/1.

Usage: used throughout prehistory – in the Upper Palaeolithic (Magdalenian), the Mesolithic, the Neolithic and the Eneolithic (Binsteiner 1992; de Grooth 1994; Zimmermann 1995, 40–41).

Evidence of extraction: Neolithic (LBK, Oberlauterbach group; de Grooth 1994, 398; Binsteiner 2002).

**5.1.11. Banat silicite** (synonymous with Banat flint, Balkan flint)

A light brown, beige orange to honey coloured silicite with white to yellowish spots and a waxy gloss. The primary sources are not yet precisely known, but on the basis of concentrations it is assumed that they lie either in the western Banat or the Banat region in Romania (the 'pre-Balkan plateau'; Kaczanowska, Kozłowski & Makkay 1981, 107; Biró, Dobosi & Schléder 2000, 118).

Munsell colour: moderate yellowish brown 10YR 5/4 to dark yellowish orange 10YR 7/4.

Usage: in the Mesolithic, the Early Balkan Neolithic (the Starčevo-Körös-Criș complex) and the Eneolithic (Kaczanowska, Kozłowski & Makkay 1981; Kozłowski & Kozłowski 1984; Bacskay & Siman 1987; Starnini 1994; Biró 1998; Starnini & Szakmány 1998).

## 5.2. SiO<sub>2</sub> minerals

**5.2.1. Siliceous weathering products of serpentinites** (*abbreviated to SWPS; synonymous with plasma, opal; Cz. křemičité zvětraliny hadců or křemičité zvětraliny serpentinitů, abbreviated in Czech to KZH*)

These originated during tropical weathering, probably in the Palaeogene, on west Moravian serpentinites and other metamorphites (Přichystal 1994, 47). The greatest concentrations are to be found in south-west Moravia near Jevišovice, Jiřice and Bojanovice. Other

sources are known in the Czech-Moravian highlands (near Třebíč) and south Bohemia (around Křemže near České Budějovice). They also occur in Waldviertel in Lower Austria, around Japons and in the gravels of the Kamp (Přichystal 1994, 47; 1997b, 353–354).

Siliceous weathering products of serpentinites are in fact microcrystalline quartzes or chalcedonies of green, brown or yellowish-brown colour with silicate minerals in their siliceous mass. Those from south-west Moravia form flat or irregularly oval concretions and feature a rugged to verruciform white cortex with a bluish to greenish tint, ranging from a few millimetres to several centimetres in thicknesses. The generally translucent, green to brownish or yellowish-green mass inside the concretion is divided in lobate fashion from the cortex. The colour of the raw material often changes from green to dark brown towards the middle of the concretion. Green varieties are termed plasma. At Japons in Lower Austria, brown, yellowish-brown to beige brown shades with an opalescent gloss occur. Dark red and purplish to violet varieties are not uncommon.

Siliceous weathering products of serpentinites have increased magnetic susceptibility, making them stand out from other siliceous raw materials; this serves as a useful identifying marker (Přichystal, pers. comm.).

Under the microscope: The remains of the trellis-like structure of serpentinite look like fine fractures under the microscope (**fig. 2: 5**). They contain no fossils or other organic structures. Relicts of silicate minerals are characteristic, while the worm-like arrangement of their biotites and green chlorite leaves in particular is striking (Přichystal 1991, 24).

Possible confusions: jasper, several varieties of hydrosilicite and limnosilicite.

Munsell colour: *Moravian SWPS* – very dark greyish brown 10YR 3/2, dusky yellowish brown 10YR 2/2, dark yellowish brown 10YR 4/2, dark yellowish orange 10YR 6/6, moderate yellowish brown 10YR 5/4, olive grey 5Y 3/2, greyish olive 10Y 4/2, greyish olive green 5GY 3/2.

*SWPS of Japons type* – light brown 5YR 5/6, dark yellowish orange 10YR 6/6, moderate brown 5YR 4/4, dark yellowish brown 10YR 4/2, pale yellowish orange 10YR 8/6, moderate yellowish brown 10YR 5/4, greyish brown 5YR 3/2, very dark red 5R 2/6.

Usage: Moravian SWPS were used in particular at the time of the Moravian Painted Ware culture (Kovárník 1992; 1994). In Lower Austria, the use of SWPS is known particularly from the Palaeolithic (Rosen-

burg) and Neolithic (LBK, Austrian/Moravian Painted Ware culture).

South Bohemian sources were used by local Mesolithic communities (Novák 1989).

Evidence of extraction: Jevišovice – Neolithic (Moravian Painted Ware culture)?, Eneolithic? (Oliva 1999, 10, 66).

### 5.2.2. Rock crystal

The major source of rock crystal in Moravia are the pegmatites of the Czech-Moravian highlands (around Kněžice and south-east of Žďár nad Sázavou; Přichystal 1999, 30). Rock crystal sources may be expected in the pegmatites of the north-western part of Lower Austria (Waldviertel).

Rock crystal was not obtained directly from pegmatites, but from deluviofluvial sediments from which a larger amount of rock crystal, transported only over short distances, could be recovered (Přichystal 1994, 47).

Usage: Rock crystal and its varieties (smoky quartz, citrine) were used in the Upper Palaeolithic (Aurignacian, Magdalenian), in the Mesolithic and the Neolithic (Moravian Painted Ware; Oliva 1990, 24; Přichystal 1999, 30).

### 5.2.3. Quartz

Quartz pebbles were probably collected from Pleistocene gravel terraces or Tertiary gravels.

Usage: Quartz was used in limited quantities throughout prehistory.

## 5.3. Natural glasses

### 5.3.1. Carpathian obsidian

Obsidian is a volcanic glass that originates during the rapid cooling of acidic (rhyolite) lava. The closest sources of obsidian are in the Zemplínské vrchy upland (syn. Zemplen mountains) of south-eastern Slovakia and their continuations in north-eastern Hungary (Tokay and Mád mountains). Obsidians have a shell-like fracture and glassy gloss. Neutron activation analysis can identify the provenance of individual artefacts, mainly on the basis of the presence of rare earth elements (Williams-Thorpe, Warren & Nandris 1984; Biró & Dobosi 1991; Přichystal 1994, 47).

### *Carpathian obsidians 1*

This term is used for obsidians from south-eastern Slovakia; they occur at Viničky, Bara, Velká Bara the Piliš elevation and Streda pod Bodrogom. They are transparent to translucent and have a dark grey to completely black colouration (Kaminská 1991, 19, fig. 5; Biró 1998, 33).

### *Carpathian obsidians 2*

Unlike the Slovak obsidians, these are opaque. Their sources concentrate at Tolcsva and between Erdöbénye and Mád. Around Tolcsva (*Carpathian obsidians 2T*) the obsidians are opaque, black and blackish-brown, while those from the Erdöbénye-Mád area (*Carpathian obsidians 2E*) are the well-known dark grey opaque obsidians with irregular zoning to striping, with alternating darker and lighter parts (Kaminská 1991, 22; Biró 1998, 33).

Possible confusions: with tachylite (from Kozákov in east Bohemia) and artificial slags. They can also be confused with Moldavites, the light to dark green tektites that occur in Moravia around Třebíč and in south Bohemia between Písek and Kaplice; evidence for the use of the latter in prehistory is, however, extremely sparse (Přichystal 1994, 47).

Munsell colour: *Carpathian obsidians 1* – black N1 to dark grey N5 (transparent pieces).

*Carpathian obsidians 2T* – black N1 to greyish black N2.

*Carpathian obsidians 2E* – greyish black N2 to dark grey N3.

Usage: Carpathian obsidians were used throughout prehistory.

Evidence of extraction: Direct evidence has not yet been found.

## 5.4. Clastic silicic rocks

### 5.4.1. North-west Bohemian quartzite (synonymous with ganister quartzite, quartz rock<sup>5</sup>)

Tertiary quartzites are secondarily silicified Tertiary sands that originated at a time of fluctuating tropical climate (periods of rain and drought) at no great depth from the surface, where there was oscillation of the groundwater. The actual quartz grains are bonded by a siliceous cement (SiO<sub>2</sub>). They occur in thick, stratified layers. In

<sup>5</sup> The term quartz rock is inappropriate in this case, as it is set aside for quartzite-rich metamorphic rocks (Přichystal 1994, 47).

the past they were widely used for industrial purposes (Malkovský & Vencel 1995; Přichystal 1997b).

#### 5.4.1.1. *Skršín quartzite* (synonymous with *Žatec quartzite*; Cz. *křemenec typu Skršín*)

The primary source of *Skršín quartzite* is on the hill known as 'Vrbka' north of Libčevce. Further sources occur at Dobřice, at the hill known as 'Tanečník' (lit. 'the dancer') near Sedlec and at Chatov (all in the Most district).

This is a fine-grained to dense quartzite of Eocene age, light grey to grey in colour with a yellowish tint; occasional lightly red tinted or pink to dark reddish-brown schliers and stains occur (Malkovský & Vencel 1995, 7).

Under the microscope: The quartz grains are smaller than 0.1mm and are unevenly distributed (**fig. 2: 6**). Admixtures of zircon are known, and more rarely pyroxenes, tourmalines, feldspars and finely dispersed rutile, which give a yellow colouration (Malkovský & Vencel 1995, 7). Very fine, crystallised silicic cement predominates over sharp-edged quartz fragments (Přichystal 1991, 25).

#### 5.4.1.2. *Bečov quartzite* (Cz. *křemenec typu Bečov*)

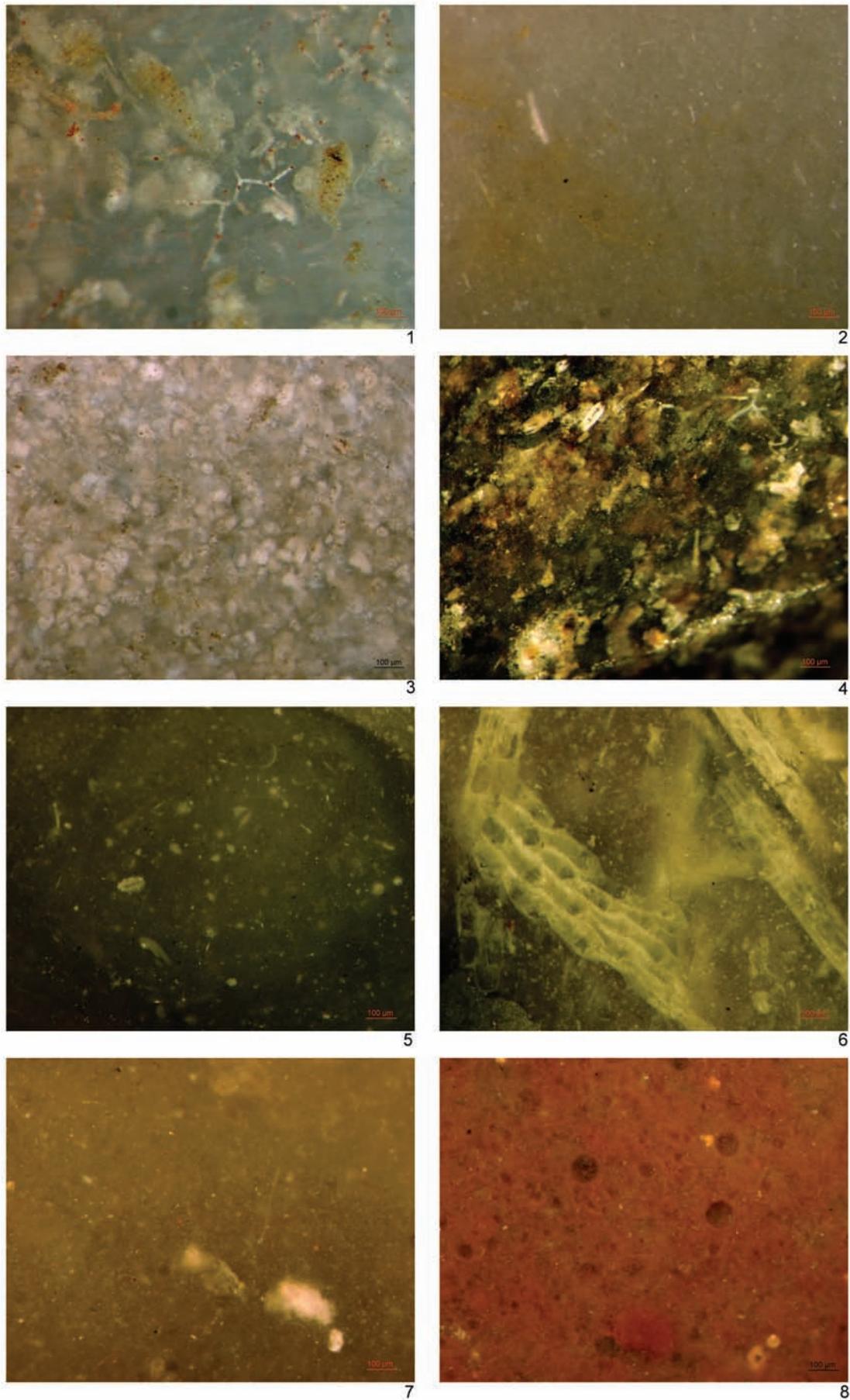
The primary sources of this quartzite are at the sites at 'Písečný vrch' (lit. 'sandy hill') and 'Verpánek', not far from Bečov (Most district). *Bečov quartzite* is remarkably glittering, as if covered in sugar. The mass is white to light grey, sometimes with a bluish-grey tinge. It is a fine- to medium-grained quartzite, formed mainly of quartz grains with chalcedony cement. It occurs in the form of concretions with a rugged cortex, either very thin or up to several centimetres thick (Malkovský & Vencel 1995, 15–16).

Under the microscope: The translucent crystals of silicic grains are linked by white kaolin cement (**fig. 2: 7**). In addition to quartz, grains of feldspar and mica occasionally appear (Malkovský & Vencel 1995, 16–17).

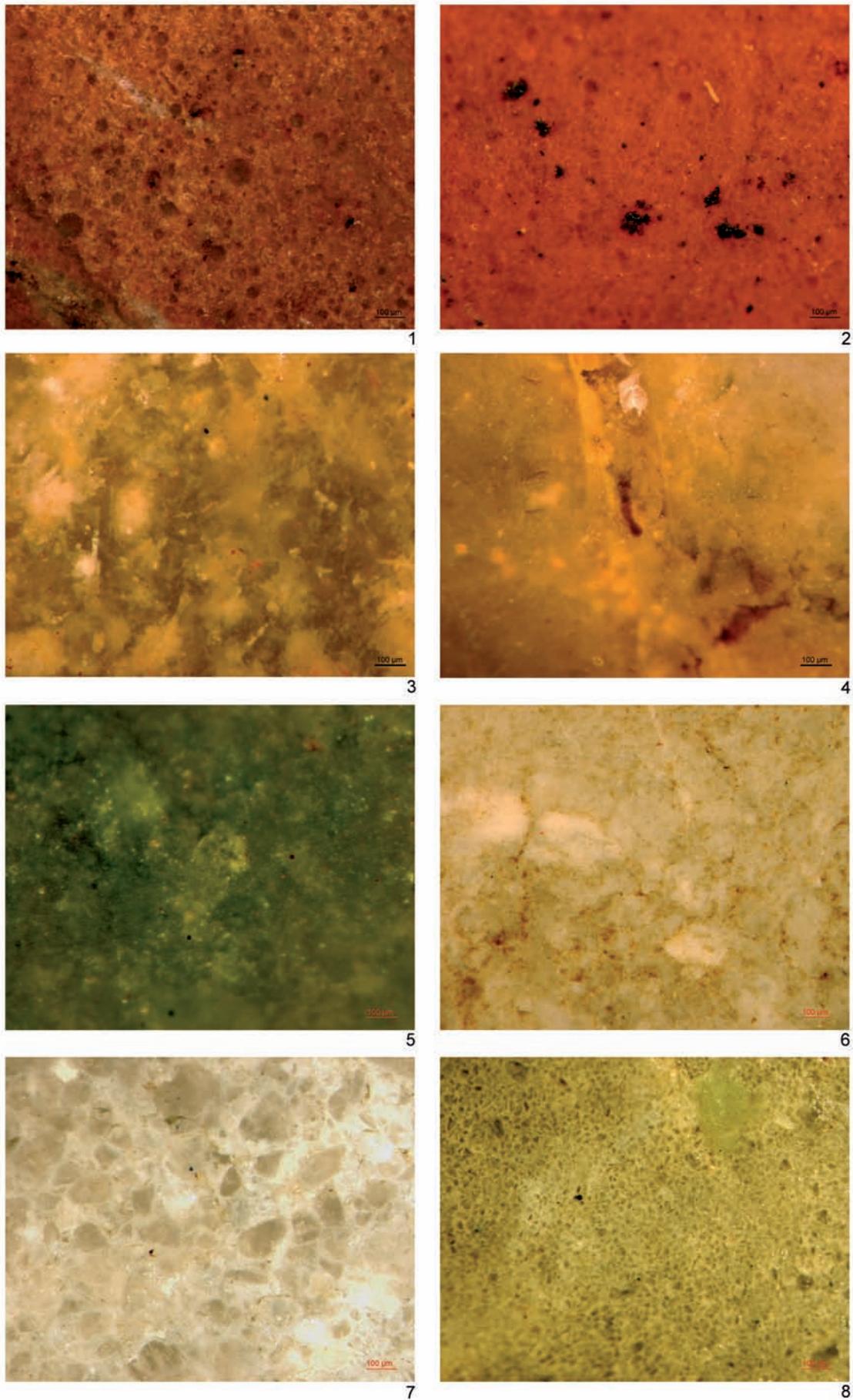
#### 5.4.1.3. *Tušimice quartzite* (Cz. *křemenec typu Tušimice*)

This quartzite occurs in the area east of Kadaň (Chomutov district), near the villages of Tušimice, Rokle and Krásný Dvůrček.

*Tušimice quartzite* occurs at depths of up to 4m in de-quartzified sandy surface chalks (Turonian), which



**Fig. 1.** Different raw materials in water immersion under a stereomicroscope: 1 – Krumlovský Les I chert, 2 – Krumlovský Les II chert, 3 – Stránská skála chert, 4 – Olomučany chert, 5 – Maastrichtian erratic flint from the Libhošťská Hůrka (Libhošť Hill) near Příbor, 6 – erratic silicite of Danian age from the Libhošťská Hůrka hill near Příbor, 7 – Krakow Jurassic silicite from Sęspów, 8 – radiolarite from the Vlára Pass (the Chmelová elevation – 925 m a.s.l.) near Vršatské Podhradie (Slovakia). Photo by I. Mateiciucová.



**Fig. 2.** Different raw materials in water immersion under a stereomicroscope: 1 – Mauer radiolarite, 2 – Szentgál radiolarite, 3 – spongolite from the surroundings of Bořitov, 4 – limnosilicite from the surroundings of Žiar nad Hronom (Slovakia), 5 – siliceous weathering product of serpentinites from Jevišovice, 6 – Skršín quartzite, 7 – Bečov quartzite, 8 – Tušimice quartzite. Photo by I. Mateiciucová

cover kaolinised gneisses with a crystalline structure and which are covered by Oligocene clays, silts and soils. The sandstones and quartzites are relatively rich in macrofauna.

Tušimice quartzites are finely glittering, fine-grained, compact quartzites, light grey or slightly brownish-grey to light yellowish-brown in colour. They sometimes contain white stains or thin layers of kaolin. They occur in tabular or nodular form (Malkovský & Vencel 1995, 12–15).

Under the microscope: Concentrations of transparent quartz crystals bonded by white cement can be observed (**fig. 2: 8**).

Munsell colour: *Skršín quartzite* – white 2.5YR 8/1 to reddish grey 6/1, yellowish grey 5Y 7/2, with pale red 10R 6/3, light red 10R 6/6, weak red 10R 5/4 to dark red 10R 3/6 schliers and stains.

*Bečov quartzite* – white 2.5Y 8/1 to light grey 2.5Y 7/1, light grey N7, light bluish grey 5B 7/1.

*Tušimice quartzite* – light grey 2.5Y 7/2 to light brownish grey 2.5Y 6/2, light yellowish brown 2.5Y 6/4, yellowish grey 5Y 7/2.

Possible confusions: with other quartzites themselves and with Lehnberg quartzite (*Kreidequarzit Typ Lehnberg*; Weissmüller 1996)

Usage: used throughout prehistory (Malkovský & Vencel 1995).

Evidence of extraction: Bečov quartzite (pit extraction) – Stroke-Ornamented Ware culture; Tušimice quartzite (pits and shafts) – Neolithic (LBK? Stroke-Ornamented Ware culture); *Skršín quartzite* – extraction can be assumed on the basis of the volume of the raw material used at Neolithic settlements (LBK and Stroke-Ornamented Ware cultures; Lech & Mateiciucová 1995a; 1995b; Malkovský & Vencel 1995, 34).