CLASSIFICATION OF LITHIC RAW MATERIALS USED FOR PREHISTORIC CHIPPED ARTEFACTS IN GENERAL AND SILICEOUS SEDIMENTS (SILICITES) IN PARTICULAR: THE CZECH PROPOSAL

JAVASLAT A PATTINTOTT KŐESZKÖZÖK KÉSZÍTÉSÉRE HASZNÁLT KŐESZKÖZÖK OSZTÁLYOZÁSÁRA, ÁLTALÁNOS TEKINTETBEN, KÜLÖNÖS TEKINTETTEL A KOVAKŐZETEKRE ÉS A KOVÁS ÜLEDÉKEKRE

ANTONÍN PŘICHYSTAL

Institute of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

E-mail: prichy@sci.muni.cz

Abstract

Lithic raw materials for chipped artefacts can be divided into five groups: a) siliceous sediments (silicites); b) minerals of SiO_2; c) natural glasses; d) clastic silica sediments; e) other rocks. Special attention has been devoted to the most important group of siliceous sediments. It is proposed to use one-word term silicite as the comprehensive one for all varieties such is chert, flint, spongolite, radiolarite, lydite, limnic silicite. As the flint should be called only the silicite originating in Upper Cretaceous chalk (and may be in Lowermost Tertiary – Danian limestones). Typical feature of silicites is a presence of microfossils in contradiction to minerals of SiO_2 that include quartz, rock crystal, chalcedony, opal and their coloured varieties (smoky quartz, citrine, jasper, agate etc.) and occur as filling of cavities in igneous rocks, hydrothermal veins or products of intensive weathering. Natural glasses suitable for chipping are represented by obsidian, pitchstone and tektites. Clastic (detrital) silica rocks are composed especially of quartz or chert clasts and incorporate quartz sandstones, orthoquartzites and chert breccias. The group of other rocks comprises for example porcellanites and hornfelses (thermally metamorphosed sediments), silicified woods, fine grained acid volcanics, silicified fossils etc.

Kivonat

*A pattintott kőeszközök nyersanyagait öt csoportba sorolhatjuk: a) kovás üledékek (szilicitek); b) SiO_2 ásványok; c) természetes üvegek; d) törmelékes kovás üledékek; e) egyéb kőzetek. Kiemelten foglalkozom az alábbiakban a legfontosabb csoporttal, a kovás üledékekkel. Javaslom, hogy a kovakőzetekre (szarukő, tűzkő, spongolit, radiolarit, lidit, tavi üledékes kovakőzetek) egységesen a „*szilicit*" terminust használjuk. Tűzkőnek (*flint*) csak a felső kréta/ alsó harmadidőszaki fehér mészköveket nevezzük. A szilicitek általános jellemzője lehet, hogy mikrofossziliákat tartalmaznak, szemben a SiO_2 ásványokkal mint a kvarc, a hegyikristály, kalcedon, opál és ezeknek a színes változatai (füstkvarc, citrin, jáspis, achát stb.) amelyek magmás kőzetek üregeiben, hidrotermális erekben vagy mállási termékekben fordulnak elő. A pattintott kőzetek készítésére alkalmas természetes üvegek közé tartozik az obszidián, a szurokkő és a tektitek. A törmelékes kovás üledékeket elsősorban kvarc vagy kova törmelékek alkotják; ide tartozik a kvarchomokkő, az ortokvarcit és a kovabreccsia. Az egyéb kőzetek közé sorolom például a porcelanitokat és a szaruszirtet (hő hatására átalakult üledékes kőzeteket), kovásodott fát, finom szemű savanyú vulkanitokat, kovásodott fosszuiliákat stb.*

KEYWORDS: CHIPPED ARTEFACTS, LITHIC RAW MATERIALS, SILICEOUS SEDIMENTS (SILICITES)

KULCSSZAVAK: PATTINTOTT KŐESZKÖZÖK, KŐESZKÖZ NYERSANYAGOK, KOVÁS ÜLEDÉKEK (SZILICITEK)

Introduction

Because of many large archaeological excavations or systematic surface field explorations conducted during the 20th century we have at our disposal numerous collections of thousands chipped artefacts of the Palaeolithic and Neolithic age. How to evaluate them from the raw material point of view? There is no doubt that the first step of such an evaluation is a correct and generally accepted classification of lithic raw materials used. Inspecting archaeological and petroarchaeological papers focussed on this problem, one can see very different approaches concerning the stone material terminology. It follows partly from early and therefore very broad use of such term as is flint or hornstone, partly from disunited terminology of the mentioned rocks in various European countries. In many papers from the first half of the 20th century the term flint (or hornstone, silex, silexite) represented an indication of almost all raw materials used for chipping and only rock crystal

HU ISSN 1786-271X; urn: nbn: hu-4106

and volcanic glass (obsidian) were differentiated. In recent times when we want and need to follow distribution of various lithic raw materials without regard to state and language boundaries, we all feel the necessity of correct terminology for lithic raw materials.

Division of lithic raw materials for chipped artefacts

The author of this contribution has had the possibility to investigate thousands of chipped lithic artefacts in the Czech Republic, Slovakia, Poland and Austria since 1979. Since the beginning of the studies he started to divide used raw materials into five basic groups (Přichystal 1984, 1997):

a) Siliceous sediments (silicites);
b) Minerals of SiO_2;
c) Natural glasses;
d) Clastic silica sediments;
e) Other rocks.

Siliceous sediments (silicites)

In English geological dictionaries and books one can find as the prevalent synoptic term for this group of sedimentary rocks usually siliceous sediments (Blumel – Rappaport, eds. 2005: 507; Nichols 1999: 204). A similar but one-word petrographical term for these sediments exists in other European languages: in German - Siliziten (Pfeiffer et al. 1985: 210), in Czech – silicity (Petránek 1963: 433), in Slovak – silicity (Vozárová 2000: 140); in Russian – силициты (Švecov 1948: 280); in Polish – silicyty (but prevalently in Polish geological literature they use the two-words term skały krzemionkowe, e. g. Żaba 2006: 402). Under the influence of central and eastern European terminology the term silicites used also some non-native English written authors (e. g. Tomkieff 1983, Kukal 1970: 394). From a practical point of view and to be unambiguous, the author also prefers this one-word term silicites (not to be confused with the term silicates, i. e. the most important group of rock-forming minerals).

Silicites are undoubtedly the most significant raw materials for chipped artefacts in almost all Europe. They are sedimentary siliceous rocks originating from chemical, biochemical, or diagenetic precipitation of SiO_2 and consisting of its various mineral modifications, first of all of cryptocrystalline silica, chalcedony, and opal; in some cases also tridymite and alpha-cristobalite are ascertained. The contents of cementing material other than siliceous or clastic (fragmentary) components may not exceed 10 %. This group is capable of embracing all chert types (including flint as one of its varieties), radiolarites, spongolites, lydites, phthanites, and limnic silicites. They form concretions (nodules) or layers, particularly in limestones and other carbonate rocks, in majority of cases of marine origin. When they originate in a lake environment, they are designated as limnic silicites. In Eastern Central Europe, it is possible to encounter in papers the term limnic quartzite as a consequence of old translations from the German language. This term should be abandoned because the term quartzite is reserved for a clastic rock (orthoquartzite) or even a metamorphic rock (metaquartzite).

As a well-defined term from the viewpoint of petrography, the term silicite may be recommended in all cases where the researcher is not sure of a reliable classification of a raw material, where he/she wants to use a general term for this extensive group of raw materials, or where differing opinions exist as to its designation due to historical development (this particularly relates to the different perceptions of the terms chert and flint). The decisive factor for placing of an unknown silica substance among silicites is finding microfossils, or their parts, in the silica substance. This term may not comprise such SiO_2 minerals as quartz, rock crystal, jasper, chalcedony or opal (i. e. substances that have originated due to magmatic, hydrothermal or metamorphic activity, in some cases also from weathering), natural glasses, or clastic silica rocks. The silicite is more unambiguous than the occasionally used terms silex or silexite (i.e. the French terms for flint and chert); moreover, the term silexite is understood by some authors of geological literature as a silica rock of igneous origin.

Moreover, in the archaeological literature we find the phenomenon that practically all well-chipping raw materials are designated as "flint, chert, hornstone", and usually only obsidian, rock crystal and quartzite are differentiated but not always. As has already been pointed out by a number of authors, the terms flint and chert were very often used without a clear definition, or as synonyms, thus being rather profane in view of a correct terminology.

Chert and flint

Within this group of raw materials the terms flint and chert present a specific problem.

As a result of the historical development there is no conformity existing in the European geological literature regarding the definition of flint and chert either. In the Anglo-Saxon literature, the definition of flint as a special variety of silicite (or of chert as the case may be) originating from chalk of the Upper Cretaceous age has prevailed since the end of 19th century. The outstanding American mineralogist and geologist J. D. Dana (1895: 281) has written: "Quartz occurs ..... as imbedded nodules or masses in various limestones, constituting the flint of the chalk formation, the hornstone of other limestones – these nodules

HU ISSN 1786-271X; urn: nbn: hu-4106

sometimes becoming continuous layers". The same opinion one can find in almost all comprehensive petrological books published during the 20th century and at the beginning of the 21st century (Fairbridge & Bourgeois, eds. 1978: 120; Pfeiffer et al. 1985; Trewin & Fayers 2005). The Czech and Slovak petrographers and geologists (Petránek 1963, Konta 1973, Mišík et al. 1985) usually apply the term flint in compliance with Anglo-American authors. All other silicites may be designated as cherts. According to the prevailing fossils their names may be further specified as radiolarite, spongolite, and diatomite. However, it is true that in some countries the definition of these two rocks is based on a different principle. In particular, the Russian (e. g. Švecov 1948) and Polish (Bolewski & Parachoniak 1978) scientific literatures define flint (krzemień, silex) as the nodular silicite, whilst stratified silicite is defined as chert (czert, silexit). Yet it is hard to be in agreement with this concept as the same silicite can often form both concretions and horizontally elongated lenses or even layers. Similarly, due to the historical development, in the Czech and Slovak Republics flint was supposedly a silicite of erratic origin from the sediments of the continental glaciation, and all local silicites were designated as cherts. Later on, this designation was taken over by e.g. Polish colleagues, who wrote about cherts of the Stránská Skála Hill, cherts of the Krumlovský Les Upland, although from the perspective of the Polish classification they should have designated them as flints. As is the modern Hungarian geological literature concerned, the term chert is used both for nodular and bedded silicites of marine origin (Haas, ed. 2001: 180).

The question of Scandinavian silicites of the Danian age

A really hard nut to crack are the Scandinavian silicites of the Danian (i. e. Early Tertiary) age that occur in Bryozoan limestones lying in the immediate superposition of the Maastrichtian chalk. In addition, the Danian silicites are substantially represented in glacial sediments of the Pleistocene continental ice sheet that are spread over a large area of Northern and Central Europe. Considering the above mentioned definition of flint, they should be termed as cherts. This problem is also evident to Danish archaeologists but in a comprehensive book on Scandinavian silicites they prefer "to follow the Scandinavian practice and refer to all chert varieties as flint" (Högberg & Olausson 2007: 25). In this case there are two possibilities: to extend the definition of flint for the silicites of Danian age as well or to use the term silicites as the author of this proposal has done for many years.

Which is the correct term: chert or hornstone?

If you hesitate between the terms chert and hornstone, the English and American geological dictionaries from the end of the 20th century and the beginning of 21st century prefer unambiguously the term chert and do not recommend using the term hornstone (Bates & Jackson, eds. 1987, 313) and already this term is usually not included in their contents (e. g. Allaby & Allaby, eds. 2003).

Conclusion

It is recommended to use the petrographically well-defined term silicite (or siliceous sediments according to dictionaries of English or American origin) in all unclear cases when there are different opinions on the rock classification. If we want to specify siliceous raw material, it is necessary to add the name of the type occurrence (banded silicite of the Krzemionki type, silicite from glacial sediments etc.). As far as the term flint is concerned, it cannot be based on its colour, lustre, translucency, shape or the fact that it appears to the observer as a high-quality, well-chipping material, sharply bordered against the limestone mass as we are again aware of silicites from a single outcrop showing different stages of silicification, and therefore with differing above-mentioned properties. In accordance with prevalent opinion and tradition in the world geological literature, it is proposed to use the term flint only for nodular siliceous rocks of the Upper Cretaceous - Maastrichtian (and may be also of Lowermost Tertiary - Danian) age coming from chalk formations or similar limestones.

Proposed definitions of selected siliceous raw materials

Silicites. Group of sedimentary siliceous rocks originating from chemical, biochemical, or diagenetic precipitation of SiO_2 and consisting of its various mineral modifications (especially of cryptocrystalline silica, chalcedony, and opal). The contents of other cementing material than siliceous or clastic (fragmentary) components may not exceed 10 %. If yes, the rock should be named silicified limestone, silicified sandstone etc. Presence of microfossils or their relics is a typical sign for classifying of a siliceous raw material into this group.

Cherts. Group of compact silicites originating in all marine sediments (limestones, marls, calcareous sandstones etc.) without regard to their age or shape (concretions, layers).

Flint. A concretional variety of silicite (chert) coming from chalk or high-quality limestone of Upper Cretaceous (Maastrichtian) and Lowermost Tertiary (Danian) age.

Radiolarite. A variety of silicite (chert) composed prevalently (more than 50 %) of the siliceous tests of the marine zooplankton called radiolaria. It can form both concretions and layers. If the presence of radiolaria is under 50 %, the rock should be called

HU ISSN 1786-271X; urn: nbn: hu-4106 © by the author(s)

radiolarian chert. The term radiolarian jasper should not be used because in this contribution is proposed to define jasper as a variety of mineral (chalcedony) of igneous, hydrotermal or weathering origin. In Central Europe, for chipped artefacts radiolarites of Mesozoic and Paleozoic age were used.

Spongolite (spongiolite, spiculite). Variety of silicite (chert) with significant content of sponge spiculas.

Phthanite. Variety of silicite (chert) of the Proterozoic age, usually of dark color. Composed prevalently of fine-grained quartz, often with thin quartz veins.

Lydite. Variety of dark to black bedded silicite (chert) of the Paleozoic age.

Limnic silicite. Variety of silicite originating in freshwater limnic (lake) environment. The presence of plant relics is a typical sign for their determination. In Central Europe limnic silicites of the Upper Tertiary (Miocene) and Upper Carboniferous – Permian age were used for knapping (Přichystal 2009). Do not use the term limnic quartzite because the quartzite is a sedimentary clastic rock or even a metamorphic rock (metaquartzite).

Silica minerals

A group of SiO minerals and their varieties such is quartz, rock crystal, citrine, smoky quartz, rose quartz, chalcedony, jasper, agate, plasma, opal. They are the result especially of magmatic, hydrotermal or metamorphic origin, and in part of weathering. Compared to silicites, no remains of microfossils are to be found, but they can often contain other minerals (chlorites, micas, tourmaline, rutile, amphibole).

Jasper. A variety of chalcedony of magmatic, hydrotermal and maybe weathering origin. It usually has a brown, red or green colour. It occurs as dykes or filling of cavities in igneous rocks. No presence of microfossils.

Siliceous weathering products of serpentinites (plasma). In Central Europe, varieties of green, yellow and brown coloured chalcedony can be found as products of intensive weathering during Tertiary and Mesozoic especially on ultrabasic rocks (serpentinites), rarely on marbles or gneisses. The green variety can be called plasma. No presence of microfossils but relicts of mother-rock minerals (especially chlorites, micas) are to be found.

Natural glasses

This group includes some glasses of volcanic origin suitable for chipping (obsidian, pitchstone) and tektites (moldavites).

Obsidian. A volcanic glass of acidic (dacite or rhyolite) composition with very low H_2O content (under 1 %). If the content of H_2O is more than 1 %, the volcanic glass is classified as pitchstone or perlite (the last one has perlitic texture with curved or sub-spherical cracks in addition).

Moldavites. Natural glasses from the group of tektites. They are represented by small fragments of green or greenish-brown glass originated as ejecta of melted terrestrial silica-rich rocks from the impact crater of Nördlingen Ries in Bavaria. They have the most important natural occurrences in southern Bohemia and western Moravia (Czech Republic).

Clastic (detrital) siliceous sedimentary rocks.

Quartzite (orthoquartzite). Unmetamorphosed quartz sandstone (clastic rock) with a silica cement.

Chert breccia. Clastic rock composed substantially of chert chips with a silica cement.

Other rocks.

Metaquartzite. A metamorphic rock usually formed by metamorphism of quartz sandstone. Because the metamorphosis is almost always accompanied by deformation, the metaquartzite has a planar or linear fabric within the rock (metamorphic foliation or lineation). If the rock contained clayey admixture, it has been changed to fine-grained muscovite.

Porcellanite. Thermally metamorphosed very fine-grained sediment (mudstone, marl, siltstone) with a dull lustre and conchoidal fracture, similar to porcelain. The thermal metamorphosis can be a consequence either of igneous rock intrusions into a sedimentary formation or can be caused by natural burning of a coal layer.

Acknowledgement

The contribution was prepared in the framework of the Czech research project MSM0021622427 “Interdisciplinary Centre for Research into Prehistoric to High Medieval Social Structures”. Comments of the both reviewers have been highly appreciated.

References

ALLABY, A. & ALLABY, M., eds. (2003): *A Dictionary of Earth Sciences.* 2nd edition. University Press, Oxford.

BATES, L. R. & JACKSON, J. A., eds. (1987): *Glossary of Geology. 3rd edition*. American Geological Institute, Alexandria, Virginia.

BLUMEL, D. & RAPPAPORT, A. eds. (2005): *Concise Encyclopedia of Earth Science*. McGRAW-Hill.

BOLEWSKI, A. & PARACHONIAK, W. (1978): *Zarys petrografii (Outline of petrography)*. AGH, Kraków. (In Polish).

DANA, E. S. (1895): *Minerals, and How to Study Them. A Book for Beginners in Mineralogy.* 2nd revised edition. New Haven.

FAIRBRIDGE, R. W. & BOURGEOIS, J., eds. (1978): The Encyclopedia of Sedimentology. *In: Encyclopedia of Earth Sciences,* **Vol. VI**. Stroudsburg, Pennsylvania.

HAAS, J. ed. 2001: *Geology of Hungary*. Eötvös University Press, Budapest.

HÖGBERG, A. & OLAUSSON, D. (2007): *Scandinavian Flint – an Archaeological Perspective.* University Press, Aarhus, Denmark.

KONTA, J. (1973): *Kvantitativní systém reziduálních hornin, sedimentů a vulkanoklastických usazenin (Quantitative system of residual rocks, sediments and volcanoclasic deposits).* Univerzita Karlova, Praha. (In Czech).

KUKAL, Z. (1970): *Geology of Recent Sediments*. Academia, Praha.

MIŠÍK, M., CHLUPÁČ, I. & CICHA, I. (1985): *Stratigrafická a historická geológia (Stratigraphic and historic geology).* SPN, Bratislava. (In Slovak).

NICHOLS, G. (1999): *Sedimentology and Stratigraphy*. Blackwell Science Ltd.

PETRÁNEK, J. (1963): *Usazené horniny. Jejich složení, vznik a ložiska. (Sedimentary rocks. Their composition, genesis and deposists)*. NČSAV, Praha. (In Czech).

PFEIFFER, L., KURZE, M, & MATHÉ, G. (1985): *Einführung in die Petrologie.* Akademie Verlag, Berlin.

PŘICHYSTAL, A. (1984): Raw materials of chipped stone artifacts in Moravia (Czechoslovakia) and methods of their research. *In: Kunchev, K. S. – Nachev, I. K. & Cholakov, N. T., eds.: 3rd Seminar on Petroarchaeology, Plovdiv .Reports,* 146-152.

PŘICHYSTAL, A. (1997): Sources of siliceous raw materials in the Czech Republic. *In: Schild, R. & Sulgostowska, Z., eds.: Man and Flint. Proceedings of the VIIth International Flint Symposium*, Warszawa. 351-355.

PŘICHYSTAL, A. (2009): *Kamenné suroviny v pravěku východní části střední Evropy (Lithic raw materials in prehistoric times of Eastern Central Europe)*. Masarykova univerzita, Brno. (In Czech).

ŠVECOV, M. S. (1948): *Petrografija osadočnych porod (Petrography of sedimentary rocks).* 2nd edition. Moskva – Leningrad. (In Russian).

TOMKEIEFF, S. I. (1983): *Dictionary of Petrology*. J. Wiley and Sons.

TREWIN, N. H. & FAYERS, S. R. (2005): Chert. *In: Selley, R. C. – Cocks, L. R. M. & Plimer, I. R., eds.: Encyclopedia of Geology,* **Vol. 5**, 51-62. Elsevier Academic Press.

VOZÁROVÁ, A. (2000): *Petrografie sedimentárnych hornín (Petrography of sedimentary rocks).* Univerzita Komenského, Bratislava. (In Slovak).

ŻABA, J. (2006): *Ilustrowana encyklopedia skał i minerałów (Illustrated encyclopaedia of rocks and minerals).* 2nd edition. Videograf, Chorzów. (In Polish).

HU ISSN 1786-271X; urn: nbn: hu-4106

HU ISSN 1786-271X; urn: nbn: hu-4106