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Lithic raw material exploitation and circulation in Préhistory. A comparative perspective in diverse palaeoenvironments
Liège, ERAUL 138, 2014, p. 103-115

2.2. Petroarchaeological research in the Carpathian Basin: methods, results, challenges

Résumé

Cet article passe brièvement en revue les études pétroarchéologiques dans un contexte géologique très spécifique dans le bassin Carpatique (également connu sous le nom de Bassin Pannonien), une région de plaine entourée par de hautes montagnes, les Alpes (côté occidental), les Carpates (au Nord et à l'Est) et les Dinarides (au Sud). Le fleuve Danube traverse cette région grosso modo du Nord-Ouest au Sud Est, reliant par sa voie navigable les Balkans au Nord de l'Europe centrale. Bien que cette région soit formée d'une unité géographique relativement fermée et qu'elle ait été politiquement unie sous le régime des Habsbourg et du royaume de Hongrie, elle est actuellement partagée entre neuf pays. La Hongrie représente la partie centrale du Bassin. Cette situation a également des conséquences sur la recherche pétroarchéologique dans la région. Pour une appréciation adéquate de la provenance et du cheminement de la matière première préhistorique, il ne suffit pas de connaître les sources de matières premières de l'actuelle Hongrie, mais nous devons également connaître le stock de matières premières de l'ensemble du bassin des Carpates, les matériaux de l'ELD, et même au-delà. Cette connaissance a conduit à la base de la méthode pétroarchéologique hongroise, base de données des collections (Biró 2005) adoptée pour les investigations concernant les ressources lithiques depuis le milieu des années '80 (Biró 1986, 1987). Une collection de comparaison de matières premières (Lithotheca, Biró & Dobosi, 1991 ; Biró et al., 2000a) a été développée et maintenue au sein du Département archéologique de l'HNM (Musée National Hongrois), dans un premier temps consacrée aux matières premières principales, puis graduellement étendue aux autres ressources utilisées en Préhistoire. Les échantillons de matières premières collectés à la source sont examinés à l'aide d'analyses variées, principalement des techniques minéralogiques, pétrographiques et géochimiques afin de distinguer les caractéristiques potentielles des sources. Parallèlement à ces études, les matériaux lithiques récoltés dans un contexte archéologique ont d'abord fait l'objet d'études macroscopiques basiques, puis d'études comparatives avec des échantillons de matériaux de la « Lithotheca ». Certains échantillons sélectionnés des matériaux archéologiques sont analysés par des méthodes plus poussées, occasionnant des destructions minimes à l'objet en utilisant des techniques testées sur des échantillons de matières premières de références et pétrographiquement caractéristiques. C'est un long processus, nous pourrions même dire, une étude sans fin. Cet article a pour but de présenter un rapport faisant le point des résultats et des travaux actuels à ce sujet.

Abstract

This paper gives a short review on petroarchaeological studies in a very specific geographical setting, the Carpathian Basin (also known as Pannonian Basin), a mainly lowland area surrounded by high mountains, the Alps (on the Western side), the Carpathians (on the North and East) and the Dinarides (on the South). The river Danube transects the area roughly, from NW to SE, connecting by its huge waterway the Balkans to North-Central Europe. Though this area forms a relatively closed geographical unit and had been politically united under, e.g., Hapsburg reign and the Hungarian Crown, it is currently divided between, for the time being, nine countries. Hungary is spreading over the central part of the basin. This situation has its consequences also on the petroarchaeological research of the area; it is not enough to know sources and raw materials within present-day Hungary but, for an adequate assessment of prehistoric raw material procurement systems and trade connections, we also have to know the raw material stock of the complete Carpathian Basin and in case of ELD materials, even beyond that. This recognition has lead to the basic method of Hungarian petroarchaeology, the collection and database approach (Biró 2005) adopted for the investigation of lithic resources since the mid-eighties (Biró ed. 1986, 1987).A comparative raw material collection (Lithotheca; Biró & Dobosi 1991, Biró et al. 2000a) was founded and maintained within the Archaeological Department of the HNM, first on chipped stone raw materials mainly; then, gradually extended over other lithic resources used in prehistory. The source-collected raw material samples are examined by various analytical, mainly mineralogical/petrographical and geochemical techniques to investigate potentials of source characterisation among them. Parallel to this, the lithic finds recovered from archaeological context are also studied, macroscopically as a basic approach and compared to the samples in the Lithotheca. On selected samples from archaeological context, further analytical studies are performed, taking into consideration minimal destruction to the object and using techniques tested on potential raw material samples that may contribute to effective petroarchaeological characterisation. This is a long, we may say, never ending process. The current paper is intended to give a state-of-art report on the results and actual tasks on the subject.

Keywords: Petroarchaeology, Lithotheca, Chipped stone artefacts, Polished stone artefacts, Quernstones

1 – Introduction

Our prehistoric ancestors had an excellent practical knowledge on their physical environment and the specific qualities of the raw materials they utilised in their everyday life. The knowledge on the source areas and basic techniques for extracting, processing and using the optimal materials was one of the basic elements of the community lore. Investigating the material heritage of prehistoric people therefore should also deal with these mineral resources, whether they are used in modern industries or not. Apart from basic problems of early technologies they may also highlight movements and contacts of prehistoric people and have important indications on the structure and operation of prehistoric societies.

2 – Research history

The need for investigating and analysing lithic raw materials as a source of historical information was raised first in Hungary by Flóris Rómer, "father of Hungarian archaeology" (Rómer 1866). He himself worked together with prominent geologists of his age, in the first place, József Szabó, also pioneering excellent figure of his discipline. Geologists, geoscientists had an important role in establishing Palaeolithic studies in Hungary and provided the natural scientific background for the finds, among them, the stone artefacts proper. Starting from the first monographs on Hungarian Palaeolithic (Kormos 1912 (Tata), Kadić 1915 (Miskolc-Szeleta cave)) the analysis of the raw material of the stone tools was an essential component in the scientific description of the lithic inventory. Especially noteworthy in this respect was the contribution of A. Vendl, especially for sites and lithic assemblages of the Bükk Mts. (Vendl 1930, 1933, 1935) (Fig. 1) .Vendl also contributed to the study of the Subalyuk monograph (Vendl 1939).

This positive tradition was kept in more recent works on Palaeolithic sites, e.g. the site monograph of Tata (Vértes ed. 1964, petroarchaeological chapter by Végh & Viczián 1964); Érd (Gábori-Csánk ed. 1968, petroarchaeological chapter by Dienes 1968) and

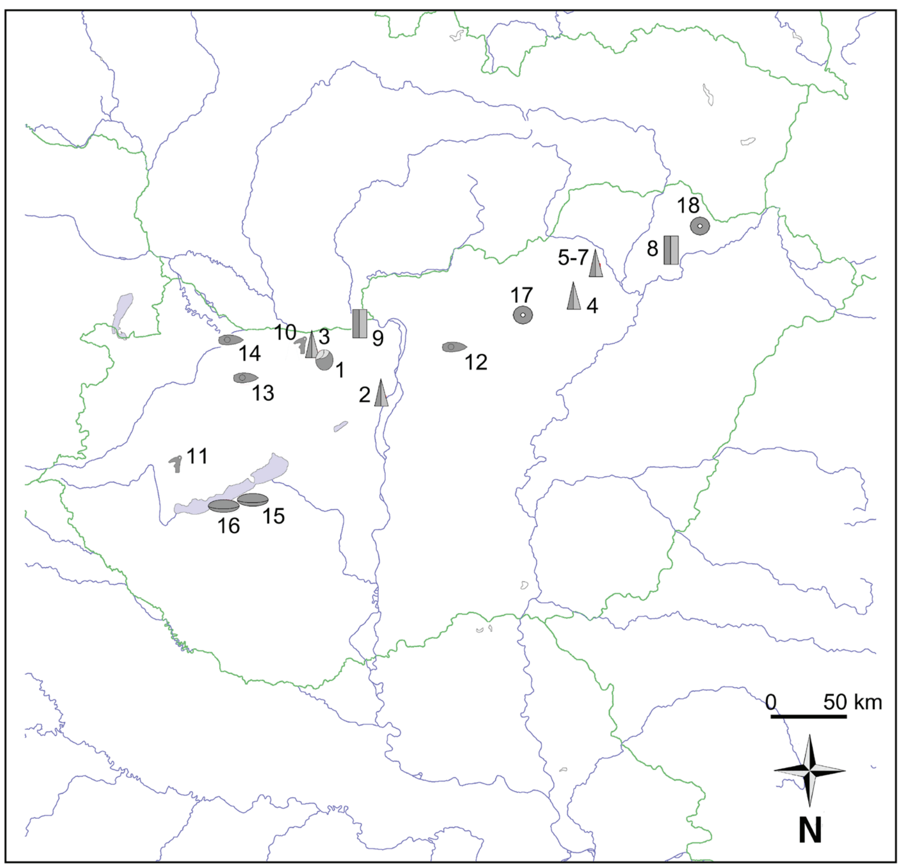


Figure 1
Map of sites mentioned in the text.

Key:
Palaeolithic sites: 1, Vértesszőlős-Limestone quarry LP; 2, Érd-Parkváros MP; 3,Tata-Porhanyó quarry MP; 4, Cserépfalu-Subalyuk cave MP; 5, Miskolc-Sólyomkút cave MP; 6, Miskolc-Büdöspest cave MP; 7, Miskolc-Szeleta cave EUP; 8, Bodrogkeresztúr-Henye UP; 9, Esztergom-Gyurgyalag UP;
Flint mines: 10, Tata-Kálváriadomb FQ, 11, Sümeg-Mogyorósdomb FQ;
Neolithic and more recent sites: 12, Aszód-Papi földek N; 13, Bakonypéterd N, 14, Gyirmót-Sugárkő N; 15, Balatonszemes N; 16, Balatonlelle CA, 17, Domoszló-Pipis MQ; 18, Sárospatak-Megyer hegy MQ

Vértesszőlős (Kretzoi & Dobosi eds. 1990, petroarchaeological chapter by V. Máthé 1990). In the meantime, an initiative to properly identify and characterise raw material types was published (Dobosi 1978, in collaboration with L. Ravasz-Baranyai).

These sites and monographs concentrated mainly on Middle Palaeolithic (in the case of Vértesszőlős, Lower Palaeolithic) assemblages and the petroarchaeological study could demonstrate basically local raw material basis and supply.

The most recent Palaeolithic monograph (on the Upper Palaeolithic site Bodrogkeresztrúr-Henye, Dobosi ed. 2000) comprised, apart from the archaeologists' raw material classifications, two petroarchaeological chapters on instrumental analytical basis, one by FTD and NAA of obsidians and one on geochemical study (PIXE-PIGE) of some siliceous raw materials from the site. (Biró *et al.,* 2000b, 2000c).

Unfortunately, the interest apparent in Palaeolithic petroarchaeology did not extend to the vestiges of more recent archaeological periods, including the "pottery" phases of prehistory. With the exception of a few prominent raw materials, esp. obsidian the general knowledge on lithic resources was very poor (Patay 1976, Lech 1981).

In the 1980-ies, raw material research efforts of the Hungarian Geological Institute under the auspices of J. Fülöp essentially promoted petroarchaeological studies.

The immediate results were (1) a diachronical survey of raw material use and processing from prehistory till modern times (Fülöp 1984); (2) a summary of existing petroarchaeological efforts (Biró 1984a); mapping and collecting Hungarian sources of chipped stone raw materials (Biró 1984b, 1986) international conference on the subject (Biró ed. 1986, 1987) (3) and finally, the establishment of the comparative collection of lithic resources in the Hungarian National Museum (Lithotheca; Biró & Dobosi 1991, Biró *et al.,* 2000a).

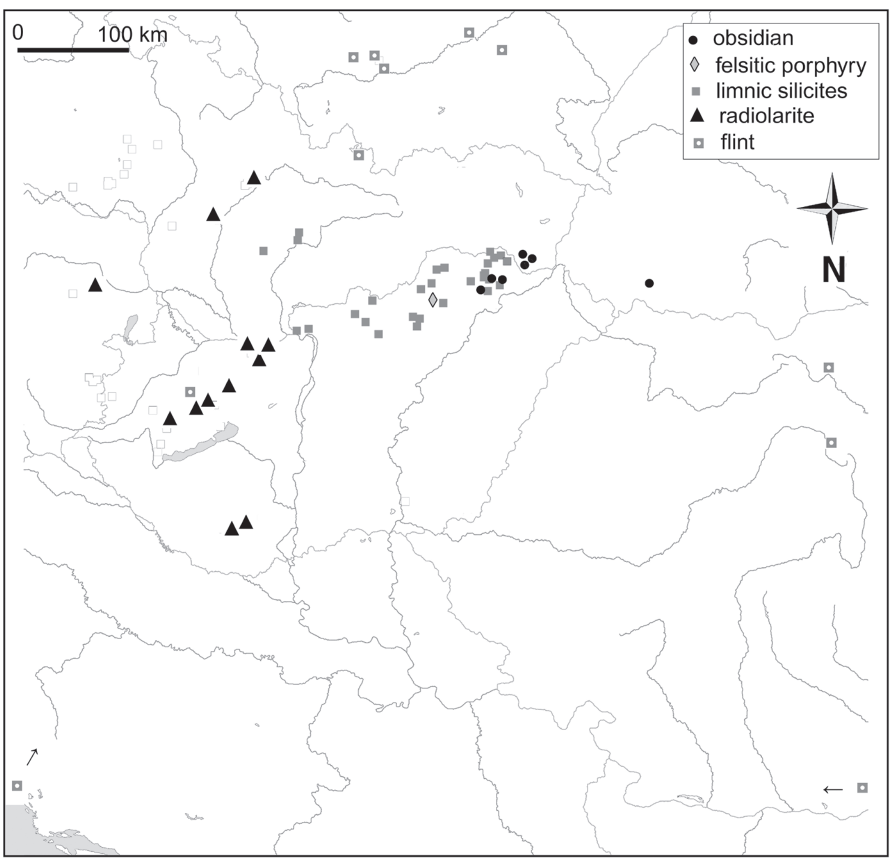


Figure 2
Map of raw material sources mentioned in the text

Key: included on the graph

After the establishment of this basic tool for research, we had several important projects, step-by-step increasing our knowledge on sources and sites (Fig. 2).

3 – Chipped stone tool raw materials

In the first run, chipped stone raw materials were investigated mainly. This is partly due to chronological and practical issues (the most important and numerous fraction of lithics is undoubtedly chipped stone tools) but also reflected on 'flint mining' research evolving with great pace from the 1960-ies (Vértes 1964, Fülöp 1973, Weisgerber 1980). Some elements of the chipped stone raw material stock served as basis of classical petroarchaeological and archaeometrical studies like obsidian (Roska 1934), Polish flint from the Holy Cross Mts. (at the Sólyomkút cave near Miskolc; Vértes 1960), "Quartzporphyr" (in modern terminology, felsitic meta-rhyolite; Vértes-Tóth 1963, Dobosi 1978). Developing techniques of fingerprinting and characterisation was systematically applied with an emphasis of non-destructive techniques (Biró & Pálosi 1986, Biró 1988a, Biró *et al.,* 1986, Biró *et al.,* 2000b, 2000c, Markó *et al.,* 2003, Kasztovszky *et al.,* 2008 etc.)

Distribution studies on characteristic raw materials were published: on obsidian (Biró 1981, 1984c; Dobosi 2011, also current paper by Biró in this volume) supported by various analytical studies like EDS-XRF (Biró *et al.,* 1986, Biró *et al.,* 1988), FTD (Biró *et al.,* 2000b) PIXE-PIGE Biró *et al.,* 2000c) or PGAA (Kasztovszky & Biró 2004, 2006, Kasztovszky *et al.,* 2008 etc.); rock crystal (Dobosi & Gatter 1996) and Szeletian felsitic porphyry (Markó *et al.,* 2003). These raw materials are fairly unique and can be efficiently characterised on the level of individual source or source region (Fig. 2.)

Considerable effort was made to characterise flint (Kasztovszky *et al.,* 2005, 2008, Biró *et al.,* 2009a), radiolarite (Biró *et al.,* 2002) and hydrothermal-limnic silicites (Szekszárdi 2005, Szekszárdi *et al.,* 2010). Flint varieties coming from outside the Carpathian Basin (mainly from the areas to the North and East of the Carpathian Mts.) are important element of the Hungarian ELD materials since the Palaeolithic times (e.g., Esztergom-Gyurgyalag, Dobosi & Kövecses-Varga 1991) and became abundant by the Late Neolithic and the Copper Age in the Eastern parts of the country (Biró 1998a, b). Radiolarite is the basic supply for the areas to the West of the Danube and we have to consider interaction zones between various mountain ranges which are historically very important. The most recent analytical considerations on the subjects were published in the framework of a Hungarian – Croatian collaboration project (Biró *et al.,* 2009, Halamić & Šošić-Klindžić 2009). Limnic silicites offer a different problematic, both analytical and terminological ones (Szekszárdi *et al.,* 2010, Biró 2010). They are the "home" raw materials for the Eastern part of Hungary, occurring in many outcrops along the foothill regions of the North-Hungarian Mid-Mountain range. The can be very varied, even at the same source, from mineralogical and physical aspects and their procurement required special skills on behalf of the knapper.

Petrographical thin sections were made on source collected as well as archaeological materials to characterise the main raw material types. (Fig. 3).

These latter raw materials, however, are more difficult to characterise and especially to separate by analytical methods, therefore we still use macroscopic "phenotypes" in distribution studies (Biró 1988b, 1998a, 1998b). On the basis of these macroscopic type groups, basic petroarchaeological characterisation of cca. 600 sites has been accomplished, from Palaeolithic to Late Prehistoric times. Currently the following "phenotypes" are separated on macroscopic level, with more or less relevance to distinguishing the sources proper:

A – Obsidian

- *Carpathian 1* (Slovakian) type
- *Carpathian 2* (Hungarian) type
- *Carpathian 3* (Ukrainian) type from Transcarpathian Ukraine

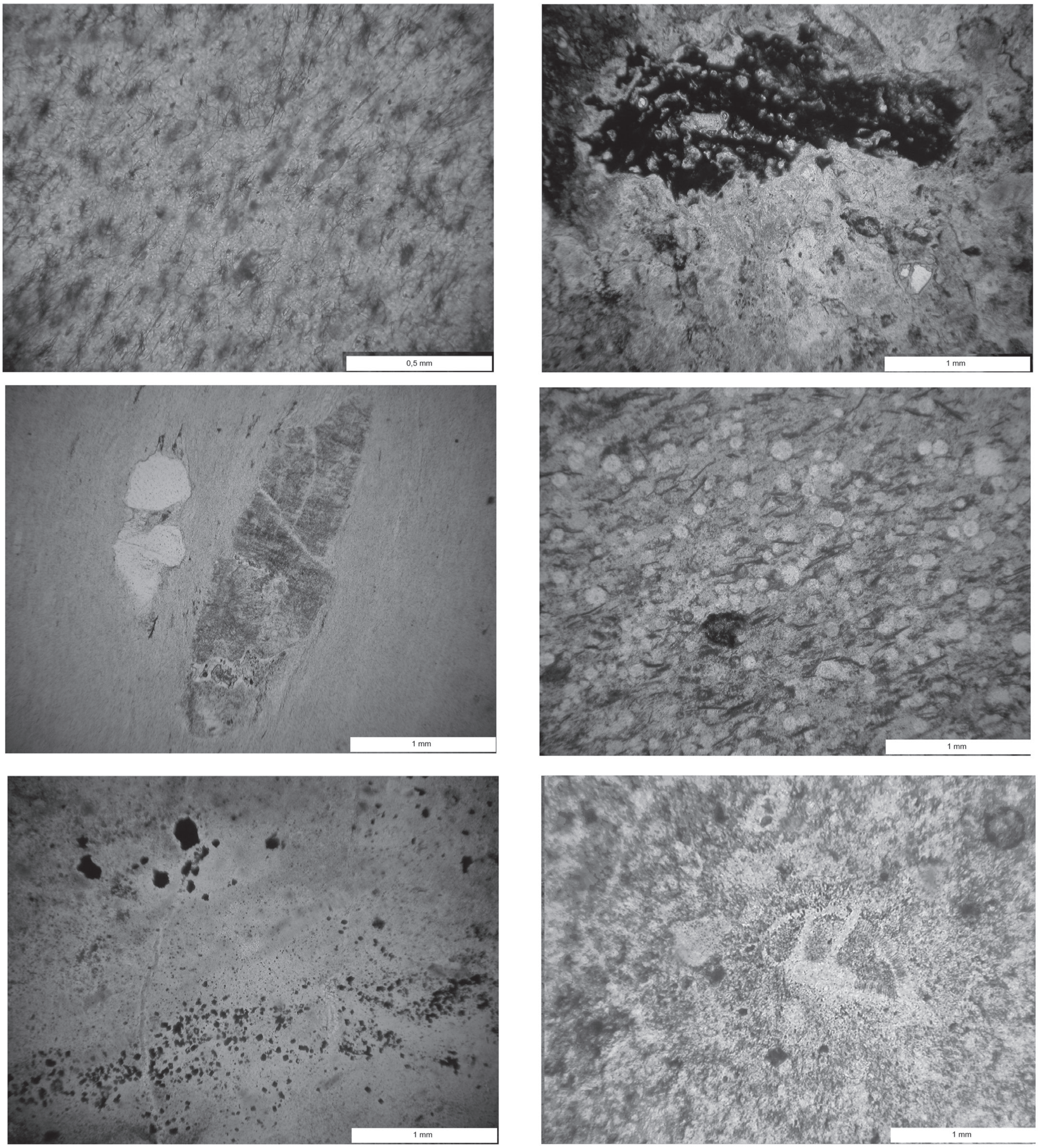


Figure 3 – Main types of chipped stone raw materials in petrographical thin section

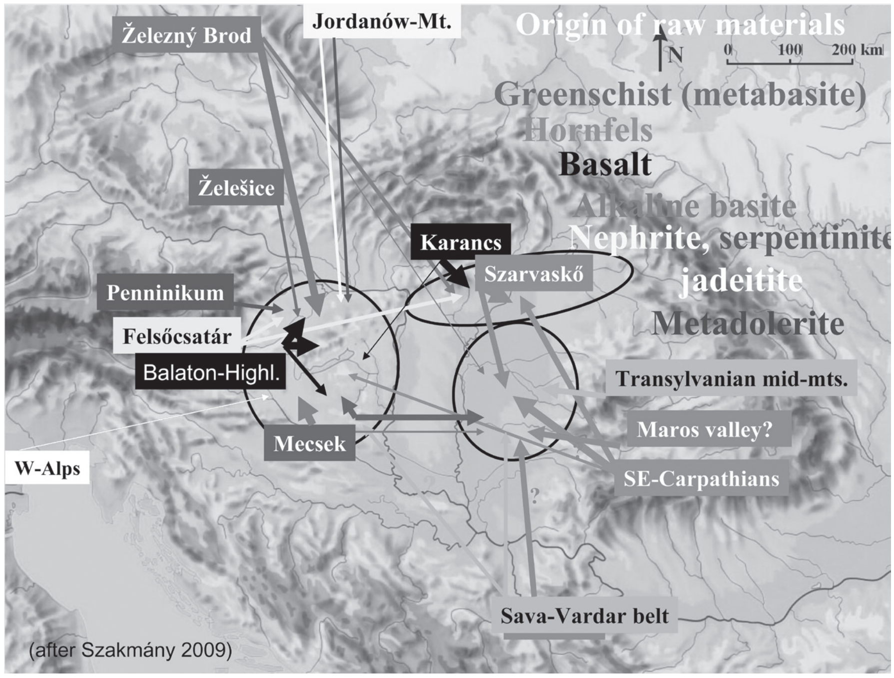
1, obsidian (Bodrogzsadány, AS); 2, limnic opal (Mátraháza, GS); 3, Szeletian felsitic porphyry (Bükkszentlászló, GS); 4, radiolarite (Lábatlan, GS); 5, limnic quartzite (Miskolc-Avas, GS+AS); 6, flint (Aszód, AS). All photos taken with 1Nikol, with 5x or 10x objectives. Scale provided on the images.

All types seem to have sub-types on the basis of macroscopic features and geochemical data. More is explained on the research of Carpathian obsidians in a separate paper in the same volume.

B – Radiolarite

Phenotypes can be separated geographically by mountains (e.g., *Mecsek radiolarite*, *Bakony radiolarite*, *Gerecse radiolarite*), find spot (*Vienna-Mauer radiolarite*) or wider region (*Carpathian radiolarite*) and colour varieties (e.g., *Szentgál radiolarite* – red Bakony radiolarites, *Úrkút-Eplény radiolarite* – mustard-yellow variant, also from the Bakony sources, *Hárskút radiolarite* – dark brown radiolarite with orange tint. Without exactly knowing the sources, on the border regions we can come across “foreign” radiolarites,

Figure 4
Raw material provinces and inflow of polished stone tool raw materials, after Szakmány 2009



probably coming from Transylvania (Maros valley), Croatia and Bosnia. These siliceous raw materials are often described as "jasper". Unification of terminology and a better knowledge of the actual sources is very important for future research.

C – Limnic and hydrothermal silicites

Limnic and hydrothermal silicites is for another large and significant group. They are extremely varied even on one source and can be very similar over large distances. Special types which can be separated with some hope of provenancing relevance include *light colour variegated Mátra limnic quartzite*, *Mátraháza-Sombokor type limnic opal* with quartz grains – fairly common along the southern fringes of the Mátra and Bükk Mountains. Tokaj limnic quartzites are especially abundant and can be more or less identified as coming from the Southern or the Northern sources of the Tokaj Mts. A point-like special variety is "*stone marrow*" (=kővelő), a hydroquartzite with high kaolinite content, basic raw material of the Bodrogkeresztúr UP site. Close to the "stone marrow" outcrops, another very characteristic hydrothermal silex can be observed with light grey stripes, often coloured with light yellow stripes as well. This source is located in the confines of Mád towards Mezőzombor, and was periodically very popular, especially in the Late Neolithic and the first half of the Copper Age.

D – Szeletian felsitic porphyry

This is a prominent raw material of the Hungarian Palaeolithic, especially the leaf-point producing industries of the Bükk Mts. and further on in the North-Hungarian Mid-Mountain range. Its popularity ended with the Palaeolithic and in more recent times we can mainly find occasional reworked pieces on some Neolithic sites.

E – Hornstone

Hornstone is a special term used mainly by Central European (German tradition) research. Anglo-Saxon terminology would call it chert. It is of sedimentary origin, typically of grey, "horn-like" appearance (hence the name, Hornstein (=szarukő). It was mainly popular as local raw material in the Palaeolithic, several regional varieties can be separated mainly on geographical arguments (*Buda hornstone*, *Bükk hornstone* and hornstone from the Balaton highlands and the Keszthely Mts.) Buda hornstone has seemingly two peaks of utilisation, in the Middle Palaeolithic (Dienes 1968) and later in the metal ages, most probably upgraded by heat treatment (Biró 2002).

Figure 5
Jadeite and nephrite artefacts from the Ebenhöch collection of the Hungarian National Museum

Top row: jadeite chisel-blade,
HNM 300/876.264. Locality: Bakonypéterd
Bottom row: nephrite chisel,
HNM 300/876.248. Locality: Gyirmót-Sugárkő

F – Flint

Flint in geological context means a young marine shallow water sedimentary rock. In this strict sense, in Hungary we have only one source at Nagytevel, West-Central Transdanubia, named *Tevel flint*. This raw material was preferentially used in the Neolithic period mainly.

Even more important, a lot of ELD flint types appeared in the central parts of the Carpathian Basin, starting from the Palaeolithic times. Among them we can find well-known Polish flint varieties like Jurassic Cracow flint, Chocolate flint, Volhynian flint and from Eastern Romania, Prut flint. From the south-east, two macroscopic phenotypes have been identified, the so-called Balkan and the Banat flint. Recent petroarchaeological studies (Biagi & Starnini 2013) suggested that the source region for both types can be the same on the lower reaches of the river Danube. Also fairly recently, high quality siliceous raw material from South-Western origin, so-called Lessini flint was found at SW Hungarian archaeological sites (Biró 2006).

G – Rock crystal

Among the special high-prestige materials occurring rarely in the lithic inventories, we can mention (Alpine) rock crystal. So far, stone tools made of this material were located on Palaeolithic sites only.

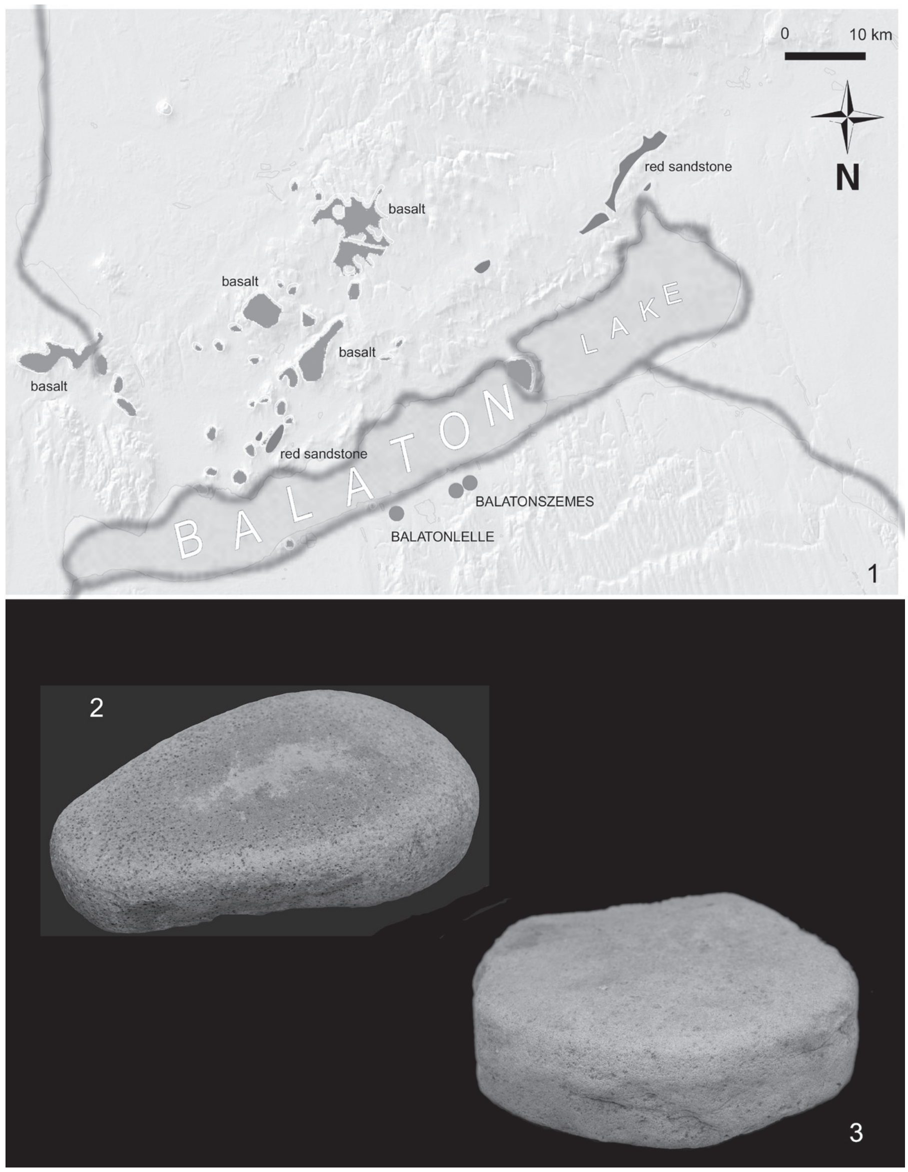


Figure 6
Large quernstones made of red sandstone and basalt tuff from Balatonszemes, transported across Lake Balaton in Early Neolithic context

1. Outline map of the area with sources of red sandstone and basalt on the Northern side of the lake Balaton; sites with giant quernstones on the Southern shore;
2. Quernstone made of basalt tuff from Balatonszemes, approx. 60 kg;
3. Quernstone made of red sandstone from Balatonszemes, approx. 80 kg.

This list is naturally incomplete, especially local resources were not listed completely.

4 – Polished stone tool raw materials

The investigation of polished stone tools and their raw material started considerably later. This group of tools has an essentially shorter time span and much less overall quantities are involved; nevertheless, polished stone artefacts (axes, chisel-blades etc.) had a high prestige in the ancient societies due to their often distant and specific, rare raw materials and the considerable amount of labour invested in them, therefore their potentials in tracing movements of peoples can be even more important (e.g., Western Alpine jadeite; Petrequin *et al.,* 2008).

Although the necessity of petrographically investigating polished stone artefacts was raised already by Rómer (1866); we made the first steps in this direction only by the second half of the 1990-ies (Szakmány & Starnini 1996, Biró 1998c, Biró & Szakmány 2000). An essential impetus was supplied by the UNESCO project IGCP-442 (http://www.ace.hu/igcp442/), resulting in the identification of the most important local and imported polished stone raw materials and their characteristics in Hungary (Szakmány 2009, Szakmány *et al.,* 2011). In this process, large collections of stray finds obtained by museums, e.g., the Miháldy-collection (Horváth 2001, Szakmány *et al.,* 2001, Füri

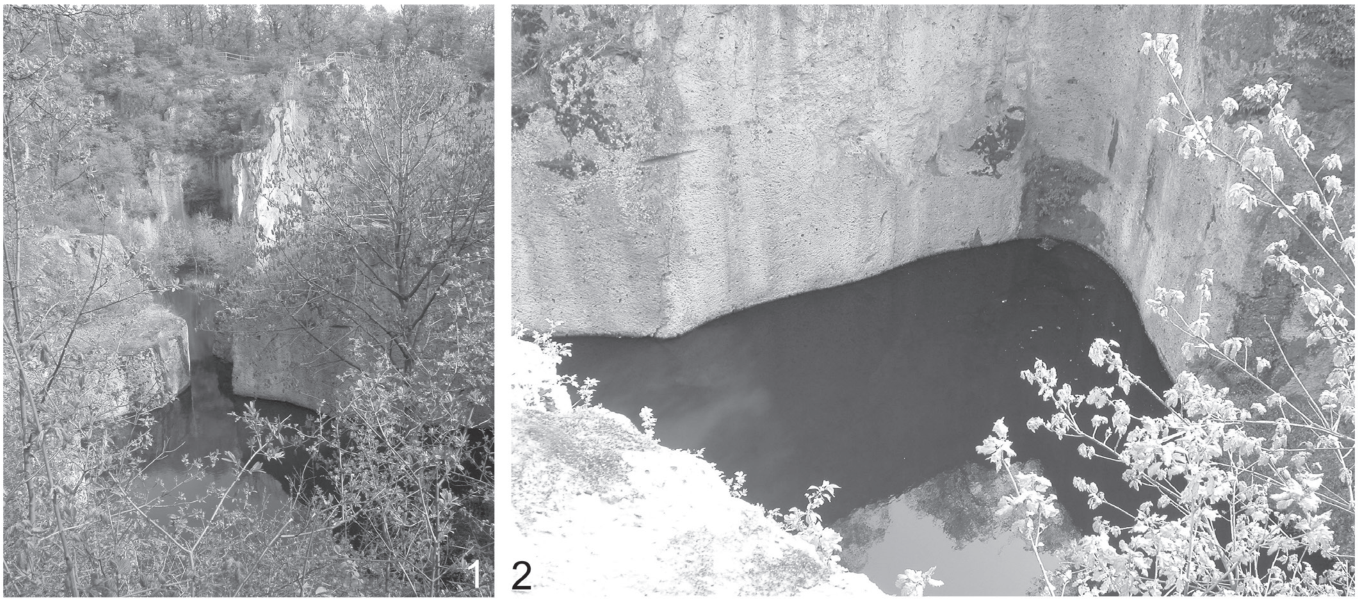


Figure 7
Mediaeval millstone quarry (hydroquartzite) on Sárospatak-Megyer hill;

1. overview of the quarry; 2. traces of extraction of millstones on the quarry walls

& Szakmány 2004) and the Ebenhöch-collection (Friedel *et al.,* 2008, 2011) and more recently, a major private collection from Diósviszló (Oláh *et al.,* 2013) helped us to identify basic raw materials used for polished stone axes in Hungary. Specific study was dedicated to polished stone axes with context from the HNM; as a result, provinces of similar supply patterns were identified. (Oravecz & Józsa 2004, 2005). The most important raw materials for polished stone axes involve local/regional basalt and basaltic andesite, greenschist from Western Hungary, blueshist from eastern Slovakia, gabbroidal rocks from various origin and long distance elements: greenschist/metabasite, hornfels and serpentinite (Fig.4). Currently we are involved in fingerprinting and analysing special long distance raw materials (ELD) in Hungary like jadeite, nephrite and hornfels (analyses in progress; Szakmány *et al.,* 2013, Péterdi in press (Fig.5). We are currently connected to the large EU project Jade2 as well (JADE 1, 2).

5 – Other lithic utensils

The most recent branch of petroarchaeological investigation is directed towards a group of artefacts that was formerly neglected in any respect. We summarise them under the loose category "other stone utensils" covering grinding stones, polishers, hammerstones etc. and also a number of 'manuport' lithics on the archaeological site where we cannot find a direct and evident use or purpose for the item. These artefacts are typically of local origin and represent a large mass to carry and to collect. The first site where 'other stone utensils' were investigated in integrated system with the chipped and polished stone tools is the Late Neolithic site Aszód-Papi földek (approx. 7500 BP), (Biró 1992, 1998a; currently in preparation for the Aszód site monograph). Recently, more and more sites, especially those of large surface preventive excavations produce tons of 'stone utensils'. Their investigation offers a lot of interesting details on the life and choices of prehistoric people (Péterdi *et al.,* 2011, Biró & Péterdi 2011, Szakmány & Nagy-Szabó 2011 etc.). The most spectacular items among this category are quernstones and millstones. They are often multi-functional tools in the sense that apart from grinding cereals they could be used for other purposes like powdering pigments and polishing other artefacts made of stone, bone/antler and even metal. Large and heavy items were transported from the sources across the water, e.g., in the case of the southern shore of Lake Balaton where grinding stones over 50 kg each, made of a specific sandstone (so-called Permian red sandstone) and basalt tuff, both from the Balaton Highland (Biró & Markó 2007) (Fig.6). Intensive research of historical stone quarries resulted in the location of quernstone and millstone quarries in the Tokaj and Mátra Mts., respectively (Fig. 7; Fig. 8.).

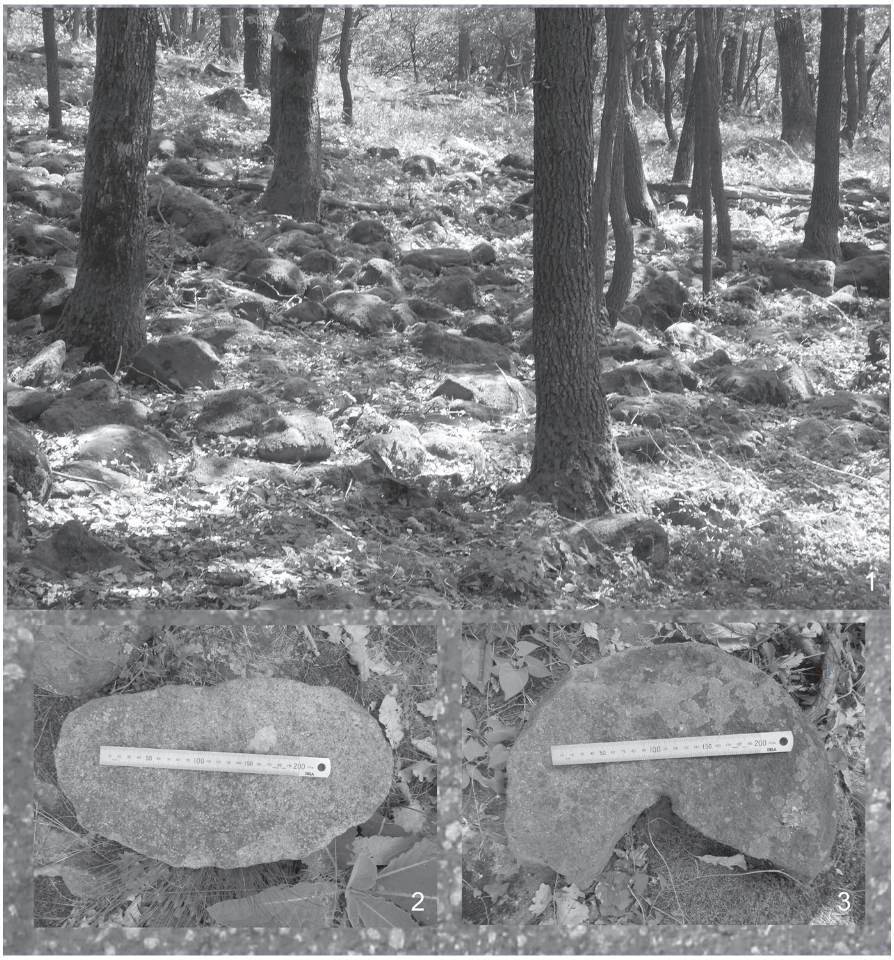


Figure 8
Quernstone/millstone quarry and workshop in the Mátra Mts.)

1. Boulders of andesite of suitable size spread over the Domoszló-Pipis hillside
2. Prehistoric „style" quernstone at the Domoszló-Pipis exploitation site
3. Millstone at the Domoszló-Pipis exploitation site

6 – Conclusions

Petroarchaeological research evolved throughout the past decades into a strong and disciplinarily well established branch of interdisciplinary sciences offering essential help for archaeological and historical studies. The basic methodology involves an extended and representative comparative collection, systematical field surveys on potential source regions, parallel survey of archaeological lithic assemblages and thematical analyses of specific groups of reference materials with archaeological sample sets.

Abbreviations used in the text

AS	Archaeological site (on Fig. 3.)
EDS	Energy Dispersive Spectrometry
ELD	Extra-Long-Distance
GS	Geological source (on Fig. 3.)
HNM	Hungarian National Museum
LD	Long-Distance
PGAA	Prompt Gamma Activation Analysis
PIXE-PIGE	Proton Induced X-Ray Spectrometry
PIXE-PIGE	Proton Induced Gamma Spectrometry
XRD	X-Ray Diffraction Analysis
XRF	X-Ray Fluorescence Spectrometry

Acknowledgements

OTKA - Hungarian Scientific Research Fund T- 025086 project (Raw material atlas, Non-metallic prehistoric raw materials on the territory of Hungary and adjacent regions), K-62874 Applications of a New Non-destructive Geochemical Method (PGAA) in Archaeometry, Culture 2000 project (Erosion and Humidity), Historic Quarries project (www.historic-quarries.org). OTKA 100385 (Provenance study of lithic raw materials of stone tools found in the Carpathian Basin)

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