CONTRIBUTION TO THE COGNIZANCE OF RAW MATERIALS AND RAW MATERIAL REGIONS OF THE TRANSCARPATHIAN PALAEOLITHIC

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Abstract: On the territory Transcarpathian Ukraine, about 100 Palaeolithic localities are known up to our days. Most of them are surface finds. In spite of the rich archaeological heritage, the elaboration of the material, especially its petroarchaeological evaluation supported by professional scientific analytical methods, is in the initial phase as yet. The aim of the present study is to supply information on the lithic raw materials of the Palaeolithic settlements in Transcarpathian Ukraine, the detailed survey and description of the primary raw materials, their identification, description and terminology, as well as the outlining of the local raw material provinces and study of the distribution of the raw materials on archaeological sites.

In the archaeological literature of Transcarpathian Ukraine, lithic raw materials are still described under incorrect petrographical terms. For example, for the raw material of Korolevo Palaeolithic site is, correctly speaking, hyaline dacite, and the "flints" of Beregovo region are indeed rocks of volcanic origin which have undergone metasomatic processes. Field survey for collecting geological samples localized 19 different raw material sources all of which yielded hard rocks with conchoidal fracture that are suitable for tool making with knapping.

Out of the 19 raw material types 11 were actually found in archaeological assemblages of the studied area. The most popular raw materials of Transcarpathian Ukraine are the Korolevo hyaline dacite, Rokosovo obsidian, (Carpathian 3 type) and siliceous rhyolite tuff varieties (type I and II), siliceous tuffite (type I and II), siliceous and opalised rhyolite (type I and II) from the Beregovo Hills area, as well as silicified sandstone (type II) and the siliceous argillite. Certain types of potential raw materials were found in archaeological assemblages as yet. These are the Kriva limno-chalcedonite and limnoopalite, radiolarite of Svalyava type I, II and III, the siliceous limestone of Svalyava and Priborzhavske, and the hornfels of Suskovo.

The paper also points out patterns in lithic raw material circulation in the prehistoric period of Transcarpathia. In the Palaeolithic, the settlement system and location of sites was largely dependent on the lithic sources. Altogether 9 types of rocks played important role: Korolevo hyaline dacite, the Carpathian 3 type obsidian from Rokosovo, 6 types of metasomatites of Beregovo Hills, and the silicified sandstone (type II). Upper Palaeolithic communities settled close to the outcrops of primary and secondary geological positions and this phenomenon is observable at each important Palaeolithic settlement.

On the basis of the principal raw material circulation of the Palaeolithic three territorial groups have been formulated. These are named after the most abundant and used rock types of the given region. Three raw material regions are recognized in Transcarpathia: volcanic, metasomatic, and sedimentary. Furthermore, sub-regions were also established in the volcanic region (Rokosovo-Maliy Rakovets and Korolevo-Veryatsa sub-regions) and in the metasomatic region (Beregovo, Muzhiyevo and Bene-Kvasovo sub-regions).

Keywords: Transcarpathia, Palaeolithic, raw material, obsidian, hyalodacite, metasomatic rocks, siliceous rocks

DOI: 10.1556/072.2016.67.2.1

Acta Archaeologica Academiae Scientiarum Hungaricae 67 (2016) 209–230
0001-5210/$ 20.00 © 2016 Akadémiai Kiadó, Budapest

1. INTRODUCTION

The territory of the westernmost part of present-day Ukraine (Transcarpathia) has been a densely inhabited area in almost all periods of human history. The political history of the area is also very eventful: till the end of the World War I, it was part of the Austro-Hungarian Monarchy, then it was attached to Czechoslovakia up till 1939. During the World War II, the larger part of the territory used to belong to Hungary while in 1945, following the end of the war it was attached to the Soviet Union. Following the disintegration of the Soviet Union, the territory is currently part of Ukraine.The political changes have direct consequences on the historical, even prehistorical knowledge on the area because sites and settlements as well as geographical names have changed constantly and are known in several versions. To overcome this problem, the Appendix contains a synonym list of geographic terms used in the text in English, Ukrainian and Hungarian *(Tab. 2).* Several hundred archaeological sites have been under research and excavations for several decades. Archaeologists from Hungary, Czechoslovakia, Soviet Union and the Ukraine took part in the work as local investigators. As a result of the spreading of processual archaeology, by the end of the 20th century, the excavations and scientific investigation of the sites and the finds themselves were already supported by various branches of natural sciences as well. In spite of this, Transcarpathian archaeology benefited only in small part, and, occasionally, from interdisciplinary research. This is true for petroarchaeological studies as well, whereas we know very well that the investigation of the raw materials has special interest in the interpretation of early prehistoric sites.

In the region of Transcarpathia, currently more than 100 Palaeolithic sites are known, most of them known from surface collections.The excavation of the first Palaeolithic sites took place in the1930s under Czechoslovakian political supremacy.[1] By the second half of the 20th century Soviet archaeological research performed here successful studies concerning the Palaeolithic period.[2] Accordingly, an organisation was established in 1969 under the name "Permanent Transcarpathian Palaeolithic Expedition" (UA: Постійно діюча палеолітична експедиція), successfully discovering dozens of new sites in a short while, and initiating systematical excavations on the localities considered as *in situ* sites. In respect of raw material studies, we can specifically mention one group of sites where significant advances were reached in respect of raw material studies. Early petroarchaeological studies commenced in Transcarpathia with the activity of V. Petrun' and by the discovery of Middle Palaeolithic settlements and workshops around Rokosovo and Maliy Rakovets and the description of the local obsidian sources.[3]

In describing the Transcarpathian Palaeolithic sites the authors generally mentioned the type of raw material identified, however, the identification of raw material types was based strictly on macroscopic observation without proper petrographical characterisation.[4] Consequently, some of the raw materials were deficiently or directly erroneously identified using a lot of incorrect names. Silex and siliceous rocks typically vary in different technical papers by language and nomenclature as recently summarised in the 2010/3 volume of Archeometriai Műhely / Archaeometry Workshop.[5] Terminological problems in former Soviet and current Russian and Ukrainian geological literature also contributed to the difficulties in correctly identifying rocks and minerals used for the production of stone tools.[6] Terms like jasper, lydite, phtanite, hornstone or geisirite have different connotations in respect of origin, even more of possible provenance. More difficulties are emerging in the case of metasomatic and hydrothermally transformed silicified rocks where macroscopic observation is not adequate for the exact identification of the rock. The knowledge on these rocks within the Eastern part of Central Europe is very important for regional distribution studies because the Carpathian Basin has always constituted a coherent unit together with its immediate surroundings. For a petroarchaeological consideration, we have to ignore current political boundaries because raw materials circulated all over the region, following natural routes and passes.

The aim of the present paper is to describe and summarise the lithic raw material basis for the Transcarpathian Palaeolithic sites, description of the primary raw materials, their identification and study of their regional distribution. The underlying research has been going on for several years now in the Transcarpathian region and by now we can outline a general view on raw material use in the Palaeolithic of the region.

[1] SKUTIL 1938.

[2] TKATCHENKO 2003.

[3] PETRUN' 1972.

[4] GLADILIN–SITLIVIY 1990; KULAKOVSKA 2002; RIZHOV 1999, 2003; TKATCHENKO 2003.

[5] See esp. GÖTZE 2010 and RÁCZ 2010a in respect of the territory under consideration.

[6] RÁCZ 2010a.

2. METHODS

Systematical field surveys have been conducted to Transcarpathian regions since 2006. In course of fieldwork, rock types seemingly suitable for the production of chipped stone tools were collected. After gathering the potential lithic raw materials, macroscopic and microscopic petrographical analysis was performed on the samples. Similar investigations were conducted on archaeological samples as well. In the followings, macro- and microscopic properties of the rocks used for the production of stone tools will be described. Chemical analyses were also conducted on the samples; the current work will concentrate on petrographical data and use the chemical results only to such an extent that is necessary for correct denomination of the rock type.

The basic method of the petroarchaeological analysis of chipped stone tools is macroscopical observation, with the aim of describing, grouping the stone tools by raw material groups on the basis of physical qualities, using only a hand magnifying glass or stereo-microscope. The selection of potential raw materials on field surveys is realised by the same method. In the case of proper comparative material some of the raw materials can be adequately identified by this method alone, but in many cases we need more detailed petrographical analysis, using polarizing microscope (thin sections) and geochemical or mineral chemical studies.

Apart from its richness in historical relics, Transcarpathia is equally rich and varied in respect of the geological past. The territory abounds in various rocks, of magmatic (volcanic), sedimentary and metamorphic origin. The mineralogical and petrographical description of these rocks is published in a rich selection of geological technical literature.[7] Geological technical literature was extensively used to centre fieldwork directed at verification and control of potential raw material sources formerly mentioned as well as the discovery and assessment of new potential source regions. Fieldwork was always preceded by studying archaeological and geological technical literature, especially geological maps.[8]

The primary macroscopic analysis of the samples was followed by petrographical thin section analysis. Altogether 164 samples were examined this way. In some of the specimens, neither macroscopic, nor microscopic analysis have provided sufficient information for the exact identification of the rock, moreover, the potential source; in such cases, further – geochemical – analyses were necessary. Chemical analysis of 4 samples (2 stone tools and 2 rocks from geological outcrops) was performed using ICP-OES and ICP-MS methods in the ACME Analytical Laboratories (Vancouver).

Obsidian samples from Rokosovo sources were also analysed chemically by Prompt Gamma Activation Analysis and Neutron Activation Analysis, respectively.[9]

Accordingly, the investigation of Transcarpathian lithic raw materials was realised in several steps, first concentrating on archaeological collections and available technical literature, followed by field surveys and collection of comparative samples. The representative samples from these surveys were subjected to macro- and microscopic analyses and geochemical investigations. As a result of these studies, the raw material economy of the region could be outlined.

3. CHIPPED STONE RAW MATERIAL VARIETIES IN THE TRANSCARPATHIAN REGION

1. Hyalodacite (glassy dacite)

Occurrence: In the vicinity of the Korolevo (Veryatsa) open-air quarry a black glassy rock can be collected along the contact zone of the dacite subvolcanic body, with aphyric or microporphyrous texture. This rock was extensively used by Palaeolithic stone knappers. Smaller (nut-fist size) or larger blocks (up to 1 meter in diameter) can be found in the loess-like sediments along the flood plain of river Tisza over the phases over the terraces marked IX. and X.[10] This territory lies within the Vihorlat-Gutin volcanic range in the North-Eastern (Ukrainian) part of the Oas-Mountains. Its formation can be related to Late Tertiary Volcanism, assigned structurally the Kutchava volcanic complex. The calcalkaline and acidic volcanites of the Late Tertiary magmatism form the so-called Intra-Carpathian

[7] Sobolyev *et al.* 1955; Maleyev 1964.

[8] Matskiv–Kuzovenko 2003; Prichodko–Koren' 1982.

[9] Kasztovszky *et al.* 2008; Rosania *et al.* 2008.

[10] Matskiv–Kuzovenko 2003.

Volcanic Arch, from the Visegrád Mts (Danube Bend) till the Hargita Mts in Eastern Transylvania in the length of approximately 500 km, following the internal arch of the Carpathes.[11]

Macroscopic description: The natural cortex of the hyalodacite is grey or dark grey, often leached and weathered. On fresh fracture the surface is black, with dull lustre. The matrix abounds in white mineral grains (feldspars). The fracture of the rock is conchoidal, easily knappable *(Fig. 1)*.

Microscopic description: In thin section, samples of hyalodacite proved to be of porphyric texture. The phenocrysts are various size plagioclases, amphibole and pyroxene as well as their aggregates. Polysynthetical twinning, zoned crystals and glass inclusions can be observed in the plagioclase. The matrix is isotropic glass. The dark matrix contains a large quantity of small, needle-like oriented plagioclase crystallites corresponding to flow direction. These microlithes often flow around phenocrysts and inclusions *(Fig. 2)*.

Chemical composition: According to chemical analysis, the composition of two representative and fresh samples yielded 66,87 and 67,42 weight% SiO_2 each, assigning the rock to the dacites. Due to high glass content (more than 50 volume% in the thin section), the rock can be classified as glassy dacite or hyalodacite.[12]

Fig. 1. Hyalodacite; remark: grid scheduling is 0.5 cm

2. Carpathian 3 obsidian

International petroarchaeological research has integrated Transcarpathian obsidian, occurring in the region around Rokosovo and Maliy Rakovets, under the name Carpathian 3 (C3) obsidian in 2008.[13]

Occurrence: At the upper reaches of Silskiy stream, to the North of the village Rokosovo and to the South of Maliy Rakovets, the Upper Tertiary Sin'ak Formation comprises obsidian blocks and bombs in an agglomerate type tuff of acidic composition.[14] The area forms the central part of the Vinohradiv Mountains in the Vihorlat-Gutin volcanic range. The size of the blocks currently available varies between a few cms to several dozens of cms. It can be collected in substantial quantities on the eroded surface and the stream valleys even today.

Macroscopic description: The blocks are typically encrusted in their natural form with light or dark cortex, resulting from interaction with the environment. The surface is often porous, weathered. The fresh fractures are black, glassy, with macroscopically observable mineral grains. The fracture is conchoidal. It is non-transparent, even in thin flakes *(Fig. 3)*.

On the basis of recent field surveys we can say that the Carpathian 3 obsidian has two sub-types. The difference can be observed both in macro- and microscopic level. In the first case, the fresh broken surface is black, with glassy lustre, occasionally with oriented grey stripes. The other version is grey on fresh broken surface, with dull lustre and a subordinate amount of darker stripes. In the matrix we can observe spherolitic forms with naked eye, emerging as brown entities in microscopic thin section surrounding some crystallites. This feature is very rarely observed for the black version of C3 obsidian.

[11] Harangi 2001.
[12] Rácz 2009b.
[13] Rosania *et al*. 2008.
[14] Matskiv–Kuzovenko 2003.

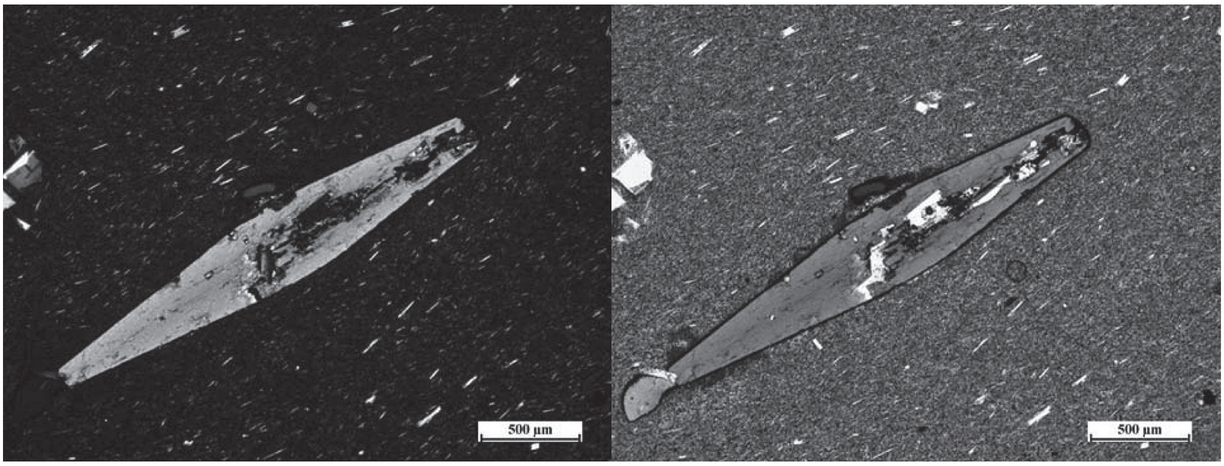

Fig. 2. Amhibole phenocryst in almost glassy groundmass in hyalodacite. Thin section microscopic photos (1N and XN)

Microscopic description: In thin section the texture of the rock is vitroporphyric with clear fluidal character formed by the unidirectional movement of the lava flow. In the matrix, alternating stripes of light and less frequently dark phases can be observed. The texture of the rock abounds in microlithes (crystallites), surrounding spectacularly the phenocrysts grouped frequently in aggregates. Torn inclusions of plagioclase, monocline pyroxene, amphibole and biotite comprise maximally 5–10 volume %. Accessory minerals observed include opaque magnetite and zircon. The plagioclase crystals are often twinning and zoned, their size may reach 2 mm. At some places they contain glass inclusions and certain resorption can be observed in the crystals. At some places in the thin section we can observe the mineral grains and inclusions disintegrating parallel to the orientation of the fluidal movement and the grains floating apart *(Fig. 4)*.

Fig. 3. Carpathian 3 obsidian

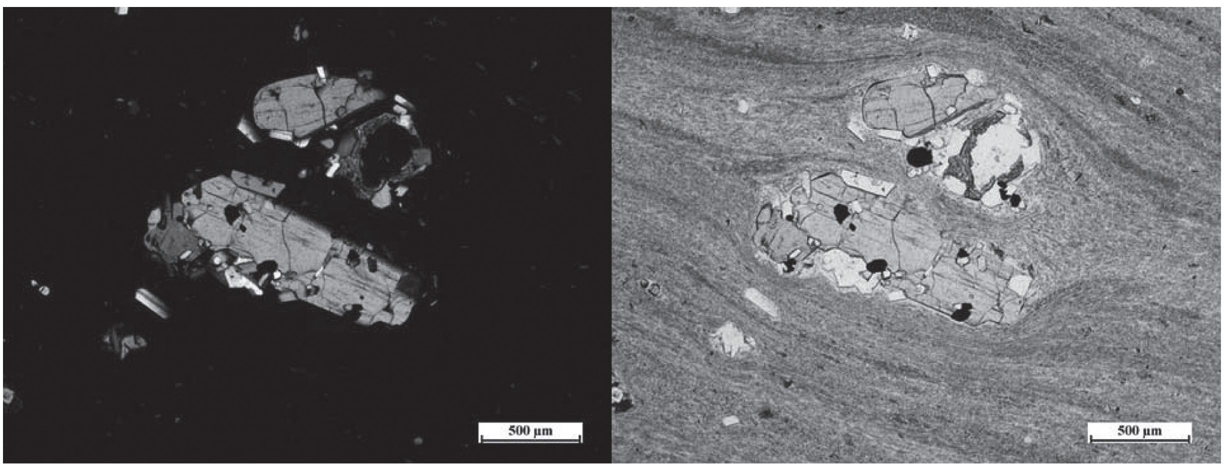

Fig. 4. Pyroxene-plagioclase aggregate in fluidal glassy groundmass in C3 type obsidian. Thin section microscopic photos (1N and XN)

The glass is transparent, colourless, the refractive index was measured by Nasedkin as N = 1,482, by Petrun' as N = 1,498 ± 0,001, indicating acidic composition.[15] The inclusions were probably formed in the deeper regions of the magma chamber.

Chemical composition: The analysis of two representative samples yielded 70,40% and 70,94% weight% SiO_2 (with LOI 0,4% and 0,3%, respectively). Consequently, the raw material was assigned to rhyolitic obsidians.

3. Metasomatically transformed (siliceous, opalised) tuffs, tuffites and rhyolites of the Beregovo Hills

The Beregovo Hills were formed as a result of Late Tertiary volcanism. Its rocks are assigned to Lower Sarmatian Dorobratovo Formation.[16]

The Palaeolithic settlements are located on the western and eastern fringes of the hills as well as concentrated on the central parts.

a) Raw materials of the western sites of the Beregovo Hills (Beregovo I–VI, Muzhiyevo A and B)

Occurrence: All of the settlements are located on the Zolotista Hill to the South-East of Beregovo. One of them is situated *in situ* (with observable stratigraphical position) while nine is only known from surface scatters. The primary raw material on all of the sites is local volcanic origin acidic rock with metasomatical alteration, offering good quality knappable rock for the Palaeolithic masters. These rocks can be collected on various spots of the hills in great quantity. They are of conchoidal fracture, highly varied in respect of colour and texture. This variety in appearance often made the identification of geological source regions difficult. The exact identification of the sources is rendered even more difficult by intensive anthropogenic influences breaking up and spreading the original bedrock.

Macroscopic description: On the basis of macroscopic features, four types could be separated within the lithics of the Western Beregovo Hills sites. The first one is a homogeneous grey variety with conchoidal fracture *(Fig. 5.1)*, the second is a more intensively silicified light grey rock with occasional pinkish shade and frequent inhomogeneities in texture *(Fig. 5.2)* (these two types occurred most frequently on the settlements Beregovo I–VI). The third variety is occurring on the site Muzhiyevo-A: it is very light, sometimes white with light blue tint. The texture is homogeneous, sometimes with rusty brown ore minerals *(Fig. 5.3)*.[17] The fourth type is typical for the site Muzhiyevo-B, a varicoloured version with most variable colours, grey or bluish with light and dark brown, purple stripes. The texture is compact, the fracture is conchoidal. There are hollows and cavities sometimes with secondary crystals on their walls (most frequently alunite) *(Fig. 5.4)*.

Microscopic description, grouping: In the case of type 1, microscopic analysis shows well the original tuffy structure of the rock (laminar appearance, uniformly fine grained matrix). In the glassy matrix there are microcrystalline quartz grains (angular crystals), opaque minerals, as well as clay mineral grains, which are pseudomorphs after feldspars are observable *(Fig. 6)*.

The second variety of the rock with inhomogeneous texture can be fairly well distinguished from type 1 under the microscope: its matrix shows initial formation of brecciated texture, with frequently occurring fissures and cavities. The matrix is composed of microcrystalline quartz crystals comprising quartz crystals of variable size. Observations indicate a silicified rhyolitic lava rock formed by multiple recrystallisation *(Fig. 7)*.

The geological map of the area shows rhyolite tuffs belonging to the Dorobratovo Formation.[18] Lava rocks are marked on the map close to the archaeological sites but they cannot be identified on the surface in the form of outcrops, mainly due to viticulture extended over the hills changing the natural environment.

The third variant is similar to type 1, with a lot of microcrystalline quartz grains though with less opaque grains and clay minerals. Moreover, on the walls of the cavities we can observe zeolite mineral grains. On the basis of microscopy, the character of the matrix and the mineral grains, it could be identified as silicified tuff *(Fig. 8)*. The exact geological source of this type could not be identified as yet.

In the case of the fourth variant, embedded in the microcrystalline matrix we can find quartz grains of variable size, often rounded, together with opaque grains. By microscopic analysis, matrix and observable minerals

[15] NASEDKIN 1963; PETRUN' 1972.
[16] MATSKIV–KUZOVENKO 2003.
[17] RÁCZ 2009a.
[18] PRICHODKO–KOREN' 1982.

the rock could be identified as silicified tuffite with considerable presence of alunite *(Fig. 9)*. Blocks of the raw material (from a few centimetres till blocks of 20-30 cm) can be found in the immediate vicinity of the archaeological site as debris.

In spite of the macro- and microscopically observable differences in the above presented four raw material types, they all belong to the same series of silicified or alunitised tuff or silicified lava rock and can originate from, potentially, the same outcrop.

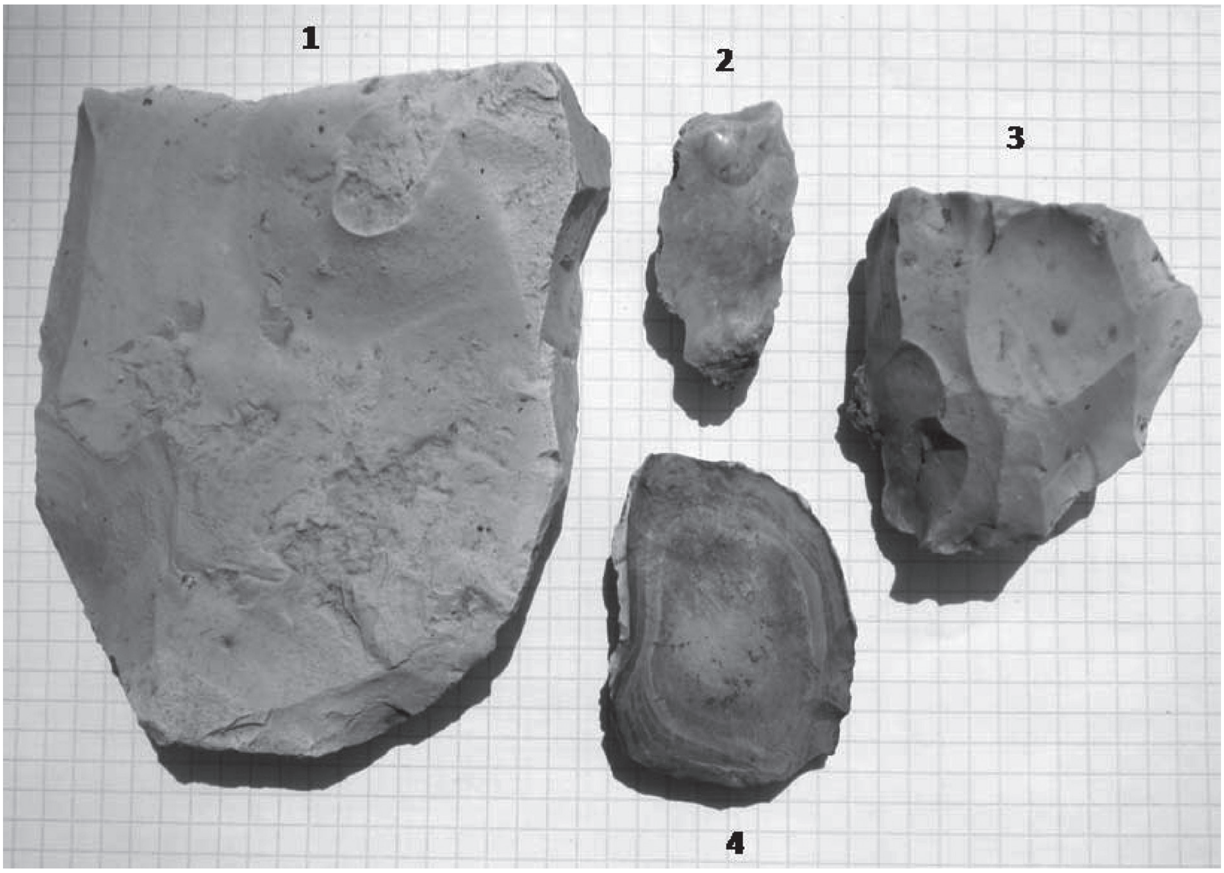

Fig. 5. Primary raw materials of the Palaeolithic sites around Beregovo

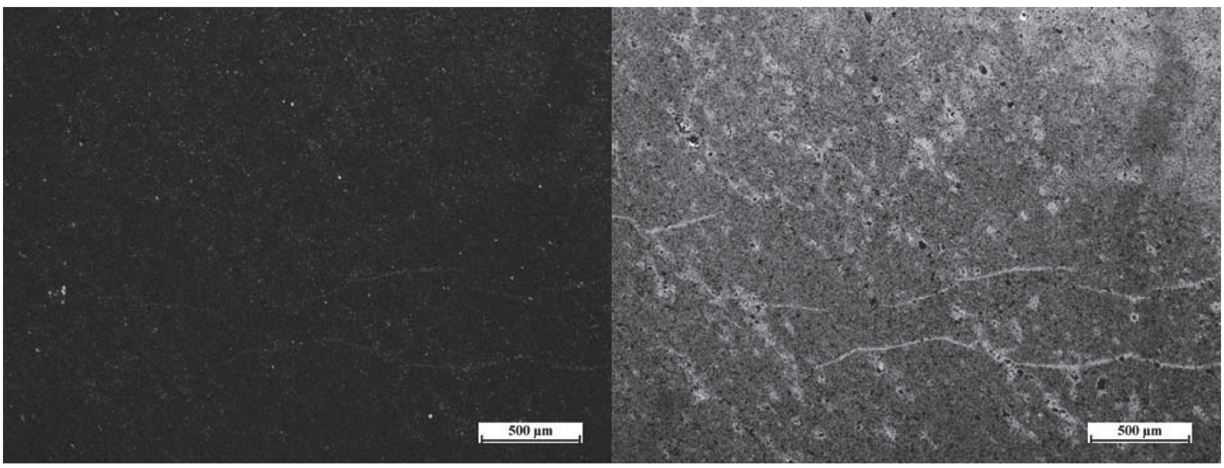

Fig. 6. Thin section microscopic photos of the siliceous rhyolite tuff (Beregovo, type I) (1N and XN)

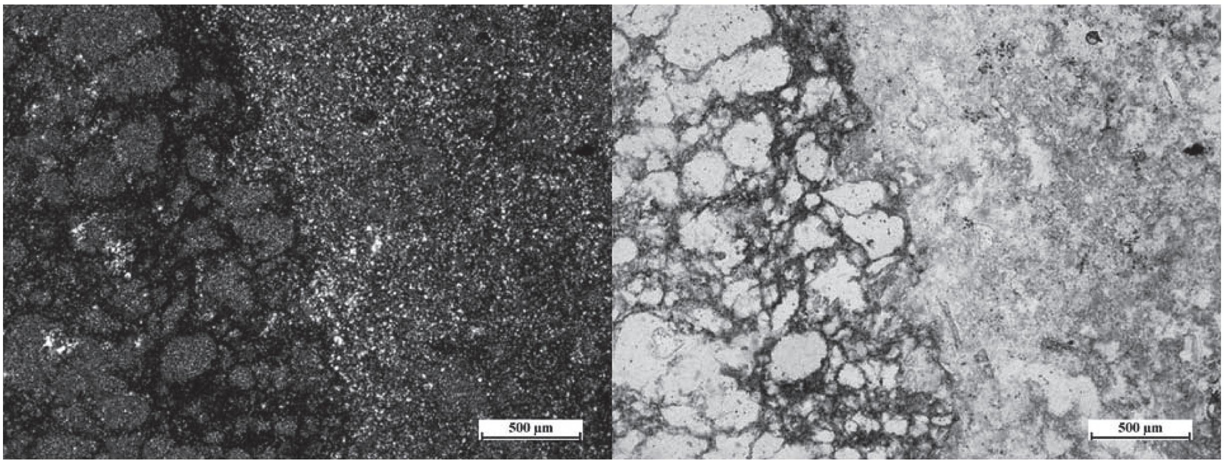

Fig. 7. Thin section microscopic photos of the siliceous rhyolite (Beregovo, type I) (1N and XN)

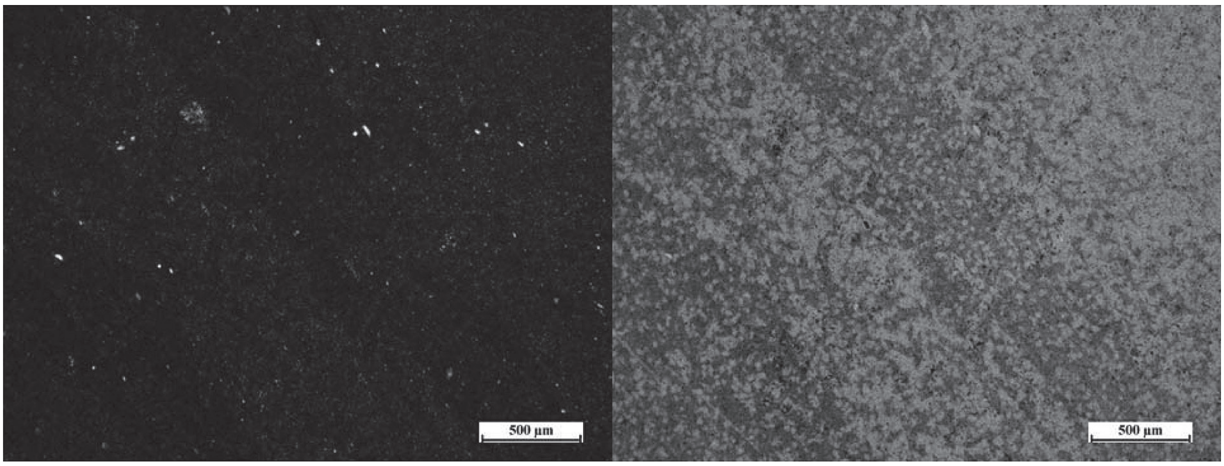

Fig. 8. Thin section microscopic photos of the siliceous rhyolite tuff (Beregovo, type II) (1N and XN)

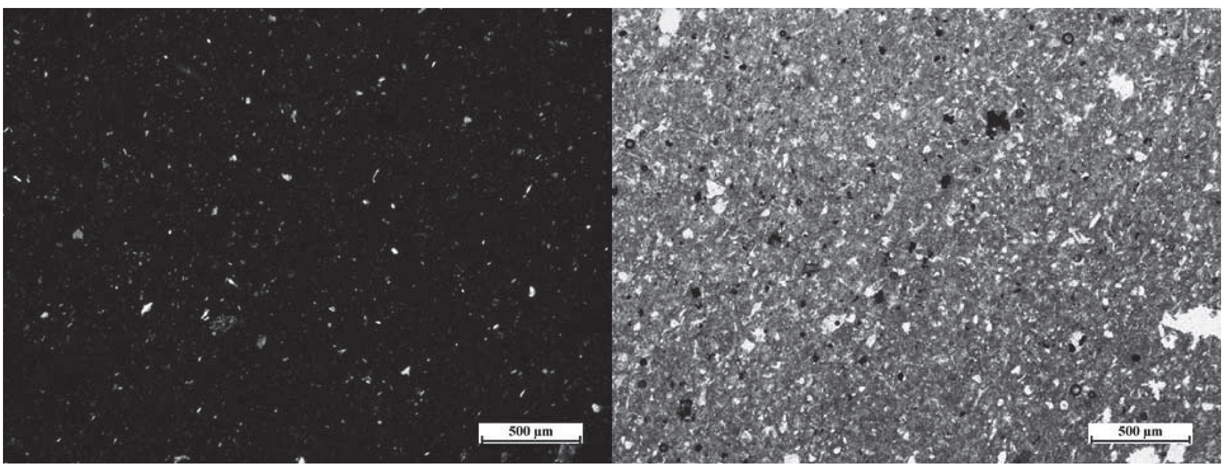

Fig. 9. Thin section microscopic photos of the siliceous tuffite (Beregovo, type I) (1N and XN)

b) Raw material types occurring around Muzhiyevo (Muzhiyevo C, D, E)

Occurrence: Three newly recovered Palaeolithic sites were located here on the surface. As they are not part of the official archaeological register as yet, they are marked here by letters of the alphabet (C, D and E). They are located to the North of the current village of Muzhiyevo, 400 m to the East of the hill Velika Berehivska. The raw material is occurring in considerable quantities, in form of debris, on the Northern side of the archaeological sites.

Macroscopic description: The primary raw material here was in all cases local, metasomatically transformed silicified rock. It is of compact homogeneous texture, conchoidal fracture and dark grey base colour, sometimes with light blue or purple tint. No stripes can be observed macroscopically *(Fig. 10).*

Microscopic description: According to the microscopic analysis, the primary raw material of the local Palaeolithic sites had a microcrystalline matrix. There were also large quantities of opaque grains in the same matrix. Part of the quartz grains were rounded, i.e., of sedimentary origin. In thin section, the matrix showed a marked striped character. The rock can be identified clearly as silicified rhyolitic tuffite *(Fig. 11).*

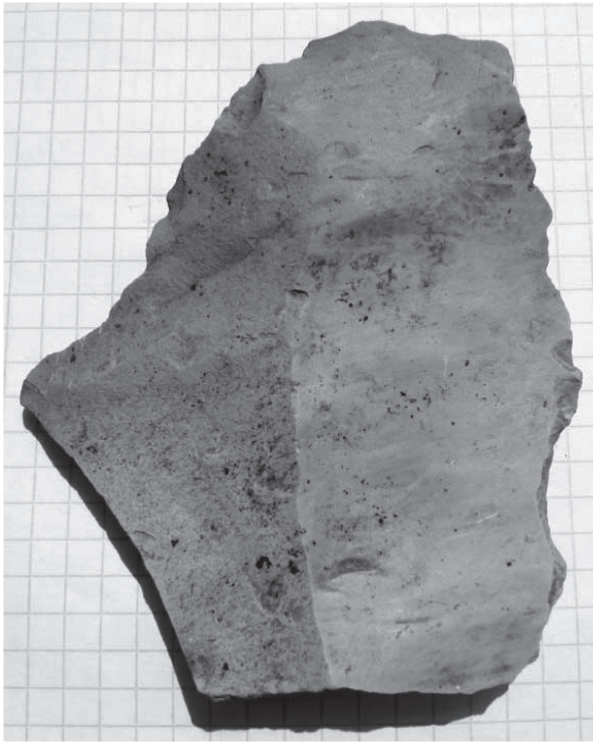

Fig. 10. Primary lithic raw material of the Muzhiyevo C site, siliceous tuffite (Beregovo, type II)

c) Raw material of the sites around Bene village (Bene I and II)

Occurrence: This territory is located on the south-western confines of the Beregovo Hills, on the right bank of the river Borzhava. Two surface Palaeolithic sites are known from here, notably from the Kisvártető (local, Hungarian name of the hill) to the North of the current village.

Macroscopic description: The primary raw material of the chipped stone tools is an adequately silicified rock of homogeneous texture and conchoidal fracture. Its colour is typically light grey or brown, often with dark brown or purple tint and stripes. The geological source of the raw material of the Bene sites could not be clearly

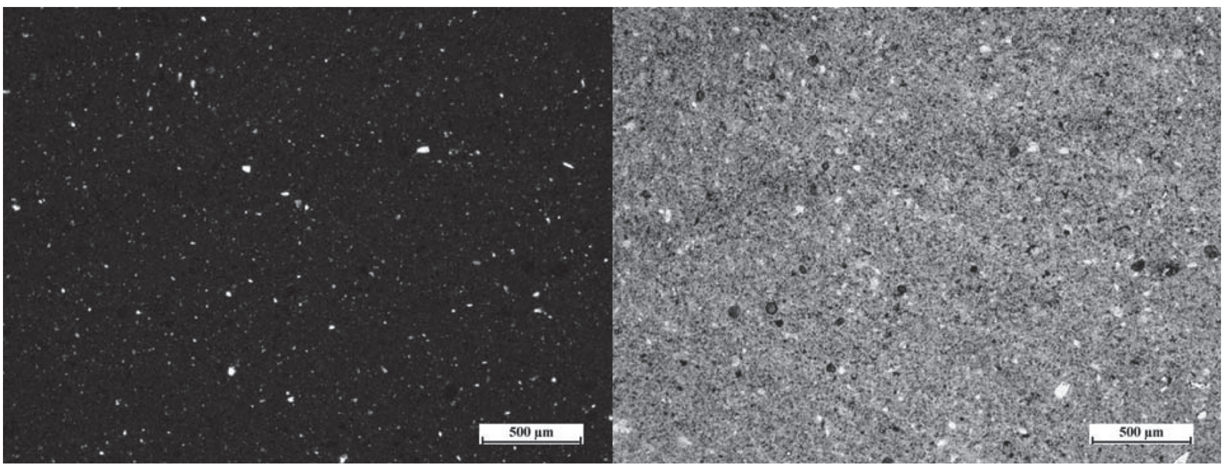

Fig. 11. Thin section microscopic photos of the siliceous tuffite (Beregovo, type II) (1N and XN)

identified as yet. Similar rocks do occur in form of debris at the neighbouring village Kvasovo. On the artefacts collected from the archaeological sites we can observe remains of the cortex, of brown or yellowish-brown colour in 0,5-1 mm thick layer *(Fig. 12)*.

Microscopic description: The matrix of the Bene samples is isotropic opal, often with relict mineral grains like lath-form plagioclase (albite crystals). In the poorly crystallised matrix we can observe opaque minerals as well. In the thin section we can observe the original (porphyric) structure of the rock. Thus, on the basis of microscopic observation the rock was identified as metasomatically transformed silicified (opalised) lava rock of rhyolitic composition (opalite) *(Fig. 13)*.

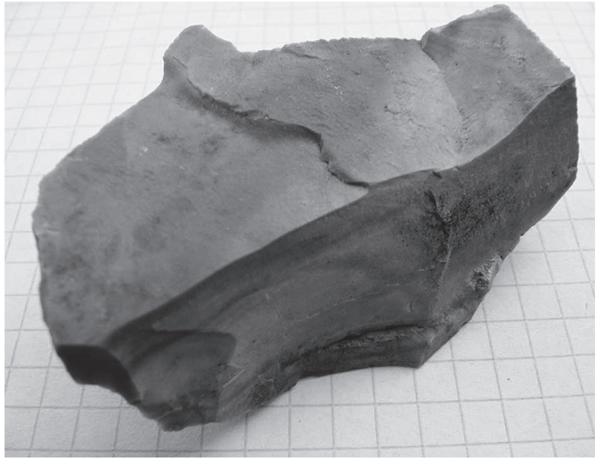

Fig. 12. Primary lithic raw material of the Bene Palaeolithic site, opalised rhyolite (Beregovo, type II)

The above listed six rock types were formerly referred to, uniformly, as "Beregovo silex",[19] and there were no detailed petrographical studies on them.

The primary lava rock probably reached the surface in a short time and cooled very fast, thus the minerals could not crystallise. The resulting homogeneous glassy lava rock was transformed by postvolcanic activity, changing the glass into opal.

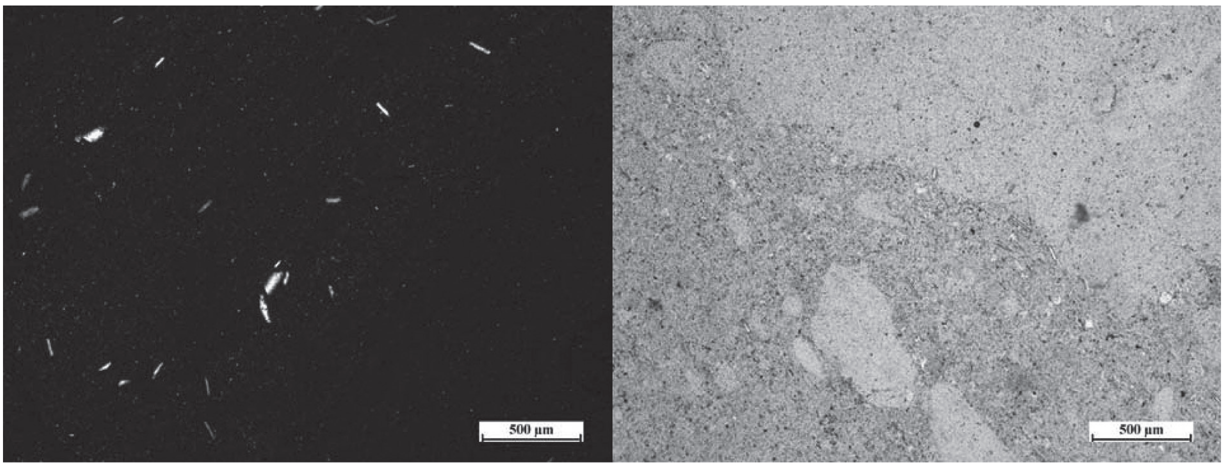

Fig. 13. Thin section microscopic photos of the opalised rhyolite (Beregovo, type II) (1N and XN)

Summing up, the macro- and microscopic investigation of the various metasomatic rocks occurring on the territory of the Beregovo Hills yielded the following raw material subtypes:

– Metasomatically transformed, silicified rhyolite tuff of Beregovo environs (sites Beregovo I–VI) – *Beregovo I siliceous rhyolite tuff*
– Metasomatically transformed, silicified rhyolite tuff of Beregovo environs (Muzhiyevo-A site) – *Beregovo II siliceous rhyolite tuff*
– Metasomatically transformed, silicified lava rock of rhyolitic composition of Beregovo environs (sites Beregovo II or IV) – *Beregovo I siliceous rhyolite*
– Metasomatically transformed, opalised lava rock of rhyolitic composition of Bene environs (sites Bene I and II) – *Beregovo II opalised rhyolite*

[19] Tkatchenko 2003.

– Metasomatically transformed, silicified – alunitised tuffite of Beregovo environs (Muzhiyevo-B site) – *Beregovo I siliceous tuffite*
– Metasomatically transformed, silicified tuffite of Muzhiyevo environs (sites Muzhiyevo-C, D, E) – *Beregovo II siliceous tuffite*.[20]

Siliceous sandstone

On the Palaeolithic site of the Transcarpathian area, apart from the above presented rocks of volcanic origin, several kinds of sedimentary rocks were equally used by prehistoric stone knappers. The most popular among them was a silicified sandstone originating from the Oligocene Menilite or Sipotian Formation of the Flysch Carpathians.

Occurrence: On several Palaeolithic sites in Transcarpathia the primary raw material is a special type of sandstone with siliceous cement of variable appearance. In the individual settlements it is present in relatively low percentages compared to other lithic raw materials. The prehistoric stone knappers probably collected this raw material from secondary sources, from river gravels in form of pebbles. On a considerable portion of the archaeological finds we can still identify the cortex of the pebble. Different size pebbles of siliceous sandstone could be identified so far in the alluvial load of the rivers Tisza, Rika and Borzhava. The primary source of the raw material,

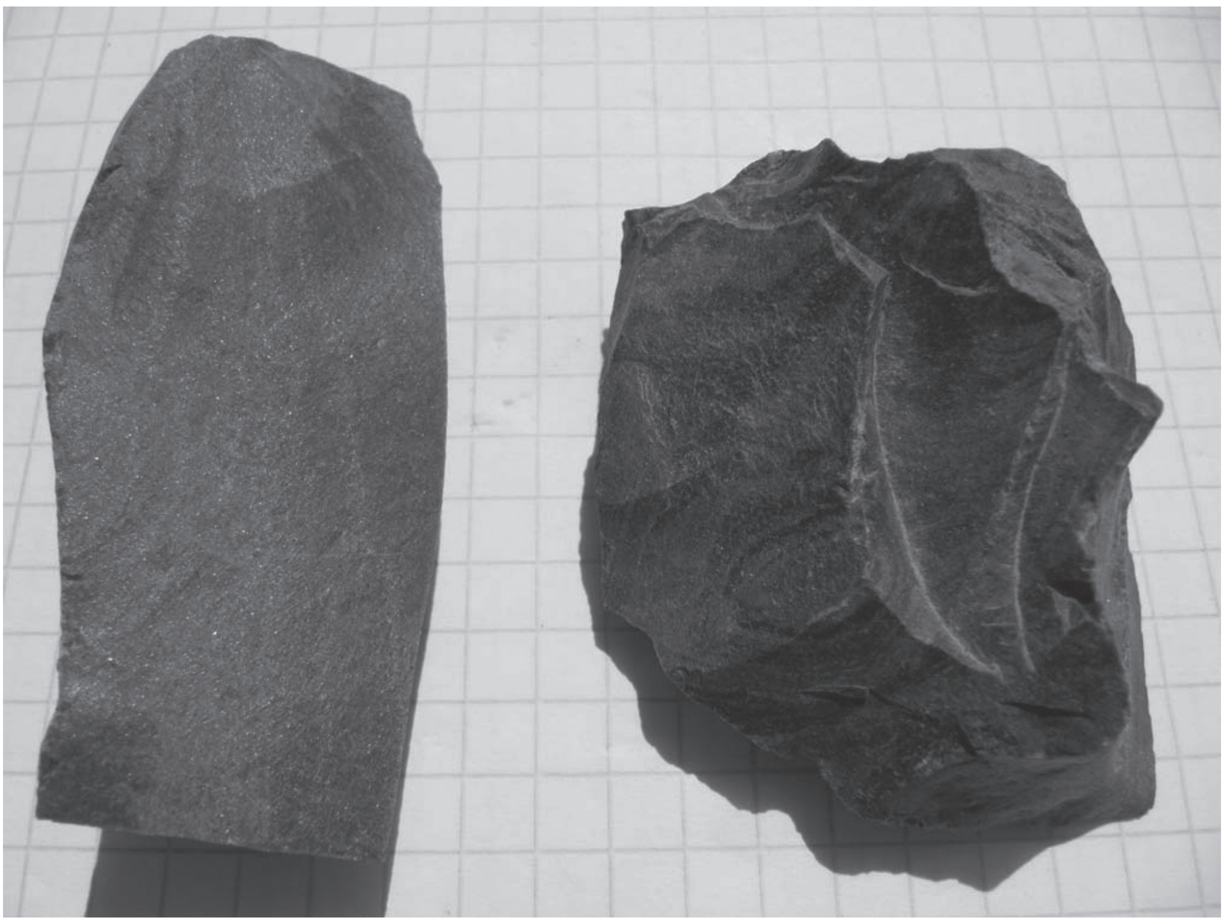

Fig. 14. Siliceous sandstone

[20] Rácz 2010b.

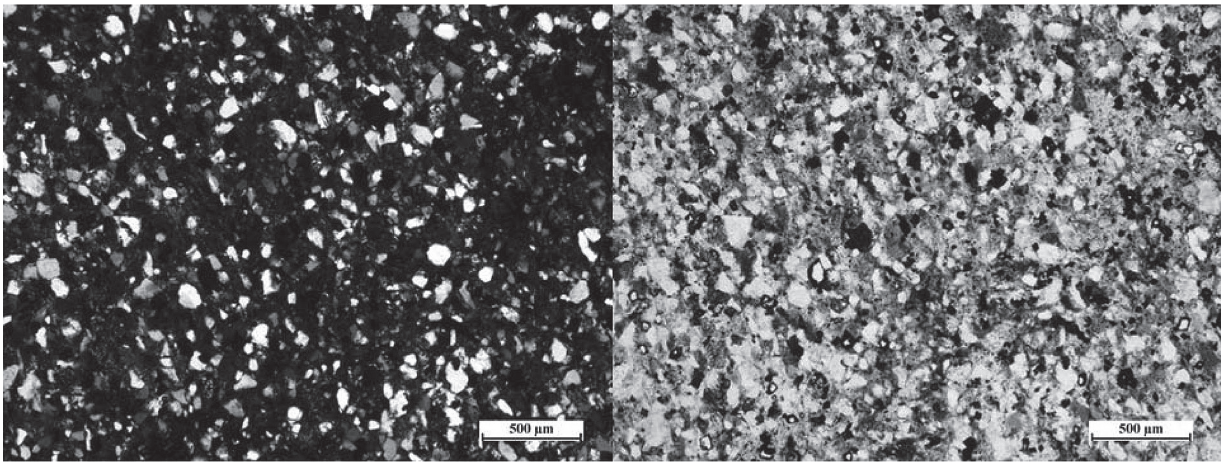

Fig. 15. Thin section microscopic photos of the well sorted finegrained siliceous sandstone (1N and XN)

however, is unknown. With an eye on the geological build-up of the region we assume that the rock is potentially originating from the Flysch-belt of the Carpathians, from the Cretaceous Sipotian or the Oligocene Menilite Formation.[21] Rivers of south-south-western flow orientation could transport the pebbles in the immediate vicinity of the archaeological sites, where, for want of better, they were used by the prehistoric stone knappers.

Macroscopic description: The surface of the most typically occurring sandstone type is dark grey, brown, with alternating darker and lighter stripes. It is typically fine grained with conchoidal fracture. The alternating light and dark stripes are most apparent on the freshly broken surface. The stripes have an oriented array. On the fractured surface, however, we can often find lenticular, circular or irregular stains, too *(Fig. 14).*

Microscopic description: In thin section it is observable that the rock is very fine to fine grained, with thin laminar siliceous binding matter. It is a matrix supported rock, the quantity of clasts is about 65-70%, which means this is a wacke. It is medium sorted, the dominant grain size is 0,05-0,02 mm, changing by layer. The clasts are almost exclusively monocrystalline quartz grains, very angular or angular, less frequently chert fragments. Occasionally we can find grains of glauconite and white mica. At some places aggregates of opaque minerals can be observed as well *(Fig. 15).*

4. RAW MATERIAL REGIONS OF THE TRANSCARPATHIAN PALAEOLITHIC

The preliminary analysis of chipped stone tools from Palaeolithic settlements in various regions of Transcarpathia, data from archaeological and geological technical literature and field survey data allows to outline the raw material circulation of the Palaeolithic period of the region. We could separate so far, on the basis of lithic raw material use and geological sources three raw material regions *(Fig. 16).* In the followings we shall try to characterise and delimit these regions.

1. Volcanic raw material region

In the volcanic raw material regions of the Transcarpathian Palaeolithic two raw material types of volcanic origin played a dominant part in the production of stone artefacts: glassy dacite from Korolevo and Carpathian 3 type obsidian from Rokosovo. Both of these raw materials were spread as dominant raw materials on clearly delimited and separate regions in spite of the fact that they occur relatively close to each other. Thus we can separate two sub-regions, accordingly.

[21] MATSKIV–KUZOVENKO 2003.

a) Korolevo-Veryatsa sub-region

The oldest Transcarpathian Palaeolithic settlements were discovered in 1974 at Korolevo in the Vinohradiv district. The oldest layers of the site are dated for nearly 1 million years BC. The cultural layers yielded finds from the Lower, Middle and Upper Palaeolithic periods as well.[22] All of the cultural layers had a common feature: the raw material dominantly used was confined to one rock type. All human inhabitants of the Korolevo site, assigned to different cultures and different time periods were using the same raw material type over hundreds of thousand years. The raw material was described in archaeological technical literature as andesite, notably Korolevo andesite since the 1970s.[23] Our recent studies on the rock proved it to be a glassy variety of dacite (hyalodacite), due to a higher SiO_2 content than supposed before.[24] Our field surveys could locate this raw material in the vicinity of the sites even today, in the form of volcanic blocks of various size.

Apart from the primary raw material (hyalodacite), Palaeolithic knappers used other rocks as well in the region, though in very modest ratio. This includes siliceous sandstone from the alluvial layers of the river Tisza and siliceous argillite as well as C3 obsidian. Raw materials of more distant origin involve limnic quartzites (silicites) of the Tokaj Mountains. The dominant raw material, however, was local glassy dacite (hyalodacite) *(Tab. 1)*.

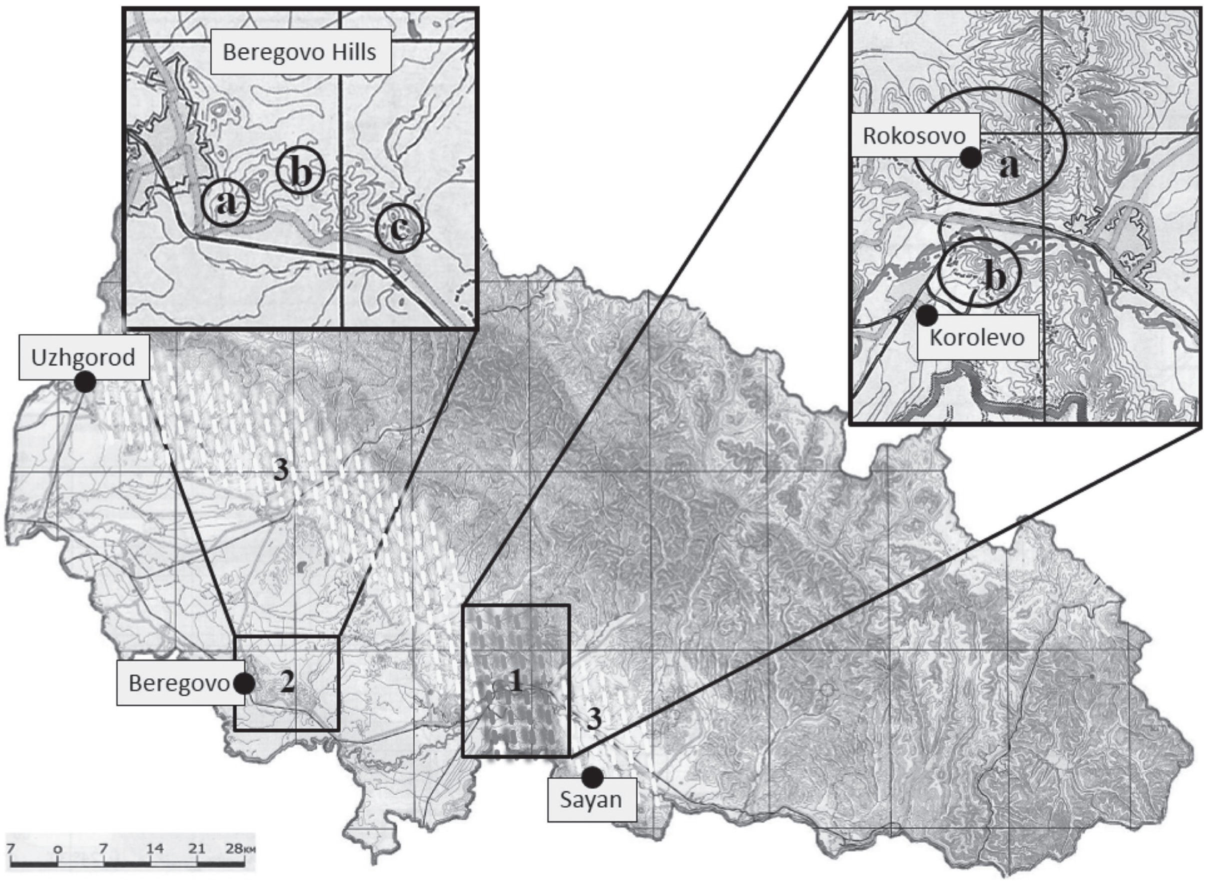

Fig. 16. Palaeolithic raw material regions in Transcarpathia. 1: volcanic; 2: metasomatical / silicified; 3: sedimentary

[22] GLADILIN–SITLIVIY 1990.
[23] See summary issue by KULAKOVSKA 2002.
[24] RÁCZ 2009b.

b) A Rokosovo-Maliy Rakovets sub-region

To the North of the Korolevo Palaeolithic settlements on the right bank of the river Tisza, Palaeolithic settlements indicate the presence of further human communities, representing different phases of the Palaeolithic period. The sites are located only a few scores of kilometres from Korolevo, but they represent an absolutely different tradition in raw material use. On the settlements around Rokosovo and Maliy Rakovets, stone knappers used mainly another local, glassy and volcanic material, i.e., local obsidian.[25] Obsidian is a volcanic glass formed by quenching (very fast cooling) of the lava. It had important role in most phases of human history, in some instances playing even cultic role (e.g. in the life of Central American cultures, contemporary to European Middle Ages or even more recent tribal cultures on the Easter Islands). The Transcarpathian obsidian source is unique as there are no more geological sources known in the whole territory of the Ukraine. We know altogether three source regions in the Carpathian Basin, generally mentioned in archaeometrical technical literature as Carpathian obsidians.[26] The sources of the Carpathian 1 and Carpathian 2 types can be found in the Eperjes-Tokaj (Prešov-Tokaj) Mountains, the former one on the Northern, currently Slovakian parts of the mountain and Carpathian 2 on the southern (Hungarian) parts.[27] Carpathian 3 obsidian occurs, as described above, in the Vinohradiv Mountains (Ukraine).

Transcarpathian obsidian was a popular raw material in the Palaeolithic period, in spite of the rather inferior quality. The glass matrix frequently contains white feldspars and other inclusions that forms an area of weakness in the rock for knappers. On the source region (Vinohradiv Mountains) we can still find it in primary position in the form of smaller and larger blocks. In the 1960s blocks of more than one meter were described by geologists.[28] The Rokosovo obsidian is special in this regard among the Carpathian sources as the known Hungarian and Slovakian sources are almost totally exploited by today, and only small lumps of obsidian can be found in secondary environment.[29]

Obsidian as lithic raw material played an important role in the Palaeolithic and Neolithic periods in Transcarpathia. On the Palaeolithic settlements we can find all the three Carpathian obsidian types *(Tab. 1).* So far we could not locate obsidian from more distant sources as yet. At the same time, Russian and Ukrainian geological technical literature have described more than ten different sources of obsidian and volcanic glass from different parts of Transcarpathia.[30] This leaves the possibility open for the accessibility of other obsidian sources apart from the already known Carpathian 1, 2, 3 sources. (On the possible occurrences of Transcarpathian obsidians, see studies by Rácz.[31]) Solving the problem would require more detailed studies on sources (verifying existence and quality suitable for knapping), but also more instrumental analysis on known Ukrainian archaeological sites with obsidian tools. On the basis of field surveys made so far, we can support the existence of only one obsidian source in Transcarpathia, i.e., that of the Vinohradiv Mountains.[32]

In the Neolithic period, seemingly the Carpathian 1 obsidian type was preferentially used in the Transcarpathian region, as much as we can judge from present data.[33] The Carpathian 1 (and, to a lesser extent, Carpathian 2) obsidian was distributed over much larger area than the Carpathian 3 type, already in the Palaeolithic period. Carpathian 3 obsidian was mainly used locally in the Palaeolithic period; it is possible, though, that it was also used by the local Neolithic cultures. As C3 obsidian got established and fingerprinted (geochemically) only recently, this issue was not examined as yet.[34]

Apart from the dominant raw materials, other raw materials were also used on the sites in lesser quantities like different siliceous rocks and metasomatically transformed rocks.

2. *Metasomatical raw material region*

A different raw material utilisation region is represented in the Palaeolithic of Transcarpathia by the Beregovo Hills. On the site Beregovo I, the first excavations were performed in the so-called Czechoslovakian Era (be-

[25] Rizhov 1999, 2003.

[26] Originally proposed by Renfrew*et al.*1965 further established by Williams-Thorpe–Warren–Nandris and co-authors, 1984.

[27] See more on their research and history by Biró 1981; Bíró 2004.

[28] Zalesskiy 1960.

[29] Biró 2004.

[30] Bobriyevitch 1952; Danilovich 1963; Fishkin 1954; Gorbatchevskaya 1969; Maleyev 1964; Merlitch–Spitkovskaya 1974; Nasedkin 1963; Radzivill *et al.* 1978; Sobolyev *et al.* 1955; Soloninko 1969; Soloninko–Timofeyeva 1981; Zolotuhin 1960.

[31] Rats 2009; Rácz 2012.

[32] Rats 2009.

[33] Potushniak 2011.

[34] Mester–Rácz 2010.

tween the two World Wars). Palaeolithic settlement traces were located on the eastern, central and western parts of the Beregovo Hills. The Palaeolithic stone knappers were using mainly local silicified volcanites for the production of lithic artefacts. At the same time, the raw material economy was fairly varied as demonstrated by regional and long-distance raw materials on the settlements. Available data indicate that the communities settled on the Beregovo Hills were establishing here short-term temporary settlements. They knew and utilised the local resources, the documents of chipping activities are observable on many places. However, they were probably spending here a short time

Table 1: Primary raw materials of the Transcarpathian Palaeolithic sites and other occurring raw materials in the region

Raw material region	Sub-region	Dominant raw material	Character of the source region	Other raw materials occurring	Character of the source region
Volcanic region	**Korolevo-Veryatsa**	Glassy dacite (90–95%)	Local, in debris	Carpathian 3 obsidian	Local (Rokosovo / Rakasz), in debris
				Siliceous sandstone and argillite	Local (Tisza alluvium)
				Limnic quartzite	LD/Regional (Tokaj Mts)
	Rokosovo-Maliy Rakovets	Carpathian 3 obsidian (85–90%)	Local, in debris	Siliceous rocks	unknown
				Metasomatically transformed rocks	unknown
Metasomatic region	**Beregovo**	Metasomatically transformed, opalised rhyolitic lava rocks, silicified rhyolite tuff and tuffite (90–95%)	Local, in debris	Siliceous sandstone	Regional (alluvium)
				Radiolarite	Regional (Pieninian belt) LD (White Carpathes)
				Carpathian 1 obsidian	LD/Regional (Tokaj-Presov Mts)
				Carpathian 2 obsidian	LD/Regional (Tokaj Mts)
				Siliceous rocks	unknown
				Limnic quartzite	LD/Regional (Tokaj Mts)
	Muzhiyevo	Metasomatically transformed, silicified tuffite (90–95%)	Local bedrock and debris	Siliceous sandstone	Regional (alluvium)
				Radiolarite	Regional (Pieninian belt) LD (White Carpathes)
				Carpathian 1 obsidian	LD/Regional (Tokaj-Presov Mts)
				Carpathian 2 obsidian	LD/Regional (Tokaj Mts)
				Siliceous rocks	unknown
				Limnic quartzite	LD/Regional (Tokaj Mts)
	Bene-Kvasovo	Metasomatically transformed, opalised rhyolitic lava rock (opalite) (85–90%)	Local, debris	Siliceous sandstone	Regional (alluvium)
				Radiolarite	Regional (Pieninian belt) LD (White Carpathes)
				Carpathian 1 obsidian	LD/Regional (Tokaj-Prešov Mts)
				Carpathian 2 obsidian	LD/Regional (Tokaj Mts)
				Siliceous rocks	unknown
				Limnic quartzite	LD/Regional (Tokaj Mts)
				Siliceous argillite	Regional (alluvium)
Sedimentary region	–	Siliceous sandstone (60–90%)	River gravel (Tisa, Rika, Ung)	Siliceous argillite	Local (alluvium)
				Glassy volcanites	Local
				Metasomatically transformed rocks	unknown
				Silicified limestone	Local or regional (alluvium)
				Radiolarite	Local or regional (alluvium)
				Carpathian 1 obsidian	LD/Regional (Tokaj-Prešov Mts)
				Siliceous rocks	unknown
				Limnic quartzite	LD/Regional (Tokaj Mts)

Table 2: Geographical names mentioned in the text

Current name (Transcribed from Ukrainian in Latin letters)	**Ukrainian name**	**Hungarian name**
Bene	Бене	Bene
Beregovo	Берегово	Beregszász
Beregovo Hills	Берегівське горбогір'я	Beregszászi-dombvidék (dombság)
Flysch Carpathians	Флішові Карпати	Flis Kárpátok
Flysch belt of Carpathians	Пояс Флішових Карпат	Kárpáti flisöv
Kutchava	Кучава	Németkucsova
Kvasovo	Квасово	Kovászó
Maliy Rakovets	Малий Раковець	Kisrákóc
Mukatchevo	Мукачево	Munkács
Muzhiyevo	Мужієво	Nagymuzsaly
Oas Mountains	Гори Оаш	Avas-hegység
Pieniny Klippen Belt	Пієнінська зона скель	Pienini szirtöv
Radvanka	Радванка	Radvánc
Rika River	Річка Ріка	Nagy-ág
Borzhava River	Річка Боржава	Borzsa
Rokosovo	Рокосово	Rakasz
Sayan	Шаян	Saján
Silskiy stream	Сільский потік	Falusi patak
Sin'ak	Синяк	Szinyák
Solotvino Basin	Солотвинська западина	Szlatinai medence
Tisa River	Річка Тиса	Tisza
Transcarpathia	Закарпаття	Kárpátalja
Transcarpathian Plain	Закарпатська низовина	Kárpátaljai-síkság
Uzhgorod	Ужгород	Ungvár
Velika Berehivska hill	Гора Велика Берегівська	Beregszászi Nagy-hegy
Veryatsa	Веряца	Verécе
Vihorlat-Gutin volcanic range	Вигорлат-хутинський вулканічний хребет	Vihorlát-Gutini vulkanikus vonulat
Vinohradiv Mountains	Виноградівські гори/Великий Шоллес	Nagyszőlősi-hegység
Zolotista Hill	Гора Золотиста	Aranyos-hegy

only and moved further on. The raw material necessary for tool production could be collected at almost any part of the hills as the Tertiary volcanites building up the area were silicified or opalised due to postvolcanic processes over almost the entire hilly region.[35] As a result of metasomatical transformation, silicified and opalised tuff, tuffite and rhyolite served as primary raw materials on the Palaeolithic settlements around Beregovo, Muzhiyevo and Bene.[36]

The location of the Palaeolithic sites here is similar in a way to the Korolevo and Rokosovo pattern. The prehistoric communities settled around the available raw material sources. On the basis of site / source location and distribution of raw material the Beregovo Hills region can be divided into three parts. These „sub-regions" show different patterns in primary raw material use. It is the only raw material region that we could subdivide so far.

a) Beregovo sub-region

The primary raw material types of the region are local metasomatically transformed, silicified rhyolite tuff, tuffite and rhyolitic lava rock. Further local rock types (other metasomatites) are present in minor quantities. In respect of regional rock types we can mention siliceous sandstones and radiolarites from the Pieniny Klippen Belt. Long distance raw materials occur rarely, comprising mainly Carpathian 1 and 2 obsidian, different silex varieties, e.g., radiolarites and limnic quartzite types. Limnic quartzite, limnic opalite and limno-chalcedonite are regionally widely used terms denoting lacustrine sedimentary silicites.[37] The geological source region of the primary raw

[35] LEYE *et al.* 1971; MERLITCH–SPITKOVSKAYA 1974; RADZIVILL *et al.* 1978; FISHKIN 1958.

[36] RÁCZ 2008a, RÁCZ 2009a, RÁCZ 2010b.

materials could be located on the surface, partly, at the northern and north-eastern parts of the sub-region, in the form of blocks of stone scattered on the surface *(Tab. 1)*.

b) Muzhiyevo sub-region

The primary raw material here is local, metasomatically transformed, silicified tuffite. Among further raw materials we find further local metasomatites. As regional raw materials we can mention siliceous sandstones and radiolarites. The long distance raw materials are very rarely occurring Carpathian 1 and 2 obsidian and siliceous rocks, e.g. limnic quartzite. The silicified tuffite mentioned as primary raw material can be found in the form of various size blocks all over the territory including the area of the archaeological sites *(Tab. 1)*.

c) Bene-Kvasovo sub-region

On the territory of the sub-region located at the eastern side of the Beregovo Hills, the primary raw material is a metasomatically transformed opalised rhyolitic lava rock (opalite), the geological source of which cannot be identified so far. On the sites Bene I and II, apart from the primary raw material there are further local metasomatite types as well. Regional raw materials include siliceous sandstone, radiolarite and other siliceous rocks. Long distance raw materials include Carpathian 1 and 2 obsidian, and other siliceous rocks, e.g., limnic quartzites *(Tab. 1)*.

3. Sedimentary raw material region

In the Palaeolithic period, temporary settlements were also formed along the foothill region of the Vihorlat-Gutin volcanic complex, from Uzhgorod to Mukatchevo till the Vinohradiv Mountains, and even further on to the east on the Ukrainian part of the Oas Mountains around Sayan.[38] On these sites the character of raw material use was basically different than the above mentioned three regions. The ratio of the dominant raw material in the archaeological assemblages was never reaching 85–90% like in the case of the formerly analysed regions.

The dominant raw material on these sites was siliceous sandstone. Different types of this raw material could be collected by the local masters in the form of pebbles from the river loads. The identification of the primary source, even delimiting the source area is problematic as the rock was transported by rivers originating from the flysch belt of the Carpathians towards the Transcarpathian Plain and the Tisza Basin.[39] The knappers must have selected from the pebbles the suitable pieces for producing cores and tools.

In course of field surveys, four potential source types for chipped stone tools were identified in the eastern parts of the region, i.e., the Solotvino-Basin as well as the northernmost margin of the Ukrainian ranges of the Oas Mountains. Two of these sources (limno-chalcedonite and limno-opalite) were identified as primary geological sources *in situ*, the other two source types (silicified argillite and siliceous sandstone) were found in secondary deposits in the alluvial sediments of rivers, in the form of pebbles. Silicified argillite could be also identified within the archaeological collections of Transcarpathia in all of the listed regions, mainly as regional raw material *(Fig. 17)*.

Palaeolithic settlements of the region comprise Palaeolithic settlements with more than 90% of stone artefacts made of siliceous sandstone (e.g., Radvanka), but in the case of most archaeological sites, this ratio is only 50–60%. Consequently, other local and regional raw materials play a more important role. Among local raw materials we can mention glassy volcanites (dacite or andesite), different metasomatically transformed volcanites as well as siliceous limestone and radiolarite. Further regional or long distance raw materials include Carpathian 1 obsidian, silex and limnic quartzite varieties *(Tab. 1)*.

5. CONCLUSION

In the Palaeolithic period we cannot prove the existence of regular and permanent long distance trade network or trade routes in the Transcarpathian area. The exotic raw materials are exceptionally rare and there is a

[37] Gyarmati 1977; Szekszárdi–Szakmány–Biró 2010.
[38] Tkatchenko 2003.
[39] Rácz 2009b.

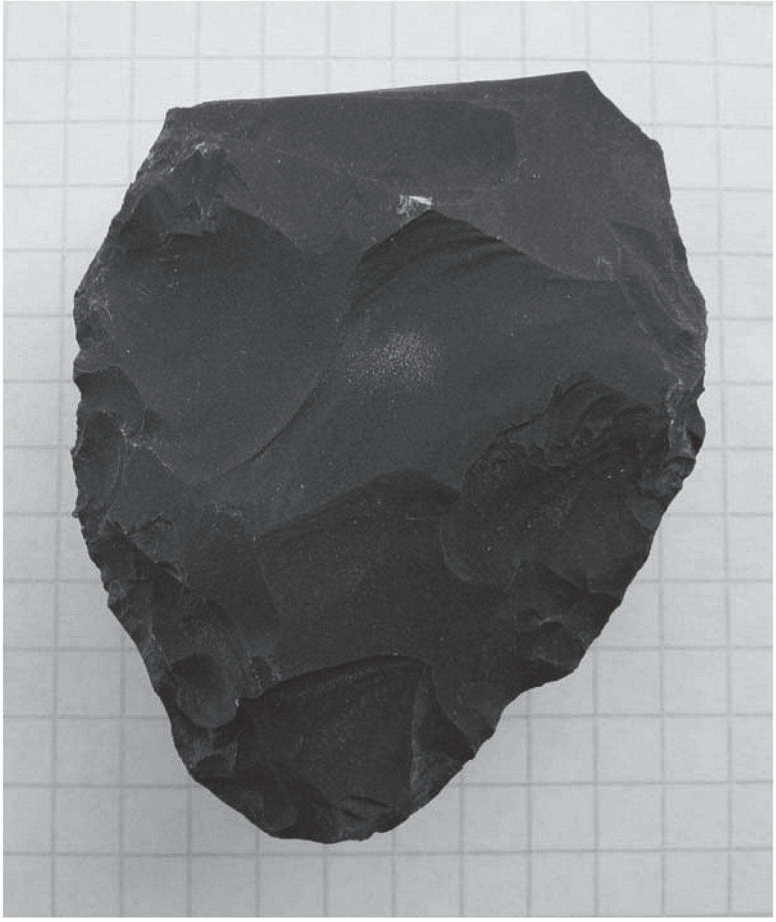

Fig. 17. Siliceous argillite

basic dominance of local and regional raw material types. It is apparent however that human communities often settled on and around significant raw material sources. This can be observed for the Korolevo, Rokosovo and Beregovo Hills Palaeolithic sites. The existence of these sites is most probably related to raw material procurement and workshop activity around the sources.

In the light of recent studies we could clarify sources and terminology for several important lithic raw materials, adding detailed petrographical analysis and by the help of these studies emend formerly erroneously identified rocks and elucidate some problematic siliceous and silicified rock types.[40]

On the basis of our current knowledge on the raw material of stone tools in Transcarpathian Ukraine we could divide the territory into three raw material regions. Palaeolithic communities in the given region were primarily using local raw materials for the production of their tools. Regional and long-distance raw materials were also observed but in much smaller amounts. It seems that the raw material regions of the Transcarpathian Palaeolithic are fairly distinct, using different primary raw materials each. The primary raw material was, in all cases, of local origin, meaning that the Palaeolithic communities were settled directly on and around the raw material sources. Criteria for separating sub-regions within the raw material regions could be as follows:

a) relatively low ratio of the primary raw material (50–70%) compared to other lithic raw materials within one archaeological site; consequently, the stone knappers had to use relatively high amount of other rocks, both local and regional ones.

[40] RÁCZ 2010a.

b) geological / topographical / petrographical variability within a region; in these cases the stone knapper masters could find several good quality raw materials in the vicinity of their habitation, resulting more varied raw material use.

The primary raw materials of the Korolevo and Rokosovo regions were good quality volcanites, thus it is not accidental that the ratio of these raw materials is about 85–95% in the archaeological assemblages of the region. Good quality and abundance of Carpathian 3 obsidian (Rokosovo) and hyalodacite (Korolevo), respectively, served a vast raw material basis for human communities during hundreds of thousand years. In the case of these regions, due to the relatively small area and the abundance of the highly specific primary raw material there is no need to separate smaller units within the region.

The situation is different for the Beregovo Hills region where archaeological sites are spread in regionally separated clusters. The raw material basis for all of them was local metasomatically transformed rocks, but exact petrographical analyses could separate these metasomatites into further sub-groups. It was found that the three topographically separate settlement clusters of the Beregovo Hills were in fact formed on slightly different raw material basis. The quality of the various metasomatites could be similar, therefore everywhere the local variety was used. Another feasible explanation that the clusters were, in fact, "workshop-on-source" type settlement and consequently using the local resources. The different raw material varieties therefore could be interpreted as sub-regions.

In respect of the sedimentary raw material region it would be too early to speak of sub-regions because from a large part of the area belonging to this largest unit we do not have enough data as yet. In general we can say that lacking proper raw material in primary geological position, secondary sources were utilised as siliceous sandstone transported by the rivers in form of pebbles. Recent field surveys resulted also in the localisation of sites using local volcanites (basically, andesite) for the production of coarse artefacts. The petroarchaeological characterisation of the region needs further fieldwork and detailed petrographical studies.

ACKNOWLEDGEMENT

The authors have to thank Bohdan Matskiv for his invaluable help in fieldwork and Sándor Józsa for the preparation of the petrographic thin sections.

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