Geoarchaeology and Archaeomineralogy (Eds. R. I. Kostov, B. Gaydarska, M. Gurova). 2008.
Proceedings of the International Conference, 29-30 October 2008 Sofia, Publishing House "St. Ivan Rilski", Sofia, 36-45.

REGARDING THE PROCUREMENT OF LITHIC MATERIALS AT THE NEOLITHIC SITE AT LIMBA (ALBA COUNTY, ROMANIA): SOURCES OF LOCAL AND IMPORTED MATERIALS

Otis N. Crandell

Chair of Mineralogy, Department of Geology, Babeş-Bolyai University, Cluj-Napoca, Romania; crandell@bioge.ubbcluj.ro

ABSTRACT. Over the past decade, research at the site of the Neolithic settlement at Limba, Alba County, western Romania, has uncovered numerous lithic artefacts. The focus of this study is to compare the material from which the chipped stone artefacts were made to known geological sources of similar lithic material. Within a day's walking distance of the settlement there are numerous sources of lithic material suitable for producing artefacts. Within an area of several days' walk or a day by boat, there are even more sources, some of very good quality material. This study has shown that although there are numerous local and near-local sources of lithic material, a large percentage of the artefacts appear to have been made from non-local materials, including sources as far away as the Prut River (in the Botoşani County area), the area between the Carpathians and the Danube, and from the Western Carpathians (in the area of Hungary and Slovakia). The observations of this study suggest that the Limba settlement was part of an extensive trade network as reflected by the high percentage of non-local materials.
Key words: lithics, trade, provenance, microcrystalline quartz, obsidian, procurement

Introduction

Location of Limba site and archaeological context

The Limba archaeological site is located in the western part of Romania, in Alba County, outside of the modern day village of Limba (from which the site derives it's name), across the Mureş River from Alba Iulia (Fig. 1-2). During the Neolithic period, the site was situated on the bank of the Mureş River, which has since then shifted position several hundred metres away. Throughout history the Mureş River has been used as a major route for transporting people and materials. Limba's close proximity to the river would have given the occupants of the settlements easier access to sources of materials further away and to other settlements along the Mureş River and its tributaries (with whom they may have traded materials to which they had easy access). As well, the settlement would have had easy contact with traders/merchants travelling along the Mureş River. The Mureş valley often floods in the Spring time, making it a very fertile area. This would also have lead to the prosperity of the settlements at Limba, and thus higher probability of surplus agricultural products to trade with other settlements and spare time to travel to procure raw mineral resources.

Three main cultures were identified at the Limba site: Starcevo-Criş phase 3B (Early Neolithic, cca. 5700-5500 BC)[a], Vinča phase A (Middle Neolithic, cca. 5500-5200 BC) and Vinča phase B (Middle Neolithic, cca. 5200-4900 BC)[b]. There is a continuous evolution between the Starcevo-Criş and Vinča layers as well as between the Vinča layers. The site appears to have been continually in use, with no signs of it being abandoned and re-established (Florescu, 2007).

Although the precise cultural associations of most of the lithic artefacts have not yet been determined, all of them are from pre-Copper Age cultures. With the exception of very small quantities of native copper, gold and silver found at some contemporary settlements, the economy of the settlement at Limba was not yet influenced by metal. In fact, at Limba, no metal artefacts have yet been found[c]. This allows us to study a pre-metal economy, where lithic materials had a relatively high value among traded commodities. Thus, there is a higher chance of finding materials and artefacts imported from long distances. Similar studies at Bronze Age sites in the same region have shown a decrease in the percentage of high quality imported chipped stone materials compared to locally available materials[d].

Samples and methods

In this study, 440 artefacts from excavations at Limba were analysed macroscopically. These artefacts were all produced by knapping. They include finished tools such as blades, scrapers, burins and possibly drill bits, as well as nuclei and debitage. Some of the artefacts (particularly the blades) show signs of usage (e.g. use-wear polish, and retouch) and breakage. The collection does not include microlithic debitage. Each artefact was individually analysed macroscopically. Some

[a]Dates given are carbon 14 calibrated (based on personal communications with Cristian Florescu, 2008).
[b]Based on personal communication with Cristian Florescu (2008), Institute of Systemic Archaeology, Alba Iulia (Florescu is currently the principal researcher at the Limba archaeological site).
[c]Based on personal communications with Cristian Florescu (2008).
[d]Unpublished studies by the author regarding Bronze Age sites at Piatra Cetea and Ghirbom (Alba County).

Fig. 1. Satellite image showing the Limba site and surrounding area

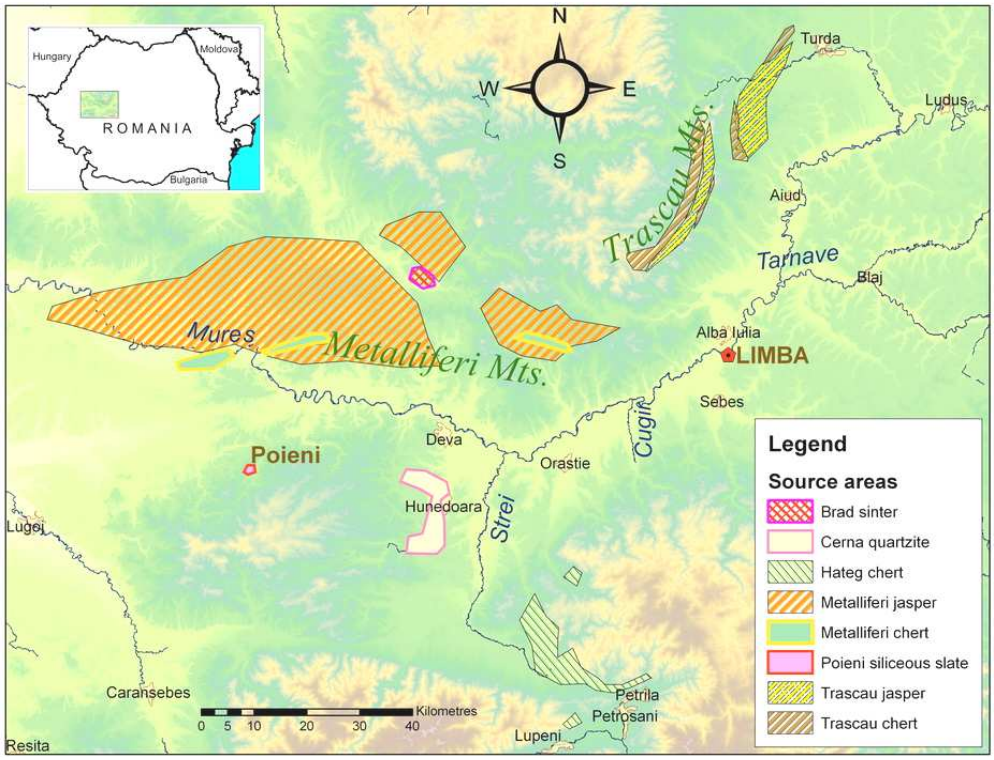


Fig. 2. Map of main local and medium-distance geological sources (the insert represents the location of the area on the map of Romania)

were also analysed with a Nikon stereomicroscope. Descriptions were recorded in a spreadsheet in Microsoft Excel. Descriptions were based on an objective system with a finite number of predefined terms. For details of the system used to describe the artefacts, see Crandell (2005).

The geological samples used in this study came from the authors' personal lithotheque and the collection of the Mineralogy Museum of Babeş-Bolyai University. Sources of lithic materials (in particular from sources not available in the museum collection) were sought by researching geological references (papers, maps). Locations with a high potential to contain sources of lithic materials were visited and samples were collected. Geological materials were analysed macroscopically. Some samples were also analysed with a Nikon stereomicroscope and optical microscopy in plan-polarised light on petrographic thin sections was carried out on a Nikon microscope at the Babeş-Bolyai University Geology Department. Descriptions were recorded in a similar spreadsheet to that used for descriptions of artefacts. Based on similar macroscopic and microscopic characteristics, geological sources were grouped into source areas (e.g. southern Trascău chert, Northern Trascău chert, Trascău and Metalliferi jasper, Techereu green jasper, Rachiş red agate). Artefacts were visually compared to geological samples. For most of the artefacts, their geological source groups were predicted based on similarity with those geological groups.

As part of a pilot study, sixteen of the geological samples from Trascău and Metalliferi jasper sources, one sample of Poieni siliceous shale and one sample of Brad sinter were analysed by Prompt Gamma Activation Analysis for comparison with each other as well as with five jasper artefacts which were also analysed (Crandell, Kasztovszky, 2008).

Results

Artefacts from Limba

The materials used to make the chipped stone artefacts at Limba vary widely in the visual characteristics, as well as in their petrographic nature. The most commonly used materials are microcrystalline quartz (MCQ) varieties, such as chert, jasper, and flint. As well, the local inhabitants used tools made from obsidian, rhyolite quartzitic sandstone, siliceous shale and microgranite. The cherts vary in colour from shades of yellowish-brown to dark brown to grey. They range from highly translucent to sub-translucent and their surface texture ranges from fine to coarse grained. The jaspers are often yellow, red or a mixture of both and vary from very intense colour to a medium intensity a few being black or dark grey. They are opaque to subtranslucent and their surface texture ranges from fine to coarse grained. The rhyolites are light and dark grey, grey-green and bluish grey. They are usually opaque with a few being subtranslucent. The surface texture of geological samples varies from fine to extremely coarse (to the point of being useless for knapping). Of the artefacts, most are medium grained. The quartzitic sandstones are light shades of brown, yellow and grey with coarse to medium grained surfaces. They are generally opaque to subtranslucent. The microgranite artefacts are coarse grained, opaque and vary in colour, being comprised primarily of speckles of black, white and browns.

The following is a general list with descriptions of materials which appear to have been used at Limba. Where not indicated otherwise, these descriptions are based on geological samples in the author's personal lithotheque and at the Mineralogy Museum of Babeş-Bolyai University. For a detailed explanation of the terminology used in the following descriptions, see Crandell (2005).

Geological occurrences of siliceous sources of lithic materials

Based on personal investigations for possible geological sources of chipped stone artefacts found at Limba, sources were separated into three categories: a) nearby sources (the Trascău Mts.), b) adjacent areas (Metalliferi Mts, Haţeg and Poiana Ruscă Mts.) and c) remote areas. The rocks found in these areas will be presented in detail, in the following.

The Trascău Mountains

There are numerous sources of lithic material in the middle course of the Mureş River suitable for producing chipped stone artefacts. Most of the sources are spread over large areas (often over 50 km long), but some are localised to very small areas (as small as a valley a few hundred metres long). Within the large sources, the materials at various locations look similar but the chemical ratios at locations within each source area likely vary (Luedtke, Meyers, 1984). The rocks are: chert (Trascău), jasper, rhyolite, quartzitic sandstone, siliceous shale and microgranite.

Trascău chert

This material is brown-grey (sometimes orangish-brown), sub-translucent to translucent, with medium to medium-fine grained surfaces, dull or satiny lustre, and often contains relics of it's parent rock (limestone). The darkness and intensity of the colour varies from source to source (Fig. 3). Weathering may cause a white, opaque patina on the surface, as well as pitting. This material occurs throughout the Trascău Mountains (particularly in the south) in or near to Late Jurassic limestone outcrops (Fig. 2). The same material (or a material of similar appearance) also occurs in the Late Jurassic limestone outcrops in the Metalliferi Mountains. Chert from the northern part of the Trascău Mountains (compared to material from more southern sources) is often darker, more opaque, slightly waxy, and with a fine grained surface. Some of this northern Trascău chert has a greenish or bluish grey colour.

Trascău jasper

This material is brownish yellow or dark red colour (sometimes a mixture of both colours), opaque to sub-translucent, with medium to fine grained surfaces, dull, satiny or waxy lustre, and may contain dendritic inclusions of manganese (Fig. 3). It may appear brecciated filled in with a cement of a different colour or opacity. In petrographic thin sections one can see a large quantity of hematite (which causes the yellow and red colour) (for examples see: Ilie, 1952; Russo-Săndulescu et al., 1976; Ghiurcă, 1997a; 1997b).

Macroscopically and microscopically, Trascău jasper appears to be the same as jasper from the Metalliferi Mountains, and in fact is likely a continuation of the same geological formations there that contain jasper (Fig. 2). Recent research utilising Prompt Gamma Activation Analysis has shown that chemical analysis can distinguish between Trascău and Metalliferi jaspers (and possibly within each mountain range) (Crandell, Kasztovszky, 2008). Jasper exists in much lower quantity in the Trascău Mountains than it does in the Metalliferi Mountains and often seems to be of a lower quality for knapping. Based on macroscopic analysis, both Trascău and Metalliferi jaspers may be easily confused with yellow-red jaspers from the Maramureş area.

Due to the higher quality and quantity of jasper in the Metalliferi Mountains, it is suspected that more jasper at Limba came from the Metalliferi sources than from Trascău sources. Preliminary chemical analyses show that sources in both locations were used. As yet though, only a few artefacts and geological samples have been chemically analysed, so it is still difficult to determine the exact origin of most of the yellow-red jaspers and the extent to which each was used remains unknown.

Trascău rhyolite

Rhyolite is found throughout the Trascău Mountains but material suitable for knapping is particularly abundant in the Geoagiu and Rimetea area. It is a dark colour (often grey or green), opaque, with medium to medium-fine grained surfaces, and a dull lustre (Fig. 4). It may contain small particles of mica. The fineness (or coarseness) of the surface grain may vary a lot. Materials from some sources in the Trascău Mountains produce a good conchoidal fracture but most do not. Some materials produce small flaking and cracking on the surface when fractured.

Fig. 3. Trascău chert (Piatra Tomii, Ampoita) andTrascău jasper (Ampoița, Ighiel) (left to right)

Fig. 4. Rameț rhyolite, Cremenea Peak siliceous shale, Craiva sandstone (left to right)

Fig. 5. Metalliferi jaspers (left to right – Bulz, Gurasada, Almaşu de Mijloc, Techereu)

Trascău siliceous shale

This material varies a lot between sources depending on what it contains. One known source between Zlatna and Feneş (at Cremenea Peak, overlooking the Valley of Paul) is shades of pink, opaque, coarse grained, and has a dull lustre (Fig. 4). Microscopic analysis shows that it contains particles of clay, silica, hematite and occasional microfossils (one gastropod was observed). It may produce a good conchoidal fracture and is suitable for knapping (see also the observations of: Ilie, 1940; 1952; 1953).

Trascău quartzitic sandstone

This material varies between sources. It generally has very small but visible quartz grains and breaks with a conchoidal fracture. It is usually a light colour, often grey, brown or yellow (Fig. 4). It may contain other materials such as clay, limestone or mica (see also Ilie, 1932).

Other materials in the Trascău Mountains

Various other lithic materials are present in the Trascău Mountains at small localised sources. They include microgranite, chalcedony, silicified wood and agate (see for example: Mârza et al., 1997). Microgranite occurs in the Arieş valley and may be the source of artefacts found at Limba. Silicified wood and agate do not appear to have been used to make the artefacts from Limba, so they will not be discussed in this article. There are also numerous large sources of andesite and basalt near to Limba. Large quantities in fact are to be found in the Mureş River. At Limba, there have not yet been found any chipped stone artefacts that appear to have been made from andesite or basalt. Although they are very low quality for making chipped stone tools, they were occasionally used for this purpose at other sites. They were frequently used though to make polished stone tools found at Limba. As this article focuses on chipped stone artefacts, andesite and basalt artefacts and sources will not be discussed.

Matalliferi Mountains, Hațeg and Poiana Ruscă Mountains

Metalliferi jasper

Metalliferi jasper is macroscopically similar to the Trascău jasper (Fig. 5). This material occurs throughout the Metalliferi Mountains (Fig. 2). Although the materials from most sources look the same and there is variation in the visual characteristics at individual locations, chemical analysis may help in distinguishing between general areas within the Metalliferi Mountains (Luedtke, Meyers, 1984). The jasper from the Metalliferi Mts. appears to be slightly better quality for knapping than the materials from nearer sources in the Trascău Mountains. It should be noted though that this is a general observation and some jasper from the Trascău Mountains is of very good quality. In the area near Techereu there is a green variety of jasper (Fig. 5). It was also described by Ghiurcă (1999).

Brad sinter

North-east of Brad (Hunedoara County) (Fig. 2 and 6), located in the Neogene andesitic pyroclastics, there is a large occurrence of this material (Ghițulescu et al, 1968; Ghergari, Ionescu, 1999; Ghergari et al., 1999). This material has various colours, from white to yellow, red, brown or orange. It is opaque, glassy, with a very fine grained surface. At the source, most rocks have a very poor conchoidal fracture but some have a very good conchoidal fracture. A few hours of searching can reveal a large quantity of material suitable for knapping. The material is not as sharp as chert or jasper.

Cerna Valley quartzitic sandstone

There are several sources of quartzitic sandstone in the northern part of the Cerna valley[e] (Fig. 2) This material is medium to fine grained, the grains being barely visible to the naked eye in some samples. They are opaque, light coloured (usually a shade of very light whitish brown or light yellowish brown) and have a dull lustre. They usually break with a conchoidal fracture. Some samples contain fossil gastropods (or casts of them) over 1 cm in thickness.

Hateg chert

This material is whitish yellow, porcelain-like in appearance, translucent in the centre, and produces a conchoidal fracture. It is found in the area between Cioclovina and Barul Mare (Hunedoara County) in the Late Jurassic limestone formations (Fig. 2) (Mamulea, 1953; Boldur, Stilla, 1967).

Poieni siliceous shale (a.k.a. "Banat Chert")

This material out crop is in the western part of the Poiana Ruscă Mts. near the town of Poieni, Timiş County (Fig. 2 and 7). In 1971, Comşa identified this material out crop and named it "Banat Chert" ("Silex de Banat") (Comşa, 1971; 1976). This material presents a mixture of various colours, such as light brown-grey to light whitish yellow. Some samples show frequently dendritic black inclusions. The material is brecciated. Microscopic thin sections show that it contains particles of clay, silica and hematite. Note that contrary to it's commonly used name, from a geological point of view this material is referred to as siliceous shale (Romanian "gresia silicioasa"), not chert (Romanian "silex").

Sources in remote areas

The materials imported from the following areas (Fig. 8) seem to be very good quality for making stone tools. This probably explains why materials came from such a long distance – i.e. they were traded further because of their good quality.

Miorcani (Prut River) flint

This material is a true flint (being found in chalk formations). It is light brown to black, translucent to highly translucent, dull to satiny, with a very fine grained surface, and often contains relics of its parent rock (chalk). This material occurs along the Prut River near the border between Romania and the Republic of Moldova. It is particularly abundant near the modern village of Miorcani[f]. It is also found at other locations along the Prut in that region[g] as well as in the Republic of Moldova at locations away from the river. This material breaks with a very good conchoidal fracture. This material is well known and various researchers have written about this source of flint (see for example, Alba et al., 1960).

Balkanic chert

This material is a light greenish brown (with different hues ranging from yellow), opaque, with occasional small round white spots and fractures evenly. It is found as cobbles along the banks of the Danube River from Oltenia to the Black Sea and throughout Constanta County (Comşa, 1976). Its geological origin is South of the Danube.

Hungarian and Slovakian (Western Carpathian) obsidian

This is a black, highly translucent to transparent, variety of obsidian found in the Western Carpathian Mountains, mainly in Hungary and Slovakia. Although the materials from Hungary and Slovakia generally have some slight macroscopic differences, since these sources are very near to each other (and far from Limba) these differences will not be discussed in this article. The source of obsidian extends also into Ukraine (near the Hungarian and Slovakian sources) but there it is of lower quality for knapping. Some researchers have suggested the possibility of a source of obsidian in Romania in the Maramureş area near to the Hungarian and Ukrainian sources (for examples, Comşa, 1976; Păunescu, 2001). Since the distance and direction would only be slightly different, this problem will not be addressed in this article either.

It is possible that obsidian from other areas (e.g. the Aegean) might have arrived at Limba. The sources of workable obsidian in the Aegean, which have been reported and studied so far are located on the Cycladic islands of Melos, Antiparos and Yali. The relevant sources in Anatolia are at Acigöl and Ciftlik. Chemical analysis of the artefacts from Limba would be able to distinguish between various sources of obsidian (Biró, 2006) but macroscopically it would be difficult. Since those sources are significantly further away and previous obsidian studies in this region have indicated a vast majority of pieces coming from Western Carpathian sources (see for example: Cârciumaru et al., 1985; Sălăgean et al., 1988), it is presumed that most obsidian artefacts found at Limba are from the Hungarian-Slovakian source area. To date, no geological source of obsidian has been found in the Apuseni Mountains (Nandris, 1975; Williams Thorpe et al., 1984), therefore all obsidian (regardless of whether it came from the Western Carpathians or elsewhere) can be considered a long distance imported material.

Discussion

The artefacts

From the excavations of the Neolithic site at Limba, 440 chipped stone artefacts have been recovered and catalogued (Table 1; see Fig. 9 for examples) The following section gives an overview of the provenance of the artefacts found at Limba

[e]Based on the author's personal observations while doing fieldwork.

[f]Based on personal communications with Irina Mihaelescu, Geology Department, "A. I. Cuza" University, Iasi. Mihaelescu has previously studied Miorcani flint, both in the lab and in situ. She has collected and studied in situ samples from the Prut River and the flint mine in Miorcani village (Mihaelescu, 2008).

[g]Based on personal communications with Virgil Ghiurca, Geology Department, Babeş-Bolyai University, Cluj-Napoca. Dr. Ghiurca has studied and written numerous repertories regarding silicate sources throughout Romania (Ghiurca, 2007).

(Fig. 10). Some of the artefacts (particularly those made from local and medium distance materials) are difficult to assign to a specific location due to variation within sources and overlap between sources. For this reason, the numbers of artefacts listed here should be considered approximations. It should also be noted that not all of the obsidian artefacts have been catalogued yet. Perhaps half of the obsidian artefacts are at present uncatalogued.

Although many sources of lithic materials far from the site may have the same appearance as local materials, artefacts of low quality are assumed to have been locally acquired and not imported. There was no reason for people to import low quality materials when they already had similar materials available nearby. It is therefore unlikely that poor quality materials would have been imported from far away. For this reason artefacts made of low quality materials, which have a match with a local material have been classified as local. Fortunately, the high quality imported materials are macroscopically distinct from materials of any known local sources.

Table 1
Presumed sources for 440 chipped stone artefacts from Limba

Sources	Material	Number of artefacts	% of total
Distant sources	Miorcani flint	107	24%
	Balkanic chert?	29	7%
	Obsidian	116	26%
	Total	252	57%
Local sources	Not differentiated	112	25%
Medium or local sources	Not differentiated	42	10%
Medium distance sources	Not differentiated	15	3%
Unknown provenance	Not differentiated	19	4%

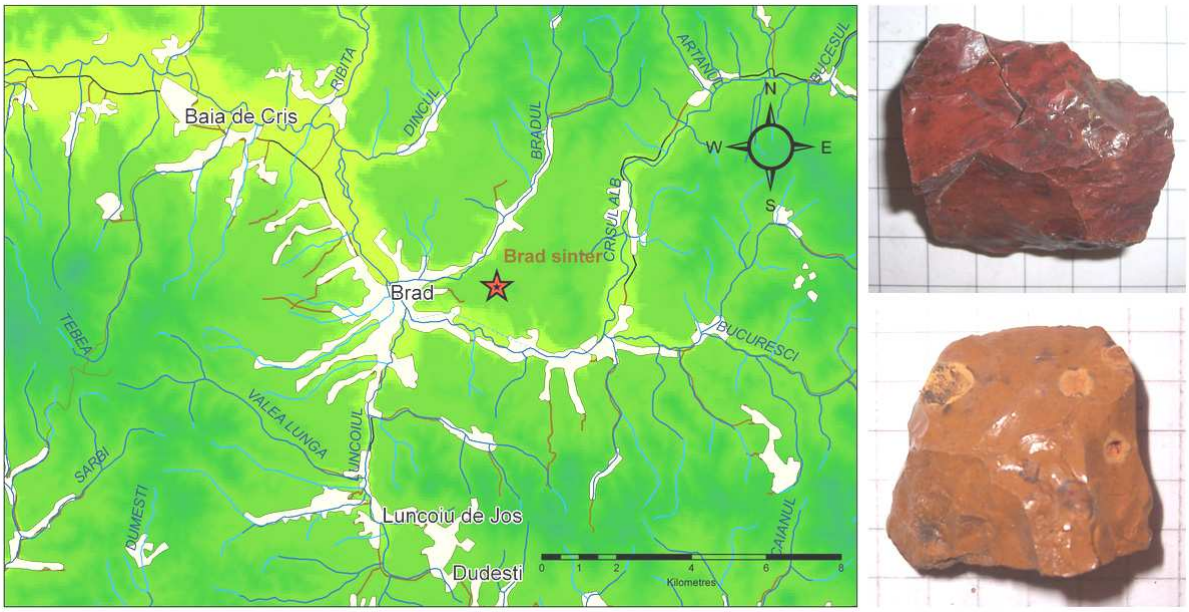


Fig. 6. Brad sinter – map showing source and surrounding area (left); two samples (right)

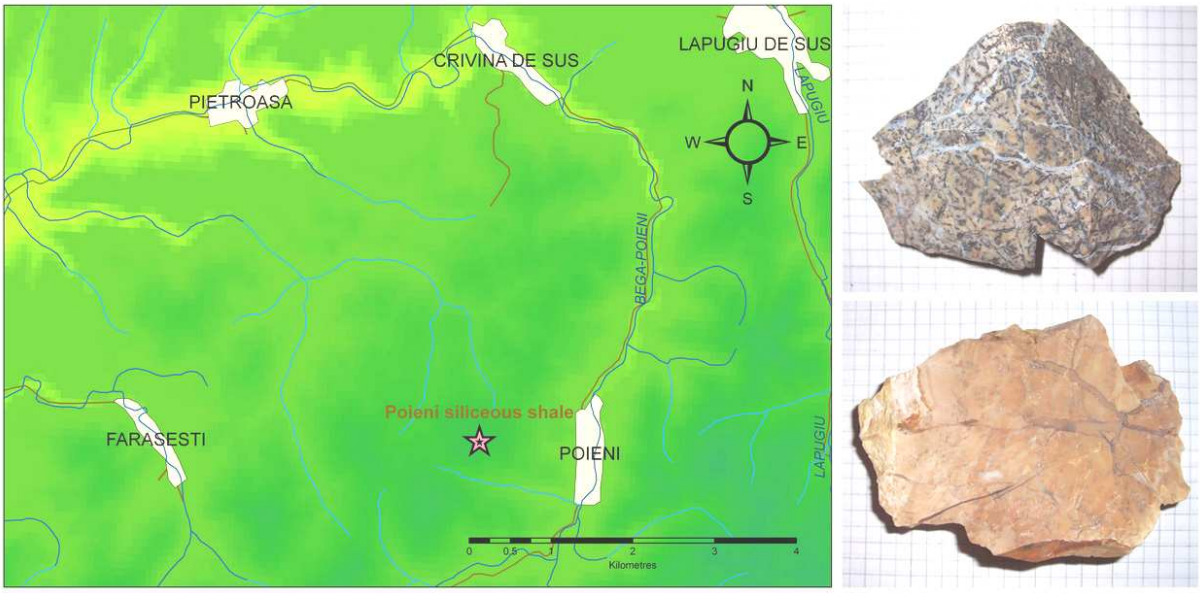


Fig. 7. Poieni siliceous shale – map showing source and surrounding area (left); two samples (right)

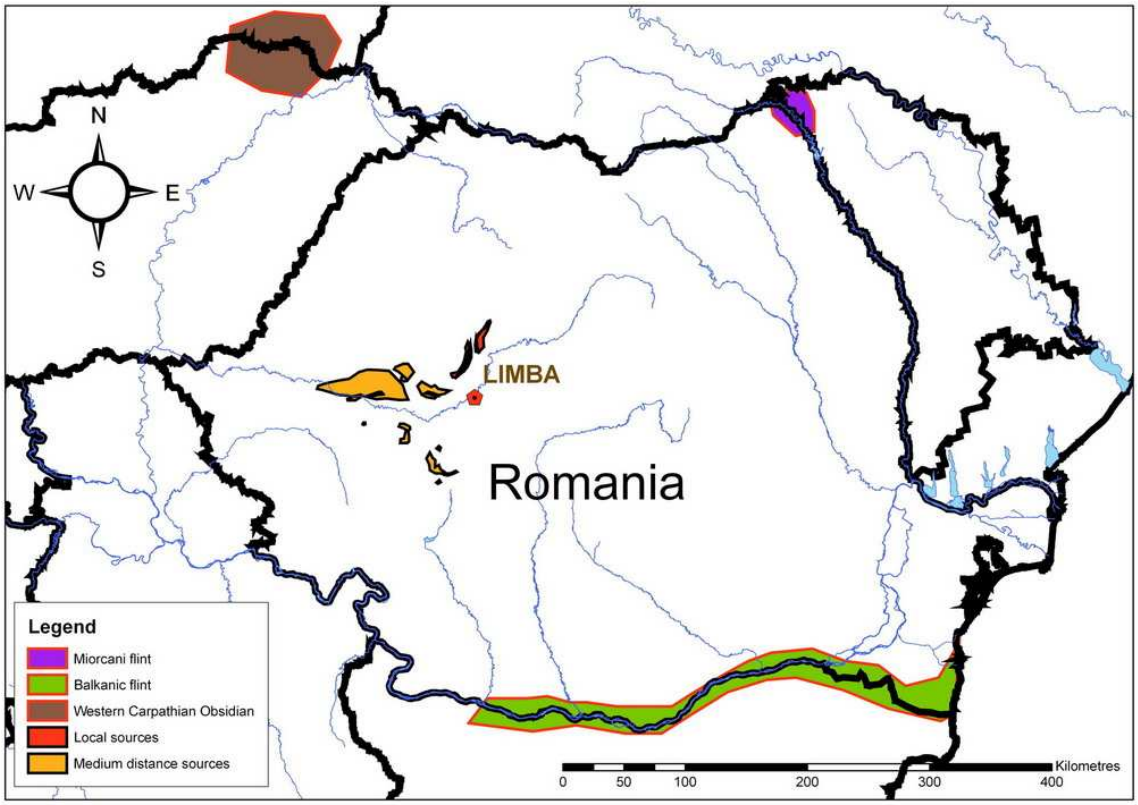
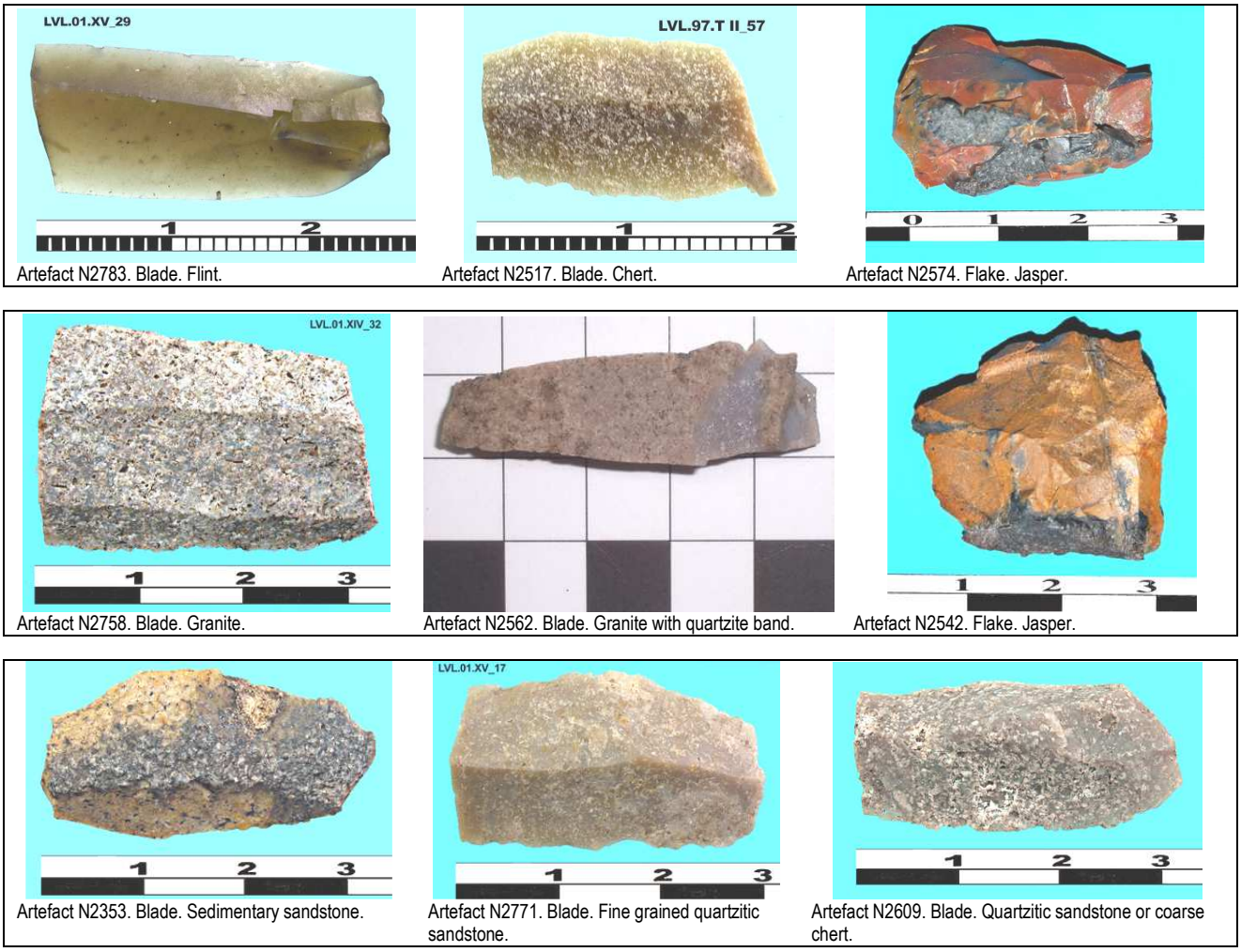


Fig. 8. Map showing main long distance (remote) geological sources



Artefact N2783. Blade. Flint.

Artefact N2517. Blade. Chert.

Artefact N2574. Flake. Jasper.

Artefact N2758. Blade. Granite.

Artefact N2562. Blade. Granite with quartzite band.

Artefact N2542. Flake. Jasper.

Artefact N2353. Blade. Sedimentary sandstone.

Artefact N2771. Blade. Fine grained quartzitic sandstone.

Artefact N2609. Blade. Quartzitic sandstone or coarse chert.

Fig. 9. Examples of artefacts

Local materials

There are approximately 102 artefacts made from local materials (possibly 10 more artefacts made of poor to medium quality) (Fig. 11). The following Table 2 lists them. Silicified wood and agate do not appear to have been used to make the artefacts from Limba. Microgranite is presumed to be from the Arieş Valley as this is the closest abundant source of this material.

Table 2
Quantities of artefacts made from local materials

Source	Quantity	Remarks	Arte-facts
Trascău chert	84	Southern Trascău chert	67
		Northern Trascău chert	10
		unknown if Northern or Southern	7
Quartzitic sandstone	5 to 18	13 artefacts might be a coarse chert	
Microgranite (probably Arieş valley)	5	artefact N2562 contains both granite and quartzite (Fig. 9)	
Rhyolite	6		
Siliceous shale	1		
Quartz or quartzite	3		

Medium distance materials

There are approximately 42 jasper artefacts which may come from either the Trascău or Metalliferi mountains. From medium distance sources, there are approximately 15 artefacts (not including the Trascău-Metalliferi jaspers already mentioned). Out of these artefacts, there are 9 made from Metalliferi jasper (these appear to be specifically Metalliferi jaspers), 1 made from Brad sinter, 4 made from Cerna valley quartzitic sandstone, and 1-3 made from Poieni siliceous shale (Fig. 12). At the time of writing, the author had very few samples of chert from the Haţeg Basin area. Based on these artefacts and written descriptions by other researchers, it does not appear that many (if any) artefacts at Limba were made from this material. Future research in the Haţeg Basin area may reveal otherwise.

Long distance materials

There are about 223 artefacts made from imported materials. They appear to be from three general sources. There are 107 artefacts made from Miorcani flint[h], more than 116 made from obsidian, and 29 possibly made from Balkanic chert (Fig. 10).

As with Haţeg Basin chert, the author had access to very few geological samples of Balkanic chert. Based on these samples and artefacts from Neolithic sites in the south of Romania, it seems likely that some of the artefacts from Limba were made from this material. More geological samples of Balkanic chert for comparison may confirm this. As north-eastern Hungary is the nearest known source of obsidian, the fact that obsidian artefacts are found at Limba in such high quantity supports the theory of well established long distance trade routes during the Neolithic.

Artefacts of unknown provenance

There are about 58 artefacts which are of unknown provenance. Of these 10 are of poor to medium quality, and therefore are likely of local origin. Another 29 may be Balkanic chert. Most of the remaining 19 artefacts were unique in appearance and could not easily be matched to known geological sources (Fig. 10). These artefacts may be made from materials from geographically small sources found within the study area which have not yet been catalogued or they may be from sources further away and brought to the site through trade.

Conclusions

The chipped stone artefacts at Limba show signs of both local and long distance procurement. It appears that more than half of the artefacts were either imported from distant sources or made from imported materials. Of the long distance chipped stone materials, half are obsidian. A quarter of all artefacts appear to have been made of local materials, in particular from the southern and middle part of the Trascău Mountains. A small amount of the artefacts are of medium distance materials (in particular jasper). The rest are from unknown sources. Based on these artefacts it would seem that imported materials were preferred and used much more than locally available materials, in particular materials from sources to the north. As Limba was located on the bank of a major waterway, it is very likely that they had relatively easy access to and contact with other settlements, thereby facilitating trade of raw materials and finished products. What the residents of Limba traded in exchange for lithic materials remains unknown. Other researchers have proposed that they may have exported salt (a relatively abundant material in the area)[i]. It is also possible that such settlements along the banks of major rivers may have served as a sort of market place where traders met to exchange goods[j].

It is possible that people did travel long distances in search of materials and fabricated the tools or produced nuclei near the material source and then brought them back. This is unlikely however because it would involve a detailed knowledge of the locations of different material sources over an enormous geographical area. It is possible though that direct procurement occurred within a limited area around each settlement in combination with trade with neighbouring groups or at occasional large group gatherings. Through exchange it is possible for materials to have moved large distances by changing ownership several times. Thereby, the materials and artefacts may move much longer distances than any individual owner ever would.

[h]Based on personal communications with Virgil Ghiurca and Corina Ionescu (both professors at the Geology Department of Babeş-Bolyai University, Cluj-Napoca with extensive experience regarding Romanian silicates). Drs. Ghiurca and Ionescu both confirmed the classification of most of these pieces as likely being Miorcani flint (Ghiurca, 2006; 2007; Ionescu, 2006; 2007).

[i]Based on personal communications with Horea Ciugudean, Muzeul Unirii, Alba Iulia. Dr. Ciugudean has studied the prehistory of salt mining in the Mureş Valley area and believes that salt was likely collected and exported throughout prehistory (Ciugudean, 2008).

[j]Based on personal communications with Horea Ciugudean. Dr. Ciugudean has worked on various excavations at prehistoric sites in Alba county, including Neolithic settlements along the Mureş River. It is his opinion that some of the Neolithic settlements along the Mureş River may have also functioned as trading posts (Ciugudean, 2008).

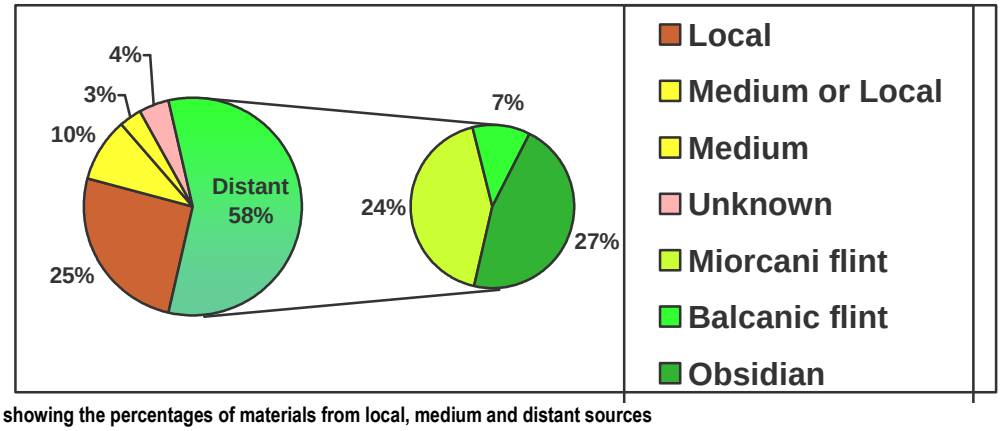


Fig. 10. Diagram showing the percentages of materials from local, medium and distant sources

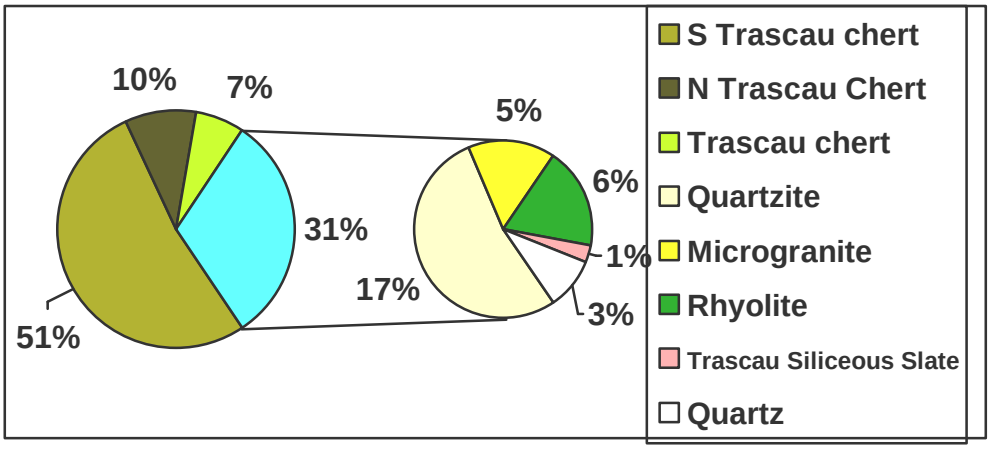


Fig. 11. Percentages of materials from local sources

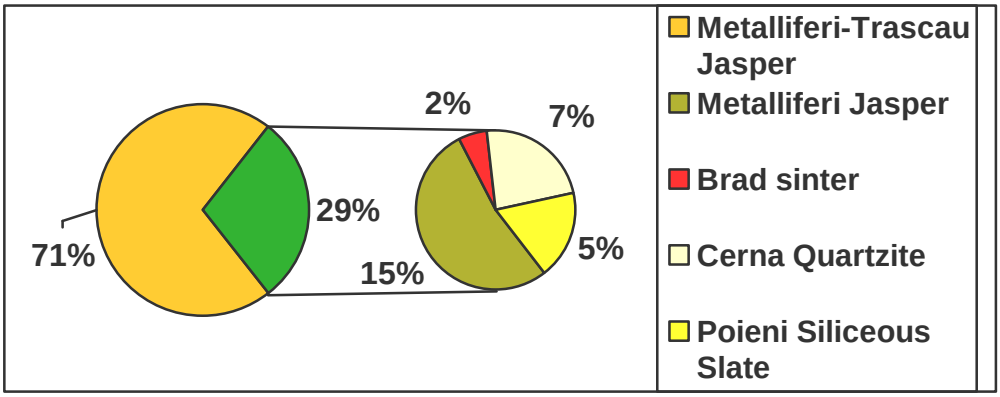


Fig. 12. Percentages of materials from medium sources (including Metalliferi-Trascău jasper)

Some of the Neolithic cultural phases at Limba are contemporary with other sites from the region and may have had contact with them, i.e. Alba Iulia – Lumea Noua, Aiud – Cetățuie, Tărtăria, Sebeş – Râpa Roşie (all four in Alba County), Turdaş (Hunedoara County) and Gligoreşti (Cluj County). Future provenance studies at these sites will help to clarify the level of contact between these and other contemporary sites.

As yet, no microlithic debitage has been recovered at Limba. It is suspected that this is due to the recovery methods commonly used at excavations. In fact, the site probably contains microlithic debitage but it was probably not recovered during excavations. Without the complete assemblage of lithic artefacts it is more difficult to determine to what degree artefacts were being brought to the site ready made or being produced at the site from nuclei acquired at the sources (or acquired through trade). The amount of local processing and production of artefacts would help reveal whether the local population was acquiring the long distance material though trade or direct procurement.

Hopefully future excavations at Limba and other sites in the area will help to determine whether artefacts made from distant materials were produced locally from blanks or nuclei, or imported ready made. As more sources of lithic materials are discovered and the size of the geological database of raw material sources increases, it will likely be possible to identify the provenance of more artefacts which are currently of unknown provenance. If these artefacts have been imported from medium to long distance, determination of their provenance may be aided by collaboration with other researchers in neighbouring regions and comparison with artefacts and geological samples in their regions.

Acknowledgments. The Techereu jasper sample is part of the collection of the Mineralogy Museum of Babeş-Bolyai University, Cluj-Napoca. It was photographed by the author with permission of the museum. All other geological samples are from the personal lithotheque of the author and were photographed by the author. All of the artefacts from this study are part of the Limba collection, housed in the artefact repository of the Institute of Systemic Archaeology ("1 Decembrie 1918" University of Alba Iulia). They were studied with the permission of Dr. Iuliu Paul, director of the Institute of Systemic Archaeology. The photographs of artefacts N2758, 2353, 2771, 2561 and 2609 were made by Doru Szabo, photographer at the institute. Artefact N2562 was photographed by the author with permission of the institute. All of the maps were produced by the author. The satellite image was produced with GoogleEarth.

References

Alba, C. N., C. Gheorghiu, I. Popescu. 1960. Depozitele sedimentare de la Rădăuți-Prut. – *Comunicări de Geologie-Geografie (1957-1959)*, 9-23.

Biró, K. 2006. Carpathian obsidians: myth and reality. – In: *Proc. 34th Intern. Symposium on Archaeometry, Institución "Fernando el Católico", Zaragoza*, 267-277.

Boldur, C., A. Stilla. 1967. Malmul inferior din Regiunea Ohaba-Ponor (Hațeg) cu privire specială asupra Callovianului superior cu Kosmoceras (Carpații Meridionali). *Dări de Seamă ale Şedințelor, 53*, 1, 305-310.

Cârciumaru, M., A. Muraru, E. Cârciumaru, A. Otea. 1985. Contribuții la cunoaşterea surselor de obsidian ca materie primă pentru confecționarea uneltelor paleolitice de pe teritoriul României. – *Memoria Antiquitatis, 9-11,* 561-603.

Ciupagea, D., M. Pauca, T. Ichim. 1970. *Geologia Depresiunii Transilvaniei*. Ed. Acad. RS România, Bucharest, 256 p.

Comşa, E. 1971. Silex de tip «bănățean». – *Apulum*, *9*, 15-19.

Comşa, E. 1976. Les matières premières en usage chez les hommes Néolithiques de l'actuel territoire Rouman. – *Acta Archaeologica Carpathica, 16*, 239-249.

Crandell, O. N. 2005. Macroscopic analysis and characterisation of chert for provenance purposes (Analiza şi caracterizarea macroscopică a silicolitelor în scopul stabilirii originii). – *Sargetia, 33*, 137-163.

Crandell, O. N., Z. Kasztovszky. 2008. The use of PGAA to distinguish between sources of jasper. – In: *37th Intern. Symposium on Archaeometry, Siena, Italy, 2008*, 216.

Florescu, C. 2007. *A History Lesson. Pottery Manufacturing 8000 Years Ago*. Ed. Aeternitas, Alba Iulia, 146 p.

Gandrabura, E. I. 1981. Studiul mineralogic, petrografic şi geochimic al eruptivului mezozoic din Munții Trascău. – *An. Institutului de Geologie şi Geofizică, 58*, 5-121.

Ghergari, L., C. Ionescu. 1999. Genetic considerations on jasper in the Brad area (Apuseni Mts., Romania). – *Romanian J. Mineralogy, Suppl. 1, 79*, N32.

Ghergari, L., C. Ionescu, Z. Püspöki. 1999. Jaspis occurrence from Brad, Apuseni Mts. (Romania). – *Gems and Gemology, 35*, 139-140.

Ghițulescu, T., G. Verdeş, R. Chința. 1968. Zăcămintele de silicolite din bazinul neogen al Bradului (jud. Hunedoara). – *Studii şi cercetări de Geologie, 13*, 1.

Ghiurcă, V. 1997a. Gemologia arheologică şi resursele gemologice actuale din partea de nord a Munților Trascău. – *Acta Musei Napocensis, 34*, 1, 829-835.

Ghiurcă, V. 1997b. Geologia resurselor gemologice din județul Alba. – *Studia Universitatis Babeş-Bolyai, Ser. Geologia, 42*, 2, 25-32.

Ghiurcă, V. 1999. The gemological resources in Hunedoara District and importance in the art of the Roman civilisation. – *Sargetia, Ser. Scienta Naturae, 18*, 5-17.

Ghiurcă, V. 2000. Aria de apariție a mineralelor silicioase de pe Culoarul Mureşului (HD). – *Acta (Siculica),* 1, 21-38.

Ghiurcă, V. 2003. Considerații gemologo-arheologice privind județele de câmpie din Oltenia, Muntenia şi a celor de podiş din Moldova. – *Studii şi Cercetări Geologie-Geografie, 8*, 7-53.

Ilie, M. D. 1932. Recerches géologiques dans les Monts du Trăscău et dans le bassin de l'Arieş. – *An. Institutului Geologic al României, 17*, 329-465.

Ilie, M. D. 1940. Structure géologique de la région aurifère de Zlatna (Roumanie). – *An. Institutului Geologic, 20*, 75-145.

Ilie, M. D. 1950. Monts Métallifères de Roumanie (Recherches géologiques entre la Valea Stremțului el la Valea Ampoiului). – *An. Comitetului Geologic, 23*, 121-197.

Ilie, M. D. 1952a. Asupra structurii geologice a regiunii Cetea-Benic-Intergalde. *Dări de Seamă ale Şedințelor, 33*, 24-26.

Ilie, M. D. 1952b. Cercetări geologice între Valea Cricăului şi Valea Ampoiței. – *Dări de Seamă ale Şedințelor, 33,* 26-30.

Ilie, M. D. 1952c. Cercetări geologice în regiunea Cluj-Cojocna-Turda-Ocna Mureşului-Aiud. – *An. Comitetului Geologic, 24*, 303-369.

Ilie, M. D. 1953. Structura geologică a depresiunii Abrud. – *An. Comitetului Geologic, 25*, 37-117.

Kasztovszki, Z., K. Biró. 2006. Fingerprinting Carpathian obsidian by PGAA: first results on geological and archaeological sources. – In: *Proc. 34th Intern. Symposium on Archaeometry, Zaragoza, 2006*, 301-308.

Luedtke, B. E., J. T. Meyers. 1984. Trace element variation in Burlington chert: a case study. – In: *Prehistoric Chert Exploitations: Studies from the Midcontinent (Eds. B. Butler, E. May). Center for Archaeological Investigations, Occas. Pap. 2,* S. Illinois University, Carbondale, 287-298.

Mamulea, M. A. 1953. Studii Geologice în Regiunea Sânpetru-Pui (Bazinul Hațegului). – *An. Com. Geologic, 25*, 211-272.

Mârza, I., C. Ionescu, A. Bodnariuc. 1997. Piroclastite Mezozoice cu silicolite de la Poiana Aiudului (Mții Trascăului-Apuseni). – *Studia Universitatis Babeş-Bolyai, Ser. Geologia, 17*, 1, 81-94.

Mészáros, N., E. Nicorici. 1962. Contribuții la stabilirea limitei dintre Tortonian şi Sarmațian între Cluj şi Turda, cu privire generală asupra conținutului şi poziției stratigrafice a Buglovianului. – *Studii şi Cercetări de Geologie, 7*, 1, 7-31.

Nandris, J. 1975. A reconsideration of the south-east European sources of archaeological obsidian. – *Bull. London University Institute of Archaeology, 12*, 71-94.

Păunescu, A. 2001. *Paleoliticul şi mezoliticul din spațiul transilvan*. Ed. AGIR, Bucharest, 274 p.

Russo-Săndulescu, D., T. Berza, I. Bratosin, R. Ianc. 1976. Contribuții la studiul petrologic al Unor magmatite alpine din Nordul Munților Trascău. – *Dări de Seamă ale Şedințelor, 62*, 165-194.

Salagean, M., A. Pantelica, L. Daraban, T. Fiat. 1988. Provenance studies of obsidian from the Neolithic settlement of Partza in South-Western Romania. – In: *1st Romanian Conference on the Application of Physics Methods in Archaeology. Vol. 1. Bucharest. 1988*, 73-86.

Williams Thorpe, O., S. E. Warren, J. G. Nandris. 1984. The distribution and provenance of archaeological obsidian in Central and Eastern Europe. – *J. Archaeol. Sci.,11*, 3, 183-212.