Mikuszowice chert
A local raw material in western Polish Carpathians
Geology, characteristics, usage

Mikušovický rohovec
Lokální surovina západní části polských Karpat
Geologie, charakteristika, užití

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Abstract
This paper presents a definition of Mikuszowice chert. Fourteen types of Mikuszowice chert have been identified. These results are useful for identifying flint artifacts in the Outer Carpathians. Mikuszowice chert artifacts have been identified in inventories dated to different time periods from the Upper Paleolithic to Early/Older Bronze Age. At present, 39 sites with Mikuszowice chert are known. The most important of these sites is a complex of 8 sites in Jaworze. The chert artifacts occur within 100 km of their source. The chert was collected during surface surveys or in primary and secondary deposits.

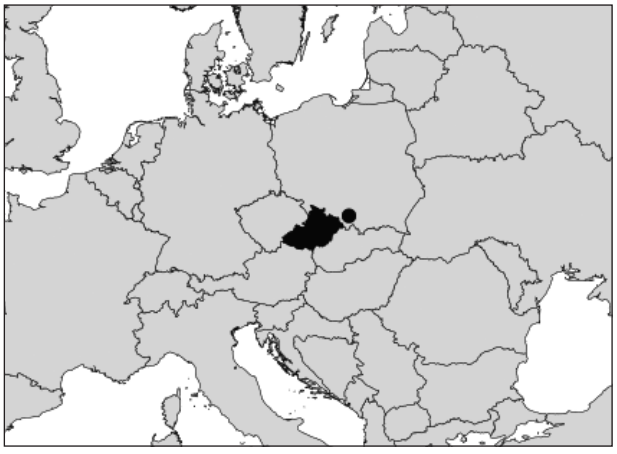
Keywords
Mikuszowice chert, flysch Carpathian Mountains, stratigraphy, characteristic, macroscopic and mikrocscopic analysis, classification, primary, alluvial, eluvial deposits, Upper Paleolithic– Early/Older Bronze Age.

It is a well known fact that the area of the Polish Carpathians is rich in stone materials useful for tool-making. So far, the following raw materials have been identified in artifact manufacture and described by researchers (although the degree of detail in these descriptions varies): Pieniny radiolarite (Kozłowski et al. 1981, Rydlewski 1989b, Pawlikowski 2009), flysch radiolarite (Rydlewski 1989b, Valde-Nowak 2009), menilite chert: black (Valde-Nowak 1991, Foltyn et al. 1998) and brown (Foltyn et al. 1998), Dynow siliceous marl (Dagnan-Ginter, Parczewski 1976), Cergowa "siliceous marl" (Budziszewski, Skowronek 2001), Geza chert (Foltyn et al. 1998), Bircza flint (Łaptaś et al. 2002), Carpathian chocolate flint (excavations P. Mitura), flysch sandstone (Valde-Nowak 1995, Foltyn et al. 1998).

One of these materials is Mikuszowice chert (Rydlewski 1989a, Valde-Nowak 1995, Foltyn et al. 1998, Pawlikowski 2009, Přichystal 2009), which is referred to as Mikuszowice hornstone in the Polish literature. Mikuszowice chert was first investigated in 1989, when J. Rydlewski (1989a) first noted (Lipnica Wielka 2, Dobczyce) this exotic material. At present, the 39 sites featuring Mikuszowice chert, which reflects the intensity of surveys and excavations (Fig. 1, Table 1). The most important of these sites seems to be the site complex 8, 8a, 10, 11, X1, X3, X4, X5 containing many artifacts from occupations in different periods, located on an alluvial fan which formed at the foothill of *Bucznik* and *Ostry* hills in the village of Jaworze 8, in the Bielsko Divide area.

Introduction to the geology of the western flysch Carpathians

The region is located within the sub-Silesian and Silesian nappes of the outer flysch Carpathians. The sub-Silesian nappe is the lowest structural unit of this part of flysch Carpathians. Surface outcrops are confined to relatively small areas concentrated in two bands: north, alongside the north border of the Carpathians, and south appearing in tectonic windows. The Sub-silesian nappe covers extensive areas of the western flysch Carpathians. The area is subdivided into a lower Cieszyn nappe and a higher Godula nappe. The Cieszyn nappe forms the area



Location of the study area on a map of Europe.
Poloha studovaného mikroregionu na mapě Evropy.

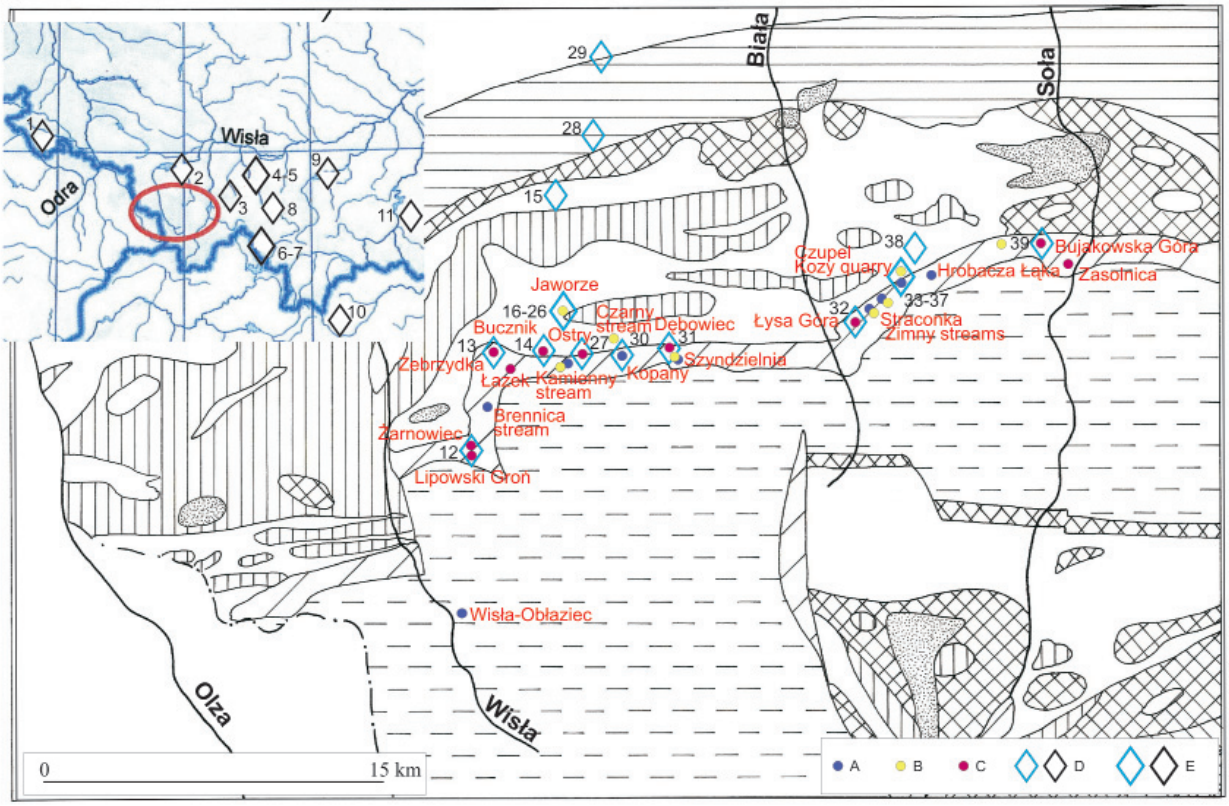


Fig. 1. Map of archaeological sites with Mikuszowice chert and raw material outcrops: A-natural deposits, B-alluvial deposits, C-eluvial deposits, D-single sites, E-group of sites, 1 Dzierżysław 1; 2 Czechowice-Dziedzice 8; 3 Targanice; 4-5 Kojszówka 3 and 5; 6-7 Lipnica Wielka 2, 8; 8 Mucharz 12; 9 Dobczyce; 10 Poprad-Matejovce; 11 Ujazd 6, 12 Ustroń, Site *Żarnowiec* (*Ździar*), 13 Górki Wielkie, Site *Zebrzydka*; 14 Jaworze, Site *Bucznik*; 15 Międzyrzecze Górne, 16-26 Jaworze 8, 8a, 10, 11, 13, X1, X3, X4, X5, "Willa";Jasienica; 27 Jaworze, Site *Ostry*; 28 Ligota 3; 29 Zabrzeg 12; 30 Bielsko-Biała/Jaworze, Site *Kopany*; 31 Bielsko-Biała Olszówka; 32 Bielsko-Biała, Site *Łysa Góra*; 33-37 Bielsko-Biała Górska street, Bielsko-Biała Czupel street; Kozy Małe, Site *Czupel* 1, 2, 3; 38 Kozy Małe; 39 Bujaków, Site *Bujakowska Góra*. Geological situation after M. Książkiewicz. Drawn by E. M. Foltyn.
Obr. 1. *Mapa archeologických lokalit s mikuszowickým rohovcem a geologickými výstupy této suroviny.*

of the Silesian Foothills and Godulska nappe and includes the Silesian Beskids and the Small Beskids. The lithological and stratigraphic profiles of flysch sediments of Silesian Beskids and Silesian Foothills are presented in Figure 2.

The Silesian nappe consists of 13 stratigraphic members with a total thickness of up to 7000 m. The oldest sediments are Jurassic Cieszyn shales, covered by Cieszyn limestones as well as flysch sediments of the Upper Cieszyn shales, Grodziskie layers and Verovice shales. In this part of the Carpathians, Lghota beds containing Mikuszowice cherts overlie the Verovice shales alongside the entire boundary of the Godula nappe. The above mentioned layers were identified by K. M. Paul and E. Tietze (1877). While conducting geological research of the western Carpathians (Szajnocha 1884) and emphasizing the chert content of these layers, the label "Mikuszowice chert" was introduced. As the authors of the original name (Lghota beds) did not define it adequately, Mikuszowice chert was not identified until detailed research of the Silesian Beskids (Konior 1938, 43-50) was conducted. As a result of this research two different levels within the Lghota beds were distinguished: the lower and the upper. The lower level consists of layers of dark shales. These shales are interlayered with thin layers of grey sandstones with siliceous-calciferous matrix. The above mentioned layers contain few layers of dark grey and black cherts. Their occurrence is limited to regions between Soła and Biała rivers and south-west and west from Jaworze.

Shales commonly occur in the upper level. Fine-grained or compact calciferous-siliceous sandstones are also present. The mineral grains of the above mentioned sandstones are cemented by silica.

The upper part of Lghota beds developed in a facies of siliceous rocks named Mikuszowice cherts. They are characterized by the appearance of bluish (locally even pale blue) cherts with thickness ranging from 10 to 18 cm. They usually occur within the central or upper part of the thin sandstones layers. The maximum thickness of

the chert layers is about 60 m (Nescieruk, Wójcik 1996, 17–18). The cherts consist of siliceous sponge spicules so based on petrography they can be classified as spongolites.

Overlying the Lghota sandstones and Mikuszowice chert, a thin (up to 1,0 m) but very characteristic member called Radiolarite layers belonging to the Cenomanian age can be identified. Black shales with manganese concretions are overlain by green shales with layers of green and red cherts consisting of radiolaria, called radiolarites.

The Mikuszowice chert layers stretch in a narrow, parallel band (from Leszna Górna to Myślenice) along the Silesian and Wieliczka Foothills, reaching the northern boundary of the Silesian Beskids (anticline Obłaziec-Brenna, Zebrzydka- 579 m above the sea level, Górka- 474 m above the sea level, Palenica Mountain by the river Wapiennica, Szczyrk), near Bielsko-Biała (Mikuszowice, Straconka, Olszówka), Jaworze and further to east in the direction of Andrychów, Wadowice, Kalwaria-Lanckorona and Myślenice, where the outcrops of this type of rock terminate (Burtanówna et al., 1937, Burtan, Turnau-Morawska 1978, Unrug ed. 1979). The beds of the Mikuszowice chert (chalcedony spongiolite) are also present in eastern Moravia and Czech Silesia (Přichystal 2009). In relation to the enormous thickness of the flysch sediments of Silesian Beskids and Silesian Foothills (up to 6000 m), the presence of the Mikuszowice chert with layer thickness of up to 20 m is insignificant. Between the Skawa and Olza rivers they form a continuous level within the top of Lghota beds.

Sub-silesian nappe. It occurs in relatively small isolated areas and some members occur only locally. The strong folding means that determining the thickness of each member is not always possible. Stratigraphic members of the above mentioned series differ from the contemporaneous Silesian series members (Unrug ed. 1979, Paul et. al 1996, Ślączka et. al 2006).

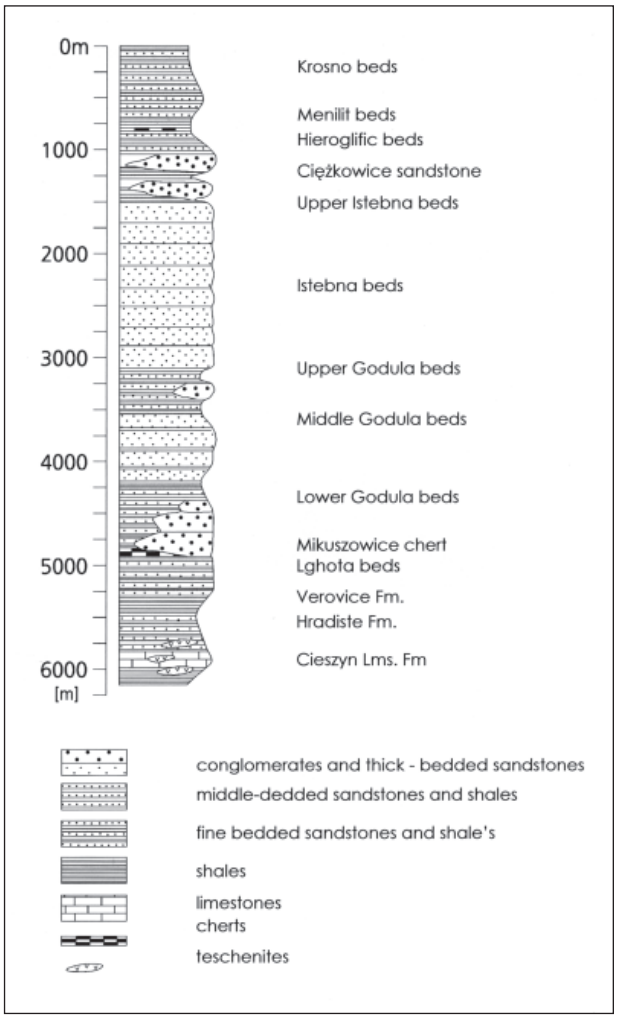


Fig. 2. Litostratigraphic profile of flysh deposits of Silesian Beskid and Silesian Foothills. After Cieszkowski et al. 2009; modified.

Obr. 2. *Litostratigrafický profil flyšovými sedimenty Slezských Beskyd a slezského předhůří. Podle Cieszkowski et al. 2009; změněno.*

The characterisation and classification of siliceous rocks

Siliceous rocks are defined as sedimentary rocks rich in silica, which have formed as a result of: chemical precipitation from solution, the accumulation of skeletal elements of silica organisms (diatoms, radiolaria, silicoflagellates and sponges) or diagenesis and weathering processes. Concentrations of silica occur in sedimentary rocks in two basic forms: as stratified formations called cherts but also as concretions. Originally most cherts consisted of amorphous silica which then developed into chalcedony (Siever 1962). The characteristic feature of most siliceous rocks is a lack of detritic components of the SiO_2 group. However the above mentioned rocks may also contain other components in various proportions: clay minerals, carbonates, phosphates, pyroclastic material, organic material and ferric oxides. The common feature of siliceous rocks is the domination of the following silica minerals in their composition: opal, chalcedony, quartz, tridymite, cristobalite.

Different types of siliceous rocks sometimes do not display clear macroscopic differences so a range of techniques are employed in their identification: transmitted light microscopy, micropalaeonthological x-ray analysis and, if necessary, also with methods that determine the chemical composition and trace elements. Macroscopic examination of artifacts can still provide useful results when the assemblages are large as statistical methods can be applied.

Among many classifications of siliceous rocks presented in the literature the classification presented by K. Kozłowski and W. Łapot (1989) is the most advanced. The above mentioned authors classify siliceous rocks as follows:

rocks with a clear origin: organic (radiolarite, spongolite) and chemical (for example organic, silica sinter, geyserite),

rocks with unclear origin (for example chert and flint),

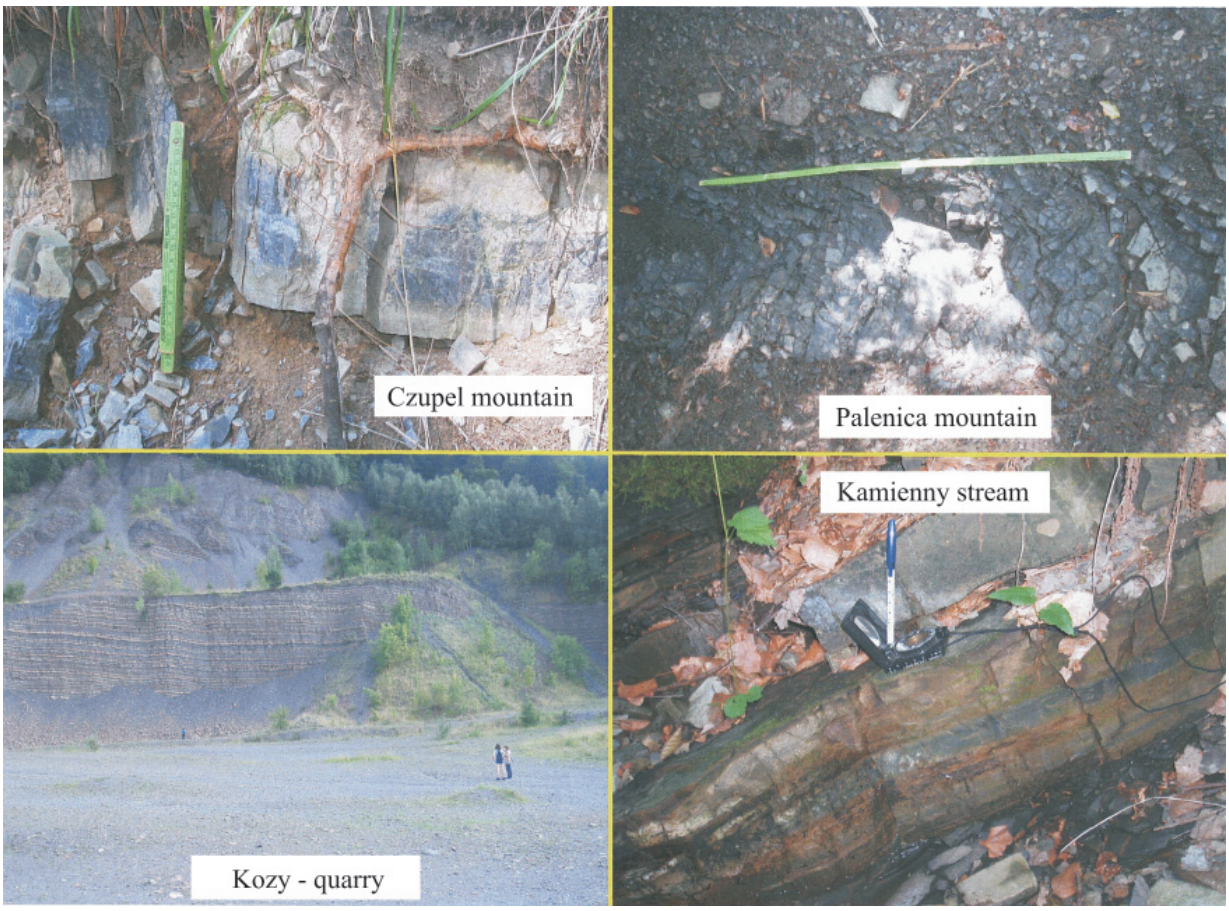


Fig. 3. The outcrops of Mikuszowice chert. Photographed by J. Ganszer.
Obr. 3. *Výstupy mikuszowického rohovce. Foto J. Ganszer.*

rocks formed in connection with weathering marlstone.

K. Łydka (1985) presented two groups of siliceous rocks: of the first group are those that resulted from the deposition of silica skeletons of invertebrates or plants and the second group which includes rocks that formed by replacement with silica. The origin of the latter group is not always easy to explain. A similar division was proposed by S. Kwiatkowski (1996):

- sediments and rocks consisting of opal, formed by the sedimentation of skeletons or opal grains, silica precipitation from solutions, or opal replacing other rocks,
- rocks composed of quartz formed by quartz replacing other rocks.

Properties and genesis of the Mikuszowice chert

The term "chert" was first used in 1729 by J. Woodward (Ryka, Maliszewska 1991, 370). This term is applied to siliceous rocks possessing massive texture consisting of chalcedony and autogenous, microcrystalline quartz usually forming regular layers in sedimentary layers. Despite their hardness (6,5–7,0 on Mohs scale) they are often very fragile and can easily break into smaller pieces. More massive and non-fractured forms can be easily polished. The research of compressive strenght of basic types of Mikuszowice cherts resulted in values between 4,71 and 6,67 MPa. However samples of Mikuszowice cherts with layers of silicified zones in the ceiling and bottom are characterized by value of 27,5 MPa. This strength is not very high whereas chalcedonies from the Świętokrzyskie Mountains has strength of 94 MPa and quartzites from 90,7 to 344,9 MPa. It is connected with quite explicit ability of cherts to divide into smaller pieces. Depending on presence of other components (especially iron and manganese compounds) cherts can have different hues: red to red-brown, ashen, blue, white, grey to black. The rock is significantly diagenetically altered, bordering on metamorphism.

The genesis of Mikuszowice chert in the sandy-shale upper part of Lghota beds was a matter of argument for a long time until microscopic research by W. Szajnocha (1927, for: Konior 1938) showed a high concentration of sponge needles in these rocks.

Later petrographic research of Mikuszowice cherts conducted by Z. Sujkowski (1933 a, 1933b, for: Konior 1938) confirmed the presence of a high concentration of sponge spicules as well as perfectly preserved but completely silicified foraminiferas. Spicules up to 1 mm long are usually arranged one by one. The cherts also contain a clay substance, a small amount of detritic quartz and

a few grains of glauconite. In the upper part of Lghota beds, Z. Sujkowski described two facies: chert (where the spongolites occur) and the facies of "layers saturated with silica". Z.Sujkowski confirmed that Mikuszowice cherts are spongolites. In contrast, on the basis of macroscopic research A. Gaweł (Konior 1938) claimed that Mikuszowice cherts are typical cherts and spongolites are uncommon.

The main components of spongolites are silica spicules of sponges (Spongiae), and the formation of spongolites is connected to the expansion of sponges in warm waters at depths of 100–500 m. Their development is dependent not only on the presence of silica in seawater but also on the presence of phosphorus. Spongolites have been forming since the Ordovician period.

Occurence of cherts and other silicified rocks in the Carpathians are strictly connected with complexes of claystone layers, as marine organisms extracted the material necessary for the formation of skeletons from clay suspended in the water (Gaweł 1951). Sujkowski (1958) argued that silica in cherts originates from clay or calciferous sediments. This author claimed that spongolites developed as shallow submarine banks of sponges under the influence of large waves. Their banks were repeatedly buried by sand or clay from tide activity.

The presented classification of the Mikuszowice cherts was developed on the basis of the results of macroscopic designations: 446 artifacts from the archeological site Jaworze 8, 97 samples from Jaworze 8a and 333 samples from alluvial cone "Jaworze". Also rock material from other sites in the Carpathians was taken into consideration. Mikuszowice cherts are known to occur in the Western Carpathians in primary, alluvial and eluvial deposits. Outcrops of primary deposits are known from the following locations: *Czupel* (654 meters above sea level, Small Beskid; the upper part), *Hrobacza Łąka* (~780 meters above sea level, Small Beskid; the upper part*), Kopany* (596 meters above sea level, Silesian Beskid, the eastern slope), the upper part of Kamienny stream (in Jaworze), Kozy (a quarry) (Fig. 3), in Wisła-Obłaziec and valley of Brennica.

The following locations can be classified as alluvial deposits of Mikuszowice chert: alluvial cones in Jaworze, in the Olszówka stream (at the foot of Szyndzielnia), Straconka, Zimny (Mroźnica) and Kamienny streams, Czarny and Szeroki streams in Jaworze at the foot of the northern slopes of *Palenica.* Eluvial deposits occur on the north-western slopes and at the foot of *Bucznik*, the western slope of *Łysa Góra*, south-western slope of *Dębowiec*, northern slope of *Łazek* in Brenna-Jasionka, northern slopes of *Lipowski Groń and Żarnowiec* (*Ździar*) in Ustroń), north-eastern slope *Zebrzydka* in Górki Wielkie and northern slope *Ostry* in Jaworze (Fig 1).

Such a large number of artifacts necessitated standardized descriptions. The issue was resolved by implementing a scheme for macroscopic description of the artifacts taking into consideration the following attributes (Pawlikowski 1992): 1- color, 2- color in UV light, 3- patina, 4- inclusions, 5- lustre, 6- transparency, 7- cleavage, 8- fracture, 9- lamination.

Fig. 4. Mikuszowice chert: 1-type Ia, 2-type I. Photographed by K. Olszewska, J. Ganszer.
Obr. 4. *Mikuszowický rohovec: 1-typ Ia, 2-typ I. Foto K. Olszewska, J. Ganszer.*

On the basis of the obtained results Mikuszowice cherts were categorized into 14 types differing in macroscopic features. The selected attributes and percentages are presented in Table 2. The detailed characteristics of each type and their color on the Munsell chart (1999) are presented below.

Type I. This is a basic type of chert, grey-blue in color (W 4/5). It is opaque or translucent, with strong cleavage and conchoidal fracture. In some samples a clear, dark lamination probably caused by manganese compounds or clay substance concentration can be noticed. Characteristic typical feature is a presence of numerous black inclusions 0.5 mm in diameter (Fig. 4:2).

Type I-a. Bright grey-blue (5B 5/1) color and silky lustre. It is characterized by conchoidal fracture. Its cleavage is weak or medium. It contains numerous, black inclusions 0.5 mm in diameter. Clear laminations can also be observed (Fig. 4:1).

Type I-A (a zone of contact of silicified rock with type I chert). The silicified rock is bright grey (10G 5/1). The fracture is regular and cleavage is weak. The chert/silicified rock contact zone is distinct.

Fig. 5. Mikuszowice chert: 1-type V, 2-typeVI. Photographed by K. Olszewska, J. Ganszer.
Obr. 5. *Mikuszowický rohovec: 1-typ V, 2-typ VI. Foto K. Olszewska, J. Ganszer.*

Type I-B (zone of contact between "gaize" sandstone and types I and II-a cherts). The sandstone is bright beige (N/4). The boundary between the sandstone and chert is clearly demarcated. The granularity of the rock is clearly visible. Weakly marked lamination and dark intercalations are also visible. The cleavage of the rock is very weak and its fracture is regular.

Type I-C (zone of contact between compact silicified rock and type I of the chert). The silicified rock is bright beige (5B 4/1) and contains few inclusions. The lamination (or layer) is clearly distinguishable. The artifacts made only of this rock and surface samples are classified as type C.

Type II is blue-grey (5PB 3/1) with mat and poor cleavage. It is characterized by regular fracture and clear banding. Inclusions (0,5 mm in size) occasionally occur.

Type III - a. It differs from the above mentioned types of chert with its dark brown color (5Y 5/2). This chert is weakly transparent with good cleavage. It does not contain any inclusions.

Type III. This type is bright brown (2,5GY 3/1-4/1) with a silky luster. It is characterized by good cleavage. Similarly to dark brown color cherts it does not contain any inclusions.

Type IV. It is chert with beige-blue color (5PB 4/1), mat, with not very good cleavage. It contains few black inclusions 0,5 mm in size.

Type V is navy-blue (5PB 3/1-4/1) with conchoidal fracture. Its cleavage and transparency are weak. It contains few black intercalations (Fig. 5:1).

Type V-A (a zone of contact of silicified rock and Type V chert). The silicified rock is bright grey (5BG 5/1-6/1) with a mat luster. Its cleavage is poor and fracture regular. It does not contain any inclusions. The boundary between the silicified rock and chert is clearly visible.

Type VI. It represents very rare (among examined artifacts) type of chert white in color (VY 8/1). This chert is translucent with conchoidal fracture and no inclusions. Usually it forms thin layers (between 2–10 mm) within the most "typical" grey-blue cherts (Fig. 5:2).

Type VII. It contains lightly colored weathered cherts (usually grey – 10Y 4/1). The rock is not transparent and does not contain inclusions. It is common in surface samples. It should be emphasized that all described types of Mikuszowice cherts do not change their color under UV light.

Microscopic and x-ray analysis of Mikuszowice chert

In order to determine the mineral composition and structure of the classified rocks, type I-a (Fig. 6:1) and type V-A (Fig. 6:2) Mikuszowice chert were examined with a microscope under polarized light. Thin sections of these rocks found in the alluvial cones of Szeroki and Kamienny paleochannels in Jaworze (Fig. 6:3) were examined using the roentgenographic method.

Microscopic research of Mikuszowice chert showed that it possesses a microcrystalline structure. Its basic components are chalcedony and quartz. Chalcedony formed as oval-shaped, irregular aggregates in irregular concentrations. In contrast, quartz forms autogenic, interrelated grains which formed from the chalcedony concentrations. Irregular concentrations of calcite 0.05 mm in diameter as well as siliceous sponge spicules 1.5–2.0 mm in length are present in the siliceous mass. Opaque mineral grains and dispersed ferric hydroxide pigment are also present.

A light grey silicified rock has identical structure and almost identical mineral composition. It is composed of a microcrystalline quartz-chalcedony mass containing calcite micrite, calcified sponge spicules, rare muscovite plates and opaque mineral grains. The roentgenographic analysis revealed almost identical diffraction pattern of chert samples and silicified rocks samples. The diffractograms display intensive reflections with values d_{hkl}= 4.27, 3.35, 2.4596 Å corresponding to diffraction of x-rays on the following faces: 10$\bar{1}$0, 10$\bar{1}$1, 1120 of β- quartz. They reflect total contents of autogenic quartz which formed during re-crystallization from chalcedony and cryptocrystallline quartz building chalcedony aggregates. There are also weak reflections of calcite (d_{hkl}= 3.69 and 3.05 Å) and gypsum (d_{hkl}= 7.62 Å) appearing on diffractograms of silicified rock samples. They indicate the presence of

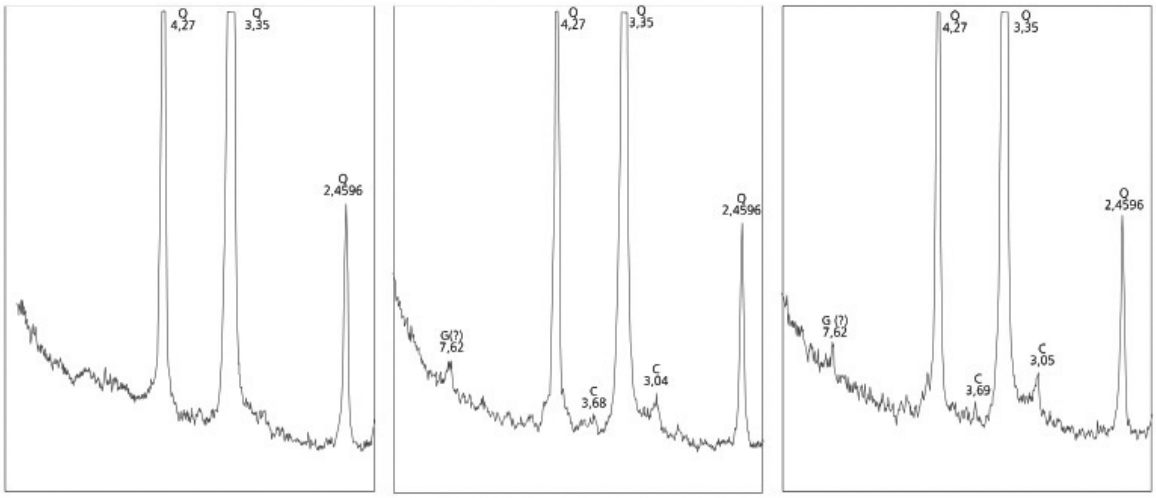


Fig. 6. X-ray diffractograms: 1 chert, 2 silicified rock, 3 silicified rock.
Obr. 6. *Rentgenové difraktogramy: 1 rohovec, 2, 3 silicifikovaná hornina.*

original calcium carbonate relics as well as epigenetic crystallization of sulphates.

This investigation indicates that compact siliceous rocks in the contact zone with Mikuszowice cherts were silicified. The silicification process was sufficiently intense to cause slight differences in mineral composition and structure between the cherts and rocks in the contact zone. The differences are reflected in macroscopic features of the above mentioned rocks.

Mikuszowice chert artifacts in the Stone Age and Bronze Age inventories

The materials were collected during surface surveys, excavations and fieldwork combining both of these methods. The proportion of chert artifacts varies considerably, which is hardly surprising. The proportion of chert ranges from 0.09 to 100% (Fig. 7). In other words, there is no single pattern of working with chert. Therefore, inventories can be preliminarily divided into three groups. In the first ("monomaterial") group, chert is the only raw material present. Unfortunately, due to the small number of surface sites, these indications are only preliminary.

In the Silesian Beskid directly under the *Ostry* (659 meters above sea level) peak, on a mid-slope plain, a surface investigation yielded a collection of 6 objects. The following chert artifacts were found: a blade-like flake, a blade, a burin on a blade, a carinated end-scraper, a side-scraper and a perforator. The blade-like flake and the blade were taken off massive single-platform cores for blades and blades and flakes. The character this collection suggest an Upper Paleolithic affinity (perhaps the Aurignacian (?).

Bielsko-Biała Straconka has similar dates. It is situated in SE hillside of (475 m s.l.) *Czupel* in the Small Beskid. A massive flake and high carinated end-scraper were discovered during a geological survey.

The Górki Wielkie site in the Silesian Beskid, at the northern slope of *Zebrzydka* (579 meters above sea level), is situated at an altitude of 470 meters above sea level. Sixteen artifacts were collected on the surface, or – more specifically – in an eroded crevice (Fig. 7:1). A single core, reduced and modified by reduction from two platforms is characteristic for prepared platforms and indistinct dorsal crest. It is clear that nearly a half of all flakes have faceted platforms. The collection of tools includes 2 end-scrapers (oblique, nosed) a core side-scraper, a perforator, a borer, a notched tool, a fragment of a leaf-shaped point with flat retouch on the ventral side on one edge. Considering the parameters of the core and the leaf-shaped point, the collection can be classified as the Swiderian culture.

At Kozy Małe *Czupel* 2 (~600 meters above sea level), the following findings were made: core *bec*, a blade with a notched, a denticulated flake. However, special attention needs to be paid to a concave truncation with a convex retouched base (=rhomb) and a small tanged point. The tang was retouched on the sides. This collection can be classified as the Ahrensburg culture (acc. Taute 1968, Kozłowski, Kozłowski 1975).

Jaworze X3 (Foltyn 2008) is also representative of the Late Paleolithic. Chert is the only raw material in all technological categories of the inventory: a pre-core, flakes, chunks, and 3 tools (an end-scraper, a notched tool, a retouched chunk). The pre-core is strongly reminiscent of the artifact found in site 10, associated with the Backed Blade Technocomplex.

Jaworze "Willa"is located at an altitude of 450 m above sea level in the NE foothill of the *Bucznik* (Silesian Beskid). The site – systematically destroyed by tree-felling activity – has yielded 23 artifacts (Fig. 7:1). Four pieces show some evidence of being worked (single neg-

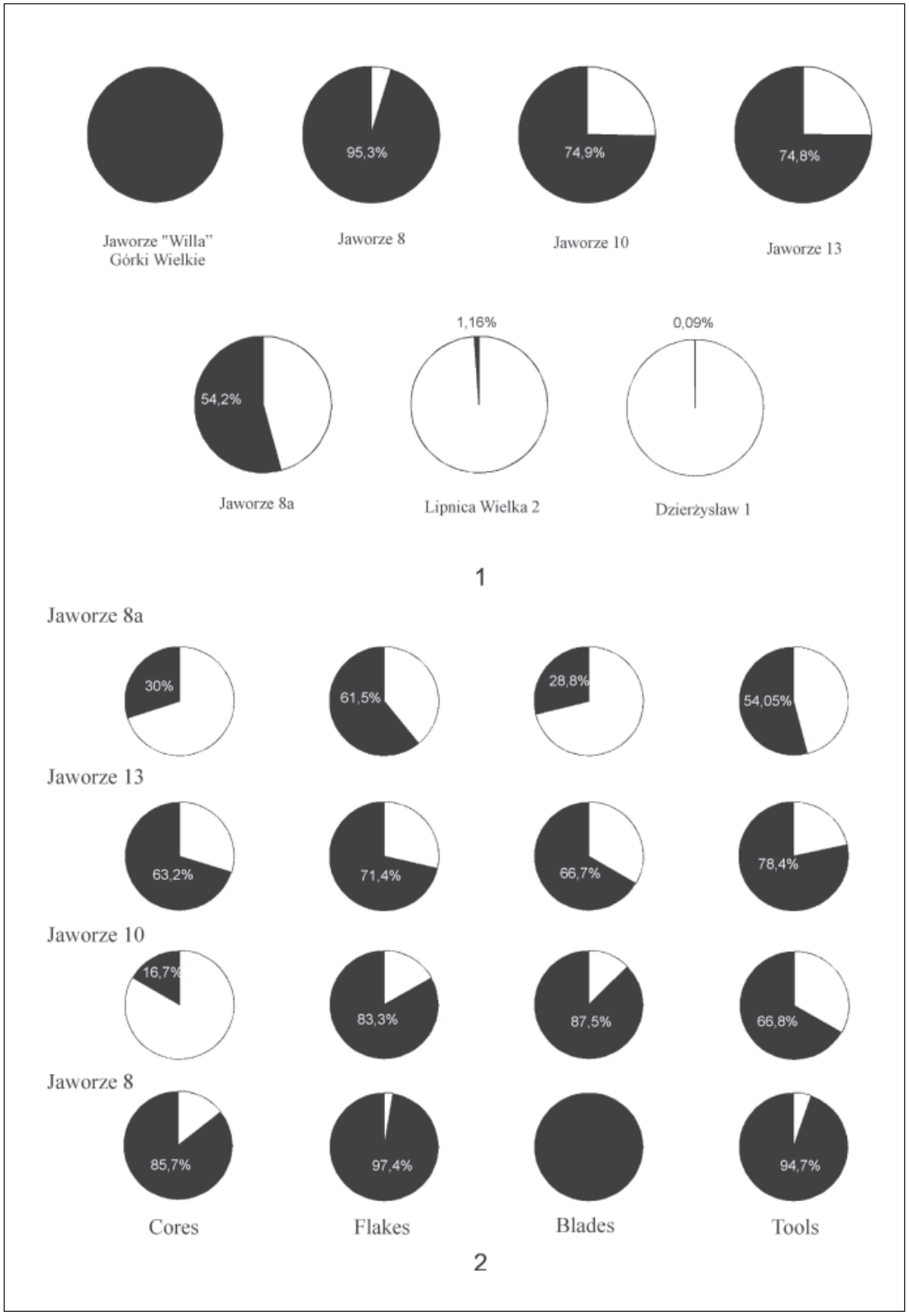


Fig. 7. Mikuszowice chert in selected inventories (1). Structure of the group of artifacts made Mikuszowice chert (2).
Obr. 7. *Výskyty mikuszowického rohovce ve vybraných inventářích (1). Struktura skupiny artefaktů vyrobených z mikuszowického rohovce (2).*

atives). Two microlithic cores have single-platforms. The tools include 3 end-scrapers, a burin on a retouched end, a straight-backed blade with a retouched base, combined tool.

A surface survey conducted at an altitude of 533 meters above sea level, in the central section of the northern slope of *Bucznik* next to a natural outcrop of weathering deposits, resulted in the recovery of 6 chert tools: flake end-scraper, a side scraper, a core perforator, a notched tool, a scraper and a core-axe.

In the town of Bielsko Biała, by the Olszówka stream (500 meters above sea level), on an extension of the *Szyndzielnia* range (1026 meters above sea level) and *Dębowiec* (686 meters above sea level) mountains (Silesian Beskid), two pieces were found: a tiny circular retouched scraper and an artifact resembling a Komornica truncation.

Cultural attribution of these three sites within the Mesolithic is still an open question.

The workshop element prevails in an interesting collection of artifacts from Kozy Małe *Czupel* 3 (~640 meters above sea level) site, consisting of an end-scraper, a pick, a crested blade and a blade.

Other than that, single objects have been found in a number of other sites. In Jaworze 8a, a geological probe opened in 1996 to explore a late interpleniglacial layer, a unifacial leaf point and a chip were found. The leaf point is culturally diagnostic – an Early Upper Paleolithic culture with leaf-points (Foltyn 2003).

A bifacially retouched backed knife from Jaworze *Kopany* (~650 meters above sea level; Silesian Beskid) site is a diagnostic form for the Early Bronze Age. A massive bipolar splintered piece was also discovered.

Out of the two findings from Bujaków site, *"pod Bujakowską Górą"* (740 meters above sea level; Small Beskid), a massive core perforator with a triangular cross-section point is a typical example of Bronze (Early) Age flint-making. The second artifact is a oblique end-scraper made on bladelet.

The two finds were contained within the upper portion of the residual soil from Ustroń *Żarnowiec* (*Ździar)*: one microlithic flake single-platform core (T. Jonderko) and a double concave-convex scraper on a core.

A perforator/groover with a sharp point made on the lateral part of a blade was found in Bielsko-Biała Czupel street. A scraper was found in Czechowice-Dziedzice 8. A so-called overshot flake (acc. Kopacz, Pelisiak 1988) was found in Bielsko-Biała *Łysa Góra* (660 meters above sea level; Small Beskid). In Zabrzeg 12, Ligota 3 and Kozy Małe *Czupel* 1 (~500 meters above sea level), a single flake was found at each site. An initial core with extraordinarily precise platform preparation was found in in Międzyrzecze. Last but not least sites Kojszówka 3, 5 and Targanice should also be mentioned.

At the second group of the inventories Mikuszowice chert occurs occasionally. One could never say that the populations of these sites ever depended on chert. The site Dzierżysław 1 is located on the so-called *Black Mountain* (Czarna Góra) in the Głubczyce Plateau. This site was excavated from 1989 to 1992. Artifacts in the lower level were classified as Bohunician. about the artifacts numbered 1175 with just a single Mikuszowice chert flake (Fig. 7:1) (Foltyn, Kozłowski 2003). The flake was imported from a distance of at least 80 km in a straight line distance (Fig. 1).

Site No. 8 in Lipnica Wielka is situated on the outer margin of a 6 meter wide terrace of the Orawa River 600 m above sea level. It was excavated in 1983 by J. Rydlewski. Of the 325 artifacts found, only two pieces were made from Mikuszowice chert (Rydlewski 2006).

Site 2 in Lipnica Wielka is located in the western part of the Orawska Valley, on the banks of the Czarna Orawa river. Excavations yielded an inventory of 1202 items, attributable to the Ahrensburg culture. As the only chert artifacts found includeone core, 6 flakes, 5 blades and 2 tools (Fig. 7:1) (Rydlewski 1989).

Mesolithic artifacts were discovered at Lipnica Wielka 2 and the raw materials used include Mikuszowice chert, for example, a small core and an armature. Unique artifacts include a backed point of the Stawinoga type, a small end-scraper of the Tarnowa type made from a different material (Rydlewski 2006).

The nearest outcrop of the Mikuszowice chert is located some 50 km north of the Lipnica Wielka site, between modern towns of Wadowice and Lanckorona (Fig. 1).

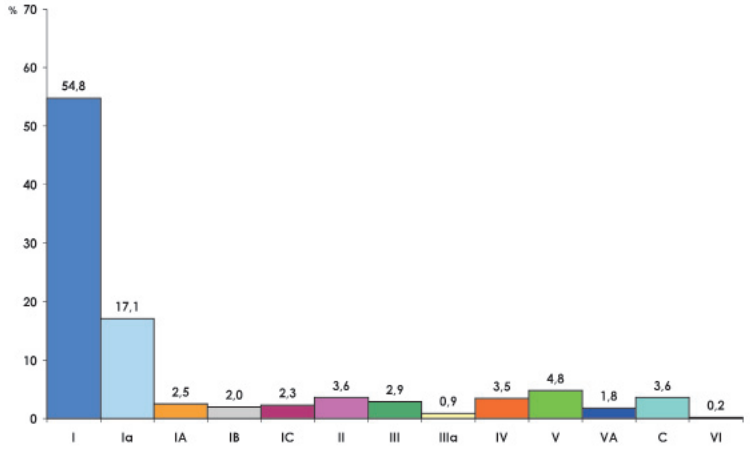
Site 6 at Ujazd is located on the left bank-terrace of Wisłoka River. This site was investigated in 1991, 2003–2004 (Gancarski 1992, Pawłowska, Petrykowski, Valde-Nowak 2003–2004, Valde-Nowak, Łanczont, Pawłowska 2005). The stone assemblage classified as Epigravettian numbers 24 items. Specimens made of Mikuszowice chert are represented by a borer and an undetermined fragment (Valde-Nowak, Łanczont, Pawłowska 2005). The nearest outcrop is 70 km distant.

The site of Mucharz 12, discovered by E. M. and E. Foltyn (2001) and subsequently excavated by A. Tarasiński and P. Valde-Nowak in 2005 is located in a bend of the Skawa river, on the western rim of the Beskid Średni Mts. (Fig. 1). Judging from preliminary information, the backfill of a shelter-like structure TL-dated to the Younger Dryas included a core and two retouchers made of Mikuszowice chert and a Swiderian tanged point made of flint (Valde-Nowak, Łanczont 2008).

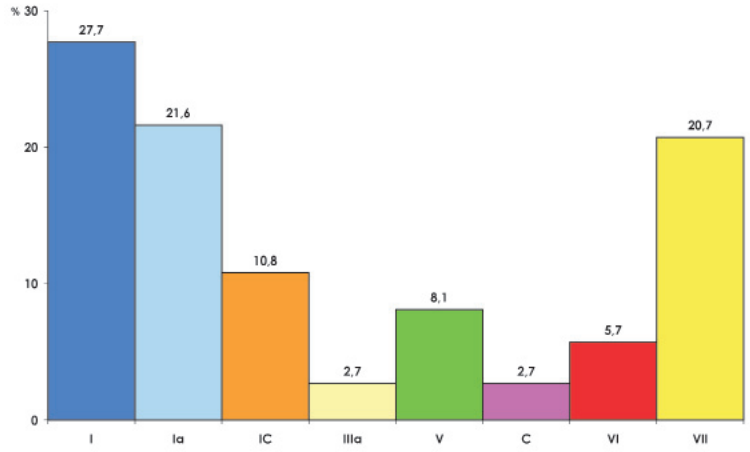
At Jaworze X5 site, a chert flake is accompanied by flint artifacts: a microlithic conical core, a trapeze, a retouched blade and a chip. The inventory featuring a trapeze is indicative of the Late Mesolithic period (Foltyn 2008).

Located in the Pisarzowice Divide region, the site of Kozy Małe has been explored superficially (excavations of R. Skoczylas, J. Ganszer). A chert microlithic conical blade core was identified. This assemblage appears mixed (Mesolithic and Lengyel culture). A chert blade was found by J. Rydlewski (1989a) in a Neolithic inventory (4 blades, flake, retouched blade) at Dobczyce which is located in Wielickie Foothills.

A mechanical mixture of materials found at Poprad-Matejovce site included a Late Paleolithic blade core



1



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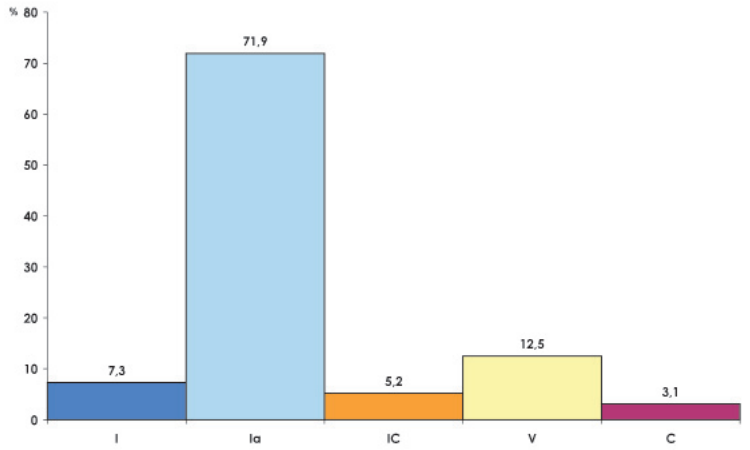

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Fig. 8. Frequency types of Mikuszowice chert and silicified rocks: 1-Jaworze, site 8, 2-alluvial cone "Jaworze", 3-Jaworze, site 8a. I–VI - symbols of chert and silicified rocks according table 2.
Obr. 8. *Zastoupení typů mikuszovického rohovce a silicifiovaných hornin: 1-Jaworze, lokalita 8, 2-aluviální kužel "Jaworze", 3-Jaworze, lokalita 8a.* I–VI - symboly rohovce a silicifiovaných hornin viz tabulka 2.

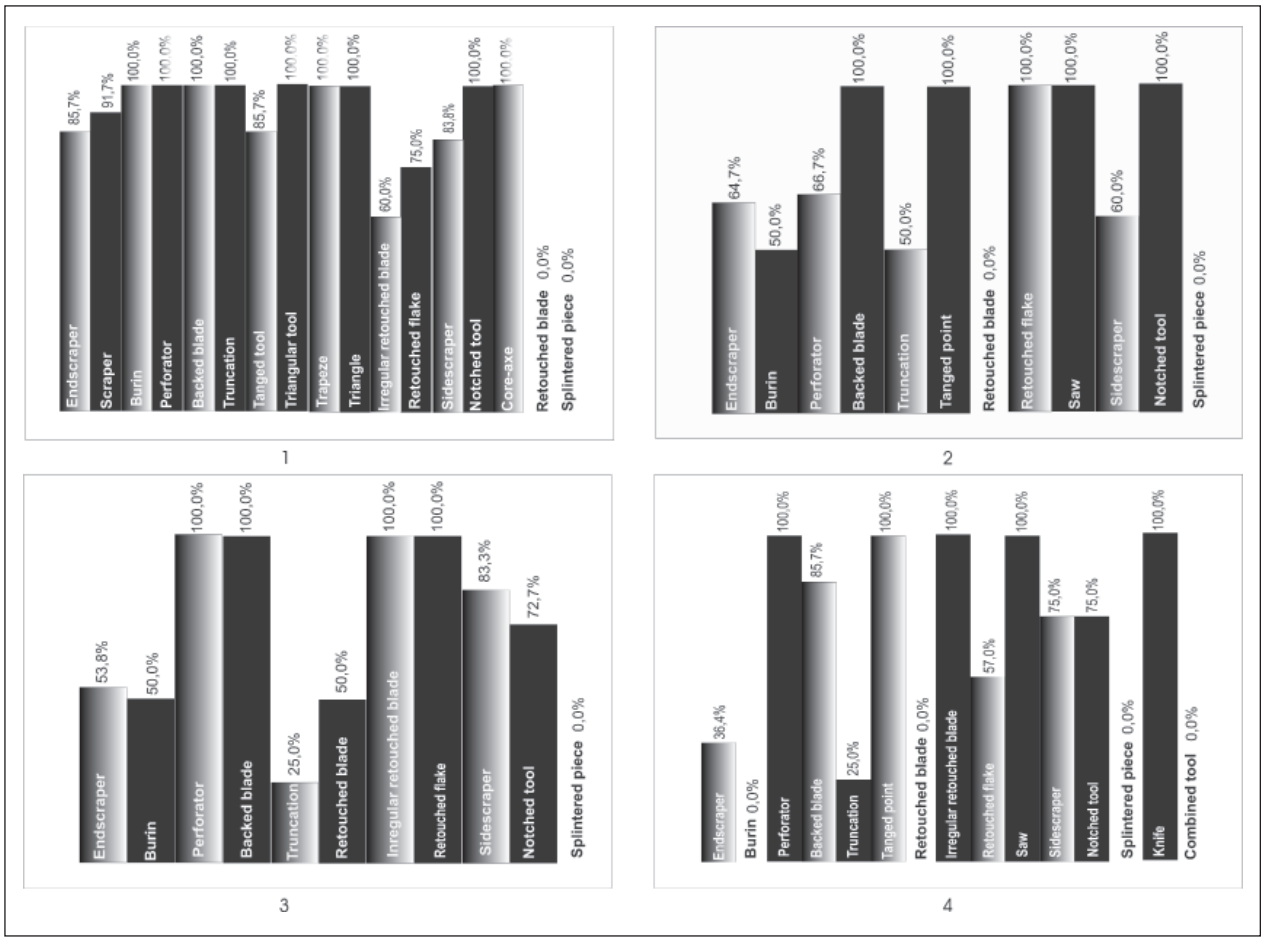

Fig. 9. Frequency of major tool groups made from Mikuszowice chert: 1-Jaworze, site 8, 2-Jaworze, site 10, 3-Jaworze, site 13, 4-Jaworze, site 8a.
Obr. 9. *Četnosti hlavních typologických skupin vyrobených z mikuszovického rohovce: 1-Jaworze, lokalita 8, 2-Jaworze, lokalita 10, 3-Jaworze, lokalita 13, 4-Jaworze, lokalita 8a.*

(P. Soják 2003, personal communication), which must have been moved some 85 kilometers from its source (Fig. 1).

The third group of chert artifacts account for a major proportion of the inventory. At Jaworze 8 explored in 1991, which in terms of stratigraphic and typological criteria correlate to the Atlantic period, almost all of the artifacts are made from Mikuszowice chert (Fig. 7:1). In terms of raw material proportions, type I is far more common than all the other types (Fig. 8:1). It has been confirmed that some of the chert originated at Straconka, located 13 kilometers to the east, despite the fact that Jaworze 8 is located on alluvial deposits, in the vicinity of rock outcrops. Individual morphological groups are comparable to a large extent (Fig. 7:2). Mikuszowice chert was used to manufacture tools in most cases (Fig. 9:1). Flint was very rarely used for making tools.

This Mesolithic assemblage is unique and does not fit previous classifications (Foltyn et al. 2002).

At Jaworze 10 excavated in 1995, the inventory of a Backed Blade Technocomplex was found in a loess-like clay. Polar-type stone rings were present in the overlying material. The stratigraphic position allows one to chronologically attribute this culture to the Younger Dryas (Foltyn, Foltyn 1998). The proportion of Mikuszowice chert in the raw material spectrum is less than 75.0% (Fig. 7:1). Blades, flakes and tools account for a distinctly greater proportion of this raw material than cores (Fig. 7:2). The majority of tools are made from chert. Flint implements are rare (see Figure 9:2).

A similarly high ratio was identified in the neighboring site 13 (Fig. 7:1). Artifacts attributable to a Backed Blades Technocomplex were found in a deposit of loess-like clay and in subfossil Allerød soil (?) (Foltyn et al. 2006). In terms of inventory groups, chert is never lower than 60% (see: fig. 7:2). As far as the collection of tools is concerned, the dependence on chert is shown in Fig. 9:3. The most numerous are specimens made from Mikuszowice chert. Tools made from flint are next.

Another site with a similar percentage of chert is Jaworze X4. Its collection of 24 artifacts includes 18 items of chert. These include 2 cores, 10 of the 11 flakes, 1 of the 2 blades, 2 of the 3 end-scrapers (comb-like and cir-

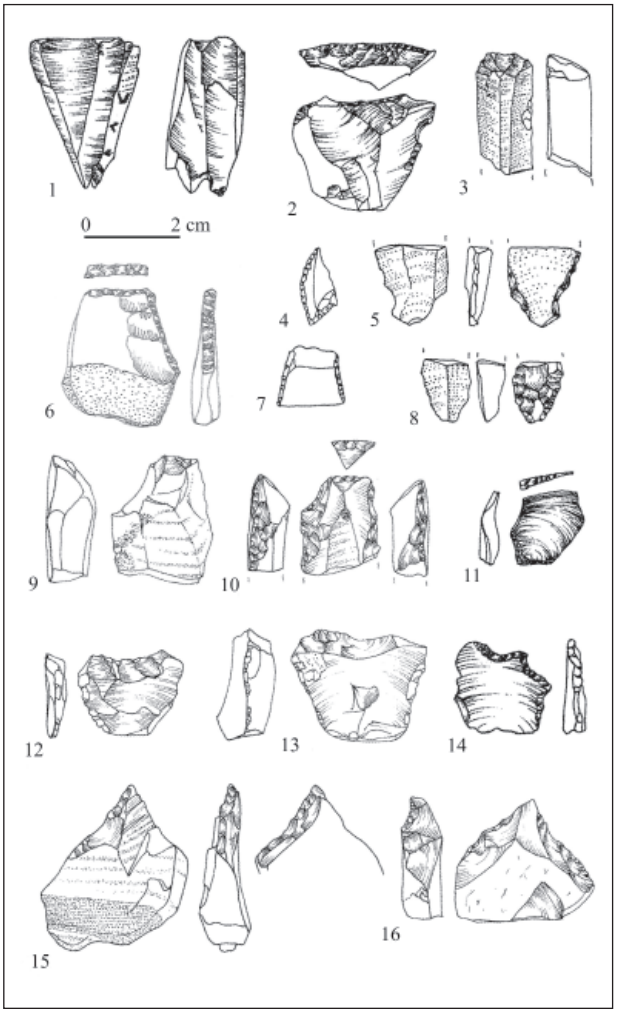

Fig. 10. Selection of artifacts made from Mikuszowice chert and flint. Jaworze, site 8: 1 – core, 3 – end-scraper, 4 – backed point, 8 – trapeze. Jaworze, site 10: 2 – end-scraper, 11 – truncation. Jaworze, site 8a: 5, 8 – tanged points, 6 – backed point, 14 – perforator. Jaworze, site 13: 9–10 – end-scrapers (10-flint), 12–13 – notched tools (13-flint), 15 – borer, 16 – perforator (flint). After E. M. Foltyn, E. Foltyn (1–8, 11, 14), E. M. Foltyn, E. Foltyn, A. Sady (9–10, 12–13, 15–16).

Obr. 10. *Výběr artefaktů vyrobených z mikuszovického rohovce a pazourku. Jaworze, lokalita 8: 1 – jádro, 3 – škrabadlo, 4 – hrot s otupeným bokem, 8 – trapéza. Jaworze, lokalita 10: 2 – škrabadlo, 11 – příčná retuš. Jaworze, lokalita 8a: 5, 8 – hrot s řapem, 6 – hrot s otupeným bokem, 14 – děrovač. Jaworze, lokalita 13: 9–10 - škrabadla (10-flint), 12–13 – nástroje s vrubem (13-pazourek), 15 – vrták, 16 – děrovač (pazourek). Podle E. M. Foltyn, E. Foltyn (1–8, 11, 14), E. M. Foltyn, E. Foltyn, A. Sady (9–10, 12–13, 15–16).*

cular), a burin on a broken end, a retouched chunk and a splintered piece-para-chopper (Foltyn 2008).

Another similar site is Jaworze X1, tentatively attributed to the Late Paleolithic. Again, chert (15 specimens) outnumbers flint (2 specimens). The chert accounts for 6 of the 7 flakes, 2 end-scrapers (comb-like and carinated), 2 notched tools, a regularly retouched blade, a side-scraper, a retouched chunk, a combined tool, and a small backed blade (Foltyn 2008).

At Jaworze 8a, however, the relationship is different. During excavation works held in 1994 and 1995, a Backed Blade Technocomplex collection was found between layers of loess-like and residual clays (Foltyn, Foltyn 1998). Similarly to site 10, dating by stratigraphy indicates the Younger Dryas. Chert pieces account for slightly more than half of all artifacts (Fig. 7:1). The variety structure is dominated by variety I-a supplemented by variety V, I, I-C, C (Fig. 8:3). The ratio of Mikuszowice chert flakes and tools is particularly high. Cores and blades from such materials are far less frequent (Fig. 7:2). More than half the tools are made from Mikuszowice chert. Flint implements are rare. The proportion of raw materials in the tool group is given in Fig. 9:4.

Jaworze 11 is located 80 meters NNE of site 13 and 60 meters SSE of site 10. Surface works that began in 1995 and continued for another couple of seasons yielded 35 artifacts attributable to the Early/Older Bronze Age (Foltyn 2008). In total, the collection features 21 chert artifacts, including a core, 2 pseudo- and splintered pieces, 8 flakes, 4 blades, 6 tools (knives, backed blade inclusions, retouched flakes, end-scrapers). The assemblage also includes a pseudo-splintered piece, 7 flakes, 6 tools (scrapers, side-scrapers, perforator, end-scraper), which are made of flint. However, the sample is rather unrepresentative due to its small size.

The inventory of site Jasienica is restricted to a scraper made from Mikuszowice chert and a flake made from flint.

*

Looking from a broader perspective it makes sense to see Mikuszowice chert as a material most often utilized locally. The working of chert was advanced and seems to have been a stop-gap solution, used to provide what was necessary "right here, right now". The further from the source, the less attractive the material was. When it was imported a long distance, it was probably a mere curiosity and did not make a useful economic contribution. The territorial range of chert products is never greater than 100 kilometers away from the source. The outmost locations where chert was found are Lipnica Wielka (50 kilometers), Ujazd 6 (70 kilometers), Dzierżysław 1 (80 kilometers) and Poprad-Matejovce (85 kilometers).

Most probably, chert simply could not successfully compete against other, better-quality materials. Most chert sites are found in the western part of Silesian Foothills and Silesian Beskid, particularly in Bielsko Divide in the strip of land between the Vistula and Wapienica rivers. Elsewhere, there are only isolated, randomly scattered sites except for the Orawa basin. The case of Jaworze 8 proves that despite the vicinity of alluvial cones or outcrops, the material (Fig. 8:1-2) was traded (which is less likely) or by direct contacts with the deposits in Straconka, located 13 kilometers away to the east. A distance of 13 kilometers permitted a return trip on the same day.

A number of factors determined people's interest in chert: the duration of settlement and intensity of activity, availability of other rocks of comparable or higher quality, the knowledge of natural conditions in the area (outcrops, quarries). Indigenous people who found it difficult to obtain other materials and were well acquainted with the availability of Mikuszowice chert were the most likely to use this material.

Sites Jaworze 8, 8a, 10, 11, X3, X4, "Willa", and Górki Wielkie *Zebrzydka* illustrate the entire processing cycle, from raw lumps to finished tools. What is striking is the preference for chert in selected types of tools only. Based on the example of Jaworze 8 and 8a it seems that varied quality of different cherts are related to selective use of the raw material (Fig. 8:1, 3). As far as retouched blades, splintered pieces, truncations, burins and – to some extent – end-scrapers, flint was usually preferred over chert (Fig. 9). Beyond any doubt, the use of chert did not differ from the use of flint. Mikuszowice chert is of similar quality to flint artifacts. The great utility of chert is confirmed by blade cores or tools reduced by surface retouch.

It can be assumed that searching for chert took the form of surface exploration (Fober, Weisgerber 1980) or collecting at primary and secondary deposits (Lech 1981). Pieces may have also been obtained from weathering rubble. Fluvially transported material was also used. There is some evidence (e.g. lack of internal cracks) indicating that chert may have been mined from rock exposures and high banks of river valleys or by quarrying. Original rock outcrops were identified on the north eastern slope of the *Kopany*, in the upper part of the *Czupel,* in the upper part of the *Hrobacza Łąka* and in the Kamienny stream valley. So far, however, we have been unable to find the actual mining locales (Chętnik 1951).

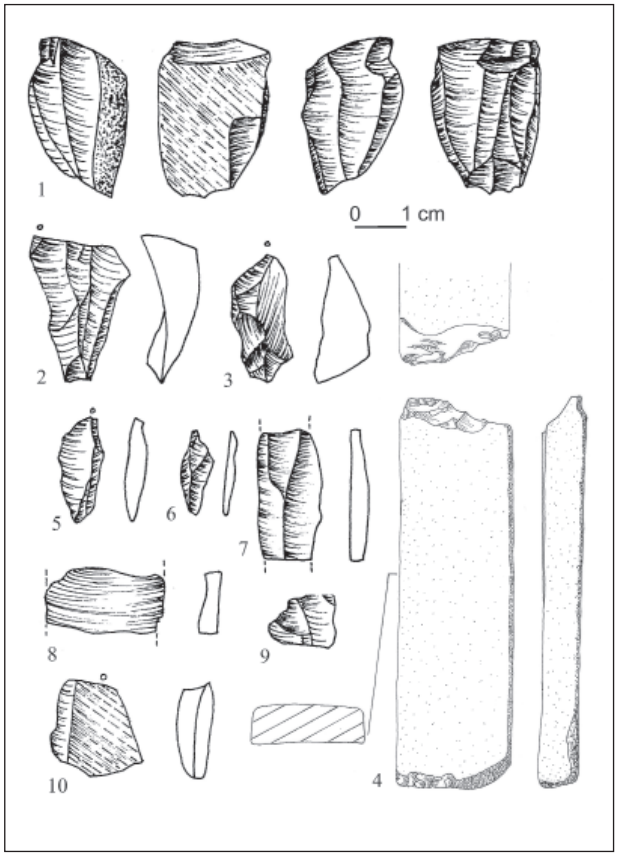

Fig. 11. Selection of artifacts made in Mikuszowice chert. Lipnica Wielka, site 2: 1 – core, 2–3, 5–6 – blades, 8–10 – flakes. Mucharz, site 12: 4 – retoucher. Dobczyce: 7 – blade. After J. Rydlewski (1–3, 5–10), P. Valde-Nowak, M. Łanczont (4).

Obr. 11. *Výběr artefaktů vyrobených z mikuszovického rohovce. Lipnica Wielka, lokalita 2: 1 – jádro, 2–3, 5–6 – čepele, 8–10 – úštěpy. Mucharz, lokalita 12: 4 – retušér. Dobczyce: 7 – čepel. Podle J. Rydlewski (1–3, 5–10), P. Valde-Nowak, M. Łanczont (4).*

Conclusion

Mikuszowice chert is a siliceous sedimentary rock composed of chalcedony and cryptocrystalline quartz. The material can be classified as spongolite. Mikuszowice chert occurs within the Lghota beds (Lower Cretaceous deposits). Primary, alluvial and eluvial deposits represent the sources. A number of outcrops was noted in Silesian Beskid and Small Beskid. This material can be macroscopically divided into 14 types.

Mikuszowice chert is known to occur at 39 sites. In terms of its genesis and frequency, three categories have been distinguished: 1. homogeneous, 2. dominance of chert, 3. occasional presence of chert.

Mikuszowice chert was primarily used in the areas where it outcropped as a local raw material. In the western part of the Silesian Foothills and the Silesian Beskids, Mikuszowice chert is the dominant raw material. The sites are concentrated in the Bielsko Divide, mainly on the strip of land between the Vistula and Wapienica rivers. Small quantities of Mikuszowice chert reached the sites located in areas further away from the outcrops. The maximum distance from the outcrops to the sites (in a straight line) is 50 km at Lipnica Wielka, 70 km at Ujazd 6, 80 km at Dzierżysław 1 and 85 km at Poprad-Matejovce.

The chert was first utilized during the Upper Paleolithic period. It was used on a large scale only in the final stages of the Paleolithic period. The use of this chert is particularly noticeable in the backed blade assemblages. Moreover, archeological sources confirm the significant role of this material in the Mesolithic period. During the Neolithic period, its (limited) use has been identified at 2 or 3 sites. Finally, Mikuszowice chert has been found in inventories dated to the Early/Older Bronze Age. However, in a number of cases it is impossible to precisely date and specify the cultural affinity of the artifacts.

The predominance of Mikuszowice chert is most apparent in flakes and tools. Its proportion in cores and blades is lower. The most common tools made from this chert are end-scrapers, perforators, retouched flakes, side-scrapers and notched tools. Backed pieces, burins, truncations, tanged points and retouched blades are also relatively common. Other tools are infrequent or absent.

Age		Upper Paleolithic			Late Paleolithic				Mesolithic		Neolithic	Bronze Age	Undefined
Sites	Cultures	Cultures with leaf points	Aurognacian Culture (?)	Epigarvettian Culture	Backed Blade Technocomplex	Ahrensburg culture	Swiderian culture	?	Jaworze-Luhačovice asemblages	?			
1. Dzierżysław 1													
2. Jaworze 8a													
3. Bielsko-Biała Straconka													
4. Jaworze *Ostry*													
5. Ujazd													
6. Jaworze 10													
7. Jaworze 13													
8. Jaworze X3													
9. Lipnica Wielka 2													
10. Kozy Małe *Czupel* 2													
11. Mucharz 12													
12. Górki Wielkie													
13. Jaworze X1													
14. Poprad-Matejovce													
15. Jaworze 8													
16. Lipnica Wielka 8													
17. Bielsko-Biała Olszówka													
18.Jaworze X4													
19. Jaworze X5													
20. Jaworze *Bucznik*													
21. Jaworze „Willa”													
22. Kozy Małe													
23. Bielsko-Biała *Łysa Góra*													
24. Dobczyce													
25. Jaworze 11													
28. Jaworze *Kopany*													
27. Bujaków *Bujakowska Góra*													
28. Bielsko-Biała ul. Czupel													
29. Czechowice-Dziedzice 8													
30. Jasienica													
31. Kojszówka 3													
32. Kojszówka 5													
33. Kozy Małe *Czupel* 1													
34. Kozy Małe *Czupel* 3													
35. Ligota 3													
36. Międzyrzecze Górna													
37. Targanice													
38. Zabrzeg 12													
39. Ustroń *Żarnowiec*													

Tab. 1. List of sites.
Tab. 1. Seznam lokalit.

Kind of siliceous rock	Symbol of cherttype	Macroscopic features		
		Color Insertions	**Lustre Transparency**	**Cleavage Fracture**
CHERT	**I**	grey-blue black	silky weak	good conchoidal
CHERT	**I a**	bright grey-blue black	silky weak	weak conchoidal
CHERT TYPE I AND SILICIFIED ROCK (CONTACT)	**I - A**	bright grey not occurring	mat non-transparent	very weak even
CHERT TYPE I, I – a AND SANDSTONE „GAIZE" (CONTACT)	**I - B**	bright beige dark grey	mat non-transparent	very weak even
CHERT TYPE I AND CAST SILICIFIED ROCK (CONTACT)	**I - C**	bright grey dark grey	mat non-transparent	weak uneven and conchoidal
CHERT	**II**	blue-grey black	mat non-transparent	middle even
CHERT	**III**	bistre not occurring	silky weak	good conchoidal
CHERT	**III-a**	bright brown not occurring	silky weak	good conchoidal
CHERT	**IV**	beige-blue black	silky non-transparent	weak conchoidal
CHERT	**V**	dark grey-navy blue black	silky non-transparent	weak mussel
CHERT TYPE V AND SILICIFIED ROCK (CONTACT)	**V A**	bright grey not occurring	silky weak	weak conchoidal
SILICIFIED ROCK	**C**	bright-beige not occurring	mat non-transparent	very weak uneven and conchoidal
CHERT	**VI**	white not occurring	silky weak	good conchoidal
WEATHERED CHERT	**VII**	grey not occurring	silky non-transparent	good conchoidal

Tab. 2. Classification of Mikuszowice chert.
Tab. 2. Klasifikace mikuszovického rohovce.

The so-called overshot flake is a unique find which was made when an axe with a triangular cross-section was being worked.

Based on the example of Jaworze 8 and 8a it can be postulated that differential quality of the different cherts is related to the selective use of the raw material. Some pieces of Mikuszowice chert were imported to Jaworze 8 from deposits 13 km distant.

In territories where the outcrops are close to the sites, the inventories display the whole cycle of lithic production – from raw lumps to production of flakes and/or blades and tools. This situation occurs at Jaworze and Górki Wielkie *Zebrzydka.*

Resumé

Příspěvek představuje klasifikaci mikuszowického rohovce z archeologické lokality Jaworze. Na základě získaných výsledků bylo vyčleněno 14 variet tohoto rohovce. Výsledky jsou využitelné pro identifikaci artefaktů mimo Karpaty. Artefakty vyrobené z mikuszowického rohovce byly identifikovány v souborech datovaných od mladého paleolitu po starší dobu bronzovou. V současné době má katalog lokalit, na kterých byl identifikován mikuszowický rohovec, 39 položek. Nejdůležitější a nejobjektivnější z těchto lokalit se jeví komplex 8 lokalit v Javorze. Oblast distribuce tohoto rohovce nikdy nepřesáhla 100 km od zdroje. Rohovce byly získávány povrchovým sběrem z primárních i sekundárních uloženin.

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