

## THE DISTRIBUTION OF CARPATHIAN OBSIDIAN IN POLAND DURING THE STONE AGE\*

### A KÁRPÁTI OBSZIDIÁN ELTERJEDÉSE A KŐKORBAN LENGYELORSZÁG TERÜLETÉN

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#### Abstract

*Obsidian, as a natural volcanic glass, was one of the best siliceous rocks available for prehistoric societies for manufacturing various tools. Due to distinctive trace and rare earth element composition, both its geological sources and chemical types can be precisely determined. This feature made obsidian an excellent record for reconstructing its distributions routes, exchange, mobility, communication network and contacts between human groups. In recent years studies devoted to recognition of obsidian provenance and variant by means of instrumental, non-destructive methods (i.e. prompt gamma activation analysis – PGAA, energy dispersive x-ray fluorescence – EDXRF) have been distinctively developed. The strong increase of application this kind of analyses has been observed also in reference to obsidian archaeological collections from present-day Poland.*

*The paper aims primarily to give a comprehensive overview of Carpathian obsidian distribution within the assemblages from Palaeolithic, Mesolithic and Neolithic, registered in Poland. Furthermore, we will focus on the changeable obsidian flow intensiveness – rather small in the Palaeolithic and Mesolithic to significant increase in the Neolithic, especially over the time of Malice development.*

#### Kivonat

*Az obszidián, azaz természetes vulkáni üveg az egyik legkiválóbb nyersanyag volt amiből az őskori közösségek eszközeiket készíthették. Jellemző nyomelem és ritkaföldfém összetételének alapján a geológiai források és a kémiai típusok is pontosan azonosíthatók. Ezen tulajdonságai alapján az obszidián kiválóan alkalmas elterjedési útvonalak, cserekereskedelem, mobilitás, kapcsolati hálózatok és embercsoportok közötti kapcsolatok rekonstruálására. Az elmúlt néhány évben jelentősen fejlődtek az obszidián származási helyének megállapítására alkalmas roncsolásmentes vizsgálatok (pl. prompt gamma aktivációs analízis – PGAA, energia-diszperzív röntgen fluoreszcencia vizsgálat – EDXRF). Ezeknek a vizsgálatoknak az elérhetővé válásával lehetőség nyílt a lengyelországi régészeti gyűjtemények obszidián leleteinek vizsgálatára is.*

*A jelen tanulmány elsődleges célja, hogy bemutassa a kárpáti obszidián elterjedését a lengyelországi ősköri, középső kőkori és újkőkori lelőhelyeken. Továbbá, megvizsgáljuk az obszidián beáramlásának dinamizmusát, amely meglehetősen szerény az őskör és a középső kőkor idején és jelentősen növekszik az újkőkorban, különösen a Malice kultúra idején.*

KEYWORDS: OBSIDIAN, STONE AGE, POLAND, NON-DESTRUCTIVE METHODS

KULCSSZAVAK: OBSZIDIÁN, KŐKOR, LEGERYORSZÁG, RONCSOLÁSMENTES VIZSGÁLATI MÓDSZEREK

#### Introduction

Obsidian is a rock of volcanic origin. The colour of obsidian divers from black, dark grey and sometimes brown-yellow to dark green, olive, orange, red, blue, purple and even gold. Distribution of the colour can be uniform, striped, ribbon or mottled (Žaba 2003).

Due to both physical (good knappability, giving sharp and hard edges of artefacts) and aesthetic properties (mostly transparent or translucent with strong glassy lustre) obsidian was eagerly used by different prehistoric societies, in various region of the world. Specific chemical composition of obsidian makes possible to trace the origin of particular artefacts, essential in studies of distributions routes, exchange, mobility, communication network and contacts between human groups.

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From the present-day Poland perspective, the nearest European territories with obsidian outcrops are central and south-eastern Slovakia, north-eastern Hungary and western Ukraine (Rosania et al. 2008). In the late 1970s, instrumental analytical methods were developed to characterise the outcrops of Carpathian obsidians. They were divided into two major groups – *Carpathian 1* (C1) related to outcrops in the vicinity of Viničky and Cejkov (Slovakia) and *Carpathian 2* (C2) from the Tokaj Mts. in Hungary (Williams & Nandris 1977; Williams-Thorpe et al. 1984). Apart from C1 and C2 type, a Transcarpathian variant of obsidian was also distinguished – C3 from the vicinity of Rokosovo, today's Ukraine (Petrougne 1972; Williams-Thorpe et al. 1984; Rosania et al. 2008).

Obsidian artefacts were found in the 2<sup>nd</sup> half of 19<sup>th</sup> century by Z. Gloger and S. Przyborowski (1876) in the south and south-eastern part of Poland. Almost at the same time obsidian items were recorded in Racibórz-Ocice, site 1<sup>1</sup> (southern Poland nowadays) as a result of excavations, carried out by German officer, Oberleutnant Rudolf Stöckel (1881)<sup>2</sup>.

However, we have to admit here that obsidian was mentioned for the first time in Polish archaeological literature in the early 1920s (Krukowski 1920, 1922; Kozłowski 1923). Since that time many of obsidian assemblages, related to the entire Stone Age, have been found in different regions of present-day Poland.

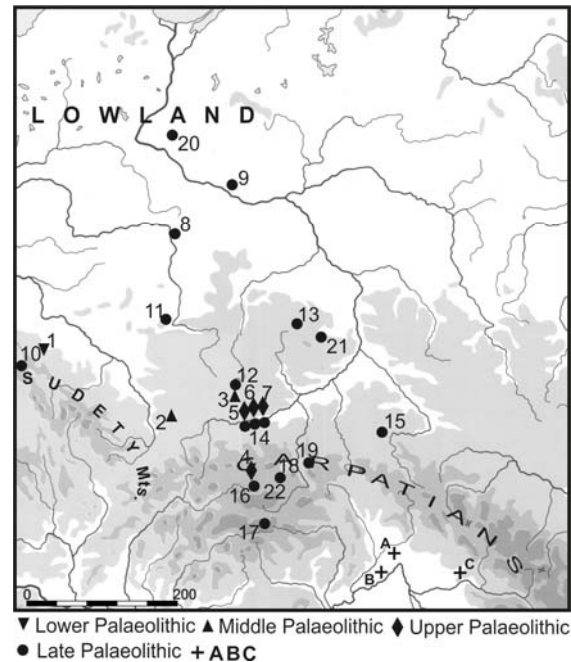
The aim of the paper is firstly to discuss the intensity of occurrence of Carpathian obsidian finds within various periods of time. Secondly, it will examine the recent results of obsidian provenance determination by means of both destructive and non-destructive methods.

### Palaeolithic

Probably the oldest obsidian artefact found in Poland is a side-scraper from Rusko, site 31 (Świdnica district), dated to the Lower Palaeolithic (Pawlikowski 1994) – **Fig. 1.; Table 1.** Next items, single tools or debitage pieces, attributed to the Middle Palaeolithic, were found in caves (Oblazowa – Nowy Targ, district and Ciemna; Kraków district) and at the site Rybnik-Kamień A, loco district (Foltyn & Foltyn, 2002; Valde-Nowak et al. 2003; Ginter 1986). The utilization of obsidian increased in the Upper Palaeolithic. From that period several assemblages, related to different traditions, are known.

<sup>1</sup> The site is known nowadays as Racibórz 113. At this paper the old name will be used.

<sup>2</sup>In 1793, as a result of the Second Partition of Poland, this area became a part of Prussia.



**Fig. 1.:** Location of main Palaeolithic sites discussed in the paper: 1 – Rusko, site 31; 2 – Rybnik-Kamień, site A; 3 – Ojców, Ciemna Cave; 4 – Nowa Biała, site 1; 5 – Kraków-Zwierzyniec, site I; 6 – Kraków, Spadzista Street B; 7 – Targowisko, site 10 and 11; 8 – Cichmiana, site 2; 9 – Płock; 10 – Mieroszów, site 9; 11 – Mokrsko; 12 – Głanów, site 3; 13 – Rydno; 14 – sites from the vicinity of Kraków; 15 – Wołódz, site 7; 16 – Oblazowa cave (Middle and Upper Palaeolithic layers); 17 – Sromowce Niżne, site 1; 18 – Skwirtne, site 1; 19 – Tylicz, site A; 20 – Nowogród, site 17; 21 – Ćmielów ‘Mały Gawroniec’. A – Carpathian 1 geological obsidian outcrops; B – Carpathian 2 geological obsidian outcrops; C – Carpathian 3 geological obsidian outcrops.

**1. ábra:** A cikkben említett legfontosabb őskőkori lelőhelyek (számozva). A, B, C: a kárpáti 1, 2, 3 nyersanyagforrások elhelyezkedése

Szeletian inventories consisting obsidian artefacts were registered in Oblazowa cave (layer XI), Aurignacian in Kraków-Zwierzyniec, and Gravettian in Kraków-Spadzista and Targowisko, site 10 – Wieliczka district (Sawicki 1949; Sobczyk 1995; Valde-Nowak et al. 2003; Wilczyński 2010a).

**Table 1.:** Chronological subdivision within Palaeolithic, Mesolithic and Neolithic in Poland (according to Hughes et al. 2018 with additions)

**1. táblázat:** A lengyel őskőkor, középső kőkor és újkőkor kronológiai tagolása, Hughes et al. (2018) nyomán, kiegészítésekkel

Time Period	Age (BP)	Sites with obsidian artefacts	References for sites chronology
Lower Palaeolithic		Rusko, site 31	Pawlikowski 1994
Upper Palaeolithic	Late Gravettian 24,000-25,000	Kraków-Spadzista	Wilczyński 2015
	Epigravettian 19,000-14,000	Targowisko, site 10	Wilczyński 2010a; 2014b
Late Palaeolithic	Magdalenian culture 15,000-11,000 BP	Ćmielów ‘Mały Gawroniec’	Przeździecki et al. 2012; Sulgostowska 2015
	Arched Backed Piece Technocomplex 11,700-10,750 BP	Nowa Biała, site 1; Sromowce-Niżne, site 1; Skwirtne, site 1; Tylicz, site A; Rydno	Tunia 1978; Schild & Królik 1981; Tomaszewski et al. 2008
	Tanged Point Technocomplex (Swiderian culture) 10,800-9,700 BP	Cichmiana, site 2; Wołodź, site 7; Glanów, site 3; Nowogród, site 17; Rydno, site XI/59	Osipowicz & Szeliga 2004; Sulgostowska 2005; Winiarska-Kabacińska & Kabaciński 2009; Osipowicz et al. 2018
Mesolithic	9,700-4,000 BP	Chwalibogowice; RydnoXIII/59; Brzozówka	Schild et al. 1975; Sulgostowska 2005; Hughes & Werra 2014
Neolithic	Early Neolithic (LBK) 7,500-6,800	Rudna Wielka, site 5; Rzeszów, site 16 (os. Piastów); Tominy, site 6; Brzezie, site 17; Olszanica	Kulczycka-Leciejewiczowa 1979; Kadrow 1990; Wilczyński 2014a; Kabaciński et al. 2015;
	Middle Neolithic/Late Neolithic Younger Danubian cultures (Stroked Band Pottery and Lengyel-Polgár complex) 6,800-6,200 BP	Kraków-Nowa Huta-Wyciąże; Racibórz-Ocice, site 1	Kurtz 1931; Furmanek 2010; Brzeska-Pasek 2016
	Middle Neolithic Malice culture 6,800-6,400 BP	Ćmielów; Rzeszów, site 16 (os. Piastów); Targowisko, site 11	Kadrow 1990; Ścibor 1992; Wilczyński 2010b, 2014b



**Fig. 2.:** Selection of Upper Palaeolithic obsidian artefacts from Targowisko, site 11 (photo by J. Wilczyński).

**2. ábra:** Válogatás Targowisko 11. felső paleolit lelőhely obszidián leleteiből (Fotó: J. Wilczyński).

The last one is especially noteworthy because of the quantity of items. Nearly 300 artefacts, including 3 tools, 29 flakes, 14 blades and ca. 250 chips, were discovered as the concentration in the western part of the site (**Fig. 2.**). Taking into account the structure of the assemblage and the presence of cortex, mostly on the surface of the flakes, it is very likely that only one nodule of obsidian was brought at the site (Wilczyński 2010a).

From that long period of time, from the Lower to the Upper Palaeolithic, very few assemblages containing obsidian items were recorded. Moreover, they occurred at the sites located only in the southern part of Poland. Only in the Late Palaeolithic, assemblages became more numerous, and obsidian items reached even the territory of Polish Lowland.

Magdalenian obsidian items are known only from one site – Ćmielów - ‘Mały Gawroniec’, Ostrowiec Świętokrzyski district (Sulgostowska 2005; Przeździecki et al. 2012). No obsidian artefacts have been found so far within Hamburgian assemblages, while numerous items made of this raw material were registered at the sites related to the Arched Backed Piece Technocomplex.



**Fig. 3.:** Selection of Late Palaeolithic obsidian artefacts from Cichmiana, site 2 (photo by P. Szejnoga).

**3. ábra:** Válogatás Cichmiana 2. késő paleolit lelőhely obszidián leleteiből (Fotó: P. Szejnoga).

One of the most important site, due to quantity of items and their variety is Rydno, Starachowice district (Schild & Królik 1981; Tomaszewski et al. 2008). Other sites, where obsidian was present, are located in southern Poland (Podhale region), namely Nowa Biała 1 in Nowy Targ district; Sromowce-Nizne, site 1, Nowy Targ district (Valde-Nowak 1987); Skwirtne, site 1, Gorlice district (Valde-Nowak 1991) and Tyliz, site A, Nowy Sącz district (Tunia 1978). However, we have to admit here that technological structure of obsidian collections is quite homogenous, including mostly flakes, occasional blades, cores and eight tools (2 end-scrapers, 3 backed pieces, a core-like burin, dihedral burin, and an undefined tool).

Obsidian was used also by Swiderian societies related to Tanged Point Technocomplex. Recently discovered in Nowogród, site 17 (Golub-Dobrzyń district) with a fragment of a blade is the most northerly of obsidian finds, in present-day Poland (Osipowicz et al. 2018) – **Fig. 1.** The most numerous obsidian collection was found on the Polish Lowland in Cichmiana (Koło district) where 49 items, including 6 tools (1 burin, 2 truncations, 2 retouched blades and 1 retouched chip) and a few dozens of small chips were found (**Fig. 3.**). Micro-wear analysis of the assemblage showed that only seven of them were used for scraping or cutting wood or other unidentified soft material

(truncations, retouched blade, blades, flakes) (Winiarska-Kabacińska & Kabaciński 2009).

In southern Poland only single obsidian finds have been recorded so far (i.e. Kraków-Bagno, Glanów, Kraków-Bieżanów 15, Wołódz, Mokrsko and Mieroszów; Krukowski 1920; Sulgostowska 2005; Osipowicz & Szeliga 2004). Similarly, single pieces may also be attributed to the Swiderian settlement complex in Rydno XI/59 (as in the case of radiolarite – Schild et al. 2011). Finally, two obsidian artefacts with problematic data should be mentioned. In the first case, its location is uncertain, defined as „somewhere near Płock” (Sulgostowska 2005), while in the case of item from Czerniejów (Lublin district; Przyborowski 1876) it is likely that raw material definition is incorrect (Hughes et al. 2018).

### Mesolithic

In comparison to Palaeolithic sites in Poland, obsidian items occurred very rarely at Mesolithic localities and only in the late phase of Mesolithic settlement development (Fig. 4).



**Fig. 4.:** Location of main Late Mesolithic sites discussed in the paper: 1 – Brzozówka; 2 – Chwalibogowice; 3 – Czyżów; 4 – Długawieś; 5 – Dzierżno; 6 – Kamień; 7 – Kraków-Zakrzów; 8 – Przedbórz; 9 – Pustynia Błędowska; 10 – Ranizów; 11 – Rytwiany; 12 – Tarnów-Rzędzin; 13 – Wrzask-Zagłoba; 14 – Zakrzów; 15 – Zgierz, site III; 16 – Rydno, site XIII/1958. A – Carpathian 1 geological obsidian outcrops; B – Carpathian 2 geological obsidian outcrops; C – Carpathian 3 geological obsidian outcrops.

**4. ábra:** A cikkben említett legfontosabb középső kőkori lelőhelyek (számozva). A, B, C: a kárpáti 1, 2, 3 nyersanyagforrások elhelyezkedése



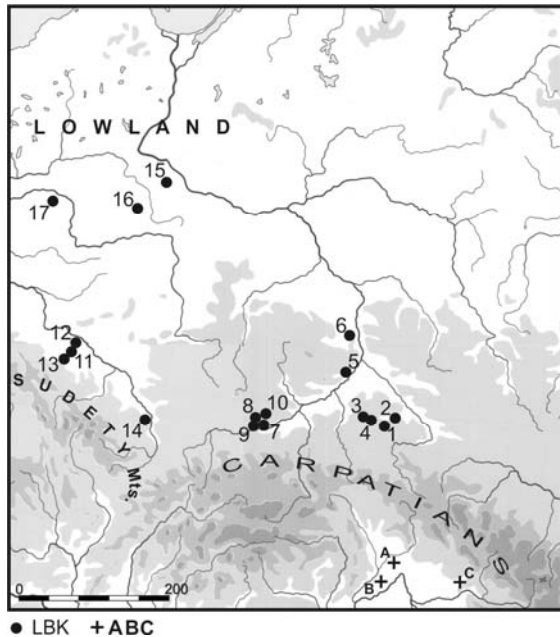
**Fig. 5.:** Selection of Mesolithic obsidian artefacts. 1 – Brzozówka, 2 – Chwalibogowice (according to Hughes et al. 2018, Fig. 4).

**5. ábra:** Középső kőkori obszidián eszközök. 1 – Brzozówka, 2 – Chwalibogowice (Hughes et al. 2018, Fig. 4 nyomán).

Assemblages, including specimens from this raw material, usually one, rarely 2 or more, were recovered at Brzozówka (Busko district) – a retouched blade and blade (Fig. 5/1); Chwalibogowice (Kazimierz district) – a trapeze (Fig. 5/2); Czyżów (Busko district) – a blade; Długawieś (Turek district) – a trapeze; Dzierżno (Gliwice district) – 2 flakes; Kamień (Kamień district) – a retouched blade; Kraków-Zakrzów (Kraków district) – a blade; Przedbórz (Radomsko district) – a blade; Pustynia Błędowska (Biały Piach, “Siedziba” III and VII) – 3 blades; Ranizów, site 1 (Kolbuszowa district) – 2 blades; Rytwiany (Staszów district) – a blade; Tarnów-Rzędzin (Tarnów district) – a blade; Wrzask-Zagłoba (Zgierz, district) – a triangle (inset); Zakrzów (Wieliczka district) – a few small blades and Zgierz, site III (Zgierz district) – a blade (Kozłowski 1923; Kozłowski 1972; Jażdżewski 1929; Cyrek 1981; Ginter 1972, 1986; Sulgostowska 2005). However, we must highlight here that most of the mentioned artefacts were found during surface prospection of the sites at the end of 19<sup>th</sup> or in the beginning of 20<sup>th</sup> century. Only few of them were documented during regular archaeological excavations. We should mention here the 10 obsidian artefacts (including a multiplatform core for flakes and blades (refitted with 3 flakes, a blade and 5 chips), 2 flakes, 3 microflake and 2 blades) found at the Rydno XIII/1958 site (Skarżysko-Kamienna district – Schild et al. 1975).

### Neolithic

In Palaeolithic and Mesolithic the number of sites, where obsidian items were unearthed, is rather small. This situation has changed significantly in the Neolithic. Up to now, more than 120 sites with obsidian assemblages were recorded.



**Fig. 6.:** Location of main Early Neolithic (LBK) sites discussed in the paper: 1 – Kormanice, site 1; 2 – Łañcut, site 3; 3 – Rudna Wielka, site 5; 4 – Rzeszów, site 16 (os. Piastów); 5 – Samborzec; 6 – Tominy, site 6; 7 – Kraków-Nowa Huta-Mogiła; 8 – Modlnica, site 5, 9 – Olszanica; 10 – Zabrzezie, site 17; 11 – Skoroszowice, site 1; 12 – Strachów, site 2; 13 – Strzelin, site 19, 14 – Dzielnica, site 17; 15 – Zagajewice, site 1; 16 – Chabsko, site 40; 17 – Kowalewko, site 14. A – Carpathian 1 geological obsidian outcrops; B – Carpathian 2 geological obsidian outcrops; C – Carpathian 3 geological obsidian outcrops.

**6. ábra:** A cikkben említett legfontosabb korai újkőkori (LBK) lelőhelyek (számozva). A, B, C: a kárpáti 1, 2, 3 nyersanyagforrások elhelyezkedése

Most of them are related to Linear Band Pottery Culture (LBK) settlement (**Fig. 6.**), when artefacts made of this raw material occurred from the beginning of its development, through the ‘music note phase’ (*Notenkopf* phase) and in the late (*Želiezovce*) phase. However, we must highlight here that the intensiveness and range of obsidian inflow was very diversified. In the beginning obsidian artefacts were distributed only in the southern part of Poland. In classic phase of LBK development obsidian items occurred much further to the north from the Carpathian region. The last phase is characterized by the occurrence obsidians together with imports of the Eastern Linear Pottery Culture or the Bükk Culture (Kaczanowska 1971, 2003; Kozłowski et al. 2014; Szeliga 2018; Szeliga et al. 2018).

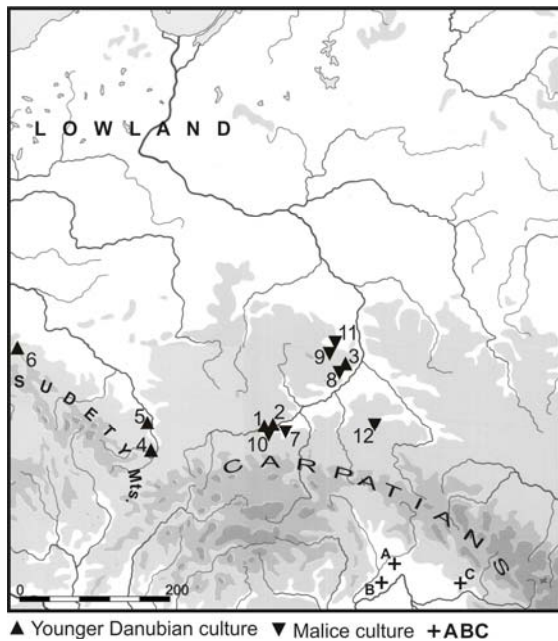
Generally speaking, most of obsidian artefacts concentrated in the south-eastern part of Poland, e.g. in the vicinity of Rzeszów, i.e. Kormanice, site 1 (Przemyśl district), Łañcut, site 3; Rudna Wielka, site 5; Rzeszów, site 16 (os. Piastów); around

Sandomierz, i.e. Samborzec, Tominy, site 6 (with 118 pieces) – middle Wisłok and San river; the Lubelska Upland and the area of Kraków-Miechów Loess, i.e. Kraków-Nowa Huta-Mogiła, site 62 (ca. 200 items), Modlnica, site 5, Olszanica (with more than 200 items, including cores, flakes, blades, tools – mainly retouched flakes and blades, truncation), Brzezie, site 17 – 39 items (Kadrow 1990; Kulczycka-Leciejewiczowa 1979; Szeliga 2009; Wilczyński 2014a; Kabaciński et al. 2015; Szeliga et al. 2018). In limited number obsidian artefacts are known from Silesia, i.e. Skoroszowice, site 1; Strachów, site 2; Strzelin, site 19; Dzielnica, site 17 (Furmanek 2010), Kujavia – Zagajewice, site 1; Chabsko, site 40 and extremely rare from Greater Poland – Kowalewko, site 14 (Kabaciński 2010) and Pyrzyce Land (Kulczycka-Leciejewiczowa 1980).

At the sites located in the vicinity of the Carpathians the complete process of obsidian elaboration has been observed (Szeliga 2009). On the area located further to the north and west, namely the Lower Silesia, Kujavia, Greater Poland and Pyrzyce Land only flake or blade blanks and sporadically tools have been recorded (Kabaciński 2010; Szeliga 2009).

Obsidian related to Younger Danubian Culture (“Stichband” or Stroke Band Pottery Culture and Lengyel-Polgár complex – Nowak 2013) are known from several sites located in Lesser Poland and Silesia (**Fig. 7.**). These specimens occurred usually in small number within the inventory, e.g. Kraków-Nowa Huta-Wyciąże an arrowhead of triangular shape, a perforator and a blade (Brzeska-Pasek 2016); Kraków-Nowa Huta-Mogiła, site 48 – 2 pieces (Kaczanowska & Kozłowski 1971), Złota-Grodzisko I (Sandomierz district) – an arrowhead (triangular in shape (Kaczanowska 1980). To the Silesian sites belong Racibórz-Ocice, site 1 where 95 obsidian artefacts were found (Kurtz 1931) – **Fig. 8.**; Dzielnica, site 17 (Kędzierzyn-Koźle district), where several dozen obsidian items were recorded, and Mierczyce, site 42 (Jawor district) – 2 items (Furmanek 2010).

The most intensive increase in obsidian distribution occurred during the period of the Malice Culture, especially in its classical phase and the gradual decline of its intensiveness, contemporaneous with the Lengyel Complex and the late phase of culture. In the beginning of Malice Culture development inventories including obsidian artefacts concentrated in the south, south-eastern part of Poland near Kraków, Sandomierz, Rzeszów and Przemyśl (Szeliga 2007) – **Fig. 7.**



**Fig. 7.:** Location of main Middle and Late Neolithic sites discussed in the paper: 1- Kraków-Nowa Huta-Wyciąże; 2 – Kraków-Nowa Huta-Mogila, site 48; 3 – Złota-Grodzisko I; 4 – Racibórz-Ocice, site 1; 5 – Dzielnica, site 17; 6 – Mierczyce, site 42; 7 – Targowisko, site 11; 8 – Samborzec; 9 – Opatów; 10 – Kraków-Nowa Huta-Pleszów; 11 – Ćmielów; 12 – Rzeszów, site 16. A – Carpathian 1 geological obsidian outcrops; B – Carpathian 2 geological obsidian outcrops; C – Carpathian 3 geological obsidian outcrops.

**7. ábra:** A cikkben említett legfontosabb középső és késő újkőkori lelőhelyek (számozva). A, B, C: a kárpáti 1, 2, 3 nyersanyagforrások elhelyezkedése

The most numerous assemblage related to the Malice Culture was found during rescue excavations in Targowisko, site 11 (Wieliczka district), on the planned route of A-4 motorway linking Kraków and Tarnów. The inventory consists of 585 obsidian items, including 69 cores, 209 flakes, 263 blades, 42 chips and chunks, and 2 tools – a retouched flake and a retouched blade. Artefacts were made of small nodules of obsidian, not exceeding 5 cm in size, mostly spherical, sometimes of cubic in shape. The cortex covering the surface of specimens is rough, often forming a porous outer layer of the concretion, which indicates that raw material was extracted directly from the outcrops (Wilczyński 2010b, 2014b).



**Fig. 8.:** Selection of obsidian artefacts from Racibórz-Ocice, site 1 (photo T. Gašior). The photo by courtesy of Muzeum Miejskie Wrocławia.

**8. ábra:** Válogatás Racibórz-Ocice, 1. lelőhely obszidián eszköziből. (Fotó: T. Gašior, Muzeum Miejskie, Wrocław).

The other large in numbers collections are known from Samborzec (Sandomierz district) – over 300 items: 15 cores, ca. 200 blades, ca. 100 flakes and 5 nodules (Kamińska 1964); Opatów (Sandomierz district) – 295 items: mostly blades and flakes, a few cores and tools (mainly retouched blades and notches (Więckowska 1971); Kraków-Nowa Huta-Pleszów (214 items, namely 7 cores, 133 flakes, 25 chunks and 49 mainly microlithic tools) – Cabalska 1964; Ćmielów (140 items: 4 cores, and 2 fragments of cores, 38 flakes, 84 blades, 7 tools, 5 nodules (Ścibor 1992) and Rzeszów, site 16 – more than 50 items: 6 cores, 12 flakes, 33 blades and 2 nodules (Kadrow 1990).

At many sites in south and south-eastern Poland assemblages including a few or only one item made of obsidian were registered, e.g. Fredropol (Przemyśl district; Wojciechowski 1989), Dwikozy, site 2, Góry Wysokie, site 9, Kamień Łukawski, site 1, Kichary Nowe, site 2, Linów, site 30/38, Polanów, site 11/79; Sandomierz-Żmigród (Sandomierz district; Ścibor 1992) and Rzeszów, site 20 (Kadrow 1990).

### ***Instrumental analysis***

Until 1990s obsidian collections from present-day Poland have been intuitively linked to outcrops based on macroscopic analyses. In order to proper identification outcrops of this raw material, a detailed recognition of its geochemical characteristics was needed. The very first attempt was undertaken by M. Pawlikowski (1994) in refers to the item from Rusko site. He applied several destructive, physical and chemical methods, such as: polarising microscopy, scanning electron microscopy, electron microprobe and X-ray diffraction phase analysis. The qualitative identification of Al, Si, Fe, Sn, Ag, Mn and Cl allowed only rough comparison of the examined piece with Slovakian and Hungarian obsidians. Taking into account the occurrence of iron and the grey colour of the artefact and opacity, the author suggested its provenance from Tokaj Mts. in Hungary.

Only twenty years later non-destructive methods for the provenance of obsidian artefacts were conducted by R. E Hughes and D. H. Werra (2014) in Geochemical Research Laboratory, Portola Valley. The energy dispersive x-ray fluorescence analysis (EDXRF) was applied to obsidian type identification for Late Mesolithic specimens from Rydno site. On the basis of quantitative composition of trace elements such as Rb, Sr, Y, Zr, Nb, Fe and Mn the geological source – Carpathian 1a and 1 b (Rosania et al. 2008) was documented. The very similar results brought next non-destructive analysis carried out for Late Palaeolithic items from Cichmiana and Mokrsko and Neolithic ones from Rudna and Kowalewko. Prompt gamma activation analysis (PGGA) was conducted in Budapest Research Reactor. Based on the data obtained by this method, quantifying most major components (oxides of Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K and H) and a few significant trace elements (mostly B, Cl, Gd and in some cases also Sc, V, Cr, Co, Ni, Cd, Nd, Sm and Eu) a similarity between Polish archaeological objects and the Carpathian 1 (C1, i.e. Slovakian, northern part of the Tokaj Mts.) was established (Sobkowiak-Tabaka et al. 2015; Kabaciński et al. 2015). Recently the same method was applied for analysing the artefacts from the Late Palaeolithic localities of Nowogród (Osipowicz et al. 2018) and the Neolithic site of Tominy (Opatów district – Szeliga et al. 2018).

The latest research were conducted by E. Hughes, D. H. Werra and Z. Sulgostowska (2018, Table 5) and examined 86 obsidian artefacts from twenty Palaeolithic and Mesolithic sites in Poland. The obtained results showed that majority of the specimens were made of Carpathian 1 chemical type of obsidian from Slovakia, while only three item from Kraków-Spadzista (Upper Palaeolithic)

were made of the Carpathian 2 obsidian variant, from Hungary.

The most recent project concerning the provenance of Neolithic obsidian of assemblages from present-day Poland, financed by National Science Centre, has been started in 2019 by D. H. Werra.

### ***Conclusions***

Except Gravettian site at Targowisko and Swiderian at Cichmiana, obsidian was used sporadically by Palaeolithic societies. Taking into account long-distance provenance (even more than 600 km from Slovakian outcrops in case of Nowogród site) and lack of well-organized system of exchange (rather occasional occurrence within assemblages), a number of non-exclusive explanations of obsidian presence might have been proposed. On the one hand, it may manifest a personal inheritance, a gift or bringing to the site together with other “southern” raw materials, e.g. Jurassic and Świeciechów flint or radiolarite (Hughes et al. 2018). On the other hand, it may express contacts and relations between more southern and northern bands – being presumably at the same time part of much wider network of ideas, social knowledge and prestige exchange (Sobkowiak-Tabaka et al. 2015).

Late Mesolithic societies used obsidian extremely rarely. The only exception is an assemblage from Rydno. However, regarding the refitting of artefacts it is very likely that only one or two nodules were utilized. It is very likely that obsidian was obtained from Neolithic communities or was just picked up from the surface at Palaeolithic sites (Cyrek 1981).

Very intensive influx of Carpathian obsidian was recorded only within Neolithic communities, especially in southern and south-eastern part of Poland. Interregional contacts between Danubian societies from southern Poland and the East Linear Pottery communities from eastern Slovakia and north-eastern Hungary are confirmed not only by presence of obsidian items, but also by the imports of vessels. These containers were registered at many sites in the southern Poland (Czekaj-Zastawny 2016; Furmanek 2010; Kamieńska 1964) and Polish Lowland (Grygiel 2001; Werra & Sobkowiak-Tabaka 2017).

At the LBK sites in the upper and middle Odra River basin in Poland and in somewhat larger numbers at sites linked with later groups, including those of the Lengyel Culture, obsidian artefacts occur rarely —usually as single finds (with the exception of the site 1 at Racibórz-Ocice). In that period interregional connections between Silesia and area of upper Tisa River basin (Hungary) are well attested in ceramic inventories (Furmanek 2010).



The raise of obsidian usage in Neolithic is related to Younger Danubian cultures, especially to Malice Culture. Both the number of sites with obsidian assemblage and, what is more important, the number of inventories increased. In that period the most intensive contacts between communities settled the southern part of Poland and Transcarpathian ones were recorded (Kulczycka-Leciejewiczowa 1979).

The disappearance of the obsidian usage tradition is probably the result of loosening the cultural contacts between Polish Late Neolithic and Transcarpathian communities. The other reason, we should take into consideration, is different technological requirements of flint-processing, namely enlargement of the metric aspect ratio of blades (Ścibor 1992).

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