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Antonín Přichystal[1], Jan Michał Burdukiewicz[2], Andrzej Wiśniewski[3]

SILICITE („FLINT") FROM OPOLE-GROSZOWICE: CONTRIBUTION TO RECOGNITION OF THE RAW MATERIALS USED DURING PREHISTORY IN THE ODRA RIVER VALLEY

ABSTRACT

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Until recently, all the erratic flints found at the Stone Age sites in the upper part of the Odra Valley were identified with silicites from the Baltic Sea. The age of Baltic flints is associated with the Uppermost Cretaceous, more precisely with the Maastrichtian or Palaeogene. However, it turned out that among these rocks, there are also silicites that are of different ages and origins. They were first found in outcrops of sands and gravels around Opole-Groszowice. So far, these flints have been distinguished in archaeological assemblages but they were usually regarded as imports from the Cracow-Częstochowa Jurassic Plateau.

The petrographic analysis proves that these silicites of brown colour are of the Jurassic age. They entered the glacial sediments via the lobes of the Drenthe glaciation. They were used in the same way as raw materials of Baltic origin. In this paper, we show some examples of Palaeolithic and younger sites, where artefacts made of brown silicite occurred.

Keywords: Odra Valley, Stone Age, Jurassic age, brown silicite, erratic raw material
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1 Institute of Geological Sciences, Faculty of Science, Masaryk University, Kotlářská 267/2, 611 37 Brno; prichy@sci.muni.cz; ORCID: 0000-0001-6653-0416
2 Institute of Archaeology, University of Wroclaw, Szewska 48, 50-139 Wroclaw; jan.burdukiewicz@uwr.edu.pl; ORCID: 0000-0001-5320-2114
3 Institute of Archaeology, University of Wroclaw, Szewska 48, 50-139 Wroclaw; andrzej.wisniewski@uwr.edu.pl; ORCID: 0000-0003-1379-333X

1. INTRODUCTION

The area of the Odra valley from Opole to the Opava Basin contains numerous sites with lithic artefacts that are referred to as the Palaeolithic, Mesolithic, Neolithic and Early Bronze Age (Burdukiewicz 1977; 1999; Foltyn *et al.* 1995; Ginter 1974; Kozłowski 1964; Wiśniewski 2006).

Among them, finds made of siliceous rocks of glacial origin dominate. Rocks that were brought to the area from distant outcrops are also present, such as the so-called Jurassic flint from the Cracow-Częstochowa Upland, Drahany type quartzite from Moravia (Janák and Přichystal, 2007; Kozłowski, 1964), or radiolarites (Wiśniewski *et al.* 2012; Wiśniewski *et al.* 2021). However, imported raw materials form minor admixtures of most assemblages.

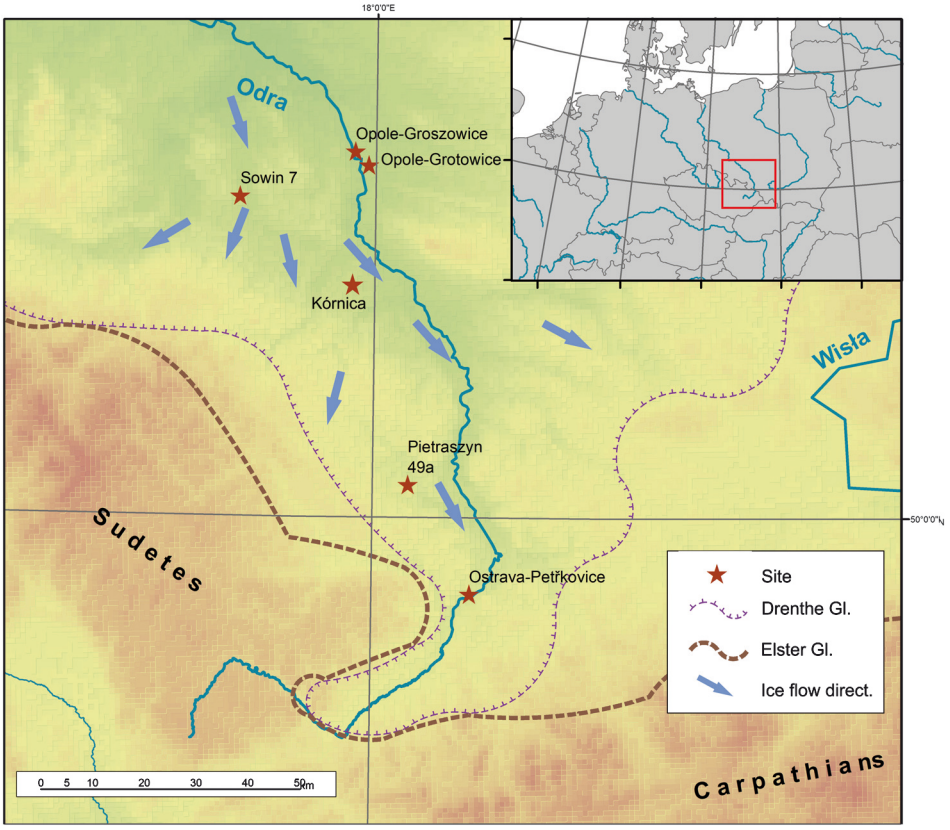

Fig. 1. Location of main sites discussed in the text, maximal extend of glaciations and direction of ice streams (after Salamon 2012)

Until recently, it was thought that among the siliceous rocks of erratic origin in the discussed area, the so-called flints from the Baltic Sea basin, usually with a homogeneous mass structure, were dominant and were associated with the Cretaceous, more precisely with the Maastrichtian or Palaeogene, *i.e.*, Danian. However, it has turned out that among these rocks, there are also silicites that are of different ages, namely of Jurassic origin. They were first found in outcrops of sands and gravels around Opole-Groszowice, Opole Province (Přichystal 2013, 105). So far, these silicites had not been recognized in archaeological assemblages.

Our work aims to present the main features of the siliceous rocks from Opole-Groszowice and to show examples of them that we have come across in collections of archaeological sites located in the Odra valley and its tributaries (Fig. 1).

The implications of this discovery are significant for considering the raw material supply strategies and contacts of early prehistoric societies living in the Odra valley. First, the presence of more erratic raw materials in the Odra belt may partly explain the occurrence of so many sites with flint materials compared to, for example, the western part of the Silesian Lowlands. The presence of siliceous rocks must have provided a significant impetus for the activity directed towards the manufacture and use of tools by the early prehistoric population. Secondly, the disclosure of the presence of Jurassic raw materials should draw the attention of researchers who have hitherto considered such raw materials as evidence of contact with the Cracow-Częstochowa Upland.

This paper consists of a geological part presenting the macro-and microscopic features of the silicites from Opole-Groszowice. We also present the current model of the ice sheet development, showing the reconstruction of directions and range of its lobes, which are the source of silica raw materials. Finally, we refer to archaeological sites where erratic raw material examples from Jurassic deposits have been found.

2. OVERVIEW OF THE OLDER OPINIONS ON THE PLEISTOCENE GRAVELS IN UPPER SILESIA

As far as older opinions are concerned, the most important papers are probably those of H. Lindner and M. Schwarzbach published in the local Upper Silesian geological journal in Gleiwitz (now Gliwice). H. Lindner (1938) studied Pliocene and Pleistocene gravels in the southern part of Upper Silesia. From our point of view, his conclusions concerning Pleistocene gravels deposited by glacial meltwater (Schmelzwasserschotter) are the most interesting. He divided the rock material of the gravels into „southern components" (i. e. coming from the Bohemian Massif) and „North Silesian components" from the Polish Jurassic, Silesian Triassic, Upper Silesian Cretaceous and Upper Silesian Tertiary. The southern components are represented by pebbles of Culmian greywacke and shale from Gesenke (the Nízký Jeseník Highland), Cretaceous (Cenomanian) rocks from the area of

Leobschütz (now Głubczyce), granite of the Friedberg (now Žulová) massif and amphibolite, diabase, phyllite from Altvatergebirge (the Hrubý Jeseník Mountains).

On the other hand, rocks of North Silesian origin are not rare. According to H. Lindner, flints of yellowish to brown colour with white grey, light-grey or black-grey weathering surfaces are always present. Based on the inclusions of fossils, H. Lindner believed them to be from the Polish Jurassic, and he also mentioned that they can be found especially around Oppeln (now Opole) and more to the south (Ratibor, now Racibórz). He also mentioned the locality of Rosenberg (now Olesno 42 km to the NE of Opole) where the Jurassic flints were dominant in a local gravel pit.

Triassic erratic boulders are represented by Upper Silesian „Muschelkalk", on the other hand, the Triassic cherts are not mentioned in the Pleistocene gravels. Whitish and yellowish Cretaceous (Cenomanian) sandstones are found up to Racibórz.

He considered silicified woods that can be found on both sides of the Odra River as erratic boulders of the Tertiary age. So-called Leitha limestone is rarer, and it appears only to the west of the Odra River with primary occurrences around Leobschütz (Głubczyce). Occasional basalt blocks come from various Upper Silesian Tertiary volcanic outcrops.

Another interesting contribution by M. Schwarzbach (1938) is the description of silicified corals of the Cretaceous age found in Pleistocene gravels along the Odra between Racibórz and Opole-Groszowice. He supposed the corals come from Klogsdorf (now Příbor-Klokočov), a very known palaeontological locality in northern Moravia. The origin of the corals is still a matter of discussion, in any case, our survey in Opole-Groszowice (see below) revealed the occurrence of rocks from the flysch belt of the Carpathians, which is from the same direction.

3. THE INVESTIGATION OF SILICITES FROM SAND PITS AT OPOLE-GROSZOWICE AND THE SURROUNDING AREA

Our attention has been focused on unusually numerous siliceous rocks in the Pleistocene gravel at Opole-Groszowice (Fig. 2). Because there are different opinions (*e.g.* in the Polish textbook of petrography by Bolewski and Parachoniak 1978, 137: the difference is based on the shape of siliceous rocks) on the classification of siliceous rocks originating in Poland, especially concerning the terms flint (*krzemień*) and chert (*rogowiec*). We prefer to use the more general term silicite for all siliceous rocks with different opinions on their designation. According to the prevalent meaning in the Anglophone geological dictionaries, „flint is a variety of chert which occurs commonly as nodules or bands in chalk" (Allaby and Allaby 2003; Murawski and Meyer 1998; Přichystal 2010; Brandl 2010). That is why we classify as flints only silicites coming from the Maastrichtian (Uppermost Creta-

Fig. 2. View of sand and gravel outcrops. Brown flint is extracted from the bottom during exploration (state in August 2017). Photo by A. Wiśniewski

ceous) chalk or maybe also the Danian (Lowermost Tertiary) limestones around the Baltic Sea because it is sometimes impossible to distinguish between them.

Sampling silicites in modern sand pits east of Opole-Groszowice has been carried out since 2005. It is evident that the composition of siliceous rocks within the erratic material here is substantially different compared with other sources in glacial deposits of southern Poland, Czech Silesia, northern Moravia, and northern Bohemia. Maastrichtian and Danian silicites (flints) are relatively rare and big pieces of concretional brownish silicite prevail. For example, we collected about 100 kg of brown silicites with nine students for half an hour in 2019. Some of the boulders have dimensions up to 18 × 15 cm and weigh almost 6 kilos. Zdeněk Gába, a Czech specialist on erratic materials in glacial sediments estimates their content in the rock fraction 5-10 cm at Groszowice about 30% (the authors thank him for the oral information).

Together with them, we found also pieces of silicified Tertiary woods (up to 40 cm), numerous sandstones and big blocks of Tertiary olivine basaltic rocks with intensive weathering surface in the sand pits at Opole-Groszowice. On the other hand, rocks from the Western Flysch Carpathians are also present, for example, dark layered menilite chert or so-called révaite (weathered silicified siltstone with a nice, banded structure) – for more detail see Přichystal and Vožďová (2014).

4. ANALYSIS OF SILICITES FROM OPOLE-GROSZOWICE

4.1. Macroscopic appearance (Figs 3-5)

The silicites of Opole-Groszowice type have prevalently dark yellowish brown to dusky yellowish brown colour (Munsell 10YR 4/2 – 10YR 2/2) or to greyish brown (Munsell 5YR 4/1 – 5YR 3/2), at the first glance similar to the colours of silicites from the Cracow-Częstochowa Jurassic that occur in red weathered clays. Their surface is without the characteristic rough cortex that we know on the Neolithic raw material mined around Cracow and transported also to Moravia or Bohemia. They have only a smooth thin relict layer of often whitish cortex, sometimes with small hard overgrowths (2-3 mm) that represent parts of fossils. The shape of silicite pieces is commonly oval, the surface is without cavities (non-rugged).

4.2. Study of silicite chips in water immersion under a stereomicroscope (Figs 6 and 7)

Investigation of silicite pieces in water immersion under a stereomicroscope revealed similar signs, as can be seen in silicites from the Cracow-Częstochowa Jurassic (Přichystal 2013, 102-105); the silicite groundmass is partly translucent, partly cloudy because of a suspension of very fine orange to red pigment and it contains numerous chips of whitish fossils in some places. Some pieces contain relics of big fossils – echinoids, their spines, corals and molluscs.

4.3. Study of the thin section under a polarising microscope (Fig. 8)

A very fine-grained groundmass composed of cryptocrystalline quartz can be seen in thin section under the polarising microscope. Relics of microfossils are filled with bigger chalcedony fibres or large ones even by quartz crystals with a diameter of around 50 microns. Small accumulations of Fe-oxides/hydroxides are spread in the groundmass but especially microfossils with quartz grains are accompanied by their higher occurrence. Similar microfossil relics filled with “megaquartz” (more than 20 microns in diameter) were described by A. Świerczewska (1997) from Jurassic chert in the surroundings of Cracow.

4.4. Density

We tried to characterize the studied silicites also by their densities. Generally, it is possible to suppose that the groundmass of older silicites is more transformed from modifications with water content (opal, chalcedony) to quartz without water. According to this supposition, the silicites of the Proterozoic and Palaeozoic ages would have higher density

Fig. 3. Examples of the brown silicite from Opole-Groszowice.
Photos by A. Přichystal and A. Wiśniewski

Fig. 4. Detail of the surface with small hard overgrowths.
Photo by A. Přichystal

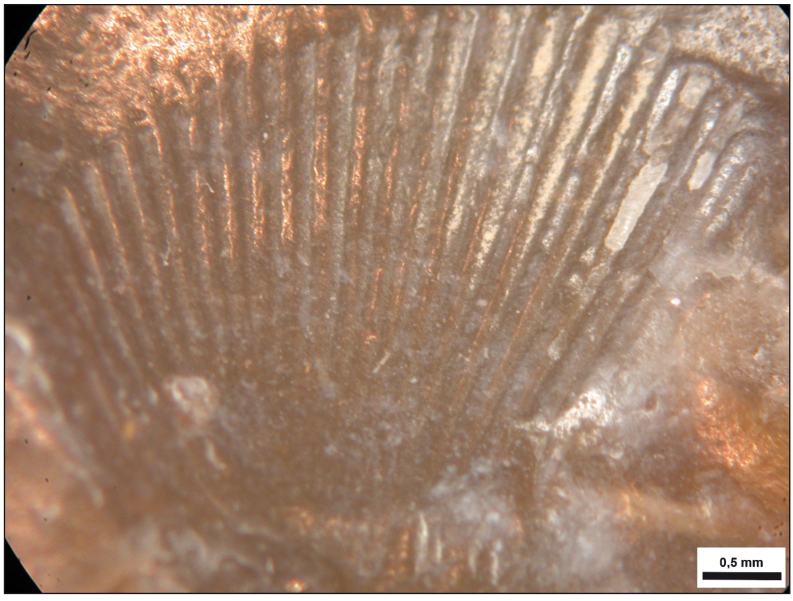

Fig. 5. The imprint of a mollusc shell on the surface of brown silicite.
Photo by A. Přichystal

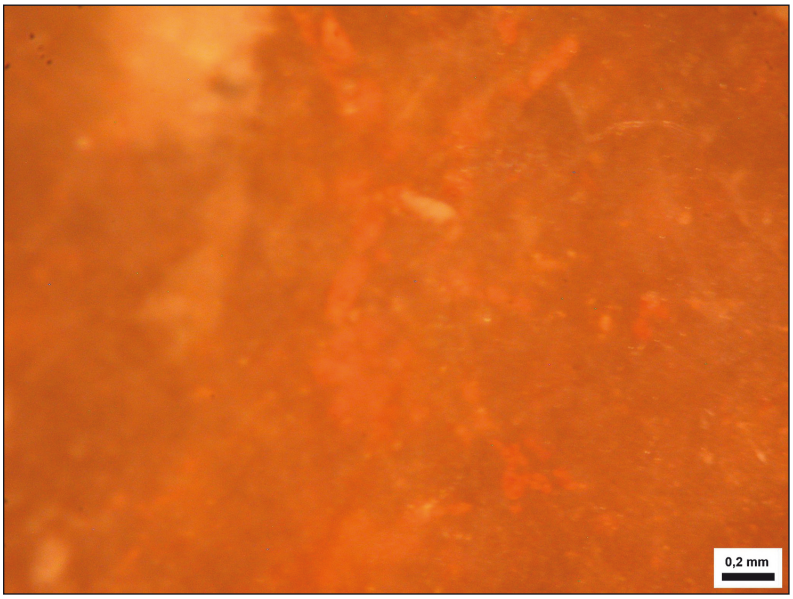

Fig. 6. Accumulation of red pigment in the siliceous mass of the Opole-Groszowice silicite. Investigated in water immersion under a stereomicroscope. Photo by A. Přichystal

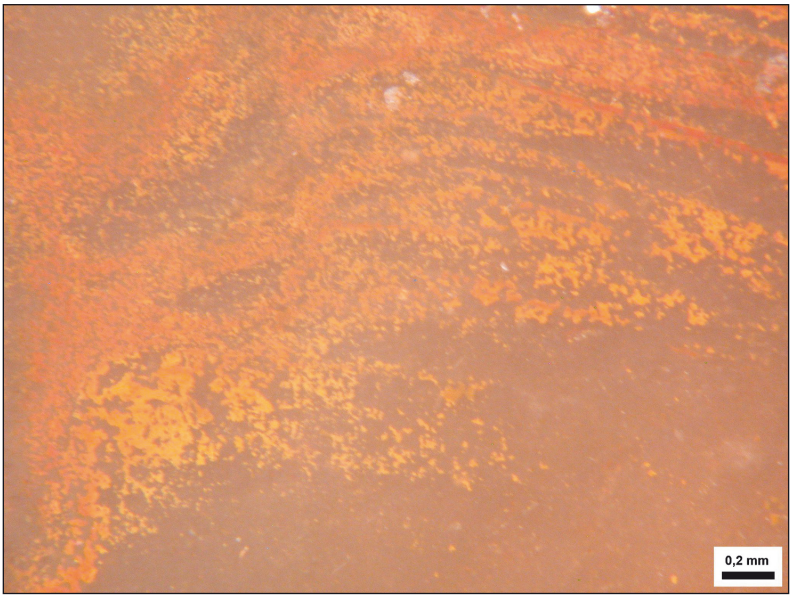

Fig. 7. Micro-cracks in the brown silicite are covered by Fe-compounds.
It is evidence of the original occurrence of nodules in red clays, products of intensive weathering of probably Jurassic limestone. Investigated in water immersion under a stereomicroscope. Photo by A. Přichystal

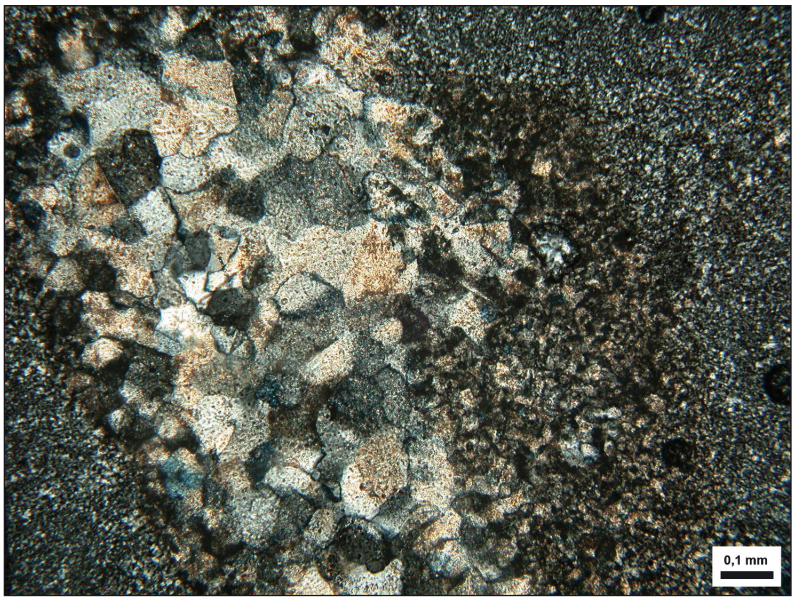

Fig. 8. Thin section of the Opole-Groszowice silicite under a polarising microscope, crossed nicols. The relict of a fossil is filled with bigger quartz crystals and intensively clouded by Fe-pigment. Surrounded by microcrystalline quartz in the groundmass. Photo by A. Přichystal

comparing the Mesozoic and Tertiary ones. We may see it on Proterozoic phthanites from Bohemia (26 samples) with their average density 2.62 ± 0.06 g/cm^3 (Eliáš and Uhmann 1968), similarly, six samples of Palaeozoic (Devonian) cherts from the Barrandian area in Bohemia have also high densities, in fact with the same average value 2.62 ± 0.015 g/cm^3 as the Proterozoic ones. On the other hand, the Oligocene menilite cherts (two samples) yielded only 2.52 g/cm^3.

The Jurassic silicite (variety A) from the southern part of Cracow-Częstochowa Jurassic (three samples from Brzoskwinia, Piekary and Mników) has a lower average density 2.589 ± 0.004 g/cm^3 and 10 Neolithic artefacts made of Jurassic silicite (probably variety G, samples given by A. Brzeska-Zastawna), yielded 2.568 ± 0.018 g/cm^3 (Přichystal *et al.* 2020). In our study, we also determined the average density of three brown silicites from Opole-Groszowice: 2.594 ± 0.004 g/cm^3, a value that is very similar to the variety A from the surroundings of Cracow.

4.5. Loss on ignition (LOI)

The loss on ignition occurs when a sample of the material is heated to high temperatures allowing volatile substances (H_2O^+, CO_2, organic matter) to escape. The first step

represents desiccation up to 100°C (H_2O^-), and then the heating continues up to 1200°C. If the LOI were only determined by the concentration of hydrates and labile hydroxy-compounds, Proterozoic phthanite and Palaeozoic lydite would have the lowest values, while Tertiary cherts would have the highest. For example, in 14 Proterozoic phthanites from Bohemia H_2O+ is under 0.33% (Dubanská *et al.* 1977).

Unfortunately, especially Mesozoic silicites also contain carbonates very often (prevalently $CaCO_3$) and they also play an important role in the values of LOI. That is why our results are ambiguous. According to our measurement, the Triassic chert from Górażdże shows a low LOI = 0.99%, and a similar LOI published by J. Stawin (1970) for Triassic chert from Imielin near Jaworzno (0.97%). Three brown silicites from Opole-Groszowice have LOI = 0.97-1.27%. J. Lech (1980) informed us about the LOI of 14 Jurassic "flints" from natural outcrops in the Cracow region with dispersion 1.07-2.41%. Our sample from Piekary gives 1.06 % and from Gojść – 1.60%. It is evident, that the Jurassic silicites from the Cracow-Częstochowa (Wieluń) Upland have a large dispersion of LOI and the brown silicites from Opole-Groszowice yielded similar data.

4.6. Possible origin

There is no doubt the silicite from Opole-Groszowice does not correspond to the main two types of silicite rocks of northern origin in glaciogenic deposits, *i.e.* Maastrichtian and Danian flints. Neither can it be derived from the southern sources because there are no similar cherts in the Cretaceous platform covering the Bohemian Massif at the border of Czech Silesia/Poland, in the area between Osoblaha/Osobłoga (Czech Silesia) and Głubczyce (Polish Silesia). Local Cretaceous spongolite forms a layered chalcedony bed of light grey to honey-brown colour. Similarly, cherts from occurrences in the Flysch Carpathians (the menilite chert, Baška chert or Mikuszowice chert) are layered and different. According to density, we can exclude silicites of the Proterozoic and Palaeozoic ages.

Concerning the local Triassic concretional chert, we know its primary occurrence in the Górażdże beds near the village Górażdże about 15 km distance SSE from Opole, which means relatively close to Opole-Groszowice. However, they have a grey and brecciated non-translucent appearance and form only small occurrences, so they cannot be the silicites of the Opole-Groszowice type.

All these data testify to the conclusion that the Opole-Groszowice silicites can be compared with „flints" from the Cracow-Częstochowa Jurassic. Of course, we cannot exclude the possibility that the name Opole-Groszowice silicite covers more varieties of siliceous rocks from southern Poland but with no doubt, the Jurassic silicite ("flint") prevails.

The natural occurrence of brown silicites is the most frequent at Opole-Groszowice. The silicites of this appearance can be followed in substantially less concentration to the south, they can be found rarely within glacial sediments in the territory of the Czech Republic (Ostrava-Opava regions).

4.7. Glacial sediments and silicites

Based on studies of glacial sediments located in the Niemodlin Plain and the Racibórz Basin as well as the Głubczyce Plateau and the Rybnik Plateau, traces of two glaciations were identified: the Elsterian and Drenthe (Saale-Odra) glaciations (Badura and Przybylski 1998; Lewandowski 1988, 2001). The better preserved forms and sediments of the Drenthe glaciation made it possible to isolate the main lobe and several sublobes, which were responsible for the transport of erratic material towards the south, including silicites known from Opole-Groszowice (Fig. 1). The main flow of the Upper Odra ice lobe is thought to have intruded southwards through a relatively narrow 40 km wide corridor between the Middle Triassic Ridge in the east and the foothills of the Eastern Sudetes in the west. South of this area, sublobe activity has been documented, including the Nysa Sublobe on the western side and the Odra Sublobe in the central part (Salamon 2015). The former, among other things, led to the deposition of the material in the Niemodlin Wall where Sowin is located, while the latter is in the area south of Racibórz.

5. EXAMPLES OF SILICITES OF THE OPOLE-GROSZOWICE TYPE FROM ARCHAEOLOGICAL SITES

Artefacts made of Opole-Groszowice-type raw material have been found in inventories located in the Odra valley. The oldest artefacts come from the Pietraszyn 49a site near Racibórz (Fig. 1). This site is dated to the beginning of MIS 3, *i.e.*, about 58 thousand years old, and is associated with the Central European Micoquian Complex (Wiśniewski *et al.* 2019). It is located in the southern part of the Głubczyce Plateau, on the southern slope of the Troja valley. Among the finds obtained so far, a large bifacial knife with a natural back, a rounded tip and a cutting edge of about 2/3 of the edge length stand out (Fig. 9). The white cortex is present on the surface. The siliceous mass is opaque and contains fragments of fragmented organisms. The mass is brown in colour. The knife was made on the spot because one of us (AW) found conjoining pieces connected with tool shaping. Thus, it can be assumed that the lump of flint was found in nearby sediments of glacial origin, deposited probably during the Odra glaciation.

Further elements come from the site Sowin 7, Nysa region, located within the Niemodlin Wall which connects the Głubczyce Plateau with the Odra valley (Fig. 1). This site provided traces of two cultural complexes, *i.e.*, the Epigravettian and Magdalenian located in sandy sediments dated to 16.2-15.4 thousand years BP and 14.7-13.8 thousand years BP, respectively (Furmanek *et al.* 2001; Wiśniewski *et al.* 2012; Wiśniewski *et al.* 2017). Among others, two retouched tools that correspond to the characteristics of the raw material from Opole-Groszowice occurred in the Epigravettian assemblage, a burin and an endscraper (Fig. 10). It is uncertain whether the raw material in both cases comes from the immediate

Fig. 9. The Micoquian site Pietraszyn 49a. A bifacial knife made of Opole-Groszowice silicite. Photo by A. Wiśniewski

Fig. 10. Artefacts from the Epigravettian layer of site 7 in Sowin. The burin and endscraper are made of brown silicite. Photo by A. Wiśniewski

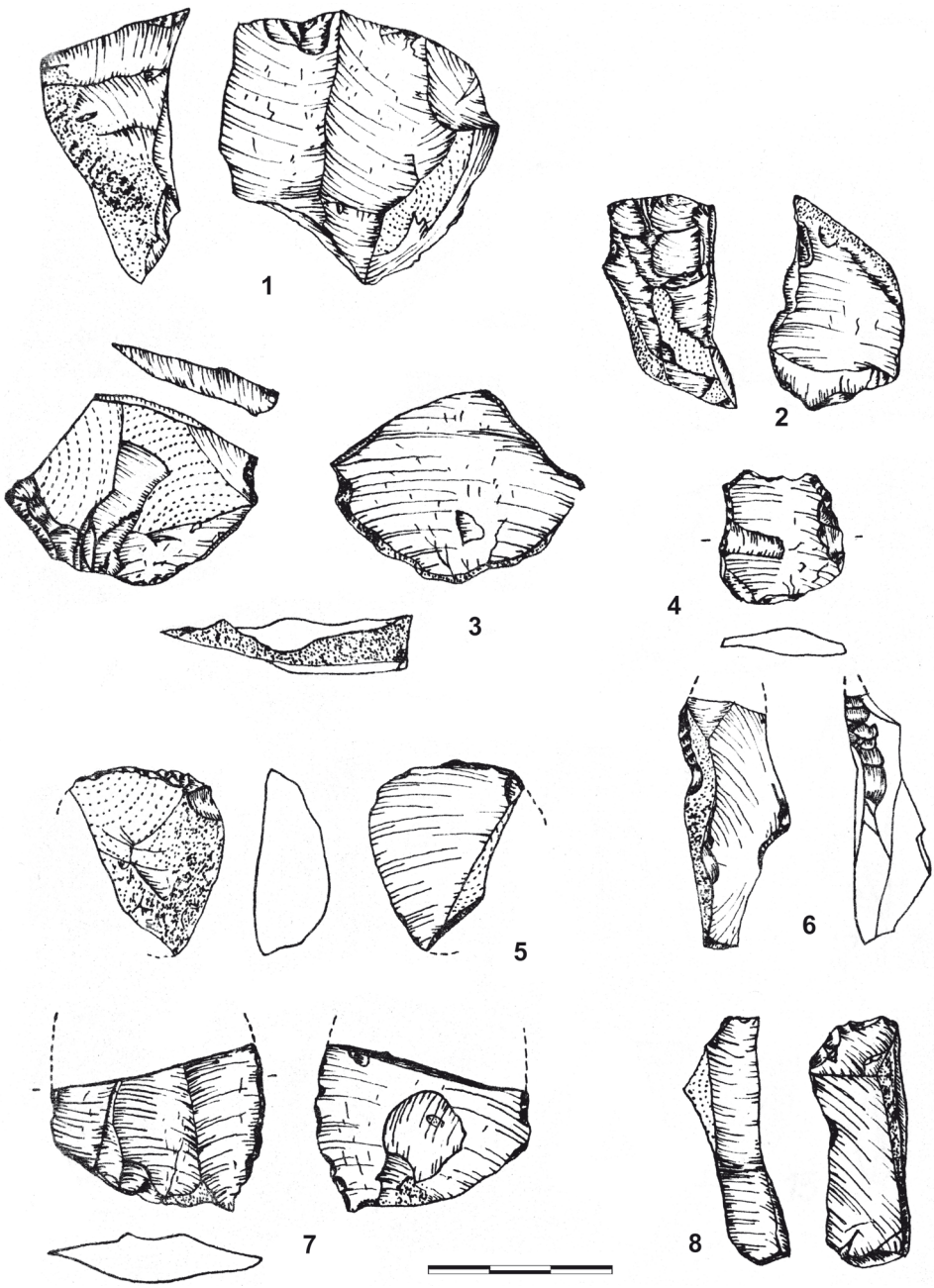

Fig. 11. Late Palaeolithic site Opole-Grotowice 41.
The artefacts were made of brown silicite (after Burdukiewicz 1977)

vicinity, but the state of preservation of the burin, an expedient tool, suggests that it was made locally. The endscraper, on the other hand, bears numerous signs of use-wear indicating that it may have been used longer and possibly transported from outside (Wiśniewski *et al.* 2021).

Several collections of the discussed silicite type were collected in 1975 during the rescue archaeological research in the area of building the industrial quarter of Opole (Fig. 1), located slightly south of Opole-Groszowice (Burdukiewicz 1977). There were recognized brown silicite nodules and discovered new sites with artefacts made of the same raw material. The site Opole-Grotowice 41 (AZP 91-37-17) delivered 24 artefacts made of brown silicite: a single-platform core, a core with changed orientation, two plunging blades, a burin on unprepared end, damaged flake endscraper, retouched blade and retouched chunk (Fig. 11).

Another site Opole-Grotowice 42 (AZP 91-37-17) delivered nine brown silicite artefacts including a damaged core, a perforator, and a fragment of a retouched blade. The third site Opole-Grotowice 40 (AZP 91-37-18) had five brown silicite artefacts including two cores. Another ten brown silicite artefacts were isolated finds.

Most of the brown silicite artefacts from Opole-Grotowice can be related to the end of the Pleistocene, especially the Allerød (Federmesser technocomplex?) and the younger Dryas periods. It can be related to the Świderian point discovered in nearby Opole-Groszowice (Ginter 1974). Some brown silicite artefacts from Opole-Grotowice could also be from the Mesolithic and Neolithic ages.

Another site with a brown silicite artefact is located near Kórnica (site 3), Krapkowice district (Wiśniewski 2006). A chunk with traces of retouching was found on the terrace of a small watercourse on the surface of an arable field (Fig. 1). This artefact is not dated, but its state of preservation indicates that it may be dated to the Neolithic or Bronze Age rather than the Middle Palaeolithic as was suggested by the discoverers (K. Bykowski and S. Pazda). The tool was made from a brown silicite resembling that of Opole-Groszowice.

Other data comes from the area of the Czech Republic. It is possible to mention a Gravettian site Ostrava-Petřkovice I (Svoboda ed. 2008) on the Landek Hill with the Odra River flowing just under the hill (Fig. 1). The locality is known by the famous Petřkovice (Landek) Venus, a female figurine made of massive hematite. Investigation of chipped artefacts obtained during excavations in 1952-1953 and 1995-1996 revealed among the prevalent silicites (flints) of erratic origin also 34 artefacts made of brown silicite with spread red mineral pigment in their siliceous mass on the one hand, on the other hand with only relics of the smooth thin whitish cortex as is characteristic for the Opole-Groszowice silicite (Přichystal 2008). So, it was concluded the Petřkovice hunters had probably followed the Odra River to the north towards Opole-Groszowice and collected brown silicite there.

6. FINAL REMARKS

The silicites of Opole-Groszowice were investigated using geological criteria including geological context, specific macro-and microscopic features, and usage of this raw material on archaeological sites. These silicites were abundant in glacial deposits of Drenthe Glaciation exposed in sand pits in Opole-Groszowice and the surrounding region, and rarely to the south of Upper Silesia, like within glacial sediments in the Ostrava-Opava region (Czech Republic). Brown silicites from Opole-Groszowice were found as erratic raw material transported probably from Jurassic deposits. However, we cannot exclude that the Opole-Groszowice silicite set covers more varieties of siliceous rocks.

The Opole-Groszowice silicite in groundmass is partly translucent, relatively cloudy by very fine orange to red pigment and it contains in places numerous chips of whitish fossils. The average density of three brown silicites from Opole-Groszowice is 2.594 ± 0.004 g/cm^3 and such value is very similar to the variety of Jurassic silicite A from the surroundings of Cracow. In addition to that, the Jurassic silicites from the Cracow-Częstochowa (Wieluń) Upland have a large dispersion of LOI and are similar to brown silicite from Opole-Groszowice.

Artefacts made of Opole-Groszowice silicites were discovered at several sites in the Odra Valley in Poland dated to the Middle Palaeolithic (Micoquian site Pietraszyn 49a near Racibórz), Upper Palaeolithic (Epigravettian and Magdalenian in Sowin, near Niemodlin) and the most abundant in Late Palaeolithic, Mesolithic and possibly Neolithic (Opole-Grotowice sites located close to the outcrops with the silicites). Another larger collection of Opole-Groszowice raw material was found in the Gravettian site Ostrava-Petřkovice I.

The silicites of Opole-Groszowice of the Jurassic age were significant raw materials for Palaeolithic hunter-gatherers in Upper Silesia. The detailed characteristics of this silicite will contribute to the identification of such raw material in other lithic collections in Silesia and neighbouring areas.

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