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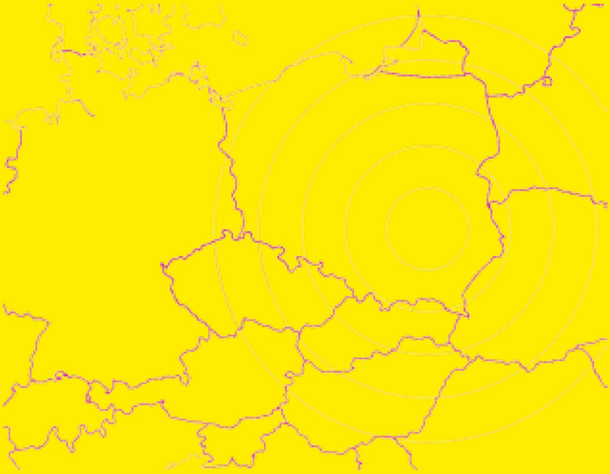

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of siliceous rocks in prehistory

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Editorial

Archaeologists working with lithic material always struggle with proper identification and description of siliceous rocks. This is especially important in attempts to study contacts between prehistoric communities, and also distribution paths.

A little over three years ago, the idea was raised to organize in Warsaw a meeting gathering archaeologists interested in siliceous rocks – their sources, exploitation, geochemical and petrographic investigations, distribution, etc. The very positive feedback to this idea exceeded all our expectations and showed a very strong urge to create a platform for sharing ideas and experiences, especially in an age of very rapidly developing methods used for analyses of siliceous rocks.

The first meeting was held in the Institute of Archaeology and Ethnology, Polish Academy of Sciences on 12 May, 2015 and was entitled *Flint in time and space – Time and space in Flint: Use of geochemical and petrographical methods in archaeology*. Most of the papers presented in preliminary form at this seminary were published in the 54th volume of this journal in 2016 (Special theme: *Investigating geochemical and petrographic methods for identifying siliceous rocks in archaeology*, edited by Dagmara H. Werra and Richard E. Hughes). Since that time we have made it our aim to organize a conference every year (in Warsaw: 01–03 XII 2016 – *Procurement and distribution of siliceous rocks in prehistory with a special theme - flint mining*; 18–20 V 2017 – *Characteristics and distribution of siliceous rocks in prehistory*; 30 X 2018 – *Siliceous rocks vs. metadata – a new perspective (presentation, definition and use)*. We have also organized analogous meetings outside Poland during international conferences (22nd Annual Meeting of European Association of Archaeologists in Vilnius in 2016 – session TH5-01: *Investigating Geochemical and Petrographic Methods for Flint Identification in Archaeology*; 24th Annual Meeting of European Association of Archaeologists in Barcelona in 2018, session 618: *Procurement and distribution of siliceous rocks in the light of geochemical and petrographic analysis in archaeology*; Fig. 1 and 2).

The meetings held in Warsaw are of a workshop nature and give a very good opportunity not only to exchange knowledge between scientists from different fields, but also to study various raw materials from Poland and neighbouring areas. Moreover, field excursions were part of the programmes (2016 – the flint mines at Borownia and Krzemionki, Ostrowiec Świętokrzyski district; 2017 – the chalk mine and cretaceous flint outcrops at Mielnik, Siemiatycze district; Fig. 3 and 4). These enabled to participants of the Workshops to study in person important places both for archaeological siliceous rocks outcrops and the Polish archaeological heritage. Symposiums were

Fig. 1. 22nd Annual Meeting of European Association of Archaeologists (Vilnius, Lithuania; 2 IX 2016). Participants of session TH5-01: *Investigating Geochemical and Petrographic Methods for Flint Identification in Archaeology*. Photo: S. Buławka.

Fig. 2. 24th Annual Meeting of European Association of Archaeologists (Barcelona, Spain; 8 IX 2018). Participants of session 618: *Procurement and distribution of siliceous rocks in the light of geochemical and petrographic analysis in archaeology*. Photo: A. Burke.

supported by the Polish Academy of Sciences (PAS) and the Institute of Archaeology and Ethnology PAS. The Seminary in 2018 was financed by the Operational Program Digital Poland, 2014–2020 – Measure 2.3. Digital accessibility and usefulness of public sector information, fund from the European Regional Development Fund and national co-financing from the state budget. The main aim was to create a framework for fostering cooperation and communication between scientists from different fields.

Fig. 3. Archaeological Museum and 'Krzemionki' Reserve (3 XII 2016). Participants of the excursion to flints mine in Borownia and Krzemionki, Ostrowiec Świętokrzyski distr. Photo: E. Józefowicz.

Fig. 4. Mielnik, Siemiatycze district (20 V 2017). Participants of the excursion to the chalk mine and cretaceous flint outcrops at Mielnik, Siematycze distr. Photo: Z. Narkiewicz.

We are delighted to have the chance to present a new volume of *Archaeologia Polona*, dedicated to the characteristics and distribution of siliceous rocks in prehistory. The papers that are published here were mostly presented in their initial form at conferences held in the Institute of Archaeology and Ethnology Polish Academy of Sciences in Warsaw on December 2016, May 2017 and in Vilnius in September 2016.

The present volume is opened by two papers concerning the distribution and use of siliceous rocks in the Palaeolithic. In *Variability of the Lithic Raw Material in the Upper and Late Palaeolithic sites in Southeastern Poland* Dariusz Bobak and Marta Połtowicz-Bobak (pp. 11–21) discuss the provenance and intensity of use of different raw materials by Palaeolithic communities settled in the south-eastern part of present-day Poland. Next, in *Preliminary Archaeopetrological Study of the Lithic Industry From the l' Hort de la Boquera Rock Shelter (Margalef de Montsant, Tarragona, Spain): Applying Mineralogical and Geochemical Techniques* (pp. 23–33), Mar Rey-Solé and colleagues apply different macroscopic and petrographic methods in order to discriminate various types of flints utilized by Magdalenian groups in northeastern Iberia.

The next group of papers deals with 'chocolate' flint – its characterization and presence in site assemblages. The first two present the contribution of Polish siliceous rocks in chronologically differential assemblages from Czech Republic. In the first of them, *Artefacts Made from Siliceous Rocks of Polish Origin on Prehistoric Sites in the Czech Republic* (pp. 35–48), Antonín Přichystal examines the occurrence of Jurassic-Cracow flint, 'chocolate' flint, Świeciechów (grey white-spotted) flint and banded (striped) Krzemionki flint at Bohemian and Moravian sites throughout the Stone Age. Pavel Burgert in *The Status and the Role of 'Chocolate' Silicite in the Bohemian Neolithic* (pp. 49–64), considers the spatial distribution and importance of this siliceous rocks among Neolithic assemblages.

Subsequent papers contribute to the discussion of the role of 'chocolate' flint in lithic processing during the Mesolithic and Neolithic in present-day Poland. In *Three Stories About the Exploitation of 'Chocolate' Flint During the Stone Age in Central Poland* (pp. 65–78), Dominik K. Płaza and Piotr Papiernik discuss conceptions of blade production within Mesolithic Janislavice, early Neolithic Linear Band Pottery (LBK) and middle Neolithic Funnel Beaker (TRB) societies. The second paper of this group, Jacek Kabaciński *Contribution to Understanding the Distribution of 'Chocolate' Flint on the Polish Lowlands in the Early Neolithic: Kruszyn, Site 13* (pp. 79–87) is devoted to Linear Band Pottery (LBK) flint distribution system developed on the Lowlands. The last paper in this group is *Characterizing 'Chocolate' Flint Using Reflectance Spectroscopy* (pp. 89–101) in which Ryan Parish and one of editors of this volume present the initial results of Visible Near-infrared (VNIR) and Fourier Transform Infrared (FTIR) enabling the characterization and differentiation of 'chocolate' flint.

The next two papers present the procurement and distribution of non- and siliceous rocks within Stone Age communities. Grzegorz Osipowicz and colleagues, in *Late Palaeolithic and Mesolithic Treatment and Use of Non-flint Stone Raw Materials: Material Collection From Site*

17 at Nowogród, Golub-Dobrzyń District, Poland (pp. 103–125), discuss results of complex analysis of non-flint stone artefacts and obsidian from a multicultural site. In *Lithic Raw Material Procurement in the Late Neolithic Southern-Transdanubian Region: A Case Study From the Site of Alsónyék-Bátaszék* (pp. 127–140), Kata Szilaggi presents the role of the Mecsek radiolarite in local network maintenance in the Late Neolithic.

The last group of papers is devoted to local raw materials, their distribution and importance in flint processing. In, *Neolithic Flint Axes Made from Cretaceous flint of the Bug and Neman Interfluve in the Collection of the Museum of Podlasie in Bialystok* (pp. 141–165), Hubert Lepionka introduces the axes made of cretaceous flint stored in Museum of Podlasie in Bialystok. The collection became the basis for a contribution to the discussion about the technology, meaning and distribution of an axes in the Neolithic. The result are useful not only for researchers of North-East part of Poland, but they have a much more wider relevance. In the text *New Perspectives on the Problems of the Exploitation Area and the Prehistoric use of the Buda Hornstone in Hungary* (pp. 167–189), Norbert Faragóa and his colleagues present the provenance, distribution and importance of this raw material within Bronze Age communities. Finally in *Examining Raw Material of Stone Tools. Siliceous Marl from the Eastern Part of the Polish Carpathians Re-interpreted* (pp. 191–201), Andrzej Pelisiak discusses a problem of the cherts and siliceous marls used for axes and flake tool production. He also points out the necessity of re-analysis of some collections in which raw materials used for tools processing might previously have been be mistakenly classified.

We cherish the hope that all presented papers will be useful and inspiring for researchers interested in siliceous rocks.

Finally, we extend special thanks to all the reviewers of these chapters for their time and commitment; the volume could not have been completed without their cooperation and assistance. These individuals include: Katalin T. Biró (Budapest), Clive Bonsal (Edinburgh), Tomasz Boroń (Warsaw), Michael Brandl (Vienna), Pavel Burgert (Prague), Piotr Chachlikowski (Poznań), Tomasz Herbich (Warsaw), Richard E. Hughes (Portola Valley), Witold Grużdź (Warsaw), Hanna Kowalewska-Marszałek (Warsaw), Jacek Lech (Warsaw), Jerzy Libera (Lublin), Jolanta Małecka-Kukawka (Toruń), Zsolt Meszter (Budapest), Adrián Nemergut (Nitra), Piotr Papiernik (Łódź), Ivan Pavlů (Prague), Andrzej Pelisiak (Rzeszów), Tomasz Płonka (Wrocław), Marta Połtowicz-Bobak (Rzeszów), Łukasz Pospieszny (Poznań), Antonín Přichystal (Brno), Joanna Pyzel (Gdańsk), Katarzyna Pyżewicz (Poznań), Romuald Schild (Warsaw), Marcin Szeliga (Lublin), Paweł Valde-Nowak (Cracow), Marcin Wąs (Gdańsk), Jarosław Wilczyński (Cracow), Andrzej Wiśniewski (Wrocław), Tadeusz Wiśniewski (Lublin), Anna Zakościelna (Lublin). The English language translation of some articles was done in consultation with Paul Barford (Warsaw), which hopefully allowed us to avoid substantive errors. Nonetheless, we take responsibility for errors that remain.

Dagmara H. Werra
Iwona Sobkowiak-Tabaka

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Variability of the Lithic Raw Material in the Upper and Late Palaeolithic sites in Southeastern Poland

Dariusz Bobak[a] **and Marta Połtowicz-Bobak**[b]

In terms of supply of good quality raw materials for stone tool manufacture, the area of southeastern Poland is rather poor. Considering research conducted so far, there are only few sites that can be the basis for analysis. Nevertheless, certain phenomena seem to be characteristic on sites in southeastern Poland in the later phase of the Upper Palaeolithic and in the Late Palaeolithic. There are usually more than one kind of raw material present. Apart from local erratic flint, imported Świeciechów (grey white-spotted) and 'chocolate' flint dominate. The presence of both Jurassic (areas near Cracow) and Volhynian flints are poorly recorded, whereas resources from the south are almost absent. These imported raw materials indicate the existence of particularly strong relations linking the areas of southeastern Poland with the Sandomierz Upland, and much weaker relationships with the territories of Lesser Poland and Western Ukraine.

KEY-WORDS: southeastern Poland, raw materials, Upper Palaeolithic, Late Palaeolithic

The areas of southeastern Poland, understood here more or less as an area within the present-day Podkarpackie Voivodeship, is one area of Poland where there are not known to be outcrops of good-quality flint. In the region of the Podkarpackie region and in the southern part of the Sandomierz Basin, there are a few silicites present. There are erratic flints present e.g., on the Kolbuszowa Plateau, in the central and southern part of the Sandomierz Basin or in the Rzeszów region (near Bratkowice, Raniżów, Wysoka Głogowska and Nienadówka; Mitura *et al.*, 2005: 436). There is also the Bircza flint, whose deposits occur on the Przemyśl Foothills (Łaptaś, *et al.*, 2002, Pelisiak 2016: 195), as well as hornstone of various types e.g., menilite hornstone from the Dukla region, hornstone from Cergowa in the Beskid Niski mountains, siliceous marls found in the Carpathians and in their foothills. Radiolarite also occurs in the Carpathians, especially river valleys (Valde-Nowak 2013: 88; Pelisiak 2016: 195). Therefore, the raw

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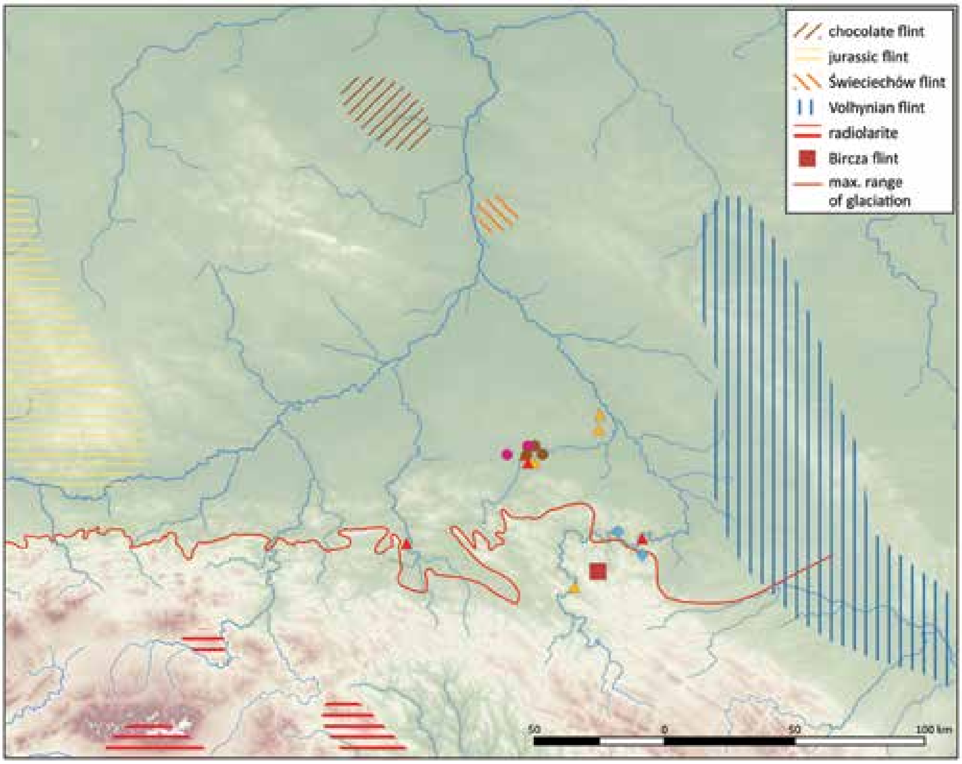

Fig. 1. Outcrops of the main raw materials used on the Palaeolithic sites of southeastern Poland. Computer graphics: D. Bobak.

materials of the discussed areas should be regarded as poor, as well as generally of low quality, and a significant number of them were not used in the Palaeolithic period. That is why groups of hunters and gatherers penetrating area of southeastern Poland used implements produced mainly from good quality imported raw materials (Fig. 1).

Although they are small in quantity, and poor in artefacts, there are Palaeolithic sites in the region covering a broad time frame, from the Middle Palaeolithic (most probably its younger part) to the Swiderian settlement. Based on the analysis of lithic raw material from them, it is possible to notice its variability and make an attempt to record similarities and differences in the use of raw materials and their directions of distribution. Due to the state of the research, which does not allow for more reliable analyses, the sites dated earlier than the younger phases of the Upper Palaeolithic have been omitted in this study. What is more, the remarks applied to the Upper and Late Palaeolithic inventory should be treated as preliminary, reflecting current, but still

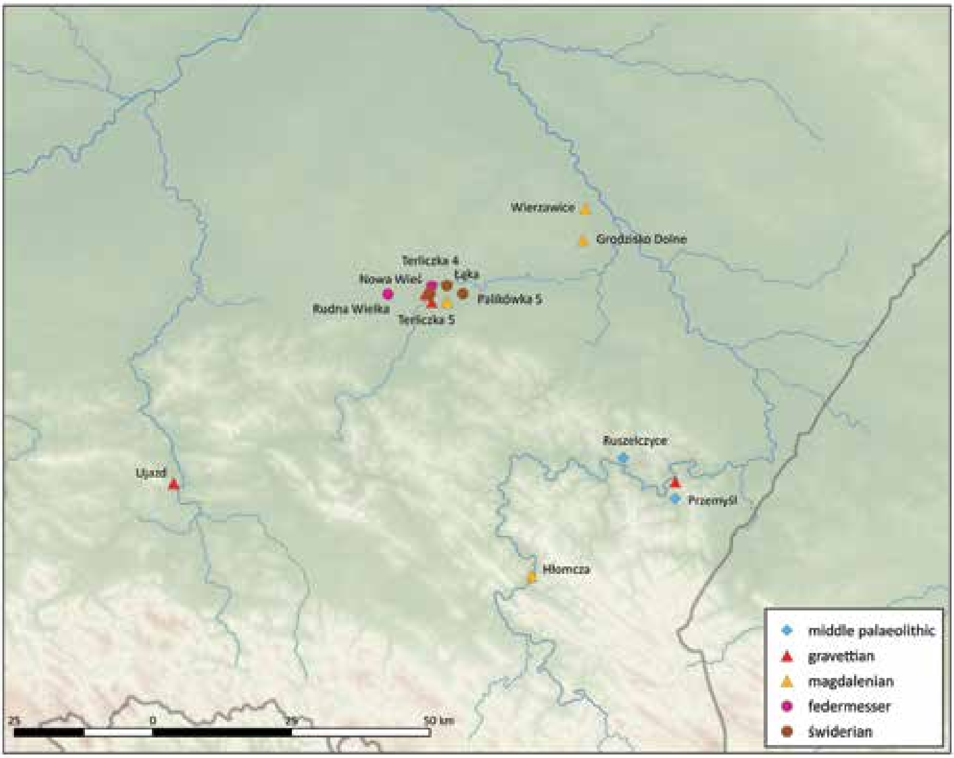

Fig. 2. The most important Upper and Late Palaeolithic sites of southeastern Poland (discussed in the text). Computer graphics: D. Bobak.

insufficient state of our knowledge about the oldest settlements in the southeastern Poland (Fig. 2).

The Upper Palaeolithic settlements are certainly confirmed by Gravettian inventories, which have been discovered so far at very few sites. The most important is the site in Przemyśl, in the former Teich's brick factory on Słowackiego street, which produced an assemblage that can be classified as Gravettian. The material has not been analysed yet. On the basis of the poor data currently available, it can be determined that the artefacts were made, among others, from Świeciechów flint (Osiński 1932; Tomaszewski and Libera 2007), and probably also from Volhynian flint (the burin presented in fig. 3: 4 in the publication of J. Tomaszewski and J. Libera 2007 is rather of Upper Palaeolithic origin). Perhaps other kinds of rocks might have been used there, but with the current lack of published research of the evidence, it is not possible to determine the complete selection of raw material.

Gravettian material was also recorded in Terliczka, Site 4 (Rzeszów district; Gębica and Mitura 2005). According to the researchers, there are two phases that can be distinguished, slightly different in respect of the raw material used there. The authors of the studies presenting the materials from Terliczka have distinguished two Gravettian horizons, perhaps different in their chronology, and also different in their composition: the first one (older?) is made of Volhynian, Dniester, and 'chocolate' flint and radiolarite, whereas the second one contains flint from Bircza, 'chocolate' Carpathian (erratic),[1] 'chocolate', Świeciechów, erratic flints and radiolarite. However, the studies do not present any information on the percentages of individual raw materials in the inventories.

A large differentiation of the raw materials can be observed on the site Ujazd 6 in the Carpathians (Pawłowska *et al.*, 2003; Valde-Nowak *et al.*, 2005). The poor stone collection is made of Volhynian and Jurassic flint, mainly green radiolarite, hornstone and limnoquartzite. The stones, except of local rocks, come from sources to the east and south. The site could be probably linked with the Epigravettian, however this can be debatable.

The collection from Nowa Wieś (Rzeszów district; Mitura and Pasieka 2005) is also included in the Gravettian or possibly Magdalenian circle. As in the case of the Terliczka 4 site, a very significant variability of the used lithic raw material is observed: artefacts are made of erratic chalk flint, Świeciechów, Volhynian flint, so-called Carpathian 'chocolate' flint, Bircza flint and radiolarite, with the predominance of Carpathian raw materials i.e., radiolarite, Bircza flint, Carpathian 'chocolate' flint, which distinguishes this assemblage from the Late Palaeolithic material.

Large differentiation is also observed in the Magdalenian sites. With regard to the four currently known inventories, only one – the assemblage from Hłomcza was made almost homogeneously of the same raw material i.e., local Bircza flint (Łanczont *et al.*, 2002, 2005). Only two tools are made of Świeciechow flint and one burin spall of Volhynian flint occurs.

Other collections were made of several different types of rocks.

The variety of raw materials used here is noticeable. On the site in Grodzisko Dolne, erratic, 'chocolate', Jurassic and Volhynian flints were noted (Połtowicz 2005: 186, 2006: 15). At the site in Wierzawice, 'chocolate', Świeciechów and erratic flints dominated, but they were accompanied by small amount of Bircza, Jurassic and possibly Volhynian flints (Bobak *et al.*, 2010: 69). The largest variation in raw materials is observed at the site in Łąka (Połtowicz-Bobak *et al.*, 2014: 241). Apart from the dominant flint types ('chocolate' and erratic flints), there were also less numerous Jurassic and Świeciechów flint (here considered together with Gościeradów flint) as well as

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[1] So-called Carpathian 'chocolate' flint is found in a secondary deposit in the area of Błażowa, Rzeszów distr., and the areas of the San river.

a few examples of Volhynian flint. In addition, there were also very few radiolarites and local hornstones as well as individual examples of Slovakian limnoquartzite and Dynów marls. It is noteworthy that this is the earliest site in southeastern Poland where a relatively large participation of Jurassic flint (more numerous than Świeciechów flint) was recorded.

In the richest site affiliated to the Federmesser culture from Rudna Wielka (Rzeszów district; Mitura *et al.*, 2005: 423) a quite high variability of raw materials was also reported i.e., next to the most numerous erratic flint from local deposits located several kilometres from the site, the study identified quite a lot of Świeciechów flint and radiolarite, as well as 'chocolate' flint. Probably one artefact might have been made of Jurassic flint. 'Chocolate' and erratic flint is also represented in the part of the inventory described as the Federmesser culture at Terliczka 4 (Gębica *et al.*, 2005).

Changes in the raw material structure are observed in Swiderian sites. It is true that the vast majority of currently known evidence of settlement comes from poor surface finds, but we also have several larger inventories obtained in the course of excavations. The information presented here is based on them.

More than one kind of flint was still used in the Swiderian inventories, but there is visible a decrease in the number of raw materials. With reference to some of the sites, a direction towards the use of certain rock types is noticeable – either 'chocolate' flint or Świeciechów flint, as for instance the large inventory from the site in Terliczka 5 near Rzeszów. Although several raw materials were used ('chocolate', erratic, Świeciechów, Jurassic flints), the most commonly used rock was 'chocolate' flint (Połtowicz-Bobak and Bobak 2007). A very homogeneous raw material of Swiderian inventory was produced by the site in Łąka: apart from the concentration of Magdalenian materials in which a large variability of raw materials is observed, another assemblage (of the Swiderian origin) was identified, in which the inventory was made almost exclusively of 'chocolate' flint (102 items out of 112; Bobak and Połtowicz-Bobak 2015: 10), accompanied by Jurassic flint. What is more, it is at the same time the best recorded site showing the difference in raw materials between Magdalenian and Swiderian inventories, deposited in the same place, and therefore also at the same distance from the outcrops of the rocks.

On the other hand, there are also recorded sites where 'chocolate' flint is known but it is not the most frequently represented kind of raw material. An example of this is a very small assemblage (22 or 23 items) from Palikówka (Rzeszów district) where the dominant raw material group is erratic flint, whereas 'chocolate' flint is the second largest group (6 items), also Świeciechów and Jurassic flint and Dynów marl are individually represented by the artefacts (Poradyło *et al.*, 2014: 11). It seems, however, that 'chocolate' flint played a particularly important role in Swiderian assemblages, although unequivocal evidence of its general role is impossible due to the very small number of excavated sites rich in artefacts.

A workshop where mainly Jurassic flint was processed was discovered in Durdy, near Tarnobrzeg (Talar 1968: 76).

In the Swiderian sites in southeastern Poland, it is worth mentioning that there is a systematic representation of Jurassic and Świeciechów flint, whereas Volhynian flint is not commonly found, even though Swiderian settlement is recorded in Western Ukraine (Bobak *et al.*, 2015, further literature there).

ANALYSIS AND CONCLUSIONS

There are few Palaeolithic inventories from the south-east of Poland that can be the basis for raw material analyses. However, it is possible to try to outline a more general picture regarding the strategies of obtaining and use of stone raw materials in these areas in different periods of the Upper and Late Palaeolithic (Table 1).

First of all, the variability of the lithic raw materials of inventories is notable regardless of chronology. Manufacturers generally used more than one kind of rock. The Swiderian inventory from Łąka, made almost exclusively from imported 'chocolate' flint, is unique. Noteworthy is the fact that the raw materials used at individual sites come from different regions, sometimes very distant from each other. Gaining rocks from distant places can be explained by the lack of good quality local raw materials. Blade technologies used by the Upper and Late Palaeolithic producers, especially Magdalenian and Swiderian ones, required or at least preferred the use of high quality lithic raw material. Nevertheless, a significant variation of chipped rocks, including those transported from considerable distances, is also observed in inventories affiliated to the Federmesser culture from Rudna Wielka and Terliczka 4, i.e., a taxonomic unit whose flint production was based on simpler methods.

On the other hand, it is striking that local rocks, for instance hornstones, were not generally used in practice. These raw materials, although of average quality, could be flaked, which was confirmed by their use in later periods (e.g., Pelisiak 2016). Similarly, the so-called Dynów marls were not used, also known as indicated by a Magdalenian core from Łąka (Połtowicz-Bobak *et al.*, 2014) and a Swiderian tool from Palikówka (Poradyło *et al.*, 2014: 11).

Erratic flint, obtained from local sources, was commonly used. This material was often used throughout the whole period, but as a rule it was only one of several raw materials, and often not the most important category. The flint from Bircza, even though it was already known in the Late Palaeolithic, was not used on a wider scale either. The only exception is the inventory from Hłomcza, made almost entirely of this kind of flint. As for other sites, even if it is recorded, it is only in the form of individual items.

What is more, it is worth considering the directions from which the raw materials were transported and the distance to their sources. The most commonly used rocks

Table 1. Raw materials on the Upper and Late Palaeolithic sites of the south-east Poland; ch – chocolate flint; chn – chocolate erratic flint; sw – Świeciechów flint; err – erratic flint; vol – volhynian flint; jr – jurassic flint; bi – Bircza flint; ra – radiolarite; oth – other.

Site	Culture	Raw material									Dominant
		ch	chn	sw	err	vol	jr	bi	ra	oth	
Przemyśl, ul. Słowackiego, Przemyśl distr.	Gravettian			+		+					?
Terliczka, Site 4, Rzeszów distr.	Gravettien (older?)	+				+			+		?
Terliczka, Site 4, Rzeszów distr.	Gravettien (younger?)	+	+	+	+			+	+		?
Nowa Wieś, Site 1, Rzeszów distr.	Gravettien?		+	+	+	+		+	+		ra, bi, chn
Ujazd Rzeszów distr.	Epigravettian?					+	+		+	+	vol, ra
Hłomcza, 1, Sanok distr.	Magdalenien			+		+		+			bi
Wierzawice, 31, Leżajsk distr.	Magdalenien	+		+	+	+?	+	+?			ch, sw, err
Grodzisko Dolne, Site 10, Leżajsk distr.	Magdalenien	+			+	+	+				?
Łąka, 1–16, Rzeszów distr.	Magdalenien	+		+	+		+		+	+	ch, ree
Rudna Wielka, Site 4, Rzeszów distr.	Federmesser	+		+	+		+		+		err
Terliczka, Site 4, Rzeszów distr.	Federmesser	+			+						?
Terliczka, Site 5, Rzeszów distr.	Świderien	+		+	+		+				ch
Łąka, 1–16, Rzeszów distr.	Świderien	+			+						ch
Palikówka, Site 5, Rzeszów distr.	Świderien	+		+	+		+				err

came from areas distant from the aforementioned territories about (and most often over) 100 km away.

The outcrops of 'chocolate' and Świeciechów flints, the most important for the areas discussed here, are about 100 km to the north of the Podkarpackie region. Similarly, the outcrops of Jurassic flint lie at a distance of more than 100 km to the west of southeastern Poland. Other materials travelled even greater distances – from sources in Slovakia (perhaps some of the Carpathian radiolarites, limnoquartzite from eastern and central Slovakia) and eastern ones (Volhynian flint; Kozłowski 2013). However, these were used sporadically.

Świeciechów and 'chocolate' flint, found at Gravettian sites came from regions from which there is no record of settlement of that time. In the assemblage from Terliczka 4, eastern imports (Volhynian and Dniester flints) and Carpathian radiolarite were recorded. These rocks determine a route of migration along the west-east axis and possibly towards the south, which tends to agree with our knowledge about the migration of Gravettian communities at the beginnings of the Last Glacial Maximum (LGM). Volhynian flint from east and limnoquartzite from the south is known from Ujazd as well.

Very numerous imports of 'chocolate' and Świeciechów flints at Magdalenian sites are associated with the presence of rich sites (including workshops) near Sandomierz (Sandomierz district; Połtowicz-Bobak 2013, further literature there). Individual radiolarites, if they do not come from secondary deposits, may be linked with the Carpathian outcrops the exploitation of which is confirmed by the Magdalenian site (a workshop) in Sromowce Wyżne - Kąty (Nowy Targ district; Valde-Nowak 1991). There are also very few cases of Jurassic flint near Cracow. All of the mentioned rocks come from the areas where Magdalenian settlement is recorded. On the basis of raw material distribution, it is possible to infer that the areas of southeastern Poland were most strongly connected with the northern edges of the Sandomierz Basin, where a distinct settlement centre has been recorded. The nature of these links remains to be clarified, although it may be assumed that these areas belonged to one territory exploited by communities affiliated to this cultural unit (Połtowicz-Bobak 2013, further literature there).

However, it is worth mentioning that there are also raw materials coming from outside the currently known borders of the Magdalenian, i.e., a few items of Volhynian flint and Slovak limnoquartzite. They can indicate the existence (perhaps indirect) of relations between communities supposedly belonging to different taxonomic units.

The directions for the distribution of lithic raw materials found at Swiderian sites clearly indicate the dominance of the connections between southeastern Poland and the areas located further to the north, on the edges of the Świętokrzyskie (Holy Cross) Mountains, where the outcrops of 'chocolate' and Świeciechów flints are located. These two kinds of flint, especially the 'chocolate' type, are the basic raw material used at Swiderian sites. The third basic raw material used by Swiderian producers was local erratic flint, but of good quality. On the other hand, Jurassic flint, coming from the areas of the Cracow-Częstochowa Upland is represented marginally. The exception here is a small workshop in Durdy (Tarnobrzeg district) in the Sandomierz Basin, where mainly cores were produced from this raw material (Talar 1967). This suggests that the Swiderian communities, occupying the areas of southeastern Poland, mainly exploited the areas located on the eastern side of the Vistula. What is more, the participation of eastern raw materials, i.e., Volhynian flint, whose outcrops are located in areas covered by the Swiderian settlement, is also very small.

It is interesting that, regardless of the chronology and cultural affiliation, the lithic raw materials represented at the sites constitute a repetitive set of types that is dominated by three of them: erratic, Świeciechów and 'chocolate' flint. Only erratic flint appears locally. The deposits of the other two not only lie beyond reach of a one-day journey, but also (in the case of sites older than Magdalenian) they are in areas outside the lands penetrated by the population of particular cultures. Therefore, it is possible to exclude gaining these resources during, for example, systematic hunting expeditions. The expeditions looking for raw materials had to be undertaken intentionally outside the areas exploited economically (hunting) by the manufacturers. In the case of the Magdalenian culture, the distribution of raw materials clearly shows the links between the southeastern Poland and the northern part of the Sandomierz Basin (the northern extent of the Magdalenian in Poland), and together with the poor supply of raw materials from the territory near Cracow suggesting little contact between these two areas (Połtowicz-Bobak 2013). The thesis about closer relations between the areas of the Podkarpacie region and the edges of the Sandomierz Basin is reinforced by observation of the settlement structure.

The same set (indicating strong links with the northern areas) of 'chocolate' and Świeciechów flints, playing the main role in the raw material composition alongside the local flint, also dominates at Swiderian sites. Components of such a set can be well explained by both mobile lifestyle and connections between the areas discussed here and the areas of the Sandomierz Upland and Lowlands. Furthermore, it is worth mentioning the constant, though usually poorly evidenced, occurrence of imported raw materials, most often flints coming from areas lying to the east – Volhynian or Dniester flint, whose presence is repeated on most sites from different periods. Exceptions, however, include imports from the south, i.e., radiolarites and a single example of limnoquartzite.

On the basis of the analysis of raw materials of inventories from southeast Poland, several phenomena can be observed. First of all, the widespread use is noticeable of two kinds of imported raw material, brought from considerable distances, together with a weak interest in local raw materials (other than erratic flint), and lack of greater interest in eastern resources (Volhynian flint) and equally good-quality flint from the Cracow region. However, eastern and western raw materials are still present in the Palaeolithic sites of today's Podkarpackie Voivodeship as opposed to the southern raw materials, which are very poorly documented.

It seems that the areas of southeastern Poland are more closely linked with areas further to the east than those located on the southern side of the Carpathians. What is more, the quantities of raw materials coming from Lesser Poland suggest poorly developed contacts with this region. At the same time, it is worth emphasizing the constant and probably systematic exploitation of flint sources deposited in the north. Taking everything into account, it is possible to develop the thesis that an important element in the formation of the cultural image was the Vistula river, which in its upper course could have comprised a significant boundary between the territories exploited by particular late Palaeolithic communities, at least ones older than Swiderian. It seems that this phenomenon should be explained by cultural determinants rather than natural ones, although its nature is still unknown to us.

Research on the Palaeolithic in southeastern Poland still does not allow us to answer many questions regarding the earliest periods of the history of this region. It is, therefore, to be hoped that that further work, especially new discoveries, will allow a deeper knowledge of the issues and provide more reliable answers to the questions asked by the researchers.

REFERENCES

Bobak, D., Łanczont, M., Nowak, A., Połtowicz-Bobak, M. and Tokarczyk, S. 2010. Wierzawice st. 31 – nowy ślad osadnictwa magdaleńskiego w Polsce południowo-wschodniej. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 31: 63–78.

Bobak, D. and Połtowicz-Bobak, M. 2015. Materiały świderskie ze stanowiska Łąka 1–16 (pow. rzeszowski) na tle osadnictwa w Polsce południowo-wschodniej. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 34: 9–16.

Gębica, P. and Mitura, P. 2005. Wstępne wyniki badań geomorfologiczno-archeologicznych przeprowadzonych na stanowisku nr 4 w Terliczce k. Rzeszowa. In M. Kuraś (ed.), *Archeologia Kotliny Sandomierskiej* 4, 19–38. Stalowa Wola, Rocznik Muzeum Regionalnego w Stalowej Woli.

Kozłowski, J.K. 2013. Raw materials procurement on the Late Gravettian of the Carpathian Basin. In Z. Mester (ed.), *The lithic raw material sources and interregional human contact in the northen carpathian regions*, 63–85. Kraków–Budapest.

Łanczont, M., Madeyska, T., Muzyczuk, A. and Valde-Nowak, P. 2002. Hłomcza – stanowisko kultury magdaleńskiej w Karpatach polskich. In J. Gancarski (ed.), *Starsza i środkowa epoka kamienia w Karpatach polskich*, 147–187. Krosno.

Łaptaś, A., Mitura, P. Muzyczuk, A., Olszewska, B., Paszkowski, M. and Valde-Nowak, P. 2002. Krzemień z Birczy. Geologia i wykorzystywanie w pradziejach. In J. Gancarski (ed.), *Starsza i środkowa epoka kamienia w Karpatach polskich*, 315–337. Krosno.

Mitura, P. and Pasieka, A. 2005. Materiały krzemienne ze stanowiska 1 w Nowej Wsi, gm. Trzebownisko, woj. podkarpackie. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 26: 5–24.

Mitura, P., Pasieka, A. and Słowik, K. 2005. Late Palaeolithic materials from site 4 in Rudna Wielka, Świlcza commune, podkarpackie voivodship. *Sprawozdania Archeologiczne* 57: 421–441.

Osiński, K. 1932. Najstarsze ślady człowieka dyluwialnego w Przemyślu. *Ziemia* 19: 278.

Pawłowska, M., Petrykowski, S. and Valde-Nowak, P. 2003. Verification surface studies of the Upper Palaeolithic site at Ujazd county of Jasło (Poland). *Praehistoria* 4–5: 153–164.

Pelisiak, A. 2016. Krzemienie narzutowe w społecznościach młodszej epoki kamienia i wczesnego okresu epoki brązu wschodniej części Karpat polskich i Podkarpacia. In W. Borkowski, B. Sałacińska and S. Sałaciński (eds), *Krzemień narzutowy w pradziejach*, 193–212. Warszawa. Studia nad gospodarką surowcami krzemiennymi w pradziejach 8.

Połtowicz, M. 2005. Wykorzystanie i dystrybucja surowców kamiennych w paleolicie Polski południowo-wschodniej. In M. Kuraś (ed.), *Archeologia Kotliny Sandomierskiej Rocznik Muzeum Regionalnego w Stalowej Woli* 4, 183–193. Stalowa Wola.

Połtowicz, M. 2006. The eastern borders of the Magdalenian culture range. *Analecta Archaeologica Ressoviensia* 1: 11–28.

Połtowicz-Bobak, M. 2013. *Wschodnia prowincja magdalenienu*. Rzeszów.

Połtowicz-Bobak, M. and Bobak, D. 2007. *Materiały krzemienne ze stanowiska Terliczka 5, woj. Rzeszów*. Unpublished conservation study. Rzeszów.

Połtowicz-Bobak, M., Bobak, D. and Gębica, P. 2014. Nowy ślad osadnictwa magdaleńskiego w Polsce południowo-wschodniej. Stanowisko Łąka 11–16 w powiecie rzeszowskim. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 35: 237–248.

Poradyło, W., Bobak, D., Pasterkiewicz, W. and Połtowicz-Bobak, M. 2014. *Wielokulturowe stanowisko nr 5 w Palikówce.* Rzeszów. Via Archeologica Ressoviensis.

Talar, A. 1967. Schyłkowopaleolityczna pracownia krzemieniarska w Durdach pow. Tarnobrzeg. *Materiały Archeologiczne* 8: 75–83.

Talar, A. 1968. Paleolit schyłkowy w południowo-wschodniej Polsce. *Rocznik Muzeów Województwa Rzeszowskiego* 1: 5–31.

Tomaszewski, A.J. and Libera, J. 2007. Paleolityczne materiały z Przemyśla w zbiorach Państwowego Muzeum Archeologicznego (dzieje kolekcji). *Rocznik Przemyski* 43 (2): 3–10.

Valde-Nowak, P. 1991. Studies in Pleistocene settlement in the Polish Carpathians. *Antiquity* 65: 593–606.

Valde-Nowak, P. Łanczont, M. and Pawłowska, M. 2005. The Upper Palaeolithic Site at Ujazd (Polish Carpatians). *Acta Archaeologica Carpathica* 40: 5–26.

Valde-Nowak, P. 2013. The North-Carpathians province of silica rock during Stone Age. In Z. Mester (ed.), *The lithic raw material sources and interregional human contacts in the northern Carpathian regions*, 87–98. Kraków.

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Preliminary Archaeopetrological Study of the Lithic Industry From the l'Hort de la Boquera Rock Shelter (Margalef de Montsant, Tarragona, Spain): Applying Mineralogical and Geochemical Techniques

Mar Rey-Solé[a], Maria Pilar García-Argüelles[b], Jordi Nadal[c], Xavier Mangado[d], Anders Scherstén[e] and Tomas Næraa[f]

The l'Hort de la Boquera site is located in the northeastern part of Iberia and its stone tool assemblage includes up to 25,000 flint artefacts. This is the first approach to the analysis of the raw material through an archaeopetrological study. Results were obtained by use of mineralogical techniques: macroscopic and petrographic analysis, Scanning Electronic Microscopy (SEM), Micro-Raman and X-Ray diffraction (XRD); additionally, Laser Ablation Inductively Coupled Plasma Mass Spectrometry was applied.

It has been possible to discriminate at least four flint categories, the 'Evaporitic flint type' (with two local subvarieties – 'Common evaporitic' and 'Garnet' varieties) that comes from local outcrops of the Ulldemolins Complex, and two flint types that had their origin further afield: the 'Charophyta flint type' (coming from the Torrente de Cinca Unit) and the 'Dark flint type' (from the La Serra Llarga Formation).

These results make this study the most comprehensive analysis of raw materials that has been carried out in the area so far.

KEY-WORDS: archeopetrology, flint, raw materials, northeastern Iberia, Hort de la Boquera

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INTRODUCTION AND OBJECTIVES

The archaeological site of l'Hort de la Boquera, dated to the Final Upper Magdalenian (from 12,250±60 BP to 11,850±45 BP and 11,775±45 BP), is located in Margalef de Montsant (Priorat, Tarragona, Northeastern Iberia; García-Argüelles *et al.*, 2014: 250; Fig. 1). It is a small rock shelter which is the result of the erosion of the tertiary Oligocene conglomerates on the valley edge and has a very homogeneous stratigraphy composed by limestone fragments, sand and pebbles.

The Seminari d'Estudis i Recerques Prehistòriques SERP (UB) has been working in there since 1998, revealing it as a very prolific site with a specific knapping area and a copious assemblage of lithic material comprising 24,108 flint remains, 976 retouched tools and 269 cores and core fragments (Rey-Solé 2016: 231).

One of the aims of this research is to discover the provenance of the different flint varieties recovered in the rock shelter in order to study the degree to which the prehistoric communities using the site had a knowledge of the surrounding environment and determine their mobility. It was expected that the use of different mineralogical and geochemical techniques would allow this goal to be reached and allow the differentiation of the flint samples.

MATERIAL AND METHODS

The archaeopetrological method

The first step in the research on the raw materials consists of the implementation of a petrological study of the archaeological lithic industry, from the macroscopic level to elemental level, intended to categorize the different types of flint. This would also allow the plotting of the geographical location of the different outcrops on the map, which is a very important step in determining the prehistoric availability of flint in the area. This will allow a picture to be built of the origin of the raw material used on the site (Mangado 2005).

Laboratory analysis: macroscopic and microscopic approach

The methodological approach consisted in the textural analysis of all the samples. The samples were first analysed macroscopically by the naked eye and also using a binocular magnifier (©Olympus KL 1500 LCD with ©Olympus TH4-200 source of light) examining a total of 25,353 lithic tools, flint flakes and cores and also 27 geological samples.

Secondly, 19 thin sections have been made from the most representative archaeological and geological samples in order to analyse them, looking for their most characteristic textural characteristics (Luedtke 1992), with an optical microscope (©Olympus BX41 with ©Olympus SC-30 camera).

We wanted to go a step forward applying other mineralogical techniques, such as Micro-Raman spectroscopy (Dubessy *et al.*, 2012), Scanning Electronic Microscopy (Bull 1983) and X-ray diffraction analysis (Bustillo and La Iglesia 1979). Finally, to resolve particular problems we have chosen Inductively Coupled Plasma Mass Spectrometry Laser Ablation.

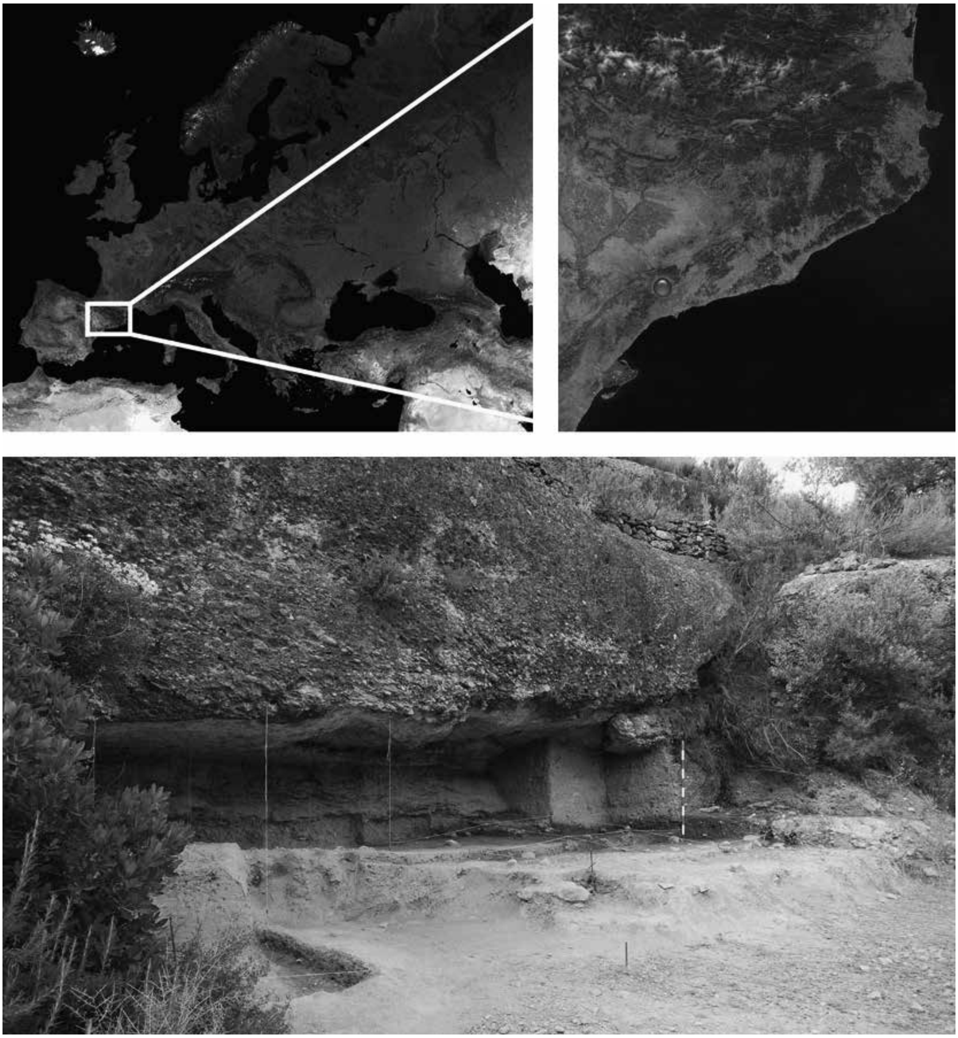

Fig. 1. General view of the location of the l'Hort de la Boquera site. Recent image of the rock shelter. Photo: M. P. García-Argüelles and M. Rey-Solé.

Fieldwork

A total of 27 flint outcrops related to the archaeological site have been visited and documented by taking pictures, writing down all the characteristics of the outcrop and picking up enough flint samples to analyse. The analysis of these flint outcrops and their comparison with the raw materials from the rock shelter have led to the preliminary identification of the potential sources of supply of the Upper Palaeolithic and Epipalaeolithic groups.

RESULTS

Flint types: characteristics and abundance at the site

The combination of techniques allowed us to discriminate at least three types of flint (Rey-Solé 2016).

– 'Evaporitic flint type': this type has two subvarieties:
  a) 'Common evaporitic': characterized by a varied colouration due to impurities, medium to coarse grain and the presence of gypsum lenticles. Low to average quality type and with a very high degree of weathering (white patina). This is represented by 950 (97.33%) stone tools, 24,008 (99.60%) flint flakes and all the cores (269).
  b) 'Garnet subvariety': this kind of flint is garnet and white coloured, opaque, it is very fine grained with no impurities, and has good qualities for knapping. It is found in spots in the 'common evaporitic' flint. It is represented by four (0.40%) stone tools and 60 (0.25%) flint flakes.

– The 'Carophyta flint type': this kind of flint is characterized by its great heterogeneity and its high quality, but the most revealing characteristics are the *Liesegang* rings and the algal fragments of *Gyrogona charophyta* found in it. It is represented by 18 (1.84%) stone tools and 21 (0.08%) flint flakes.

– The 'Dark flint type': this type of flint is black coloured and very good for knapping; microscopically it is characterized by a cryptoquartz matrix with the presence of isolated carbonated remains, some rhomboidal crystals and casts of indeterminate fossils. It is represented by four (0.40%) stone tools and 19 (0.07%) flint flakes (Fig. 2).

Raw material provenance

The characterization of archaeological and geological samples allowed us to match them in order to assign a particular origin to the discriminated types of flint. The deployment of techniques was differentially applied depending on the complexity of this discrimination (Rey-Solé 2016: 408–409).

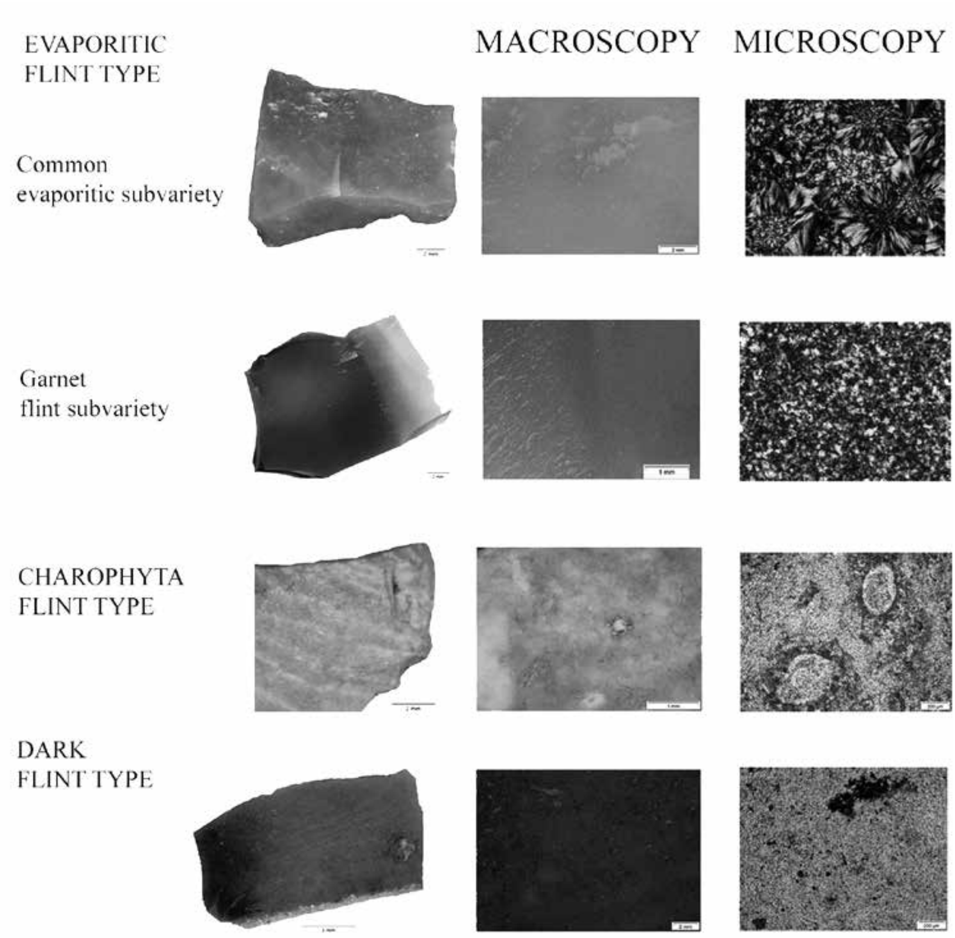

Fig. 2. The identified flint types with macroscopic and microscopic views. Computer graphics: M. Rey-Solé.

- The 'Evaporitic flint type' was compared with an autochthonous type of flint coming from the Ulldemolins Complex (lower-middle Eocene). This consists of sandstones and clays with gypsum and flint formation (Colombo 1986: 66–67), and outcrops are located between 13 to 20 km from the site[1]. This big complex is composed by at least seven different flint outcrops from seven different gypsum layers so one of the aims was to know if there was a preferred outcrop to obtain this kind of raw material.

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[1] Estimated distances by walking on the Montsant river bank, from the neareast outcrop to the farest outcrop.

The flint recovered in all of those seven outcrops have very similar characteristics, both macroscopically and microscopically, so the next step was the application of Scanning electronic microscope, Micro-Raman spectroscopy and X-ray diffraction analyses. This set of techniques proved not to be useful to our objective thus Inductively Coupled Plasma (LA-ICP) Mass Spectrometry was applied in order to know the concentration of trace elements to make easier to distinguish samples.

The LA-ICP Mass Spectrometer (©Bruker Aurora M90) was programmed to analyze 33 different elements, testing 3 spots per sample (110 µm) at seven Hz and four J/cm^2 of frequency (Rey-Solé *et al.*, 2017). The results obtained allowed us to establish two different groups with similar element concentrations, showing several geochemical relations between the majority of archaeological and geological samples. One group established a relationship between all the geological outcrops from Ulldemolins Complex with three archaeological samples and the other group established a relationship between three particular geological outcrops from Ulldemolins complex with two archaeological samples. There are three archaeological samples that seem to have a different geochemical origin than the others so we could conclude that simultaneous and different flint catchment points existed in the Ulldemolins Complex, even undiscovered ones (Rey-Solé *et al.*, 2017; Fig. 3).

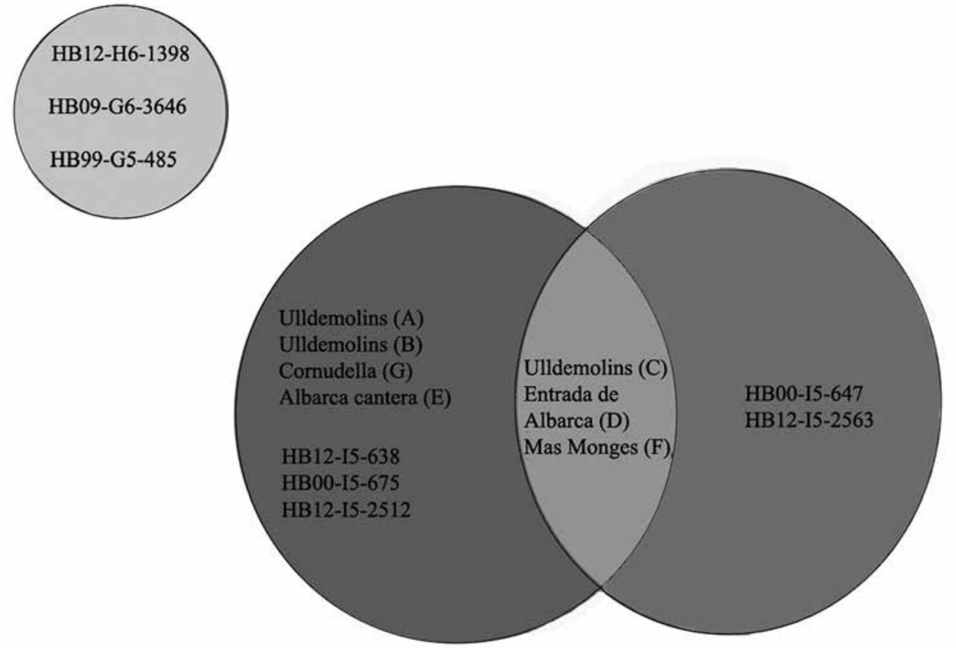

Fig. 3. Geochemical proximity of samples. Drawn: M. Rey-Solé.

- The 'Charophyta flint type': the geological surveys and the combination of techniques (macroscopic and petrographic) allowed us to match this kind of flint with an allocthnous raw material coming from Torrente de Cinca-Alcolea de Cinca Unit (Lower Miocene – Chattian- Aquitanian). This is a sandy and marly bioclastic carbonate with gastropoda and characae fragments with flint nodule formation located 75 km from the rockshelter (Rey-Solé 2016: 255; Fig. 4).
- The 'Dark flint type': the geological surveys and the combination of other techniques (macroscopic and petrographic) allowed us to match this kind of flint with an allochthonous raw material coming from La Serra Llarga (Rupelian), which is a micritic limestone formation, located at nearly 80 km from the archaeological site. It has at least three different outcrops but only two provide this kind of flint. With the macroscopic and microscopic approach, we assume that they were the same type of flint because both matrix and cortex have the same characteristics (Rey-Solé 2016: 256; Fig. 5).

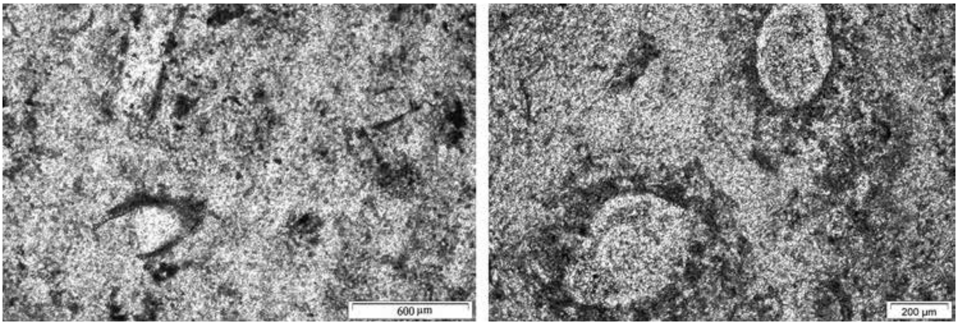

Fig. 4. Sample comparison. Left: geological sample from Torrente de Cinca Unit (600 µm). Right: archaeological sample classified as 'Charophyta flint type' (200 µm) Optical microscope. Photo: M. Rey-Solé.

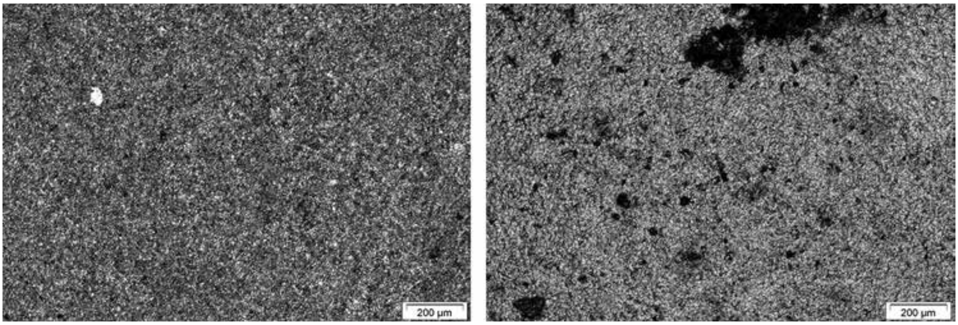

Fig. 5. Sample comparison. Left: geological sample from La Serra Llarga Formation (200 µm). Right: archaeological sample classified as 'Dark flint type' (200 µm). Optical microscope. Photo: M. Rey-Solé.

Catchment proposal hypotheses

At least three hypotheses about the exploitation of the siliceous raw material are possible. First, the prehistoric communities could remove the flint nodules directly from the host rock in primary outcrops, but this probably is not the source of the two allochthonous types of flint.

Secondly, and one of the strongest hypothesis, is the natural transport of flint nodules through the hydrographic network – rivers and its tributaries – where raw material could have been eroded from the riverbanks and terraces. This hypothesis could fit with all flint types recovered but it is strongest theory for 'Evaporitic flint type'. The Montsant river is located only 100 meters from the rock shelter, and the evaporitic flint

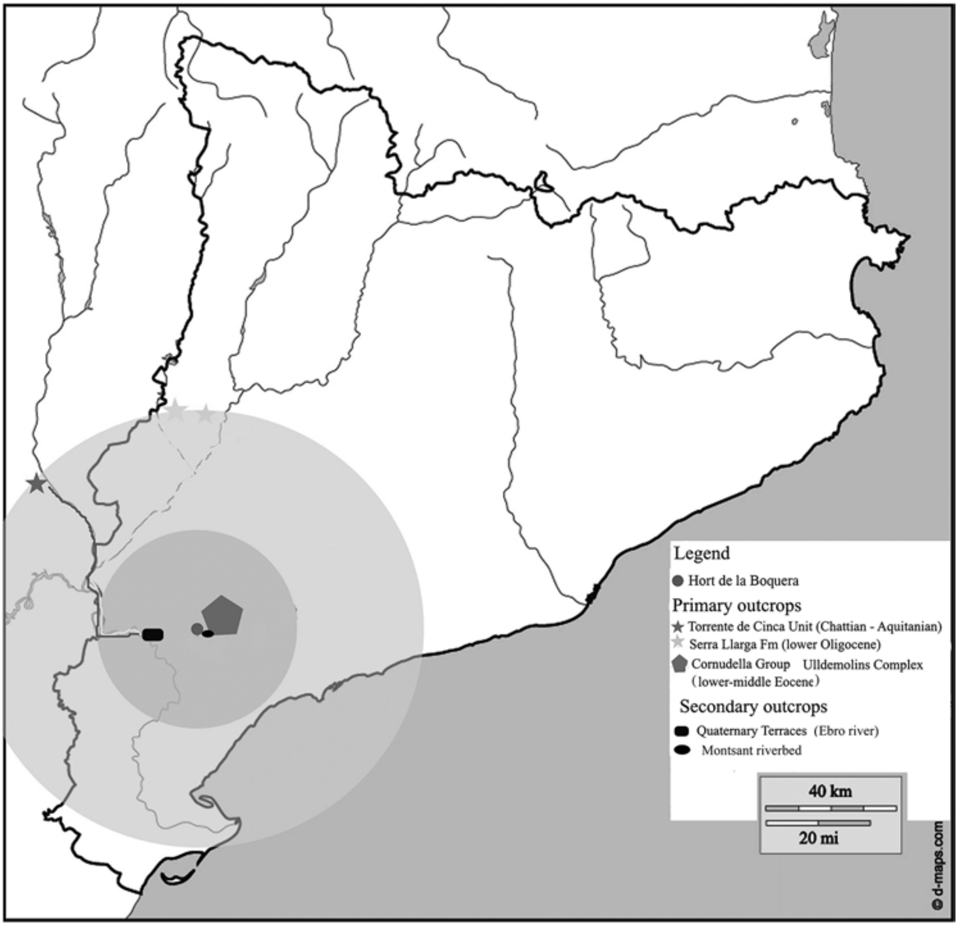

Fig. 6. Map relating the L'Hort de la Boquera site with the different primary and secondary outcrops of siliceous material. D-Maps modified: M. Rey-Solé.

nodules could be found in the river bed, but also the site is located above one of its terraces (T2; García-Argüelles *et al.*, 1993: 495). This is not the only archaeological site located in the region of the Montsant terraces, there are other examples as El Planot, Els Colls, l'Hort d'en Marquet and El Filador, and all of them are in a chronocultural correlation with these terraces (García-Argüelles *et al.*, 1993).

Regarding the minor varieties, the Ebro quaternary terraces, located at 30 km from the site, could provide the prehistoric communities with the other non-local types of flint (the 'Charophyta flint type' and the 'Dark flint type'). It is well-known that raw material could travel tens or hundreds of kilometres from its primary origin (Fig. 6).

Finally, the third hypothesis involves contacts with other human groups, when raw materials could have been exchanged by different prehistoric communities in the vicinity of l'Hort de la Boquera. This hypothesis fits well for 'Charophyta flint type' and 'Dark flint type' where lithic flakes and cores have not been found so far, strongly suggesting that the lithic tools could have come to the site already manufactured.

Other nearby Final Palaeolithic and Epipalaeolithic sites cited above located in the Montsant Valley, such as El Filador, Els Colls, L'Hort d'en Marquet and El Planot (García-Argüelles *et al.*, 2014a) do not yet have an exhaustive analysis of the lithic assemblages or studies of the provenance of the raw materials. It is true that the collections of lithic raw materials from these sites have big similarities to the l'Hort de la Boquera assemblage, but a thorough comparison between these groups is needed to obtain a regional picture and better understand some human behaviours regarding the procurement of lithic material.

CONCLUSIONS

The application of different mineralogical and geochemical techniques to the material from the l'Hort de la Boquera rock shelter has allowed us to discriminate and characterize the three different types of flint ('Evaporitic', with the 'Common flint' and 'Garnet' subvarieties, the 'Charophyta' and 'Dark flint type'). The deployment of several techniques – mineralogical and geochemical – have led us to learn which are the most adequate techniques to apply. The 'Evaporitic flint type' is an autochthonous raw material that comes from outcrops about 20 km from the site. The 'Charophyta flint type' and the 'Dark flint type' come from outcrops nearly 75 km and about 80 km from the site respectively. Knowing the provenance of the raw material used in l'Hort de la Boquera allows the construction of hypotheses about the site's raw material supply. Although there is a major type of local flint used for the lithic industry, the two subvarieties of the 'Evaporitic flint type', there is also evidence of the less frequent use of two other varieties, the 'Charophyta flint type' and the 'Dark flint type' which do not seem to occur in local outcrops.

So far we can state that the riverbanks and their terraces are an excellent location for obtaining siliceous raw materials, in this case, the Montsant river and Ebro quaternary terraces. Greater independence and self-sufficiency is reflected by the lithic assemblages of the prehistoric communities from l'Hort de la Boquera rock shelter in addition to a considerable knowledge of their environment.

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REFERENCES

Bull, P. A. 1983. Procedures in enviromental reconstruction by SEM analysis. In G. De G. Sieveking and M.B. Hard (eds), *The scientific study of flint and chert, 452 proceedings of the fourth International Flynt Symposium,* 221–225. Cambridge.

Bustillo, M. A. and La Iglesia, A. 1979. Sílex: Relación entre índices de cristalinidad y ambientes de sustitución. *Boletín Geológico y Minero* 90, fasc. 6: 86–92.

Colombo, F. 1986. Estratigrafía y sedimentologia del paleogeno continental del borde meridional occidental de los Catalánides (Provincia de Tarragona, España). *Cuadernos de Geología Ibérica* l: 55–115.

Dubessy, J., Caumon, M. C. and Rull, F. (eds) 2012. Applications of Raman Spectrometry to Earth Sciences and Cultural Heritage. In G. Ferraris (Series Editor), *European Mineralogical Union Notes in Mineralogy*. London.

García-Argüelles, M. P., Serrat, P. and Bergadà, M. M. 1993. Las terrazas del curso medio del río Montsant (Priorato, Tarragona) y su relación con los asentamientos prehistóricos. In *El Cuaternario en España y Portugal 1*, 493–499. Madrid.

García-Argüelles, P., Nadal, J. and Fullola, J. M. 2014a. El Valle de Montsant (Priorato, Tarragona), un núcleo clave de la prehistoria del NE peninsular. Los cazadores recolectores del Pleistoceno y del Holoceno en Iberia y el estrecho de Gibraltar: estado actual del conocimiento del registro arqueológico. *Servicio de publicaciones de la Universidad de Burgos* 1: 208–217. Burgos.

García-Argüelles, M.P., Nadal, J., Fullola, J.M., Bergadà, M.M., Domingo, I., Allué, E. and Lloveras, L. 2014b. Nuevas interpretaciones del Paleolítico Superior Final de la Catalunya meridional: el yacimiento de l'Hort de la Boquera. *Trabajos de Prehistoria* 71 (2): 242–260.

Luedtke, B. E. 1992. *An archaeologist's guide to chert and flint*. Los Angeles.

Mangado, X. 2005. *La caracterización y el aprovisionamiento de los recursos abióticos en la Prehistoria de Cataluña: las materias primas silíceas del Paleolítico Superior Final y el Epipaleolítico*. Oxford. British Archaeological Reports, International Series 1420.

Rey-Solé, M. 2016. *Determinación arqueopetrológica y territorial de los materiales silíceos entre el sur de Tarragona y el norte de Castellón*. Unpublished PhD thesis, University of Barcelona.

Rey-Solé, M., Scherstén, A., Naeraa, T., Olausson, D. and Mangado, X. 2017. Siliceous raw materials exploitation at Hort de la Boquera site (Margalef de Montsant, Tarragona, Spain): first approaches on LA-ICP-MS analysis. In T. Pereira, N. Bicho and X. Terrades (eds), *Raw materials exploitation in Prehistory: sourcing, processing and distribution*, 235–249. Cambridge.

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Artefacts Made from Siliceous Rocks of Polish Origin on Prehistoric Sites in the Czech Republic

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Compared with Poland, the territory of Bohemia and Moravia is not so rich in natural occurrences of high-quality siliceous rocks (silicites, 'flints'). This contribution follows distribution of the four most attractive Polish chipped raw materials (silicite of the Cracow-Częstochowa Jurassic, 'chocolate' silicite, banded Krzemionki [striped] silicite and spotted Świeciechów [grey white-spotted] silicite) in the Czech Republic. Since the middle phase of Upper Palaeolithic (Gravettian) the Jurasssic-Cracow silicites had been transported to Moravia and since its late phase (Magdalenian) also to Bohemia. The first use of the 'chocolate' silicite has been ascertained at some Late Aurignacian (Epiaurignacian) sites of central Moravia similarly as an exceptional find attesting early use of Świeciechów spotted silicite (Late Szeletian?). No finds of the banded Krzemionki silicite have been registered in Pre-Neolithic flaked assemblages in the Czech Republic.

Evidence of systematic and mass transport of silicites from the Cracow-Częstochowa Jurassic to northern/central Moravia and to eastern/central Bohemia has been found in some periods of the Neolithic (especially connected with the Linear Pottery culture). For the period of the earlier Eneolithic (Funnel Beaker culture) we can identify a small but systematic presence of raw materials from the northern foreland of the Świętokrzyskie (Holy Cross) Mountains, this comprises objects of banded Krzemionki silicite and spotted Świeciechów silicite. About 24 Moravian non-stratified finds of axes made of the banded Krzemionki silicite and polished over the whole surface can be probably connected with the Globular Amphora culture. Silicites from the Cracow-Częstochowa Jurassic appeared again in the late Eneolithic, especially as arrowheads of the Bell Beaker culture in Moravia. Only two pieces made from the Jurassic Cracow-Częstochowa silicite appeared in a collection of 1463 artefacts connected with the Early Bronze Age in Moravia.

KEY-WORDS: Polish silicites ('flints'), Czech Republic, Palaeolithic, Neolithic, Eneolithic, Early Bronze Age

INTRODUCTION

There are a number of characteristic siliceous rocks (silicites) that originated in the area that is now Poland. In the local archaeological literature, the ones that also played

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an important role also in the surrounding regions are usually termed Jurassic flint, banded (striped) flint, grey white-spotted (Świeciechów) flint and 'chocolate' flint. This contribution deals with the distribution of these flints in the Palaeolithic, Neolithic, Eneolithic and Early Bronze Age in the former lands of Czech Republic – Bohemia, Moravia and Czech Silesia. Until the First Petroarchaeological Seminar in Brno 1975, our older colleagues in former Czechoslovakia knew relatively little about Polish raw materials used for flaked tools and generally they considered almost all high quality siliceous raw materials at prehistoric sites in Czechoslovakia to be erratic flints from glacial deposits of Pleistocene continental ice sheets. On the other hand, already in 1937, Josef Skutil described six axes prepared from the banded Krzemionki flint and found in Moravia (Skutil 1937). Slavomil Vencl (1971: 74) drew our attention to occurrences of the Cracow flint in chipped collections connected with the Linear Pottery in eastern Bohemia and Moravia. Also flints of some Eneolithic axes or daggers were supposed to come from primary sources at the Baltic coast or in Scandinavia. Since 1975 the author has started cooperation with many archaeologists and geologists from Poland and in 1977 he sampled for the first time together with help of Krzysztof Sobczyk siliceous rocks from the Cracow-Częstochowa Jurassic. In recent time the Lithotheca of prehistoric raw materials at Masaryk University in Brno contains all common Polish flaked raw materials of Paleozoic, Mesozoic and Tertiary ages. In addition, the author published their basic characterisation in water immersion under the stereomicroscope and in petrographic thin sections using the polarising microscope (Přichystal 2009, 2013).

WHY THE AUTHOR PREFERS THE TERM SILICITE INSTEAD OF FLINT

The term flint and its local equivalents (in Polish it is 'krzemień', in Czech 'pazourek') originated very early and without clear definition. It appears in Polish written communications for the first time in Cracow in 1568 (Król and Migaszewski 2009), in the Czech language substantially later, in the first half of the 19th century in connection with the first German – Czech dictionary. Before this, in both countries they used only the word for 'stone making fire', i.e., Feuersteine (in Polish 'skałka' or 'krzesak', in Czech 'křesací kámen') and this term covered various rocks and minerals including flint. It is evident that both words 'krzemień' and 'pazourek' were originally also used in the same wide sense, i.e., stone for making fire.

The recent Polish petrographic definition of flint and chert ('krzemień' and 'rogowiec') is based on the siliceous rock shape: nodular siliceous rock is termed flint and the term used for layered varieties is chert (for example Żaba 2006: 231, 373). Since the end of the 19th century (Dana 1895: 281), the English and American geological dictionaries usually define flint as a variety of chert that occurs commonly as nodules and bands in (Cretaceous) chalk (e.g., Bates and Jackson eds 1987; Allaby and Allaby eds 2003) whereas chert (older synonym hornstone, now not recommended) forms 'nodules sometimes becoming continuous layers in other limestones'. Czech and Slovak petrologists have used similar definitions based on the age and origin of the siliceous rock. Michael Brandl (2010) published the same opinion as the Austrian view on the classification of these raw materials. A typical entry in a recent sedimentological dictionary might be: 'Chert occurs in nodules and in strata (bedded or ribbon cherts). Common synonyms for cherts include flint' or 'Flint is the other common name for chert. It occurs in both nodular and bedded forms' (e.g., Garrison 2010: 175). It is evident the classification of flint and chert cannot be based on the shape of siliceous rocks.

As a consequence of different opinions current in various countries, the author prefers to use the comprehensive and geologically well-defined term silicite with more detailed specification using the name of source locality, i.e., banded Krzemionki silicite (because there is also the banded Stránská skála chert in Brno, banded Pęgów flint in Poland, banded flint from glacial deposits from various places in central Europe) or the spotted Świeciechów silicite (because we know of various spotted Jurassic cherts also in Moravia or in Bavaria). As a matter of fact, in the Polish archaeological literature the term 'krzemień' (or its English equivalent flint) is used in a very broad sense corresponding to the geological chert or silicite.

The term silicite started to be used by Russian specialists in sedimentary petrography in the first half of the 20th century. It was introduced to English speaking scientists by Sergei Ivanovich Tomkeieff (1983) in his Dictionary of Petrology. The term covers all varieties of chert, including flint. The term chert is recommended only for marine silicite (Přichystal 2010). Because of the long tradition of differentiation between northern flint and local cherts in Central Europe, the author has proposed defining flint as a variety of chert (silicite) originating in the Upper Cretaceous (Maastrichtian) chalk or Lowermost Tertiary (Danian) Bryozoan limestone (we are not able very often to differ between Maastrichtian and Danian flints in Pleistocene deposits of extensive glaciated areas of Poland, Germany and the Czech Republic). Besides marine cherts, it is necessary to distinguish limnosilicites of freshwater origin. In cases of different terminology or if we are not sure of siliceous rock determination, the best resolution seems to be the use of the neutral term silicite.

SILICITES OF THE CRACOW-CZĘSTOCHOWA JURASSIC (SKCJ), ESPECIALLY VARIETY A ('KRZEMIEŃ JURAJSKI PODKRAKOWSKI') AND VARIETY G

There is no reliable evidence for the occurrence of this material on Middle Palaeolithic and early Upper Palaeolithic (Bohunician) sites in the Czech Republic. A Middle Palaeolithic side scraper made of the SKCJ (Fig. 1) was found, it is true, at an Eneolithic hillfort Starý Zámek near Jevišovice (western Moravia) but is believed to have been brought there and reutilised a community of the Funnel Beaker culture (Šebela *et al.,* 2017). Two tools (an end scraper and a side scraper) come from the Szeletian locality Drysice I – Kluče and four cores made of the SKCJ have been described from a Late Szeletian(?) site Rozdrojovice near Brno (Oliva 2001: 84), the cultural classification of the last locality is a matter of question because Zdeňka Nerudová (2016) considers it to be an Epigravettian site. As far as Aurignacian and Epiaurignacian sites in central Moravia are concerned, because of the strong patina it is very difficult to distinguish possible occasional occurrences of the SKCJ among the erratic flints that dominate these assemblages. Martin Oliva (2001: 85) mentioned rare flaked tools made of the SKCJ: one combined tool from Bělov I (Kroměříž district), one borer from Míškovice (Kroměříž district) and one end scraper found at Dubicko (Šumperk district).

Without doubt, items of SKCJ are regularly present on some south– and east-Moravian Gravettian localities as has already been mentioned by Janusz K. Kozłowski (1958). Their presence has been described from Pavlov II, Dolní Věstonice I, Jarošov II, Spytihněv I with the estimated quantity for example at Pavlov II of up to 27%, possibly 38% when the collection is evaluated without waste (Oliva 2007: 49). Surprisingly, there is almost no occurrence of SKCJ (only two pieces) at the famous Gravettian

Fig. 1. Middle Palaeolithic side scraper, silicite of the Cracow-Częstochowa Jurassic. Jevišovice-Starý Zámek, Znojmo distr., south-western Moravia. Photo: L. Plchová.

site of Přerov-Předmostí. There were no occurrences at the three localities in Brno, generally accepted as the Epigravettian, i.e., Brno-Stránská skála IV, Brno-Jundrov and Brno-Štýřice. The SKCJ appeared occasionally among the raw materials used by the Magdalenian hunters in caves of the Moravian Karst: Pekárna cave – 2% from studied 592 cores (Voláková 2001: 109); Ochozská cave – under 0.5%. A very small amount of the SKCJ has been found at some Late Palaeolithic and Mesolithic sites (Smolín, Přibice, Dolní Věstonice) in Moravia.

In Bohemia, there is no evidence of the presence of Polish siliceous raw materials in the Early Upper Palaeolithic (Bohunician?, Leaf Point complexes, Aurignacian) and in the middle phase of the Upper Palaeolithic (Gravettian). The first small occurrence of the silicites of Polish origin has been noted only in the Magdalenian collections from Tmaň – Děravá jeskyně and Putim (Vencl and Fridrich eds 2007: 101).

A real mass transport of Jurassic silicites from south Poland to Moravia, Silesia and Bohemia started at the beginning of the Neolithic when in some phases of the Linear Pottery culture (LBK) they even represented the prevalent raw material: Bylany in central Bohemia (LBK II–III, 46% of SKCJ; Ivan Pavlů and Antonín Přichystal in Přichystal 1985), Bravantice near Studénka (LBK IIb); Žopy I, Kladníky, Šišma, Mohelnice (LBK I; Mateiciucová 2000: 232, 2008: 126). In spite of its position within a glaciated area with natural occurrences of erratic flints, the Linear Pottery culture micro-region around Studénka very probably played an important mediation role in the distribution of the SKCJ further to the south (Janák *et al.*, 2016), where around Přerov, i.e., in the southern part of the Bečva Gateway, we know again of settlements with flaked industries rich in SKCJ silicite (Mateiciucová 2000, 2008; Schenk 2007): Kladníky I, LBK Ia, 65% of SKCJ; Přerov-Dluhonice II, LBK IIb, 95% of SKCJ or Šišma. LBK settlements with prevalent SKCJ raw material occur around the southern entrance of the Moravian Gateway through the Carpathian mountains: at Přáslavice (Olomouc district) 73% of SKCJ; Žopy (Kroměříž district) 63% of SKCJ (Mateiciucová 2008) and probably other sites (Fig. 2).

This distribution on a mass scale is connected with extensive raw material mining in the source area (Dzieduszycka-Machnikowa and Lech 1976; Lech 1980). After the period of Linear Pottery culture, the raw material occurred in substantially smaller quantities on several sites of the succeeding Stroked Pottery and Lengyel cultures. Janák and Přichystal (2007) published a detailed analysis of the distribution of SKCJ in Moravia during the Neolithic and the beginning of the Eneolithic. In central Moravia, the distribution of this raw material culminated probably already in the LBK Ia phase, in surrounding areas mostly from phase Ib or II. At the end of the Stroked Pottery culture (SBK IV) and the beginning of Lengyel culture (Lg I) and especially in the transitional period LgI/LgII it is possible to note again a rather higher supply of the SKCJ to Moravia. Małgorzata Kaczanowska and Janusz K. Kozłowski (1976: 213) found the Jurassic Cracow silicite at a Lengyel settlement near Těšetice-Kyjovice, Znojmo

Fig. 2. Neolithic (probably Linear Pottery culture) chips, silicite of the Cracow-Częstochowa Jurassic. Slatinice, Olomouc distr., central Moravia. Photo: A. Přichystal.

district, but according to our recent knowledge, its presence is not so high (only about 1%). Going to the west in Bohemia, the occurrence of SKCJ material declines considerably, for example in a small collection of 45 pieces from the LBK settlement at Kosoř (Praha-west district) it was used for only 2 artefacts (Nerudová and Přichystal 2011: 83).

In eastern/central Bohemia, SKCJ are also present in flaked assemblages of the Stroked Pottery culture but substantially less in comparision with older LBK assemblages, for example at Bylany, about 12% (Pavlů and Přichystal in Přichystal 1985), at Mšeno, district Mělník (a collection of 3128 artefacts, excavations of M. Lička) there were found only 4 pieces, i.e., under 0.1%, because of the near total dominance of silicites from glacial sediments (Přichystal 1987). On the other hand, SKCJ have been described more far to the west from Chrášťany near Rakovník (Lech 1993).

Raw materials of the SKCJ group occurred in the early Eneolithic is concerned, for example at the famous hillfort Hlinsko (Funnel Beaker culture) near the Moravian Gateway (only 7 pieces, i.e., around 0.2%), and also at other hillforts of the same period lying more to the south (the Prostějov area). So far, not a single piece of SKCJ material has been noted at the hillfort of Staré Zámky in Brno-Líšeň, where we know one piece of spotted Świeciechów silicite and two axes made of the banded Krzemionki silicite. In deposits of the young Eneolithic cultures in Moravia (the Jevišovice, Bošáca and Globular Amphorae cultures; the Eneolithic in Moravia has been subdivided into several stages, usually five or six, including young, late and final; e.g., Kopacz *et al.*, 2014: 4), the presence of SKCJ among flaked artefacts seems to be very rare and accidental. Occurrences of siliceous axes made of the SKCJ, variety G, are connected with the late Eneolithic Corded Ware culture in central Moravia. Surprisingly, the SKCJ, variety A, was used as an important raw material especially for arrowheads in the period of the Moravian Bell Beaker culture: 75 pieces altogether, it is 11% of the whole Moravian collection (Kopacz *et al.*, 2009). Probably from the Eneolithic period comes also a small deposit of three long blades (12–14 cm, SKCJ, variety G) from Bernartice nad Odrou, northern Moravia (Janák *et al.*, 2004).

The utilisation of SKCJ during the Early Bronze Age in Moravia (the Únětice culture and the Věteřov group) was very low. The material (1463 artefacts) from 86 Moravian localities was studied (for more details see Kopacz and Šebela 2006) and among them, only two items were of this raw material (Přichystal 2006).

‘CHOCOLATE’ SILICITE (CHoS, ‘KRZEMIEŃ CZEKOLADOWY’)

The ‘chocolate’ silicite appeared for the first time at Late Aurignacian (Epiaurignacian) sites Slatinice near Olomouc and Lhotka near Kroměříž. Oliva (2001: 85) has discussed one piece from the Aurignacian site of Bělov I. The raw material is present (0,3% from 592 cores; Voláková 2001) in the Magdalenian settlement in the Pekárna Cave (Moravian Karst). In Bohemia, the ‘chocolate’ silicite was ascertained very rarely at Late Palaeolithic sites Voletiny near Trutnov or Světlá nad Sázavou (eastern Bohemia). It was found at more Mesolithic sites in southern Moravia (Smolín, Přibice, Dolní Věstonice). The Mesolithic collection from Hořín near Mělník (central Bohemia) contains probably 1 piece.

At the Neolithic localities with Linear Pottery the ‘chocolate’ silicite occurs only as individual pieces – at Bylany, Kolín (central Bohemia), Mohelnice (?) in northern Moravia. Pavel Burgert in this volume has evaluated the role of ‘chocolate’ silicite in the Neolithic of Bohemia (Burgert 2018). He mentions its occurrences on settlements of the Stroked Pottery culture especially during the later phase IV. The find spots are spread in eastern Bohemia, prevalently in the area of the Elbe right bank between Jaroměř and Hradec Králové (ChoS up to 2% of the assemblage) where he has described even a workshop at Plotiště nad Labem (almost 9% of the ChoS in the assemblage).

This raw material occurs in small quantities in Moravian Painted Ware assemblages in southern Moravia. Two pieces were ascertained at the Funnel Beaker hillfort at Čechovsko near Prostějov. Only three Eneolithic axes made of ‘chocolate’ silicite have been found in Moravia, but none in Bohemia or in Czech Silesia (Šebela *et al.*, in preparation). One Late Eneolithic dagger made of ‘chocolate’ silicite (Fig. 3) was found

Fig. 3. Late Eneolithic dagger, 'chocolate' silicite. Osice, Hradec Králové distr., eastern Bohemia. Photo: L. Plchová.

at Osice, eastern Bohemia (Přichystal and Šebela 2015), probably of the Early Bronze Age. Three flaked artefacts including two arrowheads made of the ChoS have been described from a grave of the Bell Beaker culture in Praha – Velká Chuchle (Přichystal and Šebela 2009).

SPOTTED ŚWIECIECHÓW SILICITE (SwS, 'KRZEMIEŃ NAKRAPIANY ŚWIECIECHOWSKI' OR 'GREY WHITE-SPOTTED')

The raw material was used for a leaf-shaped point found at an Upper Palaeolithic site Míškovice-Křemenná near Holešov (Kozłowski 1972–73: 13), in recent time classified as the Aurignacian influenced by the Szeletian (Svoboda *et al.*, 2009: 163). One artefact was probably also found at the Szeletian site of Drysice I, central Moravia (Přichystal 2001). Only individual pieces were found in the Magdalenian collections from the Kůlna and Pekárna caves in the Moravian Karst (Valoch 1987). No finds have been described from the Moravian or Bohemian Mesolithic. In the Neolithic period, four pieces have been found connected with the Linear Pottery settlement at Bylany (Bohemia) and Mohelnice (Moravia). One piece was also announced from the Stroked Pottery culture site at Lobeč, NE of Mělník in Bohemia, (Spurný 1951: 134).

Perfectly flaked tools (scrapers, retouched blades) occur almost always as a few pieces at hillforts of the Funnel Beaker culture in central Moravia: Hlinsko near Lipník (32 pieces, i.e., about 1%), Čechovsko (7 pieces, i.e., 1%) and Ohrozim (1 piece) near Prostějov (Šmíd and Přichystal 2015: 93, 148). The southernmost find (1 piece) was ascertained at Staré Zámky near Brno-Líšeň (Fig. 4). Six axes made of the spotted

Fig. 4. Eneolithic (Funnel Beaker culture) end scraper, spotted Świeciechów silicite. Brno-Líšeň, Staré Zámky, Brno-město distr., southern Moravia. Photo: L. Plchová.

Świeciechów silicite (Lhotka, Nezamyslice, Velehrad, Veselíčko, Bezměrov, Želešice) are connected with the Corded Ware culture in Moravia (Šebela *et al.*, in preparation).

In Bohemia, finds of the spotted Świeciechów silicite connected with the Funnel Beaker culture are absolutely exceptional – a blade from Mradice (Neustupný *et al.*, 2008). No Late Eneolithic axes manufactured from the spotted Świeciechów silicite have been described from Bohemia (Šebela *et al.*, in preparation).

BANDED KRZEMIONKI SILICITE (KrS, 'KRZEMIEŃ PASIASTY')

There are no reliable data about the presence of this material on Palaeolithic or Mesolithic sites in the Czech Republic. Žebera (1958: 143) mentioned the presence of Krzemionki banded flint at a Mesolitic (in his text Tardenosian) locality Liblín (correctly Libín) near Hořice, district Jičín, NE Bohemia, but this seems to be very unlikely and, according to personal communication from Slavomil Vencl, the raw material is probably a variety of erratic flint.

Does this characteristic Polish silicite appear for the first time as occasional individual chips at some Neolithic sites around the Moravian Gateway? Inna Mateiciucová (2008) has not mentioned it at all among Neolithic raw materials in Moravia. Petr Gadas found a chip of the Krzemionki banded silicite at Šišma III – Amerika, district Přerov (Fig. 5), the locality is usually classified to the Linear Pottery culture but according to polished tools made of Culmian siltstone at the same place, the Funnel Beaker culture occurrence is also almost sure and the chip should be more probably connected with this culture.

Archaeological excavations at a hillfort of the Funnel Beaker culture at Hlinsko near Lipník nad Bečvou revealed 5 flaked artefacts and one polished axe. Other reliably documented occurrences of the Krzemionki silicite in Moravia are represented by 24 silicite axes of the Eneolithic age, according to their shape connected with the Globular Amphorae culture (Šebela *et al.*, in preparation). Two axes from the Eneolithic hillfort Staré Zámky in Brno-Líšeň represent the southernmost finds on the Bohemian Massif in Moravia (Fig. 6).

Three axes made of the banded Krzemionki silicite have been found also in eastern/central Bohemia: Denemark near Kutná Hora – Řivnáč culture (Zápotocký 2012: 132); Slatiny, south of Jičín – of the Bell Beaker culture and Mladotice (Chrudim district) – probably Krzemionki banded silicite, an accidental find (Šebela *et al.*, in preparation).

CONCLUSION

Without doubt, the four most spectacular Polish silicites ('flints') were also used as raw materials in prehistoric times in Moravia, Czech Silesia and eastern/central Bohemia. Regular occurrences of silicites from the Cracow-Częstochowa Jurassic (evidently from its southern part around Cracow) appeared besides the prevalent erratic flints from northern Moravia or Silesia at some south and east Moravian Gravettian sites. The author believes the most probable explanation of their substantial presence at these localities can be connected with seasonal migrations of the Gravettian hunters through depressions between the Bohemian Massif and the West Carpathians and subsequently along the Carpathian bend up to the Cracow area. In Bohemia, SKCJ have been found in only two Magdalenian collections. Their utilisation during the Moravian Epigravettian, Late Palaeolithic and Mesolithic seems to be only accidental, probably with the exception in the Magdalenian with small but systematic occurrence in caves of the Moravian Karst. Transport of SKCJ to northern /central Moravia and eastern/central Bohemia on a really mass scale started with the Linear Pottery culture. The material is present in smaller quantities in lithic collections of succeeding Neolithic and Eneolithic cultures. Surprisingly, SKCJ is present in substantial quantities in the

Fig. 5. Eneolithic (probably Funnel Beaker culture) chip, banded Krzemionki silicite. Šišma, Přerov distr., central Moravia. Photo: L. Plchová.

Fig. 6. Eneolithic silicite axe, banded Krzemionki silicite. Brno-Líšeň, Staré Zámky, Brno-město distr., southern Moravia. Photo: L. Plchová.

arrowheads of the Bell Beaker culture in Moravia. Their occurrence in Early Bronze Age findspots in Moravia is very rare (only 2 pieces in the collection of 1463 artefacts).

Only small amounts of 'chocolate' silicite appeared in central Moravia maybe even earlier that the SKCJ at some south– and east-Moravian Gravettian sites, but it is connected with the Late Szeletian or Epiaurignacian cultures. It is undoubtedly present among the raw materials of the Magdalenian settlement in the Moravian Karst (about 1% at Pekárna Cave) and as accidental finds at Late Palaeolithic and Mesolithic localities in Moravia and Bohemia. Only sometimes do the Neolithic and Eneolithic flaked collections in both regions have a few pieces of the 'chocolate' silicite. According to our current knowledge, an exception is represented by the settlements of the Stroked Pottery culture in eastern Bohemia, especially along the Elbe between Jaroměř and Hradec Králové, these are relatively rich in the ChoS. Individual pieces were found rarely in collections connected with the Funnel Beaker culture (Prostějov-Čechovsko, central Moravia).

Spotted Świeciechów silicite appeared for first time at two Upper Palaeolithic sites in central Moravia, classified as the Szeletian or the Aurignacian influenced by the Szeletian. Only individual pieces were found in the Magdalenian assemblage from the Kůlna and Pekárna caves in the Moravian Karst. No finds have been ascertained in the Moravian and Bohemian Mesolithic. SwS occurs in small quantities at some important Neolithic sites in Bohemia and Moravia as accidental pieces. A regular presence in small quantities is typical for the Funnel Beaker culture in Moravia. Four silicite axes in Moravia (none in Bohemia) are considered likely to be from the Corded Ware culture period.

There are no reliable records of the occurrence of the banded Krzemionki silicite in the Palaeolithic and Mesolithic of Moravia, Bohemia and Czech Silesia. Very scarce chips of the Krzemionki silicite are related to the Early-Middle Eneolithic (prevalently Funnel Beaker culture), and found in the southern part of the Moravian Gateway. But Moravia is relatively rich in surface finds of silicite axes made of the banded Krzemionki silicite (about 24 pieces). In northern and central Moravia they are linked with the Globular Amphora culture, in southern Moravia they are classified as imports into the milieu of the Jevišovice culture.

REFERENCES

Allaby, A. and Allaby, M. (eds) 2003. *A Dictionary of Earth Sciences (2nd edition)*. Oxford.

Bates, R. L. and Jackson, J. A. (eds) 1987. *Glossary of Geology (3rd edition)*. Alexandria.

Brandl, M. 2010. Classification of rocks within the chert group: Austrian practice. *Archeometriai Műhely* 2010 (3): 183–190.

Burgert, P. 2018. The Status and the Role of 'Chocolate' Silicite in Bohemian Neolithic. *Archeologia Polona* 56: 49–64.

Dana, E. S. 1895. *Minerals and how to study them. A book for beginners in mineralogy*. New Haven.

Dzieduszycka-Machnikowa, A. and Lech, J. 1976. *Neolityczne zespoły pracowniane z kopalni krzemienia w Sąspowie*. Wrocław-Warszawa-Kraków-Gdańsk, Ossolineum.

Garrison, E. G. 2010. *Techniques in Archaeological Geology.* Berlin, Springer. Natural Science in Archaeology.

Janák, V., Oliva, M., Přichystal, A., and Grepl, E. 2004. Hromadný nález silicitových čepelí z Bernartic nad Odrou, okr. Nový Jičín. In E. Kazdová, Z. Měřínský and K. Šabatová (eds), *K poctě Vladimíru Podborskému*, 167–175. Brno.

Janák, V., Papáková, K., Přichystal, A., Kováčik, P., Rataj, P. and Hořínková, A. 2016. Neolitické osídlení v okolí Studénky a úloha zdejšího mikroregionu kultury s lineární keramikou v distribuci silicitů krakovsko-čenstochovské jury. *Slovenská archeológia* 64 (1): 1–63.

Janák, V. and Přichystal, A. 2007. Distribuce silicitů krakovsko-čenstochovské jury na Moravě a v Horním Slezsku v neolitu a na počátku eneolitu. *Památky archeologické* 98: 5–30.

Kaczanowska, M. and Kozłowski, J. K. 1976. Studia nad surowcami krzemiennymi południowej części Wyżyny Krakowsko-Częstochowskiej. *Acta Archaeologica Carpathica* 16: 201–2016.

Kopacz, J. and Šebela, L. 2006. *Kultura unietycka i grupa wieterzowska na Morawach na podstawie materiałów krzemieniarskich.* Kraków.

Kopacz, J., Přichystal, A. and Šebela, L. 2009. *Lithic chipped industry of the Bell Beaker culture in Moravia and its East-Central European context.* Kraków–Brno.

Kopacz, J., Přichystal, A. and Šebela, L. 2014. *Lithic Chipped Industry of the young Eneolithic in Moravia and Czech Silesia.* Brno. Spisy Archeologického ústavu AV ČR 46.

Kozłowski, J. K. 1958. Przyczynek do znajomości surowców krzemiennych występujących w paleolicie i neolicie ČSR. *Wiadomości Archeologiczne* 25: 355–360.

Kozłowski, J. K. 1972–73. The origin of lithic raw materials used in the Palaeolithic of the Carpathian countries. *Acta Archaeologica Carpathica* 13: 5–19.

Król, P. and Migaszewski, Z. M. 2009. Rodzaje, występowanie i geneza krzemieni. Zarys problematyki. In P. Król (ed.), *Historia krzemienia*, 12–45. Kielce.

Lech, J. 1980. Flint Mining among the Early Farming Communities of Central Europe. *Przegląd Archeologiczny* 28: 5–55.

Lech, J. 1993. Analyse der Spaltindustrie aus der Grube 2. In M. Zápotocká, Chrášťany, Bez. Rakovník. *Ein Beitrag zum chronologischen Verhältnis der Stichtbandkeramik zur Grossgartacher und Oberlauterbacher Keramik. Archeologické rozhledy* 45/3: 436–459.

Mateiciucová, I. 2000. Časně neolitická štípaná industrie z osady Kladníky a Ivanovice na Moravě. In *Památky archeologické – supplementum* 13: 218–237.

Mateiciucová, I. 2008. *Talking Stones: The chipped Industry in Lower Austria and Moravia and the Beginnings of the Neolithic in Central Europe (LBK), 5700–4900 BC.* Brno – Praha, Dissertationes archaeologicae Brunenses/Pragensesque 4.

Nerudová, Z. 2016. *Lovci posledních mamutů na Moravě.* Brno, Moravské zemské muzeum, Studie Centra kulturní antropologie 2.

Nerudová, Z. and Přichystal, A. 2011. Kamenná štípaná industrie. In M. Lička, *Osídlení kultury s lineární keramikou v Kosoři, okr. Praha-západ.* Praha, Fontes Archaeologici Pragenses 37: 78–86.

Neustupný, E., Dobeš, M., Turek, J. and Zápotocký, M. 2008. *Archeologie pravěkých Čech / 4. Eneolit.* Praha.

Oliva, M. 2001. Gravettienská sídliště u Pavlova. K otázce využívání silicitů krakovské jury. *Acta Musei Moraviae, Scientiae sociales* 86: 45–99.

Oliva, M. 2007. *Gravettien na Moravě.* Brno – Praha, Dissertationes archaeologicae Brunenses / Pragensesque 1.

Přichystal, A. 1985. Štípaná industrie z neolitického sídliště v Bylanech (okr. Kutná Hora) z hlediska použitých surovin a jejich provenience. *Archeologické rozhledy* 37: 481–488.

Přichystal, A. 1987. *Petrografický výzkum štípané industrie ze Mšena (okr. Mělník).* Praha, Manuscript of report. Národní muzeum v Praze.

Přichystal, A. 2001. Zastoupení kamenných surovin na szeletských stanicích Drysice I a Ondratice IV (okres Prostějov, Vyškov). *Pravěk NŘ* 2000 (10): 35–39.

Přichystal, A. 2006. Surowce kamienne morawskich inwentarzy krzemieniarskich z wczesnego okresu epoki brązu. In Kopacz, J. and Šebela, L., *Kultura unietycka i grupa wieterzowska na Morawach na podstawie materiałów krzemieniarskich,* 37–45. Kraków.

Přichystal, A. 2009. *Kamenné suroviny v pravěku východní části střední Evropy*. Brno.

Přichystal, A. 2010. Classification of lithic raw materials used for prehistoric chipped artefacts in general and siliceous sediments (silicites) in particular: the Czech proposal. *Archeometriai Műhely* (3): 177–182.

Přichystal, A. 2013. *Lithic raw materials in prehistoric times of eastern Central Europe*. Brno.

Přichystal, A. and Šebela, L. 2009. Příspěvek k poznání kamenné štípané industrie z pohřebiště kultury zvoncovitých pohárů v Praze-Velké Chuchli. *Archeologie ve středních Čechách* 13: 683–686.

Přichystal, A. and Šebela, L. 2015. Silicite daggers from the territories of the Czech Republic and Slovakia (a preliminary study). In C. J. Frieman and B. V. Eriksen (eds), *Flint daggers in prehistoric Europe*, 133–148. Oxford–Philadelphia.

Schenk, Z. 2007. Jihozápadní část Moravské brány v době kultury s lineární keramikou. *Archeologické studie Univerzity Hradec Králové* 1: 211–244.

Skutil, J. 1937. O znaleziskach siekierek z tzw. pasiastego krzemienia na Morawach. *Przegląd Archeologiczny* 6: 105–106.

Spurný, V. 1951. Neolitické sídliště v Lobči. *Archeologické rozhledy* 3: 130–135.

Svoboda, J., Havlíček, P., Ložek, V., Macoun, J., Musil, R., Přichystal, A., Svobodová, H. and Vlček, E. 2009. *Paleolit Moravy a Slezska* (3. aktualizované vydání). Brno, Dolnověstonické studie 16.

Šebela, L., Přichystal, A., Král, L. and Král, P., in preparation. *Silicite axes from the lands Moravia, Bohemia and Czech Silesia*. Brno, Spisy AÚ AV ČR v Brně.

Šebela, L., Přichystal, A., Škrdla, P. and Humpolová, A. 2017. Unusual Middle Paleolithic Stone Tool from Southern Moravia with Possible Relations to Southern Poland. *Acta Archaeologica Carpathica* 52: 3–10.

Šmíd, M. and Přichystal, A. 2015. *Eneolitická hradiska na Prostějovsku. Ohrozim – Čubernice a Prostějov – Čechovice-Čechovsko*. Brno, Pravěk – Supplementum 29. ÚAPP Brno.

Tomkeieff, S. I. 1983. *Dictionary of Petrology*. Chichester.

Valoch, K. 1987. Raw materials used in the Moravian Middle and Upper Palaeolithic. In K. T. Biró (ed.), *International conference on prehistoric flint mining and lithic raw material identification in the Carpathian Basin*, 263–268. Budapest–Sümeg.

Vencl, S. 1971. Současný stav poznání postmesolitických štípaných industrií v Československu. In *Z badań nad krzemieniarstwem neolitycznym i eneolitycznym*, 74–99. Kraków–Nowa Huta.

Vencl, S. and Fridrich, J. (eds) 2007. *Archeologie pravěkých Čech / 2. Paleolit a mezolit.* Praha.

Voláková, S. 2001. K technologii štípané industrie magdaléninu: analýza jader z jeskyně Pekárny. *Acta Musei Moraviae* 86: 101–116.

Zápotocký, M. 2012. Silicitové sekery v eneolitu a starší době bronzové Čech. *Archeologie západních Čech* 4: 126–159.

Żaba, J. 2006. *Ilustrowana encyklopedia skał i minerałów.* Katowice.

Žebera, K. 1958. *Československo ve starší době kamenné*. Praha.

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The Status and the Role of 'Chocolate' Silicite in the Bohemian Neolithic

Pavel Burgert[a]

*The author dedicates this article to the 80th birthday of Prof. Ivan Pavlů (*1938)*

The article focuses on the chronological status of the distribution of 'chocolate' silicite originating from the area of south-east Poland in the prehistory of the Czech lands. The flow of 'chocolate' silicite across the Carpathian Mountains culminated in the period of the Stroke-Ornamented Ware culture (5100/5000–4500/4400 cal BC) in the area studied. Based on the analysis of the contexts of finds and the classification of the artefacts, the raw material is interpreted as an indicator of the presence of individuals or groups with an exclusive social status. Both the pattern of distribution and the status are common to other 'exotic' raw materials, especially for Carpathian obsidian, in the studied area in that same period. By comparing the spatial and chronological image expansion of both materials can lead to similar conclusions in their assessment.

KEY-WORDS: 'chocolate' silicite, distribution, chipped industry, social status, Stroked Pottery culture (SBK), obsidian, Eastern Bohemia

INTRODUCTION

'Chocolate' silicite is one of the most important lithic raw materials in the prehistory of the eastern part of Central Europe (Schild 1971, 1976; Borkowski *et al*., 2008; Werra *et al*., 2015). Its distribution range exceeds 500 km from sources (Fig. 1) and it is thereby comparable to the distribution of Carpathian obsidian (Mateiciucová 2008; Biró 2014; Burgert 2015a: Fig. 1). However, the catchment area is somewhat different due to the location of the resources above the Carpathian Arc. The purpose of this paper is to outline the specific role of 'chocolate' silicite, which results from its chronological and distributional position in the Neolithic period (Linear Pottery [Linearbandkeramik] Culture, hereinafter referred to as LBK: 5600–5000/4950 cal BC, Stroke-Ornamented Ware culture [Stichbandkultur], hereinafter referred to as SBK: 5100/5000–4500/4400 cal BC) in Bohemia (Fig. 1 and 2:A). The finds from the SBK period will be discussed more detail due to their larger number, therefore we can observe its presence in different types of localities.

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The recognition of this type of silicite, used as a raw material of prehistoric tools, was introduced into Bohemian research half a century ago by Slavomil Vencl (1971: 79). Nevertheless, not a lot of attention has been paid to it up to the present, and even in the basic syntheses devoted to the raw materials of the Neolithic lithic industries, no attention was paid to it (Popelka 1999; Šída 2006). The raw material was increasingly identified in the local sites due to research endeavours in Eastern Bohemia (Vávra 1993: 218; Čuláková 2015; Burgert 2015a: Tab. 1).

SPATIAL AND CHRONOLOGICAL DISTRIBUTION OF 'CHOCOLATE' SILICITE IN CZECH PREHISTORY

The outcrops of 'chocolate' silicite are located in the northwest part of the Świętokrzyskie (Holy-Cross) Mountains in the southeast Poland. They are located in a belt approximately 90 km long, oriented in a SE-NW direction, lying between the

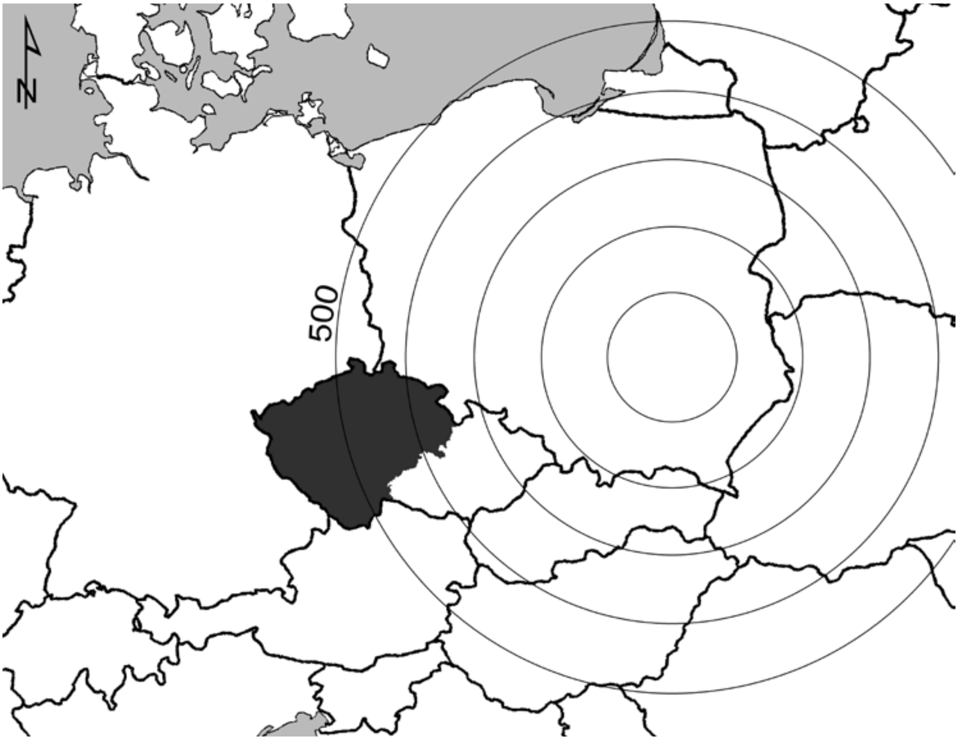

Fig. 1. Map of the eastern part of Central Europe with an indication of the area of interest – Bohemia (grey). The circles mark the distance from sources of 'chocolate' silicite at an interval of 100 km. The radius of the smallest circle is 100 km, of the largest 500 km. Drawn: P. Burgert.

valley of the Vistula at Zawichost in the east and the upper Radomka basin in the west. Around 25 sites with documented traces of prehistoric mining have been identified in this area (Balcer 1976; Budziszewski 2008: Ryc. 1), usually in the form of vertical shafts. Neolithic mining activities are documented by a sequence of radiocarbon data (5500–4450 cal BC; Schild 1995; Schild *et al.*, 1985; Budziszewski 2008: Table 1). The distance from the source to the Bohemian localities is between 500 and 600 km as the crow flies (Fig. 1).

All published or available finds of 'chocolate' silicite in Bohemia are summarised in Tab. 1. It is obvious that this raw material was sporadically used already in the period of Upper Palaeolithic and in Mesolithic, but it rarely occurs in site assemblages of this period. The spatial dispersion of finds in these periods includes the entire area of Bohemia with a slightly increased concentration in the southern and eastern parts (Fig. 3: A). This, however, is probably to some extent because more attention of researchers

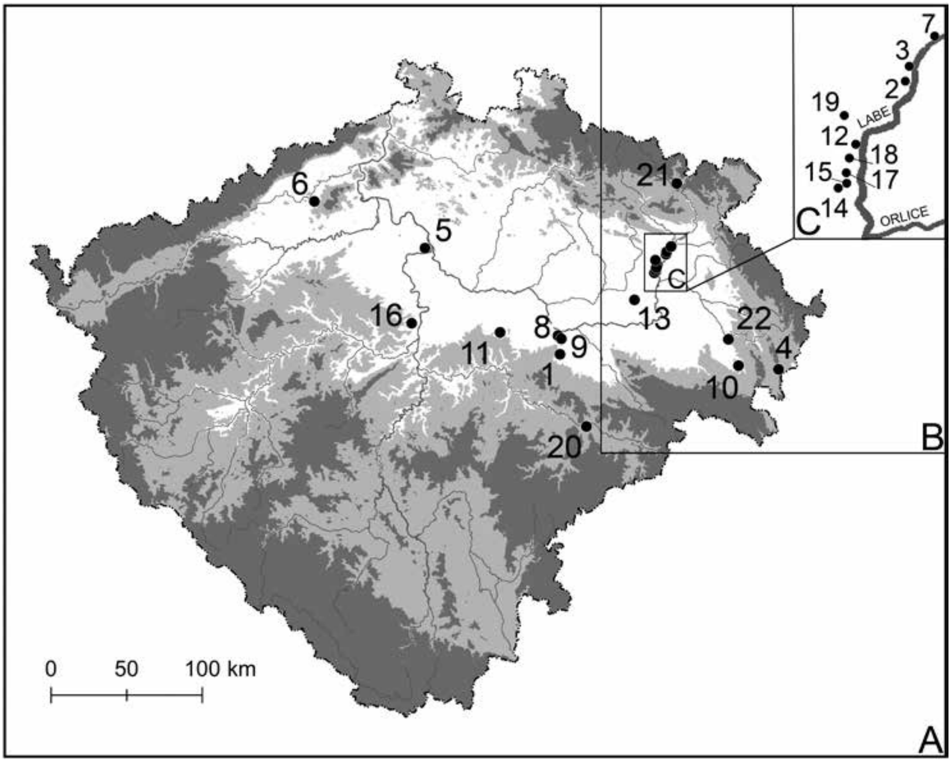

Fig. 2. The localisation of the finds of 'chocolate' silicite in Bohemia with the designation of individual area of interest. A: Bohemia; B: the eastern part of Bohemia; C: the area of the right bank of the Elbe River between Jaroměř and Hradec Králové. The numbering of sites corresponds to that in Table 1. Drawn: P. Burgert.

Table 1. Finds of 'chocolate' silicite in Bohemia. The numbering of the sites corresponds to that in Fig. 2.

No.	Locality	Region	Quantity	Form	Chronology	Reference
[1]	[2]	[3]	[4]	[5]	[6]	[7]
1	Bylany, Kutná Hora distr.	Central Bohemia	2		LBK II, III	Lech 1989: 112
2	Černožice 1, Hradec Králové distr.	Eastern Bohemia	1	blade	NEOLITHIC	
3	Černožice 2, Hradec Králové distr.	Eastern Bohemia	3	sickle blade, flakes	SBK IV	Vávra 1993: 218
4	Damníkov 1, Ústí nad Orlicí distr.	Eastern Bohemia	1		MESOLITHIC	Čuláková 2015: 91
5	Hořín u Mělníka, Mělník distr.	Central Bohemia	1		MESOLITHIC	Přichystal 2000: 44
6	Hrobčice, Teplice distr.	Northern Bohemia	1	endscraper	SBK IV	
7	Jaroměř, Náchod distr.	Eastern Bohemia	40	blades, sickle blade, endscrapers	SBK IV	
8	Kolín I, Kolín distr.	Central Bohemia	5	blades	SBK IV	
9	Kolín X, Kolín distr.	Central Bohemia	1	flake	LBK III	
10	Kornice 2, Svitavy distr.	Eastern Bohemia	1		MESOLITHIC	Čuláková 2015: 106
11	Krupá, Kolín distr.	Central Bohemia	1	flake	UPPER PALAEOLITHIC / NEOLITHIC	
12	Lochenice, Hradec Králové distr.	Eastern Bohemia	1	blade	NEOLITHIC	
13	Osice, Hradec Králové distr.	Eastern Bohemia	1	silicite (flint) dagger	EARLY BRONZE AGE	Šebela and Přichystal 2014: 75
14	Plotiště nad Labem - burial ground, Hradec Králové distr.	Eastern Bohemia	11	single platform core, blades, arrowheads	SBK IVb	
15	Plotiště nad Labem - site, Hradec Králové distr.	Eastern Bohemia	157	single platform core, cortical flakes, blades, tools	SBK IVb	
16	Praha - Velká Chuchle, Praha distr.	Central Bohemia	3	arrowheads	BELL-BEAKER CULTURE	Přichystal and Šebela 2009: 684

[1]	[2]	[3]	[4]	[5]	[6]	[7]
17	Předměřice nad Labem 1, Hradec Králové distr.	Eastern Bohemia	10	blades, flake production	SBK IV	
18	Předměřice nad Labem 2, Hradec Králové distr.	Eastern Bohemia	2	blades	NEOLITHIC	
19	Smiřice, Hradec Králové distr.	Eastern Bohemia	8	endscrapers, blades	SBK IV	Burgert 2015a: Tab. 1
20	Světlá nad Sázavou, Havlíčkův Brod distr.	Eastern Bohemia	1		UPPER PALAEOLITHIC	Přichystal 1998: 357
21	Voletiny, Trutnov distr.	Eastern Bohemia	2	endscraper, burin	UPPER PALAEOLITHIC	Vencl 1978: 10
22	Zářecká Lhota 3, Ústí nad Orlicí distr.	Eastern Bohemia	1		MESOLITHIC	Čuláková 2015: 127
Σ	Total		254			

has been focused on these two areas in the past (Vencl *et al.*, 2006; Čuláková 2015). It should be noted, however, that the overall small amount of finds, regardless of the long period of time that these periods occupy, do not allow any closer conclusions.

The vast majority of other finds from Bohemia are concentrated in the Neolithic period. In the LBK period, however, the use of 'chocolate' flint in small quantities has so far been identified only in the lithic material from the extensive assemblage of finds from the settlement in Bylany near Kutná Hora (Kutná Hora district; Přichystal 1985; Lech 1989) and also recently in material from nearby Kolín (Kolín district; Fig. 3:B). All other Neolithic finds that we can closer classify come from the subsequent SBK period. Most of the finds from the SBK period are characterised by their noticeable concentration in a later phase of this culture, referred to as SBK IV (the classification of SBK here and elsewhere in the text is in accordance with the scheme by Marie Zápotocká 1998a).

Only two finds of 'chocolate' silicite are known from the post-Neolithic period in Bohemia. The first is a set of three arrowheads from the grave of the Bell Beaker culture in Central Bohemia. The other is a silicite dagger from the area of Eastern Bohemia. While it is a solitary find without a closer context, it can be typologically included in the period of the Early Bronze Age (Šebela and Přichystal 2014: 75). These finds are referred to here only for the sake of completeness because they come from a completely different economic situation than the above-mentioned finds from earlier prehistory periods.

CONCENTRATION OF RAW MATERIAL IN EASTERN BOHEMIA

In terms of the spatial distribution of the finds of ‘chocolate’ silicite, it is obvious that their occurrence is concentrated in the eastern part of Bohemia (Fig. 2: B). This is, in general terms, a reflection of the relative closeness of this area to the location of the sources. What is striking, however, is the concentration of finds in a particular area of the right bank of the Elbe (Fig. 2: C and 3: C). This concerns only the later phase of SBK. Because of the exclusivity of this phenomenon, we will deal with it further.

In the area of the right bank of the Elbe in the section between today’s towns of Jaroměř (in the north, Náchod district) and Hradec Králové (in the south, Hradec Králové district) we can observe continuous settlement from the earliest Bohemian LBK (Pavlů and Vokolek 1996). The density of settlement culminates there in the period of the later SBK phase and it is the greatest in the entire region of Eastern Bohemia (Burgert 2017). During this period, Circular Enclo-

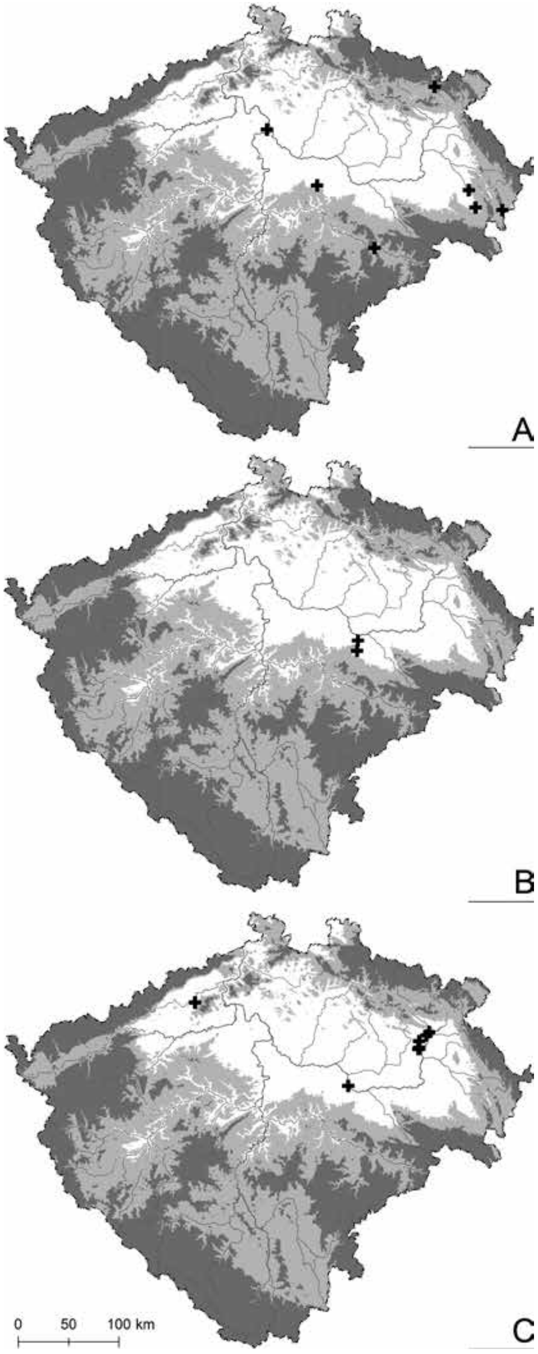

Fig. 3. The spatial distribution of prehistoric findgs of ‘chocolate’ silicite in Bohemia. A: Upper Palaeolithic and Mesolithic; B: Linear Band Pottery; C: Stroked Pottery culture. Drawn: P. Burgert.

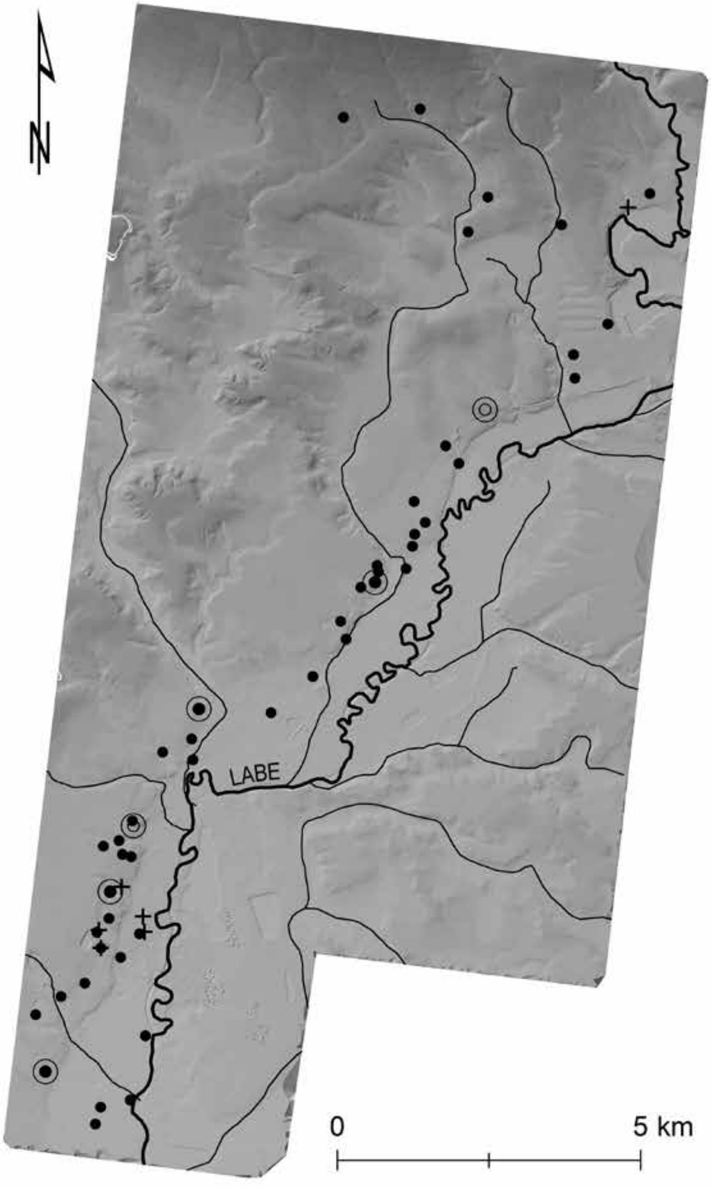

Fig. 4. Settlements at the right bank of the Elbe River in the section between Jaroměř and Hradec Králové (Hradec Králové and Náchod disrt., Eastern Bohemia, see Fig. 2: C) in the period of the late phase of Stroked Pottery culture (SBK IV). Dots: settlements; circles: Circular enclosures; crosses: graves or groups of graves. The Elbe River is reconstructed according to its situation in 1852. Drawn: P. Burgert.

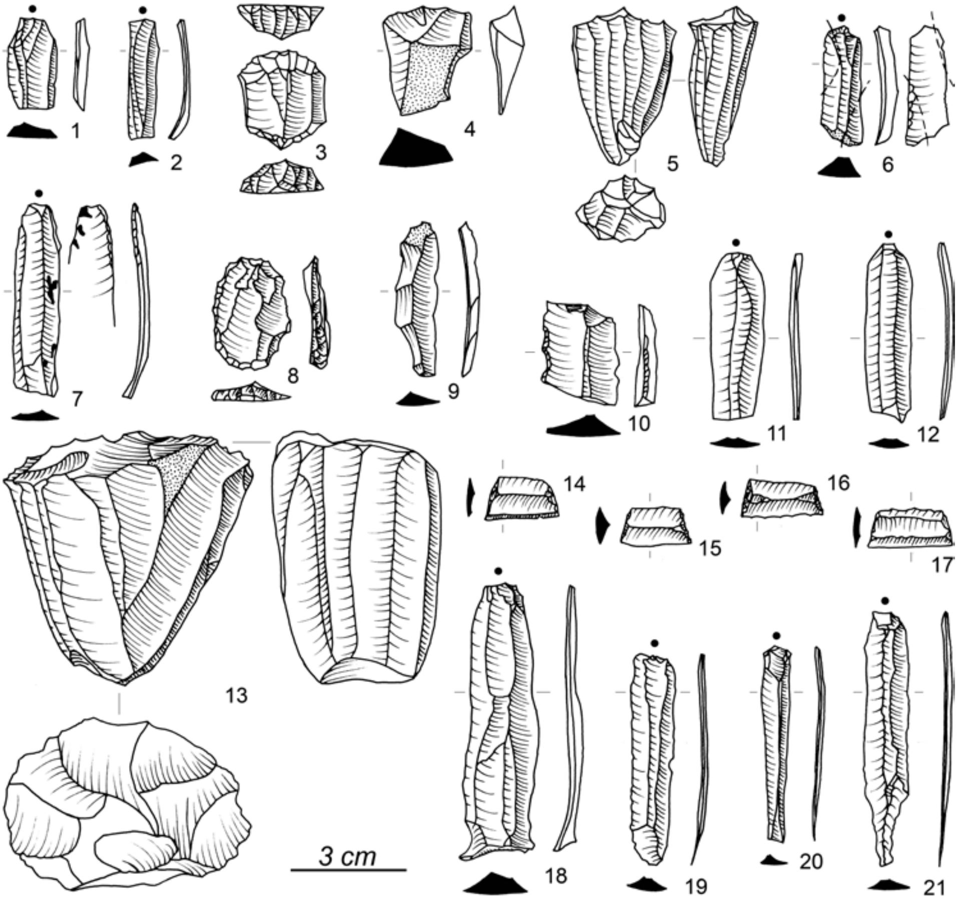

Fig. 5. Examples of 'chocolate' silicite finds from Bohemia. 1–5: Plotiště nad Labem, Hradec Králové distr., pit No. 74; 6: Jaroměř, Náchod distr.; 7: Kolín, Kolín distr. 8–10: Předměřice nad Labem, Hradec Králové distr.; 11–12: Plotiště nad Labem, Hradec Králové distr., child grave no. LVIII; 13–21: child grave no. LVII, weight of core: 223, 5 g. Drawn: P. Burgert and L. Raslová.

sures, graves and groups of graves are concentrated exclusively in this part of Eastern Bohemia (Fig. 4). This is also where, during this period, we record a large concentration of 'chocolate' silicite finds.

Most of the finds in this area are tied to settlements. They therefore come from the standard contents of settlement pits. Their representation in settlement assemblages[1] generally ranges up to 2%. An exception is object No. 74 in Plotiště nad Labem, Hradec Králové district (a clay pit with the dimensions of 23×13 m). Its filling is surprisingly homogeneous in terms of the pottery, and it is possible to classify it to the end of the later phase of SBK (SBK IVb; Burgert 2015a: 250). The chipped industry assemblage from this site comprises 1788 items with a relatively large share (8.8%, 157 items) of 'chocolate' silicite. An important find is the fact that the 'chocolate' silicite assemblage includes evidence of the processing of this raw material on site (cores, technical and cortical flakes). This is the only documented workshop for processing this raw material in Bohemia. Based on the low representation of cortical flakes with a 100% share of the cortex, it is evident that the partially pre-prepared cores were processed there.

Attention should also be paid to the presence of this raw material in graves. There are two rich children's graves, also from the Plotiště nad Labem site (this burial ground is located next to the settlement; Zápotocká and Vokolek 1997; Burgert *et al.*, 2016). In addition to necklaces made of the canine teeth of deer and the shells of gravel snails (*Lithoglyphus naticoides*) lithic items made of 'chocolate' silicite was also found there (Fig. 5). Its share represents 50% (i.e., 11 items). Both children's graves are contemporary, which was proven on the basis of the refitting of the stone flakes from their contents; in one grave (LVII), a silicite core of glacial sediments was found, from which the blades found in the second grave had been chipped (grave LVIII; Vencl 1997: 32). Just like the workshop assemblage from feature No. 74 on the same site, the graves are also classified to the end of the later SBK phase (SBK IVb).

DISTRIBUTION SCHEME

As can be seen from Table 1, 'chocolate' silicites occur in the lithic assemblages most often in the form of blades or final tools. This fact indicates a specific form of the distribution of this raw material. At present, we are aware of only two cores, both from the Plotiště nad Labem site. One comes from the already mentioned rich grave No. LVII (Fig. 5: 13), while the other one represents a part of the extensive assemblage

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[1] As a representative example can be used an assemblage from the SBK settlement in Jaroměř (Burgert 2015b). The local assemblage comprised 2015 items of chipped industry, originating from about 60 settlements features. The share of chocolate silicite in this characteristic settlement assemblage was 2% (Burgert 2017).

of lithics from feature No. 74 (Fig. 5: 5) in the adjacent settlement. It is likely that 'chocolate' silicite arrived in Bohemia in the form of prepared cores during the later phase of SBK. These were processed only in some settlements and only blades or tools were distributed further within the region.

THE LINK BETWEEN THE RAW MATERIALS AND THE TOOLS AND SEMI-FINISHED PRODUCTS

In terms of a potential link between 'chocolate' silicite and the type of tools and semi-finished products, no specific fixed link was observed. This could be partly due to the relatively small number of these tools available for analysis. However, in terms of this raw material, we know both semi-finished products (blades) without any signs of use and the blades with sickle gloss that demonstrates their long-term use as working tools, specifically in sickles (Fig. 5: 6). We have also available endscrapers (Fig. 5: 3 and 8) and a simple burin from the pre-Neolithic period. A set of four trapezes that were probably used as arrowheads from grave no. LVII in Plotiště nad Labem (Fig. 5: 14–17) has no other parallels in the region.

Some artefacts bear traces of sickle gloss and residual mastic (Fig. 5: 6–7) that suggests an original attachment of the tool in a handle made of organic material. Similarly, these observations confirm the use of at least a part of 'chocolate' silicite artefacts for the same activities as other raw materials. This also does not exclude the possibility that in addition to prepared cores of the raw material, the ready-made tools with organic handles could also have been the subject of long-distance exchange.

DISCUSSION

The 'chocolate' silicite that is the subject of this study belongs in the category of 'exotic raw materials' in the Czech environment and generally also in the SBK environment. This term is used for stone material that comes from sources that are outside the actual cultural framework in which they were found. This definition applies in the case of SBK for both 'chocolate' silicite and for Carpathian obsidian, radiolarite and basically also for Bavarian Jurassic chert and other materials too. These raw materials were the subject of long-distance and inter-cultural exchange, although the mechanisms of their distribution between the individual different cultural environments are not exactly known. Due to the distances from the sources, which in the case of Bohemia the distance from the sources of 'chocolate' silicite and the obsidian are ca. 500 km, it is considered unlikely that there was direct contact of the members of the local groups with natural outcrops. The most likely model is down-the-line exchange (Renfrew and Bahn 2000: 368), although, considering such a great distance, this model could be combined with others, especially in the areas immediately adjacent to the sources (the situation in which they initial distribution took place are unknown, for example we cannot know anything about the default conditions, such as the ownership rights of settled communities in relation to the sources).

A characteristic feature of exotic raw materials is the fact that they occur only in trace amounts in the total volume of stone tools. These raw materials therefore do not play a purely economic role, as is the case of the dominant raw materials in assemblages (in the case of the eastern part of the Bohemian SBK these are silicites from glacial sediments). Another typical feature of these raw materials is their recognisability due to their characteristic appearance. We will discuss this feature further below. It is therefore possible to assume that exotic raw materials played a specific role in the perception of prehistoric communities. Below, we will focus only on the period of the later SBK, in regard to which there are characteristic changes in the archaeological evidence. As we have already mentioned above, the finds of 'chocolate' silicite in Bohemia significantly concentrate in this period.

In the period of the later SBK phase (SBK IV), we encounter a significant phenomenon, the construction of circular enclosures (Bertemes and Meller 2012). It is also possible to observe the gradual rise of the 'urbanisation' of settlements, including changes in the treatment of waste in settlements (Končelová and Květina 2015; Burgert 2015b). Rich children's graves appear in the funeral practices, though sporadically (Zápotocká 1998b: Taf. 67–68). All these changes can be explained by a major social transformation. The bearers of these changes could be individuals or groups of people with an exclusive social status. We believe that it is the presence of exotic raw materials in the assemblages that can be one of the indicators of the presence of these individuals or groups. This assertion is based on several assumptions:

1. The occurrence of exotic raw materials, including 'chocolate' silicite, is almost exclusively linked to the areas with strong contemporary settlements with the concentration of other phenomena, such as Circular Enclosures or groups of graves. The main region with these characteristics is the right bank of the Elbe in Eastern Bohemia (Fig. 4). The same conditions, however, also apply to the area of Kolín, where we also encounter concentration of settlements, accompanied by ringworks and grave finds (Fig. 3: C);
2. An increased concentration of 'chocolate' silicite was found in rich children's graves in Plotiště nad Labem (Fig. 5);
3. 'Chocolate' silicite is, like other exotic raw materials (obsidian, Bavarian Jurassic chert), a noticeable and well-identifiable raw material. This property is typical of status symbols (Hodder 1982);

4. The cores of 'chocolate' silicite in Bohemia were processed only at some settlements, on others we can encounter only the final products, or this raw material is absent;

The control and organisation of long-distance exchange mechanisms in archaic societies is demanding because it requires cross-border transfer of multiple settlement communities. At the same time, it requires the existence of an agent that has the ability to maintain exchange demands. This agent has the character of ritual social necessity and can be personified in the form of men whose exchange organization delivers social prestige (Strathern 1969, 1971; Liep 1991; Ziegler 2012). Let us add that the monopolization of the long-distance exchange towards a narrow circle of powerful men is one of the basic mechanisms of the formation of social complexities (Terray 1974; Earle 1999).

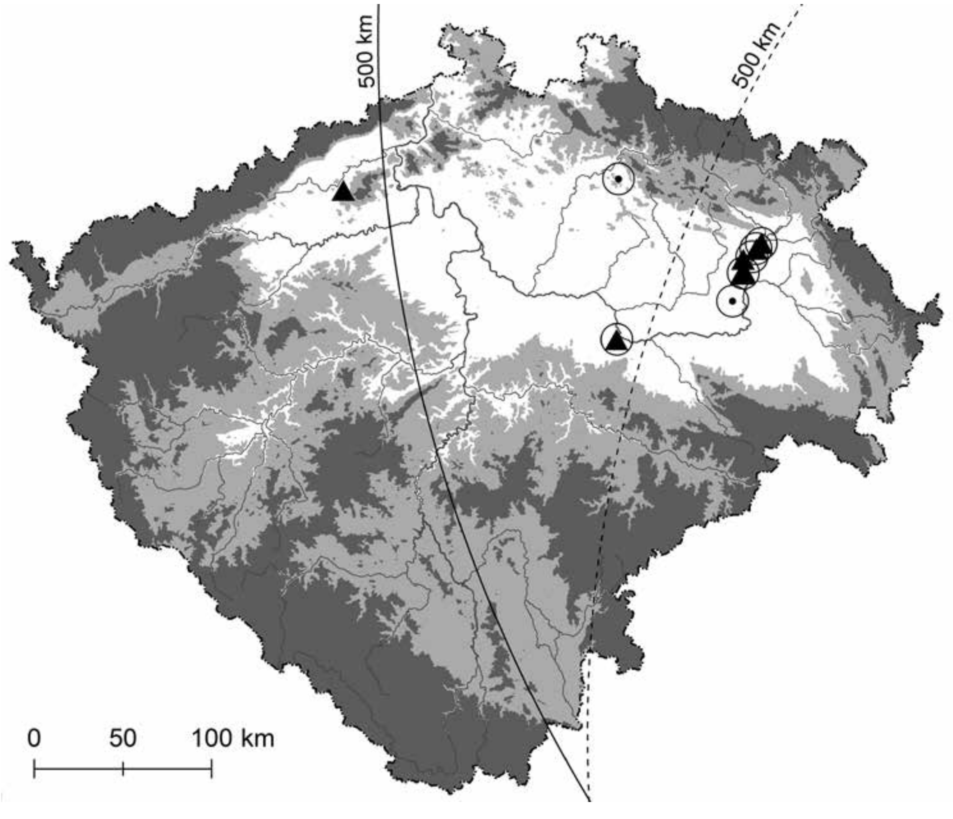

Fig. 6. Spatial distribution of finds of 'chocolate' silicite (triangles) and obsidian (circles) in the late phase of the stroked pottery culture (SBK IV). Continuous line circle: 500 km distance from 'chocolate' silicite sources; dotted line circle: 500 km distance from Carpathian obsidian sources. Drawn: P. Burgert.

We believe that on the basis of the facts mentioned above it is possible to assume that 'chocolate' silicite had an exceptional position within the framework of stone raw materials in the Late Neolithic environment in Bohemia, which excluded its purely utilitarian function. It is very likely that this raw material, and tools made from it, can be included in a group of status-enhancing symbols, which make it possible to identify the presence of individuals or groups of exceptional social status.

The status of 'chocolate' silicite defined in this manner can be compared to that of other exotic raw materials, especially Carpathian obsidian. The chronological and distributional position of both these raw materials in Czech prehistory seems to be identical (Burgert *et al.*, 2016). The occurrence of obsidian in Czech prehistory also culminates in the SBK IV period and its finds also concentrate in the area of Eastern Bohemia, specifically on the right bank of the Elbe (Fig. 6). This is also where the only two workshops in Bohemia are located in which the obsidian was chipped directly from its initial form of lump. The distance from the original sources is roughly the same for both materials and in Bohemia this is about 500 km. As with 'chocolate' silicite, we expect a similar social status in terms of the Carpathian obsidian in Bohemia. We came to this conclusion on the basis of their fundamentally identical attributes (Burgert 2015a).

CONCLUSION

In Czech prehistory, 'chocolate' silicite is one of a number of types of objects of long-distance exchange, for which we use the term 'exotic raw materials'. Its occurrence in prehistoric assemblages can be observed there from the Late Palaeolithic/Mesolithic to the late Neolithic (Table 1). Later finds (an arrowheads from grave of Bell Beaker culture and silicite dagger from the early Bronze Age) are extremely scarce. The distribution of this raw material culminates in the period of the later phase of the Stroke-Ornamented Ware culture (SBK IV). During this period, the finds are concentrated in the area of Eastern Bohemia, namely in the area of the right bank of the Elbe River in the section between today's towns of Jaroměř in the north and Hradec Králové in the south (Fig. 4). The share of this raw material in ordinary settlement complexes does not exceed two per cent and generally it is lower.

In the area of its greatest concentration, the finds of other exotic raw materials, especially obsidian, are also concentrated within the same time horizon. At the same time, we can observe a strong contemporary settlement density, accompanied by Circular Enclosures and groups of graves. This concerns both Eastern Bohemia and the area of Kolín, where there is also one minor accumulation of 'chocolate' silicite in the same period, in the later phase of SBK.

'Chocolate' silicite appears almost exclusively in the form of blades and tools in the settlement assemblages of lithic items. This fact suggests a specific form of distribution of this raw material. We currently know only one site in Bohemia where this raw material was processed in a workshop. This distribution scheme points to the specific social status of this raw material, which is also indicated by the presence of this raw material in grave finds.

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REFERENCES

Balcer, B. 1976. Position and Stratigraphy of Flint Deposits, Development of Exploitation and Importance of Świeciechów Flint in Prehistory. *Archaeologica Carpathica* 19: 179–199.

Bertemes, F. and Meller, H. (eds), 2004. *Neolithische Kreisgrabenanlagen in Europa – Neolithic Circular Enclosures in Europe. Internationale Arbeitstagung vom 7. bis 9. Mai 2004 in Goseck*. Halle, Tagungen des Landesmuseums für Vorgeschichte Halle.

Biró, K. T. 2014. Carpathian Obsidians: State of Art. In M. Yamada and A. Ono (eds), *Lithic raw material exploitation and circulation in Prehistory. A comparative perspective in diverse palaeoenvironments*, 47–69. Liège, ERAUL 138.

Budziszewski, J. 2008. Stan badań nad występowaniem i pradziejową eksploatacją krzemieni czekoladowych. In: W. Borkowski, J. Libera, B. Sałacińska and S. Sałaciński (eds), *Krzemień czekoladowy w pradziejach*, 33–106. Lublin-Warszawa, Studia nad gospodarką surowcami krzemiennymi w pradziejach 7.

Burgert, P. 2015a. Štípaná industrie z obsidiánu v Čechách. *Archeologické rozhledy* 67: 239–266.

Burgert, P. 2015b. „Stabilitas loci" of inhabitants of the Stroked Pottery site in Jaroměř. *Anthropologie* 53(3): 476–483.

Burgert, P. 2017. *Struktura a chronologie sídlišť kultury s vypíchanou keramikou ve východních Čechách*. Unpublished PhD thesis, Charles University in Prague.

Burgert, P., Vokolek, V. and Řídký, J. 2016. Prostorová analýza a datace dvou ohrazení v sídelním areálu z mladšího neolitu v Plotištích nad Labem, okr. Hradec Králové. *Archeologie ve středních Čechách* 20: 925–933.

Borkowski, W., Libera, J., Sałacińska, B. and Sałaciński, S. 2008 (eds), *Krzemień czekoladowy w pradziejach*. Studia nad gospodarką surowcami krzemiennymi w pradziejach 7. Warszawa – Lublin.

Čuláková, K. 2015. *Příspěvek k poznání mezolitického osídlení Čech*. Unpublished PhD thesis, Charles University in Prague.

Earle, T. 1999. Production and exchange in prehistory. In G. Barker (ed.), *Companion encyclopedia of archaeology*, 608–636. London, Routledge.

Hodder, I. 1982. *Symbolic and structural archaeology*. Cambridge.

Končelová, M. and Květina, P. 2015. Neolithic longhouse seen as a witness of cultural change in the post-LBK. *Anthropologie* 53(3): 431–446.

Lech, J. 1989. A Danubian raw material exchange network: a case study from Bylany. In J. Rulf (ed.), *Bylany seminar 1987. Collected Papers*, 111–120. Praha.

Liep, J. 1991. Great Man, Big Man, Chief: A Triangulation of the Massim. In M. Godelier, and M. Strathern (eds), *Big men and great men. Personifications of power in Melanesia*, 28–47. Cambridge, Cambridge University Press.

Pavlů, I. and Vokolek, V. 1996. The Neolithic Settlement at Holohlavy (Hradec Králové). *Památky archeologické* 87: 5–60.

Mateiciucová, I. 2008. *Talking Stones: The Chipped Stone Industry in Lower Austria and Moravia and the Beginnings of the Neolithic in Central Europe (LBK), 5700–4900*. Praha – Brno, Dissertationes Archaeologicae Brunenses/Pragensesque 4.

Popelka, M. 1999. K problematice štípané industrie v neolitu Čech. *Praehistorica* 24: 7–122.

Přichystal, A. 1985. Štípaná industrie z neolitického sídliště v Bylanech (okr. Kutná Hora) z hlediska použitých surovin a jejich provenience. *Archeologické rozhledy* 37: 481–488.

Přichystal, A. 1998. Kamenné suroviny z pozdně paleolitické lokality ve Světlé nad Sázavou. *Archeologické rozhledy* 50: 357–358.

Přichystal, A. 2000. Petrographische Bestimmung der Rohstoffe der gespaltenen Artefakte von der mesolit. Station in Hořín, Bez. Mělník. In K. Sklenář (ed.), *Hořín III*, 41–45. Fontes Archaeologici Pragenses 24.

Přichystal, A. and Šebela, L. 2009. Příspěvek k poznání kamenné štípané industrie z pohřebiště kultury zvoncovitých pohárů v Praze – Velké Chuchli. *Archeologie ve středních Čechách* 13(2): 683–686.

Renfrew, C. and Bahn, P. 2000. *Archaeology. Theories, Method and Practice*. London.

Schild, R. 1971. Lokalizacja prahistorycznych punktów eksploatacji krzemienia „czekoladowego" na północno-wschodnim obrzeżeniu Gór Świętokrzyskich. *Folia Quaternaria* 39: 1–60.

Schild, R. 1976. Flint mining and trade in polish prehistory as seen from the perspective of chocolate flint of central Poland. A second approach. *Acta Archaeologica Carpathica* 16: 147–177.

Schild, R. 1995. Tomaszów I, Radom Province. *Archaeologia Polona* 33: 480–488.

Schild, R., Królik, H. and Marczak, M. 1985. *Kopalnia krzemienia czekoladowego w Tomaszowie*. Wrocław – Warszawa – Kraków – Gdańsk – Łódź.

Strathern, A. 1969. Finance nad production: Two strategies in New Guinea Highlands exchange systems. *Oceania* 40(1): 42–67. doi:10.1002/j.1834-4461.1969.tb01056.x.

Strathern, A. 1971. *The rope of moka. Big-men and ceremonial exchange in Mount Hagen, New Guinea*. Cambridge, Cambridge University Press. Cambridge studies in social anthropology 4.

Šebela, L. and Přichystal, A. 2014. Silicitové dýky na území České a Slovenské republiky. Předběžná studie. *Studia Archaeologica Brunensia* 19: 67–94.

Šída, P. 2006. Distribuční areály surovin v neolitu na území České republiky. *Archeologické rozhledy* 58: 407–426.

Terray, E. 1974. Long-distance exchange and the formation of the State: the case of the Abron kingdom of Gyaman. *Economy and Society* 3(3): 315–345. doi:10.1080/03085147400000016.

Vávra, M. 1993. Neolitická plastika z Černožic. *Archeologické rozhledy* 45: 212–220.

Vencl, S. 1971. Současný stav poznání postmesolitických štípaných industrií v Československu. In: J. K. Kozłowski (ed.), *Z badań nad krzemieniarstwem neolitycznym i eneolitycznym*, 74–99. Kraków.

Vencl, S. 1978. Voletiny – nová pozdně paleolitická industrie z Čech. *Památky archeologické* 69: 1–44.

Vencl, S. 1997. Bemerkungen zur Steinindustrie. In V. Vokolek and M. Zápotocká, *Neolithische Gräber und Gräberfelder in Plotiště n. L. und Předměřice n. L., Bezirk Hradec Králové*, 5–55. *Památky archeologické* 88.

Vencl, S. (ed.) 2006. *Nejstarší osídlení jižních Čech*. Praha.

Werra, D. H., Siuda, R., Grafka, O. and Segit, T. 2015. Pierwsze próby charakterystyki geochemicznej i palinologicznej krzemienia „czekoladowego" z kopalni Wierzbica „Zele", pow. Radom. *Acta Universitatis Nicolai Copernici, Archeologia* 34: 249–270.

Zápotocká, M. 1998a. Die chronologische und geographische Gliederung der postlinearkeramischen Kulturgruppen mit Stichverzierung. In J. Preuss (ed.), *Das Neolithikum in Mitteleuropa. Kulturen – Wirtschaft – Umwelt vom 6. bis 3. Jahrtausend v. u. Z.* Band 1/2, 286–306. Weissbach, Beier & Beran.

Zápotocká, M. 1998b. *Bestattungsritus des Böhmischen Neolithikums (5500–4200 B.C). Gräber und Bestattungen der Kultur mit Linear-, Stichband- und Lengyelkeramik*. Praha.

Zápotocká, M. and Vokolek, V. 1997. Die neolithische Gräber und Gräberfeld in Plotiště N. L. und Předměřice n. L., Bezirk Hradec Králové. *Památky archeologické* 88: 5–55.

Ziegler, R. 2012. The Kula Ring of Bronislaw Malinowski: Co-evolution of an Economic and Ceremonial Exchange System. *Review of European Studies* 4(1): 15–27.

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Three Stories About the Exploitation of 'Chocolate' Flint During the Stone Age in Central Poland

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This paper argues that, despite the purely physical nature of the process of the creation of blades that later will be components of multi-material tools, this is also like an artistic act. If this is so, the manner in which we discuss the sequence of blade production can be analysed in much the same way as any other narrative works of art, like Greek literature or Shakespearean drama. The article presents three stories about cores that were used for production of blades for tools during the Stone Age, examining the systematic sequence of actions (like the choice of the raw material, core preparation, blade production, repairs of core and discarding of the exhausted core) in the form of a 5-act dramatic structure. We suggest that these five parts or acts of drama are similar to the manner in which, in Stone Age archaeology, we talk about the knapping sequence and goals of blade production. Observation of three blade cores connected with the late Mesolithic and the Early and Middle Neolithic from the central part of Poland provides an opportunity for discussion about the features of those pieces and searching for similarities and differences in the use of 'chocolate' flint during the latter part of the Stone Age.

KEY-WORDS: Late Mesolithic, Linear Band Pottery culture, Funnel Beaker culture, 'chocolate' flint, blade core

INTRODUCTION

'Chocolate' flint has very good qualities and was very often used for tool production during the Stone Age in Poland. The shape, size and internal features of that raw material caused its popularity in prehistory (Schild *et al.*, 1985; Budziszewski 2008). In our paper, we would like to present three stories about the manner of use of that raw material in the latter part of the Stone Age, analysed in the same manner as a five-act drama or short story according to the well-known methodology adopted by Gustav Freytag (1900). The creation of blades that later would become components of multi-material tools, despite the purely physical nature of the process, is like an artistic act.

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Just as in the discussion of other works of art, like cave painting or modern music, the story of their production can be analysed as such in the same way as Greek literature (as Aristotle did in his '*Poetics*') or Shakespearean drama. We think that the systematic sequence of actions in the knapping process (like the choice of the raw material, core preparation, blade production, repairs of core and discarding of the exhausted core) resembles a 5-act dramatic structure. We argue that these five parts or acts of drama are similar to the manner in which, in Stone Age archaeology, we talk about the knapping sequence and goals of blade production.

We will focus on blade cores, which are an important component of the knapping sequence; the material used as an example in our analysis are three cores of the late

Fig. 1. Location of analysed sites. Red dots – location of mentioned sites: 1–Redecz Krukowy, Włocławek distr.; 2–Brześć Kujawski, Włocławek distr.; 3–Ponikła Fryszerka, Opoczno distr. Drawn: D. K. Płaza.

Mesolithic Janislavice culture, early Neolithic Linear Band Pottery culture and middle Neolithic Funnel Beaker culture. In our opinion, these objects have clear features that could help with defining similarities or differences between those items and give suggestions about manner and goals of flint exploitation in the latter part of the Stone Age. We will discuss three 'chocolate' flint cores from three localities situated in central part of Poland – Ponikła Fryszerka, Opoczno district (Cyrek 1979), Brześć Kujawski (Grygiel 2004) and Redecz Krukowy, Włocławek district (Papiernik 2012).

1. EXPOSITION – THE SITES.

The first, Mesolithic, core was discovered on the right bank of the valley of the Pilica River somewhere between the villages Ponikła and Fryszerka (Opoczno district), where a small stream, the Cetenka, joins the river. The site is situated on sandy plain and nowadays most of the terrain is covered by woods (Fig. 2). The single platform core

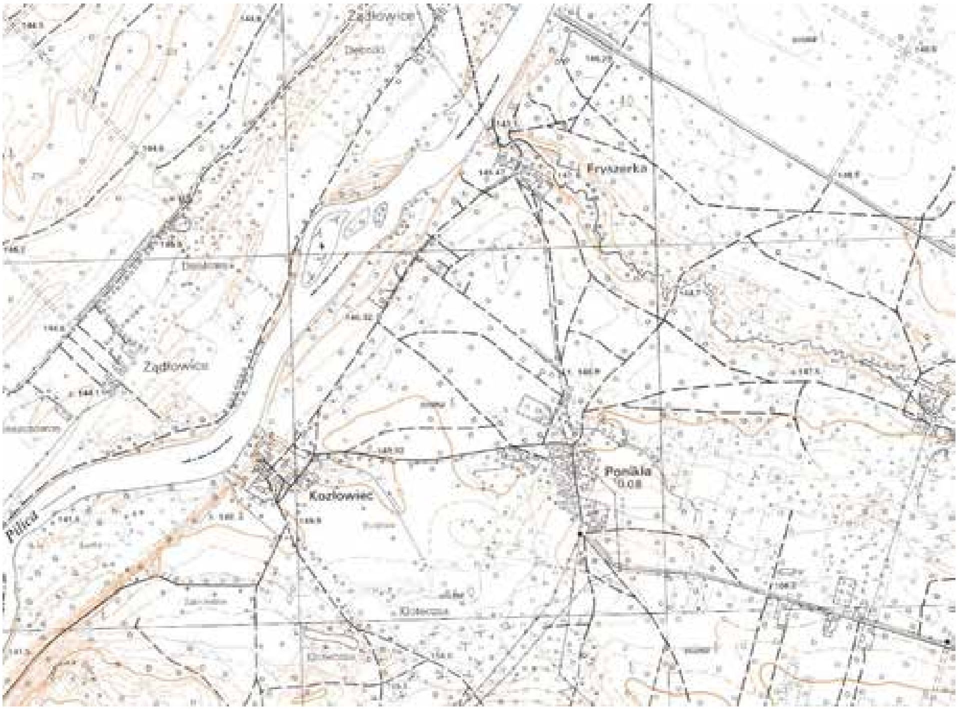

Fig. 2. Location of Ponikła and Fryszerka villages, Opoczno distr. Computer graphics: D. K. Płaza.

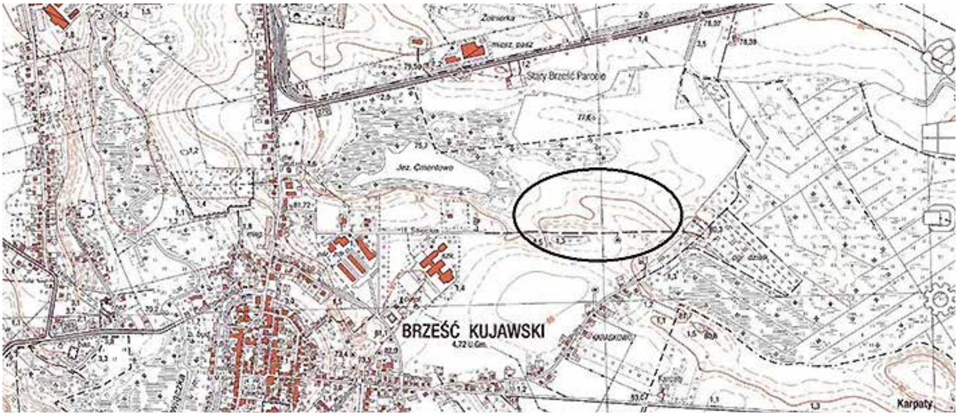

Fig. 3. Location of sites in Brześć Kujawski, Włocławek distr. Computer graphics: D. K. Płaza.

comes from field walking studies and it could be defined as an accidental find (Fig. 6). Due to characteristic features, there are no doubts that this core has late Mesolithic chronology (Cyrek 1979; Wąs 2005).

The second, early Neolithic, core was excavated from pit 592 on the Brześć Kujawski site 3, Włocławek district. This site is situated in middle part of Kuyavia and was discovered by Konrad Jażdżewski in 1933 and first explored by Stanisław Madajski in 1937. Subsequent excavations were carried out here forty years later, in 1977/1978 by Ryszard Grygiel together with Peter Bogucki (Grygiel 2004). Site 3 is a fragment of very famous large complex of early Neolithic settlement sites (number 3, 4 and 5) located in Brześć Kujawski on the southern bank of Smętowo Lake (Fig. 3). The site is situated on postglacial clay in which Neolithic farmers dug many pits where they finally threw garbage. A total area of 1975 square meters was excavated and, among the features discovered, 14 pits and 2 graves were linked with the Linear Band Pottery culture. One feature (pit 592), was a large clay pit with several niches that contained little amount of Early Neolithic materials including only six flint pieces but four of them were made from 'chocolate' flint. In one of the niches of this pit, a blade core in an advanced stage of exploitation with a single striking platform for striking blades and second platform used to produce flakes was discovered (Grygiel 2004: 170; Fig. 7).

The third, middle Neolithic, core come from most recent excavation which were conducted between 2006 and 2010 in Redecz Krukowy, Włocławek district (Papiernik 2012; Fig. 4). Materials dated from the Mesolithic to modern time were discovered on this multicultural site. The site is situated on aeolian sand in which fossil soils were discovered. During five field seasons, together more than 13 months in the field, an area of 7487 square metres was excavated (Papiernik and Płaza 2015). The site produced a huge amount of archaeological material, with more than 140,000 pottery fragments and around 25,000 flint pieces. Most of this material belonged to the earliest phase of the Funnel Beaker

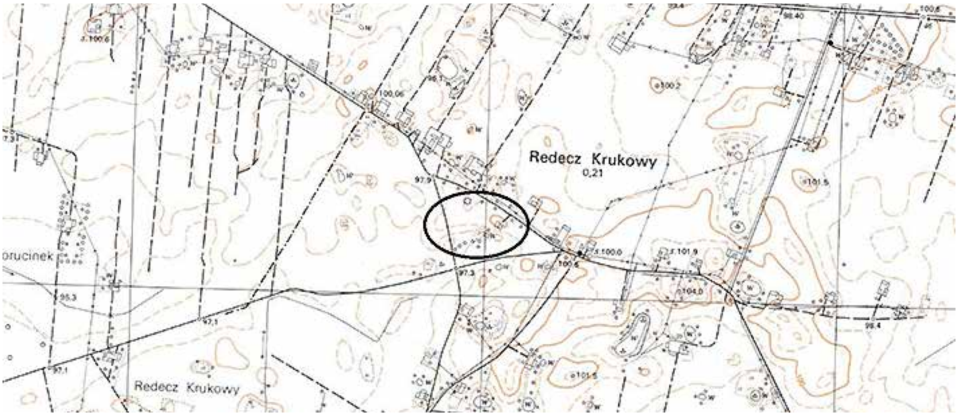

Fig. 4. Location of Redecz Krukowy site 20, Włocławek distr. Computer graphics: D. K. Płaza.

Culture (end of the V millennia and beginning of IV millennia BC). The assemblage of lithic raw materials is similar to other early Funnel Beaker culture sites (Niesiołowska 1981, 1986), with the domination of 'chocolate' flint. One of the most mysterious objects made from that material is a large single platform blade core in the early stages of blade exploitation (Fig. 8), which is one of the subjects of this article. It was discovered in the remains of the yard of one of the 'Sarnowo phase' house (Papiernik 2012).

2. RISING ACTION – THEORETICAL ASPECTS OF BLADE CORE ANALYSIS.

Cores in general have a fundamental role in the *chaine operatoire* during lithic tool production. They come in a great variety of shapes, sizes and raw material and could be divided into formalized and informal cores (Andrefsky 2005). The formal core goes through a complicated process of preparation of angles, edges and surfaces. The informal type can be knapped without preparation in an opportunistic manner. From both cores is possible to obtain a good products, but the formalized core could give more easily be used to produce a series of similar, uniform pieces. A number of the side-products from core preparation also gave the chance for the production of other casual type of tools.

In the case of the three examples analysed here, they could all be classified as prepared, formal cores. They all exhibit visible traces of the stage of preparation, (shaping) which was followed by the striking of the opening blade and then serially produced blades.

Our idea is to analyse and compare the features on all three cores. For this reason we will divide the idealised single platform blade core (Fig. 5) into several sections that

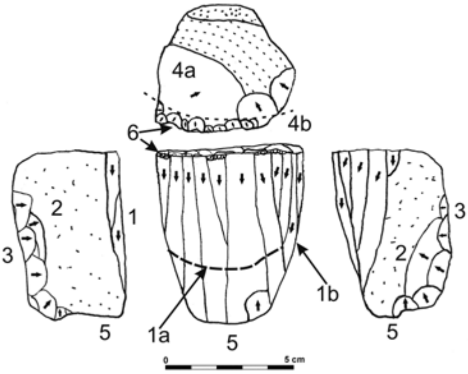

Fig. 5. Schematic core with described features and zones. Drawn: D. K. Płaza.

will be described and compared in the case of the actual archaeological artefacts. We will also analyse the dimensions and weight of all three pieces.

Each blade or flake core has to have clear features and zones like the flaking (debitage) surface with blade or flake negatives and ridges, a striking platform with traces of tablets or rejuvenation flake negatives, the sides sometimes with cortex, and the tip (Inizan *et al.*, 1999).

In our ideal core (Fig. 5) we defined several zones:

- Frontal zone – flaking surface with active (Fig. 5:1a) and passive part (Fig. 5:1b),
- Two side zones (Fig. 5:2)
- Back zone (Fig. 5:3)
- Upper zone – striking platform (Fig. 5:4) with active (Fig. 5:1) and passive zone (Fig. 5:2; Wąs 2005)
- Lower zone – tip or prepared (Fig. 5:5).

In each active zone, there could be also observed micro-technological features like trimming, or abrasion (Fig. 5:6; Inizan *et al.*, 1999). Another very interesting feature on the blade core is a horizontal curvature (Owen 1988; Wąs 2011: Fig. 2) which determines the width and depth of the active part of the flaking surface.

3. CLIMAX – RESULTS OF ANALYSIS

First story – Core for microlithic arrowheads?

The Mesolitihic core (Fig. 6) has a very regular – conical and symmetrical shape with the lower zone in the shape of a tip. It has a rectangular almost flat upper zone (striking platform) with just few irregularities on the edges, which are traces of the last blades that were struck from the core. Negatives of rejuvenation flakes cover almost 90% of that part. The active zone was less than 1 cm across and is located very close to the point of impact. On the frontal flaking surface and one side zone are visible

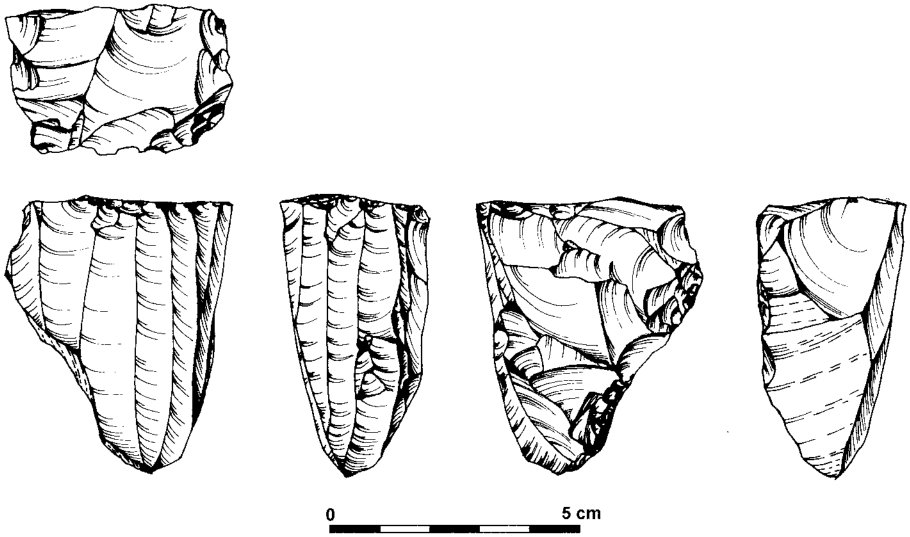

Fig. 6. Ponikła Fryszerka, Opoczno distr., late Mesolithic core of Janislavice culture. Drawn: E. Górska.

regular parallel negatives left by the flaking of long and narrow blades. The broader frontal surface for extracting blades was used last and it could be named the active part. The narrower right side of the core should be considered the passive striking platform, which is confirmed by shortened negatives of blade from an earlier stage of blade production. At that stage, the longest blade was more than 5 cm long (Table 1). Such a result indicates that it is not an exhausted core. There are 11 visible negatives of blades. The widths of the negatives after last blades are 0.81 cm and 1.21 cm. The ratio of the horizontal curvature of the core is 7.88. The random indirect goal of the use of that core could be the creation of a bullet-shaped core but due to irregularity on the back zone and left side it was quite difficult to obtain that advanced shape of the core.

The direct goal of exploitation of that core was the production of long, regular and narrow blades which could be transformed into geometric microlithic arrow inserts, such as triangles or other type of Mesolithic Janislavice Culture points (Chmielewska 1954; Kozłowski 1989). Other parts of the core could give short flakes which could also be transformed into some ordinary tools.

Second story – Core for sickles?

The Early Neolithic core (Fig. 7) has quite a regular outline but less than the Mesolithic example. It has an irregular striking platform – the upper zone - with several medium and deep negatives after rejuvenation flake. An attempt was made to remove the irregularity on the top of the core by several flakes, but this was ineffective and resulted in several deep hinged flake negatives. The lack of success of this procedure

Table. 1. Features of analysed cores.

Sites information	Location	Ponikła Fryszerka, Opoczno district	Brześć Kujawski, Włocłwek district	Redecz Krukowy, Włocławek district
	Site number		3	20
	Chronology	Mesolithic	Early Neolithic	Middle Neolihic
Dimensions	Dimensions max lenght, width, height.	lenght – 5.49 cm, width – 2.88 cm, height – 4.23 cm	lenght – 7.05 cm, width – 5.41 cm, height – 5.42 cm	lenght – 10.35 cm, width – 6.61 cm, height – 9.73 cm
	Ratio max lenght x weight – size value (Andrefsky 2005)	5.49 cm x 81 g = 444.69	7.05 cm x 174 g = 1226.1	10.35 cm x 867 g = 8973.45
	Ratio max lenght : weight – size value	5.49 cm ÷ 81 g x 100 = 6.77	7.05 cm ÷ 174 g x 100 = 4.05	10.35 cm ÷ 867 g x 100 = 1.19
	Ratio Horizontal curvature (in cm)	3.31 ÷ 0.42 = 7.88	5.41 ÷ 1.98 = 2.73	5.51÷ 2.82 = 1.95
General information	Shape from frontal zone	Conical	Squer	Rectangular
	Angle between front and upper zone	between 80 – 90 degrees	around 80 degress	around 80 degress
	Type of core	Single platform microblade core	Single platform blade core	Single platform blade core
	Number of flaking surface	1 – double sided	2	1
Frontal zone	Technical features	Partially abrasion and facetted	Point abrasion	Point abrasion
	System of negatives	Parallel	Parallel	Parallel
	Longest blade	5.49 cm	4.61 cm	8.45 cm
	Regularity and riples	Streight, very regular. Ripples hard to see.	Streight, irregular in middle and upper section. Ripples visible.	Streight, very regular. Ripples hard to see.
Left side zone	Negatives / cortex	One flake and natural surface	Cortex	Partial cortex and flake negatives
	Direction of negatives	Parallel to other parts of core	No negatives	Multidirectional
	Shape	Conical	Trapezoid	Trapezoid
Right side zone	Negatives / cortex	Microblade negatives	Negatives of preparation flake	Partial cortex, blade and flake negatives
	direction of negatives	Oblique to other parts of the core	Multidirectional	Mostly parallel. One flake from oposit side
	Shape	Conical	Trapezoid	Sub-conical

Upper zone	Number of striking platform	1	2	1
	Technical features	Passive zone with large flake negatives, active zone small flake negatives	Rejuvenation flake negatives	Active zone with rejuvenation flake, passive zone natural
	System of negatives	Multidirectional	Only frontal direction	Only frontal direction
	Shape	Rectangular	Oval	Oval
Back zone	Negatives / cortex	Negatives of preparation flake	Edge	Partly natural and edge
	Direction of negatives	Multidirectional	Edge	One side – left
	Shape	Triangle	Edge	Flat – natural and edge
Lower zone	Direction of negatives	No	One side	Rohmboid
	Shape	Tip	Trapezoid	Multidirection

could have been one of the reasons for discarding that core. On the flaking surface, in the frontal zone are visible several quite parallel but not very regular flake negatives left by the removal of varied blades, there are 10 visible negatives. The widths of the flake negatives from the last blades are 0.97 cm and 1.77 cm. The ratio of the horizontal curvature of the core is 2.72. In this core only one flaking surface for blade production was used on the frontal side. It has semicircular convex shape. At that stage, the longest blade was less than 5 cm long (Table 1). Such a result indicates that it should be considered to be an exhausted core. The left zone is fully covered in cortex and the right zone has visible negatives of preparation flaking. The back zone is formed as an edge. One of the most important points was the narrow flat basal part – the lower zone that determined the form of the produced blades. This zone was shaped with two large flakes made at quite an early stage of exploitation.

The blades were not so long, quite broad and had a rectangular end. That kind of blade was the direct goal of production. Such a blade was most important in the further transformation into tools like truncation or endscrapers rather than those used, among others, to produce sickle inserts in the Linear Band Pottery culture (Siciński *et al.*, 2016).

Third story – Core for a long knife?

The Middle Neolithic core (Fig. 8) has very regular form even that it was discarded in quite an early stage of exploitation. Its striking platform has a regular shape and is flat, the upper zone has 10 medium and small, rather flat negatives after rejuvenation flake]which create the short active part of that zone. Most of the upper zone is natural and could be classified as a passive part. There are parallel and regular negatives from the

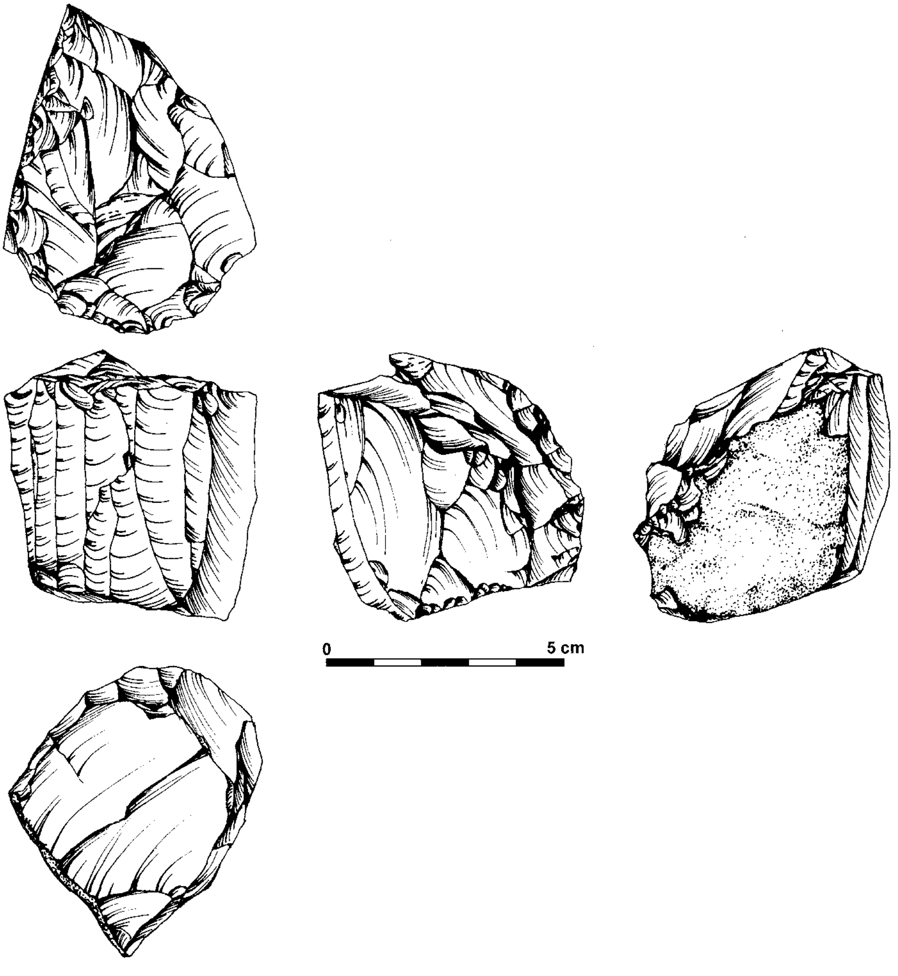

Fig. 7. Brześć Kujawski, Włocławek distr., early Neolithic core of Linear Band Pottery culture. Drawn: E. Górska.

production of long blades visible on the flaking surface – the frontal zone. There are 8 visible negatives of blades in this part. The width of the last blades negatives are 1.61 cm and 1.93 cm. On that core, only one rather narrow flaking surface for blade production was used on the frontal zone. The ratio of the horizontal curvature of the core is 1.95. After reduction of bottom zone, it has a rectangular semi-oval shape. At that stage, the longest blade was more than 8 cm long (Table 1). That observation indicates that this core was discarded at the early stage of blade production. Both left and right zone are similar with preserved traces of the preparation stage when cortical flakes were produced.

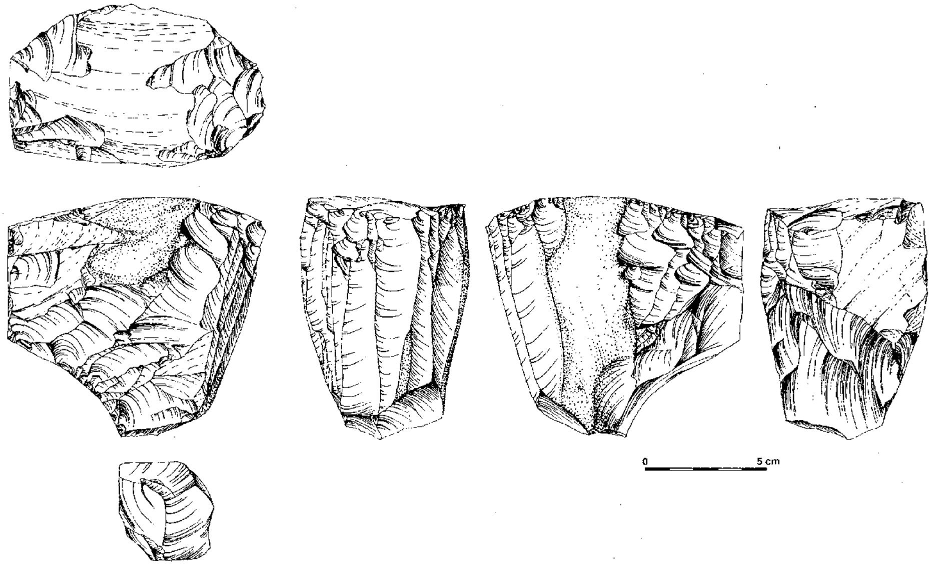

Fig. 8. Redecz Krukowy, Włocławek distr., middle Neolithic core of Funnel Beaker Culture. Drawn: E. Górska.

It is important to note that among several thousand flakes from this site, there was not a single one that could be refitted to this core (Papiernik and Płaza 2015). This could indicate that the core underwent the preparation procedure in a different place from the site in Redecz Krukowy. The back zone was formed as an edge with a small part left in natural surface condition. In that case, another important point was the prepared basal part – the lower zone that determined the shape of the produced blades. It was shaped by at least three flakes.

Due to the broad lower zone, blades were long enough and not plunging (Inizan *et al.*, 1999: Fig. 149–150). Producing that kind of straight, regular blade was the main and only goal in the use of this core. Blades of that type were useful for transformation into tools like the knives, endscrapers or sickle inserts used in Funnel Beaker culture. The most important fact is that, in our opinion, the core discussed here, and most of the blades at Redecz Krukowy had been made in another place, maybe near the outcrops of 'chocolate' flint.

4. FALLING ACTIONS – SIMILARITIES AND DIFFERENCES

In general overview, the three cores are very similar, but precise study points to clear and significant differences between them in almost all the defined zones. The analysed pieces are all single platform blade cores with traces of impact on the striking platform (zone 1; Fig. 4:1). The first important difference is located in that zone. On the Mesolithic core, soft and delicate traces of trimming together with short flake negatives from core-rejuvenation flakes are seen in the active zone. Earlier large preparation flaking created the passive zone of the striking platform. On the Early Neolithic core, there are traces of extremely strong, multidirectional impacts. It is difficult to separate an active and passive zone of the striking platform in the case of this core. The core of the Funnel Beaker culture however has a clear division between the active and passive sections with quite a similar ratio of horizontal curvature to early Neolithic core from Brzesc Kujawski. The flaking surface on the Funnel Beaker culture core are rather similar to early Neolithic core without division into passive and active zones in that part. On blades from such a core, the ridges should have parallel negatives. In contrast, the Mesolithic core has that zone – flaking surface separated into two sides that define an active and passive section. When the passive zone would be transformed into an active one, the negatives on the first blade would be diagonal, with some elements of the older active part preserved. Also the blade negatives left by the last blades of the earlier part are more regular and narrow, which reflect production of blades further used as arrow or harpoon inserts.

The back of the Mesolithic example looks like a flat prepared surface, triangular in shape. Both the Early Neolithic and Middle Neolithic ones have backs formed as an edge.

The lower part in both Neolithic cores looks similar and is formed as a rather flat surface with several flakes and that of the Mesolithic core has a conical shape, so the lower part is formed as a tip. The use of micro-technological features like trimming, or abrasion is also significant. It was most important on the Mesolithic core, but both Neolithic examples have less clear traces of that procedure.

5. EPILOGUE – CONCLUDING REMARKS

The above comments about blade cores show the complications of the story of the use of cores in the latter part of the Stone Age in the Polish lowlands. The three cores have many common features and some very important differences. One clear difference which has not been mentioned before are the overall dimensions which differentiate all three examples (Fig. 9; Table 1).

One of the reasons that induced us to undertake this work was the necessity to present the features of the Funnel Beaker culture blade core from Redecz Krukowy. Our inspiration was a paper of 2011 of Marcin Wąs, and the information supplied here can be treated as a supplement to his work. He considered flint materials connected with two cultural units, the Janislavice Culture and Linear Band Pottery culture, and concluded that those societies had two different conceptions of blade production. This statement was supported by the clearly different strategy of half-raw material

Fig. 9. Photo of the analysed cores: a – Redecz Krukowy, Włocławek distr.; b – Brześć Kujawski, Włocławek distr.; c – Ponikła Fryszerka, Opoczno distr. Photo: W. Pohorecki.

use, and use of blades and tools. Our studies of the blade core from Redecz Krukowy supplement our knowledge about the use of 'chocolate' flint during the Stone Age and shows another strategy and behaviour connected with flint processing and the use of tools. In our opinion, the core has more features in common with the 'Danube culture flintknapping strategy' than with the 'Mesolithic flintknapping strategy'.

The main question about the Redecz Krukowy 'chocolate' flint materials is whether the Funnel Beaker culture farmers could process that kind of flint for blades by themselves in the Polish lowlands. We hope that the answer will come in monographic presentation of the site soon.

REFERENCES

Andrefsky, W. Jr. 1998. Lithics*: Macroscopic Approaches to Analysis*. Cambridge, Cambridge Manuals in Archaeology.

Budziszewski, J. 2008. Stan badań nad występowaniem i pradziejową eksploatacją krzemieni czekoladowych. In W. Borkowski, J. Libera, B. Sałacińska and S. Sałaciński (eds), *Krzemień czekoladowy w pradziejach. Materiały z konferencji w Orońsku, 08–10.10.2003*, 33–106. Warszawa–Lublin, Studia nad Gospodarką surowcami krzemiennymi w pradziejach 7.

Cyrek, M. 1979. Schyłkowo paleolityczne i mezolityczne materiały krzemienne z badań powierzchniowych nad Pilicą. *Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi, Seria archeologiczna* 26: 5–40.

Freytag, G. 1900. *Freytag's Technique of the Drama, An Exposition of Dramatic Composition and Art by Dr. Gustav Freytag: An Authorized Translation From the Sixth German Edition by Elias J. MacEwan, M.A. (3rd ed.)*. Chicago, Scott, Foresman and Company.

Grygiel, R. 2004. *Neolit i początki epoki brązu w rejonie Brześcia Kujawskiego i Osłonek. Volume 1: Wczesny* neolit. *Kultura ceramiki wstęgowej rytej*. Łódź.

Inizan, M.-L., Reduron-Ballinger M., Roche H. and Tixier, J. 1999. *Technology and Terminology of Knapped Stone*. Nanterre, C.R.E.P.

Kozłowski, S.K. 1989. *Mesolithic in Poland*. Warszawa.

Niesiołowska, E. 1981. Niektóre problemy związane z materiałami krzemiennymi kultury pucharów lejkowatych z fazy AB, pochodzącymi z grobowca 8 w Sarnowie, woj. włocławskim. In T. Wiślański (ed.), *Kultura pucharów lejkowatych w Polsce (studia i materiały)*, 37–57. Poznań.

Niesiołowska, E. 1986. Materiały krzemienne z grobowca 9 w Sarnowie, województwo włocławskie, na tle fazy sarnowskiej KPL. *Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi. Seria Archeologiczna* 33, 23–48.

Owen, L. 1988. *Blade and Microblade Technology. Selected Assemblages from the North American Arctic and the Upper Paleolithic of Southwest Germany*. Oxford, British Archaeological Reports, International Series 441.

Papiernik, P. 2012 (2010–2012). Sprawozdanie z badań wykopaliskowych na stanowisku 20 w Redczu Krukowym, pow. włocławski, woj. kujawsko-pomorskie. *Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi. Seria Archeologiczna* 45: 195–238.

Papiernik, P. and Płaza D.K. 2015. Zagospodarowanie przestrzeni w środkowej i młodszej epoce kamienia na stanowisku Redecz Krukowy 20, gm. Brześć Kujawski, woj. kujawsko-pomorskie, w świetle metody składanek. *Acta Universitatis Nicolai Copernici Archeologia* 34: 217–236

Schild, R., Królik, H. and Marczak, M. 1985. *Kopalnia krzemienia czekoladowego w Tomaszowie*. Wrocław–Warszawa–Kraków–Gdańsk.

Siciński, W., Płaza, D.K. and Papiernik, P. 2016. *Ratownicze badania archeologiczne na stanowisku 10 w Kruszynie, pow. włocławek, woj. kujawsko-pomorskie (trasa autostrady A–1)*. Łódź.

Wąs, M. 2005. Technologia krzemieniarstwa kultury janisławickiej. *Monografie Instytutu Archeologii Uniwersytetu Łódzkiego*, Vol. III. Łódź.

Wąs, M. 2011. „Janisławickie" i „wstęgowe" koncepcje rdzeniowania wiórowego. Próba konfrontacji technologicznej. *Folia Archaeologica* 28: 5–23.

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Contribution to Understanding the Distribution of 'Chocolate' Flint on the Polish Lowlands in the Early Neolithic: Kruszyn, Site 13

Jacek Kabaciński[a]

'Chocolate' flint was the main raw material used by the Early Neolithic Linear Band Culture (LBK) groups in the Polish Lowlands. Since the second (note) phase of the development of this culture, the early farmers developed a complex system of distribution of 'chocolate' flint within the great-valleys zone of the Lowlands. Concretions of raw flint were transported by the Vistula river from the outcrops located on the southeastern slopes of the Świętokrzyskie (Holy Cross) Mountains to Kuyavia. They were worked into cores and processed in settlements close to the Vistula valley. Cores and blades/flakes were also exported to distant locations to the west as far as the Lower Oder basin area. One would expect the existence of specialised workshops providing materials for such a mass distribution. Kruszyn site 13, Włocławek distr., is the first LBK 'chocolate' flint workshop discovered close to the Vistula river concentrated on production of blades. This site fits well into the LBK flint distribution system developed on the Lowlands.

KEY-WORDS: Early Neolithic, Linear Band Culture (LBK), 'chocolate' flint, distribution, workshop

INTRODUCTION

In the middle of the 6th millennium BC, the territory of today Poland witnessed the first appearance of farming communities that crossed the Sudeten and Carpathian Mountain passes to the north. According to radiocarbon dates, it seems to have been a rapid colonization process and shortly after settling the loess uplands of southern Poland, the Linear Band Pottery Culture (LBK) groups spread into the fertile soil areas of the northern Polish Lowlands. The economy of LBK was based on agriculture and husbandry and at that time, flint was still a basic raw material for the production of tools for everyday activities.

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The flint industry of the LBK in the Polish Lowlands relied on the utilization of diversified raw materials, however most of it was imported to the Lowlands from the south and southeast although sometimes also locally procured good quality Cretaceous Erratic Baltic flint was used (Kobusiewicz 1997, 1999; Kabaciński 2010).

Within the flint inventories of LBK five different imported raw materials have been recorded, namely 'chocolate', Jurassic-Cracow, Święciechów (grey white-spotted) and Volhynian flints as well as obsidian (Fig. 1). The first one – 'chocolate' flint – was certainly the most common of the five on the Lowlands. It is found within the Upper

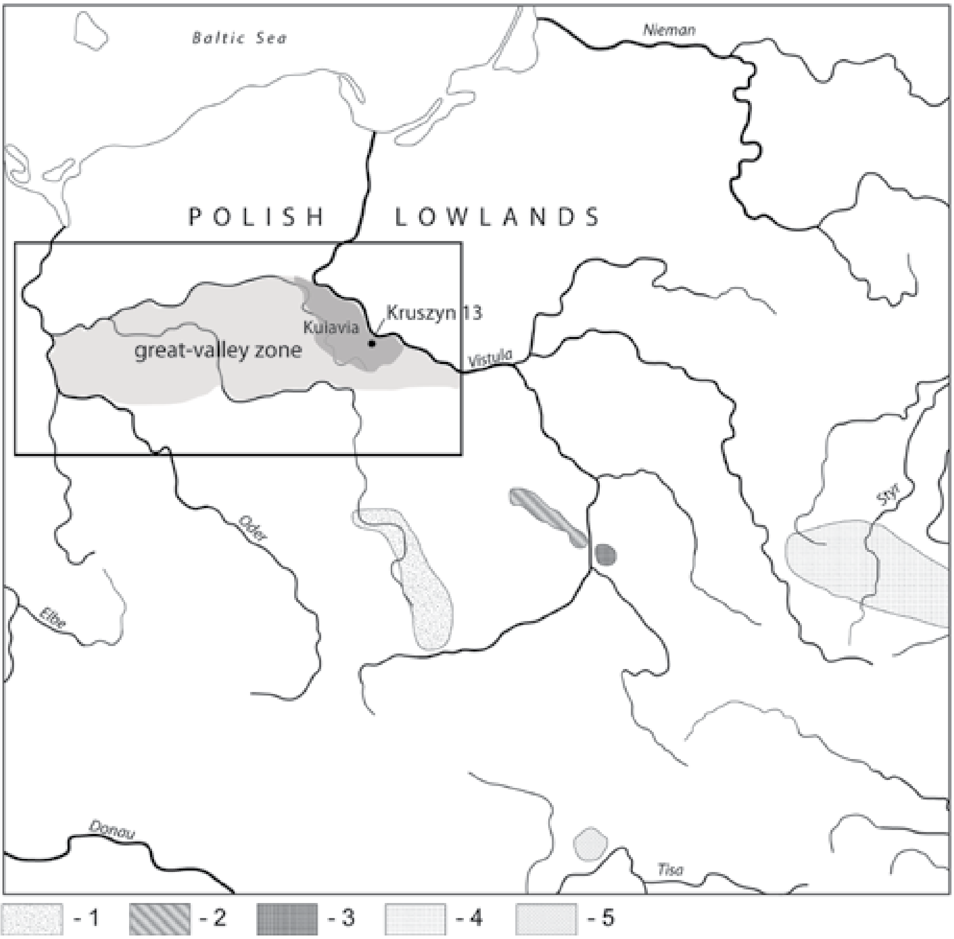

Fig. 1. Main areas and places mentioned in the text and location of outcrops of raw materials used by LBK groups in the Polish Lowlands: 1 – Jurassic flint; 2 – 'chocolate' flint; 3 – Święciechów flint; 4 – Volhynian flint; 5 – obsidian (acc. to Kabaciński 2010). The black frame indicates the extension of map on Fig. 2. Computer graphics: J. Kabaciński.

Jurassic limestone beds located on the southeastern foothills of the Świętokrzyskie (Holy Cross) Mountains (Schild 1971).

DISTRIBUTION OF CHOCOLATE FLINT IN THE GREAT-VALLEYS AREA OF THE POLISH LOWLANDS

The 'chocolate' flint is recorded already within the earliest LBK settlements known from the Polish Lowlands (Brześć Kujawski Site 3 and Smólsko Site 7, Włocławek district), and intensity of its utilization substantially increased from the beginning of phase II (the 'note' phase, as defined by Czerniak 1994) when it is present on every site, however in different frequency (from 2.9% in Lipnica Site 29, Bytów district, to 100% in Łojewo, Inowrocław district). An average share of 'chocolate' flint in raw material structure during II phase is ca. 51% and in phase III even higher – ca. 57% (Kabaciński 2010).

The 'chocolate' flint appeared on LBK sites in three different forms: (I) as raw concretions extracted from the limestone beds and still carrying cortex. On such sites a complete technological process took place, covering cortex removal, forming and preparation of cores, cores exploitation and production of tools; (II) the second group of sites are those to which already prepared cores (eventually 'clean' concretions without cortex) had been brought and exploited; (III) sites where that raw material is present exclusively in the form of blades/flakes or tools.

Respecting the form in which 'chocolate' flint appeared on LBK sites, it seems that the Vistula river valley, if not the river itself, is the most obvious route for its mass transportation.

During the initial phase of colonization of the Polish Lowlands (phase I), 'chocolate' flint was found on two sites located at a distance of several kilometres from the Vistula valley and in every case there were ready-to-process cores brought to it, most probably together with the first settlers.

A large-scale colonization of the central part of the Lowlands began along with the beginning of LBK phase II. As collected data suggest, this was synchronized with the appearance of a system of the distribution of 'chocolate' flint that became the dominating flint raw material. In a way, creation of such a system was forced by the extent of the colonized territory. Transportation of tonnes of unworked raw material over a distance of a few hundred kilometers, including the Lower Oder river basin, was not only extremely difficult but unprofitable as well. It required travellers overcoming densely forested areas cut by a net of streams and rivers, different in size and orientation. On the other hand in logistic terms, it was illogical to transport over large distances concretions covered by cortex that was not only a waste material, but also carried the risk of transporting bad quality flint.

In phase II, three chocolate flint distribution zones are visible (Fig. 2). The first covers a strip of land along the western edge of the Vistula channel, from several to about 40 kilometres wide, where raw material was delivered in the form of unworked concretions. The second zone, within which mainly cores were distributed, was slightly narrower but both zones generally occupy the same area and are functionally related as cores produced from raw concretions were subjected to short-distance distribution. To the west of areas adjacent to the Vistula river valley (zones 1 and 2) extends a vast territory of continuous but disperse LBK colonization where 'chocolate' flint was distributed in the form of blades/flakes and tools (zone 3).

In sum, during the 'note phase', two different 'chocolate' flint distribution areas existed over a large part of the Polish Lowlands stretching from the middle Vistula to the middle Oder river. The first covered most of the Kuyavia (zones 1 and 2), where raw flint concretions were imported on a mass scale from the outcrops and where short-distance redistribution of ready-to-exploit cores took place. In the second area, to the west of the first one, there was long-distance distribution of blades/flakes and tools from the area of primary import. On sites within this area, the chocolate flint is nothing more than an addendum to the locally procured erratic Cretaceous Baltic Flint. One may suppose its presence there had little economic meaning and is an expression of first of all the extra-utilitarian needs of maintaining contacts with the Kuyavian settlement centre.

During LBK phase III, an important modification of the 'chocolate' flint distribution pattern is observed, as only two distribution zones are recorded on the Lowlands.

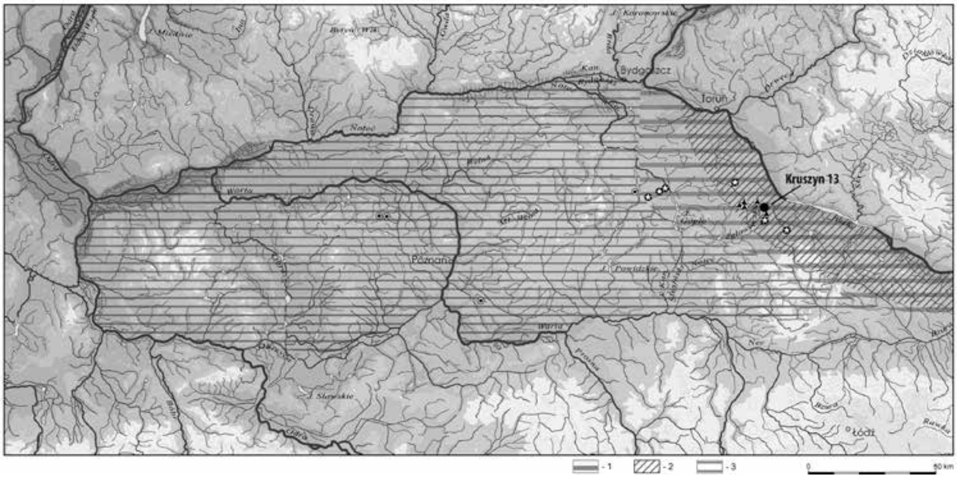

Fig. 2. Linear Band Pottery Culture. Phase II. System of distribution of chocolate flint in the Polish Lowlands (1 – zone I; 2 – zone II; 3 – zone III; star – nodules of raw material; triangle – cores; black dot in circle – blades, flakes and tools). Computer graphics: P. Szejnoga, J. Kabaciński.

The first extends along the middle Vistula valley and no wider than 20 kilometres (in effect eastern Kuyavia), where raw concretions were imported and on LBK sites a complete cycle of flint working is observed, from core forming to production of tools. Settlements in the second zone, to the west as far as the Oder river valley, were supplied with cores, afterwards exploited there for blades and flakes for tool production. That change is a consequence of the stabilization of the LBK settlement system and the logistic optimisation of the raw material exchanging network. At the same time, the 'chocolate' flint reached its maximum as a dominant raw material with average frequency of about 60% (Kabaciński 2010).

There are also other issues related to 'chocolate' flint distribution. The first is the way the chocolate flint reached Kuyavia. In the initial stage of colonization, most probably it was brought by the first settlers. However, in phase II its quantity, especially on Kuyavian sites raised rapidly and certainly an organized system of supply existed since that time. As chocolate flint came to Kuyavia in the form of raw concretions covered by thick cortex, it must have been extracted directly from primary outcrops. Mining of a 'chocolate' flint by LBK groups since phase II is confirmed for flint mine at Tomaszów, Szydłowiec district, as indicated by some of the radiocarbon dates from mining shafts as well as the typology of pre-cores (Schild *et al.*, 1975: 70n.). The evidence of Jurassic flint mining (Lech 1981) suggests it was a typical way of flint acquisition for LBK societies inhabiting Little Poland.

There are various hypotheses on how a chocolate flint was delivered to LBK Kuyavia. Some scholars suggested Mesolithic Janislavician groups played a role as trade middlemen (Kozłowski and Kozłowski 1977). Bogdan Balcer claimed that chocolate flint outcrops were at that time in territory owned by Janislavician people and 14C dates from the Tomaszów mine would confirm that (Balcer 1983: 58). However, the above mentioned techno-typological and chronological arguments support the hypothesis of chocolate flint mining by LBK groups (see also Domańska 1989).

The second hypothesis, advocated by the author of this paper, assumes the independent sourcing of 'chocolate' flint by LBK groups. Jacek Lech has pointed to two possibilities that do not exclude each other. There was either an organized distribution system or independent trips for flint were taken by people from individual settlements (Lech 1979). In the light of such a large quantity of 'chocolate' flint delivered to LBK Kuyavia it seems quite probable it came there by a direct transportation system to supply settlements located near to the Vistula valley with flint rather than through indirect exchange with Mesolithic groups. Water transport, with the help of boats or rafts should be considered, although as yet no trace of evidence for such means of transport is known from an Early Neolithic context.

Much evidence from LBK settlements located close to the Vistula valley shows the processing of 'fresh' 'chocolate' concretions brought straight from quarries already from the beginning of phase II. However, from the point of view of settlement structure,

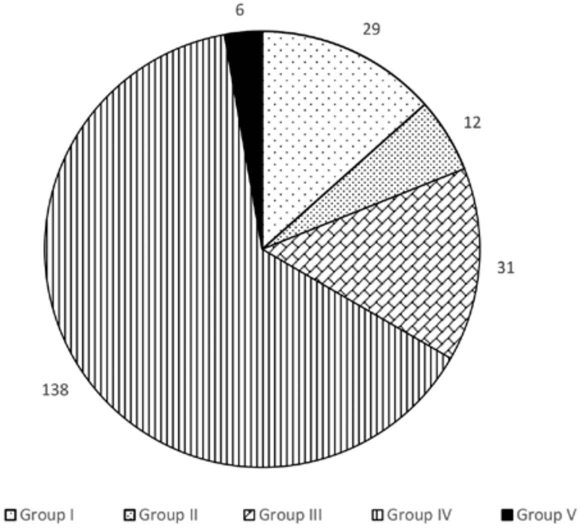

Fig. 3. Kruszyn, site 13, Włocławek distr., feature G56. Technological structure of the assemblage. Group I – preparation of cores and early stage of exploitation of cores; Group II – production of flakes; Group III – production of blades; Group IV – unidentified cores and debitage, chips and chunks; Group V – retouched tools. Computer graphics: J. Kabaciński.

one would expect sites/workshops oriented toward production of cores and production of blades/flakes in zone 1, designated for further distribution to settlements located to the west. Until now, no such core-production workshop had been recorded. However, in Kruszyn Site 13, Włocławek district, the first workshop specialized in blade production has been found.

KRUSZYN, SITE 13, WŁOCŁAWEK DISTRICT

The site No. 13 (AUT 104) at Kruszyn was recorded and excavated during the rescue excavations carried out along the A1 highway. In the course of the research a settlement of LBK dated to the 'note' phase (phase II) was excavated. Three typical LBK houses built of rows of wooden posts were found accompanied by several dozens functionally different features (Czekaj-Zastawny 2011). About 40 meters away from the settlement, two distinctly separated features were recorded, marked as G55 and G56. In feature G55, several dozen LBK pottery fragments occurred, while in feature G56 an assemblage of 216 flint artefacts was found (Kabaciński 2011).

The lithic inventory is very homogenous from the point of view of raw material structure, all but one artefact (a chip) were made of a 'chocolate' flint. The technological structure of the assemblage is also very characteristic. It contains artefacts belonging to five distinct technological groups (for details see Schild 1975; Domańska 1995; Domańska and Kabaciński 2000; see Fig. 3).

Group I - core preparation and initial core exploitation contains 29 artefacts including 12 cortex flakes, 7 cortex blades, 7 primary crested blades and 4 core trimming flakes. *Group II – production of flakes* contains 12 flakes removed from single platform cores. To *Group III – production of blades* - belong 31 blades of which 29 were struck of single platform and the remaining two from opposed platform cores. *Group IV of unidentified cores, debitage, chips and chunks* contains 138 artefacts including 3 unidentified flakes, 125 chips and 10 chunks. *Group V - retouched tools* includes 6 tools.

'Chocolate' flint processed in the vicinity of feature G56 was brought to the place in the form of cores still partially covered by cortex. Based on the different kind of cortex identified, some cores were made of concretions extracted directly from original beds while the others represent nodules from secondary beds. The longest artefacts measures 68 mm what would suggest that cores at the beginning of exploitation were not larger than 8–10 cm in length.

The technological uniformity of the assemblage is striking. With no exceptions all the artefacts are connected with classical core processing and not a single sign of scaled technique was observed. The exploitation of cores was based on well-prepared single platform cores from which first of all blades and later also rare flakes were removed. The edges of the cores were carefully trimmed as indicated by the structure of debitage platforms: 49.1% facetted, 27.3% *lisse*, 7.3% dihedral and only 3.6% cortex. No traces of core repair during its processing was recorded. The few tools include three non-characteristic retouched flakes and blades (Fig. 4).

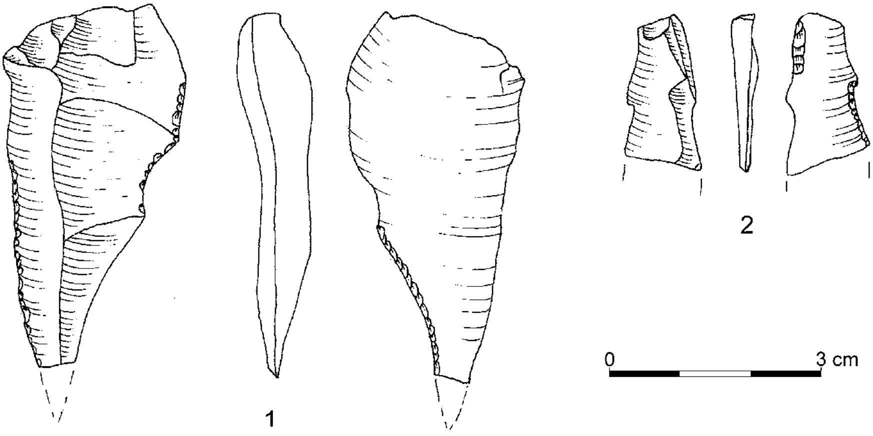

Fig. 4. Kruszyn, site 13, Włocławek distr., feature G56: 1–2 – retouched blades made of 'chocolate' flint. Drawn: J. Sawicka.

DISCUSSION

From the functional point of view there is a striking contrast between the analyzed assemblage and other LBK inventories form the Polish Lowlands, as the latter are usually typical household assemblages produced and served to fulfil the everyday needs of the settlements' inhabitants (Kabaciński 2010). The exceptional nature of this inventory is visible in: (I) the unique raw material structure, with only 'chocolate' flint processed. Such structure is sometimes recorded in LBK contexts, but only in the case when few pieces were found but never in assemblages rich in flints like that from Kruszyn Site 13 (Kabaciński 2010); (II) the uniform technological structure related to the exploitation of single platform cores and the lack of the scale technique. Such a situation is never met in LBK assemblages as the scale technique is always present in LBK, usually being the final stage in the technological chain; (III) the lack of retouched tools typical of LBK household assemblages, like endscrapers on flakes and blades, truncations or at least single cases of other types (perforators, drills, scrapers or trapezes), always present in rich collections of flint artefacts. Only a few retouched flakes and blades were encountered in Kruszyn Site 13; (IV) the specific percentage relations in between technological groups, with a well-represented group of objects representing the production of blades group, and with an overwhelming presence of chips and chunks as well as the low share of retouched tools.

These basic dissimilarities of the Kruszyn Site 13 assemblage compared with other site assemblages clearly point to the presence of a flint workshop in the vicinity of feature G56. In it, only 'chocolate' flint was processed and the aim was the production of good quality blades. Only accidentally broken or worse quality blades were left on the spot. It was a special place located outside, and at a substantial distance from, a habitation zone of LBK settlement. Such a location may suggest the workshop production was reserved for export to distant locations within LBK oecumene. The workshop for production of blades from 'chocolate' flint from Kruszyn Site 13 is the first one discovered in the Polish Lowlands and is an important contribution to the discussion on the internal raw material distribution system in the LBK.

REFERENCES:

Balcer, B. 1983. *Wytwórczość narzędzi krzemiennych w neolicie ziem Polski*. Wrocław, Ossolineum.

Czekaj-Zastawny, A. 2011. Kultura ceramiki wstęgowej rytej. In I. Sobkowiak-Tabaka (ed.), *Osadnictwo pradziejowe, wczesnośredniowieczne i nowożytne na stanowisku Kruszyn 13 (AUT 104), gm. Włocławek, woj. kujawsko-pomorskie.* Poznań, Institute of Archaeology and Ethnology Polish Academy of Sciences. Manuscript in The National Heritage Board of Poland (Narodowy Instytut Dziedzictwa).

Czerniak, L. 1994. *Wczesny i środkowy okres neolitu na Kujawach*. Poznań.

Domańska, L. 1989. Reception of Little Poland flint raw material by Kuiavian Communities of the Band Tradition. In A. Cofta-Broniewska (ed.), *Prehistoric contacts of Kuiavian communities with other Europeans Peoples*, 77–87. Archeologia Interregionalis 10.

Domańska, L. 1995. *Geneza krzemieniarstwa kultury pucharów lejkowatych na Kujawach*. Łódź.

Domańska, L. and Kabaciński, J. 2000. Krzemieniarstwo społeczności późnoneolitycznych. In A. Kośko (ed.), *Archeologiczne badania ratownicze wzdłuż trasy gazociągu tranzytowego, t. III, Kujawy, cz. 4*, 379–391. Poznań.

Kabaciński, J. 2010. *Przemiany wytwórczości krzemieniarskiej społeczności kultur wstęgowych strefy wielkodolinnej Niżu Polskiego*. Poznań.

Kabaciński, J. 2011. Wytwórczość krzemienna społeczności kultury ceramiki wstęgowej rytej na stanowisku nr 13 (AUT 104) w Kruszynie. In I. Sobkowiak-Tabaka (ed.), *Osadnictwo pradziejowe, wczesnośredniowieczne i nowożytne na stanowisku Kruszyn 13 (AUT 104), gm. Włocławek, woj. kujawsko-pomorskie.* Poznań, Institute of Archaeology and Ethnology Polish Academy of Sciences. Manuscript in The National Heritage Board of Poland (Narodowy Instytut Dziedzictwa).

Kobusiewicz, M. 1997. Sources of Flint on the West Polish Plain. In R. Schild and Z. Sulgostowska (eds), *Man and Flint. Proceedings of the VII-th International Flint-Symposium: Warszawa – Ostrowiec Świętokrzyski, September 1995*, 83–90. Warszawa.

Kobusiewicz, M. 1999. *Ludy łowiecko-zbierackie północno-zachodniej Polski.* Poznań.

Kozłowski, J. K. and Kozłowski, S. K. 1977. *Epoka kamienia na ziemiach polskich.* Warszawa.

Lech, J. 1979. Krzemieniarstwo w kulturze społeczności ceramiki wstęgowej rytej w Polsce. Próba zarysu. In W. Wojciechowski (ed.) *Początki neolityzacji Polski południowo-zachodniej*, 121–136. Wrocław.

Lech, J. 1981. *Górnictwo krzemienia społeczności wczesnorolniczych na Wyżynie Krakowskiej. Koniec VI tysiąclecia – 1 połowa IV tysiąclecia p.n.e.* Wrocław-Warszawa-Kraków-Gdańsk-Łódź.

Schild, R. 1971. Lokalizacja prahistorycznych punktów eksploatacji krzemienia czekoladowego na północno-wschodnim obrzeżeniu Gór Świętokrzyskich. *Folia Quaternaria* 39: 1–61.

Schild, R., Marczak, M. and Królik, H. 1975. *Późny mezolit. Próba wieloaspektowej analizy otwartych stanowisk piaskowych.* Wrocław-Warszawa-Kraków-Gdańsk.

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Characterizing 'Chocolate' Flint Using Reflectance Spectroscopy

Ryan M. Parish[a] **and Dagmara H. Werra**[b]

The study details a pilot experiment in which samples of 'chocolate' flint from four procurement sites in Poland and chert from the United States were characterized spectrally and distinguished using reflectance spectroscopy and multivariate statistics. The characterization of 'chocolate' flint and the successful differentiation of sources has been, and continues to be, a major research focus for understanding prehistoric consumption, use, and distribution of this favored lithic resource. Reflectance spectroscopy potentially provides an analytical methodology for identifying artefact source by successfully distinguishing spatially and compositionally unique deposits. Initial results from the study show that 'chocolate' flint can be distinguished from other silicite tool stone resources, regional lookalike materials, and by individual deposit. Future studies will test a more robust sample size of 'chocolate' flints and conduct experiments on surface weathering

KEY-WORDS: reflectance spectroscopy, 'chocolate' flint, source in Poland, Visible Near-infrared (VNIR), Fourier Transform Infrared (FTIR)

INTRODUCTION

The following study is a preliminary experiment on the application of reflectance spectroscopy to characterizing variability in 'chocolate' flint at two scales of analysis, between type formations and within a type formation. Recent studies highlight the possibility of characterizing 'chocolate' flint to a degree benefiting provenance research (Přichystal 2013; Brandl *et al.,* 2016). The current study largely builds upon the previous research and positive results presented in Parish (2016a) that demonstrated the ability of reflectance spectroscopy to differentiate between a large sample of cherts outcropping across the Southeastern United States of America. In order to assess the application of reflectance spectroscopy as a provenance technique in other regions, a preliminary sample of 'chocolate' flint was analysed. However, the results of the study should first be contextualised within a theoretical and methodological framework.

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Provenance Theory

The 'Provenance Postulate' is lauded as the fundamental principle guiding current archaeological source studies. The provenance postulate stipulates that in order for a deposit to be distinguished from all other potential sources, the variability found within the deposit must not exceed the variability found outside it (Banks and Wigand 1978). Though originally articulated in the context of ceramic provenance studies, the postulate is equally applicable to lithic provenance studies. Three main related components of this fundamental principle can be identified, spatial scale, variation, and characterization.

The spatial scale of the provenance study is important to define and is determined by the human behavioural question. The spatial scale of the study could range from an examination of inherent variation with a single artefact, deposit/outcrop, or geological formation. At different scales of analysis, the nature of variation may range considerably from homogeneous to heterogeneous. It can be expected that the variation within a single artefact would be less than that found within a deposit, and again that found within an entire geological formation, though analyses may show that such assumptions may in some cases be unfounded. Finally, the postulate stipulates the need to characterize the range of variation at the spatial scale in question in order to successfully determine if the source can be differentiated between others in the sampling universe. Therefore, it is these 'characterizations of variation' or brackets of variation ranges which the provenance researcher is attempting to distinguish and subsequently match the artefact's characterization to.

The characterization of the range of variation at various spatial scales (i.e. artefact, deposit, formation) and differentiation of the source(s) are the goals regardless of the provenance method utilized. The ranges of variation are important to know, irrespective of whether the researcher is using macroscopic attribute analysis, petrographic, or geochemical techniques. The three main components of the provenance postulate dictate the sampling strategy, the technique utilized, and the statistical methods of the provenance study. However, it is necessary to broaden our understanding of not only the presence of variation within the lithic source but also the nature of the variation.

Mechanism of Variation

The paleodepositional environment at the time of deposit formation and subsequent post-depositional alterations provide the researcher with a mechanism to study variation in lithic sources. The unique climate, geological conditions, and environment at the time of deposition impart the lithic source with a potentially diagnostic signature. This environmental signature in the form of chemistry, mineralogy, crystalline structure, … etc. within the parent formation may be inherited by the secondary forming lithic material or primary deposit of silica. In this manner, terrestrial and marine inputs may be spatially unique. The depositional signature in lithic sources is further altered regionally by weathering. The diagenetic process of flint may also be regionally specific. Though beyond the scope of the current study, further research in the areas of paleodepositional environments and postdepostional processes is warranted in order to understand the possible means by which one lithic source is differentiated from another.

The term silicite is used here to denote sedimentary siliceous rocks formed as a result of biochemical, chemical, or diagenetic precipitation of SiO_2 (Přichystal 2010). Silicite occurs as nodules forming in void spaces or as bedded planes and lenses in carbonate formations such as limestone and dolomite. The Kimmeridgian/Oxfordian 'chocolate' flint, Jurassic-Cracow flint, and Fort Payne chert discussed in the study are categorized broadly as silicite.

'Chocolate' Flint

Much literature is available on the geology of the 'chocolate' flint in preceding volumes (Krukowski 1920; Budziszewski and Michniak 1995; Hughes *et al.*, 2016). However, a brief summary is given as context in order to examine the potential reason why spectral variation within 'chocolate' flint is spatially unique.

'Chocolate' flint occurs and in prehistoric times was exploited along the northeastern slopes of the Świętokrzyskie (Holy Cross) Mountains of central Poland. The irregular, flat, and tabular nodules occur in late Jurassic carbonate deposits (Schild 1971; Hughes *et al.*, 2016). The carbonate deposits were laid down in shallow marine environments near the shore. The various cycles of silica formation occurred sporadically as shorelines stabilized in between transgression and regression phases (Budziszewski and Michniak 1995: 11). The precise parent formation for 'chocolate' flint is currently elusive, either being at the top margins of the Oxfordian, the base of the Kimmeridgian, a transitional boundary in between, or occurring in both limestone formations (Hughes *et al.*, 2016). Regardless of the position of the 'chocolate' flints in the regional geological sequence, the shallowing marine reservoir environment created a sedimentary boundary between the 'chocolate' flint horizon and the overlying banded Turonian flints (Budziszewski and Michniak 1995). The shifting terrestrial contribution, sea chemistry, and temperature regimes were only a few of the variables affecting the diagenetic process of flint formation. It is possible that more localized deposits, later exploited in prehistoric times, are internally more compositionally homogeneous due to their proximity to similar formation conditions and later alterations.

The 'chocolate' flint deposits were heavily utilized as a lithic source both regionally and much further afield. The first reported use of the lithic resources is thought to have been by communities in the Middle Palaeolithic (Schild ed., 2005) but continue to the end of the Bronze Age (Schild *et al.*, 1985). The utilization of 'chocolate' flint reflects a much broader spatial and temporal trend in the region as other lithic sources shared a similarly long period of use and distribution. The widespread distribution, consumption, and utilization of 'chocolate' flint outcropping in a relatively small geographic area makes the development of an accurate sourcing technique desirable.

Fort Payne chert

Fort Payne chert is found in the Fort Payne formation of the Southeastern United States. This is a carbonate formation laid down during the Mississippian geological subsystem (354–324 mya) at a time when much of the interior United States was covered by an inland sea. The internal structure of Fort Payne chert is very uniform, composed of cryptocrystalline silica with small amounts of chalcedonic silica and irregularly shaped pherulites (Marcher 1962). A large amount of iron oxides and brown organic material are present distinguishing it from the parent limestone. The material occurs in two forms. One type of Fort Payne chert occurs as large rounded masses of dense, dark chert. The second type occurs closer to the top of the formation and is described as highly porous, fossiliferous chert identical to the overlying Warsaw formation (Marcher 1962).

Fort Payne chert was an important lithic resource for the entire prehistoric record of the Southeastern United States. The chert was first exploited by late Pleistocene hunter-gatherer inhabitants and utilized by subsequent culture groups up until the 19th Century. The medium to fine white, tan, brown, and black-grained chert contains significant variability across deposits spanning 1500 linear kilometres. Despite efforts to distinguish Fort Payne chert qualitatively and quantitatively, the large amount of variability has frustrated provenance researchers until the application of reflectance spectroscopy.

Reflectance spectroscopy

Reflectance spectroscopy is a broad term describing any method that studies and records the interaction of electromagnetic radiation with matter. The description of reflectance spectroscopy in general is covered more thoroughly in Clark 1999; Hollas 2002; Smith 2011; and specifically applied to archaeological sourcing studies in Hawkins *et al.*, 2008; Morin 2012; Parish and Butler 2017. However, it is important to note that reflectance spectroscopy data is a measurement of the amount of radiation reflected from the surface and near-surface of a specimen by wavelength across a portion of the electromagnetic spectrum.

Reflectance data is expressed as a percentage reflectance value between 0 and 1 per wavelength unit. For example, a specimen of 'chocolate' flint might have a reflectance value of 0.058234 at wavelength 350 nm. Each reflectance value per wavelength is recorded by the spectrometer generating thousands of values. The current study uses two spectrometers whose range extends from 350 to 15,419 nm, encompassing the visible, near and into the middle infrared regions of the electromagnetic spectrum.

Expressed graphically, each sample's spectrum is a series of curves with peaks and valleys (see Parish 2016a: Fig. 1). A spectrum's peaks and valleys (features) at specific wavelength positions are indicative of atomic electron shield structure and molecular bonding. The presence of identifiable spectral features is indicative of mineral composition and slight changes in the silica matrix. Reflectance spectroscopy is very sensitive to minute compositional features and, when coupled with multivariate statistical techniques, is proving to be an effective, cost efficient, and fast method for accurately sourcing silicite tool stone resources. One of reflectance spectroscopy's more valuable potential characteristics is that analysis is non-destructive to the artefact.

METHODS

'Chocolate' flint has to date been analysed by a few different methods (Přichystal 2013; Grafka *et al.* 2015; Brandl *et al.*, 2016; Hughes *et al.* 2016; Werra *et al.* 2018). The most useful results were obtained thanks to the use of Multi-Layered Chert Sourcing Approach (MLA) by Michael Brandl (Brandl *et al.*, 2016) and stereomicroscopic appearance made by Antonín Přichystal (2013: 108).

Experiment design

In order to examine the possible application of reflectance spectroscopy to characterize and differentiate 'chocolate' flint from similar varieties of Jurassic-Cracow flint and 'chocolate' flint from the Udorka valley, two spectrometers were used to analyse a comparative sample of these and a Fort Payne chert control group. A total of 34 samples were analyzed of 'chocolate' flint from Wierzbica 'Zele', Radom distr. (n=11), Orońsko, Szydłowiec distr. (n=13), and Polany II, Radom distr. (n=10). In addition 11 samples of Jurassic-Cracow flint from Sąspów, Cracow distr., and 30 samples of Fort Payne chert from the Southeastern United States of America were analysed as lookalike controls. Therefore, the reflectance spectra of 75 flint/chert samples were recorded in order to test whether enough spectral variability existed to distinguish one material type from another and one deposit from another.

All samples were fractured via hard hammerstone percussion producing an interior less weathered surface for analysis. Just prior to analysis, a lens tissue was used to lightly wipe any dust or contaminants from the sample's surface. The two spectrometers used to gather spectral data included a PSR+ (made by Spectral Evolution), recorded radiation in the visible and near-infrared, and a FTIR 4300 (made by Aligent) in the middle-infrared. The use of both spectrometers provided high-resolution spectral data from 350 to 15,419 nm, or 3,051 raw reflectance values per sample analysed. A total of 228,825 reflectance values were collected from the 75 geological samples, each reflectance value potentially diagnostic to parent formation and/or deposit location.

Processing of the spectra was necessary due to sample surface to probe angular differences, instrument and atmospheric noise, and spectral feature intensity differences. A more thorough discussion on spectral processing can be found in Parish *et al.,* 2013; Morin 2012, and Smith 2011. The current study utilized spectroscopic, normative, and derivative transforms. The spectroscopic transform is used to convert the reflectance values into absorption in order to highlight subtle features. The normative transform minimized sample surface to probe angle differences by providing a baseline correction, in other words, standardizing the 75 flint/chert spectra. Finally, the derivative transform function was utilized in order to smooth atmospheric and instrumental noise and to highlight subtle slope change features in the spectra indicative of slight compositional characteristics.

Visual comparison of the graphic depiction of the results from each flint type and each deposit type is not often informative; this is because the spectrum of flint, compositionally dominated by silica, is similar (Fig. 1). Therefore, a stepwise discriminant function model was run to create discriminant functions between flint/chert

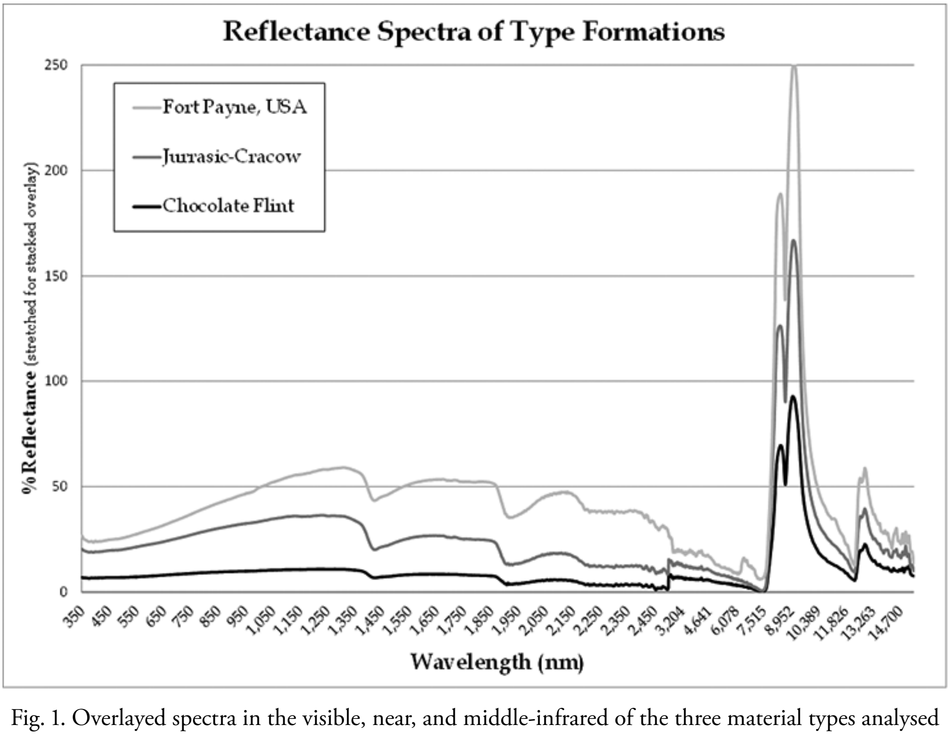

Fig. 1. Overlayed spectra in the visible, near, and middle-infrared of the three material types analysed in the study. Note the similarity of the spectral features. Spectra stacked for visibility. Computer graphics: R.M. Parish.

types and individual deposits. The stepwise discriminant function assesses the power of each reflectance value (variable) in the spectrum of a sample for group membership. An f-value of the reflectance variable is calculated and if the f-value exceeds a set threshold than the variable is not retained in the resulting function. As a result, only the most discriminatory reflectance values are used to calculate group membership. The model generates a predicted group membership nominal variable, discriminant function scores, and a scatter plot. This multivariate statistical method is demonstrated to be effective in analysis of flint/chert spectra though best applied to larger sample sets (Speer 2013, 2014; Parish 2016b).

The initial test examined whether Kimmeridgian/Oxfordian formation 'chocolate' flint could be statistically distinguished from Jurassic-Cracow flint and Fort Payne chert. The significance of the initial test was to gauge inter-formation variation between three flint/chert sources forming under similar geological conditions in marine carbonate formations. Though separated by space and time, the base mineralogy of the tool stone materials was largely the same, being composed of micro to cryptocrystalline quartz grains. The experiment was designed to characterize the spectral variation found within separate geological units. The second test examined the intra-formation variation within the Kimmeridgian/Oxfordian parent formation(s). The Jurassic-Cracow samples from the Sąspów deposit were retained for a regional control. The goal of the intra-formation experiment was to characterize variation within individual deposits (Wierzbica 'Zele', Orońsko, Polany II) of 'chocolate' flint and to distinguish one from the other using spectral data.

The two preliminary experiments were a necessary first step approach in assessing the nature of variation between and within formation types. The two tests also examined the ability of reflectance spectroscopy to characterize this variability at two scales of analysis. Finally, the application of discriminant function analysis in differentiating the tool stone materials statistically was evaluated as a mechanism to quantify the atomic and molecular bonding differences. The results of these experiments highlighted the significant results that could be attained by the application of reflectance spectroscopy in distinguishing between look-alike flint types in the Świętokrzyskie (Holy Cross) Mountains of central Poland.

RESULTS AND DISCUSSION

Inter-formation

All 75 flint/chert samples were organized into three groups; Kimmeridgian/Oxfordian formation 'chocolate' flint, Jurassic-Cracow flint and Fort Payne chert. The discriminant function model successfully assigned each sample to its respective group based upon the diagnostic reflectance values retained in the step-wise model. No samples

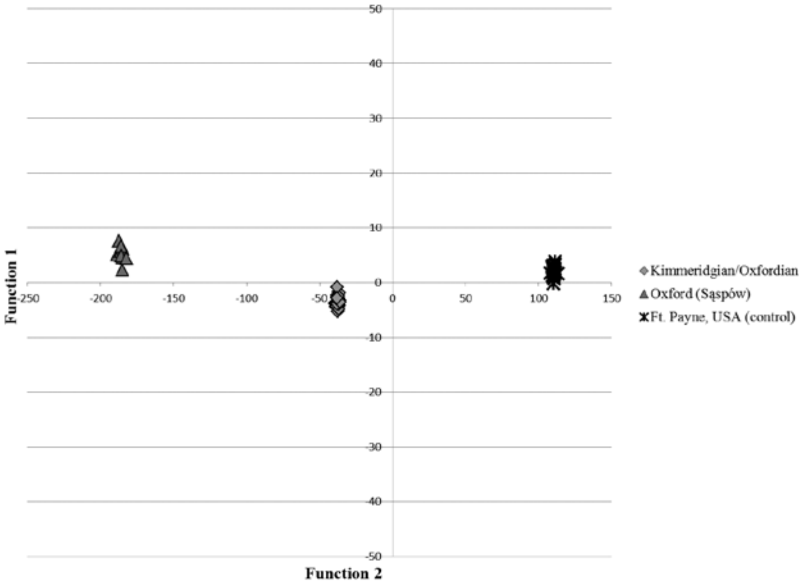

Fig. 2. Discriminant Function scatter plot depicted clear separation between all three formation type materials analysed in the study. Computer graphics: R.M. Parish.

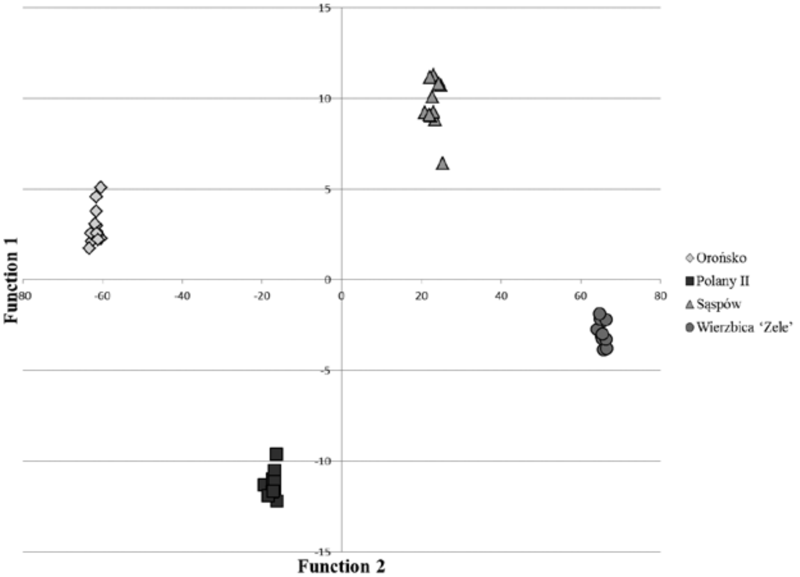

Fig. 3. Discriminant function scatter plot depicting clear separation between all three deposits of 'chocolate' flint (Orońsko, Szydłowiec distr., Wierzbica 'Zele' and Polany II, Radom distr.) and Jurassic-Cracow (Sąspów, Cracow distr.) flint. Computer graphics: R.M. Parish.

Table 1. Diagnostic reflectance wavelength (nm) variables retained in both discriminant function models.

Electromagnetic Range	Inter-formation test	Intra-outcrop test	Diagnostic Attributes Detected
Visible, Near-Infrared	556, 590, 610, 920, 1159, 1258, 1304, 1309, 1315, 1374, 1446, 1484, 1697, 1805, 1825, 1861, 1913, 1997, 2284, 2396, 2480	441, 801, 878, 892, 977, 1053, 1238, 1247, 1301, 1314, 1612, 1808, 2249, 2304, 2388	Unbound electrons, atomic structure, mineral impurities Silica phase, formation conditions Kaolinite, Illite, Montmorillonite, Limonite and other clay minerals
Middle-Infrared	2730.27197, 3635.57397, 3721.79321, 3865.49194, 4282.21533, 5417.41602, 5431.78564, 5575.48193, 5661.69971, 5776.65674, 6150.26709, 6265.22412, 6581.35596, 6753.7915, 6796.90039, 7156.14111, 7256.72852, 11222.84863, 12257.49707, 12286.2373, 12602.37988, 12760.45117, 13996.28125, 14269.31348	3132.62842, 4770.78271, 5259.3501, 6710.68262, 7601.59961, 8708.07813 8938, 9196.66211, 10073.23926, 10389.38184, 12702.9707, 13004.74316 14844.11816	Kaolinite, Illite, Montmorillonite, Organic compounds, Dolomite and Calcite, Dolomite, Smectite, Rutile, Goethite, Limonite, Glauconite, Pyrite, Manganite, Brucite, Hematite, Magnetite

were misclassified in the predicted group membership output. The model generated a scatter plot based upon function 1 and function 2 (Fig. 2). The plot shows a clear separation of the three flint/chert groups in two-dimensional vector space. Had the samples not contained enough diagnostic reflectance values, the accuracy of the model would have been severely compromised and the resulting scatter plot graph would have shown no clear separation of the sample groups. All 46 diagnostic reflectance values retained in the inter-formation model are listed in Table 1.

Intra-formation

The intra-formation model consisted of four flint groups of 45 samples from the 'chocolate' flint deposits of Wierzbica 'Zele', Orońsko, Polany II and the single group of Jurassic-Cracow samples from Sąspów. The Fort Payne chert samples were not included in this stage of the analysis. The discriminant function analysis generated a model consisting of 28 diagnostic reflectance values (Table 1) and no misclassified samples. All of the 'chocolate' flint samples were identified to their respective site deposits. The Sąspów samples were similarly classified correctly. The scatter plot of function 1 and function 2 illustrate clear group separation in two-dimensions. Therefore, the results of the model indicate that 'chocolate' flint can be distinguished from other look-alike materials and can also be distinguished from separate deposits along the strike of the prehistorically exploited geological formation.

Though the scope of the current study was small, the implication of the results is significant. The 75 samples incorporated in the study can be characterized based upon a series or range of diagnostic reflectance values through the use of multivariate statistics. Slight absorption features due to dipole molecular bonding indicate the presence of micro-mineral groups that when measured have a spatial component. Additionally, the position of the mineral impurities within the silica matrix may be related to the position of the materials within the geological formation and the conditions within which the deposit was originally deposited. Later diagenetic processes acting on the flint deposits may also have a spatial component. This means that the regional conditions and variables affecting the shallow marine deposits and later weathering of these potentially imparted a characteristic signature not previously noted by petrologic or geochemical analyses. The extreme sensitivity of reflectance spectroscopy to slight compositional and structural changes allows the differentiation of both deposits and formation types.

The reflectance spectral data do not differentiate between micro-regional weathering conditions. Though the analysis of the samples is primarily upon the surface with slight penetration to a few micromillimetres, the samples were prepared by hard-hammer percussion exposing an interior surface. It is also readily apparent that weathering conditions within a single deposit of 'chocolate' flint are variable, not uniform. Also, the samples were collected from surface debitage immediately surrounding the deposit, not from an in situ horizon exposed within the geological profile. It is however, hypothesized that the long-term diagenesis of flint, coupled with the regional deposition of the parent formation, explains the spatially distinctive spectral variation.

The relatively small sample size of the study prohibits exploring the full range of characterization by formation and by deposit. The use of discriminant function analysis is more appropriately performed on larger sample databases. Therefore, it is a bit premature to make wide ranging theoretical assumptions regarding the nature of the variation in and between the 'chocolate' flint deposits. A larger sample is needed to assess the nature and spatial patterning of the diagnostic reflectance features identified in this study and the robustness of the multivariate statistical method.

In addition to a larger sample database, future directions of the research will entail a surface weathering test that examines the affects that patina has on the accuracy of the technique for source determination. As reflectance spectroscopy has the potential to be a non-invasive provenancing method, a focused examination on analysis of artefacts compared to a geological sample database is needed. Though the characterization of flint source and differentiation of other potential sources is a necessary first step, the accurate sourcing of artefact assemblages back to the resource is the ultimate objective if an understanding of human behaviour is to be realized.

CONCLUSIONS

The study successfully demonstrated the application of reflectance spectroscopy in characterizing variation between 'chocolate' flint and Jurassic-Cracow flint sources as well as differentiating individual deposits of 'chocolate' flint along the slopes of the Świętokrzyskie (Holy Cross) Mountains of central Poland. The results demonstrate the potential for additional provenance studies the aim of which is to analytically identify the source of flint artefact assemblages. The deposits of flint investigated in the study contain a range of diagnostic reflectance values in the visible, near- and middle-infrared portions of the electromagnetic spectrum created by atomic electron transforms and molecular bonding. The spectral features are indicative of micro-mineral groups and possibly also the structure of the silica matrix. The clear separation of 'chocolate' flint by formation type and deposit may be explained by the palaeo-environmental conditions at the time of formation of the deposit and the resulting post-depositional alteration of the flint through micro-regional diagenesis. This is the fundamental principle of provenance studies; that variability in a deposit is geologically and spatially distinct from other exploited resource locations.

The positive results of the pilot study raise a great deal of optimism for the success of future sourcing programs the goal of which would be the characterization and differentiation of tool stone resources. The application of reflectance spectroscopy is shown to be a promising methodology in future provenance studies. The cost-efficient, fast, accurate, and non-destructive characteristics of reflectance spectroscopy are desirable traits in collecting source data. The PSR+ (VNIR) and 4300 FTIR devices used in the study are also portable, encouraging onsite analysis at the curation facility. Additionally, the spectral data are easily assembled into sharable databases and libraries encouraging the continuous sampling and adding of deposits across the landscape. Our broadened view of the lithic landscape will similarly expand our understanding of prehistoric resource, selection, distribution, and consumption across space and through time.

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The authors are grateful for time and advice of two anonymous reviews. The authors accept responsibility for any remaining errors. The lead author greatly appreciates the invitation to present this research at the Flint in Time and Space conference, Warsaw. Additionally, thanks to the Institute of Archaeology and Ethnology, Polish Academy of Sciences for hosting the lead author and his mother who enjoyed the opportunity to see her ancestral homeland. Funding for portions of this research was graciously provided by the Department of Earth Sciences, Memphis, USA and the National Science Foundation (#1720376). Siliceous rocks samples presented here were obtained as part of the scientific project financed by the National Science Centre (NCN) in Cracow (Poland) PRELUDIUM 2 UMC-2011/03/N/HS3/03973.

REFERENCES

Brandl, M., Hauzenberger, C., Martinez, M.M., Filzmoser, P. and Werra, D.H. 2016. The Application of the Multi- Layered Chert Sourcing Approach (MLA) for the Characterisation and Differentiation of 'Chocolate Silicites' from the Holy Cross Mountains, South-Central Poland. *Archaeologia Austriaca* 100, 119–149.

Budziszewski, J. and Michniak, R. 1995. Siliceous rocks of the North-Eastern Mesozoic margin of the Holy Cross Mountains. In J. Budziszewski and R. Michniak (eds), *Guide-Book of Excursion 2 Northern Footslopes of Holy Cross Mountains*. Warsaw, State Committee for Scientific Research and Polish Academy of Sciences.

Clark, R.N. 1999. Chapter 1: Spectroscopy of Rocks and Minerals, and Principles of Spectroscopy. In *Manual of Remote Sensing, Volume 3, Remote Sensing for the Earth Sciences*. New York, Wiley & Sons, Inc.

Grafka, O., Werra, D.H. and Siuda, R. 2015. Analysis of Organic Compounds: Applications in Archaeology and Earth Science. *Litikum* 3: 26–37.

Hawkins, A.L., Tourigny, E., Long, D.G.F., Julig, P.J. and Bursey, J. 2008. Fourier Transform Infrared Spectroscopy of Geological and Archaeological Chert from Southern Ontario. *North American Archaeologist* 29: 203–224.

Hollas, J. M. 2002. *Basic Atomic and Molecular Spectroscopy*. New York, John Wiley & Sons Inc.

Hughes, R. E., Werra, D.H. and Siuda, R. 2016. On the chemcical composition of 'chocolate flint' from central Poland. *Archaeologia Polona* 54: 99–114.

Marcher, Mevin V. 1962. Petrography of Mississippian Limestones and Cherts from the Northwestern Highland Rim, Tennessee. *Journal of Sedimentary Petrology* 32: 819–832.

Morin, J. 2012. *The Political Economy of stone Celt Exchange in Pre-contact British Columbia: The Salish Nephrite/Jade Industry*. Unpublished Ph.D. dissertation, Department of Anthropology, The University of British Columbia, Vancouver.

Parish, R.M., Swihart, G. S. and Li, Y. S. 2013. Evaluating Fourier Transform Infrared Spectroscopy as a Non-Destructive Chert Sourcing Technique. *Geoarchaeology: An International Journal* 28 (3): 289–307.

Parish, R.M. 2016a. Reflectance Spectroscopy as a Chert Sourcing Method. *Archaeologia Polona* 54: 115–128.

Parish, R.M. 2016b. Lithic Procurement Patterning as a Proxy for Identifying Late Paleoindian Group Mobility Along the Lower Tennessee River Valley. *Journal of Archaeological Science: Reports* (2016), http://dx.doi.org/10.1016/j.jasrep.2016.03.028.

Parish, R.M. and Butler, B. 2017. The Use of Dover-like Tool Stone by Pre-Mississippian Occupations in the Black Bottom of Southern Illinois. *Illinois Archaeology* 27: 118–137.

Přichystal, A. 2010. Classificiation of Lithic Raw Materials Used for Prehistoirc Chipped Artefacts in General and Siliceous Sediments (Silicites) in Particular: The Czech Proposal. *Archeometriai Műhely* 3: 177–181.

Přichystal, A. 2013. *Lithic raw materials in prehistoric times of Eastern Central Europe*. Brno.

Krukowski, S. 1920. Pierwociny krzemieniarskie górnictwa, transportu i handlu w holocenie Polski, cz. 1. *Wiadomości Archeologiczne* 5: 185–206.

Schild, R. 1971. Lokalizacja prahistorycznych punktów eksploatacji krzemienia czekoladowego na północno-wschodnim obrzeżeniu Gór Świętokrzyskich [sum.: Location of the so-called chocolate flint extraction sites on the north-eastern footslopes of the Holy Cross Mountains]. *Folia Quaternaria* 39: 1–61.

Schild, R. ed. 2005. *The killing fields of Zwoleń: a Middle Paleolithic kill-butchery-site in Central Poland.* Warsaw, Institute of Archaeology and Ethnology of the Polish Academy of Sciences.

Schild, R., Królik, H. and Marczak, M. 1985. Kopalnia krzemienia czekoladowego w Tomaszowie [sum: A chocolate flint mine at Tomaszów]. Wrocław.

Smith, B.C. 2011. *Fundamentals of Fourier Transform Infrared Spectroscopy*. New York, CRC Press.

Speer, Ch.A. 2013. *Clovis mobility at the Gault Site: A chert provenance study using Laster Ablation-Inductively Coupled Plasma Mass spectroscopy (LA-ICP-MS)*. Unpublished PhD thesis, Department of Anthropology, The University of Texas, San Antonio.

Speer, Ch.A. 2014. LA-ICP-MS analysis of Clovis period projectile points from the Gault Site. *Journal of Archaeological Science* 52: 1–11.

Werra, D.H., Siuda, R. and Małecka-Kukawka, J. 2018. A Danubian raw material exchange network: a case study from Chełmno Land (Poland). In D.H. Werra and M. Woźny (eds), *Between history and archaeology. Papers in honour of Jacek Lech*, 211–224. Oxford, Archaeopress Archaeology.

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Late Palaeolithic and Mesolithic Treatment and Use of Non-flint Stone Raw Materials: Material Collection From Site 17 at Nowogród, Golub-Dobrzyń District, Poland

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The aim of the article is to present the results of a multifaceted analysis of a collection of non-flint stone artefacts obtained during excavations of the complex of Late Palaeolithic camps at site 17 in Nowogród, Golub-Dobrzyń district. It included an obsidian artefact and objects made of crystalline rocks (quartzite, quartzite sandstone, quartz, coarse sandstone and diorite), which were created as a result of knapping the raw material using techniques similar or identical to those used during the processing of flint. The results of petrographic analysis confirmed that these raw materials had come from natural resources located near the site. Most of the analysed artefacts are represented by large flakes. In addition, one chip and two tools, a multiple burin and a pebble tool, were distinguished. Use-wear analysis showed signs of use on two artefacts, including the pebble tool. The obsidian artefact is currently the northernmost Late Palaeolithic find of this type. In order to determine the geological source of the raw material, the artefact was subjected to PGAA and XRF analysis. PGAA analysis confirmed that the obsidian originated from a source in northern Slovakia (Carpathian 1 type), probably from the Cejkov or Kašov deposits, Trebišov district. The article also describes a rock crystal and a probable concretion of quartz of this type originating from site 6 in Ludowice, Wąbrzeźno district.

KEY-WORDS: Late Palaeolithic, stone, non-flint raw materials, obsidian, traceology, PGAA, XRF, Polish Lowlands

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The present day territory of Poland was, in the Stone Age, a ‘privileged’ region owing to the numerous outcrops of high-quality, flint raw materials. Thus, for the communities of this period, flint was the basic raw material processed using knapping techniques and used for the production of stone tools. Nevertheless, for various reasons, prehistoric people did not completely abandon the use of other types of rocks. Unfortunately, this is sometimes downplayed by researchers specializing in this period, despite the appearance of publications on new collections of prehistoric stone artefacts made from non-flint rocks that are being discovered in Poland. Changing this state of affairs is imperative, only by taking into account all types of raw materials found on prehistoric sites, and analyzing them in a multifaceted way, will we be able to create a more objective vision of the economy and other aspects of life of prehistoric communities.

The main goal of this article is the presentation and multifaceted analysis of a collection of stone products made from non-flint raw materials that were obtained during excavations of the complex of Late Palaeolithic camps at site 17 in Nowogród, Golub-Dobrzyń district. It included objects made of crystalline rocks that were created as a result of knapping the raw material using techniques similar or identical to those used during the processing of flint. There is also an obsidian artefact from this site, which we believe is the northernmost Late Palaeolithic find of this type.

The article also discusses a previously undescribed fragment of rock crystal and a probable concretion of quartz of this type found at site 6 in Ludowice, Wąbrzeźno district, that had been omitted from previous publications about the site. The reason for their inclusion is the individuality and uniqueness of these findings in the context of other hunter-gatherer sites in the Polish Lowlands.

MATERIALS AND METHODS

Site 17 in Nowogród is located on a promontory in the subglacial valley of Grodno and Plebanka lakes, in the northern part of the Chełmno-Dobrzyń Lake District. It is one of several sites there (Fig. 1), currently excavated under the project titled: *Mesolithic communities of the Chełmno-Dobrzyń Lakeland – daily life, mobility, external contacts and relationships with the environment,* which is funded by the National Science Center (NCN) in Cracow (Poland; project no. 2016/23/B/HS3/00689). Archaeological research, covering an area of 232 m^2, took place here from 2014–2015. Abundant remains of prehistoric settlements were found on the site, mainly associated with groups of Late Palaeolithic and Mesolithic hunter-gatherers. The artefacts recovered are currently undergoing multifaceted analyses, the results of which will be published in the near future. This article concerns the collection of non-flint stone products from the site, totalling 17 specimens (including the obsidian artefact).

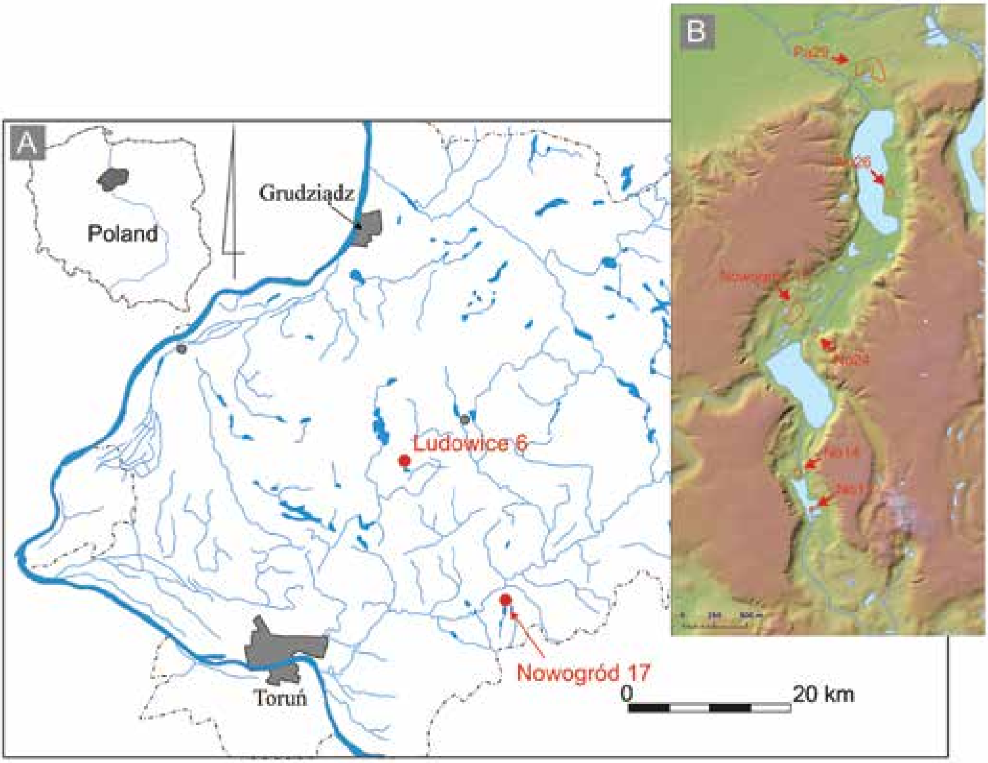

Fig. 1. Location of the archaeological sites included: A – location within the Chełmno-Dobrzyń Lake District; B – location of the site 17 in Nowogród, Golub-Dobrzyń district, within the subglacial valley of the lakes Grodno and Plebanka, with the location of other Late Palaeleolitic and Mesolithic sites. Drawn: G. Osipowicz.

Ludowice 6 site is located in the central part of the Chełmno Lake District, on the Chełmińska Height (central Poland), in the contact zone of an outwash plain (or sandur) and a large kettle hole, filled with biogenic sediments (peat). Archaeological research, covering an area of 756 m^2, took place here from 2009–2014 (Osipowicz *et al.*, 2014). On the site, remains of Late Glacial (Swiderian culture) and early Holocene (Mesolithic) settlements were found. The main settlement phase took place in the Late Mesolithic, when the site was frequently visited by people of the late Komornica culture (post-Maglemose tradition). The settlement remains from this period are a complex of short-term, seasonal camps specializing in the processing of silica-rich plants (Osipowicz 2017a, b). Archaeological research conducted within the site provided a rich and diverse collection of prehistoric artefacts, among which was a group of Mesolithic stone products made mainly of red quartz porphyry, ferruginous quartz sandstone or fine-grained red granite. They form a unique stone industry that has been described in previous publica-

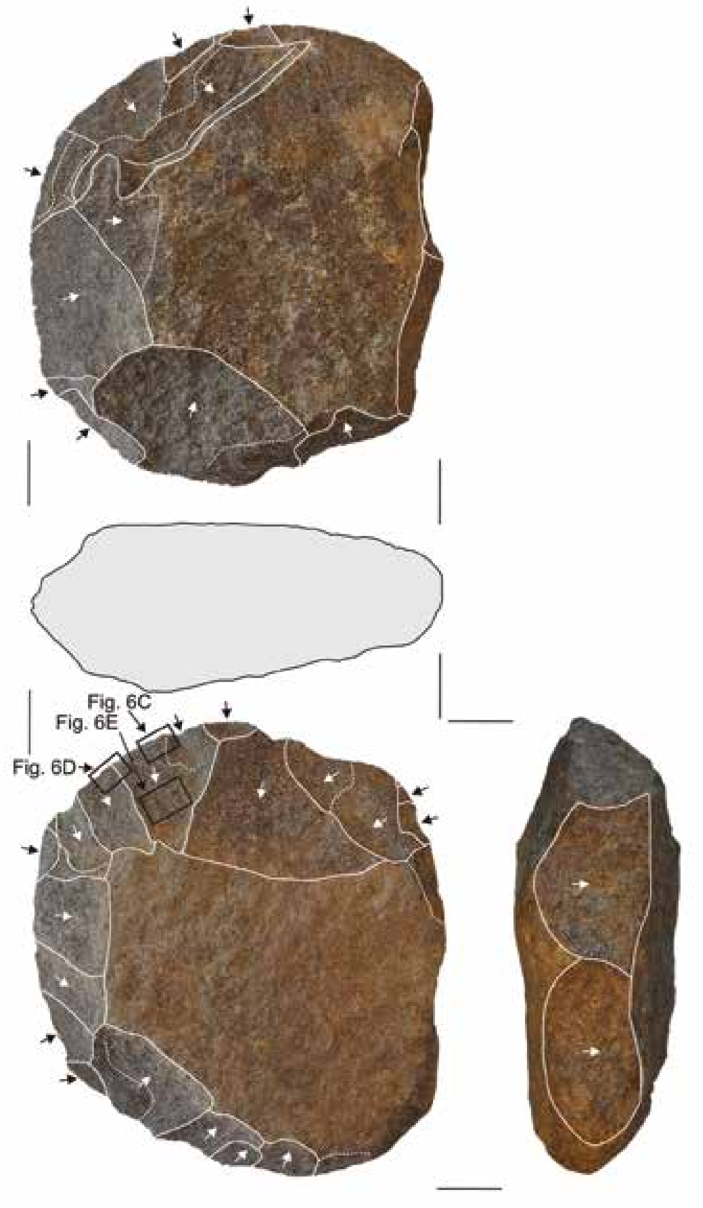

Fig. 2. Nowogród, site. 17, Golub-Dobrzyń district. Pebble tool. Computer graphics: G. Osipowicz and J. Orłowska.

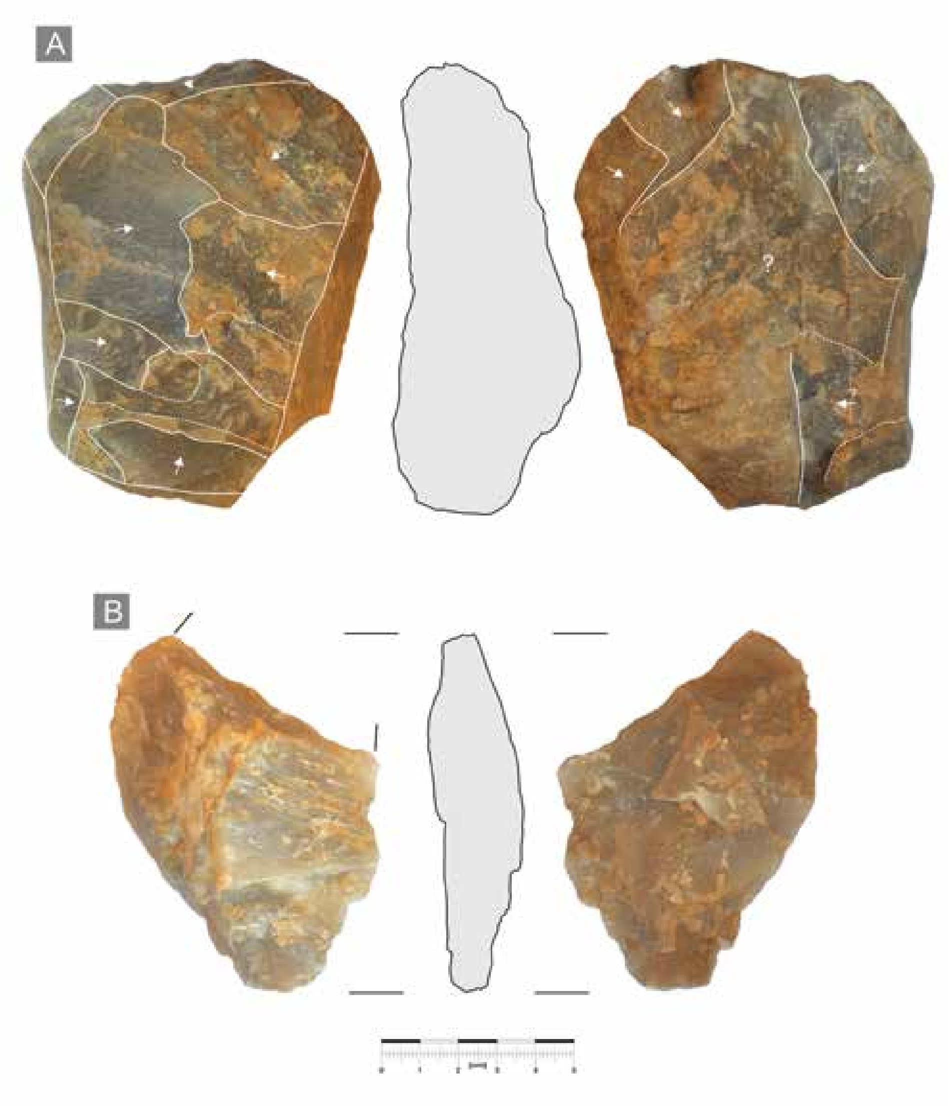

Fig. 3. Nowogród, site. 17, Golub-Dobrzyń district. Selection of stone artifact. Computer graphics: G. Osipowicz and J. Orłowska.

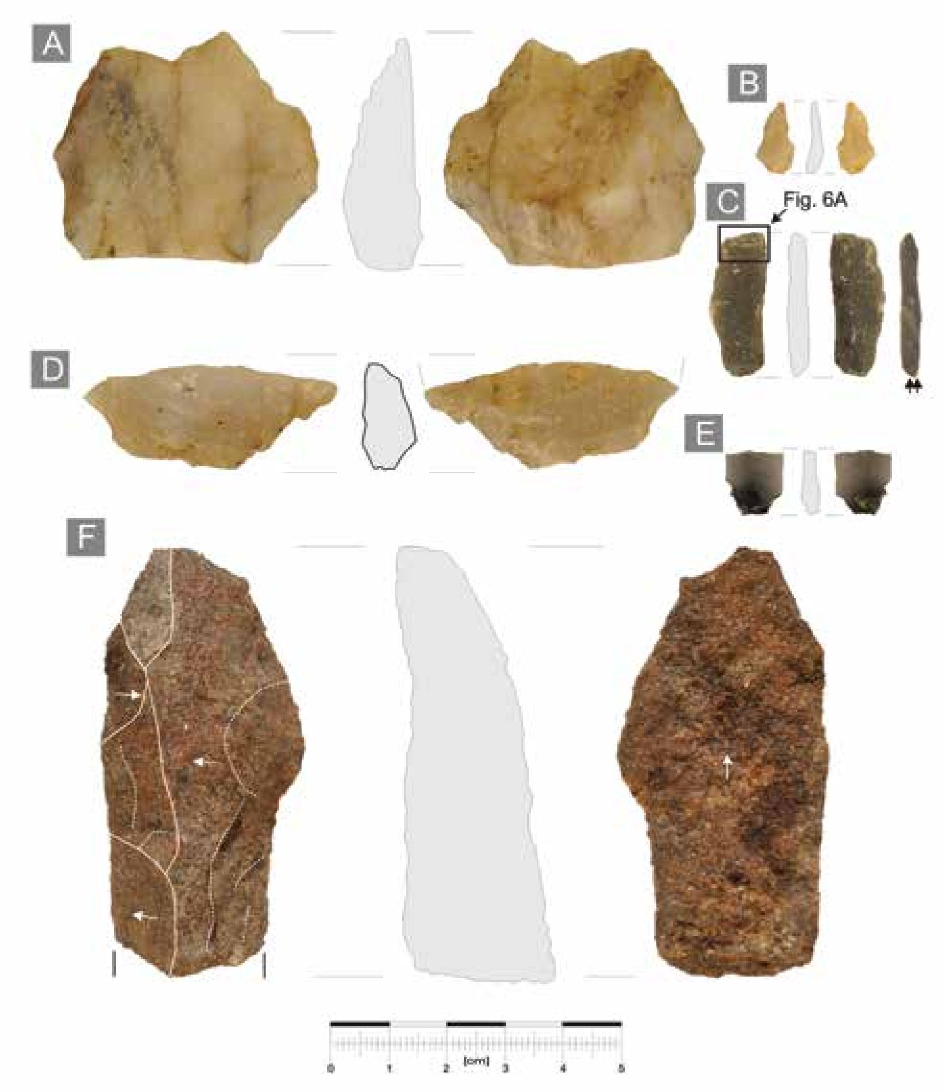

Fig. 4. Nowogród, site. 17, Golub-Dobrzyń district. Selection of stone artifact. Computer graphics: G. Osipowicz and J. Orłowska.

tions (Osipowicz and Sobkowiak-Tabaka 2014; Osipowicz 2015). Other non-flint stone artefacts were also found on the site, comprising mainly macrolithic tools. The rock crystal piece included in the study and the probable concretion of quartz of this type originated from the humus layer over one of the Mesolithic habitation areas, however their relation to the Late Glacial communities, whose camps was discovered only a few metres away, cannot be excluded. Unfortunately, the probable concretion of rock crystal was lost in unclear circumstances during the preparation of this study, therefore, it was impossible to include photographs or drawings, as well as photomicrographs of post-depositional damages observed on it. All artefacts were subjected to technological, typological, petrographic and use-wear analysis. In order to identify the geological source of the obsidian found at Nowogród, it was subjected to Prompt Gamma-Ray Activation Analysis (PGAA) and X-ray Fluorescence Analysis (XRF). The petrographic characteristics of stone materials of all the artefacts were assessed by macroscopic methods (naked eye and under the magnifying glass). The lithological examinations were applied only to materials that appeared to have been worked.

Traceological analyses were performed using two microscopes. The initial examination was done using a Nikon SMZ–2T microscope with up to 12.6X magnification (virtual magnification up to 120X) fitted with a Nikon D7100 digital SLR camera body. The photomicrographs presented in Fig. 6A–E were also made with this equipment. Observations of polish were done using a Zeiss-Axiotech microscope with up to 50X magnification (virtual magnification up to 500X) fitted with an Axiocam 105 camera. The photomicrograph presented in Fig. 6F was also made with this equipment. The terminology and methodology of the use-wear analysis performed for this paper have been described in previous publications (see Osipowicz 2010 and references therein). Microscopic investigations of the stone artefacts described in this paper were extremely difficult due to the coarse crystallinity of the raw material used during the production of most of the artefacts, and the lack of an appropriate comparative database for the recorded damage in the form of a collection of experimental artefacts. For this reason, only a very general description of the traces observed, and a cautious interpretation of their genesis, was made.

PGAA was carried out at the Prompt Gamma Activation Analysis facility of the Budapest Neutron Centre (BNC), operated by the Centre for Energy Research, Hungarian Academy of Sciences. The obsidian piece was placed into the horizontal cold neutron beam and irradiated for 18000 s (5 h). The neutron flux at the sample position of the PGAA station was about 9.6×10^7 $cm^{-2}s^{-1}$. The cross-section of the neutron beam was adjusted to 4 cm^2, so as to ensure the whole object is illuminated by the neutrons. The gamma radiation from the radiative neutron capture was detected with a High-Purity Germanium (HPGe) detector, surrounded by a Bismuth Germanate (BGO) scintillator and lead shielding; the signals were processed with a Canberra AIM 556A multichannel analyser. The facility has been described in detail in an earlier publication

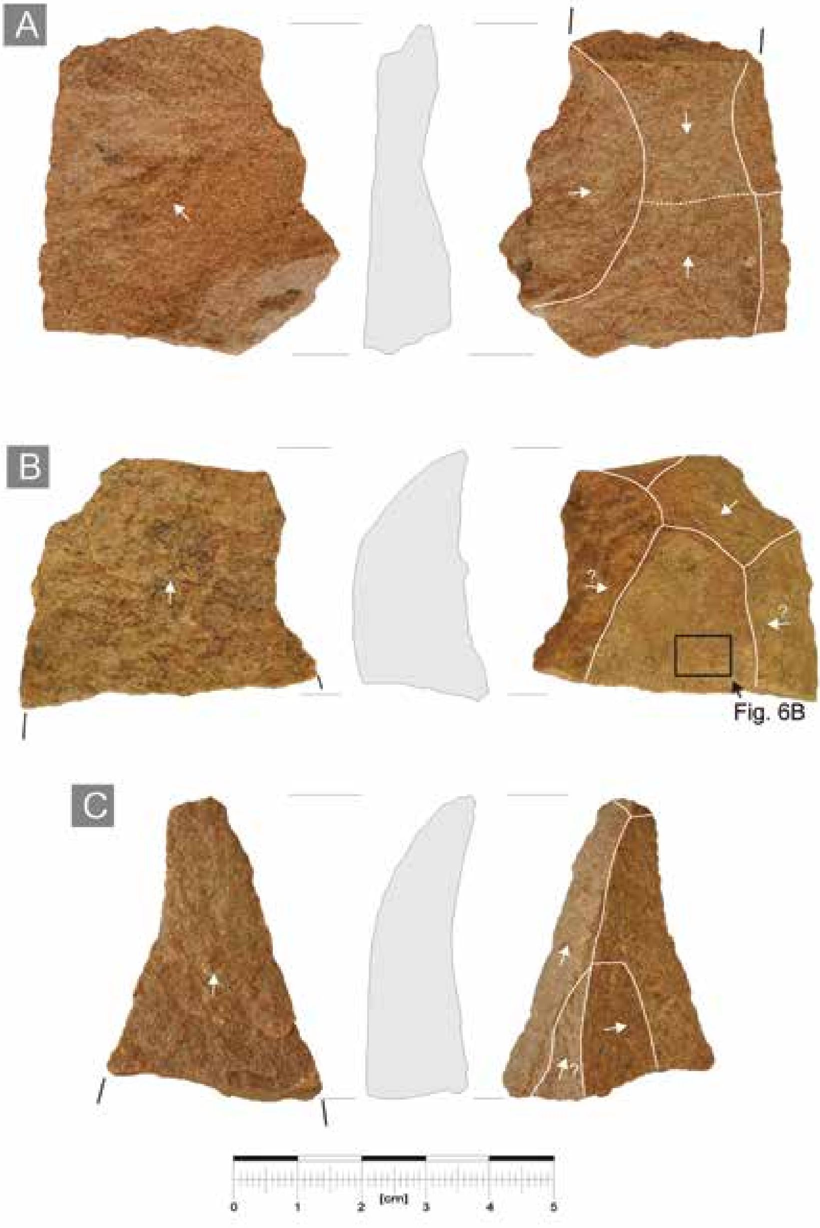

Fig. 5. Nowogród, site. 17, Golub-Dobrzyń district. Selection of stone artifact. Computer graphics: G. Osipowicz and J. Orłowska.

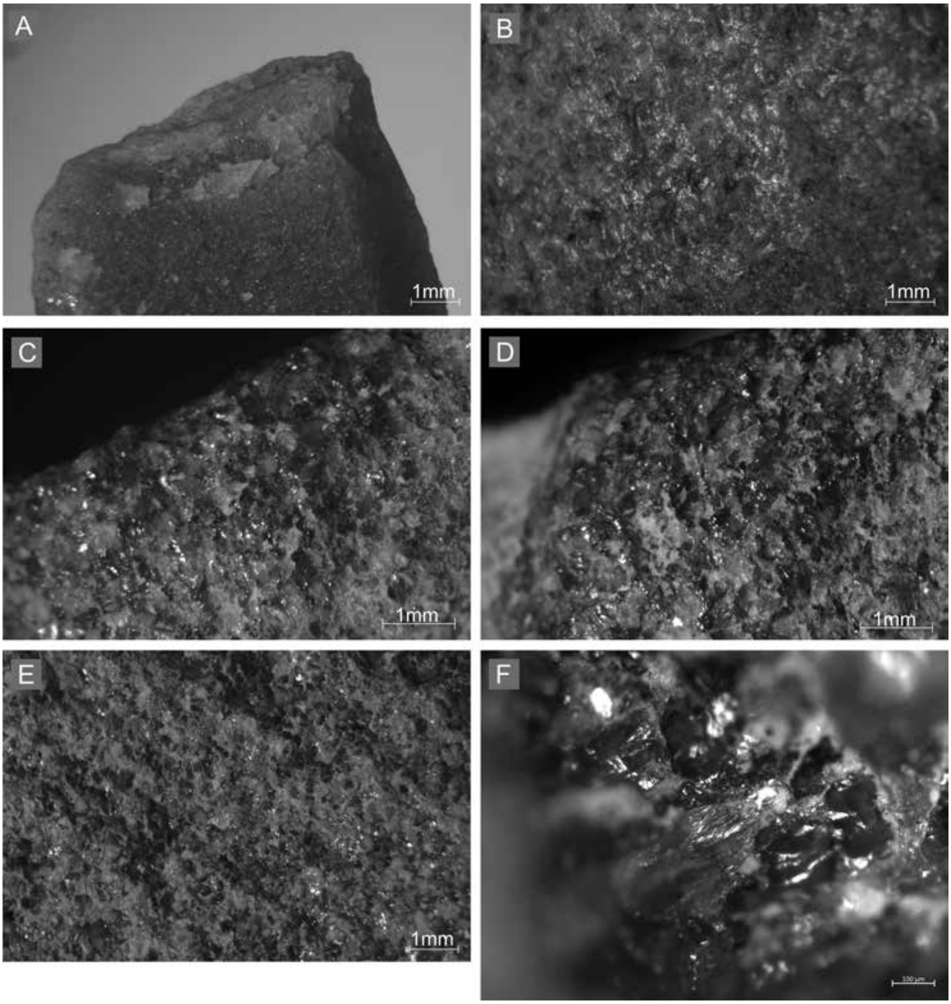

Fig. 6. Nowogród, site. 17, Golub-Dobrzyń district. Usage and technological traces observed on stone artefacts. Photo: G. Osipowicz.

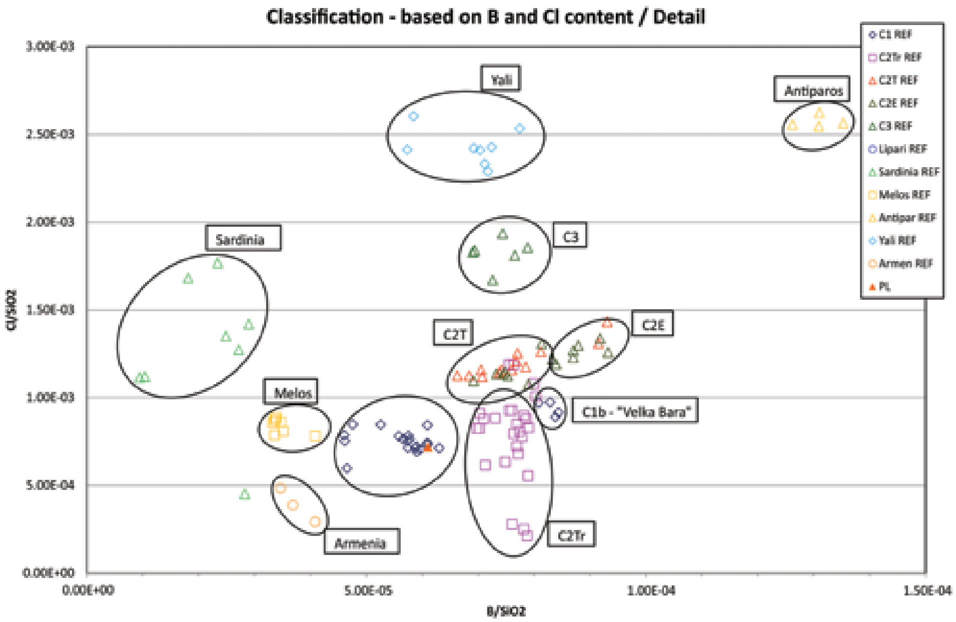

Fig. 7. The results of PGAA: classification based on B and Cl content. Computer graphics: Z. Kasztovszky.

(Szentmiklósi *et al.*, 2010). The spectrum was evaluated with Hypermet-PC gamma spectroscopy software. The element identification was done with the program ProSpeRo (Révay 2009), utilizing Prompt-Gamma Analysis Library (Révay *et al.*, 2004). The beam background has been adequately corrected for.

XRF analysis was performed using an X-ray spectrometer PANalytical MinPan4 (PW4025/00 type) using X-ray fluorescence. The obsidian sample was placed in a Teflon test cuvette with a bottom made of a Kapton foil. The measurement was carried out at a voltage of 14 kV and an amperage of 150 μA. Four measurements were carried out (two for each side of the artefact). The measurement time was 60 or 120 seconds. The device has been calibrated based on geological reference materials (molten granite and basalt).

RESULTS

Petrographic, typological and technological analyses

Detailed raw material and typological characteristics are presented in Table 1. Selected artefacts are presented in Fig. 2–5. The Late Palaeolithic population living at site 17

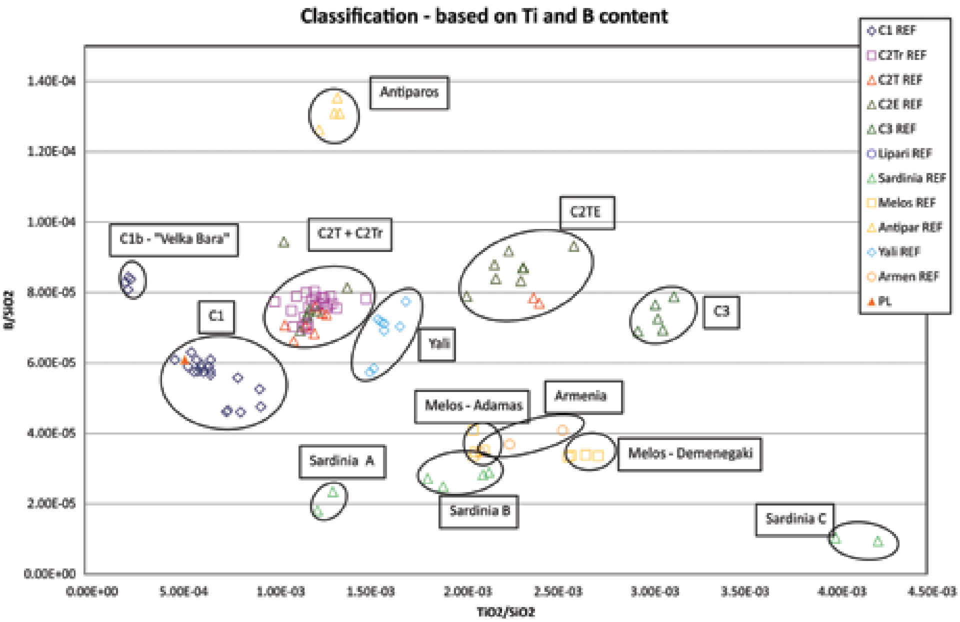

Fig. 8. The results of PGAA: classification based on Ti and B content. Computer graphics: Z. Kasztovszky.

in Nowogród used a rather diversified, but carefully selected, range of raw materials in stone processing. Among the stone materials used, four lithological varieties of rocks were distinguished. The most commonly used were quartzite (eight of the 17 finds) and quartzite sandstone (5 specimens). Other other rock types were used less frequently, represented by single specimens of quartz, coarse sandstone and diorite. The rock crystal concretion found on the site at Ludowice and the second concretion are heavily affected by postdepositional processes, which caused problems with the precise determination of the lithology of the second specimen.

Most of the artefacts analyzed (11 specimens) are large flakes. A chip and two tools were also identified. Of the tools one is the single blow multiple burin made (probably) on a quartzite blade (Fig. 4C). The second is more interesting, because it is (probably) a diorite pebble, processed on both sides around the circumference so as to create a semicircular blade covering about three-quarters of the edge on the artefact (Fig. 2). The artefact also has a kind of back formed by (blunting) negatives of flakes that are perpendicular to its axis. The object can be considered as a type of two-sided pebble tool although, considering its morphological characteristics, it cannot be ruled out that it is a kind of pre-core form of a double platform core in which preparation of the

Table. 1. Results of raw material, morphological and traceological analysis of the described stone artefacts.

No.	Site Name	Inwentory number	Raw material	Morphological description	Traceological description	Figure
1.	Nowogród, site 17	728	quartzite	fragment of a large flake	flake removed from grinding plate or grinding stone	Fig. 5B, 6B
2.	Nowogród, site 17	730	coarse sandstone	flake	no sign of use	
3.	Nowogród, site 17	732	fine-grained quartzite sandstone	flake	no sign of use	
4.	Nowogród, site 17	751	quartzite	fragment of a flake	no sign of use	Fig. 4D
5.	Nowogród, site 17	738	quartzite sandstone	flake	no sign of use	Fig. 5A
6.	Nowogród, site 17	748	quartzite	flake	no sign of use	Fig. 4A
7.	Nowogród, site 17	749	quartzite sandstone	fragment of a flake	no sign of use	Fig. 5C
8.	Nowogród, site 17	752	quartzite sandstone	flake	no sign of use	Fig. 4F
9.	Nowogród, site 17	753	quartzite	flake	no sign of use	Fig. 3B
10.	Nowogród, site 17	754	quartzite	single blow multiple burin made (probably) on blade	well-readable technological traces (hard hammer technique)	Fig. 4C, 6A
11.	Nowogród, site 17	757	quartzite sandstone	flake	no sign of use	
12.	Nowogród, site 17	759	quartzite	fragment of a flake	no sign of use	
13.	Nowogród, site 17	764	quartz	flake	no sign of use	
14.	Nowogród, site 17	765	diorite (?)	pebble tool	probably used, activity unspecified	Fig. 2, 6C-E
15.	Nowogród, site 17	767	quartzite	precore form	no sign of use	Fig. 3A
16.	Nowogród, site 17	768	quartzite	chip	no sign of use	Fig. 4B
17	Nowogród, site 17	758	obsidian	butt part of blade	no sign of use	Fig. 4E
18	Ludowice, site 6	670	quartz /rock crystal (?)	concretion	no sign of use	
19	Ludowice, site 6	173	rock crystal	concretion	no sign of use	

future flaking surface and both platforms had been made. All the artefacts described were made using hard hammer technique.

The obsidian artefact found at Nowogród is the proximal part of a small blade. Both suggested concretions of rock crystal found at the Ludowice site show no obvious traces of processing.

Use-wear analysis

Use-wear analysis of the stone artefacts from the site at Nowogród did not lead to the identification of damage that could be unambiguously considered as traces of use. Most of the pieces analysed show no signs of use at all. On some of them are only identifiable technological traces resulting from the use of a hard hammer, in the form of different types of crushing and exfoliation (Fig. 6A). On one of the surfaces on a fragment of a large quartzite flake (inventory number 728), there was clearly visible rounding and linear polishing, which is probably the result of using the specimen (initially, before knapping) as a grinding slab or grinding stone (Fig. 6B). Undoubtedly, the most interesting traces were observed on the suggested pebble tool (inv. no. 765). On its circumference, in the place of separating the flakes to form the blade, crushing is clearly visible. Their origin is ambiguous; they could be related to the process of manufacturing, its use, or both. Clear rounding and smoothing of the microrelief of the raw material were also observed on the blade of the specimen (Fig. 6C and D). It did not occur on other parts of the artefact (Fig. 6E). In the rounded areas, a kind of shiny, linear polish was evident (Fig. 6F). Further characterization and interpretation were impossible for reasons given in the Methods section, above. However, it is possible to tell with a high degree of probability that the damage described has a usage origin, which suggests we are dealing with a used tool.

Microscopic analysis of the obsidian blade from the site at Nowogród revealed no signs of use. Both pieces of rock crystals found at the site at Ludowice were also subjected to traceological analysis. They do not bear traces of processing or use; however, clear rounding of their edges was visible, resulting from long-term post-depositional processes. Therefore, from the results of the traceological research, it is not certain if we are dealing with objects brought to the site by Late Palaeolithic or Mesolithic people, or whether they were already there as a result of the movement of the ice sheet.

Analysis of the obsidian artefact using PGAA and XRF

The PGAA results are summarized in Table 2. With PGAA, we were able to quantify most of the major components in the obsidian (i.e., SiO_2, TiO_2, Al_2O_3, Fe_2O_{3t}, MnO, CaO, Na_2O, K_2O, H_2O), as well as some trace elements (i.e., B, Cl, Nd, Sm, Gd)[1].

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[1] Concentrations of major components are given as oxide values, while trace element concentrations are reported in parts per million (ppm) or micrograms/gram (ug/g) – all measurements are in weight %.

Table 2. Summary of the PGAA results of obsidian from site 17 at Nowogród, Golub-Dobrzyń district. The measured concentrations with one-sigma errors.

Trace components	Conc. / wt%	Abs. Unc. / +/-
SiO2	76.3	0.4
TiO2	0.041	0.002
Al2O3	13.1	0.3
Fe2O3	0.91	0.03
MnO	0.059	0.002
CaO	0.72	0.04
Na2O	3.72	0.08
K2O	4.84	0.10
H2O	0.282	0.007
Cl	0.055	0.001
B	0.0047	0.0001
Sm	0.00037	0.00001
Gd	0.00047	0.00003

The MgO content of the samples was found to be below the quantification limit (~0.9 weight%). In Table 2, the absolute uncertainties of the concentration values are also given. The concentrations are average values for the irradiated volume.

Among the trace elements, PGAA is especially applicable to detect B and Cl. Based on previous research, the major and trace components in obsidian are characteristic

Table 3. Summary of the XRF results of chemical composition of obsidian from site 17 at Nowogród, Golub-Dobrzyń district.

wt%	Time of analysis 60 s	Time of analysis 120 s	Time of analysis 60 s	Time of analysis 120 s	Average (n=4)
Al_2O_3	8.80	8.80	8.60	8.70	8.73
SiO_2	72.90	73.00	72.90	72.80	72.90
K_2O	11.10	11.00	11.20	11.30	11.15
CaO	2.52	2.52	2.54	2.54	2.53
TiO_2	0.22	0.22	0.23	0.23	0.23
MnO	0.25	0.24	0.25	0.25	0.25
Fe_2O_3	4.23	4.20	4.29	4.32	4.26
Total:*	100.02	99.98	100.01	100.14	100.04

* total without content of H_2O and NaO.

for their geological origin (provenance; Kasztovszky *et al.,* 2008; Kasztovszky *et al.*, 2018). Based on the B, Cl and TiO_2 content, comparisons of the composition in the investigated objects to those in previously measured reference samples, we can ascertain the provenance of the 'unknown' samples, with high reliability (Fig. 7 and 8).

As a conclusion, it can be said that the investigated sample (marked as 'PL') proved to be the C1 ('Carpathian 1') type, most likely from the sources Cejkov or Kašov.

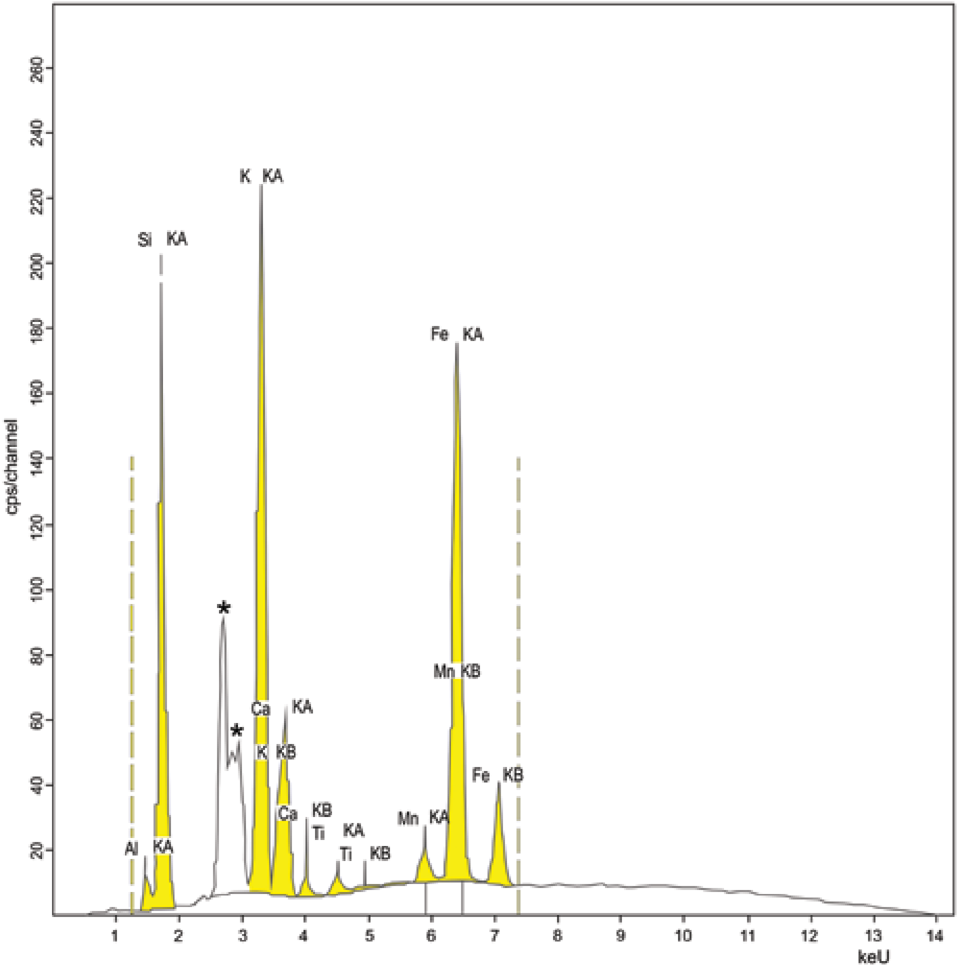

Fig. 9. The XRF spectrum of obsidian from the site 17 in Nowogród, Golub-Dobrzyń district (* – lines derived from cathode and argon excitation). Computer graphics: R. Siuda.

The results of XRF analysis are presented in Fig. 9 and Table 3. They significantly differ from the PGAA results, which will be more widely discussed below, in the part devoted to the discussion of the research results.

DISCUSSION

Industries of non-flint rocks in the Late Palaeolithic and Mesolithic of Poland are relatively poorly documented, particularly in the lowland part of the country. Generally, only a few sites have these types of artefacts in the inventories. Quartzite artefacts are known from Polish Magdalenian sites, e.g., Dzierżysław, site 35, Głubczyce district, Wilczyce, site 10, Sandomierz district, Klementowice, site 20, Puławy district (south-eastern Poland), and have been found sporadically at Świderian sites, e.g., Czerniewice, Włocławek district. Several artefacts made of quartz have been recorded at the Hamburgian site of Myszęcin (Świebodzin district, western Poland; Kabaciński and Sobkowiak-Tabaka 2013: 156), while a very interesting collection of 56 pieces made of fine-crystalline quartzite was discovered during the study of the multicultural site of Lubrza 10, Świebodzin district (Kabaciński and Sobkowiak-Tabaka 2011a, 2011 b; Osipowicz and Sobkowiak-Tabaka 2014).

A similar situation can be observed during the Mesolithic. The possibility of treatment of different varieties of non-flint rocks at Polish early Holocene sites was first put forward by Stefan Krukowski and Antoni Nowakowski (Nowakowski 1976: 68). Hanna Więckowska and Maria Chmielewska have also written about early Holocene artefacts of this type (2007: 30–33).

A relatively large, lowland, collection of Mesolithic stone artefacts, from non-flint raw materials, also comes from site 6 at Ludowice and the nearby Mesolithic cemetery at Mszano, Brodnica district (Osipowicz and Sobkowiak-Tabaka 2014; Osipowicz 2015). A contrast to the typical assemblages from the Polish lowland are those dominated by Sudeten rocks. The Ścinawa Mesolithic settlement microregion in the Lower Silesian region was perhaps of greatest interest because rocks ideal for Mesolithic knapping, such as jasper, opal, chalcedony, rock crystal, amethyst, agate, lidite, quartzite and trachybasalt, were found in the area (Bronowicki 2008). Pedunculated Komornica truncations are mentioned, for example, at the Ratno Dolne 2 site, Kłodzko district, along with points with horizontally retouched bases made of exotic raw materials like rock crystal, quartzite, porcellanite and Permian chert (Bronowicki and Bobak 1999: 61; Bronowicki 2002).

Based on previous research on the structure (assortment and frequency) of the Fennoscandian erratics found in the Polish Lowlands, we know that the main source of raw materials for stone processing in prehistory was local post-glacial rock resources, i.e., Fennoscandian erratic boulders and pebbles occurring in sediments that build numerous forms of the young glacial landscape in the Polish Lowland (among others Chachlikowski 1994, 1997, 2000, 2007, 2013, 2017, 2018; Chachlikowski and Skoczylas 2001a, 2001b). From the current petrographic survey of the structure of rock materials from site 17 at Nowogród, it can be concluded that among the communities settling this site at the end of the Late Palaeolithic, it was also common to use local erratic resources. The exclusive use of locally-available raw materials is demonstrated by the fact that the rock types most commonly used for knapping, quartzite and quartzite sandstone, occur most abundantly among the post-glacial stone materials deposited in Poland (Chachlikowski 1997: 141–149, 2013: 19–24, 60–128, 2018). The probability of imports within this group of non-flint raw materials is therefore very small. This goes against current perceptions of the structure of the imported raw materials used on the Polish Lowland in prehistory (Chachlikowski 1996, 1997: 37–44, 172–181, 2013, 2018; Chachlikowski and Skoczylas 2001b, and references therein).

Thus, for their stone industry, the Late Palaeolithic communities living in the area of Nowogród 17 probably benefited from the natural resources within the near vicinity of the site. It should be assumed that boulders and pebbles of the material exploited are found in the form of natural accumulations of rock blocks, residual morainic material embedded by the Fennoscandian ice sheet in the early post-glacial landscape of the lowland. It is known that these local accumulations of lithic materials were extremely abundant, and at the same time varied in lithological composition; these reservoirs of raw materials were useful in prehistoric stone processing, and were also used as building materials. These raw materials were probably obtained through gathering (from the ground surface), and also exploited using the open-pit method to extract appropriate (in terms of lithology and size) stone raw materials from the surrounding Pleistocene deposits (Chachlikowski 1994, 1997: 149–171, 2008, 2013: 40–59, 97–106, 2017). The Grodno-Plebanka tunnel valley, in which site 17 at Nowogród occurs, was ideally situated in this respect. Both its slopes and part of the post-glacial thresholds present here consist of sands and gravels deposited during the main stadial of the Weichselian Glaciation (Wysota 2006, 2007). The highest of the thresholds is located in the vicinity of site 17 at Nowogród. Within its area, on the surface of the Grodno-Plebanka tunnel valley, clusters of erratic boulders were found. Coarse-grained sediments (boulders and gravels), which are commonly found within in the Grodno-Plebanka tunnel valley, are directly related to the genesis of this landform. It was created as a result of the erosion of snowmelt waters beneath the Scandinavian ice sheet during the Weichselian Glaciation. The existence of boulder clusters and coarse gravels may therefore be the result of the fine fraction washout from glaciogenic sediments by melt waters under the ice sheet. These waters, flowing under high hydrostatic pressure, eroded the ice sheet substrate, causing the formation of the Grodno-Plebanka tunnel valley, while the deposits of boulder-gravel material commonly found in the bottom of the tunnel valley and in the vicinity of archaeological sites are coarse-grained residua of glaciogenic deposits.

Obsidian artefacts attributed to the Middle Palaeolithic are known from three sites: Rybnik: site A, Rybnik district, Obłazowa Cave, Nowy Targ district, and Ciemna Cave, Cracow district (Ginter 1986; Valde-Nowak *et al.*, 2003). In the Upper Palaeolithic, the utilization of obsidian increased. Single finds occur in assemblages attributed to the Szeletian (Obłazowa Cave, layer XI; Valde-Nowak *et al.*, 2003), Aurignacian (Kraków-Zwierzyniec; Cracow district; Sawicki 1949) and Gravettian (Kraków-Spadzista Street; Sobczyk 1995). A good example is the Epigravettian site of Targowisko 10 near Cracow (Wilczyński 2010). The site also yielded the largest collection of obsidian artefacts from Palaeolithic Poland. Magdalenian obsidian is known from the Ćmielów 'Mały Gawroniec' site Ostrowiec Świętokrzyski district (Sulgostowska 2005: 49; Przeździecki *et al.*, 2012). Numerous obsidian finds are connected with Arched Backed Piece Technocomplex concentrations of the Rydno complex, Starachowice district (Schild and Królik 1981; Tomaszewski *et al.*, 2008). Other sites where obsidian is present are located in southern Poland, namely Nowa Biała 1, Nowy Targ district, Sromowce-Niżne 1, Nowy Targ district (Valde-Nowak 1987), Skwirtne 1, Gorlice district (Valde-Nowak 1991) and Tylicz A, Nowy Sącz district (Tunia 1978). Obsidian was also used by societies connected with the Tanged Point Technocomplex. There are only two sites on the Plain where Late Palaeolithic obsidian artefacts have been found, Koło district, and Mokrsko, Wieluń district (Sobkowiak-Tabaka *et al.*, 2015). From southern Poland, a few stray finds are also known – 'somewhere near Płock', Kraków-Bagno, Cracow district, Glanów, Olkusz district, Czerniejów Site 2, Lublin district, Kraków-Bieżanów Site 15, Cracow district and Wołodź, Brzozów district (Krukowski 1920; Osipowicz and Szeliga 2004; Sulgostowska 2005). Single obsidian artefacts may also be attributed to the Swiderian settlement complex at Rydno (Schild *et al.*, 2011).

Against this background, the obsidian artefact from Nowogród, which is probably connected with the Swiderian culture, should be considered as an important find. Its presence at a site located so far north makes it important to carry out analyses aimed at determining the geological source of the raw material used. The PGAA study, which indicates an origin in the Carpathian 1 source area in Slovakia, can be compared with the results of this type of analysis carried out on other obsidian artefacts with identical or similar chronology. PGAA was also performed on obsidian from two Late Palaeolithic sites on the Polish Plain: Cichmiana and Mokrsko (Jażdżewski 1929; Kabaciński and Sobkowiak-Tabaka 2009). The results of the analyses showed that they are also most similar to the Carpathian 1 source (i.e., Slovakian, northern part of the Tokaj Mountains; Sobkowiak-Tabaka *et al.*, 2015). Non-destructive energy dispersive X-ray fluorescence (EDXRF) analysis was performed on obsidian artefacts from Mesolithic layers at the Rydno XIII/1959 site in central Poland (Hughes and Werra 2014). Element concentration values for the obsidian artefacts from this site indicate that the tools analysed were manufactured from Carpathian 1a/1b obsidian. Important data was provided by the latest research by Richard E. Hughes, Dagmara H. Werra and Zofia Sulgostowska (2018) that examined 86 obsidian artefacts from twenty Palaeolithic and Mesolithic archaeological sites in Poland. The artefacts were analysed with the use of non-destructive EDXRF (Hughes *et al.*, 2018: Table 5, 85), which showed that all Late and Final Palaeolithic, and also Mesolithic communities, used obsidian from the same outcrops – those of the Carpathian 1 chemical type in Slovakia.

The results of the XRF analysis of the obsidian artefact from the Nowogród site are significantly different from the results obtained by the PGAA method. As stated above, using PGAA we were able to quantify most of the major components, as well as some trace elements. With XRF, a more limited range of elements was measured (as oxide values: Al_2O_3, SiO_2, K_2O, CaO, TiO_2, MnO, Fe_2O_3). It has been shown that B, Cl and TiO_2 provide an important 'fingerprint' for obsidian. According to the TiO_2 content, not only can the major groups of obsidian sources be distinguished: *Carpathian 1:* outcrops in the vicinity of Viničky and Cejkov (Slovakia), *Carpathian 2:* Tokaj Mts. in Hungary, *Carpathian* 3: in the vicinity of Rokosovo (Ukraine), Lipari, Melos and Sardinia; but subtypes, especially those from Melos (subtype Demenegaki and Adama) and Sardinia (subtype A, B and C), can also be identified (compare Sobkowiak-Tabaka *et al.*, 2015; Kasztovszky *et al.*, 2018). The XRF analysis provided data on only one of the chemical compounds listed above, i.e., TiO_2. Unfortunately, the results obtained here are not even close to those obtained with PGAA method. They also do not fit in the average values specified for any obsidian outcrops, because the maximum value for TiO_2 is 0.20 Conc./wt% (Kasztovszky *et al.*, 2018: 184, Fig. 3b). The concentrations of other elements also differs between the PGAA and XRF analyses. Such large discrepancies can result from many factors. They may result from the sample preparation procedure and the way the analyses were conducted. To obtain reliable results for non-metallic materials using XRF, the sample should ideally be crushed, ground and then melted with a suitable flux. After melting, a suitable pellet is heat-formed from the enamel obtained, which is then analysed. In the case of archaeological artefacts this is out of the question, so the entire object is inserted into the apparatus and exposed to X-rays. Unfortunately, this type of analysis is flawed. The results may also vary according to the size of the analysed object, unevenness of the surface subjected to radiation, and other factors. Moreover, comparative studies of obsidian by PGAA and XRF have shown no correlation for elements such as Al and Si, and weak correlation for Ti and K. Similar results were obtained for elements such as Ca, Mn and Fe. The poor agreements between the PGAA and XRF data, especially for Al_2O_3 and SiO_2, can be explained partly by the absorption of the low energy characteristic X-rays in the air between the sample and the detector. Also, it should be emphasized that PGAA provides compositional data as an average over the whole irradiated volume, while XRF shows the composition of the outer few-tens-of-microns of the sample (Kasztovszky *et al.*, 2018).

Finally, it is worth discussing the possibility of linking the rock crystal found at Ludowice with the Mesolithic settlement. Besides the above noted Ratno Dolne 2 site, Kłodzko district, rock crystal was also present in the inventories of other Mesolithic sites in southern Poland, such as Jegłowa Site 2, Strzelin district (Bobak 1996, 1997) and Bielawa Site 12, Dziorżonów district (Bronowicki 1999). Importantly, the objects from Jegłowa Site 2 constitute the richest collection of rock-crystal artefacts from that area of Poland and comprises tools, raw products and waste, which indicates knowledge of the technological properties and use of this raw material by early Holocene communities in the area of what is today Poland. A connection between the pieces of rock crystal found at Ludowice and the Mesolithic communities is therefore perfectly possible, although it cannot be confirmed at the present stage of research.

CONCLUSIONS

The research on the small collection of non-flint stone artefacts discovered on site 17 at Nowogród has undoubtedly provided some interesting information, among which the most important is that associated with the obsidian artefact and the pebble tool. The presence of the latter is important evidence for the knapping of coarsely crystalline stone raw materials in order to create more than just grinding plates and grinders, as previously was thought to be the case. However, the results of the analyses carried out may also be the basis for asking many questions, especially those of a general nature, most importantly what was the real significance of this type of raw material for Late Palaeolithic communities. In an era of access to good quality flint resources, was their processing and use dictated by economic factors, or related to cultural or ritual factors, or even a matter of chance or mere curiosity? The answer to these questions undoubtedly requires the analysis of a much larger number of finds of this type. One thing is certain – this type of material must not be overlooked or underestimated.

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REFERENCES

Bobak, D. 1996. Ślady osadnictwa z epoki kamienia w Jegłowej, gm. Przeworno. *Śląskie Sprawozdania Archeologiczne* 37: 319–323.

Bobak, D. 1997. Badania mezolitycznego stanowiska Jegłowa 2, gm. Przeworno. *Śląskie Sprawozdania Archeologiczne* 39: 395–399.

Bronowicki, J. 1999. Mezolityczny mikroregion osadniczy w okolicach Bielawy u podnóża Gór Sowich. *Studia Archeologiczne* 31: 79–116.

Bronowicki, J. 2002. Obozowisko mezolityczne Ratno Dolne 2, pow. Kłodzko. *Acta Archaeologica Carpathica* 37: 5–18.

Bronowicki, J. 2008. Kamieniec, pow. kłodzki. Ścinawski mikroregion osadnictwa mezolitycznego. *Silesia Antiqua* 44: 254–257.

Bronowicki, J. and Bobak, D. 1999. Problem mezolitu w Sudetach. In P. Valde-Nowak (ed.), *Początki osadnictwa w Sudetach*, 53–74. Kraków.

Chachlikowski, P. 1994. Późnoneolityczne wybierzysko surowców skał niekrzemiennych w miejscowości Goszczewo, gm. Aleksandrów Kujawski, woj. Włocławek, stanowisko 13. *Folia Praehistorica Posnaniensia* 6: 59–121.

Chachlikowski, P. 1996. Ze studiów nad pochodzeniem i użytkowaniem surowców importowanych w wytwórczości kamieniarskiej społeczności wczesnorolniczych Kujaw. In A. Kośko (ed.), *Z badań nad genezą regionalizmu kulturowego społeczeństw Kujaw*, 121–153. Poznań–Inowrocław.

Chachlikowski, P. 1997. *Kamieniarstwo późnoneolitycznych społeczeństw Kujaw*. Poznań.

Chachlikowski, P. 2000. Kamieniarstwo społeczności kultur późnoneolitycznych. In A. Kośko (ed.), *Archeologiczne badania ratownicze wzdłuż trasy gazociągu tranzytowego, Tom III, Kujawy, cz. 4. Osadnictwo kultur późnoneolitycznych oraz interstadium epok neolitu i brązu: 3900–1400/1300 przed Chr.*, 393–409 and 605–606. Poznań.

Chachlikowski, P. 2007. Przetwórstwo i użytkowanie surowców kamiennych. In A. Kośko and M. Szmyt (eds), *Opatowice – Wzgórze Prokopiaka. Tom III. Studia i materiały do badań nad późnym neolitem Wysoczyzny Kujawskiej*, 315–338. Poznań.

Chachlikowski, P. 2008. *Osadnictwo wielokulturowe na stanowisku 8 w Chłopinach, gm. Lubiszyn, woj. lubuskie*, typescript, Institute of Archaeology, Adam Mickiewicz University, Poznań.

Chachlikowski, P. 2013. *Surowce eratyczne w kamieniarstwie społeczeństw wczesnoagrarnych Niżu Polskiego (IV–III tys. przed Chr.)*. Poznań.

Chachlikowski, P. 2017. Mining of lithic erratic raw material in the Polish Lowland in prehistory – a precedent or common practice? In A. Marciniak-Kajzer, A. Andrzejewski, A. Golański, S. Rzepecki and M. Wąs (eds), *Nie tylko krzemienie. Not only flints*, 369–387. Łódź.

Chachlikowski, P. 2018. The erratic stone raw material reservoir in the Polish Lowland and its procurement and selection within the local late Neolithic societies. Choices between the "gift" from the glacial past and the Earth's natural resources of the "south". In P. Valde-Nowak, K. Sobczyk, M. Nowak and J. Źrałka (eds), *Multas per gentes et multa per saecula. Amici magistro et collegae suo – Ioanni Christopho Kozłowski dedicant*, 537–546. Kraków.

Chachlikowski, P. and Skoczylas, J. 2001a. Exploration of stone raw-materials in stone industry of late-neolithic communities of Lowland Poland (Niż Polski). Prospects for further petroarchaelogical studies in the Kujawy region. *Przegląd Archeologiczny* 49: 17–34.

Chachlikowski, P. and Skoczylas, J. 2001b. Pochodzenie i użytkowanie surowców kamiennych spoza Niżu Polskiego w neolicie i wczesnej epoce brązu na Kujawach. *Fontes Archaeologici Posnanienses* 39: 163–190.

Ginter, B. 1986. Obsidianimporte im Spätpaläolithikum und Mesolithikum in Südpolen. In *Urzeitliche Und Frühhistorisches Besiedlung der Ostslowakei in Bezug zu den Nachbarngebieten*, 71–76. Nitra.

Hughes, R.E. and Werra, D.H. 2014. The source of Late Mesolithic obsidian recovered from Rydno XIII/1959, Central Poland. *Archeologia Polski* 59: 31–46.

Hughes, R.E., Werra, D.H. and Sulgostowska Z. 2018. On the sources and uses of obsidian during the Paleolithic and Mesolithic in Poland. *Quaternary International* 468: 84–100, https://doi.org/10.1016/j.quaint.2017.11.013.

Jażdżewski, K. 1929. Osadnictwo prehistoryczne nad górną Prosną. *Z Otchłani Wieków* 4 (5–6): 85–94.

Kabaciński, J. and Sobkowiak-Tabaka I. 2009. Big game versus small game hunting – subsistence strategies of the Hamburgian culture. In M. Street, N. Barton and T. Terberger (eds), *Humans, environment and chronology of the Late Glacial of the North European Plain*, 67–75. Mainz.

Kabaciński, J. and Sobkowiak-Tabaka, I. 2011a. Schyłkowy paleolit i mezolit. In J. Kabaciński and I. Sobkowiak-Tabaka (eds), *Osadnictwo pradziejowe i wczesnośredniowieczne w Lubrzy. Ratownicze badania archeologiczne Instytutu Archeologii i Etnologii PAN, Oddział w Poznaniu, T. III,* 21–28. Poznań, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Kabaciński, J. and Sobkowiak-Tabaka, I. 2011b. Schyłkowy paleolit. In J. Kabaciński and I. Sobkowiak-Tabaka (eds), *Materiały do wczesnych pradziejów Zachodniej Wielkopolski. Osadnictwo pradziejowe i wczesnośredniowieczne w Lubrzy. Ratownicze badania archeologiczne Instytutu Archeologii i Etnologii PAN, Oddział w Poznaniu, T. III*, 195–262. Poznań, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Kabaciński, J. and Sobkowiak-Tabaka, I. 2013. *Osadnictwo społeczności kultury hamburskiej na Pojezierzu Lubuskim. Ratownicze Badania Archeologiczne Instytutu Archeologii i Etnologii PAN Ośrodek Studiów Pradziejowych i Średniowiecznych, T. V*. Poznań, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Kasztovszky, Zs., Biró, K.T., Markó, A. and Dobosi, V. 2008. Cold neutron prompt gamma activation analysis e a non-destructive method for characterization of high silica content chipped stone tools and raw materials. *Archaeometry* 50 (1): 12–19.

Kasztovszky, Zs., Maróti,, B., Harsányi I., Párkányi, D. and Szilágyi, V. 2018. A comparative study of PGAA and portable XRF used for non-destructive provenancing archaeological obsidian. *Quaternary International* 468: 179–189.

Krukowski, S. 1920. Pierwociny krzemieniarskie górnictwa, transportu i handlu w holocenie Polski. Wnioski z właściwości surowców i wyrobów. *Wiadomości Archeologiczne* 5: 185–206.

Nowakowski, A. 1976. Surowce wulkaniczne Wieliszewa. In S.W. Krukowski and A. Nowakowski (eds), *SKAM 71, Zbiór rozpraw prahistorycznych*, 67–75. Warszawa, Zakład Narodowy im. Ossolińskich.

Osipowicz, G. 2010. *Narzędzia krzemienne w epoce kamienia na ziemi chełmińskiej*. Toruń.

Osipowicz, G. 2015. Zorganizowane i wyspecjalizowane obozowisko zbieraczy? Z wyników badań traseologicznych i przestrzennych materiałów mezolitycznych ze stanowiska Ludowice 6. *Przegląd Archeologiczny* 63: 59–85.

Osipowicz, G. 2017a. Ludowice 6 site, western habitation: A silica plant processing female gatherer campsite?. *Journal of Archaeological Science: Reports*, http://dx.doi.org/10.1016/j.jasrep.2017.08.019

Osipowicz, G. 2017b. *Społeczności mezolityczne Pojezierza Chełmińsko-Dobrzyńskiego : próba modelowej analizy wieloaspektowej funkcji i organizacji przestrzennej wybranych obozowisk*. Toruń, Wydawnictwo Naukowe Uniwersytetu Mikołaja Kopernika.

Osipowicz, G., Jankowski, M., Makowiecki, D. and Weckwerth, P. 2014. Obozowiska mezolityczne ze stanowiska Ludowice 6, woj. kujawsko-pomorskie, siedlisko zachodnie. *Wiadomości Archeologiczne* 65: 149–195.

Osipowicz, G. and Sobkowiak-Tabaka, I. 2014. New evidences for core processing of non-flint, lithic materials in the Late Palaeolithic and Mesolithic of Poland. *Journal of Lithic Studies* 1(1): 1–14.

Osipowicz, G. and Szeliga M. 2004. Analiza funkcjonalna obsydianowego liściaka schyłkowopaleolitycznego ze st. 7 w Wołodzi, woj. podkarpackie. *Acta Archaeologica Carpathica* 39: 153–160.

Przeździecki, M., Migal, W., Krajcarz, M. and Pyżewicz, K. 2012. Obozowisko kultury magdaleńskiej na stanowisku 95 "Mały Gawroniec" w Ćmielowie, pow. ostrowiecki, woj. świętokrzyskie (Pl. 104e115). *Światowit* 8, 48. Fascykuł B: 225–234.

Révay, Zs. 2009. Determining elemental Composition Using Prompt Gamma Activation Analysis. *Analytical Chemistry* 81: 6851.

Révay, Zs., Firestone, R.B., Belgya, T., and Molnár, G.L. 2004. Catalog and Atlas of Prompt Gamma Rays. In G.L. Molnár (ed.), *Handbook of Prompt Gamma Activation Analysis with Neutron Beams*, 173–364. Dordrecht-Boston-New York, Kluwer Academic Publishers.

Sawicki, L. 1949. Wyniki badań obozowiska myśliwców z epoki lodowcowej na Zwierzyńcu w Krakowie. *Archeologické Rozhledy* 1: 74–76.

Schild R. and Królik, H. 1981. Rydno a Final Palaeolithic Ochre Mining Complex. *Przegląd Archeologiczny* 29: 53–100.

Schild, R., Królik, H., Tomaszewski, A.J. and Ciepielewska, E. 2011. *Rydno. A Stone Age Red Ochre Quarry and Socioeconomic Center. A Century of Research*. Warszawa.

Sobczyk, K. 1995. *Osadnictwo wschodniograweckie w dolinie Wisły pod Krakowem.* Kraków.

Sobkowiak-Tabaka, I., Kasztovszky, Zs., Kabaciński, J., T. Biró, K., Maróti, B. and Gméling, K. 2015. Transcarpathian contacts of the Late Glacial Societies of the Polish Lowlands. *Przegląd Archeologiczny* 63: 5–28.

Sulgostowska, Z., 2005. *Kontakty społeczności późnopaleolitycznych i mezolitycznych między Odrą a Dźwiną i górnym Dniestrem*. Warsaw, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Szentmiklósi, L., Belgya, T., Revay, Zs. and Kis, Z. 2010. Upgrade of the prompt gamma activation analysis and the neutron-induced prompt gamma spectroscopy facilities at the Budapest research reactor. *The Journal of Radioanalytical and Nuclear Chemistry* 286: 501–505.

Tomaszewski, A.J., Królik, H., Ciepielewska, E., Laprus-Madej, B. and Mańka, D. 2008. Rydno's obsidians: almost all of them. In: Z. Sulgostowska and A.J. Tomaszewski (eds), *Man-Millenium-Environment: Studies in Honor of Romuald Schild*, 293–300. Warsaw, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Tunia, K. 1978. Sprawozdanie z badań stanowiska z epoki kamienia w Tyliczu, woj. Nowy Sącz. *Acta Archaeologica Carpathica* 18: 227–233.

Więckowska, H. and Chmielewska, M. 2007. *Materiały do badań osadnictwa mezolitycznego w mikroregionie Luta, województwo lubelskie*. Warsaw, Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Wilczyński, J. 2010. Obsidian products from Targowisko site 10 (powiat district of Wieliczka). In J. Gancarski (ed.), *Transkarpackie kontakty kulturowe w epoce kamienia, brązu i wczesnej epoce żelaza,* 115–137. Krosno.

Wysota, W. 2006. *Szczegółowa mapa geologiczna Polski w skali 1:50000, arkusz Golub Dobrzyń*. Warszawa, Państwowy Instytut Geologiczny.

Wysota, W. 2007. *Objaśnienia do Szczegółowej mapy geologicznej Polski w skali 1:50000, arkusz Golub-Dobrzyń*, 1–51. Warszawa, Państwowy Instytut Geologiczny.

Valde-Nowak, P. 1987. Entdeckung der Paläolithischen Fundstellen im Tal des Białka Tatrzańska-Flusses. *Acta Archaeologica Carpathica* 26: 5–35.

Valde-Nowak, P. 1991. Studies in Pleistocene Settlement in The Polish Carpathians. *Antiquity* 65: 593–606.

Valde-Nowak, P., Nadachowski, A. and Madeyska, T. (eds) 2003. *Obłazowa Cave: Human Activity, Stratigraphy and Palaeoenvironment*. Kraków.

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Lithic Raw Material Procurement in the Late Neolithic Southern-Transdanubian Region: A Case Study From the Site of Alsónyék-Bátaszék

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This article summarizes the current state of research on the flaked stone assemblages from the Late Neolithic site Alsónyék–Bátaszék, Tolna district. The raw material distribution of the nearly 6100 pieces that make up the stone tool assemblage is the focus of this paper, with a particular emphasis placed on the dominance of the local raw material. The research addresses the question of the method of procurement of the lithic raw material in the case of this enormous, extended Neolithic site. To supply an answer, basic geoarchaeological research was necessary. To that end, a field survey aimed at detecting those geological formations and lithic variations convenient for knapping was undertaken. The results of the survey reported in the second part of this paper help in our understanding of the selection strategy of the ancient knapping specialists. From these strategies, it is possible to recognize the cultural tradition and raw material manipulation of this Late Neolithic community and, in a wider sense, the southeastern group of the Lengyel culture.

KEY-WORDS: Carpathian Basin, Transdanubia, Late Neolithic, Lengyel culture, Mecsek radiolarite, local raw material characteristics and distribution, field survey

INTRODUCTION

The site at Alsónyék–Bátaszék is located in south-eastern Transdanubia (in the southern part of Hungary, Tolna district). It is situated near the Danube River, the main natural artery of communication in the area, and at the meeting point of two different regions, the Transdanubian Hills and the Great Hungarian Plain (Fig. 1). The emblematic sites of the Lengyel culture (Zengővárkony, Baranya district; Pécsvárad–Aranyhegy, Baranya district; Lengyel–Sánc, Tolna district; Mórágy–Tűzkődomb, Tolna district; and Villánykövesd, Baranya district) are also located nearby. The Lengyel settlement of Alsónyék is unique among the culture's known sites and represents a period of flourishing in its lifespan (Fig. 2).

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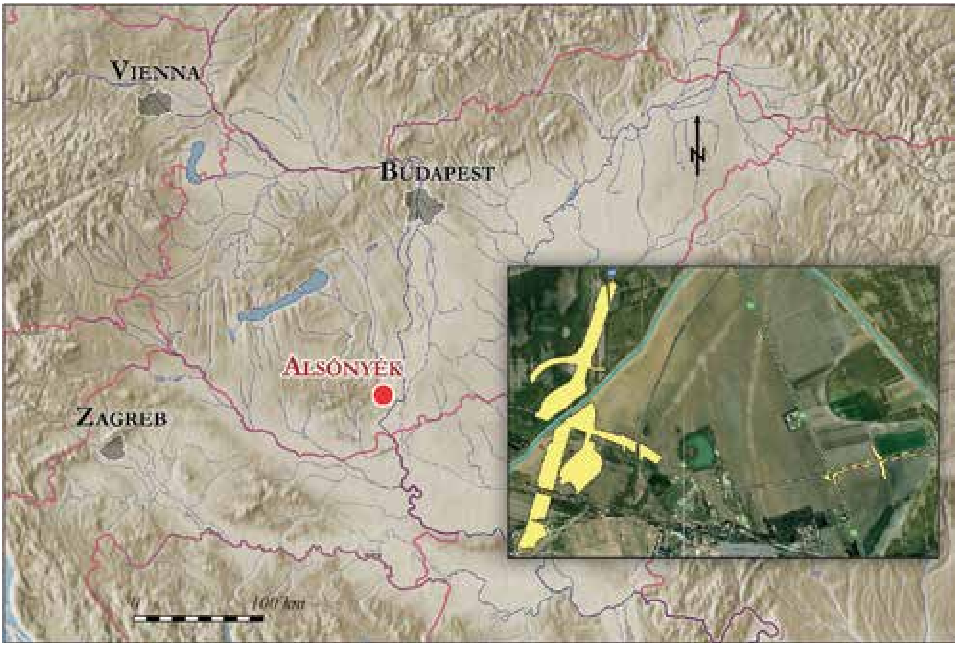

Fig. 1. Location of the Alsónyék–Bátaszék site (Tolna district) and outline plan of the excavation (Osztás *et al.*, 2013a: Fig. 1.)

The 15,443 features uncovered in the 254,417 m^2 area of the excavations reflect and provide evidence for intensive occupation at the site (Osztás *et al.*, 2013a: 18). In addition to several later periods, traces of inhabitation were found belonging to cultures which cover almost the entire duration of the Neolithic in the region (Starčevo culture, Central European Linearbandkeramik [LBK], Sopot culture and Lengyel culture). The traces of Lengyel occupation can be seen over the entire excavated area (Gallina *et al.*, 2010: 7; Osztás *et al.*, 2012: 377–378; Osztás *et al.*, 2013b: 180). Nearly 9000 of the almost 15,000 features can be assigned to the Lengyel culture, including 2300 burials, hundreds of pits, and at least 122 post-framed houses.

Alsónyék is a very important site in the Neolithic period in Hungary, as no other Neolithic site yet excavated has contained such a number of burials and post-framed houses (Osztás *et al.*, 2013b: 182). According to the relative chronology of the region, the site belongs to Lengyel II. As part of the TOTL [The times of their lives: towards precise narratives of change in the European Neolithic through formal chronological modelling] project, the opportunity was provided to absolutely date the site using the radiocarbon method. Altogether, 217 radiocarbon results pertain to the Lengyel phase. The burial activity probably began around 4710–4685 cal BC (95% probability); 4715–4690 cal BC (68% probability) and the settlement was established in 4735–4695 cal BC (95% prob-

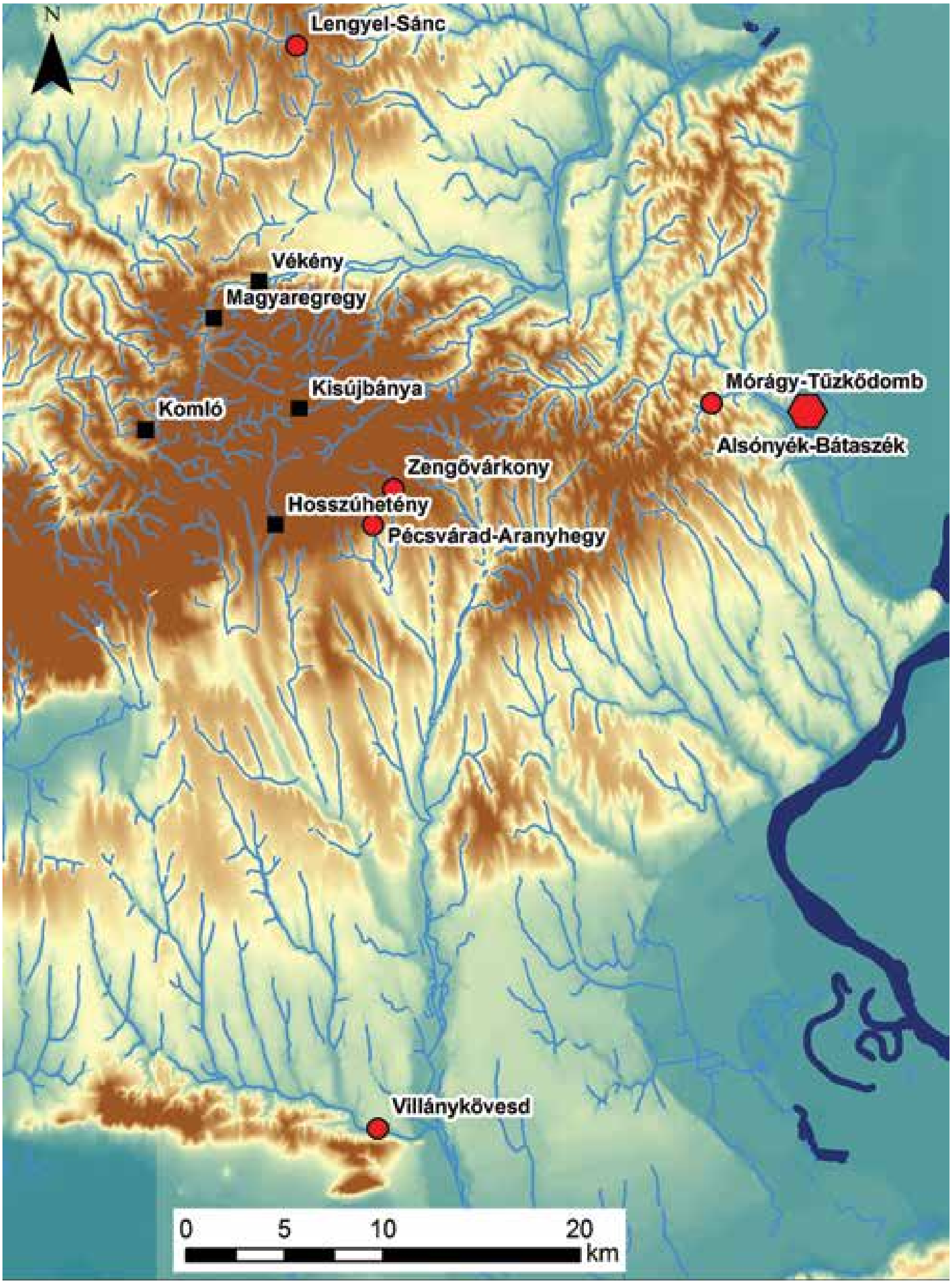

Fig. 2. Location of Alsónyék–Bátaszék (Tolna district) and major sites of Lengyel culture's South-Eastern Transdanubian group: black squares − Geological sources of Mecsek radiolarite; red dots − important sites; red hexagon − Alsónyék–Bátaszék). Computer graphics: P. Czukor.

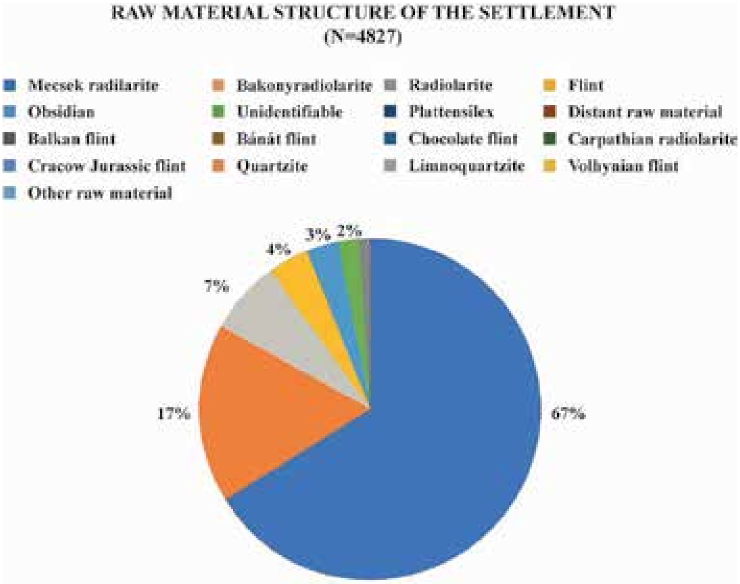

Fig. 3.1. Raw material structure of the settlement at the site Alsónyék–Bátaszék (Tolna district). Computer graphics: K. Szilágyi.

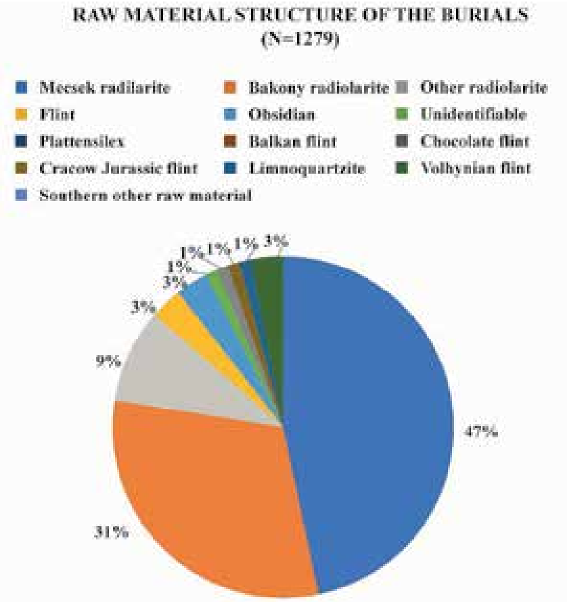

Fig. 3.2. Raw material structure of the burials at the site Alsónyék–Bátaszék (Tolna district). Computer graphics: K. Szilágyi.

ability); 4720–4700 cal BC (68% probability) in Alsónyék–Kanizsa-dűlő. Burial activity ended ca. 4705–4640 cal BC (95% probability); 4695–4670 cal BC (68% probability) and the Lengyel settlement ended around 4715–4680 cal BC (95% probability); 4695–4670 cal BC (68% probability; Osztás *et al.*, 2013b: 212–220, 222–224).

MATERIAL AND METHODS

Lithic assemblage

The entire flaked stone assemblage contains 6106 pieces (including stray finds). The majority of the stone tools came from well-defined archaeological features, mainly pits in the part of the site that was a settlement (4827 items, 79.05%). Within this settlement assemblage, the flaked stone tools derive almost exclusively from the occupation at Alsónyék–Kanizsa-dűlő (northern part of the excavation), the area where most of the timber-framed buildings are located (Szilágyi 2017a: 65–69). In addition to these settlement finds, nearly one quarter (20.95%, 1279 pieces) of the stone tool assemblage was discovered in burials across the site. As most of the burials (grave groups) are also clustered in the northern part of the site, in general flaked stone tools were found more frequently in the northern part of the excavation (Szilágyi 2017b: 104–105). Due to the density of archaeological features and the amount of the stone tools, we thus created the processing methods for material from the northern part of the excavation and applied them systematically to the rest of the site.

The raw material structure

Settlement

The raw material structure is relatively homogeneous; two kinds of radiolarite predominate (4037 items, 83.64%). One type is Mecsek radiolarite (3237 items, 67.06%), and the other is Bakony radiolarite (800 items, 16.58%). These kinds of radiolarite are suitable for knapping because they are both very homogeneous materials. Other radiolarites and flints were grouped into more general lithic groups as the pieces lacked markers that would allow a more exact provenience determination. Raw-materials coming from a farther distance include Obsidian, Plattensilex (Plattensilex/Abensberg-Arnhofen type hornstone; Binsteiner 2005), Balkan flint, Bánát flint, ‘chocolate’ flint, Carpathian radiolarite, Jurassic-Cracow flint and Volhynian flint. Five pieces were identified as coming from a non-local raw material where the exact provenience could not be determined, though an origin in the southern part of the Balkans is likely. Altogether, flaked stone tools made of more non-local raw materials were relatively uncommon in the assemblage (150 items, 3.10%). The presence of Plattensilex is very interesting as only one piece is known in the south-Transdanubian Lengyel culture so far, coming from Mórágy–Tűzkődomb, Tolna district (Zalai-Gaál 2009; Fig. 3:1).

Burials

Nearly a half of the stone tools found in burial contexts were made from Mecsek radiolarite (596 items, 46.6%); Bakony radiolarite variants were also included in larger quantities (397 items, 31.04%). It was not possible to determine the exact raw material source (e.g. mountain range of origin) of 112 examples of radiolarite and 43 examples of flint tools; thus, a single miscellaneous radiolarite and one similar flint lithic group were defined. Of the tools made from more non-local raw materials, Obsidian, Plattensilex, Balkan flint, 'chocolate' flint, Jurassic-Cracow flint, Volhynian flint and raw material of a southern origin (perhaps Balkan, like in the case of the settlement) occurred in relatively small numbers. Among these, Volhynian flint was found in the largest quantity. The number of pieces made of non-local raw material (95 items, 7.43%) is less than in the settlement, but the proportion in relation to tools of local raw materials is much higher than in the settlement assemblage (Fig. 3.2).

Raw material supply zones

Local supply zone

Mecsek radiolarite was formed during the Upper Jurassic-Lower Cretaceous period. Macroscopically, the colors of Mecsek radiolarite are very varied, with colours ranging from lilac-brown to silky greenish-blue grey. These colour variations can often occur in a single core, thereby making recognition of related items difficult. The Mecsek radiolarites are typically silky, which distinguishes them from the more brightly colored Bakony radiolarites. Mecsek radiolarite has a rough cortex that is relatively thin (1–3 mm) and sharply separated from the radiolarite. Geological sources of Mecsek radiolarite are known from Komló, Magyaregregy, Kisújbánya, Hosszúhetény and Vékény, Baranya district. The source of the Mecsek radiolarite is within the local supply zone for Alsónyék–Bátaszék; it is in the eastern part of the Mecsek Mountains, 15–30 km from the site (Bácskay and Biró 1984; Barabás 1986; Konda 1986; Biró 1988, 1989, 1990, 1998; Fig. 4).

Regional supply zones

Bakony radiolarites are one of the most important raw materials for the territory west of the Danube River. Bakony radiolarites were formed during the Middle and Upper Jurassic periods. These radiolarites are characterized by fine granularity, vivid colours and a creamy white to whitish-yellow cortex (porcelanites). The cortexes are also homogenous in texture. The colour of the Bakony radiolarite is also varied with orange-red, orange-brown, yellowish-brown, mustard and dark brown shades known. The primary geological sources lie in the Jurassic limestone of the Bakony Mountains to the north of Lake Balaton. The source of the Bakony radiolarite variations defines the regional supply zone for Alsónyék–Bátaszék; in the southern part of the Bakony Mountains, the source is 180–200 km from the settlement (Biró 1998; Mateiciucová 2008).

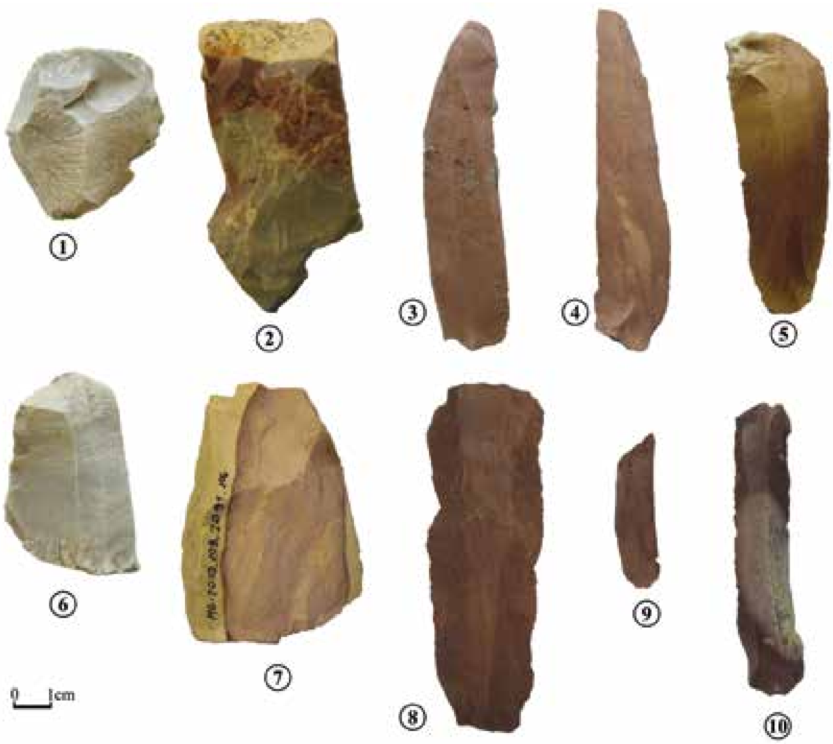

Fig. 4. Stone tools from Mecsek radiolarite at the site Alsónyék–Bátaszék, Tolna district.
1 – retouched flake; 2 – raw material block; 6–7 – cores; 3–5 and 8–10 – blades.
Computer graphics: P. Czukor.

The appearance of limnoquartzites is quite varied within one geological source, thus their identification is more difficult than that of radiolarites. There are transparent and translucent variants as well as a wide range of colours (white, bluish-white, bluish-grey, yellowish-brown and yellowish-grey). Six pieces of limnoquartzite may come from the Mátra Mountains, placing them within the regional supply zone as well. The limnoquartzite may have come from the Mecsek Mountains, but further instrumental investigation is necessary to verify this (Biró and Dobosi, 1991; Biró *et al.*, 2000).

Distant supply zones

Given the number of different non-local raw materials found at Alsónyék–Bátaszék and the availability of extensive, detailed literature concerning their properties and geological sources, these issues will not be discussed here. The sources of these raw materials reflect distant supply zones, 600–800 km away (Kaczanowska 1985; Pelisiak 1987; Mateiciucová 2008; Gurova 2011; Přichystal 2013; Szilágyi 2017a: 70–71 and Fig. 7).

RESULTS

The field survey in the East-Mecsek Mountains

In 2017 a new geoarcheological research project was started in the eastern part of the Mecsek Mountains (East-Mecsek), focused on determining the exact geological sources of the local radiolarite. The main aim of the project was to find and document the knappable raw materials in this region. Emphasis was placed on materials present in the flaked stone assemblage of the southeast-Transdanubian group of the Late Neolithic Lengyel culture. The Alsónyék site and its flaked stone collection was taken as a starting point in characterizing this larger assemblage.

The first step taken by the project was the collection and digitalization of the drift and solid geology geological maps of East-Mecsek. The second stage was to review the comparative raw material collections in the Hungarian National Museum in Budapest and the Komló City Museum. In the study of these collections we focused on the Jurassic and Cretaceous geological formations.

The documenting and sampling strategy

In maps digitalized during the first stage of research, Jurassic and Cretaceous formations were identified on the surface over quite a large territory. This area stretches from Komló to Ófalu (Baranya district) west to east and from Kárász (Baranya district) to Pécsvárad north to south. We started the field survey in valleys which contained the most formations according to these maps. The area of research was delineated according to the following three factors:

1. Selection of the formations belonging to the Jurassic and Cretaceous periods
2. Starting with larger formations on the surface
3. Starting with formations that have been previously studied and published.

The systematic field survey was started where these factors were most prevalent. At a later stage, the field investigation was continued in areas where the least information was available. All in all, the project was started with entire stream valleys that could have had a similar morphology in prehistoric times to that which they have in the present day.

Four limestone formations, one calcareous marl (Raucsik 2012b: 174–176), and one sandstone formation (Raucsik 2012d: 159–163) were selected for investigation in the first field survey. The raw materials of interest in the Márévár (Gyalog 1996: 104), Kisújbánya (Gyalog 1996: 107), Fonyászó (Raucsik 2012a: 180–183) and Óbánya Limestone Formations (Raucsik 2012c: 177–179) were formed in the Middle Jurassic and Upper Jurassic period. These raw materials have different natural forms, colours (both shade and lightness), textures, and cortexes.

During this first survey, many debris exposures with flint and radiolarite in pebble, block, and layer form were found. Reconnaissance maps that could be integrated into the database created in the first steps of the project were always made. For each point of interest, photos and samples were taken and the same information was recorded: type of observation (e.g. source rock, outcrop), field notes (other points of interest in the area), and other comments (e.g. radiolarite intercalations, tectonic information kind, post-deposition effects).

After these first stages of the project, the research area was defined in space and time. From the preliminary results it was determined that the Jurassic and Cretaceous periods were the most important. The relevant geological maps were examined and information about the raw materials deposited during these periods was collected.

Nodules and lenses of flint are mainly characteristics of the Oxfordian and Titon-Berriazian formations. The latter formations, however, are very varied in the Mecsek Mountains. Thus, macroscopically observable silica concentrations are missing in several cases; the limestone contains silica in a dispersed distribution. In the Mecsek Mountains, the upper parts of the Titon-Berriazian formations have almost no flint lenses and where flint nodules are found, they are dominated by cortex. In contrast, the lower parts of these formations can be quite rich in flint.

DISCUSSION

The 122 points of interest identified during the field survey resulted in the collection of 258 geological samples. The reconnaissance maps and field documentation were recorded and analyzed in ArcGIS. In this way, both the maps and information collected in the archives as well as the results of the field survey were integrated geospatially (Fig. 5).

It is assumed that knapping specialists made a conscious choice in selecting the appropriate geological sources for their raw material depending on what types of tools they wanted to create. The lithic raw materials played an important role in the organization of technology. It is apparent that raw material availability, size, and quality had complex influences on different aspects of stone tool technology. This fact alone makes lithic raw material an important resource for gaining insight into human land use and mobility patterns in relation to lithic technology (Andrefsky 2008, 2009).

Currently, only Raman spectroscopy was employed to analyse some of the geological and archaeological samples. This is a non-destructive phase analytical tool which is a very effective method for analyzing the mineral composition of an archaeological sample. The aim of the application of this analytical method in relation to the research goals of this project was to examine the similarities between two kinds of samples – modern (geological) and prehistoric (archaeological). This method allows the investigation of the question if the samples collected from geological formations during our field survey represent the same sources as those used by the prehistoric knappers. The results of this analysis show that the geological and archaeological samples are very similar. The amount of moganite (cryptocrystalline SiO_2) and minor carbonate in chert samples from geological and archaeological finds was similar. Thus, the moganite and carbonate content can

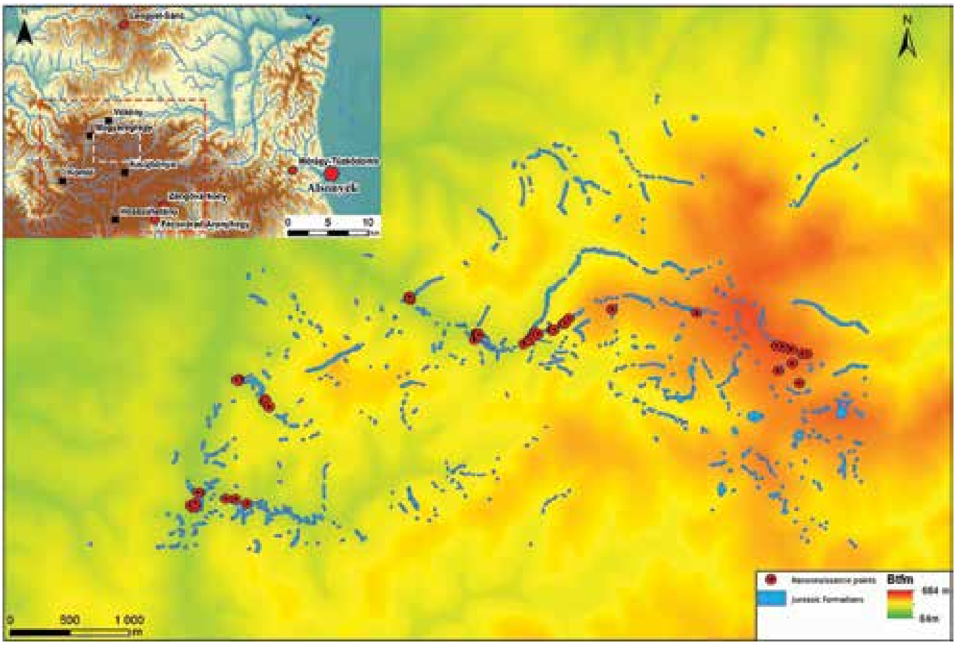

Fig. 5. The map of the microregion of the East-Mecsek geoarcheological project.
Computer graphics: P. Czukor.

be a discrimination marker during comparison of different finds with each other or with geological samples (Fig. 6). The next step of the geological research will be to create thin sections and analyze the geochemical components of the samples.

CONCLUSION

During field surveys, many quarries with radiolarite in the form of pebbles and blocks were found in East Mecsek. The petrographic formations and exact time of the genesis of these quarries were determined. It is supposed that toolmaking occurred throughout the settlement of Alsónyék. The local Mecsek radiolarite was of good quality and available in sufficient quantities for use. Most likely knapping specialists consciously chose the appropriate geological sources depending on what type of artefacts they wanted to create. The field investigation suggests that stream valleys were a good potential source of raw material, with an abundance of radiolarite pebbles. These pebbles are a secondary autochthonous source, thus the gatherer/knapper could collect the radiolarite pebbles fairly easily (Odell 2006), without pursuing the mining or digging activities needed in the case of the bedrock of the Bakony Mountains. However, the size of the

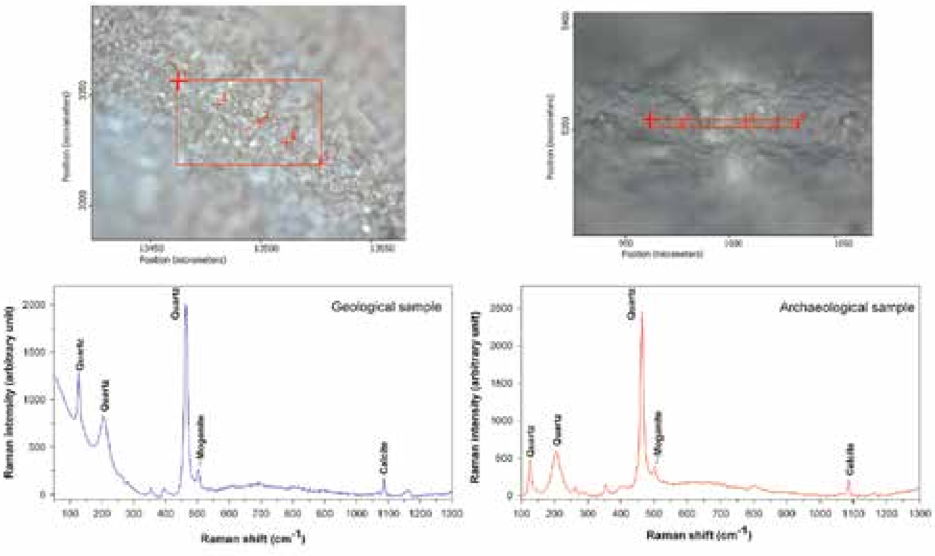

Fig. 6. The result of Raman spectroscopy. Computer graphics: K. Fintor.

pebbles was limited. Therefore, for the making of long blades, the knappers likely would have searched the bedrock (lining the stream valleys) where large radiolarite blocks were found during our field investigation, and again were saved the trouble of engaging in mining or digging activities as in the case of the Bakony Mountains. All in all, Mecsek radiolarite was probably collected continuously and this activity did not demand bigger expeditions. The farming communities settled generally some distance from the geological sources of the lithic raw materials.

Based on the distribution of the raw material, the Late Neolithic community at Alsónyék had very strong local networks. In the enormous settlement area with its the large number of features and finds, the lithics assemblage does not show evidence of widespread, intercultural networks. In contrast, imported tools from non-local raw material were found in some graves. At the current level of the research, it is possible to make some distinctions about the role of the manipulation of raw material. Everyday tools seem to have been made from local and regional raw materials. The more unique tools (i.e., long blades) were made from raw materials from more distant sources and were deposited in burials, suggesting such artefacts were an important element of the burial practice. In order to be able to interpret the entire raw material usage at Alsónyék and at a larger scale in southern-Transdanubia, it is a primary necessity to know the source of the raw material and how it was procured. All in all, the geoarcheological research on the Mecsek radiolarite (especial large-scale analytical studies) will be very important in the coming years.

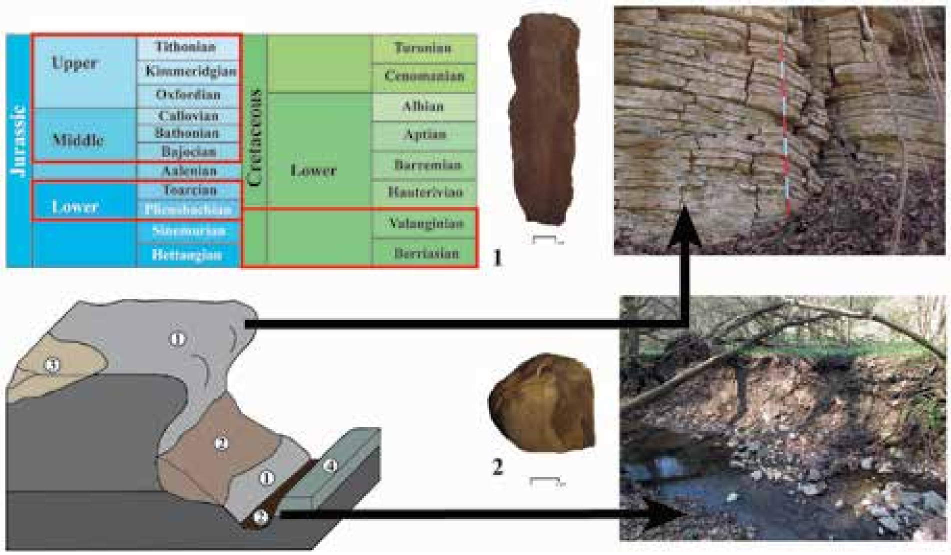

Fig. 7. Sources of different types of raw material (after Mester 2013: Fig. 4.): The red rectangles show those time periods which contain suitable knappable raw materials. The two possible raw material procurement strategies: 1 – primary autochthonous source – bedrocks – large blade from the burial; 2 – secondary autochthonous source – stream bed – average sized core from the settlement. Computer graphics: K. Szilágyi.

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REFERENCES

Andrefsky, W. JR. 2008. *Lithic technology: measures of production, use, and curation.* Cambridge, Cambridge University Press.

Andrefsky, W. JR. 2009. The Analysis of Stone Tool Procurement, Production, and Maintenance. *Journal of Archaeological Research* 17: 65–103.

Bácskay, E. and Biró, K.T. 1984. A lengyeli lelőhely pattintott kőeszközeiről. *Béri Balogh Ádám Múzeum Évkönyve* 12: 43–67.

Barabás, A. 1986. Upper Jurassic-Lower cretaceous Radiolaria from the Mecsek Mts. In *Őskori kovabányászat és kőeszköznyersanyag-azonosítás a Kárpát- medencében. 1. kötet/International conference on prehistoric flint mining and lithic raw material identification in the Carpathian Basin.*, 131–140. Budapest, Sümeg Papers (Vol. 1.), KMI Rota.

Binsteiner, A. 2005. Die Lagerstätten und der Abbau bayerischer Jurahornsteine sowie deren Distribution im Neolithikum Mittel- und Osteuropas. *Jahrbuch des Römisch-Germanischen Zentralmuseums* 52: 43–155.

Biró, K.T. 1988. Distribution of lithic raw materials on prehistoric sites. *Acta Archaeologica Academiae Scientiarum Hungaricae* 40: 251–274.

Biró, K.T. 1989. A lengyeli kultúra dél-dunántúli kőeszköz-leletanyagainak nyersanyagáról I. – On the Raw Material of the Chipped Stone Industry of South-Transdanubian Lengyel-Culture sites. *Communicationes Archaeologicae Hungariae* 4: 22–31.

Biró, K.T. 1990. A lengyeli kultúra dél-dunántúli kőeszköz-leletanyagainak nyersanyagáról II. – On the Raw Material of the Chipped Stone Industry of South-Transdanubian Lengyel-Culture sites. *Communicationes Archaeologicae Hungariae* 42: 66–76.

Biró, K.T. 1998. *Lithic implements and the circulation of the raw materials in the Great Hungarian Plain during the Late Neolithic Period.* Budapest.

Biró, K.T. and Dobosi, V.T. 1991. *Litotheca – comparative raw material collection of the Hungarian National Museum. Catalogue*. Budapest, Hungarian National Museum.

Biró, K.T., Dobosi, V.T. and Schléder, Zs. 2000. *Litotheca II – comparative raw material collection of the Hungarian National Museum 1990–1997*. Catalogue. Budapest, Hungarian National Museum.

Gallina, Zs., Hornok, P., Paluch, T. and Somogyi, K. 2010. Előzetes jelentés az M6 AP TO 10/B és 11. számú lelőhelyrészen végzett megelőző feltárásról. Alsónyék–Bátaszék (Tolna megye) 2006–2009. *Wosinsky Mór Múzeum Évkönyve* 32: 7–46.

Gurova, M. 2011. Prehistoric flint assemblages from Bulgaria: A raw material perspectives. In *Orient şi Occident/East and West. Cultură şi civilizaţie la Dunărea de jos XXVIII/Culture and Civilization at the Lower Danube*, 96–115. Călăraşi.

Gyalog, L. (ed.) 1996. *A földtani térképek jelkulcsa és a rétegtani egységek rövid leírása*. Budapest, Magyar Állami Földtani Intézet.

Kaczanowska, M. 1985. *Rochstoffe, Technik und Typologie der neolithischen Feuersteinindustrien im Nordtei des Flussgebietes der Mitteldonau*. Warszawa, Państwowe Wydawnictwo Naukowe.

Konda, J. 1986. The Mezozoic siliceous rocks of the Transdanubian Mid-Mountains. In *Őskori kovabányászat és kőeszköznyersanyag-azonosítás a Kárpát-medencében. 1. kötet/International conference on prehistoric flint mining and lithic raw material identification in the Carpathian Basin. Sümeg Papers (Vol. 1)*, 165–168. Budapest, KMI Rota.

Mateiciucová, I. 2008. *Talking Stones: The chipped stone industry in Lower Austria and Moravia and the Beginnings of the Neolithic in Central Europe (LBK) 5700–4900 BC.* Brno, Dissertationes Archaeologicae Brunensis.

Mester, Zs. 2013. The lithic raw material sources and interregional human contacts in the Northern Carpathian regions: Aim and methodology. In Zs. Mester (ed.), *The lithic raw material and interregional human contacts in the Northern Carpathian regions*, 9–22. Kraków–Budapest.

Odell, G.H. 2006. *Lithic Analysis*. Oklahoma, University of Tulsa.

Osztás, A., Zalai-Gaál, I. and Bánffy, E. 2012. Alsónyék – Bátaszék: a new chapter in the research of the Lengyel culture. *Documenta Praehistorica* 39: 377–396.

Osztás, A., Bánffy, E., Zalai-Gaál, I., Oross, K., Marton, T. and Somogyi, K. 2013a. Alsónyék-Bátaszék: introduction to a major Neolithic settlement complex in south-east Transdanubia, Hungary. *Bericht der Römisch-Germanischen Kommission* 94: 7–22.

Osztás, A., Zalai-Gaál, I., Bánffy, E., Marton, T., Nyerges, É., Köhler, K., Somogyi, K., Gallina, Zs., Bronk Ramsey, C., Dunbar, E., Kromer, B., Bayliss, A., Hamilton, D. and Whittle, A. 2013b. Coalescent community at Alsónyék: the timings and duration of Lengyel burials and settlement. *Bericht der Römisch-Germanischen Kommission* 94: 180–361.

Pelisiak, A. 1987. The flint raw material from the Central part of the Polish Jura and its utilisation in prehistory. In *Őskori kovabányászat és kőeszköznyersanyag-azonosítás a Kárpát-medencében. 2. kötet/ International conference on prehistoric flint mining and lithic raw material identification in the Carpathian Basin. Sümeg Papers (Vol. 2)*, 123–137. Budapest, KMI Rota.

Přichystal, A. 2013. *Lithic raw materials in Prehistoric Times of Eastern Central Europe*. Brno, Masaryk University.

Raucsik, B. 2012a. Fonyászói Mészkő Formáció. In I. Fózy (ed.), *Magyarország litosztratigráfiai alapegységei. Jura*, 180–183. Budapest, Magyarhoni Földtani Társulat.

Raucsik, B. 2012b. Komlói Mészmárga Formáció. In I. Fózy (ed.), *Magyarország litosztratigráfiai alapegységei. Jura*, 174–176. Budapest, Magyarhoni Földtani Társulat.

Raucsik, B. 2012c. Óbányai Mészkő Formáció. In I. Fózy (ed.), *Magyarország litosztratigráfiai alapegységei. Jura,* 177–179. Budapest, Magyarhoni Földtani Társulat.

Raucsik, B. 2012d. Mecseknádasdi Homokkő Formáció. In I. Fózy (ed.), *Magyarország litosztratigráfiai alapegységei. Jura,* 159–163. Budapest, Magyarhoni Földtani Társulat.

Szilágyi, K. 2017a. Approaching household units from chipped stone assemblages at Alsónyék-Bátaszék, south Hungary. *Bulgarian e-Journal of Archaeology* 7: 61–83.

Szilágyi, K. 2017b. Preliminary result of the lithic raw material distribution at the Alsónyék-Bátaszék Late Neolithic site (Southeastern Hungary). In S. Forţiu (ed.), *Archeovest V_I – In honorem Doina Benea – Interdisciplinaritate în Arheologie și Istorie*, 99–129. Szeged, JATEPress Szeged.

Zalai-Gaál, I. 2009. *Zur Herkunft des Schädelkults im Neolithikum des Karpatenbeckens*. Budapest, Archaeolingua.

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PL ISSN 0066-5924
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Neolithic Flint Axes Made from Cretaceous flint of the Bug and Neman Interfluve in the Collection of the Museum of Podlasie in Bialystok

Hubert Lepionka[a]

The aim of the article is to present and characterize the collection of flint axes made of Cretaceous flint from the interfluve of the Bug River and Neman that morphologically resemble the forms from the Neolithic cultures of the Polish Lowland (the Funnel Beaker Culture, Globular Amphorae Culture and Corded Ware Cultures). This group of objects consists of 10 items found in the Podlasie region. The presented axes are a small part of a large collection (50 flint axes) exhibited in the Museum of Podlasie in Bialystok. A new term for local Cretaceous flint has been introduced for the purpose of this study. Until now, this type of flint was known as Northeastern Flint, and although research to define this term has been done, it has never been fully finalized. Because of that, the author of this study has coined a new and more suitable term: Cretaceous flint from the interfluve of the Bug River and Neman. This includes a group of Cretaceous flints from the Podlasie area and contains all the local variations of it: Mielnik flint, Rybniki flint, flint from the Cretaceous beds and marls and Krasne Siolo flint

KEY-WORDS: flint axe, Podlasie region, northeastern flint, Cretaceous flint, stray finds, Neolithic, Funnel Beaker Culture, Globular Amphorae Culture, Corded Ware Culture

INTRODUCTION

The state of knowledge on flint axes across the whole area of the Odra and Vistula basin is rather variable. This material is well described in the areas of Lesser Poland, the Lublelskie and Greater Poland regions, (e.g., Włodarczak 2006; Libera 2016; Pyżewicz *et al.*, 2016). In comparison to the above-mentioned areas, the territory of today's Podlasie Province is poorly investigated in this field of research. Although this area has been studied by archaeologists since the end of the 19th century, there has never been a larger number of axes described from Podlasie Province. Discoveries made in recent years indicate that in the Neolithic and Bronze Age the local communities of this region

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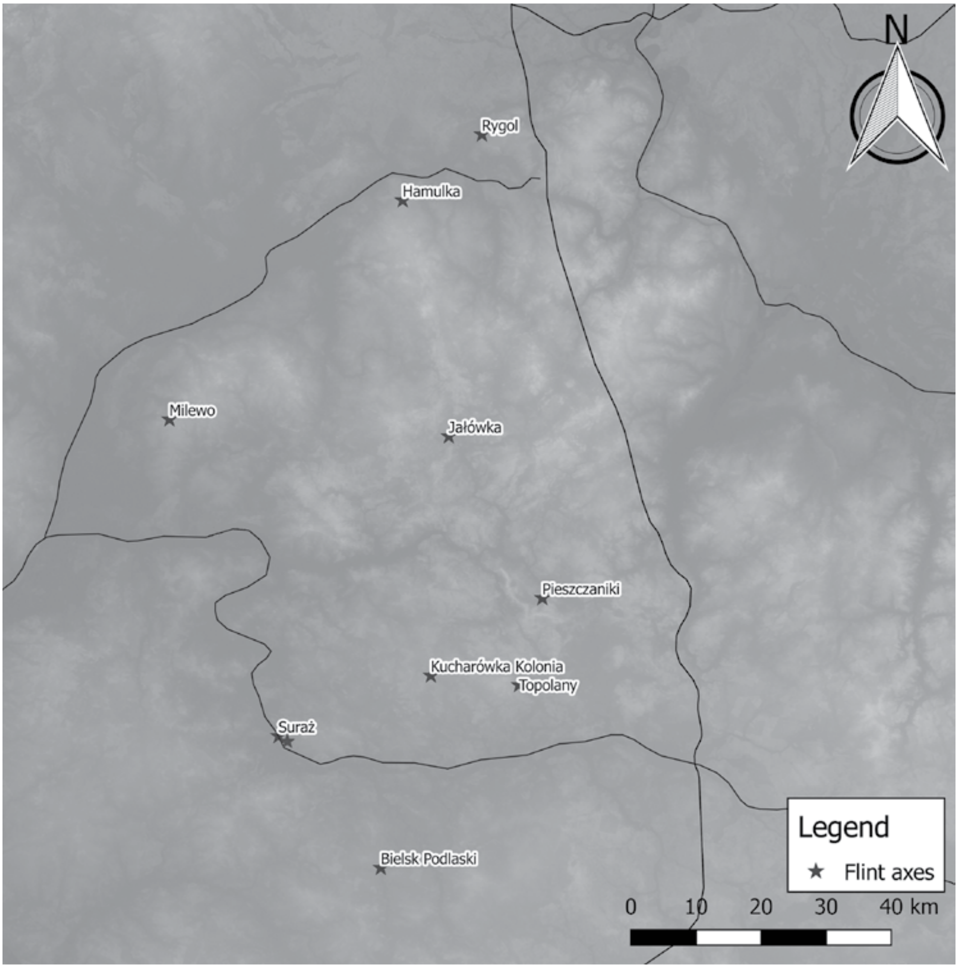

Fig. 1. Localisation of neolithic flint axes from Museum of Podlasie in Bialystok. Computer graphics: H. Lepionka.

had a number of broad cultural contacts (Wawrusiewicz *et al.*, 2015). In order to fully understand this region, we should turn to other categories of archaeological evidence.

The purpose of this work was a stylistic and taxonomic characterization of the collection of tetrahedral flint axes made from the local Cretaceous flint. The study was limited to objects related to the Neolithic cultures of the Funnel Beaker, Globular Amphora and Corded Ware Cultures (Fig. 1). The article is part of a wider discussion of the collection of flint axes from the Museum of Podlasie in Bialystok.

METHODS

The descriptive methodology is based on formal criteria drawn from works on flint axes by Polish, Lithuanian and Belarusian archaeologists (Wiślański 1966; Nosek 1967; Kulczycka-Leciejewiczowa 1996; Obuchowski 2003; Włodarczak 2006; Piličiauskas 2007; Bobrowski and Sobkowiak-Tabaka 2008; Libera 2009; Miecznikowski 2014; Libera 2016). The scheme of description and naming of individual parts of the axes was taken from the guidelines of the *Biblioteka Muzealnictwa i Ochrony Zabytków* with the changes introduced by Zbigniew Miecznikowski (Kulczycka-Leciejewiczowa 1996; Miecznikowski 2014). It was also decided to introduce standardized shapes of cross-sections and shapes of individual parts of the axe (Fig. 2).

The collection of flint axes from Museum of Podlasie in Bialystok contains 50 artefacts. The condition of these finds is various. Most of them are unbroken but some of them are damaged and some have been preserved as fragments of edges or butts (Table 1). The nature of the collection, which is mostly stray finds, does not allow us to use the context in the allocation of individual tools to an archaeological culture. It should be considered that individual finds of flint axes do not necessarily mean the presence of representatives of given cultures in Podlasie. The appearance of axes in this area may be the result of the functioning of long-distance routes or 'chain' exchange between neighbouring communities. Cultural attributions can only be done on the basis of the form and style, comparing them with tools with a more secure chronology. Analogies from the other sites with context, both near and from more distant areas, e.g., Lesser Poland, were used to categorise the axes from the Podlasie region investigated in the paper. Although if local raw materials were used to make axes of non-local style, it adds to discussions about the *modus operandi* of borderlands in the past. It seems that this methodology is justified until the characteristics of axes of local production will be better identified.

The analysis was carried out in morphologically similar groups of products. Metric features, weight, as well as the shape of individual parts of the axe were considered: the shape of the faces, the side view and cross-section, the character of the faces and side surfaces and the shape and position relative to the tool axis, blade and butt. It was only as a result of the observed correlations that particular objects registered in Podlasie were assigned to archaeological cultures.

RAW MATERIAL

The axes presented in this article were made of local Cretaceous flint described in the archaeological literature as 'northeastern flint'. The first researcher who discussed the issue of Cretaceous flint from this area was Krzysztof Cyrek (1979, 1983). The author

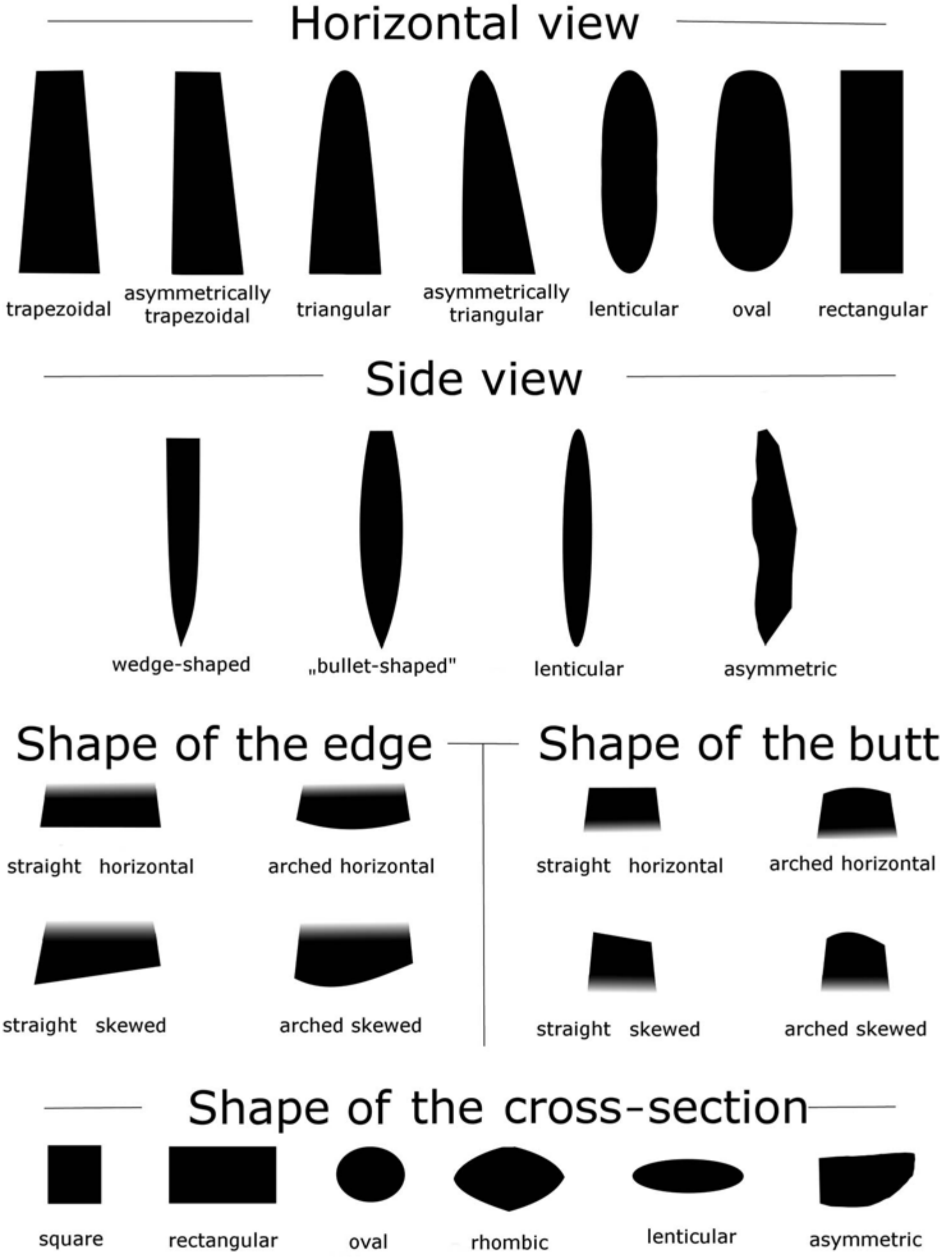

Fig. 2. Standardized shapes of individual parts of axe used in article and Table 1.
Computer graphics: H. Lepionka.

Table 1. Collection of flint axes from the Museum of Podlasie in Bialystok, described in accordance with the standardized shapes proposed in Fig. 2.

No.	localization	district	type	condition	horizontal view	side view	shape of edge	shape of the butt	shape of the cross-section
1	Białystok	loco	bifacial	unbroken	trapezoidal	lenticular	arched skewed	arched horizontal	lenticular
2	Białystok	loco	tetrahedral	repaired	trapezoidal	wedge-shaped	straight horizontal	straight skewed	rectangular
3	Bielsk Podlaski	Bielsk Podlaski	bifacial	unbroken	trapezoidal	lenticular	arched horizontal	arched skewed	lenticular
4	Bielsk Podlaski	Bielsk Podlaski	tetrahedral	unbroken	asymmetrically trapezoidal	'bullet-shaped'	arched horizontal	arched horizontal	rectangular
5	Bielsk Podlaski, site 34	Bielsk Podlaski	tetrahedral	damaged and repaired edge	trapezoidal	wedge-shaped	-	straight horizontal	rectangular
6	Brzozowo	Sokółka	tetrahedral	fragment of the body	trapezoidal (?)	wedge-shaped (?)	-	-	rectangular
7	Daniłowo Małe, site 6	Białystok	tetrahedral	partly damaged edge	trapezoidal	'bullet-shaped'	arched horizontal (?)	arched horizontal	rectangular
8	Daniłowo Małe, site 7	Białystok	tetrahedral	fragment of the edge	-	-	arched horizontal (?)	-	-
9	Dziarnowizna	Białystok	bifacial	slightly damaged edge and butt	triangular	'bullet-shaped'	straight horizontal	arched horizontal (?)	oval
10	Eliaszuki	Hajnówka	bifacial	unbroken	asymmetrically triangular	lenticular	arched skewed	arched skewed	rhombic
11	Ełk	Ełk	tetrahedral	unbroken	trapezoidal	'bullet-shaped'	arched horizontal	straight horizontal	rectangular
12	Góra Strękowa	Białystok	bifacial	slightly damaged butt	triangular	wedge-shaped	straight horizontal	straight horizontal	oval
13	Hamulka	Sokółka	tetrahedral	unbroken	asymmetrically trapezoidal	wedge-shaped	arched horizontal	arched horizontal	rectangular
14	Jałówka	Sokółka	tetrahedral	unbroken	trapezoidal	'bullet-shaped'	arched horizontal	arched horizontal	rectangular
15	Jeroniki	Białystok	bifacial	repaired edge	asymmetrically triangular	'bullet-shaped'	arched horizontal	arched skewed	oval

16	Kraśniany	Sokółka	tetrahedral	fragment of the butt	trapezoidal (?)	wedge-shaped	-	straight horizontal	rectangular
17	Krzemionki Opatowskie	Ostrowiec Świętokrzyski	tetrahedral	unbroken	trapezoidal	wedge-shaped	arched horizontal	arched horizontal	rectangular
18	Kucharówka Kolonia	Białystok	tetrahedral	unbroken	trapezoidal	wedge-shaped	arched horizontal	straight horizontal	rectangular
19	No data	No data	tetrahedral	unbroken	trapezoidal	‘bullet-shaped’	arched horizontal	straight horizontal	rectangular
20	Milewo	Mońki	tetrahedral	unbroken	trapezoidal	wedge-shaped	arched horizontal	arched horizontal	rectangular
21	Morusy	Mońki	bifacial	unbroken	oval	lenticular	straight horizontal	arched horizontal	lenticular
22	Narew	Hajnówka	tetrahedral	small fragment of the body	-	-	-	-	-
23	Pieszczaniki	Białystok	tetrahedral	unbroken	rectangular	‘bullet-shaped’	arched horizontal	straight skewed	rectangular
24	Pieszczaniki	Białystok	tetrahedral	unbroken	asymmetrically trapezoidal	wedge-shaped	arched horizontal	arched horizontal	rectangular
25	Pieszczaniki	Białystok	tetrahedral	unbroken	rectangular	‘bullet-shaped’	arched horizontal	straight horizontal	rectangular
26	Poświętne	Białystok	bifacial	damaged body	asymmetrically triangular	‘bullet-shaped’	arched skewed	arched horizontal	lenticular
27	Rygol	Augustów	bifacial	unbroken	trapezoidal	‘bullet-shaped’	straight horizontal	arched horizontal	lenticular
28	Rygol	Augustów	tetrahedral	repaired butt and damaged edge	trapezoidal	wedge-shaped	arched horizontal	straight horizontal	rectangular
29	Słomianka	Mońki	trihedral	unbroken	asymmetrically triangular	wedge-shaped	arched horizontal	straight horizontal	asymmetric
30	Sokółka	Sokółka	bifacial	damaged edge	oval	asymmetric	-	arched horizontal	oval
31	Sośnia	Grajewo	bifacial	unbroken	asymmetrically trapezoidal	asymmetric	arched horizontal	straight skewed	lenticular
32	Supraśl	Białystok	tetrahedral	fragment of the butt	trapezoidal (?)	-	-	arched horizontal	rectangular
33	Suraż	Białystok	tetrahedral	unbroken	trapezoidal	wedge-shaped	arched horizontal	straight horizontal	rectangular

34	Suraż	Białystok	tetrahedral	damaged edge	trapezoidal	'bullet-shaped'	-	arched horizontal	rectangular
35	Suraż	Białystok	tetrahedral	unbroken	trapezoidal	'bullet-shaped'	arched horizontal	arched horizontal	rectangular
36	Szpakowo	Mońki	bifacial	unbroken	oval	'bullet-shaped'	straight horizontal	arched skewed	oval
37	Topczykały	Bielsk Podlaski	bifacial	unbroken	asymmetrically triangular	'bullet-shaped'	straight horizontal	arched horizontal	lenticular
38	Topolany	Białystok	tetrahedral	slightly damaged edge	trapezoidal	'bullet-shaped'	arched horizontal	straight horizontal	rectangular
39	Tykocin	Białystok	oval	unbroken	oval	wedge-shaped	arched horizontal	straight skewed	oval
40	Wojszki	Białystok	bifacial, half-product	unbroken	oval	asymmetric	arched skewed	arched skewed	asymmetric
41	Złotoria site 53	Białystok	bifacial	slightly damaged edge	asymmetrically triangular	asymmetric	straight skewed	straight skewed	asymmetric
42	Złotoria site 56	Białystok	bifacial, half-product	unbroken	asymmetrically triangular	asymmetric	straight horizontal (?)	arched skewed (?)	asymmetric
43	Złotoria site 56	Białystok	bifacial, half-product	broken edge	trapezoidal	asymmetric	-	arched skewed	rhombic
44	Złotoria site 56	Białystok	oval	unbroken	rectangular	'bullet-shaped'	straight skewed	arched horizontal	oval
45	Złotoria site 56	Białystok	bifacial	fragment of the edge	-	-	arched skewed	-	lenticular
46	Złotoria site 56	Białystok	bifacial	fragment of the edge	-	-	arched horizontal	-	lenticular
47	Złotoria site 56	Białystok	bifacial	broken edge	trapezoidal	'bullet-shaped' (?)	-	straight horizontal	lenticular
48	Złotoria site 56	Białystok	oval	fragment of the butt	oval	asymmetric	-	arched horizontal	asymmetric
49	Ploski	Bielsk Podlaski	bifacial, half-product	unbroken	triangular	wedge-shaped	straight horizontal	arched horizontal	lenticular
50	No data	Białystok	tetrahedral	unbroken	rectangular	wedge-shaped	arched horizontal	straight horizontal	rectangular

states that this raw material is probably the same age as the Baltic flint but the deposits that were its source had not been localized, it is very similar in colour to the Baltic flint, but occurs in larger, non-cracked concretions with preserved cortex. The first division of the northeastern raw material into more precise varieties was introduced by Karol Szymczak (1992, 1995). He proposed a division into two types (mine and erratic) based on the state of preservation of the concretions. The first group is characterized by perfectly preserved flint mass and a thick, often undamaged, cretaceous cortex that has not undergone leaching processes and still retains its white colour. The second one bears traces of long-distance transport and is often preserved as cracked chunks. Another classification proposed by Szymczak is a division based on a few chemical and petrographic studies. The author introduces two varieties that are not recognizable macroscopically and have a different content of zinc (Zn) and nickel (Ni; Szymczak 1992, 1995). Two groups of raw material with different levels of these elements are visible, but unfortunately, due to the small number of samples, these data should be considered only as an interesting indication of the need for future chemical consideration.

In the Polish school of specifying flint raw material, the names of particular flint species were traditionally given according to the observation of a characteristic macroscopic feature (e.g., 'chocolate' or striped flint), or the name of the locality or region in which it appeared (Świeciechow, Volhynian, Jurassic-Cracow flint). According to the present author, the term 'northeastern flint' and its characterisation proposed by Cyrek is too imprecise to properly describe this raw material. This paper uses the term 'Cretaceous flint of the Bug and Neman interfluves', which at the same time defines the origin and spatial delimitation of the raw material in question. It is noteworthy that due to the state of petrographic and chemical research, the term refers to a group of flints, within which individual types can be recognized macroscopically.

According to current geological thought, the Cretaceous flint of the Bug and Neman interfluve was formed in the Turon period in the upper Cretaceous period (Fig. 3). Flints of this type occur in situ in tertiary sediments (e.g., Mielnik on the Bug), and more often in marlstone limes, marls, and rocks that have been transported by an ice sheet, probably, but not only, from around Grodno (Wójcik 2005: 25–26; Zalewski 2011: 297). The distinction between the geological origins is often blurred due to the numerous glaciations that occurred in this zone and moved material. Often the accumulation of concretions is the only trace of Cretaceous beds formerly deposited here (Wójcik 2005: 26).

The Cretaceous flints of the Bug and Neman interfluve group have several characteristic attributes (Fig. 4). Flint nodules occur in various shapes. For instance, flint nodules from the Roś river area are oval and regular in shape whereas samples from Mielnik are irregular and full of chalk intrusions. Cortexes are mostly only a few millimetres thick with a thick chalk layer on them. The silica mass has lots of

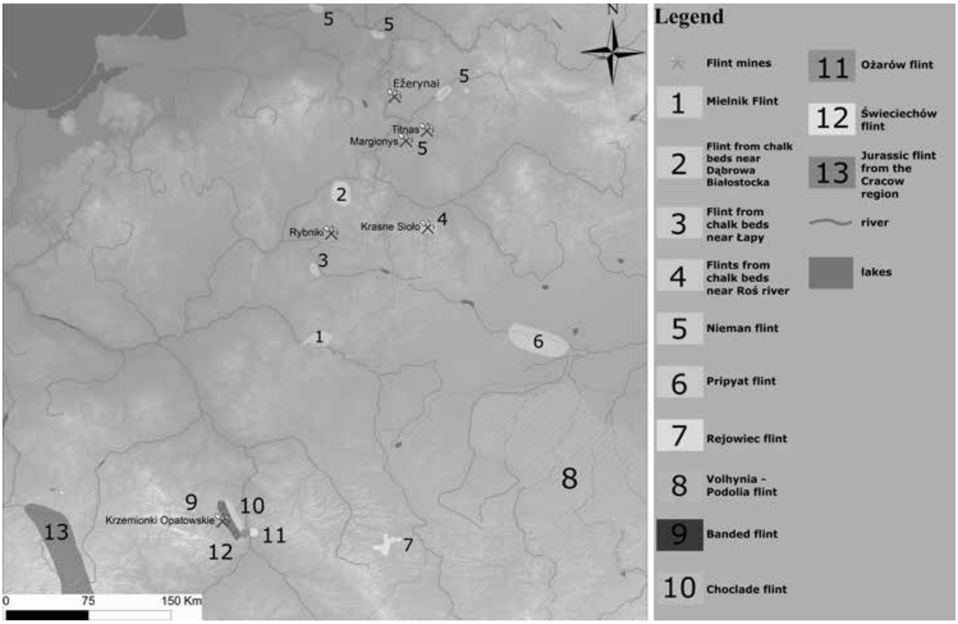

Fig. 3. Raw flint material background for Podlasie region. Based on: Balcer 1987; Szymczak 1992; Piličiauskas 2007; Lepionka 2015; Grużdź 2016. Computer graphics: H. Lepionka.

white or grey dots and 'vein-like' lines. There can also be seen an evident zoning. Just under the cortex, there is a dark zone about a centimetre thick which is distinct from the inner greyer flint mass. Sometimes chalky intrusions are situated in the body of the nodule.

Due to its 'Cretaceous' genesis, it is sometimes not simple to macroscopically separate this raw material from other Cretaceous flints such as flints from Rügen, Volhynia, and Ruthenian flint. Only a sample large enough, like a flint axe or core, can provide a good set of characteristic attributes to make proper macroscopic analyses. On the basis of data from the literature and personal examination by the author, four types of source areas of these flints can be distinugished. These are: a – flint from the Roś river area, b – so-called Rybniki flint, c – Mielnik flint, d – Cretaceous beds in the vicinity of Łapy, Dąbrowa Białostocka (Poland), Margionys, Titnas and Ežerynai (Lithuania).

Today we have evidence for exploitation of this raw material in the Palaeolithic, Neolithic and Bronze Age. Each mentioned flint outcrop was used in a different epoch. In the Palaeolithic there was in common use a raw material from Cretaceous beds in the vicinity of Łapy, Dąbrowa Białostocka (Poland); Margionys, Titnas (Lithuania) and maybe Mielnik flint (Szmit 1929; Gieysztor-Szymczak 1980; Baltrūnas *et*

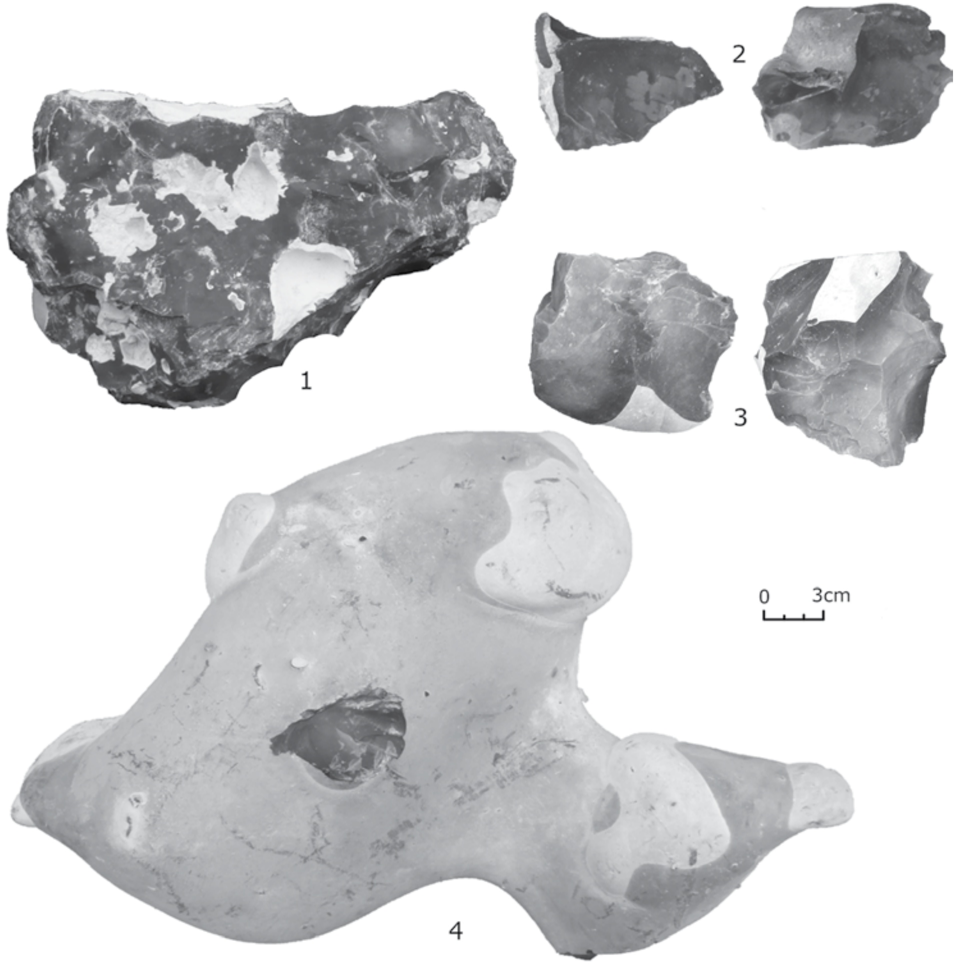

Fig. 4. Examples of Cretaceous flint of the Bug and Neman interfluve: 1–Mielnik, Siemiatycze district; 2–Cretaceous beds near Łapy, Białystok district; 3–Krasne Siolo, Grodno district. Photo: H. Lepionka.

al., 2006). The raw material was used in producing double striking platform cores for knapping blades. During the Mesolithic, it seems that an erratic variant of local Cretaceous flint was used in about the same percentage as the Erratic Baltic Flint (Szymczak 1992).

This situation changed during the Neolithic period when the first mines began to function. Hitherto, evidence for exploitation has come from mines located at Krasne Siolo and Margionys (Gurina 1976; Czarniausky 1995; Kalicki and Kalicki 2012). In the archaeological literature until recently, the beginning of mining was associated with the Neman Culture but in more recent studies it is thought to be more probable that the first miners were of the Globular Amphora Culture. The mines continued in use in the times of the Corded Ware Culture (Czarniausky 1995: 269). In the beginning, the production at Krasne Siolo was oriented towards making tetrahedral axes, later bifacial axes and sickles (Czarniausky 1995; Barska 2002; Kalicki and Kalicki 2012). In Margionys, production was similar to Krasne Siolo but without any activity in the Globular Amphora Culture period (Baltrūnas *et al.*, 2006).

In the Bronze Age, mining of Cretaceous flints of the Bug and Neman interfluve group evolved further from the situation in the Neolithic period. Flint production changed focus from tetrahedral axes to bifacial axes, daggers and sickles. In this period, some new mines were begun, like the Rybniki complex, but old known outcrops also continued to be mined: Krasne Siolo, Margionys, Titnas (Gurina 1976; Czarniausky 1995; Borkowski and Zalewski 2005; Baltrūnas *et al.*, 2006; Zalewski 2011; Kalicki and Kalicki 2012; Zalewski *et al.*, 2016).

It has been shown that the Cretaceous flint of the Bug and Neman interfluve group was an object of raw material exploitation and tools produced in the past. Current knowledge allows us to discern two phases of flint processing. The first phase is associated with Final Palaeolithic societies and was focused on blade production from double platforms cores. The second phase began in the Neolithic and was sustained in the Bronze Age. It was oriented, in the beginning, toward the production of tetrahedral axes, then in the Bronze Age changed to bifacial tools like axes, daggers and sickles.

MATERIAL

The analysis of items in the collections includes ten tetrahedral undamaged axes made from the group of Cretaceous flints of the Bug and Neman interfluve. The objects are presented in alphabetical order.

1. Axe from Bielsk Podlaski site 34, Bielsk Podlaski district (Fig. 5)
A tetrahedral axe with a trapezoidal faces. Wedge-shaped from the side view. The cross-section was, before damage, rectangular. The faces are ground to a flat surface. The side surfaces are similar to the faces. The edge has traces of flaking and the intensity of the ripples on the flake negatives suggests that a splintered-pieces technique was used. This could have been an attempt to repair the tool or reutilize it in the past, maybe in the Bronze Age. The back of the axe is horizontally straight.

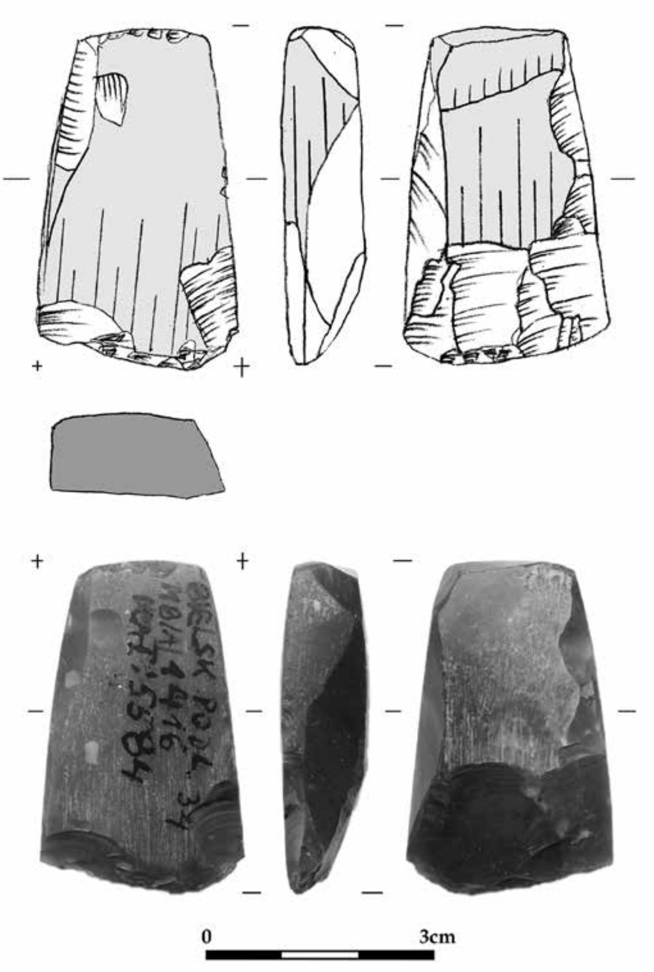

Fig. 5. Axe from Bielsk Podlaski site 34, Bielsk Podlaski district. Computer graphics: H. Lepionka.

2. Axe from Hamulka, Sokółka district (Fig. 6)
The axe from Hamulka has asymmetrically trapezoidal faces. The side view is wedge-shaped and the cross-section is rectangular. The faces are nicely ground with significant separation of the edge polished area. The side surfaces are flat and one of them is damaged maybe by the hafting. The edge is horizontally arched, as is the butt.

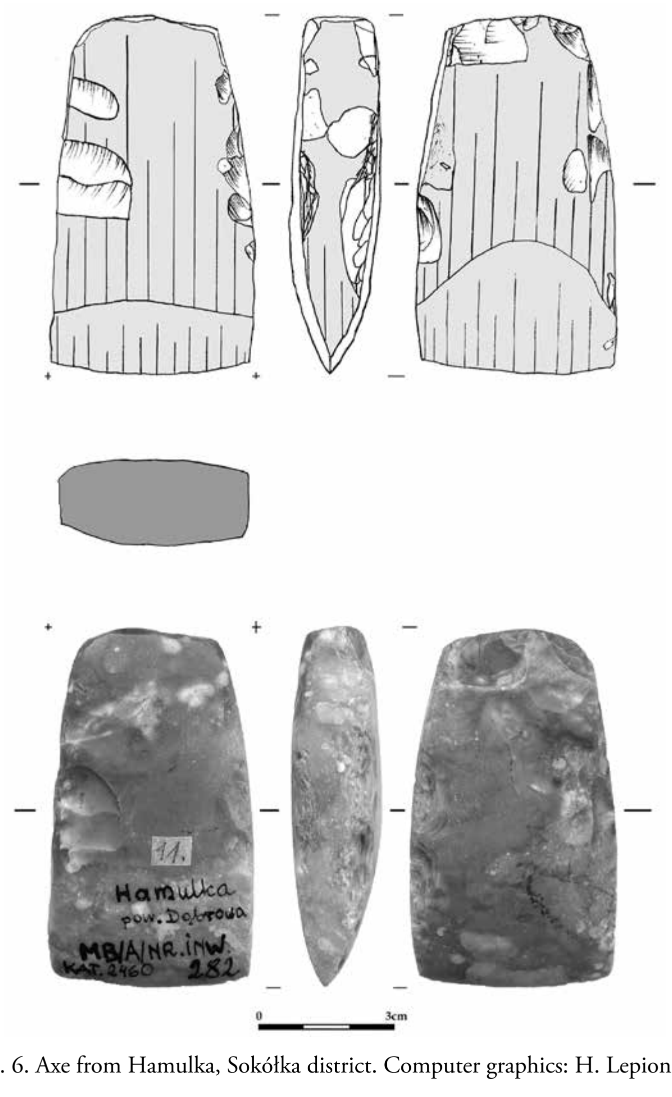

Fig. 6. Axe from Hamulka, Sokółka district. Computer graphics: H. Lepionka.

3. Axe from Jałówka, Sokółka district (Fig. 7)

This axe has trapezoidal faces. The side view is ‘bullet-shaped’ and the greatest thickness of the object is towards the blade. In the middle, the cross-section is rectangular with convex long sides. The faces are carefully ground with a few flat flake scars left. This object has three grinding zones, of which the last, near the blade, is polished. The side surfaces are thoroughly polished with a few flaking scars. The blade and butt have a horizontally arched shape.

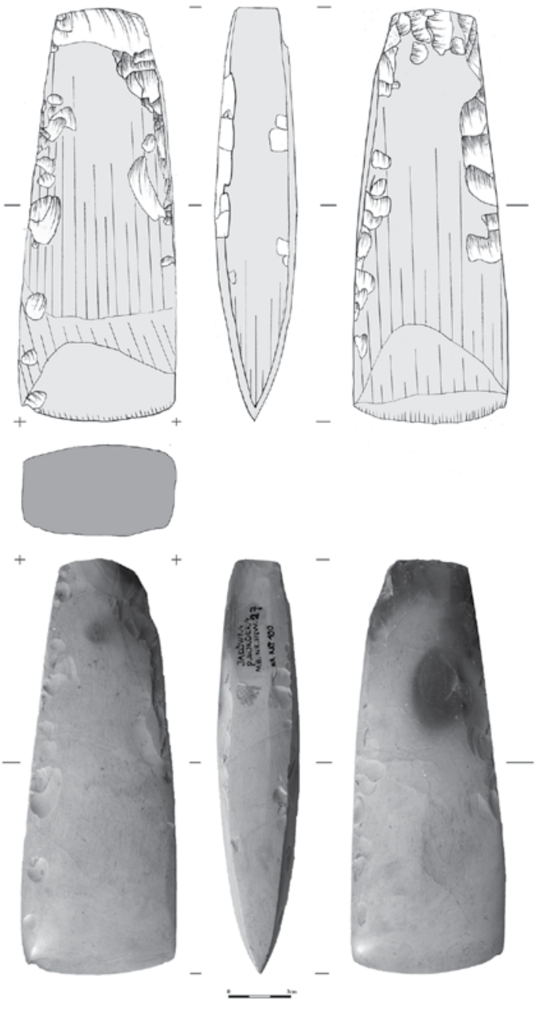

Fig. 7. Axe from Jałówka, Sokółka district. Computer graphics: H. Lepionka.

4. Axe from Kucharówka Kolonia, Białystok district (Fig. 8)

The axe found in Kucharówka Kolonia has trapezoidal faces. The side view of the tool is wedge-shaped. The cross-section has a quite rectangular shape. One of the faces was ground in central part when on edge there are left deep flaking scars, the second is ground just on the edges when the central part of face surface is natural. One of the faces has two polishing areas. The side surfaces are ground with some flake scars left. The edge is skewed arched and butt is horizontally straight.

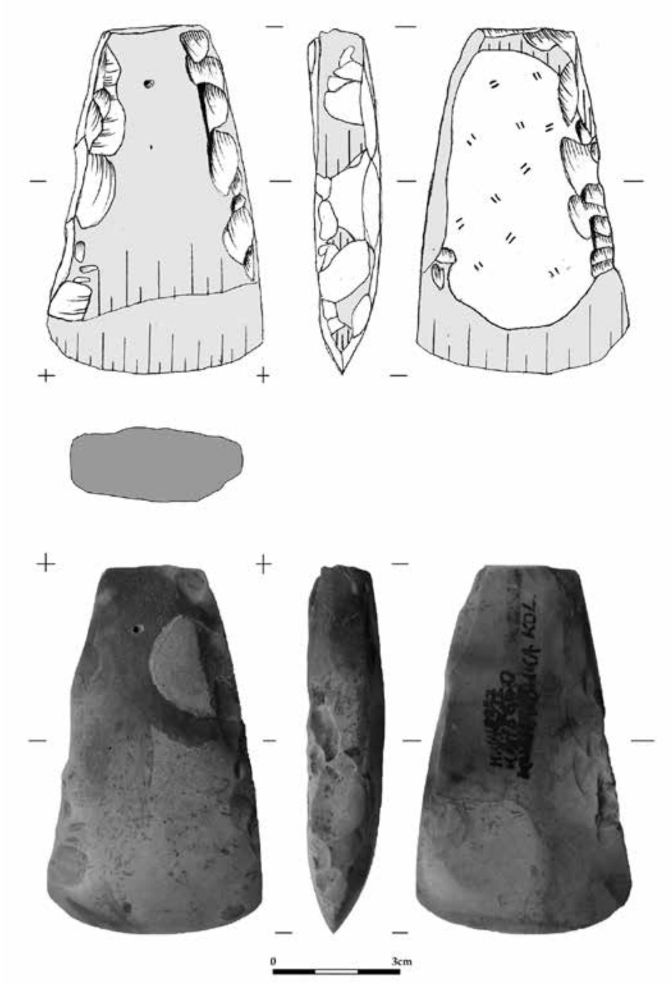

Fig. 8. Axe from Kucharówka Kolonia, Białystok district. Computer graphics: H. Lepionka.

5. Axe from Milewo, Mońki district (Fig. 9)

The axe's faces are trapezoidal and the side view is wedge-shaped. The cross-section is rectangular and the faces were probably ground by a 'machine-tool'. In justification of that hypothesis is the presence of deep and long grinding lines, similar to the ones resulting archaeological experiments (Vemming *et al.*, 1983; Madsen 1984). In the whole axe can be see a chalk intrusion typical of the Cretaceous flints of the Bug and Neman interfluve group especially of the Mielnik flint type. The side surfaces are quite round and ground with few flaking scars left. The edge and butt of the axe are arched horizontally.

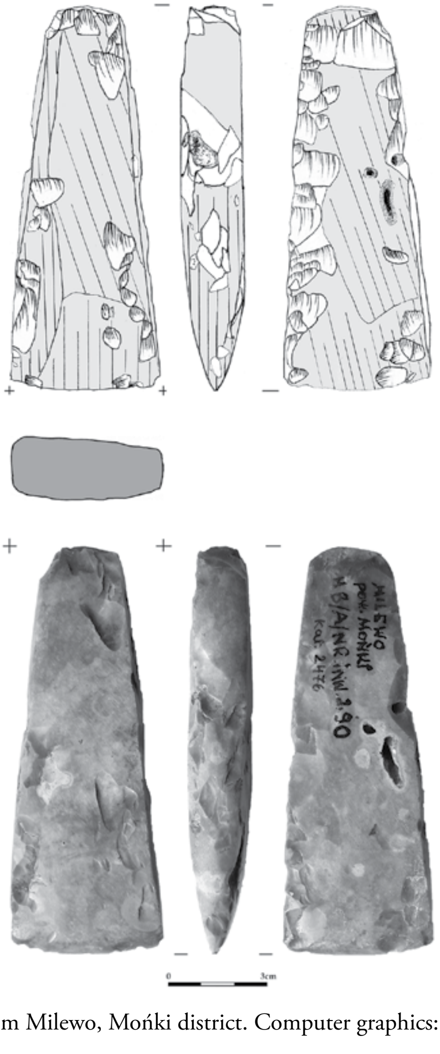

Fig. 9. Axe from Milewo, Mońki district. Computer graphics: H. Lepionka.

6. Axe from Pieszczaniki, Białystok district (Fig. 10)

The axe has rectangular faces and a 'bullet-shaped' side view. The cross-section of the object is rectangular. The axe's faces are oblique with fine polishing. On one side there are two polished areas. The side surfaces are ground with left deep flaking scars left. The edge has an arched skewed shape however the butt is horizontally straight.

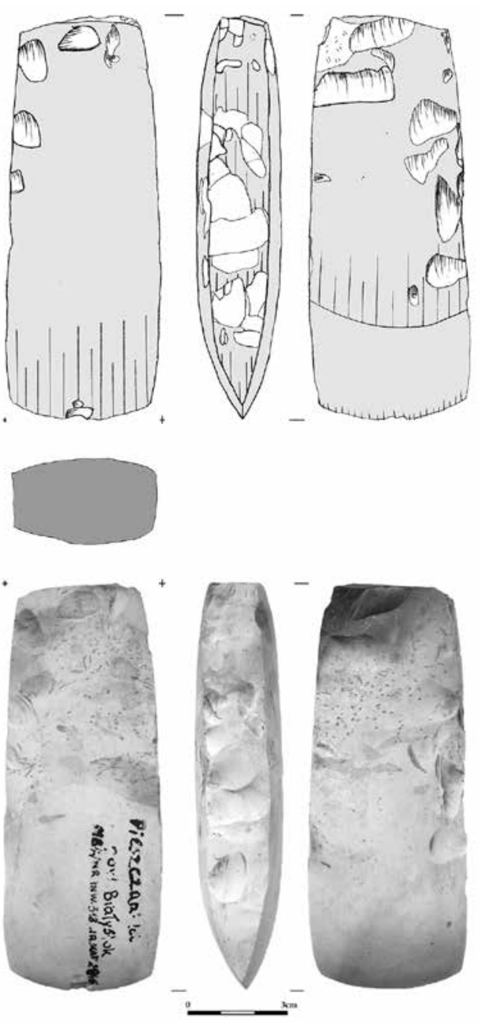

Fig. 10. Axe from Pieszczaniki, Białystok district. Computer graphics: H. Lepionka.

7. Axe from Rygol, Augustów district (Fig. 11)
The Rygol axe is made from a broken larger axe. It has trapezoidal faces and the side view is wedge-shaped. The cross-section of the tool is rectangular. The faces are ground with visible deep lines of grinding but not all flaking scars have been ground away. On both faces, there are two areas of grinding, the side faces are ground only slightly. The edge is horizontally straight. The butt is formed on the broken part and has an asymmetrical shape.

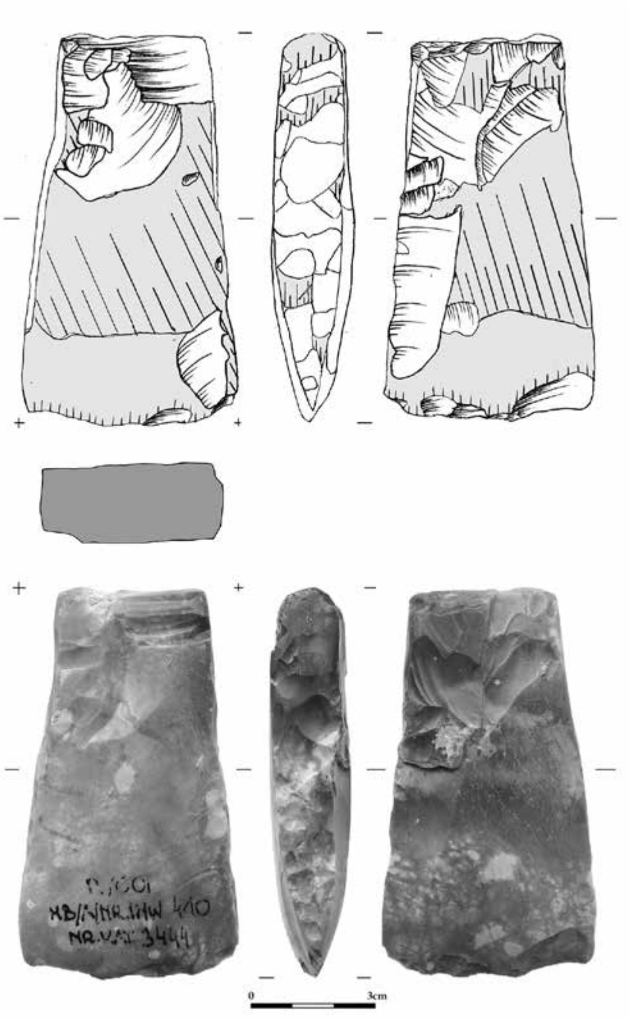

Fig. 11. Axe from Rygol, Augustów district. Computer graphics: H. Lepionka.

8. Axe from Suraż, Białystok district (Fig. 12)

The first axe from Suraż has trapezoidal faces. In side view it is 'bullet-shaped'. The cross-section is rectangular. The faces and side surfaces are finely ground. The edge is damaged by reutilization as a core or an attempt to repair the tool by flaking. The butt is arched horizontally.

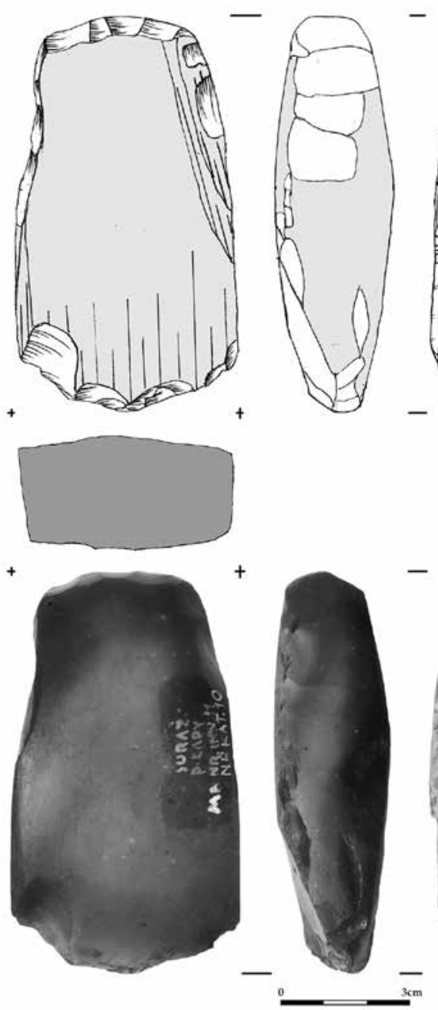

Fig. 12. Axe from Suraż, Białystok district. Computer graphics: H. Lepionka.

9. Axe from Suraż, Białystok district (Fig. 13)

This miniature axe has trapezoidal faces. In side view it is wedge-shaped and the cross-section is rectangular. The faces of the tool are finely ground and side surfaces are treated this same way. On the faces, there is a classic three area separation. The edge is horizontally straight but the butt is horizontally arched. In view of the morphology of this tool, it can be an edge of the chisel.

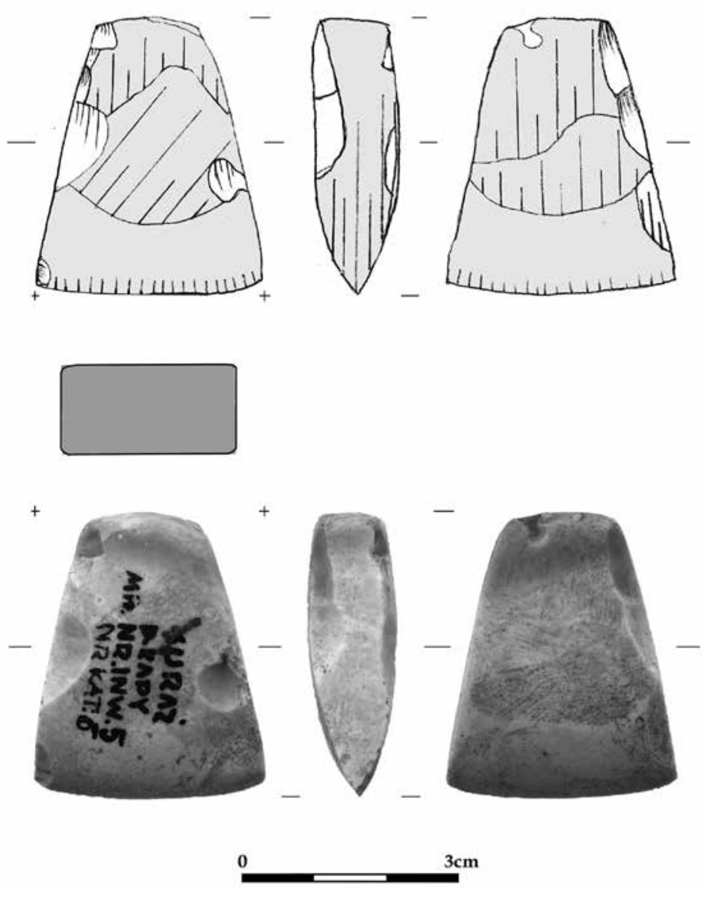

Fig. 13. Axe from Suraż, Białystok district. Computer graphics: H. Lepionka.

10. Axe from Topolany, Białystok district (Fig. 14)

The last axe chosen for this analysis has trapezoidal faces. In side view, it is bullet-shaped. The cross-section is rectangular. The faces are ground with several flake negatives left. Three areas of grinding can be seen and one of them has traces of 'machine grinding' similar to the axe from Milewo. The side surfaces are finely ground. The edge is horizontally arched. The butt is straight horizontal.

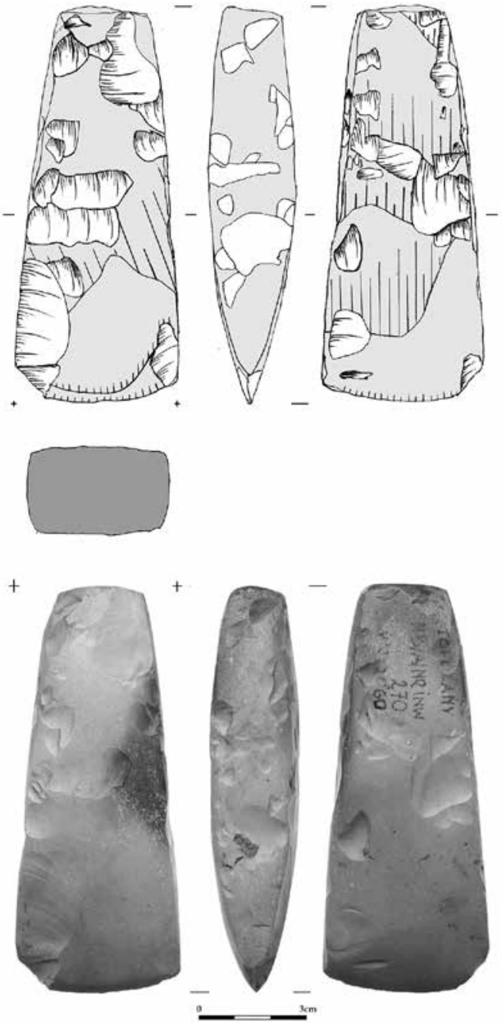

Fig. 14. Axe from Topolany, Białystok district. Computer graphics: H. Lepionka.

CULTURAL ATTRIBUTION

There are three groups of axes in the presented collection. The first one could morphologically connected to the Funnel Beaker Culture. This refers to the axe from Jałówka and the morphology of this tool clearly refers to the type B introduced by Bogdan Blacer (Balcer 1974, 2002). This type is characterized as axes with varying degrees of widening above the blades, and then narrowing towards the butt. It also includes specimens with parallel sides above the blade and then tapering towards the butt. They usually have slightly convex walls, slightly curved edges and poorly distinguished butts (Balcer 2002: 90).

The second group includes six axes with traits commonly associated with the Globular Amphorae Culture. These are the artefacts from: Bielsk Podlaski site 34, Milewo, Pieszczaniki, Rygol, Suraż and Topolany. They have a trapezoidal or rectangular shape, more often they are slender rather than stocky. In the side view, they are wedge-shaped or 'bullet-shaped'. The cross-sections are rectangular. On the frontal surfaces, often flattened out, two or three grinding zones are visible, the last of which is usually polished at the blade. Almost the entire surface of these forms is polished. The side surfaces of the objects are usually thoroughly ground with a few flaking scars left. The blades and butts shapes are straight or arched horizontally. Only in this morphological group are visible traces of the use of hard machine grinding on axes from Milewo, Rygol and Topolany. This type is characterized by long grinding lines and an extreme flattening of the ground zone (Vemming *et al.*, 1983; Madsen 1984).

The above-described group of axes matches the style of axes commonly associated with the Globular Amphorae Culture (Wiślański 1966; Nosek 1967; Kempisty 1971; Budziszewski and Grużdź 2013). These are tetrahedral specimens with a carefully made trapezoidal shape, completely or almost entirely smoothed. Their cross-sections are rectangular and very regular, and they expand to varying degrees from the butts to the blades (Wislański 1966: 39; Nosek 1967: 323–324; Balcer 1986: 209). The discussed artefacts most often appear as an element of burials.

The axe from Hamulka requires separate discussion, it has both Globular Amphorae Culture and Corded Ware Culture attributes. The issue of the occurrence of Globular Amphorae Culture axes in Corded Ware Culture inventories was addressed by Jerzy Libera, who separated those axes as a separate group (type E) in his typology of Corded Ware Culture axes (Libera 2009, 2016).

The third group includes axes of typical Corded Ware Culture morphology from Kucharówka Kolonia. In the typology of Piotr Włodarczak, based on inventories from Lesser Poland, axes from this group can be classified as types IC, dated to the third phase of development of the Corded Ware Culture (Włodarczak 2006: 28, 120). Phase III, which is a period of deep regionalization of the Corded Ware Culture, is dated in Lesser Poland to 2600/2500 – 2200 BC (Włodarczak 2006: 126).

In the typology of Jerzy Libera for the axes of the Corded Ware Culture made of Świeciechowski flint, the axe from the Kucharówka Kolonia corresponds to type A, which can be dated just like the axes from Lesser Poland (Włodarczak 2006; Libera 2016: 486).

CONCLUSIONS

Podlasie was a region abounding in Cretaceous flint, outcrops of which occur in the interfluve of the Bug and the Neman river. This raw material, described in this work as the Cretaceous flint of the Bug and Neman interfluve, is one of the least recognized flint raw materials from the territory of Poland. Based on the characteristics of macroscopic features, it has been possible to distinguish several of its variations, though many things remain unclear. Further research should be focused on petrochemical analysis. On the other hand, we do not know all the occurrences of this raw material. That problem would be a suitable topic for a future research programme.

The Museum's collection includes objects that, in their 'style', refer to the Neolithic cultures of the Polish Lowlands. Current knowledge indicates that there were two regions with tetrahedral axe production: the mines in Krasne Siolo and Margionys. Some objects in the collections can be connected to the Krasne Siolo mining complex. This refers to the characteristic zonation of the flint mass visible on the axes from Jałówka, Pieszczanniki, Suraż and Topolany. That trait is characteristic of the flint from the area of the Roś river (Gurina 1976; Czarniausky 1995; Barska 2002; Kalicki and Kalicki 2012). The rest of the axes could have been made in other hitherto unknown production sites. Future research should look for any traces of these workshops especially blanks and flakes with bifacial negatives.

In the whole picture outlined above, there is a lack of information about local, long-lasting subneolithic communities. This collection lacks axes with an oval section and a pick form of technology, equated with the products of the Pripet-Neman Culture or Neman Culture (Czarniausky 1979; Dziedzic 2011).

Finally, a few more research postulates should be put forward. The first one would be the need to create a register of flint axes from different regional institutions to confirm or modify the image drawn on the basis of the group of axes from the Museum of Podlasie in Bialystok. It should also consider whether it is necessary to include in the program the development of other macrolithic flint objects like - daggers, bifacial tools and blades of sickles. The second postulate is that it is necessary to formulate a program for the recognition of the local Cretaceous flint resources. This task should consider the broad sampling of raw materials and the analysis using Geographic Information Systems (GIS). In order to obtain the best results, it is also necessary to perform specialist petrographic, geological and chemical testing.

REFERENCES

Balcer, B. 1975. *Krzemień świeciechowski w kulturze pucharów lejkowatych: eksploatacja, obróbka i rozprzestrzenienie*. Wrocław-Warszawa-Kraków-Gdańsk.

Balcer, B. 1986. *Wytwórczość narzędzi krzemiennych w neolicie ziem Polski*. Wrocław.

Balcer, B. 2002. *Ćmielów, Krzemionki, Świeciechów: związki osady neolitycznej z kopalniami krzemienia*. Warszawa.

Baltrūnas, V., Karmaza, B., Kulbickas, D. and Ostrauskas, T. 2006. Distribution of raw material for prehistoric flint artefacts in South Lithuania. *Geografija* 42 (2): 41–47.

Barska, K. 2002. Nowe dane dotyczące powiązań kopalni krzemienia w Krasnym Siole z kulturą amfor kulistych. In M. Karczewska and M. Karczewski (eds), *Badania archeologiczne w Polsce Północno-Wschodniej i na zachodniej Białorusi w latach 2000 – 2001,* 101–111. Białystok.

Bobrowski, P. and Sobkowiak-Tabaka, I. 2008. Makrolityczne narzędzia z krzemienia czekoladowego na Niżu Polski. In W. Borkowski, J. Libera, B. Sałacińska, and S. Sałaciński (eds), *Krzemień czekoladowy w pradziejach*, 203–214. Warszawa-Lublin.

Budziszewski, J. and Grużdź, W. 2013. O technikach i metodach krzemieniarskich. In M. Przybyła, A. Szczepanek and P. Włodarczak (eds), *Koszyce, stanowisko 3: przemoc i rytuał u schyłku neolitu*, 161–178. Kraków.

Cyrek, K. 1983. Surowce krzemienne w mezolicie dorzeczy Wisły i górnej Warty. In J. K. Kozłowski and S. K. Kozłowski (eds), *Człowiek i środowisko w pradziejach,* 106–113. Warszawa.

Czarniausky, M. 1995. BY 1 Krasnaselsky, Grodna province. BY 2 Karpautsy, Grodna province. *Archeologia Polona* 33: 262–269.

Dziedzic, A. 2011. Siekierki krzemienne z kolekcji Wandalina Szukiewicza z miejscowości Kaszety w zbiorach Muzeum Archeologicznego w Krakowie. In U. Stankiewicz and A. Wawrusiewicz (eds), *Na rubieży kultur. Badania nad okresem neolitu i wczesną epoką brązu*, 321–332. Białystok.

Gieysztor-Szymczak, E. 1980. Płonka-Kozły, gm. Łapy, woj. białostockie stanowisko 1. *Informator archeologiczny* 14: 18–19.

Gurina, N. 1976. *Driewnije kriemniedobywajuszczije szachty na tierritorii SSSR*. Leningrad.

Grużdź, W. 2016. *Sierpy z krzemienia ożarowskiego na tle wytwórczości narzędzi bifacjalnych z obszaru Małopolski i Wołynia na przełomie III i II tysiąclecia BC.* Unpublished PhD thesis, Cardinal Stefan Wyszyński University in Warsaw.

Kalicki, T. and Kalicki, P. 2012. Mikroregion prahistorycznego górnictwa w Krasnym Siole (Zachodnia Białoruś) a zmiany wybranych komponentów środowiska geograficznego. *Prace i Studia Geograficzne* 50: 41–55.

Kempisty, E. 1971. Kultura amfor kulistych na Mazowszu i Podlasiu. *Materiały Starożytne i Wczesnośredniowieczne* 1: 7–34.

Kulczycka-Leciejewiczowa, A. 1996. *Opis zabytków kamiennych: propozycja standaryzacji*. Warszawa.

Lepionka, H. 2015. *Krzemienne rdzenie neolityczne ze stanowiska Brańsk 22, obiektu 31. Przyczynek do badań nad surowcem krzemiennym Polski Północno-Wschodniej.* Unpublished BA thesis, Adam Mickiewicz University in Poznań.

Libera, J. 2009. Czy siekiery krzemienne mogą być wyznacznikiem kultury amfor kulistych? In H. Taras and A. Zakościelna (eds), *Hereditas praeteriti. Additamenta archaeologica et historica dedicata Ioanni Gurba Octogesimo Anno Nascendi,* 169–179. Lublin.

Libera, J. 2016. Siekiery kultury ceramiki sznurowej z Wyżyny Lubelskiej – próba identyfikacji. In P. Włodarczak, P. Jarosz and J. Libera (eds), *Schyłek neolitu na Wyżynie Lubelskiej*, 479–492. Kraków.

Madsen, B. 1984. Flint axe manufacture in the Neolithic: experiments with grinding and polishing of thin-butted flint axes. *Journal of Danish Archaeology* 3: 47–62.

Miecznikowski, Z. 2014. *Neolityczne siekiery i topory ze zbiorów Muzeum Mazowieckiego w Płocku (T. 1).* Płock.

Nosek, P. 1967. *Kultura amfor kulistych w Polsce*. Wrocław.

Obuchowski, W. 2003. *Zabytki krzemienne i kamienne od paleolitu do wczesnej epoki żelaza z terenów Białorusi w zbiorach Państwowego Muzeum Archeologicznego w Warszawie*. Warszawa.

Piličiauskas, G. 2007. *Titnago industrija Pietryčių Pabaltijyje 2900-1700 m. pr. Kr. gludintų titnaginių kirvių tyrimų duomenimip.* Unpublished PhD thesis, University of Klaipeda in Vilnius.

Pyżewicz, K., Grużdź, W. and Dmochowski, P. 2016. Lokalna wytwórczość form czworościennych w Wielkopolsce. Wstęp do problematyki. In W. Borkowski, B. Sałacińska and S. Sałaciński (eds), *Krzemień narzutowy w pradziejach*, 309–362. Warszawa.

Szmit, Z. 1929. Badania osadnictwa epoki kamiennej na Podlasiu. *Wiadomości Archeologiczne* 10: 27–36.

Szymczak, K. 1992. *Północno-wschodnia prowincja surowcowa kultury Świderskiej*. Łódź.

Szymczak, K. 1995. *Epoka kamienia Polski północno-wschodniej na tle środkowoeuropejskim*. Warsaw.

Vemming Hansen, P. and Madsen, B. 1983. Flint axe manufacture in the Neolithic: an experimental investigation of a flint axe manufacture site at Hastrup Vænget, East Zealand. *Journal of Danish Archaeology* 2: 43–59.

Wawrusiewicz, A., Januszek, K. and Manasterski, D. 2015. *Obiekty obrzędowe Pucharów Dzwonowatych z Supraśla. Złożenie darów, przejecie terenu czy integracja kulturowa.* Białystok.

Wiślański, T. 1966. *Kultura amfor kulistych w Polsce północno-zachodniej.* Wrocław.

Włodarczak, P. 2006. *Kultura ceramiki sznurowej na Wyżynie Małopolskiej*. Kraków.

Wójcik, Z. 2005. Rybniki - „Krzemianka" - wprowadzenie geologiczne. In W. Borkowski and M. Zalewski (eds), *Rybniki - „Krzemianka". Z badań nad krzemieniarstwem w Polsce Północno-Wschodniej*. Warszawa.

Zalewski, M. 2007. *Archeologia. Najdawniejsze dzieje Puszczy Knyszyńskiej*. Warszawa – Białystok.

Zalewski, M. 2011. O potrzebie i możliwościach badań nad wydobyciem krzemienia w pradziejach na Podlasiu. In U. Stankiewicz and A. Wawrusiewicz (eds), *Na rubieży kultur. Badania na okresem neolitu i wczesną epoką brązu,* 297–303. Białystok.

Zalewski, M., Sałaciński, S. and Sałacińska, B. 2016. Eksploatacja krzemienia narzutowego w międzyrzeczu Bugu i Narwi. In W. Borkowski, B. Sałacińska and S. Sałaciński (eds), *Krzemień narzutowy w pradziejach*, 79–104. Warszawa.

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New Perspectives on the Problems of the Exploitation Area and the Prehistoric Use of the Buda Hornstone in Hungary

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The mountainous areas of the Carpathian basin have provided a wide spectrum of siliceous rocks for prehistoric people. Although the presence of outcrops of a kind of chert, named Buda hornstone was already known by geological and petrographic investigations, the developing Hungarian petroarchaeological research did not pay much attention to this raw material. Its archaeological perspectives have been opened by a discovery made at the Denevér street in western part of Budapest in the 1980s. During the excavations of the flint mine, not much was known about the distribution of this raw material in the archaeological record. Since then the growing amount of archaeological evidences showed that its first significant occurrence in assemblages can be dated to the Late Copper Age Baden culture, and it became more abundant through the Early Bronze age Bell-Beaker culture until the Middle Bronze Age tell cultures. Until now, 15 outcrops of the Buda hornstone have been localised on the surface. Based on thin section examinations taken from two different outcrops, we have made a clear distinction between three variants. In the last few years, archaeological supervision has been conducted during house constructions, suggesting the Buda hornstone occurrence takes the form of a secondary autochthonous type of source. In the framework of our research program, a systematic check of the raw materials is planned in the lithic assemblages of the nearby prehistoric sites, as well as to look for extraction pits or other mining features with the application of geophysical methods and a thorough analysis of the surface morphology.

KEY-WORDS: Copper Age, Bronze Age, lithics, raw material, mining, chert, Hungary

To the memory of Veronika Gábori-Csánk and Miklós Gábori
who unearthed the first extraction site of the Buda hornstone

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INTRODUCTION

There is a wide spectrum of siliceous rocks suitable for raw material of knapped stone tools for prehistoric people in the mountainous areas of the Carpathian basin (Biró 1988, 2008; Kaminská 2001, 2013; Rácz 2013; Crandell 2014). This richness is due to the complicated geological history of the Carpathians, developed in the Africa–Eurasia Collision Zone within the Alpine orogenesis (Földvary 1988; Plašienka *et al.*, 1997; Budai and Gyalog 2009; Mester *et al.*, 2012). In connection with the orogenic folding of the Carpathians, strong volcanic activity took place in the Carpathian forelands from the middle of the Miocene onwards. As a consequence, a series of Tertiary volcanic formations lie in the inner part of the Carpathian arc from the Danube Bend (Visegrád Mountains, Hungary) through the mountain ranges of Northern Hungary and Southeastern Slovakia to the Vihorlat-Gutinian Ridge (Transcarpathian Ukraine) and the Oaş Mountains (Northern Romania; Harangi 2001; Karátson 2006; Harangi and Lenkey 2007). Mesozoic formations comprise mainly sedimentary siliceous rock types (e.g., radiolarite, chert, hornstone), while volcanic formations contain eruptive and metasomatic ones (e.g., obsidian, limnosilicites, silicified sandstone). This richness in siliceous rocks is reflected by prehistoric lithic assemblages in archaeological sites of the region (Dobosi 1978; Biró 1988, 1998a; Simán 1991).

The question of the identification of the raw materials of prehistoric knapped stone implements was hardly raised before the 1980s. A general petrographic characterisation of the rock types occurring in the lithic assemblages was quite usual in the monographs about important Palaeolithic sites (Kadić 1916; Bartucz *et al.*, 1940; Vértes 1964a; Gábori-Csánk 1968). Despite this, the problem of the origin of the raw materials was only rarely considered, mainly for specific and very characteristic rock types, such as the obsidian (Szabó 1877), the Świeciechów (grey white-spotted) flint (Vértes 1960) or the quartz-porphyry (Vértes and Tóth 1963). Similarly, the problem of acquisition of lithic raw materials did not interest prehistorians in Hungary, although fortunate discoveries revealed the existence of prehistoric mining activities (Hillebrand 1929; Mészáros and Vértes 1955; Vértes 1964b; Fülöp 1973).

The situation changed from the 1980s onward; the geologist József Fülöp (1984) put the problem of mineral raw materials in a historical perspective. His initiative led to the linking of the geological, petrographical and archaeological problems of lithic raw materials to each other. Petroarchaeological research that began after this in Hungary had two foci: the identification of raw materials and the study of prehistoric mines (Biró ed. 1986, 1987). The first topic concerned the recognition and characterisation of siliceous rock types occurring on archaeological sites as well as the study of their distribution as a problem of circulation (Biró 1988, 1998a; Simán 1989; Bácskay 1990; Biró and Dobosi 1991; Biró *et al.*, 2000). Related analytical approaches were applied to some particularly interesting raw materials: Carpathian obsidians, Transdanubian

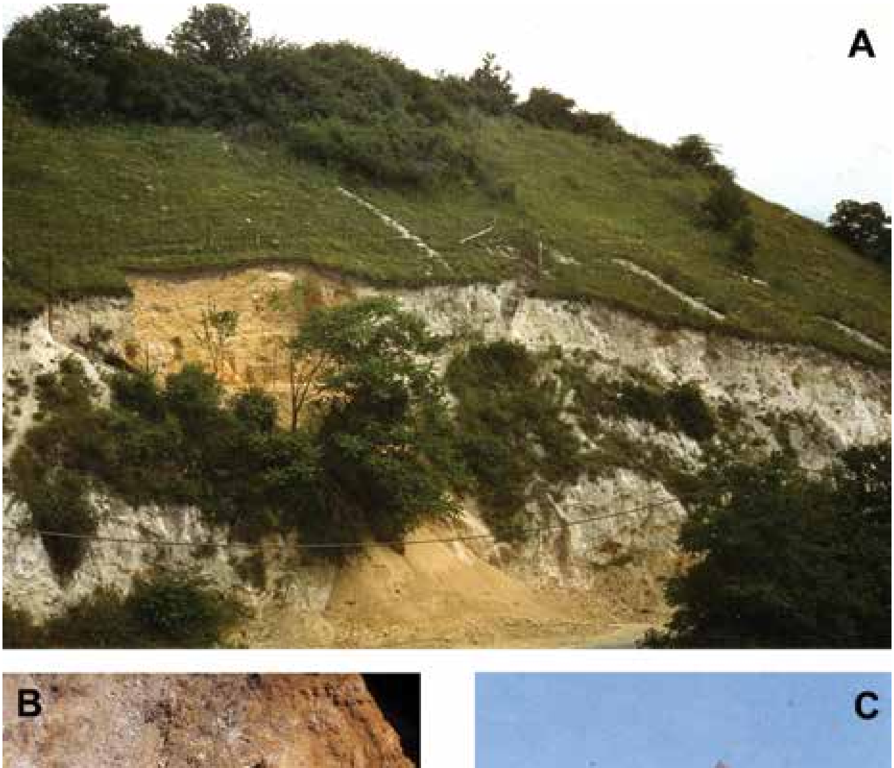

Fig. 1. Budapest-Farkasrét: A – view of the site; B – antler tools in level C; C – Mousterian-like sidescraper. Photos: M. Gábori.

radiolarites and quartz-porphyry (Oddone *et al.*, 1999; Markó *et al.*, 2003; Kasztovszky and Biró 2006; Biró *et al.*, 2009). The second topic was represented, on the one hand, by further investigations at already known mines and, on the other hand, by looking for new exploitation areas (Simán 1986, 1995a, 1995b; Biró and Regenye 1991; Bácskay 1995a, 1995b, 1995c; Biró 1995; Ringer 2003; Biró *et al.*, 2010; Szolyák 2011; Tóth 2011). The research projects concentrated only on some kind of raw materials: the Transdanubian radiolarites, the Tevel flint, the quartz-porphyry and two specific limnosilicites. As a consequence, these investigations concerned mainly the Transdanubian Range and limited areas of the Bükk and Tokaj mountains.

THE DISCOVERY AND EXCAVATIONS OF THE FLINT MINE AT BUDAPEST-FARKASRÉT

Although the presence of outcrops of a specific kind of chert, named Buda hornstone, in the Buda Mountains was already known by geological and petrographical investigations (Károly 1936; Vadász 1960; Wein 1977; Juhász 1987), the developing Hungarian petroarchaeological research did not pay attention to this potential raw material. Its archaeological perspectives were opened by a fortuitous discovery made at the Denevér street next to the Farkasrét cemetery in the western part of Budapest (Vörös 1998–1999: 69; Biró 2002: 131). A fragment of a mining tool made of antler and a few flint pieces were found and reported to the Hungarian Geological Institute. Since the pieces indicated an archaeological site, Veronika Gábori-Csánk from the Budapest Historical Museum started investigations to verify the discovery.

At the location where the antler tool fragment had been found, the Denevér street descends in a valley cut into dolomite (Fig. 1:A). On the upper part of the north-eastern slope of the valley, a reddish spot in the white dolomite was found to be an archaeological site (Gábori-Csánk 1988). Prospections by geoelectric method detected low-resistivity zones of possible extraction pits under the surface (Pattantyús-Á. 1986; Pattantyús-Á. and Simon 1986).

The excavations of the Budapest-Farkasrét site were carried out in three campaigns in 1984, 1985 and 1987 with a 7 m large and 3.5 m long trench cut in the slope (Gábori-Csánk 1988, 1989; Gábori-Csánk and Gábori 1995). Based on the morphology of the surface after excavations, the site was interpreted as a small valley which had been open during the Pleistocene but filled in before the Early Holocene. The infilling, composed by eroded slope sediments, chert detritus, pebble levels and soil lenses of torrential origin, had a complicated stratigraphy. However the archaeological material – consisting of mining tools made of antler, knapping waste of chert and hammerstones – have been found in three apparently undisturbed horizontal levels (Fig. 1:B). At the bottom of the excavated area, two extraction pits were also observed (Gábori-Csánk and Gábori

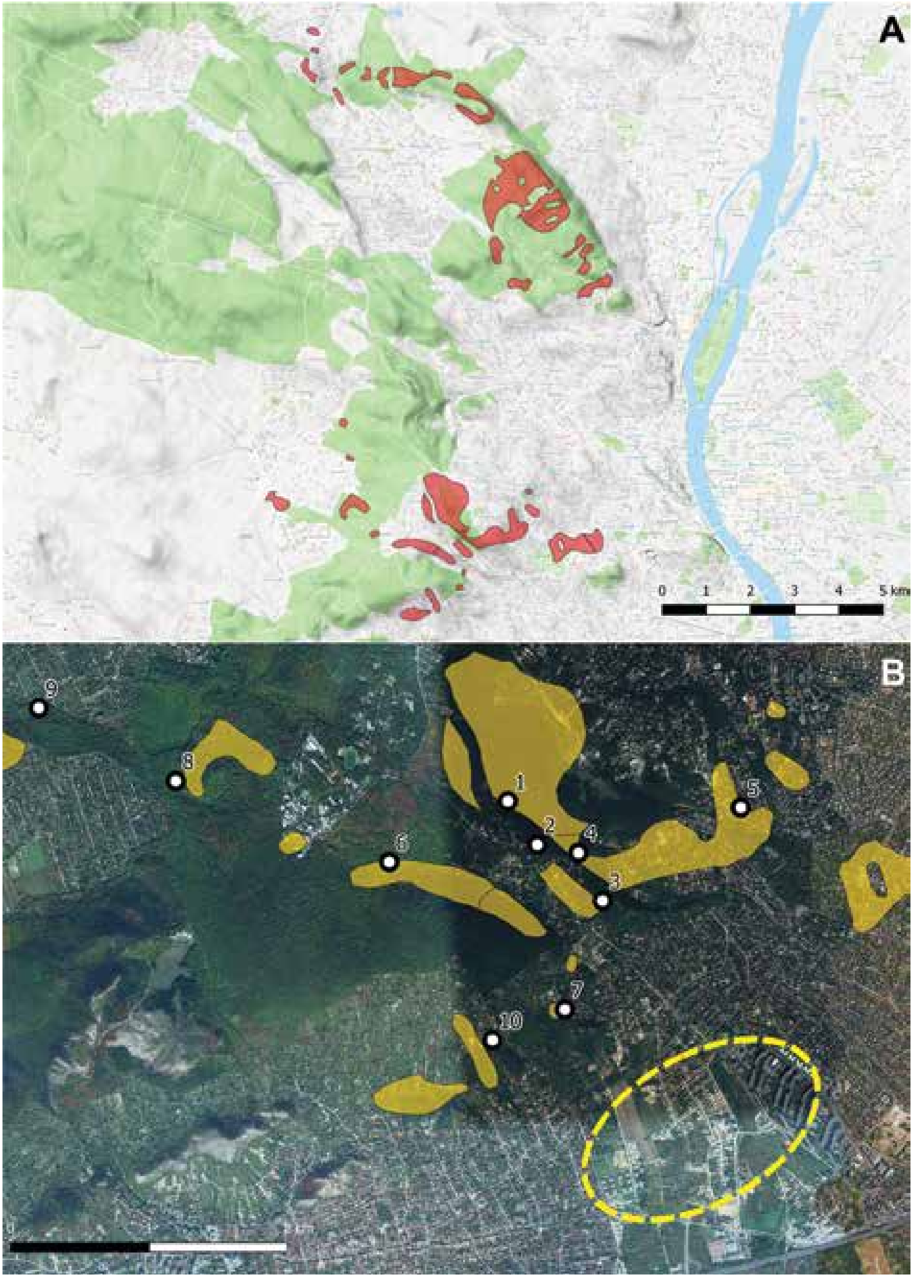

Fig. 2. Sources of the Buda hornstone: A – geological formations potentially containing siliceous rocks; B – Site 1 to 10 and ‘cherty dolomite’ formations (ochre spots) in the southern zone, occurrences of Buda hornstone in the foothills (dashed line). Basic maps: GoogleMap, CAD: N. Faragó.

1995). Of the 260 mining tools, 250 were made of red deer antler (Vörös 1998–1999, 2000). Besides nine truncated flakes and three retouched flakes, the only other lithic artefact was classified as a simple side scraper. It was considered as to be characteristic for the Mousterian (Gábori Csánk 1989: 19; Gábori-Csánk and Gábori 1995: 31).

The age of the mining activity at Budapest-Farkasrét site is very difficult to determine. Gábori-Csánk and Miklós Gábori (1995: 39–42) argued for a Middle Palaeolithic timeframe for the following reasons: 1) the down cutting of the valley of the Denevér street dates to the Holocene, while the small valley of the site has to date to the Pleistocene; 2) there are no traces of blade production in the lithic material; 3) neither polishing nor shaft holes could be found on the antler tools; 4) not one fragment of pottery but a Mousterian side scraper was found in the lowest level (Fig. 1:C). Two inconsistent radiocarbon dates have been obtained for the mine (Gábori-Csánk and Gábori 1995: 41; Vörös 1998–1999: 96): 40,350 ± 950 BP (GrN 15567) from charcoal found in the upper level and 3470 ± 80 BP (B 4709) from an antler without clear archaeological context. The first one corresponds more or less to the radiometric age of the Middle Palaeolithic Mousterian site of Érd (Gábori-Csánk 1968: 107), while the second one is younger than the dates of the flint mine of Sümeg exploited from the Middle Neolithic to the Middle Copper Age (Bácskay 1995a: 392).

THE GEOLOGICAL CONTEXT OF THE BUDA HORNSTONE

Gábori-Csánk and Gábori (1995) concentrated on the archaeological problems of the Budapest-Farkasrét flint mine. Despite this, sedimentological analysis of the stratigraphic sequence was not carried out. Concerning the origins of the sediments filling up the small valley, they cited published geological descriptions of the area. Neither the petrography nor the geological context of the extracted raw material was discussed.

According to Katalin T. Biró (2002: 131), the outcrops of the Buda hornstone were visited several times in the course of the systematic raw material surveys in the 1980s. The Lithotheca Comparative Raw Material Collection of the Hungarian National Museum has 11 samples of the Buda hornstone coming from seven localities (Biró and Dobosi 1991: 14–15, 112, 123, 136–137; Biró *et al.*, 2000: 20, 151). These localities represent geological occurrences of the formation named 'cherty dolomite' which dates to the Carnian stage of the Upper Triassic (Wein 1977: 17–19). According to recent geological nomenclature, this belongs to the Sashegy Dolomite Member of the Mátyáshegy Formation (Gyalog *et al.*, 2017). Sashegy Dolomite consists of grey dolomite formed in deep marine conditions. It contains grey or brownish-grey chert nodules and lenses, distributed parallel to the layers of the dolomite. In the Buda Mountains, it appears in the Irhás-árok–Sas-Hill zone and in the Hármashatár-Hill zone in the southern and northern part respectively (Fig. 2:A). In the northern part, chert nodules and layers also occur in the Mátyáshegy Limestone Member of the same formation (Gyalog *et al.*, 2017) but this material currently seems not to be of any archaeological importance. New palaeontological data suggest that some parts of the cherty dolomite in the southern zone could be dated to the Early and Middle Norian (Karádi *et al.*, 2016). For evaluating the accessibility of the Buda hornstone, it is worth noting that nodules can also be found in the blocks of Upper Eocene breccia-conglomerates (for example, close to the Budapest-Farkasrét site in the southern zone; Fig. 3).

BUDA HORNSTONE IN ARCHAEOLOGICAL ASSEMBLAGES

During the excavation of the flint mine of Budapest-Farkasrét, not much was known about the distribution of this raw material in archaeological assemblages. Despite its relative early mineralogical-petrographical and geological definition in the literature (Károly 1936; Vadász 1960; Wein 1977; Juhász 1987), the real recognition of this material in archaeological assemblages came only at the beginning of the 1990s. Certainly, the

Fig. 3. Buda hornstone blocks in the brecciated formation at Site 5. Photo: N. Faragó.

fact that this rock was extracted by prehistoric people drew the attention of archaeologists to the need to look for it among the raw materials in lithic assemblages.

Though the raw material of the majority (more than 80 percent) of the Early Bronze Age Bell-Beaker Culture assemblage of Budapest-Hollandi street is labelled 'Triassic hornstone', it is obvious from the paper of Biró (1991) that it is the same rock type as we know nowadays as 'Buda hornstone'. However, according to the catalogue of the Lithotheca, she created this actual denomination in 1988: samples 86/019, 86/020 and 86/021 collected respectively at the Ördög-orom, Végvári-szikla and Irhás-árok (Budapest XII) localities were attributed to 'hornstone', while samples 88/006, 89/020 and 89/019 from the same localities to 'Buda hornstone'.

Once this specific raw material had been clearly identified as Buda hornstone, it was reported from a couple of sites (Table 1, Fig. 4). Éva Csongrádiné Balogh (1992) presented a lithic assemblage from the Szigetszentmiklós-Üdülősor site of the Bell-Beaker

Table 1. Occurrences of Buda hornstone on archaeological sites (see Fig. 4).
BA – Bronze Age; CA – Copper Age; EBA – Early Bronze Age; LCA – Late Copper Age; MBA – Middle Bronze Age; MP – Middle Palaeolithic

No.	Name of the archaeological site	District, county	Age, culture	Quantity, proportion	Reference
1	Bia-Öreghegy	Pest	MBA, Vatya	>50%	Csongrádiné Balogh 1998; Horváth 2009
2	Bölcske-Vörösgyír	Tolna	EBA, Nagyrév, MBA, Vatya	5 of 28 pcs	Horváth *et al.*, 2000a
3	Budakalász	Pest	LCA, Baden	10 of 175 pcs	Balogh 2009
3	Budakalász	Pest	EBA, Bell-Beaker	80 of 86 pcs	Horváth 2017
4	Budapest-Albertfalva	Budapest XI	EBA, Bell-Beaker; CA, Furchenstich	>80%	Biró 2002
5	Budapest-BEAC	Budapest XI	MBA, Vatya		Horváth 2009
6	Budapest-Csepel, II. Rákóczi Ferenc street	Budapest XXI	EBA, Bell-Beaker	39 pcs	Biró 2002
7	Budapest-Hollandi street	Budapest XXI	EBA, Bell-Beaker	>80%	Biró 1991
8	Budapest-Káposztásmegyer	Budapest IV	LCA	25%	Biró 1998b
9	Budapest-Medve street	Budapest XXI	LCA	35%	Biró 1998b
10	Budapest-Péteri major	Budapest XXIII	MBA, Vatya		Horváth 2009
11	Csongrád-Vidre	Csongrád	MBA, Vatya		Horváth 2009

12	Dunaújváros-Koszi-derpadlás	Fejér	MBA, Vatya		Horváth 2009
13	Érd(-Parkváros)	Pest	MP, Quina type Mousterian	19 of 810 pcs	Mester 2004
14	Igar-Vámpuszta-Galástya	Fejér	MBA, Vatya		Horváth 2009
15	Kakucs-Balladomb	Pest	MBA, Vatya		Horváth 2009
16	Lovasberény-Mihá-lyvár	Fejér	MBA, Vatya		Horváth 2009
17	Mende-Leányvár	Pest	MBA, Vatya		Horváth 2009
18	Nagykőrös-Földvár	Pest	MBA, Vatya		Horváth 2009
19	Pákozd-Vár	Fejér	MBA, Vatya		Horváth 2009
20	Páty-Nagyhegy	Pest	MBA, Vatya		Horváth 2009
21	Solymár-Mátyás-domb	Pest	MBA, Vatya		Horváth 2009
22	Soroksár-Várhegy	Budapest XXIII	MBA, Vatya		Horváth 2009
23	Százhalombatta-Sánchegy / Százhalombatta-Földvár	Pest	EBA, Nagyrév, MBA, Vatya	90%	Horváth *et al.*, 2000b, 2001; Pető *et al.*, 2002; Horváth 2005
24	Szigetszentmiklós-Üdülősor	Pest	EBA, Bell-Beaker	37.9%	Csongrádiné Balogh 1992
25	Tószeg	Jász-Nagykun-Szolnok	MBA	1 of 55 pcs	Csongrádiné Balogh 1998, 2001
26	Túrkeve-Terehalom	Jász-Nagykun-Szolnok	MBA, Ottomány	4 of 10 pcs	Csongrádiné Balogh 2001; Horváth 2009

Culture, still in the close vicinity of Budapest and of the raw material sources of the Buda Mountains. The main raw material there (37.9%) was also Buda hornstone completed by quartzite pebbles, several types of radiolarites and obsidian. She published a small part of the old collections of the Middle Bronze Age sites of Bia-Öreghegy and Tószeg (Csongrádiné Balogh 1998). Apart from the important information about the use-wear analysis concerning these 34 pieces, the raw materials were also identified: more than a half of the finds of Bia-Öreghegy are made on Buda hornstone, while only a single one of the five knapped stone artefacts from Tószeg was found to be of this material. From a later publication it became obvious that this latter piece is unique among the finds from that well known and iconic site near the Tisza River, because none of the newly published 50 pieces were made on Buda hornstone (Csongrádiné Balogh 2001). In this paper, another Bronze Age tell site was mentioned from the Great Hungarian Plain, Túrkeve-Terehalom, where four of the ten analysed pieces were made of a specific 'grey hornstone variant', without any precision concerning

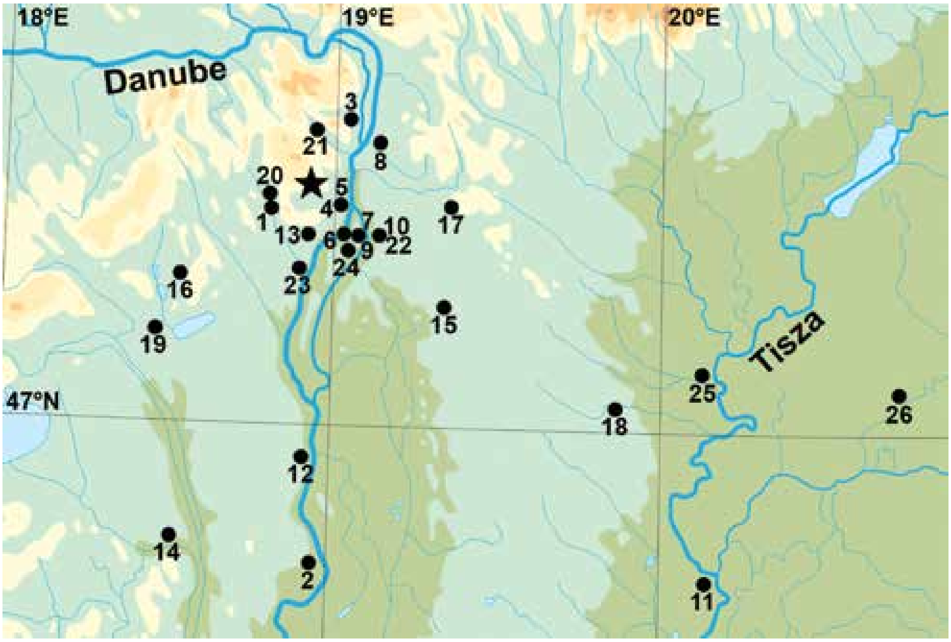

Fig. 4. The dots show the occurrence of Buda hornstone at prehistoric archaeological sites (see Table 1). The source is indicated by the star symbol. CAD: Zs. Mester.

their provenance but perhaps Buda hornstone too. From the Late Copper Age, the raw materials of both Budapest-Medve street and Budapest-Káposztásmegyer sites contained respectively 35 and 25 percent of Buda hornstone (Biró 1998b: Fig. 2). The famous cemetery of the Baden Culture at Budakalász was also mentioned in this article, but later a whole monograph was dedicated to this topic (Balogh 2009). According to the detailed analysis of the lithic assemblages found in the graves, most of the pieces could be attributed to local limnosilicite and distant radiolarite variants, and only less than 10 pieces of the 175 were made of the specific hornstone from the Buda Mountains. In 2000, another distant occurrence of the Buda hornstone, dated to the Early-Middle Bronze Age, was reported from Bölcske-Vörösgyír, lying about 100 km south of the source area (Horváth *et al.*, 2000a). Among the analysed 28 pieces, only 5 were made of Buda hornstone. Still in this paper, some references could be found to the raw material distribution of the lithic assemblage of the chronologically similar Százhalombatta-Sánchegy / Százhalombatta-Földvár sites. According to the author, 90 percent of the assemblage could be attributed to this raw material, which is not surprising, according to its close vicinity to Budapest. A later series of detailed studies were published about this very important site-complex and the lithic finds from the more recent excavation seasons, but the high ratio of the Buda hornstone remained the same among the large assemblage (Horváth *et al.*, 2000b; Pető *et al.*, 2002; Horváth 2005).

In 2002, a more comprehensive paper was published by Biró about the utilization of Buda hornstone, and new information was published about Bronze Age sites in the region of Budapest, the source of this raw material. The Budapest-Albertfalva site showed significant amount of lithic material from the Early Bronze Age Bell-Beaker Culture, and partly from the Copper Age Furchenstich culture. Among these assemblages, the Buda hornstone is dominant, comprising more than 80% of the finds (Biró 2002: 132). The author also mentioned the chronologically similar settlement and cemetery of Budapest-Csepel, II. Rákóczi Ferenc street. According to the preliminary information, 39 pieces of Buda hornstone accompanied by two broken pottery vessels were found in one single pit, which was interpreted as a symbolic grave. Due to the synthesis published by Tünde Horváth (2009), the list of the Buda hornstone occurrences from the Middle Bronze Age was completed with a series of sites: Pákozd-Vár, Kakucs-Balladomb, Igar-Vámpuszta-Galástya, Bia-Öreghegy, Budapest-BEAC, Dunaújváros-Kosziderpadlás, Lovasberény-Mihályvár, Mende-Leányvár, Nagykőrös-Földvár, Budapest-Péteri major, Soroksár-Várhegy, Solymár-Mátyásdomb, Csongrád-Vidre, Páty-Nagyhegy. The latest published information about an assemblage containing this raw material is from Budakalász, where an exceptionally large Bell-Beaker cemetery (1070 graves!) and a contemporary settlement were unearthed (Horváth 2017). Among the 86 pieces from the cemetery, only 6 were made of lydite, radiolarite or limnoquartzite, while the rest were of Buda hornstone.

NEW INSIGHTS ON THE USE OF BUDA HORNSTONE AS A PREHISTORIC RAW MATERIAL

The growing amount of archaeological evidences demonstrates the importance of this raw material in the lithic economy of prehistoric communities in the region. Thus the question arose whether more extraction places existed in its source area. The ongoing research of the authors aims to clarify the mode of acquisition and management of the Buda hornstone in time and space. It attempts to look for traces of human activities near the outcrops and for occurrence of this raw material at archaeological sites, first of all in the region, as well as to study the procurement strategies and technical behaviour related to this rock type. Finally, this research is the result of the joining of three parallel interests. Dealing with the problems of raw material sources and inspired by the research at flint mines in Poland, two of us (Norbert Faragó and Zsolt Mester) are inspired to re-study the almost unpublished Budapest-Farkasrét site. Motivated by a fortuitous discovery, one of us (Ferenc Cserpák) has attempted to find more traces of prehistoric exploitation of the Buda hornstone. And finally one of us (Dávid Kraus),

Fig. 5. Site 6 of the Buda hornstone: A – view of a stone accumulation; B – artefacts collected.
Photos: F. Cserpák, N. Faragó.

currently engaged in undertaking preventive excavations in the south-western part of Budapest is interested in clarifying contextual questions of the observed occurrences of this raw material close to prehistoric sites.

Field surveys

The first knapped artefacts of the Buda hornstone were found in Farkas valley near the Budapest-Farkasrét cemetery during an excursion in Autumn 2012. This unexpected discovery drew attention to this rock as a raw material. Based on information collected from archaeological and geological literature (Károly 1936; Dienes 1968; Wein 1977; Gábori-Csánk 1989; Csongrádiné Balogh 1992; Horváth *et al.*, 2000a; Biró 2002; Horváth 2005, 2009) a field survey program was established. Systematic prospection was started in Spring 2013. Using the geological map published by György Wein (1977), occurrences of cherty dolomite were identified in the field in both northern and southern zones. Until Summer 2017, fifteen outcrops of the Buda hornstone had been localised. Up to now, only Outcrops 1 to 9 have yielded artefacts proving the prehistoric activities and which are considered as sites (Fig. 2:B). Outcrops 10 to 15 still seem to be only geological sites. In most cases, the human activity on these sites comprises the presence of core remains and flakes without any ceramics. At Outcrop 6, however, hammerstones were also abundant (Fig. 5). The surface morphology at Outcrops 3, 6, 8 and 9 suggests the possibility of the existence of extraction structures. Evidently, this requires further investigation. It is worth noting that the dolomite embedding the chert nodules is also varied: it is highly pulverised in the Farkas valley (Sites 1, 2 and 4) and at Budapest-Farkasrét (Site 5), broken and friable at Ördög-orom (Site 3), and bedded at Végvári-szikla and Budakeszi-Kavics-árok (Sites 8 and 9).

Petrography

The chemical composition, mineralogical and petrographical definition of the Buda hornstone are less researched. Apart from Elemér Vadász (1960: 92) who studied it even in thin section (Biró and Dobosi 1991: 123; Biró 2002: 131, footnote 1), there is only an old paper of Erzsébet Károly (1936) that was dedicated to this topic. According to her data, the Buda hornstone, having silica content about 97%, occurrs in limestone and dolomite. It is a minor component of the surrounding rocks, occurring as nodules, flat nodules, lenses and layers. The colour varies from light grey to dark grey, brownish and reddish variations, but greenish, purple shades can also appear.

Based on our macroscopic observations, the horn-like lustre is not necessarily a property of this rock which occurs in lustreless variations too. It has splinter and conchoidal fracture, flat-angled cracks also can be observed. In terms of homogeneity, veins and light spots in the material were also detected in several cases. The veins run irregularly in different directions, the light grey spots are separated by a blurred border, with no directional orientation. In some pieces, there are cavities, ranging from a few mm to 1–1.5 cm, with quartz crystals inside. The cortex is whitish, light brownish, reddish, not homogeneous, rough and crumbly in many cases.

We observed several colour variants, it then emerged that they may differ in their chemical composition too. The purple colour appears along the veins and cracks in cloudy shape, possibly this is hematite, but further investigations are needed to verify this. The question arises whether it is possible to make differentiation according to colour variants. Three thin sections have been prepared from three different colour variants for investigation under the microscope. We selected a green and a red one from Site 6, and a grey one from Outcrop 12. It was soon discovered during the cutting that the green colour resulted from biological (plant) effect, the reason probably is that it was exposed on the surface for a long time. Each stone is tough, breaks along cracks and difficult to grind. The grey variant's texture is fine and full of spherical, cloudy nodules, some of them have blurred edge, other ones have sharper edges (Fig. 6: A and B). These nodules are about 0.14 to 0.76 mm in size; many of them are silicified and contain some chalcedony. The texture is full of small particles at high magnification

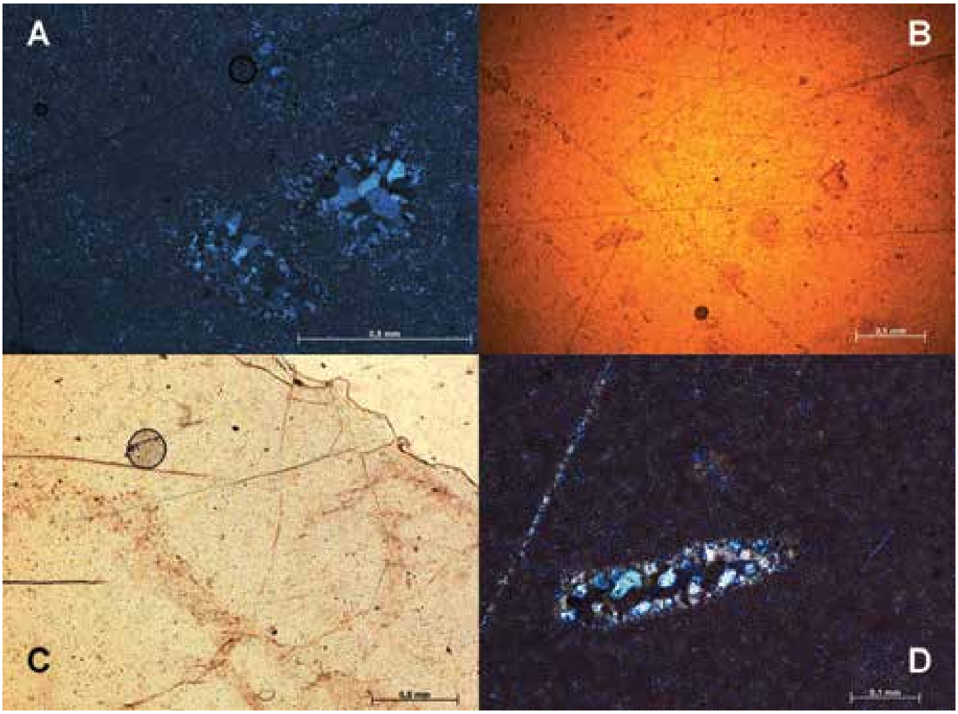

Fig. 6. Petrographic characteristics of Buda hornstone in thin sections: A – grey variant, circular fossil remains and nodule; B – grey variant, texture; C – red variant, circular fossil remains; D – red variant, nodule. Microphotos: R. K. Péter.

and there are many cracks in it. Some nodules have chalcedony and quartzite. There are some circular fossil remains about 0.16 mm in diameter. Some remains can be suspected of being shells, one of them is subsequently silicified, and its size is about 0.21 mm. The red variant's fabric is finer than the grey one, there are fewer nodules and it has some chalcedony too (Fig. 6: C and D). It is interesting that it has material filling the smaller interstices, and this is just visible in high magnification with crossed polarised light. There are some circular fossil remains, from 0.03 to 0.13 mm in diameter. An elongated fossil, 4.29 mm long and 0.32 mm wide, could be a sponge spicule. It has a few remains that could be shells, sized between 0.22 and 0.29 mm. The green variant has fewer fine inclusions; the texture is dirtier, containing a little chalcedony and quartzite. It has 1–2 nodules only; they are about 0.56 mm long and 0.1 mm wide. There are a few circular fossil remains; the biggest one is 0.38 mm in diameter.

Based on the thin section examinations, we made a clear distinction between the three samples, thus proving our basic idea that variants in colours differed also in internal properties. The grey one has a lot more nodules and it has the most fossils too, the red one has slightly less nodules and fossils and its texture is also different, lastly the green one differs greatly, it has a dirtier texture and nodules, fossils were hardly present in it. It is important to note that no conclusion can be drawn for the entire collection based only on these samples. However, these studies have justified the need for, and the importance of, further studies. Based on current field observations, different colour variants occur together, but it is still unclear whether variations based on colours would be suitable for identifying sources.

Archaeology

Although the primary autochthonous sources of the Buda hornstone could be limited to the extension of the above mentioned geological formations, other types of raw material sources need also to be taken into consideration when reconstructing prehistoric lithic procurement (Turq 2005; Mester *et al.*, 2012). The identified Sites 1 to 9 are located at 250–300 m above sea level. From this area, foothills stretch out to the south, covered by Pleistocene slope sediments and loess-like sediments (Wein 1977) in which were cut stream valleys running from northwest to southeast. These circumstances suggest the Buda hornstone could have been obtained from a secondary autochthonous type of source.

In the last few years, archaeological supervision has been conducted during house constructions in the Spanyolrét, Madárhegy, Hosszúrét, Gazdagrét and Sasad quarters lying on this foothill between 130 and 195 m above sea level (Fig. 2:B). In the western part of this area, small (up to 5 cm) patinated fragments of Buda hornstone came up in the uppermost (0 to 40 cm) soil level that can be interpreted as a result of erosional processes in the Holocene period. On the contrary, in the eastern part of the area, large quantities of bigger boulders (the size of a fist or child-head) have been unearthed from

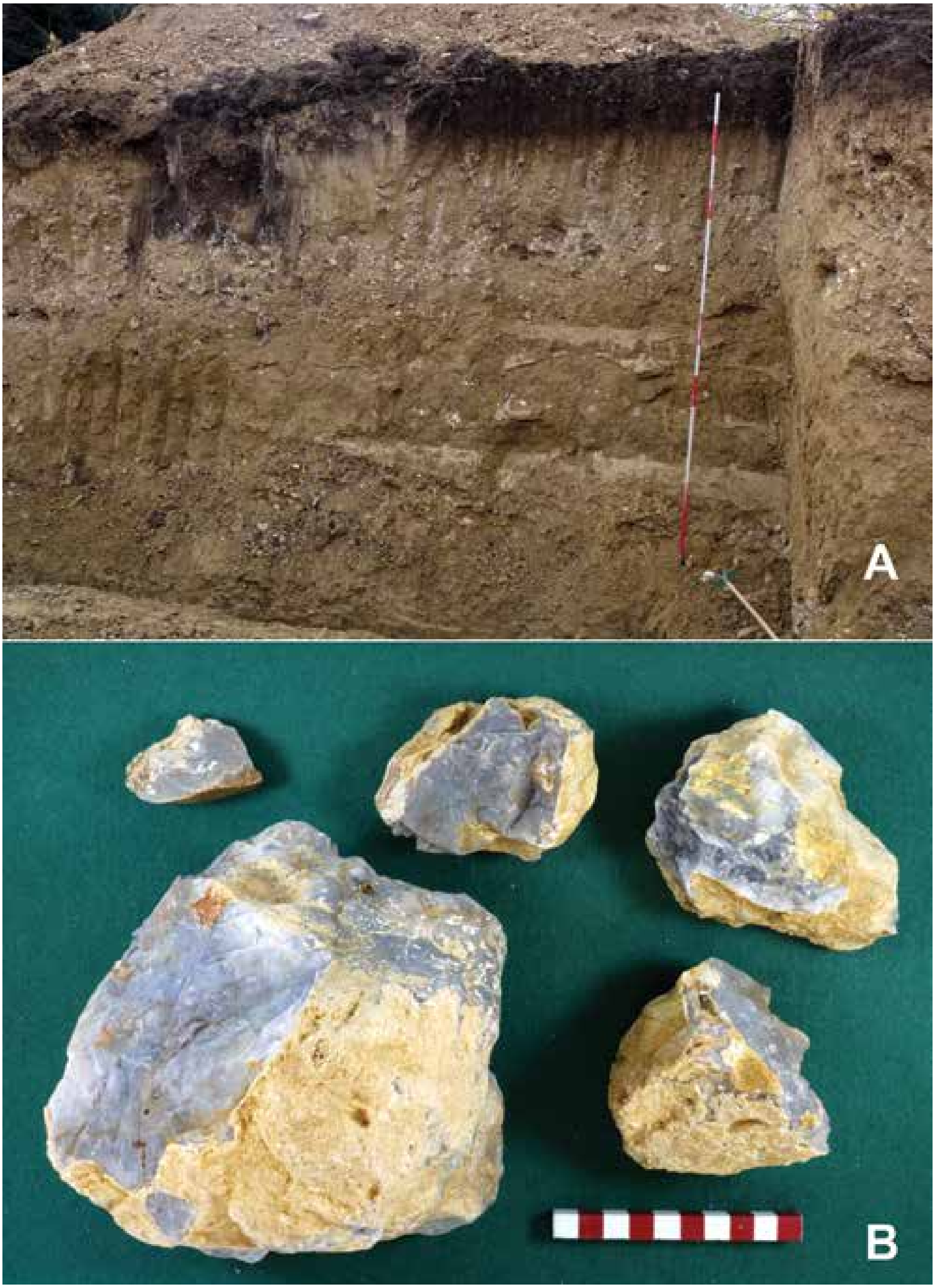

Fig. 7. Buried slope sediment with fragments of Buda hornstone in the foothill area (Nevegy köz, Budapest XI). A – profile of the site; B – Blocks collected at this locality. Photos: D. Kraus, N. Faragó.

the clayey and loessic sediments below the Holocene soil (Fig. 7). It probably represents erosional accumulations from older (probably Pleistocene) periods. The most interesting observation was made at two archaeological sites where Buda hornstone fragments have been found in the excavation of a settlement of the Transdanubian Linear Pottery culture. However it is not clear yet whether Neolithic people used this raw material.

CONCLUSIONS

The existence of Upper Triassic chert in the Buda Mountains was demonstrated by geologists in the first half of the last century (Károly 1936). It occurs in the mountains in a northern and a southern zone (Wein 1977). Its use by prehistoric people was proven by the extraction site of Budapest-Farkasrét (in the southern zone). The excavations of the site between 1984 and 1987 yielded more than 200 mining tools, made almost exclusively of red deer antler, as well as hammerstones and a few retouched artefacts among the large quantity of lithic material recovered. The radiometric dating of the mine was ambiguous: one of the dates represents a Middle Palaeolithic age, the other one an early Middle Bronze Age. Initially, it was thought that the Palaeolithic age was thought to be reliable but without any archaeological evidence.

Since this raw material has been identified as Buda hornstone, it was recognised in the archaeological material of several prehistoric sites. Its significant occurrence firstly can be dated to the Late Copper Age Baden culture, and it became more abundant through the Early Bronze age Bell-Beaker culture until the Middle Bronze Age tell cultures, namely Nagyrév and Vatya horizons. The spatial distribution of this specific raw material is fairly limited, it is fond in assemblages from within a zone about 50–100 km around the original outcrops (Fig. 4). The characteristic tool types at most localities from the Bronze Age were bifacial tools, arrowheads, saw-like tools or scrapers, altogether this industry has a rather archaic aspect. The technology of the assemblages can be characterized mostly as a flake oriented one, which is due partly to the very poor quality of this raw material (Horváth 2005, 2009). In connection with the nature of the material, some scholars suggest the possibility of deliberate utilization of fire both during the mining of the blocks and/or during the preparation of the blanks (Biró 2002; Horváth 2005). Recently, this topic has been a subject of a detailed analysis of a specific limnosilicite as well as of quartz-porphyry (metarhyolite) from the Bükk Mountains. This concluded that either obtaining or production techniques involving intense heat would need a more complicated technology, and thus the study of this question requires a more elaborate research background (Tóth 2016).

Concerning the archaeological evidence for the older dating of the Budapest-Farkasrét site, the lithic assemblage of the Middle Palaeolithic site of Érd where the Buda hornstone would have played an important role beside the dominant quartzite is often cited (Biró 1991: 94, 1998b: 160, 2002: 131; Horváth 2009: 421). They refer to the study of István Dienes (1968) who undertook an analysis of the raw materials of the site. Here it should be noted that in fact, neither Dienes nor Gábori-Csánk mention that any raw material of Érd had originated from the Buda Mountains. Dienes (1968: 111) gave only a global attribution for all the raw materials (23.8% in total) different from quartzite. Based on analogous rock types known from the mountains, he attributed sedimentary rocks with yellow and brown colour to the Jurassic, while those with grey and black colour to the Triassic. He was convinced that all these types could be collected by the prehistoric inhabitants from the nearby gravels of Helvetian (i.e. Burdigalian) age. The mistake concerning the importance of the Buda hornstone in the assemblage of Érd is probably due to the misunderstanding of the table presenting the raw material composition of the industry by tool types following the determinations of Dienes (Gábori-Csánk 1968: 174). There are hornstone ('silex corné' – 127 pcs), Triassic chert ('silex triasique' – 5 pcs), and Jurassic chert ('silex jurassique' – 1 pc.) on the list. It is clear that these names refer to general rock types, rather than specific varieties. An analysis carried out by one of us has confirmed that in fact the Buda hornstone really is present in the assemblage (Mester 2004: 236). In total 129 artefacts were attributed to more than six macroscopically different chert types. Among them 19 belong to a type similar to the Buda hornstone obtained from the Budapest-Farkasrét extraction site. So it seems hardly likely that the Neanderthals of Érd had invested a lot of energy in mining for such a small amount of raw material. Consequently, it has to be stated here, despite the conclusion made by Gábori-Csánk the Palaeolithic age of the Budapest-Farkasrét mine cannot be supported by the material from the site at Érd.

Similarly, the data referring to the Buda industry from the Lower Palaeolithic period are wrong too (Biró 1991: 94, 1998b: 160; Horváth 2009: 421). In this case also the mistake is based on the appearance of the 'hornstone' in the publication of László Vértes (1965: 104) as one of the raw materials of the pebbles found together with Middle Pleistocene fauna at the caves of the Castle-Hill of Buda. Vértes, however, showed that these finds were not artefacts.

In the framework of the ongoing research program, a systematic check of the raw materials in the lithic assemblages of prehistoric sites unearthed in the region of Budapest is planned. It will clarify if Buda hornstone were used by prehistoric knappers in other periods too. In a wider perspective, it is an important and fascinating question whether prehistoric groups had similar or different strategies for the procurement and management of Buda hornstone according to periods or cultural units. The analysis of the technical behaviour will provide further data for studying these issues.

Our first results obtained during field surveys are very promising in order to identify more extraction sites. To look for extraction pits or other mining features the application of geophysical methods and a thorough analysis of the surface morphology are required. Similarly, the geomorphological context of the Budapest-Farkasrét site needs to be understood. Thus new geoarchaeological investigations are required. The evaluation of the recently recognised occurrences in the foothill area as a potential raw material source is also crucial for a better reconstruction of procurement strategies (cf. Fernandes *et al.,* 2008). For the same reason, the petrographic characterisation of the variants have to be continued.

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REFERENCES

Bácskay, E. 1990. New investigations into the processing and distribution of flint from the Sümeg-Mogyorósdomb flint mine in Hungary. In M.-R. Séronie-Vivien and M. Lenoir (eds), *Le silex de sa genèse à l'outil. Actes du V^e Colloque international sur le Silex, Bordeaux, 17 sept.-2 oct. 1987.*, 239–249. Paris, Cahiers du Quaternaire 17.

Bácskay, E. 1995a. H2. Sümeg-Mogyorósdomb, Veszprém country. *Archaeologia Polona* 33: 383–395.

Bácskay, E. 1995b. H5. Erdöbénye-Sáspatak, Borsod country. *Archaeologia Polona* 33: 395–400.

Bácskay, E. 1995c. H9. Hárskút-Édesvízmajor, Veszprém country. *Archaeologia Polona* 33: 408–409.

Balogh, É.Cs. 2009. The lithic finds from Budakalász. In M. Bondár and P. Raczky (eds), *The Copper age cemetery of Budakalász*, 379–407. Budapest.

Bartucz, L., Dancza, J., Hollendonner, F., Kadić, O., Mottl, M., Pataki, V., Pálosi, E., Szabó, J. and Vendl, A. 1940. *Die Mussolini-Höhle (Subalyuk) bei Cserépfalu.* Budapest, GeologicaHungarica, Series Palaeontologica 14.

Biró, K.T. (ed.) 1986. *Papers for the 1st International Conference on Prehistoric Flint Mining and Lithic Raw Material Identification in the Carpathian Basin, Budapest–Sümeg 1986, vol. 1.* Budapest.

Biró, K.T. (ed.) 1987. *Papers for the 1st International Conference on Prehistoric Flint Mining and Lithic Raw Material Identification in the Carpathian Basin, Budapest–Sümeg 1986, vol. 2.* Budapest.

Biró, K.T. 1988. Distribution of lithic raw materials on Prehistoric sites: an interim report. *Acta Archaeologica Academiae Scientiarum Hungaricae* 40: 251–274.

Biró, K.T. 1991. Bell-Beaker culture lithic implements from Hungary. *Acta Archaeologica Carpathica* 30: 87–96.

Biró, K.T. 1995. H8. Szentgál-Tűzköveshegy, Veszprém country. *Archaeologia Polona* 33: 402–408.

Biró, K.T. 1998a. *Lithic implements and the circulation of raw materials in the Great Hungarian Plain during the Late Neolithic Period*. Budapest.

Biró, K.T. 1998b. Limits and connections. In M. Németh (ed.), *The Roman town in the modern city, Proceedings of the International Colloquium held on the occasion of the 100th anniversary of the Aquincum Museum 1994 Budapest*, 152–157. Budapest, Aquincum Nostrum 2.

Biró, K.T. 2002. New data on the utilization of Buda hornstone in the Early Bronze Age. *Budapest Régiségei* 36: 131–143.

Biró, K.T. 2008. Kőeszköz-nyersanyagok Magyarország területén. *A Miskolci Egyetem Közleménye A sorozat, Bányászat* 74: 11–37.

Biró, K.T. and Dobosi, V.T. 1991. *Lithotheca – Comparative Raw Material Collection of the Hungarian National Museum*. Budapest.

Biró, K.T. and Regenye, J. 1991. Prehistoric Workshop at Szentgál-Tűzköves. *Acta Archaeologia Hungaricae* 18: 337–375.

Biró, K.T., Dobosi, V.T. and Schléder, Zs. 2000. *Lithotheca II – The Comparative Raw Material Collection of the Hungarian National Museum, Vol. II*. Budapest.

Biró, K.T., Szilágyi V. and Kasztovszky, Zs. 2009. Új adatok a Kárpát-medence régészeti radiolarit forrásainak ismeretéhez. *Archeometriai Műhely* 6(3): 25–44.

Biró, K.T., Regenye, J., Puszta, S. and Thamóné Bozsó, E. 2010. Preliminary report on the excavations of the Nagytevel flint mine. *Archaeologiai Értesítő* 135(1): 5–25.

Budai, T. and Gyalog, L. (eds) 2009. *Geological map of Hungary for tourists – 1:200 000*. Budapest.

Crandell, O. 2014. Knappable lithic resources of North-Western Romania: A mineralogical study. *Journal of Lithic Studies* 1 (1): 73–84.

Csongrádiné Balogh, É. 1992. Szigetszentmiklós-Üdülősor kora bronzkori telepének kőeszköz vizsgálata. In P. Havassy and L. Selmeczi (eds), *Régészeti kutatások az Mo autópálya nyomvonalán I.*, 201–211. Budapest. BTM Műhely 5.

Csongrádiné Balogh, É. 1998. Tipológiai és traszeológiai vizsgálatok rézkori és bronzkori pattintott kőeszközökön. *Folia Archaeologica* 47: 13–41.

Csongrádiné Balogh, É. 2001. Adatok a rézkori, bronzkori pattintott kőeszközök tipológiai értékeléséhez (Jász-Nagykun-Szolnok megye). *Tisicum* 12: 91–106.

Dienes, I. 1968. Examen pétrographique de l'industrie. In V. Gábori-Csánk, *La station du Paléolithique moyen d'Érd – Hongrie*, 111–114. Budapest, Monumenta historica Budapestinensia 3.

Dobosi, V.T. 1978. A pattintott kőeszközök nyersanyagáról (Über das Rohmaterial der retuschierten Steingeräte). *Folia Archaeologica* 29: 7–19.

Fernandes, P., Raynal, J.-P. and Moncel, M.-H. 2008, Middle Palaeolithic raw material gathering territories and human mobility in the southern Massif Central, France: first results from a petroarchaeological study on flint. *Journal of Archaeological Science* 35: 2357–2370.

Földvary, G.Z. 1988. *Geology of the Carpathian Region*. Singapore–Teaneck.

Fülöp, J. 1973. Funde des prähistorischen Silexgrubenbaues am Kálvária-Hügel von Tata. *Acta Archaeologica Academiae Scientiarum Hungaricae* 25: 3–25.

Fülöp, J. 1984. *Az ásványi nyersanyagok története Magyarországon*. Budapest.

Gábori-Csánk, V. 1968. *La station du Paléolithique moyen d'Érd – Hongrie.* Budapest, Monumenta historica Budapestinensia 3.

Gábori-Csánk, V. 1988. Une mine de silex paléolithique à Budapest, Hongrie. In H.L. Dibble and A. Montet-White (eds), *Upper Pleistocene prehistory of Western Eurasia*, 141–143. Philadelphia, University Museum Monograph 54.

Gábori Csánk, V. 1989. Európa legrégibb bányászati emléke Farkasréten. *Magyar Tudomány* 34(1): 13–21.

Gábori-Csánk, V. and Gábori, M. 1995. *Őskori kovafejtő Budapest-Farkasréten*. Budapest, unpublished manuscript.

Gyalog, L., Maros, Gy. and Pelikán, P. (eds) 2017. *Budapest geokalauza. Budapest Geoguide*. Budapest.

Harangi, Sz. 2001. Neogene to Quaternary Volcanism of the Carpathian-Pannonian Region – a review. *Acta Geologica Hungarica* 44: 233–258.

Harangi, S. and Lenkey, L. 2007. Genesis of the Neogene to Quaternary volcanism in the Carpathian-Pannonian region: Role of subduction, extension, and mantle plume. In L. Beccaluva, G. Bianchini and M. Wilson (eds), *Cenozoic Volcanism in the Mediterranean Area*, 67–92. Boulder, Geological Society of America Special Paper 418.

Hillebrand, J. 1929. Neuere Ausgrabungen auf dem Avasberg bei Miskolcz in Ungarn. *Eiszeit und Urgeschichte* 6: 136–141.

Horváth, T. 2005. Stone finds from excavation seasons 1998, 1999, 2000 and 2001. Techno-typological analysis. In I. Poroszlai and M. Vicze (eds.), *Százhalombatta Archaeological Expedition SAX Annual Report 2*, 135–155. Százhalombatta.

Horváth, T. 2009. Pattintással készült eszközök kronológiai szerepe a kora- és középső bronzkor folyamán. *Tisicum* 19: 413–440.

Horváth, T. 2017. The stone implements and wrist-guards of the Bell Beaker cemetery of Budakalász (M0/12). *Vjesnik Arheoloskog Muzeja u Zagrebu* 50: 71–118.

Horváth, T., Kozák, M. and Pető, A. 2000a. Újabb adatok a középső bronzkor kőiparához: Bölcske-Vörösgyír bronzkori tell-település kőanyagának komplex (petrográfiai, régészeti) feldolgozása. *Komárom-Esztergom Megyei Önkormányzat Múzeumainak Közleményei* 7: 187–235.

Horváth, T., Kozák, M. and Pető, A. 2000b. Complex analysis of stone industry on the Százhalombatta-Földvár (Early and Middle Bronze Age). In I. Poroszlai and M. Vicze (eds), *Százhalombatta Archaeological Expedition SAX Annual Report 1*, 103–119. Százhalombatta.

Juhász, Á. 1987. *Évmilliók emlékei. Magyarország földtörténete és ásványkincsei. 2nd edition*. Budapest.

Kadić, O. 1916. Ergebnisse der Erforschung der Szeletahöhle. *Mitteilungen aus dem Jahrbuche der königlichen Ungarischen Geologischen Reichsanstalt* 23: 161–301.

Kaminská, Ľ. 2001. Die Nutzung von Steinrohmaterialien im Paläolithikum der Slowakei. *Quartär* 51/52: 81–106.

Kaminská, Ľ. 2013. Sources of raw materials and their use in the Palaeolithic of Slovakia. In Zs. Mester (ed.), *The lithic raw material sources and interregional human contacts in the Northern Carpathian regions*, 99–109. Kraków–Budapest.

Karádi, V., Pelikán, P. and Haas, J. 2016. A Budai-hegység felső-triász medence kifejlődésű dolomitjainak conodonta biosztratigráfiája. *Földtani Közlöny* 146(4): 371–386.

Karátson, G. 2006. Aspects of Quaternary relief evolution of Miocene volcanic areas in Hungary: A review. *Acta Geologica Hungarica* 49: 285–309.

Károly, E. 1936. Szarukövek a Budai hegységben (Notes sur les cherts de dolomites et calcaires se trouvant dans les montagnes de Buda). *Földtani Közlöny* 66(10–12): 254–277.

Kasztovszky, Zs. and Biró, K.T. 2006. Fingerprinting Carpathian obsidians by PGAA: first results on geological and archaeological specimens. In *34th International Symposium on Archaeometry, 3-7 May 2004 Zaragoza, Spain*, 301–308. Zaragoza.

Markó, A., Biró, K.T. and Kasztovszky, Zs. 2003. Szeletian felsitic porphyry: non-destructive analysis of a classical Palaeolithic raw material. *Acta Archaeologica Academiae Scientiarum Hungaricae* 54: 297–314.

Mester, Zs. 2004. La production lithique à la station d'Érd (Hongrie). In É. Fülöp and J. Cseh (eds), *Die aktuellen Fragen des Mittelpaläolithikums in Mitteleuropa – Topical issues of the research of Middle Palaeolithic period in Central Europe*, 233–250. Tata, Tudományos Füzetek 12.

Mester, Zs., Faragó, N. and Lengyel, Gy. 2012. The lithic raw material sources and interregional human contacts in the northern Carpathian regions: A research program. *Anthropologie* 50 (3): 275–293.

Mészáros, Gy. and Vértes, L. 1955. A paint mine from the Early Upper Palaeolithic age near Lovas (Hungary, County Veszprém). *Acta Archaeologica Academiae Scientiarum Hungaricae* 5: 1–32.

Oddone, M., Márton, P., Bigazzi, G. and Biró, K.T. 1999. Chemical characterisations of Carpathian obsidian sources by instrumental and epithermal neutron activation analysis. *Journal of Radioanalytical and Nuclear Chemistry* 240(1): 147–153.

Pattantyús-Á., M. 1986. Geophysical results in archaeology in Hungary. *Geophysics* 51 (3): 561–567.

Pattantyús-Á., M. and Simon, A. 1986. Prospecting of prehistoric flint-quarries by geoelectric method. In K.T. Biró (ed.), *Papers for the 1st International Conference on Prehistoric Flint Mining and Lithic Raw Material Identification in the Carpathian Basin, Budapest–Sümeg 1986, vol. 1*, 123–129. Budapest.

Pető, A., Kozák, M., Horvát, T. and Kovács-Pálffy, P. 2002. Examination of the stone implements of a Bronze Age earthwork in Hungary. In E. Jerem and K.T. Biró (eds), *Archaeometry 98, Proceedings of the 31st Symposium, Budapest, April 26-May 3 1998. Vol. II*, 783–791. Oxford, British Archaeological Reports, International Series 1043 (II). Archaeolingua Central European Series 1.

Plašienka, D., Grecula, P., Putiš, M., Kováč, M. and Hovorka, D. 1997. Evolution and structure of the Western Carpathians: an overview. In P. Grecula, D. Hovorka and M. Putiš (eds), *Geological evolution of the Western Carpathians*, 1–24. Bratislava, Mineralia Slovaca – Monograph.

Rácz, B. 2013. Main raw materials of the Palaeolithic in Transcarpathian Ukraine: geological and petographical overview. In Zs. Mester (ed.), *The lithic raw material sources and interregional human contacts in the Northern Carpathian regions*, 131–146. Kraków–Budapest.

Ringer, Á. 2003. Őskőkori kovabányászat és kovakő-feldolgozás a miskolci Avason (Des mines et des ateliers de silex préhistoriques sur le mont Avas à Miskolc). *Herman Ottó Múzeum Évkönyve* 42: 5–15.

Simán, K. 1986. Limnic quartzite mines in Northeast-Hungary. In K.T. Biró (ed.), *Papers for the 1st International Conference on Prehistoric Flint Mining and Lithic Raw Material Identification in the Carpathian Basin, Budapest–Sümeg 1986, vol. 1*, 95–99. Budapest.

Simán, K. 1989. Northern flint in the Hungarian Palaeolithic. In J.K. Kozlowski (ed.), *„Northern" (Erratic and Jurassic) flint of South Polish origin in the Upper Palaeolithic of Central Europe*, 87–94. Kraków.

Simán, K. 1991. Patterns of raw material use in the Middle Paleolithic of Hungary. In A. Montet-White and S. Holen (eds), *Raw material economies among Prehistoric hunter-gatherers*, 49–57. Lawrence, Publications in Anthropology 19.

Simán, K. 1995a. H4. The Korlát-Ravaszlyuktető workshop site in North-Eastern Hungary. *Archaeologia Polona* 33: 41–58.

Simán, K. 1995b. H1. Prehistoric mine on the Avas Hill at Miskolc. *Archaeologia Polona* 33: 371–382.

Szabó, J. 1877. L'obsidienne préhistorique en Hongrie et en Grèce. In F.-F. Rómer (ed.), *Congrès International d'Anthropologie et d'Archéologie Préhistoriques, Compte-rendu de la huitième session à Budapest 1876, Premier volume*, 96–100. Budapest.

Szolyák, P. 2011. Elsődleges nyersanyag-feldolgozás nyomai a szeletai kvarcporfír lelőhelyén (Bükkszentlászló). *Herman Ottó Múzeum Évkönyve* 50: 47–66.

Tóth, Z.H., 2011. Újabb adalék a szeletai üveges kvarcporfír előforduláshoz: Bükkszentlászló, Hideg-víz. *Gesta (Miskolc)* 10: 147–149.

Tóth, Z.H. 2016. Paleolithic heat treating in Northeastern Hungary? An archaeometric examination of the possible use of fire-setting in Stone Age quarries in the Bükk area. *Archaeologia Polona* 54: 129–136.

Turq, A. 2005. Réflexions méthodologiques sur les études de matières premières lithiques. *Paléo* 17: 111–132.

Vadász, E. 1960. *Magyarország földtana*. Budapest.

Vértes, L. 1960. Aus Polen stammendes Silexmaterial im ungarischen Paläolithikum und Mesolithikum. Ein Beitragzur Archäologie der Karpathen. *Acta Archaeologica Carpathica* 1: 167–172.

Vértes, L. (ed.) 1964a. *Tata. Eine mittelpaläolithische Travertin-Siedlung in Ungarn.* Budapest, Archaeologia Hungarica 43.

Vértes, L. 1964b. Eine prähistorische Silexgrube am Mogyorós-domb bei Sümeg. *Acta Archaeologica Academiae Scientiarum Hungaricae* 16: 187–215.

Vértes, L. 1965. *Az őskőkor és az átmeneti kőkor emlékei Magyarországon.* Budapest, A Magyar Régészet Kézikönyve 1.

Vértes, L. and Tóth, L. 1963. Der Gebrauch des glasigen Quarzporphyrs im Paläolithikum des Bükk-Gebirges. *Acta Archaeologica Academiae Scientiarum Hungaricae* 15: 3–10.

Vörös, I. 1998–1999. Antlers from the Prehistoric flint mine at Denevér street (Budapest – Farkasrét). *Folia Archaeologica* 47: 69–102.

Vörös, I. 2000. Antler remains from the Prehistoric flint mine of Denevér street (Farkasrét, Budapest). In Zs. Mester and Á. Ringer (eds), *A la recherche de l'Homme Préhistorique. Volume commémoratif de Miklós Gábori et de Veronika Gábori-Csánk*, 2000, 117–121. Liège, E.R.A.U.L. 95.

Wein, Gy. 1977. *A Budai hegység tektonikája*. Budapest.

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Examining Raw Material of Stone Tools. Siliceous Marl from the Eastern Part of the Polish Carpathians Re-interpreted

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Neolithic and Early Bronze Age communities which settled the eastern Carpathians Forelands and Carpathian Foothills used a variety of local and non-local siliceous raw materials. Silicites identified in archaeological material differ in quality and usefulness for making tools. Obsidian, Jurassic flint from the Cracow-Częstochowa Uplands, 'chocolate' flint, and Świeciechów (grey white-spotted) and Volhynian flints are the best quality. They were commonly used from the Early Neolithic onwards. On the other hand, some local raw materials were also in used. Among them the so-called Dynów marl or siliceous marls were suggested as the most popular. To correct the classification of raw material of these artefacts HCl (Hydrochloric acid) was used for testing both raw material samples and the artefacts of the so-called Dynów or siliceous marls. The results of the analysis shows that so-called Dynów or siliceous marl consists of several different raw material varieties. More than 50% of the analysed tools were of yellowish or grey-yellowish hornstones (cherts). Both siliceous marls and the chert came probably from different sources and each one has a different chemical composition and physical properties.

KEY-WORD: Siliceous marl, chert, Carpathians, Neolithic, Early Bronze Age

INTRODUCTION

The fertile soils of the loess upland belt of the eastern Polish Carpathian Forelands were of excellent value for early pastoral communities. This zone start to be densely settled from the very beginning of the Neolithic. From about 3800 BC, the lower parts of the Eastern Carpathian Foothills also entered into the Neolithic oecumene (Pelisiak 2018b).

The Neolithic and Early Bronze Age communities that settled the eastern Carpathian Forelands and Carpathian Foothills used a variety of local and non-local siliceous raw materials. The silicites registered in the archaeological material differ in quality and usefulness for making tools. Obsidian, Jurassic flint from the Cracow-Częstochowa Uplands, 'chocolate' flint, Świeciechów (grey white-spotted) and Vol-

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hynian flints are of the best quality. They were commonly used from the Early Neolithic onwards. However, their frequency in the lithic assemblages of subsequent Neolithic and Early Bronze Age cultures is significantly different (Kozłowski 1970; Kaczanowska and Lech 1977; Kaczanowka 1985; Czopek and Kadrow 1988; Kadrow 1990, 1997; Zakościelna 1996; Kukułka 1998; Valde-Nowak 1999, 2000; Valde-Nowak and Gancarski 1999; Mitura 2004, 2006, 2007; Dębiec 2005; Szeliga 2009; Pelisiak and Rybicka 2013; Dębiec *et al.,* 2014; Dobrzyński *et al.,* 2014; Pelisiak 2017a, 2017b).

On the other hand, some local raw materials were also in use. Among them the so-called Dynów marls or siliceous marls were frequently noted in the assemblages. The so-called Dynów marl was probably for a first time recognized in Neolithic material found near Wesoła village, Brzozów district, on the Dynów Foothills (Dagnan-Ginter and Parczewski 1976), and the sources of this raw material were suggested to be in the Baryczka River valley close to Nozdrzec, Hłudno, Wesoła and Barycz villages (Brzozów district; Parczewski 1986).

Numerous items made of so-called Dynów or siliceous marls were registered in the strong archaeological context (settlements, burials) of all Neolithic and Early Bronze Age cultures in SE Poland, e.g., from Linear Pottery culture sites in Zwięczyca, Site 3 (actually part of Rzeszów town; Dębiec *et al.,* 2014), Cieszacin, Site 41, Jarosław district (Dębiec *et al.,* 2015), and Rzeszów, Site 117 (Czopek *et al.,* 2014); the Funnel Beaker culture site in Przybówka, Site 1, Krosno district (Gancarski *et al.*, 2008); Corded Ware culture sites in Szczytna, Site 6, Jarosław district (Pelisiak 2017a) and Średnia, Site 3, Przemyśl district (Jarosz 2002); Mierzanowice culture sites in Boratyn, Site 17, Jarosław district (Nowak 2016), Kańczuga, Site 5 KM, Przeworsk district (Koperski and Kostek 1997) and Jarosław, Site 158 (Pelisiak and Rybicka 2013), and Otomani-Füzesabony culture sites in Trzcinica, Site 1, Jasło district (Gancarski and Valde-Nowak 1999) and Jasło, Site 29, (Gancarski and Valde-Nowak 1999). Also numerous blades, flakes, rectangular axes and waste from their preparation or repair, and bifacial axes have been discovered as single finds (Dagnan-Ginter and Parczewski 1976; Valde-Nowak 1988; Pelisiak 2013, 2017b). An exceptional site was discovered on the Cergowa (Mała Cergowa) Mountain near Dukla town, Krosno district. Exposures of lithic raw materials and the workshop remains found there shows the exploitation of these silicities at least in the Late Neolithic (Budziszewski and Skowronek 2001).

RE-INTERPRETATION OF RAW MATERIAL

Hydrochloric acid (HCl) was used for testing raw material samples and the artefacts. The first tests of raw material previously classified as siliceous marl were done by myself and Antonin Přichystal (Institute of Geological Sciences, Faculty of Science, Masaryk University) during the conference 'Flint in time and space – Time and space in flint.

Characteristics and distribution of siliceous rocks in prehistory' held in the Institute of Archaeology and Ethnology Polish Academy of Sciences in Warsaw in May 2017. Surprisingly, the tested material did not positively react with HCl. As a result, both the samples from the quarries and artefacts tested at the time, turned out not to be a siliceous marl but a yellowish chert (hornstone). The results of these tests were an inspiration for testing more raw material samples and artefacts previously described as made of siliceous marls.

Thirty-seven archaeological artefacts and samples of raw materials were examined: samples from the quarries in Bircza-Krępak, Malawa and Leszczawa (Przemyśl Foothills), and Ulanica (Dynów Foothills) and the artefacts from Linear Pottery, Funnel Beaker, Corded Ware and Mierzanowice cultures sites as well as single finds were subjected to analysis (Fig. 1).

The analysis has only recently begun but the results are surprising. They show that more than 50% of the analyzed artefacts previously described as made of Dynów/siliceous marl were in fact of yellowish or grey-yellowish hornstone (cherts). Moreover, the so-called Dynów or siliceous marl consists of several different raw material varieties. Both siliceous marls and the cherts may come from different sources and each one has different chemical composition and physical properties.

Within the set of analyzed artefacts, two main groups of raw material ware identified: cherts (hornstones) and siliceous marls.

The cherts (hornstones) differs in respect of colour and usefulness for tool making. If taken out of their primary sources, the basic mass of these cherts is yellowish, grey-yellowish, greenish-yellow or light brown of uniform tint, and flaked surfaces have a mild waxy shine. It is dull or almost dull, sometimes little shiny, opaque or slightly translucent. Cherts of all these variety are compact with a 'greasy' surface. The fracture is platy-flaky or conchoidal. Raw material obtained from the primary autochthonous deposits is fractures well. In the outcrops cherts of different colours occur in several beds, several or tens of centimeter apart. The cherts are more or less clearly separated from the surrounding rock. The thickness of layers and oblong lenses and slabs oscillate from 2 to 15 cm. The sinuous layers are nearly horizontal or vertical depending on the tectonic activity in this area. This made the cherts relatively easy to reach and extract. The slabs of raw material were suitable for breaking into tabular forms easy to shape axes. Cherts of very similar or almost identical colour and physical features appear at many Carpathian outcrops (Fig. 2).

There seem to be two varieties of siliceous marl used to make the analysed stone artefacts:

1. Highly weathered light grey or light-grey-yellowish siliceous marl, the colour can be lighter when dry and darker when wet. It is pumice-like, very porous and has a texture with cavities. The raw material registered in stone artefacts is two-three times lighter than 'fresh' siliceous marl from primary deposits, because 'the calcium

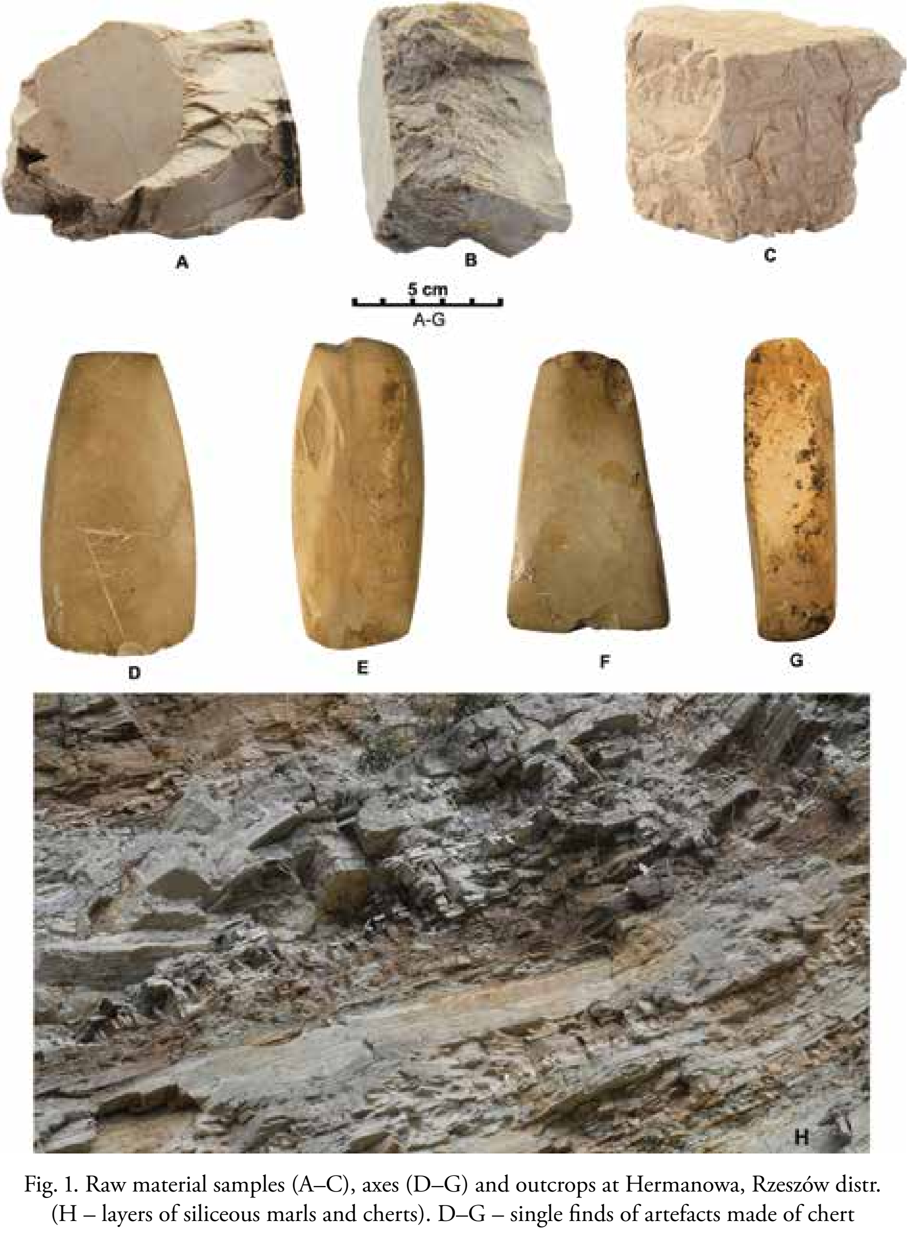

Fig. 1. Raw material samples (A–C), axes (D–G) and outcrops at Hermanowa, Rzeszów distr. (H – layers of siliceous marls and cherts). D–G – single finds of artefacts made of chert macroscopically similar to siliceous marl, D–F – single finds, G – Linear Pottery culture sites at Rzeszów (Site 117); A – Krępak, Bircza commune, Przemyśl distr.; B – Malawa, Bircza commune, Przemyśl distr.; C – Leszczawa, Bircza commune, Przemyśl distr.; D – Morochów, Zagórz commune, Sanok distr.; E – Pakoszówka, Sanok commune, Sanok distr; F – Pielna, Zarszyn commune, Sanok distr; G – Rzeszów, Site 117, Rzeszów distr. Photo: A. Pelisiak and P. Kotowicz.

dominant in non-weathered rock, appears to be easy removable by chemical weathering' (Budziszewski and Skowronek 2001: 157). Some artefacts can even float on the surface of water. The artefacts are very soft and they are easy to break and crumble. Because of the strong physical transformations of the raw material the axes and other tools are unusable in their present form. The artefacts differ in the degree of physical

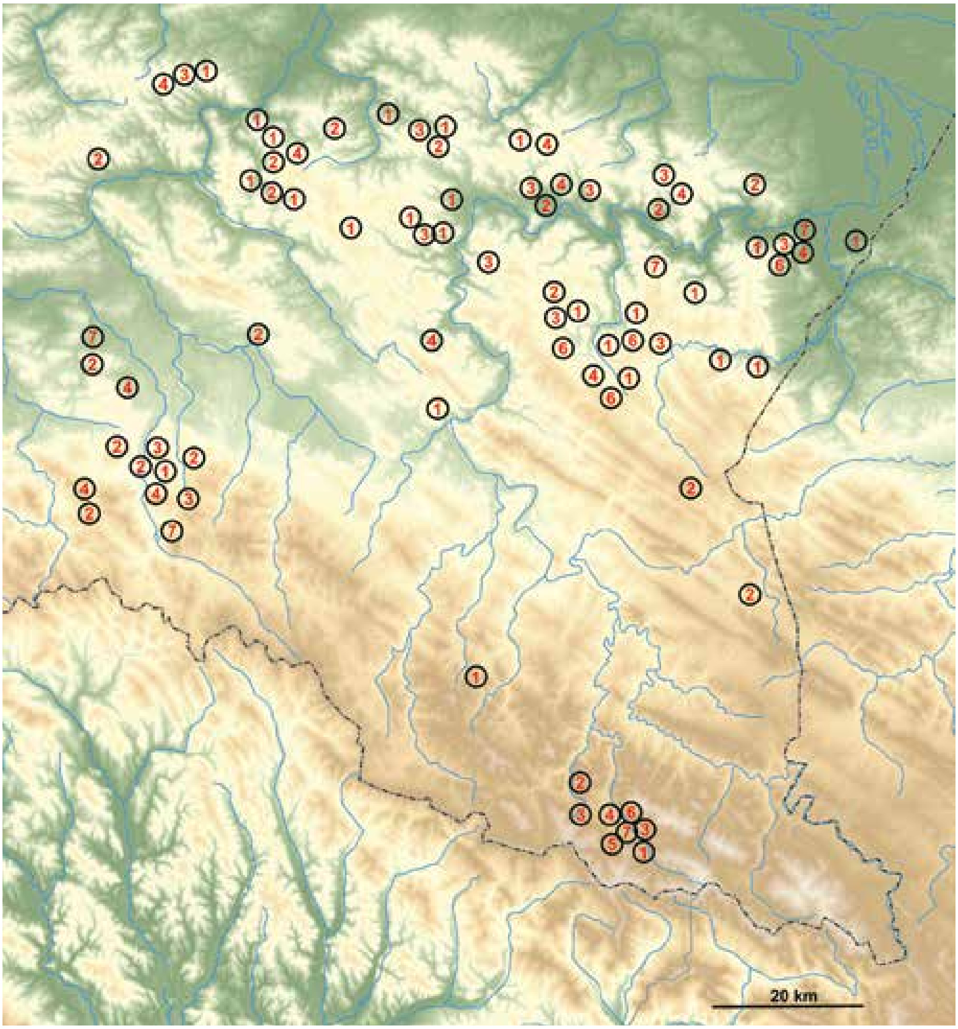

Fig. 2. Outcrops of siliceous raw material in the eastern part of the Polish Carpathians. 1 – siliceous marls including so called Dynów marl; 2 – black menilite hornstones; 3 – brown menilite hornstones; 4 – other hornstones (striped, yellowish); 5 – siliceous sandstones; 6 – so-called Bircza flint and similar rocks; 7 – flysch radiolarites. After: Pelisiak 2018b: Fig. 8,2 modified. Computer graphics: A. Pelisiak

transformation of the raw material and degree of weathering of the siliceous marl. This may depend on the soil acidity and the length of time the artefact was in such an acid environment. It should also be emphasized that the high degree of weathering and transformation of the artefacts make the identification of the primary physical characteristics of the raw material used for the production of these artefacts extremely difficult. Probably the physical features were similar to those of the material included in the second group described below.

2. In a fresh condition in the primary autochthonous and secondary autochthonous deposits this material is predominantly yellowish, grey-yellowish, greenish-yellow or light brown. This variety of siliceous marl is slightly translucent or non-translucent. In a fresh condition it fractures well and the flaked surfaces have a greasy or dull-greasy lustre. The quality is good for knapping. In the outcrops, siliceous marls occur in several levels up to 15 cm thick, several or tens of centimetres apart. The raw material is not clearly separated from the bedrock. The sinuous layers are in nearly horizontal and vertical position depending on tectonic activity on this area. This position meant that the siliceous marls were relatively easy to reach and extract. The slabs of siliceous marls are suitable for breaking into tabular forms easy to shape into axes. It should be noted that raw materials of the same type from many Carpathian outcrops could be very similar or almost identical.

The general characteristics presented above shows that in many cases, based only on an examination of the raw material of stone artefacts by the naked eye, it is difficult or impossible to properly recognize the raw material and distinguish the yellow or grey-yellow chert (hornstone) from siliceous marl.

DISCUSSION

Both cherts and siliceous marls were used for the production of axes and flake tools. Due to their physical features, they were of limited usefulness for preparation of blade cores and blade production. Consequently, blades and blade tools made of these raw materials are very rare in lithic assemblages. The axes constitute the most frequent and spectacular group of tools dated to the Neolithic and Early Bronze Age. It should be also emphasized that in the area of the eastern part of the Polish Carpathian Foothills, the siliceous marls and cherts are the only local lithic raw materials useful for production of axes using chipping methods.

Both siliceous marls, and yellowish and grey-yellowish cherts are present in many locations on the Dynów, Strzyżów and Przemyśl foothills as well as in the other parts of the eastern Polish Carpathians (e.g., Wdowiarz 1949; Gucik 1961; Kotlarczyk *et al.*, 1977; Lesczyński *et al.*, 1995; Rajchel and Myszkowska 1998; Leszczyński 2003, 2004; Garecka 2008; Górniak 2011). The sources and use of these raw materials have also been discussed in the context of general prehistoric issues (e.g., Dagnan-Ginter and Parczewski 1976; Parczewski 1986; Valde-Nowak 1995a, 1995b, 2013; Budziszewski and Skowronek 2001;

Pelisiak 2016a, 2016b, 2018a). Moreover, systematic field survey for lithic raw material resources in the eastern part of Polish Carpathians have provided new information on the availability of cherts and siliceous marls at many localities in the region (Fig. 2; Pelisiak 2016a, 2018a).

According to the classification of Zsolt Mester (Mester 2013: 12) siliceous marls and cherts in the Eastern Polish Carpathians appear in primary autochthonous, secondary autochthonous and more rarely in sub-autochthonous or residual sources. Exposures on the steep slopes of the hills and dissected river valleys allow easy access to the best quality raw material in the primary autochthonous sources. Raw material from secondary autochthonous sources in the river beds was also available but it was of worse quality than material from the exposures.

The cherts and siliceous marls were rocks with properties that allowed effective production of axes. Large number of rectangular and bifacial axes made of siliceous marls and cherts found in SE Poland suggests a relatively large production of these tools. Blocks of chert or siliceous marls extracted even from primary autochthonous sources contain mostly cracked or crumbling pieces of raw material. Only a relatively small number of block or slabs were useful for tool production. This may suggest a large scale of extraction of cherts and siliceous marls, which took place at selected locations, intended to obtain enough good quality raw material for production of these tools.

The above suggestions lead to the hypothesis that raw material could have been obtained from primary sources using a mining method. However, in the area of the eastern part of Polish Carpathians no mine-site for siliceous marls or cherts have been found yet. On the other hand, the numerous outcrops of cherts and siliceous marls registered in the area of the Eastern Carpathian Foothills are located at a relatively small distance from the Early Neolithic settlements, from Funnel Beaker and Corded Ware culture as well as Early Bronze Age Mierzanowice culture sites (Fig. 3). This can suggests that cherts and siliceous marls were exploited mainly for local use or at most for regional needs.

With no doubt, the extraction methods of cherts and siliceous marls were determined by the geological conditions. The raw material could been extracted from open-air pits or quarrying niches cut into the walls of river valleys and hillsides where cherts or siliceous marls were to be found where they were exposed by the cuttings of the riverbed into the hill sides. Dozens of such a locations are known from the eastern part of Polish Carpathians, and at least some of them may have been potential areas of useful raw material acquisition.

However, even if such methods of raw material extraction can be presumed, the low archaeological visibility of traces of such activities and prehistoric digging activities in general should be emphasized. Thus, the traces left by the raw material exploitation could be difficult to observe. Furthermore, at least some of such structures will have been exposed to damage as a result of landslides and soil movement down steep slopes and may have been completely destroyed.

CONCLUSIONS

The correct identification of raw material type is of primary importance in the studies on economy and procurement strategies, contacts and interactions between Neolithic as well as Early Bronze Age communities. Extraction of raw material, chert and siliceous marl processing and distribution of tools and blanks reflects many elements of social organization and behaviour of prehistoric communities. Communication networks can also be reconstructed from the raw material composition of archaeological assemblages.

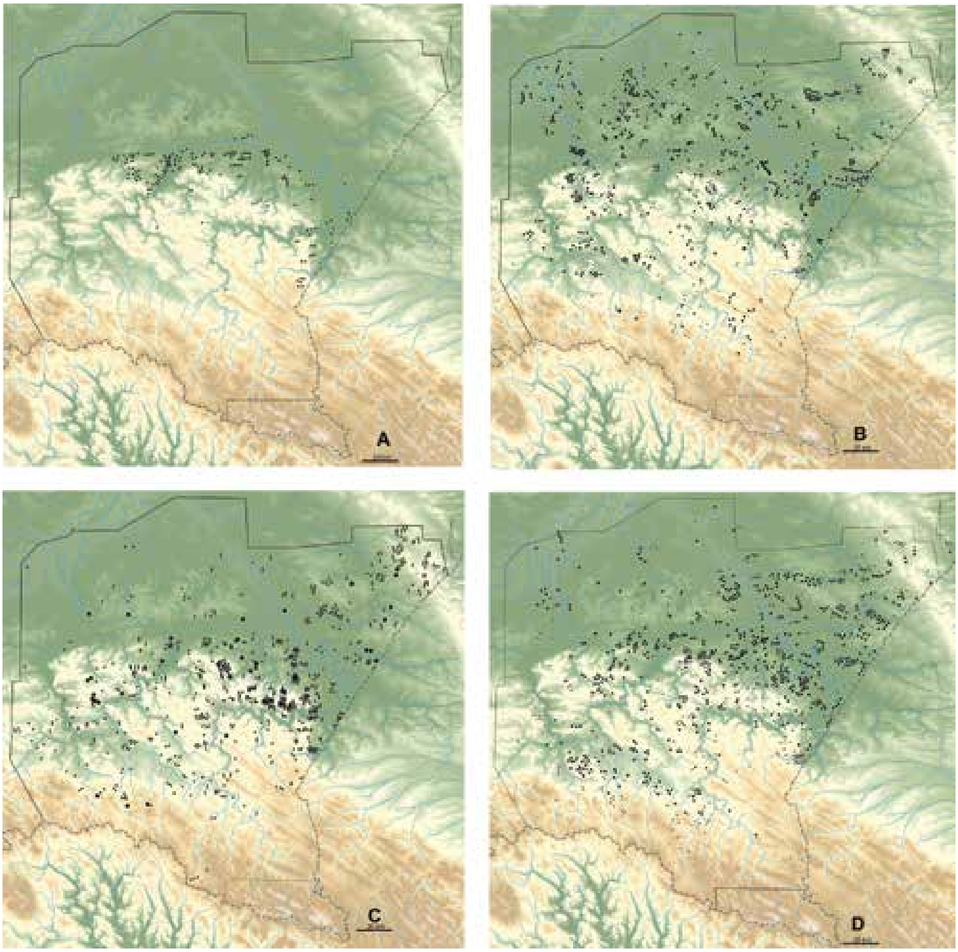

Fig. 3. Eastern part of the Polish Carpathians and Carpathian Forelands. Distribution of sites: A – Linear pottery culture; B – Funnel Beaker culture; C – Corded Ware culture; D – Mierzanowice culture. After: Pelisiak 2018b: Fig. 7.1; 7.6; 7.7; 7.8.

Siliceous marls and cherts are the only raw materials suitable for manufacture of chipped and polished tools that come from the area of the Eastern Polish Carpathians. There are various potentially significant sources of siliceous marls and cherts suitable for manufacturing of chipped and polished tools. For prehistoric research the identification of primary sources of each type of raw material is very important, but precise identification of the provenience of raw material of the artefacts is a difficult task. Surprisingly, the opinion written by Paweł Valde-Nowak in 1995 referring to the identification of the cherts and siliceous marls in the archaeological material: 'the petrographic identification, the location of its deposits and, what is interesting, the correctness of the name of siliceous marl from the vicinity of Dynów, are still posing some difficulties' (Valde-Nowak 1995b: 116) is still current. For this reasons above, the results of raw material testing suggests: (1) the necessity for the re-analysis of large part of known artefacts previously interpreted as made of so-called Dynów or siliceous marl to correct their raw material classification, (2) the need for a comprehensive characterisation of these raw materials and their sources.

REFERENCES

Budziszewski, J. and Skowronek, M. 2001. Results of the Preliminary Archaeologicacl Research in the Mount Cergowa Massif, the Lower Beskid Mountains. In J. Machnik (ed.), *Archaeology and Natural Background of the Lower Beskid Mountains, Carpathians*, 145–164. Kraków.

Czopek, S. and Kadrow, S. 1988. Osada kultury pucharów lejkowatych w Białobrzegach, stan. 5, woj. Rzeszów. *Sprawozdania Archeologiczne* 39: 73–88.

Czopek, S., Niemasik, D., Pasterkiewicz, W. and Pelisiak, A. 2014. *Rzeszów, stanowisko 117 – osada wielokulturowa*. Rzeszów, Muzeum Okręgowe w Rzeszowie.

Dagnan-Ginter, A. and Parczewski, M. 1976. Dwie kolekcje archeologiczne z Pogórza Dynowskiego. *Materiały Archeologiczne* 16: 5–28.

Dębiec, M. 2005. Materiały z badań ratowniczych na wielokulturowym stanowisku 31 w Rzeszowie. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 26: 25–63.

Dębiec, M., Dębiec, M. and Pelisiak, A. 2015. *Cieszacin Wielki, stan. 41, Pawłosiów, stan. 55 i Jankowice, stan. 9. Kompleks osad z epoki neolitu i wczesnej epoki brązu*. Rzeszów, Fundacja Rzeszowskiego Ośrodka Archeologicznego.

Dębiec, M., Pelisiak, A., Becker, V., Dębiec, M., Makowicz-Poliszot, D., Saile, T., Sebők, K., Posselt, M. and Szczepanek, A. 2014 *Zwięczyca 3. Eine bandkeramische Siedlung am Wisłok*. Rzeszów.

Dobrzyński, M., Parczewski, M., Piątkowska, K. and Rybicka, M. 2014. Zabytki kultury pucharów lejkowatych w miejscowości Jasienica Sufczyńska, stan. 5 na Pogórzu Przemyskim. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 35: 249–258.

Gancarski, J. and Valde-Nowak, P. 1999. Bronzezeitliche Spaltindustrie der Pleszów- und der Otomani-Füzesabony-Kultur aus den Siedlung Trzcinica und Jasło. Ein Überblick. In J. Gancarski (ed.), *Kultura Otomani-Füzesabony – rozwój, chronologia, gospodarka*, 181–200. Rzeszów, Muzeum Podkarpackie.

Gancarski J., Pasterkiewicz, W. and Pelisiak, A. 2008. Osada kultury pucharów lejkowatych w Przybówce, gm. Wojaszówka, stanowisko 1. In J. Machnik (ed.), *Archeologia i środowisko naturalne Beskidu Niskiego w Karpatach. Part II, Krimská Brázda*, 347–378. Kraków, Prace Komisji Prehistorii Karpat 4.

Garecka, M. 2008. Granica Oligocen/Miocen w polskich Karpatach Zewnętrznych na podstawie nanoplanktonu wapiennego. *Biuletyn Państwowego Instytutu Geologicznego* 432: 1–54.

Górniak, K. 2011. Origin of marls from the Polish Outer Carpathians; lithological and sedimentological aspects. *Mineralogia* 42(4): 163–297.

Gucik, S. 1961. Poziom wapieni detrytycznych z Birczy w Karpatach przemyskich i jego znaczenie dla stratygrafii górnej kredy i paleocenu w rejonie skibowym. *Geological Quarterly* 5: 669–685.

Jarosz, P. 2002. Kurhan kultury ceramiki sznurowej w Średniej, st.3/2, pow. Przemyśl. Wyniki badań wykopaliskowych przeprowadzonych w 2001 r. *Rocznik Przemyski* 38(2): 3–21.

Kaczanowska, M. 1985. *Rohstoffe, Technik un Typologie der neolithischen Reuersteinindustrien im Nordteil des Flussgebietes der Mitteldonau*. Warszawa, Państwowe Wydawnictwo Naukowe.

Kaczanowska, M. and Lech, J. 1977. The flint industry of Danubian communities north of the Carpathians. *Acta Archaeologica Carpathica* 17: 5–28.

Kadrow, S. 1990. The Rzeszów Settlement Microregion in Neolithic. *Acta Archaeologica Carpathica* 29: 33–70.

Kadrow, S. 1997. Osada kultury ceramiki wstęgowej rytej na stanowisku 3 w Rzeszowie-Staromieściu. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 18: 5–27.

Kotlarczyk, J., Mitura, F. and Rajchel, J. 1977. Inoceramus Salisburgensis z warstw inoceramowych w rejonie Rybotycz. *Rocznik Polskiego Towarzystwa Geologicznego* 47(3): 371–381.

Koperski, A. and Kostek, A. 1997. Zespół zabytków kultury mierzanowickiej na st. 5 w Kańczudze, woj. przemyskie. *Rocznik Przemyski* 34(3): 37–42.

Kozłowski, J. K. 1970. Z badań nad wytwórczością krzemieniarską w kulturze ceramiki wstęgowej rytej. In J. K. Kozłowski (ed.), *Z badań nad kulturą ceramiki wstęgowej rytej*, 73–94. Kraków, Polskie Towarzystwo Archeologiczne.

Kukułka, A. 1998. Drugi sezon badań wykopaliskowych na osadzie wczesnoneolitycznej w Gwóźdźcu, stan. 2, gm. Zakliczyn. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 19: 175–199.

Leszczyński, S. 2003. Bioturbation structures in the Holovnia siliceous marls (Turonian-Lower Santonian) in Rybotycze (Polish Carpathians). *Annales Societatis Geologirum Poloniae* 73: 103–122.

Leszczyński, S. 2004. Bioturbation structures of the Kropivnik Fucoid Marls (Campanian–lower Maastrichtian) of the Huwniki—Rybotycze area (Polish Carpathians). *Geological Quarterly* 48(1): 35–60.

Leszczyński, S., Malik, K. and Kędzierski, M. 1995. Margle krzemionkowe i fukoidowe w rejonie Rybitycz: nowe dane litofacjalne i stratygraficzne (Płaszczowina Skolska, kreda, Karpaty). *Annales Societatis Geologirum Poloniae* 65: 43–62.

Mester, Z. 2013. The lithic raw material sources and interregional human contacts in the Northern Carpathian regions: aims and methodology. In Z. Mester (ed.), *The lithic raw material sources and interregional human contacts in the Northern Carpathian regions*, 9–21. Kraków–Budapest.

Mitura, P. 2004. Materiały kultury malickiej i grupy tarnobrzeskiej ze stanowiska 54 w Rzeszowie. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 25: 5–90.

Mitura, P. 2006. Materiały kultury ceramiki wstęgowej rytej i kultury pucharów lejkowatych ze stanowiska 55 w Rzeszowie. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 27: 65–88.

Mitura, P. 2007. Workshop of flint processing and reparation of rectangular axes on site 34 in Niedźwiada, Ropczyce commune, podkarpackie voivodship. *Sprawozdania Archeologiczne* 59: 305–324.

Nowak, A. 2016. Zabytki krzemienne i kamienne. In M. Glinianowicz, S. Kadrow, P. N. Kotowicz, A. Nowak, and W. Poradyło (eds), *Boratyn, pow. jarosławski, stan. 17. Materiały z osad kultury mierzanowickiej i grupy tarnobrzeskiej oraz z cmentarzyska wczesnośredniowiecznego*, 51–54. Rzeszów.

Parczewski, M. 1986. *Pogórze Dynowskie w zaraniu dziejów*. Brzozów, Muzeum Regionalne PTTK w Brzozowie.

Pelisiak, A. 2013. Pojedyncze przedmioty kamienne a strefy aktywności osadniczej i gospodarczej w neolicie we wschodniej części Karpat Polskich. *Materiały i Sprawozdania Rzeszowskiego Ośrodka Archeologicznego* 34: 19–33.

Pelisiak, A. 2016a. Siliceous raw material from Bieszczady Mountains. Sources and use. *Archaeologia Polona* 54: 7–16.

Pelisiak, A. 2016b. W związku z okolicznością szczególną, o karpackich surowcach krzemionkowych uwag kilka. In B. Chudzińska, M. Wojenka, and M. Wołoszyn (eds), *Tworzenie się słowiańskiej Europy w ujęciu źródłoznawczym*, 739–745. Kraków–Rzeszów.

Pelisiak, A. 2017a. Analiza zabytków krzemiennych z grobów kultury ceramiki sznurowej i domniemanych grobów kultury mierzanowickiej w Szczytnej, pow. Jarosław. In P. Jarosz and J. Machnik (eds), *Nekropolie ludności kultury ceramiki sznurowej z III tysiąclecia przed Chr. w Szczytnej na Wysoczyźnie Kańczuckiej*, 137–158. Rzeszów.

Pelisiak, A. 2017b. Materiały krzemieniarskie odkryte w trakcie badań powierzchniowych realizowanych w promieniu 10 km od stanowiska 7 w Skołoszowie, pow. jarosławski, woj. podkarpackie. In M. Rybicka (ed.), *Wielokulturowe stanowisko w Skołoszowie, stanowisko 7, pow. jarosławski, w kontekście osadnictwa z neolitu i wczesnej epoki brązu we wschodniej części Podgórza Rzeszowskiego*, 35–58. Rzeszów.

Pelisiak, A. 2018a. Siliceous Raw Materials from the Eastern Part of the Polish Carpathians and Their Use in Stone and Bronze Ages. In D.H. Werra and M. Woźny (eds), *Between History and Archaeology. Papers in honour of Jacek Lech*, 69–77. Oxford, Archaeopress.

Pelisiak, A. 2018b. *Centrum i peryferia osadnictwa w neolicie i wczesnej epoce brązu na wschodnim Podkarpaciu i we wschodniej części polskich Karpat*. Rzeszów, Uniwersyet Rzeszowski.

Pelisiak, A. and Rybicka, M. 2013. *Stanowisko 158 w Jarosławiu, woj. podkarpackie*. Część I. *Kultura malicka i kultura mierzanowicka*. Rzeszów, Via Archaeologica Ressoviensia 3.

Rajchel, J. and Myszkowska, J. 1998. Litologia wapieni z warstwy wapienia litotaminowego z Birczy (wt) – jednostka skolska, zewnętrzne Karpaty fliszowe. *Przegląd Geograficzny* 46: 1247–1253.

Szeliga, M. 2009. Znaczenie obsydianu karpackiego w gospodarce surowcowej najstarszych społeczności rolniczych na ziemiach polskich. In J. Gancarski (ed.), *Surowce naturalne w Karpatach oraz ich wykorzystanie w pradziejach i wczesnym średniowieczu*, 287–324. Krosno, Muzeum Podkarpackie w Krośnie.

Valde-Nowak, P. 1988. *Etapy i strefy zasiedlenia Karpat polskich w neolicie i na początku epoki brązu*. Wrocław.

Valde-Nowak, P. 1995a. Stone sources from the North-Carpathian province in the Stone and Early Bronze Ages. *Archaeologia Polona* 33: 111–118.

Valde-Nowak, P. 1995b. North-Carpathians province if lithic raw materials in Stone and Bronze Age. *Archaeologia Polona* 33: 111–118.

Valde-Nowak, P. 1999. Zabytki krzemieniarskie ze stanowiska 5 w Sieteszy, gm. Kańczuga, woj. podkarpackie. *Rocznik Przemyski* 35(2): 59–66.

Valde-Nowak, P. 2000. Zabytki kamienne ze stanowiska 5 w Sieteszy, pow. Przeworsk. Badania w 1999 roku. *Rocznik Przemyski* 36(1): 33–36.

Valde-Nowak P. 2013. The north-Carpathians province of silica rocks during Stone Age. In Z. Mester (ed.), *The lithic raw material sources and interregional human contacts in the northern Carpathian regions*, 87–99. Kraków–Budapest.

Valde-Nowak, P. and Gancarski, J. 1999. Bronzezeitliche Spaltindustrie der Pleszów und der Otomani-Füzesabony-Kultur aus den Siedlung Trzcinica und Jasło. Ein Überblick. In J. Gancarski (ed.), *Kultura Otomani-Füzesabony – rozwój, chronologia, gospodarka*, 181–200. Krosno, Muzeum Podkarpackie w Krośnie.

Wdowiarz, S. 1949. *Budowa Geologiczna Karpat Brzeżnych na południowy-wschód od Rzeszowa*. Warszawa, *Państwowa Służba Geologiczna, Państwowy Instytut Geologiczny* 11.

Zakościelna, A. 1996. *Krzemieniarstwo kultury wołyńsko-lubelskiej ceramiki malowanej*. Lublin, Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej.

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BOOK REWIEWS

Jana Esther Fries, Doris Gutsmiedl-Schümann, Jo Zalea Matias and Ulrike Rambuscheck (eds.), *Images of the Past. Gender and its Representations*. Waxmann 2017: Münster, New York, pp. 220, 65 colour illustrations. Frauen–Forschung–Archäologie Band 12.

Reviewed by Zuzanna Różańska-Tuta

The issue of gender in social sciences began to be a topic of interest at the turn of the 1950s and 1960s. In the field of archaeology, this subject appeared with a twenty-year delay. The term 'gender archaeology' was introduced to the scientific discourse by Margaret Conkey and Janet Spector in their article from 1984 (Gero and Conkey 1991: XI). This was closely related to the feminist critique of science, which negatively assessed previous research made from the androcentric point of view and expressed the need to place a woman in the role of a subject (Conkey and Gero 1991: 3–4). The tasks of archaeology of gender are primarily attempts to analyse ways of constructing gender identity in the past based on archaeological sources and passing this knowledge to a wider audience, but also criticism of structures and male bias in academic and museum reality (Conkey and Gero 1997: 430; Johnson 2013: 140).

The collective work *Images of the Past. Gender and its Representations* edited by J. E. Fries, D. Gutsmiedl-Schümann, J. Z. Matias and U. Rambuscheck in 2017 in Germany, published by the international scientific publisher Waxmann, is another interesting item in line with the mainstream of cultural gender research of the past. The considerations included in the publication primarily focus on the importance of visual content as a medium of information on gender identity used by authors of popular science books, computer game developers, or curators of exhibitions in archaeological museums. The book is divided into two parts: I. Images of the Past in Academia and Popular Media and II. Images of the Past in Museums. Each of them contains five articles, written in English or German, resulting from two scientific conferences: the 'Gender in Museums' session, which was held as part of the Nordwestdeutscher Verband für Altertumskunde Symposium in Lübeck in 2013 and the 'Images of the Past: Gender and its Representations' hosted at the conference of the European Association of Archaeologists in Istanbul in 2014.

In the first article: Chloé Belard (France), critically refers to the presentation of Gallic and Celtic women in publications from the late 19th to the first half of the twentieth century. Female characters who were young and pretty, representing the type of beauty prevailing in a given era, were shown as perfect mothers and wives, looking after a household. This view has its roots in the social model of the nineteenth-century middle class. This type of depiction can also be found in many popular science publications from different fields even today. The author of the article proves that reliable analysis of archaeological material as well as Greek and Roman written sources, without neglecting the context of their creation, can allow us to change this way of thinking. The researcher mentions numerous examples of archaeological sources, both burials and individual products of material culture showing anthropomorphic performances, dated to the period that she discusses. The results of her analysis indicate that the opposing division into male and female did not exist, and the social structure of groups was much more complex.

Caroline Trémeaud (France) is the author of another article commenting on the subject, titled *How to Make Prehistory Attractive. Women's Representation of the Bronze and Iron Age*. It raises the issue of how women of the Bronze and Iron Age were presented. The researcher uses illustrations from scientific publications as examples. She comes to a similar conclusion as the author of the previously discussed article. Prehistoric women have been portrayed and are often still being portrayed through the prism of the aesthetic preferences of the times in which the illustration was made. In order to make the subject more attractive to the contemporary audience, gender stereotypes are reproduced, and the female characters are sexualised.

In his text, '*It has always been like that…' How Televised Prehistory Explains what is Natural*, Georg Koch (Germany) analyses British, German and American popular science television programs that show life in the Stone Age. These films, which have a wider audience than archaeological publications, play an important social and political role. Prehistory appears as an argument in contemporary social discourse on what is 'natural' in human life. Interestingly, the programs created in the 1980s and 1990s are characterized by more scientific, analytical approach to the subject. Back then, filmmakers collaborated with scientists and put more emphasis on questioning gender stereotypes. A change took place around the year 2000. Newer TV programs emphasize a more emotional, narrative portrayal of life in the Stone Age. Instead of scientific thesis, they rely on apparent knowledge and attempts to explain phenomena and connect them with the present, duplicating stereotypes. For example, they depict an archaeologically unproven division of work into typically 'masculine' and 'feminine' in the Paleolithic.

Another article titled *Is it all Warfare and Treasure Hunting? Gender Roles and Representations in Video Games,* written by Rachael Sycamore (England) analysis video games of which the action takes place in Antiquity or the Middle Ages, or those in which the main character is an archaeologist. Sycamore comes to the conclusion that there is a much smaller number of female rather than male characters in such games. The females that are present have their image sexualized. In addition, heroes and heroines are the subject of sexual stereotypes in relation to both their social roles and a (modern?) ideal model of physical appearance. The world itself is very much simplified. Enormous emphasis is placed in these games on warfare and combat, which highly distorts the picture of life in ancient communities.

The last article included in the publication's first part is by Katji Fält (Finland) and is titled, *Armour Fetishism, Homosociality and Masculine Display. The Representations of Medieval Knights and Viking Men in Illustrated Non-fictional Books for Young Readers*. The author analyses selected items published in the last 25 years in terms of how the masculinity of knights and vikings is represented. She finds that this is clearly characterized by a male perspective. In both cases, books about Vikings and those about medieval knights, the activities of the male community are focused on physical strength and fitness. Women are presented very rarely, in separation from the masculine world, and their depicted role in society is diminished. Both groups are presented as an impersonal whole. Male collectives are of a military nature and masculinity appears as a world of relations between the members of these collectives.

The second part of the book is opened by an article: *The Image of Women in Spanish Archaeological Museums during the last Decade. A Gender Perspective*, by Lourdes Prados Torreira and Clary Lopez Ruiz (Spain). The aim of the article was to analyse the way in which women have been presented in recent archaeological exhibitions in Spanish museums. Even though women quite often make up the majority of museum staff members and hold important positions within museums, there are still very many archaeological exhibitions that treat this social group marginally. They popularise stereotypes suggesting that gender roles have remained unchanged throughout the ages and between cultures. The researchers also cite positive examples of exhibitions where female activities were presented on an equal footing with those of men. Educational reconstructions, where there is no archaeological evidence that a given activity was typical only for women or men, show people of both sexes, for example in the case of pottery or painting in caves.

In the next text, under the title *Archäologie und Geschlecht im Germanischen Nationalmuseum, Nürnberg*, Claudia Merthen (Germany) comes to similar conclusions regarding museum exhibitions. The researcher also draws attention to the issues of unequal opportunities in the archaeological career development for women and men.

The article by Kirsten Eppler (Germany): *Frau-Mann, Jung-Alt, Arm-Reich. Museet Darstellung und visualisierung frühmittelalterlicher Gesellschafts- und Gender (re) konstruktionen im Landesmuseum Wurttwemberg* describes part of an exhibition concerning the Early Middle Ages, exhibited at the Landesmuseum Wurttemberg in Stuttgart. The author focuses on the role of Exhibition design and visual performances in Attempts at (re) constructing gender in the Middle Ages. Eppler suggests that the choice of flat, grey silhouettes - 'shadows', as a background for archaeological objects, despite binary (female-martial, young-old, etc.) presentations leave more space for imagination and the personal interpretation for visitors, therefore broadening the perspective in thinking about gender roles.

In the following text, by Christina Jacob (Germany), titled *Horkheim, Klingenberg, and Talheim. Geschlechterollen in der Archäologischen Sammlung der Stadtischen Museen Heilbronn*, the author (who is a museum worker) describes how the manner of displaying archaeological objects has changed over the past 25 years. She refers in more detail to a fragment of Neolithic exhibition, the mass burial of Talheim. The researcher concludes that the results of anthropological analyses, such as the state of teeth, and archaeological relics themselves provide little evidence for discussions about gender roles, and this issue should be the subject of guided tours and museum workshops.

The last article of the reviewed publication, titled *Man the Hunter? Zur Konzeption von Geschlechterollen im paläon, Forschungs- und Erlrbniszentrum Schöninger Speere,* is written by Gabriele Zipf (Germany). The author presents the innovative concept of an exhibition built around the discovery of Middle Paleolithic wooden spears from Schöningen (Germany). The exhibit, consisting of many artistic reconstructions showing the activities performed by contemporary people, is an example of one that displays male and female characters and children equally, without an imaginary division of their tasks based on gender.

In summary, the visual image is an extremely important tool for propagating and understanding archaeology. Reconstructions, made with the use of various techniques, enrich scientific and popular science publications, museum exhibitions, presentations accompanying lectures or archaeological television programs. The authors of the articles contained in the reviewed book focus on the ways of presenting female and male sexes in such reconstructions. In their texts they clearly show that gender stereotypes are still ubiquitous in both popular and scientific activities related to archaeology, and their impact on the perception of social roles in the past and archaeology itself is definitely negative.

I think that the articles published in *Images of the Past. Gender and its Representations* are interesting and important items that should prompt reflection among archaeologists employed in scientific and museum facilities. I can especially recommend it to Polish researchers, due to the fact that the issues of gender in the past are basically absent in the archaeological discourse in Poland.

REFERENCES:

Conkey, W.M. and Gero, J.M. 1997. From programme to practice: gender and feminism in archaeology. *Annual Review of Anthropology* 26: 411–437.

Conkey, W.M. and Gero, J.M. 1991. Tensions, Pluralities, and engendering Archaeology. An introduction to women and Prehistory. In J.M. Gero and M.W. Conkey (eds), *Engendering Archaeology. Women in Prehistory*, 3–31. Oxford.

Gero, J.M. and Conkey, W.M. 1991. Preface. In J.M. Gero and M.W. Conkey (eds), *Engendering Archaeology. Women in Prehistory*, XI–XIII. Oxford.

Johnson, M. 2013. *Teoria archaeologii. Wprowadzenie*. Kraków.

Eva Lenneis (ed.), *Erste Bauerndörfer - Älteste Kultbauten. Die frühe und mittlere Jungsteinzeit in Niederösterreich*. Wien 2018: Verlag der Österreichischen Akademie der Wissenschaften, pp. 479. numerous figures in text. Archäologie Niederösterreichs 1.

Reviewed by Joanna Pyzel

A synthetic overview of the whole prehistory and early history of a country or a certain region is always an ambitious task that poses demanding challenges. Researchers involved in such a task face many controversial questions today: who is the audience for such projects? What has to be chosen out of the constantly growing data and how should it be presented? Ernst Lauermann and Franz Pieler, editors of a new series 'Archäologie Niederösterreichs' (Archaeology of Lower Austria) followed a quite different perspective than the recent 'The Past Societies' series in Poland (Urbańczyk 2016).

The new Austrian series draws upon a five volume work from the 1990s but significantly exceeds its capacity: a printed hardback edition of not less than 11 volumes is planned, and e-book versions of them are scheduled as well.

The whole series is addressed to everyone interested in the prehistory of the Lower Austrian countryside and this broad, but still quite local target group, explicitly approached by the head of the government (*Landeshauptfrau*) in the foreword of the first book already published, justifies the choice of the publication language: it is consequently only in German, without any English summary.

Interestingly, specific volumes are not published in chronological order. The first that was released in January 2018 and is reviewed here deals with the early and middle Neolithic (MN): the Linear Pottery Culture (LBK) and succeeding western group of the Lengyel Culture (LC) as well as to a limited extent the Stroke Pottery Culture (STK). This volume was edited by Eva Lenneis, who invited 17 researchers to participate in this project.

In the traditional printed form of the book diverse modern techniques have been applied, for example virtual reconstructions and computer visualisations. In general numerous excellent figures: maps, plans, photos and drawings as well as the overall outstanding quality of this edition are its real strength. It is both an intellectual and sensual pleasure to hold such a book in one's hand and turn its pages.

It is very hard to make an overview of the whole period in one book and it is similarly difficult to summarise it in a brief review. The presented book has a lot of various types of information, very condensed, and although its predecessor was published not so long ago (Lenneis *et al.*, 1995), the growth of new data obtained due to various large-scale emergency excavations as well as special research projects is really impressive. Everyone can pick out something particularly interesting for him- or herself that is why this review will present quite a subjective view of this excellent book.

The whole volume starts off with an introduction (chapter 1), which contains a brief history of research on the early and middle Neolithic periods in Lower Austria (Joris Coolen, Michael Doneus, Elisabeth Rammer). This is followed by a presentation of a settlement of specific cultures on a regional level with relation to different natural conditions (Joris Coolen), elaborated further in more detail for selected micro-regions that were the subjects of intensive research projects, such as the Horn basin (Franz Pieler), the Melk region, known only from non-invasive survey programs (Joris Coolen) as well the St. Pölten region, extensively studied due to recent emergency excavations (Christoph Blesl and Eva Lenneis).

The core part of this volume consists of two main chapters corresponding to the main chronological parts of the period in question: chapter 2 deals with the early Neolithic LBK culture, chapter 3 with LC and STK cultures of the middle Neolithic. The structure of both chapters is very similar. At their beginnings, houses and settlements are presented, although the description of the LBK (by Eva Lenneis) is much longer that of the MN cultures (Eva Lenneis, Elisabeth Rammer). This is due to a much better state of research on the early Neolithic, which enables the application of hierarchical division of settlements into special sites, central sites, secondary sites and single households. Especially in this part of the book, much hitherto unpublished data is presented. The following sub-chapter dealing with LBK burials (Eva Lenneis), both from graveyards and settlements is similarly much longer than the corresponding section for the LC and STK (Eva Lenneis, Christine Neugebauer-Maresch), which reflects the unequal quantities of data for both periods in Lower Austria. When it comes to finds of figurines as well as anthropo- and zoomorphic vessels for the two stages of the Neolithic, the similar richness of the material available leads to comparably detailed chapters on cult and religion (LBK by Nadezdha Kotova, Peter Stadler, Eva Lenneis, MN by Elisabeth Rammer, Michael Donneus).

All other 'mundane' artefacts are described in the following sub-chapters under the common title 'material culture'. After the pottery with a discussion of the respective relative chronologies based on it (LBK by Eva Lenneis and Franz Pieler, LK by Michael Doneus and Elisabeth Rammer, STK by Eva Lenneis), lithics (both parts by Inna Mateiciucová), ground stone (LBK by Eva Lenneis, MN by Gerhard Trnka), as well as bone, teeth and antler artefacts (all by Daniela Fehlmann) are presented. In the latter parts, one can find some remarks on the Neolithic subsistence and economy, which constitutes a good transition to subsequent sub-chapters on 'economy – trade – raw materials'. The chapter then outlines issues connected with agriculture (all by Marianne Kohler-Schneider), animal husbandry including hunting practices (all by Erich Pucher) as well as raw material supply and distant contacts (LBK by Inna Mateiciucová, Eva Lenneis, Michael Götzinger, MN by Inna Mateiciucová, Gerhard Trnka, Michael Götzinger). The final sub-chapters (in both cases written by Eva Lenneis) deal with the absolute chronology of specific periods. Each of these two basic chapters has its own reference list, followed by general as well as detailed maps with catalogues of all sites from the period in study.

The shorter chapter 3 includes an additional, relatively extensive sub-chapter (placed between papers on settlements and burials) written by Wolfgang Neubauer, Goerg Zotti and Eva Lenneis on enclosures, mainly ringworks, which are the best studied type of middle Neolithic sites in Lower Austria. This presentation is based mainly on recent systematic and extensive research on them including survey but also digital terrain models used as a tool to estimate the suggested astronomic and other orientation of these monuments. The obtained results are sobering, they remove the hope for a rapid and simple solution of this fascinating phenomenon. It is worth mentioning that authors in general resist the temptation of grand narratives, remain grounded in regional data, sometimes even criticizing overhasty interpretations such as the claims that Goseck is the 'oldest observatory'. Interestingly the impact of Central German research on the circular enclosure discussion is practically ignored here: the only paper from the whole Halle ringwork conference (Bertemes and Meller 2012) mentioned in this book is by Austrian Gerhard Trnka and this omission cannot be explained by any language barrier.

This regional and highly empirical approach distinguishes the whole reviewed publication (this can explain the small mistake in the Central-European presentation of the MN with STK extending over Lesser Poland instead of the local Malice Culture: fig. 3_01). Therefore it offers a very good overview, which can serve as a starting point for subsequent studies and interpretations than a singular voice in a particular discussion for example on the origins of the LBK or circular enclosures phenomenon, although the data from this country indeed have the potential to play a crucial role in such debates. The existence of such controversies is of course not at all neglected in this book but they are only briefly mentioned and not comprehensively elucidated. Interestingly not all authors share the same point of view on different disputed topics. For example Nadezdha Kotova and Peter Stadler suggest that the origins of the LBK can be related to rapid direct contacts (migrations) from Anatolia (chapter 2.3.1.) whereas other authors (Eva Lenneis, Franz Pieler – chapter 2.4.1.1.) stress the role of the Starčevo culture in this process. There is also no consistent interpretation of the demise of the LBK: according to Lenneis the observed chronological hiatus between this culture and the LC can be explained by insufficient research (chapter 3.7.), Wolfgang Neubauer in his paper on enclosures stresses their innovative character which could have resulted from the need to legitimate power and rights of a new population (chapter 3.2.1.). This impression of a completely new beginning at this time, albeit not so explicitly stated, is additionally strengthened by data presented in other chapters (especially on economy, chapter 3.6.). It would have been tempting to follow this issue more closely, which is not, however, the task of such an overview.

Contradictions of this kind (pointed out in the preface by Eva Lenneis) are not a weakness and by no means result from a lack of cooperation between the researchers involved in the project. On the contrary – the whole books makes a very coherent and well-balanced impression. Although it is a compilation of papers by many authors almost no information is unnecessarily repeated, which is actually unusual for such publications. The whole volume is very well prepared, coordinated and supervised by the editor who did not, however, restrict the authors' autonomy too much. That is why some issues important for them (such as the excellent chapter on the reconstructions of landscape and vegetation – chapter 2.5.1.1.) have a presentation that is much longer that the average and the chapters are of disproportionally various length.

In general one can admire the discipline of all authors who, as already mentioned, consequently followed the rules of an overview of local prehistory for every interested person (finding a balance between a popular and scientific publication) and did not lose too much space to very specialised controversies or grand, pan-European narratives. This has resulted in a comprehensive compendium presenting the current state of research on the early and middle Neolithic periods in Lower Austria.

This publication does not refer to the very recent chronological estimations concerning the quite late beginnings of the LBK (Jakucs *et al.*, 2016). This may be due to the fact that, although published in 2018, the papers had been prepared since 2012. Over time more and more material will not be up to date anymore, however the whole volume will definitely not lose its relevance for a long time. Because of its consistent empiricism, this important book will be a basic source of information about the early and middle Neolithic cultures also beyond Lower Austria itself.

REFERENCES:

Bertemes, F., and Meller, H. (eds) 2012. *Neolithische Kreisgrabenanlagen in Europa =. Neolithic Circular Enclosures in Europe. Internationale Arbeitstagung, 7. – 9. Mai 2004 in Goseck (Sachsen-Anhalt).* Halle (Saale), Tagungen des Landesmuseums für Vorgeschichte Halle 8.

Jakucs, J., Bánffy, E., Oross, K., Voicsek, V., Bronk Ramsey, Ch., Dunbar, E., Kromer, B., Bayliss, A., Hofmann, D., Marshall, P., and Whittle, A. 2016. Between the Vinča and Linearbandkeramik Worlds: The Diversity of Practices and Identities in the 54th–53rd Centuries cal BC in Southwest Hungary and Beyond. *Journal of World Prehistory* 29: 267–336.

Lenneis, E., Ruttkay, E. and Neugebauer-Maresch, Ch. (eds) 1995. *Jungsteinzeit im Osten Österreichs. St. Pölten*. Wien, Niederösterreichisches Pressehaus, Wissenschaftliche Schriftenreihe Niederösterreich 102/105.

Urbańczyk, P. (ed.) 2016. *The Past Societies. Polish Lands from the First Evidence of Human Presence to the Early Middle Ages*. Warszawa, Institute of Archaeology and Ethnology Polish Academy of Sciences.

Antonín Přichystal, *Lithic raw materials in Prehistoric Times of Eastern Central Europe*, Brno 2013: Masaryk University, pp. 351, 147 illustrations in the text.

Reviewed by Katarzyna Kerneder-Gubała

The book of Antonín Přichystal *Lithic raw materials in Prehistoric Times of Eastern Central Europe* is one of the most important and valuable syntheses in the field of petroarchaeology, especially in the case of the lithic raw materials used in Central Europe during Prehistory. It was published in 2013 by the Masaryk University in Brno, and consists of 11 chapters divided into subsections.

The book is written in English, as a translation of Czech language version (Přichystal 2009). The basic part of the book discusses particular groups of raw materials. The last chapter constitutes a set of coloured illustrations (XI. *Picture Supplement*). Apart from the numbered chapters, there are parts without numeration, not included in the table of contents. A bibliography is included after each section, but there is no separate part with a list of cited literature for the whole work.

Chapter I is an *Introduction* (pp. 9–46), divided into 5 subsections. The author discusses here the context of prehistoric research in Central Europe (p. 10), with a wide list of literature and articles of special significance (p. 11). He also defines the area of research (the term 'Central Europe') and explains that the monograph is focussed especially on the Czech Republic and Slovakia. This is important, because in some later sections, the disproportion between these territories and the rest is noticeable.

Also in this part, the author describes the individual geological units of the Czech Republic, Slovakia, Hungary, Poland, Austria, Germany (chapters I.2, I.3, I.4 with subsections). He discusses the geological units of Eastern Central Europe (Hercynian Central Europe, Alpine-Carpathian area and East European Plain) with further, detailed discussion on six geological units (the Czech Massif, the Lesser Poland Upland [Małopolska Upland], the Western Carpathians, the Eastern Alps, the Pannonian Basin System and Fenosarmatian Platform). This is well illustrated on the map (p. 17).

According to the chronological order, the author describes the oldest Bohemian silicites (Fig. 23), the Devonian radiolarites of the Bardo Unit and other younger deposits, such as Jurassic limestone, Cretaceous cherts, spongiolites, sandstones and marls (p. 33). He considers also moldavite as a unique raw material – a glass of the Tertiary period, which is in fact of tektitic origin. He also pays more attention to the quaternary erratic raw materials – gravels of quartz, amphibolite, quartzite and serpentine. When discussing the Ślęża region, the author emphasizes the major role of gabbro, in his opinion used for the manufacture of polished tools by the communities of the Corded Ware Culture in this region.

In the next sub-chapter, the book's author characterizes the raw materials of the Lesser Poland Upland (Małopolska Upland), Świetokrzyskie (Holy Cross) Mountains, the Western

Carpathian (I.4.3), Eastern Alps (I.4.4) and the East European/Russian Platform regions. One of the most important parts of this chapter concerns the research methods used by the author for the analysis of raw material for flaked lithic artefacts (I.5.1) and polished tools (I.5.2), which can be helpful for other researchers who conduct works in this field.

The lengthy chapter II – Raw Materials of flaked lithic artefacts (pp. 47–186) starts with the classification of raw materials and criteria adopted by the book's author in their discussion. He underlines the problem of nomenclature for the same siliceous raw materials and proposes its unification using the term 'silicites'. This is a valuable postulate, but probably it would be difficult to change names in every country, where local terms (such as 'flint' in Poland), are already widely used. The insertion of a new term could produce a series of misunderstandings.

In the next part of chapter II, Přichystal focuses on the resources of raw materials in individual regions, starting with the Czech Republic (II.2.2). These are of a range of geological ages, from the Proterozoic ftanites, Ordovician spongiolites, Silurian and Devonian cherts (II.2.2.3–8), Late Carboniferous and Permian lymnic silicites (II.2.2.10–12), Jurassic cherts and Cretaceous spongiolites. In the part dedicated to Moravia and Silesia (II.2.3), the author describes the raw materials of the Bohemian Massif and the Carpathians, starting with Devonian and Lower Carboniferous radiolarites of the Ponikev Formation, that occur in the European Mountain range – from the Świetokrzyskie (Holy Cross) Mountains, through the Sudeten to the Pyrenees and Cornwall in England (p. 68).

The subsequent part concentrates on the raw materials of the vicinity of Brno. These are the Jurassic cherts, such as Stránská Skála or Olomučany type, well known since the 1970s and the Krumlovský Les type of chert from South West Moravia (II.2.3.10). The author mentions here that the term 'Krumlovský Les type chert' and its three variants had been coined by himself, while the Polish scholar Jacek Lech has suggested the name Moravsky Krumlov hornstone, which is still in use in the Polish literature (Lech 1981).

The next sections of the chapter II.2.3. discuss the spongiolites of Western Moravia and Silesia, the Jurassic cherts of the Pavlov Hills, the Menilite chert of the Krosno – Silesian Series and others, such as the Borsice type (p. 89), as well as Jurassic radiolarites from the territory of Moravia.

In part II.2.4, Přichystal focuses on the silicites of Austria. Among the ones mentioned are the radiolarites of Vienna Mauer from the Ober St. Veit Klippen Belt as the most important raw material (p. 94). The book's author believes that these radiolarites differ from those of the Pieniny Klippen Belt in Slovakia and refers here to the latest research in this subject, which has recently been published (II.2.4.1; see Brandl *et al.*, 2014). He compares them also to the radiolarites from the Danube river (II.2.4.2), and other sources of the Carpathian Foredeep in Lower Austria (II.2.4.3).

The regions of Thuringia, Saxony and Bavaria in Germany are the subject of the next section (II.2.5). In the opinion of the book's author, the main raw materials that occur there are erratic and Jurassic silicites. They were acquired through the use of mining methods and distributed over great distances.

The next area described in the book is Poland. This chapter constitutes a general review of Polish raw materials. It contains the basic literature for each described issue, but some of the data and references could be more recent. The author keeps here also to the division of raw materials in terms of their geological chronology. As he indicates, the oldest materials (Ordovician chalcedony cherts, Silurian lydite, and Devonian radiolarites of Bardo type) are located in the Świętokrzyskie (Holy Cross) Mountains and in Silesia. The author mentions that radiolarites of Bardo type were used during the Stone Age in Poland, but researchers have called them 'quartz- lydite shale' or 'Morzyszów type flint'.

In a further section, Přichystal discusses the Permian limnic silicites of the Intra-Sudetic Basin, the glacigenic silicites of the Opole Groszowice type that have never been described in the Polish archaeological or geological literature (p. 106), or Opole silicified chalk marl and others, of local meaning (II.2.6.16). He stresses, that Jurassic silicites were one of the most important raw materials of Central Europe that were used and distributed even in the Lower and Middle Palaeolithic. This is the reason why he discusses in detail the variants of the flints from Cracow-Czestochowa Upland (see Kaczanowska and Kozłowski 1976).

When describing the striped flint, Přichystal emphasizes its technical and aesthetic values. A separate part is dedicated to the 'chocolate' flint (silicite). Here the author has not avoided mistakes in the localization of the outcrops in Northern margin of the Świetokrzyskie (Holy Cross) Mountains, when writes, for example, that its deposits have a total length of approximately 50 km, while it is over 90 km (p. 108, see for example Budziszewski 2008). Also the most important known locations of its extraction indicated here are not complete. He lists sites such as: Wierzbica I (now Polany Kolonie II), Radom district, Orońsko II, Szydłowiec district, Gliniany, Opatów district, Iłża – Krzemieniec, Radom district, Guzów and Chronów, Szydłowiec district, but doesn't mention other important points, such as Wierzbica 'Zele', Radom district, or Tomaszów, Szydłowiec district. It can be said also, that they are listed in random order, not in accordance with their geographical spacing. The further description of raw material refers to the Romuald Schild's (1971) macroscopic division into 11 categories.

The author also describes other raw materials from Poland, such as: Cretaceous Ożarów silicite (flint), which had been discovered already in the 1920s and researched in the 1990s (p. 109), as well as Turonian age flints – Świeciechów (grey white-spotted) flint. The part about the Carpathian raw materials, where the author describes in detail the issue of the radiolarites from the Pieniny Klippen Belt (p. 111), their role during the Stone Age in Poland and indicates distribution routes in the Cracow region, Little Poland voivodeship is very important. He doesn't forget to describe other important but less known Carpathian raw materials such as the Mikuszowice chert, Bircza flint, menilite chert of the Dukla unit and the Dynów marl.

In the next section, Slovakian silicites are discussed in detail (II.2.7, p. 118). The author underlines here that the most important are the Jurassic radiolarites (II.2.7.5), that occur within the Pieniny Klippen Belt, but also in other geological units (p. 119, Fig. 69). He indicates the current problem of the distinguishing of radiolarites from different parts of primary and secondary deposits (Pieniny Klippen Belt, Wag and Vlara rivers, Vienna Triassic radiolarites, Hungarian outcrops). In the next chapters (II.2.7.6–9) the book's author underlines also the role of Miocene limnic silicites known from Central and Eastern Slovakia. In the following sections he discusses the less-known Lower Palaeozoic lydites (black siliceous rocks), obtained from pebbles since the Palaeolithic, the Carboniferous geisirite, Upper Jurassic and Lower Cretaceous cherts, Paleogene Menilite cherts already described in the part about Polish raw materials, numulite cherts and Paleogene cherts of the Ondawa type, which were used by the Corded Ware Culture communities. The author underlines the role of silicites from Poland and Hungary imported to the territory of Slovakia during the Neolithic period.

In the next chapter, the author presents the raw materials of Hungary (II.2.8.1–2, pp. 126–127). According to the ordering of the discussions according to geological chronological order, he starts with general description of the Paleozoic lydite, Mesozoic radiolarites and cherts, Miocene limnic silicites (limnic quarzites or hydroquarzites). He describes in more detail the Szentgal type radiolarite, which has a wider importance during the Neolithic and Eneolithic, with the mine of Szentgal–Tuzkuveshagy (p. 130). Other Hungarian mining sites in the Jurassic radiolarite outcrops are: Bakonycsernye – at the north end of the Bakony Mts Mountains, Harskut, Labatlan and Dunaszentmiklós of Gerecse Mountains and others. Here again the problem of distinguishing of radiolarites from different outcrops is underlined. The author dedicates a separate part of this chapter to the Sumeg chert that was widespread during the Stone Age, especially in the Neolithic (pp. 131–132), the Tevel flint (II.2.8.10) as well as tertiary geisirites, hydroquarzite, limnic silicites and others, that manifest themselves in the north-eastern part of Hungary associated with the Tertiary volcanic mountains of Tokaj-Zemplin, Bukk, Matra, Cserhat, Börzsöny and Pilis.

The problem of glacigenic deposites of silicites, are considered here as a separate part, together for all the geographical regions (II.2.1, p. 51).

The next sub-section of the book (II.3.1; Fig. 75) considers quartz and its variants, from Bavaria, Bohemia, Moravia, Hungary, Slovakia. These materials were used since the Lower and Middle Palaeolithic (Cave Kulna – Taubachien, Moravian Karst). Part II.3.3 discusses the varieties of hydrothermal chalcedony, jasper and agate of the Permian volcanic rocks. An important feature of this part are the definitions of these raw materials and their comparison with each other. This section is an important voice in discussion of differentiation and terminology of radiolarite – jasper. In some countries, these terms are wrongly used for some raw materials, what cause confusion. Radiolarite and jasper were both used during prehistory, also in the territory of Poland (see Jochemczyk 2002). The next chapter concentrates on the opal of Tertiary, volcanic rocks of the Western Carpathians (II.3.4.). The book's author discusses them with a division into those from Central Slovakia, Eastern Slovakia and Northern Hungary (p. 150). The next section provides a discussion of the siliceous weathering products of serpentinite and other metamorphic rocks. Interestingly, these materials are present also in Lower Silesia II.3.5.8 (pp. 156–157).

Finally the book's author describes natural glasses – with a map of their occurrence (Fig. 84). These are obsidian, moldavite and other types of natural glass resulting from lightning strikes (fulgurites). The author explains the origins of particular glasses and indicates their occurrence in tertiary glass in Štiavnické Vrchy in Central Slovakia, in Tokay-Zemplin hills, on the Slovak-Hungarian border, and Transcarpathian Ukraine (II.4.1.1–4). A separate chapter (II.4.1.5) constitutes the use of obsidian in prehistory, where the author emphasizes its importance in different periods. Subsequent chapters discuss the less-known raw materials that were locally used in prehistory (II.4.2–4, Fig. 86 p. 166): quartzites from various deposits of the southern part of the Czech Republic, Saxony and Saxony-Anhalt, Moravia, Lower Austria (176–177), porcelanites and hornstone, corals and silicified wood (pp. 186–187). Porcelanite, which in the opinion of the book's author also occurs in Poland – Silesian St. Anne Mountain (Góra Świętej Anny), is labelled porcelanite-jasper or even jasper by some geologists (see Woźniak *et al.*, 2010).

Chapter III (pp. 189–238) *Raw materials of Polished Stone Tools* is divided according to the genesis of rocks into three sections – metamorphic rocks, volcanic rocks and sedimentary rocks. This part is much shorter than the earlier one. The author only describes selected raw materials, that in his opinion were the most valuable. In each part, there is a detailed characterisation of the varieties of particular rocks and their provenance. After each section, as in the case of the previous chapters, there is a list of cited literature.

Přichystal first describes thermally metamorphosed greenschist and metabasite (Fig. 95), which served most frequently as the raw material for polished tools in Moravia, Silesia and Slovakia. Here the book's author draws attention to the terminological mistakes that are frequent in this field, citing his own observations. The next chapters concentrate on the metabasites of southern Moravia (p. 196), the green schist from Hungary, and the Little Carpathians in western Slovakia and Southwestern Poland. There is also a part considering the possibilities of the distribution of metabasites of the Jizerské Hhory (Jizera Mountains) in the northern Czech Republic, amphibolite and serpentinite. As the author indicates, serpentinite was one of the earliest identified and described raw material in the territory of Czech Republic and in Poland (Jańska Góra hill, Gogołów-Jordanów Massif in Lower Silesia). It is worth noting that in this chapter the book's author does not mention erratic rocks which also could have been and indeed probably were an important source of raw material, as indicated by the research of, for example Janusz Skoczylas (2001) or Piotr Chachlikowski (1994, 1997). The next section concerns Jadeite (III.I.5), where the author discusses terminological problems – jade in English means also nephrite. As he underlines, in Central Europe many raw materials have been called jadeite, but the nearest outcrops are located in the Western Alps and beyond. Eclogite is a rock coexisting with jade, used in the territory of the Czech Republic. Marble, a hard crystalline metamorphic form of limestone (III.1.8), as the author indicates, could have serve as good material for the creation of figural art. At the end of this part, the book's author describes quartz – silimanite rocks, the fibrolites of western Moravia and southern Bohemia and other metamorphic rocks located in Slovakia, Moravia and Bohemia (III.1.10).

Volcanic (igneous) rocks are the subject of chapter III.2. The author describes here diorite, porphyritic microdiorite, which occurs in the Bohemian Massif and Slovakia

(III.2.1.1–2). The next important rock discussed is andesite (p. 221–222), located in the tertiary volcanic mountains of central Slovakia, eastern Slovakia, northern Hungary and also in the Carpathian Flysch Belt and on the northern margin of the Pieniny Klippen Belt in Poland (Szczawnica-Krościenko, Wdżar Mountain). Paleozoic melaphyres of Central Europe were used for making polished tools in Slovakia. Gabbro, as the book's author indicates, was rarely used in the early Neolithic, but often for Corded Ware Culture axe production. As was already noted, this rock is common among erratic sources, and this indicates scope for some other research, this raw material is very difficult for treatment (Cholewa 2004). Chapter III.2.5 describes basalt and its outcrops in Bohemia, Moravia, Slovakia, Hungary and Poland. Basalt was willingly used in the Middle Neolithic and Early Bronze Age in Poland, especially in the regions of Greater Poland (Wielkopolska) and Kujawy. It is worth adding that these issues are discussed in-depth in papers of Chachlikowski (for example 1994, 1997), but his works are not mentioned here by the book's author. In the next sub-sections, the author describes variants of basalts: diabase, metadiabase, metadolerite of Moravia within the volcanic rocks of the Konice–Mladeč Belt and in Silesia (Czech, Polish), spilite, teschenite and picrite known from Moravia, Poland, Western Slovakia, but here probably obtained from river pebbles.

Sedimentary rocks are the subject of the next chapter (III.3). The book's author describes here siltstone, silty shale, greywacke from the Lower Carboniferous clastic rocks, known from Czech and Polish Silesia, and sandstones occurring in many outcrops of Central Europe. Also covered are Paleogene claystone in eastern Slovakia and limestone used for figural art or to make ornaments. In the next chapters are described bituminous siderite claystone (Czech local name), Brezina shale (southern Moravia), Iron ores and others, such as siltstone and claystone from various sources (III.3.1–8).

The short chapter IV (pp. 239–240) concerns the raw materials used for production of wristguards – which in the Bell Beaker Culture, Proto – Unietice and the Nitra group served to protect the inner part of the archer's wrist from the recoil of the bowstring. As the author notes – they were made mainly of sandstones, siltstones and other sedimentary rocks. However he does not mention that using schist was also very common and seems to have had a special meaning in this time (see, for example, Budziszewski and Włodarczak 2010).

Another equally brief chapter V (pp. 241–245) describes the raw materials of whetstones, that is, according to the author's definitions, small artefacts used for finishing of polishing tools or grinding during the Neolithic and Eneolithic periods, as well as in younger periods for sharpening knives and other metal tools. As the author notes, in prehistory, they were made mainly of sandstones.

Chapter VI (pp. 245–262) concerns the raw materials for mortars, saddle Querns, rotary Querns and millstones. Here the author characterizes the basic features of particular tools (p. 246). He emphasises that the function of the tool guided the selection of the raw material. Interestingly, the author discusses the succession of raw materials used for these tools during the Neolithic, Hallstatt, La Tène and early Middle Ages. He defines the most important raw materials for particular groups of tools (VI.4–VI.13), that is very valuable for future comparative studies.

Chapter VII (pp. 263–268) contains comparative information about the raw materials of stone spindle whorls from Ukraine, Poland, Moravia and Bohemia.

Chapter VIII describes halite (pp. 269–273). The major salt deposits in Central Europe are shown on a map. These are sources in eastern Slovakia – with Miocene salt rocks, used in the Middle Ages (VIII.1.), Ukrainian deposits, which were used already in the Neolithic and Bronze Age (VIII.2), Wieliczka near Cracow (VIII.3), exploited from the middle Neolithic, the Austrian (VIII.4) salt deposits from Salzkammergut and East German region in Halle. The author gives here interesting historical information about the salt exploitation and use.

One of the last chapters is devoted to the use of fossils in prehistory (pp. 275–280). Here the book's author gives interesting examples from Central European sites since Palaeolithic which confirm that prehistoric people were interested in such objects, used probably as amulets and talismans.

The last short chapter – X *Pseudoartefacts* (pp. 281–284) is also very interesting. It contains illustrated examples of pseudoartefacts, that were once thought to be authentic ancient stone artefacts.

The last part of the book (XI) contains coloured illustrations documenting the raw materials discussed earlier in the volume. This can be helpful for comparison of artefacts with particular photographs of raw materials known from Central Europe.

To summarize: In this book, the author has touched almost every problem associated with lithic raw materials and their use in prehistory and historical periods. Some issues have been treated in great detail, while others have been covered more generally, but in every part of the book, the reader will find more references to more specific literature. In some chapters, the divisions into sections and sub-sections could be less complicated, because the current arrangement causes repetition of information. The construction of the work, however, allows precisely and quickly finding desired information, because every part seems to be independent of the rest, with its own bibliography.

Of particular interest and helpful is the rich illustrative material in particular chapters with schematic maps, photographs of deposits, outcrops, as well as the colour supplement in chapter XI.

Each subsection of this part is divided into further sub-sections relating to the macro– and microscopic characteristics of the raw materials from particular geological units and their sources used in prehistory. This procedure increases the clarity and transparency of the book. But the lack of a summary of the book or individual chapters can be noted.

At some points, uncertainty is visible in the text. Some problems and raw materials are described without any explanation or references. An example is the case of the problem of the so-called radiolarite of Bardo type and its exploitation during the Mesolithic in Poland, where the author doesn't give any references to the literature or further information about this issue, when the author writes about the material for the first time (chapter I, II.2.6).

This information occurs only in next chapters. It is also noteworthy that, when discussing the Ślęża region in Poland, the book's author emphasizes the major role of gabbro used in his opinion for the manufacture of polished tools, however, as has already been said, among some other researches there are also opposite opinions on this thesis (Cf, for example, Cholewa 2004: 102). It is also noticeable that on Fig 31 (a map of Carpathian and selected geological units), there is only the territory of Slovakia and the Czech Republic shown, while the book's author describes here all Carpathian regions. For many of the geological units described in the book, there is no localisation on this map. This information could increase the clarity of the discussions. Chapter II is very detailed. It is a wide cross-section of described raw materials and areas, with bibliography for each discussed issue. In the part that refers to Polish territory, the author draws attention to raw materials that are rarely noticed, or not noticed at all, by other researchers. A valuable part of this chapter is an attempt of indication of a method for distinguishing them and maps locating the deposits discussed. Also interesting is that author give here historical information, as in chapter VIII.

In this monograph, the author presents his magnificent, valuable experience and his own discoveries in the issue that is the subject of this book. What is also valuable, the author describes raw materials already known to other researchers that were used by prehistoric communities, as well as those that have not yet been found in the material currently known from archeological sites, but their exploitation in the past could have been possible. What is also important, every issue is described here in its geological context.

This book is an invaluable source of information and a compendium of knowledge about the lithic raw materials of Central Europe.

REFERENCES:

Brandl, M., Hauzenberger, Ch., Postl, W. and Trnka, G. 2014. Radiolarite studies at Krems-Wachtberg (Lower Austria): Northern Alpine versus Carpathian lithic resources. *Quaternary International* 351: 146–162.

Budziszewski, J. 2008. Stan badań nad występowaniem i pradziejową eksploatacją krzemieni czekoladowych. In W. Borkowski, J. Libera, B. Sałacińska, and S. Sałaciński (eds), *Krzemień czekoladowy w pradziejach. Materiały z konferencji w Orońsku, 08-10.10.2003*, 33–106. Warszawa-Lublin, Studia nad Gospodarką Surowcami Krzemiennymi w Pradziejach 7.

Budziszewski, J. and Włodarczak, P. 2010. *Kultura pucharów dzwonowatych na Wyżynie Małopolskiej*. Kraków.

Chachlikowski, P., 1994. Późnoneolityczne wybierzysko surowców skał niekrzemiennych w miejscowości Goszczewo gm. Aleksandrów Kujawski, woj. Włocławek, stanowisko 13. *Folia Praehistorica Posnaniensia* 4: 59–117.

Chachlikowski, P. 1997. *Kamieniarstwo późnoneolitycznych społeczeństw Kujaw*. Poznań.

Cholewa, P. 2004. *Rola sudeckiego zaplecza surowcowego w kamieniarstwie neolitycznym na Śląsku*. Wrocław.

Jochemczyk, L. 2002. Petrograficzne badania paleolitycznych narzędzi kamiennych ze stanowiska archeologicznego na Górze Zamkowej w Cieszynie. In J. Garncarski (ed.), *Starsza i środkowa epoka kamienia w Karpatach polskich*, 247–253. Krosno.

Kaczanowska, M. and Kozłowski, J. K. 1976. Studia nad surowcami krzemiennymi południowej części Wyżyny Krakowsko-Częstochowskiej. *Acta Archaeologica Carpathica* 16: 201–219.

Lech, J. 1981. Flint mining among the early farming communities of Poland. In F.H.G. Engelen (ed.), *Third Internationale Symposium over Vuursteen, 24–27 Mei 1979 – Maastricht*, 39–45. Maastricht, Staringia 6.

Přichystal, A. 2009. *Kamenné suroviny v pravěku východní části střední Evropy*. Brno.

Schild, R. 1971. Lokalizacja prahistorycznych punktów eksploatacji krzemienia czekoladowego na północno-wschodnim obrzeżeniu Gór Świętokrzyskich. *Folia Quaternaria* 39: 1–60.

Skoczylas, J. 2001. Zróżnicowanie użytkowania czwartorzędowych surowców skalnych w Wielkopolsce w neolicie i we wczesnym średniowieczu. In A. Karczewski and Z. Zwoliński (eds), *Funkcjonowanie geoekosystemów w zróżnicowanych warunkach morfoklimatycznych – monitoring, ochrona, edukacja*, 491–501. Poznań.

Woźniak, P., Sikora, R., Lasoń, K., Markowiak, M., Haisig, J., Szulc, J. and Hagdorn, J. 2010. *Geopark Góra Św. Anny – udokumentowanie i propozycja jego ochrony*. Sosnowiec.

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