The Chocolate Flint Mines in the Udorka Valley (Częstochowa Upland) – a Preliminary Report on the Field and Lidar Surveys

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Abstract: An important role in the extraction and utilisation of siliceous rocks was played by the Udorka Valley region, situated in the south-eastern part of the Ryczów Upland. In this region, numerous outcropsof various siliceous rocks are located including outcrops of chocolate flint, and many sites with artefacts from chocolate flint dated from the Middle Palaeolithic. In Udorka Valley, in the area of chocolate flint outcrop, a number of small depressions in the ground with unfinished flint artefacts were encountered and which have been tentatively considered to be remnants of the activities of prehistoric miners. The area under scrutiny was investigated using airborne laser scanning methods (LiDAR, ALS). This paper presents the preliminary results.

Keywords: lithic raw material, silicite, chocolate flint, Stone Age mining, LiDAR survey, Poland

Introduction

The issues related to the extraction, distribution and role of siliceous rocks in the economies of the prehistoric communities who lived in the territories of Poland have been frequently addressed by archaeologists since the previous century (e.g. Krukowski 1923; Samsonowicz 1923; Schild 1971; Balcer 1975; Balcer and Kowalski 1978; Kaczanowska and Kozłowski 1976; Lech 1981; Cyrek 1983; Budziszewski and Michniak 1983 (1989); Matraszek and Sałaciński 2002; Sulgostowska 2005; Borkowski *et al.* 2008; Piotrowska *et al.* 2014). These topics are of particular importance from the viewpoint of studies on the utilisation and contribution of local flint resources in human economies, and for determination of the occurrence of so-called imported flint artefacts in assemblages encountered at sites dated to the Stone Age.

An extremely interesting in this respect is the region of the central Częstochowa Upland (the Ryczów Upland in particular), where numerous outcrops of various siliceous rocks are located (Krajcarz *et al.* 2012a, 2012b, 2014), and many sites with flint assemblages dated from the Middle Palaeolithic period (e.g. Cyrek 2009, Cyrek *et al.* 2010, Sudoł *et al.* 2016) until the Neolithic and Early Bronze Age have been identified (e.g. Pelisiak 2006; Krajcarz *et al.* 2014).

An exceptional role, especially in terms of the issue of extraction and utilisation of siliceous rocks, is played by the Udorka Valley region, situated in the south-eastern part of the Ryczów Upland (Fig. 1). Field and prospective surveys conducted in this area in the years 2012–2015 resulted in the discovery of new cave and open air sites accompanied by outcrops of flint (Sudoł *et al.* 2016), including outcrops of chocolate flint, the

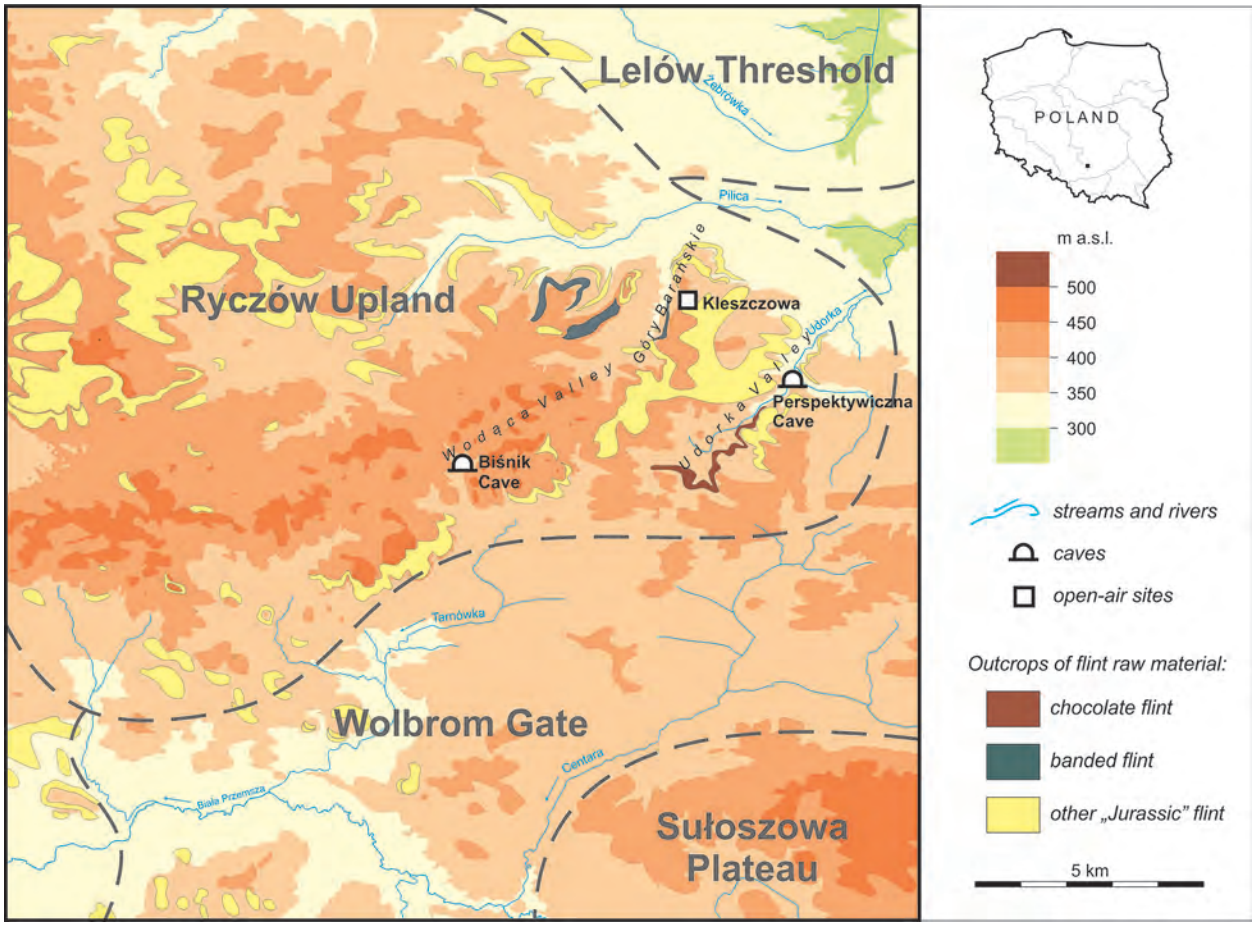

Fig. 1. Location of Udorka Valley, Olkusz and Zawiercie dist., and presented sites. Drawn: M. T. Krajcarz.

extent of which has been considered until recently to be limited exclusively to the province of the Holy Cross (Świętokrzyskie) Mountains (Krajcarz *et al.* 2012b).

In the region of the chocolate flint outcrop in the Udorka Valley, a number of small depressions in the ground containing unfinished flint artefacts were encountered and which have been tentatively considered to be remnants of the activities of prehistoric miners. To verify this thesis, the area under scrutiny was investigated using airborne laser scanning methods (LiDAR, ALS; Crutchley and Crow 2010; Sławik and Zapłata 2011), the preliminary results of which are presented in this paper.

History of the discovery

The investigations carried out in the Udorka Valley region were inspired by the results obtained within the NCN (National Science Centre, Poland) research project entitled 'Palaeolithic settlement of Wodąca and Udorka Valley (Częstochowa Upland) against the palaeoenvironmental background' (in Polish: 'Osadnictwo paleolityczne Doliny Wodącej i Doliny Udorki (Wyżyna Ryczowska) na tle uwarunkowań paleośrodowiskowych'), carried out under the management of Magdalena Sudoł in the years 2011–2014. The latter resulted in a discovery of sites, the settlement episodes of which can be related to the successive phases of the Palaeolithic and Mesolithic periods (Sudoł *et al.* 2016). Amongst them, the Perspektywiczna Cave is exceptional (Sudoł *et al.* 2013); it is a multicultural site with an abundant accumulation of flint artefacts with a predominant appearance of chocolate flint (Krajcarz *et al.* 2012b, 2014).

Simultaneously, a prospective survey conducted in the field by a research team (Maciej T. Krajcarz, Magdalena Krajcarz and Magdalena Sudoł) revealed a significant diversification of siliceous rocks encountered in this region and an occurrence of new outcrops (Krajcarz *et al.* 2012a). Amongst these, the outcrops of high-quality chocolate and banded flints merit special attention.

Fragments of chocolate flint chunks were primarily discovered only within the bed of the seasonal Udorka stream (Fig. 2). When compared with predominant types of flint materials encountered in the Udorka Valley region, they were distinctive in terms of their regular, slab-like forms. The outer surfaces of some

Fig. 2. Fragments of chocolate flint chunks in the riverbed of the seasonal Udorka stream. Photo: M. Sudoł-Procyk.

nodules showed traces of transport by water (red patina, polishing and abrading). The region of the Udorka Valley is densely forested and cut through with deep gullies, which makes it very difficult to conduct field surveys. Therefore, outcrops of this particular siliceous rock had not been discovered until 2013 (Fig. 3).

Further prospective surveys lead to a discovery of a series of pits in the surrounding areas of the outcrops, the origins of which were most likely anthropogenic in nature (Fig. 4 and 5). In their neighbourhood, especially by the edge of the slope, flake blanks and numerous flint nodules were recorded; the latter were initially prepared, which indicated that they were remnants of near-mine workshops, where the initial preparation of nodules took place. Other open sites that might have functioned as workshops, with a great share of cores and blanks made of chocolate flint, were discovered at the Kleszczowa site, Zawiercie district, in the region of the Góry Barańskie hills (Fig. 1). Interpreting the open and cave sites as relating to production is a significant criterion in considerations referring to the exploitation of local outcrops of chocolate flint and the manner of its utilisation in the Palaeolithic (particularly in its late phases, i.e. Upper and Late Palaeolithic) and Mesolithic periods. Therefore, it is important to identify precisely the possible points of extraction of chocolate flint, and determine their nature and extent.

Flint material – geological characteristics

Chocolate flint in its classical range within the north-eastern margin of the Holy Cross Mountains occurs within the limestone rocks associated with the Upper Astartian, according to the nomenclature given in the pioneer publications on the geology of that region (Samsonowicz 1923). This stratigraphic unit was rejected

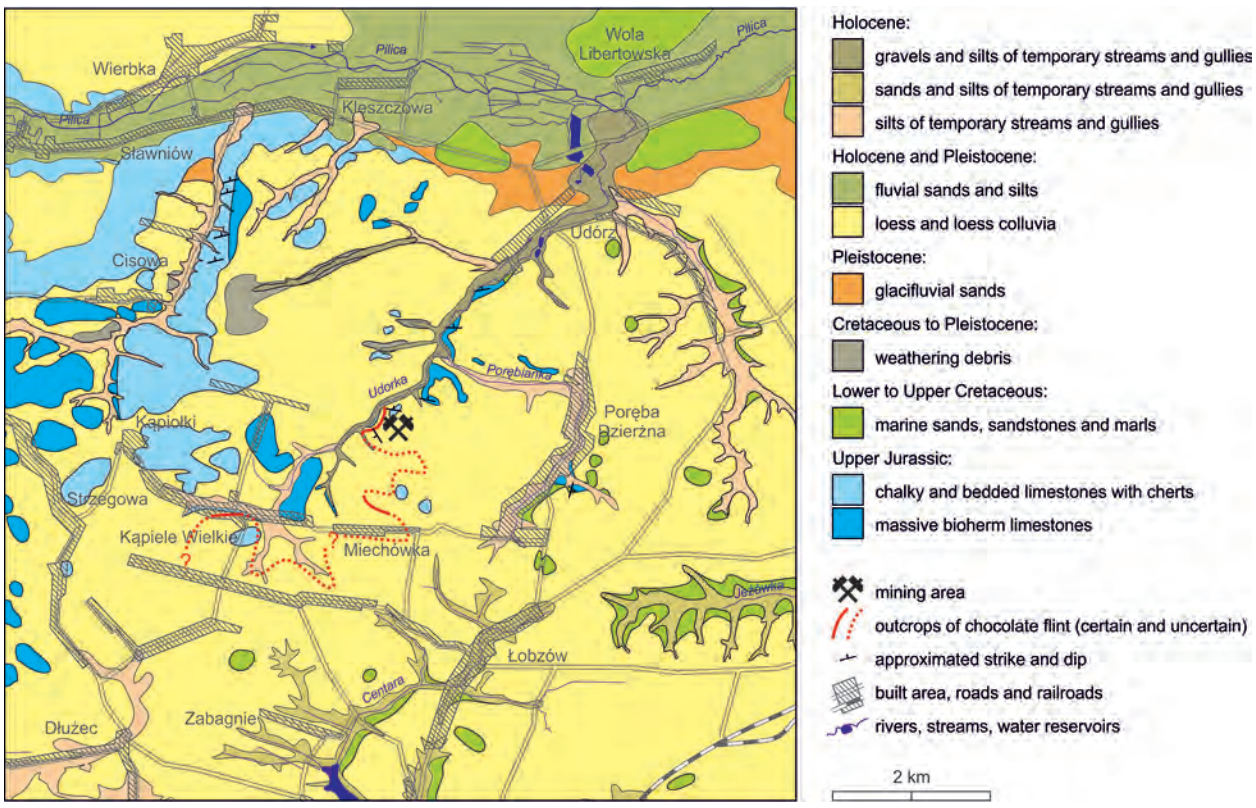

Fig. 3. Geological map of Udorka Valley and surrounding area. Map based on the Geological Map of Poland 1: 50 000, sheets Ogrodzieniec (No. 913) and Wolbrom (No. 914), modified according to field observations. Drawn: M. T. Krajcarz.

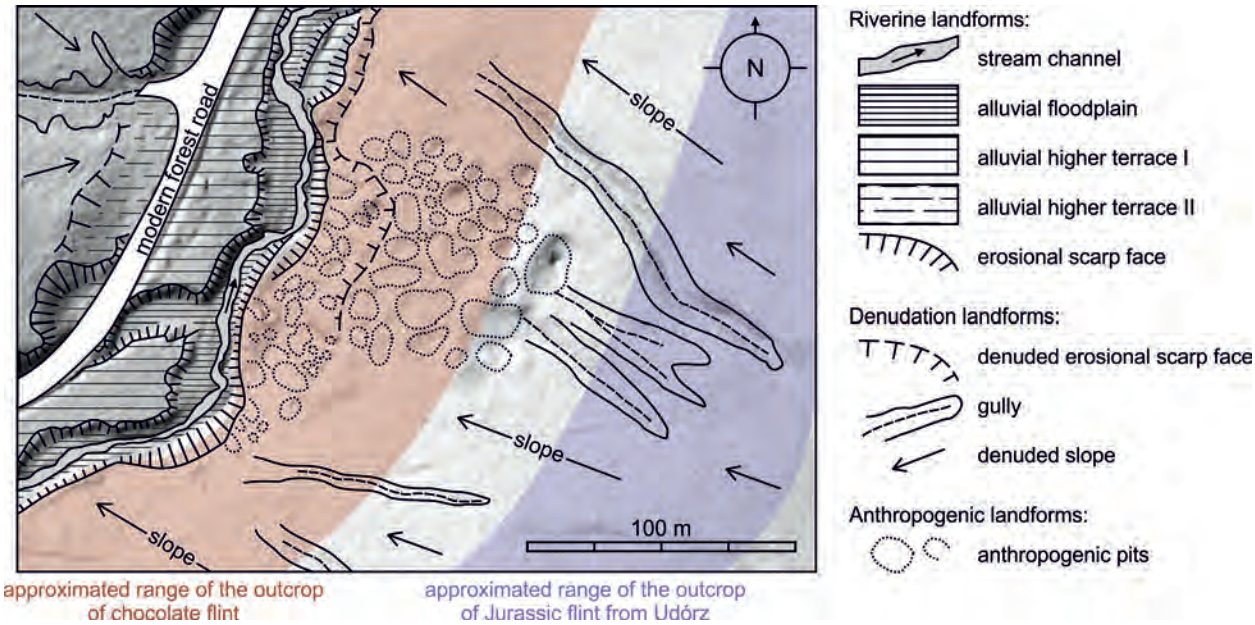

Fig. 4. Geomorphology of the flint mine area. Map based on the LIDAR image available from the Polish General Office of Geodesy and Cartography website (http://mapy.geoportal.gov.pl/wss/service/WMTS/guest/wmts/ISOK_CIEN), modified according to field observations. Drawn: M. T. Krajcarz.

Fig. 5. Pits in the surroundings of the outcrops, the origins of which were most likely of anthropogenic nature (in pictures Janusz Budziszewski and Michał Szubski). Photo: M. Sudoł-Procyk.

in the mid 1960s (Kutek 1965), and it corresponds with the current uppermost part of the Upper Oxfordian and the lower part of the Kimmeridgian. The position of layers containing chocolate flint is linked closely to the boundary between Oxfordian and Kimmeridgian sediments is although their affiliation to one of these stages has so far not been clarified. Jacek Gutowski (1998) linked chocolate flints from the north-eastern part of the Holy Cross Mountains explicitly with the Upper Oxfordian, and placed them between the *planula* and *hypselocyclum* zones. On the other hand, the Oxfordian-Kimmeridgian boundary has not been indisputably established (Cohen *et al.* 2013), and the current opinions postulated by geologists tend to localise this stratotype in Scotland, within the Boreal ammonite province, which is expected to make the ammonites of the Mediterranean province – to which the Cracow-Częstochowa Upland belongs to – no longer useful in terms of the univocal determination of the biostratigraphy of local strata.

The degree of exposure of Jurassic sediments in the surroundings of the Udorka Valley is very poor. This region is very densely forested and Jurassic deposits are mostly covered with Cretaceous sands and Quaternary loess (Fig. 3). Artificial outcrops in the form of quarries are scarce and small, not revealing the layers with chocolate flints. Natural outcrops are also small and they are mainly encountered in the context of biohermal limestones. Due to this an accurate recognition of the chocolate flint stratigraphy is impossible.

Field observations on the occurrence of chocolate flint in soils and regoliths of the Udorka Valley indicated that the layers containing this raw material, likewise the layer with cherts from Udórz, are encountered above the lithostratigraphic unit of the Upper Massive Limestone. Taking into account the fact that *Idoceras* were discovered within those limestones (Bednarek *et al.* 1978) – the ammonites commonly known from the Upper Oxfordian and Kimmeridgian, the limestones in question may be associated with both the Upper Oxfordian (as concluded by Bednarek *et al.* 1978) and Lower Kimmeridgian horizons. In general, their

biostratigraphic position is similar to that of chocolate flint-bearing strata from the Holy Cross Mountains region. Detailed lithostratigraphic correlation is difficult to find due to poor exposure of the terrain under vegetation, as mentioned above.

The chocolate flints emerge within the soils and regoliths, on the right slope of the Udorka Valley, in the forest named 'Łysa Góra' (*c.* 50°26'3' N, 19°45'8' E; Fig. 3). The linear outcrop extends further to the southwest, and diminishes on crop fields near the village of Miechówka, Olkusz district. It occurs again within regoliths in the village of Kąpiele Wielkie, Olkusz district, in the seepage zone of the Udorka stream (50°25'32' N, 19°43'50'E). Moreover, the flint can be encountered in the riverbed and alluvia of the Udorka stream, as well as in proluvial sediments of the tributary gullies. Chocolate flint is assumed to spread further to the north and south, as can be predicted from the monoclinal geological structure of the region, however so far its outcrops have not been discovered there.

A macroscopic description of chocolate flint was presented by Krajcarz *et al.* (2012b). The nodules are flat with parallel upper and lower surfaces. The thickness of nodules is 2–10cm and their diameters range from several to over a dozen centimetres. The cortex is thin (*c.* 0.5–5mm, on average 1–2mm), white, smooth but with numerous fossils and grains on the surface, clearly separated from an outside rock. Under the cortex a white, dull, non-transparent zone occurs, several mm thick and distinctly separated from the inner silica substance. The silica substance is dark, from dark-brown to yellowish-brown, greyish-brown and milky-white. It is fine-crystalline, dull, and slightly transparent, with fatty or pearl lustre. In some specimens there occur horizontal bands of coarse-crystalline silica within the substance. The knapping properties are very good. When knapped this silicite shows subconchoidal fractures. The weathered cortex is orange and the weathered silica substance is dull, non-transparent, grey to yellowish-grey or bluish-grey, and in some specimens striped. The name of 'Kraków-Częstochowa chocolate silicite' was proposed (Krajcarz *et al.* 2012b) to separate this flint from the classical chocolate silicite from the Holy Cross Mountains.

Landform of the chocolate flint extraction region

The very first discoverers of the prehistoric mining sites in Poland already paid attention to the specific ground relief of mines (Samsonowicz 1923: 22–23; Krukowski 1932: 58–59), whereas the first attempts to draw a precise documentation of this landform were undertaken in the 1940s (Sawicki 1948: 123; Sytnyk 2014: 128). However, reliable and comprehensive analyses of the ground surface morphology of prehistoric mining sites were performed no sooner than the 1990s (Budziszewski 1990, 2000; Borkowski 1995, 2005). Unfortunately, the research commenced at that time has not been continued, and our knowledge about the relationships between specific landform conditions and various types of mining technologies is still insufficient. This seems to be due to the fact that the primary landform of such sites was very susceptible to destruction caused by agricultural activity carried out by human communities in subsequent periods. As a result, it is usually preserved only in forested lands, where it is very difficult to draw accurate topographic maps using classical methods.

This situation is likely to change thanks to the introduction of airborne laser scanning methods into archaeological practice (Crutchley and Crow 2010; Sławik and Zapłata 2011). However, there are still only a few published studies based on this technique. In recent years they have just started to emerge in foreign (Utting *et al.* 2010; Tarriño *et al.* 2011, 2014) and Polish archaeology (Budziszewski and Wysocki 2012; Jakubczak 2012; Radziszewska 2015; Szubski 2016). The data obtained in such studies has revealed that the reality is far more complicated than might have been expected.

Geological analyses and field surveys carried out in the Udorka Valley, in a presumed location of chocolate flint outcrops, delivered evident traces of anthropomorphic transformations in ground relief (Fig. 4). To analyse these traces the investigators decided to use the data from airborne laser scanning obtained in the course of the project named 'IT system of the Country's Protection Against Extreme Hazards' (in Polish: 'Informatyczny System Osłony Kraju przed nadzwyczajnymi zagrożeniami' – ISOK), developed between 2007–2013 by a consortium consisting of the Institute of Meteorology and Water Management, the National Water Management Authority, the Head Office of Geodesy and Cartography, National Institute of Telecommunications, and the Government Centre for Security (Maślanka and Wężyk 2014). The data was acquired from the Geodetic and Cartographic Documentation Centre, and it covered the region of the Udorka Valley and its vicinities over an area of 50km^2. Measurement parameters of the cloud point obtained were within the standard I (WT LiDAR 2013/2014), i.e. ≥4 pts. per one sq. m, scan angle ≤25°, diameter of laser spot ≤ 0.5m (Kruczyński *et al.* 2014). The point cloud was reclassified to respond to the needs of archaeological analyses using LAStools software. A Digital Terrain Model of the TIN type (Triangulated Irregular Network), with a resolution up to 30cm, and an analogical Digital Surface Model were generated. Based on the Digital Terrain Model a series of visualisations were created using the software RVT 1.1, LiVT and Global Mapper 14.

These visualisations enclosed the following: Hillshade (shaded relief map), Multi Hillshade, Sky View Factor (Kokalj *et al.* 2011), Principal Component Analysis, Local Dominance and Local Relief Model. With regard to the studies conducted, the investigators chose a few visualisations that were considered useful for achieving their research objectives, including: Hillshade, Multi Hillshade, Sky View Factor and PCA. The data obtained were exported using QGIS software and then subjected to further processing within the generated GIS database.

An analysis of the Digital Terrain Model confirmed the preliminary assessment of the landform in the surroundings of the presumed location of the chocolate flint outcrops. Numerous anthropogenic modifications affecting the relief in this area lead to a formation of three distinctive zones (Fig. 6). In the topmost zone of the slope there is a vast area with pits of various depths and shapes (Fig. 6a). This zone extends to a height of more than 100m above the valley floor and covers an area of *c.* 0.7ha. The pits became bigger and deeper as the slope ascended. The largest one had the topmost location and dimensions of *c.* 13 x 25m, resembling a form typical of small quarries. Its entrance was located in the south. The diameters of the features situated below, further down the slope, usually amounted to just a few metres. Their reliefs have been deformed to such an extent that it is impossible to evaluate explicitly the number of extraction points. The lack of traces of distinctive waste heaps indicated that all of the features in question were remnants of exploitation of rock layers, namely limestone.

In the northern section of the lowest part of the slope, some deep, although small, structures emerged again in the form of pits or ditches several metres in dimension (Fig. 6b). These also lacked distinctive waste heaps, which led to them being considered as the remnants of exploitation performed in a similar manner to the one described above, yet on a much smaller scale.

To the south of those features the edge of the valley is broken by a vast niche extending over an area of nearly 70m in length (Fig. 6c). Within this niche there were numerous small depressions with diameters reaching up to a few metres, taking the shapes of recesses opened towards the valley. This suggested that this vast form had been shaped through time by repeatedly performed mining activities, always on a small scale. The form of these features has not provided clues for determining which particular mineral was extracted from them. There is also a lack of distinctive waste heaps, however if the waste material had been removed and dropped into the valley, it must have been periodically washed out by the stream. In the lowest part of the valley, and within its very edge, there are two vast erosional niches – the result of bank erosion caused by the flow of the Udorka River (Fig. 6d).

The form of the largest feature on the higher part of the slope indicated that they had emerged in modern times. The authors presume that neighbouring features may be of similar age. The reliefs of the small pits and ditches on the lower part of the slope were very sharp, giving an impression of being the youngest in age. This hypothesis seems to be confirmed by an analogical feature dug out in the bottom of a vast quarry on the upper part of the slope. A similar feature within the lowest part of the anthropogenic niche revealed analogous stratigraphic relationships. Unfortunately, the relationships between the exploitation carried out by establishing large pits and ditches, and the vast niche situated at the edge of the valley cannot be explicitly clarified. It can only be stated that the latter is older than the southern, natural niche eroded by the Udorka.

The above-mentioned analyses indicate that the only feature alleged to have prehistoric origins is a vast niche formed at the edge of the valley as a result of the repeatedly resumed exploitation of small pits opened towards the river. Similar features have not been recorded amongst the opencast mines of chocolate flint in the Holy Cross Mountains region (Budziszewski 2008: ryc. 27). However, this method of extraction is so easy and natural that it should be expected to have been employed under specific geological conditions. Moreover, smaller complexes of this type have already been encountered in Poland, e.g. an extraction point of banded flints named 'Skałecznica Duża', Opatów district (Jakubczak 2012), and a site 'Krzemianka', Białystok district, associated with the exploitation of secondary deposits of siliceous rocks from the moraine of the Warta Glaciation in the Knyszyn Primeval Forest (Borkowski 2005; Szubski 2016). Moreover, the site known as 'Lousberg' in Aachen (Aachen district, Germany) has proved that the extraction of siliceous rocks carried out in this manner could ultimately develop into large-scale mining (Weiner and Weisgerber 1980).

Archaeological field survey at raw material extraction points

As mentioned above, the area of presumed location of the chocolate flint outcrops was thoroughly investigated during several prospective surveys. Archaeological materials were found on the surface of small depressions occurring within a large niche situated by the valley edge, and in its closest surroundings. The investigators had difficulties in spotting them due to the quantities of forest litter. Nevertheless, they succeeded in collecting natural nodules, test nodules (Fig. 7), initial cores (Fig. 8) and flake blanks (Fig. 9). These materials were relatively scarce. Large flakes characterised by butts covered

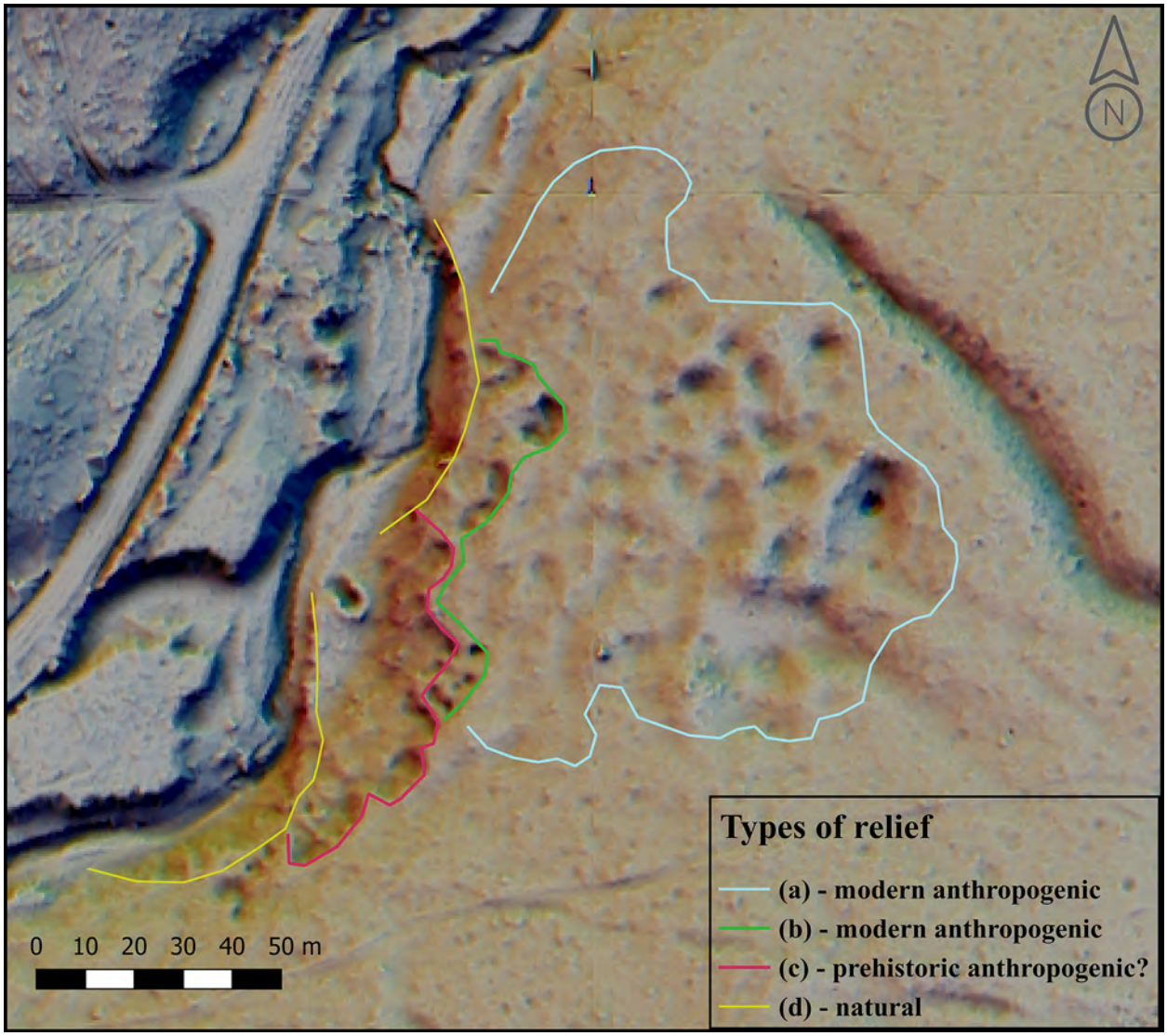

Fig. 6. The landform in the surroundings of the location of the chocolate flint outcrops based on analysis of the Digital Terrain Model. Drawn: M. Szubski.

with scars of previous blows or cortex, and strongly marked bulbs, often with visible flows, were distinctive in terms of quantity. These flakes were associated with the initial preparation of nodules, performed using a hard hammer. Unfortunately, the materials in question contained no forms that could allow a reliable cultural attribution.

Noteworthy, however, is the varied state of preservation of these flint materials. Most of the artefacts were covered with extensive white patina (Fig. 7). There were also cores and flake blanks with only slightly patinated surfaces, or showing no traces of patination at all (Fig. 10). This could have been due to various phases of extraction of raw material in this region.

Flint materials were accompanied by limestone chunks. The latter were infrequently represented and many

Fig. 7. Testing nodules with strong white patina in situ. Photo: M. Sudoł-Procyk.

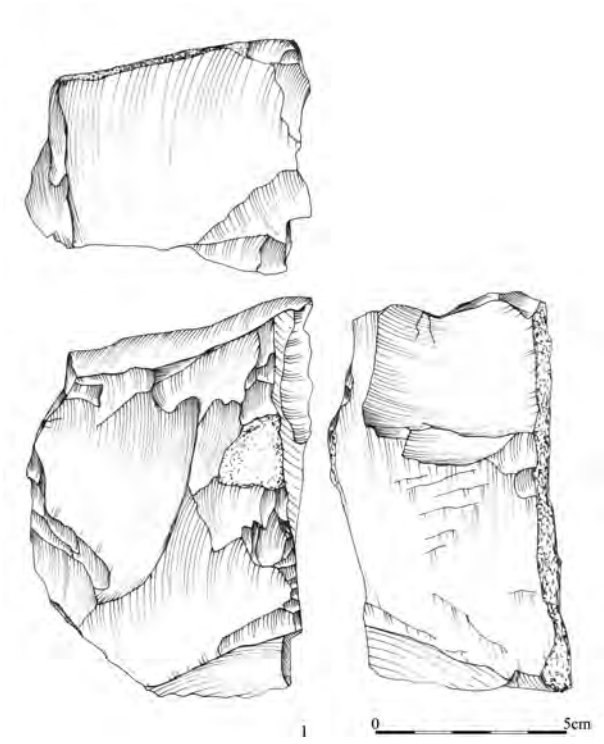

Fig. 8. Initial core from chocolate flint.
Drawn: M. Sudoł-Procyk.

were weathered, which indicates that the features had most likely been dug out from the soil and regolith, instead of the limestone rock.

The materials discovered were associated with an initial preparation of nodules, which corresponded well with the nature of the ground relief encountered at the site. This supported the hypothesis that the site under scrutiny was a remnant of a small extraction point and a near-mine workshop, where initial preparation of chocolate flint nodules was performed.

Chocolate flint in the Palaeolithic assemblages from the southern part of the Ryczów Upland

Taking into account the location of chocolate flint outcrops in the Udorka Valley, the flint assemblages obtained from several sites situated in the southern part of the Ryczów Upland were subject to analysis in respect to their potential utilisation in the Palaeolithic period.

The earliest evidence of chocolate flint utilisation comes from the Biśnik Cave (Fig. 1; Cyrek *et al.* 2010). This raw material occurred in most of the Middle Palaeolithic assemblages encountered in this cave, which has already been reported in the existing literature (Cyrek and Sudoł 2008). A discovery of chocolate flint outcrops within a distance of 10km from the site, and comparative analyses performed on the materials obtained from the outcrops, allowed the investigators to reinterpret their opinions on the long-distance import of this flint from the northwest margins of the Holy Cross Mountains into the Cracow-Częstochowa Upland, which took place in the Middle Palaeolithic period (Krajcarz *et al.* 2012b).

The oldest assemblages containing a great number of artefacts made of chocolate flint were associated with cultural levels contained within layers 19 and 18 in the Biśnik Cave (assemblages A_5–A_7; Cyrek 2013). The following items were fashioned from this raw material: a backed knife, retouched Levallois points, two cores, and small tools with denticulated and notched retouch. However, the most spectacular artefacts made of chocolate flint found in Biśnik Cave came from the youngest Middle Palaeolithic cultural levels (layers 7–5), which were linked with the assemblages E and F (Cyrek *et al.* 2010, 2014), i.e. some Levallois cores, as well as single- and double-sided backed knives. One of the knives was made of a flat flint slab (Fig. 11:1). Similar flat slabs of chocolate flint were recorded in the region of its outcrops in the Udorka Valley. The assemblages from the Biśnik Cave proved that chocolate flint was a well-known and highly appreciated raw material used for tool production by Neanderthal communities from this region since the Middle Palaeolithic period, which supports the thesis of its long-term utilisation stretching back some 200,000 years.

Recent studies carried out in the region of the southern part of the Ryczów Upland have contributed to the discovery of sites related to the Upper and Late Palaeolithic periods (Sudoł *et al.* 2016). Evidence of the utilisation of local chocolate flints in those eras was provided by assemblages encountered in the Perspektywiczna Cave (Fig. 1) in the Udorka Valley (Sudoł *et al.* 2016). The assemblage associated with the Upper Palaeolithic period was recorded by the cave entrance. It contained several dozen flint artefacts from the production and household stages. Most of these specimens were made of chocolate flint, amongst which a set of artefacts was distinctive, including large perforators (Fig. 11:2–3), large blades and blade cores (Fig. 11:4). The artefacts in question were slightly patinated. Unfortunately, based on this small assemblage it is difficult to establish reliably any cultural affiliation (Sudoł *et al.* 2016). Preliminary investigations revealed that artefacts obtained from this part of the site occurred in slope sediments, in the secondary deposit. A different state of preservation, with no traces of patination on the flint surface, was observed while examining relics of the Late Palaeolithic assemblage recorded in the upper layers of the sediments in the Perspektywiczna Cave. An occurrence of blade blanks (Fig. 11:5) and numerous core-

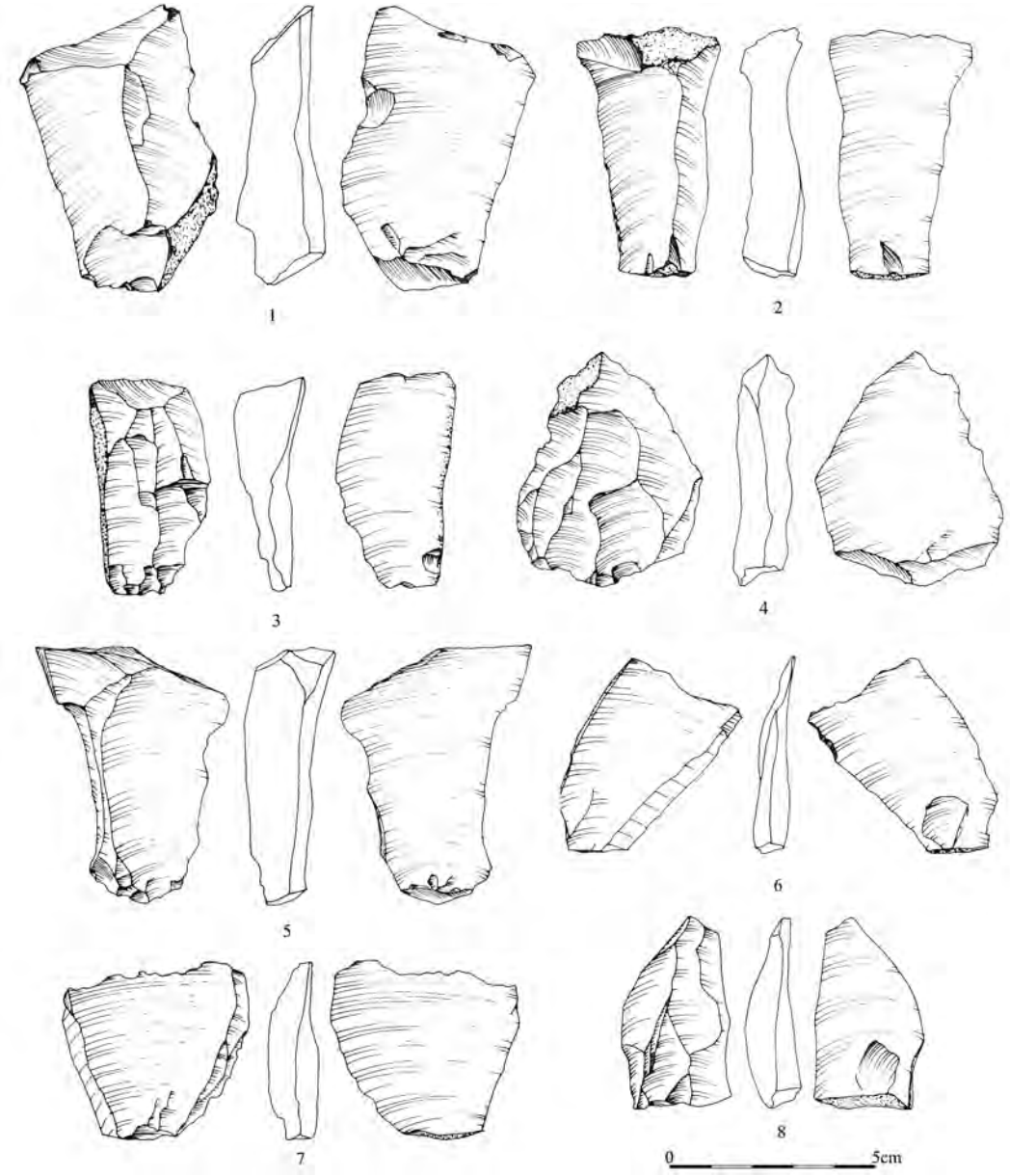

Fig. 9. Flake blanks from chocolate flint. Drawn: M. Sudoł-Procyk.

preparation flakes indicated that flint processing had been carried out at the site. The assemblages presented in this paper are the outcomes of the first stage of the research conducted, and further excavations in the Perspektywiczna Cave are expected to clarify their complex stratigraphic context.

An extremely interesting assemblage, largely based on chocolate flint, was encountered at a site identified in the course of field survey, located on the Góry Barańskie hills, near the village of Kleszczowa, situated within a distance of *c.* 2km west of the Udorka Valley (Fig. 1). Single and double platform blade cores (Fig. 12:1–3), accompanied by blade blanks and tools discovered there, allowed this site to be connected to the Late

Fig. 10. Flake blanks on the surface of one of the pits. Photo: M. Sudoł-Procyk.

Fig. 11. Choice of tools from chocolate flint: 1 – bifacial knife (Middle Palaeolithic, assemblage E from the Biśnik Cave, Olkusz dist.); 2–3 – perforators (Upper Palaeolithic, Perspektywiczna Cave, Olkusz dist.); 4 – core (Upper Palaeolithic, Perspektywiczna Cave, Olkusz dist.); 5 – blade (Late Palaeolithic, Perspektywiczna Cave, Olkusz dist.). Photo: M. Sudoł-Procyk.

Fig. 12. Choice of cores from chocolate flint (Late Palaeolithic period, Kleszczowa site, Zawiercie dist.). Photo: M. Sudoł-Procyk.

Palaeolithic period, possibly the Magdalenian. What is noteworthy is the high amount of waste products of core preparation, evidencing the production function of the site (Sudoł *et al.* 2016). Moreover, the resemblance of cores in the initial stages of exploitation obtained from the site in question to those found near the outcrops should be stressed, not only in terms of their morphology but also in respect of their state of preservation (comp. Figs. 8 and 12:3).

Conclusions

The chocolate flint outcrops in the Udorka Valley were undoubtedly of economic significance to prehistoric

communities. Utilisation of this raw material has been evidenced at numerous archaeological sites dated to the Palaeolithic, although the models of exploitation and distribution of this raw material in particular periods were different (Krajcarz *et al.* 2014; Sudoł *et al.* 2016). In the Middle Palaeolithic, Neanderthal flint knappers employed chocolate flint mostly for the most complex methods of flint processing, such as shaping knife-like bifacial tools and preparing Levallois cores. Localization of sites in spatial relation to flint outcrops seems to be of secondary significance in those times, whereas, the Upper and Late Palaeolithic sites linked to production functions were located in the close surroundings of flint outcrops.

The morphology of the extraction points of raw materials identified in the course of these studies indicates that the manner of obtaining chocolate flints in the Udorka Valley was completely different from that recognised at the Jurassic flint mines from the north-eastern margins of the Holy Cross Mountains (Budziszewski 2008). In the region studied here, it seems that the raw material was extracted through exploring small niches bored in the soil and regolith of the steep slope of the valley edge. Although the assemblages gathered so far do not enable the dating of this mining activity, the results of field survey conducted in this area indicate that at least part of it can be linked to the Palaeolithic period. The presumed manner of exploitation of raw material is not out of the ordinary with regard to such a distant past: there are studies reporting sites of this type dated even to the Middle Palaeolithic period (Vermeersch 2007).

The prehistoric mining site identified in the course of this research is relatively modest, and transformations in its ground relief took a quite trivial form. Having thoroughly analysed the Digital Terrain Model of the Udorka Valley, the investigators managed to identify similar, although even smaller, anomalies at several locations. Since the currently recognised areas of silicite extraction linked to the Palaeolithic period usually form local concentrations of prehistoric mining-related features (Vermeersch 2007; Barkai and Gopher 2009), it can be expected that the site presented in this paper is not the only one likely to be found over the extent of the Udorka Valley. Therefore, in spite of the dense forestation of the region making the task of searching for archaeological sites extremely difficult, such endeavours should most certainly be continued.

Acknowledgements

The research carried out in the Udorka Valley was inspired by investigations conducted under NCN (National Science Centre, Poland) grant no. 2011/01/N/HS3/01299, entitled *Palaeolithic settlement of Wodąca and Udorka Valley (Częstochowa Upland) against the palaeoenvironmental background*.

Further research, including the elaboration and interpretation of the ALS data obtained for locating chocolate flint outcrops in the Udorka Valley region, was conducted under NCN grant no. 2014/15/D/HS3/01302, entitled *Hunter-gatherer communities of the younger part of the Last Glaciation and Early Holocene in the middle part of Polish Jura – chronology, cultures and significance of the southern part of Ryczów Upland*.

Translated by Agnieszka Klimek

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