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THE NEOLITHIC CHOCOLATE FLINT MINE "OSZYBKA" IN PAKOSŁAW, MAZOWIECKIE VOIEVODESHIP, IN THE LIGHT OF THE SURVEY OF MARCIN BEDNARZ – NEW APPROACH TO OLD FIELDWALK MATERIALS

ABSTRAKT Kopalnia "Oszybka" w Pakosławiu województwo mazowieckie została odkryta w 1992 roku przez Marcina Bednarza w czasie badań powierzchniowych realizowanych przez studentów z Instytutu Archeologii Uniwersytetu Warszawskiego. W kolejnych trzech sezonach badawczych pozyskano około 1750 przedmiotów krzemiennych. Ten duży zbiór zawierał nie nie tylko charakterystyczne rdzenie, ale także produkty debitażu. Wstepne analizy materiału wskazywały na chronologię związaną z późnym mezolitm lub wczesnym neolitem. Po latach zespół archeologów z Instytutu Archeologii z Uniwersytetu Kardynała Stefana Wyszyńskiego z Warszawy powrócił do studiów nad tymi materiałami. Dzięki szczegółowej dokumentacji z lat 90-tych była możliwa digitalizacja i implementacja wyników do środowiska GIS. Rezultem tej procedury była możliwość analizy przestrzennej materiałów krzemiennych połączona ze studiami technologicznymi i typologicznymi.

Słowa kluczowe: kopalnie krzemienia, badania powierzchniowe, GIS, analizy przestrzenne, Marcin Bednarz

ABSTRACT The flint mine "Oszybka" in Pakosław, Mazowieckie voievodeship was discovered by Marcin Bednarz in 1992 during a field survey on an outcrop of chocolate flint conducted by students practice from Institute of Archaeology University of Warsaw. During the next three seasons about 1750 flint artifacts were collected from the site. This large assemblage contains not only the characteristic forms like cores but also debitage products. Initial research made it possible to determine the chronology of site as belonging to late Mesolithic and/or early Neolithic. Further studies were sadly interrupted by the premature death of Marcin Bednarz. After some years, according to Marcin wishes, team from the Institute of Archaeology Cardinal Stefan Wyszyński University in Warsaw returned to the studies of flint materials from the "Oszybka" flint mine. Thanks to very detailed documentation from the 90s of the last century has become possible to digitalize and integrate it into a GIS environment. As a result, we acquired many spatial analysis of flint materials and combined them with research in terms of technology and typology.

Keywords: Flint mining, fieldwalk survey, GIS application, spatial analysis

Introduction

Studies on the occurrence and exploitation of chocolate flint has a nearly 100-year tradition in Poland. The first pioneer research in the north-eastern margin of the Świętokrzyskie Mountains was conducted by J. Samsonowicz[1] and S. Krukowski[2] in the interwar period. Subsequent attempts to fully map the prehistoric mining sites located on the outcrop of chocolate flints were undertaken by R. Schild[3] and J. Budziszewski together with M. Bednarz[4]. The works of this last-mentioned researcher at the end of the XX century focused on the Iłża region. Unfortunately, due to the premature death of M. Bednarz, many of the materials he obtained were unpublished until today. Some of them went to the Institute of Archeology of the Cardinal Stefan Wyszyński University in Warsaw, where they are successively ordered and elaborated.

Some of the first materials, partially published by M. Bednarz, were the artefacts from the "Oszybka" chocolate flint mine in Pakosław, Iłża municipality, site No. 7 (AZP 79-68/56). This site is located on a massive butte of Jurassic rocks, part of the Iłża Foothils[5] (Fig.1). Numerous workshop materials and limestone debris are located at its peak and on the northern slope. In the years 1992-1994, M. Bednarz, along with students from the Institute of Archeology, University of Warsaw, carried out an extensive and detailed surface research

[1] Samsonowicz 1923, 1934.

[2] Krukowski 1920, 1922, 1939-1948.

[3] Schild 1971, 1976.

[4] Budziszewski, Bendarz 1994; Bednarz, Budziszewski 1997; Budziszewski 2008.

[5] Kondracki 2002: 272.

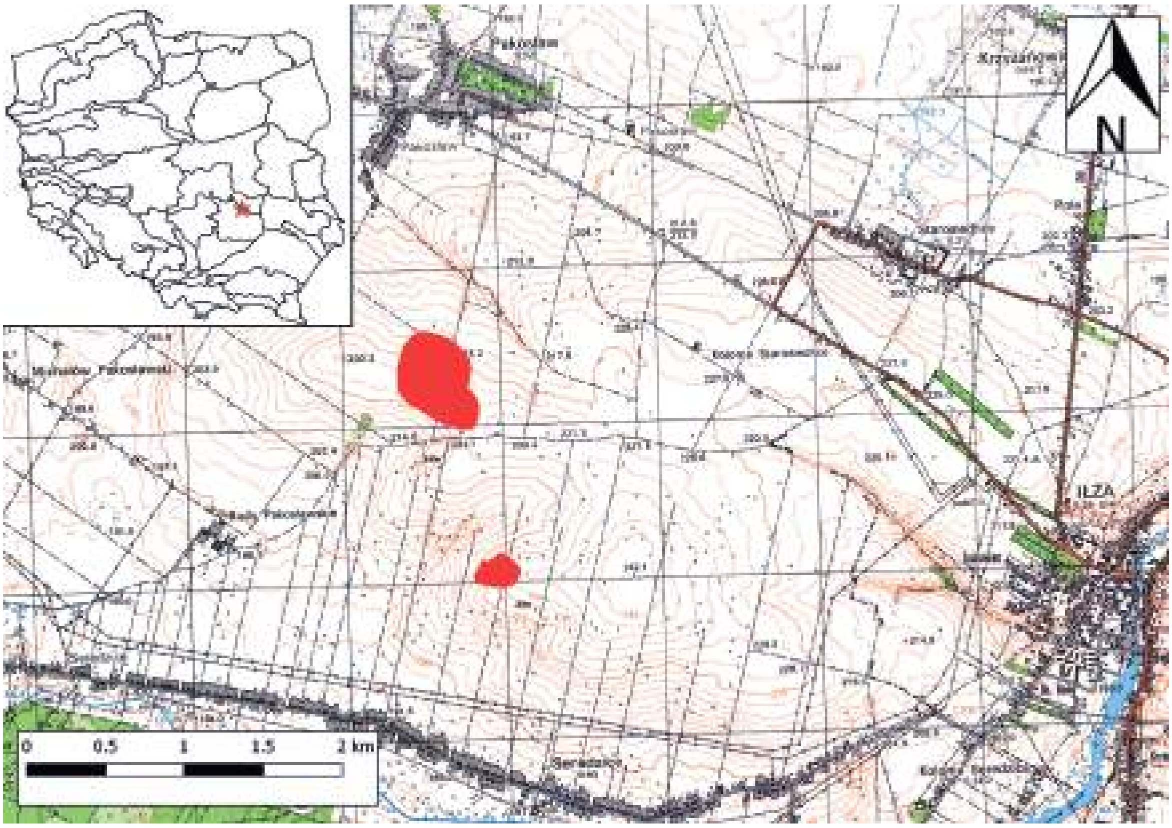

Fig. 1. Localization of chocolate flint mine "Oszybka" In Pakosław, Iłża municipality. Drawn by M.Szubski

on it. This extremely interesting exploitation site attracted their attention on account of the wealth of materials from the early Neolithic period[6]. Well-preserved materials and very detailed documentation of the findings encouraged to a reconsideration of its chronology, and a methodical analysis of the archival data. Despite the passage of years, it seemed possible to digitize the archives and integrate them into a GIS environment, and carry out reliable spatial analysis.

Method

The area of Iłża Foothills has been intensively used for agriculture since the early Middle Ages. As a result, the anthropogenic relief of all known prehistoric mining sites has been completely destroyed. Today, the sites are identified as flint mines on the basis of the character of their surface materials – a large number of flint-workshop artefacts and limestone debris. During surface surveys of such sites, various methods of material selection were adopted – from only mapping of identified artefacts, or collecting only distinctive forms, or materials from selected sample areas, to attempting to collect all the materials from the site[7]. During the research of the "Oszybka" site, Marcin Bednarz chose the extremely time-consuming option of collecting all artefacts from the bands defined by the reach of the collector's arms moving along lines crossing the site every 8-10 meters[8]. Each artefact or a group of artefacts discovered in the immediate vicinity, received an inventory number and its location was measured so that it could be plotted on a 1:1000 scale map. The preserved archives include all of the flint findings, mapped in the above manner on 5 sheets of a A3-size plotting paper. Subsequently, these plans were transferred to the official state registration maps (outline of the plots) in the scale of 1:5000. The inventory, including materials collected on the mining field, contained 1754 flint artefacts (Fig. 2) and was made in the form of a handwritten table.

Well-made cartographic documentation allows, even after years, to integrate this spatial date into a GIS environment. In order to prepare the basis of out spatial information, this documentation was subjected to multi-stage digitalization (Fig. 3).

[6] Bednarz 2001: 23-28, 35-38.

[7] Lech, Lech 1984; Libera, Zakościelna 1990; Bednarz, Budziszewski 1997; Schild 1991; Budziszewski 1990, 2000.

[8] Bednarz, Budziszewski 1997: 26.

These works can be divided into four stages:

Stage I

First in was necessary to complete the field documentation on paper done by M. Bednarz in the 1990s. It consisted of the maps made on plotting paper and the inventories of artefacts recorded in his notebooks.

Stage II

The second stage was to scan the maps in high resolution. These scans were pre-processed in graphic software, scaled and combined into one collective-map. The next step was the georeference of the generated raster files. The intersections between the borders of agricultural were used as control points. The georeference was carried out using the Helmert transformation in the QGIS software. The plan was saved in Geotiff format in the 1992 coordinate system (EPSG 2180). One challenge was the vectorization of all points on the map, due to the difficulty in deciphering some of the inventory numbers. However, by comparing the digitized map with its paper counterparts, all the numbers that raised any doubts were identified. The result was a creation of the points layer, containing an attribute table consisting of the inventory numbers and coordinates.

The original inventories of M. Bednarz containing the initial classification of flint materials were also rewritten into a spreadsheet. The inventory prepared in this way became the basis for re-development, during which the data was supplemented by macroscopic technological analyses. Particular attention was paid to the blades and blade-cores.

Stage III

The third stage was to combine the data obtained during stage II. The points layer containing the geographical coordinates of the artefacts and the prepared and supplemented inventory were transformed into CSV files (comma-separated values) allowing them to be linked, for example, in Microsoft Excel, Open Office or Libre Office software. This resulted in the creation of a merged points layer in CSV format. Subsequently transformed into the ESRI Shapefile layer, it became the basis for the database created in the QGIS software. This layer contained 1063 records (artefacts from the eastern part of the site). The geo-base, except the shapefile layer containing the developed inventory, also included a 1:1000 scale map, a 1:10 scale collective-map, topographic maps, developed ALS data and orthophotos.

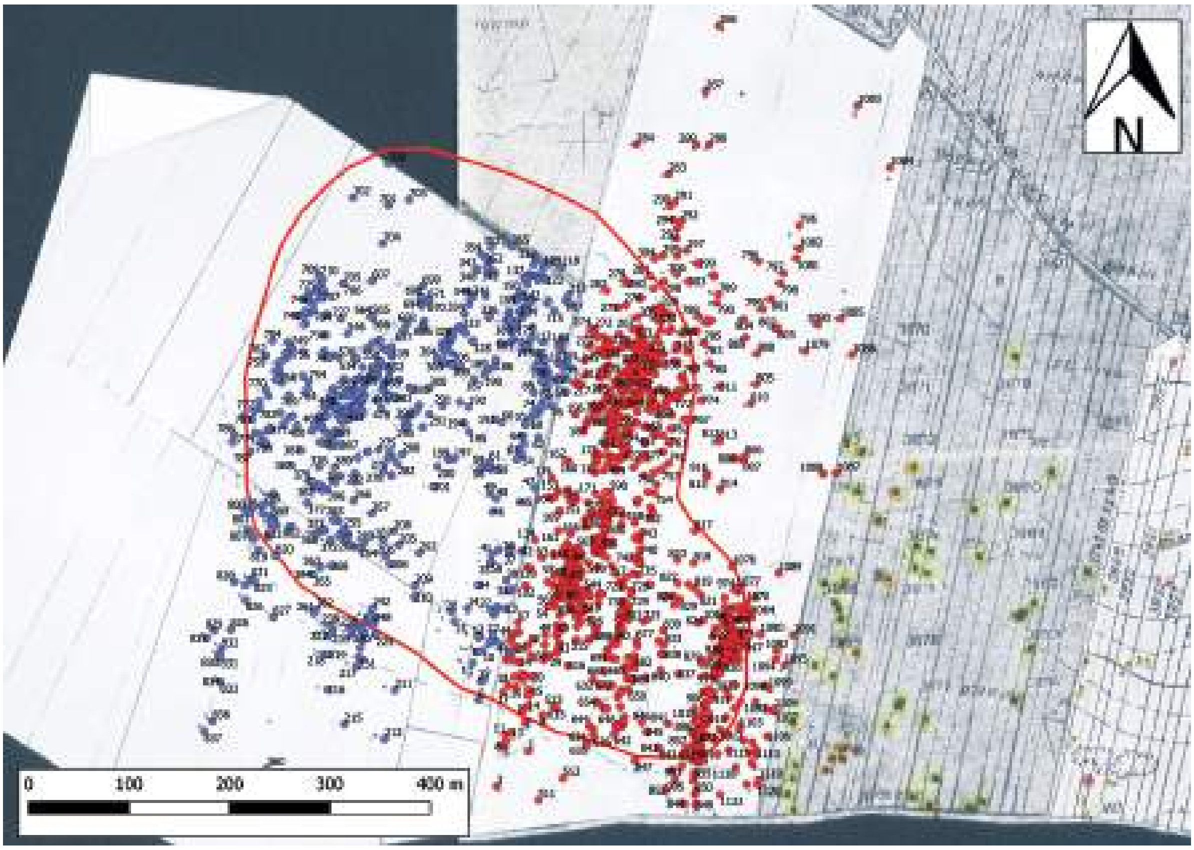

Fig. 2. Digitalized planigraphy of the site with all artefact location. Blue dots: western part of the site (not described), red dots: eastern part of the site (described in the paper). Drawn by M. Szubski

Stage IV

The final stage was the analysis and interpretation of the data contained in the GIS database. In addition to the correlation and comparison of various sources, the most important possibility offered by this technology is a spatial analysis. Thus, detailed planigraphy of artefacts was made, taking into account typological and chronological divisions, as well as analysis of the artefact's distribution density, allowing any clusters that occurred to be distinguished.

The difficulties we encountered are characteristic for working on the archival materials. The largest difficulty encountered was missing inventory numbers (no artefact, no number on the artefact), minor errors and illegibility of the documentation of the fragments. However, these were not problems that prevented work, and their number did not significantly affect the quality of the analysis.

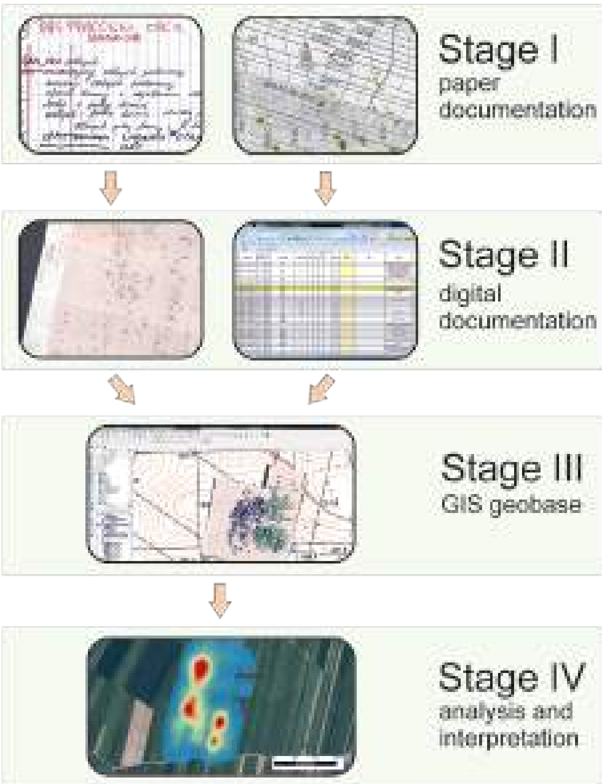

Fig. 3. Stages of work with archive data leading to GIS spatial database. Drawn by M. Jakubczak

Flint materials

The flint material obtained during the surface surveys of M. Bednarz included 1754 flint artefacts. The current study includes 1063 finds from the eastern part of the site (Fig. 2). These artefacts had a legible numbers and a field inventory in the form of a handwritten typological list. The remaining 691 artefacts originating from the western part of the site (Fig. 2) have no inventory number, and their numbers are duplicated with those from the eastern part. Organizing of this part of the collection requires much more time-consuming exertion. Before proceeding further, it was decided to make an analysis of that part of the material which was easily accessible.

The collected materials are clearly dominated by flake forms and waste, as chunks and chips (941 artefacts = 88%), which is characteristic for mining sites. A large part of them are a massive cortex and semi-cortical flakes of natural butts, derived from the preliminary flaking of cores and bifacial forms[9].

Other inventory groups are much more modest. Relatively many artefacts are blades (60 = 6%), originating mainly from a single platform cores. As in the case of flakes, the semi-cortical forms are most common among the blades. They are relatively short (up to 10 cm), with natural or prepared butts, with few percussions. They have relatively large, plain bulbs and a frequent scar, which may indicate a soft hummer percussion or a punch[10]. The shape of a blank blades suggests that it is associated with a early Neolithic flint working. However, in the case of flint-mine workshops, where most of the cores were only preliminary flaked, it is difficult to unambiguously determine.

The most interesting, and at the same time unique, artefact from the blade category is a massive semi-cortical specimen with features that indicate a direct percussion with hard hammer. The cortical surface creates its natural back, and the opposite edge is formed by careless retouch, which makes it a Zele-type knife[11] (Fig. 4: 10).

An extremely important element for learning the chronology of flint-mining sites are always a core-like forms, that are the best taxonomic determinants[12]. In the studied collection from the eastern part of the "Oszybka" site, 38 cores (4% of the inventory) were distinguished. Seventeen of them are a blade cores, mostly single-platform. Nine present the features of classical early Neolithic cores of the Danubian circle communities – single striking platform, exploitation of the narrow debitage surface, facetted active butt and flaking angel close to 90[13] (Fig. 4: 1-9). Discussion on the methods of distinguishing between Mesolithic

[9] Ginter 1974.
[10] Pelegrin 2006.
[11] Lech H. i J. 1984: 1984; Kruk 2007; Przeździecki et al. 2015.
[12] Budziszewski 2000: 33 – 36.
[13] Wąs 2011.

and Neolithic cores originating from this site have already been published by Marcin Bednarz[14]. Among the flake cores, three specimens are characteristic “Wierzbica-cores”[15] with a two-sided core edge exploitation (Fig. 4: 11). In the materials from the chocolate flint outcrop, they are usually associated with the early Bronze Age communities[16], although they can also be much younger[17]. Amorphous core forms (24 = 2%) are, above all, early forms of precores and flake cores difficult to distinguish taxonomically determination.

In the analyzed collection there are no finished tools and half made products. In contrast, in the inventory created by Marcin Bednarz, one unfinished arrowhead with a tang and three early half products of bifacial axes were recorded. Unfortunately, these artefacts have not been found and should be considered lost.

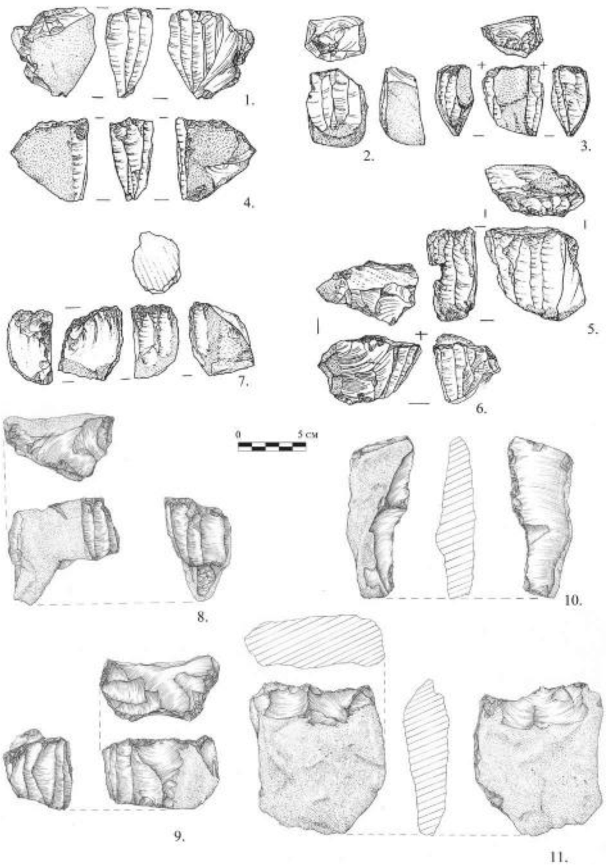

Fig. 4. Neolithic and Bronze Age flint materials.
1-9: single platform, Neolithic cores
(1-7 after M. Bednarz 2001: fig. 1 & 2);
10: “Zele-Knife”; 11: “Wierzbica-core”.
Drawn by M. Bednarz & M. Pelc

Spatial analysis

Three methods of artefacts clusters separation have been tested:

Determination of the number of artefacts per unit of area

This method has been used for a long time to determine clusters. It allows to generalize the planigraphy and present it in a simplified way. The mesh in which this analysis is performed should be adapted to the density of the material and to the size of the site. In our case, two grids were used with a mesh of 10x10 meters (Fig. 5A) and 20x20 meters (Fig. 5B). As can be seen in Figure 5, the analysis with the use of a 20-meter mesh simplifies planigraphy, but gives the possibility of easily recording of a large clusters of material. A definite disadvantage of this method is the relatively low accuracy in determining the boundaries of clusters.

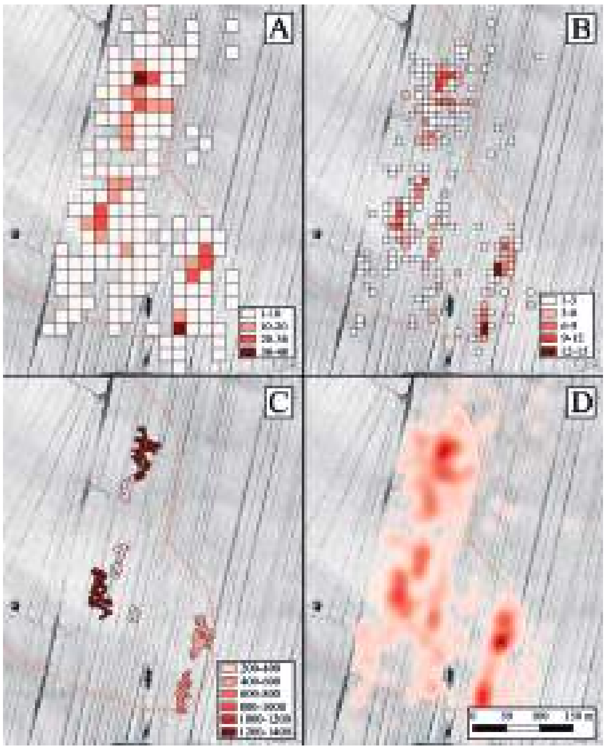

Fig. 5. Spatial analysis of flint materials from eastern part of the site: A – Determination of the number of artefacts per unit of area (vector mesh 20x20 m);
B – same as A (vector mesh 10x10 m);
C – Use of a 3m buffers; D – Density map.
Drawn by M. Jakubczak

Use of a buffers

A buffer with a diameter of 3 meters was created around each artefact. All buffers in contact with each other were aggregated to form polygons. The next step was adding a record to the attribute

[14] Bednarz 2001.
[15] Krukowski 1939-1948: 98-101.
[16] Budziszewski 1991; 1998; 2008.
[17] Cf. Migal 2005.

table containing the area of the particular polygon in square meters. The size values were divided into seven equal classes of 200 m2. Each class received a colour, the higher the value, the darker the red (Fig. 5C). In order to increase the clearance of the plan, polygons of less than 200 m2 have not been included. Both the size of the buffer, the number of classes and their span each time should be adjusted to the individual conditions of the site and the needs of the research.

Density map

Also called a thermal map, it is the visualization of the points density by the intensity of the colour increasing with the number of points. This is one of the most popular methods of cluster presentation. This type of map allows for very intuitive presentation of the artefacts location density. It is important, however, to match the radius (buffer) that is used in the analysis to meet the needs. Too large a radius obscured the image, too small does not give the desired effect. In this case, the radius was set to 20 meters for Figure 5D and 30 for Figure 6.

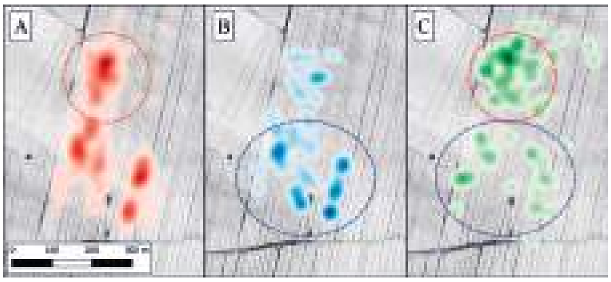

Fig. 6. Density map of the artefacts distribution: A: flakes, chips and technical chunks, B: blades and C: cores and core forms. Drawn by M. Jakubczak

The analysis of the artefacts distribution density was also applied to particular typological groups. The collection was divided into three groups – A: flakes, chips and technical chunks, B: blades and C: cores and core forms (Fig. 6). This allowed to distinguish the clusters associated with different technologies.

Results

Interpretation of the spatial analysis results revealed the existence of three clusters of materials in the eastern part of the "Oszybka" site (Fig. 5). They form an ellipsoidal concentrations extended north-south. Their layout is probably caused by the geological conditions. The course of rock layers in this area can be observed in aerial photography and data of airborne laser scanning. While, the "dilation" of clusters along the north-south axis can be associated with the direction of slope descent and the ploughing on modern fields.

These clusters, which should be interpreted as complexes of flint workshops, reveal the differentiation in terms of a composition of inventory groups. In the south and southeast workshops blades and blade cores predominate (Fig. 6). While an amorphous core-like forms and flake cores dominate in the northern cluster. This diversity is probably related to the nature of the workshops. Those in the southern part of the site seem to be associated with early Neolithic communities, and the purpose of their production was the single-platform, initial blade cores. In contrast, the northern part was exploited by much younger communities from the Bronze Age and – perhaps – the Iron Age, which used flake cores to obtain small flakes for arrowheads and produced a few bifacial tools.

Conclusions

The results of the spatial analyses obtained and the development of a part of the surface materials collection would not have been possible without the methodology of the work and the diligence shown towards documentation by Marcin Bednarz. Archival data of this quality can be successfully transferred to a GIS environment enabling precise spatial analyses and graphical presentation of the results. Spatial analyses with division into particular inventory groups revealed not only the character of the workshops located on studied site, but can also be a contribution to the discussion about the method of conducting a detailed surface surveys at sites related to the exploitation of flints. The collecting of core-like forms only makes it possible to determine the relative chronology of the mine, but does not allow for a clear determination of the flint workshops range. Thanks to the analysis of overlapping buffers (Fig. 5C), it is clearly visible how large distances are dividing the individual clusters of findings, separated by single artefacts. Thus, selective collecting of material is an opportunistic solution that does not allow a full recognition of the site. Thanks to the progressive development of GPS mobile technology, the best solution (although still extremely time-consuming) seems to be collecting only a distinctive core-like forms during the surface surveys. Whereas mass material, after initial classification, should be measured in the field, and the coordinates of its location analyzed in the GIS environment. Unfortunately, such a method would require conducting a surface surveys on prehistoric mining sites only by a specialists who can reliably classify the flint material.

Re-analyzed flint material, despite some deficiencies resulting from the time that passed from field research and the complicated fate of the collection, confirmed its Neolithic chronology postulated by Marcin Bednarz[18], as well as the extension of its functioning not only from the end of the Palaeolithic[19] to the early Bronze Age[20], but also to the final stage of this era and maybe even into the early Iron Age. The “Oszybka” flint mine in Pakosław, in terms of materials, seems to be very similar to the mines in Tomaszów, Szydłowiec district[21]. The research on our site is an another voice in the discussion on the Neolithic exploitation of chocolate flint by mining methods[22].

The results presented confirm the effectiveness of proposed analytical procedures. However, they did not exhaust the potential of materials from the mining field “Oszybka” collected by Marcin Bednarz. An inventory from the western part of the site is still waiting for the study. The results presented above indicate that it is worth taking the effort to fully develop it.

Translated by Tomasz Myśliwiec

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[18] Bednarz 2001.

[19] Bednarz 2001: 24.

[20] Budziszewski 2008: 61.

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[22] Cf. Małecka-Kukawka 2008.

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