ANTHROPOLOGIE
International Journal of Human Diversity and Evolution

**Special Issue:**
Focus on the lithics: raw materials and their utilisation during the Stone Age in Central Europe

**Guest Editors:**
Antonín Přichystal, Anne Hauzeur, Gerhard Trnka

ANTHROPOLOGIE • LV/1–2 • pp. 193–205 • 2017

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# USE-WEAR ANALYSIS APPLIED TO THE FLINTS FROM THE WIERZBICA "ZELE" MINE (POLAND)

*ABSTRACT: Wierzbica "Zele", Radom district, in Central Poland, is an important flint mining site from the Bronze Age and Early Iron Age. The site was excavated in the years 1980–1988 by Hanna and Jacek Lech. New excavations were carried out in 2012 and 2014. Archaeological works carried out in the eighties determined the character of the mining field, its natural stratigraphy and the variety of exploitation features; they also determined the period when the mine was most intensely exploited as dating to the Bronze Age and beginning of the Early Iron Age. 81 shafts and large exploitation pits were localized. The flint which was extracted here had the colour of dark chocolate and occurred in late Oxfordian limestone. The raw material has been given the general name chocolate flint of "Zele" type. The flint material obtained from fillings of individual features showed characteristics indicating exploitation by Mierzanowice culture communities of the Early Bronze Age. Radiocarbon dating indicates that some of the "Zele" shafts were dug by communities of the Lusatian culture from the early and middle phase. Analyses of workshops of Lusatian communities show that within the mine area mainly massive blade-flake blanks were produced.*

*In recent years, studies of flints from Wierzbica "Zele" have been augmented by use-wear analysis (microscope Zeiss-Axiotech). Use-wear analysis has been carried out on more than sixty specimens. Analyzed material was characterized morphologically as roughouts of projectile points, scaled pieces, side-scrapers and blade.*

*As a result of use-wear analysis several tools were identified as having served to scrape hides, cut meat or work bones/antlers. They occurred in the context of waste from exploitation of the shafts, indicating that the miners, after finishing their work, threw the unwanted remnants of their stay into the shafts/pits.*

*KEY WORDS: Use-wear analysis – Flint mining – Wierzbica "Zele" – Central Poland – Bronze Age*

## INTRODUCTION

Use-wear analysis, also referred to as traceology, is now accepted as a standard method of investigation of archaeological material, not only in the case of flint tools but also for organic (wood, shell, bones, etc.) and other lithic material. The method spread to many archaeological research centres in the world after the publication in 1957 of S. A. Semenov's work, and especially after its English language translation in 1964

Received 15 February 2016; accepted 11 August 2016.

(it is worth mentioning that the first articles written by Semenov on the this subject had appeared in the 1940s; see Korobkova 1999, Małecka-Kukawka 2001: 9–12, Longo, Skakun 2005: 8–9 and others). Since then, the microscopic method of identifying and interpreting traces of use observed on prehistoric tools has been applied in the investigation of a great variety of finds, with regard to chronology – from the Lower Palaeolithic to the Iron Age, with regard to numbers – from single artifacts to collections counting several thousand pieces, and with regard to the context of the find – settlements, graves, collective finds. In the case of flint material from flint mines, the method has only been applied marginally and, though the Polish practice in this area is limited, certain general deductions can be drawn and can serve as hypotheses to be verified in future research. It would seem that in the case of mass material from flint mines, it is necessary to consider not only the possible use of certain artifacts but also, to a greater degree than usual, post-depositional processes and events, including methods of exploration, transport and storage of archaeological material.

Certain uses of flint artifacts suggested in literature on the subject, pertaining to flint specimens from the Late Bronze and Early Iron Ages (e.g. their ritual and therefore incidental and short lasting use), would indicate the inefficacy of this method in some cases. Nevertheless, it seems that use-wear investigations are one way of avoiding erroneous descriptions, which might distort the true picture of the analyzed material (Małecka-Kukawka 2011: 139–147). In this regard, flint material from mines poses unique challenges. We present them here using finds from the Wierzbica "Zele" flint mine in the district of Radom as case studies.

In 2010 J. Lech and D. H. Werra studied flint material obtained during excavations of the Wierzbice "Zele" mine, carried out in 1980–1982 and 1985–1988 by Hanna Lech and in 1983 by Jacek Lech. Their research included use-wear analyses, providing information about the traces of wear identified on selected flint pieces. The work, using a Zeiss-Axiotech microscope, was carried out at the Laboratory of Traceology of the Institute of Archaeology, Nicolaus Copernicus University in Toruń.

**Wierzbica "Zele" (Radom District) – "chocolate" flint prehistoric flint mine**

The prehistoric mine of chocolate flint at the sacred spot (*uroczysko*) of "Zele" in Wierzbica, Radom district, is one of the most important archaeological sites associated with flint studies in the Late Bronze Age and Early Iron Age in Poland and in Europe (*Figure 1*). *Uroczysko* "Zele" as an archaeological site was first discovered by S. Krukowski in the interwar period but only appeared in archaeological literature in the 1970s. Excavations carried out in the 1980s determined the character of the mining field, its natural stratigraphy and the different mining features. It was


FIGURE 1. Prehitoric flint minig in the Bronze Age 1, Wierzbica "Zele"; 2, Krasnesiolo; 3, Rybniki-Krzemianka; 4, Grimes Graves; 5, Bečov; 6, the Krumlov Forest mines.

found that the most intensive exploitation took place in the Bronze Age and Early Iron Age (Schild 1971: 34–35, 1980: 581, Lech 1980: 39, 1982: 64–67, Młynarczyk 1983: 105, Lech, Lech 1984, 1995, 1997a, 1997b: 92–97, Lech *et al*. 2011).

The "Zele" mining field covers an area of 1.4–1.8 ha and is shaped like an elongated ellipse with its major axis of 270 m lying along a south east – north west line, while its minor axis runs south west – north east and measures 50–60 m. It therefore takes up about 15 percent of today's archaeological site (*Figure 2*). The exploitation of flint resulted in a characteristic pitted landscape, the remains of shafts and waste heaps. These were preserved for many years by a cover of forest but were levelled when the site was turned to agricultural use. Systematic surface excavations of the whole area were carried out in the autumn of 1979, followed by underground excavations over an area of 2180 m in the next years. 81 shafts and large exploitation pits were discovered and most of the flint material now being studied comes from those features (Młynarczyk 1983, Lech, Lech 1984, 1995, 1997a, 1997b, Lech *et al*. 2011).

Shaft no. 17, in the south-east part of the exploitation field, comes from the Bronze Age. The flint material from the shaft filling has been attributed by radiocarbon dating and certain characteristic traits to communities of the Mierzanowice culture (*Table 1*). A that time miners looked, first of all, for small flattened nodules which could be used to produce bifacial core tools, primarily bifacial axes and chisels of various types. Knives and sickles were also probably prepared using the bifacial technique (Lech 1982: 64–67, Młynarczyk 1983: 107–110, Lech *et al*. 2011).

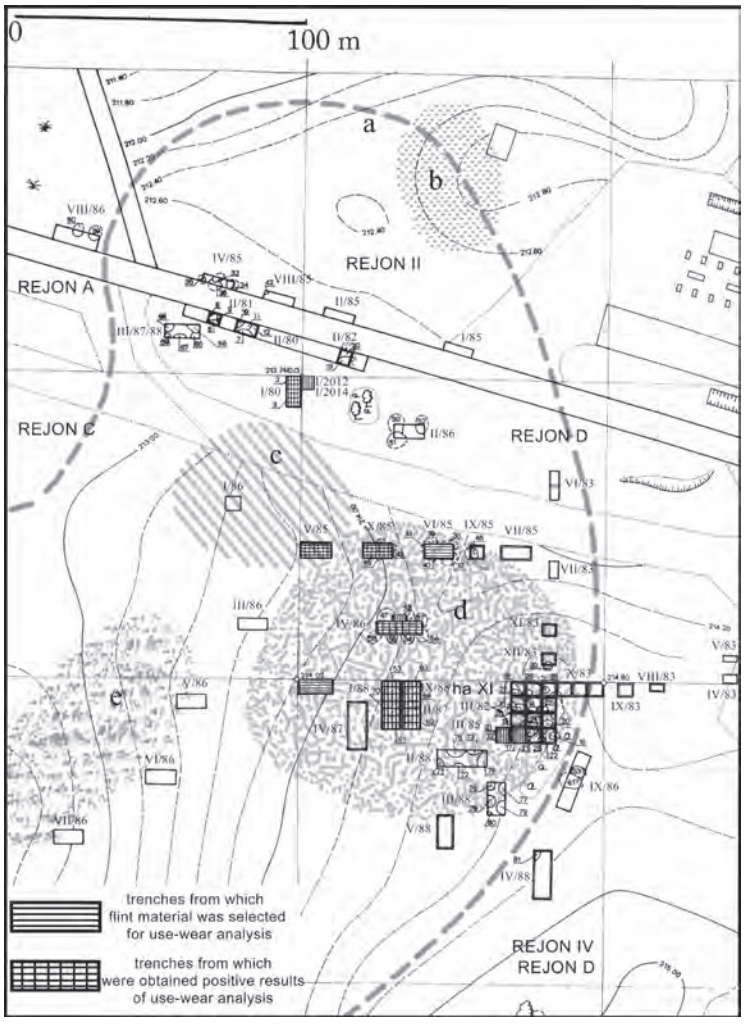


FIGURE 2. Wierzbica "Zele", Radom District. Map showing the extent of the site. A, archaeological cuttings 1980–2014, differentiation of the surface material; b, Mesolithic finds unconnected with the mine; c, area with pieces flaked by bipolar technique; d, area of frequent occurrence of cores, pre-cores, blades and fragments; e, area dominated by bifacial tool roughouts (after Młynarczyk 1983: Fig. 3; Lech 1997a: Fig. 1).

TABLE 1. Flint mine Wierzbica " Zele". Radiocarbon dating (charcoal samples only; after Lech *et al*. 2011).

| Shaft number | Depth of sample | Laboratory number of sample | Conventional dating bp | Dating in calibrated years BC – level of probability 68% |
|---|---|---|---|---|
| *Dating of north-west part of the mining field* | | | | |
| 19 | 400–410 cm | OxA-5101 | 2780±45 bp | 984–873 cal BC |
| 20 | 340 cm | BM-2383 | 3150±80 bp | 1509–1328 cal BC |
| *Dating of south-east part of the mining field* | | | | |
| 17 | 100–10 cm | GrN-11 852 | 3680±70 bp | 2188–1980 cal BC |
| 17 | 215 cm | GrN-11 853 | 3570±90 bp | 2071–1799 cal BC |
| 17 | 300–310 cm | GrN-11 854 | 3670±60 bp | 2162–1978 cal BC |
| 18 | 82–85 cm | GrN-11 856 | 2670±60 bp | 894–810 cal BC |
| 28 | 330–350 cm | BM-2385 | 2750±70 bp | 989–847 cal BC |
| 28 | 330–350 cm | BM-2385A | 2780±80 bp | 1054–863 cal BC |
| 28 | 430–450 cm | BM-2386 | 2890±110 bp | 1254–955 cal BC |
| 28 | 430–450 cm | BM-2386A | 2800±100 bp | 1134–876 cal BC |

Radiocarbon dating indicates that some of the "Zele" shafts resulted from the activity of miners belonging to Lusatian communities (Lech, Lech 1984: 194, 196–198, 1995: 475–479, 1997a: 102–107) and can be attributed to their early and middle phases. Further research is needed to determine the purpose of this production. Studies so far indicate that the workshops of Lusatian communities located within the area of the mine produced massive blade-flake blanks. Bifacial sickles, known from various parts of northern Europe, may also have been knapped there (Młynarczyk 1983: 106–108, Lech 1987: 107–110, Lech *et al*. 2011).

The flint material from "Zele" attributed to Lusatian communities from the end of the Bronze Age, included a specific type of lithic industry, characterized by the production of large massive knives, which had a long and very sharp working edge and an opposing blunt edge, either natural or retouched. The knives were knapped from big blade blanks, blade-flake blanks and flake blanks obtained from large irregular cores. If the piece had a natural blunt back, preferably with cortex, no further work was done. Otherwise, the back was shaped by retouching, with great care and sometimes in several stages. The backed knives produced in this way, occurring in several versions, are a characteristic artifact of the "Zele" industry of Lusatian communities. They were first remarked on in 1983, during excavations of shaft no. 28 and the surrounding area. Since no comparable knives were found elsewhere, in other industries in Poland or neighbouring countries, they were designated backed knives of the "Zele" type (Lech, Lech 1984: 195, 1997a: 107–111). Recent studies have shown that Lusatian communities made use of flint and, applying various knapping techniques, produced a variety of backed forms, with natural or retouched backs, similar in concept to backed knives of "Zele" type. Use-wear analysis shows these backed forms to have been used in almost one hundred percent of cases as inserts for harvesting implements (see Bronowicki, Masojć 2008, Małecka-Kukawka 2008).

**Flint material from the Wierzbice "Zele" mine**

So far researchers have examined about 13,000 flint artifacts from excavations carried out at the site in the 1980s, in 2012 and 2014 (37,300 together with natural pieces). The analyzed material came both from mine features and from archaeological cuttings in which shafts were registered and from those in which mine features were not noted – from an area demarcated by H. Młynarczyk (1983: 89) which was characterized by the frequent occurrence of cores, blades and their fragments (cutting V/85; X/85; VI/85; IV/86; IX/86; I/87; I/88; II/87) and from an area lying to the north of the region where scaled pieces occurred frequently (cutting I/80; I/2012 and I/2014; *Figure 2*).

The flint material has been divided into four inventories according to a classification list prepared for the Wierzbica "Zele" mine, taking into account weight (Dzieduszycka-Machnikowa, Lech 1976). As the work progresses some pieces are set aside for use-wear analysis, chosen on the basis of macroscopic evaluation. The specimens come from all four inventory groups but the fewest specimens were taken from group I (Natural nodules, initial forms and cores) while all the pieces from group IV (Implements) were

taken for use-wear analysis. However, it should be mentioned that specimens from this group are least often registered at flint mine sites. In the material analyzed so far, the fourth group comprises only 0.42%.

When selecting material for use-wear verification, the foremost criterion was the form and presence of retouch. Also included were blades, flakes and their fragments with a clearly distinguishable edge. Another criterion for further analysis was the presence of pseudo-retouch. This was in accordance with the methodology presented in the article which appeared in Archeologia Polski (Małecka-Kukawka, Werra 2011). On the basis of analyses of material from the Neolithic flint mine in Sąspów, it was recognized that in the case of mass flint material from mines not only the possible use of some artifacts should be taken into account but also, to a greater degree, post-depositional processes and events, such as excavation methods, transport and storing of excavated finds (Małecka-Kukawka, Werra 2011: 135).

From the region lying to the north of the area where scaled pieces were frequent (area I; *Figure 2*), flint artifacts came both from cutting I, excavated in 1980, and from excavations in 2012 and 2014. The latter excavations were carried out in the direct vicinity of cutting I/80 and will, therefore, be presented jointly.

From this region 2,888 flint artifacts were analyzed and 15 pieces (0.52%) were selected for use-wear analysis. Three specimens were found to have traces of use. The selected specimens were mostly blade fragments, flakes and morphological tools (scraper, perforator, side-scraper and retouched flake).

Cores, blades and their fragments occurred frequently in area II (*Figure 2*). From this area 48

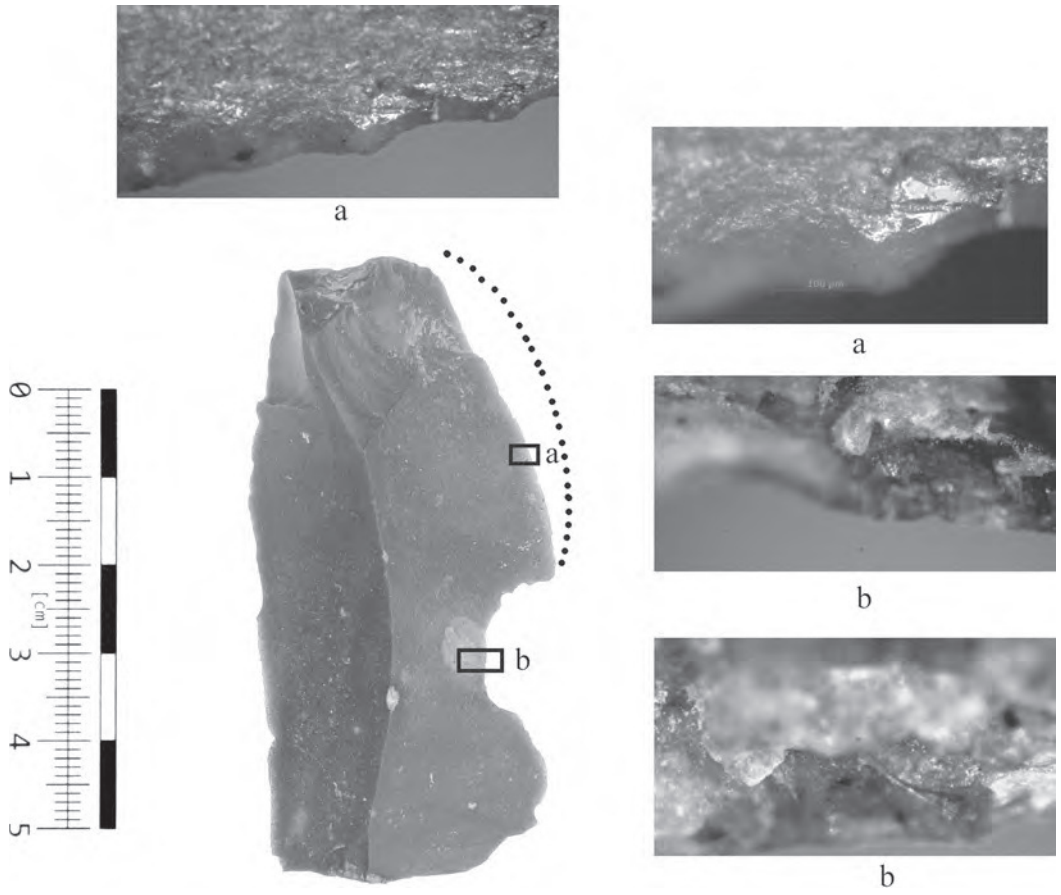


FIGURE 3. Wierzbica "Zele", Radom district. Morphologically a blade with broken off tip with niche, functionally – on fragment of cutting edge traces of cutting meat or hide: a, micropolish of cutting edge; b, ?; objective 10× (Photo J. Małecka-Kukawka; W. Ochotny).

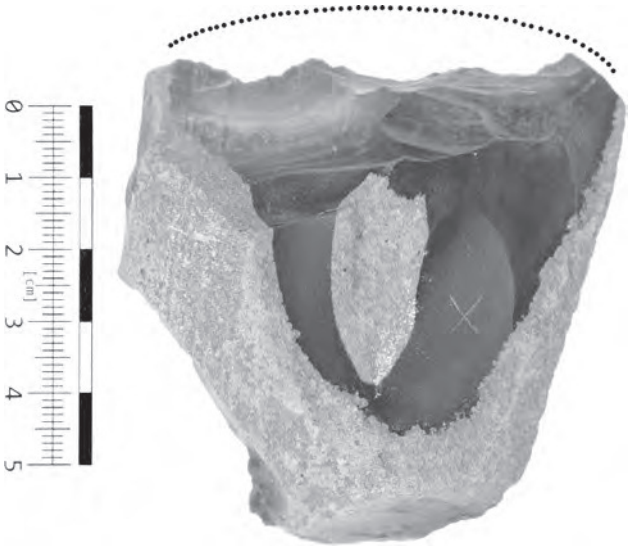

FIGURE 4. Wierzbica "Zele", Radom district. Morphologic side-scraper, functional scraper for abrasive material (Photo W. Ochotny).

specimens (0.49%) out of 9,896 flint artifacts were selected for microscopic analysis; 21 showed traces of use. The material came from cuttings nos. XI and XII from excavations in 1983, IV, V, VI and X in 1985, IV and IX in 1986, I and II in 1987, and no. I in 1988, as well as shafts 17, 30, 28, 53 and 54.

As in the case of material from area I, the analyzed specimens represented all four inventory groups, though in different proportions. They included scaled pieces, early roughouts of bifacial tools, flakes and flake fragments, a side crested blade and flakes. The tools included mainly end-scrapers, side-scrapers, projectile point roughouts, perforators and blade with continuous retouch.

**Results of use-wear analysis**

From among the fifteen analyzed specimens selected from area I, three showed traces of use (*Table 2*). The flake showed traces resulting from brief scraping of a hard material. A knife was found to have traces resulting from cutting meat. As in the first case, the traces indicated only brief use. In one case the presence of bands of shining micropolish on the edge of a flake were registered, but these traces were probably the result of post-depositional processes.

21 specimens with signs of use-wear were picked out from area II, both from features and cuttings. Most traces of use were noted on flakes, which were utilized primarily for work on hard (abrasive) material, to process bones/antlers, meat and hides (*Table 2*). One specimen showed traces of being used on ochre (Małecka-Kukawka *et al*. 2016). Two blades had traces characteristic for tools used to cut meat/hides. One of them, with broken off tip and a deep niche along one edge (post-depositional) shows clear signs of use (*Figure 3*).

We should note the typological tools which were examined. Morphologic side-scrapers served to scrape abrasive material, most probably clay, and to scrape bones/antlers (*Figure 4*). A very patinated blade with continuous retouch showed traces of having been used to work bones/antlers (*Figure 5*). A typological perforator served to make holes in hides (*Figure 6*), while a morphological borer was used for wood.

The selected end-scrapers showed signs typical for working bones/antlers and hides. A typological scraper was used for work with a hard (abrasive?) material and analysis of a side crested blade had evidence of being used to work hides.

Of special interest are two roughouts of projectile points (*Figure 7, 8*). Microscope analysis showed that their whole surface, the ridges between negative scars on the surface and on the side edges are smoothed and slightly polished. The traces on the side edges resemble marks made from scraping hides. However, here the

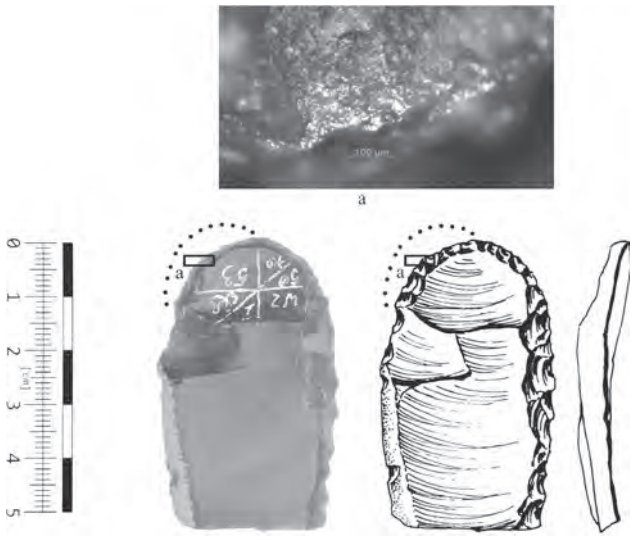

FIGURE 5. Wierzbica "Zele", Radom district. Morphologic blade with continuous retouch, with traces of scraping bone/antler, objective 10× (Photo J. Małecka-Kukawka; W. Ochotny; Draw E. Gumińska).

TABLE 2. Wierzbica "Zele", Radom district. Results of functional designations for selected flint artifacts. * Morphological groups: I. Natural nodules, roughouts, cores; II. Blades and their fragments; III. Flakes and waste; IV. Implements.

| No. | Shaft/ trench no/ year of excavations | Depth (cm) | Inventory no. | Morphological group* | Morphological description | Functions according to use-wear analysis |
|---|---|---|---|---|---|---|
| | | | | AREA I | | |
| 1 | I/1980 | 110–130 | 163 | II | blade fragment | no traces of use |
| 2 | I/1980 | 0–20 | 1 | III | flake | scraper for abrasive material, shortly used |
| 3 | I/1980 | 0–20 | 1 | III | flake | no traces of use |
| 4 | I/1980 | 110–130 | 83 | III | flake | on the edge post-depositional retouch, no traces of use |
| 5 | I/1980 | 110–130 | 287 | III | flake | no traces of use, only post-depositional smoothes |
| 6 | I/1980 | 170–190 | 228 | III | flake | no traces of use |
| 7 | I/2012 | 20–30 | 8 | III | flake | no traces of use |
| 8 | I/2012 | 20–30 | 8 | III | flake | no traces of use |
| 9 | I/2012 | 20–30 | 8 | III | flake | no traces of use |
| 10 | I/2012 | 20–30 | 11 | III | flake | no traces of use |
| 11 | I/2012 | 20–30 | 13 | III | flake | no traces of use |
| 12 | I/2012 | 0–20 | 23 | III | flake | on the edge traces of smoothes – post-depositional |
| 13 | I/2012 | 20–30 | 8 | III | flake | no traces of use |
| 14 | I/2012 | 20–30 | 8 | III | flake | no traces of use |
| 15 | I/2012 | 10–20 | 6 | III | flake | knife for cutting meat (?) – shortly used |
| | | | | AREA II | | |
| 1 | 17/II/1983 | 0–20 | 7 | IV | flake | on one edge traces of use; for abrasive material |
| 2 | 17/II/1983 | 0–20 | 7 | III | flake | Side-scraper for ochre |
| 3 | 17/II/1983 | 0–20 | 7 | III | flake | burin with traces of working in wood or in bone/antler |
| 4 | 17/II/1983 | 0–20 | 7 | III | flake | side-scraper for hide |
| 5 | 17/II/1983 | 0–20 | 7 | III | flake | on the edge a niche – post-depositional – which damage working edge side-scraper for bone/antler |
| 6 | 17/II/1983 | 0–20 | 7 | III | flake | no traces of use, on one edge damage post-depositional |
| 7 | 17/II/1983 | 0–20 | 7 | III | flake | knife for cutting meat (?) – shortly used |
| 8 | 17/II/1983 | 0–20 | 7 | III | flake | no traces of use, post-depositional damage |
| 9 | 17/II/1983 | 0–20 | 7 | IV | endscraper on a blade | side-scraper for bone/antler; traces of use on endscraper front and on side edges; on the other side post-depositional damage |
| 10 | 31/III/1985 | 150–170 | 11 | III | flake | no traces of use |
| 11 | 53/II/1987 | 50–70 | 53 | IV | side-scraper | tool for scraping bones/antler |
| 12 | 53/II/1987 | 70–90 | 23 | II | side crested blade | perforator for hide |
| 13 | 54/IV/1986 | 90–100 | 4 | III | flake | no traces of use |
| 14 | 54/IV/1986 | 90–100 | 4 | III | flake | no traces of use |
| 15 | 56/IV/1986 | 100–110 | 11 | IV | endscraper | on endscraper front weak traces after working in hide; shortly used |
| 16 | 58/III/1985 | 150–170 | 11 | IV | side-scraper | no traces of use |
| 17 | III/1985 | 100–120 | 7 | I | scaled pieces | no traces of use |
| 18 | V/1985 | 20–40 | 1 | III | flake | no traces of use, on the tip modern crushing |

TABLE 2. Continued.

| No. | Shaft/ trench no/ year of excavations | Depth (cm) | Inventory no. | Morphological group* | Morphological description | Functions according to use-wear analysis |
|---|---|---|---|---|---|---|
| 19 | V/1985 | 20–40 | 1 | III | flake partially initial | the specimen has smoothed ridges between negative scars and smoothed side edge, post-depositional damage; no traces of use |
| 20 | V/1985 | 40–50 | 3 | IV | roughout of projectile points | functionally the specimen has smoothed ridges between negative scars and smoothed side edge; smoothing of edges and gloss resemble traces left from scraping hide (*Figure 7*) |
| 21 | V/1985 | 40–50 | 3 | IV | roughout of projectile points | functionally the specimen has smoothed ridges between negative scars and smoothed side edge; smoothing of edges and gloss resemble traces left from scraping hide (*Figure 8*) |
| 22 | V/1985 | 40–50 | 3 | III | flake | scraper for abrasive material, edge is partly damage |
| 23 | X/1985 | 20–30 | 114 | IV | side-scraper | scraper for abrasive material (probably clay), visible are soothes (*Figure 4*) |
| 24 | X/1985 | 20–40 | 114 | I | scaled pieces | no traces of use, visible are marks from knapping |
| 25 | X/1985 | 40 | 115 | III | flake | side-scraper of abrasive material |
| 26 | X/1985 | 40–60 | 114 | I | scaled pieces | no traces of use, visible are marks from crushing; a core (?) or a tool chock (?) |
| 27 | IV/1986 | 90–100 | 1 | III | flake | no traces of use |
| 28 | IV/1986 | 90–100 | 1 | III | flake | no traces of use |
| 29 | I/1987 | 0–20 | 2 | III | flake | abrasive "coating" on the surface of a product, rounded edges (post-depositional?) |
| 30 | I/1987 | 40–50 | 5 | III | flake | no traces of use |
| 31 | II/1987 | 0–20 | 9 | IV | borer on a flake | borer for wood |
| 32 | II/1987 | 0–20 | 11 | IV | endscraper | no traces of use |
| 33 | II/1987 | 0–20 | 7 | III | flake | no traces of use; on the edge post-depositional damages |
| 34 | II/1987 | 0–20 | 7 | II | blade | no traces of use, on the surface post-depositional smoothes |
| 35 | II/1987 | 20–40 | 15 | I | roughout of bifacial tool | visible are only marks from knapping with hard hammer |
| 36 | II/1987 | 20–40 | 10 | I | scaled pieces | |
| 37 | II/1987 | 20–40 | 10 | I | scaled pieces | no traces of use; visible only damage from knapping |
| 38 | II/1987 | 20–40 | 10 | I | scaled pieces | |
| 39 | II/1987 | 20–40 | 18 | I | scaled pieces | |
| 40 | II/1987 | 20–40 | 13 | III | flake | side-scraper for abrasive material |
| 41 | II/1987 | 40–50 | 12 | IV | perforator | Used for making holes in hide (*Figure 6*) |
| 42 | II/1987 | 40–50 | 11 | II | blade with broken tip | with deep niche on one edge; Niche is random – post depositional; on fragment of preserved cutting edge traces of cutting meat or hide (*Figure 3*) |
| 43 | II/1987 | 40–50 | 11 | III | flake | no traces of use |

TABLE 2. Continued.

| No. | Shaft/ trench no/ year of excavations | Depth (cm) | Inventory no. | Morphological group* | Morphological description | Functions according to use-wear analysis |
|---|---|---|---|---|---|---|
| 44 | II/1987 | 40–50 | 12 | II | blade with negative flake scars on the dorsal surface | side-scraper/knife for wood |
| 45 | II/1987 | 50–70 | 21 | I | scaled pieces | no traces of use; visible only damage from knapping |
| 46 | II/1987 | 50–70 | 18 | I | scaled pieces | |
| 47 | II/1987 | 70–80 | 23 | I | roughout of bifacial tool | no traces of use |
| 48 | I/1988 | 50–70 | 53 | IV | blade with continuous retouch | patinated; visible traces of use for work in bone/antler (*Figure 5*) |

whole surface of the points is polished, suggesting they may have been carried for long periods in leather covers and /or often held in the hand.

**Conclusions**

The use-wear analysis of mass flint material from flint mines raises the question of whether there is sense in performing microscopic analysis of flints collected in massive numbers from shafts, knapping floors, waste heaps and other features associated with flint mining. The first positive results of use-wear analyses for this type of flint material were presented in 2011 (Małecka-Kukawka, Werra 2011) and concerned material obtained in excavations of the mine at Saspów, Kraków district in 1962 (Dzieduszycka-Machnikowa 1964, Klimek 2008). The results made it possible to eliminate

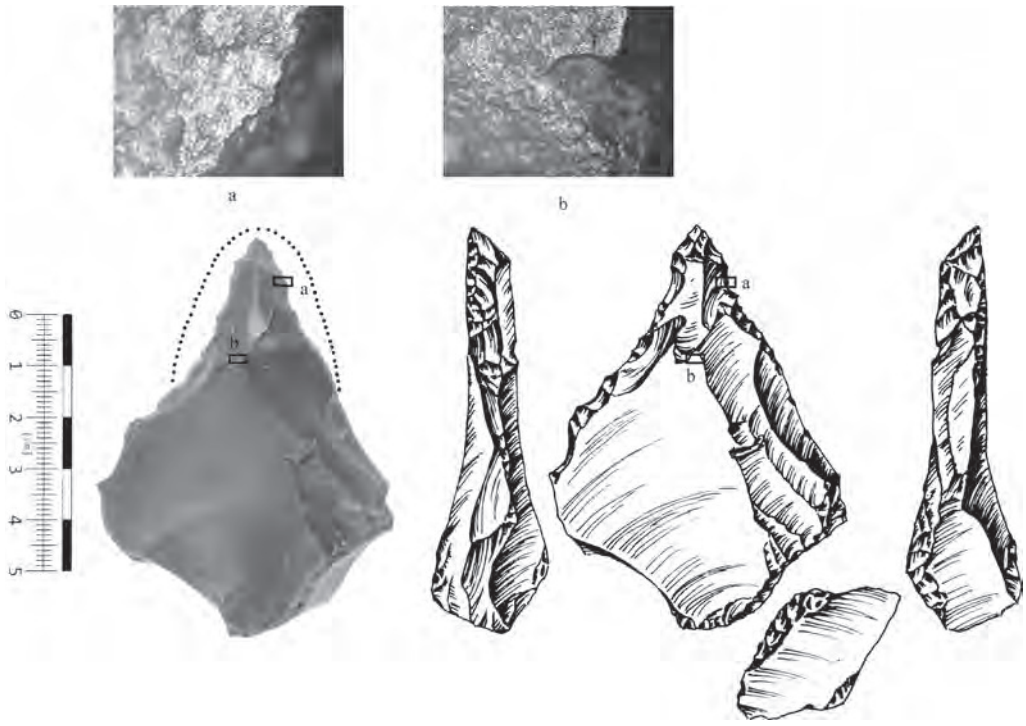


FIGURE 6. Wierzbica "Zele", Radom district. Morphologically a perforator, functionally a perforator for leather: a, micropolish in a line with cutting edge; b,? objective 5× (Photo J. Małecka-Kukawka; W. Ochotny; Draw E. Gumińska).

potential errors when qualifying certain specimens and, first and foremost, brought to light the existence of tools that evidently served specific functions (Małecka-Kukawka, Werra 2011: Table 1). These were, first of all, scrapers for abrasive material, probably weathered clay, i.e. tools associated with excavation work. Tools with traces of having been used to work wood and bone/antler were also noted. Morphological tools selected during archaeological excavations (Dzieduszycka-Machnikowa, Lech 1976) were analyzed using the use-wear method and it was found that of 48 typological tools only two specimens showed no traces of use (Małecka-Kukawka 2014: 191). The remaining tools showed signs of work with wood or bone/antler (Małecka-Kukawka 2014: 193).

The positive results obtained in studies of the Sąspów material are reflected in the use-wear analyses carried out on material from the Wierzbice "Zele" mine. First of all, the presence of implements for work with abrasive material was noted. Such tools were earlier distinguished intuitively, on the basis of macroscopic observation of various types of retouch. These are tools specifically used for earthen works or for removing clay from flint nodules (Lech 1981, Schild *et al*. 1985). Secondly, the presence of tools for processing hide and working wood and bones/antlers or cutting meat was also registered. Whereas the first type of tool can evidently be associated with excavating for flint, the second allows us to learn more about miner activities on the mine site that were not directly connected with digging and extraction of flint.

The tools which were found together with shaft exploitation waste indicate that miners who had finished work on the mine site threw the implements they had been using into the pits. Similar observations were made in the case of Neolithic material from the flint mine at Sąspów (Dzieduszycka-Machnikowa, Lech 1976: 122–123). This would show that in spite of differences in the way the raw material was exploited and despite cultural and chronological differences, we may be looking at similar human behavior (Oliva 2004: 506, 2010: 327–329, Lech *et al*. 2015). This leads us towards, on the one hand, ritual and magic practices and, on the other, towards identifying Braudel's structures of *longue durée* (Małecka-Kukawka 2014: 200).

The artifacts made from "Zele" chocolate flint, early roughouts, fragments of flint sickles and "Zele" type

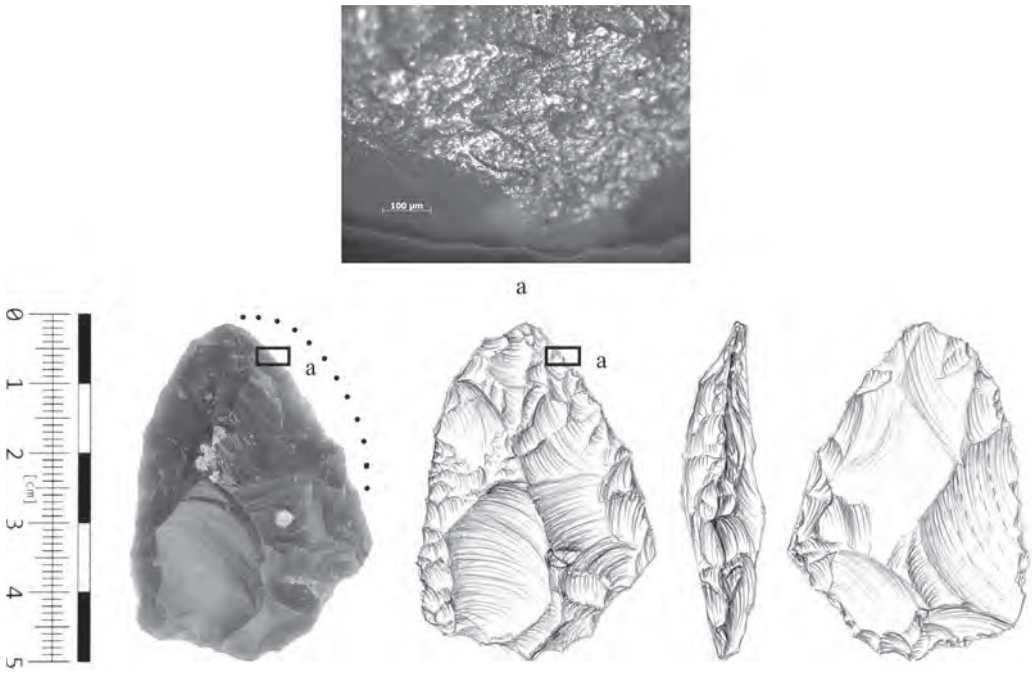


FIGURE 7. Wierzbica "Zele", Radom district. Morphologic roughouts of projectile points. all edges are smoothed over in the same way, which can be explained as a result of long term carrying of the tool in a leather pouch and/or frequent manual handling of the tool, objective 10× (Photo J. Małecka-Kukawka; W. Ochotny; Draw E. Gumińska).

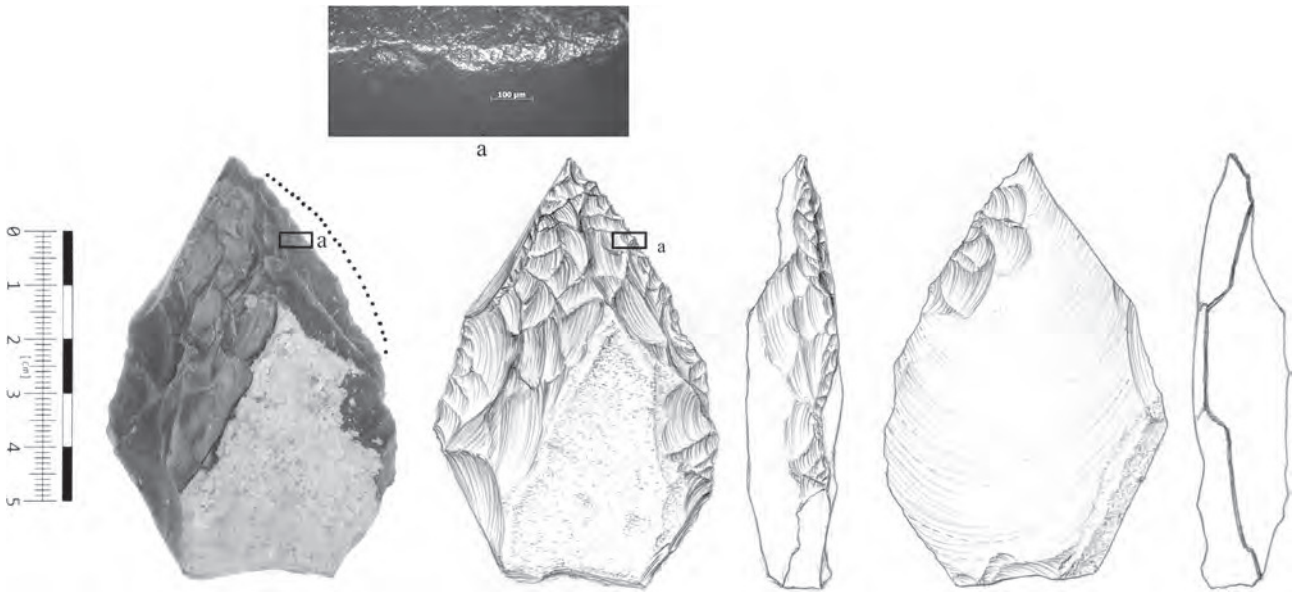


FIGURE 8. Wierzbica "Zele", Radom district. Morphologically a projectile point roughout, functionally the specimen has smoothed ridges between negative scars and smoothed side edge; smoothing of edges and gloss resemble traces left from scraping hide: a, micropolish on cutting edge, objective 10× (Photo J. Małecka-Kukawka; W. Ochotny; Draw E. Gumińska).

knives are evidence of considerable knapping skills. However, it needs to be noted that at the time when they developed such skills were not as common as in the Neolithic. Therefore, we may suppose, with great probability, that among communities of the Lusatian communities there was considerable specialization in the sphere of flint mining and knapping, especially in those settlement regions and settlements that lay near deposits of flint (Lech, Lech 1997a: 111, van Gijn 2010). This assumption would explain reduced flint knapping skills in the middle and late Bronze Age, with simultaneous occurrence of rare flint artifacts evidencing the considerable or even very considerable skill of their producers (van Gijn 1988, 2010: 217). In southern Sweden, in the region of Malmö, flint flakes and sometimes blades were used in the Late Bronze and Early Iron Ages, and even as late as the Middle Ages. The shapes were random, evidently struck *ad hoc* using simple homemade techniques. Use-wear analysis shows they were struck for utilitarian purposes (Knarrström 2001: 78–132, Högberg 2001: 189–199, 2009: 162–163). Similar analyses of material from the Wierzbice "Zele" mine indicate that the same was true of lands lying in the Vistula and Oder basins (see Lech, Piotrowska 1997, Bronowicki, Masojć 2008, Małecka-Kukawka 2008).

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