Archaeologia Polona, vol. 54: 2016, 51–65
PL ISSN 0066-5924

A Newly Discovered Source of 'Banded Flint' in the Polish Lowlands

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Rescue excavations at an artefact manufacturing site at Pęgów, Poddębice district, dated to the modern period, have produced several dozens of lumps of flint. The flint exhibits greyish and brownish bands and is macroscopically similar to the well-known banded flint occurring in the area of Krzemionki Opatowskie, Ostrowiec Świętokrzyski district. Artefacts made from this tentatively named 'Pęgów flint' have been identified in archaeological assemblages of different chronological age in the Koło Basin. To verify whether macroscopically similar nodules and artefacts come from the same outcrop and if the artefacts made of banded flint are made of the Krzemionki Opatowskie flint, instrumental neutron activation analysis (INAA) was conducted on samples of Pęgów flint and banded raw material from Krzemionki Opatowskie. Although most of the obtained results fall below INAA detection limits the compostion of chromium content in each sample- may reflect common origin of all the analysed pieces from Pęgów. INAA data suggest that the artifacts made of banded flint were mot made from Krzemionki Opatowskie material.

KEY-WORDS: 'Pęgów flint', Instrumental Neutron Activation Analysis (INAA), Koło Basin

Prior to the construction of the A2 motorway, the Institute of Archaeology and Ethnology of the Polish Academy of Sciences carried out rescue excavations at Pęgów, Poddębice district, where an artefact manufacturing site was discovered (marked as site 2 – AUT 461). Remains of multicultural settlements were found (Lusatian Culture, Przeworsk Culture, Medieval Period), of which those dated to 16–17th century AD were the most intensive, including 17 pits, an animal burial, 3 lime kilns, 17 limestone extraction pits and 1264 fragments of pottery (Seroczyński and Wysocka 2006: 43).

Present among the limestone residue in excavated lime kilns were several dozen lumps of flint raw material in various shades of grey, with characteristic bands, partially covered with cortex. Late Palaeolithic, Mesolithic and younger flint assemblages from other archaeological sites in the Koło Basin, within which the Pęgów site is located, have yielded artefacts of analogous material. Tentatively termed Pęgów flint, after the archaeological site where it was first recognized, this 'banded flint' is macroscopically similar to the famous banded flint from Krzemionki Opatowskie, Ostrowiec

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Świętokrzyski district. The aim of this paper is to discuss the geological and archaeological occurrence of Pęgów flint and present the results of INAA geochemical analysis.

GEOGRAPHICAL AND GEOLOGICAL CONTEXT

As it flows from the south, the Warta River turns west at one point; the Koło Basin is the resultant extension of the Warta River valley (Fig. 1). The second large watercourse flowing through the Basin, the Ner River joins the Warta south of Koło. Its sources are located within the Łódź Hills. The Kłodawa Plateau abuts the Koło Basin from the north, the Łask Plateau from the south and the Turek Plateau from the west (Kondracki 2009: 158).

The Koło Basin was largely formed in the period of recession of the Oder/Warta Glaciation, during which the Koło Basin was cut through the Warsaw-Berlin ice-

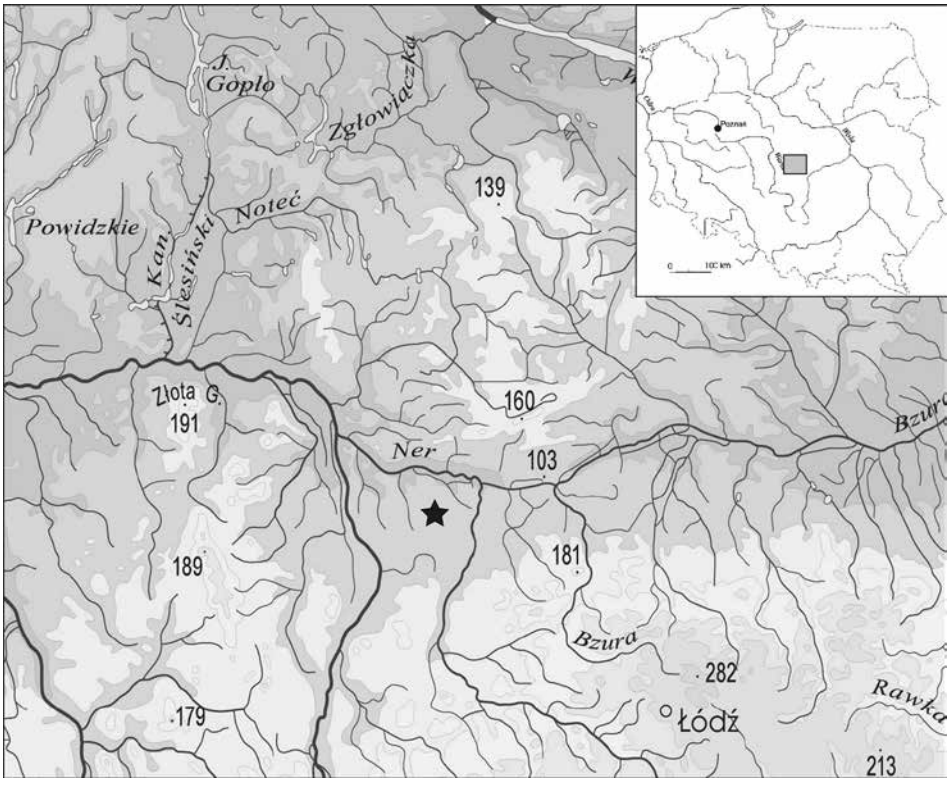


Fig. 1. Black star marks the location of the Pęgów site, Poddębice district.
Drawn by: P. Szejnoga, A. Tabaka.

marginal valley. This is one of the three great latitudinal valleys of the Polish Lowland, which discharged melt-water coming from the Scandinavian ice sheet in the Poznań phase of the North Polish glaciation (Stankowski 1995: 168).

A notable feature of the region is its considerable morphological diversity and the presence of extensive dune fields. The area of the Upper and central Bzura and Ner

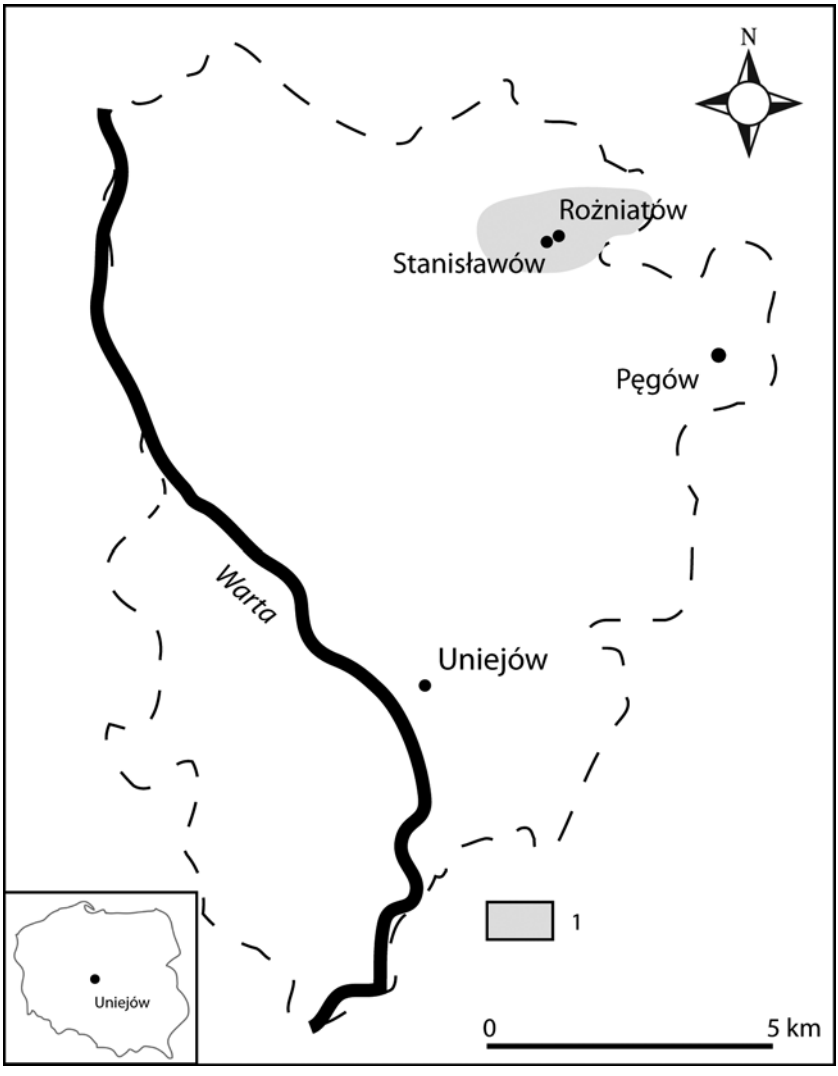


Fig. 2. Map showing the extent of Cretaceous limestone exploitation in the Uniejów district, along with the locations of archaeological sites mentioned in the text (acc. to Gorączko and Gorączko 2013). 1 – extent of modern day exploitation. Graphic design: J. Kabaciński.

Fig. 3. Structures built of calcareous marl. Sobótka, Poddębice district (a), Wilamów, Poddębice district (b). Photo: I. Sobkowiak-Tabaka.

rivers is marked by elevational differences and deep valley incisions (Chmielewska 1978: 90–94). These environmental conditions attracted several Late Palaeolithic communities and some Mesolithic groups. Particularly rich settlement remains were discovered near Cichmiana, Koło district (Kabaciński *et al.*, 2009: 111–378).

With respect to Polish Mesozoic geological units, the Koło Basin is located within the Szczecin-Łódź-Miechów Basin. Underlying Pleistocene and Holocene sediments are here Upper Cretaceous sediments, up to 3000 m thick, and partly Paleogene and Neogene sediments, mainly grey and green-grey marl, limestone and gaize, as well as carbonate/siliceous and sandy limestone (Mizerski 2009: 169–178). Occurring in the vicinity of Łódź and in the Miechów Basin, Upper Cretaceous beds, built up with carbonates and biogenic silica (Gorączko and Gorączko 2013: 54) are industrially exploited today by the local construction industry (Bolewski *et al.*, 1991: 234). Based on an analysis of microfauna, the sediments are dated to the Maastrichtian (Nowacki 1995: 11–12).

In Poddębice and the surrounding villages (Rożniatów, Dąbrowa, Zaborów, Kraski, Łęczyca district, and around the town of Uniejów), Cretaceous marls are overlaid by a thin layer of Pleistocene sediments (Fig. 2). The distinguishing traits of these sediments include their softness, porosity and low resistance to weathering. Easy to work, the rocks are a valuable construction material (Kozłowski 1986: 220–221). Houses and farm buildings constructed from the distinctive white raw material are still to be found near Pęgów, Rożniatów and Uniejów, Poddębice district. Owing to its thermal and mechanical properties, Cretaceous limestone exploited near Rożniatów is particularly suitable for building houses, making additional thermal insulation unnecessary (Fig. 3).

Nowadays the extraction activity at local limestone beds is largely limited to only one active quarry in Stanisławów, close to Rożniatów, where the limestone serves mostly as a decorative stone in gardens and buildings. However, according to the owner of the Stanisławów quarry, as late as the latter half of the 20th century local farmers continued to exploit limestone beds on a large scale for their own use or for sale. This activity ceased only after State regulations halted private exploitation of geological resources without a licence and today old extraction places are overgrown by vegetation and inaccessible for observation.

IDENTIFICATION OF THE PĘGÓW FLINT MATERIAL

The archaeological site yielding the analysed flint materials is located in the Pęgów hamlet, on the eastern slope of a valley of the Pisia River. This valley is densely cut by watercourses and ditches, and its bottom is filled with fluvioglacial sediments. Together with proglacial waters draining the front of the retreating glacier, the


0
1m

Fig. 4. Pęgów, site 2, Poddębice district, showing pits produced by the limestone extraction. General view. Photo: J. Pyzel.

sediments were deposited south of the zone of the terminal moraine of the Poznań phase (Górska 2004).

Based on construction details of lime kilns and the type of bricks manufactured at the site, the Pęgów production complex is dated to the seventeenth century (Chmielewski 2001: 27). Limestone was found to have been extracted next to the complex from deposits located just below the surface (cf. Fig. 4, 5). These open-pit mines (as Chmielewski called them) are up to several metres deep and the extracted material was heaped around the pits for transportation to nearby kilns.

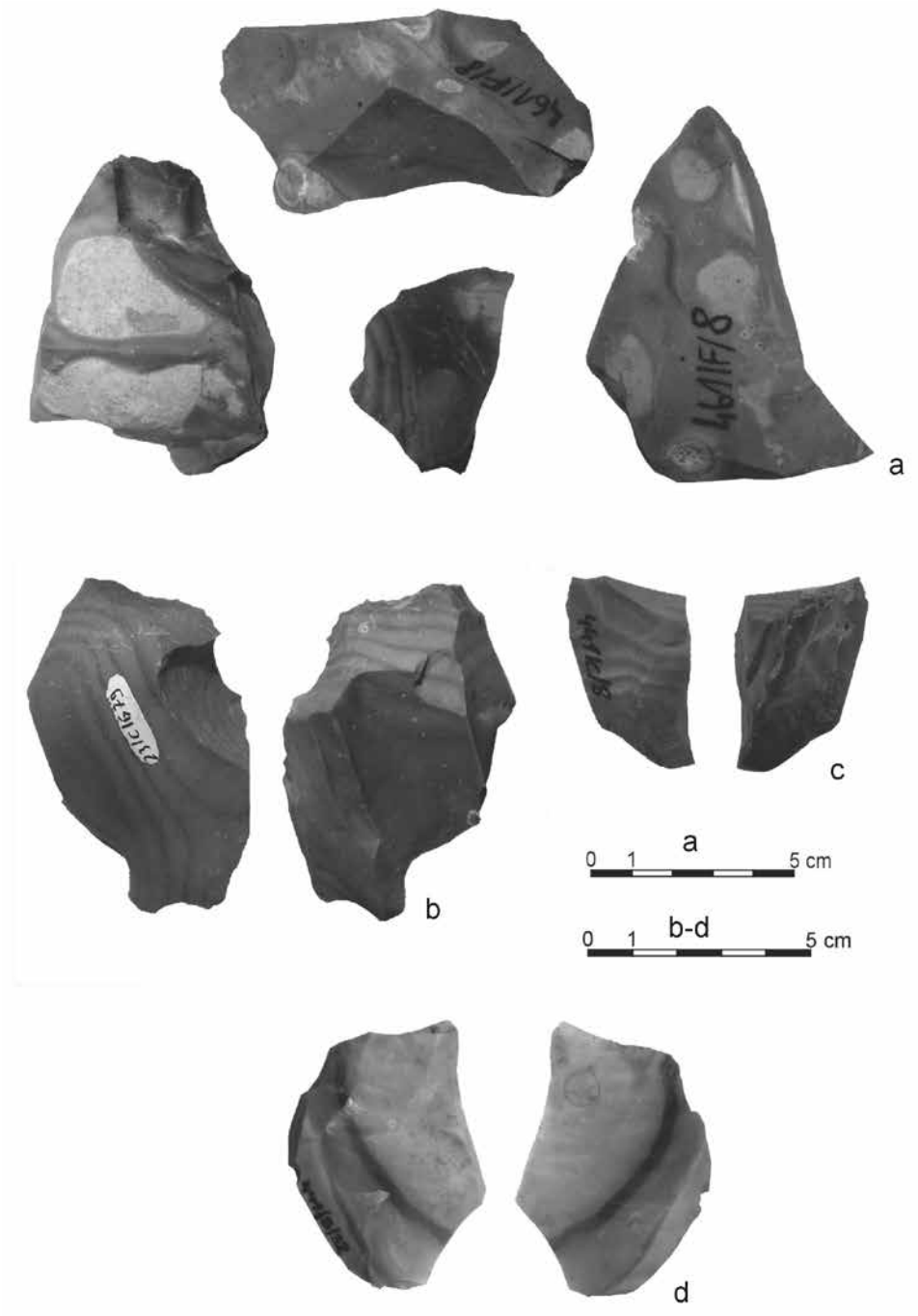
Archaeological works in the south-eastern part of the site (trench F90) recovered slightly more than ten-centimetre–large lumps of raw flint, deposited several dozen centimetres below the surface. Grey in colour and covered with cortex, they contain inclusions of limestone. Some nodules exhibit greyish or brownish bands (Fig. 6a).

The relation of flint nodules discovered during archaeological excavations to geological beds recognised in the area is not clear and two possibilities may be considered. The nodules may originate from Late Quaternary fluvioglacial deposits of the Vistulian. A thin layer of sand-gravel-clay sediments, usually less than 1 meter in thickness, overlay Cretaceous limestone beds throughout the area. However, it is also possible that banded flint occurs within Cretaceous limestone sediments. A number of arguments support the latter hypothesis. The flint nodules were found in the backfill of lime kilns made of limestone fragments so it very possible that they were originally emplaced within a limestone either from the limestone bedrock or from weathered subsurface Cretaceous layers. During our research to locate limestone quarries and related flint occurrences we have not located *in situ* flint nodules within Cretaceous beds. However our research has been limited and we have found only one active limestone quarry (Fig. 5) so such a possibility cannot be excluded. On the other hand, flint depositions within Upper Cretaceous sediments are known from relatively nearby deposits at Łódź (Ziomek 2002).

A small collection of artefacts made of grey flint with characteristic brownish or dark grey stripes exists in flint assemblages recovered from archaeological sites of various chronological periods (Fig. 6: b–d).

Four artefacts have been identified at site 2 (AUT 441) in Cichmiana and site 1 (AUT 23) in Powodów II, Poddębice district. One preparation flake was probably removed by a member of a Lusatian community that occupied site 1 (AUT 23) at Powodów II (Kabaciński and Sobkowiak-Tabaka 2006: 456). The specimen measures

Fig. 5. Stanisławów, Poddębice district. A limestone quarry – a section. Photo: J. Kabaciński.


a
b
c
0 1 a 5 cm
0 1 b-d 5 cm
d

68 x 54 x 28 mm (Fig. 6b). Other artefacts have been found in a Late Palaeolithic assemblage at site 2 in Cichmiana (Kabaciński *et al.*, 2009: 111–378). Out of more than 10,000 artefacts recovered from the latter site, only three were made from Pęgów flint. Other flint varieties used by Late Palaeolithic peoples inhabiting the site includ Baltic Cretaceous erratic flint, 'chocolate' flint, Jurassic flint and obsidian. The assemblage of artefacts made of Pęgów flint consists of an unspecified core, a chunk (Fig. 6c) and a fragment of retouched flake (Fig. 6d). Given the dimensions of its central part (60 x 39 x 5 mm; other parts are missing), at one time the flake was apparently of a considerable size. It was detached from a single-platform core. A fragment of the left edge of the flake shows retouch on the dorsal side; the broken edge was also retouched.

GEOCHEMICAL ANALYSIS[1]

We utilized geochemical analysis to determine whether samples from Pęgów, Cichmiana and Powodów, macroscopically very similar, came from the same outcrop and whether or not artefacts from Cichmiana and Powodów were made of a banded flint from Krzemionki Opatowskie. This latter possibility cannot be excluded, because Samsonowicz (1953: 107) has reported that loaf-shaped, epigenetically banded flints occur in a zone from the Holy Cross (Świętokrzyskie) Mountains to St. Margaret Mount (Góra Świętej Małgorzaty) near Łęczyca (that last mentioned locality is relatively close to our study area).

Despite nearly 100 years of research on raw flint, the origin of particular variations, the possibilities of its petrographic and mineralogical identification and exploitation in prehistory (Krukowski 1920: 185–206, 1922: 1–34; Michniak 1980: 83–106; Samsonowicz 1923: 17–24), only two varieties of raw flint have been documented in detail. These are 'chocolate' flint (Schild 1971: 1–60; Grafka *et al.*, 2014; Hughes *et al.*, this volume) and banded flint from Krzemionki Opatowskie (Budziszewski and Michniak 1984: 151–189; Pieńkowski and Gutowski 2004: 29–36; Migaszewski *et al.*, 2006, 11–28; Król and Migaszewski 2009: 12–45). Systematic investigations conducted since 2007 in the Kraków-Czestochowa Upland and Ryczów Upland have located a new region containing natural outcrops of banded flint (Krajcarz *et al.*, 2012; Krajcarz *et al.*, 2014).

[1] The authors would like to thank dr hab. Jacek Michniewicz from the Institute of Geology, Adam Mickiewicz University, Poznań, Poland, for his assistance in the geochemical analysis and interpretation of results.

Fig. 6. (a) Pęgów, site 2, Poddębice district – flint lumps, (b) Powodów II, site 1, Poddębice district – preparation flake, (c) Cichmiana, site 2, Koło district – chunk, (d) Cichmiana, site 2, Koło district – fragment of retouched flake. Photo: A. Tabaka.

Table 1. Results of the INAA analysis (4A – basic set). Activation Laboratories Ltd. ACTLABS (Canada). Pracownia Analiz Geochemiczno–Mineralogicznych 'GeoAnaliza' [Laboratory of Geochemical–Mineralogical Analyses 'GeoAnaliza']

Analyte Symbol	Au	Ag	As	Ba	Ca	Co
Unit Symbol	ppb	ppm	ppm	ppm	%	ppm
Detection Limit	5	5	2	100	0,5	1
Analysis Method	INAA	INAA	INAA	INAA	INAA	INAA
Powodów II (flake)	< 5	< 5	< 2	< 100	< 0,5	< 1
Pęgów (nodule)	< 5	< 5	< 2	< 100	< 0,5	1
Krzemionki Opatowskie (nodule)	< 5	< 5	< 2	< 100	< 0,5	2
Cichmiana (core)	< 5	< 5	< 2	< 100	< 0,5	1
Cichmiana (chunk)	< 5	< 5	< 2	< 100	< 0,5	2

Analyte Symbol	Sc	Se	Sr	Ta	Th	U
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm
Detection Limit	0,1	3	500	1	0,5	0,5
Analysis Method	INAA	INAA	INAA	INAA	INAA	INAA
Powodów II (flake)	0,2	< 3	< 500	< 1	< 0,5	< 0,5
Pęgów (nodule)	0,3	< 3	< 500	< 1	< 0,5	0,8
Krzemionki Opatowskie (nodule)	0,1	< 3	< 500	< 1	< 0,5	0,6
Cichmiana (core)	0,1	< 3	< 500	< 1	< 0,5	< 0,5
Cichmiana (chunk)	0,1	< 3	< 500	< 1	< 0,5	< 0,5

The chemical composition of flint is highly variable (Bolewski *et al.*, 1991: 128), so identifying a deposit of raw material from which a given artefact or a group of artefacts were made is challenging and usually requires geochemical composition analysis of a series of samples. In addition, micropaleontological identification is important to determine the age of the deposit. Only statistically significant repeatability of results guarantees their reliability.

INAA was employed in this study to determine the composition of major, minor, trace, and rare earth elements present in the 5 studied artefacts (Table 1). INAA has multi-elemental detection limits at the parts-per-million (ppm) level and an accuracy

Cr	Cs	Fe	Hf	Ir	Mo	Na	Ni	Rb	Sb
ppm	ppm	%	ppm	ppb	ppm	%	ppm	ppm	ppm
2	0,5	0,02	0,5	5	5	0,01	50	20	0,2
INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA
36	< 0,5	0,56	< 0,5	< 5	< 5	0,03	< 50	< 20	< 0,2
23	< 0,5	0,73	< 0,5	< 5	< 5	0,03	< 50	< 20	< 0,2
202	< 0,5	0,91	< 0,5	< 5	< 5	0,03	< 50	< 20	< 0,2
20	< 0,5	0,61	< 0,5	< 5	< 5	0,03	< 50	< 20	< 0,2
18	< 0,5	1,82	< 0,5	< 5	< 5	0,05	< 50	< 20	< 0,2

W	Zn	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu
ppm	ppm	ppm	ppm	ppm	ppb	ppm	ppm	ppm	ppm
3	40	0,2	3	5	0,1	0,1	0,5	0,1	0,05
INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA	INAA
< 3	40	< 0,2	< 3	< 5	< 0,1	< 0,1	< 0,5	< 0,1	< 0,05
< 3	< 40	1,9	< 3	< 5	0,3	< 0,1	< 0,5	0,2	< 0,05
< 3	< 40	< 0,2	< 3	< 5	< 0,1	< 0,1	< 0,5	< 0,1	< 0,05
< 3	< 40	0,3	< 3	< 5	< 0,1	< 0,1	< 0,5	< 0,1	< 0,05
5	< 40	0,4	< 3	< 5	< 0,1	< 0,1	< 0,5	< 0,1	< 0,05

range between 1 and 10% of the reported values for known standards (Glascock and Neff 2003). Although most of the results obtained here fall below detection limits the compositions of cobalt, chromium, iron, sodium and scandium (highlighted in Tab. 1) are noteworthy, with a particular variation in chromium content in each sample (Fig. 7) which reaches 202 ppm for banded flint from Krzemionki Opatowskie, and falls to 18–36 ppm for artefacts from the Pęgów area. Mindful of the limitations of small sample size, this result may reflect one source for all samples from Pęgów area and allow us to reject the possibility that artefacts from Cichmiana and Powodów were made from striped flint from Krzemionki Opatowskie.

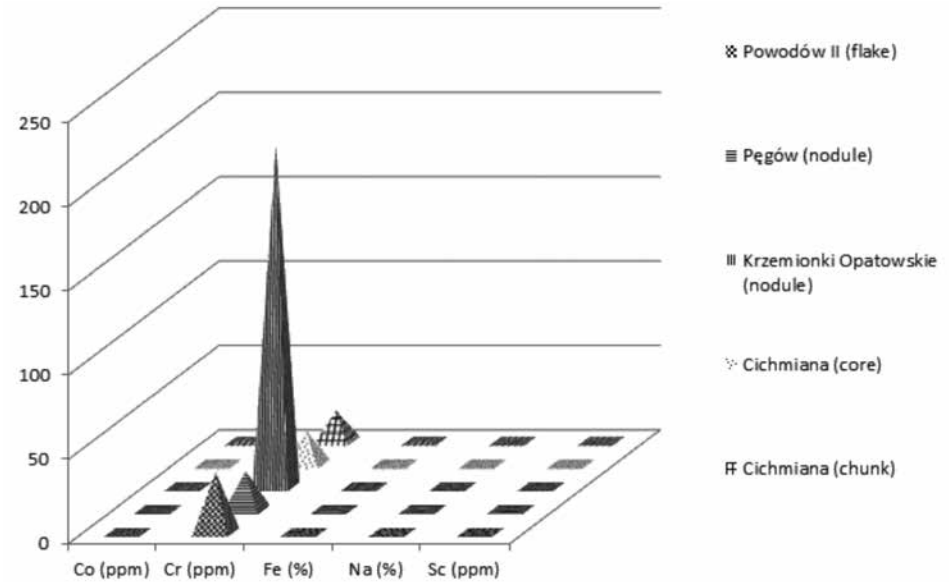


Fig. 7. Composition of selected elements determined by INAA analysis carried out at Activation Laboratories Ltd. ACTLABS (Canada). Pracownia Analiz Geochemiczno-Mineralogicznych 'GeoAnaliza'. Graphic design: J. Kabaciński.

THE USE OF THE PĘGÓW FLINT IN PREHISTORY

The small number of artefacts made from Pęgów flint suggests that it may not have been a significant resource for local prehistoric communities, although Marcin Wąs has raised the possibility that 'banded' flint, similar to Pęgów flint, may be identifiable in assemblages recovered from the village of Madeły, Wieluń district[2].

This also may be the result of lack of recognition of the raw material; characteristic bands are not distributed equally within the nodules (see Fig. 6a).

Sub-surface deposits of 'banded' flint, embedded in Upper Cretaceous limestone (Nowacki 1995: 11), were probably readily available and could be exploited by means of surface pits, as was Jurassic flint occurring in the upper part of flint-bearing limestones in the area of the upper Warta river (Ginter 1974: 12), or as were erratic materials at the settlement site in Goszczewo on Kujawy, inhabited by a community of the Globular Amphora Culture (Chachlikowski 1994: 110–112).

[2] Personal comment for which we are very grateful.

SUMMARY

The paper presents the early results of the study on the sources of 'banded flint' within the Polish Lowland. Because the investigations are still in the preliminary stages, we have focused on general findings about the location of the occurrences of Pęgów flint and have pointed to possible directions for further research.

Although the INAA method has been widely employed in archaeology (cf. Glascock and Neff 2003), in this study it was not particularly successful, so the issue of the origin of Pęgów flint and its possible geological connections remains unresolved pending further research. Geochemical analyses of many more artefacts and flint from outcrops will be required to develop a database that will allow comparisons between samples and support reliable correlations between artefacts and deposits of raw material. Recent isotopic analysis of beryllium (^{10}Be), produced inside rocks in response to exposure to cosmic radiation (Verii *et al.*, 2005: 213), seems worth pursuing as a possible 'sourcing' method but, unfortunately, at the moment further physico-chemical analyses have been prohibitive because of their high cost.

Due to different geological age there is no connection between Pęgów flint (possibly Upper Cretaceous) and banded Krzemionki Opatowskie flint (Upper Jurassic). Nevertheless, efforts oriented toward field identification of possible flint occurrences in Cretaceous limestones in the Rożniatów area should be continued to confirm (or exclude) that locality as a source of Pęgów banded flint.

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