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THE EARLY BRONZE AGE FLINT MINE AT SITE II, POLANY, RADOM DISTRICT

In 1971–1972 excavations were carried out at Site II of the flint mine at Polany, Radom District. The present author published a short report on the 1971 work in 1973. Some results of the research work at the site have also been presented, briefly too, in a few more general publications. This site is also included in the recently published catalogue of European flint mines (Chmielewska 1980, 583 ff.). The excavations uncovered one pit as a whole and a few others partly. From analysis of flint artifacts from on-site workshops and the ^{14}C date of a sample of charcoal from one of the pits, we can assume that the population of the younger stage of the Mierzanowice culture (1600–1500 BC) extracted chocolate flint at this part of the mine. These analyses certainly also permitted some conclusions to be drawn about the extraction techniques, yield size, production directions in on-site workshops, distribution of raw flint and economic and property relationships at the mine.

INTRODUCTION

A distinct increase over the recent two decades in interest in the problem of prehistoric flint mining has e.g. been reflected in a considerable extension of the basic sources related to this branch of economy. New field excavations were undertaken at a number of points of flint extraction discovered before World War Two by S. Krukowski and J. Samsonowicz (Żurowski 1962; Balcer 1971; Krzak 1970; Schild, Królik, Mościbrodzka 1977; Budziszewski 1980). Excavations were also begun at some previously unknown sites of flint extraction, uncovering new basins of it (Kobusiewicz 1967; Ginter 1974; Lech 1971; 1972; 1981b). The interest in the problems of siliceous rock exploitation results from the large significance attributed to the research on the economy of prehistoric communities. There is no doubt that ways of supplying raw flint, so necessary in making a large number of needed artifacts, were an important link in the economic system of Stone Age communities.

In his research on points of flint extraction the archaeologist has to solve a number of questions which are different from those asked at other sites. Some of them are purely geological in nature, such as the identification of a flint deposit, its situation or availability. Others already involve the activity of man. The latter, to mention briefly just the most important ones, include the identification of the type of a mining feature, the way in which the mineral was extracted, involving here the distinguishing of mining tools among the archaeological pieces, the estimation of the yield size, the identification of the directions in flint processing in the possible on-site workshops and, finally, last but not least, its chronology and cultural origin.

It would be impossible to consider all the above-mentioned questions below, for in the small, excavated area a large number of the elements of the mine have perished, and others are hardly legible due to damage. Despite these drawbacks, the features at the site of Polany II, the results of observations made on their fills, the traces of stone processing workshops and a detailed analysis of archaeological material fully deserve to be published.

1. GEOMORPHOLOGICAL SETTING OF THE AREA

The complex of the sites – prehistoric chocolate flint mines,[1] identified in the area of Polany and Wierzbica nearby, is related to the concentration of this type of flint in the Upper Jurassic rocks in the northeast border of the Świętokrzyskie (Holy Cross) Mountains. In the Świętokrzyski region (also called Łysa Góra region in the archaeological literature),

[1] For more detailed discussion of the name of this flint variety see SCHILD 1971, p. 4.

concentrations of a variety of types of flint occur much more widely. They are present in Jurassic and Cretaceous rocks at many points in this area (Ruśkiewicz 1968). For prehistoric communities only these places were important where layers and beds of flint were not too deeply embedded in the rock or detritus and could be extracted by ways provided by the contemporary state of technology. From this point of view, convenient deposits of chocolate flint occur in the belt of outcrops of limestones of the Upper Jurassic ridge which divides the Iłża foothills (the northeast border of the Świętokrzyskie Mountains) and the Radom Plain. In the relief of this region there are three distinct elevated zones running from the southeast to the northwest, separated by conspicuous depressions of the terrain. The above-mentioned belt of flint-bearing limestone outcrops is mainly connected with the central part of these elevations, formed by the Iłża hills to be seen between the lower Iłżanka river and Wierzbica. Towards the northwest, the belt of these outcrops runs then up to the area of Orońsko and Guzów, where the sediments of the Upper Jurassic ridge dip under the thick Pleistocene cover.

The area of the Iłża hills, about 4 km wide, is divided by the valleys of the Iłżanka and Modrzejowica-Chotcza rivers into 3 elevated strips, between 210 and more than 240 m a.s.l. (Fig. 1). The first, in the north part of the area, extends between Wierzbica and the valley of the Modrzejowica; the other is contained between the valley of the latter and the Iłżanka, while the third runs east from the breakthrough section of the Iłżanka and culminates near Iłża (Bartosik 1972, 21 ff.). The zone of these elevations is inclined to the northeast, where it turns into the Pakosław-Prędocin Depression, which divides it from the zone of the Chwałowice hills. From the southwest, the Mirów-Błaziny depression sets it off from the Starachowice hills.

Fig. 1. The area of the Iłża foothills

1 – the boundary of the Middle-Polish Glaciation, *2* – Polany, Site II

Partly acc. to J. Bartosik 1972, 20, Fig. 4

The region in question has many properties of weathered glacial relief (Fig. 2). It was twice covered by a continental glacier: during the Cracow Glaciation and then during the Middle-Polish Glaciation. The limit of the maximum reach of the latter glaciation (the Radomka stage) in the area of the Iłża Upland has been established south of the basin of the Iłżanka (Samsonowicz 1925, 9 ff.; Bartosik 1970, 70, Fig. 4; Różycki 1972, 167 ff., see also Fig. 1). Remnants of the passage of the continental glacier are also specifically strongly eroded monadnocks. Pleistocene covers lying over the slopes and sediments filling the hollows and depressions of the terrain.

In the southeast part of the Iłża hills, the Pleistocene sediments have been destroyed almost entirely and at many points the Upper Jurassic bedrock comes out to the surface. The sediments have also been reduced to the highest degree in the area between the Iłżanka and the Modrzejowica, where a slightly thicker Pleistocene cover, mainly in the form of moraine clay, is only seen in its north part. The thickness of these sediments increases to the north and northwest.

In the upland between Wierzbica and the valley of the Modrzejowica, the thickness of the Pleistocene sediments reaches at times a dozen or so metres, with considerable drops. Along the Wierzbica-Polany-Pomorzany line there is a distinct strip of moraine monadnocks related to the transgression of the front of the continental glacier during its oscillations (Bartosik 1972, 64). The slopes of the elevations in the form of smooth cuestas are levelled, the small valleys (now dry) are filled with sand. From beneath the denuded Pleistocene cover, at some slopes there emerge some strips of the bedrock or residual clays. As J. Samsonowicz (1923, 20) found out, the bedrock is represented by limestones from the Upper Astartian, which are the original rock of chocolate flint. They are thin-bedded limestones (less frequently oolite), detritic ones which become at the top marly ones.

Fig. 2. The geomorphology of the foothills of the Holy Cross Mountains northwest of Iłża

Tertiary forms: 1 – the old levelling level, 2 – relic hills; Quaternary and Holocene forms: 3 – denudation plains, 4 – terrace plains, 5 – erosion slopes, 6 – corraison bowls, dry dales and old drainage furrows, 7 – accumulation plains, 8 – outwash plains, 9 – kame terraces, 10 – relic hills, 11 – loess plains, 12 – dunes and drift sand fields, 13 – scarps of erosional terraces, 14 – flood plains, 15 – alluvial fans, 16 – flint mine Polany II, 17 – Wierzbica, 18 – Iłża

Acc. to J. Bartosik 1972, 18, Fig. 18 (slightly simplified)

Samsonowicz based his division of the Astartian on e.g. the occurrence of two different types of flint in the limestones of this level. According to him, epigenetic banded flint nodules form a distinct level in Lower Astartian limestones. In the Upper Astartian, on the other hand, singenetic chocolate flint formed (Samsonowicz 1923, 19ff.; 1932, 178, 191ff.; 1952, 107; Dembowska 1953, 31ff.). In the rock, they occur in a few overlaying beds, in the form of continuous layers or lens-like intrusions, in layered varying-sized flat, cake-shaped or irregular-shaped nodules. The thickness of the flint layer reaches 10 cm. The term "Upper Astartian", so frequently used until recently by the archaeologists, defined its original environment. We should point out, however, that the more recent, simplified division of the Jurassic neglects some stages of the Malm, including the Astartian by making it part of the Upper Oxfordian. Limestones, which used to be included, by Samsonowicz, too, in the Upper Astartian, are considered the youngest level of the Oxfordian (Malinowska, Dembowska 1973, 384). This division has, however, not been universally accepted.[2]

For the considerations presented below the validity of this division is of little importance. It is significant, on the other hand, that at many points the thin-bedded limestone cover forming the Iłża hills was uncovered or covered only by a thin overlay of Quaternary sediments, and that flint occurring in them was accessible to man. This fact has long been known, as is evidenced by prehistoric points of extraction of this raw material, located in the belt of the above-mentioned limestone outcrops. From the area of Iłża to the southeast, up to Orońsko and Guzów to the northwest, they arrange in 3 distinct groups: eastern (the area of Iłża), central (Polany – Wierzbica) and northwestern (Orońsko – Guzów; Schild 1971, Fig. 1).

[2] For these questions see R. Schild 1971, p.3 ff.; Schild, Królik, Mościbrodzka 1977, p. 13ff.

2. DISCOVERY OF THE POLANY II SITE

Polany is one of those localities mentioned by Samsonowicz (1923, 20) where chocolate flint was for the first time found to occur in the original environment. During the survey, carried out together with S. Krukowski in 1922 in the Łysa Góra region, Samsonowicz observed the levels of this flint in the walls of peasants' quarries then exploited at Polany. Reports on this research also mention outcrops of the limestone bedrock, also to be seen at Polany, and, at Wierzbica nearby, large amounts of limestone rubble and flint to be found on the surface of the fields (Krukowski 1923, 68 ff.). This discovery confirmed the validity of previous expectations of this researcher, who had localized the original deposits of chocolate flint in the central or eastern parts of the Lesser Poland Upland, only on the basis of an analysis of the distribution of sites where traces of utilization of this raw material could be seen (Krukowski 1920, 192 ff.).

The flint artifacts which Krukowski gathered from the area of two sites identified in 1922 were determined as Campignian (Polany I) and Pre-Campignian (Polany II).[3] These sites and the area of Wierzbica nearby is related to the concentration of research and field work by this researcher (up to 1934). The published brief mention of their results contained the first information about the existence in these two localities of flint mines and the accompanying on-site workshops (Krukowski 1939-1948, 98 ff.). In this work, the author distinguished the flint artifacts at the above-mentioned sites as the Wierzbica industry, part of the Łysa Góra cycle, with the latter also described for the first time. Among the characteristic forms of the Wierzbica industry, the author mentioned tools, bifacially worked (including knives, Prondnik knives, side-scrapers), most often made from flint nodules. Krukowski referred the age of the Wierzbica industry to the Early Holocene; he looked, on the other hand, for the traditions of the Łysa Góra cycle in the not too well identified industries of the Upper Paleolithic.

After World War Two, until the late 1960s, no research was carried out on the Wierzbica industry. The problems connected with distinguishing this unit were updated as a result of work on the inventory of chocolate flint exploitation sites, carried out in the area of the Iłża hills in 1968 by the Department of the Paleolithic of the Institute of the History of Material Culture, Polish Academy of Sciences (now the Stone Age Department). The most important questions were concerned with the basis, and accordingly, with the general validity of distinguishing this industry, and its chronology. The presence of bifacially worked forms among the specimens gathered at the sites of Polany and Wierzbica, and their strong patination, suggested that they were more ancient than Krukowski had assumed. At the same time, their analogies to forms known from the Micoqian industries were pointed out (Schild 1971, 42 ff.). Those questions could only be explained by excavations. On behalf of the Stone Age Department they were begun in 1971 and continued to 1972. They comprised two sites localized during the 1968 survey: Polany Kolonie II (Schild, Królik, Mościbrodzka 1977) and the site II at Polany (called commonly Polany II).

3. THE SITUATION OF THE SITE

Localized as a result of survey in 1968, the sites in the area of Polany belong to the central group of extraction points (Schild 1971, Fig. 1; see also Fig. 3). South of the buildings of the village of Polany, Upper Astartian limestones form a narrow strip of outcrops which up to Wierzbica show on the surface of the fields concentrations of limestone rubble, along with flint waste and limestone quarries.

Site II (51°13′ North and 21°0′8″ East) is situated at the southeast end of this strip, about 1400 m away south of the village of Polany and about 800 m away north of the hill 220 m asl (Fig. 3). It lies just below the crest, on a very smooth slope, where it runs down to a small dry valley which connects about 4.5 km northeast of the site with the strongly peaty valley of the Modrzejowica (Figs. 2 and 4). In contrast to the site of Polany Kolonie II (Schild, Królik, Mościbrodzka 1977, 10), nowhere within this site did the bedrock limestones or their detritus break through the Pleistocene sedimentary cover. They were formed by slope-displaced sands, gravels and platey clay.

The areal extent of the site is marked by the

[3] According to R. SCHILD (1971, p. 29), S. Krukowski's site of Polany II lies in the grounds of the village of Polany Kolonie and does not coincide with that presented in the paper.

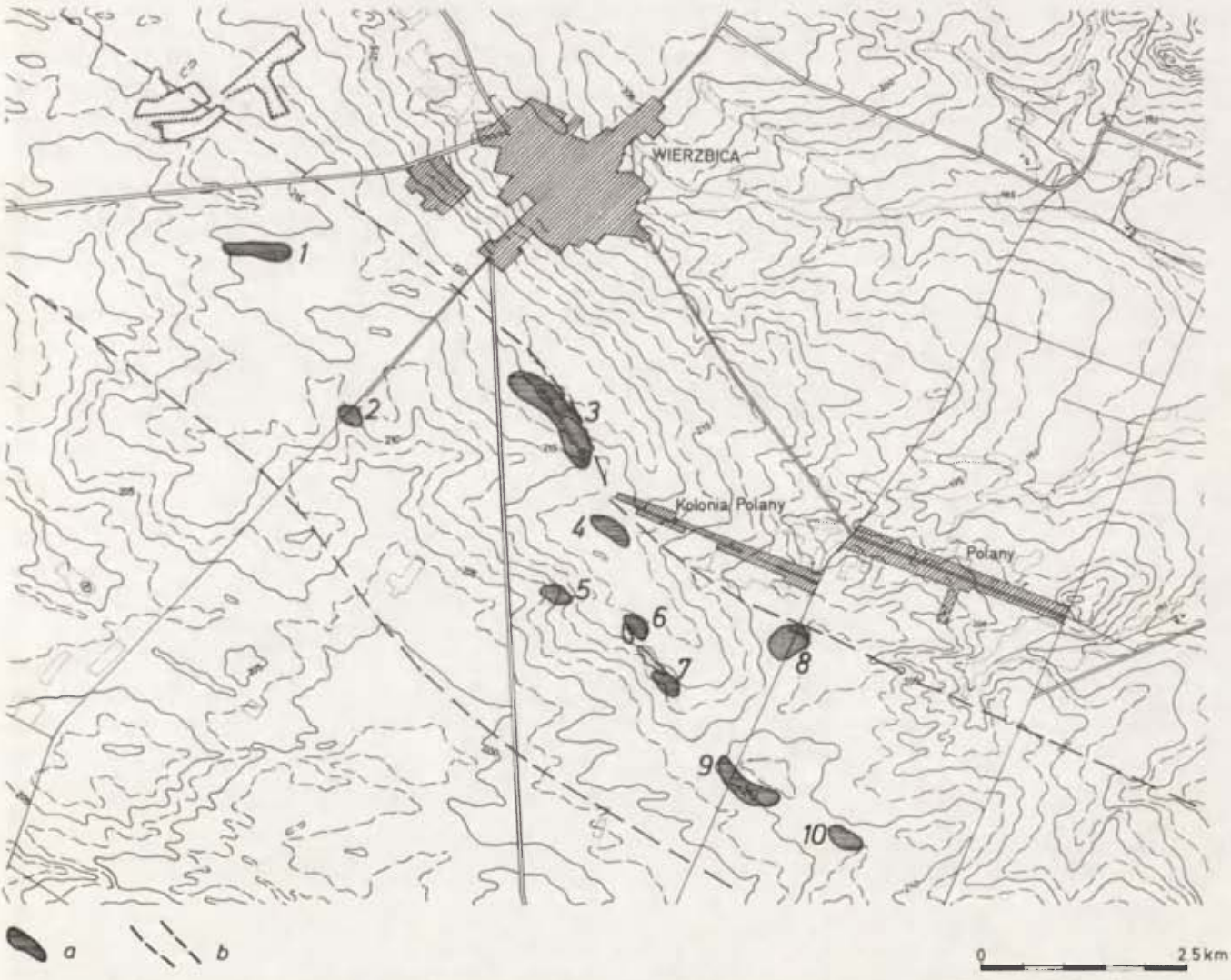

Fig. 3. The situation of prehistoric chocolate flint extraction points in the area of Wierzbica and Polany, Radom District

a – chocolate flint extraction points: *1* – Wierzbica-„Zele", *2* – Wierzbica-„Krzemienica", *3* – Polany Kolonie I, *4* – Polany Kolonie II, *5* – Polany Kolonie IV, *6* – Polany Kolonie IIa, *7* – Polany Kolonie III, *8* – Polany III, *9* – Polany I, *10* – Polany II; *b* – the approximate course of the Astartian Limestones

Partly acc. to R. Schild 1971, 18, Fig. 1

concentration on ploughable soil of flint artifacts with a large amount of limestone rubble. The surface concentration of the material is oval in shape, narrow and quite elongated, with its longer axis running from the north-north-west to the south-east-east (Fig. 5). The area of the concentration, or rather the spread of the artifacts, measured some 12,500 sq.m. It is intersected by the Polany – Osiny dirt road, parallel to the main road which connects these localities. The artifacts and natural chunks of flint which lay on the surface show heavy white patina.

The number of the site agrees with the denotations introduced during the research in 1968 (Schild 1971, 29). Krukowski does not at all mention the Polany II site. However, because the results of his research at Polany and Wierzbica have not been fully published, we cannot say that he did not know it.

Fig. 4. A view of the levelled hill slope where the flint mine Polany II is

The arrow shows its location

Photo by J. Lech

I. EXCAVATIONS

Excavations were carried out on the site in 1971 from 24 September to 5 October (by M. Chmielewska, J. Lech and J. Mościbrodzka) and in 1972 from 2 July to 8 August (by M. Chmielewska, J. Lech and H. Młynarczykówna). The work in 1971 was a reconnaissance. Its purpose was to establish the state of preservation and nature of the site. This could contribute to an explanation of some questions connected with the Wierzbica industry, for the objects found on the ground included bifacially worked pieces morphologically similar to the Micoqian and Prądnik (Prondnik) ones (Krukowski 1939-1948, 100: Schild

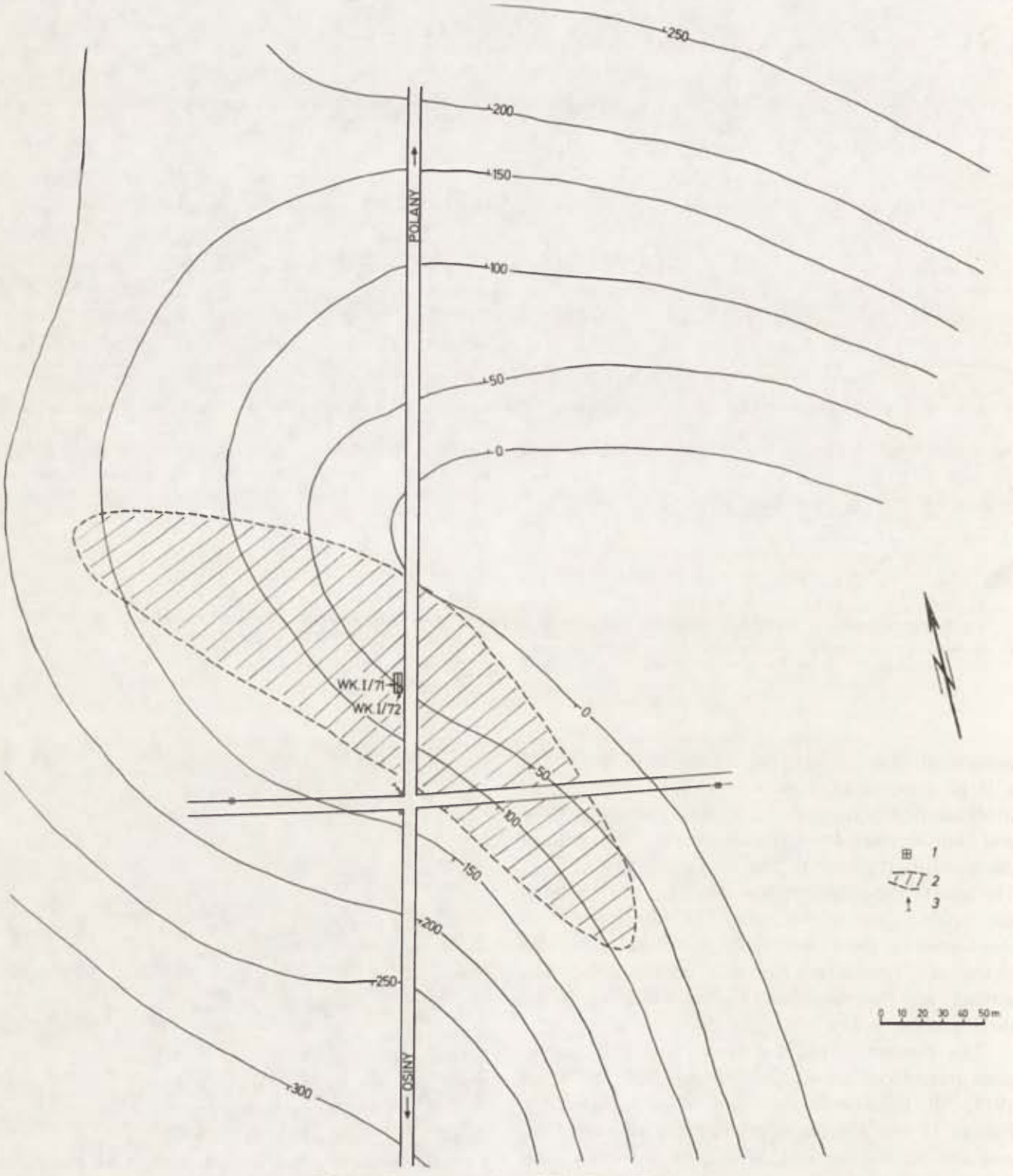

Fig. 5. A hypsometric plan of Site II at Polany

1 – boundary markers, *2* – the boundary of the spread of flint artifacts and limestone rubble on the surface of the field; *3* – the arrow shows the boundary marker no. 237; wk. – cut

1971, 45 ff.), attributed to this industry. In the first stage of the excavations it was necessary to find if they also occurred beneath the arable layer, in a more distinct stratigraphic situation, or if the surface material was the only preserved trace of human activity.

A rectangular cut (10 m × 2 m), with its longer axis running from the north-north-west to the south-south-east (deviating by 12° from the North) was made in the central section of the west part of the concentration, where a large number of bifacially worked pieces and their fragments was found. The east, longer side of the cut was 5 m distant from the west edge of the Polany – Osiny country road (Fig. 5). The cut was covered by a metric grid, with Arabic numbers for the North – South lines and Roman numbers for the West – East lines.

After removing the arable layer, 20–25 cm thick, the sediments lying underneath it were removed in arbitrary spits (with hand throwels) of 5 cm and, from the 0.5 m depth, 10 cm in thickness.[4] In the squares 1–3/I-II, just below the arable soil, a concentration of limestone rubble mixed with dark brown sandy clay was uncovered. Within it and in the lens of rust-coloured sand enclosing it there were numerous flint pieces: initially worked bifacially prepared forms, nodules and their broken fragments and flakes (Fig 6). Further down the shape and area of waste dump hardly changed. There were still flint pieces within its area and in the surrounding sand. Beyond its limits they were only sporadically encountered. During the exploration at the depth of 12–15 cm, between particular limestone chunks, there occurred large amounts of fine limestone rubble blocks and the chunks giving the dump the look of an in situ waste pile. Therefore, for the time being, the exploration of the north part of the trench was stopped.

In the remaining excavation area, underneath the arable soil, in yellowish, at places rust-coloured sand, fragments of four dark brown spots occurred. They were formed by sandy clay. It was observed that the spots were the top part of some hollows, to be seen in the northeast corner and at the east and west walls of the cut. Within them there were the greatest concentrations of flint artifacts, analogous to those uncovered in the dump in the squares 1-2/I-II intermixed with limestone chunks (see Fig. 12). Beyond the limits of these spots the number of flint pieces distinctly decreased. Their concentration in the southeast corner (squares 9-10/II) was denoted as no. 1, in the squares 6–8/II, as no. 2, and the concentration within the dump as no. 3. Fragments of the clayey depressions at the west wall soon disappeared and it is not clear if they were also the top sections of some hollows. Only flakes were found in them.

Fig. 6. Polany, Site II. The concentration of flint artifacts and limestone rubble in the north part of Cut I/71. View from the south

Photo by J. Lech

Some details of the exploration of the I/71 cut were presented earlier (Chmielewska 1973), therefore we give only the most important results of it. It was observed that the concentrations of flint artifacts roughly coincided with the limits of sand clay spots. It was found that the outlines of the concentrations decreased and moved to the east as deeper layers were removed in the squares 6–10/I-II. In the Concentration 1 the clay material vanished already at 35 cm depth, while the floor of the clay and sand material was reached in that part of the cut at 60 cm depth. Flint artifacts, in the form of flakes, occurred in the underlying sand down to 80 cm depth. Some were set vertically in the sediment.

Beginning with 45 cm depth, in the studied part of the cut, there occurred bands, lenses and layers of red clay with detrital look. They increased in thickness as lower layers were removed. Therefore, it was supposed that it underlay in situ the above-mentioned hollows. To remove its top, a narrow trench was made along the east wall of the cut. It was then found that the top of the clay level was uneven. It was uncovered at 80–120 cm depth on average (and slightly higher in the south part of the square 10/II). On the other hand, beneath the concentrations of flint artifacts, it lay much deeper and could not be reached (Fig. 7), for, because of the increasingly frequent autumn rains, the work had to be stopped.

Extending the trench to the north, the previously uncovered dump (Concentration 3) was intersected. It reached even deeper down to 35–45 cm. It was underlain by the same sands that were observed in the remaining area of the cut. Very numerous flint artifacts occurred down to 40–45 cm depth on

[4] All the depths were measured from the floor of the tilled soil and are given here in this way.

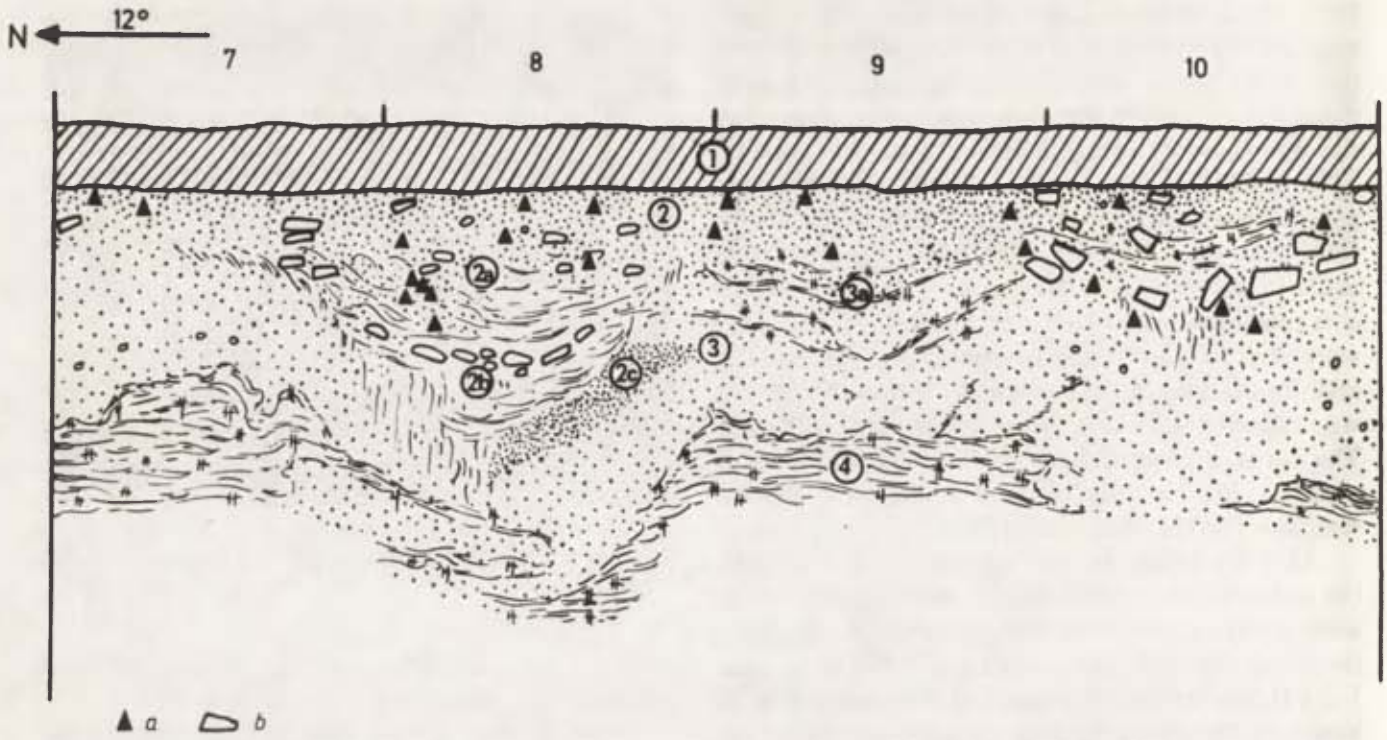

Fig. 7. Polany, Site II. The south fragment of the cross-section of the east wall of Cut I/71

1 – tilled soil, *2* – dark brown sand, *2a* – sandy clay, *2b* – sandy clay with humus intrusions, *2c* – lens of white and yellowish sand, *3* – yellowish sand, *3a* – streak of rusty red clay, *4* – rust clay; *a* – flint artifacts, *b* – limestone rubble

Acc. to M. Chmielewska 1973, 30, Fig. 1

average. The top of red and rust-coloured clay was reached here at about 80 cm depth and it was penetrated down to 95 cm.

As a result of the 1971 excavations, it was found that flint artifacts also occurred at levels beneath the arable soil, forming there well-separated concentrations. The specimens found in them differed only in terms of state of preservation from those lying on the surface of the site and in the arable soil. Objects from deeper levels were not patinated at all or only slightly. On the other hand, the research failed to give more data so as to make it possible to explain such questions as the chronology or cultural origin of the uncovered pieces or the nature of the site. From observations of the cross-section of the east wall of the trench (Fig. 7) it was inferred that the distinguished concentrations of flint artifacts lay in, most probably natural, hollows, predetermined by the karstic forms (sinkholes) of the terrain (Chmielewska 1973). A detailed analysis of the flint material coming from the excavations raised, on the other hand, a number of doubts as to the previously suggested great age of them (Schild 1971, 47ff.). The fact that no finished tools were among the artifacts, and there were numerous bifacial forms with the varying stages of working, many initially worked nodules and fragments of such specimens and of waste material (flakes), indicated that they came from much later on-site workshops. The presence of limestone rubble on the surface of the site and in concentrations with flint artifacts underlined the probability that a flint mine had existed within the site.

Fig. 8. Polany, Site II. Fragments of Cut I/72 after removing the tilled zone with a conspicuous outline of Concentration 1 in the southwest corner and of Concentration 2 in the middle part. View from the north

Photo by J. Lech

These suppositions were considered in beginning further excavations in 1972. The 1971 cut was expanded to the east with a trench (Cut I/72 – Fig. 5) of analogous shape and size. This made it possible to uncover fully the outlines of the previously distinguished concentrations of flint artifacts and to trace in greater detail the fills of the hollows where they were. The method of exploration was similar to that used in 1971, but additional cross-sections (control profiles) were introduced in the cut.

In keeping with the expectations, beneath the arable layer, the outlines of dark brown spots were uncovered, which were continuations of the top parts of the hollows with the Concentrations 1 and 2 (Fig. 8). In the north part of the cut, at that level we observed large amounts of limestone rubble and flint pieces, indicating possibly also a continuation of the Concentration 3. The hollows where they were, were deepened down to detrital clay in situ with chocolate flint nodules, and then down to the top of plate limestones which contained still another level of that raw material. The cross-sections of the hollows were observed on the walls of the cut and on control profiles, permitting an explanation of their origin. They were not, as had been supposed before, karstic sinkholes, but pits-shafts for chocolate flint extraction from a layer of residual (detrital) clay and the underlying plate limestones. Flint artifacts, with the varying degree of working, found on the surface of the site along with limestones detritus, were the relics of human activity connected with flint exploitation.

II. SHAFTS

The identification of Site II at Polany as a flint mine necessitates a more detailed consideration of its preserved elements. They include above all the extraction features, and then the remnants of the workshop where the raw flint was processed.

Within the cut, the top of detrital clay (15),[5] with a large amount of flint nodules and their natural chunks, was at 115–140 cm depth below the present surface. Its thickness was 80–100 cm. About 15–20 cm below the top of the plate limestones uncovered beneath it, there was still another level of flint nodules 10–15 cm thick. To reach these deposits, namely those of detrital clay and the nodules in the limestone rock (17), it seems that many extraction pits-shafts were dug. To do so, it was necessary to remove the overlay. The latter consisted of sands and gravels, slope-displaced along with plates of boulder clay and lenses of karstic clay, containing chemically weathered limestone chunks. Directly on the detritus there was in situ a layer of boulder clay (19), about 30 cm thick. In such material (sands and gravels) the outlines of the extraction features are hardly legible. They were most distinct in the feature uncovered in the squares 7-8/II-III, mainly in its bottom part. It is a shaft, denoted as Shaft 3, uncovered almost fully. Of the remaining features, the cut comprised only greater or smaller fragments of them. The walls of the extraction pits were quite well visible at the bottom where they penetrated the detritus and top part of the rock. Considering exactly these parts, in the cut under study we can point out fragments of at least 4 features and fragments of the upper parts of some others, however, it is difficult to establish it more precisely.

1. SHAFT 3

Its outline was visible in the North – South line in the cross-section of the west wall of Cut I/72 (Fig. 11), in the West – East line in the north and south walls of the control profile in the squares 8/II–IV (Figs. 9 and 10) and partly in the cross-section of Cut I/71 (Fig. 7). Its present opening part was uncovered soon after the tilled zone was removed. It was formed by a spot of brown, sandy clay with chunks of limestone rubble and a large number of flint artifacts of Concentration 2 (Figs. 8 and 14). On the basis of its outline and observations of the cross-sections of the walls (Fig. 10, 11 and 15), we can assume that the opening part was approximately oval, with the dimensions of about 330 cm × 260 cm. The walls of the shafts were dug up diagonally at the top. But from the boulder clay level (19), where it became less wide, and through the flint-bearing detritus clay (15) and the top of limestone (17), they were cut almost vertically. Such they were in the north and east parts of the shaft (Figs. 10, 11 and 16). The south wall was only visible at the bottom where it cut across residual detritus clay. In the North

[5] The fill levels of the lower parts of the shafts were distinguished in the course of the excavations by Dr. Jacek Lech, who also made part of the graphic documentation of Cut I/71 and the whole documentation of Cut I/72. The lithology of the described deposits of the fills of Shafts 3 and 1/2 was preliminarily elaborated by Dr. Barbara Ceranowicz from the Museum of the Earth, Polish Academy of Sciences, for which I am grateful. The numbers of the levels are given in brackets, while their colour on the (wet) Munsill scale is given as determined by Dr. J. Lech. I should like to thank here Dr. Lech for agreement for me to elaborate the materials from our joint excavations.

Fig. 9

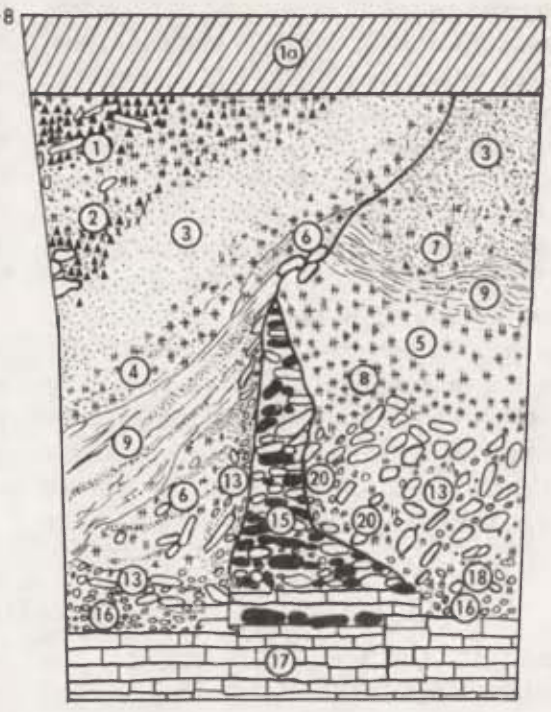

Fig. 10

Fig. 9. Polany, Site II, Cut I/72. The cross-section of the south wall of the control profile in the square 7/III with the fill of Shaft 3. The key as in Fig. 11

Fig. 10. Polany, Site II, Cut I/72. The cross-section of the control profile in the squares 8/III-IV with visible outlines of parts of Shaft 3 in the square 8/III and of Shaft 4 in the square 8/IV

5 – boulder clay with addition of gravel from Northern rocks (5YR 4/8, reddish brown). The other denotations as in Fig. 11

– South line the shaft bottom was about 1.5 m wide, and in the West – East line it was probably about 1 m or only slightly wider (no data from 1971). In the east part of the shaft, in the rock, its bottom became still less wide by about 15 cm.

The shaft was filled with intermixed and alternately bedded masses of sand, clay, chunks of weathered limestone detritus and rubble broken out from the bottom, and, at some levels, large amounts of worked flint pieces. It is difficult to trace and reproduce the dynamics of its filling. Directly on the bottom there was a layer of detrital clay (16) with limestone sand, gravel and some limestone rubble, but without flint nodules. At this level, at 180–200 cm depth, we found 13 worked flint pieces, 2 of which were stuck in the west wall of the cut (Fig. 11): an initially worked bifacial form (Plate I 6) and a flake. This material may have come from the upper levels of the dump at the shaft, since it was extracted from the deepest part of the object, at the final stage of its exploitation. Its horizontal situation indicates that it reached the shaft bottom by being washed down and slipping. Distinctly, Level 13 must have slipped down, too. From the south, where the outline of the shaft wall was already illegible, the beds dip very gently, whereas at the north side it was situated almost horizontally. In the east part, on the other hand, the levels dip very sharply (Fig. 10). The other, successive levels filling the shaft are various beds and lenses of clay (18, 8), some interbedded with sand, with a distinct flow structure (9). The slightly oblique dip of deposits which slipped or were washed down to the shaft from the south and probably from the west, indicates that the south and west walls may have been gently inclined even at considerable depth. On the other hand, the material of the levels (6, 9 and 13), which got inside the abandoned shaft over the north and east walls, is sharply inclined, and the angle became less steep as the object filled in. This assumption is also suggested by the asymmetrically bowl-like shape of the top of this whole series of the shaft fill 1 m over its bottom, with the greatest depression near the north wall (Fig. 11).

Another series of the shaft fill are sand deposits (7, 4 and 3) with a variable addition of clay. At the initial stage of its deposition, there dominated a slip and probably flow from the north and northwest of material with larger amounts of clay, underlying Level 3 (Fig. 11). The top of the sand series also shows the asymmetrically bowl-like outline. The maximum

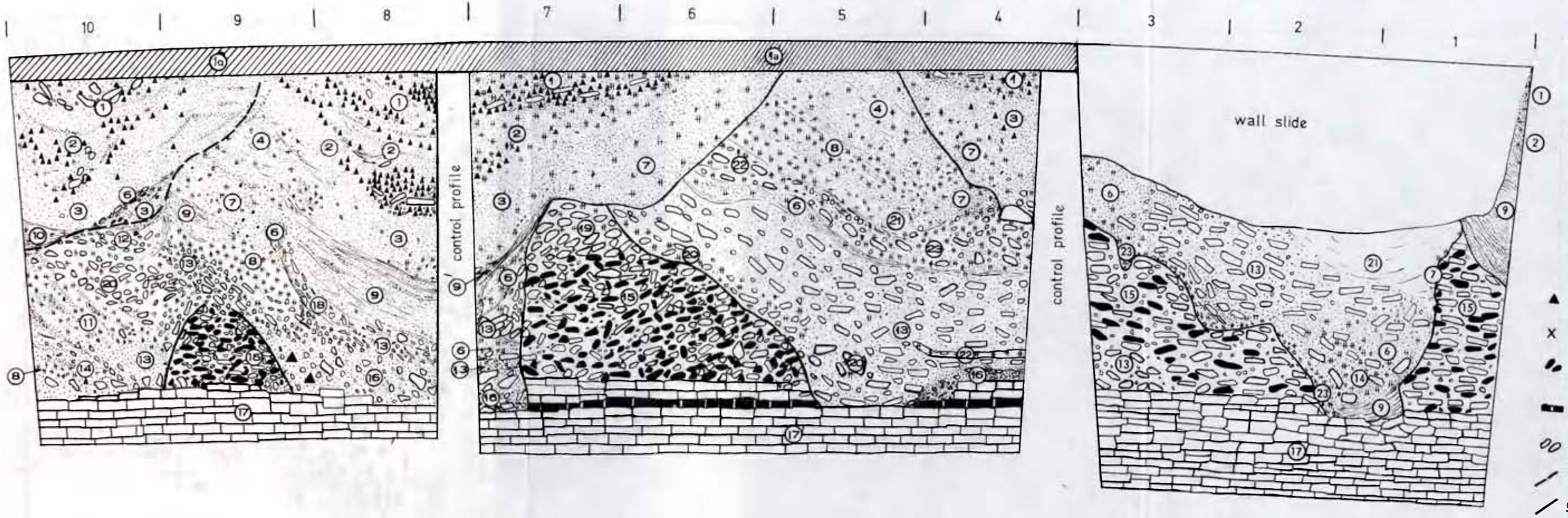

Fig. 11. Polany, Site II. The cross-section of the west wall of Cut I/72 with visible outlines of Shafts: 1/2 (sqs. 9-10), 3 (sqs. 6-8), 5 (sqs. 5-6), 6 (part of sq. 3 and sqs. 4-5), 7 (sqs. 1-3) and a slight fragment of Shaft 8 (sq. 1)

a – flint artifacts, *b* – charcoal, *c* – flint nodules in situ detritus, *d* – level of flint nodules in the top of the rock, *e* – limestone rubble, *f* – line defining the hypothetical boundary of Shaft 2, *g* – line defining the outlines of the distinguished shafts; *1a* – tilled soil, *1* – clayey sand with humus addition (7.5YR 4/6, brown), *2* – clayey sand with humus particles (10YR/3 – 4/6, brown, dull yellowish brown), *3* – sand with slight clay addition (10YR 7, bright yellowish brown), *4* – sand (10YR 7/6, bright yellowish brown), mixed with clay (7.5/6, bright brown) bedded, *6* – boulder clay with additions of gravel and sand, fine-bedded (7.5YR 5/6, bright brown), *7* – sand with slight clay addition (between 2.5Y 8/4 and 7.5YR 6/8, pale yellow to orange), *8* – silty clay (10YR 6/6, bright yellowish brown), *9* – sandy clay and clayey sand, bedded and with flow structure (2.5Y 8/4 and 10YR 6/6, pale yellow and bright yellowish brown), *10* – highly sandy clay with flow structure (7.5YR 5/6, bright brown), *11* – highly sandy clay, with flow structure (7.5YR 5/6, bright brown), with lenses of slightly clayey quartz sand (7.5Y 7/3, dull orange), *12* – clay gravel and limestone sand and additions of boulder clay and fine flint rubble (10YR 7/6 and 7.5YR 5/6, bright yellowish brown and bright brown), *13* – detrital clay with sand, rounded gravel and limestone rubble, and fine flint debris (2.5Y 8/6, yellow), *14* – mixture of detrital clay (as in Level 13) with washed boulder clay with gravel and sand from Northern rocks and with silty clay (as in Level 8 with colour as in Levels 1, 8, 13 and 5 – see Fig. 10), *15* – in situ detrital clay with a large number of chocolate flint nodules (2.5Y 7/8, yellow), *17* – platey limestone, *18* – detrital clay with addition of boulder clay and rounded gravel and limestone rubble (10YR 4/4, brown), *19* – boulder clay (on the deposit primary relative to the shafts) with gravel from Northern rock and rounded limestone rubble (5YR 3/6, dark reddish brown), *20* – boulder clay (as in Level 19) with slight addition of fine flint debris, *21* – silty clay with addition of boulder clay (10YR 7/6–6/6, bright yellowish brown), *22* – boulder clay with fine gravel from Northern rocks, with addition of silty clay (as in Level 21), sand gravel and fine, rounded limestone rubble, *23* – detrital clay with large proportions of silty and boulder clays and with fine gravel from Northern rocks and addition of fine flint debris (10YR 5/3, 5/4, 5/6 and 5/8, dull yellowish brown–yellowish brown, *24* – detrital clay with sand and rounded limestone gravel, mixed with boulder clay and fine gravel from Northern rocks (5YR 5/6, 5/8, 4/6, 4/8, bright reddish brown–reddish brown)

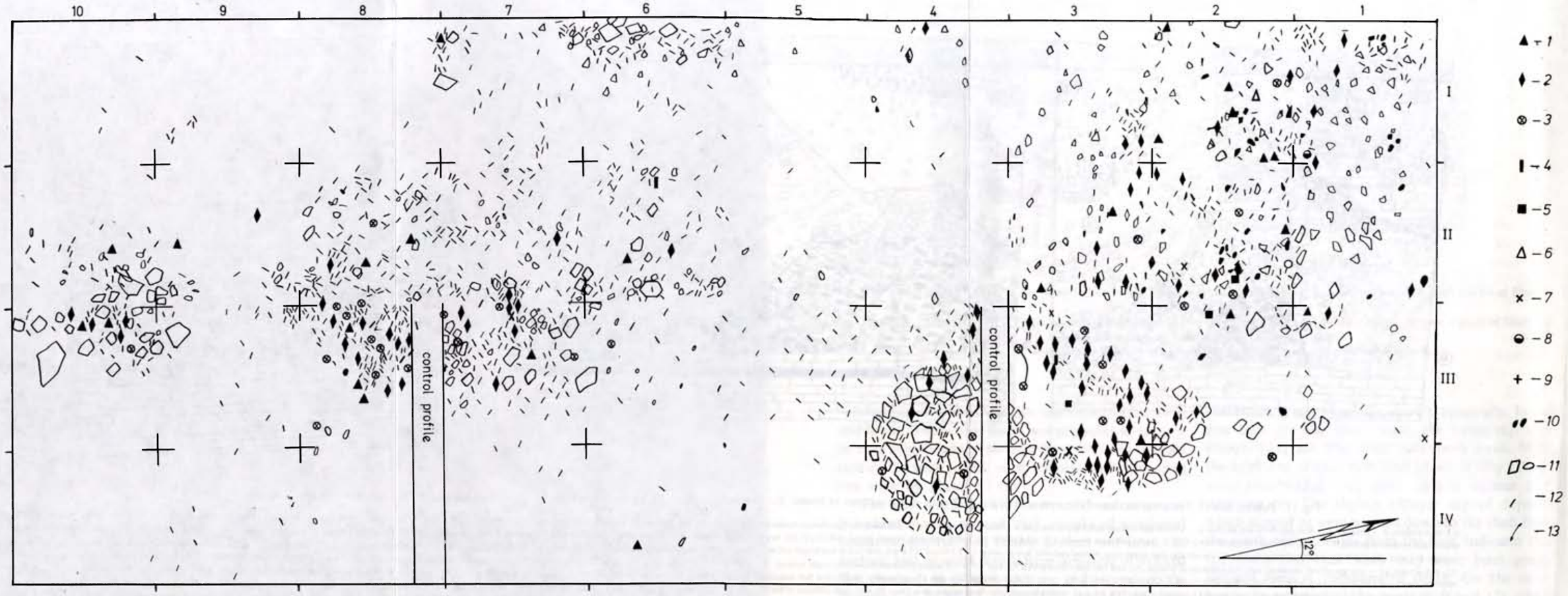

Fig. 12. Polany, Site II, Cuts I/71 and I/72. The spatial distribution of the archaeological materials of Concentration 1 (sqs. 10/II-III and the south part of the sq. 9/II-III), Concentration 2 (sqs.6–8/II-III and the north part of the sqs. 9/II-III), Concentration 3 (sqs. 1–3/I-II) and Concentration 3a (sqs. 2–4/III-IV) at a level of 10 cm below the tilled soil. In the corner of the sq. 6/I there is a fragment, probably a dump of an unidentified shaft

1 – initially worked bifacial tool, *2* – worked nodules, *3* – broken and natural nodules, *4* – flint picks, *5* – scaled pieces, *6* – cores, *7* – tools on flake blanks, *8* – flint hammer stone, *9* – charcoal, *10* – erratic pebbles, *11* – fragments of limestone plates, *12* – flakes and small flint waste, *13* – lines connecting the pieces fitting together

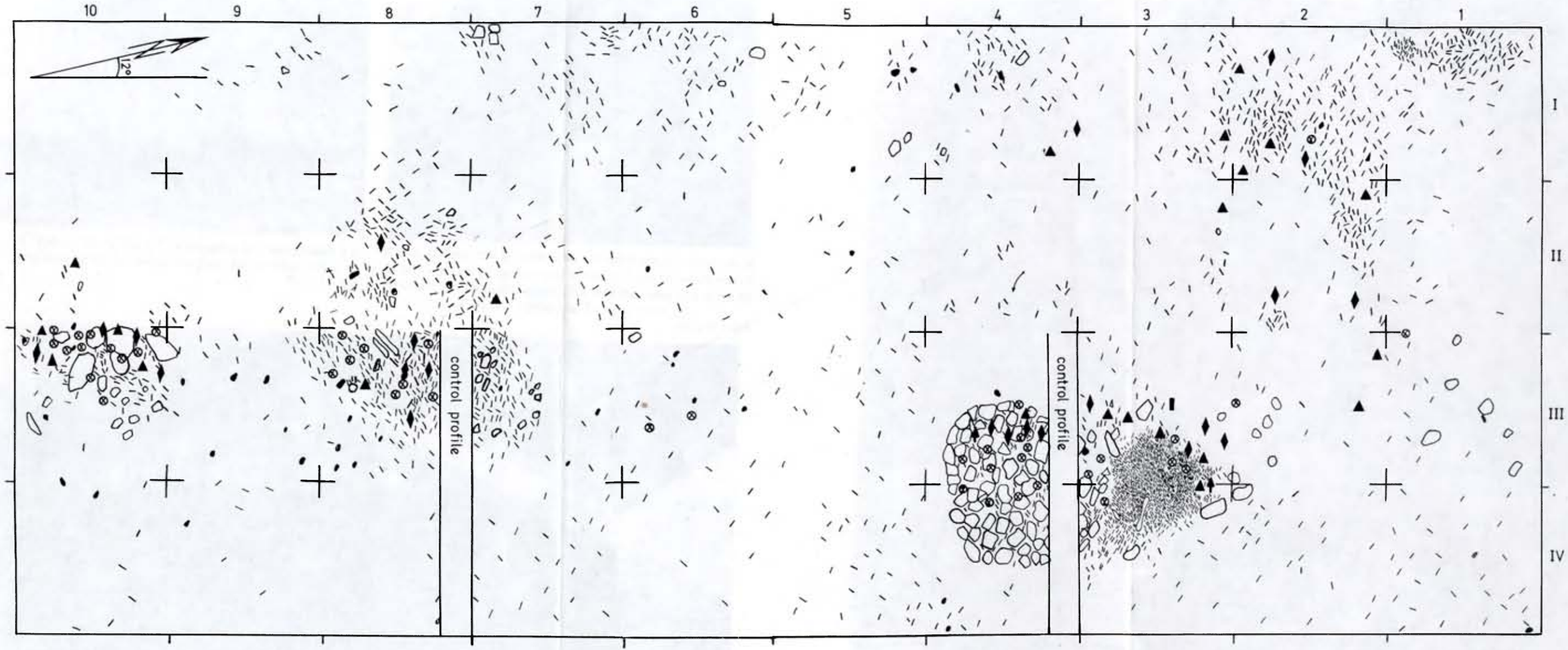

Fig. 13. Polany, Site II, Cuts I/71 and I/72. The spatial distribution of the archaeological materials of Concentrations 1, 2, 3 and 3a at a level of 15 cm below the tilled soil

The key as in Fig. 12

Fig. 14. Polany, Site II, Cut ¯/72. The outline of Concentration 2 at the level of 10 cm below the floor of the tilled soil
Photo by J. Lech

Fig. 15. Polany, Site II. View from the southeast of a fragment of the cross-section of the west wall of Cut ¯/72 and the south wall of the control profile in the square 7/III, with the upper part of the fill of Shaft 3 containing Concentration 2
Photo by J. Lech

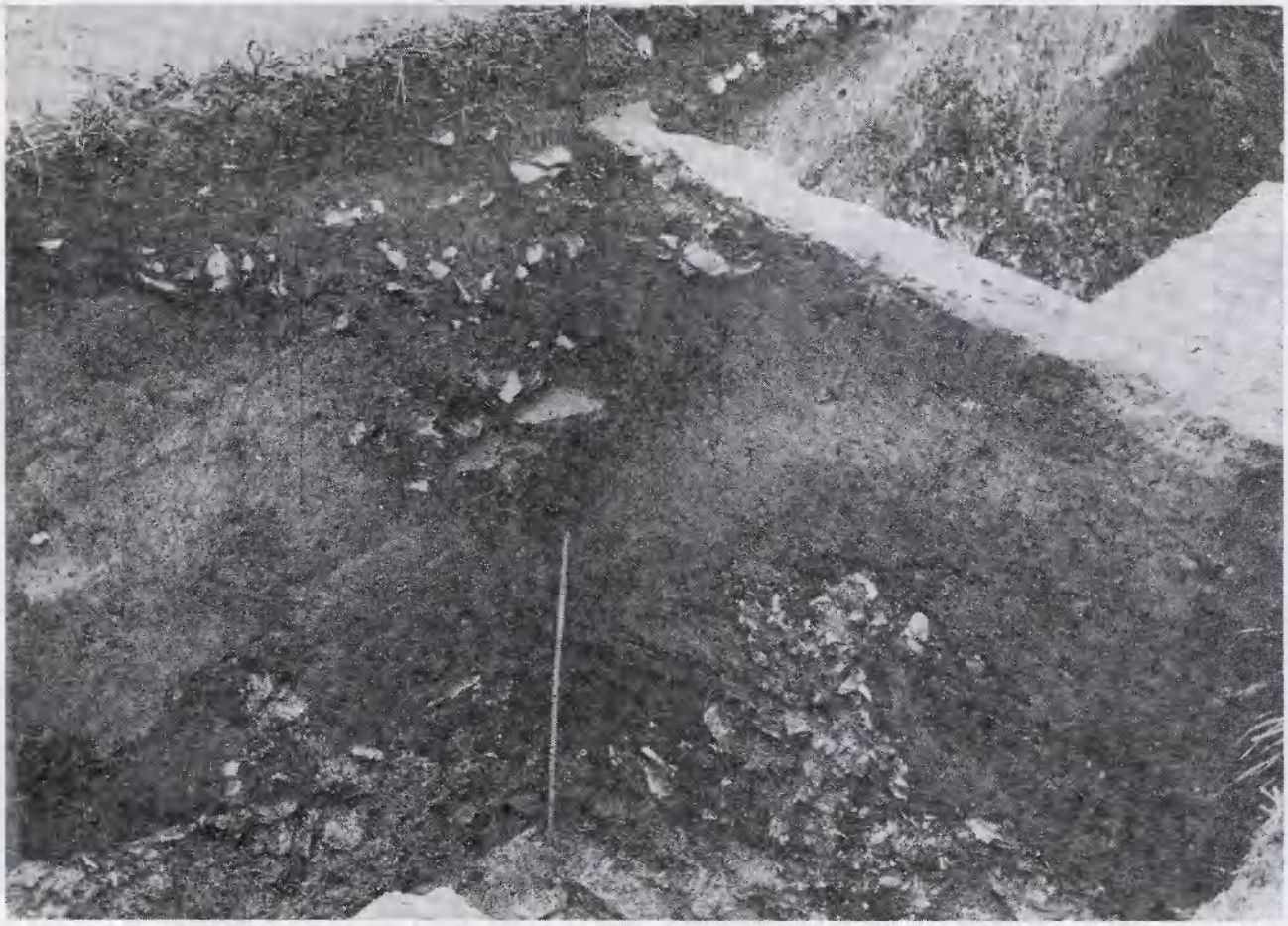

Fig. 16. Polany, Site II. View from the southeast of a fragment of the cross-section of the west wall of Cut ¯/72 and the south wall of the control profile in the square 7/III, with the fill of Shaft 3 uncovered to the top of the rock, containing Concentration 2 in its upper part
Photo by J. Lech

depth of the bowl in the North–South line was slightly shifted to the south. It may have been caused by the very slight inclination of the walls of the shaft in the north part, turning into a horizontally cut step (for communication ?) in the top of the boulder clay levels (19). The upper sections of the east and south walls were much steeper. The upper part of the shaft from the west may have looked similarly, since in Cut I/71, in the middle part of the square 8/II, the sand layer of Level 3 was reached already at 70 cm depth (Fig. 7). The bowl-like depression (3) was filled with clay and sand material (2) with humus particles and tiny pieces of charcoal. Still higher, there was another level of sandy brown clay (1), also with an addition of humus, pieces of charcoal and numerous flint specimens. The ceiling of the fill was topped with tilled soil (1a), where a great many processed flint pieces occurred. The presence of the so numerous flint artifacts along with pieces of charcoal indicates that man participated in the formation of both of the upper layers of the fill (1, 2).

2. PARTLY UNCOVERED SHAFTS

A large part of a similar shaft, denoted as Shaft 2 during the excavations, was discovered in the squares 9-10/II-III. The outline of its opening was also visible just under the tilled soil, in the form of a brown spot of sandy clay. Inside it, there were worked flint pieces and fragments of limestone of Concentration 1 (Figs. 12, 13, 17). The revealed part at the opening had the shape of an irregular half-oval, 160–170 cm large in the North–South line and about 100–110 cm at the south wall which it entered.

The materials in the upper part of the shaft (Levels 1–3) were arranged similarly to the way in Shaft 3. Just as in Shaft 3, flint artifacts formed 2 levels as it were (Fig. 18). There was only some difference in the top of Level 3, which had the shape of a more steep-bottomed bowl compared with that in the object described above (Figs. 11 and 19). Strongly sandy brown clay (10) underlay Level 3 at the south wall.

In the floor of the shaft there was a material which was a mixture of detrital clay, sand, gravel, limestone rubble and boulder clay (14), containing lenses of sand (3) and silty clay (8), and single pieces of charcoal. This conglomerate was 20–45 cm thick at the south wall of the cut. It was covered by a layer of sandy clay (11) with sand lenses, with the slip character, probably from the south and perhaps from the southeast, as would be indicated by its dip and thickness, which inreased from 5 cm at the north wall to about 65 cm to the South. Over Level 11 we observed clay lenses and packets, containing variable amounts of gravels, sands and limestone rubble, denoted in Fig. 11 as nos. 12, 13 and 20.

The walls of the shaft were not satisfactorily

Fig. 17. Polany, Site II. The outline of a part of Concentration 1 uncovered in the southwest corner of Cut I/72, after removing the tilled soil

Photo by J. Lech

Fig. 18. Polany, Site II. The southwest corner of Cut I/72 with the upper part of the fill of Shaft 1/2 with Concentration 1. View from the northeast

Photo by J. Lech

Fig. 19. Polany, Site II. The southwest corner of Cut I/72 with the fill of Shaft 1/2 uncovered to the top of the rock, containing Concentration 1 in its upper part. View from the northeast
Photo by J. Lech

legible, in particular in the lower part. There was only the distinct outline of the bottom part of the north wall, cutting across a small preserved fragment of in situ detrital clay (15). It separated the floor part of Shaft 3 from the described one. Over the detritus, it would be difficult to determine a certain boundary between them. On the west wall there was a distinct overlapping of the levels of fill of the two features.

In the course of the excavations, the floor of Levels 3 and 10 was taken as the lower boundary of Shaft 2. The materials lying below them were recognized as the remnants of another, older shaft, which was denoted as Shaft 1. Figs. 11 and 20 show this boundary, marking however, its hypothetical nature. The above-mentioned similarities in the arrangement of the levels of the upper part of Shaft 3 and the presented one indicate that they are similar objects. The difference between them is the different dynamics of filling their lower parts. In Cut I/71 we uncovered the west part of Shaft 2 (Fig. 7). We investigated and documented its particular levels down to 60 cm depth. Flint materials occurred down to 35 cm. Thus, we found part of the west boundary of the pit. With this in mind and from observations of the outline of the shaft on the south wall of the cut (Fig. 20), we can suppose that the excavations uncovered a considerable part of it.

Probably, Levels 1–3, to be seen in the cross-section of the west wall of the cut, are not, as has been presumed in the field analysis of the cross-section, only the upper fragment of the feature whose main part would be beyond the limits of the cut. This feature is supposed to have interfered with a previously existing older shaft, denoted as Shaft 1. The remnants of its fill would be the materials to be seen below Levels 3 and 10. The charcoal pieces, with the ^{14}C date of 1541 $\pm$ 81BC (BM 1235), come from their lowest level (14). The date has already been published as coming from Shaft 1 (Lech 1981b, 48). To avoid confusion in the numbering of the shafts, but also to stress the controversy over its presumed two-stage nature (doubts about which were voiced above), in the further part of the paper we denote it as Shaft 1/2.

In the fill of the presented object, below Level 3, we found only 2 flint chips, right at its bottom. The present depth of the shaft was 220 cm. In the rock there was no level of flint nodules and in the uncovered part of the shaft it was not extracted.

In the south part of the cut we uncovered a fragment of still another shaft, denoted then as Shaft 4. It was visible on the wall of the control profile in the square 8/IV. In contrast to the previously described features, in the upper levels of the squares 7–8/IV, there were no flint artifacts except 2 or 3 flakes (see Fig. 12) and nothing indicated the presence of a shaft. Neither at lower levels were any archaeological materials found. Because the shaft was only partly uncovered, there are no data with which to establish its full size and shape, in particular so as the upper part of the object was intersected from the west by the cut of Shaft 3. We can see from the cross-section of the south wall in the square 8/IV that after detritus (15) was removed, the limestone underlying it was broken out in a search for the level of flint nodules (Fig. 10). We do not know if it was reached, since in the adjacent Shaft 3, under the unextracted fragment of detritus, the flint level in the rock lay slightly lower. We can too see in the above-mentioned cross-section that close to the floor of detritus the wall of the shaft was "caved out" to make it possible to fully extract the chocolate flint nodules in it.

The present depth of Shaft 4 was about 220 cm. In the fill in its studied part we can see a more distinct segregation of the materials making it up compared with the other features presented here. The lower part is filled with a series of deposits, for the most part of rubble and clay (13, 16, 18, 20). Over it there is a

series of almost rubbleless clay materials (5, 8, 9). The upper part is filled with sand deposits, with a slight addition of clay material (7, 3). This indicates the large part of the natural factors affecting the process of filling the described shaft.

We also uncovered fragments of extraction pits within the cut in the squares 1–6/III-IV. Here, the top of the flint-bearing detritus occurred at a similar height as in the squares 7-8/III-IV, and its thickness was as much as 1 m. It was intensively exploited, as is evidenced by the discovery of as many as 4 shafts over such a small surface area. Their boundaries intersected.

In the squares 4–6/III-IV we came across traces of a large extraction feature, denoted as Shaft 5. It was cut from the south and probably from the west by the wall of Shaft 3. At its bottom, detritus with flint nodules was extracted along the North – South line over about 2 m. However, the level of nodules embedded in the rock was reached in the uncovered part of the shaft only over a short section (Fig. 11). The lower part of the feature was filled with layers and lenses of a mixture of detrital clay with Quaternary material (13, 16), or of solely Quaternary material (6, 20), with a large addition of mud and silt (21, 22, 23). The top of the clay series had the shape of a shallow hollow. It was filled with sand material (7, 4), with a lens of silty material (8) distinct in it. The origin of the fill should be connected with a dump at the shaft.

It was impossible to establish either the exact shape or the full size of Shaft 5. Its west part was in Cut I/71, where the strip of the squares 4–6/II was dug up down to 80–120 cm. Moreover, its walls were damaged by the younger shafts, namely the above-mentioned Shaft 3 from the south and south-east, and Shaft 6 from the north and (probably) from the northeast (Fig. 11).

A part of the latter one, uncovered during the excavations in 1972, ran along the whole width of the cut (squares III-IV). Its outline was visible on the walls of a control profile of the squares 3-4/III-IV (Figs. 21 and 22). The upper fragment of the west part of the shaft was within the squares 3-4/II and was not distinguished in the course of the 1971 work. The opposite part entered the east wall of Cut I/72. The collapse of the wall in the strip of the squares 1–3/III makes it additionally difficult to distinguish the limits of the objects. In the cross-section of this wall, in the square 3/III, only a small fragment of Shaft 6 can be seen (Fig. 11).

The lower part of the feature was filled with beds, lenses and packets of material which was a mixture of

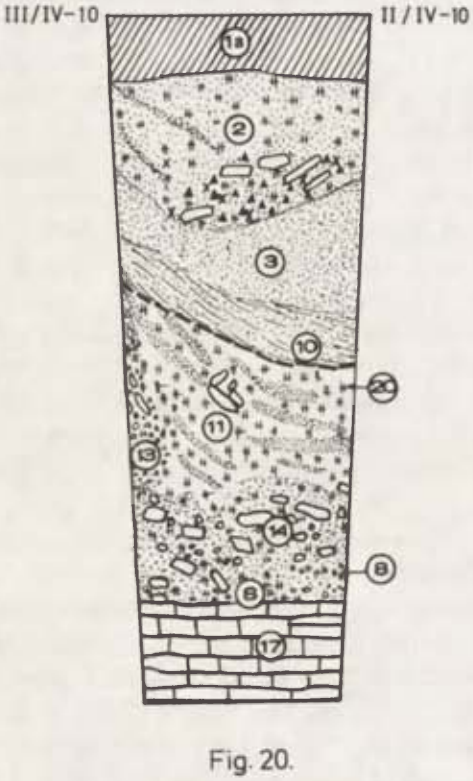

Fig. 20.

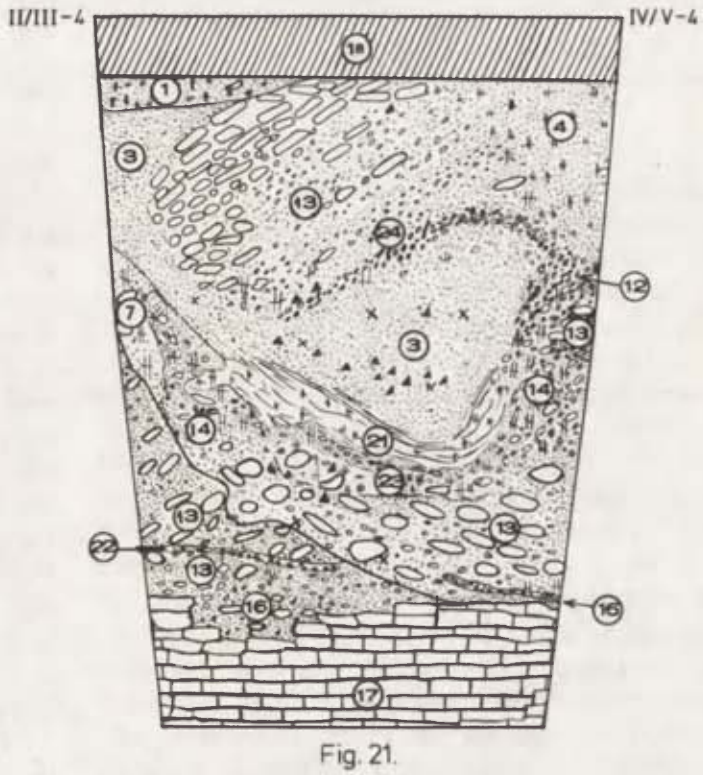

Fig. 21.

Fig. 20. Polany, Site II. Detail of the cross-section of the south wall of Cut I/72 with the fill of Shaft 1/2.
The key as in Fig. 11

Fig. 21. Polany, Site II, Cut I/72. The cross-section of the south wall of the control profile in the squares 4/III-IV with a part of the fill of Shaft 6 and the top-section fragment of the fill of Shaft 5 (left corner).
The key as in Fig. 11

Fig. 22. Polany, Site II, Cut I/72. View from the north of the north wall of the control profile in the squares 3/III-IV with part of the fill of Shaft 6 uncovered to the top of the rock and a packet of rubble and clay dump to be seen in its upper part
Photo by J. Lech

detritus and variable amounts of Quaternary material (sands, gravels, boulder clay with a varying addition of limestone rubble). Some had a distinct flow structure (10). In the lens of sandy clay there were single tiny pieces of charcoal. The arrangement of these deposits indicates that the natural processes played a large role in filling the lower part of the shaft.

The top of the upper portion of the fill was different in character from the features analysed above. In a large part, it was formed mainly by limestone rubble intermixed with clayey material, making up Level 13. This concentration of limestone rubble occurred in the squares 3-4/III-IV, just under the tilled soil. Its plane had almost a circular shape, with a diameter of 120–115 cm (Figs. 12, 23 and 24). Between fragments of limestone there were numerous flint artifacts. This rubble and clay packet was 25–45 cm thick. The diagonal position, from the northwest to the southeast, of plate limestone fragments (Figs. 21 and 22) indicates the direction from which the material, indeed the rubble part of the dump, reached the already largely filled shaft.

The remaining part of the fill was sandy material (3) with a slight addition of clay (4). Flint objects in

Fig. 23. Polany, Site II. View from the north of the north part of Cut I/72. In the foreground: the packet of limestone rubble and clay dump, uncovered by removing the tilled soil, from the top of the fill of Shaft 6 with some materials of Concentration 3a
Photo by J. Lech

Fig. 24. Polany, Site II, Cut I/72. A packet of a rubble and clay dump, uncovered to the floor, from the top of the fill of Shaft 6. View from the north

Photo by J. Lech

varying amounts were found at almost all the levels. 37 pieces come from the lower part of the fill. They were most numerous in the upper part of the rubble and clay packet (13) and in the top of the sand series (1). Dispersed pieces of charcoal were found at all levels of the fill. The only antler piece to be found at the site (probably a damaged pick) lay in the bottom of Level 3, at 150–160 cm depth, under the west wall of the cut (Fig. 25). The depth of the uncovered part of the object reached 205–210 cm.

The already mentioned collapse of the wall of the cut made it seriously difficult to observe the remanants of still another shaft, Shaft 7, uncovered in the squares 1–3/III-IV. Moreover, it was damaged by 2 later shafts made in its direct vicinity: Shaft 6 and Shaft 8 (from the North). The bottom part of the shaft, to be seen in Fig.11, was filled with clay and rubble material, resembling that in the other shafts. Its upper part was filled with sandy material with an addition of clay. Archaeological materials (mainly in the strip of the squares 1–3/III) occurred only in the top of the sand series down to about 35 cm depth.

Fig. 25. Polany, Site II. An antler pick lying in the fill of Shaft 6

Photo by J. Lech

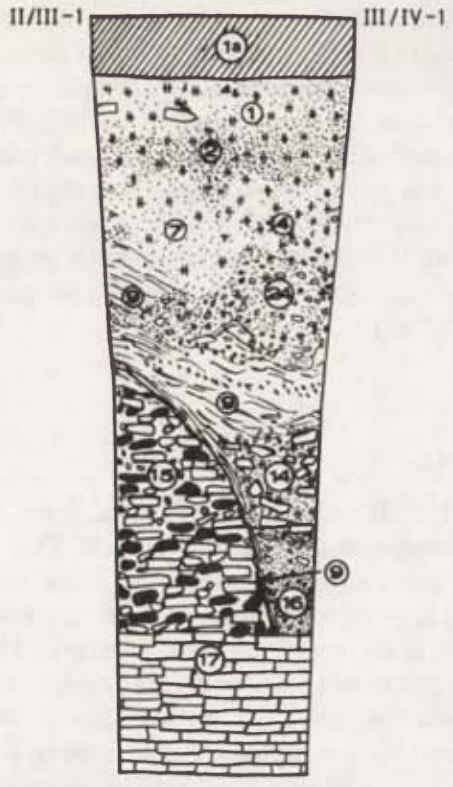

Fig. 26. Polany, Site II. The cross-section of part of the north wall of Cut I/72 with a fragment of the fill of Shaft 8
The key as in Fig. 11

In Shaft 7, in contrast to the other investigated objects, detritus was extracted to the limestone top only over a small surface area (about 0.5 m), as can be seen in the cross-section of the wall of the shaft (Fig. 11). We cannot exclude, however, that the outline of Shaft 7, uncovered in the squares 1–3/III, to be seen in that wall, is only its end section, probably the east one. Its main part may have been in Cut I/71. This possibility is also indicated by the presence of numerous worked flints along with limestone rubble, observed in the squares 1–2/I-II and partly in 3/I-II. They were encountered at the upper levels of this part of the cut, as soon as the tilled soil was removed (Figs. 6 and 12). Large amounts of them were taken from a trench dug up in 1971 at the east boundary of the above-mentioned strip of the squares, namely on the boundary of the two cuts, where they occurred down to 40 cm depth. It is then probable that they come from the upper levels filling the bowl-like hollow of the shaft, just as it occurred in a few of the features presented above. No archaeological materials were found in the lower series of the fill of Shaft 7. The present depth of the excavated part of the shaft is about 230 cm.

Only slight fragments of Shaft 8 were visible in the northwest corner of the cut, on the west and north walls (Fig. 11 and 26). This prevents a more detailed study of the feature. It was made later than Shaft 7, since it cuts across the upper part of the north wall of the latter. In the northwest corner, the lower parts of the two shafts are separated only by a thin wall of untouched detritus (Fig. 11).

3. RESULTS OF ANALYSIS OF SHAFT FILLS

The presented observations of the shaft fills indicate that they were filled mainly through the natural processes. This brought about a distinct segregation of the fill deposits. The original material came from dumps situated close to the shaft openings. The lower part of the fill was usually formed by a rubble and detritus series, followed by a series of clay and silt formations and, finally, by a series of sandy material with an addition of clay. This is a simplified pattern, which characterizes only in the most general terms the contents and dynamics of filling the shafts. In its first stage gravitational factors dominated — the sliding of limestone rubble covering the top and the slope of the dump facing the shaft. In the next stage, a large, and perhaps a dominating role, was, except for sliding, played by washing from heaps of silt and clay material. Obviously, even in the first of the mentioned series there were lenses and small beds of clayey material without rubble, just as in the clay series there was an addition of rubble and sandy material. The number of these fractions does not affect decisively the nature of a given series, and their presence does not undermine either the supposed natural filling of the pits. There are no data to support the thesis that there were any longer breaks in these processes or how long it took to fill up the pits to the top of Level 3. Its bowl-like shape can represent the conclusion of a certain stage of filling the pits, perhaps interrupted for some time.

The two lower series of the pit fills described here correspond approximately to the first and second stages of pit filling as distinguished by R. Schild in the shafts of the site Polany Kolonie II (Schild, Królik, Mościbrodzka 1977, 34 ff.). The hypotheses by this author saying that the pits at this site filled quickly, proposed from observations of the now abandoned peasants' limestone quarries, can certainly be also extended to many objects of Polany II. Similarly, Krukowski (1939–1948, 90) assumed that the pits at the site of Orońsko II had filled just over a dozen-odd years.

The series of sandy deposits with a lesser or greater addition of clay from the upper part of the fill may have been deposited over the period when the walls of the bowl-like pit of partly filled shafts had already been overgrown by scarce vegetation. By sliding, washing,

and in some periods by blowing, sandy materials, along with the washed in clayey particles, gradually filled the pit hollows. It is impossible to determine the time and rate of these processes. The top levels of this series, containing numerous flint materials, were already related to man's intervention in the final stage of filling the pits.

At a site where the extraction pits were so dense, namely at Polany II, we can expect such ones as had been fully or partly filled not by the effect of the natural forces but by material from dumps pushed into them to make space for new pits or by the overburden from the pits dug up in the vicinity. Such may have been the origin of the rubble-and-clay packet (13) in the upper part of the fill of Shaft 6 (Figs. 21 and 22), or of the lenses and packets of deposits underlying directly Level 3 of the fill of Shaft 1/2. Because these shafts have been only partly uncovered, it is difficult to distinguish between the results of a natural collapse and the purposeful activity of man.

III. MINING TOOLS

The studied part of the mine yielded, despite conspicuous mining work, few tools applied in them. On the basis of the results of analysis of the extraction pits, we could expect to find tools used for digging, extracting flint from detritus, crushing the limestone top beds, loosing and breaking out pieces of this rock and finally picking out and taking out usually platey flint slabs in it.

The set of mining tools from the Neolithic and Early Bronze flint mines in the different regions of Europe is strikingly uniform. The antler-made tools include the different kinds of picks, hoes, wedges, levers, hammers and sometimes shovels. They are the different parts of antler, most often those of a deer, appropriately divided, usually with no additional working. Bone tools are less frequent. They are specially prepared shoulder blades (shovels) and long bones (wedges, axes) of bovids. Stone tools are represented by axes, frequently flint made (also called picks), with one or two bits, hammer stones and hoe-like pieces.

1. ANTLER-MADE TOOLS

We only found on piece, probably a pick, badly preserved (as a result of chemical weathering the spongioza was destroyed). It is the proximal beam of a red-deer's antler, broken is the lower part and with one tine damaged at the top and also a trace of another broken-off tine. Part of the breaking surface bears traces of polishing (Fig. 27)[6]. They may have arisen in carrying such work where the active part of the antler was the top of the preserved tine. We did not observe any other traces of using the specimen, as a result of damage and bad state of preservation. Its present length is 46 cm, the diameter of the beam about 4.8 cm. It was found in the fill of Shaft 6, in the clay level, right at the west wall at 150–160 cm depth (see Fig. 25).

The fact that in the initial stage of excavations only one specimen made of red-deer's antler was found, must not necessarily indicate the limited range of application of antler-made tools by the miners. This is contradicted by the assemblage of various antler-made mining tools found in the fills of shafts at Polany Kolonie II (Schild, Królik, Mościbrodzka 1977, 67–76). It needs also to be pointed out that in the fills of pits at Polany II we found very small antler fragments, even splinters at times, indicating their intensive application. Some of the specimens may have perished due to the impact of the depositional environment where they rested, some still await being discovered.

2. STONE TOOLS

The most numerous are flint picks. Some authors stress that these tools were useful only in extracting flint from soft Cretaceous rocks (Schmid 1973, 27). The massive presence of these specimens at points of flint extraction from Cretaceous deposits, along with many traces of their use left on the surface of the rock (Hubert 1978, 35, Fig. 20) indicates their large usefulness for mining in Cretaceous rocks. The permanent presence of flint axes at points of flint extraction from Jurassic deposits in the Polish territory (Krukowski 1939–1948, 33; Żurowski 1962, 45; Schild, Królik, Mościbrodzka 1977, 65; Lech 1981a, 284, Plate VIII 5) indicates, on the other hand, the greater universality of application of these tools in flint mining.

[6] The polishing traces were pointed out to me by Dr. Alicja Lasota-Moskalewska for which I am grateful.

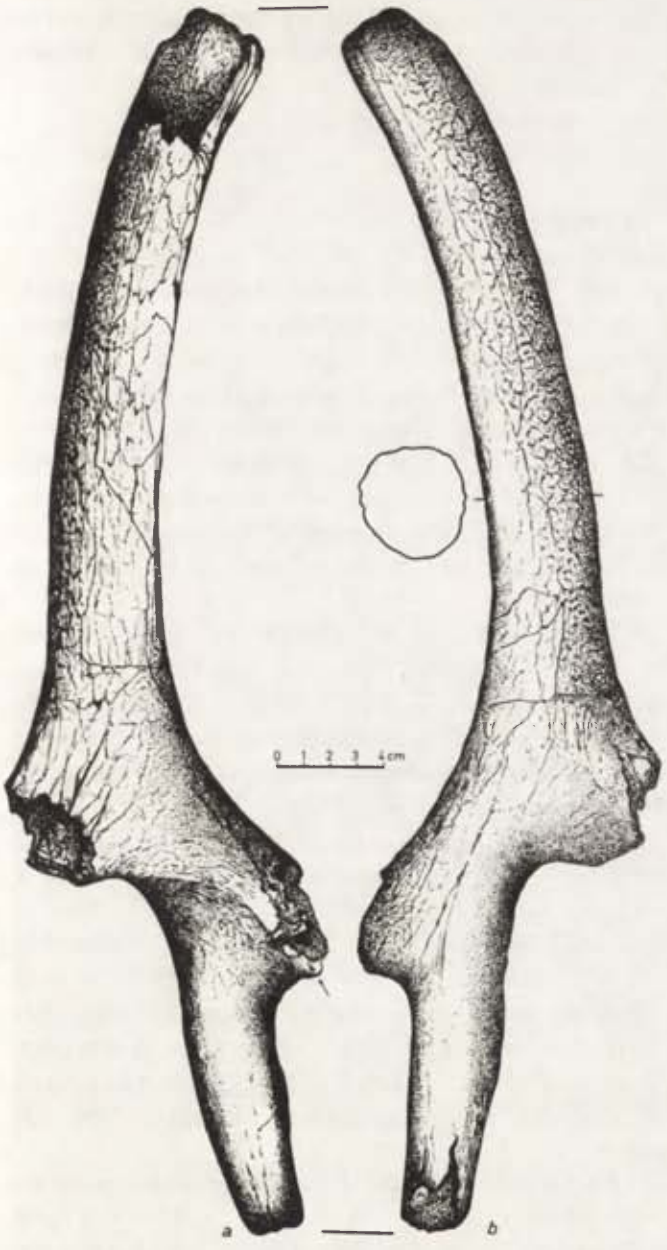

Fig. 27. Polany, Site II. A pick from a red-deer's antler, found in the fill of Shaft 6 (the arrow indicates the place of polishing)

Drawn by J. Niewiadomska

The only undamaged flint pick from the mine of Polany II comes from the fill of Shaft 6. It lay at its bottom, at 200 cm depth, in the rubble level (13). It is a pick with two bits (Plate II 1), 16.6 cm long. The specimen has a variable cross–section: it is triangular in the narrower part and high, lens–like in the wider part. In the longitudinal cross–section the piece is as if twisted from the point of its greatest width. At the narrower bit there are two retouched notches, giving it considerable penetrability, and the wider edge is sharp-arched. This pick is not patinated, its faces are matt, the edges fresh, without conspicuous use traces.

The other specimens of flint picks come from the upper levels of the shaft fills. Almost all of them are damaged. Despite this, their shape, working and even the kind of damage perit them to be regarded as picks. Moreover, still another few pieces can be determined as atypical picks.

The damaged picks include two elongated pieces with lens-like cross-section and broken bits (Plate V 3), one solid piece with tetrahedral cross-section and a broken bit and two fragments of picks (bits) with triangular and lens-like cross-sections, and also one short piece with high triangular cross-section. Some of them have already been published (Chmielewska 1973, Figs. 2C and 3F – from Concentration 2 at Pit 3; Fig. 3B – from Pit 7, Concentration 3; Fig. 3C – from the surface of Cut I/71).

The atypical flint picks, of which five were distinguished, are partly worked specimens, damaged in the course of production or working with them. The flint materials at the site also include specimens which resemble picks in their shape and preparation, but which are rather of different initially worked bifacial pieces (e.g. Plate III 1).

The hoe-like form is represented by the tall specimen (Plate IV 1 a, b), with rectangular cross-section. It was worked from the two sides to the dorsal face. The smooth ventral face of the tool was the natural surface of the nodule. Perhaps, this is an unfinished piece. Near the bit there are two invasive scars on the ventral face and one burin-like facet. The piece, found in 1971 in Concentration 1 from the upper part of the fill of Shaft 1/2 (5–10 cm depth) refits with a flake in the east part of this concentration, found in 1972 (Plate IV 1b).

The extraction, albeit to a small degree, of flint material, also from the top of limestone beds, suggests the use of hammer stones to crush the limestone. Various hammer stones were used, mainly from quartzite rocks or metamorphic rocks. They are known from sites where flint was extracted from limestones. They are usually large, oval pebbles, used in two-handed work or with a strangulation in the central part, most probably used for hafting. There are also, at times hammerstones without strangulation, and it is believed that they were used single-handed (Schmid 1973, 22 ff.; 1980, 164 ff., Figs. 146–148).

So far at Polany II no strangulated hammerstones have been found. In the upper part of the fill of Shaft 3 there lay an oval quartzite hammerstone, much surface of which bore traces of strong striking (Plate II 2 a, b). It could have been used single-handed both to crush rock and larger flint nodules. From the bottom part of Shaft 6 there come two large broken pebbles – a quartzite one with the preserved dimensions 12.3 × 10.3 × 8.2 cm and a granite one, analogously – 10 × 8.2 × 6 cm. The two specimens

have fresh breaks. The large, quartzite broken pebble was found in Shaft 1/2. These traces of damage and small fragments of broken pebbles, found in the fills of the shafts can have resulted from work aimed at digging deeper in part of their bottoms, already in the rock, in order to reach the level of flint nodules embedded in it.

V. FLINT RAW MATERIAL

Chocolate flint was repeatedly characterized and described as raw material widely used in prehistoric times in archaeological literature (Krukowski 1920, 189 ff.; Schild 1971, 6 ff.; 1976, 149 ff.). As we pointed out before, this material was at the site of Polany II extracted from two deposits. In detrital clay it occurred in the form of variable-shaped nodules and their fragments and small pieces. Among the former, there are numerous roll-like or lump-like specimens, at times narrowed or with quasi-growths, or flat cake-shaped, approximately oval with sides rounded in cross-section. The nodules had various dimensions: from the size of a walnut to about almost 20 cm length. The largest, oval, flat and cake-shaped nodule, taken out during the excavations from the level of detritus, was 17.7 cm long, 8.5–6.5 cm wide and about 2.3 cm thick. The most common were nodules 10–14 cm long. We also came across fragments of them with similar size. A large number of specimens were broken in the bed. They had sheeny fracture surfaces, at times very much so. Quite often, a nodule would be worked beginning with such natural surface, particularly so as it formed its longer side. The cortex at Polany II varied in thickness: from below 1 mm to more than 1.5 cm, or at times even more. This cortex was porous, rough and not smooth, varying in colour from light cream to yellowish rust, often with iron staining.

The flint material from the top of limestone formed the level of predominantly platey nodules more than 8–10 cm thick. They were also fractured in the bed, with sheeny fracture surfaces. It seems that their cortex was slightly lighter and thinner than that from detritic clay.

The flint mass was of dark brown colour (dark chocolate), sometimes with lighter hues, lightly transparent in thin flakes, with fine, quite uniformly distributed suspension. At places, there were conspicuous carbonate and quartz intrusions. There were also, although infrequently, specimens of waxy grey or like colour, some times with distinct stripes. In R. Schild's (1971, 7) classification of varieties of chocolate flint the raw material from Polany II is included in Group Ia.

Many authors have stressed the high technical qualities of chocolate flint. On the Mohs' scale its hardness is about 7 (Stawin 1970, 107). Researchers have pointed out in particular its perfect chipping attributes. Despite these advantages, the working of the raw material from Polany II involved some difficulties. They were caused by secondary defects, above all strong natural cracks in the nodules, as a result of which they shattered when struck. This is indicated by the enormous quantities of production waste lying over the area of the site and also dug up from deeper levels during the excavations, namely specimens damaged in the course of working, at the different stages of it. The damage was caused by internal, previously unseen fissures in the nodules.

The chemical effect of the depositional environment where most of the worked pieces at the site have lain caused their discolouration. They have only white or spotted (white spots) patina, and less frequently in the form of bluish, milky tarnish. The specimens from deeper parts of the fills are not patinated.

V. ON-SITE WORKSHOPS

The character and structure of flint materials excavated during the research distinctly indicate that they came from the raw material processing workshop within the area of the mine. Such workshops were a permanent element of the mining activity related to the flint exploitation. It is necessary to investigate their remnants, to know some elements of the functioning of the mine, such as the work organization or the yield and direction of the production, depending on the properties of the rock, but also affecting to some extent its extraction. First we considered the occurrence of flint materials, namely their stratigraphic position and horizontal distribution. In these considerations we only took into account the materials extracted from beneath the floor of the tilled zone.

1. STRATIGRAPHY AND SPATIAL DISTRIBUTION OF FLINT ARTIFACTS

Full observations of the stratigraphy and distribution of the found flint artifacts come from 1972. They include Shaft 3, the uncovered parts of Shafts 1/2 and 6. The specimens excavated in 1971 and in the north part of Cut I/72 come exclusively from the upper part of the deposits.

In the overall list of the flint materials at the site (see Table 1), we marked their stratigraphic position. It shows distinctly how few specimens were found in the floor of the shaft fills.

Thirteen pieces, including an initially worked bifacial piece (Plate I 6), come from the bottom of Shaft 3, from the depth of 180–210 cm. At the bottom part of Shaft 1/2 only two chips were found. The floor part of the fill of Shaft 6 yielded 37 pieces. Apart from the mining tools described above, they also included initially worked bifacial forms, a flint hammerstone and production waste. The presence of initially worked bifacial forms in the floor of the shaft fills demonstrates that close to them were workshops processing the raw material extracted in situ. They worked during or just after the extraction at these shafts. The rejected pieces or those moved to the dump at the pit got inside the features along with its materials already in the first, early stage of their filling. There is no certainty that the artifacts lying at the bottom of the shaft were made from raw material extracted from it.

The few artifacts from the bottom part of Shafts 1/2 and 3, from the next, upper level with worked flint are divided off by the series of fill materials, archaeologically sterile, 110–140 cm thick. As they deposited, no flint pieces got into these shafts. Probably, the workshops located nearby were then abandoned.

At Shaft 6, a number of artifacts were also found in the deposits uncovered between the floor series of the fill and their concentration from the top series. They lay at 100–140 cm depth, in the floor of Level 3, to be seen beneath the rubble and clay packet in the part of the shaft at the opening. They are also perhaps production waste, including possibly an initially worked celt. The flint specimens from this level are not discoloured, either, some of them are only slightly patinated. Certainly, there were various factors which caused the permanent, although innumerous, getting of flint artifacts into Shaft 6. Their presence in this part of the fill is no evidence to the fact that a flint processing workshop functioned close to the shaft as this series formed in it.

In the cross-section of the longitudinal walls (Figs. 7, 11, 16 and 19) and the transverse ones (Figs. 9, 10, 15 and 18), there is a distinct vertical distribution of archaeological materials gathered in the top of the fills of Shafts 1/2 (Concentration 1) and 3 (Concentration 2). It is interesting to note the two-level nature of the arrangement of materials in these concentrations. The lower level (the floor of Level 2), filling the deepest part of the top of the sharp-bottomed hollow of Shaft 1/2, is divided from Level 1 with a large addition of worked flints by a sandy level, 20–25 cm thick, where they are distinctly fewer. The upper level filled a shallow hollow with gently sloped walls. The flint artifacts at the two levels were accompanied by few, scattered chunks of charcoal.

The two-level nature of Concentration 2 is particularly distinct in the arrangement to the platey fragments of limestone (Figs. 15 and 16) and in the slight asymmetry of the two levels with flint materials. The upper level is displaced to the north relative to the materials filling the bottom part of the bowl-like hollow of the top of Level 3 of the fill (Fig. 9).

The concentration of flint materials uncovered after removing the tilled zone in the squares 3-4/III-IV at the early stage of excavations in 1972, was denoted as Concentration 3, assuming that it was a continuation of the concentration at Cut I/71. During the further research, it appeared that it lay in the top of the fill of the uncovered part of Shaft 6. Thus, it is valid to distinguish it as Concentration 3a, since most probably not all materials of Concentration 3 from 1971 belong to the fill of the feature in question. The vertical arrangement of Concentration 3a was different from these described previously. And there were also different deposits that formed here the upper fill of the shaft (see p. 153 above). Most of the flint pieces were concentrated in the upper part of these deposits.

In the north section of Cut I/72, covering the strip of the squares 1-2/III-IV, archaeological materials were found in the top levels down to 25 cm depth, sporadically down to 40 cm. They were somewhat scattered.

The spatial arrangements of the finds in the successively uncovered levels are illustrated by Figs. 6, 8, 12, 13, 17, and 28–31. Of interest are the results of observations of the horizontal outlines of the distinguished concentrations, in connection with the vertical distribution of their contents to be seen in the cross-sections of the walls of the cut. They show that these outlines reflect the shape and approximate size of the bowl-like hollows of the top of the sandy series of the shaft fills in the successively explored levels. This is particularly distinct in the strongly oblique arrangement of artifacts and limestone fragments within Level 2 of Concentration 1 from the bowl-like hollow of Shaft 1/2 (Fig. 19). Because of the steep walls of the hollow, the size of the concentration rapidly

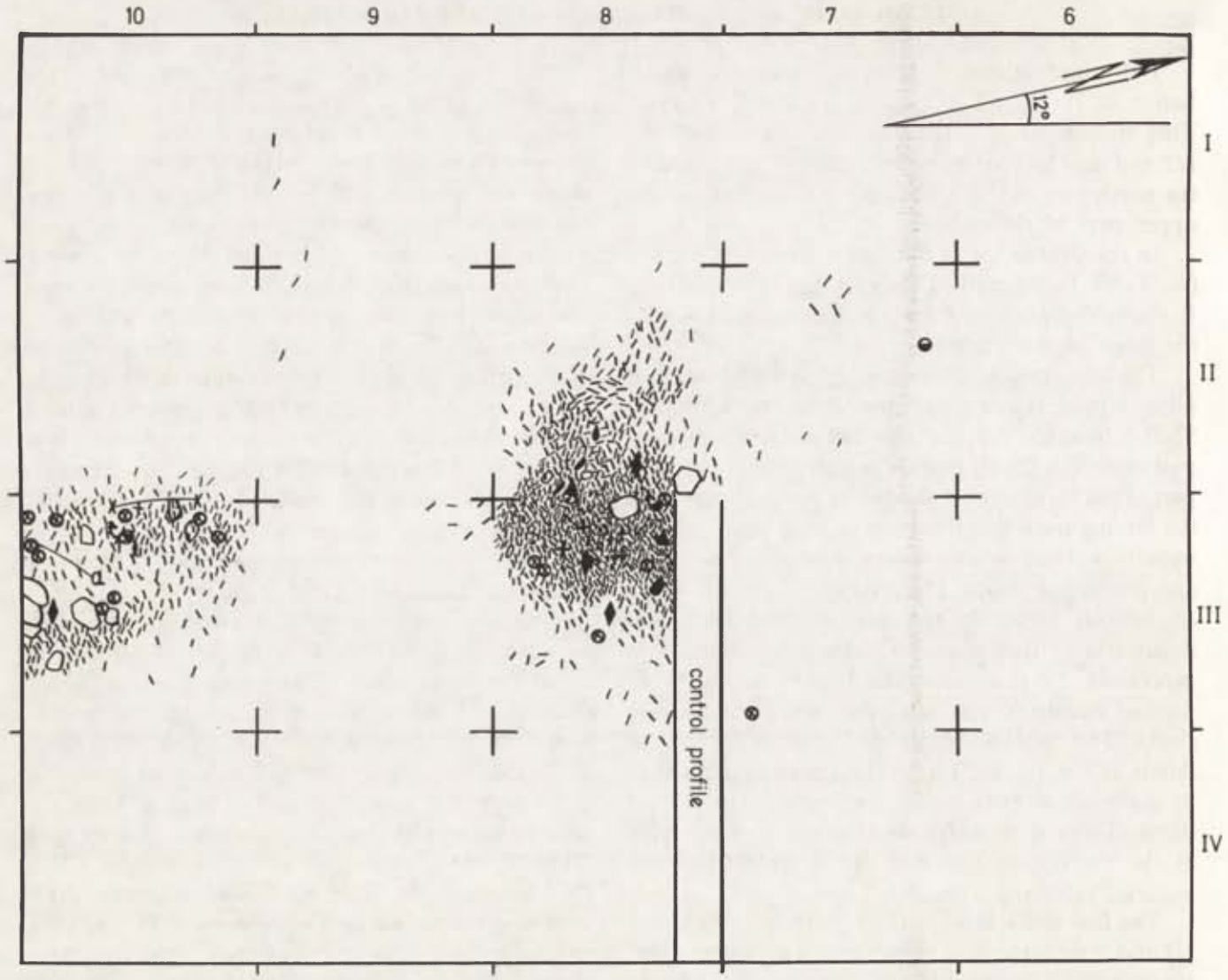

Fig. 28. Polany, Site II. The south section of Cuts I/72 with Concentration 1 (sqs. 10/II-III) and Concentration 2 (sqs. 7-8/II-III), at a level of 40 cm below the tilled soil

The key as in Fig. 12

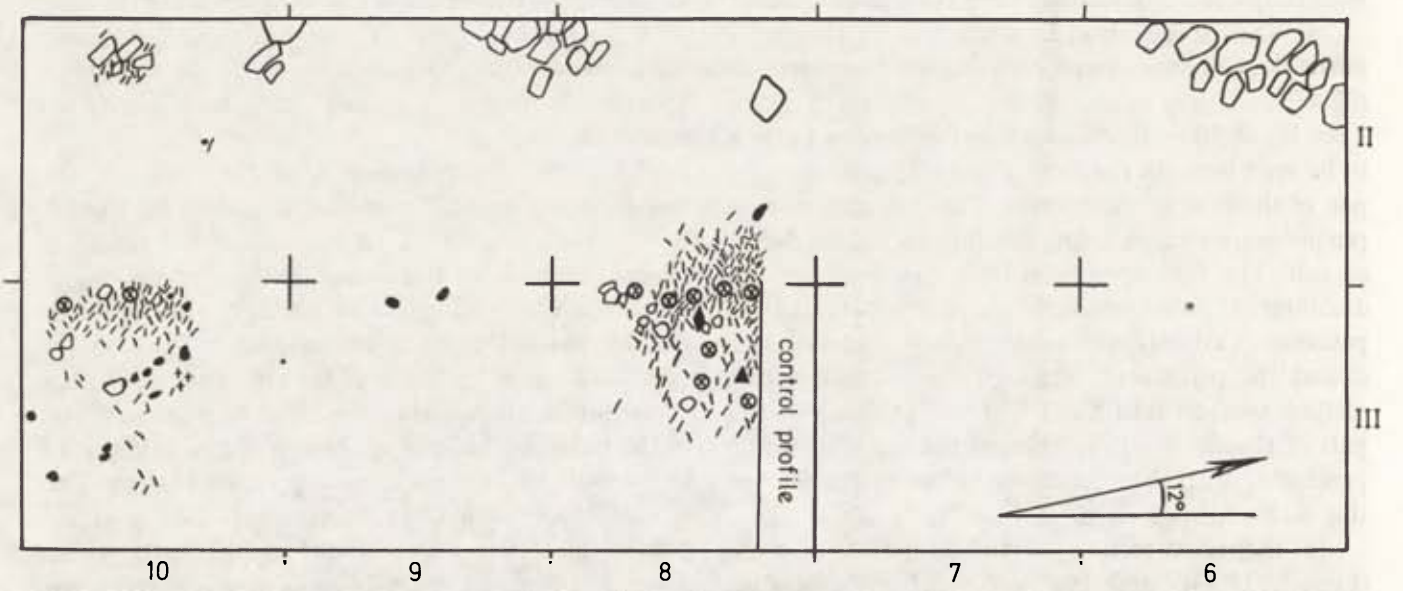

Fig. 29. Polany, Site II. The south section of Cuts I/71 and I/72 with Concentration 1 (sq. 10/III) and Concentration 2 (sqs. 8/II-III) at a level of 60 cm below the tilled soil

The key as in Fig. 12

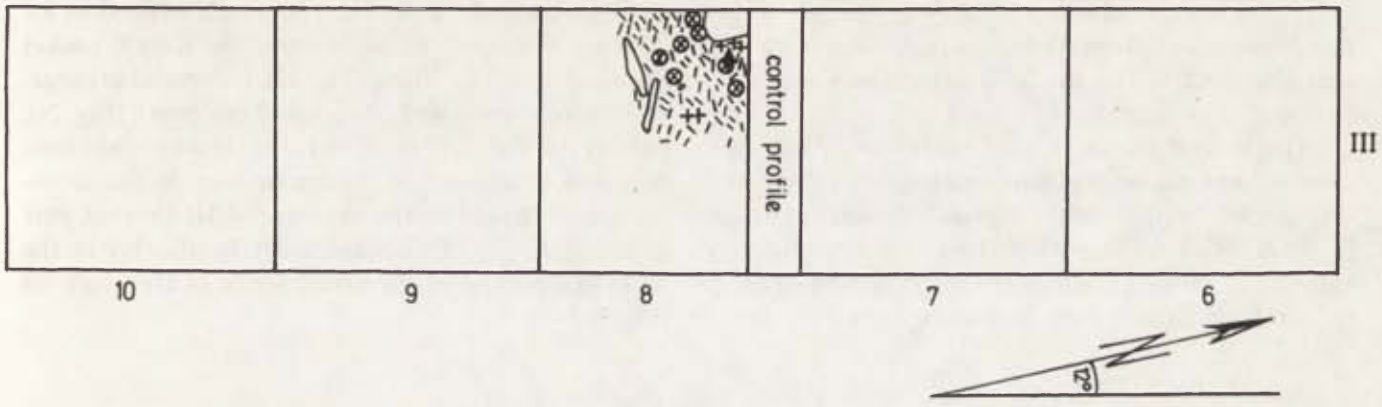

Fig. 30. Polany, Site II. The south section of Cut I/72 with Concentration 2 (sq. 8/III) at a level of 75 cm
The key as in Fig. 12

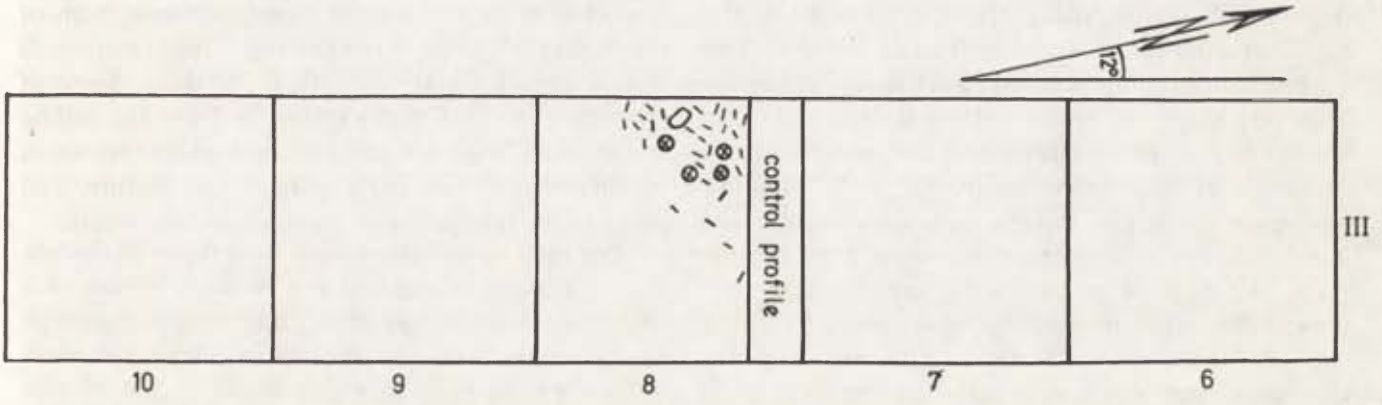

Fig. 31. Polany, Site II. The south section of Cut I/72. In the square 8/III there is the floor of Concentration 2

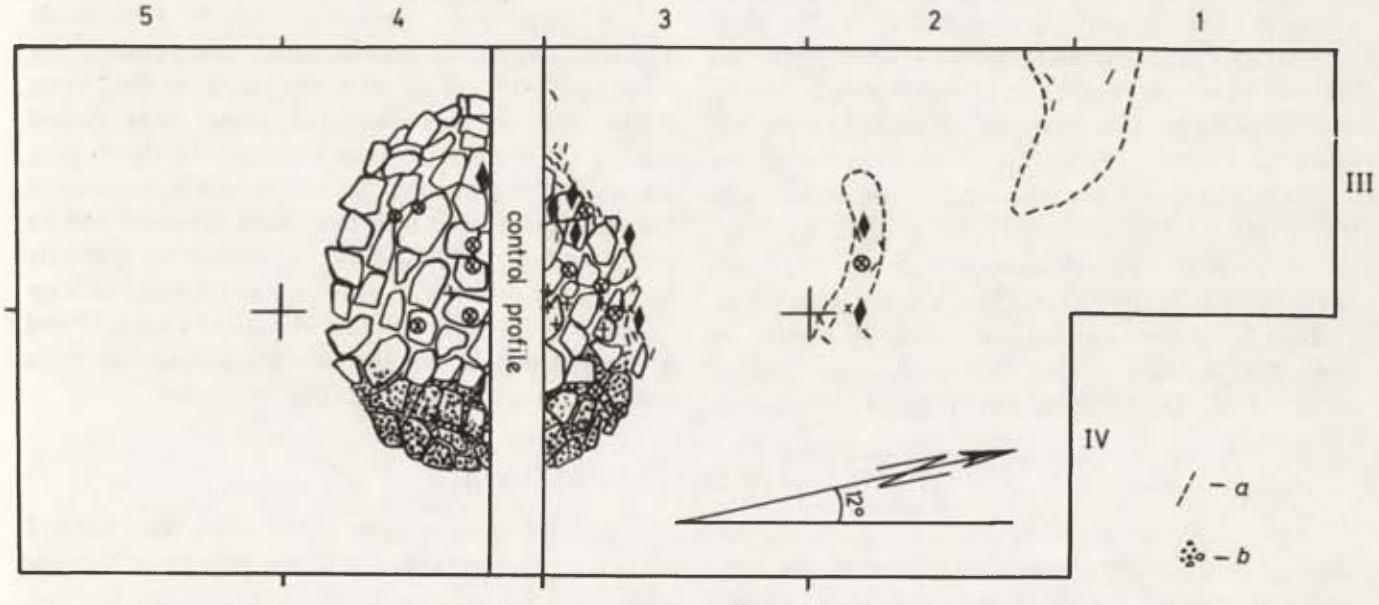

Fig. 32. Polany, Site II. The north section of Cut I/72 at a level of 40 cm below the tilled soil. In the squares 3-4/III-IV there is the bottom part of a packet of rubble and clay dump with few materials of Concentration 3a
a – rodent's hole, *b* – very fine, rounded limestone gravel, the other key as in Fig. 12

decreased towards the bottom. Some flint pieces and limestone plates stuck vertically in the deposit. This was also observed in the bottom part of Concentration 2.

The flint materials of Concentration 3a grouped close to and within the above-mentioned rubble and clay packet of the dump, almost spherical in shape (Fig. 12). Within the packet there were mainly very summarily worked nodules or their fragments. Just at its north boundary, there was to be seen a cluster of small flakes and chips (Fig. 13), which wedged in for 30 cm. The flint pieces within the dump packet occurred down to 40 cm (Fig. 32). Its spatial arrangement was investigated down to 45 cm depth (Fig. 24), namely to the top of a red and brown clay lens, archaeologically sterile. It can be seen in the cross-section of the cut in the squares 3-4/III-IV that part of the materials of Concentration 3a also lay in the bowl-like hollow of the sandy series of the shaft fill (Fig. 21).

2. ANALYSIS

A detailed investigation of the spatial configurations and stratigraphic concentrations of workshop materials raises a number of questions. The fundamental question is concerned with the nature of the distinguished concentrations. Obviously, the materials found within them are remnants from the manufacturing of material extracted in situ. The existence of such processing workshops is known from very many flint mines, both in Poland and other regions in Europe. In numerous cases materials from on-site workshops were discovered in a situation analogous to that at Polany II, namely in more or less bowl-like hollows which were the top of some stage of filling an extraction feature. Usually, they were separated from the floor of the shaft by its fill deposits, sometimes quite thick. This may evidence their later age compared with the period of the exploitation of the shaft and also the multi-stage nature of the extraction work over a given piece of the mine field (Armstrong 1926, 103; 1934, 3). It is believed that the hollows in the upper parts of the shafts, sheltered by dumps, were the appropriate places for setting up such workshops. The concentrations of materials presented here, with the features of on-site workshop processing, were not in situ workshops. The features of such objects disagree with their spatial arrangements. In them, flint artifacts and waste are chaotically intermixed with the weathered limestone rubble and platey fragments of the rock, broken out from the shaft bottoms. The materials in them are not segregated, there is no distinct position of the stone worker, as was observed at in situ flint workshops (Becker 1951, 141 ff., Lech 1981b, 104, Fig. 24; Weisgerber 1980, 547, Fig. 400). The cross-section of the concentrations also indicate the secondary arrangements of the above-mentioned materials in the top shaft fills. The steep walls of the hollow of Shaft 1/2 with Concentration 1 prevent at all the setting up of a workshop in it. Also, the space at the bottom of the hollow of Shaft 3 (containing Concentration 2) was too small for stone work to be done. Some of the specimens of Concentration 3a from the ceiling of the fill of Shaft 6 was found in a dump thrown in or slipped into the upper part of this feature, and there is no doubt about their secondary origin.

The materials of the on-site workshops of the site Polany Kolonie II occurred in a similar situation, in a secondary deposit, too. According to a monograph paper on the site, the process of filling the shaft hollows of the mine probably began in the Middle Ages, as this area began to be cultivated (Schild, Królik, Mościbrodzka 1977, 50 ff.). Possibly, we can also relate the first phase of levelling processes of the remnants of the Polany II mine and its processing workshops to this period. We should note here that in a 1791 map by the royal cartographer Charles de Perthees, the area of the site used to be wooded [7]. At a later period (19th century), the woods in the former Kielce district were exploited, which was caused among other things by the needs of the developing metallurgy. It was then that the woods in the area of the mentioned mine may have been removed and its remnants fully levelled. The two levels, with distinctly larger amounts of flint materials and limestone fragments, to be seen in the cross-section of Cuts I/71 and I/72, probably reflect the two periods of the more intensive work of the levelling processes.

VI. ARCHAEOLOGICAL MATERIALS

Almost exclusively, they are represented by flint specimens. They are production remnants, few tools and flint nodules. The latter, extracted from a deposit by prehistorical miners and rejected without testing, now form, along with the remaining workshop material and the dumps, part of the shaft fills. Table 1 shows a quantitative list of all the flint finds from the

[7] Mrs. Olga Lipińska, M.A., from the State Archaeological Museum in Warsaw let me use a photograph of this map, and I am very grateful for it.

Table 1. The general structure of flint finds from Polany, Site II

Found in:		Production waste: flake forms I flakes	II chips	III small waste	blade forms IV initially worked bifacial forms	V cores	total I–V	Tools: VIa uni-facial	VIb multi-facial core	total VIa, VIb	VII sup-ports	Total artifacts I–VII	Natural modules: whole	chunks	Total
Shaft 3	bottom rubble-clay series	8	2	–	1	–	(11)	1	1	(2)	–	(13)	–	–	13
	top: sandy series	3600	4358	900	519	1	(9378)	14	14	(28)	4	(9410)	11	317	9738
	total	(3608)	(4360)	(900)	(520)	(1)	(9389)	(15)	(15)	(30)	(4)	(9423)	(11)	(317)	(9751)
Shaft 1/2	bottom: rubble-clay series	–	2	–	–	–	(2)	–	–	–	–	(2)	–	–	2
	top: sandy series	1411	1782	451	211	3	(3858)	12	10	(22)	1	(3881)	27	149	(4057)
	total	(1411)	(1784)	(451)	(211)	(3)	(3860)	(12)	(10)	(22)	(1)	(3883)	(27)	(149)	(4059)
Shaft 6	bottom: rubble-clay series	18	5	1	9	–	(33)	1	3	(4)	–	(37)	–	–	37
	level 3	64	53	6	18	–	(141)	2	–	(2)	–	(143)	–	–	143
	top: rubble-clay packet	1317	2824	165	286	3	(4595)	10	10	(20)	2	(4617)	22	20	4659
	total	(1399)	(2882)	(172)	(313)	(3)	(4769)	(13)	(13)	(26)	(2)	(4797)	(22)	(20)	(4839)
Squares 1-2/III-IV	top down to 40 cm depth	616	1053	124	107	2	(1902)	4	13	(17)	–	(1919)	3	8	1930
Squares 1–3/I-II	top down to 40 cm depth	691	211	130	152	2	(1186)	8	7	(15)	1	(1202)	2	14	1218
	Total	7725	10,290	1777	1303	11	(21,106)	52	58	(110)	8	(21,224)	65	508	21,797
	%	35.45	47.22	8.15	5.98	0.05	96.85	0.50			0.04	97.39	2.61		100.00

Numbers in brackets are not subject to summation.

site, with division into shafts and the series of their fills. The information given below is concerned only with the first two groups described at the beginning of the chapter, since the nodules were discussed already in Chapter IV.

1. PRODUCTION WASTE (GROUPS I-V)

They include materials from working bifacial forms, initially worked forms and infrequent cores. In analyzing the assemblage of the production waste, we largely used the principles of classification of the similar workshop finds at the site of Polany Kolonie II (Schild, Królik, Mościbrodzka 1977, 52 ff.).

The materials from working bifacial forms include 3 groups: flakes, chips and small waste chunks (Table 2).

Group I. Flakes. We distinguished the following categories: 1 – cortex flakes; 2 – multi-directional, partly cortical flakes; 3 – multi-directional flakes; 4 – unidirectional; 5 – fragments of undefined flakes.

Group II. Chips: 6 – cortex chips; 7 – multi-directional chips; 8 – undirectional chips; 9 – fragments of undefined chips.

Group III includes 1 category only: 10 – small waste pieces. They are flint pieces (worked chunks) which broke away as workers broke large lump-like nodules or platey nodules, or as nodules were tried. They had no bulbs or striking waves.

In distinguishing Categories 1–9 we considered the features which formed the basis for the classification of analogous materials from the mine of Polany Kolonie II. A detailed characterization of the flakes and chips, given in the above-quoted monograph on this site, also refers to the materials from Polany II. The difference is that we include pieces with features "from removing fragments of bifacially worked edges", according to the definition given there (Schild, Królik, Mościbrodzka 1977, 55) in Category 3 – that of multidirectional flakes.

Tables 2 and 3 give some information on the discussed materials. Most information came from Shaft 3, one almost fully studied. The quantity and contribution of flakes of Categories 1, 3 and 4 in its inventory, just as in the whole studied assemblage, were close (with a slight domination of cortex flakes). The latter were the results of preliminary preparation of nodules and also of testing them. There dominate small-size flakes 3.0–3.5 cm long on average (Table 3). They result from the used technique of preparing bifacial forms, which often consisted in removing flakes by striking the longer sides of a nodule (mainly

Table 2. The general structure of the flint material assemblage from the working of bifacial forms at Polany, Site II

	Groups and categories	Shaft 3		Shaft 1/2		Shaft 6		Squares 1-2/III IV		Squares 1-3/I-II		Total		Group prop. in %*
		number	%	number	%	number	%	number	%	number	%	number	%	
I. Flakes	1. cortical	580 (30.04%)	16.08	171 (28.93%)	12.12	239 (36.54%)	17.08	74 (27.51%)	12.01	97 (27.17%)	14.04	1161 (30.54%)	15.03	
	2. multidirectional partly with cortex	322 (16,67%)	8.92	74 (12.52%)	5.25	58 (8.86%)	4.15	26 (9.66%)	4.22	66 (18.40%)	9.55	546 (14.36%)	7.07	
	3. multidirectional	507 (26.26%)	14.05	173 (29.27%)	12.26	166 (25.38%)	11.87	90 (33.46%)	14.61	89 (24.93%)	12.88	1025 (26.96%)	13.27	
	4. unidirectional	522 (27.07%)	14.47	173 (29.27%)	12.26	191 (29.20%)	13.65	79 (29.37%)	12.83	105 (29.41%)	15.19	1070 (28.14%)	13.85	
	total	(1931)	(53.52)	(591)	(41.89)	(654)	(46.75)	(269)	(43.67)	(357)	(51.66)	(3802)	(49.22)	
	5. indefinite flake fragments	1677	46.48	820	58.11	745	53.25	347	56.33	334	48.34	3923	50.78	
	Group I total	(3608)	100.00	(1411)	100.00	(1399)	100.00	(616)	100.00	(691)	100.00	7725	100.00	39.03
II. Chips	6. cortical	373	8.56	148	8.30	163	5.66	54	5.13	40	18.96	778	7.56	
	7. multidirectional	430	9.86	240	13.45	165	5.72	73	6.93	53	25.12	961	9.34	
	8. unidirectional	932	21.37	412	23.09	438	15.20	137	13.01	84	39.81	2003	19.47	
	total	(1735)	(39.79)	(800)	(44.84)	(766)	(26.58)	(264)	(25.07)	(177)	(83.89)	(3742)	(36.37)	
	9. indefinite chip fragments	(2625)	60.21	984	55.16	2116	73,42	789	74.93	34	16.11	6548	63.63	
	Group II total	(4360)	100.00	(1784)	100.00	(2882)	100.00	(1053)	100.00	(211)	100.00	(10,290)	100.00	51.99
III.	10. small waste	900	–	451	–	172	–	124	–	130	–	1777	100.00	8.98
	Total	8868		3646		4453		1793		1032		19,792		100.00

* The proportion of groups in the whole set.

Numbers in brackets are not subject to summation; percentages in brackets denote the proportion of a given category in the assemblage of whole flakes.

cake-shaped ones) across their longer axes. In the early stage of working, this gave flakes with lengths close to the width of the nodule. At a more advanced stage, shorter and wider pieces fell off.

In the sample of 940 flakes from Shaft 3, there were 24. 25% pieces with cortical platforms, 41.28% with smooth, 18.19% with facetted, and 16.28% with edged ones. Among them large platforms were 43.65%, medium ones – 24.30% and small ones were 32.04%. In the flake assemblages, from the other shafts, there was a similar proportion of platforms with the above-mentioned attributes.

Probably, not all the so numerous chips come from working bifacial forms. They also arose as large nodules were broken with hammerstones.

Group IV. Initially worked bifacial forms. It includes 2 subgroups: a – undefined forms, and b – tools (Tables 4 and 5).

In subgroup a we distinguished the following categories of initially worked pieces: 1 – at the very early stage of working; 2 – with initial bifacial working; 3 – with advanced bifacial working; 4 – fragments of initially worked undefined pieces (Categories 1 and 2); 5 – fragments of initially worked pieces with advanced working (Category 3).

Subgroup b – of initially worked tools – consickle forms (Plates IV 3, 4, III 5, V 1, and VI 1,2,3); 8 I 1, III 3, and V 2, 4); 7 – initially worked knife and sickle forms (Plates IV 3, 4, III 5, V 1, and VI 1, 2); 8 – initially bifacially worked projectile forms (Plate IV 7).

The degree of working a nodule was the criterion for establishing the category of initially worked undefined forms. No account was, on the other hand, taken of their shape, which was as a rule oval or rectangular (approximately). The few discoidal or quasi-discoidal bifacially worked pieces, numbering least than 1% in Group IV, were included in Category 3 of this group, because of their advanced, bifacial working.

The inclusion of initially worked bifacial tools in specific categories involved some difficulties. They were brought about by a lack in the analysed assemblage of finished or almost finished forms, e.g. celts ready for polishing, which could provide a pattern to make it easy to identify the purposeful forms of initially worked pieces. Another reason was that the same cake-shaped nodules, or, less frequently, rectangular fragments of platey nodules, were used for the production of celts, knives and sickles. For many specimens there was a very similar way of preparing nodules – at least, until the stage where the initially worked forms were rejected by the stone worker – raising further doubts as to the category where they should belong. In differentiating celts, account was taken of the width and thickness of a piece, usually greater than those of knife and sickle forms. It was possible, on the other hand, only exceptionally to determine the shape and type of a prepared celt in practice.

A large initially worked piece, probably a celt (Plate V 4), still at a very early degree of working, has

Table 3. Metric and statistical data for flakes at Polany, Site II

Parameters	Categories localization	1. Cortical				2. Multidirectional, partly cortical				3. Multidirectional				4. Unidirectional			
		a length	b width	c thickness	d angle	a length	b width	c thickness	d angle	a length	b width	c thickness	d angle	a length	b width	c thickness	d angle
Number in sample	Shaft 3	332	332	332	230	128	128	128	85	229	229	229	149	258	258	258	196
	Shaft 1/2	128	128	128	57	59	59	59	10	145	145	145	64	133	133	133	67
	Shaft 6	231	231	231	186	59	59	59	42	162	162	162	100	190	190	190	151
	sqs.1-2/III-IV	74	74	74	66	26	26	26	18	90	90	90	70	79	79	79	69
$\bar{x}$	Shaft 3	3.62	3.28.	0.64	98.82	4.20	3.52	0.79	99.61	3.57	2.43	0.60	99.23	3.16	2.74	0.45	97.19
	Shaft 1/2	3.41	3.30	0.61	99.75	4.13	2.94	0.53	–	3.52	2.94	0.53	98.66	3.10	2.48	0.57	96.81
	Shaft 6	3.79	3.44	0.70	97.04	4.67	4.06	1.02	100.1	3.60	3.15	0.61	96.15	3.02	2.72	0.48	96.68
	sqs.1-2/III-IV	3.31	3.24	0.67	97.32	4.31	3.61	0.95	98.89	3.61	3.22	0.70	97.00	3.18	2.98	0.53	97.41
s^2	Shaft 3	1.75	1.21	0.12	0.34	2.31	1.58	0.16	24.70	1.71	2.83	0.12	27.13	1.00	0.87	0.08	77.53
	Shaft 1/2	2.04	1.63	0.11	28.42	1.59	1.46	0.21	–	1.59	1.46	0.11	26.31	0.12	1.07	0.10	26.85
	Shaft 6	2.00	2.33	0.25	87.00	4.72	2.44	0.31	37.09	1.99	1.83	0.21	121.56	0.60	2.33	0.25	26.16
	sqs.1-2/III-IV	2.74	2.08	0.20	84.06	7.14	2.21	0.30	41.88	1.81	2.17	0.19	48.12	1.76	1.35	0.10	16.82
Mode (number in mode)	Shaft 3	2.6–3.0 (61)	3.1–3.5 (58)	0.3–0.4 (113)	96–100 (96)	3.1–3.5 (26)	3.1–3.5 (21)	0.5–0.6 (23) 0.7–0.8 (23)	96–100 (35)	3.1–3.5 (51)	2.1–2.5 (60)	0.3–0.4 (80)	96–100 (49)	2.1–2.5 (63)	2.1–2.5 (54)	0.3–0.4 (117)	91–95 (70)
	Shaft 1/2	2.1–2.5 (34)	3.1–3.5 (22)	0.3–0.4 (43)	96–100 (18) 101–105 (18)	3.1–3.5 (15)	2.6–3.0 (12)	0.3–0.4 (17)	–	2.6–3.0 (30)	2.1–2.5 (27)	0.3–0.4 (67)	96–100 (64)	2.6–3.0 (35)	2.1–2.5 (28)	0.3–0.4 (80)	96–100 (24)
	Shaft 6	2.6–3.0 (42)	2.6–3.0 (40)	0.3–0.4 (75)	96–100 (79)	3.1–3.5 (8) 5.6–6.0 (8)	3.6–4.0 (10)	0.7–0.8 (21)	96–100 (17)	2.6–3.0 (30)	2.1–2.5 (30)	0.3–0.4 (35)	96–100 (39)	2.6–3.0 (30)	2.1–2.5 (31)	0.3–0.4 (55)	96–100 (53)
	sqs.1-2/III-IV	2.6–3.0 (18)	2.1–2.5 (20)	0.3–0.4 (20)	96–100 (23)	3.1–3.5 (5) 5.6–6.0 (5)	2.6–3.0 (5)	0.3–0.4 (6)	101–105 (5)	3.1–3.5 (18)	1.6–2.0 (19)	0.3–0.4 (29)	91–95 (26)	2.1–2.5 (18)	2.1–2.5 (18)	0.3–0.4 (28)	91–95 (26)
Range	Shaft 3	1.5–7.9	1.2–10.0	0.2–1.8	90–120	1.7–8.1	1.2–8.3	0.2–2.1	90–110	1.5–9.6	0.5–7.9	0.5–1.8	90–112	1.6–6.6	0.9–6.7	0.1–2.1	90–115
	Shaft 1/2	1.4–8.2	1.1–7.2	0.1–1.7	90–110	1.7–8.1	1.1–8.1	0.2–1.9	–	1.7–7.2	0.9–7.1	0.1–1.8	90–110	1.7–7.2	1.0–6.1	0.1–1.2	90–110
	Shaft 6	1.2–10.0	1.2–9.0	0.1–2.4	90–120	1.3–9.9	1.8–9.3	0.1–2.7	90–115	1.5–8.7	1.1–8.5	0.1–2.3	90–110	1.2–6.6	1.0–7.0	0.1–1.0	90–108
	sqs.1-2/III-IV	1.5–7.9	1.2–7.3	0.3–2.3	90–110	1.8–7.1	1.2–7.3	0.3–2.3	90–110	1.1–7.0	1.1–9.3	0.2–2.2	90–112	1.4–9.0	0.5–6.5	0.2–1.4	90–110

Table 4. The general structure of initially worked bifacial forms (Group IV) from Polany, Site II

	Categories	Shaft 3		Shaft 1/2		Shaft 6		Squares 1-2/III-IV		Squares 1 3/I-II		Total	
		number	%	number	%	number	%	number	%	number	%	number	%
a. Indefinite forms	1. With very initial working	60 (39.22%)	11.54	36 (45.00%)	17.06	58 (42.65%)	18.53	22 (36.06%)	20.56	22 (26.83%)	14.47	198	15.20
	2. Initially bifacially worked	46 (30.07%)	8.85	25 (31.25%)	11.85	37 (27.20%)	11.82	20 (32.79%)	18.69	28 (34.15%)	18.42	156	11.97
	3. With advanced bifacial working	·47 (30.72%)	9.04	19 (23.75%)	9.00	41 (30.14%)	13.10	19 (31.15%)	17.76	32 (39.02%)	21.05	158	12.13
	total	(153)	(29.43)	(80)	(37.91)	(136)	(43.45)	(61)	(57.01)	(82)	(53.94)	(512)	(39.30)
	4. Fragments of artificats from Categories 1 and 2	265	50.96	106	50.24	137	43.77	23	21.49	48	31.58	579	44.44
	5. Fragments of artificats from Category 3	76	14.61	9	4.27	26	8.31	17	15.89	12	7.89	140	10.74
	fragments total	(341)	(65.57)	(115)	(54.51)	(163)	(52.08)	(40)	(37.38)	(60)	(39.47)	(719)	(55.18)
	indefinite bifacially worked forms total	(494)	(95.00)	(195)	(92.42)	(299)	(95.53)	(101)	(94.39)	(142)	(93.41)	(1231)	94.48
b. Tools	6. Axes	6	1.15	1	0.47	5	1.59	–	–	2	1.32	14	1.07
	7. Knife and sickle forms	17	3.27	14	6.64	9	2.88	4	3.74	8	5.26	52	3.99
	8. Projectile forms	3	0.58	1	0.47	–	–	2	1.87	–	–	6	0.46
	total	(26)	(5.00)	(16)	(7.58)	(14)	(4.47)	(6)	(5.61)	(10)	(6.58)	(72)	5.52
	Total	520	100.00	211	100.00	313	100.00	107	100.00	152	99.99	1303	100.00

Numbers in brackets are not subject to summation; percentages in brackets denote the proportion of a given category in the set of whole initially worked forms; bold type represents the proportions of subgroups in the whole set.

Table 5. Metric and statistical data for initially worked bifacial forms (Group IV) from Polany, Site II

	Categories and metric properties	Number in sample	x	s^2	Mode	Number in mode	Range
a. Indefinite	1. with very initial working	198					
	length		8.99	5.99	7.1–8.0	44	4.0–17.5
	width		6.07	2.99	5.1–6.0	55	2.0–14.9
	thickness		3.55	2.19	2.1–3.0	51	1.0– 8.3
	2. initially bifacially worked	156					
	length		8.98	6.25	7.1–8.0	31	5.0-20.8
	width		5.75	2.24	6.1–7.0	38	3.2– 9.5
	thickness		3.29	1.75	2.1–3.0	46	1.0– 6.9
					3.1–4.0	46	
	3. with advanced bifacial working	158					
	length		8.78	4.69	8.1–9.0	34	3.8–15.5
	width		5.61	1.93	4.1–5.0	45	2.8–10.3
	thickness		2.77	1.21	2.1–3.0	55	0.8–6.8
b. Tools	6. celts (axes)	14					
	length		8.36	9.03	7.1–8.0	4	6.8–12.0
	width		5.61	0.72	4.7–7.0	5	4.7–7.0
	thickness		2.76	1.24	2.1–3.0	8	1.8– 5.2
	7. knife and sickle forms						
	length	48	8.92	5.73	8.1–9.0	10	5.1–13.7
	width	52	4.63	1.31	4.1–5.0	18	2.4– 7.2
	thickness	52	2.03	0.34	1.1–2.0	29	1.2– 3.5

a rectangular cross-section. Another initially worked piece, probably a celt (Plate I 1) distinctly shows a lens-like cross-section. The most frequent are initially worked celts with triangular cross-section (Plates III 3c, and V 2c). They are specimens with one longer side backed. The opposite side, sometimes slightly arched, was bifacially worked by striking off flakes from its transverse edges. The straight, "backed" side was formed by a natural or artificial fracture of the nodule, from the edges of which on both surface flakes were removed (Plates III 3 and V 2a, b – a backed piece). Perhaps, if those operations had continued, these initially worked pieces would have acquired a lens-like cross-section. We cannot exclude, either, the possibility that the projected form of some initially worked pieces, "backed" with one slightly arched side (Plate V 2), may have been celts, known from the settlement of the Mierzanowice culture in its eponymic site, as Variety C "...with asymmetric, sickle-like outlines" (Balcer 1977, 190, Fig. 8 f, g).

Category 7 comprises these initially worked pieces whose projected forms may have been knives or sickles. It was impossible to differentiate strictly between them, or to carry out a more detailed division in terms of categories. Hence, the very general range of categories – knife and sickle forms. Some of the initially worked pieces included in it can represent backed bifacial knives. They are core pieces, with natural backing, frequently a cortex one, and an edge bifacially worked to a varying degree (Plate VI 2), at times much thinned (Plate III 5). The piece in Plate V 5 may have been close to completion, as is indicated by the unifacial chipping of its edge. Although backed bifacial knives are known from Early Bronze settlements (Balcer 1977, 194, Fig. 11b), as far as the backed pieces from Polany II go, we should bear in mind their waste nature. They are unfinished and we cannot be sure (perhaps with the exception of knives in Plates III 5 and V 5) that in these knife forms the natural backing was intentional.

Initially worked pieces with one arched side and slight asymmetry of the distal end relative to their longer axis refer to the sickle knives, bifacially chipped on the surface (Plates IV 3, 4, and V 1 a, b). A piece with much advanced working was found on the surface of the site at the boundaries of the cut (Plate IV 4). Initially worked pieces with one arched side, whose projected form may have been sickle knives, are much shorter than pieces found at the grave assemblages of the Mierzanowice culture (see Table 5).

We cannot exclude that the relatively thin "crescent-like" nodules with traces of initial working from the shorter, transverse sides, are also initially worked sickle forms, because one of the sides of a nodule is greatly arched (Plate VI 1 a, b, 3).

This category includes also bifacially worked knife forms with straight edges (double-edged ?). Sometimes, fragments of such pieces are much advanced in surface working.

The few specimens, distinguished as bifacially worked projectile forms (Category 8) are usually damaged. The state of their preparation, also in whole pieces, prevents their certain identification in terms of their projected form. They include a piece with an inbent base, a narrow one quasi-tanged burnt and broken at the tang and a wide initially worked piece, approximately triangular (Plate IV 7). The minimum number of whole specimens in this category prevented their being included in Table 6.

Group V. Cores. They consitute the remainder of the production remnants, apart from materials coming from the preparation of bifacial forms. Their proportion in the considered assemblage is very small (Table 1). Therefore, we did not divide them into categories, particularly so as some specimens may be early initially worked pieces. The initial processing of a lump-like nodule could have given it the look of a core. All the pieces identified as single-platform cores for flakes (Plate III 7) or ones with changed orientation (Plate VI 5). What is striking is the presence of this small core (greatly used as is indicated by changes in its orientation) in the workshop where there were flakes of all sizes and shapes. The lack of blade cores in the materials from Polany II coincides with the lack of blades in it, ones which would have been specially-produced blanks. The few pieces with proportions close to those of blade blanks were in fact blade-like flakes, struck off in preparing bifacially worked pieces. They were included in Categories 1–4 of Group I.

2. TOOLS (GROUPS VI–VII)

Group VI – in it we distinguished two subgroups: a – unifacial tools and b – multi-facial tools (Plate VI). The first includes the following categories: 1 – endscrapers (Plate III 2); 2 – sidescrapers (Plates I 2, III 4, and IV 6); 3 – perforators (Plate I 3, 4); 4 – notched pieces; 5 – denticulates pieces (Plate IV 2); 6 – retouched flakes and chunks (Plate III 8 – a blade-like flake with a retouched distal end).

In the materials of the investigated objects, the tools of these categories were most often represented by only single specimens (Table 6). They are mainly

Table 6. The general structure of tools (Group VI) from Polany, Site II

	Categories	Shaft 3	Shaft 1/2	Shaft 6	Squares 1-2/III-IV	Squares 1-3/I-II	Total number	Total %
Unifacial	1. Endscrapers	1	3	–	1	1	6	5.45
	2. Sidescrapers	1	2	1	–	–	4	3.64
	3. Perforators	2	2	1	1	–	6	5.45
	4. Notched pieces	1	–	–	–	1	2	1.82
	5. Denticulated pieces	6	3	4	2	3	18	16.36
	6. Retouched flakes and chunks	4	2	7	–	3	16	14.55
	total	(15)	(12)	(13)	(4)	(8)	(52)	(47.27)
Multifacial	7. Scaled pieces	9	6	7	5	4	31	28.18
	8. Picks	2	1	3	3	1	10	9.09
	9. Hammer stones	4	3	3	5	2	17	15.45
	total	(15)	(10)	(13)	(13)	(7)	(58)	(52.72)
	Total	30	22	26	17	15	110	99.99

Numbers in brackets are not subject to summation.

flake pieces. The fragments of initially worked pieces were used to make only denticulated tools (usually big ones) and perhaps 2 side-scrapers (Plate IV 5) and a perforator with a wide tip (Plate I 4). The flake perforator (Plate I 3) is in fact a combined tool (end-scraper + perforator + notched piece).

The subgroup of core tools consists of the three categories: 7 – scaled pieces (Plates I 5, II 4, 6, III 6, 9, and VI 4); 8 – picks (Plates II 1, III 1, IV 1, and V 3); 9 – hammer stones (Plate II 2, 3, and V 6).

Category 7 contains a small number of thin classical scaled pieces (Plates II 4, and III 6) and the more numerous scaled pieces made from fragments of rough-outs, which are usually larger and more solid. The scale scars occur as a rule at the edges (Plate VI 4). We also distinguished a bipolar, unifacial specimen from quartzite (Plate II 6).

In the group of core tools it is interesting to note the lack of arched and bihorned pieces, quite frequent at the site of Polany Kolonie II, and found previously by S. Krukowski at Wierzbica. Although in the materials from Polany II there are specimens morphologically close or even analogical to bifacial arched pieces, all of them are rough-outs of indefinite tools with working on one side of a cake-shaped nodule. One edge of them, formed by initial, bifacial removal of short flakes, does never show, however, further working. The piece, which was published earlier as a chopping tool (Chmielewska 1973, 33, Fig. 2A) is in fact, as detailed analysis has shown, also an indefinite initially worked piece. No forms resembling bihorned pieces were found in the inventory of Polany II.

Picks and hammer stones were already discussed in the chapter on mining tools. As a matter of fact, flint hammer stones are related to raw material working rather than with the process of its extraction. They mainly include uni- and bipolar edged hammer stones from damaged initially worked pieces, sometimes from their core-shaped fragments (Plates II 3, and V 6). The latter has a beck-like edge, bearing traces of strong hammering. There are also oval hammer stones from flint nodules (mostly with very summary working) and small fragments of broken hammer stones. In the assemblage from Concentration 1 (Shaft 1/2), it is interesting to note a massive hammer stone from a platey nodule (18.5 × 10 × 8.5 cm), with the strongly hammered edge of the narrowest side. It may have been used with two hands, or pehaps as a hammer stone – anvil. A large number of abandoned initially worked pieces, and of their fragments in particular, bear traces of splintering and battering on only small sections of their edges. S. Krukowski stressed that many flakes from

Fig. 33. Polany, Site II, Concentration 2. A flake struck off a flint nodule which served earlier as a support, with visible traces of cutting

Photo by S. Biniewski

the on-site workshops of the site of Wierzbica I (Polany Kolonie II, according to Schild 1971, 43) showed the scaled-piece type of fracture, caused by striking with a hard hammer stone at an angle close to 90° (Krukowski 1939-1948, 99). Also among the flint materials at Polany II such flakes occur (Plate IV 6), and the results of measurements of the angles of the considered flake assemblages indicate that a striking technique close to that indicated by this researcher was used in particular in the initial working of tools (Table 3).

GROUP VII. Supports. They are nodules which on the cortex-covered planes show scratches or narrow cuts resulting from the fact that they supported the worked flint specimens. They can be seen, e.g, in a cortical flake struck off a support nodule (Fig. 33). This group also includes flat, cake-shaped nodules with traces of light stroking on one face and fine scratches or cuts on the edge (Plate II 5).

The assemblage under analysis is complemented with a small, rectangular smoother from fine-grained quartzite.

VII. GENERAL ANALYSIS AND CONCLUSIONS

1. PRODUCTION TRENDS AND HOMOGENEITY OF THE ASSEMBLAGE

The general structure of the assemblage (Table 1) indicates that the projected production items of the on-site workshops on the location were bifacially worked forms. Materials from the working of such tools and their initially worked pieces reach about 99% of the production waste. It would not be possible to distinguish in the flake group pieces coming from the few flake cores, but their number did not probably exceed 1% of the production waste.

In the subgroup of initially worked pieces whose projected form we can define with large probability there are mainly axes, knife and sickle and some projectile forms (Tables 4 and 5). The few initially worked axes with advanced preparation show the form of a celt with a lens-like cross-section. The others, including, e.g., those with triangular cross-section, represent the working phase leading presumably to this type of axe.

In the considered assemblage there dominate, on the other hand, knife and sickle forms. Specimens of this category with one arched and an asymmetrical top are most probably rought-outs of sickle knives, bifacially worked, quite often with an extended base. The others represent probably backed knives, whereas the remaining pieces are hardly definable forms of knives or daggers. And since these forms were not finished, we cannot exclude the fact that some of them were really rough-out axes. This would apply, however, to a few pieces only. The manufacturing of knife and sickle forms, to a large extent, too, at the on-site workshops at the site confirms additionally, albeit indirectly, the fact that they worked on very flat, cake-shaped nodules, which were then rejected because of the technical defects of the raw material. The final product of their working may have been only thin, bifacial knife forms or projectile forms. Because of the early stage of their working or damage, in these assemblages these specimens are the components of indefinite rough-outs (Table 4).

Another problem, suggested by an analysis of the assemblage of the flint materials from the studied mine, is its homogeneity. It follows from the enclosed comparisons (Tables 1, 2 and 4) that in terms of the general composition and structure, the inventories of the distinguished features show large similarities. In all of them there are materials from the working of bifacial forms, rough-outs of analogous bifacial tools and few mining and processing tools, with also a slight proportion of bifacial tools common in the inventories of living sites (Table 6). Also, metric and statistical data for the distinguished flake categories (Table 3) indicate the considerable degree of resemblance between the considered flint inventories. In a few cases, the differences in the measurable features (length, witth, thickness and the striking angle) of flakes in Categories 1–4 from the compared inventories were found to be significant. They were verified by the t-Student test. There are essential differences, in the mentioned properties of flakes of Categories 1–4, between the following inventories.

Cortex flakes

Thickness: Shaft 1/2 and Shaft 6 only at the level $p = 0.05$.

Multidirectional flakes, partly with cortex.

Length: Shaft 1/2 and Shaft 6 at the level $p = 0.05$; Shaft 3 and Shaft 6 – $p = 0.05$ and 0.01.

Width: Shaft 3 and Shaft 6 – $p = 0.05$; Shaft 1/2 and Shaft 6, and Shaft 1/2 and the squares 1-2/III-IV – $p = 0.05$ and 0.01.

Thickness: Shaft 3 and Shaft 6, Shaft 3 and Shaft 1/2, and Shaft 1/2 and the squares 1-2/III-IV – $p = 0.05$ and 0.01.

Multidirectional flakes

Width: Shaft 3 and Shaft 6 – at the levels $p = 0.05$.

Thickness: Shaft 1/2 and the squares 1-2/III-IV – $p = 0.05$ and 0.01.

Unidirectional flakes

Length: Shaft 1/2 and Shaft 6 – at the levels $p = 0.05$ and 0.01.

Thickness: Shaft 1/2 and Shaft 6 – $p = 0.05$ and 0.01.

There were significant differences in terms of the stiking angle for Categories 1–4 of flakes (see Table 3) between the inventories of the following objects.

Cortex flakes:

Shaft 3 and Shaft 6, and Shaft 1/2 and Shaft 6 – at the levels $p = 0.05$ and 0.01.

Multidirectional flakes

Shaft 3 and the squares 1-2/III-IV – $p = 0.05$

Shaft 3 and Shaft 6 – $p = 0.05$ and 0.01.

At present, since the original spatial systems of the workshops from where the studied flint materials come, have not survived, it is impossible to carry out a reliable interpretation of the significance of the demonstrated differences. They were mostly conspicuous in the category of multidirectional flakes, partly with cortex (Category 2), longer and wider in the concentration from Shaft 6 than in the assemblages from Shafts 3 and 1/2. We need to note here that in the workshop leftovers from Shaft 6, there was a distinct proportion of indefinite rough-outs – quite frequently from large, lump-like or plate-like nodules (see p. 162 above). The relatively early phase of their working may have given flakes of greater sizes.

It is more difficult to explain the mentioned differences in width and thickness between flakes of some categories from the assemblage from Shaft 1/2 and the squares 1-2/III-IV. Of some significance there can be the fact that the finds from the squares 1-2/III-IV cannot be related significantly to some of the pits partly uncovered here. Thus, there is no certainty that they form a homogeneous assemblage, coming from just one workshop.

This question imposes itself with reference to also other materials coming from the different concentrations uncovered in the pit fills. As a matter of fact, they occurred on the secondary deposit, and there is no data to document their contents. It is interesting to note only the numerous pieces which fit together to be observed in all the concentrations. They occur within one concentration, consisting of fragments of damaged rough-outs, purposefully broken nodules, and rough-outs with flakes and chips from the different stages of their working (Plate IV 1 a, b) and the flakes from the same nodules. This indicates that the materials of the concentrations did not shift or scatter to any extent.

This suggests the cautious conclusion that each represents a certain part, perhaps even a significant one, of the remnants of some workshops situated close to the pit, where they got as a result of the action of much later factors. The composition, the general structure of the production waste and also the structures of the distinguished groups (Tables 1, 2 and 4) indicate that they were workshops with the same projected production, indeed those working at the same time. If there were any temporary differences between them, at most they were of the order of one or a few seasons. These workshops carried out initial working of the nodules, or of more advanced bifacial tools, with knife and sickle forms dominating. We do not know if these tools were finished on the spot at the workshops close to the shafts. During the excavations we found no such specimens. The working of the rough-outs left over at the site, even those which we included above in the advanced group, still required some operations to give it the sought form before the finish. Thus, it is highly probable that, from on-site workshops, only partly prepared pieces would be taken, while their final working and finish would occur outside the mine, perhaps in the local settlement.

2. AGE AND CULTURAL AFFILIATION OF THE MINE

We have few data on these questions. They have been provided by the distinguished assemblages of flint artifacts and the already cited ^{14}C date for charcoal from the floor of Shaft 1/2. The flint materials of Polany II, as production waste, are in their mass hardly useful for chronological and cultural determinations. Here, we can mainly take into account few advanced rought-outs, permitting the production tendencies to be identified for workshops working at the pits. This information can in turn provide premises for conclusions about the taxonomic place of the unit exploiting the mine.

The mine at Polany Kolonie, Site II, situated nearby, which has given related materials, has, from radiocarbon studies, been connected with a rather undetermined group from the turn of the Neolithic and the Early Bronze Age (Schild, Królik, Mościbrodzka 1977, 98). The production, at the workshops of Polany II situated close to the pits, of large amounts of knife and sickle forms, axes, mostly celts, and projectile forms indicates that it is possible to connect the users of the mine with some of the abovementioned groups of the Early Bronze Age, defined as representing the picorded cultural cycle (Machnik

1978, 70). As a matter of fact, the above-mentioned forms quite frequently belong to the burial equipment of cemeteries of this period (Salewicz 1937, 51, Figs. 17, 24; Głosik 1968, Plates II and VII 13; Kraussowie 1971, Plates III 1, 2 and IV 3; Machnikowie 1973, 151; Svešnikov 1974, Figs. 34-35, 37–39, 46, 48-49). They also occur, celts in particular, in some living sites contemporary with the cemeteries (Balcer 1977, Figs. 4, 5, 7 d, o, 8, 9, and 11a, b; Machnikowie 1973, Plate I 14, 15). This suggestion is also in agreement with the considerable proportion of scaled pieces in the tool group of Polany II (Table 6), including typical ones (Plate III 6), and traces of the technique of their manufacturing to be seen on the edges in many specimens.

In the course of the analysis of the flint materials from the mine, its connection with the Mierzanowice culture seemed most probable. On the other hand, the radiocarbon date of Polany II, namely 1541 + 81 years BC (Lech 1981b, 48), raised some objections when confronted with exactly these materials. As a matter of fact, it set the site in the final stage of period I of the Bronze Age. On the basis of a series of ^{14}C dates from the Iwanowice site, Cracow District, J. Machnik located the development of the Mierzanowice groups in between 1750 and 1600 BC. Thus, the time span of about 150 years (neglecting the standard error) between the site in question and the youngest Mierzanowice level of Iwanowice is equal to the development period of this group in general.

We should not forget either that some archaeologists believe that we should expect the existence of early phases of the Trzciniec culture as early as the end of period I of the Bronze Age (Gardawski 1966, 536; Miśkiewicz 1978, 190). The flint industry of this culture is not well known, we do know, however, that in its early phases flint still was an important raw material for making tools (Gardawski 1959, 97; Miśkiewicz 1978, 179). The discovery of a bifacially worked dagger on the mound cemetery of the Trzciniec culture at Guciów, Zamość District (Rogozińska-Goszczyńska 1965, 94, Fig. 1d) and of a fragment of a sickle in the Trzciniec culture level of the Bondyrz settlement, Zamość District (Rogozińska 1963, 91) can indicate that some bifacial forms known from epicorded sites may have been continued. Their production and also that of axes, slightly more frequently found at the Trzciniec sites, required good-quality raw material, such as could be obtained above all by mining. Contrary, thus, to the opinion that Trzciniec communities abandoned it, we can expect the existence of still unidentified extraction points related to the early phases of this culture, too. The connection of the studied pits of Polany II with the Trzciniec culture involves some difficulties. The above-mentioned bifacial tools are something exceptional at the Trzciniec sites, while the production waste at the on-site processing workshops of Polany II indicate that they were produced in large amounts, and thus the great demand for such forms. This is reflected in the inventories of numerous sites presented in paper of the above-mentioned authors.

This directs our attention to groups representing the Epicorded cultural cycle, the Mierzanowice culture in particular, which is also supported by the results of recent research on the Mierzanowice site (the settlement and cemetery) at Szarbia, Kielce District. They show that the above-mentioned discrepancy between the radiocarbon date for the Polany II mine and the flint forms of their processing workshops can only be apparent, since remnants of charcoal from a few features found at the different parts of the Szarbia settlement gave a series of ^{14}C dates, situating its development between 1730 ± 100 and 1430 ± 100 BC (Baczyńska 1985, 126ff.). Moreover, typological and technical differences were observed between the pottery from older features (dating from between 1739 ± 100 and 1720 ± 100 BC) and the ceramics coming from features dated from 1580 ± 60, 1510 ± 60 and 1430 ± 100 BC, indicating, according to B. Baczyńska, two phases of the development of this settlement. B. Baczyńska believes that the older, classical phase of the Mierzanowice culture came within the dates, given by J. Machnik, between 1750 and 1600 BC. It should be pointed out that the younger phase of the Mierzanowice culture, distinguished by B. Baczyńska, has so far not been identified at any site.

In the light of the above, more recent chronological identification of the Mierzanowice culture, on the basis of the ^{14}C date obtained from Shaft 1/2, we can presume that the mine of Polany II, or at least its excavated part, was exploited by a community belonging to the Mierzanowice group from the younger phase of this culture.

3. TECHNIQUES OF EXTRACTION AND ESTIMATED YIELD SIZE

The shafts uncovered in the excavated area of the site represent an open system of flint extraction. They are technically simple. They belong to a group of features which are differently defined in technical classifications of extraction units, e.g. recently as open shafts (Lech 1981a, 89). As we mentioned above, they were small-size pits dug to the top of detrital clay, containing chocolate flint nodules. Taking into ac-

count the depth at which it was now, on the one hand, and the action of denudation factors, on the other hand, particularly active after forests were removed from the area in question, we can assume that, as the mine operated, the detritus clay top was reachable at about 150–180 cm below the surface.

Because of the nature of the overlay, the pit walls had to run obliquely to the detritus clay top. The lower part of the pits below this level represents a refilled gob. The shape and size of gobs, resulting from the extraction of a flint-bearing deposit, depended on the mining techniques and their intensities. These factors often brought about an irregular outline of the profile of lower pit parts, and also their varied form. The north and east walls of Shaft 3 and the north wall of Shaft 8 ran in detrital clay vertically down to the rock (Figs. 11 and 26). The floor parts of the other walls of Shaft 3, and the walls of the other pits were sometimes obliquely widened from the bottom upwards (Fig. 11). At times, e.g. in Shaft 7, the oblique wall of its lower part was step-like in outline, or, in a wall running almost vertically through the detritus, there were visible shallow post-extraction hollows. In one case there was a cavity-like post-extraction hollow at the very bottom of a pit, whereas in Shaft 4 a wall slightly widened at the level of the extracted material (Fig. 10). In the cut area, no extraction niches, resembling those found in the detritus floors of the mines at the Polany Kolonie II site (Schild, Królik, Mościbrodzka, 34 ff.), were found.

In some pits, after removing detritus, the limestone ceiling was broken out at 10–15 cm depth, to reach the level of platey flint nodules situated there. The small range of this work, limited to only a slight part of the shaft bottom, indicates, on the other hand, that it was not the main purpose of the mining. The main object of it was detrital clay which was extracted by widening upwards the pit walls at the level of this deposit. The intensity of the deposit working is also indicated by the fact that only thin walls were left, dividing the gobs of particular extraction pits and that they were densely dug up, one close to another (Fig. 11).

It is only for Shaft 3, almost fully uncovered, that we can try to estimate, and if so, only indirectly, the amount of flint raw material extracted from it. Assuming the same number of nodules in 1 cum. of detritus as R. Schild gave for the Polany Kolonie II site and estimating the extracted clay mass at about 1.2 cu.m., we can put their number in Shaft 3 at about 500–600 pieces[8]. Similar amounts of raw material could be yielded from other shafts resembling the former one – this would rather show the slight extraction yield.

The work of 2 or 3 persons was enough to dig a hole with the parameters of Shaft 3. If the deposit occurred at 150–180 cm depth, the volume of the removed overlay have been 7–7.5 cu. ms. The time it took to do so using the then tools probably did not exceed a few days. Beacuse of the slight space of the bottom pit parts, only 1 person could extract the flint-bearing detritus. The yield transport to the surface required the help of 1 or 2 persons. Considering the small depth of the studied pits, this transport was not too difficult. It required no additional devices, whose traces can be found in shafts drilled in rocks and at considerable depth. The fragment of in situ boulder, clay, to be seen in the cross-section of the west wall of Shaft 3, and which rests on detritus (Fig. 11: 19), is probably a remnant of a communication step used in the transportation of the yield.

The technique of extraction used by the miners, which lay in digging small holes and taking the flint raw material only within the shaft opening, was the most appropriate one in the conditions of Polany II. It was economical, since the flint deposit lay not too deep, and it ensured safe work on the loose, unstable overburden.

The botanical materials found in the fills of the excavated shafts are represented only by chunks of charcoal. They are most probably remnants of fires kept near the shafts. All the identified relics (20 samples) came from cones and young branches of pine (*Pinus* sp.)[9]. Because of this, we cannot identify the season of the year when the extraction took place. At any rate, we do not know if the mining was performed in any specific season or irregularly, depending on the current need for flint raw material.

The minimum proportion of flake tools common in living sites, in the assemblage presented above, indicates that, apart from the extraction work and initial working of the raw material, at the site there was no activity in the normal range related to gaining means of existence and processing them. This suggests that the extraction work may have been carried out at a single short period. It may have been performed by a group of persons sent over from a so far undiscovered settlement for the purpose of acqui-

[8] The mass of the detrital clay was calculated by using the formula for the volume of a cylinder with an elliptic base. The successively given estimations of the work time and the number of miners needed to dig one shaft of the open type, as described in the paper, were made after the calculations by J. Lech (1972, p. 122) and R. Schild (Schild, Królik, Mościbrodzka 1977, 100 ff.), carried out on the results of excavations and experiments by S.A. Semenov (1968, 21 f.).

[9] The charcoal samples were analyzed by Mrs. Zofia Tomczyńska, Eng., from the Botanics Institute, Polish Academy of Sciences, in Cracow, for which I am grateful.

ring the raw material it needed. This expeditionary system of chocolate flint supply was also suggested for the mine Polany Kolonie II (Schild, Królik, Mościbrodzka 1977, 103) and the Neolithic part of the mine at Tomaszów, Radom District (Schild, Królik, Marczak 1985, 106).

4. THE DISTRIBUTION, ECONOMIC AND OWNERSHIP RELATIONS OF THE MINE AND THE QUESTION OF ITS HOMOGENEITY

The system of flint raw material supply strictly involves the problem of its distribution. There are few data for its detailed discussion. The studies devoted to it often give no necessary information on the proportion of chocolate flint in flint inventories at the investigated sites. Moreover, the Polany II flint does not differ from that extracted at other points in the area of Polany. We can at most point out the presence of chocolate flint at some sites, without identifying precisely the place of its extraction.

The taxonomic affiliation of Polany II suggested here restricts the range of considerations to the sites of the Mierzanowice culture. The sites of the Opatów Upland are closest (about 65–70 km away) to the outcrops of the flint-bearing limestones in the area of Polany – Wierzbica. Studies over the recent years showed large concentrations of them there, particularly in the Gierczanka river basin (Bąbel 1985, 52, Fig. 2). Apart from other varieties of flint, chocolate flint also occurs at these sites. It is particularly interesting to note the above-mentioned materials from the settlement at Site 1 at Mierzanowice, Tarnobrzeg District. They include, apart from small pieces, bifacial forms, their fragments and roughouts, also from chocolate flint (Balcer 1977, 206), resembling the features from the on-site workshops of Polany II and other extraction points nearby. We also need to mention the bifacially worked sickles from Sites 1 and 3 at Wojciechowice, Tarnobrzeg District, also produced from this raw material (Bąbel 1985, 54, 56, Fig. 8f). It needs to be said that the Mierzanowice settlements on the Opatów Upland may have acquired chocolate flint also from a less distant mine at Gliniany, Tarnobrzeg District, only a dozen or so km away (Budziszewski 1980, 601). We have not, on the other hand, identified the relations between this mine and the numerous Neolithic sites and those related to the Epicorded cultural cycle on the Opatów Upland.

Chocolate flint artifacts are also found at the latter sites, including the Mierzanowice ones in the southwest part of the Nida Basin. They include particularly numerous heart-shaped arrowheads (Kempisty 1978, 315, Table 45). Artifacts of this raw material are also found in the flint inventory of the site at Szarbia.[10] The distance between these sites from the strip where chocolate flint occurs in the area of Polany – Wierzbica is 110–120 km.

These, of necessity, very general data on the presence of chocolate flint at the sites of the Mierzanowice culture prevent us from drawing any detailed conclusions about the place of its origin, transportation routes, role in the economy and how it penetrated to other groups representing the Epicorded cultural cycle.

According to R. Schild, the mine Polany Kolonie II, situated at the very strip of the limestone outcrops, dated from the turn of the Neolithic and the Early Bronze Age, was most probably owned by the settlement unit which exploited it. The production of its on-site workshops was utilized by the inhabitants of this settlement (Schild, Królik, Mościbrodzka 1977, 107). We cannot thus exclude the possibility that similar economic and ownership relations can also be referred to the site in question here, since a much smaller range of distribution of the Łysa Góra flints, including chocolate one, was found in the early periods of the Bronze Age compared with the Neolithic (Balcer, Kowalski 1978, 139). Researchers think that this may indicate that the deposits then became the property of particular settlements situated relatively close to these deposits, which exploited them to meet their needs (Balcer 1977, 208; Schild 1976, 171; Schild, Królik, Mościbrodzka 1977, 106).

The results of previous studies on the mine Polany II gave no information for a more detailed discussion of these questions, since no traces of settlement have been found which could be connected directly with the mine under study. Neither were data acquired in the course of the excavations for calculating the real size of its mine field. The spread of flint artifacts over the surface area of the mine – which has become uniform due to long-term tillage – considerably exceeds the dimensions of the mine Polany Kolonie II, as it is eight times as large as the calculated area of its mine field. The spread of the flint materials of Polany II, shown in outline in Fig. 5, can cover a large mine field, though perhaps smaller than its range, with shafts uniformly, densely distributed in it, as in the performed cuts, or more or less isolated groups of shafts, representing separate, small extraction units. Each of these different, but possible situations must provoke different suggestions as to the organizational, economic and ownership relations of the whole site.

[10] A private communication from Miss Barbara Baczyńska, M.A., for which I am grateful.

The excavations also failed to explain the question of the taxonomic homogeneity of the mining complex Polany II. In the area of the extensive mine field of the site at Tomaszów (about 9000 sq. ms.), situated about 10 km northwest of Polany II, the research in 1973–1975 uncovered groups of shafts differing taxonomically and chronologically. They were extraction units from the early Neolithic (the cycle of Linear Pottery cultures) and from the Early Bronze Age (Schild, Królik, Marczak 1985, 52–55, Figs. 29-30). Reliable premises were also given for suggesting that a part of the mine was also exploited even in the Late Mesolithic (Schild, Królik, Marczak 1985, 74, 152ff.). We cannot thus exclude the possibility that in the still unexcavated part of the extensive mine field of Polany II there can also occur much older extraction features and also those younger than the features uncovered in Cuts I/71 and I/72. The explanation of the above-mentioned questions should be solved in the future research at the site.

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PA – Przegląd Archeologiczny, Poznań, Wroclaw
SA – Sprawozdania Archeologiczne, Wroclaw – Warszawa – Kraków
WA – Wiadomości Archeologiczne, Warszawa.
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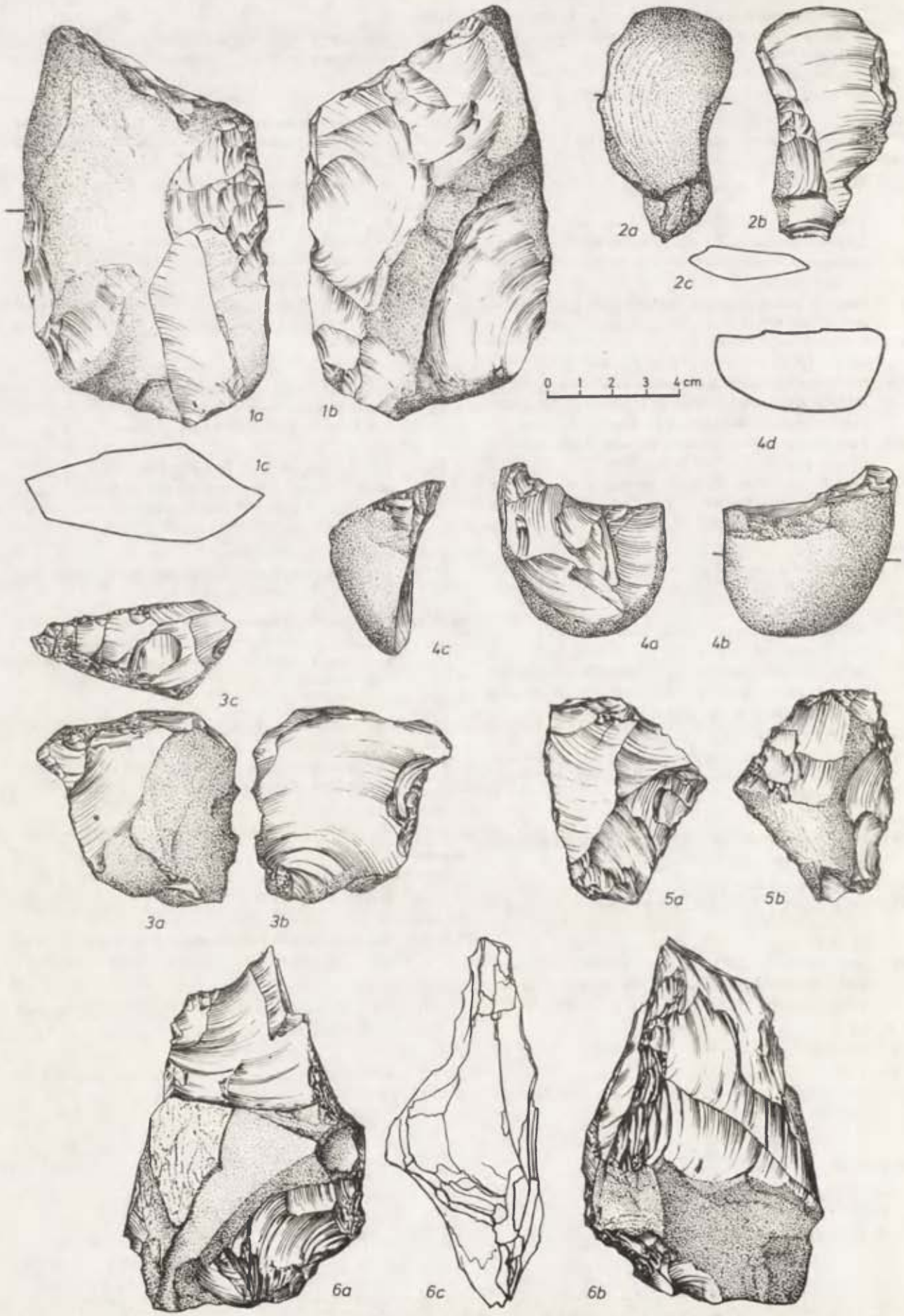

Plate I. Polany, Site II. Flint artifacts

1, 3–5 – Concentration 2 (the upper part of the fill of Shaft 3), 2 – Concentration 1 (the upper part of the fill of Shaft 1/2), 6 – he floor of the fill of Shaft 3
Drawn by I. Niewiadomska

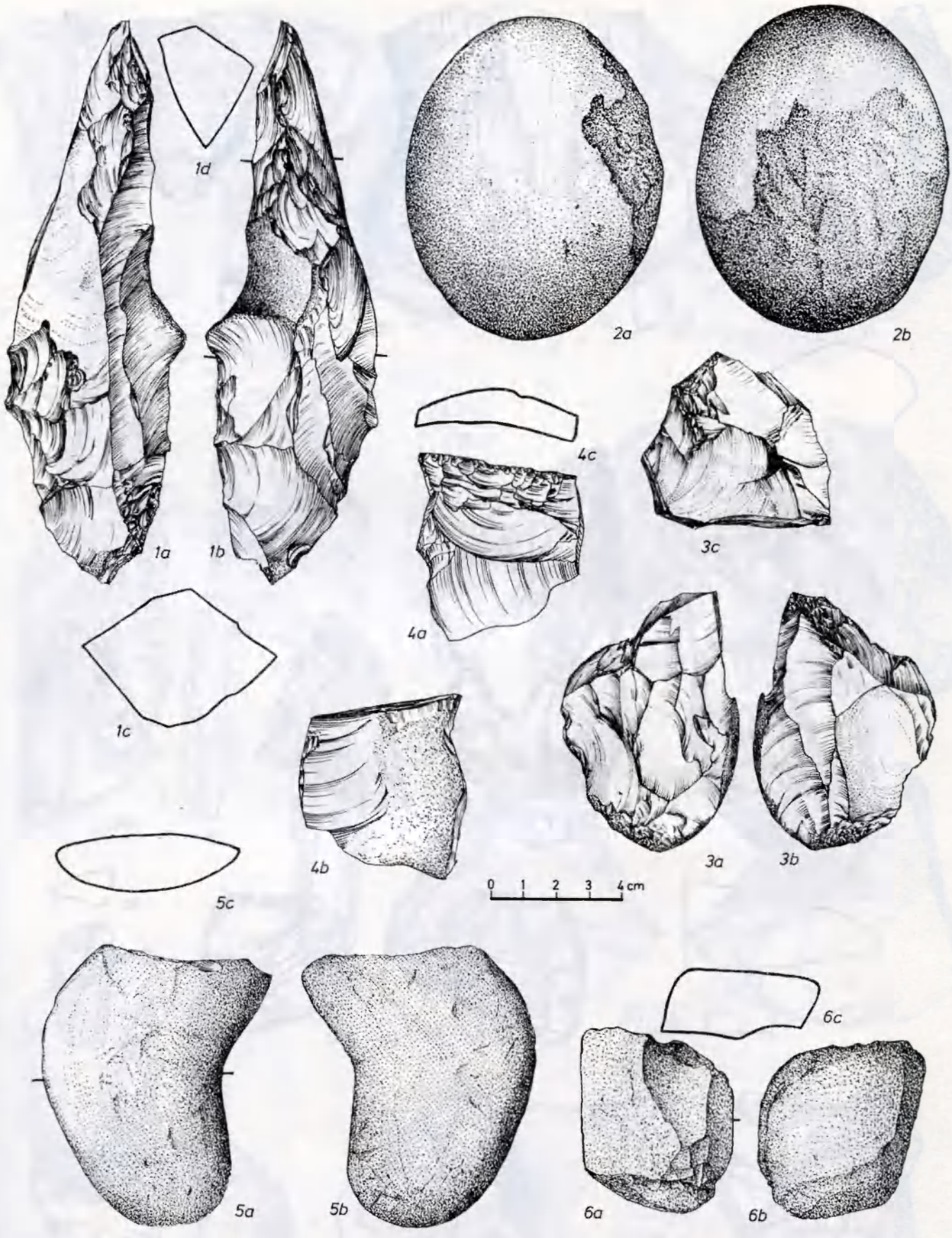

Plate II. Polany, Site II. Flint artifacts, flint nodule – support (*5 a–c*), hammer stone (*2 a, b*) and quartzite scaled piece (*6 a, b*)
1 – the bottom section of the fill of Shaft 6, *2, 4, 5* – Concentration 2 (the upper part of the fill of Shaft 3), *3* – the squares I–2/III-IV, *6* – Concentration 3a (the upper part of the fill of Shaft 6)

Drawn by I. Niewiadomska

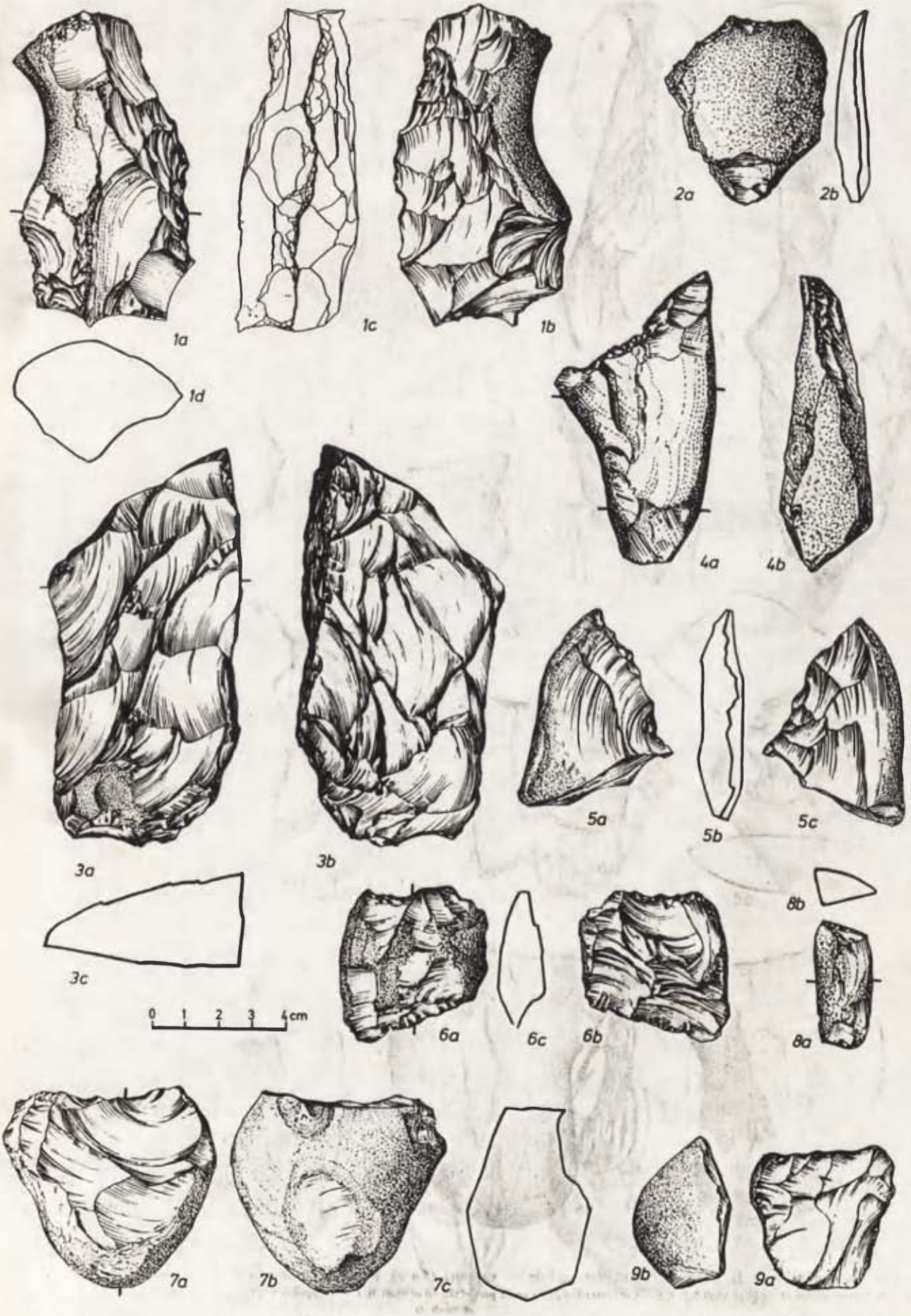

Plate III. Polany, Site II. Flint artifacts

1–3 – Concentration 2 (the upper part of the fill of Shaft 3), *4–9* – Concentration 1 (the upper part of the fill of Shaft 1/2)

Drawn by I. Niewiadomska

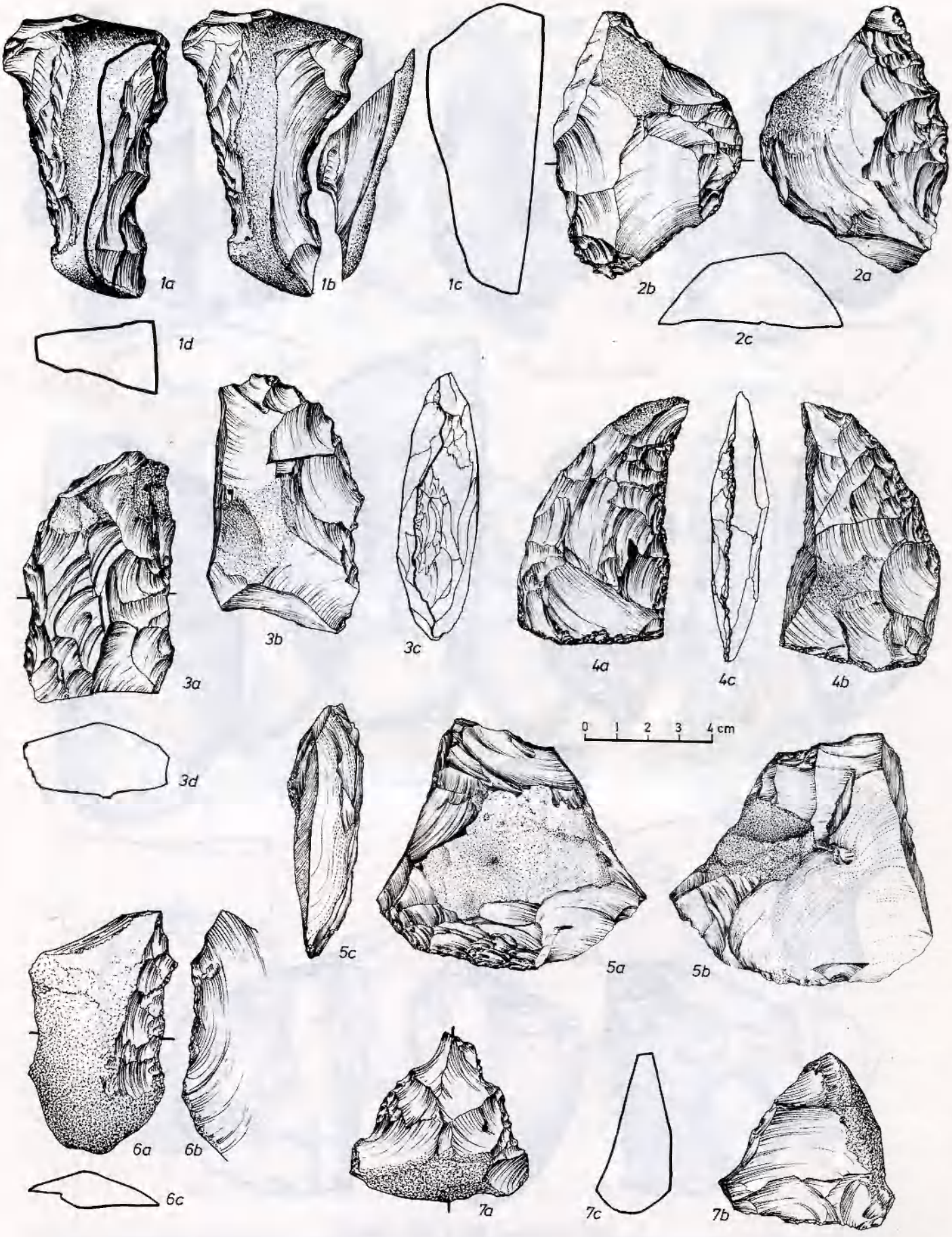

Plate IV. Polany, Site II. Flint artifacts

1–3, 5–7 – Concentration 1 (the upper part of the fill of Shaft 1/2), *4* – from the surface of the site near the cut

Drawn by I. Niewiadomska

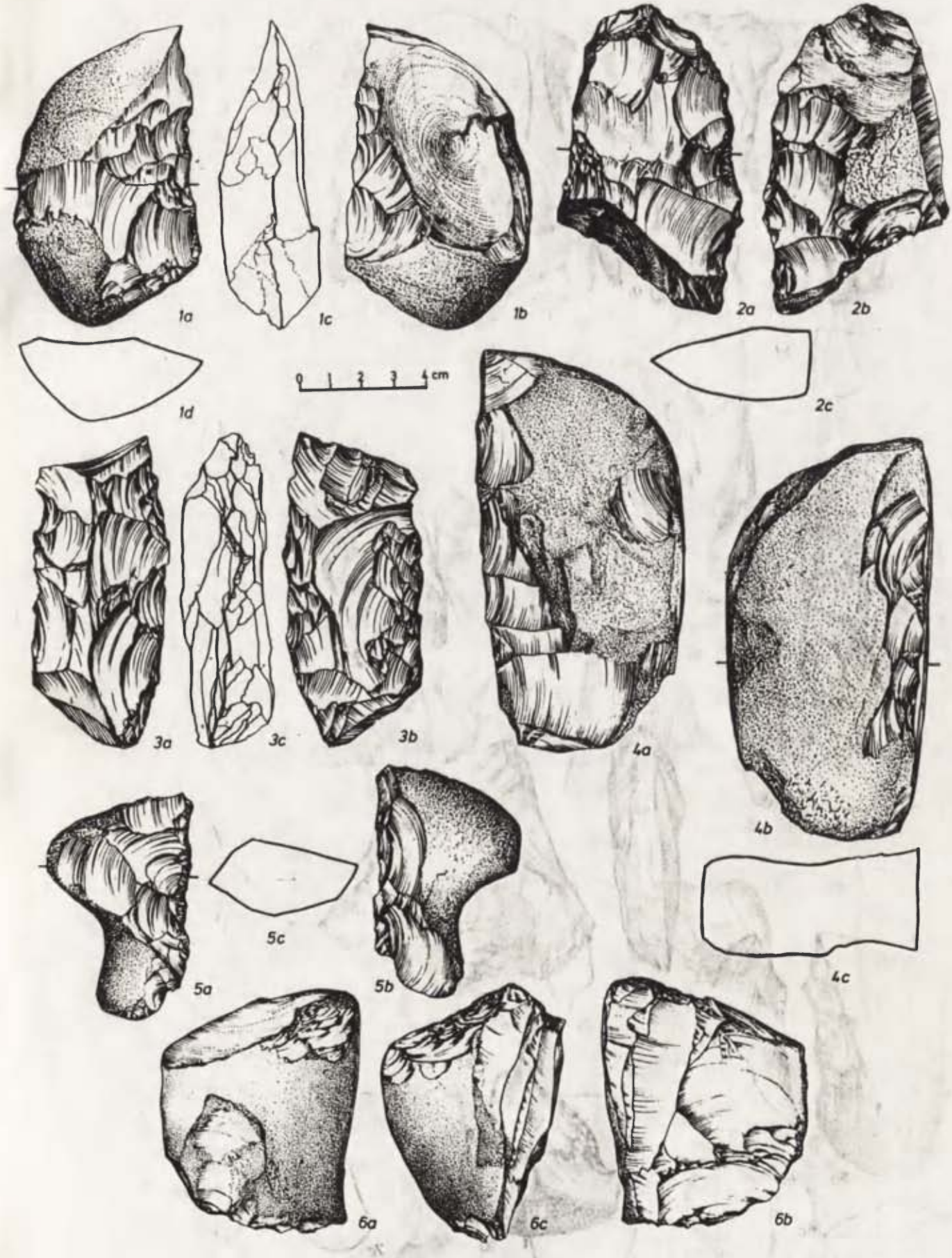

Plate V. Polany, Site II. Flint artifacts

1, 2, 5 – Concentration 3a (the upper part of the fill of Shaft 6), *3, 4* – Concentration 1 (the upper part of the fill of Shaft 1/2), *6* – the squares 1-2/III-IV
Drawn by I. Niewiadomska

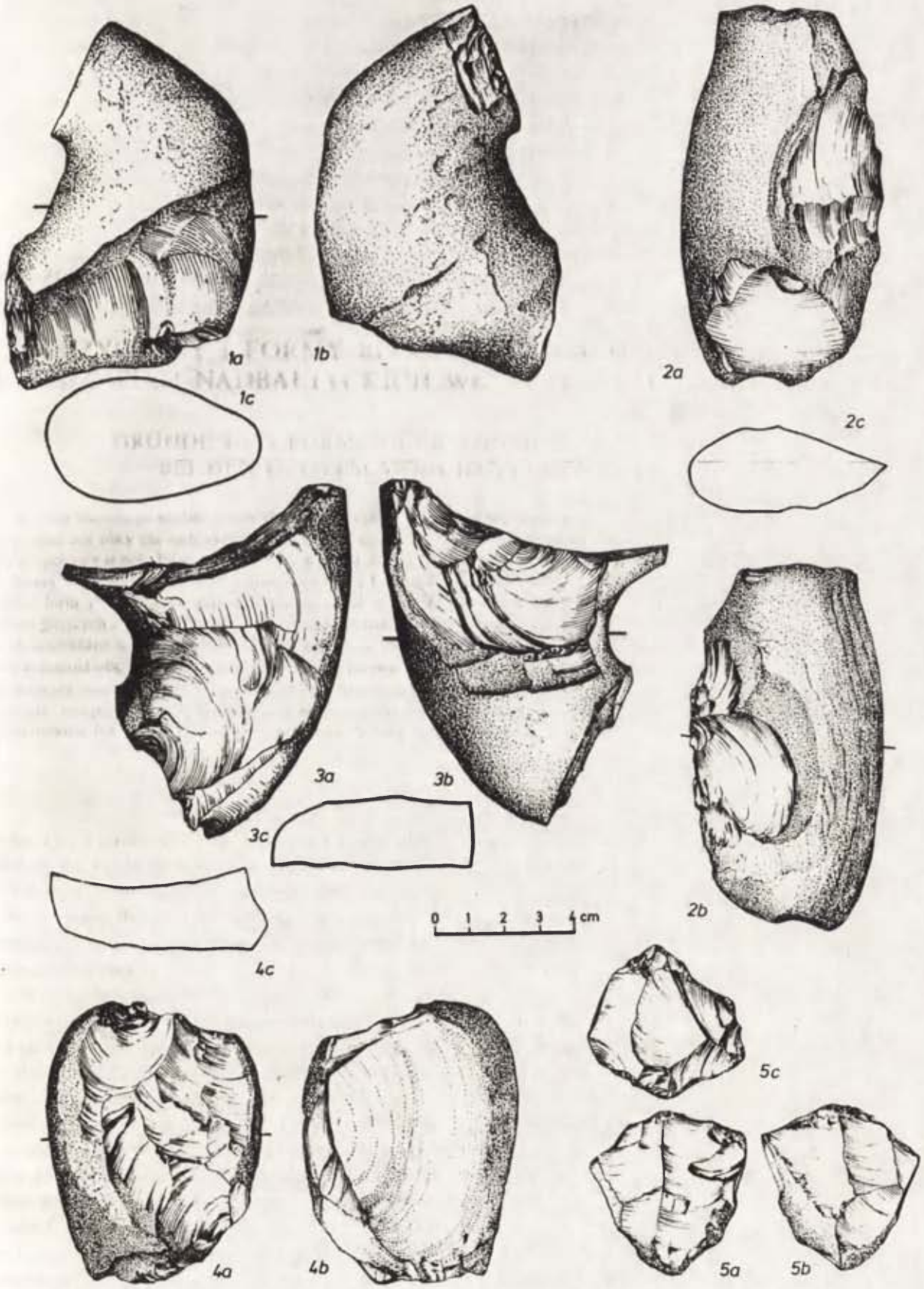

Plate VI. Polany, Site II. Flint artifacts

1-3 – Concentration 3a (the upper part of the fill of Shaft 6), 4 – the squares 1-2/III-IV, 5 – Concentration 2 (the upper part of the fill of Shaft 3)
Drawn by I. Niewiadomska