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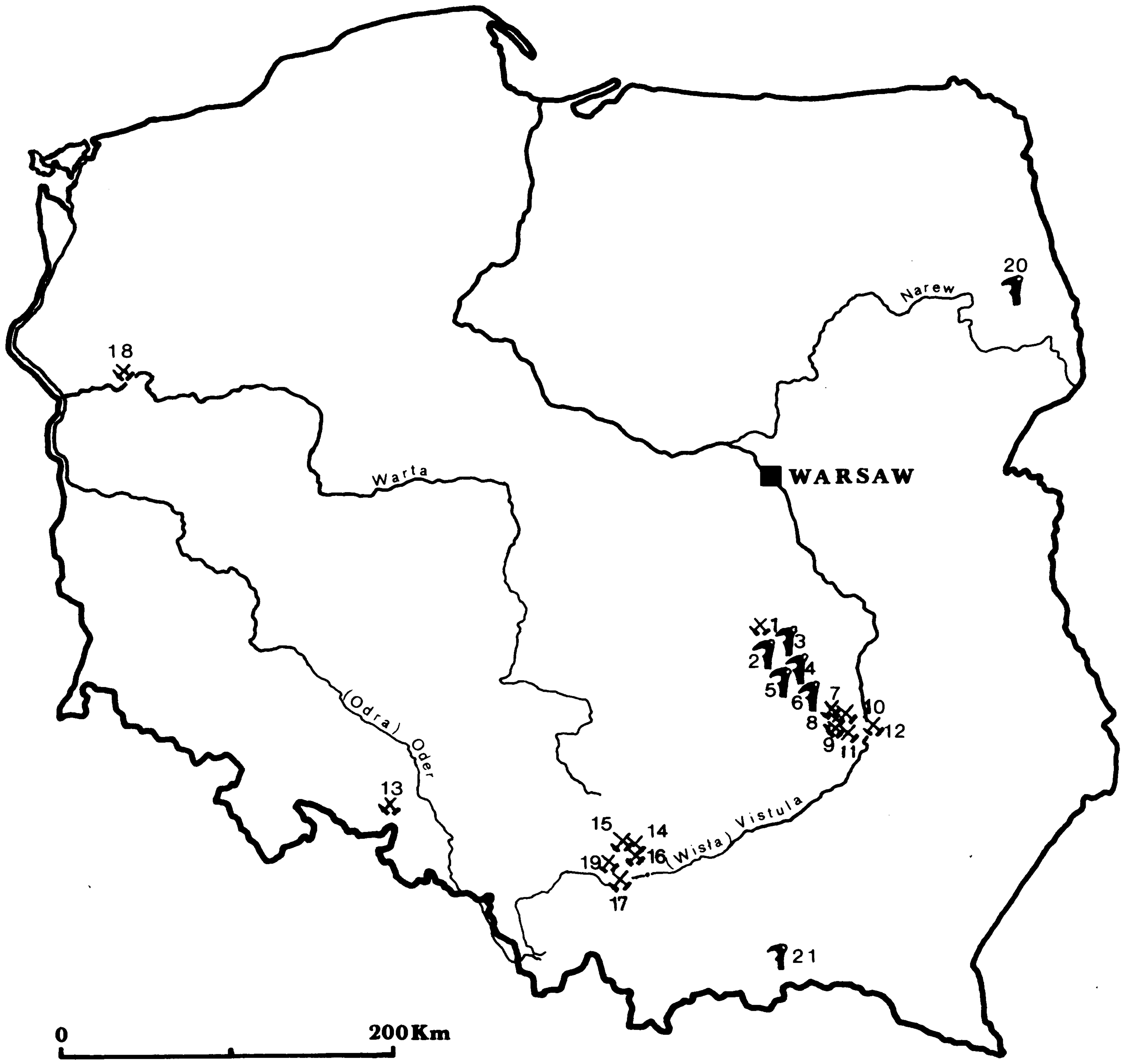

PL Poland

PL 1 Orońsko
PL 2 Tomaszów
PL 3 Wierzbica
PL 4 Polany Kolonie II
PL 5 Polany II
PL 6 Krzemionki Opatowskie
PL 7 Ruda Kościelna
PL 8 Borownia
PL 9 Korycizna
PL 10 Gliniany
PL 11 Ożarów
PL 12 Świeciechów-Lasek
PL 13 Maków
PL 14 Jerzmanowice-Dąbrówka I
PL 15 Sąspów
PL 16 Bębło
PL 17 Wołowice
PL 18 Gorzów Wielkopolski-Chwalęcice
PL 19 Brzoskwinia
PL 20 Rybniki
PL 21 Ropa

PL 3 WIERZBICA "ZELE", RADOM PROVINCE

Hanna and Jacek Lech

The Wierzbica "Zele" flint mine lies in a belt of chocolate flint deposits which occur in the Upper Jurassic limestones and their weathering products in the north-eastern fringes of the Świętokrzyskie (Holy Cross) Mountains in Central Poland. The mine lies in the area of the Iłża Foreland, near the border with the Radom Plain, approximately 20 km south of Radom. The geographical co-ordinates of the site are 51°14′45″ N and 21°03′10″ E. The site is located about 200 m south of the Wierzbice – Szydłowiec road (through Jastrząb), between Wierzbica-Osiedle and the "Przyjaźń" Cement Plant in Wierzbica. The site lies about 1.5 km west of the settlement at Wierzbica-Osiedle (Fig. 1).

The site at "Zele" in Wierzbica is one of the mines discovered by Stefan Krukowski, probably in the years 1922–34. In the autumn of 1956 Krukowski showed the site to Romuald Schild, who described it for the first time as one of the exploitation points of chocolate flint examined in surface studies in 1968 (1971:29 and 34–35). The program concentrated on searching for and mapping sites associated

Fig. 1. PL 3 Wierzbica "Zele" flint mine, Radom Province. May 1979. View of a central and south-estern fragment of the mining field from north-west: a — location of shaft 28, excavated in 1983; b — location of shaft 17, excavated in 1982.

with the exploitation of chocolate flint in the Palaeolithic and Mesolithic. The widespread "Zele" site was associated from the beginning with the Palaeolithic and Neolithic and, therefore, did not arouse great interest. Among the exploitation points of chocolate flint "Zele" was distinguished by an unusually large number of flint specimens and, in places, limestone slabs occurring on the surface. It was visited only sporadically. In 1973 a concrete road was built through the site, leading to a quarry which was being prepared for a new cement plant. The road destroyed an important part of the site. Later it turned out that the deepest shafts were in this region (*e.g.*, nos 7, 19, 20). In 1978, when Schild found that the site had been partly destroyed and was endangered, it was decided to excavate. Excavations continued from 1979 to 1988, first as rescue work and then diagnostic and for conservation purposes (Młynarczyk 1983; Lech 1984). Investigations at Wierzbica "Zele" were carried out by Hanna Lech, *née* Młynarczyk, from the Centre for the Conservation of Historical Monuments (PP PKZ), Warsaw Branch, in close cooperation with the Institute for the History of Material Culture (now the Institute of Archaeology and Ethnology, Polish Academy of Sciences). The consultants were Jacek Lech (in the years 1979–1982) and Romuald Schild (1985–1988). In the years 1983–1984 J. Lech also carried out investigations at the site as part of the same program.

From 1980 excavations were accompanied by geophysical research. Tomasz Herbich tried to develop a more effective method of determining the borders of a mine field than archaeological excavations. In 1984 work in the field was limited solely to geophysical surveying but without positive results. It was not until 1988 that these were obtained at the nearby site II in Polany (see Herbich and Lech in this volume; see also Herbich 1993a, 1993b, 1995). The extent of the "Zele" mine field was determined by means of excavations. The state of knowledge relating to the mine prior to the investigations of 1979–1988 was presented by Schild (1971, 1980). Preliminary results of work done in the years 1979–1983 were published by the authors (Młynarczyk 1983; Lech 1984). These suprising results will be discussed later. This text supplements an earlier article (Lech 1984).

The layers and sediments distinguished during excavations were studied by a geologist – Barbara Kosmowska-Ceranowicz from the Museum of the Earth, Polish Academy of Sciences. The bed rock for the chocolate flint in the "Zele" mine was Upper Jurassic limestone and marl. These were covered with various weathering clays with traces of Scandinavian elements and were all formed before the Quaternary. The presence of northern material is the result of natural geological processes. Higher up sand and clay deposits dominated, sometimes mixed with a large amount of silt and some gravel. The Scandinavian elements increased and these dominated in the top layer of deposits – in the sands and boulder clays occurring just below the *rendzina* soil and scarcely distinguishable layer of subsoil.

The chocolate flint exploited in the "Zele" mine was described by Schild (1971:8–17) and designated in general as "Zele" type black-brown chocolate flint. It differs from similar variants of chocolate flint in having less shine and in sometimes having a distinct border between the black and dark brown colours in the silica. It occurs in different forms – as small pancake-shaped nodules, as larger plate-shaped or rounded concretions and as very large round-shaped nodules about 0.5 m in diameter. These last occur more rarely and deeper. The small pancake-shaped nodules were readily used to make axes and the larger rounded nodules to make large massive blades and flake blanks. The largest concretions were not used.

The archaeological excavations carried out in the years 1979–1983 have been described in a previous article (Lech 1984). In the following years, 1983–1988, attempts were made to determine more precisely the borders of the mine field and the different kinds of exploitation units. Altogether 2180 sq. m. were excavated. The deepest excavation was 7 m deep (shafts 19 and 20). In all 81 shafts and other exploitation units were distinguished. One of the primary aims of the study was to determine the chronology of the mine using archaeological finds and the ^{14}C method. Features dating from the Late Palaeolithic to the Early Bronze Age were expected but with most from the Neolithic (Młynarczyk 1983:105–12).

In 1979, after detailed surface studies, the size of the site was determined as being approximately 400 x 300 m. It is shaped like a short kidney (Lech 1984:190–1). Excavations determined that the mine field within the site has the shape of an elongated elipse, with a longer diameter from the SE to the NW of about 260 m and a shorter diameter from the SW to the NE of about 70 m. It therefore takes up about 15% of today's site. The shape of the "Zele" mine field is connected with the location just under the surface of limestone with flint and the products of their weathering. An analysis by Zofia Tomczyńska of 3711 charcoal fragments from 224 samples, collected from the shafts examined in the years 1980–1983, indicates that in prehistoric times, when the mine field was being exploited it was covered with mixed forest. The charcoal did not come from small and young branches, as was the case with the charcoal from the Polany II mine (*cf.* Herbich and Lech, this volume). The most common trees were pine (*Pinus sp.*) and oak (*Quercus sp.*). More rare were charcoal pieces from hazel (*Corylus avellana*), ash (*Fraxinus excelsior*), hornbeam (*Carpinus betulus*) and birch (*Betulus*). Moreover, one sample contained *Populus sp.*

At one time the mine field was covered with numerous depressions in those places where the prehistoric shafts had been. Next to these were waste heaps and chipping floors (flint workshops).

The depressions were levelled when the site was turned into arable land; an event which took place fairly late, as the soil was of poor quality due to the prehistoric mining of the area. The site differed from its surroundings and the local inhabitants called it *uroczysko* "Zele". The name has two meanings: it is Slavonic for sacred spot and also as an (unspecified) landscape feature. The many limestone slabs laying on the surface from waste heaps derived from the prehistoric mining indicated to the people of historic times that here limestone could be exploited for local building needs at Wierzbica. A completely levelled quarry was found during excavations in 1980 (part of cutting I/80). Another quarry nearby, next to a large oak, was used till recently for throwing away flints gathered in the fields.

The shafts were sunk through layers of Quaternary sediments to eluvial clays and weathered limestone. Flints of different shapes and sizes were extracted from

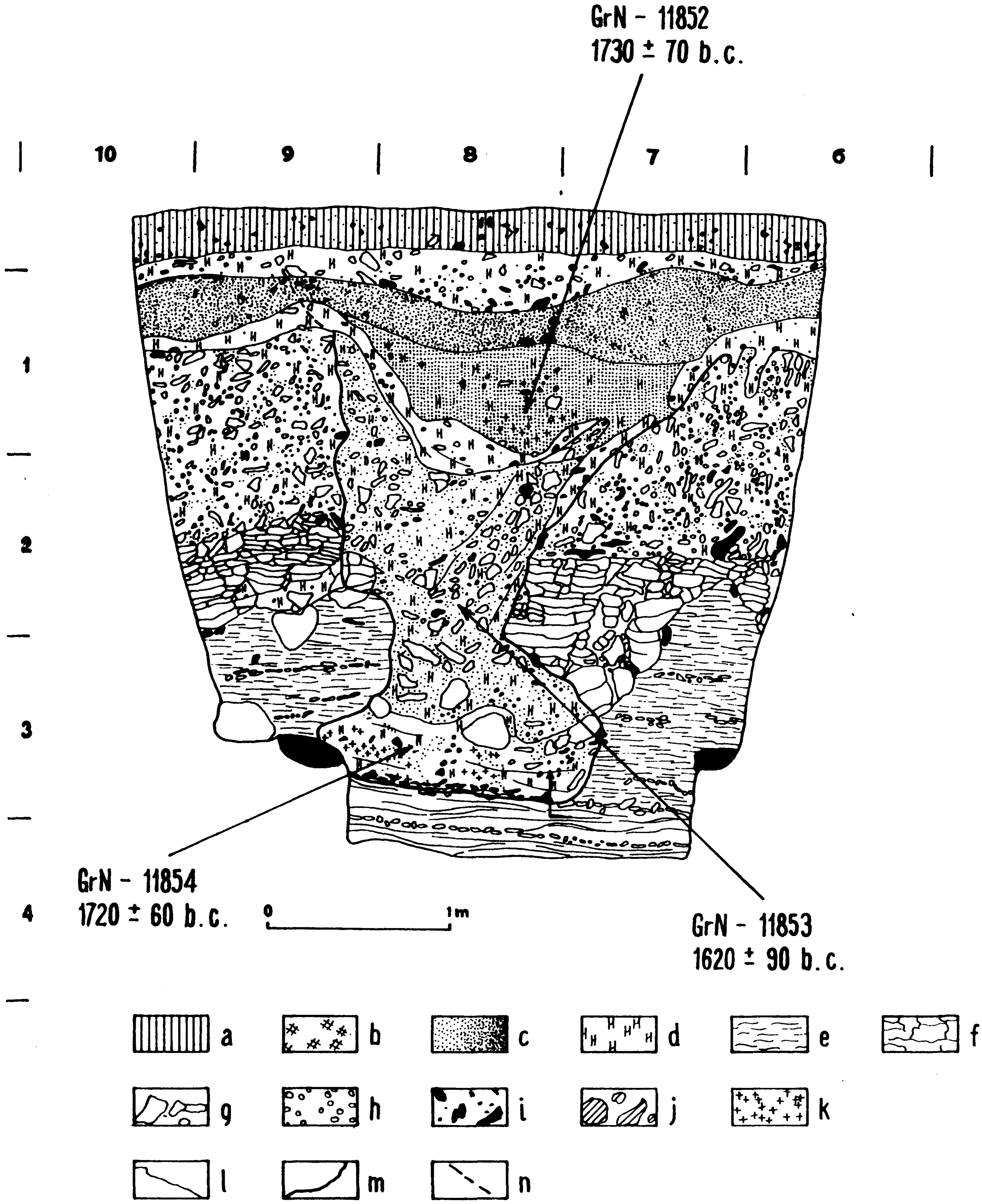

Fig. 2. PL 3 Wierzbica "Zele" flint mine, Radom Province. Cross-section of shaft 17 — west face, and radiocarbon determinations. Key for Fig. 2, 5 and 7: a — soil; b — *rendzina* soil; c — different types of sendy sediments; d — clay; e — clay without limestone, erratics, and flint debris; f — limestone bed rock; g — limestone slabs and blocks; h — limestone small debris; i — flints; j — erratic blocks; k — charcoal; l — limits of layers; m — shaft walls; n — reconstructed shaft walls.

Fig. 3. PL 3 Wierzbica "Zele" flint mine, Radom Province. Cutting III/83. Shaft 28 and cross-section of its filling — west face. Depth of shaft 4.5 m: a — location on limestone wall of shaft 28 where traces of fire and quantities of charcoal for ^{14}C dates BM-2386 and BM-2386A occurred (see Figs 4–5); b — location of charcoal sample for ^{14}C dates BM-2385 and BM-2385A (see Fig. 5).

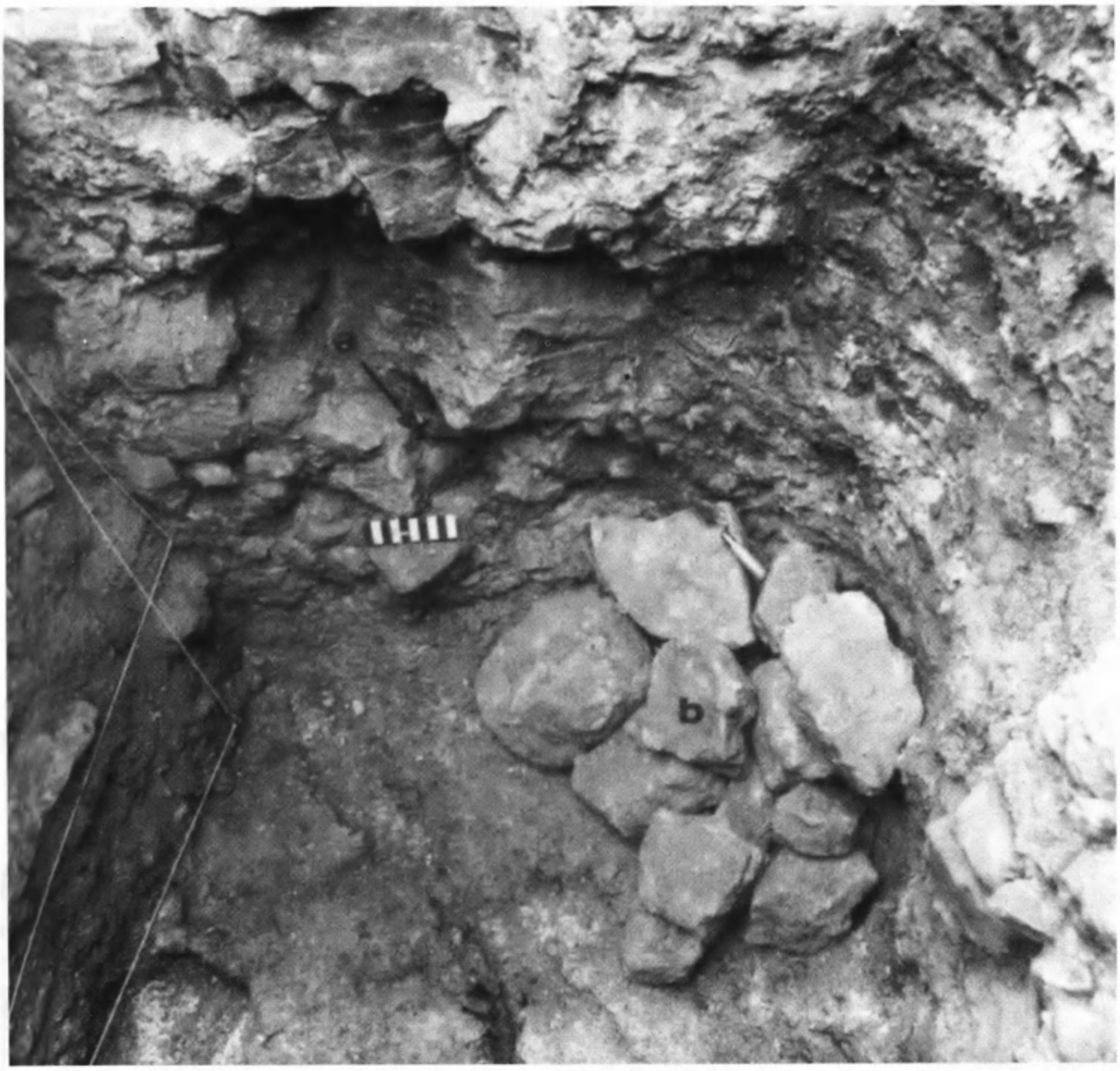

Fig. 4. PL 3 Wierzbica "Zele" flint mine, Radom Province. Cutting III/83. Bottom of the Shaft 28: a — location on limestone wall of shaft 28 where traces of fire and quantities of charcoal for ^{14}C dates BM-2386 and BM-2386A occurred (see Fig. 3 and 5); b — part of waste heap of large limestone blocks, left by miners at base of the shaft.

Jurassic limestone and their weathering products. The exploitation units of the "Zele" mine show some typological differentiation. Most of them belong to the category of open shafts with or without side workings (Lech 1981:20–32; Lech 1984:191–3). The shafts differ significantly in size, from small, *e.g.*, shaft 17 (Fig. 2), through medium-sized features, *e.g.*, shaft 28 (Fig. 3 and 5), to the occasionaly very large – shaft 19 (Fig. 6 and 7). Apart from the shafts there were also simpler exploitation units – large surface pits. Their depth was about 1.5 m or more below the level of ploughsoil. The pits were usually large with a diameter of several metres.

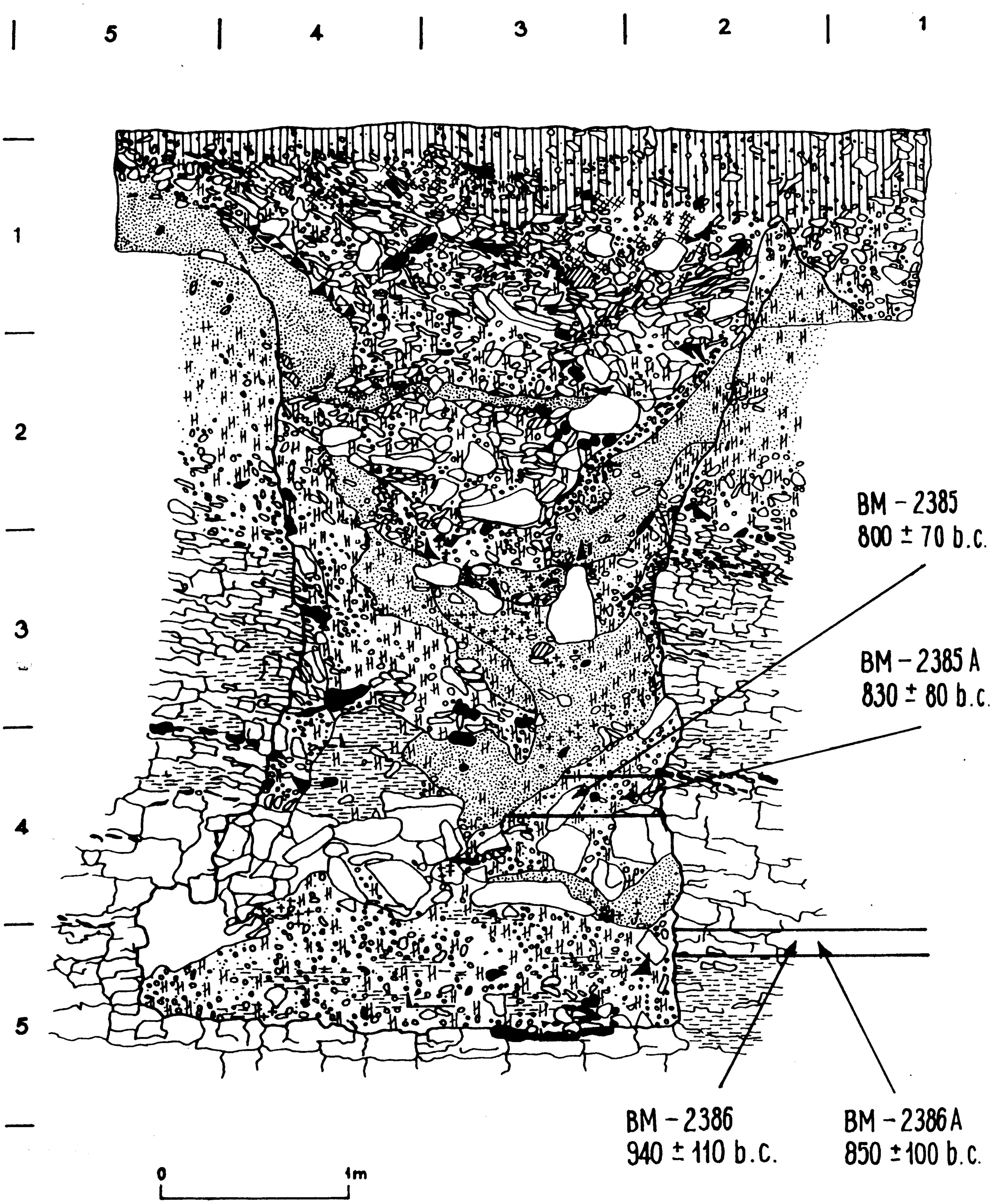

Fig. 5. PL 3 Wierzbica "Zele" flint mine, Radom Province. Cutting III/83. Cross-section of shaft 28 — west face, and radiocarbon determinations (see Fig. 3). For key see Fig. 2.

Fig. 6. PL 3 Wierzbica "Zele" flint mine, Radom Province. Cutting II/82. Cross-section of shaft 19 — south face (see Fig. 7), and lower part of shaft 20 — west face. Measuring rod 3 m: a — location of charcoal sample for ^{14}C date OxA-5101.

The exploited shafts of the prehistoric flint mine were usually filled with the debris from the new units being dug nearby (Figs 2–7). In several shafts one of the layers consisted of limestone slabs thrown in by prehistoric miners in the course of excavating neighbouring pits (also upper part of shaft 19 – Fig. 6 and 7). Natural processes such as in-wash or the weathering of materials from the shaft walls and waste heaps also played an important part in the formation of the filling (fill of shaft 19 - from the middle to the bottom – Figs 6–7). Several shafts revealed three or more phases of in-filling. Pieces of charcoal also got into the fill. They came from fireplaces used by miners when exploiting a particular shaft or neighbouring shafts (*e.g.*, radiocarbon dates from shafts 17 and 28 — Fig. 2 and 5). The filling process was

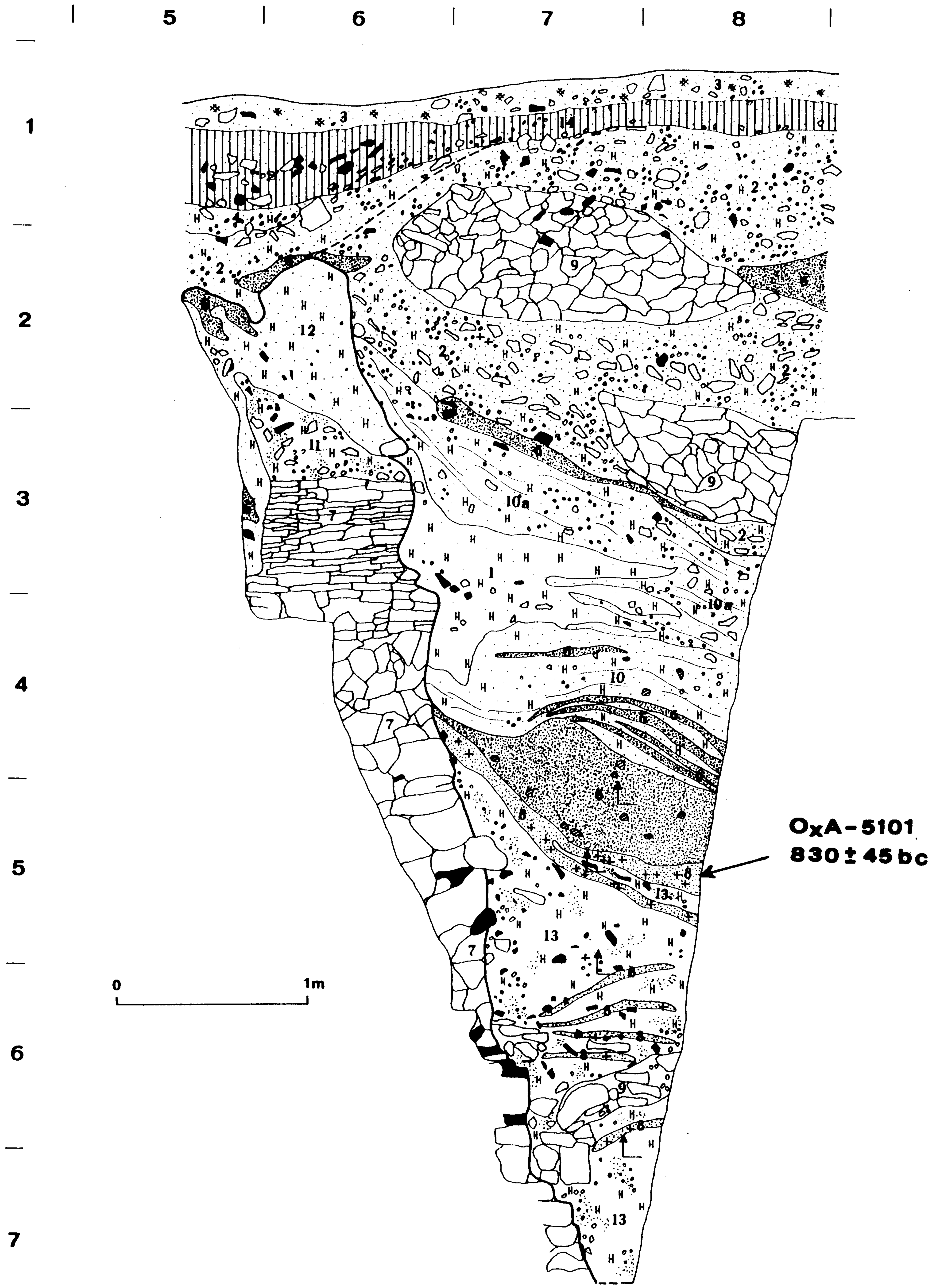

Fig. 7. PL 3 Wierzbica "Zele" flint mine, Radom Province. Cutting II/82. Cross-section of shaft 19 — south face (see Fig. 6), and radiocarbon determination. For key see Fig. 2.

completed by the formation of soil on the surface of the shaft or in the depression which marked where a shaft had been (Fig. 2, 3 and 5).

In the mine field itself and in the surrounding area there were numerous chipping floors (flint workshops). Their original arrangement was destroyed in the course of levelling of the field or during ploughing. Workshops were also located near the shafts, often on the waste heap of excavated material. In some cases worked flint was thrown into shafts together with mining debris derived from the excavation of later shafts. Only occasionally have the remains of workshops survived, *e.g.*, near shaft 17, or in partly filled shafts which served as places where the extracted flint was worked. In the workshops axeheads, as well as blades, blade-flakes and flake blanks were produced. In some cases the back edges of the large massive blanks were shaped by several series of retouches (Fig. 8). The natural (cortex) back edges were readily used. Such blades and flakes were used as knives without further preparation. The large and massive backed blades are a distinctive category from the Wierzbica "Zele" flint mine (Fig. 8). Tools of this type have not yet been recorded in prehistoric assemblages from Poland and neighbouring countries. These tools, which include several varieties, have been termed backed blades of Zele type (Lech 1984:195). An important product of the "Zele" workshops were bifacial axehead roughouts and possibly sickles.

The shafts were sunk using mainly tools made of organic materials. Only antlers from *Cervus elaphus* (Linnaeus 1758) have been preserved, unfortunately in little pieces due to the unfavourable chemical conditions in the sediments. The antlers were studied by Alicja Lasota-Moskalewska. The larger fragments showed signs of having been used as tools but no traces of having being worked. The antlers were usually used as hammers and, more rarely, as picks or levers. Miners also used large erratic stones as crushers to break up limestones and large flint nodules.

During the ten years of excavations not one pottery sherd was found at the site or nearby. This is understandable if one considers how devastated the site was. However, the many charcoal pieces in secondary deposits in the shaft fillings and single household type flint tools are evidence that camps were set up also at the mine field.

The most suprising and important outcome of ten years of excavations at the "Zele" site was its chronology. Following the initial phase of studies (1979–1982) dating was based solely on the morphology of flint finds from the site and on what was known about the occurrence of "Zele" type chocolate flint in assemblages of determined chronology and culture (Młynarczyk 1993:105–12). In 1982, when two series of charcoal samples were sent to the British Museum Research Laboratory and to the Laboratorium voor Algemene Natuurkunde Rijksuniversiteit Groningen we expected Neolithic dates (approximately 6000–4000 BP) or, less probably, dates from the Final Palaeolithic or the Early Bronze Age. The first series of dates from the British Museum (BM-2103, 2104, 2105, 2107) arrived during the excavations and was

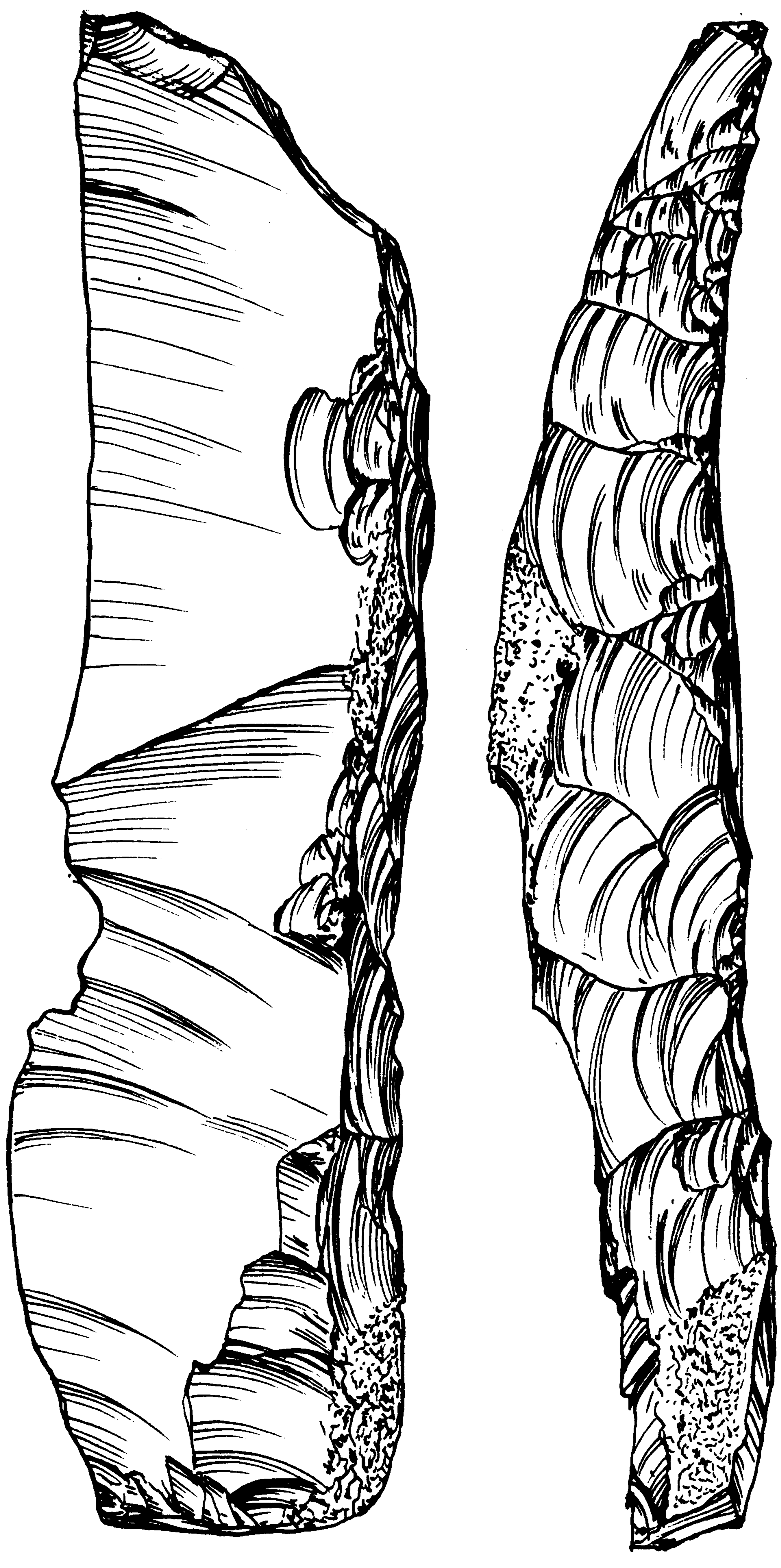

Fig. 8. PL 3 Wierzbica "Zele" flint mine, Radom Province. Backed blade of the Zele type. Natural size.

an enormous suprise (see Lech 1984: table 1). The dates were much more recent than could be expected considering our knowledge of the chronology of flint mining in the Vistula Basin and Central Europe (Lech 1981:46–51). The youngest mines could then be dated to the Middle Bronze Age (Lech 1981:48 and 51). We assumed that the dates we had received had been made younger by post-depositional contamination. In theory we saw three possibilities: a) pollution from industrial smoke from the cement plant at Wierzbica; b) influence from chemical components in the sediments; c) later occupation of the site. We supposed that the first two possibilities were more probable because after five years of studying the site we had no traces of prehistoric occupation later than that of the flint miners. In answer to our queries Richard Burleigh from the British Museum wrote:

> "Despite your preference for alternatives a) and b) in your letter, I am inclined to believe that later occupation of the site is the best explanation for our results. The influence (if any) of the neighbouring cement factory should be to make the dates older as a result of contamination from coal dust or smoke (if this occurred), and I do not think enough younger material from overlying sediments could enter the samples to give the observed results" (letter to J. Lech dated 28 September 1983).

This was the opinion Burleigh also presented in his comments on the first series of dates from "Zele" in "*Radiocarbon*" (Burleigh *et al.* 1984:70).

Fortunately systematic excavations of shaft 28 in 1983 produced rich samples of charcoal, some of which came from a fire at the bottom of the shaft and were undoubtedly contemporaneous with the extraction of the flint (Figs 3–5). We were convinced that these samples, of very good quality, would solve the problem of the shafts' chronology (see Lech 1984: plate 4). Burleigh had similar hopes:

> "I shall, of course, be pleased to receive the additional, newly excavated samples and hope that these will help to resolve the dating anomalies" (letter to J. Lech dated 28 September 1983).

In October 1983 we received a series of four dates from Groningen (Lech 1984: table 1). Three of them, dating shaft 17 (Fig. 2) and its filling pointed to the Early Bronze Age. This was confirmed by the morphological analysis of flint materials and the presence of flint from the "Zele" mine at a site of the Mierzanowice Culture from the Early Bronze Age in Szarbia, Skalbmierz commune, Kielce Province. The radiocarbon dating of shaft 17 was correct. The fourth date from Groningen (GrN-11856), dating charcoal collected from beneath a waste dump in shaft 18, again indicated the Late Bronze Age.

Since the Research Laboratory of the British Musem was confident as to the quality of the dates it had obtained and we, who had studied the site, were certain that the samples we had sent were associated with flint mining, a hypothesis combining both views had to be put forward, in accordance with the scientific competence of its authors. Thus arose the hypothesis about the continuation of flint mining to the turn of the Bronze and Iron Ages (Lech 1984:198–200). It was fully confirmed by the datings of samples from shaft 28 (Fig. 5) which were published in "*Radiocarbon*" (Ambers *et al.* 1987:191). A little later a systematic error was discovered in radiocarbon measurements run in the British Museum laboratory which included the first series of dates for "Zele" (Tite *et al.* 1987). This increased the probability of their association with the Late Bronze Age and transition from the Late Bronze Age to the Early Iron Age. Recently we obtained the date of charcoal pieces found in the lower part of the filling of shaft 19 (Lech 1984:191 and plate 3), the deepest of the exploitation units excavated so far (Figs 6–7). According to Rupert A. Housley from the Radiocarbon Accelerator Unit, Oxford University:

> "The charcoal has given a date which clearly falls within the Bronze Age, and most likely the late Bronze Age. In terms of calendar years the age suggested is the very end of the 2nd millennium BC or the beginning of the 1st millennium BC, with the latter the more likely. It is closest to GrN-11856, from below a waste dump of shaft 18, although that result (2670 ± 60 BP) was slightly later than OxA-5101" (from letter to J. Lech dated 25 January 1995).

The OxA-5101 date confirms that shaft 20 (BM-2383 3150 ± 80 BP), whose filling was cut by shaft 19, is older (Ambers *et al.* 1987:191). It also indicates that it is close in age to shaft 28 (Fig. 5).

The initial doubts about the late radiocarbon dating of the mine stemmed from the conviction that the charcoal in the fillings was not associated with flint mining but with a later occupation of the site. This is contradicted by dates for the phases of the in-filling of shaft 17 (Fig. 2) and the series of dates for shaft 28 (Fig. 5) which show that the shafts filled up fairly quickly. The interferences observed were usually the result of charcoal from a neighbouring shaft, possibly no 17, being thrown or washed in. This, however, does not appreciably influence the dating of the exploitation of a deposit. The stratigraphic analysis of the shaft fillings also indicates that they were formed during the sinking of neighbouring exploitation units or filled up naturally with material from their own waste heap mixed with similar material from a unit or units nearby. This, therefore, has no influence on the chronology of a particular part of the mine field. The same conclusions can be drawn from the series of radiocarbon dates for other mines, for instance Polany II (see Herbich and Lech in this volume) or Sąspów (Lech 1981:48). Thus the radiocarbon chronology based on scattered pieces of charcoal in the shaft fillings, as in the case of the "Zele" and Polany II mine fields, corresponds to the actual age of both sites and there is no reason to question it. The conclusion may be drawn that the "Zele" mine operated in the Bronze Age and its largest dated shafts were exploited in the Late Bronze Age which, in this area, corresponds with communities of Lusatian Culture. The Zele type backed blades described here (Fig. 8) were produced by people of this cultural tradition.

The radiocarbon dates obtained so far come from two opposite ends of the mine. Charcoal from the fillings of exploitation units in other parts of the mine field, such as the shallow pits in its centre have yet to be dated. The possibility that their chronology may differ cannot be excluded. The resolution of this question must wait till the moment when further results have been obtained.

ACKNOWLEDGMENTS

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