LOWER PALAEOLITHIC SMALL TOOLS IN EUROPE AND THE LEVANT
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Lower Palaeolithic sites with small artefacts in Poland

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Introduction

During the last years new Lower Palaeolithic sites have been found in Poland with a well-recognised stratigraphic position in Quaternary deposits. These sites were discovered by prospecting open-air mines in Trzebnica and Rusko near Wrocław in Lower Silesia (Fig. 1). The area was studied by numerous German and Polish geologists (Frech 1913; Schwarzbach 1942; Szczepankiewicz 1989). In addition, in the last years new results of field and laboratory work carried out within the framework of the KBN have become available (Burdukiewicz *et al.* 1994; Polish Committee of Scientific Research) research project no. 101559101, geological mapping (Detailed Geological Map of Poland in the scale of 1:50,000), sheets: Legnica, Oborniki Śląskie, Środa Śląska, Trzebnica and Wrocław).

New stratigraphic and palaeoecological data have been obtained from the examination of samples from cartographic boreholes executed for the sake of the above-mentioned sheets. Additionally, several boreholes from the area of Rusko, near Strzegom, were analysed, which became the basis for a series of geological cross-sections of that area (Winnicki 1990; Burdukiewicz and Mayer 1991; Burdukiewicz and Winnicki 1995; Winnicki 1997). This paper details the archaeological finds in the context of palaeogeographic issues of the Middle Pleistocene in the central part of Silesia, where the Lower Palaeolithic sites have been found.

The Middle Pleistocene stratigraphy of Lower Silesia

The part of Silesia comprising Lower Palaeolithic sites recognised so far is characterised by substantial variability of relief in a somewhat small area. In geographic terms it belongs to the Sudeten Foreland, the Silesian Lowland and the Trzebnica Ridge (Fig. 1). The Sudeten Foreland, represented here by the Strzegom Hills, is composed of old Palaeozoic crystalline and metamorphic rocks. The Silesian Lowland, stretching to the north and northeast of the discussed area, can be divided into the old moraine area and the Odra Valley cut by alluvial terrace systems. The Trzebnica Ridge displays dislocated Tertiary and Lower Pleistocene formations. The Cainozoic level of the area is represented by Tertiary and Quaternary sediments. The Tertiary consists mostly of clay and silt deposits of the Poznań series of the Middle and Upper Miocene including numerous sand bandings and local deposits of lignite. The uppermost Tertiary level is represented by Pliocene sands, gravel and kaolin clay of the Gozdnica series. Rusko-Jaroszów outcrops are widely known as some of the largest kaolin open cast mines in Poland.

The oldest Quaternary deposits are alluvial gravel and sand discovered in outcrops between Rusko and Wrocław (Fig. 1). The Middle Pleistocene is represented mainly by moraine deposits of the lodgement till type, classified by S. Różycki (1980) as belonging to the Nidanian, Sanian and Odranian Glaciations. Each lodgement till horizon is separated by ice-dammed lacustrine deposits or fluvioglacial deposits. The till horizons were also testified by lithiologic criteria (Szczepankiewicz 1989; Burdukiewicz and Winnicki 1995; Winnicki 1997).

Over the last ten years, geologists in Poland have proposed several subdivisions of the Pleistocene period (Lindner 1992; Mojski 1993; Wysoczański-Minkowicz 1995). There are also various correlations of the cold and warm periods with deep-sea oxygen-isotope stages (OIS). In general, Polish geologists accepted the division of the Pleistocene period into mega-units, called complexes, composed of several glacials and interglacials. The South Polish Complex (correlated with OIS 12-14) is divided into the Nidanian and Sanian glaciations, the latter subdivided by the Malopolanian Interglacial (Różycki 1980). This makes the South Polish Complex equivalent to the Cromerian Complex and Elsterian Glaciation in Dutch terminology (Zagwijn 1985) and contemporary with OIS 12-21 by L. Lindner (1992) and J. Mojski (1993) or OIS 14-17 by T. Wysoczański-Minkowicz (1995).

The oldest glacial deposits in Silesia are known from several buried valleys in the Silesian Lowland, as well as the Strzegom Hills and the Trzebnica Ridge (Fig. 1). According to stratigra-phic and lithiologic criteria the lower lodgement till belongs to the Nidanian Glaciation (correlated with OIS 14 or 16). It is characterised by a predominance of crystalline rocks and quartz over carbonate rocks, and by weathering-resistant material. A considerably decalcified layer of weathering and a layer of fossil soil occurred in the ceiling of the tills.

Lodgement tills of the Sanian Glaciation (OIS 12), related to the Elsterian in Germany and Holland, are very similar to the older moraine deposits in terms of macroscopic features, but they differ considerably from older tills of the Nidanian Glaciation in their petrographic indicators (Burdukiewicz and Winnicki 1995; Winnicki 1997). They are important for the stratigraphy of the archaeological lower horizon in the Trzebnica brickyard, because they directly overlie it.

The warm period (OIS 13 or 15) between the Nidanian and Sanian glaciations, is called the Malopolanian (Lindner 1992) or Przasnysz Interglacial (Mojski 1993; Wysoczański-Minkowicz 1995). Some Polish geologists assumed that it was the Ferdynandów Interglacial, known from Ferdynandów and other Polish sites (Lindner 1992). The most diagnostic feature of the Ferdynandów Interglacial is the bi-optimal floristic succession with deciduous forests divided by a cooler period with coniferous forests (Lindner 1992; Mojski 1993). Other geologists, like T. Wysoczański-Minkowicz (1995) have argued lately that the Ferdynandów Interglacial was not followed by a cold period with an inland ice sheet. In their concept, the Ferdynandów pollen profiles should be seen as the early stage of the Mazovian Complex, which corresponds to the Holstein Interglacial *sensu lato* in Western Europe (Wysoczański-Minkowicz 1995). The Malo-polanian Interglacial preceded the Sanian (Elsterian) Glaciation and it corresponds to OIS 13. It is comparable with the Bilshausen (Voigstedt?) Interglacial in Germany (Urban 1997; Mania 2000). However, some Polish geologists connect the Malopolanian (Przasnysz) Interglacial with OIS 15 (Mojski 1993; Wysoczański-Minkowicz 1995). Cold period OIS 14 is located between both of the warmer periods OIS 13 and OIS 15 and was much less icy than other glacials.

The Malopolanian Interglacial was recognised by the organogenic profile from Jasionka near Rzeszów in south-eastern Poland and other sites with beech-fir-oak forests. Kozi Grzbiet, a palaeontological site in the Holy Cross Mountains, has a similar stratigraphic position (Lindner 1992; Mojski 1993). The faunal collection from Kozi Grzbiet includes numerous snail shells, and amphibian and reptilian remains, representing warm and humid forest assemblages with some rare steppe species. The mammalian fauna is characterised by some humid forest species, including: *Castor fiber, Clethrionomys glareocelus, Sus scrofa, Alces* sp., and less frequently fauna with a preference for cooler climate: *Lemmus lemmus* and *Dicrostonyx simplicior*. The fluvio-glacial sands of the Sanian Glaciation covered sediments, which can be correlated with the Malopolanian Interglacial (Lindner 1992).

The Sanian lodgement till covered almost all of the Silesian region, except for the mountains above 600 m a.s.l. Alluvial sediments of the Malopolanian interglacial, deposited between lodgement tills of the Nidanian and Sanian glaciations, were identified in the Rusko open cast mine, the buried valley in Trzebnica and other locations in the Silesian Lowland. Below the Sanian lodgement till in Trzebnica remains of deciduous forest (macro remains of trees: ash-tree, poplar and elm; Pyszyński *et al.*1991) have been found. According to the pollen diagram analysis by T. Kuszell (1991) deciduous forest was succeeded first by dense pine forest, typical of a temperate climate and later by herbaceous plants with an admixture of isolated pines and birches. The Sanian lodgement till covered also sediment with Lower Palaeolithic small artefacts at Trzebnica, which have been found associated with the remains of steppe and forest fauna, such as rhinoceros, horse, bison, elk, deer, and boar.

According to the broader concept of T. Wysoczański-Minkowicz (1995) the Mazovian Complex (also called Great Mega-Interglacial) includes the Serniki Interglacial, a cold period, the Ferdynandów Interglacial, the Wilga Glaciation, the Mazovian (Adamówka) Interglacial, the Liwiec Glaciation and the Zbójno Interglacial, correlated with OIS 9 - 13. L. Lindner divides the Mazovian Complex into two warmer periods: The Mazovian *sensu stricto* and the Zbójno interglacials, separated by the Liwiec Glaciation (correlated with OIS 10). In his estimation, the Scandinavian glacier reached the northern part of the Mazovian Lowland during the Liwiec period (Lindner 1992). It should be correlated with the Holsteinian Complex in Germany (Mania 2000). Another geologist recognizes the Mazovian Interglacial as a single warm period of shorter duration, correlated with OIS 11 (Mojski 1993). The climatic optimum of the Mazovian Interglacial in Poland is characterised by mixed forests with fir and exotic plants like *Vitis silvestris* and *Azolla filiculoides* (Lindner 1992). The following period, called the Middle Polish Complex began with Odranian (Drenthe) Glaciation. The Odranian ice sheet covered Silesia farthest to the south, incoming to Moravian Gate between the Sudeten and Carpathian Mountains.

The Masovian Complex is represented by sands, gravel, silts and peat found in a few places, in the area of the Strzegom Hills, near Rusko, in the Silesian Lowland and the Trzebnica Ridge. In the open pit 'Halina' in Rusko had been discovered sand silts and peat deposited below the moraine deposits. The spore-pollen spectrum indicates a moderately cool climate. Alluvial sand-gravel deposits were found in open pits in the Rusko area in the Strzegomka valley. The latest observations come from the open pit 'Stanisław North' in Rusko, where coastal delta deposits merging into a terrace were found in lake sediments. The deposits provided micro-remains of the fir (*Abbies* Mill) and willow (*Salix* sp.), scarce sporomorphs, a tooth of a big hoofed animal and stone artefacts. As yet the Masovian Complex cannot be divided into smaller units in Silesia, because good pollen profiles similar to those in Central Poland (Krupiński 1995) or in Germany (Urban 1997) are not so far available. All these sediments were covered by lodgement till of the Odranian Glaciation.

The most numerous Lower Palaeolithic artefacts of Rusko 33, Rusko 42 and upper horizon of Trzebnica 2, have been found in the deposits covered by glacial tills of the Odranian Glaciation (Drenthe). They differ considerably from glacial deposits of older glaciations. Most frequently, they are lodgement tills of the yellow-brown colour, with a large content of sand and a small degree of compaction; their average thickness ranges from 3 to 6 metres.

The Trzebnica 2 site

The site was found in Trzebnica, a small town located 15 km north of Wrocław. There is an elevation called Trzebnica Ridge or Cat Mountains (Fig. 1). The ridge is distinctly visible from the south and is the result of tectonic movement of Tertiary sediments within the Fore-Sudeten Monocline. Additional tectonic and glaciotectonic movements complicated inner structure of it during the period of Sanian Glaciation (Winnicki 1997). In the eastern part of the city, on a hill slope called Winna Góra (Wine Mountain) since the XIX century is located open cast mine used by local brickyard. During a survey of this mine in 1987 the first Lower Palaeolithic artefacts were discovered at the bottom of Quaternary sediments (Fig. 2).

The Quaternary sediments in the buried valley of Trzebnica attain a thickness of just over 120 m. In the brickyard on the slope of Winna Góra the base of the Pleistocene sediments was exposed 6-14 m below the recent surface (Figs. 3-4). In the northern wall of the brickyard (Fig. 3), the deposits of the false-bedded light-grey quartz sand locally overlie the Upper Miocene clay. The sand was identified as the so-called Gozdnica series of the pre-glacial period (Burdukiewicz and Winnicki 1990). The southern wall of the brickyard (Fig. 4) exposes glacial sediments preserved as residuum of lodgement till, which has been recognized as belonging to the Sanian (Elsterian) Glaciation by stratigraphic correlation (Winnicki 1990; 1997) and indicator-stone analysis (Burdukiewicz and Meyer 1991). During excavations of the northern and southern walls a rich concentration of small lithic artefacts, covered by Sanian sediments, was unearthed. The artefacts were most probably deposited during the Malopolanian Interglacial period, dated to before the Sanian Glaciation (Figs. 3-4), and were found associated with rare fragments of animal bones. The identified animal species lived in forested and open environments (elk, red deer, wild pig, bison, horse, and rhinoceros); fish remains (pike) were also found (Pakiet *et al.* 1993; Burdukiewicz 1993).

Boreholes in the deep buried valley near the site revealed lodgement tills of the Nidanian and Sanian glaciations separated by up to 50 m thick interglacial sediments of the Malopolanian Period. The deposits contained numerous fragments of fossil wood of deciduous trees (ash-tree, elm and poplar) which are the remains of alluvial river forest growing there on black chernozem in silty clay sediments. Slightly higher sediments revealed pollen originating from dense pine forests, typical of the temperate climate zone and herbaceous plants (with rare trees of birch and pine) at the top of the pollen diagram (Pyszyński *et al*. 1991; Kuszell 1991; Winnicki 1997). The residuum of the Sanian lodgement till at this archaeological site covered lithic artefacts and animal fossils adapted to a temperate climate. The artefacts were discovered at the bottom of the Pleistocene sediments in the southern and northern walls of the Trzebnica brickyard (Figs. 2-4).

The Sanian lodgement till is well preserved in northern section of the brickyard (Fig. 3) and as residuum in the southern section (Figs. 4-5). These deposits reveal a large amount of erratic material from the East-Baltic area, typical of the Sanian (Elsterian) Glaciation (Burdukiewicz and Mayer 1991). The residual material shows traces of chemical and frost weathering and exfoliation is visible as abundant pseudomorphoses from large boulders. Such erosion was possible during the warm period of the Mazovian Complex (Śnieszko 1995). The residuum indicates a polygenetic origin. The primary layer of the lodgement till was partly washed out by meltwaters and then underwent periglacial weathering. Finally, chemical weathering occurred in warm climatic conditions, during the Mazovian Interglacial.

On top of the sands of Mazovian age, which originated from weathered glacial sediments of the Sanian Glaciation, artefacts were discovered in the upper archaeological horizon in Trzebnica, lying c. 1 m above the lower horizon (Figs. 4-5). They were much less numerous than in the lower horizon, with a frequency of just over 200 specimens. The artefacts were covered by silty diamicton up to 6 m thick. This diamicton was laminated with loosely interspersed sands and gravels. Muddy sands, muds, and glacial till of Odranian age cover the lodgement till of Sanian age in the northern section (Fig. 3). The composition of heavy minerals of Odranian till from the northern section is very similar to the diamicton from the southern section. According to detailed analysis the silty diamicton was accumulated by meltwater in ephemeral lake conditions from the dead ice mass of the Odranian Glaciation (Śnieszko 1995).

In the diamicton are visible erosional surfaces and deformations with two generations of frost fissures developed from the top. Large fissures, attaining a depth of 6 m, are interpreted as ice-wedge casts. The smaller ones, up to 1.5 m in depth should be seen as composite wedges (Figs. 4-5). From top the diamicton is covered by a composite soil complex, consisting of soil lessivé with two older illuvial horizons – It_1 and It_2, which are separated by ice wedge casts (Fig. 4). The youngest illuvium is visible in local depressions at the top of the diamicton and is correlated with the Holocene. The older illuvium is correlated with the forest phase of the Lublinian and Eemian Interglacial (Śnieszko 1995). A single flint flake was found at the bottom of the buried soil complex (Burdukiewicz *et al*. 1994).

Rusko sites 33 and 42

New Lower Palaeolithic sites at Rusko have been found in the kaolin opencast mine of the JARO Enterprise. The opencast mine is located on the northern slopes of the Strzegom Hills, which cover Cainozoic, later Tertiary and Quaternary deposits. Geological sections have been documented according to quarry's escarpments 4-6 m high (Figs. 6-10). The general aspect of the geological units of the Rusko outcrop is the presence of various deformations of the Tertiary and Quaternary deposits. The first group of deformations is associated with tectonic movements, the second one with direct movements of ice and the third one with deformations of unstable sediments with reversed density gradients (Brodzikowski and van Loon 1984; Burdukiewicz and Winnicki 1995).

The initial formation of the opencast area occurred in the Mesozoic and early Tertiary, when older sediments of Carboniferous and Palaeozoic age were partly denudated (Brodzikowski and van Loon 1984). During Tertiary times there had been a large amount of kaolin deposits, up to 50-70 m thick, accumulated in limnic environments; covered by thin bands of limnic chalk and lignite (Figs. 7-8;10). The oldest Quaternary sediments are riverbed deposits, which cover kaolin or Pliocene quartz sands of the Gozdnica series. Early tectonic activities occurred in the Neogene period and indicate local disturbances of lignite layers and superimposed quartz sands of the Gozdnica series (Szczepankiewicz 1989; Szynkiewicz and Burdukiewicz 1994). The Pleistocene sediments lie above the Neogene deposits and are subdivided by three glacial till horizons, representative for the whole of Silesia. The lower one is identified as Nidanian, the middle one as Sanian and the upper one as Odranian (Brodzikowski and van Loon 1984; Szczepankiewicz 1989; Szynkiewicz and Burdukiewicz 1994; Burdukiewicz and Winnicki 1995).

The Nidanian lodgement till is much better preserved in the opencast mine Stanisław Nord, where it is up to 5 m thick (Fig. 7). It is mostly eroded and disturbed in the opencast mine Stanisław South (Figs. 8, 10). The Nidanian glacial sediments are characterised by a predominance of crystalline rocks and quartz over carbonate rocks, a preponderance of weathering-resistant material, and a high quantity of local rocks, numerous bits of lignite and the very dark colour of the till. The Sanian lodgement till is much better preserved, and is up to 6 m thick in the opencast mine Stanisław Nord (Fig. 7). It is quite similar to the Nidanian one, but sedimentary rocks are more numerous than crystalline ones and Scandinavian rocks are also much more common than local rocks (Burdukiewicz and Winnicki 1995; Winnicki 1997). The Odranian lodgement tills, covering the whole area, differ considerably from the glacial deposits of the older glaciations. They are yellow-brown in colour, much less compact and rich in the erratic material from Central Sweden (K.-D. Mayer, personal communication). The lodgement till of Odranian age, partly eroded, is covered by sand and loess-like deposits of the Vistulian Glaciation.

The interglacial deposits have been found between the glacial series in the Rusko opencast mines (Figs. 7-10). The geologist S. Szczepankiewicz (1989) has documented a much better preserved lower interglacial series in peat bog sediments below the Sanian Glaciation in another outcrop, called Halina, located a hundred metres to the north of the outcrop Stanisław North. According to palaeo-botanical analysis of peat bog sediments the interglacial series is represented by mixed forest with such deciduous trees as elm, ash, lime and maple (Szczepankiewicz 1989, 72). The age of the interglacial deposits had been previously estimated as 'Cromerian', later renamed as Przasnysz (Brodzikowski and van Loon 1984, 132) or Malopolanian (see above).

The middle interglacial series, identified with the Mazovian Complex had been found in several places of the Rusko outcrops, between the Sanian and Odranian glacial deposits. Pollen of mixed forest dominated by coniferous trees, but with numerous oaks, ashes, elms and limes, have been found here (Szczepankiewicz 1989, 69). In the course of the archaeological excavations macro-remains and scarce sporomorphs of willow (*Salix viminalis L.*) and fir (*Abies* Mill) have been recovered in close proximity to the Rusko 33 site (Brański *et al*. 1984). They were associated with rare fauna: a tooth of a big hoofed animal and teeth of large pike (Burdukiewicz *et al*. 1996). In the same stratigraphic position the archaeological sites of Rusko 33 in the Stanisław North outcrop have been discovered (Figs. 6-8) and Rusko 42 in outcrop Stanisław South (Figs. 6, 8, 10).

The artefacts from the Rusko 33 and Rusko 42 sites were found in fine fluvial sand. Below the main archaeological horizon were sands with an admixture of gravel. The site Rusko 33 has yielded almost 350 lithic artefacts, which are very small in size, and associated with a tooth of a big hoofed animal (Brański *et al*. 1994). The finds were most probably in primary position on the shoreline of a slow flowing river or were replaced over a short distance. The Rusko 42 lithic concentration was the richest, with almost 3,700 lithic artefacts. Associated with the artefacts was a single tooth of large pike (*Esox lucius*), estimated at over 10 kg in live weight. These materials were found on the sand bank of a local stream and were possibly replaced over a short distance by flowing water. The majority of artefacts are small flakes, chips, while cores are rare. Sediments of the Odranian glacier buried both sites (Figs. 7-10). A dozen microlithic artefacts were recently found during rescue excavations under the Odranian sediments in Wrocław, Skarbowców Street (Wiśniewski *et al*. 1998).

The upper interglacial sequence has been documented in the opencast mine Stanisław South (Jastrzębska-Mamełka and Szynkiewicz 1996; Burdukiewicz *et al*. 1996). On the top of the fluvioglacial deposits of the Odranian Glaciation three depressions up to 5 m deep, filled with organogenic sediments described as RsI - RsIII, have been found (Figs. 8, 10). At least four sedimentation cycles may be distinguished within the deposits filling the buried depressions. Directly above these were clay and silt deposits, gyttja and lime bog, which provided samples for palaeob-otanical and malacological analyses (Fig. 9).

The pollen profile of the buried lake RsI is rich in herbaceous vegetation with a predominance of photophilic plants and a high frequency of grasses, sedges and motherwort. The fossil flora indicates that the lower part of the lake deposits developed in a subarctic and cool climate with park tundra plants. Later climatic conditions were warmer, with boreal and temperate forest vegetation. According to M. Jastrzbska-Mamełka and A. Szynkiewicz (1996) this pollen profile should be identified with the Lublinian Interglacial (OIS 7).

The malacological samples from the buried lake RsIII were rich in land and water species of molluscs. At the beginning the lake was not rich in plant life but later on it was inhabited by species (*Valvata cristata* and *Gyraulus crista*) indicating growing temperature of the water. Organogenic deposits from the buried lakes were deposited after deglaciation of the Odranian (Drenthe) Period, which should be correlated with the Lublinian Interglacial (Burdukiewicz *et al*. 1996). From the top the buried lakes were covered by Upper Pleistocene deposits (Figs. 8, 10).

Spatial analysis

The sites Trzebnica 2, Rusko 33 and Rusko 42 have yielded lithic artefacts in isolated spatial concentrations. They were partly destroyed by industrial exploitation of the outcrops. The lower archaeological horizon of Trzebnica was discovered at the base of Quaternary sediments, in the southern and northern parts of the outcrop (Fig. 2). In the southern part one large concentration of artefacts and three small ones with over 1,400 artefacts in total were recorded (Figs. 11-12). The artefacts are associated with small fragments of animal bones (Fig. 12). Part of the lower archaeological horizon was destroyed by the brickyard work.

In the eastern part of the trench at Trzebnica the large concentration of lithic artefacts, which is oval in shape and oriented from east to west, can be distinguished covering up to 50 m^2. Artefacts from all stages of flint processing, cores, flakes and chips, have been found. Also discovered were six hammerstones made on small quartzite pebbles and four big choppers of crystalline rock and flint (Burdukiewicz 1993). The lithics were associated with the bones of two horses, two bison, two boars, two deer and two big pikes (Pakiet *et al.* 1993). We argue that this area was most possibly the living area of the first settlers of Trzebnica. Various small lithic tools were produced on flint flakes, like side scrapers, perforators and notched tools. In the southern side of the trench small fragments of animal bones surrounded the concentration. These are the remains of animal butchery.

Two small activity areas can be distinguished on the eastern side and one on the western side of the large concentration (Fig. 11). These areas are much smaller than in the eastern and southern parts of the trench (covering 4 or 5 m^2). Most of the artefacts are tools with few flakes, and it appears that manufacture occurred elsewhere, most probably where the large concentration is located. The eastern-most concentration is associated with some pieces of horse bone (*vertebra lumbalis* and *epiphysis humeri*, probably belonging to the same medium sized horse (Fig. 12). This concentration was partly destroyed by the brickyard activities.

The next small concentration, closer to the large one, contains mostly small side scrapers, two large choppers and a fragment of an elk's scapula with cutting traces. Both small concentrations are the most possibly traces of kill or butchery sites of horse and elk. Cutting traces are visible also on the radial bone of a rhinoceros and the metatarsus of a horse. One bone fragment, probably a rib of bison or horse was polished on one flat side and lateral edges were rounded in parallel parts.

The northern wall of the brickyard was excavated in area c. 40 m^2. Almost 120 lithic artefacts have been found below the Sanian lodgement till, which were randomly dispersed. It was difficult to extend the trench area because of the collapse of the14 m high section. Few artefacts have been found in the area in front of the northern wall, which had been destroyed by the brickyard. All these artefacts derive from the horizon below the Sanian Glaciation and are the same age as the artefacts from the lower horizon in the southern wall of Trzebnica 2 (Figs. 3-5).

The upper horizon in the southern wall of the Trzebnica brickyard was found c. 1.2 m higher than the lower one, on the top of sands of Mazovian age and below the Odranian glacial sediments (Fig. 4). The artefacts were in a small oval-shaped area 30 m^2 large. The lithic concentration is located a few metres to the east comparing with artefacts distribution in the lower horizon. It was also much poorer in finds, containing about 220 lithic artefacts. The northern part of the concentration was possibly destroyed by the brickyard. In general the lower horizon at Trzebnica was much richer in artefacts and their spatial structure was more complex.

The Rusko 33 site was excavated in a restricted area, limited by the activity of the opencast mine (Burdukiewicz *et al.* 1995; 1996). All artefacts were found in fine sands of a riverbank (188.2 m a.s.l.), in original position or only slightly replaced by slow flowing water. In general, the artefacts are rather fresh in appearance with rare pieces slightly polished. They were mostly found in trench I/92, which overlaps with part of the main lithic concentration (Fig. 15). Rare artefacts were found dispersed several metres to the west. About 350 artefacts were found, and these are dominated by unretouched flakes. Cores are rare and retouched tools make up 10% of the assemblage. All artefacts are rather small (Fig. 17). Outstanding finds in the lithic concentration are fossils: coral of the *Coelosimila* genus and remains of two sea urchins. It is difficult to establish if the people inhabiting Rusko during the Mazovian Interglacial intentionally collected them or they are fossils that were accidentally deposited by river water.

The site Rusko 42 was located on a small hill (199 m a.s.l.), covered by fluvial sands of diagonal and tabular banding and with inserts of silt and mud. The overall thickness was about 2.5 m (Figs. 8, 10). A large number of lithic artefacts were recovered from fine, white-grey fluvial sands, which show postdepositional deformations. Others artefacts, mostly of bigger dimensions, were found somewhat deeper, in fluvial sand with an admixture of gravels. The archaeological horizon was covered by a thin (10-15 cm thick) layer of highly ferric, rusty fine gravel. Above the latter are glacial deposits of the Odranian Glaciation (Fig. 8).

The archaeological excavations were made on top of the buried hill. Trench I/93 yielded a very dense concentration of lithic artefacts. The next trench (I/94) was separated from the trench I/93 by an area destroyed by a conveyor belt transporting kaolin (Fig. 16). It was quite poor in artefacts, probably because this part of the site had been destroyed by the conveyor belt. A striking feature of the lithic collection from Rusko 42 which totals about 3,660 artefacts is the small number of cores (Fig. 21).

Unlike Trzebnica 2 and Rusko 33 sites numerous lithic artefacts show slight abrasion resulting from water transport as well as post-depositional fragmentation of some flakes and tools. It is quite possible that these artefacts were replaced by flowing water from a living floor in the vicinity, which was not found during the archaeological research. The escarpment with artefacts was rather narrow (Figs. 8, 10). A single organogenic find was a pike tooth (*Esox lucius*), from a fish estimated as c. 1 m long and weighing up to 10 kg (T. Wiszniowska, personal communication).

The artefacts

The low degree of standardisation of Lower Palaeolithic small artefacts was an important reason for the application of morphometric analysis (Burdukiewicz *et al*. 1979). This method was also used in the analysis of the Bilzingsleben collection (Weber 1986). However, the statistical treatment of the lithics was conducted applying the "evolution of indexes" instead of the 'evolution of culture' concept. Statistical analysis of artefacts should be arranged according to the technological model of stone processing divided into the main sequences or stages (Burdukiewicz 2002). The hierarchical system, called the 'dynamic technological classification' (Schild 1980) allows the ordering and analysis of all artefacts, from raw material procurement, initial preparation, flaking, retouch to discard and deposition of all products. Another recent method, called in France 'chaîne opératoire' is comparable but it shows rather qualitative and individual features of refitted artefacts (Pélegrin *et al*. 1988). Powerful computers have in recent times allowed the construction of vast databases, which make the multidimensional morphometric analysis of lithic assemblages possible. For the lithic collections from Trzebnica, Rusko and Bilzingsleben a database was set up of all artefact categories described using numerous metrical, morphological and technological attributes (Burdukiewicz *et al*. 1979; Burdukiewicz 1995; 2002).

Almost all of the lithic artefacts, except for hammerstones and some choppers, were made of Cretaceous and Jurassic flint collected from glacial deposits. The most remarkable feature of the analysed collections is the small size of the artefacts. To what extent was the small size a deliberate feature or just accidental, limited by the size of the nodules? From detailed prospecting of the sites' setting we know that massive nodules (up to 50 cm long) of flint were also available. Certainly, a lack of good raw material at Trzebnica and Rusko was not the reason for the small size of artefacts. Small nodules or chunks were intentionally chosen for knapping (Figs. 13-14, 17, and 18).

Lithic assemblages with small artefacts have been generally classified into three groups: cores, flakes and tools – variously retouched flakes. At the sites, where artefacts are more or less in original context and which were excavated completely or from a representative area, cores comprise from 3 to 4 per cent of an entire assemblage (Fig. 21). Such regularity is observed at Bilzingsleben and in both horizons at Trzebnica. The collections of Rusko 33, a partly excavated site, and Rusko 42, a site with redeposited artefacts, contain far fewer cores, less than 1 per cent of the total artefacts. The frequency of another important group, which includes retouched tools, is also variable from 4 per cent in the case of Rusko 42 to 16 per cent at Bilzingsleben. According to detailed analysis retouched tools were made from specific flakes, which were usually larger than the more abundant waste flakes. This may explain why the rate of retouched tools at Rusko 42 was so low in comparison to other sites (Fig. 21).

According to core and flake attribute analysis many cores have roughly prepared striking platforms and almost half of them are in an advanced or final stage of exploitation (Figs. 13, 17, 18). Cortical or partly cortical flakes (dorsal surface or butt) occur with a frequency of up to 40% in the flake group of the lower horizon of Trzebnica 2. In other collections they are even less numerous. The simple system of flaking and frequent changes of knapping direction make it difficult to identify which flakes derive from preparation and which from rejuvenation. In any case, some cores are of conical or polyhedral shape, which makes them similar to some Late Palaeolithic or Mesolithic cores (Fig. 18: 1-2). It is worth stressing that Mesolithic artefacts look archaic compared to those from the Upper Palaeolithic. J. Leopold has described Lower Palaeolithic small artefacts as "archaic" when compared to those of the Acheulean complex (Leopold 1997).

The most numerous artefacts at Trzebnica and Rusko are flakes (from 80 to 96 per cent). Some of these flakes are blade-like, with parallel edges (from 14% at Trzebnica, lower horizon, to 22% at Rusko 33). The most numerous are flakes with divergent edges. According to cross-section feature the most numerous flakes are those with a triangular cross-section (from 48% at Trzebnica, upper horizon, to 65% at Rusko 33). The next group of flakes has a trapezoid cross-section (from 28% at Rusko 42 to 41% at Trzebnica 2, lower horizon). Other flakes have an irregular cross-section. An important technological feature of the flakes is the butt surface. The majority are prepared, flat butts (34-36% in each assemblage). Faceted butts, well known in the Middle Palaeolithic Levallois technique, are rare, from 2% at Rusko 33 to 9% at Trzebnica 2, lower horizon. These most probably derive from cores with changed orientation, when the flaking surface was used as a secondary striking platform.

Measurements have enabled a detailed analysis of flake and flake tool size from Trzebnica, Rusko and Bilzingsleben. The mean length of flakes at Rusko 33 is 16 mm (like Bilzingsleben – see Burdukiewicz 2002), at Rusko 42 – 17 mm and for both horizons at Trzebnica 20 mm. Scatter plots of flake width and length for each of the assemblages is very similar and varies from 6 mm to 25 mm in length and from 5 to 30 mm in width. The flakes from the lower horizon of Trzebnica are sporadically larger (Fig. 19). The scatter plots of flake and flake tool thickness and length also shows a high degree of similarity apart from a few flakes from the lower horizon at Trzebnica (Fig. 20), where thickness varies from 2 to 8 mm. Detailed measurements have enabled us to calculate approximately deliberate preferences in stone working of the Lower Palaeolithic microlithic assemblages (Burdukiewicz 2002).

Comparison of ordinary flake and flake tool dimensions shows that some flakes were chosen for further shaping by retouch. The tools are usually shorter than average flakes (10-50 mm), but their thickness is similar. Tool width is more scattered than flake width (Figs. 19-20). Morphometric analysis shows that Lower Palaeolithic microlithic assemblages cannot be seen as just an accidental phenomenon, without any deliberate choice (Peretto 1994). Of course, they are much less standardised than blanks manufactured by the Levallois technique in the Middle Palaeolithic or the blade technique in the Upper Palaeolithic.

The retouched tools in the microlithic assemblages differ much from F. Bordes' list of Lower and Middle Palaeolithic tools (Bordes 1961). However, although traditional tool typology has frequently been criticised or totally rejected as 'exhausted blanks', it is quite clear that every technological sequence leads to final products, called tools. The definition of 'tool', especially of 'small tool' is of course another question. Microwear analysis has demonstrated that unetouched flakes were quite often used as functional tools (Steguveit 2001) we suggest to pay more attention to 'human choice'. Retouch techniques were used for the shaping of final 'tools' in the archaeological sense. In fact, lithic 'tools' were for the most part fragments of composite tools, which were tools *sensu stricto*. Figure 24 gives an idea of a hypothetical model of the technological sequences of flint processing at the Lower Palaeolithic sites with microlithic artefacts in Poland.

Microlithic tools are so small that their usage was only possible as inserts of composite tools, made from various raw materials. Such tools are known from Late Palaeolithic and Mesolithic periods, when artefacts were inserted in wood, pitch, and other hafts. Archaeological evidence for older periods is very exceptional. Rare discoveries, like the pitch from Königsaue in Sachsen Anhalt (Koller *et al*. 2001) or the wooden hafts from Schöningen in Lower Saxony (H. Thieme, this volume) show that hafted tools were also made in much older periods.

The frequency of main tool groups varies from a domination of side scrapers at Trzebnica, lower and upper horizons, to a higher frequency of notched and denticulated tools at Rusko 33, Rusko 42 and Bilzingsleben (Fig. 22). Many side scrapers were carefully made, but their shape is less repetitive than in the Middle Palaeolithic (Figs. 13-14, 17-18). In any case, some side scrapers such as those from Trzebnica (Fig. 14: 1-8) are very fine. It is necessary to remember that they were fashioned with hard stone retouchers. The notched and denticulated tools and the retouched flakes were even less standardised (Figs. 13-14, 17-18). However, these categories of were also very diversified in younger periods. Detailed microwear analysis of these tools should be conducted to determine if these tool categories differed in their function.

More particular groups of tools in Lower Palaeo-lithic microlithic assemblages are perforators and points. They are differentiated according to pointing retouch and they are classified according to the asymmetrical or symmetrical position of the point (Figs. 13-14, 18). The presence of points, including the so-called Tayac points (Bordes 1961), is rather uncertain, because we have no evidence for the use of pointed weapons other than wooden spears (Thieme, this volume). Perforators, previously seen as a type fossil for the Upper Palaeolithic and later periods are quite numerous in Lower Palaeolithic microlithic assemblages, with a frequency from 6% at Rusko 42 to 15% at Bilzingsleben (Fig. 22). Microwear analysis of some of the points from Bilzingsleben showed that they had been used mainly as scraping or cutting tools, similar to the backed knives (Steguweit 2001).

Numerous artefacts were broken during usage or after having been discarded. Because of the small dimensions of microlithic artefacts and their fragments, all deposits with artefacts need to be sieved. The deposits of all of the Polish sites discussed in this paper had been sieved and the fragments are quite numerous. The rare big tools, such as hard hammers and choppers, were found in the Trzebnica lower horizon. They are quite numerous at Bilzingsleben (Mania and Brühl, this volumne).

Taxonomy

All sites with small artefacts show a relatively high degree of similarity in despite to their time-spatial range. For this paper a statistical analysis of Polish assemblages and those from Bilzingsleben was conducted using cluster analysis and multidimensional scaling of tool attributes. The cluster analysis was made by weighed pair-group average according to Chebychev distance and it shows that the most similar assemblages are from Rusko 33 and Trzebnica upper horizon. The next group identifies Rusko 42 and Bilzingsleben with a much less similar assemblage from Trzebnica lower horizon (Fig. 23, A). Multidimensional scaling, seen as a more fruitful statistical method for discrete data, gave comparable results (Fig. 23, B). However, Trzebnica lower horizon is the most distant one, but Rusko 33 and Trzebnica upper horizon are separated further from each other than in the cluster analysis.

Taxonomic units in prehistory are usually seen as equivalents of ethnic groups. In the remote past and the very long period of the Lower Palaeolithic such units, covering hundreds of thousands of years and thousands of kilometres of geographic distance, should be seen as recurring adaptive methods to certain environments. The diversity of such environments is still poorly known. Why were such microlithic assemblages present over 1 myr ago in China (Zhu *et al*. 2001), in Central Asia (Ranov and Dodonov, this volume), Israel (Ronen, this volume) and some in Europe up to the Middle Palaeolithic (Valoch 1977; 1984). If we keep in mind the important fact that such sites existed usually in a temperate milieu, usually in wooded environments, then should be suggested that such assemblages existed when the most successful was usage of composite tools with small stone inserts.

Final remarks

Summarising the features of microlithic assemblages in Poland it is necessary to stress some degree of technological standardisation in raw material choice and a well-organised operational sequence. These artefacts are less standardised than those manufactured with Acheulean or Levallois technology, but if we take into consideration a rate of raw material efficiency (ratio of weight of raw material to length of cutting edges of produced flakes), then microlithic technology was more effective as handaxe technology.

Microlithic artefacts, well-balanced wooden spe-ars, made with small-notched tools and side scrapers, indicate usage of multiple raw materials in tool production. During warmer periods, abundant wood and other organic raw materials, and flint and other lithics were used for the production of hard and sharp small inserts in bigger composite tools. Such an option is widely known from the Mesolithic and rarely in the Upper Palaeolithic and has never been observed in much older periods. Is it possible that such developed technology started already over 1 myr ago? The new finds of hafting from Schöningen and Königsaue in Germany give us an idea about such a possibility. The spears and other wooden tools discovered at Schöningen show hitherto unknown improvements in early human behaviour.

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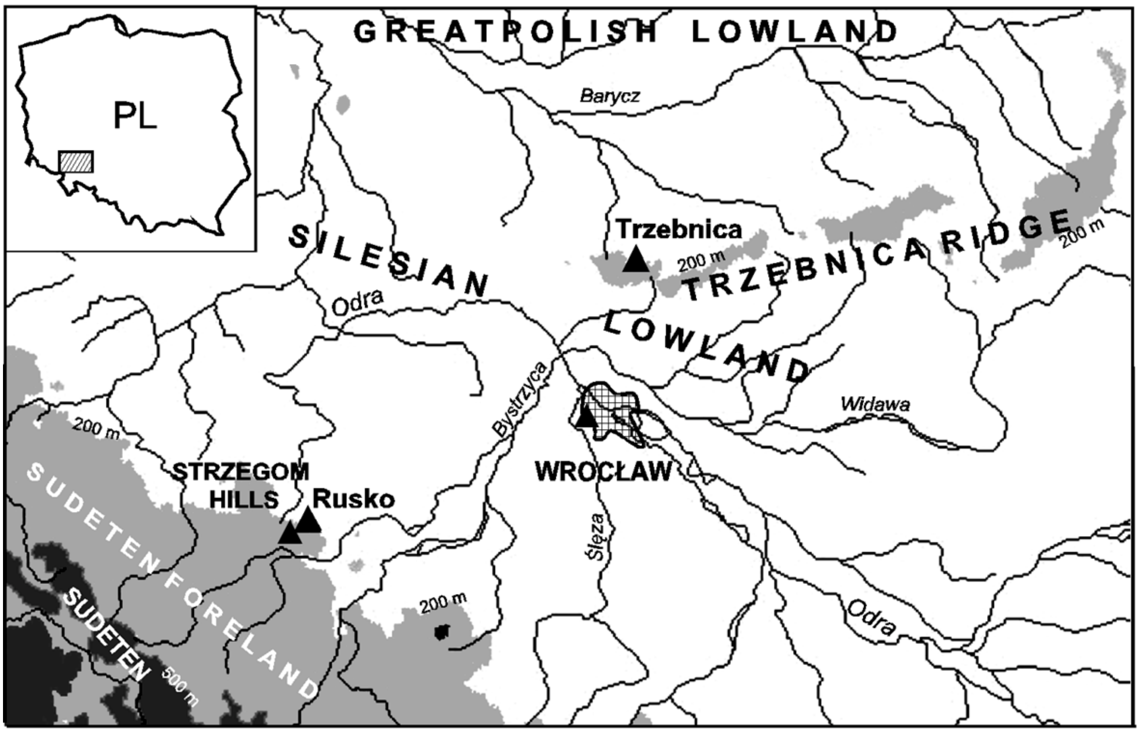


Fig. 1. The Lower Palaeolithic sites with small artefacts in Silesia (S.W. Poland).

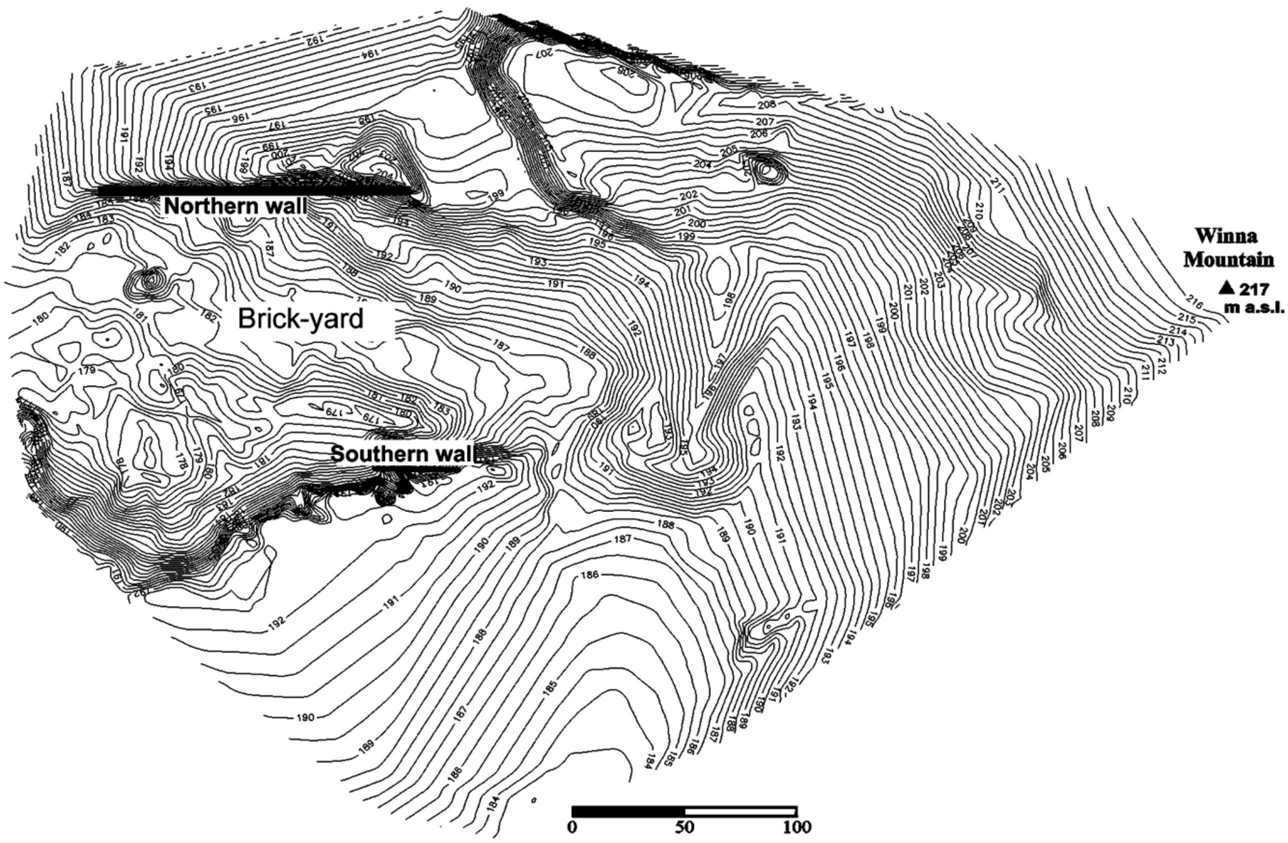


Fig. 2. Trzebnica 2. Brickyard with artefacts in the Middle Quaternary deposits.

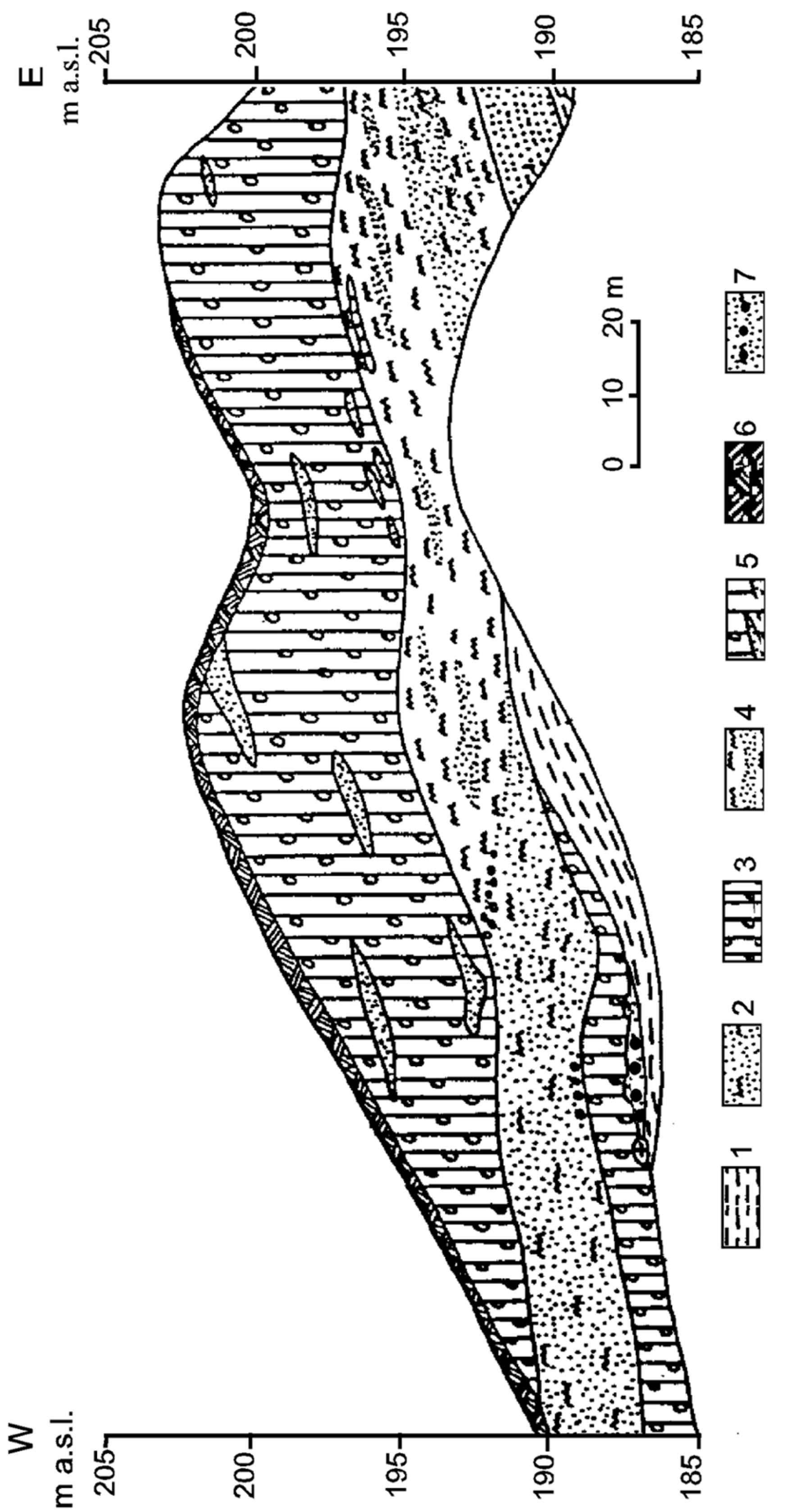


Fig. 3. Trzebnica 2. Northern section: Tertiary: 1 – Upper Miocene clays, 2 – Pliocene quartzite sands; Sanian Glaciation: 3 – lodgement till; Odranian Glaciation: 4 – muddy sands, muds, locally clayey varved muds, 5 – lodgement till; Holocene: 6 – soil (according to J. Winnicki 1997).

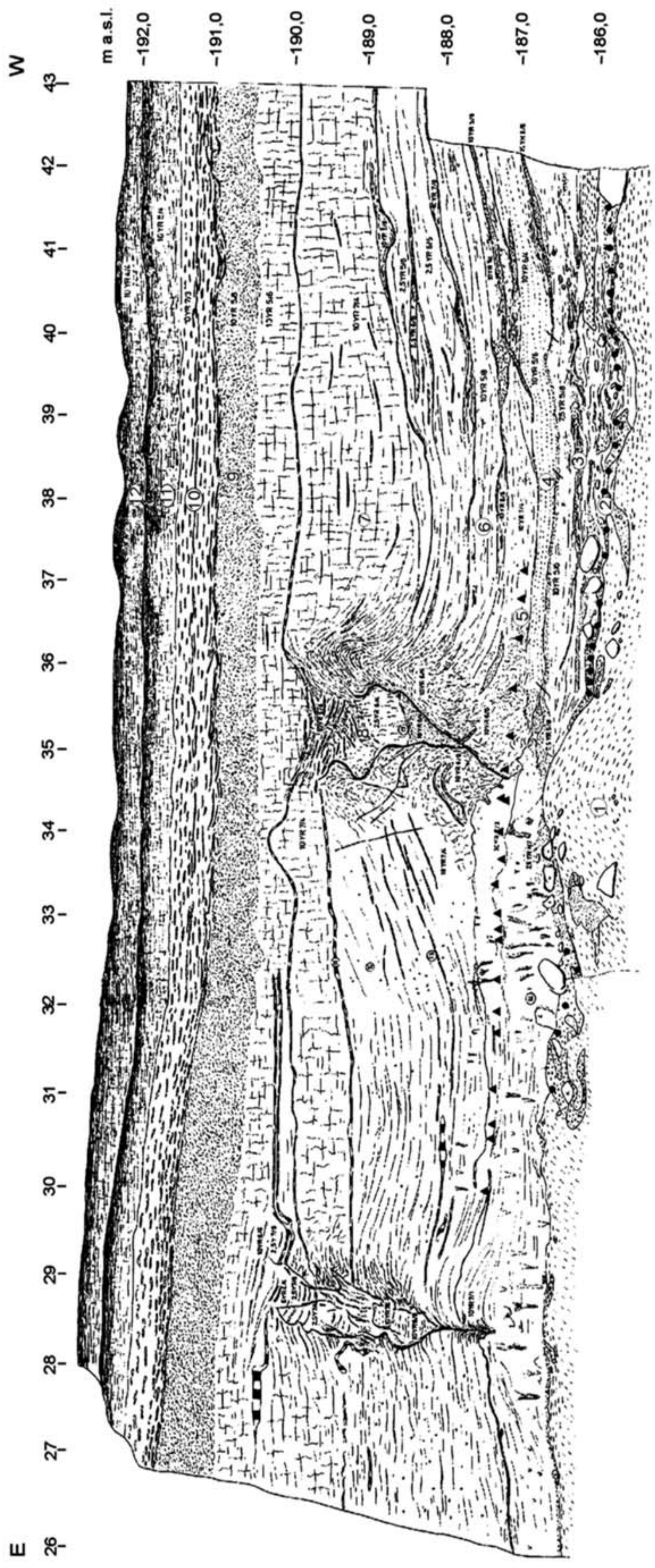


Fig. 4. Trzebnica 2. Southern section: Tertiary: 1 – Upper Miocene clays; Sanian Glaciation: 2 – sands and gravels (with lithic artefacts and faunal remains); 3 – residuum of lodgement till; Odranian Glaciation: 4 – sand, 5 – sand and gravel (with stone artefacts), 6 – sands, muds, locally clayey varved muds, 7 – silty diamicton; Lublinian Interglacial: 9 – soil lessivé; Wartanian Glaciation: 8 – pseudomorphoses from ice vedges; Eemian Interglacial: 10 – residuum of lt_2 horizon, soil lessivé; Vistulian Glaciation: 11 – silt; Holocene: 12 – recent soil; Archaeology: circles – lower horizon, triangles – upper horizon.

Fig. 5. Trzebnica 2. General view of the southern section.

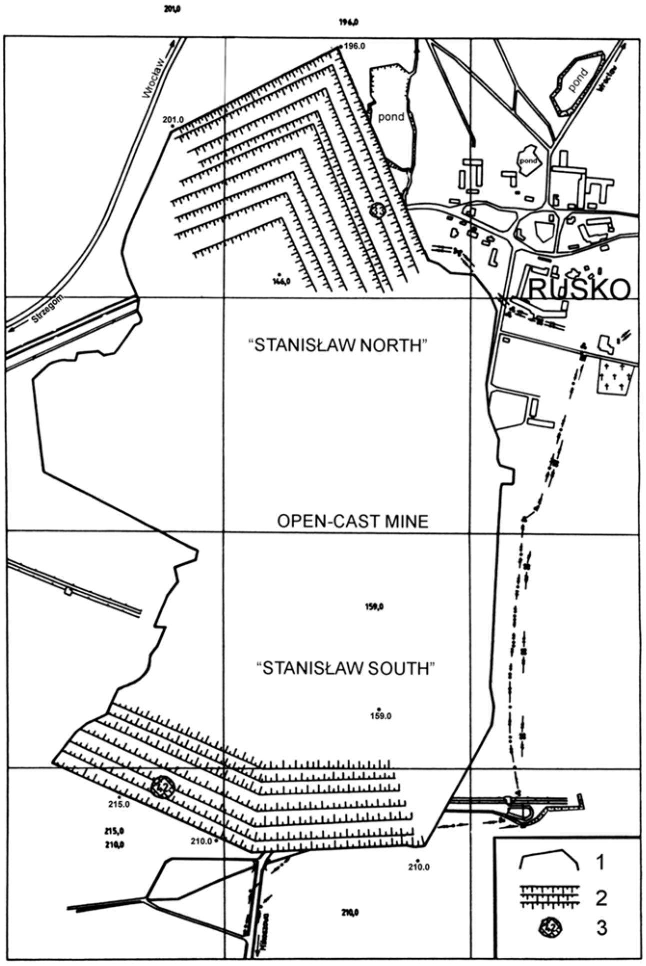


Fig. 6. Rusko near Strzegom. Opencast mine: 1 – boundary of the mine outcrop, 2– arrangement of escarpments in the mine, 3 – Lower Palaeolithic sites.

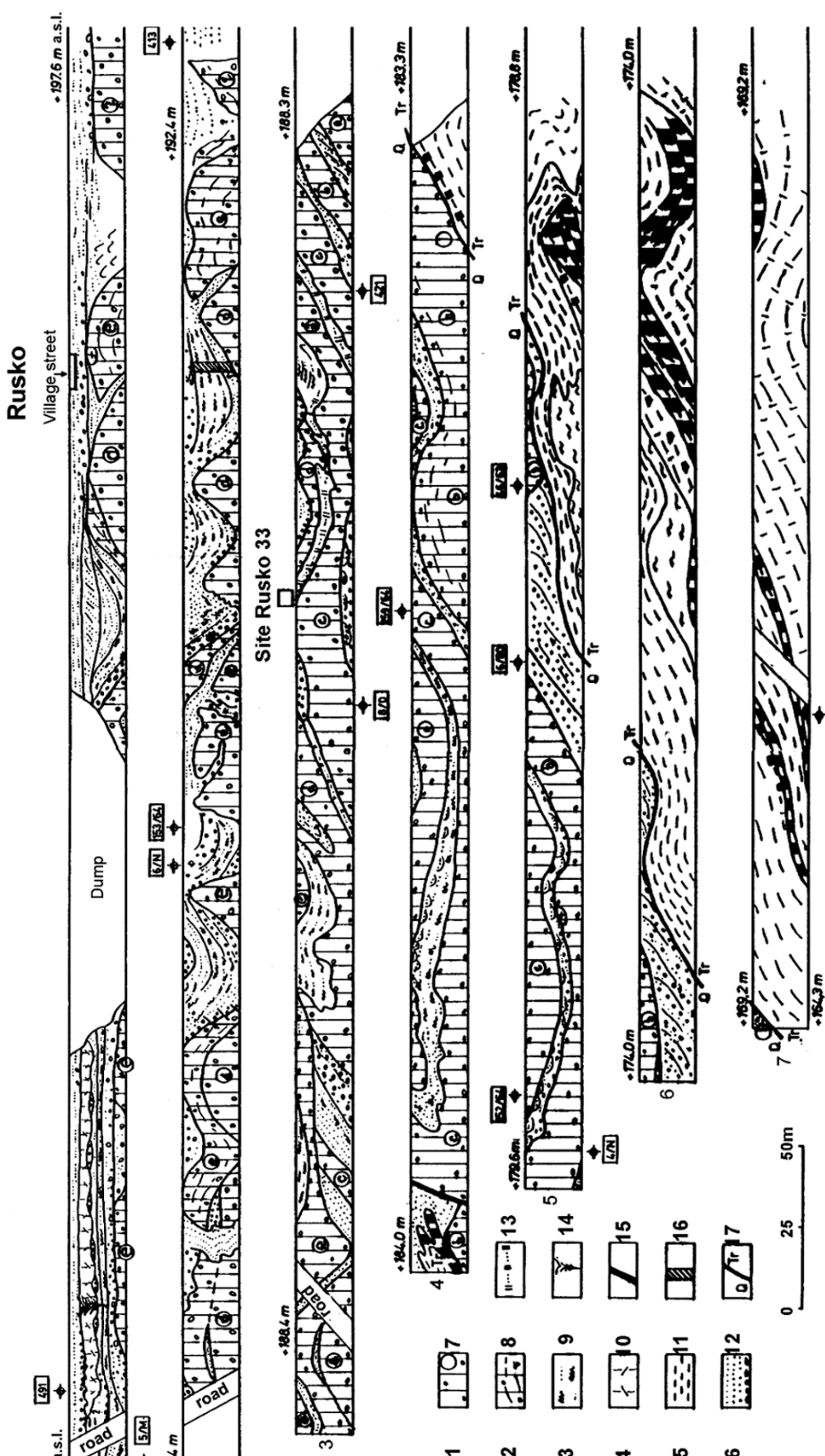


Fig. 7. Rusko 33 near Strzegom. Stratigraphy of north-eastern part of kaolin opencast mine: 1 – Neogene grey clays with plant debris, 2 – lignite, 3 – lignite-bearing clays, 4 – kaolin clay, 5 – variegated clay, 6 – gravels, 7 – lodgement tills, 8 – flow till, 9 – silts with plant debris, 10 – loess, 11 – Pleistocene clays, 12 – moraine pavements and boulders, 13 – silts with plant debris, 14 – ice vedges, 15 – faults, 16 – palaeobotanical samples, 17 – boundary between Tertiary and Quaternary (according to A. Szynkiewicz 1992).

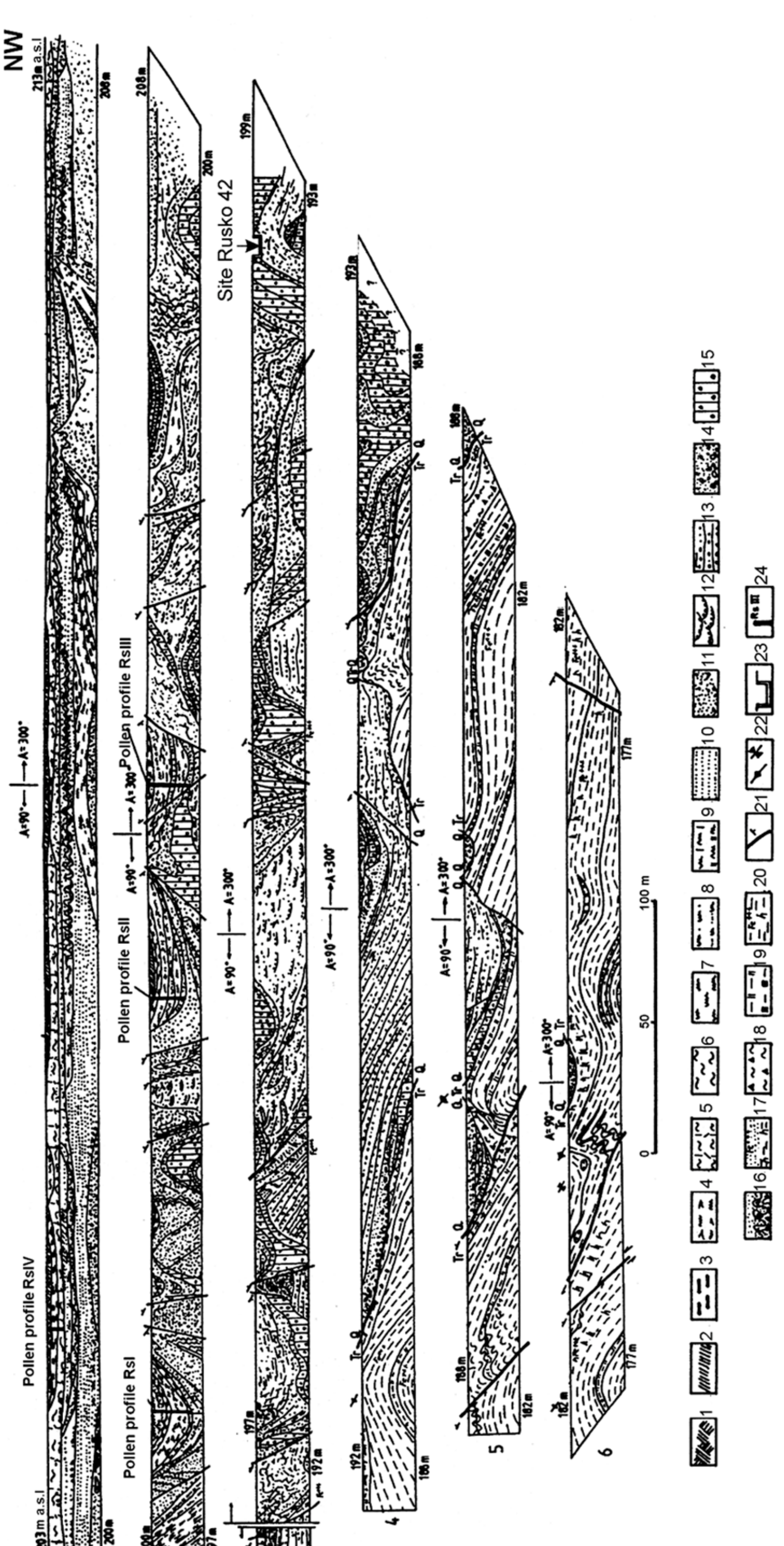


Fig. 8. Rusko 42 near Strzegom. Stratigraphy of southern part of kaolin opencast mine: 1 – recent soil, 2 – fossil soil, 3 – peat, 4 – lime bog and gytjia with molluscs, 5 – redeposited loess, 6 – dust, 7 – silt, 8 – sandy silts, 9 – silts with plant debris, 10 – fine-grained sands, 11 – sand and gravel, 12 – channel-fill deposits, 13 - bedded gravels, 14 – fluvioglacial gravels and boulders, 15 – lodgement till, 16 – disturbed clayey silt, 17 – silt and sand with hematite, 18 – Pliocene quartzite sands in kaolin, 19 – Neogene grey clays with plant debris and lignite layers, 20 – variegated clay, 21 – faults and direction of beds inclination, 22 – saddle and syncline axis, 23 – archaeological trench, 24 – paleobotanical and paleozoological samples (according to A. Szynkiewicz 1996).

Fig. 9. Rusko 33 near Strzegom. The site during archaeological excavations.

Fig. 10. Rusko 42 near Strzegom. Location of the site in kaolin opencast mine.

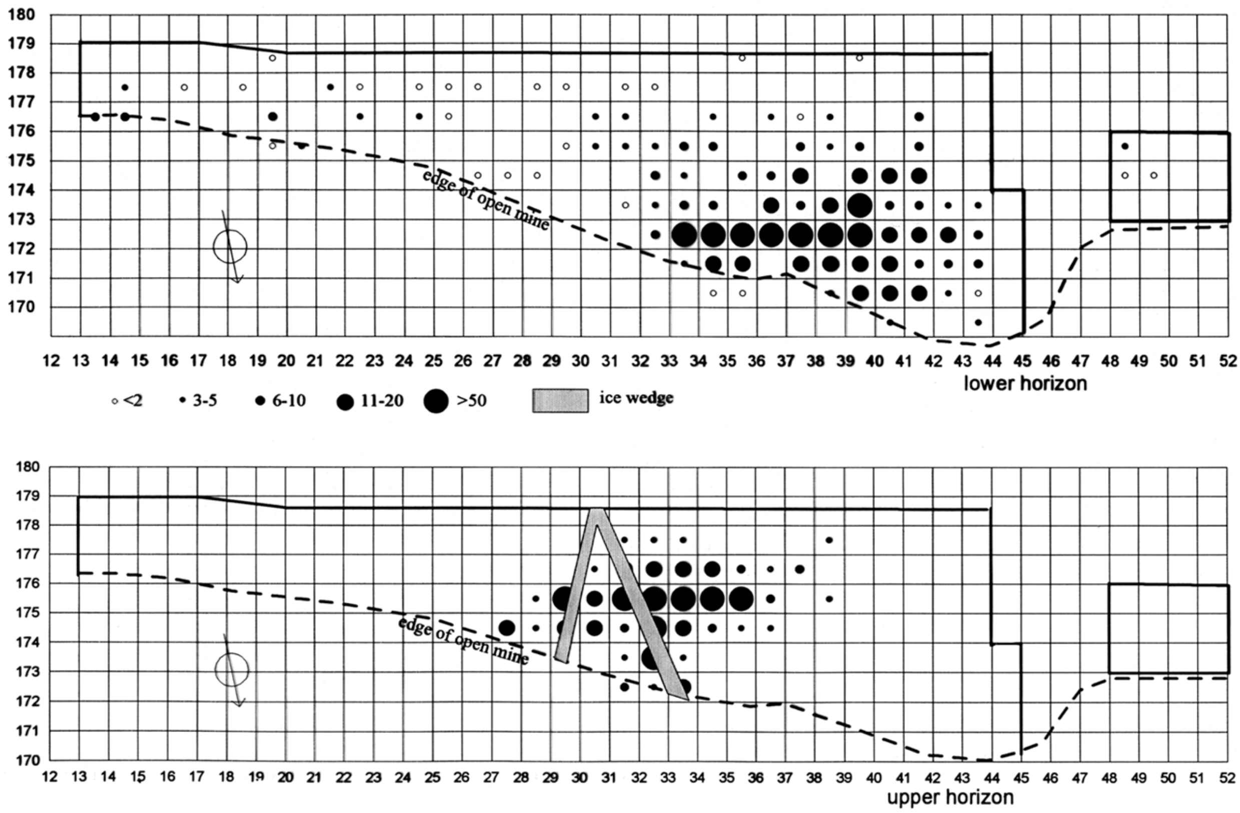


Fig. 11. Trzebnica 2. Southern section. Lithic artefact distribution.

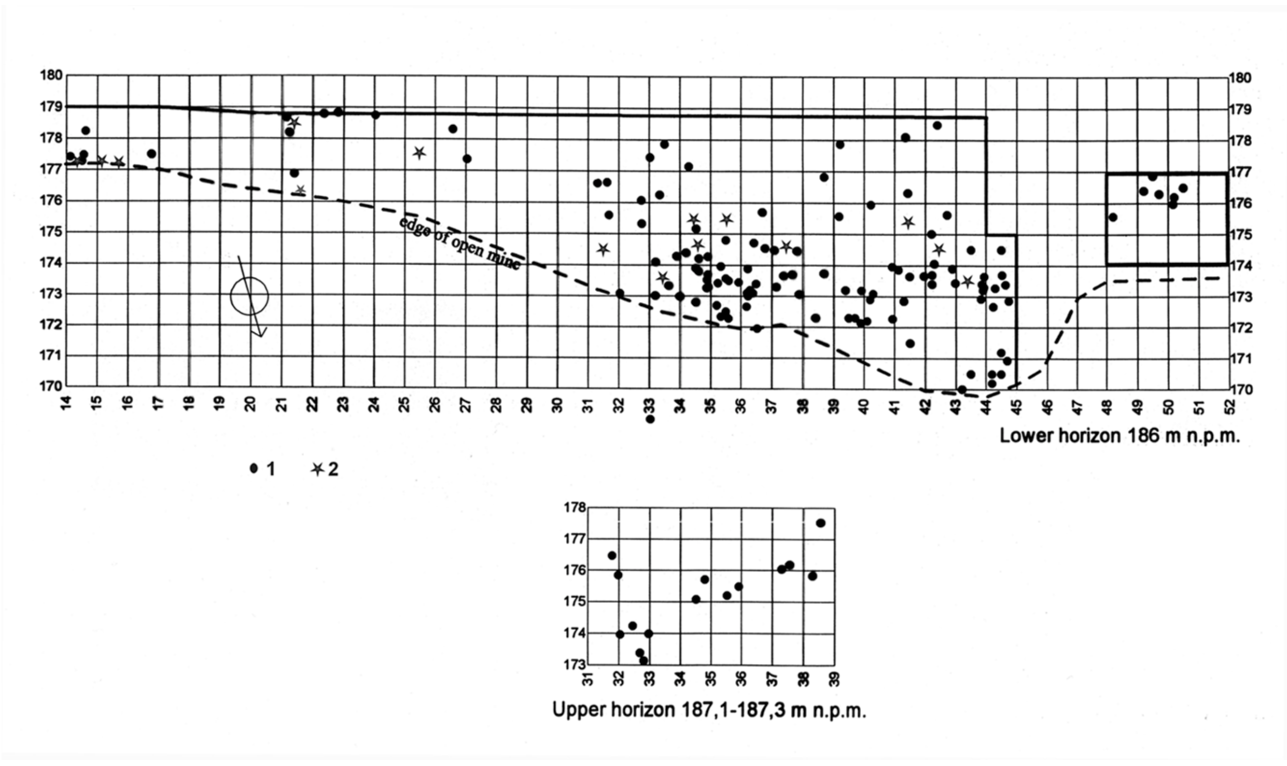


Fig. 12. Trzebnica 2. Southern section. Distribution of cores, tools and fauna: 1 – lithics, 2 – animal bones.

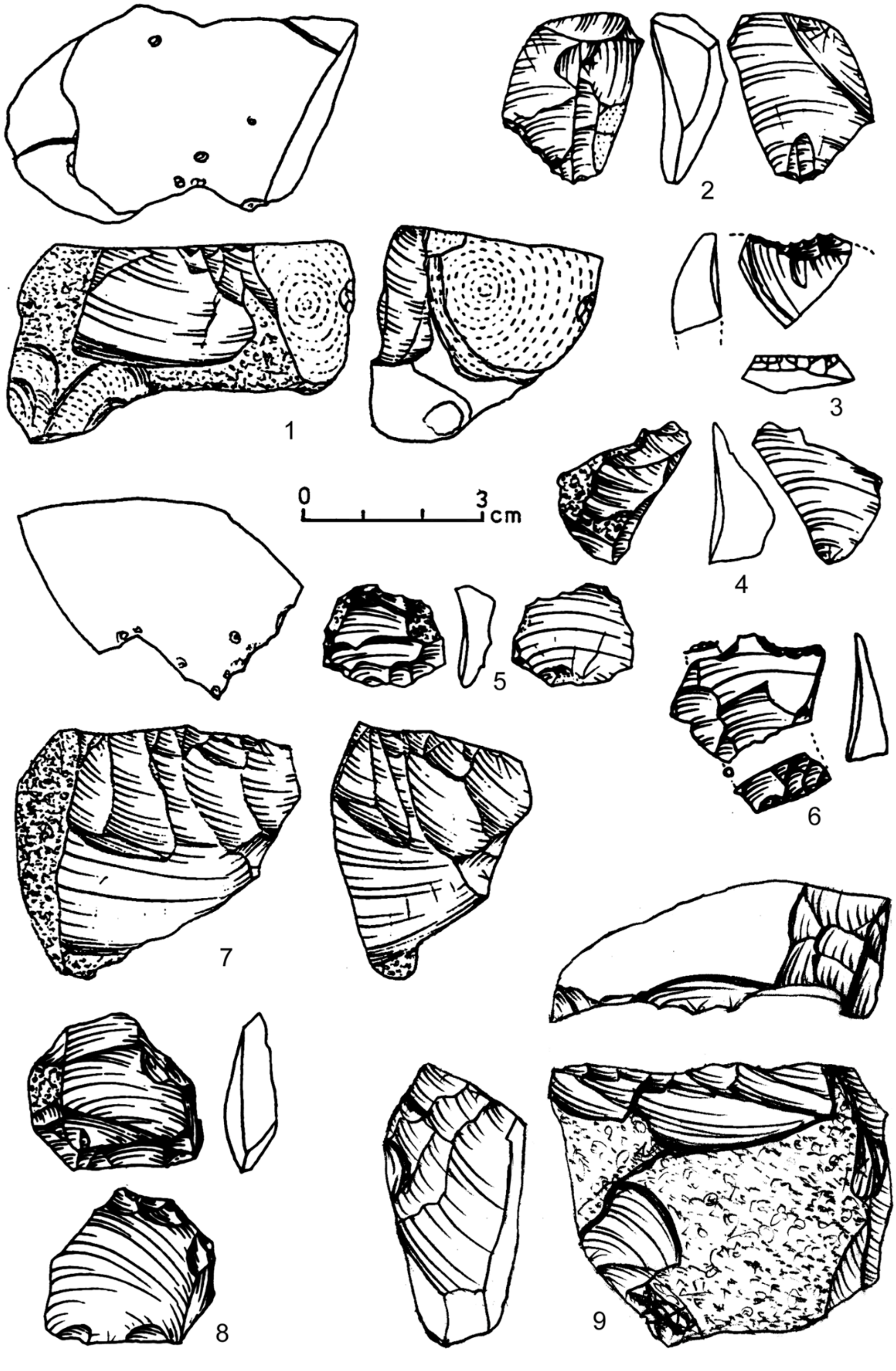


Fig. 13. Trzebnica 2. Flint artefacts from lower horizon: cores – 1, 7, 9; retouched flakes – 2, 4; notched tool – 3; side scrapers – 5, 8; perforator – 6.

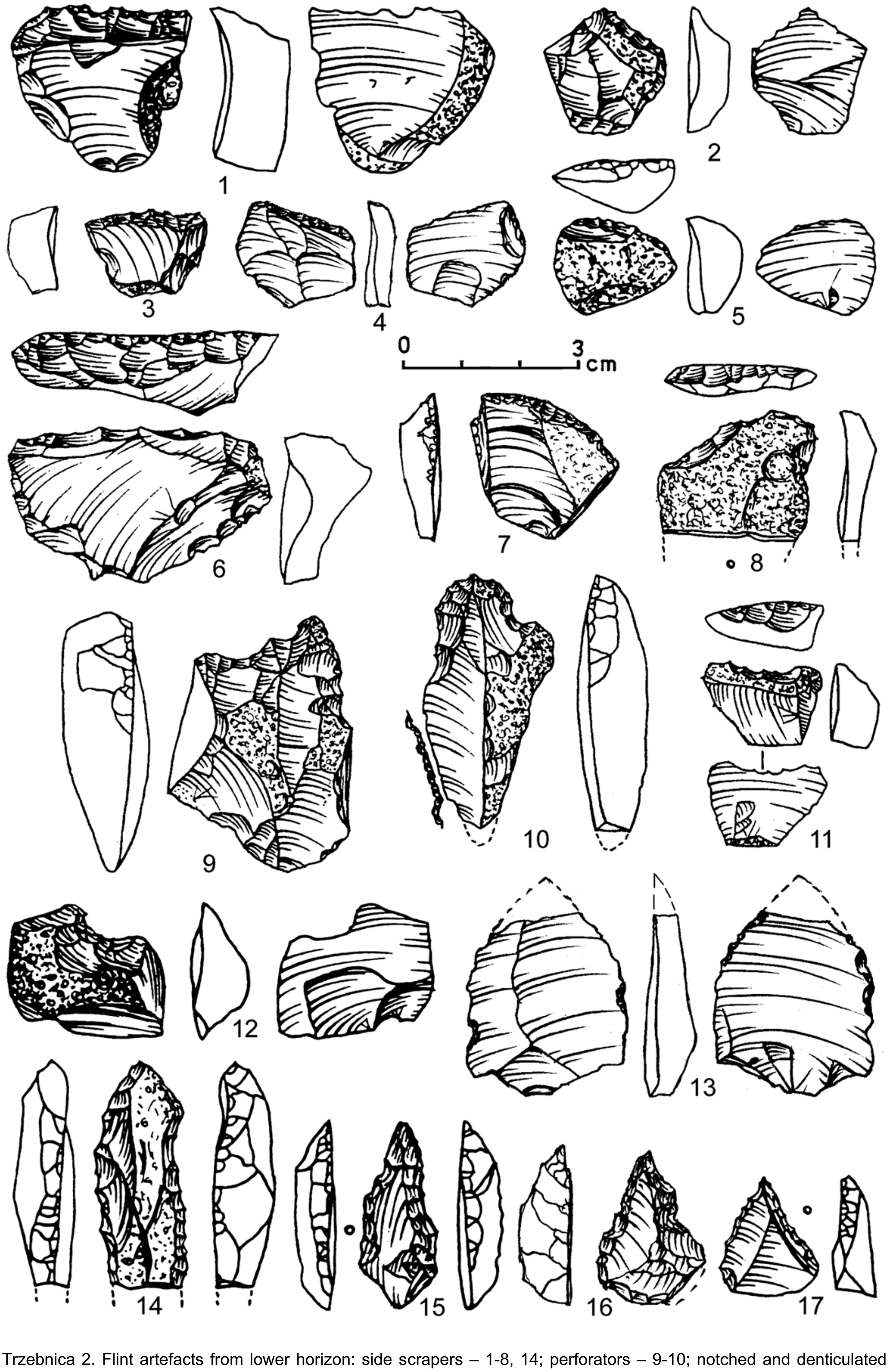


Fig. 14. Trzebnica 2. Flint artefacts from lower horizon: side scrapers – 1-8, 14; perforators – 9-10; notched and denticulated tools – 11-12; broken point? – 13; Tayac points – 15-17.

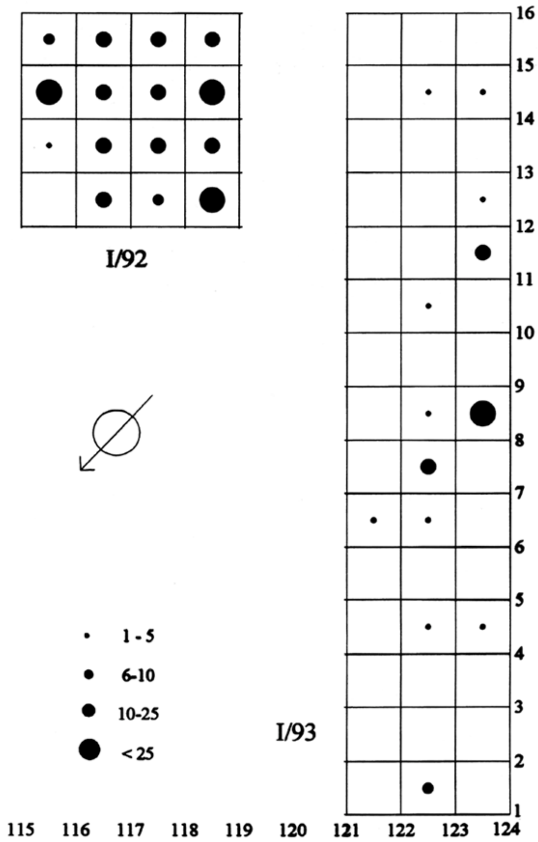


Fig. 15. Rusko 33 near Strzegom. Distribution of flint artefacts.

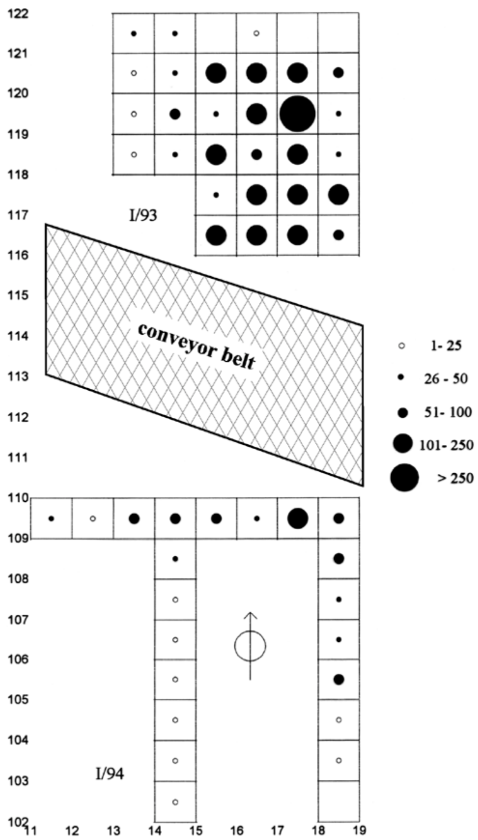


Fig. 16. Rusko 42 near Strzegom. Distribution of flint artefacts.

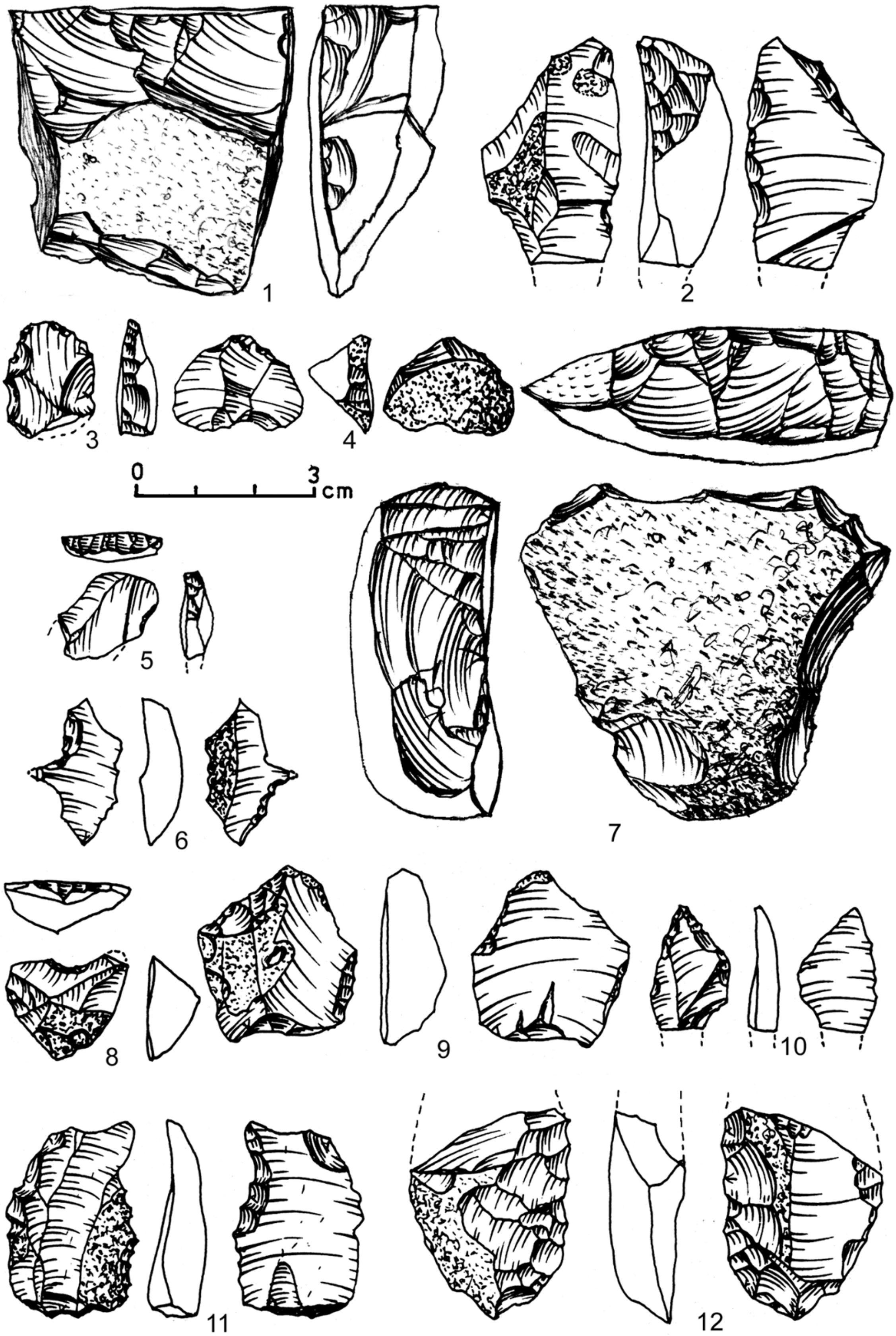


Fig. 17. Rusko 33 near Strzegom. Flint artefacts: cores – 1, 7; side scrapers – 2-5, 9; perforators – 6, 10; notched and denitculated tools – 8, 11; tool fragment with flat retouch – 12.

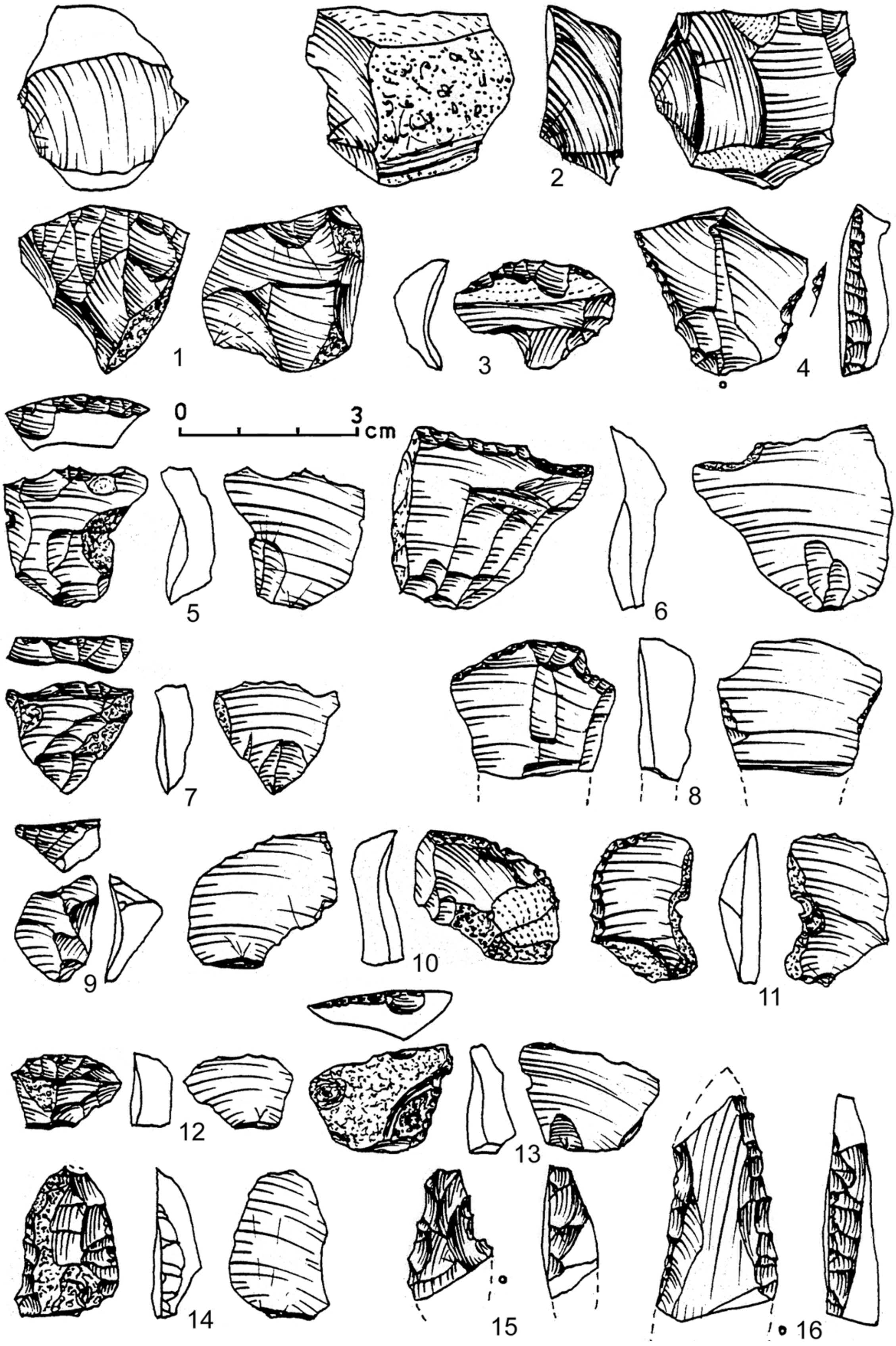
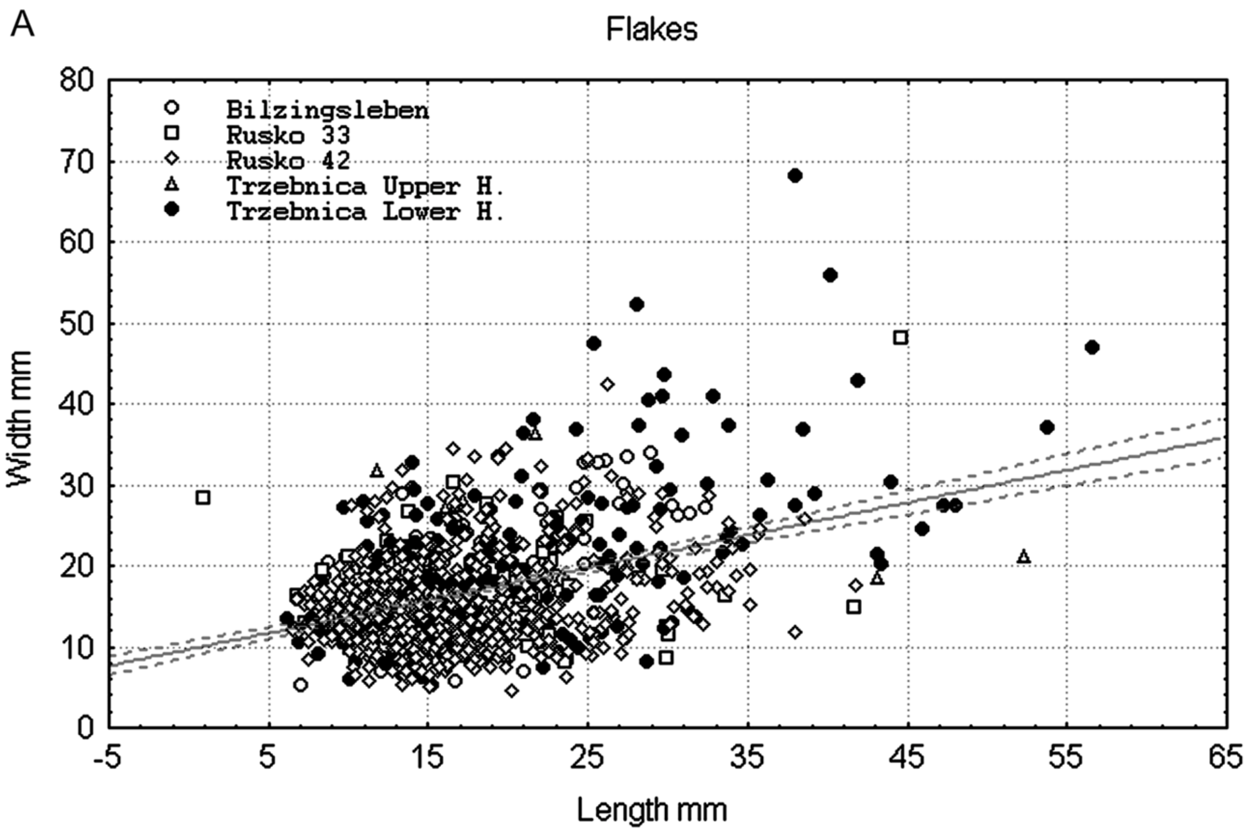


Fig. 18. Rusko 42 near Strzegom. Flint artefacts: cores – 1-2; side scrapers – 3-14; perforator or point fragments – 15-16.



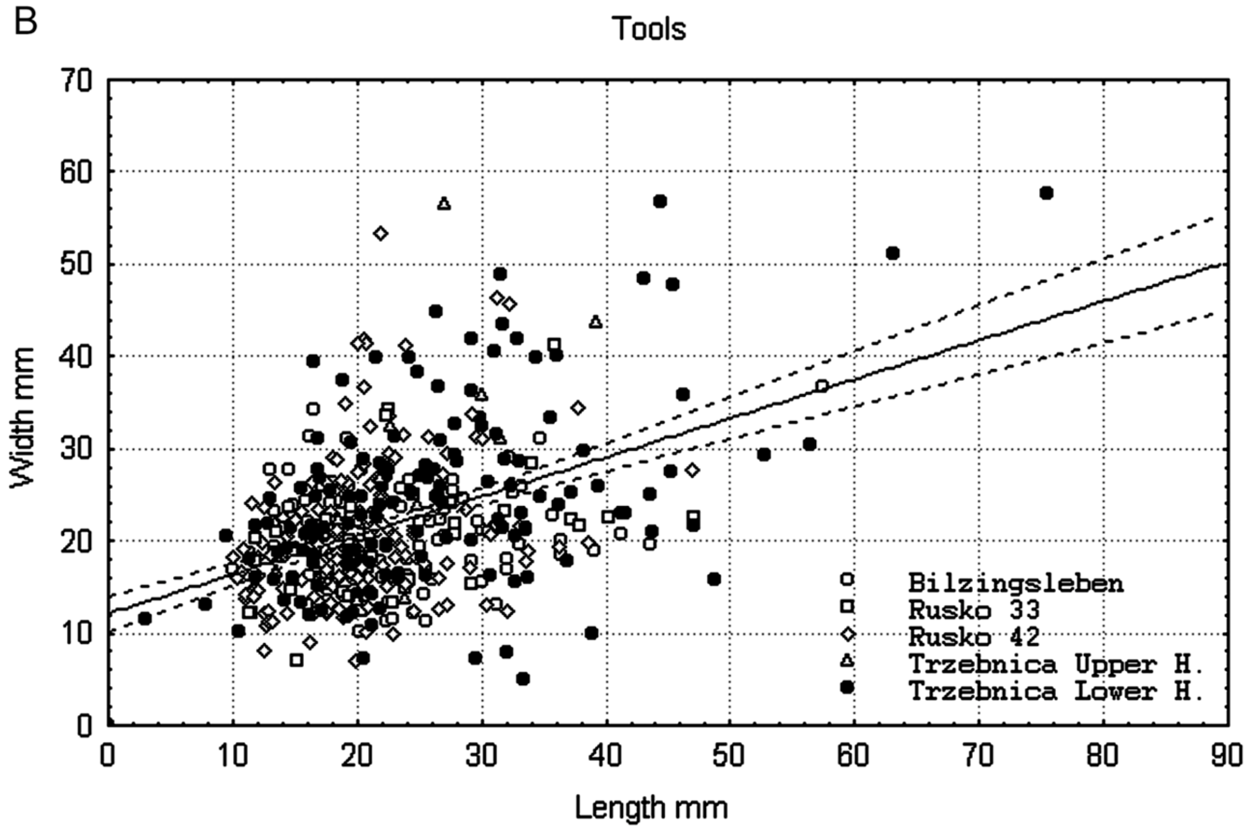


Fig. 19. Scatter plot of width and length of the Lower Palaeolithic flakes (A) and flake tools (B).

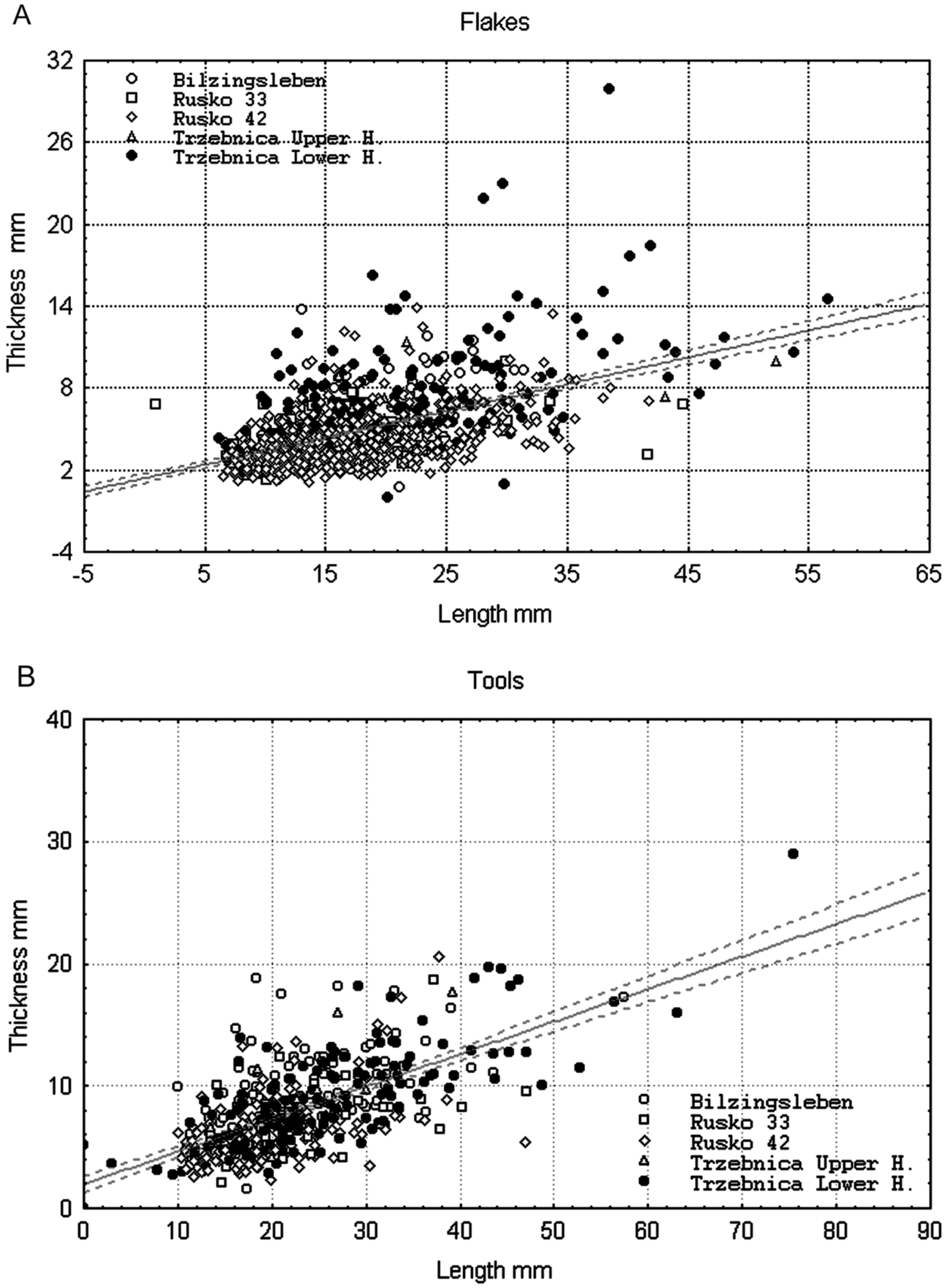


Fig. 20. Scatter plot of thickness and length of the Lower Palaeolithic flakes (A) and flake tools (B).

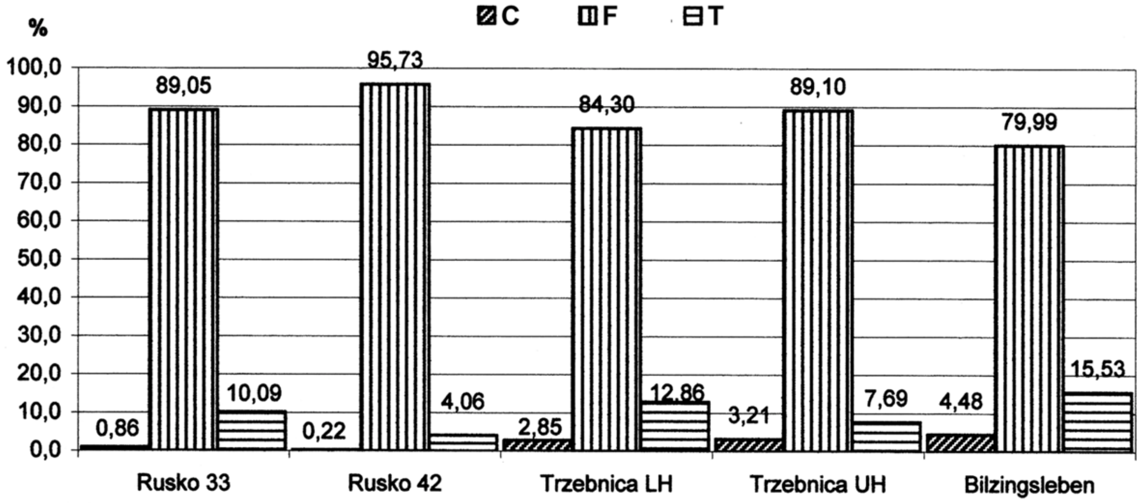


Fig. 21. Frequency of main artefact groups: C - cores, F – flakes, T - flake tools.

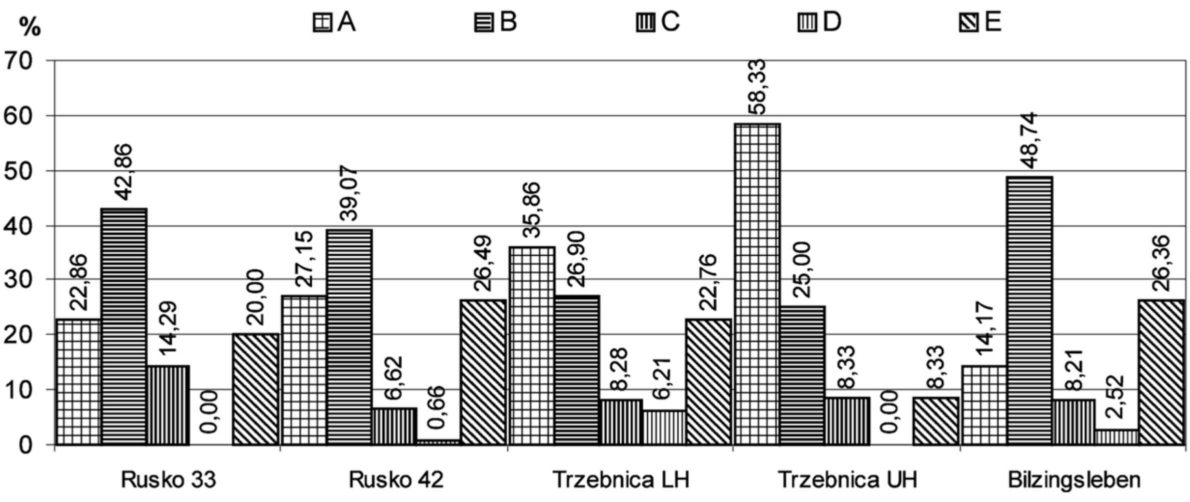


Fig. 22. Frequency of flake tool groups: A – side scrapers, B – notched and denticulated tools, C – perforators, D – points, E – retouched flakes.

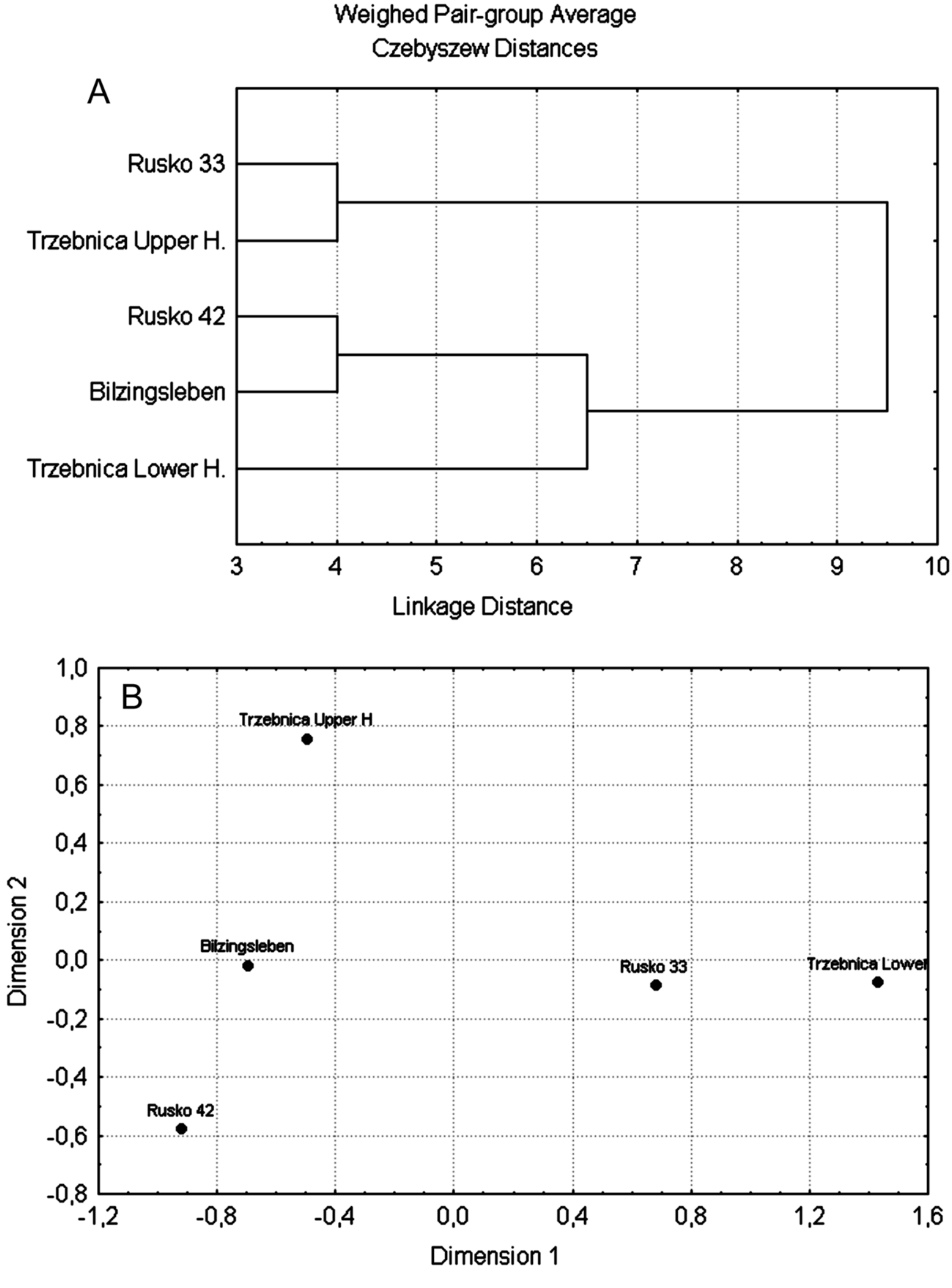


Fig. 23. Statistical similarity of tool attributes of Trzebnica, Rusko and Bilzingsleben according to cluster analysis (A) and multidimensional scaling (B).

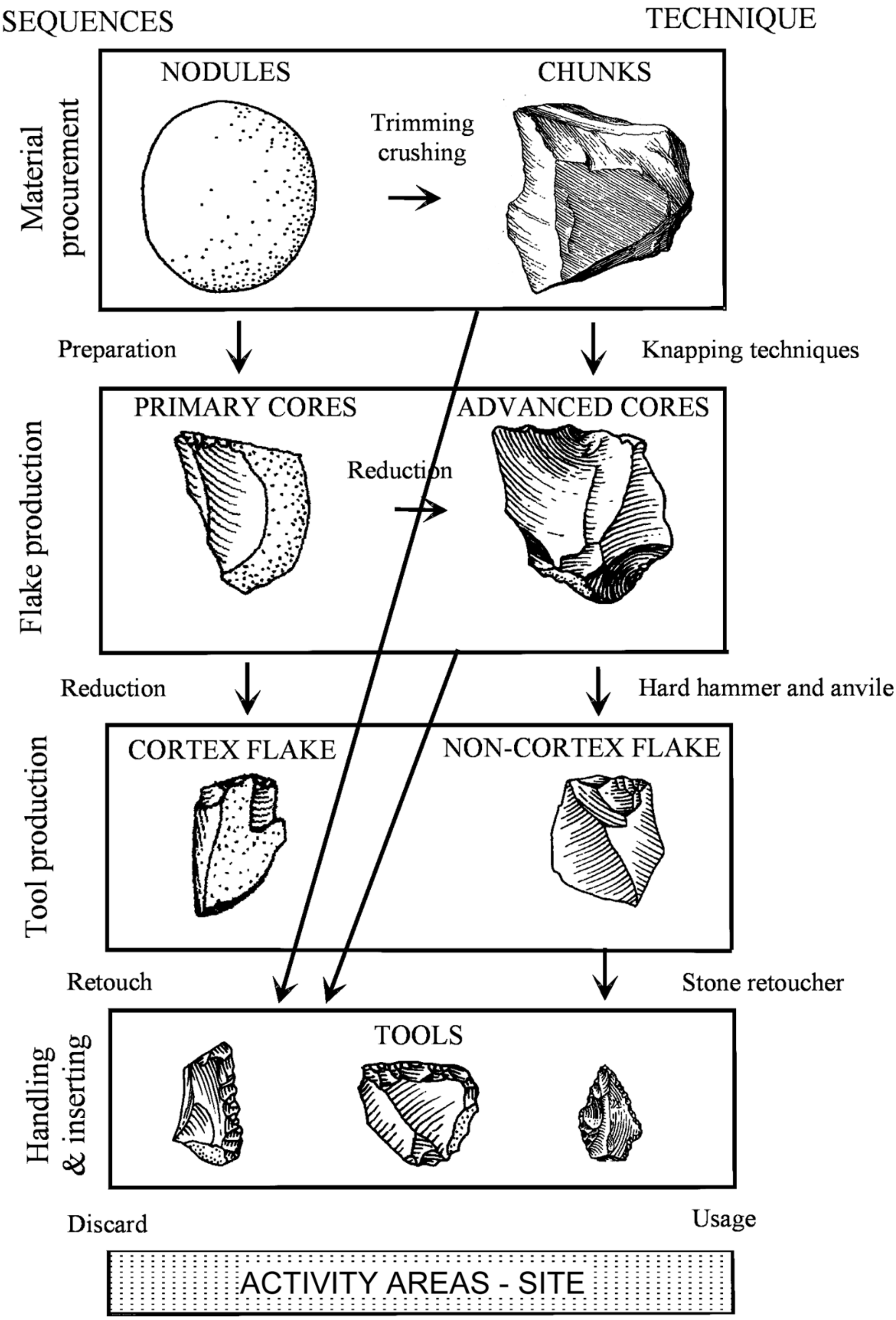


Fig. 24. Hypothetical reconstruction of the technological sequences of flint processing on the Lower Palaeolithic sites with microlithic artefacts.

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