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THE NEW PALAEOLITHIC SITE OF KSIECIA JOZEFA (CRACOW, POLAND) WITH BLADE AND FLAKE REDUCTION

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Introduction

The site of Księcia Józefa is located in the Zwierzyniec-Salwator region of Cracow, on property belonging to Norbertine nuns. It was discovered in 1997 by K. Sobczyk and V. Sitlivy during survey, and subsequently excavated by them in 1998 and 1999.

In this publication, we present the preliminary geological and technological results. One of the main aims of this paper is to present data about Middle and Upper Palaeolithic lithic technologies from an entirely new site, which occur together in the different levels of Księcia Józefa. We intentionally attempt to reconstruct reduction sequences for a series of cores to define their technological sequence before absolute dates were obtained in order to avoid "chronological" pressures in archaeological (e.g. technological) conclusions. One of the authors considers that the archaeological features and chronology do not display linear evolution; it often happens that innovations or survivals do not fit into a "general evolutionary lineage" (Chabai and Sitlivy 1993; Sitlivy 1995).

Over two years, an area of about 31 m² was excavated. The maximum depth is 6.20 m, and three archaeological levels were discovered (fig. 1). The Middle and Lower assemblages are rich in debitage which could be refitted, indicating the *in situ* position of the deposits.

Concentrations of coal and burnt flints also occurred in these levels (fig. 2). Most of the archaeological remains (of all complexes) come from a strictly delimited area: about 5 m² in the South-East part of the excavated trench. At present, 34 refit sequences have been made (not counting broken blanks, such as snap fractures or post-depositional breakage) (fig. 3). The technological and typological structure indicate that the primary use of the site was for reduction activity, with very few tools present. To date, the archaeological sequence can be summarised as follows :

1) Upper complex – peripheral or ephemeral site with isolated lithic artefacts; flake and blade debitage products, some unretouched blanks of Middle and Upper Palaeolithic type;
2) Middle complex – debitage area or workshop (fig. 4 and 5) with numerous, without exception, products of blade production; rare tools (no diagnostic types), some used blades without retouching (?) – Upper Palaeolithic type of technology;
3) Lower complex – debitage area/workshop (?) with dominant flake production of Middle Palaeolithic type and with clear evidence of blade Upper Palaeolithic debitage; rare Middle Palaeolithic tools.

TL and AMS datings are in process and carried out by H. Valladas ("Laboratoire des Faibles Radioactivités" of Gif-sur-Yvette), as well as detailed geological analyses by T. Kalicki. The estimated minimal age of the Upper complex is before the Middle Pleniglacial.

Genesis and stratigraphy of sediments

The study area

Księcia Józefa is located on the northern slope of the Vistula valley in the Cracow Gate. The Vistula river here flows between two horsts : Św. Bronisławy hill on the north and Skałki Twardowskiego on the south. Quaternary sediments cover Jurassic limestones which form the horsts and Miocene clays fill the depressions. Boreholes (S7, S8, M11, M12) on the southern slope of the Św. Bronisławy hill revealed sands of the Vistula's buried terrace (M12) under the loess cover. This terrace has a gentle slope. The thickness of the loess is up to 10 m (9.65 m in

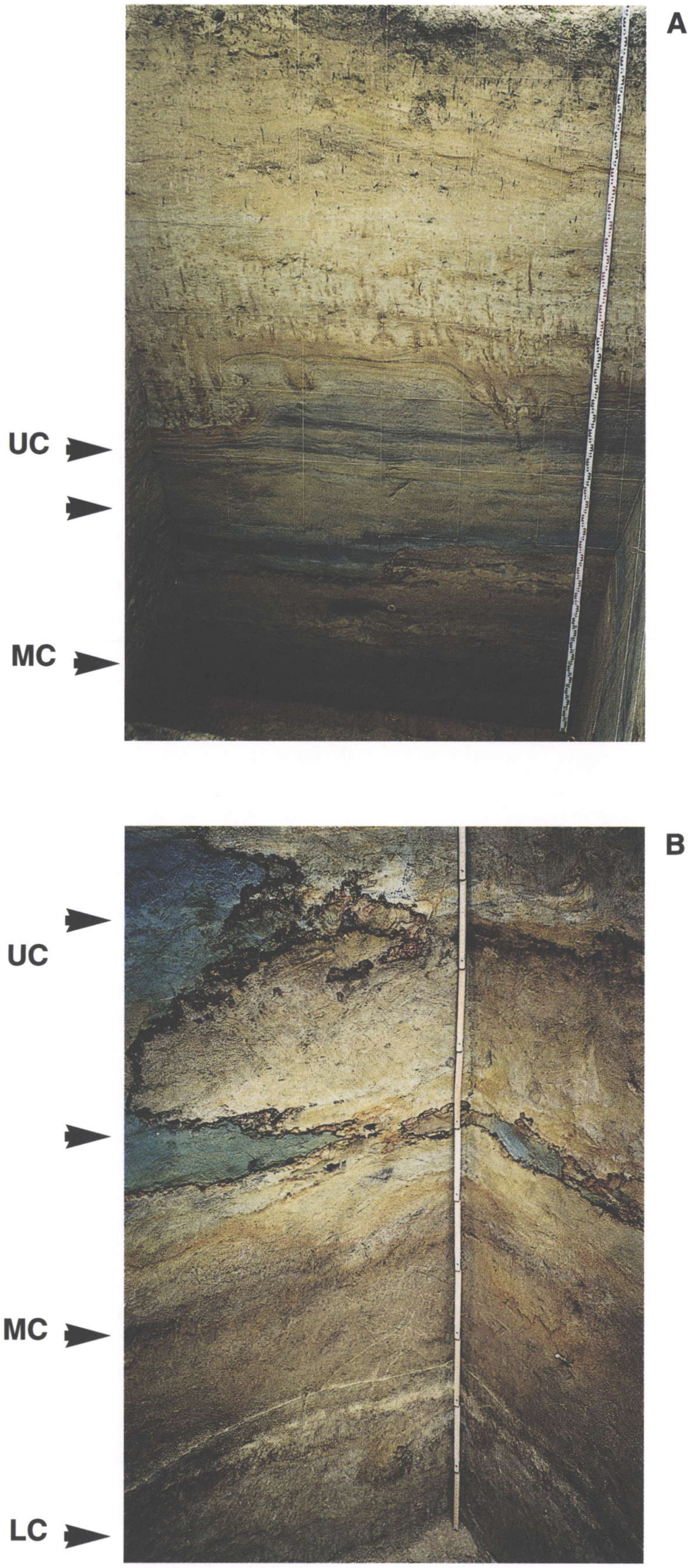


Figure 1. Księcia Józefa site. A. South Profile; South and east profiles (lower part). UC Upper complex; MC Middle complex; LC Lower complex.

A

B

C

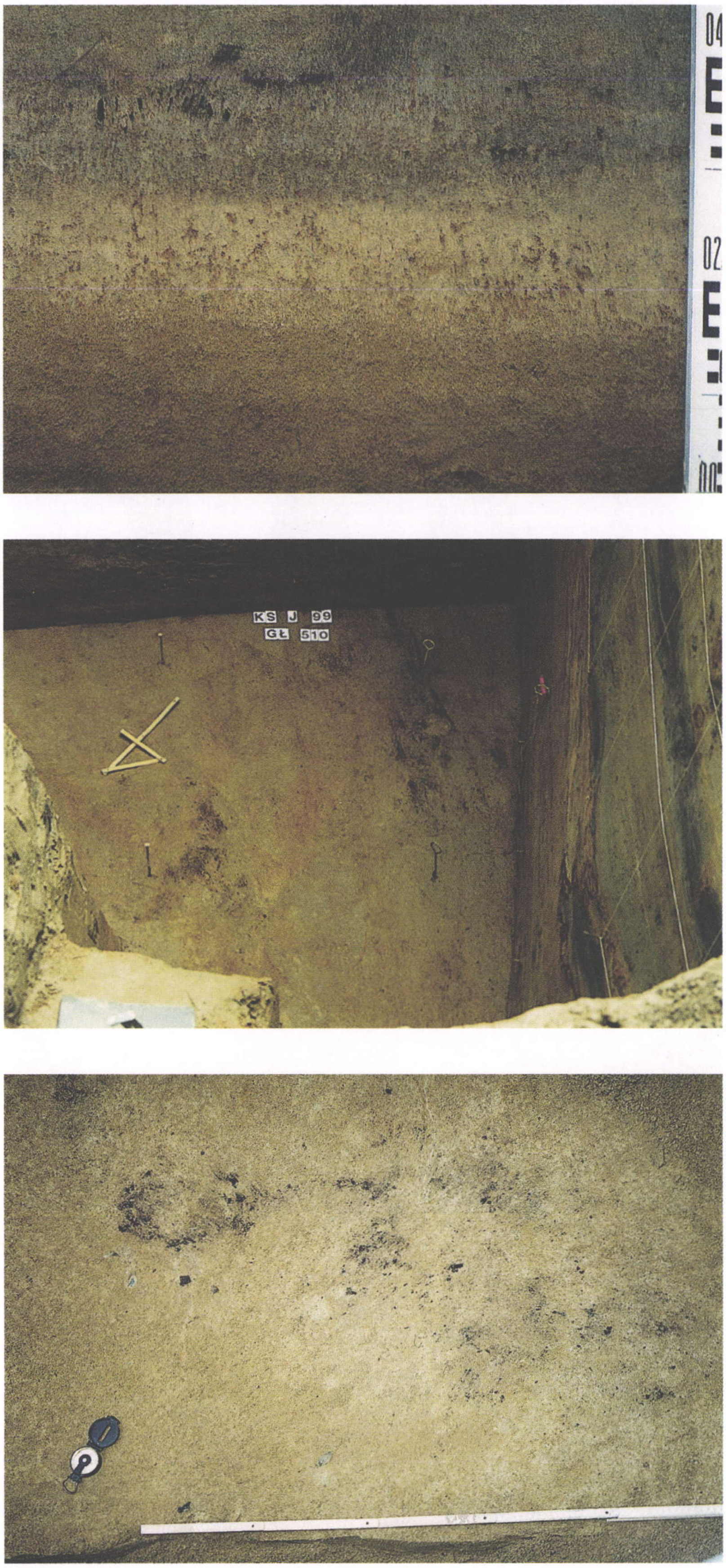


Figure 2. Concentrations of coal and burnt flints. Middle complex : A. South profile, vertical distribution; B. Horizontal distribution. Lower complex : C. Horizontal distribution.

A

B

Figure 3. Refitted flint artefacts from the Middle (A. Blade debitage) and Lower (B. Denticulate tool with facets of retouching; short massive flakes and two partial tablets) complexes.

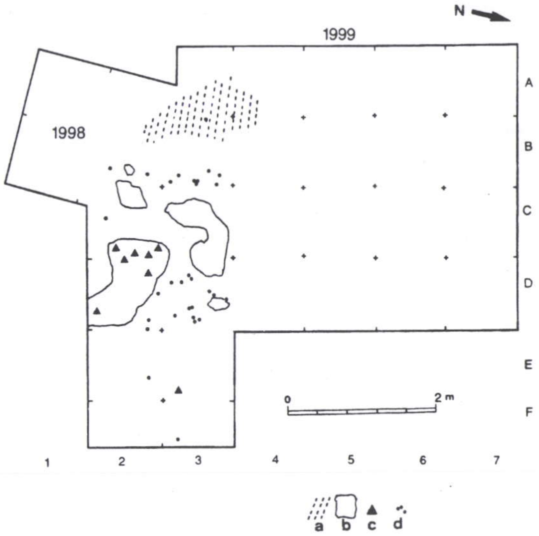


Figure 4. Middle complex. Plan of debitage area with blade production: a. concentration of coal; b. concentration of debitage products; c. blades cores; d. isolated debitage products.

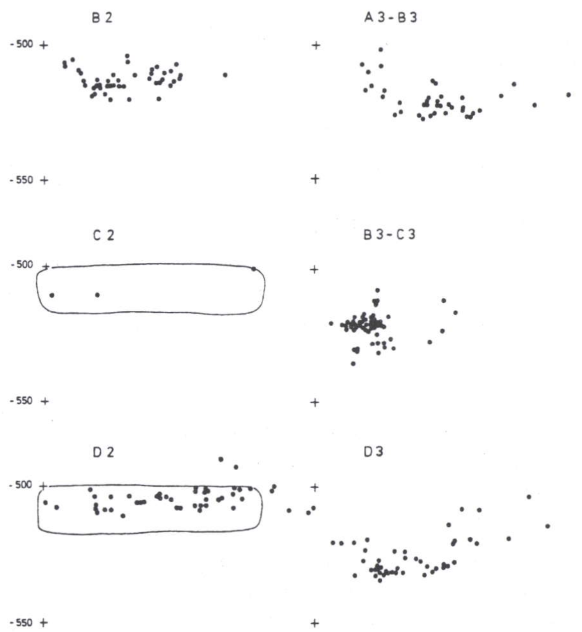


Figure 5. Middle complex: vertical distribution of lithic artefacts (in grey: concentration of debitage products with coal and burnt flints).

borehole M12) and the thickness of the sand is more than 3.5 m. The top of the buried terrace is about 10 m above the modern level of the river (fig. 6).

The site is located near the intersection of Księcia Józefa street and Malczewskiego street, a little down from borehole M12 (fig. 7). The thickness of

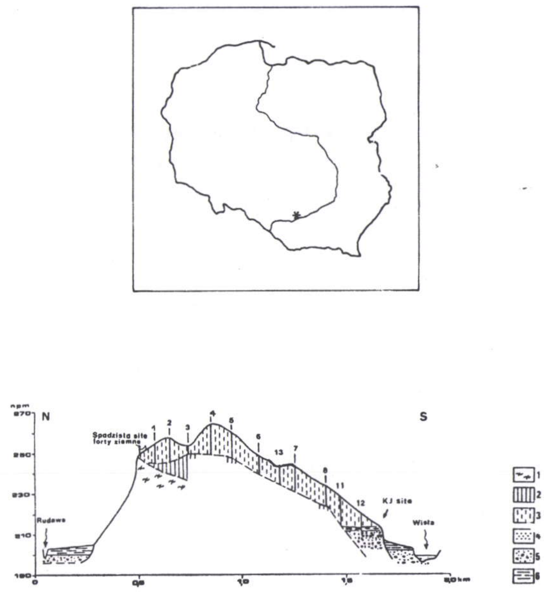


Figure 6. Location of Księcia Józefa. a. section across the Św Bronisława Hill. b. 1. Jurassic limestone; 2. Miocene clay; 3. Loess; 4. Sand; 5. Gravel with sand; 6. Silty overbank deposits.

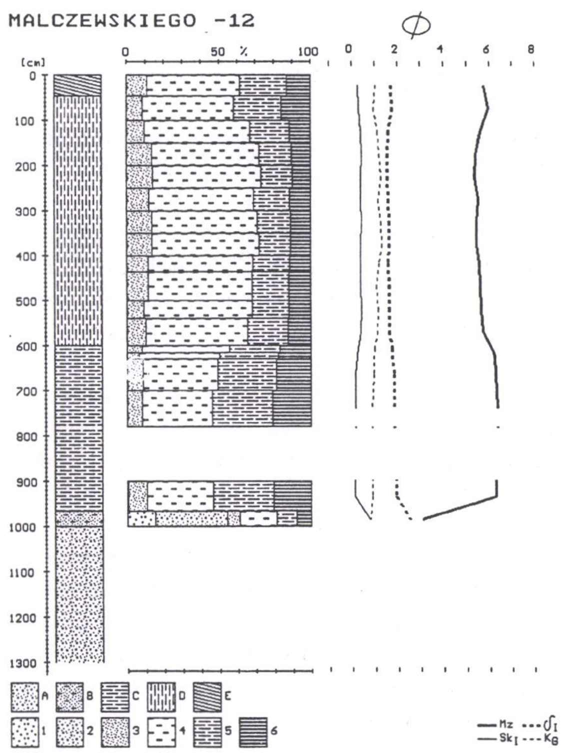


Figure 7. grain size composition and Folk-Ward grain size distribution parameters of Malczewskiego 12 borehole. A. medium sand; B. Loess; C. clayey silts; D. soil. Fraction : 1. coarse sand (-1-1φ); 2. medium sand (1-2φ); 3. fine sand (2-4φ); 4. coarse and medium dust (4-6φ); 5. fine dust (6-8φ); 6. clay (below 8φ).

loess on the site was artificially reduced, traces of which can be seen in the morphology. Three main series of different origin and different grain size of the sediments could be distinguished in the profile (fig. 8). These are eolian loess cover, silts of the overbank facies and channel sands (from top to bottom of the profile). Each series can be further subdivided into members and layers.

Series I : loess cover (eolian sediments) (fig. 9: a, b)

A 2.25-2.50 m thick layer of carbonate carbonate (2.8-5.2% $CaC0_3$) loess (Mz=5.7-6.2φ) covers the site. At the top (to 0.5 m), a weakly marked anthropogenic disturbance humus layer occurs. Three main members can be distinguished :

Member I-1. Upper loess (Mz=5.7-5.8φ), yellow-brown, carbonate (2.8-4.6%). Thickness 1.25 m.
Member I-2. Gley loess (Mz=6.1φ), grey-yellow with grey and reddish spots and rings, carbonate (5.1-5.2%) with carbonate concretions. Thickness 0.5 m.
Member I-3. Loess (Mz=6.0-6.2φ), with cryoturbation, reddish-yellow, carbonate (3.23-3%), locally stratified and filled large wedges (up to 0.5 m on the S-wall).

Series II: silty muds (overbank deposits)

Series II consists of stratified silty muds (Mz=6.0-6.8φ), grey-yellow and grey-brown (organic?), without carbonate. Thickness is 1.0-1.5 m. The top of the series is disturbed by cryoturbation (S-wall of the profile). The bottom of this series is marked by strong ferriferous layer. The silty muds can be interpreted as flood (overbank) deposits which ended fluvial accumulation on the terrace.

In the first stage, conditions of sedimentation were varied. This is documented by the erosional flood channels cut in the top of the underlying sands and also within the silty series (Member II-2). The first type of channel (width > 1.5 m, depth 0.3 m) was observed in the S-wall of the profile and was filled with blue-grey silts (layer II-2B). The second type of channel (width 1.5 m, depth 0.2 m) was observed in the W-wall of the profile and was filled with silts nearly identical to the silts into which it was cut.

The sedimentation condition then stabilised and accumulation of horizontal stratified silty muds (member II-1) started.

The dispersed Middle and Upper Palaeolithic archaeological flint artefacts of upper cultural level in the series II were found.

Member II-1. Upper silty muds (Mz=6.1-6.3φ), horizontally stratified, separated into two layers :

> *Layer II-1A.* Silty muds (Mz=6.1φ), horizontally stratified, grey-yellow, non-carbonate. Thickness is 0.3-0.5 m. Locally (S-wall of the profile) this layer disappeared due to the development of wedges at the base of the loess cover.

> *Layer II-1B.* Silty muds 1Mz=6.3φ), with weakly marked horizontal stratification, grey-brown colour due to manganese or organic content (buried soil?). Thickness is about 0.2 m, but in the S-wall of the profile, continuity of this layer is broken by the wedges.

Member II-2. Lower silty muds (Mz=6.4-6.6φ), without stratification, with traces of an erosional channel. Thickness is 0.5-0.8 m. Two layers can be distinguished :

> *Layer II-2A.* Massive silty muds (Mz=6.6φ), grey-yellow. Thickness is 0.3-0.5 m. Erosional channel present in this layer, filled by similar silty muds (Mz=6.4φ).

> *Layer II-2B.* This layer was present only locally on the S-wall and W-wall of the profile, as erosional channels fill the cut in the top of sands. There are silty muds (Mz=6.0-6.2φ) upwards (increasingly more clayey toward the top of the layer) clayey-silty muds (Mz=6.8φ), blue-grey without stratification. Thickness is 0.1-0.3 m.

Series III: sands (channel deposits)

Series III consists of yellow-reddish silty sands (Mz=2.7-3.8φ), gleyed with the intercalation of finer sediments - sandy silts (Mz=5.6-5.8φ). Thickness of the outcrop is more than 2 m. These sediments change at the base to sands of varying coarseness (Mz=1.7φ). Individual layers are underlain by reddish, ferriferous laminas.

Member III-1. Yellow-reddish silty sands (Mz=2.7-3.8φ), gleyed intercalated by strong silty sands (Mz=5.6-5.8φ). The top is undulating, cut by erosional channels and filled by blue-grey silts (layer II-5B). There are large blocks (width 0.8 m, depth 0.3 m) of fine sediments (Mz=5,8φ) surrounded by ferriferous laminas and incorporated into the sandy series in the upper part of the sands (to 0.5 m depth). The thickness of this member is about 1.5 m. The Middle culture level is about 0.7-1.0 m below the top.

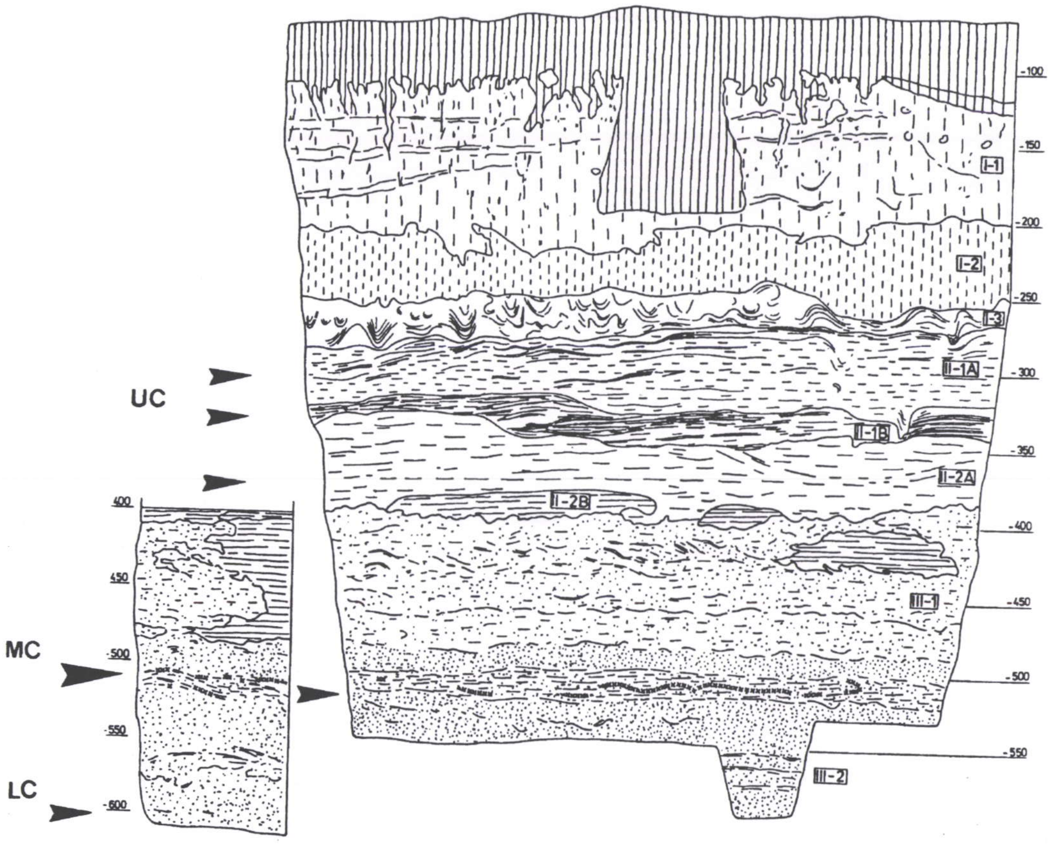


Figure 8. Western profile with Upper, Middle and Lower complexes.

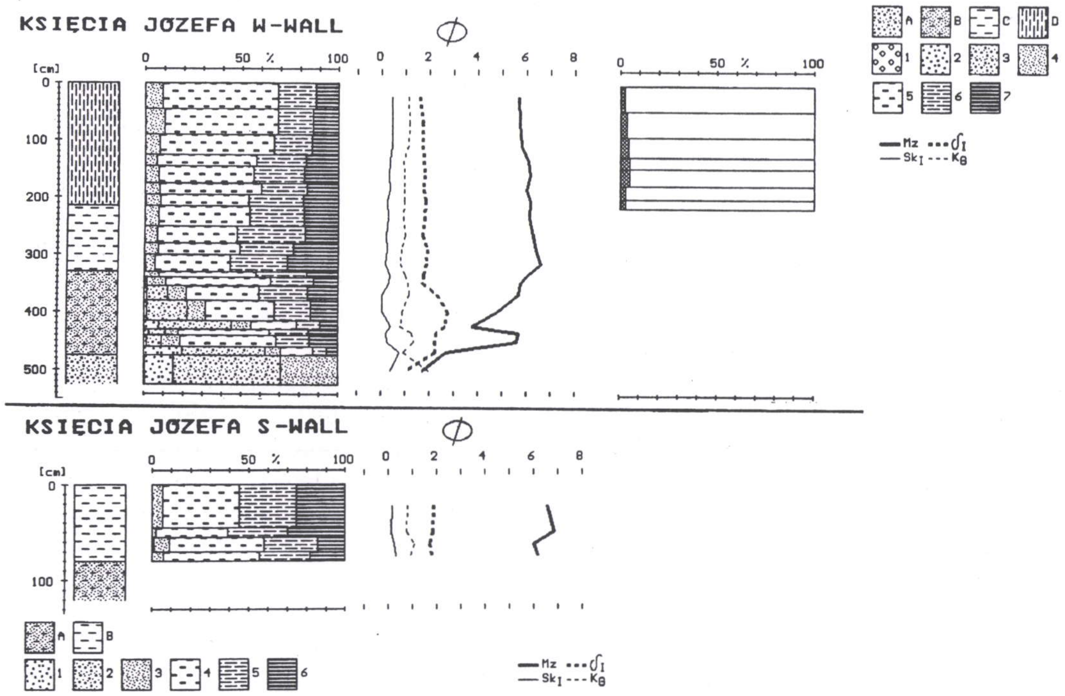


Figure 9. Grain size composition, Folk-Ward grain size distribution parameters and carbonate content : **I- W-wall**, A. medium sands; B. silty sands; C. silts; D. loess. Fraction : 1. gravel (below –φ); 2. coarse sand (-1-1φ); 3. medium sand (1-2φ); 4. fine sand (2-4φ); 5. coarse and medium dust (4-6φ); 6. fine dust (6-8φ); 7. clay (below 8φ). **II- S-wall**, A. silty sands; B. silts. Fraction : 1. coarse sands (-1-1φ); 2. medium sand (1-2φ); 3. fine sand (2-4φ); 4. coarse and medium dust (4-6φ); 5. fine dust (6-8φ); 6. clay (below 8φ).

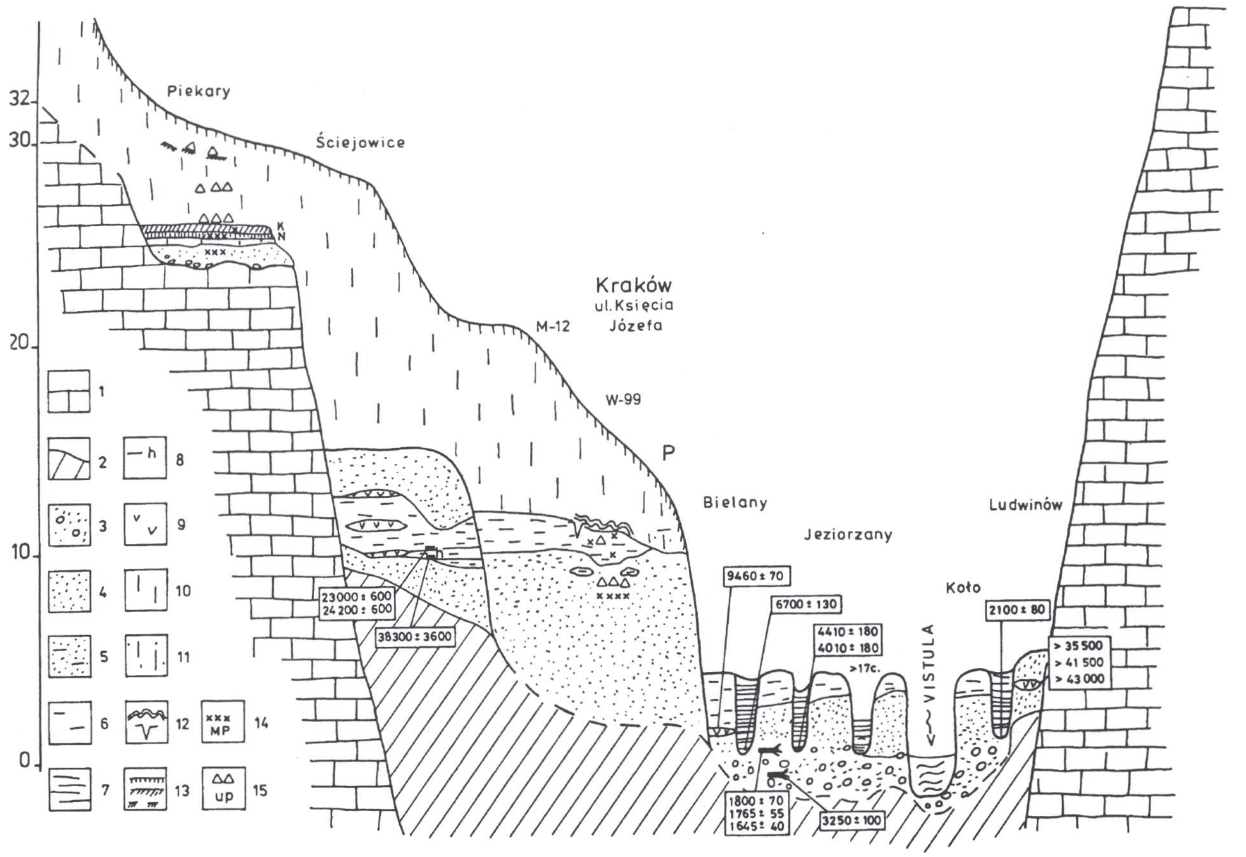


Figure 10. Schematic section across the Vistula valley in the Cracow Gate (by T. Kalicki) : 1. Jurassic limestone; 2. Miocene clay; Quaternary : 3. gravels with sands; 4. sands; 5. silty sands; 6. silts; 7. clays; 8. organic silts; 9. peats; 10. loess; 11. sandy loess; 12. cryoturbation; 13. buried soils; 14. Middle Palaeolithic cultural levels; 15. Upper Palaeolithic cultural levels.

Member III-2. Medium - and coarse - grained sands (Mz=1.7φ), yellow-reddish. Thickness of this member is 0.5 m. The Lower culture level occurs at the top of this member.

The uppermost part of the sandy series was accumulated by the braided river in cold climatic conditions (blocks cemented by permafrost) (Vistulian?). The terrace could be older than Early Vistulian and Older Pleniglacial based on elevation above the river. The Vistula terrace downstream of Cracow at the Trawniki site (TL dated to 69,000 ± 9,000 yrs BP, Gębica 1995) and at the Brzesko Nowe site (radiocarbon dated to older than 31,800 ± 700 BP, Gębica *et al.* 1998) is elevated only a few metres above the river, so it is much lower than the buried terrace at the Księcia Józefa site.

The overbank silty muds series probably accumulated during the Interpleniglacial, similar to other sites in the Vistula valley downstream from Cracow (fig. 10). This type of sediment was dated at these sites about 30,000 years BP (comp. Gębica *et al.* 1998). The riverbed level was relatively low at that time, documented by the abandoned channel fill at the Nowa Huta site. Flood water stagnated in the backswamps near the slope of the valley.

Cryoturbation at the base of the loess cover is associated with the Last Glacial Maximum and loess accumulation with the Younger Pleniglacial.

Lithic assemblages

Artefacts were generally made from local Jurassic flint of medium-sized, oblong, voluminous nodules of good or excellent quality (e.g. "chocolate" ? flint). Flint outcrops are local, within 1 km of the site but not directly at the site. One quartz pebble hammerstone and small grinding sandstone pebbles have been found.

The Upper complex is represented by a small flint assemblage (16 pieces, 14 of which are "fresh" - without patina, gloss or post-depositional damages). Artefacts came from different geological levels of Series II (silty muds). The lithic assemblage includes a large fragment of a pre-core or macro-tool (core-tool), 1 thermal fragment, 10 flakes (2 cortical, 1 semi-cortical, 1 bi-directional, 3 centripetal, 1 large rolled Levallois flake, 2 flake fragments), 4 blades (2 crested, 1 orthogonal and 1 unidirectional mesial fragment) (fig. 11, 12). However, this small collection evidenced two main reduction techniques - flake and blade production - which have no special stratigraphic and "evolutionary" significance. The assemblage is characterised by inter-stratification of Upper and Middle Palaeolithic debitage elements.

Flake production was probably initiated with a cortex removal (*décorticage)* stage, represented by flakes with developed bulbs, and plain and faceted platforms. Pre-forming of cores was achieved by removal of centripetal flakes. These are small, thin and asymmetrical; their platforms are similar. The deliberately produced blanks include a massive, wide centripetal flake with long wide dihedral platform (Levallois preferential flake - lineal method- fig. 11:1) and a smaller centripetal flake with a broken platform (Levallois?- fig. 11:2). All flakes, except one, were directly obtained by means of hard hammer percussion, confirmed by their well-developed bulbs, large and thick platforms and obtuse internal flaking angle. These flakes could have resulted from the exploitation of flat cores (e.g. Levallois) of Middle Palaeolithic type.

Blade production is evidenced by the presence of a distal fragment of a crested blade with two prepared slopes and another crested blade with one faceted, then abraded slope (fig. 12:1-2). Their initial position on the core could have been different, the first medial and the second medial or lateral. An orthogonal blade and an elongated flake with bi-directional regular dorsal pattern could indicate core pre-forming and/or their further re-preparation (fig. 12:4). A small mesial blade fragment is the only deliberately produced blank. Blank platforms are mostly broken. However, proximal ventral surfaces do not show pronounced bulbs, possibly indicating the use of soft hammer percussion. One centripetal flake was morphologically Levallois, but could not be linked to Levallois technology because of the "Upper Palaeolithic" character of its proximal part: the platform evidences intensive grinding, the bulb is absent, lip is present and the internal flaking angle is acute (fig. 12:3).

In sum, these debitage products are more characteristic for volumetric core exploitation and prepared blade production with crested blades and have no connection with the flat core reduction of Middle Palaeolithic type.

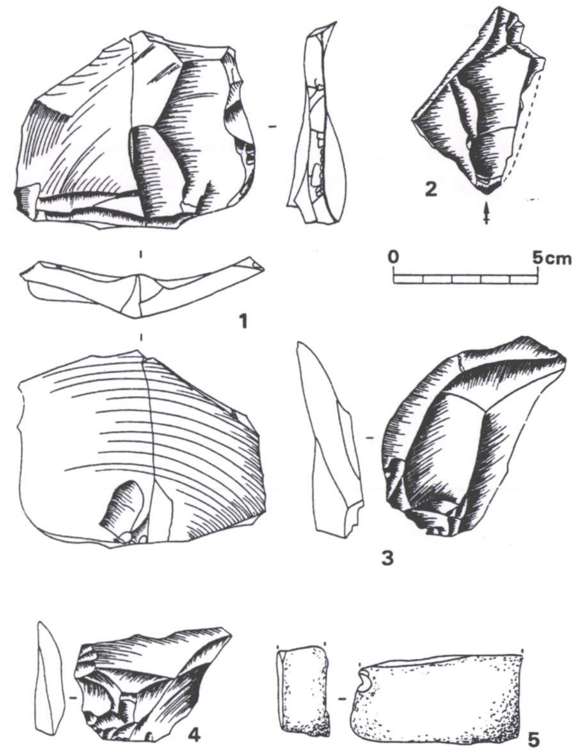


Figure 11. Upper complex. 1. Levallois flake (*Siret* accidental break); 2-4. centripetal flakes; 5. cortical flake.

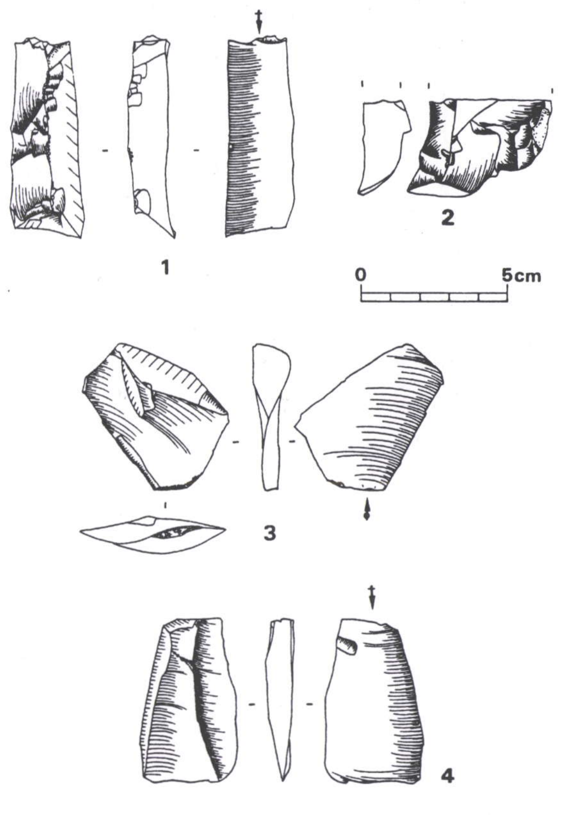


Figure 12. Upper complex. 1-2. crested blades; 3. centripetal flake with prepared, abraded platform and lip; 4. bi-directional flake.

The Middle complex is the most representative on the site and was discovered in member III-1 (silty sands) of Series III. The assemblage consists of 1560 artefacts. Altered items are rare : with patina (0.5%), gloss (0.5%) and some burnt flint (2%). The artefact composition (table 1) evidences the debitage aspect of this complex (fig. 13-22). Unlike the many workshops of this region, unworked and tested blocks of raw material are absent. It appears that local flint was tested elsewhere and transported to the site for reduction. All initial cores and core blanks destined for reduction were used for blade production. All technological categories are present. Different stages of core reduction could be distinguished - cortex removal (*décorticage*) or initial direct reduction, pre-forming, exploitation, rejuvenation and finally exhaustion or discard of cores. Metric differences (table 2) between maximum and minimum core sizes and the blades per core ratio (204 per 10) support the great intensity of core reduction.

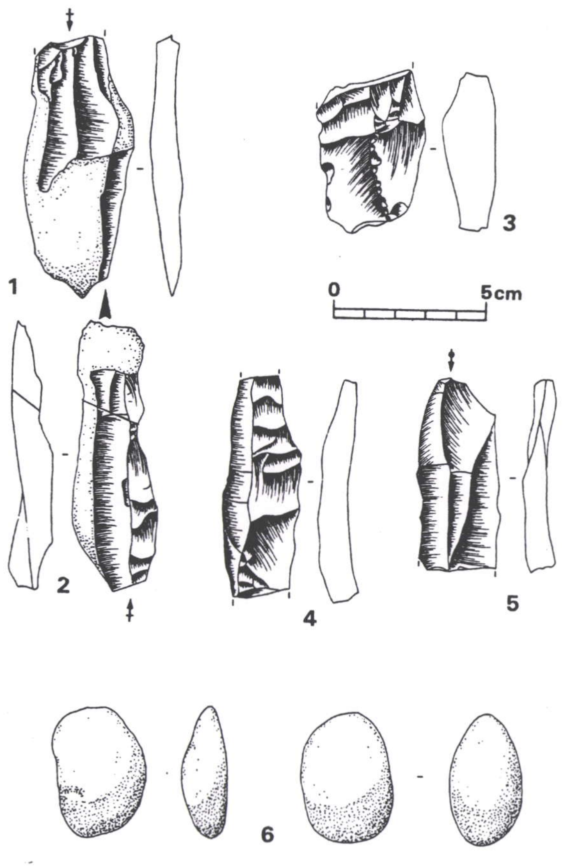


Figure 13. Middle complex. 1-2. refitted semi-cortical blades detached from bi-directional core; 3-4. crested blades; 5. final blade fragment; 6. abrading sandstone pebbles.

The cortex removal (*décorticage)* stage is attested by numerous cortical items, especially flakes (table 3). This fact and refitting flakes with cores exhibits the "flake character" of the initial stage. Blades are mostly semi-cortical and, with cortical back, were used to maintain the debitage surface. In one case (good quality, non-local "chocolate" flint), a core was not associated with refitted pieces. Debitage products, (including deliberately produced blanks) from this type of flint are rare. The core was clearly prepared outside the excavated area, probably at a previous occupation elsewhere. All flint artefacts confirm the use of blade production alone (with flakes corresponding to initial core preparation) which was based on two main *chaînes opératoires* :

1) reduction of nodule core;
2) exploitation of the narrow part of the flake.

Blade production from nodule cores is dominant in this complex (8 cores out of 10). Flint nodules are of medium size, rather oblong or cylindrical, with maximum parameters of 112 mm length, 52 mm width, and 58 mm thickness (table 2). Two types of core initialisation could be recognised :

1) direct exploitation, without core preparation;
2) with preliminary preparation of debitage surface by means of crest installation (fig. 13:2-4; 14).

Striking platforms were prepared by single removal (flat or plain platform), or sometimes by several large removals (prepared striking platform). They are situated perpendicular to the core debitage surface. Direct blade debitage started with detachment of the first elongated blanks and continued in the same manner to the stage of full reduction. The second method differs in preparation of the working surface by means of small transversal removals (flakes) to create crest(s). This procedure was often accompanied by careful abrasion of the crests. An initial crest was placed in the narrow part of a core blank or in postero-lateral position (fig. 17:1; 18; 19), in order to maintain blade debitage. Respectively, these produced double crested blades and partly prepared single-crested blades with one natural or cortical side. The main goal of the initial stage was to create the necessary flaking convexity and to prepared striking platforms without completely shaping the core (e.g. to the pre-form biface). Exploitation of direct and prepared debitage was achieved by parallel or slightly convergent methods, from one (unidirectional) or two,

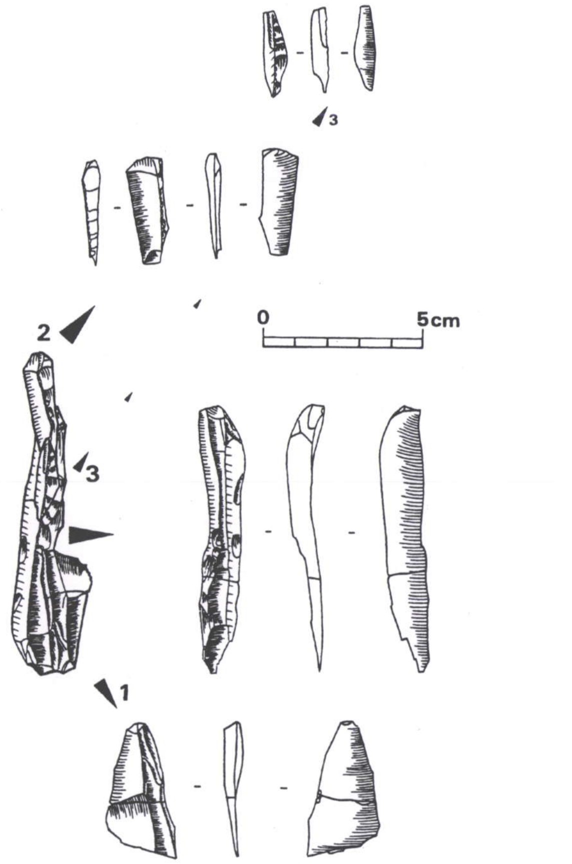


Figure 14. Middle complex : refitting of crested blades detached from bi-directional core.

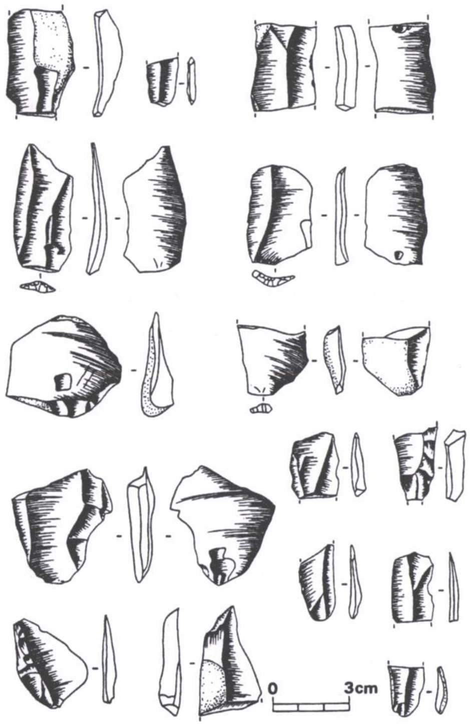


Figure 15. Middle complex : debitage products, blades and flakes from cortex removal and core preparation stages.

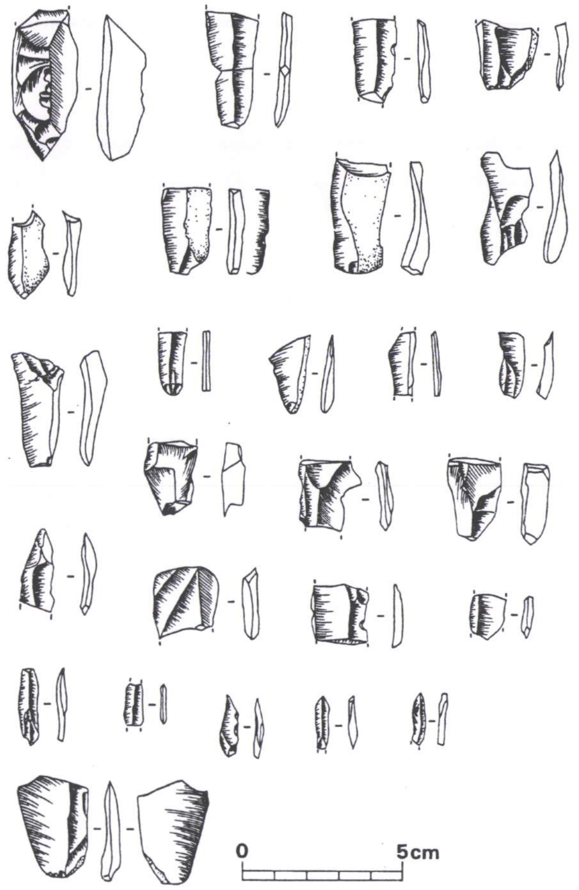
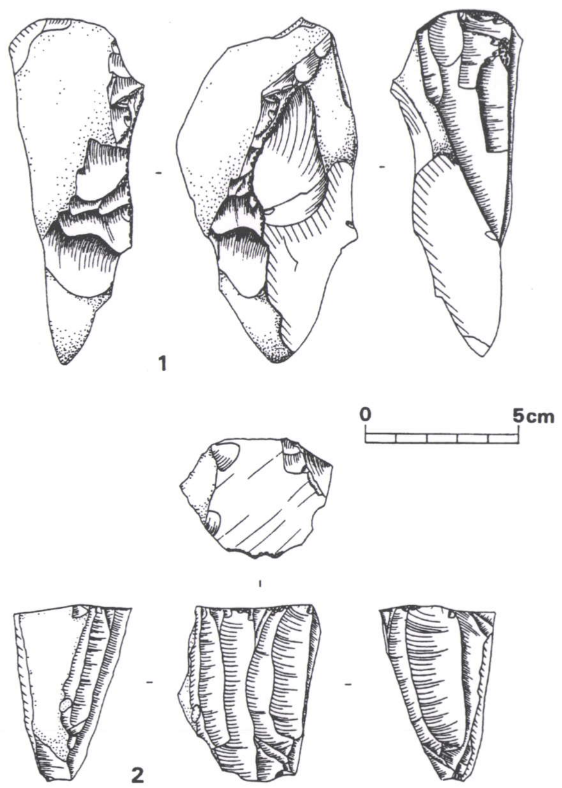


Figure 16. Middle complex : debitage products, blades, bladelets and flake from cortex removal and core preparation stages.

opposed (bi-directional) platform(s). The unidirectional method (5 cores) was used to obtain medium- and small-sized blades (fig. 17). The bi-directional method was attested by 5 larger cores and tended to produce medium-sized narrow blades (fig. 18-22). Metrical core data evidenced two independent methods : unidirectional and bi-directional. These cores do not show one reduction sequence. Exploitation from two opposed platforms permitted longer maintenance of working surfaces and the elimination of numerous accidents (e.g., hinge fractures).

Blade breakage occurs very often (only about 20% of blades are complete). Technical accidents are due to the rather high elongation and thinness of blades, according to the raw material potential, while "post-depositional effects" could be responsible for a high level of breakage. At first glance, blade fragments look like non-modified debris; deliberate segmentation is much less probable. It seems that complete blades and especially final blanks of "chocolate" flint were exported.



N° 274, D2 / 38 : prepared partially turned blade core (fig. 17:1)
Initial block : nodule.
Volume; shape : voluminous, broken.
Sizes according to working surface : 112 mm ; 52 mm ; 58 mm.
Raw material : brown flint.
Quality : good, crystal inclusions.
Alteration : thermal fracture.
Reduction stage : initial.
Shaping out : postero-lateral crest.
Striking platform(s) : flat with rest of cortex.
Striking platform angle : acute.
Left side : cortex, natural flat area, unidirectional debitage, partial crest.
Right side : thermal fracture and one unidirectional hinge removal.
Distal part : naturally pointed.
Back : cortical and postero-lateral crest.
Working surface(s) : unidirectional convergent.
Localisation : on the narrow part.
Shape and sizes of working surface : triangular (74 mm x 39 mm).
Convexity : a) longitudinal : convex;
b) transversal : convex;
c) accidents : 2 hinge fractures on the working surface.
Last visible products : large previous negative and small blades.
Maintenance / rearrangement : elimination of overhang (faceting and abrasion).
Discard / termination of debitage : thermal fracture, crystal inclusions, hinge fractures.

Figure 17. Middle complex : unidirectional partially turned blade cores.

N° 273, D2 / 44: non-prepared partially turned blade core (fig. 17:2)
Initial block : small nodule.
Volume; shape : voluminous.
Sizes according to working surface : 62 mm ; 50 mm ; 39 mm.
Raw material : chocolate flint.
Quality : very good.
Reduction stage : full debitage.
Shaping out : not visible, direct exploitation (?).
Striking platform(s) : natural flat with isolated small removals.
Striking platform angle : acute.
Left side : cortical and unidirectional working surface.
Right side : unidirectional (?) working surface.
Distal part : thinning.
Back : natural flat and one unidirectional hinge negative (?) / natural damage .
Working surface(s) : unidirectional (initially bi-directional?).
Localisation : on the wide part and both sides.
Shape of working surface : trapezoidal.
Convexity : a) longitudinal : slight convex;
b) transversal : convex;
c) accidents : 2 hinge fractures.
Last visible products : small blades; **order :** resumption of debitage from both sides to the centre.
Maintenance / rearrangement : by means of debitage and elimination of overhang (abrasion).
Discard/termination of debitage : hinge fractures (?), needs satisfied ?.(appearance after discard is well-prepared!).

Direct (unprepared) debitage was achieved according to the recurrent principle of blade production following the natural convexities of the flint nodule and by means of guide ridges (resulting from the consecutive sequence of blade removal). Maintenance and re-preparation of the flaking surface was due to the removal natural backed blades. The extension of debitage (direct and prepared) went from the narrow part of a core to one or both sides (*flancs*).

Preliminary examination of eight non-exhausted cores and refittings displays various modes of core exploitation (fig. 23) :

I. Direct, unidirectional exploitation: from the large side via a narrow working surface (1 narrow core);
II. Direct unidirectional exploitation: from 2 narrow sides via the centre of a large working surface (1 large core);
III. Direct, bi-directional exploitation: extension from a narrow bi-directional to a large bi-directional working

surface (2 narrow cores);

IV. Prepared (lateral crest(s)) unidirectional exploitation of narrow cores: from one side to another and back (2 narrow cores);

V. Prepared (postero-lateral crests only) bi-directional exploitation: from the narrow side via a large working surface to the next side and back (?), or from two sides to the large working surface (1 large core);

VI. Prepared (lateral crest) bi-directional exploitation of a flake core: from the dorsal face to a narrow working surface on the side (1 narrow core).

Partially turned bi-directional core exploitation with a narrow working surface was more common. Flat cores are absent. Exploitation of the volume and not of the surface of the initial block is clear. Continuation/maintenance of debitage was made by means of semi-cortical blades (e.g. dorsal cortex) as well as by neo-crested blades in postero-lateral position. Striking platforms were restored by elimination of overhang (retouching and/or abrading) and by partial tablets.

The final stage - exhausted cores - was represented only by two cores. Abandoned cores were still rather large and could have still been used, based on the volume remaining. Reduction was terminated because of numerous hinge fractures and sometimes because of crystal inclusions in the raw material. Some cores do not display any technical accidents or failures and blade production on these cores was intentionally terminated during initial or full debitage stages due to unknown reasons.

The technique is characterised by the use of a hard hammerstone (especially for flake removal during core preparation) as well as soft hammerstone (sandstone, cortical flint). Use of soft stone hammers could be seen on many ordinal flakes during initial and re-preparation stages of core reduction (diffused bulb-28%, presence of lip-9,4%) but more often for blade extraction (diffused bulb-41%, presence of lip-16%) (table 5).

As for debitage, only two small abrading sandstone pebbles were found, used for preparation/re-preparation of striking platforms and crests (e.g. to eliminate the overhang) (fig. 13:6).

Final products (i.e. blades), which were found during excavation are medium to small size. They are rather narrow, thin and elongated (table 2). Their elongation would be more important if they had not been broken (Elongation Index = >263). Negatives on the working surfaces of some cores suggest that exported (?) blades were bigger and narrow.

Platforms created with a single blow (flat, linear and pointed) and prepared (with several negatives and faceting and abrasion) were common and occurred nearly in the same proportions (table 5). Cortical (non-prepared) and dihedral platforms are rare.

Blade shapes are mostly rectangular (with parallel sides) and irregular, less triangular, oval (bi-convex sides) and trapezoidal (with divergent sides) (table 6).

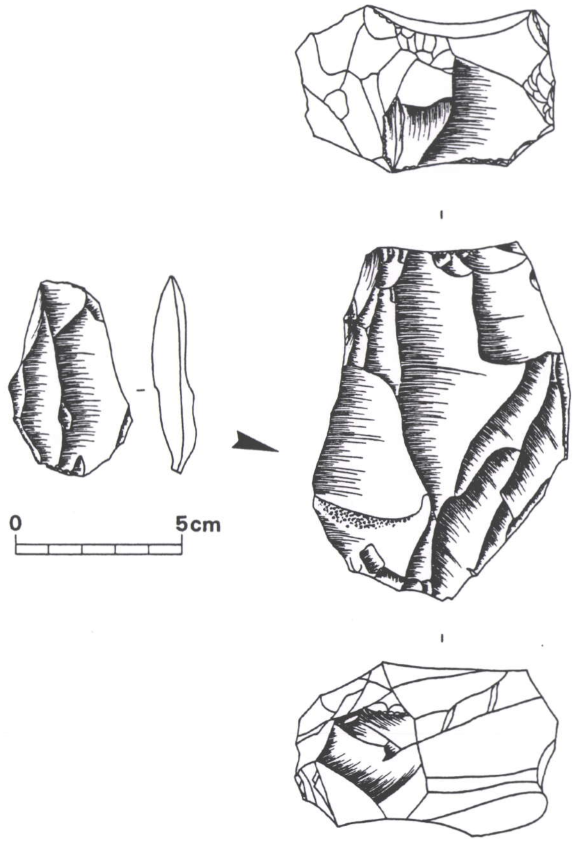
Blade profiles are mostly straight (51%) and convex (table 7); sections are triangular and trapezoidal (table 8).

44 (28%) bladelets are present. However, no bladelet cores were found. Bladelet debitage could have resulted from reduction of two small, exhausted cores or taken place in another part of the site, or resulted partly from blade production. The presence of two crested bladelets display, however, "independent" bladelet *chaînes opératoires*, which cannot yet be reconstructed.

All methods of blade production of the Middle complex clearly show the absence of Levallois technology or any other reduction techniques of Middle Palaeolithic type. The blade production concept (direct or prepared) was based on exploitation of the volume of the initial core, rather not exploitation of the surface, and was based on bi-directional/unidirectional, partially turned core reduction. Blade/bladelet (?) production of this complex is of Upper Palaeolithic type and is not accompanied (at least in the area excavated) by any Middle Palaeolithic technologies.

Retouched tools (= 4) are rare : a denticulate, a perforator, a scaled piece and an end-scraper/retouched fragment.

The Lower complex is represented by 248 stone artefacts (all of flint with one quartz pebble hammerstone), which were found at the top of Member III-2, 6 m below the modern surface. Lithic materials are fresh (95.9%), with rare patinated pieces (0.4%) and burnt flint (0.1%). The assemblage structure evidences debitage activity (table 1). Cortical pieces (table 3) show that cortex removal and preparation of flake debitage also



N° 272; C2 / 1: prepared partially turned blade core (fig. 18 and 19)
Initial block : nodule ?, fragment ?
Volume, shape : voluminous, sub-quadrangular.
Sizes according to working surface : 107 mm length, 73 mm width, 55 mm thickness.
Raw material : grey flint (Jurassic).
Quality : good with crystal inclusions.
Reduction stage : full debitage.
Shaping out : rest of 2 postero-lateral crests.
Striking platform(s) : 1st and 2nd prepared.
Striking platform angle : 1st- right; 2nd- acute.
Re-preparation of striking platform(s) : 1st- partial tablet and abrasion; 2nd- partial tablet.
Left side : working surface and lateral crest.
Right side : working surface and lateral crest.
Distal part : striking platform.
Back : big negative of one flake.
Working surface(s) : bi-directional.
Localisation : on the wide part and on 2 sides.
Shape and sizes of working surface : sub-quadrangular (size = initial block).
Convexity : a) longitudinal : ± flat;
b) transversal : convex, ≈ quadrangular;
c) accidents : hinge fractures.
Last visible products : big and medium size blades.
Maintenance / rearrangement : working surface maintained by debitage; sides by neo-crest installation; elimination of overhang (faceting and abrasion).
Discard / termination of debitage : hinge fractures.
Commentary : refitting with 1 flake.

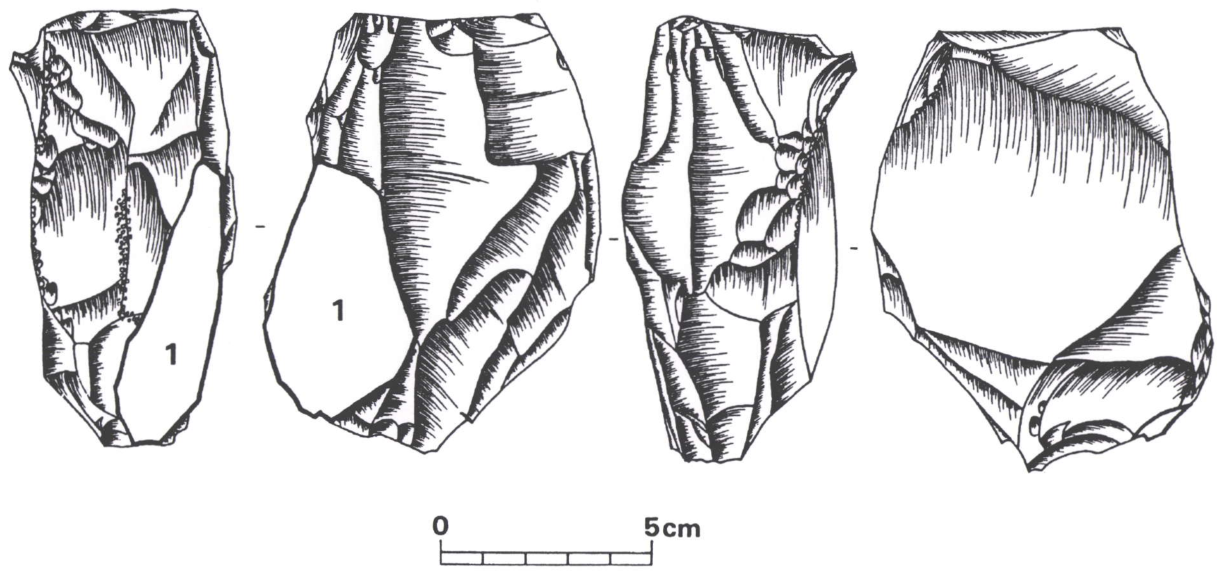


Figure 18 and 19. Middle complex : bi-directional partially turned blade core with refitted flake (1).

occurred. However, initial core blanks and tested blocks of flint are absent. Two main types of blank production can be distinguished : 1) flakes (numerous); 2) blades (rare).

Debris and blanks (table 1) which could be refitted reveal the use of different methods of flake production.

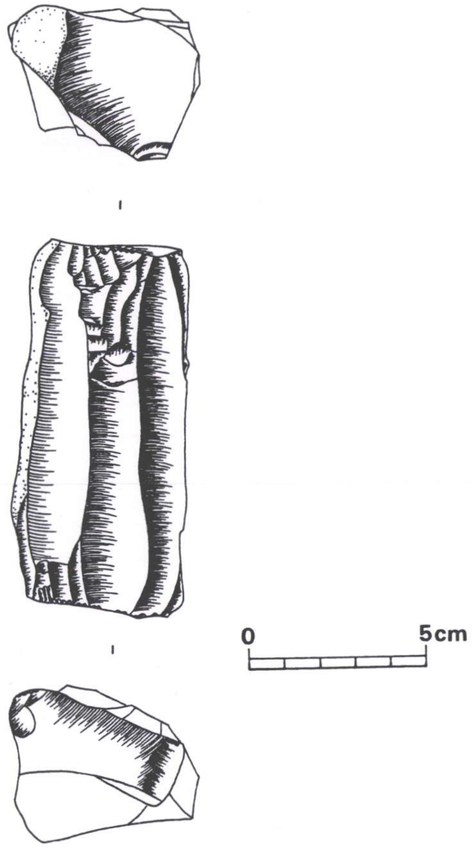


Figure 20. Middle complex : bi-directional partially turned blade core.

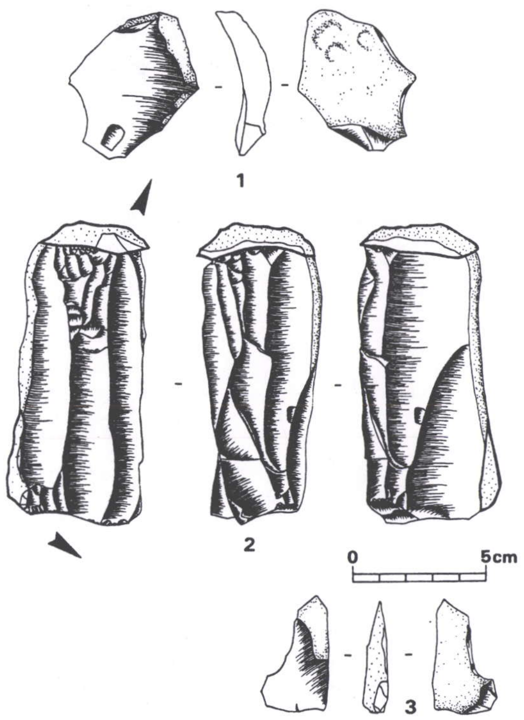


Figure 21. Middle complex : bi-directional partially turned blade core with refitted initial tablet (1) and decorticated flake (2).

N° 275, E3 / 2: non-prepared partially turned blade core (fig. 20 and 21)
Initial block : nodule.
Volume; shape : voluminous, cylindrical.
Sizes according to working surface : 104 mm ; 51 mm ; 55 mm.
Raw material : grey-white flint.
Quality : good + crystal inclusions.
Alteration : light patina.
Reduction stage : full debitage.
Shaping out : not visible, direct exploitation (?).
Striking platform(s) : 1st and 2nd flat and wide (see refitted initial tablet fig. 21:1)
Striking platform angle : 1st and 2nd right
Re-preparation of striking platform(s) : elimination of overhang by abrasion and faceting. **Left side :** minimum cortical; bi-directional working surface.
Right side : minimum cortical; bi-directional working surface.
Distal part : second striking platform.
Back : cortical and one negative of cortex removal (see refitting of cortical flake fig. 21:3).
Working surface(s) : bi-directional.
Localisation : on the narrow part and on sides.
Shape of working surface : quadrangular.
Convexity : a) longitudinal : flat;
b) transversal : convex;
c) accidents : hinge fractures.
Last visible products : big and medium blades; **order :** from narrow part to sides.
Maintenance / rearrangement : not visible or by means of debitage.
Discard / termination of debitage : hinge fractures; flat working surface.
Commentary : refitting with two flakes : from cortex removal stage and preparation of the striking platform.

Biconical centripetal (Sitlivy 1996, 126-127) or discoid (Boëda 1993) reduction is attested by a large core with numerous characteristic flakes and refitted flakes. Debitage is based on an irregular nodule. Removal of cortex and exploitation was done simultaneously by an alternating centripetal method; the angle of percussion is secant according to the core's working surfaces. A peripheral striking platform is represented by large flat and dihedral negatives. Working surfaces were used alternately, also as striking platforms to obtain flakes. The result of debitage are short, large and massive flakes (often *débordant*) with flat and crudely prepared platforms (fig. 24; 25; 26:1, 3-5) (table 5). One core reflects the initial stage of exploitation (fig. 27:1), while another is more reduced (fig. 27:2).

Unidirectional debitage is based on recurrent and repeated exploitation of oval or round nodules, often from prepared striking platform(s) which are flat, large and dihedral. Flakes and some blades with cortical, semi-cortical and unidirectional dorsal patterns and with prepared (flat and dihedral) platforms (fig. 26:2, 6) could have resulted from any of several methods :

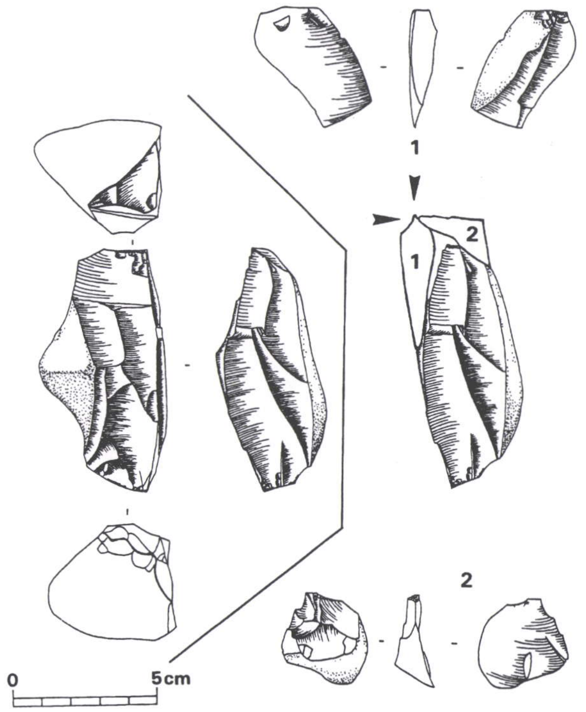


Figure 22. Middle complex : bi-directional partially turned blade core with refitted semi-cortical flake (1) and tablet (2).

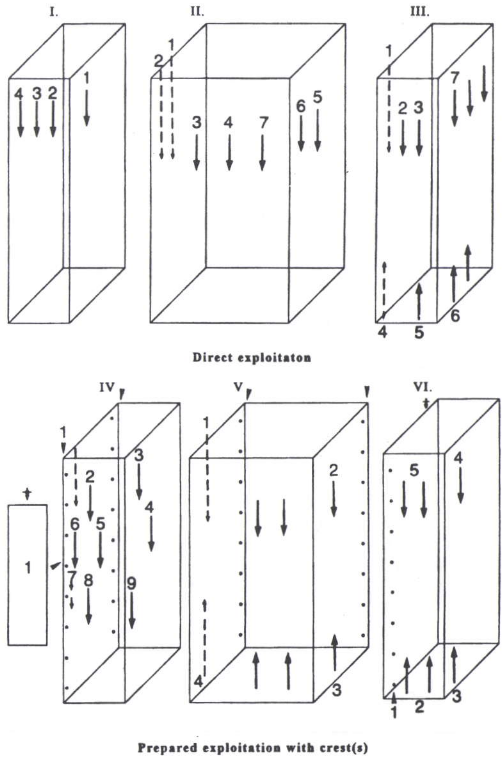


Figure 23. Middle complex : various modes of core exploitation.

N° 266, D2 / 15: non-prepared partially turned blade core (fig. 22)

Initial block : nodule
Volume; shape : voluminous, irregular.
Sizes according to working surface : 84 mm ; 45 mm ; 49 mm.
Raw material : brown flint.
Quality : good.
Reduction stage : initial.
Shaping out : not visible, direct exploitation(?).
Striking platform(s) : 1st and 2nd prepared.
Striking platform angle : 1st and 2nd acute.
Left side : cortical.
Right side : bi-directional working surface.
Distal part : second striking platform.
Back : cortical.
Working surface(s) : bi-directional.
Localisation : on the narrow part and on the right side.
Shape of working surface : quadrangular.
Convexity : a) longitudinal : convex;
b) transversal : convex;
c) accidents : hinge fractures.
Last visible products : medium blades; hinged flakes; **order :** from narrow part to right side.
Maintenance / rearrangement : none or by debitage (itself) and with abrasion and facetting.
Discard / termination of debitage : hinge fractures
Commentary : refitting with one tablet and semi-cortical flake.

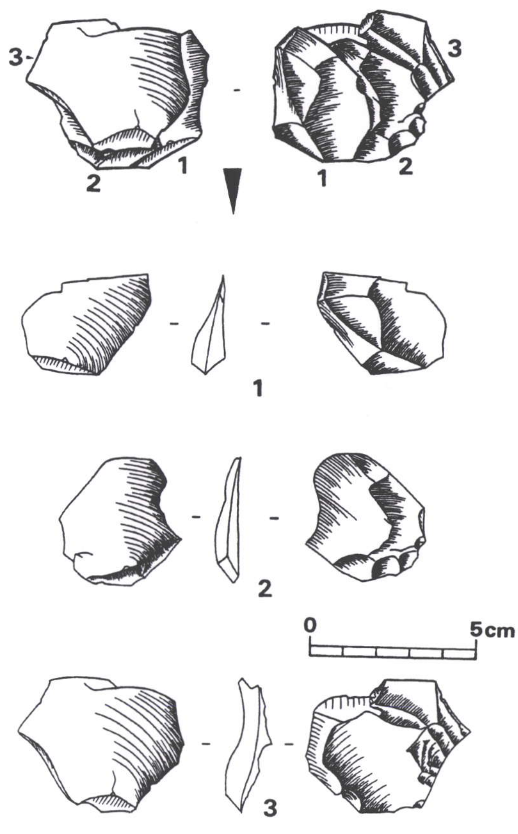


Figure 24. Lower complex : refitting of massive short flakes obtained from centripetal core.

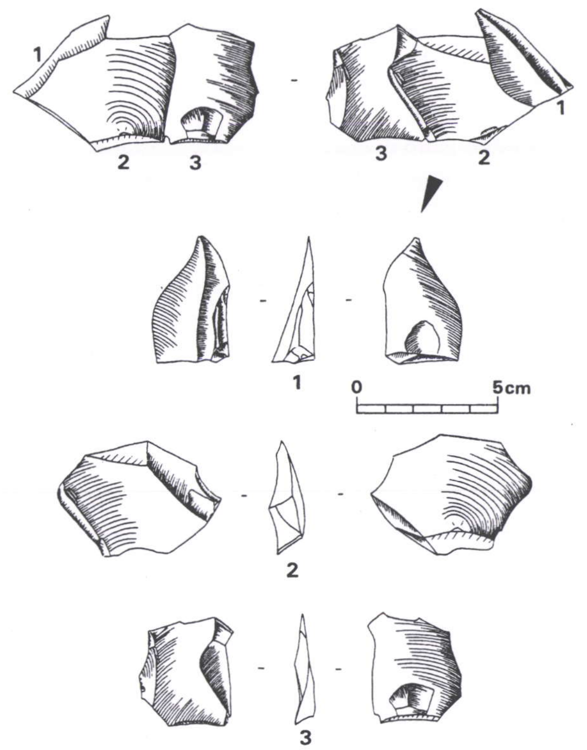


Figure 25. Lower complex : refitting of massive short flakes obtained from centripetal core.

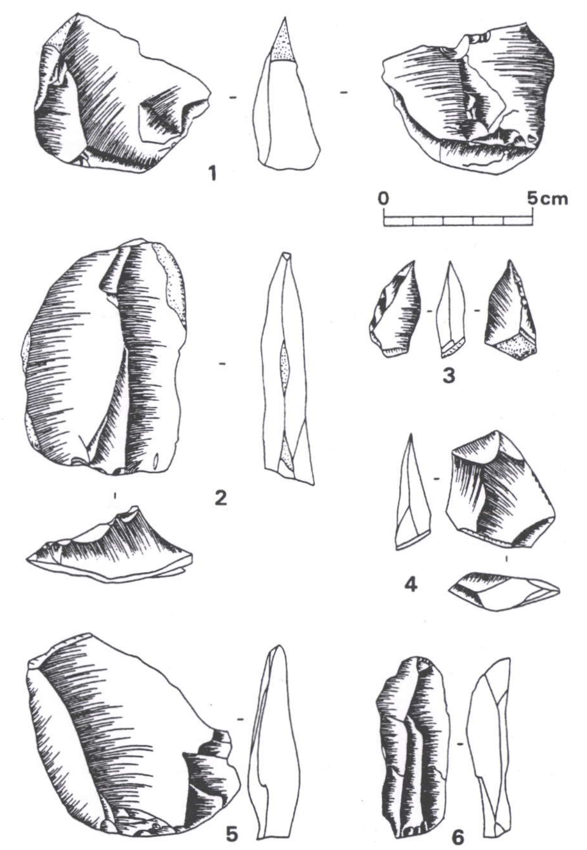


Figure 26. Lower complex : massive debitage products; 1, 3, 4, 5. centripetal, *débordant* flake; 2. unidirectional flake; 6. blade.

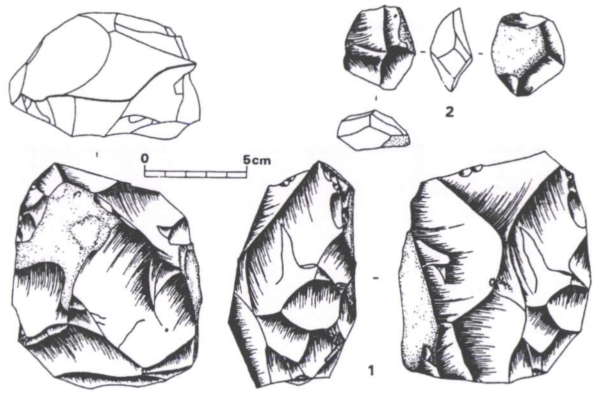


Figure 27. Lower complex : 1. centripetal biconical (discoid) core; 2. reduced centripetal biconical core.

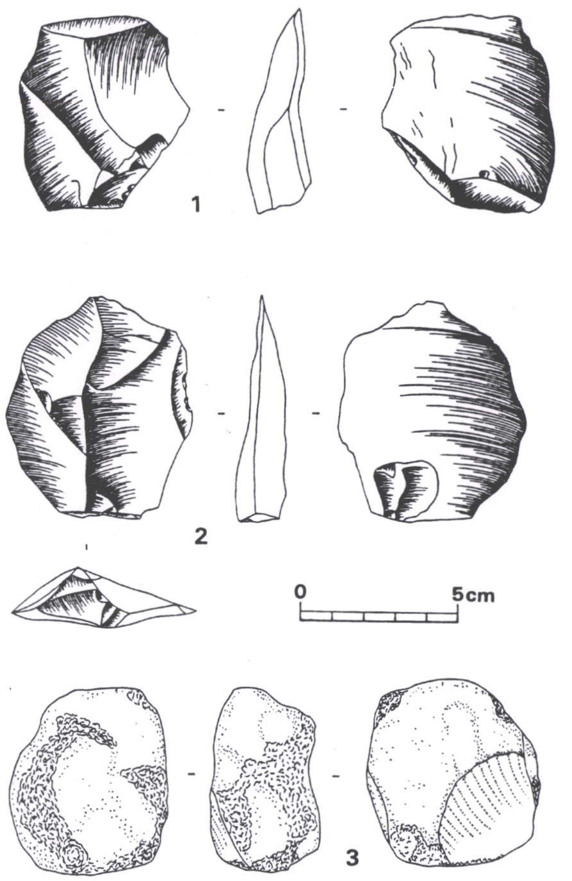


Figure 28. Lower complex : 1-2. massive centripetal flakes (Levallois?); 3. quartzite hammer stone.

a) "sausage slice" in the case, for example, of large flakes with cortical back;
b) unidirectional (based on recurrent flat cores);
c) stage of cortex removal by other method(s).

Levallois (?) debitage is attested only by two preferential, massive flakes with centripetal pattern

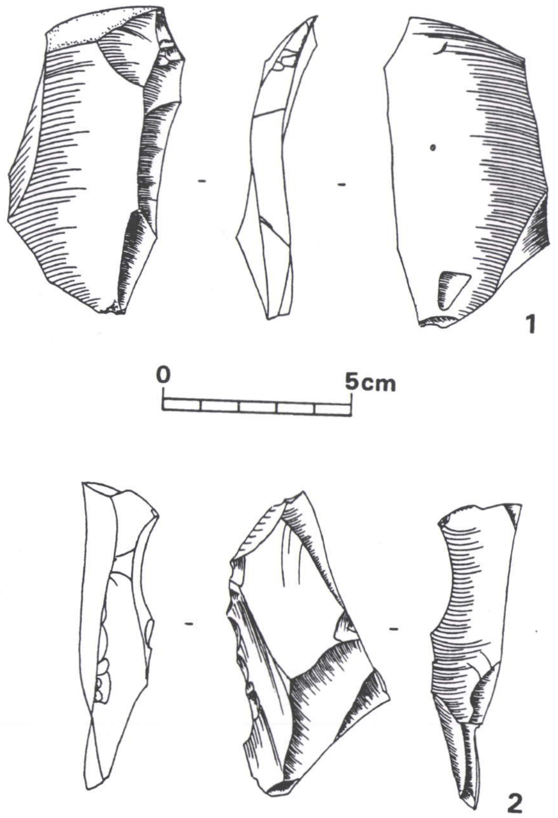


Figure 29. Lower complex : flakes tools. 1. naturally backed knife; 2. denticutate tool.

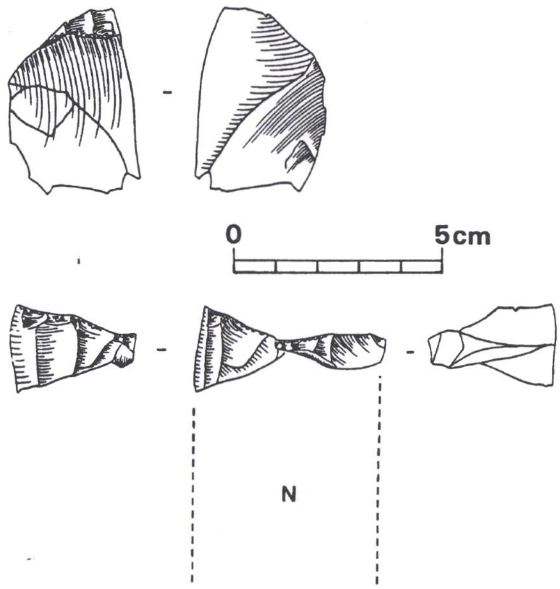


Figure 30. Lower complex : refitting of two partial tablets detached from blade/bladelet core.

and dihedral/crudely prepared platforms (fig. 28:1-2). However, these products could have resulted from non-Levallois centripetal debitage.

Debitage from massive flake is represented only by one pre-core. Further exploitation could have used centripetal (?) or Kombewa (?) methods.

Thus, flakes and some occasional blades with different dorsal pattern (centripetal, convergent, unidirectional) (table 4) could be the result of a centripetal conical/biconical method and probably from other methods. More artefacts are needed to identify these methods.

The debitage technique used direct percussion by means of a hard hammerstone (fig. 28:3) : the bulb is pronounced on 86% of the artefacts, platforms are large, proximal parts are massive and the platform angle is mostly obtuse (>81%) (table 5). Final products (i.e. flakes with or without cortex) were rarely transformed in denticulate or notched tools and naturally backed knife (fig. 29). Technology and flake reduction techniques are of Middle Palaeolithic type.

Some blades (16) and bladelets (4) could possibly have resulted from Middle Palaeolithic flake technology(-ies). However, refitting of two partial tablets with abraded overhang (fig. 30) indicates volumetric core exploitation. At present, we can only identify the presence of Upper Palaeolithic technology without any details.

Comparisons

As geological and technological comparative analyses are still in progress, little can be said at this point about similarities of these new complexes with other industries of the region. If future analyses confirm an age of earlier than the Upper Palaeolithic for these complexes, the Księcia Józefa site will be one of the rare Central European sites with advanced blade technology.

However, parallels in lithic technology (among published sites in Southern Poland) can be seen with the Piekary IIa Middle Palaeolithic complexes (Morawski excavations, Morawski 1992; Kozłowski and Kozłowski 1996). A combination of several Middle Palaeolithic debitage methods (Levallois and non-Levallois centripetal) with Upper Palaeolithic blade production occurred in the lower 7c and, more rarely, in the 7b and 7a complexes, which is the case for the Lower and Upper complexes at Księcia Józefa.

Regarding the Middle complex, no close analogies are as yet observable in Central Europe. Exclusive blade debitage of Upper Palaeolithic type (without Middle Palaeolithic components) is known from some small collections (early Weichselian and Saalien) in north-west Europe : Rocourt (Otte *et al.* 1990), Saint-Valéry-sur-Somme (Heinzelin and Haesaerts 1983) or rarely in Ukraine: Korolevo II, layer II; Korolevo I, layer Ia; (Gladilin and Demidenko 1989).

A brief examination of blade technology at Księcia Józefa displays similarities with the north-west European Middle Palaeolithic record (e.g. sites in the valley of the Vanne, Burgogne with blade debitage which can be attributed to the early Weichselian and to the lower or middle Pleniglacial) (Locht and Depaepe 1994), as well as with some Upper Palaeolithic technocomplexes in the Cracow region. However some examples of the partially turning blade debitage of the Upper Palaeolithic type across Eurasia expresses the "non-chronological" value of core morphology and their reduction from the Early Middle Palaeolithic to the Mesolithic (fig. 31, 32).

Future geological investigation will clarify the chronostratigraphy of the site.

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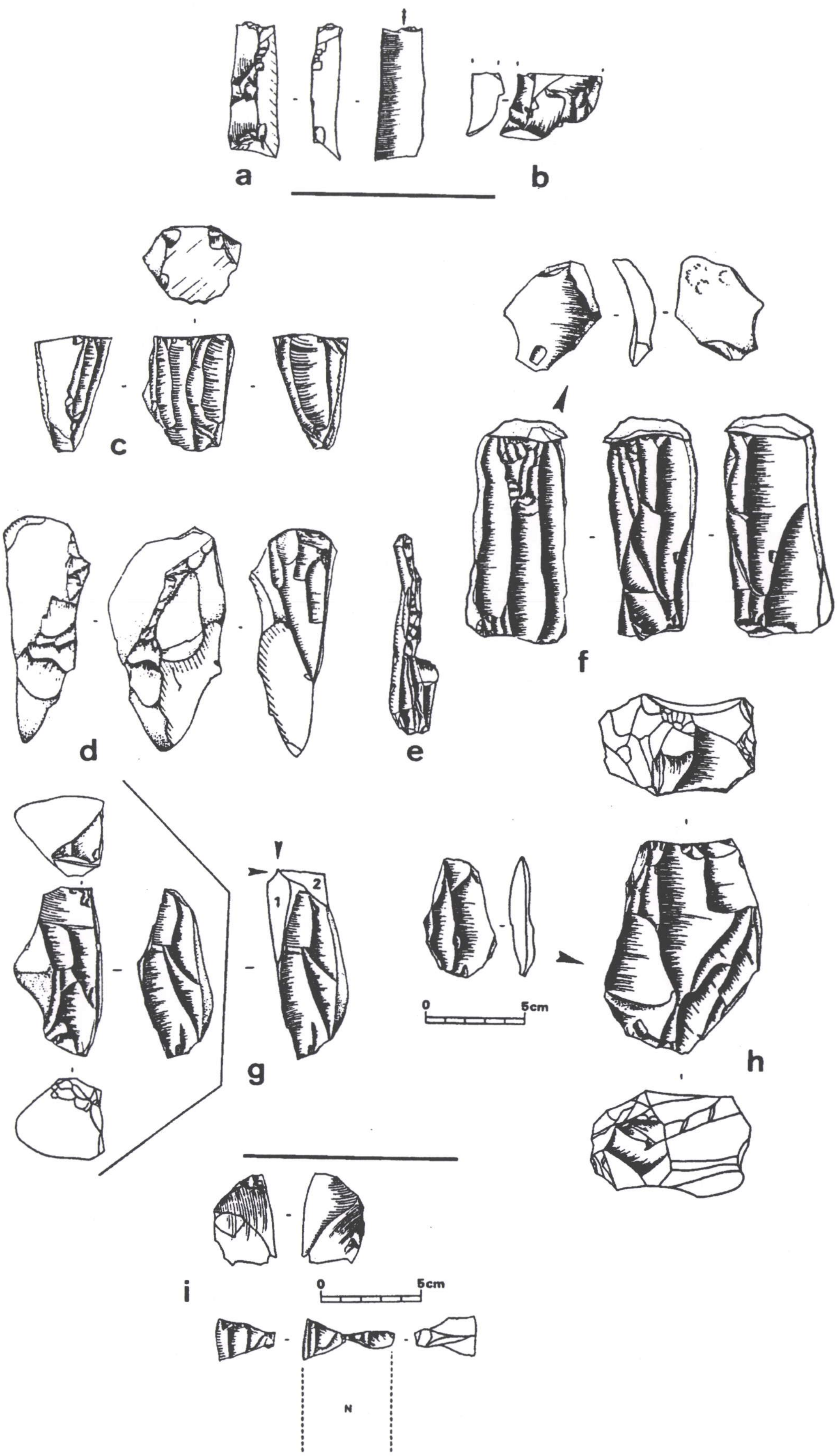

Figure 31. Księcia Józefa. Blade debitage : Upper complex (a-b); Middle complex (c-h); Lower complex (i).

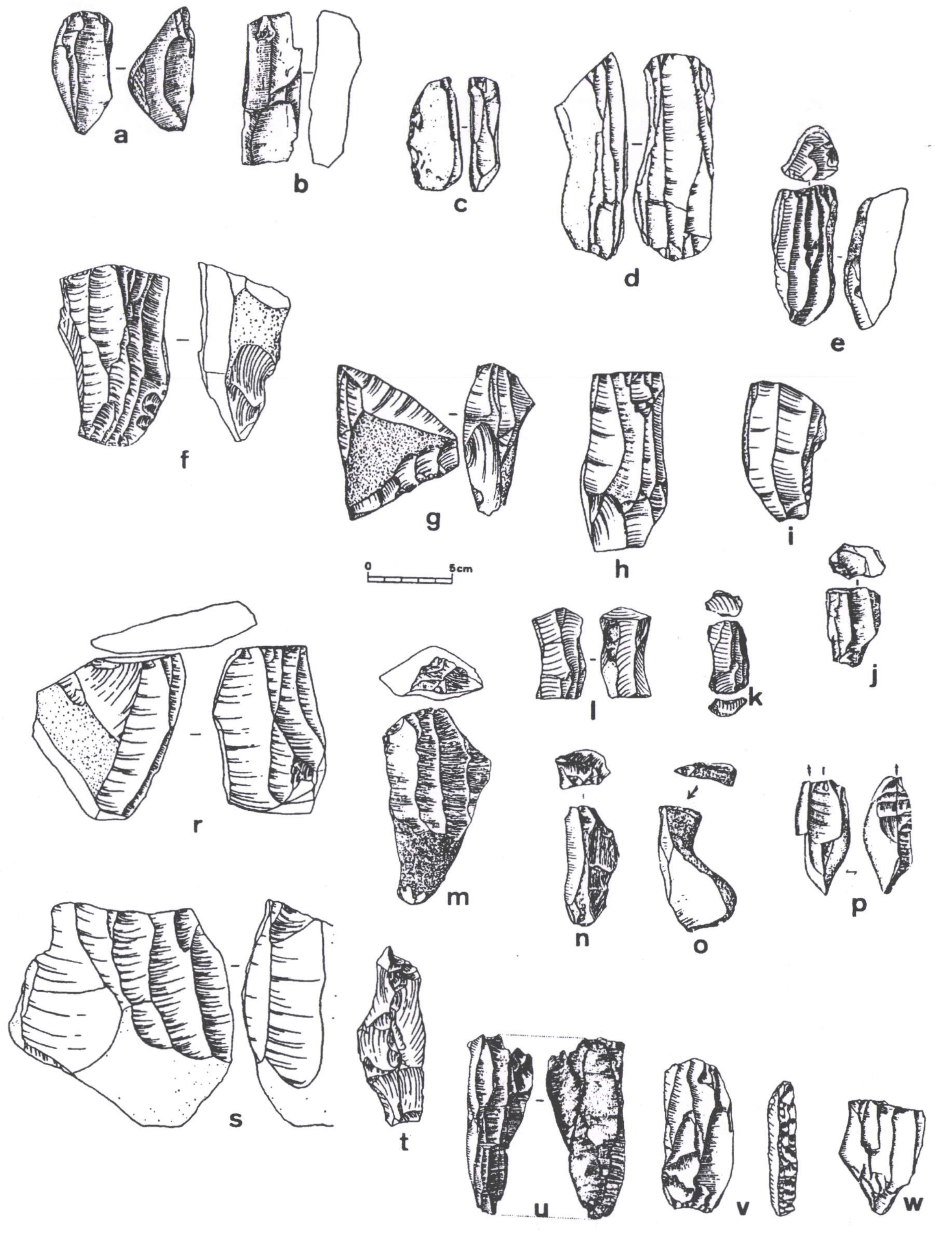

Figure 32. Palaeolithic blade debitage. **Hamburgian**: Mirkowice 33 (a) (Kabaciński *et al.* 1999); **Bromme-Lyngby Culture of Alleröd/Younger Dryas**: Bierzwnik 3 (b) (Bagniewski 1977); **Magdalenian**: Brzoskwinia (c-d) (Dagnar-Ginter *et al.* 1976); **Gravettien**: Spadzista B1 (e); **Upper Palaeolithic workshop**: Piekary IIa, layer 5 (f); **Cracow Aurignacian**: Zwierzyniec I (g), Bronislawa Hill (h), Sowiniec I/II (i) (Sachse-Kozłowska 1978); **Chatelperronien**: Roc de Combe, layer 8 (j) (Pelegrin 1995); **Middle Palaeolithic of the Weichselian and lower/middle Pleniglacial**: Lailly (m, n), Villeneuve (o) (Locht *et al.* 1994); Piekary IIa, layer 7a (r), Saint-Germain-des-Vaux (l), Seclin (k) (Révillion 1994); Rocourt (p) (Otte *et al.* 1990); **Early Middle Palaeolithic**: Piekary IIa, layer 7c (s, t), Saint-Valéry-sur-Somme (u) (Heizelin *et al.* 1983), Rissori (v) (Adam, 1991), Tabun D (w) (Sitlivy 1995b).

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	Middle Complex	Lower Complex
Blade cores	10 / 0.6%	
Flake cores		2 / 0.8%
Flakes	179 / 11.4%	116 / 46.7%
Blades	204 / 13%	16 / 6.4%
Bladelets	44 / 2.8%	4 / 1.6%
Broken blanks	11 / 0.7%	
Chips and small flakes (<20mm)	1093 / 70%	105 / 42.3%
Small angular debris	10 / 0.6%	1 / 0.4%
Retouched tools	4 / 0.2%	3 / 1.2
Abraded pebbles	5 / 0.3%	
Hard hammerstone		1 / 0.4%
TOTAL	**1560**	**248**

Table 1. Lithic artefact class.

		Middle complex	Lower complex
		(length-width-thickness in mm.)	
Cores	max	112 - 52 - 58	117 - 94 - 66
	min	38 - 32 - 17	40 - 36 - 20
	average	86 - 47.1 - 49.6	
Flakes	max	86 - 46 - 22	88 - 93 - 29
	average	32.8 - 31 - 8.4	38.9 - 38 - 10.9
	Elongation index (L / W% retio)	105.8	111
	Massivity index (T / L% retio)	25.6	28
Blades	max	>102 - 26 - 10	71 - 35 - 15
	average	>57.2 - 22.4 - 8.2	40.7 - 18.3 - 8.8
	max width	40	35
	max thickness	22	15
	Elongation index	>263	222.2
	Massivity index	14.3	21.6

Table 2. Metrical data and indexes.

	Middle Complex			Lower Complex		
	Flakes	Blades	Bladelets	Flakes	Blades	Bladelets
Cortical	16 / 10.9%	4 / 1.9%		9 / 9.6%		
Semi-cortical	25 / 17.1%	23 / 11.3%	3 / 6.8%	17 / 18.2%	1 / 6.2%	
Backed cortical	6 / 4.1%	22 / 10.8%		8 / 8.6%	3 / 18.7%	1 / 25%
Min. cortex	29 / 19.8%	34 / 16.8%	3 / 6.8%	18 / 19.3%	1 / 6.2%	
Non cortical	70 / 47.9%	119 / 58.9%	38 / 86.3%	41 / 44%	11 / 68.7%	3 / 75%
TOTAL	**146 / 99.8%**	**202 / 99.7%**	**44 / 99.9%**	**93 / 99.7%**	**16 / 99.8%**	**4 / 100%**

Table 3. Debitage classes by type of reduction.

	Middle Complex			Lower Complex		
	Flakes	Blades	Bladelets	Flakes	Blades	Bladelets
Unidirectional	42 / 33.8%	105 / 54.9%	27 / 81.8%	35 / 39.7%	6 / 42.8%	3
Bidirectional	4 / 3.2%	27 / 14.1%		4 / 4.5%		
Orthogonal	10 / 8%	13 / 6.8%	4 / 12.1%	3 / 3.4%	2 / 14.2%	
Transversal	10 / 8%	4 / 2%		5 / 5.6%		
Convergent	8 / 6.4	6 / 3.1%		8 / 9%	2 / 14.2%	1
Centripetal	17 / 13.7%	3 / 1.5%		22 / 25%	1 / 7.1%	
Débordant	7 / 5.6%	4 / 2%		8 / 9%	2 / 14.2%	
Crested	6 / 4.8%	29 / 15.1%	2 / 6%		1 / 7.1%	
Rejuvenation flakes	20 / 16.1%			2 / 2.2%		
Kombewa flakes				1 / 1.1%		
TOTAL	**124 / 99.6%**	**191 / 99.5%**	**33 / 99.9%**	**88 / 99.5%**	**14 / 99.6%**	**4**

Table 4. Dorsal scar patterns.

	Middle Complex			Lower Complex	
	Flakes	Blades	Bladelets	Flakes	Blades
		PLATFORMS TYPES			
Cortical	9 / 8.1%	1 / 1%		4 / 4.3%	
Plain	38 / 34.5%	24 / 24%	4 / 25%	50 / 54.9%	8 / 66.6%
Linear	17 / 15.4%	21 / 21%	8 / 50%	4 / 4.3%	
Punctiform	23 / 20.9%	9 / 9%	1 / 6.2%	4 / 4.3%	2 / 16.6%
Dihedral	9 / 8.1%	4 / 4%	1 / 6.2%	19 / 20.8%	2 / 16.6%
Prepared	9 / 8.1%	19 / 19%	1 / 6.2%	8 / 8.6%	
Faceted	5 / 4.5%	17 / 17%		1 /1%	
Prep. + Grinding		5 / 5%	1 / 6.2%	1 / 1%	
TOTAL	**110 / 99.6%**	**100 / 100%**	**16 / 99.8%**	**91 / 99.2%**	**12 / 99.8%**
		INTERIOR PLATFORM ANGLE (%)			
Right %	81.8	73.7	57.1	15	10
Obtuse %	15.5	26.2	28.5	81	80
Acute %	2.5		14.2	3.4	10
TOTAL	**99.8%**	**99.9%**	**99.8%**	**99.4%**	**100%**
		BULB PATTERNS			
Well-developed	7 / 6.6%	8 / 8%		14 / 15.2%	2 / 18.1%
Developed	65 / 61.3%	45 / 45%	6 / 42.8%	65 / 70.6%	3 / 27.2%
Diffused	30 / 28.3%	41 / 41%	8 / 57.1%	12 / 13%	6 / 54.5%
Absent	4 / 3.7%	6 / 6%		1 / 1.08%	
TOTAL	**106 / 99.9%**	**100 / 100%**	**14 / 99.9%**	**92 / 99.88%**	**11 / 99.8%**
		LIP PRESENCE			
YES	10 / 9%	16 / 16%	1 / 6,2%	5 / 5.4%	1 / 8.3%
		EXTERIOR PLATFORM MARGIN PREPARATION			
Trimming	4 / 3.6%	3 / 3%		4 / 3.6	
Grinding	39 / 35.4%	26 / 26%	4 / 25%	10 / 10.5%	

Table 5. Blank proximal end patterns.

	Middle Complex			Lower Complex	
	Flakes	Blades	Bladelets	Flakes	Blades
Rectangular	29 / 24.7%	34 / 28.8%	12 / 41.3%	38 / 40.8%	6 / 50%
Trapeze	7 / 5.9%	16 / 13.5%	1 / 3.4%	5 / 5.3%	
Round	2 / 1.7%			2 / 2.1%	
Oval	36 / 30.7%	16 / 13.5%	3 / 10.3%	22 / 23.6%	3 / 25%
Triangular	2 / 1.7%	17 / 14.4%	4 / 13.7%	5 / 5.3%	
Scalene	12 / 10.2%	3 / 2.5%		5 / 5.3%	1 / 8.8%
Irregular	29 / 24.7%	32 / 27.1%	9 / 31%	16 / 17.2%	2 / 16.6%
TOTAL	**117 / 99.6%**	**118 / 99.8%**	**29 / 99.7%**	**93 / 99.6%**	**12 / 100.4%**

Table 6. Blank shape.

	Middle Complex		Lower Complex
	Blades	Bladelets	Blades
Convex	44 / 40%	9 / 36%	3 / 30%
Straight	56 / 50.9%	10 / 40%	6 / 60%
Twisted	3 / 2.7%	6 / 24%	
Irregular	7 / 6.3%		1 / 10%
TOTAL	**110 / 99.9%**	**25 / 100%**	**10 / 100%**

Table 7. Blank profile.

	Middle Complex		Lower Complex
	Blades	Bladelets	Blades
Triangular	83 / 41%	33 / 80.4%	5 / 41.6%
Scalene	31 / 15.3%	5 / 12.1%	4 / 33.3%
Trapeze	68 / 33.6%	2 / 4.8%	2 / 16.6%
Polygonal	7 / 3.4%		1 / 8.3%
Irregular	13 / 6.4%	1 / 2.4%	
TOTAL	**202 / 99.7%**	**41 / 99.7%**	**12 / 99.8%**

Table 8. Blank section.