Ksar Akil
Lebanon

A Technological Analysis of the Earlier Palaeolithic Levels of Ksar Akil

Volume III: Levels XXV-XIV

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with contributions by C. A. Bergman and M. Newcomer

To the late Professor Francis Hours
who devoted his life to the unremitting
pursuit of prehistoric archaeology

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CONTENTS

CHAPTER I

INTRODUCTION

This chapter comprises three sections: firstly, a brief description of the site of Ksar Akil[1] with a history of its excavations and research; secondly, the glossary of the terms used throughout this study; and thirdly, the aims and methods of the analysis in this study of the lithic assemblages yielded in the 1937/38 seasons of excavations from Squares E4 and F4 of Levels XXV to XIV.

The rock-shelter of Ksar Akil and its excavations and researches

The Palaeolithic rock-shelter of Ksar Akil is situated some 8km east-north-east of Beirut, capital of the Republic of Lebanon, facing south on the northern side of the north branch of the Valley of Antelias (Ewing, 1947: fig. I, pp.186-188) (Fig. 1).

On the north wall of the main valley the Cave of Antelias is located (Ewing, 1947: p.188), though this site was destroyed by quarrying in the 1960's.

The basic rock in the vicinity of Ksar Akil is Jurassic limestone which is partially metamorphosed (Ewing, 1947: p.188).

This rock-shelter was discovered by two Beirut merchants digging for treasure (Day, 1926: p.158). They sank a shaft, in co-operation with Prof. Alfred Ely Day of the American University of Beirut, down to the depth of 15 metres through the rich occupation layers near the wall of the shelter (Day, 1926: p.158; Ewing, 1947: p.186).

Specimens of the lithic artifacts and faunal remains found by these treasure hunters and the American University of Beirut were sent to Prof. Marcellin Boule of the Institut de Paléontologie Humaine in Paris and to the British Museum for detailed study (Day, 1926: p.158).

The artifacts collected by Day were studied and published by Delcourt at the request of Passemard who organized the 1925 - 1926 archaeological expedition in Syria and Lebanon and mentioned Ksar Akil in a lecture given at a conference in Paris organized by the Société Préhistorique Francaise in 1927 (Delcourt, 1927: p.57; Passemard, 1927: pp.70-71; Ewing, 1947: p.186).

Since the Valley of Antelias was a rich mine for prehistorians and Ksar Akil was suspected to possess certain evidence of the Aurignacian, it was hoped that this rock-shelter would yield the best sequence of levels for prehistorians and that some factors concerning the origin and influence of the Aurignacian would be brought to light (Murphy, 1939: p.211).

In May 1937, the systematic excavation at this site was commenced under the direction of the Rev. Joseph G. Doherty, S.J. of Boston College, on the advice of Breuil, assisted by the Rev. George S. Mahan, S.J. and the Rev. Joseph W. Murphy, S.J., both of the Pontifical

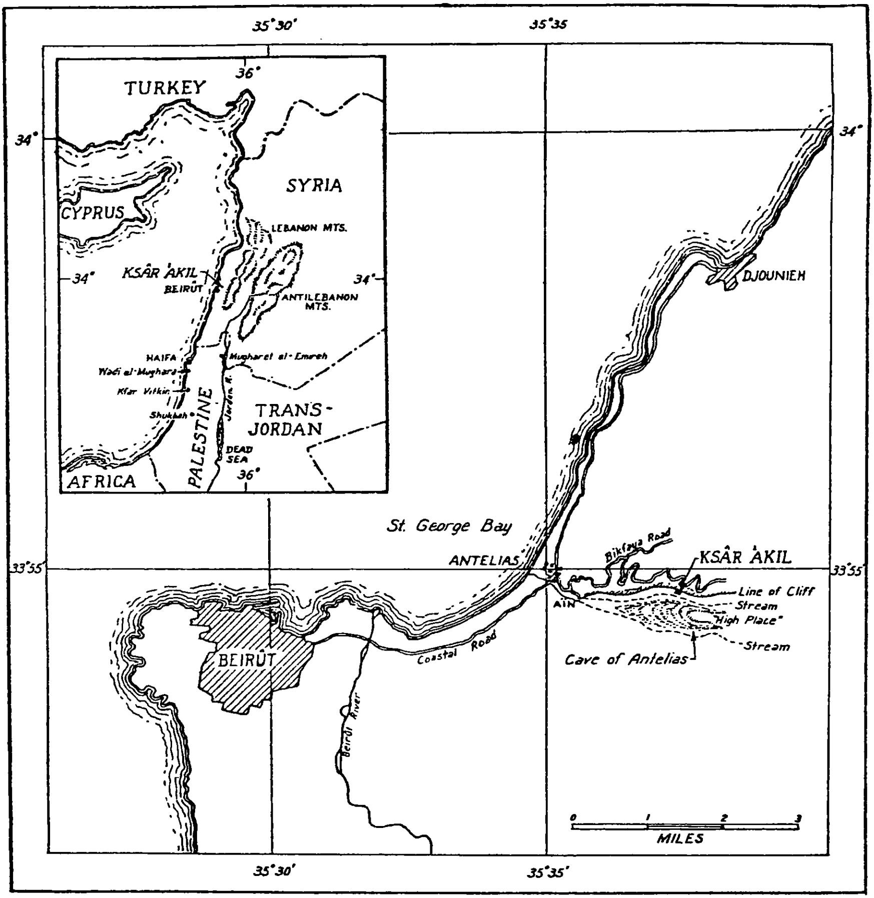


Fig. 1. Map showing location of Ksar Akil (after Ewing, 1947)

Biblical Institute of Jerusalem. The actual digging of this first campaign continued to the middle of September 1937, and in June of the following year, the Rev. J. Franklin Ewing, S.J. of Fordham University joined the excavation as palaeontologist and anthropologist and subsequently took over the directorship of the excavations (Murphy, 1938: p.272; 1939: p.211; Ewing, 1947: p.186; 1948: p.272; 1960: p.536).

These excavations seem to have been of high standard for that time, with the Lebanese workmen using sieves of medium mesh as a means of obtaining all the evidence (Murphy, 1938: p.273).

The point on the original surface from which all subsequent measurements were made was 80.9m above sea level, and the lowest point reached in the 1938 season was 61.9m above sea level, which was below the bottom of the then stream bed (66.1m) (Ewing, 1947: p.188).

The site was divided into two metre squares which were assigned alphabetical letters in a west to east direction and numbers running from north to south (Murphy, 1938: p.273) (Fig. 2).

In general, excavation proceeded normally, for the deposits at Ksar Akil had not been disturbed by natural agencies except by the treasure hunters at the shaft, but at -18.3m the greatest problem at this site was encountered with a layer of extremely hard material consisting of cemented and consolidated earth. To break this material, a sledge-hammer and drill were used, resulting in the production of numerous small flakes from this material (Ewing, 1947: p.188).

The flints which were removed in the 1937 season numbered around 2,000,000, consisting of tools, rejected fragments, trimming flakes, etc., and there were unearthed more than 1,000,000 pieces of bone (Ewing, 1947: p.190).

Photos were taken of objects and constructions <u>in situ</u>. Once the flint specimens were cleaned, they were spread out on a long work table for examination, selection, and classification, and then the numbers of each type of tool as well as the number of rejections were counted and recorded. After the classification according to types, each individual tool was marked with level and square, and was placed in uniform boxes also labelled with the same provenance (Murphy, 1938: p.274).

Ewing established 34 levels on the basis of colour and texture of the earth, alleging that the cultural materials from the various archaeological horizons corresponded with these geological divisions very closely (Ewing, 1947: p.190; 1948: p.278) (Fig. 3).

He also presented a section indicating main archaeological divisions: Gravettian from 0.0m to -3.0m, Middle Aurignacian from -3.0m to -7.0m, Chatelperronian from -7.0m to -12.0m, Mixed Zone (Transitional) from -12.0m to -15.0m, and Upper Levalloiso-Mousterian from -15.0m to the base (-19.0m) (Ewing, 1947: p.189) (Fig. 4).

The 1937/38 excavations could not be continued due to the Second World War.

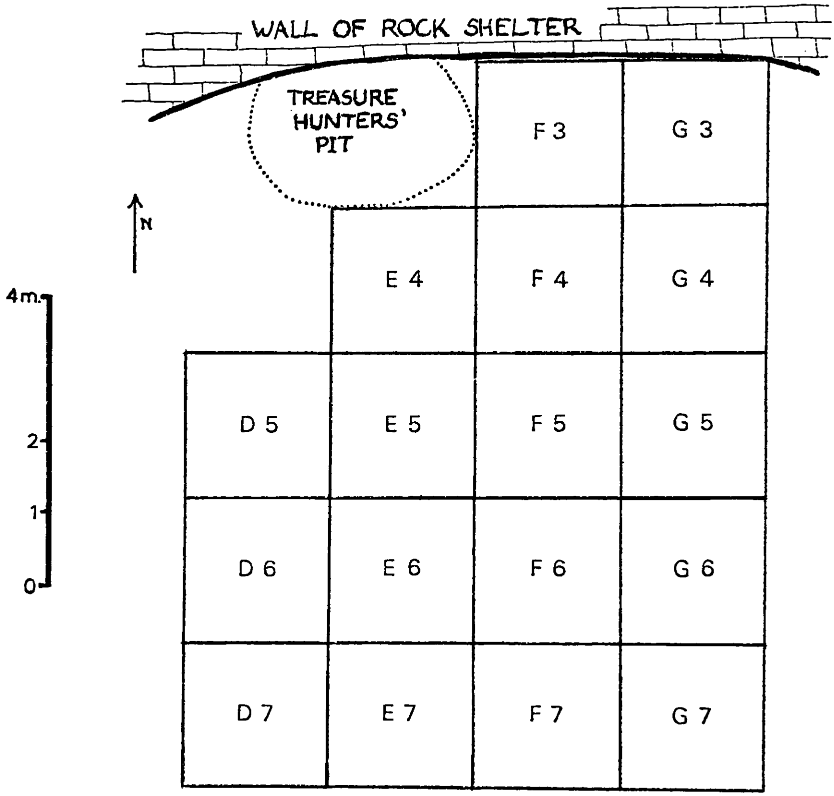


Fig. 2. Squares discriminated with combinations of alphabets and numbers in 1937/38 excavations (after Newcomer, 1972)

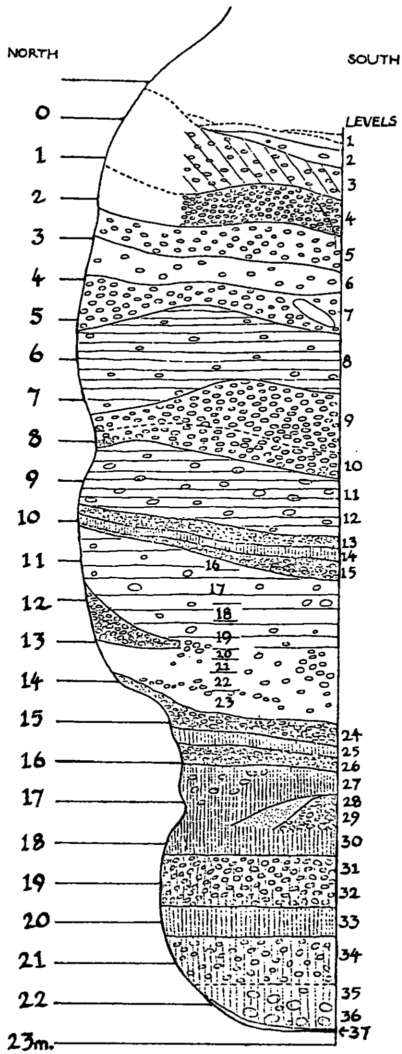


Fig. 3. Levels established by Ewing (after Newcomer, 1972)

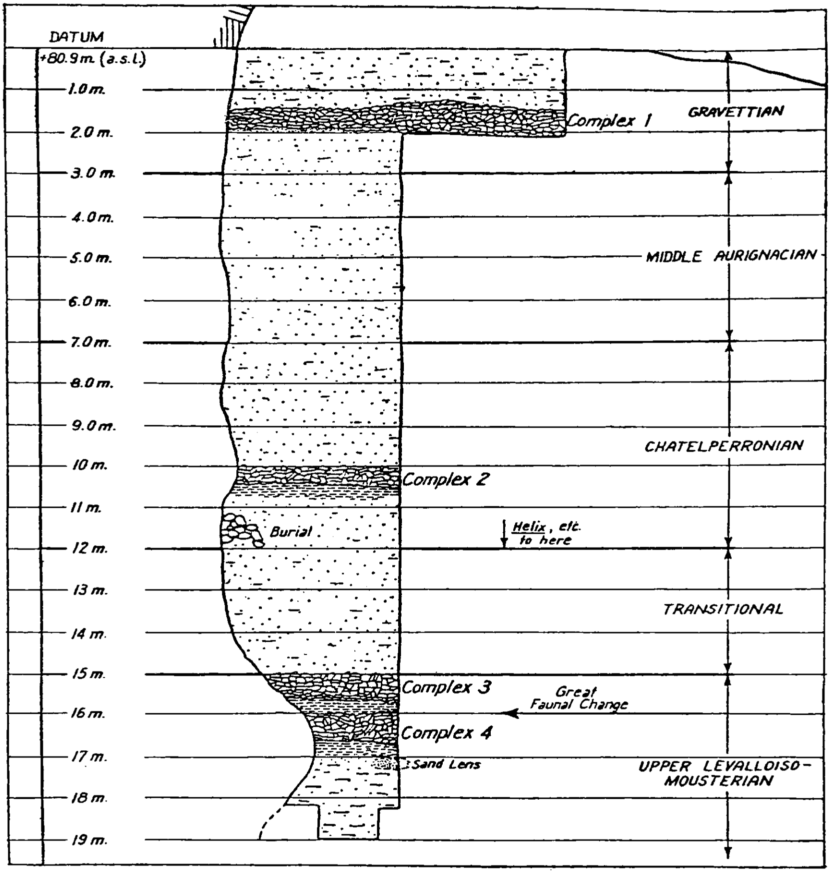


Fig. 4. Archaeological divisions proposed by Ewing (after Ewing, 1947)

After 8 years' interruption, the excavational work at this site was resumed in 1947 by the same Fordham-Boston College expedition and was finished by them in 1948 (Ewing, 1948: p.272).

During the 1947 season of excavation, Herbert E. Wright, Jr. joined the expedition as geologist to investigate geological problems of this site and its environs (Wright, 1951: p.115; Braidwood, 1951: p.113).

Some preliminary remarks on the fauna from this site were published by Murphy (1939: p.215) and Ewing (1947: pp.191-193; 1948: pp.275-276), but it was not until the 1960's, when Hooijer and Altena presented detailed studies, that the faunal problems at Ksar Akil were published in a systematic manner.

Hooijer analysed the faunal remains unearthed from Levels XXXVI (bottom) to I in both the 1937/38 and 1947/48 excavations (1961: p.4).

According to Hooijer, *Dama mesopotamica* (Iranian fallow deer) was best represented through all the levels and *Capra aegagrus* (Bezoar goat), and *Capreolus* (roe deer) were common throughout. Rhinoceros was recognized in Levels XXIXB to XXVIA only. Bos (bovines) was represented throughout the sequence in small quantities, but most abundant in Levels XXIXB to XXVIA. Gazella (gazelle) existed in all the levels above Level XXV (-15.40m) in small quantities (----: Table 25 on page 57, pp.58-60).

In conclusion, Hooijer stated that since Gazella and Dama, which indicate dry and moist climate respectively, were not in inverse proportion in relative frequency, the fauna of Ksar Akil gives no evidence for fluctuations of climate and it shows food choice of the men who occupied the rock-shelter (----: p.37, p.61).

Altena on the other hand published an analysis of molluscs from Levels XXVIII to I (with no samples from Levels XXVII to XXV) (----, 1962). He ascribed the fluctuations in the relative frequency of 45 species of mollusca partly to changes in the climate and partly to changes in the habits of the inhabitants of the rock-shelter and to slight local changes of environment, for the most common molluscan species occurred throughout the sequence of deposits (----: p.97).

In August 1938, the remains of two human skeletons were unearthed at -11.46m, one of which was said to be a child (7.3/4 years old) and was found buried under a pile of stones. This child was said to show the characteristics of the Modern Man in the capacity and thickness of the vault walls of the brain case and in the features of teeth, mandible, etc. (Murphy, 1939: p.214; Ewing, 1947: p.193: 1960: pp.538-539).

At about -15m, Level XXV or XXIV, a part of the right maxilla of a female adult, probably Neanderthaloid, was found (Ewing, 1963).

As to the radiocarbon dating, several results were obtained: 28,840 ±380 B.P. for the shells from Middle Aurignacian level at -6 to -7.5m (GrN-2195: Vogel and Waterbolk, 1963: p.173), 43,750 ±1,500 B.P.

for the dark clay band (treated as charred bone) from Upper Levalloiso-Mousterian level at -16m (GrN-2579: ----: p.174), and 44,400 ±1,200 B.P. for the charcoal from Upper Levalloiso-Mousterian level at -16m (GRO2574/75: letter from H. De Ward to Robert J. Braidwood (August, 1960): cited in Wright (1962: p.536)).

In connection with the deposits at Ksar Akil, four layer-complexes were identified by Ewing (1947: pp.193-195) (Fig. 4): Complex 1 from 1.5m to -2.0m with small, angular stones; Complex 2, almost identical to Complex 1, from -10.00m to -10.35m in which the stones were strongly cemented with small crystals of calcium carbonate, with a stratum of red clay (20 to 40 cm in thickness) underlying it; Complex 3, very similar to Complex 2, from -15.00m to -15.60m with a clay layer resembling that of Complex 2; and Complex 4 of stones and clay from -16.00m to -16.70m in which the stones were less firmly cemented than those of Complex 3. These four complexes were regarded by Ewing to have been formed during very humid periods and were correlated, on the basis of the fauna and his alleged cultural associations of the unearthed artifacts, with the Alpine glacial sequence: Complex 1 with Würm III; Complex 2 with Würm II; and Complexes 3 and 4 with Würm I. Later, Complexes 3 and 4 were combined into one complex (Complex 3). These three complexes came to be numbered from the lowest to the highest; Complex 3 became Complex 1, Complex 2 remained the same, and Complex 1 became Complex 3 (Ewing, 1948: p.275), and their correlations with the Alpine glacial sequence were also modified: Complex 3 with Würm IV, Complex 2 with Würm III, and Complex 1 with Würm II (Ewing, 1960: p.536).

In 1951, Wright (p.119) stated, on the basis of the geomorphology of the Valley of Antelias and of the coastal plain of Lebanon, that the cultural deposits (Upper Levalloiso-Mousterian to Upper Aurignacian) of Ksar Akil could be entirely dated within Würm, and in 1962 (pp.535-536) he presented two possible interpretations of the red clay layeer in Complex 2. The red soil (1) represents a time of intensified weathering, probably a time of greater rainfall and thus a pluvial sub-phase of the Würm, or (2) reflects lack of contamination by cultural debris during a period in which the rock-shelter was not inhabited.

The excavation at Ksar Akil was resumed by Tixier in September 1969 (Tixier, 1970) 20 years after the Fordham-Boston College excavation ended in 1948.

Tixier continued the excavations until 1975 when the Lebanese political instability forced him to cease the work there. This 1969 - 1975 work of excavations yielded Levantine Upper Palaeolithic materials, divided by Tixier into seven phases of the Levantine Aurignacian and final Upper Palaeolithic, from 12 levels down to -8.6m (9.6m below Ewing's datum line) (Tixier, 1974b; Tixier and Inizan, 1981).

The actual digging at Ksar Akil ended with the 1975 excavation by Tixier, and since then the research has been dealing with the technological and typological aspects of the artifacts unearthed from the site.

In the M. Phil. thesis submitted by Dortch to the University of London in 1970, an analysis of the stone tool assemblages from Layers VIII to VI of Ksar Akil was carried out based upon the tool forms found in the three layers. Dortch concluded that the tool assemblages of Layers VIII and VII could be a continuation of the Aurignacian, fully developed in the lower layer of XI, and that the tool assemblage of Layer VI should be a final stage of the Aurignacian, which is transitional between it and the Kebaran (p.180).

Newcomer (1970) published a study on the typology and method of manufacture of chamfered pieces from this site.

In 1973, Azoury and Hodson compared, by means of a computer program which put out constellations of techno-typological attributes of the lithic artifacts, 14 levels (Levels XXV to XII) of Ksar Akil, and stated that although the tools of these levels are mostly of the Upper Palaeolithic type, the Levallois technique is prominent in the Upper Palaeolithic Phase I of Ksar Akil (-15.05m to -13.00m) and disappears in Phase II (-13.00m to -10.65m) (p.303).

In the same year, Newcomer and Hodson (1973) analysed the burins of the 16 levels of the 25 Upper Palaeolithic levels (Levels XXV to I), also by means of constellation analysis, and demonstrated the usefulness of this computer technique for the analysis of Ksar Akil material.

In 1974, an experimental study was presented by Newcomer regarding the bone tools from Ksar Akil, mostly from Levels IX to V. Newcomer demonstrated through the experimental production of bone tools and their comparison with the archaeological ones from this site that the bone tools of Ksar Akil were most probably produced by scraping with various flaked stone tools, which could not be identified by him, and not by grinding (1974: pp.150-151).

Copeland (1975: pp.336-343) reviewed the thus-far alleged phases of the Upper Palaeolithic levels of Ksar Akil and gave her ideas on these phases.

In 1981, Bergman described the various point types in the Upper Palaeolithic sequence (Levels XXV to VI) at this site: Levallois point, Mousterian point, Ksar Akil point, *pointe à face plane*, and el-Wad point.

In 1983, Bergman and Newcomer published an experimental study based on their own manufacture and shooting of projectile points to replicate "impact fractures" on Ksar Akil points and *pointes à face plane* from Levels XX to XVI.

Aside from the above-mentioned studies published between 1970 and 1983, three longer projects of Azoury, Newcomer, and Bergman appeared in London in 1971, 1972, and 1985 respectively.

Azoury, in her Ph. D. thesis submitted in 1971 to the Institute of Archaeology, University of London, analysed the lithic assemblages from Levels XXV to XII, yielded in the 1937/38 excavations at Ksar Akil, from a techno-typological point of view. She established three sets of levels on the basis of technological change of tool-blank production and, especially, proportional change of occurrences of representative tools. These three groups of levels are (1) the Upper Palaeolithic Phase I from -15.05m to -13.70/12.95m (Levels XXV to XXII/XXI) with a variety of end-scrapers and burins and characterized by chamfered pieces, burins on lateral preparation, and a specialized Levallois technique for blank production; (2) the Upper Palaeolithic Phase II from -12.95m to -10.65m (Levels XX to XIV) with partially-backed or backed blades and characterized by *pointes à face plane*, blades pointed by retouch, and the debitage above -12.00m having punctiform or linear butts; and (3) the Levantine Aurignacian from -10.65m to -10.00m (Levels XIII and XII) with the burin index higher than the end-scraper index and characterized by carinated end-scrapers, inverse end-scrapers, Ksar Akil points, carinated burins, and debitage with punctiform or linear butts (----: p.17, pp.362-367).

In 1972, in his Ph.D. thesis Newcomer studied the burins of 25 Upper Palaeolithic assemblages (Levels XXV to I) unearthed in the 1937/38 excavations at Ksar Akil.

He established for these lithic assemblages three groups of levels based on the technology of blank production, burin typology, burin edges, etc. These level groupings are: Levels XXV to XIX (sub-divided into (1) Levels XXV to XXI and (2) Levels XX and XIX), Levels XVIII to XIV which were grouped on negative evidence, and Levels XIII to I (sub-divided into (1) Levels XIII to XI, (2) Levels X to VIII, (3) Levels VII and VI, and (4) Levels V to I). Newcomer showed that except between Levels XIV and XIII no clear break of burin typology was recognized and that a general evolutionary scheme existed in which truncation burins on blades with faceted butts (Levels XXV to XIX) gave way to dihedral burins on punctiform butted blades and (later) plain butted flakes (Levels XIII to I), and stated in his conclusion that the evolution of the Upper Palaeolithic sequence at Ksar Akil was continuous except between Levels XIV and XIII (----: pp.375-388).

In his Ph.D. thesis (1985), Bergman analysed the lithic assemblages from Levels XIII to VI, also unearthed in the 1937/38 excavations at Ksar Akil, from a techno-typological point of view, and in 1987 the results of this analysis were published. In his conclusion, Bergman established four groups of levels: Levels XIII to XI, Levels X and IX, Levels VIII and VII, and Level VI. After demonstrating these four groups of levels, his Stages 3, 4, 5, and 6, respectively, as being not developmentally related on the basis of abrupt technological changes observed between them, he cast doubt on calling these stages Levantine Aurignacian A, B, and C, and stressed the similarities and differences of the Ksar Akil sequence with the Near Eastern Palaeolithic of the corresponding time period: Levels XIII to XI as being unique to Ksar Akil, Levels X and IX having some techno-typological similarities to the Negev Ahmarian, and Levels VIII to VI as "Levantine Aurignacian" (1987: pp.154-155).

This concludes the history of excavations and research of Ksar Akil.

Since this site was systematically excavated by the Fordham-Boston College expedition in the 1930's, many researchers from various fields of science have joined the excavations or studied materials from it.

Many of the reports on this site seem to have been chiefly focused on the important Middle to Upper Palaeolithic transition.

Systematic studies of intra-site continuity or change in the technology and/or typology based on a large amount of lithic material have also been made by several investigators.

Such studies are still needed, for they may add informaton which would clarify a Middle to Upper Palaeolithic transition as well as the general development of the Upper Palaeolithic sequence in the area.

Glossary

This section is a glossary which generally deals with the terms used throughout this study.

ASSEMBLAGE

"A number of things gathered together; a collection, group, cluster" (*The Oxford English Dictionary*, 1933). "All the artifacts found in a given layer at a site" (Bordes, 1972: p.158).

In prehistoric archaeology, this term is used in the sense of "lithic assemblage", "tool assemblage", "burin assemblage", etc., meaning all the stone artifacts including not only tools but also waste from a certain excavation unit (Newcomer, 1972: pp.19-20).

For the Lower and Middle Palaeolithic, Bordes described the lithic assemblage emphasizing typology: 63 types of tools, 21 types of hand-axes, cores, ordinary flakes and blades, hand-axe flakes, and chips as well as utilized rocks, ochre, utilized bones, etc. (Bordes, 1961; 1972).

BLADE

Bordes (1961: p.6) described all the flakes of the Lower and Middle Palaeolithic whose length is equal to or more than twice the width to be blades, disagreeing with English-speaking scholars who differentiate between true blades with parallel ridges and edges and the less regular flake-blades.

For the lithic assemblages of the Upper Palaeolithic and the later periods, Bordes and Crabtree (1969: p.1) and Crabtree (1972: p.42) defined the blade more elaborately: specialized flake with parallel or sub-parallel lateral edges; the length being equal to or more than twice the width; cross sections are plano-convex, triangulate, sub-triangulate, rectangular, or trapezoidal; having more than two crests or ridges; associated with prepared core and blade technique; not a random flake; having on the dorsal surface two or more scars of previously removed blades.

BLADELET

Tixier (1963: pp.38-39; 1974a) established a method of differentiating a bladelet from a blade of the Epi-Palaeolithic of Maghreb: a bladelet is a blade whose width is less than 1.2cm, but there is no length limit for it.

This method is adopted in the present study, although the samples Tixier analysed and those for this study are derived from different temporal and spatial contexts.

BLANK

"A usable piece of lithic material of adequate size and form for making a lithic artifact --- such as unmodified flakes of a size larger than the proposed artifact, ---" (Crabtree, 1972: p.42).

BUTT

A part of the striking or pressing platform of a core which, as the basal part of a flake or blade, is detached with a hammer (striker) or pressure-flaker (Tixier et al., 1980: p.104).

Bordes (1961; 1972) observed various types of butts: plain butt including cortex butt, convex dihedral butt, straight multiple-faceted butt, convex multiple-faceted butt, butt taken away by retouch, and broken butt. Bordes also described the "Chapeau de gendarme" butt which is sometimes characteristic of a Levallois point (1947: p.8) and the butt with a regularizing facet to remove a troublesome area from a core platform, which was included as a plain butt (1948: p.117).

This regularizing facet identified by Bordes seems to be identical to the "partial facet" of Azoury (1971).

In addition to the butt types mentioned above, there are two more types: the linear butt which is very thin and the punctiform butt which is very small and projected (Bordes, 1967: p.44).

CHANGE OF ORIENTATION

Said of a core with a flake scar whose orientation forms right angles with previous flake scars (Crew, 1976: p.94).

CHIP

This term seems to have been used rather subjectively: flakes which are too small, irregular, and fragmentary to have been utilized in tool production --- small fragments from all artifact classes and complete pieces which measure less than 15mm in greatest dimension (Marks, 1976: p.374); 25mm in greatest dimension is seen by Crew as the boundary between chips and debitage (Crew, 1976: p.79).

COMPOSITE

Said of a piece combining one or more tools from one tool group with one or more tools from another tool group on the same blank (Newcomer, 1972: p.30).

CORE

A mass of material often preformed by the worker to the desired shape to allow the removal of a definite type of flake or blade (Crabtree, 1972: p.54). A core is usually made from a nodule, but there sometimes exist cores on flakes (Newcomer and Hivernel-Guerre, 1974).

In the course of core reduction, some portion which is not desirable for flaking may be intentionally removed to facilitate further removal of flakes, blades, etc., resulting in the production of core rejuvenation debitage like core tablets (Hamal-Nandrin and Servais, 1929).

It should be noted that a core is typed on the basis of its final morphology (Munday, 1976: p.129). Also to be noted are core conversion from one type to another and the exhaustion of a core until nothing is left (Bordes, 1961: p.71).

Cores of the Lower and Middle Palaeolithic were classified by Bordes (1961; 1972) as Levallois (flake, blade, and point types), proto-Levallois, discoidal, prismatic, pyramidal, globular, shapeless, and unclassifiable.

For the Upper Palaeolithic of Perigord, France, De Sonneville-Bordes (1960: p.20) set a core classification which is essentially the same as Bordes' for the Lower and Middle Palaeolithic, including prismatic core with a single or two striking platform(s), pyramidal core, globular core, shapeless core, discoidal core, and Levallois cores of flake and blade types.

Leroi-Gourhan on the other hand categorized cores into four types on the basis of flaking directions: concentric, uni-polar, bi-polar, and multi-polar (1966: p.247).

CRESTING

The concept and flaking process of crested debitage were discussed by Cheynier and Barnes (1937). Bordes and Crabtree experimentally demonstrated in detail that cresting is vital for successful removal of a series of regular blades from a nodule of rock whose shape is unfavorable for blade removal (1969: pp.3-4). Cresting starts with forming a more or less straight ridge on a core, very often by bi-lateral flaking. This ridge guides the removal of a first blade and facilitates the subsequent removal of a series of blades (Tixier et al., 1980: pp.82-83). As the blade detachment proceeds after an initial crested blade is flaked off, the traces of cresting on the subsequent blades become less and less. Cresting may be uni-lateral (Cheynier and Barnes, 1937) or bi-lateral, and re-cresting may be executed subsequent to the initial cresting.

DEBITAGE

Said of the intentional action of breaking a block of raw material (hard rock) in order to use the products (flakes, blades, bladelets, etc.) as they are, or to convert these products into tools by retouch. It also comprises the products of this action (Tixier, 1963: p.32; 1974a).

In the present study, debitage includes all the products of the intentional breaking of raw material but in practice excludes cores, retouched pieces, and retouch flakes (Munday, 1976: p.122).

DEBRIS

Waste material --- such as quarrying or mining waste --- having little or no definite characteristics (Crabtree, 1972: p.58).

DISTAL

Said of the extremity of a flake or blade opposite to the proximal extremity with butt and bulb (Tixier, 1963: p.35; 1974a).

DORSAL

Said of the surface of a flake, blade, etc. opposite to the ventral (bulbar) surface. The dorsal surface may be partly or totally covered by natural surface, but it usually has flake scars bounded by ridges (Tixier, 1963: p.35; 1974a).

Patterns of the flake scars on the dorsal surface may be uni-directional (Bordes and Crabtree, 1969: pp.2-3), bi-directional opposed (----: pp.2-3), crossed (Tixier, 1963: p.43; 1974a), and centripetal (Crew, 1975: p.429) or concentric (Leroi-Gourhan, 1966: p.247), depending on the flaking directions on core surfaces from which flakes or blades are derived.

FIRST FLAKE

This is called "entame" in French and is a flake which is detached from a nodule and has natural surface on all of the dorsal surface and butt (Tixier, 1963: p.33; 1974a).

The first flake may represent the initial stage of core reduction, but it may be difficult to distinguish it from cortical debitage detached at later stages of the reduction like core modification.

Munday (1976: p.121) and Marks (1976: p.376) described primary debitage or elements produced at the early stage of core reduction sequence as having more than 50% cortex on the dorsal surface.

FLAKE

Fragment of hard rock detached intentionally (1) in the course of shaping or preparation of a core: core-shaping flake or core-preparation flake, (2) from a core to produce a tool or weapon: debitage, and (3) in the course of the fabrication of a tool or weapon: retouch flake (Tixier, 1963: p.33; 1974a).

FLAKE-BLADE

Elongated flakes of the Lower and Middle Palaeolithic, whose length is equal to or more than twice the width, were described as blades by Bordes (1961: p.6), but the scholars of the English-speaking countries defined the "true blade" as having parallel ridges and edges and distinguished it from a flake-blade without such features (----: p.6).

FLAKING ANGLE

The angle formed between the dorsal surface and butt of a flake or blade (angle de chasse) as well as the angle formed between the butt and ventral surface of a flake or blade (angle d'éclatement) (Barnes and Cheynier, 1935: p.289). The angle de chasse is expected to reflect the flaking angle which is elaborately arranged prior to the detachment of desired debitage from a core (Warren, 1951: p.109).

HAMMER

Percussor used for flaking and retouching hard rock. It may be stone, animal bone, antler, etc. (Tixier et al., 1980: p.96), and may be struck on to the rock directly or indirectly with the intermediary of a punch.

Hammers may be divided into two groups: those as hard as the material being flaked and those which are softer (Ohnuma and Bergman, 1982).

Newcomer (1975: p.97) proposed the term mode for the kind of flaking used within the stage by stage framework implied by method in the manufacture of flaked lithic artifacts.

Bordes (1947; 1948; 1961) described the flakes detached with a hard hammer as having large butts, clear points and cones of percussion, pronounced bulbs, and clear conchoidal fracture marks (waves or ripples), whereas the flakes detached with a soft hammer were described as having narrow butts, often punctiform and/or lipped, no points or cones of percussion, and diffused bulbs.

HEAT TREATMENT

Thermal treatment. Method of altering siliceous materials by exposure to controlled heat. This treatment makes the stone more vitreous (Crabtree, 1972: p.94), changing the quality of the materials and making the surface exposed to heat more lustrous (Crabtree and Butler, 1964). That the heat treatment makes siliceous materials easier to work on, especially in pressure flaking, was evidenced archaeologically (Bordes, 1969; Sollberger and Hester, 1973) and ethnographically (Hester, 1972) and was confirmed experimentally

(Crabtree and Butler, 1964; Purdy and Brooks, 1971; Mandeville and Flanniken, 1974; Inizan, Roche and Tixier, 1975-1976). Change in stone material after both accidental and controlled exposure to heat may be called heat alteration, whereas the term "heat treatment" may be reserved for the heat alteration resulting from intentional exposure to heat.

HINGING

Said of a flake, blade(let), or burin spall with ventral surface turning abruptly up at the distal end away from the centre of the core or burin. This leaves the characteristic rounded tip on the distal end of the piece as well as an equally characteristic 'hook' on the core or burin (Tixier, 1963: p.45; 1974a).

LEVALLOIS

Bordes (1961) described "Levallois" as a flaking process in which the final form of the desired flake is preformed on the core by a special preparation. He recognized three types of Levallois product: flake, blade, and point. Faceting of the butt of the Levallois debitage was vital for some authors (for example, see McBurney, 1967: p.77), but Bordes rejected the importance of faceting in the determination of the Levallois debitage (1961: p.14). Although the Levallois description by Bordes was rather elastic, many authors have been adopting it in such a way that it is not always certain if the reports concerned with "Levallois" are describing the same thing (Bergman and Ohnuma, 1983: p.179).

A more detailed study of "Levallois" is presented in a later chapter in the present study, since the re-examination of this flaking process is indispensable for the Ksar Akil materials, especially for those of the Upper Palaeolithic Phase I (Levels XXV to XXII) which have been described as using a specialized Levallois technique (Azoury, 1971: p.16).

LIP

A projection found along the butt-bulbar line of a flake: the line formed by the intersection of butt and bulb. A lip is said to be characteristic of debitage produced by a soft hammer or pressure flaking (Knowles, 1953: p.69, p.77; Crabtree, 1972: p.74).

MULTIPLE

Said of a piece combining two or more tools of the same tool group on the same blank (Newcomer, 1972: p.39).

NATURALLY-BACKED

Said of a flake or blade with an unretouched sharp edge on one side and cortex surface on the other which plays the role of retouched backing. This cortex surface should be perpendicular or only a little oblique to the ventral surface (Bordes, 1961: p.33). Bordes (1961; 1972) put the naturally-backed piece in the tool category of the Lower and Middle Palaeolithic.

Boëda's (1982) experiments suggested a process in which naturally-backed debitage is intentionally produced for a certain purpose in the course of the production of a Levallois point.

PLATFORM ABRASION

An important technological device to detach a series of blades from a core successfully is the removal of the overhang formed along the edge of the core platform. The importance of this work was fully demonstrated by Bordes and Crabtree after the experimental production of a series of blades (1969: p.5).

It is demonstrable through experimental manufacture of blades that when the point of percussion or pressure is located on the margin of a core platform, an overhang left by the negative bulbs on the previous flake scars should be removed by abrasion or some other means in order to obtain blades without damaging the core platform, for such an overhang may easily cause the collapse of the core platform.

PLUNGING

Said of a flake, blade(let), or burin spall whose ventral surface turns abruptly toward the centre of the piece and takes away part of the core or burin (Tixier, 1963: p.43; 1974a).

POINT OF PERCUSSION

The point or area on a core where a flake or blade starts being detached by the contact with a hammer, punch, or anvil.

PSEUDO-LEVALLOIS POINT

This was described by Bordes (1950: p.22) as a triangular flake with a thick butt detached from a discoidal core. It resembles a Levallois point in appearance, but its axis of percussion does not coincide with the axis of the piece.

As in the case of naturally-backed pieces, Bordes (1961; 1972) put this in the tool category of the Lower and Middle Palaeolithic although it is not retouched.

RETOUCH

Retouch is the trace left by shaping, sculpting, or transforming a product of debitage into a tool or weapon, either by percussion or pressure flaking (Tixier, 1963: p.45; 1974a), and includes shaping retouch and retouch of accommodation (Bordes, 1967: p.29).

According to Bordes (1961: pp.8-10), there are basically four types of retouch for the Lower and Middle Palaeolithic: fish-scale-like retouch often seen in the Mousterian, stepped fish-scale-like retouch of the Quina Mousterian, parallel retouch, and sub-parallel retouch.

De Sonneville-Bordes described several types of retouch for the Upper Palaeolithic of Perigord, France: fish-scale-like retouch (Aurignacian retouch); abrupt retouch forming more or less right angles; "*retouche en raclette*" which is very abrupt, narrow, and continuous; and parallel retouch (so-called "Solutrean retouch") (1960: pp.20-21).

Tixier, on the other hand, described six types of retouch for the Epi-Palaeolithic artifacts of Maghreb: side-scraper retouch, scaled and stepped abrupt retouch, normal abrupt retouch, abrupt retouch on an anvil, (generally short and semi-abrupt direct) Ouchtata retouch, and invasive retouch (Tixier, 1963: pp.46-49; 1947a).

Retouch is also classified in terms of its position: alternate retouch which is worked along part or all of both edges of a piece, starting from the dorsal surface on one edge and from the ventral surface on the other; alternating retouch starting alternately from one surface then from the other on the same edge of a flake or blade; bifacial retouch which is worked on both surfaces of an object, covering each surface partially or totally; direct (or normal) retouch in which the removals start from the ventral surface; and inverse retouch in which the removals start from the dorsal surface (Tixier, 1963: pp.26-34; 1974a).

Besides the intentional retouch mentioned above, there is retouch produced accidentally, such as traces of utilization (Tixier, 1963: p.45; 1974a; Bordes, 1967: p.30) and "spontaneous retouch" produced during the detachment of a flake, blade, etc. from a core (Newcomer, 1976). "Impact fracture" may also be regarded as retouch of utilization. This fracture was discussed by Bergman and Newcomer (1983), who compared the damage seen on the points from Levels XX to XVI of Ksar Akil with that produced on the copied points by experimental bow-shooting, and recognized three types of fracture on both the original points and the experimentally-made-and-shot points: burin-like fracture, flute-like fracture, and bending fracture.

RETOUCH FLAKE

Said of a flake produced in the course of the manufacture of a retouched piece (Tixier, 1963: p.33; 1974a): burin spall (Tixier, 1963: p.33; 1974a), chamfer spall produced in the manufacture of a chamfered piece (Newcomer, 1970: p.181), re-sharpening flake of an end-scraper, etc.

STRIKING PLATFORM

The surface area on a core receiving the force necessary to detach a flake or blade which can be either natural or prepared (Crabtree, 1972: p.84).

The location of striking platforms on a core with several striking platforms may be as follows: opposed (Bordes and Crabtree, 1969: p.2), opposite rectangular --- a type in which the core surface bears the angles more or less 90 degrees about its middle (----: p.2), opposite alternate --- a type in which blades are detached on each side of a core from two opposite striking platforms (----: pp.2-3), crossed --- a type corresponding to debitage with crossed dorsal scars (Tixier, 1963: p.43; 1974a), and peripheral --- a type corresponding to debitage with centripetal dorsal scars (Crew, 1975: p.429).

VENTRAL

Said of the fracture plane formed by the shock wave of the striker inside the core, separating the flake or blade(let) from the core. On the ventral surface of a flake or blade, there are seen the cone of percussion, bulb of percussion, and waves or ripples whose concavity is always turned toward the cone of percussion (Tixier, 1963: p.35; 1974a).

WASTE FLAKE

Discarded flakes not suitable for use, usually resulting from platform abrasion, trimming, or removing of cortex (Crabtree, 1972: p.98). It should be noted, however, that the identification of this category is difficult, for the term "waste" is rather subjective.

Aim and Method

This section describes the aims and methods used in this study.

Before proceeding to the main subject, however, the present writer would like to re-examine briefly the research carried out on Ksar Akil, although the review will in part duplicate material presented earlier in this chapter. This review seems to be essential, for it may be said that the research field of Ksar Akil has been deepening its own content through giving information to and taking research results from other Palaeolithic sites in the Near East.

From the early stage of Ksar Akil research, it was expected that this rock-shelter would reveal a good sequence of the Palaeolithic levels and a certain key to the clarification of the origin of the Aurignacian (Murphy, 1939: p.211).

A huge quantity of lithic material was unearthed from this site, amounting to around two million pieces including waste, in the 1937 season of excavation alone (Ewing, 1947: p.190).

In 1943, Layers IVe and IVf of the rock-shelter of Abou Halka, south-west of Tripoli, Lebanon, had been described by Haller (1942-1943) as being related to Neuville's Upper Palaeolithic Phase I or Garrod's Lower Aurignacian, on the basis of the presence of Emiran points, "*eclats et lames à chanfrein*", Mousterian points, and Aurignacian-type tools made on blanks produced by the Levallois technique, which also had been found at el-Emireh, Djebel Kafzeh, et-Tabban, and el-Wad.

In 1947, Ewing published (p.189) his archaeological divisions for the Ksar Akil materials, i.e. Upper Levalloiso-Mousterian, Transitional, Chatelperronian, Middle Aurignacian, and Gravettian.

Works at the sites of Ksar Akil and Abou Halka led Garrod to re-examine the materials from Layers G and F of Mugharet el-Wad, Israel, which she had formerly regarded as the Upper Levalloiso-Mousterian and the Lower Aurignacian, respectively (Garrod and Bate, 1937: pp.50-55). She was encouraged by these works to conclude that Layers G and F of el-Wad represented a single assemblage, with Emiran points, of mixed characters of the Levalloiso-Mousterian and the Aurignacian (Garrod, 1951: p.123).

In 1955, Garrod reviewed the site of Mugharet el-Emireh which had been excavated by Turville-Petre in 1925, and proposed to qualify it as the type site of the "Emiran" with the Emiran point as its type fossil. She regarded the Emiran to be a transitional phase from the Levalloiso-Mousterian to the Aurignacian and to be the same as the first phase of Neuville's sexpartite scheme of the Palestinian Upper Palaeolithic (Neuville, 1951) and the Ksar Akil Transitional levels of Ewing (1947).

In 1969, a symposium was held in London to discuss the Levantine Palaeolithic terminology. At this meeting the terms "Ksar Akil Phase A" and "Ksar Akil Phase B" were adopted; the former phase (Levels XXV to XXI) replaced Neuville's "Phase I", Garrod's "Emiran", and Ewing's "Transitional"; and the latter, sub-divided into Bi (Levels XX to XVIII) and Bii (Levels XVII to XV), replaced Neuville's "Phase II" and Ewing's "Chatelperronian" (Copeland, 1975: p.337).

In the following year, the lithic materials from the Antelias Cave, located a short distance from Ksar Akil, were correlated by Copeland (1970) with those from Ksar Akil, Abou Halka, and the Amud Cave in terms of the typology and the technology of blank production; Levels VII and VI of Antelias were related to Ksar Akil Phase A, Level IVf of Abou Halka, and Layer B of the Amud Cave (Watanabe, 1970), while Level V of Antelias was correlated with Levels XXIII to XX of Ksar Akil, Level IVe of Abou Halka, and Layer B of the Amud Cave.

Meanwhile, the excavation at Ksar Akil was resumed by Tixier in 1969, and might have contributed substantially to information on the whole sequence of the Upper Palaeolithic of this site, but the work was abandoned in 1975 due to the Lebanese political instability (Tixier and Inizan, 1981).

Three Ph. D. theses which appeared in London in 1971, 1972, and 1985 yielded valuable information on the Ksar Akil material.

One of them was "A Technological and Typological Analysis of the Transitional and Early Upper Palaeolithic Levels of Ksar Akil and Abou Halka" by Azoury (1971) in which she stated that her Upper Palaeolithic Phase I of Ksar Akil (Levels XXV to XXII/XXI) was characterized by a specialized Levallois technique and that Ksar Akil did not give a clear picture of a Middle to Upper Palaeolithic transition.

Another thesis was "An Analysis of a Series of Burins from Ksar Akil (Lebanon)" by Newcomer (1972), who demonstrated, after an analysis of the burin typology and the technology of the production of burin blanks, that the Upper Palaeolithic sequence at Ksar Akil (Levels XXV to I) was broken only between Levels XIV and XIII.

The thesis which appeared in 1985 and was published in 1987 was "A technological and typological analysis of Levels XIII-VI from Ksar Akil, Lebanon" by Bergman. In his conclusion, Bergman established four stages (3, 4, 5, and 6), that is, four sets of levels (XIII-XI, X-IX, VIII-VII, and VI, respectively) which are not developmentally related, and demonstrated that they display similarities and differences with the Near Eastern Palaeolithic: Stage 3 confined to Ksar Akil, Stage 4 similar to the Negev Ahmarian, and Stages 5 and 6 broadly definable as "Levantine Aurignacian".

At present, there seems to be a view generally accepted that variations existed in the initial Upper Palaeolithic in Syria, Lebanon and Palestine (Besançon, Copeland, and Hours, 1977: p.28).

Bar-Yosef and Vandermeersch, for example, cast doubt in 1972 on the existence of the "Upper Palaeolithic Phase I" or "Emiran" in Palestine, suggesting that lithic materials thus far described to have been derived from disturbed deposits formed in the erosive period between the end of the Mousterian and the beginning of the Upper Palaeolithic, and proposed possibilities that (a) the caves in Palestine were not suitable for habitation at this period, (b) the Mousterian lasted longer in Palestine than in Lebanon and Cyrenaica, and (c) the Aurignacian existed in Palestine from the beginning of the Upper Palaeolithic .

Bar-Yosef and Vandermeersch (----) agreed, however, that at the Lebanese and Cyrenaican sites of Abou Halka, Ksar Akil, ed-Dabba, Haua Fteah, etc., there was a phase with "chamfered pieces" (Newcomer, 1970) stratified immediately above the Mousterian.

It also seems that the Emiran point, because of its random occurrences, has lost its significance as the type fossil of the "Upper Palaeolithic Phase I" or "Emiran" (Schroeder, 1969: pp.10-11; Bar-Yosef and Vandermeersch, 1972: p.222; Besançon, Copeland, and Hours, 1977: p.12).

AIM

In spite of a considerable number of articles published in the field of Near Eastern Palaeolithic studies, some of which have been cited above, there seem to be questions still unsolved concerning several aspects of the beginning of the Upper Palaeolithic of the Levant.

The earlier levels of the Upper Palaeolithic sequence at Ksar Akil have been regarded as a crucial key to the clarification of the beginning of the Upper Palaeolithic in Lebanon at least.

Bordes even cited Ksar Akil as one possible candidate for the ancestor of the Aurignacian (1968a: p.221).

Azoury (1971), Newcomer (1972), and Bergman (1985) clarified the contents of the Upper Palaeolithic of Ksar Akil from their techno-typological points of view.

The levels (XXV to XIV) to be analysed in the present study are represented in Squares E4 and F4 in the 1937/38 excavations conducted by the Fordham-Boston College Expeditions, and are included in the levels analysed by Azoury (Levels XXV to XII) in 1971.

Therefore, the results obtained in the present study will naturally overlap in several points with those of Azoury.

However, the aim of this study is to yield as much information as possible, on the basis of the present writer's own experiments in flint knapping, concerning the technological aspects of each level and clarify how the raw materials were roughed out, how the cores were shaped or prepared for the production of certain types of debitage, and how the products of debitage were utilized for certain types of tools or weapons which the people who occupied this rock-shelter at different periods needed.

It may be that when we analyse a technology in which raw materials were reduced to usable blanks that were utilized as they were or modified into tools or weapons, we reveal a certain motor habit of an individual (Schroeder, 1969: p.455) who learned the style of debitage in the society he or she belonged to (Lenoir, 1975: p.47).

A good example of this kind of study was that by Inizan (1980) for the typical Capsian and the Upper Capsian, in which she described several stages in the production of tools or weapons and several types of blanks on which they were manufactured.

Beyond the aim of the present study just mentioned, it is also hoped that a certain technological progress through time can be detected in the levels analysed.

In brief, the aim of this study is to reveal (1) certain style(s) of debitage of an individual/society for each level and (2) certain change(s) in the styles of debitage in Levels XXV through XIV.

It should be pointed out, however, that the levels established for the Upper Palaeolithic sequence at Ksar Akil may have been too thick for an analysis performed on modern standards (Azoury, 1971: p.28) and that the possibility of the localization of certain classes of artifacts (Bordes, 1964) cannot be completely excluded, for the materials to be analysed in this study were derived from Squares E4 and F4 only of each level.

Nevertheless, it is hoped that a general tendency of technological progress through time will be detected from the analysis of the lithic artifacts in the present study.

METHOD

The quantity of unbroken lithic artifacts analysed in this study is large, amounting to 8,979; 7,559 broken pieces were excluded from the analysis, for they were too damaged to reveal reliable information. And, it seemed to be unlikely that their technological attributes, most probably linked to each other, would be successfully analysed without the aid of a computer.

A well systematised statistical approach to a large number of lithic artifacts is useful (Bordes, 1964), and in fact Azoury and Hodson (1973) and Newcomer and Hodson (1973) demonstrated the usefulness of a computer in analysing a great number of lithic materials from Ksar Akil.

Therefore, it was felt that the analysis performed in this study would best be aided by a computer.

To realize this, a classification system on the pertinent materials was established, which depended on the present writer's research strategy (Hill and Evans, 1972: p.232) to detect certain technological changes in their manufacture, and the technological attributes for the analysis were either those already established by earlier experimenters in lithic technology or devised by the present writer himself on the basis of his own experiments in flint knapping.

The actual calculations of these technological attributes were performed on the Honeywell DPS 8/70 computer, using the SPSS/X VERSION 2.0 program supplied through the Computer Center, Kokushikan University, Tokyo.

The lithic materials to be analysed in the present study were derived from Squares E4 and F4 of Levels XXV to XIV which were excavated in the 1937/38 field seasons undertaken by the Fordham-Boston College Expeditions.

These materials were kept in hard-paper boxes stored in the Institute of Archaeology, University of London. Each of these boxes was labelled with depth, level, square, and excavation year.

For the analysis in the present study, the pertinent materials were at first classified into debitage, cores, retouched pieces[2], retouch flakes, and hammerstones.

Debitage was further classified into: (1) cortical debitage[3], (2) partially-cortical debitage[4], (3) non-cortical debitage[5] (sub-divided into 1) non-Levallois flake, Levallois flake, and Levallois point, 2) flake-blade (including Levallois blade and elongated Levallois point)[6], 3) blade[7], and 4) bladelet[8]), and (4) crested debitage.

Hammerstones were only checked on their dimension, weight, general shape, wear pattern, and raw material.

<u>Technological attributes for cortical debitage, partially-cortical debitage, non-cortical flake (other than that of Levallois), and crested debitage</u>

1 --- Debitage classes: Cortical debitage, partially-cortical debitage, non-cortical flake, and crested debitage

2 --- Remarks: Traces of hinging removal[9] and its direction

Whether naturally-backed

Whether a Pseudo-Levallois point

Features of cresting: primary, secondary, re-cresting, uni-lateral, and bi-lateral

Whether a change of orientation of debitage

Whether a core tablet

Trace of heat alteration

3 --- Features of butt (Bordes, 1961; 1967: p.44; 1972; Bordes and Crabtree, 1969: p.5): 1 (cortex), 2 (plain), 3 (convex dihedral), 4 (straight multiple facet), 5 (convex multiple facet), 6 (other facet including "chapeau de gendarme" and partial facet (Azoury, 1971), 7 (linear or punctiform butt), 8 (trace of overhang removal and method of its removal such as abrasion or blow), and 9 (broken butt)

4 --- Profile above butt:[10] Straight, Concave, Convex, and Crushed

5 --- Butt thickness at the point of percussion[11]

6 --- Length[12]

7 --- Width[13]

8 --- Thickness[14]

11 --- Flaking mode[15] (checked on fine-grained material only): Harder, Softer, and Questionable

12 --- Dorsal scar pattern:[16] 1 (uni-directional), 2 (bi-directional opposed), 3 (crossed), 4 (centripetal), 5 (with trace of cresting), and 6 (miscellaneous)

13 --- Number of dorsal scar(s)[17]

17 --- Hinged or Plunged

<u>Technological attributes for non-cortical debitage</u>

1 --- Debitage classes: Levallois flake and point, flake-blade, blade, and bladelet

2 --- Remarks: Trace of hinging removal and its direction

Whether naturally-backed

Whether a Pseudo-Levallois point

Whether a change of orientation of debitage

Whether a core tablet

In case of Levallois, which types of debitage: flake, blade, or point

Trace of heat alteration

3 --- Features of butt: 1 (cortex), 2 (plain), 3 (convex dihedral), 4 (straight multiple facet), 5 (convex multiple facet), 6 (other facet including "chapeau de gendarme" and partial facet), 7 (linear or punctiform butt), 8 (trace of overhang removal and method of its removal such as abrasion or blow), and 9 (broken butt)

4 --- Profile above butt: Straight, Concave, Convex, and Crushed

5 --- Butt thickness at the point of percussion

6 --- Length

7 --- Width

8 --- Thickness

9 --- Angle de chasse (formed between dorsal surface and butt)

10 --- Angle d'éclatement (formed between ventral surface and butt)

11 --- Flaking mode: Harder, Softer, and Questionable

12 --- Dorsal scar pattern: 1 (uni-directional), 2 (bi-directional opposed), 3 (crossed), 4 (centripetal), 5 (with trace of cresting), and 6 (miscellaneous)

13 --- Number of dorsal scar(s)

14 --- Number of dorsal plane(s) along longitudinal axis:[18] One, Two, and Three

15 --- Dorsal shape:[19] 1 (parallel), 2 (converging), and 3 (expanding)

16 --- Distal shape:[20] 1 (blunt) and 2 (pointed)

17 --- Hinged or Plunged

18 --- Number of parallel or sub-parallel ridge(s) on blade and bladelet

19 --- Flaking order pattern[21] on Levallois point, flake-blade, blade, and bladelet: A, B, and C

20 --- Location of point of percussion relative to dorsal ridge(s) (Gingell and Harding, 1981):[22] Type A in which point of percussion lies directly behind a clear ridge, Type B in which point of percussion lies to one side of a clear ridge, and Type C in which point of percussion lies between two clear ridges

Technological attributes for cores

With regard to cores, both the core front and core back were analysed. For convenience, the core surface with the most flake scars is treated as the core front, whereas the surface with cortex only or few flake scars is treated as the core back.

3 --- Striking platform connected with final flake scar(s): 1 (cortex), 2 (plain), 3 (convex dihedral), 4 (straight multiple facet), 5 (convex multiple facet), and 6 (broken)

6 --- Length of final flake scar(s)

7 --- Width of final flake scar(s)

15 --- Shape of final flake scar(s): 1 (parallel), 2 (converging), and 3 (expanding)

16 --- Distal shape of final flake scar(s): 1 (blunt) and 2 (pointed)

17 --- Hinging or Plunging for the final flake scar(s)

22 --- Number of recognizable striking platform(s) directly related to negative point of percussion

23 --- Minimum number of flake scar(s) clearly starting from one and the same striking platform

24 --- Location of striking platforms on core with several striking platforms (Tixier, 1963: p.43; 1974a; Bordes and Crabtree, 1969: pp.2-3): 1 (opposed), 2 (opposite rectangular), 3 (opposite alternate), 4 (crossed), 5 (peripheral), and 6 (miscellaneous)

25 --- Scar pattern: 1 (uni-directional), 2 (bi-directional opposed), 3 (crossed), 4 (centripetal), 5 (of a single flake scar), 6 (with the trace of cresting), and 7 (miscellaneous)

26 --- Features of core back: 1 (cortex excluding cortical striking platform), 2 (striking platform only), 3 (core preparation including cresting), 4 (shaping of core back), and 5 (flake scars excluding striking platform)

27 --- Core on nodule or Core on flake (Newcomer and Hivernel-Guerre, 1974)

28 --- Length of core

29 --- Width of core

30 --- Thickness of core

31 --- Remarks (considered mainly on the final detachment(s): Morphological classification into Prismatic, Pyramidal, Bi-pyramidal, Discoidal, Globular, and Miscellaneous cores

Levallois (flake, blade, point) core on the basis of observation of final detachment, and the morphological class on which it is worked

Trace of heat alteration

Possible reason for abandonment

Outline of core: 1 (parallel), 2 (converging), and 3 (expanding)

Techno-typological attributes for retouched pieces

1 --- Debitage classes or material types of the blanks: Cortical debitage, partially-cortical debitage, non-cortical flake, flake-blade, blade, bladelet, crested debitage, core, older debitage, natural stone or debris, and retouch flake

2 --- Remarks: Classes of retouched pieces[23]

Whether on Levallois blanks (flake, blade, or point types)

Trace of hinging removal and its direction

Whether naturally-backed

Whether on a Pseudo-Levallois point

Whether on a core tablet

Whether on crested debitage and features of cresting: Primary, secondary, re-cresting, uni-lateral, and bi-lateral

Trace of heat alteration

11 --- Flaking mode: Harder, Softer, and Questionable

17 --- Hinged or Plunged

19 --- Flaking order pattern in case the blank is a Levallois point: A, B, and C

20 --- Location of point of percussion relative to dorsal ridge(s) in case the blank is a Levallois point: A, B, and C

It may be seen that certain styles of debitage in the pertinent levels, as well as level by level changes in the debitage style, are revealed when the inter-connected aspects of the technological attributes presented above are analysed by computer. This study will also reveal how the raw materials were reduced for the production of desired lithic artifacts at certain levels and how the styles in this reduction sequence changed through time at Ksar Akil.

NOTES

1. The spelling "Ksâr Akil" was adopted by Newcomer (1972) after Delcourt (1927). The present writer also uses this concise spelling throughout this study instead of "Ksār 'Āḳil" (Day, 1926), "Ksar 'Akil" (Murphy, 1938), "Ksar 'Aqil" (Tixier, 1970), or "Ksâr 'Akil" (Ewing, 1947).

2. Retouched pieces may not cover all classes of "tools and/or weapons" (Tixier, 1963: p.43; 1974a), because although the former are believed to have been certain classes of tools/weapons, the latter may not necessarily be retouched. Partly for this reason but chiefly for the reason that it is impossible for the present writer with no experience in micro-wear analysis to determine certain unretouched pieces to be tools and/or weapons, the term "retouched piece" is used throughout this study instead of "tools or weapons". Also, "retouch" for the present writer includes intentional retouch such as shaping retouch and retouch of accommodation and accidental retouch such as traces of utilization, spontaneous retouch, and impact fracture (Tixier, 1963: p.45; 1974a; Bordes, 1967: pp.29-30; Newcomer, 1976; Bergman and Newcomer, 1983).

3. Debitage with cortex on all or almost all of its dorsal surface and butt is defined as cortical debitage in this study. This category is almost identical to Tixier's (1963: p.33; 1974a) "entame (first flake)" but may be detached either at the initial stage of core reduction or at later stages of core modification (Crew, 1976: p.82).

4. Debitage with both cortex and previous flake scars on its dorsal surface is defined as partially-cortical debitage in this study.

5. Non-cortical debitage is defined in this study as bearing previous flake scars on all or almost all of its dorsal surface and butt. It is believed that this debitage class represents later stages of core reduction sequence.

6. Non-cortical elongated debitage except for crested pieces, whose length is equal to or more than twice the width but which does not bear parallel or sub-parallel ridges and edges, is defined in this study as flake-blade. This definition is nearly the same as that of "flake-blade" cited by Bordes (1961: p.6) as being prevalent among the scholars in English-speaking countries.

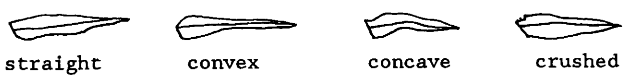
7. In this study, a blade is defined as non-cortical debitage having

parallel or sub-parallel ridges and edges and the length equal to or more than twice the width (Bordes and Crabtree, 1969: p.1; Crabtree, 1972: p.42).

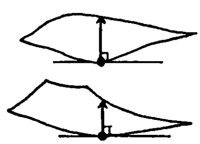
8. Tixier (1963: pp.38-39; 1974a) established a method for differentiating between a blade and a bladelet; a bladelet is restricted to a blade with the width less than 1.2cm. There is, however, no length limit for a bladelet. This method is adopted in the present study in a metrical sense; a bladelet is non-cortical debitage whose ridges and edges are parallel or sub-parallel, whose length is equal to or more than twice the width, and which is narrower than 1.2cm. Also, a blade which is shorter than 5cm is defined as a bladelet in this study (see Tixier, 1963: Fig.7).

9. The way of removing the "hooks" left by hinge fractures seems to suggest a technological device in flaking; in experimental manufacture of flaked lithic artifacts, it is very difficult to remove the hinged part on a core with a blow in the same direction as the hinged flake scar. A blow from the opposite direction, however, makes the removal of the hinged portion far easier (personal communication with Newcomer, 1979). Ways of removing these "hooks", therefore, may show technological progress in the manufacture of flaked lithic artifacts.

10. It appears that the edge between the butt and dorsal surface of debitage shows a certain technique of flaking; the production of a series of regular blades or bladelets, for example, needs the removal of an overhang along core surface-platform line, resulting in making this base profile either straight or convex. This profile is classified into four types: straight, convex, concave, and crushed.



11. Thickness of butt adopted in this study is the dorso-ventral distance at the point of percussion (Wilmsen, 1968: p.984) and therefore does not necessarily coincide with the maximum thickness of butt.



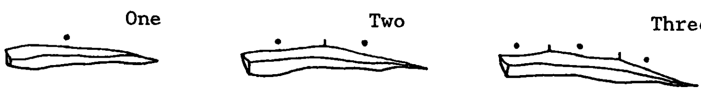
12. 13. 14.
The length, width, and thickness of debitage have been measured in various ways (Bordes, 1961; Wilmsen, 1968; Jelinek, 1975; Marks, 1976; Munday, 1976). In this study, the maximum length is measured from the point of percussion to the point of last detachment from the core (Jelinek, 1975: p.304). The maximum width is measured perpendicular to the maximum length (Bordes, 1961: p.6, and others). The maximum thickness for this study was modified from that of Munday (1976: p.121) and is measured anywhere along the length excluding bulbar area.

15. The term mode was proposed by Newcomer (1975: pp.97-98) for the kind of flaking: hard hammer, soft hammer, and pressure. To determine what kinds of hammers were used by Stone Age people for the production of flaked lithic artifacts, Ohnuma and Bergman (1982) made a study using flakes experimentally produced from fine-grained flint of Suffolk, England, with quartzite hammerstones and antler hammers, and confirmed the usefulness of the following combined criteria for the determination of flaking mode: 1) clear point and clear cone of percussion for the hard hammer mode, 2) pronounced conchoidal fracture marks on the bulb for the hard hammer mode, 3) unlipped butt and pronounced bulb for the hard hammer mode, 4) lipped butt and diffused bulb for the soft hammer mode, and 5) vague point/cone of percussion and diffused bulb for the soft hammer mode. In this study, these five criteria are used for the determination of flaking mode.

16. Dorsal scar pattern is classified in this study into 1) uni-directional (Bordes and Crabtree, 1969: pp.2-3), 2) bi-directional opposed (----: pp.2-3), 3) crossed (Tixier, 1963: p.43; 1974a) with flaking directions more than one and less than four crossing each other obliquely or at right angles, and 4) centripetal (Crew, 1975: p.429) with four directions at least running to the center of the core.

17. It seems likely that the number of dorsal scars shows certain stages of core reduction at which certain types of debitage are detached (Munday, 1976: p.120).

18. The dorsal slope along the longitudinal axis of debitage seems to reflect a certain preparation on the core surface. For example, the debitage from a centripetally prepared core should exhibit a more or less domed dorsal surface, whereas the debitage from a uni-directionally prepared blade core may show a smooth or slightly curved dorsal surface. For this reason, the number of dorsal plane(s) (one, two, or three) along the longitudinal axis of debitage is checked in this study as a technological attribute related to the preparation of the core surface.

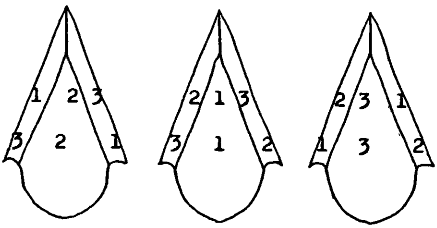


19. Dorsal shape was classified by Marks (1976: p.372) into parallel, converging, and expanding. The first has the lateral edges parallel to each other, the second has the lateral edges converging toward the distal extremity, and the third has the lateral edges expanding toward the distal extremity.

20. Distal shape was classified by Marks (1976: p.372) into "blunt", which ends in a straight, convex, or irregular shape, and "pointed".

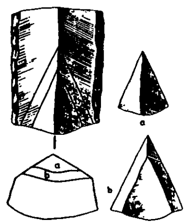
21. Order of flaking in the manufacture of a Levallois point was discussed by Bordes (1961: p.18, p.19). Crew (1976: pp.86-87) set

three patterns of flaking order for the Levallois points from the Mousterian site of Rosh Ein Mor, Israel. Although the flaking order in the manufacture of lithic artifacts may have been directly or indirectly influenced by the personal flaking manner of Stone Age people and by the quality of the raw material or other conditions, it may reflect a certain technological tradition of a Stone Age society. The determination of flaking order starts with observing two adjoining flake scars, and for this purpose the present writer discovered through conjoining experimentally made flakes that the ridge of later-detached flake scar overhangs inwards. A similar observation was made by Crew (personal communication with A.E. Marks in 1981).



A B C

Crew (1976)



Bordes (1961)

22. The relationship between flake shapes and the locations of percussion points relative to the ridges on the cores was studied by Gingell and Harding (1981) based on the analysis of the flakes from the Middle Bronze Age settlement at Bishops Cannings Down, Wiltshire, England, and it was demonstrated that four different locations of points of percussion influenced the shape of the flakes produced: Class Ia where the point of percussion lies directly behind the main ridge and long narrow flakes are produced; Class Ib where the point of percussion lies to one side of the main ridge and flakes slightly broader than Ia flakes are produced; Class II where the point of percussion lies directly behind a previous point of percussion and dished and broad flakes are produced; and Class III where the point of percussion is unrelated to dorsal ridges and short and broad flakes are produced. Because the locations of percussion points were demonstrated to influence the shapes of debitage, they are used, though modified from those mentioned above, for the analysis on the pertinent materials: Type A where point of percussion lies directly behind a clear ridge; Type B where point of percussion lies to one side of a clear ridge; and Type C where point of percussion lies about equidistant between two clear ridges.

23. Fifty-four classes of retouched pieces were established by Azoury (1971) as the type list in her Ph.D. thesis. Because the present study is focused on the technological aspects of the production of debitage as well as the relationship between the retouched pieces

and their blanks, the retouched piece categories for the pertinent materials are treated in a rather general manner. It should be made clear that because the levels to be analysed in the present study (Levels XXV to XIV) are wholly included in those analysed by Azoury in her Ph.D. thesis (Levels XXV to XII), the classes of retouched pieces for the pertinent materials are basically those of Azoury, although Azoury's work on typology is of course more detailed than that presented here. For this reason, main classes of retouched pieces generally have only a few sub-classes.

END-SCRAPERS: "Blade or flake with either distal or proximal end retouched continuously. This retouch is not abrupt" (De Sonneville-Bordes and Perrott, 1954).

1. End-scraper:
   This includes Azoury's type list (1971) Nos. 1, 2, 4, 10, 11, and 54-a)-1): End-scraper, Atypical end-scraper, Ogival end-scraper, Thick-nosed end-scraper, Shouldered end-scraper or thin-nosed end-scraper, and Circular end-scraper, which correspond to the categories of De Sonneville-Bordes and Perrot (1954): *Grattoir simple, Grattoir atypique* with irregular or badly-executed retouch, *Grattoir ogival* whose scraper front is shaped like a broken arch, *Grattoir épais à museau* made on thick debitage and whose scraper front is projected with lamellar retouch like a nose, *Grattoir plat à museau ou à epaulement* made on thin debitage and whose scraper front is shaped like either a nose or a shoulder, and *Grattoir circulaire* retouched around the whole circumference.

2. Double end-scraper:
   This is the type list No. 3 (Double end-scraper) of Azoury (1971) and *Grattoir double* by De Sonneville-Bordes and Perrot (1954) which bears two scraper fronts that oppose each other.

3. End-scraper on a retouched blank:
   This is the type list No. 5 (End-scraper on a retouched flake) of Azoury (1971) and *Grattoir sur lame ou éclat retouchée* of De Sonneville-Bordes and Perrot (1954) which bears continuous retouch on one or two lateral edges.

CHAMFERED PIECES: Newcomer (1970: pp.180-181) described "chamfered piece" as "a flake or blade showing evidence of a variation of the method for producing a burin on retouched truncation and involving two stages: (1) the preparation of an abrupt retouched platform usually at the distal end of a blade or flake and (2) the production of a transverse or clearly oblique facet (chamfer facet) which runs across the dorsal surface of the blade or flake, is slightly arched, sharp edged, and has a negative bulb of percussion adjacent to the retouched platform".

4. Chamfered piece:
   This includes Newcomer's (1970) Chamfer on straight lateral retouched platform, Chamfer on lateral retouched notch, Oblique chamfer on distal retouched notch, and Nosed

chamfered piece.

5. Multiple chamfered piece:
   This is Multiple chamfered piece of Newcomer (1970) with two chamfered edges usually at opposite ends.

BURINS: Twenty-four types of burins from Ksar Akil were analysed in detail by Newcomer (1972) in his Ph. D. thesis. In the present study, burins are basically grouped into three categories: (1) burin on a break on which the burin edge is formed by the intersection of a burin facet(s) and a single fracture plane or natural surface; (2) dihedral burin on which the burin edge is formed by the intersection of two burin facets or two groups of facets; and (3) burin on a retouched truncation on which the burin edge is formed by the intersection of a burin facet(s) and a retouched truncation (Tixier, 1963: p.27; 1974a).

6. Burin on a break:
   This is a burin on which a burin facet(s) and a single fracture plane or natural surface on the blank intersect to form the burin edge. It includes the type list No. 25 (Dihedral angle burin on a break) of Azoury (1971) and *Burin d'angle sur cassure* of De Sonneville-Bordes and Perrot (1956a) with the burin facet(s) running parallel to the burin axis.

7. Dihedral burin:
   This includes the type list Nos. 22 (Dihedral straight burin), 23 (dihedral asymmetrical burin), and 24 (Dihedral angle burin) of Azoury (1971), which correspond to the categories of De Sonneville-Bordes and Perrot (1956a): *Burin dièdre droit* with the bisector of the angle formed by two burin facets or two groups of facets being in line with the burin axis, *Burin dièdre dejété* on which one burin facet or one group of burin facets is clearly more oblique than the other and the bisector of the angle formed by two burin facets or two groups of facets is oblique to the burin axis, and *Burin dièdre d'angle* on which one burin facet or one group of burin facets is parallel to the axis of the burin and the other is at right angles or slightly oblique to the burin axis.

8. Burin on a retouched truncation:
   This includes the type list Nos. 29 (Burin on a straight retouched truncation), 30 (Burin on an oblique retouched truncation), 31 (Burin on a concave retouched truncation), and 32 (Burin on a convex retouched truncation) of Azoury (1971), which correspond to the categories of De Sonneville-Bordes and Perrot (1956a): *Burin sur troncature retouchée droite* with the truncation at right angles to the burin axis, *Burin sur troncature retouchée oblique* with the truncation oblique to the burin axis, *Burin sur troncature retouchée concave* with a concave retouched truncation, and *Burin sur troncature retouchée convexe* with a convex retouched truncation.

9. Multiple truncation burin:
This is the type list No. 33 (Multiple truncation burin) of Azoury (1971) or *Burin multiple sur troncature retouchée* of De Sonneville-Bordes and Perrot (1956a) having multiple burin edges of Class 8 mentioned above.

10. Burin on a lateral preparation:
This is the type list No. 35 (Burin on a lateral preparation) of Azoury (1971) on which a burin facet(s), starting from a lateral preparation at the distal end of the blank, is oblique to the axis of the burin. The lateral preparation is generally fine and partial.

11. Multiple mixed burin:
This is the type list No. 34 (Multiple mixed burin) of Azoury (1971) or *Burin multiple mixte* of De Sonneville-Bordes and Perrot (1956a) having multiple mixed burin edges of Classes 6, 7, 8, and 10 mentioned above.

BACKED, PARTIALLY-BACKED, AND DOUBLE PARTIALLY-BACKED PIECES

12. Backed piece:
This is the type list No. 37 (Backed piece) of Azoury (1971) or *Lame à bord abattu total* of De Sonneville-Bordes and Perrot (1956b) which is backed with more or less abrupt continuous retouch along one or less often two lateral edges. In the present study, this category includes backed pieces which are asymmetrically pointed, on which the bisector of the pointed tip does not coincide with the axis of the piece.

13. Partially-backed piece:
This is the type list No. 38 (Partially-backed piece) of Azoury (1971) or *Lame à bord abattu partiel* of De Sonneville-Bordes and Perrot (1956b) which is only partially backed by more or less abrupt retouch along one lateral edge alone. Partially-backed pieces which are asymmetrically pointed are also included in this category.

14. Double partially-backed piece:
This is the type list No. 39 (Double partially-backed piece) of Azoury (1971) (also included in *Lame a bord abattu partiel* of De Sonneville-Bordes and Perrot (1956b)) which is only partially backed by more or less abrupt retouch along both lateral edges. Again, asymmetrically pointed samples are included in this category.

TRUNCATED PIECES

15. Truncated piece:
This includes the type list Nos. 40 (Straight retouched truncation), 41 (Oblique retouched truncation), 42 (Concave retouched truncation), 43 (Convex retouched truncation), and 52 (Truncated bladelet) of Azoury (1971), which correspond to the categories of De Sonneville-Bordes and Perrot (1956b): *Pièce à troncature droit* on which the truncation is at right

angles to the axis of the piece, *Pièce à troncature oblique* on which the truncation is oblique to the axis of the piece, *Pièce à troncature concave* with a concave truncation, *Pièce à troncature convexe* with a convex truncation, and *Lamelle tronquée* on which one or both (proximal and distal) extremities are truncated by more or less abrupt retouch.

POINTES À FACE PLANE

16. *Pointe à face plane*:
This is *Pointe à face plane* of Azoury (1971: type list No. 46) and De Sonneville-Bordes and Perrot (1954): leaf-shaped piece, symmetrical or asymmetrical, with pointed tip and flat retouch, generally of the Solutrean type, covering all or part of the dorsal surface, especially at the base, tip, and one of the lateral edges, and sometimes with this flat retouch at the base and tip on the ventral surface.

KSAR AKIL POINTS

17. Ksar Akil point:
Azoury (1971: type list No. 36) described the Ksar 'Akil point as a "bladelet, rarely blade, pointed by fine -- rarely semi-abrupt -- bilateral retouch; the retouch on at least one of the edges extends from the tip to the center, sometimes one or both edges are continuously retouched. Sometimes the base has fine normal retouch on one or both edges. Occasionally, the base has inverse retouch on one edge or alternating retouch which may remove the bulb". Later, Bergman (1981) defined Ksar 'Akil point as "a blade pointed by fine, semi-abrupt, or abrupt retouch or combinations of these on the dorsal surface at the distal end. The retouch can be continuous or discontinuous along one or both lateral edges. These points are usually symmetrical -- with pointed tips roughly divided by the long axis of the blade -- and are often straight or only slightly curved in profile". In the present study, a Ksar Akil point is defined as a blade or bladelet with the features of its blank, retouch modification, etc. described by Bergman.

NOTCHED PIECES

18. Notched piece:
This is the type list No. 48 (Notched piece) of Azoury (1971) or *Pièce à encoche* of De Sonneville-Bordes and Perrot (1956b) with one or more retouched notches which are separate and more or less concave.

DENTICULATED PIECES

19. Denticulated piece:
This is the type list No. 49 (Denticulated piece) of Azoury (1971) or *Pièce denticulée* of De Sonneville-Bordes and Perrot (1956b) with a series of small notches which are adjacent or almost adjacent.

SIDE-SCRAPERS

20. Side-scraper:
This is the type list No. 51 (Side-scraper) of Azoury (1971) or *Racloir* of De Sonneville-Bordes and Perrot (1956b) with regular continuous retouch, which may be straight, convex, or concave, along one edge (Single side-scraper) or two edges (Double side-scraper). In the present study, pieces with sub-parallel, semi-abrupt side-scraper retouch as well as pieces with scaled and stepped abrupt retouch are treated as side-scrapers (Tixier, 1963: pp.46-47; 1974a; Bordes, 1961: p.8).

PIECES WITH CONTINUOUS RETOUCH

21. Piece with continuous direct retouch:
This is the type list No. 54-a)-5) (Blade or flake with continuous retouch on one edge - rarely two edges) of Azoury (1971) or *Pièce à retouches continues sur un ou deux bords* of De Sonneville-Bordes and Perrot (1956b) with continuous direct retouch on one or two edges which is neither of abrupt type characterizing backed blades nor of semi-abrupt scaled type characterizing the Aurignacian blades.

22. Piece with continuous inverse retouch:
This is the type list No. 54-a)-5) (Blade or flake with continous retouch on one edge - rarely two edges) of Azoury (1971) or *Pièce à retouches continues sur un ou deux bords* of De Sonneville-Bordes and Perrot (1956b), the retouch of which is inverse.

23. Piece with continuous alternate(ing) retouch:
This is the type list No. 54-b)-1) (Piece with alternate or alternating retouch) of Azoury (1971).

PIECES WITH DISCONTINUOUS RETOUCH

24. Piece with discontinuous direct retouch:
This is the type list No. 54-b)-2) (Piece with discontinuous large, irregular facets on the dorsal surface) of Azoury (1971).

25. Piece with discontinuous inverse retouch:
This is the type list Nos. 53 (Bladelet with discontinuous inverse retouch) and 54-b)-3) (Piece with discontinuous inverse retouch of large, irregular facets) of Azoury (1971).

26. Piece with discontinuous alternate(ing) retouch:
This is the type list No. 54-b)-1) (Piece with alternate or alternating retouch) of Azoury (1971).

DIVERS RETOUCHED PIECES

27. Core-like end-scraper:
    This is the type list No. 54-a)-2) (Core-like end-scraper) of Azoury (1971) or *Grattoir nucléiforme* of De Sonneville-Bordes and Perrot (1954) made on core by the regularization of striking platform. This class of end-scraper, however, may be almost indistinguishable from a core with platform abrasion (Bergman 1987: p.12).

28. Piercer:
    This is the type list No. 21 (Piercer) of Azoury (1971) or *Perçoir* by De Sonneville-Bordes and Perrot (1955) with straight, oblique, or incurved pointed projection, single- or double-shouldered, clearly made by bi-lateral direct retouch or alternate retouch.

29. Bec:
    This is the type list No. 54-a)-3) (Bec) of Azoury (1971) or *Perçoir atypique ou bec* of De Sonneville-Bordes and Perrot (1955) with a thick or large pointed projection made by bilateral retouch.

30. Mousterian point:
    This is the type list No. 54-a)-7) (Mousterian point) of Azoury (1971) which was described in detail by Bordes in 1961.

31. Retouched Levallois point (Bordes, 1961)

32. Splintered piece:
    This is the type list No. 50 (Splintered piece) of Azoury (1971) or *Pièce esquillée* of De Sonneville-Bordes and Perrot (1956b), generally of rectangular or square shape, with uni- or bi-facial splintered traces made by violent percussion at two opposed ends or rarely at four corners.

33. Piece with continuous retouch removing butt:
    Bordes (1972: pp.48-49) classified butts into plain butts including cortex butts, (straight-) faceted butts, convex-faceted butts, convex-dihedral butts, butts taken away by retouch, and broken butts. In the present study, the butt taken away by retouch is included in a retouched piece category under the term "piece with continuous retouch removing butt".

34. Steep scraper

35. Limace (Bordes, 1961)

36. Chopper (Bordes, 1961)

COMPOSITE RETOUCHED PIECES

37. Composite retouched piece:
    Any combination of the retouched pieces mentioned above (Classes 1 to 36) is classified as a composite retouched piece.

UNCLASSIFIABLE RETOUCHED PIECES

38. Unclassifiable retouched piece:
    Any retouched piece which does not fall into the categories of retouched pieces mentioned above (Classes 1 to 37) is treated as an unclassifiable retouched piece.

CHAPTER II

METRICAL AND TECHNO-TYPOLOGICAL FEATURES

This chapter describes the results of the statistical analyses.

The level by level descriptions which follow are the metrical and technological features of the debitage and cores and the techno-typological features of the retouched pieces.

Levels XXV

The materials of this level total 140, comprising debitage, cores, and retouched pieces, and were derived from Square E4 (-15.05m).

DEBITAGE

The debitage totals 57 pieces, of which 28 are broken. The 29 unbroken pieces consist of partially-cortical debitage, non-cortical flakes, flake-blades, bladelets, and crested debitage (Table 1) (Fig. 5).

The butts of the debitage are mainly plain and convex dihedral faceted (Table 2).

One of the butts is accompanied by partially regularizing facet (3.5%).

One of the pieces of debitage is hinged (3.5%), and 1 is plunged (3.5%).

(1) Partially-cortical debitage, non-cortical flakes, and crested debitage: 21 pieces

The profiles above the butts are straight (8: 40.0%), concave (10: 50.0%), and crushed (2: 10.0%).

The mean butt thickness is 6.4mm with the standard deviation (s.d.) of 3.0mm (20 cases), the mean length is 48.4mm with the s.d. of 15.3mm (21 cases), the mean width is 24.7mm with the s.d. of 5.1mm (21 cases), and the mean thickness is 9.5mm with the s.d. of 3.2mm (21 cases).

The flaking modes are Harder (1: 20.0%, Softer (2: 40.0%), and Questionable (2: 40.0%).

The dorsal scar patterns are uni-directional (4: 19.0%), bi-directional opposed (4: 19.0%), crossed (11: 52.4%), and with the trace of cresting (2: 9.5%).

The mean number of dorsal scars is 5.0 with the s.d. of 2.6 (21 cases).

Table 1. Frequencies of Debitage Classes in Level XXV

Category	Frequency	Percent
Partially-cortical debitage	6	20.7
Non-cortical flakes	13	44.8
Flake-blades (including 1 Levallois blade)	7	24.1
Bladelets	1	3.4
Crested debitage	2	6.9
Total	29	99.9

Table 2. Frequencies of Butt Types of Debitage in Level XXV

Category	Frequency	Percent
Plain	10	34.5
Convex dihedral faceted	9	31.0
Straight multiple faceted	4	13.8
Convex multiple faceted	5	17.2
Broken	1	3.5
Total	29	100.0

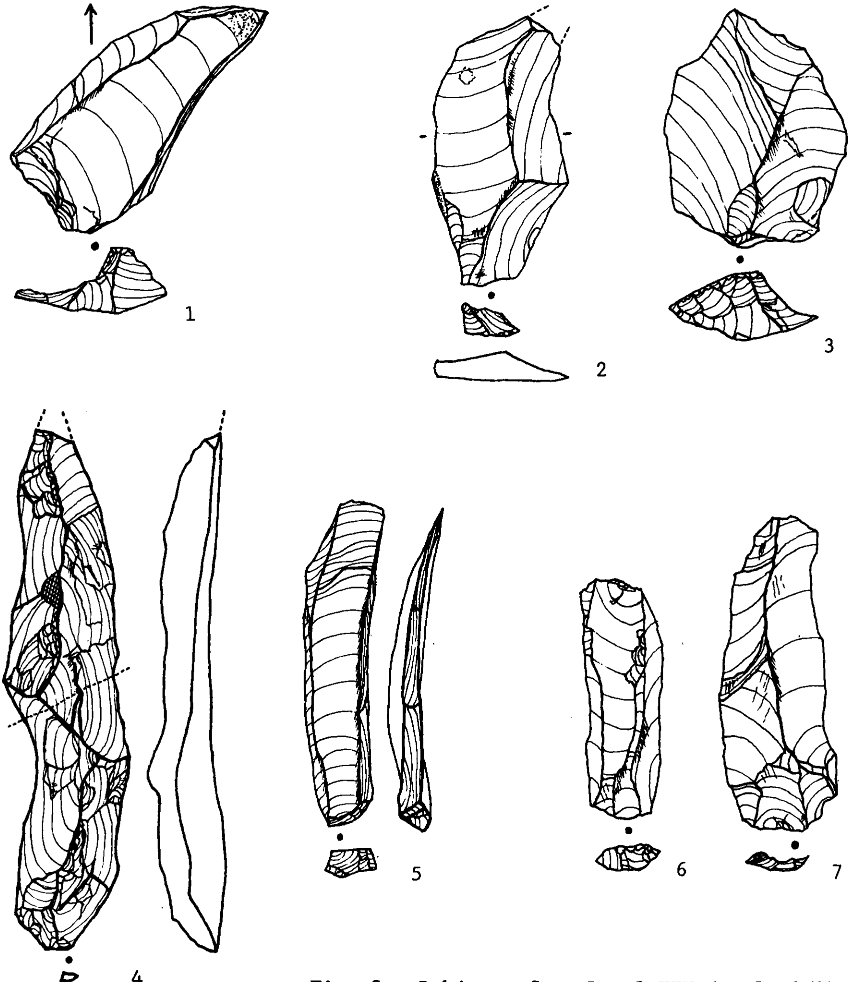


Fig. 5. Debitage from Level XXV (scale 1/1)

●: point of percussion

1. Pseudo-Levallois point
2. Naturally-baoked flake-blade
3. Non-cortical flake
4. Crested debitage
5. Crested debitage
6. Flake-blade
7. Levallois blade

(2) Flake-blades and bladelets: <u>8 pieces</u>

The profiles above the butts are straight (5: 62.5%), concave (1: 12.5%), and crushed (2: 25.0%).

The mean butt thickness is 3.8mm with the s.d. of 1.3mm (8 cases), the mean length is 46.9mm with the s.d. of 6.8mm (8 cases), the mean width is 18.0mm with the s.d. of 3.9mm (8 cases), and the mean thickness is 5.6mm with the s.d. of 1.6mm (8 cases).

The mean *angle de chasse* is 78.9° with the s.d. of 6.7° (8 cases), the mean *angle d'éclatement* is 94.9° with the s.d. of 9.0° (8 cases), and the mean total of the two angles is 173.8° (8 cases).

The flaking modes are Harder (1: 16.7%), Softer (2: 33.3%), and Questionable (3: 50.0%).

The dorsal scar patterns are uni-directional (2: 25.0%), bi-directional opposed (2: 25.0%), crossed (3: 37.5%), and centripetal (1: 12.5%).

The mean number of dorsal scars is 6.1 with the s.d. of 2.4 (8 cases).

The numbers of dorsal planes are two (5: 62.5%) and three (3: 37.5%).

The dorsal shapes are parallel (5: 62.5%) and expanding (3: 37.5%).

The distal shapes are blunt (7: 87.5%) and pointed (1: 12.5%).

The number of parallel or sub-parallel ridges on the bladelet is 2.0.

The flaking order patterns on the flake-blades and bladelets are A (1: 33.3%), B (1: 33.3%), and C (1: 33.3%).

The locations of points of percussion are A (2: 25.0%) and B (6: 75.0%).

One of the flake-blades can be defined as a Levallois blade. Its butt is a convex dihedral facet and its dorsal scar pattern is centripetal. The location of the point of percussion is B.

CORES

The cores total 21 and are classified into five categories (Table 3) (Fig. 6).

The striking platforms for the final flake scars are mainly plain and convex dihedral faceted (Table 4).

The mean length of the final flake scars is 22.2mm with the s.d. of 10.5mm (25 cases), and the mean width is 17.4mm with the s.d. of

Table 3. Frequencies of Core Classes in Level XXV

Category	Frequency	Percent
Prismatic cores	11	52.4
Discoidal cores	4	19.0
Levallois flake cores (on intermediate form between prismatic and discoidal cores)	1	4.8
Pyramidal cores	1	4.8
Miscellaneous cores	4	19.0
Total	21	100.0

Table 4. Frequencies of Striking Platform Types of Cores in Level XXV

Category	Frequency	Percent
Plain	14	50.0
Convex dihedral faceted	10	35.7
Convex multiple faceted	2	7.1
Broken	2	7.1
Total	28	99.9

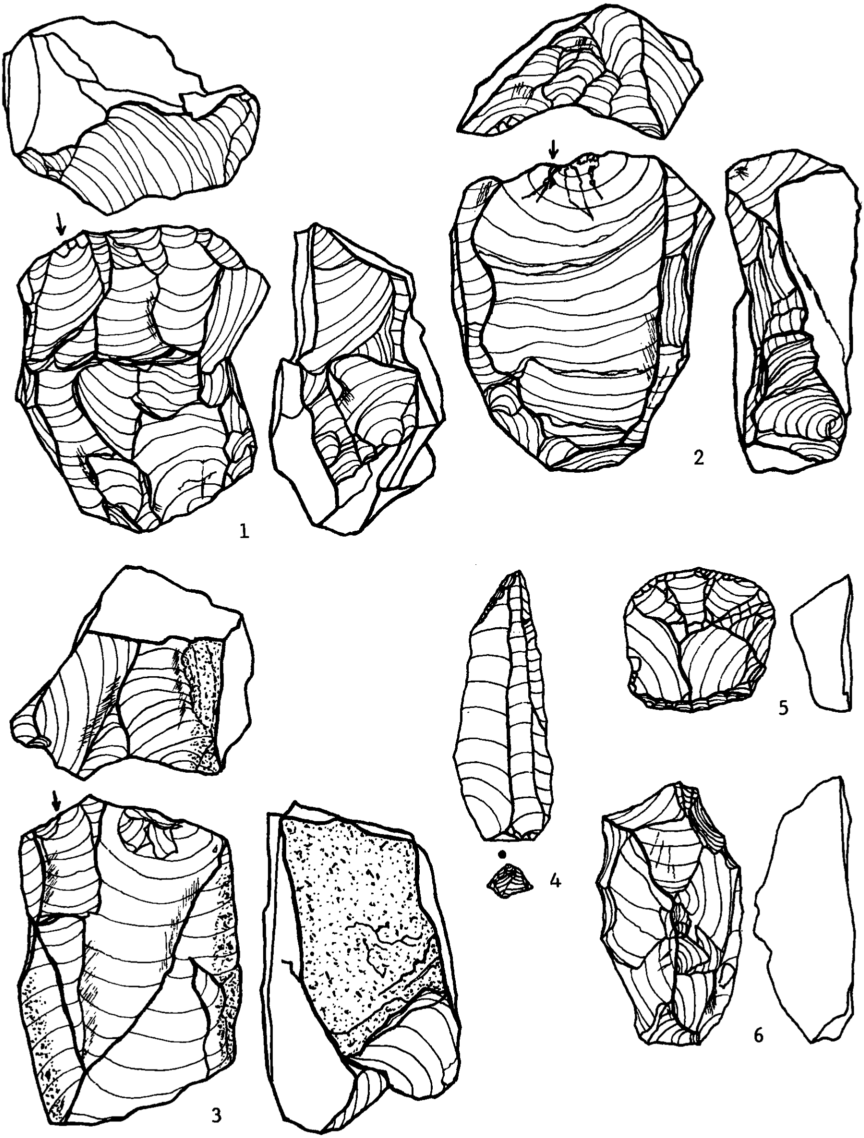


Fig. 6. Cores and retouched pieces from Level XXV (scale 1/1)

↙: final detachment
●: point of percussion

1. Opposed platform prismatic core with the trace of cresting
2. Levallois flake core in the final form
3. Single platform prismatic core on a Levallois point core
4. Partially-backed blade
5. End-scraper on a truncated non-cortical flake
6. Chamfered piece on crested debitage

6.5mm (25 cases).

The shapes of the final flake scars are parallel (7: 28.0%), converging (11: 44.0%), and expanding (7: 28.0%), and the distal shapes are blunt (20: 71.4%) and pointed (8: 28.6%).

Fifteen (53.6%) of the 28 final flake scars are hinged, and 1 (3.6%) is plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.6 with the s.d. of 0.7 (25 cases).

The mean number of flake scars starting from one and the same striking platform is 2.7 with the s.d. of 1.4 (25 cases).

The locations of striking platforms on the cores with several striking platforms are opposed (6: 50.0%), opposite rectangular (1: 8.3%), and crossed (5: 41.7%).

The scar patterns are uni-directional (4: 17.4%), bi-directional opposed (6: 26.1%), crossed (8: 34.8%), centripetal (4: 17.4%), and with the trace of cresting (1: 4.3%).

The backs of the cores are cortex (14: 6.7%), flake scars (5: 23.8%), and miscellaneous (2: 9.5%).

Three of the cores are worked on flakes (14.3%), and the rest (18: 85.7%) are believed to be worked on nodules.

The mean core length is 43.1mm with the s.d. of 7.3mm (21 cases), the mean core width is 35.8mm with the s.d. of 5.3mm (21 cases), and the mean core thickness is 22.8mm with the s.d. of 6.6mm (21 cases).

The overall shapes of the cores are parallel (12: 57.1%), converging (4: 19.0%), expanding (4: 19.0%), and miscellaneous (1: 4.8%).

One core is regarded as having been abandoned because of flaking difficulty due to hinging (4.8%).

RETOUCHED PIECES

The retouched pieces total 62, but 9 of them are broken.

The main categories of the 53 unbroken retouched pieces are the end-scraper and the chamfered piece (Table 5) (Figs. 6 and 7).

The blanks for the retouched pieces are cortical debitage (1: 2.2%), partially-cortical debitage (17: 37.0%), non-cortical flakes (17: 37.0%), flake-blades (7: 15.2%), blades (2: 4.3%), bladelets (1: 2.2%), and crested debitage (1: 2.2%).

The end-scrapers are made on partially-cortical debitage (5: 41.7%), non-cortical flakes (5: 41.7%), and flake-blades (1: 8.3%).

Table 5. Frequencies of Retouched Piece Classes in Level XXV

Category	Frequency	Percent
End-scrapers	12	22.6
Double end-scrapers	3	5.7
Chamfered pieces	20	37.7
Multiple chamfered pieces	2	3.8
Burins on break	1	1.9
Dihedral burins	1	1.9
Burins on retouched truncation	2	3.8
Partially-backed pieces	1	1.9
Truncated pieces	1	1.9
Notched pieces	1	1.9
Pieces with continuous direct retouch	4	7.6
Pieces with continuous inverse retouch	1	1.9
Becs	3	5.7
Composite retouched pieces	1	1.9
Total	53	100.2

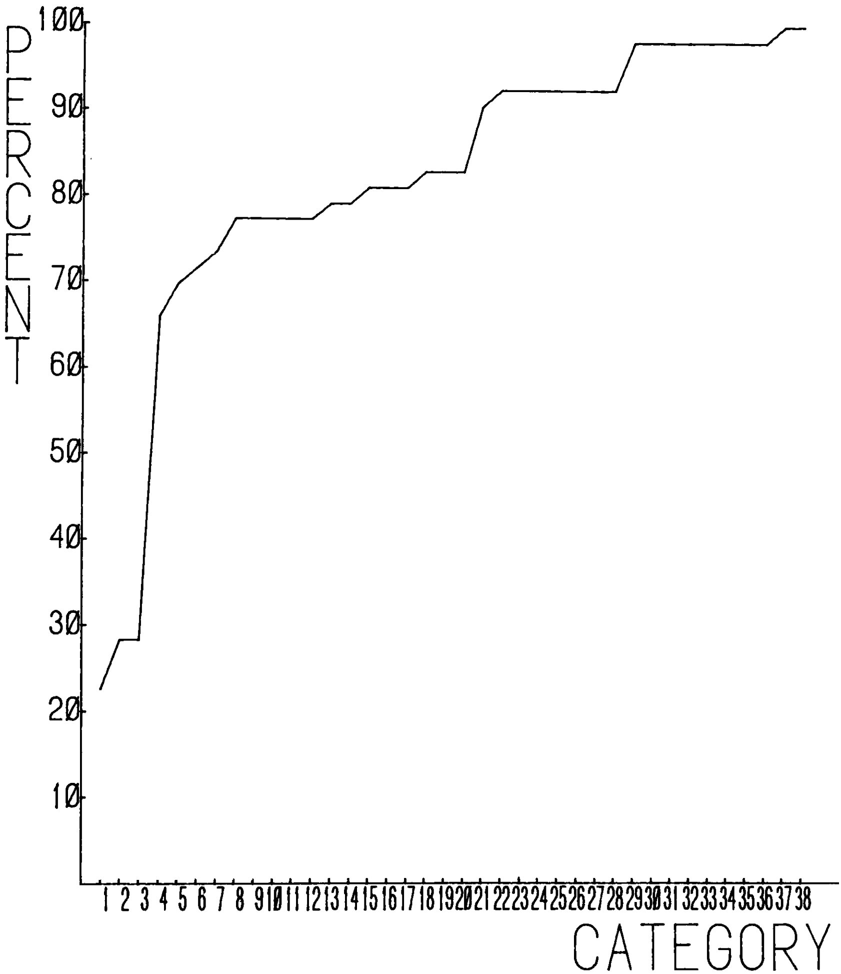


Fig. 7. Cumulative graph of retouched pieces from Level XXV: 53 pieces

The chamfered pieces are made on cortical debitage (1: 5.0%), partially-cortical debitage (3: 15.0%), non-cortical flakes (6: 30.0%), flake-blades (5: 25.0%), blades (1: 5.0%), and crested debitage (1: 5.0%).

Three of the blanks can be defined as Levallois flakes. They were used for double end-scrapers (1), notched pieces (1), and becs (1).

The flaking modes for the blanks are Harder (7: 43.8%), Softer (5: 31.3%), and Questionable (4: 25.0%).

SUMMARY

Level XXV is characterized by non-cortical flakes, prismatic cores, discoidal cores, end-scrapers, and chamfered pieces. The butts of the debitage are most often plain, convex dihedral faceted, or multiple (straight or convex) faceted. The debitage was produced chiefly with softer hammers, and usually has parallel dorsal shape, blunt distal shape, and crossed dorsal scar pattern. The striking platforms of the cores are mainly plain and convex dihedral faceted, and the overall shapes of the cores are normally parallel.

Level XXIV

The materials of this level total 230, comprising debitage, cores, and retouched pieces, and were derived from Squares E4 (-15.05m to -14.50m) and F4 (-15.05m).

DEBITAGE

The debitage totals 68 pieces, but 27 of them are broken. The 41 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, and flake-blades (Table 6) (Fig. 8).

The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted (Table 7).

Eleven of the butts are accompanied by partially regularizing facets (26.8%), and 2 are accompanied by overhang removal by abrasion (4.9%).

Three of the debitage are plunged (7.3%).

(1) Cortical debitage, partially-cortical debitage, and non-cortical flakes: <u>15 pieces</u>

The profiles above the butts are straight (7: 50.0%), concave (2: 14.3%), convex (2: 14.3%), and crushed (3: 21.4%).

The mean butt thickness is 5.4mm with the s.d. of 1.7mm (14 cases), the mean length is 38.3mm with the s.d. of 8.6mm (15 cases), the mean width is 24.6mm with the s.d. of 5.1mm (15 cases), and the mean thickness is 7.7mm with the s.d. of 2.8mm (15 cases).

Table 6. Frequencies of Debitage Classes in Level XXIV

Category	Frequency	Percent
Cortical debitage	1	2.4
Partially-cortical debitage	3	7.3
Non-cortical flakes	11	26.8
Levallois flakes	1	2.4
Flake-blades (including 1 Levallois blade and 2 Levallois points)	25	61.0
Total	41	99.9

Table 7. Frequencies of Butt Types of Debitage in Level XXIV

Category	Frequency	Percent
Cortical	1	2.4
Plain	13	31.7
Convex dihedral faceted	11	26.8
Straight multiple faceted	2	4.9
Convex multiple faceted	12	29.3
Linear	1	2.4
Broken	1	2.4
Total	41	99.9

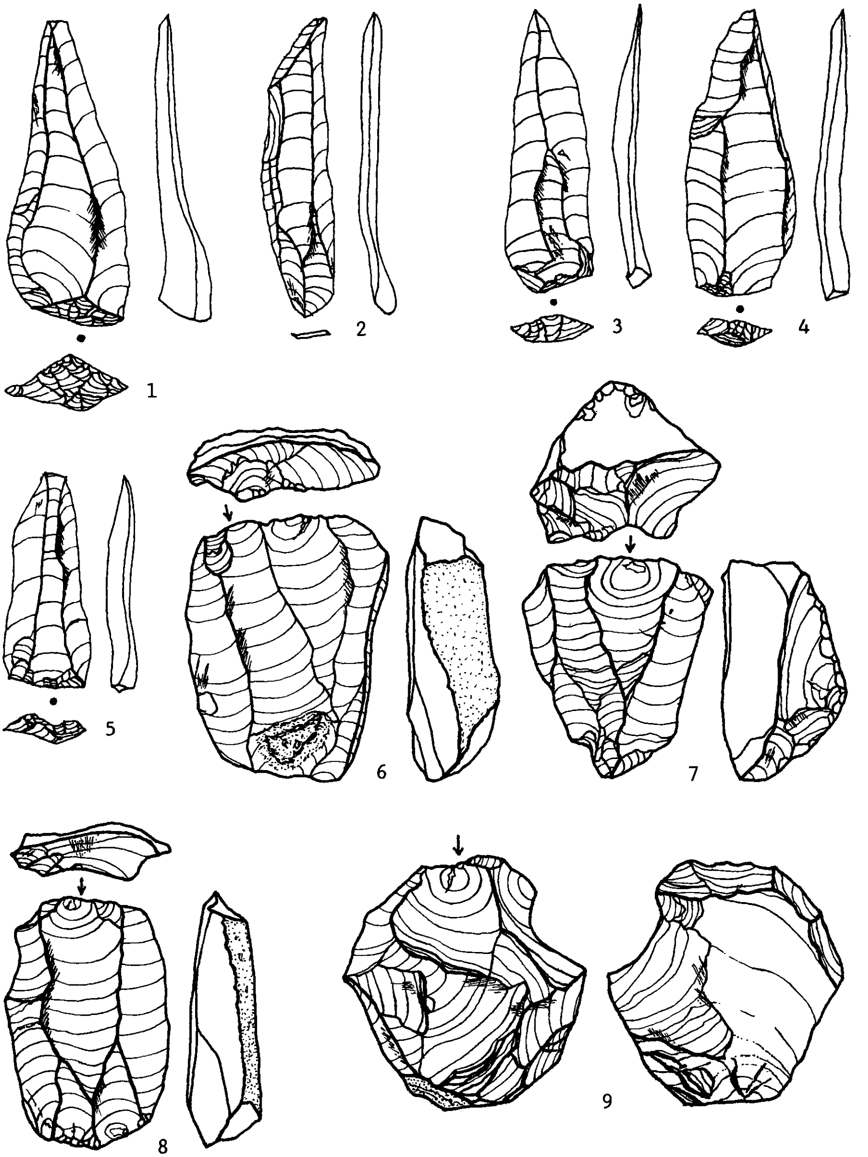


Fig. 8. Debitage and cores from Level XXIV (scale 1/1)

●: point of percussion
↓: final detachment

1. Elongated Levallois point 2. Levallois blade 3. Elongated Levallois point 4. Flake-blade 5. Flake-blade 6. Opposed platform prismatic core 7. Levallois point core in the final form 8. Opposed platform prismatic core 9. Discoidal core on a flake

The flaking modes are Harder (3: 37.5%), Softer (4: 50.0%), and Questionable (1: 12.5%).

The dorsal scar patterns are uni-directional (1: 8.3%), bi-directional opposed (5: 41.7%), and crossed (6: 50.0%).

The mean number of dorsal scars is 4.7 with the s.d. of 1.3 (14 cases).

(2) Levallois flakes and flake-blades: <u>26 pieces</u>

The profiles above the butts are straight (12: 46.2%), concave (13: 50.0%), and crushed (1: 3.8%).

The mean butt thickness is 4.5mm with the s.d. of 1.9mm (26 cases), the mean length is 51.1mm with the s.d. of 10.2mm (26 cases), the mean width is 19.7mm with the s.d. of 3.7mm (26 cases), and the mean thickness is 6.3mm with the s.d. of 2.4mm (26 cases).

The mean *angle de chasse* is 83.6° with the s.d. of 6.5° (24 cases), the mean *angle d'éclatement* is 94.3° with the s.d. of 7.4° (24 cases), and the mean total of the two angles is 177.9° (24 cases).

The flaking modes are Harder (4: 28.6%), Softer (7: 50.0%), and Questionable (3: 21.4%).

The dorsal scar patterns are uni-directional (10: 40.0%), bi-directional opposed (6: 24.0%), crossed (8: 32.0%), and centripetal (1: 4.0%).

The mean number of dorsal scars is 5.5 with the s.d. of 1.6 (26 cases).

The numbers of dorsal planes are One (6: 23.1%) and Two (20: 76.9%).

The dorsal shapes are parallel (8: 30.8%), converging (15: 57.7%), and expanding (3: 11.5%).

The distal shapes are blunt (13: 54.2%) and pointed (11: 45.8%).

The flaking order patterns on the flake-blades are A (6: 46.2%), B (4: 30.8%), and C (3: 23.1%).

The locations of points of percussion are A (7: 26.9%), B (13: 50.0%), and C (6: 23.1%).

The Levallois flake has a plain butt and its dorsal scar pattern is centripetal. The location of point of percussion is C.

One of the flake-blades can be considered to be a Levallois blade. It has a butt of convex dihedral facet. Its dorsal scar pattern is crossed and flaking order pattern is B. The location of point of percussion is C.

Two of the flake-blades are Levallois points. Their butts consist of convex dihedral facets (1) and of convex multiple facets (1). Their dorsal scar pattern is uni-directional and flaking order pattern is A. The locations of points of percussion are A (1) and B (1).

CORES

The cores total 40, but 1 of them is broken. The 39 unbroken cores are classified into 6 categories (Table 8) (Fig. 8).

The striking platforms for the final flake scars are mainly plain (Table 9).

The mean length of the final flake scars is 25.3mm with the s.d. of 12.2mm (46 cases), and the mean width is 16.8mm with the s.d. of 6.7mm (46 cases).

The shapes of the final flake scars are parallel (26: 56.5%), converging (9: 19.6%), and expanding (11: 23.9%), and the distal shapes are blunt (37: 80.4%) and pointed (9: 19.6%).

Twenty-four (44.4%) of the 54 final flake scars are hinged, and 1 (1.9%) is plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.7 with the s.d. of 0.7 (49 cases).

The mean number of flake scars from one and the same striking platform is 3.4 with the s.d. of 1.6 (48 cases).

The locations of striking platforms are opposed (11: 36.7%), opposite rectangular (3: 10.0%), opposite alternate (5: 16.7%), crossed (9: 30.0%), and miscellaneous (2: 6.7%).

The scar patterns are uni-directional (11: 23.4%), bi-directional opposed (18: 38.3%), crossed (12: 25.5%), centripetal (2: 4.3%), and miscellaneous (4: 8.5%).

The backs of the cores are cortex (18: 46.2%), striking platforms (5: 12.8%), core preparation (2: 5.1%), shaping of core back (13: 33.3%), and miscellaneous (1: 2.6%).

Two of the cores are clearly worked on nodules (5.1%), 2 are worked on flakes (5.1%), and the rest (35: 89.7%) are believed to be worked on nodules.

The mean core length is 46.9mm with the s.d. of 11.9mm (39 cases), the mean core width is 37.5mm with the s.d. of 10.8mm (39 cases), and the mean core thickness is 24.1mm with the s.d. of 9.8mm (39 cases).

The overall shapes of the cores are parallel (26: 66.7%), converging (12: 30.8%), and miscellaneous (1: 2.6%).

Three cores were most probably abandoned because of hinging

Table 8. Frequencies of Core Classes in Level XXIV

Category	Frequency	Percent
Prismatic cores	19	48.7
Discoidal cores	2	5.1
Levallois blade cores (on prismatic cores)	2	5.1
Globular cores	1	2.6
Levallois point cores (on prismatic cores)	1	2.6
Miscellaneous cores	14	35.9
Total	39	100.0

Table 9. Frequencies of Striking Platform Types of Cores in Level XXIV

Category	Frequency	Percent
Cortical	2	4.3
Plain	27	57.4
Convex dihedral faceted	10	21.3
Convex multiple faceted	8	17.0
Total	47	100.0

(7.7%).

RETOUCHED PIECES

The retouched pieces total 122, of which 18 are broken.

The main categories of the 104 unbroken retouched pieces are the chamfered piece and the piece with continuous direct retouch (Table 10) (Figs. 9 and 10).

The blanks for the retouched pieces are cortical debitage (1: 1.0%), partially-cortical debitage (10: 10.4%), non-cortical flakes (44: 45.8%), flake-blades (32: 33.3%), blades (3: 3.1%), bladelets (1: 1.0%), crested debitage (4: 4.2%), and retouch flakes (1: 1.0%).

The chamfered pieces are made on partially-cortical debitage (3: 8.1%), non-cortical flakes (15: 40.5%), flake-blades (16: 43.2%), and blades (2: 5.4%). The pieces with continuous direct retouch are on partially-cortical debitage (1: 6.3%), non-cortical flakes (11: 68.8%), and flake-blades (3: 18.8%).

Two of the blanks are Levallois flakes and were used for end-scrapers (1) and pieces with continuous alternate(ing) retouch (1). Two of the blanks are Levallois blades and were used for chamfered pieces (1) and piercers (1). Three of the blanks are naturally-backed and were used for chamfered pieces (1), burins on lateral preparation (1), and notched pieces (1).

The flaking modes for the blanks are Harder (15: 31.9%), Softer (22: 46.8%), and Questionable (10: 21.3%).

SUMMARY

Level XXIV is characterized by non-cortical flakes, flake-blades, prismatic cores, and chamfered pieces. The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted. The debitage was produced chiefly with softer hammers, and usually has converging dorsal shape and blunt or pointed distal shape. The dorsal scar patterns of the debitage are uni-directional, bi-directional opposed, and crossed. The striking platforms of the cores are mainly plain, convex dihedral faceted, and convex multiple faceted, and the usual overall shapes of the cores are parallel. The features of this level which differentiate it from Level XXV are the increases in flake-blades, debitage with converging dorsal shape, and debitage with pointed distal shape as well as the decrease in end-scrapers.

Level XXIII

The materials of this level total 1,486, comprising debitage, cores, retouched pieces, retouch flakes, and hammerstones, and were derived from Squares E4 (-14.50m to -14.40m) and F4 (-15.05m to -14.50m).

Table 10. Frequencies of Retouched Piece Classes in Level XXIV

Category	Frequency	Percent
End-scrapers	6	5.8
End-scrapers on retouched blanks	1	1.0
Chamfered pieces	37	35.6
Multiple chamfered pieces	1	1.0
Burins on break	3	2.9
Burins on lateral preparation	3	2.9
Multiple mixed burins	1	1.0
Partially-backed pieces	2	1.9
Truncated pieces	5	4.8
Notched pieces	2	1.9
Pieces with continuous direct retouch	16	15.4
Pieces with continuous alternate(ing) retouch	1	1.0
Pieces with discontinuous direct retouch	1	1.0
Pieces with discontinuous alternate(ing) retouch	1	1.0
Piercers	1	1.0
Becs	1	1.0
Retouched Levallois points	2	1.9
Splintered pieces	1	1.0
Pieces with continuous retouch removing butt	1	1.0
Steep scrapers	1	1.0
Composite retouched pieces	17	16.4
Total	104	100.5

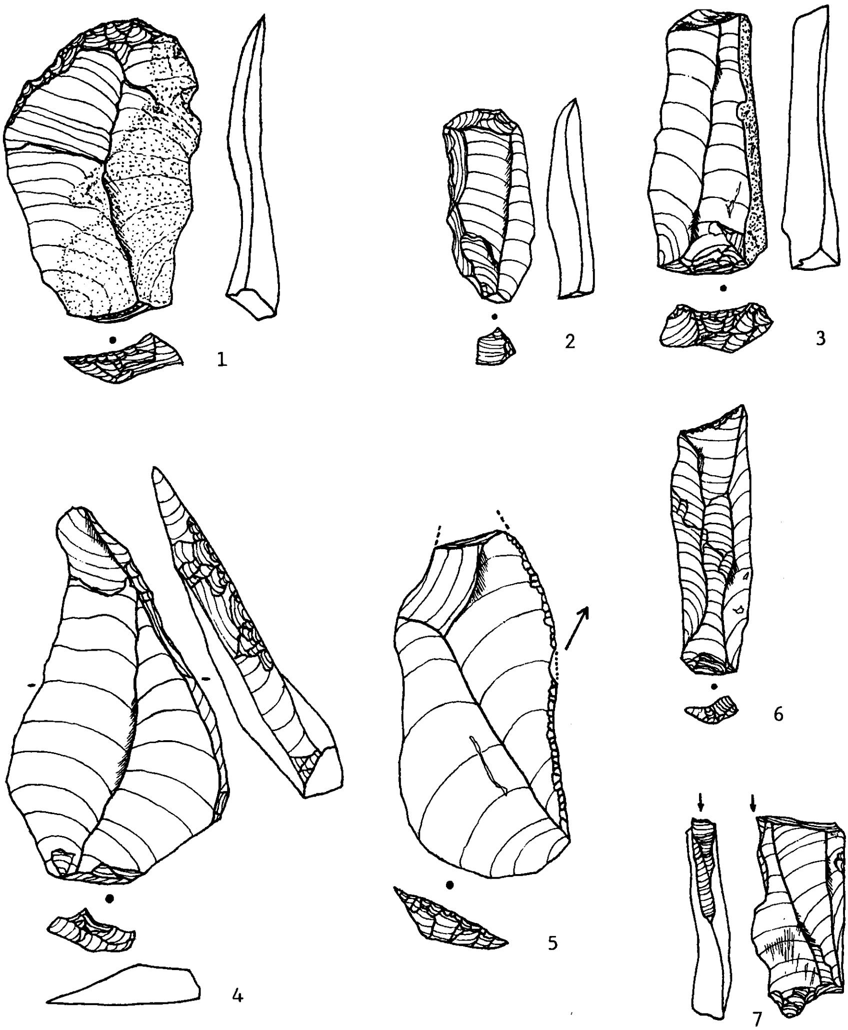


Fig. 9. Retouched pieces from Level XXIV (scale 1/1)

●: point of percussion

1. End-scraper on a non-cortical flake
2. Chamfered piece on a backed flake-blade
3. Chamfered piece on a blade
4. Partially-backed non-cortical flake
5. Flake-blade with continuous direct retouch
6. Truncated piece
7. Burin on a break on a flake-blade with continuous retouch removing butt

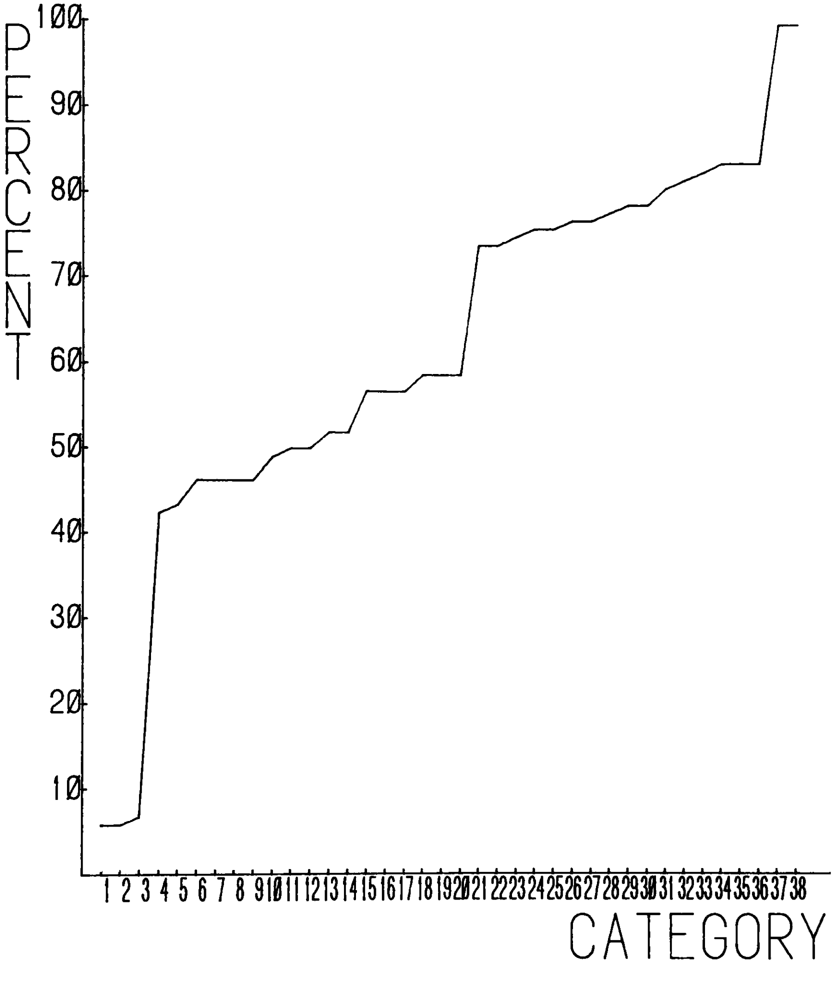


Fig. 10. Cumulative graph of retouched pieces from Level XXIV: 104 pieces

DEBITAGE

The debitage totals 788 pieces, of which 492 are broken. The 296 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, bladelets, and crested debitage (Table 11) (Fig. 11).

The butts of the debitage are mainly plain and convex dihedral faceted (Table 12).

One hundred and five of the butts are accompanied by partially regularizing facets (35.5%), 5 are accompanied by overhang removal by abrasion (1.7%), and 2 are accompanied by overhang removal by blow (0.7%).

Thirteen of the debitage are hinged (4.4%), and 14 are plunged (4.7%).

(1) Cortical debitage, partially-cortical debitage, non-cortical flakes, and crested debitage: <u>91 pieces</u>

The profiles above the butts are straight (25: 27.8%), concave (48: 53.3%), convex (3: 3.3%), and crushed (14: 15.6%).

The mean butt thickness is 6.1mm with the s.d. of 2.7mm (90 cases), the mean length is 43.6mm with the s.d. of 13.2mm (91 cases), the mean width is 27.7mm with the s.d. of 9.9mm (91 cases), and the mean thickness is 9.0mm with the s.d. of 3.5mm (91 cases).

The flaking modes are Harder (14: 31.8%), Softer (21: 47.7%), and Questionable (9: 20.5%).

The dorsal scar patterns are uni-directional (36: 45.0%), bi-directional opposed (18: 22.5%), crossed (25: 31.3%), and with the trace of cresting (1: 1.3%).

The mean number of dorsal scars is 3.8 with the s.d. of 1.8 (91 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: <u>205 pieces</u>

The profiles above the butts are straight (45: 22.7%), concave (145: 73.2%), and crushed (8: 4.0%).

The mean butt thickness is 5.1mm with the s.d. of 2.1mm (196 cases), the mean length is 51.7mm with the s.d. of 11.7mm (205 cases), the mean width is 20.0mm with the s.d. of 5.1mm (205 cases), and the mean thickness is 6.7mm with the s.d. of 2.1mm (205 cases).

The mean *angle de chasse* is 81.4° with the s.d. of 7.5° (180 cases), the mean *angle d'éclatement* is 90.5° with the s.d. of 8.7° (180 cases), and the mean total of the two angles is 171.9° (180 cases).

Table 11. Frequencies of Debitage Classes in Level XXIII

Category	Frequency	Percent
Cortical debitage	1	0.3
Partially-cortical debitage	21	7.1
Non-cortical flakes	67	22.6
Levallois flakes	6	2.0
Levallois points	8	2.7
Flake-blades (including 18 Levallois blades and 25 Levallois points)	138	46.6
Blades (including 1 Levallois point)	31	10.5
Bladelets (including 1 Levallois point)	22	7.4
Crested debitage	2	0.7
Total	296	99.9

Table 12. Frequencies of Butt Types of Debitage in Level XXIII

Category	Frequency	Percent
Cortical	5	1.7
Plain	80	27.0
Convex dihedral faceted	102	34.5
Straight multiple faceted	11	3.7
Convex multiple faceted	44	14.9
Partially faceted	21	7.1
Linear	17	5.7
Punctiform	3	1.0
Broken	13	4.4
Total	296	100.0

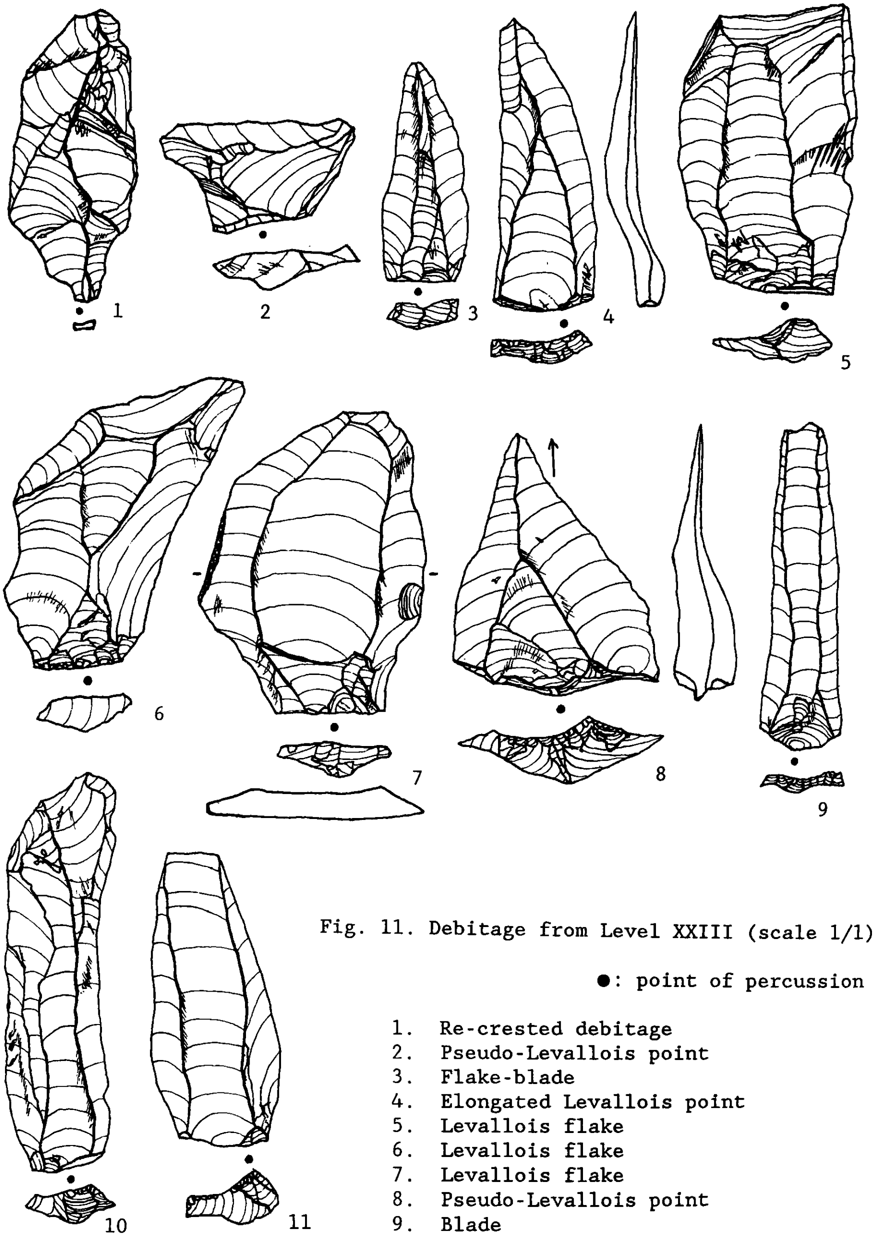


Fig. 11. Debitage from Level XXIII (scale 1/1)

●: point of percussion

1. Re-crested debitage
2. Pseudo-Levallois point
3. Flake-blade
4. Elongated Levallois point
5. Levallois flake
6. Levallois flake
7. Levallois flake
8. Pseudo-Levallois point
9. Blade
10. Levallois blade
11. Blade

The flaking modes are Harder (22: 20.6%), Softer (59: 55.1%), and Questionable (26: 24.3%).

The dorsal scar patterns are uni-directional (74: 38.9%), bi-directional opposed (52: 27.4%), and crossed (64: 33.7%).

The mean number of dorsal scars is 4.5 with the s.d. of 1.6 (202 cases).

The numbers of dorsal planes are One (54: 26.5%), Two (137: 67.2%), and Three (13: 6.4%).

The dorsal shapes are parallel (70: 34.1%), converging (188: 57.6%), and expanding (17: 8.3%).

The distal shapes are blunt (91: 45.5%) and pointed (109: 54.5%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 2.0 with the s.d. of 0.6 (53 cases).

The flaking order patterns on the Levallois points, flake-blades, blades, and bladelets are A (51: 48.1%), B (37: 34.9%), and C (18: 17.0%).

The locations of points of percussion are A (40: 21.3%), B (95: 50.5%), and C (53: 28.2%).

The Levallois flakes have plain butts (2), butts of convex dihedral facets (3), and butts of convex multiple facets (1). Their dorsal scar patterns are bi-directional opposed (3) and crossed (3), and the locations of points of percussion are A (1), B (4), and C (1).

Eighteen of the flake-blades can be considered to be Levallois blades. Their butts are plain (5: 27.8%), of convex dihedral facets (7: 38.9%), of straight multiple facets (2: 11.1%), of convex multiple facets (2: 11.1%), linear (1: 5.6%), and broken (1: 5.6%). Their dorsal scar patterns are bi-directional opposed (7: 38.9%) and crossed (11: 61.1%). The flaking order patterns are A (2), B (4), and C (2), and the locations of points of percussion are A (2: 12.5%), B (5: 31.3%), and C (9: 56.3%).

The Levallois points total 35; 25 (71.4%) of them are flake-blades, 1 (2.9%) may be a blade, and 1 (2.9%) may be a bladelet. Their butts are plain (6: 17.1%), of convex dihedral facets (16: 45.7%), of straight multiple facets (3: 8.6%), of convex multiple facets (5: 14.3%), of partial facets (2: 5.7%), linear (2: 5.7%), and broken (1: 2.9%). Their dorsal scar patterns are uni-directional (24: 68.6%), bi-directional opposed (5: 14.3%), and crossed (6: 17.1%). The flaking order patterns are A (14: 53.8%), B (8: 30.8%), and C (4: 15.4%). The locations of points of percussion are A (4: 11.8%), B (14: 41.2%), and C (16: 47.1%).

CORES

There are 128 cores, of which 23 are broken. The 105 unbroken cores are classified into 6 categories (Table 13) (Figs. 12 and 13).

The striking platforms for the final flake scars are mainly plain and convex dihedral faceted (Table 14).

The mean length of the final flake scars is 24.0mm with the s.d. of 11.0mm (150 cases), and the mean width is 16.2mm with the s.d. of 6.2mm (150 cases).

The shapes of the final flake scars are parallel (71: 47.3%), converging (40: 26.7%), and expanding (39: 26.0%), and the distal shapes are blunt (115: 76.7%) and pointed (35: 23.3%).

Seventy-four (48.7%) of the 152 final flake scars are hinged, and 1 (0.7%) is plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.6 with the s.d. of 0.7 (110 cases).

The mean number of flake scars from one and the same striking platform is 3.4 with the s.d. of 1.5 (109 cases).

The locations of striking platforms are opposed (18: 33.3%), opposite rectangular (9: 16.7%), opposite alternate (5: 9.3%), crossed (7: 13.0%), alternating (8: 14.8%), and miscellaneous (7: 13.0%).

The scar patterns are uni-directional (35: 31.8%), bi-directional opposed (36: 32.7%), crossed (38: 34.5%), and miscellaneous (1: 0.9%).

The backs of the cores are cortex (57: 54.3%), striking platforms (2: 1.9%), flake scars (23: 21.9%), and miscellaneous (23: 21.9%).

Four of the cores are clearly worked on nodules (3.8%), 4 are worked on flakes (3.8%), and the rest (97: 92.4%) are believed to be worked on nodules.

The mean core length is 46.6mm with the s.d. of 11.0mm (105 cases), the mean core width is 37.0mm with the s.d. of 10.6mm (105 cases), and the mean core thickness is 25.3mm with the s.d. of 9.3mm (105 cases).

The overall shapes of the cores are parallel (47: 44.8%), converging (50: 47.6%), and miscellaneous (8: 7.6%).

Eighteen cores were most probably abandoned because of hinging (17.1%).

Table 13. Frequencies of Core Classes in Level XXIII

Category	Frequency	Percent
Prismatic cores (including 7 cores converted from Levallois blade cores)	74	70.5
Discoidal cores	5	4.8
Levallois point cores (on prismatic cores)	3	2.9
Pyramidal cores	2	1.9
Levallois flake cores (on discoidal cores)	1	1.0
Miscellaneous cores	20	19.0
Total	105	100.1

Table 14. Frequencies of Striking Platform Types of Cores in Level XXIII

Category	Frequency	Percent
Cortical	6	4.0
Plain	71	47.3
Convex dihedral faceted	52	34.7
Straight multiple faceted	6	4.0
Convex multiple faceted	13	8.7
Broken	2	1.3
Total	150	100.0

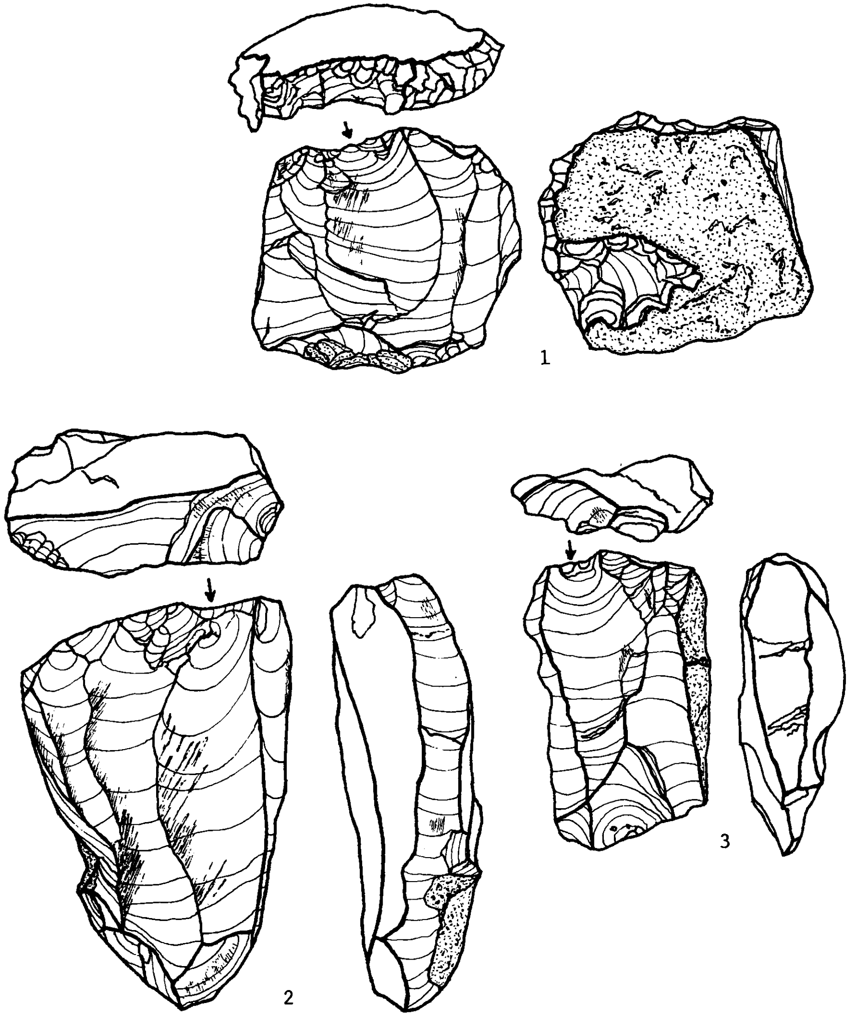


Fig. 12. Cores from Level XXIII (scale 1/1)

↓: final detachment

1. Discoidal core
2. Single platform prismatic core
3. Levallois point core in the final form

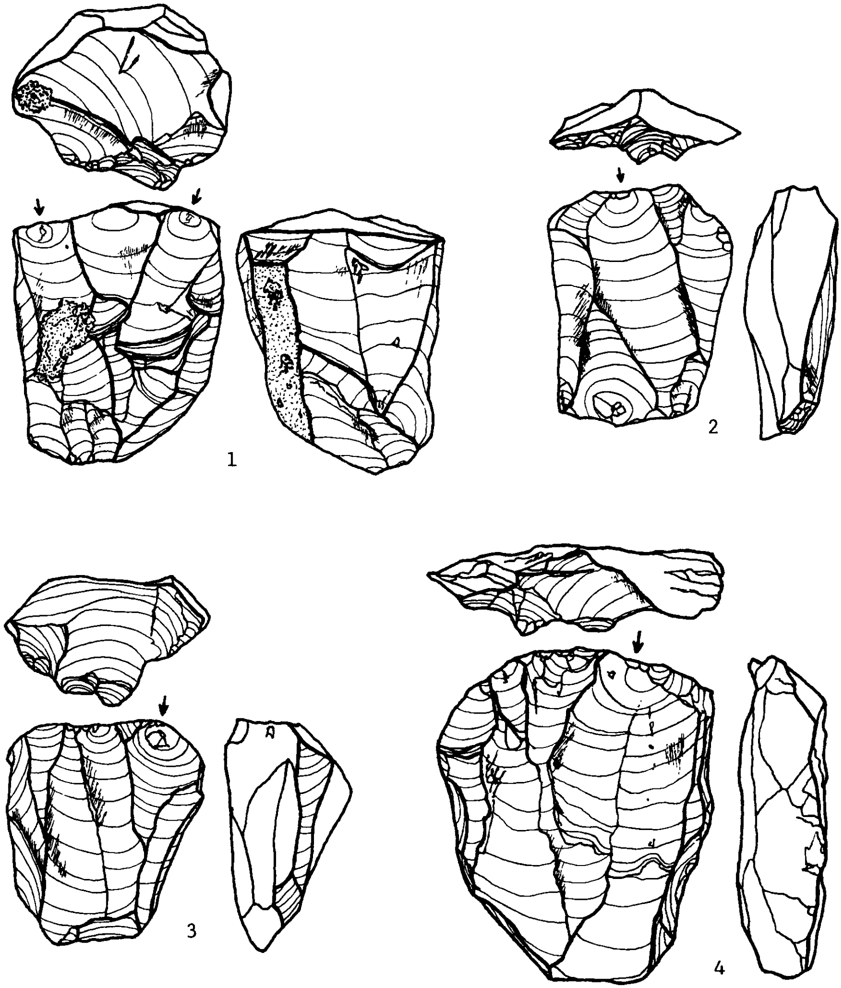


Fig. 13. Cores from Level XXIII (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core
2. Opposed platform prismatic core approaching a Levallois blade core
3. Opposed platform prismatic core approaching a Levallois blade core
4. Levallois blade core in the final form

RETOUCHED PIECES

The retouched pieces total 558, of which 150 are broken.

The main categories of the 408 unbroken retouched pieces are the end-scraper and the chamfered piece (Table 15) (Figs. 14 to 16).

The blanks for the retouched pieces are cortical debitage (9: 2.3%), partially-cortical debitage (59: 14.9%), non-cortical flakes (167: 42.2%), flake-blades (106: 26.8%), blades (26: 6.6%), bladelets (6: 1.5%), crested debitage (11: 2.8%), cores (3: 0.8%), older debitage (5: 1.3%), natural stones (1: 0.3%), and retouch flakes (3: 0.8%).

The end-scrapers are made on cortical debitage (3: 9.1%), partially-cortical debitage (6: 18.2%), non-cortical flakes (10: 30.3%), flake-blades (7: 21.2%), blades (1: 3.0%), bladelets (3: 9.1%), and crested debitage (2: 6.1%). The chamfered pieces are made on cortical debitage (2: 1.1%), partially-cortical debitage (26: 14.2%), non-cortical flakes (83: 45.4%), flake-blades (53: 29.0%), blades (9: 4.9%), bladelets (3: 1.6%), crested debitage (1: 0.5%), and older debitage (4: 2.2%).

Nine of the blanks are Levallois flakes and were used for end-scrapers (2), chamfered pieces (6), and pieces with continuous direct retouch (1). Eleven of the blanks are Levallois blades and were used for end-scrapers (1), chamfered pieces (2), burins on lateral preparation (1), pieces with continuous direct retouch (3), pieces with discontinuous inverse retouch (1), composite retouched pieces (2), and unclassifiable retouched pieces (1). Sixteen of the blanks are Levallois points and were used for chamfered pieces (8), burins on break (1), burins on lateral preparation (2), partially-backed pieces (1), notched pieces (1), pieces with continuous direct retouch (1), retouched Levallois points (1), and composite retouched pieces (1). Twenty-four of the blanks are naturally-backed and were mainly used for chamfered pieces (11: 45.8%).

The flaking modes for the blanks are Harder (44: 30.1%), Softer (74: 50.7%), and Questionable (28: 19.2%).

RETOUCH FLAKES

The retouch flakes total 11: 1 is a burin spall, 2 are chamfer spalls, and 8 are re-sharpening spalls of chamfered pieces.

HAMMERSTONES

One limestone-like nodule, which is broken and bears some traces of battering on its tip, was most probably a hammerstone. It weighs 121.2g. It is 64mm long, 58mm wide, and 37mm thick (Fig. 15).

SUMMARY

Level XXIII is characterized by non-cortical flakes, flake-blades, prismatic cores, end-scrapers, and chamfered pieces. A considerable number of Levallois blades and points are included in the flake-blades.

Table 15. Frequencies of Retouched Piece Classes in Level XXIII

Category	Frequency	Percent
End-scrapers	33	8.1
Double end-scrapers	2	0.5
Chamfered pieces	183	44.9
Multiple chamfered pieces	5	1.2
Burins on break	14	3.4
Burins on retouched truncation	22	5.4
Multiple truncation burins	2	0.5
Burins on lateral preparation	19	4.7
Multiple mixed burins	5	1.2
Partially-backed pieces	2	0.5
Truncated pieces	2	0.5
Notched pieces	4	1.0
Denticulated pieces	1	0.3
Side-scrapers	5	1.2
Pieces with continuous direct retouch	20	4.9
Pieces with continuous inverse retouch	1	0.3
Pieces with discontinuous direct retouch	5	1.2
Pieces with discontinuous inverse retouch	2	0.5
Becs	2	0.5
Mousterian points	1	0.3
Retouched Levallois points	1	0.3
Splintered pieces	1	0.3
Steep scrapers	10	2.5
Composite retouched pieces	64	15.7
Unclassifiable retouched pieces	2	0.5
Total	408	100.4

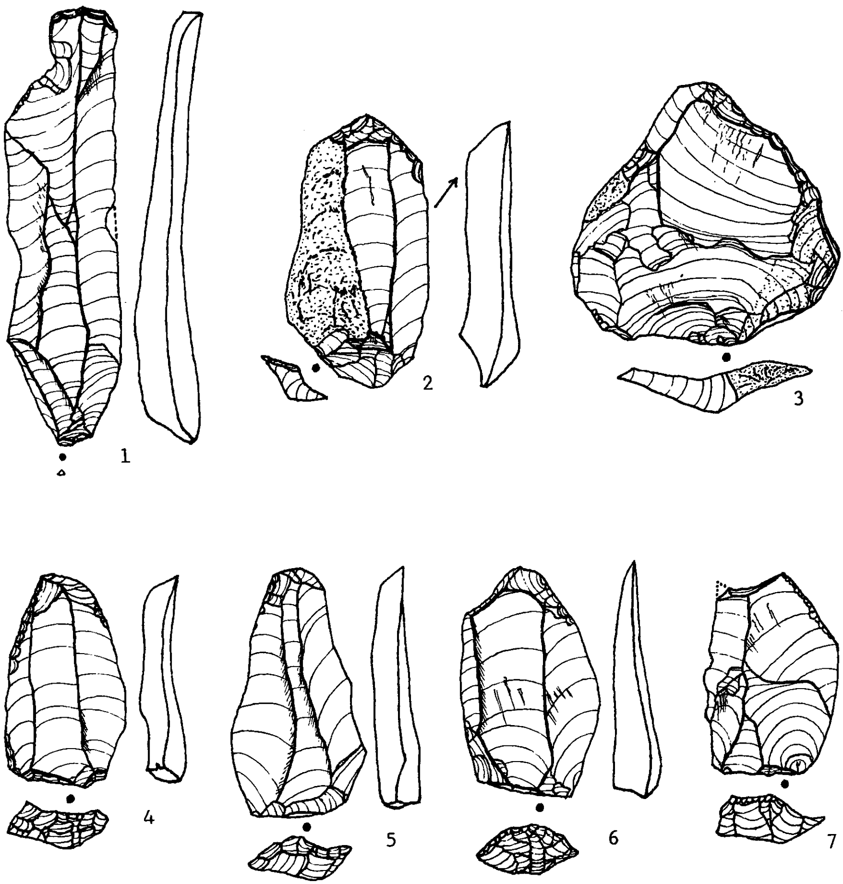


Fig. 14. Retouched pieces from Level XXIII (scale 1/1)

●: point of percussion

1. End-scraper on a blade
2. End-scraper on partially-cortical debitage
3. Chamfered piece on a non-cortical flake
4. Chamfered piece
5. Chamfered piece on a Levallois point
6. Chamfered piece
7. Probable bec

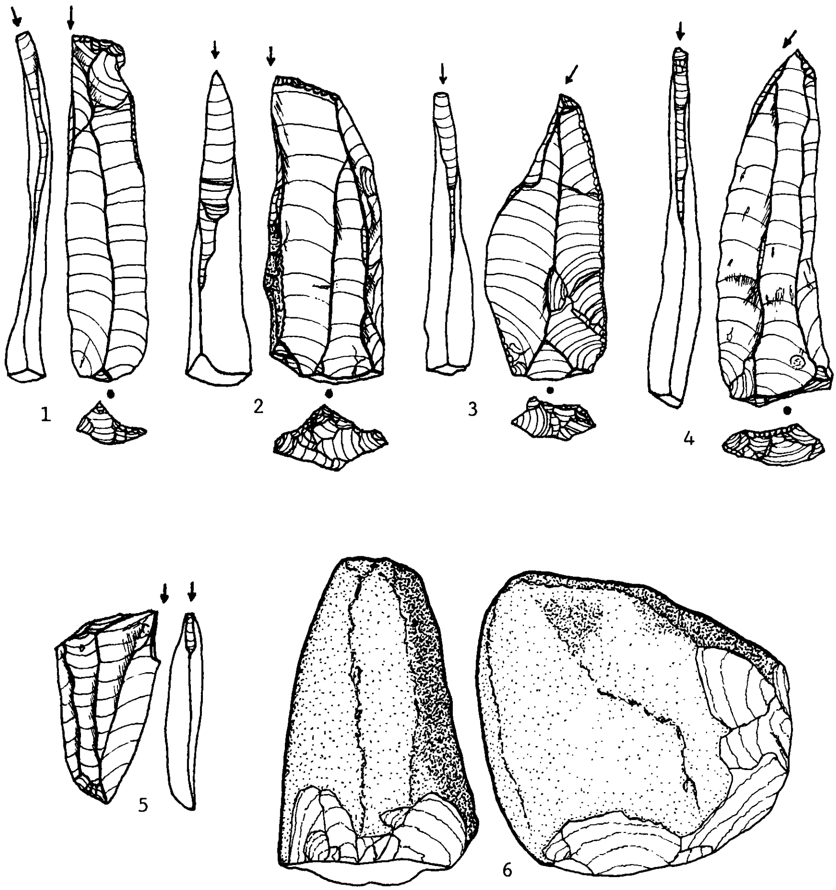


Fig. 15. Retouched pieces and hammerstones from Level XXIII (scale 1/1)

●: point of percussion

1. Burin on a retouched truncation on a blade
2. Burin on a retouched truncation on a blade
3. Burin on a lateral preparation on a Levallois blade with continuous direct retouch
4. Burin on a lateral preparation on a blade
5. Burin on a break on a truncated piece
6. Hammerstone of limestone-like nodule

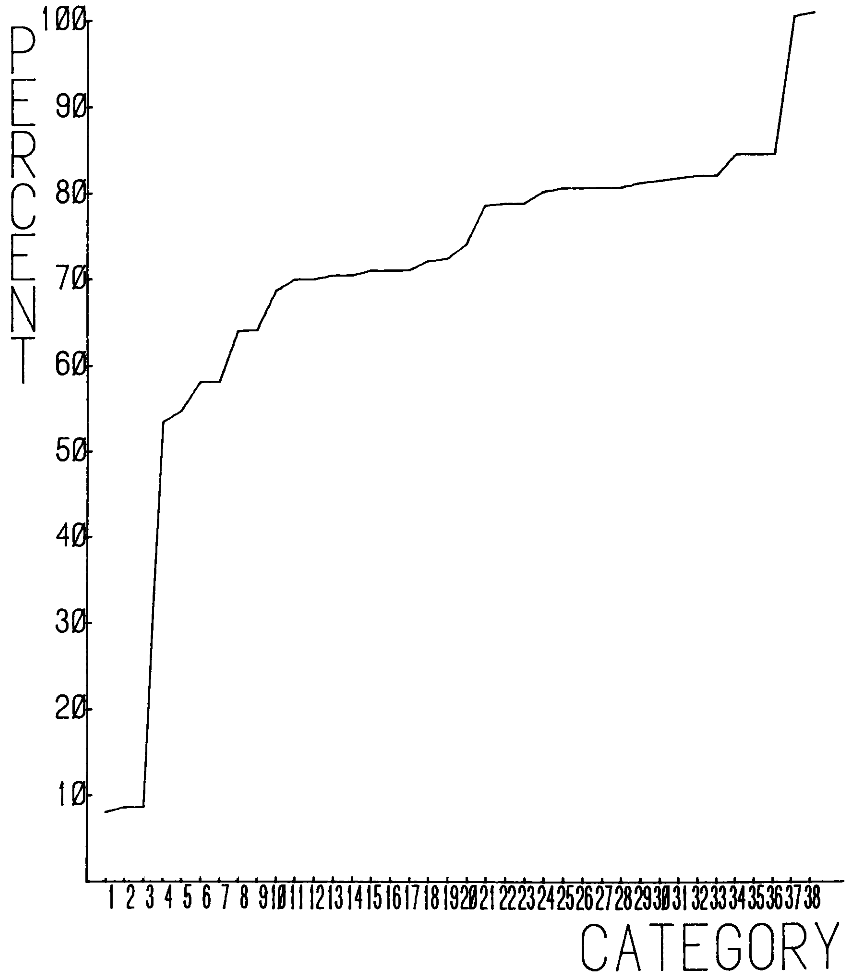


Fig. 16. Cumulative graph of retouched pieces from Level XXIII: 408 pieces

Some of the prismatic cores were converted from Levallois blade cores. Many of the retouched pieces are worked on Levallois debitage. The butts of the debitage are mainly plain and convex dihedral faceted. The debitage was produced chiefly with softer hammers, and has converging dorsal shape, blunt or pointed distal shape, and uni-directional or crossed dorsal scar pattern. The striking platforms of the cores are mainly plain and convex dihedral faceted, and the overall shapes of the cores are mainly parallel or converging. The features of this level which differentiate it from Level XXIV are the increases in cores with converging overall shapes, Levallois blades, and Levallois points.

Level XXII

The materials of this level total 4,280, comprising debitage, cores, retouched pieces, retouch flakes, and hammerstones, and were derived from Squares E4 (-14.40m to -13.70m) and F4 (-14.50m to -13.70m).

DEBITAGE

The debitage totals 2,428, but 1,557 pieces are broken. The 871 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, bladelets, and crested debitage (Table 16) (Figs. 17 to 19).

The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted (Table 17).

Two hundred and fifty-six of the butts are accompanied by partially regularizing facets (29.4%), 29 are accompanied by overhang removal by abrasion (3.3%), and 83 are accompanied by overhang removal by blow (9.5%).

Twenty-four of the debitage are hinged (2.8%), and 23 are plunged (2.6%).

(1) Cortical debitage, partially-cortical debitage, non-cortical flakes, and crested debitage: 220 pieces

The profiles above the butts are straight (55: 25.0%), concave (132: 60.0%), convex (15: 6.8%), and crushed (18: 8.2%).

The mean butt thickness is 6.4mm with the s.d. of 2.6mm (220 cases), the mean length is 50.2mm with the s.d. of 15.0mm (220 cases), the mean width is 27.4mm with the s.d. of 8.4mm (220 cases), and the mean thickness is 8.6mm with the s.d. of 3.1mm (220 cases).

The flaking modes are Harder (44: 40.4%), Softer (45: 41.3%), and Questionable (20: 18.3%).

The dorsal scar patterns are uni-directional (95: 49.2%), bi-directional opposed (38: 19.7%), crossed (44: 22.8%), with the trace of

Table 16. Frequencies of Debitage Classes in Level XXII

Category	Frequency	Percent
Cortical debitage	2	0.2
Partially-cortical debitage	52	6.0
Non-cortical flakes	150	17.2
Levallois flakes	6	0.7
Levallois points	21	2.4
Flake-blades (including 28 Levallois blades and 46 Levallois points)	344	39.5
Blades (including 10 Levallois points)	205	23.5
Bladelets (including 3 Levallois points)	75	8.6
Crested debitage	16	1.8
Total	871	99.9

Table 17. Frequencies of Butt Types of Debitage in Level XXII

Category	Frequency	Percent
Cortical	7	0.8
Plain	230	26.4
Convex dihedral faceted	249	28.6
Straight multiple faceted	75	8.6
Convex multiple faceted	204	23.4
Partially faceted	63	7.2
Linear	16	1.8
Punctiform	7	0.8
Broken	20	2.3
Total	871	99.9

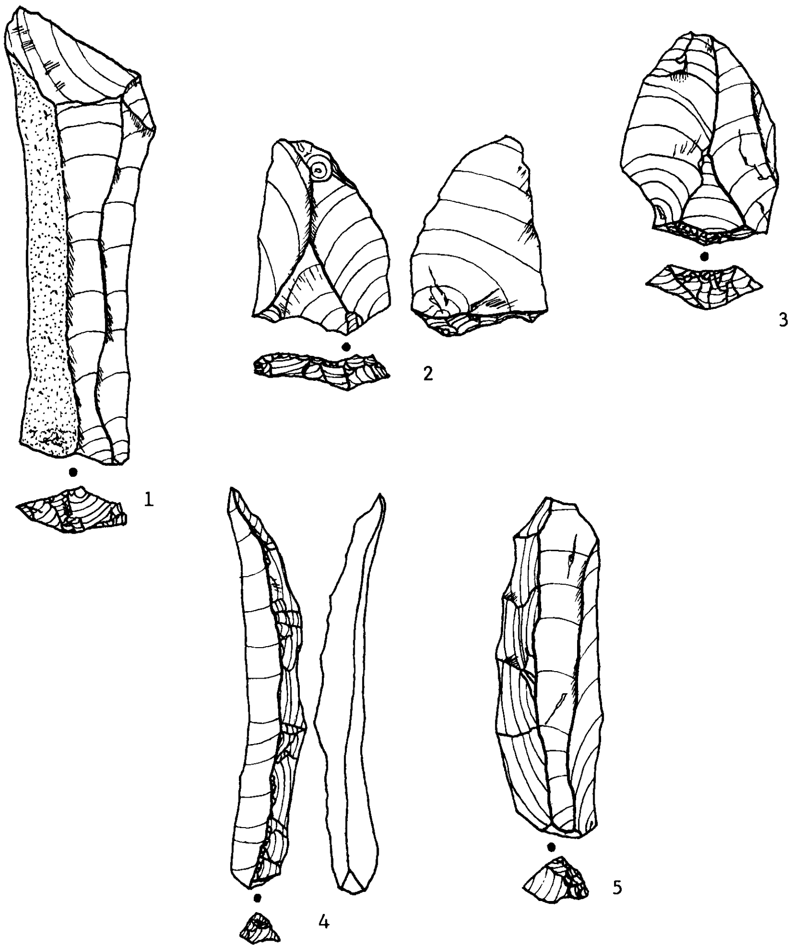
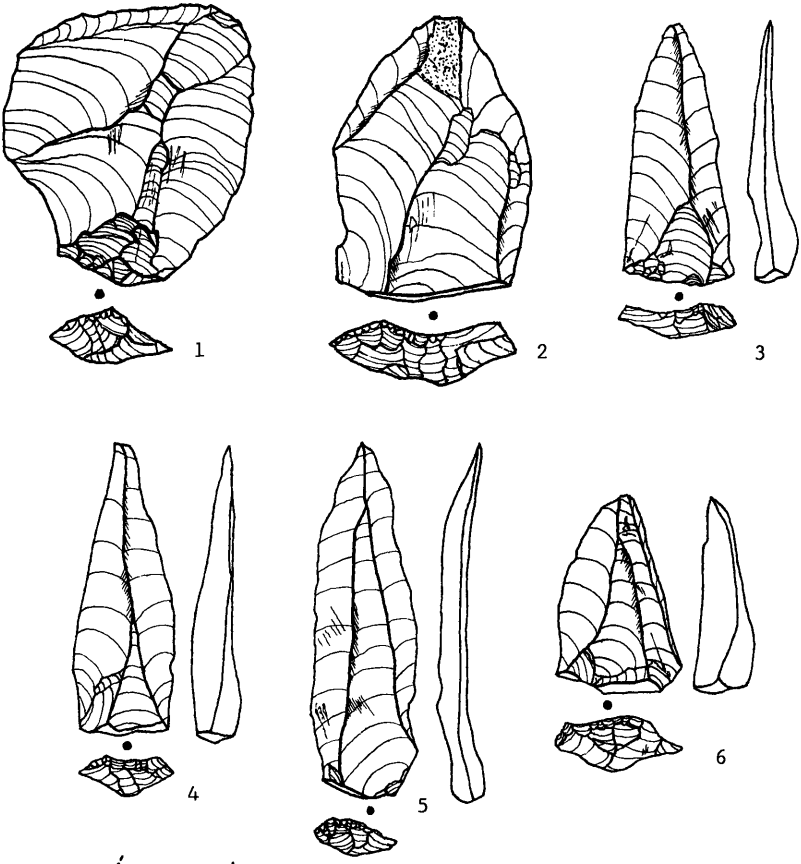


Fig. 17. Debitage from Level XXII (scale 1/1)

●: point of percussion

1. Partially-cortical debitage
2. Pseudo-Levallois point
3. Non-cortical flake, possibly resulting from failure of Levallois point production
4. Crested debitage
5. Crested debitage



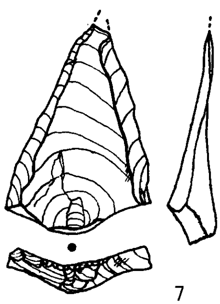


Fig. 18. Debitage from Level XXII
(scale 1/1)

●: point of percussion

1. Levallois flake
2. Levallois flake or a flake from discoidal core
3. Elongated Levallois point
4. Elongated Levallois point
5. Elongated Levallois point
6. Atypical Levallois point
7. Levallois point

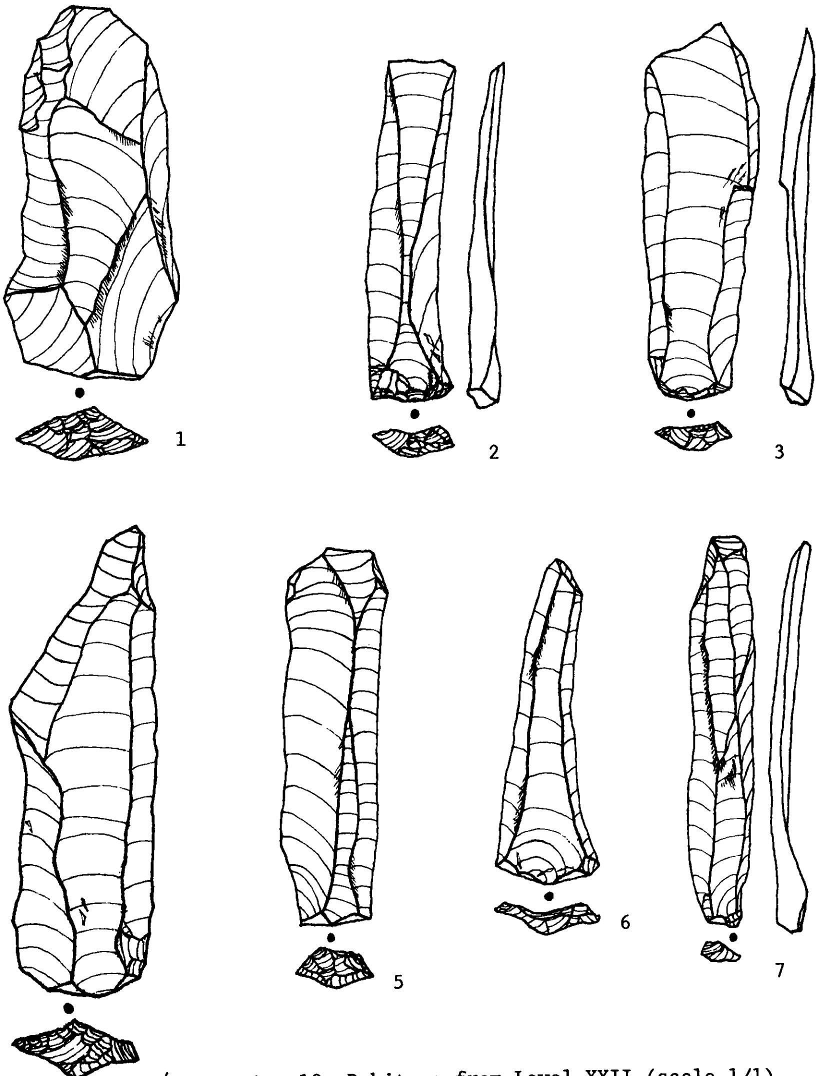


Fig. 19. Debitage from Level XXII (scale 1/1)

●: point of percussion

1. Levallois blade 2. Blade 3. Blade
4. Levallois blade 5. Blade 6. Flake-blade
7. Bladelet

cresting (14: 7.3%), and miscellaneous (2: 1.0%).

The mean number of dorsal scars is 4.1 with the s.d. of 1.8 (219 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: 651 pieces

The profiles above the butts are straight (118: 18.3%), concave (460: 71.3%), convex (22: 3.4%), and crushed (45: 7.0%)

The mean butt thickness is 5.6mm with the s.d. of 2.1mm (636 cases), the mean length is 54.7mm with the s.d. of 10.7mm (651 cases), the mean width is 20.5mm with the s.d. of 4.7mm (651 cases), and the mean thickness is 6.8mm with the s.d. of 2.4mm (650 cases),

The mean *angle de chasse* is 80.2° with the s.d. of 6.8° (616 cases), the mean *angle d'éclatement* is 95.7° with the s.d. of 7.3° (616 cases), and the mean total of the two angles is 175.9° (616 cases).

The flaking modes are Harder (99: 29.6%), Softer (178: 53.1%), and Questionable (58: 17.3%).

The dorsal scar patterns are uni-directional (353: 58.6%), bi-directional opposed (94: 15.6%), crossed (145: 24.1%), centripetal (4: 0.7%), with the trace of cresting (3: 0.5%), and miscellaneous (3: 0.5%).

The mean number of dorsal scars is 4.5 with the s.d. of 1.5 (650 cases).

The numbers of dorsal planes are One (189: 29.1%), Two (404: 62.2%), and Three (57: 8.8%).

The dorsal shapes are parallel (278: 42.7%), converging (352: 54.1%), and expanding (21: 3.2%).

The distal shapes are blunt (298: 45.8%) and pointed (353: 54.2%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 1.9 with the s.d. of 0.6 (281 cases).

The flaking order patterns on the Levallois points, flake-blades, blades, and bladelets are A (159: 57.4%), B (95: 34.3%), and C (23: 8.3%).

The locations of points of percussion are A (190: 29.9%), B (293: 46.1%), and C (153: 24.1%).

The Levallois flakes have butts of convex dihedral facets (1), of convex multiple facets (3), and of partial facets (2). Their dorsal scar patterns are crossed (5) and centripetal (1), and the locations of points of percussion are B (4) and C (2).

Twenty-eight of the flake-blades can be considered to be Levallois blades. Their butts are plain (5: 17.9%), of convex dihedral facets (8: 28.6%), of straight multiple facets (3: 10.7%), of convex multiple facets (7: 25.0%), and of partial facets (5: 17.9%). Their dorsal scar patterns are bi-directional opposed (6: 21.4%), crossed (19: 67.9%), and centripetal (3: 10.7%). The flaking order patterns are A (5) and B (1), and the locations of points of percussion are A (2: 7.4%), B (16: 59.3%) and C (9: 33.3%).

The Levallois points total 80. Forty-six (57.5%) of them are flake-blades, 10 (12.5%) may be blades, and 3 (3.8%) may be bladelets. Their butts are cortical (1: 1.3%), plain (16: 20.0%), of convex dihedral facets (21: 26.3%), of straight multiple facets (9: 11.3%), of convex multiple facets (29: 36.3%), of partial facets (3: 3.8%), and linear (1: 1.3%). Their dorsal scar patterns are uni-directional (63: 82.9%), bi-directional opposed (5: 6.6%), crossed (7: 9.2%), and with the trace of cresting (1: 1.3%). The flaking order patterns are A (31: 45.6%), B (34: 50.0%), and C (3: 4.4%). The locations of points of percussion are A (15: 18.8%), B (21: 26.3%), and C (44: 55.0%).

CORES

The cores total 149, but 14 of them are broken. The 135 unbroken cores are classified into 8 categories (Table 18) (Figs. 20 to 22).

The striking platforms for the final flake scars are mainly plain and convex dihedral faceted (Table 19).

The mean length of the final flake scars is 26.7mm with the s.d. of 12.8mm (193 cases), and the mean width is 16.8mm with the s.d. of 6.9mm (193 cases).

The shapes of the final flake scars are parallel (104: 53.9%), converging (52: 26.9%), and expanding (37: 19.2%), and the distal shapes are blunt (147: 76.2%) and pointed (46: 23.8%).

Seventy-eight (38.8%) of the 201 final flake scars are hinged, and 6 (3.0%) are plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.4 with the s.d. of 0.6 (146 cases).

The mean number of flake scars from one and the same striking platform is 2.9 with the s.d. of 1.5 (144 cases).

The locations of striking platforms are opposed (19: 32.8%), opposite rectangular (7: 12.1%), opposite alternate (5: 8.6%), crossed (10: 17.2%), peripheral (1: 1.7%), alternating (14: 24.1%), and miscellaneous (2: 3.4%).

The scar patterns are uni-directional (67: 45.6%), bi-directional opposed (31: 21.1%), crossed (40: 27.2%), centripetal (2: 1.4%), of a single flake scar (2: 1.4%), with the trace of cresting (2: 1.4%), and miscellaneous (3: 2.0%).

Table 18. Frequencies of Core Classes in Level XXII

Category	Frequency	Percent
Prismatic cores (including 1 core converted from Levallois point core)	88	65.2
Pyramidal cores	7	5.2
Discoidal cores	6	4.4
Levallois point cores (on prismatic [2] and discoidal [2] cores)	4	3.0
Levallois flake cores (on prismatic [1] and discoidal [1] cores)	2	1.5
Levallois blade cores (on prismatic [1] and discoidal [1] cores)	2	1.5
Globular cores	1	0.7
Miscellaneous cores	25	18.5
Total	135	100.0

Table 19. Frequencies of Striking Platform Types of Cores in Level XXII

Category	Frequency	Percent
Cortical	5	2.6
Plain	107	55.4
Convex dihedral faceted	66	34.2
Straight multiple faceted	4	2.1
Convex multiple faceted	8	4.1
Broken	3	1.6
Total	193	100.0

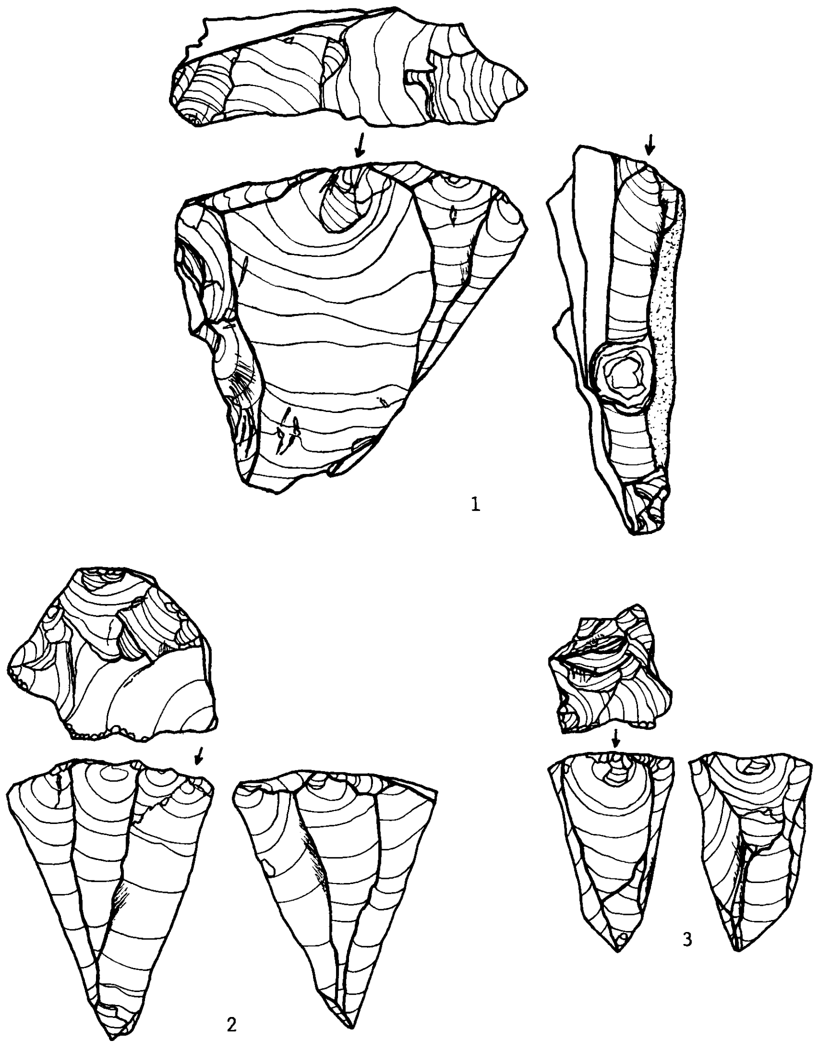


Fig. 20. Cores from Level XXII (scale 1/1)

↙: final detachment

1. Levallois flake core in the final form with the trace of a bladelet removal
2. Pyramidal core
3. Pyramidal core

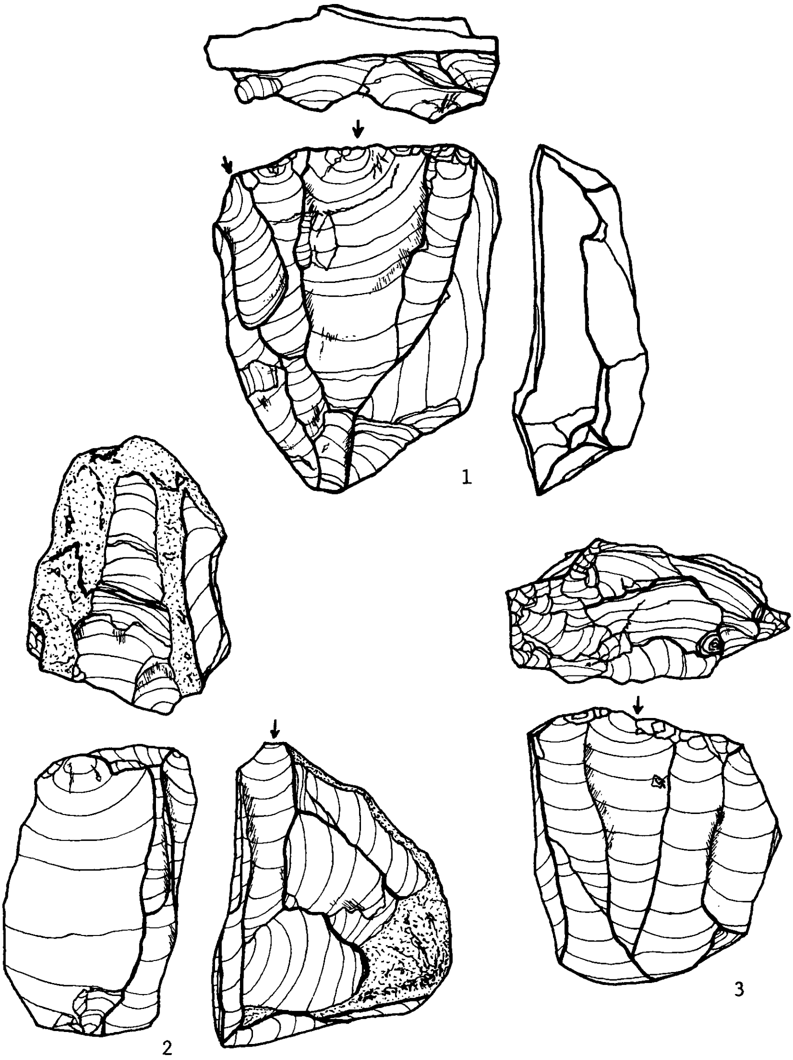


Fig. 21. Cores from Level XXII (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core
2. Single platform prismatic core with the trace of cresting
3. Single platform prismatic core

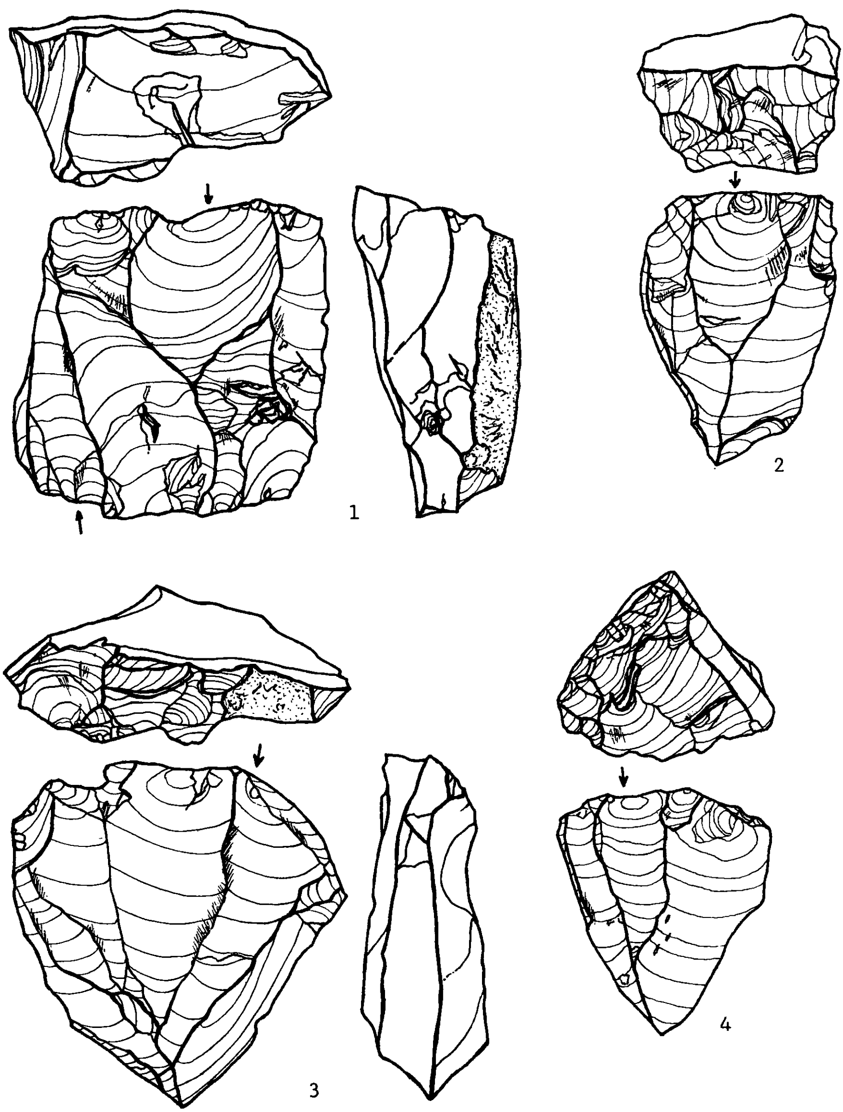


Fig. 22. Cores from Level XXII (scale 1/1)

↙: final detachment

1. Opposed platform prismatic core
2. Levallois point core in the final form
3. Single platform prismatic core converted from a Levallois point core
4. Levallois point core in the final form

The backs of the cores are cortex (77: 57.0%), core preparation (3: 2.2%), flake scars (21: 15.6%), and miscellaneous (34: 25.2%).

Three of the cores are clearly worked on nodules (2.2%), 13 are worked on flakes (9.6%), and the rest (119: 88.1%) are believed to be worked on nodules.

The mean core length is 48.6mm with the s.d. of 11.1mm (135 cases), the mean core width is 38.6mm with the s.d. of 10.8.mm (135 cases), and the mean core thickness is 24.4mm with the s.d. of 7.6mm (135 cases).

The overall shapes of the cores are parallel (65: 48.1%), converging (61: 45.2%), expanding (2: 1.5%), and miscellaneous (7: 5.2%).

Two cores show traces of heat alteration (1.5%).

Twenty-six cores were most probably abandoned because of hinging (19.3%).

RETOUCHED PIECES

The retouched pieces total 1,698, of which 418 are broken.

The main categories of the 1,280 unbroken retouched pieces are the end-scraper, the chamfered piece, the burin on a retouched truncation, and the burin on a lateral preparation (Table 20) (Figs. 23 to 27).

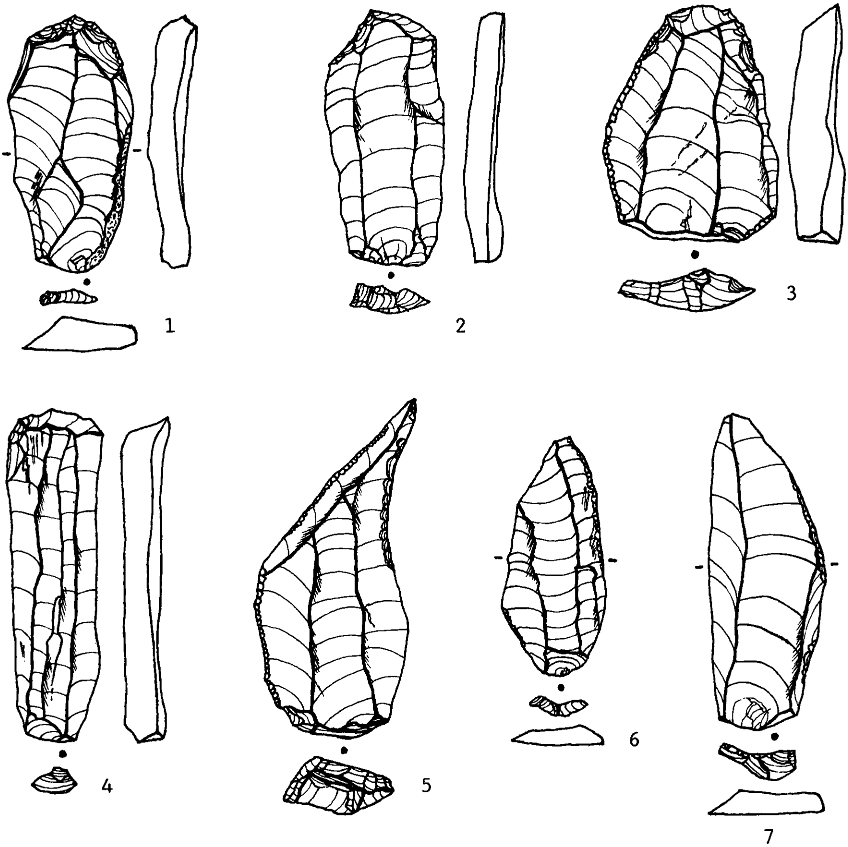
The blanks for the retouched pieces are cortical debitage (43: 3.4%), partially-cortical debitage (212: 16.7%), non-cortical flakes (381: 30.1%), flake-blades (354: 28.0%), blades (179: 14.2%), bladelets (19: 1.5%), crested debitage (23: 1.8%), cores (5: 0.4%), older debitage (37: 2.9%), and natural stones (12: 1.0%).

The end-scrapers are made on cortical debitage (17: 6.2%), partially-cortical debitage (45: 16.4%), non-cortical flakes (101: 36.9%), flake-blades (56: 20.4%), blades (32: 11.7%), crested debitage (7: 2.6%), older debitage (10: 3.6%), and natural stones (4: 1.5%). The chamfered pieces are made on partially-cortical debitage (23: 14.1%), non-cortical flakes (58: 35.6%), flake-blades (51: 31.3%), blades (20: 12.3%), bladelets (7: 4.3%), crested debitage (1: 0.6%), older debitage (2: 1.2%), and natural stones (1: 0.6%). The burins on retouched truncation are made on cortical debitage (3: 2.0%), partially-cortical debitage (33: 22.0%), non-cortical flakes (29: 19.3%), flake-blades (44: 29.3%), blades (30: 20.0%), older debitage (6: 4.0%), and natural stones (1: 0.7%). The burins on lateral preparation are made on partially-cortical debitage (11: 11.6%), non-cortical flakes (15: 15.8%), flake-blades (44: 46.3%), blades (17: 17.9%), bladelets (5: 5.3%), crested debitage (1: 1.1%), and older debitage (1: 1.1%).

Fourteen of the blanks are Levallois flakes and were used for end-scrapers on retouched blanks (1), chamfered pieces (3), burins on break (1), burins on retouched truncation (1), side-scrapers (1), pieces with

Table 20. Frequencies of Retouched Piece Classes in Level XXII

Category	Frequency	Percent
End-scrapers	274	21.4
Double end-scrapers	21	1.6
End-scrapers on retouched blanks	54	4.2
Chamfered pieces	163	12.7
Multiple chamfered pieces	15	1.2
Burins on break	55	4.3
Dihedral burins	16	1.3
Burins on retouched truncation	150	11.7
Multiple truncation burins	5	0.4
Burins on lateral preparation	95	7.4
Multiple mixed burins	21	1.6
Partially-backed pieces	12	0.9
Double partially-backed pieces	1	0.1
Truncated pieces	13	1.0
Pointes à face plane	1	0.1
Ksar Akil points	9	0.7
Notched pieces	22	1.7
Denticulated pieces	2	0.2
Side-scrapers	14	1.1
Pieces with continuous direct retouch	55	4.3
Pieces with continuous inverse retouch	9	0.7
Pieces with continuous alternate(ing) retouch	2	0.2
Pieces with discontinuous direct retouch	26	2.0
Pieces with discontinuous inverse retouch	8	0.6
Pieces with discontinuous alternate(ing) retouch	3	0.2
Core-like end-scrapers	1	0.1
Piercers	4	0.3
Becs	11	0.9
Mousterian points	3	0.2
Retouched Levallois points	10	0.8
Splintered pieces	4	0.3
Pieces with continuous retouch removing butt	1	0.1
Steep scrapers	11	0.9
Limaces	1	0.1
Choppers	8	0.6
Composite retouched pieces	176	13.8
Unclassifiable retouched pieces	4	0.3
Total	1,280	100.0



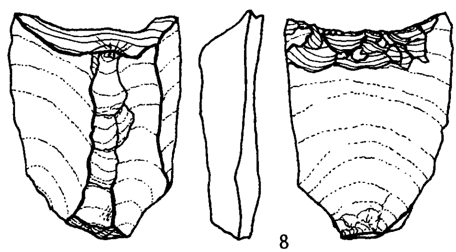


Fig. 23.
Retouched pieces from Level XXII (scale 1/1)

●: point of percussion

1. End-scraper on a naturally-backed flake-blade
2. Chamfered piece on a blade
3. Chamfered piece on a non-cortical flake
4. Chamfered piece on a blade
5. Piercer on a backed flake-blade
6. Double partially-backed piece
7. Partially-backed blade
8. Splintered piece on older debitage

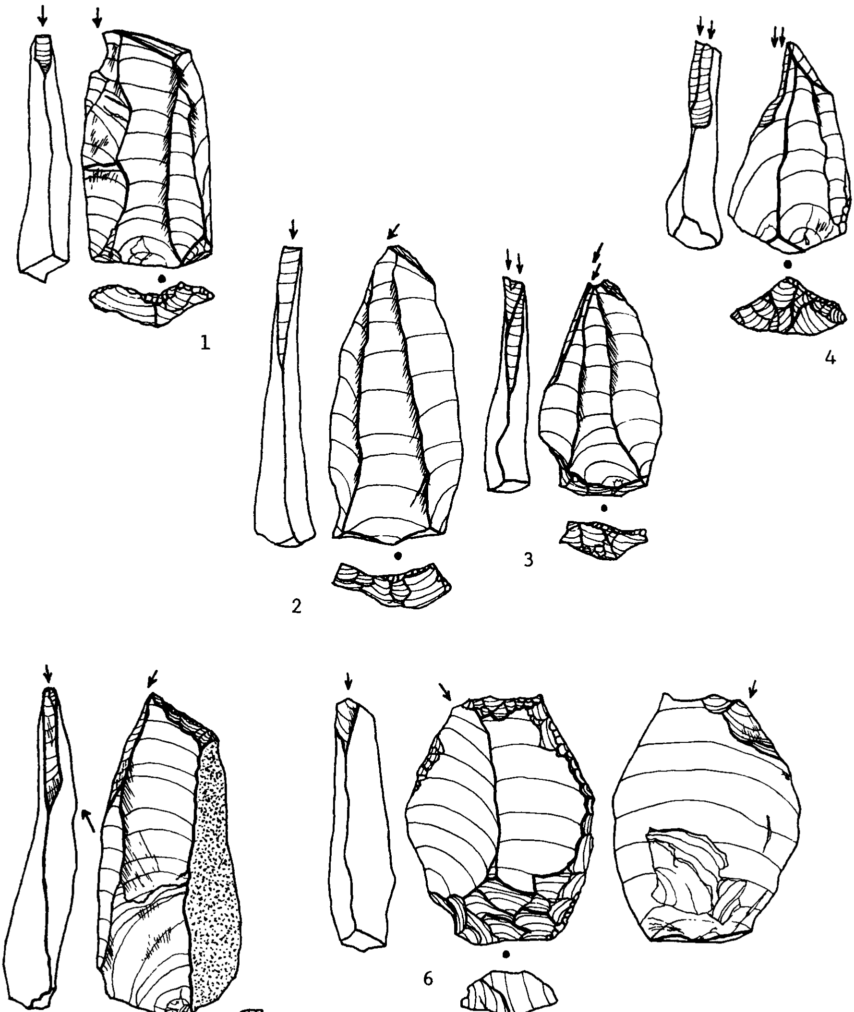


Fig. 24. Retouched pieces from Level XXII (scale 1/1)

●: point of percussion

1. Burin on a break on a flake-blade
2. Burin on a break on a Levallois point
3. Burin on a retouched truncation on a Levallois point
4. Burin on a break on a flake-blade
5. Burin on a retouched truncation on partially-cortical debitage
6. Flat burin on a retouched truncation/bec on a non-cortical flake

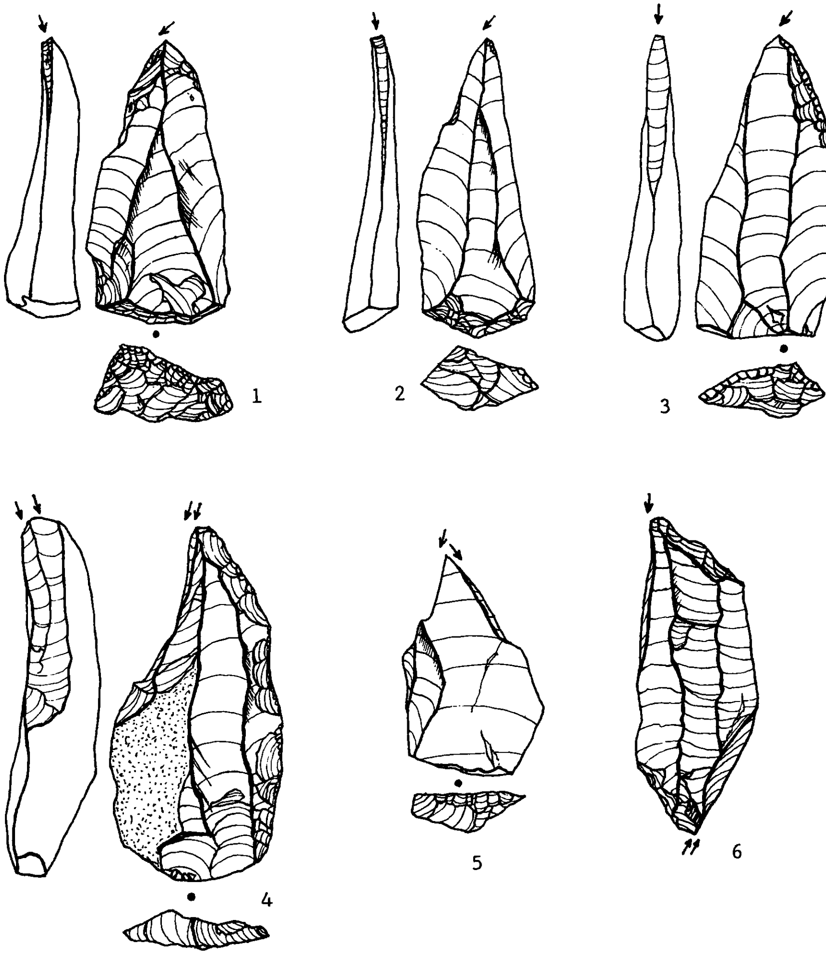
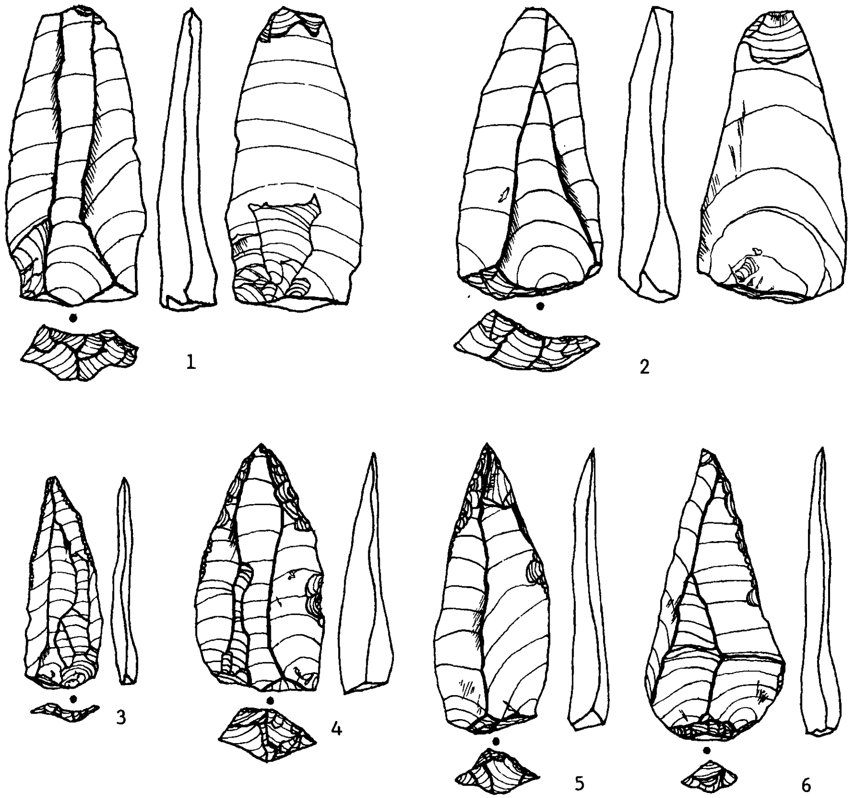


Fig. 25. Retouched pieces from Level XXII (scale 1/1)

●: point of percussion

1. Burin on a lateral preparation on a Levallois point
2. Burin on a lateral preparation on a Levallois point
3. Burin on a lateral preparation on a blade
4. Burin on a retouched truncation/side-scraper on partially-cortical debitage
5. Dihedral burin on a non-cortical flake
6. Multiple truncation burin on a blade



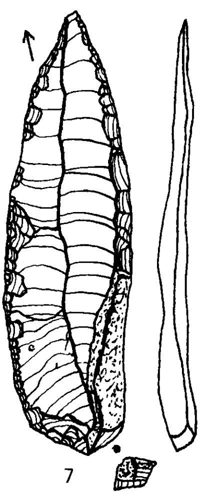


Fig. 26. Retouched pieces from Level XXII (scale 1/1)

●: point of percussion

1. Levallois point, probably with impact fracture
2. Levallois point, probably with impact fracture
3. Ksar Akil point on a bladelet
4. Mousterian point on a blade
5. Mousterian point on a flake-blade
6. Ksar Akil point on older debitage
7. *Pointe à face plane* on partially-cortical debitage

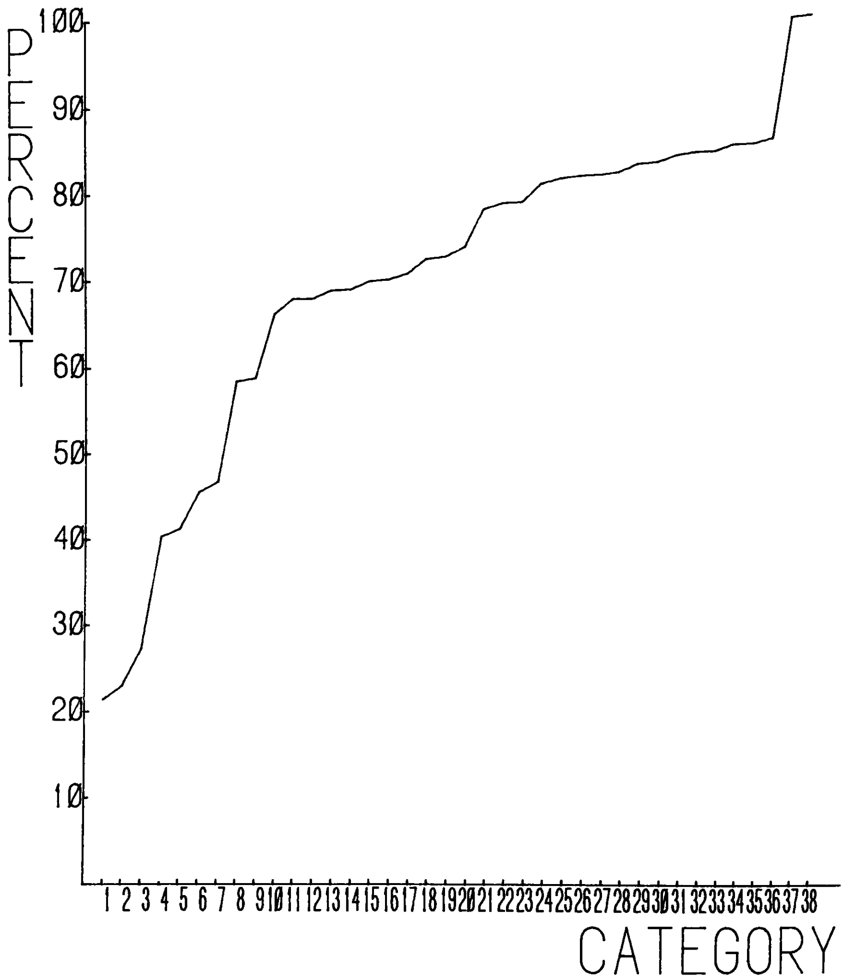


Fig. 27. Cumulative graph of retouched pieces from Level XXII: 1,280 pieces

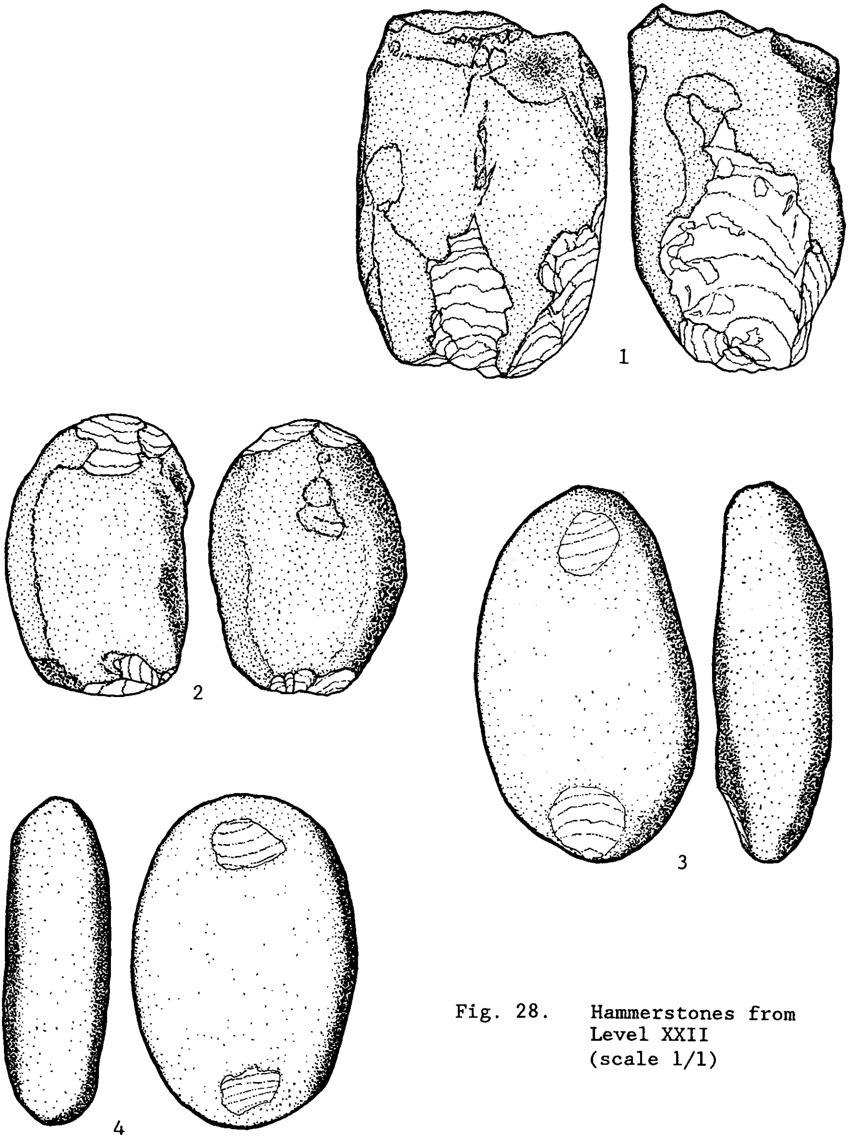


Fig. 28. Hammerstones from Level XXII (scale 1/1)

1. Hammerstone of weathered flint
2. Hammerstone of flint nodule
3. Flat hammerstone of andesite-like stone
4. Flat hammerstone of flint nodule

continuous direct retouch (4), and composite retouched pieces (3). Twenty of the blanks are Levallois blades and were used for end-scrapers (1), chamfered pieces (5), burins on break (1), dihedral burins (1), burins on retouched truncation (2), burins on lateral preparation (1), notched pieces (1), pieces with continuous direct retouch (5), and composite retouched pieces (3). Thirty-nine of the blanks are Levallois points and were used for end-scrapers (2), chamfered pieces (3), burins on break (2), dihedral burins (2), burins on retouched truncation (2), burins on lateral preparation (8), notched pieces (3), pieces with discontinuous direct retouch (4), piercers (1), becs (1), retouched Levallois points (10), and unclassifiable retouched pieces (1). Fifty-three of the blanks are naturally-backed and were mainly used for end-scrapers (15: 28.3%) and burins on retouched truncation (11: 20.8%).

The flaking modes for the blanks are Harder (204: 41.0%), Softer (202: 40.6%), and Questionable (91: 18.3%).

RETOUCH FLAKES

The single retouch flake is a burin spall.

HAMMERSTONES

Four nodules of stone are thought to be hammerstones. Two of them (of andesite-like (1) and flint (1) nodules) are flat and oval in outline (66mm x 40mm x 23mm; 59mm x 42mm x 20mm), and show some traces of battering at their margins. The third example, of weathered flint, is globular with the battering traces on its rounded tip (62mm x 48mm x 41mm). The fourth example, of flint, is rather elongated with oval cross section and bears the battering traces on its tip (49mm x 34mm x 33mm). Their weight ranges from 64.6g to 152.5g (Fig. 28).

SUMMARY

Level XXII is characterized by non-cortical flakes, flake-blades, blades, prismatic cores, end-scrapers, chamfered pieces, burins on retouched truncation, and burins on lateral preparation. A considerable number of Levallois blades and points are included in the flake-blades. The butts of the debitage are chiefly plain, convex dihedral faceted, and convex multiple faceted. The debitage was produced chiefly with softer hammers, and has parallel or converging dorsal shape, blunt or pointed distal shape, and uni-directional dorsal scar pattern. The striking platforms of the cores are mainly plain and convex dihedral faceted, and the overall shapes of the cores are mainly parallel or converging. The features of this level which differentiate it from Level XXIII are the increases in blades, end-scrapers, burins on retouched truncation, and burins on lateral preparation. Chamfered pieces, debitage with crossed dorsal scar pattern, and cores with convex multiple faceted striking platforms become less common in this level.

<u>Level XXI</u>

The materials of this level total 1,220, comprising debitage, cores, retouched pieces, and hammerstones, and were derived from Squares E4 (-13.70m to -12.95m) and F4 (-13.70m to -12.95m).

DEBITAGE

The debitage totals 570, of which 314 pieces are broken. The 256 unbroken pieces consist of partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, bladelets, and crested debitage (Table 21) (Figs. 29 and 30).

The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted (Table 22).

Ninety of the butts are accompanied by partially regularizing facets (35.2%), 9 are accompanied by overhang removal by abrasion (3.5%), and 50 are accompanied by overhang removal by blow (19.5%).

Eight of the debitage are hinged (3.1%), and 4 are plunged (1.6).

(1) Partially-cortical debitage, non-cortical flakes, and crested debitage: <u>68 pieces</u>

The profiles above the butts are straight (10: 14.9%), concave (32: 47.8%), convex (9: 13.4%), and crushed (16: 23.9%).

The mean butt thickness is 6.3mm with the s.d. of 2.3mm (66 cases), the mean length is 52.2mm with the s.d. of 14.7mm (67 cases), the mean width is 26.4mm with the s.d. of 7.0mm (67 cases), and the mean thickness is 8.7mm with the s.d. of 3.3mm (68 cases).

The flaking modes are Harder (17: 44.7%), Softer (17: 44.7%), and Questionable (4: 10.5%).

The dorsal scar patterns are uni-directional (39: 60.9%), bi-directional opposed (8: 12.5%), crossed (12: 18.8%), and with the trace of cresting (5: 7.8%).

The mean number of dorsal scars is 4.1 with the s.d. of 1.4 (68 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: <u>188 pieces</u>

The profiles above the butts are straight (38: 20.2%), concave (116: 61.7%), convex (15: 8.0%), and crushed (19: 10.1%).

The mean butt thickness is 5.4mm with the s.d. of 2.1mm (187 cases), the mean length is 54.6mm with the s.d. of 11.5mm (188 cases), the mean width is 20.1mm with the s.d. of 5.6mm (188 cases), and the mean thickness is 6.6mm with the s.d. of 2.2mm (188 cases).

The mean *angle de chasse* is 79.4° with the s.d. of 6.7° (181 cases), the mean *angle d'éclatement* is 97.8° with the s.d. of 6.9° (181 cases), and the mean total of the two angles is 177.2° (181 cases).

Table 21. Frequencies of Debitage Classes in Level XXI

Category	Frequency	Percent
Partially-cortical debitage	24	9.4
Non-Levallois flakes	39	15.2
Levallois flakes	8	3.1
Levallois points	3	1.2
Flake-blades (including 7 Levallois blades and 5 Levallois points)	80	31.3
Blades	67	26.2
Bladelets (including 1 Levallois point)	30	11.7
Crested debitage	5	2.0
Total	256	100.1

Table 22. Frequencies of Butt Types of Debitage in Level XXI

Category	Frequency	Percent
Cortical	5	2.0
Plain	70	27.3
Convex dihedral faceted	81	31.6
Straight multiple faceted	18	7.0
Convex multiple faceted	52	20.3
Partially faceted	16	6.3
Linear	8	3.1
Punctiform	1	0.4
Broken	5	2.0
Total	256	100.0

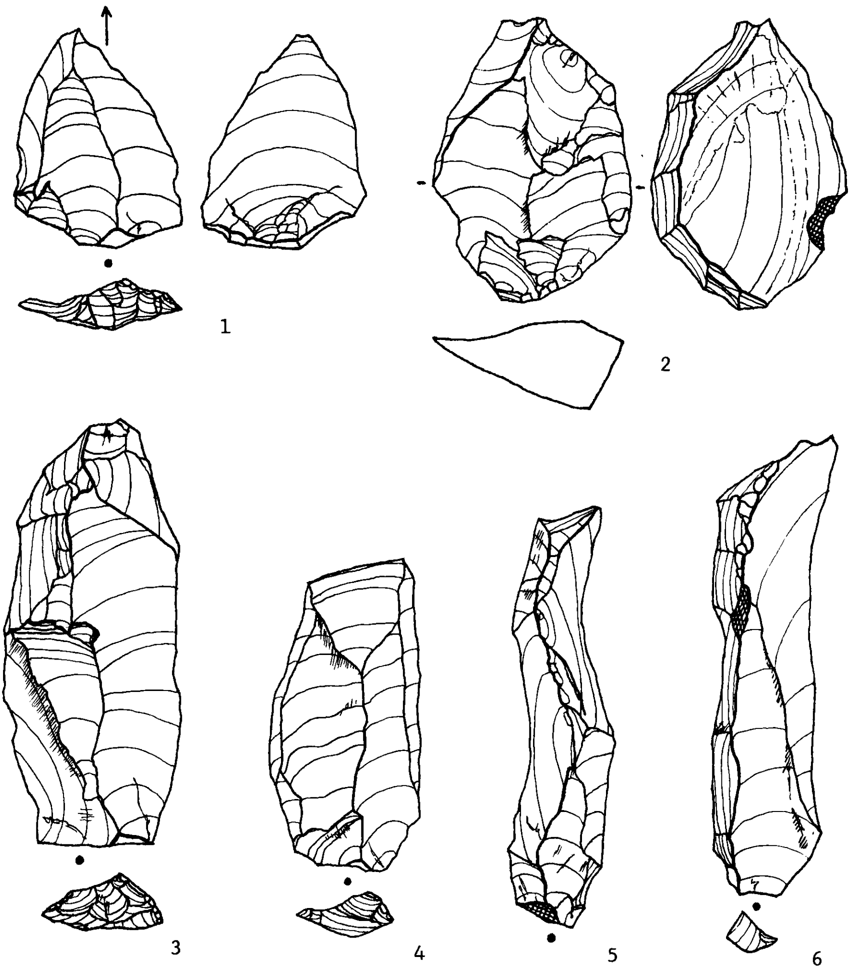


Fig. 29. Debitage from Level XXI (scale 1/1)

●: point of percussion

1. Pseudo-Levallois point
2. Core tablet
3. Re-crested debitage with the trace of hinging removal
4. Non-cortical flake or a flake-blade
5. Re-crested debitage
6. Crested debitage

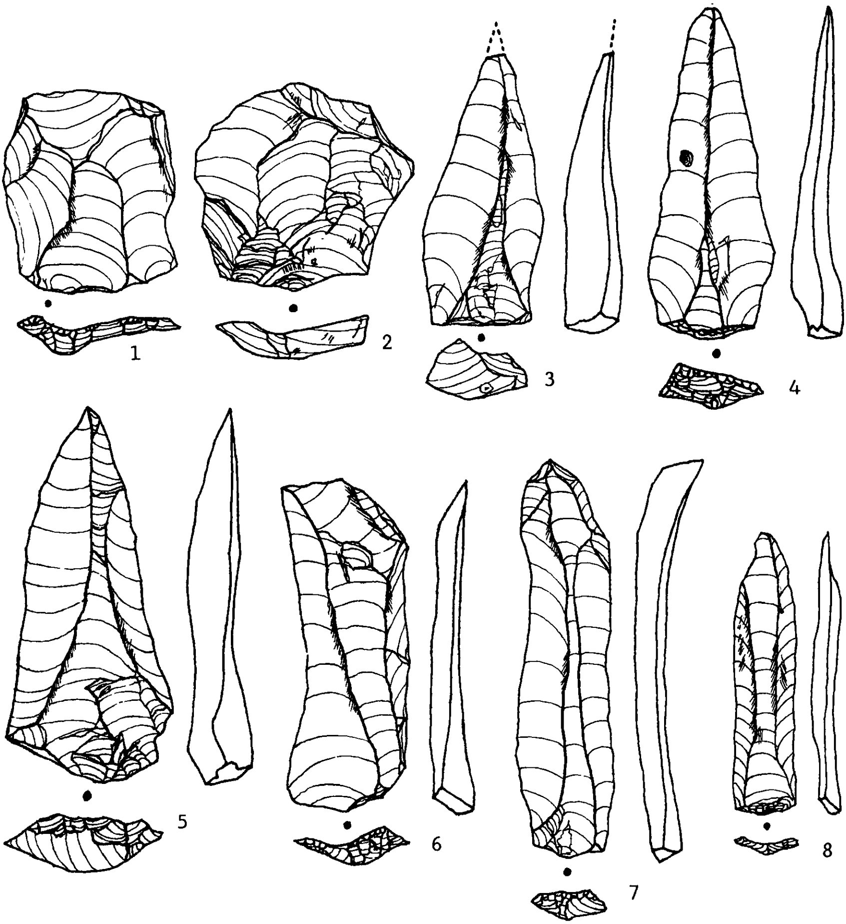


Fig. 30. Debitage from Level XXI
(scale 1/1)

●: point of percussion

1. Levallois flake
2. Levallois flake
3. Elongated Levallois point
4. Elongated Levallois point
5. Elongated Levallois point
6. Levallois blade
7. Levallois blade
8. Bladelet
9. Blade

The flaking modes are Harder (20: 19.4%), Softer (63: 61.2%), and Questionable (20: 19.4%).

The dorsal scar patterns are uni-directional (79: 44.9%), bi-directional opposed (46: 26.1%), crossed (40: 22.7%), centripetal (3: 1.7%), and with the trace of cresting (8: 4.5%).

The mean number of dorsal scars is 5.3 with the s.d. of 1.8 (188 cases).

The number of dorsal planes are One (45: 23.9%), Two (130: 69.1%), and Three (13: 6.9%).

The dorsal shapes are parallel (104: 55.3%), converging (76: 40.4%), and expanding (8: 4.3%).

The distal shapes are blunt (144: 76.6%) and pointed (44: 23.4%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 2.0 with the s.d. of 0.5 (97 cases).

The flaking order patterns on the Levallois points, flake-blades, blades, and bladelets are A (32: 50.0%), B (24: 37.5%), and C (8: 12.5%).

The locations of points of percussion are A (59: 32.2%), B (88: 48.1%), and C (36: 19.7%).

The Levallois flakes have plain butts (2), butts of convex dihedral facets (2), and butts of convex multiple facets (4). Their dorsal scar patterns are crossed (5) and centripetal (3), and the locations of points of percussion are A (2), B (5), and C (1).

Seven of the flake-blades can be considered to be Levallois blades. Their butts are plain (1), of convex dihedral facets (4), and of convex multiple facets (2). Their dorsal scar patterns are crossed (7: 100.0%). The flaking order pattern is A (2), and the locations of points of percussion are A (1), B (4), and C (1).

There are 9 Levallois points; 5 of them are flake-blades, and 1 may be a bladelet. Their butts are plain (1), of convex dihedral facets (4), of convex multiple facets (2), and of partial facets (2). Their dorsal scar patterns are uni-directional (5), bi-directional opposed (2), and crossed (2). The flaking order patterns are A (3), B (4), and C (1). The locations of points of percussion are A (2), B (3), and C (4).

CORES

The cores total 71, of which 3 are broken. The 68 unbroken cores are classified into 5 categories (Table 23) (Figs. 31 to 33).

The striking platforms for the final flake scars are mainly plain (Table 24).

Table 23. Frequencies of Core Classes in Level XXI

Category	Frequency	Percent
Prismatic cores (including 1 core converted from Levallois flake core)	45	66.2
Pyramidal cores	4	5.9
Discoidal cores (including 1 core converted from Levallois flake core)	3	4.4
Globular cores	1	1.5
Miscellaneous cores	15	22.1
Total	68	100.1

Table 24. Frequencies of Striking Platform Types of Cores in Level XXI

Category	Frequency	Percent
Cortical	2	2.0
Plain	65	65.7
Convex dihedral faceted	23	23.2
Straight multiple faceted	3	3.0
Convex multiple faceted	6	6.1
Total	99	100.0

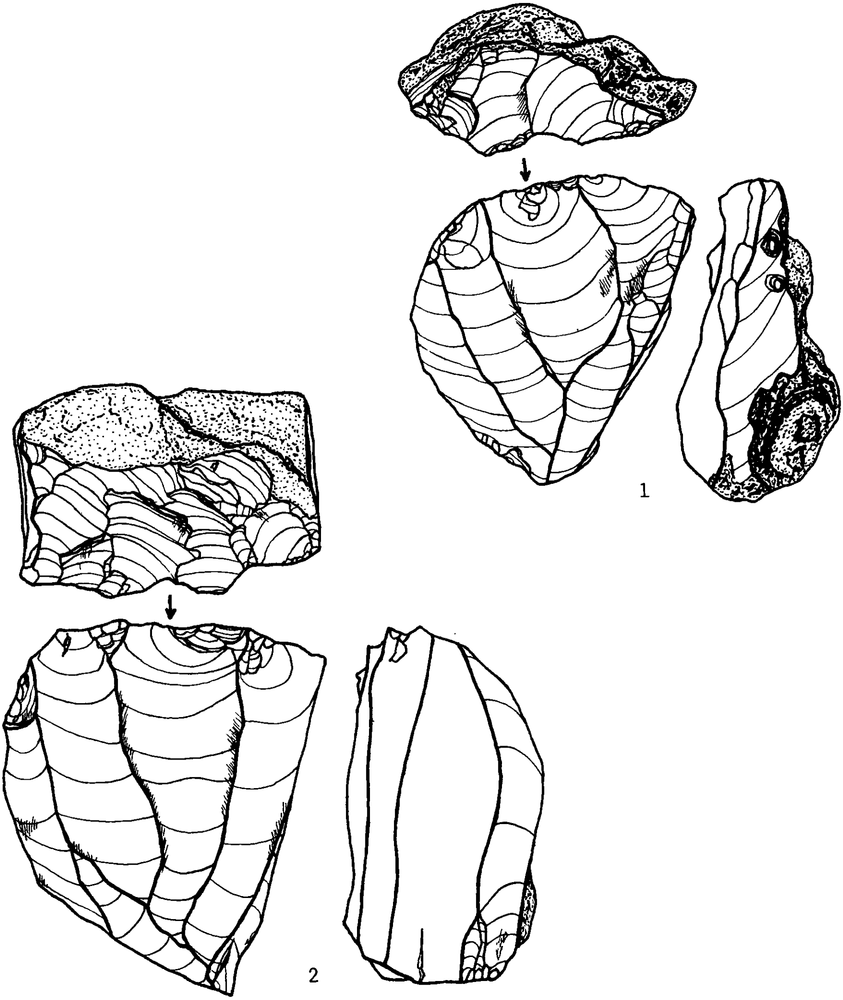


Fig. 31. Cores from Level XXI (scale 1/1)

↓: final detachment

1. Single platform prismatic core resembling a Levallois point core
2. Opposed platform prismatic core resembling a Levallois point core

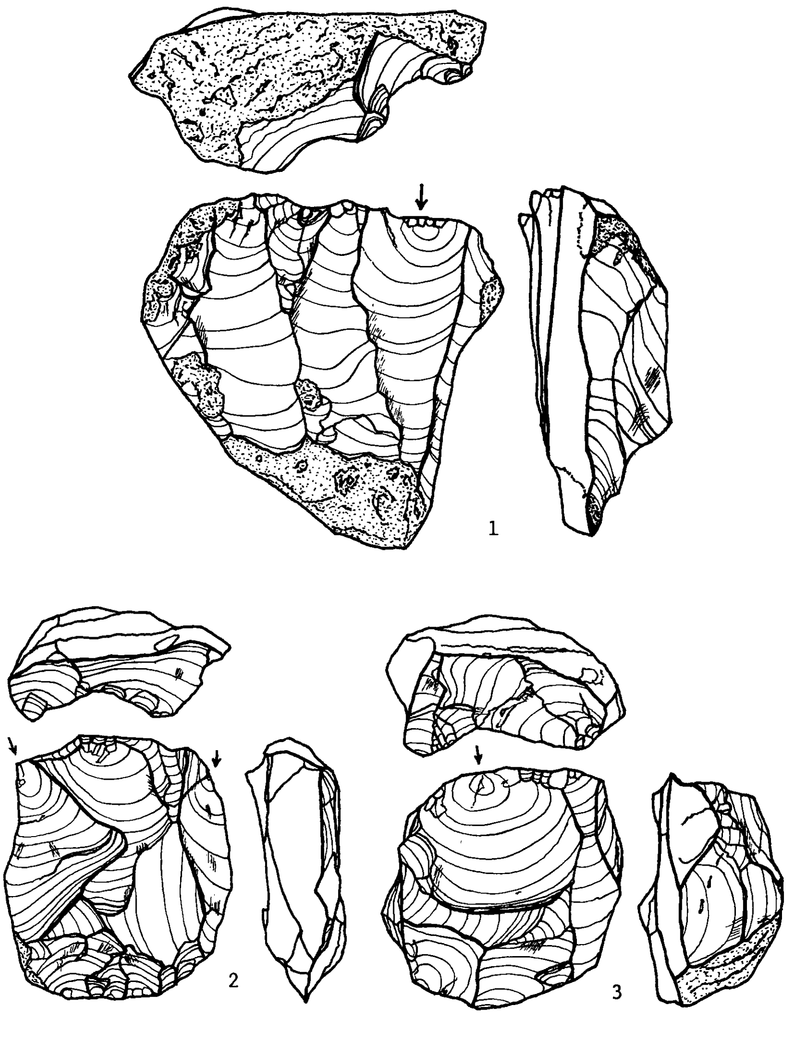


Fig. 32. Cores from Level XXI (scale 1/1)

↓: final detachment

1. Single platform prismatic core
2. Discoidal core with retouch modification
3. Discoidal core or a Levallois flake core in the final form

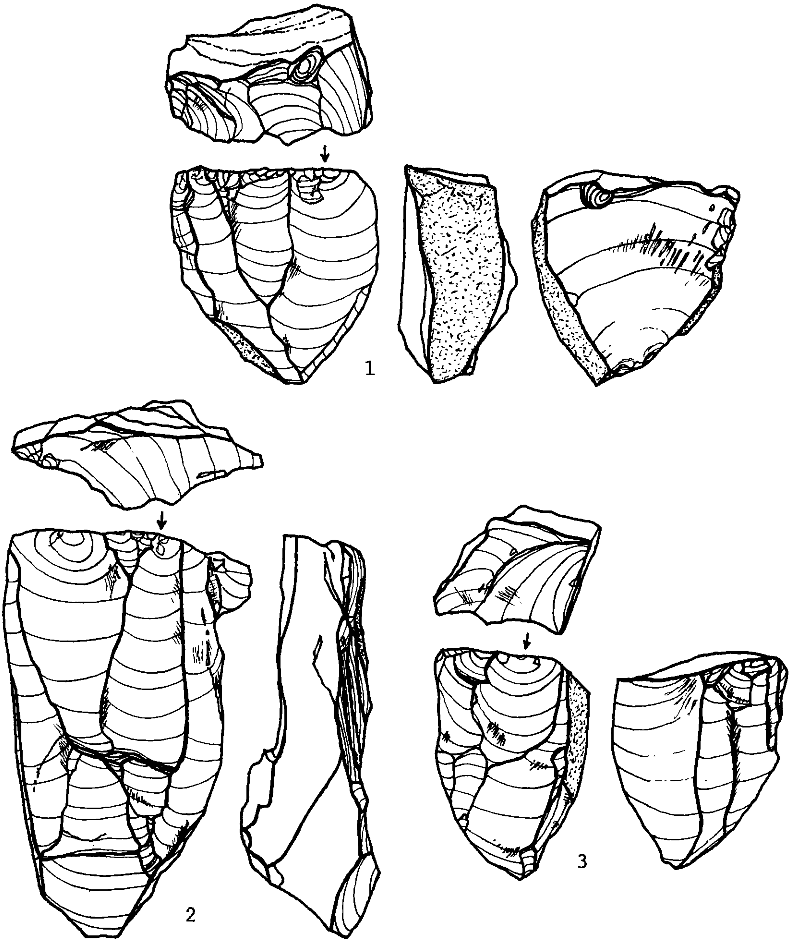


Fig. 33. Cores from Level XXI (scale 1/1)

↓: final detachment

1. Single platform prismatic core on a flake
2. Single platform prismatic core
3. Single platform prismatic core on a flake

The mean length of the final flake scars is 25.6mm with the s.d. of 11.3mm (99 cases), and the mean width is 15.5mm with the s.d. of 9.7mm (99 cases).

The shapes of the final flake scars are parallel (73: 73.7%), converging (15: 15.2%), and expanding (11: 11.1%), and the distal shapes are blunt (84: 85.7%) and pointed (14: 14.3%).

Forty-one (39.8%) of the 103 final flake scars are hinged, and 3 (2.9%) are plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.4 with the s.d. of 0.6 (72 cases).

The mean number of flake scars from one and the same striking platform is 3.2 with the s.d. of 1.4 (72 cases).

The locations of striking platforms are opposed (10: 38.5%), opposite rectangular (3: 11.5%), opposite alternate (4: 15.4%), crossed (3: 11.5%), peripheral (1: 3.8%), alternating (4: 15.4%), and miscellaneous (1: 3.8%).

The scar patterns are uni-directional (51: 68.0%), bi-directional opposed (12: 16.0%), crossed (9: 12.0%), centripetal (2: 2.7%), and miscellaneous (1: 1.3%).

The backs of the cores are cortex (36: 52.9%), striking platforms (1: 1.5%), core preparation (3: 4.4%), flake scars (12: 17.6%), and miscellaneous (16: 23.5%).

Four of the cores are clearly worked on nodules (5.9%), 10 are worked on flakes (14.7%), and the rest (54: 79.4%) are believed to be worked on nodules.

The mean core length is 50.2mm with the s.d. of 8.8mm (68 cases), the mean core width is 39.0mm with the s.d. of 10.2mm (68 cases), and the mean core thickness is 23.4mm with the s.d. of 6.8mm (68 cases).

The overall shapes of the cores are parallel (29: 42.6%), converging (29: 42.6%), and miscellaneous (10: 14.7%).

One core shows traces of heat alteration (1.5%).

Fourteen cores were most probably abandoned because of hinging (20.6%).

RETOUCHED PIECES

The retouched pieces total 575, but 148 of them are broken. The main categories of the 427 unbroken retouched pieces are the end-scraper, the end-scraper on a retouched blank, and the burin on a retouched truncation (Table 25) (Figs. 34 and 35).

The blanks for the retouched pieces are cortical debitage (15:

Table 25. Frequencies of Retouched Piece Classes in Level XXI

Category	Frequency	Percent
End-scrapers	86	20.1
Double end-scrapers	4	0.9
End-scrapers on retouched blanks	55	12.9
Chamfered pieces	3	0.7
Burins on break	26	6.1
Dihedral burins	4	0.9
Burins on retouched truncation	48	11.2
Burins on lateral preparation	22	5.2
Multiple mixed burins	9	2.1
Backed pieces	5	1.2
Partially-backed pieces	28	6.6
Double partially-backed pieces	3	0.7
Truncated pieces	1	0.2
Pointes à face plane	1	0.2
Ksar Akil points	3	0.7
Notched pieces	6	1.4
Denticulated pieces	1	0.2
Side-scrapers	8	1.9
Pieces with continuous direct retouch	16	3.8
Pieces with continuous inverse retouch	10	2.3
Pieces with continuous alternate(ing) retouch	4	0.9
Pieces with discontinuous direct retouch	12	2.8
Pieces with discontinuous inverse retouch	4	0.9
Pieces with discontinuous alternate(ing) retouch	2	0.5
Becs	3	0.7
Retouched Levallois points	2	0.5
Splintered pieces	1	0.2
Steep scrapers	2	0.5
Choppers	2	0.5
Composite retouched pieces	52	12.2
Unclassifiable retouched pieces	4	0.9
Total	427	99.9

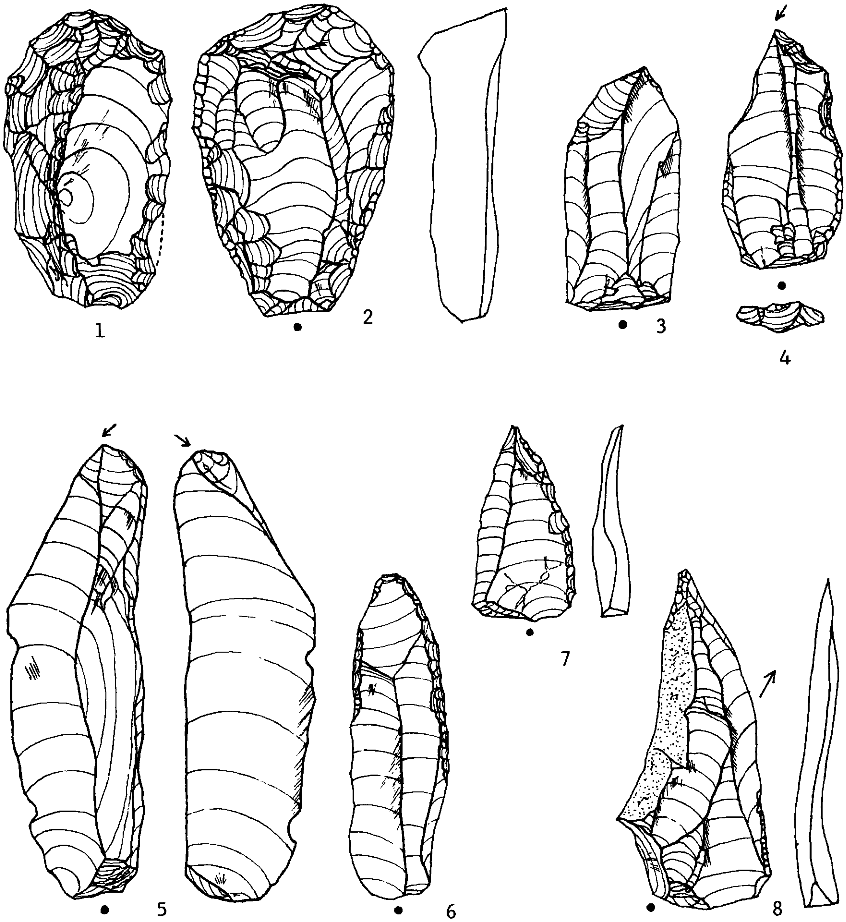


Fig. 34. Retouched pieces from Level XXI (scale 1/1)

●: point of percussion

1. End-scraper on a retouched core tablet
2. End-scraper on a retouched non-cortical flake
3. Chamfered piece
4. Burin on a retouched truncation on a backed blade
5. Burin on a lateral preparation on a flake-blade
6. Double partially-backed blade
7. Backed piece
8. Double partially-backed partially-cortical debitage

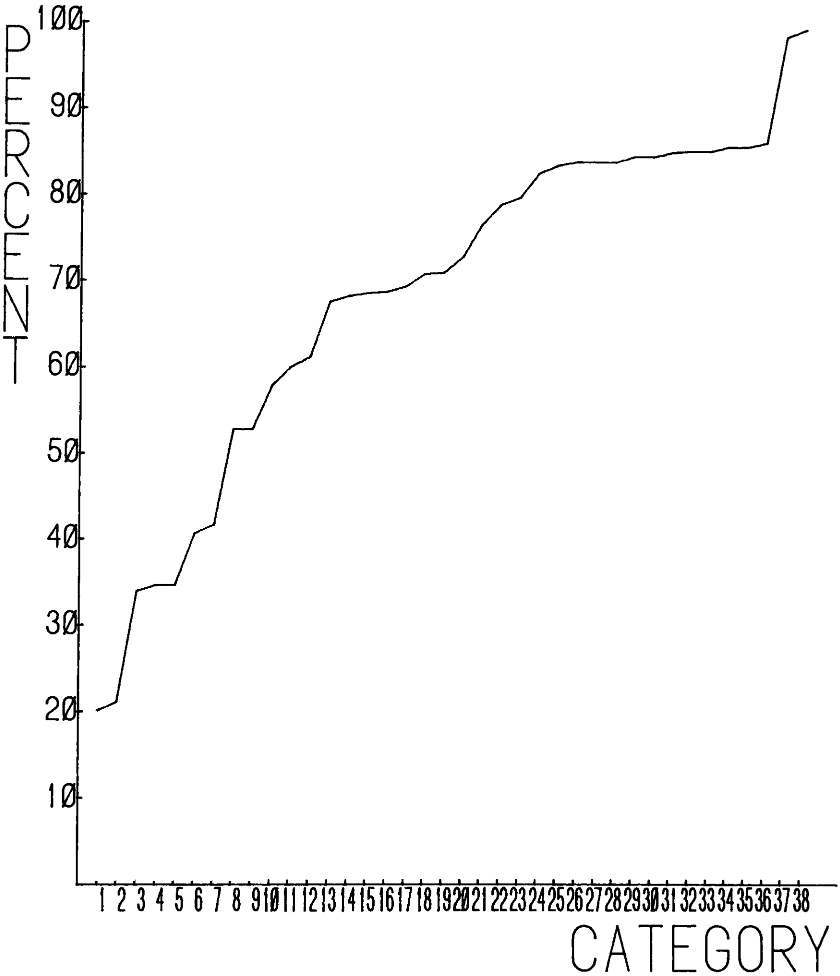


Fig. 35. Cumulative graph of retouched pieces from Level XXI: 427 pieces

3.5%), partially-cortical debitage (88: 20.6%), non-cortical flakes (91: 21.3%), flake-blades (113: 26.5%), blades (73: 17.1%), bladelets (22: 5.2%), crested debitage (4: 0.9%), cores (1: 0.2%), older debitage (18: 4.2%), and natural stones (2: 0.5%).

The end-scrapers are made on cortical debitage (1: 1.2%), partially-cortical debitage (25: 29.1%), non-cortical flakes (18: 20.9%), flake-blades (19: 22.1%), blades (16: 18.6%), bladelets (3: 3.5%), crested debitage (2: 2.3%), and older debitage (2: 2.3%). The end-scrapers on retouched blanks are made on cortical debitage (8: 14.5%), partially-cortical debitage (19: 34.5%), non-cortical flakes (17: 30.9%), flake-blades (7: 12.7%), and older debitage (4: 7.3%). The burins on retouched truncation are made on partially-cortical debitage (17: 35.4%), non-cortical flakes (7: 14.6%), flake-blades (16: 33.3%), blades (5: 10.4%), and older debitage (2: 4.2%).

Three of the blanks are Levallois flakes and were used for end-scrapers on retouched blanks (1), notched pieces (1), and composite retouched pieces (1). Four of the blanks are Levallois blades and were used for denticulated pieces (1), pieces with continuous alternate(ing) retouch (1), and composite retouched pieces (2). Six of the blanks are Levallois points and were used for end-scrapers (2), dihedral burins (1), pieces with continuous inverse retouch (1), and retouched Levallois points (2). Twenty of the blanks are naturally-backed and were mainly used for end-scrapers (8: 40.0%).

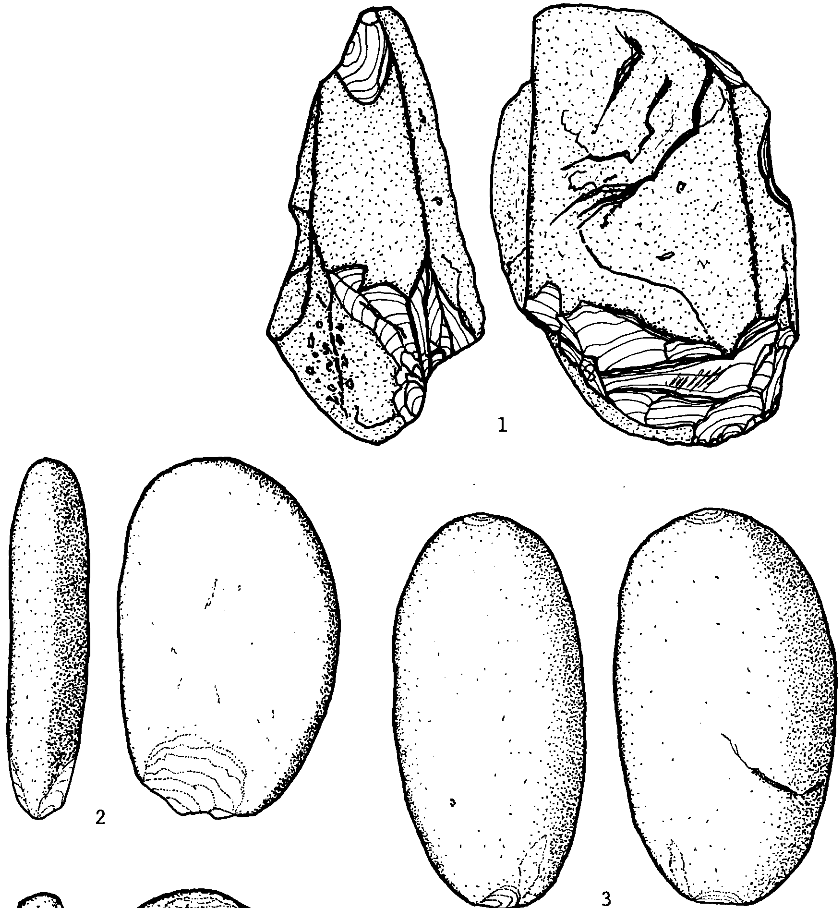
The flaking modes for the blanks are Harder (59: 29.6%), Softer (103: 51.8%), and Questionable (37: 18.6%).

HAMMERSTONES

Four nodules of stone are thought to be hammerstones. Three of them (of sandstone-like (1) and flint (2) nodules) are flat and oval in outline (83mm x 57mm x 35mm; 75mm x 42mm x 14mm; 63mm x 40mm x 15mm), and show some traces of battering at their margins. The fourth example (70mm x 42mm x 35mm), of quartzite-like stone, is elongated with oval cross section and shows the battering traces on its tip. Their weight ranges from 60.1g to 175.1g (Fig. 36).

SUMMARY

Level XXI is characterized by flake-blades, blades, prismatic cores, end-scrapers, end-scrapers on retouched blanks, and burins on retouched truncation. The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted. The debitage was produced chiefly with softer hammers, and has parallel or converging dorsal shape, blunt distal shape, and uni-directional dorsal scar pattern. The striking platforms of the cores are mainly plain and convex dihedral faceted, and the overall shapes of the cores are mainly parallel or converging. The features of this level which differentiate it from Level XXII are the increase in end-scrapers on retouched blanks and the decreases in chamfered pieces and debitage with pointed distal shape.



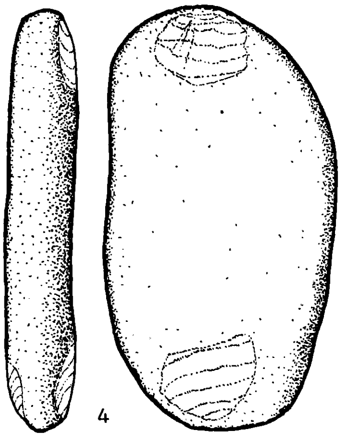


Fig. 36. Hammerstones from
Level XXI
(scale 1/1)

1. Flat hammerstone of flint
2. Flat hammerstone of flint nodule
3. Hammerstone of quartzite-like stone
4. Flat hammerstone of sandstone-like nodule

Level XX

The materials of this level total 2,421, comprising debitage, cores, retouched pieces, and hammerstones, and were derived from Squares E4 (-12.95m to -12.40m) and F4 (-12.95m to -12.65m).

DEBITAGE

The debitage totals 1,222 pieces, but 666 of them are broken. The 556 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, bladelets, and crested debitage (Table 26) (Figs. 37 to 39).

The butts of the debitage are mainly plain and convex dihedral faceted (Table 27).

Two hundred and forty-two of the butts are accompanied by partially regularizing facets (43.5%), 16 are accompanied by overhang removal by abrasion (2.9%), and 75 are accompanied by overhang removal by blow (13.5%).

Thirty-two of the debitage are hinged (5.8%), and 19 are plunged (3.4%).

(1) Cortical debitage, partially-cortical debitage, non-cortical flakes, and crested debitage: 154 pieces

The profiles above the butts are straight (37: 24.8%), concave (63: 42.3%), convex (23: 15.4%), and crushed (26: 17.4%).

The mean butt thickness is 5.1mm with the s.d. of 2.6mm (149 cases), the mean length is 56.7mm with the s.d. of 17.0mm (154 cases), the mean width is 24.1mm with the s.d. of 8.3mm (154 cases), and the mean thickness is 8.9mm with the s.d. of 3.4mm (154 cases).

The flaking modes are Harder (16: 20.8%), Softer (50: 64.9%), and Questionable (11: 14.3%).

The dorsal scar patterns are uni-directional (42: 31.8%), bi-directional opposed (26: 19.7%), crossed (17: 12.9%), and with the trace of cresting (47: 35.6%).

The mean number of dorsal scars is 5.5 with the s.d. of 3.2 (151 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: 402 pieces

The profiles above the butts are straight (87: 21.7%), concave (229: 57.1%), convex (41: 10.2%), and crushed (44: 11.0%).

The mean butt thickness is 4.4mm with the s.d. of 1.9mm (396 cases), the mean length is 55.0mm with the s.d. of 11.2mm (402 cases), the mean width is 19.2mm with the s.d. of 4.5mm (402 cases), and the

Table 26. Frequencies of Debitage Classes in Level XX

Category	Frequency	Percent
Cortical debitage	3	0.5
Partially-cortical debitage	62	11.2
Non-cortical flakes	48	8.6
Levallois flakes	1	0.2
Levallois points	2	0.4
Flake-blades (including 13 Levallois blades and 22 Levallois points)	206	37.1
Blades (including 2 Levallois points)	127	22.8
Bladelets	66	11.9
Crested debitage	41	7.4
Total	556	100.1

Table 27. Frequencies of Butt Types of Debitage in Level XX

Category	Frequency	Percent
Cortical	10	1.8
Plain	160	28.8
Convex dihedral faceted	164	29.5
Straight multiple faceted	40	7.2
Convex multiple faceted	89	16.0
Partially faceted	37	6.7
Linear	23	4.1
Punctiform	19	3.4
Broken	14	2.5
Total	556	100.0

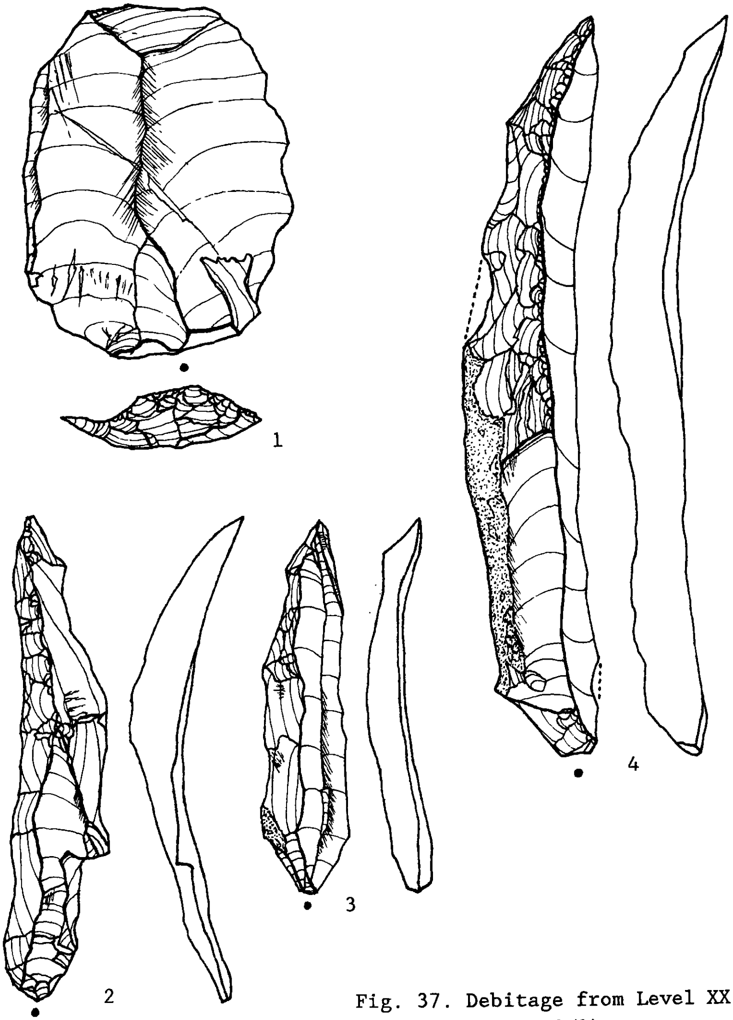


Fig. 37. Debitage from Level XX
(scale 1/1)

●: point of percussion

1. Non-cortical flake
2. Crested debitage with the trace of hinging removal
3. Crested debitage
4. Crested debitage

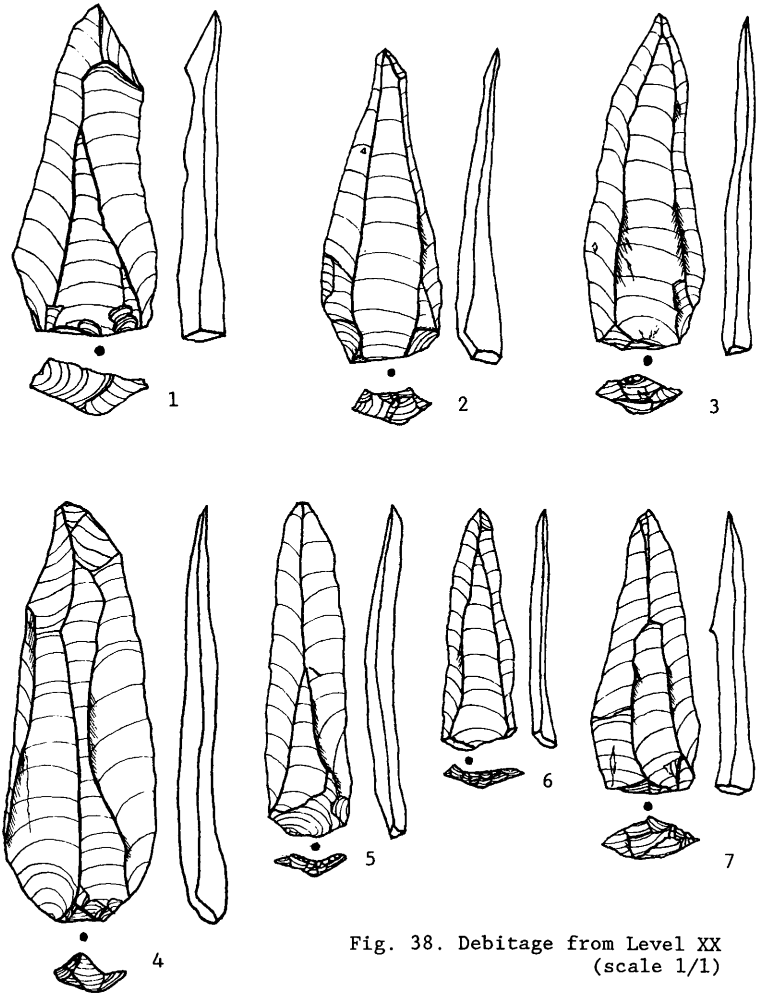


Fig. 38. Debitage from Level XX
(scale 1/1)

●: point of percussion

1. Elongated Levallois point
2. Elongated Levallois point
3. Elongated Levallois point
4. Levallois blade
5. Elongated Levallois point
6. Elongated Levallois point
7. Elongated Levallois point

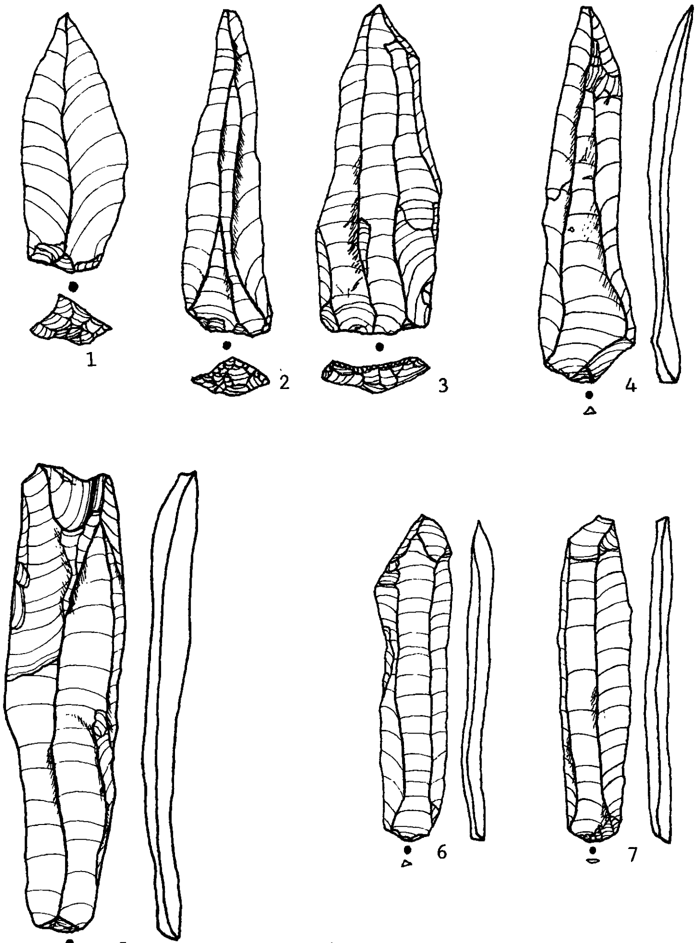


Fig. 39. Debitage from Level XX
(scale 1/1)

●: point of percussion

1. Flake-blade
2. Flake-blade
3. Blade
4. Blade
5. Levallois blade
6. Blade
7. Blade

mean thickness is 6.5mm with the s.d. of 2.5mm (402 cases).

The mean *angle de chasse* is 82.9° with the s.d. of 6.6° (368 cases), the mean *angle d'éclatement* is 97.2° with the s.d. of 7.2° (368 cases), and the mean total of the two angles is 180.1° (368 cases).

The flaking modes are Harder (31: 13.2%), Softer (169: 71.9%), and Questionable (35: 14.9%).

The dorsal scar patterns are uni-directional (126: 33.1%), bi-directional opposed (150: 39.4%), crossed (87: 22.8%), centripetal (2: 0.5%), and with the trace of cresting (16: 4.2%).

The mean number of dorsal scars is 5.2 with the s.d. of 1.7 (401 cases).

The numbers of dorsal planes are One (78: 19.4%), Two (266: 66.2%), and Three (58: 14.4%).

The dorsal shapes are parallel (264: 65.7%), converging (114: 28.4%), and expanding (24: 6.0%).

The distal shapes are blunt (316: 78.6%) and pointed (86: 21.4%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 2.0 with the s.d. of 0.6 (193 cases).

The flaking order patterns on the Levallois points, flake-blades, blades, and bladelets are A (66: 56.9%), B (34: 29.3%), and C (16: 13.8%).

The locations of points of percussion are A (133: 34.2%), B (184: 47.3%), and C (72: 18.5%).

The Levallois flake has a broken butt. Its dorsal scar pattern is crossed, and the location of point of percussion is B.

Thirteen of the flake-blades can be considered to be Levallois blades. Their butts are plain (3), of convex dihedral facets (4), of straight multiple facets (5), and of partial facets (1). Their dorsal scar patterns are crossed (11) and centripetal (2), and the locations of points of percussion are A (2), B (8), and C (1).

The Levallois points total 26; 22 (84.6%) of them are flake-blades, and 2 (7.7%) may be blades. Their butts are cortical (1: 3.8%), plain (8: 30.8%), of convex dihedral facets (6: 23.1%), of straight multiple facets (2: 7.7%), of convex multiple facets (6: 23.1%), of partial facets (2: 7.7%), and broken (1: 3.8%). Their dorsal scar patterns are uni-directional (17: 65.4%), bi-directional opposed (4: 15.4%), crossed (4: 15.4%), and with the trace of cresting (1: 3.8%). The flaking order patterns are A (12: 52.2%), B (10: 43.5%), and C (1: 4.3%). The locations of points of percussion are A (4: 15.4%), B (11: 42.3%), and C (11: 42.3%).

CORES

The cores total 175, of which 15 are broken. The 160 unbroken cores are classified into 7 categories (Table 28) (Figs. 40 and 41).

The striking platforms for the final flake scars are mainly plain and convex dihedral faceted (Table 29).

The mean length of the final flake scars is 24.0mm with the s.d. of 11.1mm (251 cases), and the mean width is 14.5mm with the s.d. of 5.8mm (251 cases).

The shapes of the final flake scars are parallel (168: 66.9%), converging (45: 17.9%) and expanding (38: 15.1%), and the distal shapes are blunt (223: 88.8%) and pointed (28: 11.2%).

One hundred and seventeen (45.7%) of the 256 final flake scars are hinged, and 10 (3.9%) are plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.5 with the s.d. of 0.7 (183 cases).

The mean number of flake scars from one and the same striking platform is 3.3 with the s.d. of 1.5 (179 cases).

The locations of striking platforms are opposed (22: 22.9%), opposite rectangular (10: 10.4%), opposite alternate (21: 21.9%), crossed (13: 13.5%), alternating (13: 13.5%), and miscellaneous (17: 17.7%).

The scar patterns are uni-directional (80: 44.2%), bi-directional opposed (60: 33.1%), crossed (25: 13.8%), centripetal (1: 0.6%), of a single flake scar (7: 3.9%), with the trace of cresting (3: 1.7%), and miscellaneous (5: 2.8%).

The backs of the cores are cortex (65: 40.6%), striking platforms (3: 1.9%), core preparation (2: 1.3%), flake scars (31: 19.4%), and miscellaneous (59: 36.9%).

Twelve of the cores are clearly worked on nodules (7.5%), 13 are worked on flakes (8.1%), and the rest (135: 84.4%) are believed to be worked on nodules.

The mean core length is 48.4mm with the s.d. of 9.7mm (160 cases), the mean core width is 36.3mm with the s.d. of 8.5mm (160 cases), and the mean core thickness is 25.1mm with the s.d. of 8.4mm (160 cases).

The overall shapes of the cores are parallel (70: 43.8%), converging (48: 30.0%), and miscellaneous (42: 26.3%).

Two cores show traces of heat alteration (1.3%).

Forty-nine cores were most probably abandoned because of hinging (30.6%).

Table 28. Frequencies of Core Classes in Level XX

Category	Frequency	Percent
Prismatic cores (including 3 cores converted from Levallois point cores)	117	73.1
Globular cores	5	3.1
Pyramidal cores	3	1.9
Discoidal cores	2	1.3
Levallois point cores (on prismatic cores)	2	1.3
Levallois flake cores (on prismatic cores)	1	0.6
Miscellaneous cores (including 1 core converted from Levallois blade core)	30	18.8
Total	160	100.1

Table 29. Frequencies of Striking Platform Types of Cores in Level XX

Category	Frequency	Percent
Cortical	13	5.2
Plain	144	57.4
Convex dihedral faceted	77	30.7
Straight multiple faceted	2	0.8
Convex multiple faceted	13	5.2
Broken	2	0.8
Total	251	100.1

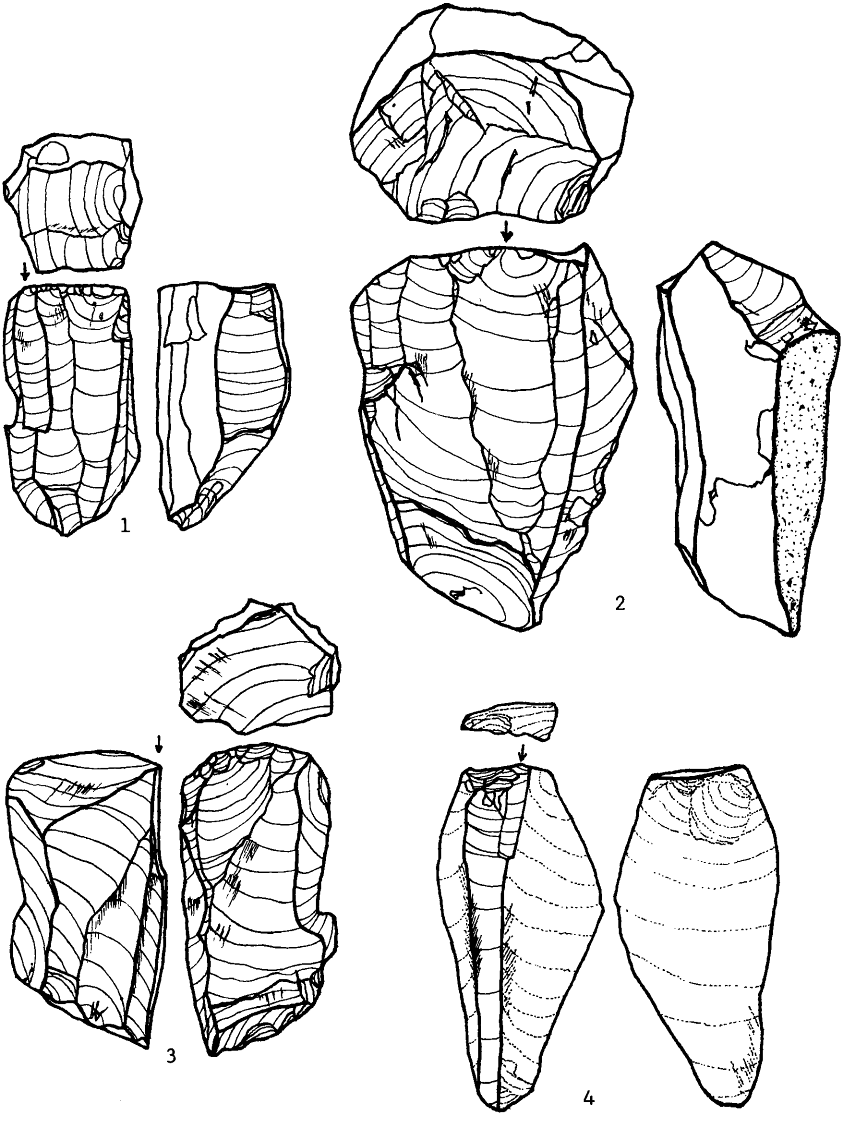


Fig. 40. Cores from
Level XX (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core
2. Prismatic core with opposite rectangular platforms, resembling a Levallois point core
3. Prismatic core with opposite alternate platforms
4. Core on older debitage

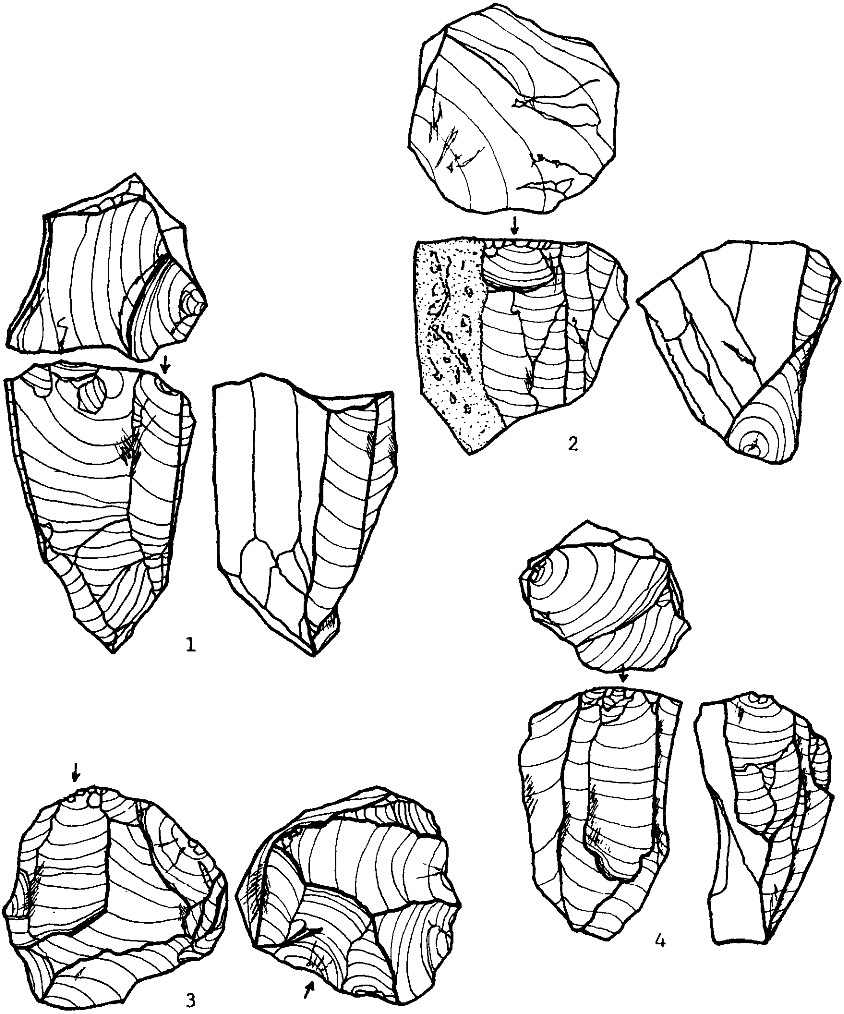


Fig. 41. Cores from Level XX (scale 1/1)

↙: final detachment

1. Pyramidal core with the trace of a core tablet removal
2. Prismatic core with opposite rectangular platforms and with the trace of a core tablet removal
3. Discoidal core on a flake
4. Pyramidal core with the trace of a core tablet removal

RETOUCHED PIECES

The retouched pieces total 1,009, of which 294 are broken.

The main categories of the 715 unbroken retouched pieces are the end-scraper and the partially-backed piece (Table 30) (Figs. 42 to 45).

The blanks for the retouched pieces are cortical debitage (25: 3.5%), partially-cortical debitage (134: 18.8%), non-cortical flakes (132: 18.5%), flake-blades (169: 23.7%), blades (158: 22.1%), bladelets (33: 4.6%), crested debitage (29: 4.1%), cores (10: 1.4%), older debitage (14: 2.0%), and natural stones (10: 1.4%).

The end-scrapers are made on cortical debitage (16: 5.6%), partially-cortical debitage (78: 27.2%), non-cortical flakes (59: 20.6%), flake-blades (58: 20.2%), blades (47: 16.4%), bladelets (1: 0.4%), crested debitage (17: 5.9%), cores (1: 0.4%), older debitage (7: 2.4%), and natural stones (3: 1.1%). The partially-backed pieces are made on partially-cortical debitage (3: 4.5%), non-cortical flakes (6: 9.0%), flake-blades (25: 37.3%), blades (24: 35.8%), bladelets (8: 11.9%), and crested debitage (1: 1.5%).

Nine of the blanks are Levallois flakes and were used for end-scrapers (6), partially-backed pieces (1), pieces with continuous direct retouch (1), and composite retouched pieces (1). Six of the blanks are Levallois blades and were used for end-scrapers (3), partially-backed pieces (1). and pieces with continuous direct retouch (2). Nine of the blanks are Levallois points and were used for end-scrapers (2), burins on lateral preparation (1), partially-backed pieces (1), Ksar Akil points (2), retouched Levallois points (2), and composite retouched pieces (1). Twenty-two of the blanks are naturally-backed and were mainly used for end-scrapers (10: 45.5%) and pieces with continuous direct retouch (4: 18.2%).

The flaking modes for the blanks are Harder (57: 18.1%), Softer (214: 67.9%), and Questionable (44: 14.0%).

HAMMERSTONES

Fifteen nodules of stone are thought to be hammerstones; 11 of these hammerstones are of basalt-like stone, 3 are of flint, and 1 is of sandstone-like nodule. The mean values of their dimensions (length, width, and thickness) are 66.8mm, 49.1mm, and 24.6mm, respectively. Their weight ranges from 33.7g to 733.2g. The smallest one of them is of basalt-like stone. It is 56mm long, 38mm wide, and 16mm thick, and weighs 56.6g. The largest one, also of basalt-like stone, weighs 733.2g, and is 96mm long, 90mm wide, and 58mm thick. Three of these hammerstones are globular and show the battering traces on their rounded tips, while 12 hammerstones are flat and trapezoidal (2) or oval (10) in outline. It is interesting to note that 10 of the flat hammerstones show the battering traces on their margins and only 2 specimens show the battering traces on their tips (Figs. 46 and 47).

Table 30. Frequencies of Retouched Piece Classes in Level XX

Category	Frequency	Percent
End-scrapers	287	40.1
Double end-scrapers	12	1.7
End-scrapers on retouched blanks	24	3.4
Chamfered pieces	5	0.7
Burins on break	32	4.5
Dihedral burins	2	0.3
Burins on retouched truncation	21	2.9
Multiple truncation burins	2	0.3
Burins on lateral preparation	10	1.4
Multiple mixed burins	12	1.7
Backed pieces	8	1.1
Partially-backed pieces	67	9.4
Double partially-backed pieces	7	1.0
Truncated pieces	6	0.8
Ksar Akil points	15	2.1
Notched pieces	8	1.1
Denticulated pieces	1	0.1
Side-scrapers	8	1.1
Pieces with continuous direct retouch	46	6.4
Pieces with continuous inverse retouch	11	1.5
Pieces with continuous alternate(ing) retouch	9	1.3
Pieces with discontinuous direct retouch	8	1.1
Pieces with discontinuous inverse retouch	6	0.8
Pieces with discontinuous alternate(ing) retouch	2	0.3
Piercers	1	0.1
Becs	2	0.3
Retouched Levallois points	2	0.3
Splintered pieces	17	2.4
Steep scrapers	12	1.7
Choppers	2	0.3
Composite retouched pieces	69	9.7
Unclassifiable retouched pieces	1	0.1
Total	715	100.0

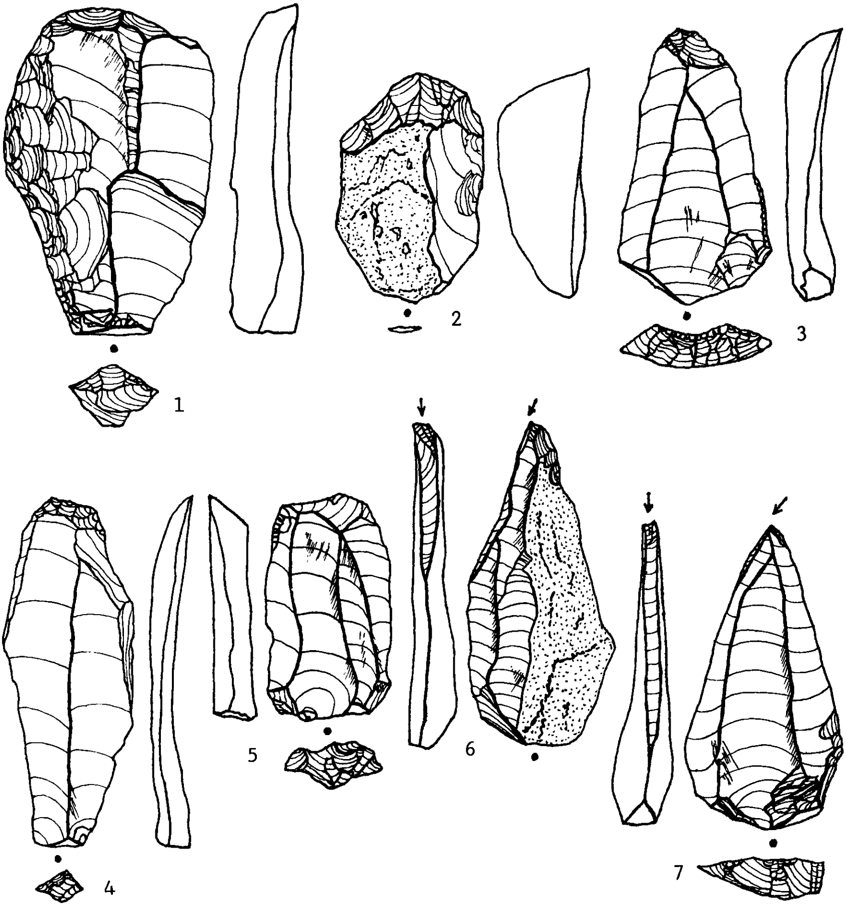


Fig. 42. Retouched pieces
from Level XX (scale 1/1)

●: point of percussion

1. End-scraper on a retouched non-cortical flake
2. End-scraper on partially-cortical debitage
3. End-scraper on a Levallois point
4. End-scraper on a Levallois blade
5. Chamfered piece
6. Burin on a retouched truncation on partially-cortical debitage
7. Burin on a lateral preparation on a Levallois point

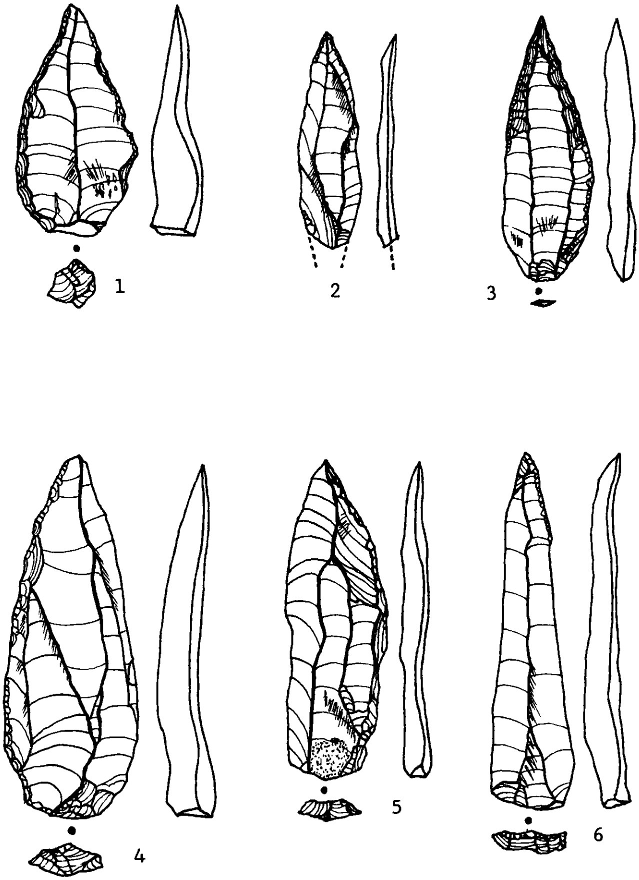


Fig. 43. Retouched pieces from Level XX (scale 1/1)

●: point of percussion

1. Ksar Akil point on a flake-blade
2. Ksar Akil point on a bladelet
3. *Pointe à face plane* on a blade
4. Backed blade
5. Backed blade or a Ksar Akil point
6. Retouched elongated Levallois point

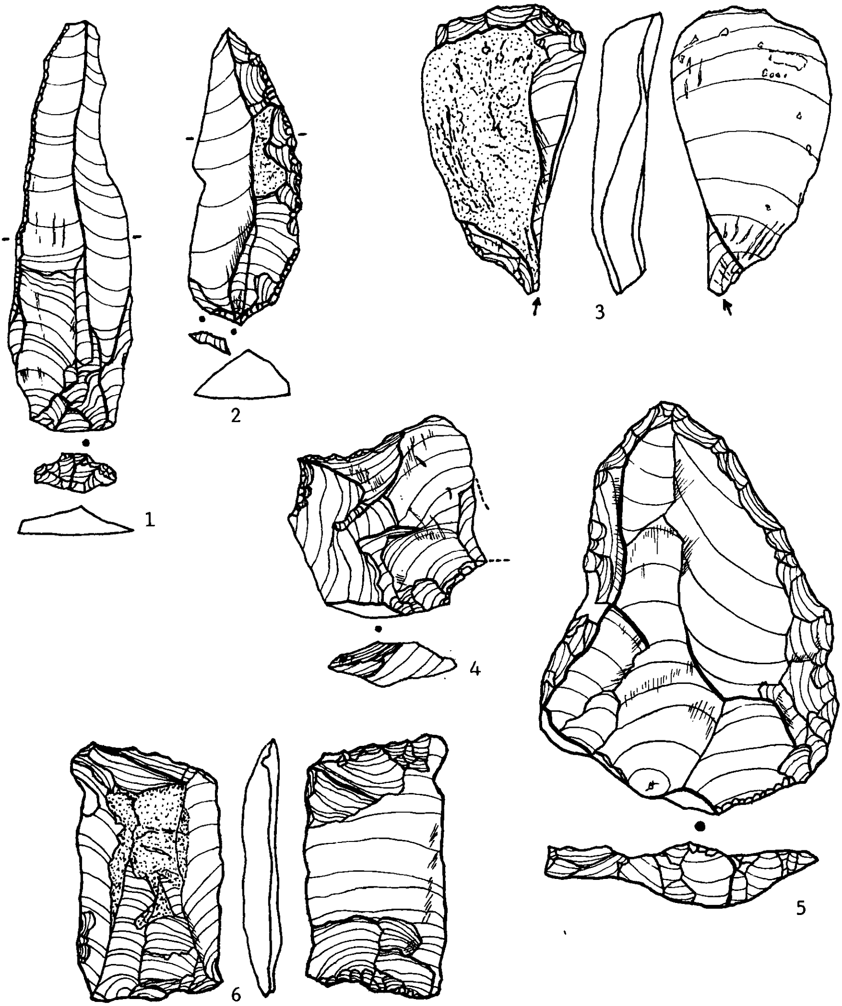


Fig. 44. Retouched pieces from
Level XX (scale 1/1)
●: point of percussion

1. Partially-backed blade
2. Backed partially-cortical debitage
3. End-scraper/burin on a retouched truncation on partially-cortical debitage
4. Bec on a non-cortical flake
5. Convergent side-scraper on a Levallois flake
6. Splintered piece on partially-cortical debitage

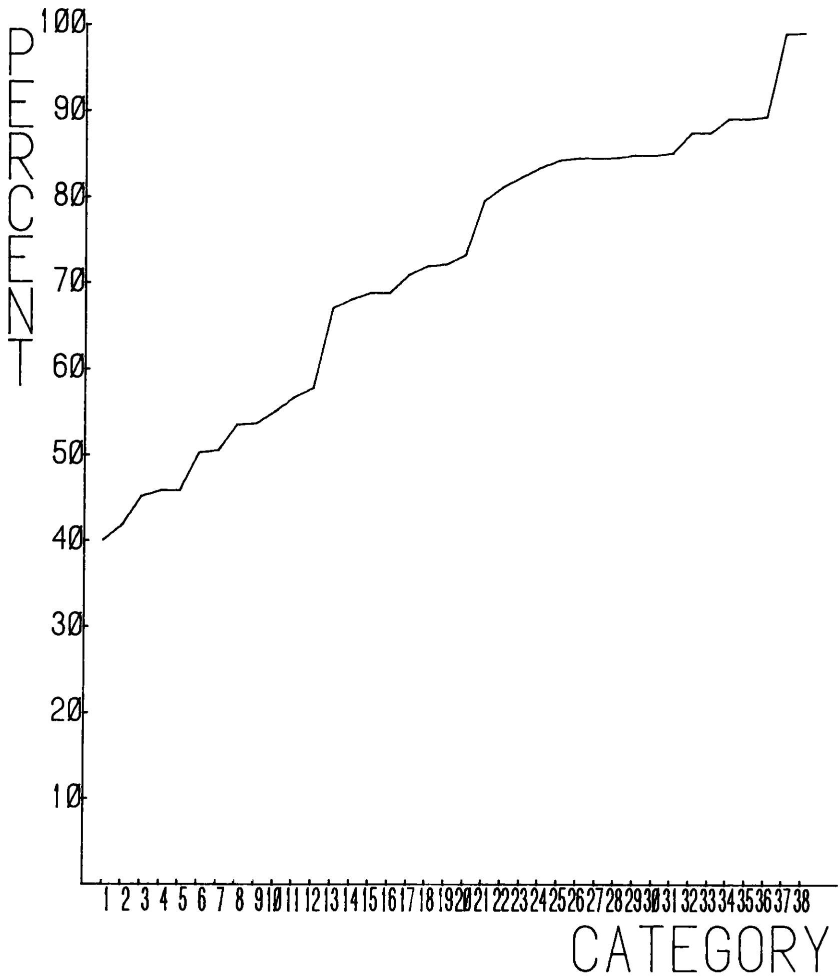


Fig. 45. Cumulative graph of retouched pieces from Level XX: 715 pieces

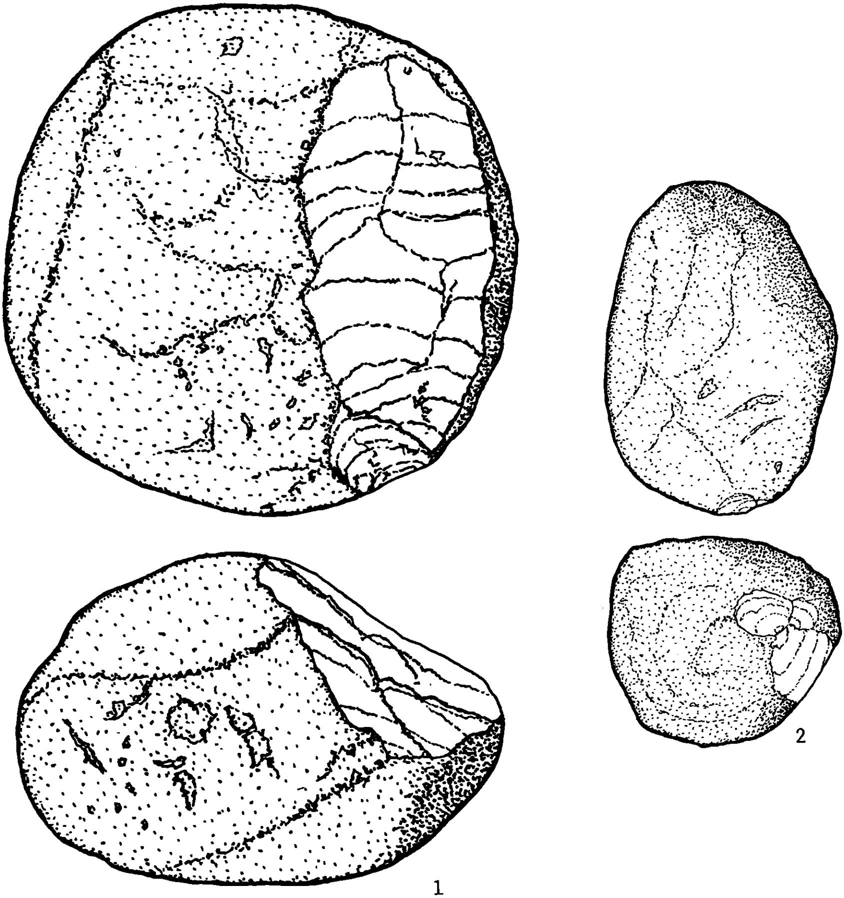


Fig. 46. Hammerstones from Level XX (scale 1/1)

1. Hammerstone of basalt-like stone
2. Hammerstone of flint nodule

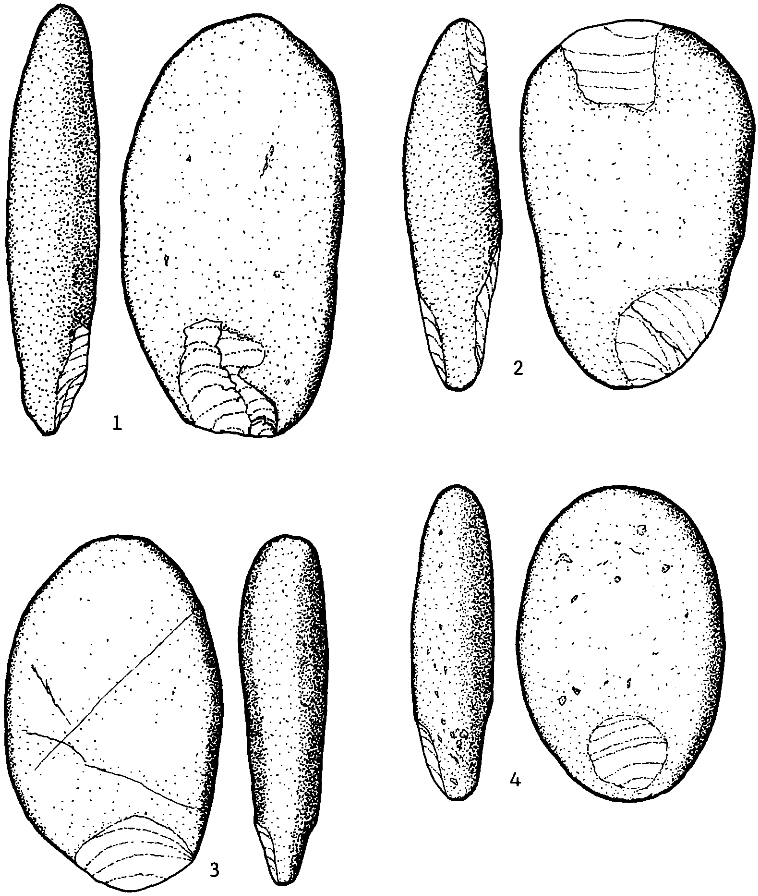


Fig.47. **Hammerstones** from Level XX (scale 1/1)

1. Flat hammerstone of basalt-like stone
2. Flat hammerstone of basalt-like stone
3. Flat hammerstone of basalt-like stone
4. Flat hammerstone of basalt-like stone

SUMMARY

Level XX is characterized by flake-blades, blades, prismatic cores, end-scrapers, and partially-backed pieces. The butts of the debitage are mainly plain and convex dihedral faceted. The debitage was produced mainly with softer hammers, and has parallel dorsal shape, blunt distal shape, and uni-directional or bi-directional opposed dorsal scar pattern. The striking platforms of the cores are mainly plain or convex dihedral faceted, and the overall shapes of the cores are mainly parallel. The features of this level which differentiate it from Level XXI are the increases in crested debitage and debitage with bi-directional opposed dorsal scar pattern. Debitage produced with softer hammers becomes more dominating in this level. End-scrapers on retouched blanks and burins on retouched truncation, on the other hand, are fewer than in Level XXI.

Level XIX

The materials of this level total 1,473, comprising debitage, cores, retouched pieces, and hammerstones, and were derived from Squares E4 (-12.40m to -12.00m) and F4 (-12.65m to -11.50m).

DEBITAGE

The debitage totals 811 pieces, of which 451 are broken. The 360 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, bladelets, and crested debitage (Table 31) (Figs. 48 and 49).

The butts of the debitage are mainly plain and convex dihedral faceted (Table 32).

Seventy-two of the butts are accompanied by partially regularizing facets (20.0%), 76 are accompanied by overhang removal by abrasion (21.1%), and 37 are accompanied by overhang removal by blow (10.3%).

Twenty-eight of the debitage are hinged (7.8%), and 9 are plunged (2.5%).

(1) Cortical debitage, partially-cortical debitage, non-cortical flakes, and crested debitage: 168 pieces

The profiles above the butts are straight (35: 21.1%), concave (75: 45.2%), convex (31: 18.7%), and crushed (25: 15.1%).

The mean butt thickness is 4.3mm with the s.d. of 2.2mm (164 cases), the mean length is 48.8mm with the s.d. of 14.3mm (168 cases), the mean width is 24.9mm with the s.d. of 10.5mm (168 cases), and the mean thickness is 8.4mm with the s.d. of 3.8mm (168 cases).

The flaking modes are Harder (8: 8.4%), Softer (72: 75.8%), and Questionable (15: 15.8%).

Table 31. Frequencies of Debitage Classes in Level XIX

Category	Frequency	Percent
Cortical debitage	6	1.7
Partially-cortical debitage	60	16.7
Non-cortical flakes	67	18.6
Levallois flakes	4	1.1
Levallois points	2	0.6
Flake-blades (including 6 Levallois blades and 4 Levallois points)	77	21.4
Blades	53	14.7
Bladelets	56	15.6
Crested debitage	35	9.7
Total	360	100.1

Table 32. Frequencies of Butt Types of Debitage in Level XIX

Category	Frequency	Percent
Cortical	7	1.9
Plain	121	33.6
Convex dihedral faceted	85	23.6
Straight multiple faceted	15	4.2
Convex multiple faceted	40	11.1
Partially faceted	7	1.9
Linear	44	12.2
Punctiform	32	8.9
Broken	9	2.5
Total	360	99.9

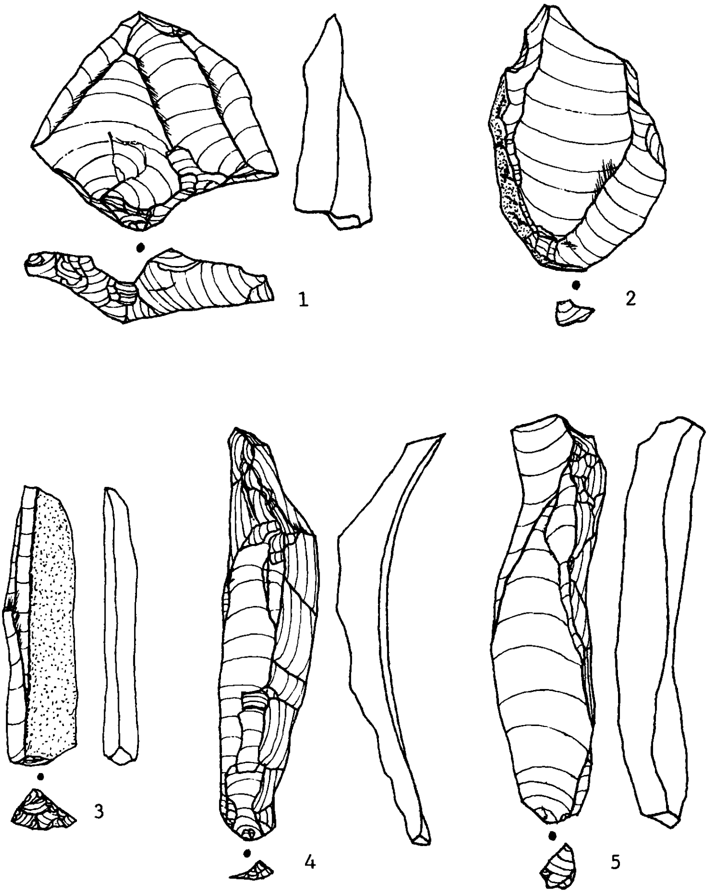


Fig. 48. Debitage from Level XIX (scale 1/1)

●: point of percussion

1. Non-cortical flake
2. Partially-cortical debitage
3. Partially-cortical debitage
4. Crested debitage
5. Crested debitage

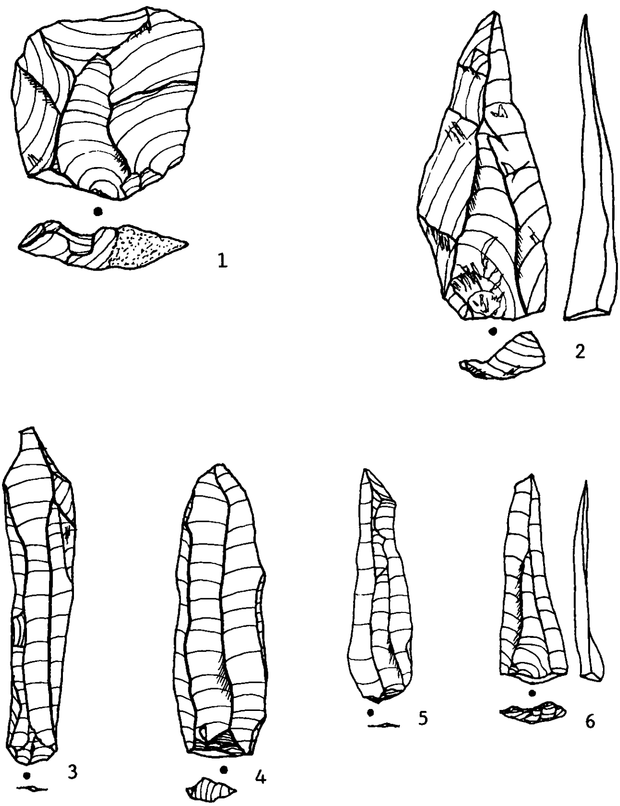


Fig. 49. Debitage from Level XIX (scale 1/1)

●: point of percussion

1. Levallois flake
2. Flake-blade resembling a Levallois point
3. Blade
4. Blade
5. Bladelet
6. Elongated Levallois point

The dorsal scar patterns are uni-directional (42: 27.1%), bi-directional opposed (39: 25.2%), crossed (38: 24.5%), with the trace of cresting (35: 22.6%), and miscellaneous (1: 0.6%).

The mean number of dorsal scars is 5.5 with the s.d. of 2.7 (163 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: <u>192 pieces</u>

The profiles above the butts are straight (56: 29.6%), concave (78: 41.3%), convex (37: 19.6%), and crushed (18: 9.5%).

The mean butt thickness is 3.6mm with the s.d. of 2.2mm (187 cases), the mean length is 50.9mm with the s.d. of 10.9mm (192 cases), the mean width is 18.5mm with the s.d. of 5.7mm (192 cases), and the mean thickness is 6.2mm with the s.d. of 2.3mm (192 cases).

The mean *angle de chasse* is 83.4° with the s.d. of 6.8° (144 cases), the mean *angle d'éclatement* is 96.0° with the s.d. of 6.7° (144 cases), and the mean total of the two angles is 179.3° (144 cases).

The flaking modes are Harder (11: 8.7%), Softer (95: 75.4%), and Questionable (20: 15.9%).

The dorsal scar patterns are uni-directional (58: 30.7%), bi-directional opposed (74: 39.2%), crossed (50: 26.5%), centripetal (2: 1.1%), and with the trace of cresting (5: 2.6%).

The mean number of dorsal scars is 5.5 with the s.d. of 1.8 (192 cases).

The numbers of dorsal planes are One (32: 16.7%), Two (138: 71.9%), and Three (22: 11.5%).

The dorsal shapes are parallel (147: 76.6%), converging (25: 13.0%), and expanding (20: 10.4%).

The distal shapes are blunt (162: 84.4%) and pointed (30: 15.6%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 2.1 with the s.d. of 0.7 (109 cases).

The flaking order patterns on the Levallois points, flake-blades, blades, and bladelets are A (20: 47.6%), B (17: 40.5%), and C (5: 11.9%).

The locations of points of percussion are A (64: 36.6%), B (87: 49.7%), and C (24: 13.7%).

The Levallois flakes have cortical butts (1), plain butts (1), and butts of convex dihedral facets (2). Their dorsal scar patterns are crossed (3) and centripetal (1), and the locations of points of percussion are A (1), B (2), and C (1).

Six of the flake-blades can be considered to be Levallois blades. Their butts are plain (3), of convex dihedral facets (1), of straight multiple facets (1), and punctiform (1). Their dorsal scar patterns are crossed (4) and centripetal (1). The flaking order pattern is A (1), and the locations of points of percussion are A (3) and B (3).

The Levallois points total 6; 4 of them are flake-blades. Their butts are plain (1), of convex dihedral facets (2), and of convex multiple facets (3). Their dorsal scar patterns are uni-directional (3), bi-directional opposed (1), and crossed (2). The flaking order patterns are A (1), B (4), and C (1). The location of point of percussion is C (6).

CORES

The cores total 155, of which 32 are broken. The 123 unbroken cores are classified into 5 categories (Table 33) (Fig. 50).

The striking platforms for the final flake scars are mainly plain (Table 34).

The mean length of the final flake scars is 23.2mm with the s.d. of 11.1mm (197 cases), and the mean width is 14.9mm with the s.d. of 6.6mm (197 cases).

The shapes of the final flake scars are parallel (153: 77.7%), converging (24: 12.2%), and expanding (20: 10.2%), and the distal shapes are blunt (179: 90.9%) and pointed (18: 9.1%).

Eighty-eight (44.2%) of the 199 final flake scars are hinged, and 6 (3.0%) are plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.6 with the s.d. of 0.6 (143 cases).

The mean number of flake scars from one and the same striking platform is 3.0 with the s.d. of 1.5 (143 cases).

The locations of striking platforms are opposed (29: 27.4%), opposite rectangular (12: 11.3%), opposite alternate (11: 10.4%), crossed (9: 8.5%), peripheral (2: 1.9%), alternating (13: 12.3%), and miscellaneous (30: 28.3%).

The scar patterns are uni-directional (37: 26.4%), bi-directional opposed (51: 36.4%), crossed (42: 30.0%), centripetal (3: 2.1%), of a single flake scar (3: 2.1%), with the trace of cresting (1: 0.7%), and miscellaneous (3: 2.1%).

The backs of the cores are cortex (48: 39.0%), striking platforms (2: 1.6%), core preparation (1: 0.8%), flake scars (32: 26.0%), and miscellaneous (40: 32.5%).

Nine of the cores are clearly worked on nodules (7.3%), 6 are worked on flakes (4.9%), and the rest (108: 87.8%) are believed to be

Table 33. Frequencies of Core Classes in Level XIX

Category	Frequency	Percent
Prismatic cores	73	59.3
Discoidal cores (including 1 core converted from Levallois flake core)	8	6.5
Pyramidal cores	3	2.4
Globular cores	3	2.4
Miscellaneous cores (including 8 cores intermediate between prismatic and pyramidal cores)	36	29.3
Total	123	99.9

Table 34. Frequencies of Striking Platform Types of Cores in Level XIX

Category	Frequency	Percent
Cortical	13	6.6
Plain	132	67.0
Convex dihedral faceted	44	22.3
Convex multiple faceted	7	3.6
Broken	1	0.5
Total	197	100.0

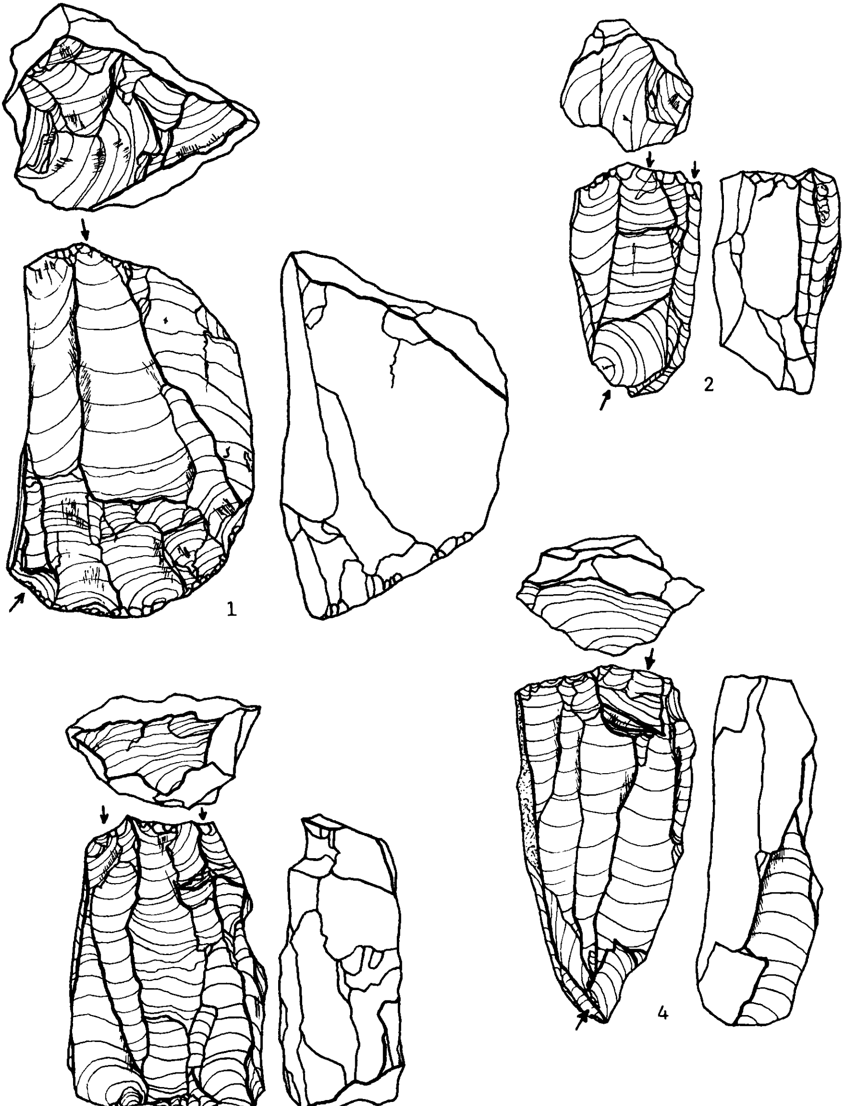


Fig. 50. Cores from Level XIX
(scale 1/1)

↓: final detachment

1. Opposed platform prismatic core
2. Prismatic core with opposite rectangular platforms
3. Opposed platform prismatic core
4. Prismatic core with opposed or opposite alternate platforms

worked on nodules.

The mean core length is 44.9mm with the s.d. of 11.1mm (123 cases), the mean core width is 33.9mm with the s.d. of 9.5mm (123 cases), and the mean core thickness is 23.1mm with the s.d. of 8.3mm (123 cases).

The overall shapes of the cores are parallel (78: 63.4%), converging (24: 19.5%), expanding (2: 1.6%), and miscellaneous (19: 15.4%).

Three cores show traces of heat alteration (2.4%).

Forty-eight cores were most probably abandoned because of hinging (39.0%).

RETOUCHED PIECES

The retouched pieces total 506, but 206 of them are broken.

The main category of the 300 unbroken retouched pieces is the end-scraper (Table 35) (Figs. 51 to 53).

The blanks for the retouched pieces are cortical debitage (9: 3.0%), partially-cortical debitage (68: 22.7%), non-cortical flakes (44: 14.7%), flake-blades (61: 20.3%), blades (66: 22.0%), bladelets (25: 8.3%), crested debitage (13: 4.3%), cores (4: 1.3%), older debitage (6: 2.0%), and natural stones (4: 1.3%).

The end-scrapers are made on cortical debitage (2: 1.3%), partially-cortical debitage (40: 26.3%), non-cortical flakes (28: 18.4%), flake-blades (29: 19.1%), blades (34: 22.4%), bladelets (5: 3.3%), crested debitage (10: 6.6%), cores (1: 0.7%), older debitage (2: 1.3%), and natural stones (1: 0.7%).

Three of the blanks are Levallois flakes and were used for end-scrapers (2) and pieces with discontinuous direct retouch (1). Two of the blanks are Levallois blades and were used for partially-backed pieces (2). Two of the blanks are Levallois points and were used for end-scrapers (1) and burins on lateral preparation (1). Twelve of the blanks are naturally-backed and were mainly used for end-scrapers (5: 41.7%).

The flaking modes for the blanks are Harder (16: 11.9%), Softer (92: 68.7%), and Questionable (26: 19.4%).

HAMMERSTONES

One weathered nodule of flint, globular in shape, is thought to be a hammerstone. It is 59mm long, 56mm wide, and 54mm thick, and weighs 270.7g. It shows the battering traces on its rounded tips (Fig. 52).

SUMMARY

Level XIX is characterized by partially-cortical debitage, non-

Table 35. Frequencies of Retouched Piece Classes in Level XIX

Category	Frequency	Percent
End-scrapers	152	50.7
Double end-scrapers	2	0.7
End-scrapers on retouched blanks	14	4.7
Burins on break	9	3.0
Burins on retouched truncation	9	3.0
Multiple truncation burins	1	0.3
Burins on lateral preparation	4	1.3
Multiple mixed burins	6	2.0
Backed pieces	2	0.7
Partially-backed pieces	19	6.3
Double partially-backed pieces	1	0.3
Truncated pieces	3	1.0
Ksar Akil points	4	1.3
Notched pieces	2	0.7
Side-scrapers	4	1.3
Pieces with continuous direct retouch	15	5.0
Pieces with continuous inverse retouch	4	1.3
Pieces with continuous alternate(ing) retouch	2	0.7
Pieces with discontinuous direct retouch	6	2.0
Pieces with discontinuous inverse retouch	1	0.3
Core-like end-scrapers	1	0.3
Piercers	1	0.3
Splintered pieces	6	2.0
Steep scrapers	2	0.7
Choppers	1	0.3
Composite retouched pieces	28	9.3
Unclassifiable retouched pieces	1	0.3
Total	300	99.8

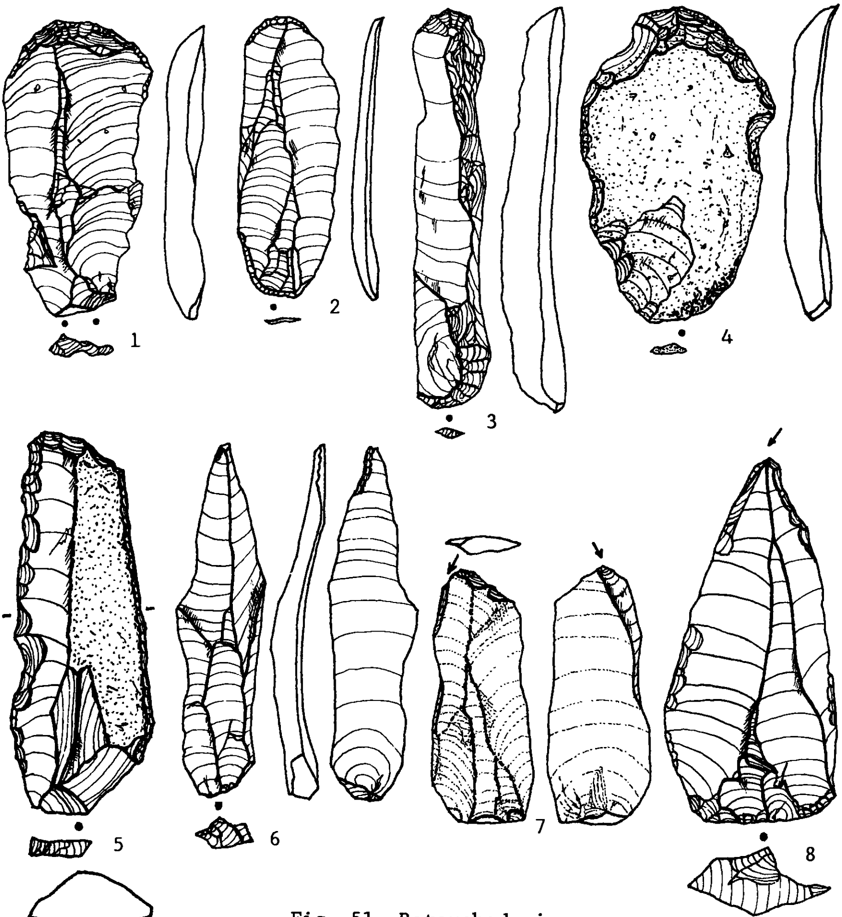


Fig. 51. Retouched pieces
from Level XIX (scale 1/1)

●: point of percussion

1. End-scraper on a blade
2. End-scraper on a blade with continuous direct retouch
3. End-scraper on crested debitage
4. End-scraper on retouched cortical debitage
5. Truncated piece on backed and denticulated partially-cortical debitage
6. Piercer on a blade
7. Burin on a retouched truncation on older debitage
8. Burin on a lateral preparation or on a retouched truncation on a Levallois point

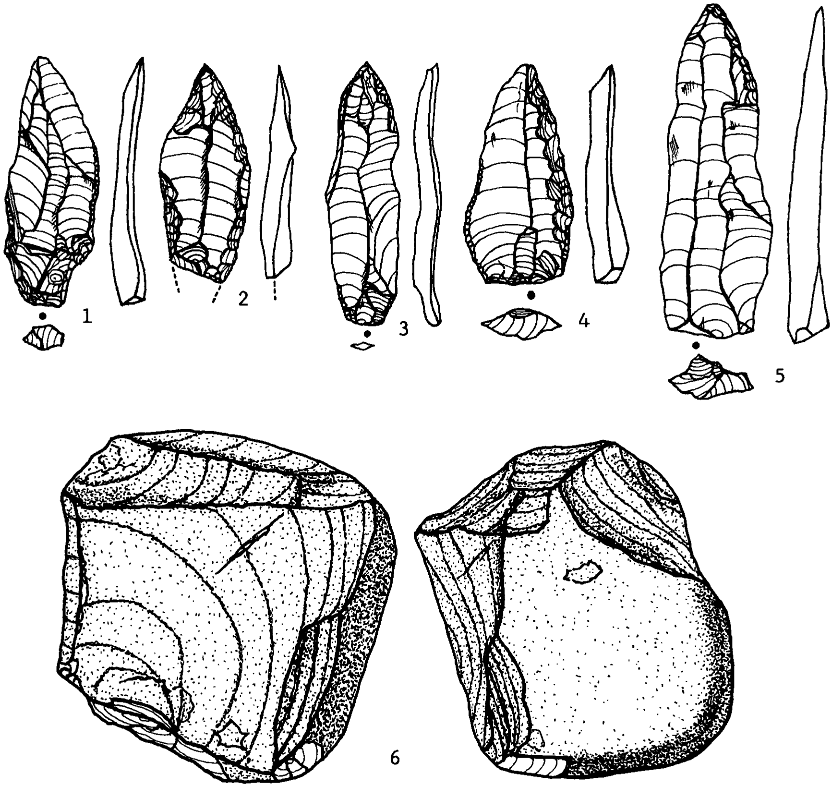


Fig. 52. Retouched pieces and hammerstones
from Level XIX (scale 1/1)

●: point of percussion

1. Double partially-backed flake-blade
2. *Pointe à face plane*
3. Ksar Akil point
4. Side-scraper on a partially-backed flake-blade
5. Ksar Akil point on a blade
6. Hammerstone of weathered flint

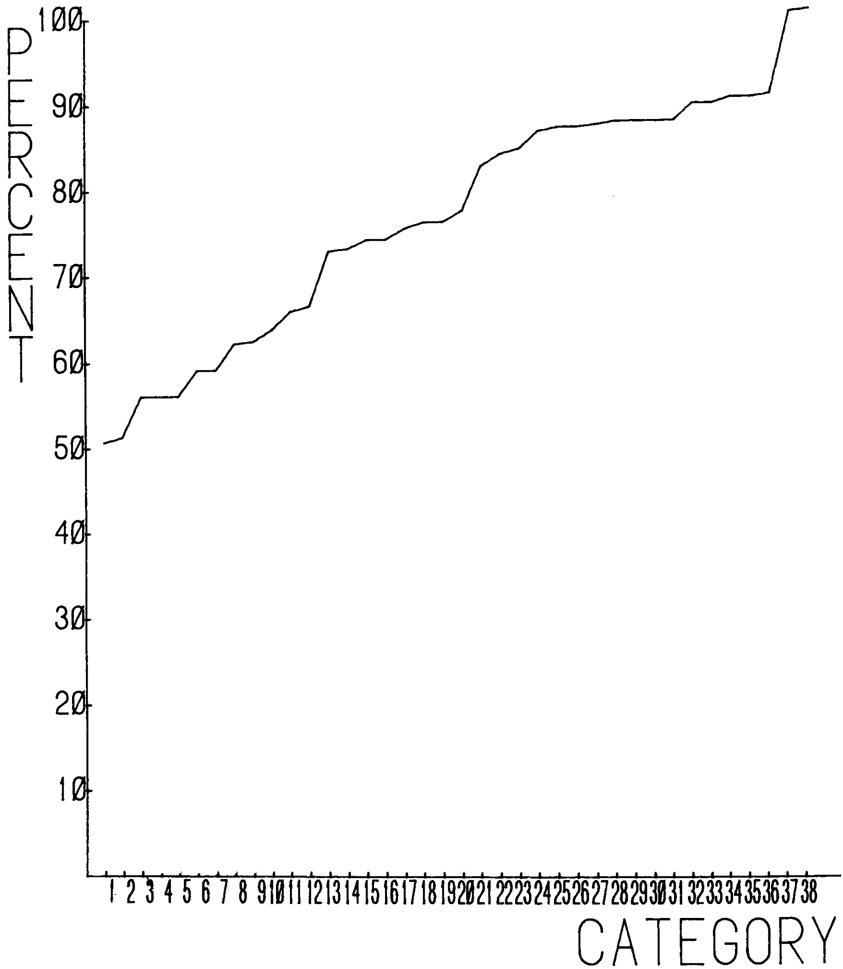


Fig. 53. Cumulative graph of retouched pieces from Level XIX: 300 pieces

cortical flakes, flake-blades, blades, bladelets, prismatic cores, and end-scrapers. The butts of the debitage are mainly plain and convex dihedral faceted. The debitage was most commonly produced with softer hammers, and has parallel dorsal shape and blunt distal shape. The main dorsal scar patterns of the debitage are uni-directional, bi-directional opposed, and crossed. The striking platforms of the cores are mainly plain, and the overall shapes of the cores are mainly parallel. The features of this level which differentiate it from Level XX lie in the increases in cores with parallel overall shapes and bladelets as well as in the decreases in debitage with converging dorsal shape and cores with converging overall shapes.

Level XVIII

The materials of this level total 834, comprising debitage, cores, retouched pieces, and hammerstones, and were derived from Squares E4 (-12.00m to -11.55m) and F4 (-11.50m).

DEBITAGE

The debitage totals 515 pieces, of which 256 are broken. The 259 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, flake-blades, blades, bladelets, and crested debitage (Table 36) (Fig. 54).

The butts of the debitage are mainly plain, linear, and punctiform (Table 37).

Twenty of the butts are accompanied by partially regularizing facets (7.7%), 90 are accompanied by overhang removal by abrasion (34.8%), and 43 are accompanied by overhang removal by blow (16.6%).

Twenty-one of the debitage are hinged (8.1%), and 7 are plunged (2.7%).

(1) Cortical debitage, partially-cortical debitage, non-cortical flakes, and crested debitage: 107 pieces

The profiles above the butts are straight (26: 25.0%), concave (28: 26.9%), convex (35: 33.7%), and crushed (15: 14.4%).

The mean butt thickness is 3.5mm with the s.d. of 2.2mm (104 cases), the mean length is 50.1mm with the s.d. of 11.2mm (107 cases). the mean width is 23.2mm with the s.d. of 9.5mm (107 cases), and the mean thickness is 7.3mm with the s.d of 3.1mm (107 cases).

The flaking modes are Harder (11: 19.3%), Softer (34: 59.6%), and Questionable (12: 21.1%).

The dorsal scar patterns are uni-directional (15: 14.6%), bi-directional opposed (28: 27.4%), crossed (25: 24.3%), and with the trace of cresting (35: 34.0%).

The mean number of dorsal scars is 6.0 with the s.d. of 2.8 (107 cases).

Table 36. Frequencies of Debitage Classes in Level XVIII

Category	Frequency	Percent
Cortical debitage	1	0.4
Partially-cortical debitage	35	13.5
Non-cortical flakes	38	14.7
Levallois flakes	2	0.8
Flake-blades	48	18.5
Blades	47	18.1
Bladelets	55	21.2
Crested debitage	33	12.7
Total	259	99.9

Table 37. Frequencies of Butt Types of Debitage in Level XVIII

Category	Frequency	Percent
Cortical	3	1.2
Plain	71	27.4
Convex dihedral faceted	33	12.7
Straight multiple faceted	9	3.5
Convex multiple faceted	9	3.5
Partially faceted	3	1.2
Linear	56	21.6
Punctiform	62	23.9
Broken	13	5.0
Total	259	100.0

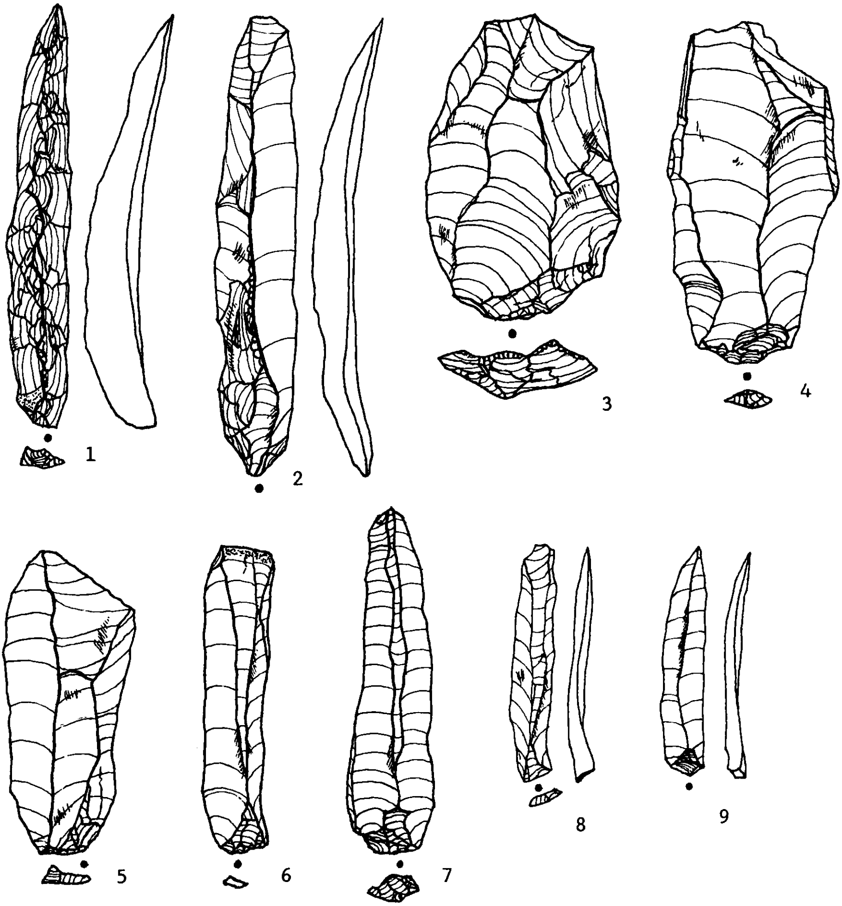


Fig. 54. Debitage from Level XVIII (scale 1/1)

●: point of percussion

1. Crested debitage	2. Re-crested debitage	3. Levallois flake
4. Blade	5. Blade	6. Bladelet
7. Blade	8. Bladelet	9. Bladelet

(2) Levallois flakes, flake-blades, blades, and bladelets: <u>152 pieces</u>

The profiles above the butts are straight (34: 23.0%), concave (26: 17.6%), convex (67: 45.3%), and crushed (21: 14.2%).

The mean butt thickness is 2.4mm with the s.d. of 1.4mm (143 cases), the mean length is 49.0mm with the s.d. of 8.8mm (152 cases), the mean width is 17.4mm with the s.d. of 4.7mm (152 cases), and the mean thickness is 5.1mm with the s.d. of 1.7mm (152 cases).

The mean *angle de chasse* is 81.9° with the s.d. of 7.0° (86 cases), the mean *angle d'éclatement* is 97.4° with the s.d. of 6.6° (86 cases), and the mean total of the two angles is 179.3° (86 cases).

The flaking modes are Harder (7: 7.1%), Softer (76: 76.8%), and Questionable (16: 16.2%).

The dorsal scar patterns are uni-directional (40: 26.5%), bi-directional opposed (71: 47.0%), crossed (36: 23.8%), and with the trace of cresting (4: 2.6%).

The mean number of dorsal scars is 5.3 with the s.d. of 1.7 (152 cases).

The numbers of dorsal planes are One (17: 11.2%), Two (114: 75.0%), and Three (21: 13.8%).

The dorsal shapes are parallel (121: 79.6%), converging (13: 8.6%), and expanding (18: 11.8%).

The distal shapes are blunt (135: 88.8%) and pointed (17: 11.2%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 2.1 with the s.d. of 0.6 (102 cases).

The flaking order patterns on the flake-blades, blades, and bladelets are A (16: 57.1%), B (8: 28.6%), and C (4: 14.3%).

The locations of points of percussion are A (69: 50.4%), B (54: 39.4%), and C (14: 10.2%).

The Levallois flakes have butts of convex multiple facets (2). Their dorsal scar patterns are crossed (2), and the locations of points of percussion are B (1) and C (1).

CORES

The cores total 45, but 7 of them are broken. The 38 unbroken cores are classified into 5 categories (Table 38) (Figs. 55 and 56).

The striking platforms for the final flake scars are predominantly plain (Table 39).

The mean length of the final flake scars is 22.1mm with the s.d. of 12.5mm (69 cases), and the mean width is 13.7mm with the s.d. of

Table 38. Frequencies of Core Classes in Level XVIII

Category	Frequency	Percent
Prismatic cores	26	68.4
Pyramidal cores	2	5.3
Discoidal cores	1	2.6
Globular cores	1	2.6
Miscellaneous cores	8	21.1
Total	38	100.0

Table 39. Frequencies of Striking Platform Types of Cores in Level XVIII

Category	Frequency	Percent
Cortical	2	2.9
Plain	53	76.8
Convex dihedral faceted	10	14.5
Convex multiple faceted	3	4.3
Broken	1	1.4
Total	69	99.9

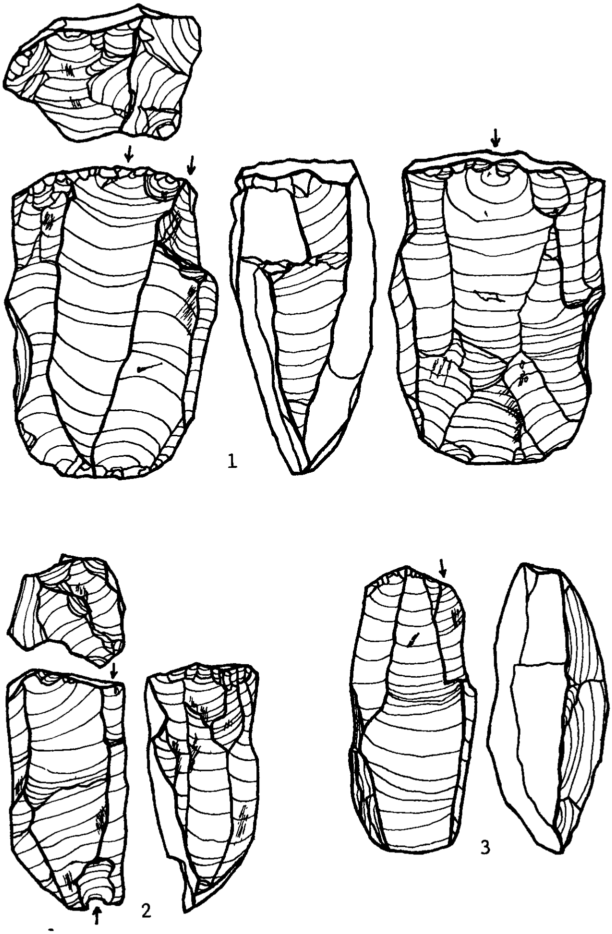


Fig. 55. Cores from Level XVIII (scale 1/1)

↓ : final detachment

1. Opposed platform prismatic core
2. Pyramidal core with opposed flake scars
3. Single platform prismatic core with the trace of cresting

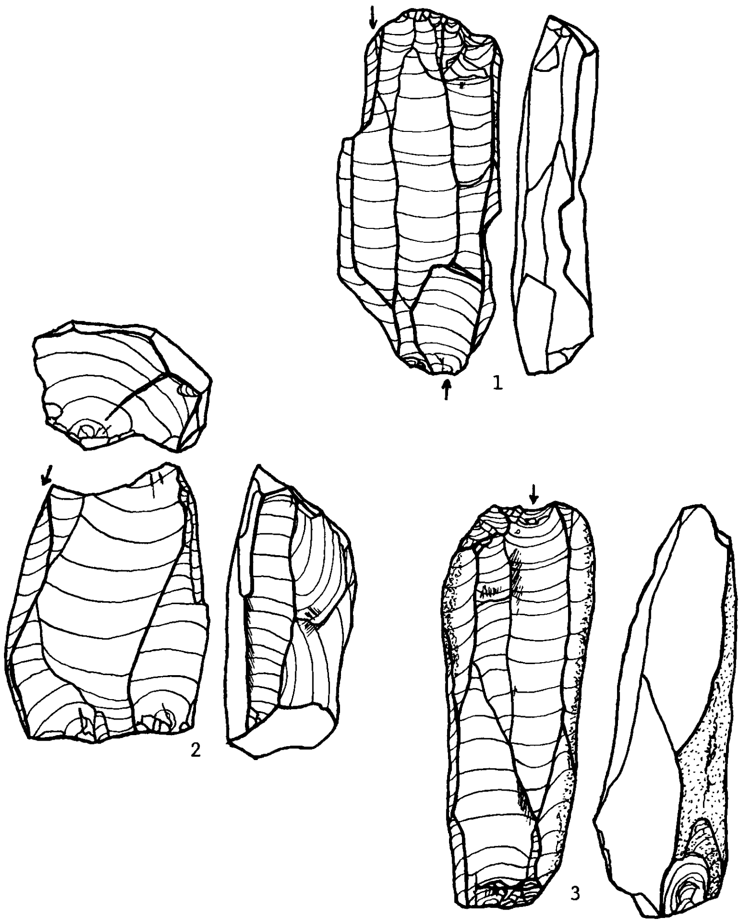


Fig. 56. Cores from Level XVIII (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core
2. Opposed platform prismatic core with the trace of cresting and of a core tablet removal
3. Opposed platform prismatic core

6.1mm (69 cases).

The shapes of the final flake scars are parallel (50: 72.5%), converging (10: 14.5%), and expanding (9: 13.0%). and the distal shapes are blunt (57: 82.6%) and pointed (12: 17.4%).

Twenty-nine (41.4%) of the 70 final flake scars are hinged, and 1 (1.4%) is plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.7 with the s.d. of 0.7 (43 cases).

The mean number of flake scars from one and the same striking platform is 3.4 with the s.d. of 1.6 (43 cases).

The locations of striking platforms are opposed (6: 17.1%), opposite rectangular (8: 22.9%), opposite alternate (2: 5.7%), alternating (5: 14.3%), and miscellaneous (14: 40.0%).

The scar patterns are uni-directional (11: 25.6%). bi-directional opposed (18: 41.9%), crossed (7: 16.3%), of a single flake scar (1: 2.3%). with the trace of cresting (2: 4.7%). and miscellaneous (4: 9.3%).

The backs of the cores are cortex (10: 26.3%), flake scars (7: 18.4%), cresting (1: 2.6%), and miscellaneous (20: 52.6%).

One of the cores is clearly worked on nodule (2.6%), 2 are worked on flakes (5.3%), and the rest (35: 92.1%) are believed to be worked on nodules.

The mean core length is 49.8mm with the s.d. of 14.3mm (38 cases), the mean core width is 33.1mm with the s.d. of 10.8mm (38 cases), and the mean core thickness is 23.8mm with the s.d. of 9.3mm (38 cases).

The overall shapes of the cores are parallel (23: 60.5%), converging (5: 13.2%). and miscellaneous (10: 26.3%).

One core shows traces of heat alteration (2.6%).

Sixteen cores were most probably abandoned because of hinging (42.1%).

RETOUCHED PIECES

The retouched pieces total 272, of which 85 are broken.

The main categories of the 187 unbroken retouched pieces are the end-scraper and the partially-backed piece (Table 40) (Figs. 57 and 58).

The blanks for the retouched pieces are cortical debitage (5: 2.7%), partially-cortical debitage (39: 20.9%), non-cortical flakes (28: 15.0%). flake-blades (35: 18.7%), blades (44: 23.5%), bladelets

Table 40. Frequencies of Retouched Piece Classes in Level XVIII

Category	Frequency	Percent
End-scrapers	84	44.9
Double end-scrapers	2	1.1
End-scrapers on retouched blanks	10	5.4
Burins on break	2	1.1
Dihedral burins	1	0.5
Backed pieces	8	4.3
Partially-backed pieces	27	14.4
Double partially-backed pieces	6	3.2
Truncated pieces	4	2.1
Pointes à face plane	1	0.5
Ksar Akil points	5	2.7
Notched pieces	1	0.5
Side-scrapers	3	1.6
Pieces with continuous direct retouch	13	7.0
Pieces with continuous inverse retouch	2	1.1
Pieces with discontinuous direct retouch	3	1.6
Splintered pieces	1	0.5
Steep scrapers	1	0.5
Limaces	1	0.5
Composite retouched pieces	12	6.4
Total	187	99.9

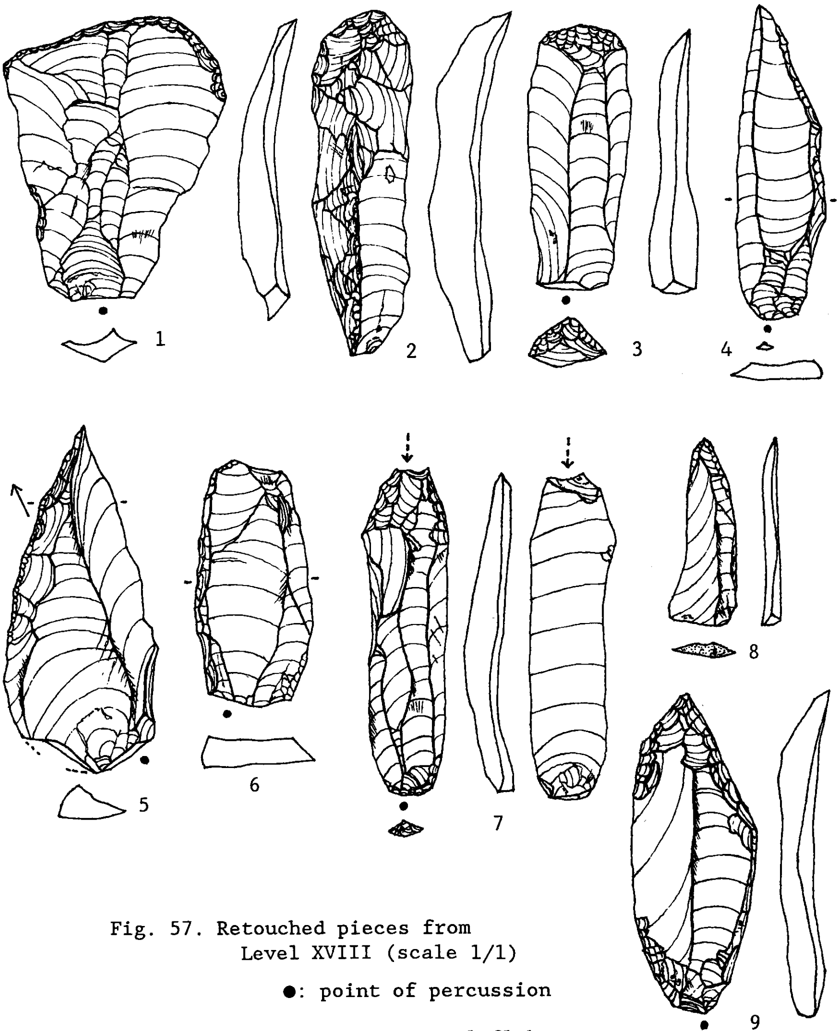


Fig. 57. Retouched pieces from
Level XVIII (scale 1/1)

●: point of percussion

1. End-scraper on a non-cortical flake
2. End-scraper on crested debitage
3. End-scraper on a blade
4. Partially-backed blade
5. Backed pseudo-Levallois point
6. Backed piece
7. Ksar Akil point on a flake-blade, probably with impact fracture
8. Ksar Akil point on a bladelet
9. *Pointe à face plane* on a blade

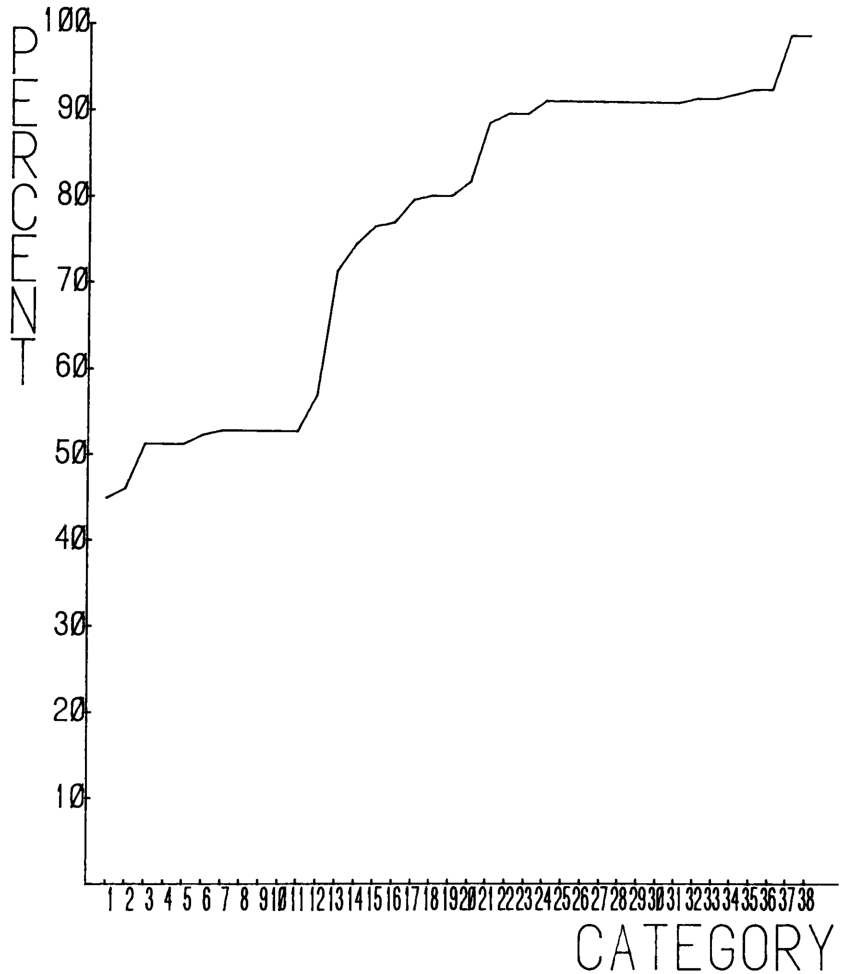


Fig. 58. Cumulative graph of retouched pieces from Level XVIII: 187 pieces

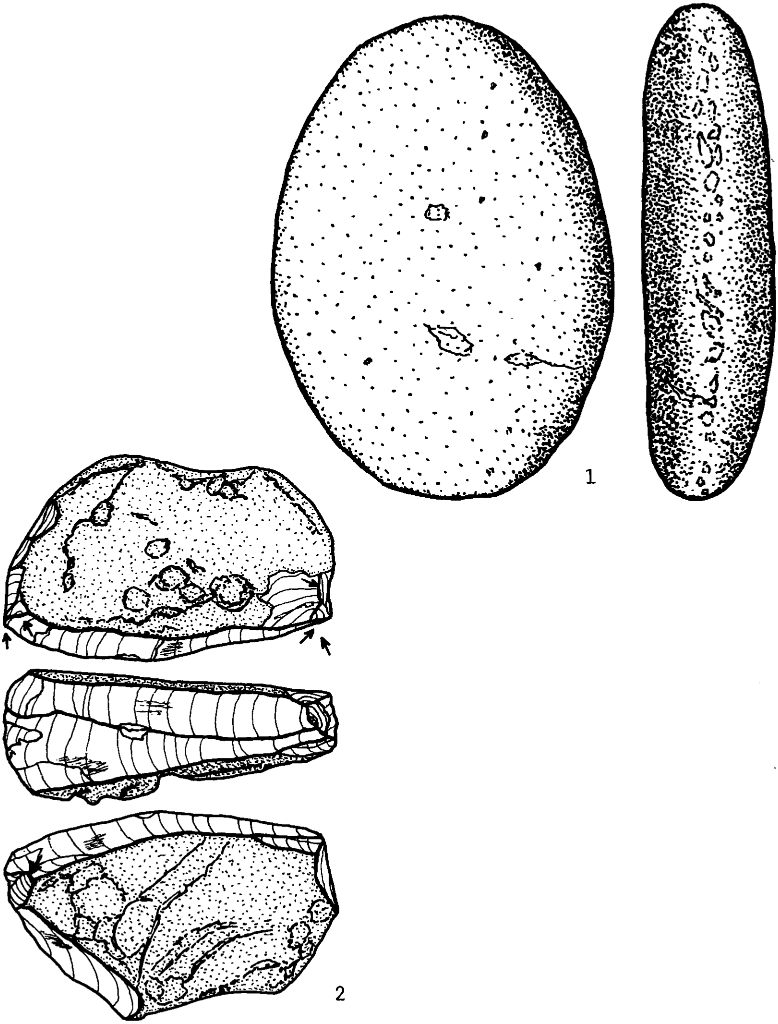


Fig. 59. Hammerstones from Level XVIII (scale 1/1)

1. Flat hammerstone of andesite-like stone
2. Flat hammerstone of flint core

(16: 8.6%), crested debitage (8: 4.3%), cores (2: 1.1%), older debitage (9: 4.8%), and retouch flakes (1: 0.5%).

The end-scrapers are made on cortical debitage (4: 4.8%), partially-cortical debitage (27: 32.1%), non-cortical flakes (20: 23.8%), flake-blades (13: 15.5%), blades (10: 11.9%), bladelets (1: 1.2%), crested debitage (3: 3.6%), and older debitage (6: 7.1%). The partially-backed pieces are made on partially-cortical debitage (2: 7.4%), flake-blades (3: 11.1%), blades (15: 55.6%), bladelets (6: 22.2%), and crested debitage (1: 3.7%).

Two of the blanks are Levallois flakes and were used for end-scrapers (1) and side-scrapers (1). Two of the blanks are Levallois blades and were used for end-scrapers (1) and pieces with continuous direct retouch (1). Five of the blanks are naturally-backed and were used for end-scrapers (3) and partially-backed pieces (2).

The flaking modes for the blanks are Harder (6: 7.1%), Softer (66: 78.6%), and Questionable (12: 14.3%).

HAMMERSTONES

Two nodules of stone are thought to be hammerstones. One of them is of andesite-like stone. It is flat and oval in outline, and bears the battering traces all along its circumference. It weighs 209.3g, and is 83mm long, 61mm wide, and 25mm thick. The other example is of flint. It is flat and rectangular in outline, and shows the battering traces at its margin. It weighs 61.3g, and is 58mm long, 38mm wide, and 23mm thick (Fig. 59).

SUMMARY

Level XVIII is characterized by flake-blades, blades, bladelets, prismatic cores, end-scrapers, and partially-backed pieces, and by a drastic decrease in burins. The butts of the debitage are mainly plain, linear, and punctiform. The debitage was produced mainly with softer hammers, and has parallel dorsal shape, blunt distal shape, and bi-directional opposed dorsal scar pattern. The striking platforms of the cores are mostly plain, and the overall shapes of the cores are mainly parallel. The features of this level which differentiate it from Level XIX are the increases in debitage with linear or punctiform butts and partially-backed pieces. At the same time, the decreases in debitage with convex (dihedral or multiple) faceted butts, debitage with uni-directional dorsal scar pattern, and cores with convex dihedral faceted striking platforms differentiate this level from Level XIX.

Level XVII

The materials of this level total 2,775, comprising debitage, cores, retouched pieces, and hammerstones, and were derived from Squares E4 (-11.55m to -11.05m) and F4 (-11.50m to -11.25m).

DEBITAGE

The debitage totals 1,568 pieces, of which 878 are broken. The 690 unbroken pieces consist of partially-cortical debitage, non-cortical flakes, flake-blades, blades, bladelets, and crested debitage (Table 41) (Figs. 60 and 61).

The butts of the debitage are mainly plain, linear, and punctiform (Table 42).

Thirty-three of the butts are accompanied by partially regularizing facets (4.8%), 344 are accompanied by overhang removal by abrasion (49.9%), and 55 are accompanied by overhang removal by blow (8.0%).

Sixty-three of the debitage are hinged (9.1%), and 20 are plunged (2.9%).

(1) Partially-cortical debitage, non-cortical flakes, and crested debitage: <u>313 pieces</u>

The profiles above the butts are straight (80: 26.0%), concave (58: 18.8%), convex (116: 37.7%), and crushed (54: 17.5%).

The mean butt thickness is 3.3mm with the s.d. of 2.6mm (308 cases), the mean length is 54.8mm with the s.d. of 15.2mm (313 cases), the mean width is 23.0mm with the s.d. of 9.0mm (313 cases), and the mean thickness is 7.5mm with the s.d. of 3.1mm (313 cases).

The flaking modes are Harder (16: 12.0%), Softer (103: 77.4%), and Questionable (14: 10.5%).

The dorsal scar patterns are uni-directional (67: 21.7%), bi-directional opposed (63: 20.4%), crossed (64: 20.7%), and with the trace of cresting (115: 37.2%).

The mean number of dorsal scars is 6.1 with the s.d. of 2.9 (312 cases).

(2) Flake-blades, blades, and bladelets: <u>377 pieces</u>

The profiles above the butts are straight (89: 24.1%), concave (44: 11.9%), convex (192: 51.9%), and crushed (45: 12.2%).

The mean butt thickness is 2.1mm with the s.d. of 1.3mm (369 cases), the mean length is 52.4mm with the s.d. of 11.6mm (377 cases), the mean width is 17.5mm with the s.d. of 5.0mm (377 cases), and the mean thickness is 5.5mm with the s.d. of 2.1mm (377 cases).

The mean *angle de chasse* is 77.8° with the s.d. of 8.3° (184 cases), the mean *angle d'éclatement* is 101.8° with the s.d. of 7.6° (184 cases), and the mean total of the two angles is 179.6° (184 cases).

The flaking modes are Harder (12: 5.6%), Softer (179: 84.0%), and

Table 41. Frequencies of Debitage Classes in Level XVII

Category	Frequency	Percent
Partially-cortical debitage	111	16.1
Non-cortical flakes	87	12.6
Flake-blades (including 4 Levallois blades and 1 Levallois point)	114	16.5
Blades	148	21.4
Bladelets	115	16.7
Crested debitage	115	16.7
Total	690	100.0

Table 42. Frequencies of Butt Types of Debitage in Level XVII

Category	Frequency	Percent
Cortical	15	2.2
Plain	208	30.1
Convex dihedral faceted	85	12.3
Straight multiple faceted	6	0.9
Convex multiple faceted	11	1.6
Partially faceted	2	0.3
Linear	175	25.4
Punctiform	176	25.5
Broken	12	1.7
Total	690	100.0

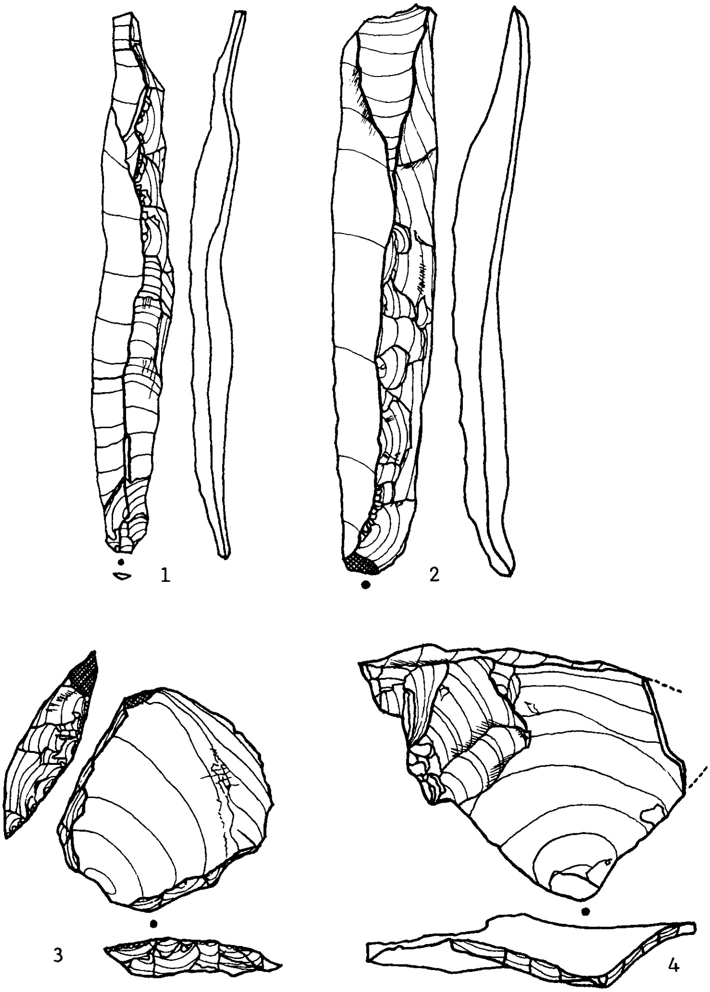


Fig. 60. Debitage from Level XVII (scale 1/1)

●: point of percussion

1. Crested debitage
2. Crested debitage
3. Core tablet
4. Core tablet

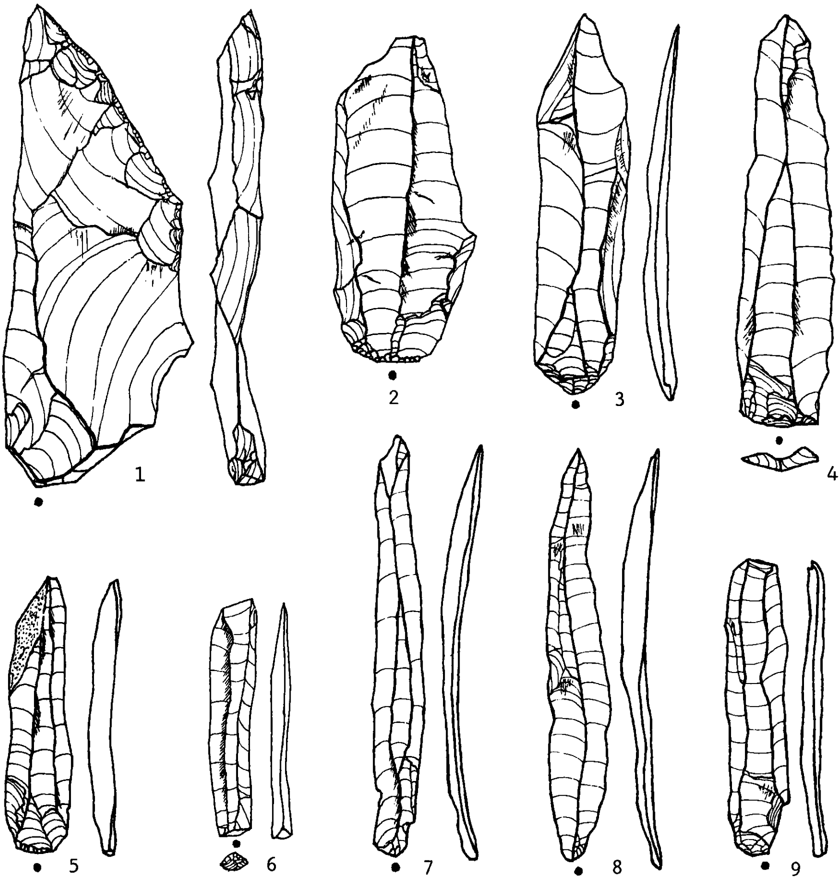


Fig. 61. Debitage from Level XVII (scale 1/1)

●: point of percussion

1. Levallois blade
2. Levallois blade
3. Levallois blade
4. Blade
5. Bladelet
6. Bladelet
7. Bladelet
8. Bladelet
9. Bladelet

Questionable (22: 10.3%).

The dorsal scar patterns are uni-directional (94: 25.0%), bi-directional opposed (187: 49.7%), crossed (92: 24.5%), and with the trace of cresting (3: 0.8%).

The mean number of dorsal scars is 5.3 with the s.d. of 1.7 (377 cases).

The numbers of dorsal planes are One (101: 26.8%), Two (239: 63.4%), and Three (37: 9.8%).

The dorsal shapes are parallel (283: 75.1%), converging (34: 9.0%), and expanding (60: 15.9%).

The distal shapes are blunt (335: 88.9%) and pointed (42: 11.1%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 1.9 with the s.d. of 0.6 (263 cases).

The flaking order patterns on the flake-blades, blades, and bladelets are A (21: 52.5%), B (16: 40.0%), and C (3: 7.5%).

The locations of points of percussion are A (194: 55.1%), B (135: 38.4%), and C (23: 6.5%).

Four of the flake-blades can be considered to be Levallois blades. Their butts are of convex dihedral facets (1), of convex multiple facets (1), linear (1), and punctiform (1). Their dorsal scar patterns are crossed (4). The locations of points of percussion are A (1), B (2), and C (1).

One of the flake-blades is a Levallois point. It has a butt of convex dihedral facets. Its dorsal scar pattern is uni-directional. The flaking order pattern is B, and the location of point of percussion is A.

CORES

The cores total 214, but 50 of them are broken. The 164 unbroken cores are classified into 5 categories (Table 43) (Figs. 62 to 64).

The striking platforms for the final flake scars are predominantly plain (Table 44).

The mean length of the final flake scars is 23.4mm with the s.d. of 12.1mm (299 cases), and the mean width is 13.3mm with the s.d. of 5.7mm (299 cases).

The shapes of the final flake scars are parallel (227: 75.9%), converging (40: 13.4%), and expanding (32: 10.7%), and the distal shapes are blunt (273: 91.3%) and pointed (26: 8.7%).

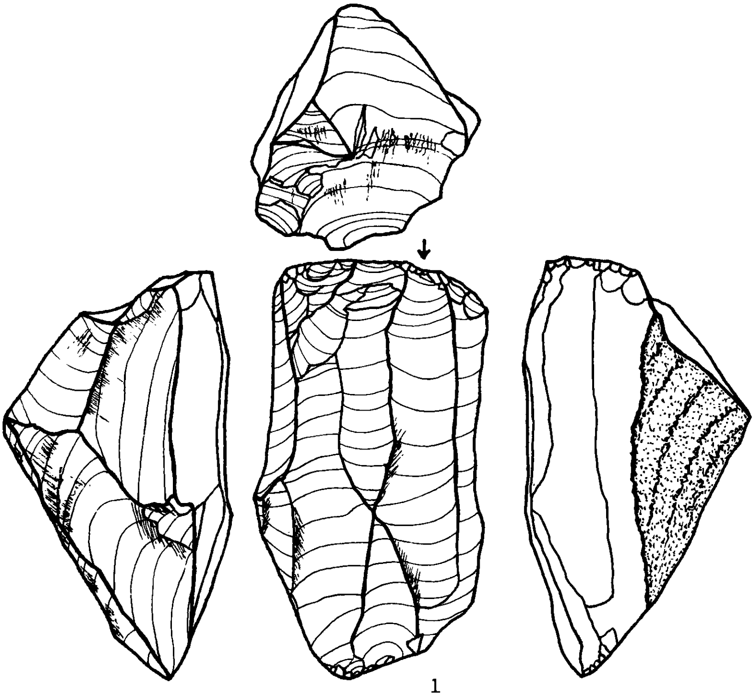
One hundred and forty-eight (49.5%) of the 299 final flake scars are hinged, and 5 (1.7%) are plunged.

Table 43. Frequencies of Core Classes in Level XVII

Category	Frequency	Percent
Prismatic cores	130	79.3
Pyramidal cores	7	4.3
Discoidal cores	6	3.7
Globular cores	3	1.8
Miscellaneous cores (including 6 cores intermediate between prismatic and pyramidal cores)	18	11.0
Total	164	100.1

Table 44. Frequencies of Striking Platform Types of Cores in Level XVII

Category	Frequency	Percent
Cortical	8	2.7
Plain	234	78.3
Convex dihedral faceted	53	17.7
Straight multiple faceted	1	0.3
Convex multiple faceted	2	0.7
Broken	1	0.3
Total	299	100.0



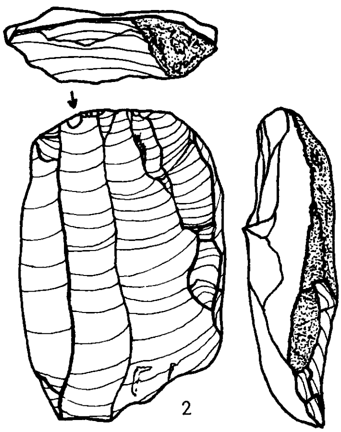


Fig. 62. Cores from Level XVII (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core with the trace of cresting
2. Single platform prismatic core

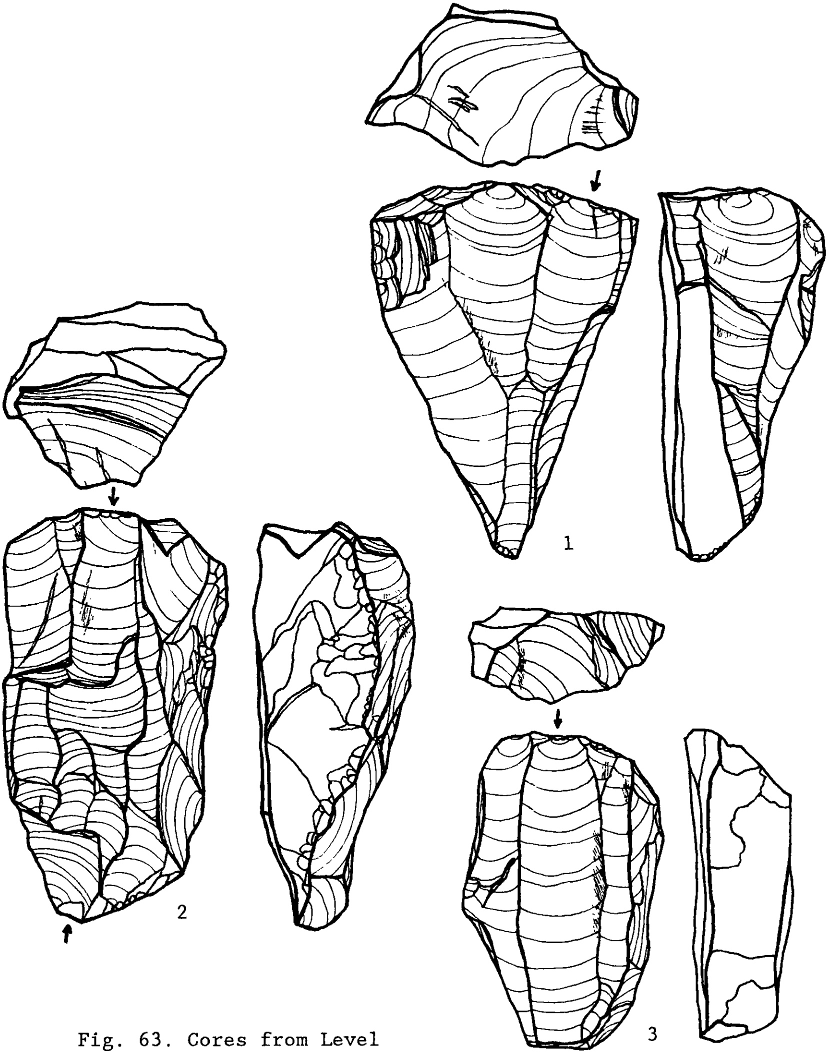


Fig. 63. Cores from Level
XVII (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core
2. Opposed platform prismatic core
   with a crested ridge
3. Opposed platform prismatic core

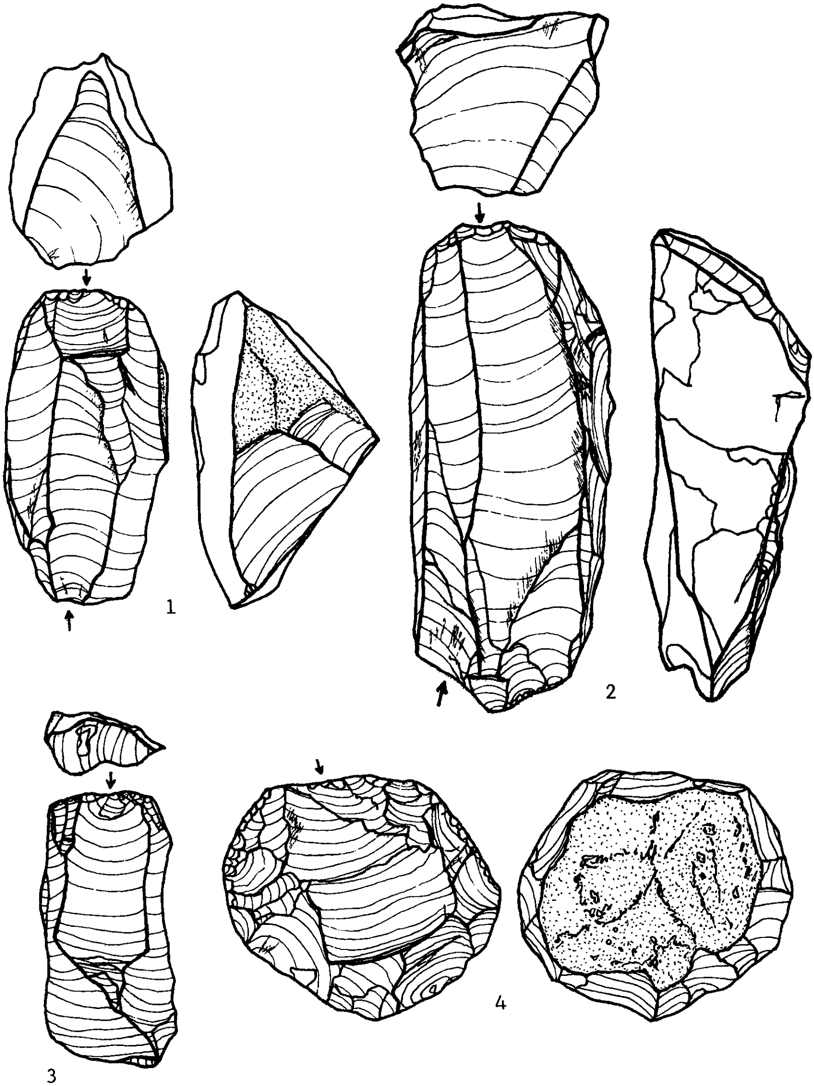


Fig. 64. Cores from Level XVII (scale 1/1)

↑: final detachment

1. Opposed platform prismatic core
2. Opposed platform prismatic core with a crested ridge
3. Prismatic core with opposite alternate platforms
4. Discoidal core

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.6 with the s.d. of 0.6 (188 cases).

The mean number of flake scars from one and the same striking platform is 3.5 with the s.d. of 1.7 (188 cases).

The locations of striking platforms are opposed (46: 34.8%), opposite rectangular (19: 14.4%), opposite alternate (12: 9.1%), crossed (12: 9.1%), peripheral (1: 0.8%), alternating (11: 8.3%), and miscellaneous (31: 23.5%).

The scar patterns are uni-directional (46: 24.5%), bi-directional opposed (82: 43.6%), crossed (42: 22.3%), centripetal (2: 1.1%), of a single flake scar (2: 1.1%), with the trace of cresting (13: 6.9%), and miscellaneous (1: 0.5%).

The backs of the cores are cortex (53: 32.3%), striking platforms (3: 1.8%), core preparation (1: 0.6%), cresting (4: 2.4%), flake scars (32: 19.5%), and miscellaneous (71: 43.3%).

Ten of the cores are clearly worked on nodules (6.1%), 4 are worked on flakes (2.4%), and the rest (150: 91.5%) are believed to be worked on nodules.

The mean core length is 53.1mm with the s.d. of 10.0mm (164 cases), the mean core width is 35.8mm with the s.d. of 9.7mm (164 cases), and the mean core thickness is 26.9mm with the s.d. of 8.5mm (164 cases).

The overall shapes of the cores are parallel (99: 60.4%), converging (33: 20.1%), expanding (3: 1.8%), and miscellaneous (29: 17.7%).

Six cores show traces of heat alteration (3.7%).

Seventy-nine cores were most probably abandoned because of hinging (48.2%).

RETOUCHED PIECES

The retouched pieces total 992, but 487 of them are broken.

The main categories of the 505 unbroken retouched pieces are the end-scraper, the partially-backed piece, the Ksar Akil point, and the piece with continuous direct retouch (Table 45) (Figs. 65 to 67).

The blanks for the retouched pieces are cortical debitage (14: 2.8%), partially-cortical debitage (72: 14.3%), non-cortical flakes (40: 7.9%), flake-blades (80: 15.8%), blades (177: 35.0%), bladelets (51: 10.1%), crested debitage (50: 9.9%), cores (19: 3.8%), and older debitage (2: 0.4%).

The end-scrapers are made on cortical debitage (11: 7.1%), partially-cortical debitage (38: 24.4%), non-cortical flakes (22:

Table 45. Frequencies of Retouched Piece Classes in Level XVII

Category	Frequency	Percent
End-scrapers	156	30.9
Double end-scrapers	7	1.4
End-scrapers on retouched blanks	22	4.4
Burins on break	4	0.8
Dihedral burins	2	0.4
Burins on retouched truncation	2	0.4
Burins on lateral preparation	1	0.2
Backed pieces	13	2.6
Partially-backed pieces	73	14.5
Double partially-backed pieces	28	5.5
Truncated pieces	9	1.8
Pointes à face plane	7	1.4
Ksar Akil points	85	16.8
Notched pieces	2	0.4
Side-scrapers	7	1.4
Pieces with continuous direct retouch	45	8.9
Pieces with continuous inverse retouch	3	0.6
Pieces with continuous alternate(ing) retouch	4	0.8
Pieces with discontinuous direct retouch	6	1.2
Pieces with discontinuous inverse retouch	1	0.2
Becs	3	0.6
Steep scrapers	9	1.8
Choppers	4	0.8
Composite retouched pieces	12	2.4
Total	505	100.2

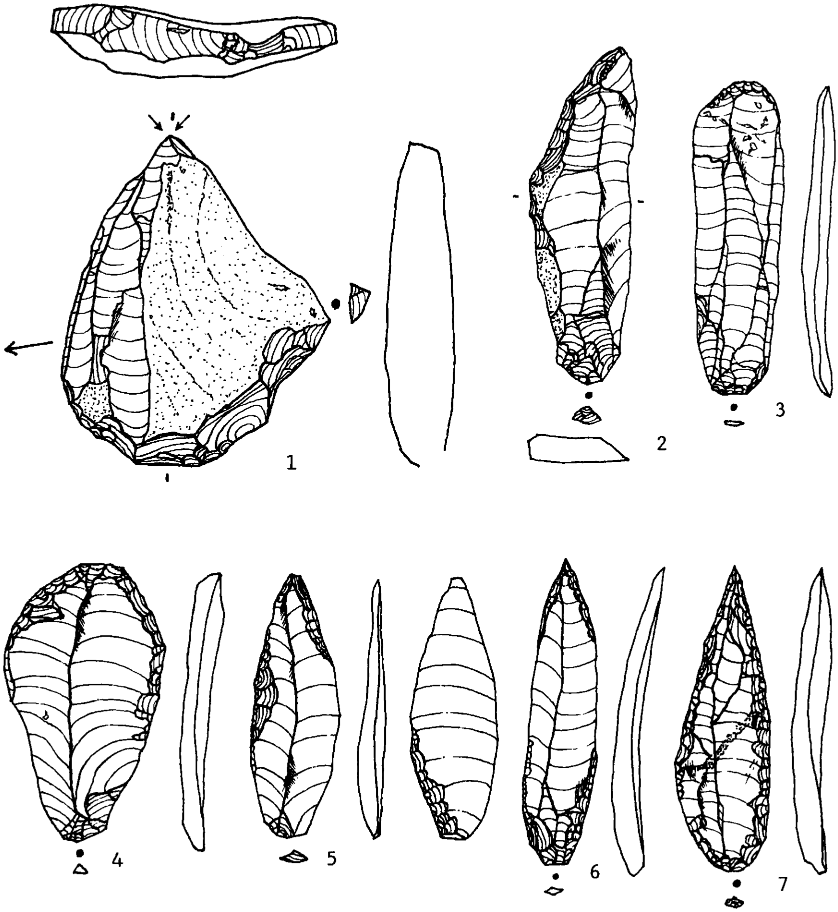


Fig. 65. Retouched pieces from Level XVII (scale 1/1)

●: point of percussion

1. Side-scraper/dihedral burin on partially-cortical debitage
2. Partially-backed blade
3. End-scraper on a blade
4. End-scraper on a retouched blank
5. *Pointe à face plane* on a blade
6. Ksar Akil point on a blade, approaching a *pointe à face plane*
7. *Pointe à face plane* on a blade

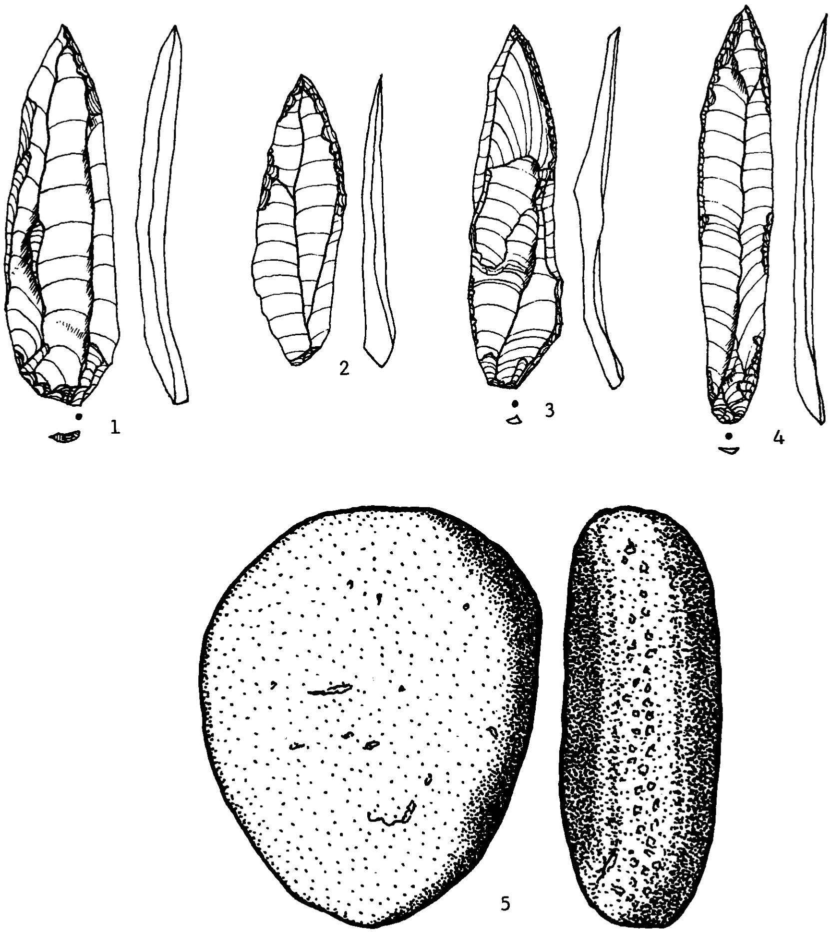


Fig. 66. Retouched pieces and hammerstones from Level XVII (scale 1/1)

●: point of percussion

1. Ksar Akil point on a blade
2. Ksar Akil point on a blade
3. Ksar Akil point on a flake-blade
4. Ksar Akil point on a blade
5. Flat hammerstone of andesite-like stone

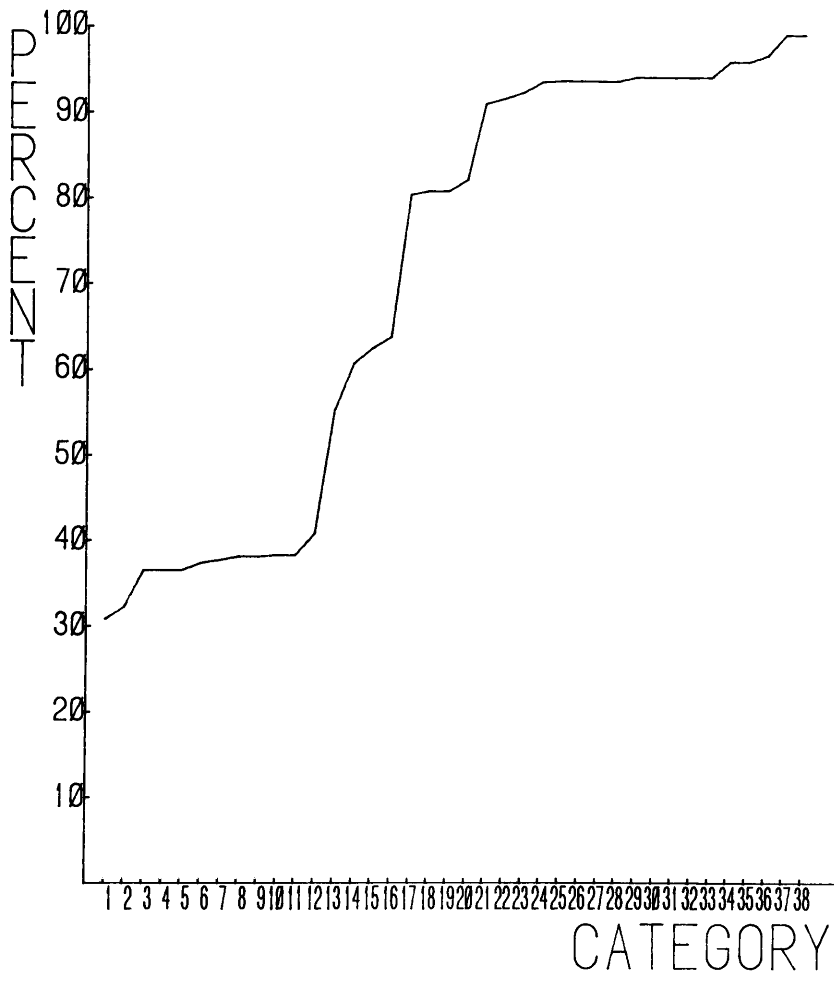


Fig. 67. Cumulative graph of retouched pieces from Level XVII: 505 pieces

14.1%), flake-blades (20: 12.8%), blades (37: 23.7%), bladelets (1: 0.6%), crested debitage (24: 15.4%), cores (1: 0.6%), and older debitage (2: 1.3%). The partially-backed pieces are made on partially-cortical debitage (6: 8.2%), non-cortical flakes (1: 1.4%), flake-blades (14: 19.2%), blades (32: 43.8%), bladelets (14: 19.2%), and crested debitage (6: 8.2%). The Ksar Akil points are made on partially-cortical debitage (4: 4.7%), non-cortical flakes (1: 1.2%), flake-blades (19: 22.4%), blades (38: 44.7%), bladelets (17: 20.0%),and crested debitage (6: 7.1%). The pieces with continuous direct retouch are on partially-cortical debitage (4: 8.9%), non-cortical flakes (1: 2.2%), flake-blades (7: 15.6%), blades (21: 46.7%), bladelets (8: 17.8%), and crested debitage (4: 8.9%).

Three of the blanks are Levallois points and were used for backed pieces (1) and Ksar Akil points (2). Six of the blanks are naturally-backed and were used for end-scrapers (5) and end-scrapers on retouched blanks (1).

The flaking modes for the blanks are Harder (14: 5.6%), Softer (199: 80.2%), and Questionable (35: 14.1%).

HAMMERSTONES

One nodule of stone is thought to be a hammerstone. It is of andesite-like stone, and is flat and oval in outline. It shows the traces of battering all along its circumference. It is 72mm long, 60mm wide, and 30mm thick, and weighs 229.8g (Fig. 66).

SUMMARY

In this level, there are no important differences in the frequencies of partially-cortical debitage, non-cortical flakes, flake-blades, blades, bladelets, and crested debitage. Prismatic cores are most numerous also in this level. Representative retouched pieces are end-scrapers, partially-backed pieces, and Ksar Akil points. It is worth noting that the Ksar Akil points increase drastically in this level. As in Level XVIII, there are very few burins. The butts of the debitage are mainly plain, linear, and punctiform. The debitage was produced mainly with softer hammers, and has parallel dorsal shape, blunt distal shape, and bi-directional opposed dorsal scar pattern. The striking platforms of the cores are mostly plain, and the overall shapes of the cores are mainly parallel.

Level XVI

The materials of this level total 1,398, comprising debitage, cores, retouched pieces, and retouch flakes, and were derived from Squares E4 (-11.05m to -10.90m) and F4 (-11.25m to -10.95m).

DEBITAGE

The debitage totals 985 pieces, of which 591 are broken. The 394 unbroken pieces consist of cortical debitage, partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, bladelets, and crested debitage (Table 46) (Figs.

68 and 69).

The butts of the debitage are mainly plain, convex dihedral faceted, linear, and punctiform (Table 47).

Fifty-eight of the butts are accompanied by partially regularizing facets (14.7%), 157 are accompanied by overhang removal by abrasion (39.9%), and 29 are accompanied by overhang removal by blow (7.4%).

Forty-two of the debitage are hinged (10.7%), and 6 are plunged (1.5%).

(1) Cortical debitage, partially-cortical debitage, non-cortical flakes, and crested debitage: 209 pieces

The profiles above the butts are straight (46: 22.3%), concave (78: 37.9%), convex (59: 28.6%), and crushed (23: 11.2%).

The mean butt thickness is 4.1mm with the s.d. of 2.6mm (205 cases), the mean length is 48.7mm with the s.d. of 13.9mm (209 cases), the mean width is 24.7mm with the s.d. of 8.3mm (209 cases), and the mean thickness is 7.2mm with the s.d. of 3.1mm (209 cases).

The flaking modes are Harder (4: 5.8%), Softer (54: 78.3%), and Questionable (11: 15.9%).

The dorsal scar patterns are uni-directional (72: 35.3%), bi-directional opposed (36: 17.6%), crossed (58: 28.4%), with the trace of cresting (37: 18.1%), and miscellaneous (1: 0.5%).

The mean number of dorsal scars is 5.2 with the s.d. of 2.5 (207 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: 185 pieces

The profiles above the butts are straight (42: 23.3%), concave (39: 21.7%), convex (71: 39.4%), and crushed (28: 15.6%).

The mean butt thickness is 2.7mm with the s.d. of 1.8mm (179 cases), the mean length is 48.6mm with the s.d. of 10.0mm (185 cases), the mean width is 18.1mm with the s.d. of 5.4mm (185 cases), and the mean thickness is 5.4mm with the s.d. of 1.8mm (185 cases).

The mean *angle de chasse* is 80.4° with the s.d. of 7.3° (107 cases), the mean *angle d'éclatement* is 101.1° with the s.d. of 7.6° (107 cases), and the mean total of the two angles is 181.5° (107 cases).

The flaking modes are Harder (6: 6.5%), Softer (73: 79.3%), and Questionable (13: 14.1%).

The dorsal scar patterns are uni-directional (49: 27.2%), bi-directional opposed (76: 42.2%), crossed (49: 27.2%), centripetal (3: 1.7%), and with the trace of cresting (3: 1.7%).

Table 46. Frequencies of Debitage Classes in Level XVI

Category	Frequency	Percent
Cortical debitage	2	0.5
Partially-cortical debitage	72	18.3
Non-cortical flakes	98	24.9
Levallois flakes	6	1.5
Levallois points	1	0.3
Flake-blades (including 2 Levallois blades)	54	13.7
Blades	55	14.0
Bladelets	69	17.5
Crested debitage	37	9.4
Total	394	100.1

Table 47. Frequencies of Butt Types of Debitage in Level XVI

Category	Frequency	Percent
Cortical	5	1.3
Plain	125	31.7
Convex dihedral faceted	79	20.1
Straight multiple faceted	4	1.0
Convex multiple faceted	19	4.8
Partially faceted	4	1.0
'Chapeau de gendarme'	1	0.3
Linear	79	20.1
Punctiform	68	17.3
Broken	10	2.5
Total	394	100.1

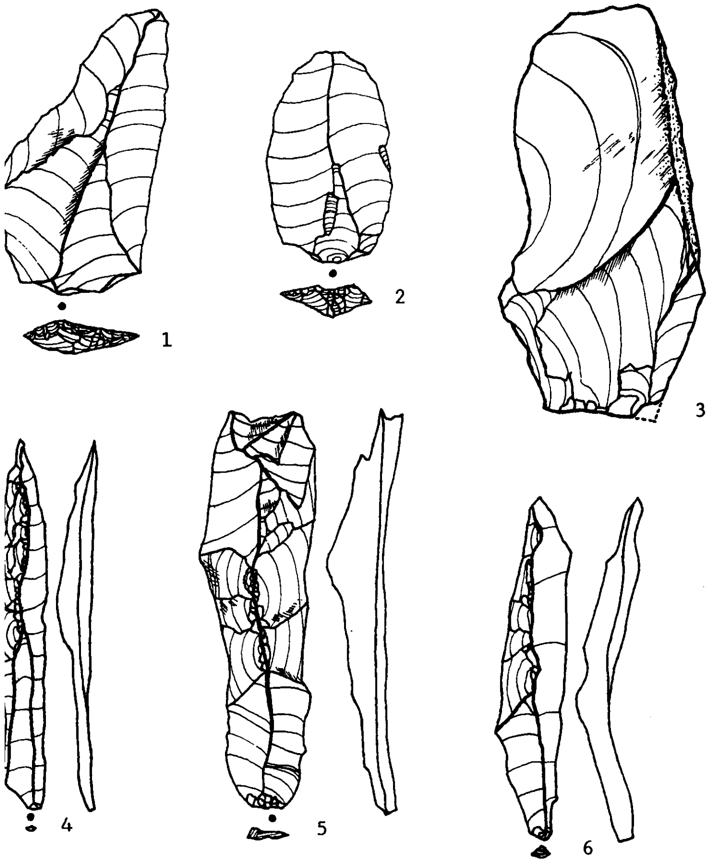


Fig. 68. Debitage from Level XVI (scale 1/1)

●: point of percussion

1. Pseudo-Levallois point
2. Non-cortical flake
3. Flake-blade
4. Crested debitage
5. Re-crested debitage with the trace of hinging removal
6. Re-crested debitage

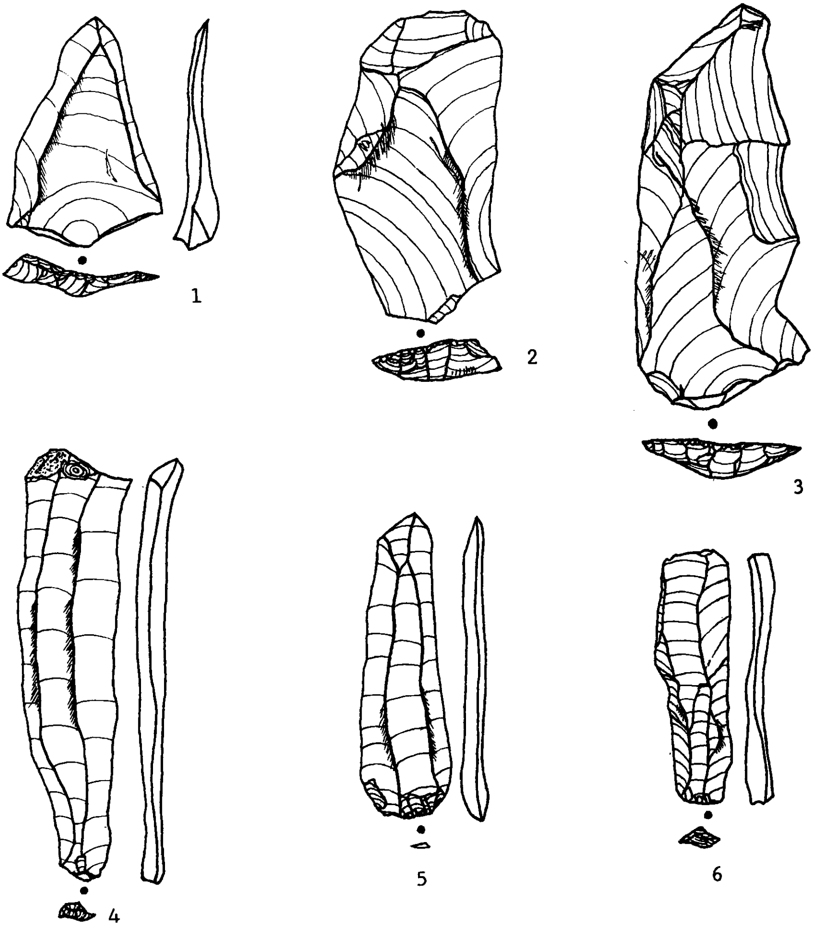


Fig. 69. Debitage from Level XVI (scale 1/1)

●: point of percussion

1. Levallois point
2. Levallois flake
3. Levallois blade
4. Blade
5. Blade
6. Bladelet

The mean number of dorsal scars is 5.3 with the s.d. of 1.7 (185 cases).

The numbers of dorsal planes are One (41: 22.2%), Two (127: 68.6%), and Three (17: 9.2%).

The dorsal shapes are parallel (139: 75.1%), converging (16: 8.6%), and expanding (30: 16.2%).

The distal shapes are blunt (174: 94.1%) and pointed (11: 5.9%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 1.8 with the s.d. of 0.7 (124 cases).

The flaking order patterns on the Levallois point, flake-blades, blades, and bladelets are A (11: 55.0%), B (7: 35.0%), and C (2: 10.0%).

The locations of points of percussion are A (98: 56.0%), B (66: 37.7%), and C (11: 6.3%).

The Levallois flakes have butts of convex multiple facets (6). Their dorsal scar patterns are crossed (4) and centripetal (2), and the locations of points of percussion are A (1), B (3), and C (2).

Two of the flake-blades can be considered to be Levallois blades. Their butts are of convex dihedral facets (2). The dorsal scar patterns are crossed (1) and centripetal (1). The location of point of percussion is B (2).

The Levallois point has a butt in *chapeau de gendarme*. Its dorsal scar pattern is uni-directional and flaking order pattern is B. The location of point of percussion is C.

CORES

The cores total 43, but 12 of them are broken. The 31 unbroken cores are classified into 4 categories (Table 48) (Fig. 70).

The striking platforms for the final flake scars are mainly plain and convex dihedral faceted (Table 49).

The mean length of the final flake scars is 22.1mm with the s.d. of 11.7mm (57 cases), and the mean width is 14.4mm with the s.d. of 6.2mm (57 cases).

The shapes of the final flake scars are parallel (43: 75.4%), converging (9: 15.8%), and expanding (5: 8.8%), and the distal shapes are blunt (52: 91.2%) and pointed (5: 8.8%).

Twenty-seven (47.4%) of the 57 final flake scars are hinged, and 3 (5.3%) are plunged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.5 with the s.d.

Table 48. Frequencies of Core Classes in Level XVI

Category	Frequency	Percent
Prismatic cores	19	61.3
Discoidal cores	3	9.7
Pyramidal cores	1	3.2
Miscellaneous cores	8	25.8
Total	31	100.0

Table 49. Frequencies of Striking Platform Types of Cores in Level XVI

Category	Frequency	Percent
Cortical	2	3.5
Plain	34	59.6
Convex dihedral faceted	20	35.1
Broken	1	1.8
Total	57	100.0

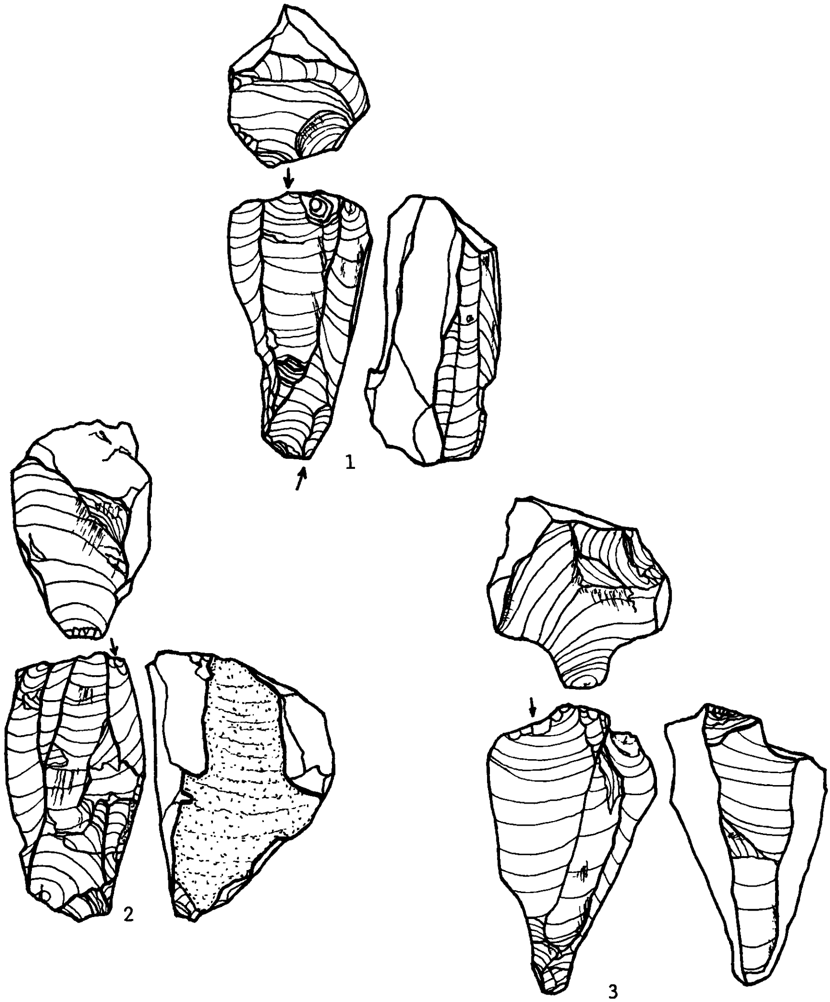


Fig. 70. Cores from Level XVI (scale 1/1)

↓: final detachment

1. Opposed platform prismatic core with the trace of a core tablet removal
2. Opposed platform prismatic core with the trace of a core tablet removal
3. Pyramidal core with opposed flake scars

of 0.6 (37 cases).

The mean number of flake scars from one and the same striking platform is 2.6 with the s.d. of 1.4 (37 cases).

The locations of striking platforms are opposed (6: 27.3%), opposite rectangular (3: 13.6%), opposite alternate (4: 18.2%), crossed (5: 22.7%), alternating (1: 4.5%), and miscellaneous (3: 13.6%).

The scar patterns are uni-directional (9: 24.3%), bi-directional opposed (10: 27.0%), crossed (15: 40.5%), centripetal (1: 2.7%), of a single flake scar (1: 2.7%), and with the trace of cresting (1: 2.7%).

The backs of the cores are cortex (12: 38.7%), striking platforms (1: 3.2%), flake scars (6: 19.4%), and miscellaneous (12: 38.7%).

Three of the cores are clearly worked on nodules (9.7%), 2 are worked on flakes (6.5%), and the rest (26: 83.9%) are believed to be worked on nodules.

The mean core length is 47.2mm with the s.d. of 7.6mm (31 cases), the mean core width is 37.4mm with the s.d. of 10.8mm (31 cases), and the mean core thickness is 25.3mm with the s.d. of 8.0mm (31 cases).

The overall shapes of the cores are parallel (18: 58.1%), converging (8: 25.8%), and miscellaneous (5: 16.1%).

One core shows traces of heat alteration (3.2%).

Sixteen cores were most probably abandoned because of hinging (51.6%).

RETOUCHED PIECES

The retouched pieces total 368, of which 217 are broken.

The main categories of the 151 unbroken retouched pieces are the end-scraper, the partially-backed piece, the Ksar Akil point, the side-scraper, and the piece with continuous direct retouch (Table 50) (Figs. 71 and 72).

The blanks for the retouched pieces are cortical debitage (2: 1.3%), partially-cortical debitage (22: 14.7%), non-cortical flakes (21: 14.0%), flake-blades (23: 15.3%), blades (40: 26.7%), bladelets (25: 16.7%), crested debitage (10: 6.7%), and cores (7: 4.7%).

The end-scrapers are made on cortical debitage (2: 4.3%), partially-cortical debitage (12: 25.5%), non-cortical flakes (7: 14.9%), flake-blades (7: 14.9%), blades (12: 25.5%), bladelets (3: 6.4%), and crested debitage (4: 8.5%). The partially-backed pieces are made on non-cortical flakes (1: 5.6%), flake-blades (2: 11.1%), blades (9: 50.0%), bladelets (4: 22.2%), and crested debitage (2: 11.1%). The Ksar Akil points are made on flake-blades (3: 25.0%), blades (3: 25.0%), and bladelets (6: 50.0%). The side-scrapers are made on partially-cortical debitage (4: 25.0%), non-cortical flakes (4: 25.0%),

Table 50. Frequencies of Retouched Piece Classes in Level XVI

Category	Frequency	Percent
End-scrapers	47	31.1
Double end-scrapers	1	0.7
End-scrapers on retouched blanks	4	2.7
Burins on break	1	0.7
Burins on lateral preparation	1	0.7
Backed pieces	3	2.0
Partially-backed pieces	18	11.9
Double partially-backed pieces	8	5.3
Ksar Akil points	12	8.0
Notched pieces	1	0.7
Denticulated pieces	1	0.7
Side-scrapers	16	10.6
Pieces with continuous direct retouch	15	9.9
Pieces with continuous inverse retouch	1	0.7
Pieces with discontinuous direct retouch	8	5.3
Piercers	1	0.7
Steep scrapers	5	3.3
Choppers	2	1.3
Composite retouched pieces	6	4.0
Total	151	100.3

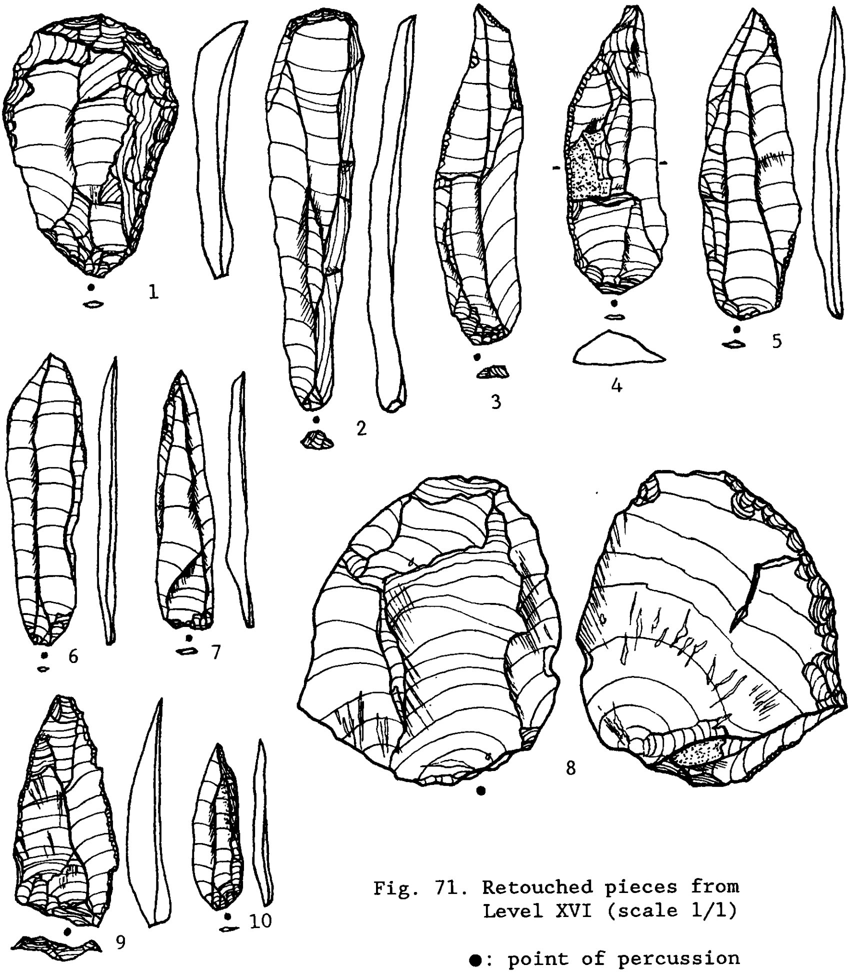


Fig. 71. Retouched pieces from Level XVI (scale 1/1)

●: point of percussion

1. End-scraper on a retouched non-cortical flake
2. End-scraper on crested debitage
3. Double partially-backed blade
4. Backed partially-cortical debitage
5. Ksar Akil point on a blade
6. Ksar Akil point on a blade
7. Ksar Akil point on a flake-blade
8. Side-scraper on a non-cortical flake
9. Ksar Akil point on a flake-blade
10. Ksar Akil point on a bladelet

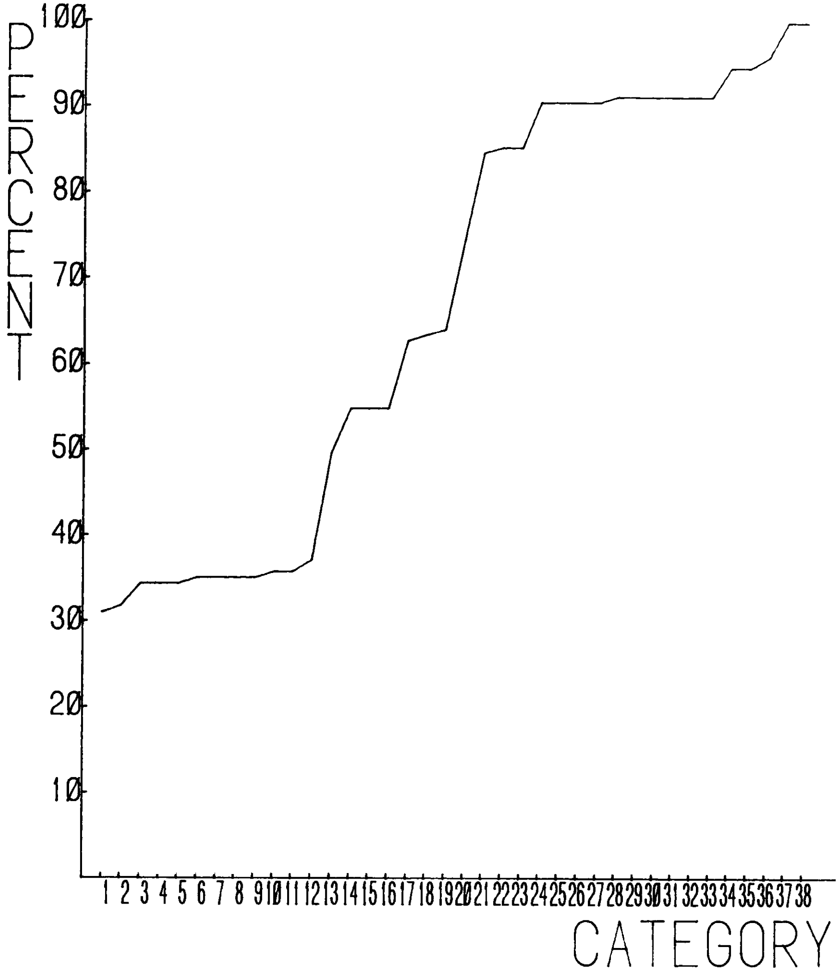


Fig. 72. Cumulative graph of retouched pieces from Level XVI: 151 pieces

flake-blades (3: 18.8%), blades (3: 18.8%), and cores (2: 12.5%). The pieces with continuous direct retouch are on non-cortical flakes (1: 6.7%), flake-blades (3: 20.0%), blades (5: 33.3%), bladelets (3: 20.0%), and crested debitage (3: 20.0%).

One of the blanks is a Levallois flake and was used for a side-scraper.

One of the blanks is naturally-backed and was used for an end-scraper.

The flaking modes for the blanks are Harder (3: 4.1%), Softer (60: 81.1%), and Questionable (11: 14.9%).

RETOUCH FLAKES

There are only 2 retouch flakes, one of which is a burin spall, and the other is a re-sharpening spall of a side-scraper.

SUMMARY

Except for the decrease in crested debitage, the main categories of debitage from this level are the same as those from Level XVII. As in Level XVII, prismatic cores outnumber other forms of cores. Representative retouched pieces are end-scrapers, partially-backed pieces, Ksar Akil points, and side-scrapers. This level shows a scarcity of burins as in Levels XVIII and XVII. The butts of the debitage are mainly plain, convex dihedral faceted, linear, and punctiform. The debitage was produced mainly with softer hammers, and has parallel dorsal shape and blunt distal shape. The main dorsal scar patterns of the debitage are uni-directional, bi-directional opposed, and crossed. The striking platforms of the cores are mainly plain and convex dihedral faceted, and the overall shapes of the cores are mainly parallel. The difference between this level and Level XVII lies in the increase in cores with convex dihedral faceted striking platforms in this level.

Level XV

The materials of this level total 197, comprising debitage, cores, and retouched pieces, and were derived from Squares E4 (-10.90m to -10.65m) and F4 (-10.95m to -10.45m).

DEBITAGE

The debitage totals 161 pieces, of which 77 are broken. The 84 unbroken pieces consist of partially-cortical debitage, non-cortical flakes, Levallois flakes, Levallois points, flake-blades, blades, and bladelets (Table 51) (Figs. 73 and 74).

The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted (Table 52).

Twenty-seven of the butts are accompanied by partially regularizing facets (32.1%), 11 are accompanied by overhang removal by

Table 51. Frequencies of Debitage Classes in Level XV

Category	Frequency	Percent
Partially-cortical debitage	16	19.0
Non-cortical flakes	40	47.6
Levallois flakes	3	3.6
Levallois points	1	1.2
Flake-blades (including 2 Levallois blades and 1 Levallois point)	14	16.7
Blades	6	7.1
Bladelets	4	4.8
Total	84	100.0

Table 52. Frequencies of Butt Types of Debitage in Level XV

Category	Frequency	Percent
Cortical	1	1.2
Plain	21	25.0
Convex dihedral faceted	28	33.3
Straight multiple faceted	5	6.0
Convex multiple faceted	20	23.8
Partially faceted	3	3.6
'Chapeau de gendarme'	1	1.2
Linear	1	1.2
Punctiform	1	1.2
Broken	3	3.6
Total	84	100.1

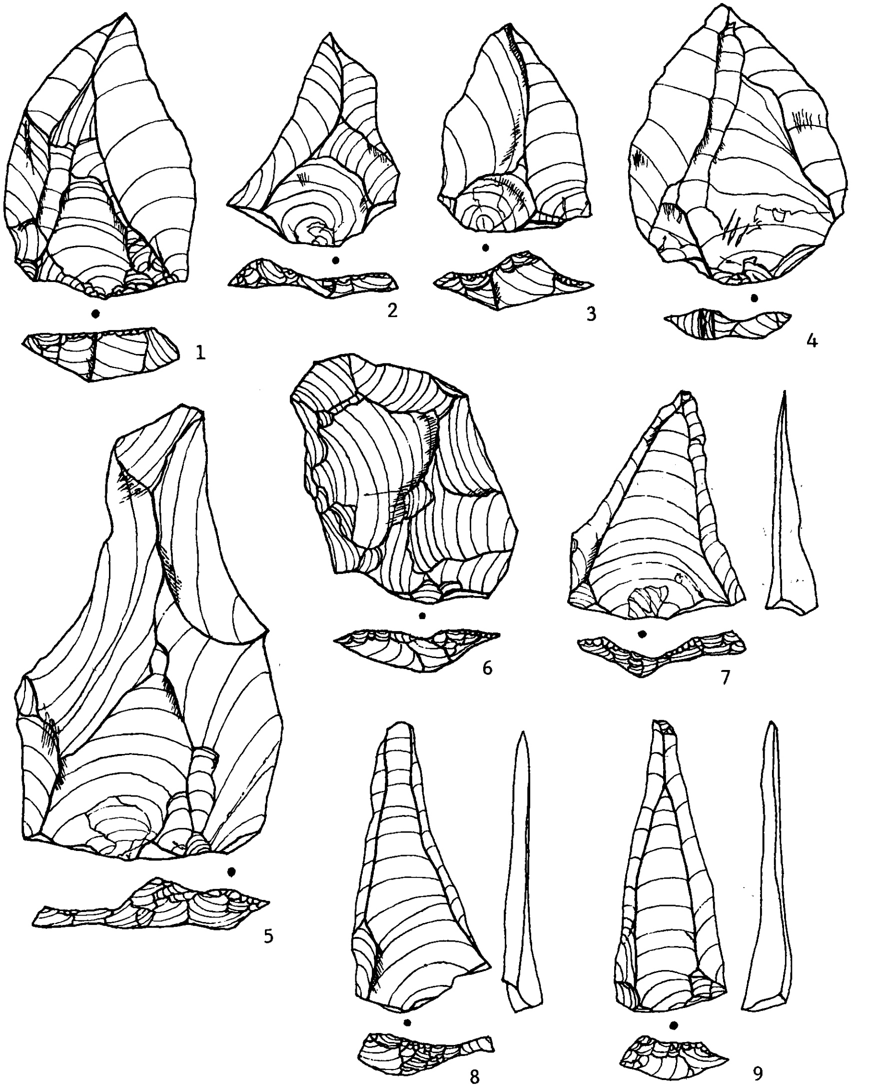
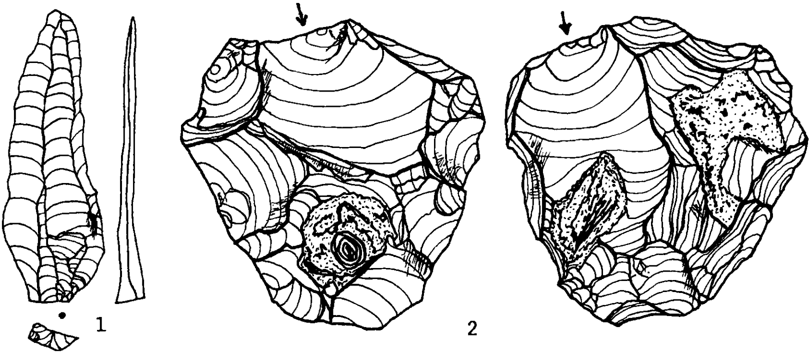
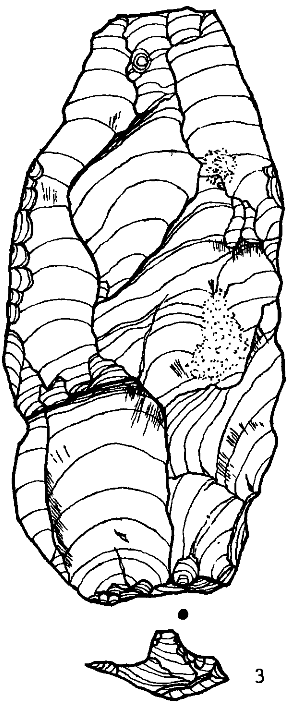


Fig. 73. Debitage from Level XV (scale 1/1)

●: point of percussion

1. Non-cortical flake
2. Non-cortical flake
3. Non-cortical flake
4. Non-cortical flake
5. Levallois flake, possibly resulting from failure of Levallois blade production
6. Levallois flake
7. Levallois point
8. Flake-blade approaching an elongated Levallois point
9. Elongated Levallois point





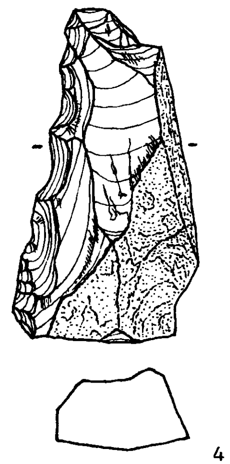


Fig. 74. Debitage, cores, and retouched pieces from Level XV (scale 1/1)

●: point of percussion
↓: final detachment

1. Blade
2. Discoidal core
3. Side-scraper on a flake-blade
4. Denticulated partially-cortical debitage

abrasion (13.1%), and 6 are accompanied by overhang removal by blow (7.1%).

Six of the debitage are hinged (7.1%).

(1) Partially-cortical debitage and non-cortical flakes: <u>56 pieces</u>

The profiles above the butts are straight (6: 11.1%), concave (41: 75.9%), convex (3: 5.6%), and crushed (4: 7.4%).

The mean butt thickness is 5.1mm with the s.d. of 1.8mm (54 cases), the mean length is 48.7mm with the s.d. of 12.3mm (56 cases), the mean width is 30.2mm with the s.d. of 7.3mm (56 cases), and the mean thickness is 7.4mm with the s.d. of 3.8mm (56 cases).

The flaking modes are Harder (1: 4.3%), Softer (17: 73.9%), and Questionable (5: 21.7%).

The dorsal scar patterns are uni-directional (27: 50.9%), bi-directional opposed (7: 13.2%), crossed (18: 34.0%), and with the trace of cresting (1: 1.9%).

The mean number of dorsal scars is 4.5 with the s.d. of 1.7 (56 cases).

(2) Levallois flakes, Levallois points, flake-blades, blades, and bladelets: <u>28 pieces</u>

The profiles above the butts are straight (5: 17.9%), concave (21: 75.0%), convex (1: 3.6%), and crushed (1: 3.6%).

The mean butt thickness is 4.9mm with the s.d. of 2.0mm (27 cases), the mean length is 53.5mm with the s.d. of 11.7mm (28 cases), the mean width is 23.5mm with the s.d. of 7.0mm (28 cases), and the mean thickness is 5.3mm with the s.d. of 1.8mm (28 cases).

The mean *angle de chasse* is 81.0° with the s.d. of 6.1° (24 cases), the mean *angle d'éclatement* is 98.9° with the s.d. of 5.7° (24 cases), and the mean total of the two angles is 179.8° (24 cases).

The flaking modes are Softer (15: 88.2%) and Questionable (2: 11.8%).

The dorsal scar patterns are uni-directional (13: 48.1%), bi-directional opposed (2: 7.4%), and crossed (12: 44.4%).

The mean number of dorsal scars is 4.6 with the s.d. of 1.5 (28 cases).

The numbers of dorsal planes are One (12: 42.9%) and Two (16: 57.1%).

The dorsal shapes are parallel (19: 67.9%), converging (8: 28.6%), and expanding (1: 3.6%).

The distal shapes are blunt (22: 78.6%) and pointed (6: 21.4%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 1.8 with the s.d. of 0.8 (10 cases).

The flaking order patterns on the Levallois points, flake-blades, blades, and bladelets are A (3: 33.3%), B (2: 22.2%), and C (4: 44.4%).

The locations of points of percussion are A (7: 28.0%), B (13: 52.0%), and C (5: 20.0%).

The Levallois flakes have plain butts (1), butts of convex dihedral facets (1), and butts of convex multiple facets (1). Their dorsal scar patterns are crossed (3), and the location of point of percussion is B (2).

Two of the flake-blades can be considered to be Levallois blades. Their butts are plain (2). Their dorsal scar patterns are crossed (2), and the locations of points of percussion are A (1) and B (1).

There are 2 Levallois points. One of them is a flake-blade. Their butts are of convex dihedral facets (1) and of *chapeau de gendarme* (1). The dorsal scar pattern is uni-directional (2). The flaking order patterns are B (1) and C (1), and the location of point of percussion is C (2).

CORES

The cores total 5 and are classified into 3 categories (Table 53) (Fig. 74).

The striking platforms for the final flake scars are classified into 2 categories (Table 54).

The mean length of the final flake scars is 20.3mm with the s.d. of 11.4mm (8 cases), and the mean width is 14.9mm with the s.d. of 9.7mm (8 cases).

The shapes of the final flake scars are parallel (6), converging (1), and expanding (1), and the distal shapes are blunt (6) and pointed (2).

Four of the 8 final flake scars are hinged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.4 with the s.d. of 0.8 (7 cases).

The mean number of flake scars from one and the same striking platform is 2.9 with the s.d. of 1.2 (7 cases).

The locations of striking platforms are crossed (2) and alternating (2).

The scar patterns are uni-directional (3) and crossed (3).

Table 53. Frequencies of Core Classes in Level XV

Category	Frequency
Prismatic cores	1
Discoidal cores	1
Miscellaneous cores	3
Total	5

Table 54. Frequencies of Striking Platform Types of Cores in Level XV

Category	Frequency
Plain	4
Convex dihedral faceted	4
Total	8

The backs of the cores are cortex (3) and flake scars (2).

The mean core length is 43.4mm with the s.d. of 9.4mm (5 cases), the mean core width is 37.0mm with the s.d. of 9.7mm (5 cases), and the mean core thickness is 14.2mm with the s.d. of 4.6mm (5 cases).

The overall shapes of the cores are parallel (3) and converging (2).

One core was most probably abandoned because of hinging.

RETOUCHED PIECES

The retouched pieces total 31, of which 11 are broken.

The 20 unbroken retouched pieces are classified into 12 categories (Table 55) (Figs. 74 and 75).

The blanks for the retouched pieces are partially-cortical debitage (1: 5.0%), non-cortical flakes (10: 50.0%), flake-blades (2: 10.0%), blades (1: 5.0%), crested debitage (1: 5.0%), cores (1: 5.0%), and older debitage (4: 20.0%).

The end-scrapers are made on non-cortical flakes (2) and blades (1). The side-scrapers are made on non-cortical flakes (1), flake-blades (1), and cores (1). The pieces with continuous direct retouch are on non-cortical flakes (1) and older debitage (2). The pieces with continuous inverse retouch are on non-cortical flakes (2) and older debitage (1).

One of the blanks is a Levallois flake and was used for a piece with continuous inverse retouch.

The flaking modes for the blanks are Softer (7: 87.5%) and Questionable (1: 12.5%).

SUMMARY

Level XV is characterized by non-cortical flakes and a considerable quantity of Levallois debitage. The butts of the debitage are mainly plain, convex dihedral faceted, and convex multiple faceted. The debitage was produced mainly with softer hammers, and has parallel dorsal shape, blunt distal shape, and uni-directional or crossed dorsal scar pattern. The features of this level which differentiate it from Level XVI lie in the increases in Levallois debitage, debitage with convex (dihedral or multiple) faceted butts, and debitage with uni-directional dorsal scar pattern, as well as in the decreases in blades, bladelets, debitage with linear or punctiform butts, and debitage with bi-directional opposed dorsal scar pattern. It is worthy to note that there are no Ksar Akil points in this level.

<u>Level XIV</u>

The materials of this level total 84, comprising debitage, cores, and retouched pieces, and were derived from Square E4 (-10.65m).

Table 55. Frequencies of Retouched Piece Classes in Level XV

Category	Frequency	Percent
End-scrapers	3	15.0
Burins on break	1	5.0
Notched pieces	1	5.0
Denticulated pieces	1	5.0
Side-scrapers	3	15.0
Pieces with continuous direct retouch	3	15.0
Pieces with continuous inverse retouch	3	15.0
Pieces with continuous alternate(ing) retouch	1	5.0
Pieces with discontinuous direct retouch	1	5.0
Pieces with discontinuous inverse retouch	1	5.0
Splintered pieces	1	5.0
Composite retouched pieces	1	5.0
Total	20	100.0

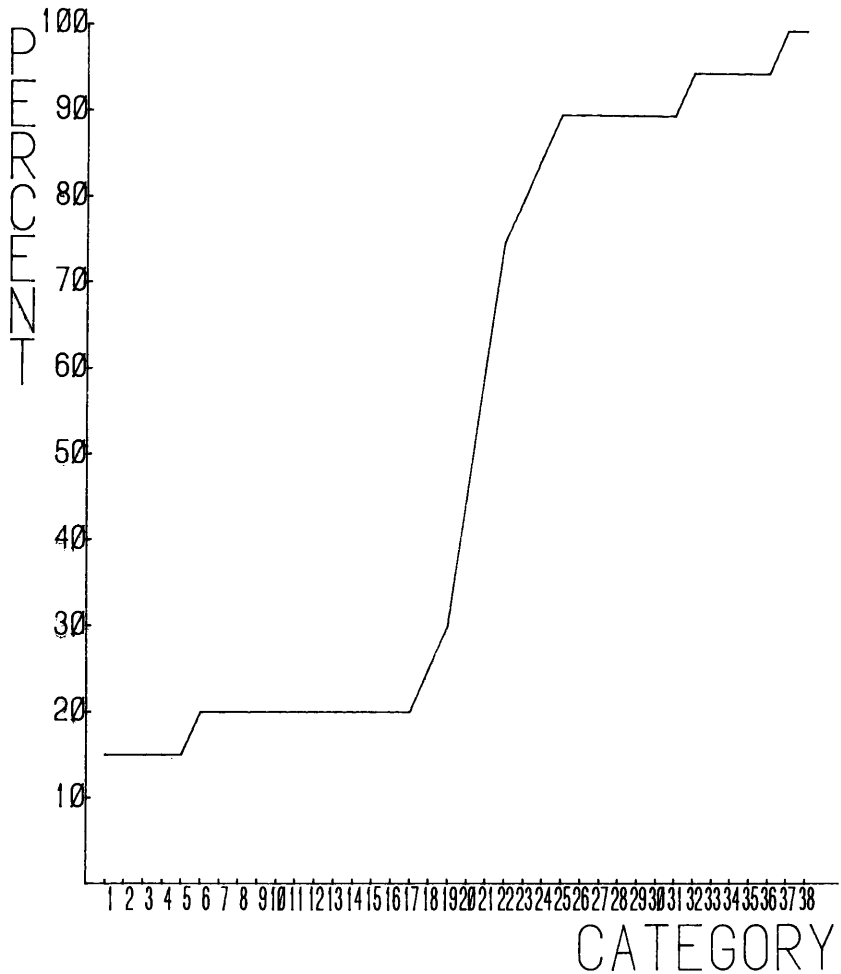


Fig. 75. Cumulative graph of retouched pieces from
Level XV: 20 pieces

DEBITAGE

The debitage totals 51 pieces, of which 11 are broken. The 40 unbroken pieces consist of partially-cortical debitage, non-cortical flakes, flake-blades, blades, bladelets, and crested debitage (Table 56) (Fig. 76).

The butts of the debitage are mainly plain and convex dihedral faceted (Table 57).

Seventeen of the butts are accompanied by partially regularizing facets (42.5%), 6 are accompanied by overhang removal by abrasion (15.0%), and 2 are accompanied by overhang removal by blow (5.0%).

Five of the debitage are hinged (12.5%), and 1 is plunged (2.5%).

(1) Partially-cortical debitage, non-cortical flakes, and crested debitage: <u>18 pieces</u>

The profiles above the butts are straight (4: 22.2%), concave (12: 66.7%), convex (1: 5.6%), and crushed (1: 5.6%).

The mean butt thickness is 5.3mm with the s.d. of 3.0mm (18 cases), the mean length is 49.3mm with the s.d. of 6.9mm (18 cases), the mean width is 25.8mm with the s.d. of 6.6mm (18 cases), and the mean thickness is 6.4mm with the s.d. of 2.1mm (18 cases).

The flaking modes are Harder (1: 11.1%), Softer (5: 55.6%), and Questionable (3: 33.3%).

The dorsal scar patterns are uni-directional (7: 41.2%), bi-directional opposed (3: 17.6%), crossed (3: 17.6%), and with the trace of cresting (4: 23.5%).

The mean number of dorsal scars is 4.9 with the s.d. of 1.6 (18 cases).

(2) Flake-blades, blades, and bladelets: <u>22 pieces</u>

The profiles above the butts are straight (5: 22.7%), concave (9: 40.9%), convex (6: 27.3%), and crushed (2: 9.1%).

The mean butt thickness is 4.5mm with the s.d. of 2.2mm (21 cases), the mean length is 55.9mm with the s.d. of 10.8mm (22 cases), the mean width is 21.3mm with the s.d. of 6.1mm (22 cases), and the mean thickness is 6.1mm with the s.d. of 2.3mm (22 cases).

The mean *angle de chasse* is 84.6° with the s.d. of 4.3° (16 cases), the mean *angle d'éclatement* is 96.8° with the s.d. of 4.4° (16 cases), and the mean total of the two angles is 181.4° (16 cases).

All 11 pieces whose flaking mode could be determined belong to the softer mode.

The dorsal scar patterns are uni-directional (10: 47.6%), bi-

Table 56. Frequencies of Debitage Classes in Level XIV

Category	Frequency	Percent
Partially-cortical debitage	2	5.0
Non-cortical flakes	12	30.0
Flake-blades	6	15.0
Blades	12	30.0
Bladelets	4	10.0
Crested debitage	4	10.0
Total	40	100.0

Table 57. Frequencies of Butt Types of Debitage in Level XIV

Category	Frequency	Percent
Plain	10	25.0
Convex dihedral faceted	15	37.5
Straight multiple faceted	1	2.5
Convex multiple faceted	4	10.0
Partially faceted	2	5.0
Linear	5	12.5
Punctiform	2	5.0
Broken	1	2.5
Total	40	100.0

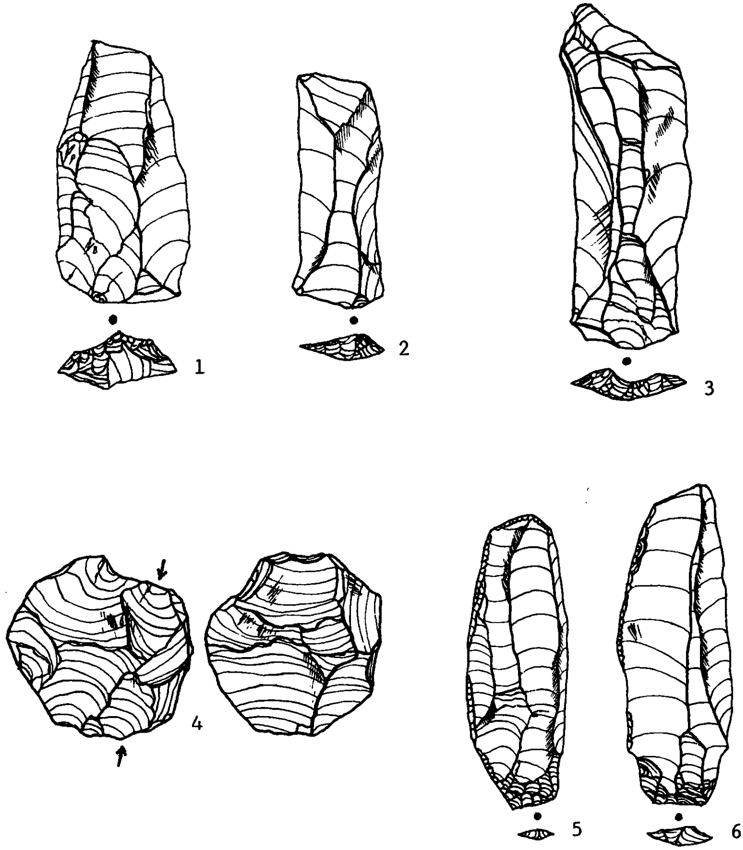


Fig. 76. Debitage, cores, and retouched pieces from Level XIV (scale 1/1)

●: point of percussion
↙: final detachment

1. Non-cortical flake
2. Flake-blade
3. Flake-blade
4. Discoidal core
5. End-scraper on a backed blade
6. Partially-backed blade

directional opposed (3: 14.3%). and crossed (8: 38.1%).

The mean number of dorsal scars is 5.2 with the s.d. of 2.1 (22 cases).

The numbers of dorsal planes are One (5: 22.7%), Two (14: 63.6%), and Three (3: 13.6%).

The dorsal shapes are parallel (18: 81.8%), converging (3: 13.6%), and expanding (1: 4.5%).

The distal shapes are blunt (19: 86.4%) and pointed (3: 13.6%).

The mean number of parallel or sub-parallel ridges on the blades and bladelets is 1.4 with the s.d. of 0.6 (16 cases).

The locations of points of percussion are A (8: 36.4%) and B (14: 63.6%).

CORES

There are 4 cores which are classified into 3 categories (Table 58) (Fig. 76).

The striking platforms for the final flake scars are classified into 3 categories (Table 59).

The mean length of the final flake scars is 17.0mm with the s.d. of 3.3mm (7 cases), and the mean width is 17.1mm with the s.d. of 14.2mm (7 cases).

The shapes of the final flake scars are parallel (4) and expanding (3), and the distal shapes are blunt (6) and pointed (1).

Two of the 7 final flake scars are hinged.

The mean number of striking platforms for one core surface directly related to a negative point of percussion is 1.6 with the s.d. of 0.9 (5 cases).

The mean number of flake scars from one and the same striking platform is 2.2 with the s.d. of 1.8 (5 cases).

The locations of striking platforms are opposed (1), crossed (1), and alternating (2).

The scar patterns are bi-directional opposed (1), crossed (1), and of a single flake scar (3).

The backs of the cores are flake scars (1) and miscellaneous (3).

One of the cores is clearly worked on nodule, and the rest (3) are believed to be worked on nodules.

The mean core length is 32.8mm with the s.d. of 9.9mm (4 cases),

Table 58. Frequencies of Core Classes in Level XIV

Category	Frequency
Prismatic cores	1
Discoidal cores	1
Miscellaneous cores	2
Total	4

Table 59. Frequencies of Striking Platform Types of Cores in Level XIV

Category	Frequency
Cortical	2
Plain	3
Convex dihedral faceted	2
Total	7

Table 60. Frequencies of Retouched Piece Classes in Level XIV

Category	Frequency	Percent
End-scrapers	5	27.8
Dihedral burins	1	5.6
Burins on retouched truncation	1	5.6
Partially-backed pieces	1	5.6
Notched pieces	1	5.6
Pieces with continuous direct retouch	1	5.6
Pieces with continuous inverse retouch	3	16.7
Pieces with discontinuous direct retouch	1	5.6
Pieces with discontinuous alternate(ing) retouch	1	5.6
Composite retouched pieces	2	11.1
Unclassifiable retouched pieces	1	5.6
Total	18	100.4

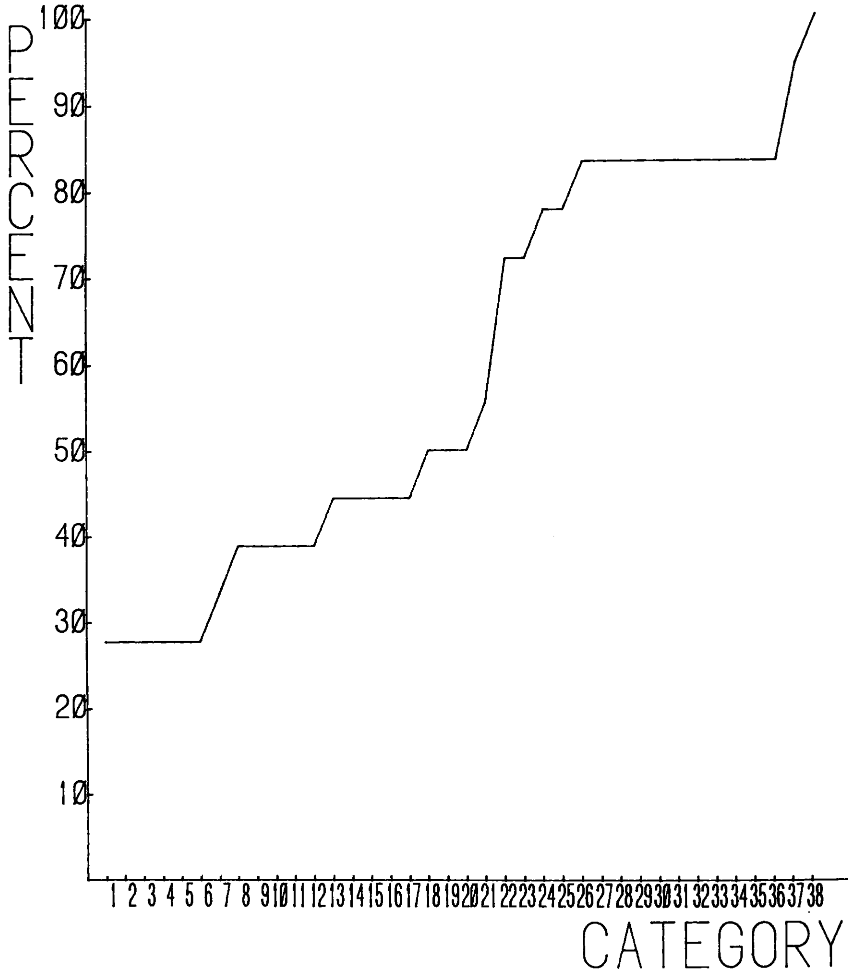


Fig. 77. Cumulative graph of retouched pieces from Level XIV: 18 pieces

the mean core width is 36.8mm with the s.d. of 14.2mm (4 cases), and the mean core thickness is 12.5mm with the s.d. of 2.1mm (4 cases).

The overall shapes of the cores are parallel (3) and expanding (1).

One core shows traces of heat alteration.

One core was most probably abandoned because of hinging.

RETOUCHED PIECES

The retouched pieces total 29, but 11 of them are broken.

The 18 unbroken retouched pieces are classified into 11 categories (Table 60) (Figs. 76 and 77).

The blanks for the retouched pieces are non-cortical flakes (3: 16.7%), flake-blades (8: 44.4%), blades (4: 22.2%), bladelets (1: 5.6%), and crested debitage (2: 11.1%).

The end-scrapers are made on non-cortical flakes (1), flake-blades (1), blades (1), and crested debitage (2). The pieces with continuous inverse retouch are on flake-blades (3).

All 11 blanks whose flaking mode could be determined belong to the softer mode.

SUMMARY

Level XIV is characterized by non-cortical flakes and blades. The butts of the debitage are mainly plain and convex dihedral faceted. The debitage was produced mainly with softer hammers, and has parallel dorsal shape, blunt distal shape, and uni-directional dorsal scar pattern more frequently. The features of this level which differentiate it from Level XV lie in the increase in blades and in the absence of Levallois debitage.

CHAPTER III

CHANGE IN TECHNOLOGY

This chapter comprises two sections. The first section documents the continuity and change in technology throughout the sequence, which are observed from the inter-level comparisons of the metrical and techno-typological features presented in detail in the preceding chapter. The second section schematically reconstructs different technologies in the manufacture of lithic artifacts which represent the two sets of levels established in the first section.

Continuity and change

DEBITAGE AND CORES

The frequencies of seven categories of debitage throughout the sequence are shown in Table 61. It may be observed in the table that partially-cortical debitage occurs more frequently in Levels XXV and XIX to XV, non-cortical flakes are less frequent in Level XX, flake-blades are more numerous in Levels XXIV to XX, and blades and bladelets first appear in Level XXIII, suddenly increase in Level XXII, and reach their highest frequencies in Levels XXI, XVIII, XVII, and XIV. Crested debitage suddenly increases in Level XX and continues to occur in higher frequencies up to Level XIV except for Level XV. The flake-blades seem to have played a major role in elongated debitage in Levels XXV to XXII, whereas the blades and bladelets gradually increase from Level XXIII onwards until they take the place of flake-blades in Level XIX. It was not until Level XX that cresting for the production of elongated debitage was often used, and it seems likely that the production of blades and bladelets gradually became more and more refined by the use of cresting from Level XX onwards.

Table 62 shows the frequencies of several categories of cores. It seems to be clear that prismatic cores are the most common type in all the levels. Discoidal cores are very common in Levels XXV and XVI to XIV, and Levallois cores in the final forms occur within Levels XXV to XX only.

It is highly likely that the intention to produce elongated debitage gradually increased within Levels XXV to XX, in which the flake-blades, blades, and bladelets were produced mainly from prismatic cores with single striking platforms. From Level XIX onwards, however, the production of blades and bladelets seems to have become more and more refined; prismatic cores with opposed and/or opposite striking platforms suddenly increased in Level XIX and reached their highest frequencies in Levels XVIII and XVII (Table 63).

The frequencies of butt types of debitage show significant changes throughout the sequence (Table 64). Cortical and plain butts are distributed in almost equal frequencies throughout the sequence. The butts of convex dihedral facets are very common except in Levels XVIII and XVII.

Table 61. Frequencies of Debitage Classes (%)

Level	Total	1	2	31	32	33	34	4
XIV	40	-	2 (5.0)	12 (30.0)	6 (15.0)	12 (30.0)	4 (10.0)	4 (10.0)
XV	84	-	16 (19.0)	44 (52.4)	14 (16.7)	6 (7.1)	4 (4.8)	-
XVI	394	2 (0.5)	72 (18.3)	105 (26.6)	54 (13.7)	55 (14.0)	69 (17.5)	37 (9.4)
XVII	690	-	111 (16.1)	87 (12.6)	114 (16.5)	148 (21.4)	115 (16.7)	115 (16.7)
XVIII	259	1 (0.4)	35 (13.5)	40 (15.4)	48 (18.5)	47 (18.1)	55 (21.2)	33 (12.7)
XIX	360	6 (1.7)	60 (16.7)	74 (20.6)	76 (21.4)	53 (14.7)	56 (15.6)	35 (9.7)
XX	556	3 (0.5)	62 (11.2)	51 (9.2)	206 (37.1)	127 (22.8)	66 (11.9)	41 (7.4)
XXI	256	-	24 (9.4)	50 (19.5)	80 (31.3)	67 (26.2)	30 (11.7)	5 (2.0)
XXII	871	2 (0.2)	52 (6.0)	177 (20.3)	344 (39.5)	205 (23.5)	75 (8.6)	16 (1.8)
XXIII	296	1 (0.3)	21 (7.1)	81 (27.4)	138 (46.6)	31 (10.5)	22 (7.4)	2 (0.7)
XXIV	41	1 (2.4)	3 (7.3)	12 (29.3)	25 (61.0)			-
XXV	29	-	6 (20.7)	13 (44.8)	7 (24.1)	-	1 (3.4)	2 (6.9)

1: Cortical debitage
2: Partially-cortical debitage
31: Non-cortical flakes
32: Flake-blades
33: Blades
34: Bladelets
4: Crested debitage

Table 62. Frequencies of Core Classes (%)

Level	Total	PR.	--Levallois-- F.	B.	P.	D.	PY.	G.	M.
XIV	4	1 (25.0)	-	-	-	1 (25.0)	-	-	2 (50.0)
XV	5	1 (20.0)	-	-	-	1 (20.0)	-	-	3 (60.0)
XVI	31	19 (61.3)	-	-	-	3 (9.7)	1 (3.2)	-	8 (25.8)
XVII	164	130 (79.3)	-	-	-	6 (3.7)	7 (4.3)	3 (1.8)	18 (11.0)
XVIII	38	26 (68.4)	-	-	-	1 (2.6)	2 (5.3)	1 (2.6)	8 (21.1)
XIX	123	73 (59.3)	-	-	-	8 (6.5)	3 (2.4)	3 (2.4)	36 (29.3)
XX	160	117 (73.1)	1 (0.6)	-	2 (1.3)	2 (1.3)	3 (1.9)	5 (3.1)	30 (18.8)
XXI	68	45 (66.2)	-	-	-	3 (4.4)	4 (5.9)	1 (1.5)	15 (22.1)
XXII	135	88 (65.2)	2 (1.5)	2 (1.5)	3 (2.2)	6 (4.4)	7 (5.2)	1 (0.7)	25 (18.5)
XXIII	105	74 (70.5)	1 (1.0)	2 (1.9)	1 (1.0)	5 (4.8)	2 (1.9)	-	20 (19.0)
XXIV	39	19 (48.7)	-	2 (5.1)	1 (2.6)	2 (5.1)	-	1 (2.6)	14 (35.9)
XXV	21	11 (52.4)	1 (4.8)	-	-	4 (19.0)	1 (4.8)	-	4 (19.0)

PR: Prismatic Cores
F: Flake Cores
B: Blade Cores
P: Point Cores
D: Discoidal Cores
PY: Pyramidal Cores
G: Globular Cores
M: Miscellaneous Cores

Table 63. Frequencies of Subclasses of Prismatic Cores (%)

Level	Total	SP	OP	ORP	OAP	O/OAP	CR	M
XIV	1	-	1 (100.0)	-	-	-	-	-
XV	1	1 (100.0)	-	-	-	-	-	-
XVI	19	8 (42.1)	5 (26.3)	3 (15.8)	2 (10.5)	1 (5.3)	-	-
XVII	130	39 (30.0)	43 (33.1)	16 (12.3)	5 (3.8)	18 (13.8)	3 (2.3)	6 (4.6)
XVIII	26	5 (19.2)	4 (15.4)	6 (23.1)	1 (3.8)	6 (23.1)	-	4 (15.4)
XIX	73	23 (31.5)	20 (27.4)	6 (8.2)	5 (6.9)	12 (16.4)	2 (2.7)	5 (6.9)
XX	114	65 (57.0)	20 (17.5)	6 (5.3)	8 (7.0)	7 (6.1)	2 (1.8)	6 (5.3)
XXI	44	28 (63.6)	8 (18.2)	3 (6.8)	2 (4.5)	-	-	3 (6.8)
XXII	87	55 (63.2)	14 (16.1)	4 (4.6)	3 (3.4)	-	5 (5.7)	6 (6.9)
XXIII	67	35 (52.2)	14 (20.9)	4 (6.0)	4 (6.0)		1 (1.5)	9 (13.4)
XXIV	19	8 (42.1)	3 (15.8)	2 (10.5)	4 (21.1)	-	2 (10.5)	-
XXV	11	7 (63.6)	3 (27.3)	-	-		1 (9.1)	

Prismatic cores with SP: Single striking platforms
OP: Opposed striking platforms
ORP: Opposite rectangular striking platforms
OAP: Opposite alternate striking platforms
O/OAP: Striking platforms intermediate between OP and OAP
CR: Crossed striking platforms
M: Miscellaneous striking platforms

Table 64. Frequencies of Butt Types of Debitage (%)

Level	T	C	PL	CDF	SMF	CMF	PF	CHG	L	P	B
XIV	40	-	10 (25.0)	15 (37.5)	1 (2.5)	4 (10.0)	2 (5.0)	-	5 (12.5)	2 (5.0)	1 (2.5)
XV	84	1 (1.2)	21 (25.0)	28 (33.3)	5 (6.0)	20 (23.8)	3 (3.6)	1 (1.2)	1 (1.2)	1 (1.2)	3 (3.6)
XVI	394	5 (1.3)	125 (31.7)	79 (20.1)	4 (1.0)	19 (4.8)	4 (1.0)	1 (0.3)	79 (20.1)	68 (17.3)	10 (2.5)
XVII	690	15 (2.2)	208 (30.1)	85 (12.3)	6 (0.9)	11 (1.6)	2 (0.3)	-	175 (25.4)	176 (25.5)	12 (1.7)
XVIII	259	3 (1.2)	71 (27.4)	33 (12.7)	9 (3.5)	9 (3.5)	3 (1.2)	-	56 (21.6)	62 (23.9)	13 (5.0)
XIX	360	7 (1.9)	121 (33.6)	85 (23.6)	15 (4.2)	40 (11.1)	7 (1.9)	-	44 (12.2)	32 (8.9)	9 (2.5)
XX	556	10 (1.8)	160 (28.8)	164 (29.5)	40 (7.2)	89 (16.0)	37 (6.7)	-	23 (4.1)	19 (3.4)	14 (2.5)
XXI	256	5 (2.0)	70 (27.3)	81 (31.6)	18 (7.0)	52 (20.3)	16 (6.3)	-	8 (3.1)	1 (0.4)	5 (2.0)
XXII	871	7 (0.8)	230 (26.4)	249 (28.6)	75 (8.6)	204 (23.4)	63 (7.2)	-	16 (1.8)	7 (0.8)	20 (2.3)
XXIII	296	5 (1.7)	80 (27.0)	102 (34.5)	11 (3.7)	44 (14.9)	21 (7.1)	-	17 (5.7)	3 (1.0)	13 (4.4)
XXIV	41	1 (2.4)	13 (31.7)	11 (26.8)	2 (4.9)	12 (29.3)	-	-	1 (2.4)	-	1 (2.4)
XXV	29	-	10 (34.5)	9 (31.0)	4 (13.8)	5 (17.2)	-	-	-	-	1 (3.5)

T: Total
C: Cortical
PL: Plain
CDF: Convex dihedral faceted
SMF: Straight multiple faceted
CMF: Convex multiple faceted
PF: Partially faceted
CHG: 'Chapeau de gendarme'
L: Linear
P: Punctiform
B: Broken

Multiple faceted butts (both straight and convex) gradually decrease within Levels XXV to XIX, are considerably less numerous in Levels XVIII to XVI, and increase again in Level XV. The butts of partial facets are especially common in Levels XXIII to XX, XV, and XIV. Linear and punctiform butts first appear in Level XXIV and gradually increase up to Level XX. They suddenly increase in Level XIX and become most numerous in Levels XVIII to XVI.

Table 65 shows the frequency of occurrence of three possible means of modifying the butts of debitage. In Levels XXIV to XX, the butts are accompanied by partially regularizing facet, but this facet suddenly decreases in Level XIX and becomes rarest in Levels XVIII and XVII. Overhang removal by abrasion first appears in Level XXIV, suddenly increases in Level XIX, and becomes most numerous in Levels XVIII to XVI. Overhang removal by blow increases considerably in Level XXII, occurs more frequently in Levels XXI to XVIII, and suddenly decreases in Level XVII. Table 65 also shows that in Levels XXIII to XX the butts were often accompanied by partially regularizing facet, whereas in Levels XIX to XVI they were very often accompanied by overhang removal by abrasion. This change seems to have occurred gradually rather than abruptly.

Plain striking platforms are the most common in all the levels, while those which are convex dihedral faceted are second most common (Table 66). Plain striking platforms are most frequent in Levels XVIII and XVII, while those which are convex dihedral faceted are least numerous in these levels. Multiple faceted striking platforms (both straight and convex) gradually decrease within Levels XXIV to XVII and do not occur at all in Levels XVI to XIV.

The striking platforms of Levallois cores, especially of flake and point types, are mainly convex dihedral faceted or multiple faceted (Table 67).

It appears that in Levels XXV to XX much of the debitage with convex dihedral faceted or multiple faceted butts (accompanied by partially regularizing facet) was being detached from the cores with plain, convex dihedral faceted, or multiple faceted striking platforms, whereas from Level XIX onwards much of the debitage with linear or punctiform butts (accompanied by overhang removal by abrasion) was being detached from the cores with plain striking platforms.

In this connection, the mean values of butt thickness of debitage and the frequencies of flaking modes presented in Tables 70 and 75 pose an interesting problem; much of the debitage in Levels XXV to XXI with thicker, faceted butts was being detached more often with hammers softer than the material than with hammers which are harder.

Throughout the sequence, hinged debitage outnumbers that which is plunged. In Levels XXV to XXI, hinged debitage occurs less frequently (from 2.8% to 4.4%) than in Levels XX to XIV (from 5.8% to 12.5%). Plunged debitage, on the other hand, occurs at random throughout the sequence (from 1.5% to 7.3%).

Similarly, final flake scars on the cores are more often hinged

Table 65. Frequencies of Partially Regularizing Facet, Overhang Removal by Abrasion, and Overhang Removal by Blow (%)

Level	Total of butt	P-R-F	O-R-A	O-R-B
XIV	40	17 (42.5)	6 (15.0)	2 (5.0)
XV	84	27 (32.1)	11 (13.1)	6 (7.1)
XVI	394	58 (14.7)	157 (39.9)	29 (7.4)
XVII	690	33 (4.8)	344 (49.9)	55 (8.0)
XVIII	259	20 (7.7)	90 (34.8)	43 (16.6)
XIX	360	72 (20.0)	76 (21.1)	37 (10.3)
XX	556	242 (43.5)	16 (2.9)	75 (13.5)
XXI	256	90 (35.2)	9 (3.5)	50 (19.5)
XXII	871	256 (29.4)	29 (3.3)	83 (9.5)
XXIII	296	105 (35.5)	5 (1.7)	2 (0.7)
XXIV	41	11 (26.8)	2 (4.9)	-
XXV	29	1 (3.5)	-	-

P-R-F: Partially regularizing facet
O-R-A: Overhang removal by abrasion
O-R-B: Overhang removal by blow

Table 66. Frequencies of Striking Platform Types of Cores (%)

Level	Total	C	P	CD	SM	CM	B
XIV	7	2 (28.6)	3 (42.9)	2 (28.6)			
XV	8		4 (50.0)	4 (50.0)		-	
XVI	57	2 (3.5)	34 (59.6)	20 (35.1)	-	-	1 (1.8)
XVII	299	8 (2.7)	234 (78.3)	53 (17.7)	1 (0.3)	2 (0.7)	1 (0.3)
XVIII	69	2 (2.9)	53 (76.8)	10 (14.5)	-	3 (4.3)	1 (1.4)
XIX	197	13 (6.6)	132 (67.0)	44 (22.3)	-	7 (3.6)	1 (0.5)
XX	251	13 (5.2)	144 (57.4)	77 (30.7)	2 (0.8)	13 (5.2)	2 (0.8)
XXI	99	2 (2.0)	65 (65.7)	23 (23.2)	3 (3.0)	6 (6.1)	-
XXII	193	5 (2.6)	107 (55.4)	66 (34.2)	4 (2.1)	8 (4.1)	3 (1.6)
XXIII	150	6 (4.0)	71 (47.3)	52 (34.7)	6 (4.0)	13 (8.7)	2 (1.3)
XXIV	47	2 (4.3)	27 (57.4)	10 (21.3)	-	8 (17.0)	-
XXV	28	-	14 (50.0)	10 (35.7)		2 (7.1)	2 (7.1)

C: Cortical striking platforms
PL: Plain striking platforms
CD: Convex dihedral faceted striking platforms
SM: Straight multiple faceted striking platforms
CM: Convex multiple faceted striking platforms
B: Broken striking platforms

Table 67. Frequencies of Striking Platform Types of Levallois Cores from Levels XXV to XX (%)

	C	P	CD	SM	CM	B	Total
Levallois flake cores	-	-	2 (40.0)	1 (20.0)	1 (20.0)	1 (20.0)	5
Levallois blade cores	-	4 (66.7)	1 (16.7)	-	1 (16.7)	-	6
Levallois point cores	-	1 (14.3)	3 (42.9)	-	3 (42.9)	-	7

C: Cortical striking platforms
P: Plain striking platforms
CD: Convex dihedral faceted striking platforms
SM: Straight multiple faceted striking platforms
CM: Convex multiple faceted striking platforms
B: Broken striking platforms

Table 68. Percentages of Cores Most Probably Abandoned Due to Hinging

Level	Total	No. and %
XIV	4	1: 25.0
XV	5	1: 20.0
XVI	31	16: 51.6
XVII	164	79: 48.2
XVIII	38	16: 42.1
XIX	123	48: 39.0
XX	160	49: 30.6
XXI	68	14: 20.6
XXII	135	26: 19.3
XXIII	105	18: 17.1
XXIV	39	3: 7.7
XXV	21	1: 4.8

(from 28.6% to 53.6%) than plunged (from 0.0% to 5.3%).

The percentages of the cores which were probably abandoned due to flaking difficulty caused by hinging gradually increase (Table 68). It seems very likely that in many cases cores were abandoned when hinge fractures caused problems that could not be removed by further flaking.

As to the frequencies of four types of profiles above butts of debitage (straight, concave, convex, and crushed), Table 69 shows that the concave profile is more common in Levels XXIII and XXII, gradually decreases from Level XXI onwards, and suddenly becomes rare in Level XVIII. Straight/convex profiles, on the other hand, gradually increase within Levels XXIII to XIX and become more numerous in Levels XVIII to XVI. The frequency changes of these four profiles above butts show that the concave profile outnumbered straight/convex profiles in Levels XXIII to XX, XV, and XIV, whereas the reverse of these proportions is observed in Levels XXV, XXIV, and XIX to XVI, undoubtedly associated with overhang removal by abrasion. This change, however, seems to have occurred gradually.

The mean values of butt thickness of debitage and debitage thickness (Table 70) show that they are strongly interrelated. The table also shows that both values gradually became smaller within Levels XXV to XIX and became smallest in Levels XVIII to XVI.

The maximum length of debitage in all the levels is 128mm (Level XX) and the minimum is 16mm (Level XVII), while the maximum width of debitage is 81mm (Level XXIII) and the minimum is 6mm (Levels XVII and XVI).

There is a gradual but clear change in the elongation of debitage. The length/width ratios of debitage are shown in Table 71. It can be seen in the table that debitage gradually became more and more elongated throughout the sequence with two peaks in Levels XX and XVII. It is also observable that the debitage in Level XV suddently became shorter.

Table 72 shows the length/width ratios of flake-blades, blades, and bladelets. The most elongated of these three classes of elongated debitage are the blades, whereas the least elongated are the flake-blades. The flake-blades become slightly more elongated in Levels XX to XVII. There is no obvious difference in the elongation of the blades except in Levels XVI and XV in which they are slightly shorter. The bladelets gradually become more and more elongated throughout the sequence except in Level XV.

Judging from the mean values of debitage presented above, it seems highly probable that debitage gradually became more and more elongated with peaks within Levels XXII to XVI, became thinner and thinner in Levels XXV to XIX, and became thinnest in Levels XVIII to XVI. In brief, debitage became longest and thinnest in Levels XVIII to XVI.

The means of the length of final flake scars on the cores range from 17.0mm to 26.7mm, those of the width range from 13.3mm to 17.4mm, and the length/width ratios show that the final flake scars were more elongated in Levels XXII to XVII (Table 73).

Table 69. Frequencies of Profiles above Butts (%)

Level	Total	S	CC	CV	CR	S + CV
XIV	40	9 (22.5)	21 (52.5)	7 (17.5)	3 (7.5)	16 (40.0)
XV	82	11 (13.4)	62 (75.6)	4 (4.9)	5 (6.1)	15 (18.3)
XVI	386	88 (22.8)	117 (30.3)	130 (33.7)	51 (13.2)	218 (56.5)
XVII	678	169 (24.9)	102 (15.0)	308 (45.4)	99 (14.6)	477 (70.3)
XVIII	252	60 (23.8)	54 (21.4)	102 (40.5)	36 (14.3)	162 (64.3)
XIX	355	91 (25.6)	153 (43.1)	68 (19.2)	43 (12.1)	159 (44.8)
XX	550	124 (22.6)	292 (53.1)	64 (11.6)	70 (12.7)	188 (34.2)
XXI	255	48 (18.8)	148 (58.0)	24 (9.4)	35 (13.7)	72 (28.2)
XXII	865	173 (20.0)	592 (68.4)	37 (4.3)	63 (7.3)	210 (24.3)
XXIII	288	70 (24.3)	193 (67.0)	3 (1.0)	22 (7.6)	73 (25.3)
XXIV	40	19 (47.5)	15 (37.5)	2 (5.0)	4 (10.0)	21 (52.5)
XXV	28	13 (46.4)	11 (39.3)	-	4 (14.3)	13 (46.4)

S: Straight
CC: Concave
CV: Convex
CR: Crushed

Table 70. Mean Values of Debitage Thickness and Butt Thickness (mm)

Debitage thickness	Total	Level	Total	Butt thickness
6.2	40	XIV	39	4.9
6.7	84	XV	81	5.0
6.4	394	XVI	384	3.4
6.4	690	XVII	677	2.6
6.0	259	XVIII	247	2.9
7.2	360	XIX	351	3.9
7.2	556	XX	545	4.6
7.2	256	XXI	253	5.6
7.3	870	XXII	856	5.8
7.4	296	XXIII	286	5.4
6.8	41	XXIV	40	4.8
8.4	29	XXV	28	5.7

Table 71. L/W Ratios of Debitage

Level	Total	L/W Ratio
XIV	40	2.3
XV	84	1.8
XVI	394	2.3
XVII	690	2.7
XVIII	259	2.5
XIX	360	2.3
XX	556	2.7
XXI	255	2.5
XXII	871	2.4
XXIII	296	2.2
XXIV	41	2.2
XXV	29	2.1

Table 72. L/W Ratios of Flake-blades, Blades, and Bladelets

Level	Flake-blade	Blade	Bladelet
XIV	2.4	2.7	3.0
XV	2.3	2.8	2.6
XVI	2.6	2.9	2.8
XVII	2.8	3.2	2.9
XVIII	2.7	3.0	2.9
XIX	2.8	3.0	2.8
XX	2.7	3.2	2.7
XXI	2.6	3.1	2.7
XXII	2.6	3.0	2.7
XXIII	2.6	3.3	2.7
XXIV	2.6	-	-
XXV	2.6	-	2.5

Table 73. L/W Ratios of Final Flake Scars on Cores

Level	Total	L/W Ratio
XIV	7	1.0
XV	8	1.4
XVI	57	1.5
XVII	299	1.8
XVIII	69	1.6
XIX	197	1.6
XX	251	1.7
XXI	99	1.7
XXII	193	1.6
XXIII	150	1.5
XXIV	46	1.5
XXV	25	1.3

The maximum length of the cores in all the levels is 53.1mm (Level XVII) and the minimum is 32.8mm (Level XIV), while the maximum width is 39.0mm (Level XXI) and the minimum is 33.1mm (Level XVIII). The maximum thickness of the cores is 26.9mm (Level XVII) and the minimum is 12.5mm (Level XIV).

The length/width ratio of cores gradually increases from Level XXV to Level XVII (Table 74). In Levels XVIII and XVII the ratios become the highest, meaning that the cores gradually became more and more elongated, reaching a peak in Levels XVIII and XVII. This change seems to be reflected to a certain extent in the L/W ratios of debitage (Table 71).

The frequencies of the harder and softer flaking modes present an interesting problem (Table 75). Although the softer flaking mode outnumbers the harder one throughout the sequence, there is a clear break between Levels XXI and XX; from Level XX onwards the difference between the frequencies of these two flaking modes gets larger. It is also interesting to note the mean values of butt thickness of the debitage detached with these two flaking modes (Table 76). Within Levels XXIV to XXII, there is no clear difference in the mean values of butt thickness of the debitage detached with the two kinds of flaking modes, whereas in Levels XVIII to XVI a clear difference is observed; the butts of the debitage detached with the harder flaking mode are clearly thicker than those of the debitage detached with the softer mode. Levels XXI to XIX seem to be intermediate between these two sets of levels.

Judging from the above observations, it seems possible that in Levels XXIV to XXII both harder and softer hammers (possibly including soft hammerstones) were used in a similar style of flaking, whereas in Levels XVIII to XVI softer hammers (or soft punches for indirect percussion (Azoury, 1971: p.96; Newcomer, 1972: p.38)) were mainly used in a certain marginal flaking in order to produce debitage which was thinner and more elongated.

The frequencies of dorsal scar patterns of debitage change considerably (Table 77). The uni-directional pattern is more common in Levels XXIII to XXI, XV, and XIV and rarer in Levels XVIII and XVII. The bi-directional opposed pattern occurs more frequently in Levels XX to XVI with a peak in Level XVIII and is less frequent in Levels XXII, XXI, XV, and XIV. The crossed pattern occurs less frequently in Levels XXII to XVII. The cresting pattern gradually increases from Level XXV onwards, suddenly increases in Level XX, and becomes most common in Level XVII. It is clearly seen that bi-directional opposed dorsal scar patterns increase as uni-directional patterns decrease and that the distribution of cresting is almost the same as that of bi-directional opposed dorsal scar pattern.

The frequencies of scar patterns on the cores roughly coincide with those on debitage; in Levels XXIV and XXIII uni-directional, bi-directional opposed, and crossed scar patterns occur in almost equal frequencies, but in Levels XXII and XXI the uni-directional pattern is most numerous and the bi-directional opposed pattern becomes most frequent in Levels XIX to XVII (Table 78).

Table 74. L/W Ratios of Cores

Level	Total	L/W Ratio
XIV	4	0.9
XV	5	1.2
XVI	31	1.3
XVII	164	1.5
XVIII	38	1.5
XIX	123	1.3
XX	160	1.3
XXI	68	1.3
XXII	135	1.3
XXIII	105	1.3
XXIV	39	1.3
XXV	21	1.2

Table 75. Frequencies of Flaking Modes (%)

Level	Total	Harder f. mode		Softer f. mode	
XIV	17	1	(5.9)	16	(94.1)
XV	33	1	(3.0)	32	(97.0)
XVI	137	10	(7.3)	127	(92.7)
XVII	310	28	(9.0)	282	(91.0)
XVIII	128	18	(14.1)	110	(85.9)
XIX	186	19	(10.2)	167	(89.8)
XX	266	47	(17.7)	219	(82.3)
XXI	117	37	(31.6)	80	(68.4)
XXII	366	143	(39.1)	223	(60.9)
XXIII	116	36	(31.0)	80	(69.0)
XXIV	18	7	(38.9)	11	(61.1)
XXV	6	2	(33.3)	4	(66.7)

Table 76. Mean Values of Butt Thickness of Debitage Detached with Harder and Softer Flaking Modes

Level	Butt thickness (Harder)	Butt thickness (Softer)
XIV	Total: 1 Mean: 4.0 mm	Total: 16 Mean: 4.3 mm
XV	1 8.0 mm	32 4.8 mm
XVI	10 4.6 mm	127 3.0 mm
XVII	28 3.8 mm	282 2.2 mm
XVIII	18 3.6 mm	109 2.6 mm
XIX	19 4.5 mm	167 3.7 mm
XX	46 5.1 mm	219 4.3 mm
XXI	37 6.3 mm	80 5.1 mm
XXII	143 5.8 mm	221 5.5 mm
XXIII	35 5.2 mm	80 4.9 mm
XXIV	6 4.3 mm	11 4.3 mm
XXV	2 4.5 mm	4 3.5 mm

Table 77. Frequencies of Dorsal Scar Patterns of Debitage (%)

Level	Total	UN	BDO	CR	CNT	CRS	M
XIV	38	17 (44.7)	6 (15.8)	11 (29.0)	-	4 (10.5)	-
XV	80	40 (50.0)	9 (11.3)	30 (37.5)	-	1 (1.3)	-
XVI	384	121 (31.5)	112 (29.2)	107 (27.9)	3 (0.8)	40 (10.4)	1 (0.3)
XVII	685	161 (23.5)	250 (36.5)	156 (22.8)	-	118 (17.2)	-
XVIII	254	55 (21.7)	99 (39.0)	61 (24.0)	-	39 (15.4)	-
XIX	344	100 (29.1)	113 (32.9)	88 (25.6)	2 (0.6)	40 (11.6)	1 (0.3)
XX	513	168 (32.8)	176 (34.3)	104 (20.3)	2 (0.4)	63 (12.3)	-
XXI	240	118 (49.2)	54 (22.5)	52 (21.7)	3 (1.3)	13 (5.4)	-
XXII	795	448 (56.4)	132 (16.6)	189 (23.8)	4 (0.5)	17 (2.1)	5 (0.6)
XXIII	270	110 (40.7)	70 (25.9)	89 (33.0)	-	1 (0.4)	-
XXIV	37	11 (29.7)	11 (29.7)	14 (37.8)	1 (2.7)	-	-
XXV	29	6 (20.7)	6 (20.7)	14 (48.3)	1 (3.5)	2 (6.9)	-

UN: Uni-directional
BDO: Bi-directional opposed
CR: Crossed
CNT: Centripetal
CRS: With the trace of cresting
M: Miscellaneous

Table 78. Frequencies of Scar Patterns of Cores (%)

Level	Total	UN	BDO	CR	CNT	SF	CRS	M
XIV	5	-	1 (20.0)	1 (20.0)	-	3 (60.0)	-	-
XV	6	3 (50.0)	-	3 (50.0)	-	-	-	-
XVI	37	9 (24.3)	10 (27.0)	15 (40.5)	1 (2.7)	1 (2.7)	1 (2.7)	-
XVII	188	46 (24.5)	82 (43.6)	42 (22.3)	2 (1.1)	2 (1.1)	13 (6.9)	1 (0.5)
XVIII	43	11 (25.6)	18 (41.9)	7 (16.3)	-	1 (2.3)	2 (4.7)	4 (9.3)
XIX	140	37 (26.4)	51 (36.4)	42 (30.0)	3 (2.1)	3 (2.1)	1 (0.7)	3 (2.1)
XX	181	80 (44.2)	60 (33.1)	25 (13.8)	1 (0.6)	7 (3.9)	3 (1.7)	5 (2.8)
XXI	75	51 (68.0)	12 (16.0)	9 (12.0)	2 (2.7)	-	-	1 (1.3)
XXII	147	67 (45.6)	31 (21.1)	40 (27.2)	2 (1.4)	2 (1.4)	2 (1.4)	3 (2.0)
XXIII	110	35 (31.8)	36 (32.7)	38 (34.5)	-	-	-	1 (0.9)
XXIV	47	11 (23.4)	18 (38.3)	12 (25.5)	2 (4.3)	-	-	4 (8.5)
XXV	23	4 (17.4)	6 (26.1)	8 (34.8)	4 (17.4)	-	1 (4.3)	-

UN: Uni-directional
BDO: Bi-directional opposed
CR: Crossed
CNT: Centripetal
SF: Of a single flake scar
CRS: With the trace of cresting
M: Miscellaneous

Table 79 shows the frequencies of striking platform location on cores with several striking platforms. Opposed striking platforms are the most common throughout the sequence. Crossed platforms are quite common in Levels XXV, XXIV, and XVI, but are rare in Levels XIX to XVII. Peripheral striking platforms occur in Levels XXII, XXI, XIX, and XVII only.

The mean numbers of dorsal scars on cortical debitage, partially-cortical debitage, non-cortical (non-Levallois) flakes, and crested debitage range from 3.8 to 6.1. The scar counts are higher in Levels XX to XVII (5.5, 5.5, 6.0, and 6.1, respectively), which may be explained by more frequent occurrences of crested debitage in these levels. The mean numbers of dorsal scars on Levallois debitage (flakes, blades, and points), flake-blades, blades, and bladelets range from 4.5 to 6.1. Except in Levels XXV (6.1), XXIII (4.5), XXII (4.5), and XV (4.6), there is no clear difference in the mean values which range from 5.2 to 5.5. The dorsal scars of this latter group of debitage are slightly more than those of the former, most probably reflecting different stages of core reductions.

Table 80 shows the means for *angle de chasse* and *angle d'éclatement*, as well as the mean totals of the two angles. The largest mean *angle de chasse* is 84.6° in Level XIV and the smallest is 77.8° in Level XVII, whereas the largest mean *angle d'éclatement* is 101.8° in Level XVII and the smallest is 90.5° in Level XXIII. It is interesting that there is a clear break in the mean totals of the two angles between Levels XXI and XX; in Levels XXV to XXI they are considerably smaller than those in Levels XX to XIV which are concentrated around 180°.

Dorsal planes of debitage are most often Two in number. The frequencies of One range from 0.0% to 42.9%, those of Two range from 57.1% to 76.9%, and those of Three range from 0.0% to 37.5%.

Turning to the dorsal shapes of debitage, we find that the parallel shape gradually increases from Level XXIV onwards until it reaches a peak in Level XVIII, whereas the converging shape shows the opposite trend; from Level XXIV onwards it gradually decreases and becomes least frequent in Levels XVIII to XVI (Table 81). The expanding dorsal shape shows the same trend as the parallel dorsal shape.

The blunt distal shape of debitage is dominant in Levels XXI to XIV, whereas the pointed shape is more common in Levels XXIII and XXII (Table 82).

Except in Level XXV where the shapes of the final flake scars on the cores are often converging, the parallel shapes are always more frequent, especially in Levels XXI to XV (Table 83). In Levels XXIII and XXII, however, converging shapes are more numerous than in the other levels.

The distal shapes of final flake scars on the cores are most often blunt, especially from Level XXII onwards (Table 84). Pointed distal shapes, on the other hand, are a little more frequent in Levels XXV to

Table 79. Frequencies of Locations of Striking Platforms of Cores (%)

Level	Total	OP	ORP	OAP	CR	PPH	ALT	M
XIV	4	1 (25.0)	-	-	1 (25.0)	-	2 (50.0)	-
XV	4	-	-	-	2 (50.0)	-	2 (50.0)	-
XVI	22	6 (27.3)	3 (13.6)	4 (18.2)	5 (22.7)	-	1 (4.5)	3 (13.6)
XVII	132	46 (34.8)	19 (14.4)	12 (9.1)	12 (9.1)	1 (0.8)	11 (8.3)	31 (23.5)
XVIII	35	6 (17.1)	8 (22.9)	2 (5.7)	-	-	5 (14.3)	14 (40.0)
XIX	106	29 (27.4)	12 (11.3)	11 (10.4)	9 (8.5)	2 (1.9)	13 (12.3)	30 (28.3)
XX	96	22 (22.9)	10 (10.4)	21 (21.9)	13 (13.5)	-	13 (13.5)	17 (17.7)
XXI	26	10 (38.5)	3 (11.5)	4 (15.4)	3 (11.5)	1 (3.8)	4 (15.4)	1 (3.8)
XXII	58	19 (32.8)	7 (12.1)	5 (8.6)	10 (17.2)	1 (1.7)	14 (24.1)	2 (3.4)
XXIII	54	18 (33.3)	9 (16.7)	5 (9.3)	7 (13.0)	-	8 (14.8)	7 (13.0)
XXIV	30	11 (36.7)	3 (10.0)	5 (16.7)	9 (30.0)	-	-	2 (6.7)
XXV	12	6 (50.0)	1 (8.3)	-	5 (41.7)	-	-	-

OP: Opposed
ORP: Opposite rectangular
OAP: Opposite alternate
CR: Crossed
PPH: Peripheral
ALT: Alternating
M: Miscellaneous

Table 80. Mean Values of Flaking Angles (Degrees)

Level	Total of Samples	AC	AE	AC + AE
XIV	16	84.6	96.8	181.4
XV	24	81.0	98.9	179.9
XVI	107	80.4	101.1	181.5
XVII	184	77.8	101.8	179.6
XVIII	86	81.9	97.4	179.3
XIX	144	83.4	96.0	179.4
XX	368	82.9	97.2	180.1
XXI	181	79.4	97.8	177.2
XXII	616	80.2	95.7	175.9
XXIII	180	81.4	90.5	171.9
XXIV	24	83.6	94.3	177.9
XXV	8	78.9	94.9	173.8

AC: *Angle de chasse*
AE: *Angle d'éclatement*

Table 81. Frequencies of Dorsal Shapes of Debitage

Level	Total	Parallel	Converging	Expanding
XIV	22	18: 81.8%	3: 13.6%	1: 4.5%
XV	28	19: 67.9%	8: 28.6%	1: 3.6%
XVI	185	139: 75.1%	16: 8.6%	30: 16.2%
XVII	377	283: 75.1%	34: 9.0%	60: 15.9%
XVIII	152	121: 79.6%	13: 8.6%	18: 11.8%
XIX	192	147: 76.6%	25: 13.0%	20: 10.4%
XX	402	264: 65.7%	114: 28.4%	24: 6.0%
XXI	188	104: 55.3%	76: 40.4%	8: 4.3%
XXII	651	278: 42.7%	352: 54.1%	21: 3.2%
XXIII	205	70: 34.1%	118: 57.6%	17: 8.3%
XXIV	26	8: 30.8%	15: 57.7%	3: 11.5%
XXV	8	5: 62.5%	3: 37.5%	

Table 82. Frequencies of Distal Shapes of Debitage (%)

Level	Total	Blunt	Pointed
XIV	22	19 (86.4)	3 (13.6)
XV	28	22 (78.6)	6 (21.4)
XVI	185	174 (94.1)	11 (5.9)
XVII	377	335 (88.9)	42 (11.1)
XVIII	152	135 (88.8)	17 (11.2)
XIX	192	162 (84.4)	30 (15.6)
XX	402	316 (78.6)	86 (21.4)
XXI	188	144 (76.6)	44 (23.4)
XXII	651	298 (45.8)	353 (54.2)
XXIII	200	91 (45.5)	109 (54.5)
XXIV	24	13 (54.2)	11 (45.8)
XXV	8	7 (87.5)	1 (12.5)

Table 83. Frequencies of Shapes of Final Flake Scars on Cores (%)

Level	Total	Parallel	Converging	Expanding
XIV	7	4 (57.1)	-	3 (42.9)
XV	8	6 (75.0)	1 (12.5)	1 (12.5)
XVI	57	43 (75.4)	9 (15.8)	5 (8.8)
XVII	299	227 (75.9)	40 (13.4)	32 (10.7)
XVIII	69	50 (72.5)	10 (14.5)	9 (13.0)
XIX	197	153 (77.7)	24 (12.2)	20 (10.2)
XX	251	168 (66.9)	45 (17.9)	38 (15.1)
XXI	99	73 (73.7)	15 (15.2)	11 (11.1)
XXII	193	104 (53.9)	52 (26.9)	37 (19.2)
XXIII	150	71 (47.3)	40 (26.7)	39 (26.0)
XXIV	46	26 (56.5)	9 (19.6)	11 (23.9)
XXV	25	7 (28.0)	11 (44.0)	7 (28.0)

Table 84. Frequencies of Distal Shapes of Final Flake Scars on Cores (%)

Level	Total	Blunt	Pointed
XIV	7	6 (85.7)	1 (14.3)
XV	8	6 (75.0)	2 (25.0)
XVI	57	52 (91.2)	5 (8.8)
XVII	299	273 (91.3)	26 (8.7)
XVIII	69	57 (82.6)	12 (17.4)
XIX	197	179 (90.9)	18 (9.1)
XX	251	223 (88.8)	28 (11.2)
XXI	98	84 (85.7)	14 (14.3)
XXII	193	147 (76.2)	46 (23.8)
XXIII	150	115 (76.7)	35 (23.3)
XXIV	46	37 (80.4)	9 (19.6)
XXV	28	20 (71.4)	8 (28.6)

XXII, and XV.

The overall shapes of cores are mainly parallel in Levels XXV, XXIV, and XX to XVI. In Levels XXIII to XXI, however, converging shapes occur about as often as parallel shapes (Table 85). It appears that the overall shapes of cores influenced the dorsal shapes of debitage and that parallel shapes of debitage were closely associated with blunt distal shapes, while converging shapes of debitage were associated with pointed distal shapes.

As to the mean numbers of striking platforms directly related to negative points of percussion, there is no clear change throughout the sequence (ranging from 1.4 to 1.7), and there is no clear change in the mean numbers of flake scars starting from one and the same striking platforms (ranging from 2.2 to 3.5).

The backs of cores are mainly cortical throughout the sequence, but this cortical core back becomes relatively rarer in Levels XVIII and XVII (Table 86).

Cores on flakes are more numerous in Levels XXV and XXII to XX than in the other levels (Table 87).

There is no remarkable difference in the mean numbers of parallel or sub-parallel ridges on the blades and bladelets. Except in Level XIV where the mean value is 1.4, the means range from 1.8 to 2.1 in Levels XXV to XV.

In all of the levels, the flaking order patterns on Levallois points, flake-blades, blades, and bladelets are most often A (from 46.2% to 57.4%), less often B (from 28.6% to 40.5%) and least frequently C (from 7.5% to 23.1%).

The locations of points of percussion on Levallois debitage, flake-blades, blades, and bladelets show inverse change through the sequence; within Levels XXIII to XVI, Type A, in which the point of percussion lies directly behind a clear ridge, increases gradually and becomes most numerous in Levels XVII and XVI, whereas Type C, in which the point of percussion is situated at the midpoint between two clear ridges, decreases gradually and becomes least frequent in Levels XVII and XVI (Table 88).

Table 89 shows the distribution of Pseudo-Levallois points, naturally-backed debitage, change of orientation debitage, core tablets, traces of hinging removal, traces of re-cresting, and traces of heat alteration. Three things are worthy to note: core tablets occur in Levels XXII to XVII only; within Levels XXIII to XIX hinging removal from the opposite direction increases gradually and in Level XVIII becomes most frequent; and re-cresting suddenly increases in Level XX and is most common in Level XVII.

Within Levels XXIII to XIX, Levallois debitage (flakes, blades, and points) gradually decreases and suddenly becomes rare in Level XVIII, most probably due to the sudden decrease in blade and point types (Table 90).

Table 85. Frequencies of Overall Shapes of Cores (%)

Level	Total	Parallel	Converging	Expanding	Miscellaneous
XIV	4	3 (75.0)	-	1 (25.0)	-
XV	5	3 (60.0)	2 (40.0)	-	-
XVI	31	18 (58.1)	8 (25.8)	-	5 (16.1)
XVII	164	99 (60.4)	33 (20.1)	3 (1.8)	29 (17.7)
XVIII	38	23 (60.5)	5 (13.2)	-	10 (26.3)
XIX	123	78 (63.4)	24 (19.5)	2 (1.6)	19 (15.4)
XX	160	70 (43.8)	48 (30.0)	-	42 (26.3)
XXI	68	29 (42.6)	29 (42.6)	-	10 (14.7)
XXII	135	65 (48.1)	61 (45.2)	2 (1.5)	7 (5.2)
XXIII	105	47 (44.8)	50 (47.6)	-	8 (7.6)
XXIV	39	26 (66.7)	12 (30.8)	-	1 (2.6)
XXV	21	12 (57.1)	4 (19.0)	4 (19.0)	1 (4.8)

Table 86. Type Frequencies of Backs of Cores (%)

Level	Total	C	SP	CP	FS	CRS	M
XIV	4	-	-	-	1 (25.0)		3 (75.0)
XV	5	3 (60.0)	-	-	2 (40.0)	-	-
XVI	31	12 (38.7)	1 (3.2)	-	6 (19.4)	-	12 (38.7)
XVII	164	53 (32.3)	3 (1.8)	1 (0.6)	32 (19.5)	4 (2.4)	71 (43.3)
XVIII	38	10 (26.3)	-	-	7 (18.7)	1 (2.6)	20 (52.6)
XIX	123	48 (39.0)	2 (1.6)	1 (0.8)	32 (26.0)	-	40 (32.5)
XX	160	65 (40.6)	3 (1.9)	2 (1.3)	31 (19.4)	-	59 (36.9)
XXI	68	36 (52.9)	1 (1.5)	3 (4.4)	12 (17.6)	-	16 (23.5)
XXII	135	77 (57.0)	-	3 (2.2)	21 (15.6)	-	34 (25.2)
XXIII	105	57 (54.3)	2 (1.9)	-	23 (21.9)	-	23 (21.9)
XXIV	39	18 (46.2)	5 (12.8)	2 (5.1)	-	-	14 (35.9)
XXV	21	14 (66.7)	-	-	5 (23.8)	-	2 (9.5)

C: Cortex
SP: Striking platforms only
CP: Core preparation
FS: Flake scars
CRS: Cresting
M: Miscellaneous

Table 87. Frequencies of Cores on Flakes

Level	Total of cores	Cores on flakes
XIV	4	-
XV	5	-
XVI	31	2: 6.5%
XVII	164	4: 2.4%
XVIII	38	2: 5.3%
XIX	123	6: 4.9%
XX	160	13: 8.1%
XXI	68	10: 14.7%
XXII	135	13: 9.6%
XXIII	105	4: 3.8%
XXIV	39	2: 5.1%
XXV	21	3: 14.3%

Table 88. Frequencies of Locations of Points of Percussion

Level	Total	A	B	C
XIV	22	8: 36.4%	14: 63.6%	-
XV	25	7: 28.0%	13: 52.0%	5: 20.0%
XVI	175	98: 56.0%	66: 37.7%	11: 6.3%
XVII	352	194: 55.1%	135: 38.4%	23: 6.5%
XVIII	137	69: 50.4%	54: 39.4%	14: 10.2%
XIX	175	64: 36.6%	87: 49.7%	24: 13.7%
XX	389	133: 34.2%	184: 47.3%	72: 18.5%
XXI	183	59: 32.2%	88: 48.1%	36: 19.7%
XXII	636	190: 29.9%	293: 46.1%	153: 24.1%
XXIII	188	40: 21.3%	95: 50.5%	53: 28.2%
XXIV	26	7: 26.9%	13: 50.0%	6: 23.1%
XXV	8	2: 25.0%	6: 75.0%	-

Table 89. Frequencies of Pseudo-Levallois Points, Naturally-backed Debitage, Change of Orientation Debitage, Core Tablets, Debitage with Traces of Hinging Removal, Re-crested Debitage, and Debitage with Traces of Heat Alteration (%)

Level	Total	PL	NB	CO	CT	HRS	HRO	RC	H
XIV	40	1 (2.5)	-	1 (2.5)	-	7 (17.5)	-	3 (7.5)	1 (2.5)
XV	84	4 (4.8)	1 (1.2)	2 (2.4)	-	10 (11.9)	1 (1.2)	-	9 (10.7)
XVI	394	8 (2.0)	6 (1.5)	4 (1.0)		49 (12.4)	14 (3.6)	8 (2.0)	22 (5.6)
XVII	690	5 (0.7)	5 (0.7)	11 (1.6)	4 (0.6)	58 (8.4)	20 (2.9)	41 (5.9)	41 (5.9)
XVIII	259	6 (2.3)	2 (0.8)	3 (1.2)	-	21 (8.1)	14 (5.4)	7 (2.7)	14 (5.4)
XIX	360	3 (0.8)	8 (2.2)	7 (1.9)	1 (0.3)	44 (12.2)	6 (1.7)	8 (2.2)	18 (5.0)
XX	556	12 (2.2)	11 (2.0)	4 (0.7)	-	69 (12.4)	8 (1.4)	13 (2.3)	9 (1.6)
XXI	256	9 (3.5)	6 (2.3)	1 (0.4)	1 (0.4)	24 (9.4)	4 (1.6)	2 (0.8)	11 (4.3)
XXII	871	19 (2.2)	11 (1.3)	7 (0.8)	1 (0.1)	64 (7.4)	4 (0.5)	5 (0.6)	73 (8.4)
XXIII	296	9 (3.0)	6 (2.0)	2 (0.7)	-	22 (7.4)	1 (0.3)	1 (0.3)	29 (9.8)
XXIV	41	1 (2.4)	-	1 (2.4)	-	2 (4.9)		-	2 (4.9)
XXV	29	1 (3.5)	1 (3.5)	2 (6.9)	-	-	-	-	1 (3.5)

PL: Pseudo-Levallois points
NB: Naturally-backed debitage
CO: Change of orientation debitage
CT: Core tablets
HRS: Hinging removal in the same direction
HRO: Hinging removal from opposite direction
RC: Re-crested debitage
H: Debitage with traces of heat alteration

Table 90. Frequencies of Levallois Debitage (%)

Level	Total of Debitage	L.F.	L.B.	L.P.	E.L.P.	Total
XIV	40	-	-	-	-	-
XV	84	3 (3.6)	2 (2.4)	1 (1.2)	1 (1.2)	7 (8.3)
XVI	394	6 (1.5)	2 (0.5)	1 (0.3)	-	9 (2.3)
XVII	690	-	4 (0.6)	-	1 (0.1)	5 (0.7)
XVIII	259	2 (0.8)	-	-	-	2 (0.8)
XIX	360	4 (1.1)	6 (1.7)	2 (0.6)	4 (1.1)	16 (4.4)
XX	556	1 (0.2)	13 (2.3)	2 (0.4)	24 (4.3)	40 (7.2)
XXI	256	8 (3.1)	7 (2.7)	3 (1.2)	6 (2.3)	24 (9.4)
XXII	871	6 (0.7)	28 (3.2)	21 (2.4)	59 (6.8)	114 (13.1)
XXIII	296	6 (2.0)	18 (6.1)	8 (2.7)	27 (9.1)	59 (19.9)
XXIV	41	1 (2.4)	1 (2.4)	-	2 (4.9)	4 (9.8)
XXV	29	-	1 (3.4)	-	-	1 (3.4)

L.F.: Levallois flakes
L.B.: Levallois blades
L.P.: Levallois points
E.L.P.: Elongated Levallois points ($L \geqq 2W$)

Table 91. Frequencies of Dorsal Scar Patterns of Levallois Flakes

Level	Total	Bi-directional opposed	Crossed	Centripetal
XV	3	-	3:100.0 %	
XVI	6	-	4: 66.7 %	2: 33.3 %
XVIII	2	-	2:100.0 %	-
XIX	4	-	3: 75.0 %	1: 25.0 %
XX	1	-	1:100.0 %	-
XXI	8	-	5: 62.5 %	3: 37.5 %
XXII	6	-	5: 83.3 %	1: 16.7 %
XXIII	6	3: 50.0 %	3: 50.0 %	-
XXIV	1	-	-	1:100.0 %

Table 92. Frequencies of Locations of Points of Percussion of Levallois Flakes

Level	Total	A	B	C
XV	2	-	2:100.0 %	-
XVI	6	1: 16.7 %	3: 50.0 %	2: 33.3 %
XVIII	2		1: 50.0 %	1: 50.0 %
XIX	4	1: 25.0 %	2: 50.0 %	1: 25.0 %
XX	1	-	1:100.0 %	-
XXI	8	2: 25.0 %	5: 62.5 %	1: 12.5 %
XXII	6	-	4: 66.7 %	2: 33.3 %
XXIII	6	1: 16.7 %	4: 66.7 %	1: 16.7 %
XXIV	1	-	-	1:100.0 %

Table 93. Frequencies of Dorsal Scar Patterns of Levallois Blades

Level	Total	Bi-directional opposed	Crossed	Centripetal
XV	2	-	2:100.0 %	-
XVI	2	-	1: 50.0 %	1: 50.0 %
XVII	4	-	4:100.0 %	-
XIX	5	-	4: 80.0 %	1: 20.0 %
XX	13	-	11: 84.6 %	2: 15.4 %
XXI	7	-	7:100.0 %	-
XXII	28	6: 21.4 %	19: 67.9 %	3: 10.7 %
XXIII	18	7: 38.9 %	11: 61.1 %	-
XXIV	1	-	1:100.0 %	-
XXV	1	-	-	1:100.0 %

Table 94. Frequencies of Locations of Points of Percussion of Levallois Blades

Level	Total	A	B	C
XV	2	1: 50.0 %	1: 50.0 %	-
XVI	2	-	2:100.0 %	-
XVII	4	1: 25.0 %	2: 50.0 %	1: 25.0 %
XIX	6	3: 50.0 %	3: 50.0 %	-
XX	11	2: 18.2 %	8: 72.7 %	1: 9.1 %
XXI	6	1: 16.7 %	4: 66.7 %	1: 16.7 %
XXII	27	2: 7.4 %	16: 59.3 %	9: 33.3 %
XXIII	16	2: 12.5 %	5: 31.3 %	9: 56.3 %
XXIV	1	-	-	1:100.0 %
XXV	1	-	1:100.0 %	-

Table 95. Frequencies of Dorsal Scar Patterns of Levallois Points

Level	Total	UN	BDO	CR	CRS
XV	2	2:100.0 %	-	-	-
XVI	1	1:100.0 %	-	-	-
XVII	1	1:100.0 %	-	-	-
XIX	6	3: 50.0 %	1: 16.7 %	2: 33.3 %	-
XX	26	17: 65.4 %	4: 15.4 %	4: 15.4 %	1: 3.8 %
XXI	9	5: 55.6 %	2: 22.2 %	2: 22.2 %	-
XXII	76	63: 82.9 %	5: 6.6 %	7: 9.2 %	1: 1.3 %
XXIII	35	24: 68.6 %	5: 14.3 %	6: 17.1 %	-
XXIV	2	2:100.0 %	-	-	-

UN: Uni-directional
BDO: Bi-directional opposed
CR: Crossed
CRS: With the trace of cresting

Table 96. Frequencies of Locations of Points of Percussion of Levallois Points

Level	Total	A	B	C
XV	2	-	-	2:100.0 %
XVI	1		-	1:100.0 %
XVII	1	1:100.0 %	-	-
XIX	6	-	-	6:100.0 %
XX	26	4: 15.4 %	11: 42.3 %	11: 42.3 %
XXI	9	2: 22.2 %	3: 33.3 %	4: 44.4 %
XXII	80	15: 18.8 %	21: 26.3 %	44: 55.0 %
XXIII	34	4: 11.8 %	14: 41.2 %	16: 47.1 %
XXIV	2	1: 50.0 %	1: 50.0 %	-

In Levels XXIII and XXII, the higher frequencies of Levallois debitage (especially of point type) are noteworthy. There seem to be no distinct butt types of Levallois flakes through the sequence. The dorsal scar patterns on the Levallois flakes are mainly crossed or centripetal (Table 91), and the locations of points of percussion are mainly B (Table 92). The Levallois blades occur more frequently in Levels XXIII, XXII, and XX, and their butts are mainly convex dihedral faceted, straight multiple faceted, or convex multiple faceted. Their dorsal scar patterns are mainly crossed or centripetal (Table 93), and the locations of points of percussion are mainly B (Table 94). The Levallois points are more numerous in Levels XXIII and XXII, and their butts are mainly plain, convex dihedral faceted, or convex multiple faceted. Their dorsal scar patterns are chiefly uni-directional (Table 95), and the locations of points of percussion are mainly C (Table 96). It is worthy to note that the Levallois points, especially those from Levels XXIV to XIX, are generally elongated (Table 90). In principle, Levallois points may be restricted to those with C-type location of points of percussion, in which the percussion points lie between two clear ridges, though they are not so restricted in this study.

As mentioned previously, Levallois cores in their final forms occur within Levels XXV to XX only (Table 62). The presence of Levallois debitage from Level XIX onwards, where no Levallois cores are found, may be explained by one or both of the following possibilities: (1) much of the Levallois debitage was produced during the reduction of ordinary (non-Levallois) cores or (2) Levallois cores were converted to other types of cores.

ASSEMBLAGES OF RETOUCHED PIECES

Judging from the cumulative graphs showing the frequencies of the 38 categories of retouched pieces (Figs. 78 to 82), there seem to be at least three groups of levels with distinct sets of retouched pieces: Levels XXIII to XXI, Levels XX to XVIII, and Levels XVII and XVI.

(1) Levels XXV and XXIV (Fig. 78)

Although there are very few retouched pieces from these levels, it may be seen that chamfered pieces and pieces with continuous direct retouch characterize these levels.

(2) Levels XXIII to XXI (Fig. 79)

These levels are characterized by end-scrapers, chamfered pieces, burins on retouched truncation, and burins on lateral preparation. The burins on retouched truncation are more numerous than those on lateral preparation. Level XXIII has fewer end-scrapers than the other two levels, but it is the richest level in chamfered pieces, resembling in this respect Levels XXV, XXIV, XXII, and XXI.

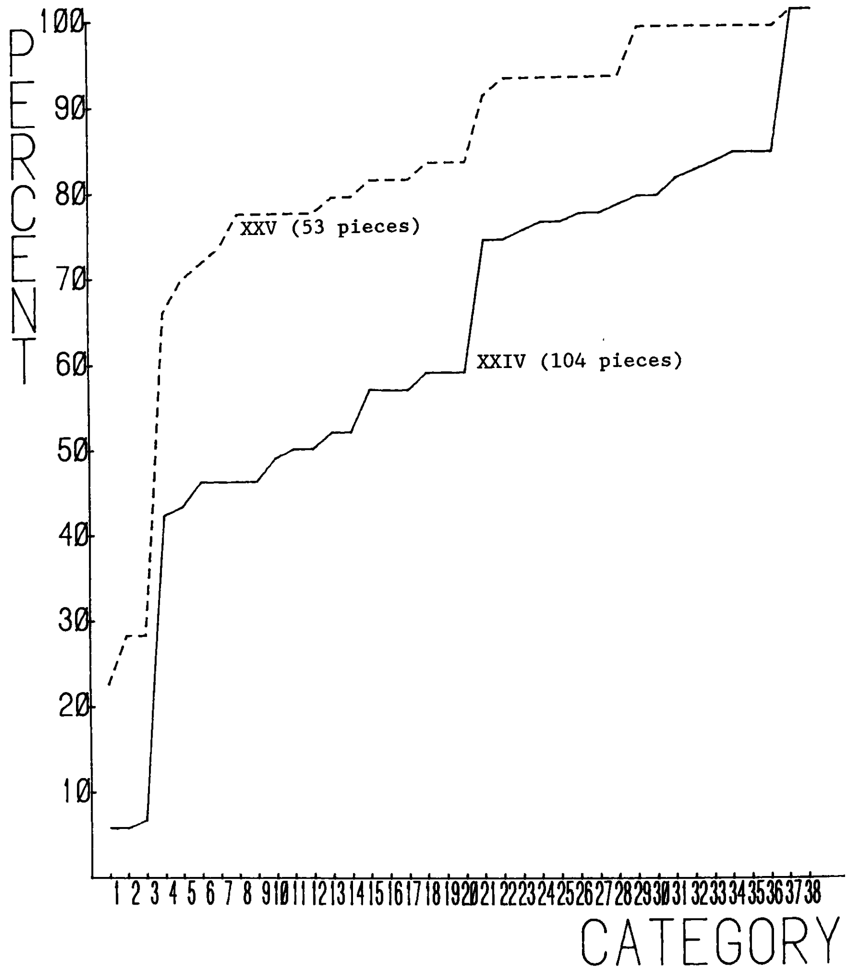


Fig. 78. Cumulative graph of retouched pieces from Levels XXV and XXIV

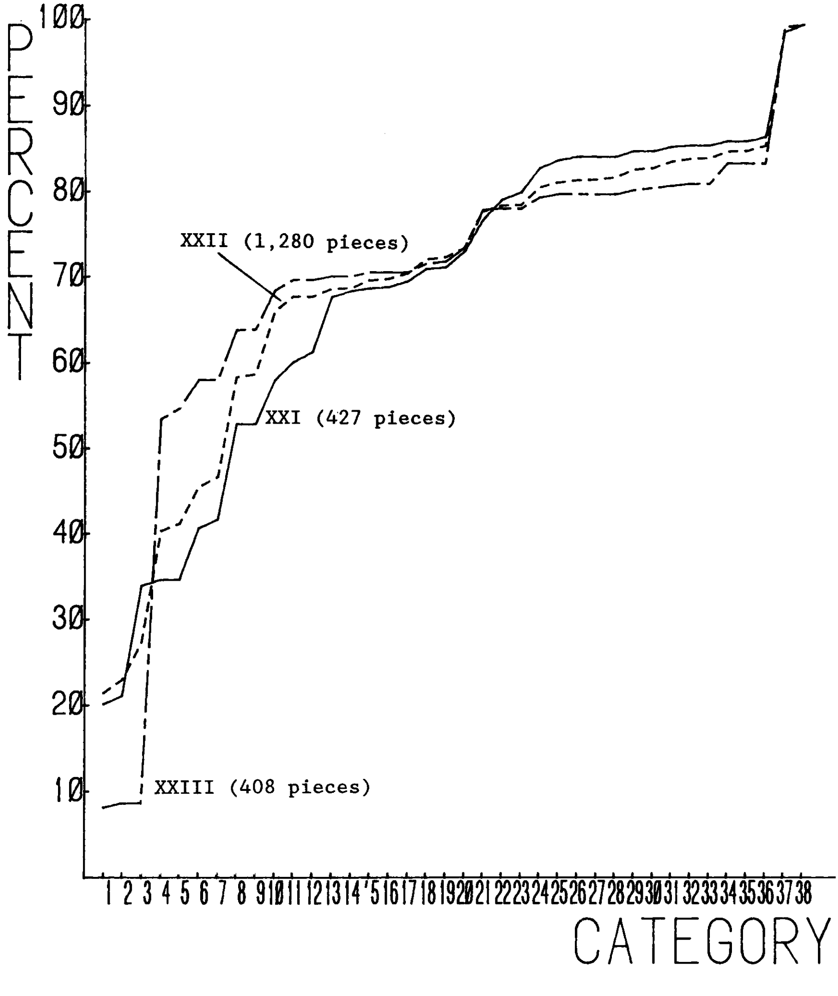


Fig. 79. Cumulative graph of retouched pieces from Levels XXIII to XXI

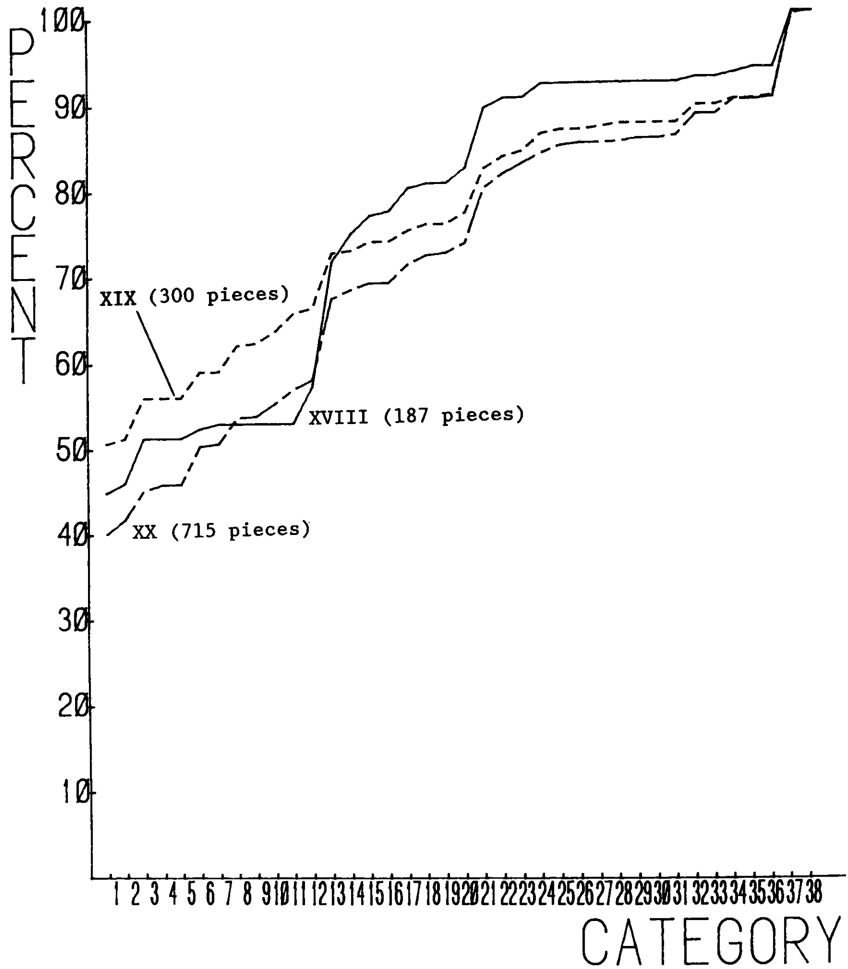


Fig. 80. Cumulative graph of retouched pieces from Levels XX to XVIII

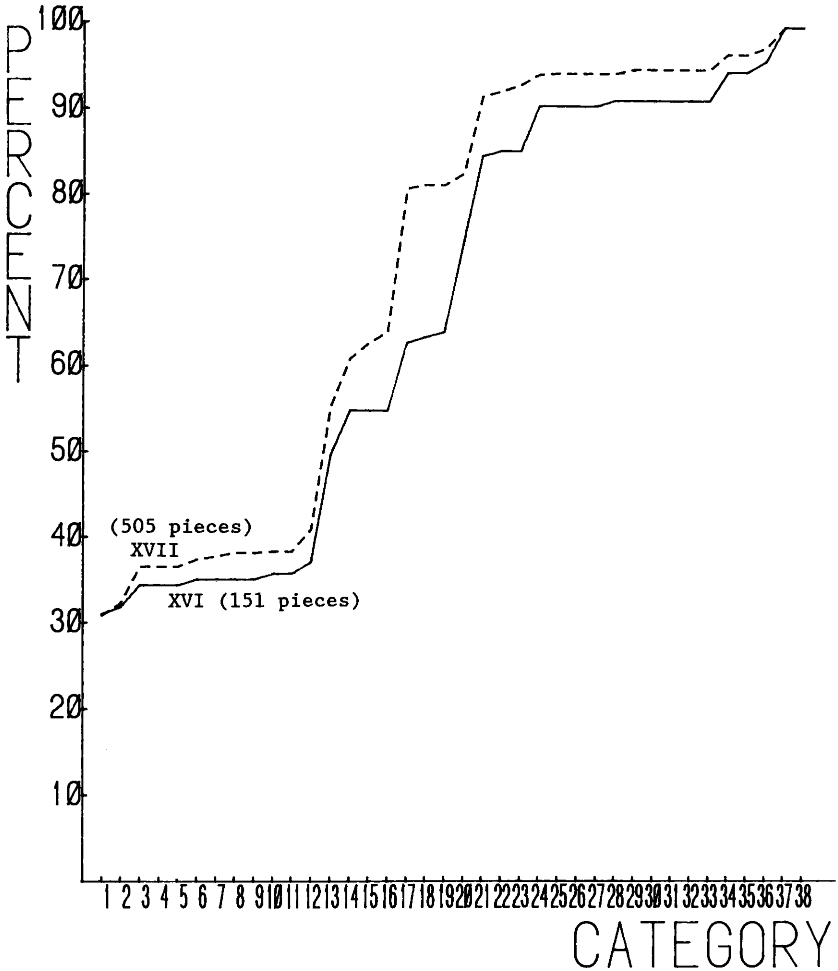


Fig. 81. Cumulative graph of retouched pieces from Levels XVII and XVI

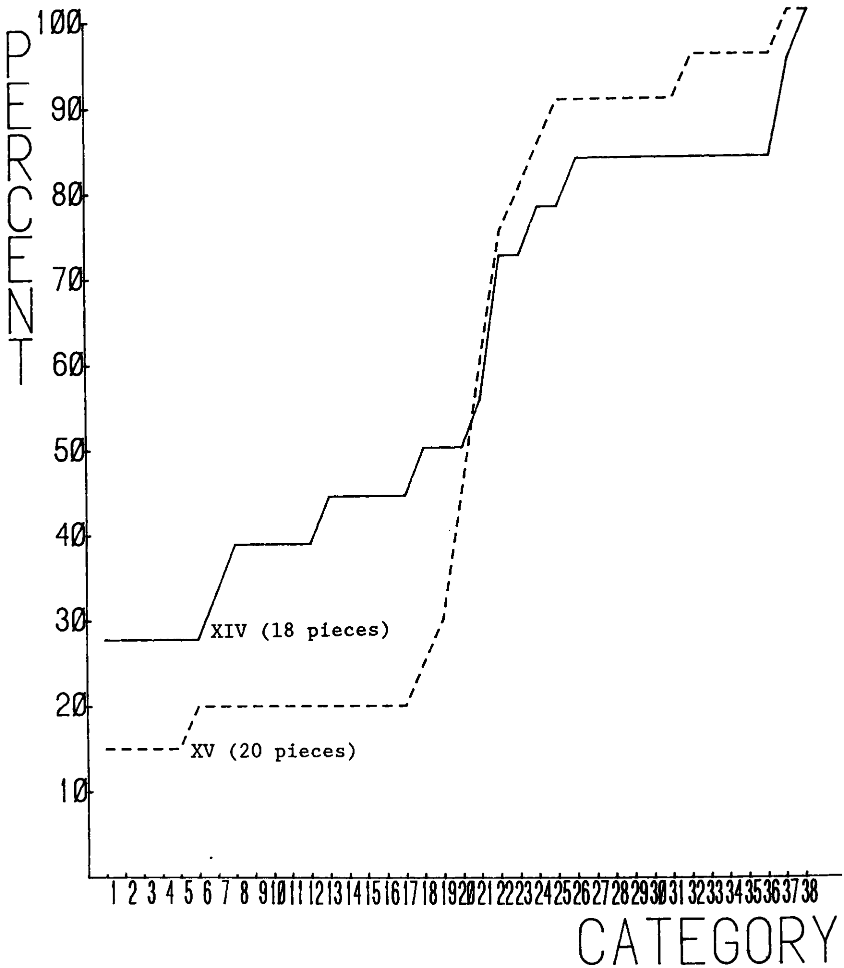


Fig. 82. Cumulative graph of retouched pieces from Levels XV and XIV

(3) Levels XX to XVIII (Fig. 80)

These levels are characterized by very high frequencies of end-scrapers (highest in Level XIX), end-scrapers on retouched blanks, backed pieces, and pieces with continuous direct retouch. Backed pieces are most numerous in Level XVIII, and in all of these three levels partially-backed pieces are dominant.

(4) Levels XVII and XVI (Fig. 81)

These levels are characterized by many end-scrapers, backed pieces, Ksar Akil points, and pieces with continuous direct retouch. Backed pieces occur most frequently in Level XVII, and the backing is most often partial in both of the levels. Ksar Akil points, which already appear in Level XXII in small numbers, suddenly become very numerous in Level XVII.

(5) Levels XV and XIV (Fig. 82)

Although very few retouched pieces were derived from these levels, it seems that end-scrapers, notched pieces, and pieces with continuous direct retouch characterize these levels. These levels, however, seem to have no clear typological connection with the preceding levels, judging from the cumulative graphs of retouched pieces.

It is interesting to note the frequency changes of point types through the sequence (Table 97). Unretouched Levallois points, which may be regarded to have been tools or weapons, gradually decrease from Level XXIV to Level XIX and suddenly become much rarer from Level XVIII onwards. Retouched Levallois points gradually decrease from Level XXIV to Level XX and are absent from Level XIX onwards. Mousterian points occur in Levels XXIII and XXII only. Ksar Akil points first appear in Level XXII and continue to occur in small quantities until they suddenly become very numerous in Level XVII.

The occurrences of these four types of points may suggest that within Levels XXII to XVIII Ksar Akil points gradually increase while unretouched and retouched Levallois points decrease and finally drop out in Levels XVII and XVI. A similar observation was published by Bergman in 1981.

In spite of sharp frequency changes in some of the retouched pieces, such as the sudden decrease of chamfered pieces in Level XXI and sudden increase of Ksar Akil points in Level XVII, Levels XXV to XVI seem to represent a continuous and unbroken sequence in the "totals and proportions of type frequencies" (Bordes, 1960: p.109). Certain retouched pieces bridge adjoining levels: chamfered pieces occur in Levels XXV to XX; retouched Levallois points decrease gradually within Levels XXIV to XX; end-scrapers change in frequencies in Levels XX to XVI; backed pieces occur frequently in Levels XVIII and XVII as do Ksar Akil points in Levels XXII to XVI.

Table 98 shows the frequencies of blank classes for the retouched pieces through the sequence. Non-cortical flakes as the blanks gradually decrease within Levels XXIV to XXII. Flake-blades also

Table 97. Frequencies of Unretouched Levallois Points, Retouched Levallois Points, Mousterian Points, *Pointes à Face Plane*, and Ksar Akil Points (%)

Level	Total of Retouched Pieces	URLP	RLP	MP	PFP	KAP
XIV	18	-		-		-
XV	20	2 *(2.4)	-		-	-
XVI	151	1 *(0.3)	-	-	-	12 (8.0)
XVII	505	1 *(0.1)	-	-	7 (1.4)	85 (16.8)
XVIII	187		-	-	1 (0.5)	5 (2.7)
XIX	300	6 *(1.7)	-	-	-	4 (1.3)
XX	715	26 *(4.7)	2 (0.3)	-	-	15 (2.1)
XXI	427	9 *(3.5)	2 (0.5)	-	1 (0.2)	3 (0.7)
XXII	1,280	80 *(9.2)	10 (0.8)	3 (0.2)	1 (0.1)	9 (0.7)
XXIII	408	35 *(11.8)	1 (0.3)	1 (0.3)	-	-
XXIV	104	2 *(4.9)	2 (1.9)	-	-	-
XXV	53	-	-	-	-	-

URLP: Unretouched Levallois points
RLP: Retouched Levallois points
MP: Mousterian points
PFP: *Pointes à face plane*
KAP: Ksar Akil Points
*( ): Percentages of unretouched Levallois points were calculated in the totals of debitage and not in the totals of retouched pieces

Table 98. Frequencies of Blank Classes for Retouched Pieces (%)

Level	Total	1	2	31	32	33	34	4	5	6	7	8
XIV	18	-	-	3 (16.7)	8 (44.4)	4 (22.2)	1 (5.6)	2 (11.1)	-	-	-	-
XV	20	-	1 (5.0)	10 (50.0)	2 (10.0)	1 (5.0)	-	1 (5.0)	1 (5.0)	4 (20.0)	-	-
XVI	150	2 (1.3)	22 (14.7)	21 (14.0)	23 (15.3)	40 (26.7)	25 (16.7)	10 (6.7)	7 (4.7)	-	-	-
XVII	505	14 (2.8)	72 (14.3)	40 (7.9)	80 (15.8)	177 (35.0)	51 (10.1)	50 (9.9)	19 (3.8)	2 (0.4)	-	-
XVIII	187	5 (2.7)	39 (20.9)	28 (15.0)	35 (18.7)	44 (23.5)	16 (8.6)	8 (4.3)	2 (1.1)	9 (4.8)	-	1 (0.5)
XIX	300	9 (3.0)	68 (22.7)	44 (14.7)	61 (20.3)	66 (22.0)	25 (8.3)	13 (4.3)	4 (1.3)	6 (2.0)	4 (1.3)	-
XX	714	25 (3.5)	134 (18.8)	132 (18.5)	169 (23.7)	158 (22.1)	33 (4.6)	29 (4.1)	10 (1.4)	14 (2.0)	10 (1.4)	-
XXI	427	15 (3.5)	88 (20.6)	91 (21.3)	113 (26.5)	73 (17.1)	22 (5.2)	4 (0.9)	1 (0.2)	18 (4.2)	2 (0.5)	-
XXII	1265	43 (3.4)	212 (16.7)	381 (30.1)	354 (28.0)	179 (14.2)	19 (1.5)	23 (1.8)	5 (0.4)	37 (2.9)	12 (1.0)	-
XXIII	396	9 (2.3)	59 (14.9)	167 (42.2)	106 (26.8)	26 (6.6)	6 (1.5)	11 (2.8)	3 (0.8)	5 (1.3)	1 (0.3)	3 (0.8)
XXIV	96	1 (1.0)	10 (10.4)	44 (45.8)	32 (33.3)	3 (3.1)	1 (1.0)	4 (4.2)	-	-	-	1 (1.0)
XXV	46	1 (2.2)	17 (37.0)	17 (37.0)	7 (15.2)	2 (4.3)	1 (2.2)	1 (2.2)	-	-	-	-

1: Cortical debitage 2: Partially-cortical debitage
31: Non-cortical flakes 32: Flake-blades
33: Blades 34: Bladelets
4: Crested debitage 5: Cores
6: Older debitage 7: Natural stones
8: Debris

gradually decrease within Levels XXIV to XV. Blades, on the other hand, gradually increase within Levels XXIV to XVI and are most numerous in Level XVII. Bladelets suddenly increase in Level XIX and are most numerous in Level XVI. Crested debitage and cores as the blanks are rather common in Levels XVII and XVI.

Table 99 shows the distribution of blank classes for the main categories of retouched pieces. End-scrapers in Levels XXV to XXII are made chiefly on partially-cortical debitage, non-cortical flakes, and flake-blades, but in Levels XXI to XVI they are chiefly made on partially-cortical debitage except for Levels XIX, XVII, and XVI in which they are also frequently made on blades. Chamfered pieces in Levels XXV to XXII are mainly made on non-cortical flakes and flake-blades. Burins on retouched truncation in Levels XXII and XXI are made chiefly on partially-cortical debitage and flake-blades. Partially-backed pieces in Levels XIX to XVI are most often made on blades and bladelets; Ksar Akil points in Level XVII are made chiefly on blades, whereas in Level XVI they are made on bladelets.

The Levallois debitage as the blanks for retouched pieces gradually decreases within Levels XXIII to XVIII and is almost negligible in Levels XVII and XVI, while the naturally-backed debitage as blanks occurs in almost the same frequencies in Levels XXIV to XVIII, decreasing in Levels XVII and XVI (Table 100).

The Levallois blanks were used mainly for chamfered pieces in Levels XXIII and XXII, for burins on lateral preparation or pieces with continuous direct retouch in Level XXII, and for end-scrapers in Level XX. In Level XXIII, 8.7% of the 183 chamfered pieces are made on Levallois blanks (flakes (6), blades (2), and points (8)). In Level XXII, 4.9% of the 163 chamfered pieces are made on Levallois blanks (flakes (3) and blades (5)), 9.5% of the 95 burins on lateral preparation are made on Levallois blades (1) and points (8), and 16.4% of the 55 pieces with continuous direct retouch are on Levallois flakes (4) and blades (5). In Level XX, 3.8% of the 287 end-scrapers are made on Levallois blanks (flakes (6), blades (3), and points (2)).

The naturally-backed blanks were used mainly for chamfered pieces in Level XXIII (6.0% of the total of chamfered pieces), and in Levels XXII to XVII they were mainly used for end-scrapers: 5.5% (Level XXII), 9.3% (Level XXI), 3.5% (Level XX), 3.3% (Level XIX), 3.6% (Level XVIII), and 3.2% (Level XVII).

As to the frequencies of the harder and softer flaking modes for the blanks of retouched pieces, there is a break between Levels XXI and XX as was the case for the debitage. Although the softer flaking mode outnumbers the harder flaking mode throughout the sequence, there is no great difference between their occurrences within Levels XXV to XXI, while from Level XX onwards the former mode greatly increases as the latter mode decreases (Table 101).

HAMMERSTONES

Twenty-eight hammerstones were derived from Levels XXIII to XVII (Table 102). They are mainly flat (20: 74.1%) and their battering

Table 99. Frequencies of Blank Classes for Main Categories of Retouched Pieces (%)

Level/Retouched piece	1	2	31	32	33	34	4	5	6	7	Total
Level XVI											
End-scrapers	2 (4.3)	12 (25.5)	7 (14.9)	7 (14.9)	12 (25.5)	3 (6.4)	4 (8.5)	-	-	-	47
Partially-backed pieces	-	-	1 (5.6)	2 (11.1)	9 (50.0)	4 (22.2)	2 (11.1)	-	-	-	18
Ksar Akil points	-	-	-	3 (25.0)	3 (25.0)	6 (50.0)	-	-	-	-	12
Level XVII											
End-scrapers	11 (7.1)	38 (24.4)	22 (14.1)	20 (12.8)	37 (23.7)	1 (0.6)	24 (15.4)	1 (0.6)	2 (1.3)	-	156
Partially-backed pieces	-	6 (8.2)	1 (1.4)	14 (19.2)	32 (43.8)	14 (19.2)	6 (8.2)	-	-	-	73
Ksar Akil points	-	4 (4.7)	1 (1.2)	19 (22.4)	38 (44.7)	17 (20.0)	6 (7.1)	-	-	-	85
Level XVIII											
End-scrapers	4 (4.8)	27 (32.1)	20 (23.8)	13 (15.5)	10 (11.9)	1 (1.2)	3 (3.6)	-	6 (7.1)	-	84
Partially-backed pieces	-	2 (7.4)	-	3 (11.1)	15 (55.6)	6 (22.2)	1 (3.7)	-	-	-	27
Level XIX											
End-scrapers	2 (1.3)	40 (26.3)	28 (18.4)	29 (19.1)	34 (22.4)	5 (3.3)	10 (6.6)	1 (0.7)	2 (1.3)	1 (0.7)	152
Partially-backed pieces	-	1 (5.3)	-	4 (21.1)	9 (47.4)	5 (26.3)	-	-	-	-	19

(Contd.)

Table 99. (Continued)

Level/Retouched piece	1	2	31	32	33	34	4	5	6	7	Total
<u>Level XX</u>											
End-scrapers	16 (5.6)	78 (27.2)	59 (20.6)	58 (20.2)	47 (16.4)	1 (0.4)	17 (5.9)	1 (0.4)	7 (2.4)	3 (1.1)	287
Partially-backed pieces	-	3 (4.5)	6 (9.0)	25 (37.3)	24 (35.8)	8 (11.9)	1 (1.5)	-	-	-	67
<u>Level XXI</u>											
End-scrapers	1 (1.2)	25 (29.1)	18 (20.9)	19 (22.1)	16 (18.6)	3 (3.5)	2 (2.3)	-	2 (2.3)	-	86
Burins on retouched truncation	-	17 (35.4)	7 (14.6)	16 (33.3)	5 (10.4)	-	-	-	2 (4.2)	-	48
<u>Level XXII</u>											
End-scrapers	17 (6.2)	45 (16.4)	101 (36.9)	56 (20.4)	32 (11.7)	-	7 (2.6)	-	10 (3.6)	4 (1.5)	274
Chamfered pieces	-	23 (14.1)	58 (35.6)	51 (31.3)	20 (12.3)	7 (4.3)	1 (0.6)	-	2 (1.2)	1 (0.6)	163
Burins on retouched truncation	3 (2.0)	33 (22.0)	29 (19.3)	44 (29.3)	30 (20.0)	-	-	-	6 (4.0)	1 (0.7)	150
<u>Level XXIII</u>											
End-scrapers	3 (9.1)	6 (18.2)	10 (30.3)	7 (21.2)	1 (3.0)	3 (9.1)	2 (6.1)	-	-	-	33
Chamfered pieces	2 (1.1)	26 (14.2)	83 (45.4)	53 (29.0)	9 (4.9)	3 (1.6)	1 (0.5)	-	4 (2.2)	-	183

(Contd.)

Table 99. (Continued)

Level/Retouched piece	1	2	31	32	33	34	4	5	6	7	Total
<u>Level XXIV</u>											
Chamfered pieces	-	3 (8.1)	15 (40.5)	16 (43.2)	2 (5.4)	-	-	-	-	-	37
<u>Level XXV</u>											
End-scrapers	-	5 (41.7)	5 (41.7)	1 (8.3)	-	-	-	-	-	-	12
Chamfered pieces	1 (5.0)	3 (15.0)	6 (30.0)	5 (25.0)	1 (5.0)	-	1 (5.0)	-	-	-	20

1: Cortical debitage
2: Partially-cortical debitage
31: Non-cortical flakes
32: Flake-blades
33: Blades
34: Bladelets
4: Crested debitage
5: Cores
6: Older debitage
7: Natural stones

Table 100. Frequencies of Levallois and Naturally-backed Debitage as Blanks for Retouched Pieces (%)

Level	Total of Retouched pieces	Levallois blanks				NB
		F.	B.	P.		
XIV	18	-	-	-		-
XV	20	1	-	-	(5.0)	-
XVI	151	1	-	-	(0.7)	1 (0.7)
XVII	505	-	-	3	(0.6)	6 (1.2)
XVIII	187	2	2	-	(2.1)	5 (2.7)
XIX	300	3	2	2	(2.3)	12 (4.0)
XX	715	9	6	9	(3.4)	22 (3.1)
XXI	427	3	4	6	(3.0)	20 (4.7)
XXII	1,280	14	20	39	(5.7)	53 (4.1)
XXIII	408	9	11	16	(8.8)	24 (5.9)
XXIV	104	2	2	-	(3.9)	3 (2.9)
XXV	53	3	-	-	(5.7)	-

F.: Levallois flakes
B.: Levallois blades
P.: Levallois points
NB : Naturally-backed debitage as blanks

Table 101. Frequencies of Flaking Modes for Blanks of Retouched Pieces

Level	Total	Harder f. mode	Softer f. mode	Questionable
XIV	11		11 100.0%	
XV	8		7 87.5%	1 12.5%
XVI	74	3 4.1%	60 81.1%	11 14.9%
XVII	248	14 5.6%	199 80.2%	35 14.1%
XVIII	84	6 7.1%	66 78.6%	12 14.3%
XIX	134	16 11.9%	92 68.7%	26 19.4%
XX	315	57 18.1%	214 67.9%	44 14.0%
XXI	199	59 29.6%	103 51.8%	37 18.6%
XXII	497	204 41.0%	202 40.6%	91 18.3%
XXIII	146	44 30.1%	74 50.7%	28 19.2%
XXIV	47	15 31.9%	22 46.8%	10 21.3%
XXV	16	7 43.8%	5 31.3%	4 25.0%

Table 102. Shapes and Types of Battering Traces of Hammerstones

Shapes				Level	Total	Types of battering traces		
F	G	E	B			O	M	AC
1		-		XVII	1		-	1
2		-	-	XVIII	2	-	1	1
-	1		-	XIX	1	1	-	
12	3		-	XX	15	5	10	-
3	-	1		XXI	4	1	3	-
2	1	1	-	XXII	4	2	2	-
-	-		1	XXIII	1	1	-	
20	5	2	1		28	10	16	2

F: flat
G: globular
E: elongated
B: broken

O: ordinary
M: marginal
AC: along circumference

traces suggest that certain kinds of marginal flaking were in practice; of the 20 flat hammerstones 16 specimens (80.0%) show battering traces near the ends on either or both of their surfaces, 2 specimens (10.0%) from Levels XVIII and XVII have battering traces along their circumferences, and only 2 specimens (10.0%) from Level XX have battering traces which do not suggest marginal flaking.

The inter-level comparisons presented above lead the present writer to summarize the technological continuity and change throughout the sequence as follows.

SUMMARY

Levels XVIII to XVI exhibit completely changed aspects in the technology of core reduction from those of Levels XXIII to XXI. This, however, seems to have resulted from a rather continuous and gradual process of technological alteration through the sequence, for almost all of the frequencies of technological attributes gradually change at different paces and opposite attributes such as concave vs. convex profiles above butts increase or decrease in inverse proportion in many cases (Fig. 83).

Caution must be exercised in comparing Levels XXV, XXIV, XV, and XIV with the other levels because of scarcity of material in these levels.

Levels XXV and XXIV, however, seem to be related to Levels XXIII to XXI/XX, except in such features as debitage classes, profiles above butts, and dorsal and distal shapes of debitage, which are more or less like those in Levels XX/XIX to XVI.

Levels XV and XIV, on the other hand, do not seem to be comparable to the preceding levels, for the metrical and technological features in these levels show only random distribution.

From the viewpoint of technology in core reduction, Levels XXV to XIV of Ksar Akil seem to be grouped into two units: Levels XXIII to (XXI or) XX and Levels (XX or) XIX to XVI.

These two sets of levels may be typically characterized as follows:

(1) Levels XXIII to XXI/XX:

Debitage:

- represented by flake-blades, blades, bladelets, and a considerable number of Levallois points which are generally elongated.
- with faceted (convex dihedral and multiple) butts accompanied by partially regularizing facet.
- with uni-directional dorsal scar pattern.
- with converging dorsal shape gradually giving way to parallel dorsal shape.
- with points of percussion located between two clear ridges.
- detached with harder or softer hammers (but softer always

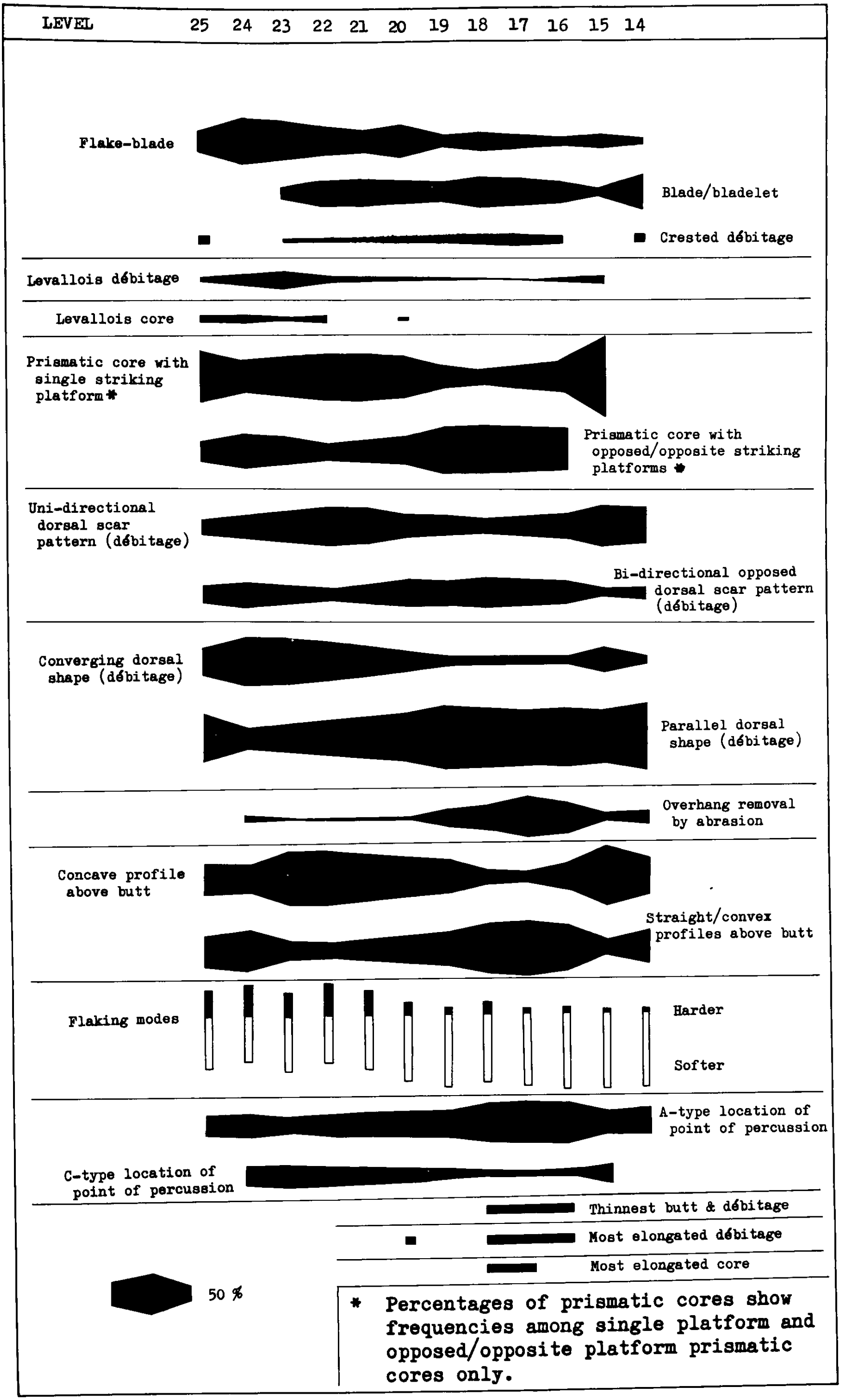


Fig. 83. Frequencies of representative technological attributes

more common).
with concave profile above butt.

Cores:
- represented by numerous prismatic cores with single striking platforms and some Levallois cores in the final forms.
- with faceted (convex dihedral and multiple) striking platforms.
- with parallel or converging overall shapes.

(2) Levels XX/XIX to XVI:

Debitage:
- represented by blades and bladelets produced with frequent use of cresting and re-cresting (especially in Levels XVIII to XVI).
- with linear and punctiform butts accompanied by overhang removal by abrasion.
- with bi-directional opposed dorsal scar pattern.
- with parallel dorsal shape.
- with elongated and thin shapes.
- with thinner butts.
- with points of percussion located behind a clear ridge.
- detached predominantly with softer hammers in marginal flaking.
- with straight or convex profile above butt.

Cores:
- represented by prismatic cores with opposed or opposite striking platforms.
- with plain striking platforms.
- with parallel overall shapes.

The change in the assemblages of retouched pieces also seems to have been unbroken, with certain categories of retouched pieces bridging adjoining levels.

As mentioned previously, the assemblages of retouched pieces can be grouped into three sets of levels: Levels (XXV, XXIV, and) XXIII to XXI, Levels XX to XVIII, and Levels XVII and XVI. This typological grouping is similar to that of Azoury (1971) and that presented by the 1969 London Symposium (Copeland, 1975; Besançon, Copeland, and Hours, 1977).

Although it is highly possible that many of the unretouched flake-blades, blades, and bladelets, which should have been produced deliberately, were used for tools or weapons as they were, it is clearly seen that these categories of debitage were frequently used for the blanks of retouched pieces (Table 103).

The frequency trends of debitage classes through the sequence are clearly reflected in those of the blank classes of the main categories of retouched pieces (Tables 61 and 99), and it appears most probable that changes in core reduction strategies are closely linked to changes in typology.

Table 103. Frequencies of Flake-blades, Blades, and Bladelets as Debitage and Blanks of Retouched Pieces

Level	Total of flake-blades, blades, and bladelets	Unretouched debitage	Blanks of retouched pieces
XIV	35	22 62.9%	13 37.1%
XV	27	24 88.9%	3 11.1%
XVI	265	177 66.8%	88 33.2%
XVII	685	377 55.0%	308 45.0%
XVIII	245	150 61.2%	95 38.8%
XIX	337	185 54.9%	152 45.1%
XX	759	399 52.6%	360 47.4%
XXI	385	177 46.0%	208 54.0%
XXII	1,176	624 53.1%	552 46.9%
XXIII	329	191 58.1%	138 42.0%
XXIV	61	25 41.0%	36 59.0%
XXV	18	8 44.4%	10 55.6%

The technology as a whole, however, seems to have changed more gradually, rather following the changes in typology, for the biggest difference in the assemblages of retouched pieces seems to be between Levels XXI and XX, whereas the technological change seems more marked from Level XX or XIX onwards.

Reconstructions of different technologies

One observation made in this study is that some of the technological attributes discussed earlier in this chapter are strongly linked to one another and were inseparable elements in the production of the lithic artifacts.

The aim of this section is to confirm several combinations of such inseparable technological elements and then to reconstruct schematically, on the basis of the combinations confirmed, the different technologies representing the two sets of levels established in the first section.

The following are the technological features which were expected to be inseparable and which were confirmed as such in the actual level by level observations.

(1) Single platform prismatic cores (Table 63) and uni-directional dorsal scar pattern of debitage (Table 77): Levels XXIV to XX.

(2) Opposed/opposite platform prismatic cores (Table 63), bi-directional opposed dorsal scar pattern of debitage (Table 77), parallel dorsal shapes of debitage (Table 81), and hinging removal from opposite direction (Table 89): Levels XVIII to XVI.

(3) Converging overall core shapes (Table 85), converging dorsal shapes of debitage (Table 81), and uni-directional dorsal scar pattern of debitage (Table 77): Levels XXIII to XXI and XV.

(4) Parallel overall core shapes (Table 85) and parallel dorsal shapes of debitage (Table 81): Levels XXV and XIX to XIV.

(5) Table 104 shows the interrelationship between dorsal and distal shapes of debitage throughout the sequence. It is evident that parallel dorsal shapes and blunt distal shapes are strongly interrelated and that converging dorsal shapes are related to pointed distal shapes more frequently than to blunt distal shapes. Within Levels XXIII, XXII, and XV, frequencies of debitage with converging dorsal shapes and pointed distal shapes (71.3% to 78.3%) are higher than the overall percentage. In Levels XXV and XIX to XV, debitage with parallel dorsal shapes and blunt distal shapes (90.8% to 100.0%) is more frequent than the overall percentage.

(6) Convex dihedral faceted butts or convex multiple faceted butts (Table 64) and partially regularizing facets (Table 65) in Levels XXIV to XX, XV, and XIV. It appears, as Bordes stated in 1947 (p.7), that the partially regularizing facet was intended to shape faceted butts by the removal of irregularity or concavity on them.

Table 104. Interrelationship between Dorsal Shapes and Distal Shapes of Debitage from Levels XXV to XIV

Dorsal shapes	Distal shapes		Total
	Blunt	Pointed	
Parallel	1,217 (83.7%)	237 (16.3%)	1,454
Converging	313 (40.5%)	460 (59.5%)	773
Expanding	186 (92.1%)	16 (7.9%)	202
Total			2,429

Indeed, the partially regularizing facet accompanies plain, convex dihedral faceted, and convex multiple faceted butts, and it is strongly suggested that in Levels XXV to XIV the partially regularizing facet was related to the shaping of faceted butts, especially convex dihedral faceted butts (Table 105).

(7) Linear/punctiform butts (Table 64), thinner butts and debitage (Table 70), and overhang removal by abrasion (Table 65) within Levels XVIII to XVI. Overhang removal by abrasion accompanies plain, linear, and punctiform butts throughout the sequence (Table 106), and it is thought that this operation was intended to detach thin debitage with thin butts without crushing the edges of striking platforms of the cores.

(8) C-type point of percussion (Table 88) and concave profile above butt (Table 69): Levels XXIV to XX and XV.

(9) A-type point of percussion (Table 88) and overhang removal by abrasion (Table 65): Levels XVIII to XVI.

(10) The length/width ratio of Levallois debitage, flake-blades, blades, and bladelets with C-type points of percussion is 2.61 (397 cases), whereas that of these classes of debitage with A-type points of percussion is 2.84 (871 cases). It seems possible, as Gingell and Harding (1981) demonstrated, that the debitage with A-type point of percussion (Class Ia of Gingell and Harding located behind a clear ridge) is more elongated than the debitage with C-type point of percussion (Class II of Gingell and Harding located between two clear guiding ridges) (Figs. 84 and 85).

(11) Straight/convex profiles above butts (Table 69), A-type point of percussion (Table 88), overhang removal by abrasion (Table 65), and thinner butts and debitage (Table 70): Levels XVIII to XVI.

In summary, Levels XXIII - XXII and Levels XVIII - XVI are very clearly contrasted by the following technological features:

Levels XXIII - XXII:

Single platform prismatic cores with converging overall shapes are strongly related to uni-directional dorsal scar pattern of debitage, converging dorsal shape of debitage, pointed distal shape of debitage, and debitage morphologically similar to Levallois point. Features of debitage are strongly interrelated, such as convex dihedral faceted or convex multiple faceted butts of debitage, partially regularizing facet, point of percussion located between two clear ridges of debitage, and concave profile above butt. There is no clear difference in butt thickness of debitage detached with the harder and softer flaking modes (Table 76). It is highly likely, therefore, that hammers of different hardness, such as hard and soft hammerstones, antler hammers, etc., were used. In general, however, there seems to have been no difference in the ways these hammers of different hardness were used.

Table 105. Butt Types Accompanied by Partially Regularizing Facet in Levels XXV to XIV

Butt type	Frequency	Percent
Cortical	3	0.3
Plain	281	30.2
Convex dihedral faceted	427	45.8
Straight multiple faceted	45	4.8
Convex multiple faceted	175	18.8
Partially faceted	-	
Linear		
Punctiform	1	0.1
Broken		
Total	932	100.0

Table 106. Butt Types Accompanied by Overhang Removal by Abrasion in Levels XXIV to XIV

Butt type	Frequency	Percent
Cortical	7	0.9
Plain	258	34.6
Convex dihedral faceted	72	9.7
Straight multiple faceted	6	0.8
Convex multiple faceted	11	1.5
Partially faceted	4	0.5
Linear	200	26.9
Punctiform	182	24.4
Broken	5	0.7
Total	745	100.0

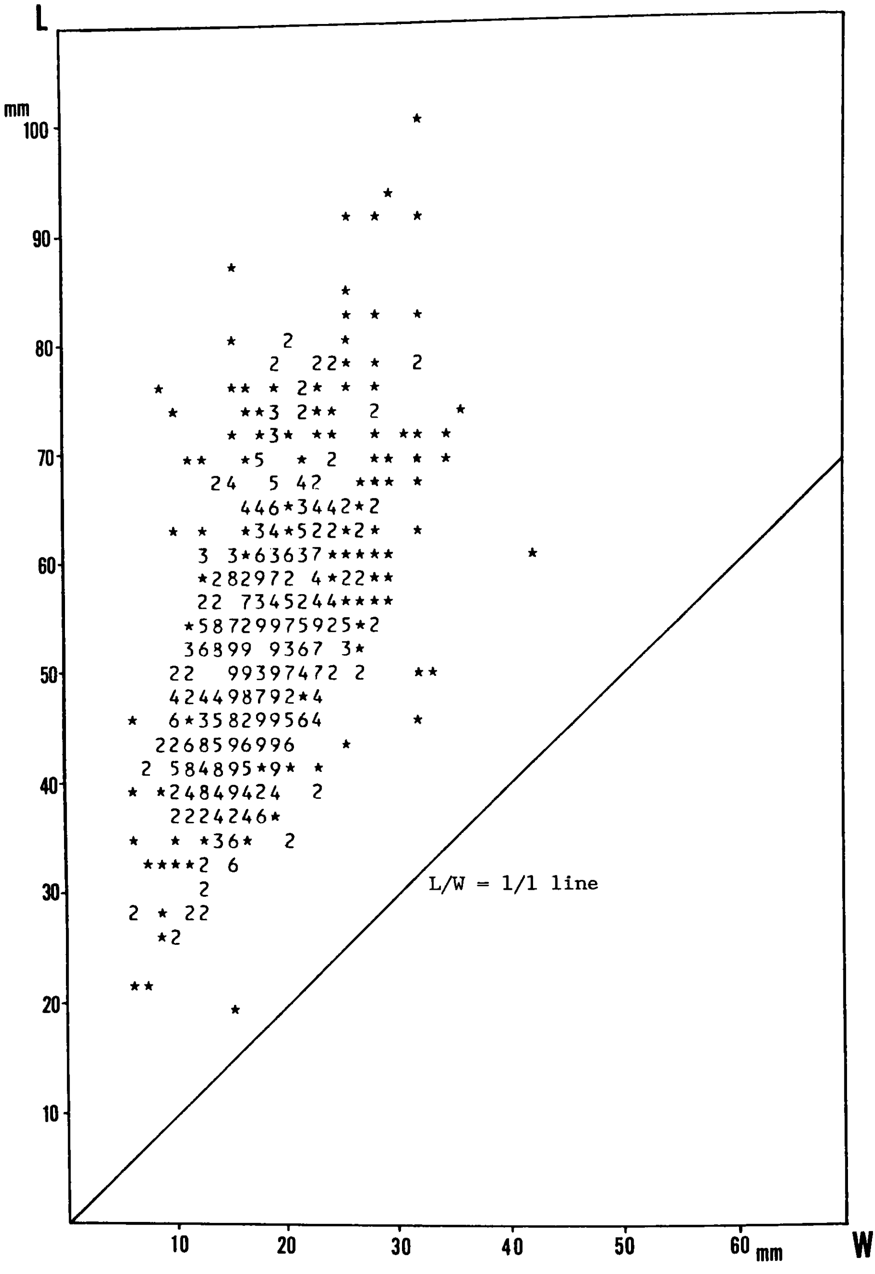


Fig. 84. Distribution of lengths (L) and widths (W) of Levallois debitage, flake-blades, blades, and bladelets with A-type points of percussion

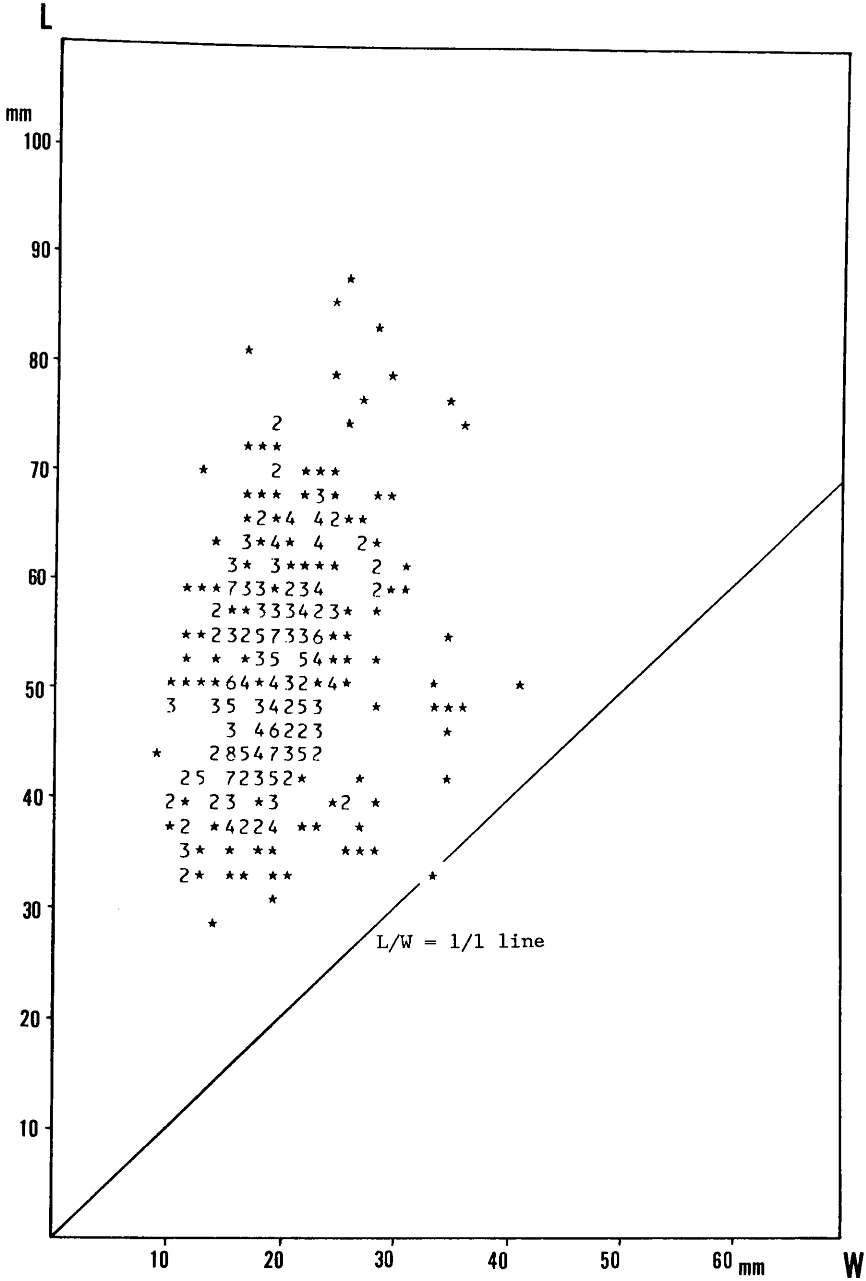


Fig. 85. Distribution of lengths (L) and widths (W) of Levallois debitage, flake-blades, blades, and bladelets with C-type points of percussion

Levels XVIII - XVI:

Opposed/opposite platforms prismatic cores with parallel overall shapes are strongly related to bi-directional opposed dorsal scar pattern of debitage, parallel dorsal shape of debitage, blunt distal shape of debitage, and hinging removal from opposite direction. Features of debitage are strongly interrelated, such as linear/punctiform butts of debitage, overhang removal by abrasion, point of percussion located directly behind a clear ridge of debitage, straight/convex profiles above butts, thinner butt of debitage, and thinner debitage. Butt thickness of debitage detached with the softer flaking mode is clearly thinner than that of debitage detached with the harder flaking mode (Table 76). This strongly suggests that the debitage detached with the softer flaking mode was produced in direct or indirect marginal flaking using hammers or punches softer than the debitage detached. Taking the features of hammerstones (Table 102) into consideration, however, it is also possible that some or much of the thinner debitage detached with the softer flaking mode was produced in an oblique way of flaking using the flat hammerstones bearing the battering traces along their circumferences (see Crabtree and Swanson, 1968).

To conclude this chapter, Figures 86 to 90 are schematic reconstructions, based on the strongly associated technological elements presented above, which the present writer believes illustrate different technologies used to manufacture lithic artifacts in Levels XXIII to XXI/XX and Levels XX/XIX to XVI.

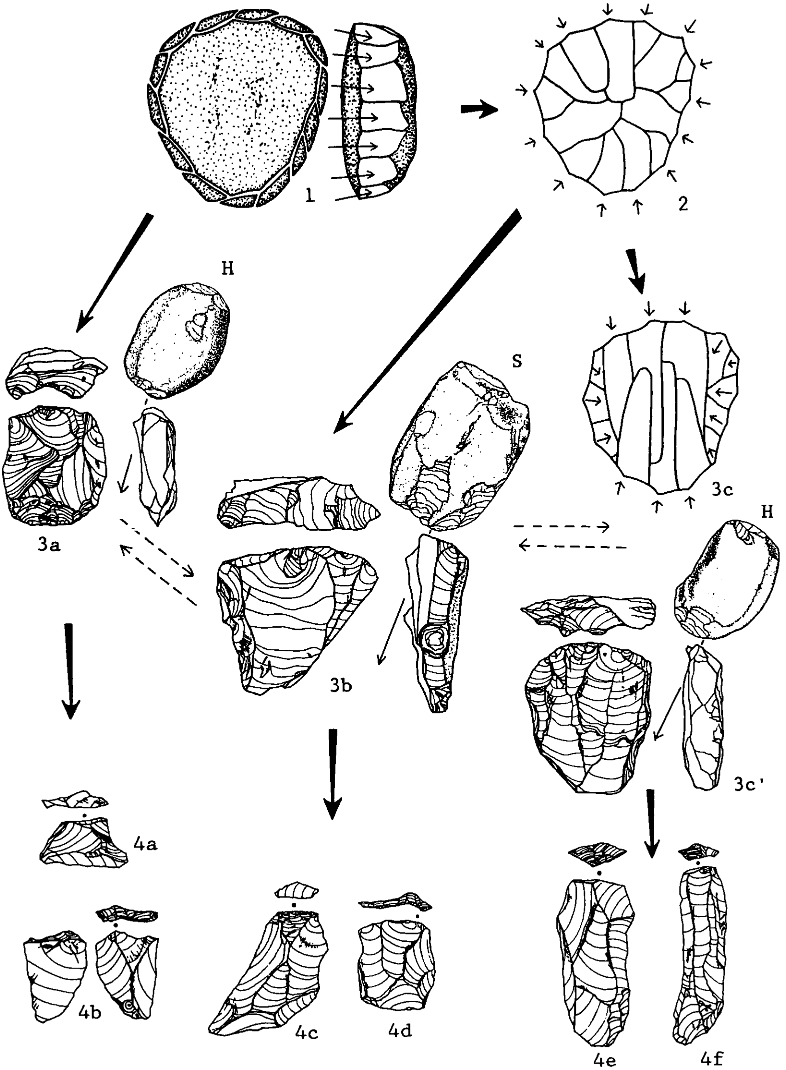


Fig. 86. Typical scheme of reduction of discoidal cores, Levallois flake cores and Levallois blade cores in Levels XXIII to XXI/XX

1. Preparation of striking platforms
2. Centripetal flaking preparing core surface

3a. Discoidal core
3b. Levallois flake core
3c. Levallois blade core with bi-directional opposed main flake scars
3c'. Levallois blade core with uni-directional main flake scars
4a - 4b. Pseudo-Levallois points
4c - 4d. Levallois flakes 4e - 4f. Levallois blades

(Note direct percussion using either a hard (H) or soft (S) hammerstone, traces of centripetal preparation on 3c and 3c', and points of percussion (●) located between two clear ridges on debitage)

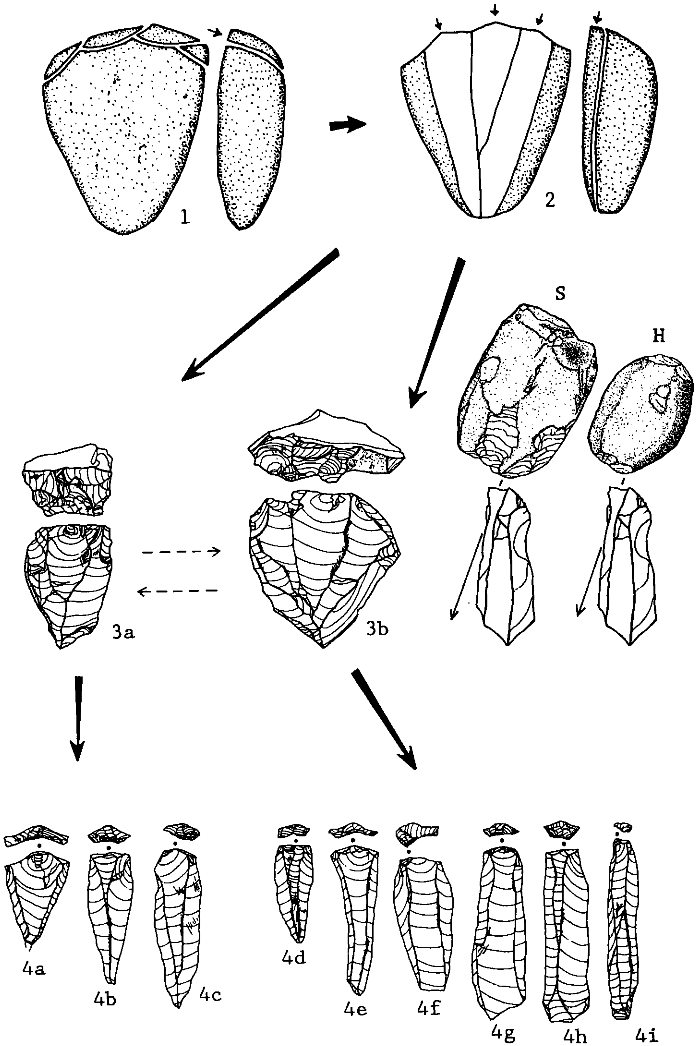


Fig. 87. Typical scheme of reduction of Levallois point cores and single platform prismatic cores in Levels XXIII to XXI/XX

1. Preparation of a striking platform
2. Initial stage of uni-directional flaking

3a. Levallois point core
3b. Single platform prismatic core
4a - 4c. Levallois points
4d 4e. Flake-blades
4f - 4h. Blades 4i. Bladelet

(Note direct percussion using either a hard (H) or soft (S) hammer-stone and points of percussion (●) located between two clear ridges on debitage)

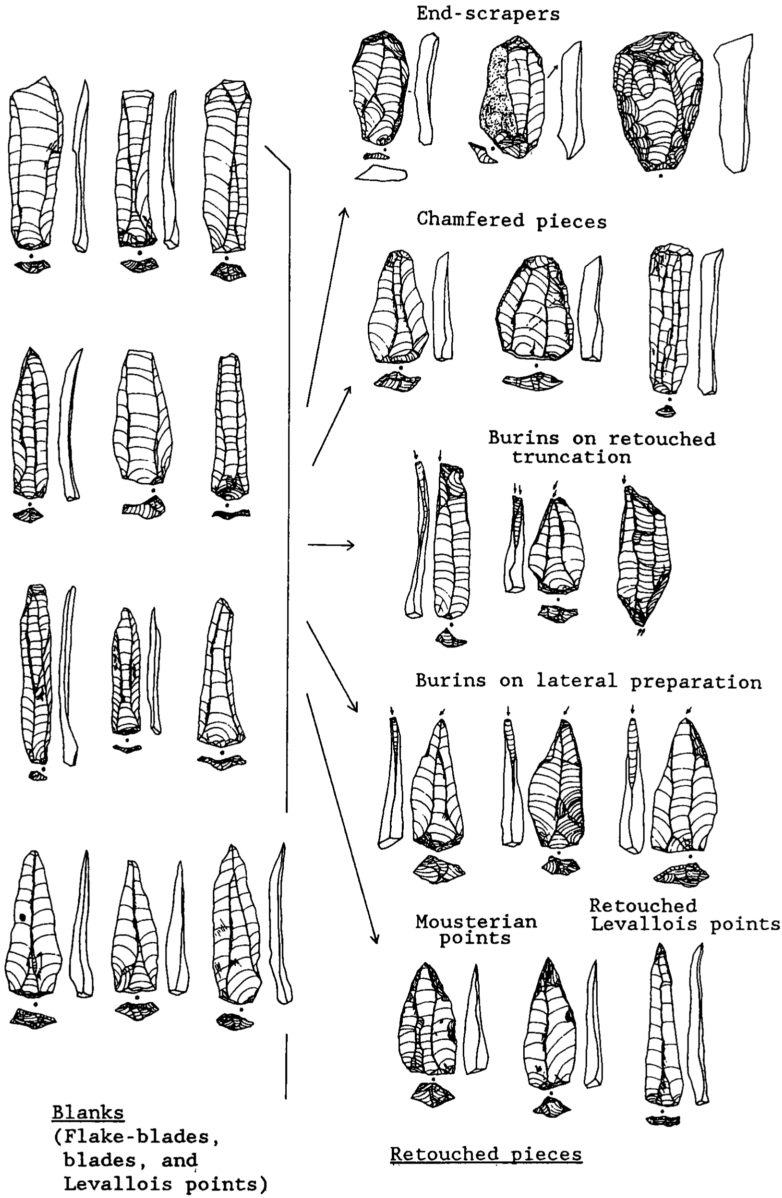


Fig. 88. Scheme of blank selection for retouched pieces in Levels XXIII to XXI/XX

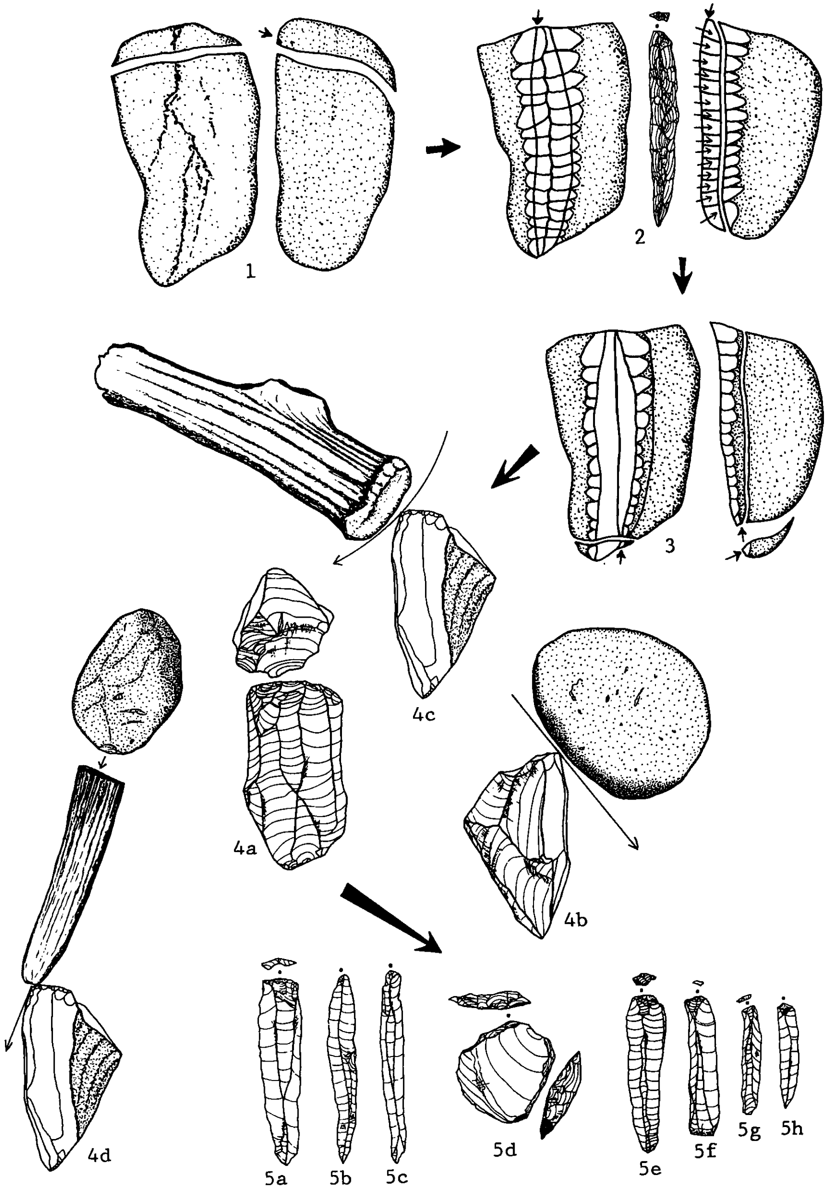


Fig. 89. Typical scheme of reduction of blade/bladelet cores in Levels XX/XIX to XVI

1. Preparation of a striking platform
2. Cresting and crested debitage
3. Preparation of an opposed striking platform

4a. Opposed platform prismatic core

4b - 4d. Possible ways of marginal flaking with "edge-ground cobble technique" (4b), direct percussion using an antler hammer (4c), and indirect percussion using an antler punch (4d)

5a-5c,5e-5h. Blades and bladelets 5d. Core tablet

(Note points of percussion (●) located behind a clear ridge and overhang removal by abrasion on blades and bladelets)

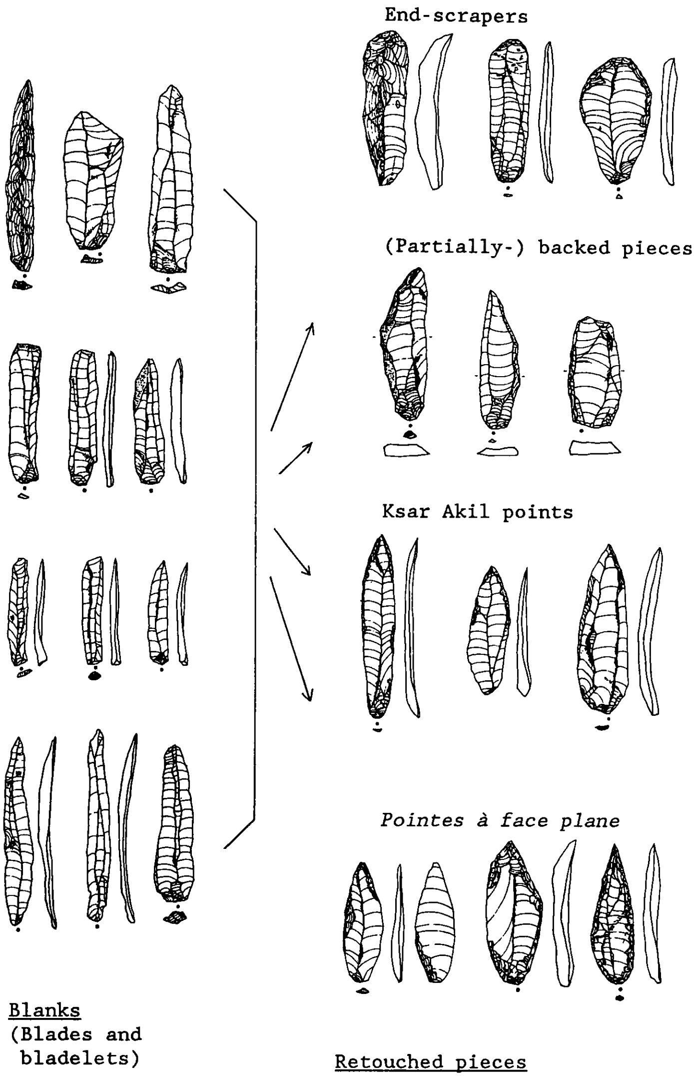


Fig. 90. Scheme of blank selection for retouched pieces in Levels XX/XIX to XVI

CHAPTER IV

A BRIEF RESEARCH HISTORY AND SOME PROBLEMS OF LEVALLOIS TECHNIQUE IN EUROPE

The "Levallois" technique was named after the type-site near Paris, Levallois-Perret, where an industry characterised by this technique was discovered about 1879 by M. Reboux (Wymer, 1968: p.72). It has been described as a process in which an important flake with a predetermined shape prepared on a core prior to its detachment is removed from the core with a final blow (see Bordes, 1961) (Fig. 91). This definition is so broad as to apply to the discoidal core and the Upper Palaeolithic prismatic blade core, which also produced flakes and blades with predetermined shapes. These non-Levallois cores are indistinguishable from Levallois cores in that the shapes of the flakes and blades from these cores are prepared prior to their detachment, as is the case with the Levallois technique. It appears, therefore, that the definition of this technique has not been sufficiently precise so far.

This chapter deals with how the Levallois technique has been described, presents a brief review of its research history, and discusses some problems associated with the technique.

It appears that Commont was among the first to describe the technique. Commont presented a fairly detailed description of the technique as early as the beginning of this century (Commont, 1909, p.122, cited in Brézillon, 1977: p. 79). According to Commont, the raw material is first roughed out to remove irregular parts, making a multilateral disc-shaped core. The flakes produced at this stage were often used to make small points. Then, a very large flake which characterises the Levallois technique is detached from the largest portion of the core surface. During the stages between the initial rough-out and the final detachment, the core is finely modified by light blows to regularize the ridge allocation on the core surface. The core thus modified is held in such a way that its surface is sloped somewhat downwards, and the majority of the core surface is removed with a proficient blow aimed at a right angle to the carefully chosen faceted portion of the striking platform. This description of the Levallois technique dealt with the process of core reduction in detail, and it is noteworthy that there has appeared no description of the technique which differs a great deal from it in some eighty years since this publication.

Commont's Levallois description was not referred to by other scholars for its technological aspects, but was used to support an hypothesis which maintained that the cores and flakes produced with this technique might be type fossils of a certain lithic industry. The leading advocate of this school was Breuil, who considered the products of this technique as cultural indicators of a certain lithic industry. He correlated the river terraces of the Somme, France, with the lithic industries of the area, and established the seven phases of the so-called Levalloisian industry (Levalloisian I-VII) (Breuil and Koslowski, 1931). Breuil also advocated the so-called "parallel phyla

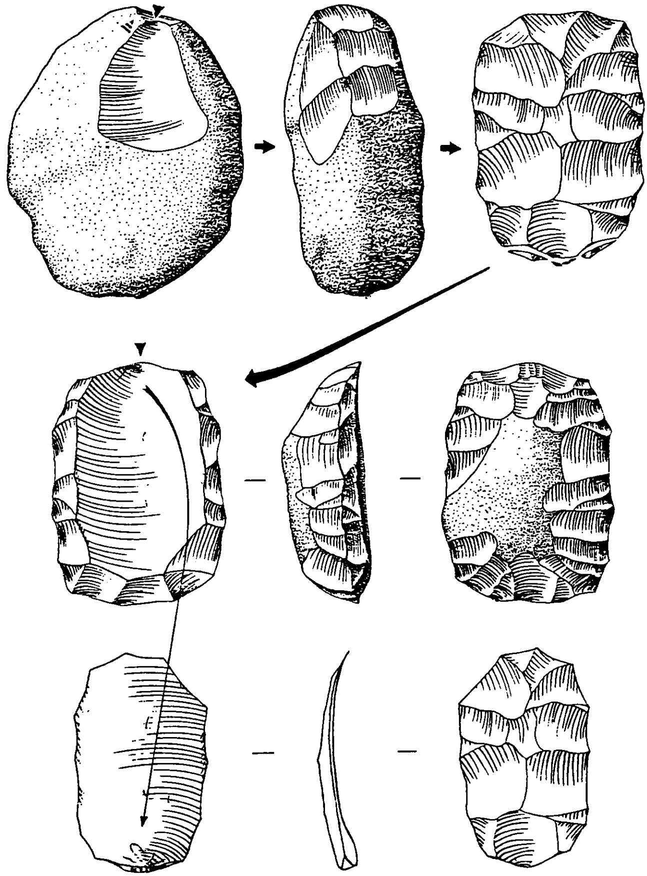


Fig. 91. Scheme of reduction of Levallois flake core (after Tixier et al., 1980)

concept", in which it was said that a flake-tool tradition of Clactonian-Levalloisian continued to exist, alternating the places of its activity with the core-biface tradition of Abbevillian-Acheulean in response to the changes in environment (Breuil, 1932: pp.571-572; 1939: p.36; Kelley, 1937: p.15; Movius, 1953: pp.163-164).

This hypothesis, however, was weakened by the fact that bifaces used for Levallois-like cores, and flakes probably detached in biface manufacture were all found associated in the Middle Acheulean assemblage at Cagny in the Somme (Breuil and Kelley, 1956) (Fig. 92), and then the basis for this hypothesis was nearly destroyed by Bordes' allegation that these cores and flakes were proto-Levallois and Levallois, as well as by his reinvestigation of the relationships between the Somme terraces and the lithic industries of the area (Bordes, 1956: pp.1-5).

The coexistence of bifaces and the Levallois technique was confirmed also in places other than Europe.

Caton-Thompson, for example, described bifaces used as Levallois cores among the Upper Acheulean materials from Kharga Oasis, Egypt (1946: p.59; 1952: Pl.48-3) (Fig. 93).

It thus became clear that "Levallois" is only a way of flaking and is not a type fossil of the flake-tool tradition distinct from the core-biface tradition, and subsequent research on Levallois material was directed to its technological aspects.

The Levallois techniques outside Europe look different from those in Europe, and as a matter of course their research was not the same.

Lowe said that in South Africa this technique emerged as a secondary element of the Palaeolithic assemblages characterised by the manufacture of bifaces, and argued against the direct application of the "parallel phyla concept" to the South African Palaeolithic, grasping the appearing process of the South African Levallois technique in an evolution of manufacture of bifaces. According to Lowe, a dimensional change of raw material, such as from quartzite pebble to large lava boulder, was brought about in a reciprocal relation to the increasing necessity of bifaces like cleavers and hand-axes, and man started detaching large flakes from large boulders to manufacture the needed tools on these flakes detached as tool blanks, in order to save the useless process of the tool manufacture, that is, continuous breaking of large boulders from the start to the finish. Lowe considered the Victoria West technique as a development of this kind in obtaining large flakes as tool blanks (1945: p.50).

A similar argument was presented by Leakey, who stated, "The technique (Victoria West) seems to have been evolved to facilitate the making of good hand-axes of reasonable size from large water-worn pebbles and small boulders in an area where these were easily accessible. To make a medium-sized hand-axe from such materials by the ordinary flaking methods of knocking off flake after flake, until the block was reduced to the required size, would have been very laborious. However, it was now found that if a boulder of, say, the size of a

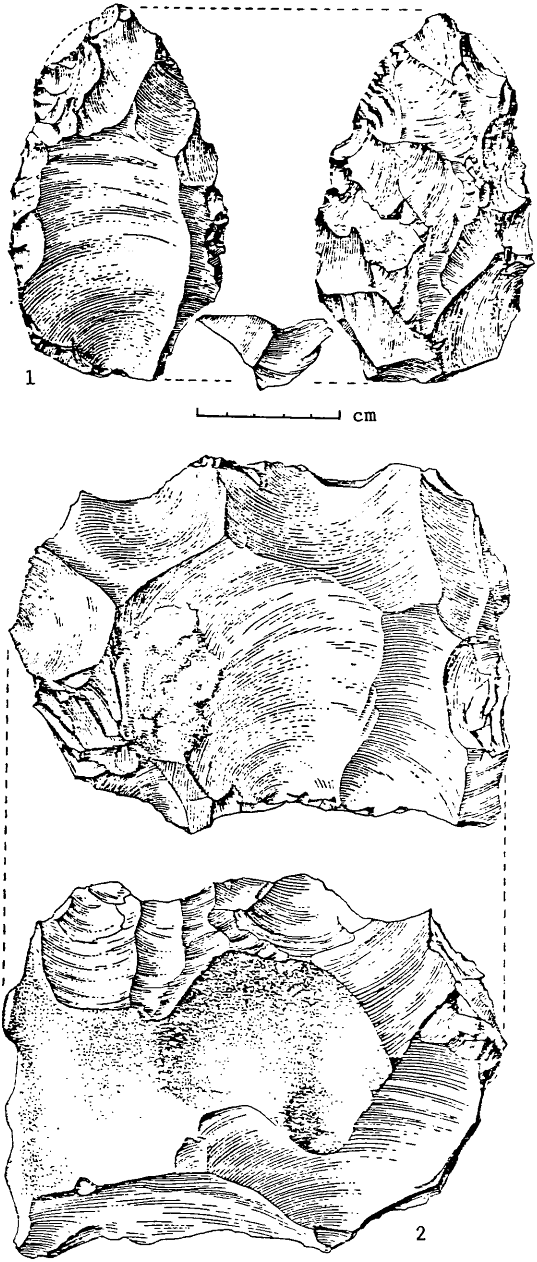


Fig. 92. Acheulean cores (after Breuil and Kelley, 1956)

1. Biface used for a core (Acheulean, Cagny)
2. Acheulean core (Acheulean, Cagny)

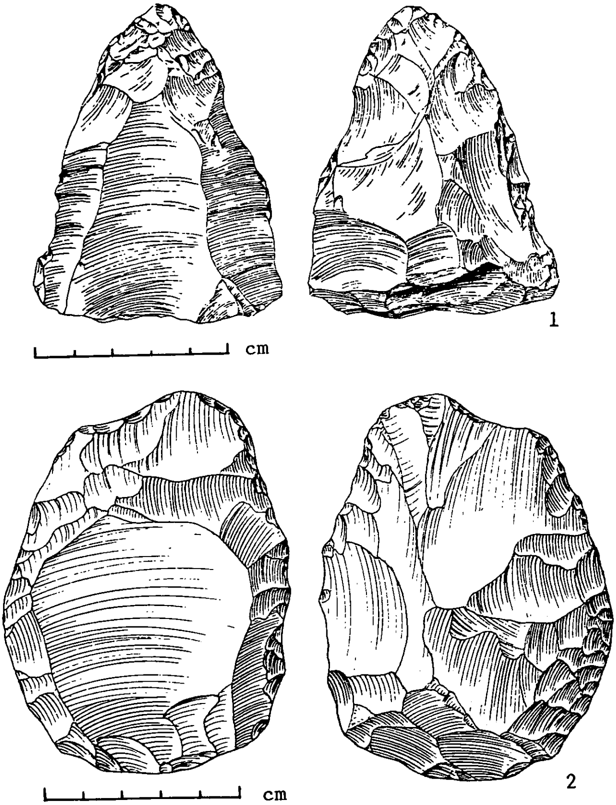


Fig. 93. Bifaces used for cores

1. Hand-axe reminiscent of a Levallois core from the Upper Acheulean of Kharga Oasis (after Caton-Thompson, 1952)
2. Acheulean biface used for a core from Montguillain (after Bordes, 1961)

football were used, it was possible to trim one side fairly carefully and then detach a large flake from that side by a single blow. Such a flake was already trimmed and needed only a minimal amount of further flaking to form an excellent hand-axe" (1955: p.133).

In 1958, the importance of raw material for the Levallois technique was emphasized by Tester. Tester suggested that the unlimited supply of large, fresh nodules of good quality stone in which one can predict the breakage direction is indispensable for the technique, mentioning the fact that at Baker's Hole, near Swanscombe, England, there are large Levallois cores abandoned extravagantly after the removal of one prepared flake.

Bordes, on the other hand, studied the technology of the Lower and Middle Palaeolithic in Europe, based on his own experimental manufacture of lithic artifacts, and published many studies dealing with the Levallois technique (Bordes, 1950). "Typologie du Paléolithique ancien et moyen" is the comprehensive compilation of his works on this subject, and it explored several problems associated with the Levallois technique (Bordes, 1961). Cited below are excerpts from the paragraphs regarding the technique in this publication (Fig. 94). (1) Levallois flake: The only correct definition of Levallois flake is that the shape of the flake is formed on the core prior to its detachment by the special core preparation. The butts comprise <u>plain</u> (*lisse*), <u>faceted</u> (*facetté*), <u>convex faceted</u> (*convexe*), and <u>dihedral faceted</u> (*dièdre*) (------: p.14). The dorsal surface (*face supérieure*) generally has centripetal (<u>convergent</u>) flake scars of core preparation, but it sometimes shows parallel or sub-parallel flake scars (----: p.17). Levallois flakes are Levallois, whether or not they are derived from the Indus, the Seine, the Vaal, the Mousterian, the Stillbay, the Soan, or the Neolithic. It is not correct to regard the faceted butt as an indispensable element for the Levallois flake, for there are often found non-Levallois flakes with faceted butts and Levallois flakes with plain butts (----: p.14). (2) Levallois point: This is a triangular flake detached from a specially prepared Levallois core. It has an axis starting from the distal end and dividing it into two, almost coinciding with the flake axis (*l'axe de l'éclat*: starting from the point of percussion and dividing the bulb of percussion into two) (----: p.18). In the case of a Levallois point with an irregular shape, the irregularity is removed with a partial retouch which does not alter its general shape (----: p.20). (3) Levallois blade core: The core preparation is not centripetal but by the continuous removal of parallel narrow flakes or blades. These removals are often executed from two opposed striking platforms. Some of the cores of this type are very like the prismatic cores (*nucléus prismatique*) of the Upper Palaeolithic (----: p.72). (4) Levallois blade: Levallois flake with the length equal to or more than twice the width. The dorsal surface exhibits the traces of the removal of blades, but it sometimes has centripetal flake scars. Some with the traces of regular and parallel flake scars are indistinguishable from the blades of the Upper Palaeolithic. Levallois blades, however, are thinner and broader than the Upper Palaeolithic blades (----: p.18). (5) Proto-Levallois: It appeared in the Middle Acheulean of Cagny in France. The idea of this flaking is identical to that of Levallois, but it differs from Levallois in that the core preparation is very crude (----: p.16).

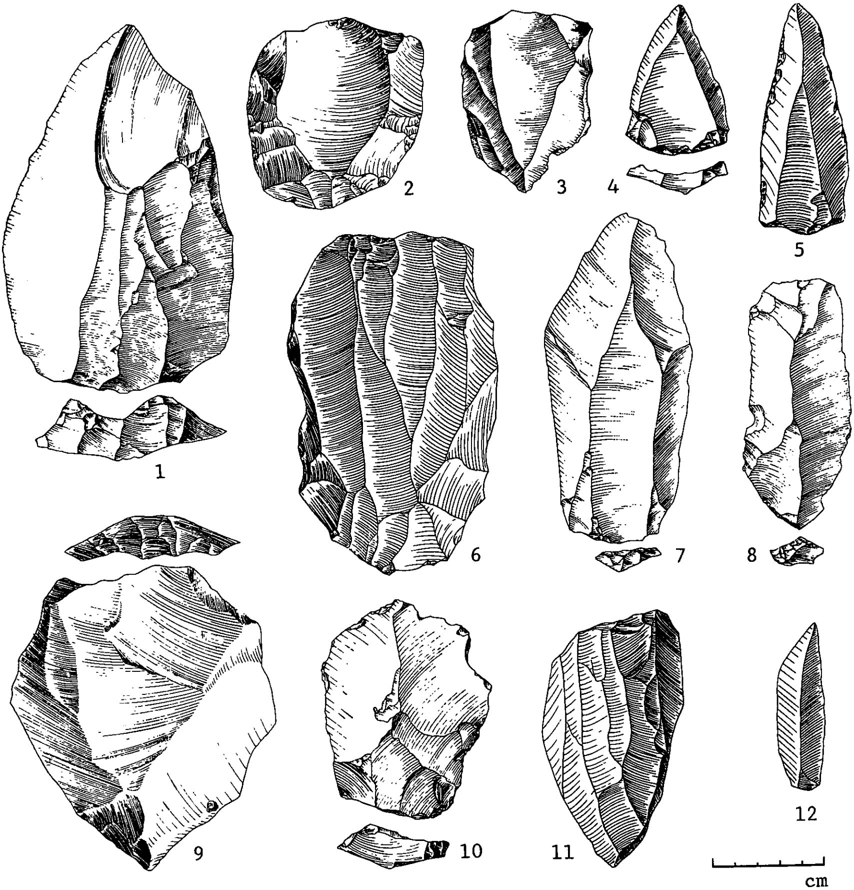


Fig. 94. Cores and flakes of the Lower and Middle Palaeolithic (after Bordes, 1961)

1. Levallois flake
2. Levallois flake core
3. Levallois point core
4. Levallois point
5. Retouched Levallois point
6. Levallois blade core
7. Levallois blade
8. Proto-Levallois blade
9. Proto-Levallois core
10. Proto-Levallois flake
11. Single platform prismatic core
12. Non-Levallois blade

Both blades and flakes are recognized in this type. The proto-Levallios flakes and blades are easily confused with waste flakes produced in biface manufacture, but the biface flakes are characterised by butts which are inclined toward the ventral surface (----: p.18). (6) Para-Levallois: This is the Victoria West technique in South Africa. A fairly thick wide flake which can be called Levallois is detached from a side of an elongated carinated core (----: p.16). (7) Prismatic core: This core resembles the prismatic blade core of the Upper Palaeolithic, but usually has only a single striking platform. This core is characterised by having a thick and almost round transverse section, differing in this respect from the Levallois blade cores (----: p.73). (8) Blade: Flake with the length equal to or more than twice the width. The length is measured along the flake axis, while the width is measured at right angles to the long axis. The scholars mainly of the English-speaking countries regard the "true blade" as having more or less parallel sides and ridges, distinguishing it from flake-blades (*éclats laminaires*). This distinction is right in principle, but it is difficult to differentiate the former from the latter by using this standard (----: p.6). (9) Pseudo-Levallois point: This is a flake which is usually triangular and whose axis of percussion is clearly deviated from a line which divides the flake in two down its main axis of symmetry. It is not detached from a Levallois core but is struck from a discoidal core (----: p.22) (Fig. 95).

In this publication, Bordes ascribed the great confusion between the Levallois technique and the faceting of striking platform to the 1947 Pan-African Congress resolution to replace "Levallois" with "faceted platform technique" (----: pp.13-14).

In 1954 Kelley, addressing the relationship between the Levallois technique and the faceting of striking platform, wrote that the angle formed by the flaking surface of a Levallois core and its striking platform ought to be almost right angles, and if the angle formed in the course of the core preparation does not fulfill this condition, faceting is carried out to modify the angle to about 90 degrees.

Meanwhile, West and McBurney rejected uncritical acceptance of Bordes' Levallois definition, and wrote, "Does an examination of the flakes and cores reveal anything which can be confidently termed Levalloisian or Mousterian in the current acceptation of these terms ?" (1954: p.147) and "Using rather more restricted connotation than that favoured by some authors (for example F. Bordes) the writer intends only flakes showing evident traces of multiple preparation of the dorsal surface together with the use of a true faceted platform" (McBurney, 1967: p.77).

In fact, it may be difficult to differentiate Levallois flakes from the flakes produced in the course of biface manufacture. Bordes himself cautioned against this difficulty, and indeed there may arise the possibility that Bordes' so-called proto-Levallois flakes might actually have been derived from bifaces and not from cores. This problem with biface flakes and Levallois flakes is directly related to the existence of the proto-Levallois as alleged by Bordes, and several studies on the biface flakes have appeared or been published.

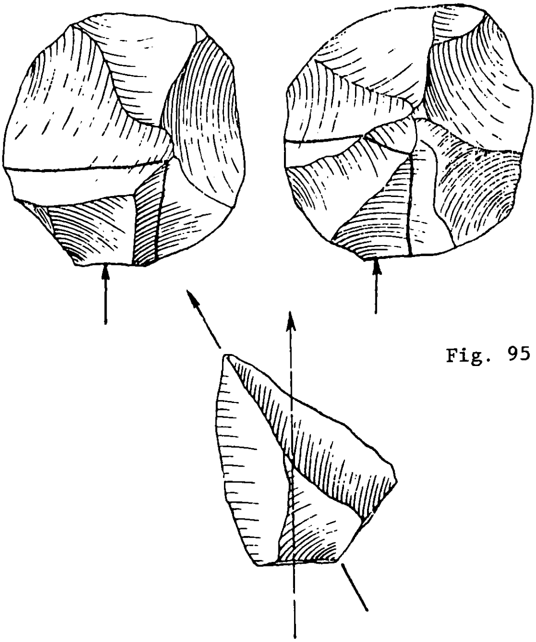


Fig. 95. Scheme of production of pseudo-Levallois point (after Bordes, 1961)

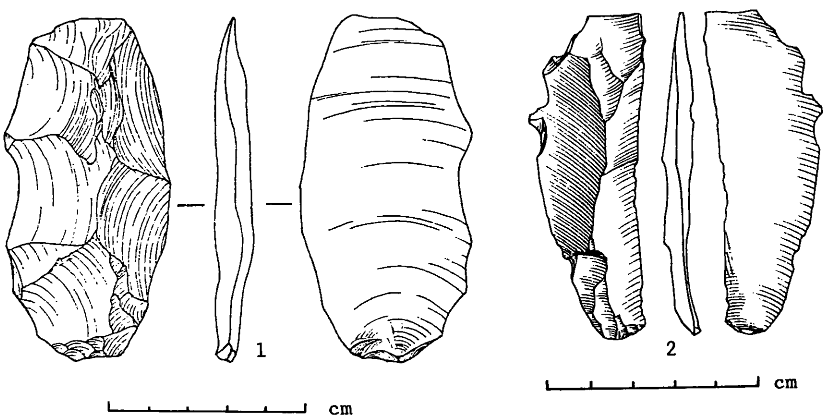


Fig. 96. Flakes produced in the manufacture of hand-axes

1. Hand-axe flake produced experimentally with a soft hammer and resembling a Levallois flake (after Newcomer, 1971)
2. Hand-axe flake from Pech de l'Azé I (after Bordes, 1972)

Newcomer published a quantitative study on the waste flakes produced when he manufactured several thin hand-axes experimentally. He established three stages in hand-axe manufacture: the first is roughing-out, the second is thinning and shaping, and the third is finishing. The second and third stages were carried out with an antler hammer, and when the hand-axe under completion at the last stage was not thin enough, a striking platform was prepared at an appropriate place on it to detach a large thinning flake. The flake thus produced resembles a Levallois flake but is thinner and exhibits a flatter bulb formed by the use of the soft hammer (Newcomer, 1971: p.90) (Fig. 96). Bordes also made a similar distinction (1961; 1972), writing, "In the case of the Mousterian of Acheulean tradition, special care must be taken not to mistake the thin flakes obtained in making handaxes for true Levallois flakes. Both show a well-prepared upper surface (in the handaxe flakes, this comes from preceding work on the tool), but the characteristics of the butts of the flakes are different. Levallois flakes show a normal butt, and since most of them are struck with a hard hammer, they have well-developed bulbs of percussion. Handaxe flakes, on the other hand, were generally struck with a soft hammer (wood, antler, or bone) and so show an extremely distinctive butt, very narrow, with a kind of overhang over the ventral face and a very diffuse bulb" (1972: pp.80-81) (Fig. 96).

The descriptions of hand-axe flakes by Newcomer and Bordes are both based on their experiments with hand-axe manufacture and as such are very convincing, but there still remain problems with the cases in which hand-axe flakes were detached with a hard hammer or Levallois flakes were obtained with a soft hammer.

It was thought that the difficulty encountered in identifying a Levallois product was due to its ambiguous definition, and efforts were made to redefine it.

Wymer divided Levallois cores into two types: one having a flake surface prepared by radial flaking, and the other having either one or two opposed striking platforms from which flakes are detached in parallel directions (Fig. 97). The former type of core has a flake surface resembling a tortoise shell, and from this core a broad flake or narrow flake (not a blade) with radial flake scars is detached, with or without a faceted butt. The latter cores comprise several prismatic types from which parallel-edged or pointed flakes are detached. According to Wymer, the prismatic core with a single platform developed into the prismatic core with two opposed striking platforms of the European Upper Palaeolithic. Wymer also said that very narrow flakes with the length equal to or more than three times the width are blades, and that such a blade should exhibit ridges running in parallel with its own flake axis. He also stated that many of the single-platform prismatic cores produce pointed blades (Bordes' so-called Levallois points) (1968: p.72; 1982: pp.115-121).

In the above dichotomy of Levallois cores by Wymer, narrow flakes with a classic Levallois preparation are not termed "Levallois blade" but "narrow Levallois flake", and the Levallois point core was described as having developed into the Upper Palaeolithic prismatic blade core. This argument questioned the idea of a "Levallois blade",

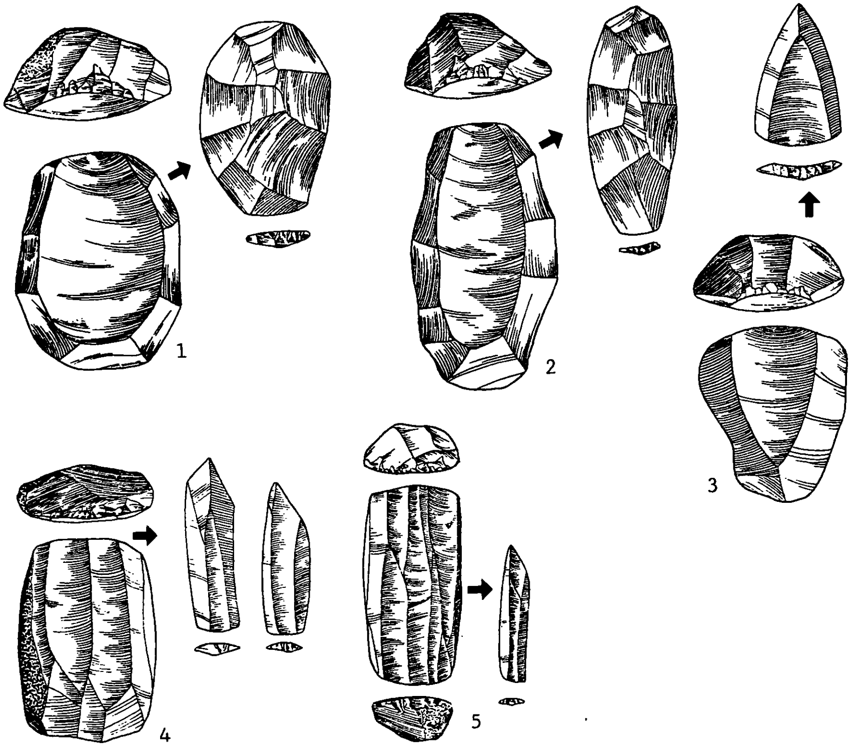


Fig. 97. Levallois cores classified by Wymer (1968)

1. Tortoise core and a flake
2. Narrow tortoise core and a narrow flake
3. Prismatic core for obtaining a single pointed flake (so-called Levallois point)
4. Prismatic blade core with a single prepared platform and blades
5. Prismatic blade core with two prepared platforms and a blade

and suggested a research direction in which importance is attached to the techno-typological relationships between Levallois point and Upper Palaeolithic blade. It is regrettable, however, that Wymer did not mention anything regarding the possibility that a narrow Levallois flake and then blade-like flakes were detached continuously from a narrow tortoise core (Bordes, 1961: p.72).

In around 1970, Bordes again published material on the Levallois technique, but it was essentially the same as what had appeared in his earlier publications. Bordes stated, for example, "Technique of preparing a core in such a way that the shape of the flake to be struck off is predetermined. It may comprise the preparation of the striking platform by removing small flakes producing facets" (1972: p.159) and "In Europe, the Levallois technique seems to appear in the lower part of the Middle Acheulean, and may have been a result of observation of accidents in the fabrication of handaxes, when a large flake, taken too 'deep', removes most of the face of the handaxe, and so has more or less the same shape. This idea that one can get flakes, which have a given shape was clearly a very promising one, since the Upper Palaeolithic type of blade is nothing more than an elaboration of the Levallois blade technique, as also are the very long blades of the Chalcolithic (Grand Pressigny type[1])" (1971: p.3).

In "*Le Débitage Levallois et ses Variantes*" published in 1980, Bordes put his Levallois ideas into shape as follows (1980) (Fig. 98): (1) Levallois flake core: (a) Classic type: It has centripetal preparation. Short cores as well as elongated cores are recognized. A classic Levallois flake with the length equal to or more than twice the width (*éclat-lame*) is produced when the final detachment fails. (b) Type with parallel preparation: These are Levallois flake cores which are generally elongated. (c) So-called "Victoria West type": It is restricted to Africa, and a wide flake is detached from a side of the core of this type. (2) Levallois point core of the typical type: A small first point is detached from the core, leaving on it Y-shaped ridges, and then a classic point (second point) is detached. A third point is also detached if possible. Also, an elongated point is sometimes detached from it. (3) Levallois blade core: This is different from most of the blade cores of the Upper Palaeolithic in that it is generally thin, but sometimes it is very difficult to distinguish between them. This core has a single or two opposed striking platforms. (4) Levallois points from other types of cores: Sometimes, a typical Levallois point is removed, intentionally or not, from a prismatic and especially a pyramidal core (*nucléus pyramidaux*). The points detached from such cores are generally elongated, like Australian Leilira points[2] for example. The Levallois-like points in the European Upper Palaeolithic may have been detached accidentally when the prismatic or pyramidal blade cores were struck by hammers on the starting points of the ridges on them. (5) Nubian core (*Nucléus "nubiens"*): This is a type reported from Nubia by J. and G. Guichard. A flake detached from this core is triangular and has a longitudinal ridge, prepared by centripetal flaking, different from Y-shaped ridges on a true Levallois point. (6) Halfa core (*Nucléus Halfa*): This is also a type from Nubia reported by A. Marks. Two small Levallois flakes are detached from this core continuously.

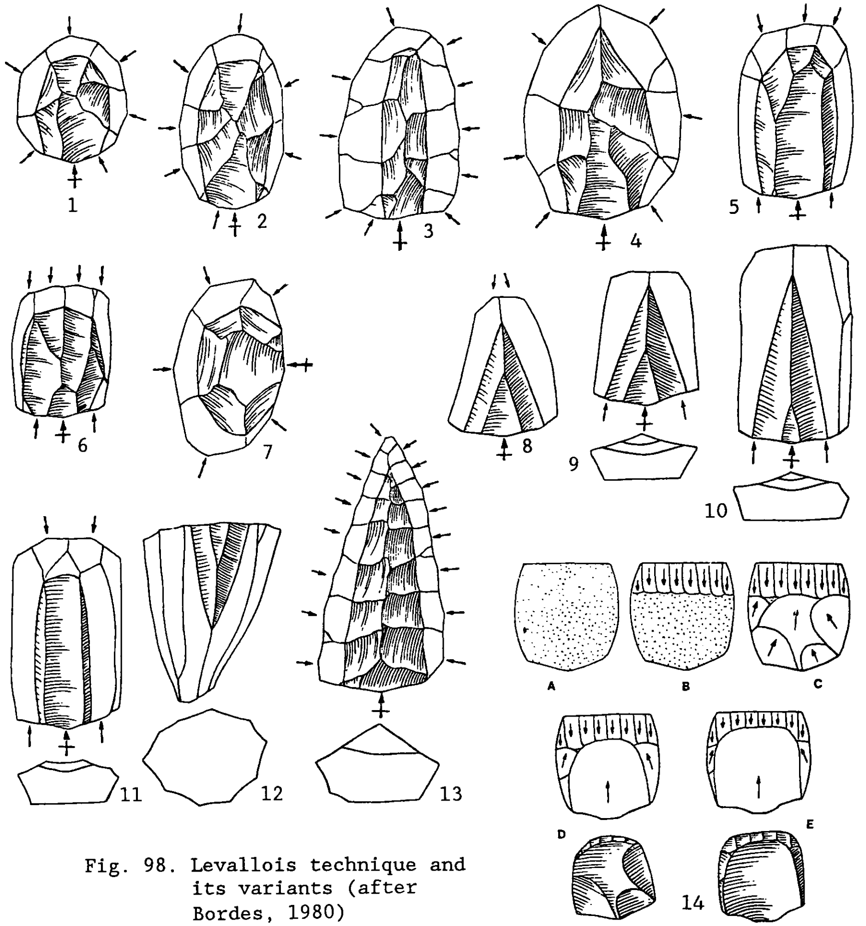


Fig. 98. Levallois technique and its variants (after Bordes, 1980)

1. Classic Levallois core 2. Elongated classic Levallois core
3. Elongated classic Levallois core for flake-blade
4. Classic Levallois core for pointed flake
5. Elongated Levallois core with parallel preparation
6. Short Levallois core with parallel preparation
7. "Victoria West" core 8. Levallois point core
9. Levallois point core 10. Elongated Levallois point core
11. Levallois blade core 12. Pyramidal core producing Levallois points
13. "Nubian" core 14. Scheme of reduction of "Halfa" core

A technological study of lithic artifacts entitled "*Préhistoire de la Pierre taillée:1:terminologie et technologie*" was published also in 1980 by Tixier, Inizan, and Roche, and in it some descriptions were also made concerning Levallois (Tixier et al., 1980). The first thing to note in this publication is that the term "Levallois method" is used instead of "Levallois technique" which had been generally used thus far. Tixier had previously suggested that the term "method" was preferable to "technique" (Tixier, 1967: p.813). The word "method" can be interpreted as a way of doing anything according to a defined and regular plan, while "technique" can be a manner of artistic execution or performance in relation to formal or practical details (*The Oxford English Dictionary*, 1933). As for the manufacture of lithic artifacts, "method" was defined by Newcomer as "stages used in making a stone artifact" (Newcomer, 1975: p.97). It is thought that the term "method" connotes the manufacturing process of a thing more than "technique", and in using this terminology for Levallois one may feel the users' ardent intention to clarify the whole process of Levallois flaking, starting from the initial rough-out of raw material to the final detachment of a flake with a predetermined shape; this is an advance on the research trend which had been popular thus far, in which too much attention was given to Levallois cores and flakes that are no more than the products of the core reduction sequence. Although there is very little difference between Bordes and Tixier regarding the descriptions of Levallois flake and point, some difference can be seen in this joint work concerning Levallois blade (Fig. 99). Levallois debitage, for example, is classified by Tixier, Inizan, and Roche in a stricter sense than Bordes into flake, point, and <u>blade with non-parallel flake scars</u> (----: p.46). They stated, "A Levallois blade core has a rectangular transversal section and two opposed striking platforms. The initial blade bears more or less transversal flake scars which are the same as those on a Levallois flake, but as continuous flaking proceeds, the flake scars on the blade become longitudinal. The essential difference between the removal of Levallois blades and that of the Upper Palaeolithic blades lies in that the ridges formed on the surface of a Levallois blade core were not aimed for facilitating the detachment of the first blade in a serial removal of blades" (----: p.50). It is thought that these authors tried to explain the difference between Levallois blades and the Upper Palaeolithic blades, which Bordes had not demonstrated convincingly.

In 1981, a study was published by Hietala and Marks on the changes in spatial organization at the site of Boker Tachtit, Israel, on the basis of the distribution plans of artifacts and reassembling of a large number of cores and debitage. In 1983, more detailed studies on these artifacts based on the core reconstructions were published (Marks and Kaufman: pp.69-125; Volkman: pp.127-190). The level by level technological processes of core reduction described in these studies may be summarized as follows (Hietala and Marks, 1981; Marks and Kaufman, 1983; Volkman, 1983).

(Level 1): A specialized method of Levallois point core production was executed, which differs from a normal Levallois method in 1) the consistent formation of at least one crested blade during core shaping and 2) the consistent formation of the point configuration by the removal of two blades from the distal end of the core immediately prior

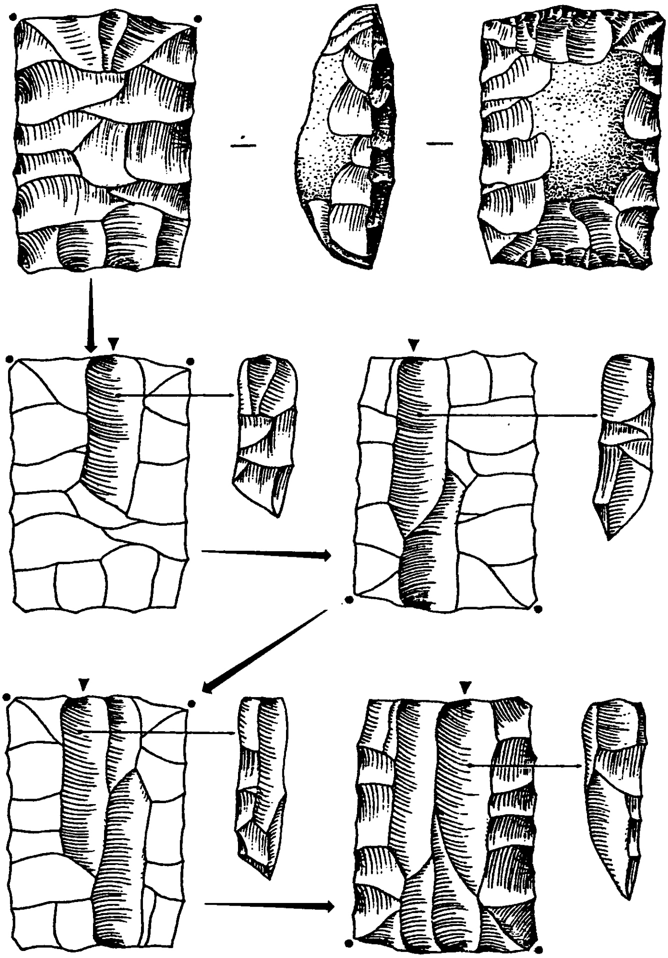


Fig. 99. Scheme of reduction of Levallois blade core (after Tixier et al., 1980)

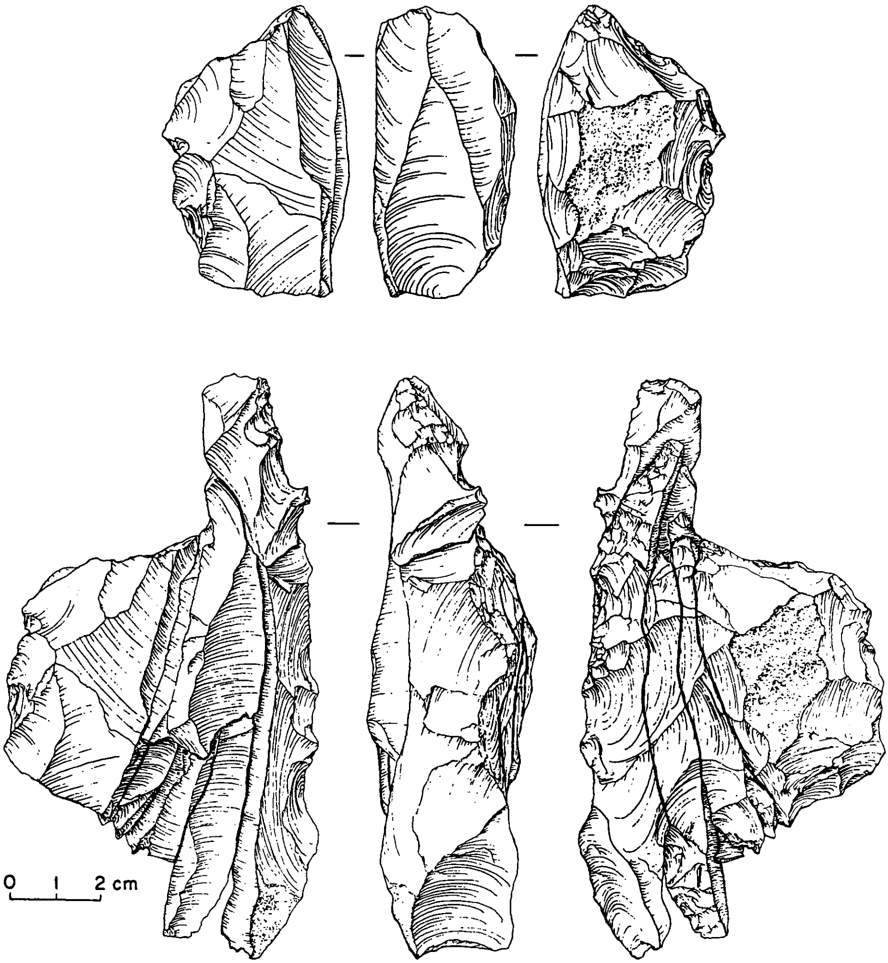


Fig. 100. Reconstruction of a Levallois point core with crested blades and blades: Boker Tachtit, Level 1 (after Marks and Kaufman, 1983; Volkman, 1983)

to the point removal (Fig. 100).

(Level 2): A number of opposed platform cores occur where blades appear to be the desired end product rather than a single Levallois-like point.

(Level 3): There is a marked decrease in Levallois point cores, an increase in opposed platform cores, and a stronger tendency toward single platform cores.

(Level 4): The Levallois method was replaced by a single platform blade technology, although a few opposed platform cores were still produced. Even without the Levallois method, points were still produced, and many of them are morphologically identical to typical Levallois points, although they were produced from single platform blade cores as part of the continuous process of blade removal.

The research results presented in these studies suggest that conjoining of cores and debitage in a given lithic assemblage is indispensable for the full understanding of the technological process in which cores were reduced according to a certain flaking scheme. These studies also suggest that without refitting Levallois cores and debitage, every conclusion regarding their manufacturing process ought to be hypothetic.

An experimental study was published in 1982 by Boëda in which the manufacture of Levallois points was classified on the basis of 30 categories (Boëda, 1982). This system was established in terms of the number of flake scars (three), flaking order, and flaking directions. Boëda performed the experimentation using direct percussion with a stone hammer and both fine-quality Grand-Pressigny flint and flint from Bergerac, France. The results obtained by Boëda may be summarized as follows. If the triangular flake scar at the base of the Levallois point is made at the last stage of the core preparation, the triangular flake derived from it may be either a blade or Bordes' first Levallois point, and the Levallois point next detached is generally elongated with the triangle very slender; two lateral flakes are detached for two purposes: (1) to prepare a longitudinal ridge at the distal portion of the Levallois point and (2) to make smooth longitudinal and lateral slopes of the Levallois point to be detached; if the two lateral flakes are detached from the opposite platform, they leave such two concave negative bulbs as to prevent the Levallois point from plunging when it is detached; and in case the method mentioned above is carried out deliberately, it may produce not only a Levallois point as the final objective but also Levallois or non-Levallois flakes or blades as well as backed or naturally-backed flakes (Fig. 101).

To be particularly noted in Boëda's study is the suggestion that so-called "waste flakes" of various types detached in the preparation of Levallois point cores may have been elaborately produced for certain purposes. This argument seems important, for it is very dogmatic to assert that certain types of flakes were detached from their corresponding cores only. It is highly probable that every stage of the reduction of a Levallois core was performed following a deliberate scheme and many of the resulting flakes were aimed at certain usages.

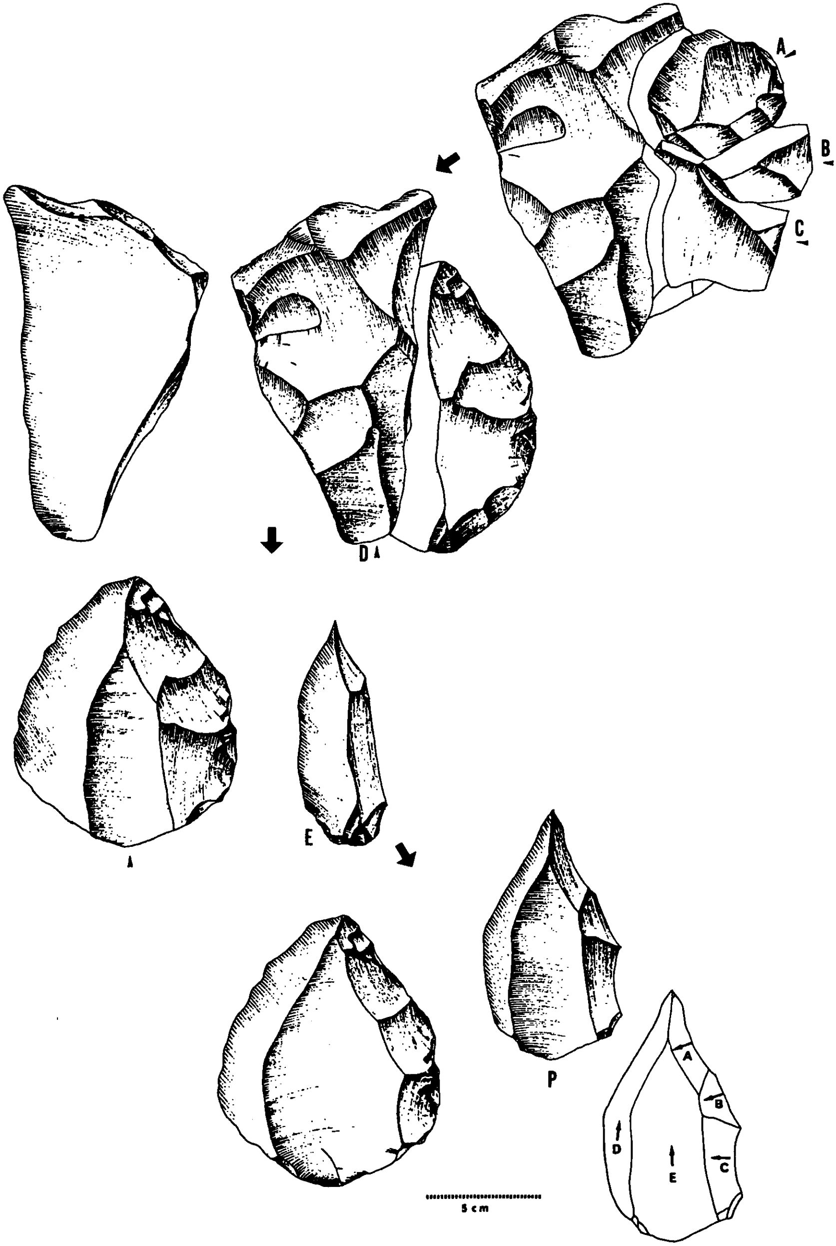


Fig. 101. Experimentally-made Levallois point and by-products (after Boëda, 1982)

A. Levallois flake B and C. Non-Levallois flakes
D. Backed flake resulting from core preparation
E. Levallois blade P. Levallois point

It is thought, therefore, that the consideration or application of Boëda's results in analysing the lithic assemblages with Levallois elements may clarify the way in which they were produced.

The present writer has presented above, although not in exact chronological order, a brief review of the research history of Levallois flaking, chiefly in Europe. It is probable that this technique has been described very similarly by many authors starting with Commont in the beginning of this century through Bordes in the 1960's and up to the present.

The present writer would like to mention some problems with this technique.

(1) A limit of core analysis.

The present writer considers that a flaking technique, Levallois for example, practiced in a certain lithic assemblage, can be clarified through the analyses of cores and flakes of the assemblage.

The first question to arise in this connection is what a lithic assemblage is. As a representative classification system for understanding a given lithic assemblage, the present writer can refer to the one established by Bordes for the Lower and Middle Palaeolithic, mainly of Europe, which comprises cores, debitage, retouched tools and/or weapons, and stone artifacts like hammers. According to Bordes, the cores and debitage of the Lower and Middle Palaeolithic in Europe can be classified as follows (Bordes, 1961; 1972): (core): proto-Levallois (flake, blade), typical Levallois (flake, blade, point), atypical Levallois (flake, blade). Discoidal, Prismatic, Pyramidal, Globular, Shapeless, and miscellaneous. (Debitage): proto-Levallois (flake, blade). typical Levallois (flake, blade), atypical Levallois (flake, blade), Levallois point, non-Levallois (flake, blade, point), Chip (a very small flake), and Hand-axe flake.

As regards cores, a different classification system, based on a different standard from that of Bordes, was published by Leroi-Gourhan (1965: p.247), in which cores were classified into Bipyramidal (*bipyramidal*), Tortoise-shaped (*en tortue*), Wedge-shaped (*en coin*), Tabular (*tabulaire*), Conical (*conique*) and Polyhedral (*polyédrique*) by their morphology, and into Concentric (*concetrique*), Unipolar (*unipolaire*), Bipolar (*bipolaire*), and Multipolar (*multipolaire*) by flaking directions seen on core surfaces (Fig. 102).

Leroi-Gourhan's core classification systems are objective in that they were established on identical standards, but these systems seem to emphasize the descriptive aspects of cores so much that core classes may be easily increased.

Apart from the problem of classifying cores, there is a limit in analysing cores. A core only exhibits the final stage of its reduction and was the thing abandoned when for some reason it was believed difficult to produce any more usable debitage from it (Crew, 1976: p.86). The core analysis, therefore, should be performed first on the final form; "a core is typed on the basis of its final morphology"

(Munday, 1976: p.129). It is highly probable that cores are struck in such a way that they are converted from one class to the other or that they are reduced until nothing is left (Bordes, 1961: p.71), and the use of cores as classification or statistical samples is limited by such conditions.

(2) Actual condition in which Levallois technology was practiced.

As is suggested above, we may try to find out the last detachment[3] on a core if we like to confirm a certain technology practiced, of Levallois flaking especially, through the observation of the core.

Prismatic, pyramidal, discoidal, and globular cores are all classified according to their morphology and as such are typed differently from a Levallois core, for we may type a given core as Levallois when we see on it a fact that debitage with a predetermined shape is detached at the final stage of its reduction after a clear Levallois preparation.

Bordes ignored such a difference in his core classification, determining Levallois cores on the morphological basis which is for the cores typed by shape. It is very probable that Levallois debitage is produced from non-Levallois cores. When a discoidal core is abandoned once and then is used again for the production of a Levallois flake, the flake thus detached is Levallois and the resulting core becomes Levallois with a discoidal shape. Similarly, Levallois points may be detached from cores with prismatic, pyramidal, and discoidal shapes. It is thought, therefore, that the presence of Levallois or the actual condition in which it was executed in a certain lithic assemblage is clarified by the analysis of the finally detached surfaces on the cores as well as by the overall analyses, most desirably by the refitting, of the cores and debitage of the assemblage.

(3) Determination of a Levallois point.

It seems to be extremely difficult to distinguish a Levallois point from a Levallois-like point detached accidentally from a non-Levallois core. There are several published descriptions of the manufacturing process of Levallois points (Bordes, 1961; Tixier et al., 1980) (Fig. 103). The manufacturing process of a Levallois point, however, seems to be ascribed to the quality of raw material or to a personal way of flaking, and it does not seem to be a good basis for differentiating between a Levallois point and a non-Levallois point.

The location of a percussion point on a core[4] seems to be very important in this connection (Fig. 104). It is believed that the point of percussion for the detachment of a Levallois point should be located between two ridges, since a Levallois point (except for a first point) can be characterised by its being flaked off following the Y-shaped ridges prepared on the core.

So, if we find a triangular flake or blade which resembles a Levallois point morphologically but whose percussion point is not situated between two ridges on the dorsal surface, we may regard it as a flake or blade resembling a Levallois point by shape.

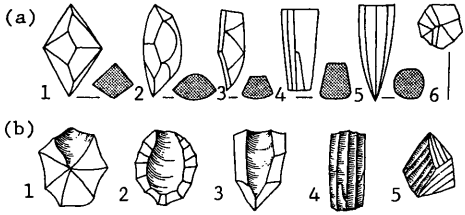
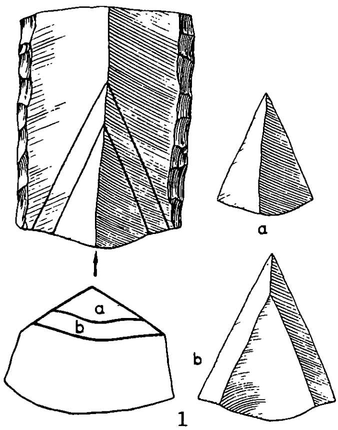


Fig. 102. Core classifications of Leroi-Gourhan (1965)

(a) Classification by shape
1. Bipyramidal 2. Tortoise-shaped 3. Wedge-shaped
4. Tabular 5. Conical 6. Polyhedral

(b) Classification by flaking direction
1. Concentric 2 and 3. Unipolar 4. Bipolar
5. Multipolar



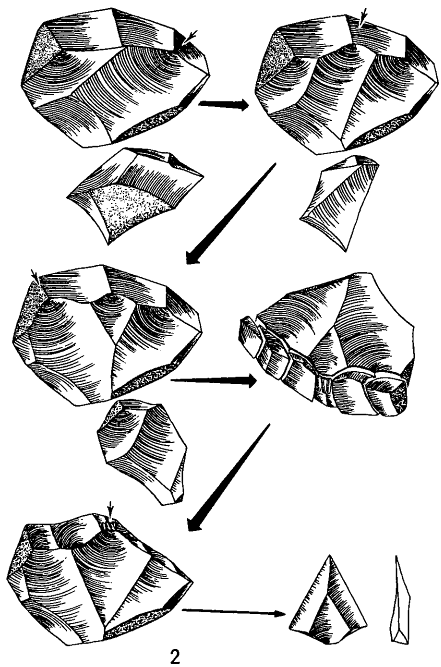


Fig. 103.
Manufacturing processes of Levallois points

1. Scheme of Bordes (1961)
2. Scheme of Tixier, Inizan, and Roche (1980)

(4) Rethinking of "Levallois blade".

It is likely that an elongated Levallois core yields an elongated Levallois flake. An elongated Levallois flake from such a core with the length equal to or more than twice the width can be described as a Levallois blade from a dimensional point of view, but the flake scars recognizable on its dorsal surface are the same as those on a Levallois flake proper.

A problem arises in this respect with a possible case in which a series of elongated flakes are detached continuously from such an elongated Levallois core, most likely with opposed striking platforms. As the continuous removal proceeds, the trace of the original centripetal preparation on the core may be gradually replaced by parallel flake scars. The elongated flakes detached at a later stage, therefore, may not be differentiated from the Upper Palaeolithic blades. It is thought that elongated flakes thus removed can be termed "blade" rather than "Levallois blade", since all the Upper Palaeolithic blades from prismatic blade cores with two opposed striking platforms ought to be termed "Levallois blade", if a series of elongated flakes detached from such an elongated Levallois core ought to be "Levallois".

According to Bordes (1971), the Upper Palaeolithic blade removal is nothing but an elaboration of the Levallois blade technique. In fact, Levallois flaking, in which a series of elongated flakes with predetermined shapes are continuously produced, cannot be easily differentiated, except by the existence of cresting and the shapes of the cores, from the Upper Palaeolithic blade production in their ideas of debitage obtention. It is thought, therefore, that the continuous production of elongated flakes from a Levallois core already exhibits the idea of the serial blade removal which is said to be characteristic of the Upper Palaeolithic and the later industries.

It is necessary here briefly to review some definitions of the so-called "true blade" said to have first appeared in the Upper Palaeolithic. The most famous definition of the true blade is that published in 1969 by Bordes and Crabtree, in which the Lower and Middle Palaeolithic blades were defined to be the flakes with the length equal to or more than twice the width, and blades of the more evolved lithic industries were defined more elaborately: specialized flakes with parallel or subparallel edges, with the length equal to or more than twice the width, with plano-convex, triangular, subtriangular, rectangular, or trapezoidal transversal sections and one or more ridges as well as two or more flake scars running longitudinally in the same direction as the flaking direction of the blades themselves (----: p.1).

According to the blade definition cited above, the blade of the Upper Palaeolithic ought to have flake scars on the dorsal surface running in the same direction as its flaking direction, but this description does not agree with Bordes' ideas published thus far in his other articles. It is clear that the Upper Palaeolithic blades include those with flake scars running in two opposed directions; Bordes had indicated before this joint work with Crabtree that Levallois blade cores sometimes greatly resemble the Upper Palaeolithic prismatic blade

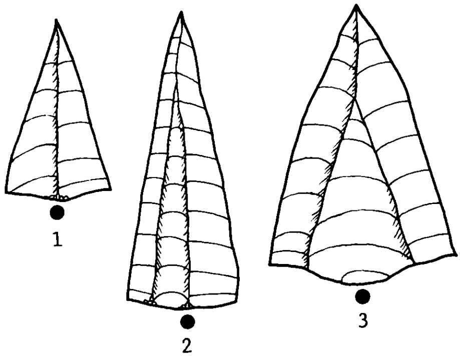


Fig. 104. Locations of points of percussion

1 and 2. Points of percussion located behind a clear ridge
3. Point of percussion located between two clear ridges

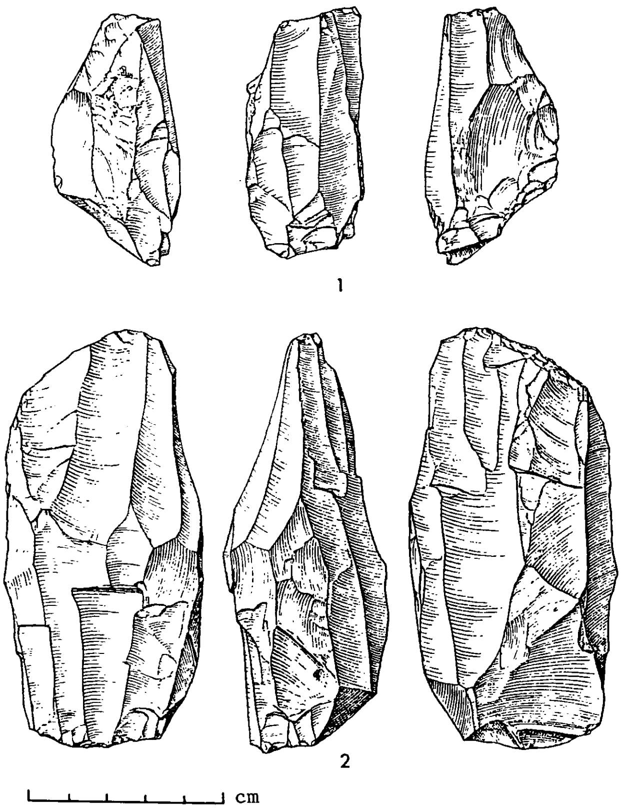


Fig. 105. Prismatic cores with opposed striking platforms of the Middle and Upper Perigordian (after Bordes, 1968b)

cores (Bordes, 1961: p.72), and had illustrated prismatic blade cores with two opposed striking platforms among the blade cores of the Middle and Upper Perigordian of the European Upper Palaeolithic (----, 1968b: p.62) (Fig. 105).

Bordes emphasised the length/width ratio as a defining element of a blade (L≧2xW: Bordes, 1961), as did Wymer (L≧3xW: Wymer, 1968), but it is thought that more attention should be paid to the serial removal of blades which Bordes and Crabtree also emphasised as characteristic. In addition, if we can define blades as predetermined elongated flakes detached continuously from cores with one or two opposed striking platforms, etc., regardless of the length/width ratio, we may define all of the flakes so produced as "blades", whether or not they may be derived from the Indus, the Seine, the Vaal, the Mousterian, the Stillbay, the Soan, or the Neolithic.

It appears therefore that the Levallois cores having prismatic shapes and exhibiting the serial removal of elongated flakes with predetermined shapes can be described as blade cores in the Upper Palaeolithic sense, rather than Levallois cores in the classic sense of a single predetermined detachment. It may be unreasonable to call such cores and flakes "Levallois" only because of the thinness of the core section and the thickness of flake butts; it may be extremely difficult to separate them from the Upper Palaeolithic blades and blade cores only in terms of the thickness of butt or core section. It is thought that these cores exhibit two different ideas in flaking: the classic Levallois idea of the detachment of a single predetermined flake and the idea of the continuous removal of blades or elongated flakes with predetermined shapes which may be Levallois or non-Levallois in morphology.

There are some cautions to be borne in mind in regard to lithic assemblages with "Levallois blades", especially of the Middle Palaeolithic: (a) whether or not centripetal flake scars are recognizable on cores with a prismatic shape and (b) whether or not blades of the Upper Palaeolithic type are found associated and are different from elongated Levallois flakes in their dimensions and existing frequencies. If, for example, both of the conditions (a) and (b) are clear and elongated Levallois flakes are fewer and bigger than the Upper Palaeolithic type blades, it may be thought that these elongated flakes were detached from a Levallois core continuously and that those detached at later stages of core reduction have shapes indistinguishable from Upper Palaeolithic blades. These elongated flakes from a Levallois core may be described as "blades" in their flaking concept and may not be called "Levallois" in the classic terminology.

It is probable, therefore, that the lithic assemblages such as those mentioned above already had the idea of the Upper Palaeolithic blade production associated with the Levallois flaking. It may be questionable, therefore, to regard all of the elongated flakes of the Middle Palaeolithic, thinner and broader than the Upper Palaeolithic blades (Bordes, 1961: p.18). as Levallois and to separate these two by following the major premise that the blade technique proper appeared first in the Upper Palaeolithic.

In this chapter the present writer has briefly reviewed the research history of Levallois, mainly in Europe, and has presented some problems with this technique and its definition.

"Levallois" has long been a difficult problem, and we still see a confusion in which there is no clear definition of it, with each author making his own descriptions.

In addition, "Levallois" seems to contain various techniques of flaking, and we need a new research method in which the idea of Levallois proper is clarified by the removal of every non-Levallois element from it.

NOTES

1. This is a technique for obtaining a series of very long blades, which flourished in the Neolithic at Pressigny-le-Grand, France (Barnes, 1947: p.628) (Fig. 106). First, a longitudinal ridge is prepared along the long axis of an elongated core by a preparation to be called Levallois (Bordes, 1947: p.27), and then a first blade is detached following this ridge. This ridge is strongly reminiscent of cresting which was often executed, chiefly in the Upper Palaeolithic period, to facilitate the removal of a series of blades from a single core, but the directions of flaking are opposite in these two cases (Cheynier and Barnes, 1937). A series of blades are detached continuously after the first blade. The difference between the Levallois and Grand-Pressigny techniques is that the latter was intended for continuous blade removal and so the first blade of Levallois-like appearance was not detached as the final aim but was simply the first of a series.

2. Dortch and Bordes (1977) reported a Levallois technique from Western Australia, and presented some interesting problems with it, stating, "Ord valley (East Kimberley) Levallois point cores range from classic forms from which one or two points were removed (*pointes du premier et du deuxième ordre*, Bordes, 1961, p.18) to transitional forms between Levallois point cores and pyramidal cores, prismatic blade cores and Levallois blade cores. Perhaps the most common of these transitional forms are those intermediate between Levallois point cores and prismatic blade cores" (----: p.4).

3. It is thought that the truncation of rings or fissures recognizable on cores and flakes is a good basis for the determination of flaking order. This standard, however, cannot be applied to coarse material which does not show clear trace of it. The present writer has confirmed from conjoining experiments on the cores and flakes which he produced himself that later flake surfaces have lips of a kind along the ridge running between them and earlier flake surfaces and that such lips are inclined inwards on the earlier flake surfaces (Fig. 107). There is no need to resort to a microscope to confirm this phenomenon; fingers are good enough to perceive this lip. In addition, this phenomenon is independent of the quality of raw material.

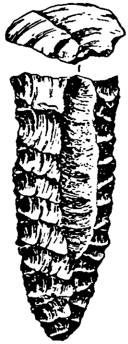


Fig. 106. Grand-Pressigny technique
(after Barnes, 1947)

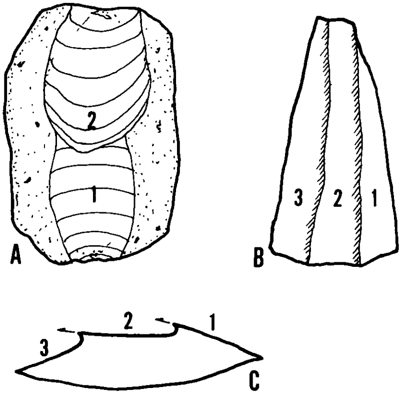


Fig. 107. Determination of flaking order

A: Truncation of rings
B: Truncation of fissures
C: Presence of lips

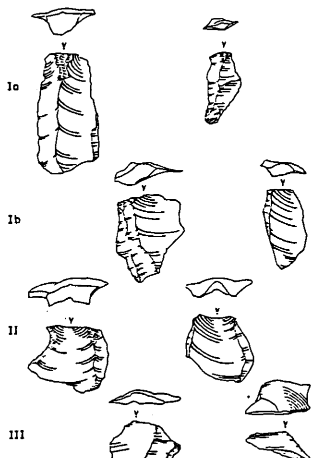


Fig. 108. Relationship between points of percussion and dorsal ridges of flakes (after Gingell and Harding, 1981)

CHAPTER V

CONCLUSIONS

The main objective of this study has been to offer information on details of technology and technological change through the sequence of the lithic assemblages from Ksar Akil, which were unearthed in the 1937/38 seasons of excavations from Squares E4 and F4 of Levels XXV to XIV.

In this final chapter, the present writer would like to review the techno-typological change through the sequence and to consider the significance of the "transitional" levels known as "Phase I" (Azoury, 1971) or "Phase A" (Besançon, Copeland, and Hours, 1977) of Ksar Akil.

Since the systematic excavation at this site was carried out by the Boston College Expedition in 1937, Ksar Akil has been one of the important sites for the Near Eastern Palaeolithic studies, chiefly because of its enormous amount of lithic materials which could be a key to the understanding of the Middle to Upper Palaeolithic transition in Syria, Lebanon, and Palestine.

Garrod (1955), especially, regarded this site to be vital in her establishing Mugharet el-Emireh as the type site of the "Emiran", which she placed at a transitional phase from the Levalloiso-Mousterian to the Aurignacian of the region and which she correlated to the first phase of Neuville's six part scheme for the development of the Palestinian Upper Palaeolithic (Neuville, 1951).

Although it may be true to say that the levels established for Ksar Akil are too thick for modern standards of analysis (see Azoury, 1971: p.28), Azoury (1971) and Newcomer (1972) revealed the techno-typological details of the transitional and early Upper Palaeolithic levels and those of the burin assemblages from the twenty-five Upper Palaeolithic levels respectively.

The present study has demonstrated that the technological change through Levels XXV to XIV was most probably continuous and gradual, and has complemented Azoury's implicit view in her thesis stating, "Although it is suspected that there is a gradual change of technology from a specialized Levallois technique in Phase I of Ksar 'Akil to an industry where the cores are prismatic and the débitage of blanks and tools have mainly punctiform butts in Phase II, this cannot be successfully demonstrated since the methods of excavation were not refined enough 30 years ago" (1971: p.18).

From a technological point of view, Levels XXV to XIV of Ksar Akil can be grouped into two sets of levels (excluding Levels XXV, XXIV, XV, and XIV with too small quantities of material): Levels XXIII to XXI/XX and Levels XX/XIX to XVI. The difference in the technologies of core reduction between these two sets of levels, however, seems to have resulted from a continuous and gradual process of technological alteration through the sequence, since most of the technological attributes gradually change at different paces.

The typological grouping of Ksar Akil levels XXV to XIV presented by Azoury comprised Phase IA (Levels XXV to XXIII), Phase IB (Level XXII), Phase IIA (Levels XX to XIX), and Phase IIB (Levels XVIII to XIV), excluding Level XXI which she considered to be a disturbed archaeological level (1971: p.17), but the present study has identified three sets of typologically distinct levels: Levels XXIII to XXI (including XXV and XXIV), Levels XX to XVIII, and Levels XVII and XVI.

As to the significance of Ksar Akil Phase I, Azoury rejected the term "transitional" defined by Garrod as an "association of flakes and flake-tools of Mousterian type with characteristic Upper Palaeolithic forms --- including narrow punched blades, and the presence, always in small numbers, of the highly specialized Emireh point --- (Garrod, 1955: p.161)". Azoury characterized the Phase I levels by Upper Palaeolithic typology plus "a specialized Levallois technique" which she correlated to the blank production in Levels C and B of Abou Sif (1971: p.16, p.95, p.363).

The biggest difference between Azoury and the present writer in basic methods of analysis has been in this problem of identifying Levallois cores and debitage, especially Levallois blade cores and Levallois blades.

Azoury differentiated Levallois blade cores from prismatic blade cores stressing the Levallois core's less acute angles between core surfaces and regularly faceted striking platforms (1971: p.100), contrasting with the prismatic core's plain or irregularly faceted striking platforms having edge abrasion as well as more acute angles between core surfaces and striking platforms (p.99). She also distinguished Levallois blades from non-Levallois blades in several features such as presence or absence of abrasion marks at the proximal ends, dorsal ridges, length/width ratios, and thickness of the blades (p.116).

In the present study, however, the term Levallois has been restricted to cores exhibiting the final stages of Levallois methods of flaking, since "Levallois" may be determined (see Chapter IV of this study) only at the final stages of core reduction, and should not be confused with purely morphological terms such as "prismatic", "pyramidal", and "discoidal".

Similarly, flake-blades have been defined as Levallois blades only when they have dorsal scar patterns other than uni-directional and bi-directional opposed which strongly suggest stages of the "classical Levallois" flaking, regardless of the other criteria presented by Azoury.

Therefore, most of the cores and blades classified by Azoury as Levallois have fallen into the categories of prismatic cores and flake-blades, and this difference in determining Levallois has consequently led the present writer to interpret Levels XXIII to XXI/XX differently from Azoury who characterized these levels as having a specialized Levallois technique. Furthermore, it is the view in the present study that Levels XXIII to XXI/XX are characterized by a form of blade technology which differs in several respects from "true blade technology".

There are a considerable number of "classical Levallois" cores and debitage in these levels decreasing gradually as one goes up the sequence. There are also a considerable number of prismatic cores in these levels which were converted from Levallois cores, especially from blade and point types. The Levallois blades and Levallois points (elongated in general) from these levels are far more numerous than the Levallois cores, meaning that many of these blades and points were removed from prismatic cores during continuous production of flake-blades or blades.

Levels XXIII to XXI/XX of Ksar Akil, therefore, can be described as having a considerable amount of "classical Levallois" cores and debitage, many flake-blades reminiscent of both Levallois and non-Levallois blades, and a form of blade technology with single-platformed prismatic cores which gives way to blade technology with opposed/opposite-platformed prismatic blade cores.

It seems highly likely, therefore, that these levels represent a certain stage of a Middle to Upper Palaeolithic technological transition, in which Levallois methods of flaking still influenced the technology of blade production.

A similar interpretation was published in 1977 by Besançon, Copeland, and Hours, who described Levels XXV to XXI as being transitional from the production of elongated Levallois debitage to a specialized technology in the production of thick, narrow, and converging shaped blades with large faceted butts (p.11, p.28).

Studies of the lithic assemblages from Boker Tachtit, Israel with persuasive technological analyses based on core reconstructions (Marks and Kaufman, 1983; Volkman, 1983) seem to suggest that there was a broad technological similarity between Levels XXIII to XXI/XX of Ksar Akil and Level 4 of Boker Tachtit.

As to Levels XX/XIX to XVI of Ksar Akil, the production of blades and bladelets is very deliberate, using cresting, re-cresting, overhang removal by abrasion, and marginal flaking with soft hammers or punches. The blades and bladelets thus produced were used as the blanks for tools or weapons such as end-scrapers, backed pieces, and Ksar Akil points. Levels XVII and XVI, especially, seem to represent the northern parallel to the southern Ahmarian such as seen at the Lagaman sites and maybe at Qafza E (Gilead, 1981: pp.269-271; Bergman, 1987: pp.143-144).

The technological distinction between these two sets of levels at Ksar Akil are not absolutely clear-cut however, and a continuous and gradual change can be traced in both the technology and typology.

This continuity was already demonstrated by Newcomer (1972) in his techno-typological study of the burin assemblages from twenty-five Upper Palaeolithic levels of this site.

It may be hoped for the future that further comparative studies of lithic assemblages, said to have existed in the initial period of the Upper Palaeolithic in Syria, Lebanon, and Palestine (Bar-Yosef and Vandermeersch, 1972), will be carried out through detailed techno-typological analyses.

In this connection, it seems highly likely that typological features reflect variations in ecological factors to a considerable extent as Binford and Binford tried to demonstrate (1966). Certain types of tools or weapons may be strong indicators of certain human ways of adaptation to environment, although they do not appear to be good type fossils of a certain industry distributed over a wide area, unless they are studied altogether with technology of their production.

It also seems likely that "techniques by which a (human) group reduced raw material to usable blanks are more directly related to learned motor habits" (Schroeder, 1969: p.455) and are inherited longer than typology.

The elements constituting a given technology may also have been devised in trials to produce tools or weapons needed at a given site, and variations in technological elements at different sites, therefore, may be better understood through studying typological variations.

It is believed that more inter-site comparisons, based on detailed analyses of technology and typology which can be separated from each other, will greatly clarify variations of the lithic assemblages of the initial period of the Upper Palaeolithic in Syria, Lebanon, and Palestine, including those from Ksar Akil, Abou Halka, Antelias Cave, Amud Layer B, and Boker Tachtit.

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APPENDIX 1

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THE CHAMFERED PIECES FROM KSAR AKIL (LEBANON)

M. H. Newcomer

Broadly speaking the term chamfered piece covers a range of types which are morphologically close to endscrapers but technologically allied to burins. The first section of this paper comprises a brief review of the literature on these tools from various sites and the second is a more detailed technological and typological analysis of chamfered pieces from Ksar Akil. The types proposed are meant for Ksar Akil only and represent an attempt to strike a balance between over subdivision and over simplification. In my opinion the fate of chamfered pieces in the literature so far has been a tendency towards over simplification, the novelty of the class itself (when it is rigidly defined!) being felt to be sufficient without further detailed analysis.

The term "*lames et éclats à chanfrein*" was first used to describe a group of upper palaeolithic tools by Haller (1942-43). For a series of pieces from Abou Halka levels IV e and f he gave the following description (Haller *op.cit.*:12): "*un éclat ou (une) lame épaisse, qui se termine en chanfrein par une facette sectionnant l'outil carrément ou légèrement de biais. Les angles formés par la facette terminale et les pans lateraux sont émoussés ou encochés par de petites retouches, alors que la partie mediane du biseau reste intacte.*" Haller thought that perhaps several pieces illustrated in Turville-Petre's el-Emireh report (1925) were "*lames et éclats à chanfrein*"; however in Garrod's later report on el-Emireh (1955) she states that there are no "*lames et éclats à chanfrein*" and only one rough transverse burin. At least two earlier publications however describe and illustrate tools corresponding to Haller's definition. The first is Vignard's report on the industry from Champ de Bagasse, near Nag Hamadi (Egypt), in which he mentions a new "*espèce de burins*" in which "*le coup de burin... a été frappé perpendiculairement au grand axe de la pièce... il conserve quelquefois... une certaine obliquité, mais il épouse toujours la forme de la pièce et, s'incurvant, donne à l'outil la forme d'un grattoir sans retouches*" (Vignard 1920: 8). Some of these tools however appear to be normal transverse burins in the accepted sense, and in two later publications Vignard (1929, 1953) identifies those pieces from Champ de Bagasse and the lone inverse example from Menchia with the true French transverse burins.

In 1937 Crowfoot wrote of a series of "blade sections" from neolithic Jericho (layers IX-XII) which have "a very shallow notch... on one corner... and a transverse facet (which) runs from this notch to the opposite edge of the blade" (1937: 47). She believed them to be made by a sort of microburin technique, described by Octobon (1935), which involved notching the blade margin, putting this notch on a narrow anvil, and striking the opposite edge with a wooden bar. After examining a series of the pieces at the Institute of Archaeology, London, I am led to doubt whether they are tools or whether they even represent a uniformly applied technique. Perrot (1968) has suggested that they may represent a method for shortening and narrowing blades for fitting them into the slots of a sickle haft. The lateral margins of some specimens do indeed show silica gloss, but many do not, and the technique was applied in one case to a core rejuvenation flake unsuitable for use in a sickle. Furthermore, while some facets run across the dorsal surface of the blade as in Crowfoot's illustration (Crowfoot *op.cit.* pl.10), others go squarely over the top as in a transverse burin and still others run over the ventral surface only.

In 1950, McBurney published tools from the lower levels (4, 5 and 6) of Hagfet ed Dabba (Libya) which he called "*une forme spéciale de burin transversal*" (McBurney 1950: 207). According to him these were a new type, made "*par un coup donné sur un des bords retouchés*" and he illustrates a series of spalls.

In a subsequent publication McBurney elaborated on these "transverse burins" from Dabba, stating that they are "generally made on a thick flake", nearly always struck from the left margin, and have "an average angle of about 45° to the plane of the bulbar face of the blade" (McBurney and Hey 1955: 202). He also notes "fairly constant ratio of just under three squills (spalls) per burin" and that these spalls may take off as much as 1 cm. of the blade's end, although 2-3 mm. is more normal.

In recording the presence of similar tools from the "Dabban" levels at the Haua Fteah (Libya), McBurney (1967) attempted to clear up the terminological and technological problems surrounding this tool group with dubious success. A possible misprint puts Vignard's first description at 1926 instead of 1920, Crowfoot did <u>not</u> use the term "chamfered blade" (this is McBurney's own invention), and Haller did <u>not</u> propose the term "*lame chamfrée*" (see above for Haller's term). McBurney here gives a novel possible method of manufacture, suggested by V. Chmielewski, that of inserting the blade into a tubular bone and rotating the blade to take off the transverse spall. He further states that "it is certain that an ordinary free-hand burin blow will not work satisfactorily, if at all". In view of these statements about manufacturing techniques (see below for criticism of his and Crowfoot's suggestions) and the fact that the Jericho examples are neolithic, the conclusion arrived at in his next paragraph hardly seems justified: "Such a combination of technological and typological characteristics provides a valuable cultural indicator" (McBurney *op.cit.*: 143).

Chamfered pieces have also recently been reported in quantity from Layer B of Amud Cave (Israel) but unfortunately the accompanying drawings are sparsely shaded and difficult to interpret (Watanabe 1964 a & b). Only one of the illustrated tools could in my opinion be a true chamfered piece, while the rest appear to be broken pieces with the edges of the break retouched. Watanabe defines them as "fragments of flakes and blades with a retouch at a corner formed by the intersection of the transversally mutilated facet and the original edge of the flake" (1964b: 20). This is also difficult to interpret, but since in both articles he compares his material with the undoubted "*lames et éclats à chanfrein*" from Abou Halka, the point is open to question.

Mrs. L.Copeland has kindly shown me a collection of 72 chamfered pieces from level V at Antelias Cave which, before destruction by quarrying, was located less than half a mile south of Ksar Akil on the right-hand branch of the Wadi Antelias. Mrs. Copeland has pointed out to me the close similarity in method of manufacture and complexity of form of this Antelias V material to that of Ksar Akil.

A word about terminology would be appropriate before proceeding with definitions. "Chamfered piece" is used here as it is briefer than Haller's "*lames et éclats à chanfrein*" and more accurate than McBurney's "chamfered blades" (the chamfer may of course be on a blade or a flake). It may be defined as a flake or blade which shows evidence of the use of chamfer blow method (the distinction between "method" and "technique" as outlined by Tixier (1967) is followed here). "Chamfer blow method" is a variation of the method for producing a burin on retouched truncation involving two stages: one, the preparation of an abrupt retouched platform (lateral straight or concave, or distal concave) usually at the distal end of a blade or flake, and two, the production of a transverse or clearly oblique facet (the "chamfer facet") which runs across the dorsal surface of the blade or flake, is slightly arced, sharp edged, and has a negative bulb of percussion adjacent to the retouched platform (fig. 1).

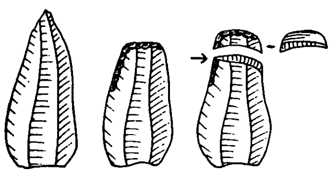

Figure 1 Method of manufacture

The main by-product of this method is the "chamfer spall" which in its most easily recognised form consists of the distal tip of a blade or flake with the following characteristics: the remains of the retouched platform on one margin, a bulb of percussion adjacent to this platform, and an obtuse angle between the ventral surface of the spall and the original ventral surface of the blade or flake from which it was removed.

The chamfered pieces from the Boston College 1937-1938 excavations at Ksar Akil were studied at the Institute of Archaeology, London University, while working on a thesis on the burins from this site. These tools appear in quantity in only four levels; there are 27 in level 25, 55 in level 24, 263 in level 23 and 228 in level 22. Their importance as a tool group in these levels cannot be overstressed as they outnumber every other tool type in certain levels and appear and disappear from the sequence rapidly. There are one each from levels 30, 28a, 28b and 26a of the 1947-48 excavations and only 7 from level 21, 5 from level 20, 2 from level 19 and 3 from level 17.

From such a large selection of chamfered pieces (total 590) one is able to derive a good picture of the techniques used in their manufacture and re-sharpening. The method of manufacture described above was easy to deduce from a careful observation of undamaged specimens made on fine-grained raw material. So far as the actual techniques used are concerned we may only make reasoned guesses based on working flint experimentally. The first stage of "chamfer blow method", the preparation of the retouched platform, requires little comment. As with the preparation of a truncation on a burin a relatively wide retouched surface is more easily made with a hammerstone than a soft hammer. The blade or flake may be either hand held or rested on an anvil, although the irregularity of the retouch on Ksar Akil specimens indicates hand held work. The second stage, the blow itself, may, like the burin blow, be accomplished by several techniques all of which can yield good replicas of the chamfer facets as found at Ksar Akil. The first and most obvious is direct percussion with hard or soft hammer. In order to take off a spall which goes over the dorsal surface instead of over the top as in a transverse burin, the blow should be angled upwards slightly from the ventral surface of the blade or flake. When blows go short as happened fairly frequently at Ksar Akil (and in my experiments) the offending hinge or step at the end of the facet may be retouched off to yield a smooth profile. Oddly enough the other extreme of badly executed blows, the plunging blow common in burin (and blade) manufacture does not seem to exist at Ksar Akil and I have not been able to produce a plunging chamfer spall experimentally. Probably the angling upwards of the blow and its transverse nature help explain this feature. A second technique is by swinging the prepared platform sharply against an anvil. Pressure flaking is a third possible technique but I doubt whether any of the pieces from Ksar Akil were made this way as the negative bulbs of the chamfer facets are usually well marked and the rest of the industry shows no evidence of the technique.

Crowfoot's idea of a laterally retouched notch being placed on an anvil and the opposite margin being struck with a wooden bar has not produced good results for me; the facets produced are straight rather than gently curved, the angle of the facet difficult to control, and a certain amount of crushing occurs on the ventral and dorsal surface of the blade where the soft hammer strikes, a feature not present on the Ksar Akil (or Jericho) chamfered pieces (Crowfoot 1937: 48). In any case the Jericho pieces are not all made on notches. Chmielewski's suggested technique of putting the blade into a tubular bone and twisting was obviously devised with only parallel sided blades in mind (McBurney 1967: 143); it has not worked at all for me.

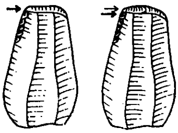

Figure 2 Method of resharpening (1)

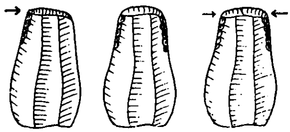

Figure 3 Method of resharpening (2)

Resharpening of chamfered pieces seems to have been carried out frequently. Three methods may be inferred: the first was by striking on the original retouched platform which often renewed only part of the edge (fig. 2). It is not always possible to say definitely whether this method has been used or whether as is sometimes the case with burins the original blow has removed two spalls at once. The second was by making a new platform on the opposite margin and giving the chamfer blow, again renewing part of the edge only (fig. 3). The third involved lengthening the original or secondary platform (or striking lower on a platform made long perhaps with resharpening in mind) and removing the whole top of the piece (fig. 4). Sharpening spalls from the first two methods would be extremely difficult to recognise. Of the lamentably small total of 8 spalls from this collection, 7 are the result of the third method of resharpening and carry an old facet on the distal end, the eighth having a truncation (fig. 8 nos. 13-18). Figure 8 number 13 shows the failure to produce a new chamfer edge using methods one and two, due perhaps to the visible flaw in the raw material.

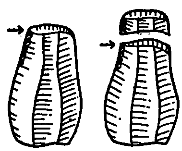

Figure 4 Method of resharpening (3)

The function of these tools, like most other palaeolithic types, is unknown. An examination under a low-power binocular microscope (27X) revealed that the chamfer edge did consistently show damage, most commonly on the dorsal surface, in the form of a row of small irregular flake scars. The same sort of damage was duplicated experimentally by dragging the chamfer edge over a piece of wood or bone in one direction only, toward the worker. Pushing the tool produced edge damage on the ventral surface. Measurement of the angle between chamfer facet and ventral surface on 100 chamfered pieces (all types) gave 53° as the mean, while the mean angle between scraper front and ventral surface on 100 scrapers (all types) from levels 25-22 was 72°, suggestive of different functions. Acutely edged chamfered pieces produced experimentally proved effective as knives. Any systematic work on the problem of function was ruled out by the amount of fresh damage all edges had sustained either during excavation or in storage.

Typological subdivisions within the group of chamfered pieces are certainly possible to make with the Ksar Akil material. These must be based on the position and shape of the retouched platform and the direction of the chamfer blow. Although they are close to burins technologically no twofold subdivision into "dihedral" and "on retouched truncation" (as is common practice in recent burin classifications) is possible since all but 4 of the 590 chamfered pieces are made on a retouched platform. Two of these exceptions were made using a vertical burin facet for the chamfer blow platform (e.g. fig. 8 no. 10), the other two being made on an unmodified flat surface or "natural" platform (e.g. fig. 8 no. 12). This has definite stylistic if not functional significance since my experiments have shown that it is as easy, if not easier, to produce the chamfer edge from a burin facet platform than from a retouched one.

The types of Ksar Akil chamfered pieces are the following:

1. CHAMFER ON STRAIGHT LATERAL RETOUCHED PLATFORM (fig. 5 nos. 1, 2; fig. 6 nos. 1-16)

This is the simplest type, one of the lateral margins having an abrupt retouched platform, and a chamfer facet more or less at right angles to this retouch and the axis of the tool. Variations do occur, the most common being when the chamfer method is applied to a rounded flake rather than a parallel sided blade; here the retouched platform may curve slightly around the corner of the flake following its original contour (fig. 5 no. 2; fig. 6 no. 10). A high percentage of type no. 1 (27%) have retouched platforms on both margins, indicating that resharpening had taken place at least once in the tool's life (fig. 6 nos. 2, 10, 12, 15). The reason for making a new platform on the opposite margin is uncertain, but my experiments suggest that continued resharpening attempts from one margin only using the first sharpening method described above eventually lead to hinge fractures from chamfer blows that do not carry all the way across the top of the piece (fig. 6 no. 16).

1
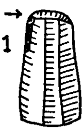
Figure 5-1

2
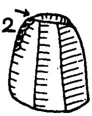
Figure 5-2

2. CHAMFER ON LATERAL RETOUCHED NOTCH (fig. 5 no.3; fig. 7 nos. 1-8)

On this type the platform for the chamfer blow is a retouched lateral notch which alters the outline of the piece. The chamfer facet is again more or less perpendicular to the axis of the piece. The use of a notch rather than straight lateral retouch may be related to the thickness of the margin of the blade or flake; when it is thick a little straight retouch will provide a suitable platform, when thinner, a notch encroaching into the thicker centre of the blade or flake solves the problem. A smaller percentage (15%) of this type shows the remains of a secondary platform on the opposite margin (fig. 7 no.3).

3
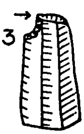
Figure 5-3

3. OBLIQUE CHAMFER ON DISTAL RETOUCHED NOTCH (fig. 5 no. 4; fig. 7 nos 9-16)

Type no. 3 has a more or less concave retouched platform placed at the end of the blade or flake, and a chamfer facet oblique to the axis of the tool. This type cannot be accounted for by technical contingencies, as type no. 2 may be. It is possible that the retouched platform formed part of the working edge of the tool. In some cases the sharp spur (false burin edge) between the chamfer facet and the platform has been retouched off, in other cases not.

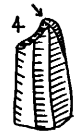

Figure 5-4

4. NOSED CHAMFERED PIECE (fig. 5 no. 5; fig. 8 nos. 1-4)

Type no. 4 resembles a nosed scraper in outline. The chamfer facet is bounded by two retouched notches, one or (rarely) both serving as platforms for the chamfer blow. Variations of type no. 4 may have nearly straight retouched platforms.

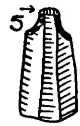

Figure 5-5

5. MULTIPLE CHAMFERED PIECE (fig. 5 no.6; fig. 8 nos. 5-7)

This type is rare but distinctive, two chamfered edges being associated on the same blade or flake, usually at opposite ends. This type is too rarely encountered in the Ksar Akil material to justify creating subtypes based on which of types 1-4 are associated.

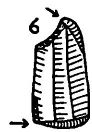

Figure 5-6

6. COMPOSITE CHAMFERED PIECE (fig. 5 no. 7; fig. 8 nos 8,9)

Type no. 6 is the composite tool, having either a scraper or a burin and a chamfer facet, again usually at opposite ends.

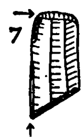

Figure 5-7

7. MISCELLANEOUS (fig. 8 nos. 10-12)

The final category, Miscellaneous covers all pieces not referable to types 1-6. There are a few bizarre forms here (fig. 8 no. 11), some broken and damaged pieces impossible to assign to a type, as well as pieces which might be considered as transitional forms between burins and chamfered pieces, although it should be noted that transverse burins are not common in these levels.

A fair number of pieces from Ksar Akil levels 25-22 show clear signs of having once been chamfered pieces but have since been transformed into various types of end scrapers. Since they are now end scrapers they have not been included in this study. Only the two chamfered pieces made on burin facets can be considered as tools transformed into chamfered pieces.

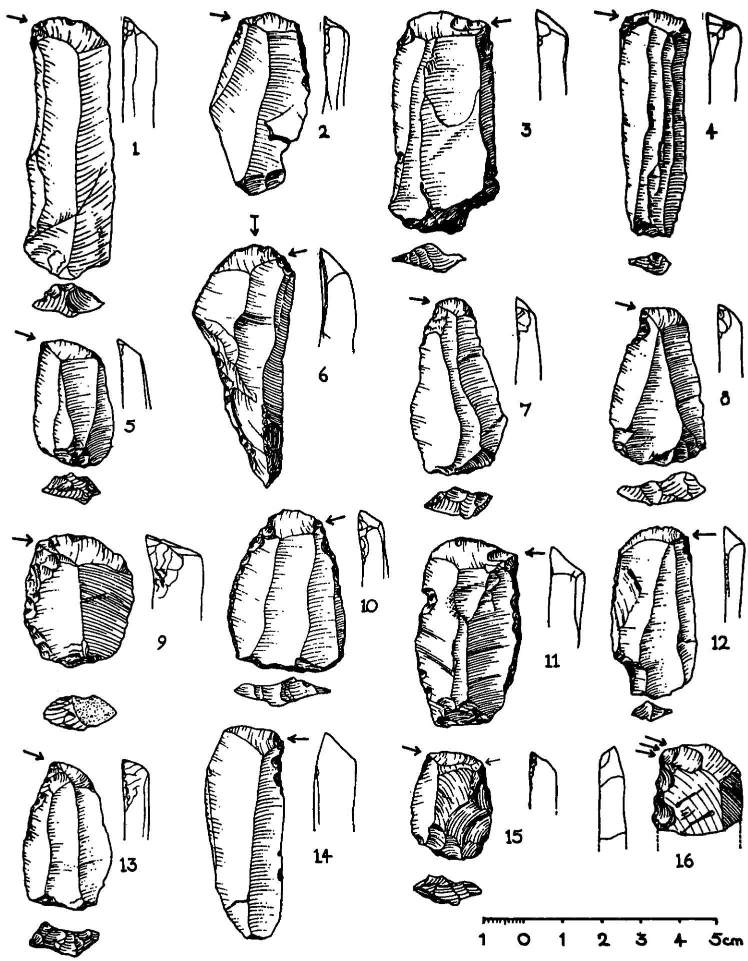

Figure 6 Numbers 1-16 type 1 (1,9 level 25; 2,11 level 24; 3,6,7,12,13,16 level 23; 4,5,8,10,14,15 level 22)

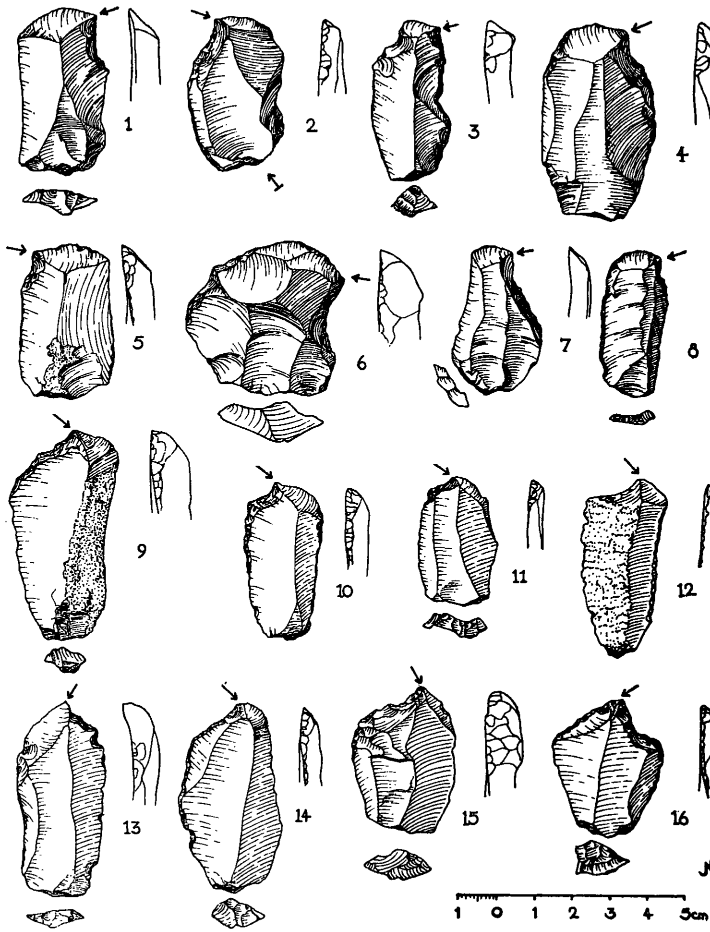

Figure 7 Numbers 1-8 type 2; numbers 9-16 type 3 (6 level 25; 15,16 level 24; 1,3,4,7,8,12 level 23; 2,5,9,10,11,13,14 level 22)

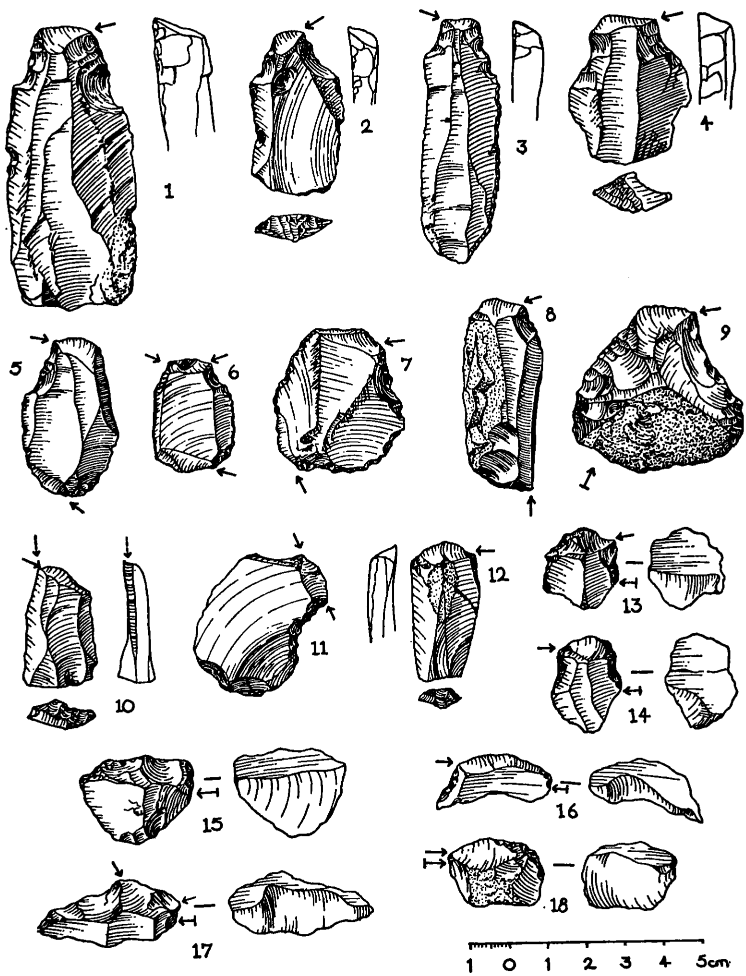

Figure 8 Numbers 1-4 type 4; numbers 5-7 type 5; numbers 8,9 type 6; numbers 10-12 miscellaneous ; numbers 13-18 chamfer spalls (4,8,12 level 24; 1,2,3,11,13,14,15,16,17,18 level 23; 5, 6,7,9,10 level 22)

	1	2	3	4	5	6	7	T.C.P.	T.T.
25	15	3	7			1	1	27	70
	(55.6%)	(11.1%)	(25.9%)			(3.7%)	(3.7%)		
24	28	8	7	4	2	2	4	55	115
	(50.9%)	(14.5%)	(12.7%)	(7.3%)	(3.6%)	(3.6%)	(7.3%)		
23	124	46	54	18	8	4	9	263	537
	(47.1%)	(17.5%)	(20.5%)	(6.8%)	(3.0%)	(1.5%)	(3.4%)		
22	108	39	44	9	15	6	7	228	1,633
	(47.4%)	(17.1%)	(19.3%)	(3.9%)	(6.6%)	(2.6%)	(3.1%)		
21	2		3	1			1	7	511
20	4	1						5	905
19	2							2	575
17	1	1	1					3	1,536
	284	98	116	32	25	13	22	590	

T.C.P.: Total Chamfered Pieces T.T.: Total Tools

It will be seen from the table above that only levels 24, 23 and 22 have enough chamfered pieces to warrant presentation on a cumulative graph (fig. 9). The marked similarities between those three levels is obvious and any attempt to trace an "evolution" of this tool group within these levels at Ksar Akil may be ruled out. Even level 25 with only 27 pieces seems to be part of the same general pattern. For the purposes of illustration then, the total of 590 pieces will be considered as a unit from which various examples of each type are drawn. The number of each type figured is roughly proportional to its frequency of occurrence in levels 24, 23 and 22.

The sudden appearance of chamfered pieces at level 25 and their virtual absence after level 22 will be made clearer when the report on the total tool assemblages appears. Since I have seen only a small amount of the material from Dabba, Haua Fteah and Jericho (and none from Amud, Abou Halka, Champ de Bagasse or Menchia) this report is comparative in only a very limited sense and generalisations about possible relationships between assemblages containing chamfered pieces would be premature. At any rate it may be hoped that Garrod's (1955: 161) speculation ("... it will be interesting to see if ... (chamfered pieces occur) in the transitional layer of Ksar Akil") has been answered.

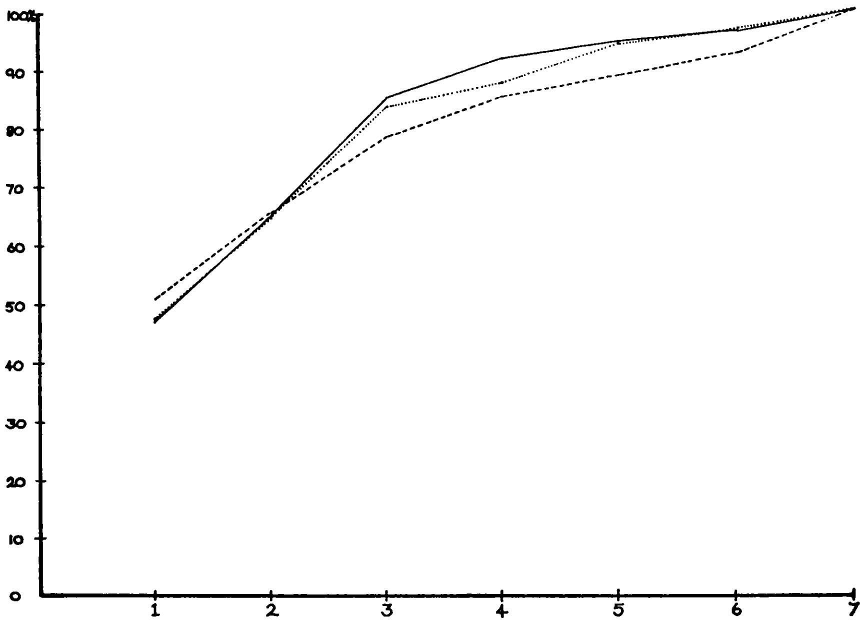

Figure 9 Cumulative graph showing distribution of 7 types of chamfered pieces in levels 24, 23, 22 (broken line level 24; solid line level 23; dotted line level 22)

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APPENDIX 2

UPPER PALAEOLITHIC POINT TYPES AT KSAR AKIL, LEBANON

C. A. Bergman

Author's note: This paper is a revised and updated version of an article originally published in 1981 in the volume *Prehistoire du Levant* CNRS, Paris.

Introduction

The Ksar Akil rockshelter is located in the Republic of Lebanon about 10 km northeast of Beirut (see Azoury 1986 and Bergman 1987 for more detailed information on Ksar Akil). The site has a long record of Upper Palaeolithic habitation and, as such, is ideal for the study of specific tool types and their changes over time. This paper presents a preliminary examination of the typology, technology and chronology of the point types. The earliest work at Ksar Akil used the Western European model, with its accompanying terminology, as a means to describe the various levels and their artefacts. Thus Ewing (1947) referred to the material recovered at 12.00 - 7.00 m as Chatelperronian. However, it soon became clear that the Near Eastern Upper Palaeolithic sequence differed markedly from that in Europe. This necessitated the development of a new scheme better suited to describe the evolution of the Levantine Palaeolithic. In 1969 an important conference on Near Eastern prehistory was held in London (Wenner Gren Symposium 1969) and dealt at some length with the problems of describing the Ksar Akil sequence. It was decided by the participants to divide the Upper Palaeolithic material into three major phases: I (levels XXV-XXI), II (levels XX-XV) and III (levels XIII-VI); the last phase, also known as the Levantine Aurignacian, was further divided into three subphases: A (levels XIII-XI), B (levels X-IX) and C (levels VIII-VI). While recent work has generally upheld the validity of these divisions (Copeland 1975; Besançon *et al.* 1977; Azoury 1986; Ohnuma 1986; Bergman 1987) there have been some modifications, most notably concerning the Levantine Aurignacian (Bergman 1987). It is no longer felt that phase III can be divided into three subphases which are, by implication, developmentally related. It has been decided to separate this series of levels into four distinct groups known as phases 3-6 (Bergman 1987: 147-148). The current view of the Ksar Akil sequence, therefore, comprises six major stratigraphic units (phases 1-6) made up of some 20 distinct levels. Beginning with the earliest material, and continuing through the sequence, we shall briefly examine the characteristic tool types and techniques of debitage of each phase before describing the relevant point types.

Material and Method

The artefacts that are presented in this article come from the

1937-1938 Boston College excavations of Ksar Akil (Murphy 1938; 1939; Ewing 1947; Bergman and Copeland 1986). While it must be recognised that these excavations were not carried out using today's methods, it is still felt that the material can be used to gain a general understanding of the typology, technology and relative chronology of the stone industries. The excavations carried out from 1969-1975 under Tixier (1970; 1974; Tixier and Inizan 1981) present a far more accurate and refined view of the sequence at Ksar Akil. Unfortunately, Tixier's excavations were interrupted by the civil disturbances in Lebanon and reached a depth of only 8.75 m which covers about 1/3 of the known deposits. This leaves the Boston College collections as the only material presently available covering the early Upper Palaeolithic at Ksar Akil.

The type list used below was formulated by Hours and discussed at the Wenner Gren Symposium (1969). It was later published under the heading "*Liste-Type developpé pour le Paléolithique supérieur et l' Epipaléolithique du Liban*" (Hours 1974). This particular type list was selected for two main reasons: 1) the list was specifically developed for the analysis of Upper Palaeolithic material from Lebanon, and 2) as it has already been used by other authors it was felt best to keep to a common nomenclature rather than create confusion by using new terms.

Upper Palaeolithic Phase 1: Levels XXV-XXI/XX

The first Upper Palaeolithic phase (UP 1) at Ksar Akil occurs at a depth of 15.05 - 13.70 m and includes levels XXV-XXI/XX (Azoury 1986: 34; Ohnuma and Bergman in press). Levels XXV-XXI/XX can be separated into two subphases on the basis of the flaking technology. The first group of levels, XXV-XXIV, are represented by a small sample in the 1937-1938 collections but appear to be characterised by opposed platform cores with parallel sides (Marks 1983; Ohnuma and Bergman in press). Levels XXIII-XXI/XX, on the other hand, have single platform blade cores which are triangular in shape with converging sides (figure 1: d, h-i). While there are differences in the technology between the two groups of levels they appear to be strongly related typologically. All of the tool kits are composed of varying percentages of Upper Palaeolithic types including end-scrapers, truncation burins and chamfered pieces (Azoury 1986: 24).

Since there is relatively little material available from levels XXV and XXIV the following comments are restricted to levels XXIII-XXI/XX. The technique of debitage used for the production of blades in these levels involves the use of single platform cores with faceted platforms. The method of detaching the blades relies on striking back from the platform edge (non-marginal flaking) resulting in relatively thick blanks with large, faceted butts. Due to the presence of these technological features, as well as the production of pieces morphologically identical to elongated Levallois points, the flaking technology was described by Azoury (1986: 86-88) as a "specialised Levallois technique". Recent work by Ohnuma (1986) and Marks and Volkman (1987) has avoided the use of the term Levallois in describing this kind of flaking technology; these authors prefer to describe the method of flaking used in levels XXIII-XXI/XX as one form of early Upper Palaeolithic blade technology. The 'Levallois' points in these

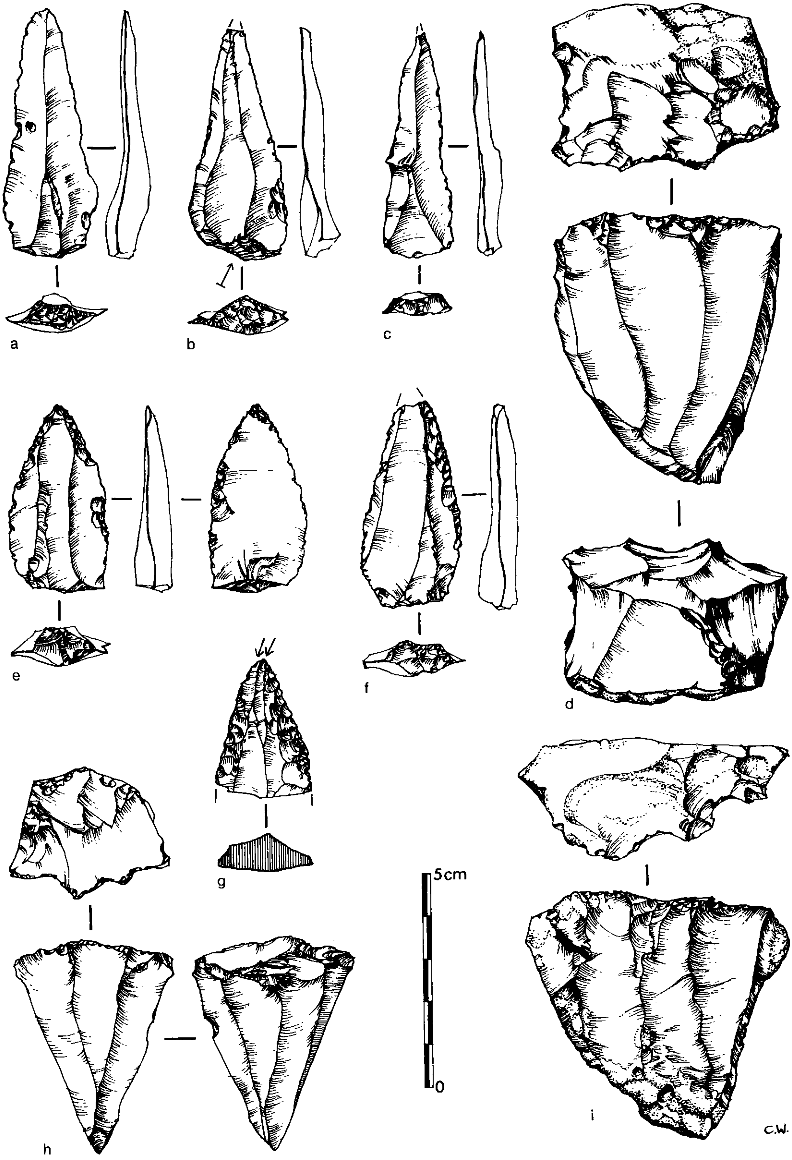

Figure 1 'Levallois' points (a-c), Mousterian points (e-g) and blade cores (d,h-i) levels are the occasional by-products of blade manufacture and do not appear to be the result of a specific flaking strategy aimed at their production alone (Marks and Volkman 1987). The points are produced when previous blade removals converge, due to the shape of the core, to form a triangular configuration. Blades are far more numerous than points which seems to indicate that the main intention of the knappers was series blade production.

Within these assemblages three point types were studied: the 'Levallois' point ([Hours' list] type A1), the Mousterian point (type A2) and the el-Wad or Ksar Akil point (type I2 or I3). Levallois points as defined by Bordes (1961; 1980) are characteristic of UP 1 and are rare or absent in the later phases (figure 1: a-c). A total of 101 points were examined of which 82 are elongated. This tendency towards production of elongated debitage is reflected in the types of cores used to produce these blanks which are pyramidal and prismatic blade cores (figure 1: d, h-i). One important technological feature is the faceting of the striking platform which modifies the flaking angle as well as minimizes overhang. Of the 101 points examined here 79 had faceted butts, while the remainder had partially faceted butts (Azoury 1986: 90). This latter butt type seems to indicate that faceting was used only when necessary to modify specific areas of the striking platform. Several of the points have discontinuous semi-abrupt retouch along one or both lateral edges on the dorsal surface. Elongated 'Levallois' points were occasionally used as blanks for the manufacture of burins (Azoury 1986: 56).

Mousterian points (Bordes 1961) occur in UP 1 but are rare (figure 1: e-g). They are most numerous in level XXII which has 13 examples and 12 of these are from the same $2m^2$ excavation unit (square F4). Elongated Mousterian points are the most common type and of those tools which have their proximal ends preserved eight have faceted butts and one has a plain butt. In profile all of the complete pieces are straight except two which are slightly curved. The pointed tip always occurs at the distal end and is formed by direct, semi-abrupt retouch which is sometimes scalar; abrupt retouch occurs on only two points. When compared with the other retouched point type found in UP 1, the el-Wad point, this group is quite distinct in terms of the style and position of the retouch used.

Before beginning the discussion of the el-Wad point in UP 1 it is worthwhile to mention a terminological problem which has appeared relatively recently. During the course of extensive field work by Israeli and American archaeologists in the northern Sinai a series of early Upper Palaeolithic sites referred to as 'Lagaman' were excavated (Bar-Yosef and Phillips 1977; Gilead 1981). The Lagaman industry is characterised by a developed blade/let technology along with numerous blade/let tools. Included among the latter are a group of artefacts identical to the Ksar Akil points of the Hours' type list (1974); however, these are called el-Wad points by Israeli prehistorians (Gilead 1981: figure 5,7). The confusion surrounding these two tool types is due, in part, to the fact that in Lebanon they are seen as having different chronological implications: the Ksar Akil points are earlier, while the el-Wad points are later (Copeland 1970; Copeland and Hours 1971; Bergman 1981; Copeland 1986). At Ksar Akil the term el-Wad point has traditionally been reserved for pieces in the Aurignacian levels XIII-VI only (see for example Copeland and Hours 1971; Copeland 1975; Besançon *et al.* 1977). While the two types, Ksar Akil and el-Wad points, can perhaps be separated on a chronological basis it is difficult to do so using morphological criteria; both types are described as blades or bladelets pointed by direct retouch (Bergman 1981; Azoury 1986: 56, 60; Copeland 1986: 13; Ohnuma 1986: 60). In addition, the morphological variation seen in the retouched points at Ksar Akil (excluding the *pointes à face planes*) is due to technological rather than typological factors. In other words, it is the original shape and size of the blanks produced to make these tools that most affects point morphology. As it is impossible to separate the points by typological description alone it is recommended that the term Ksar Akil point be dropped in favor of el-Wad point.

The el-Wad point at Ksar Akil is defined as a blade or bladelet pointed by fine, semi-abrupt or abrupt retouch or combinations of these on the dorsal surface at the distal end. In addition, one or both lateral edges may have continuous or discontinuous retouch. Depending on the flaking technology the blanks may be straight, curved or twisted in profile and the pointed tips symmetrical or offset in plan. The butt usually remains on the piece.

El-Wad points are much less common in UP 1 than in the following phase 2. They never make up more than 3% of the stone tool assemblages in UP 1 (Azoury 1986: 129). Twenty-nine tools were examined and all of these were made on blades or blade fragments (figure 2: a-b). Fifteen pieces have faceted butts and one has a punctiform butt. Of the 16 complete specimens 10 are straight or only slightly curved in profile. The types of retouch most often used to form the point are semi-abrupt and combinations of semi-abrupt with fine or abrupt. The amount, type and position of the retouch varies with each piece depending on the degree of modification necessary to shape it. Often one type of retouch (fine, semi-abrupt or abrupt) will grade into another along a lateral edge.

Among the UP 1 points in the 1937-1938 collections the Emireh point is entirely absent. A single, highly atypical example from the 1947-1948 excavations has been reported on by Volkman and Kaufman (1983).

Upper Palaeolithic Phase 2: Levels XX/XIX-XVI

The second Upper Palaeolithic phase (UP 2) is found at a depth of 12.95 to 10.95 m. This phase has been divided into two subphases by Azoury (1986: 149): 1) UP 2A or levels XX-XIX, and 2) UP 2B or levels XVIII-XVI. During this phase the blade technology which first appears in levels XXIII-XXII begins to change making any clear cut technological separation between UP 1 and UP 2 difficult. However, beginning with level XX there is a gradual trend away from single platform blade cores to those with opposed platforms. The practice of faceting the striking platform starts to disappear as plain platforms, which show signs of abrasion, become more common. The blow used to detach the blanks is close to the platform edge (marginal flaking) resulting in thinner blades with tiny butts. In addition, cresting and

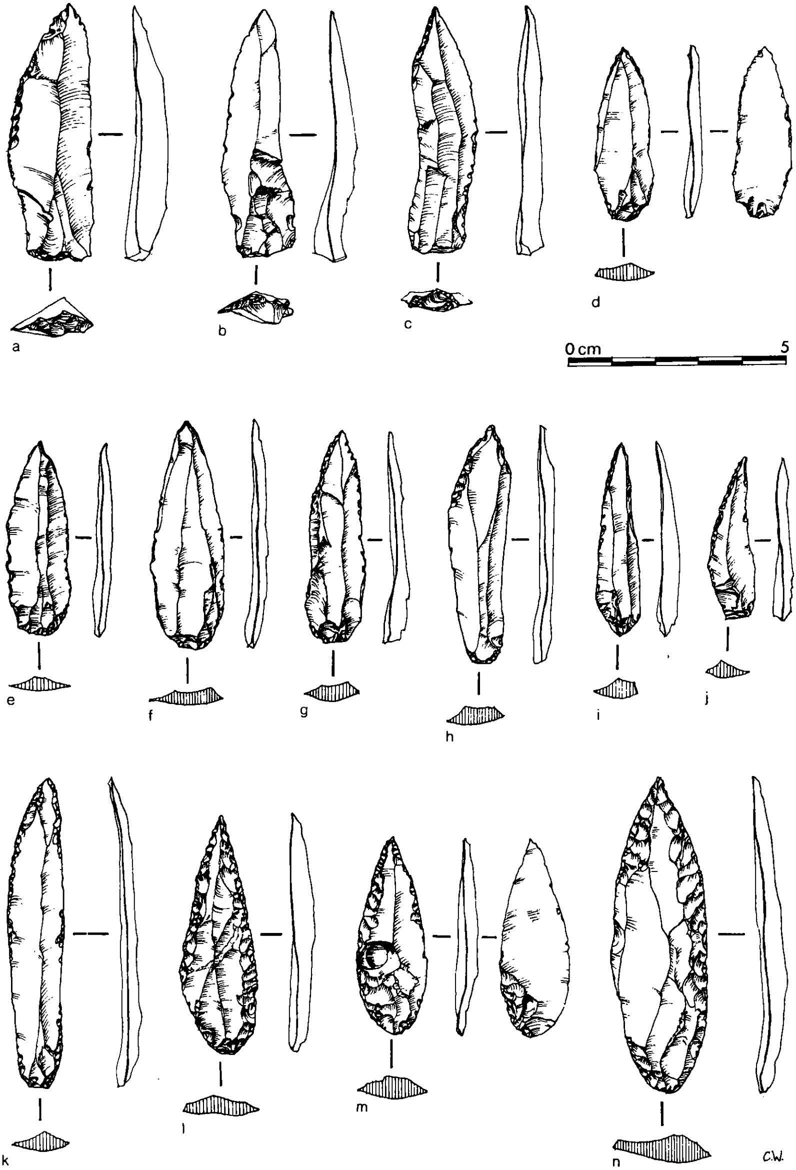

Figure 2   El-Wad points (a-k) and pointes à face plane (l-n)

the core tablet technique are much more frequently used for preparation and maintenance in UP 2. The tool kits in these levels are basically composed of end-scrapers, backed and partially backed blades as well as el-Wad points; burins are generally rare and, in some levels, account for *ca.* 1% of the tool kit (Azoury 1986: 164). Two point types were examined in these levels: the el-Wad point (type I3) and the *pointe à face plane* (type I2).

The el-Wad point is an important component of the tool kits of this phase especially in levels XVII and XVI where it makes up 16% of the assemblages (Azoury 1986: 164). It is interesting to note that the marked increase in these retouched points coincides with the disappearance of the 'Levallois' points characteristic of UP 1. This might be explained by the shift away from the UP 1 flaking technique which provided pointed blanks preformed on the core, needing no additional modification, towards a technology which produced blanks that needed to be shaped by retouch before use.

To obtain an idea of the dimensions of the el-Wad points in UP 2 75 complete points from level XVII were measured. All of these were made on blanks with blade dimensions, the majority of which fall between 40-55 mm in length and 13-14 mm in width (figure 4: 1). In level XVI a number of pieces are made on bladelets (Ohnuma 1986: 278); the impression, however, is that most el-Wad points in UP 2 are made on blades. The el-Wad points can be divided into two groups on the basis of the technology of the blanks used to make points. In levels XX and XIX 11 of the 19 entire points examined are made on blades technologically similar to those of UP 1 (figure 2: c). Of the 193 complete points examined from levels XVIII-XVI, 169 or 87% are made on blades which tend to be thin especially at the proximal end, have punctiform or linear butts, and show signs of platform abrasion (figure 2: d-h, k). Over 80% of the 212 complete el-Wad points examined are straight or only slightly curved in profile which reflects a process of careful blank selection. The types of retouch used to form the points are semi-abrupt or combinations of semi-abrupt with the other retouch types (fine and abrupt) grading into each other along an edge. There appears to be no consistent pattern to the position of the lateral retouch; Azoury (1986: 61) noted that it "varies considerably" from piece to piece.

Typologically, el-Wad points in levels XX-XVI grade into backed and partially backed blades, many of which are retouched at the distal end of the piece on one lateral edge. El-Wad points differ from these tools in two ways. First, many of the points have retouch which converges from both lateral edges to form the tip at the distal end. Second, el-Wad points which are made by retouch on one lateral edge only are symmetrical having their pointed tips roughly divided by the long axis of the blade.

The *pointe à face plane* (de Sonneville-Bordes and Perrot 1954) is a type known in Europe and at Ksar Akil is described as a generally symmetrical, leaf-shaped piece with direct, invasive retouch forming a point at the distal end. Often one or both lateral edges has additional continuous or discontinuous retouch. Some examples have their proximal ends thinned and shaped by inverse, invasive retouch (figure 2: l-n).

In levels XX-XIX *pointes à face planes* are rare. They become more numerous in levels XVIII-XVI but never exceed 3% of the stone tool assemblages (Azoury 1986: 164). All of the tools are made on blades or blade fragments which tend to be wider than those used for el-Wad points; only 18 complete points were measured, 17 of which fall between 16 and 24 mm in width. Most *pointes à face planes* are straight or only slightly curved in profile. They are formed by invasive retouch as well as combinations of invasive and semi-abrupt retouch. Abrupt retouch occurs on only a few tools. Seven points have inverse, invasive retouch at the proximal end to remove and thin the butt. The use of invasive retouch to form these points is interesting because, unlike the retouch used to make el-Wad points, the angle and sharpness of the unretouched edge can be maintained.

Level XVI is followed by two levels, XV and XIV, which are believed to be disturbed (Azoury 1986: 169, 172). Level XV is mixed and level XIV is virtually sterile representing a major stratigraphic break between the early Upper Palaeolithic levels XXV-XVI and the later Upper Palaeolithic levels XIII-VI.

Upper Palaeolithic Phases 3-6: Levels XIII-VI

The last four Upper Palaeolithic phases encompass what was traditionally thought to represent the Levantine Aurignacian or phase III at Ksar Akil (Wenner Gren Symposium 1969; Besançon *et al.* 1977). Recently the use of the term Aurignacian has been changing in Levantine Palaeolithic studies (Bergman and Goring-Morris in press). This new interpretation restricts the term to assemblages dominated by end-scrapers and burins and which contain a higher percentage of unretouched flakes as opposed to blade/lets in the debitage (Marks 1981; Gilead 1981). Only levels VIII-VI fit this description at Ksar Akil and are therefore the only Aurignacian levels as redefined above. In addition, it appears that this group of levels (XIII-VI) are not developmentally related and do not belong in a single phase as originally believed (Bergman 1987). This has led to phase III of Besançon *et al.* (1977) being separated into four distinct phases: 3 (levels XIII-XI), 4 (levels X and IX), 5 (levels VIII and VII) and 6 (level VI). It is suggested that the levels in each phase show developmental continuity but the phases are separated from each other by breaks in the archaeological sequence. Two points were studied in this group of levels: the el-Wad point (type I3), of which there exists two morphologically distinct varieties, and an el-Wad variant originally referred to as the Abu Halka point by Azoury (*pers. comm.*).

Phase 3 (levels XIII-XI) of Ksar Akil is characterised by a blade/let technology which has unidirectionally flaked cores with plain platforms that show signs of abrasion. A special feature of the technology is a high proportion of pieces with offset debitage and twisted profiles. The tool kits are dominated by burins with relatively fewer end-scrapers and retouched blade/lets. El-Wad points, usually made on twisted debitage, account for between 4% and 13% of the assemblages (Azoury and Bergman 1987: 121-125). A total of 71 el-Wad points were measured from level XI and the bar graphs (figure 4: 2) show that most are between 30-40 mm long and 8-11 mm wide. Comparing this data with that of the el-Wad points found in level XVII shows the earlier points to be, on average, both longer and wider. Sixty of the 71 points measured above are twisted in profile. Due to the morphology of these blanks 53 examples are assymetrical in plan; on 51 tools the tip is offset to the right of the long axis (figure 3: a-e).

The following phase 4 comprises levels X and IX. These two levels have a blade/let technology with many of the same features noted in phase 3: single platform cores, plain platforms, platform abrasion, cresting and the core tablet technique. A major difference occurs in the reduced number of blanks with twisted profiles and offset debitage. The tools are primarily composed of end-scrapers with lower percentages of burins. The retouched blade/lets, el-Wad points and el-Wad variants account for up to 33% of the assemblages. The el-Wad points differ in a number of ways with those of the previous phase 3, mainly due to the technology of blank production. In terms of their overall dimensions the el-Wad points in levels X and IX tend to be narrower. The bar graph (figure 4: 3) shows that for 36 complete tools measured from level X most are between 7 and 9 mm in width. Another difference is that the el-Wad points in phase 4 are usually straight or slightly curved in profile (Bergman 1987: 145); they also tend to be symmetrical in plan with the pointed tip divided by the axis of percussion (figure 3: f-l). The types of retouch used to form the points in both phases 3 and 4 tend to be fine and semi-abrupt. 'True' abrupt retouch is generally rare on el-Wad points.

A variant of the el-Wad point is also found in phase 4 and is absent in all the other levels in the upper part of the sequence (Copeland and Hours 1971; Bergman 1987). This tool type has varying amounts of inverse retouch, along one or both lateral edges, at the proximal end (figure 3: m-p). The el-Wad variants occur in smaller numbers than the el-Wad points and never make up more than 4% of the tool kits (Azoury and Bergman 1987: 127). The blanks and types of retouch used to make the variants are identical to those used for the el-Wad points.

Phase 5 contains levels VIII and VII which are flake oriented industries composed of large numbers of end-scrapers, especially the nosed and shouldered types. Both of these levels have very few el-Wad points. While points made out of stone are rare, bone and antler points are relatively common. Over 75% of the 131 bone and antler tools recovered in 1937-1938 come from phase 5 (Newcomer 1974).

The last phase 6 (level VI) marks the return of a burin dominated tool kit after their decline in the previous two phases. The highly characteristic burin on a notch (Newcomer 1971) is found in significant numbers only in level VI. El-Wad points are again rare although a few examples have been noted (Azoury and Bergman 1987: 135); a small number of bone and antler points were also recovered.

Projectile Points

In terms of manufacture all of the retouched point types described above can be produced quickly, perhaps in a matter of minutes. Taking

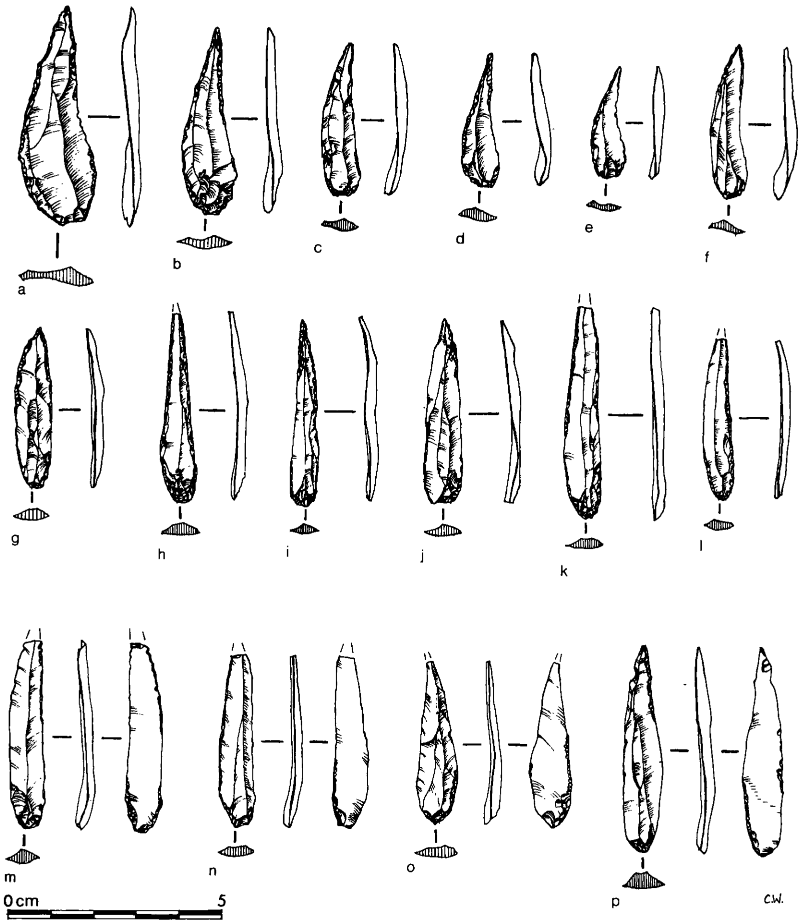

Figure 3 Twisted el-Wad points (a-f), el-Wad points (g-l) and el-Wad variants (m-p)

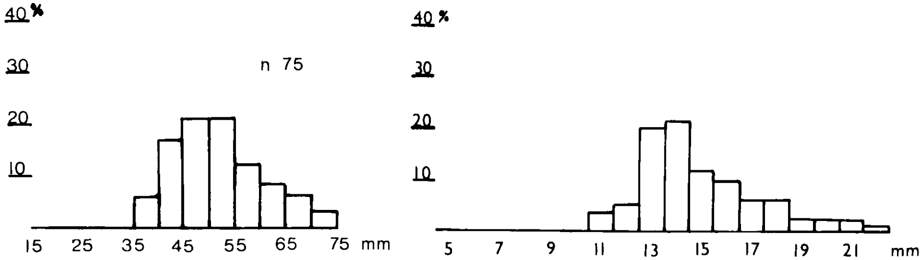

Figure 4:1 Length and width bar graphs for 75 el-Wad points (Level XVII)

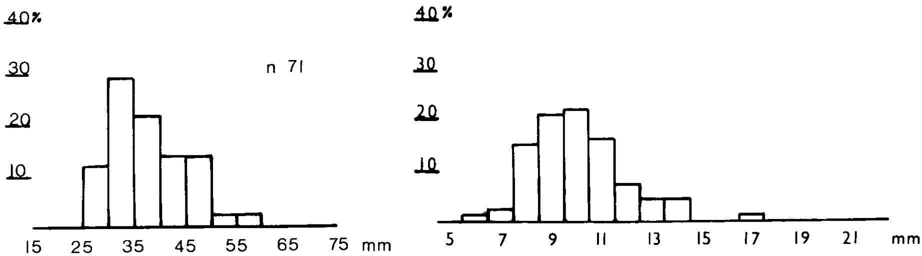

Figure 4:2 Length and width bar graphs for 71 el-Wad points (Level XI)

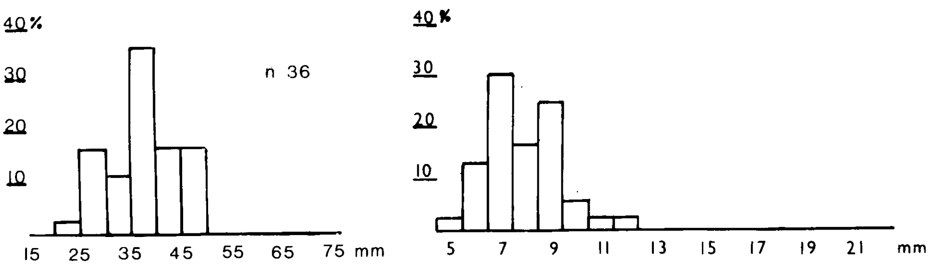

Figure 4:3 Length and width bar graphs for 36 el-Wad points (Level X)

a blade or bladelet of a desired shape and size it is simply a matter of retouching the distal end into a point and, if necessary, regularising the lateral edges. As each blank produced is different so the amount, type and position of retouch on the points will be different. Often the amount of modification needed to transform a blank into a point is minimal due to the fact that it already has the desired shape. An interesting question arises and that is, why did some cultures with similar technologies make points which were more complicated to manufacture and obviously took longer to complete?

All of the points except for a few *pointes à face planes* showed no signs of thinning at the proximal ends, tanging or shouldering to facilitate hafting. In the later part of UP 2 (eg. Level XVII) and UP 3-4 this was not necessary as the blanks used for points already had thin proximal ends due to the technique of marginal flaking. Most of the points found in the early Upper Palaeolithic (phase 1 and the early part of phase 2) have relatively large, faceted butts which are never thinned by retouch. This might indicate that heavier, thicker shafts were used during this time. Assuming some of these tools are projectile points an interesting parallel may be drawn between the points from Ksar Akil and those used in North America. North American Indian arrowheads measure 3/16" (about 5 mm) maximum thickness at their base (Hamilton 1972). Most of the points in UP 2B and 3-4 have proximal ends which are thinner than this. The change of the blade technology used in UP 1-UP 2A (levels XXV-XIX) to that used in UP 2B (levels XVIII-XVI) may reflect a change in hunting devices and strategies such as the change from hunting with a spear to hunting with a bow.

Several of the points examined during the course of this study displayed breakage similar to that caused by impact. A series of experiments carried out by the author with M. Newcomer (Bergman and Newcomer 1983) demonstrated the effectiveness of these points as projectile tips. A number of the replica points passed straight through a target which consisted of cow scapulae placed behind a piece of meat 150 mm thick. Many of the experimental points which hit the bone broke in an identical manner to the archaeological specimens.

As stated earlier the end of the Upper Palaeolithic sequence at Ksar Akil is characterised by a dramatic decline in the number of stone points. These are seemingly replaced by those made of bone and antler (see also Goring-Morris 1987: 91-92). While bone and antler points take longer to make than those of stone they are more durable (Guthrie 1983; Arndt and Newcomer 1986; Bergman in press). Antler, in particular, is extremely good at resisting the shock of impact. Not surprisingly, over 70% of the archaeological points at Ksar Akil which could have their material identified were made of antler. One other desirable quality of bone and antler projectile points became clear during the course of experimental work (Bergman in press). Many of the points shot deliberately into a target to induce breakage suffered damage which could easily be repaired by reshaping the tip. Under similar conditions stone points of the types described here would shatter (see Bergman and Newcomer 1983: figure 2) and could not be repaired or reused.

Conclusions

The point types discussed in this paper can be used as general guides to the chronology of the Upper Palaeolithic at Ksar Akil (see table 1). In the earliest Upper Palaeolithic levels (eg. levels XXIII-XXII) there is a non-Levallois flaking technology which utilises single platform cores with faceted platforms to produce blades and pieces morphologically identical to Levallois points. Beginning with level XX this flaking technology gradually begins to shift away from triangular-shaped cores which produce pointed blanks towards parallel-sided opposed platform cores producing blades with blunt distal ends. In order to make points out of these kinds of blanks they need to be modified by retouch. In UP 2 two kinds of retouch are used to produce points: 1) short retouch, generally semi-abrupt in inclination, which is used for el-Wad points and 2) invasive, semi-abrupt retouch which is used for *pointes à face planes*. It is worth noting that the second point type has so far not been reported from an early Upper Palaeolithic context anywhere else in the Levant.

In phases 3-6 all of the points can be classified as el-Wad points or variants. However, due to the changes in the technology of the blanks used to make the points these tools can be useful temporal markers. In phase 3 the el-Wad points are made on twisted blanks, while in phase 4 the points are generally narrow, symmetrical in plan and more regular in profile. In phase 5 the elaborate technology for making large blade/lets disappears and, consequently, so do the el-Wad points.

As stated above changes in the morphology of the el-Wad points at Ksar Akil is in large part due to changes in the flaking technology. It should be noted that three groups of morphologically and chronologically distinct 'el-Wad' points exist at the site: 1) the large, symmetrical points made on blades found in UP 2, 2) the twisted el-Wad points with assymetrical plan shapes found in UP 3, and 3) the narrow, symmetrical points and variants found in UP 4. In all of these cases the knappers are using the same style of retouch to make points out of blades or bladelets. The fundamental difference is that, even though raw material sources remained the same throughout these time periods, the original blanks differ in shape and size. At Ksar Akil it can certainly be stated that the term el-Wad point has little cultural or chronological significance on its own (cf. Marks 1981); the technology of the blanks used to make them provides the important information.

TABLE 1

Level(s)	Technology	Characteristic tools
XXIII-XXI/XX	a) triangular-shaped cores with converging sides b) single, faceted platforms c) large, faceted butts d) non-marginal flaking e) elongated 'Levallois' points	1) chamfered pieces 2) end-scrapers 3) truncation burins
XX/XIX-XVI	a) parallel-sided cores b) opposed, plain platforms c) tiny, plain butts d) platform abrasion e) soft hammer marginal flaking f) core tablet technique g) extensive use of cresting	1) end-scrapers 2) el-Wad points 3) *pointes à face planes* 4) backed blades 5) rare burins
XV-XIV	STRATIGRAPHIC BREAK	
XIII-XI	a) single, plain platformed blade/let cores b) tiny, plain butts c) offset debitage d) twisted debitage	1) dihedral burins 2) carinated tools 3) twisted el-Wad points
X-IX	a) single, plain platformed blade/let cores b) tiny, plain butts c) reduced percentage of offset and twisted debitage	1) end-scrapers 2) el-Wad points 3) el-Wad variants
VIII-VII	a) shapeless multiplatformed flake cores b) > 50% unretouched flakes in the debitage c) separate reduction sequences for blades and bladelets d) tiny twisted bladelets	1) nosed and shouldered scrapers 2) tiny retouched bladelets 3) bone and antler tools
VI	a) > 50% unretouched flakes in the debitage b) separate reduction sequences for blades and bladelets c) tiny twisted bladelets	1) burins on a notch 2) tiny retouched bladelets 3) bone and antler tools

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APPENDIX 3

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EXPERIMENTAL STUDIES IN THE DETERMINATION OF FLAKING MODE

by KATSUHIKO OHNUMA and CHRISTOPHER BERGMAN

Introduction

Many lithic technologists have recognised the importance of being able to identify the various kinds of tools used by Stone Age peoples in the manufacture of flaked stone artefacts (Bordes, 1948; Crabtree, 1967; Newcomer, 1975; Tixier *et al.*, 1980). These authors agree on the importance of the relationship between the tools used in manufacture and the technique employed in flaking stone; to produce certain types of artefacts appropriate flaking tools are needed.

Several authors have demonstrated that different stages in artefact manufacture sometimes require several different flaking tools and methods (Bordes and Crabtree, 1969; Crabtree, 1967; Inizan, 1980; Newcomer, 1971). With regard to biface manufacture Newcomer used comparisons of experimental and archaeological material to demonstrate that the thin bifaces of the Acheulean and the Mousterian of Acheulean Tradition were manufactured in several stages using different flaking tools and techniques. Percussors of quartzite and antler were used at the different stages of manufacture: roughing out, thinning/shaping and finishing. Inizan has pointed out the close relationship between the stages and flaking tools used in the Capsian blade(let) core reduction sequence which produces several classes of blanks.

These authors demonstrate that students of lithic technology cannot fully understand the flaking techniques used by Stone Age peoples without taking into account the various kinds of manufacturing tools used. It is important, therefore, to have a means for determining what kinds of tools were employed by prehistoric peoples in manufacturing flaked stone tools.

As early as the 1930s Barnes and Cheynier analysed the size of the butts and bulbs of percussion as well as various bulb types on Clactonian, Acheulean, Mousterian, Aurignacian and Solutrean flakes from France and England (Barnes and Cheynier, 1935). Barnes and Kidder studied the percentages of pronounced and diffused bulbs on plain and faceted butt flakes from the Mousterian, Perigordian and Aurignacian levels of La Ferrassie, France (Barnes and Kidder, 1936).

Bordes has discussed in detail the characteristic features of hard and soft hammer struck flakes (Bordes, 1947; 1948; 1961). The characteristic features recognised by Bordes may be summarised as follows: flakes detached by hard hammers generally have large butts, clear points and clear cones of percussion, pronounced bulbs, clear

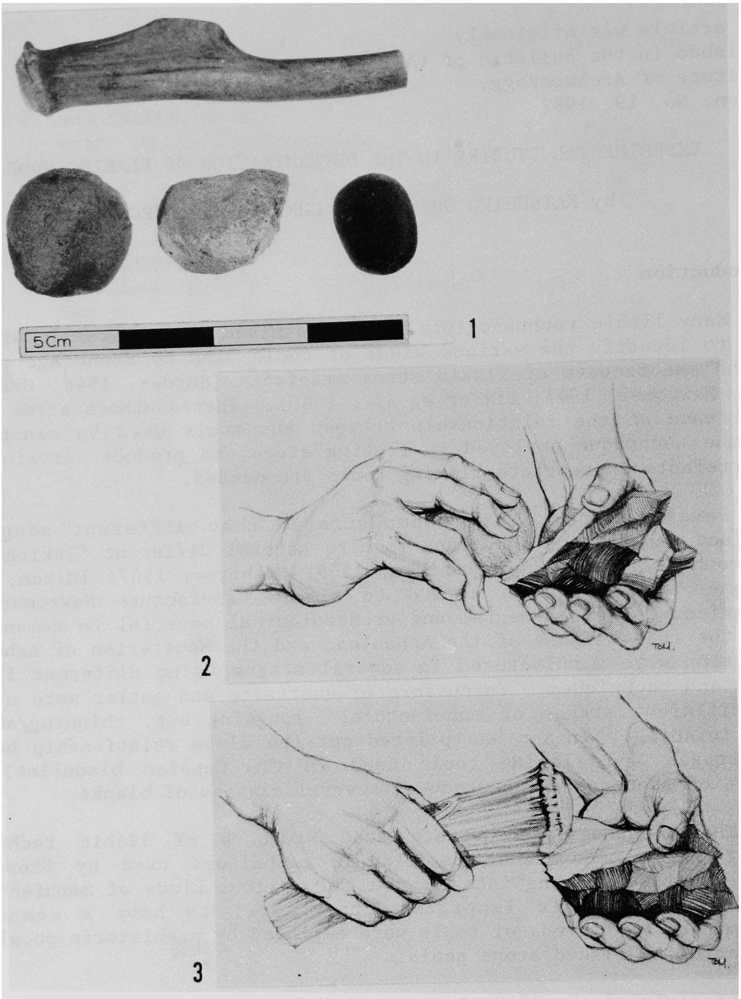

Plate I

1. Percussors used in the experimental studies and examinations: top, antler hammer; bottom (left to right), two sandstone hammerstones and a quartzite hammerstone. 2. Technique of flaking using a quartzite hammerstone; the point of percussion is well on to the striking platform. 3. Technique of flaking using an antler hammer; again the point of percussion is well on to the striking platform.

conchoidal fracture marks and they sometimes have fissures which are more or less circular on the butt. Flakes detached by soft hammers have generally narrow butts which are often punctiform and/or lipped, no points or cones of percussion and diffuse bulbs. The fact that Bordes recognised large butts on hard hammer struck flakes and smaller, narrower butts on soft hammer struck flakes is probably due to the location of the percussion point and not to the material of the percussor.

In *Stone-Worker's Progress*, Knowles discussed the bulbar characteristics of flakes. He characterised flakes detached by hard hammers as having a salient bulb and a cone of percussion. Flakes detached by soft hammers have diffuse bulbs and no cones of percussion (Knowles, 1953). After analysing the relationships between the butt type, cone presence or absence and the bulb characteristics he was able to state that 260 out of a total of 282 Lower Paleolithic flakes from Biddenham Gravels in Bedfordshire, England, were most probably detached by a hard hammer.

It was Crabtree who emphasised the important role played by soft hammerstones among Stone Age people, stating that 'some hard hammerstones will become softened from repeated use until they have the same qualities as a soft hammerstone' (Crabtree, 1967). He also recognised that the 'diffusion of the bulb will depend, largely, on the amount of surface contacted by the hammerstone' (Crabtree, 1967). Crabtree demonstrated that the 'edge-ground cobble technique', which uses a soft stone percussor, is effective for the detachment of blades with very small butts (Crabtree and Swanson, 1968).

This concludes the introductory summary of the literature concerned with flaking mode. Beyond these general guidelines no one has provided a foolproof method of linking hammer hardness to flake features. Some authors have cast doubts on how accurate one can be in determining flaking mode. Through the experimental studies and examinations, described below, we were able to achieve a great deal of accuracy in determining flaking mode as well as understanding the effects of hammer hardness on the ventral surfaces of flakes.

Experimental studies and examinations

From May to November 1980 several experimental studies by Ohnuma and examinations by Bergman, Newcomer and Ohnuma were undertaken in order to investigate how precise one could be in determining flaking mode. The term mode is used here to mean the kind of flaking tools used within the stage by stage framework implied by method (Newcomer, 1975). The following is a description of the experimental studies and examinations. In each of the tests performed the examinee(s) was not informed of how many flakes were produced by each mode, hard or soft.

Experimental study 1

Raw material: a single block of Brandon (Suffolk) flint. Percussors used: a quartzite hammerstone weighing 130 g and a Pere David's deer antler hammer weighing 210 g. Flaking technique: hand-held direct percussion; the point of

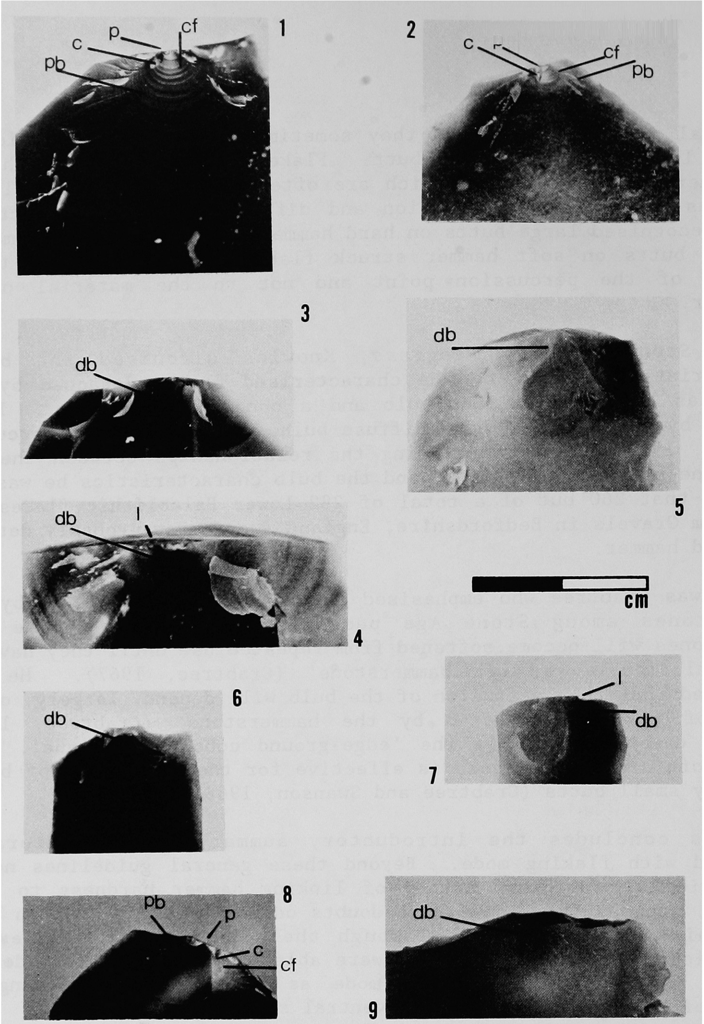

Plate II

1. Experimental flake detached with quartzite hammerstone. 2. Levallois flake from Ksar Akil, Lebanon, 1947, level XXX (Middle Palaeolithic): hard hammer mode. 3. Experimental flake detached with antler hammer. 4. Experimental flake detached with soft stone hammer. 5. Blade from Ksar Akil, Lebanon, 1947, level XXX (Middle Palaeolithic): soft hammer mode. 6. Experimental blade detached with soft stone hammer. 7. Blade from Ksar Akil, Lebanon, 1937-8, level XXII (Upper Palaeolithic): soft hammer mode. 8. Experimental flake with faceted butt detached with quartzite hammerstone. 9. Experimental flake with faceted butt detached with antler hammer. Abbreviations used in Plate II: p, point of percussion; c, cone of percussion; pb, pronounced bulb; cf, conchoidal fracture marks; db, diffuse bulb; l, lipped butt.

percussion being well on to the striking platform.

Flakes chosen for analysis: 100 flakes detached by the quartzite hammerstone and 100 flakes detached by the antler hammer. A few flakes had cortex butts, but none were faceted. Only flakes with the same general shapes and dimensions were chosen, for the aim of this study was to investigate the characteristics of the ventral surface of flakes. Each flake was wiped with a damp cloth so that the features could be seen more clearly.

Each of the 200 flakes was checked for the following features:
1. Butt: lipped or unlipped
2. Point and cone of percussion: clear or vague
3. Bulb: pronounced or diffuse
4. Conchoidal fracture marks on the bulb: pronounced or indistinct

Results:

1. Butt: 54 out of 55 (98%) of the flakes with lipped butts were detached by the antler hammer; 76 out of 91 (84%) of the flakes without lipped butts were detached by the quartzite hammerstone.

2. Point and cone of percussion: 70 out of 70 (100%) of the flakes with clear points and cones of percussion were detached by the quartzite hammerstone; 87 out of 102 (85%) of the flakes with vague or no points or cones of percussion were detached by the antler hammer.

3. Bulb: 71 out of 72 (99%) of the flakes with pronounced bulbs were detached by the quartzite hammerstone; 93 out of 109 flakes (85%) of the flakes with diffuse bulbs were detached by the antler hammer.

4. Conchoidal fracture marks on the bulb: 42 out of 42 (100%) of the flakes with pronounced conchoidal fracture marks on the bulb were detached by the quartzite hammerstone; 100 out of 156 (64%) of the flakes with indistinct conchoidal fracture marks on the bulb were detached by the antler hammer.

After the above results were obtained, it was felt that two features clear point/cone of percussion and pronounced conchoidal fracture marks on the bulb were good indicators of flaking with a quartzite hammerstone. By combining the other criteria their diagnostic value was increased. Analysis of the same flakes by using the above two criteria and combinations of the others was performed with the following results.

1. Lipped butt and diffuse bulb: 54 out of 54 (100%) of the flakes with these features were detached by the antler hammer.

2. Unlipped butt and pronounced bulb: 64 out of 64 (100%) of the flakes with these features were detached by the quartzite

hammerstone.

3. Clear point/cone of pecussion: 70 out of 70 (100%) of the flakes with these features were detached by the quartzite hammerstone.

4. Pronounced conchoidal fracture marks on the bulb: 42 out of 42 (100%) of the flakes with this feature were detached by the quartzite hammerstone.

5. Vague or no point/cone of percussion and diffuse bulb: 83 out of 95 (87%) of the flakes with these features were detached by the antler hammer.

It was observed that a cortex striking platform/butt altered the characteristics of the ventral surface of quartzite hammerstone detached flakes; the cortex absorbs the impact resulting in features closer to those of flakes detached by an antler hammer.

Examination 1

Ohnuma detached 200 flakes from a single block of Brandon flint. The flaking tools and technique were the same as those used in experimental study 1. One hundred flakes were made with each of the hammers.

1A
Examinee: Ohnuma using the method of combining criteria described above.
Result: correct (168); wrong (8); undecided (24): 168/176 = 0.954 or 95% correct.

1B
Examinee: Bergman using the same method.
Result: correct (171); wrong (17); undecided (12); 171/188 = 0.909 or 91% correct.

Comment: Ohnuma's greater accuracy is certainly due to the fact that he examined flakes that he had made a week before and as such the knowledge of the numbers of the flakes produced by each mode affected his result. Bergman on the other hand was not accustomed to using this method which may account for his slightly lower percentage of correct determinations. The results obtained by both examinees, however, convinced them of the potential reliability of this method.

Examination 2

Newcomer gave Ohnuma and Bergman 50 flakes which he had detached by direct percussion with a quartzite hammerstone and a red deer antler from a single block of Brandon flint. He made 25 flakes with each of the hammers; the examinees were not informed of this before analysing them. These flakes were examined with the method described above.

2A
Examinee: Ohnuma.
Result: correct (46); wrong (4); 92% correct.

2B
Examinee: Bergman
Result: correct (46); wrong (4); 92% correct.

Comment: It was quite interesting that three out of the four flakes that could not be correctly identified by the two examinees were the same.

Examination 3

Bergman supplied Ohnuma with 100 flakes which he had detached from two nodules of Grimes Graves flint with sandstone hammer and red deer antler. The technique of flaking employed was hand-held direct percussion and the point of percussion was well on to the striking platform resulting in flakes with large butts.

3A
Examination of 50 flakes of coarser material.
Result: correct (29); wrong (18); undecided (3); 62% correct.

3B
Examination of 50 flakes of finer material.
Result: correct (28); wrong (20); undecided (2); 59% correct.

Comment: It is clear from the results that a soft stone hammer produces very similar ventral features to an antler hammer. It is very difficult to separate flakes detached by these two types of soft hammers with any degree of certainty.

Experimental study 2

Ohnuma detached flakes with faceted butts from large flakes of Brandon flint. The flaking tools and technique employed were the same as those in the previous experiment by Ohnuma. The type of faceted butt was convex composed of multiple facets. One hundred flakes were detached with the quartzite hammerstone and 100 with antler hammer. These were examined using the same criteria as experimental study 1. Below are the characteristics of the ventral surface of both the quartzite hammerstone and antler hammer detached flakes with faceted butts.

1. Quartzite hammerstone detached flakes with faceted butts (100):
    1. Butt: lipped (1); unlipped (92); unclear (7).
    2. Point of percussion: clear (70); rather clear (1); vague (9); unclear (20).
    3. Cone of percussion: clear (8); rather clear (41); non-existent (35); unclear (16).
    4. Bulb: pronounced (10); slightly pronounced (44); diffuse (32); unclear (14).
    5. Conchoidal fracture marks on the bulb: pronounced (27); slightly pronounced (34); indistinct (29); unclear (10).

2. Antler hammer detached flakes with faceted butts (100):
   1. Butt: lipped (38); unlipped (40); unclear (22).
   2. Point of percussion: slightly clear (4), slightly clear due to the intersection of two facets (50); vague (42); unclear (4).
   3. Cone of percussion: non-existent (100).
   4. Bulb: diffuse (98); unclear (2).
   5. Conchoidal fracture marks on the bulb: non-existent (76); indistinct (24).

It was observed that each of the five ventral surface features of these 200 flakes were essentially the same as that of the previously examined flakes without faceted butts. The quartzite hammerstone detached flakes, however, generally had ventral features which were less prominent than those flakes with plain butts. Some of the quartzite hammerstone detached flakes with faceted butts could not be distinguished from those detached by the antler hammer. It was also observed that about half (56%) of the antler hammer detached flakes with faceted butts had slightly clear points of percussion most probably due to the intersection of two facets just at the point of percussion. Therefore it was felt, with regard to these flakes, one should consider also the presence or absence of the cone of percussion.

Examination 4

Fifty flakes from among those produced for experimental study 2 were examined by Bergman using the combined criteria described above. His results were very close to those of the previous examinations: correct (46); wrong (3); undecided (1); 94% correct.

Conclusions

The following conclusions have been reached as a result of the experimental studies and examinations.

In determining the kind of flaking mode (hard or soft) used by Stone Age people each of the following criteria proved valuable: (1) clear point and cone of percussion for the hard hammer mode; (2) pronounced conchoidal fracture marks on the bulb for the hard hammer mode; (3) unlipped butt and pronounced bulb for the hard hammer mode; (4) lipped butt and a diffuse bulb for the soft hammer mode; and (5) vague point/cone of percussion and a diffuse bulb for the soft hammer mode.

These criteria were established using extremely fine-grained flint from Brandon and Grimes Graves, Suffolk, England. It is recommended, in the application of this method to archaeological lithic assemblages, to use only the pieces made of fine-grained flint.

As was made clear by examination 3 the ventral characteristics of flakes detached with a soft stone hammer are difficult to distinguish, using the method described in this paper, from those detached by an antler hammer. It is probable that archaeological flakes identified as having been detached by a soft hammer include flakes detached by a soft stone hammer. Microwear analysis of the butts of flakes might provide clues as to the nature of soft hammers, although to the authors' knowledge this possibility has not been examined.

Due to the results of these studies we feel that percussors should be divided into two groups: those which are as hard as the material being flaked and those which are softer. In the case of fine-grained flint, these two groups can be easily separated on the basis of the ventral features of detached flakes. A more difficult task would be to recognise different types of percussors, such as soft stone or antler, belonging to the same group.

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Abstract

The paper describes a series of experimental studies and examinations made to determine how precisely the kind of flaking tools used in flint working can be identified from the product. As a result it proved possible to offer a series of criteria which should be useful for the determination of the flaking mode. The products of percussors which were harder than the material being flaked are easy to distinguish from those which are softer than the material, but it is more difficult to recognise percussors of different materials - e.g. soft stone and antler - belonging to the same group.

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