THE EPIGRAVETTIAN SITE OF GRUBGRABEN

LOWER AUSTRIA: THE 1986 & 1987 EXCAVATIONS

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THE EPIGRAVETTIAN SITE OF GRUBGRABEN, LOWER AUSTRIA: THE 1986 AND 1987 EXCAVATIONS

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INTRODUCTION

by

ANTA MONTET-WHITE

The existence of paleolithic sites in the Middle Danube region has been known since the 1880's. But it is Szombathy's discovery of the Willendorf figurine which brought the Wachau to the attention of prehistorians in 1911. By the 1930's a number of sites had been recorded and investigated by Bayer and others. Among the most notable sites were the Gudenus cave, a deep shelter which contained Mousterian and Magdalenian levels, and a series of open-air localities where archaeological levels attributed to the Aurignacian and the Gravettian were found stratified within series of loess deposits. A better understanding of the region's stratigraphical sequence and cultural developments resulted from new field work conducted in the 50's in parts of the open-air sites that early excavations had left intact (Fig.I-1), especially Willendorf (Felgenhauer, 1956-59), Aggsbach (Felgenhauer, 1953), and Kamegg (Brandtner, 1955).

Largely as a result of the work completed during the 1950's, the relatively long stratigraphical sequence of Willendorf emerged as the model and reference upon which the regional archaeological sequence was built. The earliest occupation at Willendorf II (level 1) was attributed to a poorly defined, early Upper Paleolithic phase with an estimated date around 40,000 BP and the most recent (Willendorf I and II, level 9) was identified as a Gravettian phase characterized by the presence of shoulder points now dated at 25,000 BP. Other sites were integrated within the time bracket provided by the Willendorf sequence. The time span of some 15,000 years that the Willendorf sequence encompasses was interpreted as the period of Paleolithic prehistory during which the region had been regularly occupied by human groups. The extreme scarcity of archaeological materials attributable to earlier Mousterian phases or to later Epigravettian or Magdalenian phases was taken as an indication that, during most of the Middle and Late Pleistocene, the region had been either intermittently traveled by groups of hunters seeking shelter in the caves of the Bohemian Plateau, like the Gudenus Cave, or completely void of human populations. The generally accepted view was that the northwest corner of the Central European Basin, including the Wachau and the Weinviertel (Lower Austria), had been, for a limited 10,000 to 15,000 year period of the Interpleniglacial, part of a broad cultural area that included Moravia and Slovakia and extended into southern Poland. While accepting this general framework, a number of prehistorians raised questions concerning the nature and origin of the earliest Upper Paleolithic horizons (Hahn, 1977) and stressed that lack of evidence clouded the interpretation of the last phases of the Gravettian (Otte 1984).

The University of Kansas project was initiated in 1981 with the objective of investigating new or poorly known sites in order to elucidate questions related to the peopling of the area during time periods not represented by the Willendorf sequence. Grubgraben was selected following a field season at the site of Kamegg in 1984 and a series of tests and a survey done in 1985. The site offered the most favorable

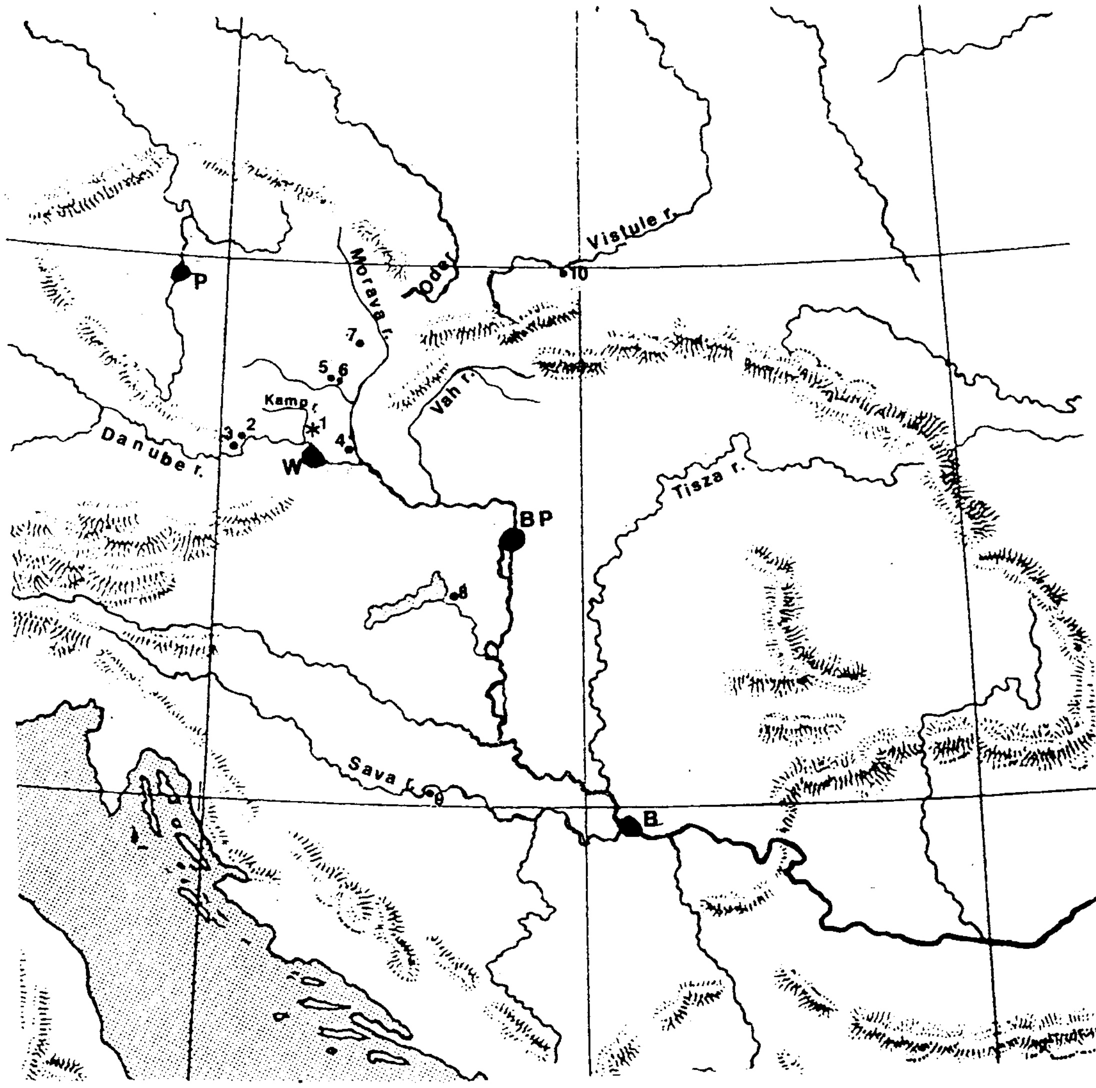


Fig. I-1 Map of Central Europe showing the location of : 1, Grubgraben (A); 2, Willendorf (A); 3, Aggsbach (A); 4, Stillfried (A); G, Pavlov (cZ); 6, Dolni Vestonice (cZ); 7,Stranska Skala (CZ); 8, Sagvar(H); 9, Kadar (Yu); 10, Spadzista (P). P, Prague, W, Vienna, BP, Budapest, B, Beograd.

conditions. It contained a long stratigraphical sequence and a series of archaeological levels which appeared to be in place. Bone preservation was good. And furthermore, the archaeological levels were relatively accessible as the loess cover above the topmost level was no more than 1m to 1.5 meter thick.

The first two seasons of excavations have contributed a body of new data. First and foremost, the discovery of a series of Epigravettian levels posterior to 19,000 BP demonstrated that there were times during the last glacial advance when the area offered sufficient natural resources to sustain groups of Paleolithic hunters. The chronological placement of the Grubgraben sequence based on archaeological and sedimentological data is corroborated by the date of 18,980 obtained from bone collagen by the University of Arizona accelerator for one of the archaeological levels (AL4). Several more dates ranging between 18,600 and 18,200 obtained by conventional methods at the Louvain laboratory confirmed the attribution of the main complex of archaeological levels (AL2-AL4) to a time period corresponding to the last Glacial maximum.

The first objective of the 1986 and 1987 excavations was to arrive at a detailed understanding of climatic and environmental changes. Contrasting environmental data obtained from archaeological levels to those derived from culturally sterile levels, it would become possible to gain an understanding of the conditions necessary for human groups equipped with an Epigravettian technology to survive, even flourish under severe conditions. Several sections of this report are devoted to the discussion of research conducted with that goal in mind: Haesaerts' study of the graben stratigraphy and sedimentology which arrives at a revised interpretation of the regional sequence and outlines the factors that contributed to making the locality attractive to paleolithic groups (chapter III) and Pawlikowsky's analyses of the morphology and mineral content of the loess deposits which complement and corroborate the sedimentological study (chapter IV).

A second and equally important goal was to investigate the adaptability of paleolithic hunting economies in response to climatic changes. Logan's study contrasts the Grubgraben faunal record to that of Willendorf, pointing out the probable effect of increasingly severe conditions on animal populations and looking for changes in hunting patterns. In addition, he presents hypotheses concerning butchering practices and seasonality of human occupation at the site (chapter VI).

The study of the artifact assemblages was oriented toward the study of raw material economy. Pawlikowski reports the negative results of a survey of raw material sources conducted in Lower Austria and establishes the probability of the long distance origins of some of the flints and radiolarites present in the Grubgraben assemblages (chapter VII). Differentiated use that Epigravettian tool makers made of the various categories of raw materials is documented in chapter VIII. The last section details some of the technological and typological characteristics of the epigravettian industries as they relate to raw material selection (chapter IX).

The Grubgraben is a ravine cut at the very edge of the Bohemian Plateau. It drains into the Kamp River at the point where its valley widens and bends to the east before reaching the Danube Valley. The slopes of the Heiligenstein to the west and the Geissberg to the east afford some protection to the ravine floor (Fig. III-1). Widely opened to the south, the ravine offers a wide view of the Kamp Valley and beyond (Fig I-2 and 3). An ecotone situation created by proximity to the river, access to the plateau and to the Danube Valley is another element that may have entered into the selection of the site by paleolithic hunters . A sunken farm road has cut a deep channel (graben) through the loess deposits that fill the ravine floor and cover the slopes. Bones and lithic pieces have eroded from the graben wall and for a long time, professional and amateurs archaeologists have known the existence of the site and collected artifacts from the graben floor (see Chapter II). The profile cleared in 1985 on the west side of

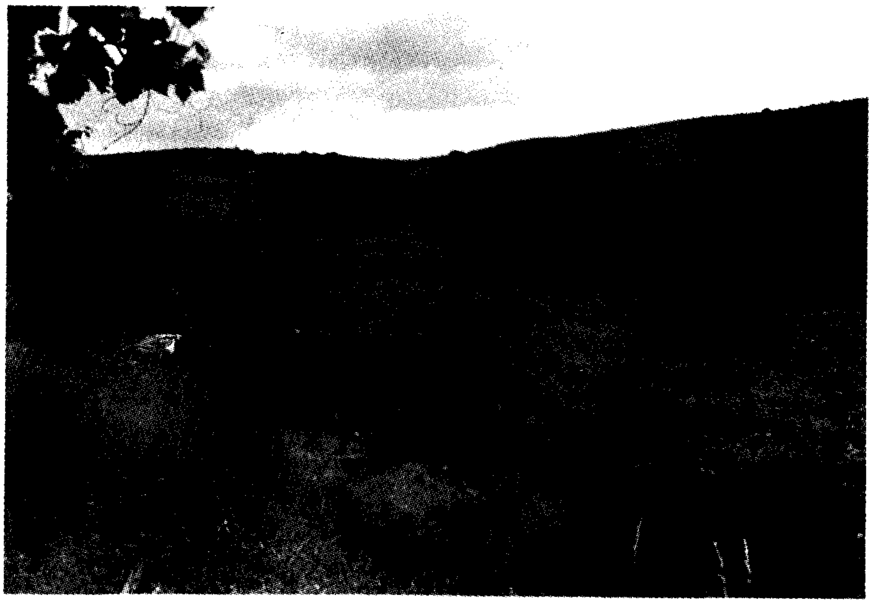


Fig. I-2 View of the Grubgraben, from the southwest, with the Zwettl vineyard in the foreground and the terraced slopes of the Geissberg behind.

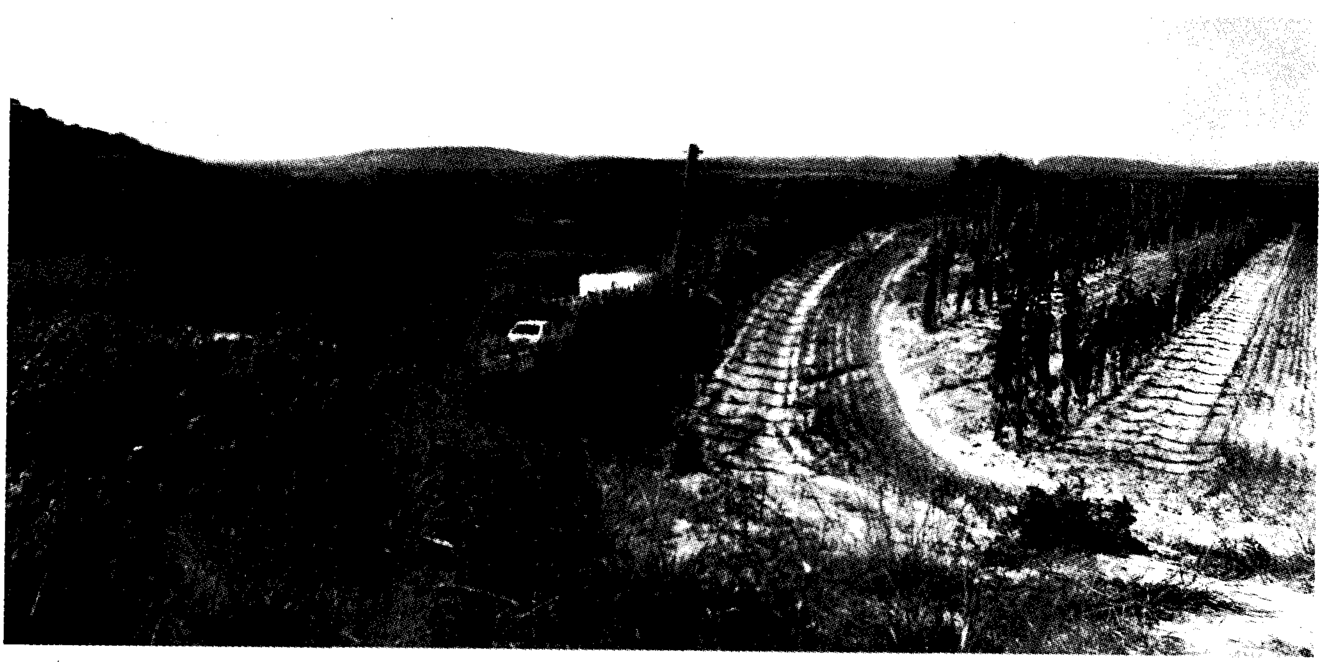


Fig. I-3 View of the Grubgraben taken from the upper vineyard on the slope of the Heiligenstein. The Zwettl vineyard and the slope of the Geissberg are in the foreground; in the distance, the Kamp valley and the low hills that form the interfluve between it and the Danube Valley barely visible in the upper left of the picture. The tent covers the excavations.

the graben (Fig.I-4, Tr85) cut through a thick accumulation of bones and artifacts which continues under the upper vineyard where it is buried under 7 or 8 meters of loess. East of the graben, in the Zwettl Abbey vineyard, archaeological levels are more accessible as the loess cover has been sectioned by terracing when the vineyard was planted.

The main excavation block included a 12m long and 2 m wide trench widened to 4.5m in a 6 m long section to form a 36 m2 surface area. The trench paralleled the graben where sedimentary units reached maximum thickness. Two additional test-pits (TP85 and TP86) located at the northern and southern ends of the vineyard served to evaluate variations in the stratigraphical sequence along the graben long axis and helped determine the extension of the site. Systematic coring by way of a hand held auger determined the extent of archaeological deposits within the Zwettl vineyard.

In the main block, excavations reached a depth of 2.5 m below the ground surface. Five archaeological levels were identified and excavated, exposing a number of features and stone structures (cf. Chapter V). The site owes a great deal of its interest to the presence of stone pavements, hearths, butchering areas and workshops which provide some understanding of the internal variability and organization of Epigravettian campsites. These data put together with hypothesis concerning seasonality of occupation provided by faunal analysis and territoriality derived from the study of raw materials origins contribute the elements for a reconstruction of settlement patterns in Central Europe during the last Glacial maximum.

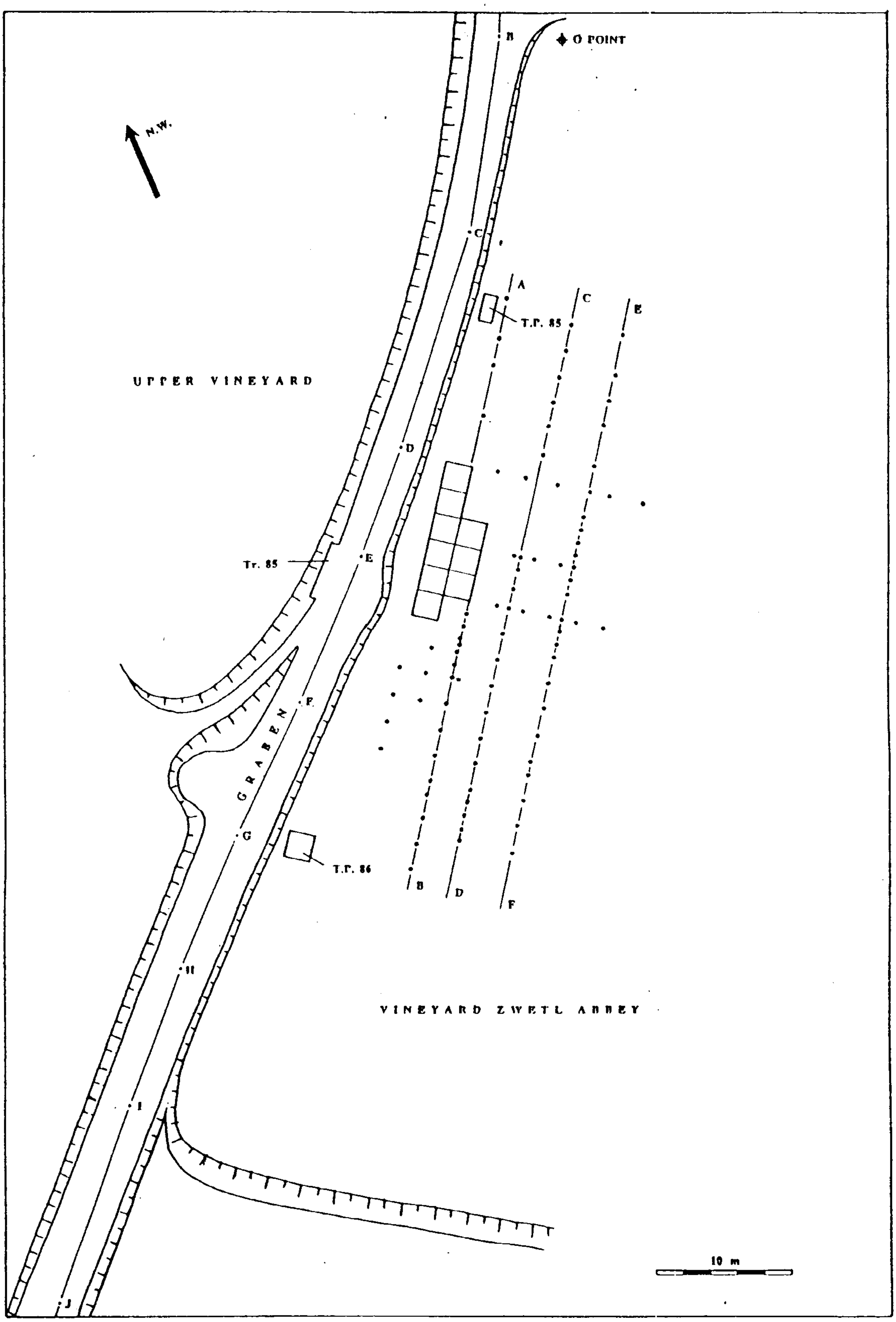


Fig. I-4 Map showing the location of the upper vineyard, the sunken road (graben) and, in the Zwettl vineyard, the excavation trench and test-pits.

II

A REVIEW OF ARCHAEOLOGICAL RESEARCH AT THE GRUBGRABEN PRIOR TO 1980

by

MARTIN URBANEK

Grubgraben was mentioned for the first time in a scientific context by Graf Wurmbrand (1879) who wrote of the discoveries of horse teeth, fragments of mammoth tusk, unidentified pieces of antler and a shapeless flint object. All these things lay together in "black earth" in front of the access to the wine cellar of a parson named Ertl. Ertl's wine cellar is located near the lower end of the Grubgraben on the way to Kammern. It does not correspond to the site described by all the later authors.

During the following decades the two parsons Gustav Schacherl (1893) and Lambert Karner paid attention to the upper section of the Grubgraben where artifacts and bones were repeatedly washed out of the natural loess profile by heavy rains. According to Gustav Schacherl (1893) a cultural layer, which in its lower, southernmost part was 12 m below the loess surface could be followed up towards the Heiligenstein for a distance of about 100 m where finally it was no more than 2 - 3 m below the present surface.

Glassner described it as more strongly marked on the left side (?) of the graben ("left hand side" - probably looking "downstream" - This would mean the side of Grubgraben, where the recent excavation took place) (Obermaier, H., 1908).

The layer 's thickness was not more than 0.10m. But Glassner mentioned sporadic charcoal and bone fragments below and above the cultural level.

In his oral report to Obermaier (1908) Glassner described firehearths towards the upper end of Grubgraben. These features were surrounded by blocks of granite (gneiss), which partly crumbled at any attempt to take them out.

Spöttl (1890) described the layer as rich in bone and flint and almost red in color. At the upper end of the bed he found fireplaces with ashes, coal and again those granite blocks. Here he noticed a remarkable concentration of flakes, cores and bones as well as clusters of massive boulders that were interpreted as foyers.

Spötll gave an extension of 78 m for the layer, its depth ranging from 2 - 3 m (upper part) to 6 m (lower part) below surface.

He wrote about his excavation of a place, obviously in the lower part, which to his mind contained the older traces of settlement.

Digging into the loess wall of a manmade cave that was used as shelter against rain by local peasants Spöttl discovered a hearth. Apart from artifacts and animal bones, he found also one "poniard" with "grooves for blood" (about 20 cm long), pieces of white quartz, and rock crystal flakes.

This excavation took place at the western side of the ravine.

Spöttl observed a strong spring to the south-east of the place described above, on the eastern side of the Grubgraben; probably he meant the now enclosed well near the lower end of the ravine.

He concluded that this water had been also at the disposal of paleolithic settlers.

H. Obermaier (1908) wrote a detailed article. He got most of his information from Edmund Glassner and from previous publications. He was the first to study some of the old collections and to refer to the importance of faunal finds. He mentioned remains of the following animals :

Elephas primigenius	(Schacherl's collection in Zwettl),
Rhinoceros tichorhinus	(Schacherl's collection in Zwettl),
Arctomys marmota	(Schacherl's collection in Zwettl),
Equus caballus	(Schacherl's collection in Zwettl and very frequent in Glassner's collection).
Rangifer tarandus	(Glassner's collection)
Cervus	
	(together with *Rangifer t., Equus c., Elephas* p. in the Museum of Natural History in Vienna).
Capra	

Obermaier gave in his article a detailed survey of the lithic archaeological material. In his opinion the raw material for artifacts originated from the fluvial sediments of the Danube river, from the Kamp valley and its surroundings within the "Böhmischen Masse." He described the minerals as "hornstein" (metamorphous, yellow to brown, breaks like flint), flint, jasper, rock crystal and various kinds of quartz. The cores and consequently the artifacts were, to his mind, relatively small. Obermaier concluded that at Grubgraben there was a pure, but early Aurignacian with archaic elements. His interpretation of the fact that there were two points and one scraper resembling Mousterian artifacts was, that "pseudo-Mousterien" elements were present (Obermaier 1908 : fig. 27). Finally he gives a survey of the artifacts.

As to the lithic material he describes distinctive tool - classes as follows :

a.) blades (rich in blades with Aurignacian type - retouch with more or less total retouch and blunted points - fig. 25, h, i, k, l, m, - occasionally with notch - fig. 25, m, - , but poor in microliths - fig. 26, b, c, -).

b.) Mousterian - type tools (as mentioned above - fig. 27 a, b, c, -).

c.) burins and perforators (- fig. 28 a, b, c, d, e, -).

d.) scrapers (on discoid or oval flakes and on blades - mostly with flat retouch - of Aurignacian type ; - fig. 29; a, b, c, d, e, f, g, h, i, - ; as well as massive pieces with steep retouch of various size and shape).

Of course Obermaier also mentions bone artifacts, one piece of red chalk from Schacherl's collections, ochre and 8 pieces of dentalia.

Kiessling (1918) gave a detailed description of the site and its location. He found a dark cultural layer which was open in the very upper part of the ravine between Geissberg and Heiligenstein where the recent excavations took place, its depth below surface ranging from about 1.20 m on the right hand side (walking up) and 8 m on the left side of the sunken road. At this time Spöttl had already died and his collections had been transfered to the "K.K. Hofmuseum" (now Museum of Natural History) in Vienna. The Schacherl collection was in Zwettl, many objects had been sent to Krems after its owner Ertl (a parson from Gobelsburg) had died and "finds from the Heiligenstein near Zöbing" were treated in the museum of Langenlois as "minerals" from the surroundings. So Ertl's collections were mixed with other material in Langenlois; only a few objects in Krems undoubtedly originate from Grubgraben and (or) Heiligenstein.

A heavy storm devastated the Grubgraben in July 1913, the farm was washed out and the road loess walls collapsed; during the road repairs workers observed the presence of flint artifacts, charcoal and large bone fragments, most of which were finally destroyed in place or removed with the mud. At the time Kiessling arrived, work was finished, but the cultural layer was clearly visible along the profiles.

Two years later, fortunately for archaeologists, another storm caused even greater damage to road and walls exposing the upper part of the cultural layer below the previous road surface.

Kiessling tried to evaluate the extension of the paleolithic settlement which seemed to be larger than he had ever believed and to study the topographic situation. He stated that during the Würm there must have been a platform set between slight elevations protecting the settlers against winds from all directions. The fact, that on the Heiligenstein-side of the ravine the layer was not as long and thick as on the Geissberg-side (where it is also on a higher level) indicated, in his opinion, that settlers' activities had decreased towards the surrounding slopes.The platform was relatively open only to the south. And in view of the existence of a nearby spring at the foot of Geissberg, Kiessling concluded that the Grubgraben must have been an ideal place for early man.

Kiessling carefully examined the profiles and dug a test pit into the road above the point where the dark layer disappeared underneath the road level.

With the help of a local assistant named Prassen and equipped with small shovels and pickaxes he dug horizontally into the loess walls wherever he could trace the cultural layer and as far as his arms could reach.

In this way he retrieved about 150 lithic artifacts (among them 70 classifiable objects), 750 objects which he described as waste, more than 100 teeth plus numerous pieces of bone and dentalia. In all, the excavated area was not larger than 3.5 m2.

Kiessling 's classification of lithic artifacts was as follows :

a.)	blades and flakes (with and without "marks from using")	total 39 .
b.)	blades with notch and Aurignac-retouch	" 1 .
c.)	microlithic blades	" 8 .
d.)	"saws" on broad blades (probably denticulates)	" 2 .
e.)	burin spalls	" 9 .
f.)	backed blades	" 2 .
g.)	Mousterian points ("Handspitzen")	" 6 .
h.)	perforators	" 5 .
i.)	burins and burins on scrapers	" 10 .
j.)	endscrapers	" 21 +
	+ 20 fragments of endscrapers	
k.)	scrapers on broad and flat flakes	" 6 .
l.)	scrapers on thick flakes including those on cores	" 14 .
m.)	sidescrapers on thin and flat flakes	" 6 .

He noticed the presence of a *Corbula Striata* (seashell) with a man made slit cut through it. There was also a tiny slab of slate with scrawls on its surface. To Kiessling it seemed as if someone had tried to make an artifact on the soft stone. A rib with artificial scrawls is also described.

In Kiessling's view, there was no doubt that the dark layer belonged to an Aurignacian occupation. He realized that there were sporadic artifacts, coal and bones on another level

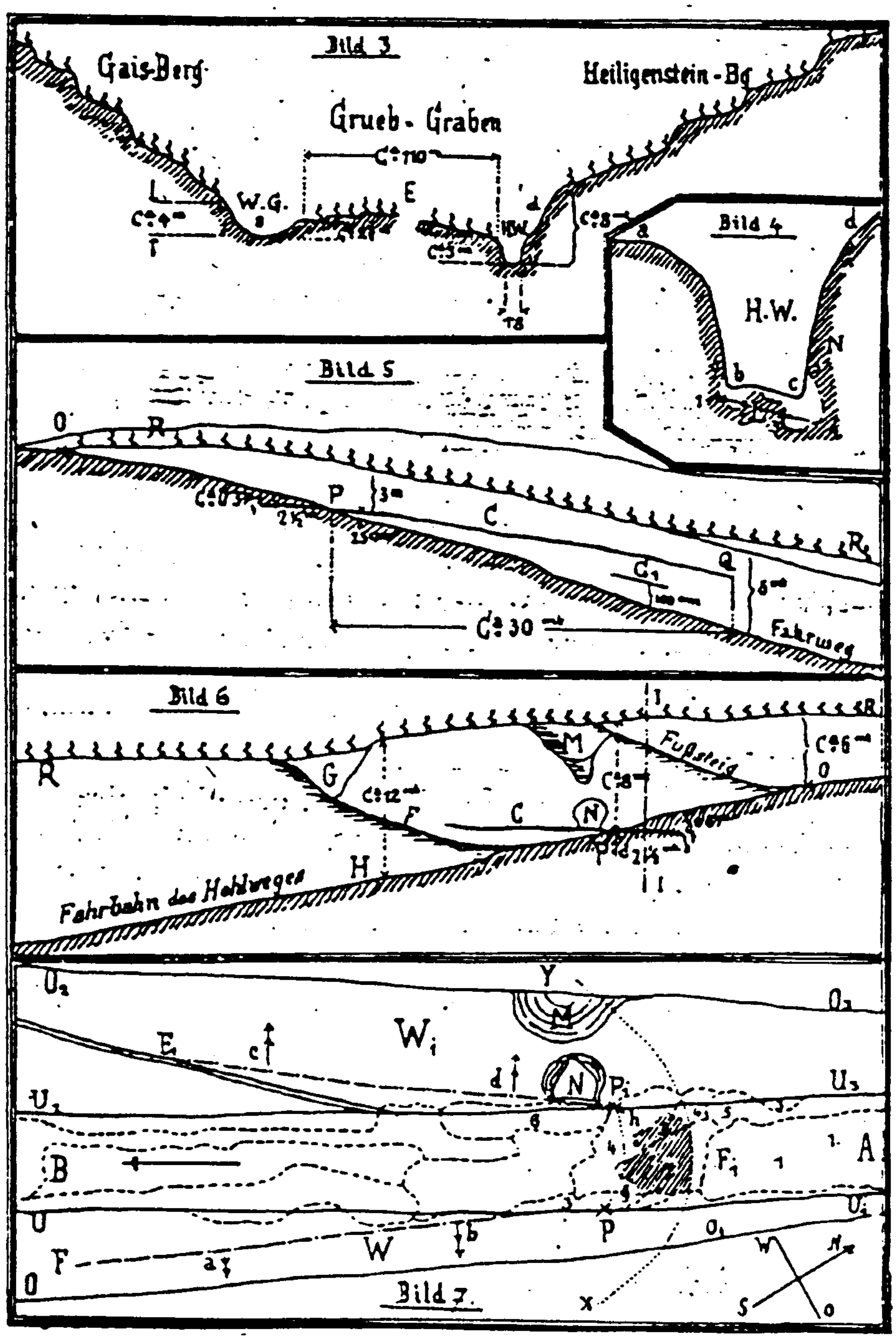


Fig. II - 1 Kiessling sketches :

• bild 3 : cross section E - W

• Bild 4 : the gorge after the 1915 rain; 1,2,3,4 are spots, where the layer was open; b,c - previous road - level; L - socle left by the water and removed by Kiessling.

• Bild 5 : eastwall ; dark layer (C) visible from Q to P where it disappeared below road-level.

• Bild 6 : westwall; C - dark layer : G,M,N - disturbed; H - road level : F - footpath; in P layer disapp.

• Bild 7 : plan of the section with Kiessling 's sondage- pit (2,3); road between U1 and U2 ; O - U walls; in g,h the layer had been washed out; numbers give levels (road ascending from A to B.

above the "Aurignacian," but if there was a homogeneous stratum it could not be separated from the surrounding loess.

Finally there are some artifacts described as "Grubgraben, 16. June 1922, oberes Niveau - B" - certainly from Bayer's excavation.

The topographic situation as shown in these sketches has considerably changed in the meantime. Kiessling mentioned heavy rains during the years 1917 and 1918 washing and hollowing out road and walls. Consequently repairs were made and the road level was raised.

Considerable damage was obviously done by local collectors. This is well illustrated by a letter addressed by J. Bayer to a Mr. Spitzwieser in which he refused to give permission for exploiting the site to Mr. Höbarth and "his friends." (Bayer was at that time professor at the Institute fur Ur-Fruhgeschichte at the University of Vienna, Höbart was custodian of the local museum in Horn - but without definite qualifications for leading excavations).

Although Grubgraben was under regular observation (J. Szombathy, H. Obermayer - Museum of Natural History; F. Kiessling; J. Bayer), illegal and uncontrolled digging continued.

On 16th of June 1922, J. Bayer started a two day excavation on the east wall of the sunken road with the permission of the Zwettl Abbot (land owner). F. Kiessling and two students, Penninger and Jenny, participated in the work.

Obermaier (1925) could distinguish two layers :

a.) at an upper level, two meters below loess - surface ; concentrations of little lithic artifacts, but mainly bones from horse and reindeer; graphite and hematite (red chalk);

Above this level dispersed bones, flint and big stones, but no cultural layer was found. (5 - 10 cm above upper level).

b.) at a lower level, 80 cm below a ; no finds were recovered from this excavation, but Obermaier admits that it could be richer than the upper level; in the upper part of the ravine layers a and b meet according to Obermaier.

In 1962 Luzius from the Bundesdenkmalamt led a two day emergency excavation (May 28, 29), for there were plans to widen the road. There are sketches by Dr. Luzius showing remains of a cultural layer on the west wall, whereas a continuous layer meets an interrupted one in an acute angle on the east wall. Unfortunately there are no further documentation available.

At the same time Prihoda of the Museum in Horn collected materials at the site . In this case also no documentation exists about the circumstances of his work.

In his survey of paleolithic sites in Lower Austria, F. Felgenhauer (1962) gave a brief summary of Grubgraben - Kammern in which he listed some basic information (all described in a more detailed way above).

Heinrich in his dissertation (1981), gave a detailed description of most of the archaeological finds from Grubgraben and mentioned the faunal material as well. According to Heinrich (1981, 113 - 198) the following collections have been treated in his dissertation:

collections	depository
Glassner	
Köhler - Ranscher	Museum of Natural History
Guler - Ritter	(Vienna)
Kiessling	
Museum Horn	
Museum Aspern / Zaya	
Prihoda	Horn (private)
Weinfurter	Institut für Ur - und Frühgeschichte (University of Vienna)
Mossler	(?) probably Museum of Natural History
Museum Langenlois (Grubgraben ?)	
Schacherl	Zwettl (private)

Numerous objects from private collections have disappeared (Heinrich 1981).

For Heinrich the material from Grubgraben is not sufficient and not marked enough to permit any interpretation. He tends to regard it as Aurignacian, for Gravettian elements seemed to be missing. It should be noted that many small specimens were probably lost because of poor recovery techniques. Heinrich described and counted 1700 artifacts. In addition he described groups of small flakes and chips which were not counted. His inventory of Grubgraben artifacts is as follows :

1.) chips and flakes unretouched (including splintered pieces) and what is described as "waste 1938
2.) chips and flakes, retouched 79
3.) blades, retouched 50
4.) blades, unretouched 38
5.) blades with Aurignacian retouch 3
6.) cores : (4 fragments, 1 scraper on nucleus 10
7.) endscrapers, sidescrapers - scrapers of all other types 135
8.) burins 49
9.) point 1
10) leaf-shaped point 1

According to the illustrations, some of the blades and bladelets seem to have been truncated although they are not described as such. One quartzite artifact described as "Handaxe-like" is illustrated in figure T XXIX/5. Pieces of ocher, red material, slate and pebbles are mentioned. However, some of the artifacts described by Kiessling and Obermaier among which was the specimen of *Corbula striata* seemed to have been missing from the collections examined by Heinrich.

In summary, old collections from the site are sizeable though scattered. They are mostly grab samples salvaged from the downcutting of the roadway and slumping of the loess walls. A number of individuals have dug potholes wherever the cultural layers were visible. Early excavation reports provide valuable information about parts of the site along the sunken road which have now disappeared.

Various authors have emphasized the Aurignacian-like appearance of the assemblages, an opinion probably derived from the relative abundance and variety of scrapers and the presence of thick, carinate scrapers. The scarcity of backed elements contributed to this attribution as well.The presence of a single leaf-shaped point is worth a special mention even though its exact provenience is not known (deepest level ?). The specimen has apparently disappeared.

Still, the site has been known for a long time and specialists, Kiessling especially, had understood its importance.

III

STRATIGRAPHY OF THE GRUBGRABEN LOESS SEQUENCE

by

PAUL HAESAERTS

GEOMORPHOLOGICAL AND GEOLOGICAL SETTING

Grubgraben is located in the vicinity of Langenlois, 15 km to the north of the Danube River, along an east-west oriented escarpment following the northern edge of the Danubian Plain. The site lies at the bottom of a ravine cut into the Palaeozoic bedrock , and is enclosed by high reliefs caped by Tertiary gravels; the Heiligenstein, at an altitude of 360 m, borders the ravine to the west and to the north, while the Geissberg, a 336 m high butte, forms its eastern edge (Fig. III-1 & Fig. IV.2). The Kamp River, a northern tributary of the Danube which has cut its valley across the Palaeozoic bedrock, flows along the western flank of the Heiligenstein; when joining the Danube Plain, it develops a much larger flood plain at an altitude of about 200 m and turns to the southeast at the foot of Grubgraben.

At Grubgraben, the loess cover is mainly developed in the central part and along the western slope of the ravine, which gives it an asymmetrical profile. Furthermore, those deposits are part of the wide loess belt which extends to the east of Krems in the Danube Plain as far as Hungary, and also to the west in the Wachau where the river has cut a narrow valley across the Palaeozoic rocks of the southern extension of the Bohemian Massif.

Many loess sections have been studied in this area since the beginning of the 1950's, especially those of Krems-Schiesstätte, Paudorf, Göttweig-Aigen, (Felgenhauer et al., 1962; Fink et al., 1976), Willendorf (Brandtner, 1956-59) and Senftenberg (Brandtner, 1954). Nevertheless, a detailed stratigraphic sequence for the Upper Pleistocene loessic deposits of this area, could only be established recently (Haesaerts, 1965, 1990). For the period between 45,000 and 20,000 B.P., this stratigraphic sequence has been based on several Upper Palaeolithic layers present in the loess, which provide good chronological markers because of their typological context but also because of the opportunity for radiocarbon dating they allow. In that respect, the loess record of Grubgraben is of major importance as it incorporates at least four Epigravettian occupation layers, the main layer being dated between 18,400 and 19,000 B.P., a period usually poorly documented in most of the loess sections of Central Europe (Haesaerts, 1985).

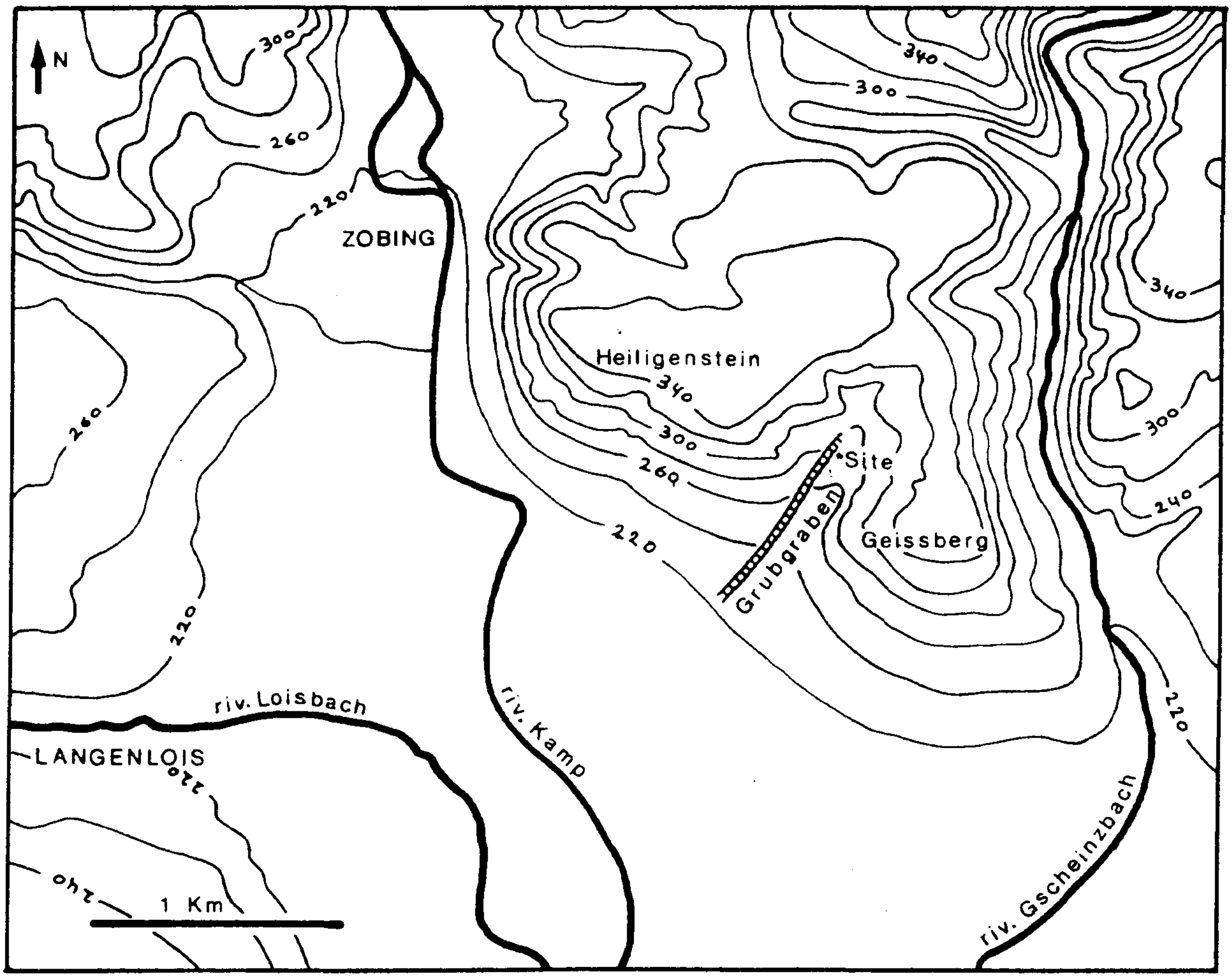


Fig. III-1 . Location of Grubgraben and topography of the surrounding area.

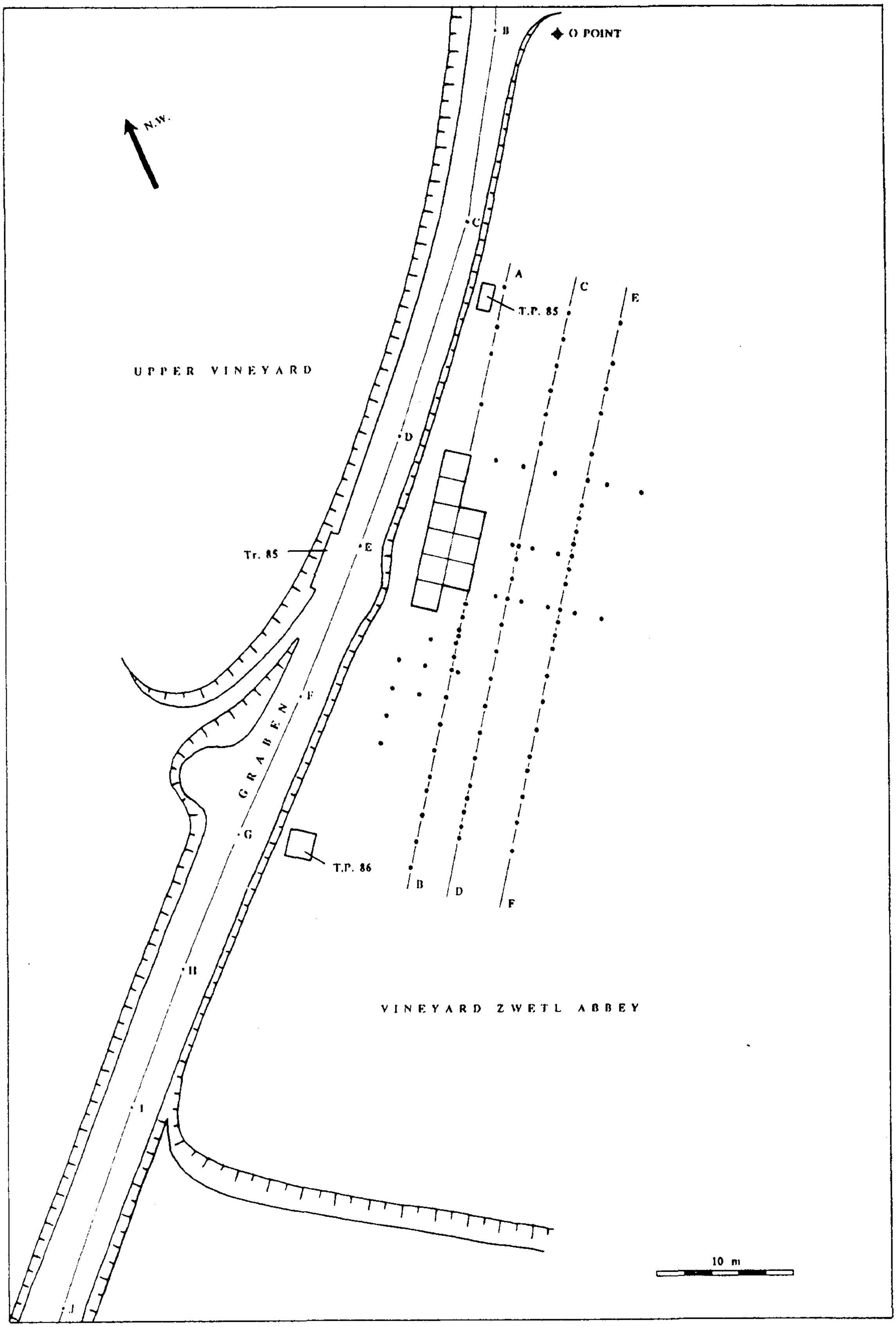


Fig. III-2. Grubgraben : location map of sections and borings

LOCAL STRATIGRAPHY

General context

Most loessic deposits at Grubgraben are accessible along both sides of a deep sunken road sunken road, developed along the western slope of the ravine. The site was first discovered here in the 1870's, more or less 40 m below the point where the graben ends (Fig. III-2). At this place, recent agriculture has strongly modified the former morphology of the top of the loess cover by creating terraces for vineyards. Indeed, at the site the western wall of the road is almost 7 m high, the upper 3 m consisting of fill (Fig. III-3). On the other hand, the height of the eastern wall along the vineyard of Zwettl Abbey does not exceed 2.5 m, which implies that the top of the loess cover has been lowered at least 1.5 m before planting the vineyard. Higher up in the ravine, the loess cover is less continuous and the faulted Palaeozoic bedrock made of gneiss, arkosic conglomerates, sandstones and shales, outcrops in patches along the slopes at a few hundred meters to the north of the Epigravettian settlement (Fig. IV.2).

Archaeologic occurrences

The main archaeological complex (AL2-AL4) was retraced when the western wall of the road was cut back in 1985 to expose the profile (Tr. 85, Fig. III-3). It is a multi-component complex with artifacts, stones, bones and humic stripes present 3 m below the top of the undisturbed loess (Fig. V.13). Two other archaeological layers were also detected at the same place in the loess; the upper one (AL1), 1 m above the main complex, the second (AL5), 0.50 m underneath it. Laterally the main complex is followed over a distance of 55 m along both walls of the graben. Further on, the extension of the main complex was mapped over an area of more than 1,000 m^2 in the parcel of the Zwettl vineyard with the help of a hand auger (Fig. III-7); most of the 95 borings reached it at a depth varying between 0.90 and 3.60 m below the present day surface. Finally, the detailed stratigraphy of the main complex was established in 1987 at the excavation site (Fig. III-4 & III-5) where three distinct occupation horizons (AL2, AL3 and AL4) separated by thin loamy layers were recognized in the prolongation of the road section.

Lithostratigraphical sequence

The stratigraphical sequence of Grubgraben combines different sets of complementary data recorded respectively on both sides of the sunken road, at the excavation site and in the Zwettl vineyard. This sequence encompasses a cumulative thickness of more than 13 m subdivided into 17 sedimentary units and 5 archaeological layers. From the top to the bottom, the succession is as follows (Figs. III-3, III-4, III-5 & III-9):

- Rew. (up to 3 m)

Terrace fill consisting of disturbed pale yellowish loess (2.5 Y 8/6 hum.) with humic lenses; at the base of it a discontinuous gravel incorporates pottery sherds and fresh bones. Only present in the western wall of the road, below the upper vineyard.

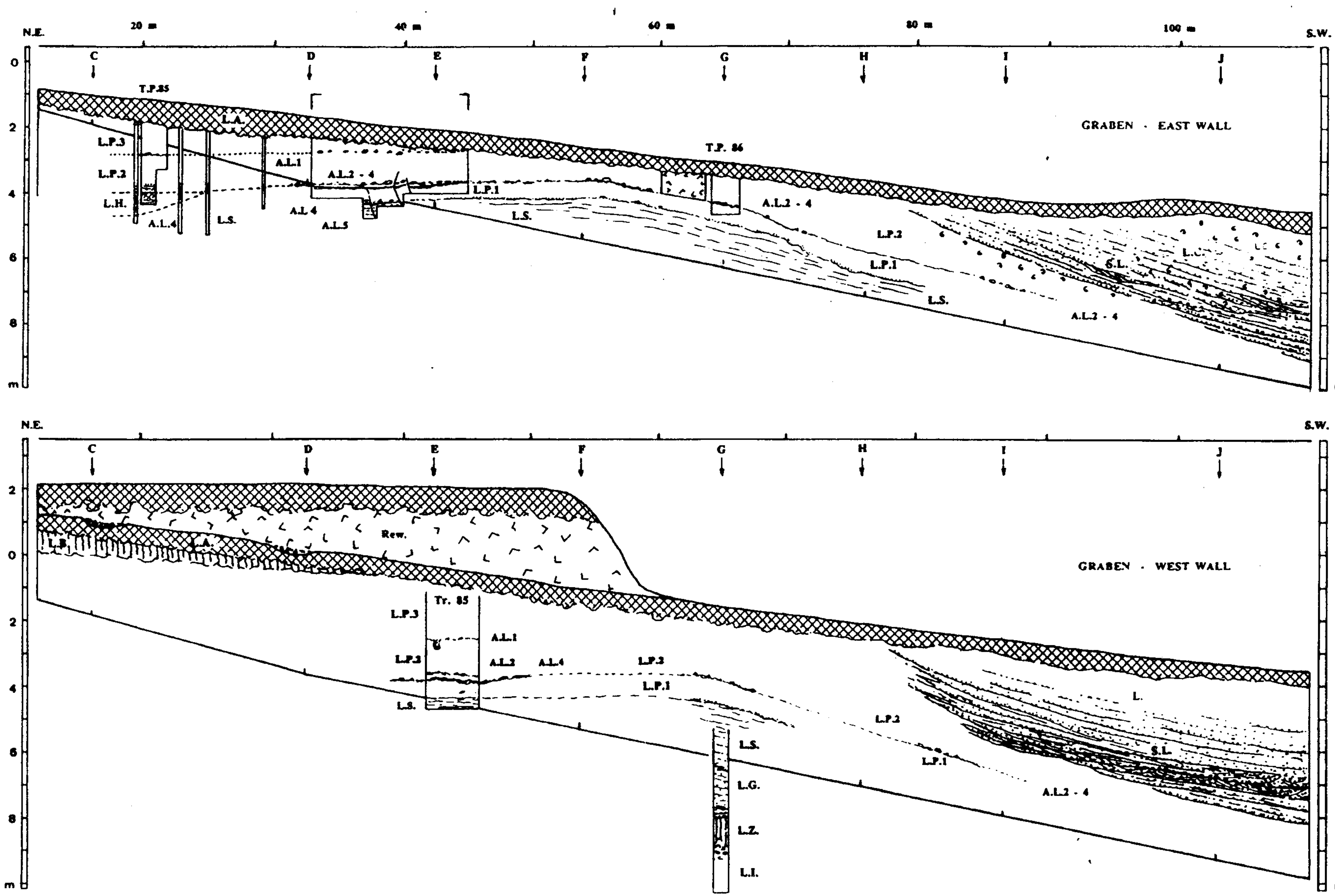


Fig. III-3. Stratigraphy of the graben (graphic symbols : see Figure 4).

- LA (0.20 to 1 m)

Dark gray brown crumbly loam (10 YR 3/2 hum.), frequently enriched in $CaCO_3$ in its lower part. Present almost everywhere at the top of the upper loess cover, it represents the surficial A1 horizon of the present day soil. In the eastern part of the Zwettl vineyard, the thickness of this horizon increases and reaches 1 m, as a result of recent human activity.

- LB (up to 0.5 m)

Yellowish brown loam (10 YR 5/4 hum.) with prismatic structure and humic clay-coatings on it; only observed underneath the recent fill (Rew.) in the western wall of the road north of P. 30, it shows the characteristics of the illuviated B horizon of a gray brown podzolic soil (Alfisol).

- LC (up to 2 m)

Homogeneous, dusty, pale yellowish loess (2.5 Y 7/4 hum.), preserved on both sides of the road south of P. 85 (Fig. III-3). The lowest part of the loess is stratified with sandy lenses; terrestrial molluscs are rather abundant (see Table 1 : mollusc assemblages), with a majority of xerophilus species mainly *Pupilla muscorum* (68.9%) together with a few hydrophilus species among which *Succinea oblonga* (15.8%).

- SL (up to 2 m)

Stratified sand and loess, filling up a gully deeply cut through the upper part of loess LP. The gully starts south of P. 60 and extends downward to the south along the road. Cross-bedded stratifications are frequent in the sandy layers in the lower part of unit SL, together with concentrations of small rounded quartz and feldspar gravels reworked from the Palaeozoic bedrock. Terrestrial molluscs present in the loamy layers of the upper part of unit SL, are dominated by hydrophilus species mainly *Succinea oblonga* (77.6%).

- LP3 (up to 2 m)

Homogeneous, dusty pale yellowish loess (2.5 Y 7/4 hum.), present above the upper archaeological layer AL1; it is only preserved in the northern part of the site where its thickness is close to 2 m in the western wall of the road (P. 45, Fig. III-3).

- Archaeological layer AL1

Upper Epigravettian horizon apparently restricted to the surroundings of the excavation site where it appears as a subhorizontal weak concentration of blocks of sandstone and gneiss, together with a small amount of flint implements and little bone fragments. Elsewhere this layer is absent or has been eroded, except in test pit 85 at the northern edge of the site, where a thin sandy layer with scattered bone fragments is present at the same altitude as AL1 and could be in its prolongation (Figs. III-3 & III-6). Archaeological layer AL1 is clearly at the interface of two loess series (LP3 and LP2); occupants settled on a subhorizontal surface which truncates the top of loess LP2.

Dark gray brown crumbly loam (10 YR 3/2 hum.), frequently enriched in $Ca CO_3$ in its lower part. Present almost everywhere at the top of the upper loess cover, it represents the surficial A1 horizon of the present day soil. In the eastern part of the Zwettl vineyard, the thickness of this horizon increases and reaches 1 m, as a result of recent human activity.

Table III-1 Mollusc assemblages from Grubgraben : (determination : Prof J. De Coninck and F. Gelaude, Institute for Palaeontology, State University of Gent). * : xerophilus species; **: little hydrophilus species; *** hydrophilus species.

Unit L.C. road section, P. 100 (576 spec.)		
-*Pupilla muscorum* (400 spec.)	69.5%	*
-*Succinea oblonga* (150 spec.)	26.0%	***
-*Helicella geyeri* or *H. striata* (20 spec.)	3.5%	*
-*Trichia hispida* (4 spec.)	0.7%	**
-*Clausilia dubia (2 spec.)*	0,3%	**
Unit S.L. road section, P.100 (361 spec.)		
-*Succinea oblonga* (280 spec.)	77.6%	***
-*Pupilla muscorum* (60 spec.)	16.6%	*
-*Vallonia pulchella (12 spec.)*	3.3%	**
-*Helicella geyeri* or *H.striata* (6spec.)	1.7%	*
- *Tricha hispida* (3 spec.)	0.8%	**
Unit L.P.2 road section, P.67 (491 spec.)		
-*Succinea oblonga* (370 spec.)	75.4%	***
-*Pupilla muscorum* (100 spec.)	20.3%	*
-*Vallonia pulchella* (20 spec.)	4.1%	**
-*Columella columella* (1 spec.)	0.2%	
Unit L.S. road section, P.65 (373 spec.)		
-*Pupilla muscorum (200 spec.)*	53.6%	*
-*Helicella geyeri* or *H. striata* (200 spec.)	40.2%	*
-*Trichia hispida* (20 spec.)	5.4%	**
-*Succinea oblonga* or *S. arenaria* (2 spec.)	0.5%	***
-*Vallonia pulchella* (1 spec.)	0.3%	**

Table III-2 Grain-size compositions of the loess at Grubgraben (cumulative values in %).

sample number	1	2	3	4	5	6	7	8	9	10	11	12
% CaCO3	11,4	22,2	28,9	29,7	14,6	26,6	14,9	14,7	18,4	9,3	7,3	7,0
> 420 m	0,4	1,1	0,3	0,5	0,6	2,5	1,1	0,9	0,5	2,3	4,5	3,4
> 295 m	0,6	1,7	0,6	1,0	1,3	3,3	1,6	1,7	0,9	3,7	7,0	5,1
> 210 m	0,9	2,5	0,9	1,8	2,2	4,2	2,5	2,5	1,6	5,3	9,7	6,9
> 149 m	1,3	3,8	1,6	3,0	4,1	5,7	5,1	4,2	3,2	7,9	13,5	9,4
> 105 m	1,9	5,3	2,5	4,8	6,6	7,6	8,5	6,2	5,5	10,9	17,1	12,1
> 80 m	3,5	7,7	4,0	7,5	10,4	10,2	12,6	8,8	9,0	14,2	20,6	15,6
> 53 m	12,6	17,1	12,9	15,8	20,5	18,1	24,7	18,3	20,4	28,5	27,5	24,1
> 20 m	59,3	67,3	67,4	68,8	71,5	63,4	72,2	76,4	70,4	69,3	57,2	68,2
> 10 m	74,1	79,6	79,2	79,6	81,6	75,1	82,6	81,6	80,1	78,2	66,0	79,2
> 2 m	89,6	88,9	88,6	89,1	89,0	86,8	89,2	89,0	88,9	87,3	82,4	87,8
< 2 m	10,4	11,1	11,4	10,9	11,0	13,2	10,8	11,0	11,1	12,7	17,6	12,2

1 : unit LC
2 : unit LP2
3 : unit LP2 (top)
4 : unit LP2 (base)
5 : unit LR1
6 : unit HH1
7 : unit LP1
8 : unit LS
9 : unit LS (base)
10 : unit LG
11 : unit LZ
12 : unit LI

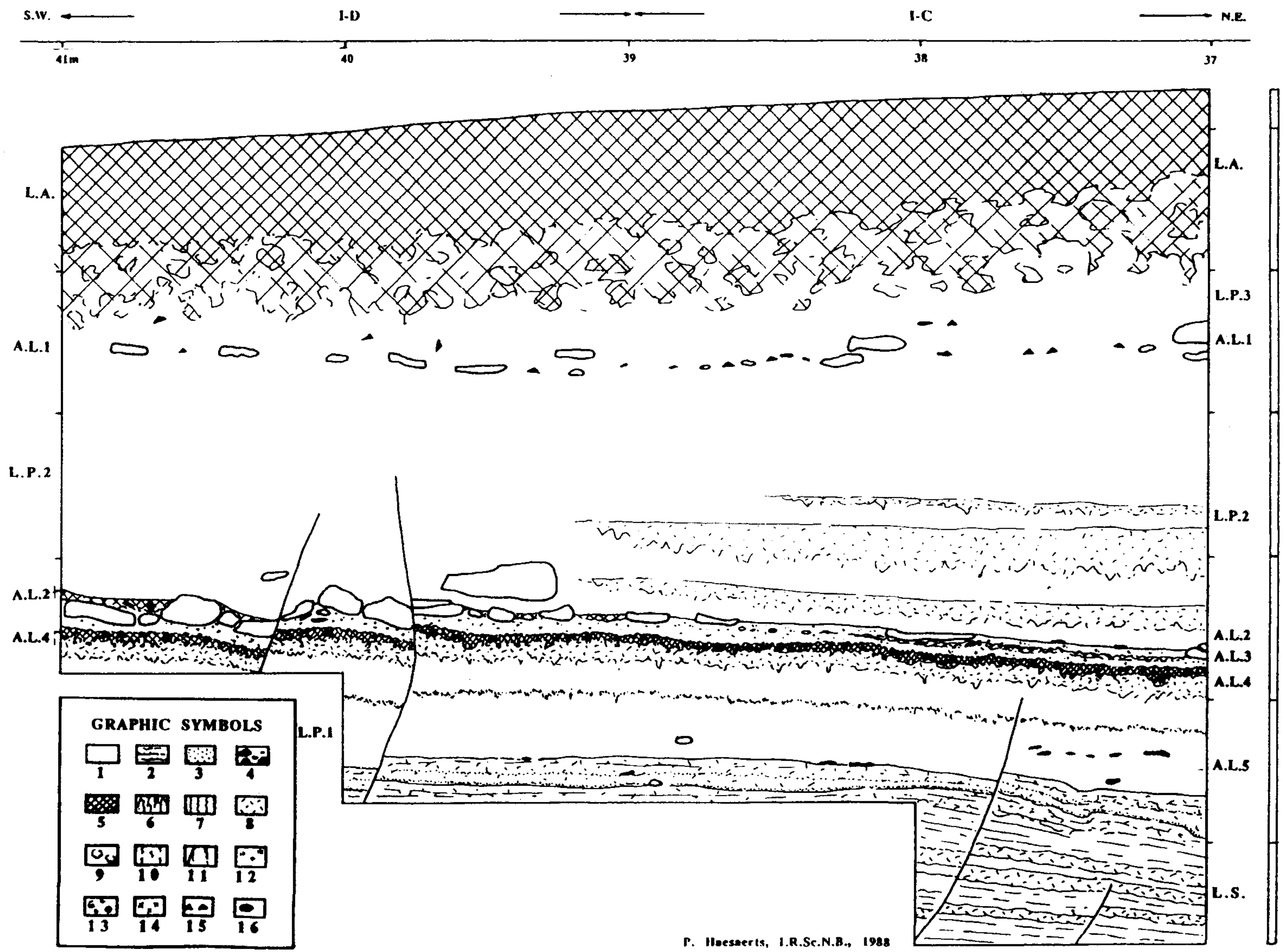
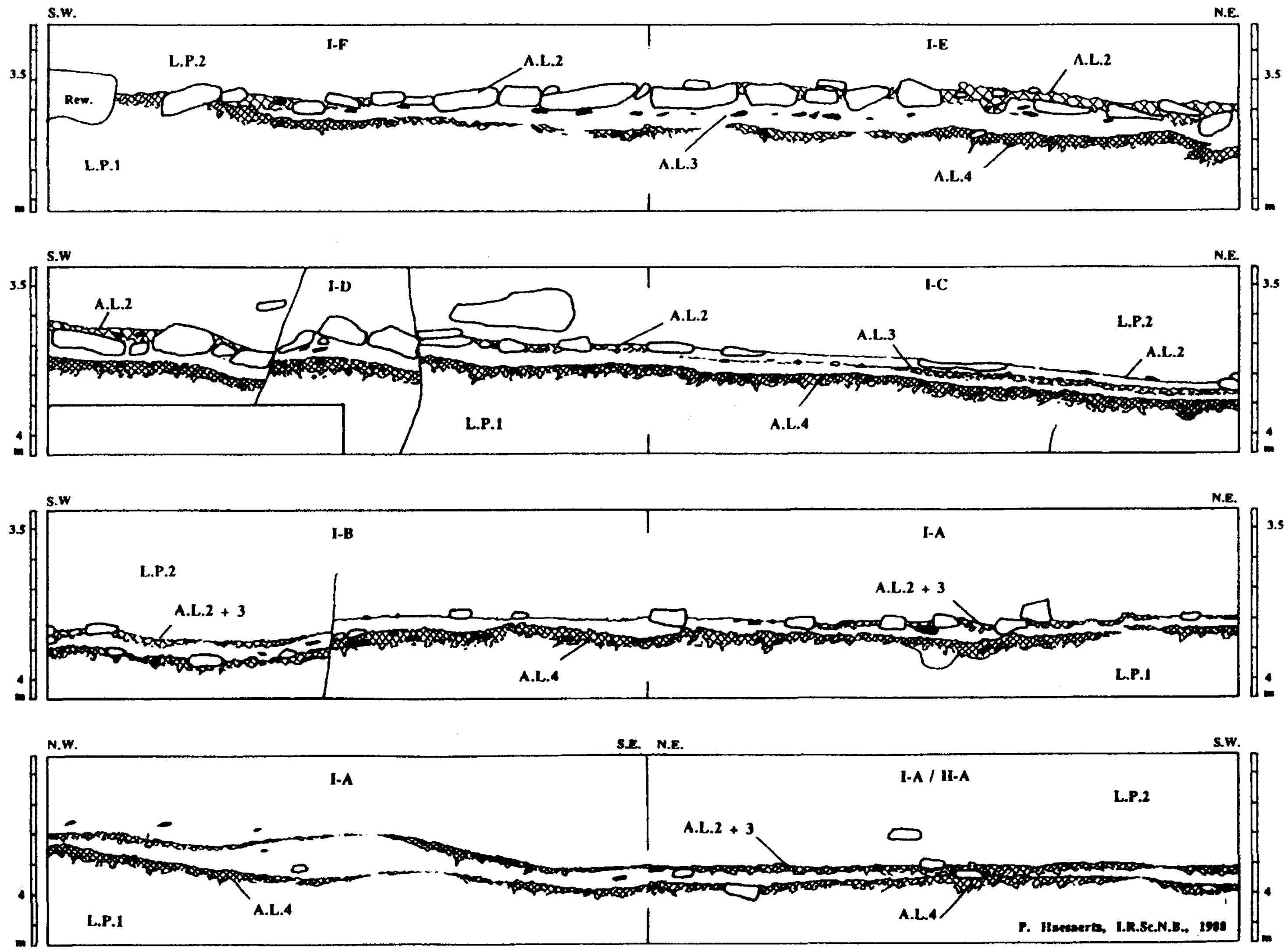
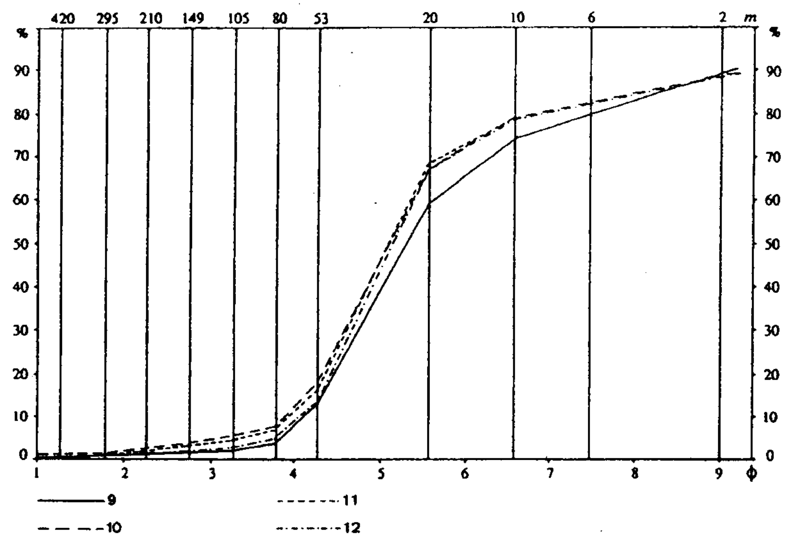
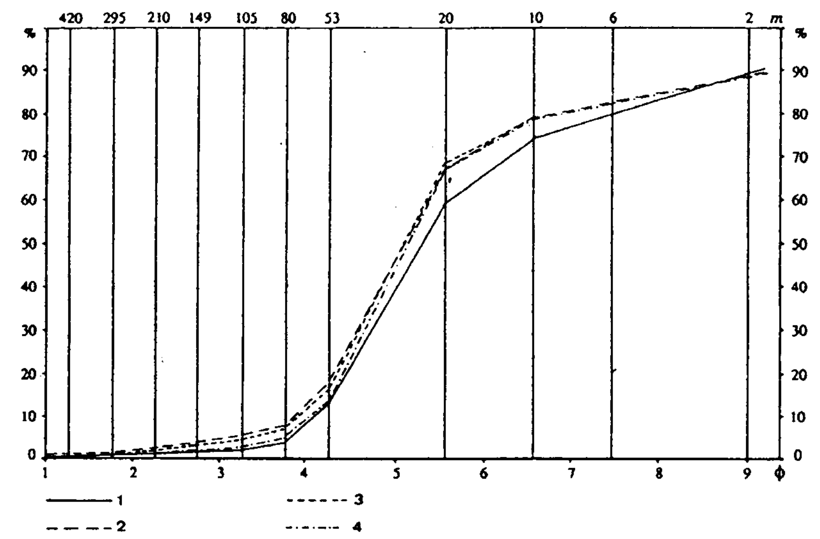


Fig. III-4.
Type section of the excavation site.
Graphic symbols.
1: loess;
2: sandy loam;
3: sand;
4: stones;
5: humic sediment;
6: Alfisol (textural B horizon);
7: brown forest soil (B horizon);
8: bleached horizon (micro-podzol);
9: calcic concretions;
10: pseudo-mycelium;
11: rootcasts;
12: iron-staining;
13: molluscs;
14: charcoal;
15: artifacts;
16: bones.

Fig. III-5.
Stratigraphy of the main archaeological complex (AL2-AL4) at the excavation site (graphic symbols: see Figure 4).







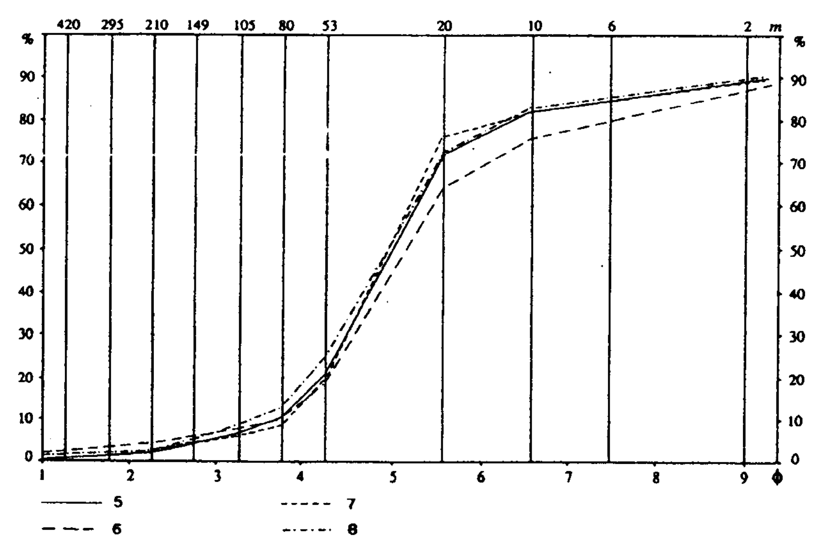


Fig. III-6. Grain-size distributions of the loessic deposits of Grubgraben.

- LP2 (0.5 to 1.5 m)

Dusty, pale yellowish loess, similar to LP3. At the excavation site three discontinuous thin light grayish horizons with iron-staining occur in the lowest part of unit LP2, while in the eastern wall of the road, the upper part of the same loess has provided a mollusc assemblage characterized by a predominance of hydrophilus species similar to the one recovered from unit SL.

- Archaeological layer AL2

Upper occupation horizon of the main archaeological complex, the stratigraphy of which has been distinguished at the excavation site (Figs III-4 & III-5). AL2 occurs here as a pavement of joining blocks of sandstone, arkose and gneiss, 10 to 40 cm in diameter. A prospection in the surroundings of the excavation site, with the use of a hand auger, has shown that the manuports covered a surface of more than 100 m² (Fig. III. 7), but the precise stratigraphic attribution of the unexcavated structures remains to be defined. At the excavation site, bones and lithic implements are not very abundant in AL2; sometimes they are found in a thin light brownish discontinuous horizon, usually on top of the stony pavement. Outside the paved structures, bones and artifacts are present on a surface which rests on the top of the discontinuous humic horizon HH2 (Figs. III-4 & III-5, excavation units I-E to I-B).

- LR2 (up to 0.03 m)

Thin, pale yellowish loessic deposit with small brown spots (10 YR 5/3 hum.); only present in the southern part of the excavation site between the bone concentration of AL3 and the stony pavement AL2 (Figs. III-4 & III-5, excavation units I-E, I-D and I-C).

- HH2 (up to 0.04m)

Discontinuous centimetric dark brown layer (10 YR 4/2 hum.), recorded in the western wall of the road (P. 45) as well as in the northern part of the excavation site.

- Archaeological layer AL3

Intermediary occupation horizon clearly distinct from AL2 and separated from it by a few centimeters of sterile loess in excavation units I-F, I-E and I-D. At the excavation site, it occurs as a concentration of bones into a pale yellowish loess with little brownish spots (Figs. III-4 & III-5; excavation units I-E, I-D and I-C). To the north of excavation unit I-C, the discontinuous dark brown layer HH2, which includes flint implements, bone fragments and scattered small blocks of stones, constitutes the continuation of archaeological layers AL2 and AL3.

- LR1 (up to 0.15 m)

Light yellowish, sandy loess (2.5 Y 7/5 hum.), occurring between layers HH2 and HHI at the excavation site, where it shows small gray brown spots and contains scattered bone fragments.

- HH1 (up to 0.04 m)

Almost continuous, 2 to 4 cm thick, black to very dark brown layer (10 YR 4/3 hum.), incorporating rather abundant flint implements, fresh or burned bone fragments and dispersed stony blocks with a diameter seldom beyond 10 cm. The upper boundary of layer HHl is usually regular and more or less sub-horizontal, while its lower boundary shows many small disturbances which are probably related to a rather intense biological activity. In the eastern and western walls of the excavation site, all units up to LP2 are

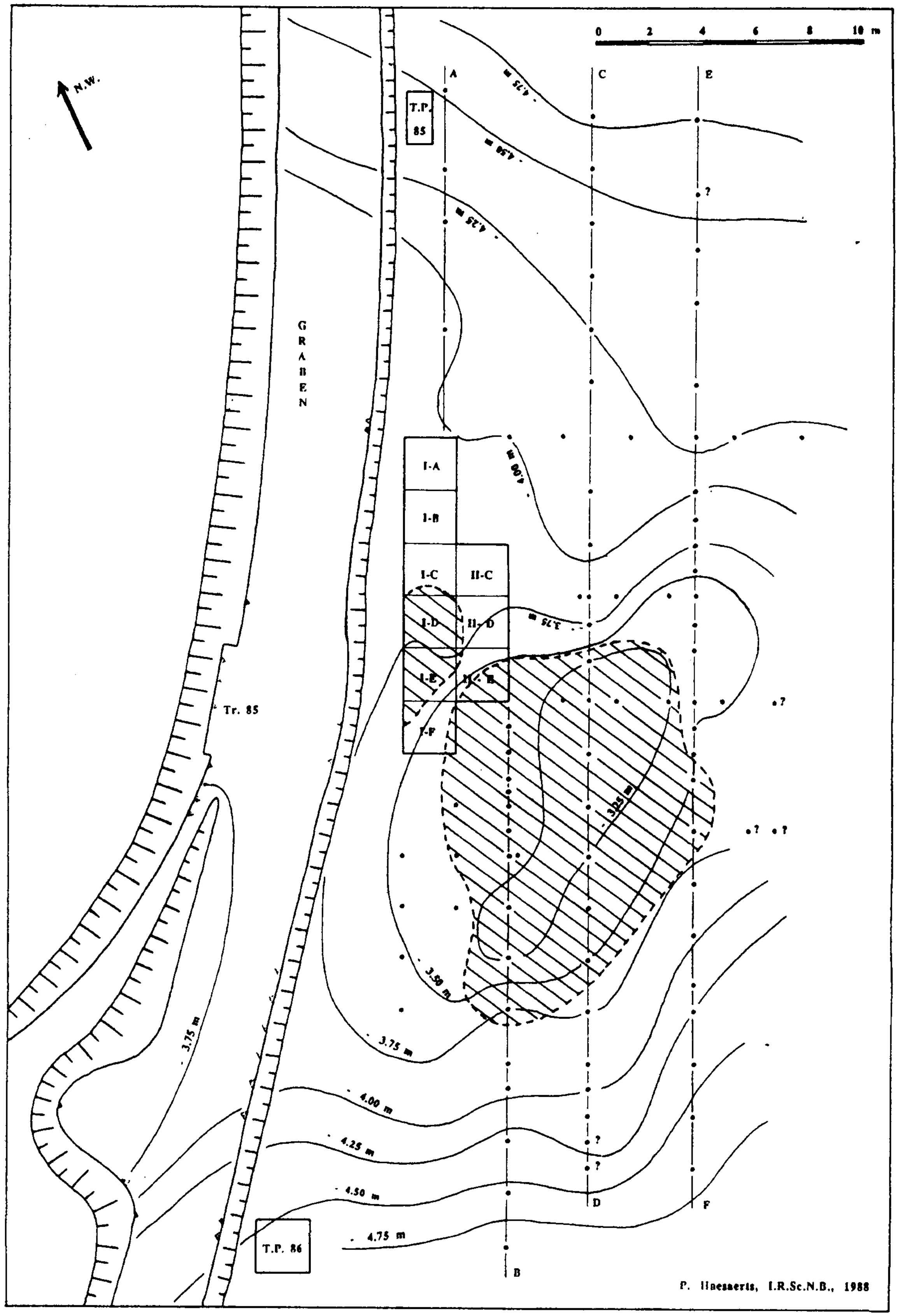


Fig. III-7. Contour lines of the top of the main archaeological complex (AL2-AL4); depths are referring to the Datum Point located at the northern edge of the site; hachured areas show the extension of the continuous stony pavements of AL2.

affected by a set of small faults which cut also across HHl with little effect upon its spatial distribution (Figs. III-4 &III-5).

- Archaeological layer AL4

Main archaeological layer, undoubtedly related to unit HHl; artifacts, bone fragments and stones are usually scattered in the dark brown layer, but at some places small pocket-like structures were also present at the base of it, or just beneath. It is the case in excavation units I-A and I-D, where they were filled with a brown yellowish loam with many little brown spots (Fig. III-5). Another characteristic of AL4 is its remarkable continuity; indeed, outside the areas where the stony pavement of AL2 extends, it has been recorded together with unit HHl over more than 1,000 m², not only in the walls of the sunken road and at the excavation site, but also in most of the borings carried out in the Zwettl vineyard (Fig. III-8). From those data, it appears that AL4 and HHI delimit the pourtour of a small promontory connected to the western slope of the ravine by a shallow depression located at the same place as the present-day sunken road.

The following radiocarbon dates are available for the main archaeological complex (AL2-AL4).

- AA-1746 = 18,960 ± 290 B.P. : bone fragment from AL4, collected in 1985 at P. 45 in the western wall of the road (accelerator facility at the University of Arizona).

- Lv-1680 = 18,400 ± 330 B.P. : several bone fragments from AL4, collected in 1987 at the excavation site (Louvain-la-Neuve, Belgium).

- Lv-1660 = 18,170 ± 300 B.P. : several bone fragments from AL3 and AL4, collected in 1985 at P. 45 in the western wall of the road (Louvain-la-Neuve, Belgium).

LH (up to 0.80 m)

This unit has only been recorded along the northern edge of the site (Fig. III-3); it consists of light gray brown loamy sand (10 YR 8/3 hum.) alternating with layers of dark brown sandy loam (10 YR 5/3 hum.), filling up a large gully oriented perpendicularly to the road. As the archaeological layer AL4 has also been recognized in several borings at the base of unit LH along the southern edge of the gully (Figs. III-7 & III-8), it is likely that the filling occurred at least simultaneously with the development of humic horizons HHl and HH2 as well as during the deposition of units LR1 and LR2.

- LPl (± 0.70 m)

Homogeneous and unstratified pale yellowish sandy loess, present everywhere below humic horizon HH1. In the graben and at the excavation site, a ten centimeter thick, slightly mottled horizon was present at the upper contact.

- Archaeological layer AL5

Lower archaeological occurrence characterized by a thin scatter of artifacts and bone fragments distributed within 10 cm loess at the base of LP1 . This archaeological layer is present locally in secondary position, at the excavation site and also in the road sections at P. 45; elsewhere it is evanescent or absent.

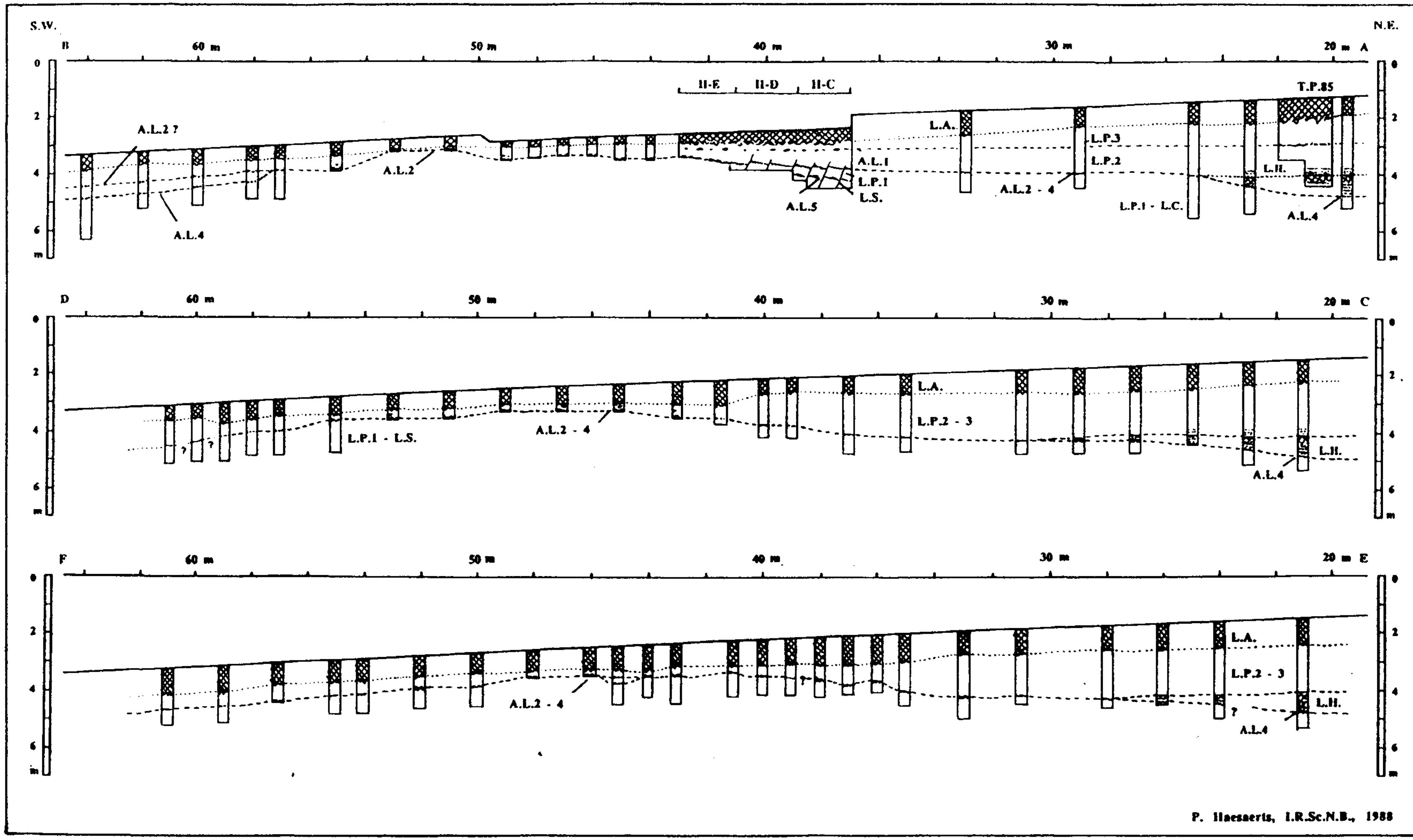


Fig. III-8. Stratigraphical sections across the Zwettl vineyard (graphic symbols: see Fig. 4).

- LS (± 2m)

Yellow loess (2.5 Y 8/6 hum.) with fine lamination and several thin pale grayish horizons with traces of iron-staining. On top of the loess occurs a thin sandy layer used as marker; further on, a mollusc assemblage from the middle of unit LS, collected at P. 65 in the western wall of the road, shows a predominance of xerophilus species, essentially *Pupilla muscorum* (53.6 %) and *Helicella geyeri* or *striata* (40.2 %). At the same place, the lower part of unit LS and the underlying units (LG to LI) were only recorded in a boring (Fig. III-3). To its base, the loess LS incorporates increasingly sandy and gray loamy lenses mixed with small gravels.

- LG (± 1.50 m)

Light yellowish brown sandy loess-like sediment (2.5 Y 5/6 hum.), with recurrent sandy layers and fine gravels, alternating with light grayish brown loamy layers.

- LZ (± 0. 80 m)

Dark brown clayey loam (10 YR 4/3 hum.), with a ten centimeter thick calcic horizon in the upper third of the unit; a second calcic horizon is developed at the contact with the underlying loess.

- LI (up to 1.30m)

Pale yellowish sandy loess with a calcic horizon in the upper part and some fine gravely layers to the base.

SEDIMENTARY AND CLIMATIC ENVIRONMENT

The lithological sequence at Grubgraben consists of five distinct loess bodies separated by several paleosols and marker horizons (Fig. III-9). The most developed paleosol (unit LZ) occurs in the lowest part of the sequence, on top of the oldest loess (unit Ll). Its degree of weathering and the high mobility of $CaCO_3$ are indicative of a major pedological event, most probably related to an interglacial period, the stratigraphical position of which is discussed below.

The overlying loess-like sediments (unit LG) belong to the first part of the following glacial period; because of their degree of hydromorphy and grain-size heterogeneity, they were probably deposited under rather cold and still humid climatic conditions.

The next loess (unit LS) is much more homogeneous and suggests an increasingly cold and dry environment, which is in good agreement with its mollusc assemblage dominated by xerophilus species. The fine lamination of the loess is probably related to the seasonal contrast of the climate at that time, whereas the weak podzolic horizons could have been induced by a recurrence of colder episodes (Haesaerts & Van Vliet-Lanoë, 1981).

A different eolian process starts with the homogeneous sandy loess LPl supposedly formed under drier conditions. It is at the beginning of this episode that the first Upper Paleolithic occupation (AL5) took place at Grubgraben, but only a small area of this oldest archaeological occurrence, mainly in secondary position, has been excavated until now.

The first well dated Epigravettian occupation of the site (AL4) took place immediately after the deposition of the dusty loess LPl , just before and during the formation of a semi-continuous dark brown humic horizon (HH1), most probably between 18,400 and 19,000 B.P. Bones and artifacts of AL4 are associated almost everywhere with the humic horizon; because of its structure and its remarkable continuity, this horizon should be considered as a pedological feature related to a short climatic warming, rather than solely as the result of anthropic activity. Indeed, from the palynological data communicated by Ar. Leroi-Gourhan, it seems that a little rise of temperature, and probably also an increase of humidity, had lead to the development of an open woodland dominated by *Pinus cembra*. At that time, the Palaeolithic settlement extended over an area of more than 1,000 m², including the top and the sides of the small promontory in prolongation of the western slope of the ravine, and as far as the edge of the gully which delimits the site to the north.

After a restart of the eolian activity, during which a thin layer of loess partly reworked by rill-wash (unit LR1) covered the humic horizon HHl , a second short improvement of the climate occurred seemingly with the development of a second, but much more discontinuous humic horizon (HH2), which is related to the second Epigravettian occupation of the site (AL3). Moreover, the simultaneous filling of the gully to the north of the side by colluviated sandy loams and humic sediments, implies an increasing activity of springs located higher up the slope and demonstrates also the relatively humid context of the climatic environment at the time of the Epigravettian occupations.

The third Epigravettian settlement (AL2) took place just at the beginning of the following loessic accumulation (unit LP2); the most expressive feature of this occupation is the construction of stone pavements exactly on the top and along the sides of the small promontory.

Usually, a homogeneous and dusty loess such as LP2 is ascribed to a cold and very dry environment; though at Grubgraben this interpretation seems to be at variance with the mollusc assemblage of the upper part of loess LP2 characterized by the predominance of hydrophilus species. Therefore it is probable that during the deposition of the loess LP2 the local climatic environment was rather humid at the site, while at the same time springs were still active higher in the ravine. In the same way, the discontinuous light gray podzolic horizons observed in the lower part of LP2, similar to those frequently recorded in the loess sequences of northwestern Europe (Haesaerts & Van Vliet-Lanoë, 1981), could also be indicative of short episodes with colder and more humid climatic conditions.

Finally, the last Palaeolithic occupation (AL1) occurred at the interface of loess series LP2 and LP3, which corresponds to a rather flat and sub-horizontal erosional unconformity. It probably took place during a short break in the eolian sedimentation, also recorded within the profile of test pit 85, where a thin sandy layer was present at the boundary between LP2 and LP3 in prolongation of ALl (Figs. III-3 & III-8).

A second major unconformity is recorded at the base of unit SL with the development of the large gully deeply cut through the underlying loess (LP2 and LP3) along both walls of the sunken road. In the lower part of the unit the cross-bedded stratifications point to a sedimentation process under running water; to the top the colluvial and loessic facies increase, changing progressively into a kind of melt-water deposit, while the terrestrial molluscs still suggest the persistence of a moist and cold environment. As a whole, unit SL corresponds undoubtedly to a humid period with a high water supply in the gully which was probably fed by several springs and by the seasonal thawing of the snow cover.

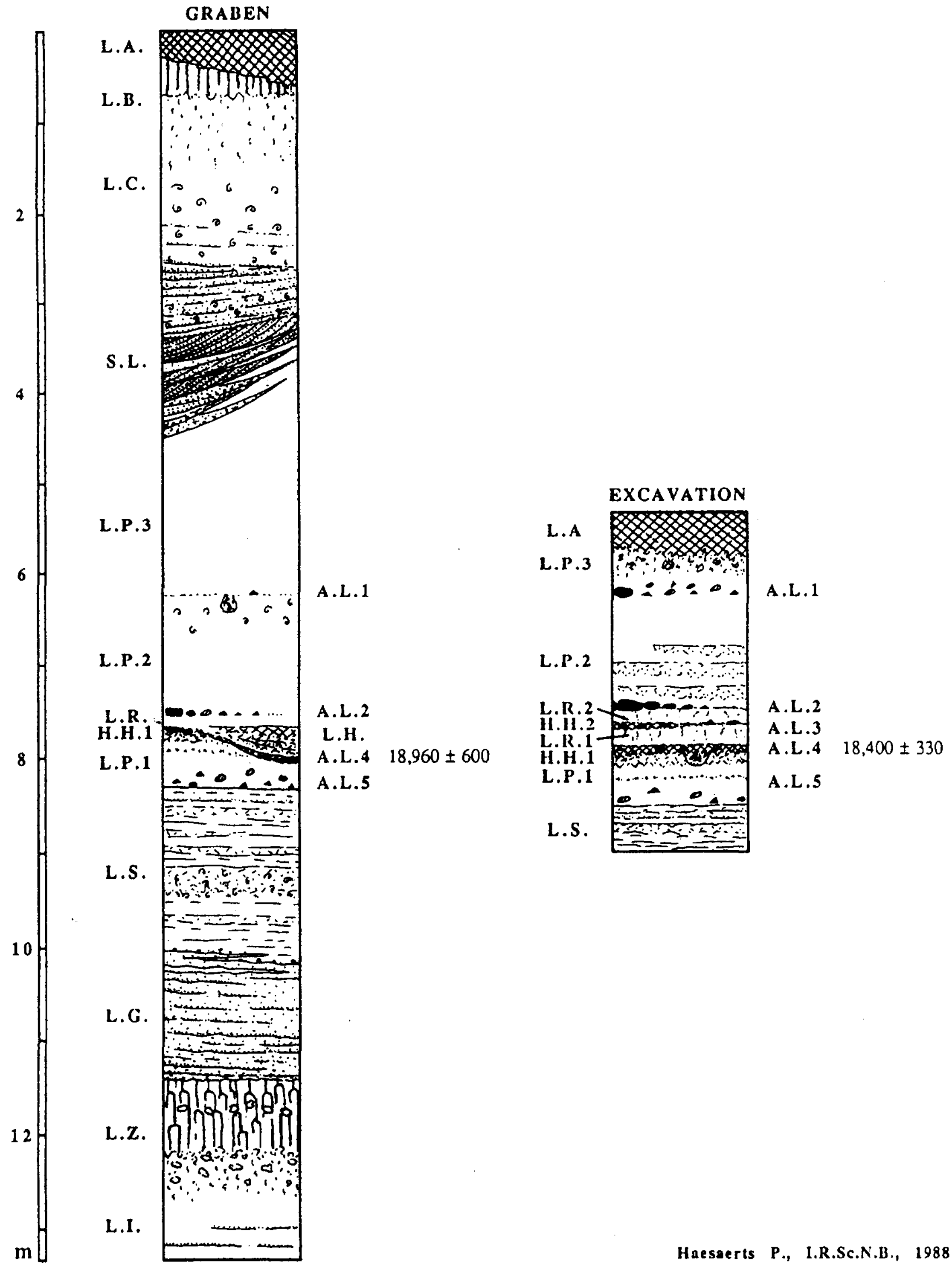


Fig. III-9. Grubgraben : stratigraphical and archaeological sequences (graphic symbols: see Fig. 10).

The upper loess (unit LC) deposited after the filling up of the large gully (unit SL) represents the last cold episode of the sequence. During the deposition of this homogeneous and well-sorted loess the climatic environment of the ravine was much drier than earlier, although some humid places still existed in the vicinity of the site at that time, as suggested by the mollusc assemblage associated with it.

Finally, at the beginning of the Holocene an alfisol developed in the upper part of the loess cover. The illuviated B horizon of this soil (unit LB) is only preserved in the western wall of the road section below the fill (Rew.), while elsewhere, an anthropic humic horizon (unit LA) rests immediately on top of the truncated loess cover.

All together, the different loessic units of Grubgraben have to be related to two different types of climatic environments; the fine laminated loess (unit LS) just prior to archaeological layer AL5 and the uppermost loess of the sequence (unit LC) are indicative of dry and cold conditions. In contrast, the intermediary dusty loess LP2 seems to have been deposited in a more humid environment, as indicated by its mollusc assemblage. In the same way, humid conditions also prevailed during the filling up of the large gully SL cut through the loess LP3, and of the gully LH as suggested by the prevalence of the colluvial processes at those levels. Moreover, the latter episode is also contemporaneous with the main Epigravettian occupations (AL2 - AL4), during which short milder and rather humid climatic events induced the growth of a continuous grass-vegetation and the development of two tiny humic horizons (units HH1 and HH2).

In that respect, it is worth considering how far the sedimentological and pedological processes could have been emphasized by the local context, more especially by the presence of several springs higher up in the ravine. Those springs, most probably in connection with the faulted heterogeneous Palaeozoic bedrock, seemed to have been active during a long period of time and may have induced a favorable biotope particularly attractive to wild life as well as to human groups. Considering the remarkable geomorphological environment of the Grubgraben, which provided a good protection from northern and western winds as well as a broad view of the Danube Plain, such a situation could also partly explain why the Epigravettian hunters settled a number of times, exactly at the same spot, within a period of several thousand years.

Finally, it is notable that almost all paleolithic occupations at Grubgraben did occur outside periods of main loessic accumulation. Indeed, Epigravettian layers AL4 and AL3 are undoubtedly connected with the development of humic horizons during a period of predominant colluvial process, while occupation layer AL2, with its light brown horizon on top, just precedes the sedimentation of loess LP2. In the same way, the last Epigravettian layer AL1, as it rests on a sub-horizontal surface which truncates the top of loess LP2, should also be related to a short pause of the loessic sedimentation.

CHRONOSTRATIGRAPHY

As a whole, the major part of the loess sequence of Grubgraben belongs to the second half of the last glaciation, from a little before 20,000 B.P. up to the Tardiglacial period. This assumption is consistent with the radiocarbon dates of the main archaeological complex (AL2-AL4), but also with the typology of the Epigravettian assemblages. Furthermore, the Grubgraben sequence can be situated within a regional stratigraphic framework based on the loess record of several Upper Palaeolithic open-air sites in the surroundings of Krems, such as Willendorf, Schwallenbach and Stratzing (Haesaerts, 1990). The main interest of these sites lies in their patterned and well documented lithostratigraphical sequences. These include at least 12 Upper Palaeolithic cultural layers, the chronological context of which is fixed by a set of

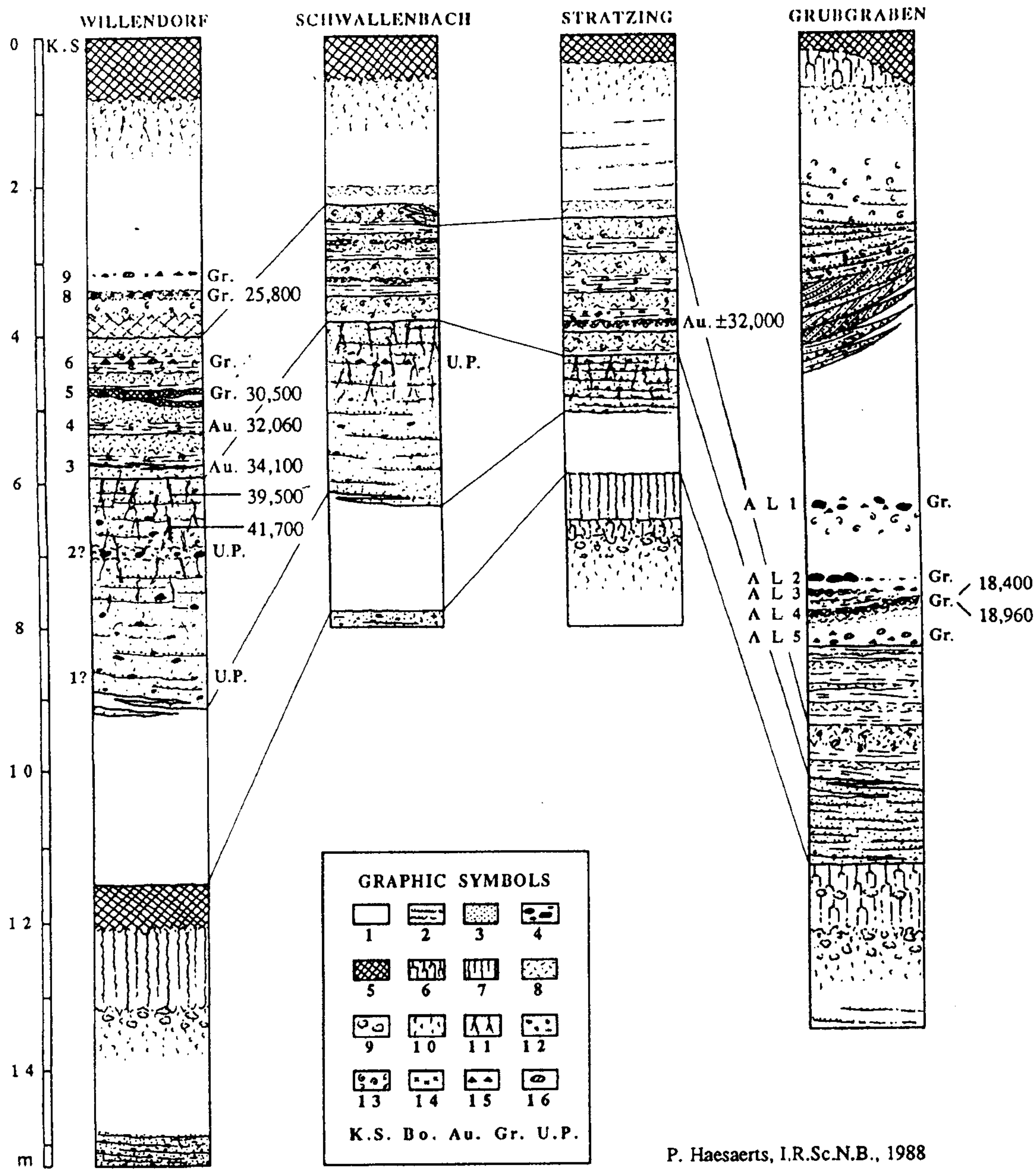


Fig. III-10. Lithostratigraphical sequence of Grubgraben compared to sections in the surroundings of Krems.

Graphic symbols. 1 : loess; 2 : sandy loam; 3 : sand; 4 : stones and gravels; 5: humic sediment; 6 : Alfisol (textural B horizon); 7 : brown forest soil (B horizon); 8: bleached horizon (micro-podzol); 9 : calcic concretions; 10 : pseudomycelium; 11: rootcasts; 12 : iron-staining; 13 : molluscs; 14 : charcoal; 15 : artifacts; 16 : bones, K.S.: cultural layers; Bo. : Bohunician; Au. : Aurignacian; Gr. : Epigravettian and Gravettian; U.P. : undifferentiated Upper Palaeolithic.

consistent radiocarbon dates covering a period between ± 42,000 and 25,000 B.P. (Fig. III-10). In such a system, it is obvious that most of the loessic units of Grubgraben belong to the upper part of the regional sequence and therefore should be younger than 25,000 B.P.

As to the lower part of the sequence of Grubgraben, it is poorly differentiated and has only been recorded in one boring. Nevertheless, the strongly developed paleosol (unit LZ) at the bottom of the sequence has its equivalent in Willendorf and in Stratzing where similar soil horizons represent most probably the last interglacial period. Indeed, at Willendorf, this soil overlies a remnant of a low terrace of the Danube, ascribed to the end of the Middle Pleistocene (Brantner, 1956-69).

The grayish heterogeneous loess-like sediment (unit LG), shows a facies similar to that of the loamy deposits always present on top of the first homogeneous loess of the last glacial period in the three sections taken as reference; those deposits were ascribed to a medium cold but rather humid episode, representing the first half of the Middle Pleniglacial between about 45,000 and 35,000 B.P. (Haesaerts, 1985; 1990). At Willendorf, this loam incorporates the archaeological layers 1 and 2 (undifferentiated Upper Palaeolithic, cfr. J. Hahn, 1977); its upper part was dated on charcoal 41,700 ± 2,500 B.P. (GrN-11195) and 39,500 ± 1,200 B.P. (GrN-11190) (Fig. III-10).

The next unit of Grubgraben is the much more extended fine laminated loess with micropodzolic horizons (unit LS). This loess body shows close similarities with the stratified loessic deposits containing most of the Aurignacian and Gravettian assemblages known in the surroundings of Krems, where they were dated in several localities between 34,000 and 25,000 B.P. (Hahn, 1977; Otte, 1981). As the facies of these deposits is also close to those of the upper loess cover at Stratzing and at Stillfried (Felgenhauer et al., 1959; Fink, 1962; Haesaerts, 1990), it seems most probable that the loess unit LS of Grubgraben encompasses part of the second half of the Middle Pleniglacial and also the beginning of the Upper Pleniglacial.

From this interpretation, it is obvious that the major part of the sequence of Grubgraben, which includes the five archaeological layers, belongs to the second half of the Upper Pleniglacial and has no or little equivalent, until now, in Lower Austria. This does not mean that loessic deposits of this period are totally absent elsewhere in that area, but they probably could not be recognized as it, because of the lack of chronological markers. The same situation also exists in the Moravian loess area (Fig. III-11), where almost all the Upper Palaeolithic settlements, dated between 31,000 and 25,000 B.P., occur at the base or below the Upper Pleniglacial loess cover (Otte, 1981; Svoboda, 1986; Haesaerts, 1985, 1990).

On the other hand the stratigraphical sequence of Grubgraben shows undoubtedly close similarities with the Upper Pleistocene loess record of Hungary (Pecsi, 1978). For instance, at Mende and at Tapiosüly, sections situated to the east of Budapest, sandy stratified rill-washed loess interlayered with pure loess, are associated with two well developed humic horizons dated respectively 20,520 ± 290 B.P. and 16,750 ± 400B.P. on charcoal (Fig. III-11). According to M. Pecsi, E. Szebenyi and M. Pevzner (1979), more humid climatic conditions also prevailed here at the end of the Upper Pleniglacial period, just before the deposition of a last homogeneous sandy loess. In a similar context, at the Palaeolithic site of Sagvar near lake Balaton, two weak humic horizons with Epigravettian material, separated by 2 m loess, were also dated 18,900 ± 100 B.P. (lower horizon.) and 17,160 ± 150 B.P. (upper horizon) on charcoal. Both horizons were ascribed to two short, rather mild and humid climatic events by V. Gabori-Csank (1976), who suggested a possible correlation with the Lascaux interstadial of Southwestern France (Leroi-Gourhan, 1967; 1980).

In such a system, it is obvious that Grubgraben provides invaluable information on the evolution of sedimentation and climate during the final part of the last glaciation. Combined with other records of Lower Austria, those data led to the development of a remarkable regional loess sequence for the Upper Pleistocene, which has to be considered, more and more, as one of the best documented stratigraphical and archaeological references for Central Europe.

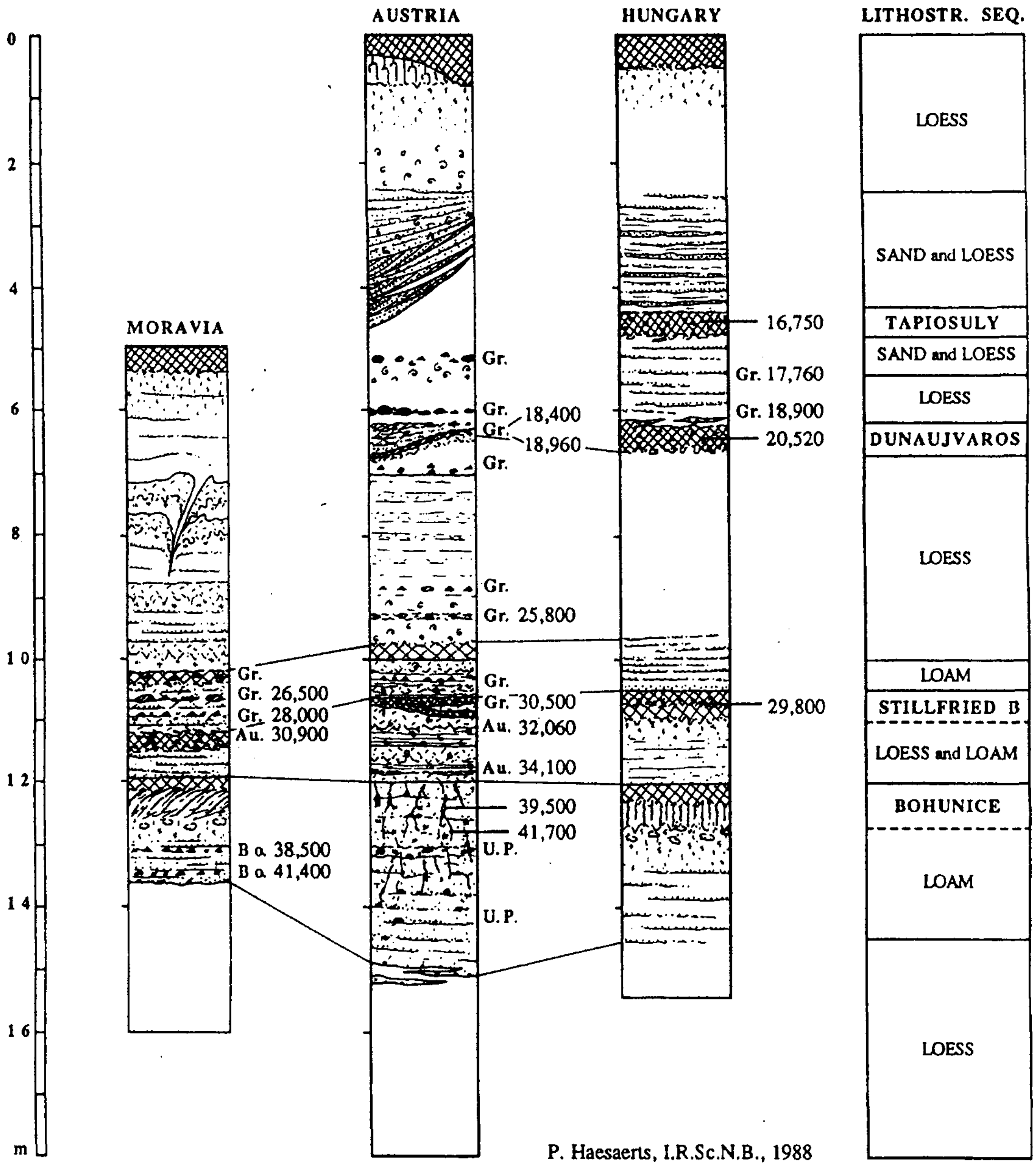


Fig.III-11 . Comparative Upper Würmian loess records of Moravia (Dolnivestonice and Stranskala), Austria (Willendorf and Grubgraben) and Hungary (Mende and Tapiosüly) (graphic symbols : see Figure III. 10).

IV

MORPHOLOGICAL AND MINERALOGICAL ANALYSIS OF LOESS SAMPLES

by

MACIEJ PAWLIKOWSKI

A series of analyses of loess samples from Grubgraben was carried out at the mineralogical laboratory of the School of Mines at Cracow to provide a set of data which would complement the sedimentological and malacological studies reported in the preceding section and provide an independent test of their results. A two section column of 37 loess samples, taken at 5 cm intervals, was collected at the excavation site in view of these analyses. The first section (I) located on the eastern wall of excavation unit JC consisted of 20 samples from the upper loess above and including the humic horizon that contains the archaeological layer 4. The second section (II) was taken from the west wall of unit IC, starting with the humic horizon down to the bottom of the excavation unit, sampling the lower loess series of the excavated trench. In addition, samples were taken from a natural outcrop at the foot of the Geissberg, on the western slope of the ravine, to obtain samples of the Paleozoic substratum in order to evaluate the contribution of local materials to the loess sedimentation (Fig. IV-1). A section was selected where the contact between loess deposits and the underlying Carboniferous rocks was clearly visible and marked by a layer of gravels with shale, sandstone and gneiss fragments which had formed above the erosion surface at the top of the Carboniferous sediments (Fig. IV-2).

Samples of sediments were dried at a temperature of 105° and weighed. Then, the sediments were mixed with water and broken down with the help of a mixer. A solution of 10 % of 0.1 NHCL was used to remove the calcium carbonates. When dried, the samples were weighed again. Sediments were then sorted through fine meshed screens and two fractions, a coarser fraction including grains greater than 0.1 mm and a finer fraction including grains between 0.1 and 0.07 mm, were selected for analysis of mineral composition by means of a polarizing light microscope and a difractometer.

A- Results of the minerological analyses:

1. The Carboniferous bedrock

Microscopically, the carboniferous shales underlying the loess sequence showed a very fine texture and a slightly parallel structure. The thin section displayed a very fine mass of clay minerals mixed with poorly rounded grains of quartz muscovite and rare feldspar. Detritic grains constituted 10 to 15 % of the sediment volume. Maximum grain size was 50 microns. Xray diffraction showed the clay minerals to be illites (Fig. IV - 3-1).

The carboniferous sandstones were composed of quartz characterized by varying degree of roundness and by grain sizes of up to 2 mm. In addition to quartz, sandstones contained plagioclase, orlthoclase, pertite, muscovite, biotite and heavy minerals (hornblende).

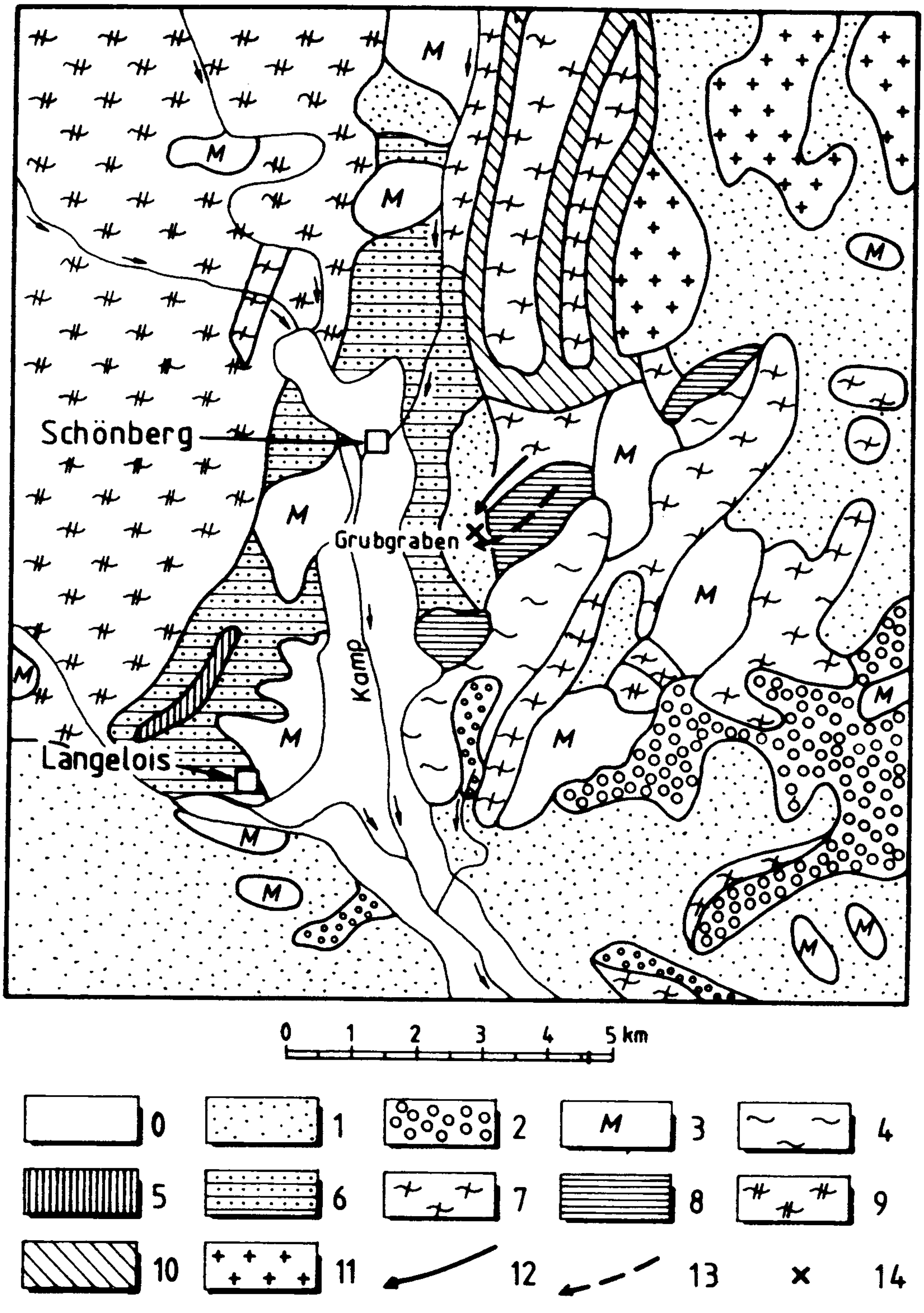


Fig. IV-1 Geological map of the area, drawn from the Geological map of Austria, Bundesamt fur Eich- und Vermessungswesen, Landesaufnahme, Wien.

0, Holocene; 1, loess; 2, gravels; 3, Miocene; 4, carboniferous rocks; 5, limestones; 6, shale; 7, orthogneis; 8, granulite and garnet gneis; 9, quartzites; 10, tuffs; 11, granites; 12, direction of main slope water transport during the lower loess sedimentation; 13, direction of minor slope water transport.

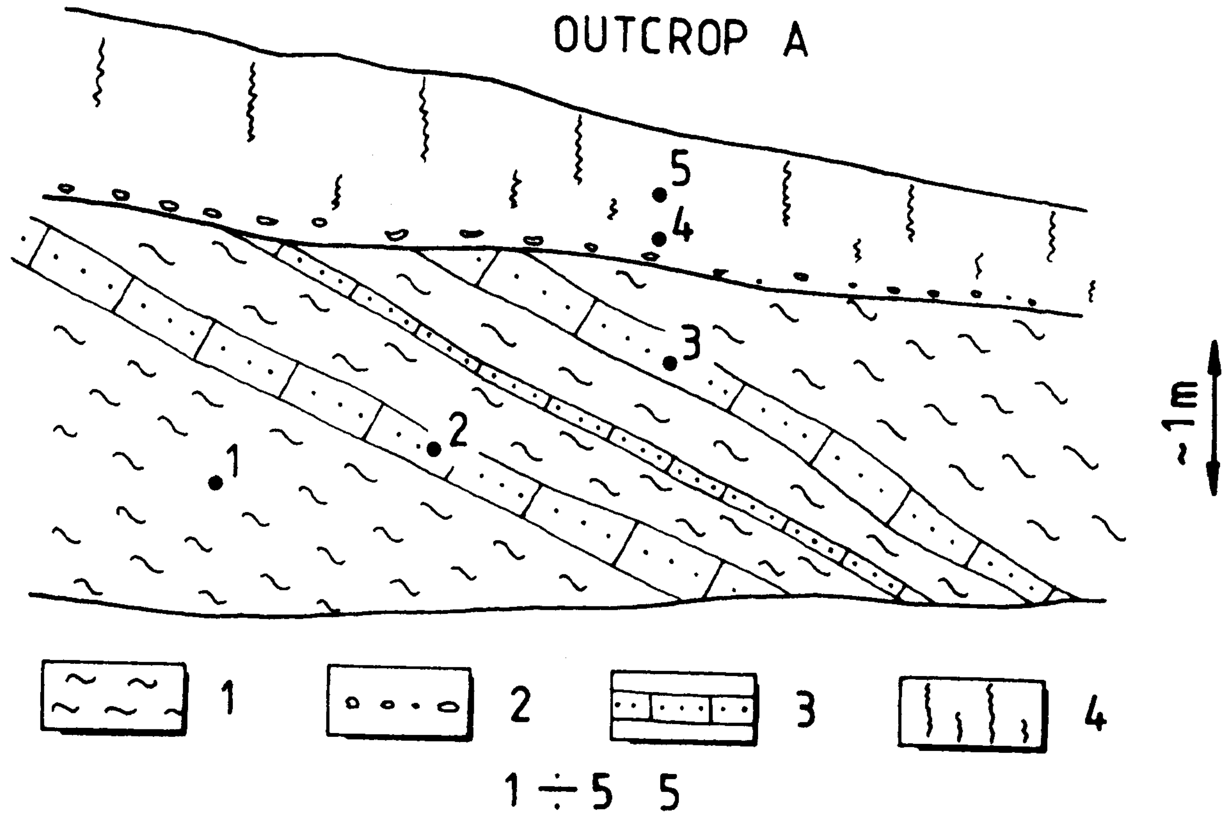


Fig. IV-2 Profile at the foot of the Geissberg (outcrop a) showing contact between the carboniferous substratum and the lower loess. 1, carboniferous shales; 2, slope gravels; 3, carboniferous sandstones; 4, loess. The numbered dots indicate samples taken for mineralogical analysis.

These elements were cemented by secondary calcite mixed with clay minerals. The Xray patterns of the carboniferous sandstones are illustrated in figures IV-5-2 and 5-3.

Loess overlying the carboniferous bedrock contained rounded fragments of carboniferous rocks as well as small gneiss pebbles. The sediment mass was composed of quartz, biotite, feldspar, garnet, amphibole, staurolite, chlorite, clay minerals and carbonates, mainly calcite and dolomite (Fig. IV.5-4 and 5-5).

2-The loess section in the excavated trench

a-The upper loess section (samples 1-20):

In the upper loess, the coarser fraction represented between 0.5% and 2.5% of the sediments (Table 4, Fig. IV-4). The fraction contained varying proportions of quartz (65%-94%), muscovite (1%-9%) and biotite (1%-27%) (Fig. IV-). The amount of angular grains remained relatively stable between samples to 17 (70% to 89%) and registered a sharp drop in samples 18 and 19 where it fell to 29%. Sample 7 contained traces of charcoal and sample 8 some minute flint splinter. These two samples register the topmost archaeological level AL1.

The finer fraction represented between 1% and 4.9% of the total samples. The samples contained smaller amounts of quartz than coarse fraction samples. The muscovite content was higher than in the coarse fraction but lesser than the one recorded in the same fraction of the lower section samples. Biotite content varied between 3% and 27% with the higher percentage in sample 16. Most quartz grains were sharp. Samples 7, 11 and 13 were characterized by little variation in quartz ratio.

b-Archaeological layer AL4 (sample 20):

AL4 is represented by sample 20 of the column. Grain size analysis documented an increase in the amount of coarse fraction and the total amount of quartz showed a marked decrease in relation to the upper section of the column. Biotite, heavy minerals and opaque minerals content fell within the range observed in the lower section of the column. Numerous flint and bone splinters were present at that level.

c- Lower loess section (samples 21-37):

(a) Coarse grain fraction (> 0.1 mm):

Percentages of this fraction ranged between 2.6 % and 7.5 % with a median of 4.0%. Maximum quartz content as 59% (Fig IV - 6a). Muscovite varied between 5.7% and 12.5%, biotite between 22 % and 53%. Most of the quartz grains had a slightly rounded shape and milky or light yellowish surface alteration.

(b) Finer grain fraction:

This fraction constituted 4% to 8% of the analyzed materials. These values were 2 to 3 times greater than the percentage of fine fraction taken from the upper loess series. Quartz formed as much as 72% and the relative proportion between angular and round grains varied between 4% and 6%, a much higher ratio than was the case for the coarser fraction. Moreover, the fine fraction contained slightly higher amounts of muscovite and correspondingly less biotite than the coarser fraction. The fine fraction appeared slightly enriched in heavy minerals when compared to the coarser fraction or to the fine fraction from section 1. Angular and rounded quartz grains showed a morphology similar to that of the components of the coarser fraction (Fig . IV-6b). Other components included biotite and heavy minerals (Fig. IV-6 C.D.).

B. General trends in the distribution of mineral components through the stratigraphic sequence.

In general terms, the coarser fractions of the sediments exhibit the greater degree of variation through the stratigraphic sequence. And, the widest range of variability is seen in the distribution of angular quartz contained in the coarser fraction.

Trends in the vertical distribution of quartz grains and other mineral components are displayed in a series of computer generated graphs which illustrate relative frequencies for samples arranged in stratigraphical order (Fig. IV-4 and 5).

Variations in the vertical distribution of muscovite and heavy minerals are relatively minor. Changes in the distribution of biotite show greater amplitude, notably in the coarser fraction of the sediment. The distribution of opaque minerals remains relatively constant with the exception of a marked increase in the one sample which corresponds to the humic horizon 2 and archaeological layer 4.

SUMMARY AND DISCUSSION

The Grubgraben ravine was formed as a result of the erosion of soft carboniferous bedrock that was surrounded by older, magmatic rocks. Residual materials derived from the slopes accumulated on the ravine floor before the loess sedimentation.

The loess sediments exposed on the walls of the 1986/87 excavations apparently accumulated in two major phases clearly illustrated by the distribution curve of quartz grains contained in the coarser fraction of the sediments. The humic horizon (Fig. IV-5, sample 20) appeared to be at the contact of the two loess series. The proportion of quartz increased toward the top of the upper loess series with the notable exception of sample 4 which corresponded to the topmost archaeological layer (AL1). The distribution of angular quartz grains displayed similar patterns.

The first stage of the lower loess formation (samples 21-36) was represented by mixed aeolian and slope sedimentation documented by the presence of wind blown material along with material washed from the surrounding slopes. More intensive eolian sedimentation is registered in samples 34, 32, and 31 and more intensive slope wash in samples 28 and 24. Changes in mineral composition occurred at the end of the lower loess sedimentation.

From a mineralogical point of view, sample 20 was similar to samples from the lower section of the column which indicates that the sediments in which AL4 is contained is part of the lower loess series.

The second stage of the sedimentation is characterized by predominance of aeolian sediments, angular quartz grains and muscovite. Disturbances in the sedimentation process of the upper loess correspond to the topmost archaeological level (sample 7) and sample 13.

Results of the analysis corroborates findings described in the preceding chapter. The sedimentation of the lower loess series took place under relatively humid conditions which continued until the formation of AL4. Drier conditions prevailed during the accumulation of the upper loess. However, interruption of the loess sedimentation together with processes of alteration correlated with human occupations.

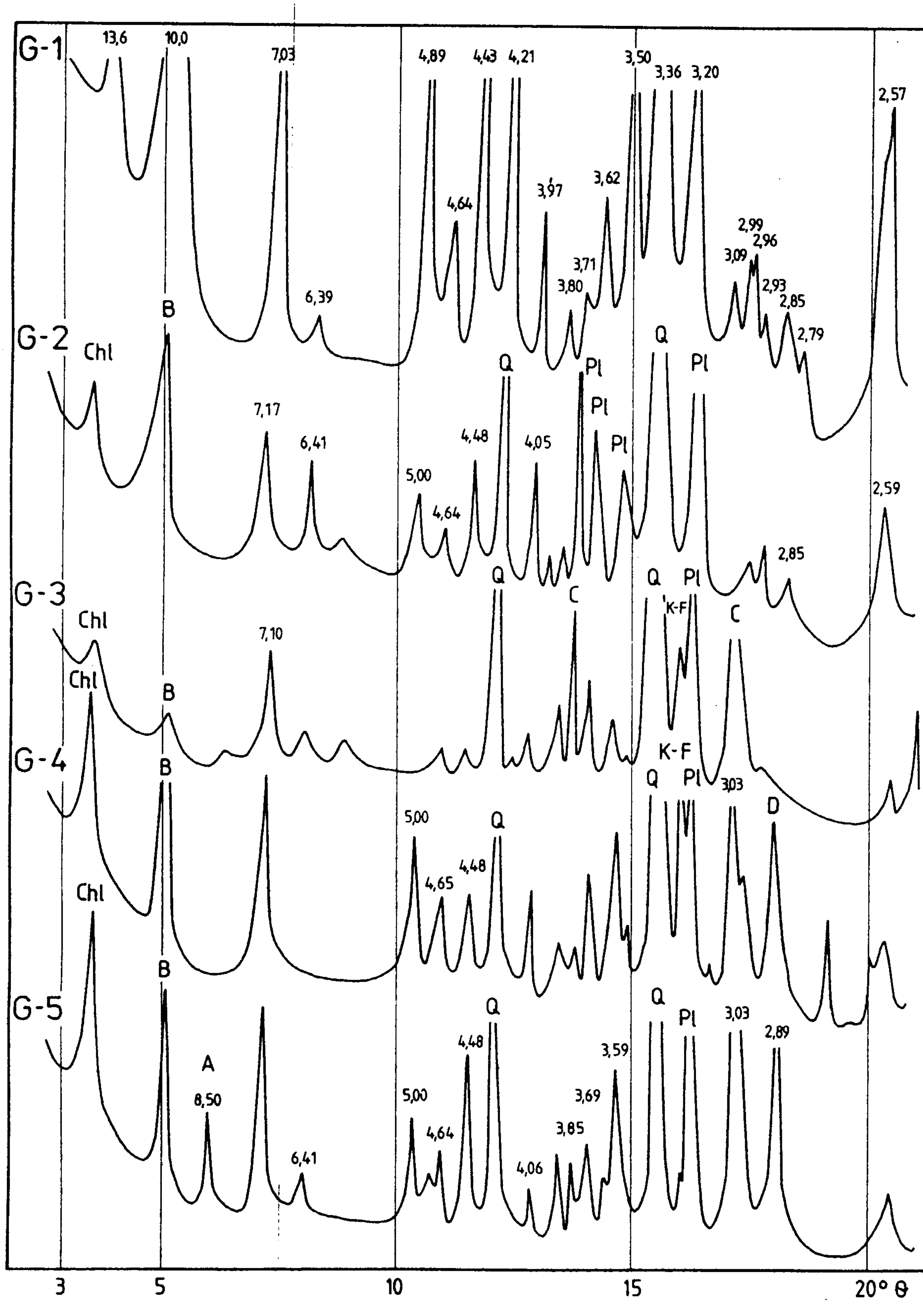


Fig. IV-3 Xray patterns of tested rock samples: G1, carboniferous shale; G2 and G3, carboniferous sandstones; G4 and G5, lower loess.

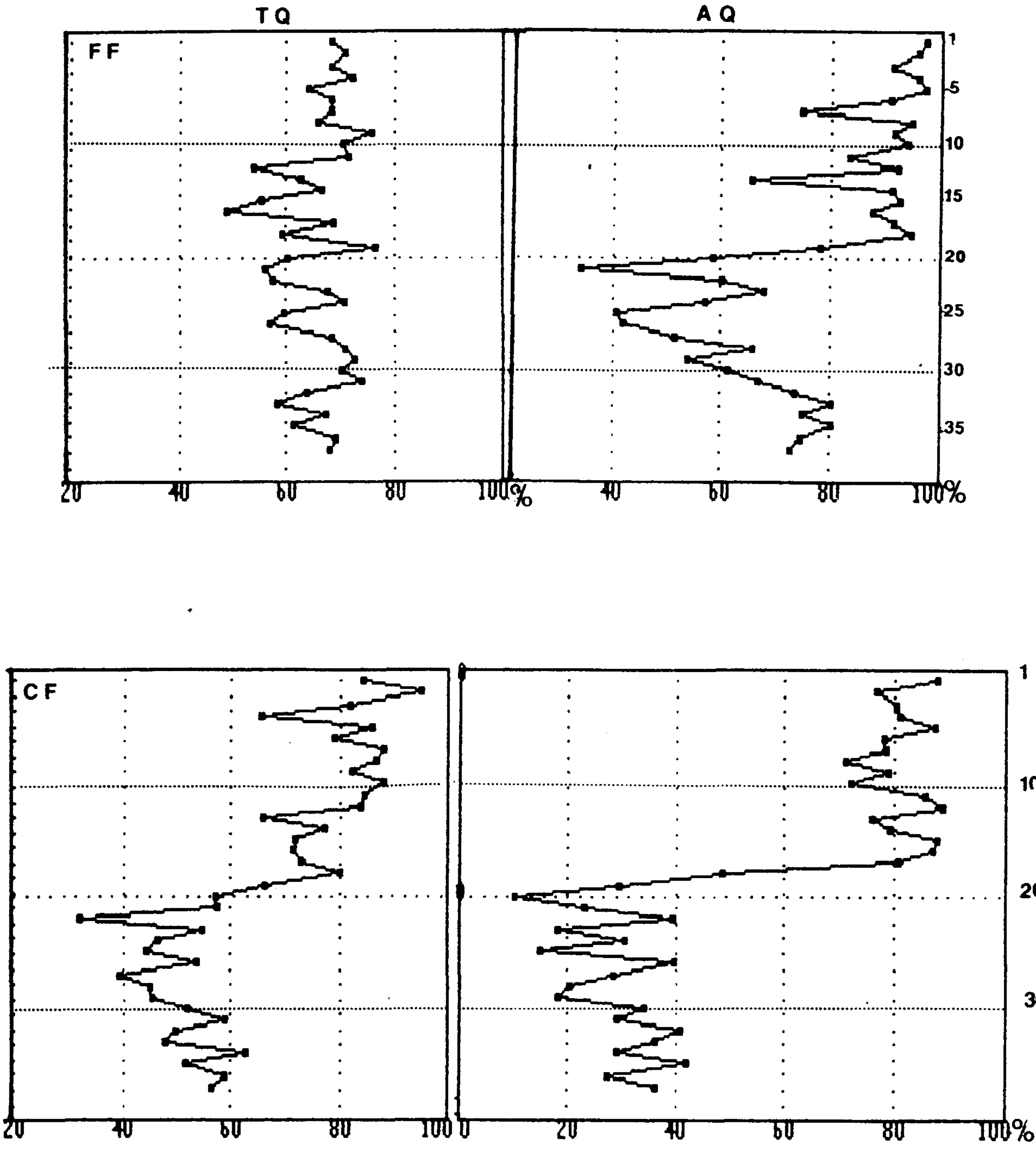


Fig. IV- 4 Loess samples from the excavation trench: Graphs of quartz grain distribution; top row, finer fraction (FF); bottom row, coarse fraction (CF); left, total quartz content (TQ); right, percentage of angular quartz grains (AQ) within the total quartz samples.

The graphs display the complete column of samples taken at 5 cm intervals; sample No. 1 is at the top, immediately below the plowzone and sample No. 37 is at the bottom of the excavation trench. Sample No. 20 corresponds to AL4.

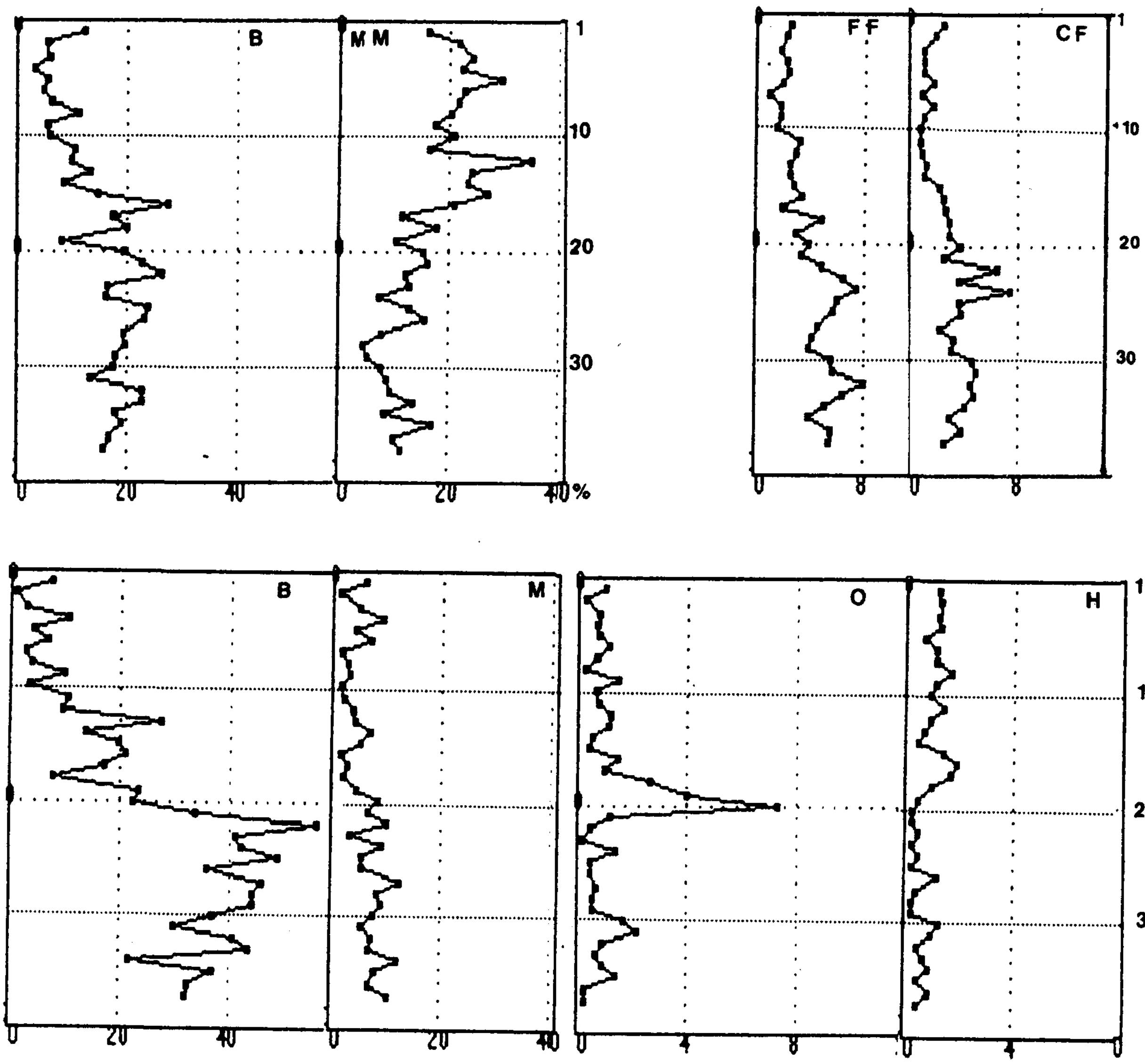


Fig. IV-5 Top right, percentage of finer fraction, 0.7 to 1.0 mm (FF) and coarse fraction, >1.0 mm (CF) within the total sediment samples; top left, distribution of biotite (B) and muscovite (M) for the finer fraction samples; bottom row, distribution of biotite (B), muscovite (M) opaque minerals (O) and heavy minerals (H) for the coarse fraction samples. Graphic display of samples as in Figure IV-4.

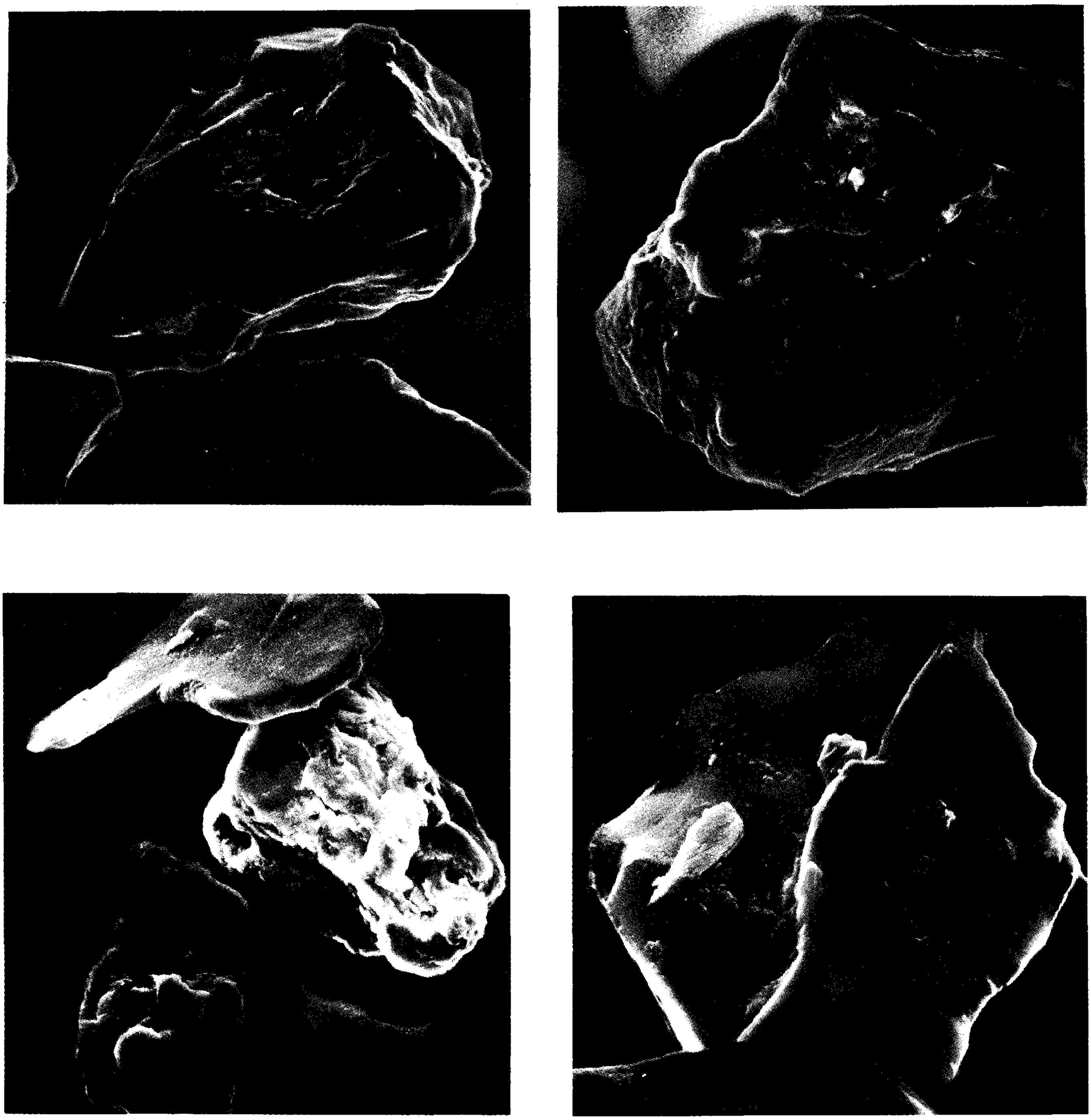


Fig IV-6

Phot. 1, sample 32. Lower loess. Fraction > 0.1 mm. Typical grain of poorly rounded quartz. SEM, enlarged 450x.

Phot. 2, sample 28. Lower loess. Fraction 0.1-0.07 mm. rounded grain of quartz. SEM, enlarged 1050x.

Phot. 3, sample 25. Lower loess. Fraction 0.1-0.07 mm. poorly rounded grain of quartz and biotite flake. SEM, enlarged 1050x.

Phot. 4, sample 23. Lower loess. Fraction 0.1-0.07 mm. flake of biotite laying on an quartz grain. SEM, enlarged 1000x.

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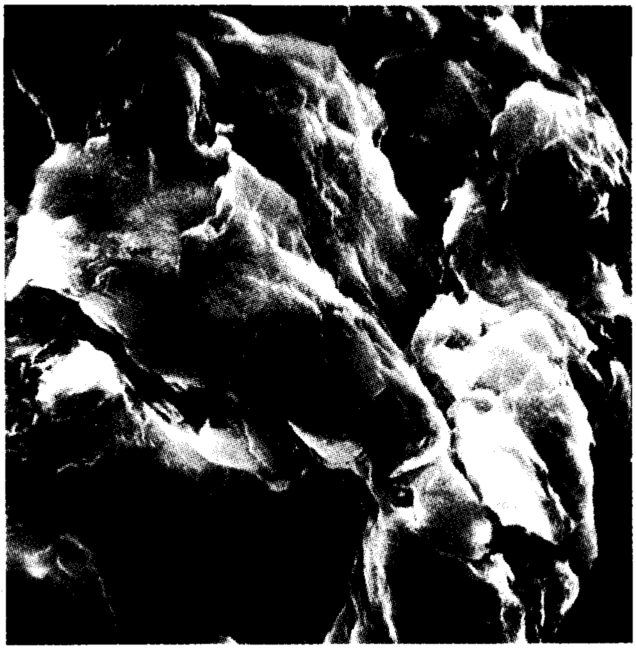

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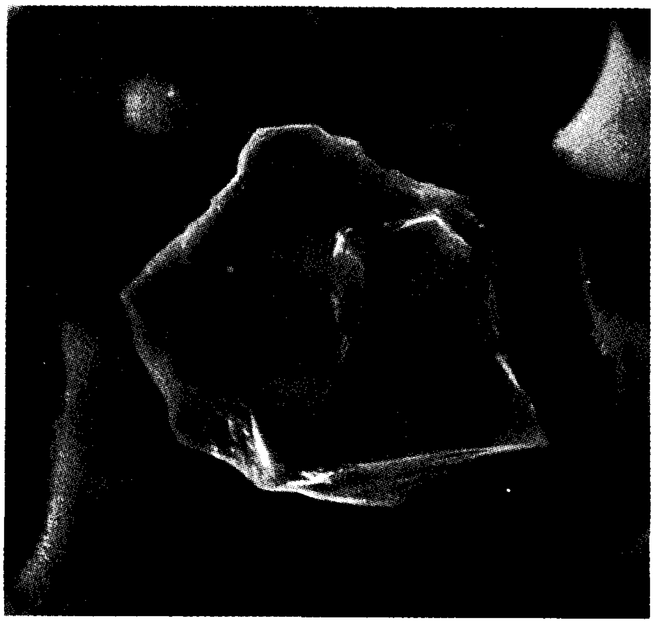

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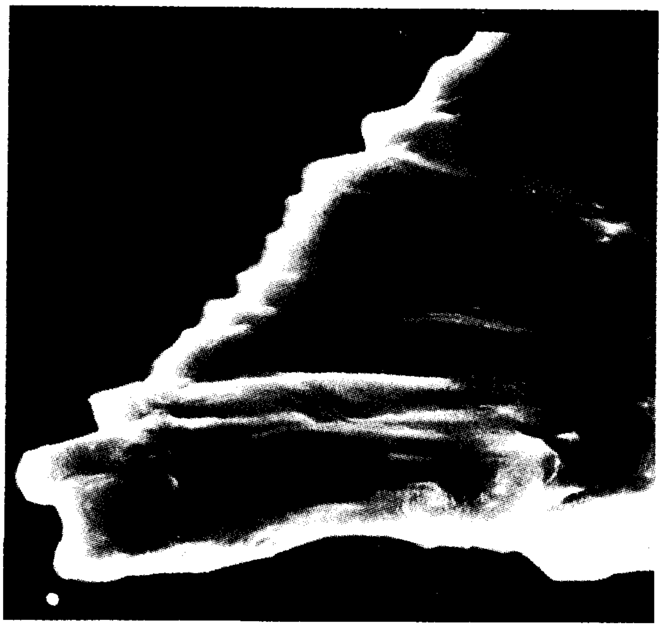


Fig. IV - 7

Phot. 5, sample 19. Upper loess. Fraction > 0.1 mm. Rounded quartz grain. SEM, enlarged 500x.

Phot. 6, sample 19. Upper loess. Fraction > 0.1 mm. Surface morphology of the grain showed in phot.5. SEM, enlarged 2500x.

Phot. 7, sample 15. Upper loess. Fraction 0.1-0.07 mm. Angular quartz grain. SEM, enlarged 700x.

Phot. 8, sample 13. Upper loess. Fraction 0.1-0.07 mm. Surface morphology of "glacial" quartz. SEM, enlarged 2500x.

V

THE ARCHAEOLOGICAL LAYERS: FEATURES AND SPATIAL DISTRIBUTION

by

Anta MONTET-WHITE

Five archaeological layers characterized by concentrations of artifacts, faunal remains, manuports, and manmade features have been identified in the 1986-87 trench (cf. supra, section III). The 1986/87 excavations focused on layers I to IV. Little is know of the lowest layer (AL5) which was identified at the base of two deep, 1.5m x 1m test-pits. The exposed surface was too limited to provide much information. Artifact scatters were thin, 15 to 20 items per square meter, including bone splinters and chips. In the absence of any diagnostic artifact, the cultural affiliation of the layer remains uncertain and the recovered bone pieces did not yield enough collagen to obtain a C14 date. AL5 corresponds probably to the lower level identified by Kiesling and Bayer in the sunken road. However, the material they collected from the lower level was not identified nor kept apart and cannot be used to establish the cultural affiliation of AL5.

Two scattergrams illustrate the vertical distribution of material remains attributed to AL1, AL2, AL3, and AL4 (Figs. V-1 and V-2). In each case, the projection represents the artifactual content of a 50 cm. wide bench of deposits. The graphs are computer generated by means of a two dimensional plot program from the NCSS library. Vertical scales are one and a half time the horizontal scales in order to provide a better estimate of variation patterns in the vertical placement of material debris.

AL1

The topmost layer, AL1 formed a vertical scatter of 20 to 25 cm along the western wall of the trench (Fig. V-1) where the greater concentration of debris occurred. Along the eastern wall of the trench, AL1 formed a 15 to 20 cm. thick band (Fig. V-2). A series of 10 to 15 cm long stone slabs introduced into the site by paleolithic occupants constituted the heaviest and largest debris at this level. Both the position of the slabs and their regular placement suggested that the plane they described constituted an occupation floor. Lithic artifacts were scattered 5 to 10 cm above and around the manuports, the smaller pieces showing a greater degree of dispersal than the larger and heavier specimens. A comparable range of vertical dispersion was noted at Kadar (Montet-White and Johnson, 1976; Montet-White, Laville and Lezine, 1986) where it was attributed to post-depositional phenomena. Widely dispersed artifacts found at depths of 5 cm to 15 cm below the manuports could have derived from AL1. However, they may also represent an earlier occupation.

Within the 1986/87 trench, the distribution of AL1 is limited to units Ie, Id, Ic, Je, Jd, and Jc. The northern limit of the artifact scatter was located between units Ib and Ic. AL1 extended to the west and to the south, beyond the limits of the excavation block. However, no trace of the level could be found in test-pit P. The negative evidence indicates that the layer 1 did not extend more than 10 to 15 m beyond the southern limits of the excavation blocks. Traces of the layer were noted on the west

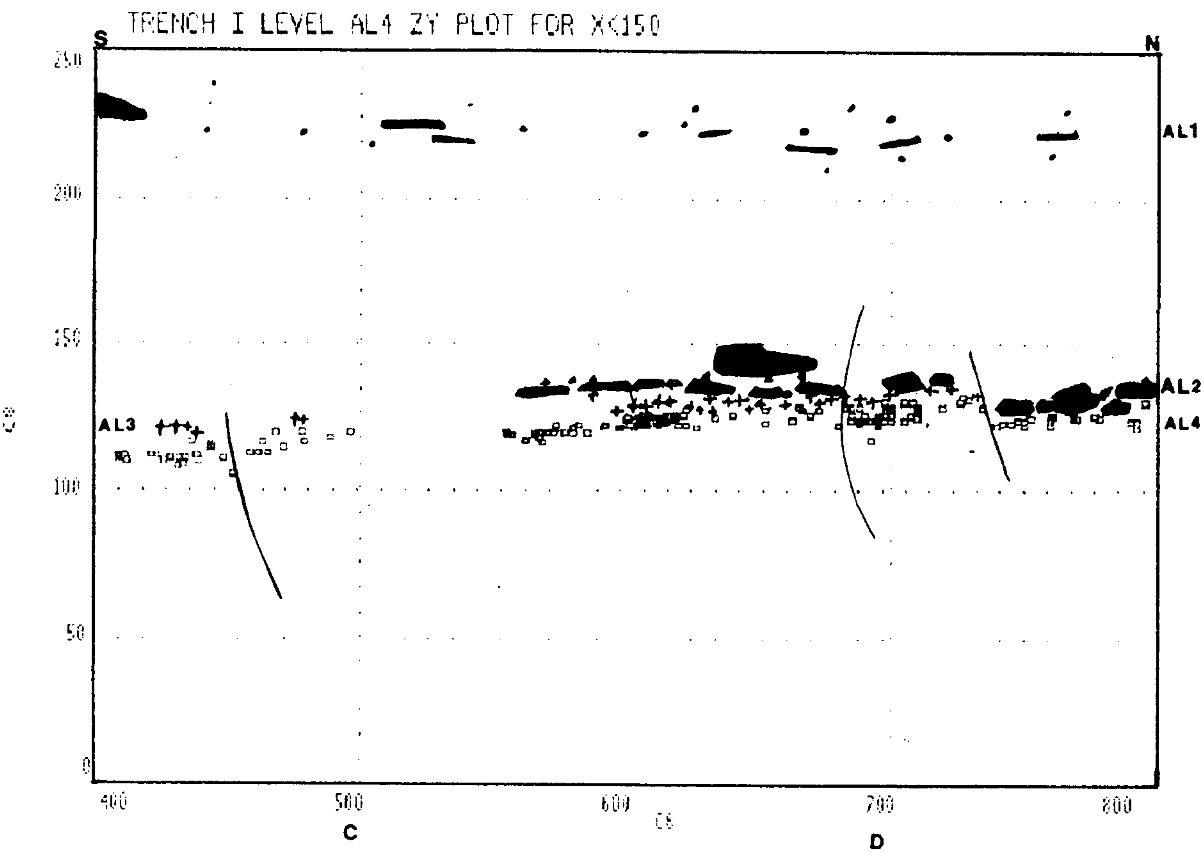


Fig. V-1 Artifact projection along the west wall of trench I (excavation units C and D). Manuports and fault lines have been added to the computer generated graph of artifact distribution.

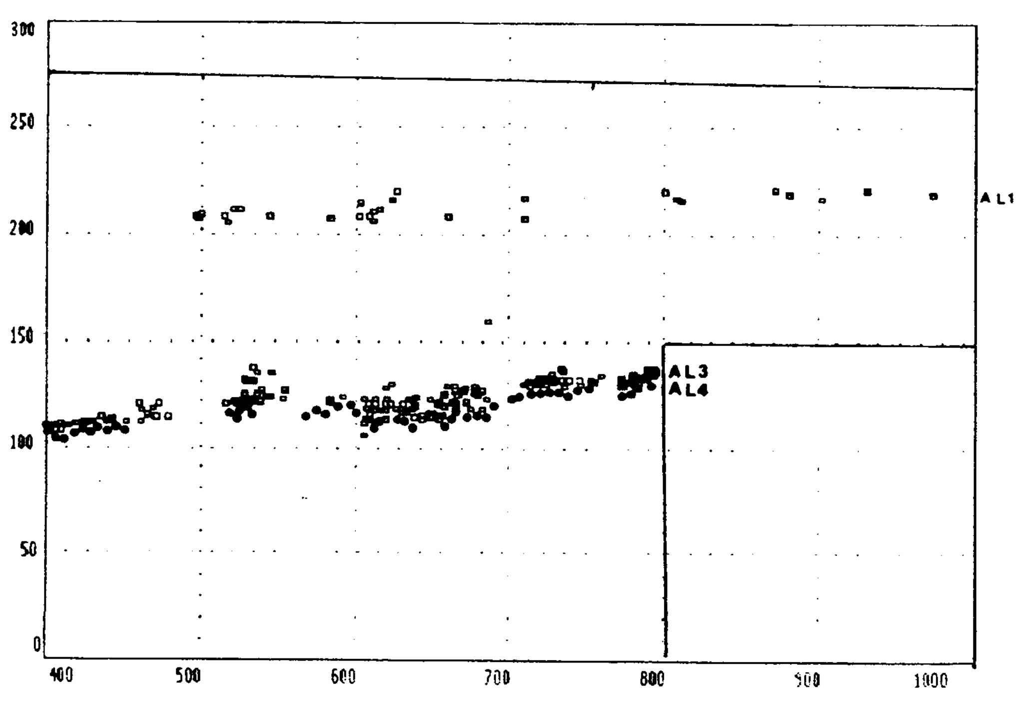


Fig. V-2 Artifact projection along the east wall of trench J. Note the AL2 scatter has disappeared.

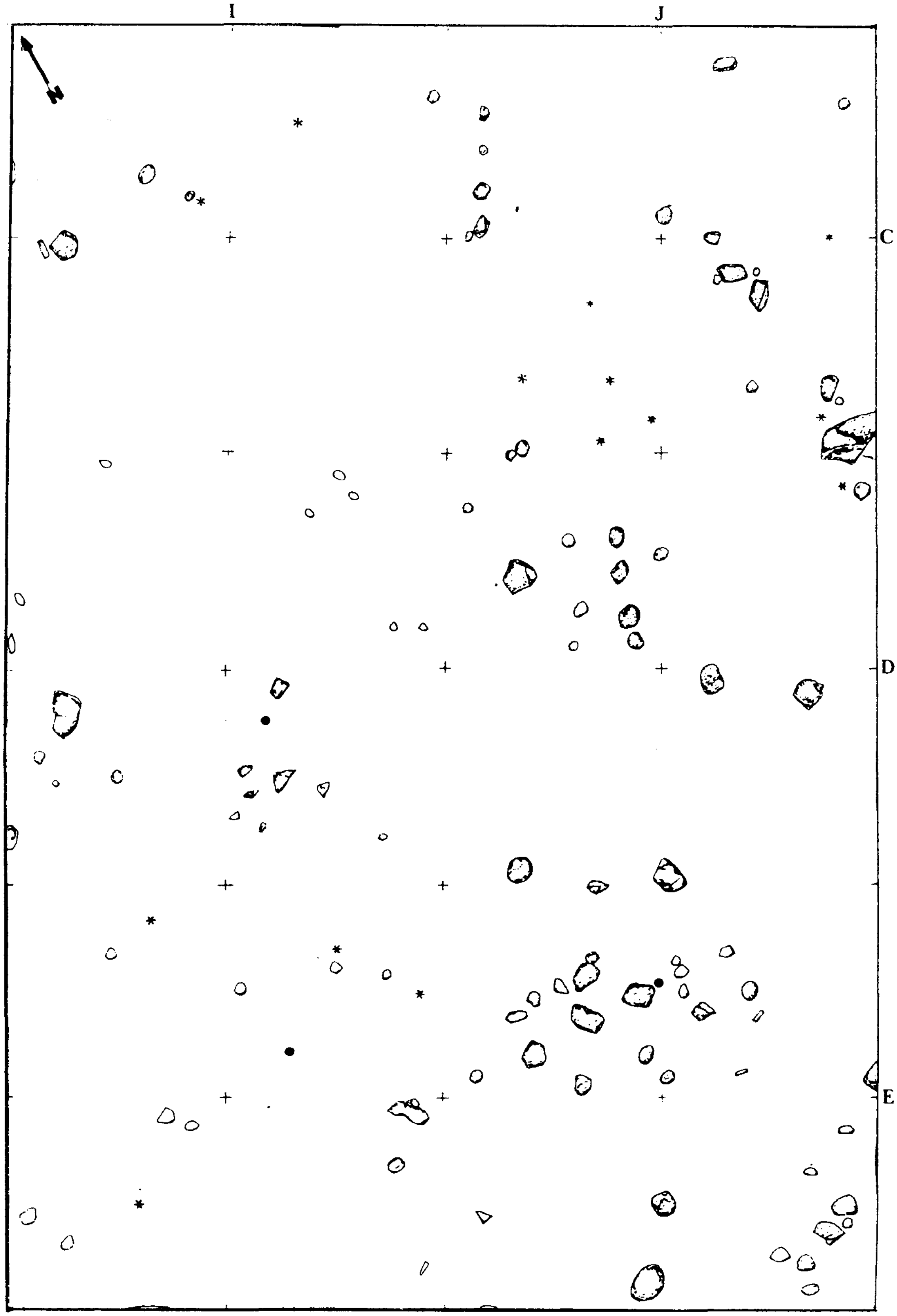


Fig. V-3. AL1: horizontal distribution of stones slabs, ocher (dots) and shells (asterisk).

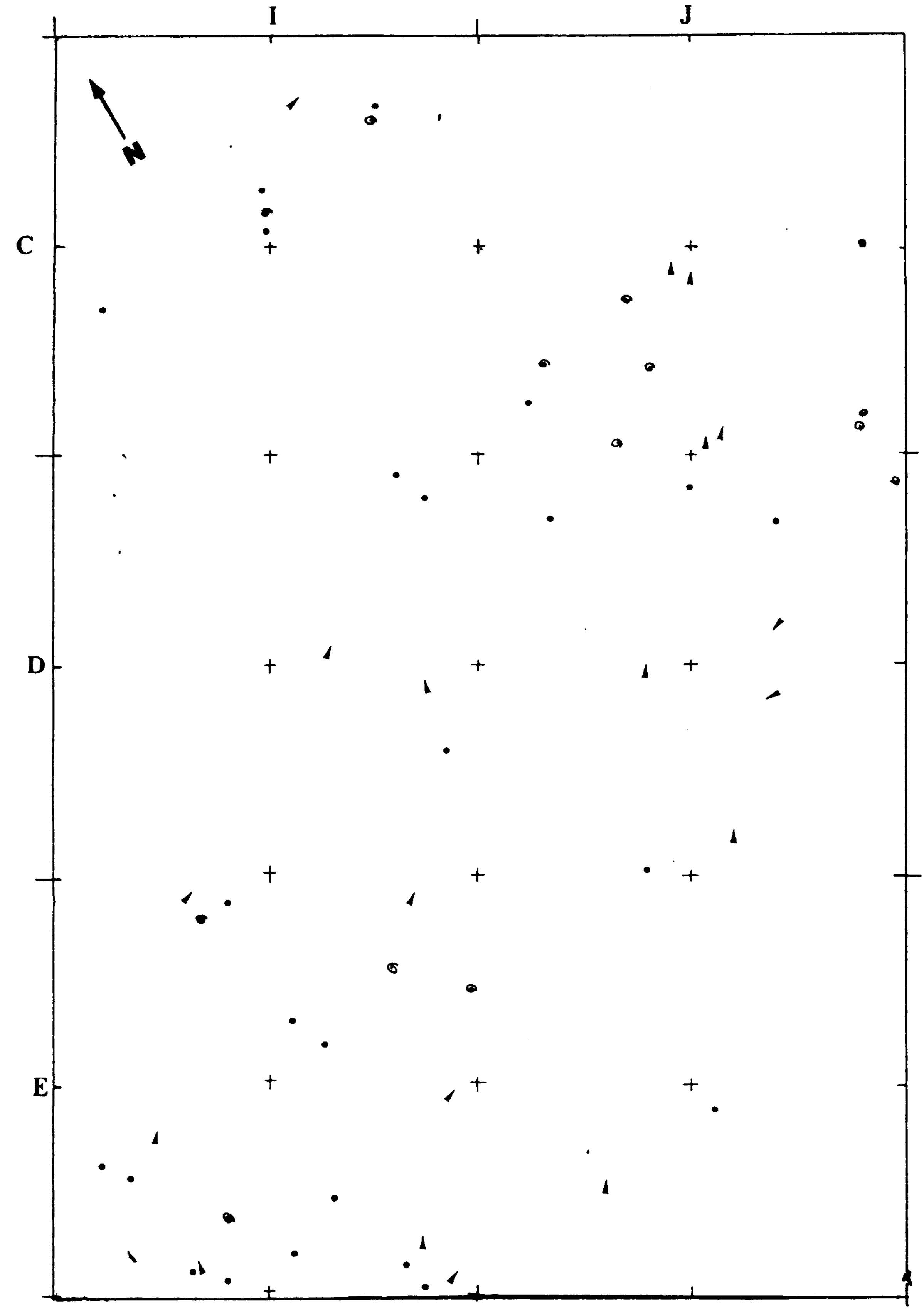


Fig. V-4 AL1: horizontal distribution of burins (triangles) and burin spalls (dots).

side of the graben where the outline of a small pit filled with burned earth and containing a few radiolarite flakes was clearly visible on the profile. Therefore, AL1 occupations extended across the graben road and under the upper vineyard.

The AL1 scatter comprised stone platelets and lithic artifacts, dentalia shells and ocher (Figs. V-3 and V-4). The latter was in the form of small fragments and patches of stained sediment. Faunal remains were scarce: half a dozen horse and reindeer teeth and a few bone splinters. However, the scarcity of faunal remains at this level does not appear to be the result of poor preservation as the few recovered specimens were in relatively good condition. Rather it may be attributed to the fact that little if any butchering and/or food consumption took place in this area of the campsite.

The density of lithic debris varied from 3 to 42 pieces per square meter with a median of 15. A small cluster of large trimming flakes from the preparation of a single block of white flint was recovered in unit IC; the core and usable blanks had been taken somewhere else by paleolithic occupants. The debris found in unit IC are the remains of one instance of flint knapping activity; they do not constitute a workshop.

A single large sandstone block was recovered from the excavated area at the edge of unit jd. Stone platelets and cobble-sized pieces were scattered around, forming no apparent patterns. These smaller stones ranging between 7 and 15 cm. in maximum dimension included sandstones, quartzites and gneiss, all materials which could have been obtained from outcrops along the ravine slopes a few 100 feet from the Kamp River gravels at a distance of 1.5 to 2 km. Some of the sandstone and quartize pieces have broken edges and a few are marked with ocher stains. Perhaps used as anvils, percussors or grinding stones, the small stone slabs were an integral part of the tool-kit. Burins and burin spalls, small blades, and flakes were among the most common artifacts. Other items included segments of dentalia shells and pieces of ocher. This was an area where shell ornaments were cut and color was prepared or used. The function of burins in this context remains unclear; they may have been used to cut dentalia shells. In any case the frequency of spalls indicates that burins were resharpened and, therefore, used within the area. However, burins and burins spalls did not match, so that burins discarded at the spot were not the ones that had been sharpened there (cf. infra).

The AL1 assemblage is a specialized tool-kit and belongs to an epigravettian phase characterized by the presence of small backed and truncated bladelets (cf. infra, schapter IX).

AL2

In contrast to AL1 which formed on a nearly horizontal surface, layers AL2, AL3 and AL4 occupied a more irregular terrain. Excavations and core tests have confirmed that a small knoll existed to the east of the wide depression which included the present day sunken road as well as trench I of the excavation block. Trench J cut through the knoll's edge. There, the cultural layers AL2-AL4 slope toward the north and west.

The cultural layer designated AL2 consisted of large manuports, artifacts and faunal remains which lie on the slope of the knoll and on a sub-horizontal, regular surface at the bottom of the graben depression. The layer was shallow, no more than one or two artifacts deep. Very little vertical dispersal of the kind noted above AL1 occurred above AL2. The upper boundary of the layer was marked locally by a few centimeters of sediments slightly enriched in humic materials. Under the main structure, the limit between AL2 and AL3 was marked by a 1 cm to 3 cm level of sterile loess. However, features built by AL2 occupants destroyed or displaced AL3, especially in the area of the hearth.

The presence of several major features characterized AL2. The main feature, Structure Id/e, consisted of an horizontal layer of large stone slabs which joined each other to form what can be described as a pavement (Figs. IV-6 and IV-8, 9, 10). The northern, eastern and southern edges of the stone structure were exposed by the 1986/87 excavations. To the west, the pavement continued under the I.5 m. wide balk. that had to be left between the excavation block and the graben road. The exposed area was 8 m long and 2.2 m wide. As rocks were not exposed in the road profile it is assumed that the pavement extended less than a meter beyond the limits of the excavations. The width of the structure is therefore estimated to have been between 3.5m and 4m.

A total of 525 stones was recovered from the Id/e pavement. The figure does not include some disintegrated blocks of gneiss that could not be recovered. Sandstones (arkoses), biotitic gneiss and gneiss are the most common materials. Pieces varied in size from 15 to 50 cm in maximum dimension with weight ranging from 500 gr. to 2 or 3 kg. Stones are not available at the site itself but must have been carried from the hillslopes surrounding the graben. The nearest modern-day source of similar stones is at the bottom of the ravine slope at distances of 200-300 m. from the site. It may be said, then, that transport of the stones and construction of the pavements did represent a sizeable investment of time and effort on the part of the site's paleolithic occupants.

The pavement showed irregularities and may well have been constructed in several stages. The overall shape is rectangular with rounded corners. At the northern edge, stones were stacked 2 or 3 deep and scattered stones set at irregular angles formed a small pile beyond the limits of the structure. This suggests that a low wall or stone pile had been erected at that end perhaps to support the posts of a superstructure. In the north corner, a circular arrangement of stones over a flat layer of smaller rocks may have constituted an intentional feature. This is difficult to ascertain as no artifacts were recovered from that spot. In the southern half (Ie) the pavement is never more than 1 stone deep and elements are not so tightly jointed as in the northern half. Manuports were set farther apart leaving some unpaved intervals. A roughly circular, unpaved zone surrounded an area at the south corner of the structure within which were burnt stones, large charred bones and burnt bone splinters. This area marked the probable location of a large hearth which would have been built above the ground with ash, burnt stones and debris scattered around after use. Traces of ocher extended under the designated hearth area and continued under the pavement. The ground and the lower side of the stones were heavily stained. A large, unpaved area at the south corner contained burnt stones and charred bones which marked the probable location of a large hearth. Fire would have been built above the ground with ash and stones scattered around after use.

A high density of debris was noted outside of the pavement in the area behind the hearth. Manuports varied from 10 to 55 cm in maximum dimension; most of them weighed less than 5 kg although the largest may have weighed as much as 30kg.

Variations in the number and placement of the stones suggest that the structure may well have been constructed in several stages and probably included several, distinct, activity areas. At the northern end (excavation unit Id), stones were stacked 2 or 3 deep. Scattered stones set at irregular angles formed small piles beyond the limits of the structure (excavation unit Ic). The more or less linear arrangement of the stones suggests that they had originally been arranged to form a low wall or a series of stone piles to support the posts of a tent.

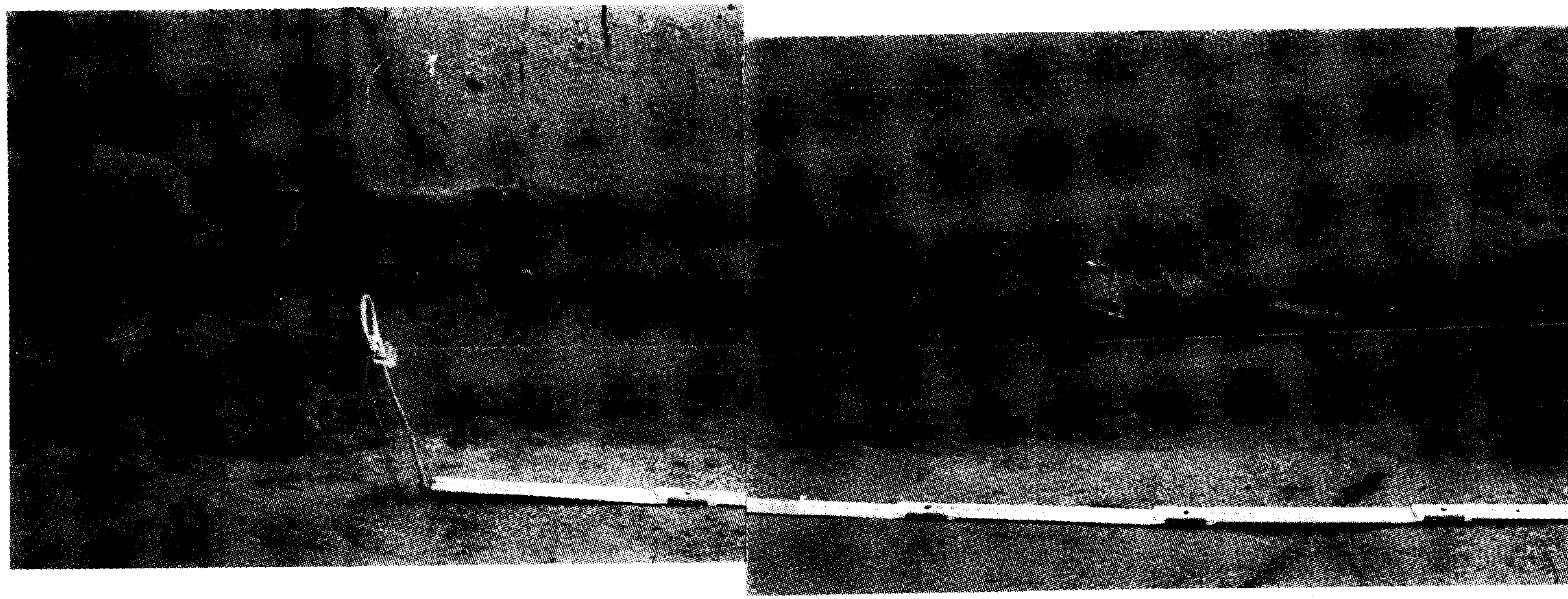


Fig. V-5 Detail of the AL2-AL4 stratigraphy. AL2 is marked by manuports, the black stains on the same horizontal plane as the blocks are disintegrated gneiss. The AL4 artifacts are clearly visible within the dark humic band. AL3 is contained in the loess between AL2 and AL4.

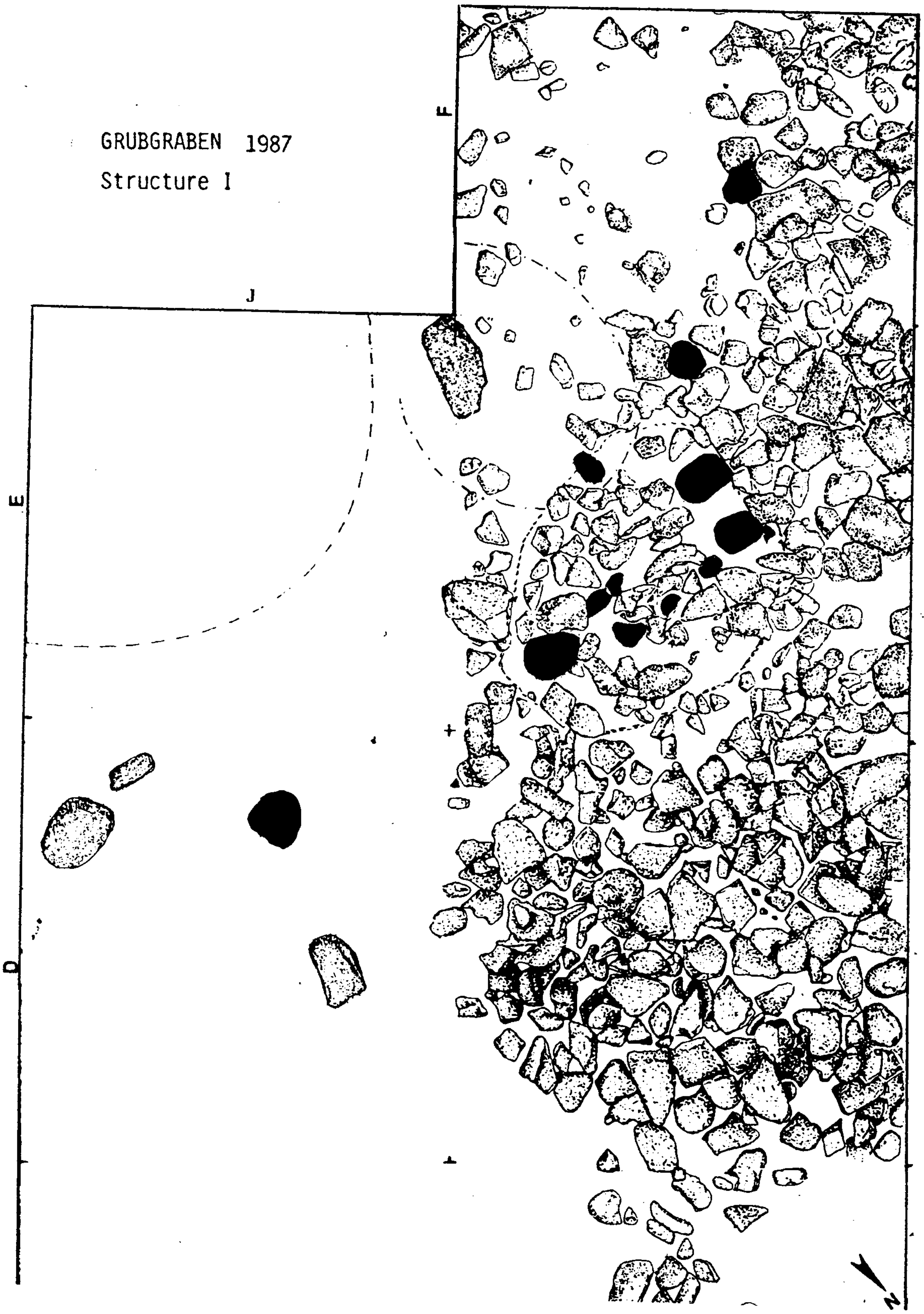


Fig. V-6 Plan of the stone structure Id/e in AL2. Black spots indicate burnt rocks. The striped lines indicate the limits of ocher concentration within the stone structure. The discontinuous line in excavation unit Je marks the outline of the second stone pavement. Drawing by Rudolf Braun.

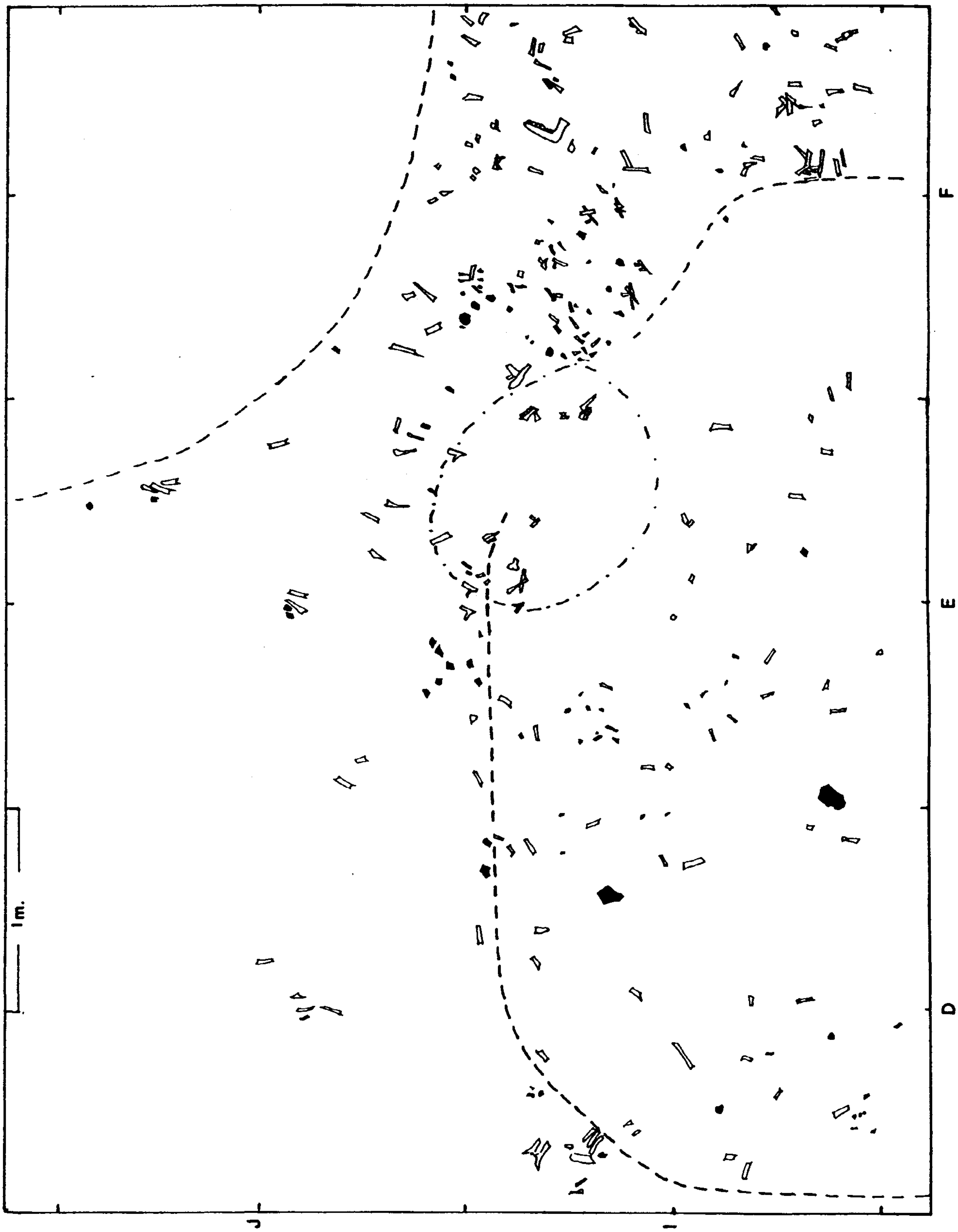


Fig. V-7 AL2, Artifact (black) and bone (outline) distribution within and around the Id/e structure.

A relatively high density of debris was noted outside the pavement, in the area behind the hearth. Among the debris were bone splinters, split reindeer mandibles, chunks of ivory, flint and radiolarite tools and chips. In addition, the refuse area contained an abundance of quartz pieces among which were large cores, cores reused as percussor, quantities of shatter and flakes. The most characteristic type of flake was a wide, rectangular piece with or without a natural cortical back opposed to a jagged cutting edge. The quantity of debris, presence of cores and trimming flakes indicate that knapping of quartz blocks was taking place there and that selected pieces were used. Direct association with bone splinters and split mandibles around the hearth further suggests that quartz pieces were used for cutting meat as well as splitting bones for marrow. Another local material, granulite, was used in the same context and probably for the same purpose.

A single very large stone set at the edge of the paved surface on the other side of the hearth may have served as a seat. Among the artifacts scattered around the large stone were pieces of antler and large fragments of ivory in a poor state of preservation.

The pavement surface was remarkably clear of debris. A total of 31 lithic artifacts, 114 bone fragments and 3 cut dentalia shells were recovered from a surface area of 8.2 square meters. A large prepared core and a denticulate scraper made on a large tabular piece, both of coarse grained radiolarite, were found on top of the pavement stones. Most of the other pieces were recovered between the stones.

Part of a second pavement was uncovered in excavation unit Je. The structure was placed on the slope and continued beyond the excavation trench. Like structure Id/e, the Je pavement was formed of large sandstone slabs and chunks of gneiss set close together. The surface was littered with large bones and artifacts. Some of the bones had been chipped but not crushed. Both the quantity and the kind of recovered debris differentiated the two paved structures which must have had different functions. Any reconstruction or interpretation of the second structure must remain tentative pending further excavations.

Extensive and detailed spatial analysis of late Paleolithic sites has provided a wealth of information concerning habitation structures, hearths, activity areas and workshops as well as zones of primary or secondary trash disposal (Leroi-Gourhan and Brezillon, 1972; Audouze *et al.*, 1981; Julien *et al*, 1988). On the basis of the information thus provided, the structure Id/e may be viewed as a domestic unit which included a habitation area contained in the northern section of the pavement and corresponded to some kind of a dwelling. A large outside hearth at the south end of the paved structure was surrounded by areas of food preparation and food consumption. Trash was rejected in the unpaved zone between the two structures. More detailed analysis of the spatial distribution of bones and artifacts following more extensive excavations will be needed to substantiate the interpretation proposed here.

AL3

Layer 3 consisted of a sheet of bones and artifactual remains contained in a yellowish, loessic matrix that extended over the whole excavated surface (Fig. V-11). The AL3 sheet of bone and artifacts continued under the AL2 pavement from which it was separated by 2 or 3 cm of sterile loess. This established that AL2 and AL3 constituted two distinct and identifiable archaeological layers. To the north of the structure, AL3 formed a thin band vertically placed between the scattered stones marking the continuation of AL2 and the well marked, dark humic band (HH1) containing AL4 (Fig. V-5). Debris density increased in the eastern section of the excavated area (Trench J) where the accumulation of bones and other materials reached a thickness of 10 to 20 cm. (Fig. V-6).

Fig. V-8 View of the pavement from the south. In front, concentration of bone fragments.

Fig. V-9 Pavement seen from the north end of the trench.

Fig. V-10 Lateral view of the northern section of the paved structure where rocks are piled two or three thick.

A certain degree of instability was noted in areas where the slope angle is more noticeable, in front of structure Je in excavation units Jc and Jd and to a much lesser extent along the western wall of excavation unit Ic. The minor faults affected most especially artifacts contained within AL3 and to a lesser degree the ones contained within the underlying AL4. The phenomena had little or no effect on the overlying AL2 as the vertical displacements caused by them were less than the thickness of the pavement stones and artifacts above the stones were left in place.

In AL3, cultural materials tended to pile up along the down slope side of the fault lines where they accumulated in 20 cm to 30 cm deep pockets.

No obvious features could be identified within the mass of broken bones and artifacts that constituted AL3. The organization of the faunal debris is not clearly apparent. An understanding of the butchering practices which produced the accumulation of bone fragments may eventually be derived from the detailed spatial analysis and refitting of the faunal remains.

AL4

The AL4 layer contained the greatest density of artifact and faunal remains. Cores and test-pits indicated that it had its maximum extension within the graben depression. A 20 cm wide, 10 cm deep, basin shaped pit had been cut into the underlying loess (Fig. V-14). A thin coat of humic material lined the bottom of the pit. A first layer of fill containing a few artifacts was overlaid by a second layer consisting of the dark humic matrix of HHI. The pit itself and the first fill corresponded to a phase of occupation that took place immediately before, or at the very onset of, the formation of the humic layer. A second occupation was stratified within the humic layer. The sequence of occupations is difficult, if not impossible to recognize outside of pits or features as the layer is no more than 5 to 6 cm thick.

Other features identified in AL4 included a deep and narrow pit filled with bones and chips (Fig. V-13) and postholes filled with a dark humic matrix. On the west side of the graben, the 85 profile cut a section through a stone built hearth at the base of HH1. Unfortunately much of the material the feature contained had been eroded and continued excavations were prevented by the massive overburden.

Maximum artifact density was recorded around the pits in units Ie and Jd, along the wall of unit Ic/d (Fig. V-12) and in unit Ia. Notable differences in the artifact cluster's content suggested the existence of several activity areas. In the southern section of the trench (Ie, If) were concentrations of reindeer mandibles, sections of fractured bones, 15 to 20 cm wide manuports and pieces of quartz which probably constituted the remains of a butchering/food preparation area (Fig. V-15). At the other end of the trench (la), large manuports, scrapers, splintered pieces, fragments of ivory and a broken stone bead represent the remains of a very different kind of workshop (Fig. V-16).

In summary, the four excavated cultural layers constitute a rich record of different aspects of prehistoric base camps during the last Pleniglacial. Repeated occupations took place during the period of relatively favorable conditions represented by the humic horizon HHI. Faunal remains are abundant, artifacts are varied and in good numbers. People settled in the ravine depression. Camps included hearths, pits and post holes and different activity areas. The same pattern continued during the time of the AL3 occupations. A change in settlement type corresponds to the AL2 occupations which took place at a time when conditions were becoming markedly drier even though traces of humidity here and probably at other spots within the area still made life possible. Previous occupants had made use of manuports, however, the construction of the stone pavement seems to have been developed as an adaptive mechanism by people who settled in the channel and on the knoll during the formation of AL2.

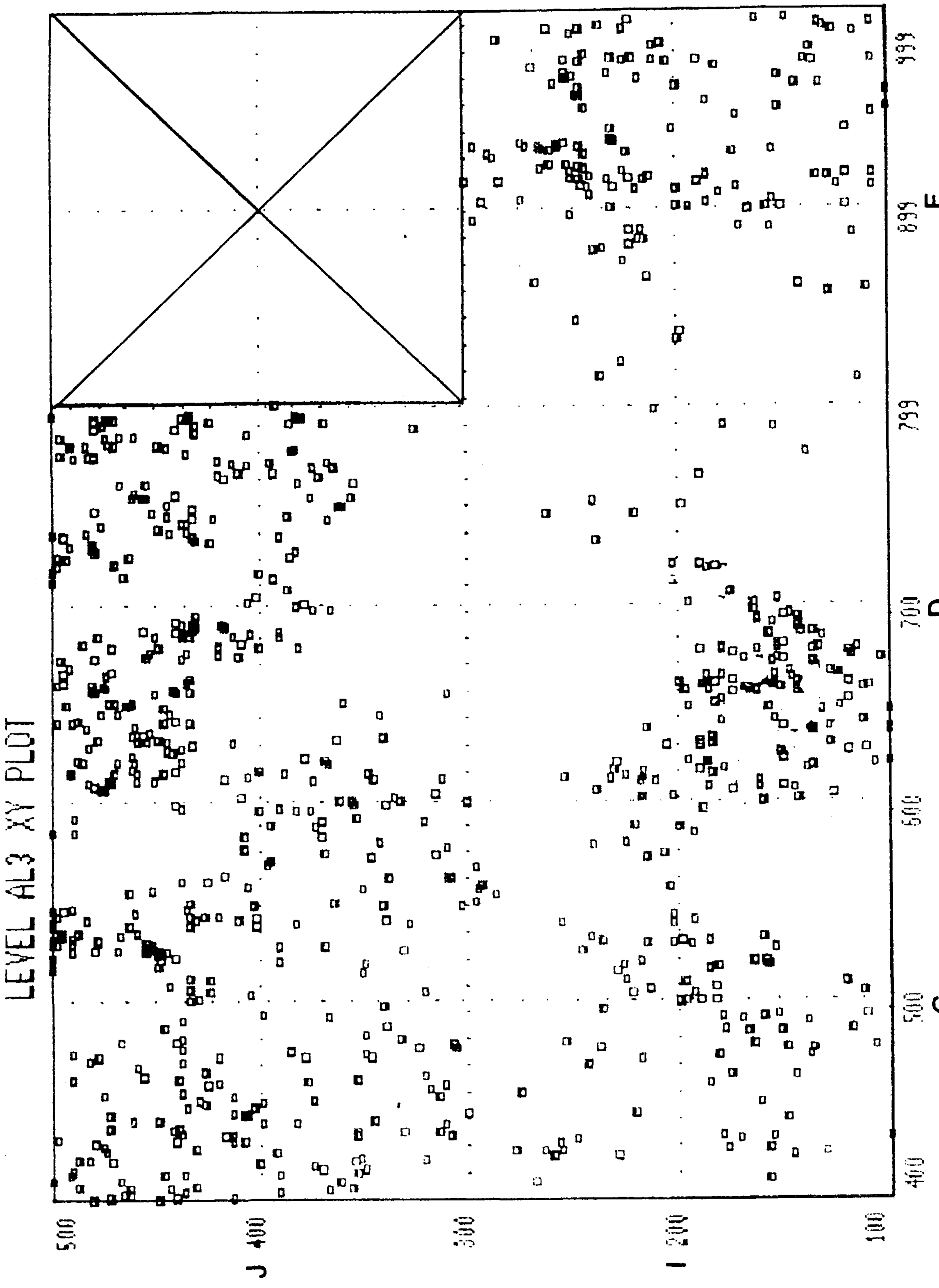


Fig. V-11 AL3: horizontal plot of artifact and bone distribution.

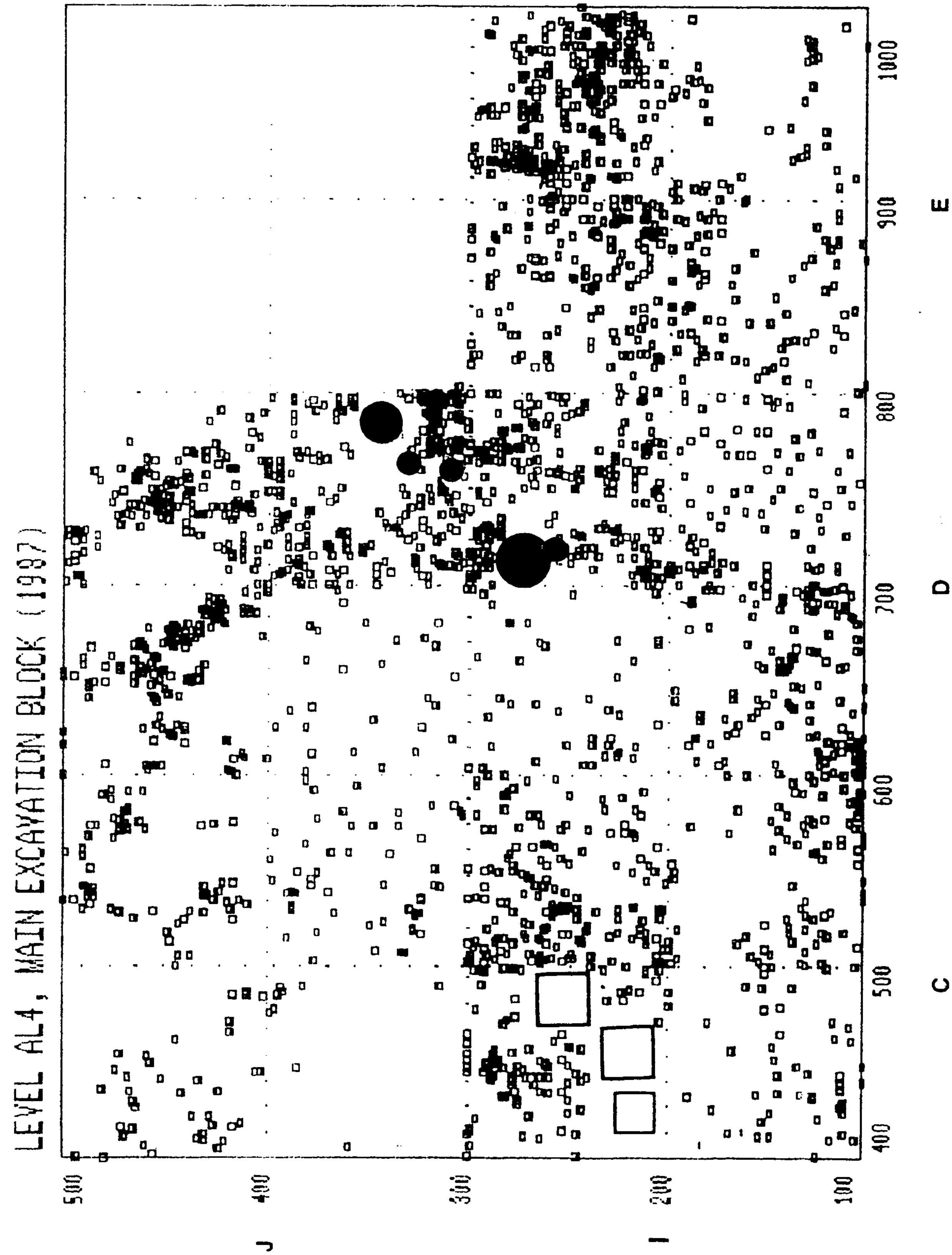


Fig. V-12 AL4 Plot of the horizontal distribution of bones and artifacts. Black circles indicate placement of features, pits and post holes. Square outlines mark places where sediment samples were taken.

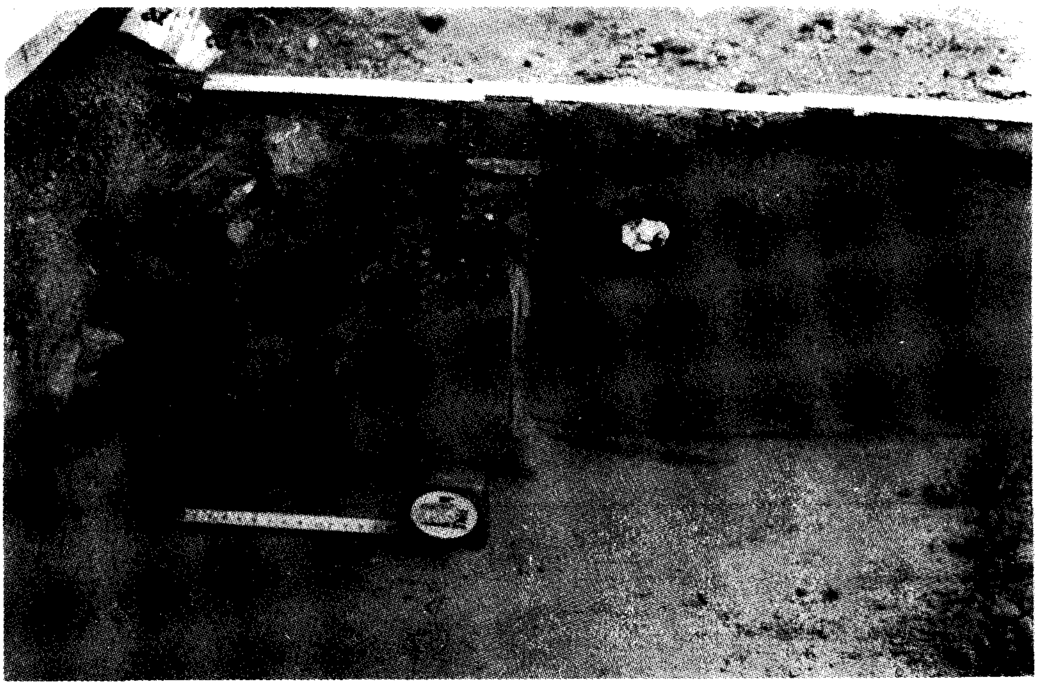


Fig. V-13 Narrow and deep pit filled with dark humic material containing artifacts and bone debris (AL4).

Fig. V-14 Basin shaped pit in excavation unit Id. The deeper pit outline marks the earliest occupation of AL4, at the very beginning of the formation of the humic horizon. The second stage of the pit fill consists of dark humic material, bones and chips.

Fig. V-15 AL4, mandibles and bone fragments at the north end of the trench (Ie/f).

Fig. V-16 AL4, flint and quartz artifacts among hearth clearing debris. The arrow indicates the perforated stone bead.

VI

THE HUNTED OF GRUBGRABEN: AN ANALYSIS OF FAUNAL REMAINS

by

BRAD LOGAN

Introduction

At the present time, 506 cranial and 505 post-cranial elements of the Grubgraben faunal assemblage have been identified (Tables VI-1-4). These include all identifiable bones and teeth from the 1985 and 1986 excavations, as well as an estimated 40% of the identifiable assemblage acquired during the more intensive investigation of 1987. The bulk of this last sample consists of remains from AL2 and AL3. Post-cranial material from AL 4, not excavated until the final two weeks of the 1987 season, has not yet been thoroughly analyzed. Mandibles and teeth from all levels, however, have been identified. Analysis of the faunal material was conducted from late June to mid-August 1987, concurrent with excavation of the site, at the Institute for Paleontology, University of Vienna and the Natural History Museum of Vienna. In this endeavor, the faunal collection at the former institution was found to be more extensive and served as the primary comparative source for identification of animal remains with regard to taxon, element, part, and side. In the identification of elements, directional nomenclature followed Driesch (1976). Measurement of elements, taken with an electronic digital caliper, followed Spiess (1979) for reindeer and Driesch (1976) for all other taxa.

The paleontological collections at the Natural History Museum, though of secondary importance for purposes of identification, were of value to this study in that they include faunal remains from the earlier Gravettian site of Willendorf. This material, housed in both the Department of Geology and Paleontology and the Department of Prehistory, was reviewed cursorily in order to confirm the faunal diversity of that site described in detail by Thenius (1956). Subsequent analysis of a portion of the Grubgraben assemblage has taken place at the Museum of Anthropology and the Museum of Natural History, University of Kansas. Still in progress, this work has focused on cranial remains, primarily teeth, on loan to that institution by the Bundesdenkmalamnt.

While animal remains at Grubgraben were abundant, their state of preservation cannot be considered ideal, especially in AL4. Beyond their initial fragmentation by the site's prehistoric inhabitants, skeletal parts had experienced considerable natural weathering, probably caused by fluctuations in the amount of moisture in their loessial matrix and its cryoturbation since the time of deposition. These processes had softened elements and too frequently reduced them to jig-saw pieces. Mandibles and their associated teeth had proved particularly vulnerable. Most careful excavation and removal, often following the application of plaster bandages, was required in order to bring these remains to the project laboratory in Gars-am-Kamp. Their conservation often demanded "microexcavation" with toothpicks, sparing use of water to clean the exposed portions, a prolonged period (at least one day) of drying, subsequent soaking with a diluted water-based glue solution, and painstaking repair of broken pieces.

Table VI-1.Identified Cranial Elements of All Taxa.

	Rangifer tarandus			*Equus caballus*			*Capra ibex*		
Element	Right	Left	Ind*1	Right	Left	Ind	Right	Left	Ind
UI1	NA	NA	NA	-	-	-	NA	NA	NA
UI2	NA	NA	NA	-	-	-	NA	NA	NA
UI3	NA	NA	NA	1	-	-	NA	NA	NA
UDI1	NA	NA	NA	-	-	-	NA	NA	NA
UDI2	NA	NA	NA	-	-	-	NA	NA	NA
UDI3	NA	NA	NA	1	1	-	NA	NA	NA
UC1	-	-	-	-	-	-	NA	NA	NA
UDC1	-	-	-	-	-	-	NA	NA	NA
UDM1		2	-	-	-	-	-	-	-
UDM2	-	4	-	-	-	-	-	-	-
UDM3	1	4	-	-	-	-	-	-	-
UP2	1	2	1?	-	1	-	-	-	-
UP3	4	4	1?	1	-	-	-	-	-
UP4	9	4	1?	3	-	-	-	-	-
UM1	8	6	-	1	-	1?	-	-	-
UM2	8	4	1?	2	-	-	-	-	-
UM3	5	-	-	1	1	-	-	-	-
L1	1	1	-	4	5	-	-	-	-
LI2	1	-	-	3	3	-	-	-	-
LI3	1	-	-	3	3	-	-	-	-
LC1	-	-	-	2	3	-	-	-	-
LDM1	-	2	-	-	-	-	-	-	-
LDM2	-	4	-	-	1	-	-	-	-
LDM3	1	4	-	-	1	-	-	-	-
LP2	15	10	1?	1	4	-	-	1	-
LP3	19	14	-	1	2	1?	-	-	-
LP4	13	14	-	2	3	-	-	-	-
LM1	13	15	-	1	-	-	-	-	-
LM2	15	14	-	2	2	-	-	2	-
LM3	17	14	-	4	-	-	-	4	-
Unident. Tooth	-	-	3	-	-	9	-	-	-
Skull Fragment	2	-	1	1	1	2	-	-	-
Antler / Horn Fragment	4	10	14	-	-	-	-	-	1
Maxilla Fragment	1	1	-	1	-	-	-	-	-
Mandible Fragment	38	34	2	11	11	3	-	4	-
Totals	177	166	28	46	43	25	-	11	1
Taxa Totals	371				114			12	
Percent	73.3				22.5			2.4	

Table VI-1 (cont.) **

Element	cf *Bos primigenius* Right	Left	Ind	*Mammuthus prim.* Right	Left	Ind	*Alopex lagopus* Right	Left	Ind
UI1	-	-	-	-	-	3	-	-	-
UM1	1	-	-	-	-	-	-	-	-
UM2	1	-	-	-	-	-	-	-	-
LC1	-	-	-	-	-	-	1	-	-
LP2	1	-	-	-	-	-	-	-	-
LP3	1	-	-	-	-	-	-	-	-
LP4	-	-	-	-	-	-	-	1	-
Totals	4	-	-	-	-	3	1	1	-
Taxa Totals		4			3			2	
Per Cent		.8			.6			.4	
GRAND TOTAL					506				

* Indeterminate
** Not included are an indeterminate large bovid molar and an unidentified large bovid/equid tooth fragment

Table VI-2. Identified Apendicular Elements of Major Taxa.

	Rangifer tarandus			*Equus* cf. *caballus*			*Capra ibex*		
Element	Right	Left	Ind	Right	Left	Ind	Right	Left	Ind
Humerus									
Prox.	-	-	-	-	-	-	-	-	-
Dist.	2	4	-	-	-	-	-	-	-
Shaft	7	4	1	6	6	-	-	1	-
Rad/Ulna									
Prox.	3	2	-	-	-	-	-	2	-
Dist.	4	-	-	1	-	-	-	-	-
Shaft	19	22	6	3	1	-	-	1	-
Femur									
Prox.	-	-	-	-	-	-	-	-	-
Dist.	-	-	-	-	-	-	-	-	-
Shaft	6	9	-	4	3	-	-	-	-
Patella	2	1	-	-	-	-	-	-	-
Tibia									
Prox.	-	-	-	-	-	-	-	-	-
Dist.	1	3	-	1	-	-	-	-	-
Shaft	24	12	3	9	4	-	-	-	-
Metacarpal									
Prox.	5	-	-	-	1	-	1	-	-
Dist.	-	2	5	-	-	1	-	-	1
Shaft	3	5	2	-	-	2	-	-	-
Metatarsal									
Prox.	3	5	-	1	-	1	-	-	-
Dist.	5	1?	-	-	1	-	1	-	1
Shaft	24	20	23	-	1	2	-	-	-
Metapodial									
Prox.	-	-	-	-	-	-	-	-	-
Dist.	-	-	1	-	-	1	-	-	-
Shaft	-	-	6	-	-	2	-	-	-
1st Phalange	-	-	2	-	-	-	-	-	2
Prox.	-	-	5	-	-	-	-	-	-
Dist.	-	-	5	-	-	1	-	-	-
2nd Phalange	-	-	1	-	-	1	-	-	-
Prox.	-	-	2	-	-	-	-	-	1
Dist.	-	-	-	-	-	-	-	-	-
3rd Phalange	-	-	1	-	-	1	-	-	1
Prox.	-	-	-	-	-	-	-	-	-
Dist.	-	-	-	-	-	-	-	-	-

Table VI-2 (cont.)

Element	*Rangifer tarandus* Right	Left	Ind	*Equus cf. caballus* Right	Left	Ind	*Capra ibex* Right	Left	Ind
Unident Phalange									
Prox.	-	-	2	-	-	-	-	-	-
Dist.	-	-	1	-	-	-	-	-	-
Sesamoid	-	-	4	-	-	-	-	-	3
Os Malleolare	-	4	-	-	-	-	-	-	-
Astragalus	2	2	-	-	-	-	-	-	-
Calcaneus	2	5	-	1	-	-	-	-	-
Os Carpale 3	-	1	-	-	1	-	-	1	-
Pisaform	1	-	-	-	-	-	-	-	-
Scaphoid	-	1	-	-	-	-	-	-	-
Os Centro-tarsal	2	2	-	-	-	-	-	-	-
Os Tarsi-centrale	2	-	-	-	-	-	-	-	-
Os Tarsal 3	-	-	-	-	-	-	-	-	-
Stylet	-	-	3	-	-	-	-	-	-
Dew Claw 1	-	-	1	-	-	-	-	-	-
Dew Claw 2	-	-	1	-	-	-	-	-	-
Dew Claw 3	-	-	1	-	-	-	-	-	-
Indeter. Fragment	-	-	17	-	-	2	-	-	-
Totals	117	105	93	26	18	14	2	5	9
Taxa Totals		315			58			16	
Per Cent		81.0			14.9			4.1	
Grand Total					389				

Table VI-3. Identified Axial Elements of Major Taxa

	Rangifer tarandus			*Equus* cf. *caballus*			*Capra ibex*		
Element	Right	Left	Ind	Right	Left	Ind	Right	Left	Ind
Atlas	-	-	1	-	-	-	-	-	-
Axis	-	-	-	-	-	-	-	-	-
Cervical Vert.	-	-	3	-	-	3	-	-	-
Thoracic Vert.	-	-	4	-	-	2	-	-	-
Lumbar Vert.	-	-	2	-	-	-	-	-	-
Sacrum	-	-	-	-	-	-	-	-	-
Caudal Vert.	-	-	-	-	-	1	-	-	-
Indeter. Vert.	-	-	1	-	-	1	-	-	-
Scapula	8	7	2	3	2	1	1	1	-
Glenoid	5	1	-	-	-	-	-	-	-
Innominate	1	-	-	4	-	-	-	-	-
Acetabulum	6	3	-	-	1*	-	-	-	-
Rib Fragment	-	-	28	-	2	-	-	-	-
Indeter. Fragment	-	-	1	-	-	3	-	-	-
Totals	20	11	42	7	5	11	1	1	-
Taxa Totals		73			23			2	
Per Cent		74.5			23.4			.4	
GRAND TOTAL					98				

* cf. *E. hydruntinus?*

Table VI-4. Miscellaneous Post-Cranial Elements by Taxa and Part.

Taxon	Element (Side, if known)
Cervid	1 Thoracic vert. frag., 1 Lumbar vert frag., 2 Scapulae frags., 1 Rib frag.
Large cervid	1Tibia shaft frag. (right), 1 Femur shaft frag. (right)
Cervid/small bovid	1 Metatarsal distal (left), 1 Femur shaft (right)
Larde bovid	1 Humerus shaft frag. (left), 1 Tibia shaft frag. (left)
Large bovid/ Equid	1 Tibia shaft frag. (right), 1 Lumbar vert. frag., 1 Rib frag., 1 Indeter. apend. frag.
Carnivora	1 Humerus distal (right)
Mustelidae cf. *Gulo gulo*	1 Tibia proximal
Lagomorph	1 1st Phalange
Total	18

In order to weigh the relative abundance of various animals in the Grubgraben assemblage, I rely on the minimum number of individuals (MNI) and the number of identified specimens (NISP), two of the standard indexes employed by zooarchaeologists for this purpose. I am aware of the disadvantages of these indexes but am in agreement with Klein and Cruz-Uribe (1984:24-38) that judicious use of both provides the best means of quantifying an archaeofauna (cf. Grayson 1979). One of the limitations of NISP is the fact that the number of elements in an animal varies among some species. An example from Grubgraben is the difference in the number of phalanges in artiodactyls (cervids and bovids) and perissodactyls (equids). The former possess 24 of these elements and the latter 12. When one adds the stylets and dew claws of *Rangifer,* for example, the number of potential elements compared to *Equus* increases yet again. NISP is also affected by any differences in the degree of bone fragmentation, a disadvantage Klein and Cruz-Uribe (1984:25) consider to be the most serious. However, these drawbacks to the use of NISP do not play a great role in the calculations of the Grubgraben assemblage. Phalanges are relatively rare at the site and do not adversely affect the totals of identified cervid/bovid and equid elements. It is more difficult to account for differences in the degree of fragmentation, whether cultural or post-depositional. Equid bones are more robust than those of *Rangifer* and *Capra ibex* and consequently may have suffered less breakage. It will be seen, however, that the relative percentages of taxa from Grubgraben are comparable with respect to *both* MNI and NISP. In this case, the two indexes reinforce each other.

The following discussion of the Grubgraben assemblage focuses on its value for providing information about the site's environment and its exploitation, its contrast with the faunal material from Willendorf in these regards, the season of the site's occupation, and the butchering practices of the site's inhabitants.

Environment and Subsistence

Animal remains from Grubgraben reflect a narrow range of faunal diversity and a corresponding focal hunting economy. Species represented include reindeer *(Rangifer tarandus)*, horse *(Equus caballus)*, ibex *(Capra ibex)*, aurochs *(Bos primigenius)*, arctic fox *(Alopex lagopus)*, mammoth *(Mammuthus primigenius)*, a mustelid (perhaps the wolverine, *Gulo gulo*), and an unspecified lagomorph. The first three of these species comprised the staples of the hunters' diet with reindeer and horse surpassing ibex in this regard. Aurochs is represented by a few teeth that could represent a single individual. The taxonomic assignment of these latter finds remains problematic and should be considered tentative. A few post-cranial fragments can only be identified as large bovid. Elements of arctic fox are limited to a single mandible fragment and a few perforated canines that suggest this animal was procured primarily for ornamental purposes and perhaps also for its fur. The mammoth is represented solely by pieces of ivory, generally in a very poor state of preservation, that may have been collected from natural-death carcasses. The lagomorph and mustelid are each represented by a single element.

All of these animals would have been at home in the pleniglacial steppe-tundra environment indicated by other environmental data from the site (see Haessarts herein). Herds of reindeer and horse were particularly abundant throughout Europe during the Upper Paleolithic (Kurtén 1968) . Dependence on the reindeer would have required a mobile settlement-subsistence pattern geared to the migratory behavior of that species. Ibex, while also gregarious, are particularly adapted to montane habitats, though they are known to descend to meadows in lower elevations during harsh winter months and during the spring (Spiess 1979; Straus 1987). These three ungulates are considered by Delpech (1983:31) to be indicative of generally cold, steppic conditions. Aurochs, a large bovid that became extinct in the 17th century, was widely distributed throughout Europe during the Pleistocene and is considered to have been an inhabitant of dense grasslands and open woodlands (Kurtén 1968:188). Delpech (1983) considers the aurochs and bison (both *B.*

priscus and *B. schoetensacki*) of the Pleistocene to be intermediate between faunal groups she defines as "cold" and "temperate". None of the animals she places in this latter group is represented in the Grubgraben assemblage (unless one accepts a single acetabulum fragment of a small equid as *E. hydruntinus*; see Table VI-3). The few smaller mammals in the assemblage, insofar as they are known, do not conflict with this interpretation of a cold, steppe-tundra environment. The ungulate species are discussed below in terms of their relative frequencies and contribution to the subsistence of the hunters of Grubgraben. First, however, the small sample of mammoth remains requires brief discussion.

Mammoth: The incorporation of mammoth bones in habitations in central and eastern Europe during the Gravettian is well documented (Kozlowski 1986). Direct evidence of hunting is more rare. In Poland, for example, one of the few kill sites containing remains of this animal is Krakow-Nowa Huta, "where mammoth remains were associated with two bone implements manufactured *in situ* and nine blades struck from two cores" (Kozlowski 1986:180). Mammoth hunting appears to have been considerably more important in the northernmost regions of central and eastern Europe where a high biomass provided more support for greater numbers of such large game (Kozlowski 1986:185). Procurement of mammoth during the Gravettian in lower Austria near Grubgraben has been documented at Willendorf I, I/N, II (Levels 5, 7-9) and, though tentatively identified, at V (Thenius 1956:162-163). Hunting of juvenile mammoth in particular may be indicated by the deciduous molars described by Thenius from the Gravettian levels of Willendorf II. Additional support for mammoth hunting in the area comes from the site of Ruppersthal, where excavation of a large concentration of skeletal remains of two mammoth also yielded two points, two blades, and a scraper (Bachmayer, *et al.* 1971). Other fauna found in association with this material included horse (*Equus* sp.), cervid, young bovid, and wolf (*Canis lupus*). Two radiocarbon dates were obtained on bone samples from Ruppersthal, 21,566±405 B.P. and 11,640±405 B.P. Given the sedimentological context of the faunal assemblage (Wurm III), the earlier date was suggested to be accurate and the later date dismissed as the result of sample contamination.

The only mammoth remains from Grubgraben identified to date consist of a few pieces of ivory (Table VI-1, Figure VI-1). This material is insufficient to support any interpretation of mammoth hunting. Its presence at the site may reflect fortuitous scavenging of mammoth carcasses in the vicinity of the site or trade for such a commodity with neighboring populations. Though none of the fragments from Grubgraben bears traces of human modification they were probably acquired for manufacture of tools or representational art. Use of ivory as an industrial or artistic medium has been well documented throughout central and eastern Europe during the Gravettian (Kozlowski 1986:180-184).

Reindeer: This animal outweighs all others in terms of both the minimum number of individuals (MNI) and the number of identified specimens (NISP) in the total assemblage. When considered in the aggregate (i.e., all levels combined), these figures for reindeer are 19 (based on the number of lower third premolars, see Table VI - 1) or 57.6% and 759 or 75.1% respectively. Of the 122 teeth and mandible fragments presently identified by their intra-level provenience (Table VI - 5), the NISP of reindeer is dominant in each level. Though still in the majority, the proportionate NISP of reindeer vis-à-vis horse is notably lower in AL 4 than in the upper levels. Whether this reflects a shift from more equable reliance on horse (or even greater, considering the relative amount of usable meat in this animal as compared to reindeer) to greater reliance on reindeer during the later occupations of the site remains to be demonstrated with greater samples of faunal material from AL 4.

Adopting the age-groups and criteria that characterize them described by Miller (1974:16-22; 38-61) and Spiess (1979:70-84), I have examined mandibular tooth eruption

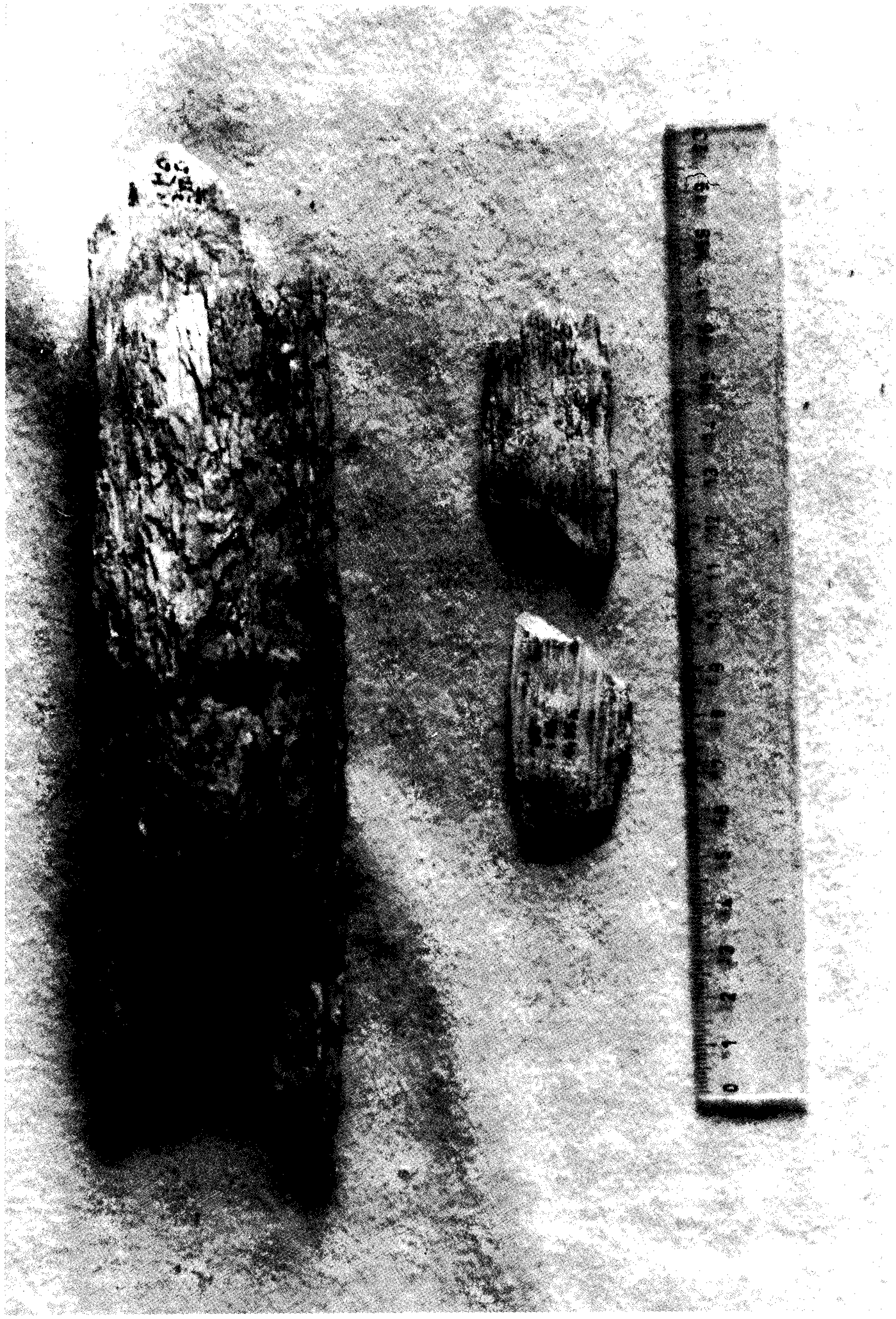


Figure VI-1. Mammoth ivory from Grubgraben. Note poor preservation of upper fragment.

Table VI-5. Distribution of Identified Mandible Fragments and Teeth.*

Taxa	AL2	AL3	AL4	Total	Per Cent
Rangifer	12	56	12	80	66.1
Equus	1	20	10	31	25.6
Capra	-	5	-	5	4.1
Other	-	2	3	5	4.1
Total	13	83	25	121	
Per Cent	10.7	68.6	20.7		

* Provenience listing is according to catalog number. As one such number may designate a mandible fragment with more than one tooth, figures presented here do not correspond to NISP presented in Tables 1-4.

Table VI-6. Age Group Composition of *Rangifer tarandus* Mandibles.

Age Group:	-2 yrs.		2 yrs.		3-5 yrs.		6-9 yrs.		10 yrs. +	
Side:	L	R	L	R	L	R	L	R	L	R
Tooth										
P2	-	-	3	-	1	2	1	4	-	-
P3	-	-	4	-	1	3	2	4	1	-
P4	-	-	3	1	2	4	2	3	1	-
DM1	-	-	-	-	-	-	-	-	-	-
DM2	2	1	-	-	-	-	-	-	-	-
DM3	2	1	1	-	-	-	-	-	-	-
M1	3	-	3	1	2	5	1	4	1	-
M2	2	-	3	1	2	7	1	3	-	-
M3	1	-	3	1	2	5	-	2	-	-
NISP (Side)	10	2	20	4	10	26	7	20	3	-
NISP (Group)	12		24		36		27		3	
Percent	11.8		23.5		35.3		26.5		2.9	
NISP (Total)	102									
MNI (Group)	3		4		7		4		1	
Percent	15.8		21.1		36.8		21.1		5.3	
MNI (Total)	19									

and wear patterns in order to determine the demographic distribution of the Grubgraben reindeer. These age-groups are also comparable to those defined by Leroi-Gourhan and Brezillon (1972:160-170) for their analysis of the reindeer assemblage from Pincevent. Only mandible fragments that contain at least two adjacent molariform teeth with well preserved occlusal surfaces were selected for this analysis. The sample consists of 31 mandible fragments with a total of 102 teeth representing at least 19 individuals. They are distributed among five age groups as follows (Table VI-6) :

Less than two years old (Figure VI-2,7): 3 (15.8%)

Two years old (Figure VI-3): 4 (21.1%)

Three-five years old (Figure VI-4): 7 (36.8%)

Six-nine years old (Figure VI-5): 4 (21.1%)

Ten+ years old: 1 (5.3%)

The distribution across the five age groups is normal, with the youngest and oldest animals composing the smallest proportion of the diet. This distribution can be adopted for comparison to future samples from the site, as well as to other Upper Paleolithic faunal assemblages from western and central Europe. For example, Spiess (1976:201) provides data from Abri Pataud, in southwestern France, for one such comparison. (Spiess distinguishes between calves and yearlings. For purposes of comparison I have lumped these categories into the less-than-two year old group.) Of 93 animals from this site, 26 (28%) fall within the less than two year old group, 11 (11.8%) in the two year-old group, 31 (33.3%) in the 3-5-year-old group, 18 (19.4%) in the six-to-nine-year-old group, and 7 (7.5%) in the ten+ year old group. The two assemblages are comparable with respect to the predominance of animals from three to five years old and the rarity of animals ten years old or greater. The most striking difference is in the reversed proportion of calves and yearlings with respect to two-year-olds in the Abri Pataud sample. Given the small sample from Grubgraben, we cannot assume with any great conviction that the hunters of that site were selecting against the youngest animals in the herd. However, such an interpretation can be adopted as a working hypothesis to be tested with an enhanced sample following future excavation of the site. It should be pointed out that the comparison here is between an open air site where faunal remains have been subject to weathering processes not experienced by the more sheltered remains of Abri Pataud. The surviving deciduous molars of calves and yearlings from Grubgraben are notably more fragile than the dental remains of older animals. It is possible that attrition has diminished what may well have been a greater example of this age group.

Wild Horse: With the exception of a relatively small acetabular fragment that may be comparable to *E. hydruntinus*, all identifiable equid elements are assignable to the larger species *E. caballus*. Chase (1986), following analysis of 11 identifiable equid elements from the 1985 test excavation, suggested that "on the basis of size and tooth morphology, most of the *Equus* are probably *E. hydruntinus*." However, this identification was based on cursory examination of the remains without access to a comparative collection. My identification is based on a review of these elements plus the complete collection from the 1986 test excavations and a large sample of the 1987 assemblage, a total of 114 cranial and 81 post-cranial equid elements, with the aid of the comparative collections in Vienna. Measurements on all equid teeth invariably compared favorably with those on the single

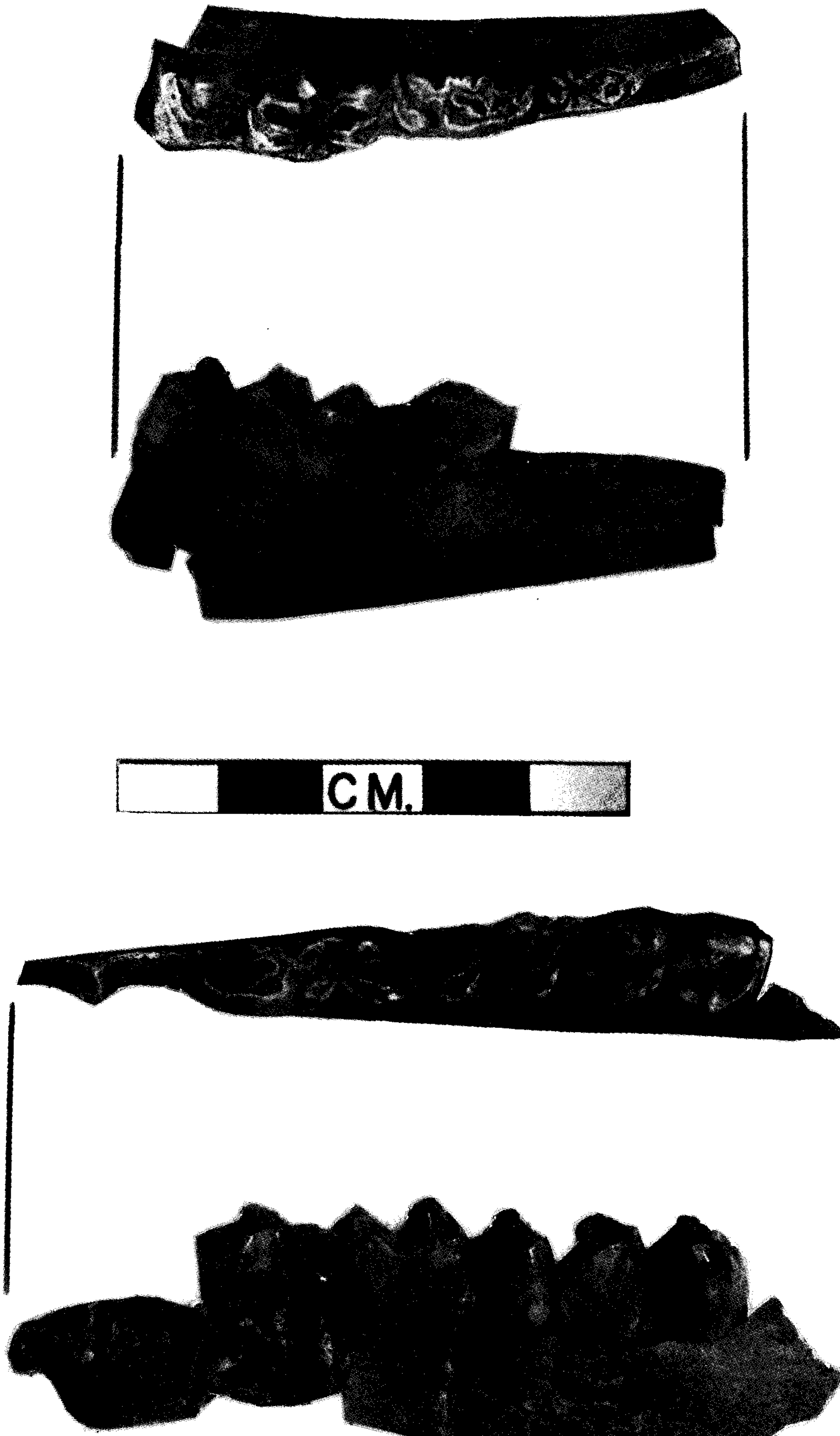


Figure VI-2. Buccal and occlusal views of mandibles of reindeer less than two years old. The high relief wear patterns of the teeth in these examples indicate death sometime during the first to seventh month (i.e., mid-June to mid-December).

Figure VI-3. Buccal view of mandibles of reindeer ca. two years old. Note variation in the presence of DM3 and eruption of premolars and M3. According to Miller's (1974 : 39-42) illustrated examples, the upper mandible shown here may be from an individual 17-27 months old.

Figure VI-4. Buccal view of mandibles of reinder from three to five years old.

Figure VI-5. Buccal view iof mandibles of reinder from six to nine years old.

specimen of *E. caballus* at the University of Vienna and also with those provided by Spiess (1979) on *E. caballus* from Abri Pataud (Table VI-7,8). Speiss (1979:272) also provides comparative measurements for the dentition of modern horse (*E. equus*), which he considers to have been of comparable size, and the equid teeth from Grubgraben fall comfortably within the range of those measurements as well. In lieu of any remains of *E. hydruntinus*, which were lacking at both the University of Vienna and the Natural History Museum of Vienna, a single specimen of *E. asinus*, a female from Tuareg Esel, western Sahara, in the former collection (UWIP 1272) was used for comparison during the identification of equid dentition. None of the teeth approach the small size of that specimen nor do any of them compare to similar data on the same species provided by Spiess (1979:273).

The wild ass is rare at Upper Paleolithic sites in southwestern France and is considered to have been more common in temperate environments (Delpech 1983). Spiess (1979:258) suggests that "during the driest (and coldest?) stadials of the last glaciation, the winter range [of *E. hydruntinus*] may have been more localized and restricted than that of the larger *E. caballus*." The wild horse on the other hand was "particularly well adapted to steppic conditions" throughout the Paleolithic (Delpech, 1983:31) . Given the cold steppe-tundra environment that prevailed during the Epi-gravettian at Grubgraben, it is not surprising that the equids represented are wild horse.

While not as numerous as reindeer in the recovered sample from the site (MNI=5, based on right lower first incisors, TableVI-1; NISP=195), the wild horse provided a significant amount of usable meat. Spiess (1979:273-274) grants an adult male of the species a weight of 350 kg of which 55% could be considered edible meat and 5% fat (during the winter). Comparable figures for an adult male reindeer are 110 kg of which 55% is edible meat and 10% is fat. Of course, the proportion of fat varies considerably throughout the seasonal cycle and is higher during the winter in females. Depending on the season, an adult male horse could provide at least three times as much edible meat as an adult male reindeer. Thus, though the MNI of horse vis-à-vis reindeer at Grubgraben is markedly lower, the relative contributions of edible meat of both animals are more equable. We can thus consider the wild horse to have been a major food source rather than a secondary supplement.

Ibex. The ibex is represented in the assemblage by 30 elements (Tables - VI-1-3) of which the number of right lower third molars provides the MNI of four (Table VI-1). A particularly tricky game animal in its montane habitat (Straus, 1987), the ibex of Grubgraben may have been more easily obtained in the vicinity of the site when they descended from the hilly terrain of the nearby Wachau to lower elevations during bad winter months or for spring foraging. Spiess (1979:281) adopts a mean weight of 40 kg for an adult male ibex of which 55% could be considered edible meat and a figure of 5% for winter fat content. Again, these figures varied considerably between the sexes and throughout the seasons. Given these measures and the number of individuals represented at Grubgraben, we can assume that ibex served a supplementary role in the Epigravettian hunting economy. That horse and ibex played important roles in the subsistence pattern probably reflects the fact that the reindeer, for a variety of behavioral reasons, does not provide a reliable single resource for hunters (Burch, 1972) .

Aurochs: As noted above, the identification of this animal at Grubgraben remains problematic. It is based on the presence of a maxillary fragment that contains a complete first molar and anterior portion of the second molar. This fragment and a second, a mandibular fragment containing the first premolar and anterior portion of the second premolar, compare favorably to material identified as *Bos primigenius* from the site of

Table VI-7. Measurements of Equid Teeth from Grubgraben.*

Catalog Number/Tooth or Tooth Row (Side)	Occlusal Length (cm)	Occlusal Breadth
IA2-428/ UP2 (L)	3.72	2.73
JC-1511/ UP3 (R)	3.01	2.79
IIP2-?/ UP4 (R)	3.13	-
IF3-1080/ UP4 (R)	2.68	2.71
IC4-1812/ UP4 (R)	2.86	2.88
IF3-1080/UM1-M3 (R)	7.70	-
IIP2-87/ UM1 or UM2 (L)	2.48	-
IF3-1080/ UM1 (R)	2.35	2.61
IF3-1080/ UM2 (R)	2.42	2.63
JC-1404/ UM2 (R)	2.63	2.60
IF3-1080/ UM3 (R)	2.95	2.28
IE2-1227/ UM3 (L)	2.81	2.40
IIP2-533/ LI1-2 (R&L)	-	6.66
IIP2-523/ LI1 (R)	1.13	1.40
IIP-369/ LI1 (L)	-	1.72
IP2-245/ LP2-P4 (L)	8.68	-
JD3-1139/ LP2-P4 (L)	9.36	-
IA2-2261/ LP2 (R)	3.20	1.50
JD3-1139/ LP2 (L)	3.28	1.48
IC3-1976/ LP2 (L)	3.18	1.48
IC1-1394/ LP3 or P4 (R)	2.73	1.76
IC3-1696/ LP3 (R)	2.91	1.76
JD3-1139/ LP3 (L)	3.11	1.69
ID4-217/ LP4 (R)	2.97	-
JD3-1139/ LP4 (L)	3.05	1.59
IC3-1947/ LP4 (L)	3.08	1.86
JE-1090/ LM2 (R)	3.25	1.25
JC-1211/ LM2 (R)	3.30	1.17
JD3-1150/ LM2 (L)	2.81	1.44
JC1-1618/ LM2 (L)	2.61	1.62
IA4-5/ LM3 (R)	2.72	1.38
JC-1029/ LM3 (R)	3.52	-
JD3-1199/ LM3 (R)	3.16	1.48
JD4-1566/ LM3 (R)	3.31	1.54

*After Driesch 1976 : 52-53

Table VI-8. Dental Measurements on *Equus caballus* from Abri Pataud and the University of Vienna

Tooth/Tooth Row	Occlusal Length (cm)[1]	Occlusal Length & Breadth[2]	
UP2	3.34		
	3.55		
	3.90		
	3.74		
	4.26		
UP3	-		
UP4	-	2.79	2.60
UM1 or M2	3.10		
	2.60		
	2.73		
	2.83		
	2.76		
	2.61		
	2.77		
	2.76		
	3.13		
UM3	3.10	2.64	2.21
LP2	-		
LP3	2.98		
LP3 or P4	2.97		
	3.02		
LM1	2.68		
LM1 or M2	2.97		
	2.70		
	2.90		
	2.75		
LM2	2.92	2.71	1.65
LM3	3.56		
	3.60		
	3.40		
	3.20		
	3.22		
	3.45		
	3.54		
	3.78		

1 From Spiess 1979 : 272
2 On specimen UWIP 2242

Kaiserstein Bruch in the collections of the Department of Geology and Paleontology at the Natural History Museum of Vienna. As the first molar is more complete and offers the best characteristics for comparison, the identification hinges on that specimen (Figure VI-6).

Delpech (1983:186) suggests the following criteria for distinguishing M1 of *Bos* and *Bison*:

1) Greater mesio-distal (anterior-posterior) length in *Bos*;

2) A rectangular shape defined by the anterior and posterior lobes on the lingual side at the "collar," or enamel line, in *Bos* and more trapezoidal shape at this location in *Bison* (more noticeable on the M3 than M1 and M2);

3) The presence of an "islet" of enamel between the two lobes of the molar that is common in *Bos* and rare in *Bison* and

4) The short and, near the enamel line, "pinched" aspect of the entostyle in *Bison* as compared to the ocassionally "extremely elongated" nature of this landmark in *Bos*.

Unfortunately, the large bovid M1 from Grubgraben cannot be assigned to *Bos* on the basis of all four of these criteria. In terms of its mesio-distal length (3.30 cm) and the rectangular shape defined by the lingual lobes when the tooth is viewed radically (Figure VI-6b) this tooth can be identified as *Bos*. However, it neither bears an islet, nor is the entostyle as elongated as the *Bos* specimen pictured by Delpech (1983:Plate 2, 5b). Indeed, in regard to this last criterion the molar from Grubgraben compares more favorably to Delpech's (1983:Plate 2, 2b) *Bison* specimen (cf. FigureVI-6a). Spiess (1979:277) also adopts the criterion of the islet as a hallmark of *Bos* but points out that it is to be found on molars with well worn occlusal surfaces. The molar from Grubgraben is from a young individual and exhibits little wear. As for the length of the entostyle, further research may yet demonstrate that this feature displays more variation among both bovids than is presently recognized. I base my identification on what I consider to be the most telling characteristic, the length of the tooth as measured according to Delpech (1983: 441; i.e., at a point one cm above the enamel line on the mesostyle). In this respect, the molar from Grubgraben compares favorably to that from Kaiserstein Bruch (3.16 cm) and to the single specimen from La Ferrassie (2.85) ascribed to *Bos* by Delpech (1983:441). Four UMI from La Ferrassie identified by Delpech (1983) as *Bison* measure 2.40, 2.45, 2.60, and 2.75 cm long, attesting to the relatively smaller size of the tooth in this bovid.

The tentative nature of this identification is further enhanced when we note that large bovid elements from Willendorf and Kamegg (see following section), two sites that bracket Grubgraben in time and that are located in its vicinity, have been identified as *Bison priscus* (Thenius, 1956; Brandtner, 1954). Thenius (1956:157) states bluntly that *Bos primigenius* "ist aus Willendorf nicht belegt." As in the case of Grubgraben, identification of the large bovid remains from these sites is based on small samples of material. Elements from Willendorf (including localities I, I/N, II and V) include a mandible fragment with P3 - M1, a fragmented P4, an isolated M3, distal humerus, distal tibia, astragalus, calcaneus, and second phalanx. Elements from Kamegg consist of an unspecified vertebra and phalange. Postcranial elements of *Bos* and *Bison* are difficult to distinguish and confident assignment ideally requires "a partial skeleton" from a single individual (Olsen, 1960:5; cf. Delpech, 1983:185-187). Given the few large bovid post-cranial remains from these sites, we cannot be certain of their identification as *Bos* or *Bison*. The teeth from Willendorf provide little additional support. On the basis of the morphological similarity on the P4 in the P3-M1 series to *Bison*, Thenius assigns the mandible fragment to that genus.

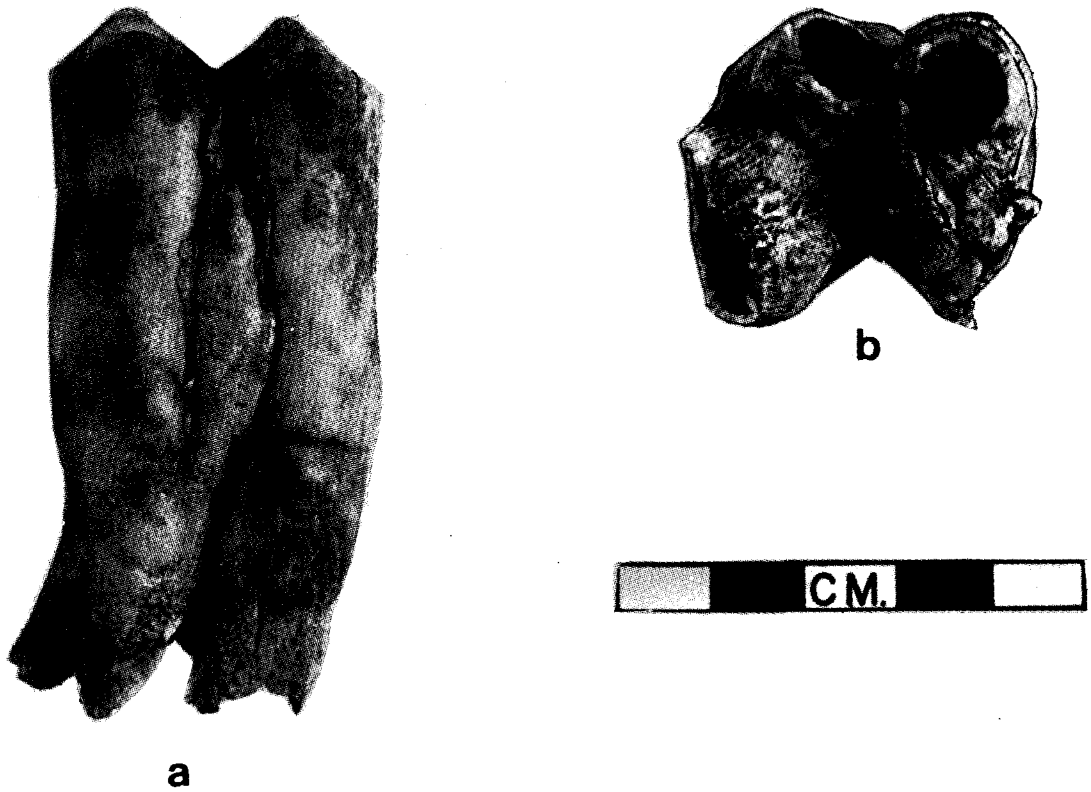


Figure VI-6. a) Buccal view of M^1 of large bovid (*Bos primigenius?*) from Grubgraben. b) Radicle view of same molar.

Figure VI-7. Buccal and occlusal views of left mandible of reindeer that died during its first year (September-June), probably during the winter months.

Delpech (1983: 185-187), following a thorough analysis of criteria that can be used to differentiate the two bovids, does not rely on premolars to distinguish *Bos* and *Bison*. She focuses instead on upper and lower molars. Given this, the identification of *Bison* at Willendorf hinges on an isolated M3 that Thenius (1956:158) assigns to that genus on the basis of the structure of its talonid. As illustrated (Thenius 1956: Fig.115), this element does lack one of the criteria noted by Delpech (1983:186) as indicative of *Bos*, the presence of an "epine" between the distal two lobes of the tooth that, while not as elongated as the ectostylid, is as well developed. An equally telling criterion, however, is the mesio-distal length of the M3, which is greater in Bos. Thenius (1956:158) provides comparative lengths of this tooth (4.60 cm) to those of *Bison bonasus* (4.00 cm), *Bison bison* (4.45 cm), and *Bos primigenius* (4.60). In this respect, the molar from Willendorf compares more favorably to aurochs than bison. Obviously, the identification of the large bovid remains from Willendorf remains as problematic as that of Grubgraben .

The habitat preferences of the two large bovids of the Upper Paleolithic in Europe differ somewhat. The aurochs prefered "mast-producing parkland scattered among grassy pastures," whereas the bison "is a grazer and optional browser who does not need as much winter shelter and is independent of fall mast production" (Spiess, 1979:261). This suggests that the bison would have fared better in the relatively barren steppe-tundra of Grubgraben during the Pleniglacial. However, Delpech (1983:31) considers both of these bovids to have been wide-spread throughout Europe regardless of climate. In her faunal-climate associations, she assigns both an intermediate place between cold and temperate animals .

Spiess (1979:278-279) suggests a large bovid (either *Bos* or *Bison*) could range in weight from 500 to 1400 kg, of which 55% would be edible meat and 5% fat (during the winter months). He notes that a kill of an adult aurochs "was equivalent to about 15 caribou or 4 horses in terms of food quantity." Given this comparison, we could conclude that the lone bovid of Grubgraben, though a young animal, would have rivaled the meat and fat contribution of most of the reindeer and horses represented in the faunal assemblage. However, I do not think we can suggest on the basis of a single animal that *Bos* served as a reliable food source. Although it would have contributed a substantial amount of edible meat, the single kill should be regarded as fortuitous when compared to the number of other ungulates represented at the site. No doubt the hunters of Grubgraben were loath to pass up a large bovid when the opportunity for taking one arose.

Grubgraben and Willendorf: A Comparison

Thenius' (1956) analysis of the faunal assemblage from Willendorf II provides the basis for comparison to the earlier Gravettian occupation of that site. Thenius' analysis focuses on selected diagnostic elements and counts of these should not be adopted as a comparable index of relative abundance to the NISP from Grubgraben. However, he does provide MNI counts for all taxa from each of the nine levels at the site. Comparison of that information with the same index of Grubgraben fauna reveals a distinct contrast in the variety of animals obtained by the occupants of the two sites. Fourteen taxa were recorded at Willendorf II, a diversity best represented in Levels 8 and 9, the latest occupations (TableVI-9). Willendorf II is located on the Donau River about 30 air km from Grubgraben and 38 river km above its confluence with the Kamp. Unlike Grubgraben, which is strategically nestled between two small hills within view of the broad plain of the lower Kamptal, Willendorf is situated in the Wachau, a region of greater relief, and is separated from the Donau by a narrow strip of floodplain. This contrast may have contributed to the differences in faunal diversity that characterize the assemblages from the two sites. It may explain the greater frequency of ibex remains at Willendorf since those animals would have been found in greater numbers in the rugged terrain of the Wachau.

Table VI-9. Minimum Number of Individuals of Taxa from Willendorf II.*

	Level								
Taxon	1	2	3	4	5	6	7	8	9
Aquila chrysaetus	-	-	-	-	-	-	-	-	1
Lepus sp.	-	-	-	-	1	-	-	1	-
Canis lupus	-	1	-	-	1	1	1	1	2
Vulpes vulpes	-	-	-	1?	1	-	1	1	9
Alopex lagopus	-	-	-	1	-	-	-	-	25
Gulo gulo	-	-	-	-	-	-	-	-	1
Ursus cf. *arctos*	-	-	-	-	1	1	1	-	1
Panthera spelaea	-	-	-	-	1	1	-	1	1
Lynx lynx	-	-	1	-	-	-	-	-	-
Cervus elaphus	1	1	1	-	1	-	-	1	2
Rangifer sp.	1	-	1	2	2	1	1	1	2
Capra ibex prisca	1	1	-	2	5	1	-	3	4
Ovicaprine indet.	-	1	-	-	1	-	-	-	1
Bison priscus	-	-	-	1	-	-	1?	-	1-2
Equus sp.	-	-	-	-	-	-	2	1	-
Mammonteus (sic) *primigenius*	-	-	-	-	1	-	1	1	1

*From Thenius 1956 : 166.

Much of the variety at Willendorf is accounted for by carnivores, including wolf *(Canis lupus)*, red fox *(Vulpes vulpes)*, arctic fox *(Alopex lagopus)*, wolverine *(Gulo gulo)*, bear (*Ursus* cf. *arctos*), cave lion *(Panthera spelaea)*, and lynx *(Lynx lynx)*. Only one of these animals, arctic fox, is definitely present at Grubgraben (the presence of wolverine must await recovery of more diagnostic remains). The contrast between the sites in this respect may stem from either or both of two factors: 1) more wide-ranging procurement of these animals for their pelage by the inhabitants of Willendorf than those of Grubgraben, 2) a greater degree of post-depositional disturbance of midden debris by carnivores with attendant natural inclusion of some through non-cultural causes. Given the regularity with which these forms are present throughout the levels at Willendorf and the notably high frequency of both species of fox in the last level, the first of these factors must account for the bulk of the carnivore remains. Though admittedly speculative, we may attribute the difference in what can be considered the pursuit of luxury items (i.e., a large quantity and variety of pelts) to the fact that the inhabitants of the harsh climate of the Epigravettian had to invest more time in economic practices that guaranteed survival as compared to those that enhanced status. Alternatively, if harder to demonstrate given the broad tolerances of all of these steppic carnivores, the contrast might reflect the effect of climatic changes on the relative abundance of these animals and the consequent ease with which they could have been obtained.

The presence of large bovids in several levels at Willendorf indicates the inhabitants of that site were, like those of Grubgraben, eclectic hunters who took such animals when possible. However, as at the latter site, smaller ungulates served as the staples. In contrast to Grubgraben, equids did not play a major role at Willendorf and only entered the diet during the later occupations of that site. This indicates a shift in subsistence practices that was to become more prevalent during Epigravettian and Magdalenian times.

It is unlikely that a contrast in local habitat underlies the regular appearance of an animal such as red deer *(Cervus elaphus)* at Willendorf and its conspicuous absence from Grubgraben. There is no reason why red deer should not be present at the latter if the environmental contrast between the two sites had been due solely to differences in local terrain. These animals are described as browsers whose preferred habitats were woodland and forests (Kurtén 1968:163). Wapiti, the present North American form considered by many to be conspecific with *Cervus elaphus* (Kurtén and Anderson 1980:317-318) , are also known to range open meadows for grasses (Murie 1951). Given these habits, we can assume that red deer could have been hunted in the "islands of woodland" that dotted the subarctic landscape inferred for Willendorf II (Thenius 1956:165) or on the broad plain of the lower Kamptal during the Epigravettian if the climatic conditions of the earlier Gravettian period maintained during that time as well. We know from geomorphic and malacological evidence, however, that this was not the case (see Haessarts, herein). In all likelihood, absence of red deer from Grubgraben is attributable to the more severe climate that prevailed in the Donau basin following the last occupation of Willendorf some 24,000 years ago and during the occupation of Grubgraben 18,900 to 18,300 years ago. This interpretation is supported by the fact that this animal, like the present wapiti, was better adapted to temperate than cold climates (Delpech 1983:31, cf. Kurtén 1968).

The fauna from Grubgraben mark a shift to a greater reliance on reindeer and horse, in effect a narrowing of the subsistence economy to fewer species with consequent increased specialization in hunting practices during the Epigravettian phase. This trend, an adaptation to pleniglacial conditions, was to climax in the focal economy of the Magdalenian hunters represented at the site of Kamegg in the Kamptal, about 16 air km north of Grubgraben. Faunal remains from Kamegg were identified by Brandtner (1965:67-68) as horse (59 elements), reindeer (nine elements), bison (two elements), rhinoceros (one element), rabbit (22 elements), and arctic fox (two elements). The narrow range of diversity at this site is comparable to that of Grubgraben but the NISP suggests an even greater intensification of horse hunting. With regard to subsistence specialization, Grubgraben occupies an intermediate place between Willendorf and Kamegg and the cultural adaptations of the periods they represent (cf. Montet-White, 1987).

Seasonality of Site Occupation

Faunal indicators of seasonality at Grubgraben are precious few. At the present time I have identified three mandible fragments that indicate the site could have been occupied during the winter months. Unfortunately two of these fragments (FigureVI-2) lack the telltale permanent molars that might have provided such an interpretation more convincing support. These specimens, IA-196 and IA2-460a, are anterior portions of left and right mandibles respectively from an animal(s) that still retained its deciduous molars at the time of death. These molars have high relief wear patterns suggesting this event occurred sometime during the animal's (assuming a single individual is represented) first through seventh months of life. This would place the time of site occupation sometime between mid-June to mid-December. Of course, this interpretation assumes the kill was not cached elsewhere and then transported to the site for processing and consumption at a later date.

The best indicator of seasonality is specimen IF1-1243, a left mandible with deciduous second and third molars, the first permanent molar and an unerupted second permanent molar (Figure VI-7). According to Spiess (1979:77), "since LM1 can become permanent as early as 3-4 months, and LM2 can be absent as late as 13 months, the presence of LM1 and absence of LM2 (not yet piercing the bone) indicates death in this 10 month span, or September through June, *but most likely indicates death in the animal's first winter*" (emphasis mine). When this specimen is compared to the other two, the wear patterns on the third deciduous molars are comparable. The anterior cusp of the first permanent molar on IF1-1243 exhibits slight lingual-buccal wear (the posterior cusp is damaged) and that of the same tooth on IA-196 bears but very little wear on the lingual side only. The slight degree of difference between them suggests they were nearly contemporaneous kills and strengthens the case for the winter death of the latter specimen .

Additional evidence of a winter occupation of the structure(s) at Grubgraben is provided by analysis of the relative proportions of post-cranial elements associated with it (Tables IV-2-3). Those elements predominant in the assemblage are precisely those associated with the least amount of usable meat. To demonstrate this I have adopted the General Utility Index (GUI), a measure of the food utility of elements devised by Binford (1978:73) based on his observations of Nunamuit treatment of caribou *(R. tarandus)* (see Table VI-10). Axial remains, to which Binford assigns higher GUI as compared to apendicular elements, compose but 20% (98 of 487 identified bones) of the post-cranial fragments for the three major taxa. This figure for reindeer is comparable (18.8%; 73 of 388 bones) . Among the apendicular remains, elements assigned the highest GUI, such as the humerus and femur, are the most poorly represented and lower limb bones with considerably lower GUI are markedly more abundant. The ratio of upper to lower limb bones among the reindeer remains (33 to 189, or 17.5) can be taken as a measure of the contrast. This ratio would be even higher if carpals, tarsals, and phalanges were included in these figures. While it is true the phalanges, astragali and calcanei from Grubgraben were generally splintered for marrow, I consider these bones fortuitous associations of lower limb elements selected for marrow extraction. The high ratio of low GUI elements and the extreme fragmentation of these remains related to marrow extraction suggests the inhabitants of the structure were forced to rely on food sources not necessary during warmer months of the year.

Table VI-10. General Utility Indexes* of Reindeer Bone and Number of Corresponding Parts from Grubgraben.

Anatomical Part	GUI	NISP
Skull (inc. maxilla)	17.49	5
Mandible	13.89	83
Atlas	23.56	1
Axis	29.64	-
Cervical vertebrae	35.71	3
Thoracic vertebrae	45.53	4
Lumbar vertebrae	32.05	2
Pelvis	47.89	10
Ribs	49.77	28
Scapula	43.47	23
Proximal humerus	30.23	-
Distal humerus	29.58	6
Humerus shaft fragments		12
Proximal Radius/Ulna	16.77	5
Distal Radius/Ulna	17.82	4
Radius/Ulna shaft frags.		47
Carpals	5.51	3
Proximal metacarpal	8.24	5
Distal metacarpal	8.83	7
Metacarpal shaft frags.		10
Proximal femur	98.32	-
Distal femur	100.00	-
Femur shaft fragments		15
Proximal tibia	27.57	-
Distal tibia	29.46	4
Tibia shaft fragments		39
Tarsals	11.20	10
Astragalus	11.23	4
Calcaneus	12.40	7
Proximal metatarsal	15.03	8
Distal metatarsal	16.24	5-6
Metatarsal shaft frags.		67
Unident. metapodial		7
First phalange	3.52	12
Second phalange	3.03	3
Third phalange	1.85	1
Unident. phalange		3

* From Binford 1978 : 73

Fragility of all recovered teeth precluded application of tooth-sectioning methods in order to observe seasonal dental annuli (e.g., Spiess, 1976). Additional support for seasonal interpretation could not be derived from other indicators, such as fetal long bones or antlers still attached to crania. Absence of such finds should not be relied upon for determination of seasonality. The lack of fetal bones in particular, given their fragility, could be attributed as easily to the extensive erosion of faunal remains at the site as to evidence of occupation between the time of calving in mid-May to mid-June and the time of rut in mid-October.

While an interpretation of a winter encampment is supported by the evidence presented above, this certainly does not preclude a more prolonged occupation of the site. Indeed, the presence of the substantial structure(s) represented by the stone pavement(s) argues for more than a brief stay. An assemblage enhanced by further excavation of the site might provide evidence of occupation during other seasons as well.

Butchering Practices

In the context of butchering practices, it is worth noting an intriguing similarity between the Late Prehistoric-Historic site of Lake Tukuto, Alaska and Grubgraben with respect to the common dependence of their inhabitants on reindeer. At Lake Tukuto it was possible to discern both the living floors of 123 houses and numerous extramural middens containing an abundance of reindeer remains. Spiess (1979:155-158) suggests primary dismemberment of the animals occurred during the fall and winter months in the area of the middens. During the fall a higher proportion of mandibles, which contain marrow but are not as rich in this regard as other elements, would have been discarded in those areas rather than being carried into the houses for processing. During the winter months when the need for marrow was greater, there was an increased selection of mandibles. This is reflected by the higher frequency with which mandibles that had been broken open for marrow are encountered within the houses. Spiess (1979:160) also suggests that the hunters of Lake Tukuto may have had a preference during winter months for two year old and three-five year old females, which would have had higher fat content than other reindeer at that time.

In the light of the Lake Tukuto scenario, the greater numbers of animals in the two years old and three-five years old age groups, the winter kills described above, the plethora of broken mandibles associated with the structure at Grubgraben, and the quantities of burned bone recovered during sample water screening acquire a definite pattern. It is suggested, by way of a working hypothesis, that the occupation of the structure did occur during the colder months of the year. I have not been able to distinguish any of the mandibles from Grubgraben on the basis of sex due to their fragmentation and consequently cannot attribute the age-group pattern to the sexual selection apparent at Lake Tukuto. However, the extraction of marrow from mandibles at Grubgraben is reflected by the patterned lack of the basal portion of the horizontal rami of nearly all specimens in the assemblage (Figures VI-2-6, 7). Moreover, the high concentration of broken reindeer, horse, and ibex mandibles and/or teeth in association with the stone pavement was noted throughout the excavation of 1987. It would be fruitful to test this hypothesis with faunal material from extramural features or concentrations at the site in order to see if the Lake Tukuto midden pattern applies to those areas as well.

With regard to patterns of carcass dismemberment, the bones from Grubgraben provide little information. Close inspection of mandible rami and the ends of limb bones revealed few discernible cut marks. A few cervid rib fragments display cut ends. The coracoid process of an *Equus* scapula bears a single cut mark as does a caudal fragment of a *Rangifer* scapula. A fragment from below the lesser trochanter of a right femur, identifiable only as cervid/small bovid, also bears evidence of cutting. The scarcity of such butchering evidence requires some explanation. I would not go so far as to suggest that this indicates the hunters of Grubgraben had scavenged the low GUI elements in the structure from carcasses left by other predators in the vicinity. While such a hypothesis would fit a scenario of a harsh winter encampment, I consider it to be untenable at this time. Signs of carnivore damage on the bones, which might have supported a hypothesis of scavenging, are not evident. I suggest the general scarcity of cut marks reflects the low incidence of certain bones and the erosion of others caused by post-depositional weathering. Proximal and distal ends of limb bones, both upper and lower, and vertebrae are relatively rare in the assemblage (Tables VI-2, 10). This is precisely where one would expect to find the most cut marks (cf. Binford, 1981:105-142). The most common end fragments are distal metapodials (Figure VI-8) but none of these bears any distinct cut marks. It is possible that many of these tell-tale bones were not only smashed for marrow but used for fuel as well. Numerous small pieces of burned bone were noted in association with the structure, particularly in the water screened samples. It is quite possible that much of the evidence of carcass dismemberment literally went up in smoke. Moreover, post-depositional weathering of bones that survived has resulted in the attrition of edges that would have contained cut marks.

The practice of marrow extraction is attested by the abundance of long bone shaft splinters, the most numerous post-cranial remains in the assemblage. Some of these fragments bear impact fractures, which reflect their breakage during this process. The distinctive green-fractured appearance of some distal metapodials (Figure VI-8) also conforms to the pattern created by marrow-bone breakage (cf. Binford, 1981:155). Again, the evidence that these low-GUI elements and mandibles were processed for marrow within the structure (AL 2 and 3) suggests a winter occupation.

Conclusions

Faunal remains from Grubgraben reflect a specialized hunting economy focused on reindeer and horse. Other animals, including ibex and large bovid, perhaps the aurochs, served as secondary food sources. Still others, arctic fox, an unidentified mustelid, and a lagomorph provided raw materials for clothing and/or ornaments. The ivory of woolly mammoth, perhaps encountered fortuituously during other activities, may have provided an industrial or artistic medium. The high proportion of fragmented bones with relatively low index food values in association with the structure at the site suggests a winter encampment. This interpretation is supported by the presence of a small sample of reindeer mandibles from animals that perished during the winter months. This does not preclude the possibility that the site was occupied for longer periods. The low diversity of species contrasts markedly with the variety of animals represented in the faunal assemblage from the Gravettian levels at Willendorf II. While some of this contrast may be attributable to differences in local habitats associated with the two sites it is more likely a reflection of the increasing severity of the Pleniglacial climate that prevailed during the Epigravettian occupation of lower Austria. Human groups adapted to the change in climate by hunting the dominant herd animals of the steppe-tundra more intensively. This trend toward specialization was maintained by Magdalenian hunters during the Late Pleistocene, as demonstrated by the predominance of horse and reindeer in the faunal assemblage from Kamegg .

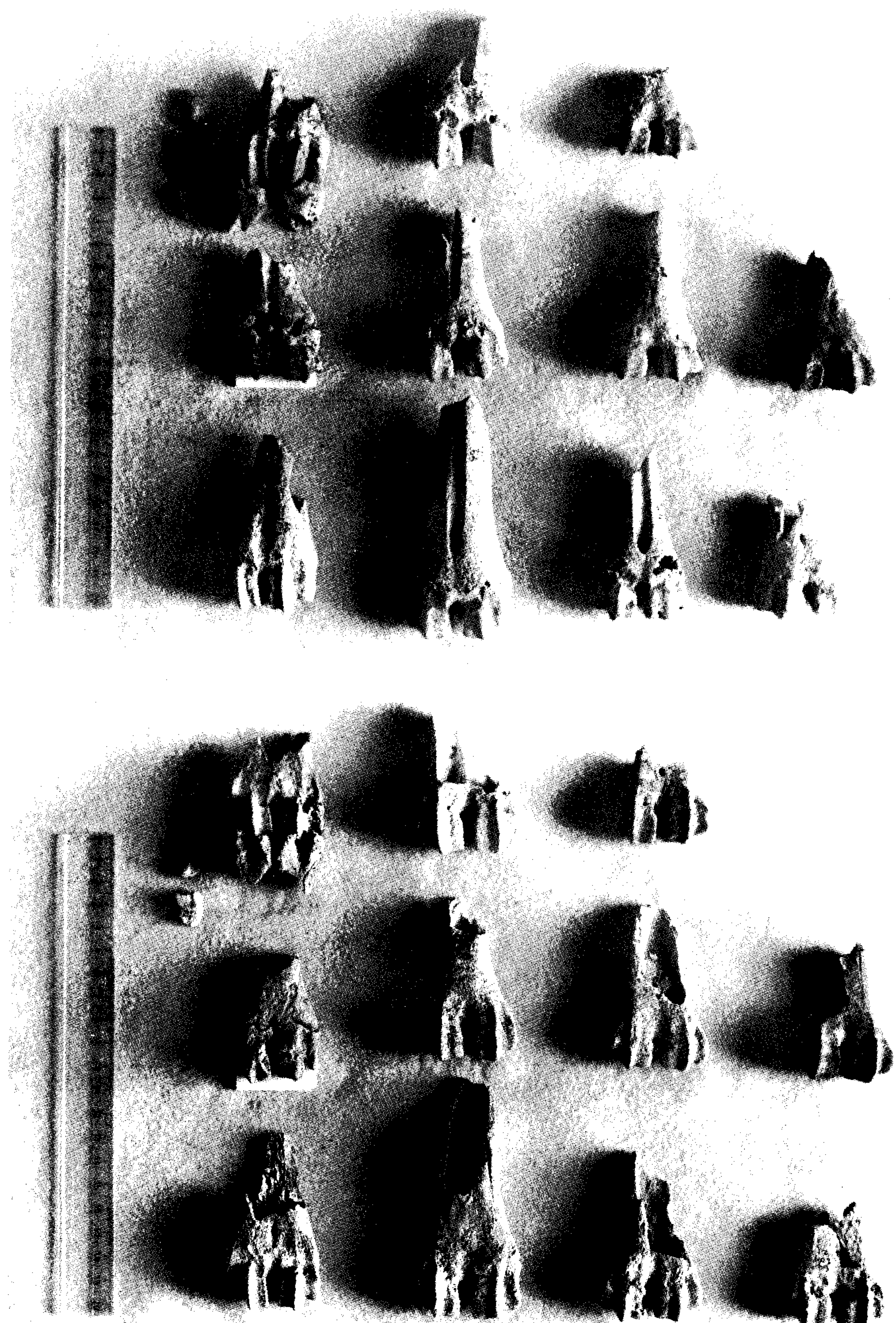


Figure VI-8. Patterned green-bone breakage of distal metapodials of ungulates from Grubgraben : elements in column to left are metatarsals of ibex; those in second column from left and lowest one in second column from right are metatarsals of reindeer; all others are metacarpals of reindeer. Dorsal view in upper photograph and volar view in lower.

VII

THE ORIGIN OF LITHIC RAW MATERIALS

by

MACIEJ PAWLIKOWSKI

The Grubgraben toolmakers made use of a variety of flints and radiolarites which do not exist in the immediate vicinity of the site. Among the materials of local origin were large pieces of sandstone (arkose), gneiss, biotitic gneiss, and quartz which can be found on the edge of the plateau and along the bluff slopes. In addition, cobbles of quartz, quartzite and granulite are relatively abundant among the Kamp River gravels. But there is neither flint, hornstone, chert, nor radiolarite to be found in either primary or secondary deposits within and around the graben. Good knapping materials are scarce in the Wachau as well. The Willendorf assemblages, for example, contain a large proportion of specimens made from imported flints while radiolarite assumed to come from the Danube River gravels and quartzites of local origin completed the inventory (Kozlowski, 1986). The regional survey undertaken in 1987 had for objective a re-evaluation of potential lithic sources within a 50 mile radius of the site. A second and equally important goal was to determine the origin(s) of lithic materials used by Paleolithic toolmakers at Grubgraben. A series of field surveys and laboratory analyses were conducted with these views in mind.

The field survey covered a territory comprised within a 55 mile radius of the site which included a variety of secondary deposits. The cobble beaches of the Danube River were possible sources of good flint-knapping materials within 15 km to 30 km of the site. The Plio-Pleistocene alluvial fans north and south of the Danube River constituted other potential sources of flint and radiolarite cobbles. The nearest occurrence of radiolarites was 70 km to 80 km to the east, in the Wiennerwald where the Mauern radiolarite quarry exploited during the Neolithic is located. The locality was included in the survey.

A variety of lithic sources are known at distances of 80 to 300 km of the site (Fig. VII-1). The nearest among these are outcrops of white flint in the area of Stranska Skala near Brno in Central Moravia which were exploited by late Gravettian groups. Further north are the Saale glacial moraines of the Upper Oder Basin which contain cobbles of northern Baltic flint. The source is known to have been exploited by Gravettian groups: Northern flints were an important component of assemblages not only at Petrjovice which is located near the edge of the glacial moraines, but also at Dolni Vestonice and at Willendorf (Kozlowski, 1988). Radiolarites are abundant to the northeast in the Vah Valley in Slovakia and to the east in Hungary, especially in the areas between Lake Balaton and the bend of the Danube (Biro, 1988).

Samples included in this study were (a) flint and radiolarite specimens collected during the 1987 survey of exposed, chert bearing sediments located in lower Austria as well as (b) archaeological samples from the Epigravettian site of Grubgraben. In addition, previously analyzed samples from more distant outcrops namely Stranska Skala (Czechoslovakia) and Makow in the Upper Oder Basin (Poland) were introduced to complement the study and to test hypotheses concerning the origin and distribution of lithic raw materials during the Epigravettian.

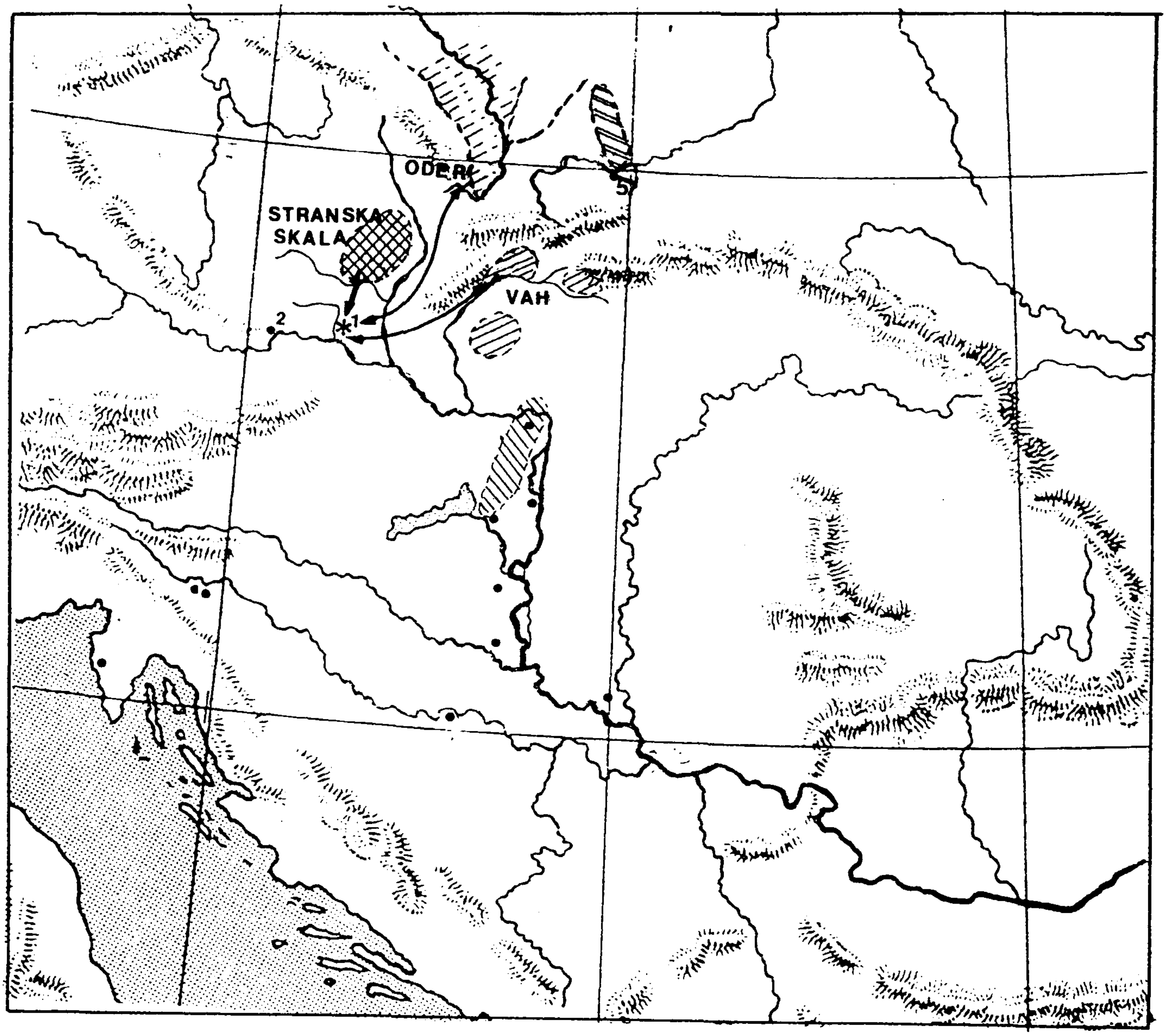


Fig. VII-1 Map of flint and radiolarite outcrops in the northwest region of Central Europe (after Koslowski, 1986).

LITHIC RAW MATERIAL SOURCES IN LOWER AUSTRIA

The 1987 survey covered areas situated within 50 miles of the site including first the Wachau, a section of the Danube Valley west of Grubgraben, second, the alluvial fans in the area of Hollabrun to the northeast, and last, the limestone hills of the Wienerwald to the southeast (Fig. V-2). The list of localities from which samples of flint and/or radiolarite were obtained, together with the abbreviations used in this section is as follows:

Late Pleistocene and Holocene Danube gravels:
1 - Willendorf, Wi,
2 - Grimsing, Gr,
3 - Barcharnsdorf, Ba,

Pleistocene Traisen River gravels:
4 - Traisen, Tr, Pre-Glacial alluvial fan gravels (Plio-Pleistocene):
5 - Hart-Kleinsdorf, Ha,
6 & 7 - Hollabrun, Ho,
8 - Oberthem,Ob,
9 - Gneixendorf, Gn,
10 - Stratzing, St, Miocene-Burdigalien Diatomites ?
11 - Parisdorf, Pa

Cretaceous limestones:
12 - Weidlingbach, We,
13 - Steinriegel,Ste,
14 - Mauer, Ma.

(a) Holocene Danube River gravels:

Since the course of the Danube River has been regulated, gravel beds are no longer accessible. However, it was possible to examine at several points along the Wachau piles of gravels that were being dredged out of the river by machinery.

The petrographic composition of the Danube gravels is relatively varied. Quartz and various types of magmatic and metamorphic rocks form the predominant elements. However, flint and radiolarite pebbles constitute a small percentage, estimated at less than 1% of the remaining rock types, which is to say that they are few and hard to find. Flint and radiolarite pebbles are usually cracked and covered with a weathered outer layer (water worn cortex). The petrographic composition of the Danube gravels along the Melk to Krems road, on the east bank of the river is largely similar to that of gravels found on the west bank between Spitz and Willendorf.

(b) The Traisen gravels :

The Traisen gravels contain predominantly fragments of metamorphic rocks and quartz. Limestone, radiolarite and flint pebbles are also present but they represent only a very small proportion of the gravels. The degree of roundness of the pebbles indicates long distance transport of the rock fragments.

(c) The cone deposits:

1. Alluvial cones in the area of Hart-Kliensdorf contain sandy sediments consisting primarily of quartz fragments and occasional radiolarite pebbles. The thickness of the deposits is not known but is estimated to exceed 30m. Radiolarite pebbles that occur in the Harlt-Kilensdorf sands are very rare and heavily weathered.

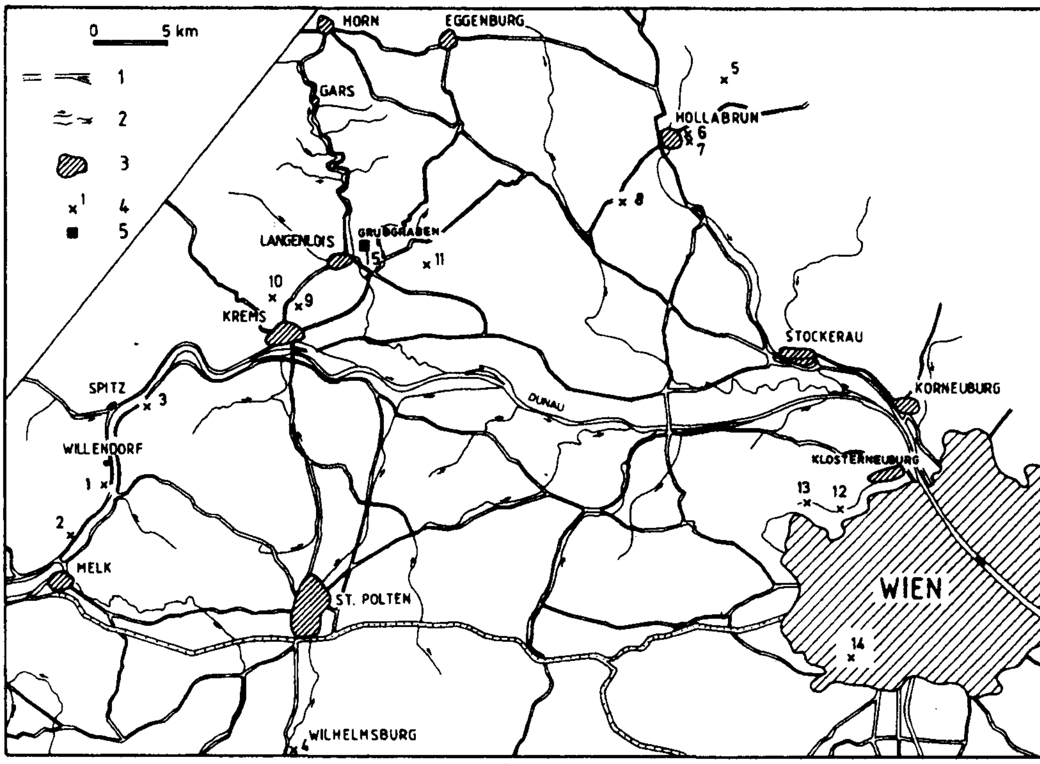


Fig. VII-2 Map of the survey area : 1, roads; 2, rivers; 3, towns and cities; 4, surveyed localities; 5, Grubgraben.

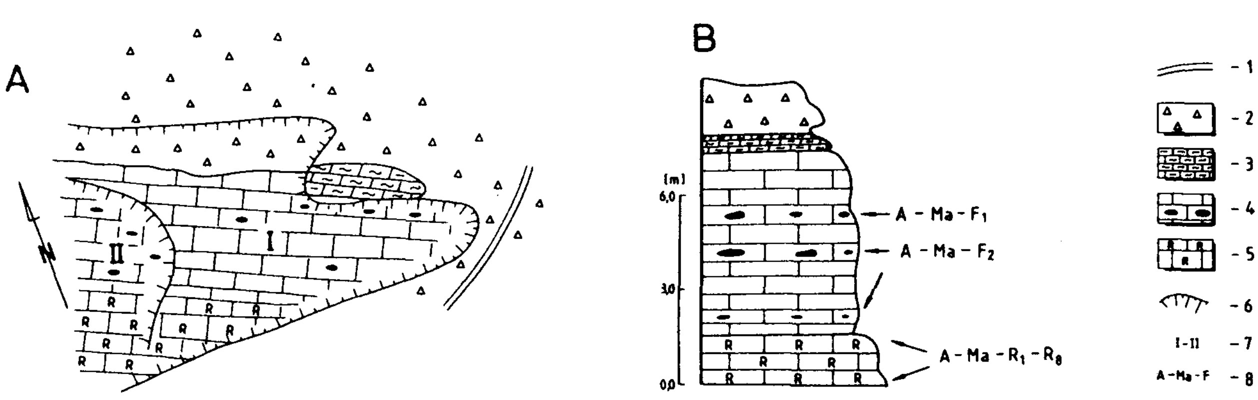


Fig. VII-3 Profile of the Mauern Quarry; A, geological map; B, profile. 1, road; 2 Holocene sediments containing Neolithic artifacts; 3, red clays; 4, limestones; 5, radiolarites; 6, slopes; 7, quarry levels; 8, samples locations.

2. Two sandpits identified in the area east and southeast of Hollabrun contain lenses of fine-grained gravels. At these localities, pebble diameter ranges between 2 and 3cm. Among the pebbles are occasional pieces of green radiolarite and greyish flint. The exposures within the sandpits were over 200 m long. Yet when the site was examined only one flint and four radiolarite pebbles were recovered. Both types were found to be very poor flaking material.

3. A large gravel pit with a 50m long exposure is located in a wooded area, about 5 km southeast of Hollabrun, near the village of Oberthen. The Oberthen gravels are characterized by variable grain size and uniform petrographic composition. The main component is quartz. Pieces of magmatic rock, and gneiss occur sporadically. The gravels have a typical fluvio-glacial structure. They are covered by a mantle of loess of varying thickness.

4. About 500 m east of the village of Gneixendorf is a large abandoned gravel pit. Gravels at the Gneixendorf pit include some large pebbles, measuring as much as 20cm in diameter, among which are rare pieces of red radiolarite. Some of the radiolarite pebbles show numerous veins of second generation calcite or quartz. The pebble surface is rough or glossy.

5. Another quarry is located outside of Stratzing, a short distance from Grubgraben. Here, gravels include fine and medium sized particles. The dominant material is quartz. A single flint pebble and a small quantity of red radiolarite pieces were recovered at the site.

In summary, the 1987 field party was able to examine and sample several outcrops of alluvial fan gravels. Differences between the various exposures appear to be minor. Flints are scarce or absent, radiolarites are rare, small to medium in size and, in the Danube gravels especially, cracked and weathered. Still, the quantity of radiolarite pebbles decreases notably from south to north. The exposures located farther north of the Danube contain smaller number of radiolarite pieces than the one located to the south. This observation confirms the view that radiolarite and flints occurring in the Danube alluvia as well as those occurring in the Plio-Pleistocene alluvial deposits were transported from the south (Alpine piedmont) rather than from the north (Carpathians). Further research to identify the origins of these materials should focus on areas located south of the river.

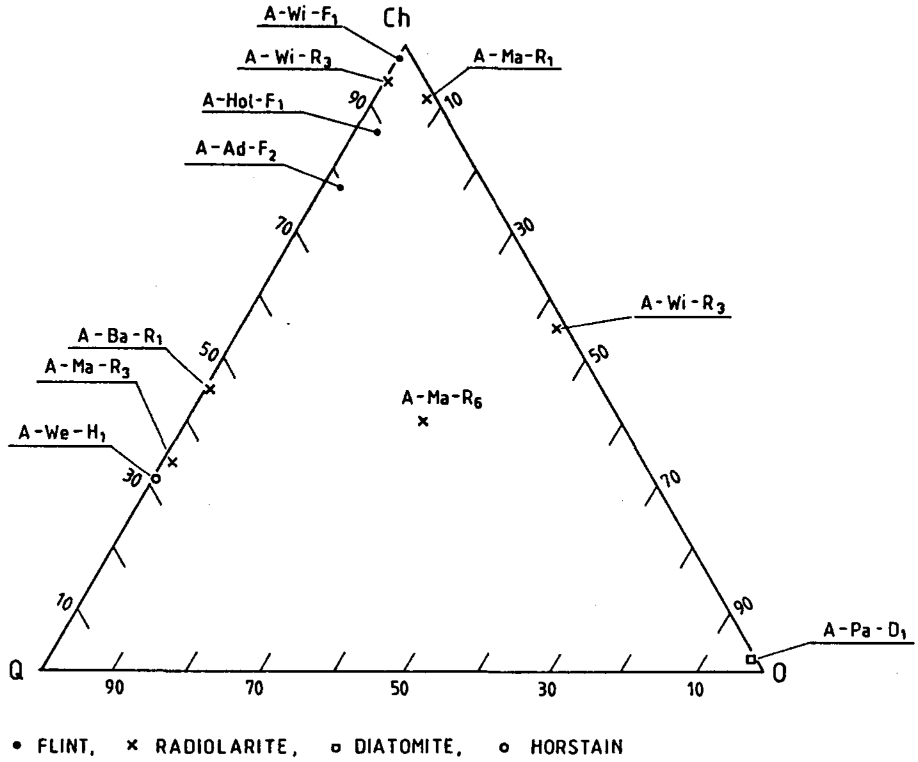
(d) Burdigalian (Miocene) diatomites

Outcrops of diatomites were found to occur in the township of Parisdorf. In a small quarry we were able to identify several petrographical types including a dark olive variety characterized by a compact structure and fairly good cleavage. Although this particular variety of raw material was not recovered at Grubgraben it could have been used for toolmaking.

(e) Cretaceous limestone

Deposits of mixed (sandstone-shale-limestone) petrographic composition were recorded at two places along the bed of the Weidling River which originates from the limestone hills of the Wienerwald and flows in a southwest to northeast direction 2km east of the Vienna city limits. The first locality was near Weidlingbach and the other near Steinrigel. In addition to materials typical of flysch, the Weilding river gravels contained only two fragments of red cretaceous radiolarite. Pieces of hornstone were noted among the sandstone and mudstone pebbles. The hornstone were greyish in color and had differing technological properties. Cracked specimens, intersected by numerous epigenic calcite veins, were predominant.

OUTCROPS



GRUBGRABEN

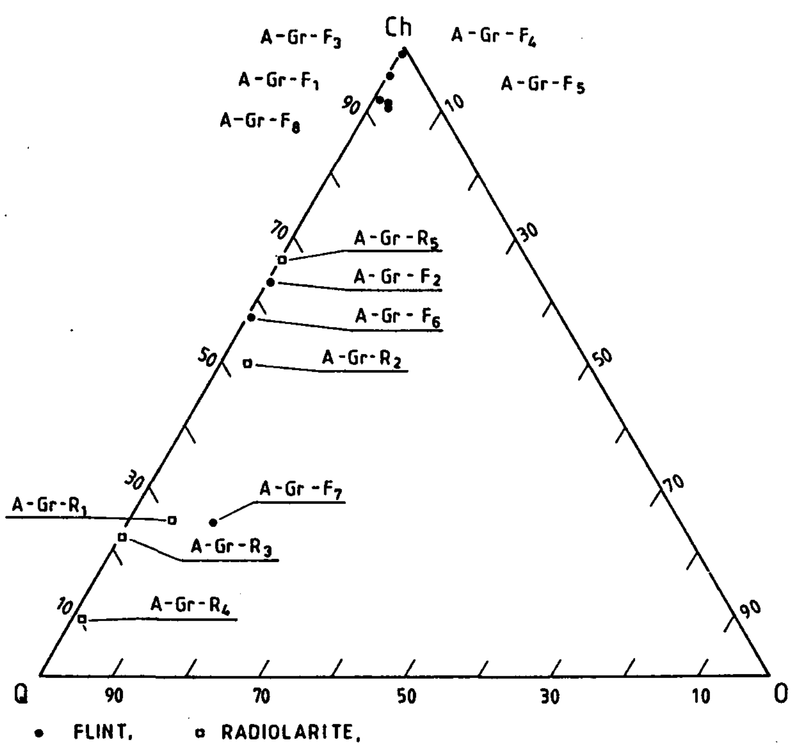


Fig. VII-4 Diagrams of mineral composition, top, survey samples, bottom, Grubgraben samples. Ch, chalcedony, O, opal, Q, quartz. Dots designate flint samples, x radiolarites, square diatomites, and circles hornstones.

The Mauern Hill is a park situated in a western district of Vienna. A small abandoned quarry is preserved inside the park. Radiolarites and limestones with flint and shales are visible on the exposed face of the quarry (Fig. VII-3). The deposits were strongly disturbed by tectonic activities. Neolithic workshops were found in sediments which lay unconformably at the top of the chert bearing deposits. The lithic artifacts they contained were all of local radiolarite. The site is generally regarded as a quarry.

SAMPLES FROM NATURAL OUTCROPS

The macroscopic characteristics of samples collected from natural outcrops in the course of the field survey are summarized in Tables VII-1 and VII-2. Variables entering in the sample descriptions include: color, presence or absence of inclusions, luster, transparency, cleavage, fracture and estimated frequency of occurrence in the deposits. Samples which exhibited good technological properties (identified by an x in the tables) were selected for subsequent detailed minerological and petrographical observations,

Samples were labelled as follows: A-W1-F1 where the first letter indicates the country of origin, A stands for Austria; the second set of letters indicates the locality of origin, Wi stands for Willendorf; the third letter indicates the type of raw material, F stands for flint, R for radiolarite, H for hornstone, D for diatomite, A for Agate. The number following the material type identifier is arbitrarily assigned to designate a variety of raw materials found at that site.

Altogether 11 samples were selected for mineralogical and petrographical analyses , i.e.: one radiolarite and two flint samples from Willendorf, A-Wi-F1, A-Wi-F2, A-Wi-R3; one radiolarite sample from Sarcharnsdorf, A-Ba-R1, one flint sample from Hollabrun A -Ho-F1, one radiolarite from Parisdorf, A-Pa-R; one hornstone from A-We-H1; and three radiolarite samples from the Mauern Quarry, A-Ma-R1 , A-Ma-R3, A-Ma-R6. Results of the mineral composition analysis are shown in Table VII-3. During the analysis, particular attention was paid to the proportion of opal, quartz and chalcedony, the latter in the form of very fine, crystalline quartz with grains smaller than 0.005 mm. Variations in the relative proportion of the three mineral components are displayed in figure VII-4. The samples form 2 clusters. One characterized by very high percentage of quartz includes 3 flint samples from Willendorf, Hollabrun and a radiolarite from Willendorf (Wi-R3). The second cluster characterized by higher percentages of chalcedony includes a hornstone sample from Weidlingbach and radiolarites from Mauer (Ma-R3) and Barcharnsdolrf. The diatomite and 2 radiolarite samples (Ma-R2 and Wi-R3) which contain higher percentage of opal fall outside of the two clusters. The distribution of flint and radiolarite samples overlaps, however radiolarite samples exhibit a much greater degree of variability in the proportion of mineral components than the flint samples.

In addition to quartz, chalcedony, and opal some of the samples contained carbonate minerals which are in relatively high percentage in the hornstone sample from Weidlingbach and one of the radiolarite from Mauern (Ma-R1); traces of opaque minerals (pyrite and iron oxides) were recovered in all samples; traces of mica, almost exclusively muscovite, were noted in two samples of radiolarite (Ba-R1 and Ma-R3). Anhydrite was identified in one sample of radiolarite (Ba-R1) and one sample of hornstone (We-H1).

Microscopic analyses were used to verify macroscopic observations. A series of polaroid photographs provide an illustration of the particular structure of each sample. The radiolariae filled with fine crystalline quartz of samples Ma-R3 and the pseudomorphs of sample MA-RG are clearly visible (Fig. VII-13).

Flint samples are fine-grained, with 75 to 95% of grains under 5 microns. With one exception (Ma-R1), the radiolarite samples contain much greater percentage of grains between 5 and 10 microns.

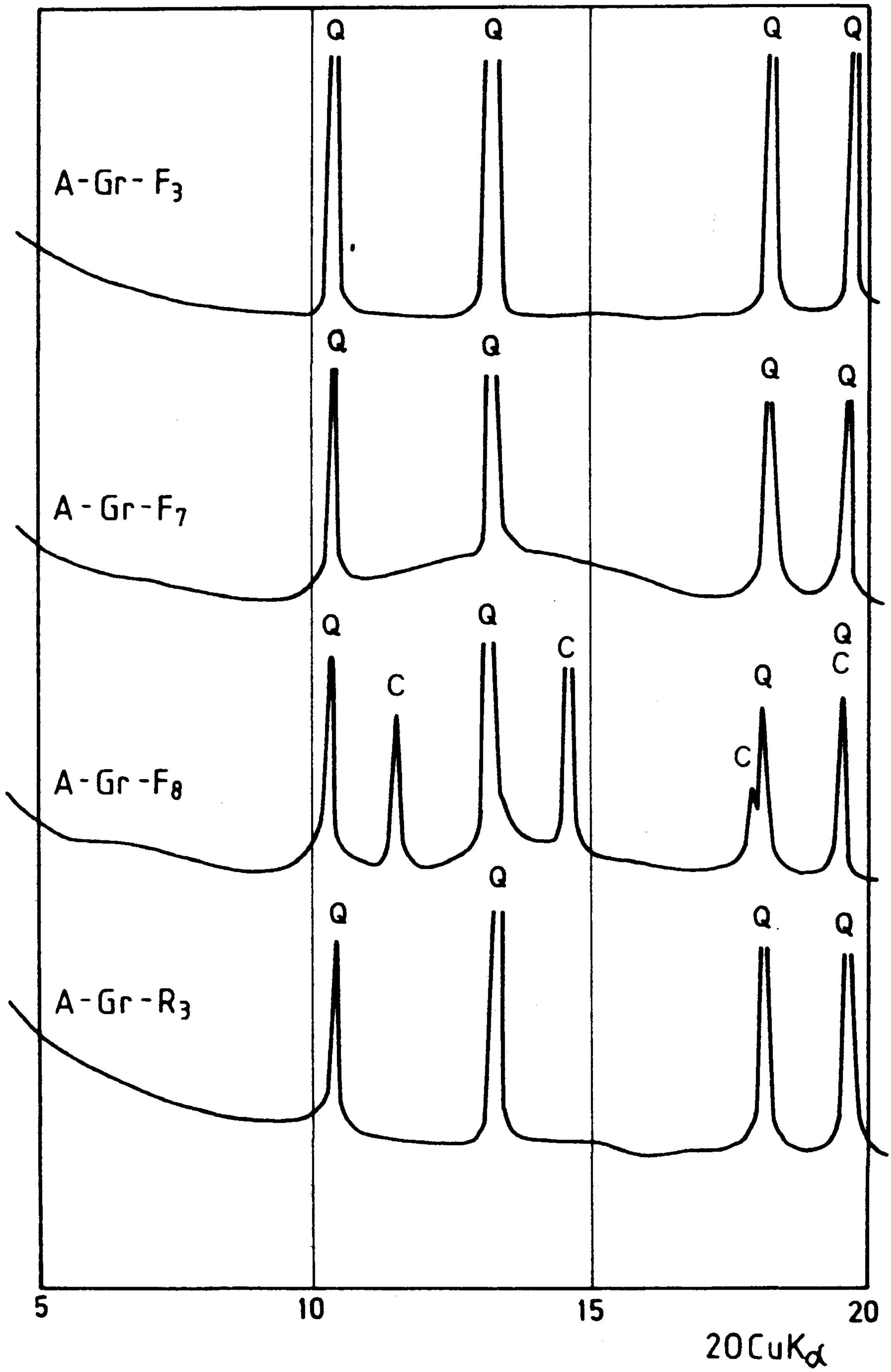


Fig. VII-5 Xray diffraction patterns of selected samples.

FLINT AND RADIOLARITE SAMPLES FROM GRUBGRABEN

Raw materials introduced by Epigravettian tool makers at the site of Grubgraben are marked by their variability. Eight varieties of flint, 5 varieties of radiolarites, and one example of agate were identified in 1987. All samples appear to have good cleavage. And there are very few pieces of cracked material.

Flints range in color from whitish (F4), to light grey (FS, F7) or grey (F6), and yellowish brown (F3) to greyish brown (F2, F1).

F2 and F8 are transparent while other varieties tend to be opaque. A heavy white patina affects F1 and F2 and spots of grey-white patina occur on F4 specimens. The presence of patina is viewed as an important descriptor of raw materials (Pawlikowski, 1989). It is formed as a result of complex chemical and mechanical processes taking place in the outer zone of fine crystal flints. Fully crystallized flint and radiolarite do not become patined.

Radiolarites are a dark reddish brown (R1), light reddish brown with occasional spots (R2), light green (R4), dark grey (R5) or marked by green and red bands (R3).

Table VII-6 summarizes data obtained from microscopic analyses; the relative frequencies of minerals are given in Table VII-7; and information concerning grain size distribution is in Table VII-8 and Figure VII-6. Series of Xray analyses were performed in the range of 0 to 20 - CuK in order to supplement microscopic studies (Fig. VII-5). Four samples were selected for Xray analysis: A-Gr-F3, A-Gr-F4, A-Gr-F8, and A-Gr-R3.

Sample A-Gr-F3

The Xray analysis established that the single component of the flint sample is quartz of the order of dhkl =4.26, 3.34, 2.46 and 2.29 A.

Sample A-Gr-F7

The diffractogram of this sample showed quartz reflections exclusively with the same dhkl values as sample A-Gr-F3. The diffractogram base was increased in the range of 10 to 17 -CuK. This confirms the presence of inclusions of a substance with weakly ordered atomic structure, in this case opal.

Sample A-Gr-F8

Xray diffraction has established that quartz is accompanied by calcite with values of dhkl = 3.85, 3.03, 2.49 A.

Sample A-Gr-R3

The diffractogram of this sample shows that the single component of the radiolarite sample is quartz.

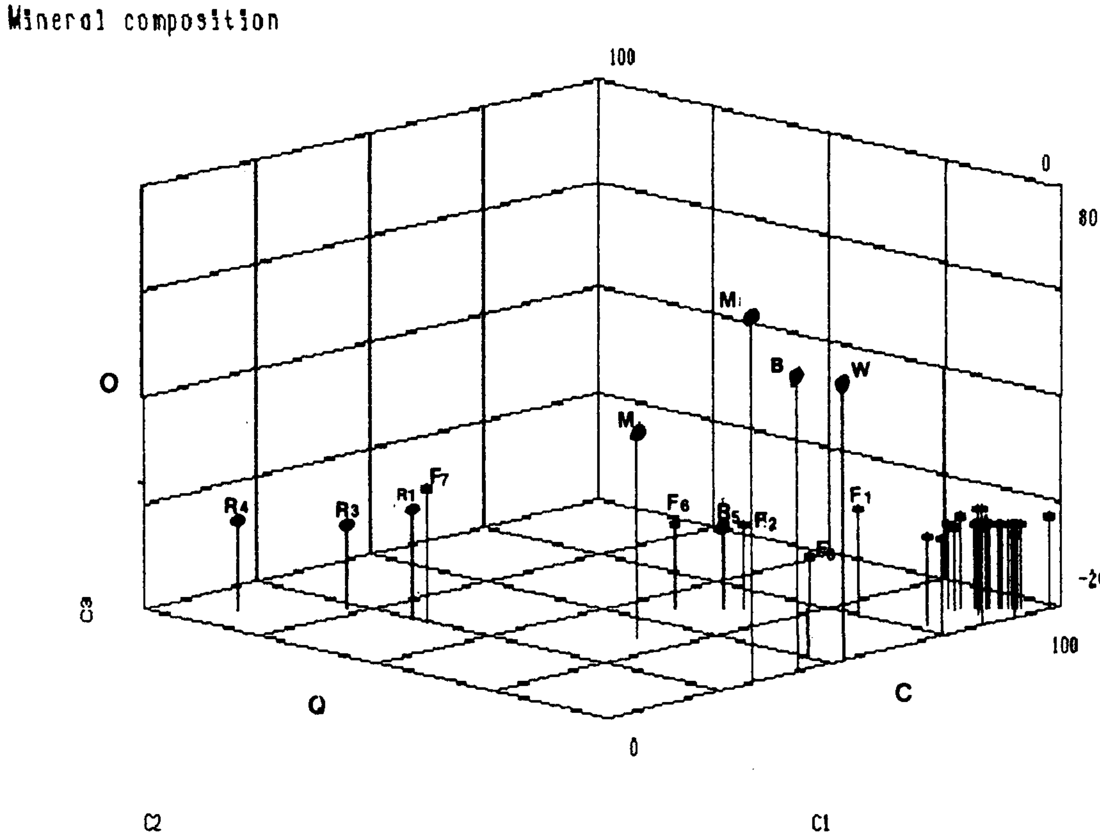


Fig. VII-6 Three dimensional diagram of mineral composition illustrating sample clusters.

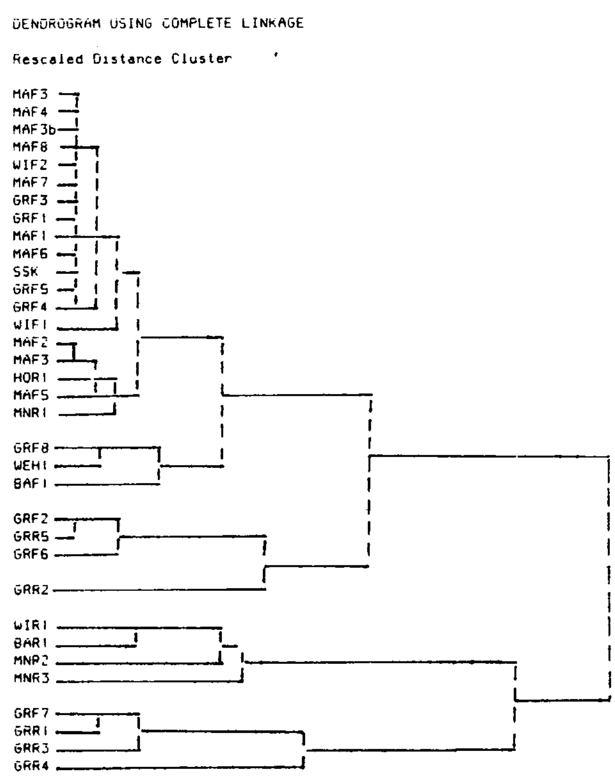


Fig. VII-7 Dendrogram derived from cluster analysis of distance matrix.

DISCUSSION

1- Flint samples:

The complex nature of the data set which includes discrete attributes and quantitative attributes presented in the form of percentages precluded the use of parametric statistics. The first step was to evaluate global similarities by counting the number of shared traits between sample pairs. All quantitative data were collapsed into discrete variable categories. The highest degree of similarities was noted between (a) samples of Northern flint from the Makow site in Upper Silesia and the Grubgraben flint categories F1 (43 % shared traits) and F2 (37%) and (b) sample of Stranska Skala flint with F5 (37% shared traits). The low proportion of shared traits between Grubgraben flints and radiolarite samples and samples from lower Austria made it very unlikely that Grubgraben materials were procured from surveyed sources in Lower Austria.

A second set of comparative analyses was done at the University of Kansas:

(a) When macroscopic attributes alone are considered, the grey, transparent, patined flint F2 shows a great deal of similarity to samples of Northern flint from Makow. The whitish-grey, opaque varieties F3, F4, F5 appear closely related to a sample from Stranska Skala. The green radiolarite has no direct equivalent but varieties of brown radiolarites are difficult to separate on the basis of macroscopic characteristics alone.

(b) A plot of the three major mineral components, chalcedony, quartz and opal (Fig. VII-6) shows a homogeneous cluster characterized by a high percentage of chalcedony which includes all of the northern flint samples, the Stranska Skala sample and the white and grey flints from Grubgraben. Grubgraben flint samples F2, F6, F7 and F8 fall outside the cluster. Furthermore, radiolarite samples from Mauern and from the Danube gravels fall well outside of the range of the Grubgraben radiolarite samples.

(c) A distance matrix was calculated from all quantitative attributes (mineral content, grain size and elements) using Euclidian distance and a dendrogram was obtained using SPSS complete linkage clustering method. The results are comparable to the ones obtained from the plot of mineral content (Fig. VII-7). Samples F1, F3, F4 and F5 fall within the range of the Makow/ Stranska Skala cluster. F8 is rejected although it shows similarity to the hornstone sample WeH1. F2 and F6 appear relatively close in terms of their mineral content even though they differ markedly in their macroscopic characteristics. On the basis of mineral content and grain size composition, F2 is separated from the main cluster in spite of its macroscopic similarities with northern flint samples.

In summary, flint categories F3, F4, F5 are close to the Stranska Skala sample both in terms of macroscopic characters and in their mineral composition. Therefore it can be said that the hypothesis of a Moravian origin of these materials is largely verified. At the present time a Upper Silesian origin for F2 remains probable because of similarities in color, transparency and patina. Furthermore flints of that type are not known anywhere else in Central Europe. The source of some of the flint varieties (F6, F7 and F8) remains unknown.

Radiolarites exhibit a great deal of variability in color texture and mineral composition. Their mineral composition overlaps that of flints although a greater degree of variability can be observed among samples studied here. The Grubgraben samples exhibit a very low degree of similarity with Mauern samples. Their origin must be sought elsewhere. The Danube gravels may have been the source of some of the reddish-brown specimens found at Grubgraben. Grubgraben samples show some macroscopic similarities to radiolarites from the Vah Basin, in texture, color and in the presence of fine linear intercalations. Although it remains to be examined and substantiated by mineralogical analysis, the hypothesis that some of the Grubgraben radiolarites originated from the Vah Basin may be considered probable.

TABLE VII -1
Characteristics of raw material samples
from naturals outcrops

Sample	color inclusions	luster transparency	cleavage fracture	frequency of occurence
1 A-Wi-F_1	black	mat	very good	0.1%
	-	-	conchoidal	
1 A-Wi-F_2	beige	mat	very good	0.1%
	-	-	conchoidal	
1 A-Wi-F_3	light brown	mat	medium	0.1%
	white spots	-	rough	
1 A-Wi-F_4	light brown	satin	bad	0.1%
	-	-	rough	
1 A-Wi-R_1	reddish-brown	mat	bad	0.1%
	white veins	medium	rough	
1 A-Wi-R_2	olive	satin	very good	0.1%
	-	-	conchoidal	
2 A-Gr-R_1	red	mat	medium	0.1%
	veins	-	smooth	
2 A-Gr-R_2	green-grey	mat	bad	0.1%
	light veins	-	rough	
3 A-Ba-F_1	grey	mat	very good	0.1%
	-	-	conchoidal	
3 A-Ba-F_2	grey	mat	bad	0.1%
	white dots	-	rough	
3 A-Ba-F_3	black	mat	bad	0.1%
	white dots	-	rough	
3 A-Ba-F_4	black	glossy	bad	0.1%
	white spots	poor	rough	
3 A-Ba-R_1	cherry	satin	very good	0.1%
	-	-	conchoidal	
4 A-Tr-R_1	brown	mat	bad	0.1%
	white veins	-	rough	
4 A-Tr-F_1	light brown	mat	medium	0.1%
	-	-	rough	
5 A-Ha-F_1	grey	mat	poor	0.1%
	weathered	-	smooth	
5 A-Ha-R_1	greenish	mat	bad	0.1%
	cracked	-	rough	

Sample number	color	transparency	fracture	frequency of occurence
6 A-Ho-R_1	geyish-green	mat	very good	0.1%
	-	transluscent	smooth	
6 A-Ho-F_2	grey	satin	medium	0.1%
	-	-	rough	
6 A-Ho-R_1	red-brown	mat	medium	0.1%
	white veins	-	rough	
8 A-Ob-R_1	brown-red	mat	bad	0.1%
	weathered	-	rough	
9 A-Gn-R_1	brown	mat	medium	0.1%
	veins	-	smooth	
	weathered			
10 A-St-R_1	red-brown	mat	bad	0.1%
	white veins	-	rough	
10 A-St-R_2	brown-green	mat	medium	0.1%
	-	-	smooth	
10 A-St-R_3	green	mat	medium	0.1%
	light veins	-	smooth	
11 A-PaD_1	olive	satin	good	deposit
	-	-	conchoidal	
12 A-We-H_1	light grey	mat	poor	2-3%
	light veins	-	rough	
13 A-Ste-H_1	grey	mat	bad	3-5%
	light veins	-	rough	
14 A-Ma-F_1	black	mat	bad	2-3%
	limestone	-	smooth	
	interlayers			
14 A-Ma-F_2	black	mat	poor	1.2%
	bluish spots	-	smooth	
14 A-Ma-R_1	red-cherry	satin	very good	deposit
	white veins	-	conchoidal	
14 A-Ma-R_2	grey-red	mat	medium	deposit
	white veins	-	smooth	
14 A-Ma-R_3	red-green	mat	very good	deposit
	spotted	-	smooth	
14 A-Ma-R_4	cherry-grey	mat	good	deposit
	spotted	-	smooth	
14 A-Ma-R_5	white-pink	mat	medium	deposit
	spotted	-	smooth	
14 A-Ma-R_1	green-grey	mat	very good	deposit
	banded	-	conchoidal	
14 A-Ma-R_7	dark green	mat	good	deposit
	-	-	conchoidal	

TABLE VII-2
Microscopic characters of raw material samples
from natural outcrops

Sample	structure texture	micro-photography	mineral components primary		secondary
A-Wi-F_1	fine and equal size crystals random	1	chalcedony	opal	opaque min.
A-Wi-F_2	fine and different size crystals random	2	chalcedony	quartz	opal carbonite opaque
A-Wi-R_3	fine and different size crystals random	3	chalcedony opal	quartz	carbonate opaque min.
A-Ba-F_1	fine and different size crystals random	4	chalcedony	quartz	opal opaque min.
A-Ba-R_1	fine and different size crystals random	5	chalcedony opal	quartz	quartz anhydrite carbonate opaque min. mica
A-Ho-F_1	fine crystals random	6	chalcedony	quartz	opal carbonate opaque min.
A-Pa-D_1	non-crystalline biogenetic random	7	opal		chalcedony quartz opaque min.
A-We-H_1	fine and different size crystals random	8	chalcedony	carbonates	anhydrite quartz opal opaque min.
A-Ma-R_1	different size crystals	9	chalcedony	opal	quartz carbonate
A-Ma-R_3	different size crystals random	10	opal	chalcedony	quartz mica opaque
A-Ma-R_6	different size crystals random	11	quartz opal chalcedony	-	carbonate opaque

TABLE VII-3
Mineral composition of raw materials from natural outcrops (% of volume)

Component	Samples					
	25	26	27	28	29	30
	A-Wi-F_1	A-Wi-F_2	A-Wi-R_3	A-Ba-R_1	A-Ba-F_1	A-Ho-F_1
chalcedony	97.4	94.8	53.3	42.1	75.4	86.9
quartz	-	4.8	1.5	0.5	19.6	10.8
opal	2.4	0.2	44.3	50.0	4.9	1.9
carbonates	-	0.1	0.6	1.7	-	0.3
mica	-	-	-	0.1	-	-
opaque minerals	0.2	0.1	0.3	0.3	0.1	0.1
anhydrite	-	-	-	5.3	-	-

Component	Samples				
		31	32	33	34
	A-Pa-D_1	A-We-H_1	A-Ma-R_1	A-MaR_3	A-Ma-R_6
chalcedony	1.5	73.7	83.4	32.9	39.5
quartz	0.6	0.3	1.1	1.1	32.2
opal	97.6	2.9	7.4	65.8	28.0
carbonates	-	13.9	8.0	-	0.2
mica	-	-	-	0.1	-
opaque minerals	0.3	0.6	0.1	0.1	0.1
anhydrite	-	9.1	-	-	-

TABLE VII-4
Grain-size analysis of raw materials from natural outcrops (% of volume)

Fractions um	Samples				
	A-Wi-F_1	A-Wi-F_2	A-Wi-R_3	A-Ba-F_1	A-Ba-R_1
0-5	97.4	94.8	53.3	75.4	42.1
5-10	2.1	4.3	35.6	24.3	36.0
10-20	0.5	0.9	11.1	0.3	13.3
20-40	-	-	-	-	8.6

Fraction	Samples					
um	A-Ho-F_1	A-Pa-D_1	A-We-H_1	A-Ma-R_1	A-Ma-R_3	A-Ma-R_6
0-5	86.9	-	73.7	83.4	32.9	39.5
5-10	8.6	-	22.3	10.3	64.0	58.0
10-20	4.5	-	-	6.3	4.1	2.5

TABLE VII-5
Characteristics of lithic raw materials
from Grubgraben.

Sample	color inclusions	luster transparency	cleavage fracture	frequency of occurence
A-Gr-F_1	brown-grey white patina	satin -	very good smooth	high
A-Gr-F_2	grey-brown white patina	satin transparent	very good smooth conchoidal	medium
A-Gr-F_3	yellow-cream	satin poor	good smooth	high
A-Gr-F_4	white grey spots	satin -	very good conchoidal	medium
A-Gr-F_5	light-grey grey-white patina	mat -	good smooth	rare
A-Gr-F_6	grey rare white spots	mat -	very good smooth	rare
A-Gr-F_7	light grey of various shades	satin -	very good smooth or conchoidal	rare
A-Gr-F_8	grey-spotted -	glossy transparent	very good smooth	rare
A-Gr-R_1	cherry-brown	satin -	very good smooth	medium
A-Gr-R_2	red-brown rare light spots	satin -	very good smooth or conchoidal	medium
A-Gr-R_3	green-cherry spotted	satin -	very good conchoidal	rare
A-Gr-R_4	light-green	satin transparent	very good conchoidal	medium
A-Gr-R_5	dark-green -	mat -	very good conchoidal	rare
A-Gr-A_1	grey, with thin white-blue rings	satin transparent	very good conchoidal	rare

TABLE VII-6
Microscopic characterization
of raw materials from the site of Grubgraben

Sample	structure texture	micro-photography	mineral components: primary	secondary	accessing
A-Gr-F_1	micro- crystalline random	12	chalcedony	quartz	opal carbonate opaque
A-Gr-F_2	fine and different size crystals random	13	chalcedony	quartz	carbonate opaque
A-Gr-F_3	fine and different size crystals random	14	chalcedony	quartz	opaque
A-Gr-F_4	fine and non crystalline random	15	chalcedony	carbonates	opal quartz opaque
A-Gr-F_5 min.	micro- crystalline random	16	chalcedony	quartz	opal opaque
A-Gr-F_6	fine and different size crystals	17	chalcedony	quartz	opaque min.
A-Gr-F_7	fine and different size crystals random	18	quartz	chalcedony opal	opaque min.
A-Gr-F_8	fine and different size crystals random	19	chalcedony	calcite	quartz opal opaque min.
A-Gr-R_1	fine and different size crystals random, veined	20	quartz	chalcedony	opal carbonate opaque min.
A-Gr-R_2	fine and different size crystals random	21	chalcedony	carbonates	quartz opal opaque min.

TABLE VII-6
Microscopic characterization
of raw materials from the site of Grubgraben

Sample	structure texture	micro-photography	mineral components primary	secondary	accessing
A-Gr-R_3	fine and different size crystals random	22	quartz	chalcedony	iron oxide
A-Gr-R_4	fine and crypto-crystalline random	23	quartz	chalcedony	opal

TABLE VII-7
Mineral composition of raw materials from
the site of Grubgraben (% of volume)

Component	Samples					
	A-Gr-F_1	A-Gr-F_2	A-Gr-F_3	A-Gr-F_4	A-Gr-F_5	A-Gr-F_6
chalcedony	90.5	62.9	94.5	90.1	89.9	57.6
quartz	8.0	36.7	4.4	0.4	7.5	42.1
opal	0.7	-	-	0.3	2.5	-
carbonates	0.7	0.3	-	8.9	-	-
mica	-	-	-	-	-	-
opaque minerals	0.1	0.1	1.1	0.3	0.1	0.3

Component	Samples					
	A-Gr-F_7	A-Gr-F_8	A-Gr-R_1	A-Gr-R_2	A-Gr-R_3	A-Gr-R_4
chalcedony	24.4	76.8	25.3	49.9	22.2	9.6
quartz	63.2	6.5	67.2	5.7	77.8	89.1
opal	12.1	1.0	5.9	3.9	-	1.3
carbonates	-	15.5	1.0	39.8	-	-
mica	-	-	-	0.5	-	-
opaque minerals	0.3	0.2	0.6	0.2	-	-

Component	Samples
	A-Gr-R_5
chalcedony	65.2
quartz	34.5
opal	-
carbonates	-
mica	0.1
opaque minerals	0.2

TABLE VII-8
Grain size distribution.
Samples from Grubgraben

Grain size um	Sample A-Gr-F_1	A-Gr-F_2	A-Gr-F_3	A-Gr-F_4	A-Gr-F_5	A-Gr-F_6
0-5	3	31.0	3.1	8.2	9.1	36.3
10-20	3.6	5.1	1.0	1.7	2.0	6.1
20-40	1.6	1.8	2.4	-	-	-
40-100	-	0.2	-	-	-	-

Grain size um	Sample A-Gr-F_7	A-Gr-F_8	A-Gr-R_1	A-Gr-R_2	A-Gr-R_3	A-Gr-R_4
0-5	24.4	76.8	25.3	49.9	22.2	9.6
5-10	72.3	20.1	73.1	38.6	69.6	87.6
10-20	4.3	2.2	2.6	1.5	9.2	2.8
20-40	-	1.9	-	-	-	-

Grain size um	Sample A-Gr-R_5
0-5	65.2
5-10	31.3
10-20	4.5

TABLE VII-9
Content of elements in raw materials from the site of Grubgraben (% of volume)

Sample	Ca	Mg	Na	K	Fe
A-Gr-F_1	0.0598	0.0107	0.0483	0.0232	0.0357
A-Gr-F_2	0.0430	0.0182	0.0215	0.0119	0.0902
A-Gr-F_3	0.0316	0.0083	0.0298	0.0197	0.0344
A-Gr-F_4	0.0451	0.0074	0.0230	0.0174	0.0300
A-Gr-F_5	0.1024	0.0078	0.0187	0.0120	0.0297
A-Gr-F_6	0.0221	0.0083	0.0186	0.0208	0.0491
A-Gr-F_7	0.0390	0.0697	0.0562	0.1400	0.1496
A-Gr-F_8	0.5387	0.0137	0.0722	0.0664	0.0394
A-Gr-R_1	0.0799	0.1142	0.1455	0.1803	0.8029
A-Gr-R_2	0.5758	0.0706	0.1235	0.1621	0.4886
A-Gr-R_3	0.0330	0.0395	0.1104	0.1259	0.1364
A-Gr-R_4	0.0687	0.1628	0.0909	0.3027	0.3819
A-Gr-R_5	0.0624	0.1906	0.1332	0.3363	0.3315

Sample	Mn	Zn	Ni	Cu	Pb	Cr
A-Gr-F_1	0.0003	0.0023	0.0046	0.0001	0.0009	0.0003
A-Gr-F_2	0.0005	0.0001	-	-	0.0008	0.0003
A-Gr-F_3	0.0002	0.0005	-	-	0.0009	0.0005
A-Gr-F_4	0.0002	0.0001	0.0008	-	0.0007	0.0003
A-Gr-F_5	0.0003	0.0007	0.0008	0.0001	0.0006	0.0004
A-Gr-F_6	0.0003	0.0013	-	-	0.0006	0.0006
A-Gr-F_7	0.0007	0.0004	0.0008	0.0001	0.0020	0.0008
A-Gr-F_8	0.0027	0.0009	0.0010	0.0003	0.0011	0.0005
A-Gr-R_1	0.0038	0.0016	0.0016	0.0001	0.0019	0.0013
A-Gr-R_2	0.0480	0.0009	0.0010	-	0.0014	0.0007
A-Gr-R_3	0.0011	0.0002	0.0005	-	0.0007	0.0006
A-Gr-R_4	0.0016	0.0008	0.0016	0.0001	0.0009	0.0012
A-Gr-R_5	0.0017	0.0008	0.0014	0.0001	0.0028	0.0013

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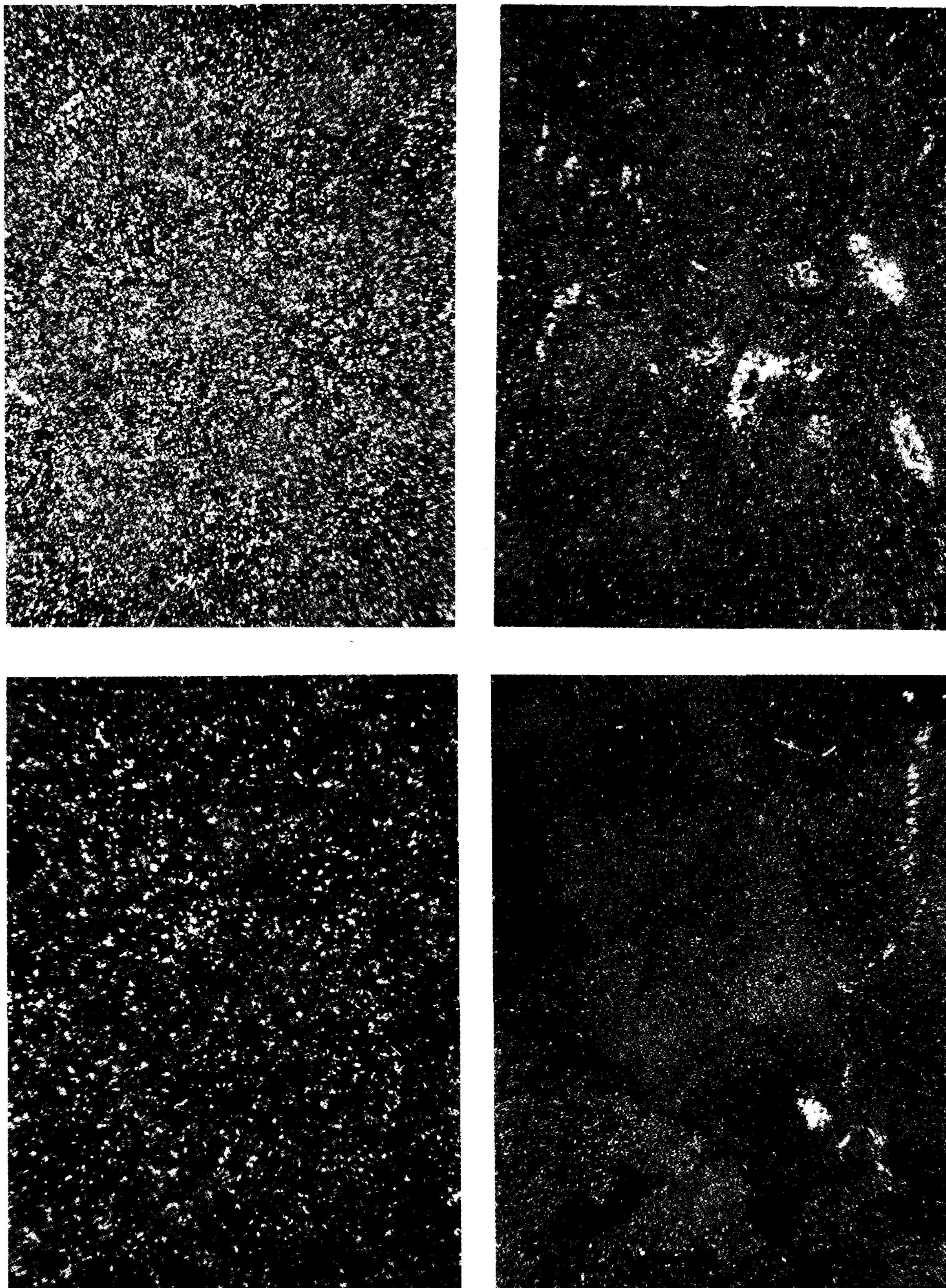

Fig. VII-8 Phot.1. Sample A-Wi-F1. Chalcedony. Polaroids x, 32x

Phot.2. Sample A-Wi-F2. Fine crystalline quartz at chalcedony background. Polaroids x. 32x

Phot.3. Sample A-Wi-R3. Opal-chalcedony background. Polaroids x. 32x.

Phot.4. Sample A-Ba-F1. Fine quartz at chalcedony back ground. Polaroids X. 32x.

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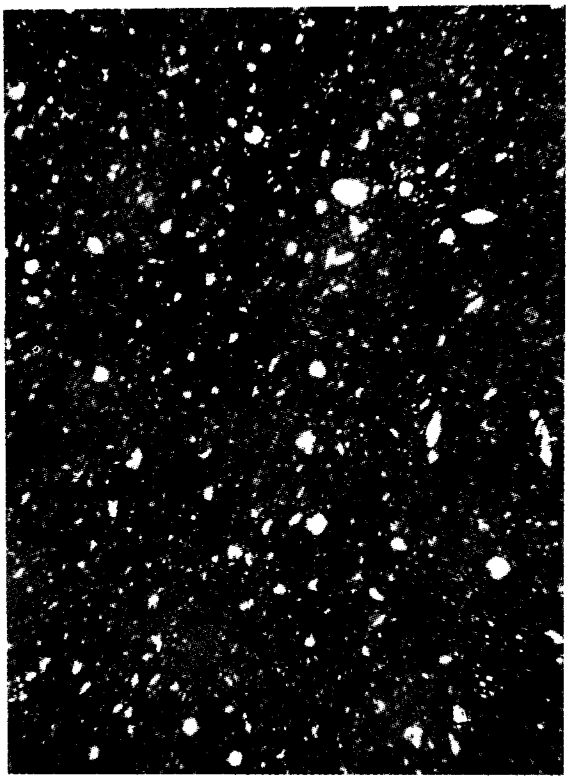

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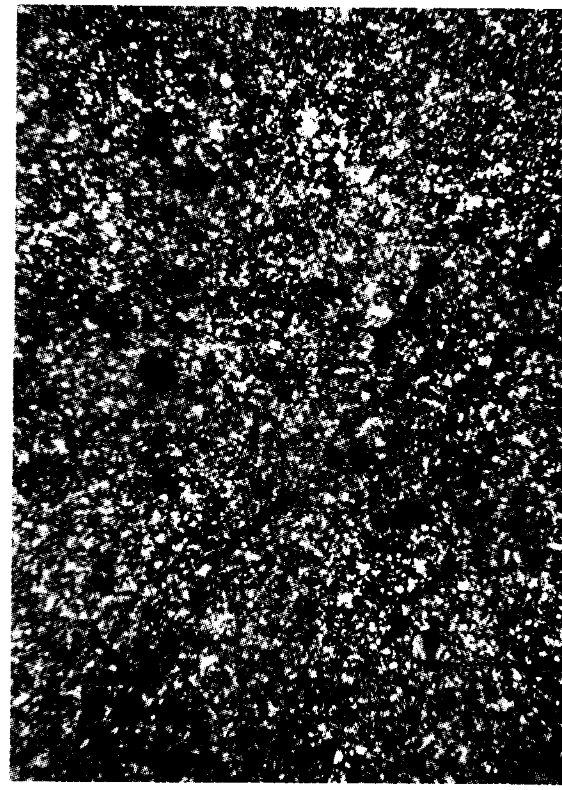

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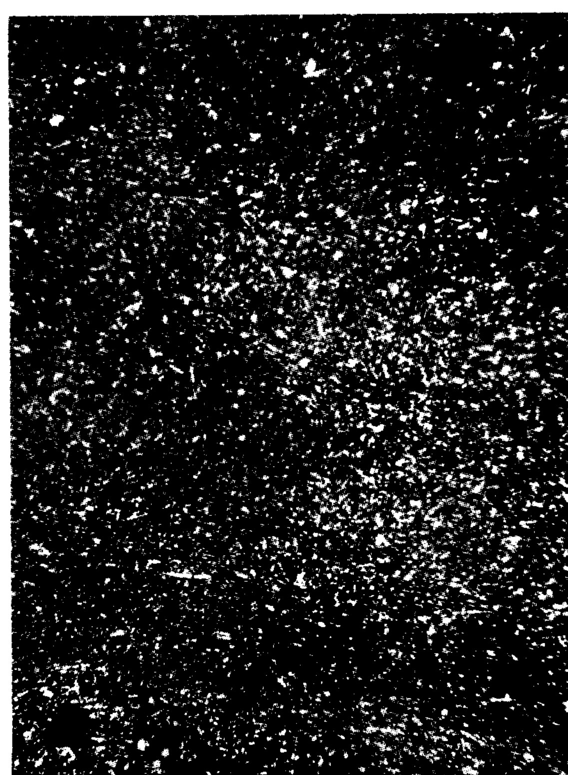

Fig. VII-9 Phot.5. Sample A-Ba-R1. Opal-chalcedony background with disseminated fine quartz. Polaroids X. 32x.

Phot.6. Sample A-Ho-F1. Chalcedony and fine crystalline quartz. Polaroids x. 32x.

Phot.7. Sample A-Ra-D1. Diatomea-opal skeletons. 1 polaroid. 32x.

Phot.8. Sample A-We-H1. Chalcedony background of hornstone. Polaroids x. 32.

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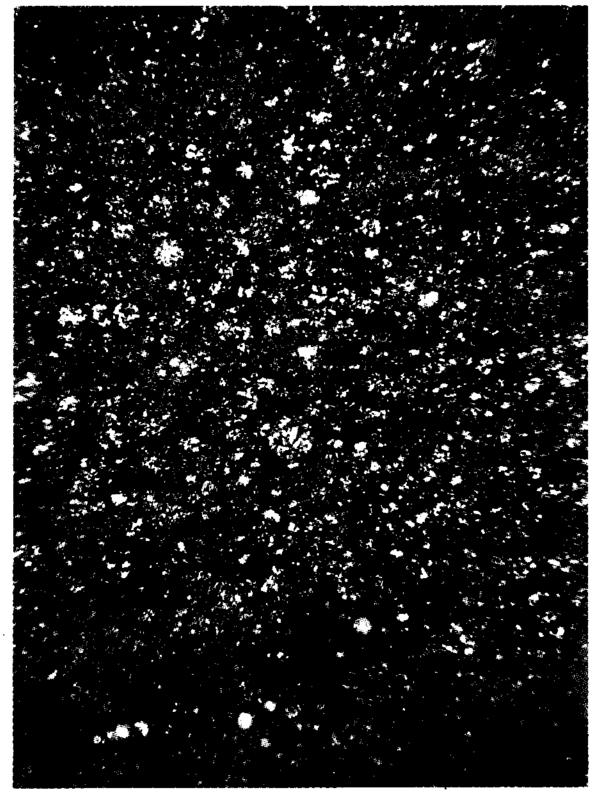

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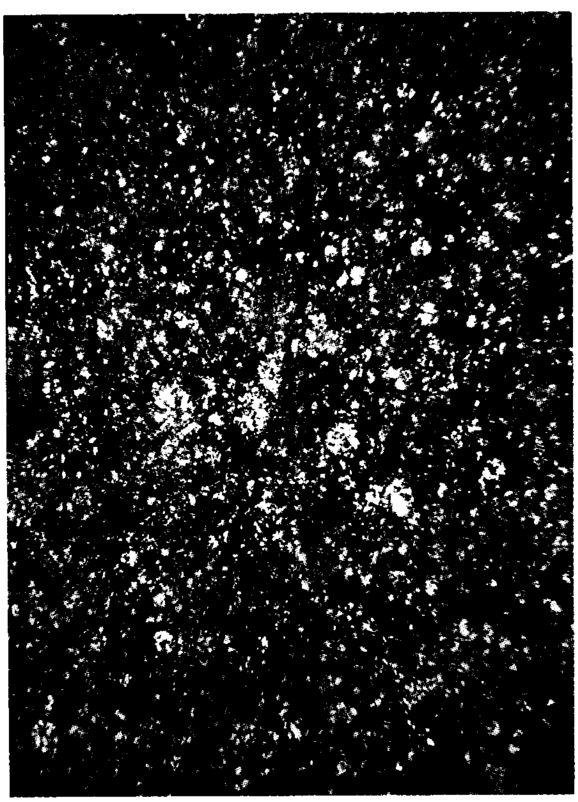
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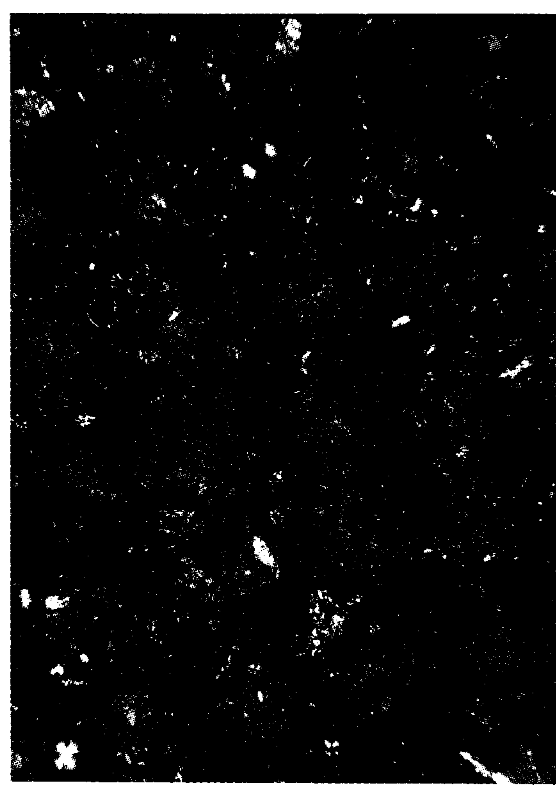

Fig. VII-10 Phot.9. Sample A-Ma-R1. Chalcedony containing concentrations of quartz and calcite veins. Polaroids x. 32x.

Phot.10. Sample A-Ma-R3. Radiolaries filled with fine crystalline quartz. Polaroids x. 32x.

Phot.11. Sample A-Ma-R6. Chalcedonic pseudomorphes after radiolaria at chalcedony-opal background. Polaroids x. 32x.

Phot.12. Sample A-Gr-F1. Fine crystalline quartz, chalcedony background. Polaroids x. 32x.

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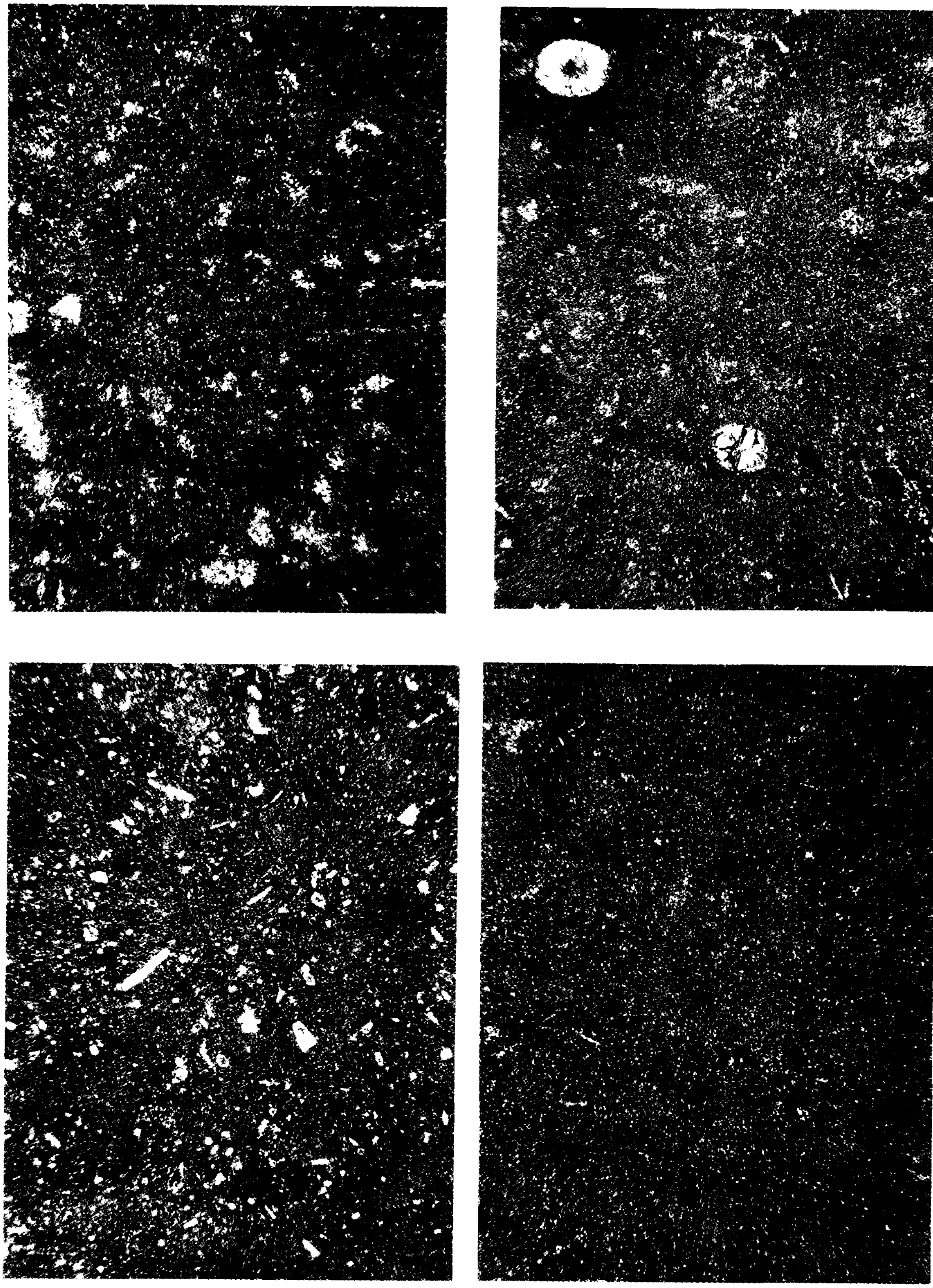

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Fig. VII-11 Phot.13. Sample A-Gr-F2. Fine crystalline quartz and chalcedony . Polaroids x. 32x.

Phot.14. Sample A-Gr-F3. Pseudomorphes of quartz after foraminifera disseminated within the calcedony mass. Polaroids x. 32x.

Phot.15. Sample A-Gr-F4. Crystals of calcite and opaque minerals, chalcedony background. Polaroids x. 32x.

Phot.16. Sample A-Gr-F5. Chalcedony . Polaroids x. 32x.

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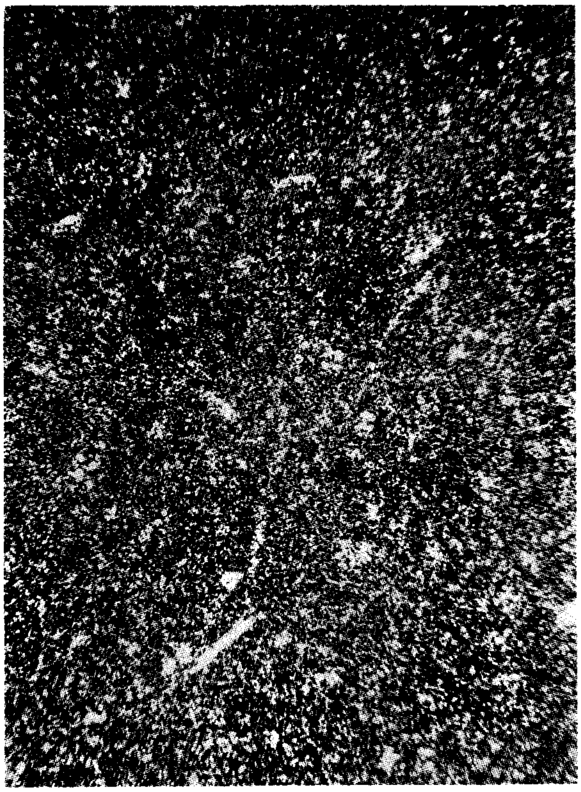

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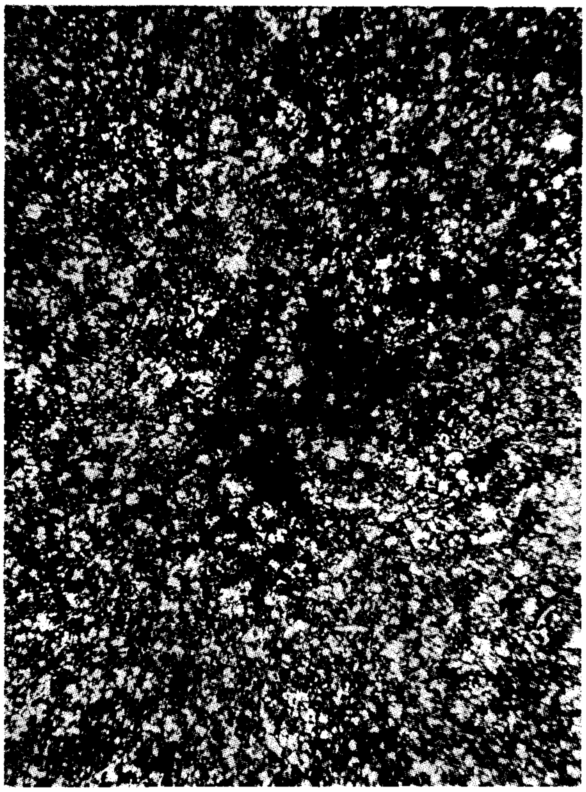

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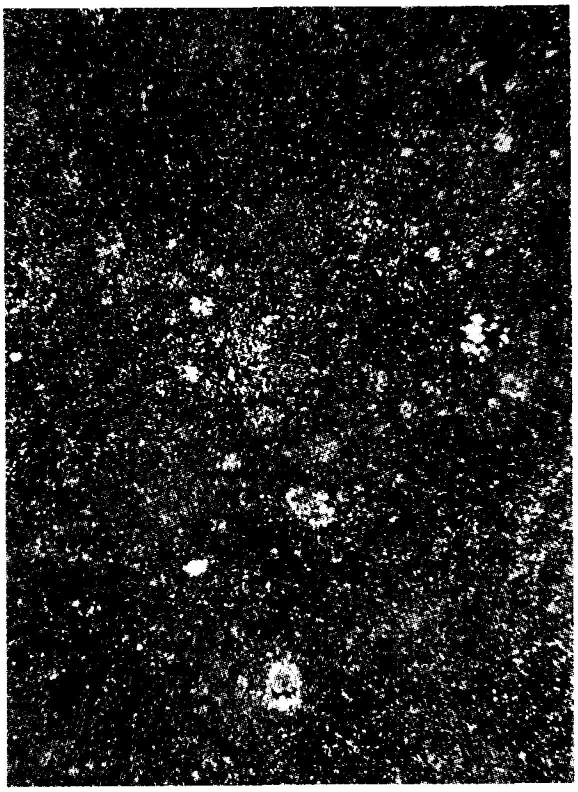

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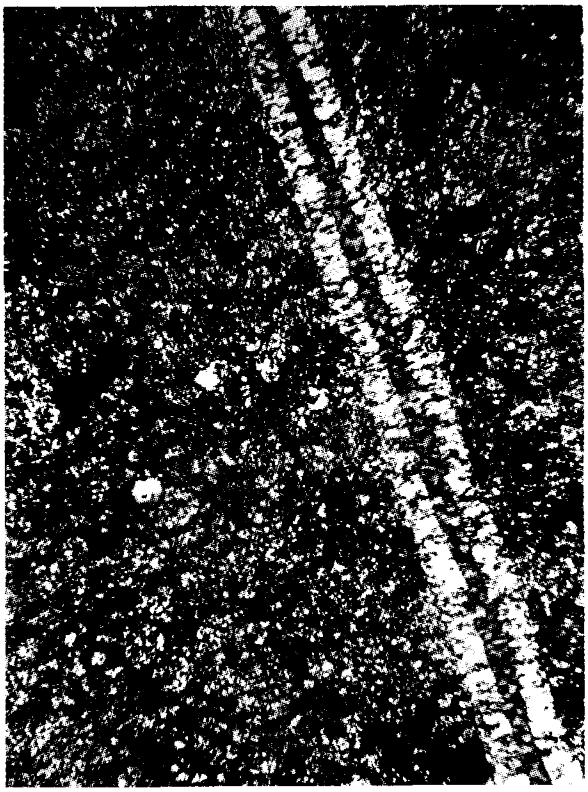

Fig. VII-12 Phot.17. Sample A-Gr-F6. Concentrations of quartz, chalcedony background. Polaroids x. 32x.

Phot.18. Sample A-Gr-F7. Quartz, chalcedony, opal (black). Polaroids x. 32x.

Phot.19. Sample A-Gr-F8. Crystals of carbonates at chalcedony background. Polaroids x. 32x.

Phot.20. Sample A-Gr-R1. Vein of fine quartz cutting the radiolarite. Polaroids x. 32x.

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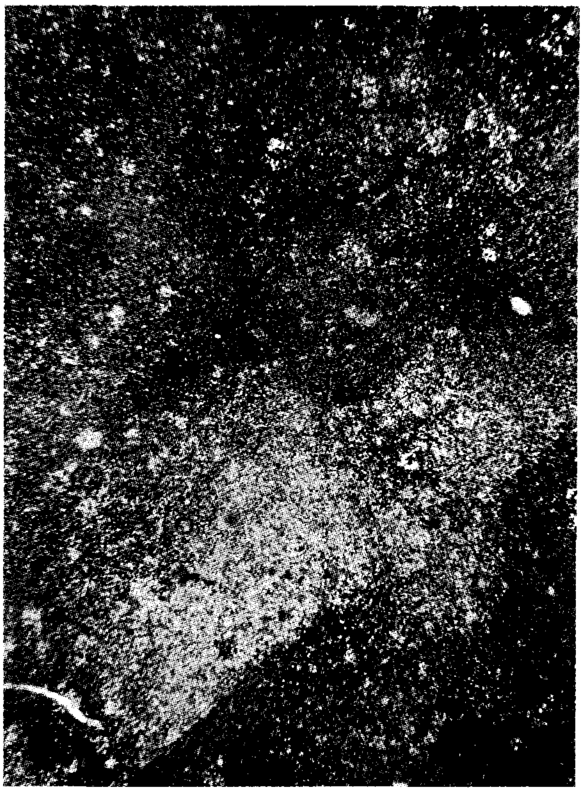

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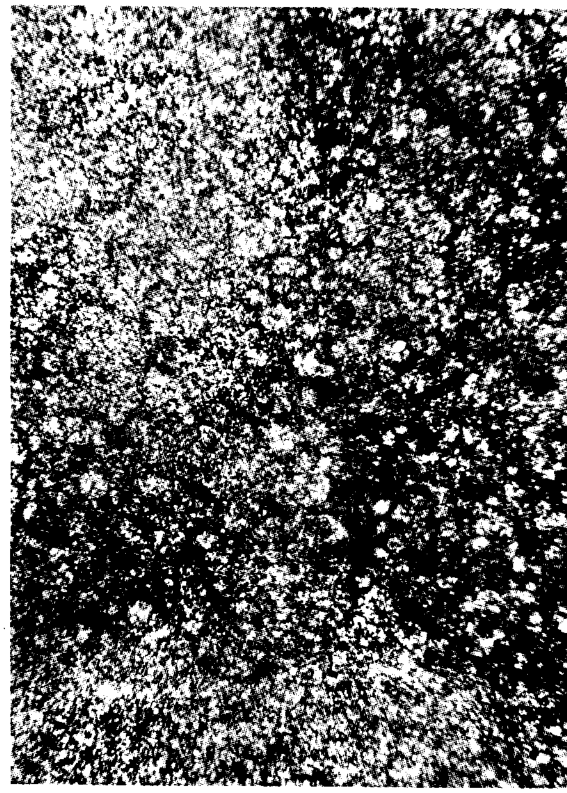

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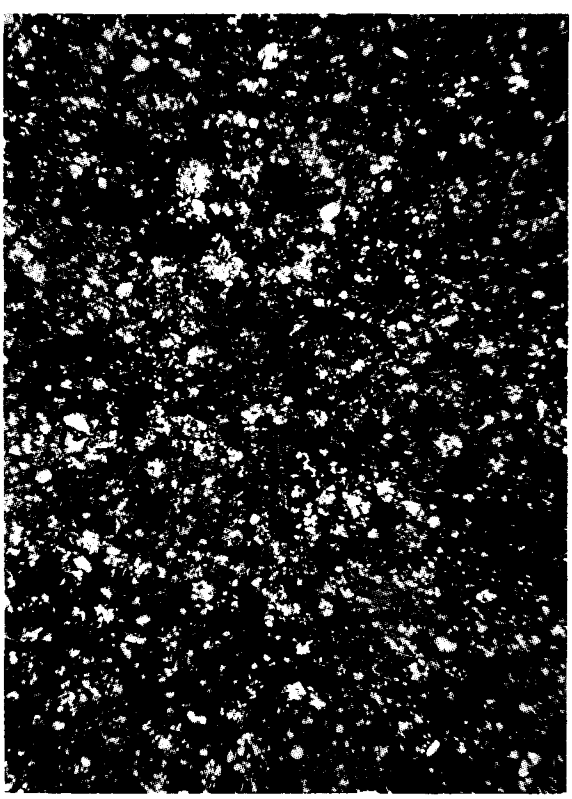

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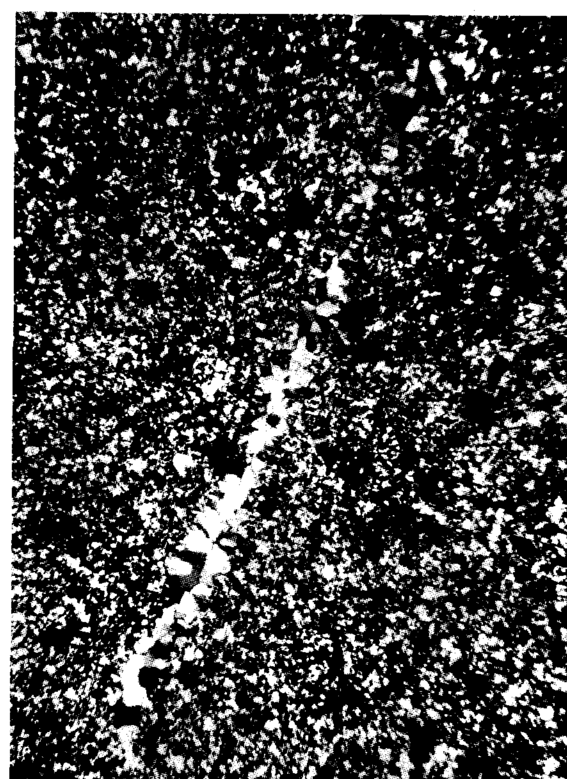

Fig. VII-13 Phot.21. Sample A-Gr-R2. Spots of carbonates in chalcedony mass. Polaroids x. 32x.

Phot.22. Sample A-Gr-R3. Dark spots of iron oxides mixed with chalcedony. Polaroids x. 32x.

Phot.23. Sample A-Gr-R4. Quartz pseudomorphes derived from radiolaria. Polaroids x. 32x.

Phot.24. Sample A-Gr-R5. Quartz pseudomorphes after radiolaria. Polaroids x. 32x.

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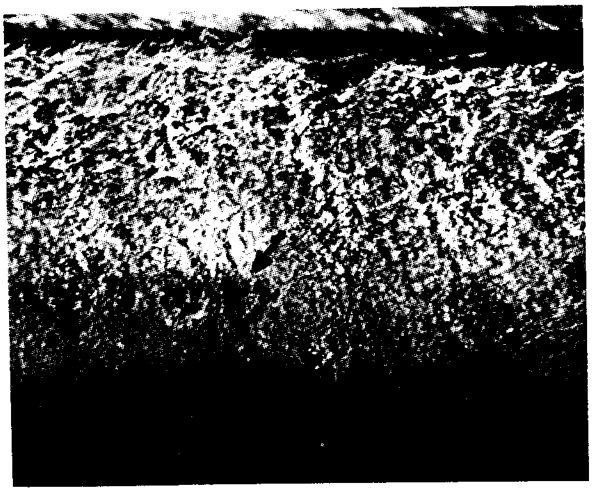
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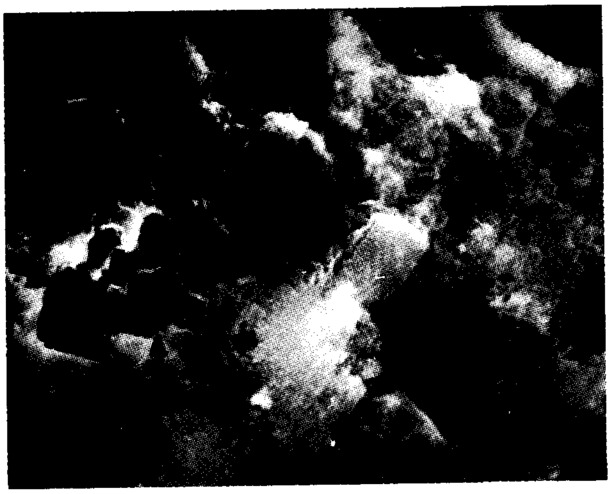
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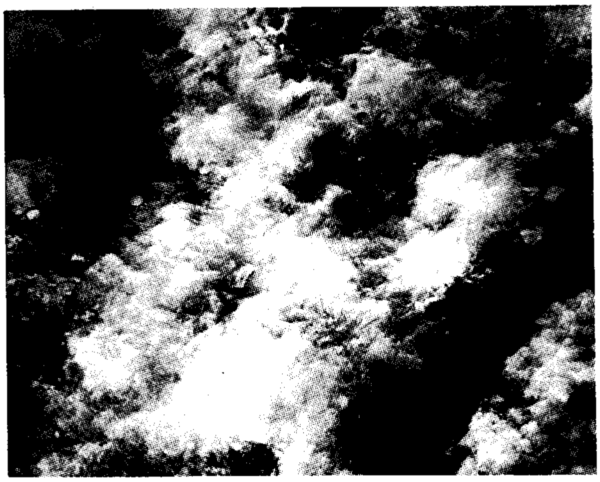
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Fig. VII-14 Phot.25. Sample A-Gr-F2. Structural changes of the flint at zone of patination. Black internal part flint. Light patina. Between patina and internal part (arrow) one can see the zone of structural changes. SEM. 100x.
Phot.26. Sample A-Gr-F2. The structure of patina. SEM. 2400x.
Phot.27. Sample A-Gr-F2. Crystals of calcite (arrows) filling up the secondary empty space at the zone of patination. Big light crystals (central part of picture) are recrystallised quartz. SEM. 2400x.
Phot.28. Sample A-Gr-R2. The structure of Internal part of radiolarite. One can see bigger crystals of quartz disseminated in the chalcedony mass . SEM. 1200x.

VIII

RAW MATERIAL USE

by

DIXIE WEST AND ANTA MONTET-WHITE

This section summarizes the study of variability in raw material use within and between the four major archaeological levels recorded todate. It focuses on the various kinds of flints and radiolarites of non-local origin and is oriented toward the study of raw material economy. Samples from AL3 and AL4 may be considered the most representative of Epigravettian industries since they were derived from middens containing the debris produced by a wide variety of activities, whereas assemblages from the AL2 habitation structure and the AL1 workshop probably represent a more limited range of activities. However, the samples are large enough to make possible a search for trends and patterns in raw material use.

1. Frequency of raw material types.

A total of 3,185 pieces weighing nearly 10 kilograms was distributed as follows: 598 items weighing 1,990 grams from AL1 , 265 specimens and 1,675 grams from AL2, 443 pieces and 1,143 grams from AL3 and 1,881 artifacts representing 4,794 grams from AL4. The top 3 levels were characterized by comparable artifact density of 21, 19 and 20 chipped stone artifacts per square meter whereas a figure of 75 lithic specimens per square meter was recorded for AL4.

The assemblages were sorted into the eight categories of flint and the five categories of radiolarites identified by Pawlikowski *(cf. supra)*. A few specimens which could not fit into these established types were assigned to unidentified or miscellaneous categories. Artifacts were then separated by level and by categories of blanks, blades and flakes, debitage, shatter and chips, tools, cores and debris. Sorted specimens were counted and weighed to the nearest gram.

Marked differences in the distribution of raw materials separate the four levels (Fig.VIII-1). In AL1 , radiolarites outnumber and outweigh flints. The former comprise 80% of the total number of artifacts and 52% of the material weight at that level. The green radiolarite variety (R4) is the dominant component (N=220) and artifacts made of brown radiolarite (R1) are in significant number (N=87). White flint (F4) is the most commonly utilized flint type whereas little use was made of the patined flint (F2).

In the assemblage from AL2, flints exceed radiolarites in both number and weight. Flint specimens account for 73% of the total number of artifacts and account for 72% of the total weight. As is the case in AL1, F2 is the most commonly used type of flint. A coarse variety of green radiolarite is represented by a prepared core and a few large tools.

Flints are even more common in layer AL3 where they account for 83% of the recovered number of pieces and 78% of the total weight. An even greater use of different types of flints is evidenced in AL4 where they comprise 95% of the artifact counts and

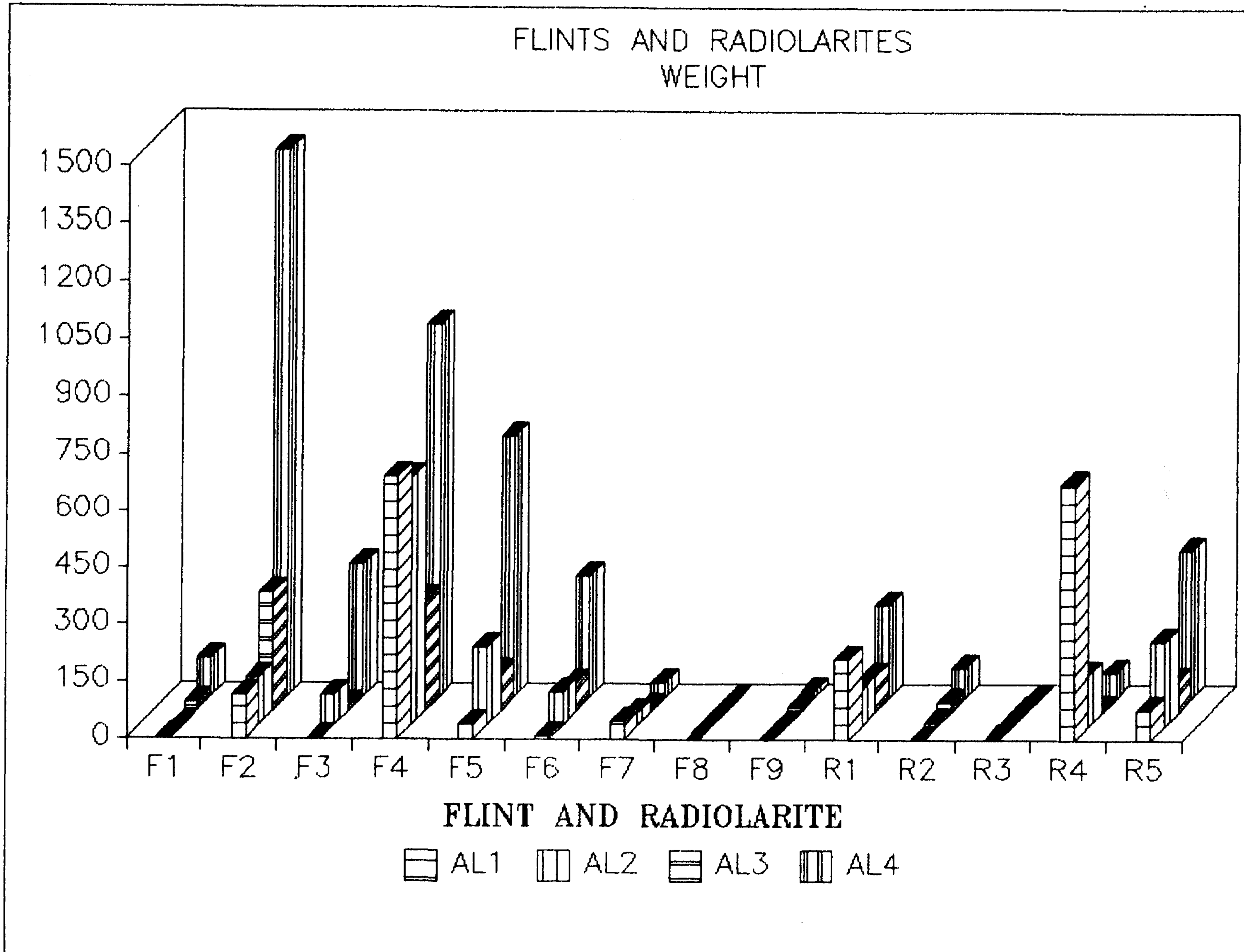

Fig. VIII-1 Weight distribution of flint and radiolarite varieties by level.

83% of the artifact weight. The quantity of patined flint (F2) increased markedly toward the bottom of the sequence and constituted an important component of the AL4 assemblage. Other varieties of flint (F3, F5, and F6) are represented in significant numbers in the lower level.

During the climatic amelioration that corresponded to the formation of AL4, there was greater use of the site as marked by the greater density of artifacts at that level, either a longer stay and/or more frequently repeated occupation of the campsite. Furthermore, occupants of AL4 must have had relatively free access to sources of patined so-called northern the source of which may have been in Silesia, in the Upper Oder region. The presence of the material, albeit in small quantities, demonstrates that acquisition points, wherever they were located, remained accessible during most of the Pleniglacial.

Throughout the sequence Epigravettian occupants relied on the white flint (F4) probably procured in the area of Stranska Skala. This does confirm that the Morava remained a major axis of communication during the Epigravettian. Varieties of radiolarites, found in small quantities in AL4, AL3, and AL2, became a more important resource in AL1. The presence of cortical pieces indicates that radiolarites were often procured in the form of water-worn pebbles which suggest that some of the material was gathered along the Danube. However, the larger blocks of green material found in AL2 and some of the brown pieces from AL1 were probably obtained from in situ outcrops. At the present stage of analysis, the Vah Basin seems the most probable, and nearest, source of these materials.

At Grubgraben, as at Willendorf (Felgenhauer, 1958-59; Kozlowski, 1986) radiolarites were used to complement other, apparently preferred, sources. According to Kozlowski (1986) assemblages from Willendorf II, levels 5, 6 and 9, contained high frequencies of flints originating from the Upper Oder Basin. Reliance on northern flint sources was a cultural tradition established during the Gravettian which persisted during the Epigravettian at Grubgraben in spite of worsening climatic conditions. During the occupation of AL1, there is some evidence of increased reliance on substitute materials as was the case at Willendorf II, levels 6 and 7.

Among the materials brought to the site, were small pieces of heterogeneous materials including agate, rock crystal, as well as flint and radiolarite. It is probable that these pieces did not come from any single source, that they were picked up when the occasion arose, and some of them probably came from the Danube gravel beaches. This fortuitous collecting of raw materials accounted for a small part of the assemblages. The bulk of the raw materials were evidently acquired as the result of long range strategy.

2. Raw materials use (Table VIII-2).

(a) The brownish, heavily patined flint (F1) is rare at all levels, represented by 1 or 2 flakes in the upper levels. The pieces recovered from AL4 include a core, a blade, several tools, a few retouch flakes, and a piece of shatter. The nature of that small assemblage and the lack of trimming flakes indicates that the material was introduced into the site in the form of prepared cores and perhaps also a few large blanks from which tools were made at the site. The ratio of usable to non usable products is 1 to 2, a rather high figure.

(b) The transparent greyish flint with white patina (F2), often designated as chalcedony in the archaeological literature and identified as Northern flint by Pawlikowsky (cf. supra) was introduced into the site in the form of small rounded pebbles with a thin water worn, outer surface or, occasionally, as tabular pieces with heavy, granular cortex. The former fits well the descriptions of the moraine materials. The latter, however, similar in texture, color and patina, do not appear to come from glacial moraines but from in situ beds.

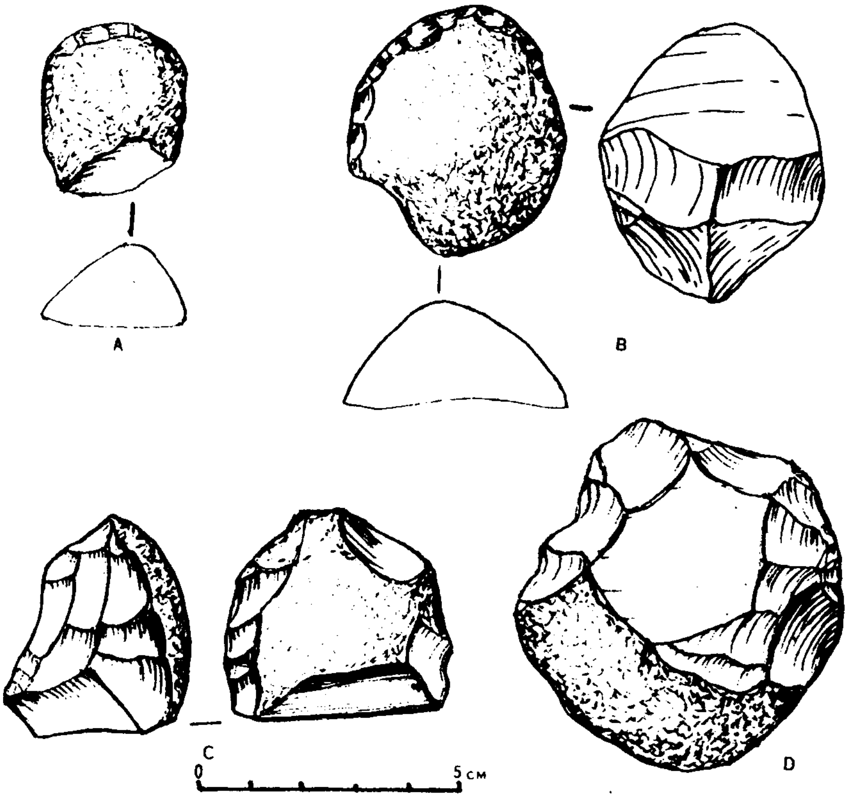

Fig. VIII-2 Tools (A and B) and cores (C and D) made from patined flint (F2) cobbles.

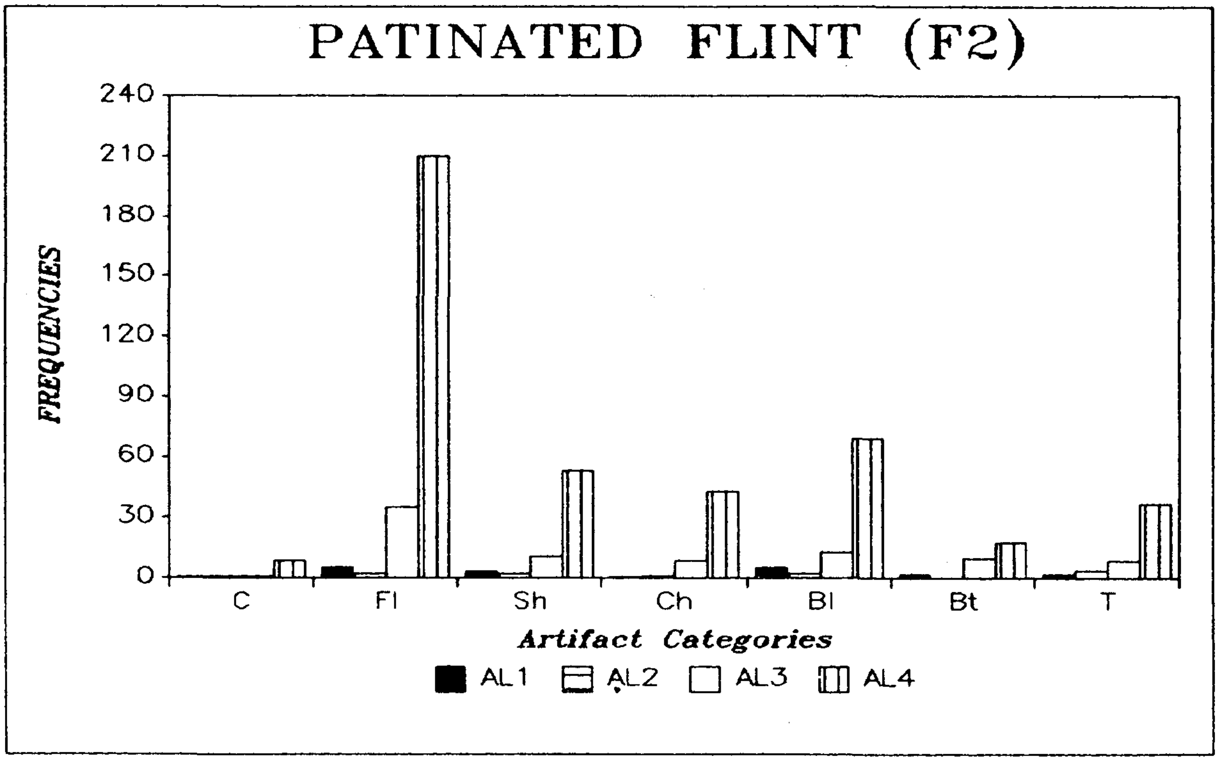

Fig. VIII-3 Frequency of patined flint (F2) by artifact categories and levels. C, cores; Fl, flakes; Sh, shatter; Ch, chips; Bl, blades; Bt, bladelets; T, retouched tools.

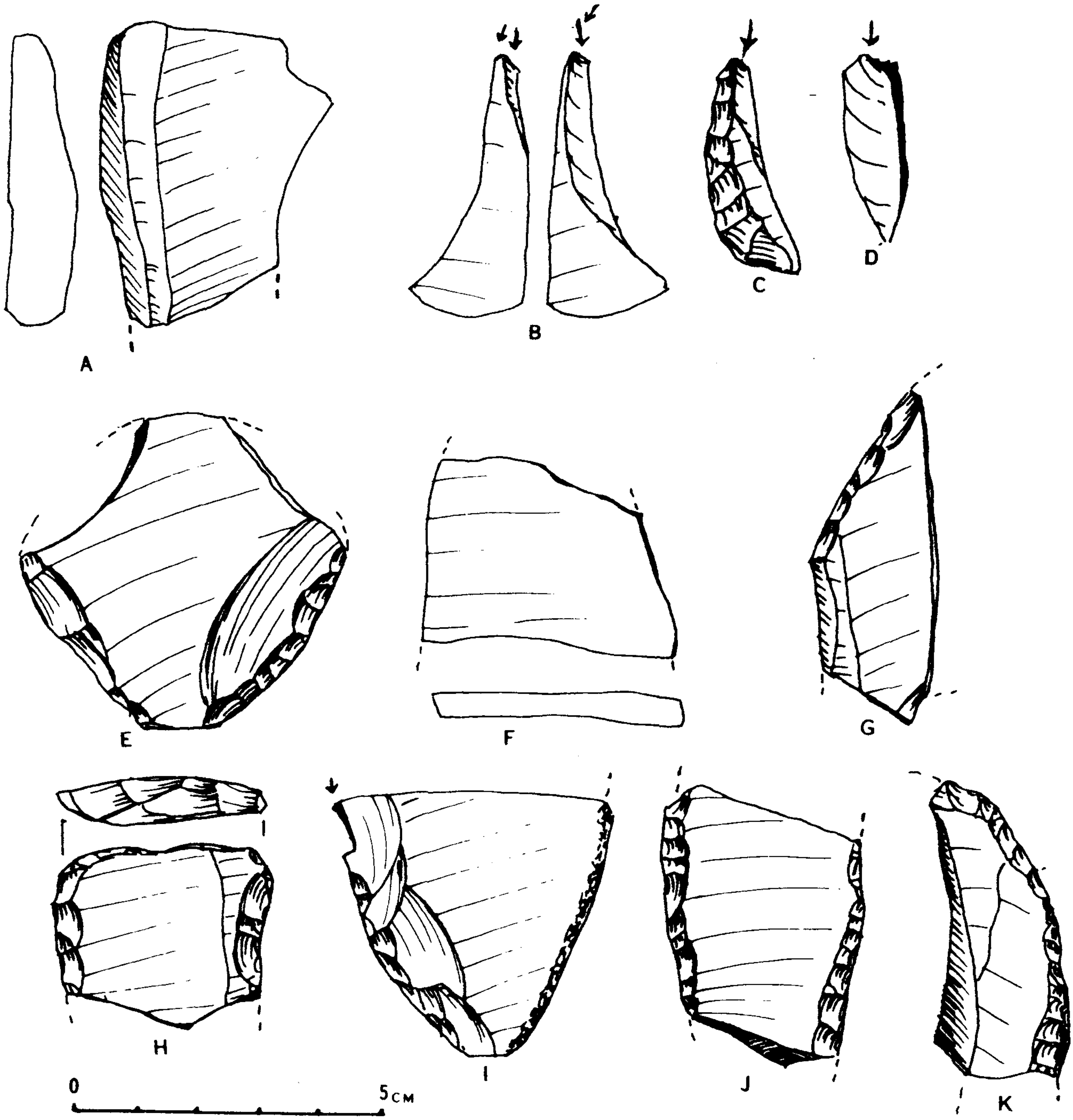

Fig. VIII-4 Spalls and reduced tabular pieces reutilized as bladelet cores, white flint (F4).

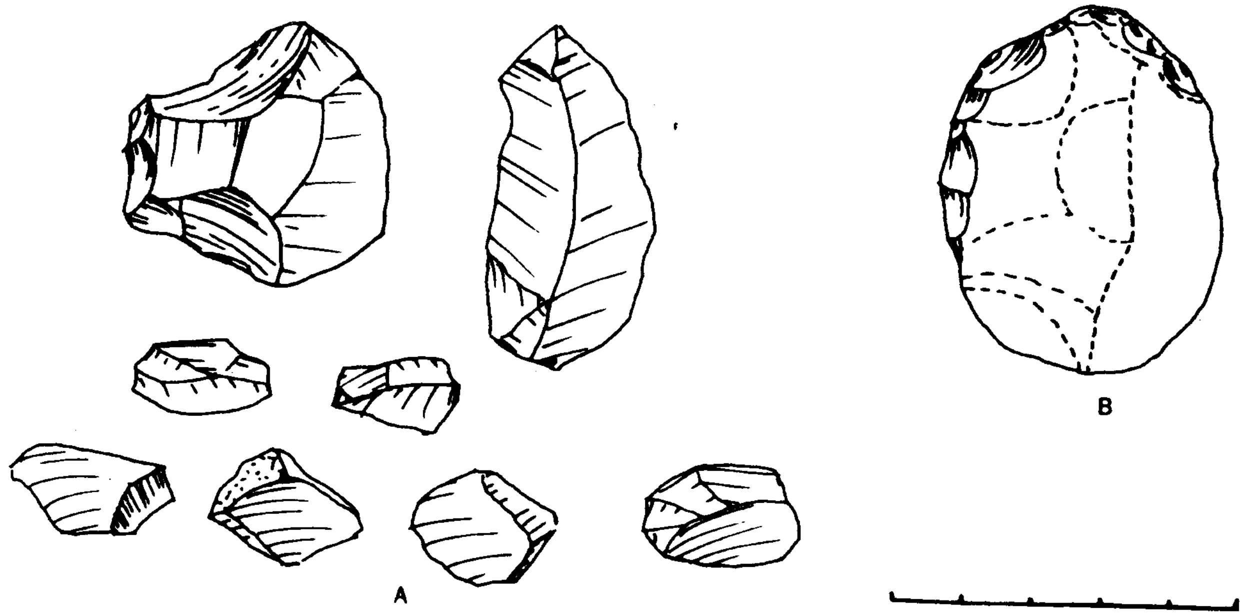

Fig. VIII-5 Blade, small flakes and "denticulate" piece derived from the reduction of an end-scraper on tabular flake; B, the scraper reconstructed from refitted pieces.

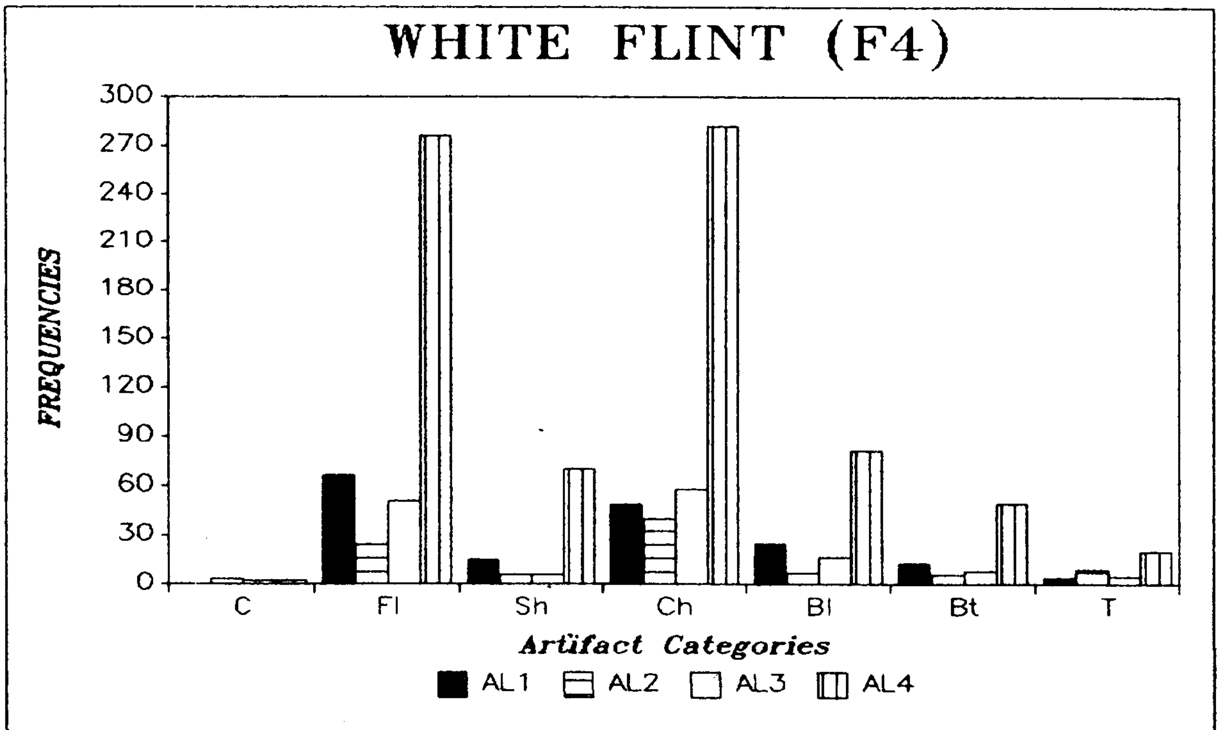

Fig. VIII-6 Frequency of white flint by artifact categories and by levels.

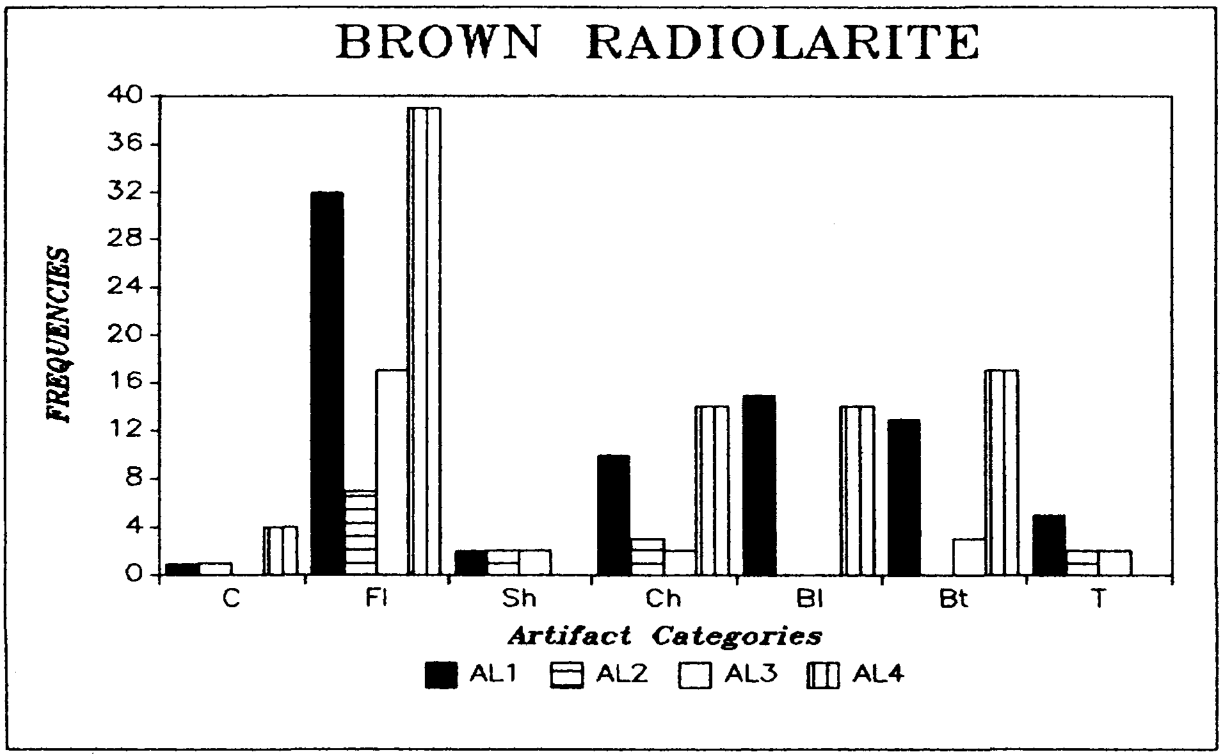

Fig. VIII-7 Frequency of brown radiolarite by artifact categories and by levels.

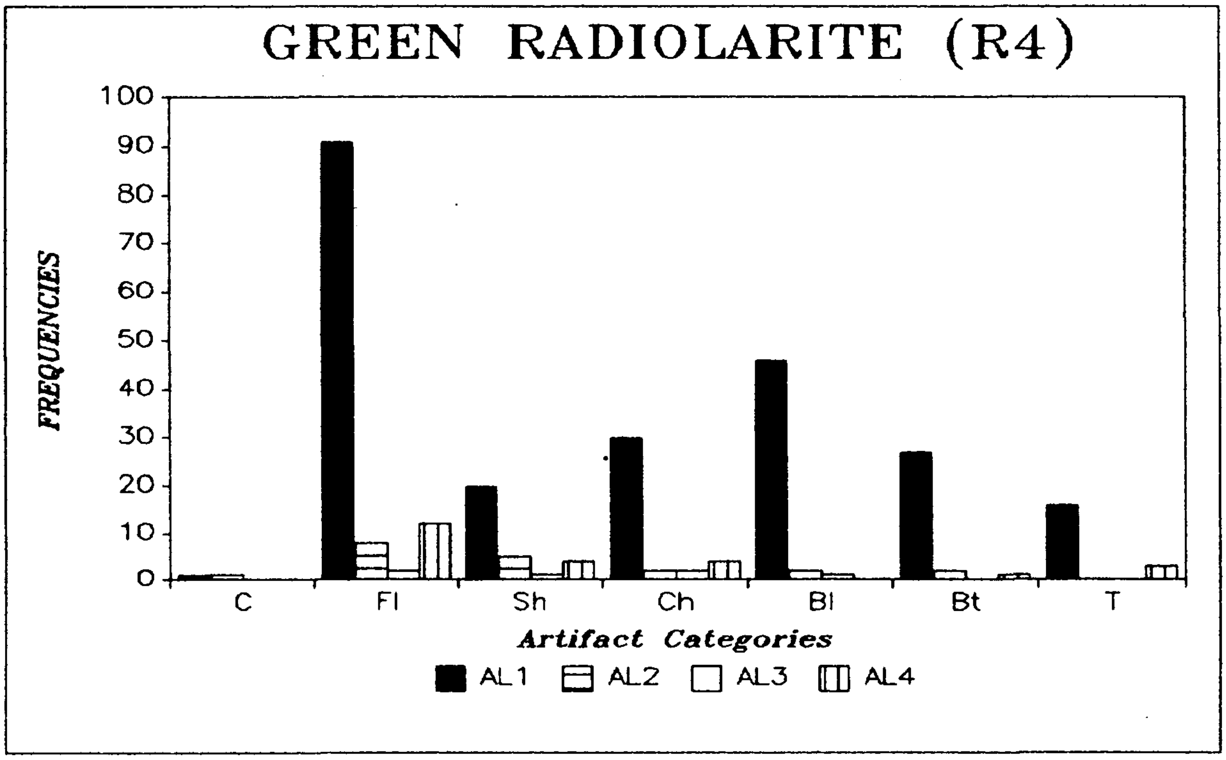

Fig. VIII-8 Frequency of green radiolarite by artifact categories and by levels.

Cap flakes removed from the end of pebbles were transformed into scrapers (Fig. VIII-2 A&B); split pebbles were turned into cores or denticulate tools (Fig. VIII-2 C&D). Small blades and spalls were drawn across tabular pieces producing burin like cores. Trimming flakes are numerous and shatter represents 11% to 12% of the artifact count. The by-products of F2 reduction are small irregular blade cores weighing between 10 and 30 grams *(cf. infra)*. Within the AL4 assemblage, the ratio of blades to cores is 7 to 1 , that of large tools is 5 to 1 and that of bladelets was 2 to 1; in all, a 15 to 1 ratio of usable products per core.

c) The white flint (F4) was the material that produced the most sizeable blanks. The small percentage of trimming flakes noted in AL2, AL3 and AL4 suggests that the blocks of materials were at least partially prepared before they were brought into the camp itself. However, an assemblage of a dozen trimming flakes found together in AL1 demonstrates that at least some complete nodules were brought in. It should be noted that the trimming flakes were found outside of the main concentration where they had been left whereas the core and usable blanks had been transported elsewhere. Thus far, our excavations have uncovered this single occurrence of the debitage of a complete flint nodule. Still, the find raises a number of questions concerning the presence, the relative importance and the localization of flint knapping workshops at the site. Testing of other areas of the site will be needed before these questions can be addressed.

Products of white flint debitage included blades and large tabular flakes. The latter were selected for the manufacture of scrapers and prismatic burins. Spalls removed by snap or by burin blow are evidence of the continued process of tool sharpening and recycling (Fig. VIII-4 B,C,D). Portions of the lateral edges of large, tabular scrapers were taken off (Fig. VIII-4 E, I, J). When completed, the process produced quadrangular blanks with lateral facets (Fig. VIII-4 F) sometimes retouched into fresh tools as well as spall-like bladelets and small blades. Scrapers made in this way are characterized by lines of abrupt retouch which cover the facet surface (Fig. VIII-4 H). A blade, several chips and a denticulate piece which, once refitted, showed that they resulted from the debitage of an end-scraper made on a tabular flake, illustrate the process of flake-core reduction (Fig. VIII-5). All categories of materials were used parsimoniously; however, the deliberate recycling of exhausted tools was especially practiced on white and grey flints (F4 and F5). Two factors account for this; first, the quality of the material and second, the larger size of the original cores from which tabular pieces and core-flakes could be obtained.

d) The grey flint (F6) is common in AL2 where cores, blanks, and waste are represented. Here again the lack of trimming flakes indicates that core preparation took place outside the habitation area. The material was used for the manufacture of larger tools. Bladelets and armatures are rare or absent.

e) The darker grey flint (F7) is represented in AL1 by a core and a range of tools, blades and flakes. Only a few pieces of this material were recovered from the lower levels. Other flint varieties (F8 and F9) are also represented by a few artifacts.

f) Radiolarites of all varieties were used primarily for the manufacture of smaller blades, bladelets and armatures in AL1 and AL4 (Fig. VIII-6 and 7). The trend is less clearly seen in AL2 and AL3 where radiolarites are less frequent. In the case of brown radiolarite, the ratio of core to blade and bladelets was 28 : 1 in AL1, 11.5 : 1 in AL4. The selection of radiolarite for the manufacture of larger tools, endscrapers and burins, was largely limited to AL1. In particular, AL1 flint knappers must have had access to sources of good quality, fine grained, green radiolarites. Chunks of coarse grained, greyish green radiolarite were recovered from AL2 and AL4. This material was used for the manufacture of large tabular pieces which were made into side-scapers and denticulates (cf. infra).

In summary, clear patterns of raw material selection and use are beginning to emerge from the analysis of the site assemblages. The white flint F4 was the preferred material at all levels. Smaller size, more inclusions and heavier cortex rendered the F2 flint somewhat less desirable. The materials seem to have become less accessible toward the end of the Grubgraben occupation. Here, as at Willendorf, radiolarites were a complement rather than a primary source of raw materials.

It is difficult to evaluate the effect that long distance acquisition had on technology. Perhaps the limited access people had to material sources led to an increase in recycling. This, in turn, favored the "invention" and use of a greater variety of small sized tools and induced the development of the flake-core technique well suited to the production of small, spall-shaped blades.

Table VIII-2a Raw materials distribution

Level AL1

	number of artifacts	%	total weight in grams	%
F1	1	.17	7	.37
F2	19	3.33	115	6.06
F3	5	.88	2	.10
F4	174	30.53	693	36.55
F5	9	1.58	41	2.16
F6	5	.88	10	.53
F7	12	2.10	49	2.58
F8	0	0	0	0
F9	0	0	0	0
R1	87	15.26	212	11.18
R2	1	.17	0	0
R3	3	.53	6	.32
R4	220	38.59	676	35.65
R5	28	4.91	78	4.11
R9	1	.17	2	.10
Misc.	5	.88	5	.26
Total	570	100	1896 gr	100

Table VIII-2b

Level AL2

	number of artifacts	%	total weight in grams	%
F1	0	0	0	0
F2	13	4.90	124	7.49
F3	10	3.77	78	4.71
F4	95	35.85	654	39.52
F5	46	17.36	207	12.51
F6	20	7.55	89	5.38
F7	9	3.40	34	2.05
F8	0	0	0	0
F9	1	.38	1	.06
R1	15	5.66	95	5.74
R2	3	1.13	8	.48
R3	3	1.13	5	.30
R4	20	7.55	135	8.16
R5	28	10.56	223	13.47
R9	2	.75	2	.12
Misc.	0	0	0	0
Total	265		1655	

Table VIII 2bc

Level 3

	number of artifacts	%	total weight in grams	%
F1	1	.26	24	2.19
F2	93	23.97	314	28.70
F3	7	1.80	15	1.37
F4	146	37.63	295	26.96
F5	40	10.31	103	9.41
F6	27	6.96	74	6.76
F7	6	1.55	13	1.19
F8	0	0	0	0
F9	2	.52	11	1.01
R1	28	7.22	94	8.59
R2	8	2.06	26	2.38
R3	2	.52	5	.46
R4	6	1.55	8	.73
R5	15	3.86	83	7.58
R9	4	1.03	15	1.37
Misc.	3	.77	14	1.28
Total	388		1094	

Table VIII-1d

Level 4

	number of artifacts	%	total weight in grams	%
F1	13	.69	102	2.15
F2	451	29.98	1434	30.29
F3	76	4.04	352	7.43
F4	783	41.63	981	20.72
F5	224	11.91	689	14.55
F6	109	5.79	322	6.80
F7	8	.42	41	.86
F8	1	.05	1	.02
F9	5	.26	18	.38
R1	105	5.63	245	5.17
R2	23	1.22	79	1.67
R3	3	.16	1	.02
R4	24	1.27	68	1.44
R5	46	2.44	391	8.26
R9	4	.21	7	.15
Misc.	6	.32	3	.06
Total	1881		4734	

IX

THE ARTIFACT ASSEMBLAGES

by

ANTA MONTET-WHITE

The artifact assemblages recovered from AL1 , AL2, AL3, and AL4 are marked by the variety of raw materials. In addition to the imported flints and radiolarites described in the preceding sections, the Grubgraben tool makers made use of local quartz, quartzite and granulite to prepare series of expedient tools and occasionally worked on rock crystal. Quartzite and sandstone pebbles from the Kamp River gravels served as percussors. The majority of ornaments were made of cut dentalia elements; however, beads and pendants were also made from both local and exotic stones.

A- THE QUARTZ ASSEMBLAGES

Quartz artifacts are present at all levels; they represent 9% of the chipped stone artifact total in AL4, 11 % in AL3 and AL2, and only 3% in AL1. Assemblages include retouched and unretouched flakes, shatter, cortical flakes and cores (Table IX-1).

Flakes are rectangular, lamellar or expanding in shape and characterized by flat, generally oblique, platforms. Most of the larger flakes exhibit traces of use along one or sometimes two edges. In a few cases, as a result of either use or intentional preparation, the line of retouch covers all or almost all of one of the lateral margins forming a straight to slightly convex, jagged cutting edge. On the other specimens, macroscopic traces of use in the form of series of irregular scars extend over part of the cutting edges. Either a natural back or a thick edge placed directly opposite or at an angle to the cutting edge probably served as a handle. These artifacts which can be classified as denticulates are the only flake tools in the assemblages (Fig. IX-1).

Cortical flakes are in relatively small proportion, 5 for 2 cores in AL3, 7 for 5 cores in AL4. None were found in AL1 and AL2. Therefore it appears that the first stage of block preparation must have taken place somewhere else, either at the point of extraction or at another area of the site. The large size of the specimens of cortical flakes which have average weights of 69 gm in AL3 and 92 gm in AL4 confirm that quartz debitage started from rather large blocks.

Cores tended to be polyhedral or prismatic as the result of removal of lamellar flakes from one or more platforms. Flaking proceeded from a flat surface which was often a natural plane in the case of large chunks of materials or was obtained by the removal of a cap flake in the case of large cobbles. Then, the production of blades and lamellar flakes continued in alternation with some platform preparation. Irregularities and inclusions in the raw materials interrupted the process. Two of the larger cores have battered edges showing that they were reutilized as hammerstones.

The majority of quartz artifacts are small pieces of shatter weighing between 5 and 35 grams, irregular in shape, often with a quadrangular cross-section and no trace of a bulb of percussion. The abundance of quartz shatter may be due to several factors.

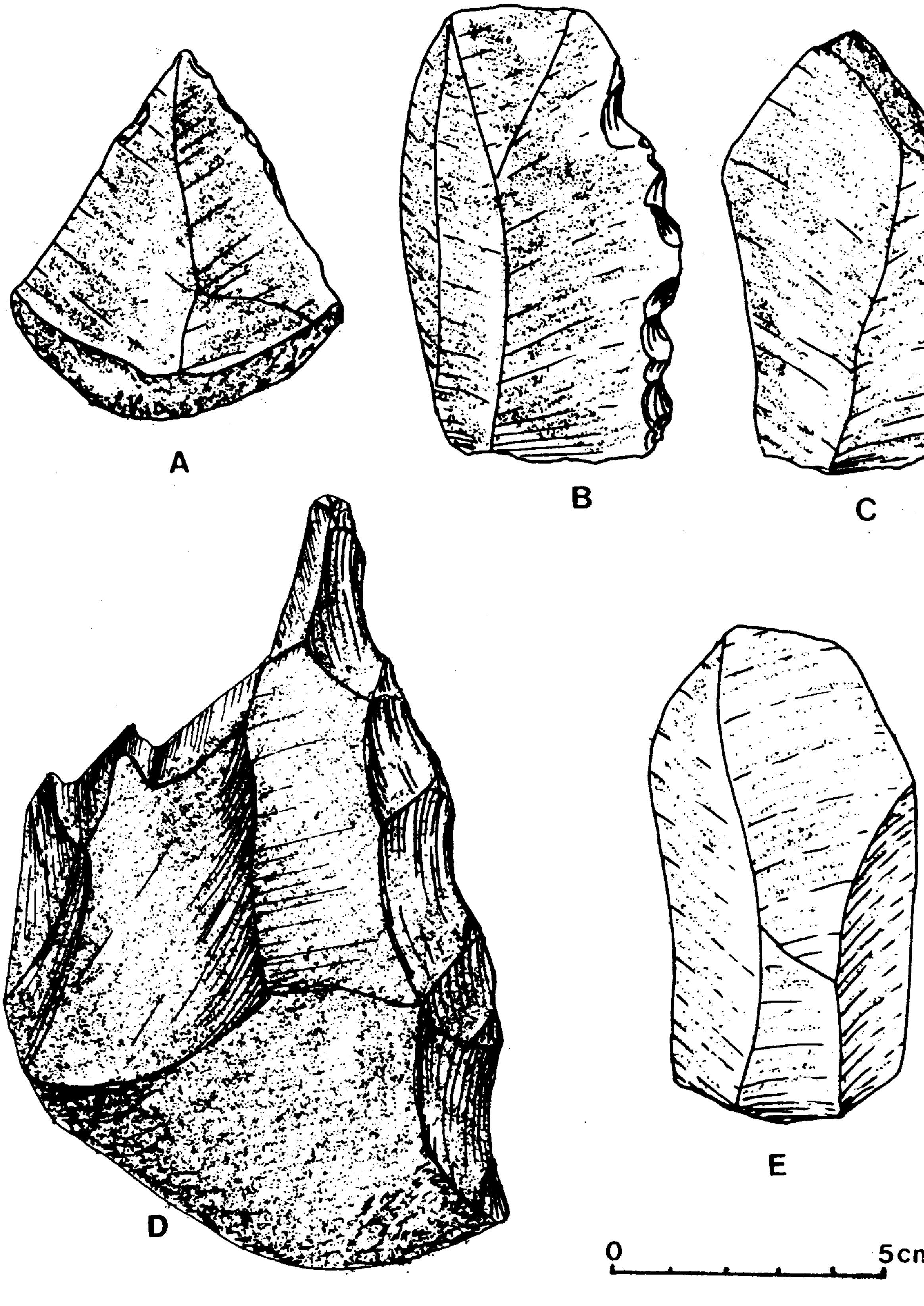

Fig. IX-1 Quartz (A-B), granulite (C, E) and quartzite artifacts (D).

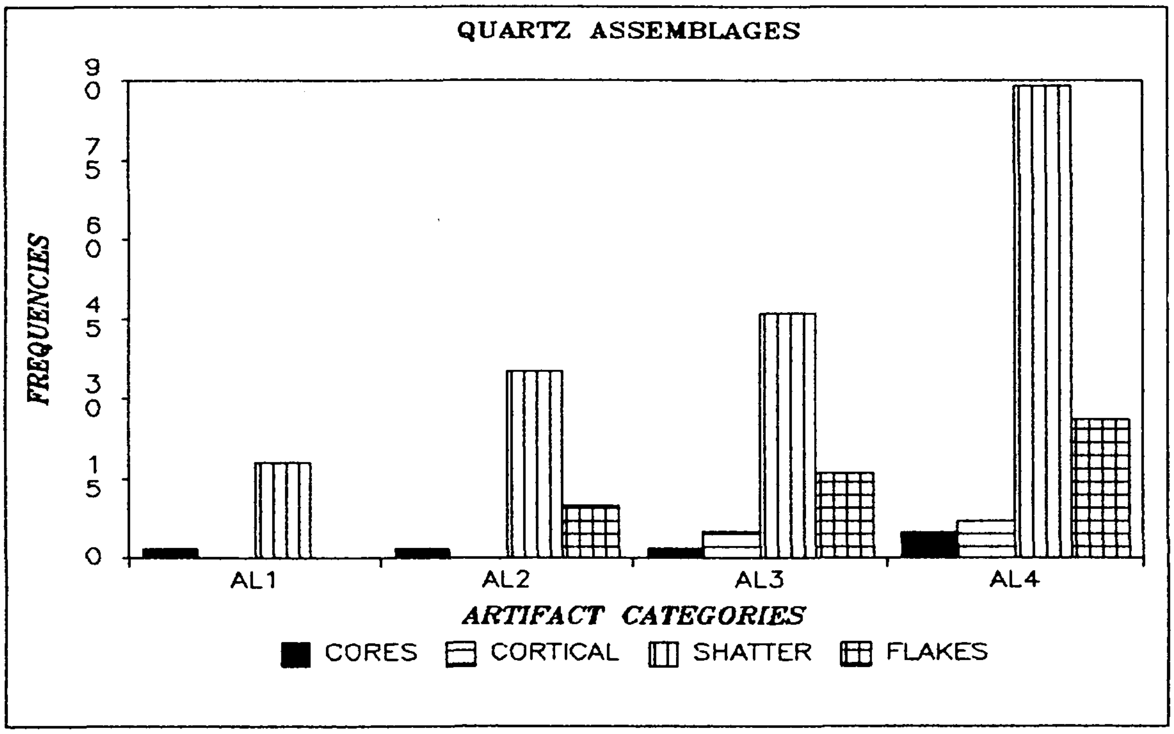

Fig. IX-2 Distribution of quartz pieces by artifact categories and by levels.

Pebbles picked from the Kamp River gravels may have been frost cracked. Alternatively, quartz chunks may have shattered when exposed to heat or when used as percussion tools.

TABLE IX-1 QUARTZ ASSEMBLAGE

	ARTIFACT FREQUENCIES				WEIGHT (IN GRAMS)			
	cores	cortical pieces	shatter	flakes	cores	cortical pieces	shatter	flakes
AL1	2	-	18	-	518	-	434	-
AL2	2	-	35	10		-	390	288
AL3	2	5	46	16	322	345	1,047	747
AL4	5	7	89	26	1,578	649	1,649	783

The relative proportion of the different categories of quartz artifacts remained relatively constant between levels considering the differences in the total number of artifacts present in each assemblage (Fig. IX-2, Table IX-1). Quartz flakes and shatter were associated with bone splinters and other faunal debris. The association is most clearly seen in AL2 where all quartz pieces were recovered in the area of the hearth along with scattered food debris. In AL4 as well, quartz pieces were more abundant in areas of hearth cleaning debris. The direct spatial association suggests that quartz artifacts were associated with butchering and cooking activities. The scarcity of quartz pieces in the AL1 workshop adds negative evidence to the proposed interpretation. In the context of butchering and cooking activities, quartz pieces may have had multiple functions, flakes being used to deflesh carcasses or cut meat, chunks or pebbles to smash long bones and mandibles for marrow. Pebbles may have also been used as pot boilers which would account for the presence of so much small shatter. The assemblage, as a whole, represents a set of expedient tools made on the spot, around the hearths, from blocks of raw materials obtained locally.

B- QUARTZITE AND GRANULITE ASSEMBLAGES

Granulite was seldom used as raw material by Paleolithic groups. It was introduced at Grubgraben in the form of cobbles with a weathered outer surface. The rock has a platy structure and tends to break into platelets when hit by a percussion tool. Knappers attempted to control the fracturing process in order to obtain wedges with a ring of cortex around three sides and a straight cutting edge or naturally backed pieces (Fig. IX-1). Blades are rare. Two specimens from AL4 have traces of use along the lateral edges. In addition to the artifact listed in Table IX-2, a number of split pebbles and choppers were recovered from the AL2 pavements. Granulite knapping produced a few expedient tools whose spatial distribution is comparable to that of the quartz specimens.

TABLE IX-2 GRANULITE ASSEMBLAGE

	CORES	WEDGES	CORTICAL FLAKES	NATURAL BACKED FL.	BLADES	SHATTER
AL2	1	1	4	0	3	4
AL3	1	0	6	3	6	4
AL4	4	4	6	8	4	7

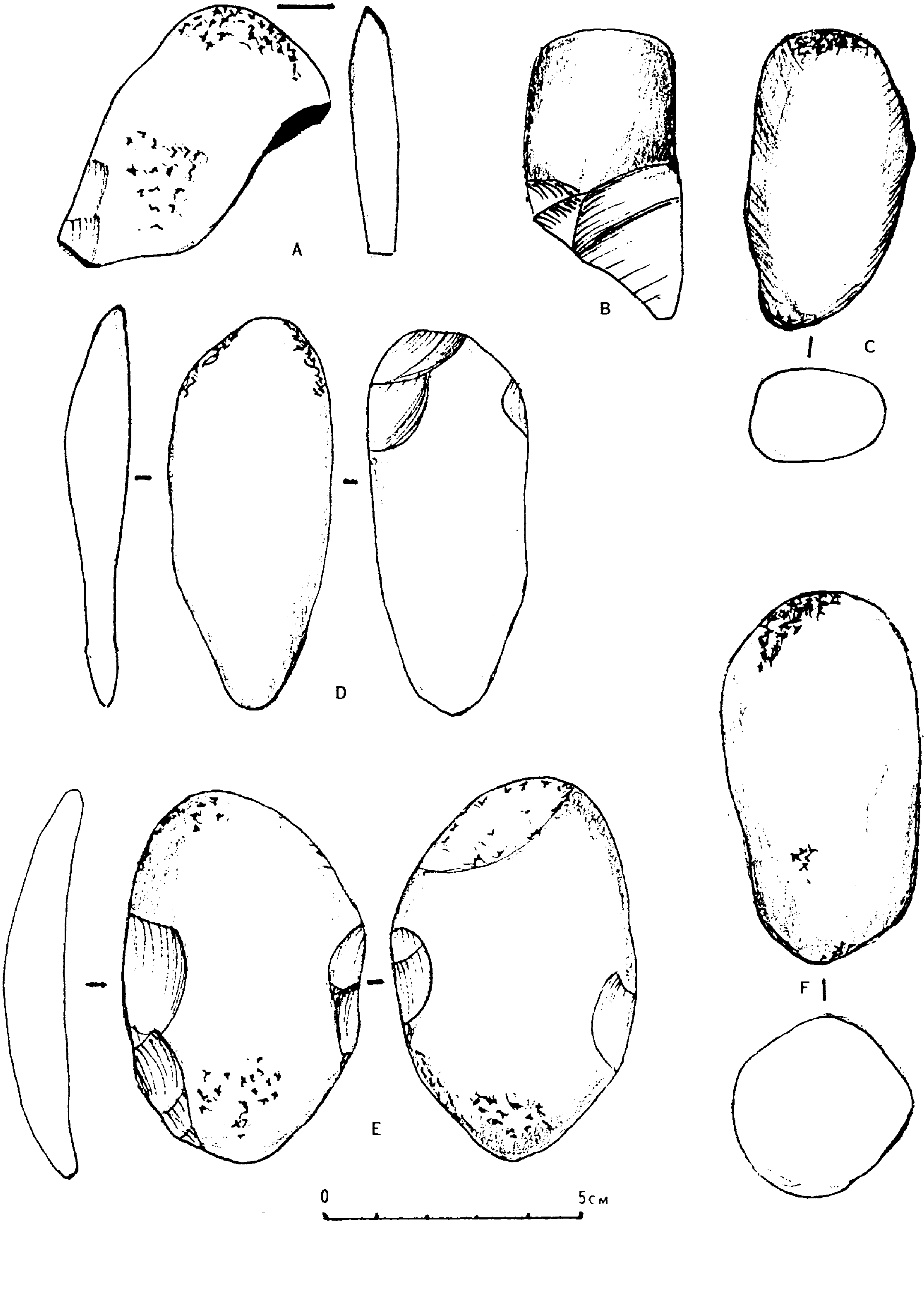

Fig. IX-3 Percussion tools.

Quartzite pieces include several choppers and picks (Fig. IX-1) which may also have been part of a butchering tool kit.

C- PERCUSSION TOOLS

Series of small quartzite, schist and sandstone pebbles with percussion marks were recovered in each level. These artifacts fall into two categories. The first includes a series of long and narrow pieces with rounded cross-sections and diameters ranging between 15 mm and 35 mm (Fig. IX-3 C, F). On these specimens traces of use are concentrated at both extremities implying use as percussion tools or pestles. Some of the specimens were broken by lateral impact (Fig. IX-3 B).

The second and more common group includes wide and thin pieces with flat or slightly curved surfaces (Fig. IX-3 A, D, E). On these specimens, pecking marks occur both at the extremities and on the distal portion of the flat surfaces. Lateral edges are often chipped and many specimens are broken. Specimens of both types occur at all levels.

D- THE FLINT AND RADIOLARITE ASSEMBLAGES

Flint and radiolarite artifacts form the bulk of the lithic industries. Samples of sediment matrix taken from AL3 and AL4 contained minute splinters of less than 3 mm indicative of the fact that some flint knapping was taking place in site. However, the flint knapping done at the AL1 workshop or around the AL2 hearth may not represent the complete reduction sequence of flint and radiolarite blocks.

1-The reduction sequence

Elements attributed to stages of the reduction sequences are as follows:

a.Cores

Cores fell into categories of "large" with weight greater than 100 gm, "small" with weight of 40 to 90 gm and "miniature" with weight of less than 30 gm. The larger specimens occurred in AL2. Among these was an unexploited specimen of coarse grained, green radiolarite which had been prepared on one side to produce a quadrangular cross-section. Two pieces of tabular raw material indicate attempts at alternate removals of blades on either side of a platform edge, across the thickness of the tabular chunk (Fig. IX-4 K). Other large cores are polyhedral and irregular (Fig. IX-5).

Small cores are flat with one or two opposed platforms (Fig. IX- 4 E, I, J, L). Removal scars indicate that the last stages of blank removal produced small flakes and bladelets of less than 30mm in their maximum dimension. Miniature cores (Fig. IX-4 H) are conical, the last stage of blank removal having produced micro-blades .

b.Trimming flakes and core renewal flakes

Large cortical flakes 70 to 100 mm in length representing the partial trimming of a block of white flint were recovered from AL1. Their number was insufficient to permit the reconstruction of the initial block. A number of cortical blades (Fig. IX-4 B, C) show that , in the case of cobbles, blade removal started with little if any trimming beyond the preparation of a platform at one of the narrow ends of the core. The length of cortical blades varies between 60 and 85 mm. Semi-crested blades (Fig. IX-4 A, D) and platform flakes are the result of rejuvenating the core by changing the platform angle while maintaining the same direction of blank removal. In other cases, flakes

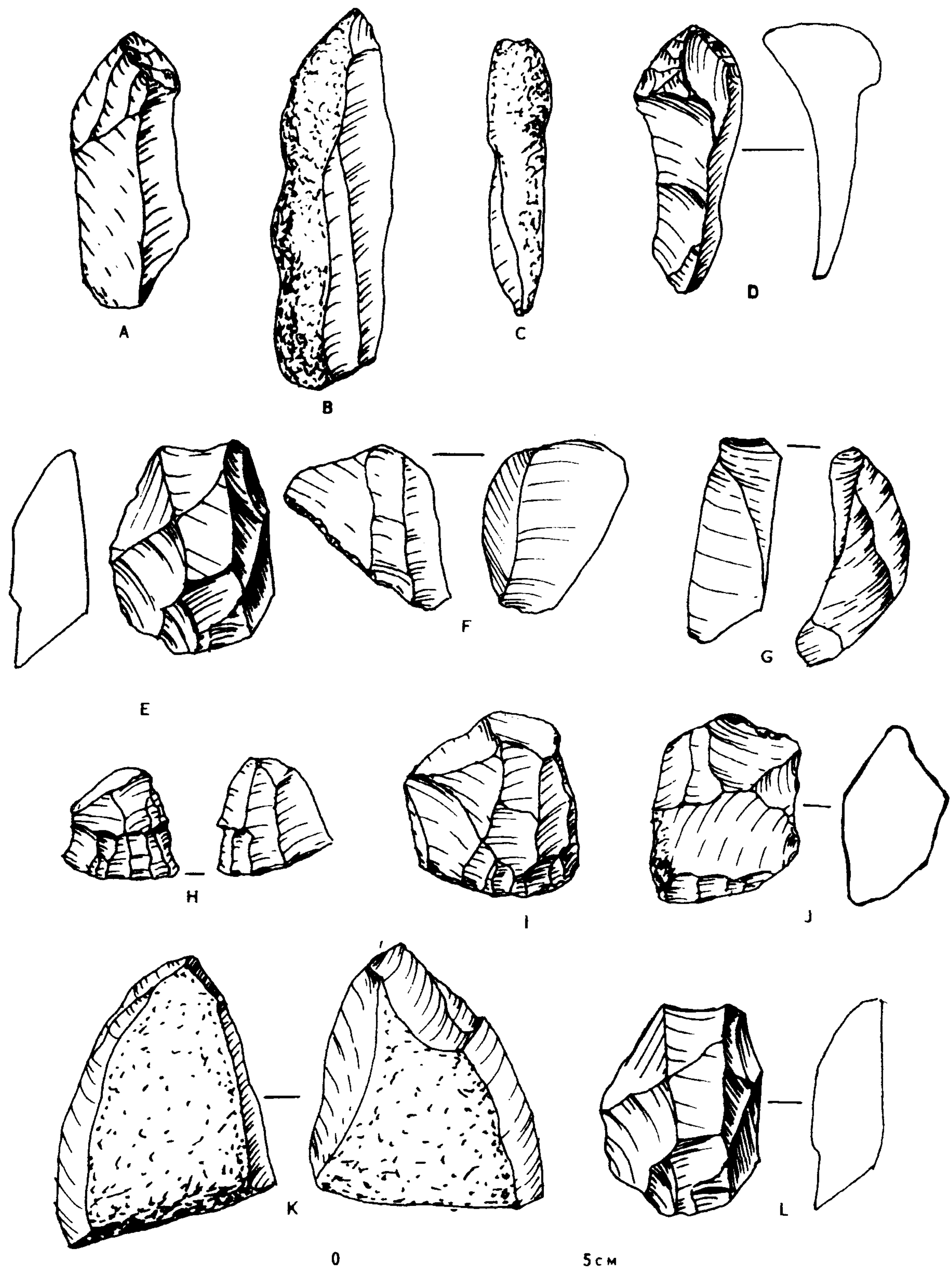

Fig. IX-4 Cores, cortical blades and core preparation products.

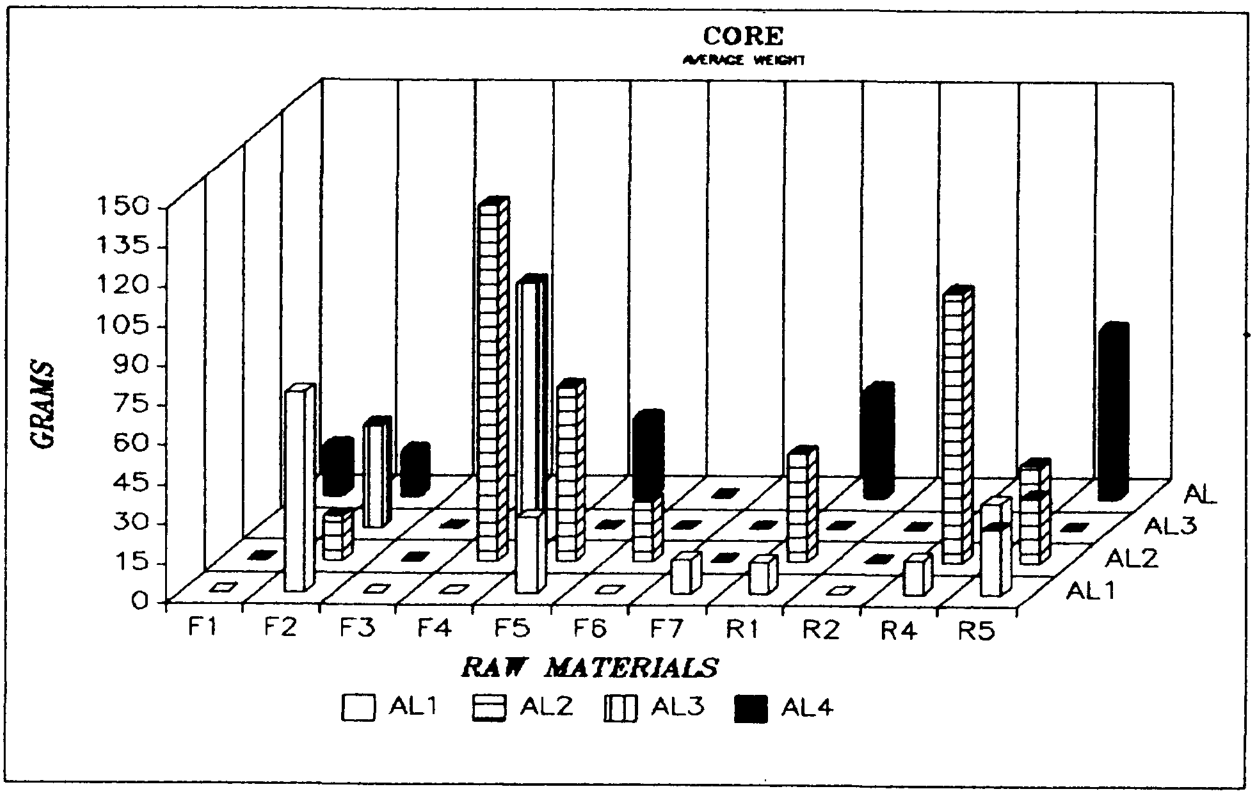

Fig. IX-5 Average weight of cores by categories of raw materials and by levels.

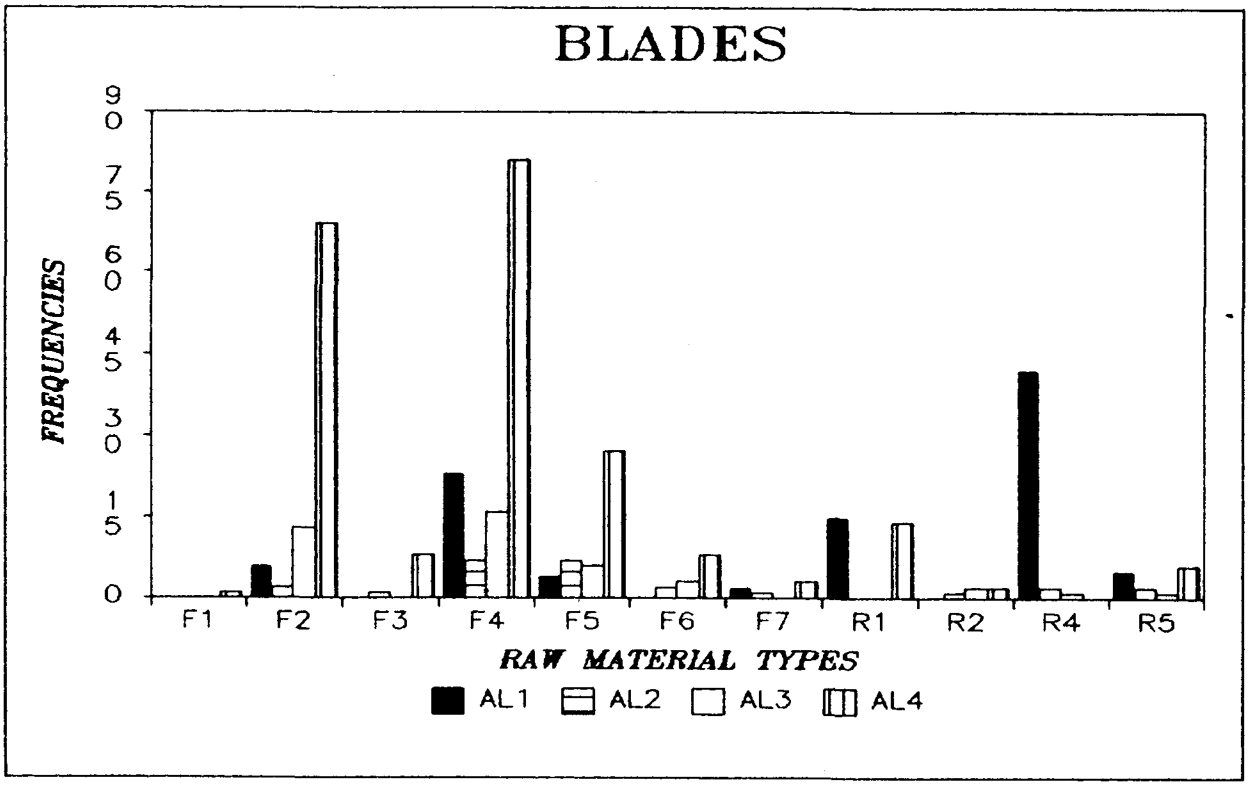

Fig. IX-6 Blade frequencies by raw material categories and by levels.

c. Flakes and Blades

The weight distribution curves of flint and radiolarite flakes show that small pieces of 1 gm or less predominate and that about 90% of the specimens fall below 10 gm in AL2, AL3 and AL4 and 80 % in AL1. (Fig. IX-6). The small size of the flake assemblage strongly suggests that flakes were the result of the secondary preparation of core platforms and the manufacture and recycling of tools.

Varieties of flint were preferred to radiolarites for the manufacture of larger blades in all levels except in AL1 (Fig. IX-6). Everywhere, most of the blades were fragmented.

With the exception of a few large, overshot blades of larger dimensions, complete blades are short and narrow as well as irregularly shaped. The small size of blades and blade fragments is reflected in the average blade weight of 4.2 gm (Table IX-5).

The larger, regularly shaped blades were used as blanks for the manufacture of scrapers, burins and other tools. Few, if any, were discarded.

In summary, the knapping process started with minimal trimming, probably in an effort to conserve materials. Once the initial platform had become unusable after a few blades had been drawn, two alternate strategies could be applied. The first involved the removal of a platform flake, some lateral preparation and the removal of a semi-crested blade. The other consisted in preparing a second platform at the other end of the core by removing the distal end of the original core. The reduction process continued until the cores were reduced to a minimum size that did not permit the production of blades of more than 30 mm. Intense reduction was equally applied to all varieties of raw materials at least in the AL3 and AL4 assemblages where the average core weight was 39 gm and 25 gm respectively. In both AL1 and AL2 a few larger cores, weighing between 60 gm and 100 gm were recovered along with some very small specimens of less than 20 gm (Table IX-3).

Large, thick flakes and tabular pieces were in turn exploited as cores to produce spall-like small blades and bladelets as mentioned in the preceding section (Fig. VIII-4 and 5). The process of tabular flake reduction completed the repertory of knapping techniques recognizable within the site assemblages.

2- The tool assemblage

Tools represent about 25% of the debitage while flakes account for 55% and blades about 20 % (Fig. IX -7). It is of some interest to note that the overall proportion remains the same between levels whereas the relative contribution of the different kinds of raw materials changes significantly as discussed earlier. The overall figures fall well within the range of assemblages from Central European Gravettian sites where flint knappers faced raw material constraints similar to those existing at Grubgraben. That is to say sites where raw materials were introduced in the form of blocks requiring little preparation and where extreme core reduction indicated a need to economize raw materials. The sites of Lubna I, II, III and IV (Czechoslovakia) where flakes accounted for 50 to 55% and blades for 10 to 20% constitute a good example of a similar situation (Kozlowski, 1986).

With the exception of AL4 where a total of 155 flint and radiolarite tools were recovered, the tool assemblages are small, 23 in AL2, 42 in AL3 and 63 in AL1. However, significant differences appear in the composition of these assemblages. The AL1 assemblage is dominated by burins and marginally retouched blades with scrapers and armatures present in lesser percentages. Scrapers constitute the dominant group in the other levels (Fig. IX-8 and Table IX-6). A greater number of scrapers was associated with the activity area around the hearth and the paved structure in AL2 and

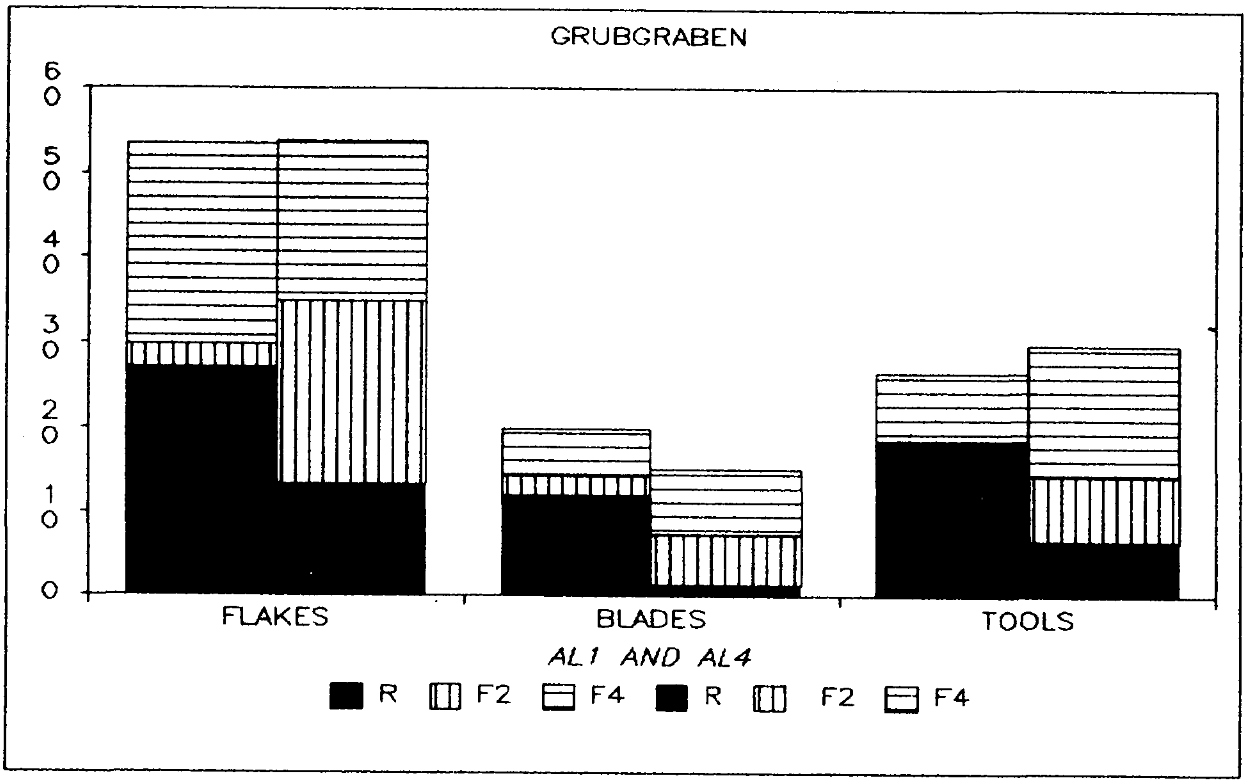

Fig. IX-7 Relative frequencies of flakes, blades and tools by raw materials for AL1 and AL4.

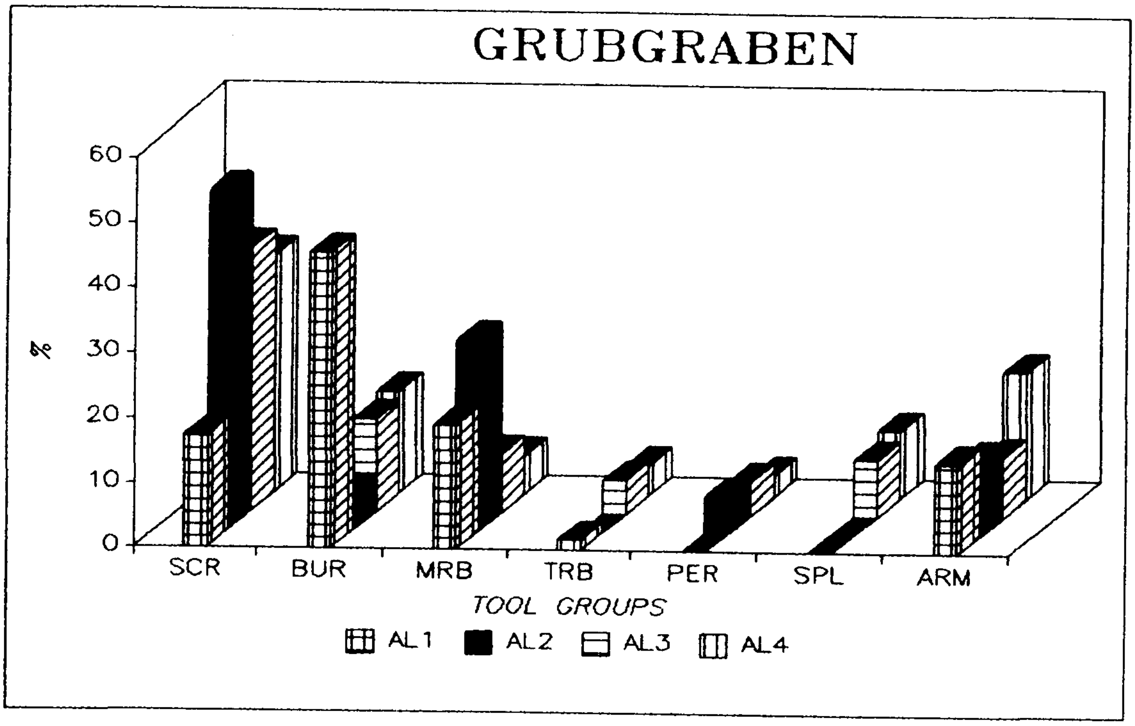

Fig. IX-8 Relative frequencies of tool groups by levels. SCR, scrapers; BUR, burins; MRB, marginally retouched blades; TRB, Truncated pieces; PER, piercers; SPL, splintered pieces; ARM armatures.

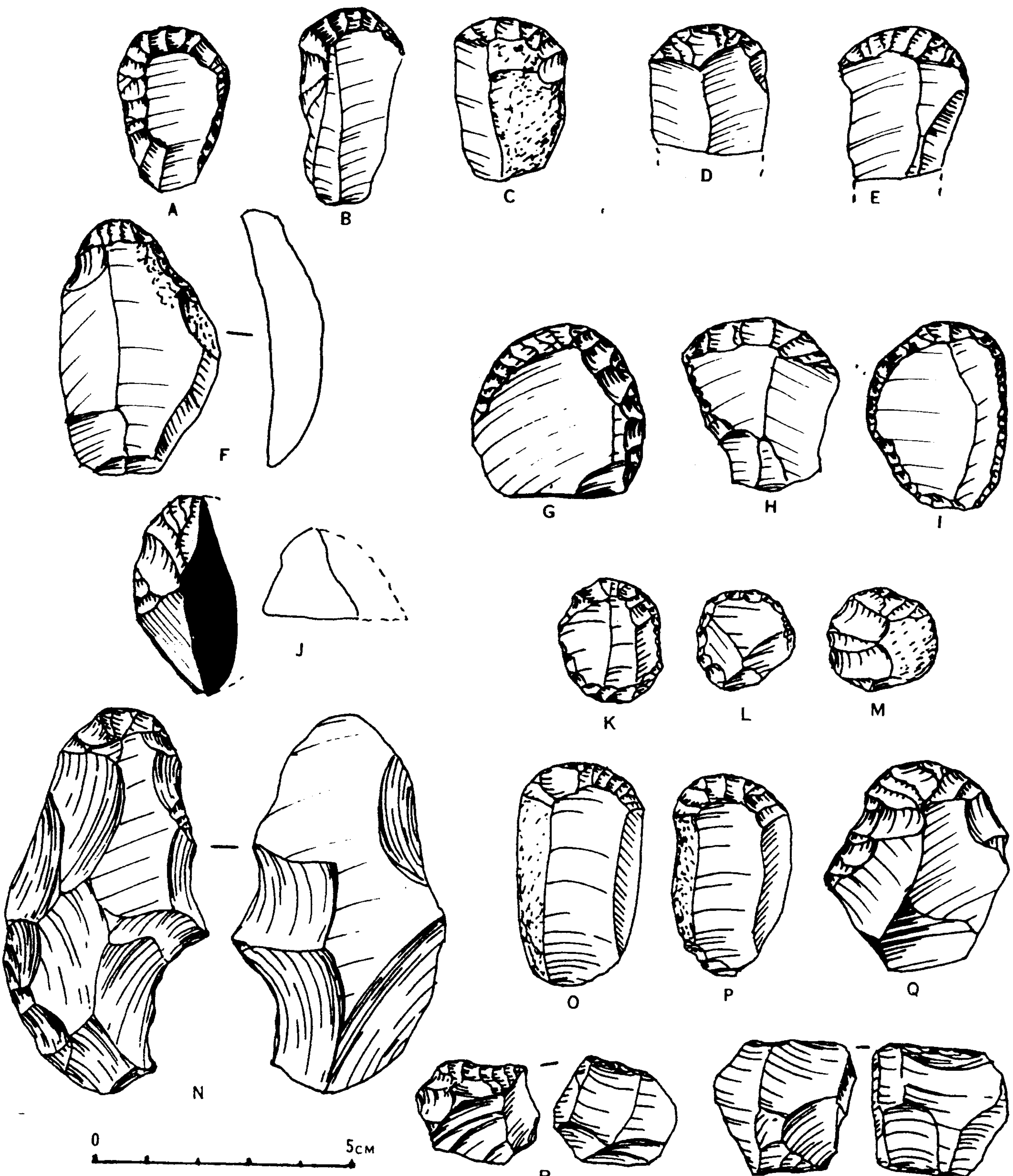

Fig. IX-9 Different varieties of end-scrapers and splintered pieces with areas of hearth cleaning debris in AL4. Burins were localized in specialized activity areas clearly identified in AL1. A comparable situation existed at Kadar where burins were found in greater number in an area located to the side of a hearth and a flint knapping workshop whereas scrapers were concentrated within the structure identified as a dwelling (Montet-White *et al.*, 1986).

The assemblages are marked by typological diversity. The 22 specimens from AL2 represent 16 different tool categories of the Sonneville-Bordes and Perrot (1954-57) type-list, the 42 tools from AL3, 22 categories and the 155 tools from AL4 fall into 29 categories. The tool kit of the AL1 workshop contained 16 different tool forms. Different factors contribute to the high degree of morphological variability of the flint and radiolarite tools: choice of blanks, intensity or invasiveness of retouch and, more important perhaps, sharpening and recycling processes. The relative importance of these different factors on each tool group is examined in the following pages. The discussion is based on the assumption that metrical variations reflect the degree of tool specialization. Therefore, measurement distributions which may show continuity or clustering are as important a component of tool definition as morphological and technological characteristics. Metrical variations are especially useful in assessing patterns of tool reduction which probably related to intensity of utilization. This is the approach taken in a number of recent studies of Mousterian variability (especially Dibble, 1988; Jellinek 1984; Rolland, 1981). The same approach has been applied independently to the study of Upper Paleolithic assemblages (Montet-White, 1982, 1988).

Scrapers

Because they produced the widest and longest blanks, flint varieties were the preferred materials for scraper manufacture in AL2 (76%), AL3 (86%), and AL4 (95%) (Fig. IX-10, Table IX-7). More specifically, flakes of patined flint F2 and blades and tabular flakes of white (F4) and grey (F5, F6) flints were selected to make end-scrapers in AL4.

Blades selected for scraper manufacture are 18 mm to 25 mm wide, which implies careful selection within assemblages where blanks of this size were in small number. It is difficult to estimate the degree of length reduction that resulted from the scraper edge retouch as so few specimens of 15 mm to 25 mm wide, unretouched blades remained within the assemblages. In any case, the Grubgraben end-scrapers on blades are short, with length varying between 35mm and 50 mm (Fig. IX-9 B, C, O, P). Scrapers on flakes are short and often as wide as they are long (Fig. IX-9 G). The scattergram of scrapers length and width shows that the distribution of scrapers on blades and that of scraper on flakes largely overlaps (Fig. IX 11). Originally, flake and blade scrapers tend to be more distinct. But, the progressive reduction due to sharpening and breakage reduces shape differences and produces an homogeneous group. Sharpening methods vary according to blank types. When resharpening by marginal retouch becomes difficult, the tip of blade scrapers is snapped off, reducing the tool length (Fig. IX-9 D,E) whereas both the end and the lateral edges of flake scrapers are broken off as described above (Fig. VIII-4) reducing the width as well as the length of the tool. In both groups, scraper edges are convex (70%) to round (20%) or flat (10%). Scraping edge retouch is parallel and lamellar on almost all specimens and sometimes extends to the lateral margins (scrapers on marginally retouched blades Fig. IX-9 A, B; scrapers on retouched flakes, H; circular scrapers, I). It seems, then, that scrapers on blades and scrapers on flakes constitute a single tool type. And, the scarcity of wide blades was compensated by using lamellar flakes and some tabular flakes.

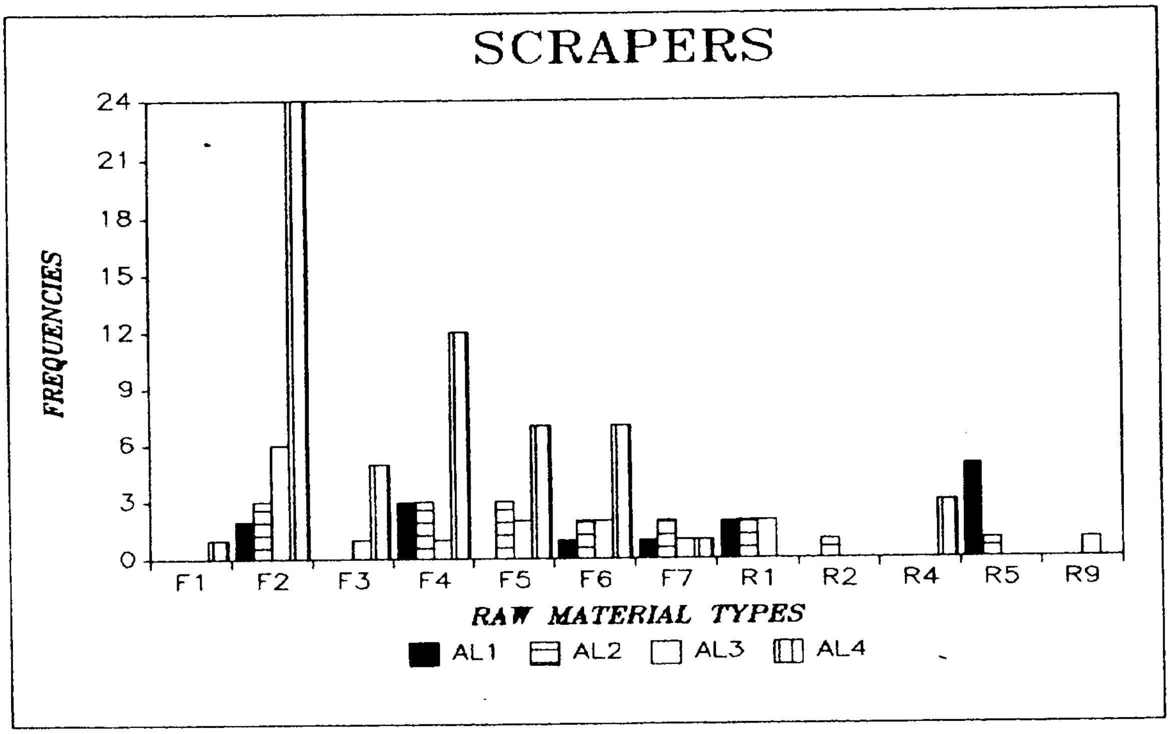

Fig. IX-10 Distribution of scrapers by raw materials and by levels.

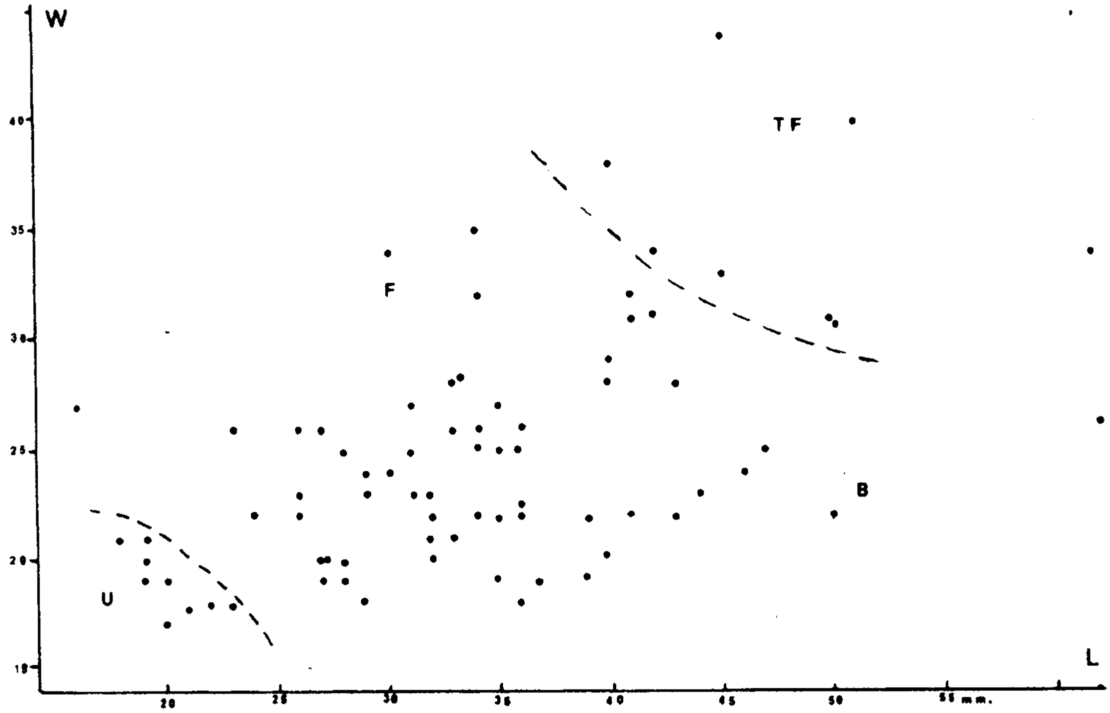

Fig. IX-11 Scattergram of scraper measurements; length on the X axis and width on the axis. U, ungiforms; B, blades; F, flakes; TF, tabular flakes.

The small group of unguiforms from AL3 and AL4 are made on blades (Fig. IX - 9 K), flakes (Fig. IX-9 L), and even cortical flakes (Fig. IX-9 M). It is difficult to know whether these artifacts are a definite tool type or whether they represent the ultimate stage of scraper reduction. However, on the width-length scattergram (Fig. IX-11), unguiforms do constitute a well defined cluster which is separated from the smaller scrapers on flake or broken blade. This argues in favor of their being a distinct tool type or, more probably, a distinct tool element perhaps associated with different types of handles.

The scrapers on tabular pieces are characterized by more or less pronounced, shouldered working edge (Fig. IX-9 F, N). Some specimens are associated with deep scalar retouch of the inner face. These specimens, which are outliers on the scattergram, may well have constituted a separate tool type. A few specimens of carinated scrapers are similar in shape and size to the small group of scrapers on thick cap flakes noted above (Fig. VIII-2 A,B). In all these specimens, the most important trait seems to be the maximum thickness of the blank and the steep, rounded shape of the scraping edge. Several of the carinates have been broken in two by hitting the crest of the dorsal face (Fig.IX-9 J). Carinates constitute a group distinct from shouldered scrapers and from the blade and flake scrapers.

The model of scraper variability at Grubgraben can be summarized as follows:

cortical flakes → carinates
tabular flakes → shouldered scrapers
flakes, blades → end-scrapers(+ marginal retouch)
blade/flake fragments → unguiforms

The Grubgraben scrapers differ from scraper series from the Gravettian levels of Willendorf II and from the Epigravettian series of Kadar. In the latter assemblages, scrapers formed a homogeneous group characterized by a narrow range of measurement variations which reflected a high degree of blank selection (Montet-White 1984, 1988). However, the Sagvar scrapers exhibit a wider range of metrical variations and include a greater variety of blanks. It appears that at Sagvar and at Grubgraben raw material constraints had considerable effect on the shape and size of lithic tools. However, in all these assemblages the common scraper form is of short to medium length, lamellar in shape, with a convex to rounded scraping edge. Lateral retouch appears as a secondary characteristic at Grubgraben where marginally retouched blades are few whereas, at Kadar especially and to a lesser degree at Sagvar, both marginally retouched blades and end-scrapers with lateral retouch are well represented.

Carinate and shouldered scrapers are represented in small numbers at Sagvar as well as at other Epigravettian sites in Hungary. Unguiforms do not appear in the Sagvar inventory. These small scrapers appear as a technological innovation in the Grubgraben assemblage.

Burins

At all levels are found a small percentage of burins made of white flint; however, a large proportion of AL4 burins are made of patined flint (F2) and AL1 burins of green radiolarite (R4) (Fig. IX-12")

In terms of size, burins fall into two groups, a larger group including specimens weighing between 18 and 53 gm and a smaller group comprised of specimens ranging between 5 and 15 gm. In addition, there is a group of burin tips which weigh between 2 and 4 gm.

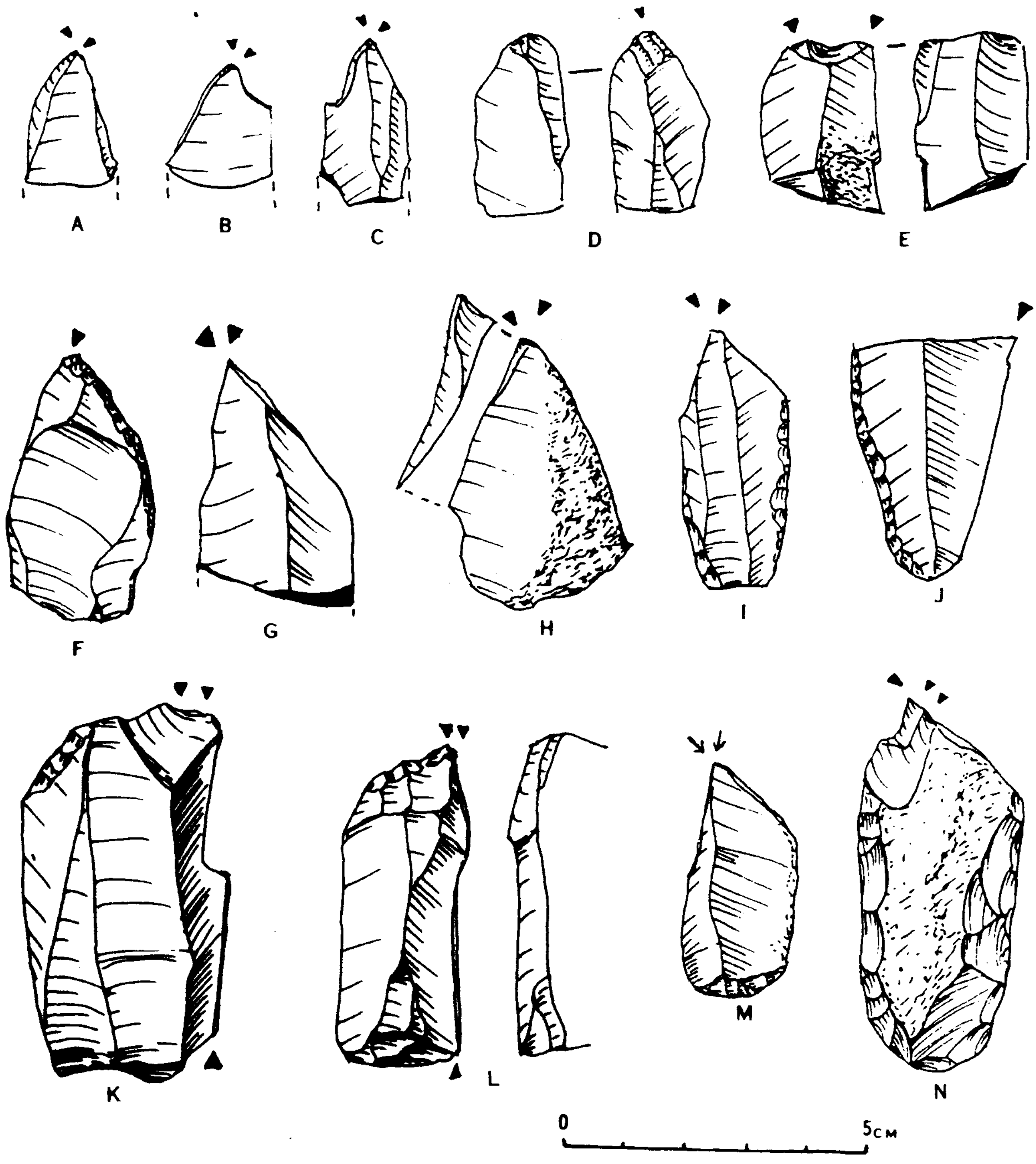

Fig. IX-12 Prismatic burins (K, L, N), light weight burins (E - J, M), and burins tips (A - C).

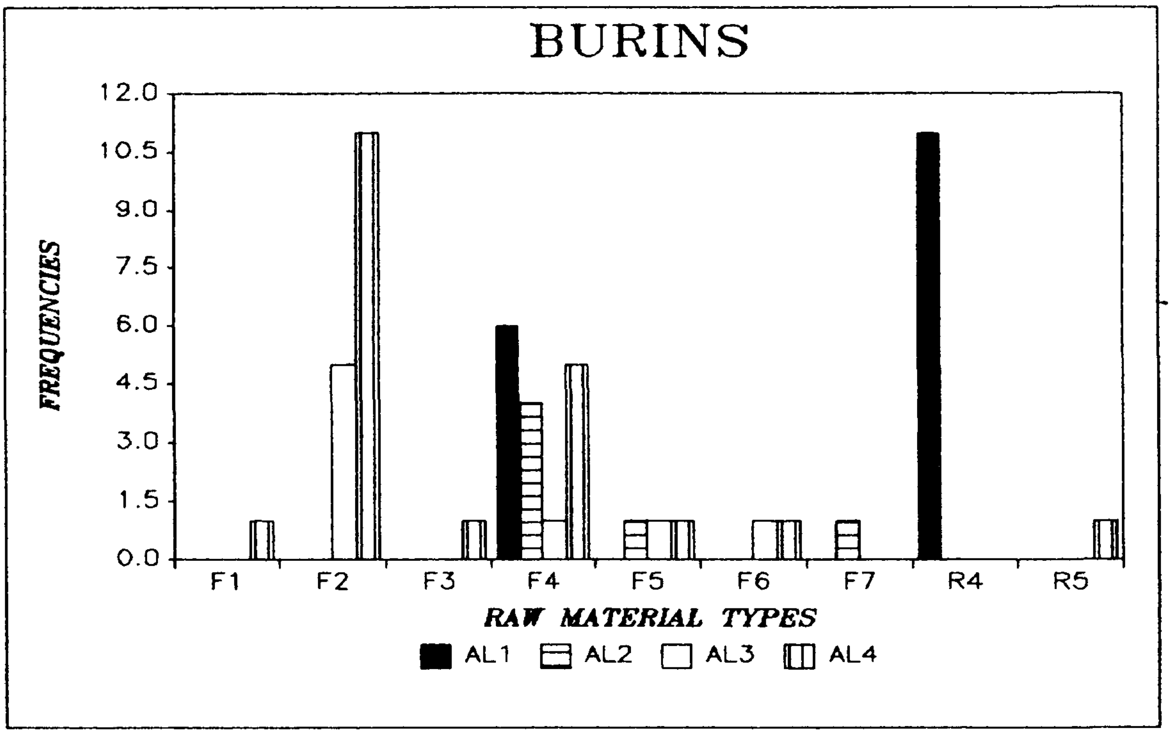

Fig. IX-12" Relative frequencies of burins by raw materials and by levels.

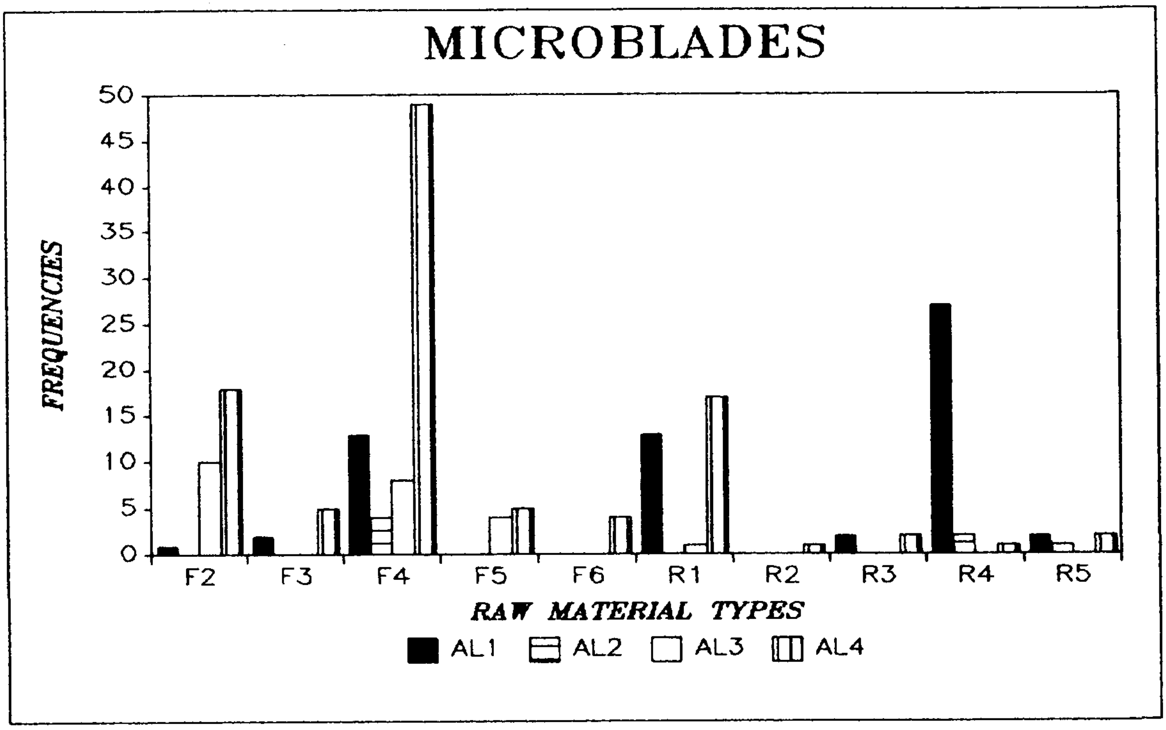

Fig. IX-12"' Relative frequencies of microblades by raw materials and by levels.

The larger artifacts are prismatic burins made on large and thick tabular flakes (Fig.IX-12, K, L, N). Prismatic burins are relatively numerous in the Gravettian industries from Willendorf. The presence of these forms in the Grubgraben assemblages may be viewed as indicative of the persistence of a particular Gravettian technology.

The smaller burins are dihedral, on snap or on truncation; they are made on blades, broken blades, and flakes (Fig. IX-12). In other words, the group of smaller burins is marked by a great deal of morphological and technological variability. All specimens show traces of sharpening. On the average, the proportion of burin spalls to burins is 4/5 to 1 (Table IX- 9). This figure may be taken as an estimate of the number of times a burin could be sharpened. To resharpen burins beyond that point, tips had to be snapped. Broken burin tips and burins on snap were probably the results of this sharpening technique.

We have not been able to refit spalls on burins, but, so far, attempts have been limited to specimens found within 4 square meters. Still, this suggests that burins were used, sharpened and carried away. The recovery of twelve brown radiolarite spalls in AL4 and 3 in AL3 where no burins of this material occurred confirm this interpretation.

Armatures

The group of armatures includes several varieties of modified microlithic blades among which are: flechettes, a series of microlithic blades with continuous, fine, abrupt and direct lines of retouch along one or both lateral edges (Fig. IX-13 F,H); backed bladelet elements, which include small (Fig. IX-13 A) and microlithic (Fig. IX-13 G) blades that are often broken and are characterized by a steep, abrupt, uni-directional line of retouch; and a variety of truncated pieces. Among the latter are microlithic pieces with a steeply retouched transverse edge (Fig. IX-13 B). The small truncated blades (Fig. IX-13 K, O) constitute a somewhat larger variant of the same form. Truncated edges associated with lateral retouch occur on small blades (Fig. IX-13 I, J , R) as well as on microlithic blades (Fig. IX-13 C,D). The first could be viewed as prototypes of the geometric armatures which developed in final Paleolithic assemblages. The thin, truncated and backed microblades are to be associated with a well defined armature type of Epigravettian industries. The one example of a small blade with two opposed truncated edges is to be associated with the group of proto-geometric (Fig. IX-13 E).

Armatures constitute 10% of the tool assemblage in AL3, 15% in AL2, 16% in AL1 and 20% in AL4. White flint is the material most commonly used in the AL4 assemblage along with patined flint and brown radiolarite whereas green radiolarite appears to have been the preferred material in AL1 (Table IX-9, Fig. IX-12'''). It should be pointed out that some of the armatures are made of rare and exotic raw materials. One of the specimens of backed and truncated blades from AL4 (Fig. IX-13 I) is made of a kind of fine grained quartzite. It is the only example of the material at the site. And one fragment of backed bladelet, from AL4 as well, is of rock crystal.

Flechettes and backed bladelet elements are present in all four assemblages. Flechettes have been described in the Aurignacian and early Gravettian levels of Willendorf (Otte, 1981) and, therefore, must be considered part of the Upper Paleolithic tool kit of the region. Small backed bladelets are abundant in later Gravettian phases along with shoulder points (Kozlowski, 1986) and become a predominant element of the Epigravettian of the Central European Basin, notably at Sagvar and Kadar (Montet-White *et al.*, 1986). Various types of truncated blades are also present at the latter two sites.

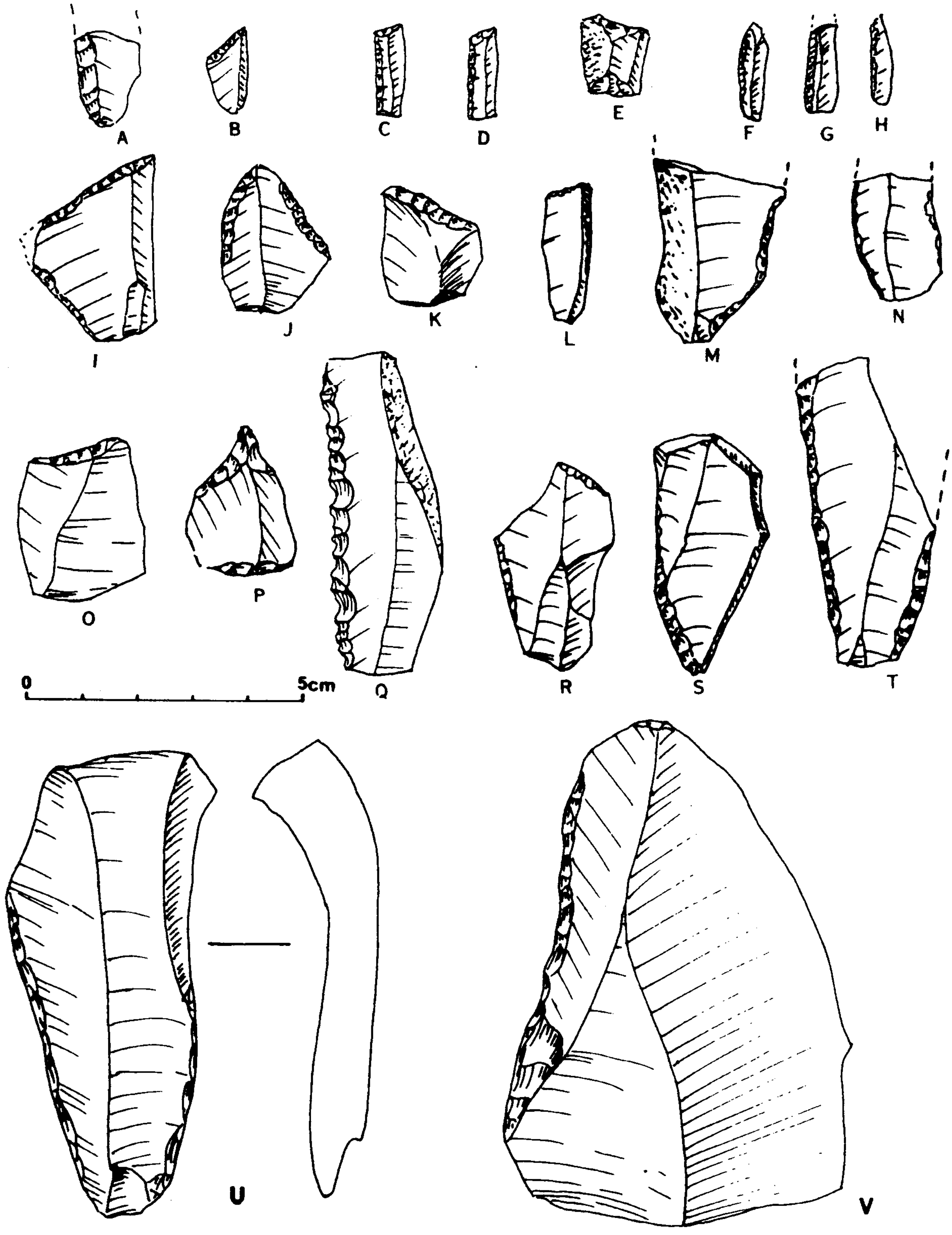

Fig. IX-13 Armatures: flechettes (F-H), backed bladelet (A), truncated bladelet (B) and blade (K,O), backed and truncated bladelets (C, D) and blade (I, J, R), piercer (P), blade with marginal retouch: fine (N), abrupt (M), scalar (S,T, U) and denticulate (Q), side-scrapers (V).

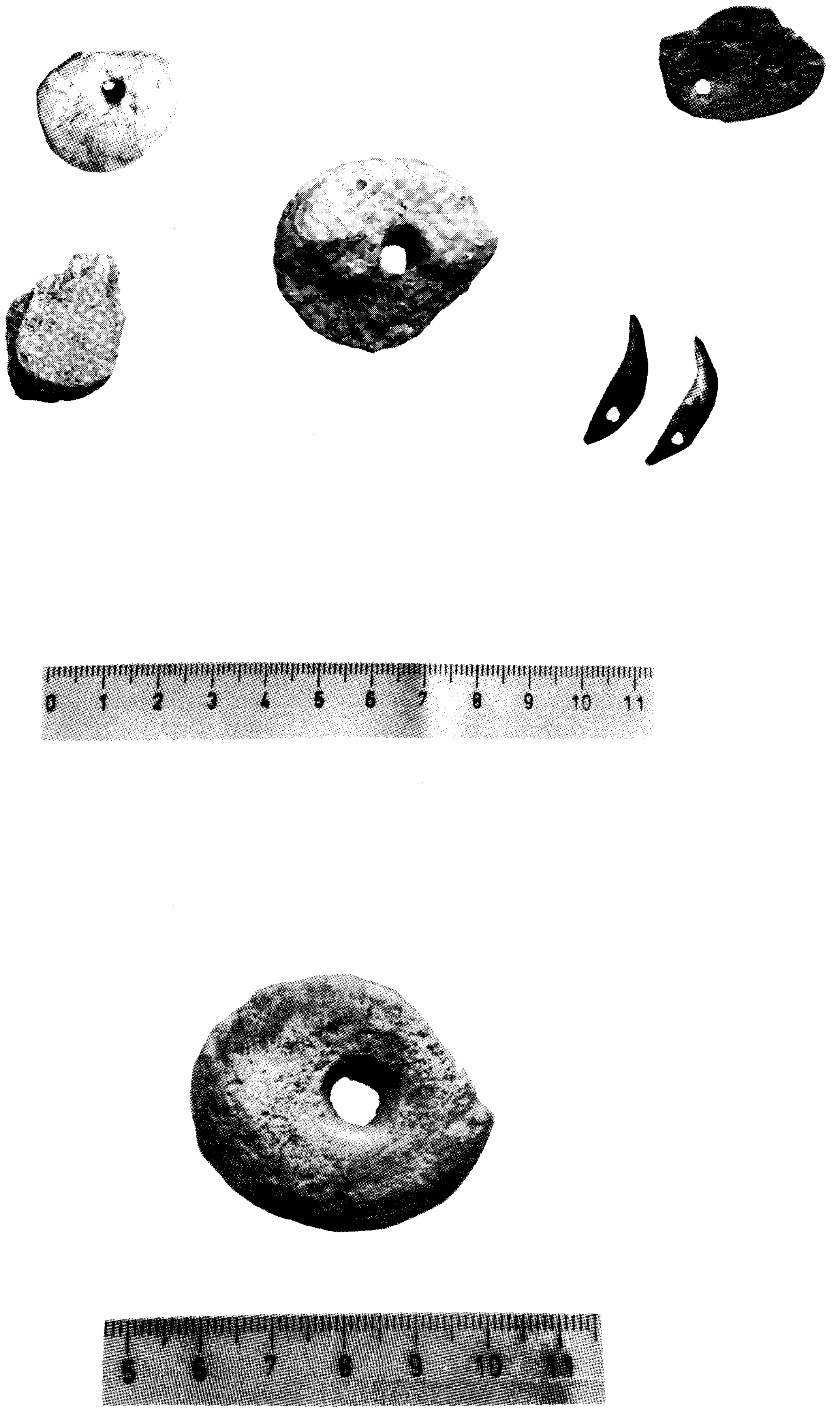

Fig. IX-14 Ornaments: pierced fox teeth, perforated stones.

The microlithic backed and truncated elements have been found only in AL1. This well characterized armature type was recorded at Sagvar in a assemblage dated at 17,760 BP as well as at several Slovenian sites in particular in level A/B of Zupanov Spodmol dated at 16,780 SP and Ovcja Jama (Montet-White and Kozlowski, 1983). At all these sites, the type is represented by a few specimens. However, their occurrence seems to fall within a limited time period around 17,000 BP and they appear to be distributed along the western edge of the Central European Basin.

Other Tools

Marginally retouched blades are relatively abundant in the AL1 workshop where they constitute 19% of the tool assemblage but are rare in the other levels where their relative frequency is between 4.5% and 6%. It may be that in the lower levels quartz and granulite flake knives were substituted for flint and radiolarite blades, especially in areas where butchering was the main activity.

Both the fine abrupt and the scalar retouch are present although not on the same specimens. In most cases, retouch is limited to the distal and/or the proximal section of the blade margins (Fig. IX-13 S, U). Many specimens are broken, either by a single fracture originating from the dorsal face (Fig. IX-13 M, N) or by multiple fractures (Fig. IX -13 T). A single specimen of naturally backed blade with a denticulated cutting edge (Fig. IX-13 O) may be a fortuitous accident.

Splintered pieces occur in AL3 and AL4. They are made from patined flint and white flint blade fragments (Fig. IX-8 R) or core fragments (Fig. IX-8 S). Series of small scalar traces along the working edge battering marks suggest that these pieces may have been used as wedges for splitting bones. Their association with areas where there are quantities of split long bones tends to support this view.

Ornaments

Mention should be made of the perforated stones and shells which were recovered at the site (Fig, IX-14). Dentalia are the most common ornament type. They occur in a variety of sizes. A number of specimens have been cut at the site. The origin of the dentalia is still uncertain but there seems to be a strong possibility that they were not fossil forms found in the Pannonian Basin (Steininger, personal communication).

Two stone beads were recovered from AL4. The smaller specimen made of light weight tuffa was decorated with irregular stripes suggesting the outer surface of a sea shell. The larger one, made of limestone, was cut and polished. The perforation had been done by drilling from both surfaces. A small portion broke off probably during the drilling process.

Another fragment of polished limestone was not drilled. A small piece of slate, oblong in shape had been smootherd and perforated near one of the narrow ends. Three fox teeth had been drilled for suspension.

Summary

The Grubgraben AL4, AL3 and AL2 assemblages belong to an Epigravettian phase with flechettes and small backed elements.

The AL1 assemblage which, in the 1986/87 excavation trench and in the graben is separated from the other levels by at least one meter of loess deposits, is characterized as an Epigravettian with backed bladelets and microlithic, truncated and backed elements. The AL1 assemblage can be characterized also as a specialized tool kit consisting mostly of burins and knives (marginally retouched and unretouched blades) and a few scrapers associated with grinding stones (pitted and broken sandstone slabs), ocher and cut dentalia. It is difficult to identify the function(s) of such a tool kit. The question of its interpretation will have to be re-examined in the context of more extensive excavations of level 1 . The preparation and knapping of one chunk of flint took place at the edge of the workshop.

The AL2 assemblage is a small but diversified assemblage of flint and radiolarite tools, including scrapers, retouched and unretouched blades and flakes, one burin and one splintered piece, and a few quartz flakes. As the tools were scattered around the hearth along with food debris, the assemblage may be interpreted as being associated with cutting meat, cooking and other domestic activities. Microwear analysis of scraper edges may help determine more precisely the end scrapers function(s).

The AL3 and AL4 assemblages are very similar. They include several kinds of scrapers (endscapers made from a variety of blanks which were heavily used, sharpened and recycled, carinates and unguiforms), a small variety of burins and some heavier prismatic burins, piercers and cutting tools which include quartz and granulite flakes as well as flint and radiolarite blades, splintered pieces perhaps used as wedges and a variety of hammerstones. The variety and relative complexity of the assemblages probably reflect a wide range of activities.

The most obvious characteristics of all four of the Grubgraben assemblages are the small number of large trimming flakes, the very small size of the chipping debris and the intensive reduction of cores and tools.

TABLE IX-3: Cores

	AL1		AL2		AL3		AL4	
	#	wt	#	wt	#	wt	#	wt
F1					1	24	1	19
F2	1	76	1	17	1	39	9	157
F3							2	80
F4			3	503	2	93	2	30
F5	1	29	1	66			4	122
F6			2	23				
F7	1	13					1	6
F8								
F9								
R1	1	12	1	41			4	41
R2							1	32
R3								
R4	1	13	1	102				
R5	2	35	1	37			3	191
R9								
T.	7	178	10	789	4	156	27	678

TABLE IX-4: Flakes

	AL0		AL1		AL2		AL3		AL4		AL3/4	
	#	WT	#	WT	#	WT	#	WT	#	WT	#WT	
F1									5	37		
F2	1	1	6	7	3	25	35	77	211	548	5	8
F3			2	2	3	25	2	6	28	113		
F4	1	4	66	377	24	56	51	98	276	466	8	5
F5			3	3	25	58	20	41	131	305	4	3
F6					7	39	12	34	41	107	1	0
F7	3	3	2	2	5	13	4	7				
F8									1	1		
F9					1	1	1	8	2	9		
R1	1	0	32	86	7	30	18	58	39	82		
R2			1	0	1	8	3	4	12	27		
R3	1	1	1	3	3	6			1	1		
R4	4	10	87	308	8	17	2	3	12	26		
R5			11	27	8	25	4	46	19	60		
R9					1	2	1	0				
Misc.			1	1			2	4	1	1		

TABLE IX-5
Blades

	AL1		AL2		AL3		AL4	
	#	wt	#	wt	#	wt	#	wt
F1							1	4
F2	6	25	2	7	8	67	69	171
F3			1	38			8	24
F4	5	104	7	21	7	26	81	153
F5	4	8	7	21	17	28	27	95
F6			2	8	3	8	8	29
F7	2	8	1	5			3	18
F8								
F9							2	3
R1	15	47					14	53
R2			1	0	2	8	2	3
R3								
R4	46	98	2	5	1	3		
R5	6	15	2	6	1	2	6	15
R9								
Misc.	1	4						
Total	105		25		50		221	

TABLE IX-6 FLINT AND RADIOLARITE TOOL COUNTS

		AL1	AL2	AL3	AL4
1a	endscrapers on blade	0	2	1	9
1b	" " on broken blade	2	1	2	14
3a	" " on retouched bl.	0	2	2	12
3b	" " on broken ret. b	3	1	2	1
7	scrapers on flakes	3	1	5	7
8	circular scrapers		1	0	3
9	unguiform scrapers	0	1	2	2
11	carinates	0	1	1	6
13	shouldered scrapers	0	1	0	2
17	scraper-burins	2	0	0	1
19	burin-trunc. blade	0	0	1	0
20	scraper-piercers	0	0	0	1
22	piercers	0	1	1	4
28	dihedral burins	21	0	2	5
30	burins on snap	2	1	1	6
32	prismatic burins	4	0	3	7
34	burins on truncation	2	0	2	4
38	burins on notch	1	0	0	1
60	truncated blades	1	0	3	7
65	marg. ret. blades	6	2	2	3
65a	" " with fine retouch	5	1	1	4
74	notches	0	0	0	3
75	denticulates	0	0	1	1
77	side-scrapers	2	2	2	4
78	raclettes	0	0	0	2
83	flechettes	5	2	1	25
85	backed bladelets	2	2	2	5
86	truncated backed blt	3	0	1	0
91	splintered pieces	0	1	4	16
	TOTAL	63	23	42	155

TOOL GROUPS :		%	%	%	%
SCRAPERS	SCR	17.54	52.20	40.34	36.32
BURINS	BUR	45.61	6	14.27	15.60
MARGINAL RETOUCH	MRB	19.30	30	9.01	5.85
TRUNCATED BLADES	TRB	1.75	0	5.26	4.55
PIERCERS	PER	0.00	6	5.26	3.25
SPLINTERED PIECES	SPL	0.00	0	8.77	10.39
ARMATURES	ARM	14.03	12	9.25	19.48

Table IX-7
Scrapers

	AL1		AL2		AL3		AL4		AL3/4	
	N	WT	N	WT	N	WT	N	WT	N	WT
F1							1	16	1	10
F2	1	1	3	21	6	43	24	170	4	23
F3					1	8	5	48		
F4	4	40	3	23	1	3	12	48		
F5			3	32	2	14	7	100	1	8
F6	1	10	2	12	2	15	7	73		
F7			2	14	1	4	1	5		
F8										
F9										
R1	2	31	2	20	2	21				
R2			1	14						
R3										
R4	5	106					3	33		
R5			1	7						
R9					1	12				
Total	13		17		22		60			

TABLE IX-8
Burins

	AL0		AL1		AL2		AL3		AL4		AL3/4	
	#	WT	#	WT	#	WT	#	WT	#	WT	#	WT
F1									1	5		
F2							5	35	11	67	2	23
F3									1	2		
F4			6	52	4	21	1	2	5	32		
F5					1	19	1	23	1	14		
F6							1	7	1	11		
F7					1	2						
F8												
F9												
R1												
R2												
R3												
R4			11	67								
R5									1	2		
R9												
Total			17		6		8		21			

Table IX-9
Bladelets and Armatures

	AL0		AL1		AL2		AL3		AL4		AL3/4	
	#	WT	#	WT	#	WT	#	WT	#	WT	#	WT
F1												
F2	1	-	1	-			10	7	18	26	2	1
F3			2	-				5	2			
F4			13	2	6	4	8	4	49	17	1	-
F5							4	3	5	1		
F6								4	1	1	1	
F7												
F8												
F9												
R1			13	2			3	1	17	3	1	-
R2								1	-			
R3			2	-				2	-			
R4			27	9	2	2		1	-			
R5			2	-	1	1		2	2	2	-	
R9												
Total	10		60		9		25		104		7	

X

THE EPIGRAVETTIAN OF GRUBGRABEN: AN OVERVIEW OF THE 1986/87 EXCAVATIONS

by

ANTA MONTET-WHITE, PAUL HAESAERTS
AND BRAD LOGAN

The 1986-87 excavations of a 12m by 4.5 m trench that parallels the sunken road of the Grubgraben sampled 4 of the 5 archaeological levels previously identified on the graben profile. The exposed area was part of a wide channel that formed the bottom of the ravine during the late Pleistocene. Series of cores have shown that the site extended beyond the channel, onto an adjacent knoll which occupied the middle of the ravine floor. Examination of the exposed deposits along the present day sunken road in addition to series of cores, test-pits and excavation trench have provided an understanding of the dynamics of the site geomorphology. It has become apparent that the placement of paleolithic campsites shifted through time perhaps in response to the changing landscape. The archaeological assemblages derived from the 1986-87 trench which exposed about 1/50 th of the estimated surface area of the site, provide samples of the kinds of activity areas, habitation structures and workshops associated with the deeper parts of the graben. Sampling of the knoll area begun in 1989 will, it is hoped, continue in the next few years. The high density and the nature of debris recovered from AL4 which included hearths, butchering areas, hearth cleaning heaps and other trash middens indicated that a whole range of activities and probably the center of the settlement were located within the deeper section of the ravine. The maximum extension of AL4 was along the north-south axis of the graben. AL3 was not as extensive in the channel but there are strong indications that the occupation extended over the knoll. Debris from AL3 represent primarily the remains of butchering activities. A complex series of stone paved structures marked the AL2 occupation(s) which occupied the ravine bottom as well as the higher ground to the east. The AL2 excavated area was interpreted as a domestic unit. At the time of the AL1 occupation, the depression had been filled, the knoll had disappeared and the ravine floor was a nearly horizontal surface. The settlement center was to the east in the area which had been a knoll in earlier times and was then at the center of the ravine. The excavated area was a workshop at the edge of the campsite.

First priority was given to the study of the site stratigraphical sequence with the double objective of (1) placing the sequence into a regional framework and (2) establishing the environmental conditions under which Paleolithic groups had been able to survive in the area.

To a large extent, the site of Grubgraben owes its significance to its geographical location in the Middle Danube Basin, just beyond the narrow stretch of the Wachau and at the edge of the northwestern extension of the central European Plain. The loess and loam sediments of the ravine fill are an integral part of the wide loess belt which extend in a west to east direction, south of the Bohemian and Moravian uplands, from the Wachau (upper Austria) to the Carpathians (northeastern Hungary). The 12 meter thick series of sedimentary units recorded at Grubgraben constitute an almost complete sequence of the Late Pleistocene. The information the Grubgraben sequence provides correlates with, and completes, the stratigraphic scheme derived from other archaeological sites in the region, most especially those of Willendorf (Felganhauer, 1954-57), Aggsbach (Felgenhauer, 1953), Stillfried (Fink, 1962), and Stratzing (Neugebauer, 1989). Data from Lower Austrian sites combine now to produce a revised regional sequence which covers most of the Upper Pleistocene.

The archaeological levels are stratified within the middle section of the Grubgraben stratigraphical sequence. The artifactual content of levels AL1 to AL4 can be placed within the cultural sequence of the region. They are attributed to two phases of the Epigravettian which have been recognized in northeast and central Hungary (Dobosi, in press) but were unknown within the vast area of the Middle Danube Basin west of Budapest. Series of C14 dates obtained from bone samples from AL4 corroborate the attribution of the archaeological levels to a time period beginning at 19,000 BP.

On the basis of the Grubgraben data, it has been possible to revise previous interpretations of the loessic record during and after the last glacial maximum, a time period which, until recently, was poorly documented in Central Europe. The paleolithic occupations correspond to periods marked by interruptions in the loess sedimentation. Levels AL4 and AL3 are placed between two loess series, LP1 and LP2, and correspond to periods of climatic amelioration marked by increased humidity and less severe temperatures during which humic horizons formed. The lower soil horizon (HH1) within which AL4 is contained is the most developed of the series. During its formation, clusters of cembra pine and juniper were part of the local vegetation. The abundance of faunal remains indicate that animal life, most especially horse and reindeer, was relatively plentiful in the area; however, the rich and varied fauna that had characterized earlier phases of the Gravettian at Willendorf was greatly reduced. The second humic horizon which corresponds to the AL3 occupation is weak and discontinuous. There is no information on the vegetation as pollen are not preserved at that level. The large quantities of bones recovered from AL3 suggest that a steppe vegetation still supported large herds of horse and reindeer.

AL2 is at the base of a loess series (LP2) and a thin humic horizon was noted just above the pavement. Therefore it can be said that the AL2 occupants probably settled on a stable surface and that loess deposition began immediately after the occupation. They too derived their subsistence from the exploitation of reindeer and horse. AL1 is placed at the interface between 2 loess series. Occupants of AL1 settled on a sub-horizontal erosion surface. Environmental information is still missing since the excavated section of AL1 yielded neither bones nor pollen. It should be pointed out, however, that the 1989 excavations uncovered an area of AL1 where faunal remains were well preserved, with reindeer as the dominant, if not the unique, element. About a meter of loess (LP3) sealed and covered the debris of AL1 occupation(s). Then, a system of channels cut through the LP3 loess and were later filled with sands and sandy ioams. This episode of down cutting and alluvial activity relates to a period of much greater humidity. Finally, a two meter mantle of culturally sterile loess constitutes the last unit of the sequence. The absence of cultural remains within the topmost loess unit must be emphasized. This negative evidence raises the question of human presence in the area during the final episode of loess deposition in the region. It may be that for a relatively limited time period climatic and environmental conditions had reached a threshold beyond which Paleolithic groups could not survive.

A long and complex sequence of loessic accumulation interrupted by episodes of soil formation, colluvial and erosional processes marked the time period from the last glacial maximum to the end of the Pleistocene. It is now well established that loess sedimentation continued, at least intermittently, in the region well into the Tardiglacial. More important to an understanding of the human prehistory of the area, it appears that a significant climatic amelioration occurred at the beginning of the 19th millennium and that a series of oscillations, during which climate was cold but slightly more humid, took place during the following 2 to 3,000 years. It was during these periods of increased humidity that, in spite of the cold conditions, human groups found sufficient resources to survive in the area. The malacofauna from LP2 confirm that the local environment remained relatively humid even during periods of loess formation perhaps because there were springs somewhere in the ravine. The presence of water sources was probably the major factor that attracted human populations into the Grubgraben. According to sedimentological and malacological data, much dryer conditions prevailed, at least locally, during the last period of loess deposition. We found no trace of cultural remains within these deposits. It appears then that lack of water was the factor that prevented human groups from settling again at the Grubgraben.

The archaeological data from Grubgraben establishes two important points: first, that the so-called arctic desert, inasmuch as there ever was an arctic desert in the Kamp Valley, did not occur during the period of the maximum extension of the glaciers but during a more recent phase; and second, that the period of time during which the area was unoccupied was relatively short, in any case, much shorter than had been previously thought.

The humid episodes associated with the formation of the two humic horizons HH1 and HH2 correspond in time to the climatic episode noted at Sagvar and correlate with the Laugerie/Lascaux intervals identified in Southwestern France (Leroi-Gourhan, 1962). The Grubgraben data confirm the interregional character of climatic ameliorations dated between 18,500 and 18,900.

A second research focus of the project was to establish the boundaries of the territory within which the Late Paleolithic groups of Grubgraben operated. A number of sites dated between 19,000 and 15,000 BP have been recorded in Hungary (Gabori, 1988; Dobosi, 1987). campsites like Pilismarot near the bend of the Danube, Sagvar, a winter camp near Lake Balaton, and a series of small hunting camps along the Danube and the Tisza Rivers. The evidence suggests that the western edge and the southern region of the Central European Basin offered a series of refuge niches to late Paleolithic hunters. In that context, Grubgraben could be interpreted as marking the northwestern end of the region in which Epigravettian groups established long term or seasonal base camps. Similarities in the technology and in the range and varieties of processing tools and more important perhaps, similarities in the type of armatures they used support the view that some degree of relationship and interaction existed between occupants of these various sites. Specialized hunting of reindeer and horse characterized their subsistence base.

The area occupied by large, seasonal Epigravettian campsites did not apparently extend beyond the Danube Valley into the Moravian plateau. Recent finds at Milovice, Southern Moravia, confirm the commonly accepted view that major Gravettian settlements belong to an earlier time period. Dates of 25,250 +280 SP (GrN 14824) and 22,900 +490 SP (ISGS 1690) place the mammoth bone hut of the main cultural layer at, or before, 23,000 BP (Oliva, 1988). At the base of the upper loess series which overlays the main occupation layer at Milovice, scattered mammoth bones, a few lithic artifacts and habitational features mark the existence of a more recent occupation with a date of 22,100 +1100 BP (GrN 14825). Oliva emphasizes that the more recent layer represents "the latest traces of Gravettian settlement in Moravia " (Oliva, 1988 :112).

And yet, the analysis of flints and radiolarites provide good evidence that the Grubgraben occupants, among others, crossed the Moravian plateau at least to the area of Stranska Skala and probably all the way to the Upper Oder Basin to obtain flint and to the Vah Valley to get radiolarites. From Grubgraben, raw material acquisition perhaps handled by hunting parties or done as part of yearly group migration meant traveling 400 to 500 km long trails. This could be possible only inasmuch as the environmental conditions and game resources were sufficient to support at least short term camps along the way. The bone and lithic scatters within the upper loess series at Milovice may well represent the remains of short term camps of Paleolithic groups whose base territory was farther south in the Middle Danube Basin.

On the basis of archaeological evidence from Lower Austria, Moravia, and Hungary and taking into account the results of raw material origins, it can be said that the limits of the hunting and raw material acquisition territory of Epigravettian groups extended well beyond the core area where the larger long term camps were located and which encompassed a series of ecotone niches along the western edge of the Central European Basin. The core area was surrounded by hunting territories to the south and east within the Danube and Tisza Plains and by hunting and raw material acquisition territories to the north along the Morava and the Vah Rivers. The movement or migration patterns within the territory and the strategy of raw material acquisition remain unknown. The evidence is too scanty even to discuss hypothetical models of how and when Paleolithic people moved within their territory.

The Grubgraben artifact and faunal assemblages contribute a great deal of new information toward a better understanding of the technology and raw material use that characterize the Epigravettian of Central Europe. As environmental pressures reduced the number of animal species who dwelled in the area, Epigravettian hunters were forced to specialize toward the exploitation of reindeer and horse. Faunal analysis demonstrated that a shift to a focal hunting strategy and the implicit changes this adaptation may have required in settlement patterns are the most important factors that distinguishe the Epigravettian of Grubgraben from the Gravettian populations of Willendorf.

At the same time, study of the lithic industries has shown that the development of microlithic armatures, the appearance of proto-geometric forms and unguiform scrapers are indices of technological change. It is tempting to interpret the appearance of new techniques related to the production and increased use of microlithic forms as a response to changes in hunting strategies. However the possibility remains that new tools and new techniques were acquired through contact with other groups. The marked preference for varieties of patined "northern" flint and white -grey flint over radiolarites was already in evidence at Willendorf. These patterns of raw material selection remained during most of the Upper Paleolithic, a notable trait of the region of Lower Austria where flint sources are scarce. However, the parsimonious use of raw material is a trait characteristic of, and largely limited to, the Grubgraben industries.

In summary, the Epigravettian of the Middle Danube Basin is clearly differentiated from the Gravettian by changes in hunting strategies, settlement patterns and territory and by technological innovations which evolved in response to the increasingly dry climate and the more limited animal resources still present in the region after 20,000 BP.

The focus of the first stage of the Grubgraben excavations has been on establishing the stratigraphic sequence, on environmental reconstruction and on establishing the conditions under which Paleolithic people could survive. The second phase will concentrate on the intrasite variability, on detailed spatial analysis of artifactual and faunal remains and their relations to the stone pavements. That aspect of the research will complete the reassessment of Epigravettian culture by providing data concerning the internal organization and structure of long term (seasonal) base camps.

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