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Wil Roebroeks

FROM FIND SCATTERS TO EARLY HOMINID BEHAVIOUR:

A STUDY OF MIDDLE PALAEOLITHIC RIVERSIDE SETTLEMENTS AT MAASTRICHT-BELVÉDÈRE (THE NETHERLANDS)

UNIVERSITY OF LEIDEN 1988

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contents

1 Historical introduction and background

In 1980 the author started a study of Lower and Middle Palaeolithic surface finds from the southern part of the Netherlands, in a project supervised by Professor P.J.R. Modderman (Leiden). Part of this project consisted in visiting Pleistocene exposures in South Limburg in order to systematically study the local stratigraphy and to look for *in situ* occurrences of palaeolithic material. On September 29, 1980, in the course of these activities, which were supported by associates of the Geological Bureau at Heerlen (Geological Survey of the Netherlands), Mr W.M. Felder found an artefact at the boundary of the Saalian/Weichselian loess deposits in the Belvédère pit near Maastricht (fig. 1).

The Maastricht-Belvédère loess- and gravel-pit is situated NW of the town of Maastricht, on the left bank of the river Maas, and lies on the edge of the so-called Caberg plateau (figs. 1 and 2). The pit had been carved into the steep cliff between the Lower and the Middle Terraces of the river Maas.

Mr Felder's discovery inspired the author to carry out a thorough investigation of the pit sections, together with two amateur archaeologists, Mr K. Groenendijk (of Eckelrade) and Mr J.P. de Warrimont (of Geulle). Several horizons containing artefacts and animal remains were found. Most of these were in stratigraphical positions showing that they were older than the last i.e. the Weichselian glaciation.

The Belvédère research was started as an archaeological project by the Institute of Prehistory of Leiden University, but has since developed into a more comprehensive project, in which scientists of several disciplines and countries are now cooperating. Since 1981, excavations have taken place each year, often under considerable time pressure and sometimes right in front of the digging machines, because the pit is still being exploited by a commercial quarrying firm (fig. 3). The present paper will deal with the results of the 1981-1985 excavations; a short note will be presented on the 1986 and 1987 digs, which will be published *in extenso* elsewhere.

The area surveyed in 1980-1987 comprises approximately five hectares. Figure 4 shows two aerial photographs of the pit, one taken in February 1980, i.e. seven to eight months before its discovery, the other in May 1986. The majority of the data presented in this volume were obtained in investigations of the area that was quarried away in the period between these dates.

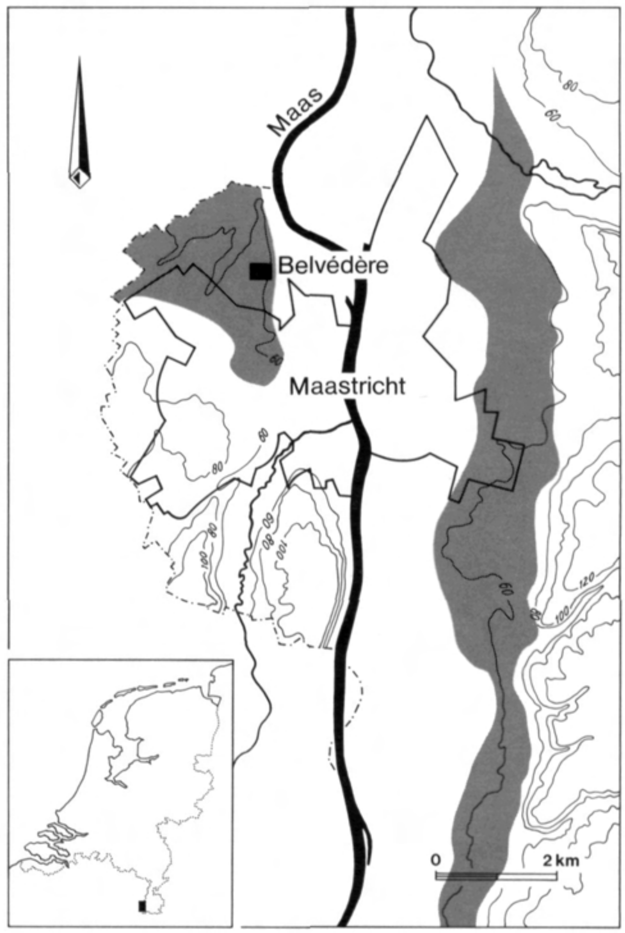


Fig. 1. Situation of the Maastricht-Belvédère pit. The shaded area shows the distribution of the Caberg Middle Terrace sediments (after: Brueren 1945). The Caberg plateau coincides with the western distribution of the Middle Terrace sediments.

At the time of the first investigations, the sites discovered were named according to their geographical position in the pit (East Trench, South Trench, etc.). After several years of fieldwork this system appeared to be impracticable, so we decided to name the different sites alphabetically, in the

Fig. 2. Situation of the Maastricht-Belvédère pit (indicated by an arrow), a view from south of the city of Maastricht (from a colour slide by Airphoto Netten).

Fig. 3. Rescue archaeology at Maastricht-Belvédère: excavation of an Early Weichselian site (Site J) in front of the bulldozer, May 1986.

order of their date of discovery. Table 1 lists the sites, their approximate age, and the areas excavated, while figure 5 shows the exact situation of the sites.

The name 'Belvédère' is in all probability to be related to the view that the edge of the Caberg Plateau must once have afforded over the valley of the river Maas. A map of the siege of the town of Maastricht in 1748[1] shows a military fortification (*redoute de Belvédère*) at the site of the Belvédère pit. From that date onwards, 'Belvédère' appears often on maps of the immediate environs of Maastricht. On the cadastral plan of 'Oud-Vroenhoven'[2], dating from 1843, 'Belvédère' is a toponym for a larger area, centred around a large rectangular building, already visible on the 1748 map to the north of the *redoute de Belvédère*.

Before it became known as a Palaeolithic site, the Belvédère pit had attracted the attention of collectors for several generations because Pleistocene fossils had been found in its exposures. In the first half of the nineteenth century there were several loess- and gravel-pits in the Caberg region. From the 1850s onwards a number of -mostly small- brick factories were founded, which exploited the loess deposits of the area[3]. In the nineteenth century the Caberg plateau became well known for the mammal fossils found in its Quaternary deposits during the construction of the Zuid-Willemsvaart canal in 1823 and in the exposures of the quarries (Crahay 1823; Van den Ende 1835; Kerckhoffs 1884; Martin 1889; Rutot 1893). In 1823 a human jaw was found about 1000 m north of the Belvédère pit below 6.5 m of loess -according to the original publication- which became known as 'la machoire de Maestricht'. The jaw was the subject of a lively discussion (Crahay 1823; Schaaffhausen 1860; Kerckhoffs 1884; De Mortillet 1886; Martin 1889; De Mortillet/De Mortillet 1910; Van Doormaal 1945;

Fig. 4. Two KLM aerial photographs of the Belvédère pit, dating from February 1980 (the top photo) and May 1986, respectively. Scale 1:6000, published with the permission of KLM Aerocarto (1980: film 9672 – photo 9261, 1986: film 0556 – photo 8528).

Fig. 5. Situation of the archaeological sites (A-K) in the Belvédère pit mentioned in the text. Scale 1:2500. (the numbers refer to the coordinates of the topographical map, sheet no. 61F, 1:25.000).

Van der Vlerk 1955) concerning the presumed Pleistocene age of the fossil, which is, however, now considered to be a recent specimen. In 1860 Charles Lyell visited the Zuid-Willemsvaart section, to which he paid considerable attention in a paragraph on 'Human remains in loess near Maastricht' in the edition of 'The Geological Evidences of the Antiquity of Man' (1863: 338-340).

Other important finds -now lost- were made in 1815-1817, during the construction of the 'Willem' fortress at the foot of the Middle terrace of the Caberg plateau, about 1.5 km south of the Belvédère site. According to a report by De Burtin[4], remains of elephant were found, and Habets (1887) also mentions the presence of hippopotamus. The detailed description of the exposure in the manuscript mentions that the fossils were found below a layer of more than 6 m of loess.

Large-scale quarrying in the Belvédère pit started in the 1890s, when Mr Baeten and Mr Lalieu bought considerable areas of land for their Belvédère company, which was officially established in 1897. The pit soon became well known locally for its loess sections and for fossils collected from the gravels and the loess (Klein 1913; Reinhold 1916, 1923; Cremers 1925). Figure 6 shows photographs of the Belvédère pit taken in the 1930s when manual exploitation of the loess and gravel favoured the recovery of fossils; some of these are now in the Museum of Natural History at Maastricht. In the 1920s important Neolithic finds and associated features were discovered and excavated at Belvédère by the National Museum of Antiquities of Leiden (Holwerda 1926-1930). Iron Age and Roman sherds were also collected from the pit area in considerable quantities (Kengen 1928; Disch 1969, 1971/1972).

Van Doormaal (1945) paid much attention to the geology of the Caberg pits. More recently, exposures in the Belvédère quarry have been described by Paulissen (1973) and Bosch (1975). The discovery by Mr Felder, mentioned

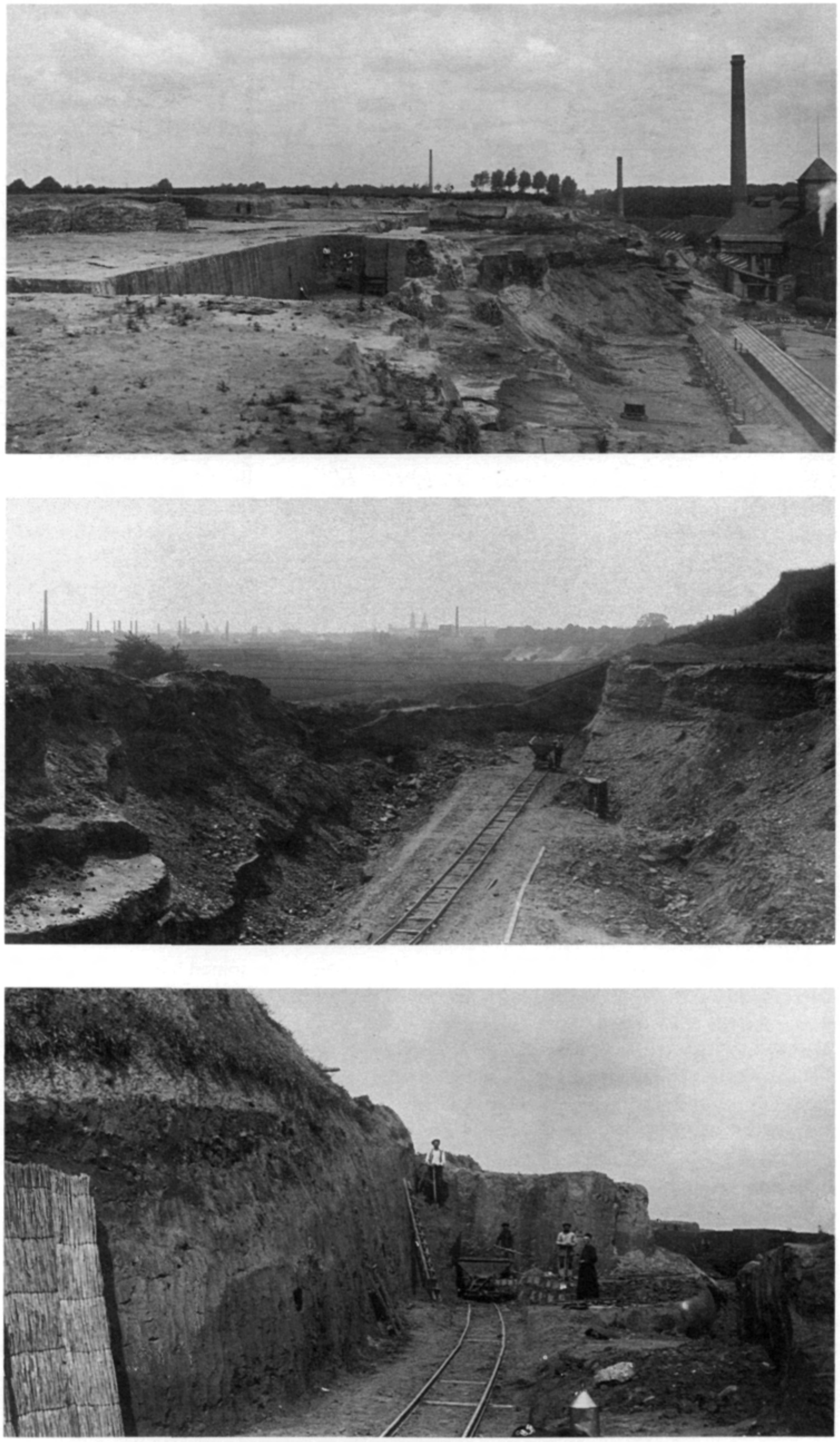


Fig. 6. A, B and C. The Belvédère pit: photographs taken in the 1930s (Municipal Archive of the city of Maastricht).

Table 1: Survey of the Maastricht-Belvédère Sites.

	Field name	'Dating'	Excavated area (m^2)	Period of excavation
Site A	Trench East I	Saalian	5	March 1981
Site B	North Trench	Saalian	19/23	July-Sept. 1981
Site C	South Trench	Saalian	264	1981-1983
Site D	Trench East II	Saalian	–	August 1982
Site E	Trench WG	Weichselian	60	Nov.-Dec. 1982
Site F	Trench East III	Saalian	42	June-July 1984
Site G	Site G	Saalian	50	1984/1985
Site H	Site H	Saalian	54	March 1987
Site J	Site J	Weichselian	210	May-June 1986
Site K	Site K	Saalian	370	Dec.'86-July'87

above, eventually led to the establishment of a multidisciplinary team that has been studying the exposures in the pit since 1980.

In 1982 an interim report on the multidisciplinary research at Maastricht-Belvédère was presented at a symposium on 'Palaeolithic Archaeology and Quaternary Stratigraphy in South Limburg', organized by the INQUA Commission for the Netherlands. Following this symposium some preliminary papers on the site were published (Roebroeks *et al*. 1983; Roebroeks 1984a). In 1985 the first synthetic review of the Belvédère Quarternary research was presented (Van Kolfschoten/Roebroeks 1985).

The specific reasons for investing a considerable amount of time, energy and money in the Belvédère project will, hopefully, become clear in this volume. In general terms it can already be said that we wanted to exploit the fact that several types of archaeological assemblages seemed to have been preserved rather well, especially in the Late Middle Pleistocene deposits in the pit. Over the years it became clear that this would enable us to compare archaeological assemblages formed within a small area over a short period of time, and to thus collect evidence of variability between 'sites' which in all probability had been formed by members of one and the same 'cultural system'. Furthermore, continuing the project also meant gaining a maximum output from the basic investments made in establishing the geological framework.

The methods used to record the archaeological phenomena at Belvédère could not be chosen freely, but were always the result of a compromise between the interests of the commercial exploiter of the pit and our own research aims, as will be shown in this volume. Particularly since 1985, the emphasis has been on the recording of large areas, instead of focussing our means on a very detailed survey of small areas.

Finally, a major drawback of this volume must already be pointed out here, in the introduction. The questions we tried to solve with the aid of our material have changed significantly in the course of the several years of rescue archaeology in the pit. At first, the major concern was to start the project and to coordinate the work of a number of prospectors and specialists, both in the field and afterwards. In the periods between the field campaigns attention was paid to the flint material, which was studied for a few basic variables such as maximum dimensions, presence/absence of a cortex and the type of striking platform. Subsequently the assemblages studied, which were limited in number through lack of the time in the field, were submitted to extensive refitting analysis. Now, many years later, we have assemblages from several sites which seem to be contemporaneous on a very fine time-scale. And we would now like to compare these assemblages using more variables than the few that seemed sufficient to answer our earlier questions. This means that in due time all the material presented in this volume will be studied again, using a greater list of variables in order to enable a detailed technological comparison of the various assemblages which were formed from the same raw material and in the same ecological environment. This 'starting all over again' will probably also involve the dissolution of some of the very complex conjoined blocks that were reconstructed from the Site C material. This will take some time, and therefore this volume has meanwhile been published as a kind of 'state-of-the-art' research intermezzo. As can be seen in the rest of this volume, not all of the sites known and excavated in the pit are treated here, so eventually there will be more publications on the archaeology of the pit, in which the flint material will be presented in a less 'impressionistic' way than has been done here.

In retrospect, this proved an incorrect approach from a systematic point of view. However, had we started with detailed analyses (like P.Callow in his presentation of the material from La Cotte de St.Brelade (Jersey) (in: Callow/Cornford 1986)) from the first excavation onwards, we would have covered a much smaller area and the refitting would have been done at a much later stage. The recording of as many sites as possible was (and still is) given utmost priority over analysis as long as fieldwork was possible.

Furthermore, the results of the refitting proved to be of great importance in the 'promotion' of the project, which, in turn, was a *conditio sine qua non* for the continuation of the excavations in the pit in the period 1981-1988. It should however be stressed that this way of working was the result of the author's lack of experience in dealing with these assemblages rather than of deliberate planning.

notes

[1] Municipal Archive of the Town of Maastricht, inv. no. 1106.
[2] Municipal Archive of the Town of Maastricht, inv. no. 1627, section A, page 2.
[3] Archive of the Municipality of Oud-Vroenhoven, Municipal Archive of the Town of Maastricht.
[4] Municipal Archive of the Town of Maastricht, Ms. collection no. 184.

2 The geology of the Belvédère pit and its wider geographical setting

2.1 Introduction

The aim of this chapter is to give a short description of the Middle and Late Pleistocene deposits at Maastricht-Belvédère in order to provide the reader with a general geological framework, certain aspects of which will be discussed in greater detail in the rest of this volume. Before we concentrate our attention on the Belvédère-pit, a description will be given of the general geological setting of the Quaternary deposits at Belvédère in a summary of the geology of the region, i.e. the southern part of the Dutch province of Limburg (2.2). The paragraphs following this regional setting discuss the lithology and lithostratigraphy of the recorded sections in the pit (2.3.2), the palaeosols present (2.3.3), and the palaeoenvironment during the formation of the deposits (2.3.4). Finally, the relative and absolute dating evidence of the different units is presented in section 2.3.5, while section 2.3.6 gives a first synthesis of the Middle Pleistocene sequence at Belvédère.

2.2 The wider geological setting

South Limburg is situated in the transitional fault-block area between the Dutch *Central Graben* and the Ardennes highlands, as shown in figure 7. The continuation of the *Central Graben* into Germany is called the *Rurtal Graben* (fig. 7). In general terms, the Ardennes Massif may be seen as an erosional area, while the *Central Graben* is a depositional environment. In South Limburg there are a large number of southeast/northwest orientated faults, of which the northernmost *Feldbiss* fault is the most pronounced. In the south, the *Central Graben* is bounded by the *Feldbiss* fault and in the north by the *Peelrand* fault. These faults developed during the Early Tertiary and have affected the geography of sedimentation and erosion in South Limburg ever since.

The subsoil deposits of the South Limburg area date from the Carboniferous, Cretaceous and Tertiary periods and are overlain by Quaternary deposits, which consist mainly of fluviatile sediments and loess.

The present-day landscape of South Limburg was sculptured during the Quaternary by the Maas and its tributaries. By the end of the Tertiary a peneplain had formed over the Ardennes and their immediate surroundings. Traces of this peneplain are still visible in the southeastern part of South Limburg; more extensive remnants occur in the neighbouring Belgian and German uplands. The highest hill in the Netherlands, the Vaalserberg, 321 m above Dutch Ordnance Level (NAP), is a slight elevation in the peneplain.

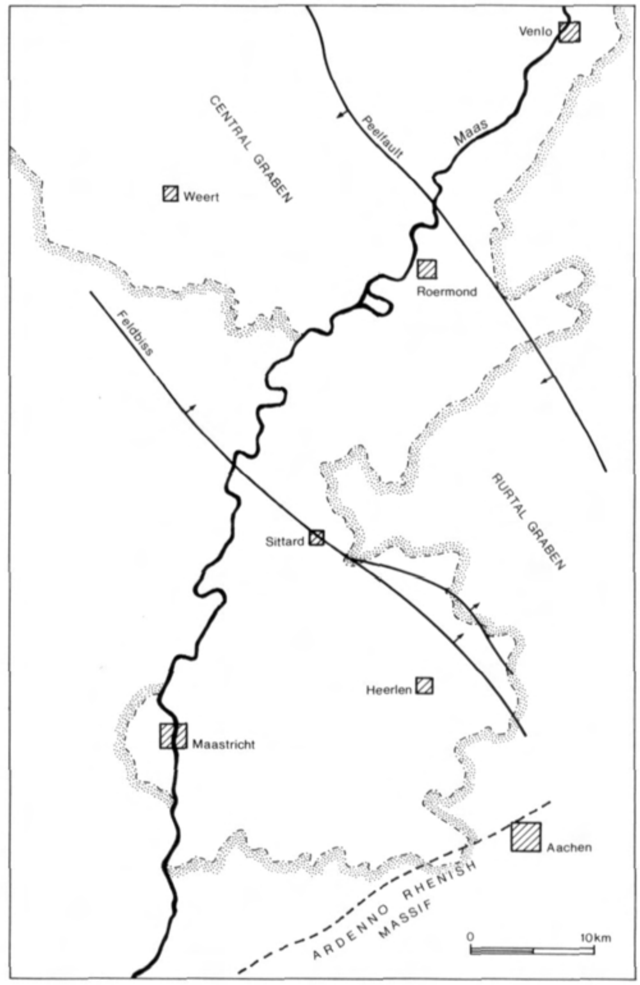


Fig. 7. Structural development of South Limburg (after: Kuyl 1980).

In the Early Quaternary the Maas took a more northeasterly course than at present (called the East Maas) from a point near Liège where it left the Ardennes to join the

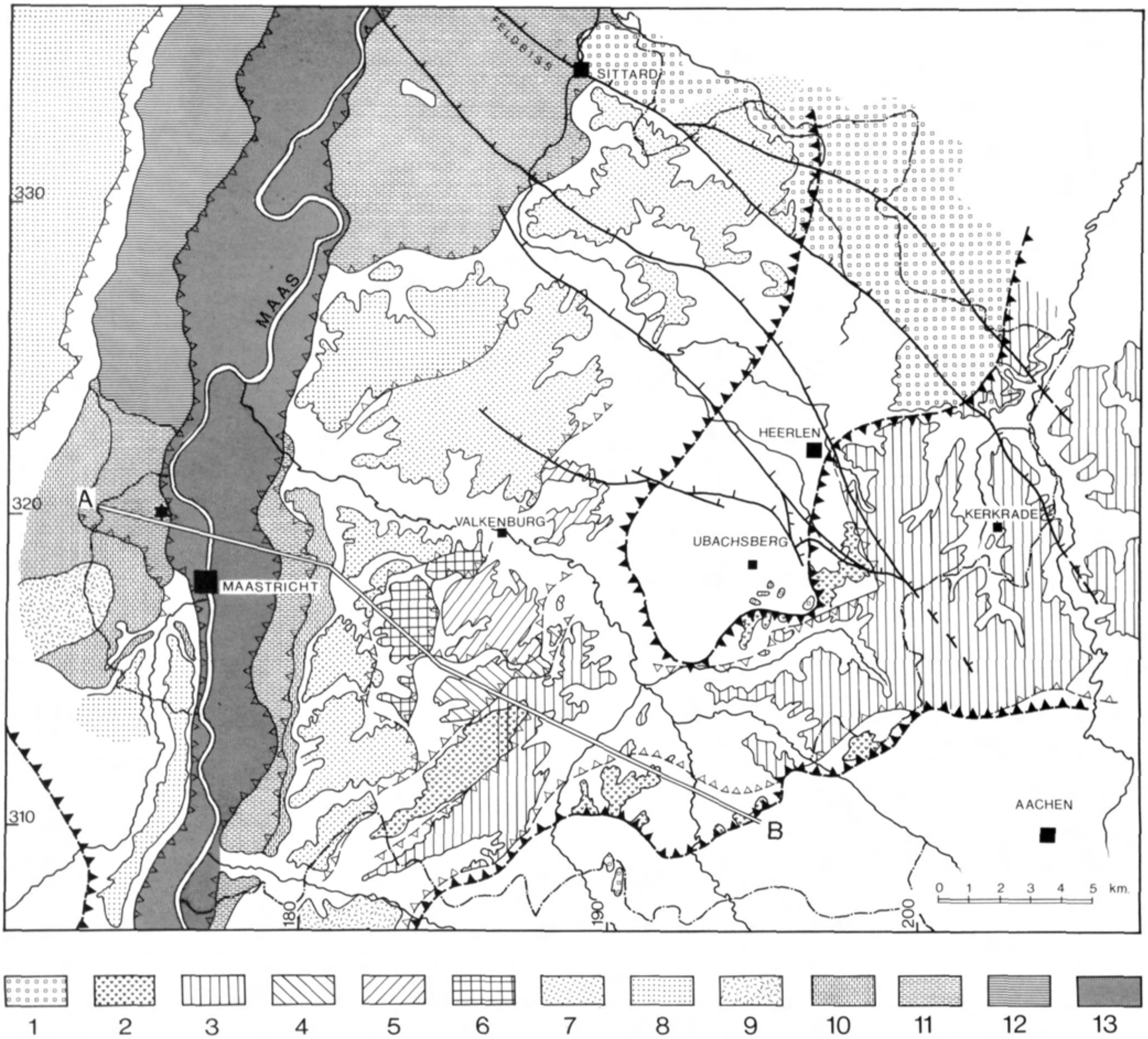


Fig. 8. The Maas terrace geomorphology of South Limburg; drawing based on data provided by the State Geological Survey at Heerlen (pers. comm. P.W. Bosch and W.M. Felder, 1980-1985). The numbers refer to the symbols used for the different terrace bodies: 1=Waubach (Tertiary deposits), 2=Kosberg, 3=Simpelveld, 4=Margraten, 5=Sibbe, 6=Valkenburg, 7=St.Geertruid, 8=St.Pietersberg, 9='s Gravenvoeren, 10=Rothem, 11=Caberg, 12=Eisden-Lanklaar, 13=Oost-Maarland. See also Table 2. (The position of the Belvédère pit is indicated by an asterisk.) The A-B line refers to the cross-section shown in figure 9.

Rhine in the environs of the town of Jülich (West Germany). A wide and shallow valley was formed in the peneplain, traces of which are still visible in the landscape (Kuyl 1980).

During the later Quaternary a series of river terraces was formed along the Maas in South Limburg; the most complete series is found to the south of the *Central Graben*. The terrace formation was related to the epirogenetic upheaval of the southeastern part of South Limburg, which began during the Early Pleistocene and eventually caused the river to shift its northeasterly course to a more westerly one, called the West Maas. After every change of course, the river cut deeper into the landscape, leaving behind the old river deposits as elevated terraces. The older the Maas sediments, the higher they lie south of the Feldbiss fault.

The terrace system of the Maas, traditionally divided into Higher, Middle and Lower Terraces with several subdivisions, has been the object of much research (Brueren 1945;

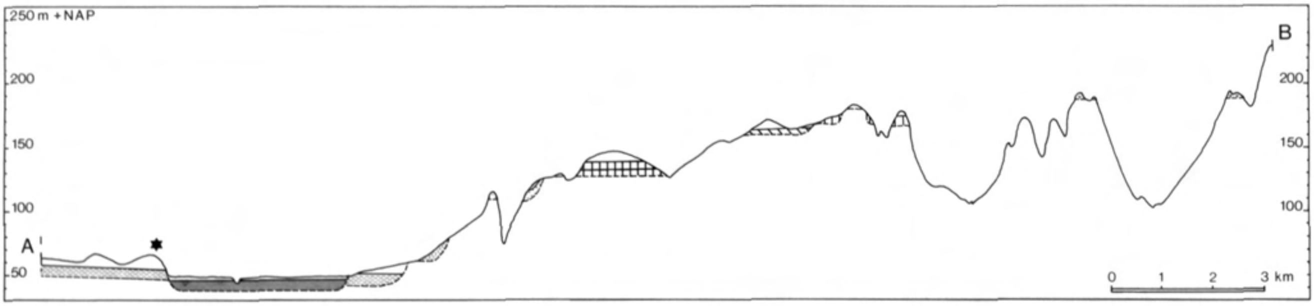


Fig. 9. Cross-section through the terrace landscape of South Limburg, along the A-B line indicated in figure 8. For the symbols used for the terrace bodies see figure 8 (after: Brueren 1945). The position of the Belvédère pit is indicated by an asterisk.

Van Straaten 1946; Zonneveld 1955; Paulissen 1973; Doppert *et al.* 1975; Felder *et al.* 1980; Kuyl 1980). The nomenclature of the terrace sequence now in use is shown in table 2. Figure 8 shows the terrace geomorphology of South Limburg based on new maps recently provided by the State Geological Survey (W.M. Felder and P. Bosch, pers. comm., 1980-1985). The new results differ only slightly from the results of Brueren (1945), on which the cross-sections through the terrace landscape shown in figure 9 are based.

Evidence concerning the ages of the different terraces is still scarce (table 2). The few biostratigraphical data available have been summarized by Zagwijn (1985). Pollen analysis of a sample from a peat bed discovered in the uppermost part of the Simpelveld Higher Terrace deposits suggests a Late Tiglian date for the formation of these sediments (Platte Bosschen locality). Sediments of the Valkenburg Higher Terrace at Süsterseel are overlain by a loess deposit with reversed magnetic polarity (Van Montfrans 1971), and pollen analysis of a peat bed found at the boundary between the terrace gravel and the overlying loess indicates that the peat was formed during the Bavel interglacial of the Early Pleistocene and thus has an age of 900 ka (Zagwijn/De Jong 1983-1984).

Finally, gravels of the Caberg Middle Terrace deposits at Maastricht-Belvédère are overlain by sediments whose faunal contents indicate that they were formed in an intra-Saalian warm-temperate phase (section 8.3 of this volume; see also: Van Kolfschoten/Roebroeks 1985). The gravels themselves contain the remains of a cold fauna, which have been assigned an Early Saalian age (Van Kolfschoten 1985).

In addition to this biostratigraphical evidence, Bruins (1980) has found (unpublished) indications of the presence of the Brunhes-Matuyama boundary in the Sint-Geertruid deposits at Nagelbeek. Paulissen (1973) identified a Middle Terrace younger than the Caberg terrace, but still dating from the Saalian, showing that a typical Eemian Interglacial soil had developed in the Eisden-Lanklaar terrace deposits.

The available data suggest that the fluviatile sedimentary sequence south of the *Central Graben* represents only a few episodes of the total stratigraphical time range of the Quaternary (Zagwijn 1985).

In the *Central Graben* itself sedimentation was more continuous than in the region south of the Feldbiss, where sedimentation alternated with erosion. In fact, the sedimentary sequence preserved in the *Central Graben* provides the most complete sequence of the Dutch Quaternary known. Quaternary sediments in this region are over 200 m thick in places (cf. Zagwijn/De Jong 1983-1984).

In the later part of the Pleistocene South Limburg was covered by loess deposits, which today vary in thickness from a few dm to more than 20 m. Figure 10 (after: Kuyl 1980) gives the distribution of loess deposits of over 5 m thick in South Limburg. In recent years the loess deposits in this region have been the object of detailed research, using physical and chemical methods developed for the earth sciences, such as thephrostratigraphy, micromorphology and thermoluminescence (TL) dating (cf. Juvigné 1977; Meijs 1980; Kuyl 1980; Vreeken/Mücher 1981; Haesaerts *et*

Table 2: The Pleistocene terrace sequence in South Limburg, with indications of the ages of the terraces as discussed in the text.

general subdivision	name	age
Lower Terrace	Oost-Maarland	
Middle Terrace	Eisden-Lanklaar	Late Saalian
	Caberg	Early Saalian
	Rothem	
	s'Gravenvoeren	
Higher Terrace	St Pietersberg	
	St Geertruid	Brunhes-Matuyama?
	Valkenburg	Bavel interglacial
	Sibbe	
	Margraten	
	Simpelveld	Late Tiglian
	Kosberg	

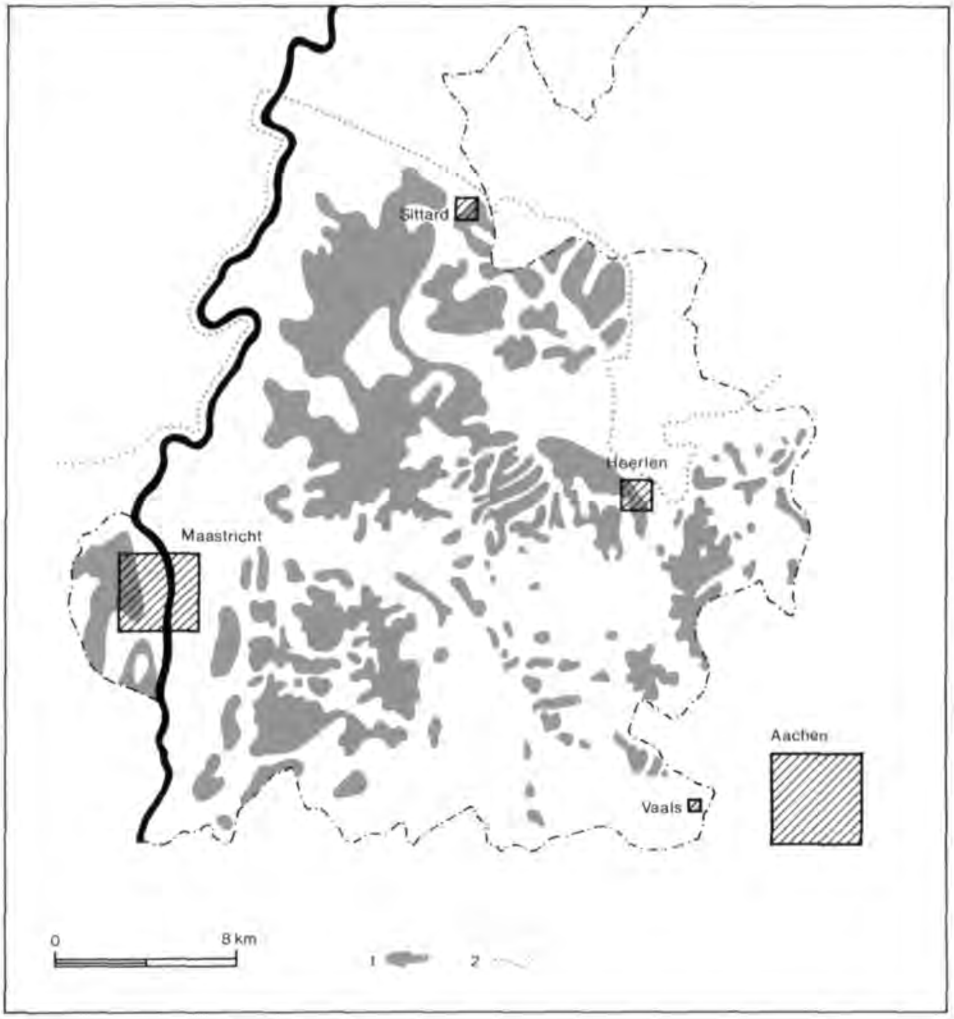


Fig. 10. Distribution of loess layers of over 5 metres thick (1) and the northern boundary of the loess (2) in South Limburg (after: Kuyl 1980).

al. 1981; Juvigné/Semmel 1981; Meijs *et al.* 1983; Mees/Meijs 1984; Meijs 1985; Vandenberghe *et al.* 1985; Huxtable/Aitken 1985; Bouten *et al.* 1985; Wintle 1987).

There are three diagnostic horizons in the loess stratigraphy of the region:

– the *Sol de Rocourt* (Gullentops 1954), interpreted as (remnants of) a soil of Eemian age, which was formed in Saalian loess;

– the *Eltville tuff*, a thin volcanic ash bed present in the toppart of the Weichselian 'Middle Silt Loam' (cf. Juvigné/Semmel 1981; Vreeken/Mücher 1981; Meijs *et al.* 1983). This layer has an estimated age of 20 ka (Haesaerts *et al.* 1981)

– the *Horizon of Nagelbeek* (Haesaerts *et al.* 1981), present above the Eltville tuff layer, and interpreted as a weakly developed 'tundra soil'.

The accidented South Limburg landscape seen today was, to a large extent, formed during the Pleistocene by the Maas and its tributaries. New tributaries of the Maas developed during each westward shift and incision phase of the river, which then formed their own valleys in the terrace landscape, each with its own series of side valleys formed by smaller rivulets. The dry valleys show great variation in size and morphology. Usually, a dry valley system has a dendritical structure, the largest dry valleys connecting up to a valley through which water flows all the year round.

Because of the large number of stream valleys and dry valleys the landscape is greatly dissected, particularly the higher terraces. Figure 11 gives a three-dimensional drawing of dry valleys formed in a Higher Terrace plateau (Sint Geertruid deposits) southeast of Maastricht. As accidented as it is, the landscape today is a smoothed version of the Pleistocene landscape contours prior to loess deposition, the anthropogenetic erosion and the formation of colluvial accumulations, which are over 5 m thick in many places (Kuyl 1980).

Finally, the extensive Cretaceous and Tertiary chalk beds

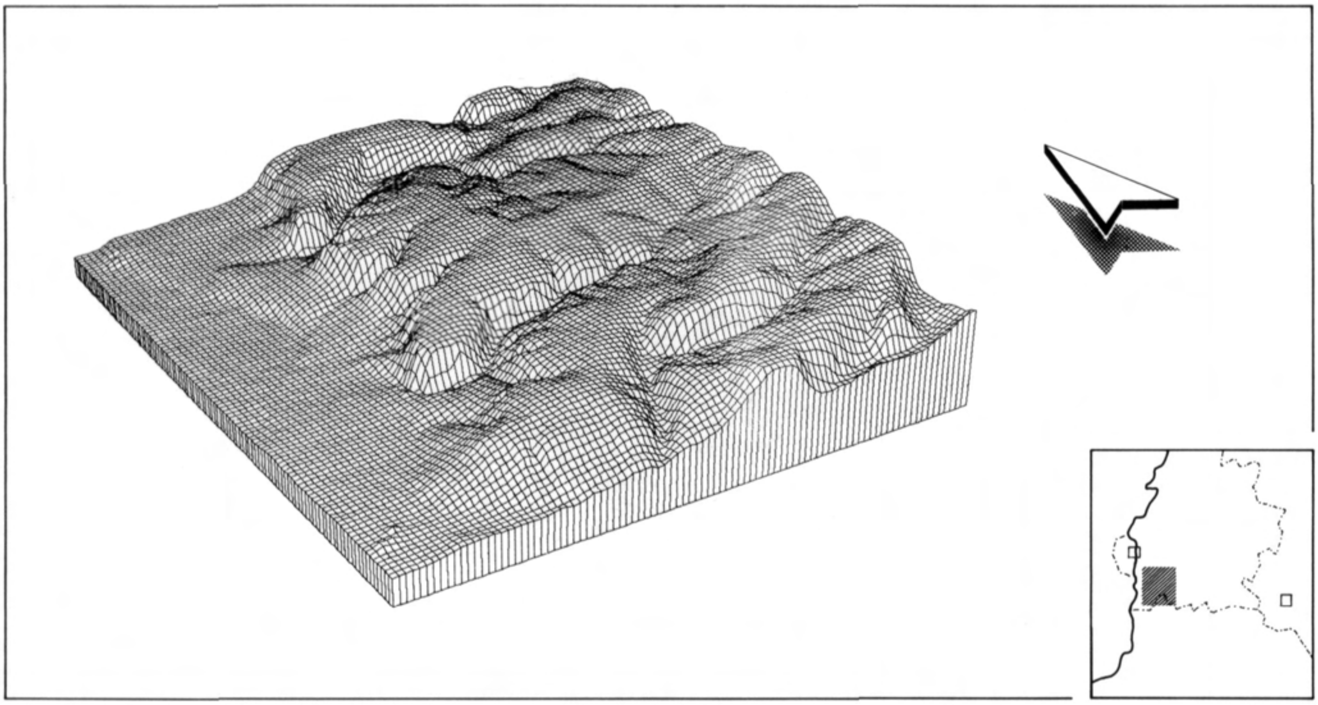


Fig. 11. Three-dimensional view of dry valleys formed in a higher (St.Geertruid) terrace plateau southeast of Maastricht. x between 178000 and 184500, y between 308200 and 315500 in the topographical map system. Vertical scale magnified 8x. Drawing made by -and published with the courtesy of- Dr J. Hartman, Amsterdam.

beneath the Quaternary sediments are responsible for many karstic phenomena throughout the working area (Kuyl 1980).

2.3 The Middle and Late Pleistocene deposits at Maastricht-Belvédère

2.3.1 INTRODUCTION

After the publication of the work of the Quaternary research group (Van Kolfschoten/Roebroeks 1985), important additional evidence concerning the pit's stratigraphy was obtained in fieldwork in 1985-1988. In the winter of 1985 an east-west section running 300 m through the pit became available for study. In 1985 and 1986 K. Groenendijk and J.P. de Warrimont recorded large parts of this exposure, the largest exposed at Belvédère since 1980. In the summers of 1986, 1987 and 1988 other long sections in the western part of the pit were recorded by students of the Institute of Earth Sciences (Free University of Amsterdam), under the supervision of J. Vandenberghe. The 1985-1988 exposures were sampled for grain-size analysis by J. Vandenberghe (Amsterdam) and for soil micromorphological analysis by H.J. Mücher (Amsterdam). Faunal remains were collected by K. Groenendijk, J.P. de Warrimont and T. van Kolfschoten (Utrecht) and T. Meijer (Haarlem). The new data obtained in the 1985-1988 fieldwork have led to a modification of the stratigraphical model developed by Vandenberghe *et al.* (1985) and to a re-evaluation of the stratigraphical position of some archaeological sites already reviewed by Roebroeks (1985). The 1985-1988 fieldwork data will be published in detail elsewhere.

The framework established in this section will be used and further developed in the presentation of the archaeological sites.

2.3.2 LITHOLOGY AND LITHOSTRATIGRAPHY

When the 1985 volume on the Belvédère project was published (Van Kolfschoten/Roebroeks 1985), units 1 to 7 as published by Vandenberghe *et al.* (1985) were explicitely understood to be *lithological* units. Since then, however, three years of quite intensive geological fieldwork have shown that matters are much more complex than was initially thought, and in fact we have been using and discarding quite a series of geological models since that published in 1985 (Vandenberghe *et al.* 1985). In essence, what has been observed in recent years in the long sections available for study is that there are many lateral transitions between lithological units, which means that, for instance, lithological unit 4 develops laterally into unit 5.1. Therefore a strict separation of lithological and lithostratigraphical units has to be made in the geological nomenclature used. The research group working at Belvédère agreed to designate the

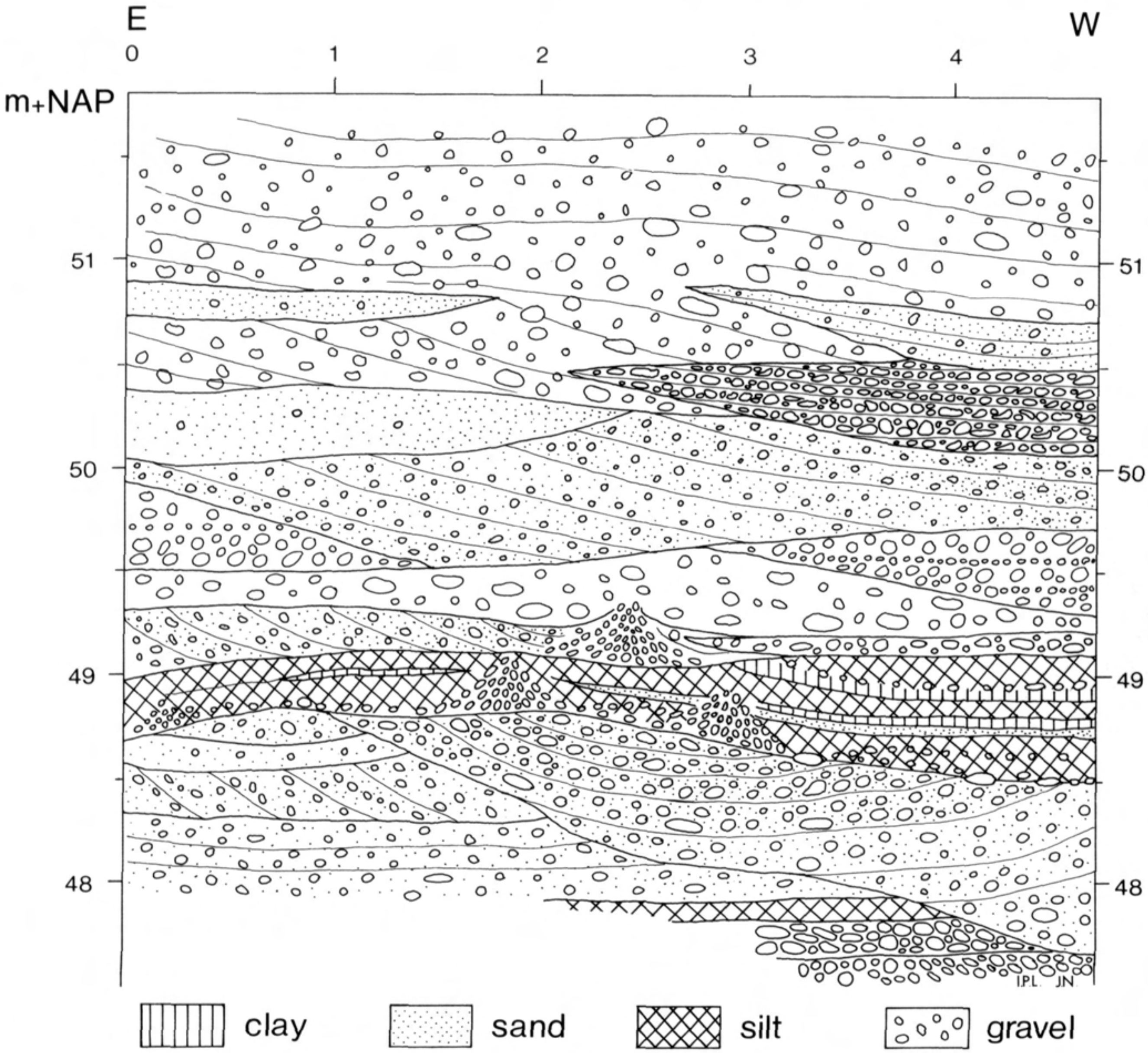


Fig. 12. Representative vertical section through the terrace gravel of Unit 3 (III-A) (from Vandenberghe *et al.* 1985).

lithological units in the same way as originally published (Units 1 to 7, cf. Vandenberghe *et al.* 1985), and to award Roman figures to the *lithostratigraphical* units. So, basically, we are dealing with two systems: lithology (Units 1 to 7) and lithostratigraphy (Units I to VII).

2.3.2.1 Lithology

Units 1 and 2 Most of the Pleistocene sediments in the Belvédère pit were deposited on the Palaeocene chalk subsoil (Unit 1) belonging to the Houthem Formation (Kuyl 1971). Oligocene marine sands (Unit 2) are found on top of the chalk in some places. The base of the Pleistocene deposits at Belvédère has an irregular surface due to karst formation and/or erosion, its average elevation being 45 to 47 m above NAP (Klein 1914; Brueren 1945; Bosch 1975).

Unit 3 Unit 3, above Units 1 and 2, consists of gravel and has a maximum thickness of 7 m. A representative vertical section of this unit is shown in figure 12. Unit 3 is heterogeneous in texture and structure: there are a number of alternating beds and lenses of different sizes and contents, but trough and narrow tabular crossbeddings are dominant.

Cobbles of several dm do occur but, on the whole, the pebble diameter is a few cm. Lenses of fine to coarse, gravelly sand occur, while occasionally silts and clays were deposited in depressions, at the base of which a gravel horizon is found. On the basis of the sedimentary characteristics observed, Vandenberghe *et al.* (1985) conclude that this lithological unit was deposited by a river with multiple channels, the individual channels not having existed for a long time. The unit was most likely formed by a braided river system.

Unit 4 Unit 4, described in the Vandenberghe *et al.* (1985) paper as consisting of greyish-white to light greenish sand with intercalated pebble horizons and being of fluvial origin, was subdivided after the 1985-1988 fieldwork. In 1985 attention was already drawn to the lateral transitions which led Vandenberghe *et al.* (1985) to distinguish several facies in this unit. At the time at which these sentences were written (February 1988), the following subdivisions had been made within lithological Unit 4:
- Unit 4.1: finely laminated fine sands and clays with the odd layer of gravel; maximum thickness about 2 m,
- Unit 4.2: a mainly horizontally bedded alternation of gravel layers, silty sands and sandy silts; maximum thickness about 2 m,
- Unit 4.3: predominantly laminated fine sands with a few clay bands, calcareous in parts; up to 1.5 m thick. Especially at its base it contains obliquely bedded coarser sands and gravel layers,
- Unit 4.4: a layer of up to 1 m thick consisting of greyish-yellow to greyish-olive fine sands with intercalated gravel layers. These sands, which are calcareous in parts, were observed in a number of fining upward sequences,
- Unit 4.5: fine sands, greyish olive silty clays, calcareous tufas (up to 90% $CaCO_3$) and intercalated sand layers. It is possible to make the following divisions within this subunit. Unit 4.5.1 consists of a lateral sequence of greyish olive silty sands and silty clays of up to 1 m thick, here and there overlain by Unit 4.5.2, consisting of calcareous tufas (up to 90% $CaCO_3$) and having a maximum thickness of 0.8 m, overlain by greyish-olive clays. Unit 4.5.3 consists mainly of silty clays and has a recorded thickness of up to 0.5 m.

Unit 5 Unit 5 consists of yellowish-brown to reddish yellow sediments that become finer in grain size from the base (Unit 5.1) to the top (Unit 5.2) and have a maximum thickness of about 2 m.
- Unit 5.1, which is everywhere stratigraphically present beneath Unit 5.2, consists of a true mixture of sand and silt loam, showing a characteristic bimodal grain-size distribution with peaks at 80-115 μm and 30-38 μm.
- Unit 5.2. consists of a better-sorted silt loam with a small amount of admixtured sand, which decreases towards the top of the sub-unit (Vandenberghe *et al.* 1985; see also fig. 13 in this volume).

The boundary between the two subunits was not always clear in the field, but in places it is very well marked by an erosional layer containing pebbles and cobbles.
Likewise, it was not always possible to differentiate between sediments of Unit 4 and Unit 5.1, which in many places show both a gradual lateral and a gradual vertical transition. Brownification, clay enrichment and homogenization as a result of soil formation disturb the original sedimentary structures in many places and have changed the textural properties of both Unit 4 and Unit 5.

It is furthermore worth mentioning that in the field Unit 5.2 showed a striking resemblance to Saalian loess deposits exposed in other pits in the region. Mücher (1985), however, explicitly interpreted this unit not as a 'pure loess', but as a sediment consisting of fluviatile deposits mixed with loess that was displaced slightly after its original deposition by wind and possibly also with loess that was deposited directly by the wind.

Unit 6 Unit 6 consists of silts and silty loam, is up to 3 m thick and has been divided by Vandenberghe *et al.* (1985) into four subunits, 6.1 to 6.4, 6.1 being the lowermost unit in stratigraphical terms and 6.4 the uppermost unit.
- Unit 6.1 was only observed in places; it consists of a silty loam of a light grey colour (6.1.1) with a homogeneous black 'humic' horizon top (6.1.2), a sequence which has been interpreted as a steppe soil (Vandenberghe *et al.* 1985; this volume, chapter 7). It has to be stressed here that a thin layer of small stones measuring less than 1 cm was observed in most places at the boundary between the light-greyish (6.1.1) and the darker loess (6.1.2) on top of it. Likewise, in several places in the pit an erosional level was observed on top of the darker loessic sediments of Unit 6.1.
- Unit 6.1 was eroded during the deposition of Unit 6.2, which consists of redeposited sediments, partly derived from Unit 6.1 deposits. Unit 6.2 is mainly a pebble zone.
- Unit 6.3 consists of finely laminated silty loams, which almost everywhere are covered by the greyish-yellow silts of Unit 6.4.
- Unit 6.5, not presented in the Vandenberghe *et al.* (1985) paper, consists of laminated silts with intercalated sand layers, the basal part of which consists mainly of a coarsely grained reddish sandy silt, deposited after a major erosional phase.

Unit 7 The uppermost Unit 7 is a massive, yellowish-brown silty loam with a carbonate content of about 15% and a thickness of up to 6 m. The upper part had been affected by Holocene soil formation, which had caused decalcification to a depth of about 3 m.

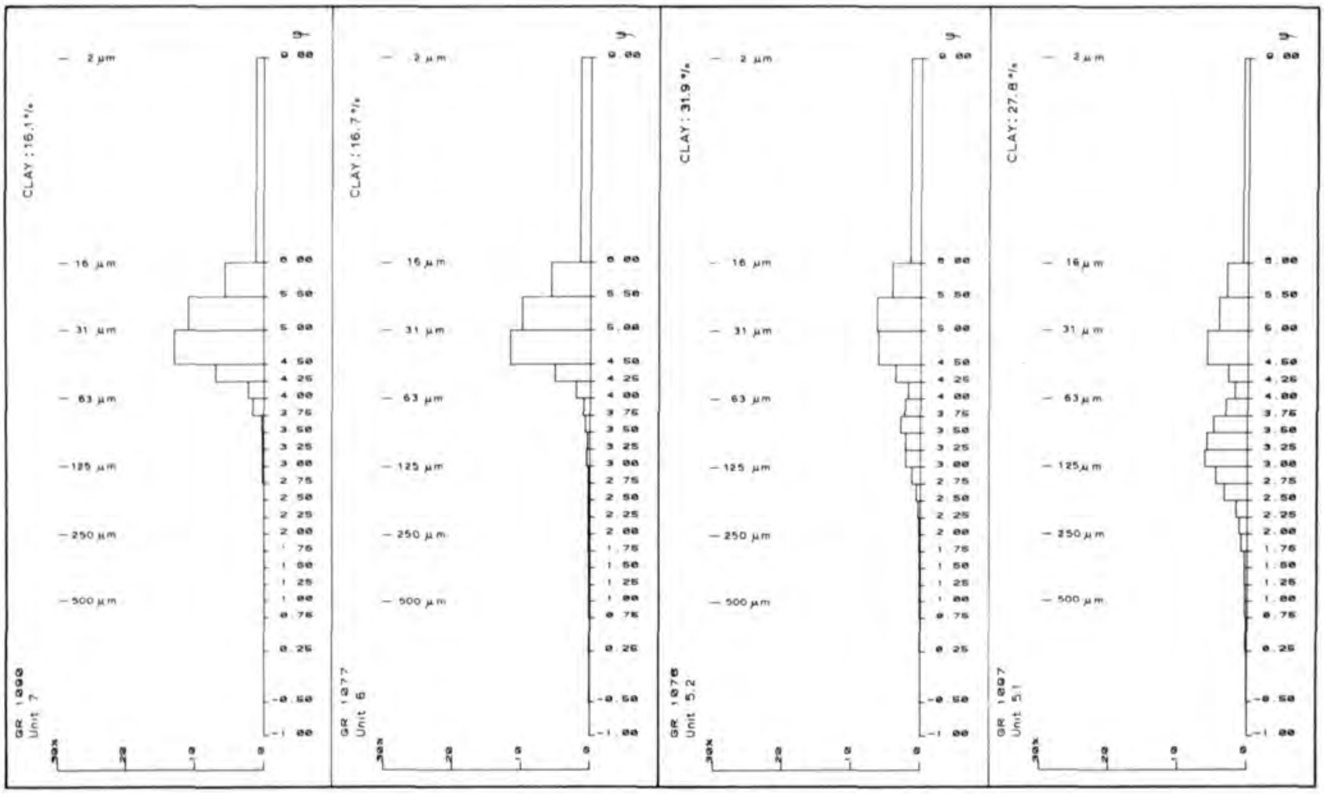


Fig. 13. Comparison of typical histograms of the grain size distribution in Units 5.1, 5.2, 6 and 7 (from Vandenberghe *et al.* 1985).

2.3.2.2 Lithostratigraphy

Figure 14 gives a very schematic representation of the stratigraphical position of the lithological units described above, as recorded in the 1987 fieldwork of the Institute of Earth Sciences. The lateral transitions which have been observed between lithological units are indicated in this figure too, as well as in table 3. This table also gives a translation of the data in terms of lithostratigraphical units.

As for the Unit IV-C complex, which is a very relevant complex from an archaeological point of view, discriminating between the smaller subunits (IV-C-I, IV-C-II and IV-C-III) is facilitated by the occurrence of erosional features between these subunits, which are (in many places) separated from each other by mostly thin (up to 5 cm thick) sand layers with small stones (most measuring less than 2 cm).

2.3.3 PALAEOSOLS

The lithostratigraphical Units IV and V and the basal part of Unit VI have been analysed micromorphologically by means of thin sections (5 to 8 cm, occasionally 8 to 15 cm). The research was carried out by H.J. Mücher, University of Amsterdam (Mücher 1985).

From the beginning of the research at the Belvédère pit onwards, micromorphological analysis was considered the most important tool for identifying the processes by which sediments containing archaeological material were deposited and for identifying and analysing post-depositional processes, e.g. soil formation.

In fact, it was thought that palaeosols could only be identified by means of micromorphological analysis or by demonstrating a catenary relationship. Other laboratory methods (e.g. granulometrical analysis) cannot provide proof of clay-illuviation processes or other forms of pedogenesis (McKeague *et al.* 1978; Mücher/Morozova 1983).

In his analysis of the Belvédère deposits, Mücher used the K-cycle concept proposed by Butler (1959) and explained in Mücher and Morozova (1983). Butler's K-cycle concept (K from the Greek *Kronos*=time) divides the Quaternary into stable periods, dominated by soil formation, and unstable periods, dominated by erosion, sedimentation, and the formation of slope deposits.

From a sedimentary point of view, two types of environments can be distinguished in sedimentary processes, namely sediment-producing and sediment-receiving areas, both of which show characteristic developments during stable and unstable phases. Figure 16 (after: Mücher 1985) gives a schematic view of the different developments that took place in these phases in the two different environments. Of course a simple correlation glacial or stadial

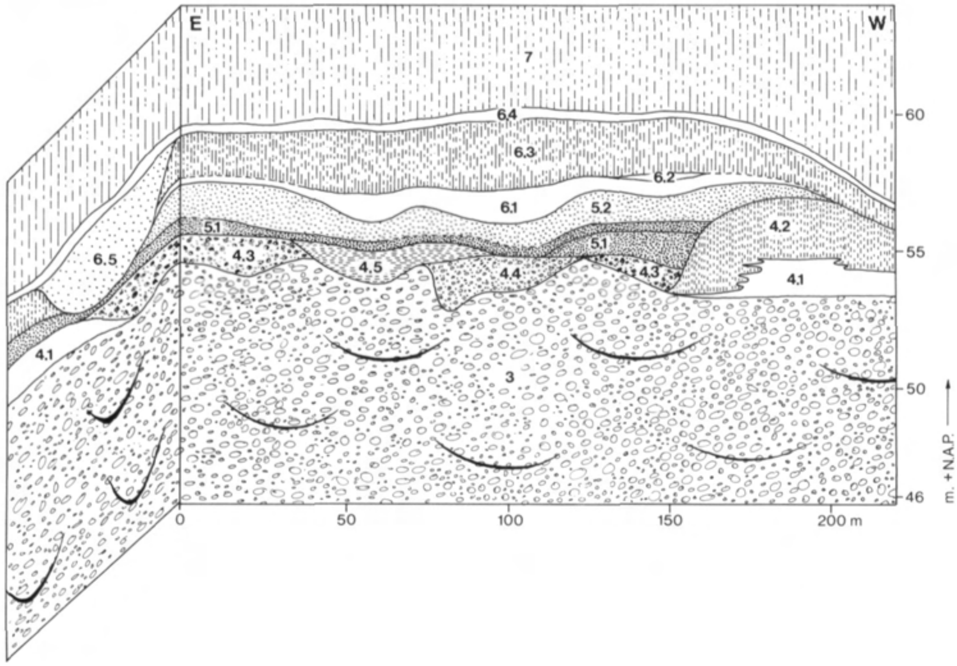


Fig. 14. Schematic cross-section through the Belvédère pit, based on the 1987 fieldwork of the Institute of Earth Sciences, Free University, Amsterdam, showing the stratigraphical position of the lithological units. Vertical scale magnified 12x.

Fig. 15. Photo of the southern part of the pit, taken in the summer of 1987, showing Units III to VII. The large boulders in the front left come from the Unit 3 gravels. The 'white band' visible halfway up the section consists of the Unit IV-C-II calcareous tufas (from a colour slide by the author).

period = unstable, and interglacial or interstadial period = stable may not be assumed. Even short-term and local events may produce slope deposits, which may bury palaeosols in areas receiving sediment, which, in turn, may be influenced by pedogenesis.

Relating the K-cycles established by Mücher to chronostratigraphical schemes is, therefore, a purely speculative matter. The concept of K-cycles is applied here to deduce local, small-scale events.

The micromorphological study of Units IV and V revealed that the 'Belvédère-pit' region may be regarded mainly as a sediment-receiving area, with sedimentation during *unstable* periods (*Ku-cycles*) and formation of palaeosols during *stable* periods (*Ks-cycles*). Mücher initially identified three Ku-cycles, during which Units IV (K_1u), V-A (K_2u) and V-B (K_3u) were formed. The stable periods following the Ku-cycles (K_1s, K_2s, K_3s) were thought to be represented by strongly to moderately truncated palaeosols, characterized by clay illuviation. Mücher interpreted these as remnants of heavily truncated luvisol palaeosols. In the absence of an A horizon and also the main part of the B horizon such a classification can only be tentative (Mücher 1985). Luvisols[1] are generally formed under deciduous forests in a temperate climate. The problems associated with differentiating between Unit 4 and Unit 5.1 sediments and interpreting lithological differences in lithostratigraphical terms are, of course, also encountered in interpreting the palaeosols. Lithological identification of the parent material -and subsequent lithostratigraphical interpretation- was occasionally problematic.

As already stated earlier in this chapter, new interpretations of the geology of the pit were generated in the 1985-1988 fieldwork, and older models have been discarded. These new models will be published in detail in due time, and in this volume only the most simple option will be presented. As for the interpretation of the palaeosol remnants present in the Unit IV-Unit V complex, the new data indicate that only two periods of major soil formation are observable in the Unit IV-V sequence. It now seems that the traces of soil formation found in the Unit IV and V-A deposits in fact all date from one major stable period. Future fieldwork and laboratory analysis will focus on this problem, which will therefore not be detailed here. Referring to the 1985 paper by Mücher, we can say that traces of this first palaeosol have been found in sections Mi_2 (thin sections 749-753), Mi_3 (thin section 839), Mi_6 (thin section 903-904) and at Site F (thin sections 0.440, 0.452, Mücher, pers.comm., 1987).

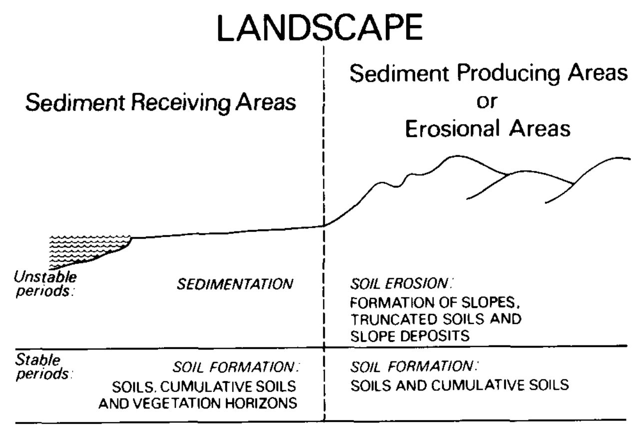


Fig. 16. Schematic representation of the events that take place in the landscape during stable and unstable periods (from Mücher 1985).

Table 3: Stratigraphical survey of the lithological units presented above (left) and their relation to the lithostratigraphical units (right).

LITHOLOGY			LITHOSTRATIGRAPHY	
7			VII	
	6.4			VI-E
	6.5			VI-D
6	6.3		VI	VI-C
	6.2			VI-B
	6.1			VI-A
	5.2			V-B
5			V	
	5.1			V-A
	3	5.1		III
	4.5.2			IV-C II
	1			I
4	4.4	5.1	IV	IV-B
	4.3	5.1		IV-A
	4.1/4.2			III-B
3			III	III-A
2			II	
1			I	

In the unstable cycle following the formation of the luvisol in the top part of the Unit IV/V-A complex the soil was eroded and Unit V-B was deposited. Subsequent soil formation resulted in a well-drained luvisol, as is clearly observable in sections Mi_2 and Mi_4 (Mücher 1985). On the basis of its stratigraphical position and its morphology, the soil formation in this stable cycle is correlated with the 'Eemian' Sol de Rocourt (Gullentops 1954).

Units VI and VII have yet to be subjected to systematical micromorphological research. However, the black 'humic' horizon in the top part of Unit VI-A has been interpreted by Vandenberghe *et al.* (1985) as a 'steppe soil' in view of a suggested catenary relationship between the topographical position and hydromorphic properties of this 'soil' (but see chapter 7). The upper part of Unit VI (i.e. VI-E) contains a cryoturbated horizon, which strongly resembles the Nagelbeek Horizon (Haesaerts *et al.* 1981), with which it is correlated on the basis of its characteristics and lithostratigraphical position. The Eltville tuff layer which so distinctly marks this horizon (Meijs *et al.* 1983) is, however, absent here.

In several parts of the pit a second *Nassboden* was observed about 1 m above the 'Nagelbeek Horizon', i.e. in the Unit VII loess deposits (fig. 17). This '*Nassboden*' consists of a dull, light-yellow (2.5 Y 6.5/3) 25-cm thick band contrasting well with the bright yellowish calcareous loess (10 YR 6.5/6) surrounding it. The upper part of the *Nassboden* consists of a 'rusty' layer, of a brown (7.5 YR 5/8) colour.

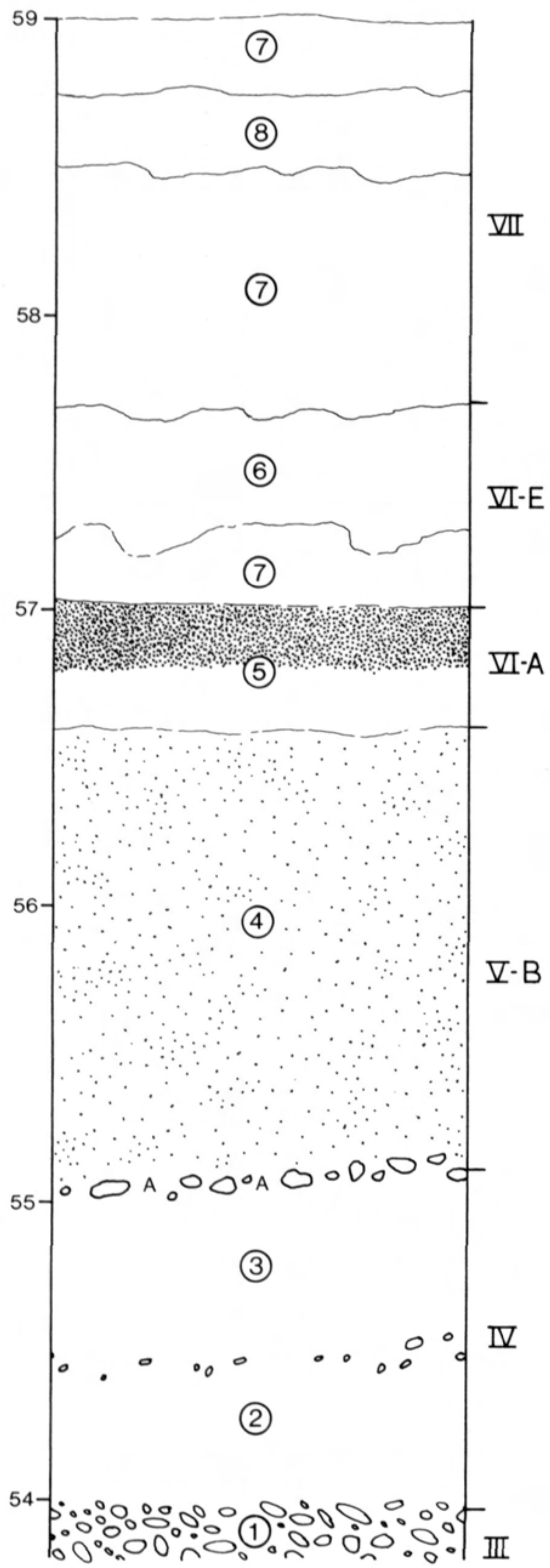


Fig. 17. Section recorded in 1983 showing the presence of a '*Nassboden*' (8) above the Horizon of Nagelbeek (approximate coordinates: 175270/319870).

1 the top of the Unit III terrace gravels
2 loamy fine sand (2.5 Y 5/3) – Unit IV
3 sandy loam (2.5 Y 5/3 – 7.5-10 YR 4/6) – Unit IV-C
4 silt loam (7.5 Y 5/6) – Unit V-B; at its base a gravel layer containing artefacts (A) and stones of up to 30 cm
5 Unit VI-A silt loam complex
6 Nagelbeek Horizont
7 silt loam (10 YR 6.5/6), calcareous
8 silt loam (2.5 Y 6.5/3) with a bright brown (7.5 YR 5/8) upper part

2.3.4 CLIMATIC AND PALAEOENVIRONMENTAL INDICATORS

Unit III According to Van Kolfschoten (1985), remains of *Elephas antiquus* had in the past been found *at the base* of the Unit III gravels. The records of other northwestern European sites that have yielded remains of *Elephas antiquus* show that this species is generally associated with temperate forests. In 1985 J.P. de Warrimont found a loamy layer with leaf impressions and molluscs in the middle of Unit 3. According to Meijer (1985, pers.comm., 1986), the molluscs indicate a continental temperate climate. Moreover, there are very few subarctic elements in the molluscan fauna.

In recent years, several remains of *Mammuthus primigenius*, *Coelodonta antiquitatis*, *Equus* sp. and *Cervus elaphus* have been found in the upper 2 m of Unit III-A (fig. 18). In 1986, Groenendijk and De Warrimont discovered a number of small mammal remains in the top part of Unit III-A, which included remains of the Norwegian lemming (*Lemmus lemmus*), ground squirrel (*Spermophilus* cf. *undulatus*) and the short-tailed vole (*Microtus arvalis*) (Van Kolfschoten *in press*). This faunal assemblage indicates that the upper part of Unit III-A must have been formed in a tundra-steppe environment, under cool climatic conditions. In the upper part of the Unit III-A gravels a series of large involutions were observed, testifying to at least local permafrost conditions. The same phenomenon has been observed in a nearby exposure (Klinkers quarry) (Vandenberghe *et al.* 1985).

Unit IV According to the palaeontological data, a distinct climatic change took place during the deposition of the fluviatile Unit IV. The mammalian as well as the nonmammalian faunas indicate that the basal part of this unit was deposited under *continental* warm-temperate conditions, while the upper part of the unit (IV-C) was clearly deposited during a *humid* warm-temperate phase (Van Kolfschoten 1985; Meijer 1985). A detailed environmental reconstruction of the archaeological sites situated in the Unit IV deposits will be given in chapter 8.

Fig. 18a. Mammoth tusk in the top part of the Unit 3 gravels, 1986 (from a colour slide by J.Vandenberghe).

Fig. 18b. *Mammuthus primigenius* molar from the Unit 3 gravels: buccal view of M2sin (BP1) (after: Van Kolfschoten 1985).

Unit V-A The very gradual (lithological) transition from Unit IV-C-III sediments to the overlying Unit V-A deposits suggests that the formation periods of these two units were closely related in time, and that they were very probably formed under the same climatic conditions. The formation of Unit V-A was followed by a major period of soil formation under warm-temperate climatic conditions.

Unit V-B This unit is considered to be a cold-phase deposit that consists of loess which was displaced after its original deposition by the wind. The palaeosol on top of Unit V-B is interpreted as having been formed under deciduous forest vegetation during the Eemian interglacial.

Unit VI This unit was, for the most part, formed under cold humid climatic conditions. The lower part of Unit VI (Unit VI-A, VI-B) has been affected by regularly developed involutions, reaching a constant depth of 70-120 cm. They have been interpreted as cryoturbations and, on the basis of their size and widespread occurrence, as indications of the existence of a former permafrost, which, according to Vandenberghe *et al.* (1985), most probably dates from the Weichselian Lower Pleniglacial. A cryoturbation level was also observed in the top part of Unit VI, which is datable to the period of permafrost conditions in the Weichselian Upper Pleniglacial.

Unit VII This is a typical loess deposit of the Weichselian Pleniglacial, in the upper part of which a Holocene Luvisol has developed.

2.3.5 DATING EVIDENCE

In this section a short survey will be given of the data relevant to the relative and 'absolute' dating of the different units in the Maastricht-Belvédère pit. More details are found in the sections dealing with the individual units.

The presence of *Mammuthus primigenius* and *Coelodonta antiquitatis* in the upper part of Unit III-A indicates that these sediments were deposited after the Holsteinian interglacial (Van Kolfschoten 1985). Paulissen (1973) dated the Caberg Middle-Terrace deposits of Unit III-A to the Saalian in his Maas-terrace stratigraphy. He is of the opinion that the younger Middle Terrace of Eisden-Lanklaar was also formed in the Saalian period. This would imply a relatively early Saalian age for Unit III-A.

Unit IV, which also forms part of the Caberg deposits, was dated on the basis of different independent forms of evidence. The micro-mammals indicate that Unit IV was formed in a warm-temperate phase before the arrival of the Saalian glaciers in the central Netherlands (Van Kolfschoten 1985); the molluscan evidence indicates that Unit IV was formed during a warm-temperate phase of an interglacial character between the Holsteinian and the Eemian (Meijer 1985).

Thermoluminescence dating (TL) at the laboratory at Oxford of five burnt flints from Unit IV-C yielded an absolute age of 270 ±11/± 22 ka (OxTL 712k, Huxtable/Aitken 1985), while a preliminary Electron Spin Resonance (ESR)

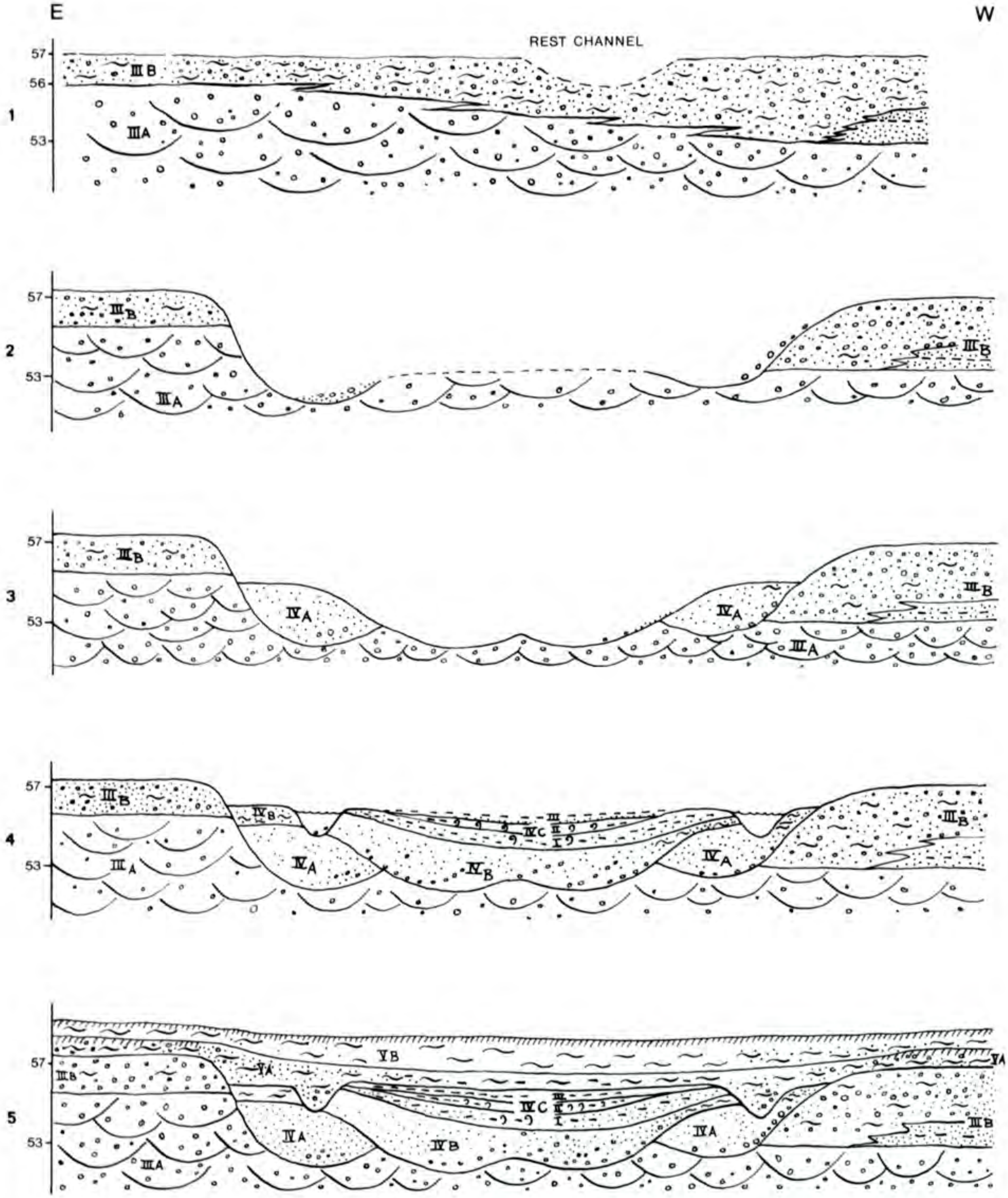


Fig. 19. Idealized representation of the genesis of the Middle Pleistocene sequence at Maastricht-Belvédère. The graphic presentation starts (1) at the end of the braided-river system, the main channel shifting its course to the east of the present Belvédère site. 5 shows the situation after the formation of the Unit V-B deposits (see table 4).

Table 4: Schematic summary of the Middle Pleistocene sequence at Maastricht-Belvédère.

lithostratigraphy		sedimentary processes/soil formation	climatic indications	archaeology	fauna[2]
		SOIL FORMATION (luvisol)	warm-temperate		
V-B		- formation of Unit 5.2 'loessic' sediments in a fining upwards sequence	cold	isolated finds	
		SOIL FORMATION (luvisol)	warm-temperate		
V-A		- alluvial deposition of a Unit 5.1 mixture of sands and loams (overbank deposits)			
IV-C	-III	- fluvial deposition of silty sands and clays (4.5.3) (overbank deposits)	warm-temperate	Sites A,D,F,H,K	isolated horse molars deer
	-II	- formation of calcareous tufas (4.5.2), up to 90% $CaCo_3$, in depressions	warm-temperate ('atlantic')		Fauna 4
	-I	- deposition of greyish olive sands and clays (4.5.1), filling depressions		Sites B,C,G	
IV-B		- formation of sandy deposits with intercalated gravel layers in gullies cut into older sediments (4.4)	warm-temperate ('continental')	isolated finds	Fauna 3
IV-A		- finely grained laminated sands deposited in abandoned branches of the main system (4.3)			
III-B		- more finely grained layers (4.1, 4.2) deposited at margins of the braided river	cold / partly permafrost		
III-A		- formation of gravel Unit 3 by a major braided river system		isolated finds	Fauna 2 Fauna 1

age determination of molluscs from Unit IV-C, carried out by R. Grün and O. Katzenberg, of Cologne, yielded an age of 220 ± 40 ka (pers.comm., 1985). Further dating of sediments, burnt flints and fossils is in progress (see section 8.3).

The heavy mineral association of the loess fraction of Unit V-B corresponds to that of pre-Weichselian loess deposits in Belgium and West Germany (Meijs 1985). A soil sample taken from the Bt horizon of the 'Rocourt' soil in the upper part of Unit V yielded TL ages of more than 75 ka (Aitken *et al.* 1986, sample 712h2).

We have already mentioned above that Units VI-A and VI-B were affected by a period of permafrost conditions in the Weichselian Lower Pleniglacial, which is dated 60-72 ka (Vandenberghe 1985b). Consequently, the sediments affected by these conditions have to be assigned an Early Weichselian age (see furthermore chapter 7).

According to Haesaerts *et al.* (1981), the Nagelbeek Horizon has an age of about 20 ka. Debenham (in: Aitken *et al.* 1986) performed a TL age determination of the layer presumed to be the Nagelbeek Horizon at Belvédère and obtained an age of 13.3 ± 3.0 ka (cf. Wintle 1987).

Overlying the Nagelbeek Horizon are the Unit VII loess deposits, which have an average TL age of 17.5 ± 3.5 ka (Huxtable/Aitken 1985; Aitken *et al.* 1986; cf. Wintle 1987).

2.3.6 STRATIGRAPHICAL AND PALAEOENVIRONMENTAL SYNTHESIS (fig. 19)

At this stage of the research only a preliminary interpretation of the sequence of events can be given. The interpretation given below, focussing solely on the Middle Pleistocene sediments, is based on partly unpublished geological field-

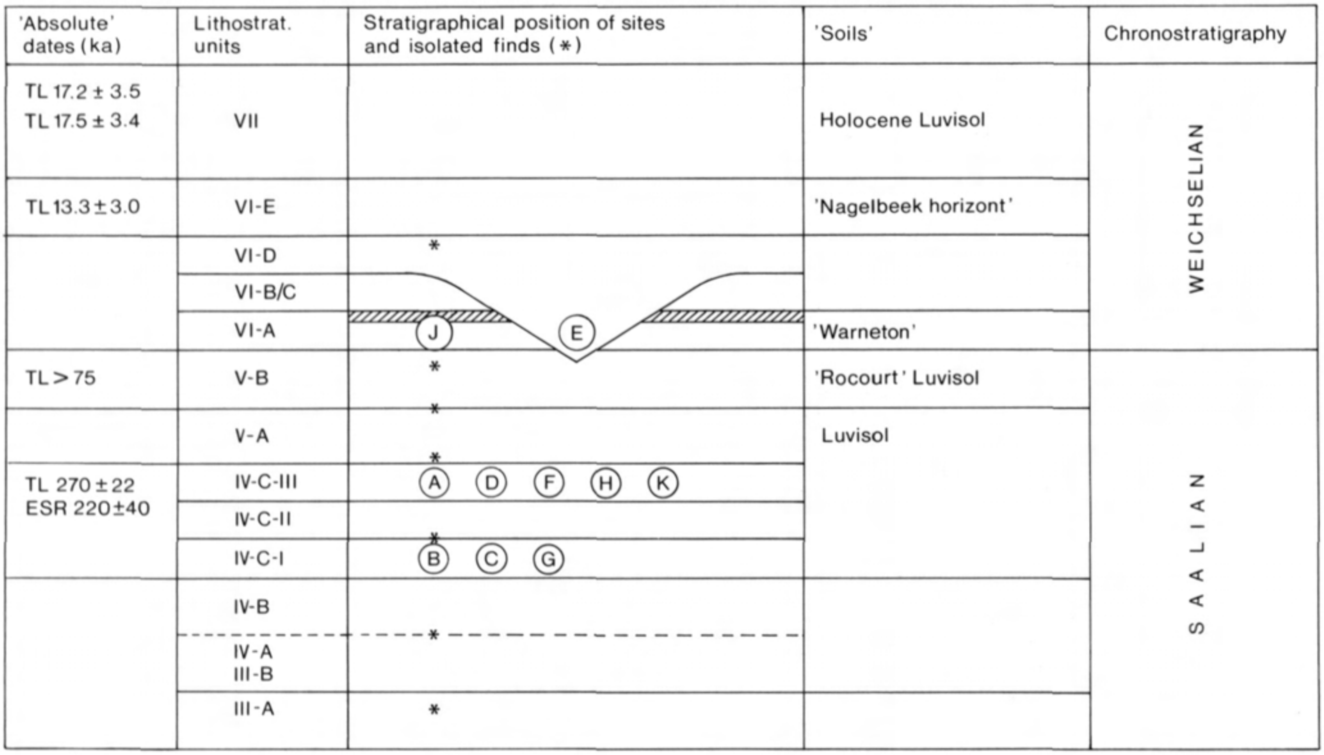


Fig. 20. Idealized survey of the stratigraphical position of the archaeological sites.

work supervised by J. Vandenberghe, who will publish the geological findings in detail elsewhere. As no further research has been done on the Weichselian sediments in the pit, the reader is referred to Vandenberghe *et al.* (1985) for details. Figure 19 gives a schematic illustration of the genesis of the Middle Pleistocene deposits in the Belvédère pit, based on a compilation of several larger sections recorded in 1981-1987.

Unit III

The gravel of Unit III-A was deposited by a major braided river system, the centre of which was situated at the site of the present Belvédère pit during the formation of the gravel unit (Unit III-A).

The more finely grained lithological Units 4.1 and 4.2 (III-B) overlying the gravels of Unit 3 may be considered marginal deposits of a (slightly) later successor of this river system, which had taken a more easterly course. By this time only a channel remained at the site of the pit. These sediments may have been deposited under climatic conditions comparable with those under which the gravels of Unit 3 were deposited. In the western and the eastern parts of the pit frost fissures have been observed in Unit 4.1.

Unit IV

– IV-A: In the following phase lithological Unit 4.3, consisting of laminated fine sand, was deposited in more localized channels, that were rather inactive and were probably deserted branches of the main system, which were slowly filled with fine sands (climbing ripples). Two probably contemporary channels were observed. They cannot be interpreted as main channels and are more likely to have been peripheral ones which contained water in times of floods.

– IV-B: The shallow channels still remaining after this phase were filled with Unit 4.4 deposits, coarser sands with intercalated gravel layers.

– IV-C: On top of these sands loamy layers with intercalated layers of sand (IV-C-I) were deposited in a calm environment, in which calcareous tufas (IV-C-II) were formed in a backswamp-like environment (lithological Unit 4.5.2). These finely grained sediments are overlain by clays and silt loams (IV-C-III).

Human occupation took place *before* the formation of the calcareous tufas,which at Sites B, C and G were present *above* the finely grained sediments which contained the archaeological remains, while a second archaeological level is placed *after* the formation of the calcareous tufa. Sites A, D, F, H and K are regarded as being situated in this upper level IV-C-III.

Unit V
– V-A: After the formation of Unit IV-C, the river disappeared from the site of the pit; the Unit V-A deposits, which are high-water sediments, here and there alternated with high-energy deposits, are interpreted as *overbank deposits* of a large river system,
The formation of Unit V-A was followed by a major stable period, as is apparent from the remnants of a luvisol palaeosol formed in the top part of the Unit IV/V-A complex.
– V-B: Elsewhere, a more local origin has been suggested for these waterlaid sediments (Vandenberghe *et al.* 1985), but heavy-mineral-analyses (Krook *unpublished*) point to a more regional provenance.
The Unit V-B sediments were the parent material in a second major period of *soil formation*, resulting in the development of a well-drained luvisol, correlated with the 'Eemian' *Sol de Rocourt* (Gullentops 1954).

Table 4 gives a schematic summary of the Middle Pleistocene sequence at Maastricht-Belvédère, while figure 20 gives an idealized schematic survey of the stratigraphical position of the archaeological sites to be presented in this volume.

notes

[1] classified in the Netherlands as *radebrik-gronden* (De Bakker/Schelling 1966) and in West Germany as *Parabraunerde* (Mückenhausen 1962).
[2] Van Kolfschoten 1985; *in press*)

3 Finds from Unit III

In the author's opinion, the Unit 3 terrace gravels (lithostratigraphical Unit III-A) have yielded only two indisputable artefacts, along with a large number of 'dubious' pieces.

Figure 21a shows a rolled flake found on October 6, 1981 by Mr W.M. Felder (Geological Survey, Heerlen). The presence of a bulbus, a large striking platform, and several dorsal negatives makes it quite certain that this flint is an artefact. The flake was found roughly in the middle of the gravel section. Mr Felder could not establish with certainty whether the flake was still in its original position; the deposits overlying the Unit 3 terrace gravels had already been removed several months before the discovery and the gravel section was of recent date. The rolled flake must have come from the upper half or the middle of the Unit 3 terrace gravels though.

Figure 21b shows a flake found on March 2, 1988, in the final stage of the writing of this manuscript. The artefact was found by Mr A. Spieksma (Institute of Prehistory, Leiden).

The Unit 3 gravels have not been subjected to an intensive archaeological survey, but were only unsystematically surveyed for artefacts in several field campaigns. The gravels contained a large amount of flint and a large number of 'dubious' flakes were recovered by survey and screening. All of these have no, or only small striking platforms, no dorsal negatives, etc. The flints that are considered artefacts on technical grounds, like the two illustrated here, had without any doubt been shifted from their original position, as is proven by their rolled condition.

At present, the Unit 3 gravels are thought to post-date the Needian interglacial which, on the basis of pollen-analytical evidence, is correlated with the Holsteinian interglacial (see: Zagwijn 1973). As indicated by the dating evidence obtained for the overlying Unit IV deposits (see chapter 8), the Unit 3 gravels were formed in the first stadial of the Saalian (cf. Zagwijn 1973). The possible date of these rolled flakes is therefore the first stadial of the Saalian.

a

b

Fig. 21. Two rolled flakes from the Unit 3 gravels, scale 2:3.

4 Finds and sites discovered in Unit IV-C-I

4.1 Introduction

In the pit three sites (B, C and G) were discovered which were stratigraphically situated *beneath* the Unit IV-C-II calcareous tufas. Their embedding Unit IV-C-I matrix produced many faunal remains, both within and outside the limits of the excavations, which made this unit a focus of interest in the multidisciplinary work.

Of the three sites presented here the 'richest', Site C, will be treated in most detail, while the interpretation of the other two sites will be limited to site-specific problems, at least in this chapter.

More general implications of the analyses of these sites will be discussed in chapter 8, which deals with the environmental and chronological context of the Unit IV-C sites, and in chapter 9, where general behavioural aspects of the hominids responsible for the assemblages recorded at the Unit IV-C sites will be discussed.

4.2 Site C

4.2.1 INTRODUCTION

Site C was discovered on August 21, 1981 during the excavation of Site B, when F. Brounen found a flake in Unit 4.5 sediments, about 30 m south of Site B (see fig. 22). The section that contained the flake had already been sampled for molluscs and small mammal remains. A small trench led to the main excavation. The site was excavated in three campaigns, from September 1, 1981, to February 11, 1982, from July 12, 1982, to September 2, 1982, and from April 5, 1983, to June 17, 1983. In 36 weeks a total area of 264 m^2 was excavated.

The excavation was carried out in the usual way: all finds macroscopically identifiable in the field were recorded three-dimensionally and individually numbered and all flints were stored separately in small plastic bags. The sediment of 38 m^2 was sieved through a 2-mm mesh sieve.

The excavation was complicated by the major problem of karst, which had caused a -mostly gradual- subsidence of the geological Units III, IV, V and VI-A. The layers above Unit 4.5 could therefore only partly be dug away mechanically and substantial amounts of sediment had to be removed by hand. Because the karst-subsided Unit 4 sediments had been followed in the 1981-1982 campaigns, the excavation site had become a depression in its environs,

Fig. 22. Site C: the first trial squares in the northern part, September 1981. In the background the Site B cutting is visible (photograph: P.J.R.Modderman).

which could hardly be protected from the huge amounts of (rain-)water that occasionally flooded the pit. In the winter of 1982/1983 the southern part of the excavation was covered by 1 to 3 m of water, causing the deposition of thick layers of sandy clay, which all had to be removed by hand at the beginning of the 1983 campaign. However, this incident had no consequences for the archaeological record, which was protected by the original Unit V layers still present on top of Unit IV.

We tried to systematically record larger areas without finds on our distribution plans by also excavating the areas around artefact concentrations as far as this was possible in view of the karst-generated disturbances mentioned above.

While the excavation was being carried out, J.P. de Warrimont and others spent several days sampling those areas which were too affected by karst to be excavated in the usual way. These areas are indicated on the general distribution maps of Site C. The area yielded only two small flakes, probably because the Unit 4 find matrix was completely mixed with other layers.

4.2.2 STRATIGRAPHY

The Site C flint assemblage was found in a matrix of well-sorted fine- to very finely-grained yellowish-brown (2.5 Y 5/3) to greyish-olive (5 Y 5/3) sands, with a silt and clay content of at least 15% by weight. Especially in the eastern part of the excavated area the sands became finer in a lateral transition to greyish-olive silty clays. Some of the finds, particulary those recovered from the northern and eastern parts of the excavated area, were discovered immediately underneath the calcareous tufa of Unit IV-C-II. Figure 23 gives a schematic representation of the section observed in square H-13, where Dr M. Aitken (Oxford) inserted TL dosimeters in 1982 for the measurement of the Environmental Dose rate. The sequence recorded in this section is representative of the Site C area in general, varying mainly in the grain size of the sediments designated as 2 and 3 in figure 23. In some parts this 'ideal' section was badly disturbed, especially in the neighbourhood of the centres of karst-generated disturbances. Figure 24 shows the section recorded in September 1981 at the eastern boundary of the northern part of the site. Here Unit IV sediments had sunk into a sinkhole and had been replaced by Unit V sediments (see also figure 25 for a photograph of this phe-

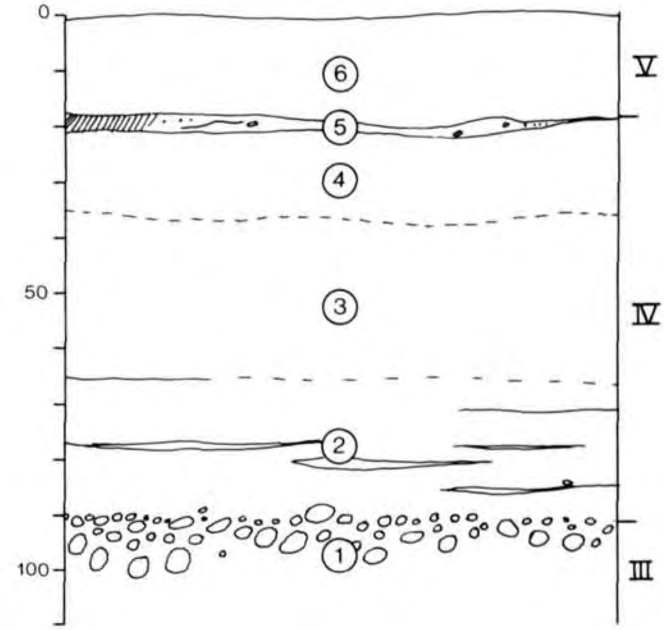


Fig. 23. Site C: section in square H 13
1 the top of the Unit III gravels
2 laminated very fine sand (2.5 Y 7.2)
3 loamy very fine sand (2.5 Y 5/3) with a few reddish yellow (5 Y 6/8) mottles, containing artefacts
4 sandy loam with the same basic colour as 3, but with a much darker appearance as a result of the abundance of Mn and Fe mottles
5 sandy loam, reddish brown
6 red silt loam (7.5 YR 6/6)
2-5 all form part of Unit IV-C, while 6 probably represents a Unit V-B deposit

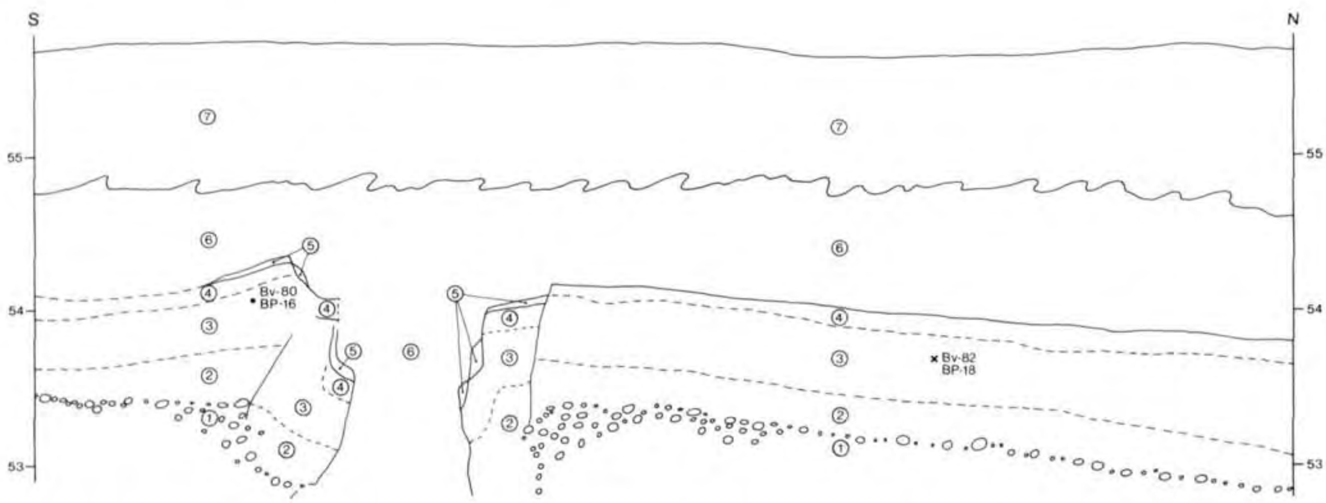


Fig. 24. Site C: section recorded at the northeastern boundary of the excavated area, as indicated. For the legend see figure 23. The BV- and BP numbers indicate the positions of artefacts and faunal remains.

nomenon). The combined data indicate that the Site C assemblage has to be placed in lithological Unit 4.5.1 and in lithostratigraphical Unit IV-C-I.

4.2.3. THE FINDS

4.2.3.1 Introduction

During the Site C excavations the following find categories were recorded: flint artefacts (fig. 26), burnt flints, bone material, charcoal and haematite. Figure 27 (separate sheet at the back of this volume) gives the horizontal distribution of all find categories, which will be presented successively in the following sections.

4.2.3.2 The flint assemblage

In total, 3067 flint artefacts were recorded three-dimensionally in the course of the Site C excavations. Figure 28 and table 5 give the size distribution of the flint material, showing that the majority of the finds (73.9%) are small flakes with maximum dimensions of less than 2 cm. The sieve residue of 38 m^2 also contained 536 chips with maximum dimensions of less than 1 cm (see section 4.2.5.2). The total weight of the Site C artefact assemblage is only 7230 g.

As a general characterization it can be said that the flint industry is to a large extent the product of a prepared-core technique, including several 'classical' Levallois flakes. Some of the larger non-cortex flakes show signs of soft-hammer flaking. Many of the butts are facetted: for the total number of flakes the *Index Facettage* is 50.4, the *Index Facettage stricte* being 43.7. For the larger flakes (≥ 5 cm) the *Index Facettage* is 62.8, and the *Index Facettage stricte* 55.3. The *Index Laminaire* of these larger flakes is 20.5. The edge angles of the flakes are small, generally not more than 40 degrees. The flakes have straight edges when viewed in cross section.

The assemblage contains only three tools (i.e. artefacts displaying signs of intentional retouch) which are all three scrapers (fig. 39). In addition to these intentionally modified artefacts, 18 of the larger flakes display macroscopical signs of use, varying in intensity. The technological characteristics of these 'used' flakes and the three tools are given in table 6 (see also fig. 29).

Most of the flints show a light colour-patination, while many of the pieces display a soil-sheen, varying in intensity. Several pieces, however, show hardly any macroscopical surface modifications.

On the basis of the specific properties of the flint material (texture, cortex, inclusions, colour), the flint artefacts could be attributed to six different Raw Material Units (RMUs), which are interpreted as incorporating the products of six different flint nodules. Contrary to the first interpretations (Roebroeks 1984a), these RMUs did not all have their own spatial scatter. The data obtained in the refitting programme, which are to be presented below, in section 4.2.4,

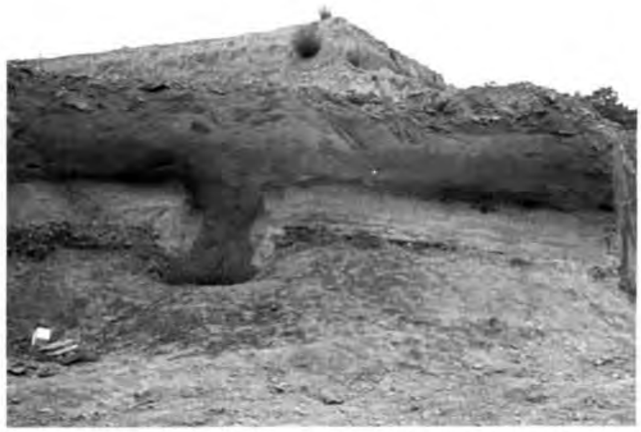


Fig. 25. Photographic representation of the karst disturbance shown in figure 24.

Fig. 26. Site C: a vertical view of square C 18, during excavation: two large flakes are indicated, to the left a plunged Levallois-flake (C 18/10, see figure 34) made from Raw Material Unit 4 (RMU 4), and to the right a RMU 6 flake (C 18/5). A poorly preserved bone fragment is visible in the top left corner. Two karst-generated fault lines can be seen running through the square in the lower half of the picture.

led to a reinterpretation of the flint distribution. In this paragraph the different RMUs will be described in terms of their general characteristics and attention will be drawn to their horizontal distributions within the excavated area (fig. 30).

It must be stressed that it was not always possible to unambiguously attribute individual elements to a specific RMU. The numerical data given in this section are therefore in the first place to be seen as approximations.

Raw Material Unit 1

This RMU consists of a relatively fine-grained blueish-white flint, with many small (<1 mm) dark blue dots, and a mod-

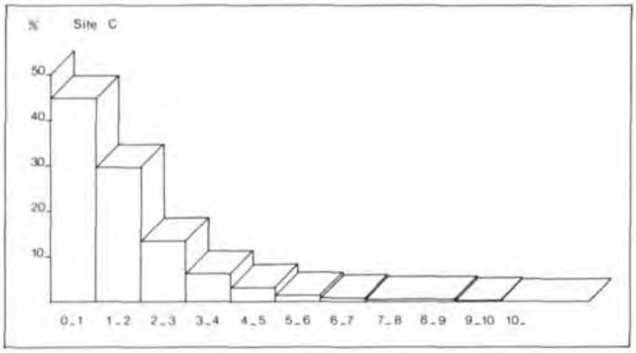


Fig. 28. Site C: size distribution of the Site C flint artefacts, based on maximum dimensions, in cm.

erately to severely rolled cortex. The approximately 90 RMU 1 elements consist mainly of debris, with a few rough flakes and flake fragments with cortex. The total weight is approximately 675 g. The horizontal distribution of the elements of this RMU is schematically indicated in figure 30.

Raw Material Unit 2 (figs. 31-32)
RMU 2 consists of a relatively coarse-grained yellow-brown flint with a fresh cortex. This RMU is represented by much debris, a large number of cortex flakes, a few larger flakes from a 'Levallois' core, two cores (three after refitting: see figs. 32 and 49) and core fragments. The total weight of elements of this RMU is about 3000 g. A comparison with the RMU 3, 4, 5 and 6 products shows that this flint nodule had been worked in a 'rougher way', which may be a consequence of the flint's grain size. All flakes seem to be the product of hard-hammer flaking, as suggested by the well pronounced bulbs. Facetted butts are less common than in the case of the other RMUs:

	RMU 2 (flakes > 5cm)	other RMUs (flakes >5cm)
IF	42.4	73.7
IFs	36.4	65.5

The horizontal distribution of the elements of this RMU is schematically indicated in figure 30.

Raw Material Unit 3
RMU 3 consists of a fine-grained blueish-white flint with a slightly abraded cortex. It is not always possible to differentiate between this RMU and RMU 4. Allowing for a certain amount of variation within one flint nodule, it would even be possible to regard RMUs 3 and 4 as a single unit. This was in fact the interpretation in the field, supported by the almost complete overlap in the horizontal distributions of the flaking debris of the two RMUs (fig. 30). However, we are here dealing with the remains of two completely

Table 5: Some quantitative data on the Site C flint assemblage (three-dimensionally recorded finds only).

max. dimensions in cm	n	% of total
0 – 1	1368	44.6
1 – 2	898	29.3
2 – 3	404	13.2
3 – 4	188	6.1
4 – 5	93	3.0
5 – 6	44	1.4
6 – 7	27	0.9
7 – 8	18	0.6
8 – 9	16	0.5
9 – 10	7	0.2
10 –	4	0.1
total	3067	99.9
burnt flints	132	4.3
pieces with cortex	509	16.6
tools	3	0.1
flakes showing use retouch	18	0.6
cores	4	0.1

different flint-knapping stages, as will be shown in the section dealing with the refitting evidence. In view of their differences in grain size, cortex and inclusions, the knapping products resulting from these two different stages have been interpreted as two different RMUs. Besides by the usual fine debris, RMU 3 is represented mainly by flakes with cortex and a few larger regular flakes which all seem to have been produced by hard-percussion flaking. The total weight of this group is approximately 800 g.

Raw Material Unit 4 (figs. 33-36)
RMU 4 consists of a fine-grained flint (finer than RMU 3), blueish-white in colour, with a very coarse-grained light brown part, and a relatively fresh and thick cortex.

This RMU comprises a dozen larger (> 5 cm) flakes, an exhausted 'Levallois' core (fig. 33) and much fine debris. The RMU 4 flakes rarely show a cortex. The majority of the larger flakes were recorded outside the main debris concentration, in the neighbourhood of some larger bone fragments. Many of the flakes show signs of soft-hammer flaking. The total weight of this RMU is approximately 1300 g.

Raw Material Unit 5
RMU 5 consists of a very fine-grained dark grey flint with a fresh cortex. Its horizontal distribution, partly overlapping that of RMU 6, is indicated in figure 30. The elements of this RMU are mainly smaller (< 5 cm) 'soft-hammer' flakes, including only a few cortex flakes. The total weight of this RMU is only 470 g. About 10% of the elements of this RMU shows signs of burning.

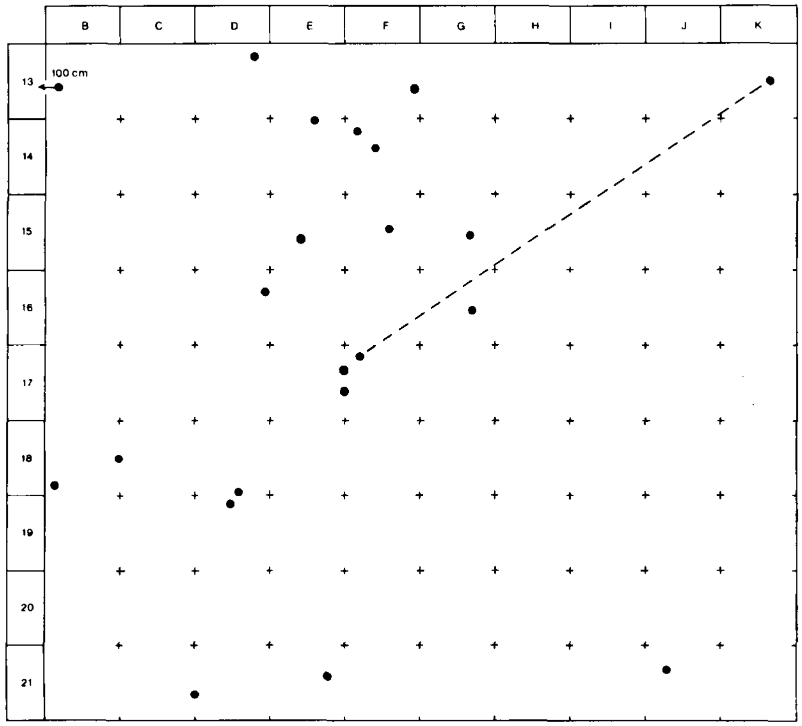


Fig. 29. Site C: horizontal distribution of tools and flakes showing signs of use retouch (see Table 6). Grid in square metres.

Table 6: Some technological characteristics of tools and flakes displaying use retouch from Site C (dimensions in mm).

find no.	length	width	max. dimens.	number of scars	striking platform	remarks
Bv 793	72	40	73	6	facetted	
Bv 897	64	38	65	4	missing	
Bv 946	67	44	70	6	missing	
Bv 1010	97	74	97	8	dihedral	
Bv 1155	78	39	78	10	facetted	
Bv 1202	100	55	100	5	facetted	
Bv 1265/ Bv 1248	101	48	107	5	facetted	
Bv 1508	82	30	83	8	plain	
A 13/6	61	30	61	3	dihedral	
B 18/4	88	40	88	10	facetted	
B 18/7	75	58	80	4	facetted	
D 16/5/ Bv 1483	52	35	86	6	dihedral	
D 18/5	63	33	69	7	dihedral	meat polish
D 19/1	86	48	86	10	facetted	
D 21/1	43	31	47	3	plain	*scraper*
E 17/10	65	29	67	8	missing	*scraper*
E 17/11	80	43	85	5	dihedral	
E 21/26	40	26	46	9	plain	*scraper*
F 17/2/ Bv 732	77	35	78	12	missing	
G 16/14	56	27	57	4	missing	
J 20/17	39	31	39	4	missing	

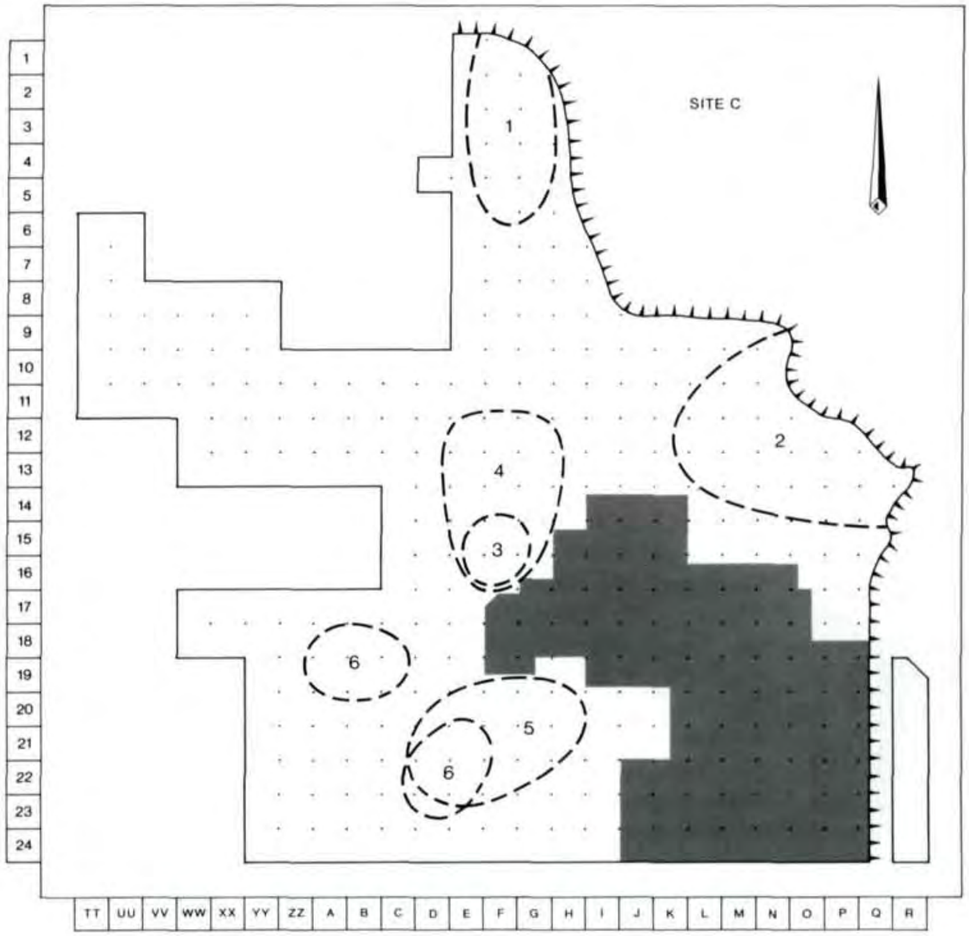


Fig. 30. Schematic horizontal distribution of the main concentrations of RMU's 1-6. Grid in square metres. The area disturbed by karst is coloured grey.

Raw Material Unit 6 (fig. 37)
RMU 6 consists of a grey fine-grained flint with a cortex severely abraded by fluvial transport. Its horizontal distribution is indicated in figure 30. Of this RMU we have a few dozen cortex flakes, while a dozen larger flakes, found outside the RMU 6 concentration, are considered to have been struck from the same flint nodule on the basis of their grain-size, colour and inclusions. The side scraper E 17/10 (fig. 39) is also ascribed to this RMU.

The overall majority of the Site C flint material could be ascribed to these six groups. Three larger flakes, found in the southern part of the site, were definitely not from the RMUs presented here and probably derive from one or more other flint nodules (fig. 38). It is furthermore worth mentioning that two of the three scrapers (i.e. E 21/26 and D 21/1, fig. 39) could not be positively related to one of the RMUs either, although they may have been produced from RMUs 5 and 6, respectively.

Artefacts produced from the different RMUs are shown in figures 31-39 and 47-64, in which they are grouped per RMU.

The refitting evidence of the Site C material will be presented below. Here it suffices to state that we managed to refit a large part of the Site C material, and that, on the whole, conjoining pieces tended to cluster spatially. In total, 21.5% of all flint pieces was refitted, that is, 70.4 % of the total weight of the Site C flint material.

4.2.3.3 Burnt flints

In total, 159 burnt flints were recorded in the Site C excavation, 132 of which were (generally small, i.e. < 2 cm) artefacts (= 4.3% of the total number of artefacts). The overall majority of the burnt artefacts were found in the southern part of the site, as shown in figures 27 and 40. Most of these burnt artefacts can be ascribed to RMU 5. Some RMU 6 flints were also found within the southern distribution of burnt flints, but these show no traces of burning at all.

Several of the burnt flints from Site C were submitted to the Oxford Research Laboratory for Archaeology and the History of Art for the purpose of TL dating (see chapter 8, table 21).

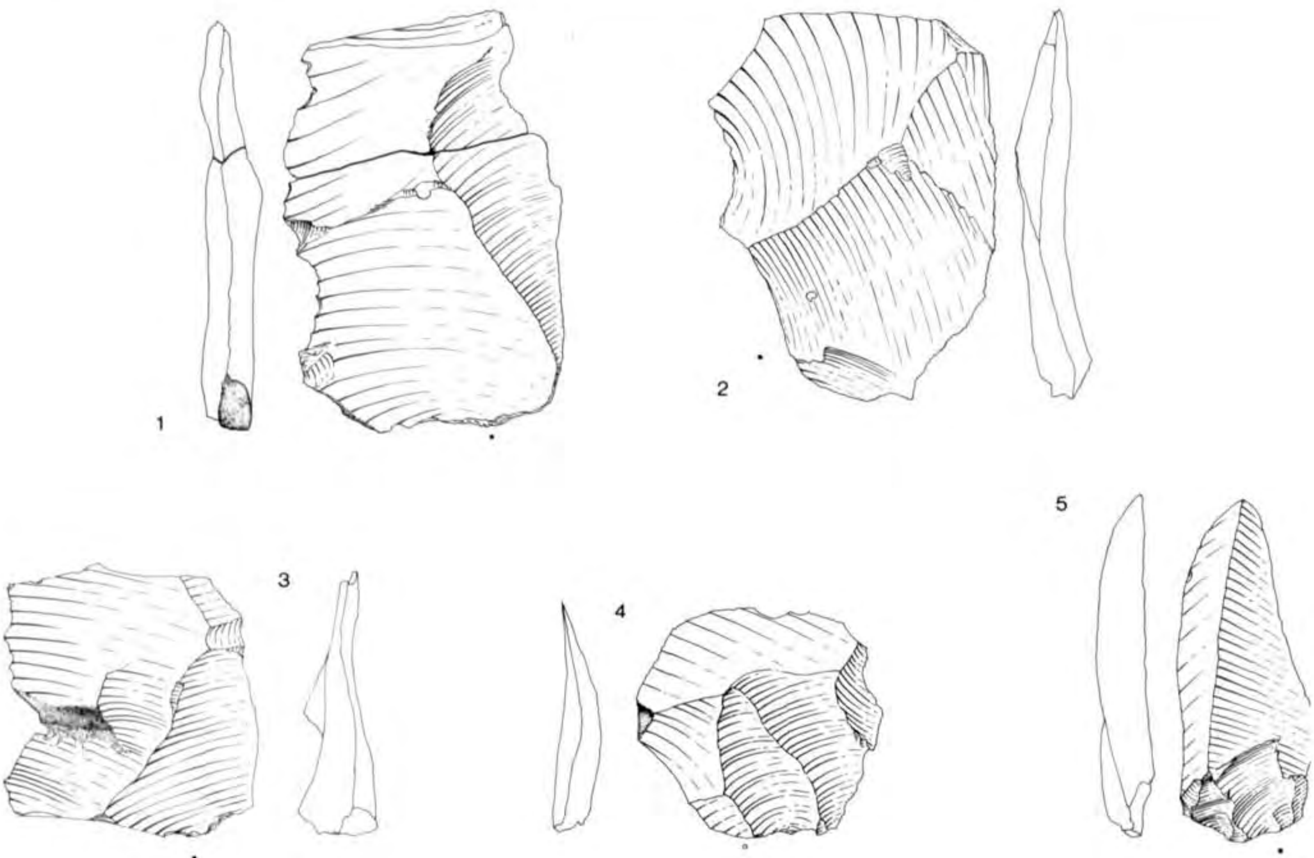


Fig. 31. Site C, RMU 2: 1-5 flakes, scale 2:3.

4.2.3.4 Faunal remains

In this section no attention will be paid to the small mammal remains and the molluscs found in calcareous parts of the Unit 4 sediments of Site C. This topic will be treated in the section dealing with the palaeoenvironmental data of the Unit IV deposits. Only the larger mammal remains will be discussed. The bone material found at Site C is on the whole poorly preserved (see figs. 26 and 42). The higher and more sandy part of the site produced several bone 'ghosts' and no intact bone fragments, whereas the lower and loamier parts of the site, although containing few bone remains overall, yielded relatively better preserved fragments. Thus, the differential decay of the bone material seems to be related to the composition of the embedding matrix, which suggests that the bone material had decomposed *in situ*.

The horizontal distribution of the Site C faunal remains is given in figure 27.

Only a few of the faunal finds could be identified: in square H-7 two complete upper milk molars of the rhinoceros *Dicerorhinus hemitoechus* were found (fig. 41) in an amorphous mass of bone and tooth fragments. The two molars (upper premolars DP2 and DP3 sin, cf. Van Kolfschoten 1985) fit together very well and show the same amount of wear. In square H-7 and in the neighbourhood of square H-7 more rhinoceros tooth fragments were found, which had very probably belonged to the same young rhinoceros.

A 41-cm long bone found in square F-24 was identified as the tibia of *Cervus (M.) giganteus*, while a bone from square D-23 was identified by Van Kolfschoten as part of a vertebra of an animal in the order of magnitude of roe deer (pers.comm., 1983).

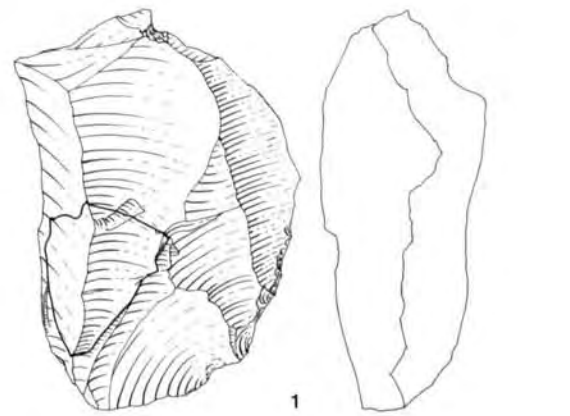
A few remarks must be made with respect to the rhinoceros remains. The fact that the Site C rhinoceros had deciduous teeth makes it possible to estimate the maximum age of the animal. In an article on rhinoceros and mammoth remains found at La Cotte de Saint-Brelade (Jersey, Channel Islands), Scott (1980) cites studies made by Borsuk-Bialynicka (1973) of the woolly rhinoceros *Coelodonta* *antiquitatis*. Borsuk-Bialynicka cites the case of a present-day rhinoceros which lost its last deciduous tooth (DP4) at the age of eight months. Although the ages at which different teeth are replaced in present-day rhinoceros may differ from those of extinct species, these data clearly indicate that the remains in the Site C faunal assemblage had belonged to a very young rhinoceros.

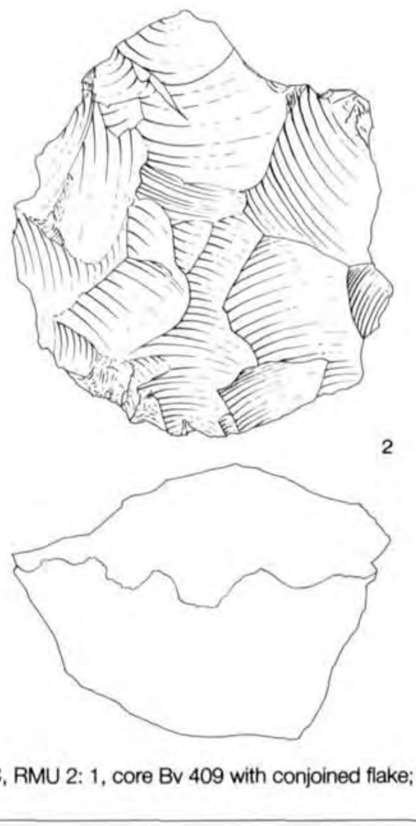
Finally it is worth mentioning that the rhinoceros remains found at Bilzingsleben (German Democratic Republic) consist mainly of lower jaws and stray teeth from -according to the excavators- smashed upper and lower jaws (Mania 1983).

4.2.3.5 Charcoal

In the course of the Site C excavations several thousands of charcoal particles were found, most of which measured less than 3 mm. The overall majority of the charcoal remains were found in two concentrations: a small one in the eastern part of the site, and a large one in the west (fig. 27).

The eastern concentration contained approximately 150 small charcoal fragments, in an ovaloid concentration of about 0.5 m^2, in squares P/Q-15. About 20 of these pieces were submitted to Dr W. Schoch at the *Labor für Quartäre Hölzer* of the Swiss Federal Institute of Forestry Research. The small size and relatively poor state of conservation of the fragments allowed only a very general identification of two pieces from this sample: one derived from coniferous, the other from deciduous wood (Schoch, in litt. 1982). This charcoal scatter was discovered in the borderzone of the RMU 2 flint artefact distribution. No burnt flints were





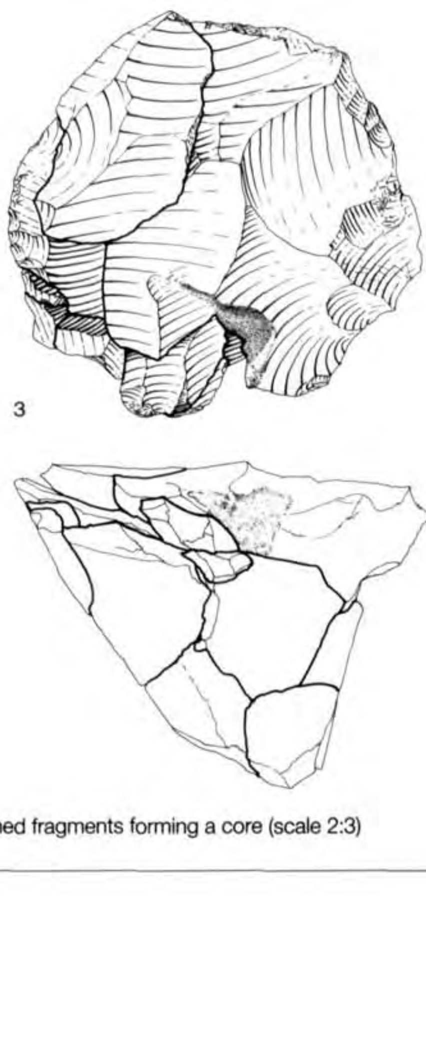


Fig. 32. Site C, RMU 2: 1, core Bv 409 with conjoined flake; 2, core Bv 557; 3, conjoined fragments forming a core (scale 2:3)

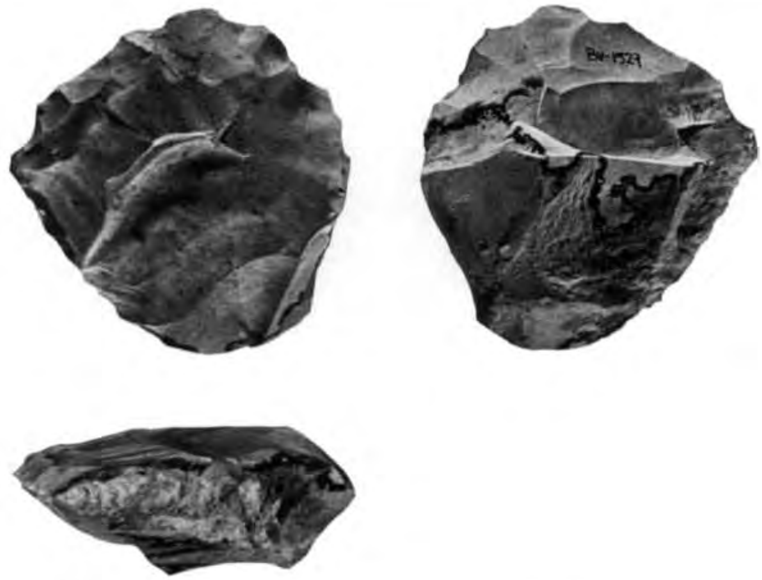


Fig. 33. Site C, RMU 4: 'Levallois' core (Bv 1527), scale 2:3.

observed among the RMU 2 material, or rather: no flints could be identified as such.

In the western charcoal concentration about 5800 pieces were recorded, most of which were smaller than 3 mm. However, this concentration which was excavated in the summers of 1982 and 1983, also contained a few larger fragments, of up to 1 cm. Figure 27 gives the spatial distribution of this charcoal concentration, which lay segregated from the main flint artefact distribution. The charcoal particles displayed a vertical distribution of 10-20 cm. A sample consisting of 20 particles from square WW-10 and 40 from square YY-12 was submitted to Dr W. Schoch. All pieces were positively identified as deciduous wood. The state of preservation of most of these did not allow identification according to species. However, a large number of particles clearly displayed uniform anatomical characteristics (distribution of the pores, etc.), indicating that all fragments were of the same wood species. Fortunately, the sample contained several pieces that were large enough to allow a positive identification of species: two pieces from square WW-10 and six pieces from YY-12 were identified with certainty as *Fraxinus* sp., ash (Schoch, in litt. 1982).

One of the first questions we asked ourselves while excavating the charcoal concentration was, of course, whether we were dealing with the results of a fire at the site of the charcoal particles, or whether other causes were to be considered, for instance the fluvial deposition of a large burnt log of wood. As the matrix did not show any signs of the effects of heat, we cannot exclude these other possibilities, which, however, have to be excluded before we may consider human involvement. The presence of a few burnt

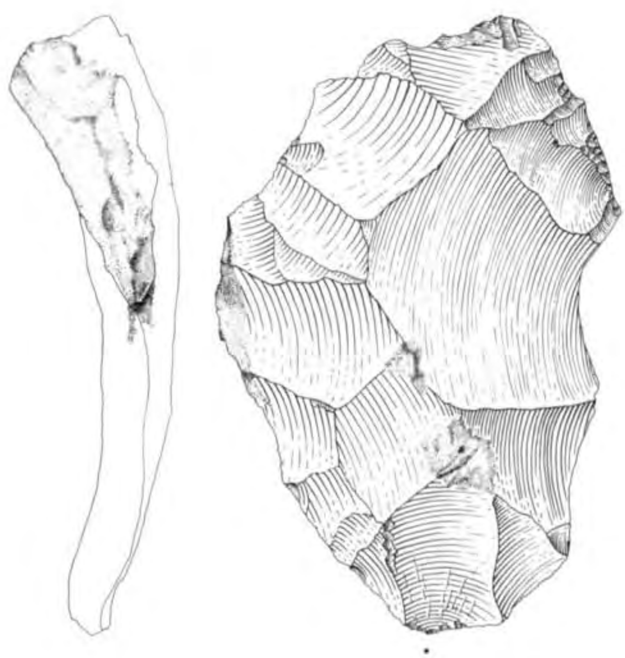


Fig. 34. Site C, RMU 4: Plunged Levallois flake (C 18/10), scale 2:3.

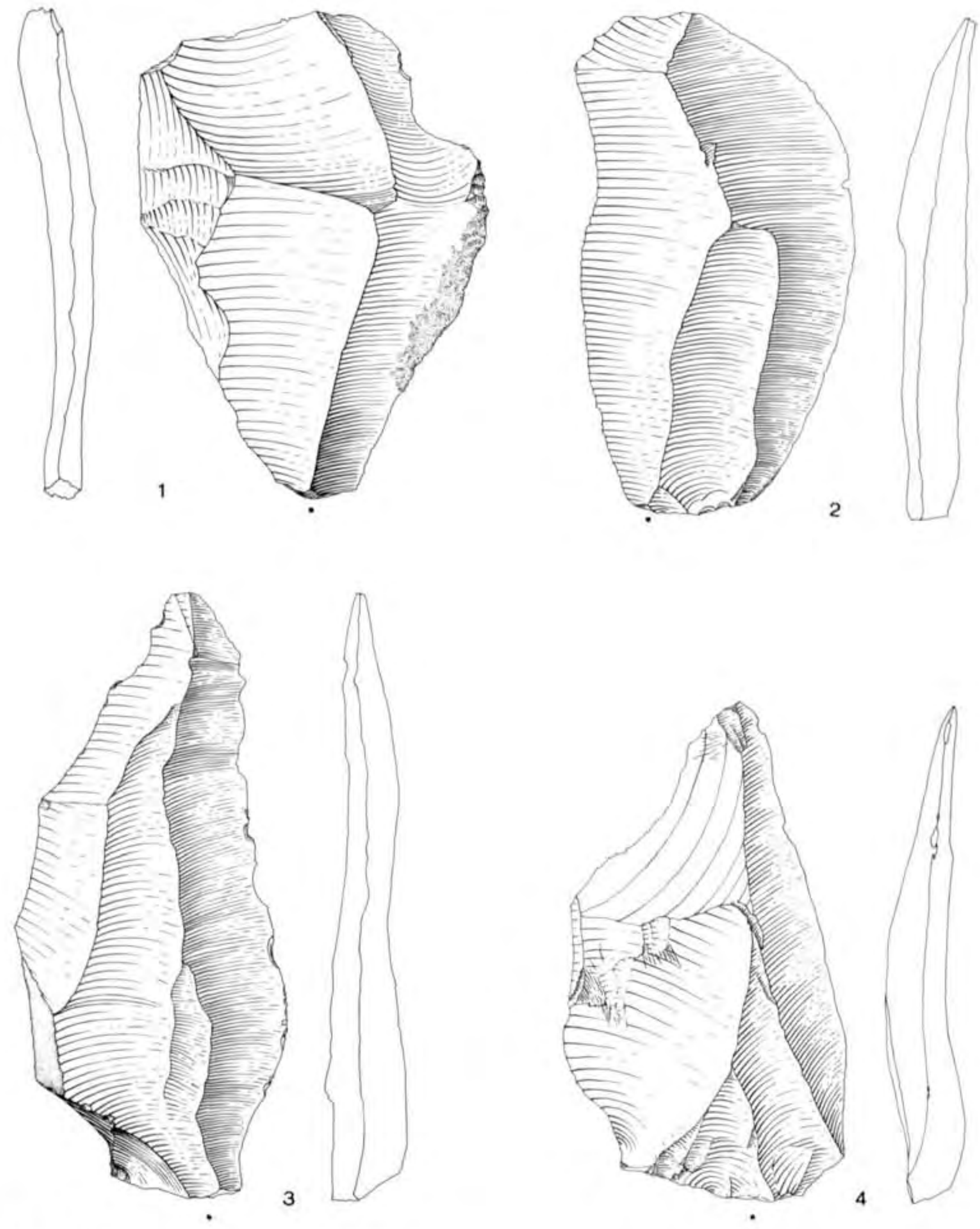


Fig. 35. Site C, RMU 4: 1-4 flakes, scale 2:3.

flints (no artefacts!) within the charcoal concentration indicates that the concentration was very probably formed as a result of a fire on the spot. Two burnt flints (XX 12/2 and YY 13/3) -broken during heating- could be fitted together (fig. 40), but then burnt flints were found over larger areas of the site. To summarize, if the charcoal concentration was the result of a fire on the spot, then this fire burned outside the recorded distribution of flint artefacts and bone material.

During the excavation of the charcoal patch a concentration of stones was discovered in square WW-10, i.e. at the northwestern periphery of the charcoal patch. Because this heap of stones (fig. 43) with a diameter of about 40 cm was initially thought to be a structure made by hominids, it was excavated with great care and the positions of the individual stones, which measured up to 11.5x6x6 cm, were recorded. However, the size range of the stones forming the concentration proved to be very large, from very small (< 1 cm)

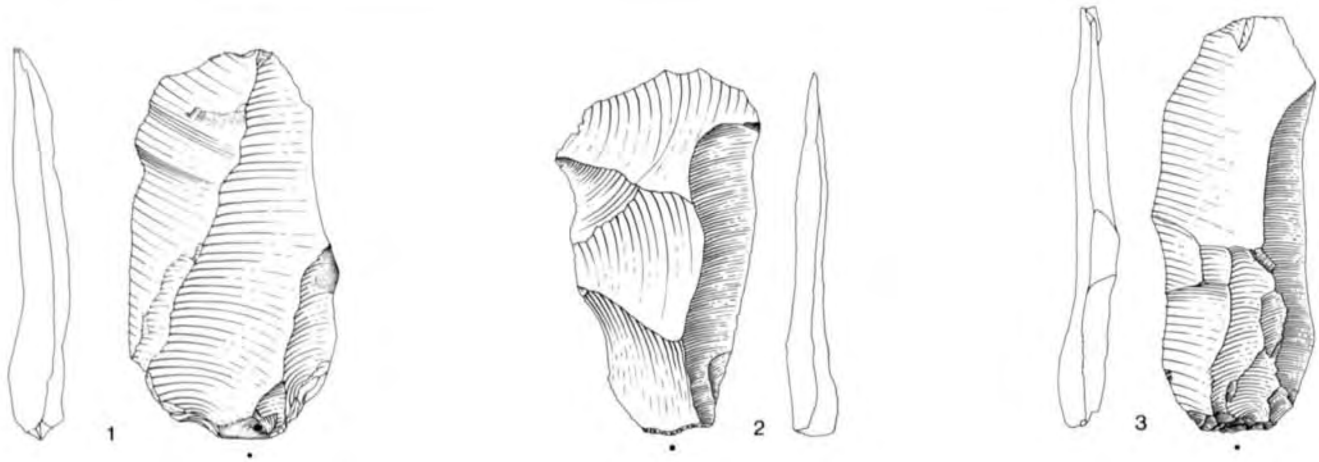


Fig. 36. Site C, 1-3 flakes (1, RMU 3?, 2-3 RMU 4), scale 2:3.

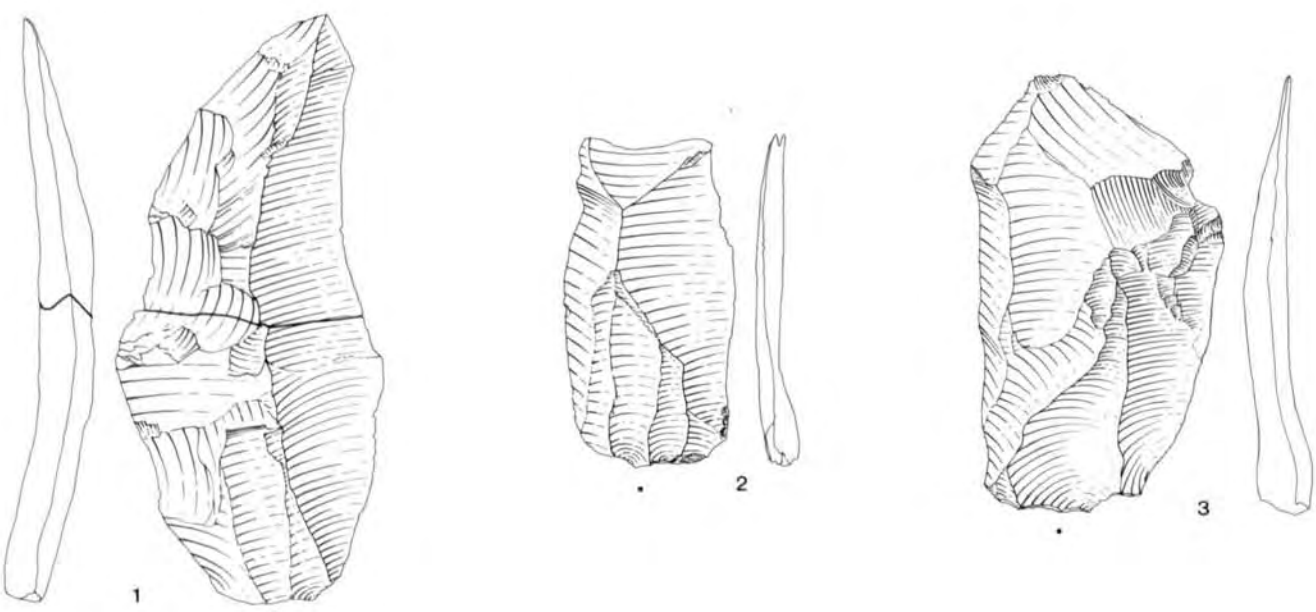


Fig. 37. Site C, RMU 6: 1-3 flakes, scale 2:3.

pebbles to large boulders, which suggested that we were dealing with a natural phenomenon: spatially limited concentrations of stones displaying a large size range occurred -usually at erosional levels- all over the pit. The charcoal patch and the stones were both situated in the western part of Site C and in the uppermost part of the Unit IV sediments. We were therefore very probably dealing with stones from an erosional level at the boundary of Units IV and V. A comparable concentration, having a diameter of about 200 cm and containing many more larger elements, was found about 4 m northwest of the first one, in square TT/UU-6. This too contained very small stones mixed with larger ones. The origin of this concentration was also ascribed to natural causes, an interpretation corroborated by geologists' assessment of the structures (J. Vandenberghe pers.comm., 1983).

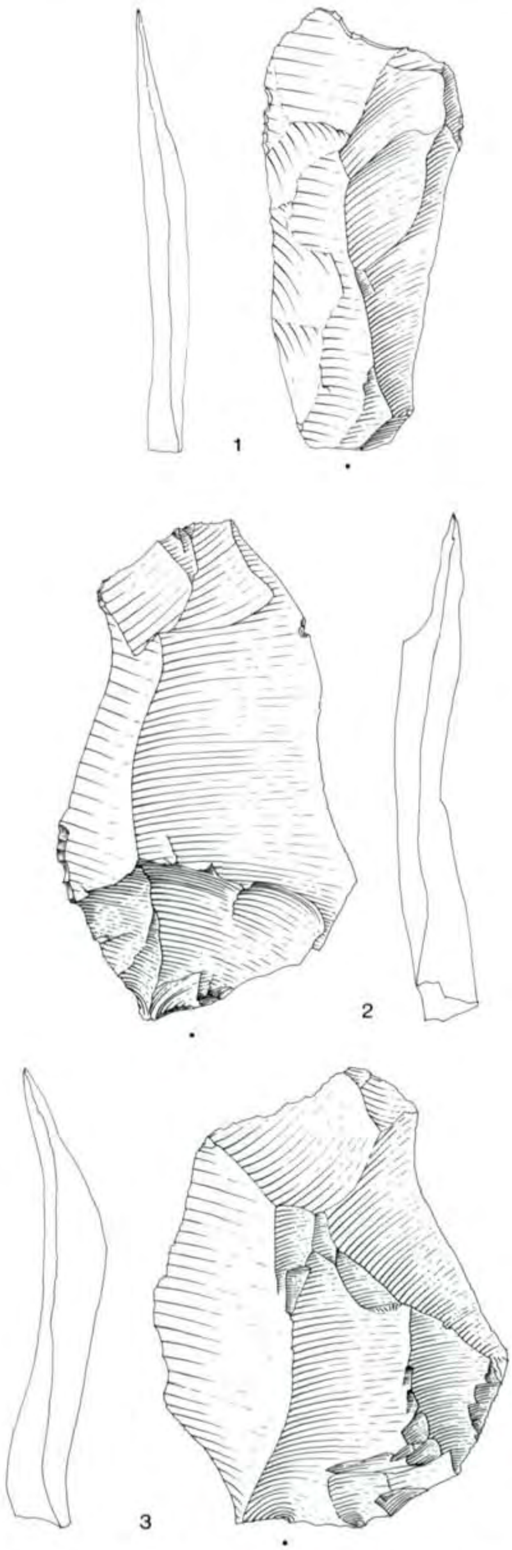


Fig. 38. Site C, 1-3, flakes not attributable to RMU 1-6, scale 2:3.

4.2.3.6 Haematite

In the course of the Site C excavation 14 small dots of reddish material were recorded, the spatial distribution of which is shown in figure 44. The reddish material was observed between the sand grains of the Unit 4 matrix, in dots ranging in diameter from 0.5 to 1.5 cm. The contrast in colour between the bright red material and the yellowish-brown (2.5 Y 5/3) to greyish-olive (5 Y 5/3) sediment enabled the recovery of the tiny fragments.

Three of these fragments were submitted to Dr C.S. Arps (National Museum of Geology and Mineralogy, Leiden) for X-ray diffraction analysis. This analysis (Arps, this volume, appendix III) demonstrated that the material was *haematite*. Figure 157 (Arps, this volume) shows the results of the analysis of sample D23/16: the dark lines indicate the diffraction pattern of the quartz particles of the Unit 4 matrix, while the fainter lines form the haematite diffraction pattern. Since haematite does not occur naturally in the soil unit, its possible origin must be discussed here.

Dutch and Rhineland prehistoric haematite sources have been the object of several publications dealing mainly with Bandkeramik raw materials (Bakels 1978; Horsch/Keesman 1982). The haematite sources closest to Maastricht are situated south of Namur in the Belgian Maas valley, i.e. approximately 70 km southwest of Belvédère. We therefore have to evaluate the possibility that small haematite fragments were transported from the Namur region by the river Maas and were finally deposited in the Maastricht region. Two observations are important in this context:

1. An important tool in the State Geological Survey's lithostratigraphical classification work is sedimentary petrography. In South Limburg Mr P.W. Bosch has been studying Maas sediments in this way for many years. According to him, small (< 0.5-1 cm) haematite fragments indeed occur in the Maas gravels of South Limburg in very small, non-quantifiable amounts. Their numerical presence is so small that, according to Bosch (pers.comm., 1986), it is virtually impossible to collect them in any numbers from natural exposures of Maas sediments nowadays.
2. The Unit 4 sediments received much attention in the course of the 1980-1988 Belvédère research in the form of excavations (Sites B, C and G) and the investigation and drawing of several hundreds of metres of Unit 4 sections. In all these activities haematite was never found outside the Site C context. This seems to indicate that the Site C haematite distribution is not part of a larger, natural 'background noise' distribution.

On the basis of these observations the horizontal and vertical association of the haematite spots and the flint assemblage at Site C can be explained by assuming human interference: the haematite must have been imported to the Site C area.

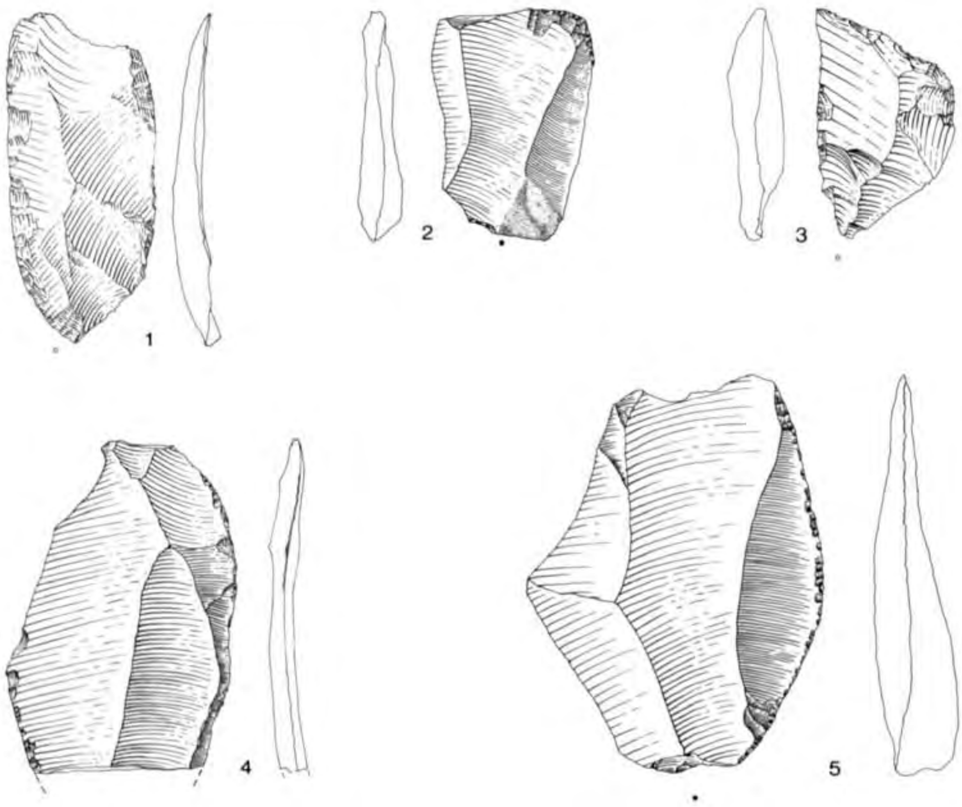


Fig. 39. Site C: 1-3, scrapers (1, E 17/10 RMU 6; 2,D 21/1 RMU 6?; 3 E 21/26 RMU 5?), 4-5 flakes showing signs of use retouch, scale 2:3.

Before we discuss the location(s) where the haematite was collected by Middle Palaeolithic man two remarks have to be made:
1. The bed of the river Maas as known to these Middle Palaeolithic groups was several kilometres wide, large parts of which may have been dry during certain periods of the year, when Maas sediments were exposed over much larger areas than nowadays.
2. Because the amount of energy invested in the procurement of goods is dependent upon the value attached to these goods, even materials present in -what nowadays seem to be negligibly- small amounts may have been looked for systematically in the Middle Pleistocene by people whose eyes and minds were certainly more adapted to the screening of the substrate than those of present *Homo sapiens sapiens*.

In the author's opinion, it is therefore impossible to state that the Site C haematite was obtained from the haematite sources near Namur in the Belgian Maas valley, although this possibility may not be alltogether excluded.

It is difficult to assess what kind of activities were responsible for the haematite distribution at Site C. In the literature prehistoric 'red ochre manipulation' has often been interpreted as evidence of 'non-utilitarian behaviour' (Edwards/Clinnick 1980; Wreschner 1980, 1982a). Velo (1984) opposed this approach, stressing the non-symbolic properties of the iron compounds of ochre, which are used as a medicine by Australian aboriginals: ochre moistened with water is applied to sores in any part of the body, and is also used in cases of internal pains (Velo 1984).

The Site C haematite spots may well be ascribable to activities related to the preparation of a hide, because treatment with ochre may inhibit or slow down the decay of hides, as discussed by Keeley (1980: 170-172).

However it may be, the presence of haematite at Site C provides unambiguous evidence of the use of red ochre at about 250 ka. Until quite recently, the Terra Amata site was thought to have provided evidence of red ochre manipulation at about 380 ka. There are however two problems involved in this Terra Amata evidence. First, the TL age of 380 ka has somehow found its way into the literature, but the age determination itself has never been published (De Lumley 1976a: 823). A published TL age determination by Wintle and Aitken (1977) suggests a younger age for the site (230 $\pm$ 40 ka), which is in accordance with Bonifay's (1975) chronostratigraphical interpretation of the site. Secondly, and more important in this context, Wreschner (1982b) now interprets the Terra Amata ochres as the

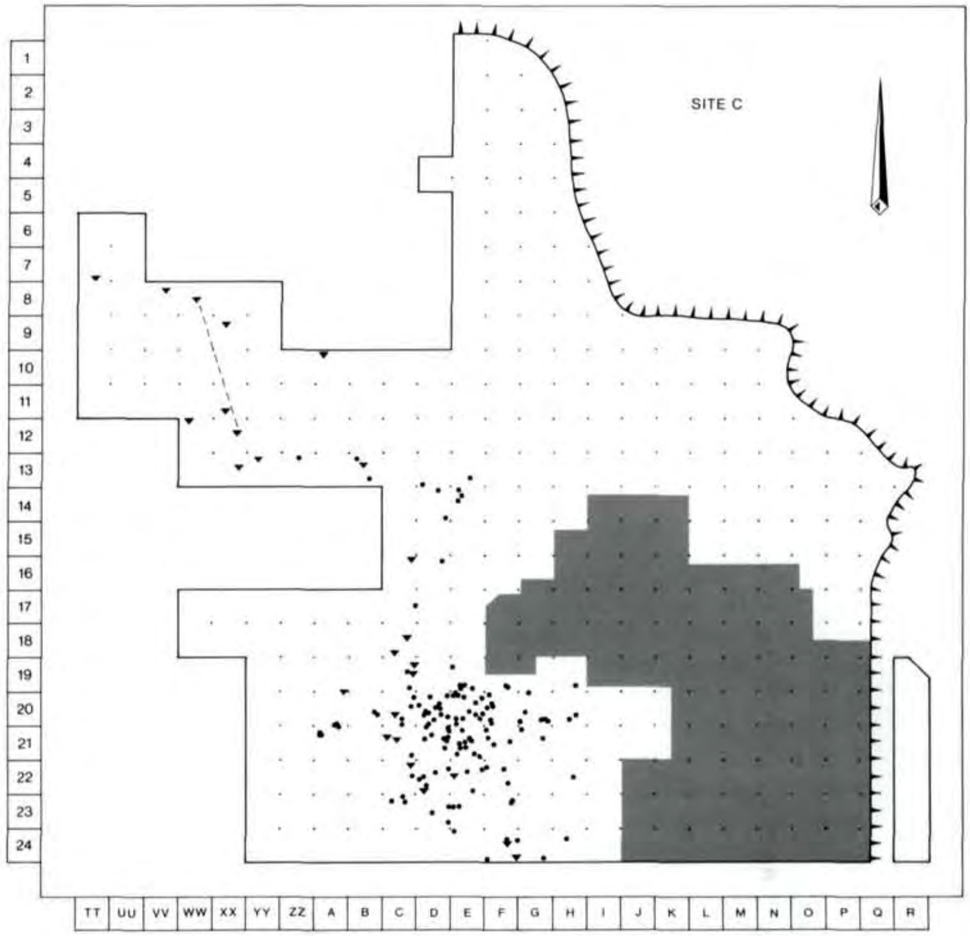


Fig. 40. Site C: spatial distribution of burnt flints. The dots indicate burnt artefacts, while the triangles refer to burnt natural pieces of flint. Grid in square metres. The area disturbed by karst is coloured grey.

results of natural agents and incidents. In his opinion the sites of Becov (Czechoslovakia, see: Marshack 1981) and Ambrona (Spain) are the only sites with an estimated age of around 250 ka where the presence of ochre can be related to human activities. Maastricht-Belvédère Site C provides a third case of human red ochre manipulation around 250 ka (see section 8.3 for the dating evidence)[1]

4.2.4 THE REFITTING PROGRAMME

4.2.4.1 Introduction

In order to obtain data on the technological aspects of the flint assemblage and especially on the site-formation processes (both human and non-human) that caused the horizontal and vertical distribution of the finds, a substantial amount of time and energy was invested in the refitting of the Site C flint material in 1983-1985. The Site C flint assemblage seemed to have a good conjoining potential, because the knapping had been done at the site, and most of the flint-knapping areas were uncovered during the excavation.

By the end of 1984, we had obtained a good impression of our main point of interest, the formation processes behind the artefact scatters. The distribution plan of the conjoining elements showed 'star-like' constellations, of different shapes and densities. The RMU 2 material displayed the lowest density, which was only partly due to the less dense horizontal distribution of its elements. An important factor was certainly also the less 'attractive' character of this material in term of conjoinability: it is a coarse-grained flint with few inclusions, which are often of help in this respect.

In 1985 the Site C material was again studied on this basis, with special attention for this less attractive RMU 2 group. Much more important, however, was the evaluation of the impression obtained in 1983-1984 that the Site C material lacked products of specific flint-working stages: for instance, for one RMU there were virtually no cortex flakes, while another appeared to lack debris associated with the production of a series of larger-lakes. In order to evaluate these impressions we systematically worked on this problem to determine whether the material was really absent or we were just lousy at conjoining flint artefacts. In this final phase the line patterns of conjoining elements gradually grew into very dark spots, because a relatively large number of mostly small flakes could be conjoined.

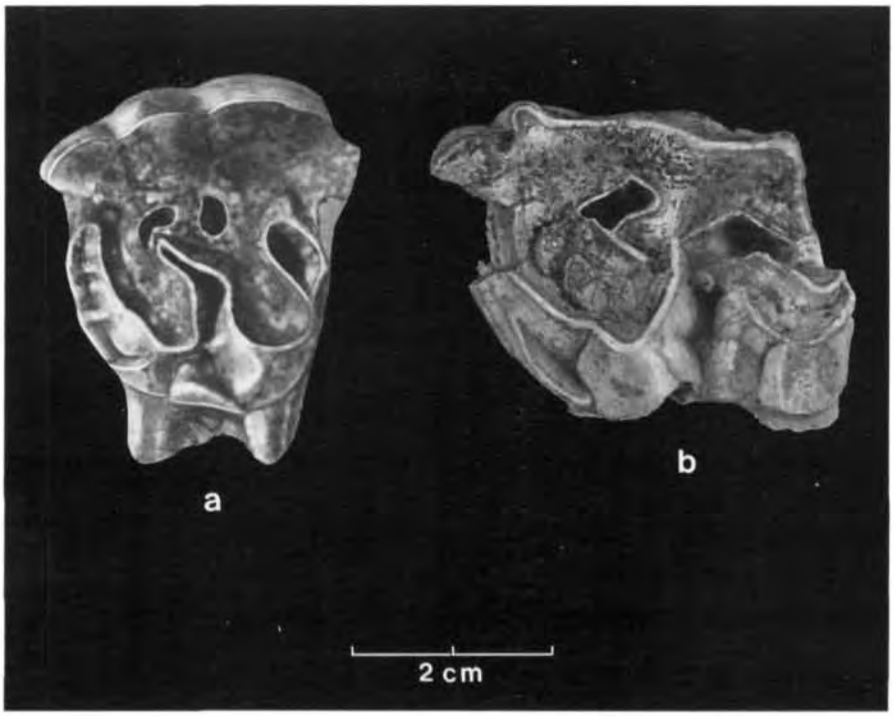


Fig. 41. Site C: two milk molars of the steppe rhinoceros *Dicerorhinus hemitoechus*, from square H-7.
a occlusal view of DP2 sin
b occlusal view of DP3 sin
(after Van Kolfschoten 1985)

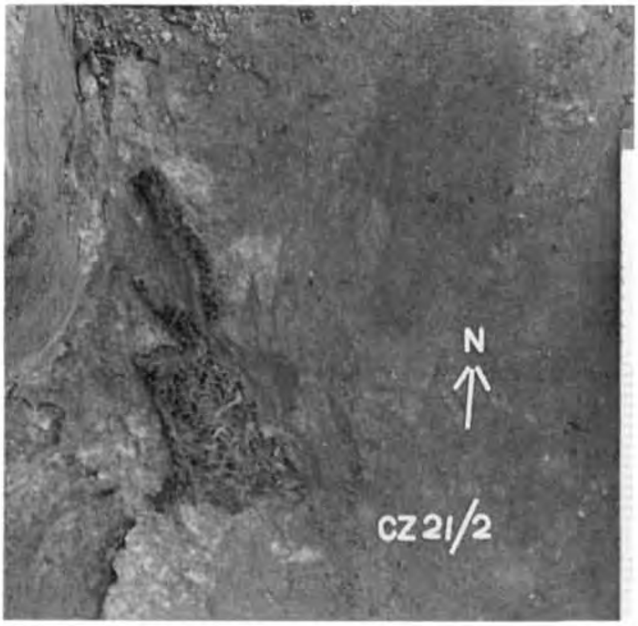


Fig. 42. Site C: a typical example of the form in which 'bone' fragments were found at Site C (C 21/2) (length is abt. 15 cm).

Fig. 43. Site C: vertical view of the (non-artificial) stone concentration in square WW-10 (smaller stones have already been removed). The largest pebble has a length of 11.5 cm. (The arrow points northwards.)

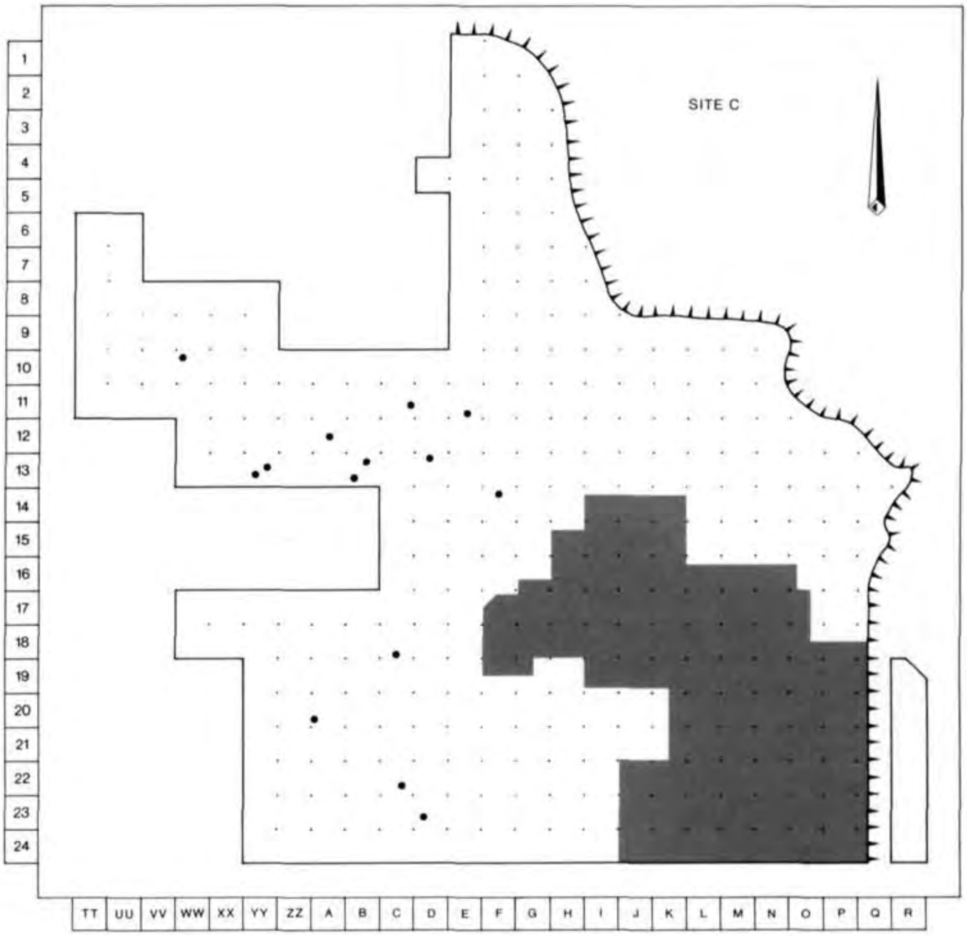


Fig. 44. Site C: spatial distribution of haematite dots. Grid in square metres. The area disturbed by karst is coloured grey.

The greater part of the refitting work to be presented here was carried out by Mr P. Hennekens, with the assistance of the author and Mr K. Groenendijk. Mrs M. de Grooth (Bonnefanten museum at Maastricht) and Mr J.P. de Warrimont occasionally joined in. Before this work was started, Mrs A. van Gijn (Leiden) studied a sample of the flint material for traces of wear (Van Gijn, this volume, appendix I).

Unfortunately, the Site C refitting studies could not benefit from a recent paper by Cziesla (1986), in which he stresses the importance of distinguishing between several types of refitting, notably *Aufeinanderpassungen*, *Aneinanderpassungen* and *Anpassungen*. These terms, which are difficult -if not impossible- to translate are used by Cziesla in the following way:

– *Aufeinanderpassungen* refer to the ventral/dorsal conjoining of, for instance, a series of flakes in a reduction sequence.

– *Aneinanderpassungen* concern the reconstruction of basic products, blanks and tools, i.e. the conjoining of broken flake fragments, broken tools, etc.

– *Anpassungen* refer to the conjoining of elements produced during the retouching of a blank into a tool or during the resharpening of a tool, for instance refitting a burin spall to the burin from which it derives.

This subdivision certainly presents considerable advantages, and should be used in future conjoining studies. The Belvédère Site C work, however, dates from the pre-Cziesla (1986) period and thus no detailed attention was paid to specific types of refitting. This is, of course, reflected in the cartographic representation shown in figure 47, in which each of the contact surfaces is linked to the other contact surfaces by means of lines (see: Cziesla 1986 for this form of graphic representation).

However, the horizontal distribution of several groups of conjoining elements isolated from the 'black areas' in figure 47 (separate sheet at the back of this volume) has been presented with dashed lines indicating refitted broken pieces (*Aneinderpassungen*) after Cziesla (1986). The continuous lines connect ventrally/dorsally fitting artefacts, while the arrows, directed towards the core, show the detaching sequence. This has been done with a limited number of

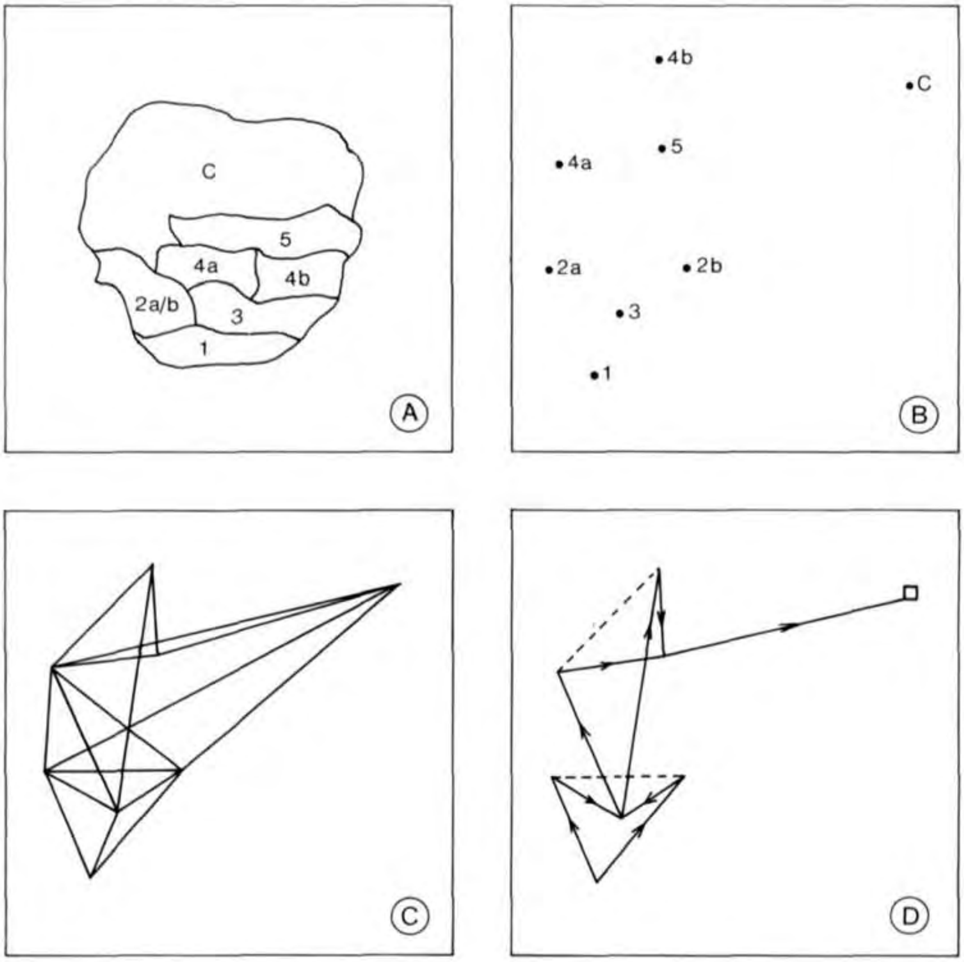


Fig. 45. The two models used for the graphic representation of the Site C refitting data (after Cziesla 1986: figure7).
A a hypothetical example of a core showing the conjoined elements (view of the striking surface) and (B) the spatial distribution of the conjoined elements (c: core, 1: flake, 2a/2b: blade broken into two pieces, 3: blade, 4a/4b blade with split bulb, 5: flake).
C all contact surfaces linked by lines.
D broken artefacts indicated by dashed lines, dorsal/ventral refit s are traced back to the core, following the reduction sequence, as indicated by the arrows.

conjoining groups, namely those whose reduction sequence could be reconstructed fairly easily. It was impossible to reconstruct a detailed reduction sequence for the large RMU 5 group of conjoining elements shown in figures 60 and 61, because the original (flat discoidal) core had a continuous working edge with two striking surfaces.

Likewise, an attempt was made to record the horizontal distribution of conjoining broken elements (figs. 65 and 66), as far as this did not involve the 'deconstruction' of larger compositions by submersion in acetone.

For clarity's sake, figure 45 (after: Cziesla 1986) gives a graphic illustration of the two forms of representation used here.

As already mentioned above, the refitting was done mainly by Mr P. Hennekens (especially from 1984 onwards). His detailed work -in which he did not avoid the fine debris- is only summarized in this volume. Here I will present the final results of the refitting programme, without going into details. Readers who would like to study the conjoined material are welcome to do so at the Leiden Institute of Prehistory.

The administration of the conjoining elements was all done by hand by the author in 1983-1985. As two cards were put into a card system for every two conjoining elements (a fits onto b; b fits onto a) for each contact surface, this grew into a tremendous, hardly manageble paper work for a block of 150 conjoining elements. This is one of the reasons why Mr M. Wansleeben (IPL) developed computer software for the recording and graphic presentation of the refitting data, from which work at other sites (Site J and Site K) will benefit. This program (Pasprogramma IPL) is available from the Institute of Prehistory and is used in combination with a program for data entry in the field.

4.2.4.2 Results and interpretation

In total, 659 pieces (= 21.5% of the flint artefacts recorded three-dimensionally) were refitted. Figure 46 gives the size distribution of the refitted artefacts, showing that a considerable percentage (30.7%) is smaller than 2 cm. 70.4 wt.% of all artefacts could be fitted together.

Figure 47 gives the horizontal distribution of refitted elements for the whole site as described above. This general

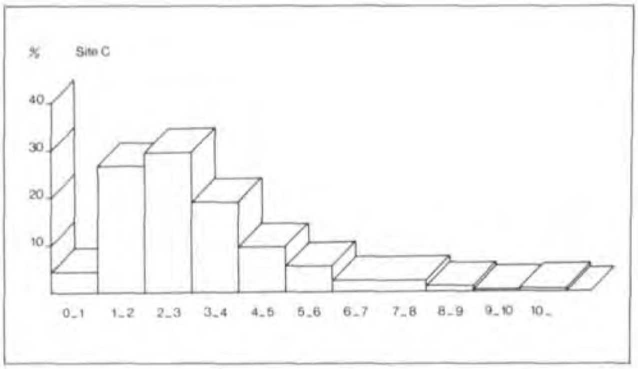


Fig. 46. Size distribution of the refitted Site C flints, based on maximum dimensions, in cm (see fig. 28).

Fig. 47. (Separate sheet at the back of the volume) Site C: horizontal distribution of all refitted artefacts, each line connecting the contact surfaces of two refitted artefacts (see figure 45, model C). Scale 1:80 (reference grid in square metres).

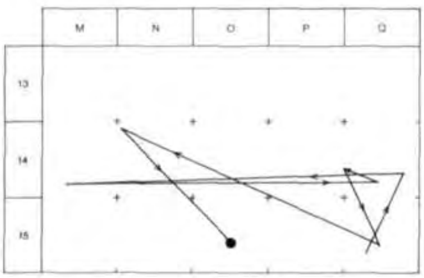


Fig. 48. Site C, RMU 2: horizontal distribution of flakes refitted to core Bv-557 (fig. 32-2). Grid in square metres.

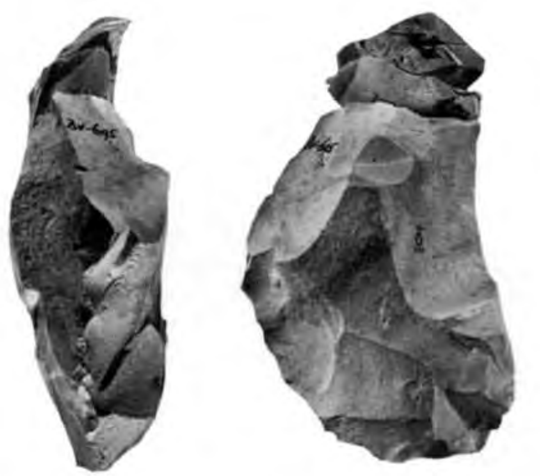


Fig. 49. Site C, RMU 2: core Bv-409, with eight conjoined flakes, scale 2:3.

picture will be detailed here, in a short discussion of the refitting evidence for each RMU.

Raw Material Unit 1

More than 60% of the total weight of this RMU was refitted. A comparison of the distribution of this RMU with the boundary of the excavation (fig. 30) shows that only part of the original distribution was sampled in the Site C excavation. The results of the refitting work show that part of the RMU 1 debris originated in the northern part of Site C. Conjoining groups generally consist of two to three refitted flakes or flake-fragments, usually with a cortex. The largest number of flakes that could be fitted together was five.

It is difficult to draw further conclusions from the refitting data, because only -a presumably small- part of the original distribution was recorded.

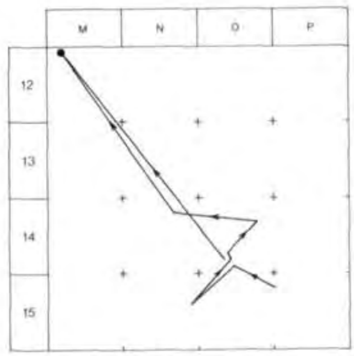


Fig. 50. Site C, RMU 2: horizontal distribution of flakes refitted to core Bv-409. Grid in square metres.

Raw Material Unit 2 (figs. 32, 48-51)

It was possible to refit 83% of the approximate total weight of this RMU (3000 g). Several larger groups of conjoining elements were obtained, which show that the associated debris represents several flint-knapping stages: rough shaping of the flint nodule by cortex removal, platform and surface preparation of the core, flake production, etc. Some of the blocks of conjoining elements are shown in figures 32 and 49.

Some small 'classical' Levallois flakes were found, in addition to a few larger ones and flakes of which only part of the dorsal side shows scars of centripetal preparation, the other part presenting the scar of a flake of larger dimensions. From this we may infer that the technology was not directed at the production of one flake, but of a whole series, the reduction sequence of which will be detailed below for RMU 4.

The refitting research showed that -at least part of the-removal of the cortex of the original nodule took place within the excavated area, mainly to the south of square

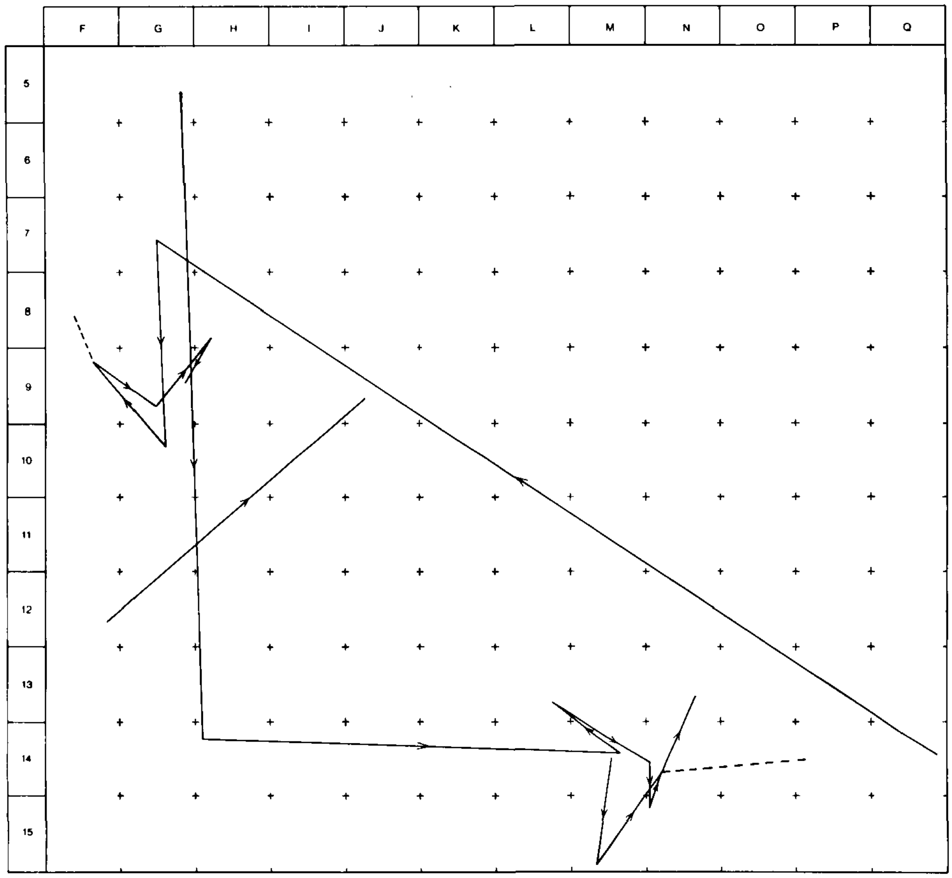


Fig. 51. Site C, RMU 2: horizontal distribution of conjoined flakes produced during decortication. Grid in square metres.

H-7 (which contained the rhinoceros remains). After this rough shaping the resulting flint block was transported to the eastern part of Site C, where it was subsequently reduced. In this reduction process three cores were ultimately produced, one of which was completely reduced by the removal of irregular flakes, which ultimately destroyed the core block (fig. 32-3). The second core (Bv 557) was discarded after a very rough surface and platform had been obtained (fig. 32-2). It should be stressed that this core need not be interpreted as a *Vollkern* (*sensu* Luttropp/Bosinski 1971) but could also be seen as an exhausted core. A third core of RMU 2, with eight flakes conjoined, is illustrated in figure 49, while the horizontal distribution of the flakes conjoined to this multi-platformed core (Bv 409) is shown in figure 50. The few regularly shaped flakes made from this RMU display facetted butts and the dorsal negatives of core preparation (fig. 31). Figure 51 shows some of the spatial relations between the area around square G-9 and the eastern part of Site C, where the greater part of the RMU 2 material was concentrated.

The refitting evidence shows that part of the debris and some of the larger flakes produced during flint-knapping are missing. This is probably due to the fact that (a minor) part of the artefact scatter was destroyed prior to excavation; therefore no behavioural inferences can be drawn from this.

Raw Material Unit 3 (figs. 52-54)

75 wt.% of the elements from RMU 3 could be fitted together. A group of 40 (mainly cortex) elements formed the largest composition (fig. 52). RMU 3 consists of the remains of a decortification/rough core shaping process; the producs of further knapping, such as large regular flakes or a core, are absent. In this interpretation the 'prepared core' was transported off the excavated area. Initial decortication of this nodule took place approximately 5 m to the south of the main debris concentration. Figure 53 shows a photograph of a few refitted decortication flakes, while figure 54 shows the horizontal distribution of the conjoined pieces as a 'horizontal' reduction sequence.

Figure 52 shows the largest composition of refitted RMU 3 elements, consisting of 40 pieces, which were all found in the debris concentration where the reduction sequence of figures 53 and 54 ended. Spatially, the debris completely overlaps that of RMU 4.

Fig. 52. Site C, RMU3: conjoined decortication flakes (n = 40), scale 2:3.

Fig. 53. Site C, RMU3: conjoined decortication flakes, lateral view, scale 2:3.

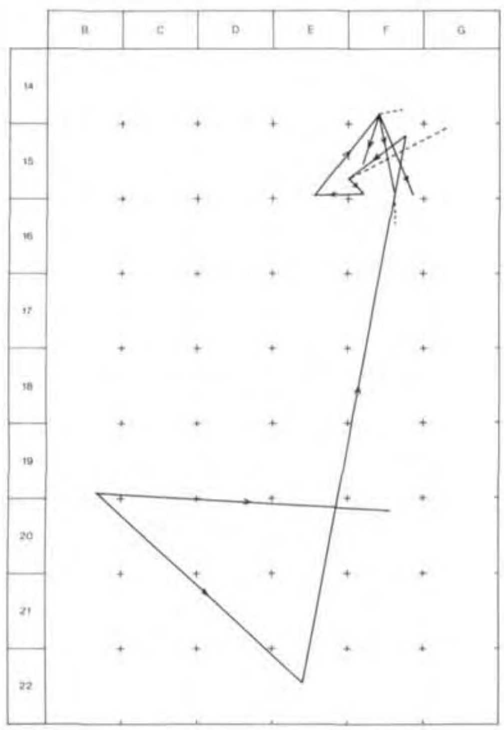


Fig. 54. Site C, RMU 3: horizontal distribution of the block of conjoined decortication flakes shown in figure 53. Grid in square metres.

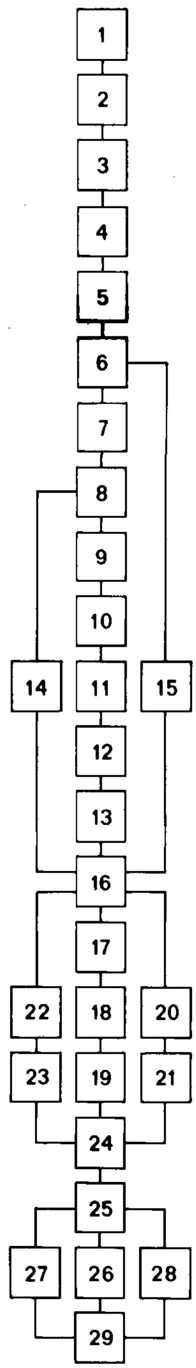


Fig. 55. Site C, RMU 4: reduction sequence of elements conjoined to core Bv-1527. The numbers refer to the individual finds and their technological characteristics as given in Table 7, and are the same as those used in figures 58 and 59. Number 1 is the highest flake in the 'stratigraphical' sequence, 29 is the core.

Raw Material Unit 4 (figs. 55-59)

Of the 1300 g of this group 50 wt.% could be refitted to form several conjoining groups; the largest, comprising 35 elements, included the 'Levallois' core Bv 1527 shown in figures 33, 56 and 57.

Figure 55 gives the reduction sequence as could be reconstructed from the flakes conjoined to core Bv 1527 (figs. 56 and 57). The numbers used in this figure are the same as those used in table 7, which gives some technological data on the conjoined elements, and also correspond to the numbers in figure 58, which shows the horizontal distribution of these elements.

Because core Bv 1527 (figs. 33, 56 and 57) has a continuous working edge it was not always possible to establish the exact 'stratigraphical' position of the individual flakes in the reduction sequence. This is why the sequence in figure 55 has to be read as a 'Harris-matrix'. The reduction sequence is illustrated in a series of photographs, beginning with the most complete block (28 elements refitted to the core), and ending with the core (fig. 56).

Most of the flakes appeared to fit onto the striking surface of the core, whereas only a few flakes could be conjoined to the striking platform, which is rather 'continuous' in the case of this core. The flakes produced in reshaping the striking platform have not been mentioned in the reduction sequence described above. If we look at the horizontal distribution of the conjoined elements and their position in the reduction sequence we can clearly see the core 'moving' over the area indicated in figure 58, small 'preparation' flakes having been produced to the north of the main debris concentration in several stages.

Table 7 shows that the core produced a rather regular alternation of smaller 'preparation' flakes and larger flakes, as visualized in figure 59.

In the series of photographs showing the actual reduction we note the absence of a few larger flakes, which were probably picked out of the flakes produced within the excavated area and discarded outside the excavated area of Site C.

In addition to the flakes produced in the flaking sequence described above there are a number of flakes of this RMU that could not be conjoined to the core sequence shown above. Some technological characteristics of flakes with maximum dimensions of 5 cm or more are given in table 8. The numbers used in this table are the same as the numbers used to indicate the flakes in figure 58, which shows their positions within the excavated area.

Seven of these larger flakes show signs of use, but no flake shows clear traces of intentional retouching. None of the flakes which could be conjoined to the core shows signs of use.

It must be stressed that the majority of these larger flakes were found outside the concentration of the RMU 4 debris,

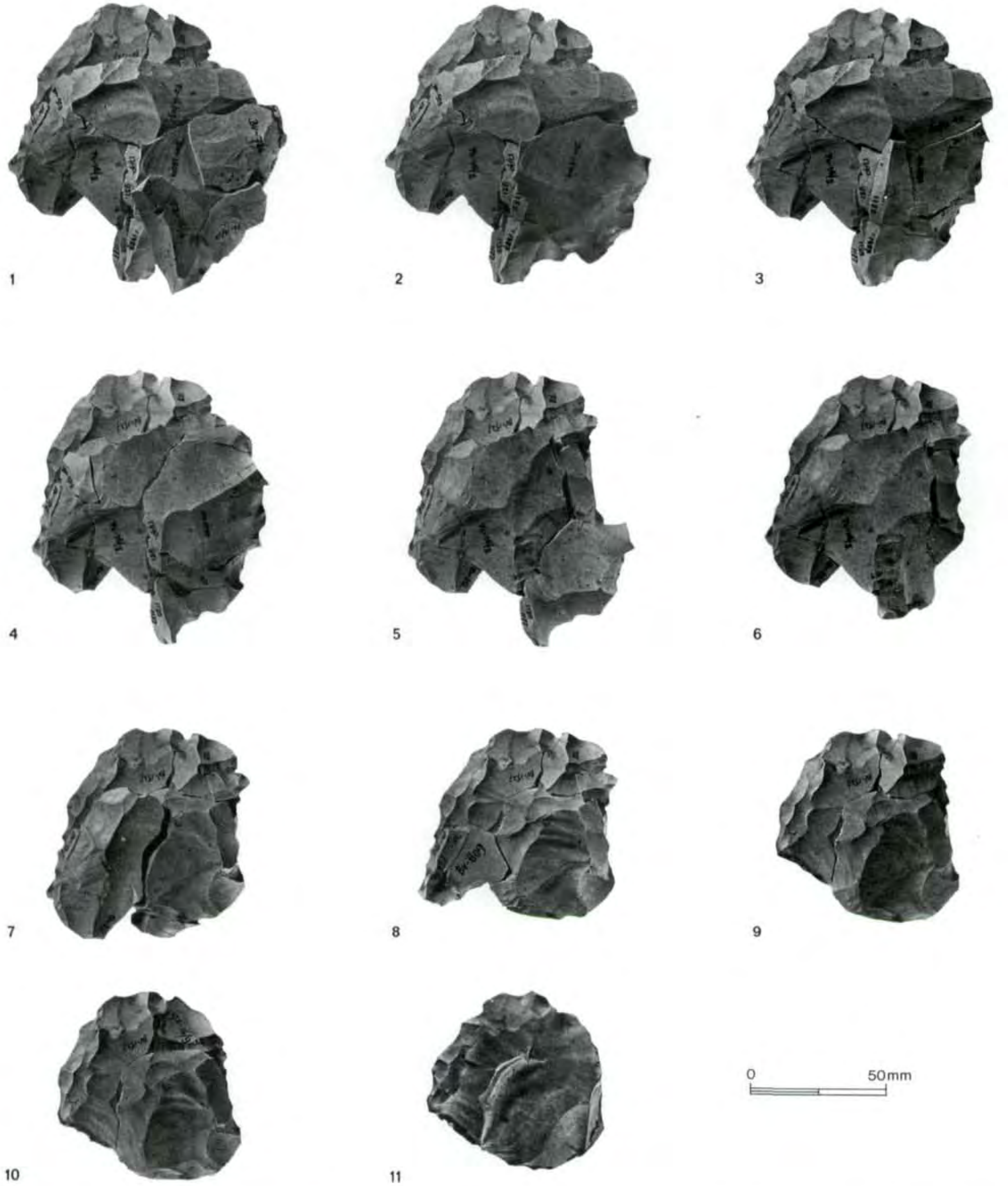


Fig. 56. Site C, RMU 4: core Bv-1527 (see figure 33) in various stages of refitting. (The orientation of the core differs slightly from that in figure 33). Scale in cm.

Table 7: Site C: Reduction sequence of core Bv 1527 (Raw Material Unit 4). (dimensions in mm)

find no.	length	width	max. dimens.	number of scars	striking platform
01 F 16/24	23	33	34	4	facetted
02 F 16/4	56	36	57	4	facetted
03 Bv 786	36	35	37	6	cortical
04 Bv 1504	53	46	54	7	dihedral
05 Bv 1397/ Bv 1399	54	11	54	8	punctiform
06 F 16/29	63	35	66	10	facetted
07 Bv 1373	15	09	17	2	missing
08 Bv 1290	45	46	46	7	facetted
09 Bv 1111	18	14	18	3	plain
10 E 17/9	24	16	25	3	missing
11 Bv 951/ Bv 1363	43	42	45	6	missing
12 Bv 1195/ Bv 1342	42	42	55	5	missing
13 Bv 1177	19	14	21	2	dihedral
14 H 11/2	24	25	31	4	facetted
15 Bv 959	18	26	21	3	missing
16 F 16/3	58	39	60	7	missing
17 Bv 892	57	30	57	8	facetted
18 Bv 778	30	14	30	3	punctiform
19 Bv 809	33	28	35	5	dihedral
20 Bv 1286	28	21	29	4	facetted
21 Bv 1167	17	15	19	3	plain
22 H 13/8	16	12	16	4	punctiform
23 Bv 806	27	24	27	4	facetted
24 F 16/36	51	51	51	14	facetted
25 Bv 1498b	13	15	17	3	missing
26 G 16/9	22	26	26	3	punctiform
27 Bv 1494	22	21	25	2	plain
28 Bv 1338	19	11	19	4	missing
29 Core Bv 1527					

Table 8: Site C: Raw Material Unit 4, non-conjoinable flakes. (dimensions in mm)

find no.	length	width	max. dimens.	number of scars	striking platform	remarks
30 Bv 780	120	57	121	6	plain	
31 Bv 1202	100	55	100	5	facetted	use ret.
32 Bv 997	98	56	100	9	dihedral	
33 Bv 1010	97	74	97	8	facetted	use ret.
34 E 17/11	80	43	85	5	dihedral	use ret.
35 C 18/10	120	82	125	18	plain(?)	plunged
36 F 17/2/ Bv 732	77	35	78	12	missing	
37 Bv 946	67	44	70	6	missing	use ret.
38 Bv 793	72	40	73	6	facetted	use ret.
39 Bv 1273	65	39	67	11	facetted	
40 J 21/21	63	42	64	11	dihedral	
41 Bv 1094	53	29	53	6	missing	
42 G 16/14	56	27	57	4	missing	use ret.
43 E 16/4	56	37	57	4	facetted	
44 Bv 1265/ Bv 1248	101	48	107	5	facetted	use ret.

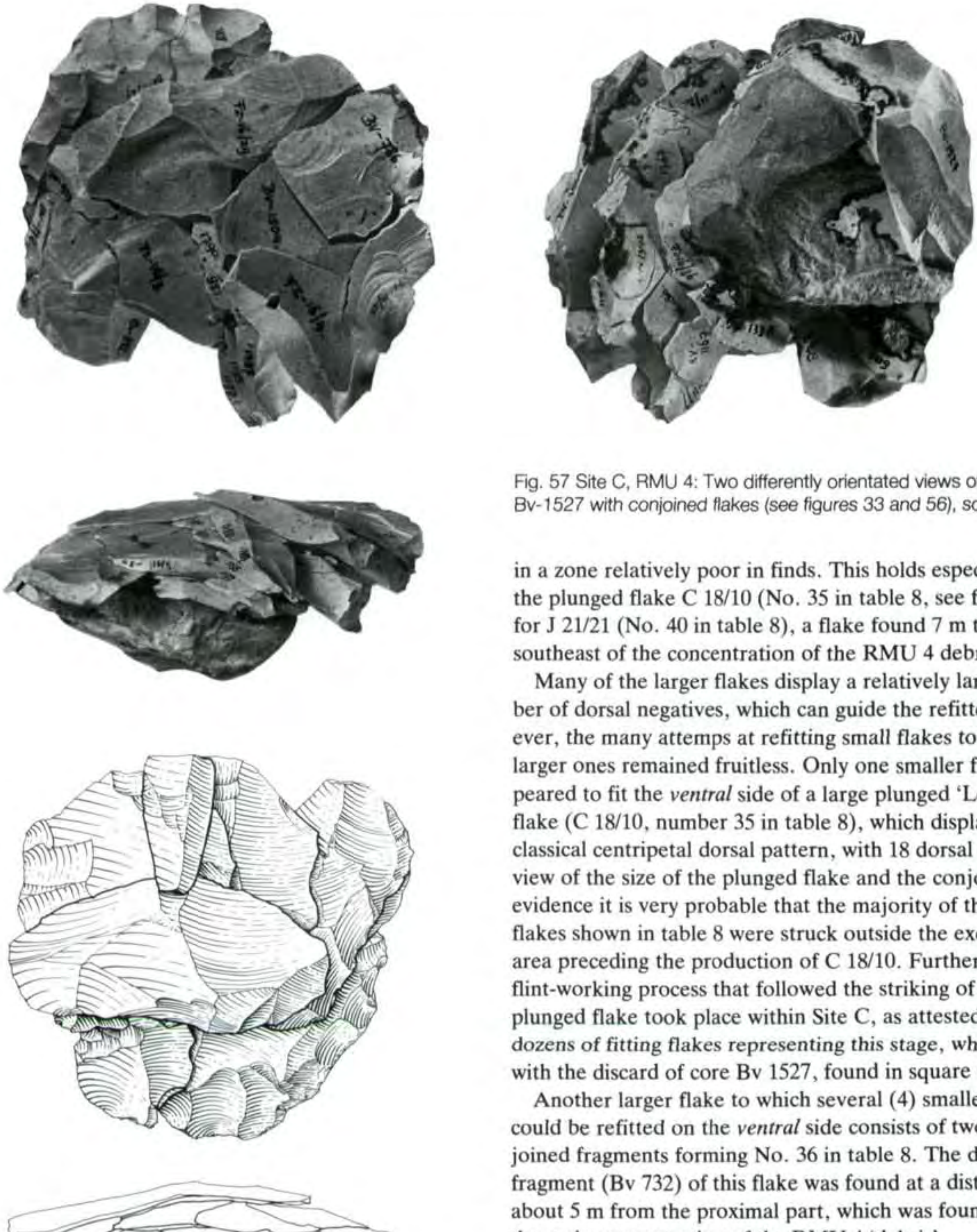


Fig. 57 Site C, RMU 4: Two differently orientated views of core Bv-1527 with conjoined flakes (see figures 33 and 56), scale 2:3.

in a zone relatively poor in finds. This holds especially for the plunged flake C 18/10 (No. 35 in table 8, see fig. 34) and for J 21/21 (No. 40 in table 8), a flake found 7 m to the southeast of the concentration of the RMU 4 debris.

Many of the larger flakes display a relatively large number of dorsal negatives, which can guide the refitter. However, the many attemps at refitting small flakes to these larger ones remained fruitless. Only one smaller flake appeared to fit the *ventral* side of a large plunged 'Levallois' flake (C 18/10, number 35 in table 8), which displays a classical centripetal dorsal pattern, with 18 dorsal scars. In view of the size of the plunged flake and the conjoining evidence it is very probable that the majority of the larger flakes shown in table 8 were struck outside the excavated area preceding the production of C 18/10. Furthermore, the flint-working process that followed the striking of the plunged flake took place within Site C, as attested by the dozens of fitting flakes representing this stage, which ended with the discard of core Bv 1527, found in square G-16.

Another larger flake to which several (4) smaller flakes could be refitted on the *ventral* side consists of two conjoined fragments forming No. 36 in table 8. The distal fragment (Bv 732) of this flake was found at a distance of about 5 m from the proximal part, which was found close to the main concentration of the RMU 4 'debris'.

If we regard the total RMU 4 assemblage in the light of the reconstructed reduction sequence shown in figures 56 and 57, we can fairly confidently say that the RMU 4 assemblage is not the product of the Levallois technology in its 'classical' sense, according to which the core is abandoned after the manufacture of one, or occasionally two flakes (Bordes 1980; Boëda 1986).

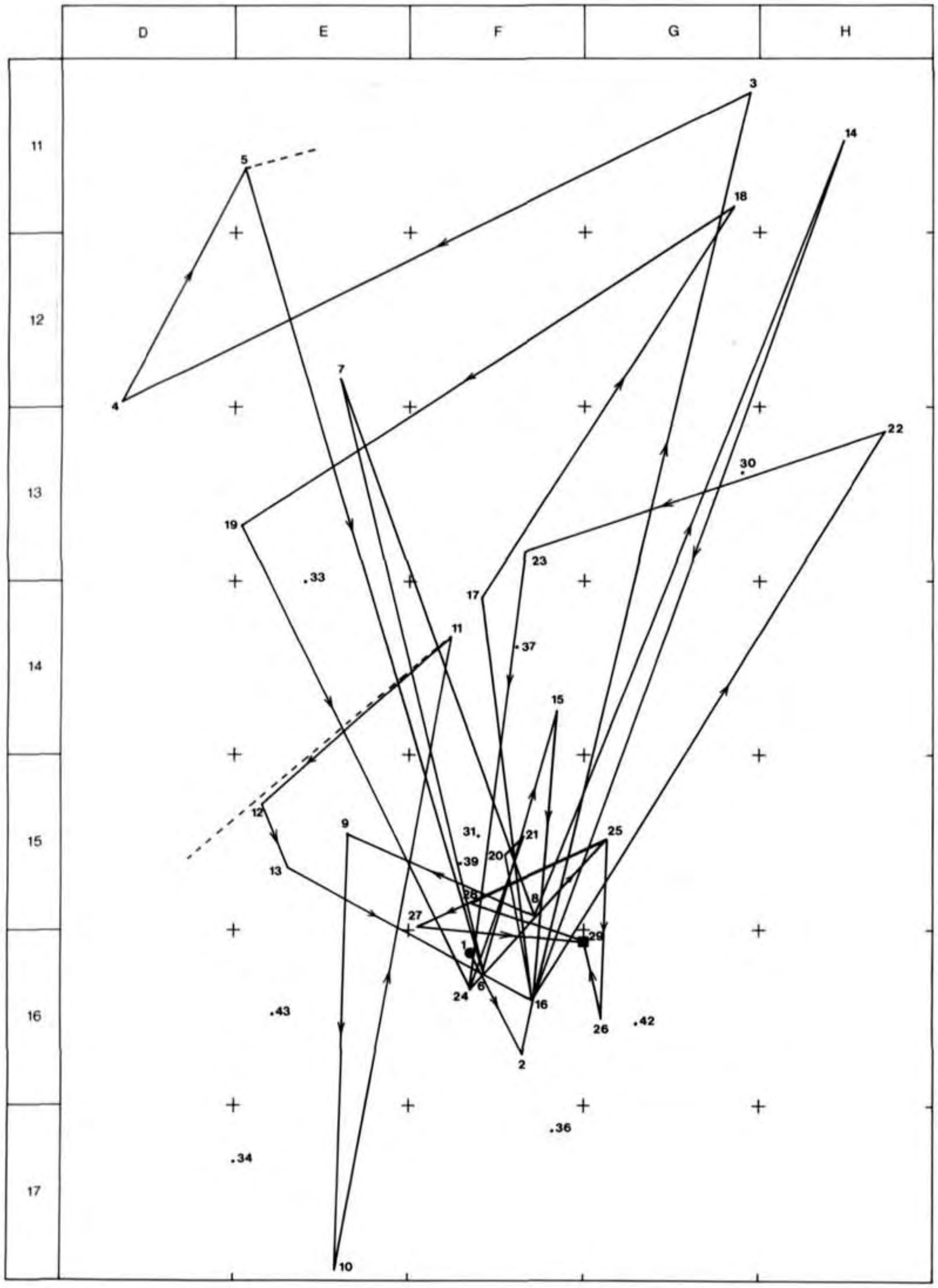


Fig. 58. Site C, RMU 4: horizontal distribution of flakes conjoined to core Bv-1527. The numbers are the same as those used in tables 7 and 8. Grid in square metres.

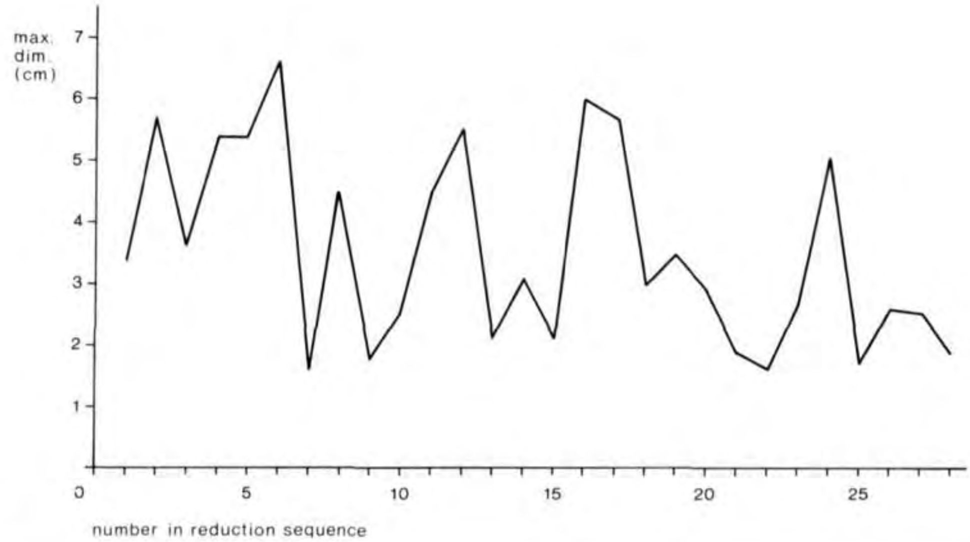


Fig. 59. Site C, RMU 4: graphic representation of the maximum dimensions of flakes conjoined to core Bv-1527, arranged according to their place in the reduction sequence (see Table 7).

Besides a few large 'classical' Levallois flakes, we have also smaller ones, and flakes of which only part of the dorsal side shows scars of a centripetal preparation, the other part displaying one scar of a flake of larger dimensions. From this and from the refitting evidence we may infer that the technology was not directed at the production of one flake, but at that of a whole series of flakes in the various phases of the reduction sequence. This type of reduction has been described as *débitage Levallois recurrent* by Boëda (1986) on the basis of his study of the cores from level IIa at Biache-Saint-Vaast (Tuffreau 1986). Like the classical Levallois, this debitage is based on a careful preparation of the convexity of the working face of the core, after which, however, not one but two or three flakes are detached from the working face by the preparation of several striking platforms. After this the sequence can be repeated, until the core is exhausted.

The refitting data of core Bv 1527 form a good archaeological corroboration of Boëda's (1986) interpretation of the *débitage Levallois recurrent*, which can be seen as a optimization of the possibilities of a block of flint.

Raw Material Unit 5 (figs. 60 and 61)
Of the total weight of approximately 470 g, 85% could be refitted, the greater part of which resulted in one block of 162 elements, with a weight of 320 g. This block is shown in figures 60 and 61.

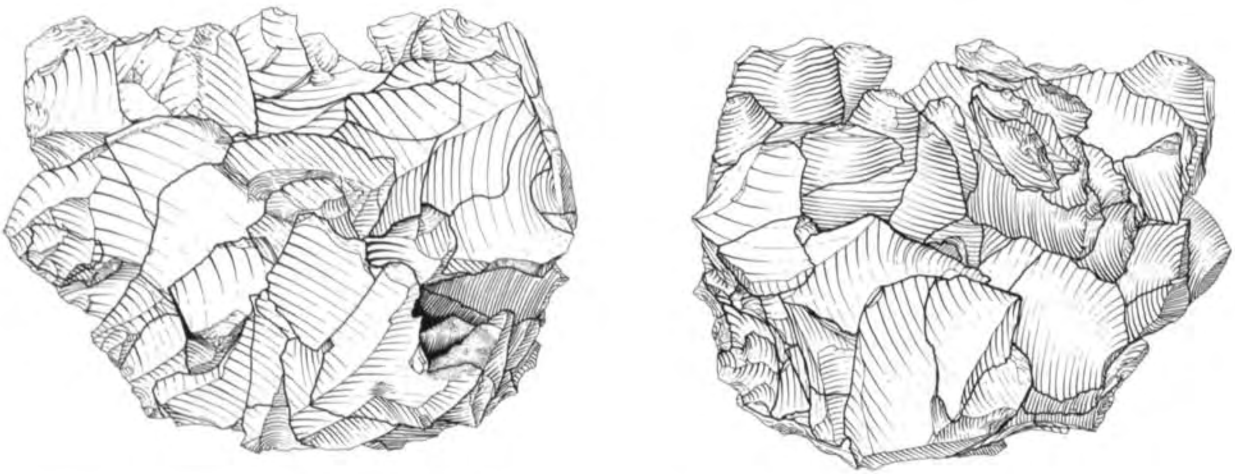
The block comprises the remains of a rather flat discoidal core with a continuous working edge and one major striking surface.

According to the refitting data, this RMU found its way into the excavated area in the form of an already reduced core, with only few cortex remaining. Inside the excavated area the RMU was soft-hammer flaked in an uninterrupted reduction cycle in which small flakes were produced, many with facetted butts. This seemingly 'useless' constant reduction resulted in a very small core, which, however, was not recovered inside the excavated area. The working of this RMU was certainly not related to the production of a handaxe-like implement, as the typical handaxe-finishing flakes are completely absent, and the resulting core was of very small dimensions (estimated maximum dimensions 5 cm). The scraper E 21/26, which might belong to this RMU, could not be conjoined to any of the RMU 5 flakes.

This RMU is by far the most 'spectacular' from the refitter's point of view. However, attempts at establishing a reduction sequence as constructed for the RMU 4 core failed due to the complexity of the reduction caused by the continuous working edge. The flakes that clearly belong to this RMU were all recorded in the southern part of the site, and seem to have all been struck from an 'imported' core, whose striking surface had already produced several larger flakes *outside* the excavated area of Site C.

Raw Material Unit 6 (figs. 62-64)
RMU 6 found its way into the excavated area in flaked condition. Inside the excavated area the RMU was roughly shaped by the hard-hammer removal of cortex flakes, one of which was very large (10x5x4 cm; weight 197 g). It appeared impossible to conjoin the flakes produced in this stage to larger flakes of this RMU.

Of the estimated weight of this RMU 70% could be joined together to form two blocks, one of 21 and one of 25 conjoining elements.



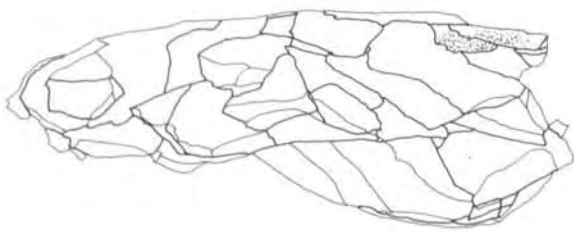


Fig. 60. Site C, RMU 5: composition of 162 conjoined elements, comprising the remains of a flat discoidal core (see the text), scale 2:3. For clarity's sake only some of the total number of conjoining elements are shown here (cf. fig. 61).

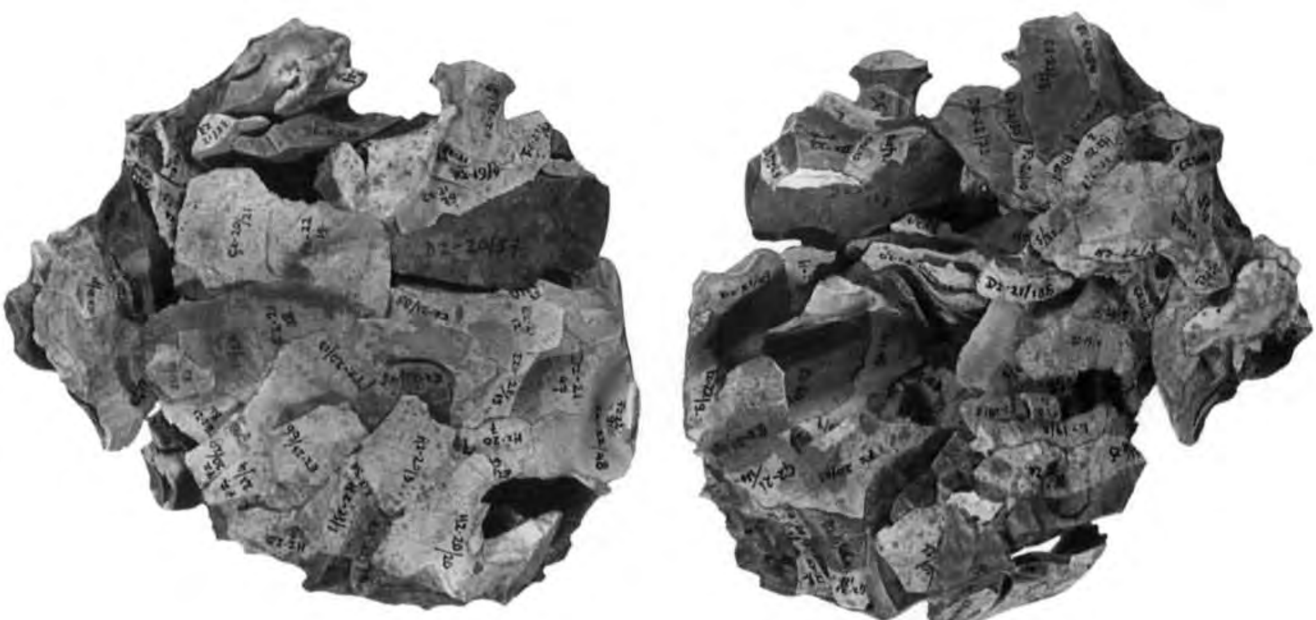


Fig. 61. Site C, RMU 5: composition of 162 conjoined elements, comprising the remains of a flat discoidal core (see the text), scale 2:3. Maximum composition.

The two blocks are illustrated in figures 62 and 63, which show that they contain several decortication flakes, block 1 (fig. 62) consisting almost entirely of decortication flakes. The horizontal distribution of their conjoining elements can be seen in figure 64. The horizontal distribution of two reconstructed detachment sequences is shown for block 1 (fig. 62), because this block consists of two pieces of flint which were split across an internal cleavage plane. It appeared impossible to reconstruct the detachment sequence of block 2 (fig. 63) due to the complex way in which the block had been reduced. Therefore, the horizontal distribution of the individual flakes constituting the block is shown here. As can be seen in figure 64, the flakes of the two blocks have different distribution patterns.

Figure 64 also shows the findspots of the larger RMU 6 flakes (and tool E 17/10), which could not be refitted to the blocks. These flakes were found north of the elements of RMU 6 blocks 1 and 2.

No flint-working debris could be refitted to the larger flakes and in the absence of any flint debris formed during the production of these flakes and in the absence of a RMU 6 core, we therefore have to assume that the production of the larger RMU 6 flakes took place outside the excavated area. The flakes were struck from a prepared core, after a fine facetting of the striking platforms. They were subsequently carried into the excavated area where, ultimately, they were found in the neighbourhood of bone fragments. A larger flake produced during the initial shaping of RMU 6 (block 1) within Site C (C 18/5) was picked out of the core shaping debris and taken to square C 18, where it was found lying beside the plunged RMU 4 Levallois flake C 18/10 (see fig. 26).

In this interpretation of the RMU 6 refitting data we therefore see a roughly shaped core enter Site C, where the flint block was worked into a core; this core was than taken outside the excavated area, where flakes were produced (and used?), some of which later returned to Site C.

Fig. 62. Site C, RMU 6: composition of Block 1, scale 2:3.

4.2.4.3 Discussion

HORIZONTAL DISTRIBUTION OF CONJOINED ELEMENTS: One of the reasons for investing time and energy in the conjoining of the material from Site C was the hope that with this method information could be obtained on the post-depositional processes that affected the original flint scatters. We have seen above, in the figures showing the horizontal distribution of conjoined elements, that, on the whole, the members of conjoining sets lay close together. But we have also seen that some of these members were found lying in one case up to 10 m apart. Some of these larger distances have already been interpreted in terms of 'transport' by hominids inside the excavated area, but what -if any- evidence do we have of this?

What we in fact need here is a kind of yardstick with which to 'measure' the spatial integrity of prehistoric flint scatters like those of Site C presented above. Newcomer and Sieveking (1980) have started developing such a reference database in a number of flint-knapping experiments in which they have recorded the horizontal distributions of waste flakes in order to collect data with which to interpret flint scatters found on prehistoric sites. The most important variable determining the size and shape of the flint scatters proved to be the flint knapper's position: the further away from the surface the flaking was done, the larger and more diffuse the spreads. Sitting positions led to rather concentrated patterns, while standing resulted in more diffuse spreads, with individual flakes travelling up to 4 m.

When using these data to interpret prehistoric flint scatters it is tempting to interpret scatters which have a larger horizontal distribution than those of Newcomer and Sieveking (1980) as having been affected by a variety of post-depositional processes. In such an interpretation only the

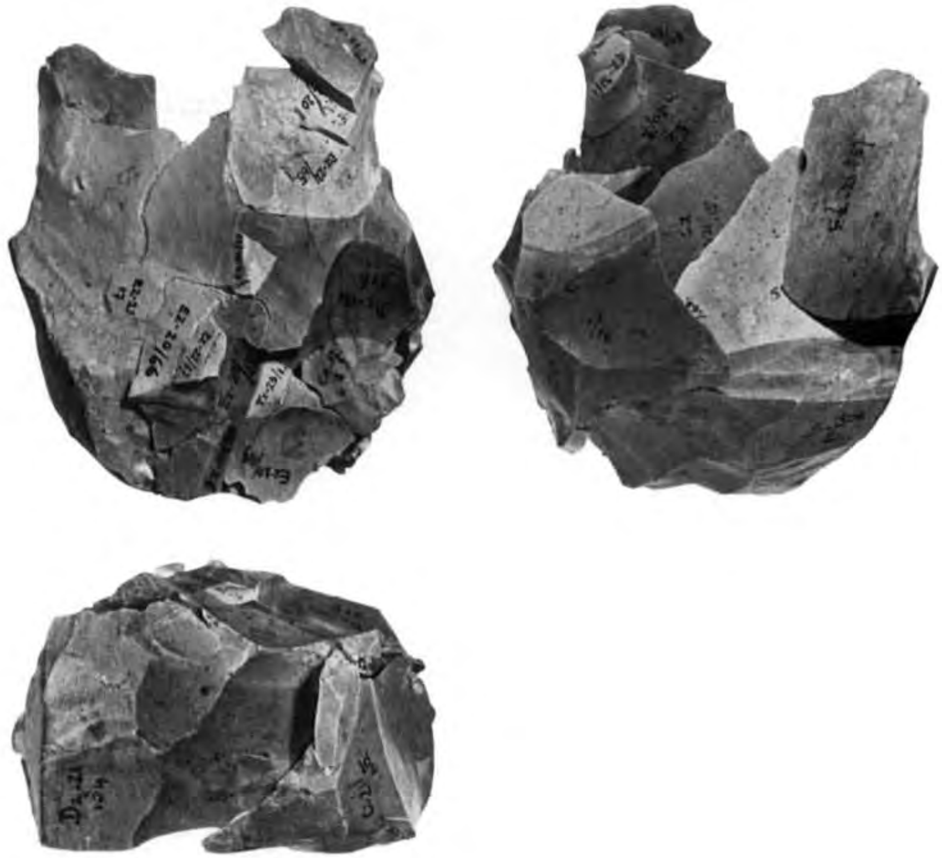


Fig. 63. Site C, RMU 6: composition of Block 2, scale 2:3.

RMU 3/4 flint scatter could be considered a primary scatter, very probably produced from a standing position (Newcomer and de Sieveking 1980: flaking experiment 19, fig. 8). However, one of the factors which may have been responsible for the larger distances over which flakes were distributed could be the behaviour of the hominids who produced the flint assemblage: by picking out flakes from the debris generated in flint-knapping and using these at another spot (than the concentration of debris) they may have 'transported' artefacts inside the excavated area. Another possibility is that the knapper did not stay at exactly the same spot all through the flint-knapping process, but moved from one area to another, thus producing a larger and more diffuse scatter.

A method for monitoring the influence of *non*-hominid processes consists of looking at the horizontal distribution of conjoined fragments of broken 'waste' flakes (*Aneinanderpassungen*), preferably of very small elements (with maximum dimensions of less than 2 cm), as these were very probably not selected for use by hominids and were therefore left in their primary positions. These could provide more reliable evidence of what went on at the site in terms of natural site-formation processes than the ventral/dorsal refits of larger flakes.

In figures 65 and 66 we have presented the horizontal distribution of a number of conjoined broken elements from Site C. A distinction has been made between sets of elements that are smaller than 2 cm and sets of members of which one or more have larger maximum dimensions.

Figures 65 and 66 and table 9 show that in a total of 74 cases more than 60% of all members lay less than 1.5 m apart, which suggests that the various flint scatters were still largely intact. The two cases in which the distances exceed the 4 m established as the maximum distance travelled by individual flakes in the Newcomer and Sieveking experiments concern sets including larger elements, one of which, a small distal fragment of a blade-like flake, was found about 5 m from the basal part of this flake (flake 36 in table 8). Another case -not recorded in figure 66 and table 9 because one of the members was found in the erosional level *overlying* the Site C Unit 4.5.1 matrix- is a small flake fragment found in square I 24 (I 24/1), which could be

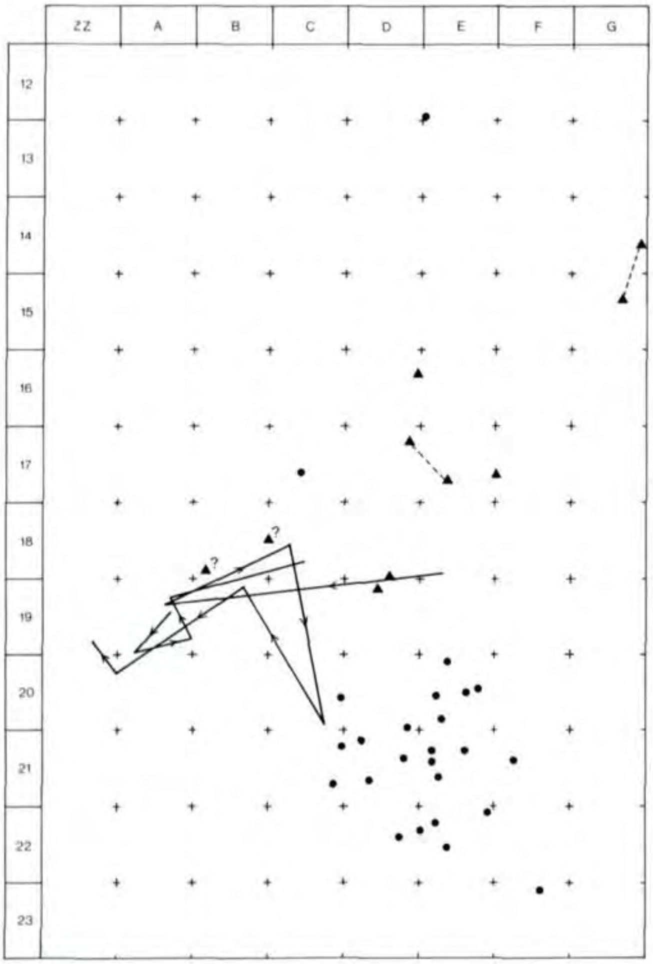


Fig. 64. Site C, RMU 6: horizontal distribution of conjoined elements and isolated larger flakes. Two detachment sequences are shown for Block 1, while the individual dots show the position of the conjoined elements constituting Block 2. The triangles stand for the larger RMU 6 flakes, as discussed in the text, while the question marks show flakes of which it is not certain whether or not they belong to RMU 6. Grid in square metres.

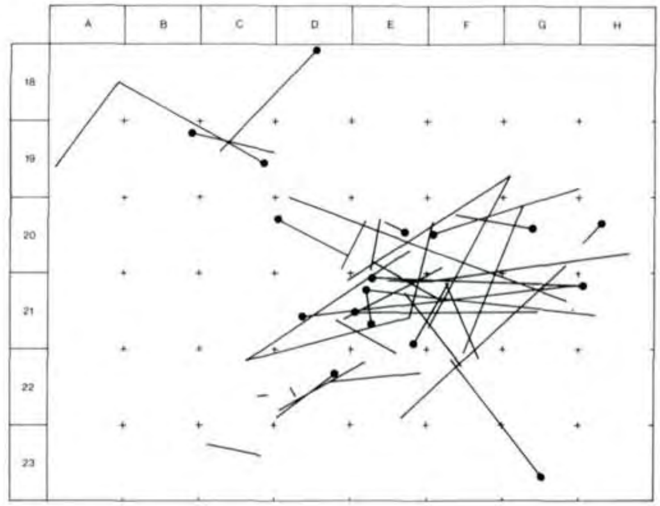


Fig. 65. Site C: horizontal distribution of conjoined broken flake fragments. The dots indicate fragments with maximum dimensions of more than 2 cm. The cluster in the top left hand corner consists of RMU 6 flake fragments, while the large cluster consists mainly of RMU 5 artefacts. Grid in square metres.

conjoined to D 21/90, found lying about 5 m away. The small I 24/1 fragment was embedded in the stone layer deposited after the erosion of the Unit 4.5.1 sediments, and had probably been transported over a short distance in that erosional phase.

Most of the flakes discussed here were probably broken in the process of knapping. It is unlikely that the weight of the sediment was responsible for this, because only a small number of conjoined flake fragments were found lying close to each other, thus suggesting breakage in the geological matrix.

The data provided by the conjoining of broken flakes may not be regarded as proof of a 'spatial integrity' of flint scatters, in this case of those of Site C. More experiments must be carried out before the question can be answered as to whether or not a horizontal distance of 2.75 m between the conjoining fragments of a split bulb indicates post-depositional disturbance.

Awaiting the results of such experimental studies, we can fairly confidently say that the Site C scatters underwent some form of horizontal disturbance, which can, however, have been only minimal as appears from the results of the conjoining studies. From the data provided by the refitted broken flake fragments we can infer that the larger distances observed in some cases between ventral/dorsal refits of larger flakes can indeed be interpreted in terms of hominids selecting flakes for use and/or moving to a different flint-knapping site. The latter possibility seems to apply to the RMU 2 and RMU 3 flint-working areas, which moved

Table 9: Site C: Horizontal distribution of conjoined *broken* flake fragments, grouped according to size.

horizontal distance (cm)	sets with members 0-2cm	≥2cm	% of total
0 – 50	9	6	20.3
50 – 100	6	11	23
100 – 150	11	5	21.6
150 – 200	3	5	10.8
200 – 250	4	2	8.1
250 – 300	3	2	6.7
300 – 350	1	–	1.3
350 – 400	1	3	5.4
400 -	–	2	2.7

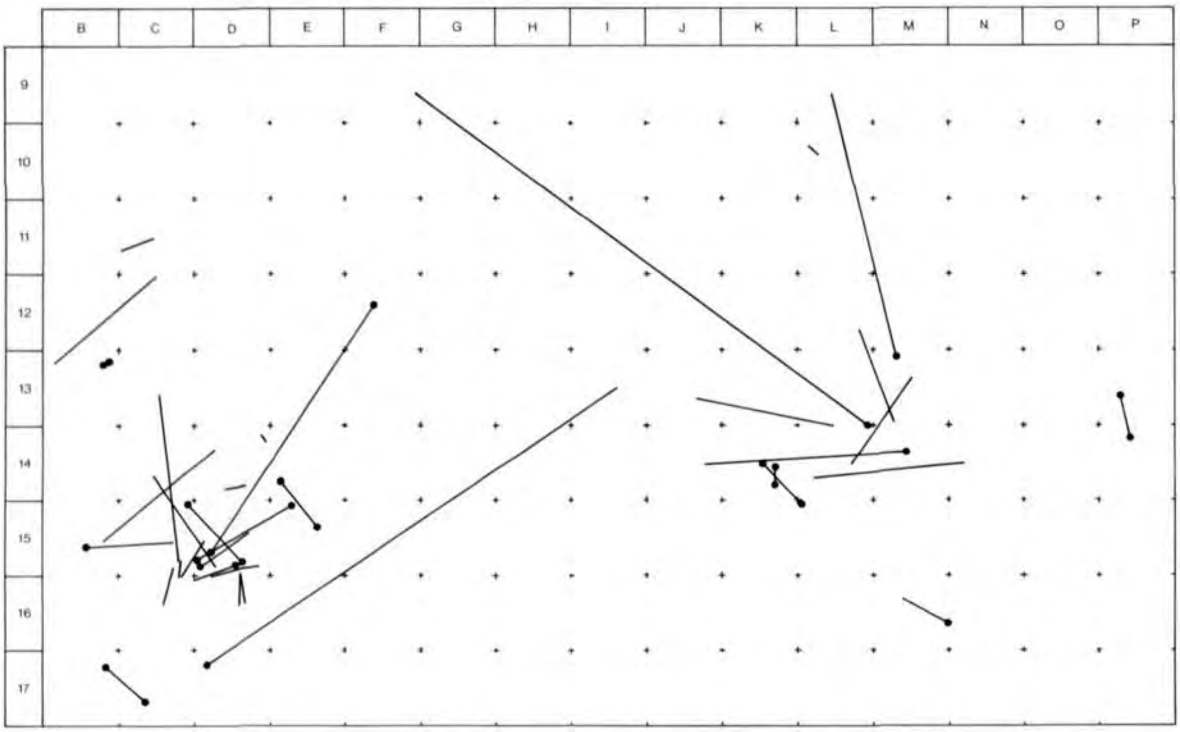


Fig. 66. Site C: horizontal distribution of conjoined broken flake fragments. The dots indicate fragments with maximum dimensions of more than 2 cm. The cluster in the left of the figure consists of RMU 3 and 4 fragments. RMU 2 flake fragments are visible to the right. Grid in square metres.

from the northern to the eastern part of the site and from the southern to the central part, respectively, as can be seen in figures 51 and 54. The RMU 4 products were distributed partly around the main concentration of debris, while the RMU 5 material showed no indications whatsoever of 'transport' of selected items inside the excavated area. The RMU 6 conjoined flakes were clearly clustered in two areas, again indicating that the flint-knapper(s) moved to a different knapping spot.

VERTICAL DISTRIBUTION OF CONJOINED ELEMENTS:
Figure 67 gives vertical plots of refitted flakes from Site C. To account for the steep slopes caused by post-depositional karst, the depth of refitted artefacts within a continuous narrow (1-m wide) strip is shown for the squares of grid E. Furthermore we have to stress the fact that the vertical distribution of conjoining elements as shown in figure 67 is influenced by the fact that the slope of the karst subsidence is not only south-north, but also east-west oriented; this resulted in a wider vertical distribution, even within an only 1-m wide strip.

As can be seen in figure 67, most of the conjoined artefacts were found over vertical distances of 5 to 20 cm, but larger vertical distances are, however, not exceptional. No attempts were made to quantify the average vertical dispersion, as this is highly problematical in view of the karst processes which affected the site. In the field, however, we gained the distinct impression that heavier pieces tended to lie near the lower margin of the vertical distribution. The karst disturbances make it impossible to quantify this impression. The degree of vertical displacement of conjoining elements at Belvédère Site C agreed fairly well with previous findings at other sites with a (very) fine sand matrix (e.g. Cahen/Moeyersons 1977; Bunn *et al.* 1980; Barton/Bergman 1982; Villa 1982; Villa/Courtin 1983; Hofman 1986).

It is not possible to point out one agent as primarily responsible for the vertical dispersal observed at Site C. We may however exclude biological activity as a major agent, as neither macroscopical nor microscopical bioturbation was observed in the matrix of Site C. As stated above, the matrix was pedologically classified as the B3tg/Cg horizon of a gleyic luvisol (Mücher 1985).

In recent years the effect of trampling has been stressed in this context (e.g. Gifford/Behrensmeyer 1977; Villa 1982; Villa/Courtin 1983). At Belvédère Site C, however, trampling cannot have played a significant role, because the site was very probably used for a short while only. Moreover, it

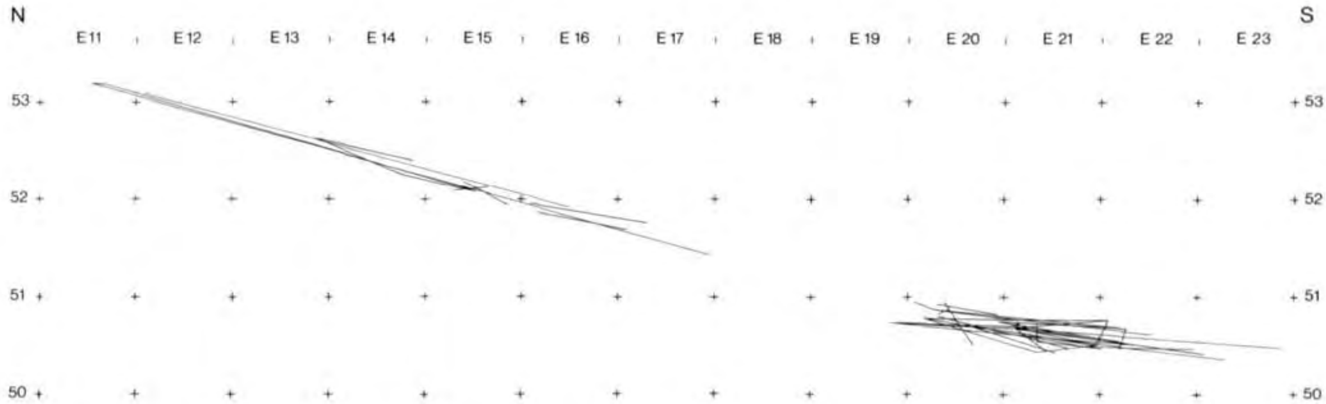


Fig. 67. Site C: vertical distribution of conjoining elements in a north-south 1m-wide strip ('E' squares). Grid in metres. Graphic representation according to figure 45, model C.

is very likely that in the Unit 4 sedimentary environment the palaeosurface of this open-air site was covered with sediment shortly after occupation.

As suggested for the British Upper Palaeolithic site Hengistbury (Barton/Bergman 1982), the vertical distribution could have been caused by differential inertia and the weight of the artefacts themselves. From the sections we know that the matrix of Site C had been affected by frost action (see 4.2.5.5). Finally, Cahen and Moeyersons (1977) have shown that alternate wetting and drying of sediments can lead to vertical movements of artefacts.

The cumulative effect of these three agents (weight, frost action, alternate wetting and drying) was probably largely responsible for the post-depositional vertical movement of artefacts at Site C.

TRANSPORT ACROSS THE SITE AND BEYOND:

The refitting programme clearly showed that flakes of RMU 4 and 6 were struck outside the excavated area, and were subsequently imported to the site. As these RMU 4 and RMU 6 imported flakes were found in the neighbourhood of the larger bone fragments, it is tempting to regard these flakes as having been imported together with the (meat and) bone material, or at any rate to be associated with it. Quite apart from this interpretation, the site can be interpreted as an area where preparatory flint working took place, the core product of which was taken to another spot, where it was reduced. Flakes produced in that stage subsequently returned to Site C.

In addition to evidence that can be used for extremely 'reconstructional' behavioural inferences, the refitting work produced sound indications of the chronological relations of some of the flint-knapping activities. As we already know, the majority of the burnt artefacts were found in the southern part of Site C and most were of RMU 5. About 10% of the 162 elements that formed the reconstructed RMU 5 'core' was severely burnt. These burnt flakes were randomly distributed within the concentration of RMU 5 debris. There were no relations observable between knapping stages and burning of artefacts. This means that this burning occurred after the flint working. As stated above, part of the RMU 6 debris distribution coincides with the western part of the RMU 5 distribution. However, none of the flints of a block of 25 refitted RMU 6 elements was burnt; in fact, not one RMU 6 flint showed signs of burning. If we do not wish to ascribe these differences to pure chance -as is indeed not our intention-, we have to assume a chronological difference between an earlier formation of the RMU 5 distribution and its burning and a later formation of the RMU 6 pattern, a time difference that may, however, have been as short as only one night.

The refitting programme discussed above provided clear evidence of the dynamics of the flint processing in- and outside the excavated area of Site C in terms of the horizontal transport of the different RMUs and their products. The presence and absence of the products of different flint-working stages are related to the complex character of cultural site-formation processes. The evidence provided by RMUs 3 and 4 and RMUs 5 and 6 demonstrates that the spatial clustering of artefacts does not necessarily have to be related to actual association in use (cf. Cahen *et al.* 1979). The refitting evidence led us to conclude that each RMU recovered inside Site C had a different 'life', reflecting different attitudes of Middle Palaeolithic man in regard of flint-working and -handling processes.

The Site C refitting evidence suggests that the Unit 4 sediments at Belvédère might contain spatial flint configurations ('sites') with only a few indications of flint knapping 'on the spot', i.e. sites into which prepared cores were introduced and where flakes were struck from these cores, which were then, sometimes, discarded after use. The core and (some of) the flakes were subsequently taken away, to be used at another site. This 'dynamic' model, centred around the differential transport of flint artefacts, *might* offer an explanation for the complete absence of hammerstones at all of the Unit IV sites excavated so far (1987).

4.2.5 NATURAL SITE-FORMATION PROCESSES

4.2.5.1 Introduction

Inferences on natural site-formation processes have to preceed conclusions on the rôle of human behaviour in the formation of the archaeological record. Therefore, in this paragraph the natural processes that affected the cultural material of Site C and the methods for determining their occurrence and effects will be reviewed in a more systematic way than has been done above.

4.2.5.2 The burial stage

As stated above, the archaeological remains were encased in a fine sand-silt-loam matrix, indicative of low-energy deposition of the fluviatile sediment in the unstable phase of the first K-cycle. Micromorphological sediment analysis showed that the archaeological remains were buried very calmly and gradually (Mücher 1985).

The molluscan evidence, obtained at the boundary of the excavated area in a low topographical position (section Mol.2 in: Meijer 1985), indicates that the local sedimentary environment was a calm one. This is apparent from the *Bithynia* ratio, i.e. the ratio between the opercula and shells of *Bithynidae* present in the sediment (see fig. 130, based on Meijer 1985).

As this *Bithynia*-ratio can be a useful indicator of site-formation processes in the case of sites in a fluviatile environment, it will be discussed here in some detail, following Meijer 1985. It is assumed that when the opercula and shell ratio is not 1:1, a certain degree of sorting has taken place as a result of movement of the water (Sparks 1964; Gilbertson/Hawkins 1978). River sediments generally contain more opercula than shells, and in most cases shells are even completely lacking, which is explained by the different behaviour of the *Bithynia* elements: after the animal has died the shell starts to float on the surface of the water, and after a while the operculum becomes detached and sinks, while the shell continues to float and is later incorporated in sediments elsewhere. Over-representation of opercula in a sediment therefore indicates a nett loss of shells, which is usually caused by sorting processes. The shells, however, are much more vulnerable to dissolution, which means that the ratio can also be a product of leaching processes. In places where the river flows less quickly and the water becomes stagnant or where a floating vegetation captures floating shells, shell accumulation may take place. In such 'shell-trap' environments shells without opercula outnumber the opercula of the individuals living there.

Of course the *Bithynia* ratio only gives an impression of the sedimentary environment of a limited area during the formation of the analysed sediments: in our case it provides information on a water body present at the boundary of the areas sampled in our excavation of Site C. Short periods with higher water energy may have occurred without noticeable changes in the *Bithynia*-ratio.

The molluscan evidence furthermore indicates that the whole area must have been covered by a dense undergrowth, which very probably limited horizontal displacements of archaeological remains in the burial stage.

The archaeological evidence suggests that displacement of materials must have been minimal; three lines of evidence will be reviewed here, the refitting data, the size distribution of the flint material and the sieve residue.

1. The fact that, as shown above, conjoining pieces tend to be clustered spatially clearly indicates that there was very little post-depositional disturbance, certainly when combined with the size distribution of these fragments as presented in figure 46. The majority (abt. 60%) of the fitted elements were smaller than 3 cm.

2. The size distribution of the three-dimensionally recorded flints has already been given in figure 28; abt. 75% of the flints has maximum dimensions of 2 cm, and 45% has maximum dimensions of 1 cm (this last percentage increases to 52.8% if we include the 536 chips recovered from the sieve residue of 38 square metres. As the ratio of the sieve residue and the three-dimensionally recorded flints of the sieved squares is in most cases about 1.35 and this residue is dominated by small chips, we could even suggest that the original Site C asssemblage contained 1368 + (1.35x1368) small chips, i.e. in total more than 3000 pieces with maximum dimensions of less than 1 cm). The horizontal distribution of the different size classes shows large and small flint fragments lying side by side (fig. 27).

3. The sediments of 38 m^2 of the 264 m^2 excavated -irregularly distributed over the excavated area- were sieved through a 2-mm mesh screen (for 'palaeontological sieving' a mesh-width of 0.5 mm was used). The sediment of another 20 m^2 that had been stored in the Belvédère brick factory to be sieved later became inaccessible when the town of Maastricht started to use the storage room for the overnight storage of large quantities of industrially polluted sediment, thus blocking the samples. Figure 68 shows the ratio of the sieve residue and the three-dimensionally recor-

ded flints of the southern part of the site. The majority (abt. 75%) of the three-dimensionally recorded artefacts are smaller than 2 cm, while the majority of the fragments in the sieve residue are smaller than 0.5 cm. The horizontal distribution of the sieve residue (fig. 68) corresponds very well to the distribution of the three-dimensionally recorded artefacts. Because this applies to all the screened square metres, we may infer that the flint assemblage of Site C was not the object of sorting processes resulting in a winnowing pattern.

To conclude, there are good reasons for assuming that the archaeological debris was hardly disturbed during the burial stage and that the spatial configuration may be used for behavioural inferences.

4.2.5.3 Soil formation

According to the micromorphological analysis of one section of Site C (Mücher 1985, Mi 6), the archaeological assemblage was situated roughly at the boundary of the Cg and B3tg horizons of a gleyic luvisol. In general terms this means that during the formation of the palaeosol the stable land surface lay at least 1 m, and more probably 1.5 m, above the level containing the archaeological remains (Mücher, pers.comm., 1985). We have to conclude that after the initial burial of the cultural remains sedimentation continued until about 1.5 m of sediment had been deposited.

During the formation of Palaeosol I, in the stable phase of the first K-cycle, the sediments of Unit IV were greatly decalcified (pH now varying from 6 to 8.6). Here and there, the presence of patches of calcareous tufa on top of Unit IV-C-I prevented the decalcification of the underlying sediments and saved faunal material from complete destruction. No clear signs of bioturbation were observed in the thin section of the sediments, which means that the observed vertical dispersion of artefacts must for the greater part have been caused by other processes.

4.2.5.4 Erosion

In an unstable phase preceeding the deposition of the Unit V-B deposits the palaeosol present in the top part of Unit IV-C/V-A was severely truncated; at Site C the entire A horizon and almost all of the B horizon were eroded in an erosional phase which may have destroyed many 'Site-C-like' flint and bone scatters originally present higher up in Unit 4. If the erosion had continued for another 50 cm, the spatial configuration of Site C would have been completely destroyed. In the western part of the trench of Site C the erosional level lay very close to the upper limit of the vertical distribution of the finds.

In the southern part of the site a small erosional gully cut into the find scatter over an area of abt. 1.5 m^2 (squares

	C	D	E	F	G	H	I
21	36	152	90	49	19	8	2
22	65	123/102	93/63	64/46	12	2/4	0
23	18	2/15	16/7	7/10	4/2	3/1	0
24	0	0	0	2/2	0/2	2	0

Fig. 68. Site C: ratio of the sieve residue and the three-dimensionally recorded flint artefacts for the southern part of the excavated area. The ratios are shown in black, while the grey numbers refer to three-dimensionally recorded artefacts from squares which were not sieved. See the text for an explanation.

D-21, D-22 and D-23). Two artefacts were found at the point where the bottom of the gully reached the Unit 4 matrix; they could be refitted to material found deeper in the Unit 4 sediment. This erosional phase probably preceded the one mentioned above.

4.2.5.5. Frost action

The matrix of Site C underwent cryoturbation, which in all probability occurred after the formation of the Unit IV complex. Frost action may have been one of the processes responsible for the vertical dispersion of artefacts in the matrix. In studying molluscs from Unit 4, Meijer (1985) noticed that many *Bithynia* opercula were broken, but that the fragments were firmly cemented together; many thin-walled larger gastropods had been completely preserved but had been crushed in the sediment. Meijer (1985) ascribed these phenomena to post-depositional movements in the sediment; frost action may have been one of the agents of these post-depositional movements.

4.2.5.6 Karst formation

The greater part of the original stratification of the site was affected by the dissolution of the Palaeocene chalk of the underlying Unit 1.

At Site C the karst features could be dated relatively accurately on the basis of the following observations:

1. No great differences in sediment thickness were observed in Unit IV or in Unit V. Such differences are related to the presence of sediment-traps. This means that no visible karst-related processes took place during the deposition of Units IV and V.
2. It can be said for the Belvédère pit as a whole that the

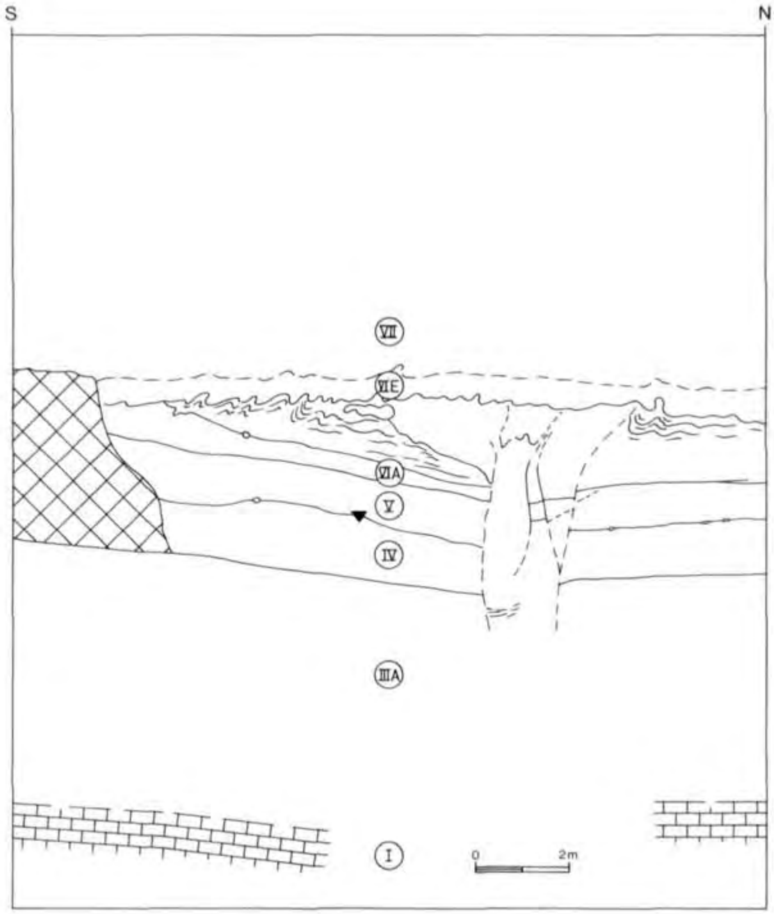


Fig. 69. Section in the southeastern part of Site C, showing a karst-generated disturbance. Indicated are the lithostratigraphical Units, while the triangle at the boundary of Units IV and V indicates the position of the core shown in figure 109. (after the original field drawing by W.M. Felder, State Geological Survey, Heerlen).

palaeosol present on top of Unit V (the 'Eemian' Sol de Rocourt) was truncated more or less evenly over the whole area studied so far.

3. The following units subsided into karstic depressions: Units III, IV, V and VI-A. The subsidence of these Units was in many cases accompanied by slump faulting (Vandenberghe 1985a).

4. The -practically levelled- Horizon of Nagelbeek (VI-E; Haesaerts *et al.* 1981) was observed everywhere on top of the fills of these depressions.

Figure 69 gives an illustration of these observations in the form of a drawing of a section immediately adjacent to the Site C excavation.

On the basis of these and similar observations at other sites, the majority of the karst features at Belvédère can be dated, the formation of Unit VI-A serving as a *terminus post quem*, and that of the Horizon of Nagelbeek as the *terminus ante quem*. According to the evidence obtained so far, the formation of karst features should therefore be dated between ± 100 and 20 ka, the last date being the estimated date of the formation of the Nagelbeek Horizon. Karst had no serious consequences for the spatial configuration of the archaeological material embedded in the Unit 4 matrix because the matrix subsided gradually towards the centres of the karstic depressions; this subsidence is clearly illustrated by the vertical distribution of joined flint artefacts shown above in figure 67.

Near the centres of the karstic depressions, however, the original spatial configuration of the cultural debris will have been severely affected. Fortunately, at Site C these centres did not overlap artefact concentrations and therefore only the peripheries of the flint scatters were affected.

4.2.5.7 *Conclusion*

To summarize, we may state that the spatial configurations as recorded during the excavation of Site C may be regarded as the material manifestations of human behaviour; on the basis of the data presented above, the cultural material recovered within the area excavated is considered to have been found in a primary archaeological context.

4.2.6 SPATIAL ANALYSIS

Although it is tempting to regard the cultural material from Site C as having been produced simultaneously, i.e. generated in one continuous and very brief period of activity, we have no sound evidence to corroborate such a supposition. We therefore have to evaluate the possibility that the spatial pattern of Site C is the cumulative product of events that were spaced through time (Kroll/Isaac 1984).

The different knapping phases in which the flint scatters were produced were very probably of short duration. From the refitting evidence of the lithic debris we cannot infer any considerable overlapping of activities related to the manufacture and use of the flint artefacts. However, in square H-14 flakes of RMU 2 and RMU 4 were found very close to each other, at the same depth, as was also observed in the case of the fragments of RMUs 4 and 6 found in square C18 (see fig. 26). This could be interpreted as the result of the vertical dispersion of flints through the sediment though. An alternative explanation is that the horizontal and vertical distribution patterns of these flakes (and bone fragments) are the result of the contemporaneous use and discard of these stone 'tools' by man.

The fact that the different flint scatters inside the excavated area 'respect' each other might indicate a spatial organization of the activities at the site, pointing to the simultaneous production of different flint scatters as an interrelated series of activities.

The limited spatial analysis to be presented below is based on the *assumed* contemporaneity of the different artefact scatters. The word 'assumed' is stressed here because in the author's opinion the problem of 'contemporaneity' is often overlooked in the spatial analysis of lithic scatters.

This topic has been discussed by Kroll and Isaac (1984), who stress that many authors tacitly assume that stratigraphically concentrated archaeological finds can be interpreted as indicative of living floors whose spatial configurations were formed in a single, continuous period of occupation. In this way an artefact distribution is regarded as the blueprint of the camp-site's layout and no alternative hypotheses are given for the formation of the spatial configurations.

In this context Kroll and Isaac use the terms organized versus compound entity: sites may have been formed as organized entities, in which the total configuration is indicative of the associated use of space, or as compound entities, in which behaviourally meaningful patterns can best be determined if the individual 'site uses' can be resolved. Of course, sites like Site C can only be subjected to spatial analysis if it is assumed that all of the materials studied in the analysis were deposited in *one* consistent form of use of the site studied. This means that we have to assume that Site C may be regarded as an organized entity.

The first question in the (1984) spatial analysis of Site C was, whether we were looking at basically two independently deposited find categories, i.e. whether the excavated flint scatter was superimposed over an already existing, naturally formed bone distribution (or vice versa). In this case one would not *expect* statistically significant spatial relations between the stones and the bones. This would more probably be the case if hominids had been involved in the formation of the flint assemblage *and* the bone assemblage.

An important observation in this respect is that all the bone material of Site C was stratigraphically concentrated at the same level as the flint artefacts. Horizontal nearest neighbour analysis of 41 larger bone fragments from the site gave a Clark/Evans ratio of 0.39, indicating a clustered distribution (Hodder/Orton 1976: 40).

Furthermore, the bone material was not only stratigraphically concentrated at the same level as the flints, but visual inspection revealed that bone fragments also tended to occur in the neighbourhood of larger flakes.

In order to analyse this inferred relationship, the distribution was recorded of 43 flints and 41 bone fragments measuring 5 cm or more. The sample of 43 flints used in this analysis in 1984 consisted of the tools and flakes with use retouch listed in table 6 and regular flakes with straight cutting edges, with maximum dimensions of 5 cm or more.

Generally speaking, spatial analytical methods can be divided into two categories: one considering the excavated area in relation to the artefacts, and the other dealing with the artefacts only. Both approaches will be discussed here.

The first approach is based on the presence and absence of artefacts in the grid squares and in a first approximation the contingency table 10 was drawn. Such contingency tables are extensively used in plant ecology and different measures of association have been suggested (Hodder/Orton 1976; Orton 1980), of which Chi-square, Q and V are the best known.

Q $(= ad - bc / ad + bc)$ and V $(= ad - bc / (efgh)^{1/2})$ both vary from +1 for positive association to -1, complete dissociation. Q and V equal 0 when there is no association, i.e. when expected and observed frequencies coincide. The data given in table 10 result in values of Q= 0.6 and V= 0.2, values which may be interpreted as indicating association. From the data of table 10 a Chi-square value of 10.78 was

Table 10: The distribution of flint artefacts and bone fragments (≥5 cm) at Site C.

		flints		
	absent	present	absent	total
bones	present	8 (a)	18 (b)	26 (e)
	absent	22 (c)	216 (d)	238 (f)
	total	30 (g)	234 (h)	264 (n)

computed, indicating that for one degree of freedom the probability of independence of the two distributions is only 0.001. Therefore a statistically significant depency could be inferred between the two distributions, which would mean that the flints and bones are related in one way or another. However, in the present case, the Chi-square value is largely determined by the contents of cell d of the table (no bones, no flint). A further increase in the number of empty quadrats would suggest an even stronger relation. As suggested by Van de Velde (this volume, appendix II), a useful approach could be to choose the sum of the quadrats covered by the individual distributions as the domain that is the sum of the table in cell (n) relative to which the two distributions are studied.

The adjusted table 11 constructed in this way gives Q and V values of -0.6 and -0.3, respectively, which in this case imply segregation. The Chi-square is now 10.39, which again means that for one degree of freedom the probability that the distributions are independent is abt. 1:1000. This time, however, segregation is indicated in accordance with the Q and V values.

Of course, not only the number of empty cells determines the results of the analysis; the outcome is also greatly dependent on the size of the quadrats used, in this case quadrats of one metre. However, on account of the -karst-determined- irregular shape of the excavated area, Whallon's (1973) method of dimensional analysis of variance could not be applied here (cf. Orton 1980: 146-149).

Of the techniques which concentrate on the artefacts themselves, and are therefore independent of the number of empty squares, nearest neighbour analysis should be mentioned. Nearest neighbour analysis of the flints and bones resulted in the following table (table 12).

This distribution yielded a Chi-square of 15.49 for one degree of freedom significant at the level of 0.001, which indicates segregation. For this kind of data Pielou (1961) suggested a coefficient of segregation (Hodder/Orton, 1976: 205): S= (c + b) N /(eh + fg). S varies from +1, when the distributions are completely segregated, i.e. are situated in different areas, to -1, when flints and bones are found in isolated pairs of one flint and one bone. S= 0 when the two find categories are randomly intermingled. In our case the segregation coefficient is 0.43, which points to a segregated distribution.

The nearest neighbour analysis therefore essentially yields the same results as the adjusted quadrat-count method, both indicating segregation of flints and bones. The initial quadrat counts (table 10) gave us what could be termed a 'bird's-eye view' of the distribution of the two find categories inside the excavated area, while the nearest neighbour and adjusted quadrat-count methods zoomed in on the distribution *per se*, yielding information on a finer scale than the first attempt.

Both attempts, while operating on different scales, seem to indicate that there are statistically significant spatial relations between the two find categories, suggesting hominid involvement in the formation of the spatial distribution; on a larger scale, the flints and bones seem to lie close together, while on a finer scale segregation is apparent, indicating that the bone fragments were 'tossed away' from the spot where the flints were discarded.

These interpretations are, admittedly, based on a very limited analysis, which started from the assumption that the finds were deposited during one continuous use of space. This assumption has not been falsified, but has not been 'proven' either!

Independent depositional events *can* lead to the same spatial pattern as an organized use of space. But such a supposition can only be verified with the aid of 'archaeological' evidence in the sense of established relations between individual flint scatters as determined by the conjoining of lithics (Cahen/Keeley/Van Noten 1979). This, of course, does not imply that the absence of such relations between flint scatters indicates the lack of any spatial organization of activities. We will return to this topic in the next section.

Table 11: As table 10, with adjustments according to Van de Velde (this volume, appendix II)

		flints		
		present	absent	total
bones	present	8 (a)	18 (b)	26 (e)
	absent	22 (c)	8 (d)	30 (f)
	total	30 (g)	26 (h)	56 (n)

Table 12: Nearest neighbour distribution of the flints and bones (≥5 cm) of Site C, indicating the number of times that a flint artefact has as its nearest neighbour a flint (a) or a bone (c), etc.

		nearest neighbour		
		flint	bone	total
base point	flint	30 (a)	11 (b)	41 (e)
	bone	13 (c)	30 (d)	43 (f)
	total	43 (g)	41 (h)	84 (n)

4.2.7 INTERPRETATION

The 'organized versus compound entity' discussion referred to above is of essential importance in the interpretation of the data of Site C in terms of human behaviour. One of the participants in this discussion is Binford, who repeatedly stresses the notion, that

'The archaeological record must be understood in terms of a different temporal perspective than is characteristic of our own or of ethnographer's experience in cultural systems.' (Binford 1987: 20).

Actually, we are here confronted with the major methodological problem

'... whether archaeologists can accurately reconstruct aspects of the lives and behaviors of early hominids that are not simply untested extrapolations from familiar modern patterns ...' (Kroll/Isaac 1984: 6).

One of the topics around which this discussion has been centred is that of the 'living floor' concept, which has been used by Binford (1987) in one of his attacks on the approach which places modern forms of behaviour back in time, using present-day hunter-gatherer groups as 'stones of Rosetta' to interpret archaeological patterns:

'The willingness ... to accomodate the data from the archaeological record to the researchers' prior beliefs regarding the character of early hominid life resulted in a decade of published material purporting to describe the character of culturally organized camp life among the early hominids. It is not surprising that this elaborate view was a simple derivative of the assumptions that guided the arguments justifying the recognition of living floors in the first place. Isaac argued that, at the very dawn of the appearance of tool-using hominids, 'men' were hunters living in social groups characterized by a male-female division of labor. The products of the hunt were returned to sleeping locations (home bases), where altruistic sharing took place among adults as well as with children. The women's role in provisioning was centered on gathering wild plant materials. Thus the social basis of later, more elaborate 'culture' was thought to be in place at the inception of tool use. It was this view of 'hunting and gathering' that both prompted the quest for and justified the indication of living floors, and in turn, living floors were then cited as evidence that this view was correct. Such a procedure is a methodological tautology.' (Binford 1987: 20).

The relevance of this reasoning to the interpretation of the data of Site C is obvious: were the individual flint scatters produced in one consistent use of the site in one short period of time or are they the results of functionally unrelated activities, independent depositional events? The point is that we have no data that allow us to choose unambiguously in favour of one of the two options.

Another 'frustration' is the discrepancy between the amount of time and energy invested in the recording of the charcoal concentration in the western part of the excavation and the information eventually gained from this, which is virtually zero in terms of behavioural evidence! The charcoal was found at the same level as the flint artefacts, and the discovery of two pieces of burnt flint that had broken during burning suggested that the charcoal may be the result of a fire on the spot. But we cannot prove that this fire is associable with hominid occupation of the site, because the concentration bears no relation to archaeological finds in its immediate environs. Of course this does not mean that there was definitely no relationship, only that it is no longer visible in the archaeological record.

The lesson to be drawn from these 'frustrations' is that we have to realize once again that even well-preserved 'sites' do not represent the preserved buried remains of specific '*moments* of the past', but are in fact to be seen as buried surface collections (Binford 1986).

In this context it seems meaningless to interpret the data of Site C in terms of one of the site 'types' as described by several authors (e.g. Binford/Binford 1966; Clark/Haynes 1970; Sivertsen 1980). An interpretation in terms of these 'types' is in fact dependent on one's assumptions concerning the humanness of the hominids who created the assemblages.

A negative approach as the one used here leads to very few nett results. When we are interested in the Pleistocene evolution of specific forms of behaviour, however, the absence of indications of, say, organized use of space in specific periods can provide valuable information on cultural changes in the Pleistocene and can focus research on more specific topics. If, for instance, analysis of more pre-*sapiens sapiens* sites should yield the 'same' results concerning the spatial relations between specific find categories as observed at Site C, then the presence of such a pattern could lead to a reevaluation of the interpretation of the individual sites.

The 'organized versus compound' problem is too often neglected, for instance in the publications dealing with Lower and Middle Palaeolithic 'hut structures' at Terra Amata (De Lumley 1969a), Bilzingsleben (Mania 1986), Lazaret (De Lumley 1969b) and Rheindahlen (Thieme 1983b). The spatial patterns at these sites have been classified and interpreted without sufficient evaluation of the dynamic processes which caused the actual static patterns. All these interpretations suffer from the 'organized entity syndrome'. For the Terra Amata case P. Villas' refitting studies have shown convincingly that De Lumley's theory concerning hut structures is not very well grounded (Villa 1978, 1982).

The lack of any indications of organized use of space at Middle Pleistocene sites is in marked contrast with the evidence provided by Upper Palaeolithic sites, where relations between individual flint scatters have often been established. Refitting studies of the lithic assemblages from the Late Upper Palaeolithic site at Meer (Belgium) have clearly shown that the various flint concentrations were closely related, and that the site obviously represents a single occupational phase (Cahen/Keeley/Van Noten 1979). Conjoining studies also yielded evidence of relations between flint concentrations at two other Upper Palaeolithic sites, namely Pincevent (France) and Gönnersdorf (West Germany).

Furthermore, unlike that of earlier sites, the patterning of Upper Palaeolithic sites can, often be explained with the aid of a seating-plan model, in which a number of people are grouped around a hearth (Binford 1978; Gamble 1986). Gamble expects

'... such a basic activity to be a feature of sites bearing labels as diverse as hunting sites, ceremonial locations, home bases and overnight transit camps ...' (Gamble 1986: 256).

Such a seating-plan model of discard production around a hearth, with the outermost edges of the toss zone (Binford 1978) lying some 3 m from the centre of the hearth, is seen by many authors as the key with which to interpret sites. Gamble (1986) cites a number of archaeological examples of the three-metres spacing principle, *all* from the Upper Palaeolithic.

As far as the author knows, this 3-m spacing principle is not yet applicable to sites created by *pre-sapiens sapiens* hominids, i.e. it is not possible to divide 'sites' into more workable units of analysis along these lines. Relations between flint scatters comparable to those recorded at Meer and Pincevent have not been published as yet for Middle and Lower Palaeolithic sites. The structures recognizable at Lower and Middle Palaeolithic sites are separate debris concentrations, generated in depositional phases which cannot be convincingly related to one another. This state of affairs may, of course, be due to our selection of sites from the earlier time periods; so far only relatively few early primary context sites have been discovered. Another explanation is that the differences in spatial patterns are related to basic differences in organizational capacities between hominids of different time periods.

As for the individual depositional phases that led to the formation of the Site C entity, the conjoining studies have indicated that we have to regard Site C as a fixed point in a dynamic system of the transport of flints in the form of cores, finished flakes and tools. This topic will be discussed in more general terms in chapter 9.

The limited spatial analysis presented above has demonstrated that hominids were very probably involved in the formation of the spatial distribution of bones and stones at Site C, either in several depositional phases or in one consistent use of space. In view of the character of this spatial relation it seems legitimate to suppose that at least some of the flint artefacts at Site C were discarded in meat procurement activities (Van Gijn, this volume, appendix I). We will return to this topic in a general discussion of the Unit IV sites in chapter 9.

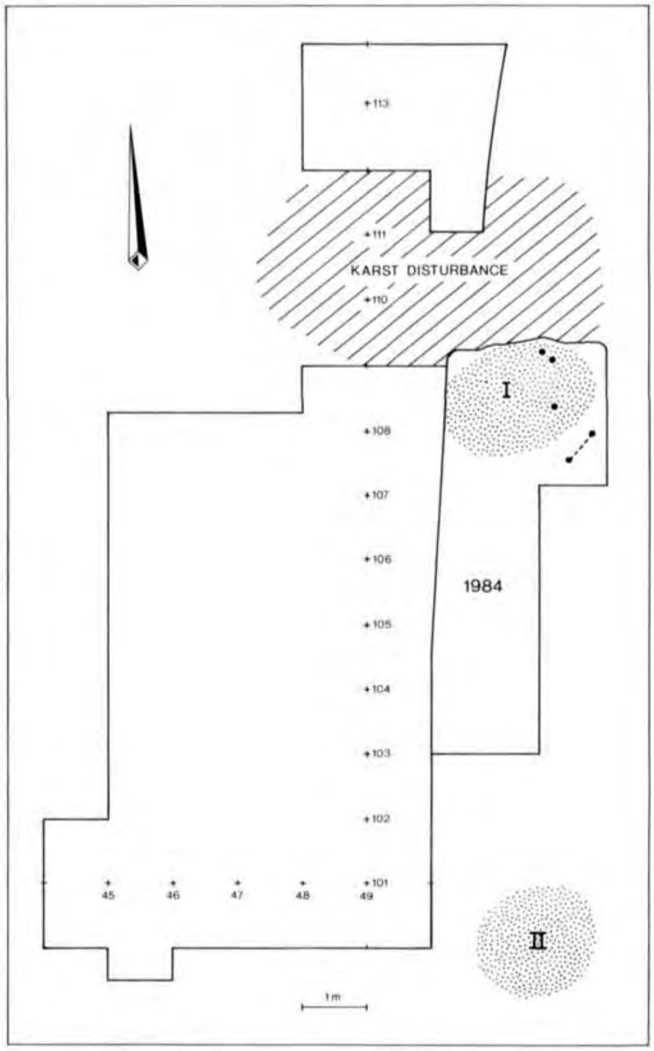


Fig. 70. Site G: position of the Site G excavation and the earlier (1984) find concentrations.

4.3 Site G

4.3.1 INTRODUCTION

In the context of the ESR dating programme of fossil material from Unit 4, Dr R. Grün and Mr O. Katzenberg (Cologne) visited the Belvédère pit on November 28, 1984. During this visit, Mr P. Hennekens observed a large concentration of molluscs in one of the new sections in the top part of Unit 4. The next day the section was sampled for the purpose of ESR dating of the molluscs; during the fieldwork on November 29 and 30, 1984, P. Hennekens, J.P. de Warimont and K. Groenendijk discovered five artefacts and a burnt flint (198411/bf) in association with bone fragments.

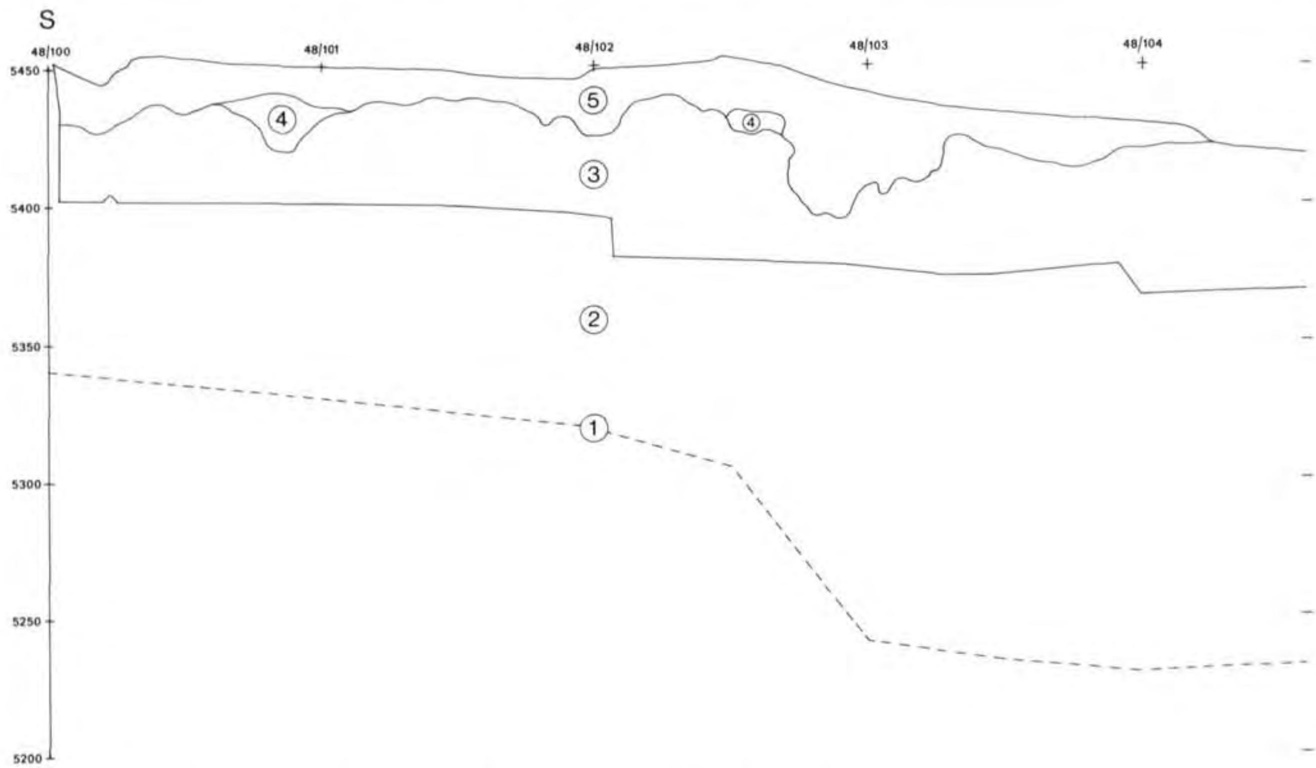


Fig. 71. Site G: idealized south-north section through the eastern profile of the '48' squares:
1 top of the (Unit 3) gravel, as inferred from the results of borings
2 fine laminated sands (2.5 Y 7/2), calcareous in parts, with intercalated gravel layers (Unit 4.4), gradually developing into
3 fine loamy sand (2.5 Y 5/3) with reddish yellow (5 Y 6/8) mottles, containing artefacts and faunal remains in its upper part. Calcareous in parts (Unit 4.5.1/IV-C-I)
4 silt loam (2.5 Y 7/3) with fine sand. Calcareous. At its base it here and there contained fine gravel and artefacts (calcareous tufas, Unit 4.5.2/IV-C-II)
5 silt loam (7.5 Y 6/6) containing Mn and Fe mottles and gravel at its base (Unit 5.1/5.2/IV-C-II/V)

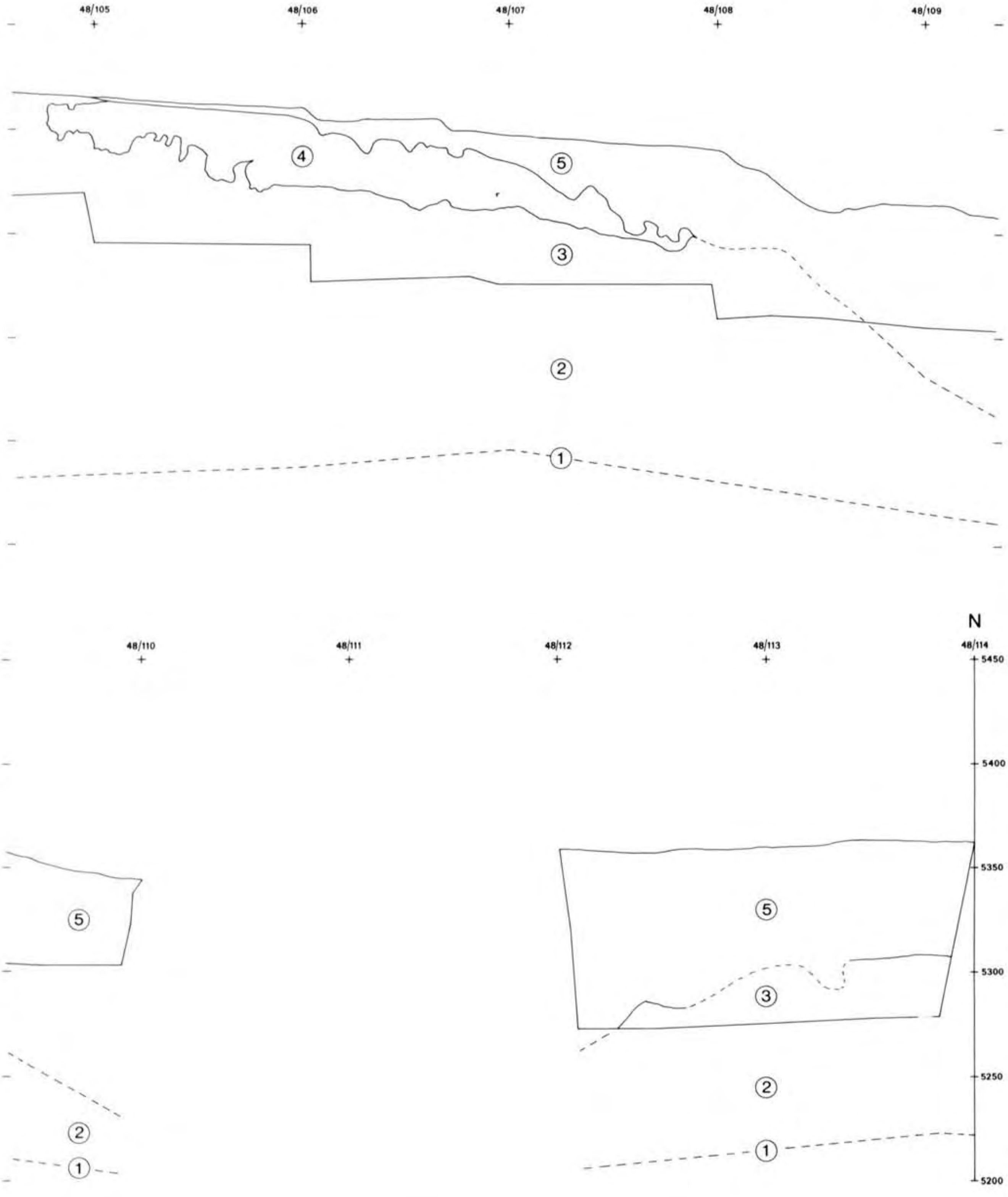
This bone material had been well preserved underneath the calcareous tufa (Unit 4.5.2). A small trial pit of 11 m^2 was excavated, which showed that the bone concentration was limited to abt. 2 m^2, although the preservation conditions were the same all over the excavated area. In December J.P. de Warrimont found a second bone concentration to the south of the first one, this time without flint artefacts (fig. 70).

The value of these first observations is limited since the Unit 4 sediments had already been removed before the discovery of the site in the immediate neighbourhood of the investigated area.

Thanks to the friendly cooperation of the exploiter of the pit, Mr F. Blom, arrangements could be made to excavate part of the undisturbed Unit 4 sediments west of the first discoveries.

The excavation took place from 3 June to 7 August, 1985, with a crew of, on average, ten people. In total, an area of 50 m^2 was excavated. The excavation was done in the usual way, as described for Site C. In view of the local abundance of molluscs and remains of small mammals in the matrix, the soil from 14 squares was sieved through a 0.5-mm mesh screen, in 5-cm thick layers.

Another bone distribution had already been recorded earlier, in 1983, about 30 metres south-southeast of the first bone concentration mentioned above and in the same stratigraphical position. At this spot the top part of the Unit 4 sediments contained several poorly preserved bone fragments, in particular an ulna of *Elephas* sp. (Van Kolfschoten 1985), and a few tiny flint scraps dispersed over an area of abt. 100 m^2. This 'site' was discovered during quarrying activities, and was destroyed that same day by the digging operations. No detailed recording had been possible, but the observations are of interest and relevance to the 1985 excavation.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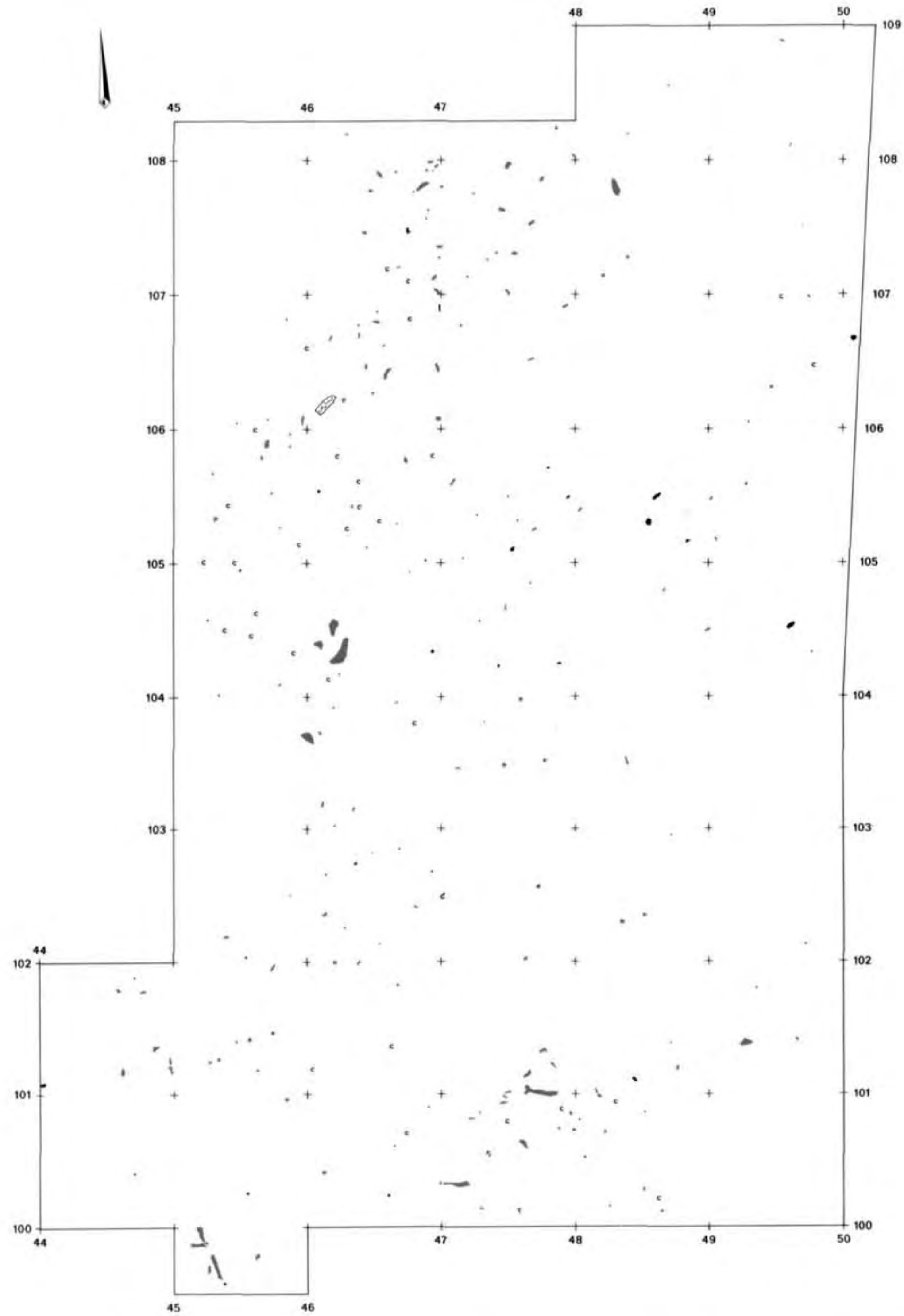


Fig. 72. Site G: horizontal distribution of recorded finds. Scale 1:50 (reference grid in square metres). Flint artefacts are indicated in black. The position of burnt flints are marked by the letter C, while faunal remains are indicated in grey.

4.3.2. STRATIGRAPHY

Figure 71 gives a schematic cross-section of the excavation, from south to north, indicating the lithological Units distinguished by Vandenberghe *et al.* (1985).

Two remarks have to be made with respect to figure 71:
1. The overall majority of the flint artefacts and bones recovered from Site G were found in the top part of the finely grained fluviatile sediments, underneath the calcareous tufa.
2. As at Site C, karst processes had disturbed parts of Site G, as is clearly visible in figure 71.

4.3.3 THE FINDS

4.3.3.1 Introduction

During the excavation of Site G the following find categories were encountered: flint artefacts, burnt flints, bone material of larger mammals, remains of small mammals and molluscs. These last two categories will not be discussed in this section, because they are not related to human activities. They will be presented in chapter 8, which deals with the palaeoenvironment of the Unit IV sites. Here the other find categories will be presented, along with their spatial distributions.

4.3.3.2 The flint material

In November 1984 four flint artefacts were found in the northern concentration of bone fragments: a small flake, a broken flake and two conjoinable fragments of a retouched blade (fig. 74-3).

In the 1985 excavation 54 flint artefacts were recorded, half of which were smaller than 2 cm (fig. 73).

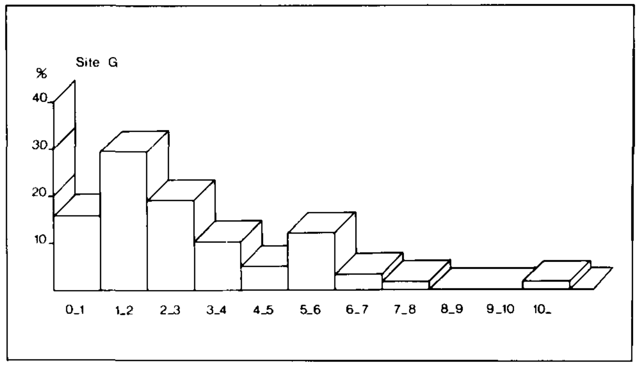


Fig. 73. Size distribution of the Site G flint assemblage, based on maximum dimensions, in cm.

The larger flakes had clearly been struck from prepared cores. The differences in raw materials show that the flakes had been produced from at least three different flint nodules. Almost all larger flakes have finely facetted butts. Particularly noteworthy is a 16.5-cm long backed knife (46/106-11) (fig. 75), the back of which is a lateral edge of the large prepared core from which it was struck (*'éclat débordant' sensu* Beyries/Boëda 1983).

Also a remarkable find is a large blade-like flake (fig. 74-1), found in two fragments lying 20 cm apart in horizontal direction in square 48/105. The basal fragment of the flake shows signs of far more intensive use than the other one, which indicates that the basal fragment continued to be used after the piece had broken.

The larger flakes from site G were studied for traces of wear by A. van Gijn (this volume, appendix I). Two 'fresh' flakes displayed clear traces of use. According to Van Gijn, flake 47/105-3 (fig. 74-5) had been used to cut meat. The backed knife mentioned above displayed an interesting wear pattern, described in detail by Van Gijn (this volume, appendix I). The traces of wear led her to the conclusion that the backed knife may have been used to cut the skin of an animal with a thick hide, like an elephant or a rhinoceros, probably during butchering activities. At the time of her study of the artefacts from Site G, Van Gijn had no knowledge of the presence of faunal remains at Site G. In actual fact, the backed knife was found amidst rhinoceros remains in the northern part of the site (see below).

In total, 23 artefacts were refitted, forming the following groups of conjoining elements:
- 6 groups of 2 conjoining elements
- 1 group of 3 conjoining elements
- 2 groups of 4 conjoining elements

Almost half of the conjoining elements consist of refitted elements of broken artefacts. The refitting indicated that some flint-knapping was done at the site: the two larger ventral/dorsal conjoining flakes 48/101-17 and 49/104-3 mus have been produced inside the excavated area because some very fine flaking debris (< 1 cm) could be refitted to them (ventral/dorsal). Figure 76 gives the spatial distribution of the refitted elements. From the differences in the raw materials used at Site G and the refitting evidence it is clear that
a) at least six larger flakes were introduced into the excavated area after having been produced elsewhere; e.g. the retouched flakes shown in figure 74 and the large backed knife mentioned above
b) at least two larger flakes were produced inside the excavated area because some very fine (< 1 cm) knapping debris could be refitted to them.

4.3.3.3 Burnt flints

None of the flint artefacts showed signs of burning. However, a total of 32 burnt -natural- flints were recorded, concentrated mainly in the northwestern part of the site, as indicated in figure 72. Some of these -generally small- burnt flints were submitted to Oxford for TL dating. The rather concentrated character of the distribution of these finds indicates that we may be dealing with the consequences of a

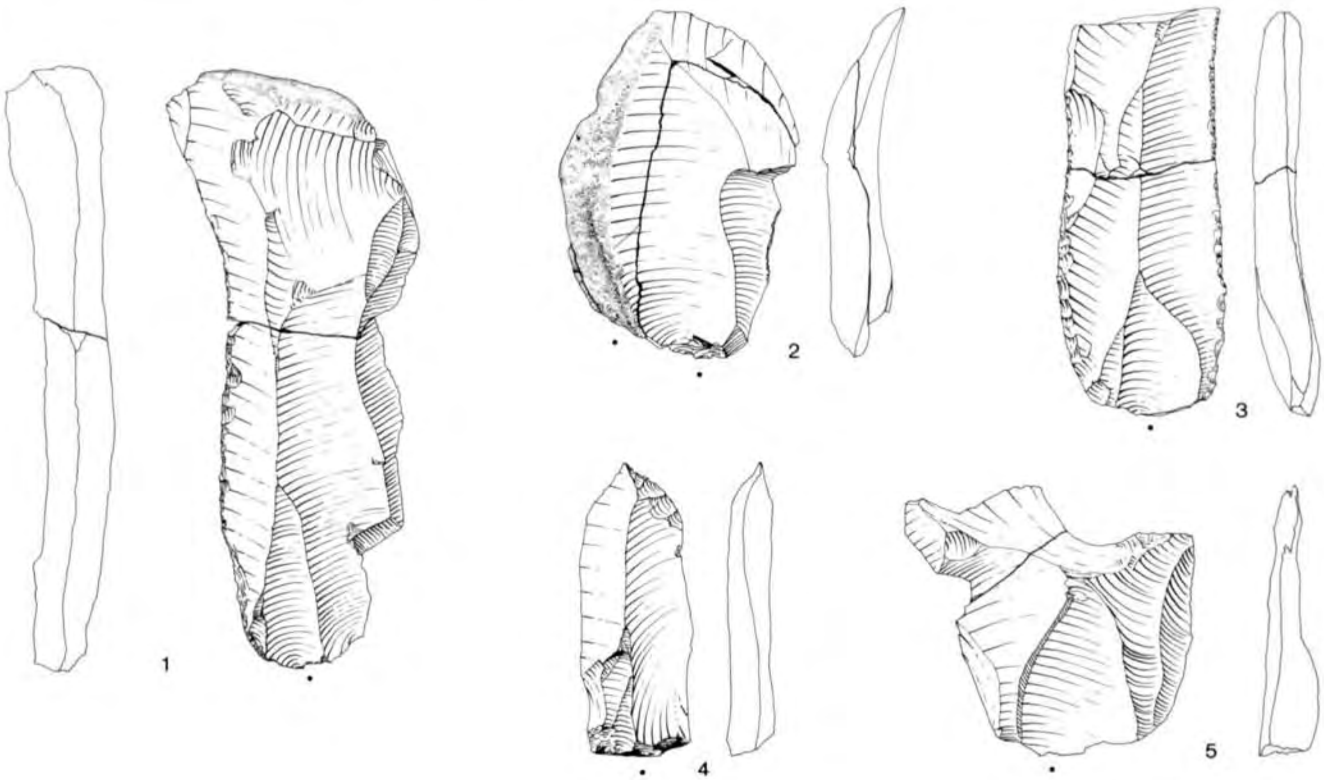


Fig. 74. Site G: flint artefacts, 1 retouched flake consisting of two conjoined fragments, 2 conjoined flakes, 3 retouched flake (side scraper) consisting of two conjoined fragments (from the area excavated in 1984), 4 retouched flake, 5 flake used to cut 'meat' (47/105-3). (Scale 2:3).

fire that burned inside or close to the area sampled in the Site G excavation.

4.3.3.4 Faunal remains

The faunal remains found at Site G, most of which were recovered in a poor state of preservation, were studied by Van Kolfschoten. Table 13 gives a survey of the identified species, the minimum number of individuals (MNI) for each species, and the number of identified elements (NIE).

The horizontal distribution of the faunal remains recovered from Site G is given in figure 72. Figure 77 gives a distribution plan of the identified dental elements.

Van Kolfschoten (pers.comm. 1986) kindly communicated the following comments on the individual species.

Rhinoceros:
Several molars and molar fragments were found in the northern part of Site G, which could be ascribed to two young rhinoceros individuals of the species *Dicerorhinus hemitoechus*. One young individual was represented by hardly worn deciduous molars from the upper dentition, another by worn deciduous molars and premolars, also from the upper dentition. This part of Site G also yielded larger bone fragments, consisting mainly of fragments of upper limb bones. The absence of metapodes and phalanges is striking. A few skull fragments were also found. South of this 'rhinoceros concentration' two badly worn molars of one (or two) old rhinoceros (*D.hemitoechus*) individual(s) were found. Furthermore, rhinoceros remains were found in November-December 1984 in the northern (I) and southern (II) bone concentrations, namely a radius and a sacrum, respectively.

Table 13: The faunal remains from Site G. Indicated are: identified species, minimum number of individuals (MNI) and number of identified elements (NIE).
Determinations by T. van Kolfschoten (pers.comm., 1986).

species	MNI	NIE
rhinoceros (*Dicerorhinus hemitoechus*)	3	15
roe deer (*Capreolus capreolus*)	2	8
red deer (*Cervus elaphus*)	2	10
straight-tusked elephant (*Elephas antiquus*)	1	2
bovid (*Bovidae* indet.)	1	1

Red deer:
Molars and molar fragments of *Cervus elaphus* were found in the southeastern part of the site. Three molars had belonged to an adult individual. Fragments of shed antler, a humerus, a metacarpus and a skull were furthermore recorded inside the excavated area. In December 1984 the southern bone concentration east of Site G (II) yielded a metatarsum of red deer, while rib fragments found in the northern bone concentration (I) (November 1984) may also have belonged to *Cervus elaphus*.

Roe deer:
Two individuals are represented in the *Capreolus capreolus* remains: an adult individual is represented by one molar, while six molars and molar fragments had belonged to a young adult individual.

Bovid:
A young large bovid was represented by one molar.

Elephant:
Two molar fragments could be ascribed to *Elephas antiquus*.

The fragmented state of the bone material does not allow us to determine which animals are represented by which skeletal parts: roe deer, bovid and elephant could only be identified by means of molar fragments. It is remarkable that the identified rhinoceros remains consist only of fragments of upper limb bones and cranial parts. Other skeletal elements are missing, with the exception of the sacrum and radius found in 1984 in the two bone concentrations east of the excavation proper. The upper limb bones are mainly represented by medial (diaphyse) elements. The clustered rhinoceros molars of two young individuals are all upper jaw elements. The identified red deer elements are all fragments of upper limb bones and the skull. The rib fragments in the northern concentration may be from a red deer too. According to Van Kolfschoten (pers. comm., 1987), the typical fragmentation of the bone material cannot be ascribed to post-depositional processes, but may point to intentional fragmentation on the spot. The absence of gnawing marks on the few well preserved bones suggests fragmentation by man.

The faunal remains from Site G can be divided into two groups on the basis of their state of preservation. Group 1 is characterised by a type of bone preservation which is quite common to the majority of the bone fragments from Site G and to the bones from (calcareous) Unit 4 sediments: brittle, light and porous bone material, of a yellowish-brown colour, which easily breaks along irregular lines. Group 2 consists of fossilized, heavier bone fragments, with sharp edges and a dark brown colour. This bone material tends to break along internal, parallel lines.

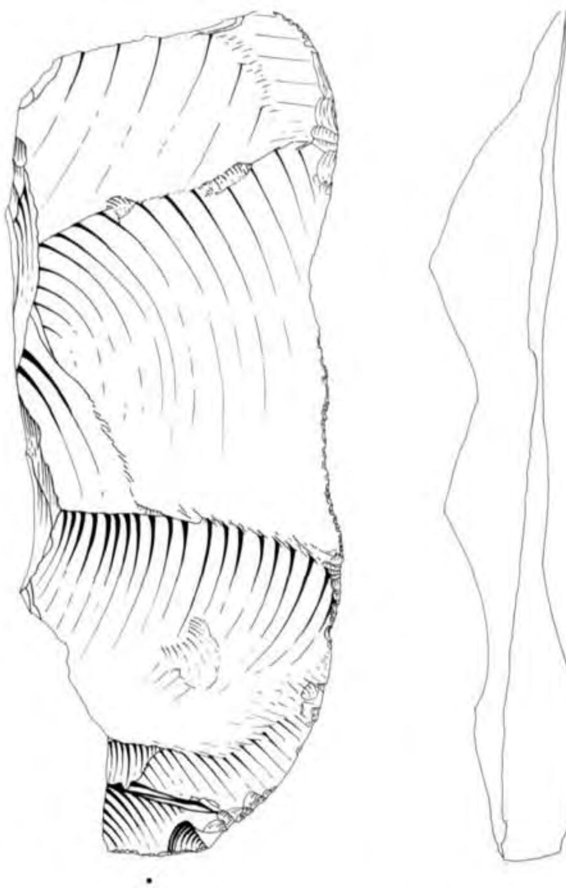


Fig. 75. Site G: Large flake (46/106-11) struck from the lateral side of a prepared core (*éclat débordant*). Scale 2:3.

In order to analyse these differences in bone preservation two bone samples (type 1: 46/106-15; type 2: 45/104-2) were subjected to X-ray fluorescence analysis. The penetration and emission depth of the X-ray bundle (diameter 1 cm) used to analyse the samples was about 0.5 mm. With this method we thus obtained information on the composition of a sample of about 0.5 mm x 1 cm^2. In order to penetrate deeper into the bone fragments, about 1 mm of the outer part of sample 2 was scraped off.

The results of the X-ray fluorescence analysis are shown in figure 80. Figure 80a shows the results after the bone fragments had been cleaned. Both samples contained large amounts of Ca and P, which are the principal components of bone. Al and Si are elements from the sediment. These were present in larger amounts in the porous type 1 sample than in the type 2 sample. The type 2 sample clearly contained significantly larger amounts of Fe and Mn than the

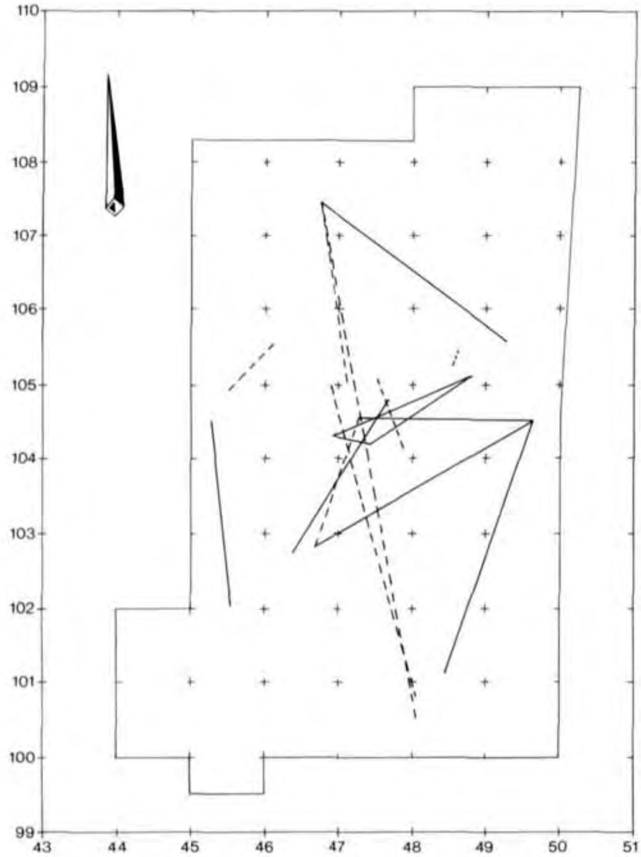


Fig. 76. Site G: horizontal distribution of conjoined flakes and flake fragments. Scale in metres.

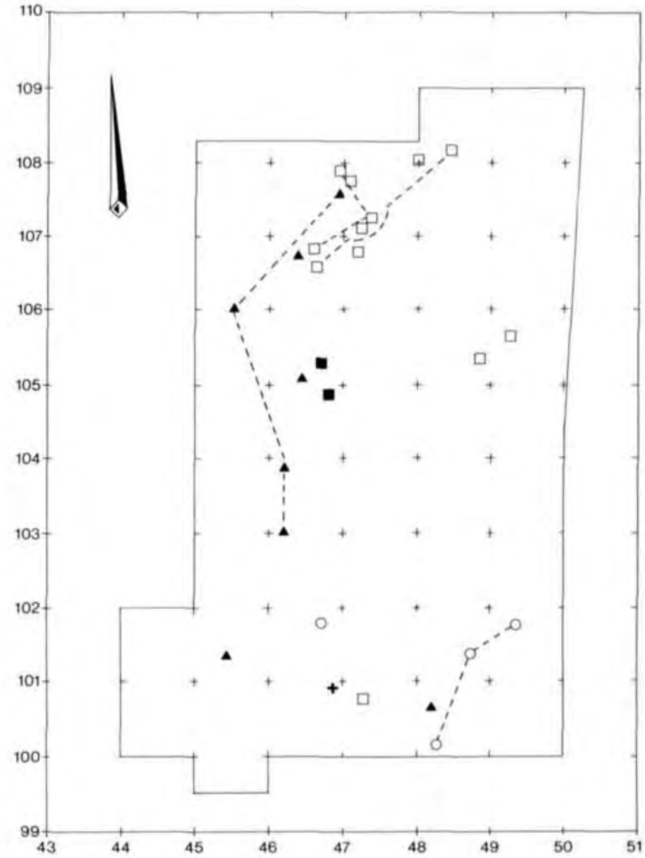


Fig. 77. Site G: horizontal distribution of identified dental faunal remains. Scale 1:100. The lines link the remains that had probably belonged to one and the same individual.

other sample. Most remarkable is the presence of the rare element Yttrium (Y) in both samples.

Figure 80b shows the results of the first (= fig. 80a) analysis of the type 2 sample and those of the analysis after 1 mm had been scraped from the outside of this bone fragment; we note remarkable differences: Al and Si were no longer detected in the second analysis, while small amounts of K, Mn and Y were found. The same values were obtained for P and Ca, while the proportion of Fe was found to have increased. Figure 80c shows a detail of figure 80b.

On the basis of these data the remarkable differences in bone preservation are interpreted as caused by infiltration of Fe and Mn, related to soil-formation processes. A very rough estimate of the amount of Fe and Mn in the type 2 sample is 10% (J.P. de Warrimont, pers.comm., 1985).

4.3.4 INTERPRETATION

Site G obviously formed only a small -non-quantifiable- part of a larger flint and bone distribution, of which about 60 m^2 could be recorded. The presence of karst features in the excavated area indicates that any faunal material originally present there was very probably destroyed. It is clear that the formation of the Site G assemblage and its horizontal distribution involved a complex interplay of several factors, of which human activities are clearly attested by flint artefacts but other (non-human) factors certainly played a part too.

Binford (1981) has discussed the problems involved in the interpretation of this kind of assemblages in great detail. Two of the concepts used by him in this respect are the *historical integrity* and the *relative resolution* of 'materials stabilized in depositional association through the operation of geological processes' (1981: 19).

Historical integrity

'... refers to the degree to which inclusions within the deposit derived from the same or different dynamic conditions in the past. For instance, if all the materials in a deposit derived from the actions of hominids, we could argue that the deposit had considerable integrity ...'(Binford 1981: 19)

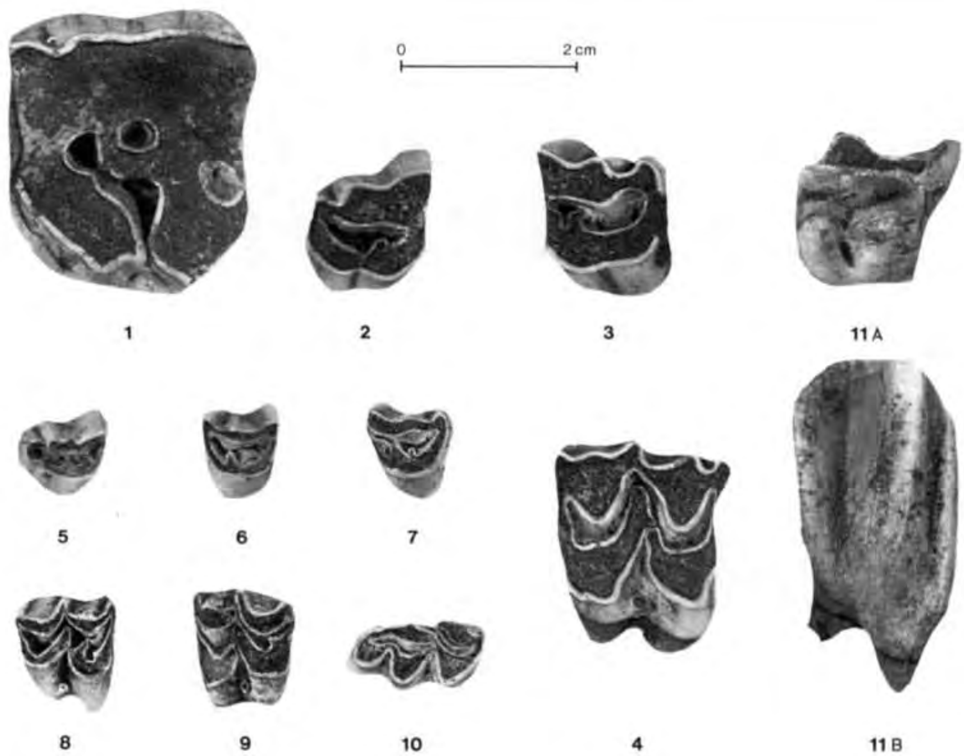


Fig. 78. Site G: some of the identified dental elements.
1 *Dicerorhinus hemitoechus*: dp2 sin., worn milk molar (46/106-12)
2 *Cervus elaphus*: P3 sin. (48/101-9)
3 *Cervus elaphus*: P4 dext. (49/101-16)
4 *Cervus elaphus*: M1 dext. (48/100-14)
5 *Capreolus capreolus*: P2 sin. (46/105-3)
6 *Capreolus capreolus*: P4 dext. of a young individual (45/106-4)
7 *Capreolus capreolus*: P4 sin. of a young individual (46/107-7)
8 *Capreolus capreolus*: M1/M2 of a young individual (46/103-24)
9 *Capreolus capreolus*: M1/M2 sin. (46/103-27)
10 *Capreolus capreolus*: M3 dext. of an adult individual (48/100-22)
11 a/b: P2 sin. of a young (adult) bovid (46/100-1)
Photos published by courtesy of T. van Kolfschoten (Utrecht).

The relative resolution

'... of an accumulation of material is to the degree to which items and classes of materials may be referable to a specifiable and limited, hence unambiguous set of events or actions in the past. Assemblages with high resolution are assemblages in which all parts are referable to the set of events or conditions in the past. Resolution of assemblages may vary independently of the degree of integrity ... it should be clear that *integrity refers to the relative homogeneity of the agents responsible* for materials in a deposit, whereas *resolution refers to the relative homogeneity of the events or situational conditions* whose by-products are preserved in the deposit ...' (Binford 1981: 19).

It is very difficult to make positive statements about the historical integrity and the relative resolution of the Site G assemblage. Such sites are usually -at best-interpreted by means of arguments from elimination, which, as stated by Binford (1981: 83), have two basic premises:
a) all the potential causes are known and listed
b) all but one of those listed are not the cause of the phenomenon in question.

A major problem in this kind of argumenting is that

'... for an argument from eliminating to be valid, one must have available unambiguous means for monitoring the alleged 'causes' and therefore a way of actually determining the degree of participation by a suggested cause in a system of past determinacy ...' (Binford 1981: 83).

With these problems in mind, the following lines of reasoning can be constructed for the interpretation of the Site G assemblage.

The combined presence of flint artefacts and faunal remains at Site G can be explained in several ways, which can be reduced to three basic explanations (cf. Isaac 1981):
1) both find categories were washed together by 'fluvial activities' or other natural depositional processes like slope wash, gelifluction, ablation of the matrix
2) the faunal remains were deposited *independently* of the formation of the artefact assemblage
3) human activities were responsible for the combined presence of the two find categories

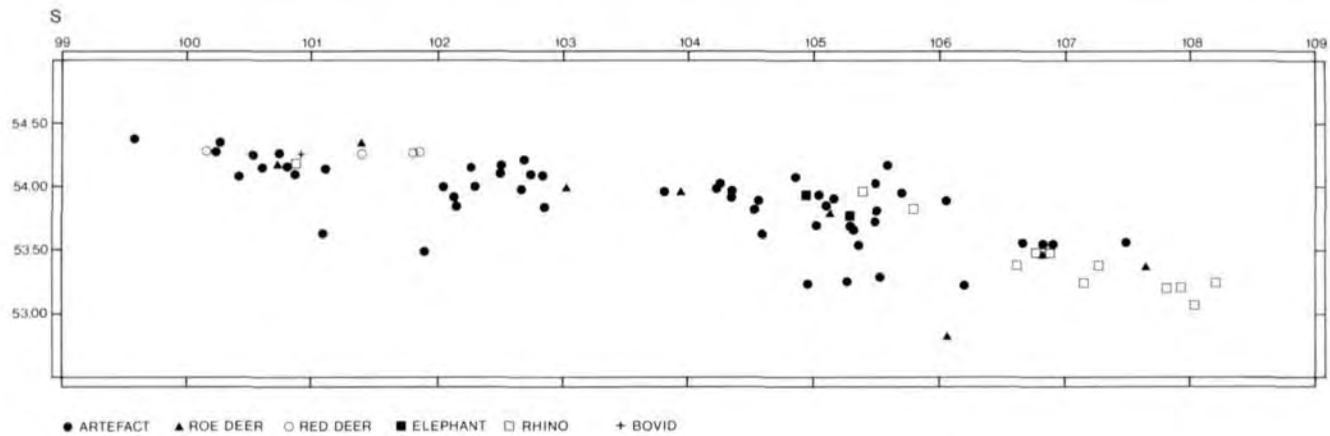


Fig. 79. Site G: vertical distribution of flint artefacts and identified faunal remains over the total site area.

To start with the first explanation, we must first of all take a look at the inferred site-formation processes, which are more or less the same as those described above for Site C. The finely grained Site G matrix contained larger bone fragments, a considerable quantity of molluscs, remains of small vertebrates and fine (< 1 cm) flint debris, which could be refitted to larger flakes. Fragments of two broken retouched flakes were found at a short distance from each other, while the spatial cluster of remains of two young rhinoceros individuals in the northern part of the site suggests a primary context for these remains too. The presence of individual molar (fragments) of a bovid, an elephant and an old rhinoceros is more difficult to explain and can tentatively be related to an erosional phase which *preceded* the formation of the rhinoceros cluster and the flint assemblage. These data indicate that no sorting of any importance had taken place, because the most 'temperate' geomorphic processes sort items according to size in relation to transport energy (Butzer 1982: 193-196). Therefore, the degree in which fluviatile processes conditioned the contents of the Site G assemblage must have been minimal. The composition and the spatial arrangement of the Site G assemblage does therefore not seem to be the result of fluvial processes.

With respect to the second suggested cause we could assume that animals died a natural death at or in the neighbourhood of Site G and that Palaeolithic man discarded his artefacts independently of, and without any causal relation to the bone fragments.

This is the problem constituted by the natural background faunas with which archaeologists working in calcareous sediments are regularly confronted. These background faunas may have been formed in a series of very complex processes, in which, for instance, the stray molars mentioned above could have been deposited as a result of the activities of hyenas (Scott 1986) or other carnivores.

Haynes (1988) has recently published the results of seven years of fieldwork in which he studied hundreds of noncultural elephant bone sites in southern Africa, from the actual moment of death of the animal or even earlier, right to bone burial or destruction.

> 'My 7-year field studies around African water sources indicate that elephant bone sites are dynamically undergoing several different processes of site-formation and modification, such as recurring death events, or different degrees of scavenging and trampling over time. The sites change, and attributes of the bone assemblages also continue to change as old bones are trampled, weathered, scavenged, gnawed or destroyed and new bones are added. The sediments containing bones may be reworked and redeposited. Thus, a *brief* study of elephant bone assemblages in the field could never provide useful analogues with which to study fossil proboscidean sites. Site-formation is a process, rarely an event. Very few sites form in only a few moments, or are preserved at once by rapid burial. Far more often an extended amount of time is involved in bone site-formation and fossilization.' (Haynes 1988: 155).

As far as the complex formation processes of natural background faunas are concerned the presence of a relatively large number of identified animals -represented by a small number of remains- poses no problems, not even when allowance is made for the possibility that the Unit 4 matrix of the Site G assemblage was formed in a relatively short period.

This interpretation, however, cannot account for the entire Site G record for the following two reasons. First, according to Van Kolfschoten (pers.comm., 1986) the predominance of (very) young individuals is not in keeping with what may be expected in a naturally formed *thanatocoenose*.

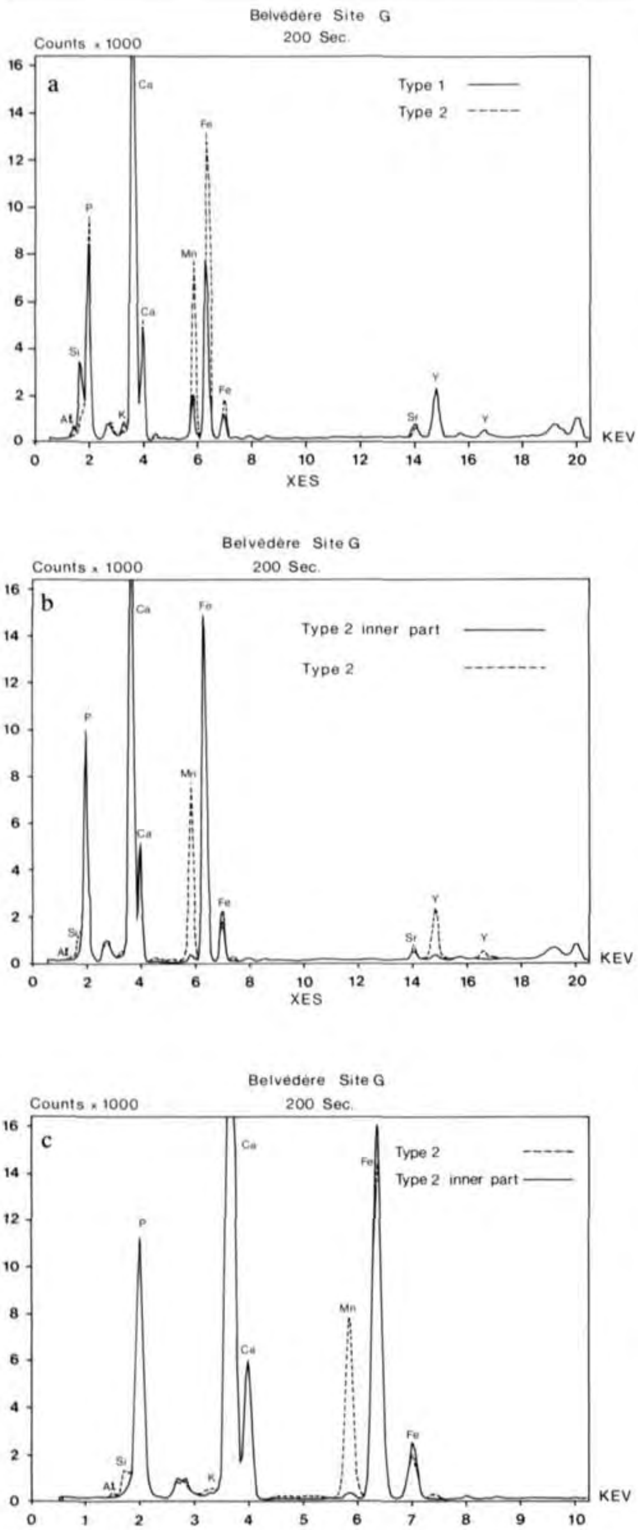


Fig. 80. a, b and c: the X-ray fluorescence analysis results obtained for bone materials from Site G. See the text for an explication.

In order to be able to evaluate Van Kolfschoten's assessment with data on the age composition of fossil assemblages from a comparable environment, I turned to the Lower Pleistocene fauna of Tegelen (province of Limburg, the Netherlands), the type locality of the Tiglian interglacial.

According to Meijer, who studied molluscan remains from Tegelen (Freudenthal/Meijer/Van der Meulen 1976), the fossil assemblages of Tegelen were formed in an environment comparable to the one in which the Unit 4 archaeological assemblages were formed (pers.comm., 1986). It is generally assumed that man was not present in northwestern Europe at that time (however, for different views see: Luttschwager/Von Bemmel 1962, and this volume, chapter 9). Therefore, the Tegelen fauna can be seen as a natural *thanatocoenose*, formed in an environment comparable to that of Site G. A thorough study of the Tegelen macro-fauna from the point of view of age classes would provide us with independent reference data for the interpretation of archaeological sites in a similar environment. Such a major task, however, has to be undertaken by a palaeontologist. For the construction of table 14 I used Bernsen's (1927, 1930-1934) descriptions of the remains of larger mammals from Tegelen. Bernsen studied the age classes, which he roughly divided into very young (with deciduous elements), young adult (permanent dentition, hardly any wear), adult, and old (severely worn dentition).

The value of this table is limited, especially in view of the small number of individuals and the lumping of the species involved. The deer remains show a clear and striking dominance of older individuals. Further analysis of the Tegelen fauna might corroborate this preliminary result, which points to a predominance of older animals in a naturally formed *thanatocoenose* (an interpretation which will be further developed and *falsified* in chapter 9). This initially led to the assumption of hominid involvement in the formation of the faunal assemblage of Site G (Roebroeks *et al.* 1986).

Table 14: The age composition of the remains of larger mammals in the Lower Pleistocene Tiglian fauna as published by Bernsen (1927, 1930-1934).

	very young (I)	young adult (II)	adult (III)	old (IV)
Rhinoceros		1	1	1
Horse	2	1	1	1
Elephant				2
Deer	2	2	5	10
Macaca				1
Pig			1	
Bear			1	
Hyena		1		
Total	4	5	9	15

Secondly, and *more important*, there are archaeological indications of the existence of a 'behavioural' relation between the flint assemblage and parts of the faunal assemblage. According to Van Gijn (this volume, appendix I), flake 47/105-3 was used on meat, while the large *éclat débordant* (46/106-11) displayed a combination of traces of wear suggesting that it had been in contact with the hide of a pachydermatous animal. The presence of this artefact among rhinoceros remains gives us the best possible archaeological evidence for translating spatial association in behavioural terms.

The data presented above indicate that man was one of the agents responsible for the formation of the Site G faunal assemblage. The poor state of preservation of most of the bone fragments does not permit identification of any cut marks present, so we cannot indicate which elements are the result of human activities, and which are part of a natural background fauna. A relationship between the presence of young rhinoceros remains and the presence of artefacts at Site G is one of the few positive links that can be constructed from the Site G material.

The post-cranial rhinoceros remains consist mainly of fragments of upper limb bones. Metapodes and phalanges are absent, whereas phalanges in particular are usually well preserved under similar conditions. According to Van Kolfschoten (pers.comm., 1987), this indicates that the composition of the faunal assemblage is partly the result of selection by a collecting agent which concentrated on the meat-yielding upper limb bones which were transported to Site G, together with the heads. It is not possible to make positive statements on the topic whether the animals involved were actively hunted or scavenged. The fact that we are dealing with young animals may be a weak indication of the hunting hypothesis (see, however, chapter 9 for an alternative interpretation).

The Site G refitting evidence fits neatly into the model developed on the basis of the Site C evidence, which suggests that Site C was part of a larger flint-handling continuum, in which cores and finished flakes were transported from site to site; Site G can be interpreted as an area to which finished flakes and prepared cores were taken and from which some were then removed again, and where flint working as such played a minor role.

With respect to the Site G assemblage, we must mention in our final analysis of Unit IV that distributions like the low-density artefact scatter of Site G have a very small chance of being discovered in sections, as opposed to denser scatters of flint artefacts as at Sites C and F. Indeed, seemingly stray flakes were found all over the Belvédère pit in the Unit IV-C deposits. These may have formed part of low-density scatters like that of Site G. In fact, one of the major reasons for excavating Site G were the faunal remains and the few flakes found in an intensive prospection of the section. The findspot of a stray flake without bone fragments in its neighbourhood certainly received a good deal of attention, but, in the absence of either faunal remains or more flints, this attention was maybe to a factor of 5 to 10 less than that paid to the first Site G finds. It is therefore very probable that the Site G assemblage is only a small part of a larger horizontal continuum, extending at least from Site C to Site G, characterized by a low flint artefact density and many faunal remains, which had only been preserved locally thanks to the calcareous matrix.

4.4 Site B

4.4.1 INTRODUCTION

On July 11, 1981, J.P. de Warrimont found a flake in the silty clays of calcareous Unit 4.5 (2.5 Y 7/3), in an exposure in the (then) northwestern part of the pit. A subsequent study of the exposures by De Warrimont, Groenendijk and the author produced more artefacts in various stratigraphical positions. Furthermore, molluscs, the remains of small mammals and fossils of larger mammals, including a skull of a giant deer, were found. Fragments of a shell of the European pond tortoise (*Emys orbicularis*) were also discovered. In view of the importance of these finds the exposures were mechanically cleaned and recorded over several dozens of metres in August 1981. At the end of August 1981 sediments overlying the find layers were removed to create the Site B cutting, which was excavated from August 24 to September 19, 1981 (fig. 81). The Site B cutting was made in an area which seemed to be devoid of karst features, about 30 m north of the (then future) northern boundary of Site C.

4.4.2 STRATIGRAPHY

Figure 82 shows the stratigraphy of Site B as recorded by the author and H.J. Mücher, who studied the micromorphology of this section (Mücher 1985, Mi 3). The Site B cutting revealed two archaeological levels. The lowermost was situated in the silty clays of Unit 4.5.1, which were generally of a greyish-olive colour (5 Y 5/3) with light yellow (2.5 Y 7/3) patches. The other was situated abt. 35 cm higher up in the profile, in a gravel layer at the base of Unit 5.2. This last level will therefore be discussed in chapter 6. The greyish-olive silty clays containing the artefacts were separated from the underlying gravels (Unit 3) by 50 to 70 cm of light grey laminated very fine sand. On top of the silty clay was a coarser deposit, consisting of a sandy loam. This deposit was capped by a gravel layer, containing stones of up to 15 cm.

Mücher (1985) interpreted the change from clayey to coarser deposits as the consequence of a transition from a relatively calm 'backswamp-like' environment to a more variable environment. Pedologically the clays containing the artefacts are classified as a Cg horizon, probably of a severely truncated gleyic luvisol (Mücher 1985).

Fig. 81. Site B: the first trial squares, September 1981

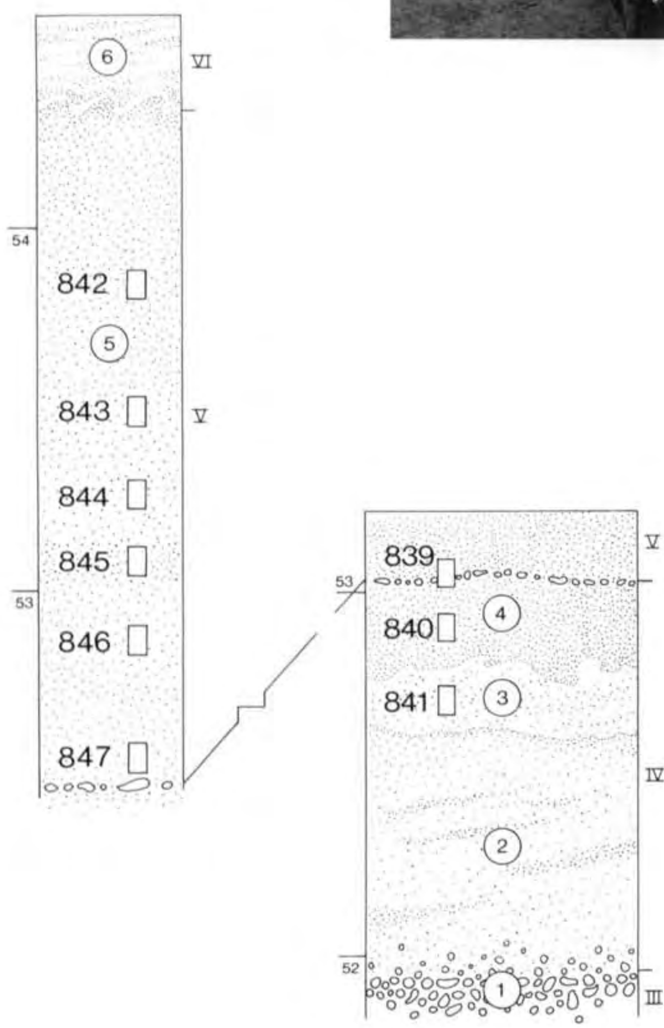


Fig. 82. Maastricht-Belvédère: Site B section sampled for micromorphological analysis (see: Mücher 1985).

1 the top of gravel unit 3
2 light grey (2.5 Y 7/2) laminated loamy very fine sand with light yellowish brown (2.5 Y 6/4) thin clay laminae (less than 5 mm thick).
3 olive (5 Y 5/3) silty clay with a massive structure, calcareous in parts, containing reddish yellow (5 Y 6/8) iron mottles. It shows an abrupt and wavy boundary with the horizon below.
4 olive (5 Y 5/3) slightly banded sandy loam and loam with reddish yellow (5 YR 6/8) iron mottles. It shows an abrupt and wavy boundary with the horizon below.
5 reddish yellow (7.5 YR 6/6) homogenous silt loam with a massive structure. It shows an abrupt and smooth boundary with the horizon below. (At a depth of 53.00-53.10 m +NAP was a horizontal band of brown (10 YR 5/3) silt loam with a massive structure. The layer shows abrupt and smooth boundary with the horizons above and below.)
6 pale brown (10 YR 6/3) laminated silt loam showing an abrupt wavy transition to the horizon below.

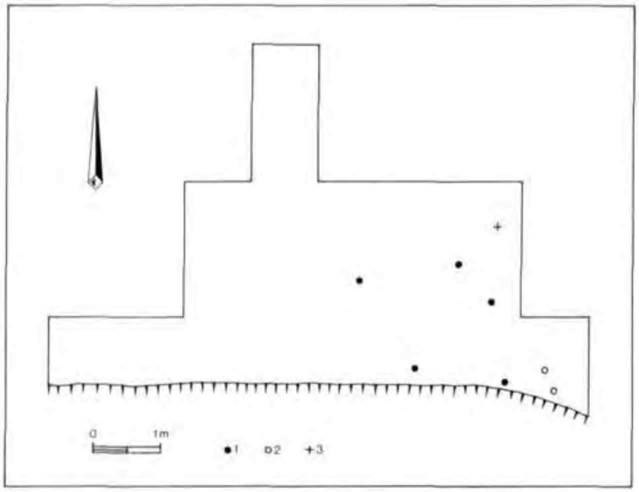


Fig. 83. Site B: Unit IV level, horizontal distribution of finds: 1. flint artefact, 2. bone fragment, 3. charcoal. Scale in m.

4.4.3 THE FINDS

In total, an area of 20 m^2 was excavated in the Unit 4.5.1 silty clays. This area produced only five flint artefacts and a few bone- and tooth-fragments. The horizontal distribution of these finds is shown in figure 83. Flake Bv 144 (fig. 84-2) was struck from a prepared core. A small flake from Site B (Bv 78) could be refitted to the the find from the first section (Bv 62). The estimated horizontal distance between these two elements was 1 to 2 m. The fact that these flakes could be fitted together indicates that some knapping had taken place at the site.

The Unit 4.5.1 sediments were calcareous in the eastern part of the cutting. Besides molluscs and remains of small mammal, tooth-fragments of red deer (*Cervus elaphus*) were found. Immediately east of the Site B cutting more red deer elements were found over a width of 1 to 2 metres during the sampling of the section for palaeontological purposes. In total, Van Kolfschoten identified five elements from Site B as the remains of red deer (1985). According to Van Kolfschoten the state of wear of a premolar (DP4) and a molar (M1) shows that we are dealing with a red deer which died when it was about half a year old, i.e. at the end of autumn or the beginning of winter. A few more fresh flakes were found in association with these mammal remains in this section, e.g. the flakes 1, 3 and 4 shown in figure 84.

4.4.4 INTERPRETATION

The finely grained character of the silty clays -indicating that the sediments were formed in a calm sedimentary environment- suggests that there might be a relation between the human activities manifested by the flints and the presence of remains of a young red deer. We did not succeed in fitting flakes from the Site B area to flakes from Site C, which would have provided us with a strong argument for inferring an interrelationship between these two sites. The Site B cutting opened only a small area in the Unit 4 sediments, too small to allow a detailed interpretation of the scarce data. The few artefacts recovered were found in the southeastern part of the small cutting, which formed the border zone of the concentration of larger mammal bones found in the section immediately east of Site B. We suggest an interpretation along the same line as that developed for the Site G data.

In retrospect it would have been wise to have extended the Site B cutting in an easterly direction but during the excavation of Site B Site C was discovered and the excavation of this site was given priority. Site B was covered with several metres of backfill in 1982, which will have to be removed by future researchers planning to restudy the Unit 4 sediments there (Gonggrijp 1982).

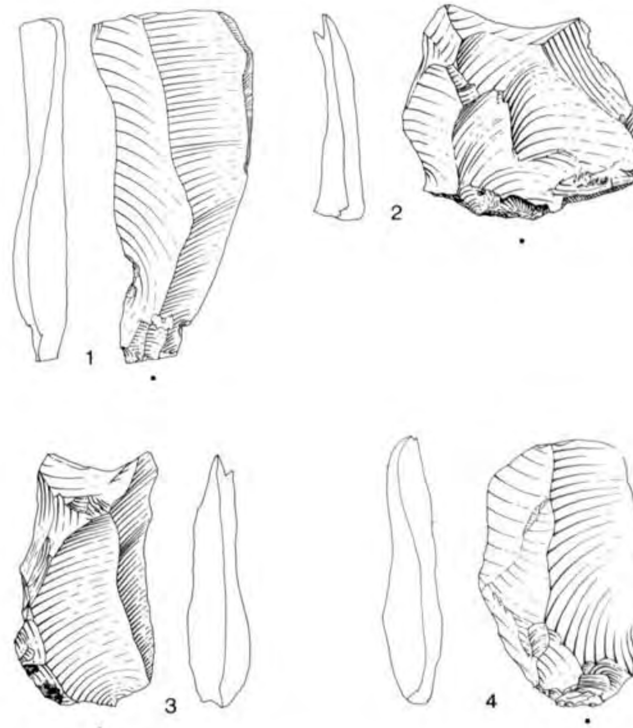


Fig. 84. Four flakes, found in Unit IV-C-I deposits in the W-E section in which Site B was situated (1, 3 and 4) and at Site B (2), scale 2:3.

note

[1] After this manuscript had been completed, Dr C. Arps suggested that the presence of the haematite concentrations *might* also have been caused by the heating of iron-hydroxides in the sediment. This is a very interesting suggestion, as the distribution of the haematite dots coincides with that of the burnt flints (see figures 40 and 44).

5 Finds and sites discovered in Unit IV-C-III

5.1. Introduction

Five Unit IV sites (A, D, F, H and K) were discovered in the Belvédère pit, which are younger than the sites discussed in chapter 4. The sites all have a Unit 5.1 matrix, and their sections display a stratigraphical sequence different from that of the Unit IV-C-I sites. However, as already mentioned in chapter 2, the correlation of their Unit 5.1 matrix with lithostratigraphical units presents a problem.

Whether the sites reported on here indeed belong to lithostratigraphical Unit IV-C-III or whether they should be placed at the base of Unit V-A or in a lower unit is still not clear at the moment. Further field studies may enable us to differentiate better between these two lithostratigraphical units. For this volume I have chosen to place these sites in the top part of lithostratigraphical Unit IV-C, that is in Unit IV-C-III (fig. 20).

It is to be stressed that this a technical solution and that more complex scenarios are theoretically possible, considering the fact that the 'sites' have been correlated using their embedding matrix as the guideline. Such a procedure obviously poses many problems, one of them being that the artefacts are generally distributed over vertical distances of 15 to 30 cm, and sometimes more, and that it is in most cases impossible to establish the original surface at the time of the deposition of the archaeological assemblages. We should in fact use the hiatus in sedimentation which enabled hominid occupation as the marker for our correlations, and not the sediments in which the archaeological remains are embedded.

So far the 'upper-level sites' have produced no significant faunal remains because, on the whole, their matrix is decalcified; the assemblages were found higher in the pedological profile than the Unit IV-C lower-level sites. We therefore have little evidence as to whether the sites were formed in the same warm-temperate phase as the lower-level sites discussed in the previous chapter. In view of the often very gradual transition from calcareous Unit IV-C sediments to the higher decalcified Unit 5.1 sediments, the author has chosen for such an interpretation, awaiting the results of further fieldwork, which will focus on this problem (chapter 8).

Finally, it has already been pointed out several times that this volume deals with the archaeological results of the 1980-1985 fieldwork; nevertheless, a short note on an important site excavated in the period 1986-1987, Site K, will be discussed here too.

In chapter 2 we have already mentioned the problems involved in differentiating between Unit IV and Unit V. In Van Kolfschoten and Roebroeks (eds., 1985) a number of archaeological sites were arranged in a stratigraphical order which turned out to be incorrect in subsequent fieldwork. In this chapter several sites will be seen to have moved to different (sub)units as a result of the rejection of earlier interpretations.

5.2 Site F

5.2.1 INTRODUCTION

On June 27, 1983, while cleaning a section for a visit of the Belvédère pit by the British Prehistoric Society, the author discovered a flake in pre-Weichselian deposits in the south-eastern part of the pit. Subsequent exploration of the section with K. Groenendijk yielded a further 30 artefacts, the majority consisting of fine debris. In view of the presence of burnt flints in this sample two TL dosimeters (326 and 328) were placed in the section in July 1983.

The next summer the site was excavated by a team of about 14 people, from June 4th to July 27th, 1984. In this period an area of 42 m^2 was excavated. The excavation was done in the same way as at Site C: all finds macroscopically identifiable in the field were recorded three-dimensionally, individually numbered and stored in small plastic bags.

In 1983-1984 the section in which the site had been discovered formed the physical border of the pit. The position of the site, halfway down the steep wall of the approximately 15-m deep pit, made mechanical removal of the layers overlying the find level a difficult and hazardous enterprise, as it was virtually impossible to reach the site with heavy equipment. The generous cooperation of Mr F. Blom and the financial support of the municipality of Maastricht (Archaeological Survey) helped to solve this problem.

5.2.2 STRATIGRAPHY

As can be seen in figure 85, the site was situated in the top part of the fill of a channel cut into Unit 3 gravels. At its base the fill consists of coarse sands with loam lenses. The sediments become finer in upward direction, developing

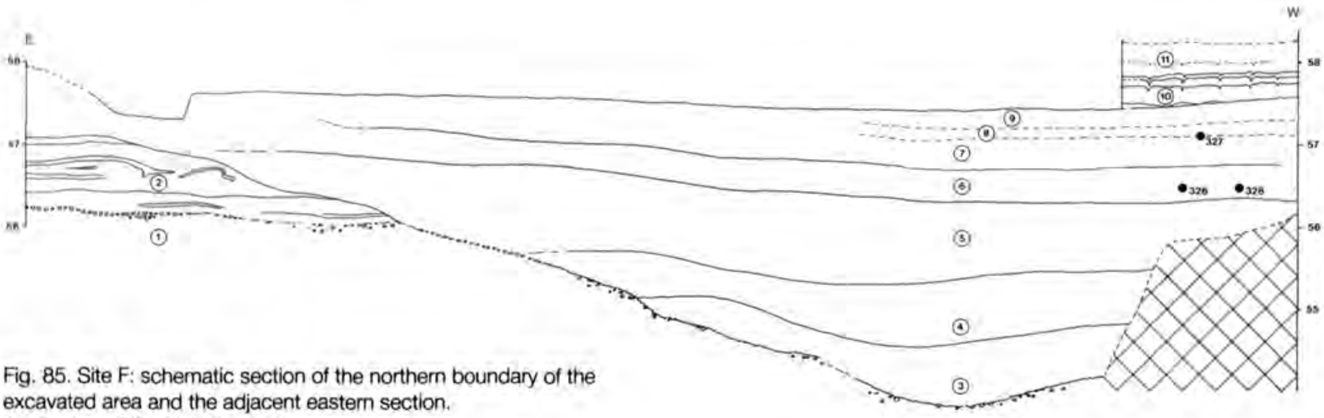


Fig. 85. Site F: schematic section of the northern boundary of the excavated area and the adjacent eastern section.

1 the top of the Unit 3 gravels
2 laminated sands, 10 YR 5/4 (Unit 4.7/III-B)
3 sandy loam, 10 YR 6/3
4 sands, 2.5 Y 7/3, laminated with 10 YR 5/6 bands (Unit 4.6/IV-A)
5 sandy silt loam, 10 YR 6/6-5/6 (Unit 5.1/IV-B)
6 silt loam, 10 YR 4/6 with greyish silt mottles, containing artefacts (Unit 5.1)
7 silt loam, 10 YR 5/6 (Unit 5.2/V-B)
8 silt loam, 10 YR 5/6-6/6, containing rust and Mn mottles (Unit 5.2/V-B)
9 *silt loam, 7.5 YR 5/6 (Unit 5.2/V-B))*
10 silt loam, 10 YR 6/3, laminated, calcareous (Unit 6.5/VI-D)
11 Nagelbeek Horizon (VI-E)

The layers 5 to 9 are shown in greater detail in figure 86. The numbers 326-328 refer to the positions of the TL dosimeters.

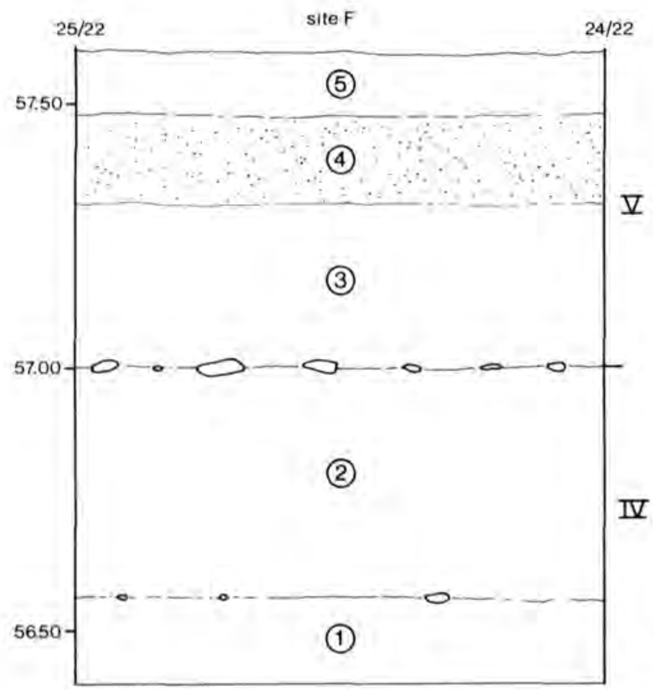


Fig. 86. Maastricht-Belvédère: Site F section 24/22 – 25/22

1 silt loam (10 YR 6/6-5/6) massive, friable with few very fine pores and very few silt mottles (10 YR 6/4), non-calcareous
2 silt loam (10 YR 4/6) massive, friable with many very fine pores, common greyish (10 YR 6/4) silt mottles, non-calcareous, containing excrements (1-2 mm) and artefacts. Clear and smooth *boundary with horizon below. At its base is a gravel layer* (TL capsules 326, 328; thin section O.452)
3 silt loam (10 YR 5/6) massive, friable with few very fine pores, few silt mottles (10 YR 6/4), non-calcareous. Abrupt and smooth boundary with horizon below. At its base is a gravel layer containing larger slates (thin section O.440)
4 silt loam (10 YR 5/6-6/6), friable to firm with few very fine pores, containing rust and manganese mottles and a few calcite concentrations. Platy structure, non-calcareous, showing a gradual and smooth boundary with the horizon below (TL capsule 327, thin section O.439)
5 silt loam (7.5 YR 5/6), very friable with few very fine pores, non-calcareous (thin section O.438), showing an abrupt and smooth boundary with the horizon below

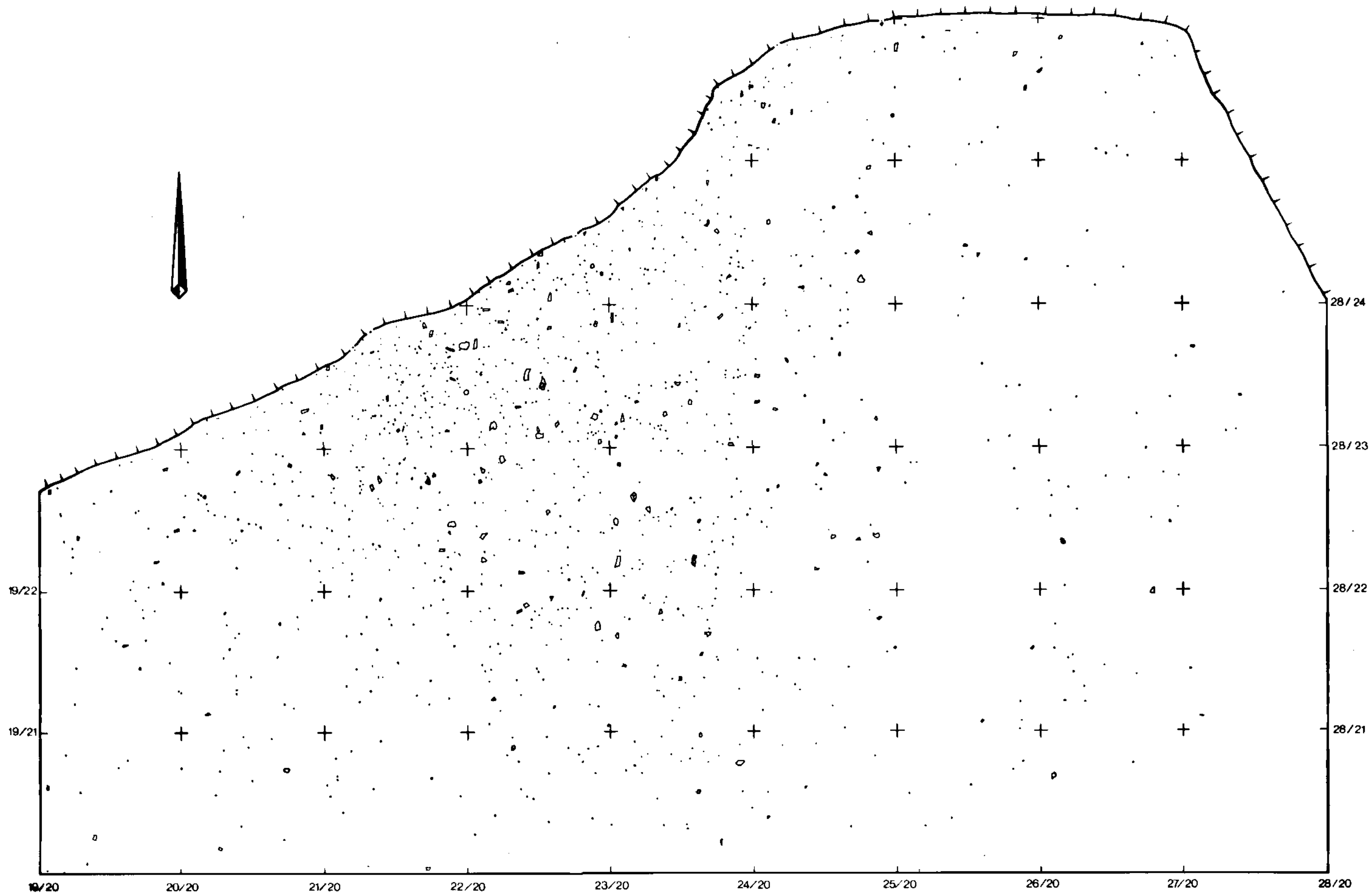


Fig. 87. Site F: horizontal distribution of the flint artefacts. Grid in square metres.

into a silt loam in the top metre of the fill. Figure 86 gives a survey of this top metre in excavation square 24/22, indicating the stratigraphical position of the TL dosimeters and the thin section numbers.

In general terms the silt loam with greyish specks forming the matrix of Site F can be classified as a Unit 5.1 sediment of the lithostratigraphical Unit IV-C-III. The presence of a large number of biopores in the sediment and of 1-2 mm large excrements, probably of *Lumbricus*, is worth mentioning. The gravel layer capping the Site F matrix contained slate plates with dimensions of up to 0.5 m^2.

From the micromorphological analysis by H.J. Mücher (pers.comm., 1987) of the thin sections indicated in figure 86 we know that the matrix containing the archaeological assemblage consisted of ill-sorted silt and fine sand with greyish-brown clay, possibly deposited by running water (rill wash, afterflow?). Furthermore, Mücher (pers.comm., 1987) found evidence of two phases of clay illuviation in the section illustrated in figure 86. Thin sections O.452 and O.440 revealed an earlier period of clay illuvation, while a second pedogenesis, resulting in the formation of a luvisol, seems to have taken place after the formation of the sediments sampled in thin sections O.438 and O.439.

In the field a 20-cm thick band of silt loam (10 YR 5/6-6/6) with a platy structure, containing specks of rust and manganese and some small calcite concretions in the upper part of the Saalian sediments at site F (layer 8 in figure 85, layer 4 in figure 86) bore a striking resemblance to features described by Bibus (1974) and others as *Nassboden* in 'Riss' loess deposits in West Germany: '...graue bis fahlrötliche Färbung, sowie eine starke Anreicherung von Mollusken und Kalkkonkretionen...' (Bibus 1974: 168). Bibus interprets these *Nassböden* as having been formed under a sparse vegetation cover above the permafrost. We sampled this horizon at Site F for indications of soil formation at this level, but no such indications were found in the thin section (Mücher, pers.comm., 1987).

5.2.3. THE FINDS

A total of 1215 flint artefacts were found at Site F, in an excavated area of 42 m². Figure 87 gives the horizontal distribution of the artefacts. Figure 88 and table 15 show the size distribution of the flints, based on their maximum dimensions. As at Site C, the greater part of the material consists of fine debris. The total weight of the Site F assemblage is 2169 g.

The dark blue finely grained flint material from Site F had a very fresh appearance. Most of the pieces displayed only a light soil-sheen, while only a few pieces had a blueish-white patina. The flakes had been struck in hard percussion, as attested by the abundance of well-pronounced bulbs and flake scars; no indications of a prepared-core technique were found, while facetted butts were almost completely absent (Index Facettage 0.1).

The flints recorded in the excavated area had probably been struck from at least two different nodules. The appearance of the cortex suggests that the original flint nodules had been transported a short distance by water and were therefore very probably collected from gravels of the river Maas.

Figure 89-8 shows the only 'tool' from this site, a small *percoir*-like implement. Only one of the flakes shows macroscopical signs of use (flake 23/20-21) and displays a series of typical '*half moon breakages*' (cf. Keeley 1980: 25). Only one small core could be identified in the Site F assemblage

Table 15: Some quantitative data on the Site F assemblage.

	max.dimensions in cm	n	% of total
	0 – 1	468	38.6
	1 – 2	438	36.1
	2 – 3	153	12.7
	3 – 4	70	5.7
	4 – 5	42	3.3
	5 – 6	25	2.1
	6 – 7	12	1.0
	7 – 8	4	0.3
	8 – 9	2	0.2
	9 – 10	1	0.1
	0 –	–	–
total		1215	100.1
burnt artefacts		15	1.3
pieces with cortex		132	11.0
tools		1	0.1
cores		1	0.1

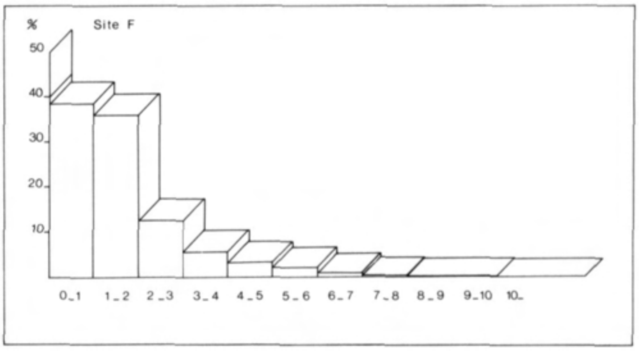


Fig. 88. Site F: size distribution of the flint assemblage, based on maximum dimensions, in cm.

(21/22-67, see figs. 89-7 and 95). A preliminary (high-power magnification) use-wear analysis of ten randomly selected larger flakes indicates that, on the whole, the soil-sheen of the flakes was so weakly developed that it would not have obliterated traces of use on hard material; if the flakes had indeed been used, it must have been to cut boneless meat or to work on fresh hide, because no traces of use were visible (A. van Gijn, pers.comm., 1985).

A comparison of the size distribution of the Site F flint assemblage with that of the flints found at Site C shows that the percentage of flakes smaller than 1 cm is slightly higher at Site C than at Site F (44.6% vs. 38.6%). In the evaluation of this difference the excavation technique, being the same at both sites, can be left out of consideration. The horizontal distribution of the Site F material (see below) does not point to sorting processes, pieces smaller than 1 cm occurring randomly between larger ones. The difference in size distribution may therefore best be explained in technological terms, Site F being a place where possibly only crude primary flaking took place, in contrast to Site C. The almost complete absence of facetted butts at Site F as compared to Site C (Index Facettage of Site F 0.1 vs. Index Facettage of Site C 50.4) clearly illustrates this point.

The flint material included 15 mostly small burnt flints which, together with a few tiny charcoal particles, indicated the presence of fire at the site. A larger burnt artefact (F 22/22-44) was used for TL dating (K 11 in: Huxtable/Aitken 1985; see section 8.3.2.1).

In order to obtain information on technological aspects and natural site-formation processes, the Site F assemblage was subjected to a short refitting programme in 1984, which was less intensive than that to which the Site C material was subjected. Most of the refitting work was done by Mr P. Hennekens, with the assistance of the author. In total, 156 artefacts were refitted, i.e. 66.7% of the total weight of the Site F assemblage. Figure 92 gives the horizontal distribution of the refitted elements while the vertical distribution of some conjoining sets is shown in figure 97. These figures

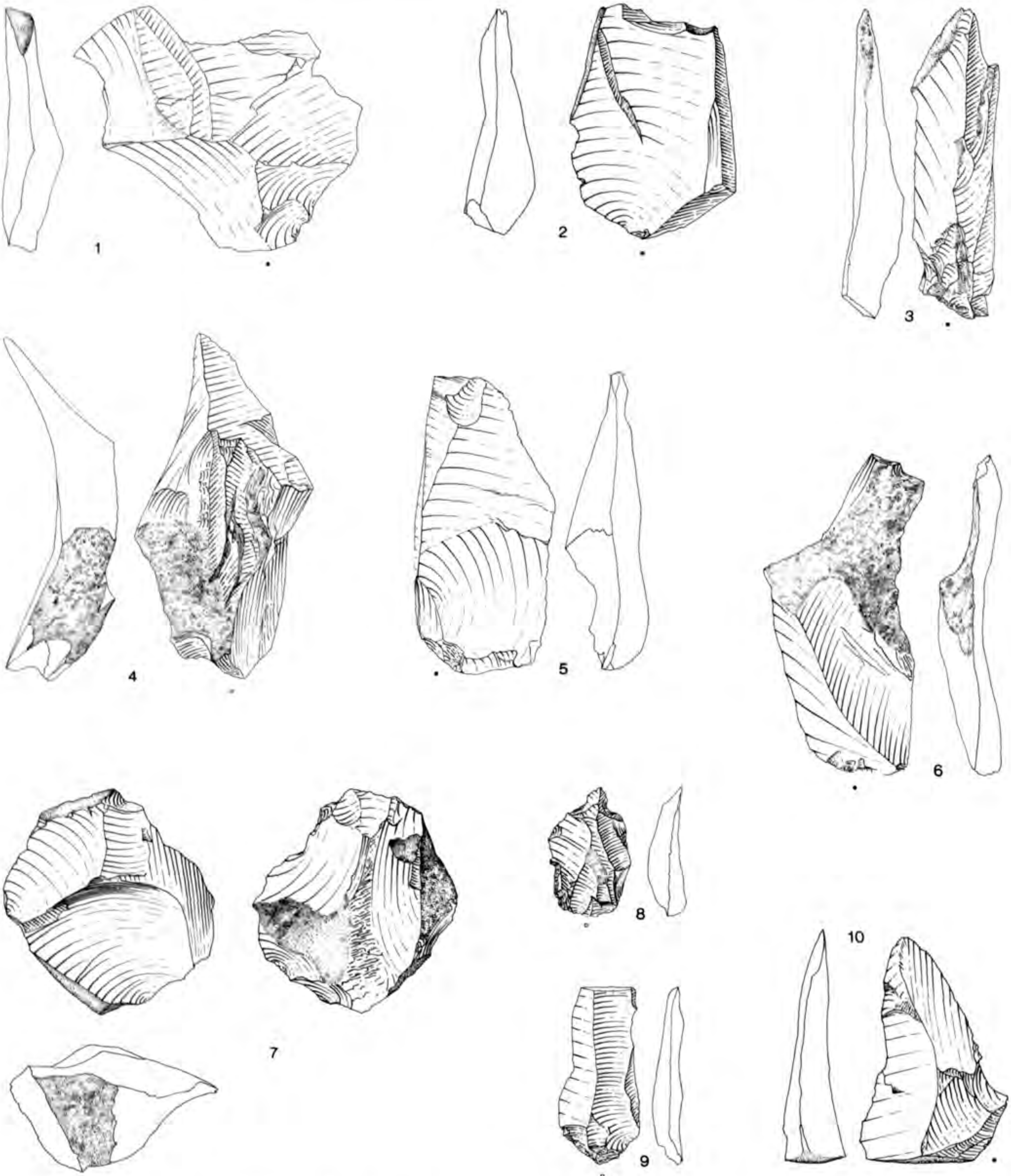


Fig. 89. Site F: flint artefacts, 1-6, 9-10 flakes, 7 core, 8 *percoir*-like implement, scale 2:3.

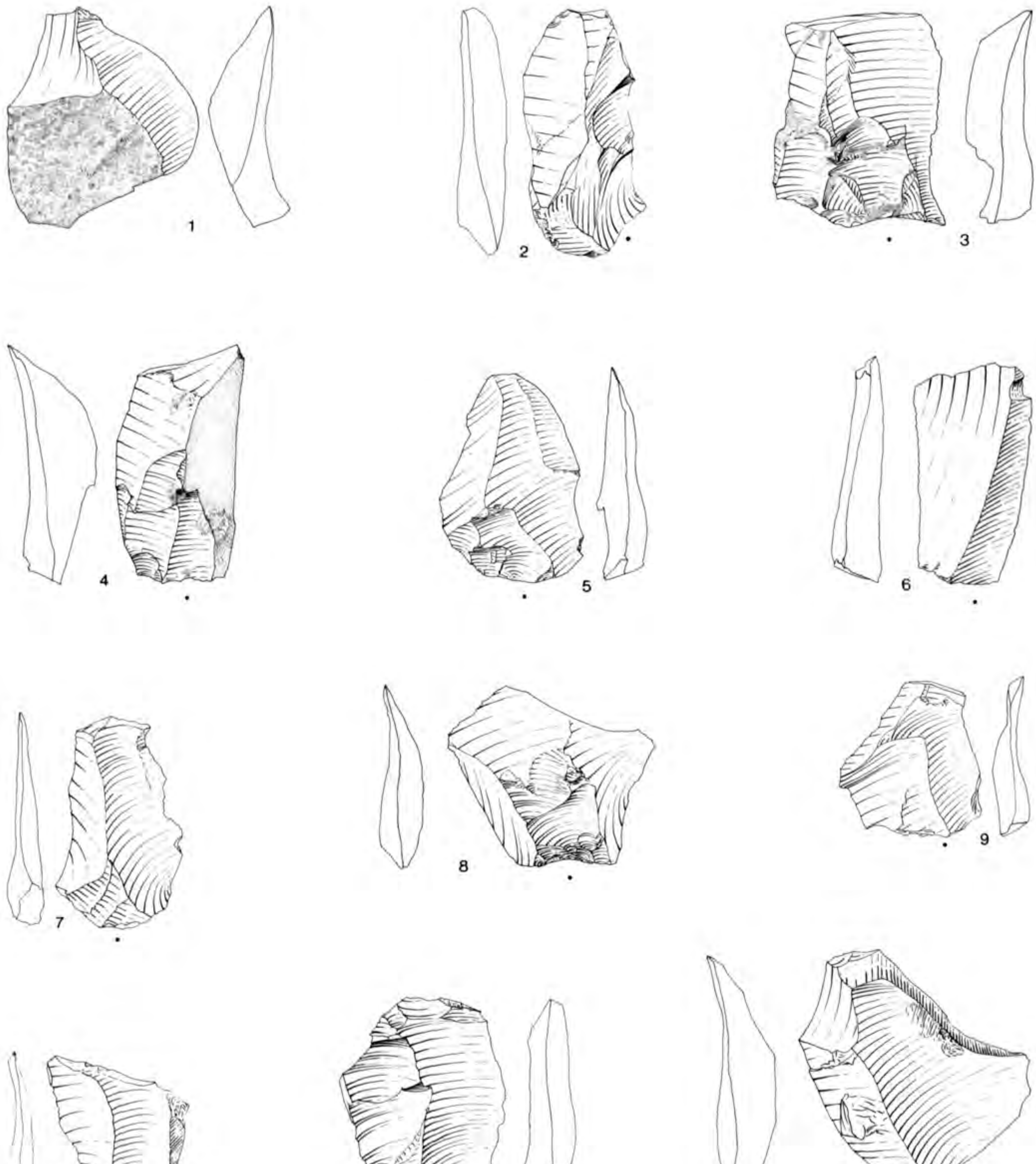


Fig. 90. Site F: 1-12 flakes, scale 2:3.

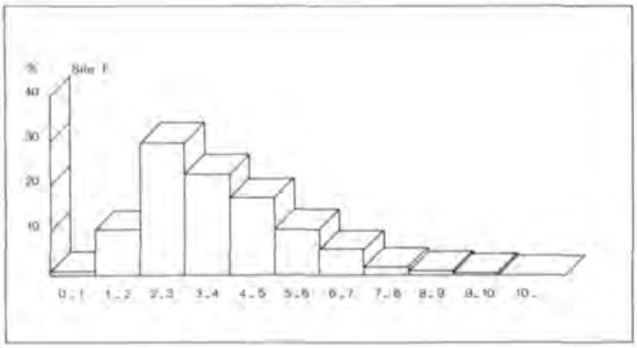


Fig. 91. Site F: size distribution of the refitted artefacts, based on maximum dimensions, in cm.

have been drawn according to model C in figure 45, in which all contact surfaces are linked.

The Site F conjoining work was done in the 'pre-Cziesla' (1986) period, as discussed for Site C in section 4.2.4, and therefore no systematic attention was paid to the different types of refits. We have tried to make up for this drawback by presenting the horizontal distribution of a number of conjoining groups in the way proposed by Cziesla (1986), as also discussed in section 4.2.4 (see figs. 93, 94 and 96).

In the course of the conjoining studies it became clear that the original nodules reduced at Site F had contained a number of internal cleavage planes, which had forced the flint knapper(s) to adapt the knapping strategy in an 'ad hoc' way, responding to the opportunities provided and imposed by these internal cleavages.

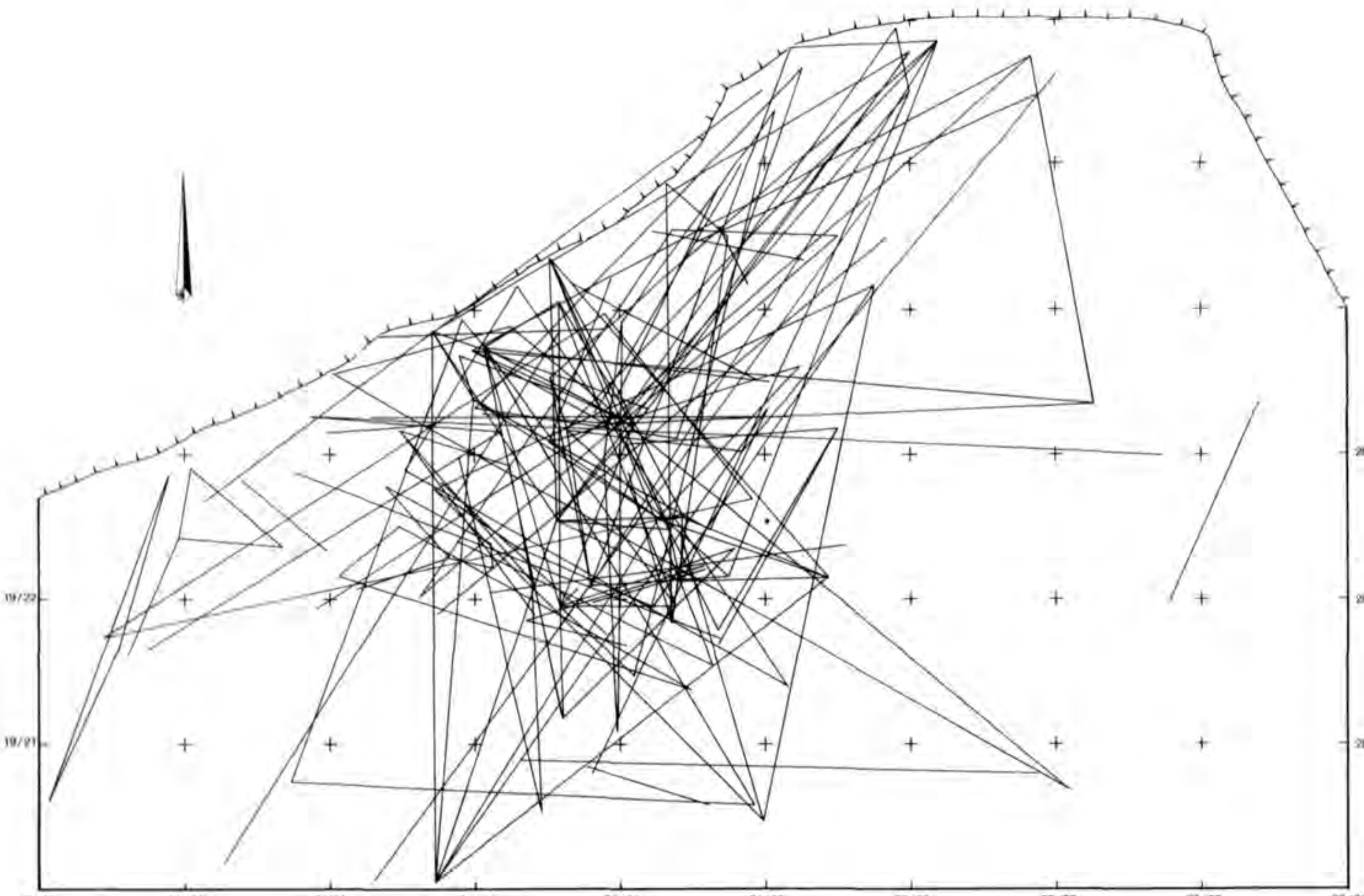


Fig. 92. Site F: horizontal distribution of conjoining elements, each line linking the contact surfaces of two refitted artefacts. Grid in square metres. Graphic representation according to figure 45, model C.

Figure 95 shows the small core 21/22-67, with five flakes conjoined to it, including a large decortication flake that had been struck before the flake from which the core itself was made. The horizontal and vertical distribution of the elements of this group is shown in figure 96.

The horizontal distribution of another five small groups of ventral/dorsal conjoining elements is shown in figure 94.

5.2.4 NATURAL SITE-FORMATION PROCESSES

As stated above, the Site F cultural remains were embedded in a silt/fine sand matrix, indicative of a low-energy deposition of the sediment. In such a sedimentary environment cultural remains may be preserved in a primary archaeolog-

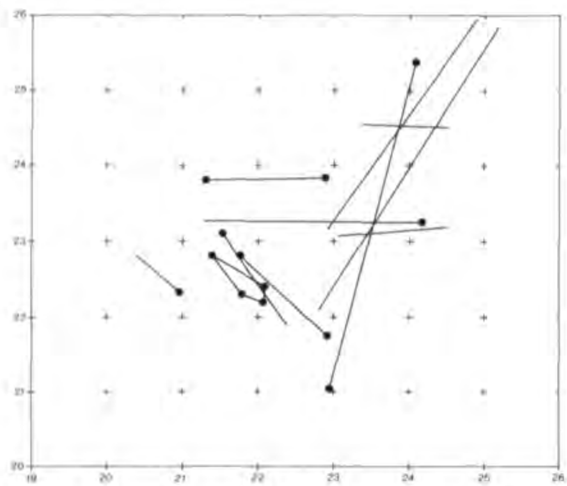


Fig. 93. Site F: horizontal distribution of conjoined flake fragments. The dots indicate fragments with maximum dimensions of more than 2 cm. Grid in square metres.

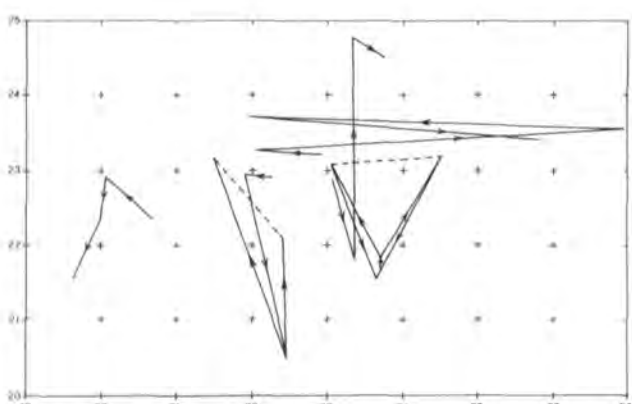


Fig. 94. Site F: horizontal distribution of some conjoining groups of dorsal/ventral refits. Grid in square metres.

Fig. 95. Site F: Core 21/22-67, with conjoined flakes, scale 2:3 (see figures 89-7 and 96).

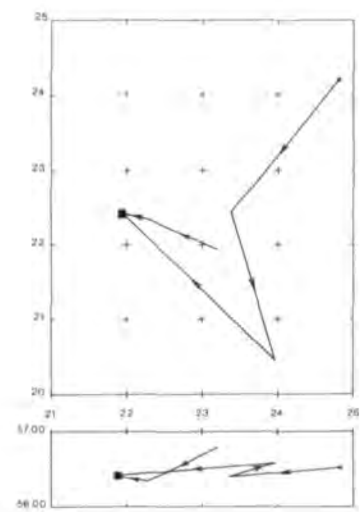


Fig. 96. Site F: horizontal and vertical distribution of flakes conjoined to core 21/22-67 (see figures 89-7 and 95). Grid in square metres.

ical context, and indeed the results of the conjoining studies seem to indicate that the spatial arrangement of the Site F finds can first of all be related to hominid activities, rather than to natural depositional processes.

But again, as discussed for Site C, the degree to which the original flint scatters may have been disturbed is difficult to assess. The horizontal distribution of conjoined fragments (fig. 93) is comparable to the pattern of RMU 5 at Site C, where conjoining elements were distributed over an area comparable in size to that of Site F. Like that of Site C, the Site F scatter is larger than the flint scatters arrived at in experimental studies (Newcomer/De Sieveking 1980), which indicates that some disturbance took place.

After the burial of the assemblage the matrix was affected by biological activity, as attested by the presence of rainworm granules. This may offer an explanation for the vertical dispersal of the artefacts, which is visualized in figure 97. It can be seen there that smaller flakes tend to display a wider vertical dispersion than larger ones, a phenomenon also observed at Site C.

5.2.5 INTERPRETATION

In the interpretation of the Site F data allowance must be made for the fact that at the time of the discovery of the site an unknown extent of it had already been destroyed by quarrying activities.

Nevertheless, it is clear that the excavated area has yielded an assemblage that does show some striking differences when compared with the Site C material. We have already mentioned the virtual absence of facetted butts, which were very common at Site C. Typical Levallois flakes were absent at Site F but present at Site C. In fact, the Site F assemblage does not show any indications of the preformation of flakes. The fact that some of the raw material had internal cleavages cannot be the only cause of these overall differences.

The absence of several larger pieces in groups of conjoinable flakes, the virtual absence of pieces with any signs of use retouch and the absence of cores (leaving out of consideration the small core made from a flake) may indicate that at Site F (one or) two nodules were reduced to form some

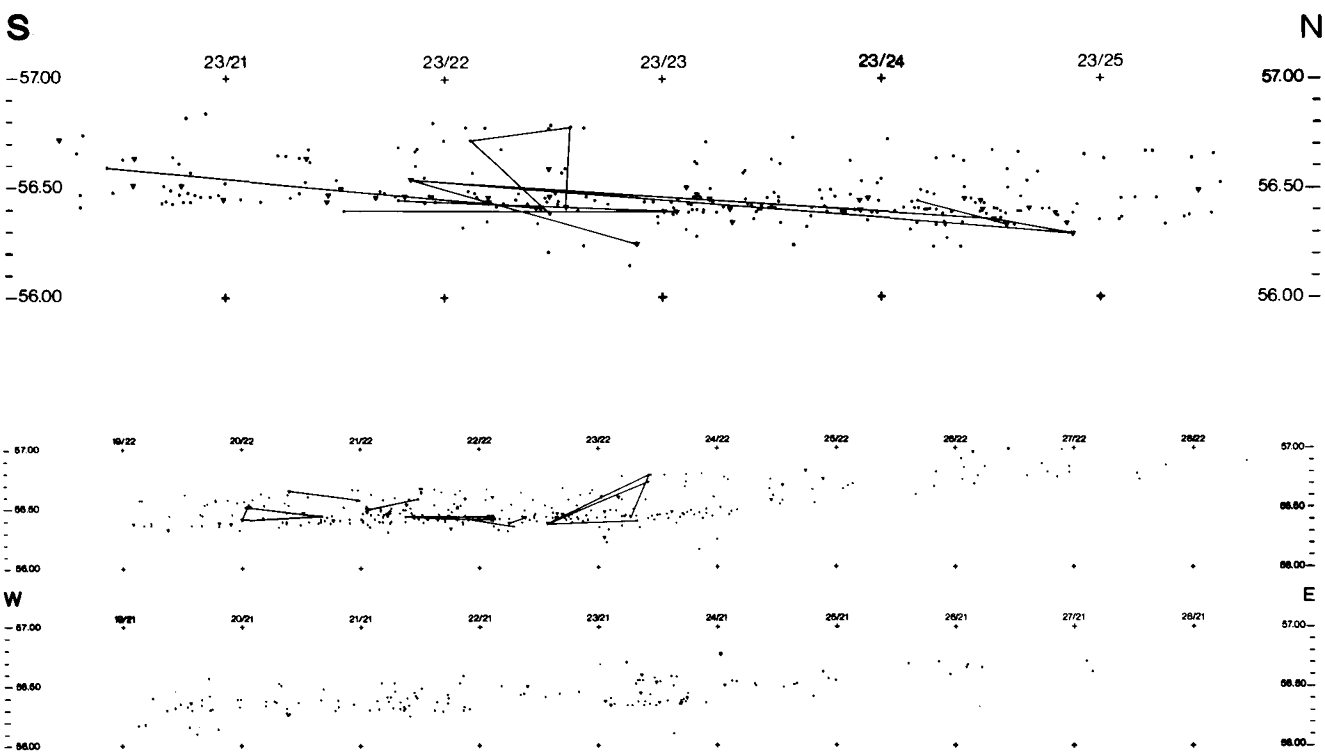


Fig. 97. Site F: vertical distribution of conjoined elements. The dots indicate artefacts with maximum dimensions of less than 3 cm, while the triangles show the position of larger artefacts.

suitable larger blanks and one or more cores, intended to be used elsewhere.

5.3 Site A

5.3.1 INTRODUCTION

The intensive investigation of the pit sections, initiated after the first find in September 1980, led to the discovery of a small concentration of flint artefacts in Saalian sediments (Site A). Site A was discovered by J.P. de Warrimont in March 1981 and subsequently investigated by a small crew of five persons under the supervision of Prof Dr P.J.R. Modderman (Leiden). The primary goal of this limited investigation was to determine the exact stratigraphical positions of the flint artefacts. The fieldwork was carried out from March 9 to March 20, 1981. After the fieldwork had been completed, the remaining parts of the site were destroyed by quarrying activities. A preliminary report on the site was published by Modderman and Roebroeks (1981).

5.3.2 STRATIGRAPHY

Figure 98 gives a survey of the Site A section, which has already been presented in detail by Mücher (1985, Mi-2). The data obtained in the 1985-1986 fieldwork have, however, led to a reevaluation of the classification of the Site A stratigraphy (cf. chapter 2).

The sediment in which the finds were embedded is now classified as the top part of Unit IV, more precisely Unit IV-C-III, whereas the earlier interpretation was that it was the base of Unit 5.2, i.e. Unit V-B in the present terminology (see: Mücher 1985, figure 2).

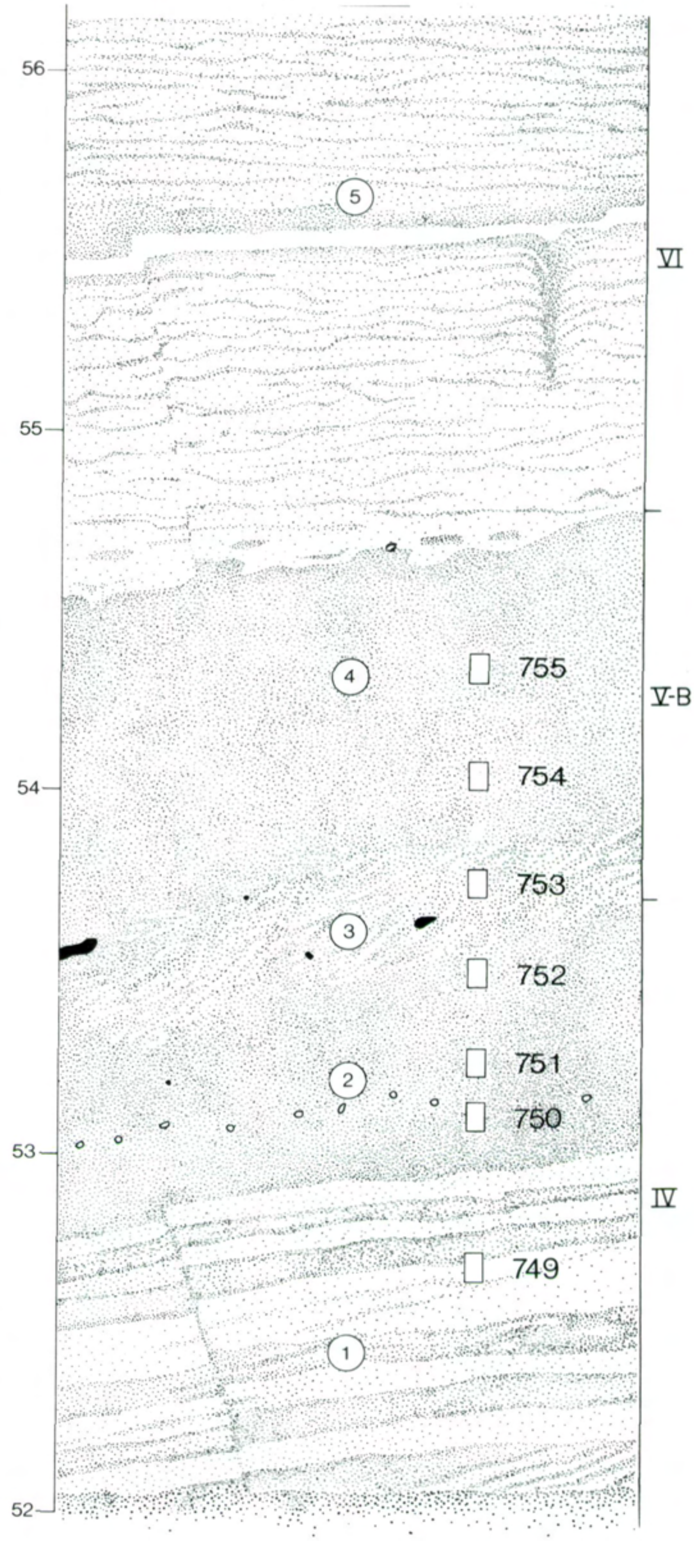


Fig. 98. Site A section:
1 light yellowish brown (2.5 Y 6/4) and light brownish grey (10 YR 6/2) loamy fine sand and fine sand with a lamination subparallel to the surface.
2 yellowish brown (10 YR 5/6) loamy fine sand turning into very fine sandy loam and loam in upward direction. Here and there a fine gravel layer subparallel to the surface. An abrupt and smooth boundary with the horizon below.
3 yellowish brown (10 YR 5/6) loam with many very pale brown (10 YR 7/4) mottles containing very fine gravel and artefacts. A clear and smooth boundary with the horizon below.
4 reddish yellow (7.5 YR 6/6) homogeneous silt loam with a massive structure, showing a clear and smooth boundary with the horizon below.
5 pale brown (10 YR 6/3) laminated silt loam showing a grey horizontal layer and a few frost cracks. An abrupt and wavy boundary with the horizon below.
The numbers 749-755 show the positions of the thin sections (Mücher 1985: profile Mi2).

Fig. 99. The Site A section as illustrated in figure 98, prior to thin-section sampling.

5.3.3 THE FINDS AND THEIR INTERPRETATION

The fieldwork done in March 1981 was essentially directed at the establishment of the geological context of the first artefacts, rather than the excavation of a larger area. Attention was therefore first paid to the cleaning and drawing of sections, during which the positions of artefacts encountered were recorded. In a small trial trench of abt. 5 m^2 34 artefacts were recorded (see fig. 100). In total, 78 artefacts were found in the fieldwork at Site A. Figure 101 gives their size distribution, indicating that the majority are small flakes. A simple, non-prepared core with one striking platform (fig. 102-3) was found, while five blade-like flakes were collected which must have been struck from a larger prepared core (fig. 102). In total, 15 artefacts could be conjoined, a combination of four artefacts forming the maximum composition. Not one flake shows signs of intentional or use retouch.

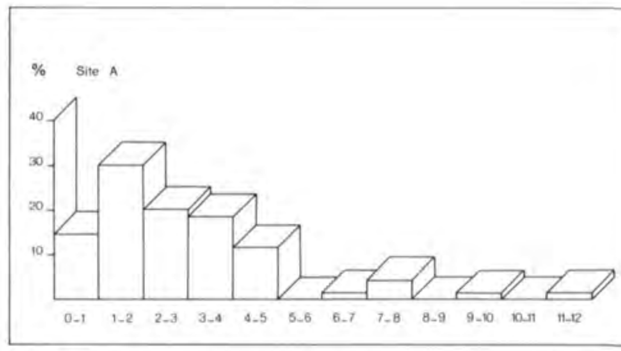


Fig. 101. Size distribution of the Site A assemblage, based on maximum dimensions, in cm.

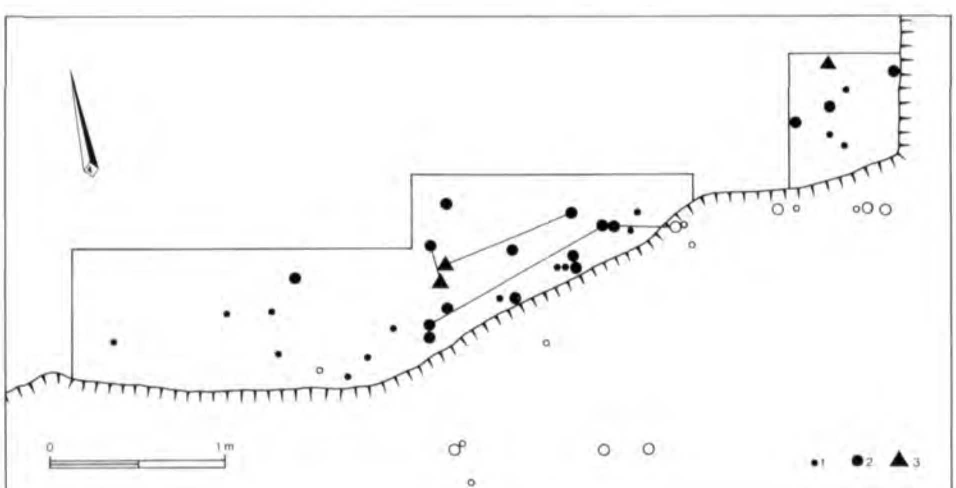


Fig. 100. Site A: horizontal distribution of three-dimensionally recorded flint artefacts (the open symbols stand for section finds), 1. artefact <2 cm, 2. artefact measuring 2-5 cm, 3. artefact of ⩾5 cm.

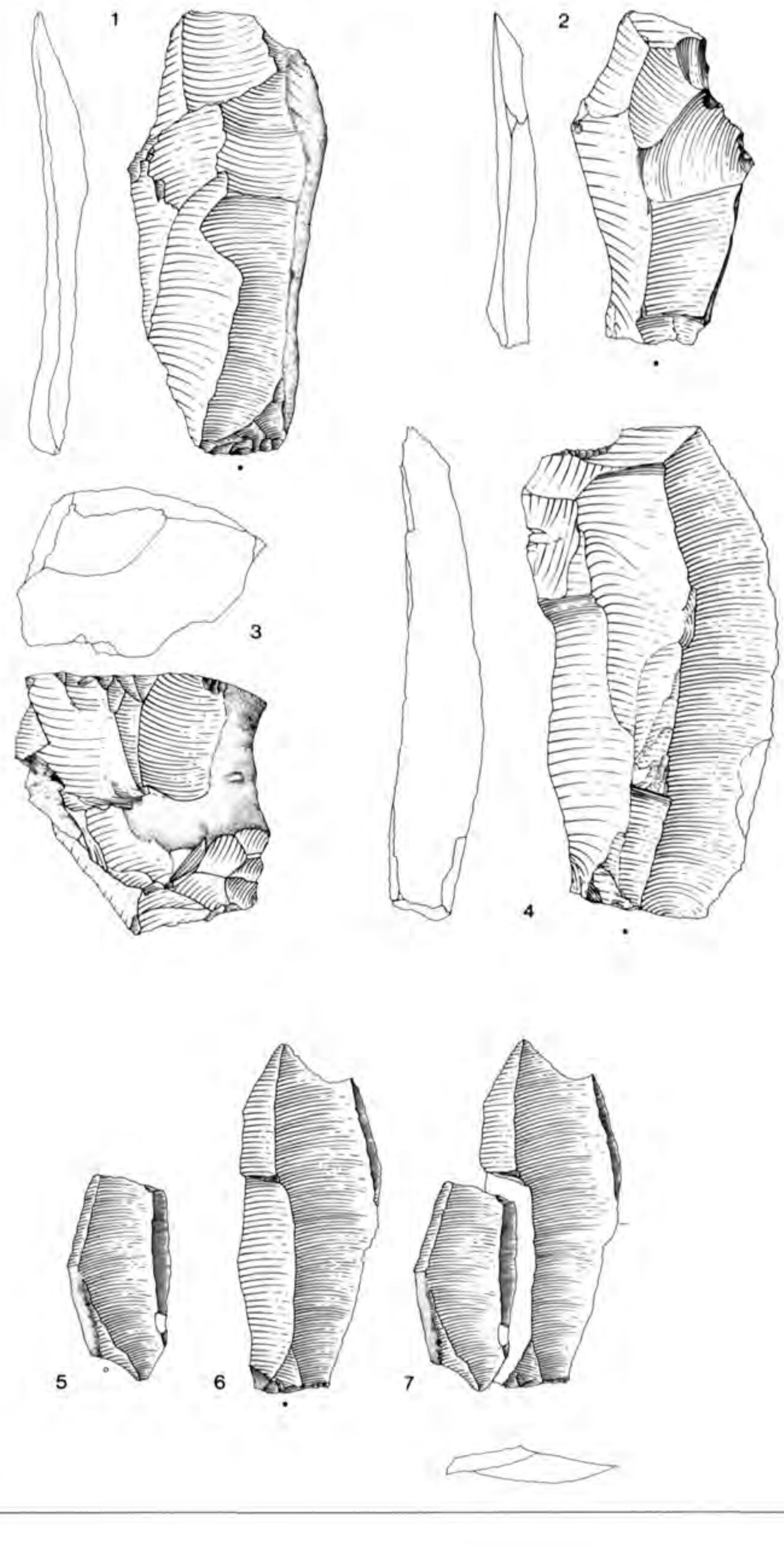


Fig. 102. Site A: flint artefacts, 1,2,4 flakes, 3 core, 5-7 conjoining blades, scale 2:3.

It is clear that in the fieldwork done at Site A only a small part of the original flint distribution was sampled. Despite the arrangements made with the exploiter of the pit, Site A, due to be properly excavated in the summer of 1981, was destroyed in quarrying activities.

5.4 Site D

On August 22, 1982, J.P. de Warrimont found three flint artefacts in a stratigraphical position comparable to that of the Site A assemblage, i.e. in the 'mottled zone' (see fig. 98) in the top part of Unit 5.1. As the site was threatened with immediate destruction by quarrying activities, we, that is, the author, J.P. de Warrimont and K. Groenendijk, had only one day in which to investigate the site.

For this reason our activities were limited to the screening of a 30-m long section. Within this area 20 artefacts were found over a distance of 8.5 m. All the finds consist of fine debris, with the exception of a discoidal core, shown in figure 103.

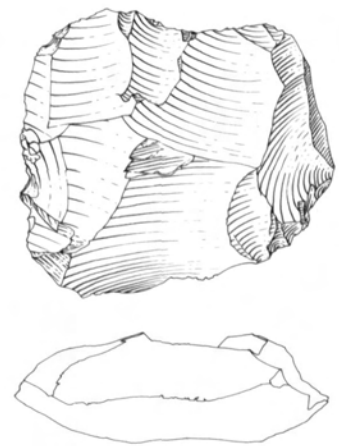


Fig. 103. Site D: discoidal core, scale 2:3.

5.5 Site K

The large Site K was discovered in 1986 during a systematical investigation of the pit sections by K. Groenendijk and J.P. de Warrimont. The site was excavated by a group of students of Leiden University and local amateur archaeologists in two campaigns, in the winter of 1986/1987 and the summer of 1987.

As there was only a limited amount of time available to excavate this large site we had to choose between a detailed survey of a small surface and a more general excavation of the largest possible area. The second option was chosen, which involved collecting finds per square metre and, to a lesser extent, per quarters of a square metre. A smaller area of 24 m2 was recorded three-dimensionally in order to obtain more detailed data on the horizontal and vertical distributions of the finds. In total, an area of 370 m2 was excavated this way, under very demanding working conditions and considerable time pressure.

Figure 104 gives a first plan of the horizontal distribution of the approximately 10,450 artefacts recorded during the excavation. The distribution map clearly indicates that many finds were lost to the southeast of the excavated area due to the activities of the commercial exploiter of the pit.

As for the surface modifications of the flint artefacts recorded, it is worth mentioning that, in general, the artefacts were found in mint condition, displaying a blueish-black colour similar to 'fresh' Ryckholt flint from the region. However, after a few minutes' exposure to the air these 'fresh' artefacts changed colour to greyish-yellow/greyish-white. In order to try to study the flints for microwear analysis in the freshest possible condition, Mrs A. van Gijn (cf. appendix I) put up her microscope in the excavation shed at the site. In her attempts at analysing the Site K flints, however, she was confronted with the same problem, of the apparently fresh flint surface changing into a 'sugary' surface under the microscope within only a few minutes' time. Microwear analysis of the Site K assemblage therefore has to be limited to the few tools and flakes that stayed 'fresh' after recovery.

The assemblage seems to have been situated in a primary archaeological context, as several refits could be established in the processing of the finds. These refits also include conjoining burnt flints, i.e. potlids that could be fitted to their 'parent' pieces.

Awaiting the results of a more detailed attribute analysis, which will take a considerable amount of time, we will give only a rough survey of the assemblage here.

The assemblage comprises approximately 10,450 flint artefacts, the majority of which constitute debris. The finds include approximately 150 tools, i.e. artefacts showing signs of intentional retouching, and 100 flakes with use retouch. The tools are dominated by various types of scrapers, and there is a very gradual transition to the used categories in the form of a decreasing intensity of retouch (cf. Isaac 1977). Figure 105 shows some of the more intensively retouched scrapers.

Indisputable examples of Levallois cores were not found among the 80 cores from Site K, while blade-cores are only represented by one fortuitous example, shown in figure 106-1. The Mousterian 'disc' preparation is represented by a dozen subregular cores, some of which stand midway between irregular 'discs' and discoidal cores.

Regular cores in Isaac's (1977) definition comprise a category in which the flake scars form an orderly geometric pattern. Almost all cores from Site K which can be classified as regular are high-backed biconvex discoid types with,

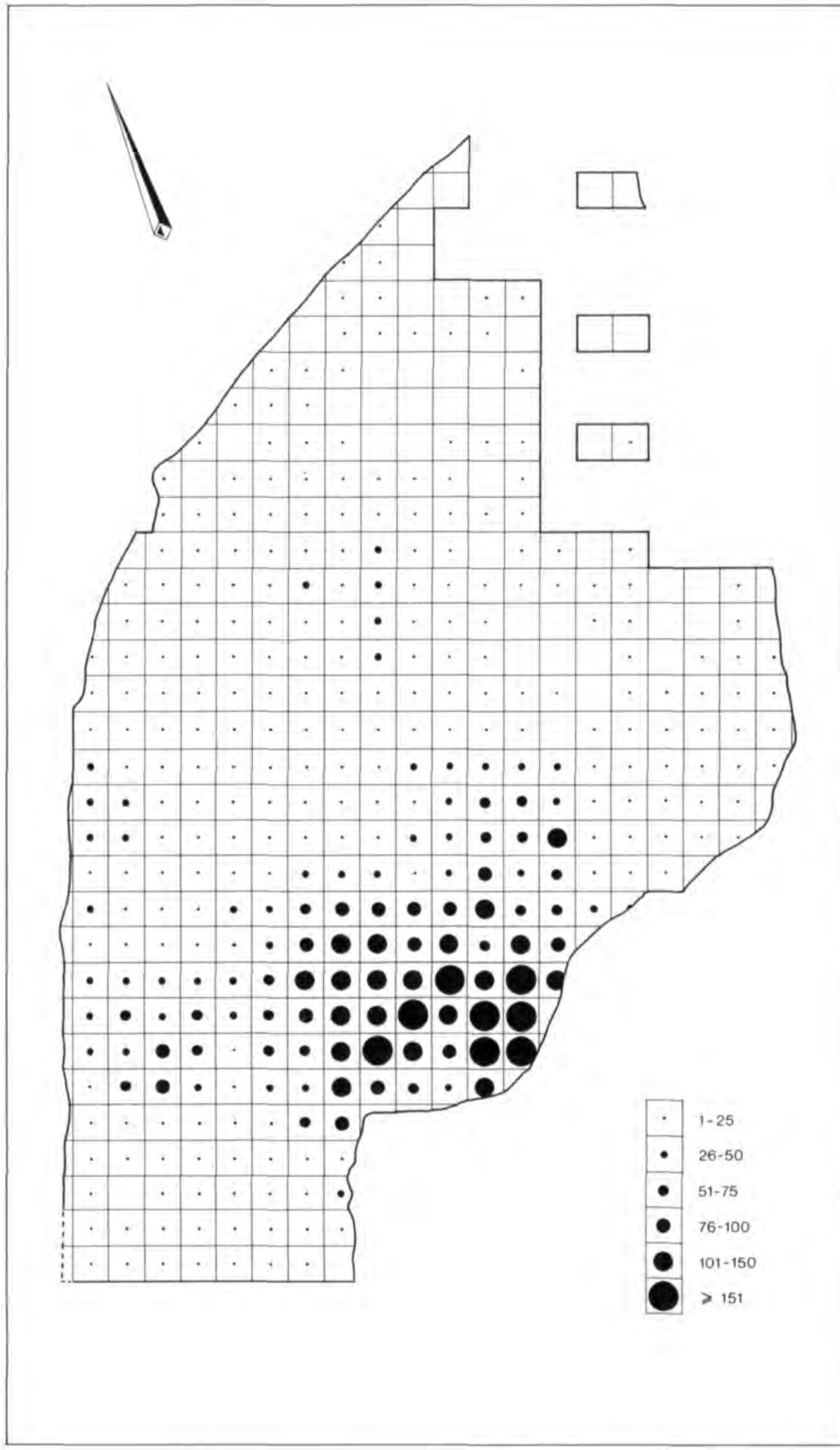


Fig. 104. Site K: map of the Site K excavation area, showing the number of artefacts per square metre.

in most cases, subregular centripetal (radial) patterns.

Irregular polyfacetted cores are cores having more than five flake scars that do not conform to a simple geometric pattern (*nucleus globuleux sensu* Bordes 1961). The greater part of the Site K core material is of this type.

Casual cores are blocks of stone with fewer than five discernable major flake scars, which are also well represented in the Site K assemblage.

The technological patterns evident in the cores, which provide no clear evidence of sophisticated preshaping of flakes, can, at first glance, also be observed in the flake material, which furthermore shows a striking absence of facetted butts. Only a very limited number of flakes shows signs of a more sophisticated dorsal preparation and facetting of butts. This may be explained in two ways:

1. The reduction sequences which *ended with the discard* of subregular biconvex discoid to irregular polyfacetted cores *started* as a rather sophisticated core preparation, in which 'Levallois' and 'disc' cores were produced. In a later stage of the reduction sequence these were reworked into other 'more primitive' core forms (cf. Boëda 1986).
2. An alternative interpretation is that the majority of the deviant flakes were *imported* to the site.

Future refitting studies and analysis of the specific flint

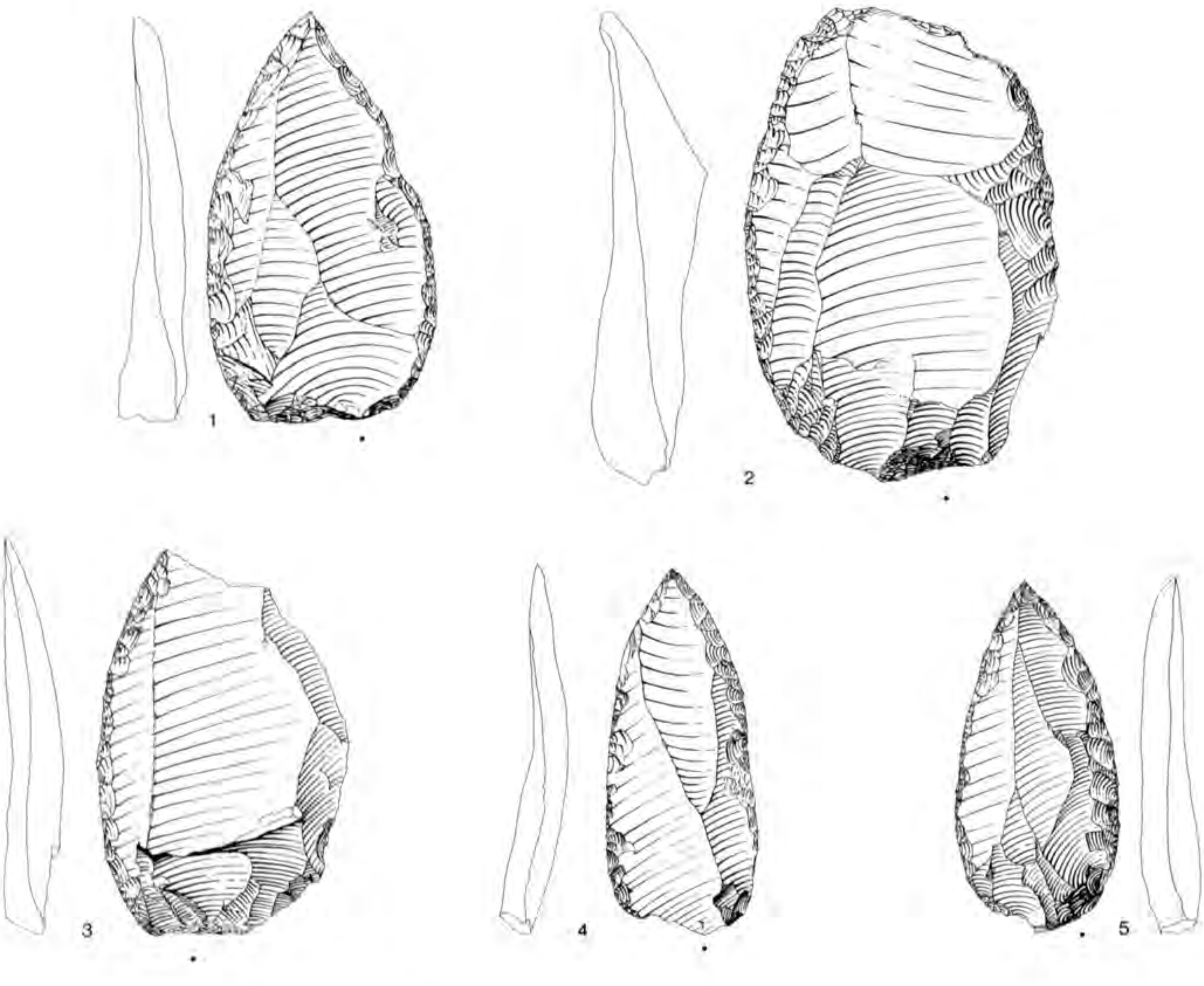


Fig. 105. Site K: 1-5 various scraper forms, scale 2:3.

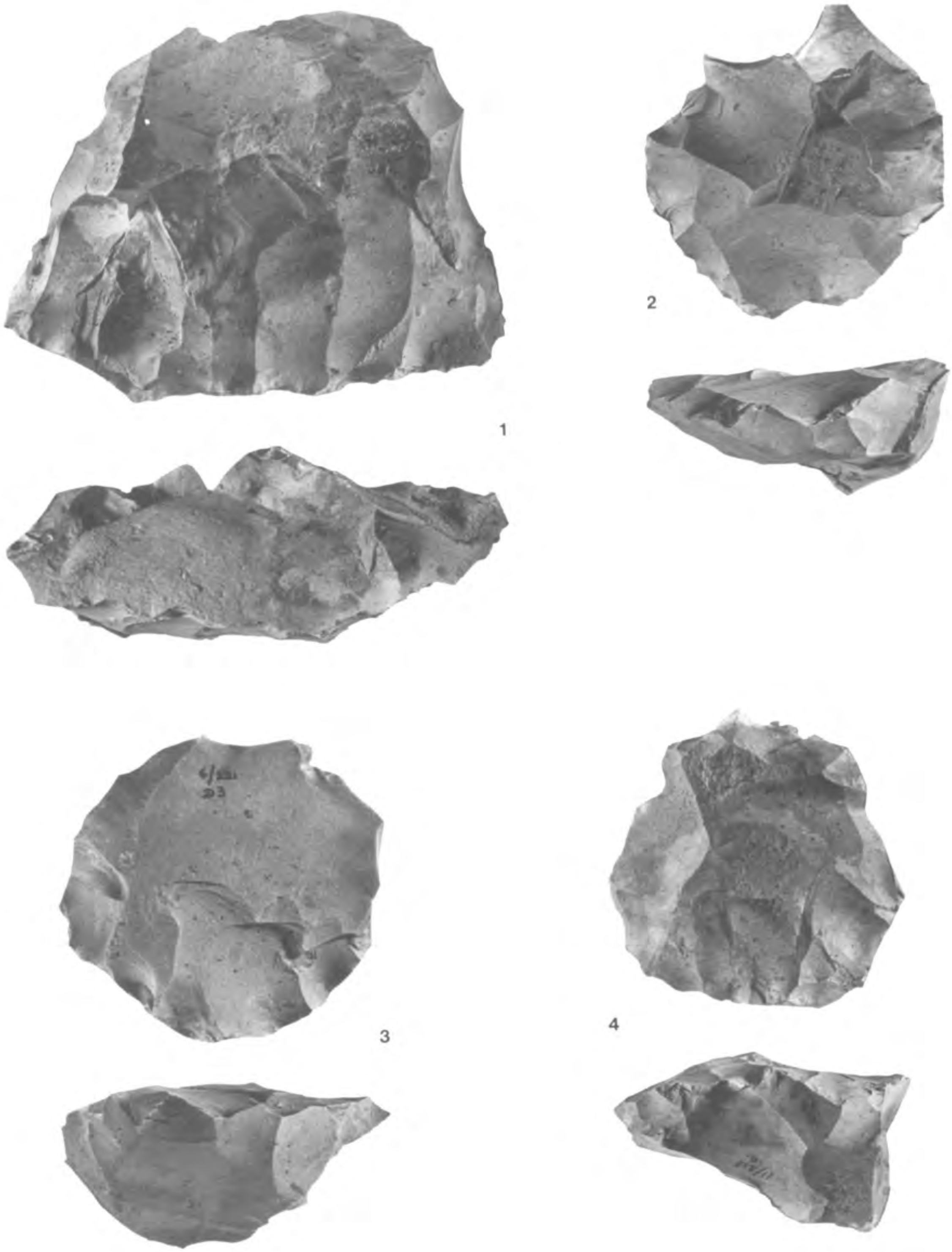


Fig. 106. Site K: 1-4 various core forms, scale 2:3.

nodules used for the different artefact classes will probably yield data enabling us to choose between these two options, or to choose for a combination of the two.

At least one of the tools, the scraper shown in figure 105-2, was probably *imported* to the site, as it is made out of a rare type of flint, which is only represented by one other piece in the Site K assemblage.

Further studies will also concentrate on the analysis of the horizontal distribution of the find categories (tools, used flakes, cores and the more than 500 burnt flints). The results of these studies might help to answer the question whether the Site K find concentration was formed in several independent depositional phases, spaced in time, or in one continuous and consistent use of the site.

6 The finds discovered in Unit V

6.1 Introduction

The Unit V sediments yielded only a few archaeological remains, none of which were demonstrably found in a primary context.

The majority of the finds ascribed to this lithostratigraphical unit essentially were recovered from thin cobble layers which were found in most places at the base of Units V-A and V-B. The Site B data will be presented here, followed by a few finds from other parts of the pit.

6.2 Site B (upper level)

The history of the Site B cutting has already been described in section 4.4, to which the reader is also referred for a description of the stratigraphy. Here it suffices to state that the finds from the upper level of Site B were recovered from a gravel layer which had eroded a soil formed in lithostratigraphical Unit IV/V-A (thin section 839 in fig. 82 of this volume; see: Mücher 1985, fig. 4).

In total, 24 m^2 were excavated in this level, which was characterized by erosional inconformities and the presence of -mostly small- stones. A total of 25 artefacts, mainly fine debitage, was recorded three-dimensionally. This small assemblage included a large Levallois-flake and a point made from a Levallois flake (fig. 108). The flint material displays a greyish-white patination, as opposed to the few flints from the underlying Unit IV-C-I loams, which were 'fresh'.

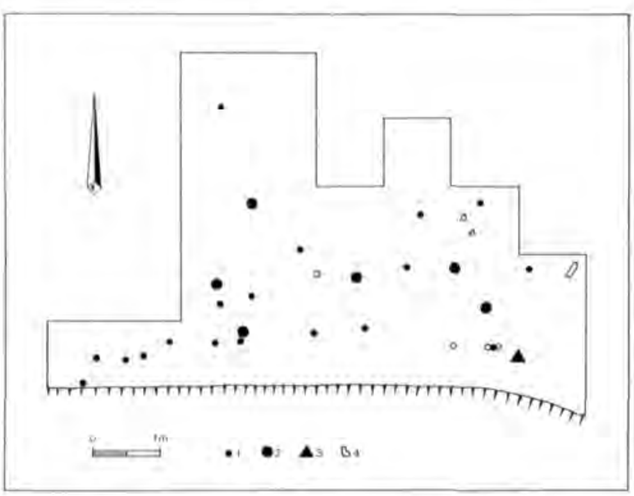


Fig. 107. Site B: upper level. Horizontal distribution of finds. 1, flint artefact <2cm, 2. flint artefact measuring 2-5 cm, 3. flint artefact of ⩾5cm (= no. 1 in fig. 108), 4. bone fragment.

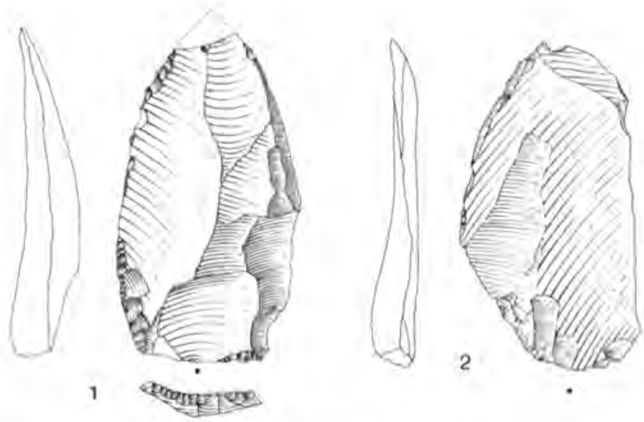


Fig. 108. Site B: 1 broken 'point', 2 flake (section find), scale 2:3.

Some faunal remains were found in the gravel layer: unidentified fragments of teeth of larger mammals (deer?) and part of a rhino humerus (Van Kolfschoten 1985). The distribution of the artefacts and the few faunal remains is shown in figure 107.

The Site B assemblage was very probably found in a secondary context in view of the matrix (a thin cobble layer) and, to a lesser degree, the fact that no artefacts could be conjoined. It is quite likely that this material in the gravel layer at Site B was originally deposited in the lower unit, Unit IV-C, and redeposited in an erosional phase following the development of the luvisol.

6.3 Other Unit V finds

We encountered artefacts in the same stratigraphical position as the finds found in the upper lever of Site B in other parts of the pit. Figure 109 shows a carefully prepared core from which blade-like flakes had been struck, found in a cobble layer at the base of Unit V-B, in a section at the eastern boundary of the Site C excavation. This section is

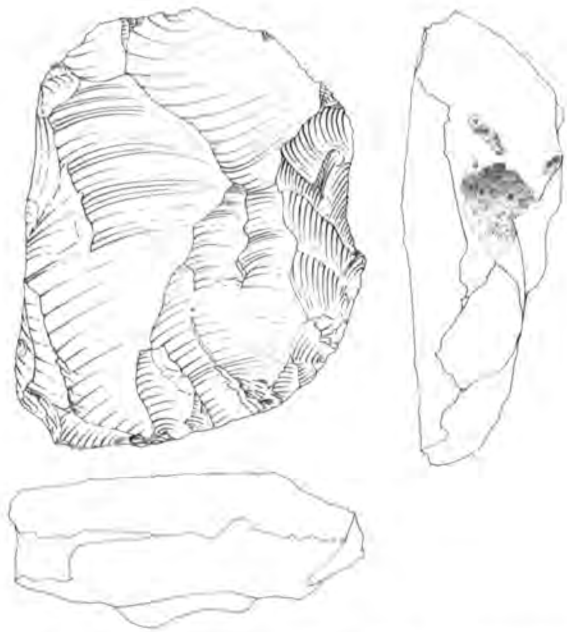


Fig. 109. Prepared core found in the gravel layer at the base of Unit V-B in a section close to Site C, scale 2:3 (see fig. 69 for the position of the artefact in the section).

shown in figure 69. In 1983 a dozen larger flakes, displaying no signs of core preparation, were found in a comparable stratigraphical position in a section approximately 120 m southeast of Site C. Part of the section is shown in figure 17.

So far, only one flake has been found higher up in the Unit, namely in 1983, when the author was cleaning a section at the edge of Site C. The flake was found approximately 25 cm below the top of Unit V-B and no signs of fissures were observed nor other phenomena which could indicate vertical displacement from a higher or lower level.

6.4 Interpretation

As already suggested for the Site B evidence, the few finds encountered in the cobble layer at the base of Unit V can be interpreted as most likely reworked artefacts that were originally present in lower units, and that were redeposited as a result of erosional processes at the beginning of or during the formation of Unit V.

7 Finds and sites discovered in Unit VI and a stray find of a 'Micoquian' handaxe

7.1 Introduction

The Weichselian sediments in the pit have received less attention than the Unit IV-C 'Saalian' deposits, from an archaeological viewpoint but also in other respects. In order to make up for this relative neglect special attention has been paid to Unit VI from the 1986 fieldwork onwards. This is partly due to the discovery of a large Middle Palaeolithic site (Site J) in Unit VI-A deposits, a site excavated in a rescue dig in 1986. A short note on this site is given in this chapter (7.2), while the finds from a site recorded higher up in the Weichselian sediments, Site E, will also be described here (7.3). For the first time in this volume the word 'handaxe' will appear in the description of these two sites, and this is one of the reasons why it has been thought appropriate to also describe a stray find of a Micoquian handaxe in this chapter (7.4). The final paragraph gives an interpretation of the Unit VI data.

7.2 Site J

7.2.1 INTRODUCTION

In the spring of 1986 an area of 210 m^2 at the base of the Weichselian loess (Unit VI-A) was excavated in a rescue excavation. The site was discovered by K. Groenendijk and J.P. de Warrimont and will be published in detail elsewhere (Roebroeks *et al.*, in prep). Here, only a preliminary note on the site can be presented following Roebroeks *et al.* (1987). The important site deserves description in this volume, because its presence has some consequences for the interpretation of the Unit VI-D Site E assemblage, to be presented below (7.3).

7.2.2 RESEARCH METHODS

Little time was available for the excavation of Site J because in May 1986 it was discovered in the middle of the area that the Blom Company, which mines the quarry, had planned to remove next. It was decided to choose an excavation strategy that would provide information about the spatial distribution of the finds over the largest possible area (the same strategy was later also appplied at Site K). This meant that most of the finds were collected per square meter, except in an area of 23 m^2, where they were individually plotted three-dimensionally in order to acquire more detailed information about their horizontal and vertical distribution. Altogether approximately 210 m^2 was excavated. We estimate that by collecting finds per square meter we were able to excavate at least three times as much of the area than would have been possible had we plotted all finds individually. During the excavation the Blom Company removed the sediments all around the excavation area so that the site remained as an elevated platform in the middle of the quarry (see fig. 110 and fig. 3, in the introduction of this volume). The quarrying machines also cut through an important concentration of flint artefacts in the southwestern part of the site. Our information about this concentration is scanty because we recovered the artefacts while being 'chased' by the quarrying machine.

Fig. 110. Site J: the excavation in full swing. The quarrying company has excavated all around the site.

7.2.3 STRATIGRAPHY

Figures 111 and 112 give schematic surveys of the geological context of Site J. The finds were stratigraphically situated above an Eemian palaeosol (the 'Sol de Rocourt') and below the 'Horizon of Nagelbeek', a weakly developed soil dated to abt. 20,000 BP (cf. chapter 2). The geological matrix of Site J is the oldest Weichselian sediment found in the quarry, and has been designated Unit VI-A in the local stratigraphy (cf. chapter 2). This unit consists of light grey loess, having a maximum thickness of 20 cm, overlain by an equally thick layer of dark grey-brown loess. The light grey loess was separated from the darker loess by an erosional level, marked by the presence of isolated small (< 1 cm) pebbles. Throughout the Unit 6.1 sediments large 'biopores' (with diameters of up to 0.5 cm) were present, which were absent in the sediments above 6.1.

The two successive layers of the unit were initially (Vandenberghe *et al.* 1985) interpreted as a soil that had been formed under steppe-like conditions. They constitute a complex that has often been observed at the base of Weichselian loess profiles in northwestern Europe ('Sol de Warneton', *sensu* Paepe and Vanhoorne 1967). However, it should be stressed here that micromorphological analysis of this inferred soil complex in other parts of the Belvédère pit did not yield any evidence of 'steppe-soil formation' in this horizon (Mücher, pers.comm., 1987). A similar complex at Seclin (northern France) has been dated by means of the TL method to 70,000-100,000 BP (Tuffreau *et al.* 1985). We provisionally accept this date as the best estimate of the age of the Belvédère Unit VI-A deposits. Artefacts were distributed vertically throughout the 30-40-cm thick unit, but the majority were found on top of the erosional layer that separates the lower light brown from the upper dark brown loess. Karst-formation processes that occurred after the deposition of the Unit 6.1 sediments had led to the subsidence of the archaeological layer. In this relatively lower position the layer was protected from the subsequent erosion that completely obliterated Unit 6.1 to the west of the site (see fig. 111).

As mentioned above, Mücher's micromorphological analysis of the Unit 6.1 sediments falsified the 'steppe-soil' interpretation. The analysis, however, did show the presence of clay illuviation cutans in Unit 6.1, indicating clay illuviation from a higher horizon. In the field, however, no B_t horizon could be identified in the overlying sediments, except, of course, for the Holocene soil in the top part of Unit 7. Climatic conditions which are generally considered favourable to clay illuviation are wet climates with a dry season (FitzPatrick 1971). According to Blum and Ganssen (1972), Koppen's C_f climates are favourable to the formation of argillic horizons. Soils with argillic horizons are reported to have been formed in loess areas during the Atlantic (Reuter 1964; Smolikova and Lozek 1973. See also: Kwaad/Mücher 1977).

In the Weichselian of northwestern Europe such climatic conditions were limited to the Early Weichselian intersta-

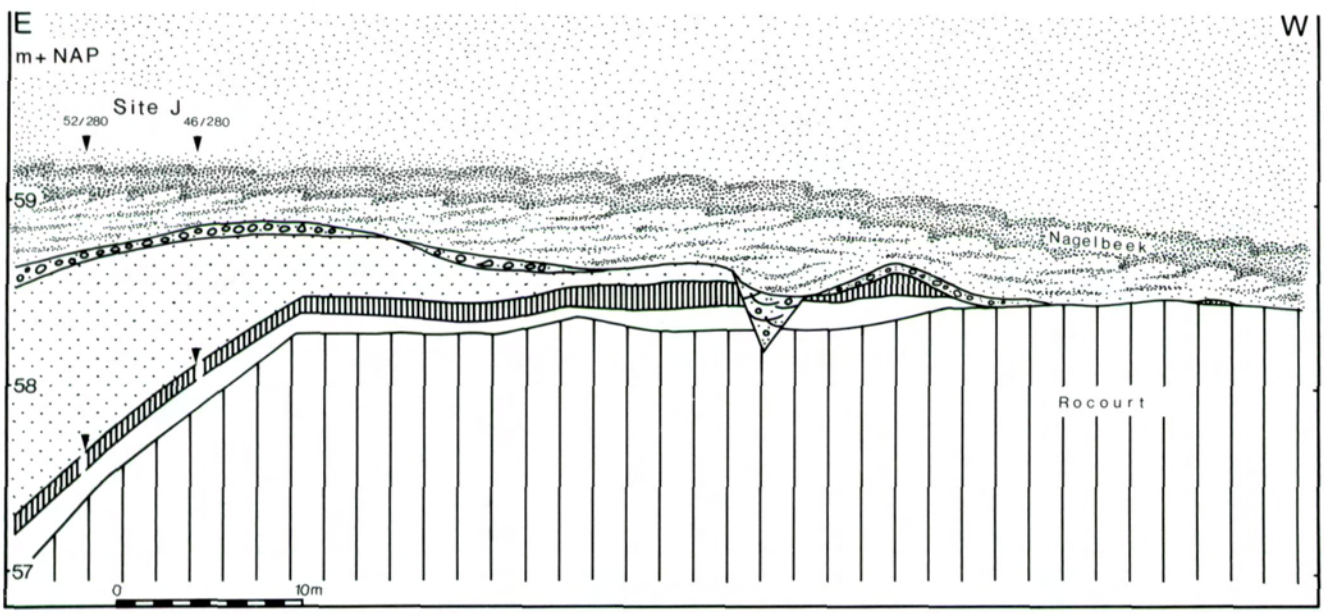


Fig. 111. Schematic profile showing the stratigraphical position of Site J. Vertical magnification 10x.

dials of Amersfoort, Brörup and Odderade (Zagwijn 1961, 1975). Pollen studies in the Netherlands have yielded evidence of these interstadials, which were characterized by a complete re-forestation of the landscape, which had been deforested in the colder Early Glacial stadials I, II and III. In the interstadials the mean July temperature will have been 15 to 17° C.

Other Upper Pleistocene records yielded essentially the same data. The La Grande Pile peat bog in northeastern France revealed a succession of organic muds overlying a Saalian till. The pollen record shows the environmental changes during the last interglacial/glacial cycle in detail. Three forest episodes interrupted by invasions of grass and herbs were attested at the base of the (Eemian) section. The lowermost forest layer was the most pronounced and its pollen diagram resembles diagrams of the last interglacial as defined in its type area in northwestern Europe. The three forest episodes correspond well to the low ice-volume substages of Oxygen Isotope Stage 5 (Woillard 1978, 1980; Woillard/Mook 1982).

The loess record in the area around Prague and Brno (Czechoslovakia) shows that the last 'interglacial' there was separated from two later forest periods by what Kukla

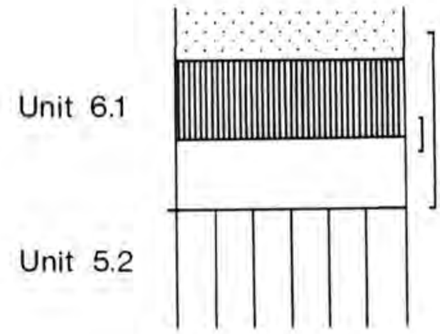


Fig. 112. Schematic profile of Site J in lithostratigraphical Unit VI-A, showing the maximum vertical extension of the artefact distribution in the unit, and how the majority of the artefacts is concentrated vertically.

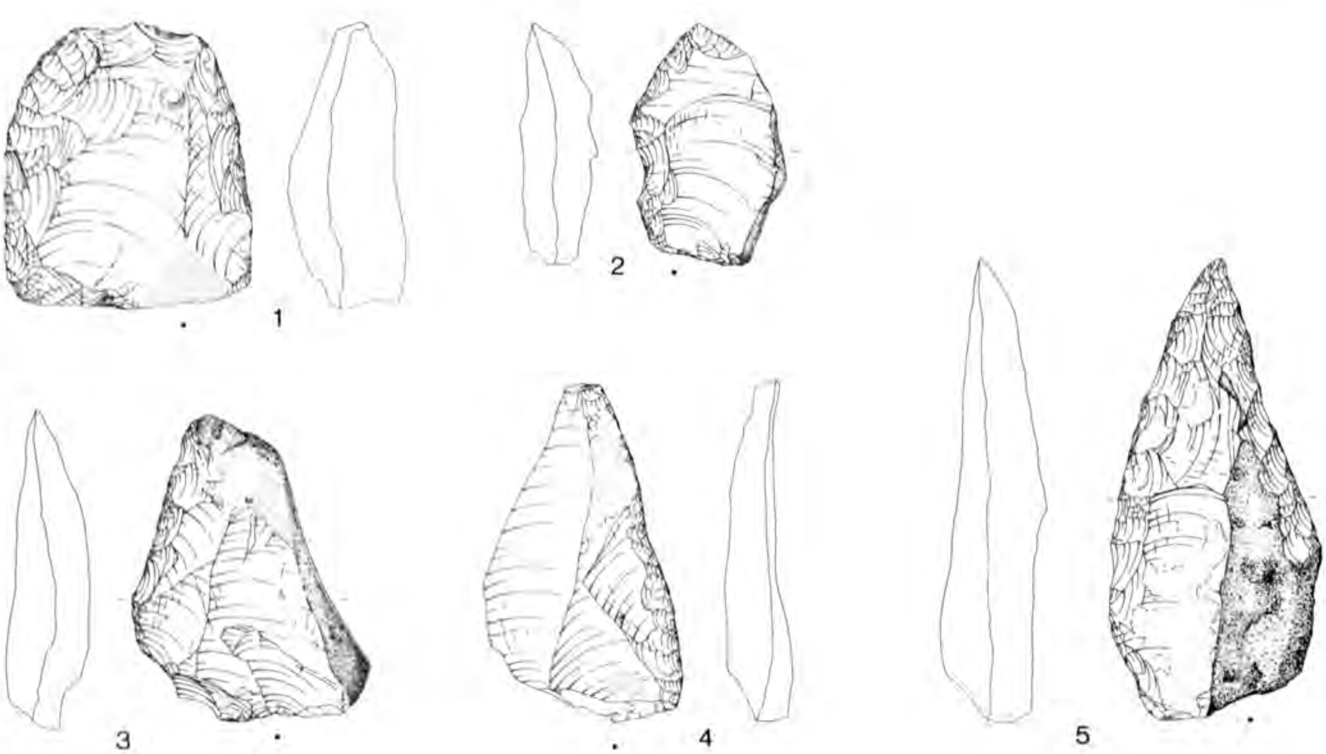


Fig. 113. Site J: 1-4: various scraper forms, 5: Mousterian point. Scale 2:3.

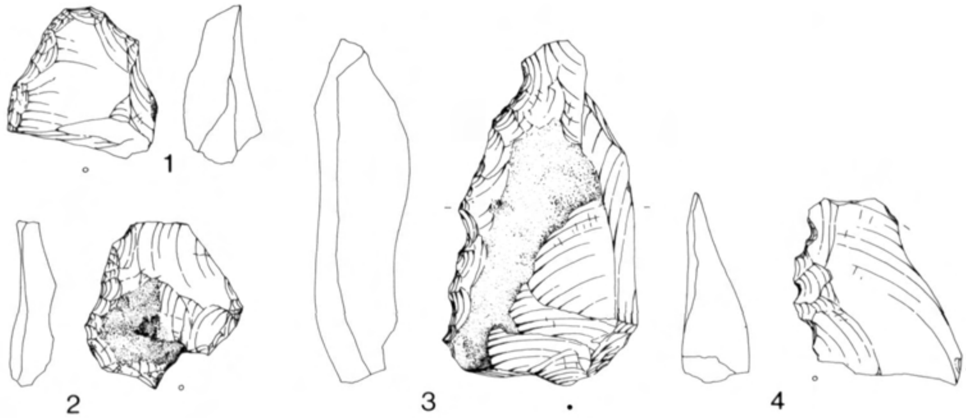


Fig. 114. Site J: 1-2: scrapers, 3-4: denticulates Scale 2:3.

(1977) calls a period with 'normal loess steppe'. Under these conditions loess sediments were formed, which show a reversed magnetic polarity. This period is correlated with the Blake event, about 110 ka (Kukla 1977).

To conclude, these data seem to indicate that the Unit VI-A sediments were deposited in the Early Weichselian. Additional support for this 'Early Weichselian' interpretation is given by the fact that the Unit VI-A and VI-B sediments were affected by a major period of permafrost conditions, which Vandenberghe *et al.* (1985) have dated to the Weichselian Lower Pleniglacial (cf. chapter 2).

7.2.4 SITE J FINDS

The finds of Site J consist of flint artefacts, a few fragments of charcoal and some poorly preserved molars. On the basis of their oblong shape and the variation in enamel thickness, the molars were identified as molars of *Mammuthus primigenius* (Van Kolfschoten, pers.comm., 1987).

Approximately 2,800 artefacts were collected, 116 of which came from the southwestern part of the site (see fig. 117) and were rescued from right in front of the quarrying machine. The flint material has not yet been studied systematically. We can therefore only provide some preliminary remarks on the technological and typological characteristics of the assemblage. The quantitative data presented here, however, are somewhat different from those presented in the paper on this site by Roebroeks *et al.* (1987), because in the meantime more work has been done on the Site J assemblage.

The raw material of almost all artefacts is a rather coarse-grained, grey-blue flint with a very rounded, dirty-white cortex. The naturally fractured surfaces exhibit a brown patination and water-rolled edges. Therefore, we assume that the raw material was collected from the riverbed exposed nearby at the time when the site was occupied.

The worked surfaces of the artefacts have no patination and have a fresh appearance.

During the Belvédère Site J excavation two flint scatters were identified, both consisting mainly of the waste from flake- and tool-production. As debris from all flint-working stages (from decortication flakes to small cores) was found, the conclusion seems justified that in this case (at least the greater part of the) tool-manufacturing took place at Site J.

It is remarkable that none of the flakes seem to have been produced with 'the' Levallois technique. Almost all flakes were detached by hard-hammer percussion and it looks as if no systematic core-reduction procedure was followed. The flakes are thick and rather heavy and in many cases some of the outer surface of the flint nodule is still visible on the dorsal side.

Most of the cores (n=22) are small and have irregular shapes (fig. 116). There are almost no blades or tools made from blades.

There is evidence that tools were maintained and resharpened at the site, although probably not on a very large scale. This was done partly by means of the 'long sharpening technique' which involved the production of a longitudinal flake along a scraper- or cutting-edge, and resulted in a sharp tool edge. Evidence of frequent use of this technique has been noted for the later Saalian industries at la Cotte de St.Brelade (Jersey, Great Britain), particularly those found in layer A (Cornford 1986).

The waste products of this technique recovered at Site J include several renewal flakes ('long sharpening flakes' or 'LSF') and two flake tools bearing negatives of such flakes. Evidence of other tool-rejuvenation techniques found in the site assemblage includes the removal of flakes along working-edges by a series of hard percussion blows and probably also the reduction of tools by continuous retouching, especially in the case of some steeply retouched scrapers (cf.

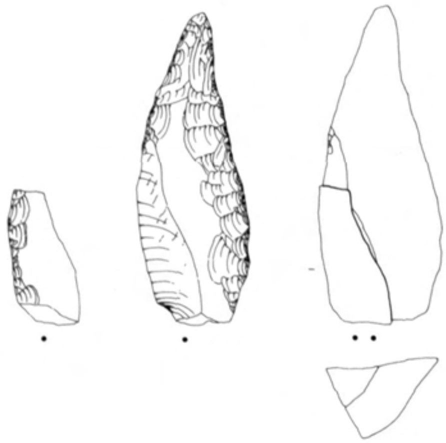


Fig. 115. Site J: 'Quinson' point-like tool with a conjoined ('resharpening') flake. Scale 2:3.

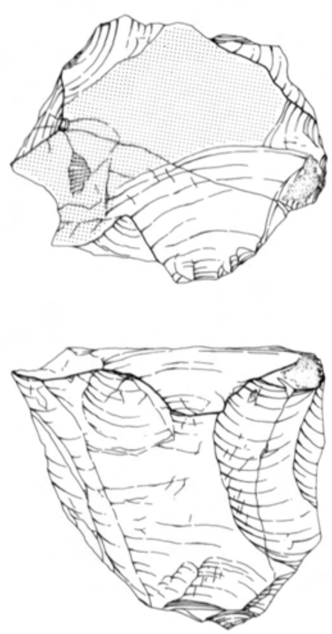


Fig. 116. Site J: core, scale 2:3.

Dibble 1987a, 1987b).

There are three small flakes in the Site J assemblage that differ from the rest of the artefacts in raw material as well as in technical aspects. They are made from light brown-grey flint with inclusions and were produced by soft-hammer percussion. What remains of their striking platforms indicates that these flakes were struck off during the resharpening of a bifacial tool ('handaxe resharpening flakes'). The flakes were found close together in the northwestern part of the excavation. Although these flakes seem to be handaxe resharpening flakes, no waste was found from the initial stages of the production of the biface and no handaxe appears to have been discarded at the site. Therefore, we assume that a bifacial artefact was transported to and from the site. Possibly the handaxe in question is the one found about 150 m away, at Site E (see below, 7.3).

Table 16 gives a survey of the 'tools' found at Site J. The intentionally retouched pieces of the assemblage include 33 complete tools and 46 broken tools and tool-fragments.

Approximately 50% (n=40) of the essential tools consists of various scraper types, including straight, convex and concave side scrapers, two small, scraper-like tools (*raclettes*), one scraper made from a core and several double-sided scrapers (figs. 113 and 114). The tools classified as 'Mousterian point' and 'Quinson point' (figs. 113-5 and 115, respectively) may, alternatively, also be seen as representing double scrapers.

The retouching of the scraper working edges is generally steep and irregular; only very rarely is it flatter and scalariform. Only a few examples, for instance a flake with transverse scraper retouching, bear the characteristics of stepped 'Quina'-like retouching.

Another dominant group (n=32, abt. 40% of the essential tools) consists of denticulates (figs. 114-3 and 114-4).

Handaxes and other bifacially worked tools are entirely absent in the assemblage. That bifacial tools were however, part of the 'toolkit', can be inferred from the presence of the 'handaxe resharpening flakes' discussed above.

The 46 broken tools (in essential count) include both scraper- and denticulate-fragments, as shown in table 16. The rather low ratio of complete and broken tools (abt. 0.7) suggests an intensive use of tools at the site, as does the occurrence of tool-rejuvenation flakes mentioned above. The complete/broken ratio is 0.5 for the denticulates, and 0.7 for the scrapers.

Among the artefacts showing no signs of intentional retouching are 37 complete flakes bearing traces of use retouch. This group also includes some naturally backed knives. The complete/broken ratio, which is about 3.4, is rather high in comparison with that of the 'essential' tools.

7.2.5 PROVISIONAL INTERPRETATION OF THE LITHIC ASSEMBLAGE

Perhaps the most striking feature of the Site J assemblage is the total absence of evidence of the Levallois core-preparation technique. In Roebroeks *et al.* 1988 we gave an explanation for the presence/absence of evidence of the 'Levallois' core-preparation method and for the technological differences between sites in terms of Middle Palaeolithic hunter-gatherer mobility.

We assume that prepared cores and/or their flake products were regularly transported in the Middle Palaeolithic,

Table 16: Survey of the Site J tool assemblage.

type	complete		incomplete		total	
	n	%	n	%	n	%
denticulates	11	15.7	21	36.8	32	25.2
scrapers – simple	8	11.5	14	24.5	22	17.4
– double	3	4.2	-	-	3	2.4
– other	6	8.6	9	15.9	15	11.8
Mousterian 'point'	1	1.4	2	3.5	3	2.4
'Quinson' point	1	1.4	–	–	1	0.8
burins	3	4.2	–	–	3	2.4
subtotal 'essential tools'	33	47.0	46	80.7	79	62.4
flakes with signs of use	37	52.9	11	19.4	48	37.7
total	70	99.9	57	100.1	127	100.1

and that this was done to ensure the availability of cutting edges for future needs. In this respect we assume that the use of core-preparation techniques reflects 'economizing behaviour', except at lithic raw material procurement sites, such as Baker's Hole (Great Brittain, Roe 1981; Robinson 1986) where the Levallois technique *sensu stricto* was used for the production of only one or a few flakes per core.

This interpretation of prepared cores and their end products as transported items is based on evidence from several Middle Palaeolithic sites. Transport of lithics in the form of Levallois cores, for instance, has been demonstrated for the Maastricht-Belvédère sites C and G (see this volume, chapter 4) and can also be inferred from the compositions of the assemblages of Lehringen (Thieme/Veil 1985) and the Rheindahlen 'Westwand-Fundschicht' (Bosinki 1966; Thieme 1983a). Another example is the Schweinskopf volcano site in the Neuwied Basin, where transported flint flakes were found in association with debris of local quartz material (Bosinski, pers.comm., 1986). Further examples are Sclayn (Otte *et al.* 1983) and Vollezele-Congoberg (Vynckier *et al.* 1986) in Belgium (see chapter 9.3). In a technological study of the Mousterian in the French Perigord region, Geneste (1985) noticed a dichotomous relationship between a Levallois assemblage type manufactured

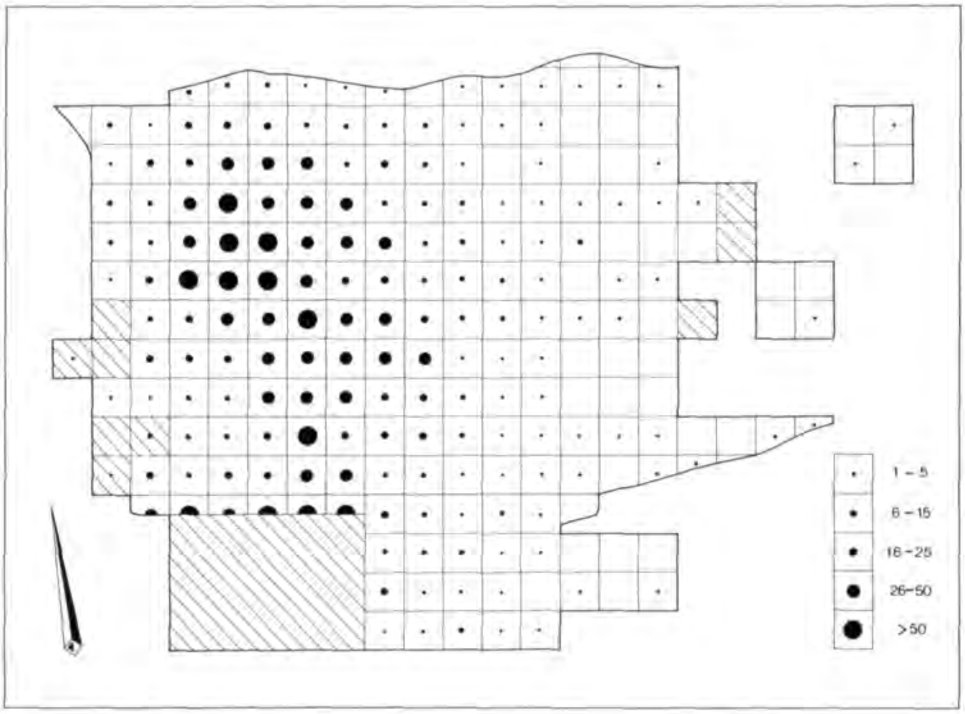


Fig. 117. Map of the Site J excavation area, showing the number of artefacts per square meter. The shaded areas were not systematically excavated.

Fig. 118. Site E: the rescue dig in front of the quarrying machines. Photograph taken from the west side of the site.

from transported raw material and a non-Levallois type, made out of locally available flint. This and other observed dichotomous patterns have led Binford (1986) to conclude that, in general, Middle Palaeolithic technologies were characterized by the production of *transported toolkits* for 'planned' uses and *expedient toolkits* intended for use 'on the spot'. We will return to this topic in more detail in chapter 9.

In the context of this discussion, the Site J assemblage could be interpreted as having been intended for occasional or 'situational' use. A plausible explanation could be that the tasks to be performed at Site J were largely unforeseen or 'unexpected' (cf. Binford 1986); another explanation could be that it was simply not necessary to use the transported cores and/or tools and that cost-benefit considerations resulted in the manufacture of tools from the locally available stone rather than use of the transported toolkit.

7.2.6 FUTURE RESEARCH

Future research will concentrate mainly on reaching the following goals:

1. While processing finds, we found that it was possible to fit a number of flakes together. After the microwear analysis has been completed, P. Hennekens will make a systematic attempt to refit the artefacts collected during the excavation. The results of this investigation will not only be used for spatial analysis of the site and technological analysis of the artefacts. They will also be used to measure the amount of horizontal displacement of the materials in order to make inferences about post-depositional processes. An interpretation of the spatial distribution of the finds has not yet been attempted. The horizontal distribution of the flint artefacts recorded in the excavation is shown in figure 117.
2. The study of post-depositional processes must be considered a necessary prelude to the testing of hypotheses on site functions. Of course the results of microwear analysis play an important role in the formulation and testing of such hypotheses. Currently, A. van Gijn is examining a sample of the artefacts to determine if, and to what extent, microwear analysis can contribute towards a functional interpretation of the materials. Our first theory on the function of the site, based on the preliminary results of our research, is that Site J was an area where specialized activities were performed.
3. A third important goal for future research will be a comparison of Site J with other sites in northwestern Europe that are more or less of the same age, such as Rheindahlen-Westwand/B1 (Bosinski 1966; Thieme 1983a; This-

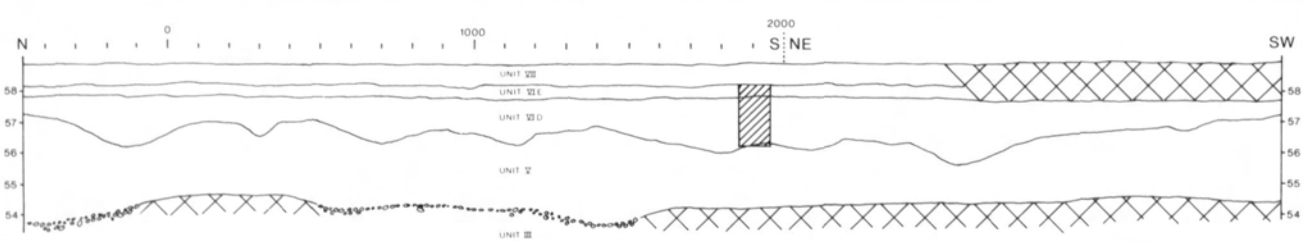


Fig. 119. Site E: schematic section of the western boundary of the excavated area and the adjacent sampled profiles; indicated are the main lithostratigraphical units. The rectangle in the centre of the figure shows the section illustrated in greater detail in figure 120.

sen 1986), Rocourt (Cahen/Haesaerts 1984) and Seclin (Tuffreau *et al.* 1985). This comparison will concentrate on the explanation of the technological differences between the flint assemblage of Site J and those of other sites.

7.3 Site E

7.3.1 INTRODUCTION

In order to obtain data on the development of *Arvicola* in the Belvédère sequence, K. Groenendijk sieved large amounts of sediments collected at the base of the Weichselian loess deposits. On November 13th, 1982, during the fieldwork, he and J.P. de Warrimont discovered several larger bone fragments and flint artefacts lying together in the eastern part of the pit. This discovery was followed by a relatively small-scale rescue excavation which took place in the second half of November and the first days of December 1982, under bad weather conditions and with a small crew (fig. 118).

From the beginning it was evident that the artefacts and bone fragments were not situated in a primary archaeological context, but had been displaced, probably over a short distance. For this reason, and because of the lack of time, we decided to collect as many samples as possible and to study the stratigraphical context of the finds. First, the finds were collected from a north-south section. Later, the deposits overlying the find layer were removed mechanically, down to a few dm above the find layer.

In total, an area of about 60 m^2 was excavated. Most flints were recorded three-dimensionally, whereas only the positions of the larger bone fragments were recorded. However, the distribution map of the finds recovered in this way is of limited value because of the varying attention given to the individual squares in the area sampled.

7.3.2 STRATIGRAPHY

The top part of the Unit V Saalian sediments at Site E had subsided as a result of karst processes, and formed a local depression in which Unit VI was more than 2 m thick. In the southern part of the sampled area small gullies, which had cut into the Unit V Saalian sediments, formed sediment traps for Unit VI. On top of these 'sediment traps' lay a practically levelled Horizon of Nagelbeek (Haesaerts *et al.* 1981). As can be seen in figure 120, the sediments between the top part of Unit V and the Nagelbeek Horizon are extremely laminated, especially at their bases. We are dealing mainly with a calcareous yellowish-brown silt loam with brown loamy and sandy lenses (*Schwemmlöss*). At the base of the laminated sequence was a calcareous brownish sandy loam containing gravel, (partly reworked tertiary) molluscs, mammal fossils and artefacts (see fig. 120). This loam had an average thickness of 10 cm, its maximum thickness being 25 cm. This subunit, which varied considerably in thickness and composition laterally, formed the

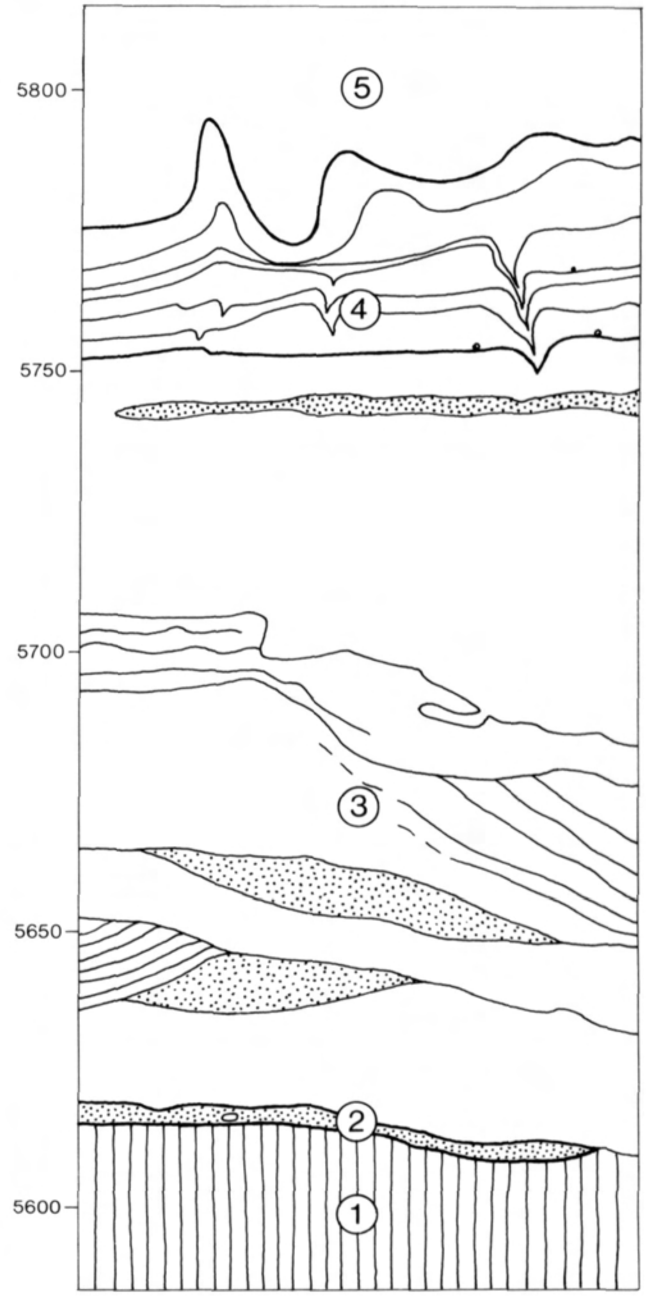


Fig. 120. Site E: detail of the section shown in figure 119.
1 homogeneous silt loam (7.5 YR 5/6) with a massive structure (Unit 5.2/V-B)
2 sandy silt loam, calcareous, reddish-brown, containing gravel, faunal remains and artefacts (the base of Unit 6.5/VI-D)
3 a sequence of laminated calcareous silt loam (10 YR 6/3), alternated with more coarsely grained lenses of reddish-brown sandy loam (stippled in the figure).
4 pale brown (10 YR 6/3) laminated silt loam with thin reddish brown loamy lenses with frost cracks (Unit 6.5/VI-D)
5 silt loam (2.5 Y 6.5/3) containing rust mottles (unit 6.4/VI-E, Nagelbeek Horizon).

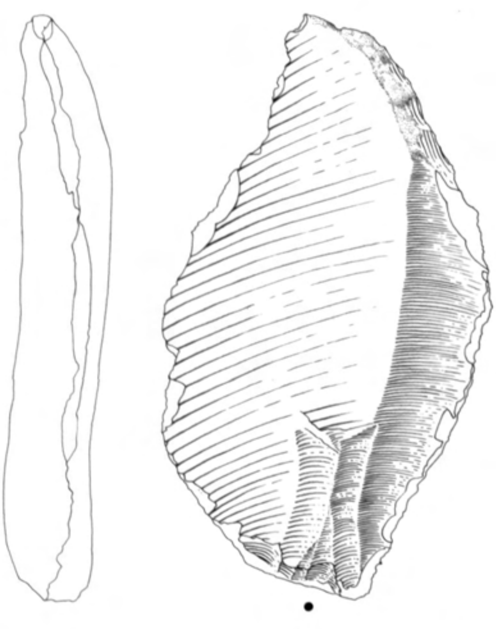


Fig. 121. Flint artefacts from above the main level at Site E (see the text).

matrix of the archaeological assemblage. The find-bearing unit was identified as subunit 6.5, i.e. lithostratigraphical Unit VI-D.

Four severely weathered flints (very glossy and with rounded ridges and edges) were collected from an erosional level immediately beneath the Horizon of Nagelbeek, at a higher position in the Unit 6.5 sequence (fig. 121).

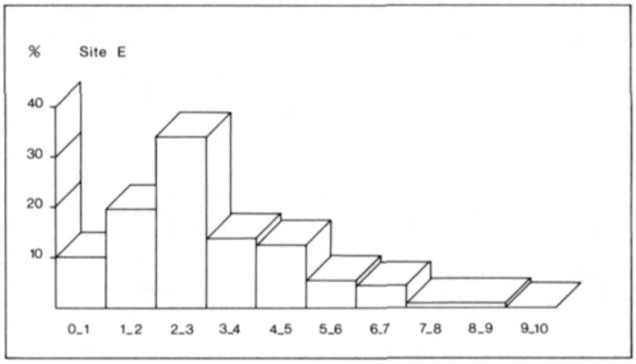


Fig. 122. Site E: size distribution of the assemblage, based on maximum dimensions, in cm.

7.3.3 THE FINDS

7.3.3.1 The flint assemblage

A total of 95 flint artefacts was recovered at Site E, the overall majority consisting of non-retouched flakes. Most of these flints have a 'fresh' appearance, the odd one having a blue-white patina. Some pieces display a light gloss. None of the flints showed evidence of frost action, while only one (non-artificial) piece was burnt (WG 53).

The majority of the flints may be attributed to at least five different flint nodules, including 'Rullen' and 'Rijckholt' flint, and were probably collected from Maas sediments.

Figure 122 gives the size distribution of the flint artefacts from Site E. In comparison with the flint assemblages from Site C and F the small number of flakes smaller than 2 cm is striking. This is certainly a result of the rather rough way in which the site had to be excavated, while the geological processes responsible for the deposition of the matrix of the finds may have removed the finer debris also.

The flint assemblage, which consisted mainly of waste material, included only a few regular flakes, among others the retouched Levallois flake WG 30 (see fig. 123-1). The only other retouched pieces are a fragment of a steep scraper (WG 3) (fig. 123-2) and the top part of a handaxe (WG 42) (fig. 123-3). The assemblage also included a flint hammerstone (WG 21).

A. van Gijn (Institute of Prehistory, Leiden University) studied several artefacts from Site E for microwear traces. Despite the fresh appearance of the pieces, no clear traces of use were found. According to Van Gijn (pers.comm., 1983), the tip of the handaxe showed no visible traces of use. Although this does not mean that the tool had not been used (see: Unrath *et al.* 1986) it is possible that the artefact was broken by shock during manufacturing or resharpening.

Six flakes were refitted to two groups of three flakes (WG 32-59-101 and WG 55-56-57) (fig. 124). Their horizontal distribution is indicated in figure 125.

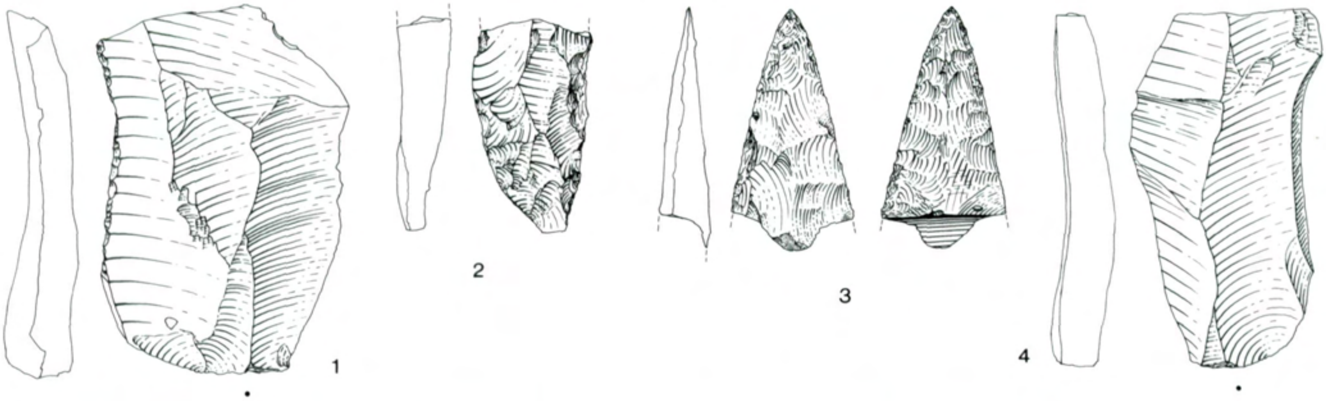


Fig. 123. Site E: artefacts 1,4 flakes, 2 basal fragment of a double scraper (WG 3), 3 tip of a handaxe (WG 42). Scale 2:3.

As yet, the handaxe tip from Site E is the only handaxe (fragment) found in a geological context in the seven years of fieldwork in the pit, leaving out of consideration the handaxe resharpening flakes from Site J. A stray find of a handaxe is described in paragraph 7.4 of this chapter.

7.3.3.2 Mammal fossils

The remains of small mammals collected in the excavation and by sieving about 0.5 m^3 of sediment will be discussed in paragraph 7.3.6. The remains of larger mammals found at Site E have been described *in extenso* by Van Kolfschoten (1985), on whose publication this paragraph is based. On the whole, the mammal remains do not show any signs of transport. Judging by their physical appearance, lateral displacement must have been limited. Van Kolfschoten identified the remains of mammoth, horse, woolly rhinoceros, red deer, reindeer, a large deer of the size of a giant deer and aurochs/bison. Table 17 shows the identified faunal remains found at Site E per species.

A molar fragment of a young mammoth was identified, while at least two horses were represented by several large bone fragments and two milk molars. According to Van Kolfschoten, the remains had belonged to a heavily built horse. The woolly rhinoceros remains consist of skull fragments (some of which could be joined together) and some teeth. The skull fragments and the unworn molars were found close to each other and had probably belonged to the same young individual. The presence of red deer is attested by an antler fragment and a radius, while reindeer was represented by several bones, an antler fragment of a young individual and a slightly worn milk molar. The molar of a large bovid had also belonged to a young individual.

7.3.3.3 Molluscs

The molluscs collected during the research at Site E have been published by Kuijper (1985), and will be reviewed in paragraph 7.3.6.

7.3.4 HORIZONTAL AND VERTICAL DISTRIBUTION OF THE FINDS

The area sampled is without any doubt only a part of a larger find scatter which extended probably to the south and the west of the excavated area. What were in all probability the richest parts of the distribution -west of Site E- had already been destroyed before the discovery of the site.

As for the horizontal distribution of the flint artefacts and the remains of larger mammals (fig. 125), it can be said that most finds were recovered from the area where Unit 6.5 was thickest, i.e. in the centre of the 'sediment-trap' depression in the western part of the sampled area. On the whole, the areas with many bone fragments also provided many flint artefacts and vice versa, because the majority of the finds were recovered from natural depressions in the Unit 5.2 sediments.

As for the vertical distribution of the finds, flint artefacts were found all through the matrix but mainly at its base, while larger bone fragments were frequently found in the upper part of the matrix described above, beneath the yellowish-brown laminated loess. Several pieces of bone and flint artefacts were found 'cemented' to each other, for instance a rhinoceros molar and artefact WG 76. One of two refitted flakes was found at the base of the find unit, while the other was recovered from the top part of the layer, just beneath the loess.

7.3.5 THE RELATION BETWEEN THE FLINT ARTEFACTS AND THE FAUNAL MATERIAL

The spatial association of flint artefacts with the remains of larger mammals as recorded during the Site E rescue operations was clearly caused by geological processes that had

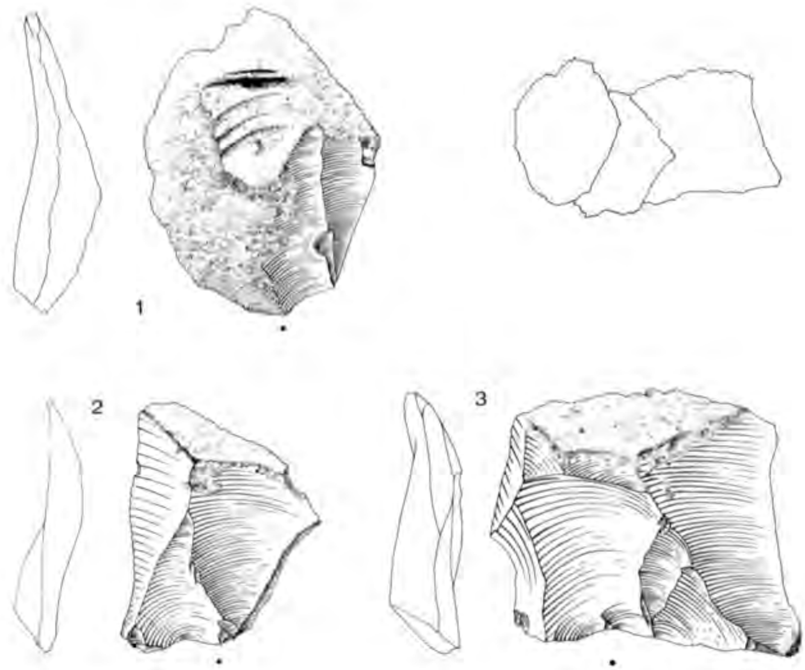


Fig. 124. Site E: conjoined flakes. Scale 2:3.

shifted material over a very limited distance. The sections studied and the structure and composition of the matrix embedding the Site E finds indicate that the enclosed material must have been affected by some reworking due to fluvial activity, probably in a low-energy environment, as is suggested by the micromorphology of the deposits (Mücher, pers.comm., 1983).

The tertiairy shells found in the Site E matrix point to the presence of small streamlets, which transported these fossils from Oligocene deposits a short distance west of Belvédère (Kuijper 1985).

Unlike the tertiairy shell material, the Pleistocene molluscs recovered from the Site E matrix are in an excellent state of preservation, which indicates that these shells can only have been transported over short distances, that is, if they were transported at all (Kuijper 1985). The same goes for the vertebrate faunal remains (Van Kolfschoten 1985), while the flint material shows no signs of transport whatsoever. Investigation of the flakes for surface modifications showed that the material was in mint condition, while several flakes could be fitted together providing further -and independent- evidence of only limited reworking of the flint assemblage.

So here we have a situation in which the archaeological association of two find categories is the result of geological processes, while on the other hand the evidence also indicates that the processes that resulted in this find complex may have disturbed an original primary association, because

Table 17: Site E: identified faunal remains of larger mammal species (based on: Van Kolfschoten 1985).

Mammuthus primigenius (mammoth)
- fragment of a lower molar

Equus sp. (horse)
- DP2 sin.
- fragment of an upper (pre)molar
- fragment of a lower (pre)molar
- humerus in. (distal part)
- unciform dext.
- metacarpus III dext.
- metacarpus III sin.
- metacarpus IV sin.
- anterior third phalange

Coelodonta antiquitatis (woolly rhinoceros)
- skull fragments
- M3 sin.
- ectoloph of an upper (pre)molar

Cervus elaphus (red deer)
- antler fragment
- radius dext. (prox.part)

Cervidae indet. (large deer)
- part of an upper molar

Rangifer tarandus (reindeer)
- dext.lingual part of an upper molar
- antler fragment
- metacarpus fragment
- metatarsus fragment

Bos primigenius/Bison priscus (aurochs/bison)
- M 1/2 dext.

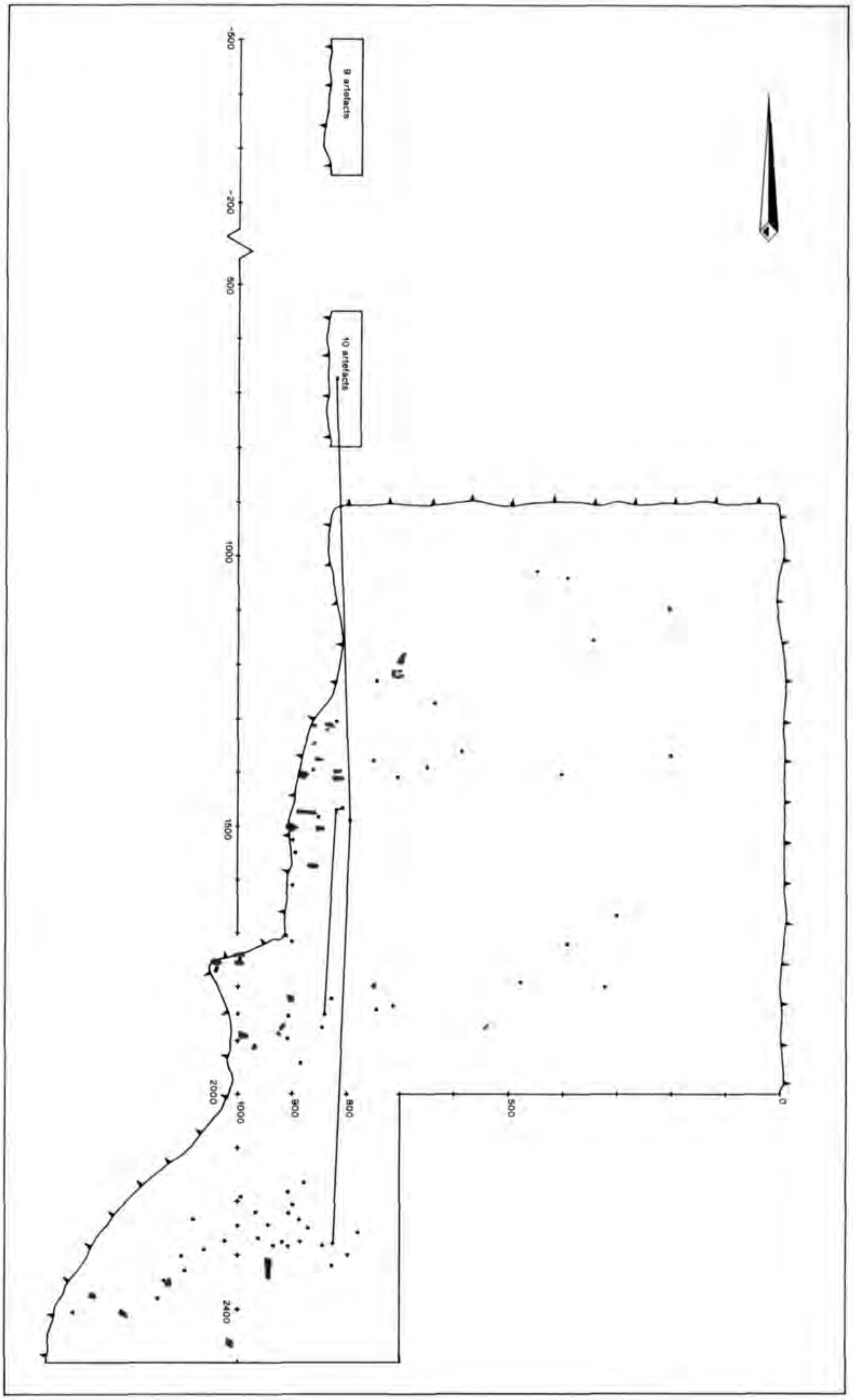


Fig. 125. Site E: horizontal distribution of recorded flint artefacts and (in grey) bone fragments. The lines connect the contact surfaces of refitted artefacts. Reference grid in metres.

both find categories seem to have been reworked over very short distances only. Four points seem to be important in the evaluation of this hypothesis of an 'earlier association', which boils down to the problem whether we can attribute the concentration of the Site E mammal fossils described here to natural processes.

1. In a first approach to the problem it is worth mentioning that -in contrast to the 'lower' Unit IV sites- the excavated area was *not* a waterside site at the time of the formation of the Site E assemblage, i.e. roughly in the 'Early Weichselian' (see 7.3.7). Whereas the Unit IV sites were all situated in the alluvial plain of the late Middle Pleistocene Maas, Site E was situated at the border of the Middle Terrace plateau, overlooking the valley of the Maas, which at that time flowed at least 5-10 m below Site E. Therefore it is highly unlikely that a considerable background fauna accumulated at this site, as must be assumed to explain a natural presence of the bone material at the site.

2. The total absence of gnawing marks on the Site E material indicates that non-hominid predators did not play an important role in the formation of the assemblage.

3. The small assemblage is dominated by remains of skulls and lower limbs. Cutmarks are absent, and so is evidence of breakage of the bones for marrow.

4. Two horses and a reindeer were represented by several identified skeletal remains (see table 17). As is the case with all macromammal remains found at Site E, we are dealing with young individuals (Van Kolfschoten 1985). The large number of young individuals over the limited area sampled was seen by Van Kolfschoten (1985) as a clear indication of hominid involvement in the formation of the faunal assemblage.

Points two and three would usually be interpreted as being the result of transport of meat-yielding bones away from the site of the initial butchering of the animals concerned (cf. Binford 1985). The absence of gnawing marks seems to exclude the possibility that carnivores were the collecting agents of the meat-yielding bones. This leaves us with two possibilities: the hunting of unexperienced individuals or the scavenging of young animals dying of attritional causes (see chapter 9). If the assumption made in point 1 above is correct -but how can it be evaluated?- and the situation of the site at the edge of the Middle Terrace 'plateau' indeed makes it difficult to explain the presence of carcasses, part of the Site E fauna can be interpreted as the remains of initial butchering by hominids of animals hunted for their meat.

7.3.6 ENVIRONMENT AND CLIMATE DURING THE FORMATION OF THE SITE E ASSEMBLAGE

Above the data have been presented for the inference that the flint artefacts and at least some of the larger mammal remains found at Site E are to be regarded as constituting

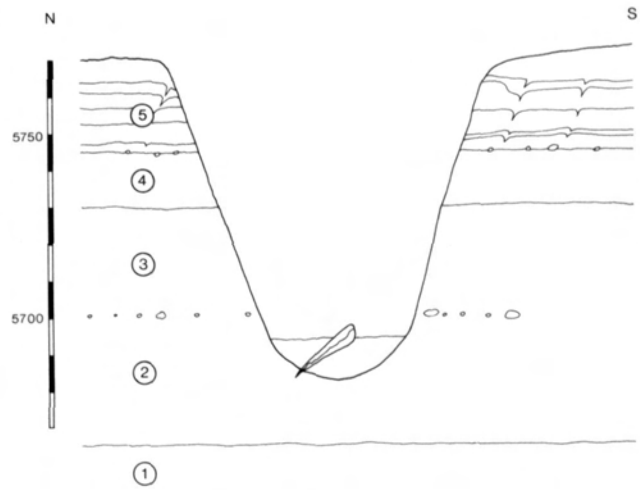


Fig. 126. Maastricht-Belvédère: section through the 'handaxe channel' (coordinates 175326/319964).
1 fine sands (10 YR 6/2) with intercalated gravel layers
2 silt loam, fine sandy (10 YR 5/6)
3 silt loam (10 YR 5/6) with common very pale brown (10 YR 7/4) mottles and very little gravel. At its base is a thin gravel layer, containing stones of up to 5 cm
4 silt loam (10 YR 5/6) with a few Fe and Mn concretions
5 pale brown (10YR 6/3) laminated silt loam, with small frost cracks, calcareous

an archaeological assemblage. According to Van Kolfschoten (1985), the fossils of the large and small mammals of Site E have to be regarded and treated as representing one single fauna. The molluscs found at Site E (Kuijper 1985) are also part of the same faunal association.

7.3.6.1 The molluscan evidence

Kuijper's (1985) analysis of the well-preserved Pleistocene shells from Site E indicates the combined presence of seven terrestrial and eight aquatic species in the matrix of the archaeological assemblage. The land snail *Pupilla muscorum* is the most dominant species. Together with *Limacidae* and *Trichia hispida* it forms the major part of the faunal remains. The rather large number of freshwater species led Kuijper to conclude that the faunal association was formed in an open area with a low vegetation. Shallow pools and marshes, which periodically dried out, were abundant. The fauna indicates periglacial conditions, comparable to those of the present-day tundras in northern Europe.

7.3.6.2 The vertebrate evidence

Table 18 lists the vertebrate faunal remains found at Site E. The most striking feature in the fauna is the abundant presence of the arctic lemming *Dicrostonyx torquatus*, which is predated by tundra birds of prey like the snowy owl *Nyctea scandiaca*, also represented in the remains. This owl might be reponsible for the abundant remains of small mammals at Site E (Van Kolfschoten 1985). The mammal assemblage also included the remains of watervole *Arvicola terrestris*. Of the larger mammals mammoth, woolly rhinoceros and reindeer preferred a cold climate and open areas. The red deer *Cervus elaphus*, which nowadays prefers woodland, seems to have been a very adaptive species, as discussed by Van Kolfschoten (1985). According to Van Kolfschoten, the habitats of the extant species and the composition of the fauna indicate a tundra/steppe environment with a cold and rather dry climate. According to Stuart (1982), the presence of *Cervus elaphus* may point to the absence of heavy snowfalls.

Table 18: Composition of the Unit VI-D Site E fauna (Fauna 5 in: Van Kolfschoten 1985).

Fauna of Site E:		minimum number of individuals
birds:		
Nyctea scandiaca	snowy owl	1
Mammals:		
Talpa europea	mole	1
Spermophilus (Urocitellus) cf.undulatus	ground squirrel	1
Cricetus migratorius	grey hamster	1
Dicrostonyx torquatus	arctic lemming	39
Arvicola terrestris	watervole	2
Microtus gregalis	narrow-skulled vole	1
Microtus oeconomus		12
Mammuthus primigenius	mammoth	1
Equus sp.	horse	2
Coelodonta antiquitatis	woolly rhinoceros	1
Cervus elaphus	red deer	1
Rangifer tarandus	reindeer	1
Cervidae indet.	(large deer)	1
Bos primigenius/ Bison priscus	aurochs/bison	1

7.3.7 THE AGE OF THE SITE E ASSEMBLAGE

The combination of the stratigraphical data and the palaeoenvironmental and taphonomical data presented above (clearly) shows that the finds have to be dated to a cold phase post-dating the foundation of the interglacial palaeosol correlated with the Eemian 'Sol de Rocourt' (see also 7.5).

Heavy-mineral-analysis of the find-bearing layer led Meijs (1985) to the conclusion that the sedimentation of the find matrix took place in the Middle Weichselian.

According to Van Kolfschoten's (1985) palaeontological assessment of the faunal assemblage of Site E, however, the fauna is of an Early Weichselian date.

To reconcile these two differing views, it could be assumed that the faunal assemblage formed in the Early Weichselian was reworked and finally deposited in the Middle Weichselian.

A provisional ESR age determination of a woolly rhinoceros tooth fragment yielded a very rough estimate of its age; ages of 135-165 ka and 105-120 ka were obtained for two pieces of the same tooth fragment, which result in an average age of 110-140 ka (Grün/Katzenberg, pers.comm., 1985). The environmental dose of the dated samples had not been measured but inferred from the stratigraphical position of the assemblage. TL capsule measurements in a comparable section near Site E, however, confirmed the soil estimate that had been used before.

The burnt flint WG 53, which is not an artefact, was submitted to the Oxford Research Laboratory for Archaeology and the History of Art for a TL age determination. The environmental dose was the same as for the ESR age determination: according to J. Huxtable (pers.comm., 1986), the burning took place some 145 ± 15 ka ago. The 'absolute' ages obtained in the ESR and TL determination were higher than we had expected on the basis of the stratigraphical position of the assemblage.

The small number of dated elements, however, means that these dates have to be used carefully. The composition of the fauna and its taphonomy already exclude a pre-Weichselian age, because late Saalian faunal remains in Unit V-B would very probably have decomposed during the Eemian soil-formation processes.

Furthermore, a problem with the dated material may be the disturbance of the finds when they were redeposited: the Unit 6.5 matrix, which contained the assemblage, included many stones, which may have enlarged the environmental dose received by the dated samples.

7.4 A 'Micoquian' handaxe from the Belvédère pit

On February 20th, 1981 the author found a large Micoquian-type handaxe in the pit, at the bottom of a recent erosional gulley that had been cut by rain- and meltwaters flowing off a larger artificial plateau, consisting of a complete Unit III-V sequence, covered by a few decimetres of a remnant of Unit VI-D. Figures 127 and 128 illustrate the artefact, while figure 126 gives a schematic survey of the stratigraphy in the erosional gulley, which was situated about 70 m southeast of Site A. The handaxe was found at the bottom of the small channel, 5 cm below a thin gravel layer that formed the base of a silt loam (10 YR 5/6) with greyish (10 YR 7/4) specks, i.e. what we would now call either Unit IV-C-III or Unit V-A. Theoretically, therefore, the handaxe may have come from any of the find levels from Unit IV-C-III upward. It was not possible to determine its position with greater accuracy because the base of

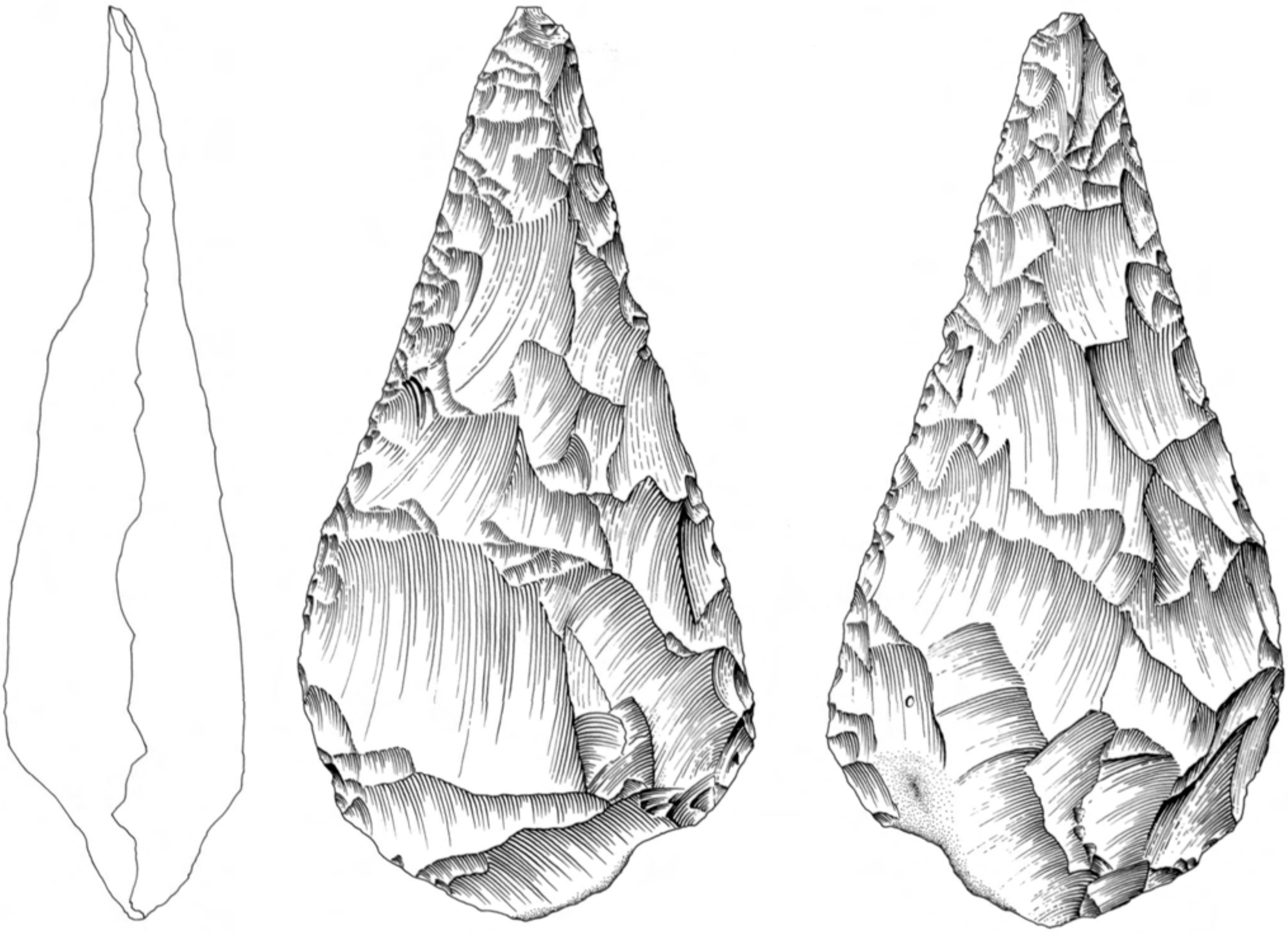


Fig. 127. The Micoquian handaxe, scale 2:3 (drawing by L.B.M. Verhart).

the channel contained clearly reworked material, like brick fragments and pieces of plastic collected by the water that had run off the surface of the plateau.

In order to try to establish its original position in the channel section, an area of abt. 5 m² was excavated from the top of the Weichselian loess remnants to the level where the handaxe was found in the days following the discovery. No artefacts were encountered in this excavation. During the fieldwork at Site A, in March 1981, a flake was found in the 'mottled zone' 5 m to the southwest of the handaxe. This flake, however, displayed surface modifications different from those observed on the handaxe. We therefore simply have no sound evidence of the original geological matrix of the handaxe: sediment scraped off the surface of the handaxe proved to be calcareous, but the bottom of the erosional gulley of course also contained reworked calcareous Weichselian loess. Sediment present in small quantities in the negative scars of the handaxe did not react at all to HCl, which may indicate that its original matrix was pre-Weichselian sediment. Another indication of its original geological matrix may be the surface modifications visible on the handaxe. One side of the artefact displays wind-gloss, which, as yet, is known only from artefacts collected from an erosional level in the upper part of Unit 6.5 (VI-D), below the Nagelbeek Horizon mentioned above in 7.3.2 (see fig. 121). Pieces collected from this level, however, show signs of severe abrasion and weathering, while the handaxe is in mint condition, apart from the wind-gloss observed on one side.

The handaxe in question is a typical example of Bosinski's (1967) *wechselseitig gleichgerichtete Kantenbearbeitung*. Its thick base consists partially of a rounded cortex. The Belvédère handaxe shows a striking resemblance to the *Micoque-Keil* from find level B2 at Rheindahlen (Thieme *et*

Fig. 128. The Micoquian handaxe, scale 2:3.

al. 1981; Thieme 1983a), which is said to have been found in the 'Eemian' parabrownearth, i.e. in the upper part of the Saalian loess. But it is very difficult to date artefacts by means of archaeological comparisons. All we can say about the Belvédère Micoquian handaxe is that its stratigraphical position is unclear and that therefore it cannot provide any evidence for the discussion on the chronostratigraphy of the 'Micoquian' in northwestern Europe (see: Bosinski/Brunnacker 1969; Löhr 1972; Thieme 1983a: 125-126). Once again we seem to be facing an isolated find of a handaxe, which is often the case with this kind of find category (see: Stapert 1979b; Keeley 1980). We will return to this topic in more detail in chapter 9 (see also: Roebroeks *et al.* 1988).

7.5 Interpretation of the Unit VI finds

Isolated artefacts have occasionally been found all over the Belvédère pit at the base of Unit VI. In 1983, K. Groenendijk and J.P. de Warrimont found seven flint artefacts concentrated at the base of Unit 6.5, in a Site C section through the centre of a karst depression.

As stated above, the Site E find scatter must have been part of a larger distribution, representing the material remains of early Weichselian human activities, preserved only locally by the presence of sediment and artefact 'traps'.

A site comparable to Site E was discovered in 1983 by K. Groenendijk and E. Meijs of the Belvédère working group at Kesselt (Belgium), 4 km west of Belvédère. The site was discovered in a systematical inspection of the loess exposure created during the reconstruction of the Albert Canal. The site, situated in a loess plateau on top of (Caberg) Middle Terrace gravels, was subsequentely excavated by the Laboratory of Prehistory of the Catholic University of Leuven. At Kesselt the find distribution was also limited to a depression, namely a gulley that had cut into the Saalian loess sediments. The Middle Palaeolithic assemblage found at this site, consisting of abt. 700 artefacts including 44 'tools', was stratigraphically associated with a faunal assemblage comparable to that of Site E. According to a preliminary report (Lauwers/Meijs 1985), this faunal assemblage included remains of *Coelodonta antiquitatis*, *Mammuthus* cf. *primigenius*, *Equus* sp., *Rangifer tarandus*, and probably also *Bison priscus*. Both the flint and the faunal assemblage of Kesselt show more signs of alteration than the Belvédère Site E assemblage. At Kesselt, for instance, many artefacts had been damaged by frost.

As far as its stratigraphical position and the contents of the (macro)faunal assemblage are concerned, the Kesselt site shows a striking resemblance to Site E at Belvédère. The dating evidence for the Kesselt site, however, is as yet rather scarce and its stratigraphical position between the 'Eemian' soil and the Horizon of Nagelbeek (Haesaerts *et al.* 1981) gives a large time range for the formation of the flint and faunal assemblages. For the time being we must await the results of the analysis of the few remains of small mammals from the site and the absolute dating work.

The quarry site Langweiler in West Germany, about 50 km east of Maastricht, is another example of a site comparable to Site E at Belvédère (Löhr 1972).

The dating evidence for the Belvédère site E has been presented in the previous section, where it was suggested that the archaeological assemblage formed in the Early Weichselian was reworked and finally deposited in the Middle Weichselian. In the light of the data obtained from Site J (7.2) it now seems very well possible that the Site E assemblage was originally situated in Unit 6.1. In the Middle Weichselian the material was eroded from its original matrix, which may have been comparable with that of Site J. Like the sites at Kesselt and Langweiler, Site E can, in the author's opinion, be interpreted as a kind of 'container' filled with remains of earlier Weichselian human activities, which have been preserved locally in a primary archaeological context, for instance in the Early Weichselian 'humic' zones. There are many sites attesting these two kinds of preservation: in northwestern France the 'limons humifères', for instance, included the typical Mousterian 'Atelier Kelley' at St.Just-en-Chaussée (Tuffreau 1977), while the assemblage of Seclin mentioned above (7.2) had a similar (loess-) stratigraphical position. At other sites the industries were found inside a *cailloutis* which had reworked the humic horizons (Marcoing, Busigny, Catigny: cf. Tuffreau 1979).

Data of relevance in determining the relationship between Site E and Site J were obtained in a preliminary analysis of the Site J flint material. As stated above, the Site J flint assemblage contained three thin small 'soft-hammer' flakes, curved towards the dorsal surface along the butt-to-tip axis and having lipped butts. They were interpreted as handaxe resharpening/finishing flakes. The three flakes were of a very light-brown/grey flint with small (< 1 mm) dots, which is rare at Belvédère. The only other example of this flint is the top part of a pointed handaxe found at Site E (fig. 123-3). The resharpening spalls could not be fitted to this fragment, but the technological aspects and the properties of the raw material suggest that the three Site J flakes were struck from the Site E handaxe.

These data point to a relation between the two lithic assemblages recovered about 150 m from each other. We must, however, stress the fact that 'Early Weichselian' humic horizons, in the Belvédère pit as well as in other parts of northwestern Europe, usually contain very little bone material in a state of preservation resembling that of the Site E faunal assemblage. At Belvédère the humic horizon (Unit 6.1) has so far produced only one poorly preserved bone fragment and very fragmentary remains of mammoth molars. At most of the archaeological sites no bone material had been preserved in this 'humic horizon'

(Rheindahlen Westwand/B1: Bosinski 1966; Thieme 1983a; Rocourt: Cahen/Haesaerts 1984; Seclin: Tuffreau *et al.* 1985; Saint-Just-en-Chausseé: Tuffreau 1977). This may indicate that the Site E faunal assemblage was originally situated at a higher, calcareous level, together with part of the Site E flint material. We do have some faint indications of the presence of such a 'higher' level: in 1985 a fragment of mammoth bone was recorded above the Unit VI-A 'humic horizon' near Site H (not discussed in this volume), while a fresh flint flake was found at the same level, at abt. 10 m from the bone.

In the discussion of the Site E flint material we stated that the flint assemblage showed no signs of having been transported over considerable distances. Combining this assessment with the data presented here, the author suggests that
1. the handaxe resharpening flakes found at Site J indicate that the people responsible for the creation of the Site J assemblage were in one way or another involved in the formation of the Site E artefact assemblage.
2. the Site E faunal and lithic assemblage probably contains the palimpsest remains of different human activities separated in time, the 'faunal output' of which could only survive because it was embedded in a calcareous matrix, deposited after the formation of Unit 6.1.

It is however also possible that the total Site E flint-faunal assemblage was formed in a relatively short time by the same group of people. In this scenario the faunal elements owe their state of preservation to the local presence of calcareous sediments within Unit 6.1. In view of the taphonomy of the site the author prefers the 'palimpsest scenario' for the interpretation of Site E.

Palaeoenvironmental and dating evidence for the Unit IV-C sites: an evaluation

8.1 Introduction

The aim of this chapter is to present and evaluate data pertaining to the palaeoenvironmental and chronostratigraphical context of the most important archaeological phenomena in the pit, the Unit IV-C sites. As already stressed earlier (chapter 5), we do not have a clear idea of the time interval between the formation of the Unit IV-C-I and the IV-C-III sites, and in fact all the Unit IV-C sites reported on in this volume could be considered contemporaneous in a very strict sense, i.e. in terms of hundreds of years. Before we discuss the palaeoenvironment of these sites, however, it has to be stressed that hardly any environmental indicators are known from the Unit IV-C 'upper level' sites (cf. chapter 2). As there are no geological reasons to assume large time differences between the formation of the sites at the two levels (see 5.1) the discussions in the present and the following chapters are based on the assumption that Sites A, D, F and K were formed under the same environmental and climatological conditions as the Unit IV-C-I sites, for which we do have sound evidence[1]

The data relevant to the discussion of the environment and climate during the formation of 'the' Unit IV-C archaeological assemblages will be presented in paragraph 2 of this chapter, while paragraph 3 will focus on the dating evidence.

The dating evidence and its interpretation brings us to a more general topic, that of the correlation of local events with stratigraphical schemes of a larger scale, a step which concerns the inferred 'established-fact' character of the local and the general sequences. The problems encountered in this step will be discussed in the final part of this chapter (8.4).

8.2 Environment and climate during the formation of the Unit IV-C-I archaeological assemblages

8.2.1 THE SEDIMENTOLOGICAL EVIDENCE

According to Vandenberghe *et al.* (1985) and Mücher (1985), the finely-grained Unit IV-C sediments were deposited in a low-energy fluviatile environment. Levee-like structures, bordered by backswamp-deposits and a gulley, were identified in a 115-m long section (Vandenberghe *et al.* 1985) (see also: Ruegg 1982).

The archaeological remains of Site C appeared to be situated on such a 'levee', which had been affected by karst formation. Figure 129 gives a reconstruction of the original geomorphology of the site prior to the karst disturbances, based on data obtained in the 1981-1983 field campaign. This figure was constructed as follows. The disturbances postdate the formation of the Unit 3 gravel, the top part of which is assumed to have had a more or less horizontal surface originally. The palaeorelief of Unit IV during the formation of the archaeological Site C assemblage is basically reflected by the distance between the top of the gravel layer and the surface occupied by man. The top of the Unit 3 gravels was recorded along the excavation grid-lines by means of manual and mechanical borings. The vertical distance between the top of the gravel and the average depth at which artefacts were found was plotted per square metre along the grid-lines and the cross-sections produced in this way were converted to obtain a rough approximation of the palaeorelief of the levee during the occupation of the site.

The evidence obtained in this way corresponds to data from sections not affected by karst disturbances (to the northwest of the site) and confirmed our expectations, based on the lateral grain-size sequence of the site, where the sediments were loamier in the lower northern and eastern parts and less finely-grained in the higher central, western and southern parts.

8.2.2 THE MOLLUSCAN EVIDENCE

Analysis by T. Meijer (1985) of the rich molluscan faunal remains from the Unit IV-C sediments containing the archaeological assemblages allowed a detailed reconstruction of the environment and climate during the formation of the archaeological assemblages of sites B and C. The site G assemblage occupied the same stratigraphical position. The molluscan faunal remains from site G have not yet been analysed completely but are expected to confirm the picture presented below, which is based on samples taken from a large number of sections (eleven in total; see: Meijer 1985). This paragraph summarizes Meijer's work (1985).
Section Moll.2, situated northeast of the Site C excavation in a low palaeotopographical position (fig. 130), was sampled for molluscs and the remains of small vertebrates before the Site C excavation was started. In his study of the

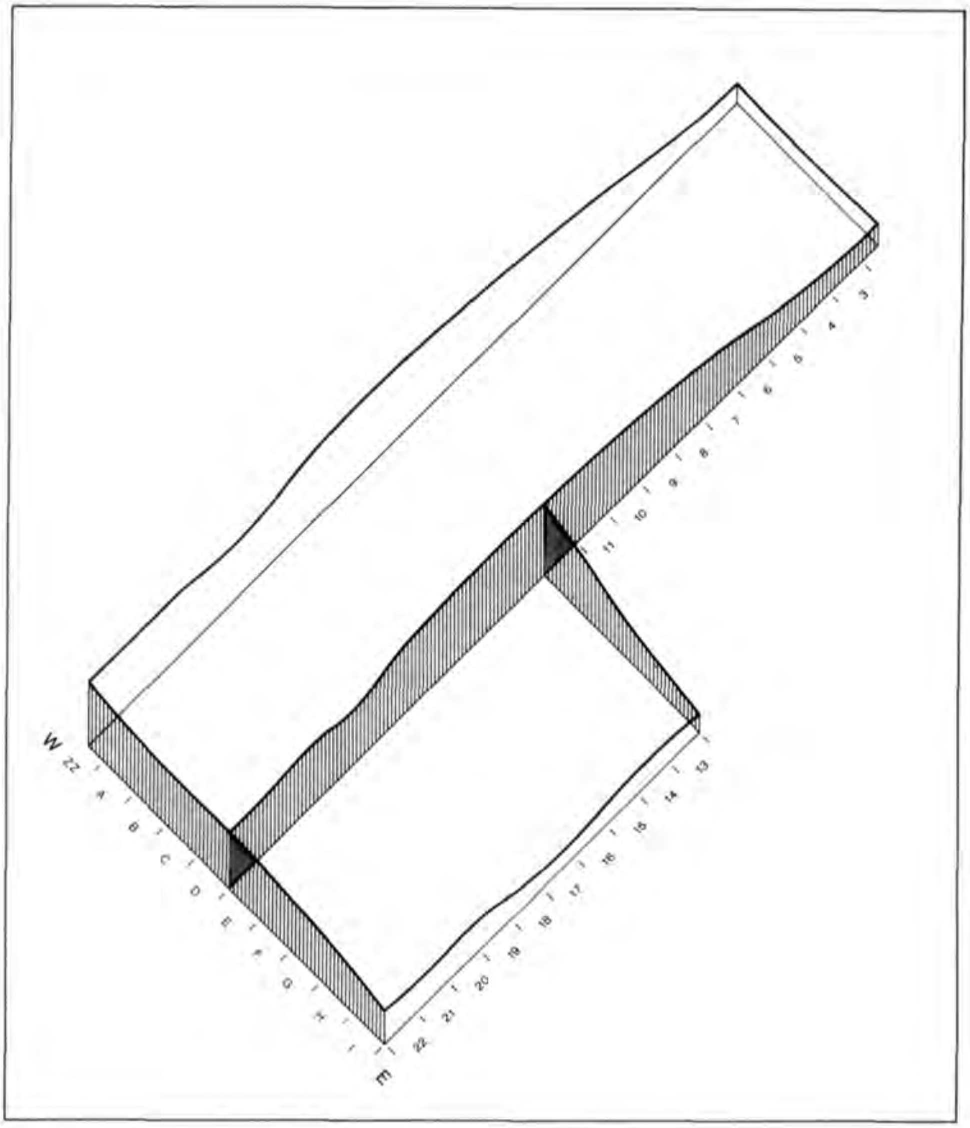


Fig. 129. Axonometric reconstruction of the morphology of the Site C area at the time of the formation of the archaeological assemblage. See the text for an explanation.

Unit IV molluscan fauna, Meijer noticed stratigraphical differences in species composition that seemed to be semi-independent of the sedimentary facies. Meijer was able to define five zones (A-E), each zone being characterized by the first occurrence of certain mollusc species at its base. These were interpreted as chronological zones (see fig. 130). The first artefacts encountered at site C were situated in the lower part of Meijer's molluscan zone D (fig. 130). Since we had ascertained that the post-depositional vertical disturbance of artefacts ranged up to 25 cm, we inferred that the archaeological assemblage of Site C had been formed at the time of the deposition of the molluscs in the upper part of zone C and the lower part of zone D. No flints were found in the calcareous tufa in the upper half of zone D and zone E, nor at Site C itself or anywhere else in the Belvédère pit.

In the immediate surroundings of the area sampled a pool of gently flowing to stagnant water with a maximum depth of 1.5 to 2 m was indicated in the composition of the fauna. The area itself was protected from the main stream of the river and had a dense aquatic vegetation, which Meijer has described as a lacustrine 'niche' in a mainly fluviatile environment. Along its borders this vegetation was of the Magnocaricion type, which grows in marshy places with at most about 20 cm of water. Periodically, perhaps in the winter, the borders on which the vegetation grew dried out. In all probability the majority of the sites sampled and analysed by Meijer in molluscan zones C-E were situated near or formed part of this Magnocaricion vegetation belt.

At a higher level in the palaeotopography the Magnocaricion was mixed with -or bordered by- alder (*Alnus*) forests with ash trees (*Fraxinus*; charcoal remains of *Fraxinus* were

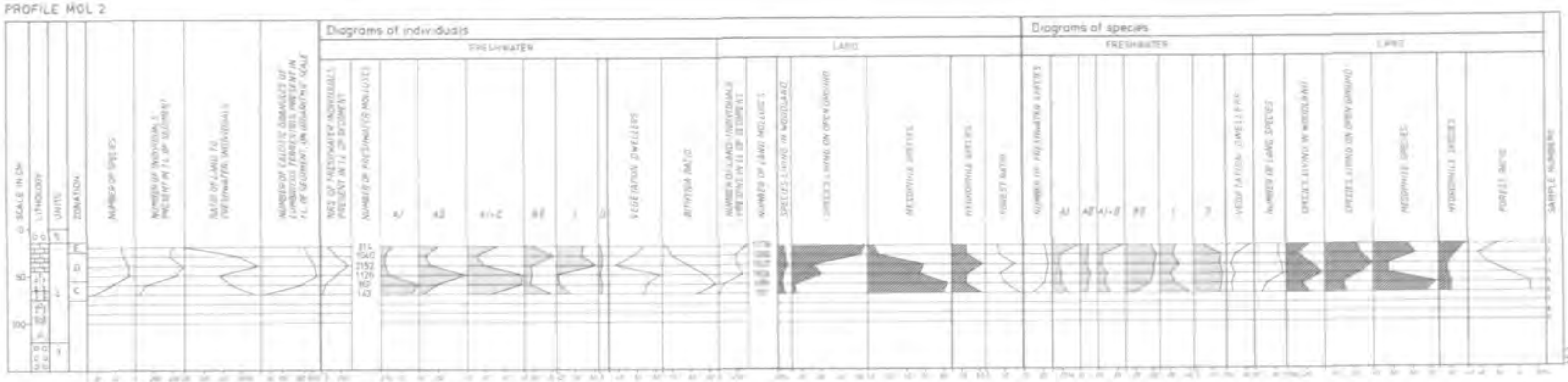


Fig. 130. Profile Moll.2, situated at the northeastern border of Site C (from Meijer 1985, figure 3).
A, B, C and D of the freshwater ecological diagrams refer to species of:
- marshes (A-I),
- stagnant, poorly vegetated waters (B-I),
- stagnant, well vegetated waters (B-II, B= B-I + B-II),
- stagnant and flowing waters (C)
- flowing waters (D).

The Bithynia ratio reflects sorting effects caused by movement of the water, a 1:1 ratio of opercula and shells being expressed as 50%, and a 2:1 ratio as 100% (see Meijer 1985).

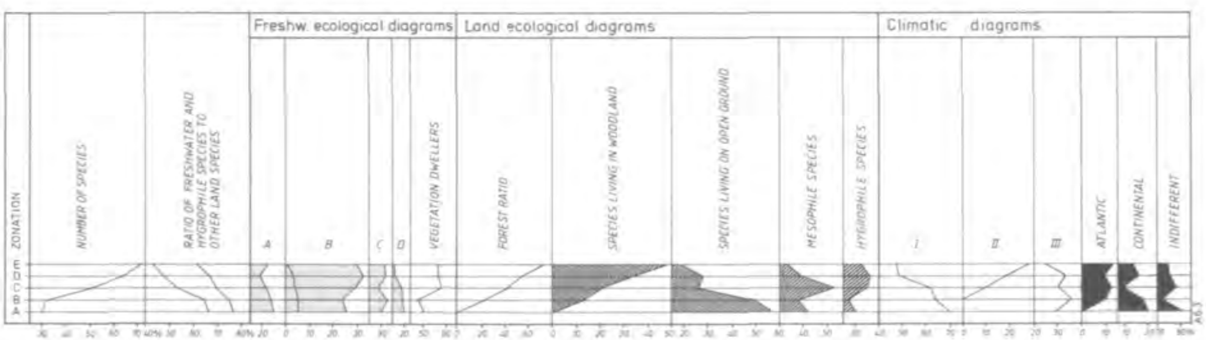


Fig. 131. Diagrams of mollusc species based on a compilation of all species present in each zone (from Meijer 1985, figure 6). See fig. 130.
I, II and III in the climatic diagrams indicate:

I species extending north of the arctic circle, most of these are common on the European mainland too; species with a restricted arctic distribution are absent in Unit 4.

II species with a habitat extending to the arctic circle or not far south of it.

III species with a habitat extending only to the southernmost part of Scandinavia or confined to the European mainland.

found at Site C). On even higher grounds the alder woods changed into deciduous forests of drier habitats; there the vegetation could have been of an open forest type with an abundant undergrowth and a dense vegetation of grasses and herbs in open areas. The possibility that there was a pine forest or a dense deciduous forest with little or no undergrowth can be excluded. The forests of the drier habitat may have been of the Fago-Quercetum type with an admixture of hazel. According to Meijer (1985), there are indications that *Ilex* also grew here. Open areas had a dense vegetation of grasses and herbs. Finally, it is to be stressed again that this reconstruction of vegetational characteristics is based solely on the study of *mollusc* assemblages!

As can be seen in figure 131 (taken from Meijer 1985), a climatic transition took place during the deposition of the Unit IV sediments. The evidence points to a slightly more continental climate before zone D than afterwards. This is in accordance with the results obtained in the study of vertebrate remains by Van Kolfschoten (1985), who arrived at an identical climatic transition (see 8.2.3).

The climatic trends are well expressed by the development of the *terrestrial* fauna. The percentage of molluscan species living in woodland environments increases from 0% in zone A to almost 50% in zone E; the percentages of species living in open terrain decreases from 58% in A to 18% in E.

Seventy species were identified in zone E; this number and the variety in species indicate the 'interglacial' status of the fauna. The most important species are *Bithynia troscheli*, which occurs in Lower and Middle Pleistocene interglacial deposits in the Netherlands, *Corbicula fluminalis*, which is associated with warm-temperate stages, *Spermodea lamellata*, which is characteristic of old woodland, and *Zonitoides sepultus*, which is an extinct species that lived in moist deciduous forests on calcareous soils and is known from Lower and Middle Pleistocene pre-Eemian interglacial deposits.

Meijer also inferred absolute data on the climate during the formation of the archaeological assemblage by comparison with the present living conditions of the various molluscan species. He concluded that the zones from zone D upward had been formed in a climate characterized by high annual rainfall (at least 800 mm vs. less than 700 mm at present). The mean annual temperature was at least 10°C (today 9.5-10°C). Mean July temperatures were certainly not below 15°C and probably reached 18°C (today 17.5°C). Mean January temperatures were more difficult to estimate, but were certainly above 0°C (today 2-2.5°C).

According to Meijer, the climatic optimum was reached in molluscan zone D, since no new mollusc species of the most demanding climate group were found in zone E, which zone contained evidence of species occurring in old woodland.

The preliminary results of the analysis of the Site G molluscan fauna (Duistermaat 1987) are essentially the same as those arrived at by Meijer (1985).

At Site G the Unit 4 sediment of 14 m^2 was sieved through a 0.5-mm mesh screen in levels of 5 cm. Duistermaat (1987) analysed the sieve residue from square 48/106. The species composition of the fauna was comparable to that of Meijer's molluscan zones D and E. In the Site G faunal remains, however, four species were identified which were not represented in the remains analysed by Meijer: *Azeca goodalli*, *Belgrandia marginata*, *Cochlodina laminata* and *Vertigo alpestris* (see 8.4.2).

The *freshwater* faunal remains point to the proximity of gently flowing to stagnant water; at Site G itself the picture is dominated by stagnant water, rich in vegetation, which gradually changed into a swamp. Furthermore, the fauna points to the presence of a Magnocaricion vegetation with dispersed alder-carrs. Like Meijer (1985), Duistermaat infers that a mixed deciduous forest grew on higher grounds. Finally, it is worth mentioning that the number of forest species indeed gradually increases in upward direction in the Site G section, but that the archaeological remains were deposited in a period in which the number of forest species had decreased significantly. The molluscan evidence indicates that the site G artefacts were deposited in a period in which the area formed a temporarily open place in a forested environment.

8.2.3 THE VERTEBRATE EVIDENCE

The results of Van Kolfschoten's (1985) study of the vertebrate remains collected from Unit IV (Units IV-A/IV-C) support Meijer's (1985) ideas on the climatological transition during the formation of Unit IV.

The faunal remains collected in the (mostly sandy) lower parts of Unit IV (IV-A/IV-B) (Van Kolfschoten's 1985 Fauna 3; see table 19) included steppe elements, for example steppe pika, *Ochotona pusilla*, ground squirrel, *Spermophilus* cf. *undulatus*, and hamster, *Cricetus cricetus praeglacialis*, which led Van Kolfschoten to conclude that the sediments had been deposited in a steppe environment, in a temperate continental climate. Species indicating the presence of woods may have come from the upper part of the IV-A/IV-B sequence (Van Kolfschoten, in press).

In 1987, Unit 4.4 yielded a large number of articulated bones of an almost complete skeleton of an adult steppe rhinoceros, *Dicerorhinus hemitoechus*, found over an area of about 7 m2 (Van Kolfschoten 1988). Figure 132 shows bones from the hind legs of this individual, while figure 133 shows a series of upper jaw molars. Close to this skeleton, which was partially saved from destruction by quarrying activities by De Warrimont and Groenendijk (1988), an ulna of another, more robust rhinoceros individual was found. These remains were not associated with any arte-

Table 19: Composition of the vertebrate faunal remains from the lower part of Unit IV (IV-A/B) (Fauna 3 in: Van Kolfschoten 1985).

fish:	
Leuciscus cephalus	chub
Chondrostoma nasus	nase
mammals:	
Talpa europaea	mole
Sorex araneus	common shrew
Neomys fodiens	water shrew
Ochotona pusilla	steppe pika
Spermophilus cf. *undulatus*	ground squirrel
Cricetus cricetus praeglacialis	hamster
Clethrionomys glareolus	bank vole
Arvicola terrestris	water vole
Microtus gregalis	narrow-skulled vole
Microtus arvalis and/or *Microtus agrestis*	vole
Microtus sp.	vole
Apodemus sylvaticus	wood mouse
Apodemus maastrichtiensis	
Mammuthus sp.	mammoth
Dicerorhinus hemitoechus	steppe rhinoceros

facts, and belong to the 'natural background fauna' (see chapter 9.4).

The faunal remains of the lower part of Unit IV and also the faunal assemblages higher up in the Unit IV sediments included remains of a small- to medium-sized murid, *Apodemus*, which, according to Van Kolfschoten (1985), differs from all other *Apodemus* species in the steepness of the slopes of the cusps in its lower molars. Van Kolfschoten has named this species *Apodemus maastrichtiensis* after the town of Maastricht. Other sites from which this species is known are Fransche Kamp at Wageningen (the Netherlands) and Miesenheim (West Germany), both Middle Pleistocene sites, dating from an intra-Saalian warm-temperate and a pre-Saalian warm-temperate phase, respectively.

The faunal remains of the upper part of Unit IV -where human activities are attested (Unit IV-C)- do not include steppe species, but instead a great number of species indicative of a more humid environment. Table 20 (Van Kolfschoten 1985) lists the vertebrate species present in Unit IV-C-I/II.

That there were deciduous woods and also open country in the vicinity is indicated by the composition of the faunal assemblage of small mammals. Noteworthy is the presence of the garden dormouse *Eliomys quercinus*, which inhabits deciduous and mixed forests and is nowadays widely distributed in the southern part of western Europe up to the (southern part of the) Netherlands.

A rather warm climate is indicated by the presence of the

Table 20: Composition of the vertebrate faunal remains from the upper part of Unit IV (IV-C-I/II) (Fauna 4 in: Van Kolfschoten 1985; also: Van Kolfschoten in press).

fish:	
Leuciscus cephalus	chub
Chondrostoma nasus	nase
Esox lucius	pike
reptiles:	
Emys orbicularis	European pond tortoise
birds:	
Anatidae indet.	
mammals:	
Erinaceus cf. *davidi*	hedgehog
Talpa europea	mole
Sorex araneus	common shrew
Sorex minutus	pygmy shrew
Neomys fodiens	water shrew
Crocidura sp.	
Eliomys quercinus	garden dormouse
Clethrionomys glareolus	bank vole
Arvicola terrestris	water vole
Pitymys cf. *subterraneus*	pine vole
Microtus oeconomus	root vole
Microtus agrestis	short-tailed vole
Microtus arvalis	common vole
Apodemus sylvaticus	wood mouse
Apodemus maastrichtiensis	
Mustela cf. *nivalis*	weasel
Elephantidae indet.	
Elephas cf. *antiquus*	straight-tusked elephant
Dicerorhinus hemitoechus	steppe rhinoceros
Bovidae indet.	
Cervus elaphus	red deer
Cervus (M.) giganteus	giant deer
Capreolus capreolus	roe deer

European pond tortoise *Emys orbicularis*, which inhabits ponds, lakes and rivers with calm waters (Stuart 1979, 1982), and requires mean July temperatures exceeding 17-18°C to hatch its eggs. The northern limits of its current breeding range in northwestern Europe lie to the south of the Netherlands. Further eastwards, in central Europe, it extends further to the north (Stuart 1982).

The larger mammals convey the same impression of the environment as the smaller ones. The weasel *Mustela nivalis* lives in forests with a high, dense vegetation. The rhinoceros *Dicerorhinus hemitoechus* and the giant deer *Cervus (M.) giganteus* are associated with open areas. Nowadays, the red deer *Cervus elaphus* prefers a temperate climate and a wooded habitat, but it has proven to be a very adaptive species (Van Kolfschoten 1985). Finally, *Capreolus capreolus*, roe deer, prefers a forested habitat.

To summarize, the species represented in Van Kolfschoten's Belvédère Fauna 4 indicate that Unit IV-C was deposited in an environment consisting of grasslands and forests and in a warm-temperate climate, which might have been somewhat warmer than our present-day climate.

8.2.4 THE PALAEOBOTANICAL EVIDENCE

Despite intensive research at pollen laboratories of the Institute of Prehistory of Leiden University and the State Geological Survey Haarlem, no fossil pollen has been found in the Unit IV sediments (De Jong 1982). The only palaeobotanical evidence from Unit IV consists of tiny charcoal particles, most of which were found at Site C. A sample of a small concentration of charcoal particles found in the eastern part of Site C was analysed by W. Schoch (Labor für Quartäre Hölzer, Birmensdorf, Switzerland), who determined that they came from coniferous as well as from deciduous trees (Schoch, in litt. 1982). He identified eight particles from the larger charcoal concentration in the western part of the site as *Fraxinus* sp. (Schoch, in litt. 1982) and a piece of charcoal collected in the upper part of Unit IV (Unit IV-B or IV-C) in the neighbourhood of Site G as cf. *Quercus* (Schoch, in litt. 1982).

8.2.5 DISCUSSION

In the previous sections data have been presented that are relevant for reconstructing the palaeoenvironment and the climate during the formation of the Unit IV-C archaeological assemblages. Even though they are based on various kinds of evidence and relate to different parts of the palaeoenvironment on different scales, these data support each other. The sedimentological evidence, for example, is confined to the river sedimentation area, while the molluscan assemblages provide information about a larger area, mainly the river valley. The larger vertebrates certainly roamed an area that was much more extensive than the river valley. The small mammal assemblage is partly a product of the activities of birds of prey, such as kestrel and buzzard (Mayhew 1977; Van Kolfschoten, pers.comm., 1985). The role of the predatory birds in the accumulation of fossil remains of small mammals in open sedimentary environments has been stressed by Mayhew (1977) in an examination of the Cromerian Upper Freshwater Bed sediments at West Runton, England. Mayhew also stressed that the excellent state of preservation of vertebrate material in owl pellets means that teeth of small mammals contained in these pellets cannot be distinguished from teeth incorporated from most other sources, except pellets of diurnal raptors. The Unit IV assemblage of remains of small mammals, therefore *partly* represents the biotope of diurnal birds of prey, filtered through their food preferences.

Finally, it is worth mentioning that large herbivorous mammals such as elephants and rhinoceros may have been partly responsible for the presence of grasslands as indicated by the molluscan and small mammal evidence presented above. Lock (1972) has given a detailed description of the effects of grazing by *Hippopotamus* in the grasslands of East Africa, and has shown that these animals are the main cause of the observed zonation of vegetation alongside permanent water sources. Turner (1975) has suggested that large Pleistocene herbivores like rhinoceros and elephants may have had a considerable effect on the vegetation by means of their grazing, browsing and trampling activities, which could have effectuated an increase in open terrains at the cost of woodland. Turner furthermore stresses that pollen spectra of sites with rich fossil vertebrate faunas have to be interpreted very carefully because false interpretations are possible on two levels: in the study of the local vegetational succession and in comparisons with other pollen spectra, which may have been affected less by 'disturbance' by larger herbivores (Turner 1975: 18).

8.3 Unit IV-C: the dating evidence

8.3.1 RELATIVE DATING EVIDENCE

8.3.1.1 Terrace stratigraphy

At Belvédère the Unit III gravels of the Caberg terrace are overlain by the fine-grained Unit IV sediments, which are genetically related to the deposition of the gravels. Unit IV was deposited towards the end of the 'Caberg Maas' activity, when less energetic conditions prevailed (Vandenberghe *et al.* 1985). According to Paulissen (1973), the Caberg Terrace can be dated to an earlier part of the Saalian. Paulissen recorded an Eemian soil that had been formed in coversands on top of the Middle Terrace of Eisden-Lanklaar (see chapter 2), which is separated from the higher Caberg Terrace by an important erosive period. Paulissen dates the Caberg Terrace to Riss I and the terrace of Eisden-Lanklaar to Riss II.

On the basis of the terrace chronology, the Unit IV assemblages therefore have to be dated to the Saalian, that is, if 'Riss' is correlated with the 'Saalian'.

8.3.1.2 Palaeosols and loess-stratigraphy

As shown above (chapter 2), the soil that had developed in the top part of the Unit IV/V-A complex is overlain by Unit V-B deposits, the upper part of which consists mainly of redeposited loess (Vandenberghe *et al.* 1985). On top of Unit V-B a distinct argillic horizon was observed, which is correlated with the Eemian Rocourt palaeosol (Mücher 1985). According to its heavy mineral associations, the loessic parent material of this luvisol dates from a pre-Weichselian loess cycle (Meijs 1985).

These data point to a Saalian or pre-Saalian date for the formation of the Unit IV assemblages.

8.3.1.3 Biostratigraphy

1. The mammalian faunal remains collected in the Belvédère pit provide the basis for assigning a *terminus ante quem*

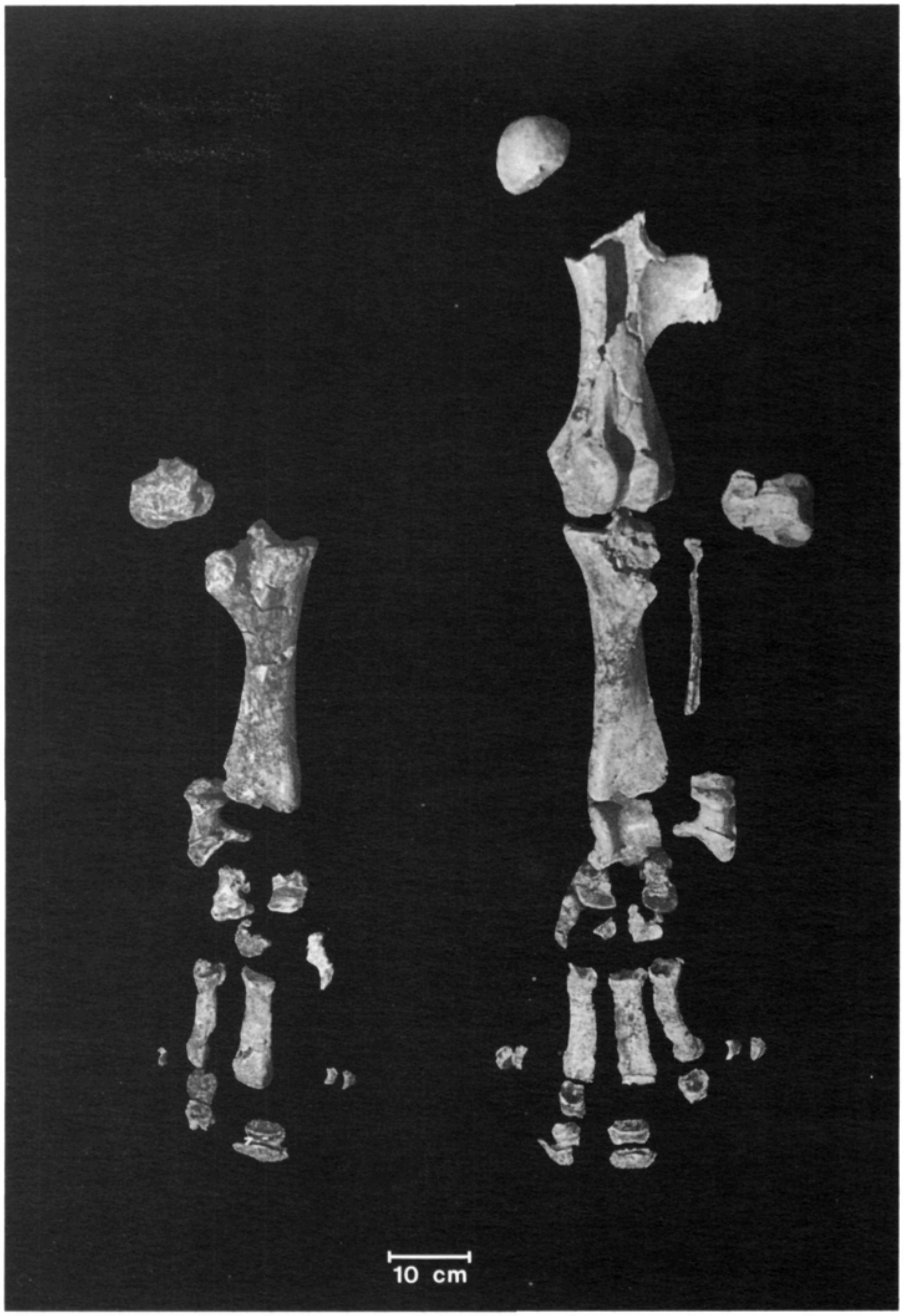


Fig. 132. Bones from the hind legs of a *Dicerorhinus hemitoechus* individual found in 1987 in Unit 4.4. sediments.

and a *terminus post quem* to Unit IV and the formation of the archaeological assemblages (Van Kolfschoten 1985).

a: *Terminus ante quem*: The faunal assemblage of Unit IV included the remains of a subspecies of watervole (*Arvicola terrestris*) which has a type of differentiation in enamel thickness that is more primitive than that of *A.terrestris* found at Rhenen (central Netherlands) in ice-pushed sediments that were deposited before the advance of the Saalian ice-sheet (Van Kolfschoten 1981, 1985, in press)[2]. The Belvédère Unit IV-C faunal remains, and consequently also the formation of the Unit IV-C archaeological assemblage, can be placed in a warm-temperate climatic stage well before the advance of the Saalian glacier in the central Netherlands.

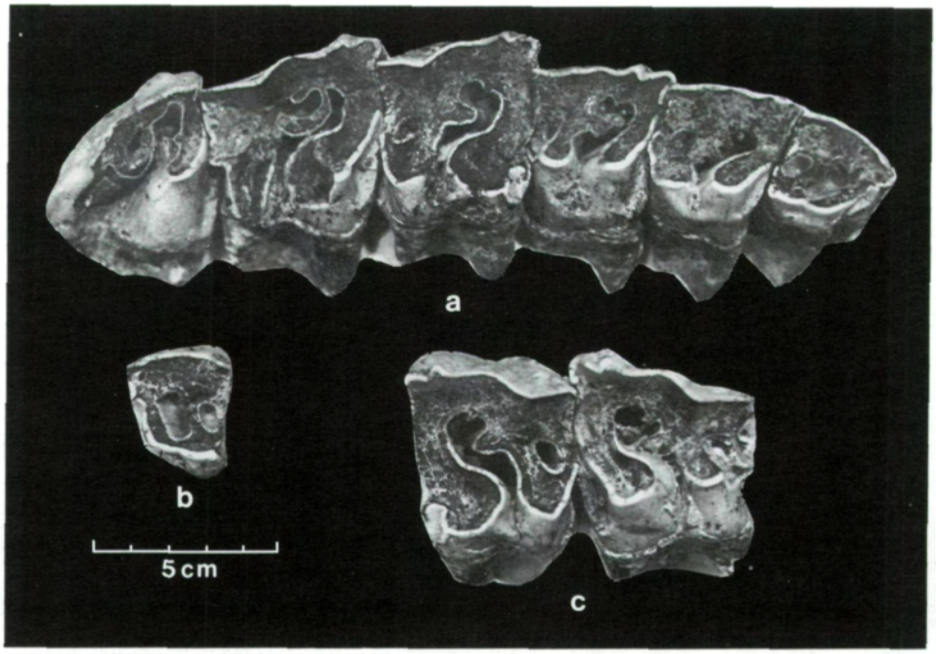


Fig. 133. Dental elements from the upper jaw of a *Dicerorhinus hemitoechus* found in 1987 in Unit 4.4. sediments.
a P2-M3 dext. (from right to left)
b P2 sin.
c M1 and M2 sin.

b: *Terminus post quem*: In the Unit III gravels underlying the finely-grained fluviatile deposits of Unit IV the remains of woolly rhinoceros (*Coelodonta antiquitatis*) and mammoth (*Mammuthus primigenius*) were found. According to present knowledge these two species do not occur in deposits older than the Saalian and its stratigraphical equivalent, the Riss glacial of central and southwestern Europe (Van Kolfschoten 1985).
The picture emerging from these data allows us to place the faunal assemblage between the Holsteinian and the advance of the Saalian ice sheet in the central Netherlands (Van Kolfschoten 1985). Therefore, the warm-temperate stage of Unit IV-C must be intra-Saalian.
2. According to Meijer (1985), the rich molluscan assemblage from Unit IV-C (76 identified species) has to be dated to an interglacial stage. In Meijer's opinion, this stage must predate the Eemian and postdate the Holsteinian.
3. The combined biostratigraphical evidence, based on analyses of the mammal and molluscan faunal remains from Unit IV-C, allows us to date the Unit IV-C assemblages to a warm-temperate intra-Saalian climatic phase between the Holsteinian and the advance of the Saalian ice sheet in the central Netherlands.

8.3.2 ABSOLUTE DATING EVIDENCE

8.3.2.1 Thermoluminescence dating

Table 21 gives the individual ages of the analysed flints, as published by Huxtable and Aitken (1985), together with some new results obtained with burnt flints from Site G and Site K. These new results confirm the TL age published for Unit IV, which was based on the measurement of four flints found close to one another at Site C (K4, 5, 6 and 13) and one burnt flint from Site F (K11). The average age obtained was 270 ka (± 11, ± 22 ka, OxTL 712k). According to Huxtable and Aitken (1985), the inclusion of K12 (a burnt flint found in a section) and K14 (one of the first Site G finds recovered outside the excavated area) would reduce this age by only 3%. The first error limit gives the standard error derived from the scatter of the individual ages around

Table 21: TL ages obtained for burnt flints from the IV-C deposits at Maastricht-Belvédère, based on data in Huxtable and Aitken 1985: Huxtable, pers.comm., 1986-1987 (see fig. 134).
* K17, K19 and K23 are single age determinations, which have not yet been incorporated in the average age.

context	find No.	Oxford Laboratory reference	TL age
Site C	Az 12/19	712 K4	300 ± 32 ka
Site C	Cz 19/15	712 K5	263 ± 27 ka
Site C	Bz 20/2	712 K6	238 ± 20 ka
Site F	22/22-44	712 K11	307 ± 28 ka
Unit 4.5	dW 84/2	712 K12	250 ± 21 ka
Unit 4.5	dW 84/1	712 K13	269 ± 26 ka
Site G	1984 11/bf	712 K14	219 ± 20 ka
Site G	49/106-2	712 K17*	238 ± 25 ka
Site G	46/105-10	712 K19*	220 ± 20 ka
Site K	7/203-1	712 K23*	218 ± 24 ka

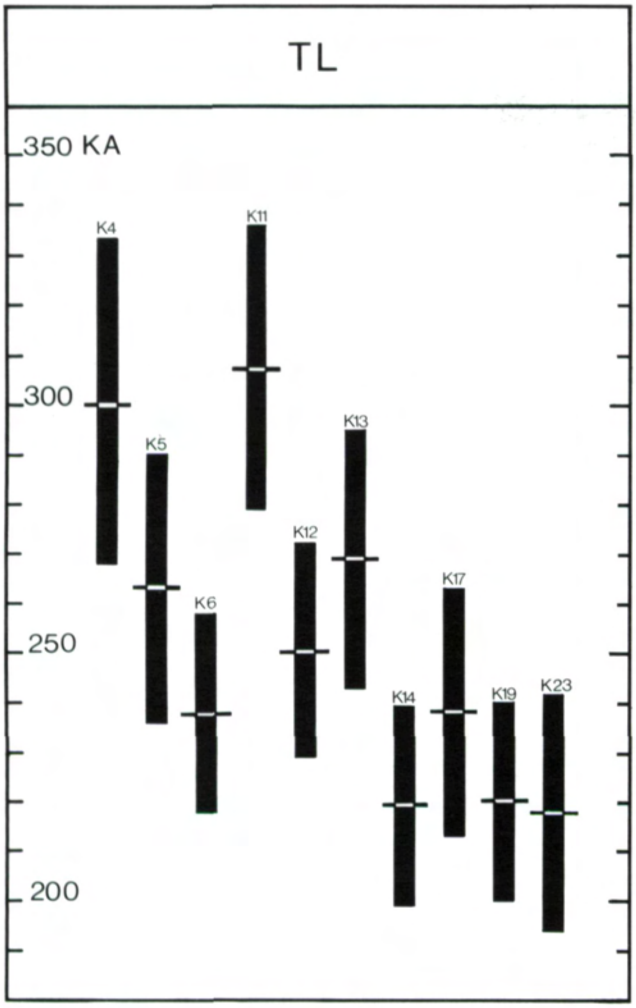


Fig. 134. Scatter of the individual TL ages of burnt flints from Unit IV-C (see table 21).

the mean value, while the second one is the predicted error, which is based on results from all quantifiable sources of uncertainty (Huxtable/Aitken 1985). With 68% confidence the age can be said to lie within a range of 250-290 ka, and with 95% confidence within a range of 225-315 ka.

After the publication of the age of 270 ± 22 ka, two more burnt flints found in the 1985 excavation of Site G, K17 and K19, and one from Site K (K23) were dated. The TL ages of these three flints are shown in table 21. Eventually, these three single age determinations will be incorporated in a new average age. This has not been done yet because the Oxford Research Laboratory is still working on samples from Belvédère.

An 'absolute' *terminus ante quem* for the formation of the Unit IV-C assemblages of 175 ± 35 ka was obtained by TL dating of a calcite concretion ('*loess kindl*') found in the top part of Unit IV-C, near Site G (Huxtable/Aitken 1985). These calcite concretions were probably formed during the first period of soil formation, i.e. during the formation of the soil in the top part of the Unit IV/Unit V-A complex.

It should be mentioned here that for the Belvédère TL age determinations on-site measurements were made with the aid of TL capsules and by means of a portable gamma spectrometer (Huxtable/Aitken 1985). Furthermore, because the annual dose, determined by both laboratory and on-site measurements, is influenced by the water content of the sample and the soil in antiquity, uncertainty about the water content is one of the factors that limit the accuracy attainable. Therefore, the author called in the help of Messrs Burrough, Dirksen and Van der Westeringh, (who at that time worked at the Agricultural University of Wageningen) who analysed the moisture content of the Site C/Unit 4.5 matrix (see Huxtable/Aitken 1985). Further TL dating work by the Oxford laboratory is in progress.

8.3.2.2 Electron Spin Resonance dating

R. Grün and O. Katzenberg (University of Cologne, West Germany) analysed a mollusc sample and five tooth-fragments from Unit IV-C for ESR dating purposes (for details of this dating method see Grün *et al.* 1987). The environmental radiation dose of the investigated sample was known only for the mollusc assemblage, which was collected especially for the ESR dating programme. The environmental radiation dose of the tooth-fragments, which were collected in 1981 and 1982, had to be estimated in the 1985 ESR analysis.

Enamel and dentine of fossil teeth always show higher uranium contents than recent teeth. In ESR dating of teeth the question is how and when the uranium uptake took place. For the Belvédère sample Grün calculated two ages, one using an *Early Uptake* (EU) model, in which the uranium migrated into the dentine and enamel shortly after the tooth was buried, and a *Lineair Uptake* (LU) age, which is based on the assumption that uranium was absorbed at a constant rate after the time of burial of the tooth. LU dates tend to agree with independent age assessments made with other methods, whereas EU dates are normally younger, down to about half of LU dates (Grün *et al.* 1987; Schwarcz *et al.* 1988). The age determinations of the Belvédère material yielded a rather large scatter of ages with an average LU age of c. 200 ka, and an EU age of c. 170 ka (Grün, pers.comm., 1985 and 1987). It should be noted that these are only preliminary results, and that further work on teeth samples from Belvédère is in progress.

ESR analysis of the mollusc sample provided results that were consistent with the TL dating evidence and that gave the Unit IV-C assemblages a provisional ESR age of 220 ± 40 ka (Grün/Katzenberg, pers.comm., 1985). Further ESR dating work is in progress.

8.3.3 DISCUSSION

The combined dating evidence, which is schematically summarized in table 22, points to a warm-temperate period between the Dutch Holsteinian Interglacial and the arrival of the Saalian ice-sheet in the central Netherlands. According to the TL dates and the provisional ESR dating results, this warm-temperate period can be placed *roughly* around 250 ka.

The accepted Dutch stratigraphy for this part of the Middle Pleistocene (figure 135, after Zagwijn 1973) is based primarily on a combination of the classic geomorphological northern European model and detailed pollen analysis. Although the Belvédère biostratigraphy is based on faunal evidence, we may assume that the warm-temperate Unit IV deposits were formed in the relatively warm early Saalian *Hoogeveen Interstadial* (Zagwijn 1973), which is represented in pollen diagrams between Holsteinian beds and late Saalian tills. In his 1973 paper in which he presented the Hoogeveen Interstadial, Zagwijn argued that this temperate phase could be classified as an 'interglacial', but 'For the time being ...', he writes, '... it is preferred to classify the temperate stage ... as an interstadial of the Saalian glaciation ...' (Zagwijn 1973: 154). This preference is based on two arguments. First, it seemed to be a relatively short phase as compared with the Holsteinian interglacial. Secondly, -maybe as a result of this short time range- *Pinus* and *Betula* were still the dominant trees in his diagrams. There was a short cold interval between the Hoogeveen Interstadial and the somewhat cooler *Bantega interstadial* (figure 135).

Turning now to the Oxygen Isotope Stratigraphy, which is the main chronological framework of the Pleistocene, we have to consider that oceanic and terrestrial events can usually only be correlated by means of geochronometric dating (Roebroeks 1986a). However, the current limits of geochronometric dating techniques and the relative values of the estimated dates of the different $^{16}O/^{18}O$ stages (Shackleton/Opdyke 1976) make correlating oceanic and

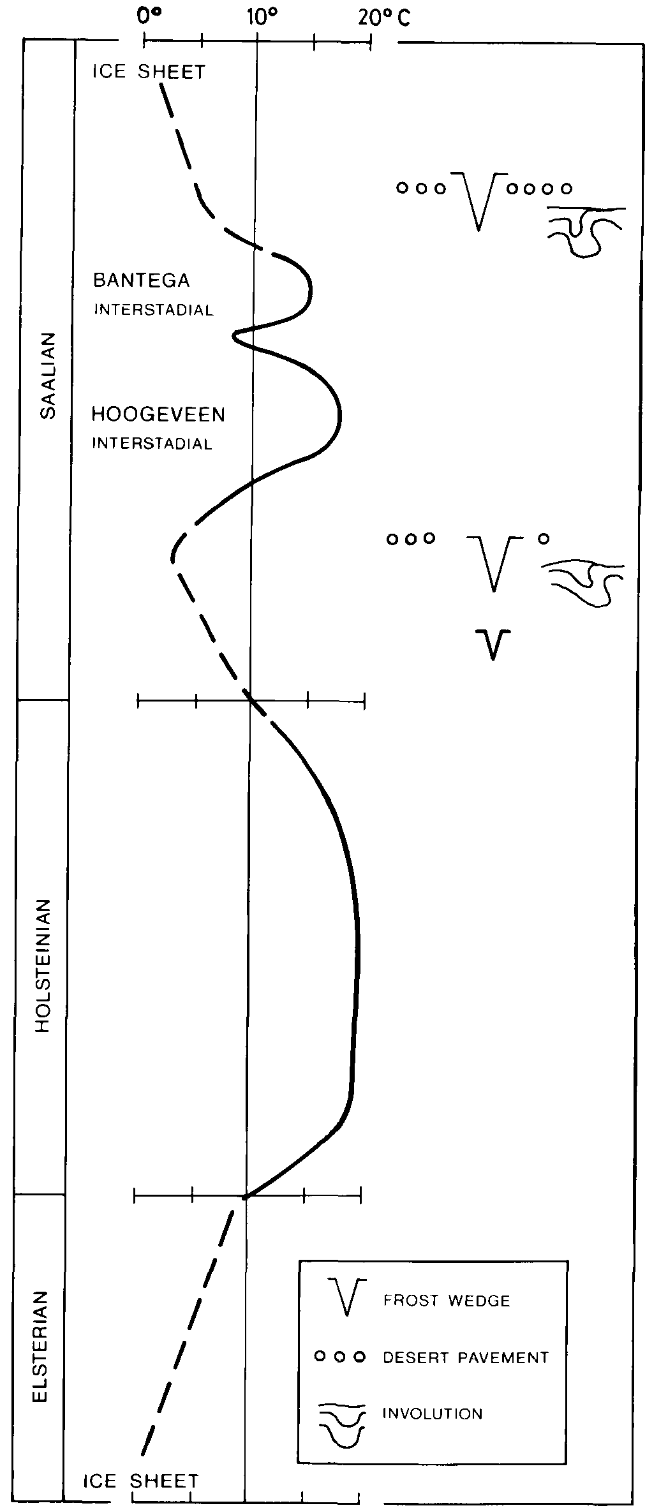


Fig. 135. Estimated changes in mean summer temperatures from Elsterian to Saalian times (redrawn, after Zagwijn 1973).

Table 22: Schematic representation of the methods employed to date the Unit IV-C deposits and the results obtained. The *maximum* range of individual TL ages as shown in table 21 is given between brackets.

Dating Method	Results
1. Terrace stratigraphy	'intra-Saalian'
2. Paleosols and loess-stratigraphy	'intra- or pre-Saalian'
3. Biostratigraphy	post-Holsteinian and predating the arrival of the Saalian ice cover
4. TL age determination	270 ± 22 ka (194-332 ka)
– *terminus ante quem*	175 ± 35 ka
5. ESR (molluscs)	220 ± 40 ka

terrestrial events a hazardous enterprise. If, however, we wish to play the 'Oceanic-Terrestrial Game' the current state of research allows us to suggest that the Unit IV-C warm-temperate phase can be correlated with Stage 7 of core V28-238 (Shackleton/Opdyke 1973). The estimated date of Stage 7 in cores V28-238 and V28-239 is 195-251 ka (Shackleton/Opdyke 1973, 1976). The age of this stage is relatively well known thanks to the presence of a volcanic ash layer in several Pacific cores, dated by means of the K/Ar method to around 230 ka (Ninkovich/Shackleton 1975). Two separate periods have been distinguished in the Stage 7 period of low ice volume, subdivided by Stage 7b, which began around 230 ka and was characterized by a significant increase in ice volume. This Stage 7b period of ice advance is considered by some authors to represent a global 'short ice age' (Ruddiman/McIntyre 1982; Andrews 1983).

The current dating evidence for the Belvédère Unit IV-C sediments does not allow correlation of the Unit IV-C warm-temperate phase with one of the two substages of low ice volume that can be distinguished within Stage 7.

An important implication of the proposed correlation of the intra-Saalian warm-temperate phase attested at Maastricht-Belvédère with Oxygen Isotope Stage 7 is that the Dutch Holsteinian interglacial has to be correlated with Oxygen Isotope Stage 9 or an even earlier odd-numbered Stage (but see 8.4.3).

8.4 The chronological background: an evaluation

8.4.1 INTRODUCTION

In the course of the interdisciplinary investigation of the Belvédère pit a considerable amount of time and energy has been -and still is- invested in the study and description of sections and the identification of the lithological units as the necessary basis for the local lithostratigraphy, which in turn, is the basis for the establishment of a chronological framework for the study of the archaeological finds.

Earlier in this chapter we have discussed the various different types of relative and 'absolute' dating evidence used in this approach. We have furthermore tried to interpret the local stratigraphical records of the pit in terms of Quaternary history against the background of other frameworks, such as the pollen-based chronostratigraphical subdivision of the Dutch Pleistocene and the oxygen isotope record.

These excercises in correlation may have seemed relatively simple and straightforward in view of the 'fits' which were found between the chronology of the Belvédère framework and other chronologies of Quaternary events. However, the 'mighty state of confusion' (Hubbard 1982) in Middle Pleistocene stratigraphy cannot be overstressed in Palaeolithic archaeology, in which many scholars are trying to study changes in human behaviour on Pleistocene timescales. It is the classification of the locally recorded events in terms of Quaternary history that gives rise to most problems:

> 'Tendencies to oversimplify in this way lead to new discoveries being forced into a pigeon-holed classification. Such arbitrary methods tend to perpetuate an illusion of security and precision in an apparently repeated confirmation of the original model. This tendency to confirm discoveries from limited amounts of data has been called *The Reinforcement Syndrome* by Watkins (1971).' (Bowen 1978: 8)

In order to stress that an interpretation of the Belvédère dating evidence in terms of Quaternary history schemes should only be regarded as a valuable working hypothesis, this paragraph will deal briefly with some of the basic assumptions of the general Quaternary schemes referred to above. We will see that (in addition to the presented 'fit-options') alternative interpretations are still possible.

8.4.2 BIOSTRATIGRAPHICAL SUBDIVISION OF THE DUTCH QUATERNARY

The biostratigraphical subdivision of the Dutch Quaternary beds is based mainly on pollen analysis (Zagwijn 1985) (see fig. 136). Meijer (1986) has presented a preliminary, non-marine mollusc biozonation of the Dutch Quaternary, while Van Kolfschoten is working on an improved vertebrate zonation (Van Kolfschoten 1985, in press).

The pollen evidence:
So far, pollen analysis has revealed 15 stages of warm-temperate climatic conditions after the first major cooling of the pre-Tiglian cold stage, which started about 2.3 million years ago. Zagwijn (1985: 18) has given a review of the different chronostratigraphical subdivisions of the Pleistocene of the Netherlands applied since 1950, showing that the number of cold and warm phases identified has increased dramatically in the last decades. The climate curve currently in use (fig. 136) has a time scale based on

- radiocarbon dates of up to 50 ka
- the first influx of augite in fluvial Rhine sediments, connected with 400-500 ka old lava flows in the Eifel
- palaeomagnetic data for the periods before 700 ka.

Zagwijn observed some striking similarities in the Dutch Quaternary climate curve and the oxygen isotope stratigraphy, '... but more dating checks would be needed to demonstrate an exact match ...' (Zagwijn 1985: 20). One of the warm-temperate phases whose 'absolute' age is the subject of a heated international discussion is 'the' Holstein interglacial (Zagwijn 1973). We will return to this topic later on in this paragraph.

The basic assumption in this approach is that individual temperate phases produce distinguishable pollen sequences. Zagwijn *et al.* (1971) have pointed to the inherent danger in

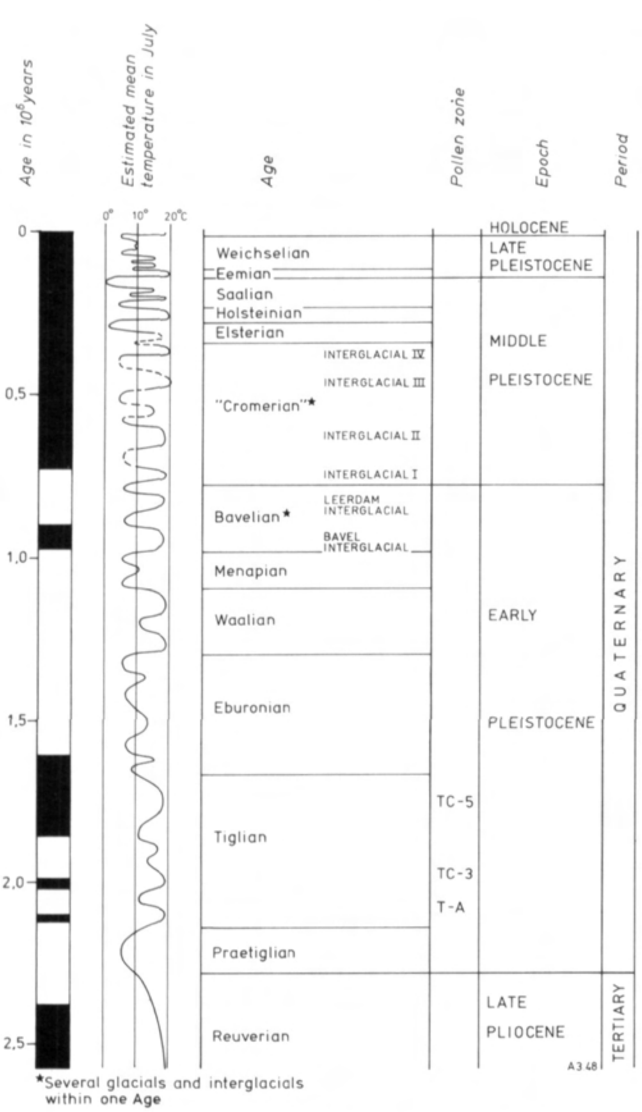


Fig. 136. Climate curve for the Quaternary in the Netherlands (source: Zagwijn 1985).

this assumption by focussing on the identification of Middle Pleistocene interglacials as 'Holsteinian'. One of the cases described is a boring in the southern part of the IJsselmeer:

'... Here from 86-104 m in the basal part of the augite-bearing .... formation a well developed, more or less complete, interglacial sequence was found ... At first it was thought that it was of Holsteinian age, but later it was found that ... the actual Holsteinian beds are situated much higher (about 30 m...).' (Zagwijn/Van Montfrans/Zandstra 1971: 51-53)

The point is that *other* biostratigraphical subdivisions generally use palynological 'dates' as their point of departure, which means that, theoretically, an 'incorrect' identification of an interglacial, and thus of the chronostratigraphical position of the reference fauna, constitutes the basis of a complex system of interrelated false assumptions. For instance, it must be explicitly stressed here that two of the main 'vertebrate' arguments for dating the Belvédère Unit IV faunal remains to a *post-Holsteinian* warm-temperate phase are

– the presence of *Coelodonta antiquitatis* remains in the Unit III gravels. According to Guérin (1980), this animal migrated from Asia to Europe at the beginning of the 'Riss-period' (Van Kolfschoten 1985).

– the presence of remains of a particular subspecies of *Arvicola terrestris* that indicate that the Belvédère Unit IV faunal assemblage is younger than the faunal assemblage of Neede (the Netherlands), which was dated to the Holsteinian interglacial on the basis of pollen analysis (see: Zagwijn 1973: 145; Van Kolfschoten 1985).

The 'vertebrate' argument is therefore *essentially based on the Holsteinian classification of the Neede flora*, because the period referred to by the term 'Riss' was probably so long that it cannot have been preceded by the Dutch Holstein *sensu* Zagwijn (1973). What if -theoretically- the Neede finds should turn out to date from a pre-Holstein interglacial?

The molluscan evidence:
Meijer's (1986) preliminary non-marine molluscan zonation of the Dutch Quaternary has four zones, one of which includes the Cromerian IV (Noordbergum) and the Holsteinian interglacials, whose faunas are fairly similar. Basically, Meijer's biozonation is based on the disappearance of demanding species in the course of the Pleistocene, such as woodland and purely fluviatile species which depended on a warm-temperate climate:

'Actually it is a regressive development: every cold stage took its toll of the most sensitive part of the fauna. Placing the moments of extinction of these species in the more or less established pollen zonation is the first step to an independent Dutch non-marine molluscan zonation.' (Meijer 1986: 162)

Meijer used the *absence* of the freshwater molluscs *Valvata naticina*, *Neumayria crassitesta*, *Belgrandia marginata* and *Pisidium clessini* to establish a *terminus post quem* for the Belvédère Unit IV faunas. These species are not known to have occurred later than the Holsteinian and at Belvédère they are absent although their habitats are well-represented. So their absence[3] (and the occurrence of *Zonitoides sepultus*) led Meijer to infer a post-Holsteinian intra-Saalian age for the Belvédère Unit IV faunal remains (Meijer 1985: 96). The close relation between this zonation and the pollen zonation will be clear.

8.4.3 THE OXYGEN ISOTOPE RECORD

'It is generally agreed that to a first approximation, the oxygen isotope record that is recovered by analysing foraminifera in deep-sea sediment cores gives a history of global continental ice volume and hence of the glacio-eustatic component of sea-level change.' (Shackleton 1987: 183).

The complexity of the sequence of events that are attested by the isotope record has been summarized by Bowen (1978) and by Shackleton in a paper referred to above (1987). According to Shackleton, one of the most serious complications is that no deep-sea core has preserved a perfect history of the isotope composition of the ocean. An aspect of this complication is that whatever foraminifera are chosen for isotopic analysis, variations in the temperature of the ocean water in which they lived have to be considered.

'Another is the generality that no geological record is perfect; in particular, bioturbation is a virtually universal source of degradation for deep-sea records.' (Shackleton 1987: 183)

It is, however, common opinion that a shift to a higher ^{18}O level indicates a shift to a colder and more glacial climate and that the record does provide the best opportunities for determining the sequence of ice-sheet advances and retreats over the past several hundred thousands of years (Covey 1984). The oxygen isotope record has two advantages over the more traditional terrestrial geological data. It is, in the first place, a global record, which is thought to reflect changes in the total amount of ice on land the world over, as there is remarkably little variation among cores taken from different areas. Secondly, it is a rather continuous record, providing an arguably complete survey of the entire Quaternary.

One of the problems associated with the oxygen isotope record has always been the displaying of the various data sets as time series. Paleomagnetic studies and dating of ash layers proved to be very helpful methods in this context (Shackleton/Opdyke 1973; Ninkovich/Shackleton 1975), but a major breakthrough was the rehabilitation of the Milankovitch theory, which suggests that Pleistocene changes in global ice volume were controlled by the earth's orbital geometry (Hays *et al.* 1976). This theory has been used as a basis for the development of fine time scales for the oxygen isotope record (Imbrie *et al.* 1984). In the context of the present volume we are especially interested in the second half of the Middle Pleistocene and the Upper Pleistocene, a time period for which a detailed oxygen isotope data set is

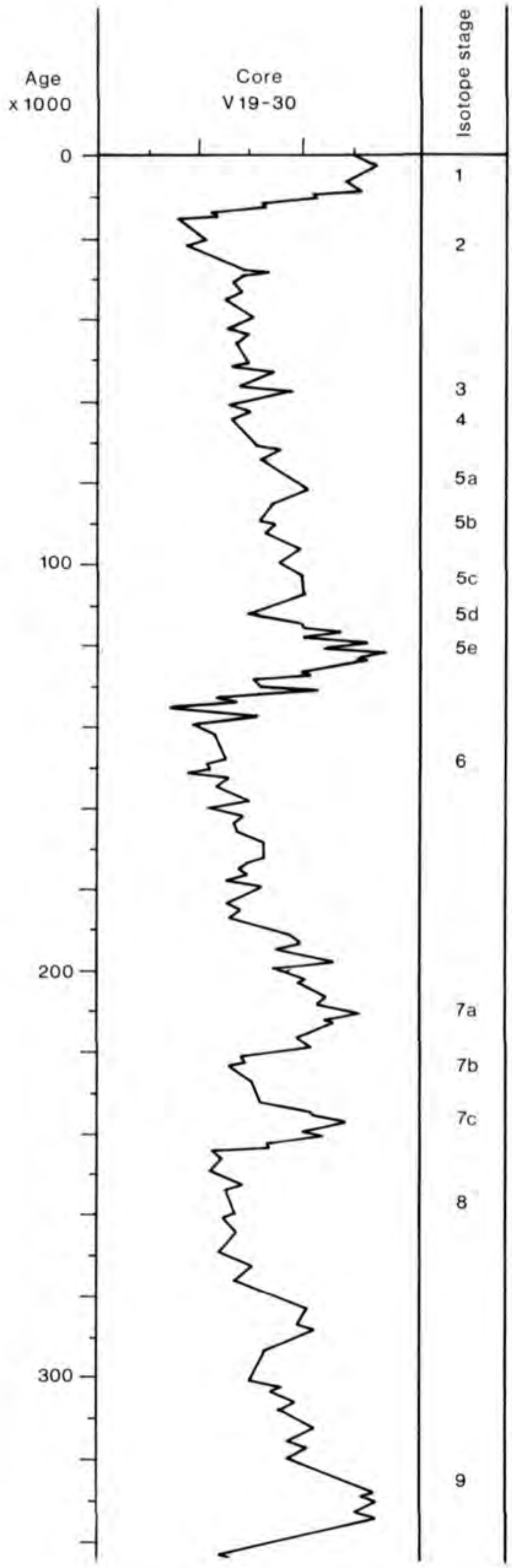


Fig. 137. Oxygen isotope stratigraphy core V19-30, showing stages 1-9 and age estimates for stage boundaries (redrawn after Shackleton and Pisias 1985, by courtesy of N. Shackleton).

now available, on a very fine time scale (Shackleton/Pisias 1985).

Figure 137 shows core V19-30, published with the permission of N.Shackleton (Cambridge, in litt. 1988). The figure shows the ^{18}O record in *Uvigerina senticosa* from V19-30, from Stage 9 to the Holocene (Stage 1). We refer to Shackleton and Pisias (1985: 308-310) for details on the method with which the time scale was obtained. It is worth mentioning here that, in their interpretation of Pacific core V28-238, Shackleton and Opdyke (1973) already stressed the fact that Stage 7 of that core was in all probability not to be equated with the 'Hoxnian' interglacial. The reason for this has recently been worked out in detail by Shackleton (1987), who has tackled the problem of the sea levels of the glacial and interglacial stages of the Brunhes period. On the basis of the analysis of a large number of cores he concludes that the extremes of stages 1, 5e, 9 and 11 are very similar:

> 'At present I do not believe that we can confidently state that any one of these four interglacials reached a significantly different level than another.' (Shackleton 1987: 186)

These four 'interglacial' peaks 1, 5, 9 and 11 are, however, isotopically significantly lighter than those of Stages 7, 13, 15 and 19. Only with Stage 23, in the Jaramillo normal event, is an 'interglacial' attested which is isotopically similar to the Holocene. Shackleton suggests that during the Stage 7, 13, 15 and 19 'interglacials' more extensive ice caps remained present in the northern hemisphere, resulting in a relatively low sea-level.

In discussing the Unit IV-C dating evidence we have already suggested a correlation of the Unit IV-C warm-temperate phase with Stage 7, a period of low ice volume which is interrupted by a short period of ice-increase (substage 7b) which may represent a cooling of glacial intensity (Ruddiman/MacIntyre 1982; Andrews 1983).

We therefore have to consider the possibility that substages 7c (250-230 ka) and 7a (220-200 ka), being divided by an approximately 15,000 years-long period of global cooling, were characterized by different floras and faunas, which might be one of the explanations for the interglacial 'traffic-jam' in this later part of the Middle Pleistocene: the current margins of error of geochronometric dating methods are too large to allow us to ascribe faunas to Stage 7c or Stage 7a on the basis of the 'absolute' dates alone. This means that hypothetically biostratigraphically different floral and faunal assemblages may sometimes be assigned 'the same age'.

At present, only few researchers would correlate Stage 7 with 'the' Holstein interglacial. In a review of the Swanscombe geological deposits and organic remains, Hubbard (1982), for instance, has proposed a correlation with Stage 11, while Brunnacker (in: Brunnacker *et al.* 1982: 245) seems to take a similar position by placing two interglacials in the 'Saale-Kaltzeit' (see also: Kukla 1977; Sarntheim *et al.* 1986; Shackleton 1987).

The limits of so-called 'absolute' dating methods (and especially of many of the 'correlation games' based on it) are illustrated by the current discussion between two groups of specialists who used the ESR dating method on shell samples from Holsteinian beds in the type area in order to determine the chronostratigraphical position of the Holstein interglacial and its correlation with the isotope stratigraphy. Sarntheim *et al.* (1986) conclude that the Holsteinian correlates with oxygen isotope Stage 11, whereas Linke *et al.* (1985) assign it to Stage 7. In the discussion generated by these conflicting results (see: Schwarcz/Grün 1988 vs. Barabas *et al.* 1988) we observe that the main cause of the differences lies in the fact that the two groups both have their own methods for deducing ages from the ESR signals of the samples studied. So here we have the (highly informative!) situation that the Holsteinian at its *locus typicus* in northwestern Germany has been assigned 'absolute' dates ranging from approximately 200 to 440 ka!

If we limit ourselves to the Dutch Pleistocene data, it is impossible to reject a correlation of the Dutch Holsteinian with substage 7c: the Belvédère Unit III gravels could have been deposited in the 'cold' phase 7b, which would then mean that the Unit IV warm-temperate phase would have to be shifted upwards to substage 7a. The pre-Eemian luvisol formed in the top part of the Unit IV/V-A sediments could then be fitted neatly into the 'temperate' beginning of Stage 6, contemporaneous with the formation of the 'temperate' faunal assemblage of Biache-Saint-Vaast in northern France and the temperate small mammals assemblages containing *Arvicola terrestris* found in sediments pushed up by the Saalian ice at Rhenen (the Netherlands, Van Kolfschoten 1981). Choosing this interpretation, however, means dismissing the 'sea level arguments' of Shackleton and others referred to above.

The point I wish to make here is that the relative ease with which different correlation games can be played means that archaeologists working with data from this time range have to be extremely careful in developing models depending strongly on behavioural events 'precisely' pinpointed in the Pleistocene time scale.

notes

[1] It is, however, worth mentioning that Meijer's study of the Unit IV-C molluscs led him to infer that by the time of the formation of the upper part of the Unit IV-C-II calcareous tufas '... the climatic optimum had already been passed ...' (Meijer 1985: 94).

[2] In earlier publications on the Belvédère fauna (e.g. Roebroeks *et al.* 1983; Van Kolfschoten 1985; Roebroeks 1986a) this species was described as *Arvicola cantiana/terrestris*. Recently, Van Kolfschoten (*in press*) has decided to also classify the Belvédère Unit IV *Arvicola* as *Arvicola terrestris*. However, he stresses the biostratigraphical position of the Unit IV *Arvicolas*.

[3] Recently, however, Duistermaat (1987) determined the *presence* of *Belgrandia marginata* in the Site G mollusc assemblage (see 8.2.2).

9 The Belvédère 'data': implications for the interpretation of hominid behaviour in the Middle Palaeolithic

9.1 Introduction

In this chapter some implications of the results of the Belvédère studies will be discussed in terms of their inferred relevance for the study of Middle Palaeolithic hominid behaviour. In the first section (9.2) we will focus on a discussion of the informative value of the Unit IV-C sites, treating such topics as inter-site variation and the degree in which the Belvédère sites are representative of Middle Palaeolithic sites in general.

This short discussion will be followed by a more general topic, the role of the transport of stone artefacts in the formation of inter-assemblage variability. The specific find circumstances in the Belvédère pit and their interpretative possibilities led to the formulation of this research question, which has been touched upon in earlier parts of this volume. In section 9.3 the role of the transport of lithics will be discussed in the broader context of the European Lower and Middle Palaeolithic.

Section 9.4 deals with the problem of discriminating between 'normal' background fauna and faunal elements introduced by hominids, a problem especially relevant to Site-G-like constellations which has already been discussed in some detail in that context.

In section 9.5 a limited number of northern European key sites of 'more or less' the same age as the Unit IV-C sites will be reviewed in the context of the topics discussed earlier in this chapter (9.2-9.4) and in chapter 8. The choice of the sites and the sequence in which they are discussed is rather subjective, and the author did certainly not try to provide an exhaustive survey.

The final paragraph of this chapter (9.6) focusses on the pseudo-artefact problem, a subject that lies somewhat outside of the scope of this volume, but with which we are confronted when talking about the colonization of northern Europe by Middle Pleistocene hominids.

Figure 138, finally, provides a map of the archaeological sites mentioned in this chapter.

9.2 The Unit IV-C sites: an evaluation

The basic idea behind the Belvédère project and the justification for the time and energy put into it is the hypothesis that the area surveyed in the course of the past eight years and the sites discovered in that area are in one way or another representative of a far larger area than South Limburg, and, perhaps, of a (much) longer time period.

What new information -one might ask- have the Belvédère sites given us about human behaviour in the Middle Palaeolithic and how representative are these inferred forms of behaviour?

For an evaluation of the sites it must be stressed that, in all probability, they can be interpreted as the remains of one and the same cultural system, which were created under more or less the same environmental conditions, over a relatively short period of time. The sites are *contemporaneous* in Pleistocene terms, having been formed in the same warm-temperate period. The Unit IV-C-I sites are very

Table 23: A comparison of the main Unit IV-C primary-context sites.

Site	Area dug (m²)	Artefacts found: Tools[a]	Cores	Flakes & chips	Total	Ratio: Tools: waste	Cores: waste	Density: Artefacts per m²	Tools per m²
B[b]	20	-	-	5	5	-	-	0.25	-
C	264	3	4	3060	3067	1:1020	1:765	11.6	0.001
F	42	1	1	1213	1215	1:1213	1:1213	28.9	0.02
G	50	3	-	48[c]	51[c]	1:16	-	1.0	0.06
K[d]	370	150	80	10220	10450	1:68	1:128	28.2	0.40

[a] = 'essential' tools count; [b] = lower level only; [c] = after refitting; [d] = preliminary figures.

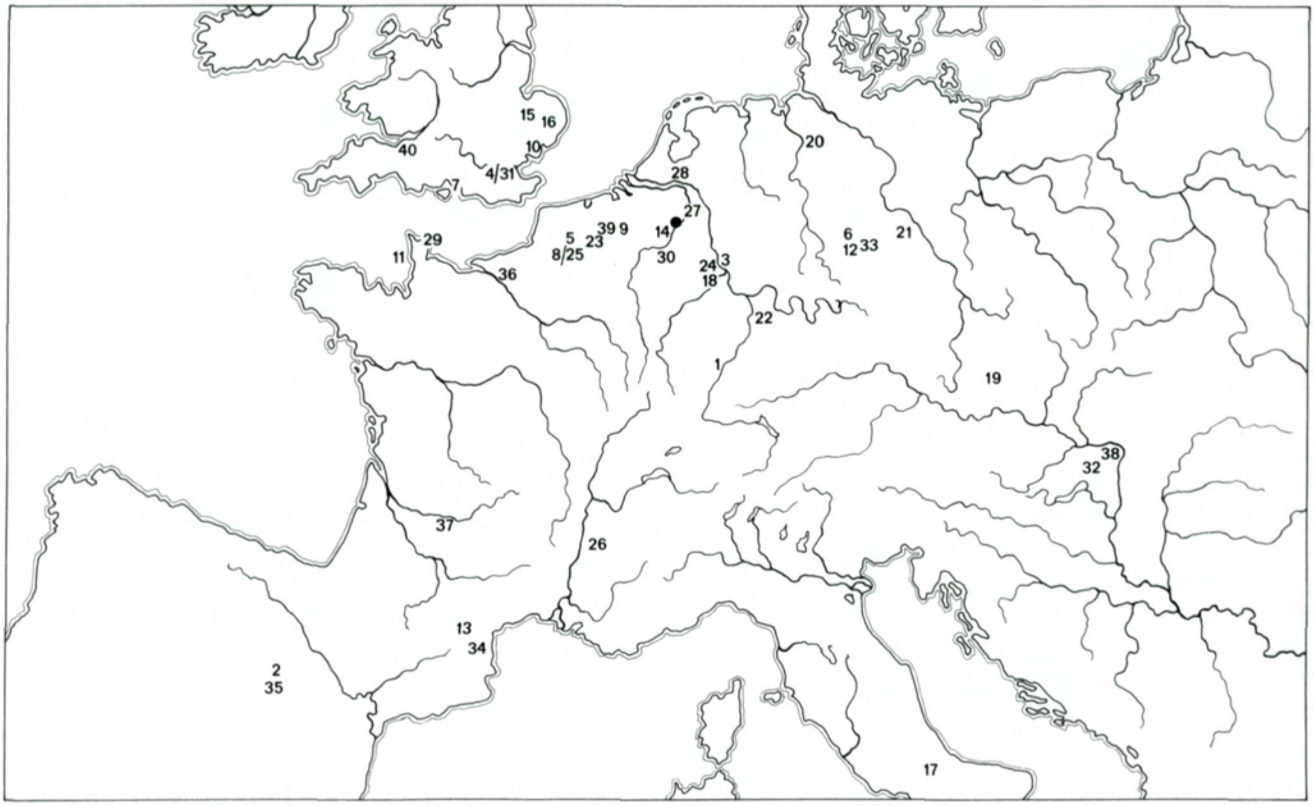


Fig. 138. Map of the sites mentioned in the text of chapter 9. The situation of Maastricht-Belvédère is indicated by a black dot.
1. Achenheim, 2. Ambrona, 3. Ariendorf, 4. Baker's Hole, 5. Biache-St.-Vaast, 6. Bilzingsleben, 7. Boxgrove, 8. Cagny, 9. Céroux-Mousty/Ottigny, 10.Clacton, 11. La Cotte de St. Brelade, 12. Ehringsdorf, 13. Ermitage, 14. Halembaye, 15. High Lodge, 16. Hoxne, 17. Isernia, 18. Kärlich, 19. Kulna, 20. Lehringen, 21. Markkleeberg, 22. Mauer, 23. Mesvin, 24. Miesenheim, 25. Montières, 26. Prélétang, 27. Rheindahlen, 28. Rhenen, 29. St.Vaast-la-Hougue, 30. Sprimont, 31. Swanscombe, 32. Tata, 33. Taubach, 34. Tautavel, 35. Torralba, 36. Tourville-la-Rivière, 37. Grotte Vaufrey, 38. Vértésszöllös, 39. Vollezele, 40. Westbury-sub-Mendip.

probably contemporaneous in terms of age differences of several hundreds of years. The age difference between the lower-(IV-C-I) and upper-level (IV-C-III) sites is more difficult to estimate, as already discussed in previous chapters. There are, however, no geological arguments for assuming large time differences, i.e. thousands of years.

In addition to contemporaneity, we may assume that no significant changes in raw material availability took place during the relatively short period of the formation of the archaeological assemblages. Finally, the sites were all discovered within a small area, of approximately five hectares.

It is therefore interesting to note, for instance, the differences in core reduction strategies observable between the assemblages from Site C, Site F and Site K, ranging from the very sophisticated *Levallois recurrent* core reduction at Site C to the wasteful reduction of non-prepared cores at Site K. Table 23, after Gamble (1986: Appendix V), gives a survey of the assemblage quantities and the relative 'richness' of the Unit IV-C sites, which provides further evidence of inter-site variation.

The comparison of these individual sites, however, presents certain limitations, which are especially connected with differences in excavation techniques, in the degree to which empty squares were incorporated in the excavated area, etc. These limitations are easy to overcome though if they are explicitly taken in consideration in comparing specific aspects of the different sites.

Table 23 shows that the majority of the Unit IV-C sites are very 'poor' sites in terms of the numbers of tools and cores and the amount of flaked stone material. They are, however, 'rich' in that the differences noted above cannot be explained away by referring to factors commonly used in these discussions, such as differences in time and the availability of raw material. We are here looking at differences caused by differences in behaviour of the participants of one and the same cultural system, who frequently visited the area of the present Belvédère pit in the context of, for example, meat procurement strategies, which were focussed on the 'collecting' of very young animals.

The inter-site variation in terms of technological differences, relative frequency of 'tools' and cores and in terms of refit observations, *can* be explained by referring to the position of what we call a site in a geographically larger flint-logistical system, in which cores, flakes and tools were manufactured, transported, used and discarded at rates dictated by the anticipation of activities on the one hand and the needs of the moment on the other (see 9.3).

The Belvédère Unit IV-C 'sites', varying from low-density 'off-site' scatters (Site G) to high-density sites (Site K), are very probably representative of debris scatters produced by Middle Pleistocene hominids in sediment-receiving riverside areas but we cannot say anything meaningful about their relation to sites formed on higher terrains.

At Belvédère we are dealing mainly with sites which, in the past (?), many archaeologists might have considered not worthy of excavation, as the absolute numbers of artefacts, and especially tools, are generally very low. Even then, the sites excavated are on the whole flint-rich sites, like Sites C, F and K, which have a much greater archaeological visibility than low-density artefact scatters like Site G, especially if no bone material is preserved. The few 'low-density sites' known from the European Lower and Middle Palaeolithic were, not surprisingly, indeed excavated thanks to the great archaeological visibility of the associated bone material. The spectacular faunal remains at Torralba and Ambrona (Howell 1966; Freeman 1975) were accompanied by a relatively small number of stone artefacts, some of which (handaxes) had been imported to the sites from sources lying several dozens of kilometres away (Howell 1988). Likewise, the Eemian site at Lehringen (Adam 1951; Thieme/Veil 1985) was discovered thanks to elephant remains, which turned out to be associated with a small number of flint artefacts. Saalian low-density sites, all discovered because of the presence of faunal remains, are known from Ariendorf in the German Neuwied basin (find level I, Turner 1986), and from the sites Tourville-la-Rivière (Vallin 1984) and Achenheim in northern France. At Achenheim, Sol 74, first considered to be of Early Weichselian age (Thevenin/Sainty 1974) but now interpreted as dating from the last cold phase of the Saalian complex (Heim *et al.* 1982), yielded remains of horse, woolly rhino, giant deer, bison and mammoth over an area of 200 m^2, in a density distribution comparable to that of Site G, which was associated with only a small number of artefacts.

Low-density scatters of the Site G type are undoubtedly underrepresented in the Unit IV-C site sample -and probably even more so in the overall Palaeolithic sites sample- while these may in fact be the most common types of 'scatters' produced by Middle Pleistocene hominids.

From ethnoarchaeological studies we have data on the densities of cultural debris scatters indicating the generally poor visibility of activities of hunter-gatherers (e.g. Hayden 1979), which stresses the importance of studying regional variations in artefact densities. Are 'rich' sites just a consequence of a palimpsest deposition of many 'poor' assemblages, or are we looking at the signatures of other processes, for instance the continuous and uninterrupted use of sites? One way of establishing this could be studying the differences in the *contents* of the assemblages.

Nevertheless, it is very probable, and in any case an interesting working hypothesis, that a large number of the 'rich' assemblages, such as Biache-Saint-Vaast in northern France, are the results of the repeated deposition of 'poor' assemblages at a rate high enough to surpass sedimentation, which could have stratigraphically isolated these 'poor' assemblages when the rate of sedimentation was higher. 'Poor' assemblages give us the opportunity to isolate the individual depositional processes behind the formation of larger lithic assemblages.

What can these isolated depositional events tell us about the behaviour of Middle Pleistocene hominids in terms of the functional character of a site with respect to the context of the subsistence-settlement system in which the site was formed? In trying to answer this question we are faced with two major problems, both dealing essentially with the character of the Pleistocene archaeological record. The first problem is that already discussed *in extenso* above, namely the problem of the organised versus compound entity discussion. For instance, how do we expect to archaeologically recognize 'base camps' in the context of this discussion? Binford and Binford (1966) suggested that archaeological evidence of maintenance activities, the preparation and consumption of food and the manufacture of tools for use at other sites could provide sound evidence of 'base camps'. Usually, however, the nature of the archaeological record is such that it is virtually impossible to distinguish between a 'base camp' assemblage and a palimpsest assemblage formed in several independent depositional events spaced in time. We are dealing with assemblages defined by three spatial coordinates, without having enough knowledge of the factor *time* involved in the formation of the spatial aggregate.

Theoretically, only a very strict spatially organised use of a site could possibly be a candidate for an interpretation in terms of one of the many site types distinguished by different authors. Further elaboration of this problem is necessary if Palaeolithic archaeology wishes to meaningfully assign a 'function' to sites painstakingly excavated and analysed.

A related problem is the spatial organisation of depositional events in a larger geographical area, involving the broader settlement system in which the sites were formed. Here our problem is that sites formed in sediment-receiving, unstable areas are greatly overrepresented in our sample of Palaeolithic sites. The overall majority of well-preserved sites, from the Early Pleistocene ones in East Africa to the Middle and Late Pleistocene ones in Europe, owe their state of preservation to *fluvial* and *lacustrine* sedimentation, which encased the archaeological remains in finely-grained matrices. To mention only a few northern European examples we can cite Swanscombe, Hoxne, Clacton, High Lodge and Boxgrove in England, Bilzingsleben, Ehringsdorf and Taubach in the German Democratic Republic, Lehringen in West Germany and Biache-Saint-Vaast and Cagny in northern France.

We get the distinct impression that we tend to focus too much on the 'wet feet' part of the settlement system, and that we have only a very limited -cave and rock shelter biased!- knowledge of what went on in higher areas, more suited to the establishment of semi-permanent settlements (cf. Gifford 1980).

The only way out of this problem is concentrating on 'lower quality data' from surface scatters and *cailloutis* sites in regional studies instead of constantly focussing on well-preserved sites in sedimentary environments (cf. Appendix IV).

9.3 Transport of lithic materials and Palaeolithic interassemblage variability

An important research aim developed in the course of the Belvédère studies is, in the author's opinion, the study of the role of the transportation of lithic artefacts in the formation of Palaeolithic assemblages.

We were first confronted with the possible implications of transport in our attempts at conjoining artefacts from the Belvédère Site C in 1983-1985. These refitting studies have been described in section 4.2, where we concluded on the basis of evidence from other sites that the data obtained had to be interpreted in terms of transport of cores and finished flakes to and from sites. We subsequently started screening the literature for data from other Middle Palaeolithic sites, at first focussing on the sites themselves and later on larger, regional patterns. This study showed that the sites were 'points' in a dynamic system of transportation of artefacts, which could be an important factor in discussing the possible explanations for 'inter-assemblage variability'. The results of this study were published in a more general paper on transport in the Palaeolithic (Roebroeks *et al.* 1988). In this paragraph we will focus on some possible implications of these studies, basing ourselves mainly on the Roebroeks *et al.* 1988 paper mentioned above, to which the reader is referred for more detailed information on this topic.

The literature study essentially demonstrated that there are many Middle Palaeolithic sites for which petrological, conjoining and other technological studies have yielded results which can be interpreted along the same 'transport lines' as those obtained for Maastricht-Belvédère. Transport strategies include the transportation of cores, finished flakes and tools. What follows here is a short description of these transport strategies, which have been divided into the transport of cores and flakes and the transport of tools.

Transport of cores is known from several Middle Palaeolithic sites, for instance Rheindahlen-Westwand/B1 (Bosinski 1966; Thieme 1983a) and Lehringen (Thieme/Veil 1985) in West Germany, Vollezele-Congoberg (Vynckier *et al.* 1986) in Belgium, Saint-Vaast La Hougue (Fosse *et al.* 1986) in northern France and several sites in the Périgord area, e.g. the 'Rissian' layers at Grotte Vaufrey (Geneste 1985; 1986a). All these sites also yielded evidence of the transport of finished flakes. The transport strategies discussed here can be associated archaeologically with several economical forms of core reduction, discussed as contrasting with the 'classical' Levallois technique by Callow:

> 'The classic Levallois technique for producing flakes by centripetal preparation (i.e. using tortoise-cores) is extravagant compared to the disc-core technique. The latter, and that directed at the production of blades, are methods for the continuous manufacture of blanks and incur very little waste (the term 'Levallois blade' is a misnomer when applied to parallel longitudinal preparation, as the underlying concept is entirely 'non-Levallois' compared to that employed at, say, Baker's Hole or Montières).' (in: Callow and Cornford 1986: 386)

Besides the examples given in the paper by Roebroeks *et al.* (1988) two other regions must be mentioned here which provided important data on this subject, namely the Languedoc in France (Tavoso 1984) and the French Alps (Malenfant 1976).

A very good example of the transport strategy referred to above is provided by the Ermitage site (Aude, France), where 72 cores and 418 flakes were found which all came from a source lying 7 km from the site (Tavoso 1984). Only seven cortical flakes were found at the site, while the technological Levalllois Index is 29%.

Also worth mentioning here are the assemblages from the Mousterian sites in the French Alps, characterized by a preponderance of 'Levallois' artefacts, which distinguishes them from the Mousterian industries in lower areas in southeastern France:

> '*Les industries du Paléolithique moyen recueillies dans les grottes des massifs subalpins francais* ont une caractéristique commune qu'elles partagent avec celles de plusieurs gisements suisses:*le débitage levallois y occupe une place prépondérante et la proportion d'éclats levallois non retouchés est remarquablement élevée*. Le débitage Levallois fut pratiqué même quand paraissait s'y opposer la médiocre qualité de la 'silexite' à Onion et de l'oelquartzit au Wildkirchli et au Wildenmannlisloch.' (Malenfant 1976: 1035, in italics in the original)

One of the most conspicuous sites in this area is the 'grotte de Prélétang', at an altitude of 1200 m, which yielded a small artefact assemblage consisting of 110 Levallois flakes, 27 non-Levallois flakes and 27 tools manufactured from flakes. The facetting index of this industry is 82.2%. The artefacts were manufactured from flint from diverse sources, which must have been imported to the site (Lequatre 1966; Malenfant 1976; Tavoso 1984). The absence of cores and debris indicates that the assemblage was imported to the site as such. Malenfant interprets Prélétang -and other sites in the Alps- as:

'... *habitats* ou *des haltes dans un environnement montagnard forestières*, d'abord et de pratique difficiles, même pour *des séjours saisonnières* et relativement *brefs* ...' (Malenfant 1976: 1036, in italics in the original).

In his opinion we are here dealing with

'... d'outillages dotés d'une extraordinaire plasticité, témoins d'une adaptation saissonnière profonde d'industries définies, hors des Alpes, comme moustériennes ...' (Malenfant 1976: 1036).

Cores and flakes were occasionally transported over large distances from their geological sources in the Middle Palaeolithic (see: Roebroeks *et al.* 1988), but 'tools' were generally discarded at greater distances from the source than flakes and cores. Figure 139 (after: Roebroeks *et al.*, 1988 figure 1) shows the relation between the distance from the raw material source near Ottigny and Céroux-Mousty (Belgium, Caspar 1984) and the form in which phtanite artefacts were discarded in Belgian Middle Palaeolithic sites. Retouched items ('tools') were generally discarded at much greater distances from the source than non-retouched items, a phenomenon also observable in the 'Rissian' Mousterian layers in the grotte Vaufrey (Geneste 1985; 1986a), and one that did not change significantly in the later stages of the Palaeolithic in these regions.

In the Roebroeks *et al.* 1988 paper we suggested, following Hayden (1976), that bifaces were very probably *curated* items which were periodically resharpened. This interpretation has found independent support in Keeley's study of microwear traces on handaxes, from which it can be inferred that there was an overlap in function between handaxes and flake tools (Keeley 1980). Hayden states that the use of soft-hammer techniques and the biface form only make technological sense if we assume that handaxes were fashioned to be resharpened and were curated. Virtually the only way of maintaining relatively sharp edge angles through many instances of resharpening by percussion is via the soft-hammer, bifacial technique. This also minimizes wastage of raw material during rejuvenation since the flakes tend to be thin, making the tool last longer. Handaxes may therefore be regarded as objects that were recycled in the system and were taken from one site to another in anticipation of future use. The 'raw material' data provided by Roebroeks *et al.* (1988) corroborate Hayden's interpretation with archaeological data, by showing that handaxes were

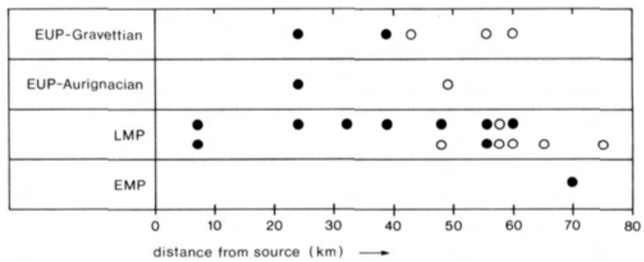


Fig. 139. The relation between the distance from the phtanite source at Ottigny/Céroux Mousty (Belgium) and the form in which phtanite artefacts were discarded.
– the black circles indicate sites that yielded blanks and retouched tools
– the open symbols are sites that yielded only retouched tools (from Roebroeks *et al.* 1988, figure 1).

transported over considerable distances.

Another very conspicuous aspect of Middle Palaeolithic technologies besides the transport strategy is the expedient manufacture of stone tools from local materials. This 'ad hoc' versus 'transported' dichotomy has been described in detail by Geneste for the Middle Palaeolithic of the Aquitaine area. Geneste defined three zones of raw material exploitation for the sites studied.

1. A zone consisting of an area of about 5 km around the sites provided 65-98% of the raw materials used. All of the flint knapping seems to have taken place at the sites. The 'utilisation index' of these raw material products is low: 5%.
2. Outside the first territory an area from 5 to 20 km around the sites provided 2-20% of the material, with a utilisation index of 10-20%. The materials entered the site in the form of prepared blocks.
3. Occasionally materials were brought in from much larger areas,involving distances of 50-80 km from the sites. Only products of the last stages of reduction sequences have been found. The utilisation index of these 'exotic' material products is very high: 75-100%.

This pattern is already observable in the case of the 'Rissian' layer VIII at Grotte Vaufrey (Geneste 1986a), which contained flint artefacts from several sources, two from areas 80 km to the west and the northeast of the site. A TL date of 120 ± 10 ka for the younger layer IV at this site (Aitken *et al.* 1986) is a *terminus ante quem* for these Grotte Vaufrey data.

Geneste has, furthermore, found evidence of a relation between technological, typological and raw material characteristics of assemblages: 'Levallois' assemblages are generally made from non-local raw materials and often contain Mousterian points, scrapers and handaxes (typical Mousterian, rich in scrapers and MTA). The 'Levallois' assemblage types contrast with assemblages which were made out of locally available raw materials using non-'Levallois' core-reduction strategies. Assemblages of this second type contain high percentages of denticulates and abrupt and irregularly retouched pieces, and can be classified as denticulate Mousterian or typical Mousterian rich in denticulates (Geneste 1985; Binford 1986).

Of course the choice between *ad hoc* and transport strategies has important consequences for the form in which lithic artefacts were discarded, as we have seen above in the case of the Belgian phtanite evidence. Transportation may be one of the key factors in Dibble's reduction model, which suggests that many aspects of scraper morphology reflect a continuum of reduction of one or more edges of flake blanks. According to this view (Dibble 1987a, 1987b), the typological variability of the scrapers is a measure of the intensity of reduction.

What if we try to interpret the much discussed 'Clactonian' along these lines? The definition of the Clactonian *excludes* the possibility of assemblages containing handaxes or 'Levallois' products ever being called Clactonian, so that, basically, the definition only refers to products of a flint-working technique in which little energy was invested:

> 'One must beware of some authors' use of the term 'Clactonian technique', which may merely denote the production of large heavy flakes with broad plain striking platforms, pronounced bulbs or cones of percussion and a high figure (say 110 to 140 degrees) for the angle between the general plane of the striking platform and the general plane of the bulbar surface. But these are all common features of the production of large flakes by use of a hard hammerstone, and can clearly occur at any stage of the Palaeolithic or even of Prehistory in general; more specifically, flakes showing these characteristics are certainly not outside the range of Acheulian industries, where they may occur for example as the initial hard-hammer removals from a large nodule as a first stage of shaping it into a handaxe, or even as blanks for handaxes themselves ... If one must seek a single hallmark, as it were, of the Clactonian, it might be better to regard the Clactonian 'chopper-cores' as providing it ... since they are in fact very uncommon in other Palaeolithic industries, though not totally absent in every case, while in the Clactonian they are relatively frequent. However, it is far better not to rely on a single characteristic feature at all, but to reserve the name Clactonian for *unmixed industries which consist wholly of the cores, flake implements and flakes of the kinds described, lack all signs of handaxe manufacture or Levalloisian technique, and, where dated, belong to the earlier stages of the Lower Palaeolithic* ...' (Roe 1981: 137, the author's italics)

Roe's definition of the Clactonian as given above has a built-in guarantee against the 'mixed' character of assemblages, which may, however, tell us much about the depositional processes behind these assemblages. Singer *et al.* (1973), reporting on the excavations at the Golf Course at Clacton-on-Sea, mention the presence of some flakes in the Clactonian industry which, if not found in a 'Clactonian context',

> '... would be accepted as the normal waste of hand-axe manufacture. This does not mean they are accepted here as such artefacts, for such an identification is critical in view of the problem in Britain of determining the sequence of the Clactonian and Acheulian industries.' (Singer *et al.* 1973: 40)

The interpretation of the Clactonian as essentially an 'ad hoc' industry is not a very original one (see Ohel 1979 for a survey of interpretations of the Clactonian), but one that should be critically evaluated now that the British site Boxgrove (Roberts 1986; Bergman *et al.*, in press) seems to be a serious candidate for a primary-context Acheulean site with a 'pre-Hoxnian' age. The author's 'ad hoc' interpretation of the Clactonian indeed sees it as an 'integral part of the Acheulean' (Ohel 1979), but not in Ohel's terms, who considered Clactonian sites to be areas for the preparatory production of handaxe roughouts, i.e. just a link in the manufacturing chain from raw material to finished tool. In this interpretation an occasional find of something that looks like a handaxe-sharpening flake or any 'Acheulean' find might indicate the presence of 'transported' tools in the toolkit of the producers of the Clactonian, who did not use (or more correctly: did not discard) the transported tools for any reason we can think of.

The 'transported versus ad hoc' dichotomy can also be used to challenge the 'cultural group' of the Taubachian, a term created by Collins (1969; see also: Valoch 1984, 1986). In general, the term Taubachian refers to assemblages containing artefacts of small dimensions including denticulates and notches. 'Taubachian' assemblages are known from several sites of a presumably last interglacial age, e.g. Taubach itself (Schäfer 1981; Brunnacker *et al.* 1983), Kulna (Layer 11, Valoch 1984, 1986) and Tata (Vértes 1964). Bilzingsleben, Vértesszöllös and Isernia La Pineta are Middle Pleistocene sites that have also been termed 'Taubachian' by Valoch (1984).

The microlithic form of Taubachian assemblages is in many cases clearly partly determined by the character of the locally available raw materials used to make the desired implements. At Kulna, however, the microlithic form of the Taubachian tools may have been determined by the reduction of larger blanks during the transportation of these objects. Valoch states that the Layer 11 (Taubachian) industry was made from heterogeneous material imported from several raw material sources, some at distances of more than 60 km from the site. The hominids who discarded the overlying Micoquian assemblage, however, used mainly flint from the immediate surroundings of the cave '... *pour la production d'outils de dimensions normales* ...' (Valoch 1984: 204, the author's italics).

Schäfer (1981) has discussed the Taubach artefact assemblage along a comparable line, opposing the notion that the small dimensions of the artefacts have to be related to factors like raw material availibility and environmental circumstances, and stressing the efficiency of these 'primitive' artefacts as the primary criterion of the producers.

Of course, the arguments developed in this paragraph are rather impressionistic and they should be worked out systematically in a more detailed study. The author is of the opinion that they could be developed into a good conceptual framework with which the Lower, Middle and also the Upper Palaeolithic could be tackled. The ideas presented here are, of course, not all new and the main topic has already been summarized in a much neglected paper by Tavoso (1984):

'Le fractionnement dans l'espace des étappes de la fabrication et de l'utilisation des outils apparait comme un modulateur puissant des caractères que nous utilisons pour décrire les outillages. Un même groupe humaine pouvait fort bien se contenter d'un grand nombre d'éclats bruts peu Levallois sur un gisement de silex, abandonner à une dizaine de kilomètres un outillage nettement Levallois et riche en éclats retouchés et n'emporter plus loin que quelques racloirs et éclats bruts.' (Tavoso 1984: 81).

This approach throws a totally new light on the Mousterian problem. The correlation between the importation of flint and the intensity of reduction (and thus the shape of the tool), the use of local flint and the predominance of denticulated and notched tools (Geneste 1985) clearly shows the way toward a tentative solution. It would be very interesting to study the patterning of the earlier Upper Palaeolithic industries (Aurignacian, Perigordian) along these lines too, in order to see whether there are any relations between specific industries and the predominant use of local or non-local materials.

The long distances over which implements were transported -and during which journeys they were repeatedly resharpened- have led us to assign a considerable *planning depth* (*sensu* Binford 1986) to Middle Palaeolithic technologies (Roebroeks *et al.* 1988). This is in marked contrast to especially Binford's assessment of the Middle/Upper Palaeolithic transition (Binford 1986, Binford in: Renfrew 1987). He stresses that Middle Palaeolithic adaptations '...appear to me to be based on tactics which do not require much planning ahead (that is, beyond one or two days); in addition to the absence of storage...there is an absence of curated technologies...' (Binford 1982b: 178). It is stated in Roebroeks *et al.* (1988) that the differences in technological organization between Middle and Upper Palaeolithic hunter-gatherer societies were less pronounced than commonly acknowledged, and that there are no convincing arguments to be derived from flint technology and flint use for great differences in fundamental forms of behaviour, such as in the capacity for anticipation and advance planning of activities. The authors tried to trace these differences on a wider chronological scale by comparing the size of raw material procurement networks in the different phases of the Palaeolithic. Figure 140 shows that the distances over which stone artefacts were transported increased considerably from the earliest Palaeolithic onwards. The observed increase in the transport distances over the Pleistocene time span could primarily be a function of expanding social networks, incorporating more people, on the assumption that the size of the procurement networks is a more or less reliable measure of the size of action radii of ancient hunter-gatherer communities.

The rise in the curve from 200 ka onwards is based exclusively on European data, which are relatively abundant from the Weichselian Middle Palaeolithic onwards. Roebroeks *et al.* (1988) have tentatively correlated this rise with the colonization of environments with dispersed food resources, relatively low 'Effective Temperature' and thus short growing seasons (cf. Rogers 1969; Gamble 1986; Kelly 1983). Fundamental forms of behaviour such as anticipation over larger time intervals and the exchange of information must be considered prerequisites for the colonization and exploitation of such regions.

9.4 Hunters, scavengers and background faunas

In the preceding chapters we have already touched upon the subject indicated in the title of this paragraph: can we discriminate between a 'normal' background fauna and faunal elements introduced by man, and if so, are the 'faunal elements' attributable to hominid activities in the form of hunting or scavenging?

It is important to try to discriminate between these two types of meat procurement on the basis of the archaeological material. As Blumenschine (1986) points out, scavenging or the foraging for and consumption of animals found dead implies that meat eating was a rather opportunistic form of behaviour, occurring irregularly and with a minimum of social cooperation. Indications of hunting activities, however, would imply that meat was more regularly consumed by these early hominids. The success of hunting practices was, to a large extent, possibly determined by social adaptations, for example group cooperation during the stalking and capturing of the game, and possibly also during its consumption. Getting a grip on the primary meat procurement strategies of Pleistocene hominids could give us a more solid base for hypothesizing on especially the social aspects of early hominid behaviour in this line of reasoning.

Until the end of the seventies, archaeologists all agreed that 'hunting' had been the primary meat-procurement strategy from the beginning of mankind onwards. One of the reasons for this *communis opinio* was that field studies of non-human primates had indicated that the eating of meat of smaller mammals by chimpansees and baboons was almost exclusively based on hunting activities (Blumenschine 1986). Early man was a hunter! Binford (1985) has

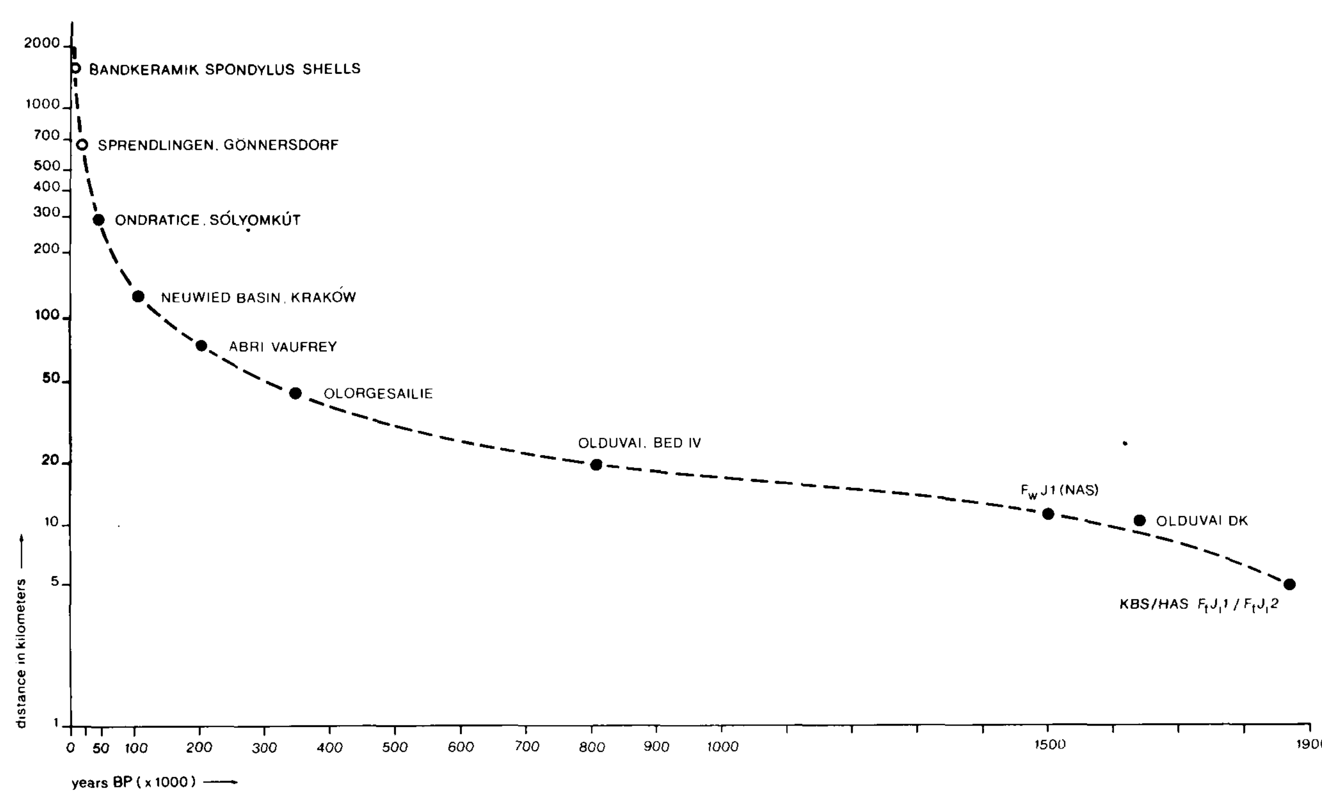


Fig. 140. Maximum distances over which raw materials were exported from their sources, from 'Oldowan' to Neolithic times.
– the black circles indicate stone artefacts
– the open circles indicate molluscs
(based on data presented in Roebroeks *et al.* 1988, with additional data from Leakey 1979).

given a survey of the way in which different authors described the social organisation of these 'hunters': tool-using hominids, hunting and living in social groups characterized by a male-female division of labour. Food sharing took place after the products of the hunt had been transported to the 'base camp', and this food sharing was seen by Isaac (1978) as one of the most important facets of the behaviour of the Plio/Pleistocene hominids and the basis for later sociocultural evolution. This interpretation of early hominid behaviour, however, has been the target of severe criticism for several years now (see: Binford 1985 for a survey), and several authors have stressed the potential role of scavenging in the meat-procurement strategies of Pleistocene hominids (Gamble 1986, 1987).

Now that scavenging is generally regarded as a meat-procurement strategy which may have been of considerable importance to early hominids, the question is, of course, how to discriminate between hunting and scavenging strategies on the basis of the archaeological material? The criteria that have been proposed in this context (see: Blumenschine 1986) are mostly based on size, age or body-part profiles characteristic of faunal assemblages obtained by specific procurement strategies, i.e. hunting or scavenging, and on the distribution of cutting and chopping marks, breakage and evidence of carnivore chewing.

The first attempts at a strict analysis of the archaeological material along these lines have not yielded unambiguous results and Blumenschine (1986) holds two factors responsible for this: one in the field of the premisses of the author in question, and a second of a methodical nature.

The first one is, in Blumenschine's opinion, related to the question to what extent indications of hunting or scavenging are seen as indications of the 'humanness' of early hominids. The best pleader of the 'hardly human' school is Lewis Binford, who continuously stresses the vital role of scavenging in the meat-procurement strategies of Lower, Middle and even Upper Pleistocene hominids, prior to the appearance of *Homo sapiens sapiens* on the archaeological scene. Binford has reassessed faunal assemblages from several pre-*sapiens* sites in the context of this discussion (Binford 1985; Binford/Stone 1986). One of the best known controversies generated in the course of his studies concerns the faunal assemblages excavated in the 1960s at Klasies River Mouth on the southern coast of Africa. In Binford's opinion, the 'Middle Stone Age' Klasies people were to a large extent dependent on the scavenging of what remained after other predators had eaten (see: Singer/Wymer 1986; Scott 1986).

With a view to the following discussion a brief outline will be given of Binford's (1985) 'look at the northern temperate zone' in terms of the hunting-scavenging discussion, for which he selected a few 'classic' sites in western Europe.

Swanscombe (Lower Gravels/Lower Loam):
In Binford's opinion, the faunal composition at Swanscombe shows all the characteristics of a natural background fauna. In his interpretation the hominids responsible for the presence of artefacts among the faunal remains were scavengers of carcasses and the hominid involvement in the accumulation of much of the faunal remains at Swanscombe was very small. The absence of tool marks on the bone material indicates that the hominids were mainly interested in meat, not in marrow.

Hoxne:
Binford mentions the predominance of heads and lower limbs of horses and evidence of systematic breakage of bones for marrow, particularly of horse bones. Fallow deer was represented by primarily meat-yielding bones. In his opinion the Hoxne fauna

'... has the characteristics of a transported and accumulated assemblage scavenged from medium to large mammals, in which heads and marrow-yielding bone were the parts most commonly transported for processing ...' (Binford 1985: 317)

Grotte Vaufrey:
The faunal assemblage from the 'Rissian' level VIII at this site points to the transport of parts of red deer, horse and occasionally aurochs to the cave. The bones are mostly upper limb bones or the meat-yielding bones. Tool-inflicted marks are virtually absent, as are indications of marrow exploitation. The presence of gnawing marks on the bones led Binford to assume that the hominids transported meat-yielding bones from previously ravaged carcasses, not from hunted animals.

Combe Grenal:
In the several Würm I and II levels at Combe Grenal larger mammals like aurochs and horses were mainly represented by essentially meat-yielding upper limb bones, while the marrow-yielding bones that had been introduced to the site showed evidence of cracking. Medium-sized animals, like red deer and reindeer, were brought onto the site in the form of a representative anatomical inventory.

'Particularly striking is the general absence of non-hominid gnawing of the bones from moderate sized animals. This contrasts markedly with Klasies River Mouth and all the earlier sites discussed here. This is taken as good evidence that the majority of the moderate body sized animals at Combe Grenal were *hunted for meat*.' (Binford 1985: 319)

Binford's conclusion of his 'look at the northern temperate zone' is that:

'At present, the inevitable conclusion seems to be that regular, moderate to large mammal hunting appears simultaneously with the foreshadowing of changes occurring just prior to the appearance of fully modern man.' (Binford 1985: 321, in italics in the original)

In the first interpretation of the Unit IV sites in terms of the research problems discussed in the preceding section the author was strongly guided by the dominance of remains of very young animals at these sites, which palaeontologists interpreted as indicative of human activities (Van Kolfschoten 1985: 72; Roebroeks *et al*. 1986). This assessment was interpreted in terms of hunting activities of Middle Pleistocene hominids, who were thought to be (partly) responsible for the formation of the Unit IV-C faunal assemblages.

A crucial factor in this interpretation was without any doubt the fact that palaeontologists working on faunas which are not associated with remains of human activities rarely find a dominance of young animals (Van Kolfschoten, pers.comm., 1985-1986). This is, implicitly, the reason why the combination of young animals and artefacts is often interpreted in terms of hunting activities. Vrba (1980), for instance, used the percentage of juvenile antilopes in faunal assemblages of South African *Australopithecus* sites to determine whether the bone collector in question was a primary predator or a scavenger.

The author presented his 'hunting' interpretation of the Unit IV-C data at several lectures and in discussions with colleagues, and was not confronted with criticism. Moreover, this interpretation seemed to be corroborated by the results of the investigation of the Early Pleistocene Tegelen faunal remains, discussed in section 4.3.4, and by the results of a recent study of deer from Tegelen, which again stressed the rarity of young individuals in the faunal remains (Van Kolfschoten, pers.comm., 1986).

In this earlier interpretation, however, one particular point was overlooked. Although the Tegelen fauna seemed to justify the inferences made regarding the Unit IV data, the point is that high percentages of the newborn individuals of all mammal species die in their first year. So we

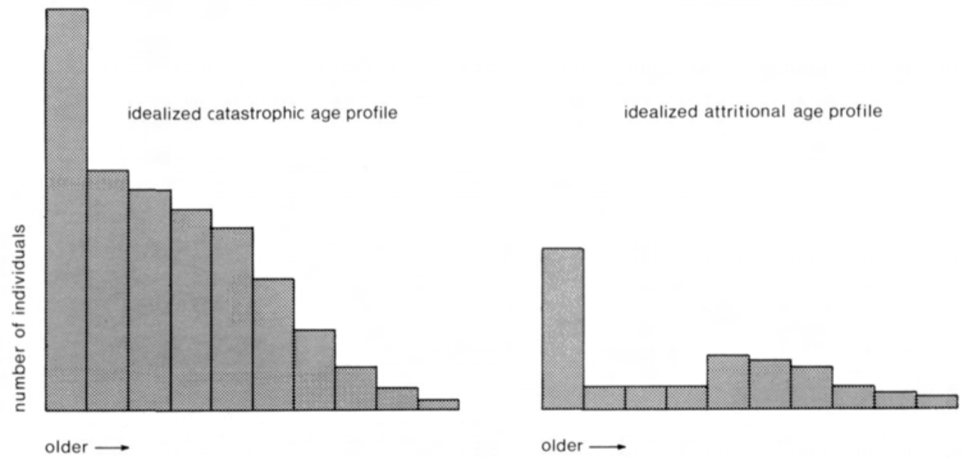


Fig. 141. On the left, the numbers of individuals in successive age classes in an idealized schematic *catastrophic* age profile and, on the right, an idealized schematic *attritional* age profile, consisting of the numbers of individuals that died between the successive age classes in the figure on the left (after: Klein and Cruz-Uribe 1984, fig. 5.4).

should be concentrating on the problem why this is not reflected in the Tegelen (and many other!) faunas, rather than wondering about the juvenile-dominated Belvédère fauna.

In order to try to answer this question, we must first consider the formation of a faunal assemblage in some detail. A faunal collection like that of Unit IV-C can be seen as representing the (preliminary) last phase of a sequence of transformation processes, in which part of a community of living animals finally ends up on the table of a palaeontologist. Klein and Cruz-Uribe (1984) have distinguished the following phases in this process:

1. *the life assemblage*: the community of live animals in 'natural' proportions (biocoenose)
2. *the death assemblage*: the carcasses that are available for collection by people, carnivores or other agents of bone accumulation (thanatocoenose)
3. *the deposited assemblage*: the carcasses or portions of carcasses that come to rest at the site (taphocoenose)
4. *the fossil assemblage*: the animal parts that survive at a site until collection
5. *the sample assemblage*: the part of the fossil assemblage that is collected

Klein and Cruz-Uribe (1984) have discussed the processes that play a role in the different phases of this series in detail. In this context only a few facets are of importance to us, namely the transformation of the life into the death assemblage, the transformation of the death into the deposited assemblage, and the transformation of the deposited into the fossil assemblage.

Figure 141 is important with respect to the transformation of a life assemblage into a death assemblage. The figures show hypothetical age profiles of mammal species of which the females give birth to at most one young a year. The 'fossil' age profiles of these species are interpreted in terms of two theoretically expectable models (Voorhies 1969; Klein/Cruz-Uribe 1984).

In the first model the successive age classes contain progressively fewer individuals. Such an age profile reflects a living population fossilized by a catastrophe. This type of profile is therefore known as a 'catastrophic' age profile (fig. 141).

In the second model prime age (reproductive, active) adults are underrepresented in comparison with their number in the living community, while young and old individuals are overrepresented. Such a profile comprises individuals dying of malnutrition, of accidents, predation and other attritional factors which had most impact on the youngest and the oldest individuals. The resulting age profile is called an attritional age profile.

One of the main factors involved in the transformation of a death assemblage into a deposited assemblage is the behaviour of the collector (see: Klein/Cruz-Uribe 1984). Different predators treat the various parts of a carcass differently, and selectively destroy bones when consuming a carcass. Furthermore, collectors tend to transport specific parts of a carcass to other sites, for instance because of their preference for those parts or because those parts are easily transported. Other parts of the carcass are left behind at the death site. Perkins and Daly (1968) have stressed the importance of this *Schlepp-effect* at archaeological sites, where bones of larger mammals may be represented by a smaller range than those of smaller mammals, which can be transported as whole carcasses. Klein and Cruz-Uribe (1984) point to the role of the portability of the skeletal elements in the interpretation of hyena sites: at two sites containing faunal assemblages generated by the activities of hyenas small ungulates were proportionally better represented by cranial material, while larger ungulates were proportionally better represented by post-cranial elements. These data clearly suggest that the percentage of young individuals in a faunal assemblage may say more about the collector's capability of transporting or destroying bones than about the collector's role as a scavenger or a primary predator. It is furthermore worth mentioning that carnivores often consume very young animals so completely that almost no skeletal parts are left for deposition. As for the transformation of the deposited into the fossil assemblage, the skeletal elements of young individuals suffer most from post-depositional processes and therefore young individuals are under-represented in the fossil assemblage.

Systematical study of faunal assemblages in which man cannot have been a formative agent -for instance because of the great antiquity of the assemblage- could in due time provide us with very relevant reference information for the interpretation of archaeological sites. We have already touched upon this topic above, in the discussion of the Early Pleistocene fauna of Tegelen. Such studies could give us detailed data on the character and variability of the kind of *natural background faunas* to be expected in specific environments. This kind of research was started only recently, as a way of studying problems encountered in the analysis of East African Plio/Pleistocene archaeological sites. Toth and Schick (1986) report that the preliminary results of these studies indicate a large variability in natural bone accumulations in terms of assemblage composition and bone modification. Furthermore,

'... a number of criteria which have sometimes been used to infer effects of hominid diversity, fracture patterns, degree of fragmentation, and some types of surface modification, can be mimicked by some natural phenomena ...' (Toth/Schick 1986: 44; see also: Haynes 1988)

The question we started with was to what extent may we use a predominance of young individuals in a fauna associated with primary-context archaeological remains to make inferences on hunting activities of Middle Pleistocene hominids? It seems legitimate to state that the age-profile of a faunal assemblage as such may only with severe restrictions be used to make positive statements on this topic (in contrast with: Roebroeks *et al*. 1986). The relatively large number of juveniles that died in their first year were a potentially important prey for scavengers, while they formed a common prey for hunting carnivores, because of their inexperience. Vrba (1980), discussing this problem, states:

'... I have found very little in the literature to test my hypothesis that scavenged assemblages should generally contain lower percentages of juveniles than primary predated ones. Kruuk presents hyena scavenging and killing totals of adult and juvenile wildebeest, zebra and gazelle in Serengeti and Ngorongoro (Kruuk 1972: table 22). Most of these data (excepting zebras at Serengeti) indicate that fewer juveniles than adults are scavenged by hyenas, while the reverse is apparent in the killing totals ...' (Vbra 1980: 268)

The often almost complete consumption of young animal skeletons by non-hominid carnivores may be one of the factors responsible for the virtual absence of young individuals in 'natural' faunal assemblages. Hominid bone collectors on the contrary, may leave behind more remains of these juvenile animals for deposition and incorporation in the fossil record.

At Belvédère we are looking at very small 'cuttings' in a riverine landscape, where hominid activities are attested by the presence of stone artefacts, spatially (horizontally and vertically) associated with bone fragments of predominantly very young animals. At Site G at least part of this spatial association could be translated in terms of hominid activities, thanks to the microwear analysis by A. van Gijn (see: Van Gijn, this volume, appendix I). Because of the relatively small number of animals involved and the generally poor state of preservation of the bone material all that can be said is that the point of departure for any inference concerning these problems has to be the proven interrelationship of the 'stones and bones'. All we can say here is that, on the assumption that they were hunters, the 'Belvédère' hominids hunted mainly very young individuals of larger mammals (here). But we have *absolutely* no base for the hunting assertion, and in fact this kind of reasoning eventually leads to treating Plio/Pleistocene hominids and their archaeological 'sites' as counterparts of present-day hunter-gatherers, thus bringing the archaeologist into a vicious circle, in which there is only a limited amount of room for evolution of hominid behaviour in the Pleistocene time span.

Another approach, advocated by Binford (1985, 1986), assumes the existence of basic differences in organizational capabilities between present-day hunter-gatherers and Middle and Early Pleistocene hominids as long as the contrary cannot be demonstrated. Instead of using the !Kung, Nunamiut, or other hunter-gatherer groups as ambulant Stones of Rosetta, advocates of this approach try to analyse what indications of specific forms of 'modern' behaviour can be found in the archaeological material. Of course, this approach also involves the risk of vicious circles. The difficulties encountered in the analysis of Early and Middle Pleistocene archaeological sites (hunting, scavenging or background faunas?) are -to the author's knowledge-only very rarely discussed when archaeologists are dealing with sites in which *Homo sapiens sapiens* played a formative role. When discussing sites from this time range, practically every archaeologist speaks of hunting activities, but what, one might ask, are the explicit arguments for this assumption?

9.5 The Unit IV-C sites in the northern European context

In recent years several northern European sites have been published which date roughly from the same time range as the Maastricht-Belvédère Unit IV-C sites.

In the Netherlands, for example, the rich quarry-sites in the neighbourhood of *Rhenen* (central Netherlands), discovered in the 1970s by Franssen and Wouters (Franssen/Wouters 1978, 1981; Stapert 1981b), were formed before the maximum extension of the Saalian ice-sheet. Most of the flint artefacts found at these sites were discovered in secondary contexts, in coarsely-grained fluviatile deposits, pushed up by the Saalian ice-cover. The assemblages collected at these sites show a striking resemblance to the Markkleeberg material (German Democratic Republic: Grahmann 1955; Baumann/Mania 1983).

The Belgian site *Mesvin* IV has yielded a rich Middle Palaeolithic flint assemblage in a secondary context, found in coarsely-grained sediments and in geological association with macro-faunal remains indicative of cold climatic conditions (Cahen/Haesaerts 1984; Cahen/Michel 1986). U/Th dating of faunal remains from the site yielded an age roughly in the middle of the 200-300 ka time range. The formation of the Mesvin IV archaeological assemblage may therefore be approximately contemporaneous with the deposition of the Unit III gravels at Maastricht-Belvédère, in a cold phase preceding the Unit IV-C warm-temperate phase. However, in the virtual absence of biostratigraphically diagnostic elements in the Mesvin IV faunal assemblage this correlation is based solely on the U/Th dates (Cahen/Haesaerts 1984).

The micro- and macro-faunal assemblages from the archaeological find layer 1 at *Ariendorf* (Neuwieder Becken, West Germany) indicate that these assemblages were formed in a cold stage either just before or just after the Maastricht-Belvédère Unit IV-C warm-temperate phase (Van Kolfschoten 1985; Turner 1986). The morphology of the stone artefact assemblage from this find layer, which is composed mainly of simple flakes, may have been dictated by the quality of the locally available raw material, being quartz, quartzite, and silicious slate (Kieselschiefer). Bosinski (1983b), however, has suggested another explanation for the morphology of this assemblage, namely that it was largely determined by the activities to be performed rather than by the raw material.

None of the sites discussed above was discovered in a primary archaeological context. The refitting evidence of the Mesvin IV and the Ariendorf sites suggests that the archaeological material may have been displaced over a limited distance only. There are a few better preserved sites in northern Europe which date from approximately the same period as the Unit IV sites at Maastricht-Belvédère.

The *Arvicolas* in the faunal assemblage from the Lower Travertines at *Ehringsdorf* (German Democratic Republic) enabled Van Kolfschoten (1985) to relate the formation of these travertines to the Belvédère Unit IV-C warm-temperate phase. U-series dating of the Lower Travertines, adjacent to the famous *Brandschichten* 'occupation layers', by Schwarcz *et al.* gave an average age of 225 ± 26 ka (Cook *et al.* 1982; see also: Brunnacker *et al.* 1983; Blackwell and Schwarcz 1986; Schwarcz *et al.* 1988). The Lower Travertines contained the products of an indisputably Middle Palaeolithic flint industry (Behm-Blancke 1960). The flints included a large number of simple, double and convergent scrapers, limaces and some bifacial points. The retouching was often scalariform, 'almost Quina-like', according to Bordes (1984), and was probably the product of several stages of reduction (cf. Dibble 1987a, 1987b). Steiner (1979) classified the Upper Travertine finds as a 'waste industry' (*Abfall-Industrie*), consisting of amorphous artefacts, comparable to the (Eemian) industries of Taubach (Steiner/Steiner 1975).

In 1922, Soergel published age divisions of fossil remains of rhinoceros (*Dicerorhinus kirchbergensis* [= *D.mercki*]) and elephant (*Elephas antiquus*) found at the travertine sites Ehringsdorf (Lower Travertines) and Taubach. Figures 142 and 143 give the age distributions of the species mentioned above, based on the identification of large numbers of individuals. Soergel used the age distributions of the larger mammal fossils to make inferences on the hunting methods of Palaeolithic groups whose flint artefacts were also found in the travertines. His approach, followed by later investigators of the Ehringsdorf site, provides a clear example of the approach in Palaeolithic archaeology that implicitly regards man as the principal or one and only agent responsible for the presence of faunal remains in deposits containing artefacts (cf. Binford 1981). In a recent review of the Ehringsdorf sites, Steiner (1979) discussed the hunting methods of the Palaeolithic groups at Ehringsdorf. His implicit approach, which is based largely on that of Soergel, can be summarized as follows:

1. human activities during the formation of the travertines are clearly attested by flint artefacts, charcoal and remains of the hominids themselves.
2. all larger mammal remains recovered from the travertines were deposited as 'Jagdbeute' (hunted game)
3. classify the elephant and rhino remains according to age, and you get information on the hunting methods of Palaeolithic man.

The age classifications made by Soergel (1922) are represented in table 24 and figures 142 and 143. According to Soergel (1922) and Kahlke (1957), rhinoceros and elephant were the most important game. The differences in the age compositions of the faunas of the two neighbouring sites Taubach and Ehringsdorf led Steiner to the conclusion that different hunting methods were applied at the two sites (cf.

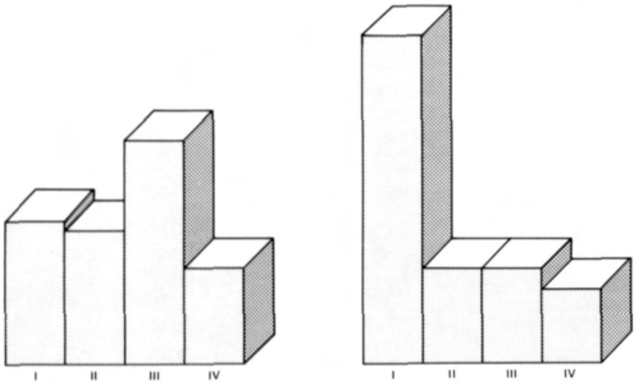


Fig. 142. Distribution of *Dicerorhinus kirchbergensis* remains according to age at (left) Ehringsdorf and (right) Taubach. I. very young individuals, II. young adult individuals, III. adult individuals, IV. old individuals. Based on data in Soergel 1922 (see this volume, Table 24).

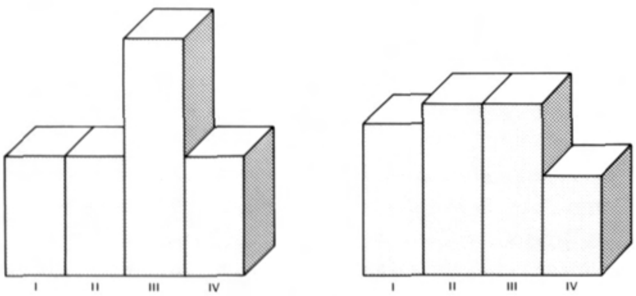


Fig. 143. Distribution of *Elephas antiquus* remains according to age at (left) Ehringsdorf and (right) Taubach. I. individuals of 0-6 years, II. 6-20 years, III. 20-50 years, IV. more than 50 years. Based on data in Soergel 1922 (see this volume, Table 24).

Table 24: Distribution of faunal remains from Taubach and Ehringsdorf according to age, as discussed in the text; based on data in Soergel 1922; Behm-Blancke 1960; Guenther 1975. See also figures 142 and 143.

	n	very young/ young indiv.	adult/ old indiv.
Taubach rhinoceros	100	71.4 %	28.6 %
Taubach elephant	60	54.3 %	45.5 %
Ehringsdorf rhinoceros	?	46.2 %	53.7 %
Ehringsdorf elephant	?	40.0 %	60.0 %

Soergel 1922; Behm-Blancke 1960): at Taubach very young to young animals formed the major part of the fauna, whereas at Ehringsdorf these age categories are less well represented. Therefore, Palaeolithic groups at Taubach must have used a more primitive hunting technique focussed on younger animals. The 'more evolved' (an interpretation based on the morphology of the stone artefacts; cf. 9.3) Ehringsdorf hominids, however, succeeded in killing large numbers of the experienced adult animals that were probably more difficult to catch. Details of the hunting techniques applied (pitfalls, etc.) are also given by Steiner (1979).

These interpretations speak for themselves. The Ehringsdorf and Taubach sites certainly deserve a reevaluation in the light of the current debate on our 'human ancestors' and the 'changing views of their behavior' (Binford 1985). Behm-Blancke (1960) has published pictures of what seem to be cutting marks on rhinoceros bones from Ehringsdorf, which show that these sites have a wealth of potential information on Middle Pleistocene human behaviour hardly matched by any other site in Europe.

One of the major problems encountered in the interpretation of these -and other- travertine sites is of course that we are dealing with faunal assemblages formed in sedimentary environments which favour the preservation of faunal elements 'produced' by a wide range of accumulating agents: natural deaths, various non-human predators, hominids, and geological processes. The 'sites' excavated in such sedimentary environments are the products of a complex series of depositional events of which hominid activities form only a part, but one that is usually given most of the credit for the 'statics' encountered, as we have seen above.

The biostratigraphical evidence from the sites of *Bilzingsleben* (German Democratic Republic) and *Miesenheim* (West Germany, Boscheinen *et al.* 1984), which includes the presence of *Arvicola terrestris cantiana* (*sensu* Van Kolfschoten, in press) in the faunal assemblages, shows that they are older than Maastricht-Belvédère (Van Kolfschoten, in press).

So far, few archaeological remains have been recovered from the Miesenheim site (Boscheinen *et al.* 1984). The fauna, however, may date from before the warm-temperate phase attested at the Bilzingsleben site, from which a large number of stone artefacts have been recovered (Van Kolfschoten, pers.comm, 1988).

Several absolute dates have been published for the Bilzingsleben travertine site and Harmon *et al.* (1980) proposed a correlation of the Bilzingsleben deposits with Stage 7 of the marine Oxygen Isotope record on the basis of a U/Th age of 228 +17/-12 ka. In view of the Belvédère Unit IV-C dating evidence discussed above, this age may be considered too young. Moreover, Cook *et al.* (1982) have reported the results of work on the dating of the site, which refer to ages of over 350 ka. Schwarcz *et al.* (1988) have recently published the results of an extensive ESR and U-series dating programme of the Bilzingsleben site. They conclude that the most likely date of the formation of the deposits bearing artifacts and hominid remains is 414 ± 45 ka at the earliest, and no later than 280 ka. Mania (1986) places Bilzingsleben explicitly above the 'typical' Holsteinian, namely in the Dömnitz-interglacial, which he considers to be the youngest of the two interglacials which form the 'Holsteinian complex'. The typical Holsteinian and the Dömnitz-interglacial are separated by the *Fuhne glacial*. Between the Dömnitz- and the Eemian-interglacial there was another interglacial, the *Rügen-interglacial*. Bilzingsleben has yielded very rich floral and faunal remains including remains of *Homo erectus* (see for the discussion on the classification of the hominid remains: Stringer 1981). Large numbers of artefacts have been found, most of which are small (10-80 mm). The retouched edges, often denticulated or notched, are straight, convex or concave. Thick scrapers were found, and points fashioned into borers. According to Mania, the material also included typical 'Levallois' cores, which means that the hominids responsible for the formation of the archaeological assemblage at least knew how to apply more complex forms of flint working. Mania (1986) presumes that the small dimensions and the poor structure of the raw material allowed only very simple forms of stone working.

Table 25 (from: Mania 1983, table 2) shows the frequency of identified mammals from a 200 m^2 section of the excavated area at Bilzingsleben. Mania (1983) explicitly treats these faunal remains as remains of *Jagdtiere*, hunted animals, and the large number of species is interpreted as indicating generalized hunting strategies, with a preference for rhinoceros (*Dicerorhinus kirchbergensis* [= *D.mercki*], *Dicerorhinus hemitoechus*), which accounted for a quarter of the total number of individuals in the 200 m^2 area. The 38 rhinoceros are mainly represented by lower jaws and individual teeth from 'smashed' upper and lower jaws. Young and adult individuals are present in equal numbers.

The predators present in the Bilzingsleben assemblage (amongst others: *Panthera [Leo] spelaea*, *Felis sylvestris*, *Lupus* sp.) are interpreted as also belonging to the group of *hunted* animals (Mania 1983: 330). In the author's opinion, analysis of the enormously rich and important Bilzingsleben site has to consider the possible *active* role of carnivores, not in the first place because their bones have been found, but because they may have participated in the taphonomic processes. As discussed above (9.4), we urgently need detailed data on the character and the variability of the kind of natural background faunas to be expected in northern temperate waterside regions. What do the 'natural faunas' of travertine or other open-air sites -i.e. faunas associated with no archaeological remains whatsoever- look like? What carnivores became fossilized there, and what do the body-part profiles look like? Such data might be useful in decoding the complex information provided by important sites like Bilzingsleben.

Table 25: Bilzingsleben, 'Steinrinne' frequency of animal species from a 200 m^2 section of the excavated area (data from: Mania 1983, table 2).

Species	Number of individuals	Relative frequency (%)
rhinoceros	38	26.02
deer	21	14.38
beaver	17	11.64
bear	17	11.64
elephant	16	10.95
bovid	8	5.48
extinct beaver	6	4.10
horse	4	2.74
boar	4	2.74
roe deer	3	2.05
lion	2	1.37
wild cat	1	0.68
fox	1	0.68
badger	1	0.68
wolf	1	0.68
other	6	4.10
Total	146	99.93

The Pleistocene sediments exposed in the *Kärlich* clay pit (Neuwied Basin, Middle Rhine area, West Germany) have provided important data on the Pleistocene stratigraphy of central Europe. The exposures, consisting of Rhine and Mosel gravels, loess and volcanic ashes, have yielded archaeological finds in several stratigraphical positions (see: Bosinski *et al.* 1980; Bosinski 1983c; Kulemeyer 1986). Of special importance here is the presence of an archaeological site in limnic sediments, which, according to palaeobotanical investigations, were deposited during a Middle Pleistocene interglacial (Urban 1983). Of special biostratigraphical importance is the occurrence of the taxa *Azolla filiculoides*, *Pterocaria* and *Celtis australis*. Although these three 'marker species' suggest a correlation with the Dutch Holsteinian (Zagwijn 1973), Urban suggests an intra-Saalian age for the 'Kärlich'-interglacial', on the basis of the composition of the flora of its terminal phase: this is dominated by deciduous trees, whereas pollen diagrams of other Holsteinian deposits in northwestern and western Europe are usually characterized by long phases of conifer preponderance (Urban 1983: 88). The archaeological finds are placed in the *Carpinus-Betula* zone of the interglacial.

The archaeological finds of the aforementioned site were found over an area of 53 m^2 and consist of the products of a very simple flint industry, mainly flakes with cortex. There are a few retouched artefacts: chopping tools, a cleaver and three handaxes. It was, however, not always easy to distinguish the artefacts from the broken stones ('tephrofacts') naturally occurring in large numbers in the find-bearing matrix: '... par exemple, dans le m^2 24 de la fouille on a compté environ 55000 pierres cassées parmi lesquels seulement 14 sont des outils ...' (Kulemeyer 1986: 46-47).

Oxford TL age determinations of burnt flints from layers C and D at *La Cotte de Saint-Brelade* (Jersey, United Kingdom) place the Middle Palaeolithic assemblages from these layers in the 238 ± 35 ka time range (Aitken *et al.* 1986; Callow 1986a). K. Scott (1980) has published the age groups of the mammals found at La Cotte de Saint-Brelade (Jersey) and discussed the role of hominids in the formation of the faunal assemblages of layers 3 and 6. In these 'Saalian' loessic deposits considerable numbers of mammoth and rhinoceros remains were found in two 'bone heaps', whereas, in contrast to other levels, artefacts were found in only relatively small numbers. Scott attributed the arrival of the two groups of mammoths and rhinoceros at La Cotte to man, who may have driven several '...relatively young animals and prime adults -those which would have been most dangerous to hunt...' off the end of a headland. The layers containing the bone heaps produced very large bones, had a very limited species representation (essentially mammoth and rhino), and yielded small numbers of artefacts. The other Saalian deposits at La Cotte, on the other hand, show dense concentrations of small bone splinters but few large bones and a wide range of species, associated with numerous artefacts. In the light of our age classification discussion it is interesting that Scott has compared the ages of the layer 3 and 6 mammoths and rhinoceros with those from the other levels. In the latter, mammoth and rhinoceros were represented by individuals considerably younger than those in layers 3 and 6: some of these individuals were

'... undoubtedly new-born. This would imply that the hunting of these large, dangerous species depended upon finding isolated young, weak animals, until, on two separate occasions, a rare opportunity presented itself to kill a substantial group of mammoth and rhino at one time ...' (Scott 1980: 150)

La Cotte de Saint-Brelade therefore seems to be a site with an age class pattern identical to that of the Belvédère Unit IV sites.

Recently, a monograph was published on the La Cotte de Saint-Brelade site (Callow/Cornford 1986), in which these bone heaps are discussed in more detail and are compared with the other layers of the fill of the ravine system. Besides demonstrating hominid involvement in the formation of the bone heaps, Callow suggests that the formation of these bone heaps was no 'incident' but the result of a strategy combining wide-ranging hunting of many different species with occasional, and probably opportunistic, large game kills in the ravines. The two large bone heaps, both situated at the base of a Saalian loess deposit, must therefore be seen as dating from the time of the abandonment of the site, the bone-heaps having been preserved almost as left by the occupants. The absence of large bone concentrations in the other layers is interpreted in terms of occasional clearance of medium-to-large bones in the narrow space in the ravine system:

'Such a practice would result in a strong bias towards preservation of unidentifiable splinters, and bones or teeth (whole or broken) whose size and shape rendered them liable to be trodden into the ground surface.' (Callow, in: Callow/Cornford 1986: 372)

This interpretation implies that the La Cotte hominids employed a consistent and widely-based strategy troughout the period of occupation, and that the abandonment of the site and the subsequent loess deposition led to the preservation of evidence which would have been destroyed in the course of continued use of the site.

Evidence obtained in the recent analysis of the *Swanscombe* deposits has led Bridgland *et al.* (1984) to a new chronological interpretation of the Swanscombe Pleistocene sequence and its rate of formation (cf. Wymer 1974; Roe 1981; Hubbard 1982). The floodplain deposits of the Lower Loam were formed under interglacial conditions, as is demonstrated by the results of the analysis of the molluscan fauna, and are traditionally correlated with the Hoxnian interglacial (Kerney 1971). Bridgland *et al.* (1984) report a TL age for the Lower Loam of 228.8 ± 23.3 ka. The quoted TL age for the Upper Loam is 202 ± 15 ka. According to the TL age determinations, there can therefore have been no significantly long interval between the formation of the Lower Loam and that of the Upper Loam. These TL age determinations indicate that the Swanscombe skull fragments, stratigraphically situated between the two Loam complexes, have an age in the 200-250 ka range, which means that they date from approximately the same period as the Maastricht-Belvédère Unit IV-C assemblages. As shown above, the Unit IV-C assemblages at Belvédère, however, postdate the Holsteinian of the Netherlands, which is traditionally correlated with the British Hoxnian. Unfortunately, the mammal fauna of Swanscombe does not provide a sound basis for a biostratigraphical placing of the site's deposits (cf. Cook *et al.* 1982).

Both the biostratigraphical evidence (Chaline 1978; Van Kolfschoten 1985) and a TL age determination of burnt flints show that the Middle Palaeolithic site *Biache-Saint-Vaast* (northern France) is younger than the Maastricht-Belvédère Unit IV-C sites. The determination of the biostratigraphical position of the site was, however, based largely on the evolutionary stage of dentition of *Arvicola terrestris*, of which, according to the excavator (Tuffreau, pers.comm., 1984), only a few diagnostic elements were found. Aitken *et al.* (1985) report a TL age of 175 ± 13 ka for the site. The archaeological finds were situated in a complex of fluvial and colluvial deposits, formed under temperate and cold-temperate conditions prior to the formation of the typical loess deposits in which the Eemian

'Sol de Rocourt' was formed (Sommé *et al.* 1986). The sedimentary complex shows a succession of two temperate phases separated by a colder interval. The first temperate peak is the most pronounced one. Sommé *et al.* (1986) interpret the palaeoloecological data as indicating an environment comparable to that of the Early Weichselian interstadials, and reject an 'interglacial' status for this temperate phase (see also: Chaline 1978; Poplin 1978). The TL age determinations mentioned above date the first temperate period recorded at Biache-Saint-Vaast to 175 ± 13 ka, i.e. the beginning of Oxygen Isotope Stage 6. The rich Middle Palaeolithic flint industry of Biache has been reviewed by Tuffreau (1986) and Boëda (1986). The debitage of all the levels is Levallois. Boëda has shown that one and the same core was used to produce several 'Levallois' flakes. Many Levallois flakes had not been transformed into retouched tools. Tuffreau (1986) suggests that the fact that the tools from several levels consist of only moderately retouched flakes may be due to the short duration of the occupation. The majority of the simple or double scrapers that dominate the toolkit show only slight retouching. Handaxes are absent. The site has yielded a very rich mammal fauna: in the 1976 campaign an area of 300 m^2 was excavated, yielding approximately 3 tons of faunal remains, among which Poplin identified several bones with cut-marks (Poplin 1978). As at Bilzingsleben, the calcareous matrix of the finds, consisting of finely-grained fluvial deposits, had also preserved remains of lion (*Panthera* sp.) and other predators (*Felis* cf. *sylvestris*, *Canis lupus*; Auguste 1986).

Finally, the *Rheindahlen* loess-pit should be mentioned, the 'type site' of Bosinski's (1982) Rheindahlen group, named after the archaeological inventory of the Saalian level B3 at that site: in the middle of the 'Saalian' loess underlying the Grey Brown Podzol (*Parabraunerde*) dating from the last interglacial a rich flint industry was found in the 'mottled horizon' (*Fleckenlehm*), which presented little evidence of the Levallois technique and included many well-made side-scrapers and points (Thieme *et al.* 1981; Thieme 1983a). At first glance, the B_3 tool assemblage shows some similarity to the Belvédère Site K material. Recently, Zöller *et al.* (1987) published a TL sediment age of 167 ± 15 ka for the *Fleckenlehm* at Rheindahlen.

9.6 Early Middle Pleistocene sites and the pseudo-artefact problem

In the author's opinion, the Belvédère Unit IV-C sites represent the oldest well-dated material remains of Pleistocene human activities in the Netherlands. The flakes from Unit III, discussed in chapter 3, date from before the formation of the Unit IV sites, possibly from the cold phase preceding the warm-temperate 'Unit IV' phase.

In recent years, however, Dutch amateur archaeologists have published a large number of lithic objects that are interpreted as artefacts and are attributed to a 'Chopper-Chopping-tool Complex' (Franssen/Wouters 1983; Van Es/Franssen 1984). The dates ascribed to these lithic assemblages generally vary from Middle Pleistocene to the earlier phases of the Lower Pleistocene, although presumed Pliocene finds have also been published (Van Es/Franssen 1984). Thanks to the generous cooperation of Mr A.M. Wouters (Lent) and others, the author has been able to study several of these 'Chopper-Chopping-tool Complex' collections in recent years. In the author's opinion, which is totally divergent from that of Mr Wouters and his colleagues, the lithic objects presented to him as artefacts belonging to the 'Chopper-Chopping-tool Complex' tradition do not show any convincing signs of human workmanship and are, alternatively, to be interpreted as *pseudo-artefacts*.

In 1983, the author was able to study a flint object found by De Heinzelin at Halembaye (Belgium), 5 km south of Maastricht. This object had been found in a section in which gravel belonging to the Sint Pietersberg High Terrace deposits was exposed (De Heinzelin 1977). In a recent outline of the Belgian Palaeolithic (Cahen/Haesaerts 1984) this find is presented as evidence of human activities in the 'Cromerian'. In the author's opinion, the flint is clearly a pseudo-artefact of the same kind as can be collected in large numbers from the flint-rich Maas terrace gravels (Bartstra 1977). 'Pre-Acheulian artefacts' collected from High Terrace Maas gravels in South Limburg were published in 1950 (Thisse-Derouette 1950). Wouters (1952-1953) critically reviewed these finds and stressed that there were many pseudo-artefacts in these flint-rich deposits.

Therefore, sound evidence of the presence of man in the earlier Middle Pleistocene of the Netherlands is virtually lacking. In fact, if we try to gather evidence of human activities in northern Europe during the earlier parts of the Middle Pleistocene, i.e. prior to the Bilzingsleben occupation phase discussed above, we are regularly confronted with the pseudo-artefact problem. There seem to be only a few archaeological sites from this time range in northern Europe. Westbury-sub-Mendip in Great Britain was presented as a site with archaeological material dating from the 'Cromerian' period (Bishop 1974, 1975; Roe 1981). According to Cook (1983), however, the flint material from this site does not show clear traces of human working, and we may well be dealing with an assemblage of pseudo-artefacts.

The Belgian site La Belle Roche at Sprimont (province of Liège) has been published as a continental counterpart of Westbury-sub-Mendip but serious objections can be made against the presented artificial character of the 'stone industry' (cf. Roebroeks 1986b). The site at Sprimont is currently being investigated by a team from the University of Liège (Cordy 1980, 1981). The site is situated on the right bank of the river Amblève in the 'La Belle Roche' limestone quarry, where carboniferous chalk is being extracted. The finds come from a horizontal karst gallery, which is part of an extensive karstic system and is exposed in the upper part of the limestone, approx. 60 m above the Amblève. The entire karstic system is filled with detrital sediments and stalagmitic deposits. The horizontal karst gallery is 12 m long and 1.5 m high, and two vertical pipes ('chimneys') less than 10 m high extend to the land surface. The sediments filling the horizontal gallery consist of a basic gravel unit, overlain by a series of mudstone layers, about 70 cm thick, sealed by a calcite layer, which has been subjected to U-series dating analysis (Gascoyne/Schwarcz 1985). The upper half of the mudstone layer contained rounded limestone cobbles, stalagmite fragments, faunal remains, and about 40 small pieces of severely weathered flint. In addition to the flint objects, it contained some quartz and quartzite pebbles (Cordy 1980, 1981). Gascoyne and Schwarcz (1985) mention that the matrix of the faunal and lithic finds must have been deposited as a series of mud flows that descended through the vertical shafts from higher levels in the karstic system, which are now eroded. Because of the presence of remains of *Ursus deningeri* and *Panthera gombaszoegensis*, Cordy has placed the rich and well-preserved micro- and macro-faunal remains which were found in a secondary context in an earlier part of the Middle Pleistocene. The U-series dating of the calcite has provided a *terminus ante quem* of 350 ka for the deposition of the mudstone layer and the objects embedded in it (Gascoyne/Schwarcz 1985).

According to Ulrix-Closset (Cordy/Ulrix-Closset 1981), the flint assemblage includes some chopping tools, cores, polyhedrons, and flakes with archaic characteristics, and resembles the 'Budien' assemblage of the Middle Pleistocene site of Vértésszöllös in Hungary (Kretzoi/Vértes 1965; for illustrations of the Sprimont flint assemblage see: Cordy 1980, 1981).

The author has visited the Sprimont site several times with the excavator, J.M. Cordy, and has had the opportunity to study the stone assemblage. Cordy was of the opinion (pers.comm., 1983) that the combination of a very primitive flint-working technique and extreme weathering makes it difficult to identify the lithic objects as artefacts, but the author could not detect any characteristics in the assemblage that could be attributed to human activities and does therefore not regard the collection as an archaeological assemblage. As Cook *et al.* (1982: 56) have stressed, in these very problematical cases '... the burden of proof must fall on the shoulders of the excavator ...'.

One of the implicit arguments for human involvement in the case of the Sprimont stone assemblage is that currently there is no flint in the Sprimont region. This is incorrect, for the site lies in the vicinity of one of the places where the well-known *Eolith* problem was studied. The Belgian geologist Rutot's first and most important eolith-site, Boncelles (Rutot 1907), lies about 12 km to the west of Sprimont. Oligocene eoliths have been collected in the surroundings of Boncelles, to the west of Sprimont, and at Baraque Michel, 25 km to the east. According to Rutot and later generations of geologists, this region was originally covered by a *cailloutis* that enclosed the eoliths. Nowadays, the remnants of this *cailloutis* are known as the (Upper) Oligocene Basal Conglomerate (Calembert 1954; W.M. Felder, State Geological Survey, the Netherlands, pers.comm., 1983). The 'fresh' eoliths collected by Rutot from this *cailloutis*, and also from higher -Tertiary- levels, are stored at the Royal Belgian Institute of Natural Sciences at Brussels, where the author has had the opportunity to study them; the general morphology of the pieces matches that of the weathered pieces found at La Belle Roche (see figures in Rutot 1907 and in Cordy 1980, 1981). Karstic sinkholes may well have trapped early Middle Pleistocene (or older) remnants of this Tertiary cover, which were subsequently transported through the karstic system into the horizontal karst gallery. The Tertiary cover was eroded in later times by the downcutting of the Amblève, which today flows 60 m below the level of the site.

This alternative explanation is supported by three observations:

1. In a limited study of the literature, the author found that even today remnants of the Oligocene cover are present at Sprimont and in its environs (Calembert 1954: 515). According to W.M. Felder (State Geological Survey, the Netherlands), *cailloutis* flints of the kind as discussed above, and eluvial flints have been found on the right bank of the Amblève (pers.comm., 1986).
2. It is interesting to note that Rutot (1907: 479) also described a case near Fonds de Forêt, 7 km southwest of Liège, where a vertical channel tapped the Oligocene cover and had transported several cubic metres of this cailloutis into a cavity.
3. In discussing the site's taphonomy, Gascoyne and Schwarcz (1985) note that 'Neither the faunal assemblage nor the mode of emplacement of the deposits indicates that any part of this cave system was ever occupied by hominids. The presence of artefacts in the cave sediments may be the result of stream transport or other sediment movement into a karstic sinkhole.' (1985: 642).

In conclusion, the absence of clear traces of human modification of the Sprimont stone assemblage and an alternative explanation for the 'natural' occurrence and morphology of the lithic objects in the karst gallery calls into question the interpretation of La Belle Roche as an archeological site. Further critical study and further evaluation of the finds and their contexts is necessary in view of the problems discussed above.

In the author's opinion, it is necessary to discuss such problems openly in order to keep false information from creeping into the written 'archaeological record' and being used in other contexts. For example, in a paper by Schwarcz and Latham (1984) on U/Th dating evidence from Vértésszöllös, Sprimont is cited as one of the sites showing that by the time of the occupation of Vértésszöllös '... lithic industries, dominated by large bifacial tools, were already made elsewhere in Europe ...' (Schwarcz/Latham 1984: 334).

The best evidence of the presence of man in northern Europe in an earlier part of the Middle Pleistocene seems to be the Mauer mandible, the earliest hominid fossil found in Europe (cf. Cook *et al.* 1982). The mandible was found in the Lower Sands in the Grafenrain quarry, at which level the biostratigraphical marker horizon of the *Mimomys-Arvicola* transition has been set (Von Koenigswald 1973). This transition must have taken place after the deposition of the Cromerian type sequence at West Runton, where *Mimomys* is still present (Cook *et al.* 1982). According to Zagwijn (in press), the typical Cromerian, as defined at West Runton, correlates with the latest interglacial (Interglacial IV) of the 'Cromerian-complex' found in the Netherlands. Van Kolfschoten (in press), however, recently stated that the fauna of West Runton is *older* than the fauna known from Noordbergum in the Netherlands, dated as Cromerian IV on the basis of pollen-analytical evidence. Van Kolfschoten infers that the *Mimomys-Arvicola* transition took place in the glacial period preceding the Cromer IV (Noordbergum) interglacial. In the Netherlands the palaeomagnetic Brunhes/Matuyama boundary is set between Interglacial I and II of the Cromerian-complex (Zagwijn *et al.* 1971; Zagwijn/De Jong 1983-1984), which indicates that the *Mimomys-Arvicola* transition took place well after 700 ka; this gives us a rough idea of the age of the Mauer mandible: taking into consideration the correlation problems mentioned we thus arrive at an age of approximately 400-600 ka.

Although Rust (1956, 1957, 1965, 1971) claimed to have found artefacts at the same stratigraphical level as that where the mandible was found, recent work by Müller-Beck, reviewed in Cook *et al.* (1982), indicates that the mandible site contained no stone artefacts.

The age of the Vértésszöllös site has recently become the object of a discussion because of an incongruity between the biostratigraphical position of this site and its U/Th dating (Schwarcz/Latham 1984). Kretzoi and Vértes (1965) originally assigned a Biharian age to the site, which they equated with an early 'Mindel' stage on the basis of the faunal assemblage, which contains remains of *Panthera gombaszoegensis*, *Ursus deningeri*, *Trogontherium scherlingi* and the vole *Arvicola cantiana*. According to Schwarcz and Latham (1984), the travertines containing these faunal remains and the associated human fossils and artefacts appear to have been deposited over a span of about 40,000 years, centred around 185 ± 25 ka. Accordingly, the Vértésszöllös site should be roughly contemporaneous with, or even younger than the Belvédère Unit IV sites, which places two *biostratigraphically* completely different faunas (cf. Van Kolfschoten in press) in the same time range. This controversy clearly reveals the limitations of the dating methods currently at our disposal.

The morphology of the Vértésszöllös stone industry, made from quartz, quartzite, flint, chert and radiolarite (Kretzoi/Vértes 1965), seems to have been dictated by the small dimensions of the raw material, as was the case at Bilzingsleben. The pseudo-artefact problem mentioned above also played a role in the Vértésszöllös analysis, since it was not always possible to make a clear distinction between naturally altered and artificial pieces during the excavation (Müller-Beck 1977; Cook *et al.* 1982).

With the sites of Westbury-sub-Mendip, Sprimont, Mauer and Vértésszöllös the main European earlier Middle Pleistocene sites relevant in this context have been discussed. This is not the place to discuss southern European Middle Pleistocene sites; Cook *et al.* (1982) have extensivly discussed the Arago cave at Tautavel (France), the chronological placement of which still gives rise to problems.

Besides the sites already mentioned above a large number of sites have been published in recent years, which are said to provide evidence of hominid occupation of Europe in the earlier parts of the Middle Pleistocene or even earlier. Bosinski, for instance, mentions the presence of artefacts below the Brunhes/Matuyama boundary in the Neuwied Basin (Bosinski 1988), while Bonifay (1988) presented a large number of Early Pleistocene 'sites' in the Massif Central at the 1988 Andernach conference on the earliest occupation of Europe.

The colonization of Europe, with its interseasonal differences in productivity of the environment and its relatively low temperatures, must have required specific forms of adaptation on the part of the hominids who were to be the first inhabitants of this continent. Overcoming the 'winter stop' of the environment must have been one of the greatest problems in this context. If archaeologists are to establish *how* and *when* early hominids became capable of surviving in these northern temperate zones then the claims for all early sites in Europe must be subjected to a critical evaluation, concentrating on the artificial character of the stone assemblages, their age determinations, etc. Such a study, involving an analysis of the original lithic assemblages, could provide archaeology with a fresh yardstick with which the colonization of Europe could be measured.

Annelou van Gijn[1]

appendix I
A functional analysis of the Belvédère flints

The Belvédère pit has yielded a considerable amount of information about the life-style of Middle Palaeolithic hunter-gatherers and the environment in which they performed their various activities. We decided to perform a functional analysis of the flint assemblage with the hope that this would shed more light on the role of the flint artefacts in the subsistence pattern.

1. Method

Use-wear analysis of flint surfaces is a fairly recent discipline, enabling the interpretation of used area, motion and contact material. Flint surfaces are damaged in use and the traces of this damage can be studied microscopically. Wear traces include edge-removals (generally referred to as 'use-retouch'), edge-rounding, polish and striations. One group of wear analysts emphasizes edge-removals and edge-rounding (Odell 1975, 1977; Tringham *et al*. 1974), whereas for others polish and striations form the basis for inferences about tool use (Keeley 1974, 1980). The method followed here is essentially that outlined by Keeley (Keeley/Newcomer 1977; Keeley 1980) and developed further by Anderson-Gerfaud (1981), Moss (1983a), Plisson (1985) and Vaughan (1985).

The Belvédère implements were studied with a reflected-light microscope (Nikon optiphot) at magnifications ranging from 50 to 560x. At the outset of the study the tools were scanned for the presence of residues prior to cleaning[2]. It soon became clear that this was a fruitless enterprise because all residues had been removed by percolating groundwater or had been consumed by micro-organisms. Initially, the flints were only soaked in soapy water and rinsed off; treatment with HCl was omitted to avoid the danger of damaging the stone. However, because some of the artefacts displayed a sheen which could possibly be a mineral deposit, it was decided in a later stage of the research to subject all artefacts to treatment with a 10% HCl solution in an ultrasonic cleaning tank, followed by a rinse with KOH. The effects of this cleaning procedure will be discussed below (paragraph 2). Throughout the analysis the tools were regularly wiped clean with alcohol to remove finger grease. The use-wear analysis was conducted prior to the refitting programme to avoid possible confusion between traces of use and secondary damage from the refitting attempts.

A total of 55 flakes was examined for the presence of traces of use. The pieces came from various sites within the quarry (table 26) and were initially selected on the basis of one criterion only: whether they still looked reasonably fresh when examined with the naked eye. The other flakes either displayed colour patina or extensive gloss, inhibiting the interpretation of tool use on the basis of polish and striations. Furthermore, all pieces shorter than 5 cm were excluded. It was argued that if the analysis of the larger flakes should prove unsuccessful, the amount of time necessary for the examination of the small debitage would be unjustified. Moreover, as Moss (1983b) has argued, edges shorter than 2 cm are less likely to have been used, certainly not without hafts. Because we may assume that plenty of raw material was available nearby, small pieces are likely to have been discarded unused. It should therefore be stressed that the sample of 55 artefacts was not a random selection, nor was it geared to specific questions regarding behavioural aspects of tool use and discard.

2. Post-depositional surface modifications

Although many of the selected pieces appeared quite fresh when viewed with the naked eye, when examined under the microscope they turned out to be patinated: the surface exhibited a greasy lustre. Sometimes this lustre was confined to a band along the edge, while the remainder of the surface was still reasonably fresh. This band of greasy lustre can easily be mistaken for fresh hide polish as indeed has been the case in the past (cf.Roebroeks 1984b). It is precisely the edges and ridges that are the first parts of the tool to be affected by patination (cf.Keeley 1980; Rottländer 1975a). Besides having a greasy lustre, the surface of many of the Belvédère flints appeared to have been dissolved and had a 'sugary' appearance (fig.144a, 144b), i.e. the surface was no longer a flat plane and had changed into a jumble of ill-defined pits and craters. As a consequence, the surface reflected a large amount of light from all directions and was very difficult to examine. This was the case with all of the stones which had a creamy or light-yellow colour. Some tools had a clear brown patina, but their surfaces had not gone 'sugary' and only displayed the greasy lustre.

In an attempt to remove the greasy lustre and to improve the appearance of the surface, all tools were immersed in a 10% HCl solution and then rinsed with KOH. This caused

Table 26: Composition of the sample studied for the presence of traces of use-wear.

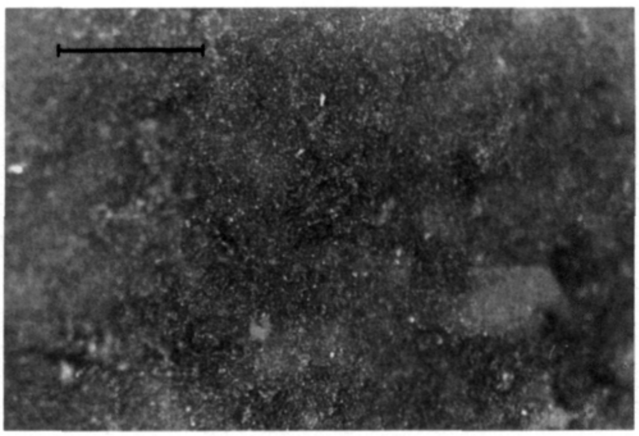
site	total recovered	length 2-5 cm	length ≥ 5 cm	total examined	lithostratigraphical attribution
B	5	3	2	5*	Unit IV-C
C	3067	684	113	34	Unit IV-C
E	95	57	11	1	Unit VI-D
F	1215	264	45	10	Unit IV-C
G	58	20	11	5	Unit IV-C

* It must be mentioned that 4 of the 5 examined artefacts from Site B derive from a nearby section.

most pieces to turn yellow to varying degrees, probably due to precipitation of the compound KCl (potassiumchloride). After renewed immersion in HCl and 24 hours of rinsing in running tap-water, some of the yellow colour disappeared. The remaining potassiumchloride was lodged in the deep pores of the stone. Remarkably enough, the few flints which had not turned yellow proved analysable. Apparently the surfaces of the stones that turned yellow had dissolved (been patinated) so extensively that deep pores had been formed into which KCl had been deposited.

It is very difficult to understand the exact process of patination and the circumstances under which it occurs. Moreover, patination is a catchall term for a variety of phenomena. Often, mechanical abrasion is also included in the category 'patinated'. Abrasion probably did play a role in the Belvédère pit because some vertical displacement is attested; in some instances it amounts to 25-40 cm (Roebroeks, this volume). The sandy matrix in which the artefacts were embedded could thus easily have abraded the tools. However, these abrasive processes produce 'gloss' and cannot be held responsible for the dissolved flint surface. It is more likely that this is attributable to chemical processes. Rottländer (Rottländer 1975a, 1975b) has argued that gloss-patina can be formed in an acidic environment, such as in a peat matrix. It is unlikely that this was the case with the Belvédère material. The result should be a smooth, shiny plane and not the irregular, cratered and 'sugary' surface of many of the Belvédère flints. Moreover, a pH-analysis of some soil samples indicated that, on the whole, the matrix is alkaline. Close to Site G, the top part of Unit IV yielded a pH of 8.6 ± 0.002 with the H_2O method and of 7.6 ± 0.001 with the KCl variant (pers. comm. J. Vandenberghe, Amsterdam, 1987). A sample from Site C yielded a somewhat lower pH: 6 – 6.5. It would therefore seem that the soil conditions were nowhere inducive to the formation of gloss-patina. It is also noteworthy that in areas where the overlying layer contained chalk, as was the case with Site G, the pieces were in considerably better condition. Perhaps the greasy lustre observed on some flints (for instance those with a brown patina) is due to gloss-patination but even this is doubtful as it has a very rough appearance.

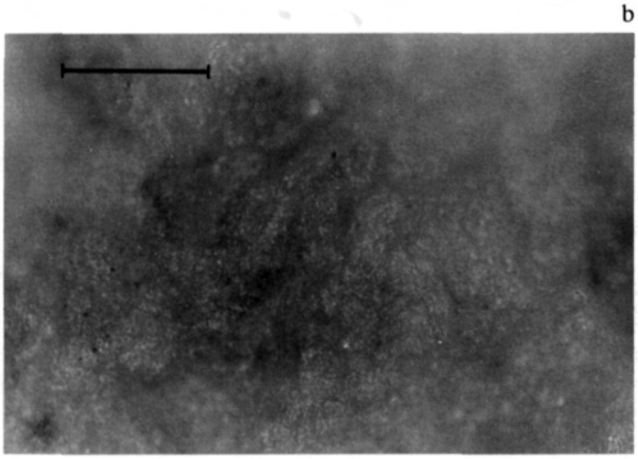
Further information on patination became available during the excavation of the Unit IV-C Site K in the summer of 1987 (not reported on in this paper). Here, artefacts were recovered in mint condition: the tools had a blueish-black colour similar to that of fresh Rijckholt flint. However, they turned grey within a few minutes and obtained the creamy, light-yellow colour characteristic of much of the



a

Fig. 144. Surface of a flint tool from Site K. a) directly after excavation, b) the same surface 5 minutes later; note the 'sugary' appearance. The scale bar measures 100 μ.

b



Belvédère material after a period varying from two days to a few months. The microscope was put up on the site so as to be able to examine the flint as soon as it was excavated. For the first two minutes or so the stone surface appeared fresh, with a flat plane. However, it quickly dissolved and became 'sugary' (figs .144a, 144b). Apparently, the flint surface had already been altered in such a way prior to its removal from the ground that exposure to light and/or dessication catalysed the dissolution process. Immersion of the artefacts in water and storage in a dark place stopped this process. Water clearly played a crucial role in the patination process, as has already been stressed before (Andersen/Whitlow 1983). The process of patination is irreversible, so it is likely that bound water is removed from the chemical composition of the flint. More research into this phenomenon will be done in the future.

Right now it suffices to conclude that of the 55 selected artefacts examined, 48 exhibited post-depositional surface modifications (dissolved surface or greasy lustre). Of these, 16 had been greatly affected, 22 moderately so, while 10 were only lightly patinated. As for the last category, it was sometimes possible to tentatively state whether a piece was likely to have been used or not.

3. Use-wear traces

Only 7 of the 55 flints which were examined were fresh enough to allow an interpretation in terms of tool function (table 27). Four of these showed no traces of use (Bv 62; 21/23-54; 46/106-1; 47/104-1). This does not necessarily mean that these flakes had not been used: experiments have shown that wear traces resulting from contact with soft materials, such as meat, fresh hide and certain green plants develop very slowly (Unrath *et al.* 1986; Van Gijn 1986; Moss 1983a). Only three tools displayed indisputable traces of wear.

One, a blade-like flake (D-18/5) with tiny edge-removals along its lateral edges (fig.145) and edge-angles of 32° and 35°, exhibited a vague band of rough, greasy polish, about 2 mm wide, which has been interpreted as the result of contact with meat. It was visible on both lateral edges. The polish showed no directionality, striations being absent, but the low edge-angles and the general shape of the tool suggest that it had been used in a cutting motion. The faint traces of retouching are probably to be associated with the tool's former use and do not seem to be intentional, because the areas of polish and retouch coincide exactly. This blade-like flake came from Site C.

Two flakes from Site G displayed traces of use. On one (47/105-3) (fig.146) a matt, vague band of polish was observed, associated with tiny, scalar edge-removals (fig. 147). This tool was interpreted as having been used on meat. The second, a large backed blade (46/106-11) (fig.148), had slightly been affected by patination but the wear-traces were

Table 27: Results of the analysis of the fresh pieces.

artefact	site	chalk matrix	interpretation
BV 62	B (Unit IV-C)	yes	no traces
D-18/5	C (Unit IV-C)	no	meat
21/23-54	F (Unit IV-C)	no	no traces
46/106-1	G (Unit IV-C)	yes	no traces
47/104-1	G (Unit IV-C)	yes	no traces
47/105-3	G (Unit IV-C)	yes	meat
46/106-11	G (Unit IV-C)	yes	hide

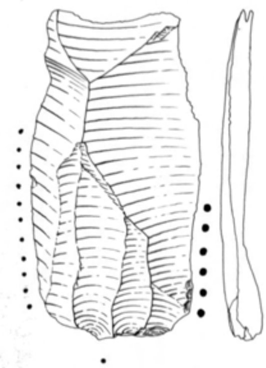


Fig. 145. Position of wear traces on D-18/5 from Site C, Unit IV-C (scale 2:3).

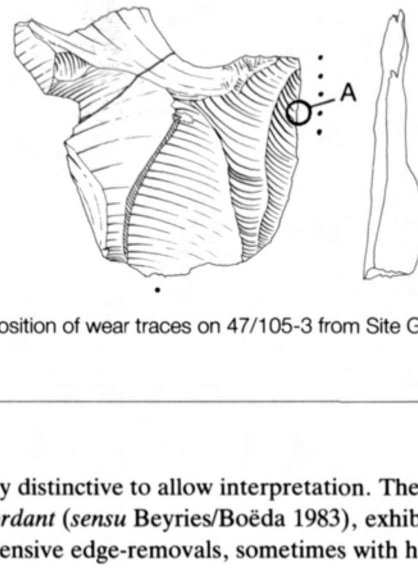


Fig. 146. Position of wear traces on 47/105-3 from Site G, Unit IV-C (scale 2:3).

sufficiently distinctive to allow interpretation. The tool, an *éclat débordant* (*sensu* Beyries/Boëda 1983), exhibited rather extensive edge-removals, sometimes with hinge fractures, which suggested that it had been used on a moderately hard material. Polish distribution varied from isolated spots to a band along the edge. The character of the polish, which was rather pitted, changed from rough and matt to rough and greasy. It displayed a directionality parallel to the edge, which suggested that the tool had been used in a longitudinal motion (fig.149a, 149b). This was corroborated by the presence of a few vague striations running parallel to the edge of the tool. The above-mentioned combination of wear-traces points to hide as the most likely contact material.

It is worth speculating a little on the character of the hide cut with this large backed blade. The greasiness of the polish in some areas suggests that the hide was in a rather fresh state. On the other hand, the polish's matt character in other areas indicates contact with a dried hide. The striations may be due to the presence of sand or dirt particles on the skin, while the rather extensive edge damage points to a medium-hard material. The type of skin that answers this description is that of pachydermatous animals such as rhinoceros and elephant. Their skins contain many dirt particles, are quite hard and the epidermal parts are dry and horn-like.

Three experiments were carried out on elephant skin (fig. 150), one with a large naturally backed blade, two with smaller blades. The former, which closely resembled the archaeological *éclat débordant* in terms of dimensions and edge angle, proved a far more effective tool for the very

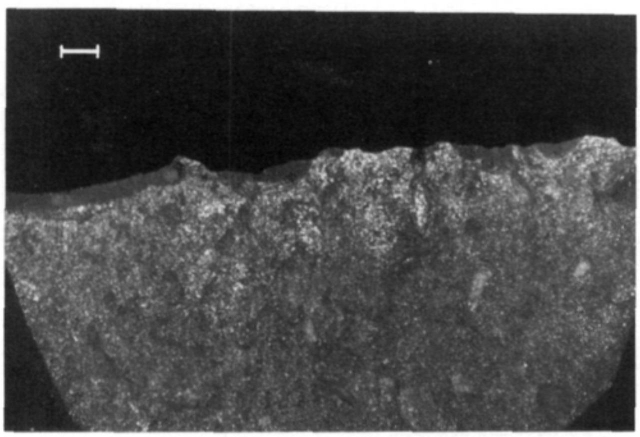
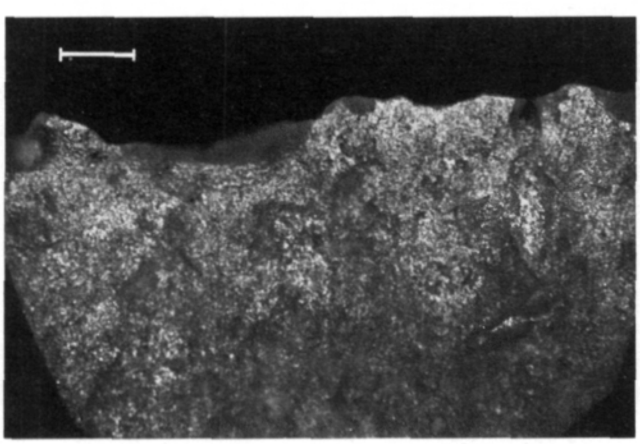


Fig. 147. Wear traces observed at point A on 47/105-3 from Site G. The scale bar measures 100 μ.



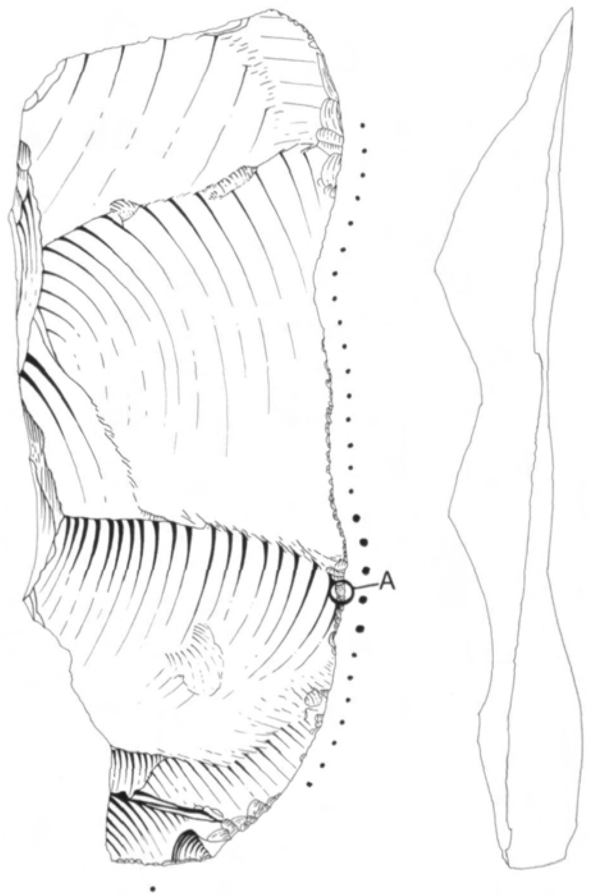


Fig. 148. Position of wear traces on 46/106-11, a large backed blade from Site G (scale 2:3).

thick (abt. 1.5 cm) elephant skin than the two smaller ones. Unfortunately, the news of the opportunity to skin such an elephant reached us a full two weeks after the animal had died, by which time the carcass had started to decompose and the skin was probably softer than that of a recently killed animal. Nevertheless, the wear-traces observed on the experimental tools closely matched those on the archaeological ones. The polish was distributed in a band, but its character was most distinctive on protruding points: it was pitted, matt and at times displayed clear directionality (fig.151a). Striations were absent, but this could be due to the fact that the dead animal had been thoroughly cleaned with a high-pressure spray in the anatomical laboratory, which could have removed sand particles from the skin. Moreover, the working conditions in a clean lab differ greatly from those in a dusty landscape. The edge damage of the experimental and the archaeological tools also bore a

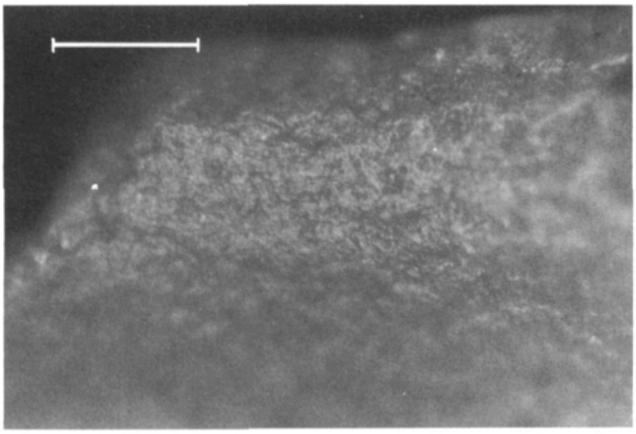


Fig. 149. Polish observed at point A on tool 46/106-11. Due to the slight patination much light was reflected from the tool. The scale bar measures 100 μ.

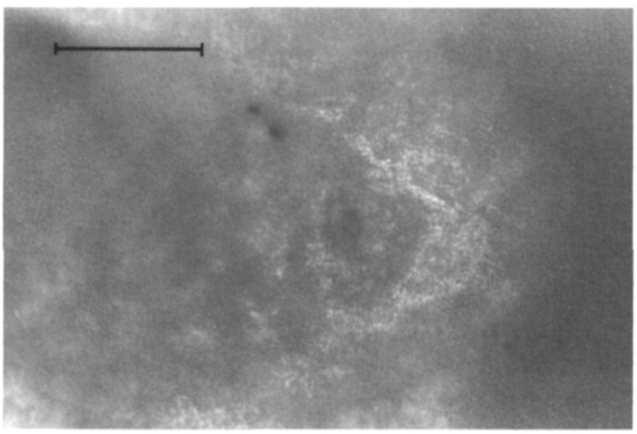
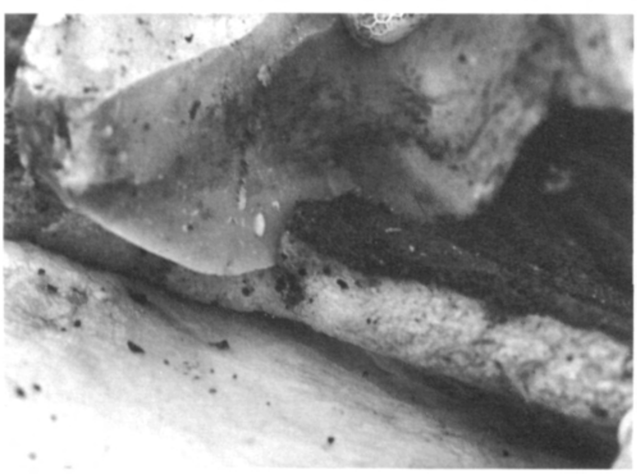
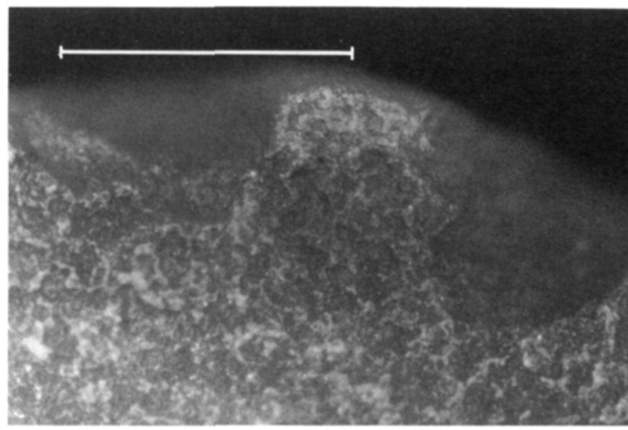


Fig. 150. Experiment with an elephant skin.



close resemblance: on the ventral aspect the retouch was tiny, scalar and overlapped one another (fig. 151b), while on the dorsal side the retouch was spaced more widely. On the basis of these resemblances a pachydermatous contact material could be suggested even though the traces on the archaeological backed blade differred slightly from those on the experimental one (i.e.the absence of striations on the experimental tools). Further evidence corroborating this interpretation is the fact that the tool was found amidst a concentration of juvenile rhinoceros remains (Roebroeks, this volume). It should be stressed that the find circumstances of the tools were not known to the micro-wear analyst prior to the study. The association of the backed blade with the bones was only communicated to her after the analysis had been completed.

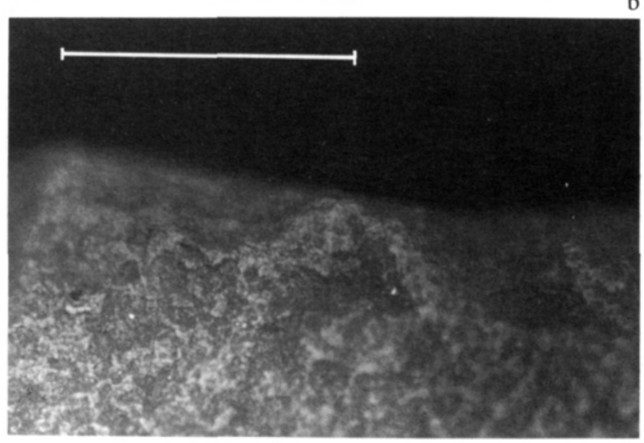
Of course, it is impossible to determine whether the animal had actually been killed by man or whether it was found dead, already killed by other predators. Or, to put it differently, microwear analysis cannot shed light on the question whether (pre-)Neanderthal man was a hunter or a scavenger (cf. Roebroeks, this volume). Roebroeks argues



a

Fig. 151. Wear traces observed on an experimental tool used to butcher (part of) an elephant. The scale bar measures 100 μ.

b



in favour of the latter possibility and in the remainder of this paper reference will be made to the more general term 'meat-collecting'.

In addition to the three tools described above with relatively clear polish, another six tools were recovered that were so lightly patinated (see paragraph 2) that it was possible to distinguish the presence of traces of wear. These are E-17/10, C-21/15, D-21/1, Bv-1265 and Bv-1248, all from Site C, and 23/23-31 from Site F. The wear-traces, however, are so indistinctive that the tools can be described as 'probably used' only. Had the tools been employed on a resistant or abrasive contact material, such as bone, dry hide, antler, silicious plants or hard wood, the resulting traces would certainly have been detected. These tools were thus probably used on a yielding material, such as soft plant, fresh hide or meat.

4. A functional interpretation of the sites from lithostratigraphic Unit IV-C

In the preceding paragraphs we have seen that the majority of the assemblages from the Belvédère pit were affected by patination to such an extent that all possible wear-traces had been obscured. It was therefore not possible to determine the former function of each individual artefact. However, it is worth hypothesizing a little further about the function of the Belvédère assemblages from lithostratigraphical Unit IV-C. The following discussion is based on the analysis of the 54 artefacts selected from this unit for wear-trace examination (see paragraph 1).

The tools exhibiting only light to moderate patination still allow us to *exclude* certain contact materials. Bone/antler, dry hide and silicious plants produce a polish on the flint after only a short period of use. Not only do polishes resulting from contact with these materials develop fast, they are also distinctive and rather well-defined in terms of their constituent polish attributes. Recent blind tests have indicated that bone/antler and dry(ish) hide are quite consistently identified by analysts (Unrath *et al.* 1986). This is also due to the fact that, in addition to a clear polish, other characteristic wear attributes are formed, such as a rounded tool edge when the tool is used on hide, or extensive edge removals in the case of use on bone. Finally, experiments simulating various post-depositional surface modifications have indicated that bone polish is the most resistant to such attacks (Plisson 1983, 1986). Hide polish can be affected to a considerable extent but is often still recognizable as such because of the extensive edge rounding and the preservation of the 'craters' characteristic of hide working (Plisson 1983). The chance of missing bone/antler- or dry-hide-working tools is therefore considerably smaller than that of overlooking tools used on materials whose associated wear attributes develop more slowly, are less distinctive and more vulnerable to post-depositional changes. Had such traces been present on the lightly patinated Belvédère artefacts, they would certainly still have been visible.

Sometimes the manufacture of bone- or antler-working tools and the scraping of dry hide (i.e.making a dried hide supple for example by working grease into it) are described as labour-intensive maintenance activities and thus indicative of base-camps. This is obviously not entirely true because, for instance, bone and antler tools can effectively be manufactured on hunting stands to kill the time while waiting for game (Torrence 1983). On the other hand, the processing of raw hides indeed requires a considerable amount of time because the softening of the hides (in the process of which the 'dry-hide scrapers' are assumed to be used) is very time-consuming.

None of the lightly or moderately patinated tools from Belvédère exhibits traces of wear suggesting bone/antler-working or dry-hide scraping. The degree of patination of these pieces is considered insufficient to have obscured such traces, had they been present. The lack of evidence of 'maintenance activities' such as hide-processing would thus make the Belvédère sites temporary encampments, for example hunting stands. However, this is of course not a valid argument in itself as it is based solely on negative evidence. Dry-hide- or bone-working tools could have been present among the part of the assemblages not selected for use-wear analysis because the tools were too small or too patinated. Moreover, it is quite possible that hides were worked at some distance from the living area in view of the stench associated with this activity: such an area could easily have fallen outside the excavated trenches.

What evidence do we have? Even though no polish was observable on most of the Belvédère tools, other attributes, such as edge damage and edge-rounding, are still interpretable. The sites of the Belvédère Unit IV-C assemblages were covered by fluviatile sediments within a very short period of time (Roebroeks, this volume). Because of this and the fact that the excavation and storage of the artefacts was done in a very careful manner it is considered justified to infer the function of the tools from the distribution and morphology of the edge-removals because the possibility of the formation of edge-removals due to post-depositional processes and careless excavation procedures may be excluded.

The use-retouch on many flakes was scalar with a feather-shaped termination spaced regularly along the edge. None of the flakes showed extensive edge-rounding. This points to a soft and yielding contact material such as meat or fresh hide. It is therefore suggested that the tools were most likely used for butchering purposes.

Butchering is generally believed to cause extensive damage to the tool because of the contact with bones and cartilage, which is reported to produce wear characteristics indicative of use on hard materials (Odell 1980). It is however contended that this is the case. If animals are butchered by an experienced person, the tool hardly comes into contact with bone; there is very little edge damage and polish is formed extremely slowly. Henk Nijland (Research Institute for Nature Management), who dissects animals every day, performed four dismembering experiments using deer and raccoon. The tools he had used for this purpose differed markedly from those used by the author in that they showed very little evidence of use. Even after 60 minutes of work, the tools showed no signs of polish whatsoever, while edge-removals consisted of scalar scars with feather terminations distributed irregularly along the edge and having maximum widths of approx. 1 mm. The tools showed very little edge-rounding; in actual fact the edge was only smoothed. Patterson reports similar wear features observed after the butchering of deer. He too arrives at the conclusion that most animals can be butchered completely without extensive contact with bone (Patterson 1976). The absence of striations is also reported in the literature (Brose 1975; Patterson 1976). Brose (1975) attributes this lack of scratches to the presence of animal fats, which form a protective layer around the stone.

The morphological attributes of the Belvédère Unit IV-C flints support the supposition that they were employed in butchering. Edge-angles are small, generally not more than 40 degrees. The tools have straight edges when viewed in cross-section, which would be ideal for cutting purposes. Both Frison (1979) and Patterson (1976) have stated that butchering can effectively be done with unmodified flakes. These constitute generalized tools which can easily be resharpened. Frison (1979) also argues that hafting would not be very effective in the case of a butchering tool, since the moisture released in the process of butchering would affect the binding. The large size of the Belvédère tools not only made hafting superfluous, but also made the tools very suitable for butchering large animals.

Of course, the functional analysis of the Belvédère Unit IV-C flint suggesting that the tools were most probably used for butchering is only speculative and is not based on firm evidence. However, the tentative supposition is corroborated by other lines of research. Geological survey has revealed that the sites attributed to Unit IV-C are situated close to a marshy floodplain. Such a spot may have served as a drinking area for animals where game could easily be trapped either by man or by other predators. The flint artefacts were found in association with bone fragments, especially at Site G. At Site C the number of unused or hardly used flakes was substantial (Roebroeks, this volume); as Tainter (1979) has argued, stone tool densities are high in areas where butchering activities were carried out. Although the information gained from the functional analysis of the flints is minimal, the evidence does lend additional support to the interpretation of the Unit IV-C sites as butchering and 'meat-collecting' stations.

notes

[1] Institute of Prehistory, Leiden University.

[2] There is some argument as to what constitutes residue and how it can be differentiated from polish. This is partially due to the fact that as yet no satisfying definition for 'polish' has been proposed (c.f. Van Gijn 1986: 13; Plisson 1985: 14-15; Vaughan 1985: VIII). In the context of this paper 'residue' is considered anything which can be removed in a weak HCl and KOH solvent, that is blood stains, plant juices, pieces of meat etc.

Pieter van de Velde[2]

appendix II
Spatial analysis: a note[1]

After a short discussion of some writings on spatial analysis it is argued that of the three methods commonly used for this purpose (nearest neighbour, local density and correlation) the local density approach frequently suffers from the impossibility of establishing the domain relative to which the relative densities can be calculated. This problem is usually evaded by turning to nearest neighbour or correlation methods, which, however, require more computational efforts. Instead it is suggested that for the related case of contingency table analysis the domain is the sum of the areas covered by the individual distributions. An example is included based on data on bone and flint artefact distributions at Belvédère Site C.

1. Introduction

In chapter 4 the problem of tied or dependent distributions of two artefact classes was considered from an archaeological point of view. An attempt was also made to provide a statistical answer to this problem. The pertinent literature, however, did not give an easy model solution (e.g. Orton 1980: 150-154) and Roebroeks turned to nearest neighbour analysis.

The data as originally presented to me are shown in table 28; the problem was to find a statistical way to calculate the degree of association between the two artefact classes. Of course, nearest neighbour methods or correlation analysis can provide valid answers, but they involve much computational effort. Contingency table analysis is a more familiar method, which can be done by hand and is much easier. However, for such an analysis the number of 'empty' quadrats has to be known, and this is where difficulties appear, as will be shown below.

The situation illustrated in table 28 and the associated research problem are fairly common in archaeology, and therefore some attention should be paid to them.

In table 29 the figures of table 28 have been recalculated for the case that the two distributions A and B are independent of one another. The values in the table are proportional to marginal expectations, i.e. to the sum of the rows and columns.

Table 28: The distribution of flint artefacts (A) and bones (B) at Belvédère Site C. The figures indicate presence (+) and absence (-) of artefacts per square metre excavated.

		A		
		+	–	sum
B	+	8	18	26
	–	22	216	238
	sum	30	234	264

Table 29: Marginally expectable numbers for table 28.

		A		
		+	–	sum
B	+	3	23	26
	–	27	211	238
	sum	30	234	264

2. A specification of the problem.

From the figures in tables 28 and 29 a Chi-square value of 10.78 can be computed; for 1 degree of freedom the probability of non-association/dependence is only 0.001. That is, the chances are only 1 to 1000 that the distributions recorded in table 28 are not associated. Simply put, the observed number of quadrats with both classes of artefacts present is 8, whereas the expected figure is only 3, i.e. there is a much greater degree of association than can be explained by chance alone. Hence there is a statistically significant dependency between the two distributions and it can be said that the bones and tools bear some relation to one another.

However, in the present case the Chi-square value is largely determined by the contents of the 'not-A/not-B' cell, which outnumbers the other table values by a factor of 10. A further increase in the number of empty quadrats ('not-A/not-B,' is the same as 'empty'), would raise the figure of this cell, increase its proportion in the total number of quadrats, and thus soar the Chi-square. The interpretation would be that the two distributions are even more related

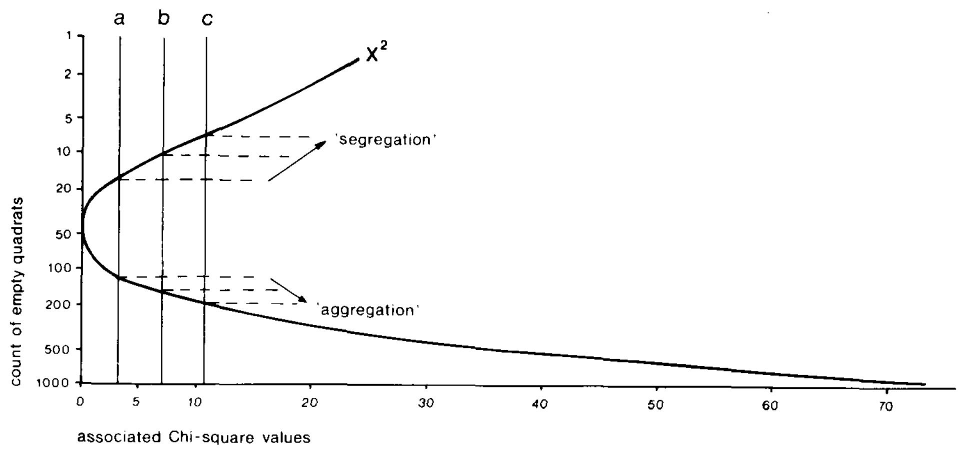


Fig. 152. When the number of empty quadrats in Table 28 is changed, the associated chi-square value changes too, and so does the interpretation. An illustration of a problem with contingency table analysis: a: p= .05 X^2= 3.84; b: p= .01 X^2= 6.63; c: p= .001 X^2= 10.83; all for df= 1.

than would appear from table 28. Conclusion: there is no apparent limit here.

However, with a decrease in the number of empty quadrats, Chi-square values drop at first to then rise steeply and become significant again when the sum of the other table values becomes larger than that under scrutiny. In that case, however, 'significance' would have to be interpreted as dissociation, instead of association. Figure 152 illustrates these changes in Chi-square values and significance with reference to the present case; the conclusion must be that these values are more dependent on the number of empty quadrats (that is, on the size of the excavation) than on properties of the distributions being compared: '...we can get almost any answer by a suitable choice of site boundary...' (Orton 1980: 145).

We thus encounter the following the problem: what is the relevant domain for the above distributions and how many empty quadrats (if any) should be assumed in the computations?

3. A review of the literature

In a general discussion of techniques for estimating association, Hietala and Stevens (1977:541-542, 549) note the problem of 'overly abundant' negative concordances (i.e. what have here been labelled 'empty quadrats') and the consequent inflation of the associated coefficients. For such cases they advocate the use of Kendall's tau-b (e.g. Siegel 1956: 213-223; Nie *et al.* 1975: 288-290). Basically, however, this is a kind of correlation coefficient, so they do not come to grips with the central problem, viz. the determination of the size of the relevant domain. They do in fact mention (but further ignore) the distinction between completely and incompletely excavated distributions.

Orton (Orton 1980: 150-154; see also Johnson 1984: 83-85) compares 'local densities' of artefact classes in each other's vicinity. 'Vicinity' is defined as a circular area of arbitrary size to be fixed by trial-and-error and statistical intuition. Comparison of the results obtained for different radii gives important clues regarding the relations between the distributions (for an illustration see Graham 1980 or Johnson 1984). At the time of Orton's writing, the significance of the coefficients had not been worked out. Graham (1980) and Johnson (1984) both continued in this direction. To Johnson, the originator of the technique, Local Density Analysis is mainly a descriptive method rather than a test of association (Johnson 1984).

Hodder and Orton (1976: 204) briefly discuss some coefficients which disregard the empty quadrats; quoting Pielou they conclude that 'one cannot judge whether the value of the coefficient departs significantly from expectation, on the null hypothesis of independence of the distributions, without taking ..[the count of empty quadrats].. into account'. Their remedies are nearest neighbour or correlation analytical methods.

Berry *et al.* (1984) discuss a method which is a generalized comparison of distances between artefacts of different classes; one obvious advantage over nearest neighbour analyses is the independence of area or density measures, and both approaches are characterized by the irrelevance of empty quadrats. It would seem however, that the shape of the distribution in the field has consequences for the results of the averaging process; a practical disadvantage is that the calculations are so complex as to require a computer.

No doubt I will have missed some discussions of this problem in the archaeological literature. But the basic problem has apparently not been solved (yet). The issue is side-stepped via bypasses to correlation analysis in standard statistical textbooks (e.g. Dixon/Massey 1956, or Hays 1973). Nevertheless, I hold to the opinion that because of the comparative ease with which Chi-squares can be computed, a straightforward solution is to be preferred (Thomas 1978).

4. Discussion: establishing a domain

For the study of the association of two artefact classes, Hietala and Stevens (1977) developed a scale ranging from uniform aggregation through indepencence to uniform segregation (cf. Orton 1982: 9). Different techniques are recommended for every interval on that scale; for instance, Chi-square analysis is appropriate for uniform distributions. Clear as their scale may be, it presents one difficulty in that the intervals are defined through 'theoretical probabilities', whereas in archaeological practice frequencies often have to be checked. The former relate to distributions known to their limits, the latter to parts of distributions (such as distributions not excavated to their limits, or not fully known, or not reliably estimated) so this is precisely the other side of the problem noted above: the domain is unknown. This is also visible in their use of indices ('for all i, j'), which are implicitly defined (p. 540-541) as spanning the whole excavation, which, in turn, is suggestive of the irrelevance of the domain of the distributions studied, or of the tacit equation of the excavated area with the theoretical domain. As noted above, Hietala and Stevens evade the problem by using Kendall's tau-b coefficient in the remainder of their article. Again, not everybody has unrestricted access to a mainframe computer; or the data may not stand up to this method because they were not gathered individually but per grave, feature or quadrat (cf. e.g. Graham 1980). It is for such situations that I am trying to find a way out.

The problem may be approached from another angle, as in the accompanying figures. In the case of a situation like that shown in figure 153a nobody would presumably be willing to deny uniform segregation of the two distributions. Neither would strong segregation be questioned in the case of excavation plans like those illustrated in figure 153b or figure 153c (the latter probably being fairly common in archaeology; e.g. Hietala/Stevens 1977: fig. 1, 57). In such cases no complicated computations are necessary: their interpretation is straightforward and statistically uninteresting.

Note that in figure 153c only frequencies can be calculated: both distributions (may) extend beyond the excavation's limits. Coefficients calculated for this type of situation are not representative of the relations between the *total* distributions. For situations like that illustrated in figure 153b the frequency counts can be converted into probabilities, for the limits of the distributions are well within the boundaries of the excavation. Below, I will not deal with analogues of figure 153c, but with completely excavated distributions only.

Matters become ambiguous only when situations like that

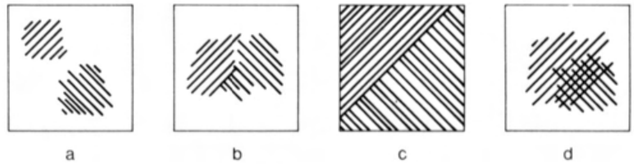


Fig. 153. See the text for an explication.

shown in figure 153d are encountered, i.e. when there is some overlap of the distributions; only then questions about the degree of association become meaningful (such a situation was also found in the excavation of Belvédère Site C). It seems therefore that a situation as in figure 153c constitutes the limit *beyond* which a statistical measure of association is not very illuminating, and within which such a coefficient could be useful. This suggests using the sum of the areas of separate distributions as the domain relative to which coefficients of association may be computed. In other words, the size of the domain is dependent only upon properties of the distributions involved, and not upon such extraneous factors as the size of the excavated area.

If a domain is established in this way, the number of jointly occupied quadrats is exactly balanced by that of empty ones; that is, their size or weight are neutralized. They contribute to the Chi-square value only in relation to the distributions of which they are part; the marginal values are reflective only of the respective joint/single dichotomies, and not of occupied/empty ones. And this is precisely the solution we were looking for.

It may be objected that the sum of maximum distributions per artefact class could also be used as a baseline: n artefacts may be distributed over at most n quadrats. The ratio of the observed and the theoretical maximum dispersion (cf. the section on densities, below) is indicative of the density of the distribution of the artefact class. By simultaneously introducing this density measure into the computation, the significance of the Chi-square becomes opaque. However, it seems best to take the *densities* as given and to study them separately. After all, the problem was the association of the artefact classes, not the densities.

If this reasoning has some ground, then (the outcome of) a Chi-square test along these lines should yield results that are similar to those obtained in nearest neighbour analysis. I will compare the outcomes obtained for the Belvédère Site C data below.

5. A test of association: an adjusted Chi-square computation

It has been suggested that in establishing coefficients of association between two artefact distributions the relevant domain is the maximum space that can be occupied by them (given their densities). In the case of Belvédère Site C the flint tools occupied 30 square metres or quadrats and the bones 26 square metres (table 28). Together, the two distributions could conceivably occupy 30 + 26 = 56 squares at the most, given their observed densities -and this is to be the sum of their counts, the domain. Tables 30 and 31 have been calculated accordingly.

The Chi-square coefficient equals 10.39 and for one degree of freedom the probability that the null hypothesis of independent distributions is true is approximately 0.001 (cf. fig. 152). In this case, however, the observed frequency of combined occurrence (8) is much *less* than that of a randomized or marginal expectation (14); there is evidence of 'strong segregation' on the Hietala and Stevens scale.

Table 30: As table 28, though adjusted for domain/number of empty quadrats as suggested in the text.

		A		
		+	–	sum
B	+	8	18	26
	–	22	8	30
	sum	30	26	56

Table 31: Expected frequencies for table 30 in the case that A and B are independent.

		A		
		+	–	sum
B	+	14	12	26
	–	16	14	30
	sum	30	26	56

On local densities

It is not difficult to compute relative local density figures for the individual distributions. In principle, n artefacts can occupy n quadrats at the most; when the n artefacts are distributed randomly over these n quadrats, the resultant expectation (binomial) for empty quadrats is:

$p(0)= (1/n)^0.(1-1/n)^{n-0}.\binom{n}{0} = 0.364$ (for n=34)

Accordingly, the probability of a quadrat being occupied by at least one artefact is 1 – p(0) = 0.636 (Corresponding figures for 41 artefacts in 41 quadrats are 0.363 and 0.637). This means that if the artefacts are randomly distributed, 0.636 x 43 = 27 (26, respectively) quadrats should be occupied; compare this with the observed value of 30 (26 respectively) quadrats. Probabilities could then also be assigned. However, this kind of excercise does not lead to any meaningful results, for what if an archaeological distribution is described as 'clustered' or 'dispersed', or even random (and preferably significantly so) (cf. Johnson 1984: 80).

Note that these densities are properties of the individual distributions, and not measures of association between distributions, as implied in the Local Density Analytical techniques described by Orton (1980), Graham (1980) and Johnson (1984).

6. Conclusions: a comparison of outcomes

In previous sections it was said that if the idea has some ground that the joint domain of two archaeological distributions is the sum of the individual distributions, then the outcome of tests based on that idea should square with the results of nearest neighbour analysis, which does not use empty quadrats. In chapter 4 nearest neighbour analysis resulted in a Chi-square value of 15.49, which is significant at the level of 0.001 (df= 1), which also indicates segregation. With a value of S= 0.429, Pielou's coefficient of segregation is between full segregation at + 1.00 and random occurrence at 0.00 (see Hodder/Orton 1976: 205).

Thus, the results obtained with the different techniques lead to the same conclusion. It may also be inferred that in this case at least the proposed solution to the delimitation of a domain yields an outcome comparable with those of other methods involving more computational effort.

notes

[1] Thanks are due to Wim van Zanten for his criticism and comments.

[2] Archaeological Centre, Leiden University.

C.E.S. Arps[1]

appendix III
The identification of haematite as the colouring agent in red ochre from the Middle Palaeolithic Site C at Maastricht-Belvédère, The Netherlands, by means of x-ray diffraction analysis

In the course of the excavations carried out by the Institute of Prehistory, 14 crusty pieces of reddish material, ranging in diameter from about 0.4 to 1.5 cm, were collected from the sandy deposits at Site C. The constrast between the red material and the yellowish-brown (2.5 Y 5/3) to greyish-olive (5 Y 5/3) sediment and the crusty character of the concentrate made recovery of the tiny and fragile fragments possible. Three samples were submitted to our museum by the excavator (W. Roebroeks) for analysis of the red stain (fig. 154).

A granulometric analysis (fig. 155) showed the sedimentary rock to be a reasonably- to well-sorted finely to very finely-grained quartz sand with a silt and clay content of up to 15% by weight. The grain-shapes vary from subangular or angular (the majority) to well-rounded. A binocular microscopic investigation of the red concentrate revealed that the staining agent surrounded the larger quartz grains as a very thin coating or had clotted together with the silt and clay particles. Individual reddish crystal grains, e.g.haematite, were not visible.

The main part of the red crusty material (fig. 154) was sampled and carefully ground in order to release the reddish powder, but at the same time care was taken to avoid breaking the quartz grains. The sample was placed in a concave glass dish filled with alcohol and the finest fraction of the reddish powder could be separated from the bulk sample by panning. This concentrate required further grinding to obtain a suitable grain-size for the production of a distinct X-ray diffraction pattern.

Using a Debeye-Scherrer powder camera (Philips PW 1024) with a diameter of 114.6 mm (fig. 156) and Fe-radiation and X-ray powder diffraction, a photograph was made, in which, by comparison with 'standard' photographs, only the presence of quartz could be detected. This museum's routine technique for mineral identification did not reveal the presence of a mineral phase that could be held responsible for the reddish stain of the investigated sample.

Determined to solve the problem, we carried out another experiment. This time the separated very finely-grained concentration was sent to the X-ray laboratory of the Institute of Earth Sciences, State University of Utrecht (Dr W.M.M. Heijnen). In this laboratory a special powder diffraction camera (fig. 156) is employed, viz. the Guinier-De Wolff Quadruple Focussing Camera (Enraf Nonius, Delft), with which diffraction angles of extremely high

Fig. 154. Haematite-concretion Bv-894. The scale bar measures 1 cm.

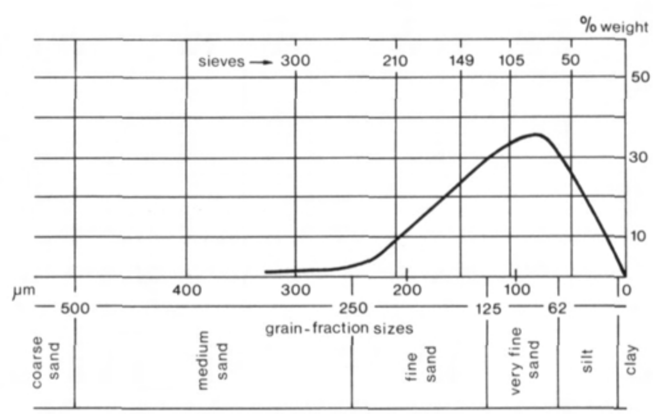


Fig. 155. Grain-size distribution of the sediment in which the Site C haematite-concretions were found.

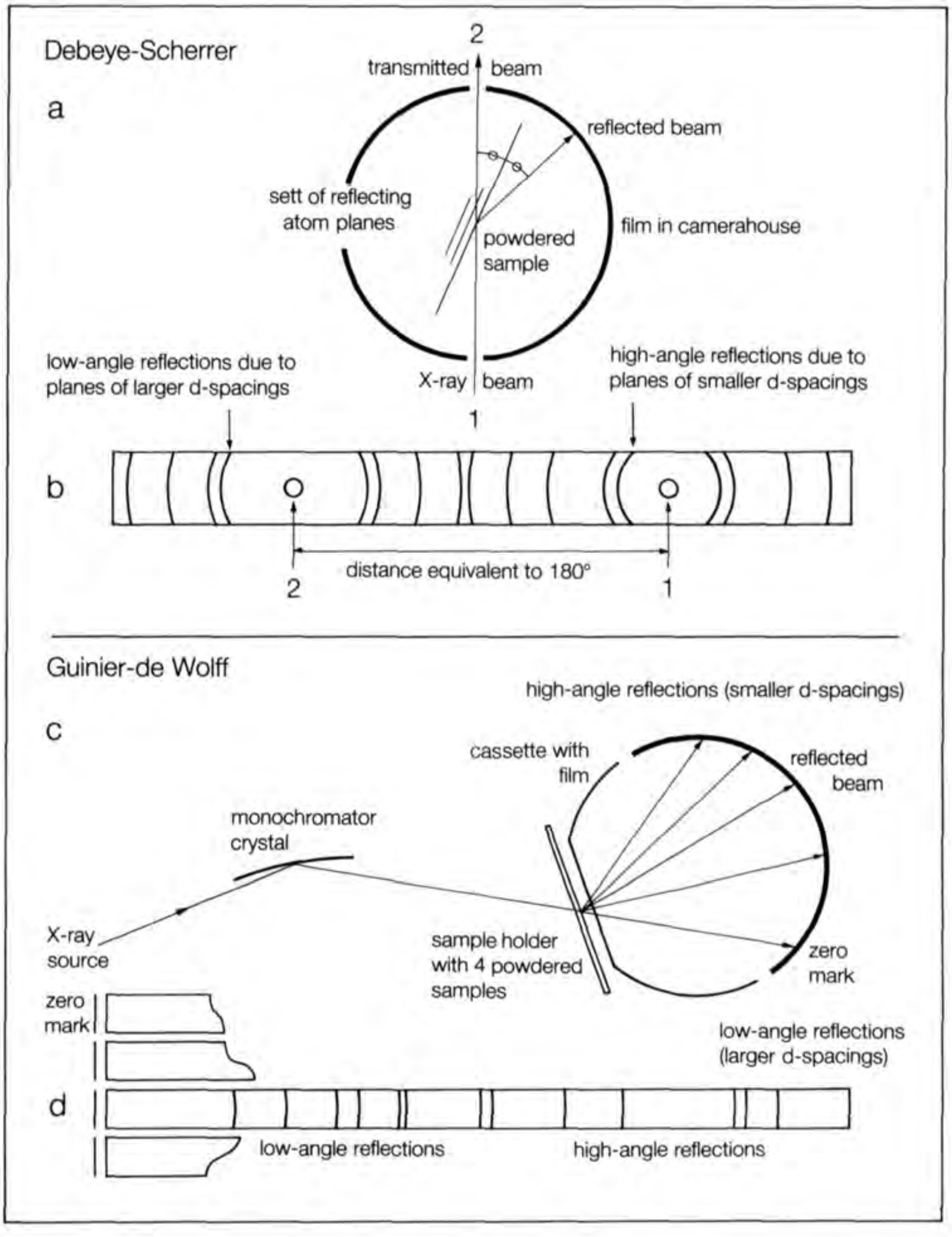


Fig. 156. X-ray powder diffraction data as can be obtained with a Debeye-Scherrer and a Guinier-De Wolff camera.

precision can be obtained. The dispersion of this camera is equivalent to that of a 229.2-mm Debeye-Scherrer camera. This time an X-ray tube producing Cu(KoC)-radiation was used. Exposure time was set at 2.5 hours with an X-ray intensity of 40 kV and 20 mA. Figure 157 is the result obtained after the development of the exposed film. It (again) clearly shows the quartz diffraction lines, but also reveals the presence of a number of additional weak lines. A millimetre scale was used to measure the distance between the lines and the zero-mark (incident beam). The dispersion constant was 4 mm per degree of the diffraction angle.

From the diffraction angles the so-called interplanar spacings, i.e. the distances between the planes of atoms in a crystal lattice, also known as d-spacings, can be calculated. For this purpose conversion tables are used, e.g. that of the National Bureau of Standards, Applied Mathematical Series 10, 1950 (USA). Each mineral is characterized by a series of specific d-values with different intensities. In figure 157 the main diffraction lines of quartz are clearly visible. The d-values of the strongest lines have been indicated. The few weak extra lines were identified as representing the main characteristic line of haematite (alpha-Fe_2O_3). But the

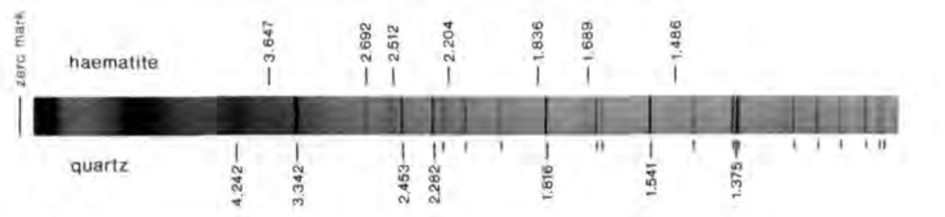


Fig. 157. X-ray diffraction data obtained with sample D23/16, indicating the mixture of quartz and haematite.

relative intensities of these lines could hardly be estimated. The haematite lines are also indicated in fig. 157, together with their d-values. In table 32 the complete set of visible d-values of quartz and haematite are listed and compared with values from the literature (Joint Committee on Powder Diffraction Standards, 1974). The values of goethite, alpha-Fe_3^+ O(OH), are added for comparison, although this iron hydroxide mineral cannot be held responsible for the red stains in the sand deposit of the Belvédère prehistoric site.

From the X-ray analysis it can therefore be concluded that the 'red ochre' stain was caused by the presence of haematite.

note

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Table 32

QUARTZ				HAEMATITE				GOETHITE	
J.C.P.D.S.		Belvédère		J.C.P.D.S.		Belvédère		J.C.P.D.S.	
d	I	d	I	d	I	d	I	d	I
4.26	35	4.242	40					4.98	10
3.343	100	3.342	100					4.18	100
2.458	12	2.453	30	3.66	25	3.674	w		
2.282	12	2.282	30					3.38	10
2.237	6	2.236	15	2.69	100	2.69	r	2.69	30
2.128	9	2.127	20					2.58	8
1.980	6	1.977	15	2.51	50	2.512	rg		
1.817	17	1.816	40					2.49	16
1.672	7	1.671	15					2.452	25
1.659	3	1.658	10					2.252	10
1.608	<1			2.201	30	2.204	w		
1.541	15	1.541	30					2.192	20
1.453	3	1.451	10	1.838	40	1.836	w		
1.418	<1							1.799	8
1.382	7	1.382	15					1.721	20
1.375	11	1.375	30	1.690	60	1.689	r	1.694	10
1.372	9	1.372	15	1.596	16	1.595	w	1.564	16
1.288	3	1.287	10					1.509	10
1.256	4	1.255	10	1.484	35	1.486	w		
1.228	2	1.226	5	1.452	35			1.453	10
1.1997	5	1.196	10					1.392	8
1.1973	2	1.195	w					1.357	8
1.1838	4	1.180	5					1.317	8
1.1802	4	1.176	5	1.310	20				
1.1530	2			1.258	8				
1.0816	4			1.189	8				
				1.162	10				
				1.141	12				
				1.102	14				

d: interplanar spacings
I: intensity of reflection
w: weak, r: reasonable, rg: reasonably good

Wil Roebroeks

appendix IV
A note on Middle Palaeolithic surface sites in South Limburg

This section contains a short discussion of the (Lower and) Middle Palaeolithic surface sites in the immediate neigbourhood of Belvédère, i.e. in South Limburg and the bordering parts of Belgium.

The possibilities of discovering Palaeolithic (and later) sites in this and, for that matter, any other region are determined by the presence of geological outcrops which can be divided into natural and man-made features.

Natural features are sites where geological processes caused the removal of the sediments burying and embedding archaeological assemblages. The currently known distribution of Middle Palaeolithic surface sites in our working area, for instance, is, as we will see below, the product of Pleistocene (and modern) human activities, but also of geomorphological processes. As we will illustrate in figure 158, almost all Palaeolithic surface finds were found in areas in which Late (and often Middle) Pleistocene loess deposits (if at all present) have almost completely disappeared. This is usually the case on top of the steeper slopes between the different terraces of the terrace system of the river Maas.

Man-made geological outcrops consist of quarries, trenches made in road-construction, canals, pipelines, etc.

In this context it is worth discussing the theoretical composition of the archaeological assemblages from Lower and Middle Palaeolithic sites in this region. As already stated earlier in this volume, the character of an archaeological assemblage is only to some extent determined by processes in the systemic context (Schiffer 1975), the burial of archaeological material generally being a natural process, at least in the time periods dealt with in this volume. As Binford (1982a) has stated, burial processes strongly condition the character of association in buried deposits, i.e. the composition of stratigraphically defined assemblages. Human activities in areas with a high sedimentation rate cooperate with natural sedimentation processes in creating what will here be called very *fine-grained* assemblages which -ideally- may be interpreted as the material consequences of *one* uninterrupted use of a single site. The assemblages from the Unit IV sites at Belvédère presented above were formed in a fluviatile environment with a high sedimentation rate and are interpreted as relatively fine-grained assemblages. Binford (1982a) has stressed that intersite variation in lithic debris can be expected to be greatest in regions with a high sedimentation rate, whereas human activities in areas with a low sedimentation rate may result in the production of palimpsest assemblages, occurring as thin lenses on a stabilized surface. These coarse-grained stratigraphical assemblages are assumed to show far less variability.

Before the flint assemblages of the sites in our working area can be evaluated the sedimentary regimes of those sites must be discussed.

Generally speaking, no significant Pleistocene deposits from 'temperate' periods are to be expected outside the sedimentation area of the river Maas and its tributaries; we may therefore safely assume that fine-grained archaeological assemblages dating from Pleistocene 'temperate' periods are in this area limited to river-valley sites.

Loess deposits formed in glacial periods may affect the grain of archaeological assemblages produced outside the river valleys, rendering them more fine-grained. The Pleistocene loess record in our working area, however, shows large erosional inconformities and no signs of continuous sedimentation at all. Pre-Weichselian loess, whether or not exposed, is rare, and (if at all present) occurs in layers of only modest thickness, while the larger part of the Weichselian loess dates from the second half of the Weichselian Pleniglacial. Belvédère is one of the places where this relatively late date has been established. The age of the approximately 6 metres thick Unit VII loess cover was found to be 17.5 ± 3.5 ka (cf. chapter 2). Lower and Middle Palaeolithic occupation at the time of the deposition of this loess is not to be expected in view of the then prevailing severe climatic conditions.

To summarize, in this working area fine-grained archaeological assemblages may first be expected in the sedimentation plains of rivers, because in temperate periods fluviatile sedimentation is virtually the sole preservation agent of fine-grained assemblages. In cold phases loess deposition could theoretically have buried an assemblage 'on the fine-grained side' of the fine-grained – coarse-grained continuum.

It is to be stressed that, purely theoretically, any material remains of human activities can preserve their fine-grained character without being buried by sediments. It is however very unlikely that this situation will ever be encountered for

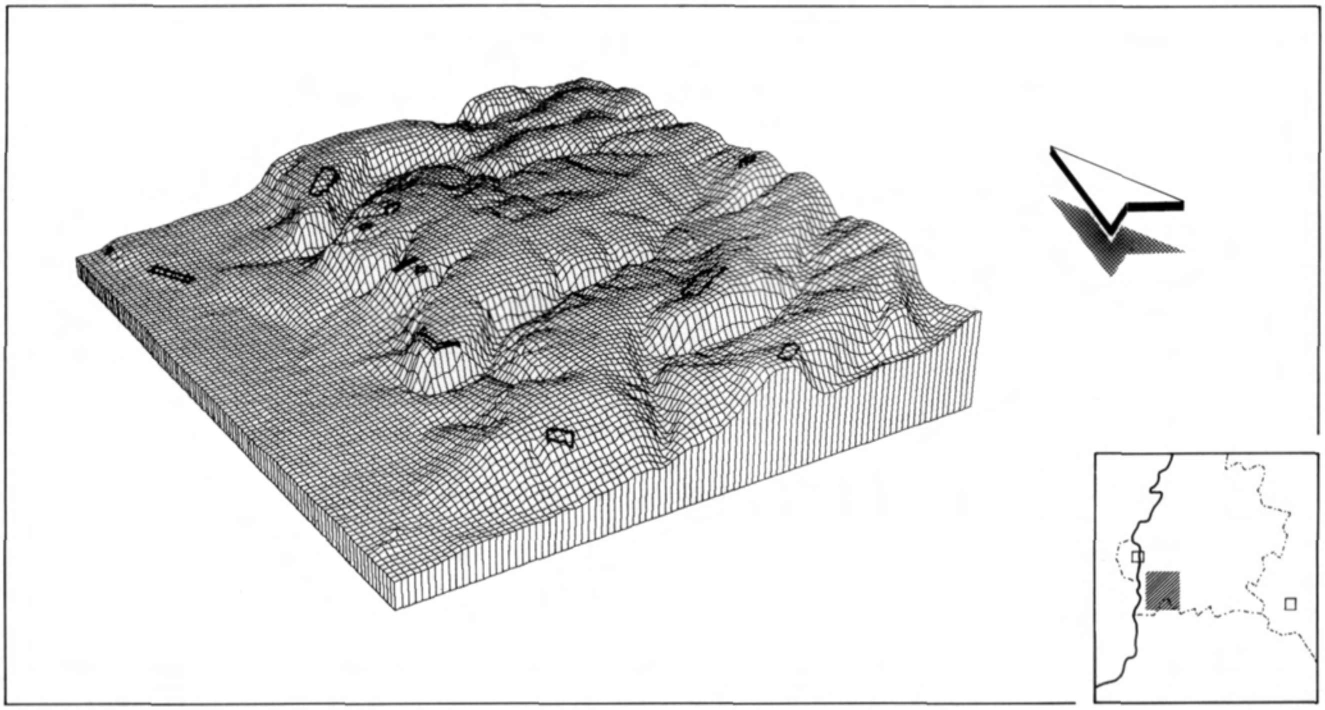

Fig. 158. Situation of the major Middle Palaeolithic surface sites in the area shown in figure 11, southeast of Maastricht. x between 178000 and 184500, y between 308200 and 315500 in the topographical map system. Vertical scale magnified 8x. Drawing made by -and published by courtesy of- Dr J. Hartman, Amsterdam.

the period and the working area we are dealing with. Therefore, the assemblages of surface sites must in the first place be considered extremely coarse-grained, having been formed as the results of multiple, unrelated depositional events, widely spaced in time.

Focussing our archaeological attention on the -usually better preserved- fine-grained 'sites' may eventually result in the construction of land-use models based on the -generally short-term- sites produced in areas with a high rate of sedimentation (cf. Gifford 1978). For this important reason surface sites in the surroundings of Maastricht-Belvédère must also be incorporated in this study.

In the course of the past 100 years, but mainly during the past two decennia, a large number of artefacts have been found in South Limburg, which are characterized by the combined presence of three attributes:

1. They all have a porcelain-like surface, caused by the combination of a white patina and wind-gloss (Stapert 1976, 1981a), and often show traces of frost action.
2. They are found exclusively in areas where the loess has been eroded or is only present as a thin layer covering the Pleistocene terrace gravels.
3. Typologically and technologically they can be placed in the Lower and Middle Palaeolithic.

Artefacts with these three attributes date from the Lower and Middle Palaeolithic. In 1980-1984 the author, assisted in 1983 and 1984 by Mr F. Brounen (I.P.L.), collected data on sites that had yielded such artefacts. The data are now stored at the Institute of Prehistory of Leiden University. On the basis of these data a distribution map was drawn of sites in an area to the southeast of Maastricht.

The area shown in figure 158 is the most prolific in this context. At the sites shown on the map artefacts were collected in numbers varying from a dozen to several thousands. The richest of these sites is Sint Geertruid 'De Hej', where good workable flints were found in the chalk exposed in a steep cliff between a high and a middle terrace of the Maas terrace system, and in the same chalk exposed in a dry valley. The flint must have attracted Palaeolithic hominids, like, milennia of years later, the Neolithic groups that exploited the flint mines of Ryckholt-Sint Geertruid (Roebroeks 1980, 1981c; Wouters 1980). The Sint-Geertruid 'De Hej' site is characteristic of the surface sites in this region: they are all restricted to areas lying on top of the steep cliffs between the river terraces or at the top of the steep slopes of dry valley systems. Figure 158 clearly visualizes the geomorphology of these sites. The figure was drawn with the help of Dr J. Hartmann (Amsterdam).

In the author's opinion it is very probable that there are more Palaeolithic cultural remains farther away from the edges of the terrace plateaus, towards the centre of the plateau, where the loess layer is up to 20 metres thick. In these areas geological outcrops are, however, very rare, but a few data indicate that these plateaus were also visited. This is for instance attested by the Weichselian evidence from the Belgian site Kesselt, 4 km west of Belvédère, (cf. chapter 7). Weichselian finds from the ENCI pit at Maastricht (Roebroeks 1981a) are further evidence of this. The German plateau site 'Rheindahlen', about 60 km northeast of Maastricht, has several Middle and Late Pleistocene archaeological find layers (Thieme 1983a).

The various Belvédère sites were discovered thanks to the presence of a geological outcrop that is very rare in the working area, namely a quarry cut into the slopes between a lower and a middle terrace of the river Maas. The well-preserved Unit IV sites owe their state of preservation to the fluviatile environment in which they were formed, but the state of preservation of the Site E assemblage may be more common of cold-stage accumulations produced outside river sedimentation areas, as shown by, for instance, the evidence from Kesselt (Lauwers/Meijs 1985). Leaving this site out of consideration, the only information provided by the known sites outside the river-valley areas on palaeoenvironment, dating or human behaviour is that 'at some time in the Lower and Middle Palaeolithic human groups were present here'. The data obtainable from these surface sites and from the plateau region in general are partly dependent on the questions asked by the archaeologist studying this topic. An important question in this context is whether it is justified to treat the assemblages from the plateau sites as having been at least partly produced in environments completely different from those with 'full interglacial' conditions. It could be inferred that in 'glacial' periods exploitation of the environment was significantly different from exploitation in full interglacial conditions. In interglacial periods the river Maas and its tributaries may have formed the basic lines of communication through a widely forested area. Exploitation of the environment was probably largely based on the presence of these natural ways, which were also the source of important inorganic resources like water and flint. In colder periods at least the flint outcrops in steep cliffs would be easier to discern, and in any case easier to exploit in the absence of a deciduous forest vegetation cover. On the basis of these considerations the hypothesis can be formulated that in our working area Middle Palaeolithic land use was centred around the river valleys in interglacial phases, while the higher plateaus outside the river valleys were more significantly integrated in the land use of Palaeolithic groups in (colder) periods with less vegetation.

However, as already stated above, the overall absence of sedimentation outside the river valleys in interglacial periods makes it rather difficult to test this hypothesis. Theoretically, Palaeolithic assemblages dating from Middle or Late Pleistocene interglacials will simply not have been preserved in a way which now makes them recognizable as evidence of occupation of our working area in a 'temperate' climate unless they were situated in sediment traps like caves, abris, karst depressions and dry valleys. However, so far no such preserved evidence has been recovered.

In the author's opinion, archaeology must at least try to develop the means for relating the few well-preserved sites to the data from the much less informative (surface and other) sites providing the bulk of archaeological evidence. Focussing our archaeological attention on the spectacular well-preserved sites can be compared with the approach in history concentrating on the description of the lives of 'well-documented' members of the upper class, kings and princes, without even trying to analyse the social and economic context in which these well-documented persons (sites) functioned and flourished.

In view of all the discussed problems, South Limburg and the neighbouring Belgian and German loess areas are an ideal region for studying the topics mentioned above: in the first place the Belvédère research, as presented in this volume and in Van Kolfschoten and Roebroeks (eds.) 1985, has provided us with a framework which can be filled in in greater detail in later research. Secondly, the State Geological Survey has invested a tremendous amount of energy in a detailed mapping of Quaternary and pre-Quaternary deposists in South Limburg (Felder/Bosch 1984, 1988). Finally, the activities of the local amateur archaeologists enabled the drawing of a distribution map of Middle Palaeolithic surface sites, a few of which deserve further research.

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summary

The Belvédère loess and gravel pit, situated northwest of the town of Maastricht, has been the object of an intensive archaeological-geological investigation since 1980. The aim of the research was to study the remains of human activities during the last and penultimate glaciation and the deposits containing archaeological finds. The pit has been exploited for almost a century now, but until 1980 no Palaeolithic artefacts had ever been discovered there. The interdisciplinary research of the pit, which consists largely of a virtually uninterrupted series of archaeological rescue excavations, is still being continued. New discoveries may lead to a different interpretation of the geological context of the archaeological finds than that presented in this volume.

Chapter 2 (The geology of the Belvédère pit and its wider geographical setting) gives a brief outline of the geological history of South Limburg, with particular emphasis on the Pleistocene, and continues with a more detailed description and interpretation of the deposits found in the pit. In total, five lithostratigraphical units were distinguished in the Pleistocene deposits (III up to and including VII). Unit III, consisting of coarse gravel and sands of the Caberg Middle Terrace deposits, is interpreted as a deposit formed by a river with numerous tributaries under cold climatic conditions. The following Unit IV deposits were formed under warmer conditions, presumably by a meandering stream. The Unit V deposits consist of a sequence, fining upwards, of fine sands and displaced loess. Unit VI consists of (reworked) Weichselian loess deposits. Unit VII, finally, is interpreted as a typical loess deposit from the Pleniglacial period of the last glaciation.

The faunal remains recovered from the various deposits present a picture of the climate and the environment at the time of the formation of the lithostratigraphical units and the archaeological assemblages found in them. In addition, they constitute a reliable basis for the *relative* dating of the deposits in the pit. The dates of the individual deposits resulting from this relative dating method are confirmed by the *absolute* dates (obtained with the aid of Thermoluminescence and Electron Spin Resonance). The Unit IV-C deposits are the most interesting from an archaeological and palaeontological point of view because they appeared to contain several archaeological assemblages in a primary context and also large amounts of palaeontological material (mammal and molluscan remains). These Unit IV-C deposits were formed in a warm-temperate period in the Saalian which presumably corresponds to the Hoogeveen interstadial (see chapters 2 and 8). The absolute dates indicate an age of 200-250 ka (see chapters 2 and 8), on the basis of which a correlation with Stage 7 of the oxygen isotope stratigraphy is proposed. That this correlation is only one out of several possible options is demonstrated in chapter 8 in a critical analysis of the presuppositions of such correlations.

Chapter 3 up to and including 7 contain the results of the archaeological research carried out from 1980 to 1985 and also a brief description of later excavations. Figure 20 gives a schematic survey of the stratigraphical positions of the different sites (A up to and including K) discussed in this volume, while figure 5 shows their positions in the pit.

The methods used to record the find scatters in the field were always a compromise between our own wishes and the commercial interests of the firm exploiting the pit, which of course affected the degree of detail in the recording. Since 1985 the main aim has been to record find scatters over the largest possible area. On some occasions the finds were collected per square metre in rescue excavations.

Some of the themes dealt with in the interpretation of the data presented are the role of the transport of flint artefacts in the formation of flint assemblages and the relation between flint artefacts and bone.

The evidence obtained in refitting flint from the Unit IV sites indicated that these 'sites' represent only one stage of a complex system of production, transport and discard of artefacts. For example the flints recovered from Site C appeared to be the products of at least six different flint nodules or Raw Material Units. Of some of these nodules mainly decortication flakes were found (figs.52 and 53), whereas another nodule had been introduced into the excavated area in the form of an already largely reduced core (figs.60 and 61). These and other observations, particularly at Site G, led to the assumption that the *transport* of flint objects largely accounts for the great technological and typological differences in the artefact composition of Middle Palaeolithic find complexes. The underlying theory is that the production of flint artefacts intended to be used elsewhere results in different assemblages than the ad hoc production of flakes for local use. Chapter 9 (The Belvédère data: implications for the interpretation of hominid behaviour in the Middle Palaeolithic) discusses this assumption in a wider context: data from other sites indicate that there is indeed a relation between, for example, the transport of flints and certain 'economical' forms of core reduction. In addition, frequently retouched objects (such as handaxes) are usually found at a greater distance from their raw material source than artefacts that show no or virtually no signs of retouching. In this chapter it is also suggested that the spatial incongruity of the various stages of flint processing could provide a key to the 'Mousterian problem' -a topic already introduced in the discussion of two Unit VI (Weichselian) sites in chapter 7.

The archaeological record shows that the distances over which objects were transported by hominids increased substantially in the course of the Pleistocene, as is discussed in chapter 9 (see fig.140).

The associated occurrence of artefacts and -usually poorly preserved- bone at some of the Belvédère sites led to speculations on the origin of these spatial associations. How are we to differentiate between, on the one hand, faunal elements that occur on a distribution map as part of the natural background fauna and, on the other, elements introduced by hominids? If the evidence suggests that we are indeed dealing with elements introduced by hominids, as was for example the case with the results of the analysis of wear traces on the finds from Site G (figs.148 and 149; see Van Gijn, Appendix I), we must then decide whether these elements are attributable to scavenging or hunting. This problem is discussed in the descriptions and interpretations of the individual sites and in the more interpretative chapter 9, in which it is suggested that the currently available data do not yet permit us to choose between these two options and that our present interpretations are based more on our views on the 'humanness' of these early hominids than on actual sound evidence.

samenvatting (Dutch summary)

De löss- en grindgroeve Belvédère, gelegen ten noordwesten van de stad Maastricht, is sinds 1980 het object van een uitgebreid archeologisch-geologisch onderzoek, gericht op bestudering van resten van menselijke activiteiten in de laatste en voorlaatste 'ijstijd' en van de afzettingen waarin de archeologica worden aangetroffen. De groeve is al bijna een eeuw in exploitatie, maar het eerste paleolithische artefact werd pas in 1980 ontdekt.
Het interdisciplinaire onderzoek van de ontsluiting , dat hoofdzakelijk uit een vrijwel constante aaneenschakeling van archeologische noodopgravingen bestaat, loopt nog steeds. Door nieuwe inzichten zullen mogelijk latere publicaties met betrekking tot de details van de geologische context van de archeologica verschillen van de in het proefschrift gepresenteerde gegevens.

In hoofdstuk 2 (The geology of the Belvédère pit and its wider geographical setting) wordt, na een korte schets van met name de Pleistocene geologische geschiedenis van Zuid Limburg, ingegaan op beschrijving en interpretatie van de in de groeve ontsloten afzettingen. Binnen de Pleistocene afzettingen in de groeve worden in totaal vijf lithostratigrafische eenheden onderscheiden (III tot en met VII). Unit III, bestaande uit grove grinden en zanden behorende tot de Caberg middenterras-afzettingen, wordt geïnterpreteerd als een afzetting gevormd door een verwilderde rivier onder koude klimaatsomstandigheden. De daarop volgende Unit IV-afzettingen zijn onder warmere omstandigheden gevormd, waarschijnlijk door een meanderende stroom. De Unit V-afzettingen bestaan uit een fining upwards sequentie van fijne zanden en verplaatste löss, terwijl ook Unit VI voornamelijk uit omgewerkte löss bestaat. Unit VII tenslotte wordt geïnterpreteerd als een typische löss uit het Pleniglaciaal van de laatste ijstijd.

De faunaresten die in de verschillende afzettingen verzameld konden worden geven ons een beeld van klimaat en milieu ten tijde van de vorming van de lithostratigrafische eenheden en de erin aangetroffen archeologische assemblages. Daarnaast bieden zij een goed houvast voor een *relatieve* datering van de afzettingen. '*Absolute*' dateringen (Thermoluminescentie en Electronen Spin Resonantie) ondersteunen de op relatieve dateringen gebaseerde ouderdom van de diverse afzettingen in de groeve.

Archeologisch en paleontologisch gezien zijn de Unit IV-C afzettingen het meest interessant, omdat deze op meerdere locaties archeologisch materiaal in primaire context opgeleverd hebben, naast grote hoeveelheden paleontologisch materiaal (zoogdier- en molluscenfauna's). Deze Unit IV-C afzettingen zijn gevormd in een gematigd-warme/interglaciale fase in het Saalien, die waarschijnlijk met het Hoogeveen-interstadiaal correspondeert (zie hoofdstuk 2 en 8). De absolute dateringen indiceren een ouderdom in de ordegrootte van 200-250 ka (zie hoofdstuk 2 en 8), op basis waarvan een correlatie met Stage 7 van de zuurstof-isotopen stratigrafie voorgesteld wordt. Dat deze correlatie slechts één van verschillende opties is, wordt in hoofdstuk 8 in een kritische analyse van de vooronderstellingen van dergelijke correlaties gedemonstreerd.

In de hoofdstukken 3 tot en met 7 worden de resultaten van het archeologisch onderzoek in de periode 1980-1985 beschreven, terwijl ook latere opgravingen kort aan de orde komen. Figuur 20 geeft een zeer schematisch overzicht van de stratigrafische positie van de verschillende sites (A tot en met K) die in het proefschrift behandeld worden, terwijl figuur 5 de locatie van deze sites binnen de groeve weergeeft.

De methodes gebruikt bij het documenteren van de vondstspreidingen in het veld zijn steeds een compromis geweest tussen onze eigen vraagstellingen en de commerciële belangen van de exploitant van de groeve, hetgeen uiteraard consequenties had voor de mate van gedetailleerdheid van documentatie. Vanaf 1985 ligt de prioriteit in eerste instantie bij het documenteren van vondstspreidingen over een zo groot mogelijk oppervlak, waarbij in spoedsituaties vondsten in een vierkante metergrid worden verzameld.

Thema's die bij de interpretatie van de gepresenteerde gegevens behandeld worden zijn onder andere de rol van het transport van vuurstenen artefacten bij de vorming van vuursteen-assemblages en de relatie vuurstenen artefacten – botmateriaal.

Op basis van het weer aaneenpassen (*refitten*) van vuursteen van de Unit IV sites bleek, dat deze 'sites' slechts één punt vormen in een complex systeem van vervaardiging, transport en afdanken van artefacten. Zo konden binnen Site C producten van minstens zes verschillende vuursteenknollen geïdentificeerd worden: van sommige knollen werden binnen de opgraving hoofdzakelijk cortex afslagen aangetroffen (fig. 52 en 53), terwijl een andere 'knol' in de vorm van een reeds ver opgebruikte kern de site 'binnen kwam' (fig. 60 en 61). Op basis van deze en andere waarnemingen, onder andere op Site G, is verondersteld dat het *transport* van vuurstenen voorwerpen een belangrijke rol speelt in de grote verschillen (zowel technologisch als typologisch) in artefactsamenstelling van middenpaleolithische vondstcomplexen. De gedachte hierachter is dat bewerking van vuursteen *gericht op* toekomstig gebruik elders een andere artefact-neerslag oplevert dan de ad-hoc productie van afslagen voor locaal gebruik. In hoofdstuk 9 (The Belvédère data; implications for the interpretation of hominid behaviour in the Middle Palaeolithic) is deze veronderstelling in een breder kader uitgewerkt: gegevens van andere sites indiceren dat er inderdaad een relatie bestaat tussen bijvoorbeeld transport van vuurstenen en bepaalde 'economische' vormen van kernpreparatie, terwijl ook sterk

geretoucheerde voorwerpen (onder andere vuistbijlen) doorgaans op een grotere afstand van de oorspronkelijke grondstofbron aangetroffen worden dan niet of nauwelijks geretoucheerde artefacten. In dit hoofdstuk wordt voorts gesuggereerd dat de ruimtelijke incongruentie van diverse stadia van vuursteenbewerking onder andere een sleutel vormt tot de oplossing van het 'Moustérien probleem'. Ook bij de bespreking van twee Unit VI (Weichselien) sites (hoofdstuk 7) komt dit thema aan de orde.

De afstanden waarover voorwerpen archeologisch waarneembaar door hominiden getransporteerd werden blijken in de loop van het Pleistoceen dramatisch toe te nemen , zoals in Hoofdstuk 9 aangetoond wordt (zie fig. 140).

Het geassocieerd voorkomen van artefacten en – meestal slecht geconserveerd – botmateriaal in sommige Belvédère sites doet vragen naar de genese van deze ruimtelijke associaties. Hoe maken we een onderscheid tussen enerzijds fauna-elementen die als een onderdeel van de natuurlijke achtergrondfauna op een verspreidingskaart terecht komen en anderzijds elementen die door hominiden geïntroduceerd zijn? Als we dat laatste soms kunnen veronderstellen – zoals bijvoorbeeld bij Site G op basis van de resultaten van gebruikssporenonderzoek (fig. 148 en 149; zie Van Gijn, Appendix I) – worden we geconfronteerd met de keuze uit twee opties: die van aaseten tegenover die van jacht. Deze problematiek komt bij de specifieke site-presentaties en interpretaties aan de orde en vervolgens in het meer interpretatieve hoofdstuk 9, waarin gesuggereerd wordt dat de basis voor de uiteindelijke keuzes tussen dergelijke opties voorlopig ontbreekt en dat de huidige keuzes meer te maken hebben met het 'mensbeeld' dat we van deze vroege hominiden hebben dan met 'harde feiten' .

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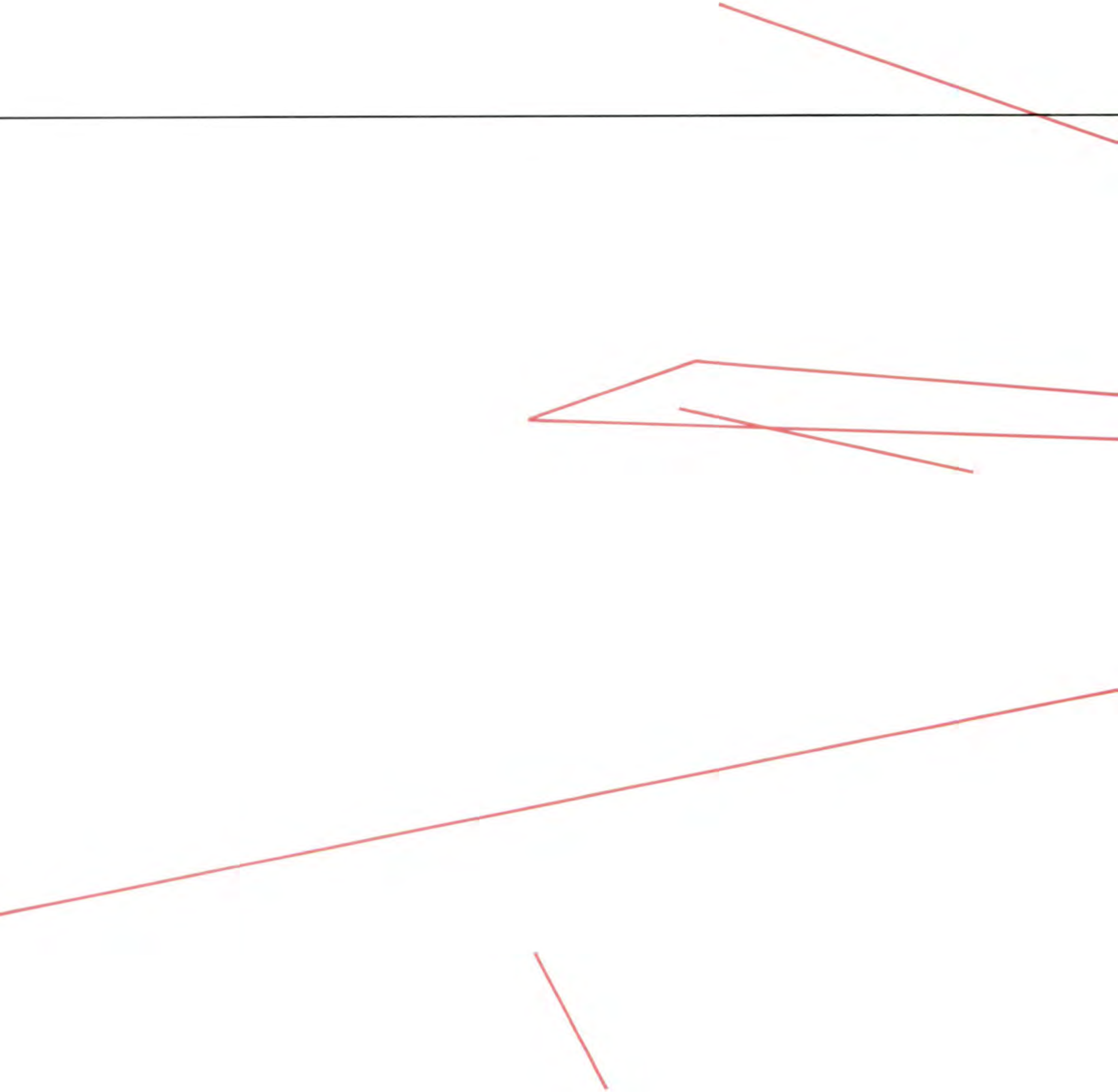
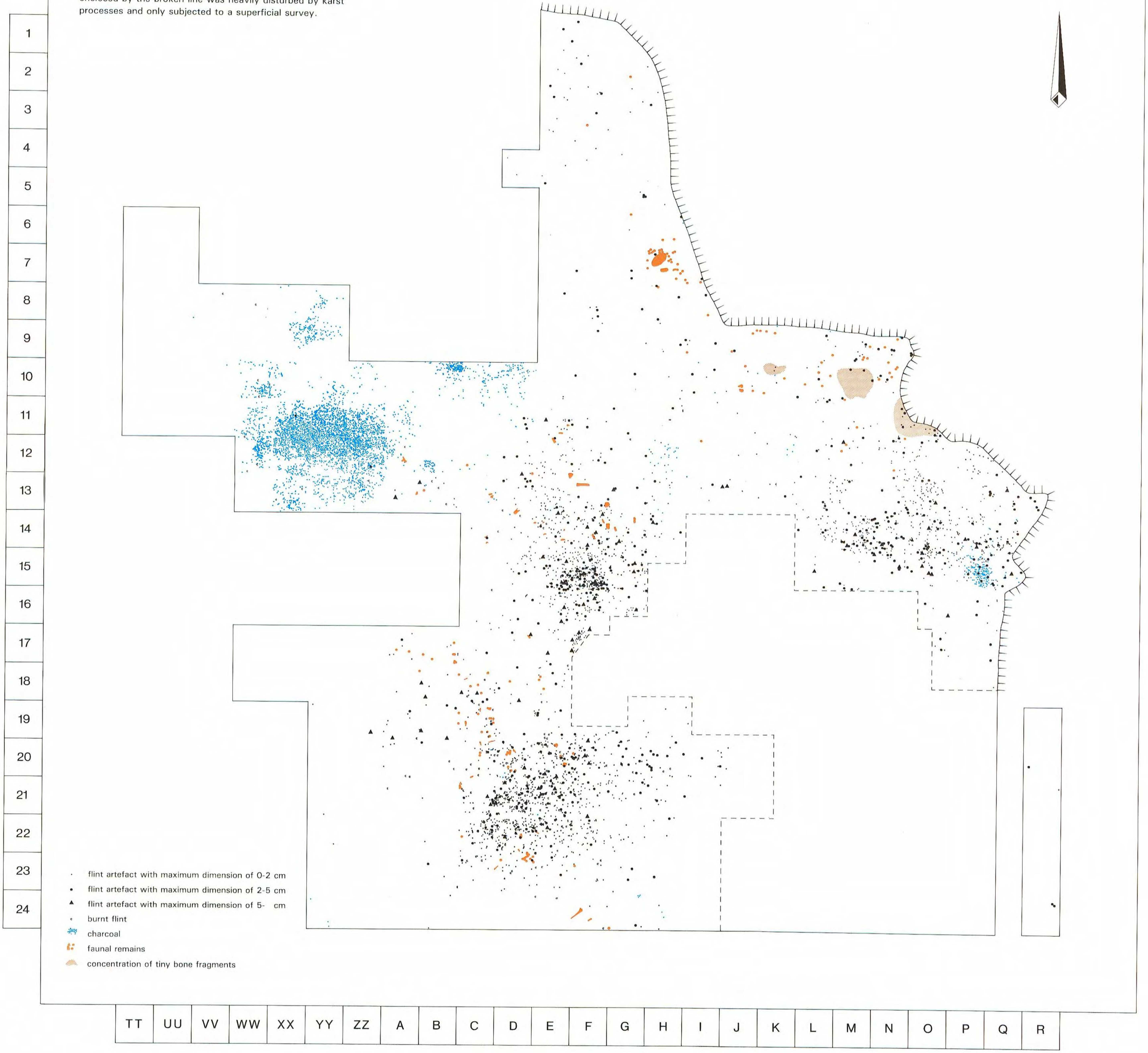


Fig. 27. Maastricht-Belvédère, Site C. Horizontal distribution of flint artefacts, burnt flints, faunal remains and charcoal fragments. Scale 1:80 (Reference grid in square metres). The blank area enclosed by the broken line was heavily disturbed by karst processes and only subjected to a superficial survey.



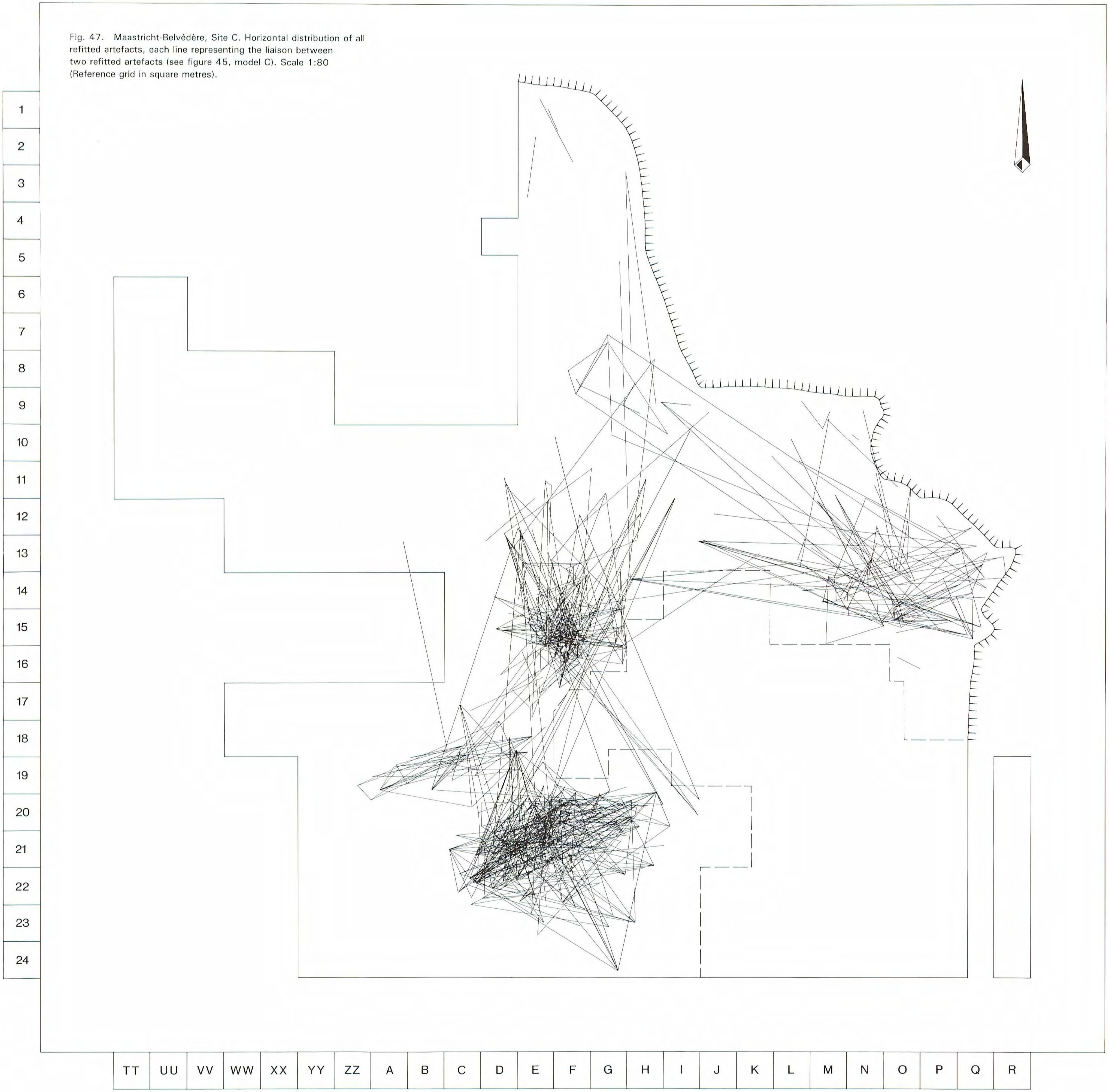


Fig. 47. Maastricht-Belvédère, Site C. Horizontal distribution of all refitted artefacts, each line representing the liaison between two refitted artefacts (see figure 45, model C). Scale 1:80 (Reference grid in square metres).