ANALECTA PRAEHISTORICA LEIDENSIA

42

2010

ANALECTA PRAEHISTORICA LEIDENSIA 42

ANALECTA PRAEHISTORICA LEIDENSIA 42

PUBLICATION OF THE FACULTY OF ARCHAEOLOGY
LEIDEN UNIVERSITY

EELCO RENSINK

EYSERHEIDE

A MAGDALENIAN OPEN-AIR SITE IN THE LOESS AREA OF THE NETHERLANDS AND ITS ARCHAEOLOGICAL CONTEXT

LEIDEN UNIVERSITY 2010

Series editors: Corrie Bakels / Hans Kamermans

Editor of illustrations: Joanne Porck

Translation: Kelly Fennema

ISSN 0169-7447
ISBN 978-90-818109-0-6

Subscriptions to the series *Analecta Praehistorica Leidensia*
and single volumes can be ordered exclusively at:

P.J.R. Modderman Stichting
Faculty of Archaeology
P.O. Box 9515
NL-2300 RA Leiden
The Netherlands

This publication was made possible with a grant from Cultural Heritage Agency, Amersfoort

Contents

1 Introduction

In 1985 Mr A.F.L. Blezer discovered a concentration of flint artefacts on a field near the hamlet of Eyserheide (municipality of Gulpen-Wittem) in the hills of the province of Limburg (the Netherlands) (fig. 1.1). A year later, when an archaeological inventory was made of the reallocation area of Mergelland-Oost authorized by the Landinrichtings-dienst (= Land Reallocation Service), these finds were brought to the attention of Mr F. Brounen (Leiden). Among the more than 300 flint artefacts were some large blade cores with one or two oblique striking platforms and tools made of blades, among which burins, end scrapers, a borer and a backed bladelet (Brounen 1987). This combination of tool types is characteristic of the Magdalenian of Northwest Europe. Comparable finds had earlier been made in the hills of Dutch Limburg near Sweikhuizen (Arts and Deeben 1987b) and near Mesch (Rensink 1991). Brounen immediately recognised the special character of the flint artefacts of Eyserheide. Further inspection revealed that some artefacts could be refitted, among which flakes onto a core. This might point to a relatively undisturbed site from the Magdalenian that was not yet completely affected by slope erosion and/or agricultural land use. The small dimensions (20 × 25 metres) of the find concentration and the location on a relatively flat part of a loess-covered plateau were also indications for this.

In the Netherlands the geographical distribution of Magdalenian sites is limited to the southeastern part of the country and mainly to loess-covered plateaus. Hence they are extremely rare in the Netherlands. Because of their position on or near the present surface, they are susceptible to disturbances caused by present-day land use and continuing erosion of the Limburg loess landscape.

The pressure of both land use and erosion and the wish to prevent further disturbance to the site led to an excavation near Eyserheide in 1990 (fig. 1.2). Moreover, an excavation fitted very well in the PhD research that the author was conducting in 1988-1993 into Magdalenian sites in Northwest Europe. One of the objectives of this research was to make an inventory of data that could provide information on the technological organisation of Magdalenian hunters and gatherers in this area. In relation to this research, the occurrence of four types of flint among the surface finds of Eyserheide was an attractive factor. This combination made it possible, amongst others with data on refitting, to analyse in which way the inhabitants of the camp site dealt with the different types of flint. The location of the site in the natural distribution area of one of the used types of flint, namely Simpelveld flint, also played a role in the decision to excavate the site. Artefacts of this type of flint have not only been found in Eyserheide but also in some nearby Dutch and German sites.

The excavation of the Magdalenian site of Eyserheide was carried out in April 1990, July to September 1990, and in April 1991 by students of the then Institute of Prehistory of Leiden University, in cooperation with Mr Blezer, members of the Archeologische Werkgemeenschap Nederland, amateur archaeologists, and volunteers. During the excavation, two small concentrations of flint artefacts were completely excavated and a zone with more dispersed finds was excavated to a large extent. The total area excavated in Eyserheide was 183 m^2. This investigation constituted the third excavation of a settlement from the Magdalenian in the Netherlands. Comparable excavations were earlier carried out in Sweikhuizen-Groene Paal (Arts and Deeben 1983, 1987b) and in Mesch (Rensink 1991). At both these locations small concentrations of stone artefacts from the Magdalenian were investigated in respectively 1982-1983 and in 1986. The Dutch sites form part of a group of open-air sites north of the Ardennes Massif in Belgium. This group also comprises the sites of Kanne and Orp-le-Grand in Belgium (Vermeersch et al. 1985, 1987) and Alsdorf (Löhr 1979), Kamphausen (Thissen 1989), and Beeck (Jöris et al. 1993) in that part of Germany that borders on the Netherlands. They are situated in a well over 100 kilo-metres wide loess belt that extends from Brussels in central Belgium to Krefeld and Bonn in the German Rhineland. We are dealing here with the most northwesterly sites in the extensive distribution area of the Magdalenian.

Eyserheide and the other sites mentioned above are linked to the earliest human occupation of the Netherlands after the extreme cold of the Glacial Maximum of the Weichsel ice age, about 20,000-18,000 BP. After a period of many

Figure 1.1 Topographical position of the site (asterisk) southwest of the hamlet of Eyserheide in the loess-covered hills of Dutch Limburg.

Figure 1.2 Excavation of the Eyserheide site in August 1990.

thousands of years, small groups of hunters and gatherers re-enter for the first time the loess-covered landscape between Meuse and Rhine. The last previous occupation by groups of hunters and gatherers may even date back to the period of the Neandertals in the late phase of the Middle Palaeolithic. Sites from the Aurignacian and Gravettian are lacking in the area, and the sites from the Magdalenian reflect the earliest occupation of the area by representatives of the species *Homo sapiens sapiens*. Unfortunately, there are no traces of organic materials, nor are absolute dates (C^{14}, AMS) available. Also on the basis of similarities in the origin and use of stone raw materials in well-dated Magdalenian sites in the German Central Rhineland, a date just at the end of the Pleniglacial (c. 13,300-12,700 BP), before the Bølling interstadial, is the most likely (see chapter 8).

Figure 1.3 Location of the site (arrow) on a loess-covered plateau on the southern margin of the Eiland van Ubachsberg. The photo was taken from the road between Eys and Trintelen, facing west.

Figure 1.4 Panoramic view from the location of the excavation over the hills of Dutch South Limburg in the direction of Germany. The photo was taken facing southeast.

This time span forms part of a period when hunters and gatherers from the Magdalenian dispersed from southwestern and/or central Europe over more northerly areas, among which the southern part of Poland, Thuringia and the Central Rhineland in Germany, the Ardennes Massif in Belgium, and the Paris Basin in France. Prior to this period of colonisation, groups of Magdalenian hunters and gatherers lived already for a few thousands of years in more southern areas of Europe, in particular in southwestern France and northern Spain. Both areas are rich in sites with tools characteristic of the Magdalenian, as well as numerous expressions of 'art', among which the wall-paintings of the caves of Lascaux and Altamira are well-known internationally. The paintings were made in a phase of the Magdalenian in which the Netherlands and adjacent parts of Northwest Europe did not yet know human occupation due to the cold of the Pleniglacial of the Weichsel ice age (Soffer and Gamble eds. 1990).

At the end of the 1980s and beginning of the 1990s a few short publications appeared on the site near Eyserheide (Brounen 1987; Rensink 1992a, 1992b; Rensink et al. 1991). A comprehensive description of the find material and the results of the excavations however never materialised.
The aim of this monograph is to present as completely as possible the results of the investigation in Eyserheide. Prior to the description of the find material, we will first go into the topographical and geological location of the site (chapter 2) and the applied methods and techniques of fieldwork (chapter 3). The descriptions and analyses of the find material form the principal part of the monograph and are presented in chapter 4. A contribution by K. Sano on the results of microwear analysis has been included as chapter 5. In chapter 6, attention is given to the spatial distribution of the finds and to the question which information can be inferred from this in terms of human behaviour. The group of Magdalenian open-air sites, of which Eyserheide is one, is the focus in chapter 7. Chapter 8 examines the relationship between the northern open-air sites and sites from the Magdalenian in the Central Rhineland and the Belgian Ardennes. The monograph is concluded with a short deliberation on the importance of the site of Eyserheide for the research into the northern Magdalenian (chapter 9).

2 Topography, soil and geology

2.1 Location

The Magdalenian site of Eyserheide is located in the municipality of Gulpen-Wittem in the southeastern part of the Dutch province of Limburg (fig. 1.1). This part of Limburg has landscape characteristics that are unique in the Netherlands. Pre-eminently, the area is a hilly landscape in which loess-covered plateaus, slopes and partially deeply-incised stream valleys and dry valleys follow each other at short distances. We are dealing here, at least by Dutch standards, with pronounced differences in relief and geomorphology. The highest point in the Netherlands near Vaals (321 m +NAP = Dutch Ordnance Datum) is located 11 km southeast of the site.

As are the adjacent parts of Belgium and Germany, the hilly landscape of Limburg forms part of an extensive loess area that extends from Brussels in the west to Krefeld in the east. From a geological perspective, this area forms the transition zone between the foothills of the Eifel and the Ardennes in the south, and the extensive area with coversands of the Northwest European Plain in the north. The small rivers and streams flowing in the Limburg loess area, among which the Gulp, Geul and Eyserbeek, form part of the drainage area of the Meuse river. They are fed by small brooks that often owe their existence to slope springs and other places where water seeps from the slopes.

2.2 Geology and soil

The southern part of Limburg where the site of Eyserheide is located can be regarded as the ‘foreland’ to the more southern Ardenno-Rhenish massif. This massif was formed in the Carboniferous period. According to the geological map of Southeast Limburg, scale 1:50 000 (Kuyl 1980), marine deposits (shales and quartzitic sandstones) from the Carboniferous only come to the surface in the deeper parts of the Geul valley southeast of Epen. This is the southernmost point of the Geul valley on Dutch soil. The distance from this point to the site of Eyserheide is c. 7 km.

Eyserheide lies on the southern side of a vast and elevated plateau, the so-called Eiland van Ubachsberg (figs. 1.3 and 2.1). This plateau, on which are located amongst others the villages of Voerendaal, Ubachsberg, Elkenrade and Trintelen, covers an area of c. 7 × 8 km. Its subsoil mainly consists of marine deposits dating from the Upper Cretaceous (Kuyl 1980; fig. 2.2). In this period, South Limburg formed part of a subsidence zone, and sedimentation of chalk occurred on a large scale in a sea that was becoming increasingly deeper. For a large part these chalk deposits belong to the Maastricht Formation, Kunrader facies (indicated by code Mt1 on the geological map). These deposits occur in South Limburg north of the Geul in particular and are characterised by alternating hard and soft chalk (Felder 1975). Immediately south of the Eiland van Ubachsberg surface older deposits from the Upper Cretaceous, namely those of the Gulpen Formation 3 (Gu3). They outcrop in the slopes of the deeply-incised stream valleys, for instance in the valley of the Geul and the valley of the Eyserbeek. The Gulpen Formation 3 is composed of chalk of Lanaye and Lixhe, a white chalk in which layers of irregular black flint occurs. Even deeper in the Geul valley and for a small part in the Eyserbeek valley at Eys occur deposits of the Gulpen Formation 2 (Gu2). These deposits are known as chalk of Vijlen and Beutenaken, and consist of light grey, glauconitic soft chalk.

East of the site, from Simpelveld to the Dutch-German border and south of it, marine deposits of the Vaals Formation (Va) are found at the surface. These deposits consist of glauconitic fine sands (Vaals greensands). And finally, south of Lemiers in the southeasternmost corner of Limburg, both chalk of the Gulpen Formation (Gu2) and sands of the Aken Formation (Ak) occur.

The geological map of the southeastern part of Limburg further shows marine deposits from the Tertiary in the highest part of the Eiland van Ubachsberg, in the immediate vicinity of the site. These are micaceous fine sands of the Tongeren Formation (Klimmen Deposits; ToK) dating from the Oligocene. Small areas with pene plain deposits from the ancient river Meuse can be found amidst these deposits, for instance near Trintelen. These sediments belong to the Kiezelooöliet Formation (Waubach Deposits; Koö) and consist of gravel, sand and clay layers. They date to the last phase of the Tertiary (the Pliocene).

The Eiland van Ubachsberg was created as a result of the Meuse shifting its channel westward at the beginning of the Pleistocene, under influence of the epeirogenetic uplift

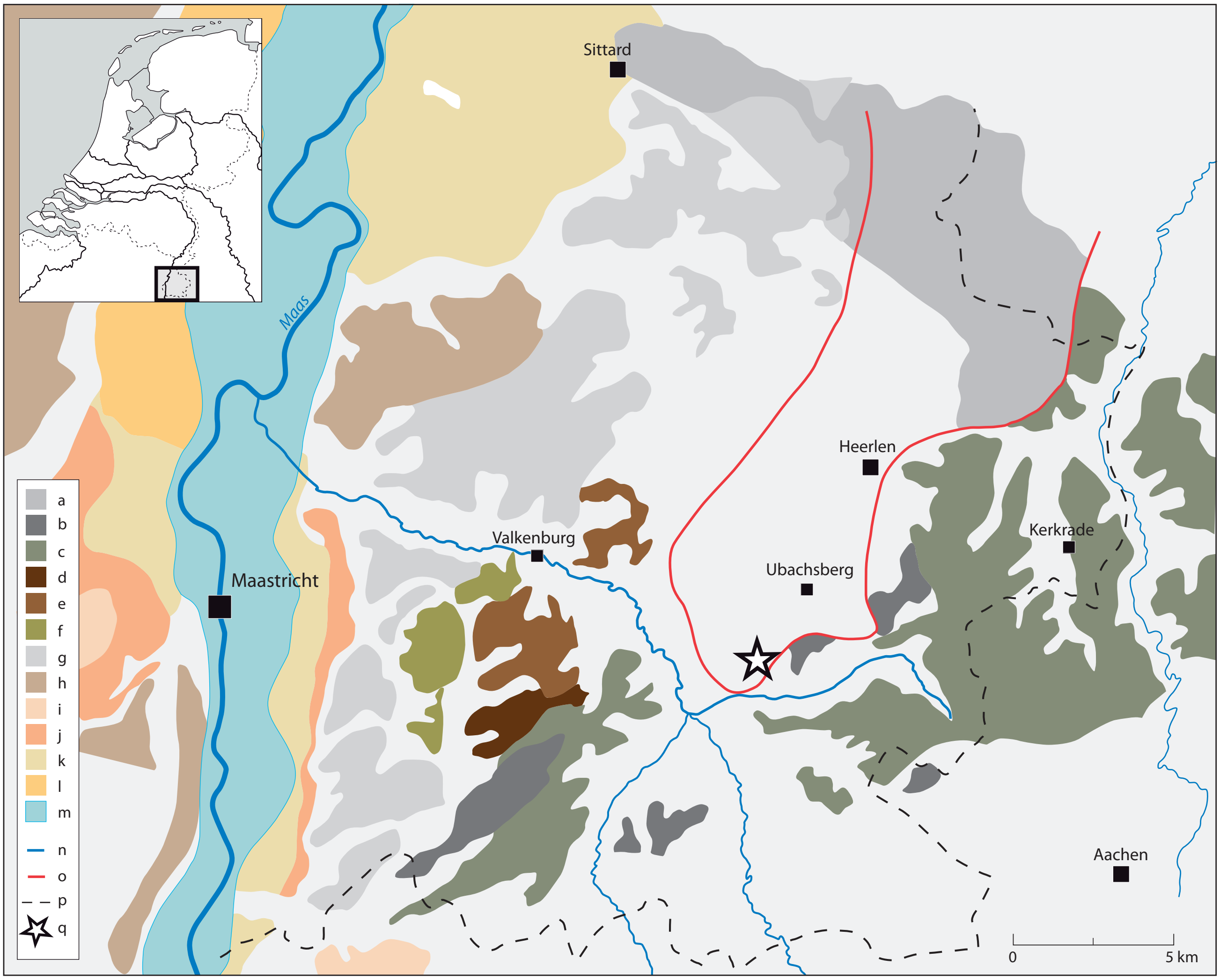


Figure 2.1 Meuse terrace geomorphology of South Limburg with the position of the site of Eyserheide (asterisk) and boundaries of the Eiland of Ubachsberg and terrace bodies of the Meuse (see fig. 8 in Roebroeks 1988, with adaptations). a= Waubach (Tertiary deposits), b= Kosberg, c= Simpelveld, d= Margraten, e= Sibbe, f= Valkenburg, g= St.Geertruid, h= St.Pietersberg, i= 's Gravenvoeren, j= Rothem, k= Caberg, l= Eisden-Lankaar, m= Oost-Maarland, n= river Meuse and smaller streams, o= the Eiland of Ubachsberg, p=land-frontier, q= position of Eyserheide site.

of the Ardenno-Rhenish massif. The island forms as it were the divide between the area with deposits of the East Meuse in the east, and the area with younger Pleistocene deposits of the West Meuse in the west. Small areas with remnants of Pleistocene terraces of the East Meuse, namely Kosberg Deposits (Kb) and Simpelveld Deposits (Sv), have been recorded on Dutch soil from Epen to Eygelshoven, east and southeast of the Eiland van Ubachsberg. By the shift of the Meuse and the concomitant erosion, the Kosberg Deposits in particular were cleared in many places. Deposits of the West Meuse are found in southeast Limburg southwest and west of the Eiland van Ubachsberg. The distribution area of these deposits is however considerably larger and extends to the Dutch-Belgian border near Maastricht. The fact that Pleistocene deposits of the Meuse are lacking on the Eiland van Ubachsberg demonstrates that this area remained free from activities (sedimentation and erosion) of the Meuse. Elsewhere in South Limburg, the West Meuse has asserted itself almost everywhere, leaving behind a fossil river terrace landscape (fig. 2.1).

In large parts of the South Limburg landscape, deposits from the Cretaceous and the Tertiary and/or the gravel-rich

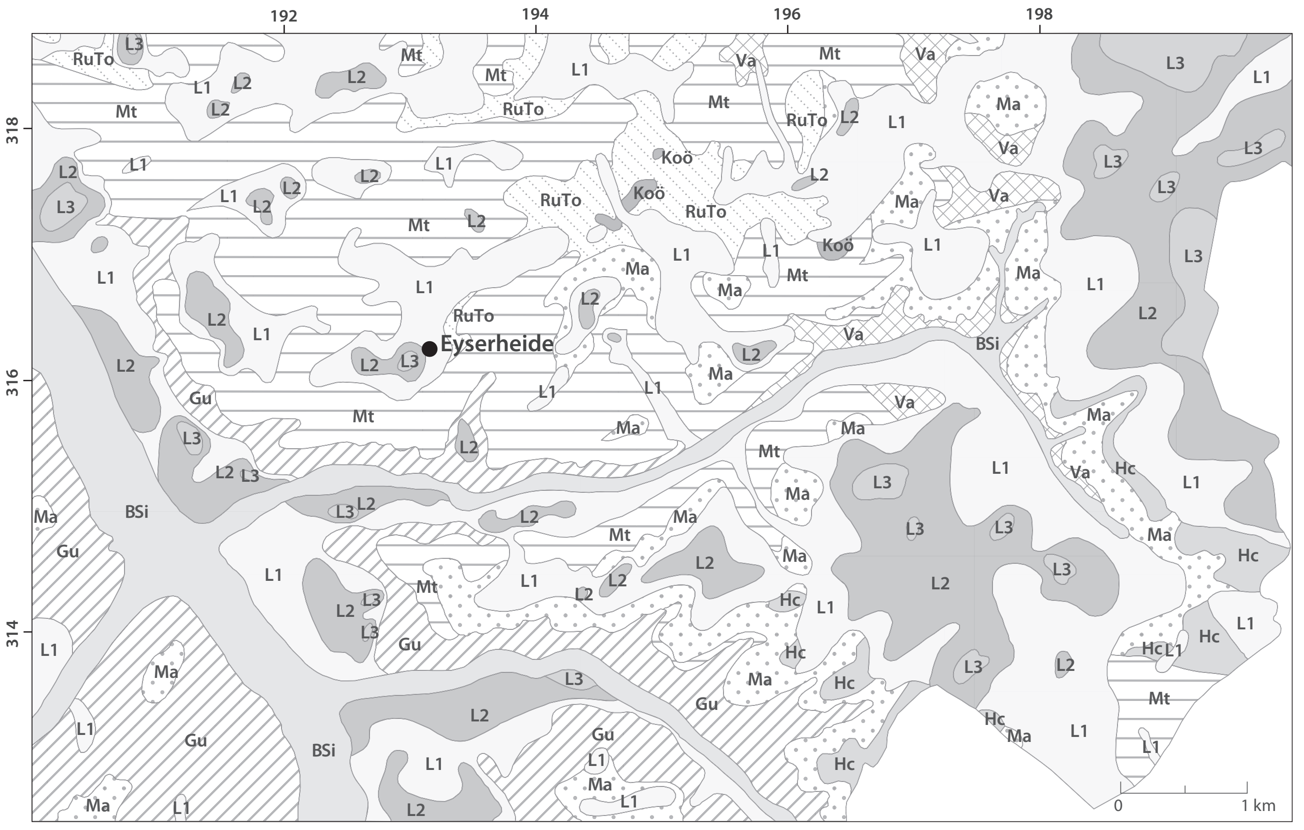


Figure 2.2 Detail of the Geological Map of the Netherlands (Kuyl 1980, Main map) showing Eyserheide and surroundings with the distribution of (pre)Quaternary deposits.
Holocene: *B*si= brook deposits (Singraven Formation); Pleistocene: L3= loess with a thickness >8 m, L2= loess 5-8 m, L1= loess 2-5 m (Twente/Eindhoven Formation), Hc= fluvio-periglacial deposits (Hoogcruts Deposits), Ma= terrace deposits from the river Meuse (Sterksel Formation, Kedichem Formation, Tegelen Formation, Kiezeloöliet Formation); Tertiary: Koö= peneplain deposits from the ancient river Meuse (Kiezeloöliet Formation), RuTo= marine deposits (Rupel Formation and Tongeren Formation); Cretaceous: Mt= marine deposits, Kunrader facies (Maastricht Formation), Gu= marine deposits (Gulpen Formation), Va= marine deposits (Vaals Formation).

terrace deposits of the Meuse are covered by aeolian deposits from the Pleistocene. These are loess deposits from the Saale and/or Weichsel ice age. In particular on the flatter parts of the plateaus, the sequence of loess deposits can reach considerable thicknesses. On the plateau at Eyserheide, the thickness of the loess sequence measures in the main between 2 and 5 metres (code L1, Kuyl 1980). Circa 500 m southwest of the site, the loess sequence is thicker: loess with a thickness of 5-8 m (L2) and more than 8 m (L3) (fig. 2.2). Although loess was originally deposited rich in chalk, the upper 2-3 m of the sequence is completely decalcified under influence of soil formation (Mücher 1973). On the margins of the Eiland van Ubachsberg, at places where the loess sequence is completely eroded, slope deposits come to the surface. And finally, in the lower parts of the landscape, among which the stream valleys, deposits of eroded and reworked loess are found. Locally there was also peat formation (Singraven Formation).

2.3 Local geological situation

The excavation spot lies on the southern margin of the Eiland van Ubachsberg, at a height of 193 m +NAP and above a deeply incised dry valley (fig. 2.3). At Trintelen, about 1200 m northeast of the site, this dry valley cuts into the plateau to join the water-carrying valley of the Eyserbeek c. 2 km further south at Eys. From the starting point at Trintelen (210 m +NAP) to the valley of the Eyserbeek (c. 110 m +NAP), there is a difference in height of c. 100 m. Viewed from the south and southeast, the site occupies a prominent, elevated position in the present landscape (figs. 1.3 and 1.4). The presence of the dry valley reinforces this position.

As a result of the draining of water and the corresponding erosion, the margins of the plateau are very irregular, and at various points dry valleys have formed. At less than 30 m east of the site, the initial stage of such a valley can be

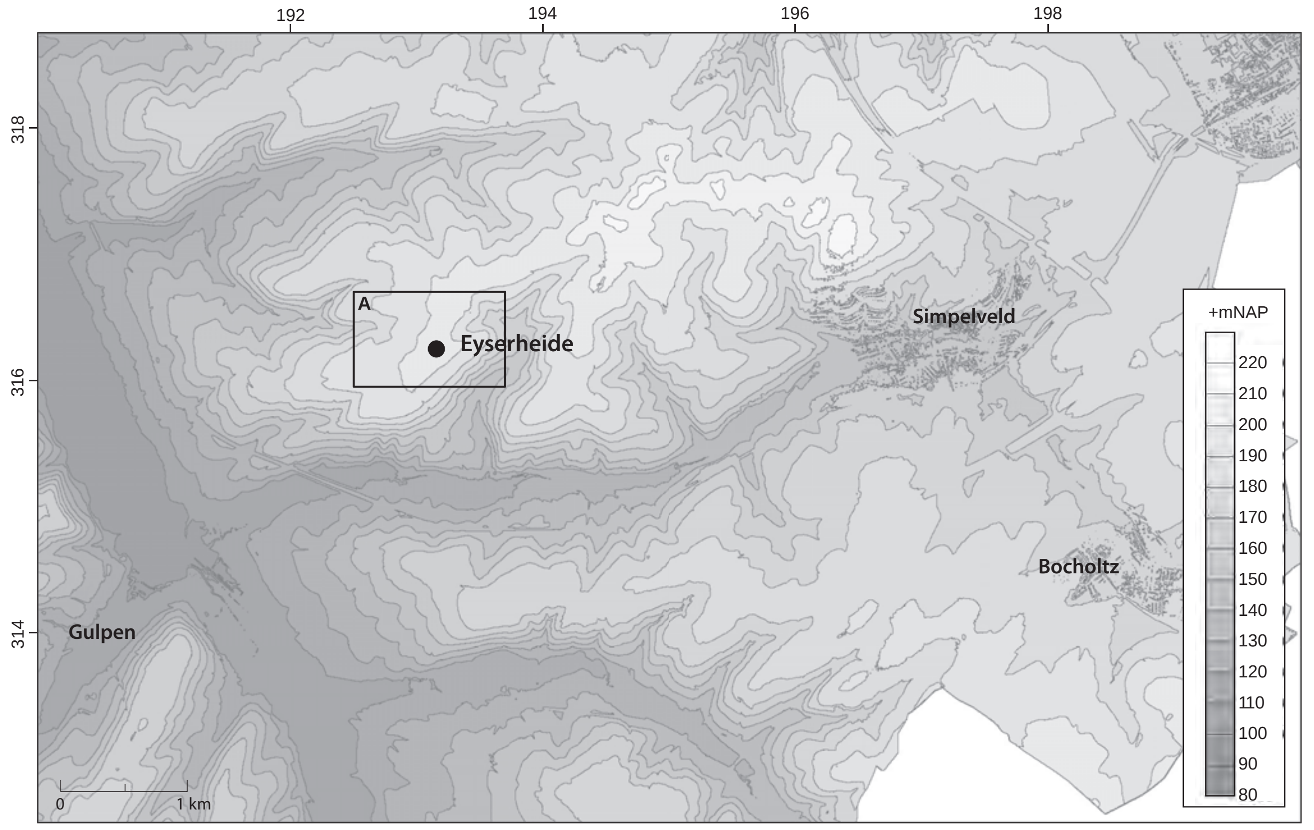


Figure 2.3 Contour map of Eyserheide and surroundings and location of the site at c. 193 m above Dutch Ordnance Level (*Normaal Amsterdams peil*) on the southwestern edge of the heavily incised plateau. Source: Actueel Hoogtebestand Nederland.

observed in the field (fig. 2.4). Today this valley no longer carries water and it forms the connection between the margin of the plateau on which the village of Eyserheide is located, and the southwest-northeast orientated dry valley between Trintelen and Eys. The Eyserbeek flows through Eys and, just north of Gulpen, discharges into the Geul, the most important tributary of the Meuse in this area. The Eyserbeek runs c. 1 km south of the site, whilst the distance to the Geul is c. 2.5 km.

When looking in detail at the situation of the terrain and the relief locally at the site, the following can be observed. The north-south section of the plot of land on which the site lies shows a rather flat surface with slope percentages varying between 0.7 and 1%. The west-east section on the other hand consists of a fairly steep slope with percentages that locally exceed 2.5%. In particular in the eastern part of the plot of land, towards the beginning of a dry valley, there is a steeper slope than in the central part of the excavation spot. Based on this, we allowed already at the start of the excavation for the possibility of (a higher degree of) erosion of this part of the site (see chapter 6).

Due to borings, it is known that at the excavation spot the loess sequence has a thickness of minimally 1 metre. The top of this sequence consists of a plough zone with an average thickness of c. 25-30 cm. In the profiles that were described during the excavation, a truncated Holocene soil could be recorded. This indicates that the top of the loess sequence has been subjected to erosion and/or was completely incorporated into the plough zone. In places where there are no disturbances (tree falls, and such like), a horizon can be followed under the plough zone that is red-brown in colour and into which illuviation and enrichment of clay has taken place. We are dealing here with the Bt horizon of a Holocene soil, the thickness of which can measure up to 90 cm. This horizon, particularly in the topmost part immediately under the base of the plough zone, is very homogenised and is transected up to the deeper parts by burrowing and root tunnels. In addition, cracks were observed in the Bt horizon which on the basis of their shape and size can be regarded as frost or contraction cracks. Disturbance of the original soil profile is further demonstrated by the occurrence of places where the Bt horizon is

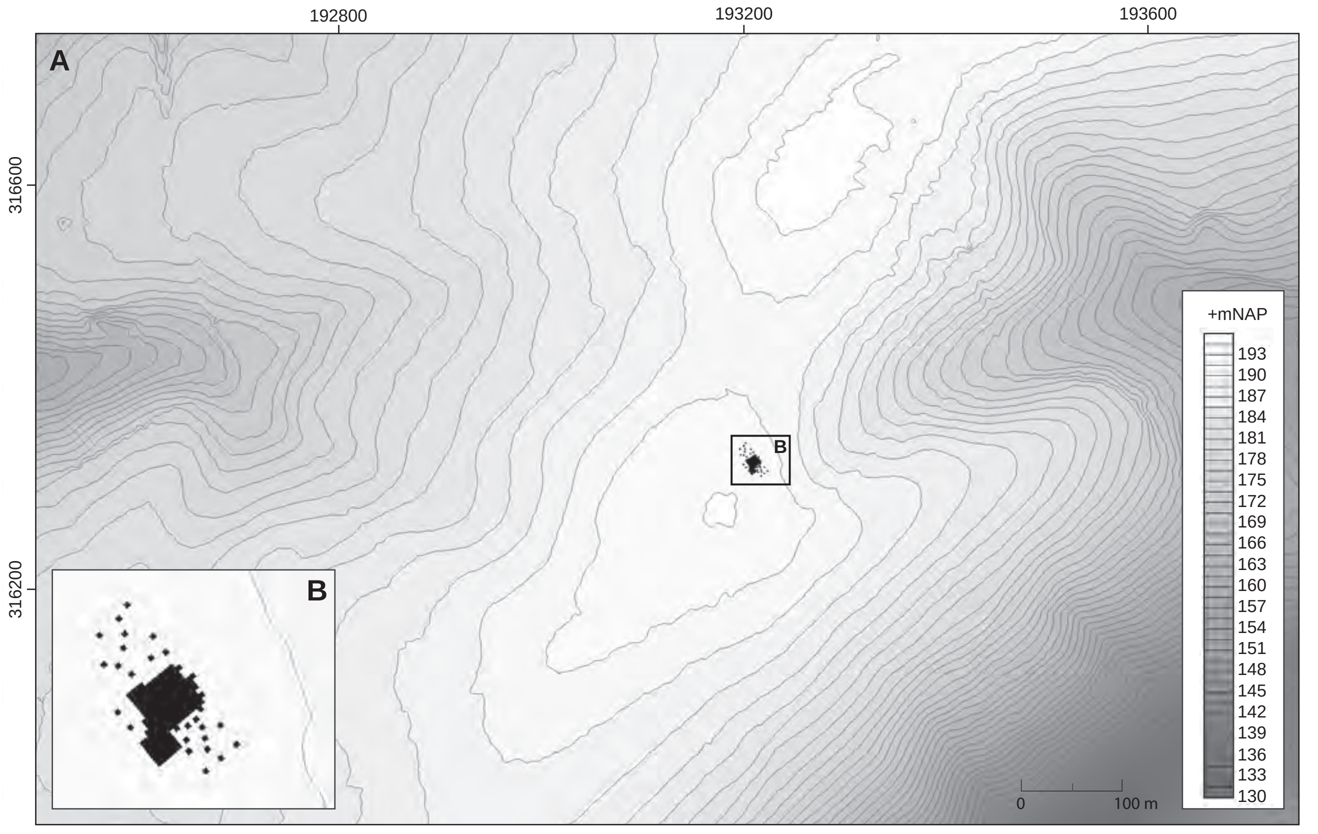


Figure 2.4 Detail of map in fig. 2.3 with position of trial trenches (April 1990) and excavation (Summer 1990, April 1991). The site is located on an elevated part of the terrain at the beginning of a dry valley. Source: Actueel Hoogtebestand Nederland.

lacking. These are visible below the plough zone in the plane and in the profiles as lighter discolourations and are filled in with relatively clay-poor sediment. We are probably dealing here with remnants of tree falls belonging to a former (Holocene) forest. The non-ploughed part of the archaeological layer was directly under the plough zone in the top of the Bt horizon. Besides, at various places finds have been made in the remnants of the backfills of the tree falls.

In spite of the effects of erosion, a substantial layer of loess still covers the plateau on which the site is located and the adjacent slopes. Apparently, erosion has brought the archaeological layer (nearer) to the surface, without affecting the archaeological site too much. It was probably only in the past century that serious disturbance of the archaeological layer occurred as a result of agricultural activities (Rensink 1992b). For a more detailed discussion of the pedological situation at the location of the site and the role of post-depositional processes on the preservation and location of the archaeological finds, the reader is referred to chapter 6.

3 Research methods

3.1 Introduction

In this chapter the methods and techniques of field research are discussed that were used at the site and in its immediate surroundings in 1990 and 1991. Point of departure of the fieldwork was the information of Mr Blezer regarding the location and distribution of the flint artefacts. This distribution measured c. 35 × 15 m and was situated in the central part of a long, narrow field at most at 100 m from the margin of the plateau.

3.2 Measuring system and borings

In preparation of the excavation in 1990, on 27th October 1989 five grid lines were marked out and six borings carried out. With the aid of a theodolite and surveying rods the first grid line was marked out from the Eyserbosweg, perpendicular to the road and towards the field in a southeasterly direction, with a length of almost 120 m (A-D, fig. 3.1).
At the spot where this line intersected the western boundary of the plot of land to be investigated, a second grid line was

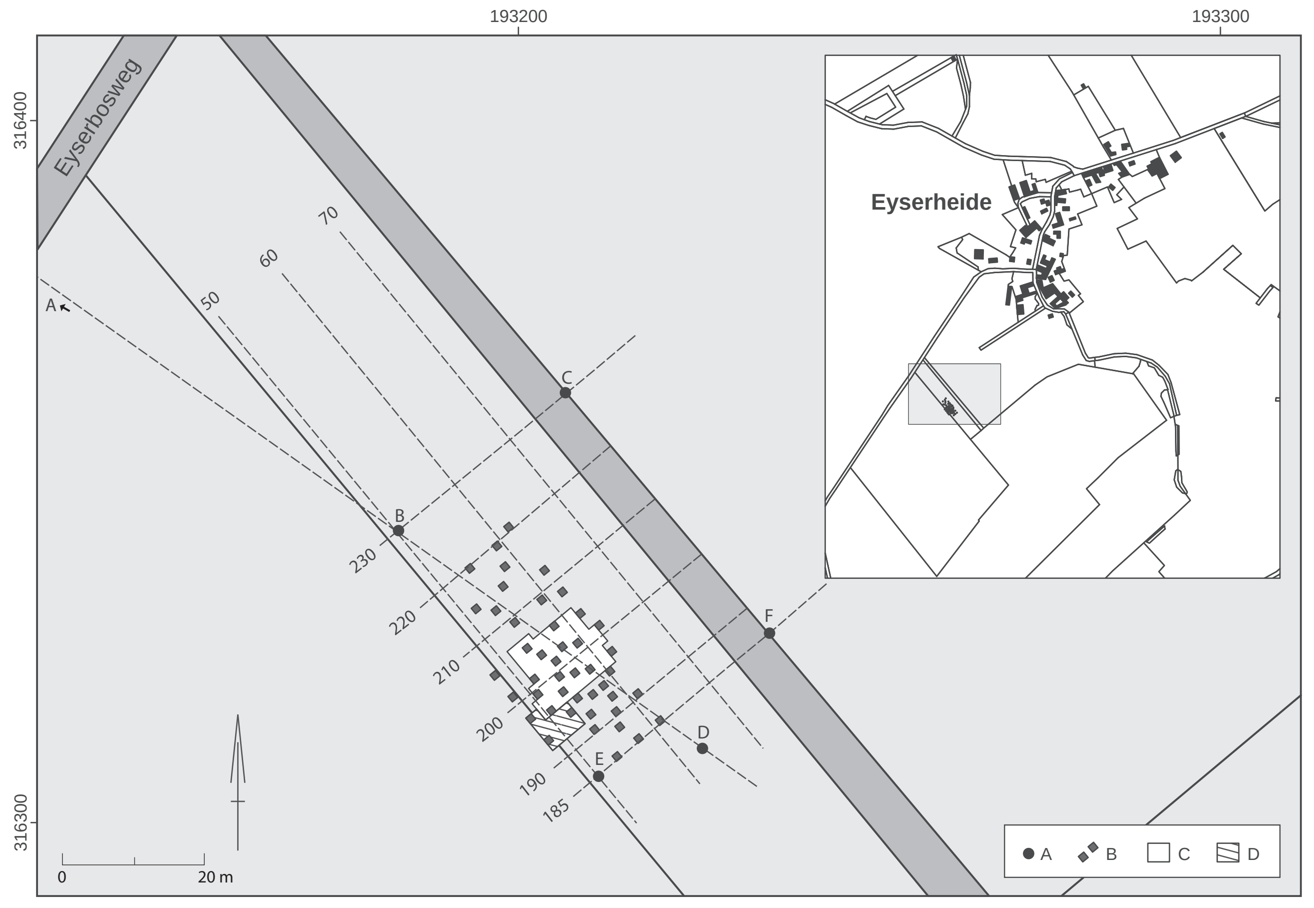


Figure 3.1 Position of the investigated plot of land and excavation with important co-ordinate lines and measuring-points in the grid system. Grid co-ordinates are at 5-metre (185 to 190) and 10-metre (190 to 200, etc.) intervals. For an explanation of the grid system, see text.

marked out parallel to the boundary of the plot. This grid line with a length of 45 m started at measuring point 50/230 (B) and finished at measuring point 50/185 (E). From these measuring points, two lines (B-C and E-F) of more than 35 m length were marked out, perpendicular to the two principal grid lines, and extending to the eastern margin of the plot of land. The latter two grid lines subsequently served as reference for the marking out, with a theodolite, of 42 trial squares in April 1990. From measuring point 50/230 (B) the NAP height was determined at 193.87 m. With the a small wooden stake this and other measuring points were marked in the field.

For a first understanding of the soil structure, six borings were carried out with a 7 cm auger on grid line A-D from 70 to 95 m. The distance between two consecutive boring points was 5 m. The results of the borings were as follows. Underneath the plough zone (Ap), there is locally a 25-30 cm thick layer with loose clay-poor sediment which was interpreted as E horizon. The thickness of this horizon varies from 25 to 60 cm. Underneath there is a horizon rich in clay that carries on to the maximum boring depth of 1.2 m (borings 1, 4-6). It concerns a well-developed Bt horizon. In borings 2 and 3 the C horizon was possibly struck between 1 and 1.2 m below ground level (bgl). The results point to a relatively intact profile of a Holocene loess soil, of which only the top was incorporated into the plough zone. The bored-out sediments of borings 1-6 were kept and sieved with water on a 1 mm sieve. On sorting of the residue no flint chips or other artefacts were recovered.

3.3 Research of April 1990

From 17th to 27th April 1990 trial pits were dug with a small team with the aim of locating the concentration(s) of flint artefacts and of gaining insight into the scale and degree of disturbance of the site. The focus was on the central part of the field where most finds had been collected on the surface. Based on information from Mr Blezer, 42 trial squares of 1 × 1 m were marked out in an area of 35 × 15 m (surface area of more than 500 m^2, fig. 3.4, F). Point of departure for marking out the trial squares were the principal grid lines that had been marked out with wooden stakes in October 1989 (see paragraph 3.2). The x-co-ordinates of the trial squares varied from 47 to 63, and the y-co-ordinates from 185 to 221.

Prior to the excavation of the trial squares, first the NAP height of the surface level was determined with a theodolite. Subsequently, every square was excavated with a trowel to a depth of 30 cm under the base of the plough zone (fig. 3.2). Finds from the plough zone were collected per square of 1 × 1 m, and those from the underlying sediment were measured three-dimensionally. A theodolite, three wooden measuring staffs and a plumb line were used for this measuring. Of all measured-in finds the numbers of the square, and the x-, y- and z-co-ordinates were recorded on a form. In addition, the contours of artefacts and unworked stones larger than 5 cm were drawn on a ground plan. After the square was trowelled to the desired depth, the final height of the plane was determined. And finally, the excavated sediment was dumped back into the square concerned, this with a view to sieving the sediment in the summer of 1990.

Figure 3.2 Digging of trial squares of 1 x 1 m during the preliminary investigation in April 1990.

In 19 out of 42 trial squares one or more artefacts from the Magdalenian were measured in. In the richest square, 54/203, seventy-two artefacts were measured in, including a dihedral burin and an end scraper on blade, and fragments of stones (fig. 3.3). The position of most artefacts in this

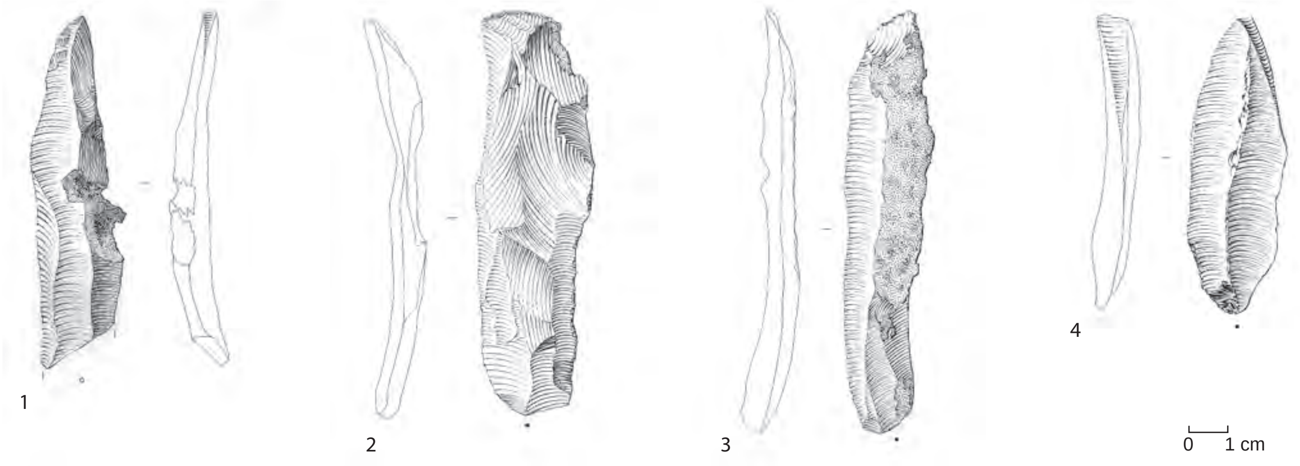


Figure 3.3 Retouched tools from trial square 54/203. 1 Lacan-burin, 2 end scraper on blade, 3 borer on blade and 4 dihedral burin (scale 1:2). Drawings: H. de Lorm.

square, between 5 and 20 cm under the base of the plough zone, seemed to indicate that in this part of the site the archaeological layer had not been seriously affected by ploughing activities. The number of finds in the other squares varied from 1 to 26. Squares with relatively large numbers of artefacts (between 17 and 26) were all situated at less than eight metres from square 54/203. Thus an indication was obtained of the exact position and the dimensions of the site, as well as the depth at which the archaeological material was lying in relation to the present-day surface level.

3.4 Excavation of July-September 1990

Based on the results of the preliminary investigation in April 1990, an area of 10 × 10 metres was selected for excavation (fig. 3.4, A). Point of departure in the choice of this area was the richest trial square 54/203. The entire surface of 100 m^2 was excavated in July and August. The system of squares of 1 × 1 m and the working practice of April 1990 were thereby retained: measuring of the starting height, trowelling of the plough zone and collection of finds in squares of 1 m^2, trowelling of the sediment underneath the plough zone and three-dimensionally measuring of the finds, and determination of the final height (fig. 3.5). Squares without any finds were excavated to minimally 30 cm under the plough zone, while squares with finds were excavated to maximally 20 cm under the find with the deepest position. Discolourations in the plane and other indications of disturbances of the soil profile were drawn on a plan with a scale of 1:20. The contours of large artefacts and stones were again drawn. With a view to the investigation of micro-debitage, the sediment was collected and sieved of

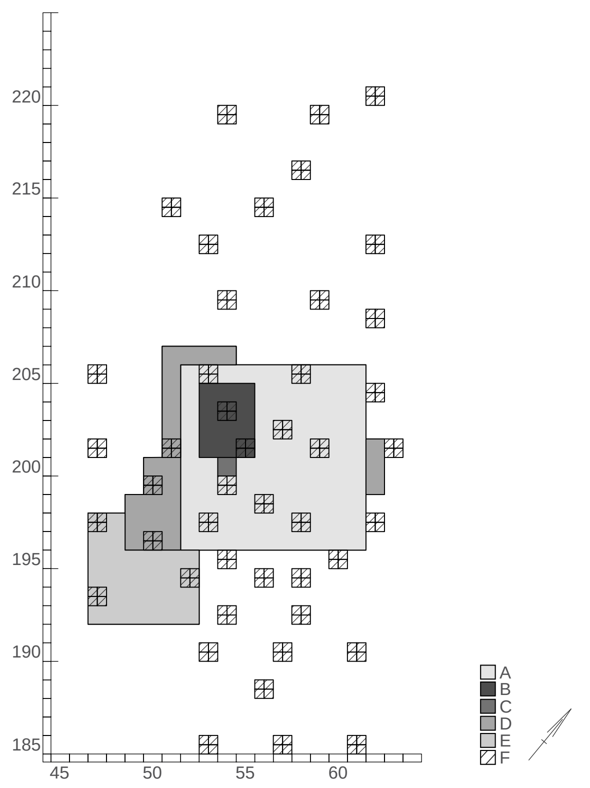


Figure 3.4 Position of area excavated in the summer of 1990 (A to D) and in the spring of 1991 (E) and of the trial squares in April 1990 (F). The letters B and C correspond with the area of clusters A and B, of which the sediment from underneath the plough zone was sieved. Grid co-ordinates are at metre intervals.

Figure 3.5 Manual, two-dimensional recording of artefacts with two measuring-staffs and a plumb line.

Figure 3.6 Sieving of sediment with a 4 mm sieve and water tank.

eleven squares in the most find-rich part of the excavation (fig. 3.4, B and C). A sieve with a 4 mm mesh was used for this. Through sieving an approximation was obtained of the number of finds that was missed in the trowelling of the sediment. In order to sieve the sediment, a slurry tank was used in the first weeks of the excavation, from which water was pumped up and piped to the sieve (fig. 3.6). Due to the hot and dry weather, especially in the second half of July and in August, the excavated sediment of many squares could be sieved dry. The aim of sieving was to gain insight into the occurrence of very small flint chips and to collect backed bladelets, burin spalls, broken-off tips of worked edges, etc.

After the area of 10 × 10 m was excavated, new squares were marked out along its edges and excavated (fig. 3.4, D). The plough zone of these extra squares was not trowelled but the sediment was sieved on a mesh of 1 cm. The sediment underneath the plough zone was examined with a trowel to maximally 30 cm underneath this zone. In this way the number of excavated squares increased considerably. A total of 159 squares of 1 m^2 was excavated.

For a proper assessment of the depth position and the pedological context of the finds and to determine the character and role of post-depositional processes of the find distributions, three contiguous soil profiles were drawn on a scale of 1:20. The position of these profiles is as follows (fig. 3.7):

Profile 1(S1): southwest-northeast profile from measuring point 52/204 to measuring point 62/204 in the northern part of the excavated area (length 10 m);

Profile 2 (S2): southwest-northeast profile from measuring point 52/198 to measuring point 62/198 in the southern part of the excavated area (length 10 m);

Profile 3 (S3): southeast-northwest profile from measuring point 56/196 to measuring point 56/206 in the central part of the excavated area (length 10 m).

In places where pit backfills were visible in the plane and/or profile, two additional profiles were drawn:

Profile 5 (S5): southwest-northeast profile from measuring point 57/203 to measuring point 59/203 (length 2 m);

Profile 6 (S6): southeast-northwest profile from measuring point 55/203 to measuring point 55/204 (length 1 m).

Furthermore, planimetric drawings were made of several squares, scale 1:10. In these squares disturbances of the plane were visible which formed the reason for the making of drawings. It concerns squares west of the area with a high find density (squares 51/201, 51/202, 51/203, 52/203, 52/204, 53/202, 53/203), a few contiguous squares in the eastern part of the excavated area (squares 57/203, 58/201, 58/202, 58/203, 59/201, and 59/202), three adjacent squares south of the area with the high find density (squares 53/199, 54/197,

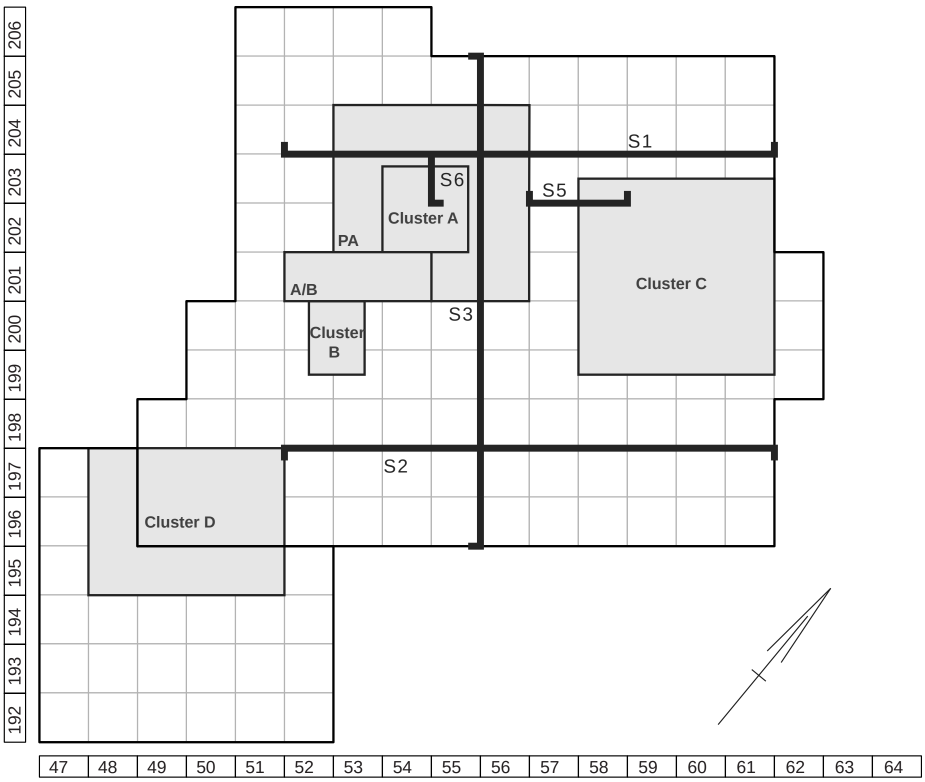


Figure 3.7 Position of drawn and described profiles (S1 to S3, S5 and S6) and of distinguished clusters (A to D), periphery of cluster A (PA) and zone A/B. Grid co-ordinates are at metre intervals.

and 54/198), and square 50/198. A part of these squares is contiguous with the above-mentioned profiles, thus enabling a good comparison of the drawings of profiles and plane. For these squares a good insight was obtained into the character and size of the disturbances. Square 57/202 was already excavated in April 1990 but was again excavated in the summer of 1990 to the level reached in April, after which a planimetric drawing was made. This square was later deepened, also with a view to the presence of a pit backfill in the north face of this plane (= profile 5).

3.5 Research of April 1991

In April 1991 the fieldwork was continued for another two weeks in the southern part of the site. The reason for this continuation was the discovery of a relatively high density of finds in square 49/196 at the end of the excavation campaign in 1990. In April 1991, 25 squares of 1 × 1 m were examined, in the same area where trial pits 47/193, 47/197 and 52/194 were excavated in April 1990 (fig. 3.4, E). The most westerly of these pits were lying on a level with the boundary of the plot which separated the field of the excavation from the field (with maize) to the west of it. Of all 25 squares the plough zone and the underlying sediment were planed down with a trowel to 30 cm underneath the plough zone. During the field investigation in 1991 no additional profiles or planes were drawn.

3.6 Processing of finds

An important part of the find processing was carried out simultaneously with the fieldwork in a hut at the excavation. Daily activities were the washing, numbering and description of the finds. A code list was used for the description of the finds. After the excavation, the field and find data were entered in a computer at the Institute of Prehistory in Leiden.

Refitting of flint artefacts took place between October 1990 and April 1992 in the then auxiliary building of the Institute of Prehistory in Maastricht. The refitting was mainly carried out by A. Verpoorte (Leiden), in addition to whom A. Smit (Harderwijk) and P. Hennekens (Maastricht) spent quite some time on this activity. During the processing, the finds were weighed, raw materials units were distinguished, and typological and technological characteristics of the flint artefacts were described. From September 2004 onward the author continued the processing of the find material of Eyserheide. Over a period of four years, the find lists were checked and where necessary corrected and expanded. Besides, all artefacts were weighed individually and compositions of fitting artefacts were described accurately.

An important contribution to the Eyserheide research was supplied by K. Sano, at that time attached to the University of Cologne. Sano examined a selection of tools, blades and flakes made of Orsbach flint on the presence of microwear traces. His findings have been included as chapter 5 in this monograph.

4 The finds

4.1 Introduction

The focus of this chapter is the flint assemblage of the Magdalenian site of Eyserheide, and properties of the used raw materials and typological and technological characteristics of the worked flint are extensively described. Apart from artefacts of flint, unworked and partially heated stones form part of the finds. These stones are also described in this chapter.

4.2 Raw materials

4.2.1 Introduction

Eyserheide is located in the Belgian-Dutch-German Chalk area that is roughly bounded in the west by the towns of Liège, Maastricht, and Tongeren, and in the east by Heerlen and Aachen. East of Liège, the Land of Herve (in French: *Pays de Herve*) forms the southern boundary, while the area extends in a westerly direction to close to Namen (see Felder and Felder 1998, fig. 86). In particular through the activities of local archaeologists are numerous prehistoric sites known in the area, among which more than 30 exploitation places of flint (Felder 1998). These locations mainly lie in the Dutch part of the Chalk area and date to the Neolithic. The famous flint mines of Rijckholt-St.Geertruid lie 14 km as the crow flies southwest of Eyserheide (Rademakers 1998). Locations of flint extraction are known from the small river Geul downstream and 7 km further northwest in and around Valkenburg aan de Geul. Here Valkenburg flint was exploited in the Middle Neolithic (Brounen et al. 1993).

The location of Eyserheide in the distribution area of chalk from the Upper Cretaceous (Gulpen Formation and Maastricht Formation) and the variety of types of flint occurring in this chalk are reflected in the characteristics of the worked flint. For the manufacture of stone tools, the flint knappers of the Magdalenian used four types of flint. As regards the processing and analysis of the stone artefacts, this variation offers many benefits. Thus metric and technological features of artefacts can be described per type of flint and they can be compared with each other. It also offers the possibility of determining differences and similarities in the method of working in relation to properties of the flint. Moreover, an investigation can be carried out into the relationship between flint types on the one hand and tool types on the other. Such a relationship can point to selection of a certain type of flint for the fabrication of a certain type of tool, such as burins of Orsbach flint (see 4.5.5).

4.2.2 Description of the types of flint

The determination of the flint used in Eyserheide was done with the naked eye and in some cases with a small magnifying glass. The following characteristics were looked at: colour of flint and cortex, properties of cortex (coarse, eluvial, fluvially rolled), grain size (fine- or coarsely grained), presence and colour of patina, and size, form and colour of inclusions. The occurrence of patina on artefacts in most cases did not hamper the recognition of the type of flint. An important characteristic of one of the used types (Simpelveld flint), namely a thin layering or lamination is even enhanced by patina. Patina has thus proved to be an aid in the determination of this type of flint. In the sizeable group described as South-Limburg flint, the large diversity in the colour of the patina is striking, both of the cortex and on the worked surfaces. This also enabled us to further divide this group into a large number of Raw Material Units (RMUs, see 4.6).

With a view to the determination of the flint, a small expert meeting took place on 19th June 2009 between the author and Mrs M. de Grooth and Mr F. Brounen. During this meeting an examination was made of some 30 artefacts of which the type of flint could not be determined properly. For the purpose of determination, use was made of an extensive reference collection of flint types from the Chalk area in Dutch Limburg. This collection was put together and is managed by Mrs De Grooth (De Grooth 1994).

The finds of the site of Eyserheide comprises 3416 artefacts from the Magdalenian (table 4.1). On the basis of external features observable with the naked eye, four types of flint can be distinguished:

The first type of flint is known by the name of Simpelveld flint (Arora and Franzen 1987). The lithostratigraphical origin is not fully known. According to Felder (1998, 190), the flint originates from the eastern facies of the Lanaye Chalk in the upper part of the Gulpen Formation. The flint is somewhat coarse grained, light to dark grey in colour, tabular

	South-Limburg flint							
	Simpelveld flint	Valkenburg flint	Eluvial	Terrace	Indet	Orsbach flint	Flint indet	N
Complete cores	3	1	.	10	.	2	.	16
Core fragments	5	2	5	7	.	81	.	100
Complete flakes	98	5	15	127	28	141	1	415
Flake fragments	91	8	46	174	62	183	4	568
Complete blades	15	1	3	12	7	29	.	67
Proximal fragments of blades	39	4	5	36	32	54	.	170
Medial fragments of blades	27	4	15	58	38	65	.	207
Distal fragments of blades	36	3	4	33	24	64	.	164
Blades with non-patinated breaks	29	2	8	30	14	43	1	127
Crested blades	3	.	.	2	.	1	.	6
Crested blade fragments	18	1	5	16	5	26	.	71
Rejuvenation flakes	7	1	3	11	2	10	.	34
Retouched tools	9	4	14	19	8	41	.	95
Blades and flakes with edge damage	7	1	4	8	3	13		36
Burin spalls	2	.	.	1	6	13	.	22
Indet	1	.	.	.	3	.	.	4
Chips	127	3	4	70	626	447	37	1314
Total	517	40	131	614	858	1213	43	3416

Table 4.1 Eyserheide. Number of Magdalenian artefacts per flint type and artefact type (all dimensions). Counts before refitting of broken pieces.

and not translucent (fig. 4.1). Small light flecks are common. An important characteristic of the flint is the laminated structure. This layering or lamination runs parallel to the narrow sides of the flint slabs in the form of alternating light and dark bands, varying in thickness from 1 to 5 mm. Especially when the surface of the flint is patinated, the layering is clearly visible macroscopically. The cortex on the flint is neither coarse (*Bergfrisch*) nor smooth (fluvially rolled). These characteristics indicate an origin from flint eluvia, that is places where flint slabs outcrop due to mechanical weathering and dissolving of the top of the chalk. Slope deposits also qualify as raw material source. On the narrow sides of the flint slabs, natural, blunt break surfaces can be present in places where the cortex is absent. The tabular and homogeneous structure makes this flint eminently suitable for the manufacture of blades, whereby the narrow side served as core face.

A small group of artefacts has been described as Valkenburg flint. The flint originates from the Upper Cretaceous Maastricht Formation, of which the Schiepersberg Chalk and (in particular) the Emael Chalk contain regular formed pieces of Valkenburg flint (Felder 1980). This flint is grey-beige in colour and coarser grained than Simpelveld flint (fig. 4.2). As does the latter flint, Valkenburg flint occurs in the form of slabs and the cortex is neither coarse (*Bergfrisch*) nor fluvially rolled. As place of origin, zones qualify with flint eluvium at the top of the weathered chalk, as well as slope deposits. Usually the artefacts are off-white and have a matt patina. There are also artefacts with brown-grey dots in the patina which can merge into continuous thin bands or lamination. An attribution of these artefacts to the group of Valkenburg flint is less certain. We could also be dealing here with a variation of Simpelveld flint in which the layering, as visible in the patina, is less pronounced than in artefacts that have been described as Simpelveld flint. The fact that there is an overlap in the characteristics of both types of flint is underlined by compositions of refitted artefacts of ‘unequivocal’ Simpelveld flint. Artefacts can be present in these that show more dark-coloured flecks and dots than a characteristic lamination.

The third type is designated as Orsbach flint by Dutch archaeologists. The flint originates from the Lixhe Chalk of the Gulpen Formation, of which only the upper layers (Chalk of Lixhe 3) contain more or less regular nodules

Figure 4.1 Simpelveld flint. From left to right: three compositions of refitted blades (refit groups S302, S308, and S301), borer and burin on a break. The borer has a length of 10 cm.

Figure 4.2 Valkenburg flint. Bottom right the only core (259A 165, refit group V1.00) of this type of flint in the inventory of Eyserheide. The core has a length of 15.1 cm.

(Felder and Felder 1998, 112). The colour of the flint varies from dark grey to black grey (fig. 4.3). It is a moderately fine-grained, rather matt flint that is faintly translucent in the edge zone of some artefacts. Grey to white inclusions in the form of amorphous to wispy flecks are common.
The cortex is white to beige in colour and usually feels coarse and irregular by the presence of protuberances and hollows. A smooth, rolled cortex or other traces of fluvial weathering pointing to transport in a river bed are completely lacking. Only on a small number of artefacts are black, old natural fissures visible. The worked surfaces are characterised by a matt-finished, lead-grey patina with a hint of light, blue-white marbling. But also artefacts appear to be not or hardly patinated and with a 'fresh' appearance.

Flint nodules from the Lixhe Chalk are in the main small and irregular in shape and unsuitable for systematic working (Felder and Felder 1998). In Eyserheide, more regular and relatively large nodules seem to have been used mainly, with good properties for working. This can be inferred from the occurrence of (fragments of) long and regular blades of Orsbach flint. Besides, the majority of burins is made of this type of flint, which emphasizes its significance for the production of tools.

The group of flint of which most Magdalenian artefacts were found, has been described with the common domination of South-Limburg flint. This group comprises several varieties of flint but share one common characteristic: they cannot be attributed to one of the other above-mentioned types. Three varieties can be distinguished within this group of South-Limburg flint:

1. Meuse terrace flint. Group of artefacts with smooth, rolled and heavily weathered cortex (fig. 4.4). These characteristics are the result of transport by water in a river bed and point to an origin of the flint in gravel-rich, Pleistocene deposits of the Meuse. The shape of the flint nodules is ovate to oblong. Within this group there is a large diversity in colours, varying from grey-black to more brownish, black-blue and yellow-green hues. The flint is quite homogeneous in grain size, from fine grained to moderately fine grained, but not translucent or glassy. However, in the edge zones of blades and flakes the flint can be translucent. Small inclusions commonly occur, in a small number of cases the inclusions are chalky. The colour of the patina is usually off-white to pale blue. On the basis of the smooth, fluvially rolled cortex this flint is referred to as Meuse terrace flint.
2. South-Limburg eluvial flint. Group of artefacts with in most cases a regular, 'eluvial cortex'. The flint is blue-grey in colour and has dark and lighter inclusions in the shape of flecks and dots. As there are no indications for fluvial transport, an origin of the flint from a river terrace is not likely. Probably the flint has been collected from residual and/or slope deposits. Regarding the properties of the flint, the majority of the artefacts shows a similarity with those known from Middle Neolithic sites in the surroundings of Rijckholt and Sint Geertruid. In literature the name often used for this flint is flint of the type Rijckholt, 'Rijckholt flint', or 'Rijckholt-Sint Geertruid flint'. However, the distribution of this flint covers a much larger area than Rijckholt and Sint Geertruid and its immediate vicinity. In fact, the flint can be collected in all locations where Lanaye Chalk and Lixhe Chalk (Gulpen Formation) are outcropping. This is the reason why it has been suggested to refer to this flint with the name of Lanaye-Lixhe flint (Felder 1998, 159).
3. Remaining group of artefacts within the group of South-Limburg flint of which the type and origin cannot be further specified. We are dealing as a rule with white to blue-grey patinated artefacts without cortex parts. Because of this an attribution to one of the two above-mentioned varieties is not possible. In any case the artefacts cannot be counted as one of the groups of Orsbach flint, Simpelveld flint or Valkenburg flint.

On the basis of the above division, an overview has been made of the number of artefacts that have been attributed to the four distinguished raw materials groups (table 4.1). This table shows that South-Limburg flint with 1603 specimens is best represented, and that within this group terrace flint occurs significantly more often than eluvial flint, insofar as recognisable on the basis of cortex. The number of artefacts described as Orsbach flint and Simpelveld flint is respectively 1213 and 517. Significantly fewer artefacts of Valkenburg flint were retrieved (n=40). Table 4.2 gives an overview of the charactertistics of the cortex on artefacts (>2 cm) in the raw material groups. This table shows that regular, eluvial cortex forms by far the main part in the groups of Simpelveld flint, Valkenburg flint and South-Limburg eluvial flint. Within the group of terrace flint, a smooth, rolled by fluvial transport cortex dominates, but 'eluvial cortex' also occurs especially in deeper parts of hollows that did not suffer or less so from the transport of the flint nodule over the river bed. An irregular, eluvial cortex characterises the majority of artefacts of Orsbach flint. But also artefacts have a regular cortex, comparable to that of Simpelveld flint and Valkenburg flint.

4.2.3 Provenance of the flint

From the distribution of geological formations in southeast Limburg (Kuyl 1980) and field surveys in 1989 and 1990 by Mr A. Blezer transpires that the four types of flint can be collected within a radius of 5 km from the site of Eyserheide. It is not possible to indicate with certainty the exact locations

Figure 4.3 Orsbach flint. From left to right: two dihedral burins, blade core with refitted blade fragment (refit group O6.00), blade end scraper and borer with corresponding blade core (refit group O2.00). The borer has a length of 11.3 cm.

Figure 4.4 Meuse terrace flint. Flint with heavily rolled, brown cortex, which is the result of fluvial transport. The core and the composition left of it of refitted blades represent refit group M3.00.

Type of flint	Eluvial cortex						
	Regular	Irregular	Smooth	Fluvially rolled	Natural fissure	Indet	N
Simpelveld flint	183	34	.	.	2	2	221
Valkenburg flint	30	2	.	.	1	.	33
South-Limburg flint, eluvial	69	9	.	.	.	.	78
South-Limburg flint, terrace	3	9	18	327	4	.	361
Orsbach flint	167	249	63	.	.	5	484
Total	452	303	81	327	7	7	1177

Table 4.2 Characteristics of cortex on artefacts larger than 2 cm per flint type.

of origin. Thus, we should take into account that Magdalenian hunters and gatherers exploited sources that nowadays are no longer visible as such in the landscape or are accessible. As a result of a covering layer of loess, colluvium or present-day land use, for instance the presence of a vegetation cover or buildings, they can be largely or completely hidden from view. At the foot of the slopes of stream and dry valleys, Late Upper Palaeolithic flint exploitation sites could be hidden under a thick layer of colluvium from the Holocene.

Potential extraction places of Orsbach flint (Lixhe Chalk, Gu3 on Subsidiary Map 1 (Pre-Quatenary) in Kuyl 1980) and South-Limburg flint with eluvial cortex (Lanaye Chalk, Lixhe Chalk, Gu3) can be found in the deeper parts of the valleys of the Eyserbeek and Selzerbeek south and southeast of the site. The distribution area of Orsbach flint continues into the adjacent German part of the valley of the Selzerbeek. Here the small town of Orsbach is located on a plateau above the valley of the Selzerbeek and at 1 km from the Dutch-German border. Further west both types of flint can be found in the slopes of the Dutch Geul valley. One of the locations where Orsbach flint occurs naturally lies directly east of Wijlre.

The natural distribution area of Simpelveld flint (Kunrade facies, MT1 and Lanaye Chalk, Gu3) lies in the southeastern part of Dutch Limburg, south of Heerlen (Arora and Franzen 1987). Eyserheide forms part of this distribution area. Southeast of the site, Neolithic exploitation sites of Simpelveld flint are known between Simpelveld and Over-Eys, from places where the Eyserbeek cuts through the eastern facies of the Lanaye Chalk (Felder 1998, 190-191). Exactly where the flint was extracted in the Neolithic is not known. Presumably the distances from the extraction to the exploitation places were at most a few hundred metres. The occurrence of Simpelveld flint is further known from the northern margin of the Eiland van Ubachsberg near Winthagen.

Natural sources of Valkenburg flint (Kunrade facies, MT1) can be found in the wider surroundings of Eyserheide, among which the Ransdalerveld c. 3 km northwest of the site. In this location large pieces of Valkenburg flint can be collected in slope deposits.

Finally, fluvially rolled terrace flint occurs east of the road Trintelen-Ubachsberg at a distance of less than 2 km from the site. There are lying on the surface peneplain deposits of the ancient river Meuse from the Tertiary (Waubach deposits, Koö) and terrace deposits of the Meuse from the Pleistocene (Simpelveld deposits and Kosberg deposits, Ma). The Waubach deposits and Kosberg deposits are here considered part of the Kiezeloöliet Formation (Kuyl 1980, 73-78). This formation contains flint nodules that originally were part of the Maastricht Formation and the Gulpen Formation, and which the Meuse has incorporated into her river bed. With regard to the dimensions and degree of rounding, they are comparable to the nodules that the flint knappers worked in the Magdalenian in Eyserheide.

4.2.4 Division of types into RMUs

On the basis of characteristics of the flint visible to the naked eye (4.2.2) and results of refitting (4.3), the four types of flint have been further divided into smaller Raw Material Units or RMUs. Making such a division is for various reasons sensible as part of the analysis of sites from the Palaeolithic and Mesolithic. Thus can be examined how many flint nodules or slabs were (minimally) worked at the site and of which types of artefacts (core, flake, blade, tool) an RMU consists. On the basis of this composition and refitting can be determined which stages of modification a RMU has been subjected to within the excavated area. RMUs of which only one or a small number of artefacts have been recovered, form an indication of transport to the site, of for instance prepared cores or a set of blades. In addition, the spatial distribution of the artefacts recorded three-dimensionally and belonging to one and the same RMU provides an insight into locations where RMUs have been worked and where products of this working were used, maintained and/or discarded (see 6.6). And finally, the attribution of artefacts to RMUs forms a good point of departure for the conjoining or refitting of artefacts (see 4.3).

The allocation of artefacts to RMUs has taken place in particular of artefacts larger than 2 cm. For small artefacts, and especially for specimens without cortex, such an allocation was often not possible. A total of 39 RMUs were distinguished which comprise a total of 857 artefacts (table 4.3). Over half of these (n=463) could be refitted and form part of refit groups (see 4.3). The group of South-Limburg flint consists of 20 RMUs. This means that artefacts originating from minimally 20 flint nodules are present in this group. This large number of distinguished RMUs is chiefly due to the heterogeneous character of the group of terrace flint. Thus there are clear differences in character and colour of the cortex, colour of the flint and patina, inclusions (flecks, fossils), and grain size. Of the 20 RMUs, the majority belongs to the subgroup of terrace flint. Within the group of South-Limburg flint, the number of refitted and assigned artefacts varies per RMU from two (M23) to 91 (M15). Cores and core fragments form part of 13 of the 20 RMUs.

The three other flint types are significantly more homogeneous with regard to external characteristics, such as cortex, colour, and inclusions. For this reason, the attributions to RMUs in the groups of Simpelveld flint, Valkenburg flint and Orsbach flint were established almost exclusively on the basis of refitting. Only non-refitted artefacts (n=8) have been assigned to RMU S5. In the group of Orsbach flint 14 RMUs were distinguished (O1 to O10, O12 to O14, and O16), and in the group of Simpelveld flint four RMUs (S1 to S3, and S5). They consist respectively of 61 and 126 artefacts. Due to the small number of artefacts, among which one core, the group of Valkenburg flint only comprises one RMU. Later in this chapter (4.6), the RMUs will be described in detail regarding their artefact composition and technological characteristics.

4.3 Refitting

Since the first applications in the 1960s and 1970s, for instance in the Magdalenian site of Pincevent in France and the Late Palaeolithic site of Meer in Belgium (Cahen et al. 1980), refitting of stone artefacts forms a regular and indispensable component of the processing of Late Upper and Late Palaeolithic sites. Satisfying results have been obtained for locations where distributions of archaeological find material reflect a single and, preferably, short-lived phase of use or occupation (high resolution and high integrity). But refitting can also contribute to the 'unravelling' of sites with large densities of stone artefacts and other categories of archaeological material, so-called palimpsests. With the help of refitting, a better insight can be gained into depositional and post-depositional processes that underlie the formation of concentrations at locations with a relatively complex and long history of occupation. Nonetheless, its application to Palaeolithic sites in the Netherlands has remained limited (for some important examples, see Roebroeks 1988; Johansen and Stapert 2004; De Loecker 2006). In the case of the site of Eyserheide, much time has been spent on refitting of stone artefacts, the more so because the occurrence of different groups of raw materials and varieties of flint was greatly conducive to the results. Refitting was carried out after the end of the excavations in 1990 and 1991 in the former auxiliary building of the Faculty of Archaeology of Leiden University in Maastricht. In the refitting, all artefacts larger than 2 cm (n=1925) were included. Of these, 667 artefacts (35%) could be refitted.

For a further distinction into types of refits we used Cziesla's (1986, 1990) division into *Aufeinanderpassungen*, *Aneinanderpassungen*, *Anpassungen*, and *Einpassungen* (see De Loecker 2006, 33):

1. *Aufeinanderpassungen* (refitting of production sequences) refers to the refitting of all products of 'basic' or 'primary' production/reduction. It concerns only ventral/dorsal conjoining, e.g. flake series in a reduction sequence.
2. *Aneinanderpassungen* (refitting of breaks, intentional or not) indicates the reconstruction of 'basic products' like flakes, blanks and tools. It mainly concerns the refitting of broken flake or blade fragments.
3. *Anpassungen* (refitting of modifications) concerns the refitting of all products resulting from the modification of a blank into a tool or the resharpening of a tool.

As Cziesla (1986, 1990) already mentioned, all flint artefacts originate in a 'basic' or 'primary' production and/or 'secondary' modifications (*Anpassungen*). Besides these three types of refits, a fourth class was introduced (Cziesla 1986), namely *Einpassungen* (inserts). This group concerns the refitting of objects produced by natural processes (frost- and heat-damage).

The above division into types of refits produces the following picture of the site of Eyserheide (table 4.4). Within the total number of refitted artefacts *Aufeinanderpassungen* occur most often (n=439), followed by *Aneinpassungen* (n=249) and *Einpassungen* (n=57). Noticeable is that *Anpassungen* that are connected with secondary modifications are completely absent. Regarding the tools, we are exclusively dealing with refitting broken pieces. They were broken unintentionally into two or more pieces as a result of resharpening or use.

RMUs	Refitted artefacts						
	Cores and core fragments	Flakes	Rejuvenation flakes	Blades	Crested blades	Retouched tools	Total
S1	2	19	.	16	4	.	41
S2	1	11	.	12	.	.	24
S3	1	9	1	6	1	1	19
S5	.	32	.	2	.	.	34
V1	1	3	.	.	.	.	4
M1	1	7	1	1	.	1	11
M2	.	1	.	3	1	.	5
M3	1	12	.	6	3	.	22
M4	1	1	.	3	.	.	5
M5	1	14	.	4	.	1	20
M6	1	9	.	11	.	2	23
M7	.	6	1	11	.	.	18
M8	1	12	.	5	3	.	21
M9	3	20	.	6	2	2	33
M10	1	3	.	4	.	4	12
M11	.	10	.	3	.	.	13
M12	1	3	.	3	.	.	7
M13	1	8	.	8	.	1	18
M14	.	.	.	.	.	.	0
M15	2	17	1	9	.	.	29
M17	1	5	.	2	.	1	9
M18	.	3	.	.	.	.	3
M19	2	14	1	4	3	2	26
M21	.	.	.	.	.	3	3
M23	.	.	.	1	.	1	2
O1	8	1	.	.	.	.	9
O2	3	1	.	.	.	1	5
O3	5	2	.	.	.	.	7
O4	4	.	1	3	1	.	9
O5	5	.	.	.	.	.	5
O6	1	.	.	1	.	.	2
O7	4	.	.	.	.	.	4
O8	1	1	.	1	.	.	3
O9	2	1	.	.	.	.	3
O10	2	.	.	.	.	.	2
O12	3	.	.	.	.	.	3
O13	3	.	.	.	.	.	3
O14	3	.	.	.	.	.	3
O16	2	1	.	.	.	.	3
Total	68	226	6	125	18	20	463

Table 4.3 Composition of RMUs per artefact type for refitted artefacts (left) and assigned artefacts (right) (all dimensions). Counts before refitting of broken pieces.

Assigned artefacts						
Cores and core fragments	Flakes	Rejuvenation flakes	Blades	Crested blades	Retouched tools	Total
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	8	.	.	.	.	8
.	.	.	.	.	.	0
.	14	.	1	.	.	15
.	1	.	.	.	.	1
.	6	2	8	.	1	17
.	8	.	4	.	.	12
.	24	2	9	.	2	37
.	.	.	.	.	.	0
.	5	.	4	.	.	9
2	11	1	6	.	.	20
.	5	.	.	.	.	5
.	16	.	4	1	.	21
.	29	2	14	.	1	46
.	3	.	5	1	.	9
.	17	1	5	.	2	25
.	3	.	3	.	.	6
.	40	.	18	4	.	62
.	12	1	2	.	.	15
.	21	1	7	.	.	29
2	27	.	20	.	8	57
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
.	.	.	.	.	.	0
4	250	10	110	6	14	394

		Production sequences	Breaks	Modifications	Inserts	N
Simpelveld flint	RMU's	102	30	.	2	118
	Other artefacts	45	36	.	.	75
Valkenburg flint	RMU's	4	.	.	.	4
	Other artefacts	7	4	.	.	11
South-Limburg flint	RMU's	205	107	.	5	280
	Other artefacts	2	4	.	.	6
Orsbach flint	RMU's	18	8	.	44	61
	Other artefacts	56	60	.	6	112
Total		439	249	0	57	667

Table 4.4 Number of types of refits in RMUs and in compositions not assigned to RMUs per flint type and total number of refitted artefacts (all dimensions). Counts before refitting of broken pieces.

Aufeinanderpassungen and *Aneinpassungen* occur most in the group of South-Limburg flint. This result cannot be seen disconnected from the heterogeneous character of the flint and the large number of RMUs in this group. This considerably increased the chance of finding 'refits' than in the other types of raw material. In the other raw material groups it was not possible, prior to the refitting, to divide artefacts into RMUs. Nonetheless, refitting of artefacts of in particular Simpelveld flint has yielded good results. Of this type of flint 193 artefacts could be refitted, of which 147 were *Aufeinanderpasungen*. The tabular structure of the flint and the systematic way in which the cores were reduced probably contributed to the successful refitting of artefacts of Simpelveld flint.

The largest compositions of refitted artefacts (refit groups) are constructed around cores of Simpelveld flint and terrace flint. They comprise 41 (refit group S1.00), 24 (S2.00), 19 (S3.00), 22 (M3.00), 23 (M6.00), and 33 (M9.00) artefacts (table 4.5a). Information on the method with which flint in Eyserheide was worked is based to a large extent on these compositions. In the group of Orsbach flint, the number of refitted artefacts in compositions with cores is significantly smaller, namely nine maximally (refit groups O1.00 and O4.00). The other compositions in this group vary from two to seven refitted artefacts, among which many conjoining fragments of cores. As a result of these small numbers, data is limited on the method of reduction of cores of Orsbach flint on the basis of refitting. Compared to Simpelveld flint and South-Limburg flint, compositions of refitted artefacts without a core are well represented though in the group of Orsbach flint (table 4.5b). For carrying out technological analyses, they are however of limited value.

4.4 Description of the finds

4.4.1 Introduction

The finds associated with the occupation of Magdalenian hunters and gatherers of the camp site of Eyserheide comprises 3416 flint artefacts and 123 fragments of unworked stone. In addition, a few dozen Mesolithic and Neolithic artefacts were collected. These finds will not be considered in this chapter. It is unlikely that small and dispersed fragments of charcoal recorded three-dimensionally underneath the plough zone are linked to occupation in the Magdalenian. Probably the charcoal ended up in the soil in the course of the Holocene as a result of bioturbation. Charcoal in a proper archaeological context, for instance in a hearth constructed with stones, was not found.

In the total collection of Magdalenian artefacts, chips, that is flakes with maximum dimensions less than 2 cm, are represented best with 1314 pieces (= 38%) (table 4.1). Less numerous but still in considerable numbers occur fragments of flakes with 568 pieces (17%) and complete flakes with 415 pieces (12%). Addition tells us that well over two-thirds of the flint assemblage consist of waste products of the flint knapping. Blades chiefly occur in the form of proximal, medial and distal fragments, 127 pieces of which have a non-patinated break ('fracture plane'). Together with 67 complete blades, there are a total of 735 pieces (22%) present. The number of crested blades is significantly smaller, namely 71 broken pieces and 6 complete pieces. The remaining types of artefacts, among which complete cores (n=16), fragments of cores (n=100), retouched tools (n=95), blades and flakes with macroscopically visible edge damage ('use retouch', n=36) and burin spalls (n=22), together amount to no more than 10% of the flint inventory.

Simpelveld flint

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
S01.00	34	12	2	41	902.8
S02.00	18	12	.	24	1014.6
S03.00	18	2	.	19	583.9
S05.01	14	.	.	14	171.1
S05.02	13	4	.	15	156.2
S05.03	2	.	.	2	17.1
S05.04	3	.	.	3	16
Total	102	30	2	118	2861.7

Valkenburg flint

Refitgroep	Production sequences	Breaks	Inserts	Artefacts N	Weight
V01.00	4	.	.	4	902.2

South-Limburg flint

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
M01.00	8	.	.	8	314.3
M01.01	2	2	.	3	9.2
M02.01	2	4	.	5	80.5
M03.00	9	11	.	15	282.9
M03.01	.	.	.	4	25.4
M03.02	3	.	.	3	13.2
M04.00	5	.	.	5	395.1
M05.00	4	2	.	5	255.8
M05.01	3	3	.	5	44.6
M05.02	2	.	.	2	11.8
M05.03	2	.	.	2	10.7
M05.04	.	2	.	2	13
M05.05	4	.	.	4	37.5
M06.00	15	13	.	23	1017.2
M07.01	5	4	.	7	94.7
M07.02	2	4	.	4	47.7
M07.03	2	2	.	3	67.7
M07.04	2	.	.	2	33.4
M07.05	2	.	.	2	65.2
M08.00	3	2	.	4	803.6
M08.01	6	.	.	6	36.2
M08.02	2	2	.	3	48.3
M08.03	6	.	.	6	60
M08.04	.	2	.	2	19.6
M09.00	25	8	3	31	571.1
M09.01	2	.	.	2	17.9
M10.00	6	.	.	6	100.6

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
M10.01	2	.	.	2	43.3
M10.02	2	.	.	2	18.4
M10.03	.	2	.	2	13.4
M11.01	7	4	.	9	113.8
M11.02	3	2	.	4	216.8
M12.00	4	.	.	4	262.7
M12.01	2	2	.	3	10.5
M13.00	10	2	.	11	370.5
M13.01	3	.	.	3	23.7
M13.02	2	.	.	2	44
M13.03	.	2	.	2	3.5
M15.00	11	.	.	11	692.1
M15.01	3	2	.	4	65.5
M15.02	2	.	.	2	247
M15.03	2	2	.	3	126.2
M15.04	2	2	.	3	33.6
M15.05	.	2	.	2	6.5
M15.06	.	2	.	2	2.6
M15.07	.	2	.	2	33.4
M17.00	5	.	.	5	100.6
M17.01	2	.	.	2	7.3
M17.02	.	2	.	2	3.1
M18.01	3	.	.	3	27.8
M19.00	.	.	2	2	184
M19.01	5	5	.	8	119
M19.02	3	.	.	3	169.6
M19.03	2	.	.	2	14.6
M19.04	2	.	.	2	35.5
M19.05	.	2	.	2	79.1
M19.06	.	3	.	3	32.8
M19.07	.	2	.	2	20.8
M19.08	.	2	.	2	17.6
M21.01	2	2	.	3	21.9
M23.01	.	2	.	2	1.5
Total	201	107	5	280	7639.9

Orsbach flint

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
O01.00	2	.	8	9	420.8
O02.00	3	.	3	5	132.7
O03.00	2	2	5	7	194.1
O04.00	4	6	3	9	193
O05.00	.	.	5	5	176.8

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
O06.00	2	.	.	2	266
O07.00	.	.	4	4	92.8
O08.00	3	.	.	3	102.2
O09.00	.	.	3	3	14.3
O10.00	.	.	2	2	55
O12.00	.	.	3	3	45.9
O13.00	.	.	3	3	33.9
O14.00	.	.	3	3	60.7
O16.00	2	.	2	3	60.4
Total	18	8	44	61	1848.6

Table 4.5a

Simpelveld flint

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
301	5	2	.	6	74.4
302	3	2	.	4	52.6
303	2	.	.	2	7.8
304	2	.	.	2	7.7
305	4	.	.	4	30.9
306	3	.	.	3	10.4
307	3	2	.	4	36.2
308	10	10	.	17	200.6
309	9	.	.	9	133.4
310	.	2	.	2	17.9
311	.	2	.	2	20.6
312	.	2	.	2	9.9
313	.	2	.	2	19.4
314	.	2	.	2	15
315	.	2	.	2	7.6
316	.	2	.	2	8.1
317	.	2	.	2	7.5
318	2	.	.	2	6.9
319	2	.	.	2	9.8
320	.	2	.	2	82.9
321	.	2	.	2	8.9
Total	45	36	0	75	768.5

Valkenburg flint

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
401	3	.	.	3	64
402	2	.	.	2	12
403	.	2	.	2	12.8

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
404		2	.	2	9.1
405	2	.	.	2	17.3
Total	7	4	0	11	115.2

South-Limburg flint

Refitgroup	Production sequences	Breaks	Inserts	N	Weight
501	.	2	.	2	33.4
502	2	.	.	2	5.7
503	.	2	.	2	11.2
Total	2	4	0	6	50.3

Orsbach flint

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
601	8	.	.	8	113.1
602	2	.	.	2	29.1
603	3	6	.	7	87.1
604	3	.	.	3	41.4
605	3	.	.	3	21.4
606	3	.	.	3	36.2
607	3	.	.	3	22.5
608	2	.	.	2	7.4
609	2	.	.	2	12.3
610	3	.	.	3	4.4
611	2	.	.	2	17
612	2	2	.	3	23.9
613	2	.	.	2	6.4
614	2	.	.	2	17.9
615	2	4	.	4	81
616	2	2	.	3	23.9
617	2	.	.	2	42.1
618	2	.	.	2	34
619	2	.	.	2	3.2
620	4	4	.	6	28.8
621	2	2	.	3	30.9
622	.	2	.	2	20.3
623	.	2	.	2	14.4
624	.	2	.	2	2
625	.	2	.	2	3.3
626	.	2	.	2	40.8
627	.	2	.	2	6.5
628	.	3	.	2	9.8
629	.	2	.	2	45.5
630	.	2	.	2	16.5

Refitgroup	Production sequences	Breaks	Inserts	Artefacts N	Weight
631	.	2	.	2	12.7
632	.	2	.	2	4.1
633	.	2	.	2	12.4
634	.	2	.	2	13
635	.	2	.	2	6.7
636	.	2	.	2	5.5
637	.	2	.	2	12.4
638	.	.	2	2	21.8
639	.	3	.	3	20.5
640	.	2	.	2	8.1
641	.	.	2	2	21.2
642	.	.	2	2	26.5
643	.	2	.	2	15.1
Total	56	60	6	112	1023.1

Table 4.5b

Table 4.5 Number of types of refits in RMUs (a) and in compositions not assigned to RMUs (b) per refit group and total number and weight of refitted artefacts per refit group (all dimensions). Counts before refitting of broken pieces.

4.4.2 Cores

The number of complete cores of the Eyserheide site amounts to 16 (table 4.1). Ten cores belong to the group of South-Limburg flint. The other complete cores are made of Orsbach flint (n=2), Simpelveld flint (n=3), and Valkenburg flint (n=1). Thanks to refitting of fragments, two cores of Orsbach flint (O1 and O3) could also be described as complete cores. Including these two reconstructed cores, the number of complete cores totals 18 (table 4.6). Besides, the assemblage contains 13 incomplete cores. Although the majority is composed of three to five refitted fragments, in these cases refitting did not lead to completely reconstructed cores. Among the incomplete cores are ten pieces of Orsbach flint.

Of the 18 complete cores, core 51/197 2 (M10) has the smallest dimensions. The core has a length of 5.7 cm, a width of 4.4 cm, a thickness of 2.8 cm, and weighs 64.7 grams. The largest and heaviest piece (259A 165) is made of Valkenburg flint (V1) and was collected on the surface prior to the excavation. The artefact is more than 15 cm long, nearly 9 cm wide, and was struck from a flint slab with a (minimal) thickness of 53 mm. It weighs 880 grams. The total weight of all 18 complete cores is 6758 grams. None of the cores has characteristics observable with the naked eye (red colouring, potlids, crackle) that would indicate contact with fire.

Of all complete cores, 17 have been described as blade cores. Cores made of flakes are absent in the flint assemblage of Eyserheide, while only one core (part of RMU M17) was used for the removal of bladelets (*nucléus à lamelles*). Following the description of the cores of the Magdalenian sites of Kanne and Orp-le-Grand in Belgium (Vermeersch et al. 1985, 1987), a distinction was made of the blade cores into the following categories:

- blade core with one striking platform (*nucléus à un seul plan de frappe*);
- blade core with two opposite striking platforms and one core face (*nucléus à deux plans de frappe opposés pour débitage sur une même face*);
- blade core with two striking platforms and two opposite cores faces (*nucléus à deux plans de frappe pour débitage sur faces opposées*);
- blade core with two crossed striking platforms (*nucléus à deux plans de frappe croisés*).

Among the complete blades cores are six pieces with one striking platform and six pieces with two opposite striking platforms and one core face. Of the two other types, only three and two pieces were found. With the exception of one core of Orsbach flint (O1), all complete cores have reached the stage of blade production (*plein débitage*). They show the negative scars of one or – more often – a sequence of scars of two or more regular blades. In a few cases (parts of)

RMU	Find no.	(In) complete	Number of refitted core fragments	Type of core	Burnt	Percentage of cortex	Length	Width	Thickness	Weight
S01	259A 108	complete	2	5	no	50-74	120	77	39	414.0
S02	259A 321	complete	.	3	no	25-49	100	87	50	826.0
S03	259A 107	complete	.	4	no	25-49	113	69	37	363.0
V01	259A 165	complete	.	4	no	25-49	151	89	53	880.0
M01	259A 322	complete	.	6	no	25-49	82	52	52	213.0
M03	57/199 12	complete	.	5	no	25-49	105	43	36	196.4
M04	259A 323	incomplete	.	3?	no	50-74	91	63	39	260.9
M05	259A 205	complete	.	3	no	50-74	69	36	62	163.6
M06	259A 373	complete	.	3	no	50-74	125	99	57	783.0
M08	259A 239	complete	.	3	no	50-74	120	72	62	772.0
M09	259A 179	incomplete	3	4	no	<25	indet	indet	indet	107.6
M10	51/197 2	complete	.	4	no	25-49	57	44	28	64.7
M12	51/195 22	complete	.	3	no	50-74	148	27	45	242.7
M13	259A 208	complete	.	5	no	<25	99	59	40	275.9
M15	259A 209	complete	.	4	no	<25	106	69	53	490.0
M17	56/200 4	complete	.	4	no	<25	65	50	25	90.0
M19	259A 325	incomplete	2	4	no	25-49	90	59	43	184.0
O01	55/202 2	complete	8	2	no	<25	134	67	58	405.7
O02	259A 105	incomplete	3	3	no	25-49	133	52	18	87.3
O03	54/202 155	complete	5	3	no	0	92	38	41	220.5
O04	54/204 77	incomplete	3	3	no	<25	74	43	34	93.1
O05	259A 368	incomplete	5	3	no	<25	77	52	43	176.8
O06	53/204 23	complete	.	4	no	<25	91	68	47	262.1
O07	259A 103	incomplete	4	4	no	25-49	62	48	35	92.8
O08	58/202 1	complete	.	6	no	50-74	69	44	25	95.0
O09	50/200 5	incomplete	3	indet	no	<25	indet	indet	indet	13.5
O10	49/196 8	incomplete	2	indet	no	25-49	64	44	20	55.0
O12	54/203 13	incomplete	3	indet	no	25-49	44	48	21	45.9
O13	55/201 41	incomplete	3	indet	no	<25	31	39	27	33.9
O14	259A 74	incomplete	3	indet	no	<25	79	48	24	60.7
O16	259A 101	incomplete	2	indet	no	<25	indet	indet	indet	75.9

Table 4.6 Quantitative and qualitative data on cores after refitting of broken pieces. Dimensions in mm and weights in grams.

blade scars are visible over the entire length and width of the front of the core. A good example is a core made of rolled terrace flint that forms part of RMU M8 (fig. 4.28). The occurrence of such blade cores and numerous fragments of blades indicates that the production of blades was the primary objective of the Magdalenian flint knappers at Eyserheide.

On nearly all complete blade cores is cortex present on one or both flanks and/or the back. The presence of cortex and the considerable size indicate that many of the cores were far from exhausted. Only one blade core, part of RMU O3, is completely stripped of cortex. This core has a (remnant) length of more than 9 cm.

Important features of the Magdalenian cores of Eyserheide have been summarized in table 4.7. For the descriptions of the longitudinal profile (*section longitudinal*) and cross section (*section transverse*) and the mode of blade production (*plein débitage*) was utilized the terminology applied to the Magdalenian sites in the Paris Basin (for instance, Marsangy, see De Croisset 1983). In the text below characteristics of cores are briefly described by raw material group. For a description of the way of working the flint nodules, the reader is referred to paragraph 4.6.

Simpelveld flint:
Three complete blade cores were made of tabular nodules of Simpelveld flint. They all have a rectangular cross section but a variable longitudinal profile as a result of differences in the number and position of striking platform(s) and core face(s). The cores belong to the type with one striking platform (S2), two opposite striking platforms and one core face (S3), and two opposite core faces and (more than) two striking platforms (S1). With the exception of the core faces, the cores are still substantially covered with cortex. Because of the rectangular form, the careful preparation and shaping of it was apparently less necessary than for cores in the group of Meuse terrace flint. The width of the core faces corresponds with the thickness of the flint slabs. Of core 259A 321 (S2), the dimensions of the core face were 12.5 × 4.9 cm. The longest blade negative has a length of more than 12 cm. The core face of core 259A 107 (S3) is shorter and narrower (10.3 × 3.9 cm), and the longest blade negative has a length of only 6 cm. Both cores have a *crest unifacial* on the back. Also core 259A 108 (S1) shows the negatives of long and regular blades. In contrast to the two earlier mentioned cores, not one but both long, narrow sides of the flint slab were used as core face. During the reduction sequence, the core was repeatedly turned over and careful preparation of the striking platform was executed. In the stage of *plein débitage*, four different striking platforms were utilised for the removal of blades (see 4.6.2).

Core 259A 321 (S2) is a good example of a *débitage frontal* executed on one of the narrow sides of the flint slab. In core 259A 107 (S3), during the end phase of core reduction, *débitage frontal* changed to *débitage semi tournant*. The original flank of the flint slab has become part of the core face.

Valkenburg flint:
Of this type of flint only one core (259A 165, V1) was retrieved. The core is made from a relatively thick, tabular piece of flint. As with the cores of Simpelveld flint, the cross section is rectangular. The use of two opposite striking platforms has led to a longitudinal profile that has been described as *parallelogramme à plans de frappe orthogonaux*.
The right side is still largely covered with cortex, while on the opposite side the negatives of some blades and a (non-patinated) frost-split surface are visible. The dimensions of the core face are larger than in the cores of Simpelveld flint, namely 15.1 × 5.2 cm. The longest blade negative visible on the core has a length of 10.7 cm. The back of the core shows a *crest bifacial*. As in core 259A 107 (S3), the reduction sequence gradually switched from the narrow ventral side of the core to one of the sides. The left flank of the flint slab has thereby become part of the core face and *débitage frontal* changed to *débitage semi tournant*.

South-Limburg flint:
Ten complete cores of this group were made of ovoid to oblong and, as a result of fluvial transport, rolled nodules of flint. In some pieces no working of the back has taken place and the original exterior of cortex has been completely retained (*dos cortical*). In all cases these are cores of terrace flint (M1, M6, M8, and M12). The backs of other cores had been worked and show in particular negatives of larger flakes, among which at times cortex parts have been retained. The presence of a crest (*unifacial* or *bifacial*) was determined only in two cases in the group of South-Limburg flint. On some cores traces are visible of systematic core preparation on the flanks of the core (M3, M8). They are (parts of) negatives of consecutive, regular flakes. They were created by the removal of flakes from the front of the core and perpendicular to the (future) core face. In the stage of *plein débitage*, these negatives were largely removed as a result of blade production from the core face.

The length of the core face of the cores of South-Limburg flint varies from 6.4 cm (bladelet core M17) to 14 cm (M12). A core with a noticeable wide core face is core 259A 373 (M6). The dimensions of this core face are 12 × 9.5 cm. With the exception of RMUs M13 and M15, the number of negatives of blades on the core face amounts to maximally five. We are dealing here with *débitage frontal* or *débitage semi tournant*. In one core (M13), the method of *plein*

RMU	Complete / incomplete	Type of debitage	Type of core	Longitudinal section	Cross-section	Dimension of core face (in mm)	Number of blade scars on core face	Maximum length of blade scars (in mm)	Back
S01	complete	élaboré	5	par2	rectangular	83 × 47	5	83	striking surface 2
S02	complete	élaboré	3	pda	rectangular	125 × 49	5	93	crest unifacial
S03	complete	élaboré	4	par1	rectangular	103 × 39	8	60	crest unifacial
V01	complete	indet	4	par1	rectangular	151 × 52	6	107	crest bifacial
M01	complete	simplifié	6	indet	indet	75 × 48	5	75	dos cortical
M03	complete	élaboré	5	par2	trapezoid	99 × 36	4	90	striking surface 2, prep. flakes
M04	incomplete	indet	3?	indet (pdc)	indet	indet	5	indet	indet
M05	complete	indet	3	pda	triangular	68 × 37	5	65	cortex, crest
M06	complete	simplifié	3	pdc	trapezoid	120 × 95	3	120	dos cortical
M08	complete	simplifié	3	pdc	trapezoid	122 × 70	5	122	dos cortical
M09	incomplete	élaboré	4	indet	indet	indet	indet	indet	indet
M12	complete	simplifié	3	pdc	trapezoid	140 × 32	5	140	dos cortical
M13	complete	élaboré?	5	par2	trapezoid	97 × 45	6	99	striking surface 2
M15	complete	élaboré	4	tra	trapezoid?	100 × 63	6	100	cortex, prep. flakes
M17	complete	lamelles	4	tra	indet	64 × 43	5	41	prep. flakes, natural fissure
M19	incomplete	indet	4	indet (tra)	indet	indet	1	89	indet (cortex)
O1	complete	éclats	2	.	.	.	0	.	crest, prep. flakes
O2	incomplete	indet	3	indet	indet	122 × 50	2	122	cortex, natural fissure
O3	complete	indet	3	pda?	trapezoid	89 × 42	5	82	natural fissure
O4	incomplete	indet	3	indet	indet	indet	indet	86	natural fissure
O5	incomplete	indet	3	indet	indet	74 × 45	1	46	crest bifacial
O6	complete	élaboré	4	tra	trapezoid	91 × 68	9	75	prep. flakes, natural fissure
O7	incomplete	indet	4	indet	indet	62 × 45	6	50	cortex, prep. flakes
O8	complete	simplifié	6	par 1	rectangular	46 × 21	1	50	striking surface 2

Blade core with one striking platform:
pdc = partie distale corticale
pdp = partie distale en pointe
pda = partie distale en arête
indet = not determined

Blade core with two opposite striking platforms:
tra = forme trapézoïdale
tri = forme triangulaire
par1 = parallélogramme à plans de frappe orthogonaux
par2= parallélogramme à tables opposées

Table 4.7 Characteristics of complete and fragments of cores. NB: core 51/197 2 (RMU M10) was during processing not available for study and has not been included in the list.

Left flank	Right flank	Main sequence (plein débitage)	Crest on back	Reason of discard of core
cortex, blade negatives	cortex	semi tournant	absent	core face <10 cm, irregular shape core
cortex	cortex, crest prep. flakes	frontal	present	step fractures?
cortex, crest prep. flakes	cortex	semi tournant	present	step fractures, irregular core face
blades, natural fissure	cortex, crest prep. flakes	semi tournant	present	step fractures, irregular core face
cortex	prep. flakes	semi tournant	absent	step fractures, blades < 7 cm, coarse grained inclusion
cortex, prep. flakes	cortex, prep. flakes	frontal 2x	absent	step fractures, cortex holes, irregular surface
(cortex)	indet	indet	indet	indet
cortex	cortex, prep. flake	frontal	present	step fracture, blades <6 cm
cortex	cortex, prep. flake	frontal	absent	indet
cortex, prep. flakes	cortex	frontal	absent	indet
indet	indet	semi-tournant?	indet	indet
cortex	cortex, prep. flakes	frontal	absent	step fracture?
edge striking surface	cortex, prep. flakes	tournant	absent?	step fractures, cortex holes
cortex, prep. flakes	1 flake	frontal	absent	indet
prep. flakes	absent	frontal	present	blade failure, small dimension core
indet (cortex)	indet (cortext)	frontal	indet	indet
prep. flakes	prep. flakes	.	present	indet
crest prep. flakes	crest prep. flakes	semi tournant	absent	too thin, irregular core face with cortex
crest prep. flakes	natural fissure	semi-tournant	present	natural fissure, core fragmentation?
indet	crest prep. flakes	indet	absent	outrepassé
crest prep. flakes	prep. flakes, cortex	frontal	present	blade failure, irregular striking surface
prep. flakes	natural fissure	semi-tournant	absent	step facture platform 2?
blades	prep. flakes, natural fissure	semi-tournant	absent	blades < 55 mm, coarse-grained inclusion
cortex	cortex	frontal	absent	step fractures, blade < 45 mm

débitage has been described as *débitage tournant*. Of this core, the back and front have been used for the removal of blades. The core has two opposite core faces and two opposite striking platforms.

Orsbach flint:
The complete cores of Orsbach flint are diverse in type, shape and dimensions. The only core with exclusively negatives of flakes (*nucléus informes*) was made of this flint (O1). The core was bifacially worked with the aim of making two core crests (*crêtes longitudinales*). Four cores of Orsbach flint (O2 to O5) belong to the blade cores with one striking platform. Of these, only the core of RMU O3 is complete, and composed of five conjoined fragments. This core has a length of 9.2 cm, a width of 3.8 cm, and a thickness of 4.1 cm.

4.4.3 Core fragments

In particular in large artefacts (cores) are continuous cracks visible that were created by frost action. During the process of flint-knapping, but also under influence of post-depositional processes can artefacts break up along the cracks into two or more pieces. Especially cores of Orsbach flint fell victim to this. Of this flint, 81 core fragments have been recovered (table 4.1). In the groups of South-Limburg flint and Simpelveld flint occur respectively twelve and five fragments split along frost cracks. Among these is a split part of the front of core 259A 108 (RMU S1). Two such core fragments have been found of Valkenburg flint.

Fragments of which the breaks ('fracture planes') are not patinated were probably split as a result of contact with a ploughshare. Many of these fragments come from the surface or the plough zone. In a small number of cases these fragments were successfully refitted (O2, O4, O5, and O7), but only the cores of RMUs O1 and O3 could be reconstructed completely. For frost-cracked fragments that could not be refitted, it was not possible to indicate from which type of core they originated. From the large number of fragments of cores of Orsbach flint could be inferred that the number of cores of this flint and worked and discarded at the site was originally much larger than would appear from the overview of complete cores (table 4.7). In the evaluation of the number of cores from the site of Eyserheide, this should be duly taken into account. In the group of Meuse terrace flint, the cores that form part of RMUs M4 and M9 are heavily fragmented as a result of contact with a ploughshare. Of the latter core, two conjoined pieces were found on the surface prior to the excavation (259A 179, 259A 180), and one conjoined fragment many years after the excavation (259A 507). Together they constitute, at a rough estimate, a third of the original volume of the core. Nonetheless, 28 flakes and blades could be refitted onto the reconstructed part (see 4.6.4). The core fragment of RMU M4 corresponds with the distal end of a probably large blade core with one core face and one striking platform. The back of this fragment consists completely of cortex which would point to a core with a *dos cortical*.

4.4.4 Flakes

Artefacts larger than 2 cm and connected with the rough shaping and (further) preparation of cores, such as the creation of a striking platform or the maintenance of the core face and flanks, have been described as flakes. They are waste products of the flint knapping on which no traces of further working (intentional retouch) or edge damage ('use retouch') are macroscopically visible. Most flakes and flake fragments are made of South-Limburg flint (n=452), followed by Orsbach flint (n=324), Simpelveld flint (n=189), and Valkenburg flint (n=13) (table 4.1). Of this number, only 13 flakes are larger than 7 cm. These are in particular flakes of Meuse terrace flint, the majority of which forms part of compositions of refitted artefacts. Decortication flakes are defined as flakes of which the dorsal surface consists of at least 75% cortex. In the small group of Valkenburg flint, decortication flakes are rather well represented with 31% (table 4.8). These flakes indicate that the first stage of working of RMU V1 (and other tabular nodules of Valkenburg flint?) was carried out at the site itself. The dorsal surface of flakes in the other raw material groups has in the main no cortex or a covering of less than 25%. For the groups of Simpelveld flint, South-Limburg flint and Orsbach flint the percentages of these artefacts are 82%, 67% and 74% respectively. These high percentages indicate that rough shaping of the flint nodules, including the removal of cortex parts, was carried out before they reached the camp site of Eyserheide. There are differences though in this regard between RMUs, a subject that will be raised later in this chapter (4.6). A comparison between South-Limburg eluvial flint and Meuse terrace flint also makes clear that flakes in the latter group are more often covered for more than half with cortex (34.5% versus 19.5%).

In the group of Simpelveld flint, the presence of flakes bearing cortex at both the butt and the distal end should be mentioned. These flakes are connected with the preparation and maintenance of the core face, through the removal of flakes struck from the flanks of the flint slab and perpendicular to the (future) core face. Because of the tabular structure of the flint and the presence of cortex on either side of the core face, both the butt and the distal end of the preparation flakes are covered with cortex.

The number of core rejuvenation flakes of the site amounts to 34. The majority of these was removed during the rejuvenation of the striking platform, whereby the edge of

Simpelveld flint

	Flake	%	Rejuvenation flake	%	Blade	%	Crested blade	%
No cortex	71	37.6	4	57.1	58	45.3	6	28.6
<25%	84	44.4	3	42.9	29	22.7	10	47.6
25-49%	22	11.6	.	.	31	24.2	4	19
50-74%	5	2.6	.	.	8	6.2	1	4.8
>75%	7	3.7	.	.	2	1.6	.	.
Total	189	99.9	7	100	128	100	21	100

Valkenburg flint

	Flake	%	Rejuvenation flake	%	Blade	%	Crested blade	%
No cortex	.	.	.	.	2	14.3	.	.
<25%	7	53.8	1	100	4	28.6	1	100
25-49%	.	.	.	.	3	21.4	.	.
50-74%	2	15.4	.	.	5	35.7	.	.
>75%	4	30.8	.	.	.	0	.	.
Total	13	100	1	100	14	35.7	1	100

South-Limburg flint

	Flake	%	Rejuvenation flake	%	Blade	%	Crested blade	%
No cortex	175	38.9	8	53.3	128	53.3	16	57.1
<25%	126	28	6	40	55	22.9	10	35.7
25-49%	61	13.6	.	.	37	15.4	2	7.1
50-74%	33	7.3	1	6.7	13	5.4	.	.
>75%	55	12.2	.	.	7	2.9	.	.
Total	450	100	15	100	240	99.9	28	99.9

Orsbach flint

	Flake	%	Rejuvenation flake	%	Blade	%	Crested blade	%
No cortex	94	29	1	10	97	45.3	7	26.9
<25%	145	44.8	7	70	88	41.1	11	42.3
25-49%	51	15.7	1	10	23	10.7	5	19.2
50-74%	27	8.3	1	10	6	2.8	3	11.5
>75%	7	2.2	.	.	.	0	.	
Total	324	100	10	100	214	99.9	26	99.9

Table 4.8 Amount of cortex on artefacts larger than 2 cm per flint and artefact type. Counts before refitting of broken pieces.

the striking platform and the adjoining part of the core face were removed. For the complete removal of the striking platform, only a few indications have been found in the shape of core tablets (*tablettes nucléus*). A beautiful example is made of Meuse terrace flint (M13) (fig. 4.5-1). There are also indications of a radical correction of the core face. An example is a large and relatively thick flake that was struck from the front of the core, at the moment when the core face had already served for blade production (fig. 4.5-2).

4.4.5 Crested blades

As with the blades, few crested blades have been found intact. Before the refitting of broken pieces, there were six complete pieces, ten proximal parts, 26 medial parts, and 26 distal parts. Nine broken crested blades have non-patinated breaks. Of the complete crested blades, the longest piece has a length of more than 22 cm. This blade is made of South-Limburg, eluvial flint and consists of five broken and refitted pieces (M2). Seven other crested blades have a length

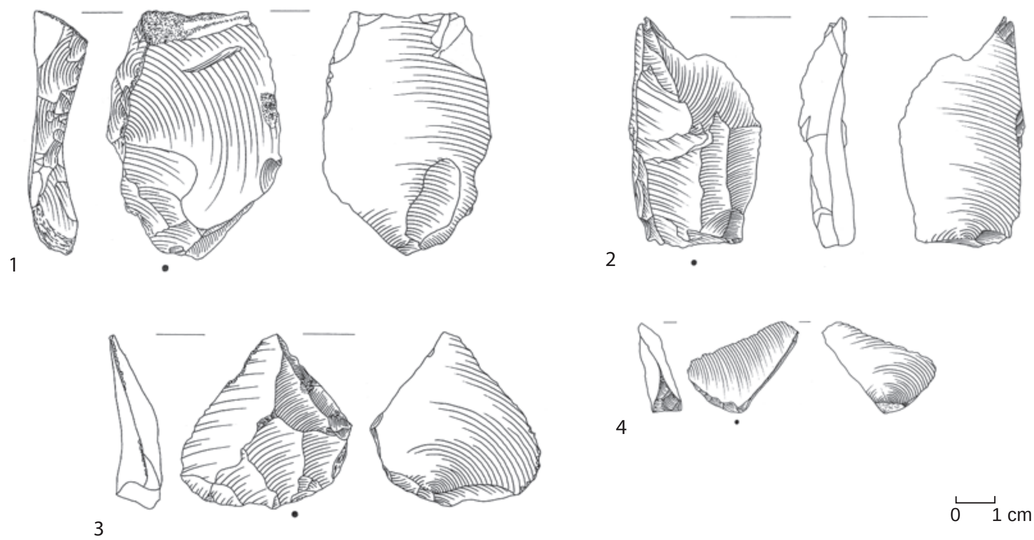


Figure 4.5 1-3 core rejuvenation flakes; 4 resharpening flake? (scale 1:2).

of more than 10 cm. They are composed of two or more conjoined fragments (fig. 4.6-2).

Table 4.9 shows an overview of the characteristics of crested blades within the four raw material groups. This shows that most pieces were made of South-Limburg flint and Orsbach flint. One-sided (unilaterally) prepared blades occur in larger numbers than two-sided (bilaterally) prepared blades. For blades that were struck first (*primaires*), after the preparation of a core crest, the ratio between unilaterally and bilaterally prepared blades is 1.9: 1. For the subsequently struck blades (*secundaires*) this ratio is 9: 1. In the group of unilaterally prepared blades, pieces with traces of core preparation on the left side (*unilateral gauche*) are best represented.

The amount of cortex on the dorsal surface of crested blades corresponds on the whole with those of the flakes. Of 24 bilaterally prepared blades, twelve pieces have no cortex and eight pieces have less than 25% cortex on the dorsal surface. Only in four cases cortex covers more than 25% of the dorsal surface. For the unilaterally prepared blades (n=51), the division is of a different kind: 18 pieces no cortex, 22 pieces less than 25% cortex, and 11 pieces more than 25% cortex. An explanation for this (small) difference is that with the unilateral preparation of a core crest less cortex is removed than in the case of bilateral preparation. Besides, it cannot be ruled out that unilateral core preparation occurred especially at the beginning of the process of core reduction, at the moment when large parts of the core were still covered by cortex.

4.4.6 Blades

A total of 735 artefacts have been described as blades, or 22% of the total of Magdalenian artefacts (table 4.1). Compared with the number of 67 complete blades (after refitting of broken pieces: 80), the number of proximal (n=170), medial (n=207) and distal fragments (n=164) is significantly higher. Also fragments of which one or both breaks are non-patinated, occur frequently (n=127). In the groups of South-Limburg flint and Orsbach flint, medial fragments of blades are best represented. In the group of Simpelveld flint we are dealing with in particular proximal and distal fragments. A possible explanation for this is that medial parts of Simpelveld flint were used as tool and/or that these parts were carried away for future use at other locations.

On most blades cortex is lacking or cortex covers less than 25% of the dorsal surface. In the group of Simpelveld flint, we are dealing with 87 pieces (68%), in the group of South-Limburg flint with 183 pieces (76%), and in the group of Orsbach flint with 185 pieces (86%) (table 4.8). They show that the production of blades occurred at the moment that the core face and the adjoining flanks of the core were largely or completely stripped of cortex. Blades of which the dorsal surface is covered with more than 75% cortex only occur in small numbers in the groups of Simpelveld flint (n=2) and South-Limburg flint (n=7). In the latter group, in six out of seven cases these are artefacts of terrace flint.

An overview of the lengths of complete blades (table 4.10) shows that blades longer than 10 cm occur most in the group of Simpelveld flint. Of the 19 complete pieces (= after

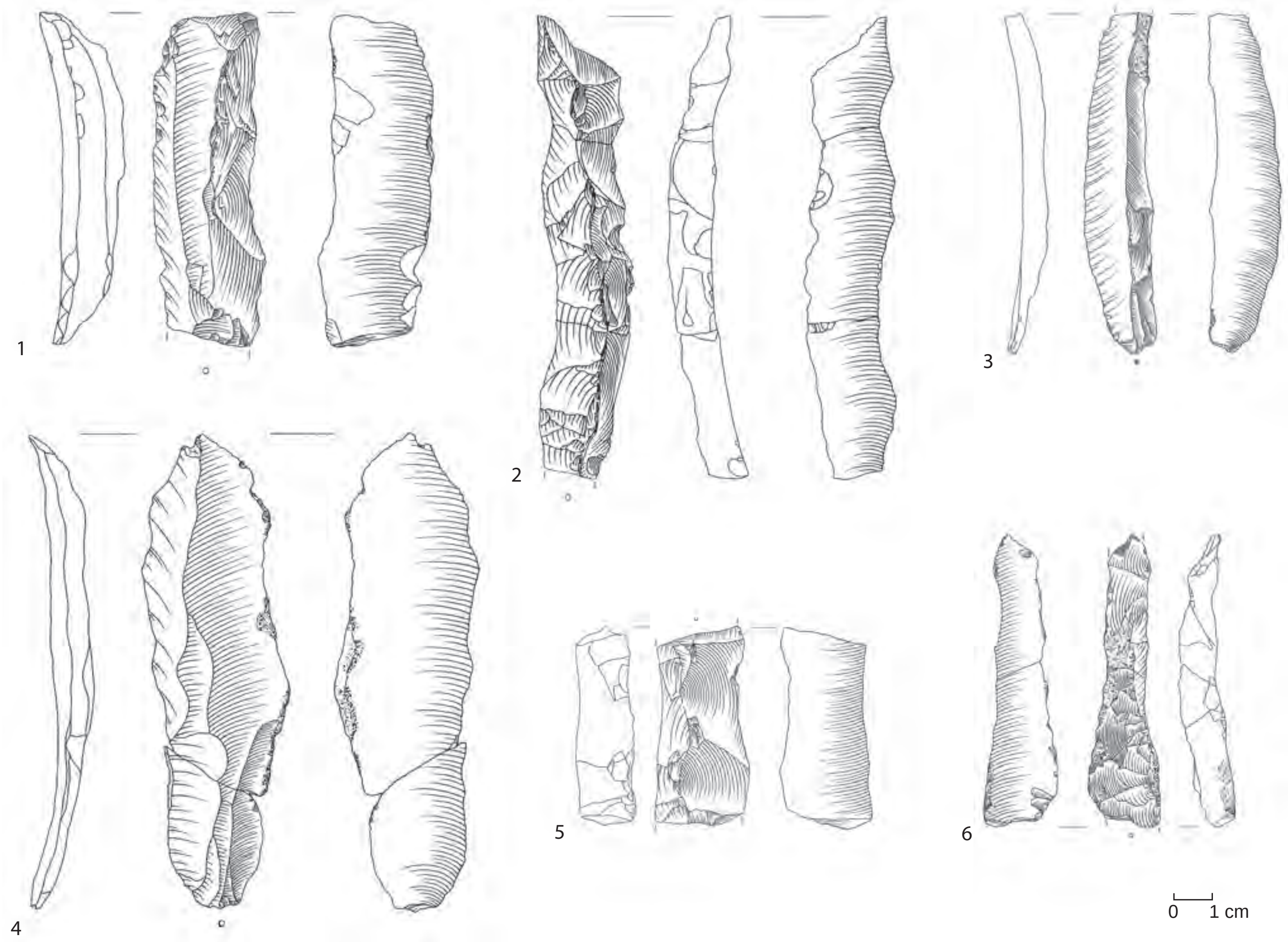


Figure 4.6 1-3, 5-6 crested blades; 4 complete blade (scale 1:2).

	First generation			Second generation			Indet	
	Unilateral, left	Unilateral, right	Bilateral	Unilateral, left	Unilateral, right	Bilateral		N
Simpelveld flint	6	2	7	2	2	.	2	21
Valkenburg flint	.	1	.	.	.	.	.	1
South-Limburg flint	7	9	9	2	1	.	.	28
Orsbach flint	11	6	7	2	.	1	.	27
Total	24	18	23	6	3	1	2	77

Table 4.9 Characteristics of crested blades per flint type (all dimensions). Counts before refitting of broken pieces.

refitting of broken items), seven pieces are longer than 10 cm. The longest blade (54/202 107) has a length of 13.6 cm and forms part of refit group S308. The refitting of blade fragments in the group of Simpelveld flint yielded another two complete blades with lengths of 12.4 and 16.7 cm. Of these the blade longer than 16 cm also forms part of refit group S308.

Of 25 complete blades in the group of South-Limburg flint, 18 have a length of less than 7 cm. In the group of Orsbach flint, this number amounts to 24 out of a total of 35 pieces. Based on these numbers, the knapping of South-Limburg flint and Orsbach flint has yielded fewer long blades than that of Simpelveld flint. There are however also complete blades of Orsbach flint and South-Limburg flint

Before refitting

Length in mm	Simpelveld flint	Valkenburg flint	South-Limburg flint	Orsbach flint	N
<20	.	.	.	.	0
20-29	.	.	1	2	3
30-39	3	.	5	6	14
40-49	1	.	3	5	9
50-59	2	.	6	4	12
60-69	.	1	3	5	9
70-79	.	.	1	2	3
80-89	1	.	1	5	7
90-99	3	.	1	.	4
100-109	1	.	.	.	1
>110	4	.	1	.	5
Total	15	1	22	29	67

After refitting

Length in mm	Simpelveld flint	Valkenburg flint	South-Limburg flint	Orsbach flint	N
<20	.	.	.	.	0
20-29	.	.	1	2	3
30-39	3	.	5	6	14
40-49	1	.	3	6	10
50-59	2	.	6	4	12
60-69	.	1	3	6	10
70-79	.	.	1	2	3
80-89	1	.	1	5	7
90-99	5	.	2	1	8
100-109	1	.	.	.	1
>110	6	.	3	3	12
Total	19	1	25	35	80

Table 4.10 Lengths of complete blades, before and after refitting of broken pieces, per flint type (lengths in mm).

that have a length of more than 10 cm. Of South-Limburg flint, the longest blade measures 11.7 cm. After refitting of broken pieces, two pieces of 11.1 and 11.8 cm can be added to this. Both artefacts were made of terrace flint and form part of the composition of refitted artefacts around core 259A 373 (refit group M6.00). In the group of Orsbach flint, conjoining of broken pieces yielded two complete blades of considerable lengths (12.1 and 13.4 cm).

On the basis of the above lengths we can conclude that the knapping of flint nodules in Eyserheide was aimed at producing blades with lengths of more than 10 cm. The lengths of tools (see 4.5) also point to this. Another indication forms the presence of (non-refitted) fragments of blades with considerable lengths. If more of these fragments could have been refitted, the percentage of (complete) blades longer than 10 cm would have been much higher than is the case now.

Looking at the widths of medial fragments of blades, a clear peak lies at the width classes 10-14 mm (25.6%), 15-19 mm (21.1%), and 20-24 mm (22.8%) (table 4.11). Together medial parts with widths between 10 and 24 mm account for almost 70% of the total. The blades of Simpelveld flint in particular attest to a high degree of standardisation with regard to the widths. Of 27 medial fragments, 25 pieces (92.5%) are between 10 and 25 mm wide. A width of less than 10 mm does not occur and only one medial fragment is slightly wider than 25 mm. Compared to South-Limburg flint and Orsbach flint, the range of dimensions of medial fragments of blades is significantly smaller.

Width in mm	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
2	.	0	.	0	1	2.7	.	6.2	1	3.4
3	.		.		.		4		4	
4	.		.		2		.		2	
5	.	0	.	0	.	10.8	1	7.6	1	8.2
6	.		.		1		2		3	
7	.		.		4		.		4	
8	.		.		1		1		2	
9	.		.		6		1		7	
10	1	25.9	.	25	2	21.6	3	32.2	6	25.6
11	.		.		4		1		5	
12	1		.		7		5		13	
13	1		.		6		1		8	
14	4		1		5		11		21	
15	1	37.0	1	25	4	18.0	3	20	9	21.1
16	3		.		3		3		9	
17	1		.		5		3		9	
18	2		.		5		2		9	
19	3		.		3		2		8	
20	.	29.6	.	25	2	19.8	5	24.6	7	22.8
21	2		.		4		2		8	
22	4		.		3		1		8	
23	1		1		7		5		14	
24	1		.		6		3		10	
25	1	7.4	.	25	3	18.9	1	6.1	5	13.4
26	1		.		7		2		10	
27	.		.		3		.		3	
28	.		1		2		1		4	
29	.		.		6		.		6	
30	.	0	.	0	2	6.3	1	3.0	3	4.3
31	.		.		2		.		2	
32	.		.		.		.		.	
33	.		.		1		.		1	
34	.		.		2		1		3	
35	.	0	.	0	1	1.8	.	0	1	1.0
36	.		.		.		.		.	
37	.		.		.		.		.	
38	.		.		.		.		.	
39	.		.		1		.		1	
Total	27	99.9	4	100	111	99.9	65	99.7	207	99.8

Table 4.11 Widths of medial parts of blades per flint type (widths in mm).

Also in the group of South-Limburg flint does the peak lie between 10 and 25 mm: 66 pieces, i.e. 59.5%. But there are also relatively many medial parts wider than 25 mm. In this group 21 pieces (18.9%) have a width between 25 and 30 mm and seven pieces (6.3%) have a width between 30 and 35 mm. Also the medial fragment with an exceptional width of 39 mm is made of South-Limburg flint. Comparable widths are lacking in the group of Simpelveld flint. Although medial parts wider than 25 mm do occur in the group of Orsbach flint, the number (n=6) is limited. The widest blade of this flint measures 34 mm.

An overview of the thicknesses makes it clear that the majority of medial parts of blades has a thickness of 1 to 6 mm (table 4.12). In the group of South-Limburg flint, we are dealing with 78 pieces (70%) and in the group of Orsbach flint with 54 pieces (83%). By far the most medial parts of blades in the group of Simpelveld flint have a thickness of 3 to 8 mm, viz. 24 out of 27 pieces (89%).

In table 4.13 an overview is given for the distinguished raw material groups of characteristics of the butt of complete and proximal fragments of blades (see also fig. 4.8). The table clearly shows that there is a great diversity of types of butts. In paragraph 4.8.3, and after the description of the RMUs, we will go deeper into the meaning of this diversity.

4.5 Tools

4.5.1 Introduction

For the description of retouched tools the numerical codes were used that form part of the general list of codes of the excavation of Eyserheide. In accordance with the procedure applied at the Belgian Magdalenian sites of Orp-le-Grand and Kanne (Vermeersch et al. 1985, 1987), the typological list of F. Bordes (1978) and the corresponding numbers were also utilised.

In addition to technological characteristics, the attribution of the Eyserheide site to the Magdalenian is based on typological characteristics of the retouched artefacts. After refitting of broken pieces, a total of 87 flint artefacts were described as retouched tools (table 4.14). This means that 2.5% of the total Magdalenian flint assemblage consists of retouched tools. However, this number of 87 should be regarded as minimum of the original number of tools that was left behind on the site. In the first place, the site was not excavated entirely and tools could be present beyond the excavated area (and especially in the plough zone). Besides, only part of the excavated sediment was sieved, as a result of which small tools (including backed blades) and broken parts of tools were probably partially overlooked. Moreover, the analysis of microwear traces on artefacts of Orsbach flint shows that also artefacts without retouch and/or macroscopically visible edge damage can have been used as tools (see Sano's contribution in chapter 5). Flint artefacts without retouch but with abrasions visible to the naked eye, have been described as blades and flakes with edge damage ('use retouch').

By far the most retouched tools (n=64) were made of blades. But also bladelets (backed bladelets) and flakes (scrapers, retouched flakes) were used for the manufacturing of tools. Of eight small fragments of retouched pieces, it is not known whether they were made of a blade or a flake. Complete cores or core fragments split along frost cracks do not provide any indication for use as tool.

The long and regular blades selected for use as tool could simply be transformed by retouch into various types of tools. The most important types are burins (n=31), scrapers (n=14), borers/becs (n=7), and retouched blades (n=12) (table 4.14). Backed bladelets, a diagnostic tool of the northern Magdalenian, are represented by only 6 pieces.

4.5.2 Scrapers (fig. 4.9)

Of twelve end scrapers from Eyserheide, three pieces are complete and nine pieces are broken. They were made of long and regular blades and have been described as *grattoirs simple sur lame* and *grattoirs sur lame retouchée*. A scraper on flake also forms part of the retouched tools.

The blade end scrapers are characterised in general by a lightly retouched and slightly curved (four pieces) to semi-circular (also four pieces) working edge which points to short-term use and/or working with soft materials. Of two scrapers the working edge has been described as irregular and the working edge of one piece had been broken off. The width of the scraping edges varies from 1.3 to 3.2 cm. A shared characteristic of all eight scrapers of South-Limburg flint is the position of the scraping edge on the distal part of the blade. Of two scrapers of Simpelveld flint, the scraping edge was made once on the proximal part and once on the distal part. The same applies to two scrapers of Orsbach flint (table 4.15).

1: *Grattoirs simple sur lame*

Three complete blade end scrapers have lengths of 10.7 cm, 9 cm and 7.6 cm. In all cases the scraping edge was made on the distal part of the blade. The longest piece (54/203 65) is made of South-Limburg, eluvial Rijckholt flint (Lanaye flint), and has a slightly curved and lightly retouched working edge (fig. 3.3-2). On both lateral edges abrasion is visible as a result of use (or hafting?). Another complete blade end scraper is 259A 318, also made of Rijckholt flint (Lanaye flint), with an eluvial cortex. The scraping edge is semi-circular. As a result of retouching, the adjacent part of the

Thickness in mm	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
1	.	.	.	.	9	8.1	10	15.4	19	9.2
2	2	7.4	.	.	20	18.0	5	7.7	27	13.0
3	7	25.9	1	25	18	16.2	13	20	39	18.8
4	4	14.8	1	25	15	13.5	11	16.9	31	15.0
5	5	18.5	1	25	6	5.4	4	6.2	16	7.7
6	2	7.4	.	.	10	9	11	16.9	23	11.1
7	3	11.1	.	.	8	7.2	5	7.7	16	7.7
8	3	11.1	1	25	10	9	2	3.1	16	7.7
9	.	.	.	.	3	2.7	1	1.5	4	1.9
10	1	3.7	.	.	7	6.3	1	1.5	9	4.3
11	.	.	.	.	4	3.6	2	3.1	6	2.9
12	.	.	.	.	1	0.9	.	.	1	0.5
Total	27	99.9	4	100	111	99.9	65	100	207	99.8

Table 4.12 Thicknesses of medial parts of blades per flint type (thicknesses in mm).

Blades						
Type of butt	Simpelveld flint	Valkenburg flint	South-Limburg flint	Orsbach flint	N	%
Cortex	1	.	1	3	5	1.9
Plain	15	2	31	21	69	25.6
Dihedral faceted	3	.	7	4	14	5.2
Faceted	3	.	10	11	24	8.9
Punctiform	5	.	4	3	12	4.5
Eperon	18	2	23	23	66	24.5
Splintered	10	1	18	22	51	19
Indet	5	.	10	13	28	10.4
Total	60	5	104	100	269	100
Crested blades						
Type of butt	Simpelveld flint	Valkenburg flint	South-Limburg flint	Orsbach flint	N	%
Cortex	.	.	.	.	0	0
Plain	2	.	1	1	4	28.6
Dihedral faceted	.	.	1	.	1	7.1
Faceted	.	.	.	1	1	7.1
Punctiform	.	.	.	.	0	0
Eperon	4	.	.	1	5	35.7
Splintered	2	.	.	.	2	14.2
Indet	.	.	1	.	1	7.1
Total	8	0	3	3	14	99.8

Table 4.13 Type of butt on complete and proximal fragments of blades and crested blades.

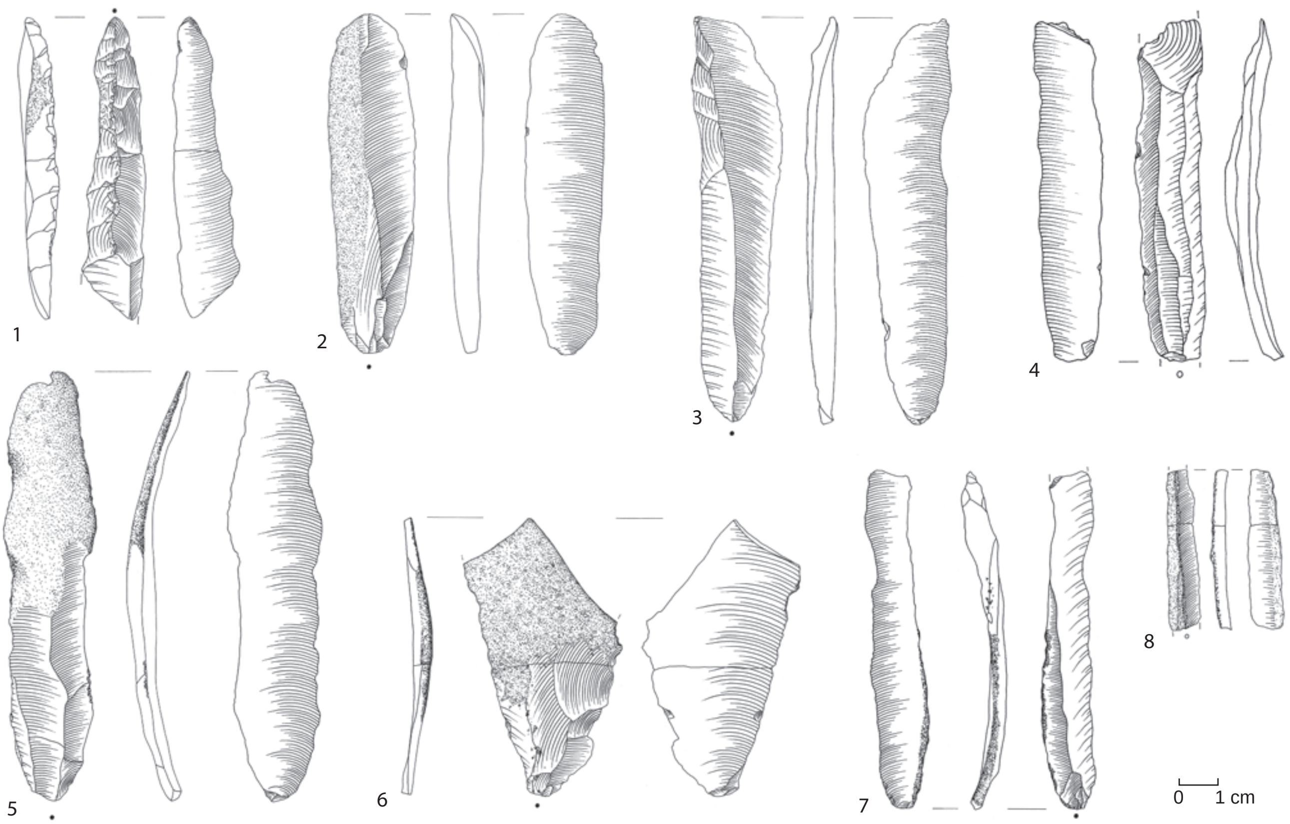


Figure 4.7 1 crested blade; 2-5, 7 blades; 6 failed blade; 8 bladelet (scale 1:2).

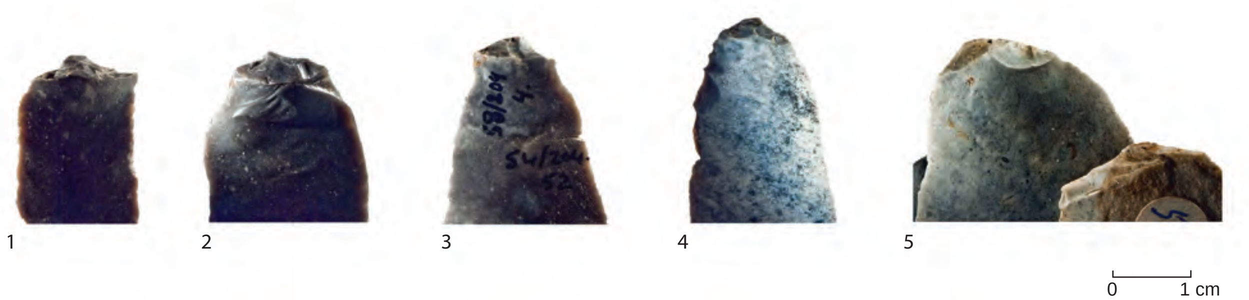


Figure 4.8 Proximal parts of blades and butts with traces of *en éperon* preparation. 1-2 Orsbach flint; 3-5 Meuse terrace flint (scale in cm).

cortex on the dorsal surface was removed (fig. 4.9-3). The third piece is made of Orsbach flint and has a remarkably straight and narrow scraping edge of only 1.3 cm wide (fig. 4.9-2). No cortex remains are present on this scraper.

The lengths of broken pieces vary between 3.0 cm and 7.8 cm. Two broken end scrapers could be assigned to one and the same core of terrace flint (M6) and form part of refit group M6.00 (see 4.6.4). The working edge of both scrapers is located on the distal part. A fragment of a scraper with a narrow, slightly curved scraping edge (53/202 56 and 53/203 8) was also made of South-Limburg flint. Two broken scrapers of Orsbach flint have a complete scraping edge. Scraper 58/203 10 was made of a remarkably regular blade, of which the working edge was made on (or towards) the distal part of the blade (fig. 4.9-5).

Retouched tools			South-Limburg flint				
Tool type	Simpelveld flint	Valkenburg flint	Eluvial	Terrace	Indet	Orsbach flint	N
Backed bladelet	1	.	1	1	2	1	6
Borer/becs	1	1	1	.	.	4	7
Burins	3	1	3	3	1	20	31
Combination tool	.	.	.	.	.	1	1
Scraper	3	.	3	5	.	3	14
Retouched blade	1	.	4	3	1	3	12
Notched blade	.	.	.	.	.	1	1
Truncated blade	.	1	.	3	1	3	8
Piece esquillee	.	.	.	.	.	1	1
Retouched flake	.	.	1	1	1	1	4
Notched flake	.	.	.	2	.	.	2
Total	9	3	13	18	6	38	87
Blades and flakes with edge damage (‘use retouch’)	8	1	2	9	3	10	33

Table 4.14 Numbers of retouched tools per tool type and per flint type. Numbers of flakes and blades displaying edge damage (‘use retouch’) are shown separately. Counts after refitting of broken pieces.

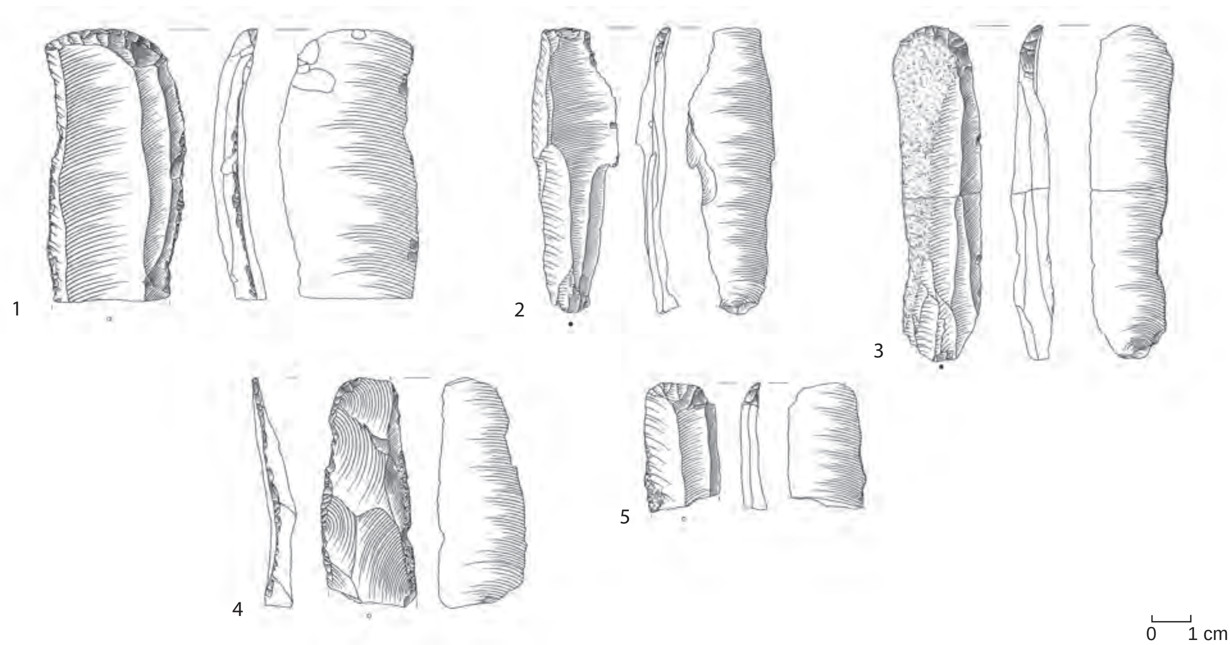


Figure 4.9 Blade end scrapers. 1, 3 flint of the type Rijckholt; 2, 5 Orsbach flint; 4 Simpelveld flint (scale 1:2).

3: *Grattoirs sur éclat*
Among the scrapers is one piece made on a flake. The scraper forms part of RMU S3 (refit group S3.00), and was made from a thick decortication flake. The flake was one of the first artefacts to be removed from the top of the core (see paragraph 4.6.2).

9: Grattoirs sur lame retouchée
One of the lateral edges of four broken scrapers was retouched intentionally. One scraper (51/195 15) of Simpelveld flint has a broken-off working edge on the distal part (fig. 4.9-4). This working edge was originally slightly curved or semi-circular and lightly retouched. The left long side of the blade was retouched down the entire length. The second broken scraper of this type of flint has a narrow, semi-circular scraping edge. This scraper, of which only the end was retrieved, shows retouch on the left side.

A scraper of eluvial Rijckholt flint (Lanaye flint; fig. 4.9-1) was made on a remarkably broad blade. The scraping edge covers the full width and is 3.2 cm wide. Thus, the working edge is considerably wider than that of all other end scrapers made on blades. The latter piece (50/195 7) is made of Meuse terrace flint (M13) and has a complete scraping edge on the distal part. In contrast to most other scrapers, the edge is irregular. The left lateral edge of this artefact has been retouched.

4.5.3 Composite tools (fig. 4.10-6)

22: *Perçoir-burin*
A composite tool (51/197 1) was made from a narrow blade of Orsbach flint. The artefact has retouch near the dorsal end of the left side, while on the other side the (remnant of a) negative scar of a burin spall is visible. The working edge has broken off, as a result of which it was not possible to determine whether it concerns for instance a burin on truncation or a Lacan burin. The other side towards the proximal part of the blade has a lightly retouched working edge with a small pointed borer end. This working edge has been described as borer.

4.5.4 Borers and becs (fig. 4.10-1-5)

23: *Perçoirs simples*
Seven artefacts have been described as borer or bec, four of which are complete borers on blade. The longest piece (54/203 19) measures 11.3 cm and could be refitted onto a blade core of Orsbach flint (refit group O2.00; fig. 3.3-3). The distal end has a bilateral, lightly retouched working edge that indicates that the artefact was used as borer. The tip has broken off. A second borer (54/204 60) has a chipped distal end. The abrasions are located both dorsally and ventrally at the tip of the artefact. In addition, edge damage ('use retouch') is visible on the right side. In two other complete borers is the working edge more robust. One of these is made of Orsbach flint and consists of three fitting broken pieces that together form a complete borer (fig. 4.10-2). The working edge has been made on the thicker, proximal part. By retouching both long sides, a pointed borer end was obtained. The opposite edge is complete, and corresponds with the slightly curved, distal end of the blade. 'Use retouch' is visible on this edge. The last complete borer (53/200 88 and 53/200 95) also has the working edge on the thicker, proximal part. The tool was made from a regular blade of Simpelveld flint having parallel lateral edges and arrises (fig. 4.10-1). The tip of this borer has also broken off.

A broken borer of South-Limburg, eluvial flint consists of two conjoined fragments (259A 316 and 317). The borer has a lightly retouched working edge and could be refitted onto the medial part of a retouched blade (M21; fig. 4.33). And finally, a broken-off tip of a borer or bec of Orsbach flint (51/205 2) should be pointed out (fig. 4.10-5).

27: *Becs simples* (fig. 4.10-3)
The only tool described as bec consists of two broken pieces (50/192 14 and 50/197 3) and is made of Valkenburg flint. The working edge has bifacial retouch that converges near the tip of the artefact. The working edge was made on the distal end. As the tip is broken off, it cannot be excluded that we are here dealing with a bec-burin.

4.5.5 Burins (figs. 4.10-4.12)

The group of burins (n=31) consists of three burins on a break, 21 dihedral burins, two burins on truncation, two Lacan burins, and one bec-burin. The type of two other, broken burins could not be determined. By far most burins are made of Orsbach flint, viz. 20 pieces (table 4.14). This number contrasts sharply with the number of seven burins of South-Limburg flint. Despite the large quantity (of fragments) of regular blades, there are only three burins of Simpelveld flint. This unequal division points to the flint knapper(s) having a preference for Orsbach flint as raw material for the manufacturing of burins. The working edge of 16 burins was made on the proximal part and of ten burins on the distal part of blades. Of five broken ends of burins, the position of the working edge could not be determined (table 4.15).

Burins on a break:
This type of burin is represented by only three pieces. They are one broken piece of Simpelveld flint, one broken piece of Valkenburg flint, and one broken end of Orsbach flint. The burin of Simpelveld flint was made of a long, regular blade and has a (remnant) length of 8.1 cm (fig. 4.10-7). A burin spall was removed on the distal end. The blade has no retouch on the edges. The only burin of Valkenburg flint was

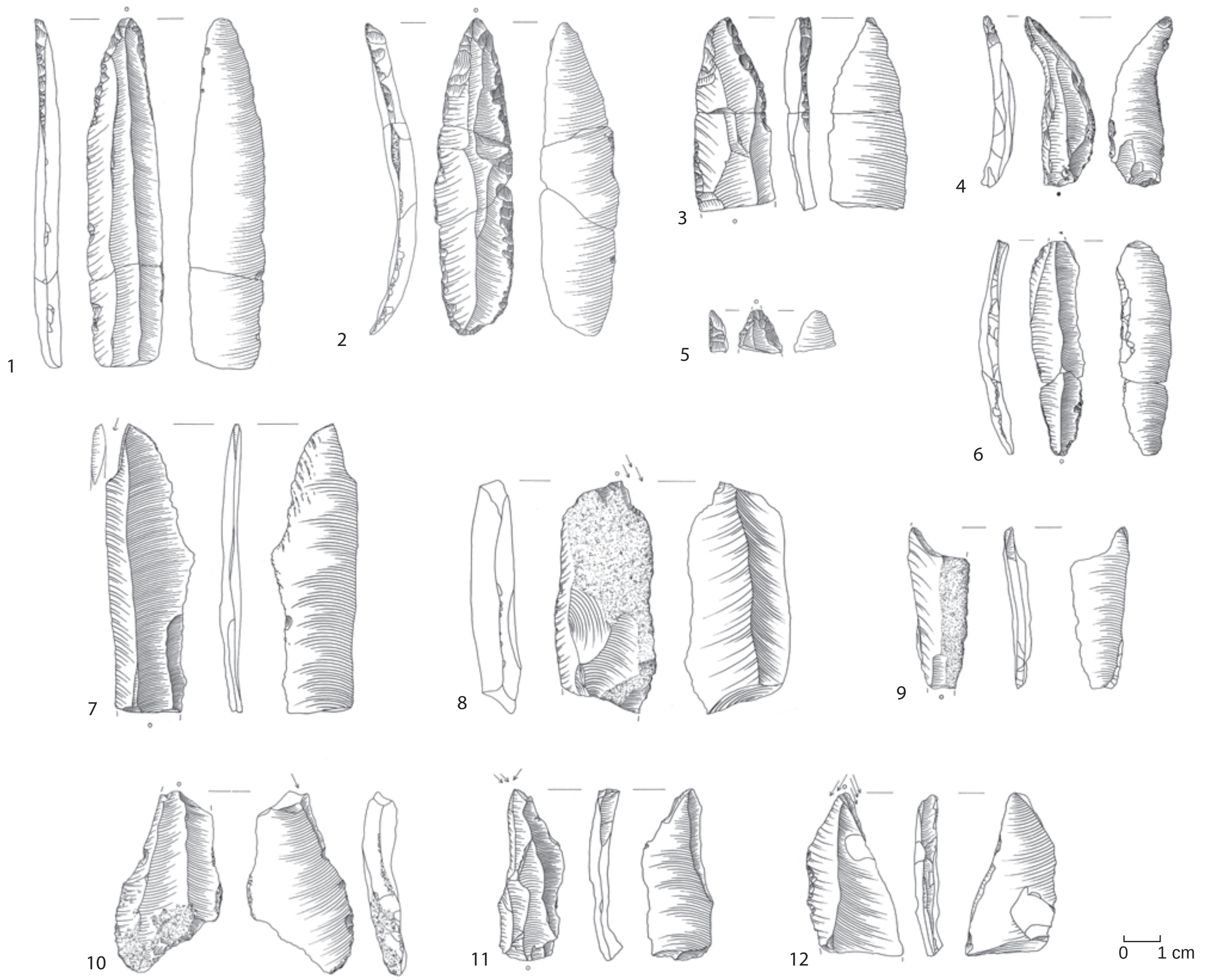


Figure 4.10 1-5 borers and becs; 6 composite tool; 7-8 burins on a break; 9-10 broken burins; 11-12 dihedral burins (scale 1:2).

not made from a blade but from a waste piece, the dorsal surface of which consists of more than 50% cortex remains. On the thick end of this piece a burin spall was removed (fig. 4.10-8). Also visible are step-wise, in the shape of a succession of step fractures, the ends of negative scars of three burin spalls removed earlier. The burin tip has traces of abrasion probably as a result of use. A burin on a break of Orsbach flint was made of a thick flake and is also chipped at the working edge.

Dihedral burins:
With 21 pieces the dihedral burins are the best represented type of burin in Eyserheide. Of this number, 15 pieces are made of Orsbach flint. The other dihedral burins are made of South-Limburg flint (n=5) and Simpelveld flint (n=1). On many burins are visible the negative scars of two burin spalls which together form a chisel-shaped burin tip. There are also dihedral burins of which the working edge has been repeatedly resharpened. The clearest example is a broken dihedral burin of Orsbach flint from which at least seven burin spalls were removed: from the left side three burin spalls and from the right side four (fig. 4.11-7). Of six dihedral burins of Orsbach flint only the broken-off working edge has been found (fig. 4.11,10-15).

The dihedral burins are further subdivided into *burins dièdres d'axe médians* (30), *burins dièdres d'axe déjetés* (30bis) and *extrémités de burins d'axe dièdres* (30ter).

End scrapers				
Type of flint	Proximal	Distal	Indet	N
Simpelveld flint	1	1	.	2
South-Limburg flint	.	8	.	8
Orsbach flint	1	1	.	2
Total	2	10	.	12

Dihedral burins				
Type of flint	Proximal	Distal	Indet	N
Simpelveld flint	1	.	.	1
South-Limburg flint	3	1	1	5
Orsbach flint	10	2	3	15
Total	14	3	4	21

Burins				
Type of flint	Proximal	Distal	Indet	N
Burins on a break	1	1	1	3
Dihedral burins	14	3	4	21
Burins on truncation	.	2	.	2
Lacan burins	.	2	.	2
Becsteker	.	1	.	1
Broken burins	1	1	.	2
Total	16	10	5	31

Table 4.15 Position of the working edge of blade end scrapers and dihedral burins (per flint type) and of the total number of burins made of blades per burin type. Counts after refitting of broken pieces.

30: *Burins dièdres d'axe médians*

In *burins dièdres d'axe médians* is the burin tip created more or less on the longitudinal axis of the blade. Of eleven burins of this type, seven pieces are made of Orsbach flint and four pieces of South-Limburg flint. In all cases the burins were made on blades with thicknesses between 0.5 and 1 cm. In eight burins is the working edge made on the proximal part of the blade and in three pieces on the distal end.

A fine example of a complete and regular shaped burin is made of South-Limburg flint. The artefact has a solid, broad (0.8 cm) working edge and retouch on the left lateral edge near the bulb of percussion (fig. 3.3-4). The right lateral edge shows traces of abrasion. Such traces are also present on the central dorsal arris, especially near the medial part towards the working edge. It possibly concerns here damage as a result of hafting. Another example of a burin of South-Limburg flint is 259A 1 (fig. 4.11-1). The tool was made on a large, broad blade of Rijckholt flint (Lanaye flint) and exhibits on the proximal part the scars of respectively one and three burin spalls. The opposite side shows intentional retouch. We are possible dealing here with a second, broken-off (scraping?) working edge and it was originally a composite tool. Two regularly shaped burins (51/195 16 and 53/202 81) are made of Orsbach flint. The former burin shows abrasion on the working edge which is the result of the removal of a burin spall. In the first instance on the right side and subsequently on the left lateral edge (small negative scar of bulb of percussion preserved) a burin spall was removed. The other dihedral burin (53/202 81) displays the scars of respectively four and three burin spalls and was resharpened several times (fig. 4.11-7). Both on the working edge and on the lateral edges are traces of abrasion visible. A burin of Orsbach flint with retouch on both lateral edges, from the middle of the artefact to the negative scars of the burin spalls, is burin 54/204 24 (fig. 4.11-6). Because of the presence of retouch it concerns possibly originally a burin on truncation or Lacan burin that was transformed into a dihedral burin (cf. transformation burins in Orp-le-Grand, Vermeersch et al. 1987, 32).
The working edge was created on the proximal part.
The opposite side shows a complete and semi-circular distal end (feather).

30bis: *Burins dièdres d'axe déjetés*

Burins of which the burin tip lies outside the longitudinal axis of the blade have been described as *burins dièdres d'axe déjetés.* Four pieces of these have been found at Eyserheide, among which one complete (53/200 1) and two broken pieces of Orsbach flint. The complete piece has the burin tip on the proximal part and a complete, tapering distal end (fig. 4.11-4). The artefact was made on a crested blade and has a length of 8.7 cm. A burin spall was removed from the left top. The negative scar of this is 'semi-circular', and is more or less perpendicular to the negative scar of a second burin spall that was removed parallel to the central axis and from the top. The tool slightly brings to mind a busked burin. Also the end of burin 57/199 5 has these characteristics, with the difference that on this burin are visible the negative scars of several burin spalls. On the third burin (259A 3), the working edge is also made on the proximal part (fig. 4.11-9). The negative scars of two burin spalls can be found on the ventral side of the artefact.

A burin made of Simpelveld flint (51/202 12) has at the top a small non-patinated break and thus was broken off recently (fig. 4.11-3). Therefore it is not clear whether we are dealing here with a *burin dièdre d'axe médian* or a *burin dièdre d'axe déjeté*. Also the working edge of this artefact was made on the proximal part of a blade. On the left, lateral edge is visible a small notch and 'use retouch'. The artefact is broken and has a (remnant) length of 8.1 cm and a thickness of 0.9 cm.

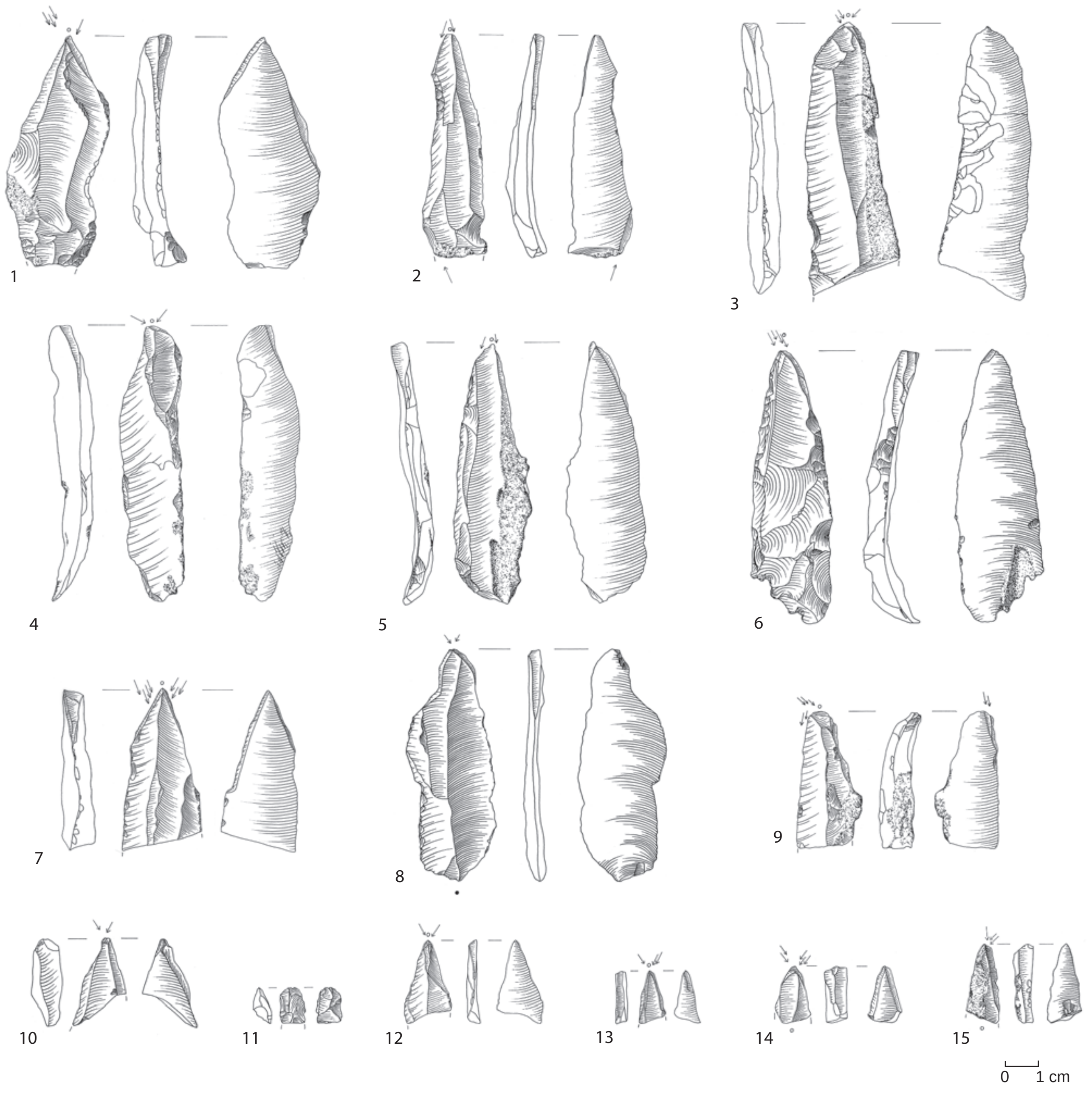


Figure 4.11 1-9 dihedral burins; 10-15 ends of dihedral burins (scale 1:2).

30ter: *Extrémités de burins d'axe dièdres*
Broken-off working edges of dihedral burins are represented by six pieces, five of which are of Orsbach flint (fig. 4.11-10-15). They underline the importance of Orsbach flint for the manufacture of burins at the site of Eyserheide. The dimensions vary from 1.0 to 2.7 cm. In all cases it seems to concern broken working edges of *burins dièdres d'axe medians*. They could have been broken off during use or during the resharpening of the burin tip. In the latter case the attempt to remove a new burin spall has led to a fracture near the top of the working edge of the artefact (K. Sano 2010, pers. comm.).

36bis: *Burins cassés*
The type could not be determined of two fragments of burins of Orsbach flint. On artefact 259A 462 two scars, presumably of burin spalls, are visible on the left side towards the distal end. The adjacent part of the working edge is broken off and shows a conspicuous arched fracture (fig. 4.10-9). The other fragment (56/196 5) has a remnant of a burin spall on the ventral side, which rarely occurs in the group of burins of Eyserheide (fig. 4.10-10). The break displays both a non-patinated and a patinated part. The working edge was made towards the proximal part. The distal part is completely present and is relatively wide (fans out) with cortex remains.

Burins on truncation:
Compared to the number of dihedral burins, burins on truncation with three pieces occur significantly less often.

38: *Burins d'angle sur troncature retouchée*
A complete burin on truncation consists of two conjoined fragments (55/197 25 and 259A 278) and is made of Simpelveld flint. The burin has an oblique truncation (38bis) and displays on the distal part the scar of a burin spall (fig. 4.12-3). The occurrence of the small negative of the bulb of percussion shows that the burin spall was removed after the blade was already truncated by retouching. For that reason the burin has been described not as a Lacan burin but as a

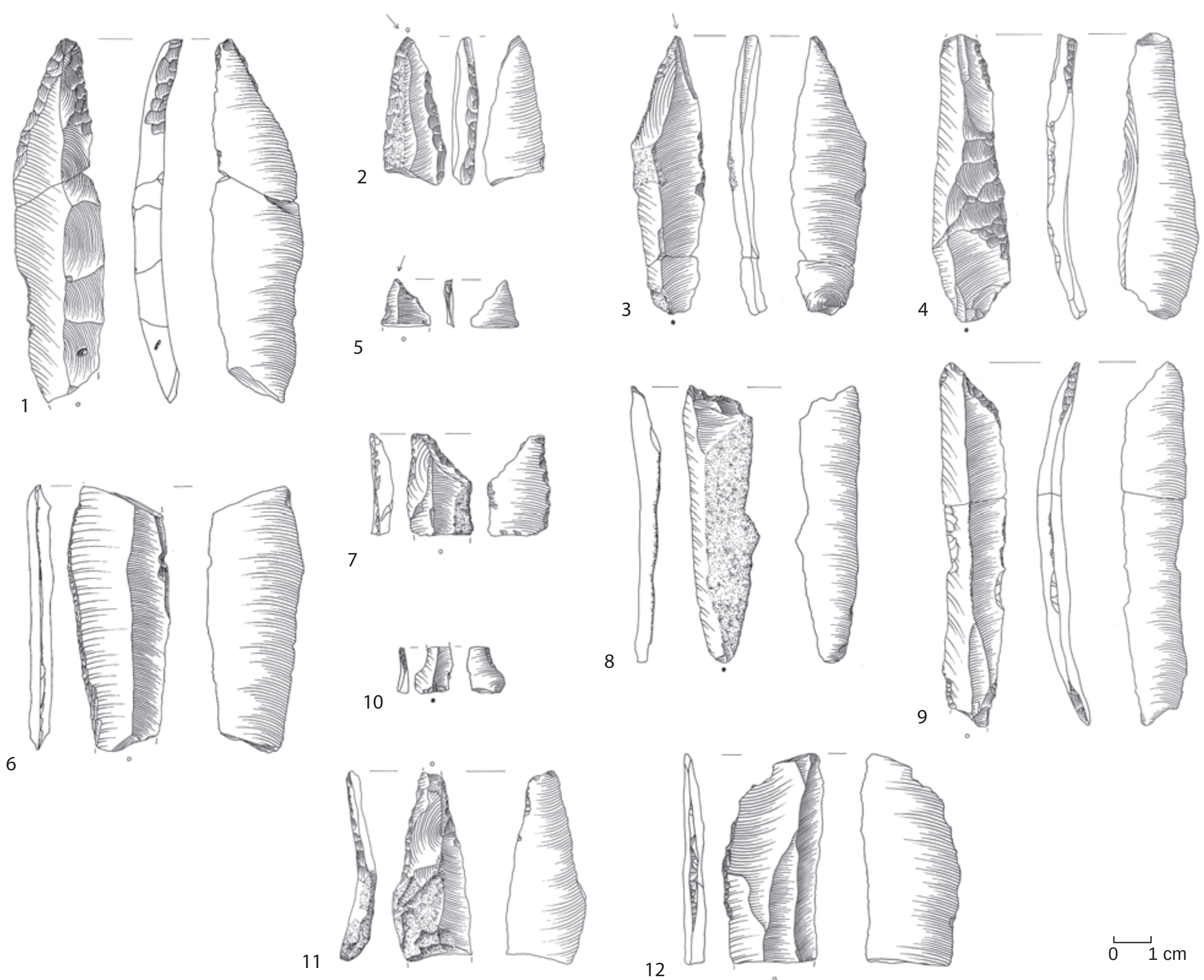


Figure 4.12 1 bec burin; 2-3 burins on truncation; 5 Lacan-burin; 4, 6-12 retouched and truncated blades (scale 1:2).

burin d'angle sur troncature retouchée oblique. The length and thickness of the artefact are 7.6 and 0.5 cm respectively. Remnants of cortex are visible on the dorsal surface.

Of the second burin on truncation (54/202 220), only the working edge has been preserved (fig. 4.12-2). Presumably this burin had intentional retouch on both long sides. Also on this artefact has the negative scar of the burin spall been completely preserved. The artefact is made of South-Limburg flint with a regular, eluvial cortex.

39: *Burins de Lacan*
There are only two Lacan burins present in the flint assemblage of Eyserheide. The first Lacan burin consists of two broken pieces (259A 399 and 54/203 41) and has a (remaining) length of 9.4 cm. The artefact is made of Orsbach flint and has halfway the dorsal surface an irregular hollow with cortex (fig. 3.3-1). The working edge shows the remnant of a scar of a burin spall. As result of retouching, a part of the negative has been removed. For this reason the artefact has been described as a Lacan burin.

The second piece (51/196 1) is the broken end of a Lacan burin (fig. 4.12-5). The end has been truncated abruptly on the right side. The left side shows the remnant of the scar of the burin spall. As with the previous find, a part of the negative scar has been removed as a result of retouching. The working edge was on the distal end of a blade (or flake?).

Bec-burin:
One tool has been described as bec-burin (fig. 4.12-1). The artefact consists of two conjoined fragments (52/201 41 and 54/202 84) and forms part of the group of South-Limburg flint (Rijckholt flint). The working edge was made on the distal part of the blade and has on both lateral edges intentional retouch that converges near the top of the artefact. Here the negative scars are visible of two small burin spalls that have been struck from the ventral side. For this reason the artefact has been classified not as a bec but as a bec-burin.

4.5.6 Other tools (figs. 4.12 and 4.13)
62: *Fragments de lames retouchées*
A total of twelve tools have been described as (fragment of a) retouched blade. They are made of Simpelveld flint (n=1), South-Limburg flint (n=8), and Orsbach flint (n=3), and down the lateral edge have been partially retouched on one side or on both. In most cases we are dealing with proximal or medial fragments of blades with a width between 2 and 3 cm. Three pieces have a width between 1.5 and 2 cm.

85: *Lamelles à dos*
The number of backed bladelets from the site of Eyserheide is low with five pieces. It concerns one complete pieces, two proximal fragments, a medial fragment and a fragment with a non-patinated break. In all pieces one of the long sides has been abruptly retouched. They are made of South-Limburg flint and Orsbach flint and vary in width from 0.5 to 1 cm. The complete backed bladelet forms part of refit group M17.00 and could be refitted onto core 56/200 4 (fig. 4.32).

Blades and flakes with 'use retouche'
Several blades (n=27) and flakes (n=9) display macroscopically visible edge damage ('use retouche') on one of the lateral edges which may point to the use of the artefact as tool. Besides, we should take into account that blades and flakes have been used but due to weathering of the surface (patina), they no longer show any visible traces of use.

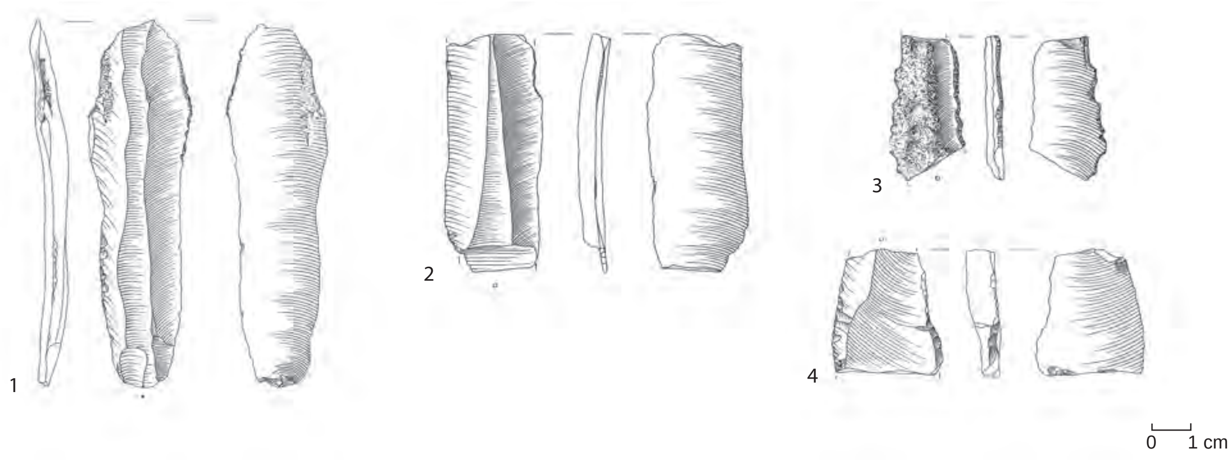


Figure 4.13 1-2 blades with edge damage ('use retouch'); 3-4 retouched blades (scale 1:2).

Complete tools

Type of tool	Max. length	Mean Length	Max. width	Mean width	N
Backed blade	50	.	10	.	1
Borer	113	88	23	21	4
Dihedral burin	87	74	26	22	5
Burin on truncation	85	81	24	22	2
End scraper	107	91	30	25	3
Total	.	.	.	.	15

Fragments of tools

Type of tool	Max. length	Mean Length	Max. width	Mean width	N
Backed blade	38	23	20	10	5
Borer	100	.	21	.	1
Bec	101	77	24	23	2
Burin on a break	81	73	31	23	2
Dihedral burins	81	54	30	23	9
Burin on truncation	94	67	22	19	2
End scraper	73	54	36	25	6
Retouched blade	79	48	29	22	11
Total	.	.	.	.	38

Table 4.16 Data on dimensions (in mm) of complete and fragments of retouched tools made of blades. Counts after refitting of broken pieces.

4.6 Description of RMUs

4.6.1 Introduction

In this part of the monograph will be described in detail technological characteristics of Magdalenian flint-working in Eyserheide. The description is made on the basis of data which can be extracted from the compositions of refitted artefacts. In 4.3 we mentioned that refitting of artefacts of Simpelveld flint and South-Limburg flint has yielded good results. In particular for several compositions of refitted artefacts incorporating a core, it has proved possible to specify further the aim and sequences of successive actions (*chaînes opératoires*; Pelegrin et al. 1988) of the flint knapper(s). These actions concern different flint-knapping stages, including the preparation and maintenance of the striking platform and the removal of blades with regular and parallel lateral edges.

In the following paragraphs the technological descriptions will be presented for each RMU. The descriptions start with those of Simpelveld flint (4.6.2), after which data of RMUs in the groups of Valkenburg flint (4.6.3), South-Limburg flint (4.6.4), and Orsbach flint (4.6.5) will be discussed. In the concluding paragraph (4.8), the results of the technological investigation of Eyserheide will be compared with data from ‘classic’ Magdalenian sites in the Paris Basin.

4.6.2 Simpelveld flint

RMU S1 (figs. 4.14 and 4.15; table 4.17)

General:

RMU S1 comprises 41 refitted artefacts which together form refit group S1.00. The central component in this RMU is blade core 259A 108, onto which 39 artefacts could be fitted. RMU S1 thus represents the largest and most complete composition of conjoined artefacts in Eyserheide. The artefacts of refit group S1.00 together have a weight of 903 grams. The weight of the core is 414 grams. Its dimensions are: length 12.0 cm, width 7.7 cm, and thickness 3.9 cm.

Raw material:

Core 259A 108, including a small conjoined core fragment (56/201 12), and 39 refitted (fragments of) artefacts have been made from a tabular nodule of grey-black and moderately fine-grained Simpelveld flint. On the basis of the composition of conjoined artefacts, the piece of flint had at the start of the flint-knapping a minimal length of 22 cm and a minimal width of 10 cm. The slab had an eluvial cortex that in general was regular and smooth. At the top of the flint slab was a bulge that was removed in the first stage of core reduction.

Figure 4.14 Refit group S1.00. Composition of artefacts with core 259A 108 of Simpelveld flint. a = complete composition, b = front of core, c = back of core, d = composition of flakes and blades refitted onto the front of the core (scale 1:2).

Core:
Blade core with two opposite striking platforms and two opposite core faces (*nucléus à deux plans de frappe pour débitage sur faces opposées*). The two core faces are on the narrow sides of the flint slab and form the front and backs of the core. The striking platforms were made at the top and base of the slab. Both flanks of the core consist mainly of cortex, and in addition the negative scars of some decortication flakes are visible on the right side. In the reduction of the core, four different faces (striking platforms) were used, namely two at the top and two at the base of the core. As a result of this working practice, the form of the core is slightly lozenge-shaped. On the front of the core (core face 1), an irregular hollow is visible. The base of the core consists of a conspicuous V-shaped point. This point is the result of the presence of an oblique core face on the back of this part of the core.

Technology:
From the composition of refitted artefacts emerges that in an early stage of core reduction, the narrow top of the flint slab was worked. Here the irregular end of the slab was reduced by the removal of a decortication flake (KA7 in fig. 4.15). Subsequently, smaller flakes, of which KA6 to KA4 could be refitted, were alternately removed from the top. Also KA3 was probably struck in this stage, but from the front and more towards the central part of the core. The working of the top led to a wide and irregular core crest over a length of c. 9 cm. On the back of the core, a striking platform was made (striking platform 1) with the aim of removing the core crest. Artefacts connected with the creation of this striking platform have not been retrieved, c.q. do not form part of refit group S1.00. The removal of the crest has resulted in crested blade KA2 and an oblique side on the top of the core. This side has subsequently served as striking platform (striking platform 2) for the removal of blades from the narrow back of the core.

Prior to removal of blades from the back of the core, preparation of the core face was carried out. The two flakes KB6 and KB5 are also the result of this preparation. From striking platform two consecutive blades (KB4, KB3) were

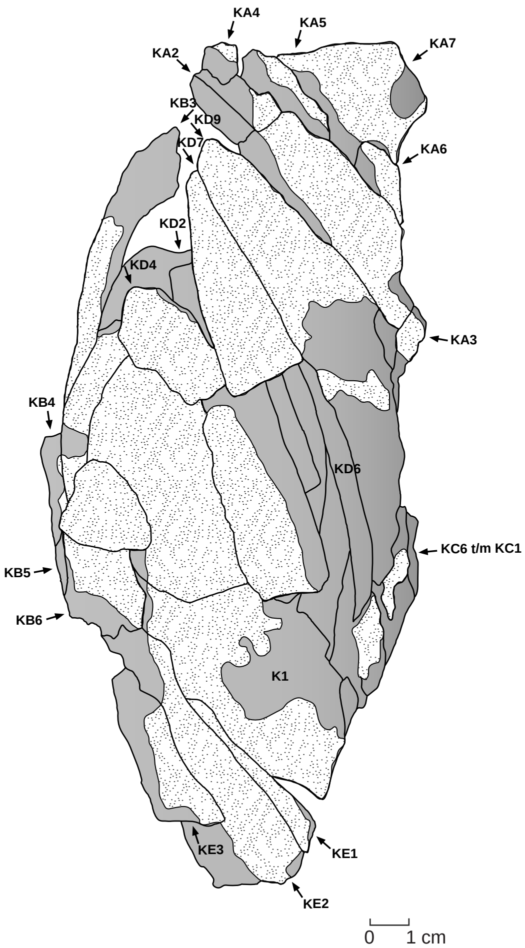


Figure 4.15 Refit group S1.00. Compositions of artefacts refitted onto core 259A 108 (scale 1:2). The codes (KA7, etc.) correspond to the codes mentioned in table 4.17, the arrows indicate the direction of debitage of the refitted artefacts (scale 1:2).

subsequently removed with lengths between c. 8 and 12 cm. In the refit group, the proximal part of KB3 extends above the striking platform as that was present at the time of discard of the core. From this can be inferred that the striking platform was repeatedly prepared again and/or rejuvenated. Presumable KB4 and KB3 were not the first blades to be struck from the back of the core. In fact, on the dorsal surface of KB4 a remnant of a blade negative is visible that points to the removal of one or more blades from the *base* of the core, prior to the removal of KB4 from striking platform 2 on the *top*. Possibly these artefacts (absent in refit group S1.00) were the first blade products of the core. As a result of continued working, the negative scars of artefacts, removed during earlier stages of core reduction from the narrow back, are no longer visible. For this reason nothing can be said about these early stages of flint working and the corresponding knapping (blade) products.

In the next stage, core preparation was carried out on the front and halfway the flint slab, and a core crest was made. The negative scars of the flakes hereby removed are visible on the dorsal side of crested blade KD9. Halfway the front of the core, six flakes (KC6 to KC1) could be refitted that are connected to the above-mentioned preparation of the core crest. As a result of the tabular structure of the flint and the direction of debitage perpendicular to the narrow side, the flakes have cortex remains on both the butt and the distal end. The flakes were removed before crested blade KD9 was struck off.

In a next stage striking platform 1 was rejuvenated. From this platform a series of at least six blades were struck, always with interim preparation: crested blade KD9, blade KD8 of which the distal end is missing, blade KD7 of which the proximal part was found, complete blade KD6, and two blades of which the distal ends (KD5 and KD4) could be refitted onto the core. The ends of some of the blades ‘disappear’ under preparation flakes KC6 to KC1 on the front of the core. The series of blades was not completely recovered. Between the above-mentioned, refitted blades and two later removed blades KD2 and KD1 is an open space of ‘missing’ blades visible. In this stage of *plein débitage*, the core face shifted gradually from the narrow front to the broader left flank of the core. This explains the presence of cortex on the dorsal surface of blades KD2 and KD1. Thereafter a few more blades were removed from the narrow front (= original location of core face 1). The last specimen of these ended in a step fracture. Abrasion on the left top of the core face further indicates a less careful working practice. And finally, a part of the left flank of the core has split off, probably as a result of the presence of a frost crack.

The flint knapper then continued the process at the base of the core. After removal of some preparation flakes halfway the back and the creation of a new striking platform (striking platform 4), a series of rather broad blades were struck from the base. The width of these blades is equal to the width of the flint slab. Of these KE3 to KE1 have been retrieved and could be refitted onto the narrow back of the base of the core. Striking platform 4 corresponds with a number of negative scars of long, narrow blades up to the hollow on the front and base of the core. These (not retrieved) blades were presumably removed earlier than KC6 to KC1. They thus reflect a non-documented stage of blade production prior to stage E.

Tools:
Retouched tools are not represented in refit group S1.00.

RMU S1								
Refit group S1.00	PRS	Artefact type	(In)complete	Length	AFW	WAC	SPB	Remarks
54/202 119	KA7	flake prim.	complete	43	A1	upper side	.	decortication
55/202 78	KA6	flake sec.	complete	32	B2	upper side	.	preparation crest
52/198 1	KA5	flake tert.	complete	27	B2	upper side	.	preparation crest
54/202 64	KA4	flake sec.	incomplete	17	B2	upper side	.	preparation crest
55/202 151	KA3	flake tert.	incomplete	36	B2	upper side	.	preparation crest
55/202 86–54/202 135	KA2	crested blade sec.	complete	93	C1	core face 1	platform 1	.
54/202 133	KA1	flake tert.	incomplete	35	B2	upper side	.	.
56/200 30–53/199 15	KB6	flake prim.	incomplete	38	D3	back	.	maintenance core face 2
54/203 6	KB5	flake tert.	complete	28	D3	back	.	maintenance core face 2
259A 139	KB4	blade tert.	distal	37	C1	core face 2	platform 2	1st generation
53/203 73	KB3	blade tert.	complete	82	C2	core face 2	platform 2	1st generation
52/200 5	KB2	crested blade sec.	medial	51	C1	core face 2	platform 2	1st generation
54/202 127	KB1	flake sec.	complete	51	B	back	.	preparation flake?
259A 146	KC6	flake tert.	incomplete	31	B3	front	.	preparation crest
55/201 5	KC5	flake sec.	incomplete	21	B3	front	.	preparation crest
55/202 126	KC4	flake tert.	incomplete	26	B3	front	.	preparation crest
55/203 60	KC3	flake sec.	incomplete	26	B3	front	.	preparation crest
55/202 88	KC2	flake tert.	complete	29	B3	front	.	preparation crest
61/201 1	KC1	flake tert.	complete	20	B3	front	.	preparation crest
54/202 164	KD9	crested blade sec.	complete	124	C1	core face 1	platform 1	2nd generation
53/201 12–54/202 193	KD8	blade tert.	proximal	82	C2	core face 1	platform 1	2nd generation
54/199 1	KD7	blade sec.	proximal	59	C2	core face 1	platform 1	2nd generation
55/202 120	KD6	blade tert.	complete	127	C2	core face 1	platform 1	2nd generation
55/202 130	KD5	blade tert.	distal	83	C2	core face 1	platform 1	2nd generation
54/202 27*54/202 33	KD4	blade tert.	distal	94	C2	core face 1	platform 1	2nd generation
259A 411	KD3	flake prim.		32	A1	left flank/core face 1	.	
54/204 62–55/202 80	KD2	blade sec.	medial	93	C2	left flank/core face 1	platform 1	2nd generation
53/202 106	KD1	blade tert.	distal	43	C2	left flank/core face 1	platform 1	2nd generation
54/202 157–52/200 3	KE6	crested blade	distal	106	C1	back	platform 3	3th generation
259A 389	KE5	blade tert.	proximal	28	C2	back	platform 3	3th generation
55/202 25	KE4	blade tert.	proximal	65	C2	back	platform 3	3th generation
55/201 25	KE3	blade tert.	medial	44	C2	back	platform 3	3th generation
54/202 100	KE2	blade sec.	complete	94	C2	back	platform 3	3th generation
53/202 1	KE1	flake tert.	complete	57	C2	back	.	hinge fracture
259A 108 * 56/201 12	K1	core	complete		E	.	.	discard core

Table 4.17 Reduction sequence of core 259A 108 (refit group S1.00), length of artefacts in mm.
PRS: position in refit sequence; AFW: activity of flint working; WAC: working area of core; SPB: striking platform used for blade production.
A: decortication, A1= removal decortication flake, A2= removal decortication blade; B: preparation and shaping, B1= creation of striking platform, B2= creation of crest, B3= removal of preparation flake, (rough) shaping of core; C: blade removal (*plein débitage*), C1= removal of crested blade, C2= blade removal; D: maintenance and improvement, D1= maintenance and correction of striking platform, D2= maintenance and correction of core flank, D3= maintenance of core face (extraction table), D4= rejuvenation, removal of rejuvenation flake, including core tablet; E: core discard.

RMU S2 (figs. 4.16 and 4.17; table 4.18)
General:
RMU S2 consists of 24 conjoined artefacts that together form refit group S2.00. In this large composition core 259A 321 is the central component. The total weight of refit group S2.00 is 1015 grams. The dimensions of the core are: length 10.0 cm, width 8.7 cm, and thickness 5.0 cm. The core weighs 826 grams and is twice as heavy as core 259A 108 in RMU S1.

Raw material:
Core 259A 321 and 23 refitted (fragments of) artefacts were struck from a tabular piece of grey-black Simpelveld flint. On the basis of the composition of conjoined artefacts, we can assume the following dimensions of the piece of flint: length > 15 cm, width > 9.1 cm, and thickness 5.4 cm. The flint has a very homogeneous, eluvial cortex in which some hollows and inclusions up to 1 cm in diameter are present. The flint is moderately fine grained. On the base and back of the core, two small, black-grey natural (non-worked) surfaces are visible. The patina of the flint is grey-blueish, and shows the for Simpelveld characteristic grey-white banding. Parallel to these a few frost cracks are visible, parallel to the longitudinal direction of the flint slab.

Core:
Blade core 259A 321 with one striking platform and one narrow (long) side used as core face for the removal of blades. The flanks of the core consist mainly of cortex, in particular the left flank is covered with cortex (fig. 4.16). On the right flank, negative scars of flakes are also visible. The back displays traces of rough shapening of the core. Here are amongst others present the negative scars of two large flakes and two natural (non-worked) surfaces. The left back consists of a core crest that is partly the result of the removal of the two large flakes. Along the edge, the negative scars of smaller flakes are also visible. The base of the core is also roughly, bifacially knapped and ends in a crest on the intersection of two worked surfaces (*partie distale en arrête*).

The core face is flat to slightly convex in shape. Also the negative scars of blades on the core face point to the use of one striking platform. This striking platform is to a large extent flat, towards the edge of the core face the striking platform is more irregular and at the edge even abraded ('dented'). One of the blade negatives on the core is 9.3 cm long and 2.5 cm wide.

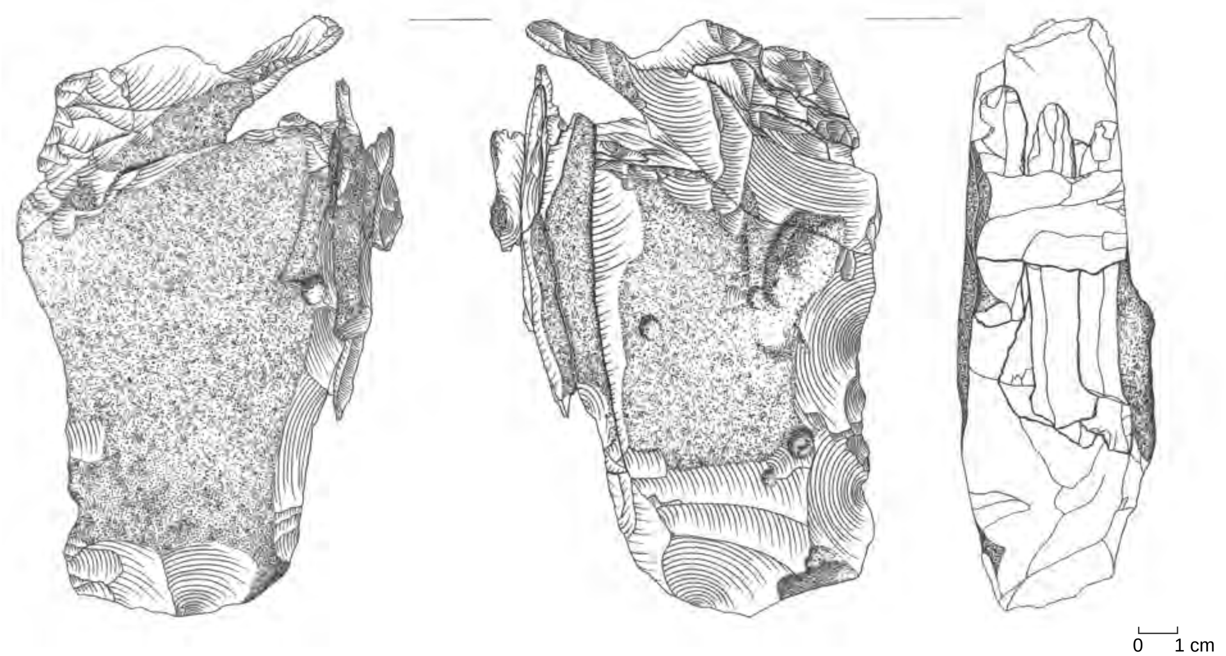


Figure 4.16 Refit group S2.00. Composition of artefacts refitted onto core 259A 321 of Simpelveld flint (scale 1:2).

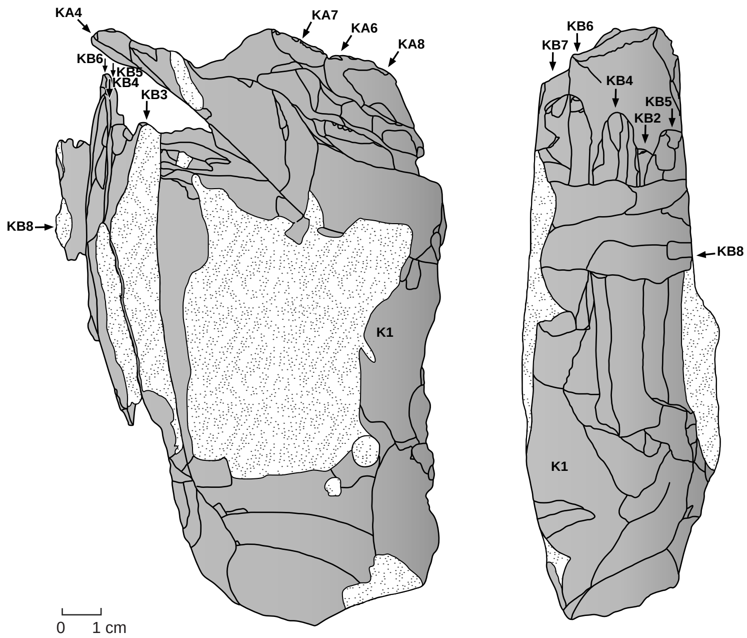


Figure 4.17 Refit group S2.00. The codes (KA7, etc.) correspond to the codes mentioned in table 4.18, the arrows indicate the direction of debitage of the refitted artefacts (scale 1:2).

Technology:
There are no indications of decortication of the core on the site itself. Artefacts with more than 75% of cortex remains on the dorsal surface are missing in refit group S2.00. It should be mentioned that the flanks of the core have only partially been stripped of cortex. On top of the core four flakes (KA8 to KA5) could be fitted which were all removed from the right flank. This part of the flank was, in this stage of flint working, already stripped of cortex by the removal of relatively large flakes from the top of the core. The negative scars of these flakes were used as striking platform for removal of the above-mentioned sequence of four refitted artefacts. The last flake to be removed (KA5) is connected with the creation of a core crest by alternately removing flakes at the top of the core. By the removal of robust crested blade KA4, the core was 'decapitated' for making a striking platform. This blade clearly extends above the core face which points to interim preparation of the striking platform and reduction of the core face as a result of the removal of blades.

KB9 and KB8 are fine examples of flakes connected with the preparation of the narrow core face of the core. They were struck perpendicular to the longitudinal direction of the flint slab and their aim was to optimise the convexity of this surface. As a result of the tabular shape of Simpelveld flint, both flakes have cortex on both the butt and the distal end (see also composition S1.00). Next, from the core face were struck several blades with a length of c. 8 to 10 cm. KB4 lies more centrally on the core face and has no cortex remains. Nearer to the cortex-covered flanks, a few blades were removed (for instance KB5) with a relatively wide back that mainly or completely consists of cortex. Insofar as present, the butts of the blades are smooth (*lisse*). Also the edge of the striking platform shows no indications of careful preparation in connection with the application of *en éperon* technology.

The core was discarded the moment the edge of the striking platform became heavily 'dented' and the removal of blades apparently faltered. The last blade to be struck (KB1) was removed from the left side of the core face and ends in a step fracture. At the time of discard the core was all but exhausted. Also because of the thickness of the flint slab, there was still sufficient volume for the production of one or several new series of blades.

Tools:
Retouched tools are not represented in refit group S2.00.

RMU S2								
Refit group S2.00	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
53/197 7	KA8	flake tert.	incomplete	28	B1	upper side	.	.
51/196 17	KA7	flake sec.	complete	40	B1	upper side	.	.
259A 135	KA6	flake tert.	incomplete	45	B1	upper side	.	.
49/198 2	KA5	flake tert.	incomplete	28	B2	upper side	.	preparation crest
259A 124	KA4	crested blade tert.	complete	109	C1	core face	.	.
259A 163 * 259A 155	KA3	flake tert.	?	?	.	.	.	.
49/193 5	KA2	flake tert.	incomplete	55	.	upper side	.	rejuvenation striking platform
60/199 15	KA1	flake tert.	incomplete	31	D1	upper side	.	
259A 137	KB9	flake tert.	complete	53	D3	front	.	maintenance core face
259A 150	KB8	flake tert.	incomplete	47	D3	front	.	maintenance core face
52/197 15 *259A 174	KB7	blade sec.	medial	60	C2	core face	platform 1	.
51/196 11	KB6	blade tert.	proximal	48	C2	core face	platform 1	.
52/199 16 - 259A 117	KB5	blade sec.	proximal	87	C2	core face	platform 1	.
49/196 26 – 49/196 20	KB4	blade tert.	proximal	89	C2	core face	platform 1	.
55/204 18 – 51/197 13	KB3	blade tert.	?	>120	C2	core face	platform 1	.
49/196 13 – 50/194 8	KB2	blade tert.	proximal	85	C2	core face	platform 1	.
50/196 4	KB1	blade sec.	distal	33	C2	core face	platform 1	.
259A 321	K1	core	complete	10	E	.	.	discard core

Table 4.18 Reduction sequence of core 259A 321 (refit group S2.00), length of artefacts in mm. For an explanation of the codes, see table 4.17.

RMU S3 (figs. 4.18-4.19; table 4.19)
General:
RMU S3 represents the third group of refitted artefacts incorporating a core of Simpelveld flint. The composition consists of 19 artefacts (refit group S3.00). Its total weight is 583.9 grams. Of this group, core 259A 107 forms the central component. The dimensions of the core are: length 11.3 cm, width 6.9 cm, and thickness 3.7 cm. The weight of the core is 363 grams.

Raw material:
Core 259A 107 and its refitted artefacts were made of a tabular piece of black-grey Simpelveld flint.

On the basis of the composition of conjoined artefacts, we can assume at the start of the process of knapping the following dimensions of the piece of flint: length > 19 cm, width > 8.5 cm, and thickness 3.8 cm. The flint slab originally tapered towards the end and had a smooth and regular, eluvial cortex. The flint is moderately fine grained, but there are a few coarse-grained inclusions visible with a diameter of maximally 4 mm. The striking platform displays a frost crack. The patina of the flint is grey to blue-grey.

Core:
Core 259A 107 has one core face and two opposite striking platforms (fig. 4.18). The striking platform at the top of the core forms the remnant of an originally clearly larger striking platform and is oblique to the core face. The opposite striking platform at the base still extends over the full width of the core and is more or less perpendicular to the core face. As in the other cores of Simpelveld flint, the core face was made on the narrow front of the flint slab. As a result of several step fractures, its surface is irregular. The left flank consists only for a small part of cortex remains, and in addition on this flank the negative scars of a few relatively short and wide blades are visible. The right flank is less worked and consists almost entirely of cortex. The back is roughly knapped and shows a conspicuous concave core crest which is worked on one side (unilateral). During the knapping of this side, cortex parts were removed to a large extent. We have the impression that the dimensions of the core have been strongly reduced by actions connected with core rejuvenation and blade production. Originally the core was probably significantly larger.

Technology:
From a technological point of view, refit group S3.00 offers interesting information because the way differs in which the two striking platforms were made. The first knapping of the core probably took place outside the excavated area. With the exception of KA9, decortication flakes are missing in refit group S3.00. The removal of core tablet KA9 has resulted in a striking platform (striking platform 1) over the full width of the top of the core. The core tablet was struck from the narrow front of the core in such a way that an oblique split towards the back of the core was achieved. There are no indications of the creation of a crest (*crête longitudinal*) on the front of the core (core face) prior to the phase of *plein débitage*. A crested blade (KA8) could be refitted onto the core face and displays traces of preparation of the then edge of the core face, whereby cortex was removed. This preparation probably served to steer (again) the blade production, after a series of blades had already been removed. As in crested blade KA8, the subsequently

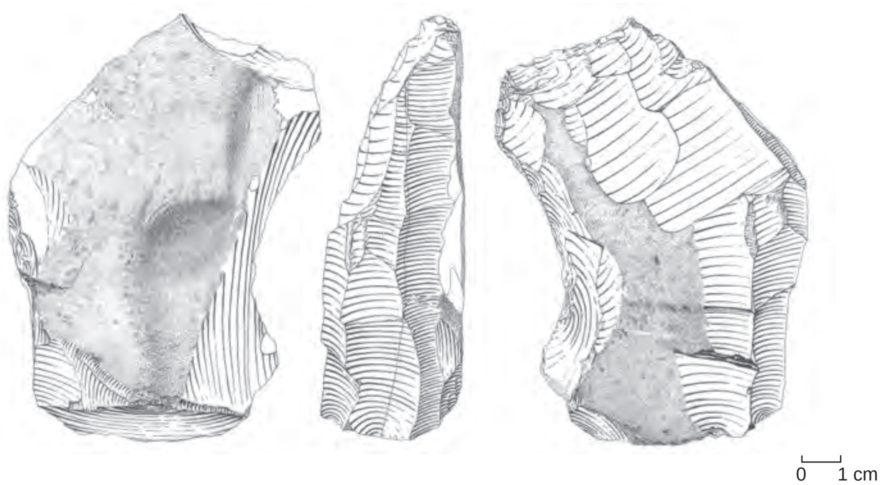


Figure 4.18 Core 259A 107 of Simpelveld flint (scale 1:2). Drawing: J. Nederlof.

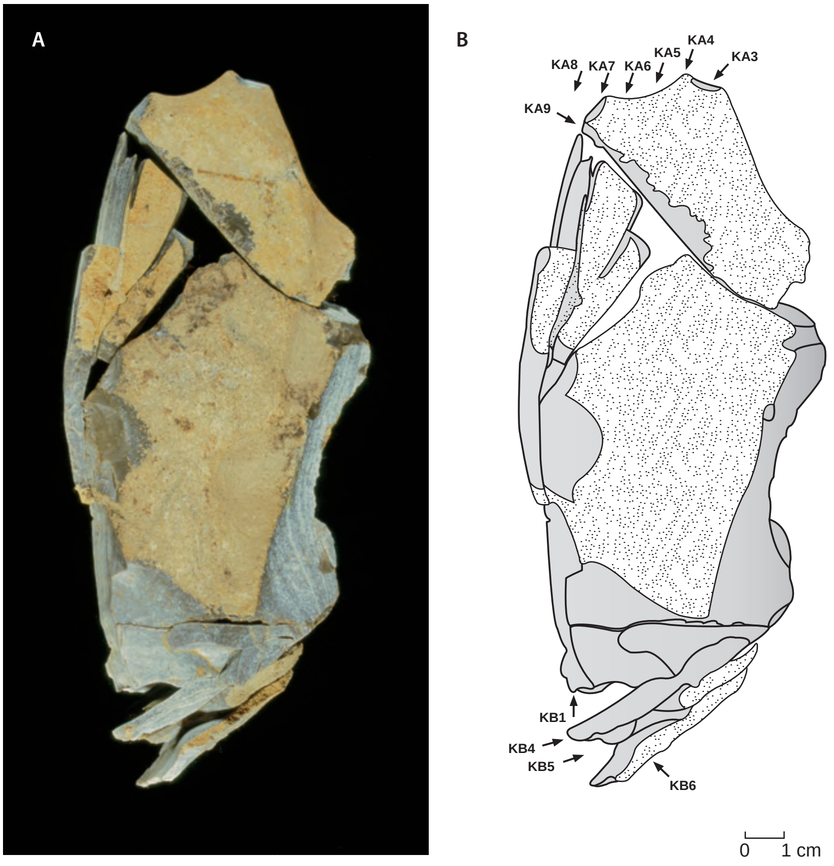


Figure 4.19 Refit group S3.00. Composition of artefacts refitted onto core 259A 107 of Simpelveld flint (a). The codes (KA7, etc.) in b correspond to the codes mentioned in table 4.19, the arrows indicate the direction of debitage of the refitted artefacts (scale 1:2).

removed blade (KA7) had a length of minimally 10 cm. Yet this series of blades does not represent the first stage of blade production of core 259A 107. For on the dorsal surfaces of KA8 and KA7, a part of the negative scar of a blade is visible that was removed in an earlier stage from the *base* of the core. This blade had a length of at least 15 cm. The negative scar demonstrates that the phase of *plein débitage* occurred earlier, from the base of the core. Blades connected with this phase of blade production are not represented in refit group S3.00.

After the removal of KA8 and KA7, blades were removed with lengths of less than 10 cm (KA6 and KA5). Subsequently the flint knapper removed two thick, blade-like flakes, at which time the striking platform was not prepared further and he presumably switched to the use of a hard hammerstone. An indication of this is blade-like flake KA4, of which the butt measures 1.5 × 1.5 cm. The negative scars visible on the core face and the adjacent part of the left flank belong to the artefacts last struck from striking platform 1. They point to thick, somewhat widely fanning-out flakes with lengths of less than 6.5 cm.

After this series of blades and blade-like flakes, the base of the core was used (again!) as striking platform. The refitted flakes KB7 to KB2 show a fine sequence of larger flakes that are connected with the preparation of this striking platform. They were removed from different positions on the core: KB6 from the right flank, KB5 and KB4 from the front (= side of the core face), and KB2 from the left flank. The latter flake has been described as a core rejuvenation flake. By removing this flake, the then striking platform was completely obliterated. From striking platform 2 several artefacts were struck, with regular interim rejuvenation of the striking platform. In the last stage of flint knapping, using striking platform 2 no longer yielded the desired results, namely long blades with regular lateral edges. Step fractures on the core face attest to failed attempts to remove

RMU S3								
Refit group S3.00	PRS	Artefact	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
259A 151	KA9	flake prim. scraper	complete	77	A1	upper side	.	decortication
55/202 138	KA8	crested blade tert.	distal	71	C1	core face	platform 1	1st generation
55/202 19 – 56/201 32	KA7	blade tert.	proximal	103	C2	core face	platform 1	1st generation
53/202 105	KA6	blade tert.	distal	44	C2	core face	platform 1	1st generation
59/202 5	KA5	blade tert.	proximal	29	C2	core face	platform 1	1st generation
54/202 162	KA4	blade tert.	complete	70	D3	core face	.	correction convexity of core face?
56/205 6	KA3	blade tert.	medial	43	C2	core face	.	correction convexity of core face?
58/199 2	KA2	blade tert.	complete	35	C2	left side/core face	platform 1	failure (step fracture)
58/202 11	KA1	blade sec.	complete	55	C2	left side/core face	platform 1	.
55/204 34	KB7	flake tert.	complete	17	B1	bottom	.	preparation platform 2
54/202 79	KB6	flake sec.	complete	31	B1	bottom	.	preparation platform 2
259A 130	KB5	flake sec.	complete	55	B1	bottom	.	preparation platform 2
57/204 20	KB4	flake tert.	complete	57	B1	bottom	.	preparation platform 2
53/203 61	KB3	flake tert.	complete	18	B1	bottom	.	preparation platform 2
58/204 1	KB2	rejuvenation flake tert.	complete	40	B1	bottom	.	rejuvenation platform 2
57/203 15	KB1	flake tert.	complete	37	C2	core face	platform 2	blade failure (step fracture)
259A 157	KC1	flake tert.	complete	22	B2	back	.	
259A 107	K1	core	complete	113	E	.	.	core discard

Table 4.19 Reduction sequence of core 259A 107 (refit group S3.00), length of artefacts in mm. For an explanation of the codes, see table 4.17.

blades. One of these 'blades' (KB1) is 3.7 cm long and could be fitted onto the core. The core was discarded the moment the surface of the core face was very irregular. The desired, convex shape of the core face had by then completely disappeared.

Tools:
There is a retouched artefact in refit group S3.00, namely a scraper made on the thick decortication flake (KA9) that was removed from the top of the core.

RMU S5 (fig. 4.20; table 4.20)
General:
RMU S5 consists of four small groups of conjoined artefacts of Simpelveld flint. Refit group S5.01 comprises 14 flakes, together weighing 171 grams. Refit group S5.02 is made up of 15 artefacts and weighs 156 grams. Refit groups S5.03 and S5.04 consist respectively of two and three artefacts. On the basis of identical characteristics of the flint, including the cortex, the four refit groups have been assigned to one and the same RMU. No core is present.

Raw material:
As no core has been recovered, it cannot be determined whether a tabular piece of flint had been used. Also the original (minimum) dimensions of the piece of flint are not known. A few artefacts have cortex remains on the distal end which could be an indication of working of tabular flint (compare RMUs S1 to S3). The flint is moderately fine grained and is characterised by an eluvial cortex, the surface of which is however different from that of the other RMUs in the group of Simpelveld flint. There are more irregular hollows and bulges, and moreover the cortex still feels 'fresh' in some places. Locally there are inclusions with a diameter of more than 1 cm. The patina of the flint is grey-white to olive green-black with respectively grey and white-grey small specks and dark bands and surfaces. Frost cracks and frost surfaces are lacking in the artefacts of refit groups S5.01 to S5.04.

Assigning RMU S5 to the group of Simpelveld flint was done on the basis of the presence of an eluvial cortex, bands and lamination. However, on many artefacts these bands and the lamination are absent or are far less pronounced than in RMUs S1 to S3.

Core:
No core has been retrieved.

Technology:
Because of the absence of the core, it is not known where the artefacts of refit groups S5.01 to S5.04 were originally located in respect of the core (for instance at the top or at the base). It also cannot be determined to which type of core the series of refitted artefacts are connected.

In refit group S5.01, first a large flake (PA14) was removed from the 'right flank'. This artefact has cortex on both the distal end and on the butt. After the removal of this (striking platform?) preparation flake, first from the 'top' and then from the 'left flank' four smaller flakes (PA13 to PA10) were removed. Possibly they are related to the preparation of a core face. In the next stage of core reduction, a few blades or flakes were struck from the core face (not retrieved). Thereafter the striking platform was completely rejuvenated by removing thick core rejuvenation flake PA9 from the left edge of the core face. In a second attempt at rejuvenating the striking platform, a large part was removed of the (future) striking platform and the left flank with cortex. The distal end of this flake PA8 is completely covered with cortex and fans out thickly in this place. Next a correction of the striking platform and/or core face has taken place by removing the relatively small flakes PA6 and PA5. Also four flakes that were subsequently removed (PA4 to PA1) have relatively small dimensions and are probably related to this correction.

The second sequence of refitting artefacts (refit group S5.02) starts with broken flake PB13. This flake and several, in a later stage removed, artefacts have cortex remains on the distal part. For the removal of these artefacts use was made of one and the same striking platform. This striking platform had already been completely stripped of cortex as the butts have no cortex. In the interim the flint knapper had again prepared this side of the striking platform.

Two refitted blade fragments (refit group S5.03), a distal and a medial fragment, were also assigned to RMU S5 on the basis of patina (bands and specks) and characteristics of the cortex. Assuming that this assignment is correct then both artefacts demonstrate that the preparation of the core has led to a striking platform and core face suitable for blade production. Distal fragment 51/193 14 has a length of well over 7.5 cm and shows on the right side traces of core preparation by removal of flakes perpendicular to the striking direction of the blade. Also three conjoined flakes with cortex on the butt have been assigned to RMU S5 (refit group S5.04) on the basis of the characteristic patina.

Refit group S301 (fig. 4.21)
Composition of five refitted (fragments of) blades, incorporating one broken specimen that consists of two conjoined fragments (PA4). The blades were removed from a core with two opposite striking platforms. The blade removed first (PA5) was struck from 'striking platform 1'. Four other refitted blades were subsequently removed from an opposite 'striking platform 2'. Among these are two complete blades, of which PA1 has a length of well over

13 cm. This blade was made after *en éperon* preparation of the striking platform had been carried out. As a result of the shearing (?) of the edge of the striking platform, traces of this preparation are however no longer easy to see. The butt of the second complete blade PA4 displays two small facets but lacks the characteristics *en éperon* spurs. Notable is that both refitted broken pieces of PA4 are completely without patina (!), in contrast to the blade lying above it and the three blades lying underneath it. These blades do have the for Simpelveld characteristic grey-blue surface-covering patina.

The composition provides a good example of the systematic way of removing long blades from the narrow long side of a slab of Simpelveld flint.

Refit group S302:
Composition of three refitted blades, among which one broken specimen that consists of two refitted broken pieces (PA3). The blades have been struck from a tabular piece of flint with a very regular, eluvial cortex. With the exception of medial fragment PA2, this cortex covers the entire length of the right 'high' back of the blades. Because of this high back, the blades are triangular in cross-section. The first removed blade PA3 and blade fragment PA1 show traces of core preparation on the edge of the back and the core face, presumably with the aim of removing irregularities at the edge of the core. The three blades have all been struck from the same direction (unidirectional) and originally had

Figure 4.20 Refit groups S5.01 (b, d) and S5.02 (a, c). Compositions of refitted flakes of Simpelveld flint assigned to RMU S5 (scale in cm).

RMU S5

Refit group S5.01	PRS	Artefact	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
53/200 36	PA14	flake tert.	complete	48	B	Indet	.	.
53/200 62	PA13	flake tert.	complete	35	B	Indet	.	.
52/200 20	PA12	flake tert.	incomple	29	B	Indet	.	.
53/200 46	PA11	flake tert.	complete	39	B	Indet	.	.
53/200 81	PA10	flake tert.	complete	29	B	Indet	.	.
53/200 37	PA9	flake tert.	complete	57	B	Indet	.	.
53/200 63	PA8	flake sec.	complete	46	B	Indet	.	.
52/200 23	PA7	flake sec.	complete	48	B	Indet	.	.
53/200 104	PA6	flake tert.	complete	28	B	Indet	.	.
259A 172	PA5	flake tert.	complete	32	B	Indet	.	.
53/200 97	PA4	flake tert.	complete	34	B	Indet	.	.
53/200 71	PA3	flake tert.	complete	33	B	Indet	.	.
52/200 22	PA2	flake tert.	complete	39	B	Indet	.	.
53/199 22	PA1	flake tert.	complete	44	B	Indet	.	.
Refit group S5.02								
53/199 4	PB13	flake sec.	incomplete	19	B	Indet	.	.
48/196 6	PB12	flake tert.	incomplete	41	B	Indet	.	.
53/200 25	PB11	flake tert.	incomplete	44	B	Indet	.	.
53/200 85	PB10	flake tert.	incomplete	29	B	Indet	.	.
53/200 66	PB9	flake tert.	incomplete	39	B	Indet	.	.
53/200 60 – 53/199 17	PB8	flake tert.	complete	52	B	Indet	.	.
53/200 47	PB7	flake tert.	incomplete	34	B	Indet	.	.
53/200 45	PB6	flake sec.	complete	52	B	Indet	.	.
53/200 35 – 53/200 82	PB5	flake tert.	incomplete	56	B	Indet	.	.
49/196 5	PB4	flake tert.	incomplete	28	B	Indet	.	.
53/200 83	PB3	flake tert.	incomplete	41	B	Indet	.	.
53/200 65	PB2	flake tert.	complete	39	B	Indet	.	.
53/200 96	PB1	flake tert.	complete	37	B	Indet	.	.
Refit group S5.03								
51/193 14	PC2	blade tert.	distal	77	C2	Indet	.	.
53/200 48	PC1	blade tert.	medial	44	C2	Indet	.	.
Refit group S5.04								
53/200 99	PD3	flake tert.	incomplete	29	B	Indet	.	.
52/197 5	PD2	flake tert.	complete	30	B	Indet	.	.
53/200 74	PD1	flake tert.	incomplete	26	B	Indet	.	.

Table 4.20 Reduction sequence of refit groups S5.01 to S 5.04, length of artefacts in mm. For an explanation of the codes, see table 4.17.

Figure 4.21 Refit group S301. Composition of refitted blades of Simpelveld flint. Although part of this refit group, two conjoined broken pieces of a blade are not patinated. The other artefacts are patinated though (scale in cm).

considerable lengths. In PA3 this was a length of minimally 12 cm, while the last struck blade PA1 had a minimal length of 15 cm.

Refit group S307:
Composition of three refitted flakes, of which one specimen consists of two broken pieces. This broken flake (PA3) is related to the preparation of the striking platform by removal of a flake from the right side of the core and perpendicular to the core face. The next flake PA2 was also struck from this side and has taken away the entire striking platform. It is a thin core rejuvenation flake or core tablet on which parts of negative scars of blades are visible on the front (= former location of the core face). Both flakes have cortex remains on the butt and at the distal end. The distance between these cortex parts is c. 4.5 cm, from which can be inferred that use was made of a relatively thin slab of flint. The flake last removed (PA1) was struck from the front of the core and is also connected with the rejuvenation of the striking platform.

Refit group S308 (fig. 4.22; table 4.21):
Fine composition of nine conjoined blades and blade fragments (refit group S308). The weight of the composition, consisting of a total of 17 artefacts, is 200.6 grams. The artefacts are made of grey-black Simpelveld flint with a very regular, eluvial cortex. The flint is mainly moderately fine grained. Parallel to the longitudinal direction of the blades, a zone occurs with more coarse-grained inclusions. This zone is in particular visible on the last struck blades in refit group S308. The flint is grey-blue patinated. The lamination of the Simpelveld flint is clearly visible due to alternating light grey and blue-grey bands, parallel to the striking and longitudinal direction of the blades. On the basis of refit group S308, the slab of flint used had a length of minimally 18.5 cm and a width of minimally 4 cm. No core has been retrieved. On the basis of the direction of debitage of the refitted blades, a blade core with two opposite striking platforms was used.

In refit group S308 blades were first struck from ‘striking platform 1’ on the ‘top’ of the core. Of these blades, PA9 with a length of 9.8 cm extends to about halfway the core face. Of earlier struck blade PA10, a large proximal part has been retrieved which shows on the dorsal side traces of the preparation of a core crest. This preparation was executed on the transition of the core face to the right flank of the core. An attempt to remove another blade from striking platform 1 failed. This failed ‘blade’ PA8 has a slightly facetted butt and a small lip which points to careful preparation of the striking platform. Nonetheless, the blade ended in a hinge, and the length of it is no more than 3.7 cm.

Next, a second opposite striking platform (‘striking platform 2’) was used, from where a blade with a length of c. 12.5 cm was struck. Of this blade only a small part with non-patinated breaks has been recovered (PA7). In this phase of *plein débitage* other blades were also removed from this opposite striking platform. This is implied by the striking direction of negative scars on the dorsal side of some of the refitted blades.

For the removal of the next blade (PA6) the flint knapper again used ‘striking platform 1’. The blade had a considerable length of minimally 11.7 cm and extended over c. two thirds of the (diminishing) core face. The next blade was also struck from the ‘right top’ of the core. This blade (PA5) consists of five fragments but could not be completely reconstructed: an intermediate part is lacking. The last refitted blade (PA4) that was also struck from ‘striking platform 1’ (and always from a rejuvenated striking platform) consists of three fragments and is complete. This blade extended over the entire core face up to ‘striking platform 2’ and has a length of 16.7 cm. As with the other blades, one of the flanks consists of cortex remains.

In a following phase, the core was turned and ‘striking platform 2’ on the base of the core was used again. A blade of which a fragment has been retrieved (PA3) and a complete

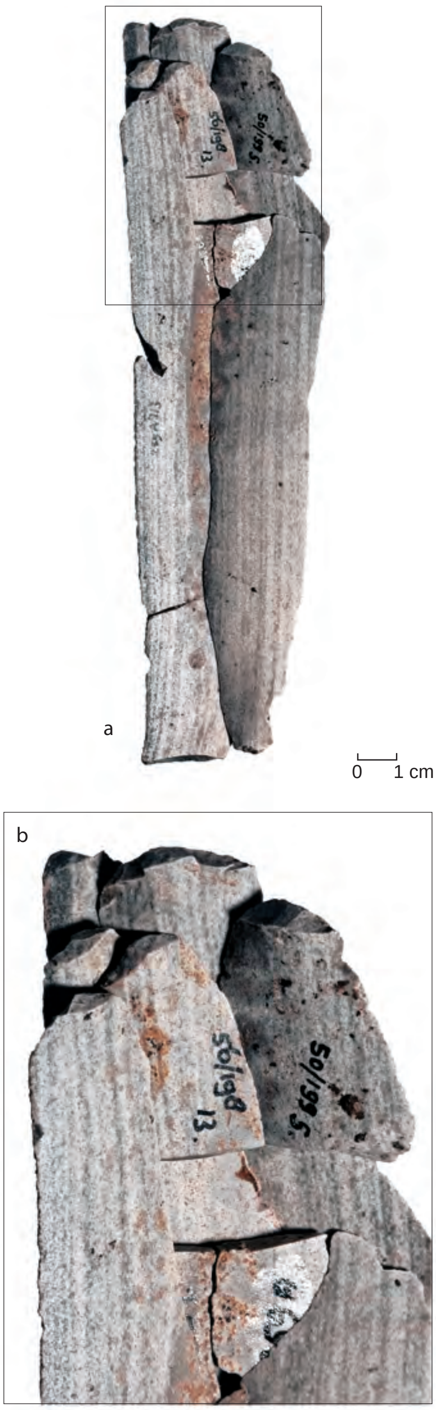


Figure 4.22 Refit group S308. Composition of refitted blades of Simpelveld flint (a). The longest specimen measures over 16 cm. The fact that the butts are 'staggered' (see b) points to interim preparation of the striking platform during the process of blade removal (scale in cm).

Refit group S308	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
52/201 33	PA10	blade sec.	incomplete	79	C1	core face	platform 1	1st generation
55/202 49 – 259A 442	PA9	blade tert.	complete	99	C2	core face	platform 1	1st generation
50/199 5	PA8	blade tert.	complete	38	C2	core face	platform 1	1st generation
57/204 21	PA7	blade tert.	incomplete	29	C2	core face	platform 2	2nd generation
54/202 7	PA6	blade tert.	incomplete	117	C2	core face	platform 1	3th generation
54/204 2*54/198 15 * 259A 396*56/198 13* 259A 131	PA5	blade tert.	proximal	100	C2	core face	platform 1	3th generation
55/197 16–259A 113 * 259A 448	PA4	blade sec.	complete	167	C2	core face	platform 1	3th generation
54/200 11	PA3	blade sec.	incomplete	42	C2	core face	platform 2	4th generation
54/202 107	PA2	blade tert.	complete	136	C2	core face	platform 2	4th generation
54/202 58	PA1	flake tert.	incomplete	28	D3	core face	.	.

Table 4.21 Reduction sequence of refit group S308, length of artefacts in mm. For an explanation of the codes, see table 4.17.

blade PA2 with a length of 13.6 cm were the first results of this. The butt of the latter blade clearly shows traces of *en éperon* preparation.

Refit group S308 provides a good indication of the alternate use of two striking platforms (bidirectional) and the interim preparation of striking platform 1 (fig. 4.22). The proximal parts of the blades struck from this striking platform are 'staggered' in relation to each other. This means that in fact that they were not struck from one and the same striking platform but always from a rejuvenated striking platform that was put back slightly as a result of interim preparation. The blades have partly facetted butts, and there are clear lips on the transition between the butt and the ventral side of the blades. Both characteristics point to an application of *en éperon* technology and a soft hammer technique.

In refit group S308 one artefact has been described as a tool, namely a retouched blade (=PA6).

Refit group S309 (fig. 4.23; table 4.22):
The artefacts of refit group S309 have been struck from a tabular piece of moderately fine-grained Simpelveld flint. On the basis of the presence of cortex remains on two artefacts (PA8 and PA6), this slab had a thickness of c. 6 cm. The flint has all characteristic properties of Simpelveld flint: regular, eluvial cortex, grey-blue patina, and clear bands (lamination) parallel to the longitudinal direction of the flint slab.

The composition consists of nine refitted flakes that are related to the rejuvenation of the core edge, and rejuvenation and preparation of the striking platform. PA9 was removed first by hard percussion, whereby a part of the edge of the core was removed (probably consisting exclusively of negative scars of large flakes). The negative scar of this

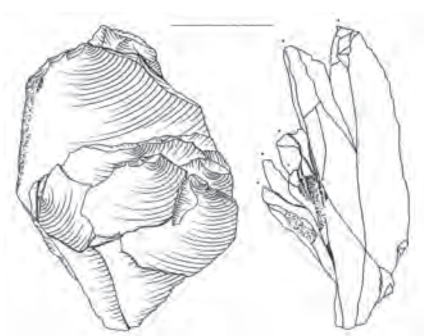


Figure 4.23 Refit group S309. Small composition of refitted artefacts of Simpelveld flint (scale 1:2).

Refit group S309	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
54/202 126	PA9	Rejuvenation flake tert.	complete	80	D2	Indet	.	removal core edge
54/202 25	PA8	Core tablet tert.	complete	81	D1	Indet	.	.
53/203 40	PA7	Flake tert.	fragment	27	B3	Indet	.	.
54/202 19	PA6	Flake tert.	fragment	36	B3	Indet	.	.
57/197 7	PA5	Flake tert.	fragment	27	B3	Indet	.	.
54/202 5	PA4	Flake tert.	complete	20	B3	Indet	.	.
54/202 149	PA3	Flake tert.	complete	21	B3	Indet	.	.
54/202 153	PA2	Flake tert.	complete	30	B3	Indet	.	.
52/201 6	PA1	Flake tert.	complete	37	B3	Indet	.	.

Table 4.22 Reduction sequence of refit group S309, length of artefacts in mm. For an explanation of the codes, see table 4.17.

large flake was used as striking platform for the removal of some, presumably regular flakes or blades. This can be inferred from core rejuvenation flake PA8 of which the narrow front shows parts of negative scars of two regular blades. With the removal of this flake (= thin core tablet), a large part of the then striking platform of the core was taken away. Between the butt of flake PA8 and that of the next series of flakes is a gap of 2.5 cm. This indicates interim preparation of the striking platform, whereby the core face has been utilised for a longer time from the same striking platform. A new striking platform was obtained by the removal of flakes PA7 and PA6. The remaining five refitted flakes (PA5 to PA1) are smaller in size and point to the repeated working and maintaining of the striking platform.

4.6.3 Valkenburg flint

RMU V1

General:

RMU V1 consists of core 259A 165 and three artefacts that could be fitted onto this core (refit group V1.00). The weight of the core and accompanying artefacts is 902.2 grams. Core 259A 165 is a surface find and it has the following dimensions: length 15.1 cm, width 8.9 cm, and thickness 5.3 cm. The weight of the core is 880 grams.

Raw material:

The Magdalenian flint knapper has used a tabular piece of flint that originated from residual (eluvial) or slope deposits. To this origin points a homogeneous, rather smooth and lightly weathered (but not rolled) cortex on the left flank of the core. There are no indications of fluvial transport and thus of an origin of the flint slab from terrace deposits. At the start of the working, the flint slab was minimally 15 cm long and at least 5 cm thick.

The flint slab has been described as Valkenburg flint, though the tabular shape and homogeneous eluvial cortex strongly remind us of Simpelveld flint. Compared to Simpelveld flint, this flint is however slightly coarser grained and the sequence of thin bands (lamination) is less clearly visible in the patina. However, there are numerous grey-blue spots visible that, parallel to the longitudinal direction of the flint slab, can form dark and often interrupted bands. The colour of the patina is blue to blue-grey. A few frost cracks are visible in core 259A 165.

Core:

Core 259A 165 has two opposite striking platforms and a broad core face (15.1 × 5.2 cm) that takes up both the narrow front and (part of) the right flank of the core. The left flank consists to a large extent of cortex, while on the back the negative scars of two large preparation flakes are visible. These flakes have been alternately removed from the core and have resulted in a core crest (*crête longitudinale*). The narrow front and right flank display (parts of) negative scars of blades, struck from a striking platform at the top of the core (striking platform 1). Remarkable is that this striking platform is not oblique to but almost perpendicular to the core face. Its surface is much abraded (dented). The right flank has a large, non-patinated surface. At this place a part of the core was (recently) split off, whereby parts of the negative scars of blades were ‘taken away’. The second, opposite striking platform is completely preserved on the base of the core.

Technology:

First of all the top of the core was used as striking platform (striking platform 1) for the removal of blades from the narrow front of the core. One of these blades had a length of minimally 11 cm. Striking platform 1 also served for the removal of blades from the right, wide flank of the core. As a large part of the core face is missing here (non-patinated surface of 10.5 × 6.2 cm), nothing can be said about the dimensions of these blades.

In a later stage of flint working, the core was turned and an opposite striking platform (striking platform 2) on the base of the core was used. A refitted blade-shaped flake (PA1) was removed from this striking platform and has prematurely terminated in a hinge fracture. Other attempts to remove blades also failed. On the front several negative scars of short blades are visible that ended in hinges and step fractures.

Refit group V401:

Composition of three refitted artefacts, among which core rejuvenation flake 52/200 1 (PA3). With the removal of this flake, the then top of the core, consisting of a part of the striking platform and the adjacent part of the core face, was taken away. From the dorsal side of flake PA2 can be inferred that the striking platform had been prepared by the removal of short, thin flakes. The edge of the core itself is slightly abraded. On the ventral side of the flake are visible negative scars of four blades, which had been removed from the narrow front of the flint slab. This front (= the then core face) had at that time a width of no more than 4.5 cm. After removal of the core rejuvenation flake, flakes PA2 and PA1 were removed from respectively the right and left flank of the core. By the striking off of flake PA1 again a large part of the striking platform was removed, but this time the core face had been spared completely. The flake was struck perpendicular to the core face and has cortex on both the butt and the distal end. On the basis of these, a thickness of the flint slab of c. 5 cm can be assumed.

4.6.4 South-Limburg flint

RMU M1

General:

This RMU comprises seven artefacts refitted onto core 259A 322 (refit group M1.00), a small composition of three refitted artefacts (refit group M1.01), and 15 assigned artefacts. The weight of refit group M1.00 is 314.3 grams, and of refit group M1.01 is 9.2 grams. Core 259A 322 is a surface find and it has the following dimensions: length 8.2 cm, width 5.2 cm, and thickness 5.2 cm. The weight of the core is 213 grams.

Raw material:

Black-grey terrace flint with rolled cortex as a result of fluvial transport, mainly brown (yellowish) in colour on the core. On two refitting decortication flakes, the cortex is smoother and there are more green-yellow hues. The flint is fine grained and has a white grey-blue patina with small blue-grey specks and spots. There are a few coarse-grained inclusions, of which a large specimen with a diameter of 2 cm on the left base of the core is the most conspicuous. The original dimensions and shape (oval or oblong) of the flint nodule are not known. On the basis of the composition of conjoined artefacts, the nodule had a length of at least 10 cm. Frost cracks and natural frost surfaces are lacking.

Core:

Small complete core with two crossed striking platforms (*nucléus à deux plans de frappe croisés*). This is a 'blade core' with one core face and a pointed distal end. The left side of this end shows the beginning of a second striking platform (striking platform 2), and, on the right side, the negative scar of a blade-like flake. This flake terminated in a step fracture. At the top of the core, a few blades and blade-like flakes have been struck from the first striking platform (striking platform 1). Both striking platforms have an irregular surface and have been reworked lightly at the edge near the core face (striking platform preparation).

The core face, which has been utilised from striking platform 1, has a width of 5 cm and extends over the entire front of the core. Its surface is flat to slightly convex. The right flank consists of parts of negative scars of two large flakes (*grands enlèvements lateraux*), and the left flank mainly consists of cortex. The back of the core is semi-circular in shape and also to a large extent consists of cortex (*dos cortical*). In addition, (parts of) negative scars of large flakes are visible on this side which are partly related to the preparation of both striking platforms.

Technology:

Among the refitted artefacts of refit group M1.00 are two decortication flakes, one of which was removed from the right base of the core and the other from the right front. They indicate that the first stage of core reduction was executed on the site. Indications of making a crest (*crête longitudinale*) at the location of the future core face are lacking among the refitted and assigned artefacts. On the core itself are no negative scars visible which would indicate the creation of one or more crests on the front. Among the assigned artefacts are a few fragments of blades though, of which the dorsal surface consists exclusively of cortex. Blade production (*plein débitage*) in the last phase of core reduction, as far as can be inferred from the negative scars on the core, was limited to the removal of some relatively short blades from the core face. Of these a medial fragment with a steep retouch could be refitted onto the left ventral side of the core.

The core was discarded after an attempt to remove a blade from striking platform 1 resulted in a broadly fanning-out blade-like flake. No systematic blade production has taken place from striking platform 2, exclusively some blade-like flakes were removed from this striking platform. Later attempts resulted in flakes that 'crashed' on a bulge on the right flank of the core. A coarse-grained inclusion on the left base of the core was probably the reason why the flint worker abandoned the further shaping and preparing of striking platform 2.

Tools:

Among the artefacts refitted onto core 259A 322 is a medial fragment of a partially retouched blade (54/202 36). The retouch was probably also applied to the proximal part. This part though was not recovered during the excavation.

RMU M2 (fig. 4.27)

General:

This RMU consists of five refitted broken pieces of a crested blade (refit group M2.01). The weight of the refit group is 80.5 grams. In addition, one non-refitted artefact has been assigned to RMU M2.

Raw material:

Fine-grained, grey-blue to olive green flint. Underneath the cortex the colour of the flint is more green-brown in places. The broken pieces together form a part of a blade with a length of more than 22 cm. Hence, the artefact was struck from a large-sized piece of flint, the length of which was minimally 25 cm. The cortex is whitish and is somewhat rough to the touch. This points to an origin of the flint nodule from eluvial or slope deposits. On de distal end of the blade and on the assigned flake 53/199 1 patina is scarcely present, and the original colour of the flint is still easy to recognise. The broken pieces are grey-white to blueish patinated towards the proximal part. Inclusions are visible as white to grey-yellow speck and spots, locally there are larger inclusions present (up to 0.5 cm). Frost cracks and frost surfaces are absent.

Core:
No core has been retrieved.

Technology:
It concerns a large fragment of a crested blade of which the proximal part is lacking. The end consists of two refitted fragments (see below) but is complete. The medial and distal parts of the blade display on the left side of the dorsal surface consecutive negative scars of flakes and dented flakes perpendicular to the striking direction of the blade (fig. 4.27). The result of the removal of these flakes was a core crest (partial). There are also cortex remains on the left side. The right part shows the negative scars of an also remarkably long blade. This blade was struck from the same side of the core as the crested blade. On its dorsal surface is visible a negative scar (length 4 cm) of a blade or blade-like flake. This artefact was struck from a second, opposite striking platform. From this can be inferred that the crested blade originated from a core with two opposite striking platforms.

Between fragments 55/203 74 and 55/202 52 the medial part of the blade displays a remarkable S-shaped, patinated break. This break was presumably created unintentionally during the removal of the blade (K. Sano March 2010, pers. comm.). After the crested blade was removed from the core, the flint knapper struck on the distal end of the blade whereby a piece was broken off (flake 57/204 8). This flake shows on the dorsal side traces of the original core crest.

Notable is that almost no other artefacts of RMU M2 have been found. The assigned flake (53/199 1) displays on the dorsal surface, as does refitted flake 57/204 8, negative scars reflecting a core crest. This artefact points to further working and preparation of the core in the camp site of Eyserheide.

Tools:
Tools are not represented in RMU M2.

RMU M3 (figs. 4.24; table 4.23)
General:
RMU M3 consists of 14 artefacts (refit group M3.00) refitting onto a core 57/199 12 and two small groups of four (refit group M3.01) and three (refit group M3.02) refitted artefacts. In addition, on the basis of the characteristics of the flint, 17 artefacts could be assigned to this RMU. The weight of the core with the refitted artefacts is 282.9 grams. The core has a weight of c. 196 grams. The dimensions of the core are: length 10.5 cm, width 4.3 cm, and thickness 3.6 cm.

Raw material:
Moderately fine-grained, black to olive green terrace flint with locally coarse-grained inclusions (up to 1 cm). The flint has a characteristic spotted, blue-grey to light grey patina. Also occurring are dark parts with blue-grey to grey-white spots and wisps. The cortex is brown and rolled due to fluvial transport, and is in some places gravelised. Locally there are large hollows present and the cortex is very irregular, especially on the right flank and the back of the core. In the flint, calcium inclusions and many small grey specks are visible. A few frost cracks are recognisable on the front and back of the core. With the exception of one place on the right flank of the core, natural fractures are lacking. Probably originally there was an oblong piece of flint with the following minimum dimensions: length 15 cm, width 5 cm, and thickness 4 cm.

Core:
The core is complete and has two opposite core faces, one of which is on the front and the other on the back of the core. The edges of both striking platforms are partially chipped and partially reworked, otherwise the surface is irregular. On the front of the core, core face 1 is slightly convex to flat, and on the back core face 2 is slightly convex. In both cases there are irregularities in the surface caused by step fractures. The left flank consists of cortex that on the front of the core forms the limits of core face 1. On the base of the core, the cortex continues into the distal parts of flakes (*enlèvements transversaux*) that are related to the preparation of the back of the core, possibly the creation of a core crest. As a result of the use of core face 2 and the removal of blades from this side, the negative scars of these preparation flakes have largely disappeared. The right flank is irregular in shape and has a ragged surface with hollows of cortex. The dorsal side of the core is to a large extent formed by core face 2 and a large hollow.

Technology:
The artefacts refitted onto the core (refit group M3.00) are related to the later phases of core and striking platform preparation and blade production, including the creation of a central crest (*crête longitudinale)* on the front of the core. In refit group M3.00, blade KA3 was the first struck artefact on the front of the core (= core face 1). The blade was struck from striking platform 1 at the top of the core. The dorsal surface consists of cortex remains, distal parts of negative scars of preparation flakes and a negative scar of a blade also struck from striking platform 1. After blade KA3 was removed, flake KA2 and a missing flake were removed with the aim of further shaping a core crest. Subsequently the crest was removed by striking off crested blade KA1 from striking platform 1. The dorsal surface of this blade partially

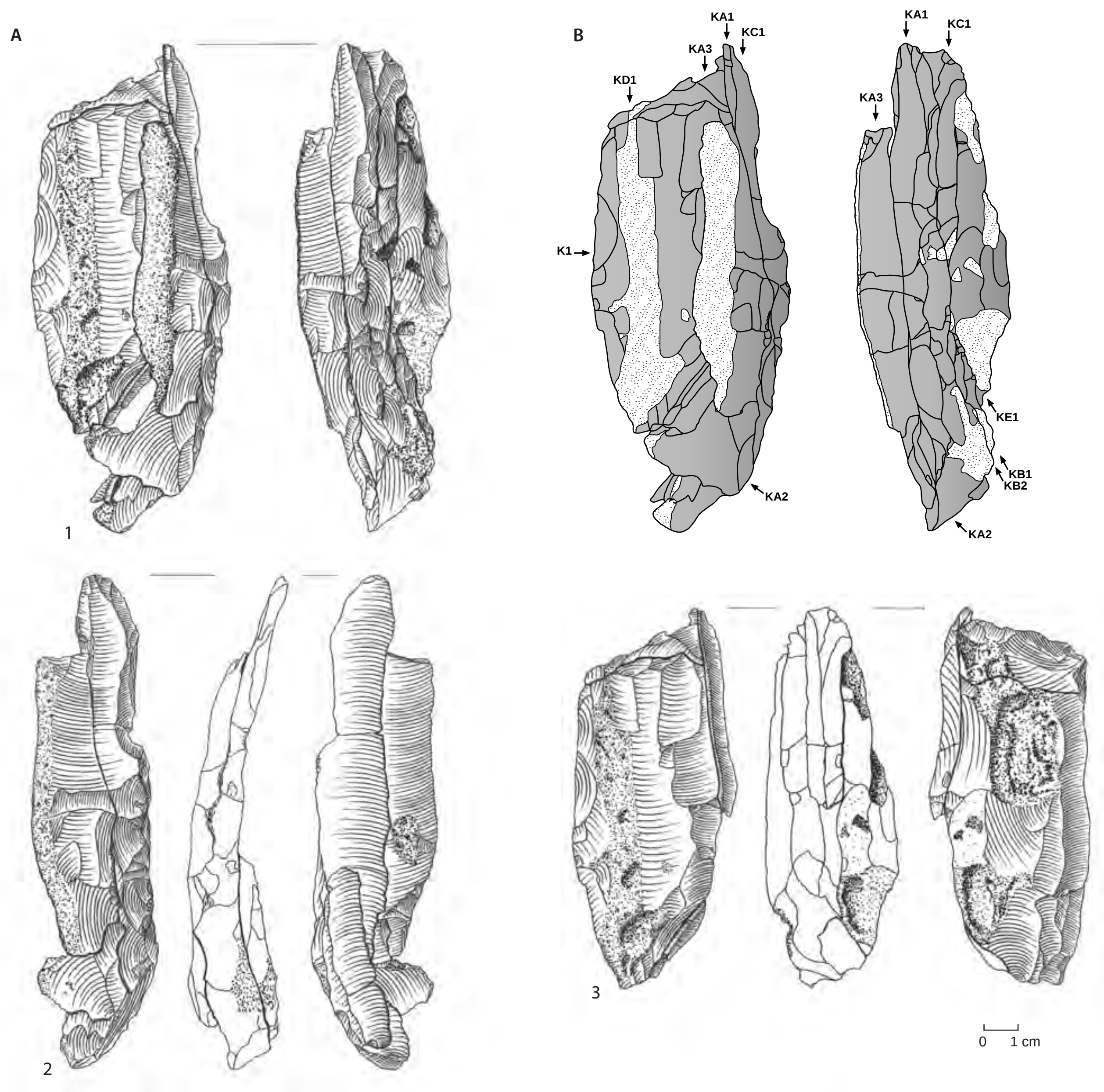


Figure 4.24 Refit group M3.00. Composition of artefacts refitted onto core 57/199 12 of Meuse terrace flint. The codes (KA7, etc.) in b correspond to the codes mentioned in table 4.23, the arrows indicate the direction of debitage of the refitted artefacts (scale 1:2).

shows a fine sequence of negative scars of alternately removed flakes, or a carefully made core crest (*crête bifaciale partielle*). The blade has a length of c. 15.2 cm and protrudes on both short sides of the core. The proximal part of the blade shows a small (and partially recently broken-off) butt. Because of the damage, it was not possible to determine whether *en éperon* preparation had taken place.

Next, the flint knapper turned the core and made a second, opposite striking platform. As a result of continuing core reduction, this striking platform itself is no longer present. Moreover, artefacts that are connected with the creation of this striking platform do not form part of refit group M3.00. That we are dealing with a striking platform is shown by the direction of debitage of two blades (KB2 and KB1). They

RMU M3								
Refit group M3.00	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
53/203 54	KA3	blade sec	distal	92	C	core face	platform 1	1st generation
54/204 61	KA2	flake tert.	complete	33	B2	core face	.	creation of crest
54/203 3-54/206 10-54/204 65	KA1	crested blade tert.	complete	152	C1	core face	platform 1	1st generation
53/204 5-54/202 113	KB2	blade tert	distal	48	C2	core face	platform 2	2nd generation, correction shape of core face?
55/203 77-53/202 55	KB1	blade tert	proximal	59	C2	core face	platform 2	2nd generation, correction shape of core face?
53/202 12-58/203 2	KC1	blade tert.	proximal	64	C2	core face	platform 1	3rd generation
54/204 46-57/202 9	KD1	flake sec.	complete	40	D1	upper side	.	
259A 331	KE1	flake tert.	incomplete	22	D1	core face	.	creation of striking platform 3
57/199 12	K1	core	complete	105	E	.	.	core discard
Refit group M3.01								
55/203 52	PA4	flake sec.	incomplete	21	B	indet	.	early in sequence
61/205 6	PA3	flake tert.	incomplete	23	B	indet	.	early in sequence
53/200 70	PA2	flake sec.	incomplete	35	B	indet	.	early in sequence
55/199 9	PA1	flake tert.	complete	28	B	indet	.	early in sequence
Refit group M3.02								
259A 332	PB3	flake sec.	complete	40	B	indet	.	early in sequence
53/195 1	PB2	flake tert.	incomplete	22	B	indet	.	early in sequence
55/202 23	PB1	flake sec.	complete	22	B	indet	.	early in sequence

Table 4.23 Reduction sequence of core 57/199 12 (refit groups M3.00-M3.02), length of artefacts in mm. For an explanation of the codes, see table 4.17.

were removed almost immediately after the removal of crested blade KA1, but from the opposite, short side of the core. The blades are relatively short and were possibly struck to remove irregularities from the core face.

Subsequently the flint knapper returned again to striking platform 1 and removed a narrow blade with a triangular cross-section (KC1) from the top of this surface. The proximal part shows a slight ‘lip’ and an irregular butt. Indications are lacking of an *en éperon* preparation of the edge of the striking platform. Refitted flake KD1 shows that striking platform 1 was rejuvenated in the next stage of flint working. From the newly prepared striking platform two blades were removed that both ended in step fractures. After removal of these two unsuccessful blades, the striking platform was again reworked. Hereafter one more attempt was made to remove a blade. The negative scar of this (intended) blade can be seen on the left top and shows again a step fracture.

The next stage of core reduction is related to the use of the second core face on the back of the core. For that a new striking platform was made at the base of the core by removing a few relatively short flakes. Of these flakes, one fragment (KE1) could be refitted onto the core. As a result of this reworking, a part of the core face on the front of the core has been changed into a striking platform for the purpose of the removal of blades from the back of the core. A new core face was created on this back which also displays blade scars. The longest blade removed from this side (insofar as visible as negative scar on the core) had a length of c. 9 cm. The presence of hollows and the fact that the four blades last removed had ended in step fractures, were probably the reason for the flint knapper to discard the core definitively.

RMU 3 contains two small compositions of refitted flakes (refit groups 3.01 and 3.02) that could not be refitted onto the core. They have cortex remains on the dorsal surface and they are the result of preparation of the core in an early stage of core reduction. Furthermore, we should point out the occurrence of a large medial fragment of a crested blade (*crête bifaciale*; 259A 304) among the finds assigned to RMU M3. This artefact gives an indication that in the process of core reduction, at various times investments were made into the creation of a crest (cresting).

Tools:
One tool, a truncated blade, was encountered that forms part of RMU M3.

RMU M4
General:
Composition of five refitted artefacts (refit group M4.00) among which core fragment 259A 323. This refit group, together with 12 assigned artefacts, forms RMU M4. The weight of the core fragment with the refitted flake and blades is 395.1 grams.

Raw material:
Grey-olive green, moderately fine-grained terrace flint with underneath the cortex more brown-green zones. As a result of fluvial transport, the cortex is rolled, smooth and dented. The colour of the cortex is dark brown. Of the core only a fragment has been found, a side of which consists of a large non-patinated break. On the basis of the artefacts that could be refitted onto the core fragment, a minimum length of the core of 19.7 cm can be assumed. The flint contains small to large, coarse-grained inclusions. An inclusion with a diameter of c. 3.5 cm is visible on large flake KA1. Frost cracks or frost-split surfaces are not present. One of the assigned artefacts (259A 340) has a natural (non-worked) fractured plane.

Core:
Only a core fragment is present with a non-patinated surface. Probably as a result of ploughing, the core was split into several pieces, only one of which has been recovered. On this fragment are visible the distal end of the core face and the adjacent cortex parts (*partie distale corticale*). Because only a small part of the core has been found, it is not possible to determine the type of core, nor the process of flint-knapping (from initial shaping of the core or decortication to *plein débitage* in the form of blade production). Characteristics of the artefacts refitted onto the core fragment point to a blade core with one striking platform. A further indication of this are the ends of the negative scars of blades on the narrow end of the core: these negative scars concern only distal parts of blades which were all struck from one and the same direction (*taille unidirectionelle*). Presumably the left flank consisted to a large extent of cortex. No negative scars of flakes are visible on the core fragment which would indicate preparation of this flank.

Technology:
No indications have been found of the making of a core crest or the removal of a crested blade. Only the central part of blade KA4 shows over a length of c. 2 cm the beginning of a core crest (*crête partielle*) that was obtained by alternately removing flakes. Among the artefacts assigned to RMU M4 are no crested blades. From the ‘top’ of the core a number of very large, wide blades have been struck. Of these, a complete blade (KA4) and two medial parts (KA3 and KA2) could be refitted. These blades show cortex remains on the dorsal surface. Blade KA4 has a small facetted butt and a protruding small ‘lip’ (+ abraded?). The length of the blade is 11.7 cm. A non-refitted, proximal fragment (58/199 1) and

the negative scars of blades on the core fragment also point to systematic blade production of RMU M4.

After removal of blade KA2, the flint worker ceased striking off blades and from the left top side (= core face) and halfway the core, more or less perpendicular to the striking platform direction of the blades, a large flake (KA1 = *enlèvement transversale*) was removed. As there are no other refitted artefacts, the method and aim of modification of this part of the core cannot be determined further. What can be inferred from the negative scars of the core fragment is that after removal of KA2, a second series of blades was struck from the 'top' of the core.

Tools:
One tool has been assigned to RMU M4, namely a medial fragment of a wide blade with irregular edge damage along the right, long side (54/203 58). The cortex and patina of this artefact are identical to those of the above-mentioned composition of five refitted artefacts. For this reason the artefact has been assigned to RMU M4.

RMU M5
General:
This RMU consists of six small refit groups (M5.00 to M5.05). Refit group M5.00 comprises of core 259A 205 and four artefacts that refit onto the core. The total weight of this composition is 255.8 grams. The core itself weighs 163.6 grams and has the following dimensions: length 6.9 cm, width 3.6 cm, and thickness 6.2 cm. The core was found on the surface prior to the excavation. The other refit groups consist of five and four (two compositions) and two (three compositions) artefacts. Together they have a weight of 117.6 grams. The number of artefacts that has been assigned to RMU M5 is 37.

Raw material:
Fine-grained terrace flint, black-grey to olive green in colour with white-blueish patina, sometimes with dark zones and spotted. As a result of fluvial transport the cortex is rolled and it is brown-yellow in colour. There are also less smooth and more irregular parts. In view of the occurrence of cortex remains on both flanks of the core, we could be dealing here with a tabular piece of flint with a width of c. 3 cm. However, it is more probable that the core was made of the end of an ovoid or oblong flint nodule. The length was minimally 14 cm. No inclusions, frost cracks or frost surfaces are present in the flint. Non-refitted artefacts have been assigned to RMU M5 on the basis of characteristics of the patina and cortex.

Core:
Small blade core (259A 205) with two core faces. Core face 1 is c. 6.9 cm long and 3.5 cm wide, and takes up the largest part of the front of the core. The second core face is on the top of the core and corresponds with the striking platform that was used for the removal of blades from core face 1. Core face 2 is perpendicular to core face 1. As a result of ploughing, the core has been damaged on two edges, here non-patinated chippings are visible. The left side of the core consists entirely of cortex. The right flank also has large cortex remains and – adjacent to the right top of the first core face – a part of a negative scar of a large flake (*enlèvement laterale*). The back of the core consists of cortex and negative scars of flakes, which form a core crest over a length of c. 3 cm. The back of the core is narrower, that is to say core face 1 and the adjacent part of core face 2 form the widest part of the core.

Technology:
On the basis of refit group M5.00, the method and sequence of core reduction can only be roughly determined. Based on the occurrence of cortex remains on many of the refitted and assigned artefacts, the first stage of working probably took place in the camp site itself. Decortication flake KA1 is the result of removing one of the ends of the flint nodule at the base of the core, without a striking platform having been made there. Also, several large flakes were removed from the top. Two flakes (KA3 and KA2) could here be refitted onto the core. They give evidence of the creation of a striking platform and extend respectively 4.1 and 1.5 cm beyond this part of the core (struck from the right side). In a later phase this striking platform was used as core face 2, from where a few short blades were removed. As the edge was damaged recently, little can be said about the method of preparation of the core edge.

There are no indications of the making of a core crest (*crête longitudinale*) on the front of the core. Fragments of crested blades are lacking in RMU M5. Also on the front of the core no (parts of) negative scars are visible, related to the alternate removal of flakes for the benefit of a core crest.

Among the assigned artefacts are mainly flakes (n=27), among which a number of decortication flakes and only one flake without cortex. RMU M5 further comprises several fragments of blades that are indicative of the production of blades. Two proximal parts of blades (54/201 14 and 52/200 25) have a small butt and a small lip, and both butts are facetted as well.

Tools:
259A 314 is a broken blade end scraper with a semi-circular scraper edge and a patinated break. The scraper edge is high (1.0 cm) and rather abrupt, and made on the distal part of a blade.

RMU M6 (figs. 4.25 and 4.26; table 4.24)
General:
This RMU is represented by refit group M6.00 consisting of core 259A 373 and refitted flakes, blades and retouched tools. The composition consists of 23 (fragments of) artefacts which together weigh 1017 grams. The core itself weighs 783 grams and has the following dimensions: length 12.5 cm, width 9.9 cm, and thickness 5.7 cm. As with many other cores, we are dealing with a surface find that Mr Blezer discovered prior to the excavation.

Raw material:
Core 259A 373 and the accompanying, refitted artefacts were struck from an oval flint nodule, the cortex of which is heavily rolled and dented as a result of fluvial transport. At the surface, the cortex is (dark) brown in colour. In the more weathered and deeper parts the colour is yellow-brown to yellow. These characteristics point to an origin of the flint from a river terrace. The flint is moderately fine grained and black-grey to olive green in colour. On the basis of the composition of refitted artefacts, the flint nodule had the following (minimum) dimensions at the start of the knapping process: length 15 cm, width 11.0 cm, and thickness 6.3 cm. In contrast to other RMUs within the group of Meuse terrace flint, the artefacts of RMU M6 are all over patinated. The colour of the patina is blue-grey to white-grey. Underneath the cortex are wispy, red-brown to yellow-brown bands visible with a width of up to 1.5 cm.

Core:
Large and wide blade core with one striking platform and one core face on which cortex remains are still present. The flanks are largely covered with cortex. One decortication blade and some blades with cortex remains have been removed on the left side of the core face: scars of preparation flakes are lacking here. Towards the base, a large scar of a flake is visible on the right flank. The back of the core consists almost entirely of cortex (*dos cortical*). Only on the top is a large worked surface which is the result of the removal of a (decortication) flake for the benefit of the striking platform. The striking platform is smooth and towards the edge irregular as a result of the occurrence of 'staggered' step fractures. The shape of the core face is slightly convex.

Technology:
Many of the artefacts that were struck off this nodule of terrace flint have been recovered and form part of refit group M6.00. Especially on the left side of the core face is the sequence of removed blades to a large extent complete.
The composition provides a good impression of the working of a core without the striking platform, the core face and/or the flanks having been carefully prepared. During the whole process of core reduction, it sufficed to make and use one striking platform and one core face. Other parts of the core are mainly unworked and consist of cortex.

The results of refitting show that the reduction of the core began with the removal of large and thick decortication

Figure 4.25 Refit group M6.00. Composition of artefacts refitted onto core 259A 373 of Meuse terrace flint (scale 1:2).

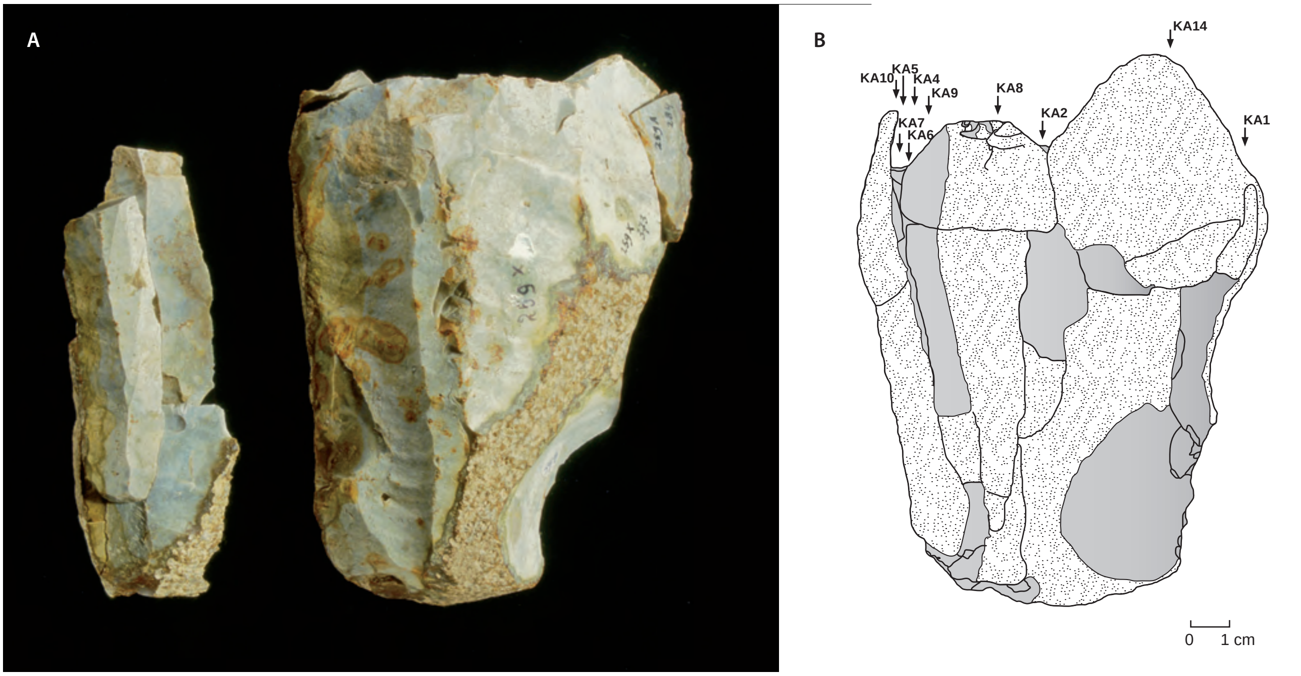


Figure 4.26 Refit group M6.00. The codes (KA14, etc.) in b correspond to the codes mentioned in table 4.24, the arrows indicate the direction of debitage of the refitted artefacts (scale 1:2).

flakes (KA14, KA11), while use was made of a hammer stone (hard percussion technique). No indications have been found of the preparation of a crest (*crête longitudinale*): traces of a crest on the core or (fragments of) crested blades are absent. There was also no careful preparation of the flanks. After the creation of the striking platform, a series of minimally seven blades were removed from the left side of the core face. Several of these blades, including broken pieces, could be refitted onto the core. The first blade (KA10) extends over the full length of the front of the core and displays on the dorsal surface only cortex (decortication blade). As a start was made immediately with blade production (*plein débitage*), the subsequently struck blades (KA9 to KA3) also have cortex remains on the dorsal surface and/or the sides. A complete blade (KA8) consists of three conjoined broken pieces and has a length of more than 10 cm. The occurrence of smooth butts (*lisse*) indicates that careful preparation of the edge of the striking platform (*en éperon*) did not take place. The core does not show either traces of such a preparation.

The right side of the front of the core has yielded only one blade of which a medial fragment (KA1) could be refitted. This blade extended to about halfway the core and is significantly shorter than the specimens struck from the left side. The remainder of the front consists of cortex and the negative scars of two large flakes. One of these is a decortication flake that could be refitted onto the core, near the edge of the striking platform.

Tools:
Of the blades removed from the left front of the core, two pieces (KA7 and KA4) were retouched into end scraper. Furthermore, two blades in refit group M6.00 display 'use retouch'.

RMU M7 (fig. 4.27)
General:
RMU M7 comprises five small refit groups (M7.01 to M7.05) and nine non-refitted, assigned artefacts. Refit group M7.01 consists of seven artefacts, and the other groups of four and three (in each case one composition) and two (two compositions) artefacts. The total weight is 308.7 grams. We are dealing exclusively with flakes, blades and a rejuvenation flake. A core could not be assigned to RMU M7.

Raw material:
Fine-grained terrace flint, olive green (green-brownish) in colour. There are few non-patinated surfaces which makes it difficult to determine the exact colour of the flint. The flint

RMU M6								
Refit group M6.00	PRS	Artefact	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
51/197 22*51/196 9	KA14	flake prim.	complete	66	A1	upper side, right	.	.
51/196 16	KA13	flake prim.	incomplete	29	A1	upper side	.	.
48/193 2	KA12	flake tert.	incomplete	21	B3	upper side	.	.
259A 275	KA11	flake prim.	incomplete	45	A1	upper side	.	.
50/197 5-53/200 13-53/200 52	KA10	blade prim.	complete	111	A2	core face, left	platform 1	.
54/200 20	KA9	blade sec.	incomplete	26	C2	core face, left	platform 1	.
50/193 12-53/200 64*53/200 32	KA8	blade sec.	complete	105	C2	core face, left	platform 1	.
259A 315	KA7	blade sec, endscraper	incomplete	68	C2	core face, left	platform 1	.
259A 253-49/196 38	KA6	blade tert.	incomplete	106	C2	core face, left	platform 1	.
49/196 25-259A300*xx-49/196 27	KA5	blade sec.	incomplete	118	C2	core face, left	platform 1	.
51/197 10	KA4	blade tert. endscraper	incomplete	78	C2	core face, left	platform 1	.
259A 264	KA3	flake tert.	complete	16	D1	platform 1, left		.
51/194 1	KA2	blade sec.	incomplete	28	C2	core face	platform 1	probably knapping failure
259A 284	KA1	blade sec.	incomplete	33	C2	core face, right	platform 1	.
259A 373	K1	core	complete	125	E	.	.	discard core

Table 4.24 Reduction sequence of core 259A 373 (refit group M6.00), length of artefacts in mm. For an explanation of the codes, see table 4.17.

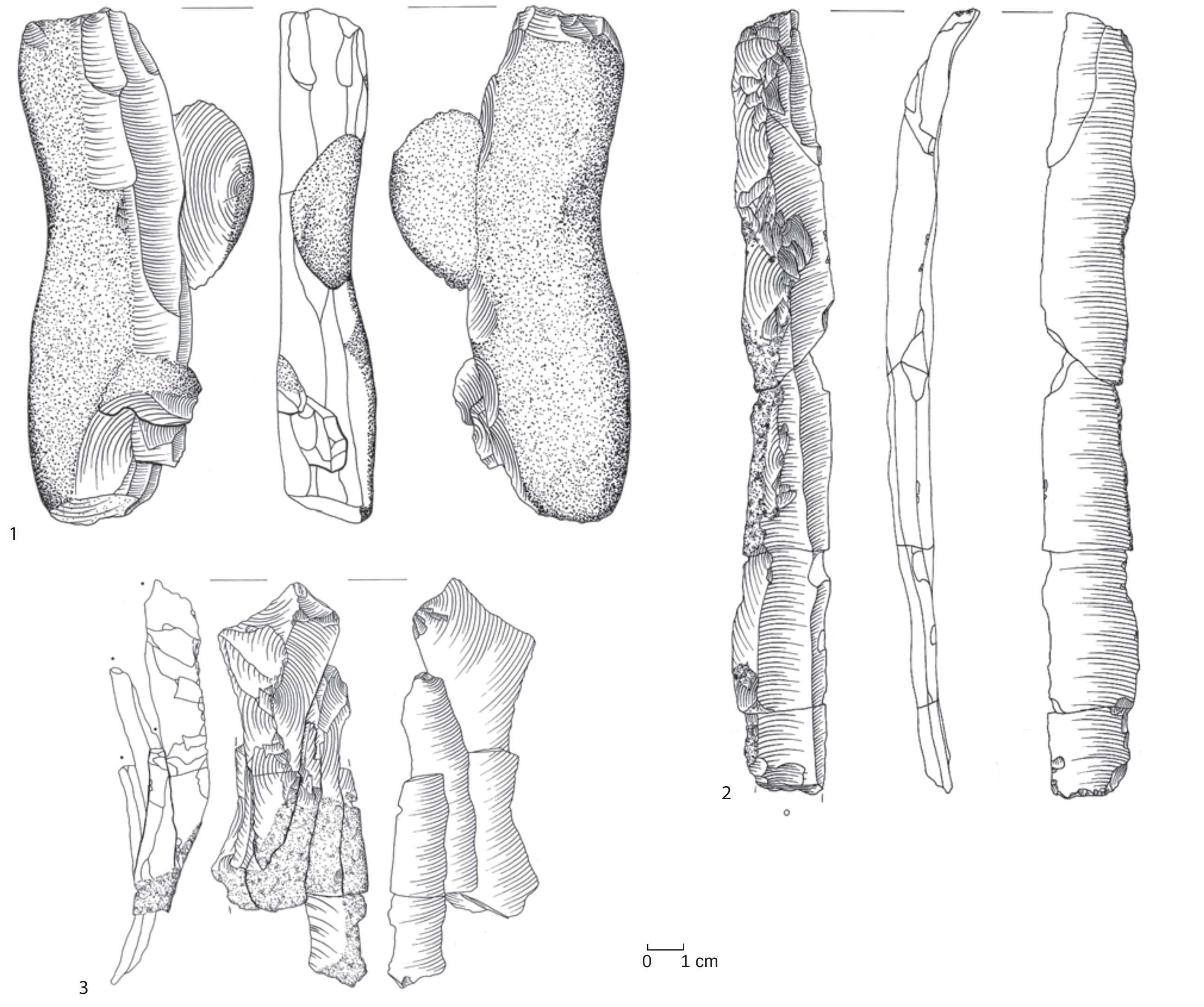


Figure 4.27 Refit groups M12.00 (1) and M7.01 (3) of Meuse terrace flint, and M2.01 (2) of eluvial flint (scale 1:2).

has a smooth, rolled cortex as a result of fluvial transport. The colour of the cortex is (different hues of) brown. There are some coarse-grained inclusions and one flake has an *inclusion calcaire*. Another flake has two natural hollows. There are also natural surfaces that are orange-brown to brown-yellowish patinated. This colour is different from the worked surfaces which have a white-blueish and partly spotted patina (*vermiculée*).

Core:
No core has been retrieved. Based on the negative scars of the dorsal surface of a blade in refit group M7.03 and the opposite direction from which the blade itself was struck, the core presumably had two opposite striking platforms.

Technology:
As the core is lacking, technological aspects and characteristics of the working of RMU M7 can only be described for a few components. Among the assigned artefacts is a fragment of a decortication blade. Two larger flakes with cortex remains are probably related to the (initial) shaping of the core and the rejuvenation of the core face.

Refit group M7.03 shows that after striking off a small core tablet, a number of long and regular blades were removed from the core. In a later phase some blades were removed from an opposite striking platform. In any case, from this second striking platform, a blade with a minimal length of 10 cm was struck (the proximal part is missing).

The artefact concerned ends in an *outrepassé*. As a result of this, a part of the core face was 'taken away'.

A different stage of blade production is represented in refit group M7.01 (fig. 4.27). In this group is a proximal part of a blade present of which the butt infers the use of *en éperon* technique. This and three other dorsally/ventrally refitted blades (PA4 to PA1) were struck from one and the same striking platform. Prior to this, there was a stage of core reduction with the direction of debitage more or less perpendicular to these blades. The negative scars on the dorsal surface of core rejuvenation flake PA5 are an indication of this. This flake has taken away the edge of the core, i.e. both a part of the striking platform and the adjacent part of the core face.

Also refit group M7.02 comprises a few regular and broad blades. Unfortunately, there are few proximal parts of blades in the find material of RMU M7. The use of *en éperon* technology can therefore not be determined with certainty. Moreover, there are no indications of the preparation of a crest. Crested blades are absent among the refitted and assigned artefacts.

Tools:
No tools have been retrieved that form part of RMU M7.

RMU M8 (fig. 4.28)
General:
This RMU consists of five refit groups (M8.00 to M8.04) in which a total of 21 refitted artefacts were included (fig. 4.30). The refit groups are relatively small and vary in number from two (M8.04) to six (M8.01 and M8.03) conjoined artefacts. The refit groups have a total weight of 967.7 grams. Core 259A 239 forms part of refit group M8.00 and it has a weight of 772 grams. The dimensions of the core are: length 12 cm, width 7.2 cm, and thickness 6.2 cm. On the basis of characteristics of the flint and cortex, 20 non-refitted artefacts have been assigned to RMU M8.

Figure 4.28 Refit groups M8.00-M8.04 of Meuse terrace flint. The back of core 259A 239 consists completely of cortex (*dos cortical*). The core has a length of 12 cm.

Raw material:
Fine-grained terrace flint, light olive green to light brown (core) and light grey (refitted blade) in colour. The flint has a smooth, rolled and heavily dented cortex as a result of fluvial transport. Locally there are shallow hollows. The colour of the cortex is light brown and locally cream-brown. The colour of the patina on the worked surfaces is yellow creamy. A fossil of a shell is visible in the cortex of the core. The flint nodule was originally oval or oblong in shape and had a large flat end (= base of the core). Few inclusions are present and frost cracks or frost fracture surfaces are absent. An inclusion with a diameter of 2.3 cm is visible on the striking platform of the core.

Core:
A complete, large and regular blade core (259A 239) with one striking platform and one core face. The core face has a width of c. 7 cm and extends over the entire front of the core. The flank shows cortex, and towards the core face, the ends of some larger negative scars of preparation flakes which are perpendicular to the negative scars of blades on the core face. By the removal of blades, negative scars of flakes related to the preparation of the left flank have to a large extent been taken away. For the remaining part this flank consists of cortex. The right flank is completely covered by cortex, the first negative scar is a blade negative on the core face. Also the back and the base of the core consist of cortex (respectively *dos cortical* and *partie distale corticale*).

At the top of the core is a striking platform of 6.5 × 5 cm. The edge of the striking platform consists of smaller, non-patinated surfaces which are probably the result of damage to the core by ploughing. For the preparation of the striking platform, some large but thin flakes were removed. In profile the core face is flat and in cross-section slightly convex.

Technology:
Blade core 259A 239 is the product of systematic blade technology in the Magdalenian, in which one or more series of blades with regular long edges are struck from one and the same core face. One striking platform is thereby used (compare RMU M6). As only three artefacts could be refitted onto the core (refit group M8.00), the process of core reduction cannot be reconstructed. Among the assigned artefacts are no decortication flakes, but there are many flakes with cortex parts on the distal ends. On this basis it is

presumed that the core was carried to the site in a preliminary worked state. In the camp site of Eyserheide, the working of the core has probably consisted mainly in preparation of the striking platform and (at an earlier stage than can be determined on the basis of negative scars on the core) in the shaping of the core face and the left flank. The small compositions of refitted artefacts in refit groups M8.01 to M8.04 are an indication of this.

Of RMU M8 some non-refitted fragments of blades have been recovered. Two refitted blades in refit group M8.02 have traces of preparation of a core crest on the dorsal surface and have been described as crested blades. Also because of abrasion of the edge of the striking platform are proximal parts of the scars of blades lacking on the core. Thus blades were longer than can be 'measured' on the basis of scars on the core. Two blade scars indicate the removal of blades with lengths of minimally 11 cm.

The scar of a blade on the right part of the core face ends in a step fracture. The medial part of this blade could be refitted onto the core. However, the presence of this step fracture could hardly have been the reason for discarding the core. At the time of discard, the core still had enough 'volume' and a very serviceable core face. There are no indications of application of *en éperon* technology. A small part of the edge of the striking platform (patinated) shows reworking of the edge. Elsewhere the way of preparation of the edge of the striking platform can no longer be reconstructed because of recent chipping.

RMU M9 (fig. 4.29; table 4.25)
General:
RMU M9 comprises two refit groups. M9.00 consists of 31 (fragments of) refitted artefacts and has a weight of 571 grams. As only a part of the core has been retrieved, the dimensions and the weight of the core are not known. M9.01 is a small composition of two refitted artefacts. In addition, five non-refitted artefacts have been assigned to RMU M9 on the basis of characteristics of the flint and cortex.

Raw material:
Fine-grained terrace flint, olive greenish to light yellow-orange in colour with orange-brown bands and a thin brown band underneath the cortex. The flint has cortex that is rolled and heavily dented due to fluvial transport, which is brown-yellowish in colour. We are dealing here with an (originally) oblong piece of flint in which inclusions are visible as small round spots and larger 'wisps' and planes. At the start of the flint-knapping, the flint nodule had a minimum length of 18 cm and a minimum width of 9 cm. On the non-patinated break of a flake are fissures visible in the flint. The core probably disintegrated along these fissures into several pieces as a result of contact with a ploughshare.

Core:
The core is far from complete and consists of three refitted fragments with non-patinated breaks (259A 179, 259A 180, and 259A 507). The three fragments all form part of refit group M9.00. As only small fragments have been found, the type of core is not certain. Fragments 259A 179 and 259A 507 each comprise a part of a striking platform and the adjacent part of the core face. Together with the refitted artefacts, they indicate the working of a core with two opposite striking platforms. Both fragments display traces of a careful preparation of the edge of the striking platform. At the time of discard, parts of the core were still covered with cortex remains, as is shown in core fragment 259A 180.

Technology:
For this core it is difficult to determine exactly the sequence of events due to the high degree of fragmentation. In refit group M9.00 are five artefacts of which the dorsal surface consists of more than 75% cortex remains. They are an indication that the first stage of reduction (decortication) of RMU M9 was carried out in the camp site of Eyserheide.

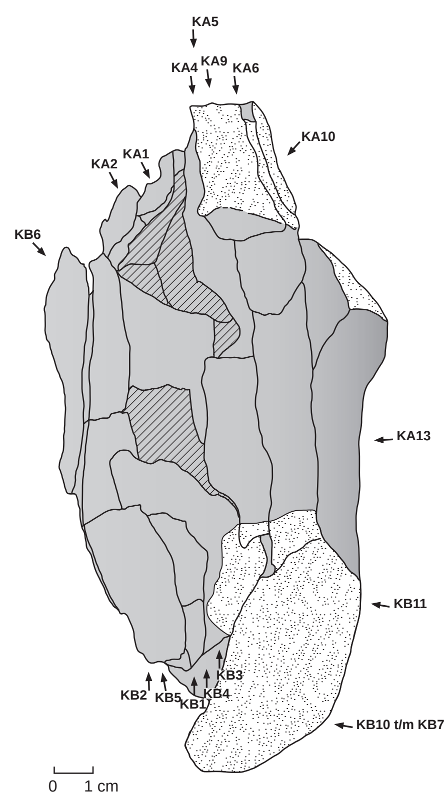


Figure 4.29 Refit group M9.00 of Meuse terrace flint. The codes (KA13, etc.) correspond to the codes mentioned in table 4.25, the arrows indicate the direction of debitage of the refitted artefacts (scale 1:2). The core is not complete, three small fragments (hatching) were recovered.

RMU M9								
Refit group M9.00	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
55/203 84	KA13	flake prim.	incomplete	54	A1	right flank	.	.
56/201 30	KA12	flake prim.	incomplete	35	A1	upper side	.	.
55/203 89	KA11	flake sec.	complete	67	B1	upper side	.	.
54/202 158	KA10	flake sec.	complete	37	B1	upper side	.	.
54/202 8	KA9	flake sec.	incomplete	37	B1	core face	.	.
54/202 187	KA8	flake tert.	complete	39	B1	upper side	.	.
259A 410	KA7	flake sec., rejuvenation	complete	49	B2	core face	.	.
56/200 13-55/202 100	KA6	crested blade tert.	distal	119	C1	core face	platform 1	1st generation
55/202 9	KA5	blade tert.	distal	48	C2	core face	platform 1	1st generation
55/201 12	KA4	blade tert.	complete	81	C2	core face	platform 1	1st generation
55/202 47	KA3	flake tert.	complete	27	D1	upper side	.	.
53/200 105	KA2	flake tert.	complete	34	D	back	.	core maintenance
53/203 35	KA1	flake tert.	complete	36	D	back	.	core maintenance
54/202 1	KB11	flake prim.	complete	50	A1	buttom	.	.
54/203 5	KB10	flake sec.	complete	21	B1	back	.	.
55/203 71	KB9	flake tert.	complete	17	B1	back	.	.
55/202 74	KB8	flake sec.	complete	27	B1	back	.	.
55/203 98	KB7	flake sec.	complete	38	B1	back	.	.
54/202 53	KB6	flake tert.	complete	58	B3	lenft flank	.	shaping of flank
55/202 90	KB5	blade tert.	medial	44	C2	core face	platform 2	1st generation
54/202 48-54/204 64	KB4	flake tert.	complete	48	C2	core face	platform 2	1st generation
54/202 105	KB3	flake tert.	complete	57	C2	core face	platform 2	1st generation
XX						core face	.	creation of crest
54/202 112-259A 245	KB2	crested blade tert.	distal	92	C1	core face	platform 2	.
58/201 15-259A 249	KB1	blade tert.	proximal	69	C2	core face	platform 2	1st generation
259A 179*259A 180*259A507	K1	core	incomplete		E	.	.	discard core
Refit group M9.01								
56/201 20	PA2	flake	fragment	35	B	Indet	.	core preparation
56/200 5	PA1	flake	complete	48	B	Indet	.	core preparation

Table 4.25 Reduction sequence of core 259A 179 (refit groups M9.00-M9.01), length of artefacts in mm. For an explanation of the codes, see table 4.17.

The working began at the top of the core by removing a few flakes (KA12, KA10, and KA9). In this stage of core reduction, a large and thick flake (KA13) with cortex was removed from the right flank of the flint nodule, whereas decortication flake KB11 was removed from the base.

By the removal of a series of flakes, knapping was done at the top to prepare striking platform 1. Here a few smaller, relatively thin flakes and blade-like flake KA11 were removed. More towards the central part of the core, at any rate after the removal of decortication flake KA13, a series of flakes has been removed perpendicular to the direction of the future core face (*éclats transversaux*). These flakes are related to the shaping of the core face. On the right front this working has led to a clear core crest (*crête unifacial*), as can be inferred from the dorsal side of core preparation blade KA6. This blade was struck from striking platform 1 at the top of the core and is the first result of utilising the core face for blade production (*plein débitage*). Next from striking platform 1 were struck a blade, the distal part (KA5) of which could be refitted onto the core, and a blade-like flake (KA4).

In a later phase the core was turned and a second, opposite striking platform was used. Four dorsally/ventrally refitted flakes (KB10 to KB7) with cortex remains on the dorsal surface are related to the preparation of this striking platform (= striking platform 2). Further working of the flank has taken place, among others by removing flake KB6 from the top of the core and perpendicular to the core face. From striking platform 2, subsequently a start was made with blade production. After removal of blade KB5 (the medial part of which could be refitted onto the core), attempts to remove blades did not lead to the desired result. This was the reason for interim preparation of the core face and the creation of a new crest ('*neo crête partielle*') on the central part of the front of the core. The scars on the distal part of blade KB2 show this interim preparation. Hereafter the removal of blades was continued. As far as can be inferred from refit group M9.00, blade KB1 is the last element that was struck off the core. This blade, of which the proximal part has been recovered and the break is non-patinated, refits onto core fragment 259A 507. And finally, two flakes (KA2 and KA1) should be pointed out, that are related to the maintenance of striking platform 1. They could be refitted onto the back of the core.

RMU M9 is a good example of a careful way of blade production, in which use is made of one and the same core face and two opposite striking platforms. Unfortunately, proximal parts (butt) of blades are lacking, with the exception of KB1. This fragment has a clear lip and partially facetted butt with a spur, which points to application of *en éperon* technology.

Tools:
To the category of tools, a flake with a groove or notch (55/201 12) has been attributed. However, it is not clear whether this groove or notch was made intentionally.

RMU M10 (fig. 4.30)
General:
RMU M10 comprises four small refit groups (M10.00 to M10.03) that in total consist of twelve artefacts. M10.00 is the largest composition with six artefacts and is constructed around core 51/197 2. The core has a weight of 64.7 grams and the following dimensions: length 5.7 cm, width 4.4 cm, and thickness 2.8 cm. The weight of refit group M10.00 is 100.6 grams. The other refit groups consist of two artefacts each and together weigh 75.1 grams. In addition, 21 non-refitted artefacts have been assigned to RMU M10.

During the processing of the find material of Eyserheide, core 51/197 2 and accompanying, refitted artefacts (refit group M10.00) were no longer present in the collection of finds. The description of this refit group is for this reason only based on a first analysis, carried out in 1991, of the core and refitted artefacts. At that time a photograph (fig. 4.30) was taken of the core, and use was made of this for the description below.

Figure 4.30 Refit group M10.00 of Meuse terrace flint. Composition of artefacts refitted onto core 51/197 2. The core has a length of 5.7 cm.

Raw material:
Fine-grained terrace flint, brown-orange in colour with orange to rust-brown bands underneath the cortex. The flint has a smooth, rolled cortex, brown to yellow-brown in colour. In the flint many small specks and spots are visible, grey to yellowish in colour, sometimes also wispy. There are also medium-sized, coarse-grained inclusions. Frost cracks or frost-fractured surfaces are absent. Some parts of the flint are more patinated than others. In those places where the patina covers the entire surface, the patina is white in colour and spotted.

Core:
Core 51/197 2 is a small and complete core with two opposite striking platforms. One of the flanks and a part of the back have cortex remains, the other parts show the scars of flakes and blades. The core has been about ‘three quarters’ reduced. Scars of long, regular blades are lacking.

Technology:
As the core was no longer available for analysis and the number of refitted artefacts is small, a technological description of RMU M10 was not possible. One of the artefacts that could be refitted onto the core is a dihedral burin made on a blade (KA5). Of the refitted artefacts, this blade was the first to be removed. In a later stage two flakes and, from the opposite striking platform, two blades were struck. The longest blade (KA2) is 7.7 cm long and terminated in an *outrepassé*. The second blade (KA1) is also complete and has a length of 6.1 cm. The conjoined artefacts indicate the removal of a few blades from core 51/197 2.

Among the artefacts assigned to RMU M10 are four decortication flakes. This indicates that the first stage of core reduction was carried out at the location of the excavation. Among the artefacts are no fragments of crested blades. Two blades that refit onto each other (refit group M10.01) have been described as a blade with macroscopically visible edge damage (’use retouch’) and a truncated blade. The largest blade is 9 cm long and 3 cm wide, and thus significantly larger than the (remaining) length of the core which is no more than 5.7 cm.

Tools:
Four tools have been attributed to RMU M10. A small dihedral burin could be refitted onto core 51/197 2 (refit group M10.00). In addition, there is an obliquely truncated blade that is composed of two broken pieces with a non-patinated break (refit group M10.03), and the earlier mentioned used (?) blade and truncated blade which together form refit group M10.01.

RMU M11
General:
To this RMU belong refit groups M11.01 and M11.02 and 45 non-refitted, assigned artefacts. The refit groups consist of respectively nine and four artefacts, and together have a weight of 330.6 grams. A core is lacking in RMU M11.

Raw material:
Moderately fine-grained terrace flint, black-grey in colour. There are also olive green to dark red-brown parts. The cortex is smooth, rolled and locally heavily dented (irregular) as a result of the incorporation of the flint nodule into the river bed. The colour of the cortex is brown to yellow-brown. Also because of the colour and the occurrence of wide, red-brown bands the flint reminds us slightly of Rullen flint. There are few inclusions, one large-sized inclusion (> 4 cm) is visible in blade 54/202 161. The flint is blue-greyish patinated, while the bands are patinated green-yellowish to brown-greenish. The bands, partially spotted, are visible in particular directly underneath the cortex. There are also artefacts without cortex remains, of which both the dorsal and the ventral sides show bands. On the basis of these characteristic bands several non-refitted artefacts were assigned to RMU M11.

The flint nodule was probably oblong with rounded edges and must have had a considerable length (> 17 cm) and width (> 9 cm). The occurrence of a large decortication flake also points to the flint nodule having been large originally.

Core:
No core has been retrieved. On the basis of refit group M11.01, it seems to concern a blade core with one striking platform but this is far from certain as the number of refitted artefacts is small. A blade in refit group M11.01 indicates a regular, convex shape of the core face.

Technology:
RMU M11 consists of two groups of refitted artefacts: a sequence of fragments of blade-like flakes and of blades (refit group M11.01), and a core tablet and two striking platform rejuvenation flakes (refit group M11.02). As the core is missing and the number of refitted artefacts is small, we can only pronounce on the outlines of the method of core reduction and the sequence of technological actions. Some large, non-refitted flakes, the dorsal surface of which consists of more than 75% cortex, point to decortication of the flint nodule at the location of the excavation. Refit group M11.01 consists of nine refitted artefacts and to a certain extent provides an insight into the method of preparation of the core face, at the time when cortex had largely been removed already from the ‘top’ of the core. Assuming one striking platform at the top of the core, a few long, thin flakes were removed from the left front. The distal part of the one these flakes (PA7) could be refitted. Some negative scars of other flakes are visible on the dorsal surface of blade PA1. The flakes concerned are related to the maintenance of the core face and to obtaining the correct convexity of this plane. After they were removed, a start was made with the blade

production (*plein débitage*), and a series of blades was removed from the 'top' of the core. The proximal and distal parts of one of these blades (PA1) could be refitted. The intermediate, medial part is missing. This blade had a length of 17.5 cm. The proximal part has a butt with a characteristic bulge, which indicates *en éperon* preparation of the striking platform.

There are no indications of the making of a core crest. The convexity of the core face is due to the removal of a series of large and thin flakes (among which PA7 to PA5) from the left flank of the core.

Tools:
Not refitted, but still assigned to RMU M11 is a proximal part of a blade of which parts of the butt seem to have been removed. On the ventral side near the scar of percussion a narrow edge of retouch is visible over a length of c. 1 cm.

RMU M12 (fig. 4.27; table 4.26)
General:
RMU M12 comprises two small refit groups (M12.00 and M12.01) which consist of respectively four and three artefacts. Refit group M12.00 weighs 262.7 grams and comprises core 51/195 22. The weight of the core is c. 242 grams. The artefacts of refit group M12.01 together weigh 10.5 grams.

Raw material:
RMU M12 was at the start of the core reduction an oblong and thin piece of terrace flint with a length of minimally 15 cm. The texture is moderately fine grained. As non-patinated breaks are lacking, the colour of the flint could not be determined well. A small abrasion at the top of the core shows a brown-black colour. The flint has a smooth, rolled cortex which is the result of transport in a river bed. The colour of the cortex is brown-grey, locally parts are more brown-yellowish in colour. Small (1-2 cm), coarse-grained inclusions are visible in the flint. Frost cracks or frost-fractured pieces are absent.

Core:
Complete blade core 51/195 22 with one striking platform and one core face was made of an oblong and narrow piece of terrace flint. With the exception of the striking platform at the top and the core face on the narrow front, the core mainly (flanks) and completely (back) consists of cortex. The end is formed by a natural and patinated old fracture surface. The striking platform is small (3.3 × 2.3 cm) and displays a scar of a flake that ended in a step fracture. The edge of the striking platform was locally reworked (faceted), but clear indications of an application of *en éperon* technology are lacking. The core face (14 × 3.2 cm) is on the narrow ventral

RMU M12

Refit group M12.00	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
52/200 16	KA3	flake prim.	complete	33	A1	right flank	.	preparation crest?
50/193 3	KA2	flake sec.	complete	28	B2	left flank	.	preparation crest?
53/200 26	KA1	crested blade tert.	incomplete	21	C2	afbouwvlak	platform 1	.
51/195 22	K1	core	complete	148	E	.	.	discard core
Refit group M12.01								
49/196 39	PA2	Blade sec.	proximal	26	C2	(core face)	(platform 1)	.
54/203 92 - 54/202 159	PA1	Blade tert.	complete	97	C2	(core face)	(platform 1)	.

Table 4.26 Reduction sequence of core 51/195 22 (refit groups M12.00-M12.01), length of artefacts in mm. For an explanation of the codes, see table 4.17.

side and has a slightly convex shape. The negative scars present point to the removal of two blades from the striking platform up to the other narrower end of the core. Both blades had a length of c. 14 cm.

Technology:
The working of core 51/195 22 was in the first instance directed at making a core crest on the long, narrow side of the flint nodule. Thus consecutive flakes were removed from the top, one element of which (small decortication flake KA3) could be refitted onto the core. Some distal ends of negative scars of flakes on the right flank point to preparation and creation of a core crest. They were struck from the narrow front of the flint nodule and perpendicular to the future core face. The small, refitted flake KA2 is an example of this.

Due to the oblong shape of the flint nodule and, concomitantly, the presence of a narrow core face (3.2 cm), the core has yielded only a few blades. The first struck artefact was a crested blade, of which a small fragment (KA1) could be refitted onto the core. The last removed blade on the left top of the core ended in a step fracture. Hereafter the core was discarded. The flint knapper did not choose to make a second, opposite striking platform.

A proximal part of a blade and a complete blade form refit group M12.01 and also originate from RMU M12. Both artefacts have a small and partially faceted butt.

Tools:
No tools of RMU M12 have been retrieved.

RMU M13
General:
RMU M13 consists of 18 refitted artefacts which together form refit groups M13.00 to M13.03. The largest refit group is M13.00 and comprises core 259A 208 onto which 10 artefacts could be refitted. The total weight of this group is 370.5 grams, of which the core takes up 275.9 grams. The dimensions of the core are: length 9.9. cm, width 5.9 cm, and thickness 4 cm. The small refit groups M13.01 to M13.03 consist of respectively three (one composition) and two (two compositions) artefacts. Together they have a weight of 71.2 grams. In addition, 25 non-refitted artefacts have been assigned to RMU M13.

Raw material:
RMU M13 concerns a black-grey to brown-olive green, fine-grained terrace flint. The colour cannot be determined exactly due to the almost complete absence of non-patinated surfaces. The cortex is in general smooth and rolled as a result of transport by water in a river bed. Locally the cortex is heavily dented and weathered. Only in a large hollow in the core is the cortex much less heavily weathered and even rough still. The colour of the patina of the heavily rolled natural fracture surfaces is brown-green. The worked surfaces are blue-greyish patinated with characteristic, small dark blue specks. Locally there are also blue spots and bands visible. Grey inclusions ranging from small to large are present, for instance there is one with a diameter of c. 5 cm on the core face. Frost cracks and frost surfaces are absent.

Core:
The blade core (259A 208) is complete and has two striking platforms as well as two opposite core faces (*nucléus à deux plans de frappe pour débitage sur faces opposées*). The front of the core shows the remnant of the first used core face (core face 1) and consists of a few negative scars of blades and blade-like flakes. A part of these negative scars enclose a large hollow with cortex. The core face on the back (core face 2) is more complete and also shows negative scars of blades, struck from the base of the core. Viewed from the back, the right flank has a few blade negatives that border the above hollow with cortex. The other flank consists partially of cortex in which a hollow is present as well. In addition, on the intersection between flank and core face are (parts of) negative scars visible of larger flakes. In relation to both core faces are two striking platforms, of which the first striking platform (striking platform 1) is on the top of the core. This striking platform is very irregular to coarsely chipped and tapers slightly.

Technology:
Presumably the front and left flank of the core were in the first instance used as core face. In a later phase the core was turned and the back served as core face for the production of blades.

The first stage of reduction is not represented by refitted artefacts, that is the removal of decortication flakes and the creation of the first striking platform (striking platform 1) on the top of the core. During the use of striking platform 1, a few short blades and blade-like flakes were removed from the first core face (core face 1). Their negative scars extend to about halfway the front of the core. A large hollow on the left top of the core face and an irregular cortex part and hollow on the right flank impeded a successful working of this part of the core. Thus, a negative scar of one of the blades ends in the hollow with cortex. To remove this obstacle, the flint knapper decided to create a new core crest. This attempt however was soon abandoned: adjacent to the natural hollow small negative scars are visible which cannot be regarded but as the beginning of the creation of a crest.

Next, striking platform 2 was created on the base of the core with the aim of removing blades from the back of the core. To this end decortication flake KB6 was removed and next (on the adjacent part of the back) flake KB5. In refit group M13.00 the first-mentioned flake forms a characteristic tablet that extends obliquely above striking platform 2. Between this artefact and striking platform 2 is an ‘open space’ (no refitted artefacts). This indicates that the flint knapper prepared the striking platform in the interim. A few flakes were thereby removed that ended in step fractures. Compared to the front of the core, removing blades from the back was more successful. From striking platform 2 a series of blades was removed, of which the proximal part of a blade (KB2) and a complete blade (KB 1, though halfway the core ending in a step fracture) could be refitted. As far as could be inferred from the negative scars on the core, the longest blade had a length of more than 10 cm. The core face on the back is flat to slightly convex and has some irregularities as a result of step fractures.

By making striking platform 2 on the base of the core, a part of core face 1 was taken away from the front. The striking platform displays negative scars of irregular flakes which were struck perpendicular to the longitudinal direction of core face 1 (*éclats transversaux*). The edge of striking platform 2 is locally facetted.

Two refitted flakes in refit group M13.02 indicate that the first stage of knapping was probably carried out in the camp site of Eyserheide. The dorsal surface of both artefacts consists completely of cortex. Of some non-refitted artefacts that have been assigned to RMU M13, the dorsal surface is also largely covered with cortex remains. No crested blades or fragments of them have been retrieved. Also, there are among the refitted artefacts hardly any fragments of blades with regular parallel edges. That RMU M13 did yield such blades can be inferred from the occurrence of some non-refitted tools, made of relatively narrow blades with parallel sides. Together with the negative scars of blades on core face 2, they form an indication of the successful method of removing blades. And finally, a fine core tablet has been assigned to RMU M13 (fig. 4.5-1). This tablet points to complete rejuvenation of the striking platform in an earlier phase of modification than was documented on the basis of refitted artefacts in refit group M13.00.

Tools:
Conjoined artefacts 53/203 8 and 53/202 56 together form the distal end of a blade end scraper with a semi-circular scraper edge, that is lightly retouched. Another find assigned to RMU M13 is the distal end of a blade scraper, with an irregular scraper edge. And lastly should be mentioned the proximal part of a blade with a small notch on the right lateral edge (51/199 6).

RMU M14
General:
This small RMU consists exclusively of non-refitted artefacts. Assigned to RMU M14 are three flakes and three blades.

Raw material:
RMU M14 is a fine-grained terrace flint, olive green to olive brown in colour. The cortex is in general yellow-brown, eluvial and regular. But there are also artefacts (259A 257 and 59/201 18) with locally a smooth cortex, the colour of which is browner. The flint is white-blueish patinated, and white wisps are visible in the patina. Directly underneath the cortex is a characteristic thin dark brown band. There are also yellow-olive green bands visible in the patina, which remind us of the bands on artefacts that form part of RMU M11. On the basis of this resemblance it cannot be excluded that the artefacts of RMU M11 and RMU M14 belong to one and the same raw material unit. Inclusions are rare and are small in size. Frost cracks and frost surfaces are absent.

Core:
No core has been retrieved.

Technology:
The artefacts assigned to RMU M14 all have cortex remains that take up more than 25% of the dorsal surface. As the core and refitted artefacts are missing, nothing can be said about the method of core and striking platform preparation. Three fragments of blades with long, regular lateral edges indicate a systematic method of blade production. They are relatively broad blades: the broadest specimen is 3.3 cm wide. Blade 58/202 27 is a proximal fragment of a blade and has a small facetted butt (*en éperon*).

Tools:
No tools have been retrieved.

RMU M15 (fig. 4.31; table 4.27)
General:
RMU M15 consists of 29 refitted artefacts that together form refit groups M15.00 to M15.07. The largest of these (M15.00) has eleven artefacts, among which core 259A 209. The core has a weight of 490 grams and the following dimensions: length 10.6 cm, width 6.9 cm, and thickness 5.3 cm. The total weight of refit group M15.00 is 692.1 grams. The other refit groups consist of four (M15.01), three (M15.03, M15.04), and two (M15.02, M15.05, M15.06 and M15.07) artefacts. Also more than 60 non-refitted artefacts were assigned to RMU M15. In view of this large number of artefacts and the not very diagnostic characteristics of the flint, it is not certain whether the said

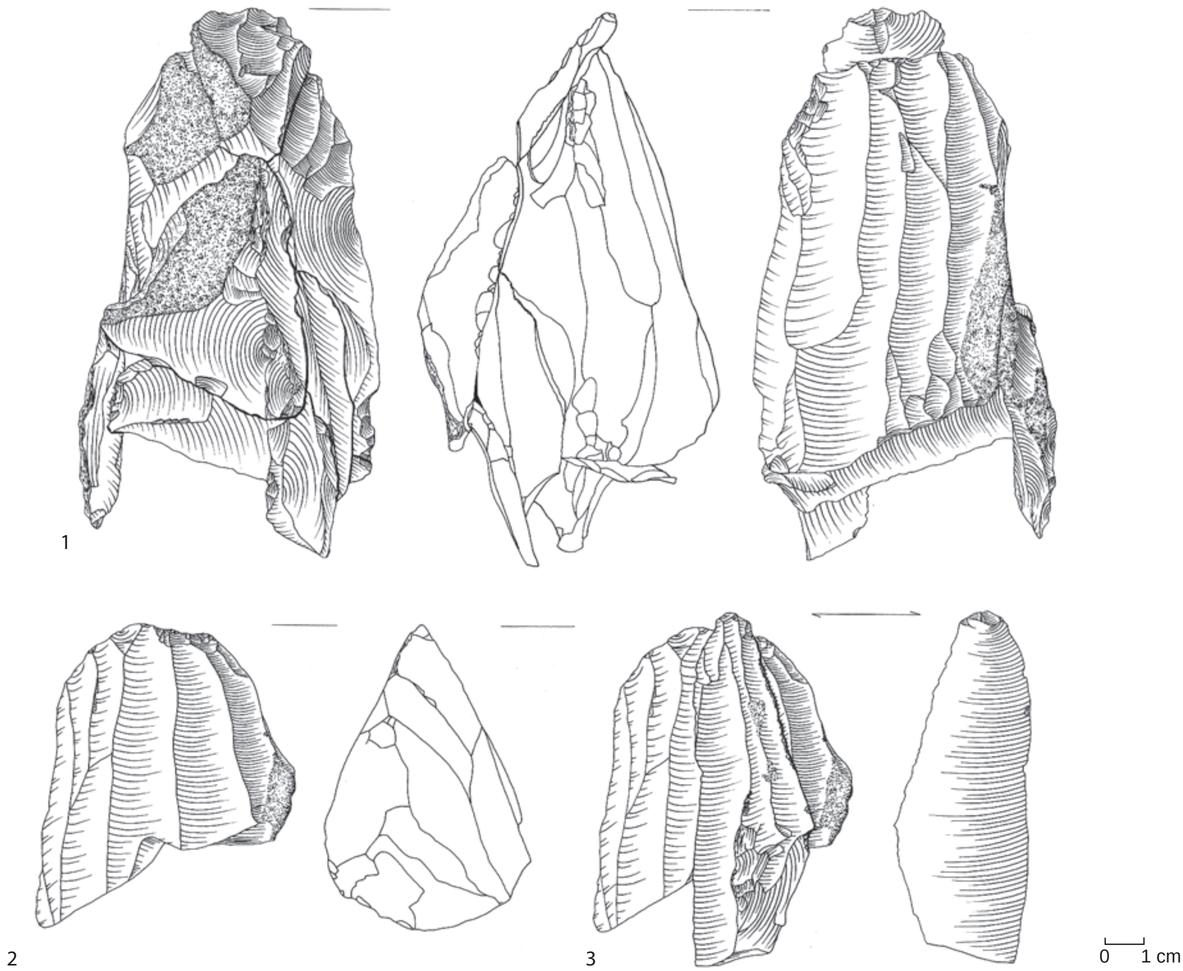


Figure 4.31 Refit groups M15.00 (1) and M15.02 (2-3) of Meuse terrace flint. The core fragment in M15.02 possibly originally formed part of core 259A 209 in M15.00 (scale 1:2).

60 artefacts all actually do originate from one and the same RMU. Possibly RMU M15 represents the knapping products of two (or more?) cores that show many similarities with regard to properties (grain size, colour, patina) of the flint.

Raw material:
RMU M15 is a fine-grained terrace flint. The colour is black-grey to olive green with slightly brownish parts. The through fluvial transport rolled, smooth cortex is brown in colour and is heavily dented. There are few inclusions. A large specimen with a diameter of 3 cm is visible on the front (= side of the core face) of core 259A 209. There are also frost cracks visible on this surface. Frost-fractured natural surfaces are lacking. The patina of the flint is white-grey to grey-blue. In addition, consecutive, light coloured grey-blue bands are visible in this flint.

Core:
Complete blade core (259A 209) with two opposite, oblique striking platforms and one core face (*nucléus à deux plans de frappe pour débitage sur une même face*). The core face is slightly undulating to flat. The left flank of the core contains remains of cortex and the negative scars of large flakes. The right flank is largely formed by a large worked surface perpendicular to the core face. The back of the core displays cortex remains and parts of negative scars of large flakes. This side is irregular and is in cross-section trapezoid (*forme trapézoïdale*). This shape is the result of the use of two opposite, oblique striking platforms.

The striking platform on the top of the core (striking platform 1) is slightly irregular and rather flat. There is a succession of some step fractures at the edge, that is to say there where the striking platform changes into the core face.

RMU M15

Refit group M15.00	PRS	Artefact type	(in)complete	Length (mm)	AFW	WAC	SPB	Remarks
259A 187	KA5	flake sec.	incomplete	61	B3	back	.	.
61/201 5	KA4	flake sec.	incomplete	53	B3	back, left flank	.	.
259A 385	KA3	flake tert.	incomplete	23	B3	back	.	.
55/202 1	KA2	flake tert.	complete	75	B3	back	.	.
59/202 16	KA1	flake tert.	incomplete	38	B3	back	.	.
59/200 39	KB4	flake tert.	incomplete	42	D1	platform 1	.	.
59/201 10	KB3	flake tert.	complete	40	D1	platform 1	.	.
61/203 3	KB2	flake tert.	complete	19	D1	platform 1	.	.
62/201 1	KB1	flake tert.	incomplete	53	D1	platform 1	.	.
61/200 8	KC1	flake sec.	complete	46	B1	buttom	.	creation platform 2
259A 209	K1	core	complete	106	E	.	.	discard core
Refit group M15.01								
60/200 2	PA4	flake tert.	complete		B	indet	.	.
60/201 23	PA3	flake tert.	complete		B	indet	.	.
59/200 6	PA2	flake tert.	complete	25	B	indet	.	.
259A 200	PA1	flake tert.	complete	30	B	indet	.	.
Refit group M15.02								
54/203 18	PB2	retouched blade prim.	proximal	90	C2	core face	indet	tool use
259A 210	PB1	core fragment	incomplete	79	E	.	.	knapping failure?
Refit group M15.03								
60/200 1	PC2	flake tert.	complete	28	B	indet	.	step fracture
56/200 2 – 59/201 9	PC1	core tablet	complete	87	D4	indet	.	rejuvenation
Refit group M15.04								
259A 191 – 60/199 6	PD2	blade tert.	proximal	63	C2	(core face)	.	
259A 271	PD1	flake tert.	incomplete	47	C2	(core face)	.	

Table 4.27 Reduction sequence of core 259A 271 (refit group M15.00-M15.04), length of artefacts in mm. For an explanation of the codes, see table 4.17.

The striking platform on the base of the core (striking platform 2) is rather flat with a somewhat abraded edge.

The core face extends over the entire front of the core, and has a length of 10 cm and a width of 6.3 cm. Negative scars of successive blades are visible on the core which were struck from striking platform 2. One of these scars has a length of 7 cm and ends in a step fracture. A negative scar of another blade extends to the top of the core, from striking platform 2 and completely across the core face up to striking platform 1. The scar has a length of c. 11 cm and a width of 2.8 cm. The right side of the core face shows a negative scar of a blade struck from the right top of the core, from striking platform 1.

The core was discarded at a time when there was still sufficient 'volume' present and the blade production could easily have been continued, for instance by turning the core and (after preparation) to again utilise striking platform 1.

To M15 was also assigned core fragment 259A 210. Presumably this is the distal end of originally a large blade core with a succession of very regular blade negatives. It is likely that this core fragment was at the start of the reduction of RMU M15 part of core 259A 209.

Technology:

Because of the small number of artefacts refitted onto the core, the method of core reduction (preparation of the flanks, striking platform preparation, etc.) could only be determined in outline. Decortication flakes are lacking among the refitting and assigned artefacts. Two flakes (KA5, KA4), of which the dorsal surface is covered with 25-50% of cortex remains, could be refitted onto the back of the core. They are related to the shaping of the base and flank of the core. Both flanks were prepared by removing larger flakes, thus completely removing the cortex on the right flank. From the left back, refitting flake KA4 has taken away a part of the cortex of the left flank.

There are no indications of making a central crest (*crête longitudinale*) on the front of the core. Among the refitted and assigned artefacts are no complete or fragments of crested blades. Only the distal part of blade 52/200 10 (non-refitted) possibly indicates the preparation of a crest. Another possibility is that we are dealing with a struck-off edge of the striking platform.

During the working of core 259A 209, first a striking platform (striking platform 1) was created on the top. Three flakes connected with the preparation of this striking platform could be refitted onto the core and they extend above the core face. From here flake KB4 was removed first: this flake extends further beyond the striking platform than flake KB1. This indicates interim reworking and preparation of the striking platform in the course of blade production (*plein débitage*) from striking platform 1. An attempt to rejuvenate the striking platform on the right top ended in a flake with a hinge (KB2). This last made striking platform, as visible on the core, was hardly utilised again.

Next the core was turned 180º and an opposite striking platform (striking platform 2) on the base of the core was used. Refitted flake KC1 is related to the preparation of this striking platform. This flake extends c. 1 cm above the core face. The subsequent successful removal of blades is shown in the succession of regular negative scars of blades on the regularly-formed core face. Utilising striking platform 2 has resulted in the scars of blades struck from striking platform 1 having been 'taken away'. Although a considerable number of blades were removed, not a single blade could be refitted onto core 259A 209.

Core 259A 209 was originally much longer, especially if we assume that core fragment 259A 210 in refit group M15.02 was originally part of the core. Both the flint, the cortex and the narrow white bands that show on the surface of the patinated flint are identical. Besides, the core fragment displays, as does core 259A 209, a succession of fine blade scars. One of these removed blades (PB2) has macroscopically visible edge damage ('use retouch') and could be refitted onto the core fragment. Not long after the removal of this blade, the core broke. Was the core broken on purpose, after which the flint knapper continued to modify core 259A 209? Another possibility is that the core split into two pieces unintentionally along a frost crack (see Orp-le-Grand, Vermeersch et al. 1987, fig. 14.4, p. 23).

Tools:

Among the artefacts assigned to RMU M15 is a proximal part of a large blade (refit group M15.02) on which 'use retouch' is visible along the left lateral edge and close to the butt. The butt is facetted and has a lip, which indicates application of *en éperon* technology.

RMU M17 (fig. 4.32)

General:

This RMU consists of nine refitted artefacts which together form three refit groups (M17.00 to M17.02). Refit group M17.00 comprises a complete small core (56/200 4) and four artefacts refitted onto this core. The total weight of this refit group is 100.6 grams. The small core weighs c. 90 grams and has the following dimensions: length 6.5 cm, width 5 cm, and thickness 2.5 cm. Refit groups M17.01 and M17.02 each contain two artefacts. In addition, 15 non-refitted artefacts have been assigned to RMU M17.

Raw material:

RMU M17 is a fine-grained (terrace?) flint. The colour of the flint is probably grey-yellowish. As the core and the

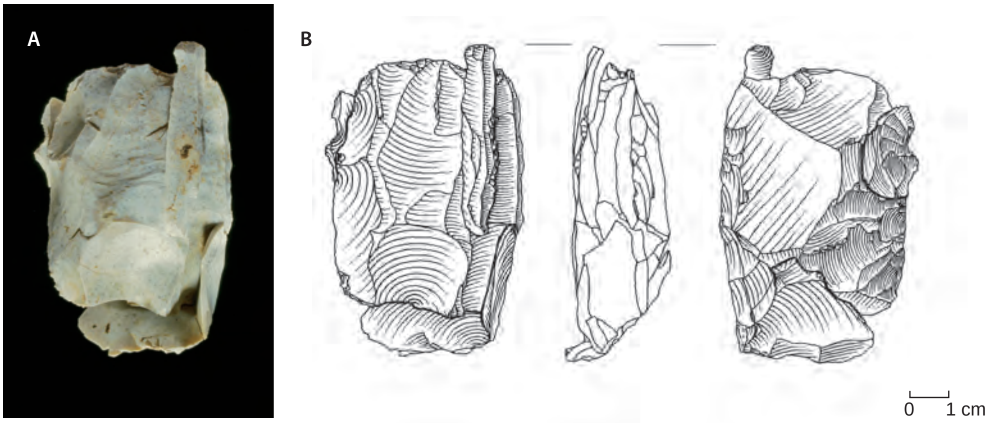


Figure 4.32a and b Refit group M17.00. Small core 56/200 4 of Meuse terrace flint with refitted backed blade (scale 1:2). The length of the core is 6.5 cm.

conjoined artefacts are entirely covered with patina, the colour cannot be determined accurately. The colour of the patina is grey to grey-white. Neither on the core nor on the artefacts refitted onto the core are cortex remains present. One of the assigned artefacts (57/202 20) has a smooth, by fluvial transport rolled cortex. The flint is further characterised by some large inclusions with a diameter of more than 3.5 cm, for instance in artefact 55/202 101. There are also many small specks and spotted inclusions visible. An old fracture surface forms a large part of the back of the core. In addition, a frost crack is visible on the front and over the entire length of the core.

Core:
Small bladelet core (56/200 4) with two opposite striking platforms and one core face. The core is rather broad and thin and has a slightly convex core face (6.4 × 4.3 cm). The left flank consists of the scars of three flakes. Of these, one flake was struck from the striking platform on the top of the core and two flakes were removed from the base. The scars of these flakes are perpendicular to the core face. Other, smaller flakes have been struck from the top of the core. In fact, there is no right flank to speak of. The core face continues here directly into a natural fracture surface on the back of the core. The back is rather flat, which results in the flakes related to the preparation of the striking platform and the flanks having small dimensions. On either side of the natural fracture surface are scars of such flakes visible.

The striking platform (striking platform 1) at the top of the core is almost smooth. Here the striking platform is largely formed by the scar of a flake. Striking platform 2 is on the base of the core and is more irregular. This surface shows the scar of a flake that ended in a step fracture. The longest scar on the core points to the removal of a small blade or bladelet with a minimal length of 4.1 cm.

Technology:
As the number of refitted artefacts is small, little can be said about the method of reduction of the core. Products of the first stage of core reduction (decortication, the shaping of the core whereby remaining cortex parts are removed) are lacking completely among the refitted and assigned artefacts. As far as can be inferred from the scars on the core face, striking platform on the base of the core was used first. Probably also blade-like flake KA2 was removed in this ‘first stage’ of core reduction. Next, (again) rejuvenation of the striking platform has taken place by the removal of flake KA1. This flake extends obliquely above both the striking platform and the core face. Subsequently, the flint knapper turned the core 180º and has chosen to use the opposite, top as striking platform. From this opposite striking platform (striking platform 1) a few small, narrow blades and blade-like flakes were removed. Of these a complete backed bladelet with abrupt retouch on the medial part (KB1) could be refitted halfway the core. During the use of striking platform 1, the left flank of the core was probably in the meantime reworked. The alternating removal of some flakes on this side, among which flake KC1, has led to a (new?) core crest on the transition from the left flank to the back of the core. Because of this interim preparation, a part of the left side of the core face has been taken away. The continued use of the core face has led to parts of the scars of the preparation flakes also having been taken away.

Next, striking platform 2 on the base of the core was used anew. An attempt to remove a blade (or core rejuvenation flake?) from this side failed. This is shown by the presence of a wide, deep negative scar on the core face. After striking platform 2 was rejuvenated, a last attempt was made to remove a blade. This 'blade' was struck from the right base of the core and had a length of only 3 cm.

Fragments of blades or crested blades are lacking among the artefacts assigned to RMU M17. Also absent are scars of blades and/or bladelets that point to a systematic reduction of the core. Because of the small dimensions, the core seems to have been most suitable for the production of bladelets. The bladelet from which backed bladelet KB1 was made, is an example of this. The artefact has small, facetted butt and a lip on the ventral side which points to the application of *en éperon* technology. On the core, the edges of both striking platforms show however no indications of this kind of preparation.

Tools:
A complete backed bladelet, the medial part of which has abrupt retouch, forms part of refit group M17.00. The bladelet was removed from the central part of the core face from striking platform 1.

RMU M18
General:
RMU M18 consists of three refitted artefacts (refit group M18.01) and 29 assigned artefacts which have been described as flakes (n=22) and blades (n=7). There is no core present. The weight of refit group M18.01 is 27.8 grams.

Raw material:
Light brown, fine-grained terrace flint which at places where the patina is lacking is slightly translucent. The patina is usually blue-whitish in colour and does not cover the entire surface, but is present there as a faint trace. Towards the edge, the patina is more spotted and underneath the cortex it has (almost) disappeared. The assigning of 29 artefacts to RMU M18 is largely certain, because of the occurrence of a characteristic light brown, non-patinated band or zone underneath the cortex. The cortex has brown-yellow hues, and is rolled and locally heavily dented as a result of transport by water in a river bed. The cortex is not rolled in the hollows but is still rather rough (eluvial) and irregular.

Core:
No core has been retrieved.

Technology:
With the exception of one artefact, all artefacts have cortex remains. There are also a few decortication flakes present. The flakes are related to the preparation of the striking platform, the flanks and/or the back of the core. As the core is lacking and only three flakes could be refitted, the position of the artefacts within the reduction sequence cannot be determined. Some fragments of blades point to the execution of *plein débitage* and the removal of blades. Of two irregular blades, one piece has a small, flat butt and a 'small lip'. The butt of the second blade is chipped. There is however a small bulge that indicates application of *en éperon* technology.

Tools:
There are no tools among the artefacts assigned to RMU M18.

RMU M19
General:
This RMU consists of 26 refitted artefacts which together form nine refit groups (M19.00 to M19.08). In refit groups M19.01 to M19.04 we are dealing with four small compositions of dorsally / ventrally refitted artefacts. The number of artefacts varies from two (M19.03, M19.04) to eight (M19.01). In the other refit groups are conjoined broken pieces of flakes and blades. Refit group M19.00 consists of two refitted parts of a blade core. In addition, on the basis of characteristics of the flint and cortex were assigned to RMU M19 two fragments of cores, 27 flakes, 20 blades, and 8 tools. In contrast to most other RMUs within the group of South-Limburg flint, we are not dealing here with the knapping products of one core. Probably the products of three or more cores are represented in RMU M19.

Raw material:
The artefacts are made of fine-grained to moderately fine-grained, black-grey flint in which locally coarse-grained inclusions ('specks') are present. The artefacts are blue-grey to blue-white patinated. The origin of the flint is the Chalk of Lanaye and it can be designated as Rijckholt flint. Most artefacts have regular, eluvial cortex remains. There are also hollows and more irregular cortex parts, such as two refitted fragments of cores show. Indications of transport of the flint in a river bed (rolled, smooth cortex, traces of dents) are lacking. For this reason we are not dealing with terrace flint.

Cores:
Two fragments of a core (259A 325 and 259A 326) with non-patinated breaks could be refitted to each other (refit group M19.00). Together they form about two thirds of a blade core with two opposite striking platforms. There is one core face on which a blade scar is visible with a length of 8.9 cm and a width of 2.2 cm. The blade was struck from the top of the core (striking platform 1). A large part of the striking platform and the back of the core have split off. The edge of the striking platform, as far as has been preserved, is irregular

and locally abraded. Both the left and right flanks and the back side of the core consist of cortex remains. The second striking platform was created by removing a large flake.

Technology:
Five dorsally/ventrally refitted artefacts (refit group M19.01) were probably removed during the preparation of one of the flanks of a core. The direction of debitage of all flakes is more or less the same, that is to say they have been struck from the same side of the core. On the distal end of four flakes are cortex remains visible, while the butts are without cortex. In a composition with three refitted artefacts (refit group M19.02) artefact 259A 424 is noticeable. It is a thick, plump 'Clacton-like' flake of which the dorsal surface consists entirely of cortex and a non-patinated fractured surface.

Among the artefacts assigned to RMU M19 are a few decortication flakes. They indicate that the first (?) stage of core reduction of one or more cores in the group of RMU M19 was carried out in the camp site of Eyserheide. A core rejuvenation flake consists of an intentionally removed core edge and the adjacent part of the core face. This part displays the negative scars of broader flakes and of a non-prepared (flat) striking platform (refit group M19.05).

The production of blades in RMU M19 is indicated by for instance complete blade 54/203 24 with regular lateral edges and a length of more than 11 cm. Another indication is three conjoined broken pieces of a crested blade (refit group M19.06) with a length of almost 13 cm (fig. 4.6-2). As the proximal part is missing, the blade was originally longer. There are also fragments of blades with regular, parallel lateral edges (for instance 54/204 79, 52/194 5).

Tools:
Among the artefacts assigned to RMU M19 are eight (retouched) tools. The most striking of these are two end scrapers (259A 318 and 259A 320), a complete dihedral burin (259A 1), and a bec burin consisting of two broken pieces (54/202 84 and 52/201 41). They indicate that flint nodules originating from the Chalk of Lanaye and collected in eluvia and/or slope deposits (eluvial cortex) were used for the production of different types of tools. End scraper 259A 318 is a good example of the application of *en éperon* technology. The butt is facetted and has a clear 'lip'.

RMU M21 (fig. 4.33)
General:
RMU M21 consists of three refitted artefacts (refit group M21.01) which together weigh 21.9 grams.

Raw material:
The colour of the flint has not been determined due to the lack of non-patinated surfaces. The artefacts have been described as a separate raw material unit on the basis of the occurrence of a brown-white yellowish, up to 6 mm wide band underneath the cortex and a regular, not rolled by river transport cortex. These characteristics point to an origin of the flint nodule from eluvial or slope deposits.

Core:
No core has been retrieved.

Technology:
Not applicable.

Tools:
We are dealing here with two refitted fragments (259A 316 and 259A 317) of a borer on blade, and a refitted medial fragment of a blade with retouch (53/199 20).

RMU M23
General:
RMU M23 consists of two conjoined broken pieces which together form the medial part of a narrow blade or bladelet. After refitting, the (not complete) artefact weighs 1.5 grams. Because of the brown colour of the flint, this artefact was possibly manufactured of Rullen flint (Warrimont and Groenendijk 1993). The fluvial rolled cortex points to an origin from a river bed or river terrace, possible the river Voer. This small river flows through the source area of Rullen flint south of Maastricht on either side of the Dutch-Belgian border. This would indicate a transport distance of 10-15 km.

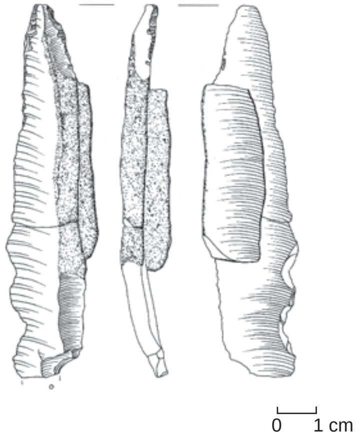


Figure 4.33 Refit group M21.01. Borer consisting of two conjoined broken pieces and refitted medial part of retouched blade (scale 1:2). The artefacts are made of South Limburg flint and have 'eluvial cortex'.

Core:
No core has been retrieved.

Technology:
Not applicable.

Tool:
The artefact has on the right lateral edge macroscopical traces of use ('use retouch').

4.6.5 *Orsbach flint*

RMU O1 (fig. 4.34-1)
Complete core of Orsbach flint consisting of eight conjoined fragments split along frost cracks (refit group O1.00). The core has only scars of flakes and is both on the front and the back roughly knapped. Because of the bifacial removal of flakes, the shape reminds us slightly of a bifacial tool from the Middle Palaeolithic. The working has resulted in two opposite ridges (*crêtes longitudinales*) on both long sides of the artefact. The base of the core has a thickness of 5.8 cm and is clearly thicker than the top which has a thin and slightly pointed end. Near the thick part, the flint knapper 'wrestled' with the shaping of the core because of the presence of hollows in the flint. In vain he tried to remove the thickening at the base. At this place some flakes, struck from the left ridge, have ended in step fractures. Hereafter the roughly shaped core was discarded. Apparently it was not possible to give the thick plump base the right shape. Another possible reason which may have led to discarding the core is the occurrence of frost cracks. In any case, the creation of a striking platform for blade production was abandoned. Both on the front and on the back of the core are cortex remains present. One flake could be refitted onto the core. The dimensions of the core are: length 13.4 cm, width 6.7 cm, and thickness 5.8 cm. Weight: 405.7 grams (including refit 421 grams).

RMU O2 (fig. 4.3)
Large fragment of long, narrow and thin blade core of Orsbach flint consisting of three conjoined fragments split along frost cracks (refit group O2.00). Two blade scars on the front (= core face) point to a blade core with one striking platform. Cortex remains are present on the front and on refitted decortication flake 53/202 61. The flake has been struck from the left top of the core. Parts of the back of the core are missing as a result of splitting along frost cracks. As the worked surfaces and the frost-split surfaces are slightly glossy, splitting along frost cracks may have occurred already during the flint-knapping. Another indication for this are traces of (renewed) preparation of the right, lateral edge of the artefact. This preparation was carried out after the top of the core had broken along a frost crack. The left lateral edge displays over its entire length traces of core preparation, by alternating removal of flakes.

The blade scar with the greatest length (c. 12 cm) covers the entire length of the core face and corresponds with refitted blade borer 54/203 19. The edge of the striking platform is locally facetted, presumable at the place from where the next blade would have been removed. The dimensions of the core are: length 13.3 cm, width 5.2 cm, and thickness 1.8 cm. Weight: 132.7 grams (including refit 53/202 61).

RMU O3 (fig. 4.34-2)
Small, complete blade core consisting of five conjoined fragments split along frost cracks (refit group O3.00). The core has one striking platform. The core face on the narrow front shows the scars of some blades. Of these, the largest (length 8.2 cm) extends from almost the top to the base of the core. The left lateral edge consists of a core crest and scars of (smaller) flakes that were removed in order to obtain this crest. The crest was created after the base of the core had split along a frost crack. This can be inferred from the occurrence of a large frost-split surface on the back of the core. On the right flank is also an old frost-split surface visible. Apparently, the core has also split along a frost crack on this side, with which a part of the core face was 'taken away'.

The core is widest near the striking platform, and towards the base the core becomes narrower to end in a narrow point. This point is also the result of the old splitting of the core along frost cracks. The remaining, preserved part of the core face is convex. The core was discarded after attempts to remove blades ended in step fractures. A flake (53/199 12 – 54/200 13) could be refitted onto the striking platform of the core.

The dimensions of the core are: length 9.2 cm, width 3.8 cm, and thickness 4.1 cm. Weight: 194.1 grams (including refits 53/199 12 – 54/200 13).

RMU O4
Fragment of a small core, consisting of three conjoined fragments split along frost cracks (refit group O4.00). As a result of frost-splitting a part of the back is missing. The preserved part can be designated as an 'angular' and irregularly shaped 'flake core'. It shows the negative scars of two rather large flakes that were removed from the top of the core (striking platform). The striking platform itself consists of parts of negatives of two flakes and has hardly been reworked.

Originally the core was larger and had a wider and significantly longer core face. The removal of flake 54/201 31 * 55/202 82 has led to a large part of the core face having been taken away (unintentionally), as was the base of the

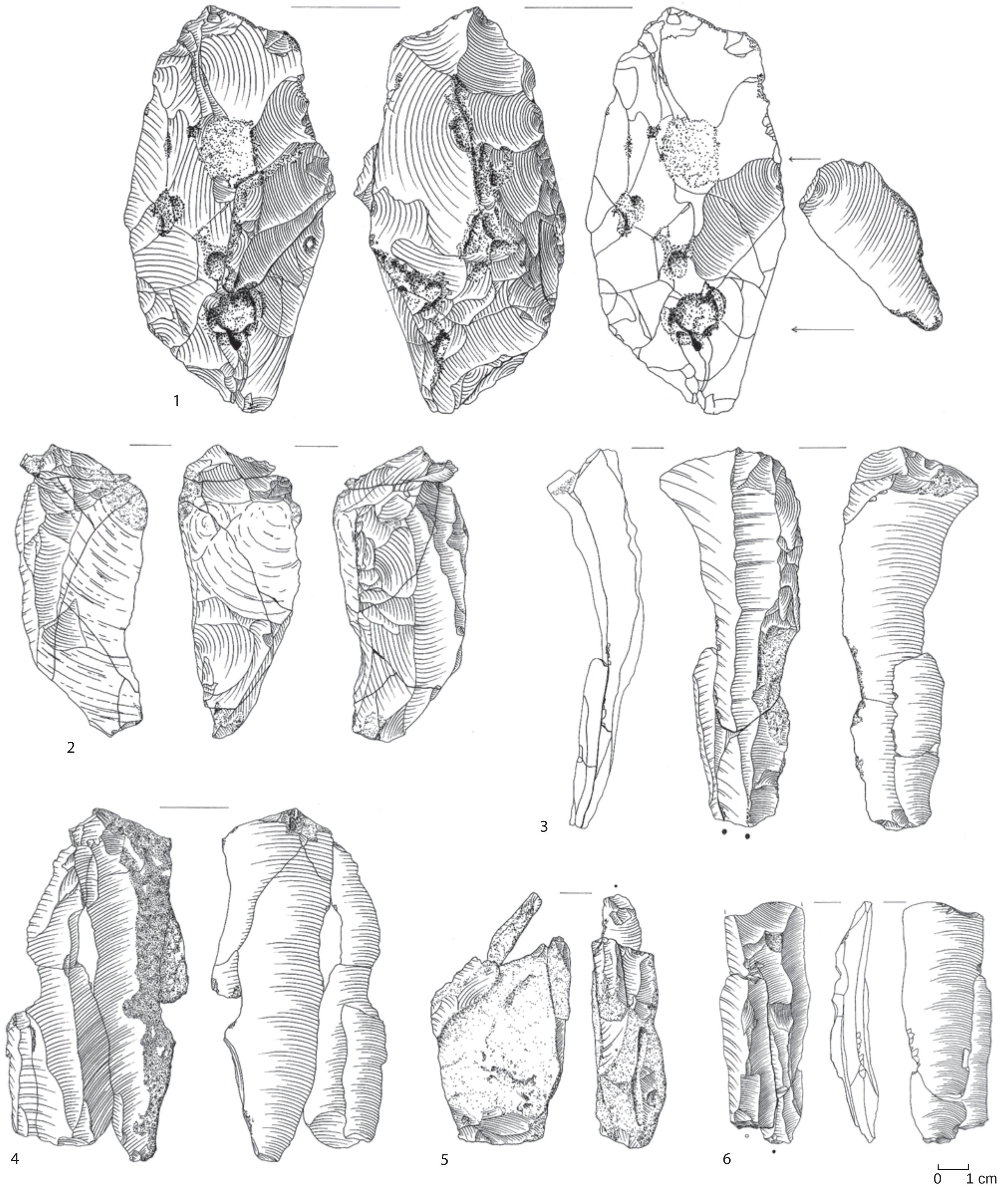


Figure 4.34 Orsbach flint. Refit groups with core O1.00 (1), O3.00 (2) and O8.00 (5), and refit groups without a core O615 (3), O603 (4) and O621 (6). (scale 1:2).

core (*outrepassé*). The scars that are visible on the dorsal surface of this flake and on refitted blade 54/202 189 – 259A 47 indicate that earlier this was a core with regular blade scars. Also the distal part of blade 259A 19 – 54/201 61, that could be refitted onto the *outrepassé*, would indicate this. There are also indications of intensive working on the right lateral edge of the core face. The (remaining) dimensions of the core are: length 7.4 cm, width 4.3 cm, and thickness 3.4 cm. After refitting of the *outrepassé* the dimensions are as follows: length 8.9 cm, width 5.2 cm, and thickness 3.4 cm.

RMU O5

Almost complete core with one striking platform consisting of five conjoined fragments split along frost cracks (refit group O5.00). The core only has flake scars. The left back of the core consists of a crest which is the result of bifacial removing of flakes. This has led to a characteristic convex shape of this part of the core. On the front, at the position of the core face, indications of the creation of a crest are lacking. The base of the core consists largely of a hollow with cortex. Cortex remains are also present on the right lateral side.

Scars of flakes point to the use of a striking platform at the top of the core. This striking platform consists of scars of two flakes and has otherwise not been modified. The core was probably discarded after an attempt to remove a blade or a blade-like flake resulted in splitting the core into several parts. A crack between two split parts can be followed from the point of impact on the striking platform parallel to the core face and up to the base of the core. The dimensions of the core are: length 7.7 cm, width 5.2 cm, and thickness 4.3 cm. The weight of the core, of which a small fragment is missing, is 176.8 grams.

RMU O6 (fig. 4.35)

Complete blade core (53/204 23) with one core face and two opposite striking platforms (refit group O6.00). The front of the core shows parts of scars of eight, partially regular blades. The distal part (53/203 56) of one of these blades could be refitted centrally onto the core face. The back of the core consists of (parts of) negative scars of larger preparation flakes and a frost-split surface that was already present during the core reduction. This surface, as are the adjacent worked surfaces, is whitish patinated. After a part of the back had split along a frost crack, the flint knapper tried to create a new core crest. This is indicated by the negative scars of a few small preparation flakes which are visible along the edge of the frost-split surface over a length of c. 3.5 cm. The front of the core shows traces of preparation before the blade production (*plein débitage*) was started. Probably the preparation was geared towards obtaining a biconic volume, for which use was made of two ridges on both long sides of the core. On the left side of the core face, traces have been preserved that are related to the creation of such a ridge. Traces of a ridge on the opposite, right side are no longer present as a result of the removal of blades.

The striking platform at the top of the core displays clear traces of striking platform preparation, in the shape of negative scars of small flakes and a few 'bulges' (*en éperon* preparation, fig. 4.35). The second, opposite striking platform is smaller, flat and not prepared. From this side a blade was struck with a length of minimally 7.5 cm. The core face is convex in shape and extends over the entire front of the core. Blade scars are visible up to the right flank of the core, up to the place where a part of the core face was taken away as a result of splitting along a frost crack (*débitage semi-tournant*). Most blade scars are the result of blade production from the striking platform at the top of the core.

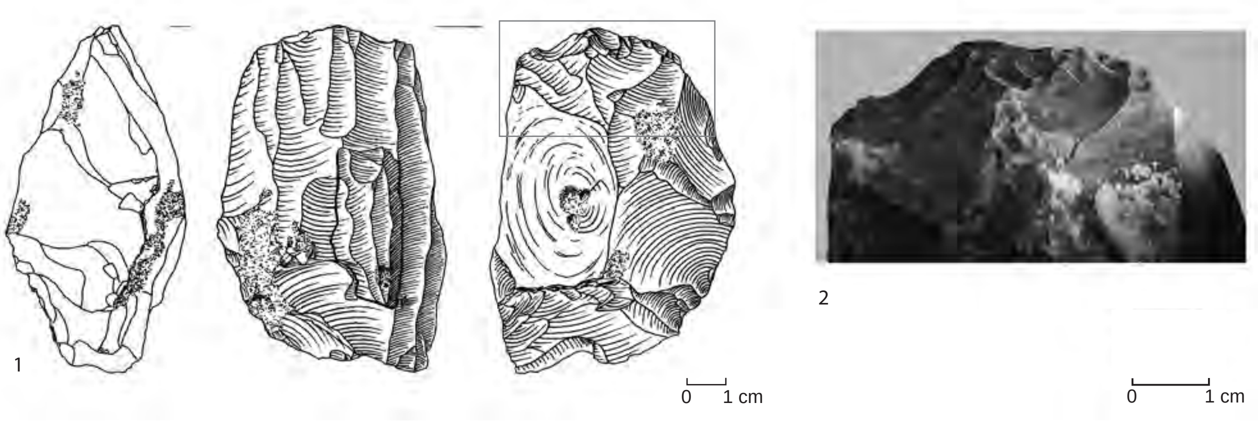


Figure 4.35 Refit group O6.00. Blade core of Orsbach flint with frost-cracked face (1) (scale 1:2) and traces of *en éperon* preparation (2) of the striking platform (scale in cm).

In contrast to other cores of Orsbach flint, core 53/204 23 is not fragmented as a result of frost and/or contact with a ploughshare. The dimensions of the core are: length 9.1 cm, width 6.8 cm, and thickness 4.7 cm.

RMU O7
Small core of Orsbach flint consisting of four conjoined fragments split along frost cracks (refit group O7.00). The artefact is not complete. A part of the front is missing as a result of the splitting of the core along frost cracks. Here two non-patinated breaks are visible. The core is small but can be designated as blade core with two opposite striking platforms. Both from the top (striking platform 1) and from the base (striking platform 2) blades and/or blade-like flakes were removed. The left flank consists of flake scars and a coarse-grained inclusion. The right flank is partially formed by the side of the core face that was used from striking platform 2. On this flank are visible distal parts of scars of three blades. The back shows negative scars of a few flakes, and cortex remains.

Striking platform 1 at the top of the core displays scars of small preparation flakes and a partially abraded edge. This striking platform is rather narrow and reminds us of a Neolithic, non-polished cutting edge of an axe. Striking platform 2 is much wider and irregular at the edge. The dimensions of the core are: length 6.2 cm, width 4.8 cm, and thickness 3.5 cm.

RMU O8 (fig. 4.34-5)
Remarkably small but complete core made of a piece of tabular Orsbach flint (refit group O8.00). On both sides the core consists largely of cortex remains, both the left flank and the right flank have not been worked. The narrow sides of the piece of flint have all been worked and show scars of flakes and short blades. On the front is a narrow core face and on top of the core a slightly oblique striking platform. Almost half of the core face consists of cortex remains. The worked part borders on the striking platform and displays a blade scar, of which the proximal part (53/202 42) could be refitted onto the core. Corresponding striking platform 1 is irregular and has a 'bulge' as a result of the removal of consecutive flakes, which ended in step fractures, among which refit 259A 28. On the opposite, narrow back is the second core face consisting of the scar of a blade-like flake. The end of this scar merges into the ends of scars that are visible on striking platform 1. The blade-like flake has been struck from striking platform 2 which consists of some flake scars.

The dimensions of the core are: length 6.9 cm, width 4.4 cm, and thickness 2.5 cm. The few products that this core has yielded are remarkably short. There has not been any systematic and careful working of this core aimed at obtaining a series of long and regular blades (indication of working by a child?).

RMU O9
Three conjoined small fragments of a core split along frost cracks (refit group O9.00). Only a small part of the core face and of the striking platform has been preserved. Further characteristics could not be determined.

RMU O10
Two refitted fragments which possibly form part of a core (refit group O10.00). Both the front and the back have an irregular surface with many irregular cortex remains. Only flake scars are visible. There is no core face or striking platform. Remaining length 6.4 cm, width 4.4 cm, and thickness 2.0 cm. Weight: 55.0 grams.

RMU O12
Fragment of a core consisting of three conjoined frost crack pieces which together form a part of the front (the core face), a striking platform, and a part of the back of the core (refit group O12.00). The back consists of cortex. The core is thin and there are no flanks to speak of: the core face merges in fact into cortex on the back. On the core face are visible several scars of blades, blade-like flakes and small flakes. The surface is rather irregular because of the succession of small scars near the edge of the striking platform. The striking platform itself consists of a scar of a large flake that was struck perpendicular to the longitudinal direction of the core. The edge of the striking platform is not facetted, nonetheless some 'bulges' can be observed. These bulges are the result of the removal of small flakes from the striking platform. When the core was discarded, the edge of the striking platform was serrated. The dimensions of the core are: (remaining) length 4.4 cm, (remaining) width 4.8 cm, and (remaining) thickness 2.1 cm. Weight: 45.9 grams.

RMU O13
Three conjoined fragments of a core split along frost cracks (refit group O13.00). A part of the core face and the striking platform have been preserved. On the back, mainly irregular cortex remains are visible. Further characteristics could not be determined. Remaining length 3.1 cm, width 3.9 cm, and thickness 2.7 cm. Weight: 33.9 grams.

RMU O14
Three conjoined fragments of a core split along frost cracks (refit group O14.00). The break surfaces are not patinated. We are possibly dealing here with the lateral side of a core, consisting of cortex and some flake scars, and the adjacent part of the core face. Here the distal part of a blade scar is visible. Further characteristics could not be determined. Remaining length 7.9 cm, width 4.8 cm, and thickness 2.4 cm. Weight: 60.7 grams.

RMU O16
Two refitted core fragments which together form part of the core face and a striking platform (refit group O16.00).

Refit group O601
Composition of eight refitted flakes (PA8 to PA1) with irregular cortex remains, including a few hollows. At some places a clear white-grey patina is present. This patina is spotted and can be observed on all artefacts. The flakes are related to a, at first sight, non-systematic preparation of a (not further to be determined part) of a core. Also because of the irregular surface, some flakes have irregular shapes and thicknesses. The two last removed flakes (PA2 and PA1) are more regular and thinner. On the dorsal surface, they have almost no cortex parts.

Refit group O602
Small composition of two refitted flakes. The last struck artefact (PA1) is an irregular core rejuvenation flake which took away part of the edge of a core. The flake has a part of both the core face and the striking platform. The part of the core face shows two flake scars, of which one flake (PA2) could be refitted. The part of the striking platform displays consecutive scars of thin flakes. A clear faceting is visible on the edge which indicates interim preparation of the core edge by removal of small flakes (*en éperon* preparation).

Refit group O603 (fig. 4.34-4)
Small composition of three refitted blades. Of the first struck blade (PA3), the medial and distal parts have been found. This fragment could be refitted onto a large complete blade, consisting of four broken pieces (PA2). The blade is 12.1 cm long and 3.9 cm wide. The third blade is a small medial part (PA1). With all artefacts we are dealing with products of the phase of *plein débitage*, in which blades with considerable widths have been removed from a relatively long (> 12 cm) and wide (> 7 cm) core face. The blades have been struck from the same striking platform.

Refit group O612
Small composition of two refitted blades, one of which (PA1) consists of two conjoined broken pieces. The first struck blade (PA2) was removed from a first striking platform from the ‘top’ of the core. The blade is narrow (maximum width 1.4 cm) and ends in a clear step fracture. Also one or two predecessors of this blade ended in step fractures, probably about halfway the core face. Next the core was turned 180º and the flint knapper used a second opposite striking platform. The aim was to remove the created bulge halfway the core face. The proximal part of this second blade split during the removal.

Although refit group O612 consists only of two blades, the direction of debitage of both artefacts indicates the use of a blade core with two opposite striking platforms. At the time of removal of both blades, the length of the core face was minimally 12 cm. In profile both blades show a ‘slightly curved’ shape. This points to the use of a core with a regular and convex core face.

Refit group O615 (fig. 4.34-3)
Small composition of two refitted, complete blades (PA2 and PA1) which both consist of two conjoined broken pieces. So in total the composition consists of four artefacts. The first struck blade (PA2) extends over the entire core face and has even taken away a large part of the left flank and the opposite side of the core. There is *outrepassé* in which the proximal part of the blade is rather thin and narrow. Halfway the core, the blade has split off significantly thicker (maximum thickness 2.5 cm) and wider (maximum width 4.4 cm). On the dorsal surface of the blade are the scars of two long and regular blades visible, the longest of which had a length of more than 13 cm. The scar of this blade extends to the opposite side of the core. The second blade (PA1) was struck from the same striking platform as blade PA2. Although the blade is complete, its length is only 6 cm.

Refit group O615 points to the use of a regular blade core of Orsbach flint with two opposite striking platforms. From the core, presumably several consecutive blades were struck with a minimal length of 13 cm. Use was thereby made of careful preparation of the edge of the striking platform in *en éperon* technique. The butt of blade PA2, which ended in an *outrepassé*, shows this kind of preparation in a beautiful way.

Refit group O620
Composition of four blades (PA4 to PA1) of Orsbach flint. Light grey spotted zones occur commonly in the flint. With these, these blades are distinguished from other artefacts of Orsbach flint in which comparable light grey spots are absent. The first struck artefacts are crested blade PA4, of which the distal end could be refitted, and blade PA3 of which two broken pieces could be refitted.

Both blades have been struck from the same striking platform from the ‘top’ of the core. Next, core preparation has taken place from the top of the core face and perpendicular to the striking direction of the blades. Flake PA2 is the result of this preparation. After this interim preparation, blade PA1 was removed. This complete blade has a length of 10 cm and was struck from the same striking platform as the two earlier mentioned blades. As far as can be inferred from refit group O620, use was made of a core with one striking platform. The length of the core face was c. 10 cm during the removal of the refitted blades.

Refit group O621 (fig. 4.34-6)
Composition of two blades of Orsbach flint with white-grey, spotted patina (compare refit group O601). The first removed blade (PA2) ended in a step fracture. Next, the blade was broken intentionally towards the proximal part and splintering of the fracture plane has occurred. We are possibly dealing here with a working edge of a *pièce esquillée*. The second blade consists of two conjoined broken pieces (PA1) and is the proximal part of a broad blade. This blade has an arched break. An open space is visible between the two broken pieces.

4.7 UNWORKED STONE (figs. 4.36 to 4.38)
Apart from flint, also other varieties of natural stone came to light during the excavation of the Eyserheide site. Although it is not always clear whether, and if so how they are connected with the occupation of the site in the Magdalenian, it is regarded highly likely for several fragments. They are relatively large pieces of unworked stone which display sharp and angular breaks and/or traces of heating. As will be discussed in chapter 6, a few fragments of heated stone have been found underneath the plough zone in the centre of cluster A. It also proved possible to refit together fragments of heated stone. Naturally rounded stones and fragments of other types of stone, without traces of heating and recovered from the surface or the plough zone will not be considered in this paragraph.

Siltstone (code 15)
The majority of the stone fragments is formed by a yellow-white siltstone. We are dealing with 71 fragments which together weigh 1827 grams and the dimensions of which vary from 1 to 13 cm. They were mainly found in and underneath the plough zone in the area of cluster A. As no fragments could be refitted together, it is not clear whether they originate from one and the same piece or from two or more larger pieces. Two fragments bearing traces of heating were found on the boundary between sections 54/202 and 55/202 in the centre of cluster A, amidst mainly large artefacts of flint and numerous other fragments of siltstone (fig. 4.36).

Quartzitic sandstone Devonian Meuse area (code 16)
In and close to cluster A were found both in and underneath the plough zone a total of seven fragments of a locally layered quartzitic sandstone from the Devonian. The majority is locally coloured red as a result of heating. In places where is no red colouring, the quartzitic sandstone is yellow-brown in colour.

The largest fragment is find number 56/200 34, onto which two smaller fragments (55/203 103 and 55/203 104) could be refitted (fig. 4.37). Together they form a part of a thin slab of sandstone with a minimum length of 21 cm and a minimum

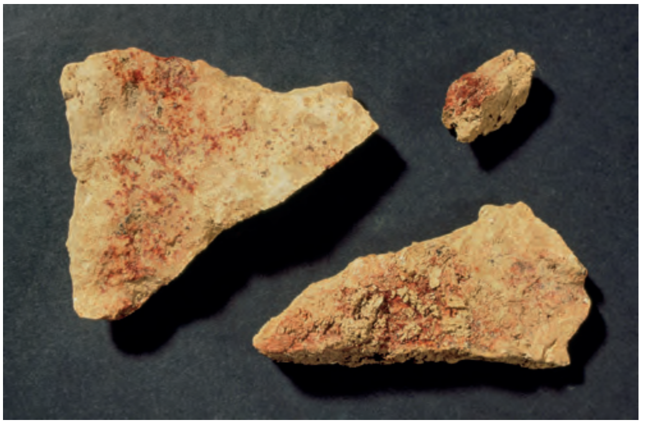


Figure 4.36 Fragments of fine siltstone with red colouring as a result of heating, originating from the centre of cluster A. Both fragments are 6.7 cm long.

Figure 4.37 Refitted fragments of a slab of quartzitic sandstone (Devonian) with red colouring as a result of heating. The largest fragment (56/200 34) has a length of 16.9 cm and weighs 530 grams.

Figure 4.38 Refitted fragments of quartzitic sandstone bearing traces of heating. The specimen on the left has a length of 13.1 cm and weighs 240 grams.

width of 8 cm. The break between 56/200 34 and the small fragment 55/203 103 is coloured red, which indicates that this part flew off as a result of heating. The break between 56/200 34 and 55/203 104 on the other hand is 'fresh' and probably the result of ploughing.

A smaller fragment is 54/198 20. From the top of this piece an even smaller fragment has split off that is almost entirely coloured red and also displays traces of heating at the base. Another refitted fragment (55/202 59) is also largely coloured red, while a third refitted piece 54/202 115 is coloured red at the edge. And finally, in the southern part of the excavation two stone fragments were found which also have been described as quartzitic sandstone from the Devonian. Also these fragments display traces of heating.

The total weight of the above nine fragments is 961 grams. Refitting has unfortunately not made it possible to determine whether all fragments originate from the same piece of quartzitic sandstone. If this would be the case, then originally it would have been a large tabular piece of stone of considerable size. Slab-shaped sandstones are known from other Late Palaeolithic sites in the Netherlands, for instance from the Hamburgian site of Oldeholwolde. There flat, heated stones were found in a hearth and are interpreted as (fragments of) 'baking sheets' for roasting meat and possibly also fish (Stapert 1982, 78). As a result of using the stone in or above a fire, parts of the sandstone slab are coloured red and had chipped off. It is quite possible that the fragments in Eyserheide are (also) the remnants of such a 'baking sheet'.

Quartzitic sandstone (code 41)

Ten fragments have been found of an olive green (break surfaces) to brown-greenish (surface), fine-grained quartzitic sandstone. Based on the occurrence of rolled sides due to fluvial transport an origin from a gravel-rich terrace of the Meuse is likely. The largest fragment has a length of c. 14 cm and consists of two refitted fragments (51/193 27 and 259A 548). The majority of this quartzite originates from the southern part of the excavated area (48/197 3, 51/192 27, and 51/194 14), and from cluster B and its surroundings (50/192 2, 52/200 15, and 53/200 75). Neither on the surface nor on the break surfaces are any traces visible of heating.

Fine-grained sandstone from Meuse gravel (code 42)

In a number of squares relatively small fragments of a fine-grained sandstone have been recorded. A few fragments could be refitted onto larger fragments that had been incorporated into in the plough zone. Also this stone could have been collected in a Meuse terrace at a relatively short distance from the site (W. Felder, pers. comm. 1990). Fragments of this fine-grained sandstone also display red discolorations, which are probably the result of contact with fire. The small fragment 54/202 120 is a split-off piece and refits onto both 56/199 22 and 259A 447 (fig. 4.38). This fragment is clearly coloured red at the base.

The refitted fragments 55/198 19 and 54/203 15, and refitted fragments 56/202 49 and 55/203 102 can also be attributed to the same sandstone. Three of these pieces are coloured red as a result of heating. An exception is 55/203 102 which has a green-greyish colour and was probably not heated. In addition, a heated piece (55/202 169), and three non-heated fragments of this fine-grained sandstone were collected that could not be refitted.

As the majority of this sandstone comes from the surface and the plough zone, it is not clear which meaning exactly should be attached to the occurrence of these stones. They possibly (also) formed part of a hearth structure in the centre of cluster A, the character of which can no longer be determined due to disturbances of the archaeological layer by ploughing.

Quartzitic sandstone (code 43)

This group consists of eleven fragments, the majority of which bear traces of heating. Also on these pieces are the breaks sharp and angular. Some large fragments (259A 444, 259A 445, 51/195 1) have a tabular shape, and the base consists of heavily weathered, irregular 'cortex' with small hollows. A large hollow of cortex is visible in the large fragment 56/204 24.

Contrary to the above quartzitic sandstone with code 41, the colour of this stone is not olive green but grey-brownish, while the flat top in most cases is grey-orange as a result of heating. Some fragments of this sandstone could also be refitted.

Coarse-grained quartzite (code 44)

Nine fragments of this quartzite have been found, of which at least five pieces have traces of heating in the form of red coloration of the top (259A 443) and/or a dull grey colour on the break surface at the base (56/201 45, 55/202 143). The pieces all have sharp, angular breaks. A few fragments could be refitted together.

4.8 Conclusions technology

4.8.1 Introduction

In this concluding paragraph of chapter 4, the conclusions are discussed of the Eyserheide investigation with regard to the characteristics and mode of working of the lithic raw materials on the basis of five themes. These themes are derived from a synthesising article on the use of flint in Magdalenian sites in the Paris Basin in France (Audouze et al. 1988). The article is incorporated in the publication *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen* that appeared on the occasion of the international congress of the same name in Liège, Belgium in 1986 (Otte 1988). In this article, Audouze et al. (1988, 56) raise the subject of trends and variability in flint modification for the 'classic' Magdalenian sites of Pincevent, Etiolles, Marsangy, and Verberie. Results of technological investigations of these sites are hereby discussed and compared together. The following themes are focused on:

1) selection and character of lithic raw materials;
2) variations in raw material working in relation to (properties of the) raw materials;
3) intentions of the flint knapper and productivity of the cores;
4) selection of blades for use as tool;
5) results of technological research in relation to data of use-wear analysis.

The technological investigation of the above Magdalenian sites in the Paris Basin goes back to the 1960s (Habitation no. 1 in Pincevent; Leroi Gourhan & Brézillon 1966) and is characterised by very detailed descriptions and analyses. As in Eyserheide, the results of refitting proved to be very significant for obtaining insight into successive operations of flint working (*la chaine opératoire*). The decision to compare the data of Eyserheide with this group of French sites is also obvious from the perspective of the supply of lithic raw materials. As does Eyserheide, Pincevent, Etiolles, Marsangy and Verberie are located in the immediate vicinity of sources of good quality flint, which the Magdalenian hunters and gatherers exploited on a large scale for the manufacture of stone tools. This circumstance increases the surplus value of comparative technological research: possible variations or similarities in flint working cannot be attributed to local or regional differences in supply and/or quality of the flint. In more nearby regions, such as the German Middle Rhineland (Gönnersdorf and Andernach) and the Belgian Ardennes (Verlaine, Chaleux, Goyet) sites from the Magdalenian are located at distances between 30 and 120 km from good quality flint sources. As a result, there is a different (here more economical) mode of raw material use (see chapter 8). Moreover, refitting of artefacts from cave sites in the Ardennes has not taken place or has yielded significantly fewer sizeable sequences of refitted artefacts. Also for these reasons is a comparison of technological data of sites in both regions not considered in this paragraph.

The aim of this paragraph is to evaluate the results of the technological investigation of the site of Eyserheide in the light of the four themes first mentioned, and to compare them with the data of the sites in the Paris Basin. In this discussion, theme 5, i.e. the relationship between results of technological research and data of use-wear analysis, will not be considered (for an overview of the results of that investigation, see chapter 5). In its place, attention will be paid to the reasons that may possibly have been underlying the (early) discard of cores in Eyserheide and in the French sites.

4.8.2 Selection and characteristics of lithic raw materials

In the camp sites of Pincevent, Marsangy and Verberie, Magdalenian hunters and gatherers have utilised spherical (*globuleux*) and oblong (*allongé*) flint nodules. The rounded shape of the nodules is the result of transport by water and the incorporation of the flint into river beds. Based on the dimensions, it is assumed that the flint nodules in Marsangy (30 to 40 cm) and Verberie (up to 30-35 cm) were transported over relatively short distances by the Yonne and Oise rivers respectively. The quality of the flint in these sites has been described as good to very good. The quality of the flint in Pincevent is average. As a result of (prolonged) transport in the river bed of the Seine, the nodules are spherical or oblong and rarely larger than 20 cm. In Etiolles, the cores were made of tabular flint (*silex tabulaire*) with exceptional dimensions. This flint has not undergone transport in the Seine river bed but originated from flint-containing Cretaceous layers that outcrop on the slopes of the valley of the river. The length of the flint slabs is between 30 and 60 cm.

For determining the initial form and dimensions of the flint nodules that Magdalenian hunters and gatherers used in Eyserheide, we looked at morphological and metric characteristics of cores and data on compositions of refitted artefacts. A comparison with the data of Pincevent, Marsangy and Verberie shows that the initial form of the nodules of Meuse terrace flint in Eyserheide is very comparable. For this group, we can assume oval or lenticular (M6) to oblong (M3, M9, M11, M12) nodules with rounded shapes as a result of transport in a river bed (table 4.28). For other RMUs the basic form could not be determined with certainty. The reason for this is the lack of a core (M18, M23), the fragmentary condition of cores (M4, M19), and the fact that cores were reduced to a considerable extent and/or that only a few artefacts could be refitted onto the core (M1, M5, M13). On the basis of the origin from Pleistocene gravel-rich terrace deposits of the Meuse, these flint nodules would also have had an oval, lenticular or oblong shape.

Based on the compositions of refitted artefacts, the nodules of Meuse terrace flint used in Eyserheide had dimensions of minimally 15 cm. For some RMUs (M4, M9, M11) a dimension of minimally 18 cm was determined. These dimensions are comparable with the, compared to Marsangy and Verberie, relatively small flint nodules that Magdalenian hunters and gatherers worked in Pincevent. The width varies between 3 cm (M12) and 11 cm (M6), and the thickness between minimally 4 cm (M3) and 8 cm (M15).

Pieces of South-Limburg flint originating from eluvial or slope deposits (M2, M14, M19) also probably had considerable dimensions. RMU M2 is the best indication for this. This RMU consists of a fragment of a core preparation blade of more than 21 cm long, on which a chalky, weathered cortex is present. As the proximal part is missing, it can be assumed that the blade was struck from a piece of flint with a length of at least 25 to 30 cm.

In Eyserheide, tabular flint is present in the form of Simpelveld flint (S1 to S3) and Valkenburg flint (V1). The slabs were collected from flint eluvia and/or slope deposits. Although the shape is comparable with the flint slabs of Etiolles, the slabs used in Eyserheide are considerably smaller and thinner. The slabs, from which three cores of Simpelveld flint were made, were minimally 15 cm long and between 3.8 and 5.4 cm thick. These dimensions are directly expressed in the length and width of the core face of the cores and hence in the lengths of the blades that could be struck from them (see table 4.7). Remarkable is that the cortex of the worked slabs is very homogeneous and flat, and has few irregularities (S1 to S3, S6 and V1). These characteristics and possibly also the rather uniform thickness of the slabs point to selection of flint slabs with advantageous properties for working. Flint, of which the cortex is irregular (hollows and bulges), was apparently regarded as less suitable for the production of blades. An exception to this is RMU S5 within the group of Simpelveld flint. The cortex of artefacts in this raw material unit is more irregular than that of artefacts in RMUs S1 to S3.

The complete cores of Orsbach flint are generally smaller than the specimens made of other types of flint. As the number of artefacts refitted onto cores is small, little can be said about the initial form and dimensions of the flint used. Moreover, cores of Orsbach flint have been found mainly as fragments. As a result of working and/or contact with a plough, many specimens have disintegrated along frost cracks into smaller bits. There is the impression that the suitability of this type of flint for the production of long and regular blades was very variable. In a few cases the cores are so small (for instance O8) that a systematic blade production would not have been possible. But use was also made of pieces of Orsbach flint that were suitable for the application of the ‘classic’ Magdalenian method of core preparation. Cores 259A 105 (O2) and 53/204 23 (O6) with a regular core face and a succession of regular negative scars of blades are good examples of this.

4.8.3 Variations in flint working

In the Magdalenian of the Paris Basin, flint nodules are worked as a rule according to an established scheme (*un même schéma conceptuel*). With a view to successfully removing blades with the desired form and dimensions, control had to be continually kept of the shape and volume of the flint nodule or slab during the process of core reduction. Technological investigation of the flint artefacts in the French sites has shown the importance of the following parameters (patterns) (Audouze et al. 1988, 59):

a) use of a rectilinear crest parallel to the longitudinal direction of the flint nodule to guide the ripples of the first blade;
b) strong obliqueness (*obliquité*) of one or more striking platforms in relation to the core face;
c) regular convexity of the flanks of the core and the curving (*cintrage*) of the crest, in order to prevent early complications (which can lead to the termination of the process of core reduction) and the disappearance of ripples;
d) control of the thickness and regularity of the flanks by making and utilising a crest on the back of the core which could possibly also serve as point of departure for the removal of a series of blades (*une série laminaire*);
e) creation of a spur (*éperon*) to precisely delimit *le point d’impact* of the hammer tool on the core with the aim of removing blades.

The importance of the above parameters is the outcome of numerous, detailed technological studies of Magdalenian sites in the Paris Basin (Karlin 1972, 357-359; 1975, 353-355; Pigeot 1987, 25-89; Pelegrin 1992). Despite the general application of an established scheme, variations in flint working do occur. They can (also) be seen as adaptation to differences in the shape, size and quality of the lithic material, which require a certain degree of flexibility from the flint worker. Audouze et al. (1988, 59) however consider these variations of minor importance in relation to the technological uniformity in flint working in the Magdalenian of the Paris Basin:

> “Les chaînes opératoires varient d’un bloc à l’autre dans l’articulation des différentes opérations tout en restant fondées sur les mêmes principes et sur une même évaluation des qualités de la matière… Il n’existe pas de séquence opératoire strictement répétée mais une succession de phases de préparation/débitage/réfection dont l’alternance et l’itération sont décidées au fur et à mesure du travail. Cette forte variabilité n’efface pas l’unité technique et stylistique du débitage du silex dans le Magdalénien du Bassin Parisien parce que les variantes renvoient toutes à une même façon d’envisager et de résoudre les difficultés pour des intentions similaires”.

Regarding the find material of Eyserheide, the following can be stated on the above five parameters (a to e) or patterns:

a) Use of a rectilinear crest parallel to the longitudinal direction of the flint nodule to guide the ripples (waves) of the first blade.

The degree of investment in the making of a first core crest prior to the phase of blade production (*plein débitage*)

RMU	Cortex	Grainsize	Inclusions	Natural break surface	Shape of nodules	Length (mm)	Width (mm)	Thickness (mm)	Volume (LxWxT)
S1	chalky, weathered, regular	medium	few, small	absent	tabular	>220	>100	39	>8600
S2	chalky, weathered, regular	medium	few, small	present	tabular	>150	>91	54	>7400
S3	chalky, weathered, regular	medium	few, small	absent	tabular	>190	>85	38	>6150
S5	chalky, weathered, irregular	medium	few, medium-sized	absent	tabular	indet	indet	indet	indet
V1	chalky, weathered, regular	coarse	several, medium-sized	present	tabular	>150	>90	>50	>6750
M01	rolled, fluvial	fine	few, medium-sized	absent	indet	>100	indet	indet	indet
M02	chalky, weathered, irregular	fine	several, small	absent	elongated?	>220	indet	indet	indet
M03	rolled, fluvial, irregular	medium	many, small	absent	elongated?	>150	>50	>40	>3000
M04	rolled, fluvial	medium	several, large	absent	indet	>197	indet	indet	indet
M05	rolled, fluvial	fine	few, small	absent	elongated?	>140	indet	indet	indet
M06	rolled, fluvial	medium	few, large	absent	oval	150	110	63	10400
M07	rolled, fluvial	medium	few, medium-sized	present	indet	indet	indet	indet	indet
M08	rolled, fluvial, irregular	fine	few, large	absent	indet	>130	>72	indet	indet
M09	rolled, fluvial	fine	few, small and large	present	elongated	>180	>90	>60	>9750
M11	rolled, fluvial	medium	several, large	absent	elongated	indet	indet	indet	indet
M12	rolled, fluvial	medium	few, small	absent	elongated	>150	30	>70	>3150
M13	rolled, fluvial	fine	several, small and large	absent	indet	>130	indet	indet	indet
M14	chalky, weathered, fluvial?	fine	few, small	absent	indet	indet	indet	indet	indet
M15	rolled, fluvial	fine	few, large	absent	Indet	>150	>80	>80	>9600
M17	rolled, fluvial?	fine	many, small; few, large	present	indet	indet	indet	indet	indet
M18	rolled, fluvial	fine	several, large; chalk	absent	indet	indet	indet	indet	indet
M19	chalky, weathered, (ir)regular	fine/medium	many, small	absent	indet	indet	indet	indet	indet
M21	chalky, weathered, regular	indet	indet	indet	indet	indet	indet	indet	indet
M23	rolled, fluvial	indet	indet	indet	indet	indet	indet	indet	indet
O1	chalky, weathered, irregular	fine	few, small	absent	indet	indet	indet	indet	indet
O2	chalky, weathered, irregular	fine	few, small	absent	tabular?	>130	>55	indet	indet
O3	chalky, weathered, irregular	fine	few, large	absent	indet	indet	indet	indet	indet
O4	chalky, weathered, irregular	fine	few, large	absent	indet	indet	indet	indet	indet
O5	chalky, weathered, irregular	fine	few, small	absent	indet	indet	indet	indet	indet
O6	indet	fine	few, small	absent	indet	indet	indet	indet	indet
O7	chalky, weathered, regular	fine	few, large	frost split surface	indet	indet	indet	indet	indet
O8	chalky, weathered, irregular	fine	few, small	absent	tabular	indet	indet	24	indet

Table 4.28 Quantitative and qualitative characteristics of the flint nodules for distinguished RMUs.

has not been determined well in the finds of Eyserheide. Compared to the French sites, compositions of refitted artefacts are less sizeable and less complete. Hence, operations of core preparation near the (future) core face, among which the creation of a rectilinear core crest, are often not represented in the compositions. Moreover, of 18 complete cores, 17 specimens were discarded as blade cores. As a rule, the core faces of these cores display scars of blades. Possible traces of the creation of a core crest have completely disappeared by continuing blade production.

Of the isolated (non-refitted) crested blades cannot be said whether they are connected with the making of the first core crest or with later operations, such as the interim preparation of a core crest during the phase of *plein débitage*. A shared characteristic of these blades in the site of Eyserheide is the (virtual) lack of cortex parts (table 4.8). This characteristic can be seen as an indication of careful preparatory working and decortication of the front of cores, prior to moving on to making a first core crest. Another possibility is that core crests were made in the meantime and were removed during the phase of *plein débitage*.

In the group of Simpelveld flint, in RMUs S1 and S3 (refit groups S1.00 and S3.00), occur respectively four and one crested blade. Of these, one specimen is connected with the making of a first core crest at the top of the core. Moreover, 20 non-refitted crested blades have been retrieved of Simpelveld flint, among which two complete specimens. From this number can be inferred that, despite the elatively small thickness of the flint slabs and the presence of two natural crests (*deux crêtes naturelles*) parallel to the core face, a certain importance was attached to control of the process of blade debitage by way of cresting. The application of this seems to underline the importance of Simpelveld flint for the production of series of long and regular blades (see for example S308).

Within the group of South-Limburg flint, interim preparation of a central crest at the level of the (future) core face has been recorded through refitting. A good example of this is RMU M3 (refit group M3.00, see 4.6.4). In this refit group, a crested blade has been included which was removed from the first used striking platform and presumably during the phase of *plein débitage*. In addition, among the artefacts assigned to RMU M3 occur fragments of crested blades. There are also blades with traces of core preparation (cresting) present in compositions of refitted artefacts in RMUs M8, M9, and M19. The importance of a core crest is emphasised by the occurrence of non-refitted complete (n=2) and fragments of crested blades (n=29) in the group of South-Limburg flint. On the dorsal side of these artefacts, cortex is lacking or cortex takes up less than 25% of the dorsal surface.

The only clear example of a rectilinear crest parallel to the longitudinal direction of the flint nodule prior to the phase of *plein débitage* is RMU O1 of Orsbach flint (see 4.6.5). Through making two opposite crests, one on the front and one on the back, the core has achieved a volume that both in the longitudinal direction and transversely (*transversale*) offered the necessary convexity for further modification and blade production. Nonetheless, the flint knapper decided not to continue the working. The removal of the first crested blade did not take place.

The importance of cresting in the group of Orsbach flint is further demonstrated on the basis of one complete blade and 24 fragments of crested blades. In which phase(s) of core reduction cresting occurred is not possible to ascertain for the group of Orsbach flint. In the small compositions of refitted artefacts around cores of this type of flint, crested blades do not occur.

b) Strong obliqueness (*obliquité*) of one or more striking platforms in relation to the core face.

A characteristic of systematically reduced blade cores in the Magdalenian of the Paris Basin is the occurrence of one or two striking platforms which are positioned obliquely in relation to the core face. Cores of the site of Eyserheide also have such oblique striking platforms. A good example in the group of South-Limburg flint is core 259A 209 in RMU M15 (fig. 4.31). The linear profile of this core is trapezoid (*forme trapézoïdale*). Other examples with a comparable linear profile are the cores that form part of RMUs M3 and M9. An example of an obliquely positioned striking platform in the group of Orsbach flint is RMU O6 This blade core has strong faceting on the edge of the striking platform which points to application of *en éperon* technology during the removal of blades from this core (fig. 4.35). Also of the narrow and thin blade core RMU O2 does the striking platform take up an oblique position in relation to the core face. In the small, complete cores of Orsbach flint (among which RMU O8), there is on the other hand no oblique striking platform.

In the tabular Simpelveld and Valkenburg flint, the making and maintenance of an oblique striking platform has not been well documented. In core RMU S3 there is however an oblique striking platform at the top of the core which was obtained by the removal of one flake. The striking platform at the base of the core on the other hand is more or less perpendicular to the core (fig. 4.18). This position was only created in the last phase of core reduction. Thanks to refitting we know that the modification of the base (= striking platform 2) of this core was in the first instance directed at the creation and rejuvenation of an oblique striking platform. As a result of the removal of a last (core rejuvenation) flake, the oblique position of the striking platform in relation to the core face was in fact taken away.

The angle between the striking platform and the core face of the only core of Valkenburg flint (259A 165) is almost 90°. In this core, the striking platform and the core face are almost perpendicular to each other. Apparently less importance was attached to the creation and maintenance of an obliquely positioned striking platform, at least in the last phase of core reduction just before the core was discarded.

c) Regular convexity of the flanks of the core and curving (*cintrage*) of the crest.

As in the French sites, there is in Eyserheide a relationship between the (initial) shape of the flint nodule and the method of preparation of the flanks and of the core face. The most prominent is the difference in modification between the rectangular, tabular pieces of Simpelveld flint and the rounded, ovoid to oblong nodules of Meuse terrace flint. On the cores of the former flint, one of the narrow sides (S2 and S3) or both opposite, narrow sides (S1) of the slab functioned as core face for the production of blades. As long as this narrow side was utilised for the removal of blades, the core face was delimited on either side by the edges of the flint slab. These edges served as two natural, parallel crests and in a number of cases show traces of preparation, in which cortex was removed from the adjacent part of the flank. Despite the presence of natural crests, investment was made in the preparation of one or more (?) core crests on the front of the core (*crête postérieure*). The aim of this crest(s) was to be able to control the thickness of the slab. Blade production took place by the removal of successive series of blades from the long narrow side of the slab of flint. Maintenance in the meantime of the flanks and the core face occurred by the removal of thin flakes perpendicular to the core face. As a result of the tabular form of Simpelveld flint, these flakes display cortex parts on both the striking platform and on the distal end. They form part of RMUs S2 and S3 (refit groups S2.00 and S3.00). The aim of this maintenance was to keep the convexity of the core face up to standard.

In the modification of cores of Meuse terrace flint, blades were not removed from the narrow side but from the broad front of the flint nodule. The variation in the operations directed at careful preparation and maintenance of the flint was much greater. Thus, in a number of cases clearly more attention was given to the shaping and maintaining of the flanks, by removing consecutive flakes from the top of the core, perpendicular to the direction of the (future) core face and prior to the phase of *plein débitage* (for instance, M3 and M8). Flaws or imperfections were removed by adaptations in the working practice and in particular by interim maintenance of the part of the flank adjacent to the core face.

Indications of rejuvenation of a large part of the core face, during which irregularities (step fractures, inclusions) related to this surface were taken away in one go, are rare in Eyserheide. There are few core rejuvenation flakes that point to the removal of a large part of the flank(s) of the core or the complete removal (rejuvenation) of the striking platform.

One measure directed at maintenance of the core face was the making of a second striking platform on the opposite side of the core. Both in the group of Simpelveld flint (S1 and S3) and the group of Meuse terrace flint (for instance M3, M9, M15) do cores occur with a second, opposite striking platform. For Pincevent it is assumed that the creation of this second striking platform was also meant for streamlining and controlling the core face, including the removal of irregularities (among which step fractures) which had been created by striking blades off the first, opposite striking platform (*un moyen commode pour re-caréner la table*). The alternating use of two opposite striking platforms, as was demonstrated in Verberie, was relatively little used in Eyserheide. As far as could be determined on the basis of compositions of refitted artefacts and blade scars on cores, this working practice was applied to RMUs S1, S3, S4, M3, M9 and M15. In the group of Orsbach flint, RMU O6 has two opposite striking platforms. The blade scars on this core however offer no clues to the alternating use of both striking platforms. Other cores of Orsbach flint are mainly represented by fragments. Hence, nothing can be said about the way and the order in which blades were struck from the core.

d) Control of the thickness and regularity of the flanks by making and utilising a crest on the back of the core.

In table 4.7 is indicated for the site of Eyserheide whether a core ridge (crest) is present on the back of the core. Such a ridge is the result of one-sided (unilateral) or alternating (bilateral) removal of flakes. From the crest, the thickness and regularity of the flanks of the core could be controlled.

On the cores of tabular Simpelveld flint and Valkenburg flint, in three out of four cases (S2, S3, V1) there is a crest present on the back of the core. Core 259A 107 (S3) shows in this place a prominent crest (*crête unifacial*) with a very concave form. The dorsal side of core 259A 321 (S2) also has a unilateral crest, while in core 259A 165 (V1) there is a *crête bifacial*. In all cases the crest was made on the narrow dorsal side of the flint slab, that is the part parallel to but opposite the core face. On core S1 no crest is (any longer) visible as a result of alternating use of the narrow ventral and dorsal sides of the flint slab for the removal of blades. Traces of a crest on the (then) back of the core were removed as a result of continued modification. Also the sequence of refitted artefacts does not offer a definite answer about the (former) presence of a crest.

What is striking is that on several cores of South-Limburg flint a crest is lacking on the back of the artefact. These cores are characterised by the presence of cortex on this part of the core (*dos cortical*; M1, M6, M8, M12). In these cases the flint knapper did not invest in the shaping of the back of the core, which is a characteristic of a *débitage simplifié* (see below). Also on the cores with a second, opposite core face (M3 and M13) no crest was demonstrated, presumably for the same reason as in RMU S1. Remnants of a crest are visible though on cores 259A 205 (M5) and 56/200 4 (M17). Of core 259A 322 (M1), the distal part has a crest which has served as starting point for the removal of a small series of blade-like flakes (*une série laminaire*). The only bladelet core of the site of Eyserheide has a core crest on the left side of the back (M17).

The core face of core 259A 179 (M9) is bounded on both long sides by two prepared surfaces. Although they remind us of a crest, they should be regarded as 'normal' preparation of the flanks. Due to the fragmentary condition of the core, it is not known whether there was a crest on the back of the core.

On nearly all cores of Orsbach flint is a crest demonstrated, but the position of these is very variable (table 4.7). In only three cases (O1, O3 and O5) is the crest on the back of the artefact, of which two have been described as *crête bifacial*.

e) Creation of a spur (*éperon*)

A preparatory operation that should be regarded as an important feature or component of *le débitage Magdalénien classique*, was the creation of a spur (*éperon*) on the edge of the striking platform, exactly at the point of transition from striking platform to core face. In this way *le point d'impact* of the hammer tool on the core could be determined more precisely (Karlin 1972). In Eyserheide, the use of *en éperon* technology, as part of *débitage élaboré* (see below), could be demonstrated for the raw material groups of Simpelveld flint, South-Limburg flint, and Orsbach flint (table 4.13). Traces of this method of core preparation are visible in the form of blades with butts *en éperon*. Fine examples of *en éperon* preparation of the striking platform in the group of Orsbach flint are offered by cores RMU O4 and O6. In this group there are also proximal fragments of blades with clearly faceted butts (fig. 4.8). They are evidence of preparation all-around a central ridge by making small facets which converge and result in a small spur.

It should be stressed that application of *en éperon* technology, on the basis of characteristics of the butts of blades, was not used frequently. With the exception of M8 and M9 (but: only 1 specimen), also other types of butts are present in RMUs in the group of South-Limburg flint. Of in total 56 specimens, butts with *en éperon* preparation occur 14 times (table 4.29). This number indicates that there has not been a consistent application of *en éperon* technology in the group of South-Limburg flint. Also RMUs S1 to S3 and S308 in the group of Simpelveld flint show different types of butts (table 4.29). Of 19 blades, of which the butt has been preserved, seven pieces have a butt with a spur (*éperon*). In particular refit group S308 is a prominent example of systematic blade production. This refit group consists of five refitted blades, the lengths of which vary between 10 and 17 cm. The proximal parts all have butts *en éperon*, there is however no careful form of preparation or faceting. No indications have been found in refit group S2.00 that point to application of this technique.

4.8.4 Intentions of the flint knappers and productivity of cores

In order to determine the intentions of the flint knappers and the productivity of the cores, we have looked at the relationship between on the one hand the properties of the flint (morphology and dimensions of the nodules, quality of the flint, etc.) and on the other hand the desired end products and the degree of investment which the flint worker thought necessary for those. Regarding the latter point, Audouze et al. (1988) make a distinction between two strategies for the Magdalenian sites in the Paris Basin: *débitage élaboré* and *débitage simplifié*. In the first strategy, regular and careful preparation and maintenance of the core takes place.
The productivity of the core is high as is shown by the occurrence of successive series (generations) of long and regular blades in the compositions of refitted artefacts. Often these blades are carried away to other locations for future use. In the case of *débitage simplifié*, the flint knapper clearly invested less in operations directed at preparation and maintenance of the core. As a result of this, there are many short and less regular formed blades. There are also often *accidents de taille*, which can lead to the premature discard of the core. For Pincevent, Audouze et al. (1988, 60) point to less careful preparation of cores made of flint nodules of average quality and relatively small dimensions. On the basis of refitting, it could also be demonstrated that products of these cores were as a rule not transported to other locations. In other words, they are not components of a transported toolkit. They were retouched on the spot and used as 'ad hoc' tool in the execution of domestic activities in the camp site itself (*production domestique*).

To get an insight into the intensity of modification and the productivity of cores in Eyserheide, two sources of information were used: 1. compositions of refitted artefacts and 2. blade scars on the core. In the case of large compositions of refitted artefacts, including core, phases and

	S1	S2	S3	S308	M1	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M17	M18	M19	N
Blade complete	3	·	1	2	·	·	1	2	·	·	·	·	2	2	·	3	·	1	1	·	2	20
Blade proximal	2	5	2	3	·	5	2	3	2	4	2	1	1	1	2	2	1	5		2	3	48
Blade non-patinated break	·	·	·	1	1	1	·	·	·	·	·	·	·	1	·	·	·	2		·	1	7
Butt type																						
Cortex	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	0
Plain	1	2	1	3	·	1	1	1	1	1	·	·	1	·	1	2	·	1	·	1	2	20
Dihedral faceted	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1	1	·	1	·	1	4
Faceted	1	·	·	·	·	1	·	2	1	·	·	·	·	1	·	·	·	1	·	·	1	8
Punctiform	·	·	·	·	1	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1
Eperon	2	·	2	3	·	·	1	·	·	2	1	1	·	2	·	1	·	4	·	1	1	21
Splintered	1	2	·	·	·	3	1	2	·	1	·	·	·	1	1	1	·	2	·	·	1	16
Indet	·	1	·	·	·	1	·	·	·	·	1	·	2	·	·	·	·	·	·	·	·	5
Total	5	5	3	6	1	6	3	5	2	4	2	1	3	4	2	5	1	8	1	2	6	75

Table 4.29 Types of butt on complete and proximal fragments of blades in RMUs in the groups of Simpelveld flint and South-Limburg flint.

transformations in stone working can be recognised (well) before the core was discarded. Flake and blade scars on the core provide insight into the last phase of core reduction and the (remaining) potential of the core at the time of discard.

Débitage élaboré: RMUs S1, M3 and M9

RMU S1 is the most prominent example of a *débitage élaboré* in the find material of Eyserheide. During successive phases of working, the core has been turned 180º several times, whereby both the narrow front and the back of the flint slab served as core face. Different phases of core and striking platform preparation at different places at the top and base of the core are evidence of a complex succession of technological operations.

In Eyserheide, application of a *débitage élaboré* has also been recognized in the group of Meuse terrace flint. End products of this strategy are carefully worked blade cores, a slightly convex surface of the core face, and one or two oblique striking platforms. In addition there are scars of several regular blades visible on the core face of cores. They indicate the removal of blades with a length varying from 10 cm to more than 15 cm.

In this connection should be pointed out the composition of refitted artefacts around core 57/199 12 (RMU M3, refit group M3.00, fig. 4.24). This refit group shows that operations related to the preparation and maintenance of the core face and the striking platform were carried out at various times in the process of core reduction, with the aim of maintaining the correct shape for the production of long and regular blades. The occurrence of (fragments of) crested bades in refit group M3.00 underlines the importance that he flint worker attached to a central crest to be able to control the process of blade production. Two opposite striking platforms were then used alternately to remove blades.

A second example of *débitage élaboré* is RMU M9 (refit group M9.00). Although we are dealing here with a heavily fragmented core, a good evaluation of the method of reduction of this RMU was possible on the basis of data on refitting. Also this core had two opposite striking platforms, whereby use was made (alternately?) of one and the same core face. Another characteristic of this strategy, namely the carrying-out of *'des aménagements plus importants'*, has also been established for RMU M9 (see 4.6.4).

Débitage simplifié: RMU M6, M8

Although the above strategy of *débitage élaboré* is characteristic of *le débitage Magdalénien classique*, the flint knappers in Eyserheide regularly invested less time and energy in the working of the cores. The composition of refitted artefacts around core 259A 373 (refit group M6.00) is the best testimony to such a simplified method of working the core. Notwithstanding the large number of artefacts that could be refitted onto the core, there are no indications of the creation of a central ridge (cresting) at the location of the future core face. Probably with this core it was sufficient to use a natural ridge parallel to the longitudinal direction of the flint nodule to guide the first (series of) blades. In this regard, Pelegrin (1992, 110) remarks on Marsangy: *Au plus simple, le débitage d'un nodule peu épais de section lenticulaire, allongé et régulier, pouvait débuter sans crête préalable dès l'ouverture d'un plan de frappe à l'une des ses extremités.* Following the remark by Pelegrin, we can also assume for RMU M6 a not really thick lenticular flint nodule. In the case of a flint nodule with a greater thickness, the making of two artificial crests (*deux crêtes postérieurs*) on the front of the core would presumably have been required. Indications of this working practice have been found among others in Marsangy.

Another characteristic of RMU M6, but also of core M8, is the lack of a crest on the dorsal side. On both cores, and probably also on core M4 of which only a fragment has been found, the back of the core consists entirely of cortex (*dos cortical*). Also the flanks display cortex remains. Apparently the initial form sufficed and preparation all around the flint nodule was not necessary. In these cases the flint knapper's attention went to the core face and (renewed) preparation of the striking platform. It is important to note that in the composition of refitted artefacts of RMU M6 (refit group M6.00) two end scrapers on blade are present. It shows that this more opportunistic way of core reduction has yielded blades which were meant for immediate use in domestic tasks, with blanks retouched and used as end scrapers on the spot.

Productivity of cores:
Also on the basis of the results of refitting, Pigeot (1987, 62-68) makes a connection for Etiolles unité U5 between the method and intensity of flint working (*débitage élaboré* versus *débitage simplifié*) and the productivity of cores. She distinguishes four categories:

a) *débitage élaboré, peu productif*: large blades in small numbers, c. 15, with dimensions of 25 to 30 cm and even 30 to 40 cm. Cores were discarded at the time when blades with lengths of 15 to 20 cm could still be removed from the core. Careful working (*pas de chute de soin*) until the end of the core exploitation;
b) *débitage élaboré, très productif*: large blades in large numbers, c. 20 blades of 15 to 20 cm or 20 to 25 cm. Core reduction was terminated and the core discarded when the core face still had a length of 20 cm;
c) *débitage simplifié, peu productif*: there is little preparation and the use of natural two-plane angles (*dièdres*) as decortication ridge (*crête d´éntame*) for the removal of blades. Little rejuvenation of the striking platform has taken place. The production is limited to one to twelve blades with lengths between 10 and 20 cm.
d) *débitage simplifié 'de reprise'*: re-use of earlier discarded cores at a different location than where core reduction took place before. Many working errors are probably the result of 'novices', inexperienced knappers (beginners).

For the other three French sites (Marsangy, Verberie, and Pincevent), dimensions of the core face in combination with the number and dimensions of blade scars on this core face were used to determine the potential of cores at the time of discard. In Marsangy, the dimensions of the core face vary from 12 to 17 cm, and in Verberie from 9.5 to 14 cm. The last struck blades in Marsangy have a minimal length of 9 cm. The debitage stopped when it was still possible to remove one or two blades with a length of 10 to 12 cm. In Verberie, at the time of discard of the core, it was still possible to remove blades with a length of 8 to 10 cm. The care taken to prepare the core decreases greatly in the late phase of core reduction, just before the moment when the core is discarded. This manifested itself in numerous *accidents de taille* and in the small dimensions of the last struck blades (in Verberie 3.5 to 6.5 cm). In Pincevent, on the basis of the negatives on cores little can be said about '*constantes*'. Blade cores from this site have often served in the late phase of reduction for the production of small blades or bladelets (after 'reorganisation' of the core).

If we compare the data of Etiolles with those of the site of Eyserheide, it emerges that also for this site there is a relationship between the method of working and the productivity of cores. RMU S1 has a *débitage élaboré, très productif*. Refit group S1.00 consists of more than 40 artefacts which could all be refitted onto blade core 259A 108 (see 4.6.2). The debitage of the core comprised the removal of blades from two opposite core faces, whereby use was made of four striking platforms. If an estimate is made of the productivity of this core on the basis of numbers and dimensions of refitted artefacts, we can assume at least 17 blades with dimensions from minimally 8 cm onward. At the time of discard of the core, the dimensions of core face 1 on the front of the core were 8.3 × 4.7 cm, and of core face 2 on the back 13.4 × 2.8 cm. As far as could be reconstructed, the production from striking platform 1 was greatest. Minimally nine blades with lengths of more than 12 cm were removed from this striking platform. The core faces of the cores of RMUs S2 and S3 also still had considerable dimensions at the time of discard, namely 12.5 × 4.9 cm and 10.3 × 3.9 cm respectively (table 4.7). A high productivity of these cores is shown by the results of refitting and the number of blade scars (S2 n=5; S3 n=8). RMU S2 was still suitable for the removal of blades longer than 10 cm. In the case of RMU S3, the longest blade negative has a length of only 6 cm. The last phase of blade production of this core probably yielded exclusively short blades. By shifting the core face from the narrow front to the side (flank) of the flint slab, the core was at a certain time no longer suitable for the removal of long and regular blades. Composition S308, consisting of nine refitted blades, also forms an indication of high productivity, however without us being able to link this sequence to a core. The longest complete blades in this composition are 13.6 cm and 16.7 cm.

The largest core of the site of Eyserheide is made of Valkenburg flint and has a core face measuring 15.1 × 5.2 cm. The occurrence of six blade scars and the length of the longest specimen of 10.7 cm points to systematic blade production in the last phase of *plein débitage*, just before discard of the core.

In the group of South-Limburg flint, the length of the core face varies from 6.4 (M17) to 14 cm (M12). The number of blade scars, as visible on the core face of the cores, is very uniform: five or six (table 4.7). In a few cases (for instance M8 and M12) the longest blade negative covers the entire length of the core face. This indicates efficient use of the flint nodule, whereby the full length of the core face was utilised for the removal of blades. In the group of terrace flint, the removal of blades with a length of more than 10 cm was still possible for RMUs M6, M8, and M12 (= *débitage simplifié*). The cores of these RMUs are characterized in all cases by a *dos cortical* and a *débitage frontal*. On the basis of the dimensions of the core face and its potential for the removal of blades with lengths of more than 10 cm, these cores were discarded earlier than the specimens that were the result (end product) of a *débitage élaboré* (M3, M9). The reason for this discard is not clear: not only do the cores of RMUs M6 and M8 still have considerable dimensions, core M8 also shows a fine succession of blade negatives without irregularities or step fractures. Another core with a *dos cortical* (core 259A 322) forms part of RMU M1. Compared to the cores in RMUs M6, M8 and M12, this core is further reduced. The core face has a length of 7.5 cm and a width of 4.8 cm, and is thus considerably smaller than that of other cores with a *dos cortical* in the group of Meuse terrace flint.

To gain further insight into the productivity of RMU M6, the dimensions were compared of complete and fragments of crested blades and blades from core 259A 373 with those of 259A 108 in RMU S1 (table 4.30). From the table can be inferred that there are no clear differences between the two raw material units concerning the lengths, widths and thicknesses of the blade products. The blades in RMU M6 do however have more cortex on the dorsal surface. Of the two complete specimens and six fragments, half have an amount of cortex of more than 50%. This amount also comprises the lateral edges of the removed blades. Only one fragment has no cortex, and on two fragments the share of cortex is less than 25%. In RMU S1, ten out of 17 blades have less than

	RMU S1		**RMU M6**	
Length (mm)	Complete	Incomplete	Complete	Incomplete
20-29	.	1	.	1
30-39	.	1	.	1
40-49	.	2	.	.
50-59	.	2	.	.
60-69	.	1	.	1
70-79	.	.	.	1
80-89	1	2	.	.
90-99	2	2	.	.
100-109	.	1	.	2
110-119	.	.	2	.
>120	2	.	.	.
Total	5	12	2	6
	RMU S1		**RMU M6**	
Width (mm)	Complete	Incomplete	Complete	Incomplete
0-4	.	.	.	.
5-9	.	.	.	.
10-15	.	4	.	.
15-19	.	2	.	3
20-24	1	4	2	.
25-29	3	2	.	2
30-34	1	.	.	.
35-39	.	.	.	.
40-45	.	.	.	1
Total	5	12	2	6
	RMU S1		**RMU M6**	
Cortex	Complete	Incomplete	Complete	Incomplete
No cortex	.	3	.	1
<25%	2	5	.	2
25-49%	2	2	.	1
50-74%	1	2	1	2
>75%	.	.	1	.
	5	12	2	6

Table 4.30 Dimensions of blades struck from core 259A 108 (refit group S1.00) and core 259A 373 (refit group M6.00). a= length of complete blades (after refitting of broken pieces), b= width of complete and broken blades, c= amount of cortex on dorsal surface.

25% cortex on the dorsal surface and specimens with more than 75% cortex do not occur. From the differences in the amount of cortex can be inferred that blades in RMU S1 had significantly more cutting edges than those of RMU M6. Core 259A 108 (S1) was dealt with much more economical than core 259A 373 (M6). The former core has yielded minimally 17 blades, while the number of blades struck from core 259A 373 cannot have been more than ten. This underlines the difference between *débitage élaboré* and *débitage simplifié* in terms of yield and productivity of both cores.

The productivity of cores of Orsbach flint was presumably very variable. Many cores of this type of flint had split along frost cracks and were documented as fragments. Nothing can be said about the productivity of the cores concerned on the basis of these fragments. Moreover, compositions of refitted artefacts, including core, in the group of Orsbach flint contain far fewer artefacts than in the groups of Simpelveld flint and South-Limburg flint. Data on the productivity of cores of Orsbach flint are for this reason not amply available. They are based in particular on characteristics of the cores themselves.

Regarding the complete cores, there are clear differences in the dimensions of the core faces, and the number and dimensions of blade scars that are visible on the core (table 4.7). RMU O6 has the largest number of blade negatives (n=9) of all cores found in Eyserheide. This core completely complies morphologically (slightly convex core face, oblique striking platform) with the cores that are the result of *le débitage magdalénien classique*. Of other cores of Orsbach flint (O5, O8), the number of blade negatives is low and the removed blades did not exceed 5 cm in length. Core 58/202 1 in RMU O8 only measures 6.9 × 4.4 cm and has two core faces with very small dimensions of 4.6 × 2.1 cm and 5 × 2 cm. What was intended with the working of this small core is unclear (children?).

4.8.5 Selection of blades for use as tool

In Pincevent, Marsangy, Verberie and Etiolles, the blades selected for use are longer than the average lengths of the blades that were discarded unused at the sites concerned (Audouze et al. 1988, 66). As criteria for selection widths and thicknesses of blades are regarded as more important than lengths, as is demonstrated in a comparison of dimensions of unused and used blades in Verberie (H19).

Data on the lengths and widths of the complete and broken tools of Eyserheide are presented in table 4.31. If two blades with partial use-wear retouch are left aside, the tools with the greatest length are a borer (11.3 cm) and an end scraper (10.7 cm). They are longer than the longest, complete burins which have dimensions of 8.7 cm (dihedral burin) and 8.5 cm (burin on truncation). The average lengths of the complete borers, burins and end scrapers vary from 7.4 to 9.1 cm. We do have to bear in mind though that these lengths are minimum dimensions. As a result of working, such as making a working edge and the resharpening of the working edge through retouch and the removal of burin spalls, and use, the measured lengths of tools could be significantly shorter than the blades from which they were made. For this reason it is assumed that blades with a minimum length of 10 cm were selected for use as end scraper, burin or borer/bec. A few broken end scrapers and burins with lengths between 7 and 10 cm and a broken bec burin with a length of 10.1 cm also form an indication for this.

The average widths of complete borers, burins and end scrapers lie very close together: from 2.1 cm (borers) to 2.5 cm (end scrapers). Also the broken pieces of these types of tools have average widths that mostly lie within the same range (table 4.32), namely from 1.9 cm (burins on truncation) to 2.5 cm (end scrapers). The average widths of broken pieces of blades with retouch and blades with use-retouch are very comparable, 2.2 and 2.3 cm respectively. These widths fall within the peak of widths of the non-retouched, medial parts of blades, which lies between 1.5 and 2.5 cm (see section 4.4.6 and table 4.11). It should be noted that of the total number of burins, end scrapers and borers/becs, only six specimens have a width between 0.5 and 1.5 cm. This number contrasts sharply with 70 medial fragments of blades that fall in the same range. This is an indication of selection of wider blades (> 1.5 cm) for the manufacture of these types of tools. The idea of selection on width of blades is further strengthened by the occurrence of tools made of blades with a width of more than 2.5 cm. Within the group of broken burins on a break, dihedral burins and end scrapers the largest widths are respectively 3.1 cm, 3.0 cm, and 3.6 cm. Notable is that corresponding widths in the group of non-worked, medial fragments of blades are hardly represented (see table 4.11). This applies in particular to end scraper 259A 320 with a width of 3.6 cm. This scraper forms part of the group of South-Limburg flint and more specifically RMU M19 which has been described as eluvial Rijckholt flint.

Regarding the thicknesses of tools (end scrapers, burins and borers/becs), it is noticeable that 30 out of 44 specimens have a thickness of 5 to 7 mm (table 4.31). Tools made of thinner (< 5 mm) or thicker (> 8 mm) blades are present with only five and nine specimens respectively. When these thicknesses are compared with those of non-retouched, medial parts of blades, we can assume a careful selection of blades with specific thicknesses. Almost no use was made thereby of the ample supply of blades thinner than 5 mm which take up more than 50% of the medial fragments (viz. 116 out of

Length (in mm)	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	> 100	N
End scrapers	.	.	.	.	.	.	.	1	.	1	1	3
Burins	.	.	.	.	1	.	.	3	3	.	.	7
Borers and becs	.	.	.	.	1	.	.	.	1	.	2	4
Total	.	.	.	.	2	.	.	4	4	1	3	14
Width (in mm)	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	>50	N
End scrapers	.	.	.	3	6	1	1	1	.	.	.	12
Burins on a break	.	.	.	.	1	.	.	.	.	.	.	1
Dihedral burins	.	2	3	5	6	4	1	.	.	.	.	21
Burins on truncation	.	.	.	1	1	.	.	.	.	.	.	2
Lacan-burins	.	.	1	.	1	.	.	.	.	.	.	2
Borers and becs	.	.	.	1	5	.	.	.	.	.	.	6
Total	.	2	4	10	20	5	2	1	.	.	.	44
Thickness (mm)	0	1	2	3	4	5	6	7	8	9	>10	N
End scrapers	.	.	.	1	.	2	1	5	2	.	1	12
Burins on a break	.	.	.	.	.	.	1	.	.	.	.	1
Dihedral burins	.	.	1	1	1	3	5	4	1	3	2	21
Burins on truncation	.	.	.	.	.	1	1	.	.	.	.	2
Lacan-burins	.	.	1	.	.	.		1	.	.	.	2
Borers and becs	.	.	.	1	.	1	2	2	.	.	.	6
Total	.	.	2	2	1	7	10	13	3	3	3	44

Table 4.31 Dimensions of retouched tools (end scrapers, burins and borers/becs) made of blades, length of complete tools, width (complete and broken), thickness (complete and broken).

Width (in mm)	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	N
Medial blade fragment	7	17	53	44	47	28	9	2	.	.	.	207
Retouched tools	.	2	4	10	20	5	2	1	.	.	.	44
Thickness (in mm)	0	1	2	3	4	5	6	7	8	9	>10	N
Medial blade fragment	.	19	27	39	31	16	23	16	16	4	16	207
Retouched tools	.	.	2	2	1	7	10	13	3	3	3	44

Table 4.32 Width (in mm) and thickness (in mm) of medial blade fragments and retouched tools (end scrapers, burins and borers/becs).

207 specimens). Tools with a thickness of 8 mm or more are reasonably well represented with nine specimens. These are six dihedral burins and three end scrapers on blades.

The data of Eyserheide regarding the selection of blades for further working and use as tools fit well with the picture of the Magdalenian sites in the Paris Basin.

4.8.6 *Discard of cores*

In the last column of table 4.7 is indicated what possibly could have been the reasons for the discard of the cores by the Magdalenian flint workers. Based on characteristics of the cores themselves, one or more of the following factors could have played a role:

a core face is no longer sufficiently convex;
b the angle between the striking platform and the core face is going towards 90 degrees;
c striking platform has irregular surface, short flakes with step fractures;
d damages to the core face as a result of accident in core working (step fractures, negative scars of irregular and rather short blades or *outrepassé*);

e irregularities in flint, frost cracks, inclusions, etc.;
f shifting of the core face towards the side(s) of the core;
g core has too small dimensions for producing blades with sufficient (desired) lengths.

In Eyserheide, the discard of cores seems to be related in most cases to irregularities of the core face as a result of the occurrence of step fractures (d). In a number of cores, these irregularities coincide with the presence of cortex holes or other irregularities (e), in view of successful blade production, 'crucial' places of the core, for instance at the level of the core face. Both factors could have influenced the convexity of the core face in a negative sense. One factor that probably (also) would have had a bearing on the discard of cores of tabular Simpelveld flint is the unwanted shifting of the core face from the narrow side towards the wide side(s) of the core (f).

In other cases it is not clear why no more use was made of cores. Examples of this are the cores with a *dos cortical*, of which the volume is still considerable, such as the cores that form part of RMUs M6 and M8. The core belonging to RMU M15 also still had more than sufficient volume and few to no irregularities to have been further reduced.

5 Lithic functional analysis

Katsuhiro Sano

5.1 Samples and methods

All flints excavated at Eyserheide originate from Cretaceous chalk layers in Dutch Limburg and were collected from secondary deposits (residual and slope deposits, river terrace deposits). The lithic raw materials were classified into four flint types, including, Simpelveld flint (15.1%), Valkenburg flint (1.2%), South Limburg flint (46.9%) and Orsbach flint (35.5%) (table 4.1). While heavy patination covers the surface of Simpelveld, Valkenburg and other flints, considerable numbers of Orsbach flints are so fresh that the pieces allow us to observe use-polish. For this reason, 44 Orsbach flints were selected for traceological analysis.

Although flint artefacts were already washed before this research, the sample was first observed carefully in order to confirm the presence of residues on the surfaces. Flints without residues were cleaned using a KOH-solution (1%). A total of 44 flint artefacts from Eyserheide was examined with the *low power approach* (LPA) and the *high-power approach* (HPA) (table 5.1). Trace patterns were digitally photographed using a digital single-lens reflex camera installed into a stereo microscope and a metallographic microscope.

The LPA concerns macro-traces including edge damage, macro-rounding, and fractures (Tringham *et al*. 1974; Cotterel and Kamminga 1979, 1987; Odell and Odell-Verecken 1980; Odell 1981; Akoshima 1981, 1987; Midoshima 1982; Vaughan 1985; Pawlik 1994; Steguweit 2003). The formation patterns of these macro-traces reflect performed motions and the relative degree of hardness of worked materials. Motions that can be reconstructed are longitudinal motion, transverse motion, perforating, grooving, wedging, and projection. The LPA generally deals with three categories of hardness, namely hard, medium hard and soft. Hard material (HM) includes antler, bone, ivory, shell, teeth, and stone. Medium hard material includes wood, and soft material includes meat and herbaceous plants. Nevertheless, identification of the relative hardness of worked materials based on only the LPA is far from simple, since the formation patterns of the macro-traces result from multiple factors, such as edge angle, shape of edge and hardness of lithic raw materials, and extraneous agencies often prevent us from distinguishing use-wear traces from non-use-wear traces (Moss 1983; Vaughan 1985; Van Gijn 1990). Particularly, soft material produces just slight, tiny edge damage which easily occurs during the flake production process (Newcomer 1976; Brink 1978; Nishiaki 1994; Midoshima 1996), depositional and post-depositional processes (Flenniken and Haggerty 1979; Gifford-Gonzalez *et al*. 1985; Nielsen 1991; Midoshima 1994; MacBrearty *et al*. 1998) and post-excavation processes (Wylie 1975; Gero 1978). The macro-traces were observed under a stereo microscope at magnification ranging from 10x to 30x.

Orsbach flint	**N**	**Analysed samples**
Blades	255	32
Flakes	324	6
Burins	20	5
End scrapers	3	1
Borers	4	0
Total	606	44

Table 5.1 Analysed samples and numbers of artefacts of Orsbach flint per artefact type from Eyserheide (see table 4.1).

The HPA (Keeley and Newcomer 1977; Keeley 1980; Kajiwara and Akoshima 1981; Plisson 1985; Vaughan 1985; Midoshima 1986, 1988; Van Gijn 1990; Pawlik 1994; Lemorini 2000) requires higher magnification, basically between 100x and 400x and micro-traces including polishes, striations, and micro-rounding are observed with this approach. The HPA is often represented by polish that provides us with an opportunity to interpret more clearly the materials that were worked. Keeley (1980, 83) claimed that specific polish patterns reflect specific contact materials and therefore polishes are distinguishable from one another. On the one hand, most use-wear analysts confirmed similar associations of the identified polishes with the specific worked materials, except for some excessive contradictions (Newcomer *et al*. 1986, 1988; Grace 1989); on the other hand, they reached the conclusion that there is not a one-to-one correspondence between polish types and worked materials. As frequently described (Kajiwara and Akoshima

1981; Vaughan 1985: 31-33; Midoshima 1986, 1988; Symens 1988: 178; Rots 2004), polishes of antler, bone and ivory are quite similar and are almost indistinguishable from each other. Distribution patterns of polishes and micro-rounding indicate approximate motions involved, and striations show the direction of the motion. In this study, these micro-traces were observed using a light reflecting metallographic microscope at magnification 100x-400x.

5.2 Results

5.2.1 Blades

Of the 32 blades in the sample, 13 show use-wear traces on the lateral edges and a broken end, and these items are characterised by a total of 18 independent use zones (IUZ) (table 5.2). Twelve of the IUZs seem to have been used for working antler, bone or ivory. Nine lateral edges of the typical Magdalenian blades exhibit composite traces, including bright, smooth polishes, striations and bifacially developed edge damage that represent antler, bone, or ivory (ABI) sawing. However, most were not well developed, and polishes were formed on limited high spots on the microtopography of the surface (figs. 5.1a,c; 5.2b; 5.3c and 5.4a). Obvious striations are also found together with generic weak polish (figs. 5.1b; 5.2d and 5.4b), which is indicative of the longitudinal direction of the motion involved. Relatively large edge damage is discontinuously distributed on both surfaces of lateral edges, which imply longitudinal actions when working hard materials (figs. 5.1d; 5.2c and 5.3d). Putting all this evidence together allows us to conclude that these blades (figs. 5.1-1-2; 5.2-2; 5.3-2, and 5.4-1) were used to saw ABI for relatively short durations and that they were not repeatedly employed for several tasks.

One steeply retouched blade retains residues on its ventral surface (fig. 5.4c,d). The provenance of this residue is still unclear, and it is debatable whether these residues derived from a Magdalenian context as no organic materials were discovered from the archaeological layer.

Several blades present more faint use-polishes, such as generic weak polish and smooth pitted polish (fig. 5.5c). The blade shown in figure 5.5-2 displays discontinuous edge damage and smooth pitted polish on both surfaces along the edge (fig. 5.5d). These suggest that this implement was employed with a longitudinal motion. The edge damage is generally slight, and may have resulted from the medium hardness of the worked materials or the relatively obtuse edge angle (58°). Both the edge damage and the polishes are not sufficiently distinctive to identify precisely the worked materials.

Interesting scars on one Eyserheide blade are the polishes derived from either plant-cutting or wood-working (fig. 5.5a). The polishes have a bright, smooth and domed appearance as typical of plant/wood-polish, but these are somewhat unusually associated with numerous striations. Contrary to other polishes found in the Eyserheide assemblage, this polish is well developed. Bifacial, discontinuous edge damage is observed on the same edge, exhibiting a denticulate edge line. This represents a longitudinal motion. The dimension of the edge damage, as well as the edge angle, indicate that this edge relates to working of medium hard materials. Altogether, this blade was probably used for wood-working.

One retouched blade has pitted, rounding polishes resulting from hide processing on the right-side edge of the medial portion (fig. 5.6a); this is interrupted by deliberate

High power approach	Wood, longitudinal motion	Hide, longitudinal motion	Antler, bone or ivory, transverse motion	Antler, bone or ivory, longitudinal motion	N
Broken end	.	.	.	1	1
Lateral sides	1	1	2	9	13
Low power approach	Hard or medium hard material, longitudinal motion	Hard material, transverse motion	.	.	
Lateral sides	2	2	.	.	4
Total number of independent use zones					18

Table 5.2 Functions by IUZ of blades from Eyserheide.

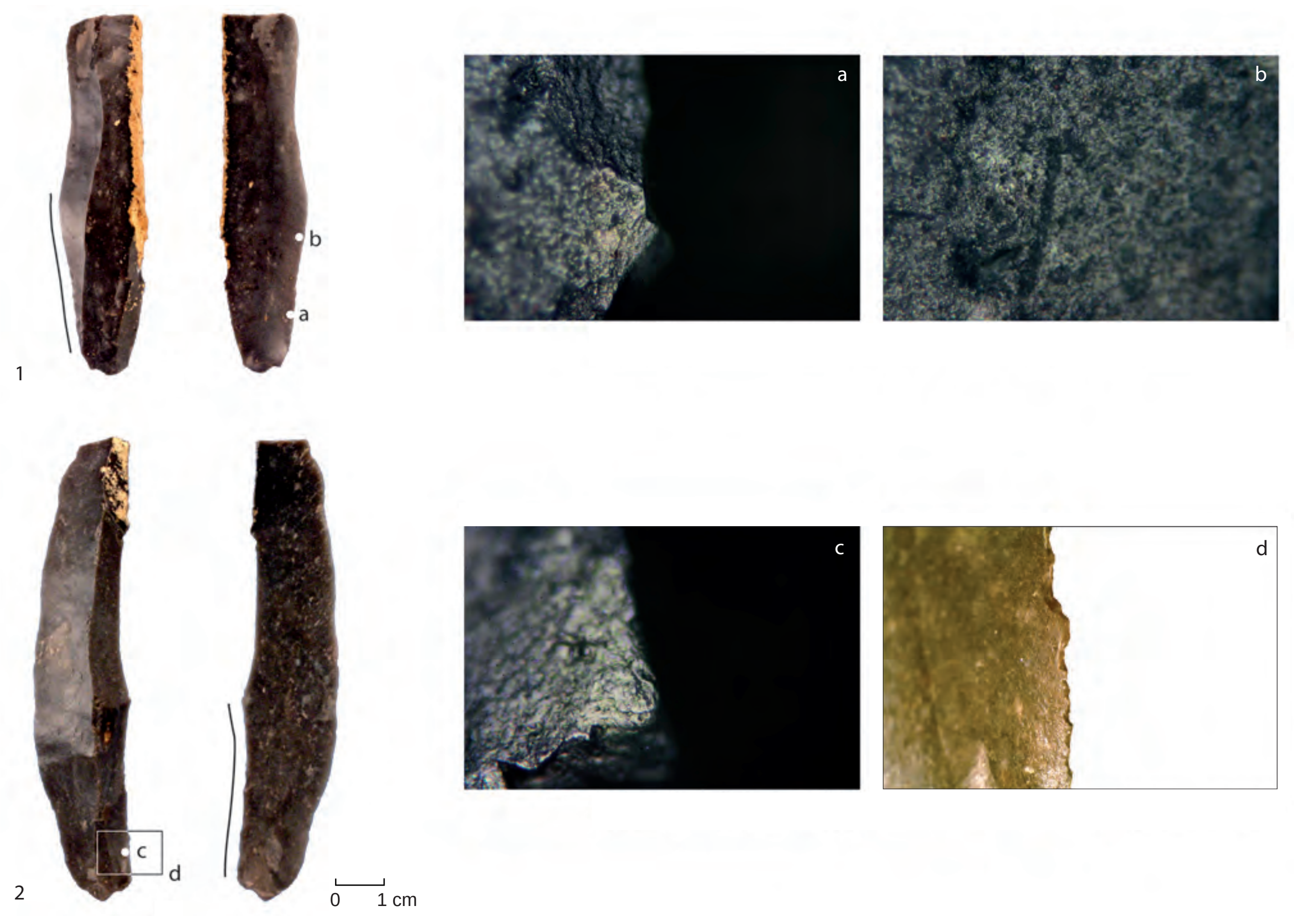


Figure 5.1 Blades 53/200 42 (1) and 53/204 10 (2). Solid lines show edges used in a longitudinal motion. a, c: polish resulting from ABI sawing (200x); b: GWP and striation (200x); d: edge removals (10x).

retouch. Since edge damage (fig. 5.6b) on the ventral surface of the retouched edge is isolated and is not accompanied by any other use-wear traces, the removals probably occurred due to retouching by accident. Therefore, the retouch was almost certainly applied after its primary use, after which the blade appears to have been discarded.

Three blades provide no clear evidence of their function, scars on these pieces stemming from post-depositional modification. One blade shows only generic weak polish on the notched edge (fig. 5.6c,d) that cannot be considered clear evidence of use. In fact, the notch itself is one of the most frequent types of edge damage to result from trampling (Midoshima 1994; McBrearty *et al*. 1998), and in the case of this item, this interpretation can certainly not be excluded. One other blade has more distinctive trampling notches on the edge of the distal portion (fig. 5.3a b), as well as “scuff marks” (Shea and Klenck 1993) on the surface. The other blade suffers from a few occurrences of edge damage, but shows noticeable post-depositional surface modification, such as bright spots (fig. 5.2a) (Levi-Sala 1986, 1993). Although bright spots could also be linked to hafting (Rots 2003, 2004, 2005; Rots *et al*. 2006), the distribution of the bright spots on this implement, and the lack of use-wear traces on other edges, rather implies that the alterations stem from a post-depositional context.

Four crested blades and one thick blade at the primary stage of the reduction sequence were examined, of which one crested blade and the thick blade exhibit use-wear traces (fig. 5.7, 1-2). In both cases, transverse motions are indicated, probably due to the obtuse edge angle and concave edge lines. The crested blade has generic weak polish and smooth pitted polish on the left side of the edge and large edge damage is visible on the dorsal surface of the same edge (fig. 5.7a). The thick blade displays polishes caused by

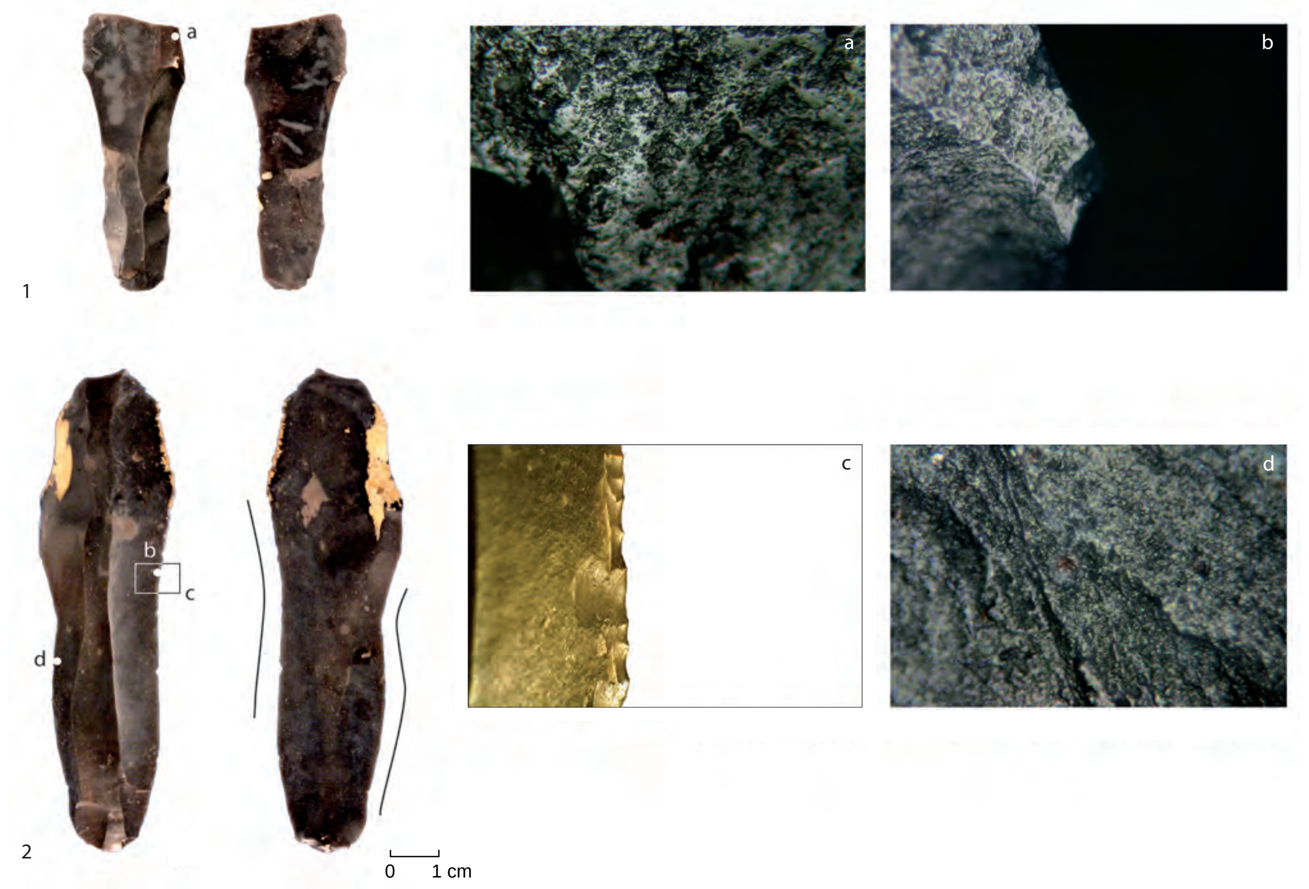


Figure 5.2 Blades 54/202 23 (1) and 54/202 50 (2). Solid lines show edges used in a longitudinal motion.
a: bright spots (100x); b: polish resulting from ABI sawing (200x); c: edge removals (10x); d: GWP and striation (200x).

ABI-working on the ventral surface and large, regular edge damage on the dorsal surfaces (fig. 5.7b, c). These scars demonstrate use of the item as an ABI-scraping tool.

Straight edges in section are the most efficient for longitudinal motions, such as cutting, sawing (Moss 1986; Van Gijn 1990). However, primary products of lithic reduction generally have irregular edges. Furthermore, the blades at the primary stage of reduction are in general thick and acquire an obtuse edge. Probably for these reasons, the lateral sides of the blades at the primary stage have a tendency to be used with transverse motions.

On the whole, the ratio of the flint artefacts with distinctive use-wear to those without use-wear is relatively low. Almost half of the analysed specimens show no use-wear traces. In addition, the use-wear traces observed are not well developed and most of the blades have just one independent use zone. Therefore, blades produced at Eyserheide were mostly unused, and even the blades which were used were not very intensively done so.

5.2.2 Flakes

A high ratio of the analysed flakes shows evidence of use, as use-wear analysis of the flint artefacts from Magdalenian sites in the Paris Basin and the Upper Palaeolithic lithics from Klithi in Greece have already demonstrated (Moss 1986, 1997; Symens 1986). Four out of six flakes exhibit use-wear traces, whereby three of them were probably used for ABI-working, and one piece was employed to process hard organic materials, such as ABI, shell, and teeth (table 5.3). None of them were used in longitudinal motions, most probably for the same reasons as blades removed at the primary stage of reduction sequences were not selected for tasks involving longitudinal motions.

One flake with a pointed distal end exhibits polishes from ABI-working as well as flute-like fractures on the tip (fig. 5.8a,b). These reveal that this piece was used to engrave ABI. On the other hand, one other flake has an arced edge on the distal end, which has an obtuse edge and looks like a burin. This pseudo-burin edge displays polish from

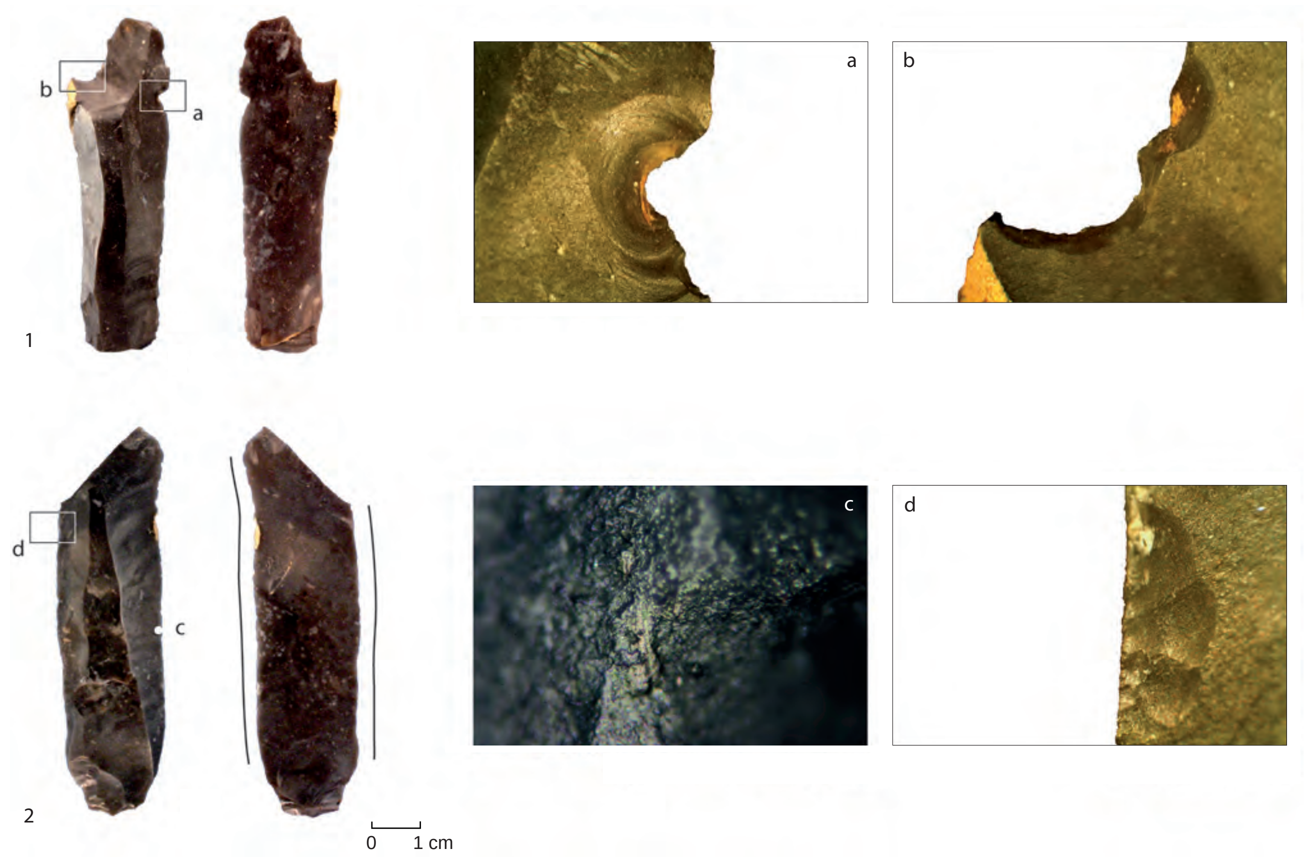


Figure 5.3 Blades 57/203 13 (1) and 54/202 136 (2). Solid lines show edges used in a longitudinal motion. a, b, d: edge removals (10x); c: polish resulting from ABI sawing (200x).

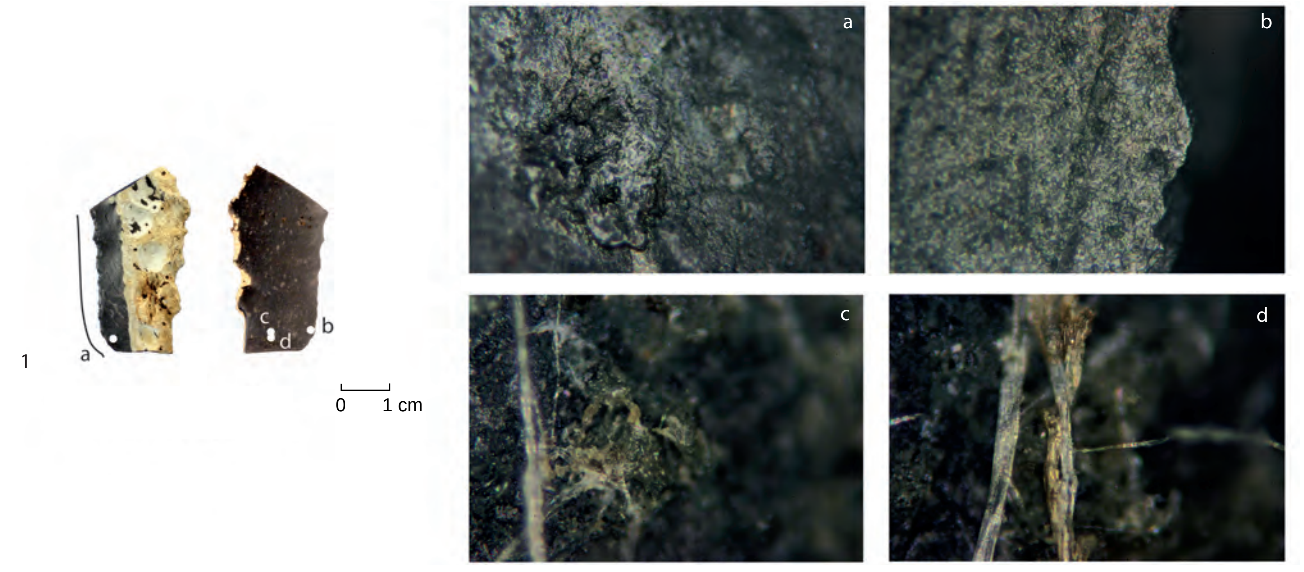


Figure 5.4 Blade 53/200 89 (1). Solid line shows edges used in a longitudinal motion. a: polish resulting from ABI (200x); b: GWP with striation (200x); c, d: residues (200x).

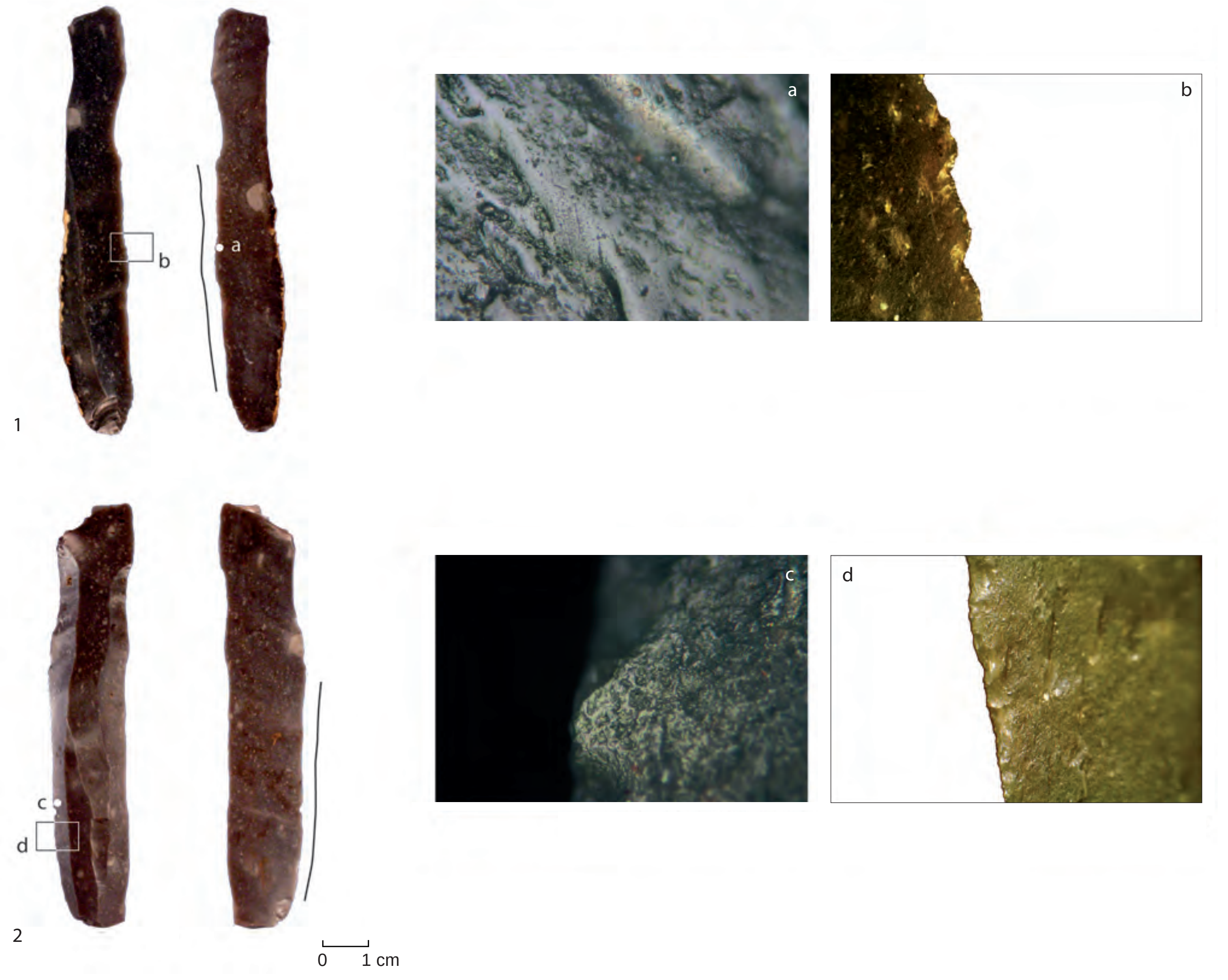


Figure 5.5 Blades 55/202 13 (1) and 55/203 3 (2). Solid lines show edges used in a longitudinal motion. a: polish resulting from plant/wood working (200x); b, d: edge removals (10x); c: SPP (200x).

High power approach	Antler, bone or ivory, transverse motion	Antler, bone or ivory, grooving	Hard organic material, grooving	N
Tip	.	1	.	1
Distal end	2	.	1	3
Total number of independent use zones				4

Table 5.3 Functions by IUZ of flakes from Eyserheide.

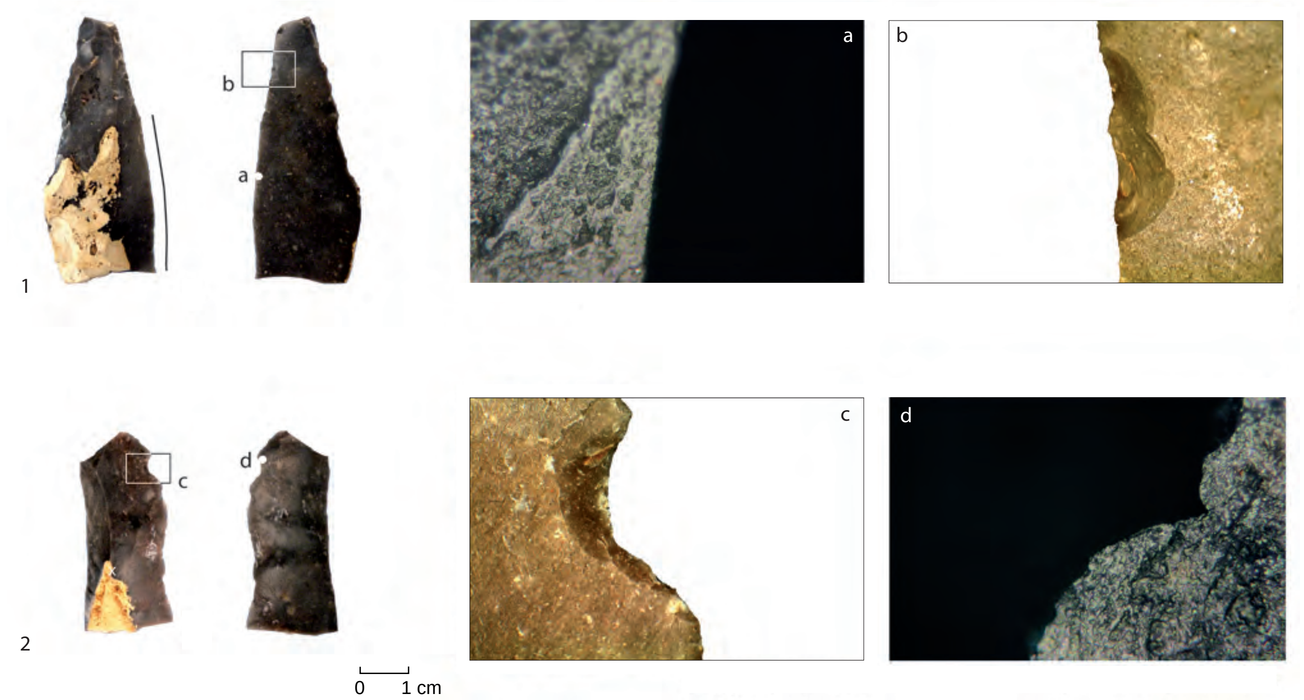


Figure 5.6 Blades 53/200 34 (1) and 52/201 20 (2). Solid line shows edges used in a longitudinal motion. a: polish resulting from hide cutting (200x); b, c edge removals (10x); d: SPP (200x).

ABI-scraping and regularly distributed large edge damage on the dorsal surface (fig. 5.8c,d). The item was most probably used for ABI-scraping. Without exception the flakes include only one independent use zone per item; thus, they may have been assigned ad hoc to a task for a short duration according to their morphologies, and were not used repeatedly.

5.2.3 Burins

The most commonly worked materials of burins are hard organic materials such as antler, bone or ivory. Although one burin has traces from hide-scraping on its distal end and only vague traces on the burin facets, as well as burin bit, the remaining four analysed burins show traces of ABI-working (table 5.4).

The main action using burins was in transverse action rather than grooving. Four burin facets exhibit polishes from ABI-scraping (figs. 5.9b, 5.11a). In addition to burin facets, the distal end and the lateral sides linked with burin facets also show polishes caused by ABI-scraping and exhibit edge damage on the opposite side to the surface on which polishes developed (figs. 5.9a, 5.11b). The burin in figure 5.9-1 has three IUZs, all of which display scars from ABI-scraping. Altogether seven IUZs were probably used to scrape ABI. Three burins show scars from grooving ABI on the burin bits (figs. 5.9-2, 5.10-2, 5.11-1).

The distal end of a burin has an arced morphology and exhibits traces from hide-scraping (fig. 5.10a, b). In addition, edge-abrasion was observed on the ridge, which might stem from hafting. Hafting traces suggest that this implement was hafted during hide-working. The traces found on the burin facets provide no clear distinction and it is unclear whether the scars developed in the course of utilisation or hafting. If the scars are derived from hafting, the burin technique has been performed to adjust the flint tool to a socket.

The burin in figure 5.11, no.1 shows traces from ABI-scraping on its left burin facet and scars from ABI-grooving on its burin bit. Furthermore, this burin has use-wear on the right burin facet and both lateral sides; however, these working edges exhibit just slightly developed polishes and therefore the exact worked materials are uncertain. The unifacially and continuously distributed, large edge damage on the burin facets, as well as on the left-side edge, indicate that both working edges were almost certainly used to scrape hard materials. The right-side edge displays scars that represent longitudinal action against hard or medium hard materials. Hafting traces were also observed on the ridge and the left-side edge of the implement (fig. 5.11c,d). While the temporal relationship between use-wear traces between the left burin facet and the conjoining lateral edge is

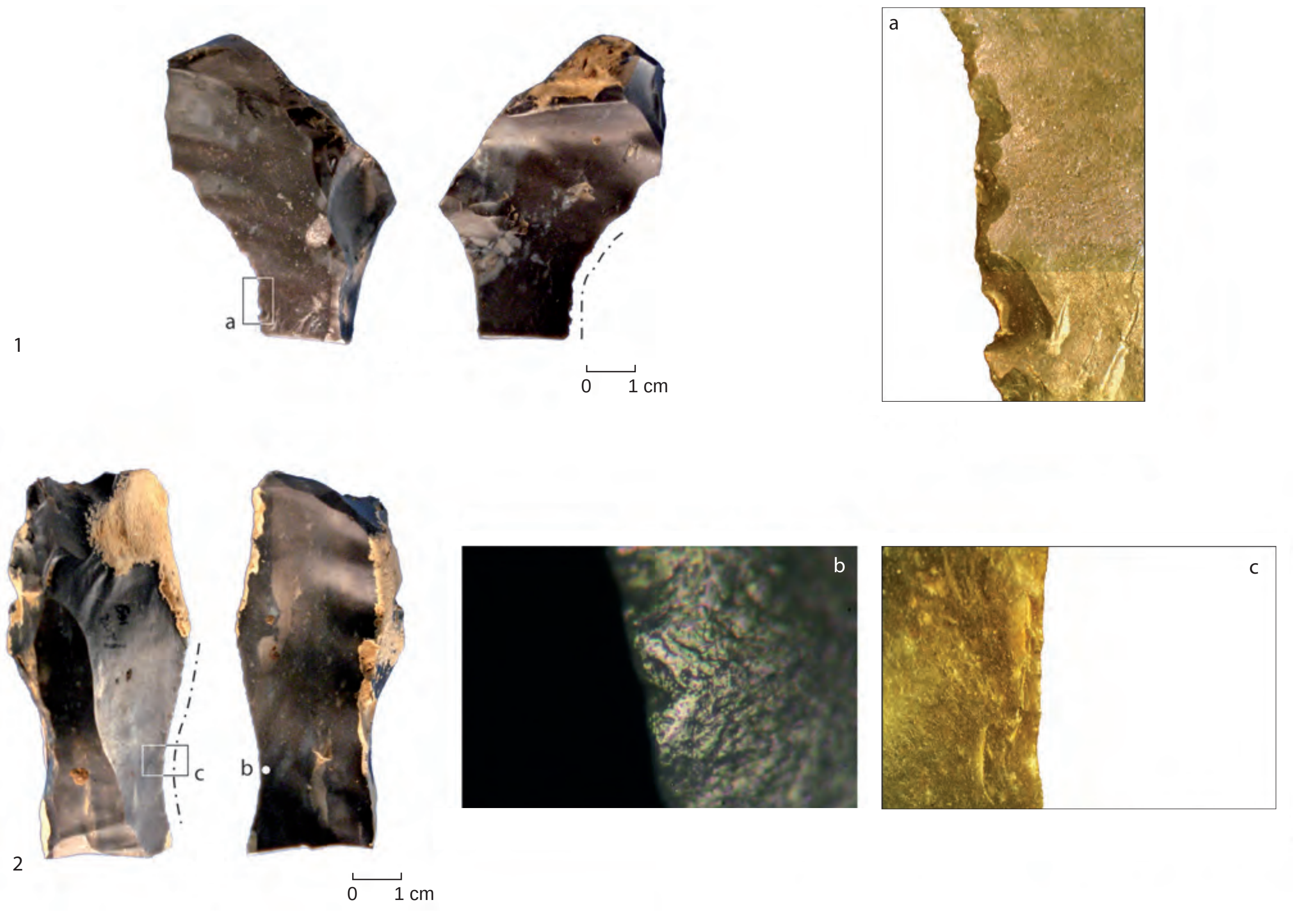


Figure 5.7 Blades 53/199 2 (1) and 54/202 109 (2). Dashed lines show edges used in a transverse motion. a, c: edge removals (10x); b: polish resulting from ABI working (200x).

High power approach	Hide, transverse motion	Antler, bone or ivory, transverse motion	Antler, bone or ivory, grooving	N
Burin bit	.	.	3	3
Burin facet	.	4	.	4
Distal end	1	1	.	2
Lateral sides	.	2	.	2
Low power approach	Hard or medium hard material, longitudinal motion	Hard material, transverse motion	unc, longitudinal motion	
Burin facet	.	1	.	1
Lateral sides	1	1	1	3
Total number of independent use zones				15

Table 5.4 Functions by IUZ of burins from Eyserheide.

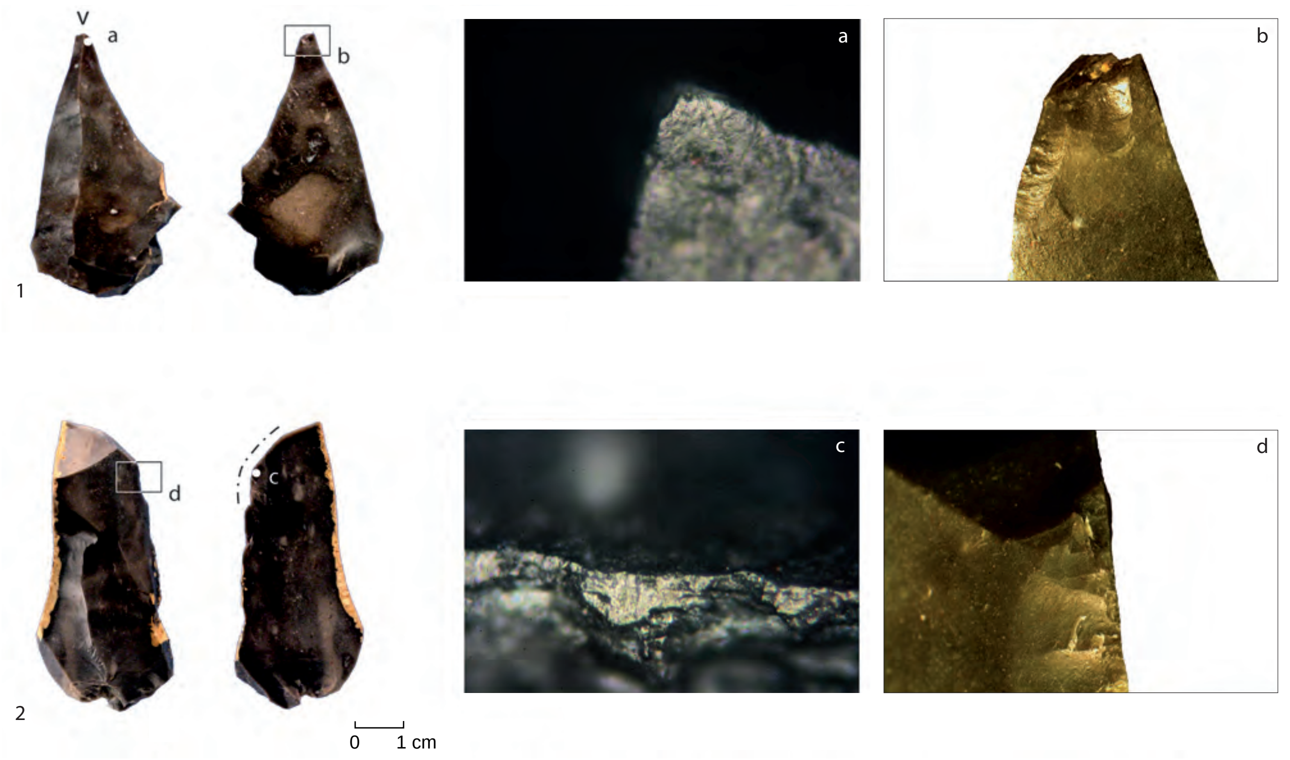


Figure 5.8 Flakes 58/203 12 (1) and 55/200 1 (2). Dashed line shows edge used in a transverse motion. V shows an edge worked for engraving. a: polish resulting from ABI working (200x); b: flute-like fractures (10x); c: polish resulting from ABI scraping (200x); d: edge removals (10x).

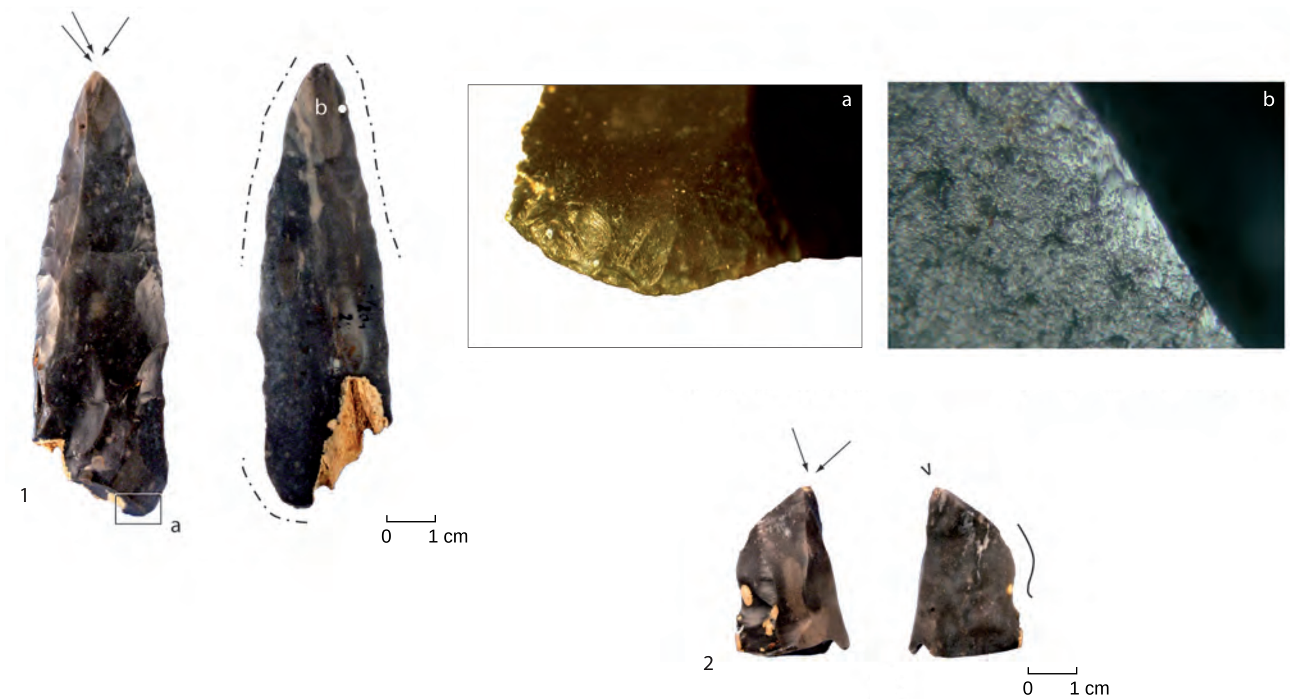


Figure 5.9 Burins 54/204 24 (1) and 57/199 5 (2). Dashed lines show edges used in a transverse motion. Solid line shows edge worked in a longitudinal motion. a: edge removals (10x); b: polish resulting from ABI scraping (200x).

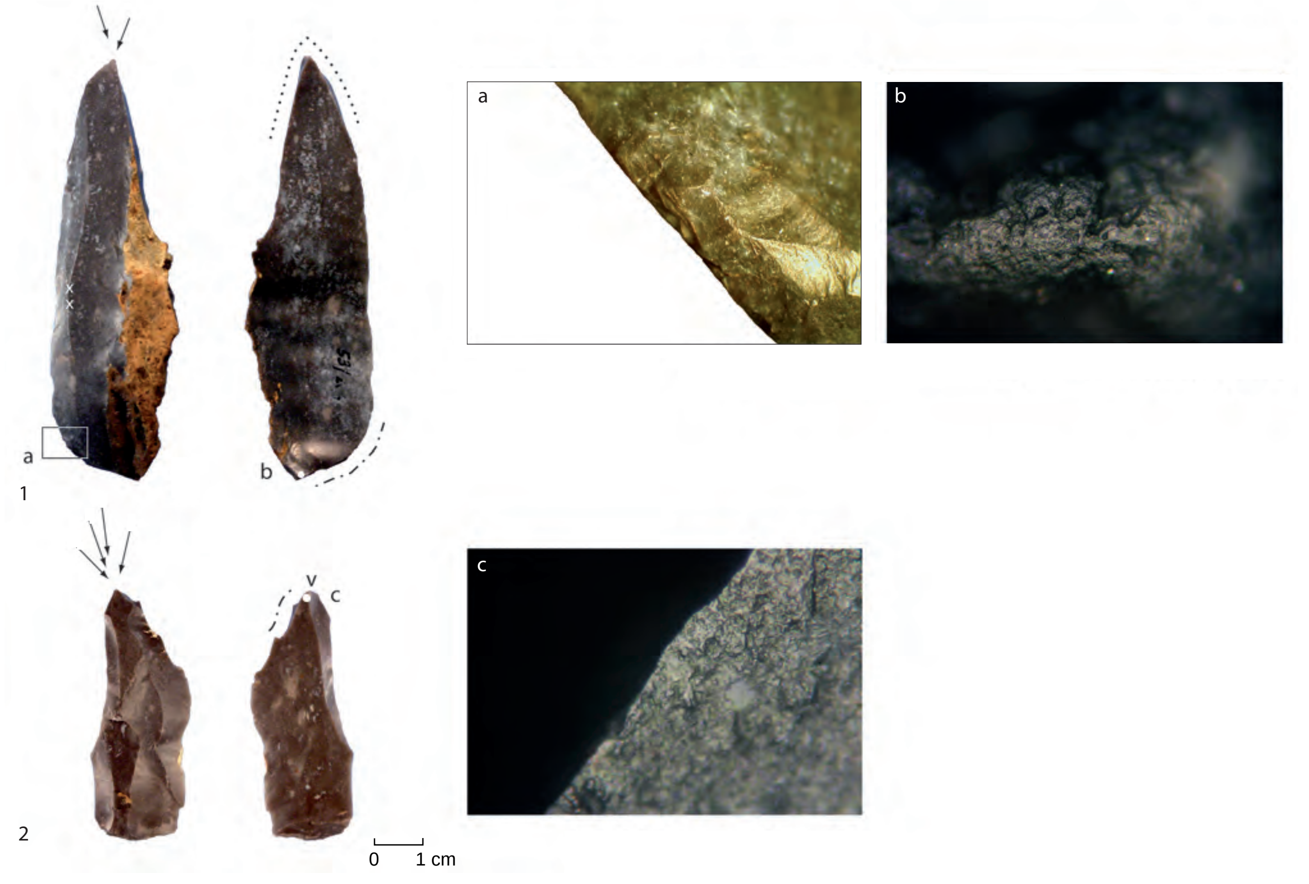


Figure 5.10 Burins 53/204 8 (1) and 54/202 121 (2). Dashed lines show edges used in a transverse motion. Dotted line shows an edge used, but motion is uncertain. X shows traces of hafting. a: edge removals (10x); b: polish resulting from hide scraping (200x); c: polish resulting from ABI graving (200x).

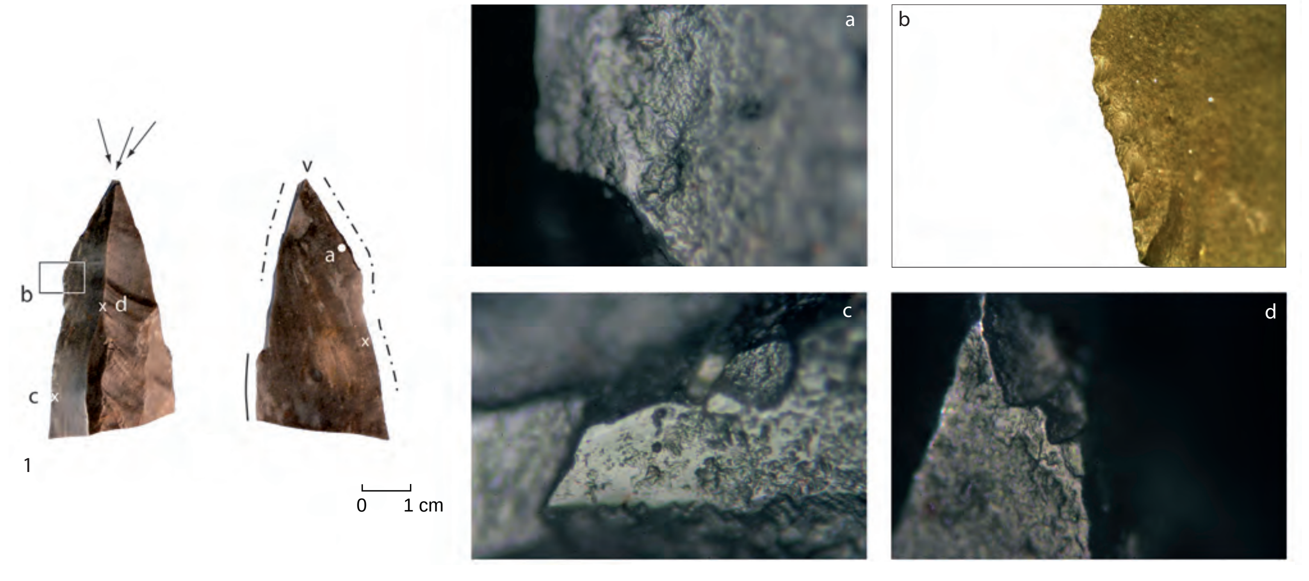


Figure 5.11 Burin 53/202 81 (1). Dashed lines show edges used in a transverse motion. Solid line shows an edge used in a longitudinal motion. X shows traces of hafting. a: polish resulting from ABI working (200x); b: edge removals (10x); c: bright spots (200x); d: polish possibly caused by hafting (200x).

obscure, the traces on the right-side edge are interrupted by the last burin facet of the same side. Therefore, both lateral edges might have been used before this piece obtained the burin facets.

5.2.4 *End scrapers*

One end scraper was analysed and it shows traces corresponding to lightly developed polish from hide-scraping (fig. 5.12a). The scars show that this end scraper was used to scrape hides, but also that it was not very intensively used, at least after this piece acquired the last retouching on the distal end. The end scraper has bright spots (fig. 5.12b) and possible hafting traces on the ridge. Thus, this implement may have been hafted during usage, as would appear to be generally valid for end scrapers in the Upper Palaeolithic.

5.3 Discussion and Conclusion

The high ratio of ABI-working in comparison to other tasks suggests that the main activity using lithic artefacts at Eyserheide was hard organic material processing, though no organic materials were recovered from the site. Production of hard organic artefacts such as projectile points and shafts or perhaps the manufacture of ornaments from hard organic materials may have resulted in the scars of hard organic materials. Eyserheide and other Magdalenian sites in the Meuse-Rhine loess area are interpreted as briefly used camp sites (see 7.9) where numerous blanks were prepared using abundant Cretaceous flints from secundary deposits (residual and slope deposits, river terrace deposits) in the direct vicinity of the site. On the other hand, the traceological analysis in this study indicates that production of hard organic tools or ornaments was also conducted at Eyserheide.

Nonetheless, this does not mean that the results of the traceological analysis reject the hypothesis of previous studies. Indeed, the traceological analysis shows that processing of antler, bone and/or ivory and some other tasks were performed at Eyserheide; however, the frequency of the lithic utilisation is generally low. Most of the blades bear use-wear traces on just one side of the lateral edges, contrary to blades from Gönnersdorf (Sano 2009). Moreover, the traces on the lithic artefacts analysed were overall rather slightly formed than well developed, which could be explained by the lithic artefacts at Eyserheide not having been very intensively or repeatedly used. Some of the analysed blades have long, straight edges and were suitable for use as tool, whereas these blades do not bear micro-wear traces. Why these items were discarded, even though they had still effective edges, is therefore an important question. Perhaps, as previously interpreted, many blades may have been just expediently used without leaving microscopically visible traces.

High power approach	Hide, transverse motion	N
Endscraper edge	1	
Total number of independent use zones		1

Table 5.5 Functions by IUZ of an end scraper (n= 1) from Eyserheide.

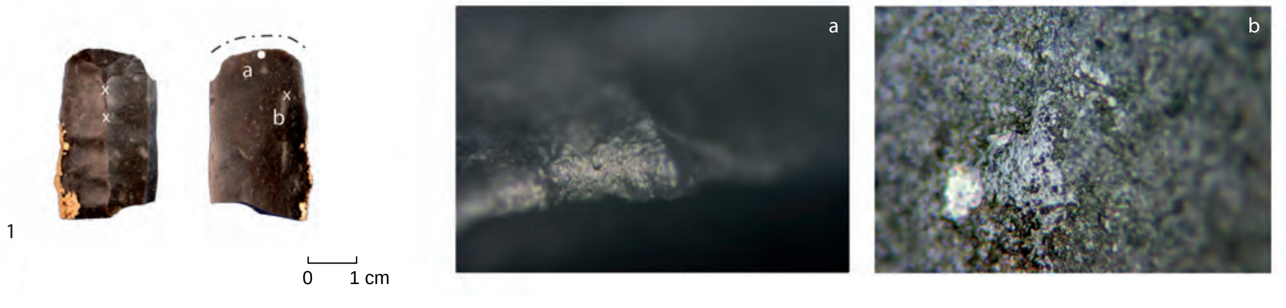


Figure 5.12 End scraper 58/203 10 (1). Dashed line shows edge used in a transverse motion. X shows traces of hafting. a: polish resulting from hide scraping (200x); b: bright spot (200x).

Sample number	Figure	Find no.	Type of artefact	Independent use zones	Motion	Worked material	Remarks
1	5.11-1	53-202-81	burin	burin bit	grooving	antler, bone or ivory	
				burin facet: right	transverse	hard	
				burin facet: left	transverse	antler, bone or ivory	
				side edge: right	longitudinal	hard/medium hard	
				side edge: left	transverse	hard	
				ridge/side edge:left	hafting	wood or antler, bone or ivory	
2	5.10-1	53-204-8	burin	burin facet: right	uncertain	uncertain	
				burin facet: left	uncertain	uncertain	
				distal end	transverse	hide	
3	5.10-2	54-202-121	burin	burin bit	grooving	antler, bone or ivory	
				burin facet: right	transverse	antler, bone or ivory	
4	5.9-1	54-204-24	burin	burin facet + side edge: right	transverse	antler, bone or ivory	
				burin facet + side edge: left	transverse	antler, bone or ivory	
				distal end	transverse	antler, bone or ivory	
5	5.9-2	57-199-5	burin	burin bit	grooving	antler, bone or ivory	
				side edge: right	longitudinal	uncertain	
6	5.12-1	58-203-10	end scraper	endscraper edge	transverse	hide	
				ventral surface	hafting	uncertain	
7	5.6-2	52-201-20	blade	notched edge	uncertain	uncertain	
8	5.4-1	53-200-89	blade	side edge: left	butchering	bone, hide, (flesh)	Residues
9	5.6-1	53-200-34	blade	side edge: right	longitudinal	hide	
10	5.1-1	53-200-42	blade	side edge: right	longitudinal	antler, bone or ivory	
11	5.1-2	53-204-10	blade	side edge: right	longitudinal	antler, bone or ivory	
				side edge: left	longitudinal	antler, bone or ivory	
12	5.2-1	54-202-23	blade	all IUZs	uncertain	uncertain	
13	5.2-2	54-202-50	blade	side edge: right	longitudinal	antler, bone or ivory	
				side edge: left	longitudinal	antler, bone or ivory	
14	5.3-1	57-203-13	blade	side edge: right	trampling	-	
				side edge: left	trampling	-	
				medial portion	trampling	-	
15	5.3-2	54-202-136	blade	side edge: right	longitudinal	antler, bone or ivory	
				side edge: left	transverse	antler, bone or ivory	
16	5.5-1	55-202-13	blade	side edge: right	longitudinal	wood	
17	5.5-2	55-203-3	blade	side edge: left	longitudinal	hard/medium hard	

Sample number	Figure	Find no.	Type of artefact	Independent use zones	Motion	Worked material	Remarks
18		55-204-31	blade	side edge: left	longitudinal	hard/medium hard	
19		53-200-15	blade	all IUZs	uncertain	uncertain	
20		52-200-11	blade	all IUZs	uncertain	uncertain	
21		52-200-21	blade	all IUZs	uncertain	uncertain	
22		52-203-10	blade	all IUZs	uncertain	uncertain	
23		53-199-9	blade	all IUZs	uncertain	uncertain	
24		53-202-80	blade	all IUZs	uncertain	uncertain	
25		54-201-16	blade	all IUZs	uncertain	uncertain	
26		54-201-52	blade	side edge: right	longitudinal	antler, bone or ivory	
				side edge: left	longitudinal	antler, bone or ivory	
27		54-202-62	blade	all IUZs	uncertain	uncertain	
28		54-202-63	blade	side edge: left	transverse	hard	
29		54-202-205	blade	all IUZs	uncertain	uncertain	
30		55-199-11	blade	all IUZs	uncertain	uncertain	
31		59-204-6	blade	all IUZs	no usewear	no usewear	
32		61-202-4	blade	all IUZs	uncertain	uncertain	
33		55-201-27	blade	all IUZs	uncertain	uncertain	
34	5.7-2	54-202-109	blade	side edge: left	transverse	antler, bone or ivory	
35		53-200-102	blade	all IUZs	uncertain	uncertain	
36		55-202-39	blade	all IUZs	uncertain	uncertain	
37		55-204-33	blade	all IUZs	no usewear	no usewear	
38	5.7-1	53-199-2	blade	side edge: right	transverse	hard	
39		54-202-39	flake	distal end	grooving	hard	
40	5.8-2	55-200-1	flake	distal end	transverse	antler, bone or ivory	
41		54-202-140	flake	all IUZs	uncertain	uncertain	
42	5.8-1	58-203-12	flake	tip	grooving	antler, bone or ivory	
43		61-200-2	flake	distal end	transverse	antler, bone or ivory	
44		55-202-71	flake	all IUZs	uncertain	uncertain	

Table 5.6 All analysed samples of Orsbach flint and results of the use-wear analysis. IUZs = independent use zones.

6 Spatial distribution of finds

6.1 Introduction

In the preceding chapters 4 and 5, we focused on the flint assemblage of the site of Eyserheide and to the information on Magdalenian lithic use that can be inferred from the characteristics of the flint artefacts (raw materials, typology, technology, use-wear traces). In this chapter, the focus is on the spatial distribution of the archaeological material, as documented during the excavations in 1990-1991. A first analysis of this distribution and interpretation in terms of human behaviour and spatial organisation was carried out by A. Smit (1992). Following this study, we will in this chapter address the role of post-depositional processes and the way in which Magdalenian hunters and gatherers organised and used the camp site of Eyserheide. Point of departure for analysis is the flint artefacts and the unworked stone that were plotted in three dimensions underneath the plough zone. The division of flint artefacts into RMUs and artefact types (see chapter 4) will be used in an attempt to determine activity areas and for instance locations of modification of individual flint nodules.

In the past forty years, interest has increased hugely in the analysis and interpretation of find distributions in Late Upper Palaeolithic sites of Northwest Europe. Since then numerous sites with (presumed) good preservation conditions have been subjected to spatial analysis (see for instance Leroi-Gourhan and Brézillon 1966; Berke et al. 1984; Julien et al. 1988; Stapert 1989, 1990; Bullinger et al. 2006; Leesch et al. 2010). The majority of these are open-air sites of which the spatial distribution of stone tools and lithic debris have been analysed, whether or not in connection with faunal remains and remains of a hearth and/or habitation structure. Magdalenian sites in Northwest Europe have played a prominent role in the development of methods and techniques of intrasite spatial analysis. An early and important example of this is the open-air site of Pincevent, located in the river basin of the Seine c. 70 km southeast of Paris. Because of the clustering of finds around three hearths, Leroi-Gourhan (in: Leroi-Gourhan and Brézillon 1966) proposed for Habitation no. 1 one large structure consisting of three hearths. The results of the excavations of habitation units in Pincevent section 36 formed the foundations of the spatial model which he published six years later (Leroi-Gourhan and Brézillon 1972). This model assumes fixed patterns in the spatial position of archaeological material in the immediate vicinity and on either side of a hearth (A) (fig. 6.1). In the dispersal of the tools, flint and bone debris and ochre, Leroi-Gourhan recognised six zones which are distinguished from each other in the composition and density of finds. Zones B1 and C represent respectively an activity area (B1: *l'espace domestique interne*) and the sleeping area (C) inside a tent or hut structure. In zone B1 the amount of retouched tools is high and ochre occurs. The other zones (B2 and D to G) extend, in the form of successive semi-circular rings, on the other side of the hearth. B2 is designated as *l'espace domestique externe* and contains the material residue of activities deposited outside the habitation structure. Compared to B1, tools and ochre in zone B2 are less numerous. Zones D to F are the result of depositing of stone and bone debris in dumps located at distances of 1 to 2 m (D), 3 to 4 m (E), and 5 to 6 m (F) from the centre of the hearth (*espace d'évacation*). Zone G lies at an even greater distance from the hearth and consists of isolated finds.

After the publication of Leroi-Gourhan and Brézillon in 1972, several other habitation units, consisting of stone artefacts and animal bone material around or in the vicinity of hearths constructed with stones, have been excavated in Pincevent, but also in other locations in the Paris Basin: Verberie (Audouze et al. 1981), Marsangy (Schmider 1984, 1992), and Etiolles (Pigeot 1987). Parts of the spatial model of Leroi-Gourhan were thereby called into question (Audouze 1987b; Julien et al. 1987). An important question was centred on the size, shape and location of the habitation structure in relation to the hearth. Was this hearth in the centre, near the entrance or completely outside the (assumed) structure? Contrary to Leroi-Gourhan and with reference to the results of ethnographic research by Binford (hearth seating model, see 6.8.3), Audouze (1987b) proposes a position of the hearth in the open air, at a few metres from the entrance of the tent. This change in view has however not led to general consensus about the spatial relationship between habitation structures and hearths in Pincevent and other sites in the Paris Basin. The lack of archaeological

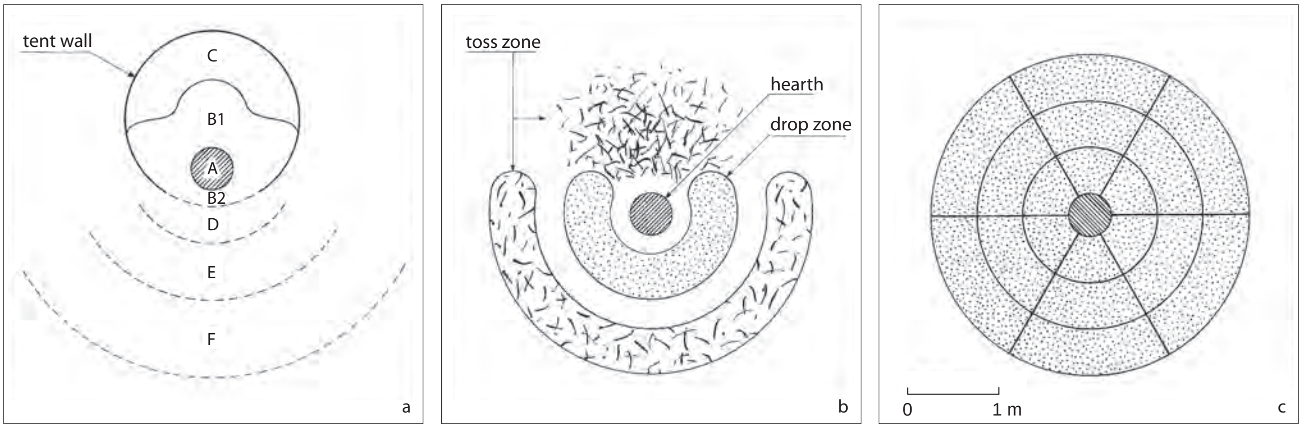


Figure 6.1 a: Tent model of Leroi-Gourhan. A= hearth, B1= activity area with relatively many tools and ochre, B2= dense concentration of (flint) stone and bone waste, C= sleeping area, find poor, D-G= zones with a decrease in the quantity of waste per zone. The diameter of the tent is c. 3 m (after Leroi-Gourhan and Brézillon 1972, 254, fig. 174); b: Binford's hearth seating model. The drop zone corresponds with the area where the persons are seated (close to the hearth) and where a wide range of activities is carried out (after Binford 1978, 1983 fig. 89); c: Stapert's ring and sector method. Division of find concentration with central hearth into rings and sectors (after Stapert 1989).

traces of tent or hut structures, for instance configurations of soil marks (postholes) or circles of stones (tent weights), and limitations of interpretation in particular with regard to find-poor parts of excavated habitation units (interpreted by Leroi-Gourhan as sleeping places) are to a considerable extent the reason for this.

In the German Central Rhineland, clusters of stone artefacts and animal bones around a central hearth have been analysed for Andernach and Gönnersdorf (Bosinski 1979; Stapert and Terberger 1989). In all cases we are dealing with well-preserved and carefully excavated open-air sites from the Magdalenian, whereby the aim was as far as possible an exact documentation of the position of individual finds and structures. In contrast to Pincevent, in both German sites, but also in Etiolles, circles of large stones were found with inside them a central hearth (Etiolles: Julien et al. 1988; Olive et al. 1988; Pigeot 1987). They have been interpreted as remains of circular habitation structures. One of the large concentrations (C1) at Gönnersdorf comprised a circle of postholes, within which a central hearth was present (Bosinksi 1979). At sites where archaeological evidence for habitation structures and hearths is lacking, the spatial analysis is directed to particularly or even exclusively (at locations where organic remains and ochre are not present) dispersals of stone artefacts. Not only characteristics of the artefacts themselves, such as type of artefact and dimensions, were of great value there, but also the results of refitting and use-wear analysis for gaining a further insight into the spatial organisation and use of the camp sites. The analyses are as a rule characterised by application of non-statistical methods in which horizontal distributions of finds, as recorded in general plans are evaluated with the naked eye and interpreted. Following the model of Leroi-Gourhan for section 36 in Pincevent, many of these analyses have led to the reconstruction of a circular habitation structure (hut or tent) in the most find-rich parts of sites. However, in the absence of archaeological traces of the habitation structures themselves, the archaeological furnishing of proof of these reconstructions is usually meagre. As a result, the outcomes of analyses should be treated with the necessary caution (see for instance Orp-le-Grand in Belgium, Vermeersch et al. 1984). An important example of spatial analysis of a Late Upper Palaeolithic site in the Netherlands is the Hamburg site of Oldeholtwolde (Stapert 1982; Johansen and Stapert 2004). The study of this site has led to the development of a new method of spatial analysis, namely the 'ring and sector method'. We will further discuss this method in paragraph 6.8.4.

Compared with well-preserved open-air sites which are covered by fine-grained, low-energy sediments and in which spatial patterns are still more or less intact, less attention has been paid to spatial analysis of surface sites from the Magdalenian. In view of their position on or directly beneath the present-day surface, the archaeological layer has in many cases been ploughed up or otherwise been disturbed, for instance by bioturbation. Organic materials also would have decayed completely as a result of chemical processes. All the same, this category of sites can contain valuable information about the way in which prehistoric hunters have organised and used the camp site. Moreover, surface sites, because of the often strong effects of abiotic and biotic processes, form an important ‘training ground’ for the research of post-depositional processes. Acquiring knowledge about these processes is indispensable for a spatial interpretation of observed distribution patterns, regardless of the degree of disturbance of a site. This research of surface sites is very important for a good understanding of sites covered by sediments which as a rule are described as well preserved.

In this chapter the focus will be first on the horizontal and vertical distribution of flint artefacts and the unworked stone (6.2 and 6.3). The data presented will serve as basis for a discussion of post-depositional processes and the influence these processes will have had on the spatial position of the finds (6.4). In the next paragraph (6.5), the composition of finds in four distinct clusters (clusters A, B, C, and D) will be considered. Subsequently, attention will be paid to the horizontal distribution of artefacts measured in three dimension belonging to one and the same RMU (6.6) and of retouched tools over the excavated area (6.7). For the sake of the intra-spatial analysis of the most find-rich part of the Eyserheide site (clusters A and B), the hearth seating model of L. Binford and the ring and sector method of D. Stapert will be discussed and applied in paragraph 6.8. The chapter will conclude with a brief discussion (6.9).

6.2 Horizontal distribution

6.2.1 Introduction

The fertile loess area of Dutch Limburg, where the site of Eyserheide is located, has been an agrarian area for a very long time. Many of the higher and rather flat plateaus and their margins have been in use as cultivated fields since the Middle Ages, in particular for cultivating wheat and maize. The plot of land, where the site is located, has at any rate been used since the middle of the 1980s alternately as cultivated field (maize cultivation) and grass land. Present-day land use has had important consequence for the intactness of the site. Due to repeated ploughing of the top soil, the archaeological layer, which was originally embedded in an intact layer of loess, has been disturbed, and artefacts have ended up on the surface and in the plough zone. Of the total of flint artefacts, 484 specimens (14%) were found at the surface of the field prior to and for a small part after the excavation of 1990-1991 (table 6.1). During the trowelling of the plough zone 792 flint artefacts (23%) were recovered. The majority of the artefacts was collected, also by trowelling, underneath the plough zone: 2140 specimens (63%). This division demonstrates that already at the start of the excavation, more than 1/3 of the documented artefacts were in the top soil (plough zone) disturbed by ploughing.

If we look at the composition of finds per artefact type, it is noticeable that the majority of the complete cores, ten specimens, was collected by Mr Blezer from the surface between 1985 and 1990. Only two pieces came to light in the summer of 1990 during the trowelling of the plough zone. Also only few complete cores (n=4) were measured in beneath the plough zone. The number of fragments of cores originating from the plough zone is on the other hand quite high. In particular fragments of cores of Orsbach flint were encountered in the ploughed top soil. As the breakages (fractured planes) are not patinated, we presumably are dealing here with cores that were hit by the ploughshare and have split along frost cracks into two or more pieces.

Of the retouched tools, 51 specimens come from the surface or from the plough zone (table 6.1). A total of 44 retouched tools were been measured in three dimensions beneath the plough zone. The tools collected by Mr Blezer from the surface are representative, as far as type is concerned, of the (composition of) tools originating from the excavation.

6.2.2 Artefacts from the plough zone

Figure 6.2a-c shows the distribution of the artefacts found in the plough zone according to three size classes and per square of 1 × 1 m. The plough zone finds with maximum dimensions less than 2 cm show a distribution without there being clear clusters (fig. 6.2a). The peak of the distribution though lies in the eastern part of the excavated area, east of the 55 × grid line. This could point to smaller artefacts having been displaced downslope towards the more easterly dry valley (see fig. 2.4). We should bear in mind though that the plough zone was not sieved and that artefacts with small dimensions were missed during the trowelling of this plough zone. This makes it impossible to establish the exact meaning of the distribution as shown in figure 6.2a.

For the plough zone finds with dimensions between 2 and 5 cm, the peak of the distribution lies between gridline 54 and 59 (fig. 6.2b). A number of the western squares corresponds with squares from which many artefacts were measured in three dimensions beneath the plough zone. Compared to the artefacts smaller than 2 cm, the number of ‘find-rich’ squares with more than 5 artefacts is smaller. Nonetheless, the distribution is still diffuse. Also in the southern part are squares with relatively large numbers of artefacts. Based on the view that during the trowelling of the plough zone larger artefacts were missed less frequently, the reliability of the distribution is greater for artefacts larger than 2 cm (as represented in fig. 6.2b) than for artefacts with smaller dimensions. Neither does the distribution of plough zone finds larger than 5 cm show clearly delimited clusters (fig. 6.2c). Of many squares, the plough zone has yielded not a single artefact with a minimum dimension of 5 cm. It is

	Surface	Plough zone	Loess soil	N
Complete cores	10	2	4	16
Core fragments	31	32	37	100
Complete flakes	68	62	285	415
Flake fragments	119	152	297	568
Complete blades	11	5	51	67
Proximal fragments of blades	25	36	109	170
Medial fragments of blades	28	47	132	207
Distal fragments of blades	28	28	108	164
Blades with non-patinated break	53	47	27	127
Crested blades	2	1	3	6
Crested blade fragments	18	15	38	71
Rejuvenation flakes	10	5	19	34
Retouched tools	26	25	44	95
Flakes and blades with edge damage	5	5	26	36
Burin spalls	0	5	17	22
Chips	50	322	942	1314
Indet	0	3	1	4
Total	484	792	2140	3416

Table 6.1 Numbers of finds (all dimensions) per artefact type and find context: surface, plough zone and non-ploughed part of the loess soil. Counts before refitting of broken pieces.

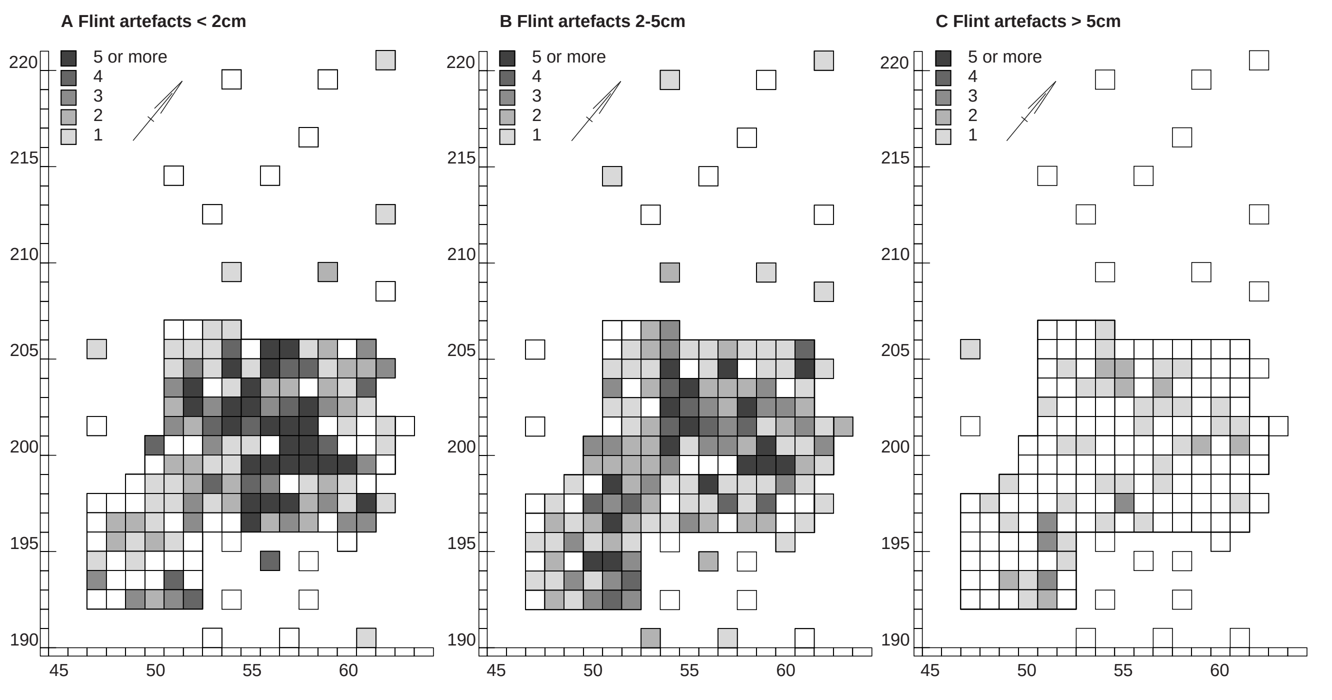


Figure 6.2 Densities of artefacts in the plough zone per square of 1 x 1 m, a= <2 cm, b= 2-5 cm, and c= >5 cm.

also noticeable that four rich squares with three artefacts lie in the southern part of the excavated area. In the northern and eastern part, per square of 1 × 1 m at most two artefacts larger than 5 cm were found in the plough zone. There are no squares with high density of finds here.

From the distribution maps of plough zone finds can be inferred that squares with 5 or more artefacts are (also) located at the periphery of the excavation. For this reason it should be assumed that artefacts are still present in the plough zone beyond this area. Another indication of this is the occurrence of plough zone finds in trial squares from April 1990, even in squares at more than 10 metres from the excavated area (fig. 6.2a-b). The fact that in the years after the excavation artefacts have still been collected from the surface also shows that the site has not been excavated completely.

6.2.3 Artefacts plotted in three dimensions

For an assessment of the dispersal of the artefacts plotted in three dimensions, each square of 1 × 1 m was further subdivided into four small units of 50 × 50 cm and maps were made that show the number of specimens per unit of 50 × 50 cm. Compared to the plough zone finds, the artefacts plotted in three dimensions show a different distribution (figs. 6.3). In some places there are clearly high densities of artefacts, of which the concentration of finds in squares 54/202, 54/203, 55/202, and 55/203 is most noticeable. In these squares with a surface area of 4 m^2, 302 flint artefacts larger than 2 cm were recovered beneath the plough zone (fig. 6.3b). Square 54/202 yielded the most artefacts larger than 2 cm: 130. Also the distribution of artefacts larger than 5 cm shows an increase in density in the number of artefacts in these four squares, though the number of units of 50 × 50 cm with five or more artefacts is smaller (fig. 6.3c) Compared with other parts of the excavation we are clearly dealing here with a cluster of artefacts. On the basis of the position of the artefacts larger than 5 cm, the cluster was further confined to an area of 1.70 × 1.70 m and a surface area of 2.9 m^2. This find-rich area will hereafter be referred to as cluster A (see fig. 3.7).

Cluster A has no clear boundaries but is surrounded by a zone with decreasing numbers of finds. In the remaining parts of squares 54/203, 55/202 and 55/203 and the contiguous squares 53/202, 53/203, 53/204 and 55/204, the numbers of artefacts larger than 2 cm are still relatively high. There is however a clear decrease in the number of artefacts larger than 5 cm. The squares around cluster A, with the exception of squares 52/201, 53/201 and 54/201, have been designated as the periphery of cluster A. This periphery is maximally four metres long and four metres wide, and has a surface area of 11.1 m^2. In one of the squares concerned, square 53/202, relatively many artefacts were measured in (n=53). As will be described later in this chapter (6.4), we are probably dealing with artefacts that originally formed part of cluster A. As a result of bioturbation (tree fall), artefacts have been moved and have secondarily ended up in a tree fall pit.

About three metres south of cluster A, the number of artefacts increased again in squares 52/199, 52/200, 53/199 and 53/200. In particular in the distribution of artefacts larger than 5 cm is this second cluster clearly visible (fig. 6.3c). The cluster measures 1.2 × 1.5 m (surface area 1.8 m^2), and has been designated as cluster B. Between cluster A and cluster B, in three adjacent squares (52/201, 53/201 and 54/201) clearly fewer artefacts larger than 5 cm were plotted in three dimensions. These squares together represent zone A/B.

In the other parts of the excavation, artefacts between 2 and 5 cm and larger than 5 cm were recovered in smaller numbers, and the find density beneath the plough zone is lower. There is mainly a thin distribution of artefacts, while at the periphery of the area, squares commonly occur without finds. About four metres east of cluster A, squares 58/201, 59/201, 60/200 and 60/201 do show a higher density, especially with regard to artefacts with maximum dimensions less than 5 cm (figs. 6.3a-b). Also, compared to adjacent squares, more artefacts larger than 5 cm were plotted in three dimensions. As will be discussed later in this chapter, we are presumably dealing here with a heavily depleted concentration, from where most artefacts as a result of erosion, bioturbation and/or present-day land use (ploughing) have been moved downslope and/or have been incorporated into the plough zone. For the sake of intra spatial analysis, an area of 4 × 4 m has been designated as cluster C.

And finally, the southern part of the excavated area should be pointed out. Here square 49/196 with 38 artefacts larger than 2 cm has yielded significantly more finds than the other squares in this part of the excavation. The finds came to light at the end of the excavation campaign in the summer of 1990. They formed the reason for continuing the excavation in April 1991. Square 49/196 and eleven contiguous squares together form an area of 3 × 4 m and have been designated as cluster D. This zone is heavily disturbed as a result of ploughing and bioturbation (see 6.4).

As has been indicated in the text above, clusters A and B, and to a lesser degree clusters C and D, are also visible in the distribution of artefacts plotted in three dimensions larger than 5 cm (fig. 6.3c). The distribution of artefacts smaller than 2 cm is much vaguer. On the basis of these artefacts, clusters A and B cannot be clearly distinguished from each other. Both clusters together represent in fact a find-rich area

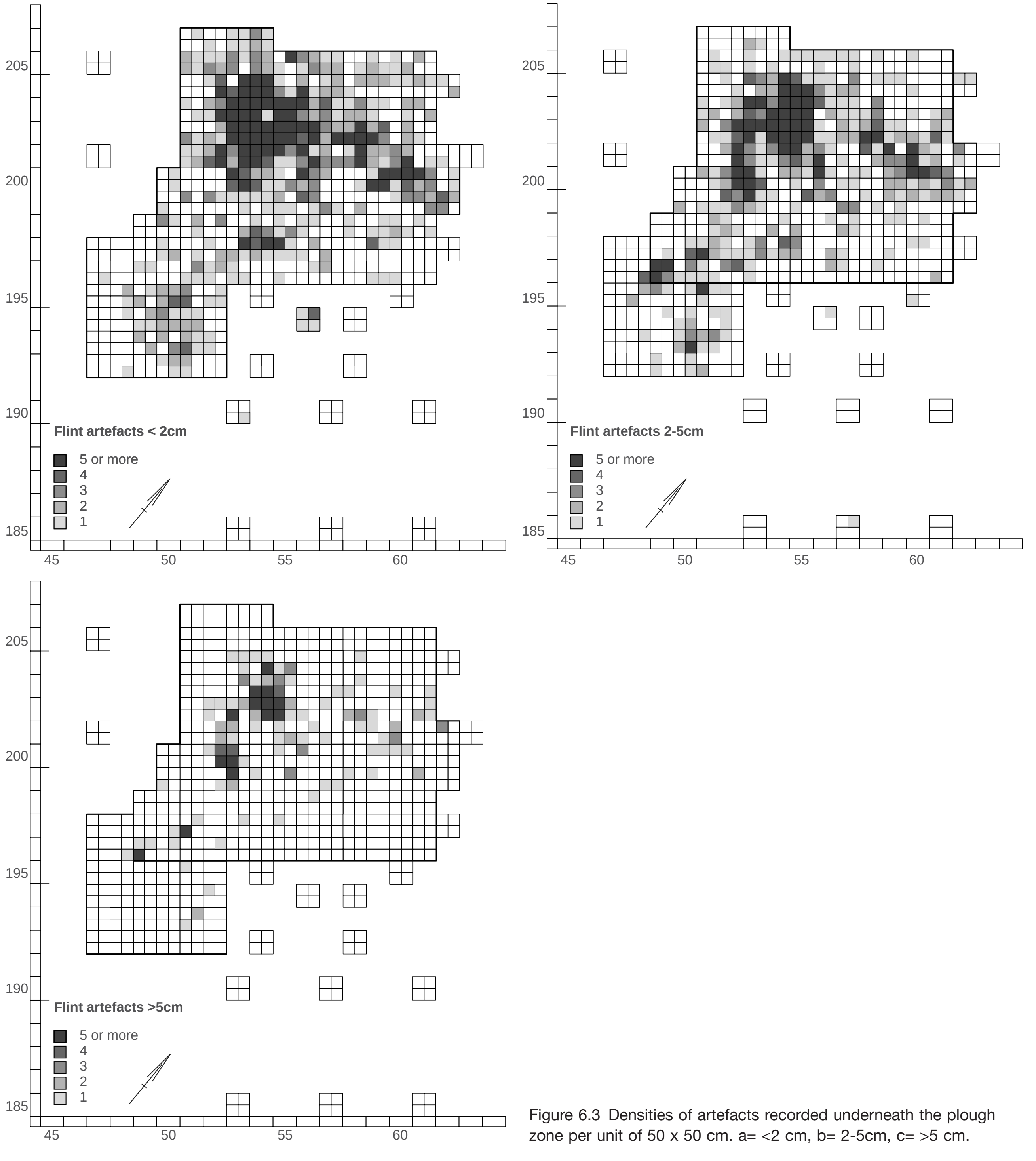


Figure 6.3 Densities of artefacts recorded underneath the plough zone per unit of 50 x 50 cm. a= <2 cm, b= 2-5cm, c= >5 cm.

covering a surface of c. 16 m² (fig. 6.3a). Later in this chapter an attempt will be made to give an explanation for this discrepancy. The central question here is whether post-depositional processes (for instance slope wash and bioturbation) could possibly be the cause of the more diffuse distribution of artefacts with small dimensions.

Finally, burnt flint artefacts are only represented by few specimens and show a very diffuse distribution. Even within the four clusters, the numbers are very low and there are no specific locations with large(r) densities of such artefacts. In the case of the site of Eyserheide, burnt artefacts do not form an indication of the presence and location of one or more hearth(s).

6.2.4 *Unworked stone from the plough zone*

From the in total 123 fragments of unworked stone, 30 pieces came from the plough zone (table 6.2). Eight pieces of these were in the plough zone of squares 54/203, 55/202 and 55/203, that is to say in the area that was designated as cluster A on the basis of artefacts *plotted in three dimensions*. Five of these bear traces of heating, among which two fragments (55/203 103 and 55/203 104) of quartzitic sandstone from the Devonian (code 16). Both fragments could be refitted onto a large fragment that came to light in square 56/200, at 3 m at most from square 55/203 (refit group 16.01). This piece (weight: 531 grams) was lying at the base of the plough zone, on the transition to the top of the non-ploughed part of the loess soil. Possibly this piece was displaced a few metres from cluster A in an easterly direction as a result of ploughing.

Two refitted fragments of quartzitic sandstone also bear traces of heating and they originate from the area of cluster A (refit group 43.01). Four other heated fragments have been found in the plough zone and at a short distance from these finds, in the periphery of cluster A. Together with fragments of (heated) stones recovered from beneath the plough zone, they indicate that there must have been a small hearth at the time of the occupation of Magdalenian hunters and gatherers (see 6.8.2).

Fragments of unworked stone also came from the plough zone of zone A/B (n=2) and, at a larger distance from cluster A, from the area of cluster D (n=5) (table 6.2). These are two fragments of a very fine siltstone (code 15), a fragment of quartzitic sandstone from the Devonian (code 16), and four fragments of quartzitic sandstone (codes 41 and 43). Also a number of these fragments bear traces of heating. The remaining eleven fragments were found outside the clusters mentioned, for instance in square 50/192 in the far south and in square 56/200 in the central part of the excavation. It is noticeable that east of the gridline with x co-ordinate 58, no fragments of unworked stone have been encountered in the plough zone, among which in the 16 squares of 1 × 1 m which together represent cluster C. Also the plough zone of the small area of cluster B has not yielded any unworked stone.

6.2.5 *Unworked stone plotted in three dimensions*

Of unworked siltstone (code 15), 38 fragments were found in cluster A in spatial connection with a high density of flint artefacts (figs. 6.6 and 6.7, table 6.2). Moreover, 20 fragments of the same siltstone were found in the periphery of cluster A (n=14) and in the zone between clusters A and B (n=6). On the basis of this close spatial association with cluster A, a relationship between the numerous fragments of siltstone and the use of the location in the Magdalenian seems to be obvious. The total number of fragments of this siltstone is 64. They vary in weight from 0.5 to 455.9 grams.

Of the quartzitic sandstone from the Devonian (code 16), yellow-brown in colour and with a rather smooth top, only a small number of fragments were found underneath the plough zone. They are all partly or completely coloured red as a result of heating. Two fragments come from cluster A and one from the zone between clusters A and B. An important observation is that these fragments could be refitted onto a large fragment from the plough zone (refit group 16.02).

In cluster A and its periphery also fragments were found of fine-grained sandstone from Meuse gravel (code 42), quartzitic sandstone (code 43) and coarse-grained quartzite (code 44). A part of these again bear traces of heating and could be refitted onto fragments from the plough zone.

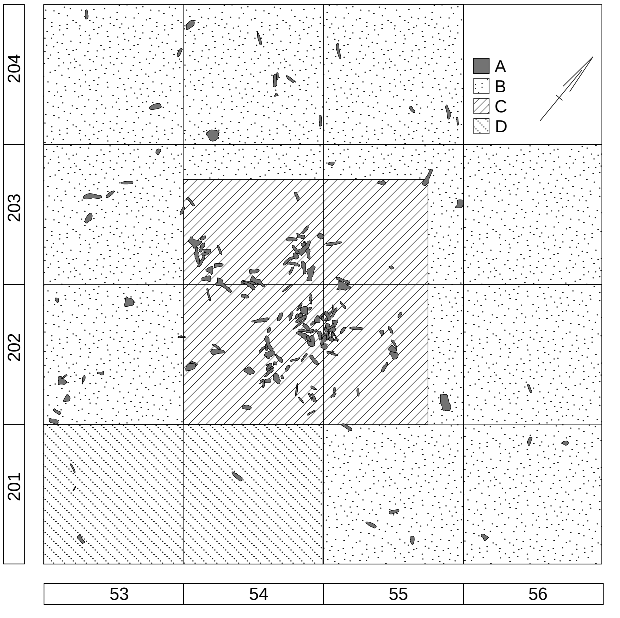


Figure 6.4 Horizontal distribution of artefacts >5 cm and fragments of non-worked stone >5 cm (A) in cluster A (C), the periphery of cluster A (B), and zone A/B (D).

			Loess soil							
	Surface	Ploughzone	Cluster A	Periphery A	Zone A/B	Cluster B	Cluster C	Cluster D	Other sections	N
Siltstone (code 15)	1	6	38	14	6	1	1	.	4	71
Quartzitic sandstone (code 16)	.	5	2	.	1	.	.	1	.	9
Quartzitic sandstone (code 41)	1	6	.	.	.	3	.	.	.	10
Fine-grained sandstone (code 42)	3	6	3	1		.	.	.	.	13
Quartzitic sandstone (code 43)	4	4	2	.	1	.	.	.	.	11
Coarse-grained quartzite (code 44)	1	3	3	2	.	.	.	.	.	9
Total	10	30	48	17	8	4	1	1	4	123

	Ploughzone							
	Cluster A	Periphery A	Zone A/B	Cluster B	Cluster C	Cluster D	Other sections	N
Siltstone (code 15)	.	.	1	.	.	1	4	6
Quartzitic sandstone (code 16)	2	.	.	.	.	1	2	5
Quartzitic sandstone (code 41)	.	.	1	.	.	2	3	6
Fine-grained sandstone (code 42)	2	2	.	.	.	.	2	6
Quartzitic sandstone (code 43)	2	1	.	.	.	1	.	4
Coarse-grained quartzite (code 44)	2	1	.	.	.	.	.	3
Total	8	4	2	0	0	5	11	30

Table 6.2 Numbers of fragments of unworked stone recovered from surface, plough zone and loess soil (a) and from the plough zone (b) in different parts of the excavation.

The presence of fragments of unworked stone bearing traces of heating indicates that in (the centre of) cluster A a fireplace was present at the time of Magdalenian occupation. It is reasonable to assume that the stones formed part of a small hearth. As a result of bioturbation and ploughing of the archaeological layer, a large part of the hearth has been disturbed, which led to fragments of heated stones ending up in the plough zone (see 6.4). Unfortunately, there is no longer an intact or largely preserved hearth.

Outside cluster A and its periphery, the number of stones plotted in three dimensions is significantly smaller (see table 6.2). Within the boundaries of clusters C and D, only two fragments of unworked stone were plotted. It should be pointed out though that the plough zone of cluster D has yielded relatively many pieces. Whether these finds indicate the possible presence of a second hearth a few metres south of cluster A could not be determined.

Figure 6.5 Flint artefacts, including two long blades of Simpelveld flint, and fragments of unworked siltstone in square 54/202 in cluster A.

6.2.6 Ochre? (Bertil van Os)

Among the fragments of very fine siltstone (code 15) are two pieces of which one side is coloured red (fig. 4.36). Both fragments have been found close together in the western part of square 55/202 in the centre of cluster A (fig. 6.6). They had a relatively deep position in the archaeological layer in L4 (193.42 m +NAP) and L6 (193.34 m +NAP). The stones can easily be mistaken for chalk. Further investigation showed however that it is very fine siltstone with the appearance of travertine. The limited density, the eluviation hollows and the lack of visible quartz make it likely that we are dealing here with a diatomite or gravel slate. This type of stone occurs in the Ardennes and, as has the Devonian quartzitic sandstone (code 16), can have been transported by the Meuse and deposited on a terrace along the Meuse. Black minerals are visible in the siltstone. These minerals are ferruginous (see below). It probably concerns goethite (FeO(OH)). This is a very common iron mineral that is formed in an oxidising environment in freshwater, river or lake sediments, and in lake soils. It is the most important mineral in brown ochre. If goethite is heated, it can be changed into hematite. This mineral has after heating a typical red colour and is often the main component of red ochre. Goethite is mainly found in stones and is formed during diagenetic processes by interaction with ferruginous ground water or formation water with the stone.

Figure 6.6 Two fragments of siltstone (code 15) bearing traces of heating in the centre of cluster A.

The composition of the black minerals (including the matrix), the 'ochre'-coloured flecks and the naked stone without these phenomena have been analysed with XRF (roentgen fluorescence). It has thus been determined what the black dots and red flecks on the fine siltstone are. The outcome of the analyses, together with an analysed chalk as reference, is summarised in table 6.3.

Figure 6.7 Fragments of siltstone in the centre of cluster A.

Sample no.	Site	Find no.	Remarks	SiO_2	CaO	P_2O_5	K_2O	Al_2O_3	TiO_2	Fe_2O_3	MnO	Bal
				%	%	%	%	%	%	%	%	%
877	Eyserheide	55/202 122	.	37	0.338	0.111	1.05	2.54	0.302	12	0.083	47
878	Eyserheide	55/202 142	'ochre'	67	0.337	0.107	1.07	4.77	0.256	4.07	0.038	22
880	Eyserheide	55/202 142	'ochre' absent	68	0.335	0.134	0.437	1.89	0.053	1.15	0.024	28
881	Eyserheide	53/203 45	'ochre' absent	72	0.303	0.157	0.453	2.1	0.091	0.986	0.055	24
882	Eyserheide	53/203 45	black mineral	59	0.334	0.121	0.766	2.63	0.186	2.24	0.771	34
883	Eyserheide	53/203 45	'ochre' absent	68	0.252	0.15	0.401	1.65	0.066	1.08	0.025	28
879	limestone	reference	.	4.19	47	0.062	0.009	0.651	0.066	0.272	0.022	48

Table 6.3 Main components of very fine siltstone (code 15) recovered from the centre of cluster A in Eyserheide.

The results of the analysis confirm the notion that we are dealing with a stone that mainly consists of SiO_2. This is the most important component of sand, siltstone, diatomite or gravel slate. The SiO_2 content is slightly underestimated, probably because the stones were not cleaned and on the surface were still present loess and organic dust, which absorb roentgen radiation. Both the red flecks and the black dots show a high iron content. This is an indication that we are indeed dealing with goethite respectively hematite. The black dots have a slightly higher manganese content than the red flecks. The reaction of goethite to hematite can be described according to the reaction mechanism:

$$2\ FeO(OH) \rightarrow Fe_2O_3 + H_2O$$

The transition (dehydration) occurs at a temperature between 300º and 350º C (Gialanella et al. 2010). The structure of the goethite crystals can however remain intact up to 900º C. The above indicates that the 'ochre' found is probably of natural origin and was formed after heating of the stones whereby the goethite was changed into hematite. This could mean that the stones were used as hearth stones. It is unlikely that 'ochre' was afterwards put on the stone.

6.3 Vertical distribution

The vertical distribution of the artefacts plotted in three dimensions, that is artefacts that were directly underneath the base of the plough zone or deeper in the loess soil, varies greatly. The vertical distribution will be discussed in more detail for the excavated squares adjacent to the west-east profile 1 and the north-south profile 3 (fig. 6.11). For the position of both profiles in the excavated area, the reader is referred to figure 3.7. Data on the number of artefacts and depth of artefacts in these squares have also been included in tables 6.4 (profile 1) and 6.5 (profile 3).

In the squares with y co-ordinate 203 and adjacent to profile 1 (squares 52/203 to 61/203), the vertical distribution of artefacts varies between 10 and 55 cm. In the western part, this spread is greatest and in particular in the squares that form part of cluster A (54/203, 55/203) or its periphery (53/203, 56/203). Although the total vertical spread is here 55 cm, there are particularly large numbers of artefacts in L2 to L5, from 5 to 25 cm beneath the base of the plough zone. At this depth, 159 of 293 artefacts (=54.3%) were found in the four mentioned squares. Further east, towards the dry valley, the number of finds clearly decreases. Moreover, there is a clear 'leap' in the vertical spread of the artefacts: from 50 cm in square 58/203 to maximally 15 cm in squares 59/203, 60/203 and 61/203 (table 6.4). The latter squares are four to five metres east of cluster A.

The squares bordering the north-south profile 3 with x co-ordinate 55 show a similar picture with regard to the area of cluster A and its periphery (table 6.5). In four adjacent squares 55/201, 55/202, 55/203 and 55/204 the vertical distribution is large, in square 55/202 this distribution even amounts to 80 cm. Also here we see larger numbers of artefacts in layers 2 to 5, that is again at a depth between 5 and 25 cm beneath the base of the plough zone. A total of 185 artefacts were found in these four squares in this part of the non-ploughed loess soil. At a deeper level (layers 6 to 15) this number is 62.

Looking finally at the vertical distribution of flint artefacts in some other squares with a high find density, it is found that this distribution outside the zones with disturbances (see 6.4) is relatively limited. In the most find-rich square 54/202 in cluster A, 172 out of 191 flint artefacts had a depth, between 0 and 29 cm below the plough zone (layers 1 to 6, table 6.6). Small and large artefacts have been found together and regularly dispersed at this depth. The layer between 25 and 29 cm (layer 6) contained the most finds

Square	52/203	53/203	54/203	55/203	56/203	57/203	58/203	59/203	60/203	61/203	N
Layer 1	1	3	6	3	.	1	.	2	1	1	18
Layer 2	3	10	17	12	2	3	1	1	.	4	53
Layer 3	5	6	24	15	2	3	.	.	1	2	58
Layer 4	3	6	19	15	3	1	2	.	.	.	49
Layer 5	3	6	12	7	3	2	4	.	.	.	37
Layer 6	.	7	.	11	.	1	2	.	.	.	21
Layer 7	1	8	3	4	4	1	2	.	.	.	23
Layer 8	1	3	.	1	1	.	2	.	.	.	8
Layer 9	.	3	.	4	1	1	1	.	.	.	10
Layer 10	2	6	2	.	.	.	1	.	.	.	11
Layer 11	.	2	.	1	2	.	.	.	.	.	5
Layer 12	.	.	.	.	.	.	.	.	.	.	0
Total	19	60	83	73	18	13	15	3	2	7	293

Table 6.4 Vertical distribution of three-dimensionally recorded artefacts (all dimensions) in squares 52/203 to 61/203 parallel to profile 1, in layers of 5 cm.

Square	55/196	55/197	55/198	55/199	55/200	55/201	55/202	55/203	55/204	55/205	N
Layer 1	.	2	1	2	1	.	5	3	5	5	24
Layer 2	.	2	4	.	1	1	11	12	4	1	36
Layer 3	.	4	1	.	2	4	37	15	4	2	69
Layer 4	.	.	.	.	1	6	34	15	3	.	59
Layer 5	.	1	.	1	.	5	24	7	3	.	41
Layer 6	.	1	.	5	4	4	3	11	5	.	33
Layer 7	.	1	.	1	.	4	.	4	4	.	14
Layer 8	.	.	.	.	.	2	.	1	.	.	3
Layer 9	.	2	.	.	.	2	.	4	.	.	8
Layer 10	.	.	.	.	.	2	1	.	2	.	5
Layer 11	.	.	.	.	.	2	2	1	.	.	5
Layer 12	.	.	.	.	.	3	2	.	.	.	5
Layer 13	.	.	.	.	.	.	1	.	.	.	1
Layer 14	.	.	.	.	.	1	.	.	.	.	1
Layer 15	.	.	.	.	.	.	1	.	.	.	1
Total	0	13	6	9	9	36	121	73	30	8	305

Table 6.5 Vertical distribution of three-dimensionally recorded artefacts (all dimensions) in squares 55/196 to 55/205 parallel to profile 3, in layers of 5 cm.

Square 54/202		Refitted artefacts in RMU's																	Artefacts	Unworked stone
Height	Layer	S1	S3	S4	S6	M1	M3	M5	M7	M8	M9	M11	M12	M19	O3	O4	O12	Other artefacts	N	N
193.63-193.59	L1	.	1	.	1	1	.	1	.	.	1	.	.	1	.	.	.	7	13	2
193.58-193.54	L2	.	.	1	1	.	.	1	.	1	1	.	.	.	.	.	1	19	25	3
193.53-193.49	L3	2	.	.	1	2	.	.	2	.	2	1	.	.	.	.	.	18	28	2
193.48-193.44	L4	3	.	2	.	.	1	2	1	.	2	.	.	.	.	.	.	25	36	7
193.43-193.39	L5	3	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	15	19	5
193.38-193.34	L6	2	1	.	3	.	.	1	1	.	1	.	1	.	2	.	.	39	51	2
193.33-193.29	L7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	5	7	1
193.28-193.24	L8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
193.23-193.19	L9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.
193.18-193.14	L10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
193.13-193.09	L11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	.
193.08-193.04	L12	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.
193.03-192.99	L13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	4	.
192.98-192.94	L14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	.
192.93-192.89	L15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
192.88-192.84	L16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
192.83-192.79	L17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.
Total		11	2	3	6	3	1	5	4	1	8	1	1	1	2	1	1	140	191	22

Table 6.6 Square 54/202 (cluster A). Vertical distribution of three-dimensionally recorded, refitted artefacts in RMUs and other (non-)refitted artefacts, in layers of 5 cm.

Square 53/200		Refitted artefacts in RMU's										Artefacts	Unworked stone
Height	Layer	S5	M3	M6	M7	M9	O10	M10	M12	M13	Other artefacts	N	N
193.60-193.56	L1	.	.	.	.	.	.	.	.	.	6	6	.
193.55-193.51	L2	.	.	.	.	.	.	.	.	.	5	5	.
193.50-193.46	L3	.	.	1	1	.	.	1	.	.	5	8	.
193.45-193.41	L4	2	.	.	.	.	.	.	.	1	10	13	.
193.40-193.36	L5	15	1	3	1	.	1	.	1	5	26	53	2
193.35-193.31	L6	6	.	.	1	1	.	.	.	.	11	19	.
193.30-193.26	L7	.	.	.	.	.	.	.	.	.	1	1	.
193.25-193.21	L8	.	.	.	.	.	.	.	.	.	2	2	.
193.20-193.16	L9	.	.	.	.	.	.	.	.	.	1	1	.
193.15-193.11	L10	.	.	.	.	.	.	.	.	.	.	.	.
Total		23	1	4	3	1	1	1	1	6	67	108	2

Table 6.7 Square 53/200 (cluster B). Vertical distribution of three-dimensionally recorded, refitted artefacts in RMUs and other (non-)refitted artefacts, in layers of 5 cm.

with 51 specimens. This layer roughly corresponds with the lowest part of the non-ploughed loess soil that is heavily homogenised as a result of Holocene bioturbation. Fragments of unworked stone in square 54/202 give a similar picture with regard to their depth: all stones were found between 0 and 35 cm below the plough zone. At greater depth, almost exclusively smaller artefacts have been found with dimensions between 1 and 4 cm. In square 54/202 artefacts were plotted up to 83 cm beneath the base of the plough zone (or up to 113 cm below the surface). Within the entire excavated area, this square and a few adjacent ones have the greatest vertical distribution of artefacts plotted in three dimensions.

There is a limited vertical distribution in square 53/200, the richest square in cluster B. In this square, 85 of the 108 flint artefacts have been found between 15 and 30 cm beneath the base of the plough zone (layers 4 to 6; table 6.7). The part of the loess soil between 0 and 15 cm below the plough zone contained significantly fewer artefacts (in total 19). In this square, post-depositional processes seemed to have had less influence on the archaeological layer. An explanation for this is that cluster B remained outside the influence of tree falls and/or they had a greater depth in the loess soil (more cover by loess). At a depth of more than 35 cm below the plough zone, only three artefacts all having maximum dimensions smaller than 3 cm have been found.

In the discussion of the post-depositional processes (6.4), we will enter deeper into the possible reason of above-mentioned, noted differences in the vertical distribution of flint artefacts.

6.4 Post-depositional processes

6.4.1 Introduction

Before we go in paragraphs 6.5-6.9 into the spatial distribution of finds measured in three dimensions and the information that can be derived from this distribution in terms of human behaviour, we will focus in this paragraph on post-depositional processes. In the case of Eyserheide, post-depositional processes comprise both natural and anthropogenic processes. Both have been defining for the position, as documented during the excavation, and composition of the finds and thus for the possibilities that the archaeological remains offer for spatial analysis. The following two factors are important: 1. the degree to which different categories of archaeological material have been preserved, and 2. the degree to which the original spatial distribution of this material is still intact.

There are many post-depositional processes that can lead to weathering of archaeological material and erosion of an archaeological layer (see for instance Schiffer 1976, 1987; Wood and Johnson 1978; Colcutt 1992). They can be divided into three groups: abiotic, biotic, and anthropogenic. Examples of abiotic processes are the effect of water, wind, frost and gravity, soil formation (forming and transport of minerals, decalcification), and natural fires. Biotic processes comprise burrowing by macro, meso, and micro fauna, the penetration of roots of trees and plants into the soil, the decaying of roots, and the toppling of trees. Anthropogenic processes are connected with occupation, use and development of the area in which a site is located by people in later phases of prehistory, in historical and/or modern times. Examples are agricultural land use, construction of infrastructure, soil improvement, levelling, and lowering of the water table. An anthropogenic process that can lead to vertical distribution of artefacts during the occupation of a camp site is trampling (Villa and Courtin 1983; Gifford-Gonzales et al. 1985). Post-depositional processes are often poly-cyclic and can reinforce each other. Thus, the ploughing of a slope can cause a high degree of erosion and hence affect an archaeological site. But processes can also nullify each other. An example of this is frost action which makes artefacts come to the surface. As a result of burrowing by animals, artefacts can later be covered again by sediment.

In most cases, sites of prehistoric hunters and gatherers have been subjected to abiotic and biotic processes, whereby original spatial patterns can have been disturbed and well-delimited, dense concentrations can have become less distinct. The degree of disturbance of sites and displacements of artefacts by anthropogenic processes depends much on the depth of the archaeological layer at the time when an area (again) becomes occupied, used or developed. Sites lying on or close to the surface, of which Eyserheide is an example, are evidently more susceptible to disturbances by present-day land use than sites that are hidden under a thick layer of sediments. The degree of disturbance by abiotic and biotic processes of sites covered with sediments depends to a large extent on the time span between on the one hand the time of cultural deposition of the archaeological material and on the other hand the time of deposition of the overlying sediments. The longer the time span is, in other words how longer archaeological traces and materials have been lying at the surface, the greater the chance that a site is affected by post-depositional processes. The position of sites beneath a layer of sediment can be the result of abiotic processes, such as aeolian sedimentation (cover sands, loess and drifting sand) and fluvial sedimentation (gravels, clay and sand), of biotic processes (peat formation), and anthropogenic processes. An example of the latter is the erecting of dikes, banks, and mounds but also sod manuring for agricultural objectives (sod soils) belong to this category.

Well-preserved open-air sites from the Magdalenian consisting of archaeological materials embedded in fine-grained sediments, are rare even on a Northwest European scale. Well-known examples are Pincevent, Verberie and Etiollles southeast of Paris, and Champréveyres and Monruz along Lake Neuchatel in Switzerland. They are located in the immediate vicinity of rivers (Paris Basin sites) and lakes (Swiss sites) where gradual deposition of respectively fluvial and lacustrine sediments under very calm sedimentary conditions has led to optimal conservation of remains of camp sites. The excavated habitation units thus offer excellent opportunities for intra-site spatial analysis and for the investigation of prehistoric human behaviour and spatial organisation of camp sites on a detailed scale (see for instance Pigeot 1987; Olive 1988a; Leesch et al. 2010). A high spatial integrity is indicated by the presence of more or less intact living floors, consisting of precisely delimited hearths, distributions and accumulations of flint knapping debris, and small activity areas where short-term tasks were carried out. An example are locations where tools have been maintained and resharpened, as can be inferred from the occurrence of small retouch debris. In the Dutch system developed for the evaluation of archaeological sites (Deeben et al. 1999), these sites would score high on the criterion of integrity. In Etiolles, organic materials have hardly been preserved and a much lower score would be applicable to the criterion of conservation, or the degree to which archaeological materials have been preserved.

In this paragraph, the effects of abiotic, biotic and anthropogenic processes on the site of Eyserheide will be briefly discussed. In the last part, attention focuses on the disturbing results on the site by modern land use (ploughing).

6.4.2 Slope processes

From the stratigraphical position of artefacts in the Bt horizon of a Holocene loess soil and c. 30 to 60 cm below the present surface (see 6.3), it can be inferred that sedimentation of loess occurred after the occupation of the site in the Magdalenian. A layer of loess has covered the occupation horizon and the associated archaeological material. From a point of view of conservation, this gradual embedding of the finds in a layer of loess was of great importance. During a period of c. 15,000 years, the layer has worked as buffer in the remaining part of the late Pleniglacial, in the Late Glacial and in the Holocene against slope erosion and other post-depositional processes. Without this layer of loess, the site would probably have fallen victim completely to slope wash.

As we discussed in chapter 2, the site of Eyserheide is located on the southern margin of a loess-covered plateau, on the higher part of a plot of land that has alternately been used as cultivated field and as grassland. On the basis of altitude measurements of the present surface, it is known that the percentages of the west-east slope vary from 2.4% to 3% and of the north-south slope from 0.7% to 1.0% (respectively profile A and profile B in fig. 6.8). The percentages of the west-east slope are such that we should take into account movement of archaeological material towards the dry valley. This valley has cut into the margin of the plateau c. 50 m northeast of the excavation spot (see also fig. 2.4). In particular between the time of occupation and the time of (renewed) deposition of loess, archaeological residues would have been vulnerable to slope erosion, for instance as a result of surface water washing away on a frozen sub-soil during the end of the Pleniglacial and/or the cold phases of the Late Glacial. In view of the open character of the late Pleniglacial landscape and the high, wind-sensitive location of the site on the margin of the plateau, the wind could have shifted (wind erosion) in particular small artefacts, including micro debitage.

In the Holocene, from the arrival of agriculture and large-scale deforestation in the Neolithic, slope erosion probably brought the archaeological layer closer to the surface. On the basis of characteristics of the (truncated) Holocene loess soil, we should take into account erosion of the A horizon, the E horizon and possibly also the top of the Bt horizon. The artefacts that were (possibly) present in this part of the Holocene soil would have been either washed downslope or incorporated into the plough zone.

To obtain an insight into the effects of geological processes and wind erosion on the site, the sediment was sieved of eleven squares (53/201 to 53/204, 54/202 to 54/204, and 55/201 to 55/204) of 1 × 1 m (fig. 3.4). The squares correspond to the central and most find-rich part of the excavation, i.e. to the area of cluster A and its periphery. Only sediment collected from underneath the plough zone was sieved. The sieve residue of these squares contained 133 flint chips smaller than 10 mm and 60 chips with maximum dimensions between 10 and 19 mm (table 6.9). Also collected in the sieve residue were 10 artefacts larger than 2 cm. During the trowelling of the same squares, 169 artefacts smaller than 10 mm and 159 artefacts between 10 and 19 mm came to light underneath the plough zone, so in total 328 pieces (table 6.9). For artefacts smaller than 10 mm this gives a ratio between artefacts plotted in three dimensions (n=169) and artefacts collected from the sieve residue (n=133) of 1: 0.79, and for artefacts between 10 and 19 mm a ratio of 1: 0.38 (159 plotted artefacts versus 60 artefacts from the sieve residue). Using these ratios, a (rough) assessment can be made of the size distribution of flint artefacts at the start of the excavation in 1990. What is meant by this is the distribution of artefacts according to size

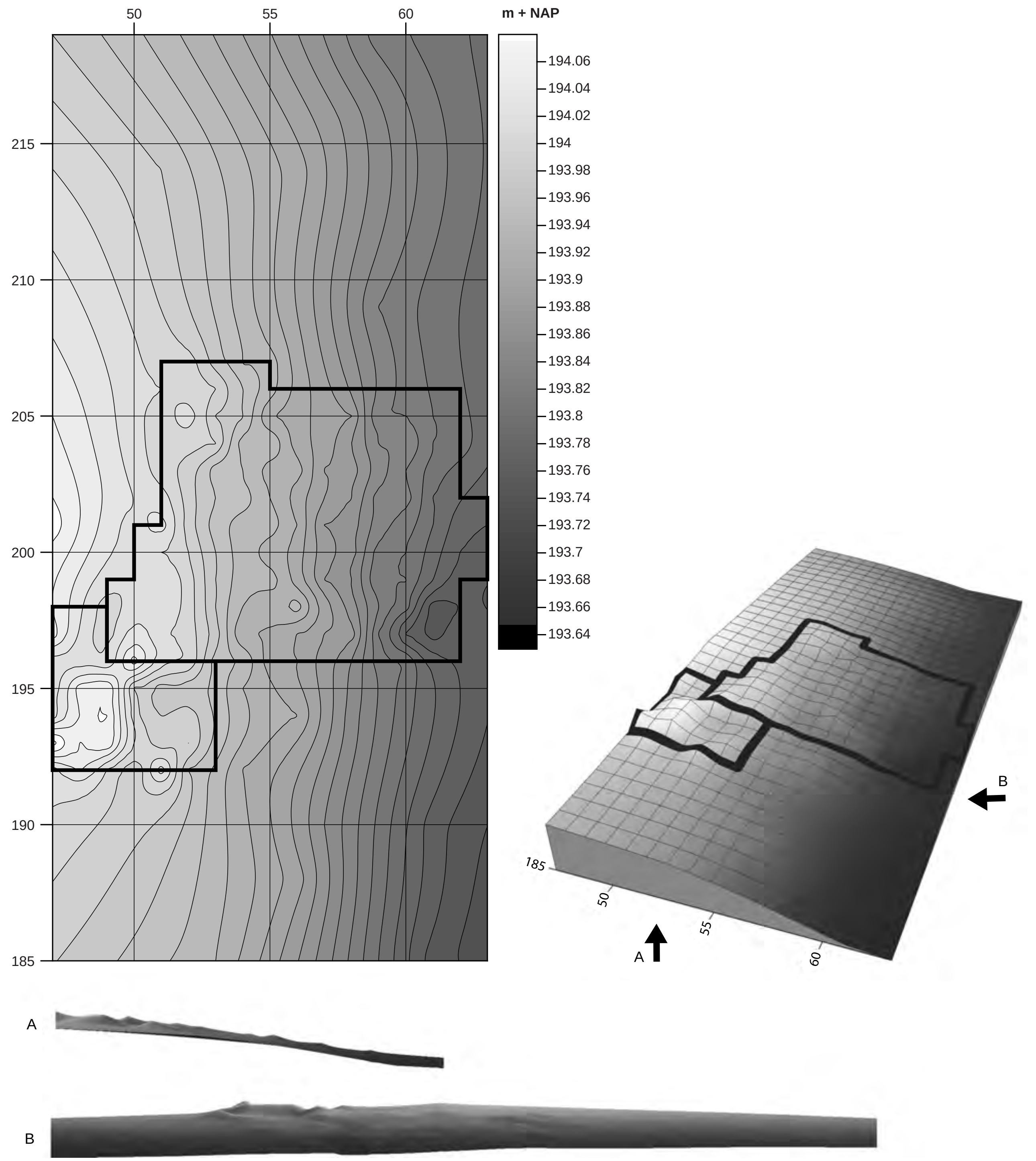


Figure 6.8 Limits of the excavated area projected onto a contour map. The contour map is based on height measurements of the surface taken with a theodolite (compared to NAP) at the corners of the excavated squares of 1 x 1 m.

Square	Simpelveld flint	Valkenburg flint	South-Limburg flint	Orsbach flint	Burnt	N	Neolithic artefacts	Unworked stone
53/201	1	.	9	9	1	20	.	.
53/202	.	.	6	8	.	14	.	.
53/203	5	.	4	10	.	19	.	.
53/204	5	.	14	7	1	27	1	.
54/202	.	.	10	11	1	22	.	.
54/203	1	.	10	9	1?	21	.	.
54/204	.	.	3	6	1	10	.	.
55/201	.	.	9	8	.	17	.	.
55/202	.	.	13	4	2	19	1	.
55/203	2	.	9	3	.	14	.	.
55/204	2	.	6	9	1	18	1	2
Total	16	0	93	84	8	201	3	2

Table 6.8 Sieving results. Numbers of artefacts per flint type per sieved square of 1 x 1 m, and numbers of burnt artefacts, Neolithic artefacts and fragments of unworked stone.

	Artefacts collected from sieve				Artefacts recorded three-dimensionally			
Square	<10mm	10-19mm	>20mm	N	<10mm	10-19mm	>20mm	N
53/201	14	6	.	20	9	11	8	28
53/202	12	2	.	14	26	19	53	98
53/203	12	7	.	19	13	22	25	60
53/204	19	6	2	27	9	8	9	26
54/202	15	6	1	22	24	37	130	191
54/203	11	8	2	21	10	8	66	84
54/204	6	3	1	10	17	11	23	51
55/201	10	6	1	17	2	9	25	36
55/202	13	6	.	19	33	18	70	121
55/203	14	.	.	14	25	12	36	73
55/204	7	10	3	18	1	4	26	31
Total	133	60	10	201	169	159	471	799

Table 6.9 Numbers of artefacts originating from the sieve residue (left) versus numbers of three-dimensionally recorded artefacts (right) per square of 1 x 1 and in three size classes (<10 mm, 10-19 mm and >20 mm).

which would have been recorded during the excavation, had the sediment of all excavated squares, including that of the plough zone, been sieved with a sieve with a mesh of 4 × 4 mm. An important assumption here is that the ratios between finds plotted in three dimensions and finds from the sieve residue, as determined for eleven squares of 1 × 1 m in the central part of the excavation, are representative for the other parts of the excavated area, including the upper part of the loess soil disturbed by ploughing.

In table 6.10 we have divided all 3416 artefacts from the Magdalenian into size classes of 1 cm and by find context (surface, plough zone and non-ploughed part of the loess soil). The table shows that the category of 10 to 19 mm occurs most often (n=962) and takes up 28.2% of the total. Artefacts smaller than 10 mm are less numerous with 529 specimens (15.5%). If we add both categories together, then artefacts smaller than 20 mm take up 43.7% of the flint artefacts. Next, in table 6.11 is given the expected size distribution of artefacts based on extrapolation of the results of the sieve investigation and the above ratios. In this expected distribution, chips smaller than 20 mm take up 54% of the (newly determined) total of artefacts (n=4214). The conclusion is that through sieving of the sediment of all squares indeed more small artefacts would have been collected (which is in line with the expectation), but there is not a great increase in artefacts smaller than 20 mm: from 43.7% (documented) to 54% (expected). On the one hand, this may be seen as indication of a careful way of excavating and of the idea that during trowelling of the sediment relatively few small artefacts have been missed. On the other hand, the expected size distribution indicates that the (original) composition of the artefacts by size has changed as a result of post-depositional processes. Karlin and Newcomer (1982) describe a small lithic scatter in Pincevent consisting of 537 artefacts, of which 60 flakes, 20 blades, and 15 bladelets. The largest number of artefacts (more than 400) is formed by chips smaller than 1 cm^2. Such chips are released when retouching tools and preparing the striking platform of cores. Assuming a closed find complex (in other words, we are dealing with the products of one core), the proportion of small chips (minimally 74%) is significantly higher than has been determined for the site of Eyserheide.

The distribution of artefacts according to size in nearby Magdalenian sites in the loess area between Meuse and Rhine (see chapter 7) also gives an indication of the degree of (in) completeness of the flint assemblage of Eyserheide. In the Belgian site of Orp-le-Grand, the sediment of find-rich squares was sieved with a sieve with a 4 mm mesh

Maximum dimension (in mm)	Surface	Plough zone	Loess soil	N	%
1-9	4	84	441	529	15.5
10-19	62	291	609	962	28.2
20-29	107	188	389	684	20
30-39	87	102	256	445	13
40-49	91	65	183	339	9.9
50-59	59	37	104	200	5.9
60-69	30	14	65	109	3.2
70-79	21	5	37	63	1.8
80-89	7	3	24	34	1
90-99	6	.	15	21	0.6
100-109	4	2	6	12	0.4
110-119	1	.	7	8	0.2
120-129	3	.	2	5	0.1
130-139	1	.	2	3	0.1
140-149	.	1	.	1	0.1
150-159	1	.	.	1	0.1
Total	484	792	2140	3416	100.1

Table 6.10 Numbers of artefacts per size class and find context (surface, plough zone, recorded three-dimensionally in loess soil).

	Eyserheide				**Mesch**			
	Documented artefacs		Expected artefacts		Documented artefacts		Expected artefacts	
Maximum dimension (in mm)	N	%	N	%	N	%	N	%
1-9	529	15.5	947	22.5	565	9.2	13634	77.3
10-19	962	28.2	1328	31.5	2057	33.6		
20-29	684	20	698	16.6	1394	22.8	1892	10.7
30-39	445	13	445	10.6	764	12.5	764	4.3
40-49	339	9.9	339	8	443	7.2	443	2.5
50-59	200	5.9	200	4.7	324	5.3	324	1.8
60-69	109	3.2	109	2.6	226	3.7	226	1.3
70-79	63	1.8	63	1.5	147	2.4	147	0.8
80-89	34	1	34	0.8	66	1.1	66	0.4
90-99	21	0.6	21	0.5	37	0.6	37	0.2
> 100	30	1	30	0.7	97	1.6	97	0.6
Total	3416	100.1	4214	100	6120	100	17630	99.9

Table 6.11 Documented and expected distribution of Magdalenian artefacts per size class. Expected numbers were obtained by extrapolation of data from sieved squares. Data on Mesch are from Rensink 1991, table 1.

(Vermeersch et al. 1987, 11). In one of the two sectors, sector East, the number of flakes and fragments of flakes smaller than 2 cm (*esquilles*) amounts to over 71.000 (!). In sector West, the sediment of fewer squares was sieved but still 7300 chips were retrieved. The percentages for both sectors are 85% and 73% respectively. On the basis of extrapolation of data from sieved squares in the Dutch site of Mesch, the expected amount of flint chips smaller than 2 cm is 13.634 or 77% (Rensink 1991, see also table 6.11). Also these percentages are significantly higher than that (54%) assumed for the site of Eyserheide, if all the sediment had been sieved.

Finally, during the excavation in 1990, five samples were taken underneath the plough zone in order to determine the presence of micro debitage, among which a sample of 1800 cm^2 originating from square 55/201 immediately south of cluster A. This sample was sieved over a 1 mm mesh and contained four small chips of flint (maximum dimensions 2 mm, 3 mm, 4 mm, and 6 mm). Two samples from square 53/202, where there is a tree fall pit (see 6.4.5.), contained two small artefacts, viz. a chip of 5 mm at c. 10 cm beneath the plough zone and a small chip of 2 mm at a deeper level and associated with the filling of the tree fall pit. Two nearby squares, 54/203 and 55/203, each also yielded only one small chip of flint of respectively 3 and 2 mm.

From the above data we conclude that a (important) part of the small fraction of flint chips was no longer present at the start of the excavation in Eyserheide. Slope wash and/or wind erosion have presumably displaced (very) small artefacts to beyond the boundaries of the excavated area, already shortly after Magdalenian hunters and gatherers left the camp site. Besides, we should take into account displacements of small artefacts that were found underneath the plough zone as a result of post-depositional processes, as can be inferred from the diffuse distribution of artefacts smaller than 2 cm in the area of clusters A and B (fig. 6.3a). The distribution of larger artefacts is less diffuse, in particular artefacts larger than 5 cm were found much more concentrated (fig. 6.3c). An explanation for this difference is that small-sized chips are lighter and thus more ‘sensitive’ to displacement due to slope wash and/or wind erosion, but also for instance due to bioturbation (see 6.4.5.). Hence, they are moved earlier and further.

The size distribution of artefacts larger than 2 cm approaches that of Pincevent section 36, for which a good state of preservation is assumed. When we compare this distribution with that of Eyserheide, it is noticeable that both graphs correspond quite well for artefacts larger than 6 cm (Smit 1992, figure 1). In Eyserheide, artefacts between 2 and 3 cm are proportionally better represented than in Pincevent section 36, while in the latter unit artefacts between 3 and 6 cm show higher percentages. It is not known whether these differences are related to differences in raw material use, the effects of post-depositional processes and/or should be regarded as a result of different ways of excavating.

6.4.3 *Chemical weathering*

In Dutch Limburg, the upper three metres of the loess is completely decalcified as a result of Holocene soil formation (Mücher 1973; Vleeshouwer and Damoiseaux 1990). Taking into consideration the association of most artefacts with the Bt horizon of a Holocene loess soil, the archaeological layer of the site of Eyserheide was, in any case from the beginning of Holocene soil formation, within a metre beneath present surface. As a result of this position and solution and eluviation of chalk, organic materials of prehistoric age have decayed completely. This situation applies to almost all Palaeolithic and Mesolithic sites in the Pleistocene sand and loess area of the Netherlands, with a position of the archaeological material in decalcified sediments and above groundwater level. Only very exceptionally are non-modified organic remains and objects of bone, teeth or antler from the Palaeolithic or Mesolithic found (for instance, Zutphen-Ooijerhoek, see Groenewoudt et al. 2001) in stream valleys with a continuing high groundwater level and/or calcareous sediments. Organic objects or remains from these periods are not known from the loess-covered hills of Dutch Limburg.

The fact that organic remains have not been preserved obviously imposes limits on an interpretation of the site of Eyserheide in terms of functional use, and nature and season(s) of occupation. Thus due to the absence of faunal remains, information on exploited hunting game by the inhabitants of the camp site is lacking. Also about the use of (specific types of) organic implements of bone, teeth, antler and/or ivory we are completely in the dark. Chemical weathering has further led to patination of the flint artefacts especially of South-Limburg flint, Simpelveld flint and Valkenburg flint. Most of these are largely or completely patinated: an investigation into use-wear traces on these artefacts is therefore not useful. An exception is formed by the artefacts of Orsbach flint. Artefacts of this type of flint are, as far as can be seen with the naked eye, usually not or less patinated. This observation was the reason for having a small selection of retouched tools of Orsbach flint investigated for use-wear traces already at the time of excavation in 1990 (A. van Gijn of the Faculty of Archaeology in Leiden). As a result of the positive results of this analysis, K. Sano carried out use-wear analysis on c. 60 artefacts of Orsbach flint in 2008-2009, as part of his PhD research at Cologne University, Germany. In chapter 5 an account is given of the methodology and results of this research.

6.4.4 *Frost and drought processes*

The influence of frost on the archaeological finds can be inferred from the occurrence of frost cracks in large artefacts in particular. As discussed in chapter 4, several cores were split along frost cracks into numerous fragments. With 100 pieces, these fragments are well represented in the flint assemblage, especially when compared to the much lower number of complete cores (table 4.1). Cores of Orsbach flint in particular were susceptible to frost action. As comparatively many fragments came from the surface or the plough zone, the ploughshare has presumably been an important cause of the splitting of cores. The fracture planes of these split fragments are non-patinated.

For the Magdalenian site of Orp-le-Grand, it has been determined on the basis of refitting that distances over which frost-split fragments have been displaced were relatively limited (Vermeersch et al. 1984). In sector East they do not exceed 8 cm in a vertical direction and rarely 20 cm in a horizontal direction. Only in three cases are there displacements of between 20 and 70 cm. In sector West, the maximum distance between refitted, frost-split fragments is 55 cm. A comparable analysis of the site of Eysherheide is impeded by the fact that frost-split artefacts came especially from the surface and the plough zone. Refitted fragments found underneath the plough zone and with patinated fracture planes occur less often. Moreover, the documented distribution of finds in Eyserheide immediately underneath the plough zone is strongly determined by biotic processes which also could have caused horizontal and vertical movements (see 6.4.5). For these reasons it is difficult to accurately determine the influence of frost action (gelivation) on the archaeological layer.

During the end of the late Pleniglacial and/or the cold stages of the Late Glacial, frost and/or drought possibly led to a network of cracks (polygons) in the loess soil. An indication of the (former) presence of such cracks are thin bands of lighter coloured sediment which were formed after the period of soil formation in the Holocene and stand out at some depth beneath the plough zone. In relatively undisturbed parts of the Bt horizon of the Holocene soil, these polygons were clearly visible, for instance in square 53/200 (fig. 6.9). They are the result of illuviation and eluviation of clay or reduction of the soil in (former) frost and/or drought cracks. It is plausible that the polygon structures in the loess soil have influenced the vertical distribution of the archaeological material. In particular smaller artefacts could have been displaced from higher parts in the loess soil, by the influence of water seeping out, in a vertical direction. The fact that artefacts plotted in three dimensions have been found in an oblique or upright position can presumably be partially attributed to the subsiding of artefacts into frost and/or drought cracks.

Frost action can also have led to the upfreezing of artefacts. From observations in arctic areas is known that in particular large stones end up higher in the soil and even on the surface

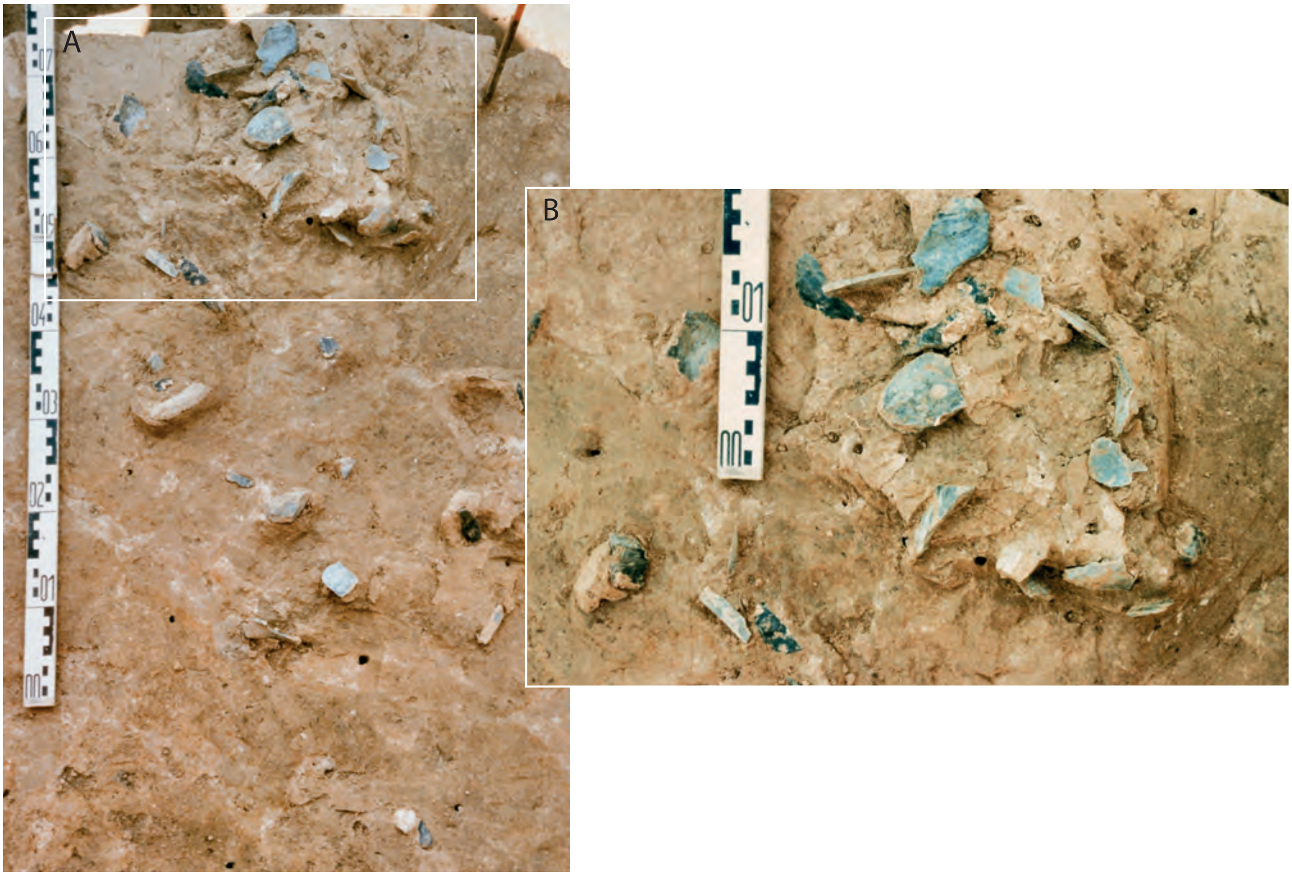


Figure 6.9 Distribution of flint artefacts and fragments of unworked stone in square 53/200 in cluster B. The thin bands with lighter coloured sediment in the Bt-horizon point to (former) frost and/or drought cracks

by the influence of frost (Schiffer 1987, 286). The fact that 12 out of 16 complete cores and 63 out of 100 core fragments, but also larger fragments of unworked and heated stone, come from the surface or the plough zone, is possibly an indication that this process of upfreezing of artefacts has occurred on the site of Eyserheide (table 6.1).

6.4.5 Biotic processes

For all part of the excavation we should take into account horizontal and vertical movements of unworked stone and flint artefacts as a result of bioturbation. Via tunnels of burrowing animals such as insects, worms and moles, small artefacts can end up deeper in the soil. Artefacts with larger dimensions can also have been moved along tunnels of rabbits and channels of tree roots. The occurrence of artefacts at more than 80 cm beneath the present surface, for instance in square 54/202 in the centre of cluster A (table 6.6), can thus be explained. Especially in places where the Bt horizon of the Holocene soil is interrupted by tree-fall pits with looser sediment (see below), the disturbing role of bioturbation on the archaeological layer has been large. Both plant roots and animals by preference seek out looser sediment whereby artefacts can have been displaced (again) in a horizontal and vertical direction.

Tree-fall pits have been demonstrated as discolorations in profiles and in the horizontal plane. Not only is the sediment lighter in colour, the amount of clay is significantly lower there. There is often a loose and crumbly structure. They form as it were discontinuities in the Bt horizon and thus in the non-ploughed part of the archaeological layer. In view of its occurrence immediately underneath the plough zone, and the dimensions and irregular boundaries of the discolorations, they have been interpreted as remains of tree falls (Kooi 1974; Crombé 1993). The fact that they are visible as discolorations in the Bt horizon of the Holocene soil demonstrates that they are younger than the period of (Holocene) soil formation. The presence of Neolithic artefacts in a number of tree-fall pits indicates that the pits originated during or after the period of the Neolithic. They have thereby acted as 'artefact traps' of artefacts from the Magdalenian and the Neolithic.

Because at Eyserheide we used a grid-system of squares of 1 × 1 metre, we should bear in mind that tree fall pits were not everywhere recognized as such underneath the plough zone. Thanks to the description and drawing of profiles and planes, a good impression has been obtained though of the depth, size and boundaries of them. We can also assume that the pits were originally larger than the sizes outlined in the Bt horizon during the excavation. Because of the ploughing of the upper part of the loess soil, the shallow parts of tree fall pits were incorporated into the plough zone and were no longer recognisable as such. Artefacts that had been embedded in these parts, form part of the collection of finds from the plough zone and surface. At a deeper level though, artefacts found in tree fall pits were originally also part of the archaeological layer but as a result of disturbance of this layer by tree falls, they may have ended up at a deeper level. This happened at the moment when the roots were pulled loose from the loess soil. Into the pit that was thus created artefacts fall back after some time as a result of weathering of the root ball. Artefacts can also, when they were originally on the edges of the pit, end up in the pit itself. By their location in a secondary position, an unknown number of artefacts has remained beyond the reach of the plough and has not been incorporated into the plough zone.

Squares comprising tree fall pits and/or heavily disturbed sediment have been marked with shading in figure 6.12. In the central part, we are dealing with 25 squares of 1 × 1 m which correspond with c. 20% of the total surface of this part of the excavation. In the southern part were 30 squares of 1 × 1 m disturbed as a result of bioturbation.

For gaining a better insight into the extent of the disturbances, planimetric drawings, in a number of cases at different depths, were made of the squares concerned. The most important locations with a loess soil disturbed by bioturbation are discussed below:

Figure 6.10 Irregular outline of natural disturbance (tree fall pit) with lighter coloured and speckled sediment in square 53/203 directly west of cluster A.

Area (south)west of cluster A:
A relatively large area showing evidence of disturbances by bioturbation was located immediately west and southwest of cluster A (fig. 6.13). In eight contiguous squares of 1 × 1 m, several disturbances were observed here which are the result of bioturbation. Partly these are mole tunnels, but also zones were recognized with loose, white and spotted sediment in which locally brown coloured, clay-rich sediment is visible. In a first instance it was not clear what the size of the disturbances was and to what extent they would continue towards cluster A and the western edge of the excavated area. Thus, in square 52/203 no disturbances were recognised immediately beneath the plough zone, but there were though drought fissures that were filled in with lighter coloured sediment (6.4.4). It emerged that the disturbance, as observed in squares 53/202, 53/203 and 53/204, continued into square 52/203 at a deeper level.

That this part of the excavation suffered badly from bioturbation is underlined by the adjacent squares 51/201 and 51/202. Also here clear discolorations are outlined, from a depth of c. 20 cm underneath the plough zone. In the western part of the nearby square 53/202 a small cluster of finds came to light in a small but disturbed area of 20 × 40 cm. The other parts of this square showed a 'normal' Holocene loess soil consisting of a red-brown Bt horizon with a few lighter coloured bands, which together formed parts of polygons. The disturbance was plotted at 27 cm below the base of the plough zone, and presumably would have been larger in size higher up in the soil profile. No planimetric drawing is available of adjacent square 52/202, probably because no disturbance had been recognized here during the trowelling of the sediment.

The area of cluster A with the above disturbance corresponds with the southwestern part of profile 1. On the north face of squares 52/203 and 53/203, a pit was identified in this profile in which whitish coloured sediment was present (fig. 6.11). The pit has been interpreted as the remains of a tree fall, of which remains have also been retrieved in the surrounding squares. Between measuring points 53/204 and 54/204, this tree fall takes up c. 75% of profile 1. The fill consists of deoxidized (bleached) sediment, in particular in the lowest part is light grey to white sediment present. Another feature

Figure 6.11 Schematic representation of field drawings of profiles 1 to 3. A= plough zone, B= tree fall pit, C= burrowing tunnels and other traces of bioturbation, D= loess soil.

is that the sediment is spotted and contains locally smeared, red-brown oxidation spots. In the fill are also visible large spots, probably parts of animal tunnels and/or root channels. Some of these are black-grey in colour, which indicates illuviation of humus into these parts of the loess soil.

From the base of the tree fall, c. 80 cm below the present surface, is visible a succession of thin layers of deoxidized and (red)brownish sediment. The small layers are no more than 2 to 3 mm thick and locally show interruptions. In this part of the soil were also small places with enrichment of clay, which in diameter have a length of no more than 5 mm. They occur dispersed at this depth. In a number of cases there are vertical bands of clay visible, the length of which is maximally 15 cm and the width maximally 3 mm. These clay bands were possibly formed along former drought fissures.

It is not clear whether west of cluster A we are dealing with remains of a large tree fall pit or two (or more) smaller pits (fig. 6.13). In view of the nearness of cluster A, we should take into account that flint artefacts and unworked stone, which originally formed part of cluster A, have been moved as a result of bioturbation in a westerly and northwesterly direction. An example of this is the small cluster of artefacts in the western part of square 53/202. They were possibly moved sideways and up with the root ball and ended up c. 1 to 1.5 m west of cluster A.

Area of cluster C:
A few metres east of cluster A is the area, somewhat downslope and towards the dry valley, that has been designated as cluster C. During the excavation of squares 58/202, 59/201, 60/200, and 60/201 it became clear that the sediment of these and a few adjacent squares was very disturbed (fig. 6.12). A large discoloration was clearly identified in profile 5 between measuring points 57/202 and 59/202 and in the horizontal plane of squares 57/202 and 58/202 (fig. 6.15). We are dealing here with a natural pit which immediately underneath the plough zone had a size of minimally 1.6 m. Its base was irregular and reached to a

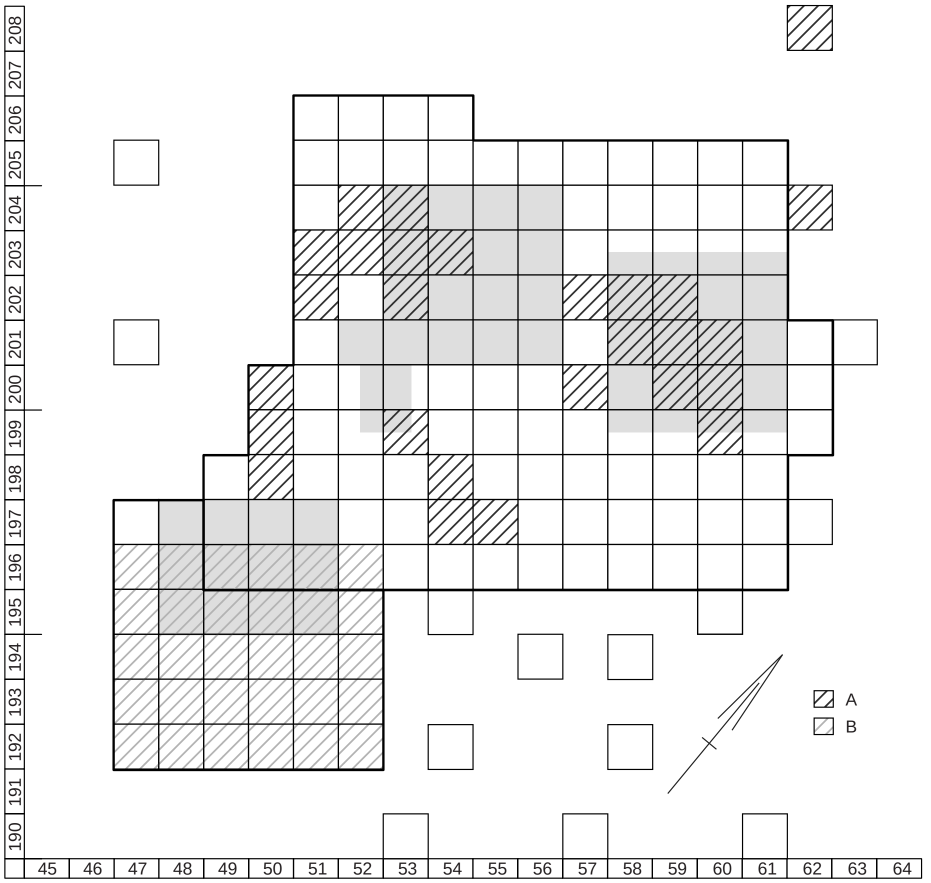


Figure 6.12 Position of squares with disturbances as a result of bioturbation (tree falls) (A) and of disturbed southern part of the excavation (B). The position of the clusters is marked in grey.

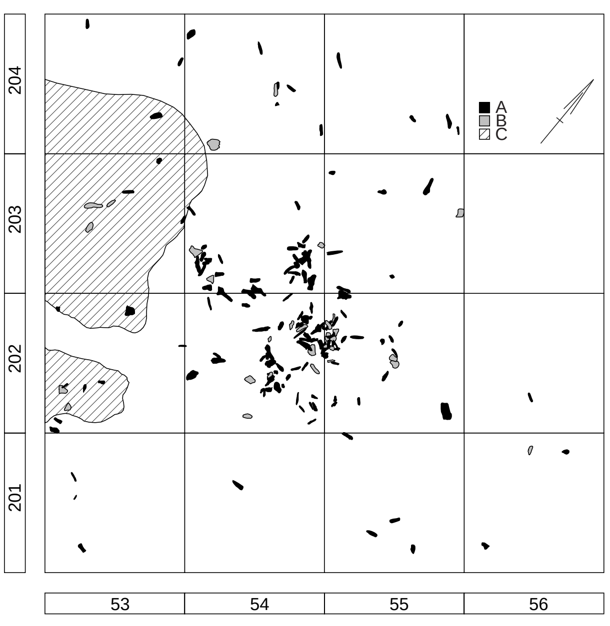


Figure 6.13 Position of finds in cluster A and its periphery: A= flint artefacts >5 cm, B= fragments of unworked stone >5 cm, and C= disturbed loess soil as a result of a tree fall.

depth of at least 55 cm under the base of the plough zone. This pit consisted of lighter coloured, clay-poor sediment in which traces of bioturbation in the form of burrowing tunnels of animals and root channels commonly occurred. In view of these features, also in this part of the excavation the presence of a tree fall is assumed. As a result of this tree fall, the original Holocene loess soil (with the occurrence of the characteristic, red-brown and clay-rich Bt horizon) was heavily disturbed.

Other disturbed areas:
Disturbances by bioturbation were visible in square 49/196 and in squares that were excavated in its vicinity (47/192, 48/193, 47/194, and 48/194). Although traces of tree falls are lacking or were not recognised as such, a strong degree of disturbance was observed in the entire southern part of the excavation.

And finally, dispersed over the excavation, in individual squares or in a small number of adjacent squares, disturbances of the loess soil have been observed. Examples are squares 54/197, 54/198, and 55/197 (fig. 6.12). On the basis of profile 2 and the planimetric drawings that were made of these squares, we are also dealing in this zone with disturbances that were created as a result of a tree fall. Also in this location lighter coloured sediment was outlined in the profile and in the horizontal plane. Another example are trial squares 62/204 and 62/208 on the northern margin of the excavation. Both squares were heavily disturbed as a result of bioturbation. There are rust-brown spots and white/grey parts with relatively loose sediment, in which worm channels are visible. The artefacts plotted in three dimensions all came from this disturbed sediment.

Figure 6.14 Cluster A: artefacts and fragments of unworked stone in oblique and upright position as a result of bioturbation (root channels and burrowing tunnels).

For the sake of intra-spatial analysis, it is important to determine to which extent artefacts have been moved in the soil as a result of bioturbation. In order to clarify the extent of vertical movement, tables have created which give an overview of the depth position (in layers of 5 cm) of artefacts found underneath the plough zone (see also Crombé 1993, table 1). From these tables it was found that there exists a clear connection between on the one hand the presence of remains of tree falls and on the other hand the depth and dimensions of artefacts. In squares with tree falls, the vertical distribution of stone artefacts is less concentrated and more random, both with regard to depth and dimensions, than in squares where indications for such tree falls are lacking. As an example of a square with a tree fall pit, square 53/203 can be mentioned. In this square artefacts with dimensions between 0 and 6 cm (n=59) were lying at different depths and more or less randomly dispersed and mixed up, with relatively large numbers of artefacts (n=22) at a depth between 60 and 85 cm beneath present surface (layers 7 to 11; table 6.12). Artefacts larger than 4 cm came especially from the deeper parts of the pit, as were three large fragments (total weight 828 grams) of siltstone (code 15). Both characteristics, the dispersed position and the occurrence of large artefacts at a depth of more than 60 cm beneath the present surface, support the notion of a tree fall and the functioning of the pit as artefact trap. The position of a complete core of Orsbach flint in adjacent square 53/204 at a depth of 25-30 cm underneath the plough zone is possibly also related to this tree fall.

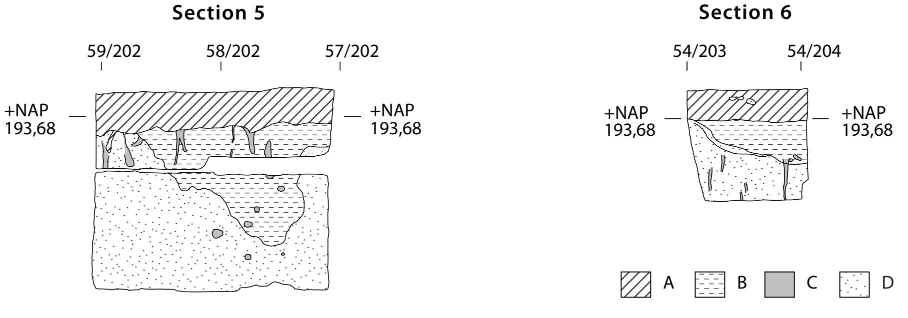


Figure 6.15 Schematic representation of field drawings of profiles 5 and 6. For legends, see figure 6.11.

Square 53/203		Maximum dimensions in mm										Artefacts	Unworked stone
	Layer	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	N	N
193.62-193.58	L1	.	2	.	1	.	.	.	.	.	.	3	.
193.57-193.53	L2	4	6	.	.	.	.	.	.	.	.	10	.
193.52-193.48	L3	3	2	.	.	1	.	.	.	.	.	6	.
193.47-193.43	L4	2	3	1	.	.	.	.	.	.	.	6	.
193.42-193.38	L5	1	3	2	.	.	.	.	.	.	.	6	.
193.37-193.33	L6	1	1	3	.	.	2	.	.	.	.	7	1
193.32-193.28	L7	1	1	1	2	3	.	.	.	.	.	8	.
193.27-193.23	L8	1	.	1	.	1	.	.	.	.	.	3	1
193.22-193.18	L9	.	.	2	.	.	.	.	.	.	1	3	1
193.17-193.13	L10	.	3	2	.	1	.	.	.	.	.	6	.
193.12-193.08	L11	.	1	.	1	.	.	.	.	.	.	2	.
Total		13	22	12	4	6	2	.	.	.	1	60	3

Table 6.12 Square 53/203 (periphery of cluster A, tree fall feature). Vertical distribution of three-dimensionally recorded artefacts per size class, in layers of 5 cm. The last column shows the vertical distribution of fragments of unworked stone.

In contrast to square 53/203, square 54/202 in cluster A has not yielded any indications of a tree fall pit. The vertical distribution of the artefacts plotted in three dimensions is clearly more regular. Of 191 artefacts that were collected from underneath the plough zone, 179 pieces (= 94%) were found between 30 and 65 cm below the present surface (layers 1 to 7; table 6.13). Also fragments of stone come from this depth. Of the flint artefacts, 12 pieces were found deeper in the loess soil, i.e. deeper than 70 cm below ground level. With the exception of a distal fragment of a blade (length 6.1 cm), these artefacts are all smaller than 4 cm.

The distances over which artefacts have been displaced in a horizontal direction are usually not considered to be large (i.e. 5 metres or more). This is shown amongst others by the small size of clusters A and B. Moreover, numerous artefacts could be refitted that were found at a distance of less than 2 m from each other. A good example are the artefacts that form part of RMU S5 (refit groups S5.01 to S5.04) of Simpelveld flint in cluster B. In the discussion of the spatial distribution of RMUs we shall go more deeply into distances between refitted artefacts and their meaning (see 6.6).

6.4.6 Anthropogenic processes

From the composition of the artefacts according to find context can be inferred that in particular large artefacts (cores) and large stone fragments were ploughed up from the archaeological layer and have ended up in the plough zone or at the surface (see table 6.1).

During the excavation, all flint artefacts found beneath the plough zone were measured in three-dimensions. This method of recording has the advantage that the relationship between the distribution of artefacts and post-depositional processes in the part of the archaeological layer not disturbed by ploughing can be studied thoroughly. Moreover, application of the method makes it possible, on the basis of simulations, to gain insight into the consequences of deeper ploughing on the distribution of the artefacts plotted in three dimensions. What would have happened to this distribution had the plot of land in Eyserheide been ploughed not to 25 to 30 cm, but deeper? Which spatial patterns would have remained visible and which would have disappeared?

The effects of deeper ploughing the plot in Eyserheide on the archaeological layer is made clear when we show the distribution of flint artefacts at different depths (10 cm, 20 cm, and 30 cm) beneath the plough zone. This procedure has been applied to the central part of the excavated area by ‘leaving out’ in the first case the upper 10 cm of the vertical distribution, in the second case the upper 20 cm, and in the third case the upper 30 cm. Thus maps were obtained of three

Square 54/202		Maximum dimensions in mm													Artefacts	Unworked stone
Height	Layer	0-9	10	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129	N	N
193.63-193.59	L1	1	.	1	3	1	1	2	1	1	1	1	.	.	13	2
193.58-193.54	L2	2	5	6	4	4	3	.	.	.	.	1	.	.	25	3
193.53-193.49	L3	7	6	2	2	6	.	3	1	1	.	.	.	.	28	2
193.48-193.44	L4	1	5	7	3	6	5	2	2	1	3	.	.	1	36	7
193.43-193.39	L5	3	2	3	5	1	3	1	1		.	.	.	.	19	5
193.38-193.34	L6	8	12	8	4	5	5	3	2	1	1	1	1	.	51	2
193.33-193.29	L7	1	3	2	1	.	.	.	.	.	.	.	.	.	7	1
193.28-193.24	L8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
193.23-193.19	L9	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.
193.18-193.14	L10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
193.13-193.09	L11	.	1	.	1	.	.	.	.	.	.	.	.	.	2	.
193.08-193.04	L12	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.
193.03-192.99	L13	.	1	1	2	.	.	.	.	.	.	.	.	.	4	.
192.98-192.94	L14	.	1	1	.	.	.	1	.	.	.	.	.	.	3	.
192.93-192.89	L15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
192.88-192.84	L16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
192.83-192.79	L17	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.
Total		24	37	32	25	23	17	12	7	4	5	3	1	1	191	22

Table 6.13 Square 54/202 (cluster A). Vertical distribution of three-dimensionally recorded artefacts per size class, in layers of 5 cm. The last column shows the vertical distribution of fragments of unworked stone.

hypothetical distributions of finds prior to the excavation, in case the field had been ploughed respectively 10 cm, 20 cm and 30 cm deeper (fig. 6.16).

In order to get a good picture of the consequences of ploughing deeper, first the ‘real’ numbers of artefacts plotted in three dimensions per unit of 25 × 25 cm are indicated (fig. 6.16a). This distribution clearly shows the position of the two important clusters A and B. The number of artefacts in the selected area is 1028 (100%). They were underneath the plough zone with an average thickness of 25 cm in this part of the excavation.

In the hypothetical case of ploughing 10 cm deeper, almost a quarter (22%) of the total number of artefacts are lifted out of their positions and incorporated into the plough zone. The remaining part (78%) remains beyond the reach of the plough and for the time being untouched. The distribution shows that clusters A and B essentially do not change with regard to their size (fig. 6.16b). There is a decrease though in the number of artefacts, in particular in the central part of cluster A.

In figure 6.16c the find distribution is presented which would have been obtained had the plot at Eyserheide been ploughed 20 cm deeper. In that case more than half (56%) of the artefacts falls victim to the plough. The distribution reveals that cluster A has been heavily thinned out, only in the eastern part is still a small find-richer area. Despite a decrease in the number of finds, cluster B remains clearly visible though. This means that cluster A at 20 cm deeper ploughing is more susceptible to the disturbing actions of the plough than cluster B.

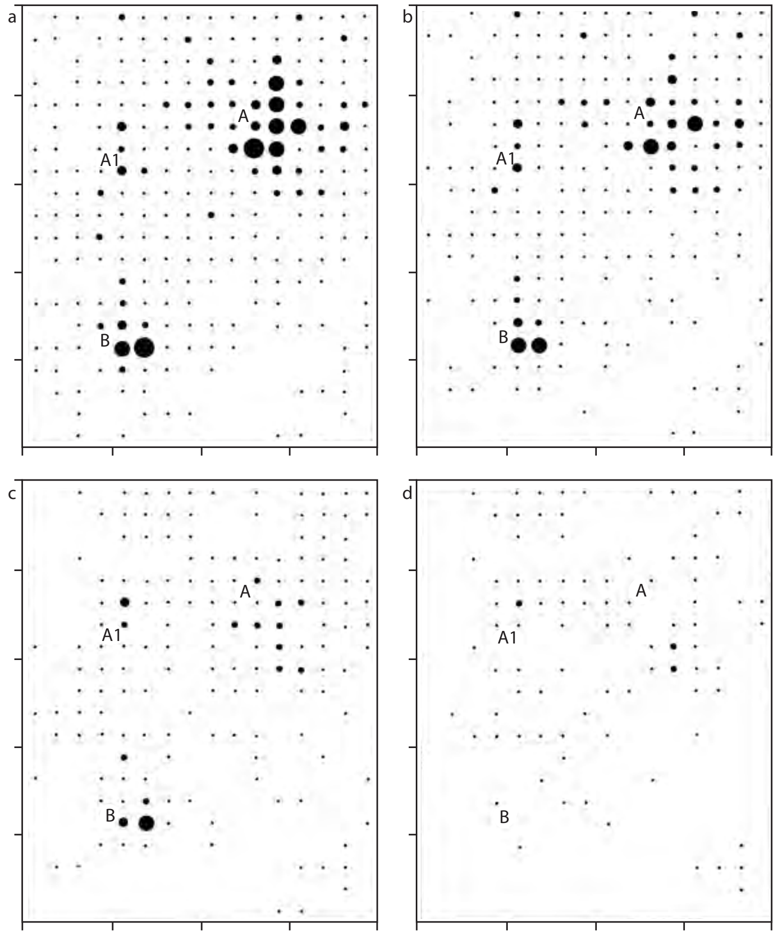


Figure 6.16a-d Number of artefacts plotted in three dimensions per unit of 25 x 25 cm in the central part of the excavation. a= actual numbers of plotted artefacts, b-d= numbers of plotted artefacts if the plot of land would have been ploughed 10 cm, 20 cm and 30 cm deeper respectively.

In the case of ploughing 30 cm deeper, the distribution of artefacts has become very faint: almost nothing is still visible of the patterns documented during the excavation. Clusters A and B are no longer recognisable as such and the area of cluster B is even completely devoid of finds (fig. 6.16d). In this situation, there are only 148 (14%) left of the total number of artefacts found underneath the plough zone. The other 880 artefacts (86%) have all been incorporated into the plough zone.

From the above discussion can be inferred that deeper ploughing of the plot at Eyserheide would have had far-reaching consequences from an archaeological point of view. In the first place, the percentage of artefacts plotted in three dimensions decreases strongly, from 78% after ploughing 10 cm deeper to only 14% after ploughing 30 deeper. This decrease implies automatically that the number of plough zone finds – and hence the visibility of the site at the surface – increases. With continuous land use these finds would have ended up dispersed over the field and would not or hardly have been of value to spatial analysis. Furthermore, as the field is ploughed deeper, the spatial patterns underneath the plough zone are increasingly thinned out. In the case of a depth of 10 cm the damage is still not too bad and the patterns stay largely intact. At ploughing 30 cm deeper on the other hand, there is only a heavily thinned-out and diffuse find distribution, and clusters A and B can no longer be distinguished. The decision to deep plough the plot only once would have been a catastrophe from an archaeological point of view. It is clear that in that case no data could be derived from the distribution regarding which activities were carried out where in the camp site.

6.4.7 Discussion

In this paragraph we have paid attention to a series of post-depositional processes that, from the moment when hunters and gatherers of the Magdalenian left the camp site, have had an influence on the composition and spatial distribution of the find material. From the discussion can be concluded that the original archaeological layer and distribution of unworked stone and flint artefacts were affected to a considerable degree. The occurrence of finds in natural pits (tree falls) and the fact that almost one third of the documented artefacts was collected from the surface or from the plough zone are importance evidence. The effects of the falling over of trees are clearly recognisable in both characteristics of the loess soil (remains of tree falls) and the vertical distribution of the artefacts. It is clear that both natural and anthropogenic processes have moved artefacts from an *in situ* context to a location in a secondary position. Moreover, small chips (smaller than 2 cm) are less numerous than can be expected in the case of a complete assemblage consisting of debris of the flint working. And finally, no features (soil marks) have been recognised or were present that are related to the Magdalenian phase of occupation.

6.5 Characteristics of clusters

6.5.1 Introduction

In the preceding paragraph, several post-depositional processes were discussed, which have led to disturbances of the archaeological layer of the Magdalenian site of Eyserheide. Already considerable time before artefacts and unworked stone ended up in the ploughed top soil did geological, chemical and biotic processes influence the original composition and position of the archaeological material. Compared to other open-air sites from the Magdalenian (for instance Pincevent, Etiolles, Gönnersdorf, Neuchâtel-Monruz, Hauterive-Champréveyres), the spatial integrity of the Eyserheide site should be regarded as low. Compared with these sites, the distribution of the archaeological material is less suitable for intra-site spatial analysis. But it has also become clear that not all parts of the excavation were affected in the same way or equally intensive. There are for instance contiguous squares in which indications are lacking of tree fall pits or other disturbances of the archaeological layer. For these parts, there is a good chance that specific activities, for instance the working of specific flint nodules or the cleaning of hides, can still be recognised in the distribution of the archaeological finds. Also the research of other excavated Magdalenian sites in the Dutch-Belgian loess area subscribe to the notion that spatial information can be obtained from sites disturbed by ploughing (see chapter 7).

In this paragraph, the intrinsic characteristics of the four distinguished clusters A to D in the site of Eyserheide are the focus. As discussed in paragraph 6.2.3, the clusters were determined on the basis of the larger densities of flint artefacts recorded three-dimensionally in the parts concerned of the excavation. For an overview of the location of the clusters, the reader is referred to figure 3.7.

6.5.2 Cluster A and its periphery

Cluster A consists of square 54/202 and the adjacent parts of squares 54/203, 55/202, and 55/203. The cluster has been excavated completely and, based on the position of the artefacts and stones larger than 5 cm, it is slightly oval in shape (fig. 6.13). The small cluster has a diameter of 1.7 m, and yielded from underneath the plough zone 273 flint artefacts larger than 2 cm, among which 9 retouched tools and 8 used blades and flakes (table 6.14). Complete cores are lacking, but seven fragments of cores of Orsbach flint were found in cluster A. With an average of 94.5 flint artefacts per square metre we are dealing with a high density. As we will discuss later in this chapter (6.8.4), retouched tools in the

Artefact type	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
Cores	.	.	.	.	.	.	.	.	.	.
Core fragments	.	.	.	.	.	.	7	6.5	7	2.6
Flakes	26	48.1	1	100	59	53.2	53	49.5	139	50.9
Rejuvenation flakes	.	.	.	.	3	2.7	2	1.9	5	1.8
Burin spalls	.	.	.	.	.	.	1	0.9	1	0.4
Blades	18	33.3	.	.	37	33.3	34	31.8	89	32.6
Crested blades	8	14.8	.		4	3.6	3	2.8	15	5.5
Retouched tools	.	.	.	.	6	5.4	3	2.8	9	3.3
Blades and flakes with edge-damage	2	3.7			2	1.8	4	3.7	8	2.9
Total	54	99.9	1	100	111	100	107	99.9	273	100

Table 6.14 Numbers of three-dimensionally recorded artefacts >2 cm per flint type and artefact type in cluster A.

form of burins, end scrapers and retouched blades were found in particular in the western half of the cluster. Mainly in the central part, 48 fragments of unworked stone were measured in three dimensions, of which 38 fragment of a yellow-white siltstone (code 15). The sizes of these fragments vary from less than 1 cm to 12.9 cm, and the heaviest specimen weighs 456 grams. Compared with other parts of the excavated area, also the plough zone of these squares yielded more finds. We should therefore allow for a concentration disturbed and thinned-out by ploughing. Presumably, an important quantity of the surface finds originally formed part of cluster A.

The large quantity of (fragments of) flakes and blades points to the working of cores in this part of the excavated area. South-Limburg flint and Orsbach flint with respectively 111 and 107 artefacts larger than 2 cm are the most important RMUs in cluster A. But also a considerable number of artefacts of Simpelveld flint were found, namely 54 specimens. From the position of artefacts assigned to RMUs can be inferred that at least three cores of Simpelveld flint, six cores of South-Limburg flint and four cores of Orsbach flint were worked in cluster A (see 6.6.6). This number of *minimally* 13 worked cores is striking in view of the small size of the cluster and the relatively small number of 273 artefacts found underneath the plough zone.

In the group of South-Limburg flint and Orsbach flint flakes are dominant, and blades and fragments of blades are represented by smaller numbers. Of Simpelveld flint comparatively many blades (n=18) and crested blades (n=8) were found. They point to repeated carrying out of actions related to core preparation and blade production in cluster A. Despite the emphasis on waste products of the flint working, (complete) cores are lacking: only core fragments of Orsbach flint split along frost cracks occur among the finds of cluster A. This could indicate that the majority of the cores were not discarded in cluster A itself but in its periphery or in other locations. Another possibility is that cores were ploughed up from the archaeological layer at cluster A. In that case, they form part of plough zone and/or surface finds.

The periphery of cluster A has a surface area of 11.1 m^2 and surrounds this cluster in the west, north and east. Compared to cluster A, fewer flint artefacts larger than 2 cm were found in this zone, namely 210 (table 6.15). The average find density is 18.9 artefacts per m^2. As can be expected, this zone has not only in a spatial perspective but also with regard to raw material composition a direct relation with cluster A. Artefacts of Orsbach flint occur frequently (n=107) in the periphery of cluster A. More than 50% of the artefacts originating from this area were manufactured of this flint. There is a difference in this respect with cluster A, where the

Artefact type	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
Cores	.	.	.	.	.	.	1	0.9	1	0.5
Core fragments	1	3.1	.	.	.	.	7	6.5	8	3.8
Flakes	15	46.9	.	.	44	62	53	49.5	112	53.3
Rejuvenation flakes	.	.	.	.	2	2.8	.	.	2	1
Burin spalls	.	.	.	.	.	.	2	1.9	2	1
Blades	14	43.8	.	.	19	26.8	32	29.9	65	31
Crested blades	1	3.1	.	.	2	2.8	4	3.7	7	3.3
Retouched tools	.	.	.	.	2	2.8	5	4.7	7	3.3
Flakes and blades with edge-damage	1	3.1	.	.	2	2.8	3	2.8	6	2.9
Total	32	100	0	0	71	100	107	99.9	210	100.1

Table 6.15 Numbers of three-dimensionally recorded artefacts >2 cm per flint type and artefact type in the periphery of cluster A.

majority of the artefacts has been described as South-Limburg flint (mainly Meuse terrace flint). The proportion of artefacts of Simpelveld flint is, compared with cluster A, more or less equal. The number of retouched and 'used' tools (n= 13) in the periphery of cluster A is lower than in cluster A itself. In the periphery of cluster A, seven core fragments of Orsbach flint and one core fragment of Simpelveld flint were recovered from underneath the plough zone. Also a complete core of Orsbach flint forms part of the finds of the periphery. As complete specimens are practically lacking, the question remains unanswered whether cores worked in cluster A were discarded in the periphery. Also here, cores were possibly ploughed up from the archaeological layer and ended up at the surface or in the plough zone.

Zone A/B has been distinguished as a separate zone bordering on cluster A. The zone consists of three contiguous squares 52/201, 53/201 and 54/201, and separates cluster A from the more southerly cluster B. The zone is clearly less find-rich than cluster A and (most parts of) its periphery. In the squares concerned, 38 flint artefacts larger than 2 cm were measured in three dimensions (table 6.16). This means an average find density of 13 artefacts per m^2. In the raw material composition, the occurrence of a blade and a tool of Valkenburg flint is noticeable. The zone consists mostly of artefacts of South-Limburg flint (n=15) and Orsbach flint (n=14). Cores and core fragments are lacking in this part of the excavation.

6.5.3 Cluster B

About three metres south of cluster A, a second cluster (B) of flint artefacts came to light. This small location covering an area of 1.5 × 0.8 m yielded 119 artefacts larger than 2 cm (table 6.17). Not only the horizontal but also the vertical distribution of these finds was very limited. By far the most specimens were at a depth of 15 to 30 cm below the base of the plough zone, covered by a thin layer of loess and clearly beyond the reach of the plough. Of the four raw material groups, Simpelveld flint occurs most often (n=45), followed by South-Limburg flint (n=37) and Orsbach flint (n=29). The proportion of Simpelveld flint is considerably higher here than in cluster A. In addition, there are eight artefacts of Valkenburg flint.

The number of retouched tools and flakes/blades with edge damage ('use retouch') larger than 2 cm is 11, i.e. 9% of the total number of artefacts in cluster B. No complete cores were found, though three fragments of cores of Orsbach flint were retrieved. The number of artefacts smaller than 2 cm is low.

6.5.4 Cluster C

Outside the area of clusters A and B, fewer artefacts were found underneath the plough zone. Also the plough zone

Artefact type	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
Cores	.	.	.	.	.	.	.	.	.	.
Core fragments	.	.	.	.	.	.	.	.	.	.
Flakes	2	28.6	.	.	8	53.3	7	50	17	44.7
Rejuvenation flakes	.	.	.	.	.	.	.	.	.	.
Burin spalls	.	.	.	.	.	.	.	.	.	.
Blades	4	57.1	1	50	6	40	6	42.9	17	44.7
Crested blades	1	14.3	.	.	.	.	.	.	1	2.6
Retouched tools	.	.	1	50	1	6.7	1	7.1	3	7.9
Flakes and blades with edge-damage	.	.	.	.	.	.	.	.	.	.
Total	7	100	2	100	15	100	14	100	38	99.9

Table 6.16 Numbers of three-dimensionally recorded artefacts >2 cm per flint type and artefact type in zone A/B.

Artefact type	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
Cores	.	.	.	.	.	.	.	.	.	.
Core fragments	.	.	.	.	.	.	3	10.3	3	2.5
Flakes	35	77.8	2	25	16	43.2	10	34.5	63	52.9
Rejuvenation flakes	1	2.2	1	12.5	.	.	.	.	2	1.7
Burin spalls	.	.	.	.	.	.	.	.	.	.
Blades	6	13.3	4	50	16	43,2	8	27.6	34	28.6
Crested blades	1	2.2	1	12.5	1	2.7	3	10.3	6	5
Retouched tools	1	2.2	.	.	1	2.7	3	10.3	5	4.2
Flakes and blades with edge-damage	1	2.2	.	.	3	8.1	2	6.9	6	5
Total	45	99.9	8	100	37	99.9	29	99.9	119	99.9

Table 6.17 Numbers of three-dimensionally recorded artefacts >2 cm per flint type and artefact type in cluster B.

itself yielded fewer finds in these parts. There are two areas nonetheless where there is a higher density of flint artefacts than in other parts of the excavation. An area with a surface area of 16 m^2 is located a few metres east of cluster A and has been designated as cluster C. Although we cannot speak of a 'real' cluster, this area is distinct from the surrounding squares by having more artefacts larger than 2 cm, namely 125 (table 6.18). In cluster C, in particular artefacts of South-Limburg flint (n=82) occurred, among which several flakes with large dimensions. An important part of these has been described as Meuse terrace flint (RMU M15) on the basis of a fluvial rolled brown cortex, the white to white-beige colour of the patina and other features (among which inclusions) of the flint. The number of artefacts of Orsbach flint (n=28) and Simpelveld flint (n=14) is clearly lower. Two tools were found in cluster C, one specimen of which was made of Valkenburg flint. No other artefacts of this type of flint were recovered from cluster C.

On the basis of refitting data and the presence of a large, non-anthropogenic pit, it is likely that cluster C was disturbed to a great extent (see 6.4.5). The surface area over which finds have been made is considerable. Although this relatively large size can be seen as an indication of cluster C (originally) having been larger than cluster A, horizontal displacement of artefacts as a result of post-depositional processes is obvious.

6.5.5 Cluster D

Cluster D is located in the southern part of the excavation and covers an area of 12 m^2. Although the average find density is only 6.6 artefacts per m^2, this cluster is important from the perspective of spatial analysis and the determination of locations of knapping of RMUs. In this zone, at a few metres from clusters A and B, five (fragments of) retouched tools larger than 2 cm were found underneath the plough zone. Square 49/196 distinguishes itself by a remarkably high find density. During the last week of the excavation campaign in 1990, this square yielded 38 Magdalenian artefacts larger than 2 cm. Because of this high number we considered the presence of a new concentration of flint artefacts, of which square 49/196 could form a part of the periphery. The excavating of squares in the southern part of the excavation in April 1991 showed however that this was not the case.

Cluster D consists mainly of artefacts of South-Limburg flint (n=31) and Orsbach flint (n=24) (table 6.19). In both groups, flakes are the most frequently occurring artefact type, but also blades occur relatively often. In the group of Simpelveld flint (n=19), blades (n= 11) are even better represented than flakes. This can point to blade production and/or transport of selected knapping products of this flint. Compared to

Artefact type	**Simpelveld flint**	**%**	**Valkenburg flint**	**%**	**South-Limburg flint**	**%**	**Orsbach flint**	**%**	**N**	**%**
Cores	.	.	.	.	.	.	1	3.6	1	0.8
Core fragmens	.	.	.	.	1	1.2	5	17.9	6	4.8
Flakes	8	57.1	.	.	56	68.3	11	39.3	75	60
Rejuvenation flakes	.	.	.	.	1	1.2	1	3.6	2	1.6
Burin spalls	.	.	.	.	1	1.2	.	.	1	0.8
Blades	5	35.7	.	.	21	25.6	8	28.6	34	27.2
Crested blades	1	7.1	.	.	2	2.4	1	3.6	4	3.2
Retouched tools	.	.	1	100	.	.	1	3.6	2	1.6
Flakes and blades with edge-damage	.	.	.	.	.	.	.	.	.	.
Total	14	99.9	1	100	82	99.9	28	100.2	125	100

Table 6.18 Numbers of three-dimensionally recorded artefacts >2 cm per flint type and artefact type in cluster C.

Artefact type	Simpelveld flint	%	Valkenburg flint	%	South-Limburg flint	%	Orsbach flint	%	N	%
Cores	.	.	.	.	1	3.2	.	.	1	1.3
Core fragments	.	.	.	.	.	.	2	8.3	2	2.5
Flakes	6	31.6	2	40	14	45.2	12	50	34	43
Rejuvenation flakes	.	.	.	.	.	.	.	.		
Burin spalls	.	.	.	.	.	.	.	.		
Blades	11	57.9	2	40	12	38.7	8	33.3	33	41.8
Crested blades	1	5.3	.	.	1	3.2	1	4.2	3	3.8
Retouched tools	.	.	1	20	3	9.7	1	4.2	5	6.3
Flakes and blades with edge-damage	1	5.3	.	.	.	.	.	.	1	1.3
Total	19	100.1	5	100	31	100	24	100	79	100

Table 6.19 Numbers of three-dimensionally recorded artefacts >2 cm per flint type and artefact type in cluster D.

cluster A, the number of worked RMUs is low in cluster D. Also for this part of the excavation, we should bear in mind the remnants of a concentration heavily disturbed by bioturbation and ploughing. Because of these disturbances, it is difficult to determine what the original size and artefact composition would have been.

6.6 DISTRIBUTION OF RMUS

6.6.1 Introduction

In this paragraph we shall enter more deeply into the distribution of artefacts belonging to one and the same RMU. From tables 6.20-6.22 can be inferred that refitted artefacts that form part of RMUs were collected in different find contexts. The distribution of artefacts according to find context (surface, plough zone and the underlying loess sediment) can differ significantly per RMU. This indicates that original distribution patterns of RMUs were disturbed to different extents as a result of the ploughing of the plot of land. The percentages of ‘ploughed artefacts’ in large compositions of refitted artefacts range from 9% (S5) to more than 50% (M15, M19). These differences are possibly related to the original depth of the artefacts and to the micro relief at the time of the Magdalenian occupation. At some places, the covering layer of loess could have been thicker than at other places. Besides, more erosion has possibly occurred locally, in particular in the eastern part where the gradient of the slope towards the dry valley is slightly steeper. And finally, it cannot be excluded that deeper ploughing has taken place in some parts of the site, with the result that there more artefacts have ended up in the plough zone than in other locations.

6.6.2 Simpelveld flint (table 6.20)

RMU S1 (fig. 6.17):

This composition around core 259A 108 comprises 41 refitted artefacts, eight specimens of which were recovered from the surface or the plough zone. The other 33 artefacts were found underneath the plough zone. RMU S1 thus offers good possibilities for spatial analysis, though also artefacts of this RMU can have been moved by abiotic (slope erosion) and biotic (bioturbation) processes in a vertical and/or horizontal direction. The position of the finds indicates working of RMU S1 in cluster A, in or near squares 54/202 and 55/202. In particular in the centre of cluster A flakes, blades and fragments of blades of this RMU occurred amidst numerous fragments of unworked natural stone. The artefacts in refit group S1.00 show that successive operations of core reduction (core and striking platform preparation, blade production, striking platform rejuvenation, etc.) were carried out at one and the same spot. Products have been found of all stages of working of RMU S1 in cluster A and in its periphery. The complex mode of core reduction, whereby use

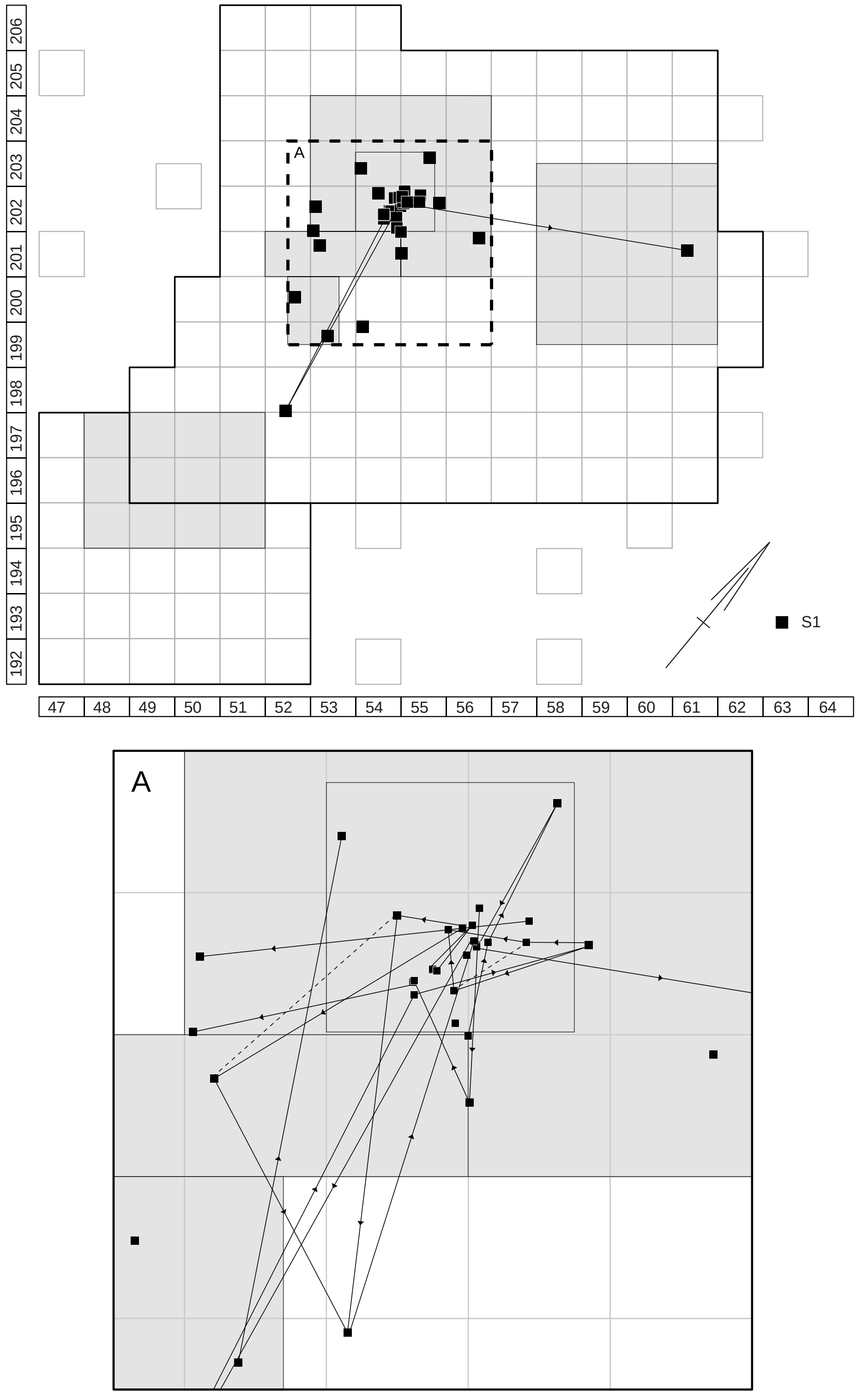


Figure 6.17 RMU S1, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line= broken pieces. Grid co-ordinates are at metre intervals.

			Three-dimensionally recorded and refitted artefacts in loess soil							
RMU	Surface	Plough zone	Cluster A	Periphery cluster A	Cluster A/B	Cluster B	Cluster C	Cluster D	Other sections	N
S1	5	3	21	6	1	2	1	.	2	41
S2	9	7	.	1	.	.	.	5	2	24
S3	4	4	4	3	.	.	2	.	2	19
S5	1	2	.	.	.	27	.	1	3	34
S308	5	5	4	1	1	.	.	.	1	17
S309	.	1	6	1	1	.	.	.	.	9
V1	1	2	.	.	1	.	.	.	.	4
Total	25	24	35	12	4	29	3	6	10	148

Table 6.20 Spatial distribution of three-dimensionally recorded, refitted artefacts >2 cm of Simpelveld flint (RMUs S1-S3, S5, and S308 and S309) and Valkenburg flint (RMU V1). The first two columns indicate the numbers of artefacts collected from the surface and plough zone.

was made of two opposite core faces and four striking platforms, and the length and regularity of the blades point to an experienced flint worker.

Only a few artefacts of RMU S1 were found outside cluster A or its periphery. It is striking that the two artefacts that were found furthest from this cluster, namely south of cluster B (KA5) and in cluster C (KC1), are two non-retouched flakes. Both artefacts form part of two series of refitted artefacts which were almost exclusively recovered from cluster A and its periphery. For this reason they are no indication of core reduction at some metres from cluster A. The slightly lower position of cluster C does not exclude that artefact KC1 was moved downslope as a result of geological processes. There are no indications of intentional transport of knapping products of RMU S1 from the area of debitage to other locations in the excavated area. Blades that are missing in refit group S1.00 could possibly be present in the plough zone outside this area.

RMU S2 (fig. 6.18):
Compared with RMU S1, many artefacts of RMU S2 were collected from the surface or in the plough zone. In total we are dealing with nine surface finds and seven plough zone finds, the original position of which can no longer be ascertained. Of the other refitted artefacts (n=8), five pieces were measured in three dimensions in cluster D, in the vicinity of square 49/196. These artefacts reflect a stage of core preparation (KA8) at the top of the core and of blade production (KB4 to KB1) from the front of the core. In any case, RMU S2 thus seems to have undergone working in the southern part of the excavated area. Also the provenance of artefacts from the plough zone point to working of RMU S2 in this part. The find-rich square 49/196 is possibly the remnant of a relatively dense cluster of flint artefacts, which as a result of bioturbation and ploughing have ended up dispersed over the southern part. The fact that 16 out of 24 refitted artefacts of RMU S2 were incorporated into the plough zone, underlines the thought that this part of the excavation has to a large extent been disturbed as a result of ploughing.

A proximal blade fragment with a length of 9.2 cm (KB3) lies completely eccentric of the other artefacts measured in three dimensions of RMU S2. The artefact was recovered north of cluster A. We could be dealing here with an artefact that was struck from core 259A 321 in cluster D and was subsequently carried to cluster A for further working and/or use.

RMU S3 (fig. 6.19):
This RMU consists of 19 refitted artefacts, of which less than half (n=8) was recovered from the surface and from the plough zone. The spatial distribution of the artefacts

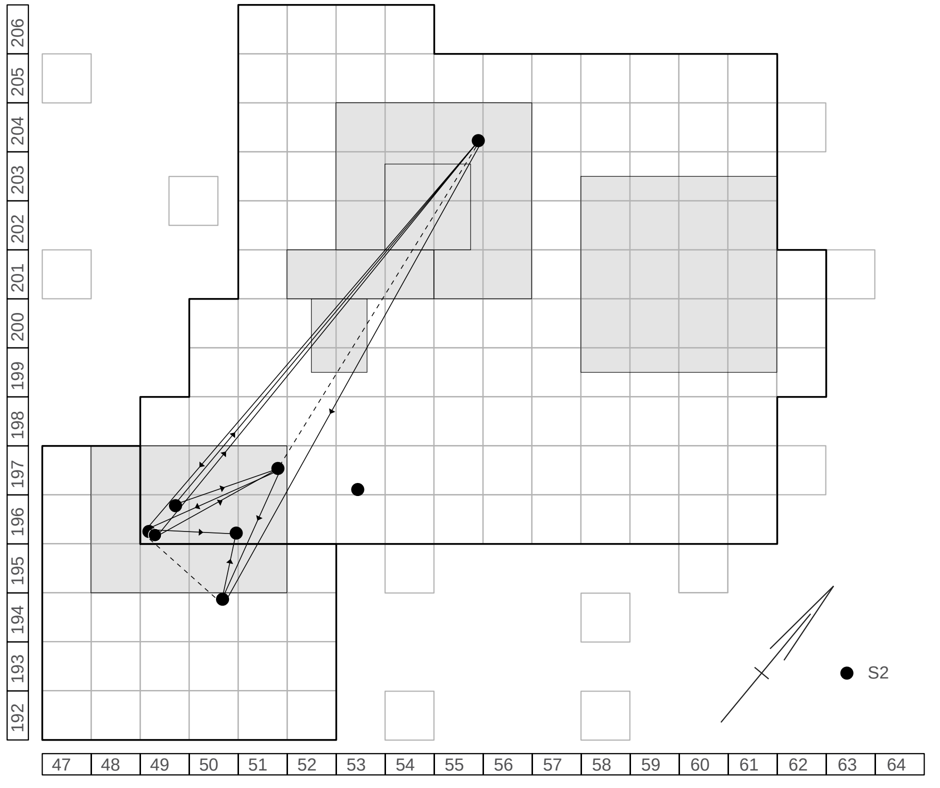


Figure 6.18 RMU S2, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

recorded-three dimensionally points to working of core 259A 107 in and around cluster A. There, in an area of 2 × 3 m, seven artefacts from RMU S3 were found. The artefacts are related to both blade production from striking platform 1 (KA8 to KA6, KA4) and preparation of striking platform 2 at the base of the core (KB7, KB6, KB3). Besides, four artefacts were found at a few metres from cluster A and its periphery, among which a failed blade (KA2) and a complete blade with a length of 5.5 cm (KA1). There are no indications of intentional transport of tools or other artefacts of RMU S3 within the boundaries of the excavation.

RMU S5 (fig. 6.20):
Compared with other RMUs in the group of Simpelveld flint, the distribution pattern of RMU S5 is much less disturbed by ploughing. Of a total of 34 refitted and eight assigned artefacts, only six pieces were not found underneath the plough zone. Nearly all artefacts were lying very concentrated in the southern part of square 53/200 in cluster B. A total of 31 artefacts of RMU S5 were found here, of which 27 pieces form part of refit groups S5.01 to S5.04. With the exception of two conjoined blade fragments (refit group S5.03), these are rather large flakes related to core preparation. As the core is missing it is not known to which part(s) of the core this preparation was applied. The position of most artefacts over an area of less than 1 m^2 can be explained in two ways. Either part of the reduction of RMU S5 was carried out in cluster B, or we are dealing with a location where knapping debris of this RMU was dumped.

In contrast to most other RMUs, there is no spatial relationship between RMU S5 and cluster A or its periphery. One metre west of cluster B, two flakes have been recorded three-dimensionally that form part of refit group S5.01. In addition, two flakes were lying in the southern part of the excavation, at a distance of three to five metres from cluster B. They form part of refit groups S5.02 and S5.04 which largely consist of refitted series of artefacts recovered from cluster B.

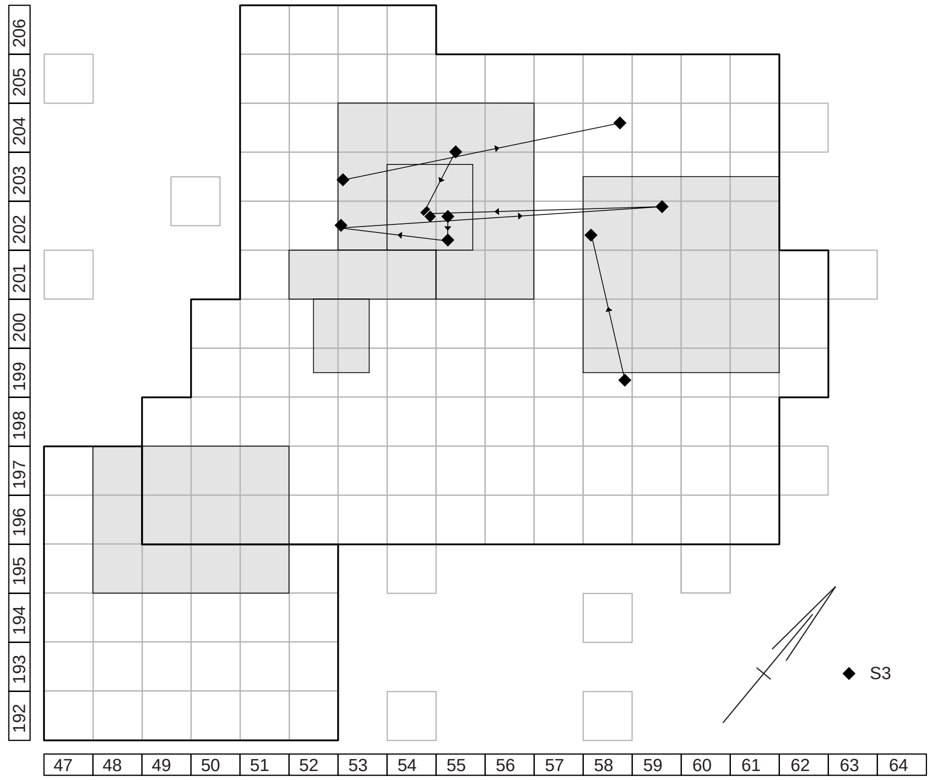


Figure 6.19 RMU S3, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

S301 to S319 (figs. 6.21-6.23):
Other artefacts of Simpelveld flint form part of smaller compositions of refitted artefacts (refit groups S301 to S319). Refit group S308 consists of a series of nine blades (PA10 to PA2) and a flake (PA1). Three blades are composed of conjoined broken pieces which largely originate from the surface and from the plough zone. Taking into consideration the position of (fragments of) artefacts measured in three dimensions, cluster A can be assumed as location of blade production of S308 (fig. 6.21). From this cluster originate a blade with edge damage ('used blade'), a complete blade, a proximal part of a blade (zone A/B), and a distal fragment of a blade. The distribution of the plough zone finds of S308 is clearly greater (for instance, squares 50/199 and 57/204). Presumably this distribution is the result of regular ploughing of the plot of land, whereby artefacts could have been moved over several metres. The distribution pattern of S309 (fig. 6.22) is very comparable with that of S308 (fig. 6.21). Of nine refitted flakes, six pieces were found in cluster A (in square 54/202), and two specimens in the periphery of cluster A and in zone A/B. This distribution points to S309 also having been worked in cluster A (perhaps the refitted artefacts of S308 and S309 represent the knapping products of one and the same core?). No artefacts belonging to this refit group were recovered from other parts of the excavation.

The knapping products of S308 and S309 show a comparable distribution to that of refitted artefacts belonging to RMUs S1 and S3. In addition, artefacts from refit groups S301 to S307, and S310 to S319 have been found in cluster B, cluster C and cluster D (fig. 6.23). As mentioned earlier, cluster D is also the location where RMU S2 had undergone modification. There is a possibility that one or more small compositions of refitted artefacts of Simpelveld flint in fact belong to RMU S2, but they could not be refitted onto artefacts of refit group S2.00.

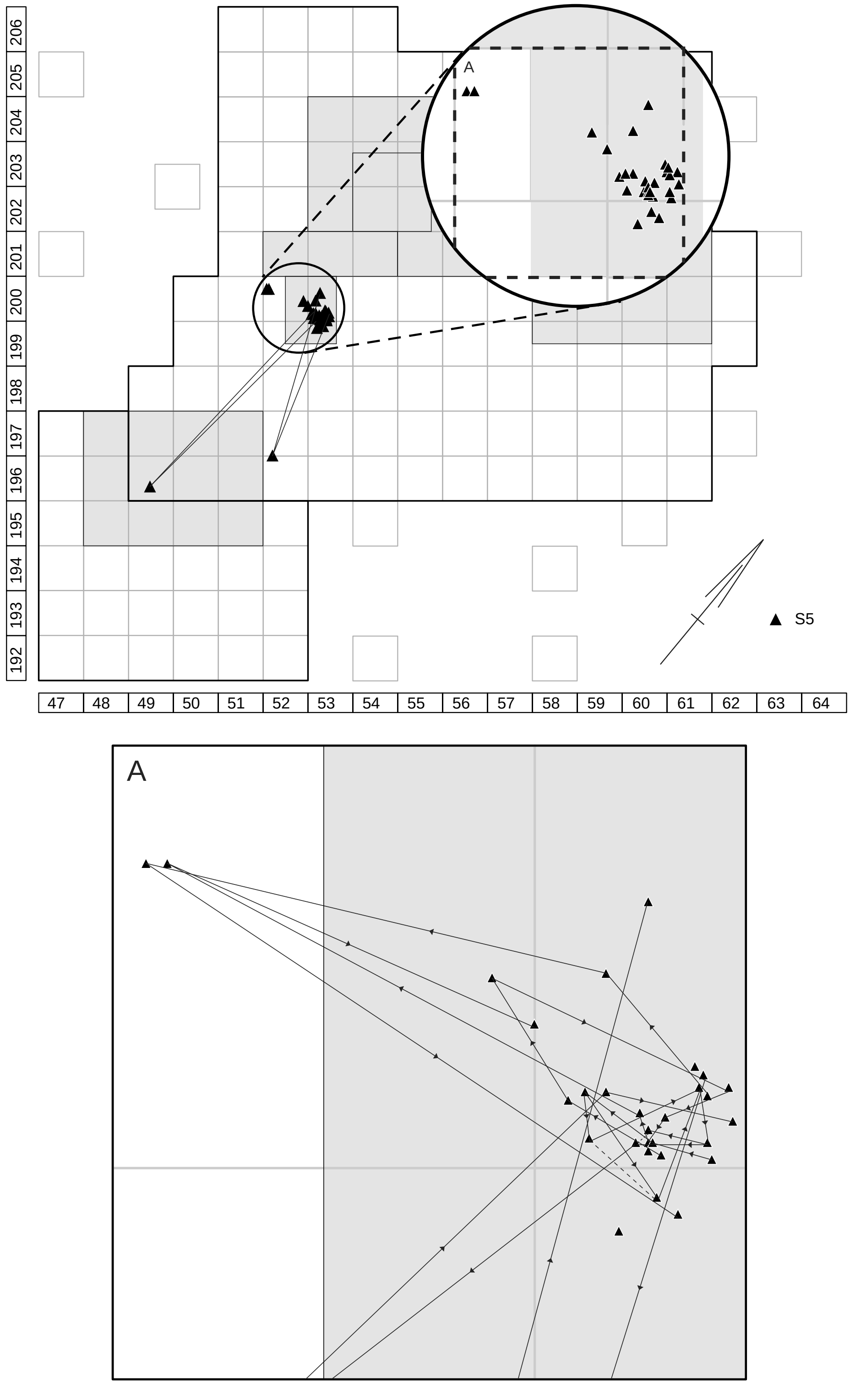


Figure 6.20 RMU S5, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

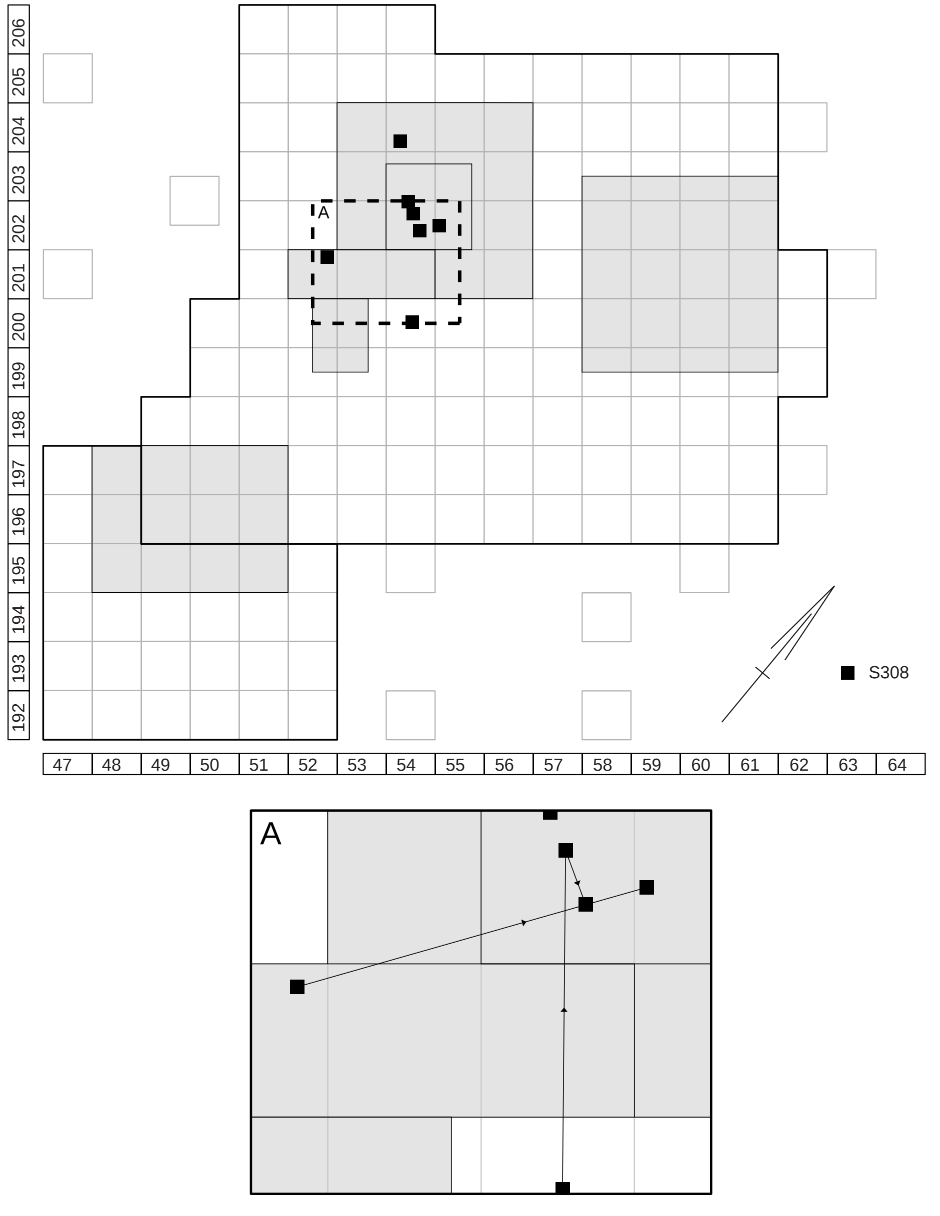


Figure 6.21 S308, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

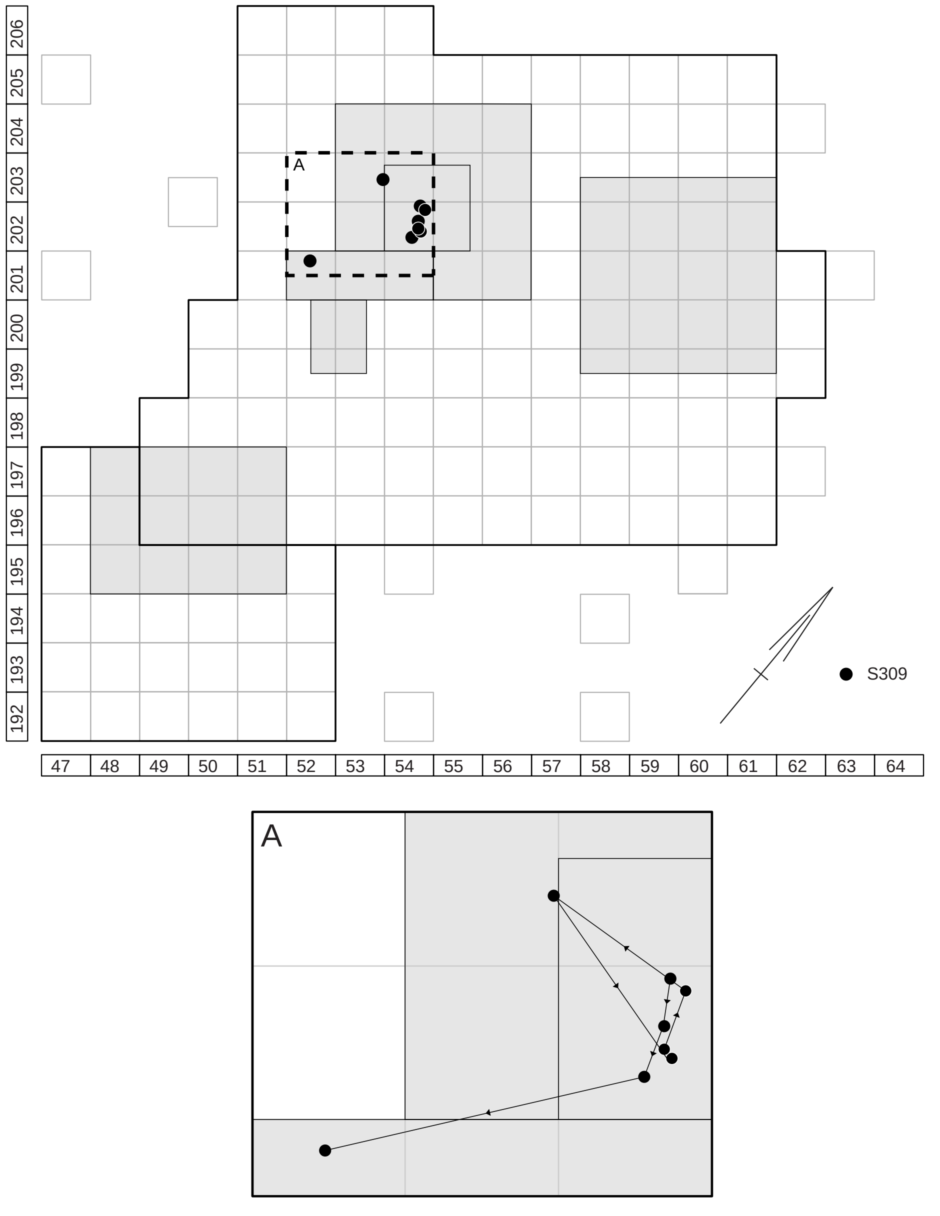


Figure 6.22 S309, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

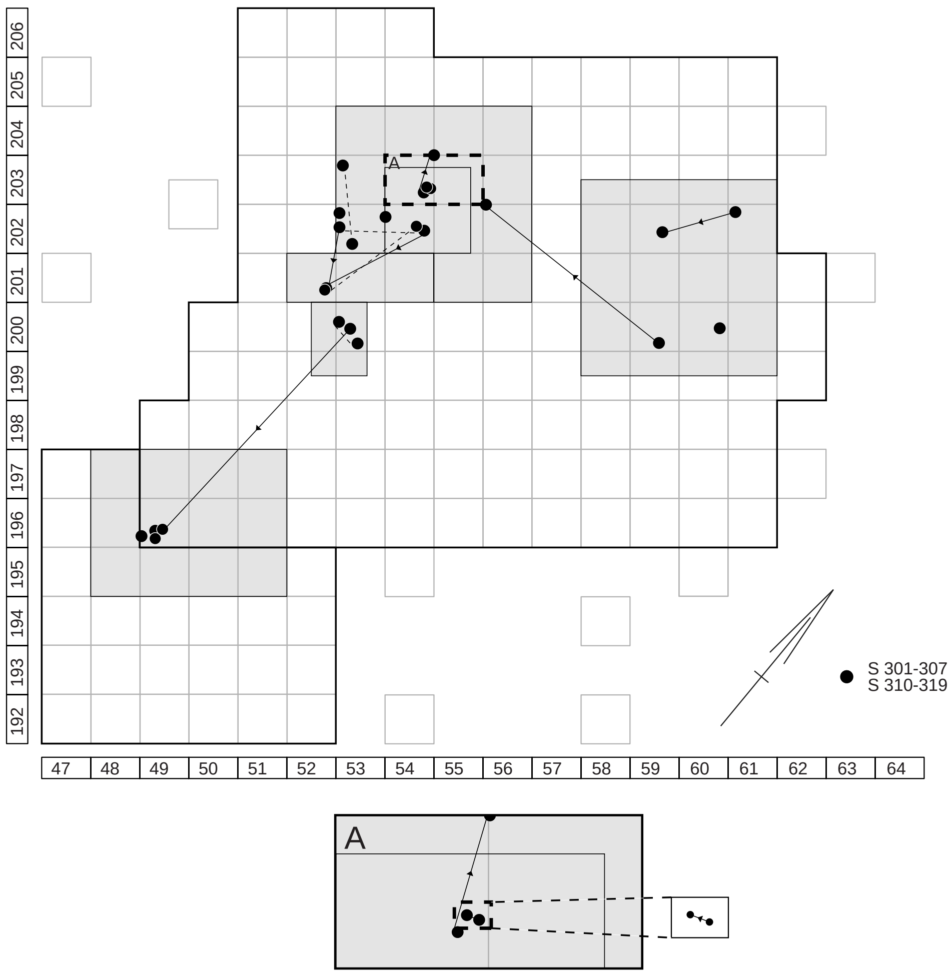


Figure 6.23 S301-S307 and S310-S319, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

6.6.3 Valkenburg flint

RMU V1 (fig. 6.24; table 6.20):

Three out of four artefacts belonging to refit group V1.00, among which core 259A 165, were collected from the surface and the plough zone. The fourth artefact is a blade-like flake that could be refitted onto the core. This artefact was found in zone A/B.

V401 to V405 (fig. 6.24):

Artefacts of Valkenburg flint mainly occurred in the southern part of the excavated area, in cluster B (n=8), in cluster D (n=5), and in squares in the vicinity of both clusters. Refit group V401 consists of three flakes, of which two pieces were lying close to each other in cluster B and one piece over three metres further south in cluster D. Two conjoined fragments of a blade (refit group V403) and a fragment of a crested blade refitted onto a distal part of a blade (refit group V405) originated from cluster B. Both cluster A and cluster C yielded one artefact of Valkenburg flint only, respectively a complete flake and a truncated blade.

6.6.4 South-Limburg flint (table 6.21)

RMU M1 (fig. 6.25):

The distribution of refitted artefacts of RMU M1 points to working of core 259A 322 in cluster A and/or in the periphery. Over an area of 25 m^2, seven artefacts of this RMU were recorded three-dimensionally in this area and its immediate vicinity, which could all be refitted onto the core.

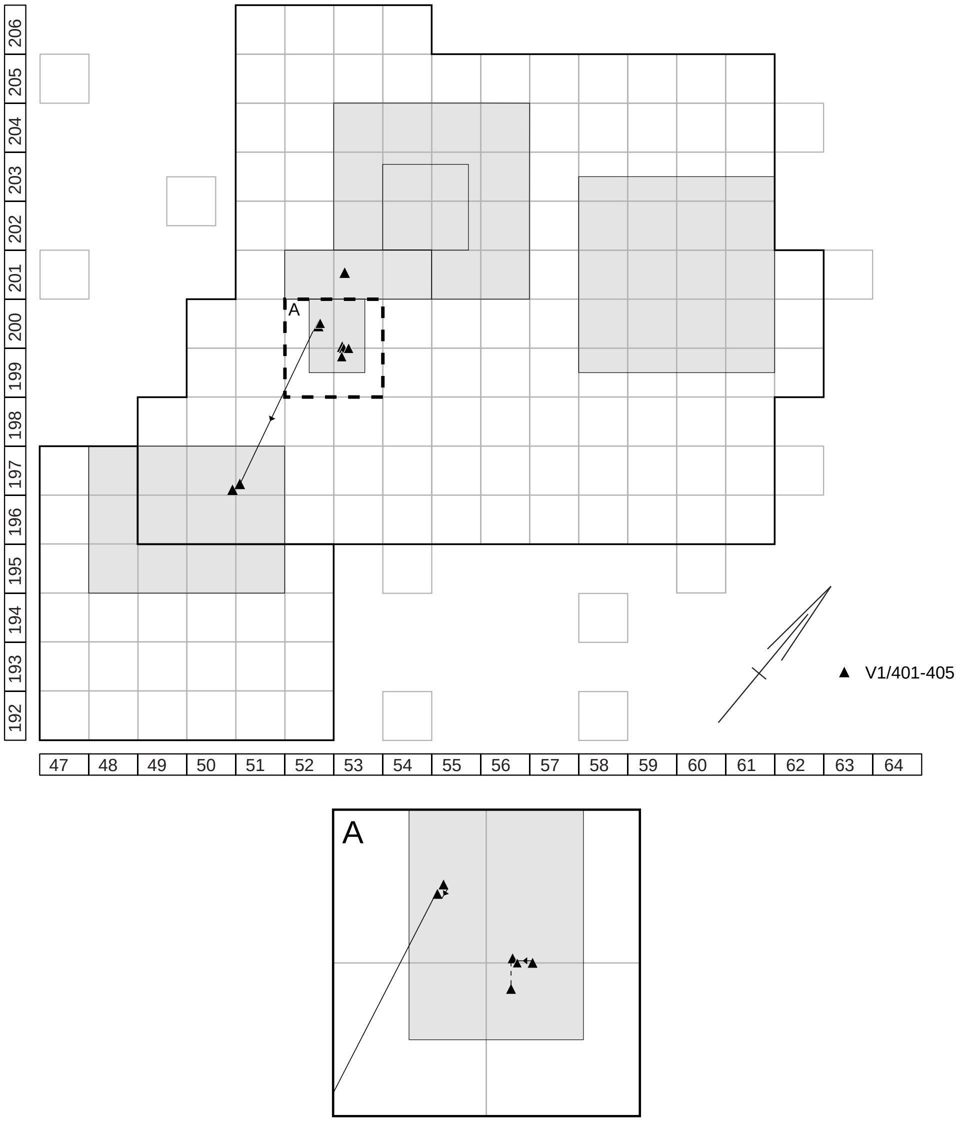


Figure 6.24 RMU V1 and V401-405, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

Among these are flakes with cortex remains and a retouched blade fragment. Four artefacts were lying close together in the southern part of cluster A, a short distance from numerous fragments of unworked siltstone (code 15). The flakes with cortex remains indicate that the core was prepared on the spot. Blade production and the manufacture of at least one tool could be demonstrated by the occurrence of a retouched blade fragment (54/202 36) in cluster A. One artefact recovered from the western part of the excavation (square 51/205) could be refitted to artefacts from cluster A. The distance between this artefact and the nearest refitted artefact in cluster A is 4.2 m. Of the non-refitted artefacts assigned to RMU M1, five pieces originate from cluster A and its periphery. Cluster B yielded a distal fragment of a blade and a flake of RMU M1. Other artefacts, all flakes smaller than 2 cm, were lying in zone A/B and in cluster C. The artefacts from clusters B and C could not be refitted. Of the in total 26 refitted and assigned to RMU M1 artefacts, 10 pieces were collected from the plough zone and from the surface. This number demonstrates that the original distribution of artefacts of RMU M1 was heavily disturbed by ploughing.

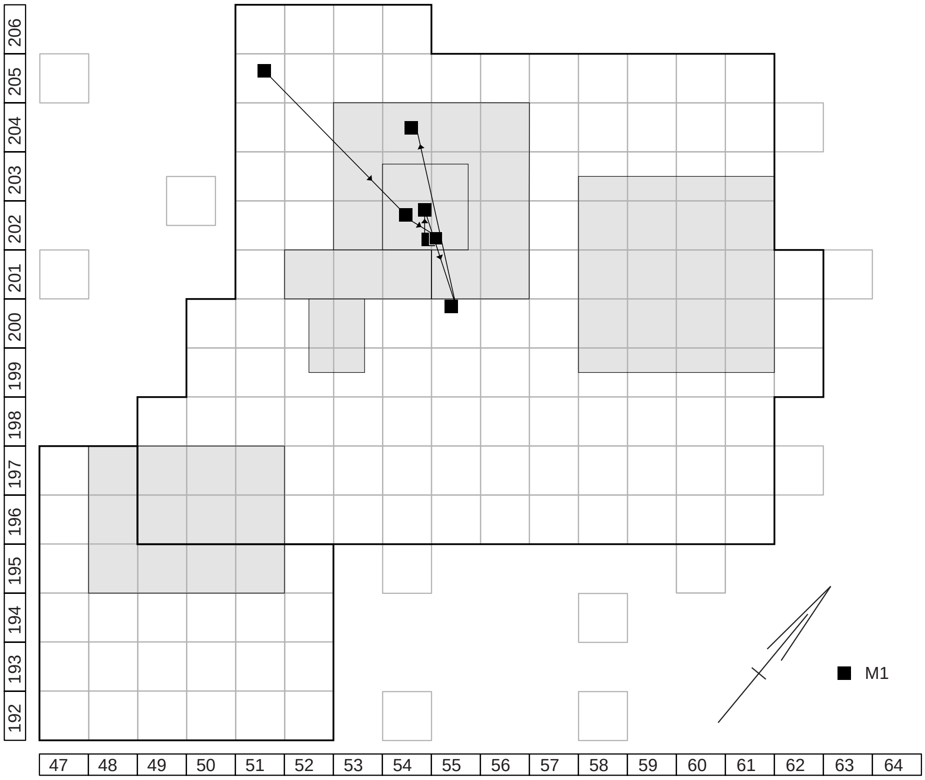


Figure 6.25 RMU M1, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

RMU M2 (fig. 6.26):
This RMU consists of four conjoined fragments of a crested blade and one refitted flake. These fragments together form a large broken piece of a crested blade with a length of c. 24 cm. Of this artefact, a medial part was found in cluster A and the distal part and another medial part in the periphery of cluster A. The conjoined broken pieces were lying in three contiguous squares of 1 × 1 m north and east of the centre of cluster A. A refitted flake (57/204 8) which was struck from the crested blade, was lying at a distance of 2 to 3 metres north of the mentioned broken pieces. A flake that could not be refitted but was assigned to RMU M2, was found just east of cluster B.

It is plausible that within the excavated area only a large crested blade and a few small flakes were removed from the core. Earlier and later stages of core reduction in the form of refitted or assigned artefacts were not demonstrated.

RMU M3 (fig. 6.27):
This RMU consists of 39 artefacts, of which 18 specimens were measured in three dimensions in the area of cluster A and its periphery. We are dealing here with ten refitted and eight assigned artefacts. The spatial distribution of the refitted artefacts is limited to an area of 3 × 2.5 m. The corresponding core (57/199 12) was found a few metres east, but in the plough zone.

Of the artefacts refitted onto the core, six specimens were found in the periphery of cluster A. They were lying in particular west and south of cluster A and partially in the part of the periphery disturbed by a tree fall (squares 53/202, 53/203 and 53/204). Among these artefacts are both flakes and fragments of blades. From this can be inferred that RMU M3 has undergone both core preparation and blade production in or near cluster A. Also due to the presence of the tree fall, the artefacts were rather dispersed, which made it impossible to demonstrate the exact location of working. Remarkable is a fragment of a flake (57/202 9) and the proximal part of a blade (58/203 2) lying at the periphery of cluster C and a few metres outside the distribution of the other artefacts. The fragments could be refitted onto respectively a fragment of a flake and the medial part of the blade that were found in the periphery of cluster A at

			Three-dimensionally recorded and refitted artefacts in loess soil							
RMU	Surface	Plough zone	Cluster A	Periphery cluster A	Cluster A/B	Cluster B	Cluster C	Cluster D	Other sections	N
M1	4	.	4	1	.	.	.	.	2	11
M2	1	.	1	2	.	.	.	.	1	5
M3	2	6	3	6	.	1	.	.	3	21
M4	1	1	2	.	.	.	1	.	.	5
M5	2	2	10	3	.	.	1	.	2	20
M6	6	5	.	.	.	3	.	4	2	20
M7	3	.	8	2	1	4	.	.	.	18
M8	5	3	4	3	.	.	4	.		19
M9	6	5	13	4	.	1	1	.	2	32
M10	4	2	.	.	.	1	.	4	1	12
M11	3	2	2	.	.	.	5	.	.	12
M12	.	2	1	.	.	2	.	1	1	7
M13	6	1	.	.	2	6	.	1	.	16
M14	.	.	.	.	.	.	.	.	.	0
M15	8	6	2	.	.	.	10	.	2	28
M17	1	3	1	.	1	.	1	.	2	9
M18	2	.	.	.	.	.	.	.	1	3
M19	11	9	2	.	1	.	.	2	1	26
M21	2	.	.	.	.	1	.	.	.	3
M23	.	.	.	.	.	.	.	.	1	1
Total	67	47	53	21	5	19	23	12	21	268

Table 6.21 Spatial distribution of three-dimensionally recorded, refitted artefacts >2 cm of South-Limburg flint (RMUs M1-M15, M17-M19, M21 and M23). The first two columns indicate the numbers of artefacts collected from the surface and plough zone.

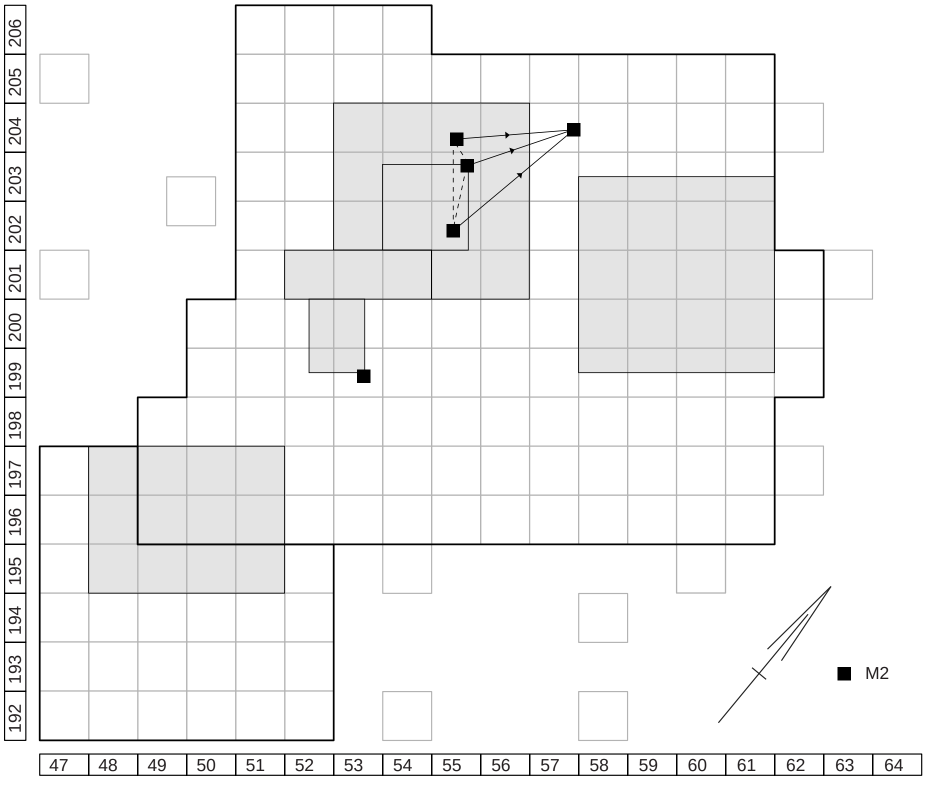


Figure 6.26 RMU M2, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

distances of 4 and 5 metres further (south)west. A fragment of a large flake (53/200 70) was recovered from cluster B and could be refitted onto a flake from square 55/199. Possibly core 57/199 12 was also worked at some distance from cluster A. But we should also bear in mind the possibility of horizontal movement of artefacts as a result of post-depositional processes. The provenance of 13 artefacts from the plough zone and from the surface shows that a part of the original distribution of artefacts belonging to RMU M3 was affected as a result of ploughing.

RMU M4 (fig. 6.28):
This RMU is very incomplete, also because only a small part of the core has been recovered. This fragment was collected from the surface. The core has a non-patinated fracture plane and a clearly recognizable brown cortex. RMU M4 is composed of twelve artefacts measured in three dimensions, of which three specimens could be refitted onto core fragment 259A 323. Two refitted artefacts come from cluster A and one from cluster C. The position of both first-mentioned artefacts points to blade production and/or use of blades in the western part of cluster A. Of nine assigned artefacts, four pieces were also found in cluster A and its periphery. These artefacts (two fragments of blades, and two fragments of flakes) underline the notion that RMU M4 was modified in this part of the excavation.

Outside cluster A and its periphery, a flake (zone A/B), a flake smaller than 2 cm (cluster B), a proximal part of a blade and a flake smaller than 2 cm (cluster C), and a proximal fragment of a blade (remaining zone) were found underneath the plough zone. How this wide distribution of artefacts, dispersed over three clusters and beyond, should be explained is not clear. Possibly RMU M4 was modified in different parts of the excavated area. But artefacts could also have been moved horizontally over many metres as a result of post-depositional processes. As mentioned, the core is only documented by a small fragment that was collected from the surface. The small number of conjoined artefacts do not make it possible to say anything with certainty on location(s) of modification.

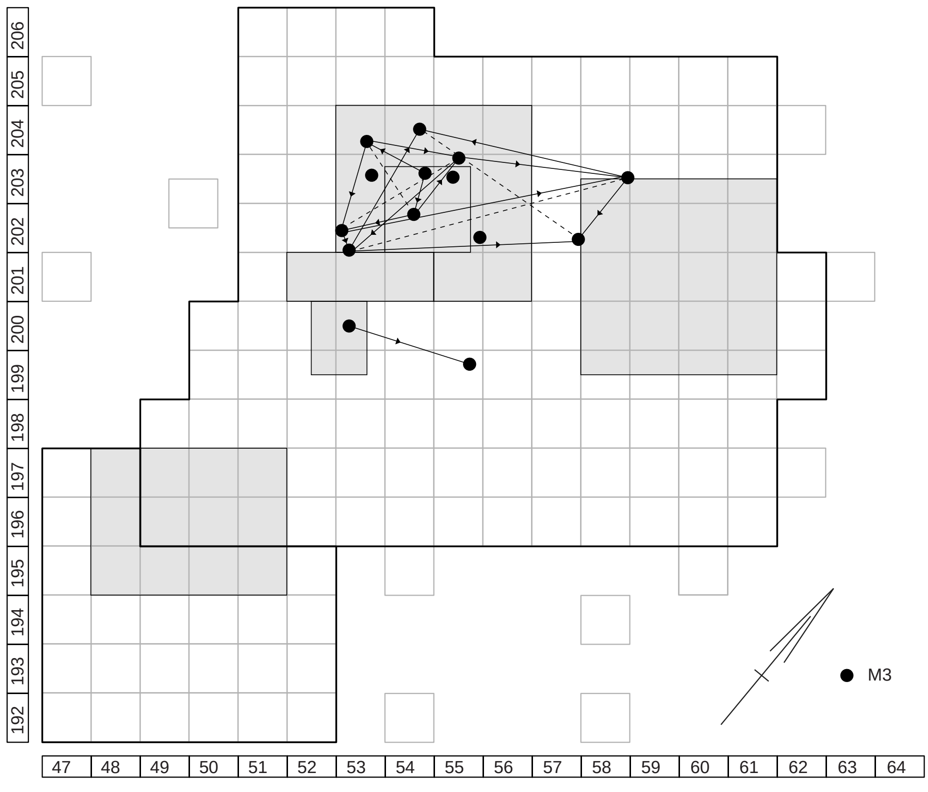


Figure 6.27 RMU M3, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

RMU M5 (fig. 6.29):
This RMU comprises 40 artefacts measured in three dimensions, of which 15 pieces could be refitted (refit groups M5.00 to M5.05). Of these artefacts, ten specimens were found in cluster A and three specimens in its periphery. The distribution of these artefacts is not more than 3 m^2. Artefacts from cluster A are represented both in refit group M5.00, of which core 259A 205 forms part, and in the other refit groups. Most of these are flakes with dimensions between 3 and 6 cm. These flakes have cortex remains and largely derive from the western part of cluster A. One specimen has been retouched. In addition, a complete blade and two blade fragments of RMU M5 were collected in this part of the excavation. Worth mentioning is that refitted artefacts in squares 54/202 and 54/203 were collected in an area of c. 1 × 0.5 m. Also the position of several non-refitted artefacts points to modification, including production of blades, in cluster A and/or its immediate vicinity.

Three refitted and twelve assigned artefacts show a relationship with other parts of the excavation. Zone A/B yielded two flakes and the proximal part of a blade, and cluster C two fragments of flakes and a complete flake and blade. Artefacts were also found outside the clusters, among which two specimens in square 57/202 which form part of refit groups M5.00 and M5.02. The meaning of these artefacts at a few metres from cluster A is not clear. Also to RMU M5 applies that the original distribution of artefacts has been disturbed as a result of ploughing. This can be inferred from the occurrence of four refitted and twelve assigned artefacts in the plough zone and at the surface.

RMU M6 (fig. 6.30):
RMU M6 corresponds with refit group M6.00 and consists of eleven artefacts recorded three-dimensionally and refitted onto core 259A 373. Compared to the earlier discussed RMUs, the distribution of knapping products of this flint

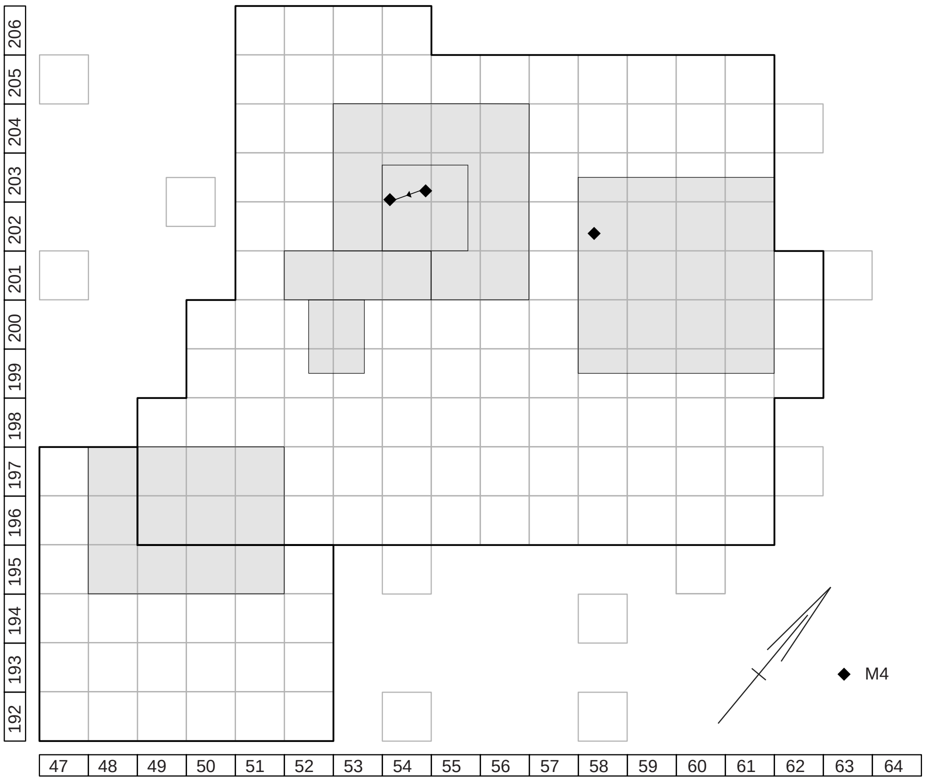


Figure 6.28 RMU M4, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

nodule is clearly different. None of the artefacts was found in cluster A or in the periphery of this cluster. Apparently, the modification of RMU M6 and the use of products of this RMU took place entirely outside the main activity area (= cluster A) of the excavation. The artefacts were recovered in cluster B (n=4), cluster D (n=5), and the here adjoining southern part (n=2). This distribution points to modification, in the form of core preparation and blade production, in the area south of cluster A and to a relationship between clusters B and D.

Four conjoined broken pieces, together part of two blades, were found in cluster B. They point to removal of blades from core 259A 373 on the spot or to selected blades having been carried away from cluster D to this location in order to be used. Both blades are not complete: the ‘missing’ parts were found in cluster D and even further south, in square 50/193. Also other artefacts were collected from this part of the excavation, among which scraper 51/197 10 in cluster D. With this, there seems to be a connection between on the one hand cluster B and on the other hand cluster D and the southernmost part of the excavation. Between both locations there is a relatively ‘empty’ area where no artefacts of RMU M6 came to light.

The relatively large dispersion of the artefacts in the southern part could be related to the high degree of bioturbation in this part of the excavated area. Other processes, such as throwing away artefacts or slope wash, could also have played an important role. Another possibility is that end products, among which two end scrapers, were not used in the place where they were made but in the vicinity. Which stages of core reduction were carried out where exactly is difficult to determine. Moreover, twelve artefacts of this RMU were collected from the surface and from the plough zone. The conclusion is that also in the case of RMU M6 we are dealing with the remains of an originally denser distribution of artefacts, of which clusters B and D both formed part.

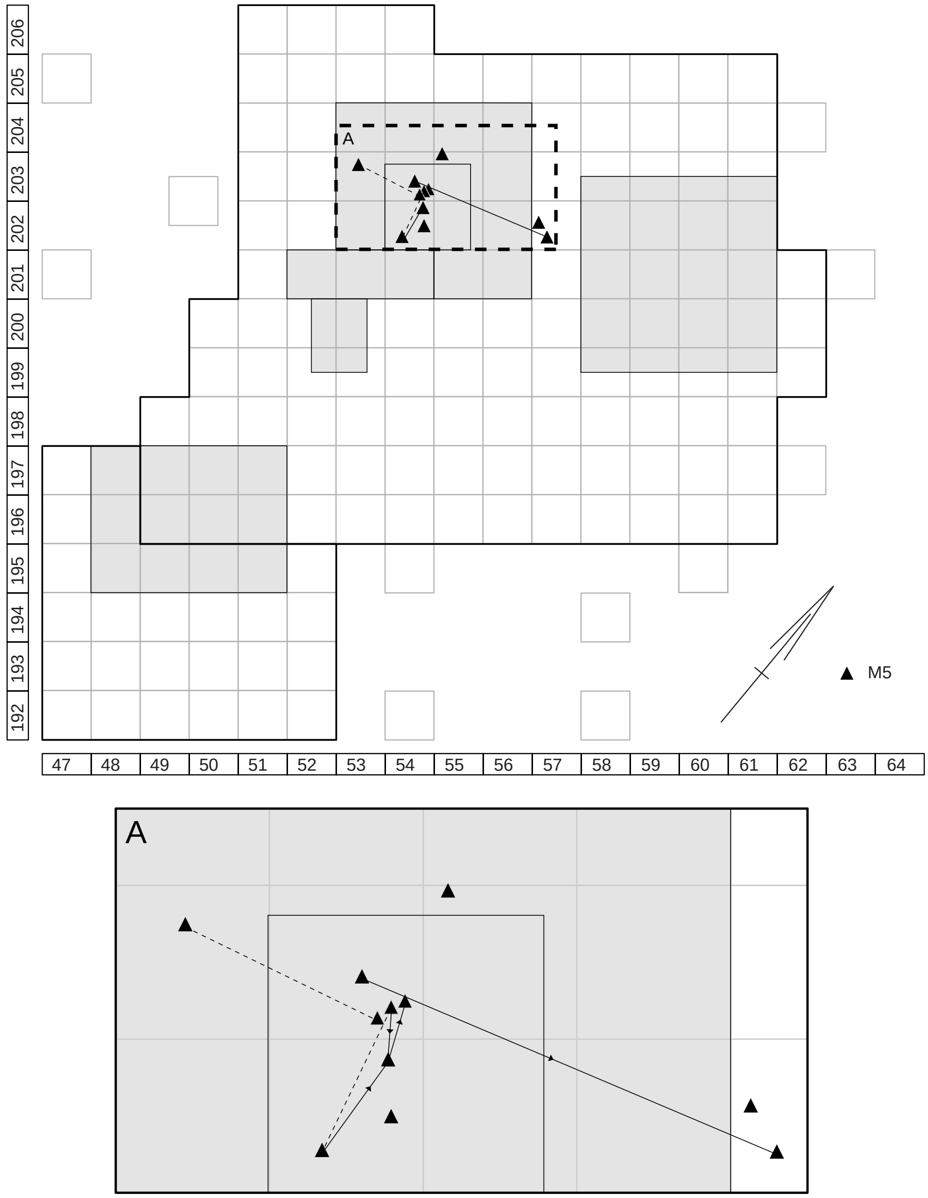


Figure 6.29 RMU M5, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

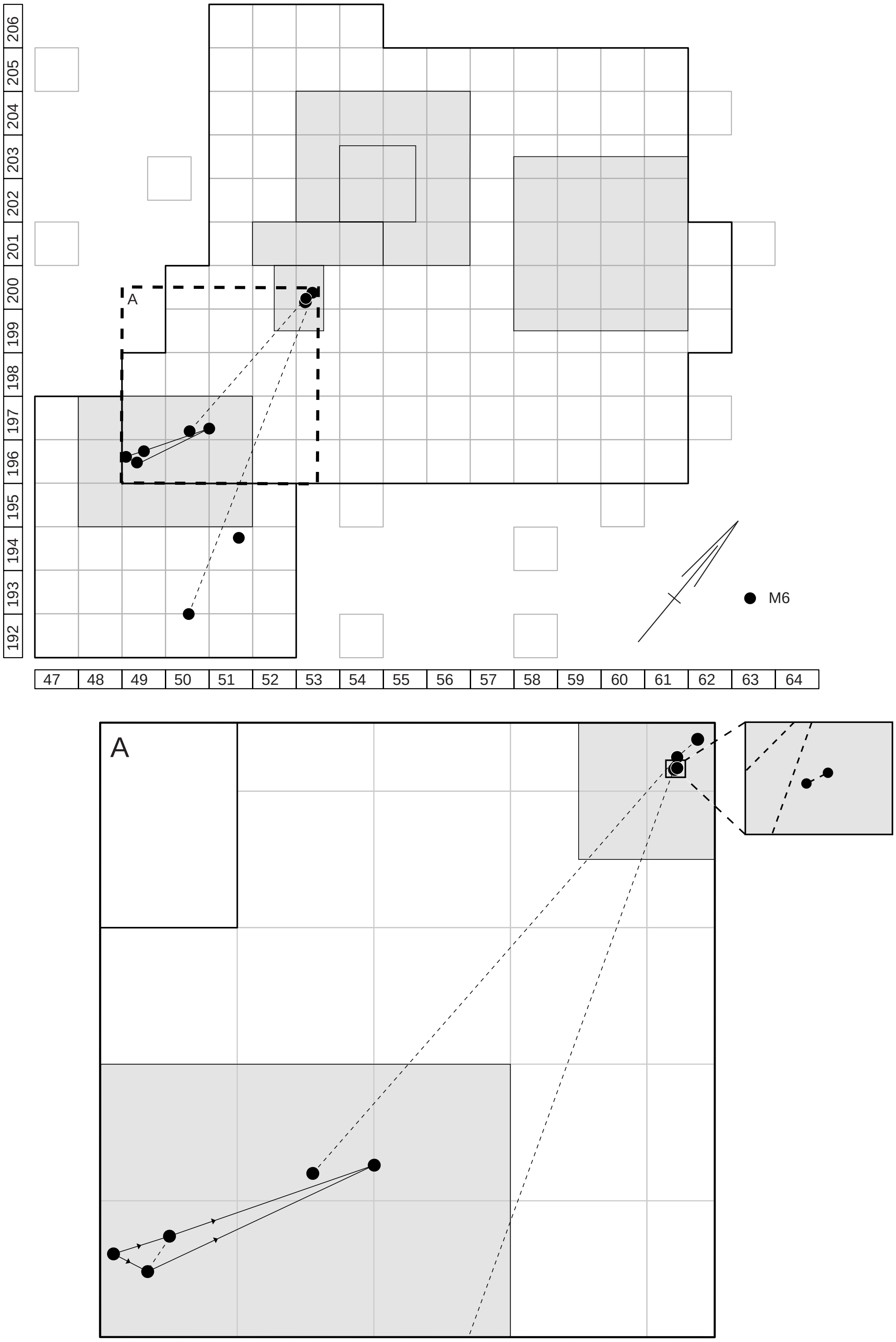


Figure 6.30 RMU M6, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

RMU M7 (fig. 6.31):
The distribution of the artefacts belonging to RMU M7 is mainly connected to the area of cluster A and the periphery. There ten refitted artefacts were lying close together, in an area of c. 2 × 1.5 m. Moreover, one or more artefacts from this find-rich part are represented in all refit groups (M7.01 to M7.05). Among the refitted artefacts are two large flakes, a core rejuvenation flake, and proximal, medial and distal parts of blades with large dimensions. The artefacts came to light in the centre and in the western part of cluster A. They point to core preparation and blade production in this part of the excavation. Unfortunately, the core itself was not found.

Four refitted artefacts of this RMU originated from cluster B, consisting of twice a distal end of a blade and a fragment of a blade and a flake. The fact that these artefacts dorsally/ventrally could be refitted onto artefacts recovered from cluster A indicates a relationship between clusters A and B. The distance between artefacts in both clusters is 1.5 to 3 m. The position of these artefacts is possibly related to the partial working of RMU M7 in cluster B. Another possibility is that a selection of fragments of blades was carried to cluster B to be used there (see also RMU M6, but then from cluster D!). A relationship with cluster C or cluster D could not be determined on the basis of the refitting evidence. Cluster C yielded a medial part of a blade and a fragment of a flake which were assigned to RMU M7. They do not form part of the compositions of refitted artefacts.

RMU M8 (fig. 6.32):
This RMU consists of twelve refitted artefacts plotted in three dimensions: nine fragments of flakes, two fragments of crested blades and one medial fragment of a blade. An important part (n=8) was found in the centre of cluster A and in the northwest part of the periphery of this cluster. East of there, at c. 6.5 metres and separated by an empty zone, four refitted artefacts were found in the area of cluster C. These are three flakes larger than 3 cm and the distal end of a crested blade. Taking into consideration the position of the refitted artefacts, it is suggested that RMU M8 was reduced in or near cluster A and in cluster C. Refit groups M8.01 and M8.03 contain artefacts from both cluster A and its periphery and from cluster C. A medial blade fragment that could be refitted onto core 259A 239 (surface find) was found in cluster A (refit group M8.00). Two broken pieces which together form a complete blade, also form part of this refit group and they were collected from the plough zone of squares 57/202 and 57/203. Both squares are located between the periphery of cluster A and cluster C.

The existence of a relationship between cluster A and cluster C is further demonstrated by the occurrence of non-refitted artefacts of RMU M8 in these clusters. Other parts of the excavation yielded a fragment of a frost-cracked artefact, two flakes and a medial fragment of a blade. They were mainly in the vicinity of cluster C. And finally, we should point to five surface finds and three plough zone finds > 2 cm belonging to RMU M8.

RMU M9 (fig. 6.33):
This RMU consists of 33 refitted artefacts, i.e. the largest composition of refitted artefacts within the group of Meuse terrace flint. With the exception of two artefacts, they all belong to refit group M9.00. The core has only been preserved partially in the form of three conjoined fragments with non-patinated fracture planes. Apart from one artefact, artefacts of this RMU were found within an area of c. 4 × 3.5 m. A total of 22 artefacts were found underneath the plough zone, of which 14 specimens in cluster A and four specimens in its periphery. These are mainly flakes with maximum dimensions between 3 and 6 cm, among which a decortication flake and flakes with few or no cortex remains. There are also fragments of blades, a part of a crested blade, and two retouched tools. The artefacts were lying more or less dispersed over the area of cluster A, with a few pieces lying very close together in its centre. Together with two non-refitted artefacts originating from the same area, they point to core preparation and production of blades in this find-rich part of the excavation.

Outside cluster A, knapping products of RMU M9 occurred in cluster B (complete flake without cortex) and in cluster C (proximal part of a blade). Both artefacts form part of refit group M9.00 and link clusters B and C to cluster A and the periphery. East of cluster A, three artefacts were found close together in squares 56/200 and 56/201. One specimen of these could be refitted onto an artefact recorded three-dimensionally in cluster A.

Also from this RMU originate relatively many artefacts from the surface or from the plough zone, among which eleven artefacts which form part of refit group M9.00 (=33%).

RMU M10 (fig. 6.34):
Refit group M10.00 consists of core 51/197 2, two flakes, two blades, and a burin that were found in the southern part. Taking into consideration the position of these artefacts, the knapping of RMU M10, including the removal of (a few) blades and preparation flakes, took place in cluster D. One refitted, complete blade was found in cluster B. This artefact points to a spatial relationship between cluster B and the southern part of the excavation, including the area of cluster D. It is plausible that this blade was carried to cluster B and there discarded (after use?). The same probably applies to a non-refitted medial fragment of a blade that was

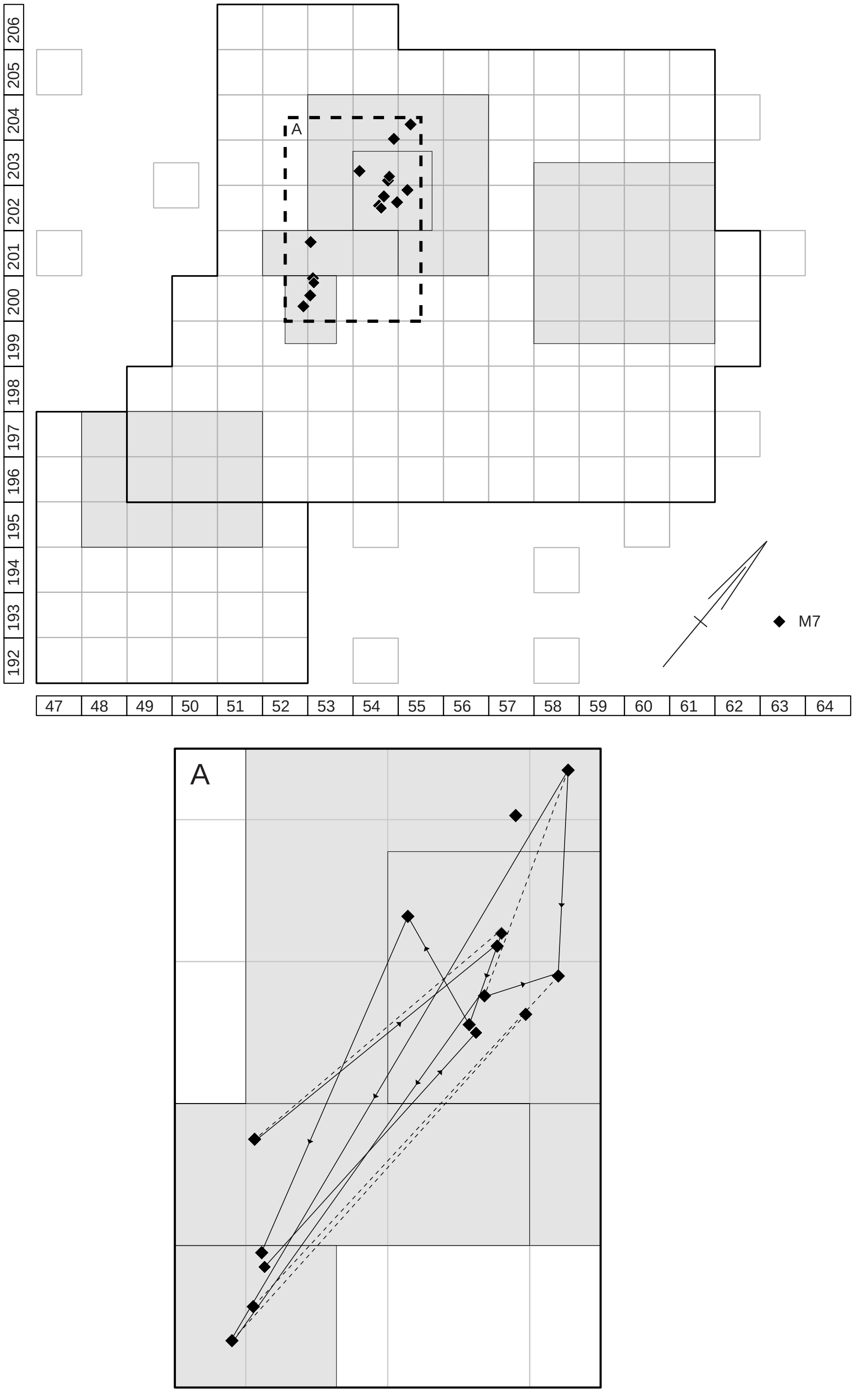


Figure 6.31 RMU M7, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

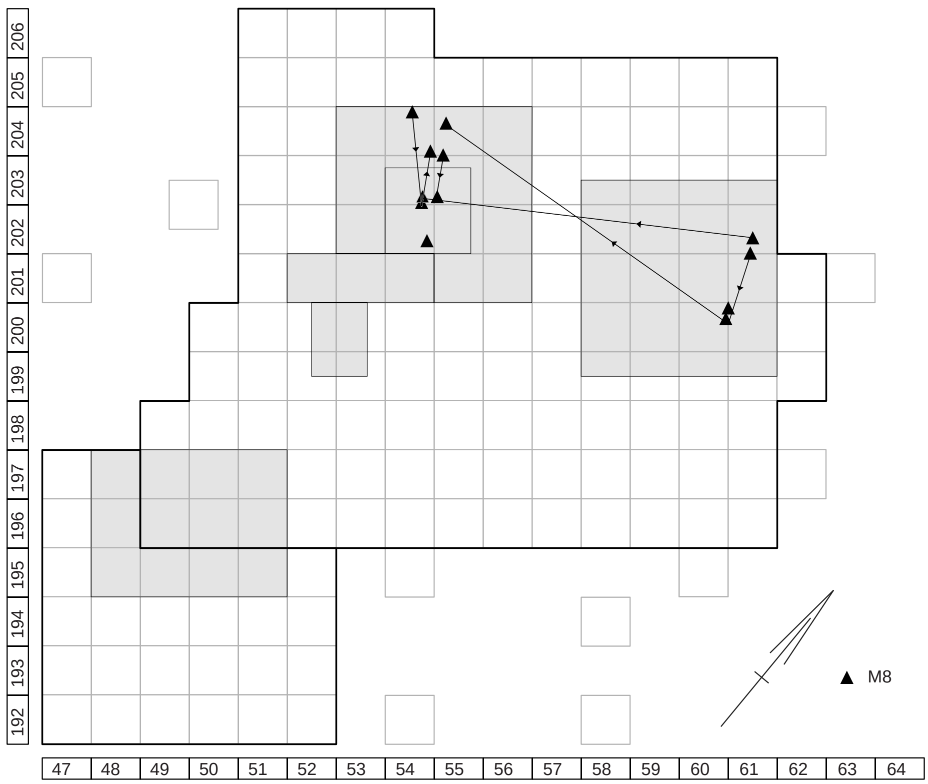


Figure 6.32 RMU M8, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

found in square 52/200. The position of a dihedral burin in square 50/193 could be an indication of the use of retouched tools of RMU M10 at the southern edge of the excavation, just south of the location where this RMU was probably worked.

RMU M11 (fig. 6.35):
The distribution of artefacts belonging to RMU M11 is mainly connected with the eastern part of the excavation, east of x-co-ordinate 58. Artefacts from cluster C are present in refit groups M11.01 and M11.02. Unfortunately, the core is lacking in the flint assemblage of Eyserheide. Both refit groups represent small compositions of preparation flakes (usually without cortex). Refit group M11.01 also contains a complete blade (61/199 1) which was found in cluster C. The distal part of another refitted blade (length > 17 cm) came to light in cluster A. This cluster further yielded a fragment of a remarkably large and thick decortication flake, which forms part of refit group M11.02. In contrast to other RMUs, artefacts of RMU M11 are lacking in the periphery of cluster A.

Because of the occurrence of the decortication flake mentioned above, RMU M11 was possibly tested in cluster A, by the removal of a core tablet and possibly a few striking platform preparation flakes. Subsequently, preparation and rejuvenation of the striking platform and blade production were carried out in cluster C. A total of 20 refitted and assigned artefacts recorded three-dimensionally originated from this part of the excavation. Among the small number of artefacts from cluster A are two distal fragments of a blade with dimensions larger than 10 cm. In addition, a (non-refitted) medial fragment of a blade was found in cluster B. We could possibly be dealing here with the transport of selected artefacts from cluster C to the area of clusters A and B to be used there. The distance from these artefacts to other artefacts of RMU M11 recorded three-dimensionally in cluster C is 4 to 8 metres.

RMU M12 (fig. 6.36):
It concerns the distribution of the small refit group M12.00, consisting of three refitted flakes on core, and refit group M12.01, consisting of conjoined fragments of two blades.

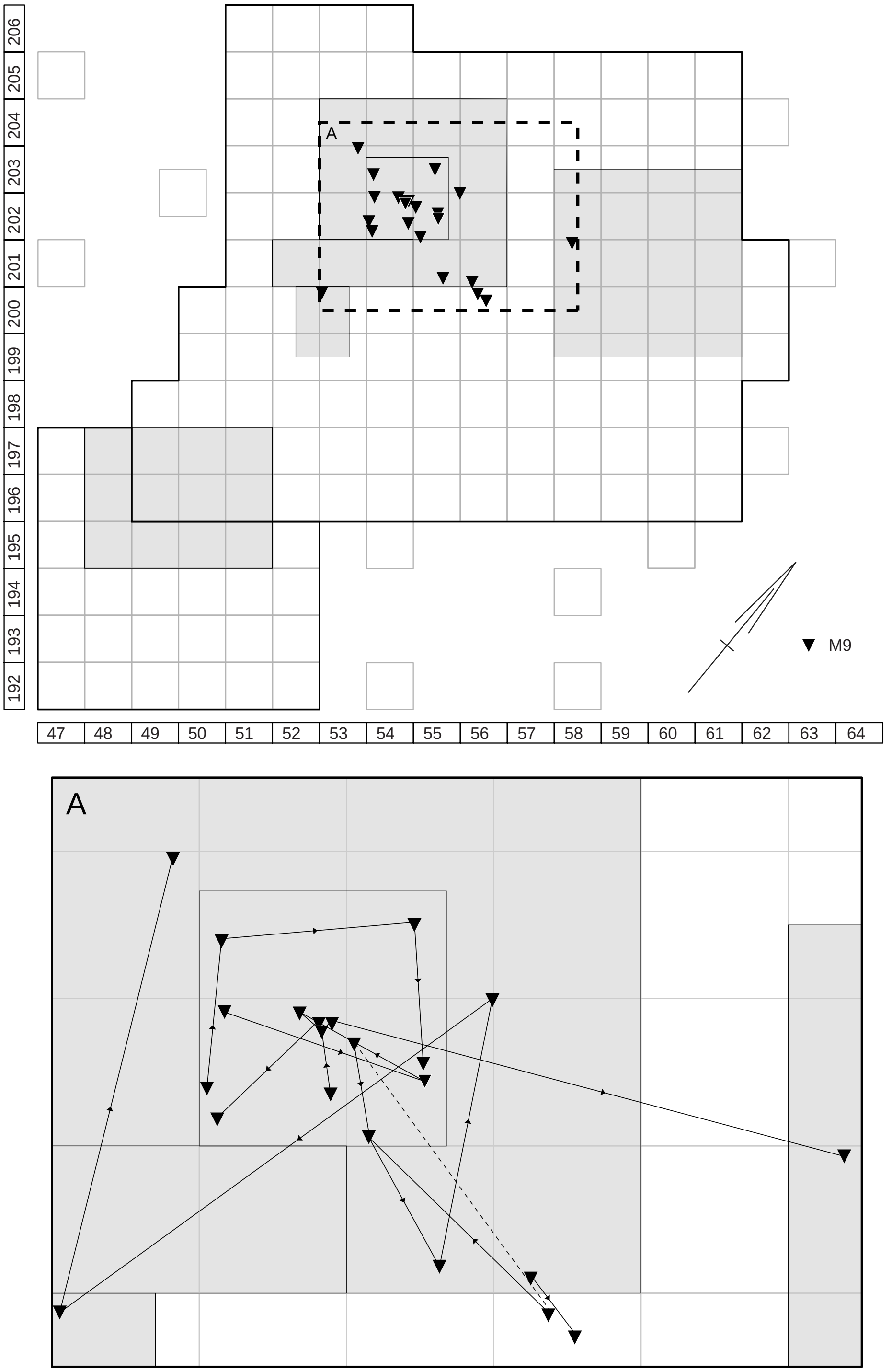


Figure 6.33 RMU M9, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

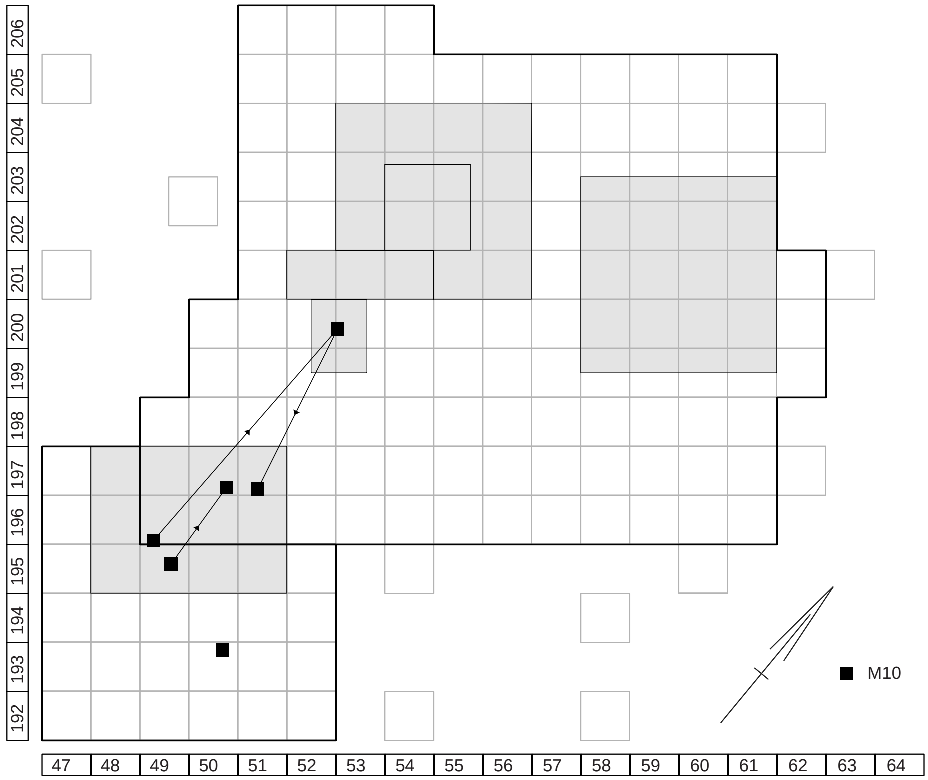


Figure 6.34 RMU M10, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

No blades could be refitted onto the core. Although the number of refitted artefacts is small, we are dealing with a large distribution in the central and southern part of the excavation. Two flakes that could be refitted onto the core originated from cluster B. A third refitted flake was found in square 50/193, c. 7 m south of this cluster. Of refit group M12.01, the distal part of a crested blade was found in cluster A. Onto this blade could be refitted the proximal part of a blade that originated from square 49/196 in cluster D, over 5 m south of cluster A. How this spatial distribution and these large distances between refitted artefacts should be explained is, also because of the small number of artefacts, not clear. Also assigned and measured-in artefacts originated from different parts of the excavation, among which a small flake (length 2.3 cm) from cluster C. Of RMU M12, seven artefacts were collected from the plough zone and the surface. Also the distribution of this RMU shows that an important part of the archaeological layer was disturbed by ploughing.

RMU M13 (fig. 6.37):
Of ten artefacts refitted onto core 259A 208 (refit group M13.00), five specimens were recorded three-dimensionally in cluster B. The distribution of these artefacts is limited to an area of 50 × 70 cm. It concerns a complete blade, two fragments of blades and two flakes. In view of their position, it seems that the modification of RMU M13 was (also) carried out in cluster B. One artefact of refit group M13.02 also points to a relationship with cluster B, but there are also refitted artefacts recovered from zone A/B (blade and flake), the periphery of cluster A (two fragments of a scraper), and cluster D (flake). The distribution of the majority of these finds is limited to an area of 5 m^2. The flake that was found in cluster D was lying c. 5 m south of cluster B and clearly outside this distribution. This artefact could be refitted onto a flake in square 53/200, which underlines the importance of cluster B in the distribution of RMU M13. Possibly the broken blade scraper was also made there and subsequently used and discarded in the periphery of cluster A.

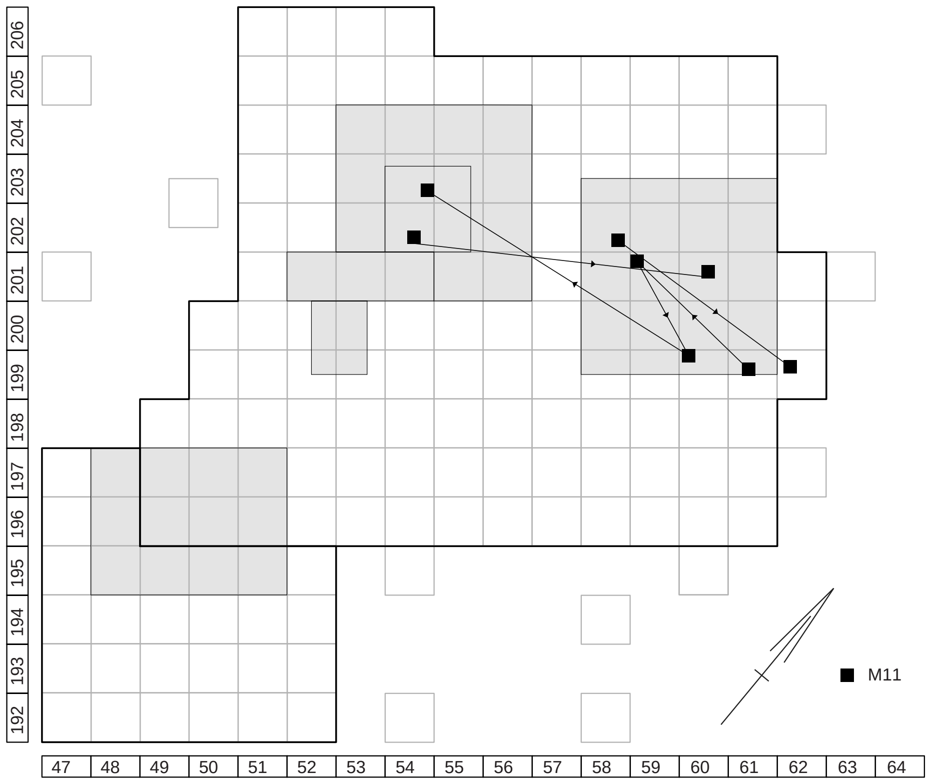


Figure 6.35 RMU M11, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

RMU M14:
This RMU consists of six non-refitted artefacts, of which a fragment of a flake and a medial fragment of a blade were found in cluster C. A proximal fragment of a blade originates from the plough zone of square 58/202 that forms part of cluster C. The plough zone of square 54/204 yielded a fragment of a small flake in the periphery of cluster A. No core of this RMU was retrieved. Because of the small number of artefacts and the lack of refits, it cannot be determined where RMU M14 was modified. Taking into consideration the position of two artefacts recorded in three dimensions, a relationship with cluster C is the most obvious.

RMU M15 (fig. 6.38):
The largest composition within RMU M15 is refit group M15.00 which consists of eleven artefacts, among which blade core 259A 209. The majority of the artefacts of this refit group originates from the area of cluster C, c. 4 to 5 m east of cluster A. Looking at the position of these artefacts, among which three large refitted flakes, the core was worked in the eastern part of the excavation. Refitted flakes belonging to the small refit groups M15.01 and M15.03 were also found in cluster C or in its immediate vicinity. Cluster A yielded a proximal fragment of a broad blade with edge damage (‘use retouch’) and a complete flake of more than 7 cm. The former artefact could have been carried from cluster C to be used there, however for the larger flake this possibility of transport is less likely. The fact that 15 refitted artefacts were collected in the plough zone or at the surface, demonstrates also in this case that an important part of the original find distribution was disturbed by ploughing and was incorporated into the plough zone.

The relationship between RMU M15 and cluster C is underlined by the position of 21 non-refitted flakes, three blade fragments and a fragment of a burin spall in this part of the excavation. But also a few artefacts were found in cluster A, among which two distal fragments of blades, and in the periphery of cluster A and in cluster B. We should bear in mind that in RMU M15 the products are represented of two or even more cores. We are dealing here with a white

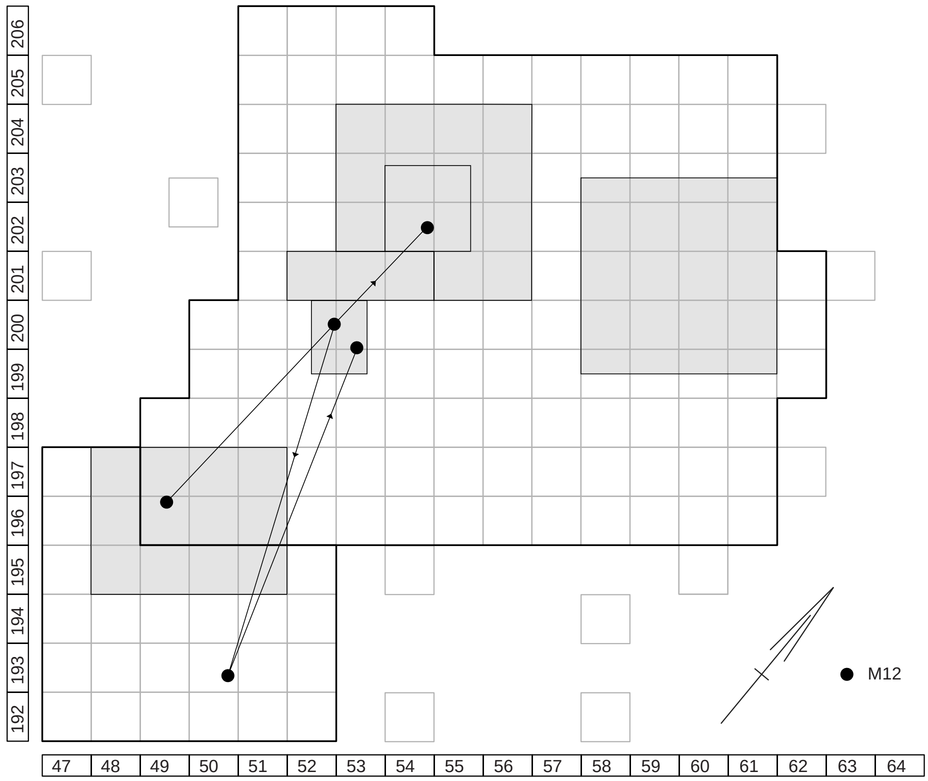


Figure 6.36 RMU M12, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

patinated (terrace) flint, of which many artefacts have been found without cortex remains.

RMU M17 (fig. 6.39):
Of this RMU, the core and three preparation flakes which could be refitted onto the core (refit group M17.00) were found underneath the plough zone. A refitted tool, backed bladelet 259A 319, has been documented as surface find. The core was found in square 56/200 immediately east of the periphery of cluster A. Two refitted flakes were found at a short distance from the core, in square 57/200 and square 54/201. The latter square forms part of zone A/B. Cluster A yielded one flake refitted onto the core. Other refitted artefacts were collected from the surface and plough zone, but a flake was also found in square 60/200 that forms part of cluster C. The distribution of three-dimensionally recorded artefacts points to working of the core in the central part (cluster A and periphery) and/or eastern part (cluster C) of the excavation. A connection between RMU M17 and the mentioned parts is further underlined by the position of non-refitted artefacts which were assigned to RMU M17 based on characteristics of the flint. Of these, five pieces were found in cluster A and the periphery, and two pieces in cluster C. Both cluster B and the southern part of the excavation, among which cluster D, yielded no products of RMU M17.

RMU M18 (fig. 6.40):
This RMU consists of 29 non-refitted fragments of flakes and blades with cortex parts and a small composition of three refitted flakes (refit group M18.01). They have been described as a separate RMU on the basis of a red-brownish colour of the flint which is translucent at the edges. With the exception of seven surface finds and one plough zone find, all artefacts were found beneath the plough zone. They were lying dispersed over the area of cluster A and its periphery and over the area of cluster C. Two artefacts were at some distance south of this zone: a refitted flake in square 53/197 and an assigned flake in square 61/196. It is striking that in particular large flakes and blade fragments occur in cluster C, while in (the periphery of) cluster A most artefacts are smaller than 3 cm (compare M15). The largest flake measures 6.9 × 8.7 cm and comes from cluster C.

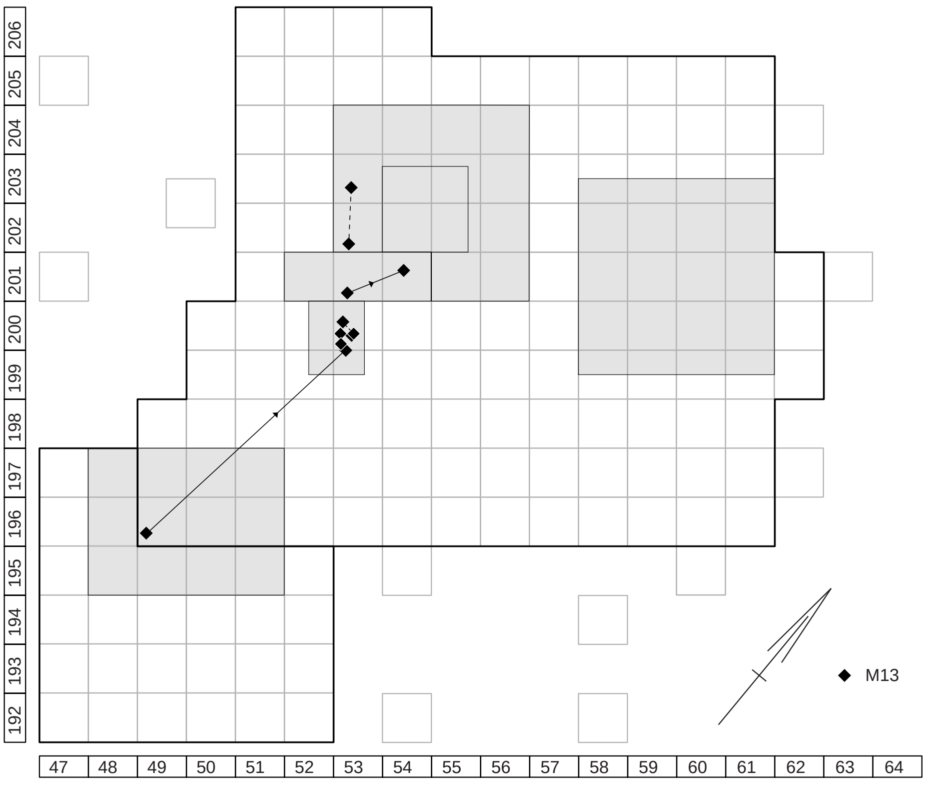


Figure 6.37 RMU M13, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

As RMU M18 only consists of one small refit group of three refitted flakes, very little can be said about the location(s) of the working of the core (which was not found). The location of the three-dimensionally recored artefacts points to a connection between RMU M18 and the central and eastern parts of the excavation, that is the area in which clusters A and C are located.

RMU M19 (fig. 6.41):
On the basis of the colour of the flint, blue-grey patina and eluvial cortex, several artefacts have been described as Rijckholt flint. They have been attributed to one RMU (M19) but are presumably the knapping products of two or more cores. Large compositions of refitted artefacts do not occur. In all cases we are dealing with small refit groups (M19.01 to M19.08) which mainly consist of flakes or fragments of blades. Of the in total 26 refitted artefacts, as many as 20 pieces were collected from the plough zone or from the surface. This number demonstrates that the 'original' distribution of artefacts of RMU M19 was affected to a large extent as a result of ploughing. Among the surface finds are two refitted fragments of a core (refit group M19.00).

Five refitted artefacts were recorded three-dimensionally in cluster A (flake and medial part of a blade), cluster D (flake and fragment of crested blade), and the zone between clusters A and B (fragment of burin). The distribution of artefacts which could not be refitted largely coincides with the central part of the excavated area, from the northern part of the periphery of cluster A to cluster D. South of the latter cluster, no artefacts of RMU M19 have been found. In cluster C, only one flake came to light.

Because of the large number of plough zone and surface finds and the small number of refits, it is not possible to determine specific locations of working. Probably two (or more?) cores of this RMU were worked in clusters A, B and D.

RMU M21 (fig. 6.42):
Of the three artefacts which together form RMU M21 (refit group M21.01), one specimen was found beneath the plough zone. It is a fragment of a retouched blade in cluster B. This

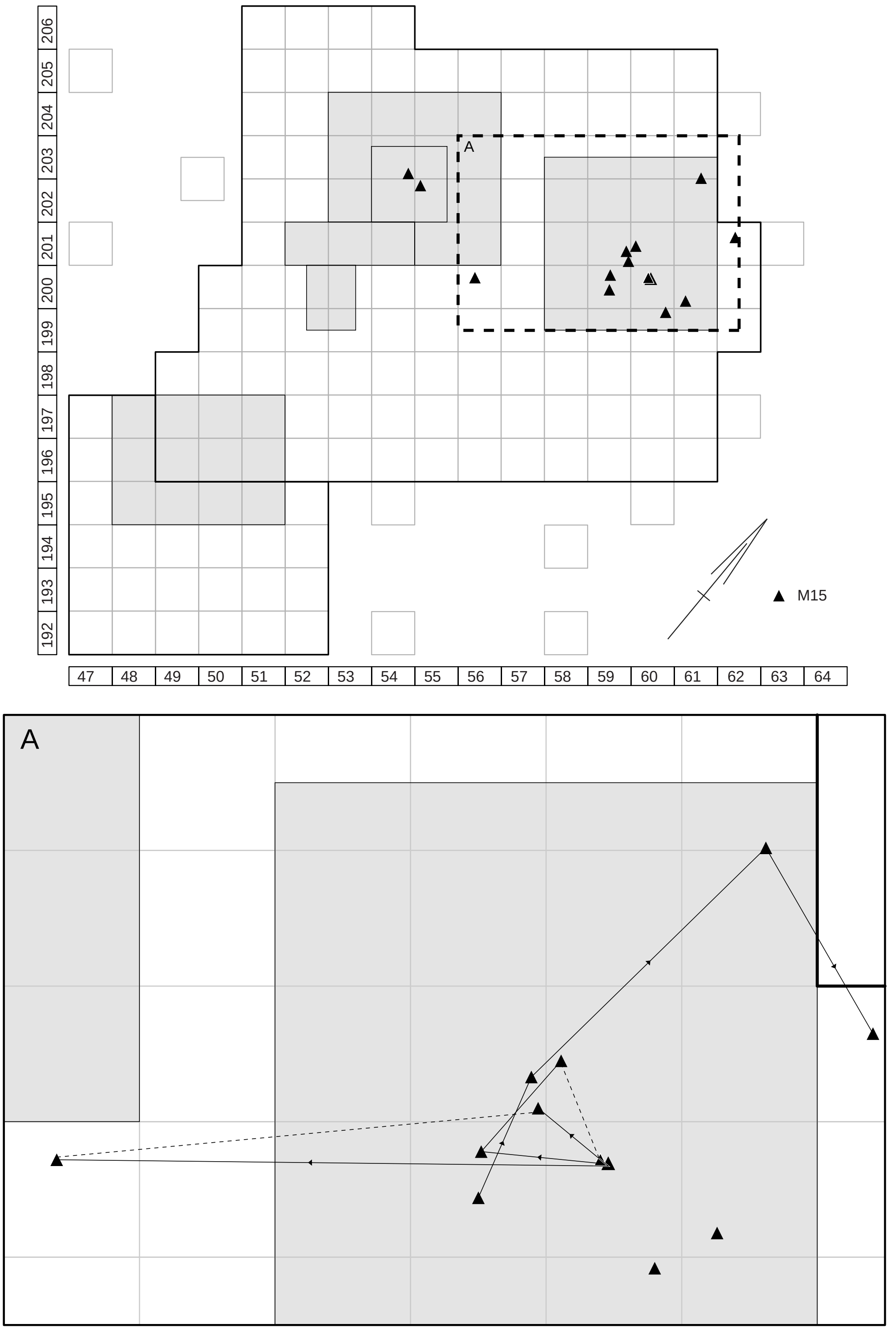


Figure 6.38 RMU M15, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

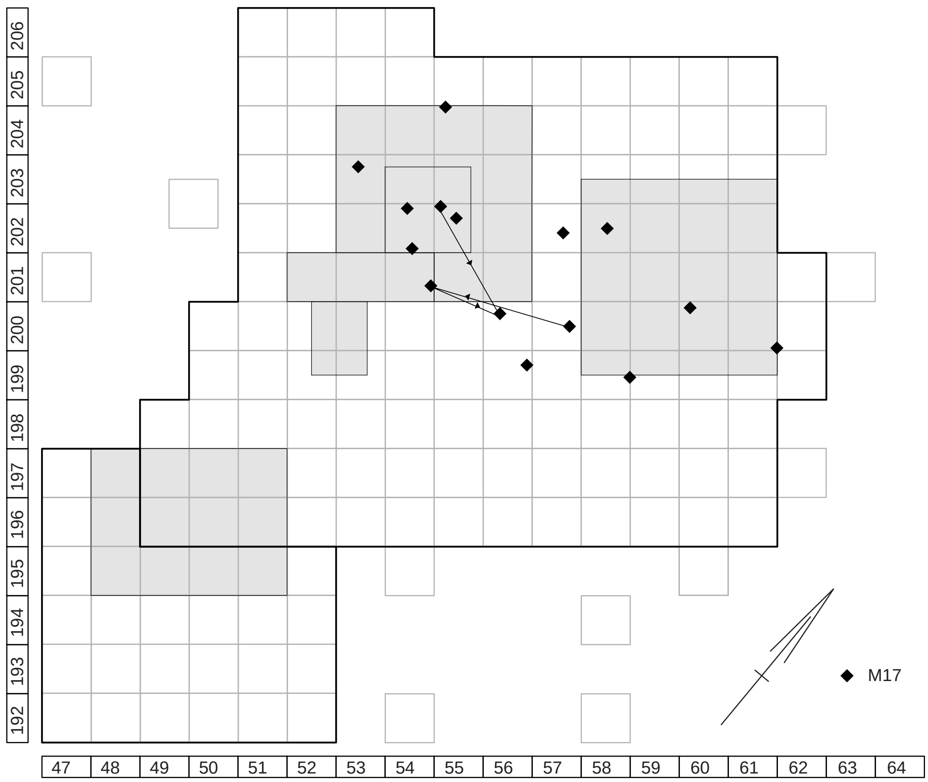


Figure 6.39 RMU M17, horizontal distribution of refitted and assigned artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal. Grid co-ordinates are at metre intervals.

fragment refits onto a complete borer which consists of two conjoined broken pieces. Both broken pieces are surface finds.

6.6.5 Orsbach flint

RMU O1 to O16 (fig. 6.43; table 6.22):
The distribution of refitted artefacts of Orsbach flint (RMUs O1 to O16, refit groups O1.00 to O16.00) makes the importance clear of cluster A and the periphery for the working of Orsbach flint. Of dorsally/ventrally refitted artefacts, several pieces were recovered from this part of the excavation. The number of refitted artefacts, however, is small: in most cases only one or two artefacts could be refitted onto cores. In square 53/199 in the southern part of cluster B, two artefacts of Orsbach flint were found that could be refitted onto artefacts collected in cluster A and/or its periphery. One of these artefacts refits onto a core consisting of five frost-cracked fragments (RMU O3), of which four pieces were found in the area of cluster A. A small core fragment from cluster B forms part of RMU O4, of which a blade and a core rejuvenation flake were measured in three dimensions in cluster A. A distal fragment of a blade and the core onto which this fragment could be refitted, both originate from the periphery of cluster A (RMU O6). Figure 6.43 further shows the position of conjoined fragments of cores of Orsbach flint split along frost cracks, and by means of dotted lines, the relatively large distances between locations of conjoined fragments. The most prominent example of this are two core fragments belonging to RMU O10, of which one fragment was found in square 53/200 (cluster B) and one fragment in square 49/196 (cluster D). Both fragments were lying more than 5.5 metres from each other. Another example are two core fragments in square 57/199, a few metres east of cluster A. They could be refitted onto fragments recovered from cluster A and the peripheral zone. In view of the depth of these fragments, at more than 15 cm beneath the base of the plough zone, it is not likely that the relatively large distances between conjoined fragments were the result of ploughing, whereby cores ‘were pulled apart’ by the ploughshare.

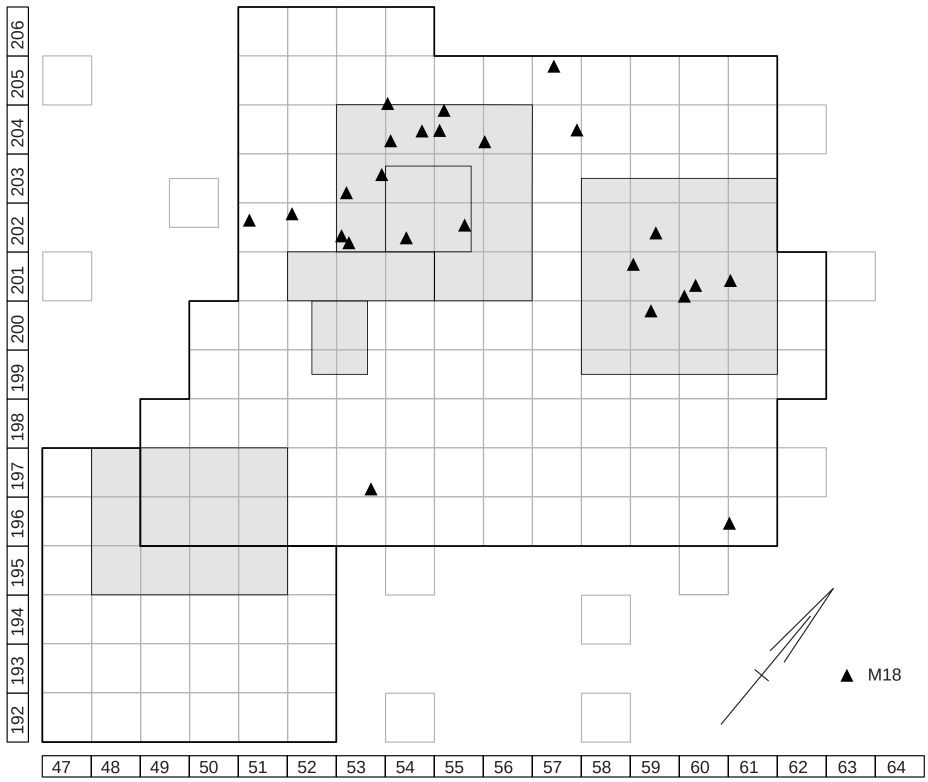


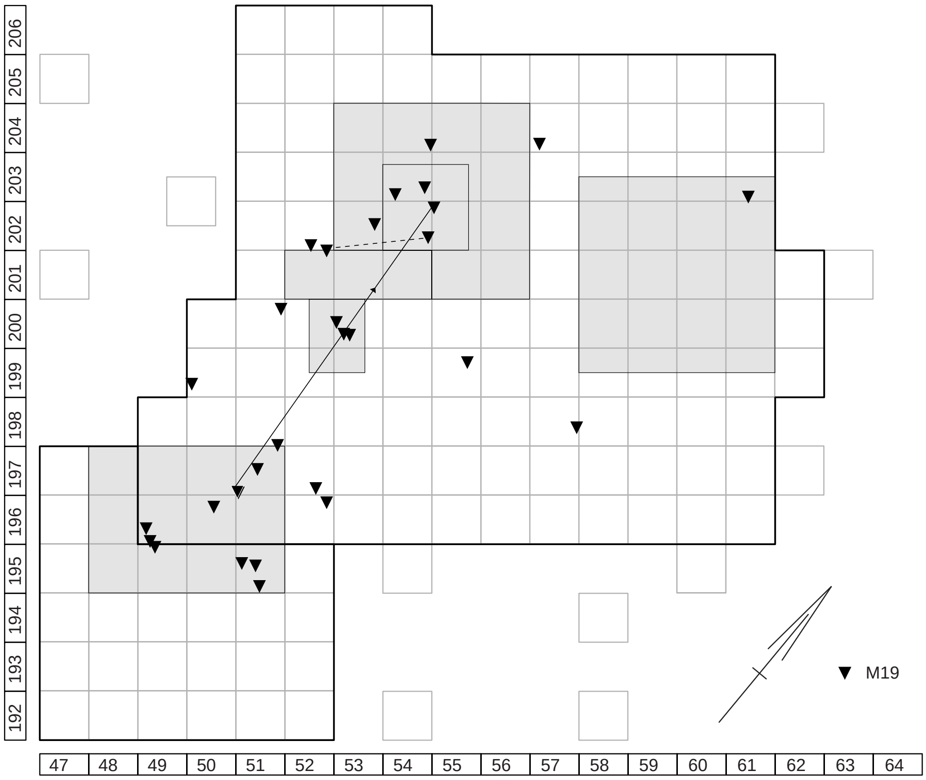
Figure 6.40 RMU M18, horizontal distribution of refitted and assigned artefacts plotted in three dimensions beneath the plough zone. Grid co-ordinates are at metre intervals.

The distribution of refitted artefacts of Orsbach flint in refit groups without a core (O601 – O643) fits in with that of the refit groups with a core (fig. 6.44). The distribution emphasises the importance of cluster A, but also of cluster B for the occurrence of refitted artefacts of Orsbach flint. Clusters C and D lie almost completely outside this distribution. Two conjoined fragments of a blade and the medial part of a crested blade were found in cluster D. The distal part of this crested blade came to light in cluster B. Close to the eastern margin of the excavation, a core rejuvenation flake was found that could be refitted onto a flake recovered from the western part.

6.6.6 Conclusions distribution RMUs (fig. 6.45; tables 6.20 to 6.22)

In tables 6.20 to 6.22, data on the distribution of refitted artefacts of RMUs within the groups of Simpelveld flint, South-Limburg flint and Orsbach flint have been listed. Several RMUs (S1, S3, S308, S309, M1, M5, M7, M8 and M9) are represented by four or more three-dimensionally recorded artefacts in cluster A. Here 35 artefacts of Simpelveld flint and 39 artefacts of Meuse terrace flint (larger than 2 cm) were found that form part of the RMUs mentioned. If we add to these the number of refitted artefacts recovered from the periphery of cluster A it then becomes clear that the peak of the distribution of these RMUs lies in this part of the excavation. We are dealing with a find-rich location where several cores of different types of flint were prepared and where blades were produced. The importance of cluster A for the debitage of Meuse terrace flint is underlined by the occurrence of six refitted artefacts of RMU M3 in the periphery of cluster A. Of other RMUs in the group of South-Limburg flint (M2, M4, M11, M12, M15, M17 and M19), only one or two artefacts were encountered in cluster A and/or the peripheral zone.

Although the number of refitted artefacts is smaller, RMUs O1 to O4 also show a relationship with cluster A. Looking at the results of refitting, it is assumed that these RMUs have also undergone modification in cluster A and/or its immediate surroundings. Outside this area, small numbers of the RMUs mentioned have been found, among which two artefacts in cluster B.



Figiure 6.41 RMU M19, horizontal distribution of refitted and assigned artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

Small cluster B consists of 27 artefacts of RMU S5. Mostly these are flakes larger than 3 cm which form part of refit groups S5.01 to S5.04 (table 6.20). Of RMU S1, only a medial fragment of a crested blade and a flake are represented in cluster B, while knapping products of RMUs S2, S3, S308 and S309 are completely lacking in cluster B. This observation points to cluster B as location of debitage or deposition of artefacts of RMU S5. A relationship with cluster B has not been demonstrated for the other RMUs within the group of Simpelveld flint.

Apart from in cluster A, artefacts of Meuse terrace flint are well represented in cluster B. Four artefacts of both RMU M6 and RMU M7 were found in this cluster, as well as six artefacts of RMU M13. When we look at the spatial position of other artefacts, then RMU M6 has no relationship whatsoever with (the periphery of) cluster A, but does with cluster D. There four refitted artefacts (> 2 cm) of RMU M6 were found. RMU M7 does show a relationship with the area of cluster A though. Of this RMU, eight refitted artefacts were found in this cluster. Of other RMUs within the group of South-Limburg flint, the number of artefacts in cluster B amounts to only one or two. The picture emerges of cluster B consisting of (isolated) flakes and blades of RMUs of which the highest densities of finds occur in cluster A and the periphery (M3, M7, M9) and in cluster D (M6). Remarkable is the high amount of blades (n=16) and the presence of blades with edge damage ('use retouch') (n=3) of South-Limburg flint in cluster B. They point to blade production in cluster B and/or transport of selected end products to this area.

RMUs of which the peak of the distribution *does not* lie in (the periphery of) cluster A or cluster B are S2, M11 and M15. Of RMU S2, five refitted artefacts originate from cluster D and one artefact from the periphery of cluster A, namely a proximal fragment of a blade with a length of 9.1 cm. Products of RMUs M11 and M15 were recovered in particular from cluster C, but also cluster A yielded some artefacts of both RMUs.

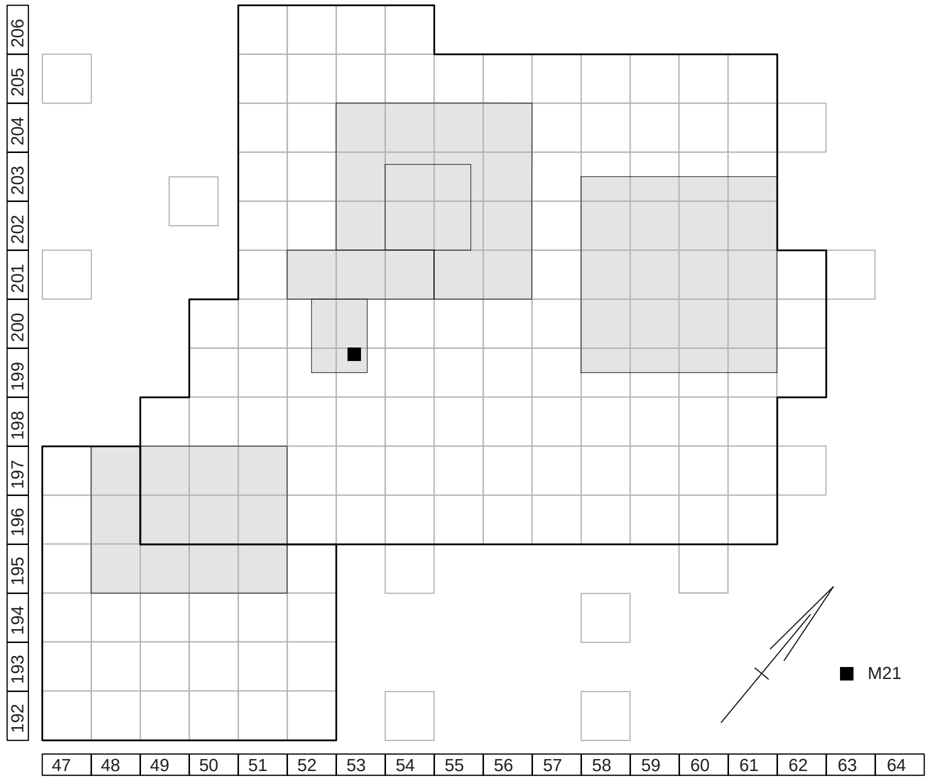


Figure 6.42 RMU M21, position of fragment of retouched blade plotted in three dimensions beneath the plough zone. Two refitted fragments of a borer were collected from the surface. Grid co-ordinates are at metre intervals.

The most important conclusions of the investigation into the spatial distribution of refitted and non-refitted artefacts belonging to RMUs can be summarised as follows (fig. 6.45):

1. Artefacts of Simpelveld flint, South-Limburg flint and Orsbach flint were found in all four clusters. With the exception of one flake, Valkenburg flint is lacking in the main concentration of the Eyserheide site, i.e. cluster A and its periphery;
2. The peak of the distribution of RMUs S1, S3, S308, S309, M1, M3, M5, M7, M8 and M9 lies in cluster A and/or its periphery. Other RMUs show a spatial association with cluster B (S5, M13), cluster C (M11, M15), and cluster D (M6, M10, S2);
3. Of RMUs of which the peak of the distribution lies in cluster A or cluster B, artefacts were also found in other parts of the excavation, both in other clusters and beyond;
4. Taking into consideration the data of refitting and the horizontal distribution of (refitted) artefacts belonging to one and the same RMU, there is no relationship between clusters B and C, and neither between clusters C and D.

6.7 Tools (fig. 6.46; table 6.23)

Among the finds of Eyserheide are 95 artefacts which have been described as retouched tools. Of this number, 52 specimens originate from the surface or from the plough zone. These artefacts form part of the ploughed-up part of the archaeological layer and can have been displaced over several metres as a result of repeated ploughing of the plot of land. For that reason they will not be considered in this paragraph.

The distribution of the retouched tools found underneath the plough zone shows similarities with those of the waste products of South-Limburg flint and Orsbach flint. Most tools were recovered from cluster A, from the periphery of cluster A, from zone A/B and from cluster B (fig. 6.46). In these parts, a total of 26 retouched tools came to light, i.e. 60% of the total number of three-dimensionally recorded tools (n=43). The number of retouched tools in cluster A and the peripheral zone is 19. The tools were made of South-Limburg flint (n=8) and Orsbach flint (n=8). Of Simpelveld flint only few blades and flakes with edge damage (‘use retouch’) were found in this area. Among the tools there are borers, dihedral burins, end scrapers, and a fragment of an steeply

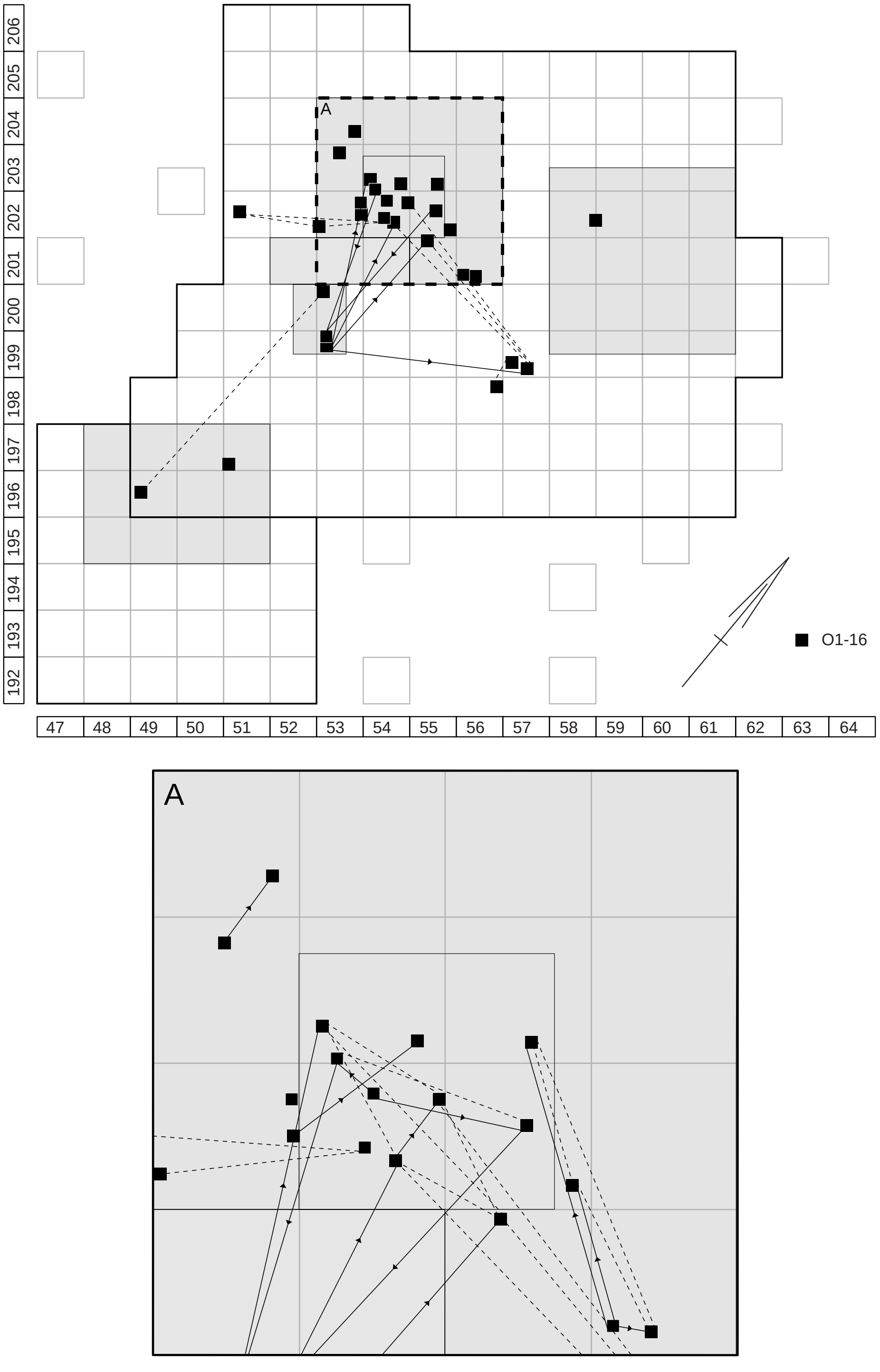


Figure 6.43 RMU O1 to RMU O16, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

			Three-dimensionally recorded and refitted artefacts in loess soil							
RMU	Surface	Plough zone	Cluster A	Periphery cluster A	Cluster A/B	Cluster B	Cluster C	Cluster D	Other sections	N
O1	.	5	1	3	.	.	.	.	.	9
O2	2	1	1	1	.	.	.	.	.	5
O3	.	1	3	1	.	1	.	.	1	7
O4	2	3	3	.	.	1	.	.	.	9
O5	1	2	.	.	.	.	.	.	2	5
O6	.	.	.	2	.	.	.	.	.	2
O7	2	2	.	.	.	.	.	.	.	4
O8	1	.	.	1	.	.	1	.	.	3
O9	1	2	.	.	.	.	.	.	.	3
O10	.	.	.	.	.	1	.	1	.	2
O12	.	.	1	1	.	.	.	.	1	3
O13	.	3	.	.	.	.	.	.	.	3
O14	1	2	.	.	.	.	.	.	.	3
O16	2	.	.	.	.	.	.	1	.	3
Totaal	12	21	9	9	0	3	1	2	4	61

Table 6.22 Spatial distribution of three-dimensionally recorded, refitted artefacts >2 cm of Orsbach flint (RMUs O1-O10, O12-O14, and O16). The first two columns indicate the numbers of artefacts collected from the surface and plough zone.

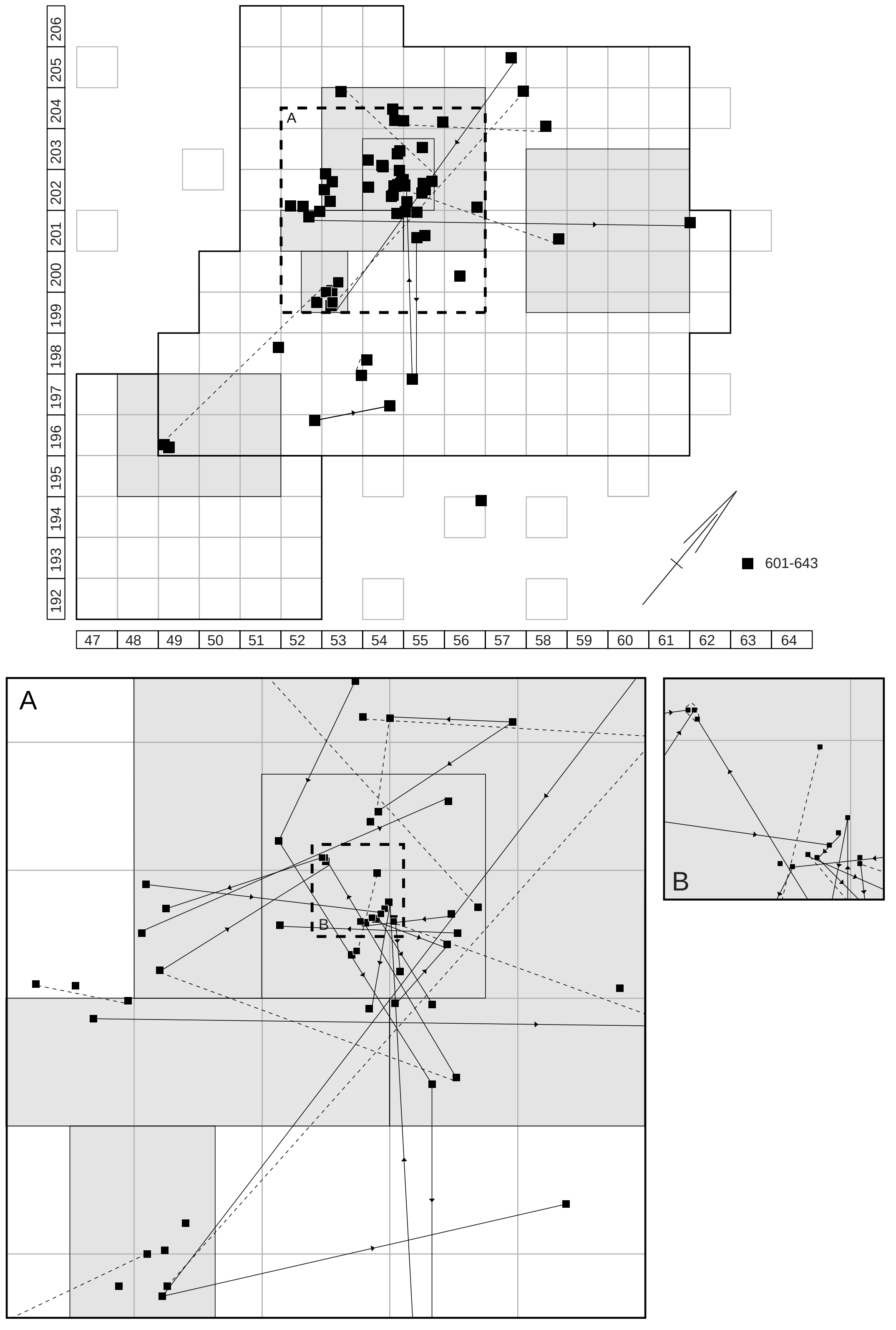


Figure 6.44 O601 – O643, horizontal distribution of refitted artefacts plotted in three dimensions beneath the plough zone. Solid line = ventral/dorsal, broken line = broken pieces. Grid co-ordinates are at metre intervals.

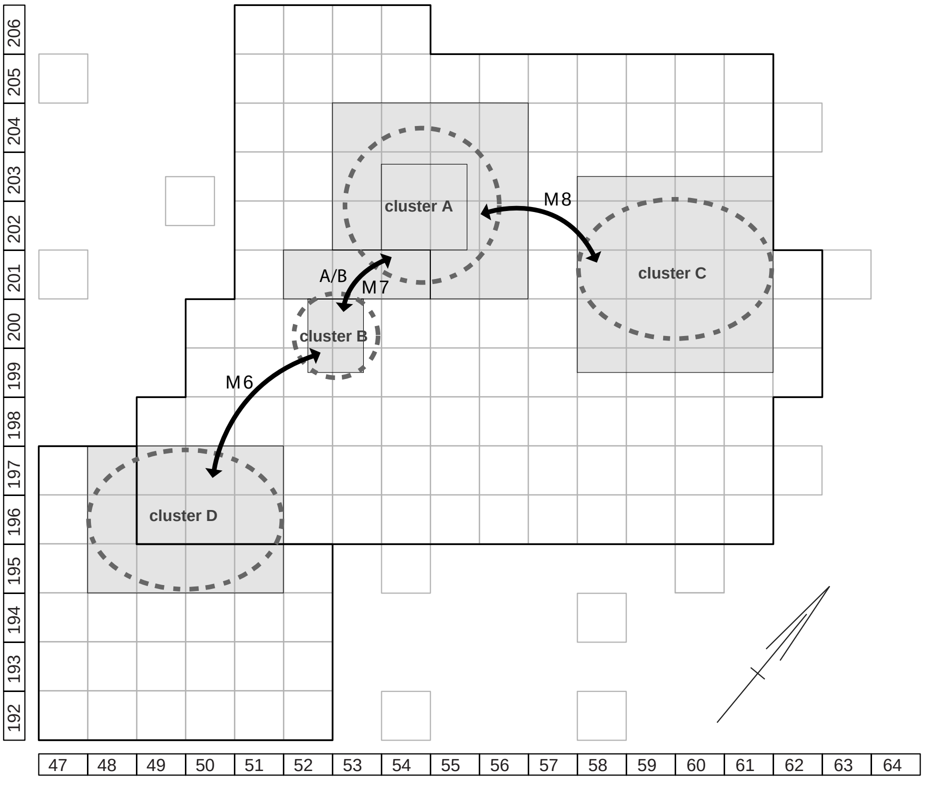


Figure 6.45 Relationships between clusters on the basis of refitted artefacts. Transport of artefacts and contemporaneous use of clusters is indicated by refitting of knapping products especially of RMU M8 (clusters A and C), RMU M7 (clusters A and B) and RMU M6 (clusters B and D).

retouched artefact. Later in this chapter (6.8.4) we will go further into the position of these artefacts when discussing the ring and sector method of D. Stapert (1989). This method was applied to cluster A and surroundings in the central part of the excavation.

The number of retouched tools measured in three dimensions in cluster B is only four, including a borer fragment and a complete burin. The borer fragment is made of Simpelveld flint and the complete dihedral burin of Orsbach flint. One fragment of a retouched blade has been assigned to RMU M21. The other tool is also a fragment of a retouched blade manufactured of Orsbach flint.

Outside clusters A and B, significantly fewer artefacts were found (fig. 6.46 and table 6.23). This does not mean that also in other parts of the excavated area tools could have been used and discarded, for instance in cluster D. Here, compared to the number of waste products of flint working, relatively many retouched tools have been found, among which two end scrapers of Meuse terrace flint (M6 and M13), an end of a Lacan-burin of Orsbach flint, and a fragment of a bec of Valkenburg flint. Furthermore, cluster D yielded a retouched blade of South-Limburg flint. A few metres south of cluster D two burins came to light, at a distance of over eight metres from cluster A. These are a small, broken dihedral burin of Meuse terrace flint (M10) and a burin on a break of Simpelveld flint.

And finally, we should draw attention to an area with some dispersed retouched tools in the eastern part of the excavation, immediately north and south of cluster C. Among these are a broken dihedral burin and a broken-off working edge of a dihedral burin of Orsbach flint. Of the same flint, and just inside the area of cluster C, a fragment of a blade end scraper was found. Cluster C yielded further one truncated blade, and compared to cluster A, the number of retouched artefacts is significantly lower.

An important observation is that in cluster A and in its periphery only some blades displaying edge damage (‘use retouch’) of Simpelveld flint were found, but no retouched tools of this flint. As highlighted in paragraph 6.2.2., in this

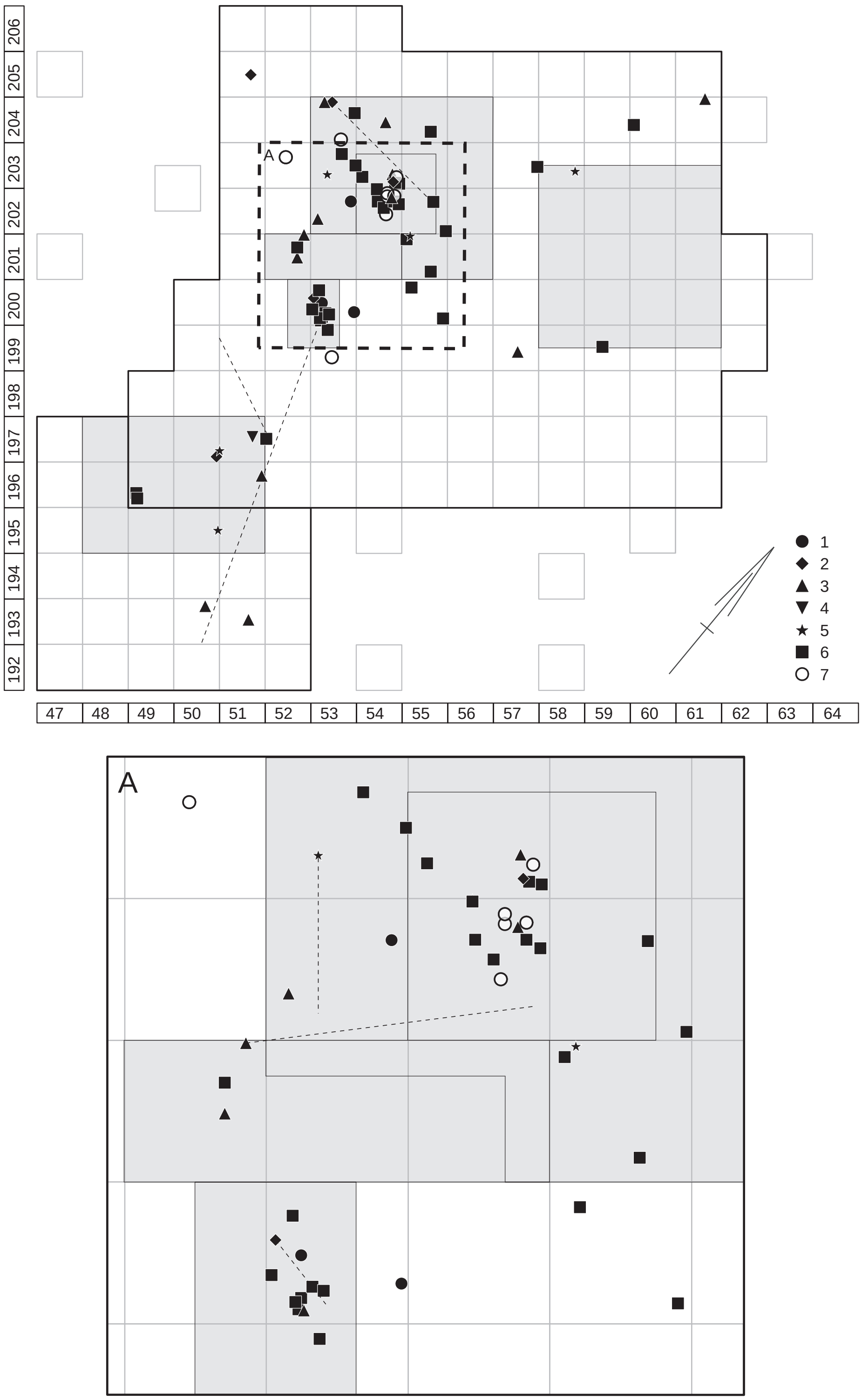


Figure 6.46 Horizontal distribution of three-dimensionally recorded tools. Broken line = conjoined broken pieces of tools. 1 backed bladelet, 2 borer/bec, 3 burin, 4 composite tool, 5 end scraper, 6 retouched blade, blade with edge damage ('use retouch'), 7 retouched flake, flake with edge damage ('use retouch').

			Tools recorded three-dimensionally in loess soil						
Tool type	Surface	Plough zone	Cluster A	Periphery cluster A	Zone A/B	Cluster B	Cluster C	Cluster D	Other sections	N
Backed bladelets	1	3	.	.	.	.	.	.	1	5
Steeply retouched blade	.	.	.	1	.	.	.	.	.	1
Borers on blade	1	1	1			1				4
Booruiteinde	.	.	.	1	.	.	.	.	1	2
Becs on blade	.	.	.	.	.	.	.	1	.	1
Burins on a break	.	1	.	.	1	.	.	.	1	3
Dihedral burins	5	7	2	3	.	1	.	.	3	21
Burins on truncation	.	2	.	.	.	.	.	.	.	2
Bec-steker	.	.	.	.	1	.	.	.	.	1
Broken burins	1	1	.	.	.	.	.	.	.	2
Lacan burins	1	.	.	.	.	.	.	1	.	2
Combination tools	.	.	.	.	.	.	.	1	.	1
End scraper on blade	4	1	1	1	.	.	1	2	.	10
Broken end scraper	.	1	.	1	.	.	.	.	.	2
Scraper on flake	1	.	.	.	.	.	.	.	.	1
Retouched blade	8	3	2	.	.	2	.	1	2	18
Notched blade	.	.	.	.	1	.	.	.	.	1
Truncated blade	4	2	.	2	.	.	1	.	.	9
Piece esquilee	.	1	.	.	.	.	.	.	.	1
Retouched flake	1	2	2	.	.	.	.	.	1	6
Notched flake	.	.	1	1	.	.	.	.	.	2
Total	27	25	9	10	3	4	2	6	9	95
Blades with edge-damage	5	4	8	4	.	6	.	1	4	32
Flakes with edge-damage	.	1	.	1	.	.	.	.	2	4
Total	32	30	17	15	3	10	2	7	15	131

Table 6.23 Spatial distribution of three-dimensionally recorded retouched tools (per type) and flakes/blades displaying edge damage ('use retouch'). The first two columns indicate the numbers of tools collected from the surface and plough zone. Counts before refitting of broken pieces.

area both debitage waste and many (fragments of) long and regular blades of Simpelveld flint were found. It underlines the notion that blades of Simpelveld flint may have been produced on the spot for use in other camp sites in the Meuse-Rhine loess area.

6.8 Clusters A and B: interpretation

6.8.1 Introduction

With a view to intra-site spatial analysis and, also based on the results thereof, to a functional interpretation of the site of Eyserheide, (the periphery of) cluster A and nearby cluster B take up an important position. This part of the excavation with a surface of c. 20 m^2 is characterised by a high density of retouched tools, flint debitage, and fragments of unworked, partially heated natural stone (see 6.8.2). With regard to the slightly circular cluster A, the question seems justified whether the archaeological material found there represents the residue of activities around a central hearth, and if so whether these activities took place inside or outside a tent or hut structure. To what extent does the horizontal distribution of the finds indicate the presence of one or more habitation structures? And which activity areas, whether or not connected to a hearth, could possibly be recognised in this distribution?

Before we will address these questions, we shall examine in the next paragraph whether we are possibly dealing with a central hearth in cluster A (6.8.2). Subsequently, the distribution of flint artefacts in the area of clusters A and B will be confronted with the hearth seating model of L. Binford (6.8.3) and with the ring and sector method of D. Stapert (6.8.4). Data that can be inferred from this model and this method will in their turn be evaluated based on data on cultural and natural (post-depositional) formation processes in this part of the excavation (6.8.5). At the end of this chapter (6.9) a general conclusion regarding the use and organisation of the camp site of Eyserheide is presented.

6.8.2 A central hearth or not?

A frequently occurring phenomenon in well-preserved Magdalenian open-air sites in Northwest Europe are hearths constructed with stones (see for instance Olive 1989, Plumettaz 2007). Also based on ethnographical research, they are generally regarded as focal points of domestic activities, such as the preparation of food, working of stone, and manufacturing and repairing of hunting gear. The fire places not only provided heat, but also light and were thus a central component from the perspective of communication between group members and social activities of the group (also) in the evenings. Starting from this role as focal point, much importance should be attached to the occurrence of hearths in prehistoric hunter-gatherer sites. They form a suitable point of departure for spatial analysis and the application of methods aimed at determining the way in which camp sites were used and organised. As Leesch et al. (2010, 53) observe:

> "Detailed studies of well-preserved sites have demonstrated that most of the domestic and technological activities performed in Magdalenian camp sites took place in the immediate vicinity of hearths. Consequently, as many authors have already underlined, fireplaces present the major site-structuring features crucial for the understanding of Upper Palaeolithic human behavior."

The presence of a hearth manifests itself in different ways in the archaeological record of the Magdalenian. Clearly visible are hearths constructed with stones, of which the hearth stones bear traces of heating and the spatial lay-out is still intact, as part of well-preserved living floors in open-air sites such as Verberie, Etiolles and Champréveyres. But also locations with heat-altered sediment and concentrations of charcoal, burnt bone and ash can indicate a fire place during the occupation of a camp site. In cases where direct evidence is lacking, the distribution of burnt stone artefacts and of backed bladelets can be an indirect means for determining and locating hearths. In the Swiss open-air sites of Champréveyres and Monruz, backed bladelets have been found in close spatial association with remnants of hearths. These tools are generally regarded as part of hunting gear, as "small lithic elements that probably formed the lateral inserts of the antler projectile points" (Leesch et al. 2010, 65). The position of backed bladelets in the immediate vicinity of hearths is the result of performing activities connected with the manufacture and maintenance of hunting gear. For this fire was required "to soften the adhesive in order to remove the used pieces and to haft new ones onto the points".

In Eyserheide, an intact hearth constructed with stones has not been found in cluster A, nor in any other part of the excavation. Moreover, possible other traces (charcoal, burnt bone and/or ash) of a hearth probably were destroyed completely as a result of (Holocene) soil formation, already a long time before the disturbance of the archaeological layer by modern human land use. Looking at the position of unworked stone, we observe that fragments of these were found in particular in the centre of cluster A, in the eastern part of square 54/202 and the western part of square 55/202 (fig. 6.47). The majority of these has been described as a very fine siltstone (code 15), including two fragments bearing traces of hematite which must have been formed after heating of the stones (see 6.2.6). No red-coloured surfaces, cracks or other traces were observed on other fragments of siltstone that could point to contact with fire. In contrast, fragments of other types of stone, recorded three-dimensionally in the same area, do display traces of

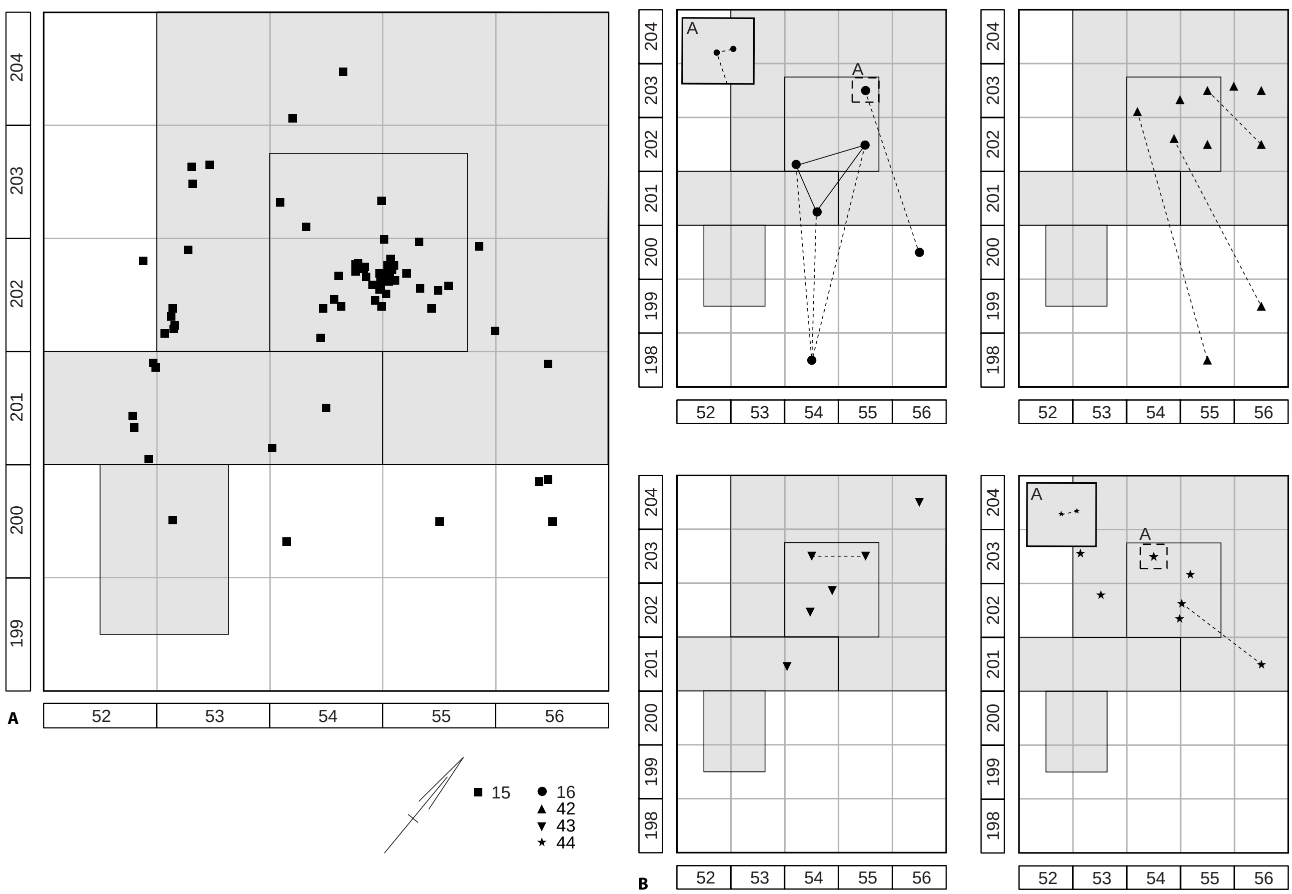


Figure 6.47 a: Clusters A and B and surroundings. Distribution of fragments of fine siltstone (code 15) plotted in three dimensions beneath the plough zone; b: Clusters A and B and surroundings. Distribution of fragments of quartzitic sandstone from the Devonian (code 16), fine-grained sandstone from Meuse gravel (code 42), quartzitic sandstone (code 43) and coarse-grained quartzite (code 44). Solid lines represent refits between fragments plotted beneath the plough zone. In cases of a broken line, refits include stone fragments collected from the plough zone.

heating (figs. 4.37 and 4.38). They were lying close together in an area of 2 × 1.5 m, with two fragments on the boundary of squares 54/202 and 55/202. Some of these could be refitted onto larger fragments, also bearing traces of heating and originating from the plough zone. During trowelling of the plough zone, refitted conjoined fragments were found in particular east and southeast of cluster A, dispersed over an area of c. 6 × 3 m. These stones were ploughed up from the archaeological layer and, after incorporation into the plough zone, could have been displaced over a few metres as a result of ploughing. These are both fragments of quartzitic sandstone from the Devonian (code 16), fine-grained sandstone from Meuse gravel (code 42), quartzitic sandstone (code 43), and coarse-grained quartzite (code 44). In view of the position of the three-dimensionally recorded pieces in cluster A, it is plausible that these fragments are connected with the occupation of Magdalenian hunters and gatherers of the camp site of Eyserheide. An interpretation of these stones as remnants of a small hearth structure is evident. The exact size and shape cannot be further specified as a result of the high degree of disturbance.

Other indications of a hearth in the site of Eyserheide are very rare. From the central part of the excavation with a surface area of 42 m^2, including clusters A and B, originate only 24 (fragments of) burnt artefacts. Their distribution is very random: there is no clear clustering in the centre of cluster A. Hence, they do not form an indication of the location of a hearth. The rare occurrence of burnt artefacts is a general feature of open-air sites from the Magdalenian. Leesch et al. (2010, 64) give the following explanation:

"The particularly low proportion of burned flints in Late Upper Paleolithic context is a characteristic feature of this period and is probably related to the mode of functioning hearths … The stone-covered structures functioning with brushwood would indeed largely prevent the flakes and chips produced in the immediate vicinity of the hearth to drop among the embers."

Another method which may enable us to locate hearths, namely based on the position of backed bladelets, cannot be applied to the site of Eyserheide. Of this type of tool, only one implement has been found underneath the plough zone, in square 53/200 close to cluster B. Although we should bear in mind the possibility that backed bladelets were not observed during the trowelling of the sediment of the non-ploughed part of the loess soil, this is not the case for cluster A and the periphery. During the sieving of the sediment of squares in this area, no (fragments of) backed bladelets were found in the sieve residue.

Based on the above data, the following can be concluded. The position of conjoined fragments of heated stone in the find-rich area of cluster A (both measured in three dimensions and plough zone finds) makes us presume that we are dealing with the remnants of a hearth constructed with stones. In view of the position of the heated stone fragments and the clustering of numerous fragments of very fine siltstone (including two fragments which display traces of heating) in the same area, a position of the presumed hearth in the centre of cluster A, near co-ordinates 55.00 / 202.60, is considered likely. It should be emphasised here that this is a rough determination of the location. As a result of bioturbation and the disturbing actions of the plough, stones have become dispersed, as can be inferred from the distances between conjoined broken pieces (partially with fresh breaks!). For this reason the exact location of the (presumed) hearth cannot be determined with certainty. Also activities related to the use and possible maintenance of the hearth, such as the clearing-out of burnt and broken stones, can no longer be determined. If we view the presence of heat-altered stones in the area of cluster A, then we can assume a small structure with few furnishings (compare *foyers cuvettes* and *foyers plats* from Pincevent).

6.8.3 Binford's hearth seating model

Ethnographical and ethnoarchaeological investigations of camp sites of historically documented hunters and gatherers have been of great value for the analysis of spatial patterns in Late Upper and Late Palaeolithic sites (see for instance Gamble and Boismier 1991). In this respect, the work of L. Binford deserves a special mention. Binford describes the way in which Nunamiut Eskimo deal with waste in the Mask site, an observation stand with five hearths in North Alaska (Binford 1978, 1983). Point of departure is a small group of people who on one side of a central hearth and in a sitting position are performing activities in the open air. The material residue of these activities is expressed in fixed spatial patterns, namely drop zones, forward toss zones, backward toss zones, and dumps (fig. 6.1b). The drop zone corresponds with the area where the persons are seated and consists of small objects and waste which fall to the ground during the carrying-out of activities. As people are seated on one side of the hearth, the shape of the drop zone is semi-circular. Larger objects and larger waste are for practical reasons thrown backward (backward toss area) or forward (forward toss area) and end up in the toss zones. The backward toss zone is located behind the positions of the seated persons, while the forward toss zone extends to the other side of the hearth. The toss zone is not only distinguished from the drop zone by its position in relation to the hearth. There are also differences in the sizes of the objects and the waste that are found there: small objects and small waste in the drop zone versus larger, thrown-away objects and waste in the toss zone. Binford considers the handling of waste described here as typical of activities around a central hearth in the open air. In covered areas, where the hearth forms the centre of a tent or hut, a toss zone is lacking or this zone stands out less clearly. The reason for this is that food remains and stone debitage are not left lying about inside but that they are collected and carried away outside in a concentrated form. At some distance from the tent or hut, they are deposited in the form of dumps (Binford 1983).

With the aid of his hearth seating model, Binford subjected the tent model of Leroi-Gourhan (1966) for Pincevent Habitation no. 1 to a further investigation (see 6.1). For this unit, Binford concludes that only the southeastern hearth I was possibly lying inside a habitation structure. The other hearths II and III meet his criteria for outdoor hearths: there are drop zones and toss zones in the distribution of finds around both hearths. According to Binford, both hearths were not in use simultaneously. Change of wind direction was for the inhabitants reason to construct and utilise a new hearth. They thereby took up a different position in relation to the hearth in order to avoid the smoke (Binford 1983, 157).

Application of the hearth seating model to the spatial distribution of stone artefacts in cluster A and surroundings in the Eyserheide site yields the following picture. Figure 6.48a shows an overview of the distribution of all flint artefacts in units of 50 × 50 cm in and around cluster A. The units with the highest number of artefacts are immediately west and south and at maximally two metres from the supposed location of the hearth (= LH with co-ordinates 55.00/202.60). If we divide the artefacts into three size categories (< 2 cm, 2-5 cm, and > 5 cm) and we

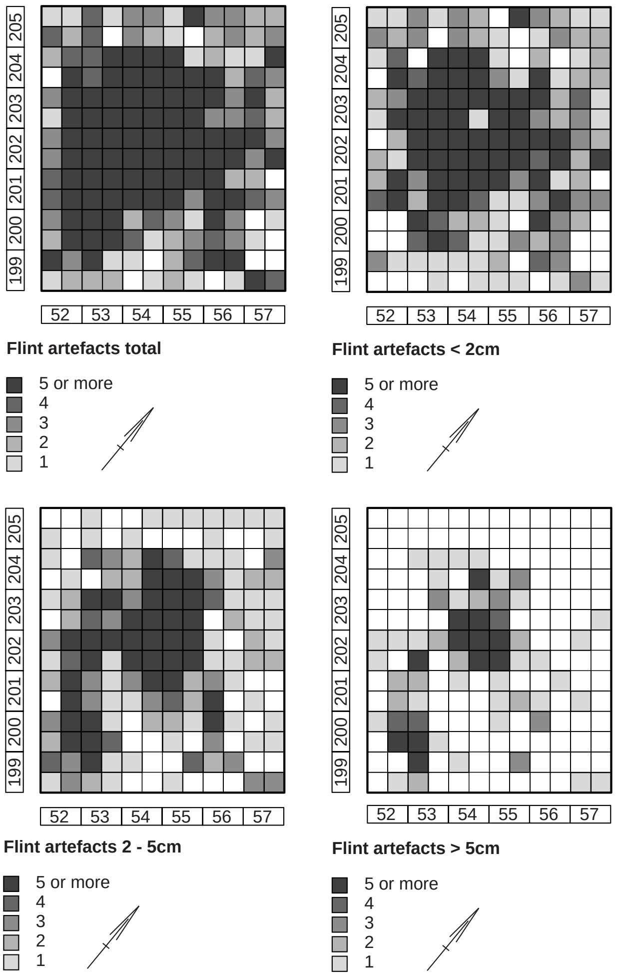


Figure 6.48 Clusters A and B and surroundings. Densities of flint artefacts in units of 50 x 50 cm (total of artefacts) and according to size (<2 cm, 2-5 cm, and >5 cm).

look at the spatial distribution of artefacts according to size category, then the following points are noticeable (fig. 6.48 b-d):

– the units with the highest numbers of artefacts are located in particular close to LH. This observation also applies to artefacts larger than 5 cm, of which we can presume that all pieces have been found beneath the ploug zone during the excavation. But also the distribution of artefacts between 2 and 5 cm corresponds with this picture, though units with relatively high numbers of artefacts also occur at larger distances from LH. Artefacts smaller than 2 cm have been found over a larger area and more dispersed, but also in this case are the units with high densities lying nearby and mainly (south)west of LH. From this observation can be concluded that we cannot speak of a clear difference in the spatial distribution of small, medium and large artefacts, as can be expected when assuming Binford's hearth seating model.
– east of LH, the number of units of 50 × 50 cm with large numbers of artefacts between 2 and 5 cm and larger than 5 cm is lower than west of LH. This observation argues against the presence of a forward toss zone. Nonetheless, it cannot be excluded that artefacts have ended up on the east side of LH as a result of throwing away of objects or larger pieces of stone waste.
– if we look at the distribution of the medium artefacts (between 2 and 5 cm) then two narrow zones with larger numbers of artefacts are visible south of LH. They are separated from each other by a relatively find-poor area. One of these zones borders directly onto LH, while the second zone lies about 3 m south of LH. Also in this second zone there is one unit in which relatively many (n=5) artefacts larger than 5 cm were found. Although these numbers are small, this spatial picture could be seen as an indication (though a weak one) of the presence of a backward toss zone.

6.8.4 *Stapert's ring and sector method* (fig. 6.49a-b; table 6.24)

The distinction described in the previous paragraph between drop zones and toss zones underlies the ring and sector method of D. Stapert (1989, 1990). The method consists of dividing the distributions of finds ('mobilia') around central hearths (domestic hearths) in Palaeolithic sites into rings and sectors. By counting the number of tools, cores and burin spalls per ring of 50 cm and per sector of 60 degrees, it can be determined whether and if so in which parts of a concentration, the mentioned categories of finds are present in small or large numbers. Stapert has applied the ring and sector method to several Late Upper and Late Palaeolithic sites, such as Oldeholtwolde (Hamburg culture), several habitation units in Niveau IV-2 of Pincevent, and in Gönnersdorf CI and CIII (Magdalenian). From this analysis, two types of distributions emerged. In the first distribution (unimodal), most tools occur near the hearth (often between 0.5 and 1.5 m), and the number of tools decreases as the distance to the hearth increases. Stapert considers this distribution as characteristic of activities around hearths in the open air (open-air hearths). In the second distribution (bimodal), there is a first peak between 0.5 and 1.5 m, and a second peak between 2 and 3 m from the hearth. Stapert gives as explanation for this second peak the throwing away backward of objects and the landing and accumulation of these objects against an obstacle, that is to say the

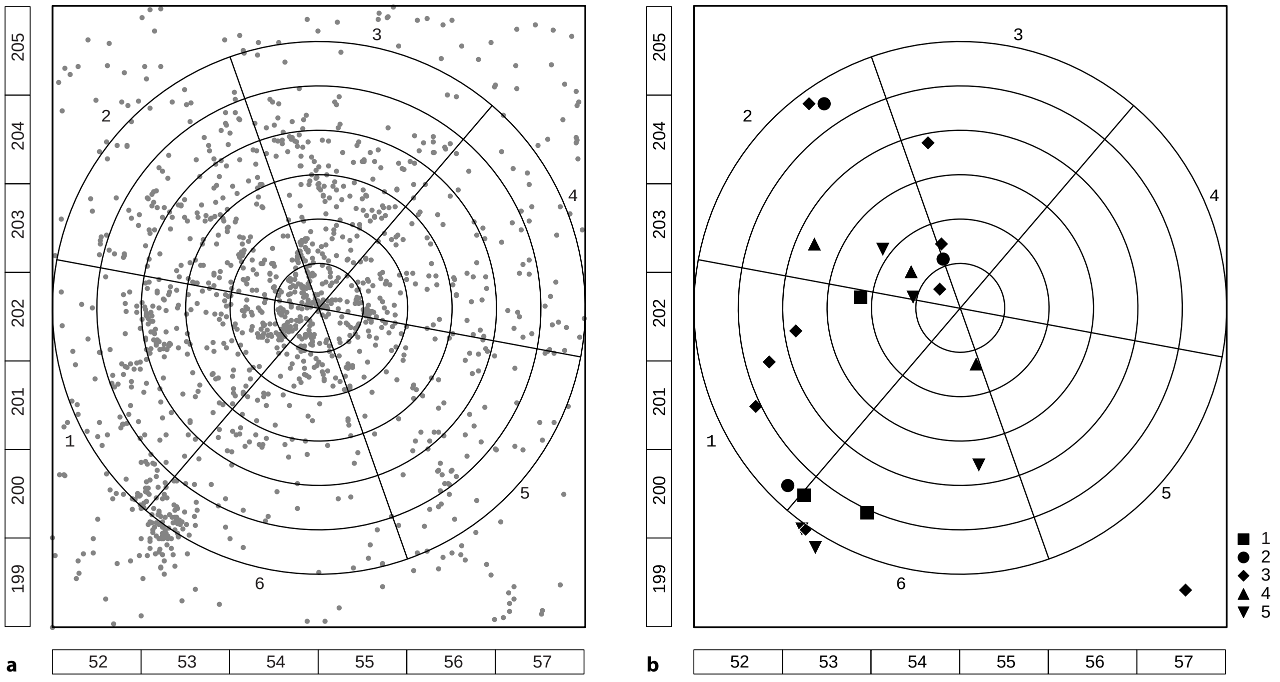


Figure 6.49 Clusters A and B and surroundings. Division of the central part of the excavation into rings and sectors (1-6) according to Stapert's ring and sector method, and distribution of all artefacts (a) and retouched tools (b) plotted in three-dimensions. 1 backed bladelet or blade, 2 borer/bec, 3 burin, 4 end scraper, 5 retouched blade.

wall of a tent or hut. This is called the barrier effect. Stapert regards a bimodal distribution as indication of activities carried out around a central hearth located in a tent or hut. Based on the results of the ring and sector method, Stapert assumes for Pincevent hearths in the open air. All analysed habitation units are characterised by unimodal ring distributions.

The fact that in Eyserheide all flint artefacts found underneath the plough zone were measured in three dimensions, makes it possible to apply the ring and sector method of intra-site spatial analysis to cluster A and surroundings. The area was thereto divided into six rings with a width of 0.5 m, and into six sectors. Two important assumptions were thereby made, namely 1) artefacts in cluster A reflect activities carried out in the immediate vicinity of a hearth, and 2) the hearth was located in the central part of cluster A, approximately level with co-ordinates 55.00 and 202.60.

Earlier in this paragraph (6.8.2), we discussed the issue and problems related to the determination of the presence and the exact location of a hearth in cluster A. When reading the text below and in the evaluation of the results of the ring and sector method, this issue should be borne in mind.

The supposed location of the hearth (LH) acts as centre of the division of cluster A and surroundings into rings and sectors, based on the coordinates 55.00 and 202.60. Using six sectors Stapert regards as a sufficient number for sites with low densities of finds within 3 metres from the centre of the hearth. In order to be able to compare the results in a proper way with other sites analysed by Stapert, we have opted for not letting the sectors coincide with x or y co-ordinate lines which form part of the grid system used in Eyserheide. For the sake of analysis, cluster A was divided into two halves based on a dividing line, the orientation of which is exactly north-south. This line was used as point of departure for determining the boundaries of the six sectors by means of marking off angles of 60 degrees. Subsequently, numbers of the following categories of retouched tools were counted per ring and per sector: backed bladelets, burins, end scrapers, borers/becs, and retouched blades. Because of the small number of complete cores, it was not meaningful to include this category of finds in the analysis. In several sites, cores have been found in particular in the periphery at a larger distance from the hearth, which is probably related to the forward and backward throwing of these artefacts into the toss zones. Whether this pattern also applied to the site of

Distance to supposed location of hearth (in cm)						
Ring	Backed blade	Borer/bec	Burin	End scraper	Retouched blade	N
0-49	.	.	1	.	.	1
50-99	.	1	1	2	1	5
100-149	1	.	.	.	1	2
150-199	.	.	2	1	1	4
200-249	.	.	1	.	.	1
250-299	2	2	2	.	.	6
Total	3	3	7	3	3	19
Sector	Backed blade	Borer/bec	Burin	End scraper	Retouched blade	N
1	1	1	3	.	.	5
2	.	2	2	2	2	8
3	.	.	2	.	.	2
4	.	.	.	.	.	0
5	.	.	.	.	.	0
6	2	.	.	1	1	4
Total	3	3	7	3	3	19

Table 6.24 Results of counting the retouched tools according to Stapert's ring and sector method.

Eyserheide could unfortunately not be determined due to the small number of complete cores found beneath the ploughzone.

The results of the ring and sector method are summarised in figure 6.49 and table 6.24. From the table it is clear that the distribution of the retouched tools over the six rings of 0.5 m is very random. Tools have been measured in three dimensions both near to the central point of LH and at a greater distance from this point. Thus, (fragments of) burins were found in five out of six rings. Relatively many tools were found between 0.5 and 1 m (n=5); 1.5 and 2 m (n=4), and 2.5 and 3 m (n=6). The observed spatial distribution consisting of three 'peaks' cannot be called either unimodal or bimodal, as is common in Late Palaeolithic sites (Stapert 1989, 37). The distribution in Eyserheide is such that there is no question of a meaningful pattern.

The distribution of retouched tools over sectors clearly shows a different picture (fig. 6.49b). In sectors 4 and 5, east of LH, retouched tools are lacking completely (!). On the other side of LH, 15 out of 19 retouched implements were found in sectors 1, 2 and 3. These sectors form the western half of cluster A. Such a distribution with large numbers of tools in the western part of a concentration is a general feature of Magdalenian sites with a central, domestic hearth. Examples are several habitation units in Pincevent. Stapert (1989) supposes that this distribution is related to the wind direction at the time of occupation of the camp sites. Not to be inconvenienced by the smoke, the inhabitants were seated on one side of the hearth with the wind coming from the back. The pattern is regarded as an indication of the position of the hearths and the performing of activities in its immediate vicinity in the open air. In the case of a tent of hut structure, the wind direction would probably not have played an important role in the choice of seats around the hearth. In that case, the distribution of retouched tools would have had a different character. Another argument in favour of activities in the open air is the lack of accumulations of tools/artefacts at greater distance from the hearth. No indications are visible in the distribution of artefacts of the barrier effect, in the form of an enrichment of finds in the outer ring 6 of sectors 1, 2 and 3 (distance to centre of 'hearth' is 2.5 to 3 m) or possibly at a greater distance from there.

Because of the small number of tools, it is not meaningful to compare different types of retouched tools with each other with regard to their distance to the supposed location of the hearth. Thus, only one backed blade was recorded three-dimensionally in the analysed area of cluster A. The spatial pattern that has been established for habitation units in Pincevent, namely backed bladelets near the hearth, borers and burins at a slightly large distance, and scrapers even further from the hearth (Stapert 1989), can for this reason not be established in a meaningful way for Eyserheide.

6.8.5 Evaluation

In the preceding two paragraphs, we discussed the distribution of the archaeological finds (flint artefacts) in the central, find-rich part of the excavation at Eyserheide, confronting this distribution with the hearth seating model of Binford (6.8.3) and the ring and sector method of Stapert (6.8.4). In this analysis, we assumed an ideal situation of intra-site spatial analysis, i.e 1) cluster A represents the remains of one activity area or one habitation unit with a central hearth, and 2) the archaeological materials of this cluster were found in primary archaeological context. In this paragraph, we will examine both points in more detail using additional data on cultural and natural site formation processes for the central part of the excavated area (clusters A and B).

1) Stapert (1989) points to two factors that should be taken into account when using his ring and sector method and determining the number of rings and thus the maximum distance between the centre of the domestic hearth and the outer ring. Within the area to be analysed, there should not be two or more overlapping habitation units. And the area to be analysed is characterised also by the absence of dumps. In the case of Eyserheide, a distance of three metres was chosen between the centre of the supposed location of the hearth and the outer ring. By using this distance, the northern part of cluster B falls within ring 6 of the analysed area. The cluster is located c. three metres south of the centre of cluster A. Not only its small size, but also the composition of artefacts is noticeable in this cluster. The cluster consists of 35, mostly refitted flakes belonging to RMU S5. They are to a large extent responsible for the designation and defining of the location as cluster B. But even if we leave these artefacts aside, this is a small but important area. In contrast to cluster A, artefacts of Valkenburg flint have been found here. In addition, 16 flakes and 16 (fragments of) blades of Meuse terrace flint occur. They partly originate from RMUs of which knapping products have also been found in cluster A (M3, M7, M9) and cluster D (M6, M10).

The chance that cluster B represents a second habitation unit at a short distance from cluster A, is considered small. The very small size of the cluster (1.8 × 0.7 m) and the relatively small quantity of flint artefacts are indications of this. The possibility of cluster B reflecting a small dump cannot be excluded though. With a view to an interpretation of cluster B, it is important to note that almost no knapping products of RMU S5 were found outside cluster B, with the exception of a few pieces in the southern part of the excavation (fig. 6.20). In cluster B itself, no flake or chip smaller than 2 cm of RMU S5 was found, which would have been expected had this RMU (also) been worked at this location. For this reason cluster B is not seen as the location of debitage of RMU S5. An interpretation as dump of preparation flakes of this RMU which represent an early stage of core reduction, completed with a few (used?) blades and flakes of other RMUs, is more likely. Besides, it should be borne in mind that artefacts could have ended up in cluster B as a result of post-depositional processes.

Taking into consideration the position of the northern part of cluster B within the analysed area, we should bear in mind that the retouched tools in ring 6 and in sectors 1 and 6 (see fig. 6.49b) possibly do not relate to activities carried out in cluster A around a central hearth (hearth-related activities). But even if we exclude these implements from the analysis, the general picture of retouched tools clustering in the western part of cluster A (sectors 1, 2 and 3) remains intact.

2) To gain further insight into natural site formation processes and the extent to which parts of the analysed area of clusters A and B have been disturbed, an overview was made of the depth of three-dimensionally measured artefacts in the non-ploughed part of the loess soil. Per square of 1 × 1 m, the number of artefacts was counted recovered from the base of the plough zone to a depth of maximally 30 cm (layers 1 to 6), and the number of artefacts that occurred at a deeper level (layers 7, 8 etc.) If almost all or all artefacts were recovered from the upper 30 cm, it is considered an indication of a relatively small extent of disturbance of the archaeological layer as a result of bioturbation and specifically of tree falls. For squares with high numbers of artefacts at a deeper level (more than 30 cm) beneath the plough zone, a larger extent of disturbance of the archaeological layer is assumed. In these squares more artefacts were found at a deeper level than could be expected exclusively based on homogenisation (bioturbation).

The result of this counting of artefacts is represented in figure 6.50. From this figure can be inferred that within the area of 30 m^2, large differences exist at short distance in the vertical distribution of artefacts and thus in the degree of disturbance of the archaeological layer. There is a relatively high degree of disturbance in the western part (squares 53/201, 52/202, 53/202 and 53/203). The majority of these squares corresponds with the area of the tree fall which shows up as a discoloration in the loess soil immediately west of cluster A. In nine out of twelve squares in the central part of the analysed area (squares with x co-ordinates 54 and 55), the vertical distribution of the artefacts is limited largely or completely (80 to 100%) to the upper 30 cm of the non-ploughed area of the archaeological layer. This part corresponds with cluster A and some adjacent squares that form part of the periphery of cluster A. Compared to the adjacent squares, only square 55/201 shows a large vertical

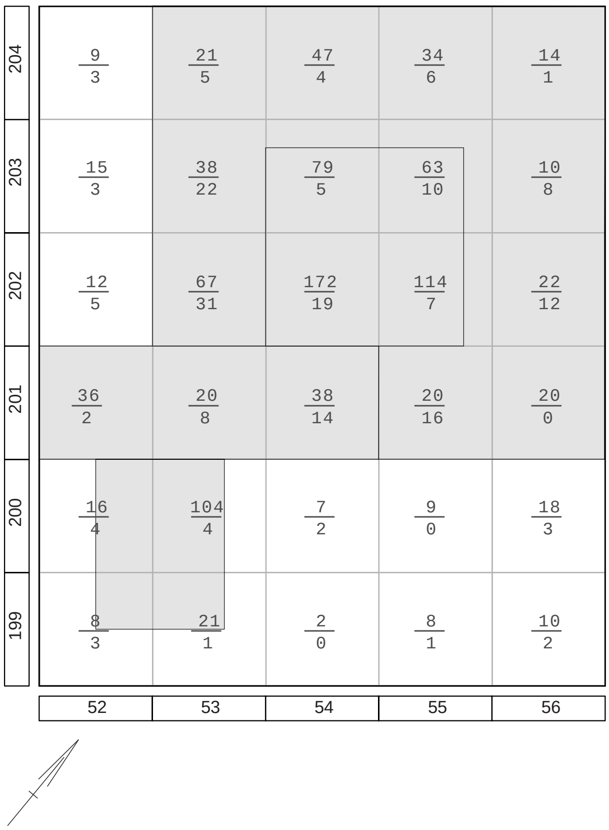


Figure 6.50 Clusters A and B and surroundings. Ratio of the number of artefacts plotted in three dimensions in the upper 30 cm (above dash) and at a deeper level (below dash) of the non-ploughed part of the loess soil, per square of 1 x 1 m.

distribution: in this square 45% of the artefacts were found at a depth of more than 30 cm beneath the base of the plough zone. And finally, the eastern part (squares with x co-ordinate 56) shows a relatively uniform picture regarding the vertical distribution of artefacts. In four out of six squares, more than 80% of the artefacts originate from the upper 30 cm of the non-ploughed part of the archaeological layer.

Data on horizontal displacements of artefacts in cluster A and surroundings were obtained through refitting and the distances between refitted artefacts of RMUs in this part of the excavation (S1, S3, S5, S308, S309, M1, M3, M5, M7, M8 and M9; see table 6.25). The overview shows that distances between refitted artefacts within RMUs are very variable and, with the exception of RMU S5, in many cases (n=44) they amount to two or more metres. This underlines the idea that artefacts can have been moved over considerable distances also in a horizontal direction as a result of post-depositional processes. We should also mention the relatively

	RMUs											
Distances (in cm)	S1	S3	S5	S308	S309	M1	M3	M5	M7	M8	M9	N
0-49	7	1	17	1	3	.	1	2	1	.	4	37
50-99	3	.	3	.	.	2	1	1	2	1	5	18
100-149	5	1	1	.	2	.	2	.	1	2	2	16
150-199	1	.	1	.	.	.	4	2	1	1	3	13
200-249	4	1	.	2	1	1	.	.	.	.	.	9
250-299	2	.	.	.	.	.	2	1	2	.	.	7
300-349	.	1	1	.	.	.	.	.	1	.	1	4
350-399	1	.	1	.	.	1	1	.	1	.	2	7
400-449	.	.	.	.	.	1	1	1	.	.	.	3
450-499	1	1	.	.	.	.	1	.	.	.	.	3
500-549	1	.	3	.	.	.	.	.	.	.	.	4
550-599	.	1	.	.	.	.	1	.	1	.	.	3
600-	1	1	.	.	.	.	.	.	.	2	.	4
Total	26	7	27	3	6	5	14	7	10	6	17	128

Table 6.25 Horizontal distances between find locations of three-dimensionally recorded and refitted artefacts using distance classes of 50 cm. The refitted artefacts belong to RMUs of Simpelveld flint and Meuse terrace flint which were worked in cluster A and surroundings.

large number of refitted fragments of artefacts with non-patinated breaks. Several specimens of these were found in the analysed area of cluster A, *underneath* the base of the plough zone and thus apparently outside the reach of the ploughshare. This observation indicates that fragmentation of artefacts after the period of the Late Glacial and presumably in 'recent' times was not restricted to the ploughed top soil. Possibly, the ploughshare disturbed the archaeological layer locally deeper than was thought likely in the first instance, based on the thickness of the plough zone.

Finally, we should in any case take into account that only a part of the tools connected with the activities in cluster A were actually found in this area underneath the plough zone. For an unknown number of tools that originally formed part of cluster A, it is very likely that they were collected from the plough zone or from the surface. Of course, these artefacts cannot be included in the analysis. Assuming a fixed direction and fixed pattern in the many years of ploughing of the plot in Eyserheide, it can moreover not be excluded that more artefacts (including tools) were ploughed up from specific areas (furrows) than from other areas. No concrete indications of this were found though during the field work. And we should bear in mind a (small) distortion of the results of the analysis because of the occurrence of tools in cluster B. The northern part of this cluster falls just inside the area analysed by rings (ring 6) and sectors (sector 6).

6.9 Discussion

In 1980 D. Cahen, C. Karlin, H. Keeley and F. Van Noten published an interesting article on the subjects of spatial patterns, technology of stone working and function of tools in two open-air sites from the end of the last ice age: Pincevent in France and Meer in Belgium. In the article, two at that moment relatively new methods of lithic analysis were discussed together, namely refitting and use-wear analysis. About 30 years later, this article is, in this author's opinion, still a substantial source of information and inspiration for archaeologists who are involved in spatial patterns in Late Upper Palaeolithic sites. The article provides a good picture of the possibilities which both methods offer for 'unravelling' and interpreting prehistoric hunter and gatherer sites in which lithic concentrations are present. Also important is the observation of the authors that refitting and use-wear analysis can provide new insights into spatial aspects of sites that have been preserved less well (provided they were excavated in a proper manner):

> "Les méthodes que nous allons décrire requièrent certaines conditions de gisement, de fouilles et de conservation du matériel. S'il est vrai qu'elles produiront tous leurs effets lors de l'étude de sols d'habitats non perturbés, elles s'avèrent aussi très efficaces pour l'analyse de sites moins bien conservés auxquels elles confèrent de nouvelles dimensions. Ce serait donc une erreur de les réserver à quelques stations dites exceptionnelles." (Cahen et al. 1980, 210).

The results of the investigation of Eyserheide are a confirmation of the view of the authors as set out in the above quotation. Also in this research did the results of refitting prove to be invaluable for gaining insight into the post-depositional history of the camp site, locations of working of individual flint nodules and possible contemporaneous use of locations (see below). The processing of the Eyserheide site offered furthermore the opportunity to use the results of two other studies that became available just before and several years after the publication of Cahen et al. in 1980, namely the hearth seating model of L. Binford (1978) and the ring and sector method of D. Stapert (1989).

In paragraphs 6.8.3 and 6.8.4, the distribution of flint artefacts in clusters A and B of the site of Eyserheide was discussed in the light of the hearth seating model and the ring and sector method. Two important assumptions were thereby used, namely 1) a hearth constructed with stones was present in or near the centre of cluster A, on a level with co-ordinate 55.00 / 202.60, and 2) locations where artefacts were plotted in three dimensions underneath the plough zone correspond with the locations where the occupants of the camp site deposited these artefacts, dropped them on the ground or tossed them to. From the discussion on the post-depositional processes (see 6.4 and 6.8.5), we know that this situation, i.e. a position of the find material in *primary archaeological context*, does not apply to the site of Eyserheide. After the Magdalenian hunters and gatherers abandoned the camp site, various processes influenced the archaeological layer and the position of the finds themselves. We can mention in chronological order from the end of the Pleniglacial to modern times:

- wind and water surface erosion, whereby small artefacts in particular will have been displaced, partly to (far) beyond the excavated area (end of the Pleniglacial);
- sedimentation of loess, with the result that remains of the camp site became embedded in a preserving layer of fine-grained sediments (end of the Pleniglacial);
- the lifting up through frost of large artefacts and large-sized fragments of unworked stone (end of the Pleniglacial);
- the splitting of artefacts and large-sized fragments of unworked stone by repeated alternation of frost and thawing (end of the Pleniglacial);
- the sinking of (mainly) small artefacts into frost cracks and/or drought fissures (end of the Pleniglacial, Late Glacial, Holocene);

- eluviation of chalk and soil formation as a result of chemical weathering, complete decomposition and eluviation of organic remains (Holocene);
- homogenisation of the upper part of the loess soil by biotic processes and displacement of stone artefacts in root channels and burrowing tunnels (Holocene);
- the toppling over of trees and accumulation of artefacts in the pits that were thus created (Holocene);
- land use, including ploughing of the plot of land, and incorporation of the upper part of the loess soil into the plough zone (historical and modern times).

In Eyserheide, about one third of the archaeological material was collected from the surface or the plough zone, an amount that is comparable with the site of Sweikhuizen-GP, where 36.5% of the material consists of surface or plough zone finds (Arts and Deeben 1987b, 130). The original position of these finds in the settlement area can no longer or, in the case of finds from the plough zone, can only be determined in outline. By ploughing the surface, traces of post-depositional processes that had earlier taken place in the upper part of the loess soil can no longer be recognised as such. Underneath the plough zone are locally natural disturbances (= remains of tree fall pits) in which artefacts have become incorporated that were displaced horizontally or vertically. As a result of the working of trees, plants (bioturbation) and animals, the vertical distribution of the archaeological material underneath the plough zone amounted in many squares to 30 cm or more. In cluster A, artefacts were even collected up to a depth of one metre below the present surface. In addition, the western limit of this cluster could not be determined properly because of the presence of a large, tree fall pit. If we take these data into consideration, it is clear that in Eyserheide no well-preserved and stratigraphically well-defined living floor (in French: *sol d'habitation*) was exposed. Despite the embedding of the archaeological material in fine-grained loess, presumably already shortly after the occupation of the location at the end of the Pleniglacial, the archaeological layer was affected to a large extent. The vertical distribution of the flint artefacts but also the lack of a hearth or habitation structure *in situ*, hampers the determination of the exact stratigraphical position of the living floor at the time of occupation of the site in the Magdalenian. This applies for instance to cluster A, where in square 54/202 172 out of 191 artefacts were recovered from the upper 30 cm of the non-ploughed part of the loess soil (table 6.13). Together with fragments of unworked stone, these artefacts, including many pieces that could be refitted, were distributed regularly in this part of the loess soil. Thus, they are of little value in determining the exact position or depth of the Magdalenian living floor in the Holocene loess soil. The relatively large numbers of artefacts that were measured in three dimensions in cluster B at a depth of 15-30 cm beneath the plough zone (for instance 85 out of 108 artefacts in square 53/200) could indicate that in this part of the excavation a small part of the original living floor was actually preserved. A comparable, very limited vertical distribution of (mostly refitted) flint artefacts has not been documented in cluster A nor in other parts. Assuming the depth position of these artefacts in cluster B, the living floor at that time was at this location between 40 and 55 cm beneath the present-day surface.

In view of the above processes, the possibilities of intra-site spatial analysis are relatively limited in Eyserheide, certainly compared to well-preserved habitation units known from Magdalenian open-air sites abroad: Pincevent, Verberie, Marolles, Etiolles, Monruz, Champréveyres, etc. As in Eyserheide, the archaeological material of these sites became gradually embedded in fine-grained sediments shortly after the period(s) of occupation. We are not dealing here, as in Eyserheide, with aeolian deposits (loess) but with sediments of large rivers (Seine, Yonne, and Oise in the Paris Basin) and lacustrine deposits (Lac du Neuchâtel in Switzerland). In terms of potential of sites for spatial analysis, the differences in post-depositional history between Eyserheide and the mentioned sites are however of more importance. Due to the relatively large depth of the archaeological finds compared to the present-day surface, settlement features and concentrations of stone artefacts have remained largely intact in the French and Swiss sites, in particular the deeper lying archaeological levels. For these levels we can speak of 'high resolution archaeology' (Audouze and Enloe 1997) and well-preserved living floors. That aside, the deciphering of the 'depositional puzzle' is also for this category of site no easy task. The critical considerations of the spatial model that Leroi-Gourhan formulated for Pincevent section 36 is an example that shows this. As we discussed earlier, data on use-wear analysis and refitting, but also for instance of experimental archaeology, can be an important tool (Cahen et al. 1980). Results of ethnographical and ethnoarchaeological research have been important, according to the author, in particular for gaining insight into the *complexity* of cultural, dynamic formation processes that form the basis of the static archaeological processes.

Insight into the extent of disturbance of the archaeological layer in Eyserheide was mostly obtained thanks to the results of refitting and differences in the find context (surface, plough zone, non-ploughed part of the loess soil) of the artefacts. For instance, artefacts associated with tree fall pits could be refitted into artefacts that were also collected underneath the plough zone but outside natural pits. Despite this evidence of disturbances of the archaeological layer, spatial analysis has yielded information on the organisation and use of the camp site of Eyserheide. Two clear clusters (A and B), two less find-rich clusters (C and D) and an adjoining area with a dispersed position of Magdalenian artefacts were recognised. As far as can be said on the basis of the data of the excavation, cluster A reflects the main activity area or 'core' of the camp site. In favour of this argue the high density of knapping products of various RMUs, the number and diversity of retouched tools and the presence of fragments of non-worked stone with traces of heating in the centre of cluster A. The stones have been interpreted as remnants of a small hearth that was completely disturbed by ploughing and other processes. In addition, a rough insight was obtained into the locations where individual flint nodules have been worked and where tools have been used and/or discarded. The distribution of knapping products belonging to RMUs and the results of refitting demonstrate that various flint nodules were worked in cluster A and its periphery. Good examples of these are RMU S1 of Simpelveld flint and RMUs M3 and M8 of Meuse terrace flint. The cores forming part of these RMUs were worked according to *le débitage magdalénien classique* and point to the presence of at least one experienced flint worker in the camp site of Eyserheide. This person (these persons) presumably was (were) seated immediately west of the supposed location of the hearth, in a zone from where also retouched tools and blades with use-wear traces were retrieved. The fact that no retouched tools have been recovered of RMUs S1 and M8, indicates that blades were struck for future use in other camp sites. For RMUs of Simpelveld flint in particular, we should allow for transport of blade products to other locations. Retouched tools made of this flint are (almost) completely lacking in the site of Eyserheide, despite the large number of long and regular blades that have been producted at the site.

With reference to the spatial use of cluster A, the configuration of finds should be mentioned in the southern part of square 54/203. This square forms the western part of cluster A and was one of the trial squares that were excavated in April 1990. Artefacts with small dimensions are almost completely lacking in this square and the amount of retouched tools and blades measured in three dimensions is large. Among the finds are a complete blade end scraper (length 10.7 cm), complete borer (length 11.3 cm), and a complete dihedral burin (length 7.9 cm) (see fig. 3.3). This part of cluster A lies at less than one metre from but beyond the reach of the more westerly situated, tree fall pit (fig. 6.13). In the square 54/203, 94% of the artefacts were measured in three dimensions from the base of the plough zone to maximally 30 cm beneath this base. If we look at the southern part of square 54/203, it is noticeable that the distribution of large artefacts is more or less U-shaped surrounding a space with almost no finds (fig. 6.13). As we are dealing here with a relatively undisturbed part of the Holocene soil, this distribution *possibly* (!) reflects a location for working of flint and/or use of retouched tools by one person.

The central character of cluster A and the peripheral zone, and an interpretation as multi-functional activity area is emphasised by the number and, especially also, the diversity of retouched tools. Among the retouched tools are a steeply retouched blade and (fragments of) borers, burins, end scrapers and retouched blades. Broken ends of working edges mainly originate from burins made of Orsbach flint. They were probably broken by accident as a result of resharpening of the working edge or during use, for instance during the working of bone and antler. Judging from the results of the ring and sector method, tools were especially used and discarded in the western part of cluster A. The results point to the performance of domestic activities in the open air and in the vicinity (west) of a small hearth structure. The fact that cluster A is the remnant of an originally richer concentration and that (many) artefacts were not found in a primary archaeological context, makes it difficult however to evaluate correctly the outcomes of the ring and sector method. Thus, the distribution of the artefacts does not offer indications of accumulation of artefacts against a tent wall. Also the distinction, that Binford makes between drop and toss zones, a spatial characteristic of performing activities around a central hearth and in the open air, cannot be determined with certainty for the same reason.

Artefacts from the Magdalenian have also been recovered from outside the central area of clusters A and B. In view of the smaller numbers of waste products and tools, and less diversity in RMUs, these zones, at only a few metres from clusters A and B, were less intensively used and/or the archaeological layer had been subjected more to the disturbing action of the plough. The distribution of RMUs and data of refitting point to a relationship between clusters A and B, clusters A and C, and clusters B and D. Cluster D has no spatial relationship with cluster A, but does have one with cluster B. The fact that clusters could be linked to each other by refits may indicate that different locations were used simultaneously. In this notion, the clusters contain the archaeological residue of activities (including flint knapping and tool use) that were carried out during one and the same phase of occupation. Because a well-preserved living floor has not been preserved, we should be cautious with statements about which locations exactly were used simultaneously. For instance, the possibility that cores, flakes and blades discarded in the first instance were (re-)used in a later occupation phase cannot be excluded. Whether the location has been reused or whether we are dealing with one single occupation event can not be determined on the basis of differences in the stratigraphical position of the finds.

An indirect indication of a relatively short occupation is the mixing up of retouched tools and waste products of flint working in cluster A, and the lack of small concentrations of knapping products removed from one and the same flint nodule, that could be interpreted as dumps (with the exception of possibly cluster B). With a longer stay, there is the expectation that more would have been invested in site maintenance activities, among which the dumping of waste, and in a spatially more differentiated use of the camp site. In this regard we could also point out the lack of small clusters of certain types of tools, burin spalls and/or retouch waste which point to selective use of locations for bone and antler working, cleaning of hides etc. In the distribution of three-dimensionally recorded artefacts, it was also not possible to determine locations where blades were produced exclusively. Blades were produced at spots where also other activities were carried out, among which preparation and maintenance of cores and use and discard of tools (see also Pincevent, Cahen et al. 1980, 218).

The investigations of Magdalenian open-air sites in the Paris Basin have shown that (waste) products of carefully worked cores were often lying close to a hearth and the knapping products of badly executed debitages further away from the hearth (see for instance Audouze et al. 1988). Earlier in this paragraph, we mentioned that products of *le débitage magdalénien classique* were recovered in the centre of cluster A, close to the location where a hearth was possibly present. Whether this careful method of core preparation also occurred in other parts of the excavation, cannot be stated with certainty. An important reason for this is that no clear picture has been obtained of the activities carried out in cluster C and cluster D. Possibly both clusters reflect (strongly) thinned-out remains of larger find concentrations, whereby – in the case of cluster D – it cannot be excluded that a hearth formed part of the cluster. As the southern part of the excavation was heavily disturbed by bioturbation, it is not known whether the working of flint nodules (for instance M6) and the use of tools has taken place there in the proximity of a hearth, as is supposed for cluster A. RMU M6 is regarded as a good example of the application of a *débitage simplifié*. From the core, with a *dos cortical*, blades were removed that were probably meant exclusively for use in the camp site of Eyserheide itself. Two blade end scrapers that could be refitted onto the core underline this notion.

With the results of the spatial analysis of the site of Eyserheide, it has been demonstrated, in the opinion of the author, that open-air sites from the Late Upper Palaeolithic located at the surface and disturbed by ploughing and/or bioturbation should not be excluded from analysis in advance. Not only are they important for a better understanding of the effects of post-depositional processes on find distributions in Palaeolithic surface sites. They are also important for further insight into the use and organisation of camp sites, though information on the spatial organisation will usually be less detailed than with well-preserved living floors. The potential of ploughed open-air surface sites from the Magdalenian for obtaining spatial information is further shown in the results of analyses in Alsdorf (Löhr 1979), Kanne and Orp-le-Grand (Vermeersch et al. 1985, 1987), and Sweikhuizen-GP (Arts and Deeben 1987b).

When processing the site of Eyserheide we have opted, with the aid of the hearth seating model of L. Binford and the ring and sector method of D. Stapert, to first analyse and interpret the spatial distribution of artefacts in the find-rich, central part of the excavation, assuming a position of the artefacts in primary archaeological context. Subsequently, the results were critically examined and possibilities of interpretation were differentiated, taking into account the (locally heavily) disturbance of original spatial patterns by post-depositional processes. In view of the results achieved for the site of Eyserheide, we would recommend this procedure also to other prehistoric hunter-gatherer open-air sites with a heavily disturbed archaeological layer.

7 Regional context: Magdalenian sites in the Meuse-Rhine loess area

7.1 Introduction

In the preceding three chapters we reported on characteristics of technology and typology of the flint industry (chapter 4), the results of use-wear analysis (chapter 5), and the spatial distribution of the archaeological materials (chapter 6) of the Eyserheide site. The aim of this chapter is to put the site in a wider geographical perspective and to include in our investigation data of nearby Magdalenian open-air sites. The information of these sites will hopefully contribute to a well-founded interpretation of the Eyserheide site itself. As we already noted in chapter 1, Eyserheide is not a unique Magdalenian open-air site in this part of the Northwest European continent. Together with a few nearby Dutch, Belgian and German sites, the site forms a small group of c. ten open-air sites on the northwestern edge of Magdalenian territory. They are related to the earliest occupation of the loess belt north of the Ardenno-Rhenish Massif after the Glacial Maximum of the Weichsel ice age, c. 20,000-18,000 BP. As far as we can say now, they reflect activities of the first modern people (=representatives of the species *Homo sapiens sapiens*) who lived in the loess area in small temporary camp sites.

Evidence of human occupation from the early phases of the Upper Palaeolithic, that is from the periods of the Perigordian, Aurignacian and Gravettian and with a date between c. 35,000 and 18,000 BP, is absent from the same area. This absence of evidence does not mean that during this long timespan people did not sporadically visit the area. An indirect indication of this forms the presence of good quality flint in Aurignacian and Gravettian sites in the Central Rhineland in Germany. This flint originates from Cretaceous deposits between Maastricht and Aachen and points to the presence of exploitation sites from the early Upper Palaeolithic, of which no traces have yet been found.

The Magdalenian sites that will be discussed in this chapter lie in a predominantly gently undulating hilly landscape, the surface of which consists of loess deposits (see 7.2). This area covers a surface of c. 180 × 50 km and lies between the cities of Brussels in the province of Brabant (Belgium) and Cologne and Düsseldorf in the Lower Rhine region (Germany). It comprises the central and northeastern part of Belgium, the southernmost part of the Netherlands, and the Niederrheinische Bucht in Germany. In this monograph this area will be referred to as the Meuse-Rhine loess area. On the basis of the landscape characteristics mentioned, we have chosen to take this area as unit of analysis and discussion. Moreover, Magdalenian sites there share an important archaeological characteristic: they are exclusively open-air sites. In contrast to the Belgian Ardennes, Schwabische Alb and other more southern areas with traces of occupation from the Magdalenian, no prehistoric caves or rock shelters (*abris sous roche*) are known from the Meuse-Rhine loess area. This does not mean that we should not allow for remnants of human activities in caves and rock shelters, for instance in the Dutch-Belgian Cretaceous area. In limestone formations in deeply incised stream valleys are possibly karst phenomena (caves and rockshelters) present, which were used as natural shelters in the Palaeolithic. If present, they are hidden under metres-thick layers of washed-down loess (colluvium) and have so far remained beyond the reach of archaeological observation.

After a short description of landscape features of the Meuse-Rhine loess area (7.2), the Magdalenian sites will be briefly presented (7.3). Subsequently, we shall go into the landscape setting of the sites in this area (7.4), and the circumstances that have led to conservation and erosion of occupational traces from the Magdalenian (7.5). Similarities and differences in the size and material content of the sites, such as exploited raw materials and composition of the tools, are the focus in paragraphs 7.6 to 7.8. The chapter is concluded with a discussion of the meaning of observed differences in terms of inter-site variability and site function (7.9).

7.2 Geology and landscape

The loess zone, to which Eyserheide and nearby Magdalenian open-air sites are connected, is part of the most northern margin of the Northwest European loess belt. A small number of sites is located just north of the northern boundary of the loess zone. There layers of cover sands from the last ice age or fluvial deposits of the Rhine and Meuse are lying on or close to the present-day surface.

On a larger geographical scale, the Meuse-Rhine loess area forms a transition zone between the uplands of the

Ardenno-Rhenish Massif in the south and the cover-sands landscape of the North European Plain in the north (fig. 7.1). Meuse and Rhine are by far the most important rivers in the area and, together with numerous large and small tributaries, such as the Méhaigne and the Geer in Belgium, the Geul in Dutch Limburg, and the Rur in Germany, take care of the drainage of water from this area. Both the Meuse, Rhine and smaller watercourses have formed the present-day landscape to a large extent. The hills are largely lower than 200 m +NAP and are for a large part covered by a layer of fine-grained, aeolian loess (Mücher 1973; Bouten et al. 1985). Characteristic landforms are elevated, loess-covered plateaus and deeply incised, often asymmetrical stream and dry valleys. The loess deposits date from the Saale and/or Weichsel ice age(s) and can attain a thickness from a few metres up to 30 metres in the Niederrheinische Bucht. More or less complete loess profiles are known from several quarries and have partly been described and studied extensively, such as near Nagelbeek (Haesaerts et al. 1981), Kesselt (Gullentops 1954), and Maastricht-Belvédère (Vandenberghe et al. 1985). Holocene fluvial sediments are found in stream valleys. Loess washed down from slopes (colluvium) is present everywhere in stream and dry valleys.

7.3 Presentation of the sites

Since the discovery and excavation in 1974 of a Magdalenian site near the German town of Alsdorf (Löhr 1979), the following sites have been investigated in the Meuse-Rhine loess area by means of excavations: Orp-le-Grand and Kanne in Belgium (Vermeersch et al. 1985, 1987) and Sweikhuizen-Groene Paal, Mesch and Eyserheide in the Netherlands

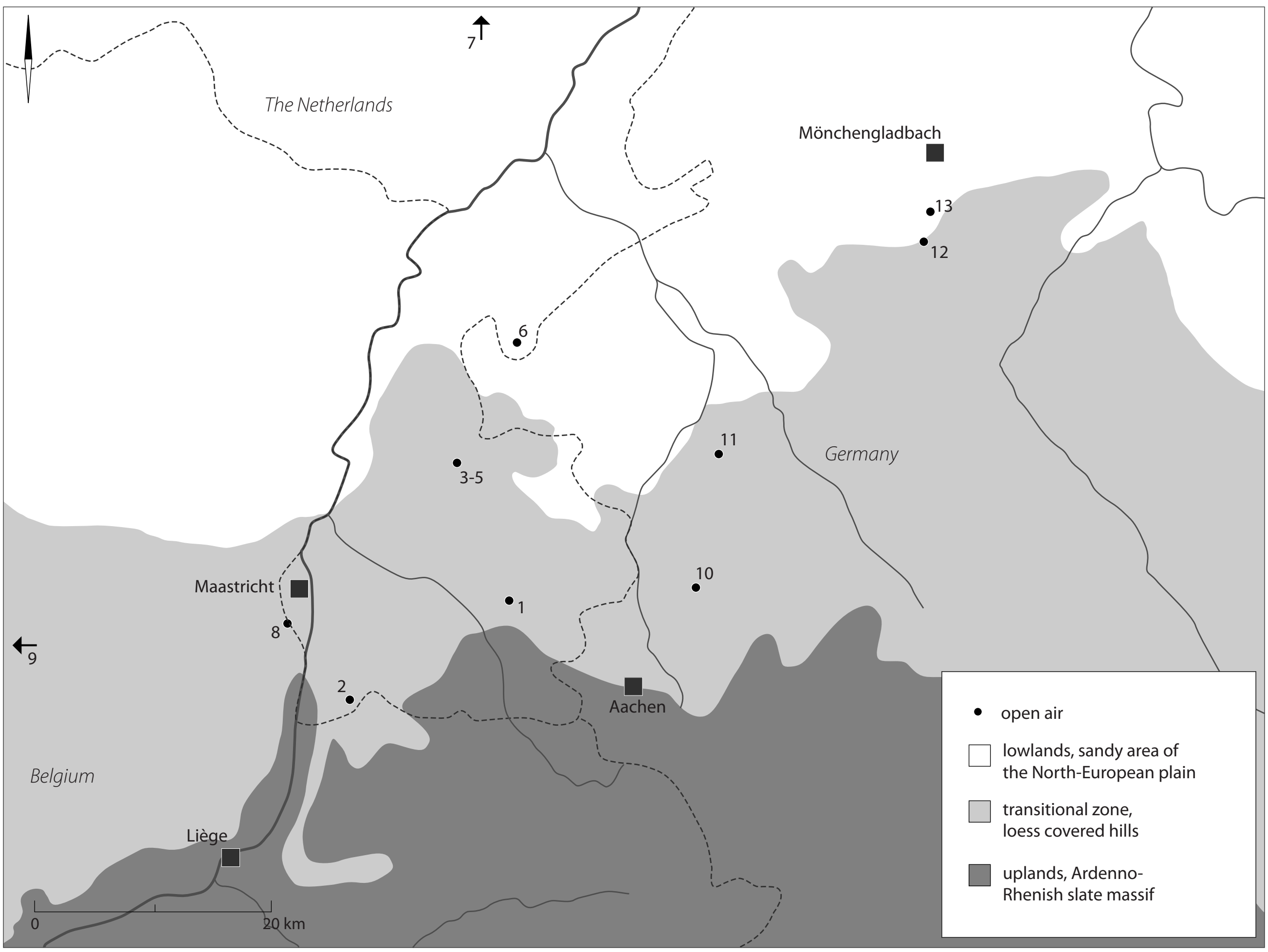


Figure 7.1 Location of Magdalenian sites of the Meuse-Rhine loess area: 1 Eyserheide, 2 Mesch-Steenberg, 3-5 Sweikhuizen, 6 Echt-Koningsbosch, 7 Griendtsveen, 8 Kanne, 9 Orp-le-Grand, 10 Alsdorf, 11 Beeck, 12 Kamphausen, 13 Galgenberg.

(Arts and Deeben 1987b; Rensink 1993). A number of sites is exclusively known from surface finds, among which Koningsbosch in Dutch Limburg, and Kamphausen (Thissen 1989) and Beeck (Jöris et al. 1993) in Germany. For an overview of the data on the above mentioned sites, see tables 7.1 to 7.8.

Kanne:
Kanne is located in northeast Belgium, c. 5 km southwest of the Dutch city of Maastricht. The site lies along the alluvial plain of the small river Geer (in Dutch: Jeker). Magdalenian artefacts were revealed in 1979 at several locations during the digging of a canal in the valley of the river Geer (Vermeersch et al. 1985). Three sections were investigated, whereby three concentrations of archaeological material were found in sector Central. The most find-rich of these, on the boundery of the excavated area and already partially destroyed by bulldozers before excavation, consisted of an accumulation of flint waste, blades and blade fragments and three cores. Also most of the tools and a few hammer stones were recovered from this concentration. The second concentration was located only 5 m away and has yielded preparation flakes, (fragments of) blades and tools. The third concentration, also at the edge of the excavated area, revealed mainly fragments of heated stones. In addition, two hammer stones and a core were found there. Both latter concentrations were interpreted as *zones d'évacuation des déchets* (Vermeersch et al. 1985, 44). In the second concentration it concerns debris of flint working, and in the third concentration stones that formed part of a hearth (*produits de vidange de foyer*). The presence of in particular burins and burin spalls in the third concentration points to an area of specialised activity (*zone d'activité domestique*) or a depository of tools that were used in domestic activities. Artefacts, among which only a few tools, were found in the base of an erosion channel in *secteur sud*.

In the publication of Kanne, the dynamics of core reduction have extensively been described, also using data of refitting (Vermeersch et al. 1985). The list of tool types, which F. Bordes (1978) formulated for the French site of Laugerie-Haute, was used as basis for the typological classification of the retouched tools.

Orp-le-Grand:
The sites of Orp-le-Grand are located in the province of Brabant in the central part of Belgium on a loess-covered plateau above the valley of the Ruisseau de Jauche, a very small tributary of the Petite Gette. In 1979, two lithic concentrations, designated as sector East and sector West, were excavated there by the Katholieke Universiteit Leuven (Catholic University Louvain) by P.M. Vermeersch and his team (Vermeersch et al. 1987). The centres of these two concentrations were only nine metres from each other. Orp-East was excavated over an area of 63 m^2 and consisted of a very dense accumulation of stone artefacts, among which 63 large cores and 438 retouched tools. In Orp-West, investigated over an area of 88 m^2, the concentration of artefacts was less dense and 27 cores and 143 tools were found. Despite the fact that both concentrations were lying close together, they probably do not date to the same time. As the artefacts of sector West have been more affected by cryoturbation, it is assumed that this concentration is older than that of sector East (Vermeersch et al. 1987, 49). Also the fact that artefacts of both concentrations could not be refitted onto each other indicates a difference in age (Vermeersch et al. 1987, 11).

According to the excavators, the distribution of flint artefacts in the east section, and in particular in two find-poor zones (A1 and A2, Vermeersch et al. 1987, fig. 32) in the centre of the concentration, points to the presence of an obstacle, possibly the wall of a tent or a comparable construction. It would concern a circular tent with a floor space of 9 m^2 and a diameter of 3.4 m. Based on the distribution of sandstone (*grès*) and burnt artefacts, it is assumed that there was hearth in the entrance of the 'tent'. An intact hearth was not found. Also for Orp-le-Grand a typological classification of the tools is based on the list of F. Bordes (1978).

Sweikhuizen:
In the Dutch part of the Meuse-Rhine loess area, three Magdalenian sites are known from the loess plateau of Sweikhuizen-Puth, south of Geleen near the village of Sweikhuizen. They are lying between 95 m and 108 m +NAP (fig. 7.2). Further south, at the foot of the plateau and c. 50 m lower, flows the Geleenbeek.

The site of Sweikhuizen-Groene Paal (GP) was completely excavated in 1982-1983 (Arts and Deeben 1987b). The finds consists of 481 tools and 25 complete cores. In the middle of the find concentration, hundreds of pieces of quartzite were found, of which the larger fragments formed a circular structure with a diameter of three to four metres. A plausible explanation is that these stone represent the remains of a small habitation structure. In the eastern part, there where the stone circle was interrupted, was presumably the entrance to the tent. Here fragments of a sandstone slab were found with traces of heating. It is assumed that these finds mark the location of the hearth, near the entrance to the tent.

It appears from the distribution of the finds that the working of flint also largely took place near the entrance to the tent, near the supposed location of the hearth. Various backed bladelets were lying in the vicinity of the hearth. Presumably these implements were on the spot removed

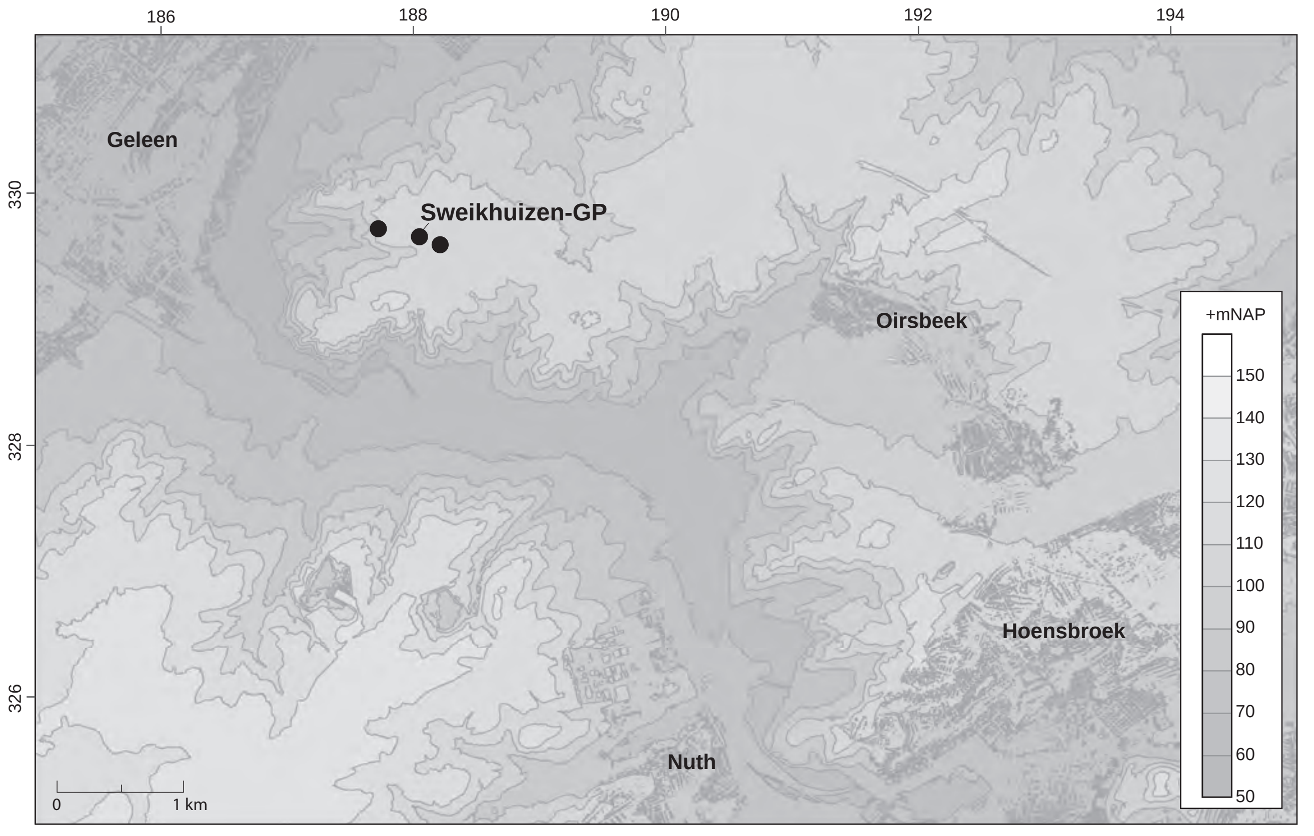


Figure 7.2 Contour map of the area between Geleen and Hoensbroek in Dutch Limburg. Location of the sites of Sweikhuizen-Oude Stort (OS), Sweikhuizen-Groene Paal (GP), and Sweikhuizen-Koolweg (KW). Source: Actueel Hoogtebestand Nederland.

from arrows and replaced by new ones (retooling). Relatively few finds were made in the northwestern part of the stone circle; we are possibly dealing here with a sleeping area. An accumulation of tools against one of the tent walls further points to a storage place.

The nearby site of Sweikhuizen-Oude Stort (OS) was at the time of discovery in 1954 already completely disturbed (dug up). Based on the characteristics of the retouched tools, this site was also attributed to the Magdalenian (Wouters 1985). The third site, Sweikhuizen-Koolweg (KW), located to the east, was investigated with a small-scale trial excavation. Possibly this location and the completely excavated settlement of Sweikhuizen-GP were occupied simultaneously. Some artefacts of non-local Simpelveld flint from the two settlements could be refitted onto each and this could indicate that a few families put up their tents simultaneously at Sweikhuizen. However, because refitted artefacts from Sweikhuizen-KW are surface finds, there are some uncertainties concerning the exact provenance of these artefacts (J. Deeben, pers. comm. 2011).

Mesch:
The site is located northeast of the village of Mesch in the rural district of Eijsden on the southern margin of a loess plateau, at a height of c. 120 m +NAP (Rensink 1991). The site occupies a very strategic position on the southern margin of the loess-covered plateau that is bordered in the south by the valley of the Voer, a small tributary of the Meuse (fig. 7.3). The wide Holocene valley floor of the Meuse is only 3 km to the west. The gently sloping surface of the Pleistocene terrace of the Meuse changes into a steeper slope about 100 metres south of the site. This slope connects the margin of the plateau with the valley floor of the Voer. The difference in height between the site (120 m +NAP) and the valley floor near Mesch is c. 50 m.

The site of Mesch was excavated in 1986 to a large extent. The finds consist of more than 6000 flint artefacts, including over 60 cores and 72 retouched tools. No indications were found of the presence of a habitation or hearth structure. The small number of retouched implements and the occurrence of large, roughly knapped cores and large flakes

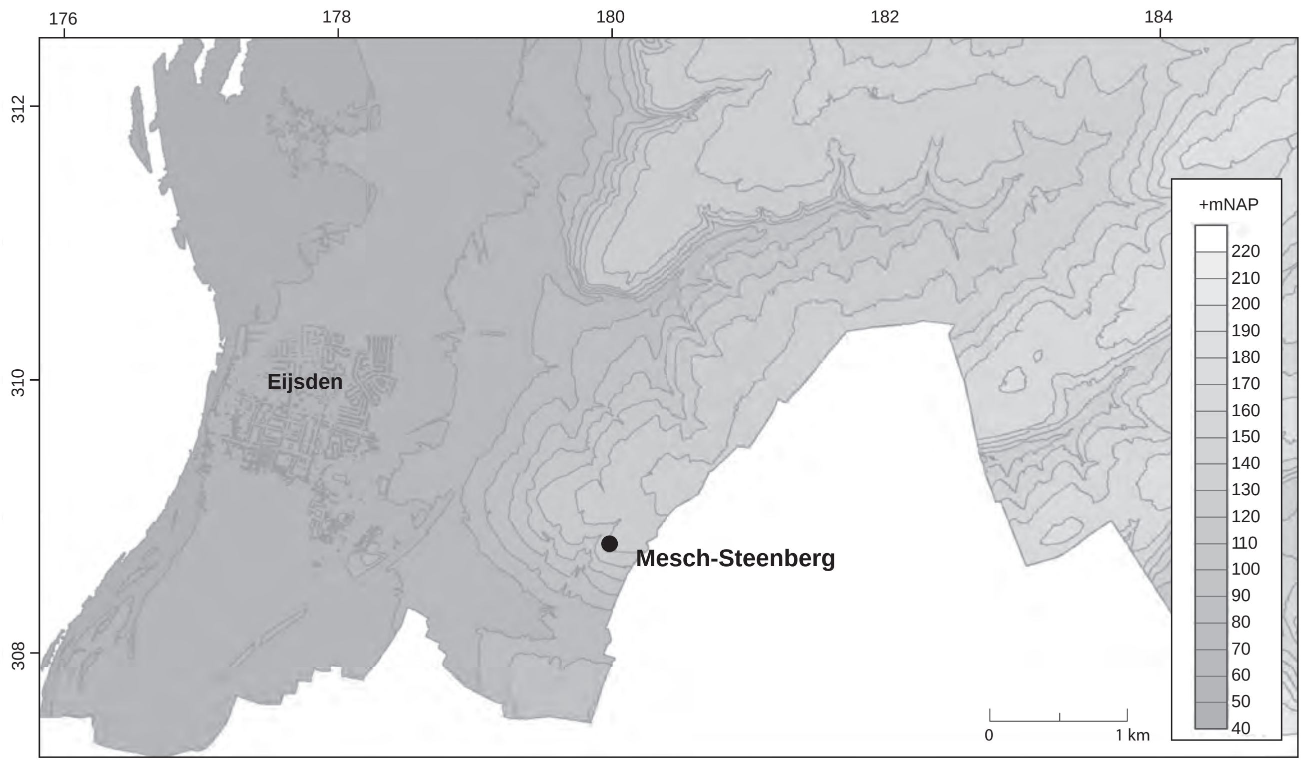


Figure 7.3 Contour map of the area south of Maastricht (Eijsden and surroundings). Location of the site of Mesch-Steenberg. Source: Actueel Hoogtebestand Nederland.

with cortex remains lend the site the character of a flint working place. But also large and regular blade cores occur as well as numerous fragments of long blades with parallel sides. At least part of the flint originates from gravel deposits of the river Voer and was carried up to the margin of the loess plateau. Subsequently, selected (fragments of) blades produced on the spot seem to have been transported to other camp sites, as can be inferred from the small number of retouched tools and many pieces of (deliberately?) broken blades found at the site. These could be camp sites in the valley of the Voer or the valley of the Meuse, or slightly further away and southward, settlements in caves in the nearby foothills of the Belgian Ardennes.

Koningsbosch:
This site is located on Dutch soil in the rural district of Echt-Susteren, immediately north of the loess area at a short distance from the Dutch-German border. The site was discovered in 2007 and lies at c. 52 m +NAP on the high terrace of the Rhine. Circa 1 km west is a prominent steep terrace edge which marks the transition from the Rhine terrace to the high terrace of the Meuse. The latter terrace has a height of 30 to 35 m +NAP and lies several metres lower in the landscape. The finds of this newly-discovered surface recovered to date amount 58. Based on the morphological characteristics of the cores, the scars of long, regular blades and the occurrence of frost cracks, the site can be attributed to the Magdalenian. Among the tools are five large and thick burins on flakes and a blade end scraper. There are also a few fragments of crested blades and blades.

Griendtsveen:
In a sand quarry near Griendtsveen in the rural district of Deurne (province of North Brabant) near the moorland area of the Peel, flint artefacts came to light in 1958, which later were attributed to the Magdalenian (Wouters 1983). This is the first site from the Magdalenian that was discovered in the Netherlands. Situated c. 45 km north of the loess area, it is moreover the most northerly site from this period in the Netherlands. The site is located on a gentle ridge in a

low-lying sandy area in which peat had formed in the Holocene. There was no excavation at the time. In view of the circumstances of the find, the site must already have been largely disturbed (dug up) by the time of the discovery. By far the most artefacts were found *ex situ*, at the bottom of the sand quarry and in piles of sand. Besides, a few finds were collected in stratigraphical context from the face of the quarry. According to Wouters (1983), they were located c. 60-80 cm underneath the level of the layer of Usselo. The number of artefacts from the site amounts to 1365. Of these, 142 specimens were described as tools. Also cores, flakes, blades and a soft hammer stone (*retouchoir*) form part of the inventory. The location was completely levelled in 1958.

Alsdorf:
The Magdalenian site of Alsdorf (Kreis Aachen-Land) was discovered in 1974 on a loess plateau at a height of 178 m +NAP and between the valleys of the Rur and the Wurm. At the start of the investigation, a part of the site had already been dug up as a result of quarrying gravel: the site was noticed at the edge and in the profile of a gravel quarry. In a small area of a few square metres, a clear concentration of stone slabs and flint artefacts was observed (Löhr 1974). At the time of discovery about 10,000 artefacts could be saved. The University of Cologne carried out a rescue investigation in the same year. Over a surface area of 34 m^2, another 5000 stone artefacts and stone slabs were thereby revealed. Possibly the stone slabs, c. 200 specimens of quartzite and quartzitic slate (*quartzitischer Schiefer*), formed part of a pavement. The flint artefacts have a remarkable composition of raw materials and tools. Burins were found frequently and end scrapers are lacking almost completely among the documented finds. A comprehensive publication on the excavation and the finds appeared written by H. Löhr (1979).

Beeck:
The Magdalenian site of Beeck (Stadt Geilenkirchen, Kreis Heinsberg) was discovered in 1986, and is located only 15 km from Alsdorf on a loess plateau at a height of 80 m +NAP (Jöris et al. 1993). The plateau borders onto the valley of the Rur in the northeast and onto the valley of the Wurm in the northwest. The finds were collected from the surface and originated from the middle and lowest part of a gentle slope which slants towards the east to the Beeckfließ. The upper part of the slope west of the site lies c. 10 m higher above the valley of this stream. Most finds were made in an area of approx. 20 × 15 m. Thanks to measuring in of the artefacts a few find-rich and find-poor zones could be distinguished. A concentration of artefacts was interpreted as a place of flint working for the production of blades. In 1993, the number of artefacts of this site amounted to 1195, of which 51 were described as tools. Also some 35 cores occur which were intended without exception for the production of bladelets and blades.

Kamphausen:
Kamphausen (Gemeinde Jüchen, Kreis Neuss) is a surface site, from where in the 1980s and 1990s Magdalenian artefacts were collected during systematic field surveys. Of these finds, the artefacts collected in the period 1982-1992 have been extensively described by Höpken (1994). The site is located on a south-orientated slope on the south side of the Kamphausener Höhe, with a position of 90 m +NAP a prominent height in the wider surroundings. Although artefacts were found dispersed over an area of maximally 90 × 60 m, there is a concentration of 20 × 20 m. As in Eyserheide, the artefacts were made of various types of flint. We can mention seven flake cores and two bladelet cores, burins, scrapers and backed bladelets. Scrapers occur rarely and the implements that were found are in general a-typical.

Galgenberg:
Also known from surface finds is the site of Galgenberg (Stadt Mönchengladbach), c. 1 km north of the site of Kamphausen. Also this site was described by Höpken (1994, 32-34). Up to 1993, 23 stone artefacts were collected from this site, among which three cores, two fragments of blades, and a fragment of a crested blade. Given the characteristics of the patina and the high degree of similarity between the cores of this site and those of Kamphausen, Galgenberg is also regarded as a site from the Magdalenian. However, retouched tools are lacking among the 23 artefacts mentioned by Höpken and a date of the site in a later phase of the Late Palaeolithic cannot be excluded.

Vermeersch and Symens (1988, 247) further mention a small number of surface finds in the Belgian loess and sand area which presumably date to the Magdalenian: Lixle-Sur le Bois (Cahen and Peuskens 1977-79), Tourinnes-la-Grosse and Oedelen-het Maandagse. An isolated find is a blade core with two opposite striking platforms and long and regular blade scars from Rijckholt-Sint Geertruid in Dutch Limburg. The artefact can probably be attributed to the Magdalenian (Roebroeks 1994).

7.4 Position in the landscape (site location)

Compared to the flat cover-sand landscape of the Northwest European Plain, the hilly landscape of the Meuse-Rhine loess area shows a variety in relief and other landscape features. At relatively short distances, elevated plateaus, gentle to steep valley slopes, partly deeply incised dry valleys and flat valley floors of mainly smaller watercourses succeed each other. Assuming the continuous character of the spatial behaviour of prehistoric hunters and gatherers (Zvelebil et al. 1992), we can imagine that at the time of Magdalenian occupation main landscape zones and intermediate zones offered specific possibilities in terms of shelter (occupation), view (resource monitoring), raw material exploitation, water supply, and for the exploitation of faunal and floral food resources (hunting/fishing and gathering respectively). Also ritual activities, for instance during the gathering of two or more groups, are not expected to have taken place randomly in the landscape. They were probably connected to locations with specific terrain features and/or of historical meaning, and strategically located with respect to seasonally and/or year round available food resources.

The mentioned diversity of characteristics of the landscape and possibilities in terms of occupation and exploitation is not reflected in the location of Magdalenian sites in the northern loess area. The majority has an elevated landscape position on or near the margin of a loess-covered plateau. In a few cases the plateau dominates one water-carrying stream valley (Sweikhuizen-GP and -KW) or a dry valley (Eyserheide). But sites are also located on plateaus that form part of a watershed and that separates water courses of two different catchment areas. Good examples are the sites of Alsdorf and Beeck located on plateaus between the catchment areas of the rivers Rur and Wurm. Further north is the site of Kamphausen on a height which functions as a watershed between the Niers and the Kommer Bach. The loess plateau on which the site of Mesch is situated dominates the valley of the Voer in the south and the valley of the Meuse in the west.

Despite the elevated position of the sites in the landscape, running water in the form of streams and small rivers is never far away (table 7.1). Thus the distance from the concentrations of Orp-le-Grand to the Jauche is 500 m as the crow flies, from the site of Sweikhuizen-GP to the Geleenbeek 1 km, from the site of Mesch to the Voer 500 m and from the site of Alsdorf to the Broichbach 200 m. Such distances could be covered in a short time with differences in altitude between plateau areas and valley floors not exceeding a few dozen metres. We should note though that at the time of occupation of the sites the relief was more pronounced than it is nowadays (see also Thissen 1989, 315). In the course of the Holocene, and in particular from the period when agriculture appeared in the area (Linear Pottery Culture, c. 5300 BC), the erosion of loess deposits has increased sharply. As a result, the lower parts of the landscape have become filled up with thick layers of colluvium. Together with sedimentation by rivers and streams, these processes of erosion and colluviation have led to levelling of the relief as was present during the stay of Magdalenian hunters and gatherers in the area.

Another shared characteristic is the topographical position of sites at ‘the entrance’ to a dry valley. As we mentioned in chapter 2, the site of Eyserheide lies a stone throw from the spot where a dry valley cuts into the margin of the plateau. A comparable position in the landscape is known from Kamphausen (Höpken 1994). For Orp-le-Grand, Vermeersch et al. (1987, 8) point to the nearness of a *petite valon sec* that is largely filled with colluvium. We can imagine such dry valleys functioning as a kind of ‘entrance ways’ to the slopes and valley floors of the deeply incised stream valleys a few dozen metres lower in the landscape (and *vice versa*).

And finally, there is a similar orientation in the slope or landscape section on which the sites are situated, namely facing south, southeast or east (table 7.1). This orientation applies to the sites of Orp-le-Grand, Mesch, Eyserheide, Beeck and Kamphausen, and is probably connected to a preference for the warmer, southerly plateau margins and slopes as temporary place of residence.

7.5 Conservation and erosion

The conservation of Magdalenian sites on elevated plateaus is due to the embedding of the finds in a layer of loess and the conservation of the loess deposits on flat or slightly sloping parts of the terrain. In all excavated sites (Orp-le-Grand, Kanne, Eyserheide, Sweikhuizen, Mesch and Alsdorf) artefacts were found in loess sediments, in the B2t horizon of a Holocene podzol soil which is characterised by illuviation of clay (*un sol brun lessivé*). Based on this pedological position, a few dozen centimetres under the present surface, we can assume that the finds were covered by a layer of loess (see for instance Löhr 1974). Regarding the find situation in Orp-le-Grand, Vermeersch et al. (1987, 47) note:

> “Considérant que les vestiges archéologiques étaient situés à l’intérieur de l’horizon B2t, il nous semble logique de supposer que l’accumulation loessique n’avait pas encore pris fin, de sorte que l’aire d’occupation a pu être recouverte d’un apport continu de loess qui, finalement, a scellé le site sous environ 60 cm de sédiments”.

In Kanne, the flint concentrations were at a depth of at least 25 cm beneath the top of a layer of loess (Vermeersch et al. 1985, 45). There the artefacts were also found in the B-horizon of a Holocene soil.

The presence of a conserving layer of loess presumably kept the sites located on or near the margins of plateaus from complete destruction by erosion (Löhr 1974, 293). But there is one exception, and in this context the special position of the site of Mesch should be pointed out. The location lies on the southern margin of an extensive plateau that slopes slightly towards the valley of the Voer with a slope gradient of more than 2.5%. Around the site, no loess deposits, but gravel-rich deposits of the Pleistocene Meuse terrace outcrop.

Site number	Site name	Year of discovery	Year of excavation	Excavated area (m2)	Topographic location	Altitude above sea-level	Orientation	Distance to waterstream (m)	Water course	Difference in height (m)
1	Eyserheide	1985	1990-1991	159	edge loess plateau	193	southeast	1100	Eyserbeek	90
2	Mesch	1979	1986	152	edge loess plateau	120	south	500	Voer	50
3	Sweikhuizen-OS	1954	no excavation	.	slope loess plateau	95	west	750	Geleenbeek	40
4	Sweikhuizen-GP	1981	1982-83	625	loess plateau	107	indet	1000	Geleenbeek	40
5	Sweikhuizen-KW	?	1985	46	loess plateau	108	indet	1100	Geleenbeek	40
6	Koningsbosch	2008	no excavation	.	plateau, river terrace	52	indet	3500	Saeffeler Bach	15
7	Griendtsveen	1958	no excavation	.	low sand ridge	30	indet	indet	indet	indet
8	Kanne Central	1978	1978	115	edge valley floor	64	west	200	Geer	5
8	Kanne South	1978	1978	90	edge valley floor	65	west	200	Geer	5
9	Orp-West	?	1979	88	loess plateau	108	south	500	petit Gette	30
9	Orp-East	?	1979	63	loess plateau	108	south	500	petit Gette	30
10	Alsdorf	1974	1974	34	loess plateau	178	.	200	Broichbach	.
11	Beeck	1986	no excavation	.	loess plateau	80	east	.	Beeckfließ	<10
12	Kamphausen	1982	no excavation	.	loess plateau	90	southeast	.	erosion gully	22
13	Galgenberg	1984	no excavation	.	loess plateau	78	northeast?	1000	Niers	.

Table 7.1 Magdalenian sites of the Meuse-Rhine loess area: general data.

This indicates that at the margin of the plateau either no loess was deposited or, and this is more probable in view of the slope gradient, the loess cover has completely eroded. Nevertheless, the majority of the artefacts were in the loess and underneath the plough zone. For a better understanding of the local geological situation, a deep trial trench was dug during the excavation of 1986. This showed that the horizontal distribution of the flint artefacts coincided with the location of a former karst subsidence with a diameter of 25-30 m (Rensink 1991). This karst subsidence was already (almost) completely filled with loess sediments at the time of the occupation or use of the location by Magdalenian hunters and gatherers. Because of the slightly deeper position of the archaeological layer below the present-day surface (= top Meuse terrace), this layer has not eroded in the area of the karst subsidence. But the layer was ploughed, whereby a part of the artefacts became incorporated into the plough zone.

At some sites, such as Orp-le-Grand, Mesch and Eyserheide, the loess layer was subjected, in the course of the Holocene, to first soil formation and subsequently to erosion, as can be inferred from the occurrence of truncated Holocene loess soils. Erosion has led to the upper part of the Holocene soil (A and partly B2t horizon) having been removed or having been incorporated into the plough zone, whereby artefacts were brought to the surface. The degree of erosion of the archaeological layer and/or disturbance of it by ploughing however differs from location to location. The southern part of the settlement of Sweikhuizen-Groene Paal had already disappeared at the beginning of the excavation in 1981-82 as a result of erosion. In Orp-le-Grand, few artefacts were damaged by ploughing, from which can be inferred that the archaeological layer was only recently ploughed (Vermeersch et al. 1987, 8). A relatively low degree of disturbance also accounts for the surface site of Beeck, as the finds collected from the surface and plotted on distribution maps still showed meaningful spatial patterns (Jöris et al. 1993). In Alsdorf, the majority of finds was found in the plough zone, which points to a high degree of disturbance of the archaeological layer (Löhr 1974, 293). On finds collected from the surface and plough zone at Mesch much damage as a result of ploughing was recognised. Apparently, these artefacts had been incorporated into the plough zone for a long time prior to the excavation. Of the finds of Kamphausen (n=339), as much as 45.4% was recently damaged by a plough (Höpken 1994).

It is expected that traces of activities of Magdalenian hunters and gatherers were eroded in particular in relatively steep slopes, which connect the elevated plateaus with the valley floors. As a result of the presence of sloping terrain, combined with deforestation and cultivation, the loess layer was more vulnerable to erosion there. In the Dutch part of the loess area, only one Magdalenian site (Sweikhuizen-Oude Stort) has been documented from a slope, and it is plausible that the finds were in secondary position. The site of Beeck lies on a slope orientated to the east and, despite the heavily truncated soil profile that was demonstrated on the basis of borings (even the Bt horizon has not been preserved), has been described as a well-preserved site (Jöris et al. 1993). If this classification is correct, the find situation in Beeck shows, depending on the time of covering of the archaeological layer by loess and the depth of this layer beneath the present-day surface, that remains of camp sites from the Magdalenian can also be found *in situ* in slope zones.

Finally, little can be said about the conservation of Magdalenian sites in river and stream valleys in the Meuse-Rhine loess area. In these low-lying sections of the landscape not only erosion but also sedimentation has occurred. Hence, open-air sites dating from the Late Upper Palaeolithic, but also from later prehistoric periode may have ended up deep under the present surface. It is clear that for such traces to become accessible we will have to rely on deep soil interventions by man, such as non-archaeological digging for the purpose of the construction of houses and roads and the development of 'new' nature, whereby river and stream sediments from the end of the Weichsel ice age are exposed. That Magdalenian sites can be present in low-lying zones is demonstrated by the special location of the site of Kanne in northeast Belgium (Vermeersch et al. 1985). As mentioned in paragraph 7.3, the site accidently came to light underneath a layer of loess and colluvium at the edge of the alluvial plain of the small river Geer. Such strokes of luck are very important to get a better insight into the diversity of site types and the regional character of the Magdalenian occupation of the Meuse-Rhine loess area.

7.6 Raw materials and technology

7.6.1 Introduction

The finds from the Magdalenian sites in the Meuse-Rhine loess area consist mainly of stone artefacts (table 7.2). Based on typological characteristics of the flint tools, they can be attributed to the Magdalenian (see below). This attribution is supported by morphological characteristics of the well-prepared blade cores and data on blade technology and the way in which the flint nodules were worked. Especially thanks to the results of refitting, insight has been gained for the excavated Belgian and Dutch open-air sites into the sequence of technological operations (in French literature described as *chaîne opératoire*, Pelegrin et al. 1988) during the process of core reduction. Compositions of refitted

Site number	Site name	Excavation	Cores	Core fragments and blocks	Flakes	Blades	Crested blades	Tools	Tool waste	Other artefacts	Chips <2 cm	N	References
1	Eyserheide	yes	16	100	1017	735	77	131	22	4	1314	3416	This publication, table 4.1
2	Mesch	yes	66	110	2196	1370	72	72	14	35	2185	6120	Rensink 1991, tables 2 and 3
3	Sweikhuizen-OS	no	.	.	.	.	.	ca. 60	.	.	.	.	Wouters 1985
4	Sweikhuizen-GP	yes	40	47	9868	1311	148	481	101	198	.	12194	Arts and Deeben 1987b, tables 7 and 26
5	Sweikhuizen-KW	no	.	.	.	.	.		.	.	.	.	.
6	Koningsbosch	no	3	7	24	11	3	8	.	2	.	58	.
7	Griendtsveen	no	present	.	present	present	.	142	present	.	.	1365	Wouters 1983, 104
8	Kanne Central	yes	19	.	2338*	2064*	120	83	60	83	11064	15748	Vermeersch et al. 1985, table 3
8	Kanne South	yes	6	.	744*	393*	30	15	1	12	579	1765	Vermeersch et al. 1985, table 3
9	Orp-West	yes	27	10	1428	703	35	146	158	198	7300	10005	Vermeersch et al. 1987, table 2
9	Orp-East	yes	63	16	7020	2913	213	438	830	718	71200	83411	Vermeersch et al. 1987, table 2
10	Alsdorf	yes	107	36	5326	3737	.	361	.	.	.	9567	Löhr 1979, 1995
11	Beeck	no	ca.35	.	.	.	.	51	.	.	.	1195	Jöris et al. 1993
12	Kamphausen	no	9	.	171	90	20	33	5	11	.	339	Höpken 1994, collection 1982-92
13	Galgenberg	no	3	.	11	3	.	.	.	6	.	23	Höpken 1994, collection 1984-92

Table 7.2 Magdalenian sites of the Meuse-Rhine loess area: numbers of artefacts per type. *For Kanne sector Central and sector South the numbers of flakes and blades mentioned include (retouched) tools.

artefacts were for the first time extensively described for Kanne (Vermeersch et al. 1985, 28-34) and Orp-le-Grand (Vermeersch et al. 1987). Also for the Dutch sites of Sweikhuizen-Groene Paal, Mesch and Eyserheide was refitting of stone artefacts carried out.

The aim of this paragraph is to discuss the characteristics of lithic raw materials and stone artefacts that were found in the camp sites of the northern Magdalenian. Based on their location with regard to geological formations and, hence, lithic raw materials associated with these formations, the sites have been divided into two groups: 1) in the immediate vicinity of Cretaceous sources of good quality flint: Orp-le-Grand, Kanne, Mesch, and Eyserheide (see 7.6.2), and 2) at a distance of minimally 5 km from these primary Cretaceous sources: Sweikhuizen, Alsdorf, Kamphausen, Galgenberg, and Beeck (see 7.6.3).

7.6.2 Sites in the area with Cretaceous flint sources

As discussed in chapter 2, part of the subsoil of the Meuse-Rhine loess area consists of flint-containing formations from the Upper Cretaceous (Gulpern Formation and Maastricht Formation). In the Belgian region of Haspengouw, north of the Meuse between Namur and Tongeren, and in the region of Maastricht-Aachen, these formations can attain considerable thicknesses of many dozens of metres (Felder 1975; Kuyl 1980). Flint nodules with considerable dimensions can be collected in the chalk itself (*in situ*) and in residual deposits, the so-called flint eluvium. Nodules of flint may have been displaced along slopes and incorporated into slope deposits. Rivers and streams have cut into the flint-containing Cretaceous layers in the course of the Pleistocene, whereby lumps of flint have ended up in the beds of water courses. In this regard, the Meuse has played by far the most important role. In Dutch Limburg and the immediately adjacent parts of Belgium and Germany, flint forms a considerable component of the Pleistocene terraces of this river. Magdalenian hunters and gatherers gratefully made use of the large supply of flint, as far as it could be collected in deposits on the surface. Only in the Middle Neolithic were flint nodules extracted at a large scale by means of open-cast mining and the quarrying of mine shafts, such as in Rijckholt in Dutch Limburg at only a few kilometres from the Magdalenian site of Mesch (Rademakers 1998).

Within the area with Cretaceous deposits, all sites show a strong dominance of artefacts manufactured of local flint (see next chapter, table 8.1). In Orp-le-Grand and Kanne, nodules used for the production of stone tools originated from flint-containing chalk that outcrops in stream valleys near the sites. In Orp-le-Grand these are lumps of flint with such large dimensions (c. 30 cm) that they cannot have been transported by the small river Petite Gette (Vermeersch et al. 1987, 8). The nodules are elongated (*allongés*), cylindrical or egg-shaped (*ovoïdes*) in shape. In Kanne, sectors Central and South, flint nodules with similar dimensions and shapes were used. A dominance of local flint also applies to the site of Mesch (Rensink 1991). The majority of the flint worked there has been designated as Rullen flint. This flint, that in its pronounced form is honey coloured, originates from the Lanaye Chalk (Gulpen Formation) and is known from several locations in the Voer region on either side of the Dutch-Belgian border, for instance near Rullen, Vrouwenbos and Rodebos (De Warrimont and Groenendijk 1993). Nodules of fluvial rolled cortex could have been collected from gravel-rich deposits of the small river Voer c. 50 m lower but at a short distance from the site (Rensink 1991). In Mesch also black-grey flint from the Lanaye Chalk, known as Rijckholt flint, occurs. One artefact, a roughly knapped pre-core, is made of Simpelveld flint and was carried to the site from the northeast over a distance of minimally 15 km. For the worked flint of Eyserheide, exploitation places are assumed within a radius of 5 km from the site. As sources qualify Tertiary and Pleistocene terrace deposits of the (ancient river) Meuse (terrace flint) and residual deposits and/or slope deposits (eluvial Simpelveld flint, Valkenburg flint and Orsbach flint) (see 4.2).

Technological studies of the stone artefacts of Orp-le-Grand, Kanne, Mesch and Eyserheide show that, within the general high standard of flint working that is typical of the Magdalenian, strategies of flint working can differ from nodule to nodule. In outline, three strategies can be distinguished. Of these, two were aimed at the production of blades and one at the production of bladelets.

The first strategy consisted of careful preparation of the core and regular maintenance of the striking platform and (the convexity of) the core face. Blade production started after the creation of a core crest on the front and back of the core and a careful preparation of the edge of the striking platform by *en éperon* technique. The strategy is synonymous with a high-grade, standardised working technique of flint, aimed at the production of several series of blades from one and the same core. For Orp-le-Grand and Kanne, Vermeersch and Symens (1988, 244) speak of *le débitage magdalénien classique*. In the publication on Kanne and Orp-le-Grand, Vermeersch et al. (1985, 1987) depict several *nucléus à lames avec un ou deux plans de frappe*, which can be regarded as the end result of this strategy. Large well-prepared cores with a succession of regular blades scars, a slightly curved (convex) core face and indications of *en éperon* preparation of the striking platform are good examples. In Eyserheide, a few RMUs (M3, M9) in the group of terrace flint testify to this strategy and a careful handling of the flint nodules. For the tabular Simpelveld flint, RMUs S1 to S3 and S309 can be mentioned as example (see 4.6.2). The strategy described here fits in well in the tradition of the Magdalenian and is also known from 'classic' sites in other regions, such as Verberie and Pincevent in the Paris Basin (see 4.8).

Although the aim is also to produce blades, in the second strategy less time and energy has been spent on the preparation and maintenance of the core. There was a less careful and more 'uneconomic' way of core reduction compared to *le débitage magdalénien classique*. In particular the first stages of working show less investment in the preparation and shaping of the core. Cortex parts are commonly present and can even largely or completely cover the sides or back of the core (*dos cortical*). The creation of a core crest or *en éperon* preparation of the striking platform has not or only incidentally taken place. Also, for the production of blades in most cases only one striking platform and core face were used. The second strategy can be designated as *débitage simplifié*. In Kanne, sector South, this strategy has been determined for at least two cores, based on compositions of refitted artefacts. About one of these cores, the following is remarked (Vermeersch et al. 1985, 34):

"Du stade du plein débitage seuls les produits irréguliers ou corticaux ont pu être remontés. Les deux plans de frappe furent réaménagés à plusieurs reprises, mais ils subirent eux-mêmes très peu de préparation et restèrent souvent lisse. La table d'enlèvements est large (env. la moitié du contour du nucléus) et ne présente pas de convexité nette".

Among the finds of Eyserheide, compositions of refitted artefacts of terrace flint around the cores (RMUs M6, M8) comply with the criteria laid down for this strategy (see 4.6.4). The back of both cores consists completely of cortex and there is only one striking platform present that was obtained in a simple way by the removal of one large flake from the top of the core. Indications of *en éperon* preparation are lacking.

The third strategy of flint working was aimed at obtaining narrow, thin blades, i.e. bladelets. Although demonstrated in all sites, the production of bladelets seems to have played a subordinate role compared with that of blades. Of 19 cores in Kanne, sector Central, only one specimen has been described as bladelet core, made from a thick flake (Vermeersch et al. 1985, fig. 12.3). For Orp-East, a few blade cores can be pointed out that were used for the manufacture of bladelets in the end stage of core reduction. In addition, both in sector East and in sector West thick flakes were utilised for the production of bladelets (Vermeersch et al. 1987, 20 and 23). For a number of artefacts, we can speak of a transitional form between bladelet cores and core-shaped burins. In Eyserheide, bladelet cores made of flakes are lacking, and only one core, part of RMU M17, has served for the production of bladelets. One of these bladelets was retouched into a backed bladelet which could be refitted onto the core (see 4.6.4).

The proximity of sources of good quality flint and the large dimensions of the flint nodules are reflected in the dimensions of the cores (table 7.3). In Orp-le-Grand, the largest pieces have dimensions of c. 20 cm and weights of 2080 grams (sector West) and 3410 grams (sector East). The largest core of Kanne, sector Central has a length of 19.7 cm and a weight of 2655 grams. Of 61 complete cores found in Mesch, 34 pieces have a length between 10 and 15 cm and eight pieces a length between 15 and 20 cm. The largest specimen is 21.7 cm long and weighs c. 2 kg. This core is comparable in weight to the largest specimen of sector West in Orp-le-Grand. The majority of complete cores in Eyserheide is smaller with lengths between 5.7 and 15 cm. The largest specimen, made of tabular Valkenburg flint, has a length of 15.1 cm and weighs 880 grams. Apparently, in Eyserheide smaller flint nodules were used for blade production and/or the cores were reduced more than in the other three sites. Especially for the group of terrace flint we should take into consideration smaller dimension of the original material. Nonetheless, the cores of Eyserheide still have considerable dimensions and they were not completely reduced or exhausted.

In table 7.3 is indicated which types of cores are represented in the sites of Orp-le-Grand, Kanne, Mesch, and Eyserheide. Blade cores with one or two opposite striking platforms and one core face occur most frequently in all sites. Cores exclusively showing the negatives of flakes and which have been discarded before the stage of *plein débitage* are described by Vermeersch et al. (1985, 1987) as *nucléus informes*. In Orp-le-Grand, six (sector East) and one (sector West) specimens of such cores have been found. The site of Mesch takes a special position in this regard with a high number of 17 pieces, moreover six cores have been described as pre-cores. They are roughly knapped pieces of flint which were already discarded in the very first phase of core reduction. Pre-cores do not occur in the other sites. As we discussed in chapter 4, among the complete cores of Eyserheide is only one core with exclusively scars of flakes. This core is made of Orsbach flint (RMU O1). Cores with crossed or several striking platforms and cores made from flakes only occur in small numbers.

From the blade scars on cores can be inferred that the flint working was aimed at obtaining long blades with regular and parallel sides. In order to evaluate well the intentions of the

Site number	Site name	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8	Type 9	N	Cortex = 0	Mean dimension (cm)	Max.dimension (cm)	Min. dimension (cm)	Mean weight (gr)	Max. weight (gr)	Min. weight (gr)
1	Eyserheide	.	1	6	6	3	2	.	.	.	18	1	10.3	15.1	5.7	375	880	65
2	Mesch	6	17	14	18	.	4	.	1	1	61	12	11.9	21.7	6	677	2000	144
4	Sweikhuizen-GP	.	15	11	.	.	.	.	.	.	26	6	6.8	23.8	2.8	.	.	.
6	Koningsbosch	.	.	.	3	.	.	.	.	.	3	3	10.3	11.8	8.3	481	625	243
7	Griendtsveen	.	.	.	present	.	.	.	.	.	.	.	.	.	.	.	.	.
8	Kanne Central	.	.	7	6?	3	.	.	3?	.	19	.	14	19.7	9.1	1155	2655	290
8	Kanne South	.	.	.	6?	.	.	.	.	.	6	.	8.5	.	.	.	.	.
9	Orp-West	.	1	13	9	0	3	1	2	.	29	8	9.6	18.2	5.2	511	2080	64
9	Orp-East	.	6	31	13	4	2	3	4	.	63	18	10.7	22.5	5.5	600	3410	110
10	Alsdorf	.	.	.	.	.	.	.	45	.	107	.	.	.	.	.	.	.
11	Beeck	.	.	.	present	.	.	.	present	.	ca.35	.	.	.	.	.	.	.
12	Kamphausen	.	.	4	1	1	.	.	1	2	9	.	5.3	8.3	3.2	.	.	.
13	Galgenberg	.	.	1	.	.	.	.	2	.	3	.	6.6	7.5	6	.	.	.

Table 7.3 Magdalenian sites of the Meuse-Rhine loess area: data on complete cores. Type 1= block/pre-core; type 2= core for flakes; type 3= blade core with one striking platform; type 4= core with two opposite striking platforms and one core face; type 5= core with two striking platforms and two opposite core faces; type 6= core with two crossed striking platforms; type 7= core with several striking platforms; 8= core on flake or frost-split piece.

flint knappers during the stage of *plein débitage*, information has been collected on the dimensions of blades. Data concerning these were published for the sites of Kanne (Vermeersch et al. 1985, fig. 18) and Orp-le-Grand (Vermeersch et al. 1987, fig. 17). Moreover, blades recovered from the sites of Mesch and Eyserheide were measured by the author himself, as part of the processing of both sites.

In all four sites, blades are mainly present as broken pieces and the number of complete pieces is small. In Orp-East, the longest complete blade measures 17 cm and in sector West 9.1 cm (table 7.4). The average length of complete blades in both sectors is respectively 6.0 and 5.7 cm. These values do not say much though about the actual dimensions of the end products. Because long blades break easily, long specimens are underrepresented in the group of complete blades. Also the lengths of complete blades from Kanne, with a few exceptions all shorter than 10 cm, cannot be regarded as representative for the same reason. Also based on refitting of broken pieces, for Orp-le-Grand the production of blades longer than 12 cm and even 15 cm has been taken into consideration (Vermeersch et al. 1987, 27). The longest, complete blade in the inventory of Mesch measures over 13 cm and of seven other pieces the length is between 10 and 13 cm. Also at this site, the aim of flint working seems to have been the striking of minimally 12 cm long blades. These dimensions concur with those of the blades in Eyserheide and in particular with those of the group of Simpelveld flint (see 4.4).

The investigation of widths of blades is based on that of medial fragments, of which many hundreds of pieces have been found. In Orp-le-Grand, the widths of medial fragments from sector East and sector West are very comparable (table 7.5). The modal value lies between 1.8 and 2.6 cm (Vermeersch et al. 1987, fig. 17). As a rule, medial fragments in Kanne are narrower, in particular in sector Central, where widths between 0.8 and 1.2 cm form a clear peak with c. 140 pieces (Vermeersch et al. 1985, fig. 18.1). Medial blade fragments in sector South are on average broader, given the peak of the distribution between 1.2 and 2.0 cm. The data of Eyserheide fit well into the picture of Orp-le-Grand. Over two thirds (68%) of the measured medial parts has a width between 1.2 and 2.6 cm. Broad blades with a width of minimally 3 cm are rare in Eyserheide, as are narrow blades with a width between 0.8 and 1.2 cm, which are well-represented in Kanne, sector Central. In Mesch, the peak of the distribution lies between 1 and 2.5 cm, which is comparable with Eyserheide and Orp-le-Grand.

With regard to thicknesses of medial blade fragments, the highest values in Orp-le-Grand lie between 0.3 and 0.8 cm. In Kanne, sector Central many of the blades are not only narrower but also thinner with thicknesses between 0.1 and 0.3 cm.

Site number	Site name	N	Complete	Cortex=0	Proximal fragment	Cortex=0	Medial fragment	Cortex=0	Distal fragment	Cortex=0	Max. length (cm)	Mean length (cm)	Ecart type (cm)
1	Eyserheide	608	67	47%	170	54%	207	54%	164	53%	16.7	6.83	.
2	Mesch	962	41	63%	318	81%	457	78%	187	80%	13	5.82	.
8	Kanne Central	1947	81	.	571	.	1005	.	290	.	>10	.	.
8	Kanne Central not in situ	624	23	.	186	.	333	.	82	.	.	.	.
8	Kanne South	374	44	.	84	.	188	.	58	.	>10	.	.
9	Orp East	2913	78	76%	861	81%	1454	81%	520	74%	17	5.98	2.40
9	Orp West	703	21	.	187	.	384	.	111	.	9.1	5.71	1.73
9	Orp not in situ	501	6	.	142	.	292	.	61	.	6.9	4.54	2.18

Table 7.4 Data on blades from Orp-le-Grand (sector West and sector East), Kanne (sector Central, Central not in situ, and sector South), Mesch and Eyserheide. Average length of blades in the two Dutch sites has been calculated on the basis of complete blades, including complete specimens after refitting of broken pieces.

	Eyserheide	Orp East	Orp West	Kanne Central	Kanne South	Kamphausen
Width in mm	%	%	%	%	%	%
2-3	2.4	.	.	.	.	.
4-5	1.4	.	.	3.8	1.6	4.5
6-7	3.4	0.2		8.3	5.5	15.5
8-9	4.3	1.9	1.6	17.1	6.6	22.7
10-11	5.3	4.6	6.0	15.9	9.9	10
12-13	10.1	7.3	6.6	5.5	10.4	11.8
14-15	14.5	6.7	8.1	8.8	12.6	15.5
16-17	8.7	8.5	9.9	7.6	12.1	6.4
18-19	8.2	12.5	11.0	7.6	10.4	5.4
20-21	7.2	11.0	10.7	7.1	8.8	3.6
22-23	10.6	9.4	9.1	5.0	8.2	1.8
24-25	7.2	10.6	11.4	4.0	3.8	.
26-27	6.3	6.7	5.2	3.8	3.8	1.8
28-29	4.8	5.4	5.6	1.9	2.7	0.9
30-31	2.4	5.2	6.5	3.8	3.3	.
32-33	0.5	3.9	1.8	.	.	.
34-35	1.9	2.1	3.4	.	.	.
> 36	0.5	4.5	3.5	.	.	.
Total	99.7	100.5	100.4	100.2	99.7	99.9
	n=207	n=1454	n=384	n=422	n=182	n=110

Table 7.5 Proportion of medial broken pieces of blades according to width from Orp-le-Grand (sector West and sector East), Kanne (sector Central and sector South), Eyserheide, and Kamphausen. Percentages mentioned for Orp-le-Grand, Kanne and Kamphausen are given by approximation, based on Vermeersch et al. 1985 (table 18.1), 1987 (table 17A) and Höpken 1994.

7.6.3 *Sites outside the area with Cretaceous flint sources*

The sites of Sweikhuizen-GP and -KW, Koningsbosch, Alsdorf, Beeck, Kamphausen and Galgenberg are located outside the area with Cretaceous flint sources, at distances of minimally 5 km from primary sources of good quality flint. In the surroundings of the sites, flint occurs exclusively in secondary context in Pleistocene river deposits. These concern not only deposits of the Meuse. In the Niederrheinische Bucht in the southeastern (German) part of the Meuse-Rhine loess area, the Rhine has eroded Early Pleistocene terraces of the Meuse. As a result, flint nodules that were incorporated in the first instance into Meuse deposits ended up secondarily in younger and gravel-rich deposits of the Rhine (*Rhein-Maas-Mischfazies*; for a discussion, see Floss 1994, 96).

The location of the above sites near flint-containing terrace deposits of Meuse and/or Rhine is expressed in the composition of the raw materials used. In the sites of Sweikhuizen, fluvially rolled flint is by far the most frequently used material (table 8.1; Arts and Deeben 1987b). As a result of transport by water, the flint nodules are usually elongated or oval in shape. At the German site of Beeck, flints were obtained from Early Pleistocene terrace deposits of the Meuse, which contain nodules with considerable dimensions of more than 20 cm. More than 99% of the stone artefacts were made of this terrace flint (Jöris et al 1993, 261). Also in Alsdorf, Kamphausen and Galgenberg flint from local terrace deposits is by far the most frequently used material (Löhr 1979; Thissen 1989; Höpken 1994).

The strategies of flint working in Orp-le-Grand, Kanne, Mesch and Eyserheide also were also recognised in the sites outside the area with Cretaceous flint sources. For Beeck, Jöris et al. (1993) mention two strategies both aimed at the production of blades. The first strategy is characterised by preparation of the back of the core, including the creation of a core crest, and application of an *en éperon* technique. In the publication on Beeck, a core is depicted schematically which is the result of this strategy (Jöris et al. 1993, fig. 4.3b). This core can be regarded as product of *le débitage magdalénien classique*. Apart from carefully reduced blade cores, there are also cores present with one striking platform, of which the back and the lateral sides consist largely of cortex. They are the result of a more simple, 'uneconomic' way of core reduction. Traces of *en éperon* preparation of the striking platform are absent. Finally, Jöris et al. point to the reduction of cores with the aim of the production of bladelets. Bladelet cores are as a rule smaller than blade cores and were made of frost-split pieces of flint, flat flakes or relatively thick blades. In the latter case, bladelets were first removed from the long (lateral) thin side, while in a later stage the dorsal side is also utilised for striking off bladelets (see Jöris et al. 1993, fig. 4.1).

In Kamphausen, the first mentioned, for the Magdalenian classic strategy of core reduction has not been determined on the basis of characteristics of cores. Only some proximal fragments of blades, of which the butt shows traces of *en éperon*-like preparation, point to the possible application of it (Höpken 1994, 25). As regards the second strategy, the picture of Kamphausen fits in with that of Beeck. Of nine cores, four pieces have one striking platform whereas the back of these cores is still largely covered in cortex and has been hardly or not worked. They are made of local terrace flint. On two cores are, despite their small size, still cortex parts visible (Höpken 1994, table 5, 5-6). This observation testifies to a minimal preparation and little investment in the first stages of core reduction aimed at decortication and preparation of the back of the core. The relatively large distances over which flint nodules have been transported by the Meuse are manifested in the sizes of the cores. The majority of the cores in Kamphausen has a length between 3 and 6 cm, while the length of the largest piece is less than 9 cm (Höpken 1994, table 5). In Galgenberg, the smallest and largest cores measure respectively 6 and 7.5 cm. Thus the largest cores of both sites are only a few centimetres larger than the smallest specimens in Orp-le-Grand, Mesch and Eyserheide. Besides, two small exhausted cores of Orsbach flint occur in Kamphausen. The intensive way of use points to a very economical handling of this non-locally available raw material (see 8.2).

Anong the finds of Sweikhuizen-GP, the largest core measures 23.8 cm and the smallest specimen 2.8 cm. Eleven complete cores have only flakes scars, but 14 blade cores also occur. The average length of the complete cores is 6.8 cm: they are thus on average significantly smaller than the cores found in sites located inside the area of Cretaceous deposits (table 7.3). Although located at minimally 20 km to the north of primary Cretaceous sources of good quality flint, three complete cores recovered from the Dutch surface site of Koningsbosch have considerable dimensions. The lengths of the largest and smallest specimens are respectively 11.8 and 8.3 cm. In all three cases we are dealing with a well-prepared blade core with one striking platform.

The use of nodules of Meuse terrace flint with relatively small dimensions is further manifest in the sizes of the blades. In Kamphausen are represented seven complete blades, the lengths of which vary between 1.6 and 4.5 cm (Höpken 1994, fig. 21). As regards the widths of the blades, there is a clear peak between 0.7 and 0.9 cm (39 of a total of 110 specimens), but also widths of 1.2 cm and between 1.4 and 1.6 cm occur relatively often (table 7.5). Blades with a width between 2.5 and 3 cm are an exception. Compared with the sites of Orp-le-Grand, Mesch and Eyserheide, the inventory of Kamphausen points to the removal of not only shorter but also narrower blades. It is obvious to link these differences to the smaller dimensions of the flint nodules as present in river terrace deposits in the direct surroundings of the site of Kamphausen. But also other factors could have played an important role, including the removal of blades from already largely reduced cores of (non-local) Orsbach flint.

Data on the dimensions of blades are not available for the site of Beeck. Judging from the blade scars on cores, considerably larger and more regular blades may have been produced at the site than is indicated by the blades actually found there (Jöris et al. 1993, 264). One possible explanation is that regular blades produced at the site have been retouched into tools and that they were used there in domestic activities. Blades that were struck off on the spot and were not used as tool have a less regular shape.

7.7 Characteristics and compositon of tools

From the large supply of blades, specimens with the desired shape, length, width and/or thickness were selected for immediate use or to be further worked into a tool. By means of retouching, long and regular blades could easily be transformed into several types of tools. In by far the most cases, tools were made of blades with regular and parallel sides, but also crested blades, bladelets and more irregularly shaped blades were used as tool. To a much smaller extent were tools made of flakes, for instance dihedral burins made of large and thick flakes in Echt-Koningsbosch.

Most sites are characterised by a wide repertoire of types of tools (table 7.6). Although the numbers and proportions in terms of percentages differ, backed bladelets, blade end scrapers, burins, borers and/or becs occur in all sites. They point to a broad variety of domestic activities (*activités domestiques*) carried out at the sites which are however difficult to specify. An important reason for this is that organic remains, such as tools made of antler, bone or ivory and faunal remains (butchering waste) have not been preserved. Moreover, as a rule, stone tools are not suitable for use-wear analysis due to patination. As yet, use-wear traces have only been identified on artefacts of Orsbach flint in the flint assemblage of Eyserheide (see contribution by Sano, chapter 5).

Site number	Site name	Backed bladelets	End scrapers on blade	Scrapers on flake	Burins	Becs	Borers	Retouched tools	Flakes and blades with edge-damage (use retouch?)	Notched tools	Truncated tools	Pièces esquillées	Combination tool	Other tools	N	References
1	Eyserheide	6	13	1	31	.	7	16	33	3	8	1	1	.	120	This publication, table 4.14
2	Mesch	9	10	.	9	9	6	20	.	.	4	.	.	.	67	Rensink 1991, table 7
3	Sweikhuizen-OS	19%	7%	.	20%	.	3%	.	.	.	.	2	1	.	ca.60	Wouters 1985
4	Sweikhuizen-GP	118	42	1	93	.	5	130	63	16	7	.	6	.	481	Arts and Deeben 1987b, table 11
5	Sweikhuizen-KW	.	.	.	.	.	.	.	.	.	.	.	.	.	?	
6	Koningsbosch	.	1	.	7	.	.	.	.	.	.	.	.	.	8	
7	Griendtsveen	29%	11%	.	39%	.	14%	.	.	.	2%	3		4	142	Wouters 1983
8	Kanne Central	1	7	2	35	3	.	21	.	5	3	.	2	6	85	Vermeersch et al. 1985, table 7
8	Kanne South	.	.	1	1	.	.	9	.	.	2	.		2	15	Vermeersch et al. 1985, table 7
9	Orp-East	30	51	2	220	8	6	59	.	26	14	.	8	14	438	Vermeersch et al. 1987, table 15
9	Orp-West	2	22	.	66	4	3	24	.	8	5	.	8	1	143	Vermeersch et al. 1987, table 15
10	Alsdorf	103	1	21	159	2	12	33	.	.	30	.	.	.	361	Löhr 1979
11	Beeck	1	3	4	18	8	.	4	.	.	6	.	.	1	45	Jöris et al. 1993
12	Kamphausen	5	1	.	5	5	2	9	.	.	2	.	.	4	33	Höpken 1994, 26-29
13	Galgenberg	no retouched tools			.	.	.	.	.	.	.	.	.	.	0	Höpken 1994, 32-34

Table 7.6 Magdalenian sites of the Meuse-Rhine loess area: tool composition.

A shared feature of all northern Magdalenian sites is the (almost completely) lack of lithic points. In the inventories of Orp-le-Grand, Kanne, Sweikhuizen-GP, Eyserheide and Alsdorf, such tools are absent. It reinforces the cultural attribution of the sites to the Magdalenian and not to a later period of the Late Palaeolithic (*Federmesser* culture, Ahrensburg culture), when lithic points commonly occur. In the site of Kamphausen a steeply retouched implement possibly represents the fragment of a flint point (Thissen 1989, 320). Prior to the excavation, a Creswell point was recovered from the surface at or near the excavation spot of Mesch. In the opinion of the author, no important conclusions should be linked to the occurrence of such isolated points. Especially when collected from the surface, it is very doubtful that they may be linked to the Magdalenian occupation of the sites. They could just as well be the result of hunting activities of Late Palaeolithic hunter-gatherers.

A type of tool that is generally seen as a component of the armature of Magdalenian hunters and gatherers are backed bladelets. These small lithic tools probably formed the lateral inserts of antler projectile points and occur in all excavated sites, but their numbers very considerably. In Sweikhuizen-GP, where wet-sieving of the excavated sediments was carried-out, backed bladelets are the dominant tool type (table 7.6). In Alsdorf, they take second place after burins, while in Orp-le-Grand sector East also relatively many backed blades occur. In the excavated sites of Kanne, Mesch and Eyserheide and in the surface sites of Beeck (one specimen) and Kamphausen (five specimens) they occur with low percentages. It should be noted that in Mesch and Eyserheide only a part of the excavated sediment was sieved. Nevertheless, also these sieved squares, among which squares in cluster A in Eyserheide, have yielded no backed bladelets. An evaluation of the number of found backed bladelets in the German sites of Beeck and Kamphausen is not useful as both inventories consist solely of surface finds.

From the above mentioned data, we may infer that activities related to hunting, such as the manufacture and the maintenance of projectile points (backed bladelets) have not played a major role in most of the sites. The almost complete lack of bladelets cores at most of the sites seems to be a further indication of this. All the same, indications of the maintenance of hunting gear by means of retooling are not completely lacking. In Orp-le-Grand, a concentration of backed bladelets at the entrance to the (supposed) tent is probably related to retooling, possibly close to the location of a hearth (Vermeersch et al. 1987, 50). The same may apply to a cluster of backed bladelets in the eastern part of the stone circle at Sweikhuizen-GP. Fragments of a heated stone slab indicate the presence of a hearth, near the entrance of the supposed tent.

Burins occur in all sites in rather high percentages. There is a clear dominance in Orp-le-Grand sector East, where 49% of the tools consist of burins (Vermeersch et al. 1987). Also in other sites are the percentages considerable, for instance between 30% and 45% in Kanne, Eyserheide and Beeck. In Sweikhuizen-GP burins are a less important tool category with a percentage of 19.3%. The group of burins comprises dihedral burins, burins on a break, burins on truncation and so-called Lacan-burins. The latter are characterised by the occurrence of an oblique retouched working edge and are well represented in Orp-le-Grand, Kanne, Sweikhuizen-GP and Beeck. The inventories of Mesch, Eyserheide and Alsdorf show a different picture. Lacan-burins are rare or absent, while dihedral burins dominate or occur in equal numbers with burins on truncation. Also noticeable is the occurrence of burins made of large and thick flakes in Echt-Koningsbosch. Although the number of artefacts from this surface site is small, all burins found (n=5) were so far made of such flakes. In all cases they are dihedral burins displaying a robust working edge on the distal end of the flake.

Another observation concerns the near total lack of blade end scrapers in the inventories of Alsdorf and Beeck. In the (very incomplete!) inventory of Beeck are three specimens which were described as a-typical. In Alsdorf, only one blade end scraper was found. These small numbers, however, do not necessarily point to a minor role of hide processing at both locations. An alternative explanation is that not blade end scrapers were used for this activity but broad scrapers made of flakes. Of these flake scrapers, four were found in Beeck (Jöris et al. 1993, fig. 7: nos. 15 to 18) and in Alsdorf as many as 21 specimens. These so-called *Breitkratzer* can be labelled as locally manufactured, opportunistic tools made of locally available terrace flint. In the sites of Orp-le-Grand, Kanne, Mesch, Sweikhuizen-GP and Eyserheide blade end scrapers occur more often. Judging from the specimens illustrated in publications, scrapers occur with both a broad, rather straight scraping edge and with a semi-circular working edge. Based on the rather steep scraping edge, the former scrapers were possibly used more intensively. Scrapers with a semi-circular working edge are usually retouched lightly. This could be an indication of short-lived use and/or the working of less hard materials (for instance hides). Scrapers also occur with continuous retouch on both lateral edges and an intentionally retouched, round scraping edge.

Another conspicuous element in the inventories is large borers with an often thick, pronounced working edge (becs). Long axial pointed becs are well-represented in the inventory of Mesch. Comparable becs are known amongst others from the Magdalenian site of Marsangy in the Paris Basin (Schmider 1992). Schmider defines becs as tools with a narrow, beak-shaped point (working edge) that was obtained by means of unilateral retouching. In contrast to a bec, a borer (*perçoir*) has a finer and shorter working edge which displays bilateral retouches (Schmider 1988, 195).

In Mesch, nine retouched artefacts have been described as becs. Two of these are axial becs with a long, elongated point on the longitudinal axis of the tool. Other becs have a less pronounced working edge. There are also becs made of crested blades. The cross-sections of such blades are triangular and correspond with the usual cross-section of axial becs.

Taking into consideration measurements of the main types of retouched tools, the lengths of complete specimens are very variable in the sites of Orp-le-Grand, Kanne, Mesch and Eyserheide (table 7.7). Of a total of 53 complete end scrapers, burins and borers/becs, seven pieces have a length of more than 10 cm. In Orp-le-Grand sector East, two complete burins have a size of more than 12 cm. The lengths of other tools lie mainly between 4 and 10 cm, whilst complete end scrapers are slightly longer than burins and borers/becs. For the mentioned sites, the widths of retouched tools show a large degree of standardisation pointing to selection of blades with specific widths. Of 96 blade end scrapers, 76 pieces have a width between 1.5 and 3.0 cm (table 7.8). For dihedral burins this number is 40 of a total of 63 pieces. Burins on truncation and Lacan-burins are made of slightly narrower blades. Among 34 borers/becs are eleven pieces made of blades with a width between 2 and 2.5 cm.

For sites located outside the area with Cretaceous flint sources, fewer data are available on dimensions of tools. In Kamphausen, the longest, complete burins have a length of c. 5 cm (Höpken 1994, tables 6 and 7). Other tools have mainly been found as broken pieces and are considerably smaller in size, with the exception of a broken burin and a broken bec. Looking at the illustrations of the tools in Beeck, we can assume for the complete tools a length between 4.5 and 8 cm. Based on characteristics of the patinated break surface, a number of the broken tools was presumably hafted. In this connection, the width of Lacan-burins can be pointed out, which is very standardised, namely between 2.2 and 2.8 cm. This standardisation forms an indication of hafting and the selection of blades with specific widths for the production of Lacan-burins.

Finally, for the site of Beeck are taken into consideration ‘typological transformations’ of Lacan-burins (Jöris et al. 1993). As a result of use and resharpening, the long working end of Lacan-burins was shortened step-by-step, which caused a transformation into burins on truncation:

> “Die Beecker Lacamstichel weisen eine umlaufende und auf die Fläche greifende Retusche auf, die bei anderen Stichelformen fehlt. Die macht es u. E. möglich, Stichel an Endretusche mit einer solchen umlaufenden Retusche als “Lacamstichel” in einem fortgeschrittenen Stadium der Nachschärfungssukzession anzusprechen” (Jöris et al. 1993, 264-265).

7.8 Site size and settlement features

Magdalenian sites in the Meuse-Rhine loess area consist of concentrations of stone artefacts which, as a general rule, are small in size. In many cases, the excavated surface covers less than 200 m^2, and the concentrations of Orp-le-Grand, Mesch and Eyserheide could each be documented (almost) completely within such an area (table 7.1). The possibility that the excavated concentrations form small sections of larger settlement areas, consisting of closely together positioned, simultaneously used habitation units (cf. Pincevent, Etiolles, Gönnersdorf), is not considered plausible. In Alsdorf, 80 trial squares were excavated east of the find concentration, however without any results. The excavation of a zone of c. 450 m^2 around the concentration in Sweikhuizen-GP yielded no indications of a second concentration. In the same area, at a distance of 400 m (Sweikhuizen-OS) and 150 m (Sweikhuizen-KW), two other Magdalenian sites were identified. Whether there was simultaneous occupation could not be determined with certainty. In Orp-le-Grand, we are dealing with two clear concentrations at a distance of only five metres from each other. In view of the results of TL-research (Vermeersch 1991) and differences in the extent to which artefacts have been affected by frost action, the two concentrations are not regarded as being contemporaneous. And finally, field surveys in the surroundings of the excavation locations of Mesch and Eyserheide have not yielded indications of nearby concentrations from the Magdalenian. We should take into consideration that in Mesch, outside the area of the karst subsidence in the zone where Pleistocene Meuse gravels outcrop, adjacent or nearby concentrations could have been eroded completely. Hence, it cannot be excluded that we are dealing with a relatively small section of an originally much larger activity area. On the loess plateau of Eyserheide, concentrations may be covered by a layer of loess and thus remained outside the reach of the plough. As a result they could possibly be present but have not (yet) been identified based on surface finds.

The site of Kanne deserves special mention. At this location, along the alluvial plain of the river Geer, we obviously are dealing with rather dispersed concentrations of mainly flint debitage and not with one, spatially bounded camp site. The data point to several locations of specialised activity and a zone in the landscape to which Magdalenian hunter-gatherers repeatedly returned (see discussion 7.9).

End scrapers	**Length in mm**													
	<10	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	>120	N
Eyserheide	.	.	.	.	.	.		1	.	1	1	.	.	3
Mesch	.	.	.	.	.	.	2	.	.	.	.	.	.	2
Kanne Central	.	.	.	.	.	.		1	1	.	.	.	.	2
Orp-East	.	.	1	.	.	.	1	1	.	.	.	1	.	4
Orp-West	.	.	.	.	1	.	2	1	.	.	1	.	.	5
Total	0	0	1	0	1	0	5	4	1	1	2	1	0	16
Burins	**Length in mm**													
	<10	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	>120	N
Eyserheide	.	.	.	.	1	.	.	3	3	.	.	.	.	7
Mesch	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Kanne Central	.	.	.	.	1	.	2	.	.	1	.	.	.	4
Orp-East	.	.	1	.	.	1	2	1	1	.	.	.	2	8
Orp-West	.	.	.	2	2	.	2	1	.	.	.	.	.	7
Total	0	0	1	2	4	1	6	5	4	1	0	0	2	26
Borers/becs	**Length in mm**													
	<10	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	100-109	110-119	>120	N
Eyserheide	.	.	.	.	1	.	.	.	1	.	1	1	.	4
Mesch	.	.	.	1	.	.	1	1	.	1	.	.	.	4
Kanne Central	.	.	.	.	.	1	.	.	.	.	.	.	.	1
Orp-East	.	.	.	.	.	.	.	.	.	.	.	.	.	0
Orp-West	.	.	.	.	.	1	.	.	1	.	.	.	.	2
Total	0	0	0	1	1	2	1	1	2	1	1	1	0	11

Table 7.7 Lengths (in mm) of complete end scrapers, burins and borers/becs in Eyserheide, Mesch, Orp-le-Grand (sector West and sector East), and Kanne (sector Central).

End scrapers	**Width in mm**											
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	>50	N
Eyserheide	.	.	.	3	6	1	1	1	.	.	.	12
Mesch	.	.	.	1	1	5	.	1	1	.	.	9
Kanne Central	.	.	1	.	3	3	.	.	.	.	.	7
Orp-East	.	.	4	9	17	11	5	.	1	.	.	47
Orp-West	.	.	.	4	6	6	4	.	1	.	.	21
Total	0	0	5	17	33	26	10	2	3	0	0	96
Burins	**Width in mm**											
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	>50	N
Eyserheide	.	2	4	6	9	4	1	.	.	.	.	26
Mesch	.	.	1	1	1	2	1	.	.	.	.	6
Kanne Central	.	1	3	9	5	3	3	1	.	.	.	25
Orp-East	2	2	10	28	17	17	7	3	.	.	.	86
Orp-West	.	5	2	10	13	5	4	1	.	.	.	40
Total	2	10	20	54	45	31	16	5	0	0	0	183
Borers/becs	**Width in mm**											
	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	>50	N
Eyserheide	.	.	.	1	5	.	.	.	.	.	.	6
Mesch	.	3	3	3	2	3	1	.	.	.	.	15
Kanne Central	.	1	.	.	2	.	.	.	.	.	.	3
Orp-East	.	1	.	1	1	.	1	.	.	.	.	4
Orp-West	.	.	1	1	1	1	1	.	.	1	.	6
Total	0	5	4	6	11	4	3	0	0	1	0	34

Table 7.8 Widths (in mm) of complete and broken end scrapers, burins and borers/becs in Eyserheide, Mesch, Orp-le-Grand (sector West and sector East), and Kanne (sector Central).

Indications of settlement features (habitation structures) come from two locations: Sweikhuizen-GP (in the shape of a stone circle) and Alsdorf (in the shape of stone slabs which were possibly part of a floor pavement). And although heated stones were demonstrated within the concentrations of Orp-le-Grand sector East, Kanne, Sweikhuizen-GP and Eyserheide, no large hearths constructed with stones were found there, such as are known from Magdalenian sites in for instance the Central Rhineland (Gönnersdorf and Andernach) and the Paris Basin (for instance Etiolles, Pincevent). The latter sites were not 'ploughed up' and thus the circumstances of conservation are clearly better. Stones belonging to one and the same structure were found there in close spatial association with large quantities of settlement debris. Nonetheless, there seems to be an essential difference in investment in hearth structures between on the one hand the mentioned German and French sites and on the other the northern loess sites. During the excavations in Orp-le-Grand, Mesch and Eyserheide, no or only few fragments of (heated) stones were recovered from the surface or from the plough zone. In the case of intensive use of and/or prolonged stays at these settlements, comprising hearths that were used and cleared regularly, the number of such fragments should have been much higher.

7.9 Discussion

A traditional point of particular interest in regional Palaeolithic research is to determine the variability (in the position in the landscape and in material culture) between assemblages and their meaning in the wider context of prehistoric land-use and settlement systems. Ethnographic and ethnoarchaeological studies have contributed to a better insight into the way in which 'historically documented' groups of hunters and gatherers ('ethnographic foragers', see Porter and Marlowe 2006) in different parts of the world used their natural surroundings (see for instance Gamble and Boismier 1991). The majority of these studies centre on the relationship between on the one hand characteristics of the natural environment and on the other the exploitation of food and other resources and mobility of hunters and gatherers (Binford 1980; Kelly 1983). The studies demonstrate that mobility strategies can differ strongly, in response to variations in the supply and the nature of primary food sources in time and space. But also internal factors (social, religious) may have determined the selection of the location of camp sites, the mobility and composition of human groups and the organisation of the settlement system.

Among the broad range of ethnographic and ethnographical research, the work of L.R. Binford on the Nunamiut in North Alaska in particular has proved to be an important source of inspiration for archaeologists active in the field of the Late Upper Palaeolithic. Binford (1980) distinguishes foraging and logistical strategies of land use, which he considers characteristic of respectively foragers and collectors. Foragers position their base camps, so-called residential sites, in the immediate vicinity of resources, the exploitation of which occurs as required and on a daily basis. The exploitation takes place using an encounter strategy on locations at a short distance from the base camp. When the resources become depleted, the base camp is moved and a new territory is exploited. The frequency of moving the base camp is high, in other words there is a high residential mobility. The opportunistic way in which resources are exploited implies that the degree of anticipation and planning depth is low as a rule. Also hardly or no storage of goods takes place. A foraging mode of land use is characteristic of groups of hunters and gatherers that live in areas with varied but dispersed and (when it concerns time and place of supply) unpredictable food resources.

In a logistically organised system, the base camp is moved less frequently, in other words there is a low residential mobility. The camp is strategically positioned in relation to food and other resources and serves as operation base for logistical expeditions by task groups. These expeditions usually take place at larger distances from the base camp, directed at the exploitation of specific sources at specific locations. The collected goods are brought back to the base camp or stored elsewhere for later use. The settlement system of collectors comprises apart from residential sites and locations also field camps, observation stands and caches. Implementation of logistical strategies is characteristic of hunters and gatherers living in areas with mobile and in time concentrated occurring food sources. Binford mentions the system of land use of the Nunamiut in North Alaska as an example of this system.

Several researchers have pointed out that the forager-collector dichotomy is a strong simplification of the complexity of hunter-gatherer groups. In a comparable sense, residential and logistical strategies of mobility and land use must also be regarded as strong simplifications of in reality more complex forms of spatial organisation. Often it concerns "variable mixes of these two dimensions" (Kelly 1983, 278). Nonetheless, the distinction between the two strategies often serves as 'framework' for the description of various characteristics of behaviour of hunters and gatherers, such as technological organisation, social structure and degree of anticipation and planning depth. In other words, we are dealing with a set of interrelated notions while taking the forager-collector dichotomy as starting point.

In order to translate the statical data of the archaeological record into dynamic systems of mobility and land use, methods have been developed directed at analysis of intrinsic characteristics of sites. An example of this is the method proposed by Chatters (1987). Following Binford, Chatters distinguishes residential and logistical mobility, of which he supposes that they leave behind different manifestations in the archaeological record. Making this assumption, he next formulates expectations regarding characteristics of base camps and field camps of foragers (foraging mode of land use) and of collectors (logistically organised system). Thus Chatters mentions archaeological measures for components that are directly linked to resource acquisition strategies: mobility, predation and technology. Each of these components has different dimensions. Mobility, for instance has: mobility type, mobility frequency, stability, demography, scheduling, and range. As archaeological measures of mobility type, Chatters considers diversity in tools and features, inter-assemblage variability, anatomic part distributions and bone fragmentation (Chatters 1987, 340-344).

The method proposed by Chatters (or comparable methods) has seen almost no application in the research of site types and strategies of mobility and land use in the Magdalenian. This may partially have to do with the scant influence of results of 'middle range' research published in English-language journals on the work of mainly French-speaking archaeologists working in the field of the northwest European Magdalenian. But also limitations of the method itself presumably play an important role. These limitations are recognised as such by Chatters. Hence he remarks regarding the applicability of the archaeological measures (1987, 353):

"In all cases, application entails ordinal scale comparisons of assemblages among deposits for which all other conditions are equal with respect to the data category being investigated. For example, predation strategies can only be discerned through comparison of assemblages for which postdepositional histories and the influence of chemical weathering are demonstrably equivalent."

In the Magdalenian of Northwest-Europa open-air sites in the Paris Basin and along Lake Neuchatel in Switserland most meet the criteria that Chatters mentions. Lying in fine-grained sediments deposited by main rivers (Pincevent, Verberie, Etiolles, Marsangy, Marolles) and in lacustrine deposits (Monruz, Champréveyres), they are locations with comparable conditions of preservation. Because of the high degree of integrity (well-preserved habitation units with most of the finds concentrated around hearths) and the conservation of organic remains, these sites are in principle suitable for the application of methods as proposed by Chatters.

The research in the Paris Basin underlines the importance of the conservation of faunal remains for the determination of the duration of occupation and functions of sites (Olive 2004, 799). Thus for Pincevent, habitation units in level IV 20 are interpreted as belonging to a large seasonal camp connected with collective hunting of reindeer at the end of summer or beginning of autumn, "au moment du regroupement des troupeaux avant la migration d'automne" (Julien and Karlin 2001). In Pincevent IV.0 there is evidence for a longer duration of occupation, perhaps several months, and for mixed hunting of big game that may have been present all year long in the Paris Basin. For the concentrations of Etiolles, where the fauna remains were badly preserved, the duration of the occupation can be less well estimated. For the most find-rich units an occupation of no more than a few months is assumed. On the basis of data from archaeozoological investigations, also for other sites is mentioned "de séjours de courte durée", linked to hunting reindeer in the autumn in Verberie and hunting horses for instance in the site of Marolles near the confluence of the Seine and Yonne (Olive et al. 2000).

If we turn to the Magdalenian open-air sites of the northern loess zone, it is evident that archaeological measures of mobility, such as anatomic part distributions and bone fragmentation, cannot be 'scored' as archaeological organic remains have decayed completely. Also the measure of feature diversity is difficult to determine for the surface sites concerned. Through bioturbation and present-day land use, settlement features can be heavily disturbed, and thus the exact nature can no longer be ascertained (see Eyserheide). Hence they no longer qualify as 'measure' to determine the diversity between sites. Moreover, in the Meuse-Rhine loess area we are dealing with a number of open-air sites that have not been completely excavated or which are only known from surface finds. Finally, stratified sites (*gisements clairement stratifiés*) are missing, which are very important for the investigation into the 'time depth' of occupation and possible changes in the use of locations through time (see Olive 2005). Added together, these factors impose heavy restrictions on detailed, comparative research and the assigning of meaning to inter-assemblage variability and ultimately attributing functions to prehistoric hunter-gatherer sites. Given these restrictions, in the text below a broad, functional interpretation of the Magdalenian sites in the Meuse-Rhine loess area is presented, taking into consideration the following characteristics: location in the landscape and size of the sites, investment in habitation and hearth structures, and composition of the stone artefacts.

A topographic characteristic with which almost all sites comply is their location on or at the margins of elevated plateaus. Such an elevated location, often high above stream and/or dry valleys, is a generally known phenomenon of Late Upper and Late Palaeolithic open-air sites in Western Europe. Assuming that, during the occupation of the locations at the end of the Pleniglacial of the Weichsel ice age (see chapter 8), a vegetation of trees on the higher parts of the landscape was completely lacking, the exposed position of the camp sites would offer a splendid view onto nearby valleys, slopes and plateaus. Thus they were important locations from a perspective of food supply and more specifically for monitoring animal food sources, among which horse and reindeer (see Thissen 1989, 315; Rensink 1991). But also the spotting of other groups of hunters and gatherers or the being recognisable themselves for these groups can have played an important role. Apparently more importance was attached to a panoramic view over the landscape than to the proximity of a river, stream or good quality raw material source. With the exception of Kanne, the distance of all sites to the nearest permanent water course was 500 m (Mesch) or more (table 7.1). Also the distance from the camp sites to the exploited flint sources was minimally a few hundred metres. The close proximity of a water or flint source thus seems not to have played a decisive role in the choice of location for the majority of the camp sites.

Earlier in this chapter we mentioned the presence of remnants of settlement features, such as a tent circle in Sweikhuizen-GP, a 'paved floor' in Alsdorf and a small hearth in Orp-le-Grand and Eyserheide. In addition to these investments, we can point to the transport of and bringing together of many kilos of flint to the camp sites for further working and use. In the case of the Eyserheide site, there are even indications for the transport of flint nodules from at least five exploitation places and from different directions (fig. 7.4). Such investments do not accord with the notion of briefly used camp sites, erected for the execution of specific, short-term activities and with a more or less random location in the landscape. They rather argue in favour of carefully chosen locations (fixed points) on or at the margins of loess plateaus with a temporary, central function in the regional settlement system. The occurrence of relatively high numbers and various types of stone tools is in keeping with this notion of a 'multi-functional' stay of at least a few days. In all excavated sites, tool types typical of the the Magdalenian occur side by side and only in one site (Orp-East) does one specific type make up almost 50% of the tool inventory (table 7.6). And even if the relatively high amount of burins at sites such as Alsdorf, Beeck, Eyserheide and Orp-East may illustrate the importance of antler, bone and/or ivory working, the variations in tool types are such that there is insufficient reason to speak of special-task camps (contra Jöris et al. 1993, 270-271). Such an interpretation does not take into account the combination of activities which are considered likely for most sites: resource monitoring (elevated position in the landscape), hunting activities (backed bladelets), core reduction and blade production (flint waste) and variation in domestic activities, such as working of antler, bone and/or ivory (burins and borers/becs), hide processing (scrapers) and maintenance of hunting gear (retooling). This set of activities and the investments connected with them rather argue in favour of an interpretation of the majority of the excavated sites (Orp-le-Grand, Sweikhuizen-GP, Eyserheide, and Alsdorf) as briefly used base camps of, in each case, a small social unit (one nuclear family), the precise composition of which cannot be further specified on the basis of the archaeological data.

In the sites of Mesch and Kanne, sector South the numbers of retouched tools are small, while knapping products linked to the first stages of core reduction, for instance large preparation flakes with cortex parts, are numerous. Notable for the inventory of Mesch is further the occurrence of large pieces of roughly worked flint (pre-cores). Moreover, both sites are lying a short distance from good quality lithic raw material sources. Based on these characteristics, Mesch and Kanne can be designated as flint extraction and production sites (*sites d'extraction et production*) where cores, blades and/or tools were produced for future purposes at other locations.

In Poland, sites interpreted as workshops from the Late Palaeolithic have been known for a long time and have been investigated through excavations (Ginter 1974, 1984). They can be divided into two groups: workshops located at extraction points and workshops location off extraction points (Ginter 1974, 83). The former workshops are associated with the locations of raw material extraction itself and are characterised by the occurrence of hardly worked pieces of flint, pre-cores unsuitable for further use, waste pieces and numerous flakes with cortex parts. Only few blades and blade fragments occur. Apart from Polish sites, also the Dutch site of Waubach (Arts 1984) and a number of concentrations in Groitzsch in Germany (Hanitzsch 1972) can be assigned to this category of workshops. The workshops located off extraction points are situated in the surroundings of extraction points, at a distance of a few hundred metres to a few kilometres. At these locations, nodules of flint were further worked, after the first preparation was already carried out at the point of extraction. Important features of these workshops are the occurrence of cores in various stages of reduction and a large volume of debitage material. Flakes without cortex outnumber flakes with cortex remains, and blades unsuited to the manufacture of tools generally occur.

If we compare the artefact composition of workshops located off extraction points in Poland with that of Mesch, there are important similarities in a number of aspects (Rensink 1991,

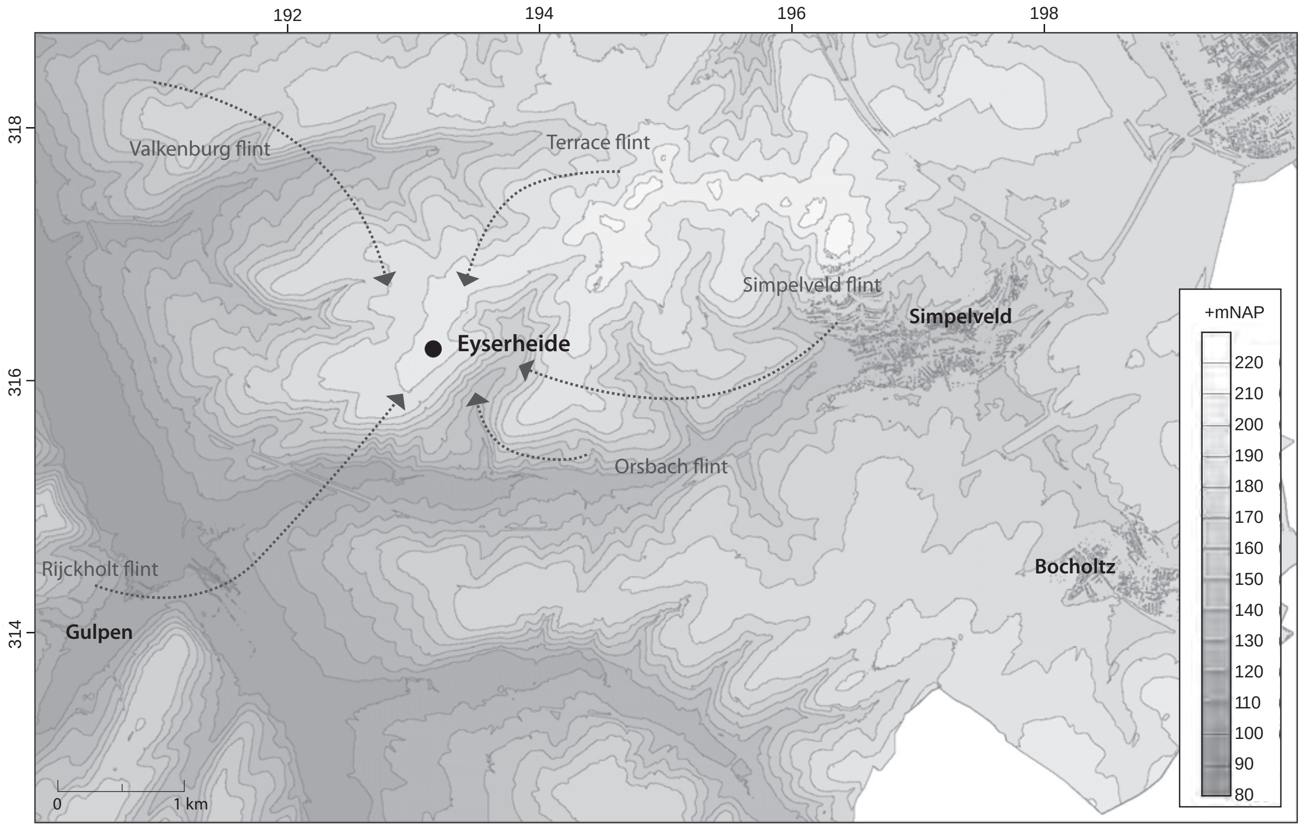


Figure 7.4 Contour map of Eyserheide and surroundings and (possible) directions of transport of types of flint worked at the site. Despite the fact that the exact locations of exploitation can not be determined, directions of transport can be reconstructed by approximation, based on the distribution of geological formations in the area.

table 11). In the Polish complexes, waste products take up considerable percentages, varying between 48% and 65% (flakes) and 29% and 49% (blades). Pre-cores and cores take up less than 5%. The percentages of retouched tools are low and amount to less than 1%. The fact that the percentage of tools in the inventory of Mesch is higher (2.1%) indicates that domestic activities and/or retooling may have played a bigger part there than at the Polish sites. Another difference is that so-called workshop and extraction tools are lacking in Mesch (or were not recognised as such?). Based on similarities in artefact composition and location of the sites in the vicinity of sources of good quality flint, the site of Mesch can be designated as workshop located off extraction point. We are dealing with a location where numerous flint nodules were brought to, were worked and discarded before the stage of blade production (*plein débitage*) was attained. Moreover, many flint nodules reached the stadium of well-prepared blade cores and from these cores many long and regular blades were struck.

In the publication on the Mesch site, the author proposed that Magdalenian hunter-gatherers used the location primarily as an observation post (Rensink 1991). This interpretation is based on the following observations:

1. from the elevated location, the occupants of the camp had a good view of large parts of the surrounding hilly landscape. They would have been able to spot herds of reindeer and/or other game at considerable distances;
2. blades manufactured at the location seem to have been principally intended for future use at other locations; accordingly, the execution of domestic activities, such as working of bone or hide, would not seem to be the main reason for singling out this location;
3. large nodules of flint were collected in the valley of the river Voer and subsequently transported to the edge of the plateau. It supports the idea that the location was primarily chosen for its splendid view. In this particular case, we have a fine example of the transport of *local* lithic materials, which has allowed us to gain a better

understanding of the function of the site and the activities performed.

It should be stressed that the above mentioned functional interpretation of the Magdalenian site of Mesch is exclusively based on the location of the site in the landscape and on data regarding provenance and use of lithic raw materials. Because organic remains have not been preserved in this and the other northern loess open-air sites, it is possible to make statements on only a part of the activities that were carried out in the camp sites. Moreover, archaeological data on seasonality are completely lacking. Assuming that burins were used in bone and/or antler working and that this was one of the main activities carried out in Eyserheide and in other camp sites, its meaning in terms of season of occupation is slight. This activity could in principle have taken place at any period of the year. Following the data of Pincevent, Verberie and other sites in the Paris Basin, antlers could have been obtained during the reindeer hunt, during the annual migrations of these animals in the spring and autumn. But "freshly" shed antlers could also have been collected in the landscape at the end of summer and in the beginning of autumn. Another option is that antlers were kept submerged in water as cache and were worked in other seasons than the spring and autumn. (B. Grønnow, pers. comm. 2009). Finally, hunting activities in the northern Magdalenian of course were not or not exclusively aimed at reindeer, as is clearly demonstrated by the large diversity of hunted species represented in the faunal assemblages of Andernach and Gönnersdorf in the Central Rhineland and those of the Belgian cave sites. Burins could also have been used for working bones of other animals which could be hunted in other or even all seasons of the year.

Though we cannot make inferences on seasonality from faunal remains (not being preserved) nor from the results of micro-wear analysis (burins could have been used for antler, bone and/or ivory working in all seasons), there are some indirect indications that may be worthwhile to mention in this context. With the exception of Kanne, which has a sheltered topographical position along the valley of the river Geer, all sites are located on high loess plateaus, in exposed places. Taking into account the still cold, stadial conditions of the late Pleniglacial in which the northern loess open-air sites should be dated (see chapter 8), the notion that these sites reflect cold-season occupations is not very likely. In this phase of the Weichsel ice age, loess was still being deposited in an open landscape characterised by a dry, steppe tundra landscape and completely devoid of trees at least in the higher sections. As pointed out by Straus and Otte in their paper on the Bois Laiterie Cave and the Magdalenian of Belgium (1998, 264):

> "Following the logic that people would naturally prefer to take advantage of available shelter (i.e. caves) especially in winter, that game would seek shelter during winter in the protected, well-watered valleys of the Ardennes fringes rather than on the open, windswept plains of Middle Belgium, and that flint nodules would be difficult or impossible to obtain under the snow or in frozen earth, it can be hypothesized that the open-air Magdalenian sites of Limburg, Brabant and Hainaut were mainly occupied by people in the warm season."

In addition to the arguments mentioned above, a further indication of 'warm season occupations' would be the lack of large habitation structures or hearth structures, as has been discussed earlier in this chapter (7.8).

Following the suggestion made by Straus and Otte in the above quotation on the possibility of seasonal occupation and complementarity of areas which are characterised by different landscape features, in the next chapter we will place the Magdalenian open-air sites of the Meuse-Rhine loess area in a broader, Northwest European perspective, incorporation archaeological data from two more southerly regions in our investigation: the Central Rhineland in Germany and the Belgian Ardennes.

8 Northwest European context

8.1 Introduction

The sites of the Meuse-Rhine loess area that were discussed in chapter 7 are the remnants of small camp sites of Magdalenian hunters and gatherers who, about five thousands of C^{14} years after the extreme cold of the Last Glacial Maximum around 18,000 BP and following the colonisation of more southerly (South Germany) and easterly (Thuringia, southern Poland) regions, dispersed over parts of Northwest Europe (Housley *et al.* 1997; Blockley *et al.* 2000; Blackwell and Buck 2003). From this point of view, they should be studied in the broader perspective of colonisation and the exploration and exploitation of 'marginal' areas which had not seen human occupation for many thousands of years. A research theme that fits in this broader perspective is the relationship between the Magdalenian occupation of geographically distinct areas. Is there a relationship between the occupation of the Meuse-Rhine loess area and that of nearby areas, and if so which are the indications of this? Should the northern loess zone be regarded as part of a more extensive territory of hunters and gatherers from the Magdalenian? And on which points was there complementarity between areas, for instance in the exploitation of food and raw material resources? In order to be able to answer these questions, it is necessary to place the sites of the Meuse-Rhine loess area in a larger geographical framework. In view of the topographical location of the sites of the Meuse-Rhine loess area on the northwestern fringe of Magdalenian territory, it seems evident to include data on more southerly regions in the research.

As discussed in chapter 7, prehistoric organic remains in the northern sites have not been preserved as a result of post-depositional processes. For the examination of relationships between the Magdalenian occupations of the Meuse-Rhine loess area and those known from other areas, we therefore have to turn to characteristics of stone artefacts. Determinations of stones have provided valuable insights for numerous sites in several European regions into the presence, provenance and use of local and non-local raw materials, and into the distances over which and the directions from where raw materials have been transported. Starting from the linear distance between locations of sites and the associated source areas, inferences have been made on (changes in) mobility and on the size of territories of Palaeolithic hunters and gatherers (Demars 1982; Mauger 1983, 1985; Geneste 1988; Roebroeks *et al*. 1988; Féblot-Augustins 1997, 1999). An important assumption in these studies is that raw materials were not obtained by exchange between human groups or by means of special expeditions (direct procurement), but that the exploitation and transport of these were embedded in seasonal migrations or hunting trips of human groups in the course of their annual round (Binford 1979). Based also on transport distances of lithic materials, a high degree of residential mobility is assumed for the Magdalenian of Northwest Europe. Straus (1991, 171) remarks in this regard:

> "If the Magdalenian hunters of the North European Plain engaged in very extensive residential mobility over vast ranges and obtained flints that are highly nonlocal with respect to such sites as Pincevent, Chaleux and Gönnersdorf, either through contacts with other groups or by visiting the actual sources, that was not necessarily the case in other European regions inhabited in the same periods of time. The emerging Magdalenian model of the North European Plain must not be uncritically applied in other regions."

The investigation of non-local materials further offers for stratified sites the possibility of obtaining an insight into trends and continuity in long-term land use of Magdalenian hunters and gatherers. A good example is Pincevent and the information that can be inferred from a non-local, Tertiary brown flint (*silex brun*). Artefacts made of this flint first came to light during the investigation of Habitation no.1 (Leroi-Gourhan and Brézillon 1966). In subsequent years, small quantities of artefacts of s*ilex brun* were also recovered from other habitation units during excavations. As the flint mainly occurs as retouched tools and blades/bladelets, it is assumed that the artefacts formed part of a transported, light-weight toolkit that was brought to Pincevent in anticipation of use during the first days of occupation of the new camp there. The source area of *silex brun* is the area of the confluence of the Marne and Seine rivers, c. 50 km north and northwest of Pincevent (Mauger 1985). Importantly, artefacts of this Tertiary flint have been found in several habiation units associated with different stratigraphical levels.

This observation points to planned and annually (?) recurring migrations of groups of Magdalenians from the Marne area to the location of Pincevent. The picture emerges of small, mobile groups that anticipated the arrival of reindeer and the possibility of a collective hunt in a favourable location (river crossing) near Pincevent in the late summer and/or autumn, as can be inferred from characteristics of the faunal remains (David and Enloe 1992). Such planning and organisation directed at a successful exploitation of a heavily clustered, in time and space, food resource require thorough knowledge not only of the topography of the regional landscape (where) but also of the migratory behaviour of reindeer (when) during the cold phase of the Early Dryas stadial.

The leitmotiv of this chapter is formed by the data about presence, provenance and use of non-local lithic materials in Magdalenian sites in the Meuse-Rhine loess area and in two more southerly regions, namely the Central Rhineland in Germany and the Ardennes Massif in Belgium. After we have presented an overview of non-local lithic materials in the northern loess sites (8.2), we will examine which stone varieties Magdalenian hunters and gatherers in the Central Rhineland used for the manufacture of stone tools (8.3). The question whether both areas formed part of the annual range (or territory) of the same human groups we will address in paragraph 8.4. Next, the focus is on the Magdalenian occupation of Belgian caves and its relationship with the open-air sites of the Meuse-Rhine loess area (8.5). In paragraph 8.6 we will discuss some trends in the procurement and use of Dutch flint materials in the northern Magdalenian. At the end of this chapter (8.7), concluding remarks are made concerning the relationship between Magdalenian sites in Northwest Europe, also taking into consideration the chronological position of Eyserheide and the other open-air sites in the Meuse-Rhine loess area.

8.2 Meuse-Rhine loess area: non-local raw materials

Most of the Magdalenian open-air sites in the Meuse-Rhine loess area are characterised by the occurrence of (small quantities of) stone artefacts made of non-local materials, that is to say of stones of which the source locations are minimally 10 km (as the crows flies) from the camp sites. They are present in all sites located outside the area with Cretaceous flint sources, but the amount and the technological and typological form in which artefacts occur vary between sites. Sites located within short distance from Cretaceous flint sources (Orp-le-Grand, Kanne, Mesch and Eyserheide) have yielded almost no artefacts of non-local stone. In the inventory of Mesch we are dealing with one roughly knapped piece (pre-core) of Simpelveld flint. Natural occurrences of this type of flint lie c. 10-15 km northeast of Mesch in the eastern part of Dutch South Limburg and east of the small river Geul where Eyserheide is located. Non-local raw materials recovered from sites located outside the area with Cretaceous flint sources include the following types of stone (tables 8.1-8.2):

Baltic flint:
Löhr (1979, 36) points to the presence of artefacts of northern erratic flint (Baltic flint or *Baltischer Feuerstein*) in the inventory of Alsdorf, imported over a distance of minimally 70 km from the northern moraine area. According to Löhr, the inventory comprises three tools and 15 blades of this flint. Regarding these artefacts, he speaks of a primary toolkit or "eine zum Lagerplatz mitgebrachte Grundausstattung" (cf. artefacts of *silex brun* in Pincevent). Three artefacts of the inventory of Beeck have been described as Baltic flint, including one blade end scraper. This scraper is distinguished from two other scrapers made of local Meuse terrace flint by a regular, semi-circular working edge (Jöris et al. 1993, fig. 7.2). The finds of the surface site of Kamphausen, situated c. 35 km from the northern moraine area contains two backed bladelets possibly of Baltic flint. Because of the small size and the absence of cortex, the determination of the raw material is however not certain. Also for other sites we should bear in mind the possibility of uncertain attributions for the same reason. In contrast to the mentioned German sites, no artefacts of Baltic flint were recovered in Eyserheide and the other Dutch sites (or were not recognised as such?).

Simpelveld flint:
This type of flint is present as non-local raw material in the inventories of Sweikhuizen-GP and Sweikhuizen-KW. Its natural source area, i.e. the area of Simpelveld-Wittem in the eastern part of Dutch South Limburg, is situated c. 10-15 km southeast of both sites. In the completely excavated site of Sweikhuizen-GP these are end products of the stage of *plein débitage*, namely five blades and eleven blades and bladelets retouched into tools. The tools consist of three backed bladelets, three burins, a composite tool and four retouched and used blades. A core and some flakes of Simpelveld flint are present in Sweikhuizen-KW. The other artefacts agree with the picture of Sweikhuizen-GP and consist of seven blades and seven tools. Of the finds recovered from the surface at Kamphausen, one artefact, a fragment of a blade with an oblique end retouch, has been described as Simpelveld flint (Höpken 1994, plate 6:18). The distance between the source area and Kamphausen is at least 30 km. For the small and incomplete inventories of the surface sites of Beeck and Galgenberg no mention has been made of the occurrence of Simpelveld flint.

Site number	Site name	Raw material	N	%	Source	Distance (km)
1	Eyserheide	South-Limburg flint	1603	47	Meuse gravel deposits, slope deposits	<5
		Orsbach flint	1213	36	residual and/or slope deposits	<5
		Simpelveld flint	517	15	residual and/or slope deposits	<5
		Valkenburg flint	40	1	residual and/or slope deposits	<5
2	Mesch	Rullen flint	3050	86	gravel deposits, eluvium, slope deposits	<5
		Rijckholt flint	480	13	gravel deposits, eluvium, slope deposits	<5
		Simpelveld flint	1	<1	residual and/or slope deposits	10-15
3	Sweikhuizen OS	terrace flint	.	>99	Meuse gravel deposits	<5
		yellow-brownish quartzite	3	<1	indet	indet
		yellow-brownish, translucid flint	.	<1	indet	indet
4	Sweikhuizen GP	terrace flint	12174	>99	Meuse gravel deposits	<5
		Simpelveld flint	16	<1	residual and/or slope deposits	10-15
		freshwater quartzite	7	<1	indet	indet
5	Sweikhuizen KW	terrace flint	.	>99	Meuse gravel deposits	<5
		Simpelveld flint	19	<1	residual and/or slope deposits	10-15
6	Koningsbosch	terrace flint	58	>98	Meuse gravel deposits	<5
7	Griendtsveen	southern silex	>1200	>99	Meuse gravel deposits	<1
		translucid flint	.	<1	indet	indet
		freshwater quartzite	10	<1	indet	indet
8	Kanne C.	silex	15748	100	chalk outcrops, residual and/or slope deposits	<1
	Kanne S.	silex	1765	100	chalk outcrops, residual and/or slope deposits	<1
9	Orp-le-Grand W.	silex	10005	100	chalk outcrops	<1
	Orp-le-Grand E.	silex	83411	100	chalk outcrops	<1
10	Alsdorf	terrace flint	9567	99	Meuse gravel deposits	<5
		Vetschauer flint	5	<1	residual and/or slope deposits	10
		Baltic flint	18	<1	ground moraine	70
		Jurassic chert	87	<1	Main gravel deposits	200
11	Beeck	terrace flint	.	>99	Meuse gravel deposits	<5
		Orsbach flint	5	<1	residual and/or slope deposits	20
		Baltic flint	3	<1	ground moraine	80
12	Kamphausen	terrace flint	189	57	Meuse gravel deposits	<5
		Orsbach flint	122	37	residual and/or slope deposits	35
		Obourg flint?	6	2	chalk layers near Mons?	>150
		Simpelveld flint	1	<1	residual and/or slope deposits	35
		Baltic flint?	2	<1	ground moraine	35
		Chalcedon?	9	3	Rhine gravel deposits?	?
13	Galgenberg	terrace flint	23	>99	Meuse gravel deposits	<5

Table 8.1 Magdalenian sites of the Meuse-Rhine loess area. Data on raw materials used and distance to source locations.

Moraine flint	Cores	Tools	Blades	Flakes	Other artefacts	N
Eyserheide	.	.	.	.	.	0
Mesch	.	.	.	.	.	0
Sweikhuizen-GP	.	.	.	.	.	0
Sweikhuizen-KW	.	.	.	.	.	0
Alsdorf	.	3	15	.	.	18
Beeck	.	1	.	.	2	3
Kamphausen	.	2?	.	.	.	2?
Total	0	6	15	0	2	23
Simpelveld flint	**Cores**	**Tools**	**Blades**	**Flakes**	**Other artefacts**	**N**
Eyserheide	3	9	167	196	142	517
Mesch	1	.	.	.	.	1
Sweikhuizen-GP	.	11	5	.	.	16
Sweikhuizen-KW	1	7	7	4		19
Alsdorf	.	.	.	.	.	0
Beeck	.	.	.	.	.	0
Kamphausen	.	1	.	.	.	1
Total	5	28	179	200	142	554
Orsbach flint	**Cores**	**Tools**	**Blades**	**Flakes**	**Other artefacts**	**N**
Eyserheide	2	41	282	334	554	1213
Mesch	.	.	.	.	.	0
Sweikhuizen-GP	.	.	.	.	.	0
Sweikhuizen-KW	.	.	.	.	.	0
Alsdorf	.	.	.	.	.	0
Beeck	.	.	.	.	5	5
Kamphausen	2	22	67	44	2	137
Total	4	63	349	378	561	1355

Table 8.2 Numbers of artefacts of non-local raw materials per artefact type.

Orsbach flint:
In the Lower Rhineland sites of Kamphausen and Beeck, artefacts have been found of grey, very homogeneous flint with a milky, dull-blue patina. This flint bears a strong resemblance to the flint that in Eyserheide has been described as Orsbach flint (see chapter 4). In Kamphausen, Orsbach flint with over 100 artefacts takes up a substantial proportion (36%) of the lithic materials. The artefacts consist of a small exhausted core, flakes, blades, crested blades and tools. This broad composition of different types of artefacts points to transport of prepared cores, blades and/or tools from the eastern part of Dutch South Limburg or the adjacent German part (vicinity of the small village of Orsbach) to the camp site of Kamphausen. That Orsbach flint was important for the production of tools is shown in the fact that c. two thirds of the tools of Kamphausen has been made of this type of flint. The tools are larger and broader than the unworked blades found at the site, which may indicate the transport and bringing in of ready-made tools. Also, blades used for tools may have been manufactured in the camp site of Kamphausen itself, struck from cores that at that moment still had relatively large dimensions.

In Beeck, five artefacts were found of the same, very homogeneous flint that was described as Orsbach flint in Kamphausen. Which artefacts are represented in this small group, could not be made out from the publication of this site (Jöris et al. 1993).

In Alsdorf occur two cores and some blocks (*Trümmer*) of a rather similar flint which is described as *Vetschauer Feuerstein* by Floss (1994, 264-265). The distance of the site to the nearest source locations of this flint is c. 15 km. In contrast to Simpelveld flint in Sweikhuizen-GP and Jurassic chert in Alsdorf (see below), we are dealing here with an indication of transport of cores.

Freshwater quartzite:
Artefacts of a fine-grained freshwater quartzite are known from the inventory of Sweikhuizen-GP in the form of seven backed bladelets (Arts and Deeben 1987b). As no waste products of this quartzite have been found, these artefacts probably entered the site in the form of ready-made (and probably hafted) tools. The quartzite may derive from primary Tertiary sources in the German Central Rhineland, but this could not be confirmed by a neutron activation analysis of some of the quartzite artefacts found at Sweikhuizen (for comparable analyses of freshwater quartzite in Andernach, see Grünberg 1986).

Jurassic chert:
In Alsdorf, 87 artefacts have been found of a dull-yellow, very homogeneous stone that Löhr (1979, 1995) describes as Jurassic chert (*Jurahornstein*). The artefacts are 71 bladelets, six burins, five backed bladelets, a retouched blade and four burin spalls. Löhr (1979, 36) mentions as raw material source the terraces of the river Main in the southern Mainz Basin, which would mean a transport distance of c. 200 km. According to Floss (1994, 264), the artefacts were struck from five different pieces, which he regards as an argument for a provenance from the terraces of the Main where Jurassic chert is amply available. Because this chert only occurs sporadically in the terraces of the Rhine, the deposits of this river are considered less likely as natural source.

Thanks to the presence and identification of the above mentioned, non-local stone varieties, we catch glimpses of an important part of the organisation of the lithic technology of hunters and gatherers from the northern Magdalenian, namely the transport and use of artefacts of non-local materials. Looking at the artefacts of Simpelveld flint in Sweikhuizen-GP and Mesch, two different transport strategies seem to have been used, namely that of blades and tools in the former site versus that of a pre-core in Mesch. At Kamphausen, Orsbach flint seems to have entered the site in the form of cores, blades and finished tools. The data correspond with those of Magdalenian sites in other regions: good quality flint and/or other stone materials were worked in the extraction places or in temporary camp sites in the vicinity of the source locations and subsequently, probably through strategies of embedded procurement (see 8.4), were transported to camp sites outside the natural source area of the lithic materials concerned. Both types of flint, Simpelveld flint in Sweikhuizen-GP, Sweikhuizen-KW and Kamphausen, and of Orsbach flint in Alsdorf, Beeck and Kamphausen, link these sites to Dutch South Limburg east of the Geul, in the case of Orsbach flint possibly also to the adjacent German area.

In this context, the Eyserheide site and its location in the source area of Simpelveld flint and Orsbach flint deserves full attention. As discussed in chapter 4, this site yielded numerous artefacts (including cores, flakes, blades and small debitage) of both flint types reflecting all stages of flint knapping. At Eyserheide, at least three nodules of Simpelveld flint and ten nodules of Orsbach flint were transported to the site and were worked there. We should therefore take into account that the camp site of Eyserheide or similar (but not documented) camp sites, situated in the same area and also providing evidence of an extensive use of locally available Simpelveld flint and Orsbach flint, may have functioned as suppliers of artefacts of both types of stone. In anticipation of future use, partially prepared cores, blades and-or finished tools were produced at these sites and transported to camp sites located outside the area with primary Cretaceous flint sources.

In an attempt to test the above proposed relationship between sites, we compared the dimensions of retouched tools and blades of Simpelveld flint from Eyserheide with those of Sweikhuizen-GP and Sweikhuizen-KW. As almost all implements of this flint are broken, little can be said about the original lengths of the blades that served as initial form for the manufacture of these tools. In general, retouched tools and blades of the Eyserheide site, both complete and broken pieces, are longer than those recovered from the Sweikhuizen sites (table 8.3a). This observation is in line with our expectations, given the different topographical position of Eyserheide and Sweikhuizen in relation to source locations of Simpelveld flint. Concerning the width of the tools, we should mention the very uniform width of three backed bladelets of Simpelveld flint in Sweikhuizen-GP: they were made of narrow bladelets with a width of 0.6 cm. Other types of tools are manufactured of blades and have widths that vary between 1.1 and 1.9 cm and, in this respect, no real differences exist with the retouched tools recovered from Sweikhuizen-KW (widths between 1.2 and 1.9 cm). Compared with these, the retouched tools of Simpelveld flint in Eyserheide are generally wider: only one piece is narrower than 2 cm and has a comparable width to the tools of Sweikhuizen-GP and -KW (table 8.3b). This could indicate that in the camp site of Eyserheide, or in a comparable camp site located nearby, relatively narrow blades of Simpelveld flint were selected for future use in more northern locations in the Meuse-Rhine loess area. Data on the widths of the (non-retouched) blades in Sweikhuizen-GP and -KW are in agreement with those of Eyserheide. For this reason it is very

	Retouched tools			Blades		
Length in mm	Eyserheide	Sweikhuizen-GP	Sweikhuizen-KW	Eyserheide	Sweikhuizen-GP	Sweikhuizen-KW
0 - 9	1	1	.	2	.	.
10-19	.	3	1	18	1	3
20-29	.	.	1	27	3	2
30-39	.	.	2	26	1	1
40-49	1	1	1	29	.	.
50-59	.	1	.	16	1	.
60-69	1	1	.	9	.	.
70-79	1	.	.	6	.	.
80-89	2	.	.	3	.	.
> 90	2	.	.	11	.	.
Total	8	7	5	147	6	6

	Retouched tools			Blades		
Width in mm	Eyserheide	Sweikhuizen-GP	Sweikhuizen-KW	Eyserheide	Sweikhuizen-GP	Sweikhuizen-KW
0-5	.	.	.	.	.	.
6-9	.	3	.	6	.	1
10-14	1	1	3	24	1	3
15-19	.	3	2	44	3	.
20-24	6	.	.	49	2	2
25-29	1	.	.	20	.	.
30-34	.	.	.	3	.	.
>35	.	.	.	1	.	.
Total	8	7	5	147	6	6

Table 8.3 Length (above) and width (below) of retouched tools and blades (complete and fragments) of Simpelveld flint in Eyserheide, Sweikhuizen-GP and Sweikhuizen-KW. Counts after refitting of broken pieces, tools made of blades only.

well possible that they were struck in the camp site of Eyserheide (or, again, in a comparable and nearby camp site) and were transported from there to the loess plateau at Sweikhuizen. There are no indications that would point to a similar transport of bladelets of Simpelveld flint from Eyserheide to other sites. As discussed in chapter 4, in Eyserheide the production of such artefacts, which were important for the manufacturing of hunting gear (backed bladelets), does not seem to have played an important role.

From the data presented above, it is (of course) difficult to draw conclusions about a relationship and contemporaneous occupation between Eyserheide and the Sweikhuizen sites. In fact, though such a relationship is possible, it cannot be demonstrated with certainty on the basis of the presence and dimensions of artefacts of Simpelveld flint in last-mentioned sites. It is clear that such a proof of contemporaneous occupations can only be obtained through refitting and the establishment of refits between artefacts recovered from Sweikhuizen-GP and -KW and artefacts from Eyserheide. An attempt to do this has however not yet been made.

If we look at lithic technologies of hunter-gatherer societies in a more general sense, several factors may have played a role in the handling of lithic raw materials, such as the character of the exploited food resources (Torrence 1983) and settlement mobility (Binford 1980; Kelly 1983; Shott 1986). Moreover, differences may be expected in response to variations in the availability of good quality raw materials (Schiffer 1975; Bamforth 1986). Wiant and Hassen (1984, 105) state that technology “is organized as an adaptive response to geographic and temporal variations in lithic and biotic resources and is designed to minimize tool costs.” Cores of good quality, non-local raw materials have generally been worked in a more systematic and careful manner than their counterparts of local raw materials. Moreover, blades and finished tools of non-local stone have been used and maintained in a more durable manner (curated technology). Cores made of local and often inferior types of stone attest to a more opportunistic (*ad hoc*) working (expedient technology). Apparently, less stringent requirements had to be met of the quality (length, thickness and regularity) of the end products The blades are generally shorter and more irregular and tools are less carefully retouched. Also the resharpening and rejuvenation of the working edge has occurred less frequently, in other words less time and energy have been invested to extend the life span of artefacts. From this can be inferred that technological and typological characteristics of Late Upper Palaeolithic assemblages to a large extent may be determined by the way in which local and non-local lithic materials were dealt with.

Contrary to the statements made above, in the area with good quality Cretaceous flint sources (Orp-le-Grand, Kanne, Mesch and Eyserheide) strategies of core reduction seem to have been totally unrelated to the use of local or non-local raw materials. Both strategies, careful versus rudimentary, occur side by side, whereby exclusive use was made of *local* flint varieties (see 7.6.2) All the same, within the supply of local raw materials, selection probably did take place of flint nodules with specific properties (size, shape, quality) with a view to the application of *le débitage magdalénien classique*. Cores that show these properties but were worked less carefully are possibly the product of less gifted flint knappers or an apprentice flint knapper. Besides, we can imagine that not every activity required an optimal set of blades and/or tools. Depending on the nature of the activity and on whether this activity was planned or not, a less careful form of stone working and a less durable use of tools sufficed (expedient technology).

For the Magdalenian sites outside the area of Cretaceous flint sources though, we can speak of a relationship between the provenance and use of raw materials. For the site of Beeck is pointed out the less than economical use of local terrace flint. Relatively large nodules of homogeneous terrace flint, that in principle was suitable for blade production, were worked rudimentarily and discarded in an early stage of core reduction (Jöris et al. 1993, 261). Another observation concerns the retouched tools. Pieces of non-local raw materials were made of larger and more regular blades (Kamphausen), were more regularly retouched (blade scraper from Beeck) and/or more frequently resharpened (burin spalls and/or retouch waste in Alsdorf) than pieces made of local raw materials. As far as can be deduced from the published data, characteristics of *le débitage magdalénien classique* can be observed in particular on artefacts made of non-local raw materials in Kamphausen and Beeck. Cores and corresponding knapping products of local Meuse terrace flint are smaller in size and have a less regular form. Examples of ad hoc tools recovered from other sites are scrapers on flakes in Alsdorf and dihedral burins made of thick flakes in Echt-Koningsbosch.

8.3 Central Rhineland

In the Niederrheinische Bucht in the eastern part of the Meuse-Rhine loess area, the Rhine is by far the most important river. If we follow the river upstream from Cologne and in a southerly direction, we come to a classic region for research of the northern Magdalenian, namely the Neuwied Basin in the Central Rhineland. This relatively low-lying basin (c. 20 × 30 km) near Koblenz was formed by tectonic movement and is surrounded by the Eifel in the west, the Hunsrück in the southwest and the Westerwald in the east. At the northwestern end of the Neuwied Basin, not far from the Andernach Gate (*Andernacher Pforte*) where the Rhine leaves the basin, are the famous open-air sites of Andernach and Gönnersdorf, respectively west and east of the river (fig. 8.1). The distance between the two locations is at most 2 km. They belong to the most important and most extensively researched and published Magdalenian sites of Europe.

Excavations on the Martinsberg in Andernach started in 1883 by H. Schaaffhausen (1888, see Bolus and Street 1985). The investigation was directed at parts of an extensive settlement from the Magdalenian, covered by a four metres thick layer of volcanic ash originating from the Maria Laach volcano. Little under a century after their discovery, the finds of these early excavations, among which 849 stone artefacts, were described by G. Bosinski and J. Hahn (1972). Fieldwork was again undertaken in Andernach from 1979 to 1983. On the basis of refitting of stone artefacts and of faunal remains, the proximity of the old excavation pits of Schaaffhausen could be determined. An adjacent and intact part of the settlement was also excavated over an area of c. 140 m^2 (Veil 1982, 1984). The excavation revealed three concentrations of archaeological material, of which concentrations CI and CIII could no longer be investigated completely. In addition, it became clear that above the level with artefacts from the Magdalenian there was a second archaeological layer present with finds belonging to the *Federmesser* culture.

The site of Gönnersdorf lies c. 40 m above the present water level of the Rhine and is nearer to the river than that of Andernach. In 1968 during the digging of a wine cellar, a rich site from the Magdalenian was revealed, embedded in loess sediments which in turn were covered by a layer of volcanic ash from the volcano of Maria Laach. This eruption of this volcano, at the end of the Allerød interstadial in the Eifel, is

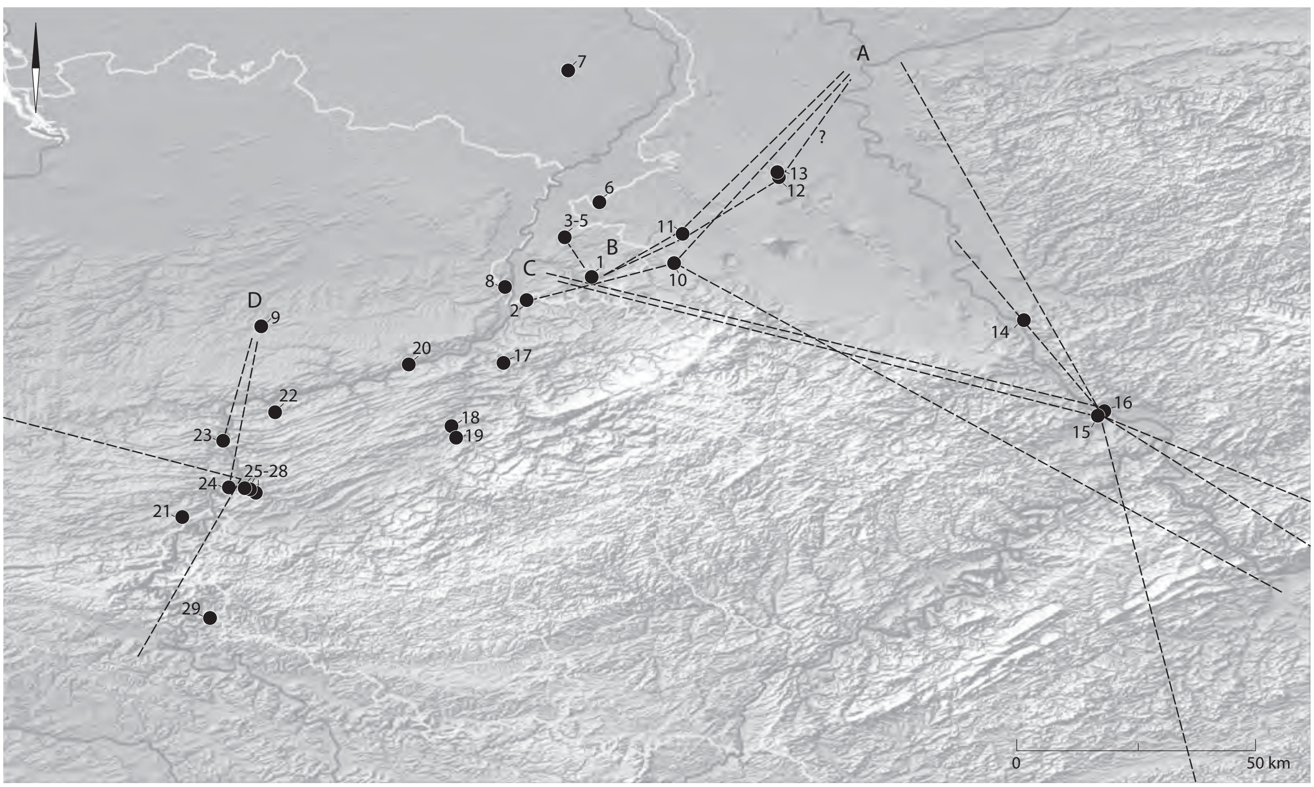


Figure 8.1 Contour map of Northwest Europe with the location of Magdalenian sites. The lines link sites to raw material areas. 1 Eyserheide, 2 Mesch-Steenberg, 3-5 Sweikhuizen, 6 Echt-Koningsbosch, 7 Griendtsveen, 8 Kanne, 9 Orp-le-Grand, 10 Alsdorf, 11 Beeck, 12 Kamphausen, 13 Galgenberg, 14 Oberkassel, 15 Andernach, 16 Gönnersdorf, 17 Grotte Walou, 18 Verlaine, 19 Grotte du Coléoptère, 20 Engis, 21 Trou des Blaireaux, 22 Grottes de Goyet, 23 Bois Laiterie, 24 Trou Da Somme, 25 Trou Magrite, 26 Chaleux, 27 Trou du Frontal, 28 Trou des Nutons, 29 Roc-la-Tour.
A= source area of moraine flint (Baltic flint), B= source area of Simpelveld flint and Orsbach flint, C= source area of Rijckholt flint, D= source area of Senonien flint.

dated by radiocarbon around 11,000 BP (or c. 11,000 cal BC, see Street et al. 1994). In 1968, 1970-1974 and 1976 under the supervision of G. Bosinski, the remains of three large habitation structures and a smaller structure were excavated over an area of 687 m^2 (Bosinksi 1979). In 1968, the excavation was directed at concentration CI, of which a part had already been dug up during the construction of the wine cellar. The field work in 1970-1976 yielded the remains of two large habitation structures (CII and CIII) and a smaller structure (CIV). The large structures are oval to round in shape and have a diameter of c. six to eight metres. They consist of stone slabs, small pits and very rich accumulations of settlement waste, such as stone artefacts and fragments of animal bones. Figurative images are present in the form of line engravings of animals and schematically represented female figures in stone (Bosinski and Fischer 1974, 1980) and small statues of human figures made of antler and ivory. In the northern part of the excavated area, CIV consists of a circle of stones with a central hearth (Terberger 1992).

Due to the good conditions of preservation, the presence of hearth and habitation structures and the wealth and diversity of the finds, Andernach and Gönnersdorf are very important for the research of the material culture, food economy, and settlement types of the northern Magdalenian. Moreover, from the presence at both sites of ornamental molluscs, originating from distant source areas, including species from the Mediterranean, we catch glimpses of the existence of social relationships between human groups. The available data point to the circulation of ornamental molluscs in exchange networks that extended over large parts of Magdalenian territory. From the patterns we can infer that human populations living in different areas were not 'autonomous', but operated within a framework of social alliances (Rensink 1993, chapter 6).

For both Andernach and Gönnersdorf, extensive research has been undertaken into the nature and provenance of the broad spectrum of lithic raw materials used for tool production, including a comparative study of artefacts and geological samples by Floss (1994; see tables 8.4 to 8.6). In the Central Rhineland, fine-grained, good quality flint does not occur in primary or in secondary (for instance river deposits) contexts. Two regionally available stones, Tertiary quartzite (*Tertiärquarzit*) and chalcedony, offered a good alternative for the manufacture of long and regular blades. In Andernach (excavations 1979-1983), artefacts struck from several varieties of fine-grained and homogeneous Tertiary quartzite make up 68% of the inventory of stone artefacts. In Gönnersdorf, this percentage is 19%. The number of artefacts of chalcedony is lower in both sites. Despite the relatively small distance to the source areas, both types of raw

	Distance							
Raw materials	Km	CI %	CII %	CIII %	N	%	Weight	%
Tertiary quartzite (*Tertiärquarzit*)	30-40	90.3	5.0	84.2	15822	68.3	19650	78.2
Chalcedony	40	2.2	0.2	8.8	684	2.9	475	1.9
Baltic flint (*Baltischer Feuerstein*)	100	7.5	0.3	7.0	1199	5.2	950	3.8
Meuse flint (*Maasfeuerstein*)	100	.	86.5	.	5001	21.6	3185	12.7
Palaeozoic quartzite (*Paläozoischer Quarzit*)	80?	.	8.0	.	460	2.0	865	3.4
Total		100	100	100	23166	100	25125	100

Table 8.4 Andernach-Martinsberg. Numbers of artefacts (>3 mm) per flint type and divided over three concentrations (excavation 1979-1983), and distance of site to the nearest raw material source. After Floss 1994, 196, 210.

	Distance					
Raw materials	Km	Cores	Blades / bladelets	Flakes	N	%
Tertiary quartzite (*Tertiärquarzit*)	30-40	39	2456	1790	4285	80.3
Chalcedony	40	3	87	106	196	3.7
Baltic flint (*Baltischer Feuerstein*)	100	5	220	140	365	6.8
Meuse flint (*Maasfeuerstein*)	100	.	380	.	380	7.1
Palaeozoic quartzite (*Paläozoischer Quarzit*)	80?	.	109	.	109	2.1
Total		47	3252	2036	5335	100

Table 8.5 Andernach-Martinsberg. Numbers of cores, blades/bladelets and flakes per flint type (excavation 1979-1983) After Floss 1994, 193 ff.

	Distance							
Raw material	Km	CI %	CII %	CIII %	N	%	Weight (kg)	%
Tertiary quartzite (*Tertiärquarzit*)	12	44.8	3.1	14.8	15181	18.6	19396	25.4
Idem, Ratingen type	45	1.1	.	.	212	0.2	265	0.3
Chalcedony	30-40	1.3	2.0	7.0	2893	3.5	767	1.0
Brown flint (*Kieseloolith*)	70	.	0.8	7.7	1934	2.4	1098	1.4
Baltic flint (*Baltischer Feuerstein*)	100	39.6	.	4.8	9093	11.1	6000	7.8
Meuse flint (*Maasfeuerstein*)	80-100	10.4	68.8	11.3	31024	37.9	15540	20.3
Patinated flint	.	.	12.8	.	9204	11.2	5000	6.5
Siliceous slate (*Kieselschiefer*)	<5	2.5	4.8	41.4	12035	14.7	28000	36.6
Palaeozoic quartzite (*Paläozoischer Quarzit*)	80?	0.1	0.2	0.2	146	0.2	280	0.4
Chert (*Hornstein*)	<5	.	<0.1	0.1	30	<0.1	15	<0.1
Other raw materials	.	0.1	<0.1	0.3	34	<0.1	31	<0.1
Total		99.9	92.7	87.6	81786	100	76392	99.7

Table 8.6 Gönnersdorf. Numbers of artefacts (>3 mm) per flint type and divided over three concentrations, and distance of site to nearest raw material source. After Floss 1994, 219 ff.

materials were dealt with in a careful and economic way as can be inferred from the intensive use of cores, the high amount of retouched tools and the frequent occurrence of use-wear traces on artefacts. Regarding the cores in Andernach, three pieces of chalcedony have an average length of 5.5 cm. The average length of complete blades is no more than 4.4 cm.

Besides locally and regionally available raw materials, the occupants of the settlements of Andernach and Gönnersdorf used non-local stone varieties (Floss 1994). A raw material that connects both German sites with the northern moraine area is Baltic flint (*Baltischer Feuerstein*). The southernmost limit of this area is near Düsseldorf and Krefeld, c. 100 km north of Gönnersdorf and Andernach. Baltic flint makes up 5% of the total number of artefacts in Andernach, and 11.1% in Gönnersdorf. With the exception of CII, it occurs in Gönnersdorf in all concentrations, with the highest amont in CI (39.6%).

Of direct importance for the investigation of the Magdalenian occupation of the Meuse-Rhine loess area is the occurrence of so-called Meuse flint (*Maasfeuerstein*) in both German assemblages. The area with Cretaceous flint sources between Liège, Maastricht and Aachen is considered as source area of this flint, that is to say the central part of the Meuse-Rhine loess area in which the open-air sites of Kanne, Mesch and Eyserheide are located. Over 21% of the artefacts from Andernach (n=5001, weight=3185 grams) was made of non-local Meuse flint, among which the majority (86.5%) of the artefacts in CII. The artefacts of this group have been described as Rijckholt flint. It is a black to dark grey flint with a transparent matt shine (*im Glanz glasig-matten*). The cortex was described as ”hellbraun, kreidig und hart” with a 1 to 2 mm thick edge (Floss 1994, 205). Characteristics of the cortex point to a provenance from primary (Cretaceous deposits) and/or secondary (residual or slope deposits) context. On only two artefacts (<0.1%) are traces visible that point to an origin from terrace deposits. In Gönnersdorf, Meuse flint is quantitatively the most frequently used stone (37.9%). Also for this site is there a clear relationship between this flint and CII, where 68.8% of the artefacts were made of Meuse flint. But Meuse flint also occurs in the other concentrations. Within the extensive group of Meuse flint (n=31024, weight=15540 grams), three sub-groups are distinguished: brown flint (*Kieselfeuerstein*), Rijckholt flint (*Rijckholt-Feuerstein*) and dark grey-yellow Meuse flint (Floss 1994, 229). The cortex of the first two is light in colour and not rolled, which indicates a provenance from primary context (*Bergfrisch*) or from residual and/or slope deposits. Together, they make up c. 99% of the total of Meuse flint. About the provenance of both brown flint and Rijckholt flint, Floss (1994, 229) remarks the following:

> “Beide Feuersteine wurden in primären Kreidekalken des Maasgebietes gefunden, wahrscheinlich zwischen Lüttich und Maastricht, wo die Maas primäre Kreideschichten durchschnitt. Für diese Herkunftsbestimmung sprechen auch die mikroskopischen Erscheinungsbilder von Proben des Maasgebietes und aus Gönnersdorf.”

The dark grey-yellow Meuse flint is synonymous with Meuse terrace flint and forms only c. 1% of the total group. As potential source area Floss names the western part of the Niederrheinische Bucht, northeast of Eschweiler and along the Rur, where flint-bearing terraces of the Meuse are lying at the surface (Floss 1994, fig. 35).

In view of the location of Eyserheide near primary sources of Simpelveld flint, three blades manufactured of this flint in Andernach should be mentioned, of which two pieces could be refitted dorsally/ventrally (Floss 1994, fig. 219 nos. 14 and 15). The artefacts were lying in CIII at the edge of the area excavated in 1979-1983 and were probably associated with a part of the settlement located outside this area. There is no spatial connection with CII. In Gönnersdorf, also three artefacts of Simpelveld flint were recovered which in all cases are retouched tools: a burin on truncation, a burin on a break and a fragment of a burin that was secondarily reworked into a scraper (Floss 1994, fig. 220, nos 1-3). The tools are made of blades and display traces of a long and intensive use. They were found dispersed in CI, CIII and CIV and do not show a relationship with CII, this despite the fact that CII is characterised by a high amount of Meuse flint originating from the same source area.

For non-local Meuse flint, Floss (1994, 205) speaks of a high degree of utilisation (*Ausnutzungsgrad*). Of all blades and bladelets recovered in Andernach (n=380), 66% is retouched, while use-wear traces have been observed on 60% of all retouched blades and bladelets. No cores were retrieved of this flint, but exclusively tools, blades, bladelets and small debitage. Small flint chips are probably connected with the resharpening and retouching of stone tools. The picture emerges of ready-manufactured blades and tools that were brought from the Liège-Maastricht-Aachen region to the settlement of Andernach, and that were possibly also used in previously occupied camp sites in between (*en route*). Besides blades and tools, in Gönnersdorf also prepared cores of Meuse flint were brought into the site. All these data strengthen the idea of a systematic exploitation of Cretaceous sources of good quality flint in the Meuse Rhine loess area, at a distance of 100-120 km from both German sites.

Finally, it is striking that artefacts of terrace flint with fluvial rolled cortex are almost completely absent in the inventories of Andernach and Gönnersdorf. The low percentages of terrace flint in both settlements are in stark contrast to the high percentages of artefacts made of (locally available) Meuse terrace flint in Eyserheide, Sweikhuizen-GP and -KW, Alsdorf, Kamphausen and Beeck. In paragraph 8.7 we will go into the possible meaning of this discrepancy.

8.4 Interpretation of raw material data

The broad spectrum of non-local raw materials in the inventories of Andernach and Gönnersdorf and data on the provenance of these materials may give an indication of, in general terms, the size of the territory exploited by the occupants of both settlements. The following explanations are possible for the presence of Meuse flint among the finds of the two German sites (Rensink 1993):

1. The occupants of the settlements of Andernach and Gönnersdorf obtained good quality, non-local Meuse flint by means of exchange. It could involve two autonomous, regional groups that kept in contact with each other and that exchanged stones with each other in the form of prepared cores, blades and tools.
2. The occupants of the settlements of Andernach and Gönnersdorf mounted special expeditions to primary flint sources in the Meuse-Rhine loess area in order to obtain good quality flint. Their stay in the source areas was short and specifically directed at the exploitation of flint (direct procurement, cf. Binford 1979).
3. The occupants of the settlements of Andernach and Gönnersdorf did not stay the entire year in the Central Rhineland but exploited food and other resources also in more northern areas as part of the annual mobility cycle. Depending on variations in the supply of food sources in the Central Rhineland, the occupation of camp sites in the Meuse-Rhine loess area was brief and incidental, or longer and more structural (for instance one season) in character. Lithic raw materials were obtained by means of embedded procurement (cf. Binford 1979) and subsequently transported from the Meuse-Rhine loess area to the Central Rhineland.

Although above mentioned explanations are presented here in the first instance in order to account for the presence of artefacts of Meuse flint in the settlements of Andernach and Gönnersdorf, they are also relevant for our picture of the social context in which Magdalenian hunters and gatherers operated in the Meuse-Rhine loess area. Taking into consideration antropological, ethnoarchaeological and archaeological studies on the social structure of hunter-gatherers (see for instance Steward 1969, Wobst 1974, Binford 1979), in the case of the first explanation we are dealing with a maximum band (30 to more than 100 individuals) in the area, and in the case of the second explanation with specialised working parties consisting of few individuals only. Regarding the third explanation, we must consider one small social unit or one nuclear family (represented by the father, mother, childeren and/or grandparents) as the inhabitants of Magdalenian camp sites of the Meuse-Rhine loess area.

The first explanation, i.e. that Magdalenian hunters and gatherers formed an autonomous maximum band in the Meuse-Rhine loess area is not considered likely. Against this explanation argues the geographical position of the open-air sites on the very northern margin of Magdalenian territory. This peripheral position, combined with the context of colonisation in which the northern loess sites should be placed (chapter 7), cannot be reconciled well with a permanent stay and a year-round mobility cycle of Magdalenian hunters and gatherers. Moreover, in the case of an autonomous maximum band, the occurrence of aggregation camps of smaller social units (nuclear families) belonging to two or microbands can be assumed. Remains of such large residential camp sites (‘aggregation sites’) are not known from the Meuse-Rhine loess area.

The second explanation assumes special expeditions from the Central Rhineland to Cretaceous source locations in the Liège-Maastricht-Aachen region “.. for the express and exclusive purpose of obtaining raw material for tools” (direct procurement, cf. Binford 1979). This explanation fits well with the remark made by Vermeersch et al. (1987, 54) that Magdalenian hunter-gatherers were in sites such as Orp-le-Grand and Kanne “… en quête de matière première, sans jamais y rester longtemps.” Also, this explanation fits with the hypothesis made by Straus and Otte (1998, 264) that “… the open-air Magdalenian sites of Limburg, Brabant and Hainaut were mainly occupied by people in the warm season. These places would be repeatedly visited specifically for their abundant, high quality flint.” and with the overall classification of the sites as ‘quarry-workshops’ (Straus and Otte 1998, 262). Nonetheless, there are some objections againt above mentioned views, for the following reasons:

1) With the exception of Kanne, the sites are situated on loess-covered plateaus, at a distance of at least hundreds of metres from the locations where flint is extracted and collected.
2) A number of Dutch and German sites (Sweikhuizen, Echt-Koningsbosch, Alsdorf, Kamphausen, Galgenberg, Beeck) is located *outside* the area with Cretaceous sources of good quality flint.
3) With the exception of Mesch and Kanne, the sites show relatively high numbers and high diversity of retouched tools, which is not in agreement with the interpretation of the locations as flint exploitation sites (see 7.6).

Besides the above arguments, there is an additional argument that is related to the availability of raw materials in the Central Rhineland itself. The occupants of Andernach and Gönnersdorf used on a large scale a fine-grained, homogeneous Tertiary quartzite. This quartzite is eminently suitable for the production of blades, as can be inferred from the occurrence of up to 22.2 cm long blades with regular parallel sides in Andernach (Floss 1994, 197). Floss speaks in this connection of "hervorragenden Bearbeitungseigenschaften". Sources of Tertiary quartzite are present in large numbers in the Central Rhineland, at a relatively short distance from the two German settlements. From a point of view of raw material supply, the mounting of special expeditions aimed at the exploitation of flint sources at a distance of 100-120 km from both sites was therefore not necessary (G. Bosinski pers. comm. 1988).

According to the author, the third explanation, namely the exploitation of Cretaceous Meuse flint as part of regular, seasonal movements of Magdalenian hunters and gatherers (embedded procurement), fits well into the picture of the broader context of colonisation and the northward movement coupled with it. The explanation moreover fits in with characteristics of the artefacts made of Meuse flint. They indicate a light-weight toolkit and components of a curated technology, which were probably used and maintained in a durable way in small temporary camp sites ('transit camps') after leaving the source locations in the Liège-Maastricht area and before reaching their final destination, i.e. the settlements of Gönnersdorf and Andernach (see also 8.6). In this context, we can also refer to Floss (1994, 265) who mentions a comparable interpretation for the occurrence of artefacts of northern Baltic flint and Jurassic chert (*Hornstein*) in Alsdorf: "Sie wurden in einer Grundausstattung bei der Erstbegehung des Platzes eingebracht. Es bestehen keine Argumente, in den aus ortsfremden Rohstoffen bestehenden Artefakten einen Beleg von Tausch-kontakten zu sehen (vgl. H. Löhr 1979, 43)."

Last but not least, the exploitation of Meuse flint through strategies of embedded procurement is also in agreement with the interpretation of the majority of the northern loess sites as briefly used base camps of, in each case, one small social unit (nuclear family), and not as flint exploitation sites, and with the provisional interpretation of these sites as seasonal, summer occupations (see 7.9).

Based on the arguments presented above, we conclude that the Magdalenian sites of the Meuse-Rhine loess area form the remains of camp sites of small human groups that in other periods of the annual mobility cycle were in the Central Rhineland. In other words, the presence in Andernach and Gönnersdorf of non-local, 'Dutch Cretaceous flints' is interpreted as a reflection of embedded procurement, and not that of exchange or direct procurement. This, of course, has important consequences for our picture of the Meuse-Rhine loess sites in the settlement system of the northern Magdalenian. Following this interpretation, the sites do not reflect a complete but only a partial settlement record. The same applies, of course, to Andernach and Gönnersdorf in the German Central Rhineland and particularly for the concentrations (in both sites CII) in which Cretaceous Meuse flint is the dominant raw material. In this respect, we should point out the clear differences in characteristics of the archaeological record of both areas. As discussed in chapter 7, the northern open-air sites are small in size and consist of clearly smaller numbers of retouched tools than the German sites. Moreover, during the excavations of Orp-le-Grand, Kanne, Sweikhuizen, Mesch and Eyserheide no large settlement features and no indications of artistic activity were found, in contrast to Andernach and Gönnersdorf. Also, no surface complexes are known from the Meuse-Rhine loess area that remind us slightly in size, and in numbers and composition of the stone artefacts of Andernach and Gönnersdorf and, hence, could possibly be the remains of comparable camp sites. Obviously, we are dealing with differences not only in intensity and/or duration of occupation, but also in site function(s) and the frequency with which specific locations in the landscape were returned to.

The differences mentioned above seem important for the distinction between an initial pioneer phase and a residential camp phase of occupation as Housley et al. (1997) proposed in their work on the recolonisation of the northern parts of Europe after the Glacial Maximum of the Weichsel ice age.

The archaeological record of the Meuse-Rhine loess area fits well into the picture of an initial pioneer phase of occupation, "… when only a few small hunting parties moved to explore the previously unpopulated areas" (Housley et al. 1997, 45). The archaeological evidence of Andernach and Gönnersdorf, with extensive habitation and hearth structures, artistic objects, large quantities of artefacts and tools, and a large variety in lithic raw materials, however does not fit the image of small 'hunting parties'. These characteristics seem consistent with repeated and longer occupied settlements in a residential camp phase, erected at strategic locations on either side of the Rhine at a short distance from the spot where the river leaves the Neuwied Basin. In accordance with this, the settlements of Gönnersdorf and Andernach reflect residential camps, or "… the places from which the next pioneer phase was launched into previously unoccupied territory" (Housley et al. 1997, 45).

To conclude this paragraph, the following three points are considered important for the research into the earliest human occupation of the Meuse-Rhine loess area after the Last Glacial Maximum:

1) Magdalenian sites reflect an initial pioneering phase of occupation, consisting of incidental and/or seasonal hunting expeditions and other activities, among which the exploitation of good quality flint sources. Apparently, and in contrast to the more southerly regions such as Southern Germany, the Central Rhineland and the Belgian Ardennes, this initial pioneering phase of occupation was not followed by a permanent, residential camp phase of occupation. The absence of very find-rich and extensive settlements with large habituation and hearth structures, as known from Gönnersdorf and Andernach, and with artistic representations in stone form an important indication of this (see later in this chapter).
2) The Magdalenian occupation of the Meuse-Rhine loess area was contemporaneous with or falls in any case in the same time span as that of Gönnersdorf and Andernach. If we look at the series of AMS radiocarbon dates of Andernach and Gönnersdorf, for both sites ranging from c. 13,300 BP to 12,700 BP (Street, pers. comm. 2011), this means a possible time depth of the northern Magdalenian open-air sites of c. 600 C^{14} years. If we use calibrated dates, then all AMS radiocarbon dates fall before 15,000 cal BP (Street et al. 1994; Blockley et al. 2000). Thus, they date the Magdalenian occupation of Andernach and Gönnersdorf and, in an indirect way, those of the open-air sites of the Meuse-Rhine loess area at the end of the Pleniglacial (climatic event GS 2 as recorded in the Greenland GRIP ice core, Johnsen et al. 1997) and prior to the prominent and sudden warming that marks the beginning of the Late Glacial interstadial (climatic event Gl 1, reffered to as Meiendorf interstadial in Central Europe and Bølling interstadial in West-Europe). On the basis of dates obtained from Greenland ice cores, the beginning of this interstadial is dated to around 14,700 cal BP (see also Street 2000, 63).
3) Assuming that the open-air sites of the Meuse-Rhine loess sites were occupied in the warm season (summer), this would mean that Magdalenian groups were not present in the Central Rhineland in this period of the year, but returned to their camp-sites there at the end of or after the summer. Importantly, this scenario would fit very well with data on seasonality from the faunal remains (and especially horse) of Gönnersdorf. These data point to the hunting of horse all year round, with the exception of summer (July, August and September, M. Street, pers. comm. 2011).

Concerning the second point, we would like to remind that as a result of the complete decay of organic remains in the northern loess sites, the possibility of synchronous occupation with Magdalenian sites in the Central Rhineland based on radiocarbon dates cannot be investigated further. From the stratigraphical position of the archaeological layer in for instance Eyserheide, associated with the Bt-horizon of a Holocene loess soil, can be inferred that after the camp site was abandoned, loess sedimentation still continued. At this location, but also at the other sites located nearby a loess layer with a thickness of at least 25 cm was deposited on the occupation surface. A comparable stratigraphical position applies to Gönnersdorf, where the excavated concentrations of archaeological material were also covered by a thin layer (c. 20 cm) of loess.

8.5 Relationship with cave sites in the Ardennes Massif?

Although the above relationship between the Magdalenian occupation of the Meuse-Rhine loess area and that of the German Central Rhineland, in view of similarities in the provenance of the used lithic raw materials, may be obvious, the presented ‘model’ also has a limitation or weakness: it regards the sites of the Meuse-Rhine loess area in a chronological and cultural perspective as a homogeneous group. Without further considerations, all sites are treated *a priori* as one group and are related to the Magdalenian occupation of the Central Rhineland. Hence, the ‘model’ does not take into account 1) the time depth that these sites possibly represent, 2) shifts of territories through time and the dynamic character of land use of mobile hunters and gatherers, and 3) the rich Magdalenian record of Belgian caves on the northern and northwestern margins of the Ardennes Massif (Dewez 1987, 1992). Although in a clearly different geological and landscape setting, namely in the steep valley slopes of the Meuse and tributaries (Lesse, Ourthe), some of these caves are located within a distance of less than 70 km (as the crow flies) from Orp-le-Grand, Kanne, Mesch and Eyserheide. The distance between Grotte Walou and the site of Mesch is only 25 km (fig. 8.1). We should therefore bear in mind the possibility that not only the occupants of the settlements of Andernach and Gönnersdorf, but also those of Belgian caves may have visited (parts of) the Meuse-Rhine loess area and exploited sources of good quality flint there.

As in the Central Rhineland, the research of Magdalenian sites in the Belgian Ardennes goes back to the 19th century. There was an important difference in the focus of research though. In contrast to the excavations of the open-air settlement of Andernach by Schaaffhausen, research in the Ardennes Massif was exclusively directed at caves and abris (rock shelters). Already between 1865 and 1870, E. Dupont investigated caves in the steep valley of the Lesse, a tributary of the Meuse in southern Belgium (Dupont 1867, 1872). The locations concerned, among which Trou de Chaleux, Trou des Nutons and Trou du Frontal, yielded for that time unprecedented rich assemblages of stones and organic tools, remains of hunting game, art objects and ornamental fossil shells. Later in the 19th century, similar finds were made in Grotte de Goyet, east of Namur, and in a cave near Verlaine in the valley of the Ourthe near Liège.

After the pioneering work of Dupont, excavations were carried out in the 20th century in Grotte du Coléóptère in Bomal-sur-Ourthe (Dewez 1987), Trou des Blaireaux in Vaucelles (Bellier and Cattelain 1986), Bois Laiterie (Otte and Straus 1997), Trou Da Somme (Miller and Noiret 2009), and Grotte Walou in Trooz (Dewez et al. 1993). Renewed research was also carried out in locations already investigated long ago, for instance in Chaleux in 1985-1988 (Otte ed. 1994). A site of a totally different nature is Roc-la-Tour at the southern margin and in the French part of the Ardennes Massif (Rozoy 1988, 1989). This is the only Magdalenian open-air site that is at present known in the area. Over an area of 110 m^2, the site yielded no less than 1600 retouched stone artefacts and slabs of schist with line engravings. In contrast to the Belgian caves, organic materials have not been preserved here.

In a recently published article on the Magdalenian in Belgium, Miller and Noiret (2009) make a distinction between two clusters of sites (see also Charles 1996; Straus and Otte 1998, 263). The first cluster, designated the Meuse Valley group, corresponds with the upstream part of the Meuse and includes the small tributary of the Lesse. The cluster comprises Trou Da Somme, Trou du Frontal, Trou des Nutons, Trou de Chaleux, Trou Magrite, Bois Laiterie, Goyet, and Vaucelles (fig. 8.1). This cluster corresponds with an area where flint sources are lacking. Moreover, other formations comprising stone materials suitable for blade production, such as Tertiary quartzite in the Central Rhineland, are also absent there (see for data on raw material sources in Belgium, Caspar 1984; Krupa 1990). Only sporadic use was made of local stone that could be collected in the immediate vicinity of the caves, such as lydite in Chaleux. As a result of this geological situation, the occupants of the caves in the Belgian Ardennes had to resort to importing flint from elsewhere. For the flints recovered by E. Dupont in Trou de Chaleux and in other caves in the valley of the Lesse, three possible source areas are mentioned (Otte 1994, 24, table 1): the Champagne area in northern France, the region of Hainaut (Henegouwen) in southern Belgium, and the province of Liège in northeast Belgium. Determinations of the artefacts excavated in 1985-1988 in the cave of Chaleux indicate a provenance of the majority of the flint from Hainaut (Otte 1994, 90-93). A small part of the flint is possibly from the Champagne region. According to the Dutch geologist W.M. Felder, who was involved in the determination of the flint of Chaleux, there is no flint from Haspengouwen among the artefacts collected in 1985-1988. Cave sites in the Meuse Valley group have also yielded silicified limestone from the region Charleville-Mézières in Champagne in northern France. Of this raw material, more than half (57%) of the artefacts in Trou Da Somme was made. Artefacts of this stone are also represented in the inventories of Bois Laiterie, Trou de Chaleux, and Trou du Frontal but in lower percentages. In the latter three sites, fine-grained flint is the dominant raw material. Regarding the provenance of the flint in the relatively small inventories of Trou Da Somme and Bois Laiterie, Miller and Noiret (2009, 43) state the following:

> "Macroscopic comparison of flint from the cave sites of Trou Da Somme and Bois Laiterie and the open-air workshop sites of Orp and Kanne suggests that the fine-grained, white-patinated flint from the cave sites is similar to that of Orp. The flint at Kanne, in eastern Belgium near the Dutch border, is quite different, particularly with respect to cortical characteristics, and does not seem to have been transported to the western group sites."

The fact that flint artefacts occur in all cave sites and often in large numbers, shows that Magdalenian hunters and gatherers regularly visited and exploited sources of good quality flint outside the Ardennes area. In the publication on Chaleux, three strategies are mentioned with regard to the provision of non-local flint (Otte 1994, 94): as rough pieces of flint, as prepared cores, and as end products in the form of blades and finished tools. As a result of the continuous working of the cores and intensive use and resharpening of tools, partly *en route* in earlier visited camp sites, the dimensions of the artefacts were strongly reduced. This is well illustrated by the cores of Chaleux, originating from the excavations by Dupont. These pieces show a distinct economic use of the flint, in many cases to the stage of complete exhaustion (*l'épuisement*). Of 167 cores, the average length varies from 4.3 cm (cores with one striking platform) to 4.85 cm (cores with two or more striking platforms). The maximum dimensions range from 7.9 to 8.6 cm (Dewez 1987, 57). Also pointed out is the production of small flakes at the end of the process of core reduction. Two methods of debitage of cores of non-local flint are mentioned for Chaleux (Otte 1994, 27):

> "En conclusion, deux types de débitage semblent se dégager à travers les nucléus découverts dans la grotte. Le premier très soigné, démontre une bonne maîtrise de la taille, bien que les produits de ce débitage ne soient pas très homogène. On observe une utilisation maximale de la matière première, probablement due à l'éloignement des gisements de silex. Le second type de taille, beaucoup plus simple, a essentiellement fourni des éclats. Des rognons entiers ou

fragmentaires ont été exploités afin d'en extraire quelques produits souvent petits et informes. Ici aussi, il semble que les tailleurs de Chaleux désiraient exploiter au maximum la matière première présente sur le site. Toutefois, on peut se demander pourquoi des rognons de mauvaise qualité étaient rapportés sur le gisement."

Looking at the proximal fragments of blades found at Chaleux (Otte 1994, 99), it appears that an important characteristic of *le débitage magdalénien classique*, viz. *en éperon* preparation of the striking platform, was applied by the flint workers, as part of the first strategy mentioned in above quotation.

If we follow the Meuse downstream from Namur in the direction of Liège, we reach the second cluster of sites, that of the Ourthe Valley group (Miller and Noiret 2009). The group consists of Grotte Walou, Grotte de Verlaine, Grotte du Coléoptère, and Engis (fig. 8.1). Of these, Grotte Walou is located in the valley of the small river Magne, at a distance of only 20-30 km (as the crow flies) from the open-air sites of Mesch and Kanne. Engis is located between Huy and Liège in the valley of the Meuse, while Grotte du Coléoptère and Grotte de Verlaine are located at less than 5 km from each at the edge of the valley of the Ourthe. In view of the position of the Ourthe Valley group at a short distance from the Meuse-Rhine loess area, these sites will be discussed here briefly:

Grotte Walou:
In Grotte Walou (province of Liège, Belgium), excavations were carried out between 1985 and 1990 by La Société wallonne de Palethnologie (Dewez et al. 1993) and between 1996 and 2004 by l'Association pour la Promotion et la Protection de l'Environnement wallon (Draily 1998).
Of all Belgian caves, this cave comprises the most complete and well-documented sequence of sediments from the Upper Pleistocene, from the Holocene into the Pre-Weichselian (probably Eemian; Pirson et al. 2006). Grotte Wallou has yielded fauna remains and artefacts in different stratigraphical levels and different Palaeolithic periods: Creswellian, Magdalenian (couche B4), Gravettian (couche B5), Aurignacian and Mousterian (unit C). The campaigns between 1996 and 2004 were aimed at the oldest level with Mousterian artefacts, as the Late Upper Palaeolithic levels had largely then been dug up already. Data on the artefacts from the Magdalenian have hardly been published. Grotte Walou is located near the Plateau of Herve (*Plateau de Herve*) and in the immediate vicinity (within a radius of 5 km) of natural occurrences of flint (Draily 1997, 117). It is unlikely, however, that these nodules were used by Magdalenian flint knappers for the production of long and regular blades. Dewez (1987, 16) writes de following on this:

"Dans le sud de la Hesbaye, de même que sur les parties hautes du Plateau de Herve, le Maestrichtien n'est plus quère représenté que par ses faciès d'altération c'est-à-dire sous forme d'un conglomérat à silex. Ce dernier est essentiellement consitiué de rognons et de débris de silex, plus ou moins altérés en surface et enrobés dans une gangue argileuse."

Grotte de Verlaine:
Grotte de Verlaine, near the river Ourthe, was excavated by P. Destinex and L. Moreels (1888) and amateur archaeologists. During these digging activities the infill of the cave was completely removed. Both stone artefacts and worked bone, among which a uniserial harpoon / barbed point of reindeer antler could be attributed to the Magdalenian. The fauna assemblage consists of different species of animals, among which mammoth, bear and hyena, but is probably only partially connected to occupation of the cave in the Magdalenian (Charles 1996). A description of the lithic raw materials and types of tools used in the cave of Verlaine is by Dewez (1987, 368-374). The description shows that the lithic material consists almost exclusively of flint and that the majority is patinated. Within this group dominates a rather fine-grained flint of good quality, which is dark grey in colour (sometimes almost black) and in which lighter specks are visible. Also occurring is a less fine-grained, greyish flint with yellowish or beige specks. Dewez (1987, 368) further mentions "quelques silex à texture grenue de teinte beige, qui se patinent de taches grisâtres disséminées sur toute la surface. Cette variété de silex nous paraît étrangère au pays."

In Grotte de Verlaine, the largest of twelve measured cores is 9.1 cm (Dewez 1987, 369). From this core a few flakes were removed, without there being an exhausted core. The length of other cores varies from 3.2 to 5.9 cm. These dimensions are comparable with those of the cores of Chaleux and are significantly smaller than the majority of cores in Kanne, Mesch and Eyserheide. The complete blades of Grotte de Verlaine have an average length of 5.5 cm, while the longest piece measures 13.1 cm. Among the retouched tools are backed bladelets, truncated blades (*troncatures*), a blade with notch, borers, blade scrapers, burins and two artefacts with alternating retouch (Dewez 1987, figs. 241-243).
Apart from flint, four fragments of chalcedony and two fragments of a fine-grained quartzite form part of the finds examined by Dewez. According to Dewez, the quartzite resembles Wommersom quartzite, as known from Mesolithic sites in Belgium and southern Netherlands.

Grotte du Coléoptère:
This small cave was excavated completely by Hamal-Nandrin and Servais (1925) in 1923 and 1924, during which also an adjoining part of the terrace was investigated. The

publication on this research is just a summary. Between 1972 and 1978 other parts of the terrace were excavated, the first results of which were published in the form of a preliminary report (Dewez 1975). Underneath a layer with find material from the Bronze Age (couche 4), Mesolithic (couche 5) and Ahrensburg culture (couche 6) was a layer with artefacts from the Magdalenian (couche 8). The layer comprised amongst others stone artefacts (backed bladelets, burins, end scrapers), objects of bone and antler (among which harpoons of reindeer antler, *pointes de sagaies*, a *double biseau* and a *bâton de renne munis d'une perforation*) and partially perforated fossil molluscs. The Paris Basin is mentioned as provenance area of these molluscs. An important part of the flint is dark grey to almost black in colour and has lighter specks.

Engis:
This cave site is located close to the Meuse between Huy and Liège. Around 1830, P.C. Schmerling carried out the first excavations in this cave. Apart from stone artefacts from the Mousterian and Perigordian, a child's skull of a Neandertal and finds from later phases of prehistory, the cave probably also contains artefacts from the Magdalenian, among which backed bladelets. Further data, for instance on the composition and provenance of lithic raw materials, are lacking.

An important observation made by Dewez (1987, 368) is that artefacts made of a dark grey to almost black, good quality flint predominate in Grotte de Verlaine and Grotte du Coléoptère, and that this flint is only sparsely present in caves located in the more southerly valley of the Lesse (Chaleux, Trou des Nutons). This difference could point to the exploitation of two geographically distinct source areas, namely the region of Hainaut by the occupants of caves in the Lesse valley versus the region of Haspengouwen and/or the Liège-Maastricht region by the occupants of caves in the Ourthe area. According to this scenario, we could be dealing here with two regional groups ('maximum bands') that functioned independently of each other in time and/or space. Unfortunately, for the sites of the Ourthe Valley group, data on the provenance of raw materials are at present insufficient to test this hypothesis. In this context, and following Miller and Noiret (2009), both a connection with Magdalenian sites in the Meuse-Rhine loess area (Kanne, Mesch) and with the Magdalenian occupation of the German Central Rhineland (Gönnersdorf and Andernach) cannot be excluded.

8.6 Discussion

Although little can be said about migration routes of important hunting game (reindeer and horse) at the time of occupation of Magdalenian sites in Northwest Europe (but, see Gordon 1988), we can imagine that the river valleys of Rhine and Meuse were important, natural corridors of both animals and people between the Belgian-German uplands and the adjacent, southern part of the Northwest European Plain. From the northern exit of the Neuwied Basin northwestwards, the Rhine transects the Rhenish Slate Massif over a distance of c. 40 km. In this zone, the Rhine valley forms a narrow gorge before fanning out further downstream, near the present town of Bonn, into the southern part of the Niederrheinische Bucht. With the exception of the Ahr, important rivers flowing into the Rhine do not occur in this part of the Rhenish Slate Massif. We can well imagine that Magdalenian hunters and gatherers followed the banks of the Rhine from the Neuwied Basin (Andernach and Gönnersdorf) up to the present town of Cologne in the Niederrheinische Bucht. From this point, sources of good quality flint were 'within reach', that is in the Liège-Maastricht-Aachen region c. 60 km west and in the northern moraine area c. 60 km north. Indications of migrations of human groups from the Central Rhineland northwards and over comparable distances are also available for earlier and later phases of the Palaeolithic. Thus flint from Cretaceous deposits in the Liège-Maastricht-Aachen region has been recovered in Middle Palaeolithic (Plaidter Hummerich, Tönchesberg), Early Upper Palaeolithic and Late Palaeolithic contexts in the Central Rhineland (Floss 1994, Bosinski et al. 1995). And though it is tempting to connect this consistent pattern of transport of non-local flints with the presence of the Rhine valley, serving as natural corridor and providing direction for movements of Palaeolithic hunter-gatherers, this cannot be stated with certainty. In this respect, Floss (1994, 145) remarks regarding sites from the Middle Palaeolithic:

> "Auch wenn der Ausgangspunkt des Transportes, das Maasgebiet, bekannt ist, muß der genaue Wanderweg der Gruppe angesichts fehlender Silices, die auf dem Wege in das Neuwieder Becken hinzukamen, offen bleiben. Die Wanderweg dürfte über die Eifel verlaufen sein".

In the discussion of the raw materials used in the settlements of Gönnersdorf and Andernach (8.3), we reported the near absence of artefacts of Meuse *terrace flint* in the inventories of these two sites. This observation is at odds with the large-scale use of them in the camp sites in the central and eastern part of the Meuse-Rhine loess area: Eyserheide, Sweikhuizen-GP and -KW, Alsdorf, Beeck, and Kamphausen. This discrepancy in used raw materials indicates that occupants of these camp sites mainly exploited terrace flint for local needs and not in anticipation of use during a later phase of the mobility cycle, for instance in the camp sites in the Central Rhine Valley. Because of its absence in all other sites, the working of Valkenburg flint in Eyserheide can also be regarded as meeting local demand. In view of the suitable properties for the production of blades, it is striking that Simpelveld flint and Orsbach flint have hardly played a role in the raw material provision of Andernach and Gönnersdorf. Apparently, we are dealing with flint types of which the exploitation was directed at and met both *local* (Eyserheide) and *regional* demands. The fact that Simpelveld flint was a raw material of regional importance can be inferred from its occurrence in the sites of Mesch, Sweikhuizen-GP, Sweikhuizen-OS, and Kamphausen. In addition, numerous artefacts of Orsbach flint have been recovered in Kamphausen. Eyserheide and other camp sites, located near natural sources of Simpelveld flint and Orsbach flint, possibly functioned as operating base for expeditions in a northerly and northeasterly direction. With a view to these expeditions, cores were worked and blades and tools manufactured that were subsequently taken away to locations outside the Cretaceous area (see 8.2).

Compared to the types of flint mentioned, Rijckholt flint, and collected from primary or secondary contexts, that is to say with 'eluvial cortex', played a different role in the technological organisation of Magdalenian groups. In view of the very high proportion of Rijckholt flint within the group of Meuse flint in the inventories of Andernach and Gönnersdorf, we can speak of an '*export product*' of supra-regional importance. The composition of lithic raw materials in sites in the Meuse-Rhine loess area itself underlines this notion. Despite the location of Eyserheide at less than 5 km from the nearest source locations, Rijckholt flint collected from secondary, residual and/or slope deposits makes up only a small part of the inventory of this site (RMU M19, n= 83). Given the strong dominance (>99%) of Meuse terrace flint in Sweikhuizen-GP, Alsdorf, Kamphausen and Beeck, this type of flint also did not play an important role in the camp sites in the central and eastern part of the Meuse-Rhine loess area. Apparently we are dealing with a stone of which the exploitation and working was not primarily meant for local (as indicated by the inventory of Eyserheide) or regional use. It is rather a raw material that was exploited with a view to use in camp sites in the Central Rhineland and possibly also in the cave sites of the Ourthe Valley group in the Belgian Ardennes.

A possibility is that Magdalenian hunters and gatherers extracted and worked Rijckholt flint at or near the source locations and immediately prior to their departure to camp sites in the Central Rhineland and/or Belgian Ardennes. Floss (1994, 229) mentions the formations of chalk between Liège and Maastricht as probable source of Rijckholt flint, of which artefacts have been retrieved in Gönnersdorf (and Andernach). Based on the distribution of the Lanaye Chalk and the location of Neolithic exploitation places, primary (Chalk deposits) and secondary (residual and slope deposits) occurrences of Rijckholt flint are limited to the southwest of Dutch Limburg, i.e. the area west and south of the river Geul, and to the adjacent Belgian area (F. Brounen, pers. comm. 2011). In this area are two Magdalenian sites located on either side of the Meuse and only 5 km from each other, viz. Kanne and Mesch. Hence, the question that presents itself is whether these locations are related to the Magdalenian occupation of the German Central Rhineland. Can we make further statements about this, based on data from the two sites?

Artefacts from the excavated sections in Kanne were made of a very homogeneous and good quality flint from the Gulpen Formation (Vermeersch et al. 1985, 27). This flint, in the shape of large nodules, can be collected in large quantities along the slopes of the Geer valley. The flint is fine-grained and has a blue-whitish colour and sometimes shows a gradual change to more coarse-grained parts. The cortex is not fluvially rolled, but very crumbly and thick. These characteristics correspond with those of Rijckholt flint collected from primary and/or secondary contexts. Thus Kanne, with a position on the flank of the valley of the river Geer, not only from its location in the landscape takes up a special position in the Meuse-Rhine loess area. It also is the only Magdalenian site where Rijckholt flint, collected from primary or secondary (slope) deposits, has been worked at or very close to the exploitation locations themselves.

Of the site of Mesch, 480 artefacts larger than 2 cm have been described as flint of the type Rijckholt, of which five cores and 24 tools (Rensink 1991). At this site, however, the flint originates only partially from primary or secondary contexts: of many artefacts, the cortex is heavily rolled as a result of fluvial transport and incorporation of the flint nodules into the bed of the Pleistocene Meuse. A function of the camp site of Mesch as supplier of Rijckholt flint (in the form of prepared cores, blades, tools) for use in camp sites in the Central Rhine region seems less likely for this reason. This site does provide important information, though, on the role that Rijckholt flint may have played in the Magdalenian of Northwest Europe. A look at the ratios between artefacts struck of Rullen flint (of which most artefacts were found in Mesch) and those of Rijckholt flint, shows that this ratio for cores is 10:1, for flakes larger than 2 cm 8:1, for blades 11:1, and for tools 2:1 (Rensink 1991, tables 4-7). The latter ratio forms an indication of the importance of Rijckholt flint for the manufacture of stone tools. It has also been demonstrated that medial blade fragments made of this flint were on average broader than those of Rullen flint. A few tools were made of strikingly broad blades of Rijckholt flint, among which a blade end scraper with a width of 4.1 cm. These data are possibly an indication of a different use ('status') of

Rijckholt flint compared to, also locally available, Rullen flint. In this respect, the high proportion of retouched tools (n=10) and blades displaying edge damage (n=2) in the group of Rijckholt flint in Eyserheide also should be pointed out. Moreover, the broadest scraper of this site (width of 3.6 cm) is made of flint of Rijckholt (see chapter 4).

8.7 Conclusion

Data on the provenance of lithic materials used in the Central Rhine Valley and the Belgian cave sites have contributed to a better understanding of the relationship between the Magdalenian occupation of the Meuse-Rhine loess area and that of other regions. The occurrence of Cretaceous flint from sources c. 30 km north of the Meuse (the area of Orp-le-Grand) in cave sites south of Namur (Trou Da Somme and Bois Laiterie) qualifies the image that *all* sites are related to the Magdalenian occupation of the Central Rhine Valley. Based on the data presented in this chapter, the following relationship beween areas and sites is suggested as hypothesis for future research (fig. 8.2):

- Orp-le-Grand. Both camp sites (Orp-West and Orp-East) are located in the immediate vicinity of sources of good quality flint from the Senonian. The occurrence of these sources has probably to a large extent determined the choice of the location of both camp sites. Flint was worked and blades were produced on a large scale in both locations, probably partially with a view to future use in caves (of which Trou Da Somme and Bois Laiterie could be examples) south of Namur along the flanks of the Meuse valley and at the western edge of the Ardennes. Data on the provenance of flint materials do not point to a relationship between Orp-le-Grand and other, more easterly open-air sites of the Meuse-Rhine loess area.
- Kanne and Mesch. Within the group of northern open-air sites, these sites are most flint exploitation sites in nature. They can be regarded as locations where blades and tools were manufactured of Rijckholt flint (Kanne) and Rullen flint and Rijckholt flint (Mesch) for use in the camp sites themselves, but probably also in anticipation of future use in camp sites outside the Dutch-Belgian Cretaceous area. In view of their position near primary sources of Rijckholt flint and the extensive use of this flint in Gönnersdorf and Andernach, it is evident to link both sites to the Magdalenian occupation of the German Rhineland (Andernach and Gönnersdorf). In view of the

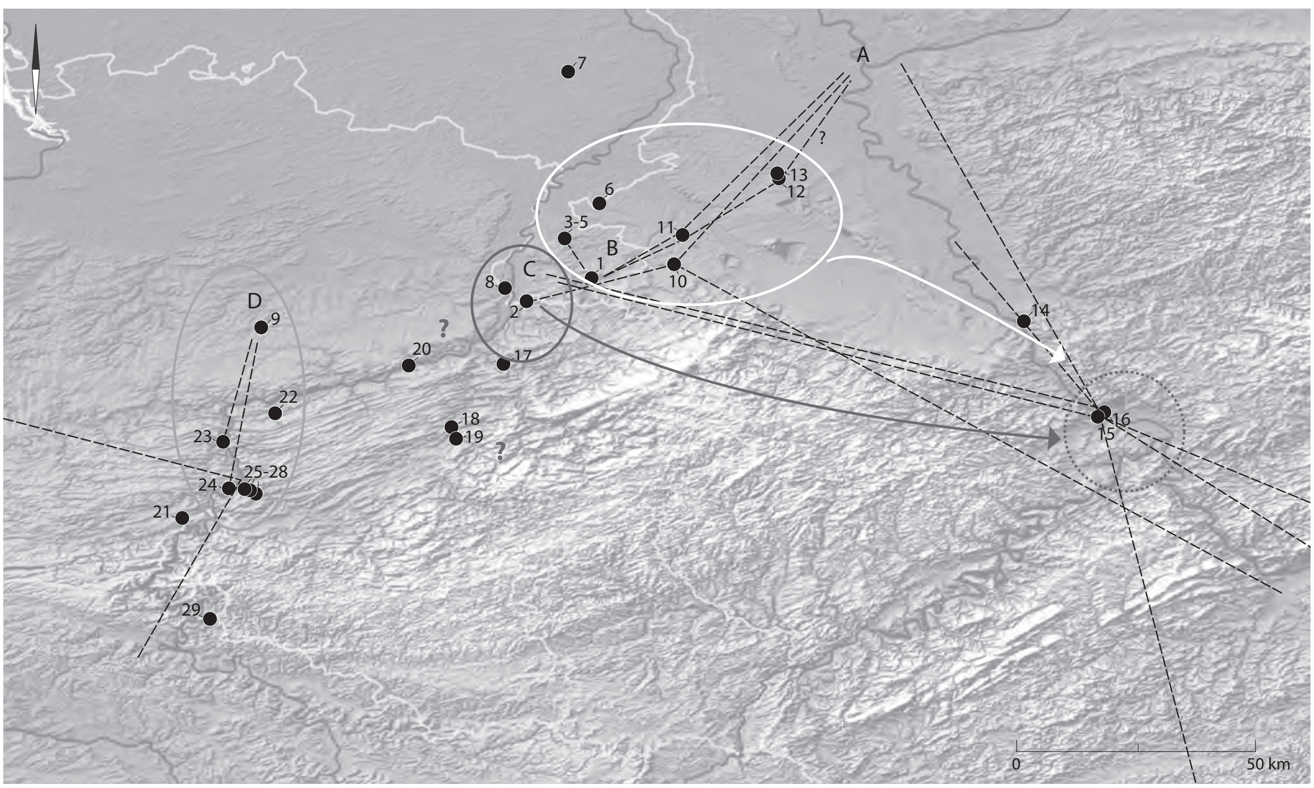


Figure 8.2 Relationships between areas and sites in the northern Magdalenian. For explanation, see text, and for legend, see figure 8.1.

short distance of Kanne and Mesch to the catchment area of the Ourthe, a relationship with the cave sites of the Ourthe Valley group is also a possibility. Further research into the exact character and origin of the worked flint in these sites (Verlaine, Coléoptère) is necessary to give a decisive answer to this point.

– Eyserheide, Alsdorf, Sweikhuizen-GP and -KW, Beeck and Kamphausen. With the exception of Eyserheide, these sites are located at least 10 km away from primary sources of Cretaceous flint. On this basis as well as the composition of the artefacts, they cannot be designated as flint exploitation sites. An interpretation as briefly occupied base camps by a small social unit (one nuclear family) is considered likely (see 7.9). For the production of stone artefacts use was made mainly of local terrace flint, but also artefacts of Orsbach flint, Simpelveld flint, Baltic flint (*Baltischer Feuerstein*) and, in Eyserheide, eluvial Rijckholt flint form part of the inventories. Both latter types of flint occur as non-local materials in Gönnersdorf and Andernach (see 8.3). Moreover, Sweikhuizen-GP has yielded artefacts of a freshwater quartzite which possibly originates from the Central Rhineland. For this reason it is evident to (also) link the above six sites to the Magdalenian occupation of the Central Rhine Valley.

We conclude this chapter with the (possible) implications of the presented data for the date and time depth of Magdalenian occupation of the Meuse-Rhine loess area. Earlier in this chapter, prior to the discussion of the Belgian cave sites, we indicated that the AMS radiocarbon dates of Gönnersdorf and Andernach (c. 13,300-12,700 BP) could be regarded as directional for the date of Eyserheide and nearby sites, namely in a late phase of the Pleniglacial (climatic event GS 2 as recorded in the Greenland GRIP ice core) and some C^{14} centuries prior to the prominent and sudden warming at the onset of the Late Glacial interglacial, that is to say prior to climatic event Gl 1e (in Central Europe: Meiendorf interstadial) (see 8.4). The notion that occupants of Belgian caves exploited flint sources in the western part of the Meuse-Rhine loess area and may have erected camp sites there (Orp-le-Grand, Kanne and Mesch?), seems to have no real implications for the time span in which the northern loess sites should be placed. Based on AMS radiocarbon dates, Charles (1996) assumes the time span of 12,900 to 12,600 BP as peak of Magdalenian occupation of caves in the Belgian Ardennes. Bearing this time span in mind, we can assume a slightly longer period within which sources of good quality flint in the Belgian-Dutch Cretaceous area could have been exploited, namely from 13,300 to 12,600 BP.

9 General conclusion

Magdalenian sites are as yet a rare phenomenon in the hills of the Meuse-Rhine loess area. In this area of over 10,000 km^2, we are dealing with six excavated sites and a few surface complexes, while a small number of sites is known from the Pleistocene sandy soils north of the area with loess deposits. If only from the perspective of rarity, they deserve our full attention in the future during surface surveys and the inspection of loess profiles which are the result of non-archaeological digging. But also when making an inventory of often extensive collections of amateur archaeologists, close attention is required. They form a rare and valuable source of information on the earliest human occupation of the Meuse-Rhine loess area after the Glacial Maximum of the Weichsel ice age. The constant erosion of the loess landscape will in the decades to come lead to ‘new’ sites coming to the surface and into the sight of (amateur) archaeologists. Looking at the position in the landscape of the known sites, new discoveries can be expected on or at the edge of loess-covered plateaus, above a (former) stream valley and at ‘the entrance’ to a small dry valley. The chance of finds actually coming to the surface depends on the thickness of the covering loess layer and thus the depth of the archaeological layer in relation to the present-day surface. But also modern land use plays an important role. For discovering surface finds, an important condition is that fields are ploughed and well washed by rain, as is shown by the discovery of the sites of Orp-le-Grand, Mesch, Eyserheide, Sweikhuizen-GP and -KW, Beeck, Kamphausen and Galgenberg. In landscape zones where the loess layer is still (largely) intact or where there is other land use (pasture land, forest), Magdalenian sites will for the time being remain unnoticed.

The site of Eyserheide and the other open-air sites of the Meuse-Rhine loess area have yielded but a small part of the rich material culture of the Magdalenian, as known from sites (among which many caves) in southwest and central Europe. This is partly explained by the susceptibility of the archaeological material to degradation processes in loess soils. In all sites, faunal remains and other organic materials have not been preserved as a result of Holocene soil formation and the position of the archaeological layer near the present surface in completely decalcified loess. As a result, we have no idea which remains from which animal species were left behind in the camp sites and which types of organic tools were made and used by the occupants. In addition, special find categories, such as fossil, ornamental molluscs or small sculptures of ivory have not been preserved (insofar they were originally present!). Also not known from the northern loess sites are engravings in stone, a conspicuous element in more southerly French, German and Belgian Magdalenian sites. In the author’s opinion, this absence of engravings cannot be explained by the absence of geological formations in the area, containing stones suitable for engraving. Local deposits of the Meuse and Rhine offer a large and varied supply of stones, and some of these may have been used for this purpose. In addition, the homogeneous, eluvial cortex of specific types of flints, including Simpelveld flint and Valkenburg flint, was in principle suitable for engraving. Nevertheless, in Eyserheide no incised lines are visible in the cortex of artefacts made of these flints. And finally use could be made of chalk, which is a softer stone that can be collected locally in the area with Cretaceous deposits. That chalk was used for engraving is demonstrated by a piece of chalk in Etiolles, bearing engravings of amongst others a horse (Taborin et al. 2001). In Eyserheide and the other loess open-air sites no engravings in chalk were found though.

The number of stone artefacts known from the Magdalenian sites in the Meuse-Rhine loess area differs greatly from each other. Which meaning should be attached to this exactly is not clear. At the start of the excavations, two sites (Kanne and Alsdorf) were already considerably disturbed by non-archaeological digging and thus could no longer be investigated completely. At the excavation locations of Mesch and Eyserheide, a few dozen Magdalenian artefacts have been collected from the surface in the years following the excavations. This indicates that artefacts were dispersed over a larger area than excavated as a result of ploughing. Moreover, we should take into account erosion, through which small artefacts, including backed bladelets and small fragments of tools, are under-represented in the inventories. Needless to say, small artefacts may also have been overlooked in squares of which the sediment was not sieved. And finally, the sites of Koningsbosch, Beeck, Kamphausen and Galgenberg are exclusively known from surface finds. The conclusion is that any further examination of the sites will be based on incomplete datasets. Therefore we should be cautious when interpreting quantitative and qualitative differences in the finds between sites.

Among the Magdalenian open-air sites of the Meuse-Rhine loess area, Eyserheide occupies a special position. In this respect can be pointed out the appealing results of the investigation of raw materials, refitting and use-wear traces. In the first place, the inventory is distinct from those of other excavated sites (such as Orp-le-Grand, Kanne and Mesch) by the large diversity of flint materials that were worked at the site. The location of the site in the vicinity of primary Cretaceous deposits containing different types of flint is reflected in the composition of the raw materials. Also thanks to this diversity, numerous artefacts could be refitted, thus considerably increasing the possibilities of technological analyses. Thanks to large compositions of refitted artefacts (RMUs M3, M6, M9, S1 and S3), a comparison proved possible and meaningful between technological characteristics of the flint assamblage of Eyserheide and those of Magdalenian sites southeast of Paris (Pincevent, Verberie, Marsangy and Etiolles). Trends in flint working and technological operations that have been described for the French sites have also been recognised in the finds of Eyserheide. Regarding morphological and metric characteristics of the worked terrace flint, there are parallels between Eyserheide and Pincevent in particular. Other similarities are the distinction between *débitage élaboré* and *débitage simplifié* and indications of a less careful way of working (*chûte de soin*) during the last stage of core reduction. From technological studies can be inferred that the classic way of Magdalenian stone working, *le débitage magdalénien classique*, saw general application around 13,000 BP in the loess sites at the northern fringe of Magdalenian territory. And finally, Eyserheide is to date the only site in the Meuse-Rhine loess area where artefacts have been investigated on use-wear traces and for which the analysis has yielded positive results (Sano, see chapter 5). The results point to working of antler, bone and/or ivory, that is materials that have decayed as a result of post-depositional processes, and not to very intensive or repeated use of the artefacts investigated.

The site of Eyserheide and the other open-air sites of the Meuse-Rhine loess area fit into the ‘big story’ of the colonisation of and dispersal over the northern parts of Europe of groups of Magdalenian hunters and gatherers at the end of the Weichsel ice age. Ameliorated climatic conditions after the extreme cold of the Last Glacial Maximum and after a hiatus in human occupation of many thousands of years, have led to humans visiting for the first time again areas in Northwest Europe. Thanks to the rejection of numerous conventional and ‘highly problematic’ radiocarbon dates and the availability now of a large number of ‘new’, and far more reliable AMS radiocarbon dates of (humanly modified) organic material (for the Belgian Ardennes, see Charles 1996), our insight into the chronology of the process of colonisation has increased tremendously in the past decades. Magdalenian hunters and gatherers arrived around 13,600 BP in the Thuringia Basin and around 13,400 years BP in the German Central Rhineland (Housley et al. 1997). The occupation of the Belgian Ardennes started presumably around the same time as that of the Central Rhineland, while the Paris Basin was visited for the first time by people from the Magdalenian a few centuries later, around 13,000 BP. This time span corresponds with the end phase of the Pleniglacial (*die Endphase der jungpaläolitischen Steppe*, Bosinski 1987), and is characterised by a dry, steppe-like environment in which different species of herbivores lived (‘Mammoth Steppe’ cf. Guthrie 1990). At the beginning of the Late Glacial interstadial (climatic event Gl 1e as recorded in the Greenland GRIP ice core, Meiendorf interstadial), the temperature increased considerably in a short time-span of a few dozen years. This sudden warming is dated to around 14,700 cal BP. In response, the diversity in vegetation and fauna increased, in particular in river valleys and in other more sheltered areas of the landscape. It is important to note that this period of far-reaching climatic and environmental changes followed a few (C^{14}) centuries *after* Magdalenian hunters and gatherers moved into parts of Northwest Europe, in a period of still cold climatic, stadial conditions. Radiocarbon dates further show that regions were not occupied simultaneously or for an equally long time. In contrast to the Belgian Ardennes and the German Central Rhineland, for instance, the majority of the excavated sites (among which Pincevent, Verberie, Ville-Saint-Jacques, Marolles) in the Paris Basin is dated to *after* the Meiendorf interstadial (or Bølling interstadial).

Which reasons exactly underlie the migrations of Magdalenian hunters and gatherers from the cultural core areas in southwest Europe to more northerly areas and along which routes these migrations exactly occurred is difficult to ascertain from the available data. One possibility is that human groups moved gradually in a northerly direction in the tracks of important game, such as reindeer, horse and saiga antelope (for overviews, see Delpech 1989, 1992). New AMS radiocarbon dates of the Magdalenian site of Maszycka Cave near Krakow in southern Poland (T. Terberger, pers. comm. 2011), point to the possibility of alternative scenarios, namely a rapid migration to the southern margins of the North European plain already in the second half of the 17th millennium cal BC. Also in view of the position in the landscape of numerous sites along rivers and smaller watercourses, it is likely that the valley bottoms functioned as important migration routes for both groups of humans and herds of animals. We can also imagine that roughly south-north orientated valleys of large rivers, like the Rhine and Meuse, had a 'guiding' role in the exploration of areas (far) north of the existing habitats. Moving into northern areas, in first instance without any knowledge of the natural landscape and the raw material and food resources present there, required flexibility and adaptations (adaptive responses) of the groups of hunters and gatherers concerned. Whether the colonisation would be successful or not was only partially dependent on climate, vegetation and herewith connected the nature and availability of primary food sources. Of more importance was the 'cultural baggage' of the groups of hunters and gatherers concerned in terms of for instance social relationships, communication and exchange of information (Gamble 1991). An example is the ability to share with other members of the group new experiences regarding location and time of availability of natural food sources. To translate these experiences into efficient strategies of exploitation, with possible consequences for the size and composition of groups, degree of mobility, choice of location of the camp sites, hunting practices and specific elements of material culture, was very important. In this connection, great importance should be attached to the role of small, pioneering groups of humans who as first ones explored unknown and, for a long time, unoccupied landscapes at the very edge of their annual range (annual territory). For instance during short hunting trips, the potential could be determined of landscapes in terms of exploitation of food sources, raw materials and such like. By having these explorations carried out by small groups, risks of food shortages for larger social units could be avoided. After their return, 'new' information could be exchanged with members of the own group and/or members of other groups, during aggregations at specific locations (of which Andernach and Gönnersdorf could be examples) in the course of the annual mobility cycle. This way the foundation could be laid for a decision on a more structural presence or stay in northern 'marginal' areas.

The site of Eyserheide and the nearby open-air loess sites are remnants of smaller camp sites which, also in view of their position on the northern edge of the extensive cultural territory of the Magdalenian, fit in well with the picture of a pioneer phase of occupation (see chapter 8). With a view to a functional interpretation of the site of Eyserheide, data on the nature and origin of the used flint are considered very important. Although in all cases of local provenance (< 5 km), nodules of five types of flint and several pieces of other types of stone (siltstone, quartzitic sandstone) were carried from different source locations and different directions to the location of the camp site at the margin of a loess plateau (fig. 7.4). This observation, together with a high degree of typological diversity of the retouched tools, are an indication of a temporary, central function of the camp site in the settlement system of Magdalenian hunter and gatherers. Also the results of use-wear analysis seem to fit into the picture of a multi-functional camp site, where the use of non-modified blades and flakes (as far as determined in the group of Orsbach flint) also played an important role. Because of these characteristics, an interpretation of the Eyserheide site as a temporarily occupied base camp of a small social unit (one nuclear family) is considered most likely. This interpretation is preferred to that of for instance flint exploitation site or special purpose site, as in a general sense the sites of the Meuse-Rhine loess area are referred to.

Of the types of flint worked in Eyserheide, artefacts have also been recovered from other sites in the eastern part of the Meuse-Rhine loess area. It concerns Simpelveld flint in Sweikhuizen-GP and -KW and Kamphausen, and Orsbach flint in Kamphausen and Beeck. The distance of these sites to the nearest source locations varies from 10 to 30 km. Eyserheide is located in the natural source area of these two types of flint and shows a significantly more extensive use and working. It is quite possible that Eyserheide was one of the camp sites where cores, blades and/or tools of Simpelveld flint and Orsbach flint were produced, that were subsequently taken away to camp sites *outside* the area of flint-bearing Cretaceous deposits. Given this transport over distances of minimally 10 km, both types of flint were not only of local but also of regional importance. A different role was played in the technological organisation of Magdalenian groups by Rijckholt flint with 'eluvial cortex'. Artefacts of this flint were not found in Sweikhuizen-GP and -KW, nor in the German open-air sites in the eastern part of the Meuse-Rhine loess area, but they were retrieved in Andernach and Gönnersdorf despite the clearly larger distance (100-120 km) of both sites to the source area. Moreover, in Andernach CII and Gönnersdorf CII in particular we are dealing with sizeable quantities of artefacts. On this basis we seem to be dealing with an 'export product' of supra-regional importance.

The use of *en éperon* preparation of the striking platform, on the basis of characteristics of the butt of blades (*talons en éperon*), has been demonstrated in all excavated Magdalenian sites of the Meuse-Rhine loess area. This links these locations from a technological point of view to sites in more southerly regions, among which the Belgian Ardennes, the Paris Basin, and the German Central Rhineland. By using *en éperon* technique, the flint workers not only achieved a technical and functional aim, namely obtaining an optimal cutting surface in the shape of blades with parallel regular lateral edges with a length of 12 to 15 cm. But this working practice, at the northern fringe of the cultural distribution area, also provided continuity of an ‘everyday’ and characteristic element in the cultural tradition of the northern Magdalenian. The application of *en éperon* technique is not an exclusive feature of the Magdalenian but goes back in time to the Aurignacian, Gravettian and the Protomagdalenian (= Périgordien VII). For the latter phase, *en éperon* preparation of the striking platform of cores has been demonstrated in Laugerie-Haute (Dordogne), Abri Pataud, Le Blot (Haute-Loire), and Les Peyrugues (Lot) in southern France (Surmely and Alix 2005). The sites are dated to around 22,000 BP, at the beginning of the Last Glacial Maximum, and are a few thousand years older than the earliest phase of the Magdalenian (0). In these sites, traces of *en éperon* preparation have been observed on large and regular blades, the butt of which shows a characteristic spur (*talons en éperon*). They have been described as “les beaux produits de plein débitage”. For comparable specimens Surmely and Alix (2005) refer to the Magdalenian of the Paris Basin: “A notre connaisance, les seul spécimens comparables, d’un point de vue qualitatif et quantitatif, à ceux du Protomagdalénien ne se rencontrent que dans quelques gisements du Magdalénien d’Ile-de-France, comme Etiolles et Les Tarterêts, où le débitage laminaire est tourné vers la production de grandes lames.”

Following the above quotation, there are two periods or cultural phases in the Upper Palaeolithic in which *en éperon* technique was applied in a systematic way and in a pronounced form: the Protomagdalenian in southern France around 22,000 BP and the Magdalenian IV-VI in the period from c. 13,000 BP (Etiolles) to 11,800 BP. However, for instance in southwestern France, also in the intervening phases of the Magdalenian flint knappers used *en éperon* technology, provided that large nodules of good quality flint were locally available (M. Langlais, pers. comm. 2011). Obviously, we are dealing with a practice in stone technology that was deeply rooted in the cultural tradition of the Magdalenian, aimed at optimising of the process of blade production. Hand in hand with the dispersal of groups of hunters and gatherers over parts of Northwest Europe, good quality flint sources not earlier visited became available for exploitation, like the flint-bearing Cretaceous deposits that are found in the Meuse-Rhine loess area. Thanks to the presence of these sources, *le débitage magdalénien classique* could be continued in previously unoccupied, ‘marginal’ landscapes, far away from the cultural core area in southwestern France.

To conclude this monograph, we return to the site of Eyserheide in the hills of Dutch Limburg. With this study we have been able to demonstrate that (ploughed-out) surface sites can be of great value for the investigation of Late Upper Palaeolithic societies. Regardless of the degree of disturbance, they provide information on the choice of locations of camp sites in the landscape, on the nature and provenance of worked raw materials, and on aspects of stone technology, provided that during the processing full attention is given to refitting. Besides, stone artefacts originating from surface sites are not by definition unsuitable for analysis of use-wear traces, as is shown from the results of the research of K. Sano. When not completely disturbed by ploughing and excavated according to modern standards, they are even important for spatial analysis and interpretation of spatial patterns in terms of the organisation and use of camp sites at the end of the Weichsel ice age. In this context, it is important that the findings of the investigation of Eyserheide, but also those of the nearby located sites in the Meuse-Rhine loess area, are tested. Although future excavations could certainly play a part there, we may also think of renewed research into finds of already excavated sites, for instance aimed at a characterisation and identification of used lithic raw materials and the precise determination of the associated source locations. By putting the data of both excavated and non-excavated (surface) sites in a broader geographical framework, our picture of the Magdalenian occupation of the Meuse-Rhine loess area can be refined further.

References

Akoshima, K. 1981. An experimental study of microflaking, *Kokogaku Zasshi* 66, 1-27.

Akoshima, K. 1987. Microflaking quantification. In: G. D. Sieveking and M. H. Newcomer (eds.), *The human uses of flint and chert. Proceedings of the fourth international flint symposium held at Brighton 1983*, Cambridge, 71-79.

Arora, S.K. and J.H.G. Franzen 1987. Simpelveld vuursteen: een nieuw type vuursteen, *Archeologie in Limburg* 32, 23-27.

Arts, N. 1984. Waubach: A Late Upper Palaeolithic/ Mesolithic raw material procurement site in Limburg, The Netherlands, *Helinium* 24, 209-220.

Arts, N. and J. Deeben 1983. Archeologisch onderzoek in een Late Magdalénien-nederzetting te Sweikhuizen, gemeente Schinnen. Een overzicht van de resultaten van 1982, *Archeologie in Limburg* 16, 2-5.

Arts, N. and J. Deeben 1987a. On the northwestern border of Late Magdalenian territory: ecology and archaeology of early Late Glacial band societies in Northwestern Europe. In: J.M. Burdukiewicz and M. Kobusiewitz (eds.), *Late Glacial in Central Europe, Culture and Environment*, Wroclaw, 25-66.

Arts, N. and J. Deeben 1987b. *De opgraving, analyse en interpretatie van een Magdalénien nederzetting bij Sweikhuizen, provincie Limburg*, Amsterdam (unpublished report, University of Amsterdam).

Audouze, F. 1987a. The Paris Basin in Magdalenian times. In: O. Soffer (ed.), *The Pleistocene Old World, Regional Perspectives*, New York, 183-200.

Audouze, F. 1987b. Des modèles et des faits: les modèles de A. Leroi-Gourhan et L. Binford confrontés aux résultats récents, *Bulletin de la Société Préhistorique Française* 84, 343-352.

Audouze, F. 1992. L'occupation magdalénienne du Bassin parisien. In: *Le Peuplement Magdalénien. Paléogéographie physique et humaine (Actes du Colloque de Chancelade)*, Paris (Editions du Comité des Travaux Historiques et Scientifiques), 345-356.

Audouze, F., D. Cahen, L. Keeley and B. Schmider 1981. Le site magdalénien du Buisson Campin à Verberie (Oise), *Gallia Préhistoire* 24, 99-143.

Audouze, F., C. Karlin, D. Cahen, D. De Croisset, P. Coudret, M. Larriere, P. Masson, M. Mauger, M. Olive, J. Pelegrin, N. Pigeot, H. Plisson, B. Schmider and Y. Taborin 1988. Taille du silex et finalité du débitage dans le Magdalénien du Bassin Parisien. In: M. Otte (ed.), *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen*, Oxford (BAR International Series 444), 55-84.

Audouze, F. and J. Enloe 1991. Subsistence strategies and economy in the Magdalenian of the Paris Basin, France. In: N. Barton, A.J. Roberts and D.A. Roe (eds.), *The Late Glacial in north-west Europe: Human adaptation and environmental change at the end of the Pleistocene* (CBA Research Report 77), 63-71.

Audouze, F. and J.G. Enloe 1997. High resolution archaeology at Verberie: limits and interpretations, *World Archaeology* 29, 195-207.

Bamforth, D.B. 1986. Technological efficiency and tool curation, *American Antiquity* 51, 38-50.

Bellier, C. and P. Cattelain 1986. Le Trou des Blaireaux à Vaucelles, *Helinium* 26, 46-57.

Berke, H., J. Hahn and C.-J. Kind (eds.) 1984. *Jungpaläolithische Siedlungsstrukturen in Europa* (Kolloquium 8-14 Mai 1983, Reisenburg/Günzburg), Tübingen.

Binford, L.R. 1978. Dimensional analysis of behavior and site structure: Learning from an Eskimo hunting stand, *American Antiquity* 43, 330-361.

Binford, L.R. 1979. Organization and formation processes: Looking at curated technologies, *Journal of Anthropological Research* 35, 255-273.

Binford, L.R. 1980. Willow smoke and dogs' tails: Hunter-gatherer settlement systems and archaeological site formation, *American Antiquity* 45, 4-20.

Binford, L.R. 1983. *In Pursuit of the Past. Decoding the archaeological record*, London.

Blackwell, P.G. and C.E. Buck 2003. The Late Glacial human reoccupation of north-western Europe: new approaches to space-time modelling, *Antiquity* 77, 232-240.

Blockley, S.P.E., R.E. Donahue and A.M. Pollard 2000. Radiocarbon calibration and Late Glacial occupation in north-west Europe, *Antiquity* 74, 112-121.

Bolus, M. and M. Street 1985. 100 Jahre Eiszeitforschung am Martinsberg in Andernach, *Archäologisches Korrespondenzblatt* 15, 1-9.

Bordes, F. 1978. Le Protomagdalénien de Laugerie-Haute-Est, *Bulletin de la Société Préhistorique Française* 75, 501-581.

Bosinski, G. 1979. *Die Ausgrabungen in Gönnersdorf 1968-1976 und die Siedlungsbefunde der Grabung 1968*, Wiesbaden (Der Magdalénien-Fundplatz Gönnersdorf Band 3).

Bosinski, G. 1987. Die grosse Zeit der Eiszeitjäger. Europa zwischen 40 000 und 10 000 v. Chr., *Jahrbuch des Römisch-Germanischen Zentralmuseums* 34, 3-139.

Bosinski, G. and J. Hahn 1972. Der Magdalénien-Fundplatz Andernach (Martinsberg), *Rheinische Ausgrabungen* 11, 81-257.

Bosinski, G. and G. Fischer 1974. *Die Menschdarstellungen von Gönnersdorf der Ausgrabung 1968*, Wiesbaden (Der Magdalénien-Fundplatz Gönnersdorf Band 1).

Bosinski, G. and G. Fischer 1980. *Mammut- und Pferdedarstellungen von Gönnersdorf*, Wiesbaden (Der Magdalénien-Fundplatz Gönnersdorf Band 5).

Bosinksi, G., M. Street and M. Baales 1995. The Palaeolithic and Mesolithic of the Rhineland. In: W. Schirmer (ed), *Quaternary field trips in Central Europe* 2, München, 829-999.

Bouten, W., G. van Eijsden, A.C. Imeson, F.J.P.M. Kwaad, H.J. Mücher and A. Tiktak 1985. Ontstaan en erosie van de lössleem-gronden in Zuid-Limburg, K.N.A.G., *Geografisch Tijdschrift* 19, 192-208.

Brink, J., 1978. Notes on the occurrence of spontaneous retouch, *Lithic Technology* 7, 31-33.

Brounen, F.T.S. 1987. Mogelijke Magdalénien-site te Eys. In: H. Stoepker (ed.), *Archeologische Kroniek van Limburg over het jaar 1986* (Publications de la Société Historique et Archéologique dans le Limbourg 123), 246-247.

Brounen, F.T.S. and P. Ploegaert 1992. A tale of the unexpected: Neolithic shaft mines at Valkenburg aan de Geul (Limburg, the Netherlands), In: C. Bakels (ed.), *The End of Our Third Decade. Papers Written on the Occasion of the 30th Anniversary of the Institute of Prehistory, Volume 1*, Leiden (Analecta Praehistorica Leidensia 25), 189-223.

Brounen, F.T.S., H. Pisters and P. Ploegaerts 1993. In het hol van "de Leeuw": een kalksteenwand met prehistorische vuursteenmijnen. In: *Valkenburg aan de Geul, Historisch en Heemkundige Studies in en rond het Geuldal*, Jaarboek 1993, 7-35.

Bullinger, J., D. Leesch and N. Plumettaz 2006. *Le site magdalénien de Monruz, 1. Premiers éléments pour l'analyse d'un habitat de plein air*, Neuchâtel (Archéologie neuchâteloise 31).

Cahen, D., C. Karlin, L.H. Keeley and F. Van Noten 1980. Mèthodes d'analyse technique, spatiale et fonctionnelle d'ensembles lithiques, *Helinium* 20, 209-259.

Cahen, D and N. Peuskens 1977-1979. Sites paléolithiques entre Meuse et Geer au nord de Liège, *Les chercheurs de la Wallonie* 24, 17-49.

Caspar, J.P. 1984. Matériaux lithiques de la préhistoire. In: D. Cahen and P. Haesaerts (eds.), *Peuples chasseurs de la Belgique préhistorique dans leur cadre naturel*, Brussels, 107-116.

Charles, R. 1993. Towards a new chronology for the Belgian Lateglacial: recent radiocarbon dates from the Oxford AMS system, *Notae Praehistoricae* 12, 59-62.

Charles, R. 1996. Back into the north: the radiocarbon evidence for the human re-colonisation of the north-western Ardennes after the Last Glacial Maximum, *Proceedings of the Prehistoric Society* 62, 1-17.

Chatters, J.C. 1987. Hunter-gatherer adaptations and assemblage structure, *Journal of Anthropological Archaeology* 6, 336-375.

Colcutt, S.N. 1992. The effects of non-anthropogenic phenomena on artefact taphonomy. In: R.N.E. Barton (ed.), *Hengistbury Head, Dorset, Volume 2: The Late Upper Palaeolithic and Early Mesolithic sites*, Oxford (Oxford University Committee for Archaeology Monograph 34), 64-77.

Cotterell, B. and J. Kamminga 1979. The mechanics of flaking. In: B. Hayden (ed.), *Lithic Use-wear Analysis*, New York, 97–112.

Cotterell, B. and J. Kamminga 1987. The formation of flakes, *American Antiquity* 52, 675-708.

Croisset, E. De, 1983. Les nucléus du Pré des Forges à Marsangy (habitations N11, H16, D14), *Centre de Recherches Préhistoriques, Cahier 9*, 23-32.

Crombé, Ph. 1993. Tree-fall features on final Palaeolithic and Mesolithic sites situated on sandy soils: how to deal with it, *Helinium* 33, 50-66.

Cziesla, E. 1986. Uber das Zusammenpassen von geschlagener Steinartefakte, *Archäologisches Korrespondenzblatt* 16, 251-265.

Cziesla, E. 1990. On refitting stone artefacts. In: E. Cziesla, N. Eickhoff, N. Arts and D. Winter (eds.), *The Big Puzzle: International symposium on refitting stone artefacts*, Bonn, 9-44.

David, F. and J.G. Enloe 1992. Chasse saisonnière des Magdaléniens dans le Bassin parisien, *Bulletin et Mémoires de la Société d'Anthropologie de Paris* 4, 167-174.

Deeben, J., B.J. Groenewoudt, D.P. Hallewas and W. Willems 1999. Proposals for a practical system of significance evaluation in archaeological heritage management, *European Journal of Archaeology* 2, 177-199.

Delpech, F. 1989. L'environnement animal des Magdaléniens. In: M. Otte (ed.), *Le Magdalénien en Europe*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 38), 5-30.

Delpech, F. 1992. Le monde magdalénien d'après le milieu animal. In: *Le Peuplement Magdalénien. Paléogéographie physique et humaine* (Actes du Colloque de Chancelade), Paris (Editions du Comité des Travaux Historiques et Scientifiques), 127-135.

Demars, P.-Y. 1982. *L'utilisation du silex au Paléolithique supérieur. Choix, approvisionnement, circulation – Le example du bassin de Brive*, Paris (Cahiers du Quaternaire 5).

Dewez, M. 1975. Nouvelles recherches à la grotte du Coléoptère à Bomal-sur-Ourthe (province du Luxembourg). Rapport provisoire de la première campagne de fouille, *Helinium* 15, 105-133.

Dewez, M. 1987. *Le Paléolithique Supérieur Récent dans les Grottes de Belgique*, Louvain-la-Neuve (Publications d'Histoire de l'Art et d'Archéologie de l'Université Catholique de Louvain 17).

Dewez, M. 1992. Le Magdalénien en Belgique, origine et filiation. In: *Le Peuplement Magdalénien. Paléogéographie physique et humaine* (Actes du Colloque de Chancelade), Paris (Editions du Comité des Travaux Historiques et Scientifiques), 205-210.

Dewez, M., S. Collcutt, J-M. Cordy, E. Gilot, M-C. Groessens-Vandijck, J. Heim, S. Kozlowski, D. Lacroix and P. Simonet 1993. *Recherches à la grotte Walou à Trooz (Province de Liège, Belgique). Premier rapport de fouilles* (Société Wallonne de Palethnologie, mémoire 7).

Dewez, M. (ed.) 2008. *Recherches à la grotte Walou à Trooz (Belgique). Second rapport de fouille*, Oxford (BAR International Series).

Draily, C. 1997. Trooz, Forêt. La Grotte Walou, gisement préhistorique. In: *Le patrimoine archéologique de Wallonie*, 117-119.

Draily, C. 1998. Campagnes de fouilles 1996-1998 à grotte Walou à Trooz, *Notae Praehistoricae* 18, 25-32.

Dupont, Ed. 1867. *Etude sur l'Ethnographie de l'Homme de l'Age du Renne dans les cavernes de la vallée de la Lesse* (Mémoires Couronnés de Académie Royale des Sciences, Lettres et Beaux-Arts de Belgique tome XIX).

Dupont, Ed. 1872. *L'homme pendant les Ages de la Pierre dans les environs de Dinant-sur-Meuse*, Brussels.

Eickhoff, S. 1989. Zur Analyse der latenten Strukturen und der Siedlungsdynamik der Konzentration II von Gönnersdorf, *Jahrbuch des Römisch-Germanischen Zentralmuseums* 36, 117-158.

Féblot-Augustins, J. 1997. *La circulation des matières premières au Paléolithique*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 75).

Féblot-Augustins, J. 1999. Raw material transport patterns and settlement systems in the European Lower and Middle Palaeolithic: continuity, change and variability. In: W. Roebroeks and C. Gamble (eds.), *The Middle Palaeolithic Occupation of Europe*, Leiden, 193-214.

Felder, W.M. 1975. Lithostratigrafie van het Boven-Krijt en het Dano-Motien in Zuid-Limburg en het aangrenzende gebied. In: W.H. Zagwijn and C.J. van Staalduinen (eds.), *Toelichting bij Geologische Overzichtskaarten van Nederland*, Haarlem, 63-72.

Felder, W.M. 1980. NL 2 Valkenburg, Prov. Limburg. In: G. Weisgerber, R. Slotta and J. Weiner (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit*, Bochum (Veröffentlichungen aus dem Deutschen Bergbau-Museum Bochum 22), 568-572.

Felder, W.M. 1998. Overzicht van prehistorische vuursteen-exploitaties binnen het Krijtgebied tussen Aken-Heerlen-

Luik-Maastricht en Tongeren. In: P.C.M. Rademakers (ed.), *De prehistorische vuursteenmijnen van Ryckholt-St.Geertruid*, Maastricht (Werkgroep Prehistorische Vuursteenmijnbouw), 169-192.

Felder, P.J. 1998. Onderzoek van vuursteen in de Limburgse regio. In: P.C.M. Rademakers (ed.), *De prehistorische vuursteenmijnen van Ryckholt-St.Geertruid*, Maastricht (Werkgroep Prehistorische Vuursteenmijnbouw), 157-159.

Felder, W.M. and P.J. Felder 1998. Geologie van de omgeving van het prehistorische mijnveld te Ryckholt-St. Geertuid. In: P.C.M. Rademakers (ed.), *De prehistorische vuursteenmijnen van Ryckholt-St.Geertruid*, Maastricht (Werkgroep Prehistorische Vuursteenmijnbouw), 111-136.

Flenniken, J. and J.C. Haggerty 1979. Trampling as an agency in the formation of edge damage: An experiment in lithic technology, *Northwest Anthropological Research Notes* 13, 208-214.

Floss, H. 1994. *Rohmaterialversorgung im Paläolithikum des Mittelrheingebietes*, Mainz and Bonn (Monographien des Römisch-Germanisches Zentralmuseum 21).

Franken, E. and S. Veil 1983. *Die Steinartefakte von Gönnersdorf*, Wiesbaden (Der Magdalénien-Fundplatz Gönnersdorf Band 7).

Gamble, C.S. 1991. The social context for European Palaeolithic art, *Proceedings of the Prehistoric Society* 57, 3-15.

Gamble, C.S. and W.A. Boismier (eds) 1991. *Ethnoarchaeological Approaches to Mobile Campsites. Hunter-Gatherer and Pastoralist Case Studies*, Michican (International Monographs in Prehistory, Ethnoarchaeological Series 1).

Geneste, J.M. 1988. Systèmes d'approvisionnement en matières premières au Paléolithique moyen et au Paléolithique supérieur en Aquitaine. In: J.K. Kozlowski (ed.), *L'Homme de Neandertal, vol. 8: La Mutation*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 35), 61-70.

Gero, J.M. 1978. Summary of experiments to duplicate post-excavational damage to tool edges, *Lithic Technology* 7, 34.

Gialanella, S., R. Belli, G. Dalmeri, I. Lonardelli, M. Mattarelli, M. Montagna and L. Toniutti 2011. Artificial or natural origin of hematite-based red pigments in archaeological contexts: the case of Riparo Dalmeri (Trento, Italy), *Archaeometry* 53, 950-962

Gifford-Gonzales, D.P., D.R. Damrosch, J. Pryor and R.L. Thunen 1985. The third dimension in site structure: An experiment in trampling and vertical dispersal, *American Antiquity* 50, 803-818.

Gijn, A.L. van, 1990. *The Wear and Tear of Flint: Principles of Functional Analysis Applied to Dutch Neolithic Assemblages*, Leiden (Analecta Praehistorica Leidensia 22).

Ginter, B. 1974. The extraction, production and distribution of raw material and flint products at the Late Palaeolithic in the northern part of Central Europe, *Przeglad Archeologiczny* 22, 5-122 (English summary).

Ginter, B. 1984. The Swiderian flint workshops in the Upper Warta region. In: H. Berke, J. Hahn and C.J. Kind (eds.), *Upper Palaeolithic settlement patterns in Europe*, Tübingen, 221-234.

Gordon, B.C. 1988. *Of Men and Reindeer Herds in French Magdalenian Prehistory*, Oxford (BAR International Series 390).

Grace, R., 1989. *Interpreting the function of stone tools*, Oxford (BAR International Series 474).

Groenewoudt, B.J., J. Deeben, B. van Geel and R.C.G.M. Lauwerier 2001. An Early Mesolithic assemblage with faunal remains in a stream valley near Zutphen, the Netherlands, *Archäologisches Korrespondenzblatt* 31, 329-348.

Grooth, M.E.Th. De, 1994. A reference collection (lithotheque) of the flint types exploited and used in the southern Netherlands and the Flemish region, *Notae Praehistoricae* 14, 163-164.

Grünberg, J.M. 1986. *Charakterisierung des Rohmaterials der Steinwerkzeuge mit naturwissenschaftlichen Verfahren am Beispiel des späteiszeitlichen Fundplatzes Andernach*, Cologne (unpublished Magisterarbeit, Universität Köln).

Gullentops, F. 1954. Contributions à la chronologie du Pleistocène et des formes du relief en Belgique, *Mémoires de l'Institut Géologique de l'Université de Louvain* 18, 125-248.

Guthrie, R.D. 1990. *Frozen fauna of the Mammoth Steppe*, Chigago.

Haesaert, P., E. Juvigné, O. Kuyl, H. Mücher and W. Roebroeks 1981. Compte rendu de l'excursion du 13 juin 1981, en Hesbaye et au Limbourg néerlandais, consacrée à la chronostratigraphie des loess du Pléistocène supérieur, *Annales de la Société Géologique en Belgique* 104, 223-240.

Hamal-Nandrin, J. and J. Servais 1925. La grotte dite du Coléoptère. Rapport sur les fouilles 1923-1924, *Revue Anthropologique* 35, 120-141.

Hanitzsch, H. 1972. *Groitzsch bei Eilenburg. Schlag- und Siedlungsplätze der späten Altsteinzeit*, Berlin.

Höpken, C. 1994. *Die Steinartefakte von Kamphausen und Galgenberg bei Mönchengladbach und deren Stellung im späten Jungpaläolithikum Nordwesteuropas*, Cologne (unpublished thesis, University of Cologne).

Housley, R.A., C.S. Gamble, M. Street and P. Pettitt 1997. Radiocarbon evidence for the Lateglacial human recolonisation of Northern Europe, *Proceedings of the Prehistoric Society* 63, 25-54.

Jöris, O, R.W. Schmitz and J. Thissen 1993. Beeck: Ein special-task-camp des Magdalénien. Neue Aspekte zum späten Jungpaläolithikum im Rheinland, *Archäologisches Korrespondenzblatt* 23, 259-273.

Jöris, O, R.W. Schmitz and J. Thissen 1995. Beeck. In: W. Schirmer (ed.) *Quaterary field trips in Central Europe*, vol 2, (G. Bosinski, M. Street and M. Baales, 15 The Palaeolithic and Mesolithic of the Rhineland), 954-957.

Johansen, L. and D. Stapert 2004. *Oldeholtwolde, a Hamburgian family encampment around a heart*h, Lisse.

Johnsen, S.J., H.B. Clausen, W. Dansgaard, N.S. Gundestrup, C.U. Hammer, U. Andersen, K.K. Andersen, C.S. Hvidberg, D. Dahl-Jensen, J.P. Steffensen, H. Shoji, A.E. Sveinbjörnsdóttir, J.W.C. White, J. Jouzel and D. Fisher 1997. The ‰ 18O record along the Greenland Ice Core Project deep ice core and the problem of possible Eemian climatic instability, *Journal of Geophysical Research* 102, 26397-26410.

Julien, M., C. Karlin and P. Bodu 1987. Pincevent: Où en est le modèle théorique aujourd'hui?, *Bulletin de la Société Préhistorique Française* 84, 335-342.

Julien, M., F. Audouze, D. Baffier, P. Bodu, P. Coudret, F. David. G. Gaucher, C. Karlin, M. Larriere, P. Masson, M. Olive, M. Orliac, N. Pigeot, J.L. Rieu, B. Schmider and Y. Taborin 1988. Organisation de l'espace et fonction des habitats Magdaléniens du Bassin Parisien. In: M. Otte (ed.), *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen*, Oxford (BAR International Series 444), 85-107.

Julien, M. and C. Karlin 2001. Un habitat saisonnier de plein air au Tardiglaciare. L'example du campement de Pincevent (Seine-et-Marne). In: J.-C. Miskovsky (ed.), *Géologie de la Préhistoire, méthodes, techniques et applications* (Association pour l'étude de l'environnement géologique de la Préhistoire), Paris, 1399-1413.

Kajiwara, H. and K. Akoshima 1981. An experimental study microwear polish on shale artefacts, *Kokogaku Zasshi* 67, 1-36.

Karlin, C. 1972. Le débitage. In: A. Leroi-Gourhan and M. Brézillon, *Fouilles de Pincevent, Essai d'analyse ethnographique d'un habitat magdalénien*, Paris, (VII^eme supplement à Gallia Préhistoire), 263-277.

Karlin, C. 1975. Le débitage. In: B. Schmider and C. Karlin, Le gisement Paléolithique supérieur des Tarterets I à Corbeil-Essonne (Essonne), *Gallia Préhistoire* 18, 315-357.

Karlin, C. and M.H. Newcomer 1982. Interpreting flake scatters: an example from Pincevent, *Studia Praehistorica Belgica* 2, 159-165.

Keeley, L.H. 1980. *Experimental Determination of Stone Tool Uses: A Microwear Analysis*, Chicago and London.

Keeley, L.H. and M.H. Newcomer 1977. Microwear analysis of experimental flint tools: a test case, *Journal of Archaeological Science* 4, 29-62.

Kelly, R.L. 1983. Hunter gatherer mobility strategies, *Journal of Anthropological Research* 39, 277-306.

Kooi, P.B. 1974. De orkaan van 15 november 1972 en het ontstaan van „hoefijzervormige" grondsporen, *Helinium* 14, 57-65.

Krupa, A.-G. 1990. *Recherches sur des matières lithiques au Paléolithique moyen en Belgique*, Liège (Mémoires de Préhistoire Liègeoise 19).

Kuyl, O.S. 1980. *Toelichtingen bij de geologische kaart van Nederland 1:50.000. Blad Heerlen (62W Oostelijke helft, 62O Westelijke helft)*, Haarlem.

Leesch, D., J. Bullinger, M.-I. Cattin, W. Müller and N. Plumettaz 2010. Hearths and hearth-related activities in Magdalenian open-air sites: The case studies of Champréveyres and Monruz (Switzerland) and their relevance to an understanding of Upper Palaeolithic site structure. In: M. Połtowicz-Bobak and D. Bobak (eds.), *The Magdalenian in Central Europe*, Rzeszów, 53–69.

Lemorini, C., 2000. *Reconnaitre des tactiques d'exploitation du milieu au Paleolithique Moyen: Etude fonctionnelle des industries lithiques de Grotta Breuil (Latium, Italie) et de La Combette (Bonnieux, Vaucluse, France)*, Oxford (BAR International Series 858).

Leroi-Gourhan, A. and M. Brézillon 1966. L'Habitation magdalénienne no. 1 de Pincevent près Montereau (Seine-et-Marne), *Gallia Préhistoire* 9, 263-385.

Leroi-Gourhan, A. and M. Brézillon 1972. *Fouilles de Pincevent*, *Essai d'analyse ethnographique d'un habitat magdalénien*, Paris (VIIeme supplement à Gallia Préhistoire).

Levi-Sala, I. 1986. Use wear and post-depositional surface modification: A word of caution, *Journal of Archaeological Science* 13, 229-244.

Levi-Sala, I. 1993. Use-wear traces: processes of development and post-depositional alterations. In: P. C. Anderson, S. Beyries, M. Otte and H. Plisson (eds.), *Traces et fonction: les gestes retrouvés*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 50), 401-416.

Loecker, D. De 2006. *Beyond the Site*. *The Saalian archaeological record at Maastricht-Belvédère (The Netherlands)*, Leiden (Analecta Praehistorica Leidensia 35/36).

Löhr, H. 1974. Ein neuentdeckter Magdalénien-Fundplatz bei Alsdorf, Kr. Aachen-Land, *Archäologisches Korrespondenzblatt* 4, 293-297.

Löhr, H. 1979. *Der Magdalénien-Fundplatz Alsdorf, Kreis Aachen-Land. Ein Beitrag zur Kenntnis der funktionalen Variabilität jungpaläolithischer Stationen*, Tübingen (unpublished Ph.D. thesis).

Löhr, H. 1995. Alsdorf. In: W. Schirmer (ed.) *Quaterary field trips in Central Europe*, vol 2, (G. Bosinski, M. Street and M. Baales, 15 The Palaeolithic and Mesolithic of the Rhineland), 951-954.

Löhr, H., A. Zimmermann and J. Hahn 1977. Feuersteinartefakte. Der Bandkeramische Siedlungsplatz Langweiler 9, Gem. Aldenhoven, Kr. Düren, *Rheinische Ausgrabungen* 18, 148-186.

Mauger, M. 1984. L'apport des microfossiles dans l'identification des silex. Exemple du Magdalénien de l'Ile-de-France, *Bulletin de la Société Préhistorique Française* 81, 216-220.

Mauger, M. 1985. *Les matériaux siliceux utilisés au Paléolithique supérieur en Ile-de-France: occupation du territoire, déplacements et approche des mouvements saisonniers*, Paris (Thèse de Doctorat, Université de Paris I).

McBrearty, S., L. Bishop, T. Plummer, R. Dewar and N. Conard 1998. Tools underfoot: Human trampling as an agent of lithic artifact edge modification, *American Antiquity* 63, 108-129.

Midoshima, T. 1982. An experimental study of edge-damage formation, *Chubu Kochi no Kokogagu* II, 66-98.

Midoshima, T. 1986. Usewear on obsidian artefacts: an experimental study of polish, *Kanagawa Koko* 22, 51-77.

Midoshima, T. 1988. Usewear and lithic raw materials: polishes on chert, sanukaito, silicified tuff, *Kokogaku Zasshi* 74, 1-28.

Midoshima, T. 1994. Effects on trampling of lithic artifacts, *Kyusekki Kokogaku* 48, 43-55.

Midoshima, T. 1996. Spontaneous retouch as a possible cause of 'edge damage' on flakes, *Kyusekki Kokogaku* 52, 13-25.

Miller, R. and P. Noiret 2009. Recent results for the Belgian Magdalenian. In: M. Street, N. Barton and T. Terberger (eds.), *Humans, environment and chronology of the Late Glacial of the North European Plain*, Mainz (Römisch-Germanisches Zentralmuseum, Tagungen Band 6), 39-53.

Moss, E.H. 1983. Some comments on edge damage as a factor in functional analysis of stone artefacts, *Journal of Archaeological Science* 10, 231-242.

Moss, E.H. 1986. Further work on the functions of flint tools at Pincevent (Seine-et Marne), France: sections 36 and 27. In: D.A. Roe (ed.), *Studies in the Upper Palaeolithic of Britain and Northwest Europe*, Oxford (BAR International Series 296), 175-185.

Moss, E.H. 1997. Lithic use-wear analysis. In: G.N. Bailey (ed.), *Klithi*: *Palaeolithic settlement and Quaternary landscapes in northwest Greece, Vol. 1: Excavation and intra-site analysis at Klithi*, Cambridge, 193-205.

Mücher, H.J. 1973. Enkele aspecten van de loess en zijn noordelijke begrenzing, in het bijzonder in Belgisch en Nederlands Limburg en in het daaraangrenzende gebied in Duitsland, *Geografisch Tijdschrift* 7, 259-276.

Newcomer, M.H. 1976. Spontaneous retouch, *Staringia* 3, 62-64.

Newcomer, M.H., R. Grace and R. Unger-Hamilton 1986. Investigating microwear polishes with blind tests, *Journal of Archaeological Science* 13, 203-217.

Newcomer, M.H., R. Grace and R. Unger-Hamilton 1988. Microwear methodology: A reply to Moss, Hurcombe and Bamforth, *Journal of Archaeological Science* 15, 25-33.

Nielsen, A.E. 1991. Trampling the archaeological record: An experimental study, *American Antiquity* 56, 483-503.

Nishiaki, Y. 1994. Spontaneous retouch during lithic production, *Tokaidaigaku Kochinai Isekichosadan Hokoku* 4, 111-125.

Odell, G.H. 1981. The mechanics of use-breakage of stone tools. Some testable hypotheses, *Journal of Field Archaeology* 8, 197-209.

Odell, G.H. and F. Odell-Vereecken 1980. Verifying the reliability of lithic use-wear assessments by 'blind tests': The low-power approach, *Journal of Field Archaeology* 7, 87-120.

Olive, M. 1988a. *Une habitation magdalénienne d'Etiolles: l'Unité P15*, Paris (Mémoire Société Préhistorique Française 20).

Olive, M. 1988b. Une forme particulière d'économie de débitage à Etiolles. In: J. Tixier (ed.), *Technologie préhistorique* (Notes et monographies techniques 25) 27-36.

Olive, M. 1989. Etiolles: quels foyers pour quels usages? In: M. Olive and Y. Taborin (eds.), *Nature et Fonction des Foyers Préhistoriques*. Actes du Colloque International de Nemours 1987, Nemours (Mémoires du Musée de Préhistoire d'Ile de France 2), 197-207.

Olive, M. 2004. À propos du gisement magdalénien d'Etiolles (Essonne): réflexion sur la fonction d'un site paléolithique, *Bulletin de la Société Préhistorique Française* 101, 797-813.

Olive, M. 2005. La perception du temps dans les sites magdaléniens de plein air du Bassin parisien. Du temps d'une occupation au temps des occupations. L'exemple du site d'Étiolles, *Bulletin de la Société Préhistorique Française* 102, 763-770.

Olive, M., N. Pigeot and Y. Taborin 1988. Les structures d'habitat d'Etiolles: deux schémas d'implantation. In: M. Otte (ed.), *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen*, Oxford (BAR International Series 444), 13-28.

Olive, M., F. Audouze and M. Julien 2000. Nouvelles données concernant les campements magdaléniens du Bassin parisin. In: B. Valentin, P. Bodu and M. Christensen (eds.), *L'Europe Centrale et Septentrionale au Tardiglaciaire*, Actes de la Table-ronde internationale de Nemours 14-15-16 mai 1997, Nemours (Mémoires du Musée de Préhistoire d'Ile-de-France 7), 289-304.

Otte, M. (ed.) 1988. *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen*, Oxford (BAR International Series 444).

Otte, M. (ed.) 1994. *Le Magdalénien du Trou de Chaleux (Hulsonniaux – Belgique)*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 60).

Otte, M. and L.G. Straus (eds.) 1997. *La Grotte du Bois Laiterie*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 80).

Pawlik, A. 1994. *Die mikroskopische Analyse von Steingeräten. Experimente–Auswertungsmethoden –Artefaktanalysen*, Tübingen (unpublished Ph.D. thesis, University of Tübingen).

Pelegrin, J. 1985. Réflexion sur le comportement technique. In: M. Otte (ed.), *La signification culturelle des industries lithiques*, Oxford (BAR International Series 239), 72-82.

Pelegrin, J. 1992. Remarques sur le débitage laminaire. In: B. Schmider (ed.), *Marsangy. Un campement des derniers chasseurs magdaléniens, sur les bords de l'Yonne*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 55), 108-115.

Pelegrin, J., C. Karlin and P. Bodu 1988. Chaînes opératoires: un outil pour le préhistorien. In: J. Tixier (ed), *Technologie Préhistorique*, Paris (Notes et Monographies Techniques 25), 55-62.

Pigeot, N. 1987. *Magdaléniens d'Etiolles. Économie de débitage et organisation sociale (l'Unité d'habitation U5)*, Paris (25e supplement à Gallia Préhistoire 35).

Pilati, M. 2009. U-shaped scatters: struggling between theoretical models and archaeological facts. In: F. Cavulli (ed.), *Defining a methodological approach to interpret structural evidence*, Oxford (BAR International Series 2045), 13-22.

Pirson, S., P. Haesaerts, M. Court-Picon, F. Damblon, M. Toussaint, N. Debenham and C. Draily 2006. Belgian cave entrance and rock-shelter sequences as palaeoenvironmental data recorders: the example of Walou cave, *Geologica Belgica* 9, 275-286.

Plisson, H. 1985. *Étude fonctionelle d'outllages lithiques préhistoriques par l'analyse des micro-usures: recherche méthdologique et achéologique*, Paris (unpublished Ph.D. thesis, Université de Paris I).

Plumettaz, N. 2007. *Le site magdalénien de Monruz, 2. Étude des foyers à partir de l'analyse des pierres et des remontages*, Neuchâtel (Archéologie neuchâteloise 38).

Połtowicz-Bobak, M. 2009. Magdalenian settlement in Poland in the light of recent research. In: M. Street, N. Barton and T. Terberger (eds.), *Humans, environment and chronology of the Late Glacial of the North European Plain*, Mainz (Römisch-Germanisches Zentralmuseum, Tagungen Band 6), 55-66.

Porter, C.C. and F.W. Marlowe 2006. How marginal are foragers habitats?, *Journal of Archaeological Science* 34, 59-68.

Rademakers, P.C.M. (ed.) 1998. *De prehistorische vuursteenmijnen van Ryckholt-St.Geertruid*, Maastricht (Werkgroep Prehistorische Vuursteenmijnbouw).

Rensink, E. 1991. L'observation du gibier et le débitage des nucléus: un poste de guet du Magdalénien à Mesch (Limbourg, Pays-Bas), *Helinium* 31, 5-59.

Rensink, E. 1992a. Eyserheide: A Late Magdalenian site on the fringe of the northern loessbelt, *Archäologisches Korrespondenzblatt* 22, 315-327.

Rensink, E. 1992b. Ein Fundort aus dem späten Magdalénien in Eyserheide. In: *Spurensicherung. Archäologische Denkmalpflege in der Euregio Maas-Rhein*, Mainz (Führer des Rheinischen Landesmuseums Bonn und des Rheinischen Amtes für Bodendenkmalpflege 136), 503-508.

Rensink, E. 1993. *Moving into the North. Magdalenian occupation and exploitation of the loess landscapes of northwestern Europe*, Leiden (unpublished Ph.D. thesis, University of Leiden).

Rensink, E., A. Smit and A. Verpoorte 1991. Bewoningssporen uit het Late Magdalénien in Nederlands-Limburg (gemeente Wittem), *Archeologie in Limburg* 49, 37-42.

Richter, J. 1990. Diversität als Zeitmass im Spätmagdalénien, *Archäologisches Korrespondenzblatt* 20, 249-257.

Roebroeks, W. 1988. *From find scatters to early hominid behaviour. A study of Middle Palaeolithic riverside settlements at Maastricht-Belvédère (the Netherlands)*, Leiden (Analecta Praehistorica Leidensia 21).

Roebroeks, W. 1994. Een jong-Paleolithische kernsteen uit de Schoone-Grubbe (Ryckholt-Sint Geertruid), *Archeologie in Limburg* 60, 17-18.

Roebroeks, W., J. Kolen and E. Rensink 1988. Planning depth, anticipation and the organization of Middle Palaeolithic technology: the „archaic natives" meet Eve's descendants, *Helinium* 28, 17-34.

Rots, V. 2003. Towards an understanding of hafting: the macro- and microscopic evidence, *Antiquity*, 805-815.

Rots, V. 2004. Prehensile wear on flint tools, *Lithic Technology* 29, 7-32.

Rots, V. 2005. Wear traces and the interpretation of stone tools, *Journal of Field Archaeology* 30, 61-73.

Rots, V., L. Pirnay, P. Pirson and O. Baudoux 2006. Blind tests shed light on possibilities and limitations for identifying stone tool prehension and hafting, *Journal of Archaeological Science* 33, 935-952.

Rozoy, J.G. 1988. Le Magdalénien supérieur de Roc-la-Tour I, *Helinium* 28, 157-190.

Sano, K. 2009. *Functional variability in the Late Upper Palaeolithic of north-western Europe: A traceological approach*, Cologne, (unpublished Ph.D. thesis, University of Cologne).

Schaaffhausen, H. 1888. Die vorgeschichtliche Ansiedelung in Andernach, *Bonner Jahrbücher* 86, 1-41.

Schiffer, M.B. 1975. The effects of occupation span on site content. In: M.B. Schiffer and J.H. House (eds.), *The Cache River Archaeological Project: An Experiment in Contract Archaeology*, 265-269.

Schiffer, M.B. 1976. *Behavioral Archaeology*, New York.

Schiffer, M.B. 1987. *Formation Processes of the Archaeological Record*, Albuquerque.

Schmider, B. 1984. Les habitations magdaléniennes de Marsangy (vallee de l'Yonne). In: H. Berke, J. Hahn and C.J. Kind (eds.), *Upper Palaeolithic settlement patterns in Europe*, Tübingen, 143-158.

Schmider, B. 1988. Un outil spécialisé dans le Magdalénien du Bassin Parisien: Le bec; sa place dans l'habitat. *Revue Archéologique de Picardie* 1-2, 195-200.

Schmider, B (ed.), 1992. Marsangy. *Un campement des derniers chasseurs magdaléniens, sur les bords de l'Yonne*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 55).

Schmider, B. and C. Karlin 1975. Le gisement Paléolithique supérieur des Tarterets I à Corbeil-Essonne (Essonne), *Gallia Préhistoire* 18, 315-357.

Shea, J.J. and J.D. Klenck 1993. An experimental investigation of the effects of trampling on the results of lithic microwear analysis, *Journal of Archaeological Science* 20, 175-194.

Shott, M. 1986. Technological organization and settlement mobility: An ethnographic examination, *Journal of Anthropological Research* 42, 15-51.

Smit, A. 1992. *Ruimtelijke analyse van een Magdalénien-vindplaats in Eyserheide*, Leiden (Master thesis, Faculty of Archaeology, Leiden University).

Soffer, O. and C. Gamble (eds.) 1990. *The world at 18.000 BP. Vol 1. High latitutes*, London.

Stapert, D. 1982. A site of the Hamburg tradition with a constructed hearth near Oldeholtwolde (province of Friesland, the Netherlands); first report, *Palaeohistoria* 24, 53-89.

Stapert, D. 1989. The ring and sector method: intrasite spatial analysis of stone age sites, with special reference to Pincevent, *Palaeohistoria* 31, 1-57.

Stapert, D. 1990. Within the tent or outside? Spatial patterns in Late Palaeolithic sites, *Helinium* 30, 14-35.

Stapert, D. and T. Terberger 1989. Gönnersdorf concentration III: Investigating the possibility of multiple occupations, *Palaeohistoria* 31, 59-95.

Steguweit, L. 2003. *Gebrauchsspuren an Artefakten der Hominidenfundstelle Bilzingsleben*, TAU 2, Rahden/Westfalen.

Steward, J.H. 1969. Postscript to bands: on taxonomy, processes, and causes. In: D. Damas (ed.), *Contributions to Anthropology: Band societies*, Ottowa (Contributions to Anthropology, Bulletin 228), 288-95.

Straus, L.G. 1991. The role of raw materials in Upper Paleolithic and Mesolithic stone artifact assemblage variability in Southwest Europe. In: A. Montet-White and S. Holen (eds.), *Raw Material Economies Among Prehistoric Hunter-Gatherers*, Kansas (Publications in Anthropology 19), 169-185.

Straus, L.G. 1997. Synthesis: Bois Laiterie's place in the stone age prehistory of Belgium. In: M. Otte and L.G. Straus (eds.), *La Grotte du Bois Laiterie*, Liège (Etudes et Recherches Archéologiques de l'Université de Liège 80), 369-384.

Straus, L.G. and M. Otte 1998. Bois Laiterie Cave and the Magdalenian of Belgium, *Antiquity* 72, 253-268.

Street, M. 2000. Aspects of Late Upper Palaeolithic settlement and chronology in northern Central Europe. In: B. Valentin, P. Bodu and M. Christensen (eds.), *L'Europe Centrale et Septentrionale au Tardiglaciaire*, Nemours (Mémoires du Musée de Préhistoire d'Ile-de-France 7), 55-71.

Street, M., M. Baales and B. Weninger 1994. Absolute Chronologie des späten Paläolithikums und Frühmesolithikums im nördlichen Rheinland, *Archäologisches Korrespondenzblatt* 24, 1-28.

Street, M., N. Barton and T. Terberger (eds.) 2009. *Humans, environment and chronology of the Late Glacial of the North European Plain*, Mainz (Römisch-Germanisches Zentralmuseum, Tagungen Band 6).

Surmely, F. and Ph. Alix 2005. Note sur les talons en éperon du Protomagdalénien, *Paléo* 17, 157-176.

Symens, N. 1986. A functional analysis of selected stone artifacts from the Magdalenian site at Verberie, France, *Journal of Field Archaeology* 13, 213-222.

Taborin, Y. 1984. Les nouvelles habitations préhistoriques d'Etiolles (Essonne, France). In: H. Berke, J. Hahn and C.J. Kind (eds.), *Upper Palaeolithic settlement patterns in Europe*, Tübingen, 133-141.

Taborin, Y., M. Christensen, M. Olive, N. Pigeot, C. Fritz and G. Tosello 2001. De l'art magdalénien figuratif à Étiolles (Essonne, Basin parisien), *Bulletin de la Société Préhistorique Francaise* 98, 125-132.

Terberger, T. 1988. Ein Zeltringbefund des Magdalénien-Fundplatzes Gönnersdorf, Neuwieder Becken, *Jahrbuch des Römisch-Germanischen Zentralmuseums 35*, 137-159.

Terberger, T. 1992. Les structures de l'habitat de Gönnersdorf, nouveaux résultats. In: *Le Peuplement Magdalénien. Paléogéographie physique et humaine (Actes du Colloque de Chancelade)*. Editions du Comité des Travaux Historiques et Scientifiques, Paris, 431-441.

Thissen, J. 1989. Ein Fundplatz des Magdalénien am linken Niederrhein bei Kamphausen. gem. Jüchen, Kreis Neuss, *Archäologisches Korrespondenzblatt* 19, 315-323.

Torrence, R. 1983. Time budgeting and hunter-gatherer technology. In: G.N. Bailey (ed.), *Hunter-gatherer economy in prehistory*, Cambridge, 11-22.

Tringham, R., G. Cooper, G. Odell, B. Voytek and A. Whitman 1974. Experimentation in the formation of edge damage: A new approach to lithic analysis, *Journal of Field Archaeology* 1, 171-196.

Vaughan, P.C. 1985. *Use-Wear Analysis of Flaked Stone Tools*, Arizona.

Valentin, B. 1989. Nature et fonctions des foyers de l'habitation nº1 à Pincevent. In: M. Olive and Y. Taborin (eds.), *Nature et Fonction des Foyers Préhistoriques (Actes du Colloque International de Nemours 1987)* Nemours (Mémoires du Musée de Préhistoire d'Ile de France 2), 209-219.

Valentin, B., M. Julien and P. Bodu 2002. Lithic raw material economy in the Late Glacial of the Paris Basin. Case studies from Magdalenian, Federmesser and Long Blade Technology hunter-gatherers. In: L.E. Fisher and B.V. Eriksen (eds.), *Lithic raw materials in Late Glacial and Early Postglacial Europe* (BAR International Series 1093), 117-132.

Vandenberghe, J., H.J. Mücher, W. Roebroeks and D. Gemke 1985. Lithostratigraphy and paleoenvironment of the Middle and Late Pleistocene deposits at Maastricht-Belvédère, Southern Limburg, The Netherlands, *Mededelingen Rijks Geologische Dienst* 39, 7-18.

Veil, S. 1982. Der späteiszeitliche Fundplatz Andernach, Martinsberg, *Germania* 60, 391-424.

Veil, S. 1984. Siedlungsbefunde vom Magdalenien-Fundplatz Andernach. Zwischenbericht über die Grabungen 1979-1983. In: H. Berke, J. Hahn and C.J. Kind (eds.), *Upper Palaeolithic settlement patterns in Europe*, Tübingen, 181-193.

Vermeersch, P.M. 1991. TL dating of the Magdalénien sites at Orp, Belgium, *Notae Praehistorica* 10, 27-29.

Vermeersch, P.M., R. Lauwers, H. van de Heyning and P. Vynckier 1984. A Magdalenian open air site at Orp, Belgium. In: H. Berke, J. Hahn and C.J. Kind (eds.), *Upper Palaeolithic settlement patterns in Europe*, Tübingen, 195-207.

Vermeersch, P.M., R. Lauwers and P. Van Peer 1985. Un site Magdalénien à Kanne (Limbourg), *Archaeologia Belgica* 1, 17-54.

Vermeersch, P.M., N. Symens, P. Vynckier, G. Gijselings and R. Lauwers 1987. Orp, site Magdalénien de plein air, *Archaeologia Belgica* 3, 7-56.

Vermeersch, P.M. and N. Symens 1988. Le Magdalénien de plein air en Belgique. In: M. Otte (ed.), *De la Loire à l'Oder. Les civilisations du Paléolithique final dans le nord-ouest européen*, Oxford (BAR International Series 444), 243-251.

Vermeersch, P.M. and M. Maes 1996. Chronostratigraphy of the Magdalenian at Orp, *Notae Praehistoricae* 16, 87-90.

Villa, P. and J. Courtin 1983. The interpretation of stratified sites: A view from underground, *Journal of Archaeological Science* 10, 267–281.

Vleeshouwer, J.J de and J.H. Damoiseaux 1990. *Bodemkaart van Nederland, schaal 1: 50.000. Blad 61-62 West en Oost, Maastricht-Heerlen*, Wageningen.

Warrimont, J.P. de and A.J. Groenendijk 1993. 100 jaar Rullenvuursteen: een kleurrijke vuursteensoort nader bekeken, *Archeologie in Limburg* 57, 37-46.

Wiant, M.D. and H. Hassen 1984. The role of lithic resource availability and accessibility in the organization of lithic technology. In: S.C. Vehik (ed.), *Lithic Resource Procurement (Proceedings from the Second Conference on Prehistoric Chert Exploitation)*, 101-114.

Wobst, H.M. 1974. Boundary conditions for Paleolithic social systems: a simulation approach, *American Antiquity* 39, 147-178.

Wood, W.R. and D.L. Johnson 1978. A survey of disturbance processes in archaeological site formation, *Advances in Archaeological Method and Theory* 1, 315–381.

Wouters, A.M. 1983. Magdalénien uit het Peelgebied, *Archaeologische Berichten* 14, 99-108.

Wouters, A.M. 1985. Nogmaals bewoningssporen uit het Magdalénien van Sweikhuizen, *Archeologie in Limburg* 23, 51-53.

Wylie, P.C. 1975. Artifact processing and storage procedures: A note of caution, *Lithic Technology* 4, 17-19.

Zvelebil, M., S.W. Green and M.G. Macklin 1992. Archaeological landscapes, lithic scatters and human behavior. In: J. Rossignol and L. Wandsnider (eds.), *Space, time and archaeological landscapes*, New York, 193-226.

Summary

In this monograph an extensive account is given of the results of the excavation and processing of an open-air site from the Magdalenian close to the hamlet of Eyserheide (municipality Gulpen-Wittem, province of Limburg) in the loess area of Dutch Limburg. In the Netherlands the geographical distribution of sites from the Magdalenian is restricted mainly to loess-covered plateaus in the southernmost part of the country. They are thus very rare, certainly on a national scale. Because of their position on or near the present-day surface, these sites are susceptible to disturbances as a result of current land use and the continuing erosion of the Limburg loess landscape. By carrying-out an excavation, further disturbance of the site of Eyserheide by agricultural land use could be prevented. The excavation was carried out in 1990 and 1991 by the Institute of Prehistory (now Faculty of Archaeology) of Leiden University.

The site of Eyserheide is located at 193 m above Dutch Ordnance Level on the southern margin of an extensive and elevated plateau, the so-called Eiland of Ubachsberg (chapter 2). The location of the site in the distribution area of chalk formations from the Upper Cretaceous (Gulpen Formation and Maastricht Formation) and the diversity in types of flint in this chalk are reflected in characteristics of the worked flint. For the manufacture of stone tools the Magdalenian flint knappers utilised four types of local, eluvial flint, namely Simpelveld flint, Valkenburg flint, Orsbach flint, and Rijckholt flint. On the basis of weathered but not fluvial rolled cortex, an origin of these flints from eluvial and/or slope deposits is likely. In addition, extensive use was made of local Meuse terrace flint. Based on properties of the flint visible to the naked eye and the results of refitting, flint types have been further divided into smaller Raw Material Units (RMUs). Information on the way in which the flint was worked in the camp site of Eyserheide is based mainly on detailed descriptions of compositions of refitted artefacts within RMUs of Simpelveld flint (S1, S2, and S3) and Meuse terrace flint (M3, M6, M9).

Among the Magdalenian open-air sites of the Meuse-Rhine loess area, Eyserheide occupies a special position. In this connection can be pointed out the results of our research into raw materials, refitting and use-wear traces. Also because of the satisfying results of refitting, the possibilities of technological analysis increased considerably. Moreover, a comparison has proved possible and meaningful between technological characteristics of the flint material of Eyserheide and those of ‘classic’ Magdalenian sites southeast of Paris (Pincevent, Verberie, Marsangy, and Etiolles). Trends in flint working and technological operations described for the French sites have also been recognised in the finds of Eyserheide (chapter 4). Regarding the morphological and metric characteristics of the worked terrace flint, there are parallels between Eyserheide and in particular Pincevent. Another resemblance is the distinction between *débitage elaboré* and *débitage simplifié* and the less careful way of working (*chûte de soin*) during the last stage of core reduction. The results of the technological investigation demonstrate that several flint nodules were worked according to the classic way of Magdalenian stone working (*le débitage magdalénien classique*), with application of *en éperon* technology. Finally, Eyserheide is the only site in the Meuse-Rhine loess area where artefacts have been investigated on use-wear traces and the analysis of which yielded positive results (chapter 5). Analysis of 44 artefacts of Orsbach flint indicates working of antler, bone and/or ivory, that is materials that have decayed as a result of post-depositional processes. Another important conclusion is that the analysed artefacts had been used for a short time and not very intensively. The results also provide an indication of hafting and the use of non-modified blades and flakes in the camp site (as far as could be established in the group of Orsbach flint).

In Eyserheide, about one third of the archaeological material was collected from the surface or from the plough zone. Besides, numerous artefacts have been found in secundary position in natural disturbances (= remnants of tree-fall features) and in the homogenised top of the non-ploughed part of the loess soil. Because of the fact that artefacts were displaced horizontally and/or vertically, the possibilities of interpretation of spatial patterns in terms of human, spatial behaviour are limited. Nevertheless, the spatial intra-site analysis has yielded valuable information on the organisation

and use of the camp site (chapter 6). Recognised were two clear clusters (A and B), two less find-rich clusters (C and D), an intermediate zone (A/B), and adjoining areas with a more dispersed position of Magdalenian artefacts. As far as can be reconstructed on the basis of the find distribution, cluster A reflects the main activity area or 'core' of the camp site. In favour of this argues the high density of three-dimensionally recorded waste products and retouched tools, and the presence of stones with traces of heating mainly in the plough zone at cluster A. The stones have been interpreted as the remnants of a small hearth, the exact position of which unfortunately could not be established with certainty. In cluster A and its periphery, various flint nodules were worked and the production of blades was an important activity. Good examples are RMU S1 of Simpelveld flint and RMUs M3 and M9 of Meuse terrace flint. These RMUs were worked according to *le débitage magdalénien classique*, which indicates the presence of at least one experienced flint knapper in the camp site of Eyserheide. This person (or persons) was (were) probably seated immediately west of the presumed location of the hearth, in a zone from where also waste material was retrieved of other cores, (working edges of) burins, end scrapers and other types of retouched tools. Cluster B is located at only two metres from cluster A and consists for an important part of refitted flakes belonging to RMU S5. Whether we are dealing here with a small flint workshop or a place for dumping stone artefacts is not clear. Other cores were worked at a larger distance from cluster A, among which RMUs S2 and M12 in the southern part and RMU M15 in the eastern part of the excavation.

The site of Eyserheide and the other open-air sites in the Meuse-Rhine loess area fit into the big 'story' of the colonisation and dispersal of groups of Magdalenian hunters and gatherers over the northern parts of Europe at the end of the last ice age. Improved, but still cold stadial conditions led to areas in Northwest Europe being visited again for the first time after the extreme cold of the Last Glacial Maximum and after a hiatus in human occupation of many thousands of years. As regards the function of the camp site of Eyserheide, the transport and the bringing in of many kilos of flint from different exploitation places to the camp site form an important fact. Such an investment does not fit the picture of a briefly used camp site with a more or less random position in the landscape. The data rather argue in favour of a carefully chosen location on the margin of a loess plateau with a temporary, central function (focus) in the then settlement system. The occurrence of various types of retouched stone tools also is in keeping with the notion of a 'multi-functional' stay of longer duration, for instance a week or several weeks. An interpretation of the site of Eyserheide, but also of those of other excavated sites (Orp-le-Grand, Sweikhuizen-GP, and Alsdorf) as temporary base camps of a small social unit (one nuclear familiy) is considered likely (chapter 7). This interpretation is preferred to that of flint exploitation site or special-task site, as the sites in the Meuse-Rhine loess area in a general sense are referred to in publications.

Of the types of flint found in Eyserheide, artefacts have also been retrieved in other sites of the Meuse-Rhine loess area. It concerns Simpelveld flint in Sweikhuizen-GP and -KW and Kamphausen, and Orsbach flint in Kamphausen and Beeck. The distance of these sites to the nearest source locations in the hilly landscape of Dutch Limburg varies from 10 to 30 km. Eyserheide lies near primary sources of both types of flint and has yielded indications of a more extensive use and working. It is quite possible that Eyserheide was one of the camp sites where blades and tools of Simpelveld flint and Orsbach flint were produced, which subsequently (as components of a mobile toolkit) were carried away to camp sites *outside* the area with primary flint sources. Based on this transport, the two types of flint were not only of local but also of regional importance.

Rijckholt flint, with 'eluvial' cortex and recovered from residual and/or slope deposits, played a different role in the technological organisation of Magdalenian groups. Artefacts of this flint are *absent* in Sweikhuizen-GP and -KW as well as in the German open-air sites of the Meuse-Rhine loess area. Artefacts of 'eluvial' Rijckholt flint are present though in the extensive inventories of Andernach and Gönnersdorf, in spite of the location of both sites at clearly larger distances (100-120 km) from primary and secundary source locations. Moreover, in Andernach CII and Gönnerdorf CII we are dealing with considerable quantities of artefacts. On this basis we can speak of an 'export product' of supra-regional importance. The occurrence of eluvial Rijckholt flint links the sites of Gönnersdorf and Andernach to the source area of this flint between Maastricht and Liège, that is to say to the area in which the Magdalenian sites of Kanne and Mesch are located.

Based on data on the provenance of lithic raw materials in the Magdalenian sites of the Meuse-Rhine loess area, the Central Rhineland and the Belgian Ardennes (chapter 8), the following relationship is suggested between sites and areas:

- Orp-le-Grand. Both camp sites (Orp-West and Orp-East) are located in the immediate vicinity of sources of good quality flint from the Senonian. Flint was worked and blades and tools were produced on a large scale in both locations. The use of similar flint in Trou Da Somme and Bois Laiterie indicates a relationship between the area of Orp-le-Grand and caves south of Namur at the western edge of the Ardennes. Data on the provenance of flint materials do not point to a relationship between Orp-le-Grand and other, more easterly open-air sites of the Meuse-Rhine loess area.

– Kanne and Mesch. Within the group of northern open-air sites, these sites are most flint exploitation sites in nature. They can be regarded as locations where blades and tools were manufactured of Rijckholt flint (Kanne) and Rullen flint and Rijckholt flint (Mesch) for use in the camp sites themselves, but probably also in anticipation of future use in camp sites outside the Dutch-Belgian Cretaceous area. In view of their position in the direct vicinity of primary and secundary sources of Rijckholt flint and the extensive use of this flint in Andernach and Gönnersdorf, it is evident to link both sites to the Magdalenian occupation of the German Rhineland. But a relationship with the cave sites of the Ourthe Valley group is also a possibility. Further research into the exact character and origin of the worked flint in these sites (Verlaine, Coléoptère) is necessary to give a decisive answer to this point.
– Eyserheide, Alsdorf, Sweikhuizen-GP and -KW, Beeck and Kamphausen. With the exception of Eyserheide, these sites are located at least 10 km away from primary sources of good quality, Cretaceous flint. On this basis as well as on the composition of the artefacts, they cannot be designated as flint exploitation sites. An interpretation as temporary occupied base camps by a small social unit (one nuclear family) is considered likely. For the production of stone artefacts use was made mainly of local terrace flint, but also artefacts of Orsbach flint, Simpelveld flint, Baltic flint (*Baltischer Feuerstein*) and, in Eyserheide, eluvial Rijckholt flint form part of the inventories. Both latter types of flint occur as non-local materials in Gönnersdorf and Andernach. Moreover, Sweikhuizen-GP has yielded artefacts of a freshwater quartzite which possibly originates from the Central Rhineland. For this reason it is evident to (also) link the above six sites to the Magdalenian occupation of the Central Rhine Valley.

On the basis of the raw material data and the proposed relationships between sites and areas, the occupation of the Eyserheide site and that of other open-air sites in the Meuse-Rhine loess area fall in the same time span as that of Gönnersdorf and Andernach. If we taken into consideration the AMS radiocarbon dates of Andernach and Gönnersdorf (c. 13,300–12,700 BP), this means a possible time depth of occupation of the northern open-air sites of c. 600 C^{14} years. If we assume calibrated dates, then all AMS radiocarbon dates fall before 15,000 cal BP. Thus, they date the Magdalenian occupation of Andernach and Gönnersdorf and, in an indirect way, the open-air sites of the Meuse-Rhine loess area in the late phase of the Pleniglacial (climatic event GS 2 as recorded in the Greenland GRIP ice core) and some centuries prior to the prominent and sudden warming at the onset of the Late Glacial interstadial, that is to say prior to climatic event Gl 1e (in Central Europe: Meiendorf interstadial). The beginning of this warming-up is dated to around 14,700 cal BP.

Samenvatting

In deze monografie wordt uitgebreid verslag gedaan van de resultaten van de opgraving en de uitwerking van een openluchtvindplaats uit het Magdalénien nabij het gehucht Eyserheide (gemeente Gulpen-Wittem, provincie Limburg) in het lössgebied van Nederlands-Limburg. In Nederland beperkt de geografische verspreiding van vindplaatsen uit het Magdalénien zich hoofdzakelijk tot met löss bedekte plateaus in het uiterste zuiden van het land. Daarmee zijn ze, zeker op landelijke schaal, uitermate zeldzaam. Vanwege de ligging ervan aan of nabij het huidige oppervlak zijn ze kwetsbaar voor verstoringen ten gevolge van hedendaags grondgebruik en de voortgaande erosie van het Limburgse lösslandschap. Door middel van het uitvoeren van een opgraving kon verdere verstoring van de vindplaats van Eyserheide door agrarisch grondgebruik worden voorkomen. De opgraving is uitgevoerd in 1990 en 1991 door het Instituut voor Prehistorie (thans Faculteit der Archeologie) van de Universiteit Leiden.

De vindplaats van Eyserheide ligt op 193 m +NAP aan de zuidelijke rand van een uitgestrekt en hooggelegen plateau, het zogenaamde Eiland van Ubachsberg (hoofdstuk 2). De ligging van de vindplaats in het verspreidingsgebied van formaties van kalksteen uit het Boven-Krijt (Formatie van Gulpen en Formatie van Maastricht) en de verscheidenheid van typen vuursteen in deze kalksteen weerspiegelen zich in kenmerken van de bewerkte vuursteen. Voor de vervaardiging van stenen werktuigen hebben vuursteenbewerkers uit het Magdalénien gebruik gemaakt van vier typen van lokale, eluviale vuursteen, namelijk Simpelveldvuursteen, Valkenburgvuursteen, Orsbachvuursteen en Rijckholtvuursteen. Op basis van verweerde, maar niet fluviatiel afgeronde cortex is een herkomst van deze vuursteen uit eluviale en/of hellingafzettingen aannemelijk. Daarnaast is op grote schaal gebruik gemaakt van lokale Maasterrasvuursteen. Aan de hand van met het oog zichtbare eigenschappen van de vuursteen en de resultaten van *refitting* zijn vuursteentypen nader verdeeld in kleinere grondstofeenheden of *Raw Material Units* (RMU's). Informatie over de wijze waarop de vuursteen in het kampement van Eyserheide is bewerkt, baseert zich hoofdzakelijk op gedetailleerde beschrijvingen van composities van passende artefacten binnen RMU's van Simpelveldvuursteen (S1, S2 en S3) en Maasterrasvuursteen (M3, M6 en M9).

Temidden van de Magdalénien-openluchtvindplaatsen van het Maas-Rijn lössgebied neemt Eyserheide een bijzondere positie in. In dit verband kan worden gewezen op de resultaten van het onderzoek van grondstoffen, *refitting* en gebruikssporen. Mede door de fraaie resultaten van *refitting* zijn de mogelijkheden van technologische analyse aanzienlijk vergroot. Bovendien is een vergelijking tussen technologische kenmerken van het vondstmateriaal van Eyserheide en die van 'klassieke' Magdalénien-vindplaatsen ten zuidoosten van Parijs (Pincevent, Verberie, Marsangy en Etiolles) mogelijk en zinvol gebleken. Tendenzen in vuursteenbewerking en technologische handelingen die voor de Franse vindplaatsen zijn beschreven, zijn ook in het vondstmateriaal van Eyserheide herkend (hoofdstuk 4). Wat betreft de morfologische en metrische kenmerken van het bewerkte terrasvuursteen zijn er parallellen tussen Eyserheide en vooral Pincevent. Een andere overeenkomst is het onderscheid tussen *débitage elabor*é en *débitage simplifié* en de minder zorgvuldige wijze van bewerking (*chûte de soin*) tijdens de laatste fase van reductie van kernen. De resultaten van het technologische onderzoek tonen aan dat verscheidene vuursteenknollen zijn bewerkt volgens de klassieke wijze van Magdalénien-steenbewerking (*le débitage magdalénien classique*), met toepassing van *en éperon* technologie. Ten slotte is Eyserheide de enige vindplaats in het Maas-Rijn lössgebied waarvan artefacten op gebruikssporen zijn onderzocht en waar de analyse positieve resultaten heeft opgeleverd (hoofdstuk 5). De analyse van 44 artefacten van Orsbachvuursteen wijst op de bewerking van gewei, been en/of ivoor, dat wil zeggen materialen die als gevolg van post-depositionele processen zijn vergaan. Een andere belangrijke conclusie is dat de geanalyseerde artefacten kortstondig en niet zeer intensief zijn gebruikt. Ook geven de resultaten een duidelijke aanwijzing voor het gebruik van niet-gemodificeerde klingen en afslagen (voor zover vastgesteld in de groep van Orsbachvuursteen) in het kampement.

In Eyserheide is circa eenderde van het archeologische materiaal verzameld van de oppervlakte of uit de bouwvoor. Bovendien zijn talrijke artefacten aangetroffen in secundaire positie in natuurlijke kuilvullingen (= restanten van boomvallen) en in de gehomogeniseerde top van het niet-verploegde deel van de löss bodem. Doordat veel artefacten horizontaal en/of vertikaal zijn verplaatst, zijn de mogelijkheden van interpretatie van ruimtelijke patronen in termen van menselijk, ruimtelijk gedrag beperkt. Desondanks heeft de ruimtelijke intra-site analyse waardevolle informatie opgeleverd over de inrichting en het gebruik van het kampement (hoofdstuk 6). Er zijn twee duidelijke clusters (A en B), twee minder vondstrijke clusters (C en D), een tussenliggende zone (A/B) en aangrenzende zones met een verspreide ligging van Magdalénien-artefacten herkend. Voor zover op basis van de vondstverspreiding kan worden gezegd, weerspiegelt cluster A het belangrijkste activiteitsgebied of de 'kern' van het kampement. Hiervoor pleit de hoge dichtheid van ingemeten afvalproducten en geretoucheerde werktuigen, en de aanwezigheid van stenen met sporen van verhitting in het centrum van cluster A. De stenen zijn geïnterpreteerd als de overblijfselen van een kleine haard, waarvan de exacte positie niet met zekerheid is vastgesteld. In cluster A en in de randzone ervan zijn diverse vuursteenknollen bewerkt en was de productie van klingen een belangrijke activiteit. Goede voorbeelden zijn RMU S1 uit Simpelveldvuursteen en RMU's M3 en M9 uit Maasterrasvuursteen. Genoemde grondstofeenheden zijn bewerkt volgens *le débitage magdalénien classique* hetgeen wijst op de aanwezigheid van ten minste één ervaren vuursteenbewerker in het kampement van Eyserheide. Deze persoon (of personen) zat (zaten) vermoedelijk direct ten westen van de veronderstelde locatie van de haard, in een zone waar ook bewerkingsafval van andere kernen, (werkkanten van) stekers, schrabbers en andere typen van geretoucheerde werktuigen zijn aangetroffen. Cluster B ligt op slechts twee meter afstand van cluster A en bestaat voor een belangrijk deel uit passende afslagen behorende tot RMU S5. Of het hier gaat om een kleine bewerkingsplaats van vuursteen of om een dumpplaats van stenen artefacten, is niet duidelijk. Andere kernen zijn op grotere afstand van cluster A bewerkt, waaronder RMU's S2 en M12 in het zuidelijke deel en RMU M15 in het oostelijke deel van de opgraving.

De vindplaats van Eyserheide en de andere openluchtvindplaatsen van het Maas-Rijn lössgebied passen in het grote 'verhaal' van de kolonisatie en verspreiding van groepen van Magdalénien-jagers en verzamelaars over de noordelijke delen van Europa aan het einde van de laatste ijstijd. Verbeterende, maar nog altijd koude stadiale condities hebben ertoe geleid dat, na de extreme koude van het Last Glacial Maximum en na een hiaat in menselijke bewoning van vele duizenden jaren, gebieden in Noordwest-Europa voor het eerst weer door mensen worden bezocht. Ten aanzien van de functie van het kampement van Eyserheide vormt het transport en het samenbrengen van vele kilo's vuursteen vanaf verschillende exploitatieplaatsen naar het kampement een belangrijk gegeven. Een dergelijke investering past niet in het beeld van een kortstondig gebruikt kampement met een min of meer willekeurige ligging in het landschap. De gegevens pleiten eerder voor een zorgvuldig gekozen locatie aan de rand van een lössplateau met een tijdelijke, centrale functie (focus) in het toenmalige nederzettingssysteem. Het voorkomen van diverse typen van geretoucheerde, stenen werktuigen sluit eveneens aan bij de gedachte van een 'multi-functioneel' verblijf van langere duur, bijvoorbeeld een week of enkele weken. Een interpretatie van de vindplaats van Eyserheide, maar ook die van andere opgegraven vindplaatsen (Orp-le-Grand, Sweikhuizen-GP en Alsdorf) als tijdelijk basiskamp van een kleine sociale eenheid (een *nuclear family*) wordt aannemelijk geacht (hoofdstuk 7). Aan deze interpretatie wordt de voorkeur gegeven boven die van *flint exploitation site* of *special-task site*, zoals de vindplaatsen van het Maas-Rijn lössgebied in algemene zin in publicaties worden aangeduid.

Van de in Eyserheide aangetroffen typen van vuursteen zijn ook artefacten gevonden in andere vindplaatsen van het Maas-Rijn lössgebied. Het gaat om Simpelveldvuursteen in Sweikhuizen-GP en -KW en Kamphausen, en om Orsbachvuursteen in Kamphausen en Beeck. De afstand van deze vindplaatsen tot de dichtstbijzijnde bronlocaties in het heuvelland van Nederlands-Limburg varieert van 10 km tot 30 km. Eyserheide ligt in het natuurlijke verspreidingsgebied met primaire voorkomens van beide typen vuursteen en heeft aanwijzingen opgeleverd voor een beduidend grootschaliger gebruik en bewerking. Het is goed mogelijk dat Eyserheide één van de kampementen was waar klingen en werktuigen van Simpelveldvuursteen en Orsbachvuursteen zijn geproduceerd, die vervolgens (als componenten van een *mobile toolkit*) zijn meegenomen naar kampementen *buiten* het gebied met primaire vuursteenbronnen. Uitgaande van dit transport waren beide typen vuursteen niet alleen van lokale, maar ook van regionale betekenis. Een andere rol speelde Rijckholtvuursteen met 'eluviale cortex' en afkomstig van eluviale en/of hellingafzettingen in de technologische organisatie van Magdalénien-groepen. Artefacten van deze vuursteen zijn *afwezig* in zowel Sweikhuizen-GP en -KW als in de Duitse openluchtvindplaatsen van het Maas-Rijn lössgebied. In de omvangrijke inventarissen van Andernach en Gönnersdorf komen artefacten van Rijckholtvuursteen daarentegen wel voor, ondanks de ligging van beide vindplaatsen op duidelijk grotere afstand (100-120 km) van primaire en secundaire bronnen van dit type vuursteen. Bovendien gaat het in Andernach CII en in Gönnersdorf CII om aanzienlijke hoeveelheden artefacten. Op basis hiervan kunnen we spreken van een 'exportprodukt' van boven-regionale betekenis. Het voorkomen van 'eluviale' Rijckholtvuursteen verbindt de vindplaatsen van Gönnersdorf en Andernach met het brongebied van deze vuursteen tussen Maastricht en Luik, dat wil zeggen met het gebied waarin Kanne en Mesch liggen.

Op basis van gegevens over de herkomst van lithische grondstoffen in de Magdalénien-vindplaatsen van het Maas-Rijn lössgebied, het Midden-Rijngebied en de Belgische Ardennen (hoofdstuk 8), wordt de volgende relatie tussen vindplaatsen en gebieden voorgesteld:

– Orp-le-Grand. Beide kampementen (Orp-West en Orp-Oost) liggen in de directe nabijheid van bronnen van goede kwaliteit vuursteen uit het Senonien. Op beide locaties is op grote schaal vuursteen bewerkt en zijn klingen en werktuigen geproduceerd. Het gebruik van overeenkomstige vuursteen in Trou Da Somme en Bois Laiterie wijst op een relatie tussen het gebied van Orp-le-Grand en grotten ten zuiden van Namen aan de westelijke rand van de Ardennen. Gegevens van het onderzoek van grondstoffen duiden niet op een relatie tussen Orp-le-Grand en de andere, meer oostelijk gelegen openluchtvindplaatsen van het Maas-Rijn lössgebied.
– Kanne en Mesch. Binnen de groep van noordelijke openluchtvindplaatsen dragen deze vindplaatsen het meest het karakter van *flint exploitation sites*. Ze kunnen worden beschouwd als locaties waar klingen en werktuigen zijn vervaardigd van Rijckholtvuursteen (Kanne) en Rullenvuursteen en Rijckholtvuursteen (Mesch) voor gebruik in de kampementen zelf, maar vermoedelijk ook in anticipatie op toekomstig gebruik in kampementen buiten het Nederlands-Belgische Krijtgebied. Gezien hun ligging in de directe nabijheid van primaire en secundaire bronnen van Rijckholtvuursteen en het grootschalige gebruik van deze vuursteen in Andernach en Gönnersdorf, ligt het voor de hand beide vindplaatsen te verbinden met de Magdalénien-bewoning van het Duitse Midden-Rijngebied. Maar ook een relatie met de grotvindplaatsen van de *Ourthe Valley group* behoort tot de mogelijkheden. Nader onderzoek naar de precieze aard en herkomst van de bewerkte vuursteen in deze vindplaatsen (Verlaine, Coléoptère) is nodig om uitsluitsel te krijgen op dit punt.
– Eyserheide, Alsdorf, Sweikhuizen-GP en -KW, Beeck en Kamphausen. Met uitzondering van Eyserheide liggen deze vindplaatsen op minimaal 10 km afstand van primaire bronnen van goede kwaliteit Krijtvuursteen. Op basis hiervan én de samenstelling van de artefacten kunnen ze niet als *flint exploitation sites* worden aangeduid. Een interpretatie als tijdelijk bewoonde basiskampen door een kleine sociale eenheid (een *nuclear family*) wordt aannemelijk geacht. Voor de productie van stenen artefacten is voornamelijk gebruik gemaakt van lokale terrasvuursteen, maar ook artefacten van Orsbachvuursteen, Simpelveldvuursteen, morenevuursteen (*Baltischer Feuerstein*) en, in Eyserheide, eluviale Rijckholt vuursteen maken deel uit van de inventarissen. Beide laatstgenoemde typen vuursteen komen voor als niet-lokale materialen in Gönnersdorf en Andernach. Daarnaast heeft Sweikhuizen-GP artefacten uit een zoetwaterkwartsiet opgeleverd die mogelijk afkomstig is uit het Duitse Midden-Rijnland. Om deze reden ligt het voor de hand om genoemde vindplaatsen (eveneens) te verbinden met de Magdalénien-bewoning van het Midden-Rijngebied.

Op basis van de (grondstof)gegevens en de voorgestelde relaties tussen vindplaatsen en gebieden, valt de bewoning van de Eyserheide-site en die van andere vindplaatsen in het Maas-Rijn lössgebied in dezelfde tijdsspanne als die van Gönnersdorf and Andernach. Als we AMS-dateringen van beide Duitse vindplaatsen in ogenschouw nemen (c. 13.300-12.700 BP), moeten we rekening houden met een tijdsdiepte van de noordelijke openluchtvindplaatsen van ca. 600 C^{14}-jaren. Gaan we uit van gecalibreerde dateringen, valt deze tijdspanne vòòr 15.000 cal BP. Daarmee dateren ze de Magdalénien-bewoning van Andernach en Gönnersdorf en, op indirecte wijze, de openluchtvindplaatsen van het Maas-Rijn lössgebied in de late fase van het Pleniglaciaal (klimatologische ‘gebeurtenis’ GS 2 zoals geregistreerd in ijskernen in het Greenland Ice Core Project) en enkele eeuwen vòòr de markante en plotselinge opwarming aan het begin van het Laat-Glaciaal interstadiaal, dat wil zeggen vòòr klimatologische gebeurtenis Gl 1e (in Centraal Europa: Meiendorf interstadiaal). Het begin van deze opwarming is rond 14.700 cal BP gedateerd.

Acknowledgements

The excavation and processing of the Magdalenian site of Eyserheide was a labour-intensive and time-consuming job, in the end spread over a period of 21 years, to which many people have contributed. The idea to investigate the site dates from 1989 and originated within the walls of the Institute of Prehistory (now Faculty of Archaeology) of Leiden University. I owe Prof. dr Leendert Louwe Kooijmans and Prof. dr Wil Roebroeks many thanks for offering me the opportunity to excavate the site as part of my PhD research in Leiden between 1988 and 1993.

Drs Fred Brounen, with whom I shared an office in Leiden, introduced me to the local archaeologist Lambert Blezer who had discovered the Magdalenian site of Eyserheide in 1985. His enthusiasm was a great source of inspiration for all participants in the excavation. The sudden death of Lambert Blezer in August 1994 abruptly ended our pleasant collaboration and my hopes of presenting him with the first copy of this monograph.

The field work could not have taken place without the cooperation of the owners of the plot of the excavation and the adjoining plot. I should like to thank Mr Bindels (Nijswiller) and Mr Cox (Eyserheide) for granting their permission. Special thanks are also due to the Province of Limburg and the Municipality Wittem (now Municipality Gulpen-Wittem) for their financial support.

In 1990 and 1991 numerous people, students and local archaeologists as well as volunteers participated in the fieldwork. I am especially grateful to Joyce van Dijk, Jan Kolen, Annet Schmidt, Art Smit and Alexander Verpoorte. I also would like to thank the following persons, in alphabetical order: Lambert Blezer, Alex Brokke, Fred Brounen, Lauren Bruning, Ayla Çevic, Arie van Dijk, R. Doomen, Marianne Follak, Ronald Frank, Tiziano Goossens, Paul Hennekens, Berrie van Hoof, Mirjam van Ieperen, Hans Jongepier, Dimitri De Loecker, Jan Martinali, Sjaak Mooren, Natascha Moses, Eric Olijdam, Martijn van Poecke, Tim de Ridder, Annemiek Robeerst, Thijs Schaepman, Marie-Claire Schallig, Jan-Albert Schenk, Leon Vrancken, Patrick Vynckier, V. Vynckier, Nick Widdershoven, and Jan-Willem van Zessen. In addition, 15 members of the Archeologische Werkgemeenschap voor Nederland (AWN) participated in the excavation as part of a fieldwork course.

After the excavation campaigns of 1990 and 1991, many days were spent refitting the stone artefacts in the (then) auxiliary building of the Institute of Prehistory on the Wilhelminasingel in Maastricht. I should like to thank dr Alexander Verpoorte (Leiden), drs Art Smit (Harderwijk) and Paul Hennekens (†) who so patiently dealt with this huge job.

For the determination of the types of flint, I was expertly supported by drs Fred Brounen (Leiden) and dr Marjorie de Grooth (Bad Münstereifel). The small expert meeting that took place at the author's house on 19th June 2009 was a valuable and pleasant experience. The determination of non-worked natural stone was carried out by drs Eva Kars (Amersfoort) and Prof. dr Henk Kars (Amsterdam), and the use-wear analysis by dr Katsuhiro Sano (Sendai, see chapter 5). I am very grateful to them for their contributions.

The contributions of my present colleagues at the Cultural Heritage Agency in Amersfoort should not go unrecorded. Prof. dr Jos Bazelmans and drs Jos Deeben arranged funding for respectively the drawing of artefacts and the making of maps, ing Willem Derickx assisted in mapping the exact location of the excavation and drs Menne Kosian was actively engaged in making the first distribution maps. Ton Penders made the photos of (compositions of) flint artefacts in a very professional way. The chemical analysis of fragments of unworked siltstone was carried out by dr Bertil van Os of the Cultural Heritage Agency (see paragraph 6.2.6).

Drs Marjolein Haars (Amsterdam) made the majority of the maps in the Rijksdienst building. I valued the cooperation with Joanne Porck MA (Leiden), who took care of preparing the figures for publication. The drawings of the flint artefacts were made by Raf Timmermans MA (Leiden), unless stated otherwise.

Dr Leo Verhart and drs Luc Amkreutz, respectivley former and present curator of the Rijksmuseum voor Oudheden in Leiden, and drs Sjeng Kusters, keeper of the archaeological depot of the province of Limburg in Maastricht arranged for me to have the long-term loan of the finds of the site of Eyserheide. For which my thanks. Prof. dr P. Vermeersch (Leuven) allowed me access to the collections of the Belgian Magdalenian sites of Kanne and Orp-le-Grand and Prof. dr Harald Floss (Tübingen) showed me artefacts from Andernach and Gönnersdorf and samples of raw materials which were used for the production of stone tools in both sites.

Particular thanks go to drs Kelly Fennema (The Hague), who so diligently devoted herself to the translation of the Dutch text into English.

Without the continuous encouragement of my family, this study would not have known a beginning, let alone a completion. I much valued the support they gave me to finish the job.

Picture credits

M. Haars: 1.1, 2.2, 2.3, 2.4, 3.1, 3.4, 3.7, 4.15, 4.17, 4.19b, 4.24b, 4.26b, 4.29, 6.2-6.4, 6.8, 6.11-6.13, 6.15, 6.17-6.44, 6.46-6.49, 7.2, 7.3

H. de Lorm: 3.3, 6.1

J. Nederlof: 4.18

J. Pauptit: 4.1-4.4, 4.19a, 4.26a, 4.28, 4.30, 4.32a, 4.36-4.38

T. Penders: 4.8, 4.14, 4.20-4.22, 4.35-2,

G. Poels: 1.3, 1.4

J. Porck: 2.1, 6.45, 6.50, 7.1, 7.4, 8.1, 8.2

E. Rensink: 1.2, 3.2, 3.5, 3.6, 6.5-6.7, 6.9, 6.10, 6.14, 6.16.

K. Sano: 5.1-5.12

R. Timmermans: 4.5, 4.6, 4.7, 4.9-4.13, 4.16, 4.23, 4.24a, 4.25, 4.27, 4.31, 4.32b, 4.33, 4.34, 4.35-1