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The Michelsberg site Maastricht-Klinkers: a functional interpretation

Maastricht-Klinkers is one of the sites in the northwestern area of the Michelsberg culture for which it will be attempted to arrive at a functional characterisation. The examination of the lithic assemblage and especially the analysis of the wear traces on the flint implements constitute the focus of the research into functional differentiation between Michelsberg sites. The present results have demonstrated that Maastricht-Klinkers can be considered a residential site, from which a variety of activities have taken place.

1. Introduction

The analysis of the Michelsberg site Maastricht-Klinkers (province of Limburg, the Netherlands) forms part of a long-term investigation into the functional differentiation between various sites in the northwestern area of the Michelsberg culture (c. 5500-4800 BP)[1]. There are a number of reasons why such a functional differentiation may exist. First, sites are located in ecologically very different environments, such as riverine zones, pleistocene sands or loess areas (Eckert 1988; Lüning 1968; Verhart/ Louwe Kooijmans 1989; Vermeersch 1988). Second, it is clear that different types of sites have been recovered: causewayed enclosures as well as open settlements, characterised by a cluster of pits, postholes and numerous distinct find concentrations. The causewayed enclosures have for the most part produced bones from domesticated animals (Beyer 1970), the open sites bones from wild animals (Parent *et al.* 1987; Scheck 1977).

The expected differentiation in the settlement system is very difficult to substantiate because of the poor preservation of material remains in the majority of the sites, e.g. the lack of zoological and paleobotanical remains, and because most of the known sites consists of surface scatters mainly composed of flint artifacts. The only material which could systematically be recovered, was stone. Flint was therefore selected as the basic study material to attempt to trace the function of sites.

The analysis of the usewear traces on the flint is pivotal in this research. An integrated high and low power method was chosen for the wear trace analysis. In addition, other variables, such as the location of the site, the soil marks, sherds and stone were involved in the determination of the function of the various sites within the settlement system.

In the following, the location of the site, the find circumstances, the soil marks and the various finds will first be discussed. Subsequently, the results of the wear trace analysis will be presented, followed by a characterisation of the site of Maastricht-Klinkers.

2. The location of the site

The site is located to the north of the town of Maastricht, in the province of Limburg[2], and has been named after the loess and gravel quarry of the Klinkers' company which is situated on the spot (fig. 1). The topographical indication of the area is the Caberg. The site is situated on the highest level (c. 62 m + NAP) of a valley terrace (Caberg-3; *cf.* Van den Berg 1989). The terrace of Geistingen is located to the east of the site; this is the lowest terrace, through which the present-day river Meuse is running. To the west, the find location is circumscribed by a small brook called the

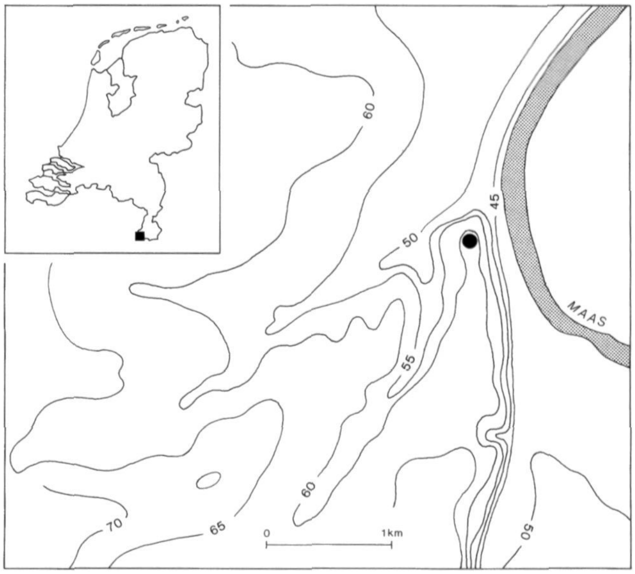


Figure 1. Location of Maastricht-Klinkers in the Netherlands and contour map of the site location. Height in m. above NAP (scale 1:25 000).

Heeswater. This stream has cut deep into the landscape, resulting in a large difference in height, amounting to more than 20 m, between the terrace on which the site is located and the stream valley.

The location of the site within the landscape is striking: it is situated on the northern rim of a protruding zone of the Caberg, bordered on two sides by river valleys (fig. 1). The site is located within the loess zone, only a short distance from the sandy plateau (the Kempen Plateau, Belgium, see fig. 2).

The subsoil of the site consists of loess deposits in which a brick soil has formed (Mücher 1986, 65). At present, the gradient of the terrain is rather limited and amounts to slightly less than two degrees. However, the decapitation of the loess profile and the presence of colluvium suggest that the gradient must have been steeper in the past and that, likely, part of the terrain has been prone to erosion (Theunissen 1990). The erosion has probably taken place during the period between the Bandkeramik occupation and the Bronze Age. This supposition is based on the limited depth of the features from the Bandkeramik period and the Michelsberg culture, as compared to those from the Bronze and Iron Age. Moreover, archaeological finds from these later periods of prehistory are virtually lacking in the colluvium.

3. Research history

Archaeological remains from the neolithic period, the Iron Age and the Roman period have been recovered from the Caberg area ever since 1920 (Disch 1969, 1971-72; Holwerda 1935; Sprenger 1948; Thanos 1994). Holwerda undertook a number of excavations in the Belvédère quarry, just one kilometer to the south of the Klinkers quarry[3].

The site Maastricht-Klinkers was discovered by Jean-Pierre de Warrimont from Geulle, in January 1989. During the extraction of the loess, a number of neolithic pits were found (Theunissen 1990). Because of the character of the finds and the fact that the archaeological remains were under immediate threat of being destroyed, an excavation campaign was undertaken by the Institute of Prehistory of the University of Leiden during the months of April and May. After the termination of the excavation, De Warrimont and other amateur archaeologists from the region regularly inspected whether the loess extraction activities had yielded more archaeological remains. An area over two hectares in size was monitored for archaeological remains.

4. The archaeological data

Because of the time pressure caused by the loess extraction activities, the quality of the data collected is rather variable. On some parts of the terrain only a superficial inspection had been possible. Most of the finds were retrieved by troweling the features; no sieving was practised. Samples for botanical research were taken from a few pits.

The majority of the archaeological remains found dates from the Linearbandkeramik culture and from the Iron Age. Some features can be attributed to the Late Neolithic or the Bronze Age, whereas seventeen features and/or find concentrations can be ascribed to the Michelsberg culture (see fig. 3)[4].

The Michelsberg site covers an area of approximately one hectare. With the exception of the northern side, the boundaries of the site are known; therefore, only in northerly direction could the site have been larger. Most of the features and the find concentrations have been discovered in the central part of the plateau, in an area of c. 70 × 50 meters.

4.1. Features

The Michelsberg features are recognizable on the basis of their colour and contents, and can therefore be distinguished from features dating to other periods. The majority of the features is quite shallow, with only the bottom of the original pit remaining (see table 1 for a descriptive chart of their morphological characteristics).

It has proven difficult to interpret the features. Features nrs. 0.27, 0.34, 0.16, Im, 0.31, 2.24 and 2.5 are considered to be caused by human activities, considering their depth, contents and colour. The shallow features nrs. Iy, IIi and IIh can be either intentionally dug, or they constitute natural depressions. Features nrs. 3.14 and 4.7 are probably tree fall-pits in which some archaeological material has accidentally been incorporated. A remarkable feature is a paved surface of cobbles extending over an area of some 60 m^2; unfortunately, this pavement could not be dated.

4.2. Pottery

Approximately 1220 pottery sherds from the Michelsberg culture have been collected, amounting to c. 14.5 kilo. The pottery is tempered with quartz and some pounded pottery and is, for the most part, undecorated. Some of the rim sherds display *Lochbückel* ornamentation, *Tupfenleiste*, imprints of a spatula, ears or knob lugs. A preliminary analysis of the pottery has revealed the presence of three types of rims (Theunissen 1990). One of the rim types is associated with the tulip beakers. The other two rim types have a relatively straight profile and a flattened or converted rim. Two carinated profiles could be reconstructed. Additionally, fragments from one baking plate were retrieved.

The pottery assemblage can probably be ascribed to the MK III phase of the Michelsberg culture (Lüning 1968, 84). The pottery displays parallels with the material from the Rhineland because of the presence of tulip beakers, baking

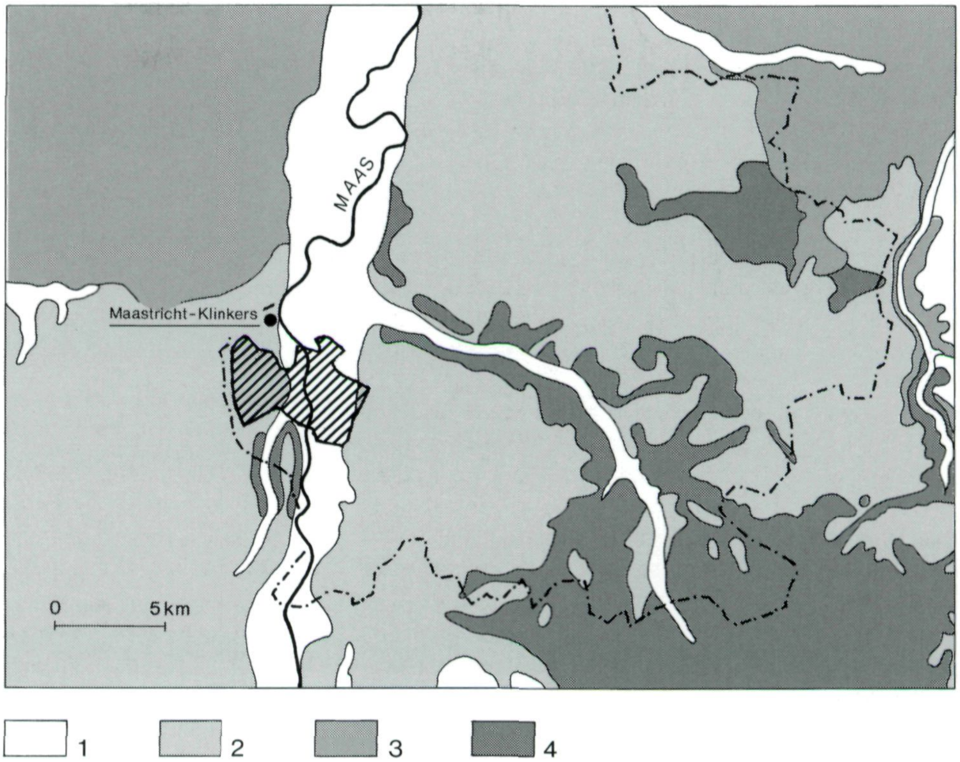


Figure 2 . Geological map of Southern Limburg. Legend units: 1. Holocene deposits, 2. Pleistocene loess, 3. Pleistocene sand, 4. Tertiary and older deposits.

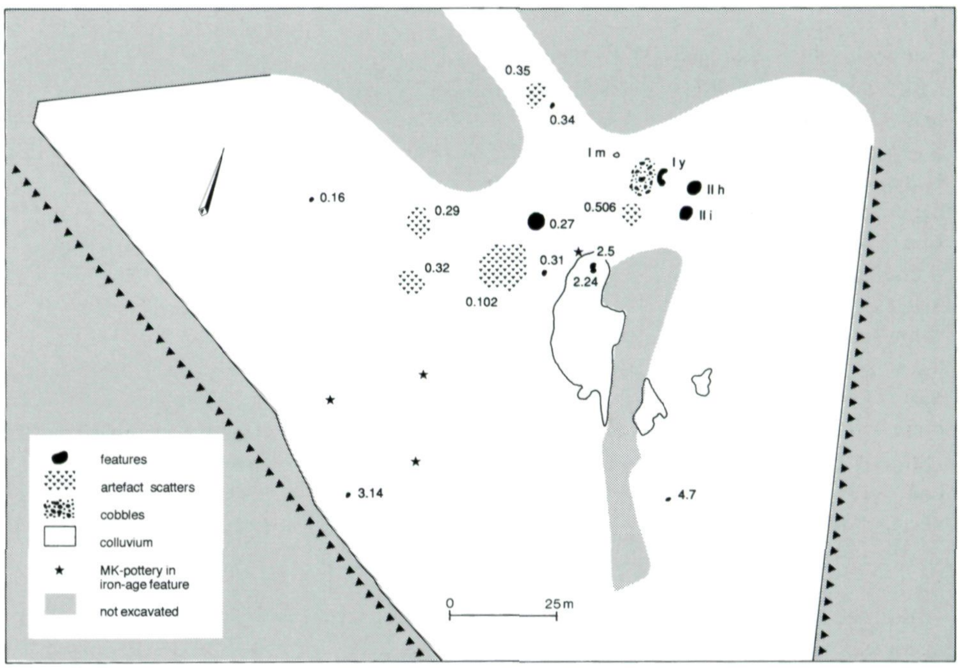


Figure 3. Maastricht-Klinkers: excavation plan.

Table 1. Maastricht-Klinkers: feature characteristics and content.

feature	diametre	depth	shape	colour	lithics	pottery	
					freq.	freq.	gr.
0.34	0.50	0.30	bowl	dark gray/black	3	14	150
3.14	0.65	0.50	-	grey/white	9	-	-
.Im	0.70	0.40	flat	yellow/grey	12	8	70
0.16	0.60	-	-	-	6	39	420
0.31	1.5×1.0	0.30	bowl	brown/grey	18	30	439
2.5	0.55	0.15	-	brown/grey	15	-	-
2.24	1.20	0.15	-	brown/grey	4	80	1395
4.7	1.3×0.70	0.70	irregular	grey/white	14	2	15
0.27	3.50	0.30	bowl	dark gray/black	66	431	4641
.Iy	4.0×1.0	0.20	-	-	99	273	3510
.IIh	3.0	0.10	-	dark gray/brown	69	141	1505
.Ili	3.0	0.10	-	dark gray/brown	27	68	915

plates, *Tupfenleiste* and tempering with quartz. The carinated profiles and the ornamentation with *Lochbückel* (Louwe Kooijmans 1976, 249) point to influences from the Chasséen culture; this can also be said for the Belgian Michelsberg assemblages. Other characteristics of the Belgian Michelsberg assemblages such as pottery tempered with flint and the presence of tranchet or flake axes (Vermeersch 1988), however, are lacking in the Maastricht-Klinkers assemblage.

4.3. FLINT

A total of 385 flint artifacts has been retrieved from Maastricht-Klinkers[5]. Many of the excavated Michelsberg sites have produced a similarly small number of flint objects (*cf.* Untergrombach, Munzingen and Mayen). However, very extreme differences in the size of the flint assemblages have been noted (Lüning 1968, 69). There are, for example, a few sites, such as Thieusies and Boitsfort, where several thousands of flint and stone artifacts have been discovered. In the following, the flint assemblage will be discussed in terms of the origins of the raw material, technology, present state and typology.

4.3.1. Sources of raw material

The flint assemblage has been divided into a number of raw material types on the basis of color, the presence or absence of characteristic intrusions, grainsize and character of the cortex (tab. 2)[6]. The majority (71.7%) of the artifacts has been produced from Rijckholt flint. Light-grey Belgian flint (Creemers/Vermeersch 1989; Löhr *et al.* 1977) comes second in importance, whereas only a limited number of artifacts is made of nodules deriving from the river terraces.

It is very difficult to determine whether the flint used at Maastricht-Klinkers has been collected or mined. The majority of the raw material types can be found both in primary context (chalk layers), or in secondary deposits, such as eluvial and riverine sediments (Löhr *et al.* 1977). It is known that during the Michelsberg period flint has been mined from the primary chalk deposits, but it was also collected from eluvial[7] and riverine sediments (Hubert 1974; Löhr *et al.* 1977; De Warrimont/Groenendijk 1993). Three indicative factors have been used to differentiate mined from collected flint: surface characteristics, artifact category and dimensions.

The surface characteristics which have been encountered include cortex and secondary coloration. On the basis of the coloration (De Warrimont/Groenendijk 1993) and the character of the cortex, it can be inferred that part of the used flint has been collected from eluvial and riverine deposits. There are no demonstrable differences[8] between the types of flint in the extent to which cortex[9] was present on the artifacts (tab. 2). Rolled cortex or patination was observed on 50 artifacts. The flint most probably derived from the terraces of the river Meuse or from surfacing riverine deposits. The cortex on the other artifacts (N=107) is relatively rough; the fact that the elevated portions are slightly rounded could indicate that the flint is not *bergfrisch*. On a number of artifacts it was observed that the surface directly beneath the cortex displays a reddish-brown coloration by iron, indicating the matrix in which the flint was embedded contained a certain amount of this element. This observation implies that the flint could not have been mined.

A second indication for differentiating between mined and collected flint is the artifact category. It is assumed that

Table 2. Maastricht-Klinkers: flint origin and cortex characteristics.

flint type	frequency	%	weight (gr.)	%	frequency			% cortex
					rolled cortex	rough cortext	total cortex	
terrace flint	24	6.2	517.2	5.8	12	7	19	79.2
'Meuse-eggs'	1	0.3	5.4	0.1	1	-	1	100.0
Rijckholt-type	276	71.7	7376.8	82.4	28	79	107	38.3
Rullen-type	6	1.6	50.9	0.6	1	1	2	33.3
Valkenburg-type	3	0.8	34.3	0.4	-	2	2	66.7
Simpelveld-type	4	1.0	102.6	1.2	-	2	2	50.0
light greyisch Belgian-type	31	8.1	413.3	4.6	1	13	14	45.2
Orsbach-type	4	1.0	39.2	0.4	1	1	2	50.0
other	11	2.9	296.5	3.3	-	1	1	9.1
indeterminable	25	6.5	112.3	1.3	6.	1	7	28.0
total	385	100.1	8948.5	100.1	50	107	157	40.8

polished axes (including their rough-outs), chisels, pointed blades and horse-shoe shaped scrapers normally were produced from mined flint (De Grooth 1991, 159). At Maastricht-Klinkers polished axes, pointed blades and horse-shoe shaped scrapers have indeed been found. Most probably, therefore, these artifacts have been made of mined flint.

The dimensions of the various artifacts form the last indications as to whether we are dealing with mined or collected flint. It is frequently assumed that artifacts with a minimum length of five (for flakes) to eight (for blades) cm have been produced from mined flint (De Grooth 1991; Louwe Kooijmans/Verhart 1990; Wansleeben/Verhart 1990). Maastricht-Klinkers has produced 133 artifacts[10] with a length over five cm and 34 which are longer than eight cm[11]. From the total of 133 artifacts ten display rolled cortex, a feature which excludes the possibility that they were made from mined flint. In addition, 34 implements display the rough cortex described above and several show iron coating. These observations make clear that larger dimensions of artifacts are not a reliable indicator for mined flint, because, evidently, artifacts of considerable size could be made from eluvial flint as well. There is also ample evidence that the riverine and eluvial deposits contained flint nodules of sufficient size to allow the production of sizable artifacts[12].

The use of flint during the Michelsberg period indicates that artifacts from mined flint have been 'imported', but that reduction of local eluvial and riverine flint took place as well. This is certainly the case for sites which are located at some distance from flint mines such as those in the Rhineland (Arora/Franzen 1987; Höhn 1984; Orzschig 1979), Westphalia (Willms 1982) and the middle of the Netherlands (Louwe Kooijmans 1980; Louwe Kooijmans/Verhart 1990). However, from the data of Maastricht-Klinkers and "De Kaap" at Rijckholt (Waterbolk 1994), it has become apparent that those sites in the direct vicinity of flint mines produce flint assemblages with a considerable number of artifacts made of a raw material not deriving from the mines[13].

4.3.2. *Technology*

Up to now, the flint technology of the Michelsberg culture has not been intensively analysed, nor does it form the main interest of the present article. Nevertheless, some general and site specific characteristics of the flint technology have been discussed by several authors (a.o. Fiedler 1979; Louwe Kooijmans/Verhart 1990; Lüning 1968; Vermeersch 1988; Waterbolk 1994).

From research by Fiedler (1979) and Louwe Kooijmans and Verhart (1990) it appears that in the northwestern distribution area of the Michelsberg culture (Middle Neolithic A, 5300-4700)[14] both pressure flaking and hard and soft hammer percussion have been practised. The artifacts from Maastricht-Klinkers have not been investigated for traces indicative of the reduction technique employed. It is the impression of the author, however, that the majority of the implements has been produced by soft-hammer percussion.

Considering the presence of hammerstones and debitage, such as cores, decortification and core-rejuvenation flakes, the flint must have been worked locally (tab. 3). Despite of the fact that 41% of the artifacts displays cortex (tab. 2), only a few (6%) have cortex on more than half of their dorsal surface. This implies that, most likely, the flint nodules were stripped of most of their cortex elsewhere. The presence of one core preparation blade and 22 core rejuvenation flakes points to the practise of core preparation

Table 3. Maastricht-Klinkers: artefact categories versus flint origin.

	terrace	'Maas-eggs'	Rijckholt	Rullen	Valkenburg	Simpelveld	light-grey Belgian	Orsbach	other	indeterminable	total
tools:											
point	1	-	2	-	-	-	-	-	-	-	3
pointed retouched blade	-	-	9	-	-	-	-	-	-	-	9
scraper	-	-	40	1	-	-	2	-	1	-	44
borer	-	-	1	-	-	-	-	-	-	-	1
combination tool	1	-	3	-	-	-	-	-	-	-	4
retouched blade	1	-	19	-	-	-	4	-	2	-	26
notched blade	-	-	-	-	-	-	1	-	-	-	1
truncated blade	-	-	-	-	-	-	1	-	-	-	1
sickle blade	-	-	2	-	-	-	-	-	-	-	2
retouched flake	1	-	15	-	-	-	3	-	1	-	20
denticulated flake	-	-	1	-	-	-	-	-	-	-	1
truncated flake	-	-	1	-	-	-	-	-	-	-	1
retouched block	-	-	1	-	-	-	-	-	-	-	1
retouched core rej.flake	-	-	4	-	1	1	-	-	-	-	6
splintered/bifacial retouched piece	-	-	6	-	-	-	1	-	-	-	7
quartier d'orange	-	-	2	-	-	-	-	-	-	-	2
axe	-	-	4	-	-	-	-	-	1	-	5
hammerstone	2	-	5	-	-	-	1	-	2	-	10
total	6	-	115	1	1	1	13	-	7	-	144
debitage:											
block	2	-	4	1	-	-	2	-	-	18	27
decortication flake	3	-	9	-	-	-	2	-	-	2	16
crested flake	-	-	1	-	-	-	-	-	-	-	1
core	-	-	10	-	-	-	1	-	-	-	11
core rejuvenation flake	2	-	10	-	-	-	1	-	-	1	14
resharpening flake	-	-	1	-	-	-	-	-	-	-	1
blade	2	-	47	1	1	-	5	-	-	2	58
flake	9	1	78	3	1	3	7	4	4	-	110
other	-	-	1	-	-	-	-	-	-	2	3
total	18	1	161	5	2	3	18	4	4	25	241

Table 4. Maastricht-Klinkers: core types and characteristics.

	primary tool type	secundary use	flint origin	cortex	weight
blade core with two platforms	-	wedge	light grey Belgian	rough	68.8
discoidal blade core with one platform	axe	-	light grey Belgian	-	81.1
discoidal flake core with one platform	axe	hammerstone	Rijckholt	-	101.3
flake core with one platform	-	-	Rijckholt	-	111.8
flake core with two platforms	-	-	Rijckholt	rolled	55.0
flake core with two platforms	-	-	Rijckholt	rolled	112.1
flake core with multiple platforms	-	-	Rijckholt	rolled	122.2
flake core with multiple platforms	-	-	Rijckholt	rough	193.6
flake core with multiple platforms	-	-	Rijckholt	rough	178.1
flake core with multiple platforms	-	-	Rijckholt	-	8.5
flake core with multiple platforms	-	-	Rijckholt	-	131.7
flake core with multiple platforms	axe	-	Rijckholt	-	49.3
flake core with multiple platforms	hammerstone	-	Rijckholt	rough	91.5
flake core with multiple platforms	-	hammerstone	terrace	rolled	143.1
flake core with multiple platforms	-	hammerstone	terrace	rolled	139.0
flake core with multiple platforms	axe	hammerstone	other	-	80.5
flake core with multiple platforms	axe	hammerstone	other	-	33.3
flake core with multiple platforms	axe	hammerstone	light grey Belgian	-	66.7

and rejuvenation of the striking platform. Contrary to what has frequently been observed for Bandkeramik reduction strategies, the entire platform was not removed during rejuvenation, but only a portion of it.

A total of 18 cores has been retrieved, among which two blade and 16 flake cores (tab. 4). Eleven cores were discarded and seven were secundarily used for other purposes (fig. 4b)[15]. It is remarkable that six axe fragments and one hammerstone have also been secundarily used as core. This indicates a technological organisation in which re-use of flint frequently occurred. The cores with more than one striking platform form the largest category (fig. 4a). All cores have very slight dimensions[16] and a minimal weight, indicating that most of them can be considered exhausted.

It is not clear whether the cores of Rijckholt type of flint have been used for the production of macrolithic blades[17]. Due to their small dimensions, cores from axe fragments are not suitable for this purpose. The inferior quality of the flint of most of the other cores makes it highly unlikely that they produced macrolithic implements. Only three cores of high quality Rijckholt flint could have delivered macrolithic artifacts. Debitage indicating the former presence of large blade cores, such as core rejuvenation pieces of considerable size, has not been encountered. It is therefore probable that macrolithic artifacts have not been produced on the site.

The combination of small flake cores and eluvial Rijckholt flint has also been found on a settlement site in the near vicinity of the Rijckholt flint mine, called "De Kaap". The large blade cores which one would expect at such a short distance from the mines have only been found incidentally. However, on the basis of their size and high quality flint, Waterbolk assumes that a number of blades and tools from blades have been made on mined flint (Waterbolk 1994, 44).

The knappers apparently did not select specific types of flint for the production of certain artifact categories. Moreover, in terms of the flint used, no significant differences could be demonstrated between the retouched implements and the debitage, nor between blades and flakes. The diversity in raw material is only connected with the number of artifacts: the artifact categories with the highest scores (unretouched flakes and blades) also display the most diverse range of flint types (see tab. 3).

Significant differences could be demonstrated between artifact categories in terms of the presence or absence of cortex ($X^2 = 29.932$, df = 17, p = 0.0268). Cortex is more frequently encountered on tools[18] which have not been specifically modified, such as splintered pieces, bifacially retouched implements, retouched core rejuvenation pieces and retouched flakes, than on specifically modified implements as scrapers, pointed blades, points, and borers. It appears, therefore, that not specifically modified artifacts have more frequently been produced from the exterior of the flint nodules.

4.3.3. *State of the artifacts*

Forty percent of the flint implements is broken. Tools are more frequently broken than debitage ($X^2 = 5.377$, df=1, p = 0.0204; tools E = 57.2; O = 68; debitage E = 95.8, O = 85).

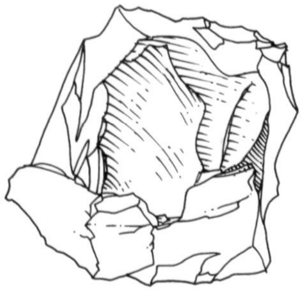


Figure 4. Maastricht-Klinkers: a) flake core with multiple striking platforms (nr. 220), b) flake core with multiple striking platforms used as hammerstone (nr. 22), c) tear-shaped point with impact fracture on the tip and polish from a hard unknown material △ (nr. 19), d) triangular point with impact fracture on the tip and bone polish ◆ (nr. 20), e) pointed blade used for boring, scraping and cutting hide ● (nr. 126), f) pointed blade used in a transverse and longitudinal motion on material '10' □ and as a sickle knive ○ (nr. 16), g) pointed blade used for scraping hide ● (419), h) pointed blade used for scraping and cutting hide ● (nr. 421). Scale 2:3.

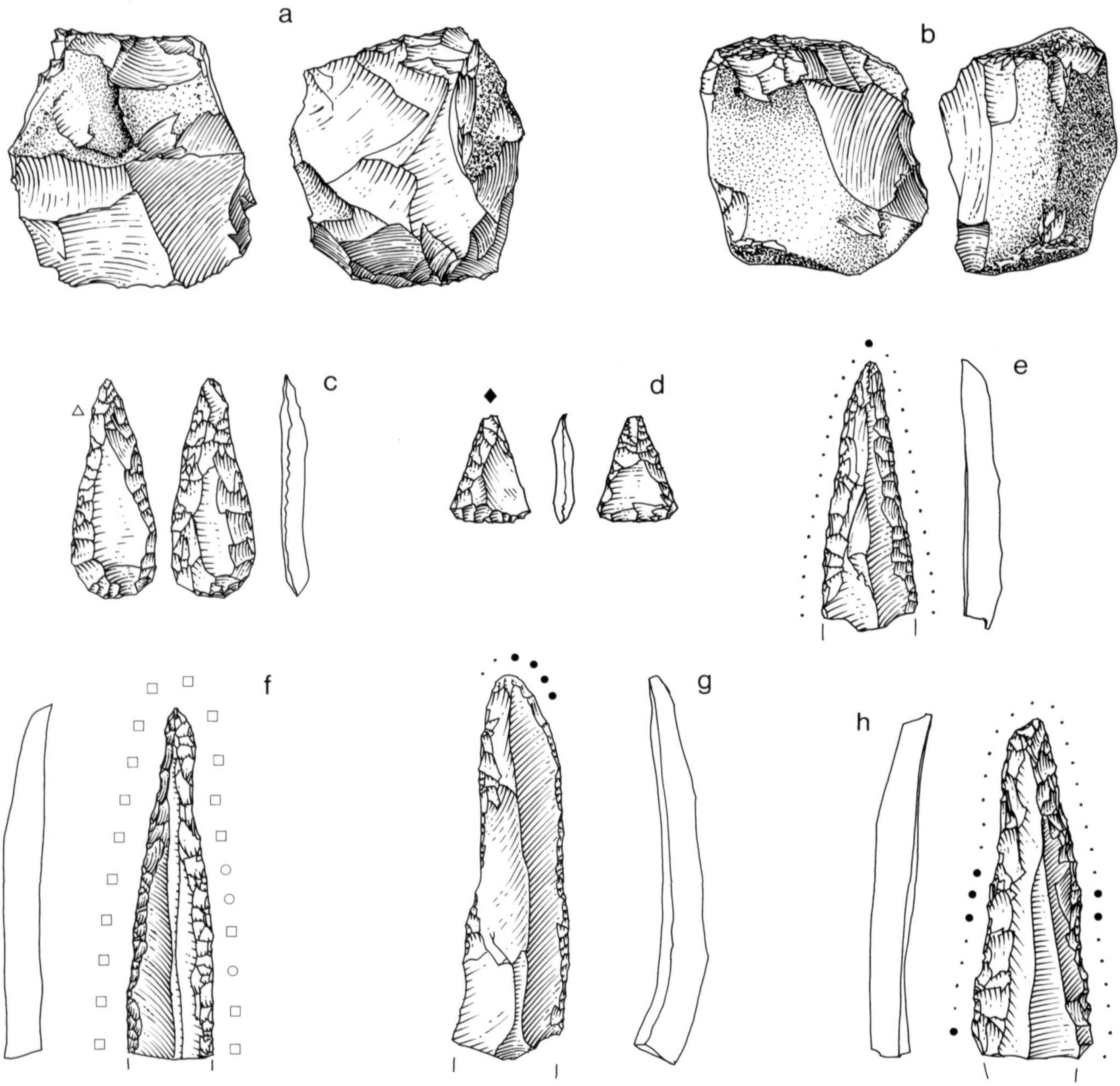


Table 5. Maastricht-Klinkers: scraper types and size of the complete scrapers.

	lenght (mm)		width (mm)		thickness (mm)		weight (g)		complete	total
	mean	s	mean	s	mean	s	mean	s		
end-scraper on blade	72.7	18.8	30.7	4.9	12.0	3.6	24.8	9.3	3	3
end-scraper on blade with lateral retouche	86.6	33.1	36.6	3.2	12.7	3.8	44.1	25.7	7	13
double end-scraper on blade with lateral retouche	99.5	37.5	42.0	11.3	14.0	1.4	60.8	32.7	2	2
end-scraper on flake	53.0	7.1	46.5	5.0	16.5	0.7	39.5	13.2	2	4
double end-scraper on flake with lateral retouche	66.2	10.0	44.7	5.3	12.0	2.6	33.0	8.0	6	6
double end-scraper on flake	75.0	0.0	57.0	0.0	12.0	0.0	49.2	0.0	1	1
wide end-scraper on flake	60.5	11.6	49.8	6.5	14.3	2.7	48.3	24.1	8	11
side-scraper	44.0	0.0	28.0	0.0	16.0	0.0	16.2	0.0	1	1
scraper on rejuvenation flake	68.0	0.0.	37.0	0.0	13.0	0.0	14.1	0.0	1	1
scraper not identified	-	-	-	-	-	-	-	-	-	2
total									31	44

The state of the artifacts also displays significant differences between artifact categories ($X^2 = 51.926$, df = 17, p = 0.000). Especially pointed blades (E = 4.2, O = 9) and retouched blades (E=12.3, O = 21) have frequently been broken, whereas scrapers, on the other hand, often are not (E = 20.8, O = 13). Additionally, significant differences could be demonstrated between various categories of debitage ($X^2 = 66.752$, df = 7, p = 0.000[19]). Blades especially are more often broken than predicted (E = 23, O = 48), flakes less frequently (E = 66.3, O = 82).

Ten percent of the artifacts exhibits traces of burning, mostly in the form of potlids. There are no significant differences between tools and debitage in terms of number of burned pieces.

4.3.4. Typology

The majority of the artifacts are made on flakes (N = 176). However, blades (N = 119) are more frequently modified (47% of the total number of tools) than flakes (37%). The assemblage contains a remarkably high amount of tools (37.4%), with scrapers constituting the largest category. Virtually the entire range of Michelsberg artifact types is represented: tear-shaped and triangular points, pointed blades, macrolithic scrapers and polished flint axes (tab. 3)[20].

In the following, the various tool categories will be briefly discussed in terms of their typological characteristics.

Points

One tear-shaped (fig. 4c) and one rather small, symmetric triangular point with straight basis (fig. 4d) have been encountered. Both display surface retouch extending to roughly halfway the implement and are produced on coarse grained flint. The basis of a third point is lacking which makes it impossible to determine the type. It concerns a rather large, narrow specimen (measuring 39×16×4 mm) with retouch along the borders only.

Pointed blades

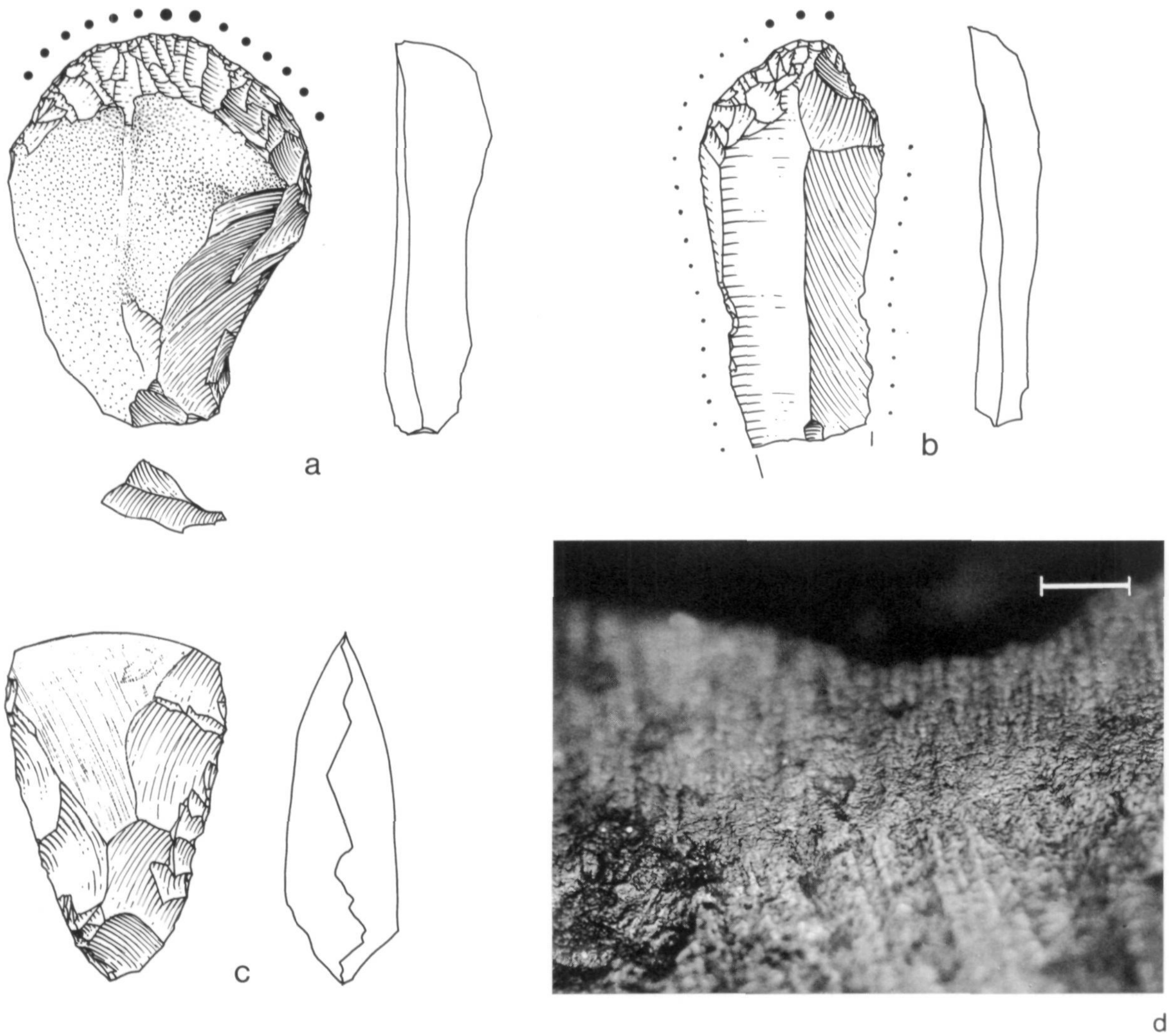
Nine pointed blades have been recovered[21]. Generally, they display rather steep, lateral retouch over the entire length of the blade . Five tools have a slightly rounded point (figs 4e, f), one a tongue-shaped tip (fig. 4g) and one an acutely angled tip (fig. 4h) (Fiedler 1979). Two pieces could not be classified further. All of the pointed blades have been broken. The length varies from 63 mm to 102 mm (mean dimensions are 79×24×9 mm).

Scrapers

As has already been mentioned above, the scrapers constitute the largest tool category (N = 44). They are more frequently made on flakes (52.3%) than on blades (40.9%). The most general type is the blade scraper with lateral retouch (fig. 5b), followed by the horse-shoe shaped scraper (fig. 5a) (tab. 5). For the most part the scraper heads display a regular retouch. Edge angles vary between 50 and 95 degrees. The distribution of the edge angles is unimodal with 50 scraper heads showing an angle between 70 and 80 degrees. Most of the scrapers are complete, having a length varying from 44 to 135 mm.

Combination tools

One scraper/borer, one scraper/truncation, one burin with a retouched lateral edge, and one reamer with a retouched lateral edge were encountered. The burin (fig. 13b) and the reamer (fig. 14a) with retouched lateral edges are actually not combination tools in the strict sense of the word. Reason to classify them in this category is that both are macrolithic artifacts which, in terms of their shape, dimensions and type of modification, differ from the category of burins and reamers into which they would be classified normally. The reamer is partially polished: on its right lateral edge and on its dorsal aspect.



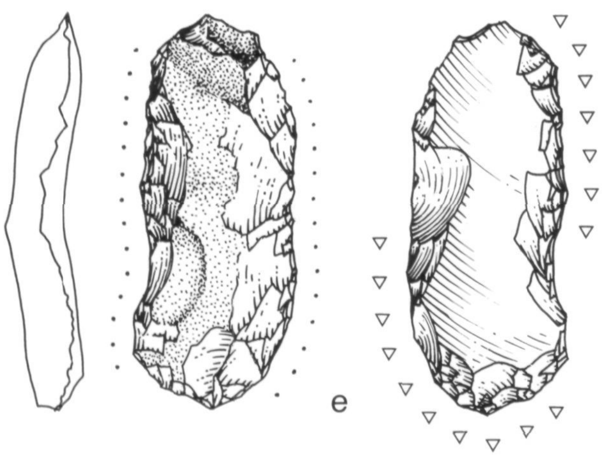


Figure 5. Maastricht-Klinkers: a) horseshoe shaped scraper used for scraping hide • (nr. 349), b) scraper on a blade used voor scraping and cutting hide • (nr. 246), c) polished axe with probably resharpened cutting edge (nr. 314), d) micrograph of observed polish on cutting edge axe (artifact nr. 314, 300×, bar equals 50 μ.), e) splintered piece used as a wedge on hard material △ (nr. 5). Scale 2:3.

Table 6. Maastricht-Klinkers: artefact categories versus type of stone.

	quartz		quartzite		quartzitic sandstone		sandstone		granite		total
	freq.	g	freq.	g	freq.	g	freq.	g	freq.	g	
retouchoir	-	-	1	62.3	-	-	-	-	-	-	1
polish stone	-	-	-	-	-	-	1	244.0	-	-	1
quern	-	-	-	-	1	557.0	1	244.0	-	-	2
pierced pendant	-	-	1	15.2	-	-	-	-	-	-	1
block	9	181.2	14	307.5	-	-	9	171.1	2	52.2	34
other	-	-	3	257.3	-	-	-	-	-	-	3
total	9	181.2	19	642.3	1	557.0	11	659.1	2	52.2	42

Splintered pieces

All splintered pieces share bifacial retouch or splintering and a rather coarse shape (fig. 5e). However, the category is rather heterogeneous in terms of shape (varying from longitudinal to round) and size (length varies from 48-87 mm, width from 32-61 mm and thickness from 12-28 mm). The character and distribution of the retouch is also very variable: fine and coarse retouch, distributed both continuously and discontinuously along the edge, either in a regular or irregular fashion, have all been observed.

Axes

Two small, complete thin-butted axes made of Rijckholt type flint have been recovered at the site. One of them is made from a broken polished axe; its dimensions are 56 × 40 × 21 mm. Traces of polishing are still visible on the central part of the axe, whereas the lateral edges and the cutting edge have been secundarily retouched. The other complete axe (fig. 5c) displays a pointed oval cross section and has been partially polished. The flake scars are still visible on both aspects of the implement. The cutting edge has been polished in a direction different from the remaining of the tool (fig. 5d), which may suggest that it was resharpenened.

In addition to the complete axes, three axe fragments have been retrieved: two butt fragments and a butt with central part. It concerns thin-butted axes with a pointed oval or oval cross section. The polishing facets run parallel to the length of the tool. Two fragments display a flattening of the lateral edges and one shows bifacial flake scars at the butt end.

Several flakes and other debitage from polished axes are present in the assemblage. Axe fragments were also secondarily used as core or hammerstone, or even first as core and subsequently as hammerstone.

Retouched blades

The assemblage contains 28 retouched blades. Generally, they display a rather irregular retouch, located equally frequently on one as on two lateral edges and extending either over the entire length of the tool or along portions of it. Regular, carefully executed retouch is only found on the macrolithic blades and broken tools. Five complete blades were recovered, with a mean length of 83 mm ($\sigma = 22.3$). The length of the retouched blades is significantly greater than that of the unretouched blades (61.5 mm, $\sigma = 22.6$). Two sickle blades, displaying the characteristic highly reflective gloss, have been found. One of them has been retouched only marginally, the other has a steeply retouched lateral edge (fig. 13c).

Other tools

Twenty retouched flakes have been retrieved, generally displaying retouch on only one lateral edge; the irregular retouch is distributed along parts of the edge only . The flakes, which are less frequently broken than the blades, have a mean length of 49.1 mm ($\sigma = 10.3$ mm).

Only four artifacts have been truncated, notched or denticulated. One flake, very coarsely denticulated on both lateral edges, is remarkably large (74×51×24 mm) and heavy (77 gr) (fig. 8c).

One block and six core rejuvenation flakes (fig. 14e) have been modified by means of retouch. Only one borer has been found, of which only the tip is remaining. Two *quartiers d'orange* (De Puydt 1902) have been collected. These are specifically shaped, longitudinal, thick flakes with a triangular or quadrangular cross section. The longitudinal functional edge, which is never retouched, characteristically has an angle of 70-90 degrees.

Last, a bifacially retouched artifact should be mentioned (fig. 11b). It has been attributed to a separate category, that of bifacially retouched tools. It has an axe shape and has been carefully retouched; one lateral edge displays a polished facet.

4.4. STONE

The majority of the stone material retrieved (N = 42), amounting to approximately two kilo, consists of quartzite, quartzitic sandstone and regular sandstone (tab. 6). All varieties can be found locally. Most of the artifacts are irregular blocks with an unknown function. The quartz fragments (181 gr) have possibly been used as temper for pottery. Only part of the stone material can be interpreted as tools. One long, slender quartzitic pebble displays impact scars on one end; possibly, this artifact can be interpreted as a *retouchoir*.

One cube-shaped sandstone, measuring 50×50×50 mm, has six rounded sides; this artifact may have functioned as a rubbing or polishing stone. In addition, two grindstone fragments have been found, one of sandstone, one of quartzitic sandstone. These fragments are too small to determine whether it concerns grinding stones or querns.

One remarkable find concerns an oval-shaped, darkgrey quartzitic rolled pebble, with double conical perforation at one end[22] (fig. 6).

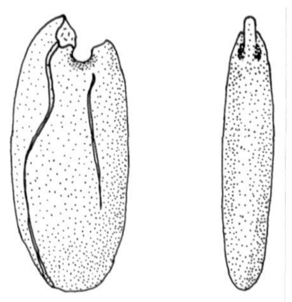


Figure 6. Maastricht-Klinkers: rolled pebble with double conical perforation (drawing by L. Theunissen). Scale 2:3.

4.5. Botanical remains

Features 0.32, 0.31 and 2.24 have been sampled for botanical research. The first two have produced charred domesticated cereals: naked six-rowed barley (*Hordeum vulgare var. nudum*) and wheat (*Triticum sp.*) as well as various species of weeds such as orach (*Atriplex prostrata*), goosefoot (*Chenopodium album*), black bindweed (*Polygonum convolvulus*) and catchfly (*Silene sp.*) (data kindly provided by C.C. Bakels).

4.6. Find circumstances

More than 80% (N = 342) of the stone and flint material and 90% of the pottery (circa 13 kilo) derives from features. The remaining material has been collected from the undisturbed matrix[23]. Therefore, the majority of the assemblage from Maastricht-Klinkers consists of artifacts which have ended up in pits or depressions.

As was already mentioned in paragraph 4.1, it turned out to be difficult to attribute a function to these pits and depressions. Because of the fact that they lack internal structuring, categorizing them is only possible on the basis of their diameter: small features with a diameter less than one meter, middle sized features measuring between one and two meters in diameter and large features (3-3.5 m in diameter). It has been investigated whether there is a relationship between the size of the features and their contents. Another question which has been addressed is the character of the find deposition: how have the finds found their way into the pits or depressions? If the contents of a feature could be associated with one activity, variation in the contents of the features should be expected (Schiffer 1976). If rubbish from various activities has been repeatedly dumped in the same pits, or if the material from one activity has been discarded in different pits, there should be no difference in the contents of the features.

The features contain for the most part both pottery and flint (tab. 1). The largest features produced most of the discarded rubbish. The percentage of flint tools varies from 0 to 50% between different features[24]. A significant difference could be demonstrated between small, middle sized and large features ($X^2 = 13.059$, df = 2, p = 0.0015). The larger features show (with the exception of feature IIh) virtually identical percentages of tools and debitage ($X^2 = 0.131$, df = 2, p = 0.9368). Feature IIh is significantly different ($X^2 = 7.982$, df = 3, p = 0.0464) because of its low percentage of tools (E = 25.6, O = 16). In all other respects, however, feature IIh resembles the others. Most probably a little more debitage from reduction has accidentally ended up in this pit or depression.

The diversity of artifact categories turns out to be related, generally speaking, to the number of artifacts. It appears from the wear trace analysis that this also applies to the diversity of contact materials. The use wear analysis has also indicated that there are no significant differences in the degree of interpretability of the artifacts, nor in their preservation or the number of used artifacts or used edges.

Indications for the presence of primary deposits includes adjacently found sherds joining together and the presence of sherds of considerable size. However, fragments of one axe and one vessel have incidentally been found in different features as well.

To conclude, we can state that the features probably contain settlement debris which is both primarily and secondarily deposited. The deposits from the various activities cannot be separated anymore. The amount of discarded material is related to the diameter of the pits and/or depressions.

Table 7. Maastricht-Klinkers: artefact categories versus results of the usewear-analysis.

	analyzed	not interpretable	number of artefacts			used edges	hafted
			without traces	use unsure	used		
point	3	-	-	1	2	2	-
pointed retouched blade	8	-	-	-	8	19	2
scraper	41	1	-	-	40	76	10
borer	1	-	-	-	1	1	-
combination tool	4	-	-	-	4	10	-
retouched blade, incl.sickle blade	27	2	-	1	24	50	8
notched blade	1	-	-	-	1	1	-
truncated blade	1	-	-	1	-	-	1
retouched flake	18	-	12	-	6	10	-
denticulated flake	1	-	-	-	1	2	-
truncated flake	1	-	-	-	1	1	-
retouched block	1	-	-	-	1	2	-
retouched core rej.flake	6	-	2	1	3	6	-
bifacial retouched tool	1	-	-	-	1	2	1
splintered/bifacial retouched piece	6	-	1	-	5	10	-
quartier d'orange	2	-	1	-	1	2	-
axe	3	-	1	1	1	1	-
blade	42	-	12	1	29	51	4
flake	41	-	22	2	17	27	-
block	3	-	1	-	2	2	-
core rejuvenation flake	5	-	5	-	-	-	-
total	216	3	57	8	148	275	26

5. The usewear analysis

5.1. Method and sampling strategy

In the present research elements of both the low-power (Odell 1977; Shea 1991;Tringham *et al.* 1974) and the high-power method (Van Gijn 1990; Keeley 1980) have been used in an integral fashion. After cleaning the artifacts[25], a stereomicroscope is employed in order to determine whether or not the artifact displays traces of use[26]. The artifacts with traces of use are described in terms of the use retouch and edge rounding. Additionally, the presence, distribution and reflectivity of the polish is studied in a cursory fashion. Subsequently, the exact character of the polish is determined with the aid of an incident light microscope[27]. Artifacts which do not display polish when examined with low magnifications but could nevertheless might have been be used, are studied with the incident light microscope as well.

All tools in the assemblage have been studied for traces of use. The debitage has been sampled; criteria for selection included a minimum length of two cm and the presence of a regular edge which could potentially be used or else a sturdy point (compare Van Gijn 1990, 92; Moss 1983, 193). Burned artifacts have not been selected because generally wear traces are not interpretable after an artifact has been burned.

5.2. Results

A total of 229 artifacts (53.6% of the assemblage) has been studied for the presence of wear traces, among which 216 flint and 13 stone artifacts[28]. On not less than 68.5% (N = 148) of the artifacts, traces of use were present (tab. 7). On 25.9% of the artifacts no traces were visible, whereas from 6% the use is unsure or not interpretable due to patination, damage or resharpening.

Due to the excellent preservation of the artifacts, the percentage of artifacts which were not interpretable is very low in comparison with other assemblages (Van Gijn 1990, table 3). The good preservation may be attributed to the deposition in loess sediments which abrade the surface of the flint implements to a lesser extent than, for example, a sandy matrix. Another reason may be the speed with which the artifacts have been covered after discard. The artifacts from Maastricht-Klinkers largely derive from pits or depressions which have probably been filled quite quickly. Because of this fact they have hardly been subjected to trampling by humans or animals.

The majority (N = 84) of the 148 artifacts with traces of use, have more than one used edge, or edges which were used more than once, either for different contact materials or different motions. Altogether the 148 artifacts with wear traces have 275 used edges (tab. 7). On 210 used edges

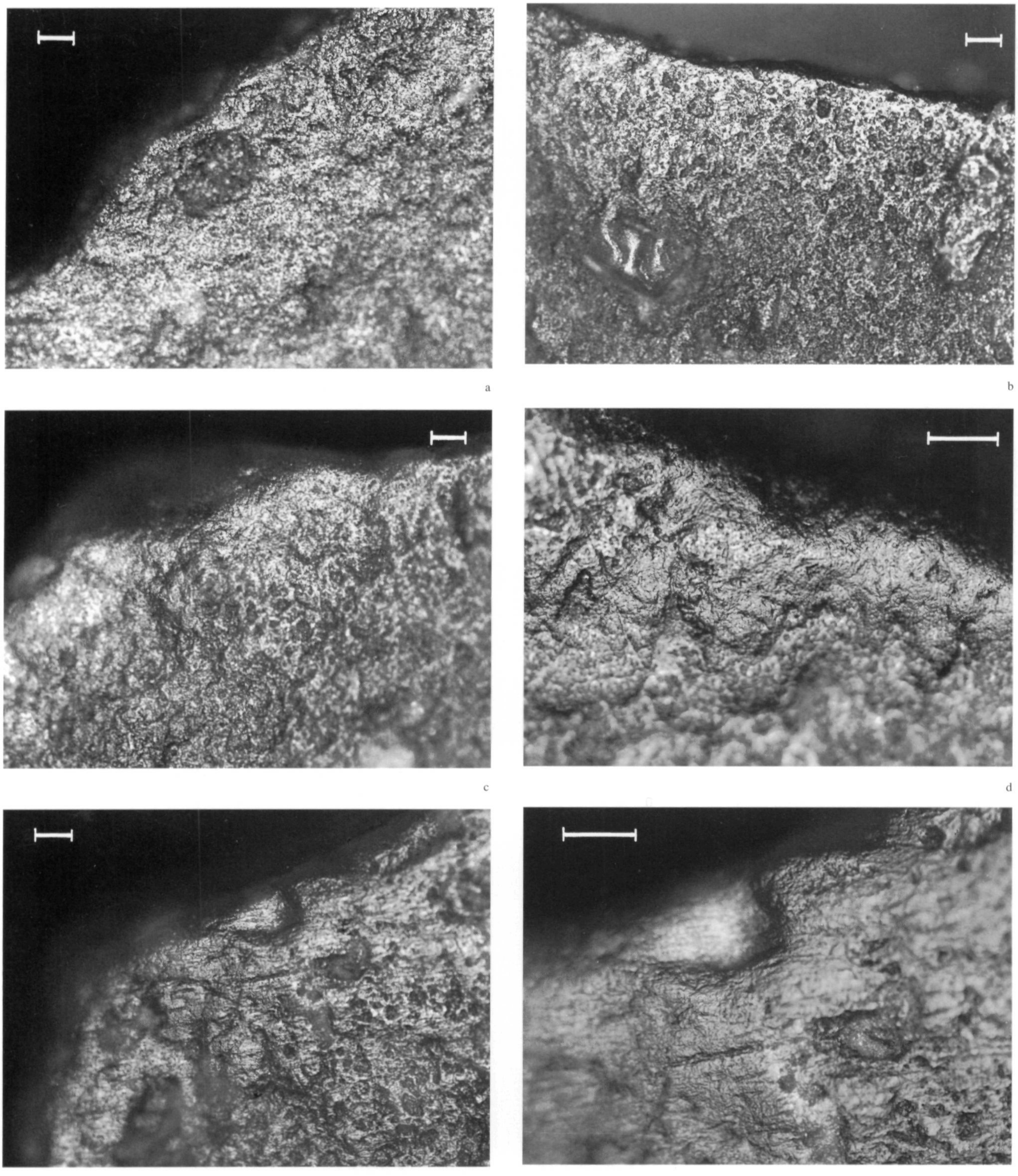


Figure 7. Maastricht-Klinkers: micrographs of observed wear-traces from hide working. All bars equal 50 μ. a) scraping fresh hide (artifact nr. 14, 150×), b) scraping hide (artifact nr. 201, 150×), c) scraping hide (artifact nr. 312, 150×), d) scraping hide (artifact nr. 423, 300×), e) boring hide (artifact nr. 126, 150×), f) boring hide (same artifact, 300×).

Table 8. Maastricht-Klinkers: motion versus worked material inferred by used edges.

	longitudinal	transverse	carving	boring	piercing	chopping	wedging	pounding	milling	hoeing	unsure	total
meat	1	-	-	-	-	-	-	-	-	-	-	1
hide	42	53	2	2	-	-	-	-	-	-	7	106
meat/bone	1	-	-	-	-	-	-	-	-	-	-	1
bone	2	2	-	-	1	-	-	-	-	-	-	5
antler	1	-	-	-	-	-	-	-	-	-	-	1
silicious plant	12	3	-	-	-	-	-	-	-	-	-	15
non-silicious plant	-	1	-	-	-	-	-	-	-	-	-	1
wood	17	17	-	-	-	-	1	-	-	-	1	36
'23'	-	3	-	-	-	-	-	-	-	-	-	3
'10'	24	13	-	-	-	-	-	-	-	-	2	39
stone	-	1	-	-	-	-	-	-	-	-	-	1
soil	-	-	-	-	-	-	-	-	-	1	-	1
soft animal	-	1	-	-	-	-	-	-	-	-	-	1
medium animal	1	2	-	-	-	-	-	-	-	-	-	3
hard animal	-	-	1	-	-	-	-	-	-	-	-	1
medium vegetal	2	2	-	-	-	-	-	-	-	-	-	4
hard vegetal	1	-	-	-	-	-	3	-	-	-	-	4
soft inorganic	-	-	-	1	-	-	-	-	-	-	-	1
hard inorganic	-	-	-	-	-	-	-	1	-	-	-	1
soft unknown	2	5	-	-	-	-	-	-	-	-	2	9
medium unknown	5	6	1	-	-	-	3	-	-	-	3	18
hard unknown	1	3	-	-	1	1	-	-	-	-	-	6
unknown	2	6	1	-	-	2	1	-	1	-	4	17
total	114	118	5	3	2	3	8	1	1	1	19	275

(76.4%) the contact material could be determined exactly (hide, bone etc.) (see tab. 8). On 15 used edges it was merely possible to give an indication of the character (plant, animal or mineral) and hardness (soft, medium or hard) of the contact material. On 33 used edges only the hardness could be determined and on 17 the contact material could not be specified.

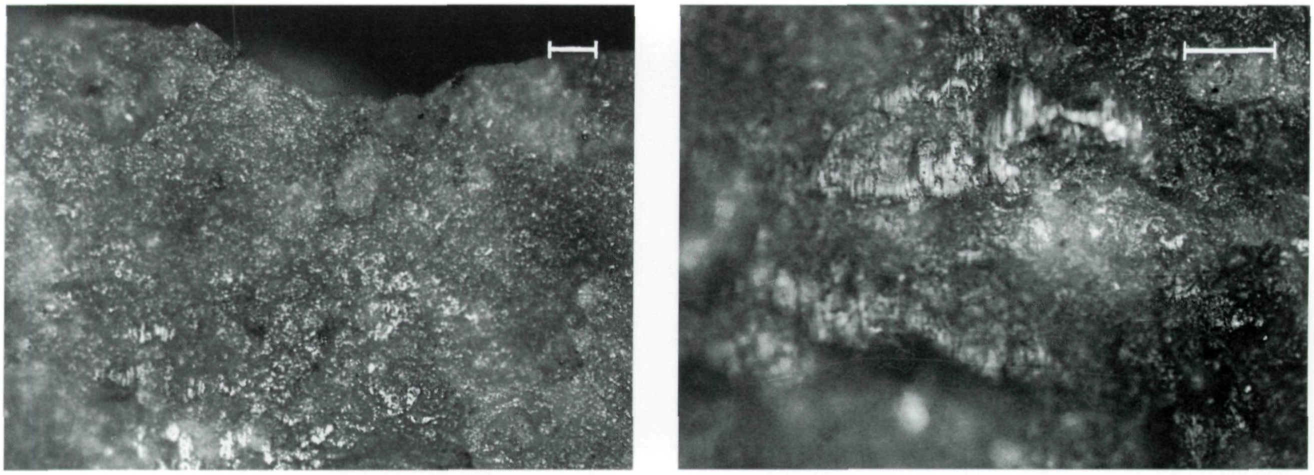
In the following pages the activities which were executed will be discussed. The treatment of animal, plant, mineral and unknown materials will be drawn on. The characteristics of the wear traces will only be summarily described. For further information concerning the appearance of various wear traces the reader is referred to Keeley (1980), Van Gijn (1990), Odell and Odell-Vereecken (1980) and Shea (1991).

5.2.1. Animal materials

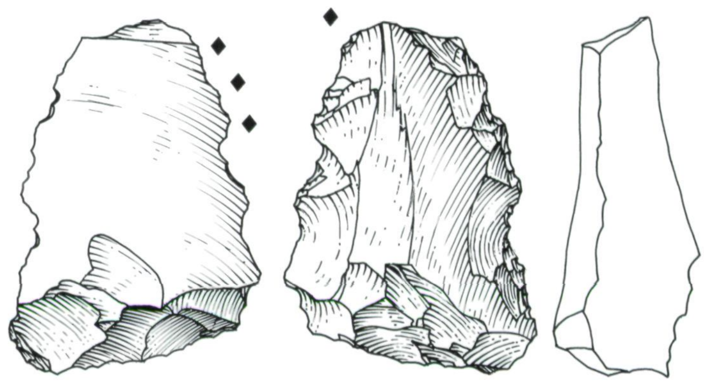
Hideworking

Wear traces indicating the working of hide have been encountered on 106 used edges, 38.5% of the total number of used edges. Characteristic traces of wear include a severely rounded edge and a well-defined band of polish; the polish is either matt or quite bright and displays a cratered topography (fig. 7). Striations are frequently visible within the band of polish. A total of 53 used edges have been employed in a scraping movement, 42 for cutting, two for boring and two for carving hide (tab. 8).

Relatively little is known about the process of hide treatment in prehistoric times: the trajectory from skinning an animal up to the production of a finished product. Despite of the fact that ethnographic research (a.o. Witthoft 1958), historical investigations (Stambolov 1969) and experimental approaches have clarified the various stages of hide working and the possibilities for treatment, it has turned out to be difficult to correlate these to the archaeological context. The use wear analysis provides us with indications about the role of flint artifacts in the process of hide working. The character of the wear traces could suggest the state of the hide at the time of treatment (however, see Unrath *et al.* 1986). A greasy, bright polish indicates the treatment of fresh or wet hides (fig. 7a). At Maastricht-Klinkers this type of wear has been encountered on 12 used edges. The large majority (N = 94), however, displays a rough, cratered polish with numerous striations (figs 7b-f). This type of wear would indicate the treatment of dryer hides. The large number of striations on some of the used



a b



c

Figure 8. Maastricht-Klinkers: micrographs of traces from scraping bone. All bars equal 50 μ. a) artifact nr. 413 (150×), b) same artifact (300×), c) retouched flake used for scraping bone ♦ (nr. 413). Scale 2:3.

edges could either be the result of the addition of a coloring or conservation agent, such as ochre or ashes, to the presence of additives used for absorbing grease such as dust or sand, or else to dirt adhering to the skin during its treatment.

Fresh hide working turns out te be a rare occurrence at Maastricht-Klinkers. For the most part dry hides have been worked, possibly representing the currying stage of the hide working process. Traces from cutting, carving and boring hide can be associated with the subsequent modifications of the hide into end-products such as clothing, site furniture and so forth.

Bone and antler working

Traces from working bone are present on four used edges. Two edges were used for cutting or sawing. The resulting use retouch consists mainly of a continuous row of edge removals, most of them with a hinged termination. The polish is distributed in isolated spots, it is very bright, highly reflective and quite rough (figs 8a, b). Two edges, located on the same serrated flake (fig. 8c), were used for scraping bone. The resulting polish is smoother and edge removals occur less frequently than on cutting and sawing implements. One point displays traces from bone as well, indicating that the implement had been used as a projectile, contacting bone during its trajectory.

Only one artifact exhibits traces which are attributable to antler working; the motion in which this particular artifact was used is either sawing or carving. The traces consist of isolated spots of a bright, flat, pitted polish as well as edge removals. Last, one combination tool displays traces suggesting the carving of animal material; in this case the attributes of the wear traces do not allow a further specification of the worked material.

Meat cutting and butchering tools

The lateral edge of a long end-scraper has been used to cut meat. Possibly, two blades were also employed for cutting meat: they show traces attributable to contact with a soft or medium-hard animal material. Traces from cutting meat only develop very slowly (Anderson-Gerfaud 1981; Van Gijn 1990; Vaughan 1985): the visible wear traces consist of a band of rough, greasy polish and, incidentally, very small feather-terminated edge removals. These traces develop more rapidly on fine than on coarse-grained flint and become invisible after only slight alterations of the flint surface. The number of artifacts in a prehistoric assemblage displaying wear attributable to contact with meat is therefore small and cannot be considered representative of the original number of implements used in this activity (see Van den Dries/Van Gijn in press for percentages).

Butchering traces have been encountered only once, on a blade: meat polish is visible, alongside traces indicative of contact with bone[29].

5.2.2. *Plant materials*

Silicious plants

Use wear traces related to the harvesting of cereals or the cutting and processing of silicious plants as reed, wild grasses and sedges, have been encountered on a total of 15 used edges (5.5 %). On two artifacts the gloss can even be discerned with the naked eye.

A considerable variation in the character of the wear traces can be noted (fig. 9). Three varieties can be distinguished. First, a polish which is very similar to the type encountered on the sickle fragments from Linearband-keramik context (Van Gijn 1990): the gloss has a very rough and cratered appearance, is very bright and distributed in a band (figs 9a, b). The polished surface is scarred by numerous striations. The use retouch measures between one and two mm in width and, generally speaking, has a feather termination. A second variety concerns a polish with a somewhat smoother appearance, displaying considerably less striations (figs 9e, f). The third type is characterized by a polish with a more confined distribution and a very rough micro-surface (figs 9c, d); these traces show considerable resemblance to the ones referred to as unknown material '10' (see below).

Experiments with the harvesting of cereals such as emmer, barley and breadwheat, generally produce a well-defined band of highly reflective polish with very few striations (Van Gijn 1990; Juel Jensen 1988). Juel Jensen (1988) has hypothesized that the large amount of striations on the archaeological sickle blades could be due to contact with the weeds growing among the cereal stems. Samples from Linearbandkeramik context show charred remains of weeds to be present among the charred grains (emmer, einkorn), an observation supporting the hypothesis of Juel Jensen (Bakels/Rousselle 1985). However, it turns out from experiments with harvesting cereals with interspersed weeds that the striations only appear after a considerable period of use (Van Gijn 1990)[30]. Remarkably enough, contrary to these experimental findings, the implements from Maastricht-Klinkers display numerous striations, even though they were apparently only lightly used. Unfortunately, very little is known about the character of the crops grown during the Michelsberg-period. It is still unclear what determines the diversity in use wear traces: the species of cereals, the presence of weeds or the manner of working.

Non-silicious plant

Only one flake has been used on non-silicious plants. The polish is, contrary to the highly reflective polish resulting from contact with silicious plants, rather matt and smooth. Edge removals are virtually absent. It is unlikely that the contact material concerns roots or tubers, but it is as yet impossible to infer the exact character of the plant in question.

Wood working

Traces from the working of wood have been encountered on 36 used edges (13.1%). Contact with wood causes the development of a smooth, bright polish with a domed topography; moving away from the used edge the density of the polish gradually diminishes (fig. 10). The edges display slight rounding and edge removals.

The majority of the activities demonstrated, can be considered as light wood working: cutting or sawing (N = 17) (fig. 10a, b) and scraping or shaving (N = 17) (figs 10c, d). Heavy wood working such as the felling and splitting of trees is not well represented. Only one implement could be interpreted as a wood splitting tool. Chopping tools with wood working traces are lacking, but it should be stressed that the wear traces which develop from heavy wood working activities are almost entirely confined to edge removals. Polish is encountered only sporadically, and is often not sufficiently diagnostic to allow an interpretation. The contact material will, in those cases, be interpreted as hard vegetal or hard unknown. This, among others, pertains to some splintered pieces displaying extensive edge damage: they can, with a high degree of probability, be considered as implements used for heavy wood working.

Non-specified plant material

Four used edges have been employed for the treatment of medium-hard plant material, four for hard plant materials. The character of the contact material could not be specified further.

5.2.3. *Inorganic materials, stone- and soil working*

One flake has been used to scrape a (soft) stone. The polish consists of flat, matt streaks with a very clear directionality, virtually excluding the possibility that the traces are due to natural causes. One borer should, most

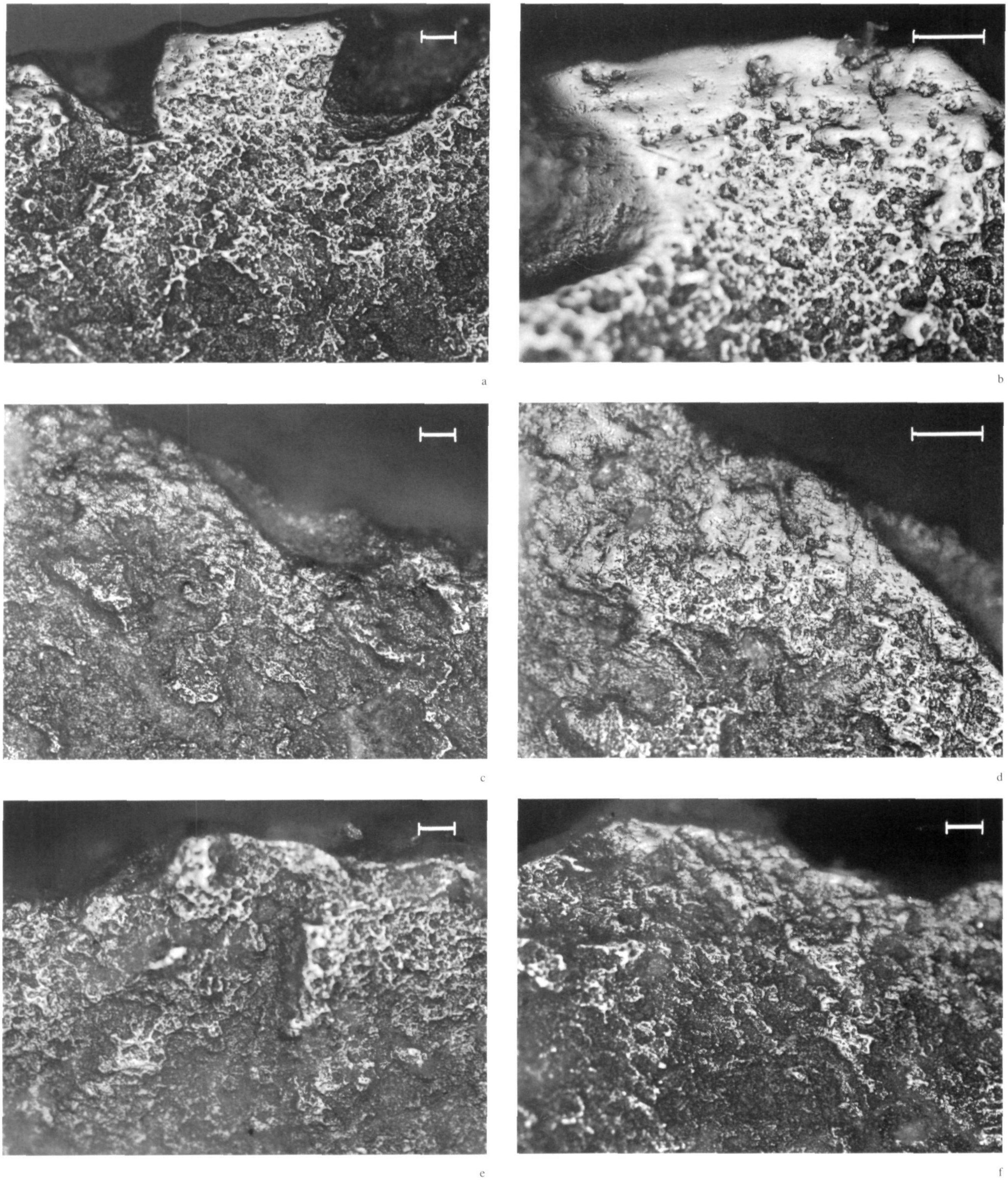


Figure 9. Maastricht-Klinkers: micrographs of traces from cutting silicious plants. Typical sickle gloss as observed on LBK tools a) artifact nr. 196 (150×), b) same artifact (300×), c) less spread, rougher polish on artifact nr. 417 (150×), d) same artifact (300×), e) smoother polish with less striations on artifact nr. 245 (150×), f) smoother polish with less striations on artifact nr. 198 (150×). All bars equal 50 μ.

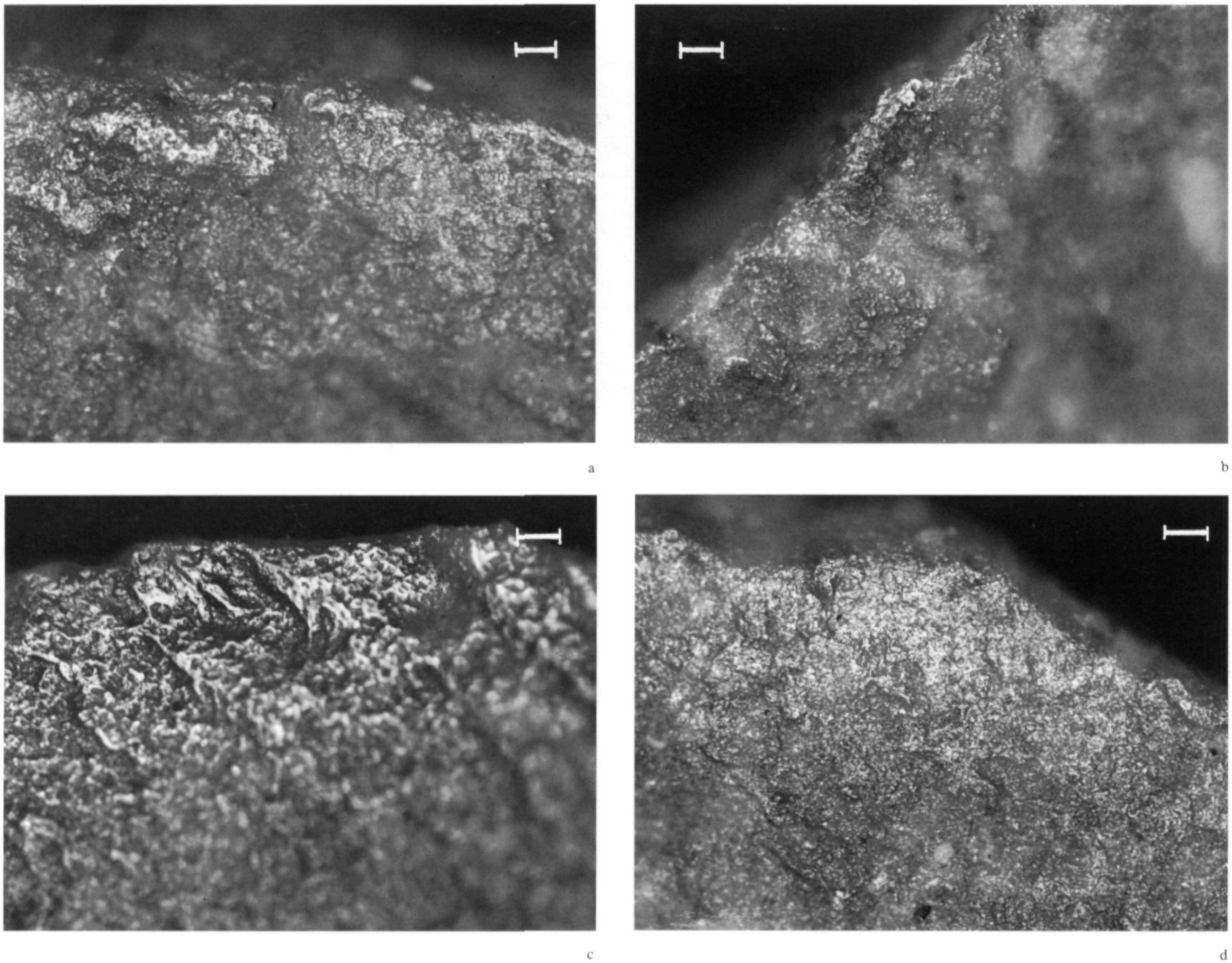


Figure 10. Maastricht-Klinkers: micrographs of traces interpreted as being from contact with wood. All bars equal 50 μ. a) longitudinal motion artifact nr. 418 (150×), b) longitudinal motion artifact nr. 308 (150×), c) transverse motion artifact nr. 416 (150×), d) wood planing artifact nr. 75 (150×).

likely, been interpreted as having been used to bore a soft stone; however, this is an uncertain interpretation because this implement shows light traces of burning. One block has been employed as a pounding tool on hard inorganic material, most probably stone.

Wear traces resembling those resulting from the working of soil (fig. 11a) (Van Gijn 1988) have been noted on one bifacially retouched implement whose shape resembles an axe (fig. 11b). The polish is most intensive on the ridges of the flake scars and the least visible on the end opposite the cutting edge of the tool. Numerous striations, oriented perpendicular to the cutting edge, are present in the polish. The totality of the wear traces suggests the tool was used as a hoe.

5.2.4. Unknown material

Material '10'

A total of 39 used edges (14.2%) display a bright, cratered, rough polish which is distributed in a band (fig. 12). At the more elevated parts of the surface the polish has a more flat, smooth and almost fluid appearance (figs 12e, f). Within the polished area numerous striations can be discerned (figs 12a-d). Edge removals vary in size from one to two mm; most frequently they display a feathered or hinged termination. They are bifacially located, and distributed in a continuous or clustered fashion. Generally, the edge displays considerable rounding.

This particular combination of wear traces is not homogeneous but shows considerable internal variability; it

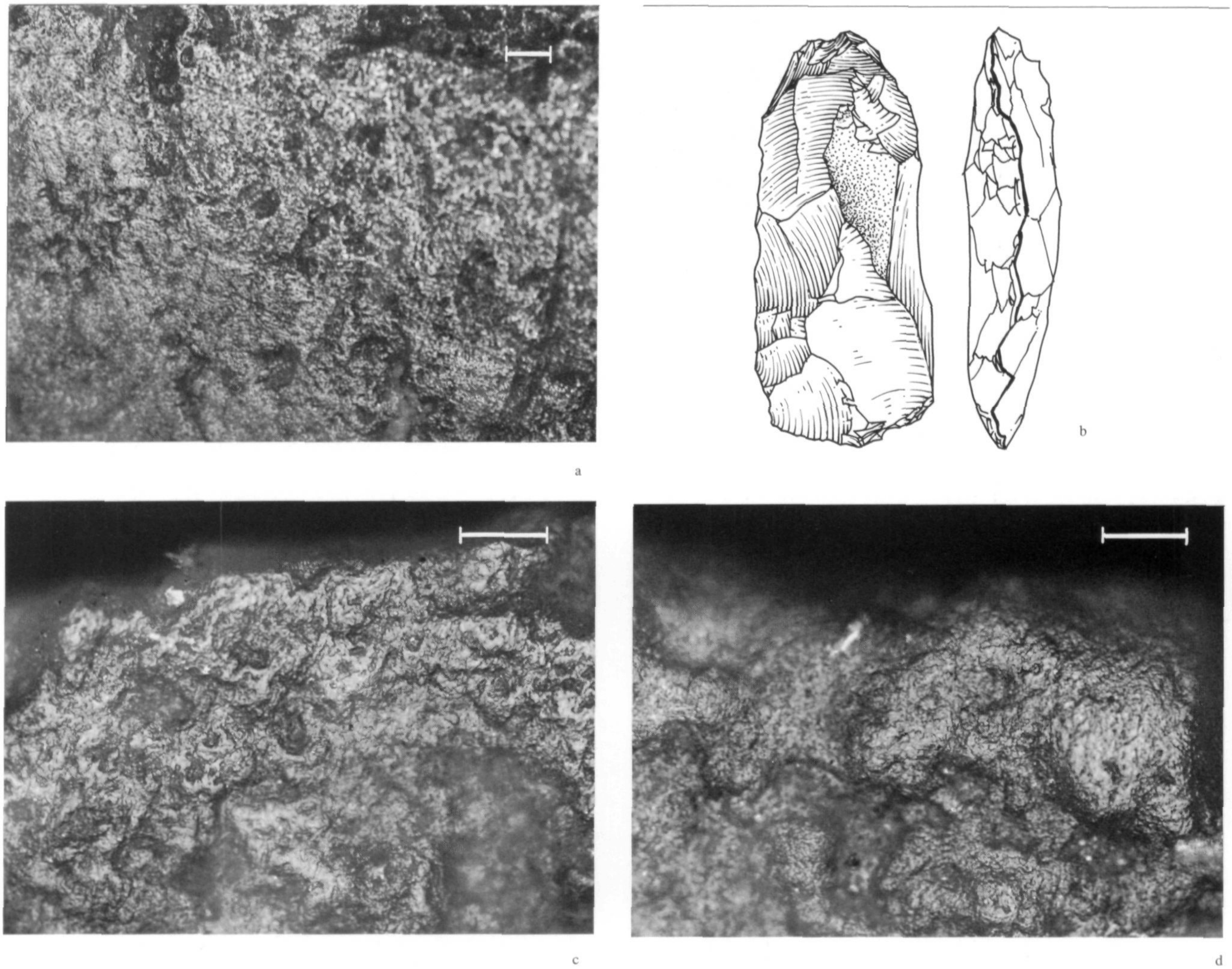


Figure 11. Maastricht-Klinkers: micrographs of hoeing-traces and polish '23'. All bars equal 50 μ. a) hoeing traces (150×) seen on bifacially retouched tool (nr. 214), b) bifacially retouched tool (nr. 214) probably hafted and used as a hoe (scale 2:3), c) polish '23', smooth polish on the dorsal side of artifact nr. 262 (300×), d) polish '23', rough, cratered polish on the ventral side of artifact nr. 262 (300×).

still has to be experimentally replicated. This implies that the contact material is unknown at present. The character of the wear traces is most similar to traces from plant materials. Especially the traces from silicious plants display a number of similarities to polish '10', although the the intensity of the polish and the amount of striations differ. Possibly, the activity responsible for polish '10' is the harvesting and processing of plants for the manufacture of fibres. Another possiblity is the processing of hides. The considerable rounding of the edge, the striations and the intensity of the polish also result from working hide.

As to the motion, both transverse (N = 13) (figs 12c-f) and longitudinal (N = 24) (figs 12a, b) directions have been encountered, which would indicate that the same material has been treated in different ways.

This type of wear traces has not only been noted for Maastricht-Klinkers, but also on the Michelsberg site of Koslar 10 (Germany), the coastal sites of Brandwijk-Het Kerkhof and the Hazendonk (both dating to Hazendonk phase 2 and 3) (Van Gijn, pers. comm.), and on several Chasséen sites in France. Until recently this type of wear traces had never been found on tools from other archaeological periods, but re-examination of some Linearbandkeramik artifacts from Elsloo revealed their presence here as well (Van Gijn, pers. comm.). It appears therefore that material '10' is not exclusively linked with the Michelsberg culture or to middle-neolithic cultures in general.

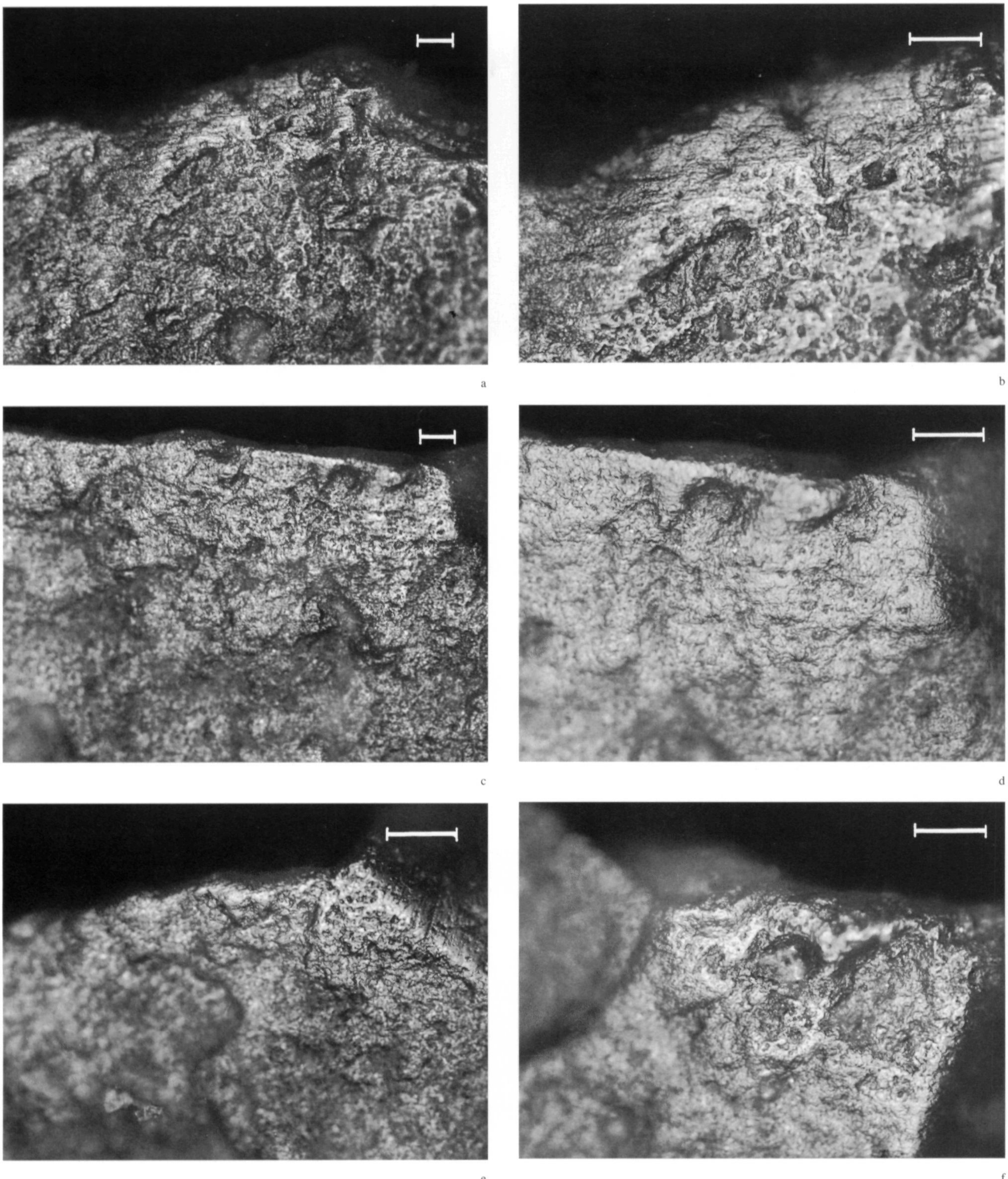


Figure 12. Maastricht-Klinkers: micrographs of traces of material '10'. All bars equal 50 µ. Longitudinal motion, rough and cratered polish a) seen on artifact nr. 124 (150×), b) same artifact (300×), c) transverse motion, rough and cratered polish seen on artifact nr. 165 (150×), d) same artifact (300×), e) transverse motion, fluid appearance seen on artifact nr. 49 (300×), f) transverse motion, fluid appearance seen on artifact nr. 165 (300×).

Material '23'

Material '23' (Van Gijn 1990) has been found on three used edges, all three employed in a transverse motion. Just as is the case with polish '10', polish '23' concerns a combination of wear traces whose origin is still unknown. Highly characteristic is the fact that both aspects of the used edge display entirely different traces. One aspect shows a smooth, highly reflective polish (fig. 11c), whereas the opposite aspect displays a rough, matt polish with numerous striations (fig. 11d). The distribution of the traces is limited to a length of 1.5 to 2.5 cm along the used edge. This would indicate the width of the contact material or the width of contact with the tool. Keeley (1977, 71) supposes that the traces are caused by the dehairing of hides with the addition of mud or by treatment with a damp plant-based compound (Sliva/Keeley 1994). However, in view of the limited extent of the wear traces, Van Gijn (1990, 86) considers treatment of thin branches of, for instance, brambles a more likely explanation.

5.2.5. Indeterminable traces

For 33 used edges it was impossible to infer the exact character of the contact material. Nine edges were used on a soft material, 18 on matter of medium hardness, and six on a hard substance. The hardness of the contact material could not be determined for the remaining 17 worked edges, but the wear present definetely indicated that they had been used.

5.3. THE RELATIONSHIP BETWEEN MORPHOLOGY AND FUNCTION OF ARTIFACTS

Typological descriptions of flint assemblages usually differentiate between tools and (production) waste. Use wear analysis has made clear that not only the tools, but also a considerable amount of waste has been intentionally used. With respect to the tools from Maastricht-Klinkers analysed in this study, it could be noted that 80% of them displays traces of use, compared to 53% of the waste. The tools can be further subdivided into specifically modified artifacts (point, pointed blade, borer, scraper, combination tool, *quartier d'orange*, axe, and bifacially retouched tool), versus the other modified implements which are not specifically retouched. It appears that this subdivision is meaningful in terms of the frequency of use: the specifically modified artifacts almost all display wear traces (92%), whereas only 68% of the remaining modified artifacts show such traces.

The typological reference of many of the specifically shaped prehistoric artifact categories, such as scraper, borer and axe, was made on the basis of formal analogies with modern artifact types. However, use wear analysis (Juel Jensen 1988) and ethnographic research (a.o. Odell 1981; White *et al.* 1977) indicates that artifacts which can be differentiated on the basis of morphological criteria, do not necessarily differ in terms of their function. The extent to which morphology and function correlate, differs for each period or archaeological culture, as well as for artifact category. With respect to the Michelsberg culture, this aspect is not yet fully known, because only a limited number of artifacts has so far been analysed for traces of use (Van der Beken 1985; Bienenfeld 1986).

In the following, the artifacts from Maastricht-Klinkers will be discussed in terms of their morphology and function. The morphological features of the edges will be examined first. Subsequently, the functional homogeneity of the different artifact categories will be dealt with, using a selection of categories as an illustration. Last, the presence or absence of traces of hafting, the number of used edges, and the intensity of use, will be compared between the various artifact categories.

5.3.1. Features of the individual used edges

The shape of the edge determines to a large extent the use to which an artifact is put (*cf.* Van Gijn 1990; Moss 1986). From previous analyses, it appears that, regardless the archaeological culture the assemblage belongs to, edges with a straight or regular frontal aspect are more frequently selected for use. Consequently, in the present study this morphological feature served as a selective criterium for incorporating an implement into the sample to be examined for wear traces. Artifacts with a straight frontal aspect and a regular shape when seen from above display the largest variability in applied function (Van Gijn 1990). Implements with an overhanging or convex shape are most suitable for transverse motions, whereas those with a straight or concave edge are best for cutting purposes.

Edge angle

Some authors have shown that the edge angle[31] could be an indication for specific activities (Broadbent/Knutsson 1975; Tainter 1979; Wilmsen 1968). The present research also reveals that there is indeed a relation between the angle of an edge and both the motion to which it is put (tab. 9) and the contact material (tab. 10)[32].

Longitudinal motions have for the most part been carried out with edge angles of 25-60° (mode 35-40°). This is significantly different ($X^2 = 76.073$, df = 8, p = 0.000[33]) from edges used for transverse motions. For the most part the latter display edges with an angle between 35-80° (mode = 65-70°). Carving, pounding, and hoeing implements, as well as wedges, usually possess a rather obtusely angled working edge of 55-90°.

Edge angles differ significantly with respect to the type of contact material worked[34]. For the working of silicious plants (figs 13a-c) and material '10' edges with an angle of

Table 9. Maastricht-Klinkers: edge-angle, divided into classes, versus motion.

	25-30°	35-40°	45-50°	55-60°	65-70°	75-80°	85-90°	95-100°	105-110°	total
longitudinal	18	42	25	10	6	1	1	2	-	105
transverse	2	11	17	21	29	20	9	3	1	113
carving	-	-	-	-	3	-	-	-	-	3
chopping	-	-	-	-	2	1	-	-	-	3
wedging	-	-	-	2	4	1	1	-	-	8
hoeing	-	-	-	-	1	-	-	-	-	1
total	20	53	42	33	45	23	11	5	1	233

Table 10. Maastricht-Klinkers: edge-angle, divided into classes, versus worked material.

	25-30°	35-40°	45-50°	55-60°	65-70°	75-80°	85-90°	95-100°	105-110°	total
meat	-	-	-	1	-	-	-	-	-	1
hide	6	13	17	13	24	16	5	4	1	99
bone	-	1	1	2	-	-	-	-	-	4
meat/bone	-	1	-	-	-	-	-	-	-	1
antler	-	-	-	1	-	-	-	-	-	1
silicious plant	-	11	2	-	1	-	-	-	-	14
non-silicious plant	-	-	1	-	-	-	-	-	-	1
wood	10	7	8	4	4	1	1	1	-	36
'23'	-	1	1	-	1	-	-	-	-	3
'10'	-	14	11	6	1	1	-	-	-	33
stone	-	-	-	-	-	-	1	-	-	1
soil	-	-	-	-	1	-	-	-	-	1
total	16	48	41	27	32	18	7	5	1	195

Table 11. Maastricht-Klinkers: worked material and motion versus retouch inferred by used edges.

	longitudinal		transverse		carving		boring		piercing		wedging		hoeing		unsure		total
	n	y	n	y	n	y	n	y	n	y	n	y	n	y	n	y	
meat	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
hide	19	23	9	44	2	-	-	2	-	-	-	-	-	-	2	5	106
bone	-	2	-	2	-	-	-	-	-	1	-	-	-	-	-	-	5
meat/bone	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
antler	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
silicious plant	4	8	1	2	-	-	-	-	-	-	-	-	-	-	-	-	15
non-silicious plant	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
wood	15	2	10	7	-	-	-	-	-	-	1	-	-	-	1	-	36
'23'	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
'10'	13	11	9	4	-	-	-	-	-	-	-	-	-	-	1	1	39
stone	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
soil	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
total	52	48	34	59	2	0	0	2	0	1	1	0	0	1	4	6	210

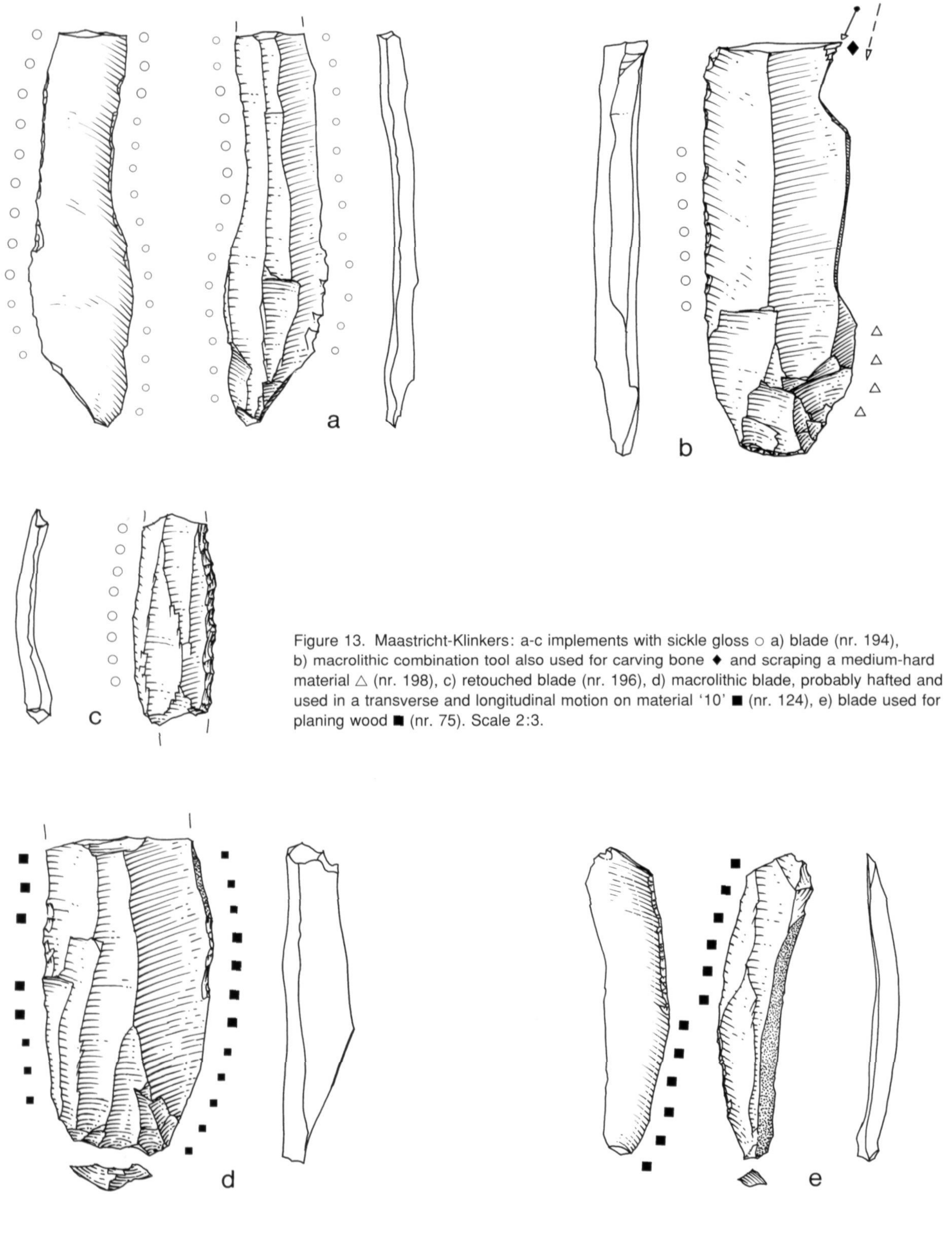


Figure 13. Maastricht-Klinkers: a-c implements with sickle gloss ○ a) blade (nr. 194), b) macrolithic combination tool also used for carving bone ♦ and scraping a medium-hard material △ (nr. 198), c) retouched blade (nr. 196), d) macrolithic blade, probably hafted and used in a transverse and longitudinal motion on material '10' ■ (nr. 124), e) blade used for planing wood ■ (nr. 75). Scale 2:3.

35° or 40° seem to have been preferred. Implements used for the treatment of hides show the largest variation in edge angle: the mode lies around 65-70°, and is determined by the predominant representation of scrapers. For slicing hides edges were selected which had angles between 40° and 45°. The implements used for working wood generally display a more acute edge angle (for the most part 25-50°, mode 25-30°)[35].

To conclude, it can be noted that, despite significant differences in terms of motions and contact materials, a considerable overlap exists: edges displaying an angle between 35° and 50° have been used for various contact materials. Edges with an angle of 65° and 70° were employed in a variety of motions. We therefore have to be careful to attribute a specific function to an implement, solely on the basis of its edge angle (contra Tainter 1979).

Retouch

An edge can be further modified and adapted to its future use by applying intentional retouch. It was possible to reveal a relationship between the presence of intentional retouch and contact material. Bone, meat, antler and soil have only been worked with modified working edges (see tab. 11). In contrast, wear traces from the contact with soft non-silicious plant, material '23', stone and butchering have only been noted on unretouched edges. The remaining contact materials have been worked with both retouched and unretouched edges but nevertheless significant differences still exist ($X^2 = 26.428$, df = 3, $\alpha = 0.000$). Edges used on hide (E = 58.9, O = 74) and on silicious plants (E = 8.3, O = 10) have been retouched more frequently than expected. In contrast, wood (E = 16, O = 27) and material '10' (E = 17.3, O = 23) have been worked more often with unretouched edges.

5.3.2. The functional homogeneity of artifact categories

Tables 12 and 13 display, per artifact category, the inferred contact material and motion respectively. In the following, the functional homogeneity of the various artifact categories which were differentiated in this study will be discussed.

In order to facilitate a comparison between the different artifact categories, it was necessary to standardize the variables in which these categories could vary. For this purpose the diversity has been determined for each artifact category, making use of the notions of richness, evenness and heterogeneity (Bobrowski/Ball 1989). The term richness (Hurlbert 1971) refers to the number of different contact materials and motions. Evenness provides an indication of the distribution of working edges across the different contact materials and motions. The concept of heretogeneity is a combination of richness and evenness as expressed in one value (Peet 1974)[36]. These three indices will first be discussed for contact materials and subsequently for the motion executed.

Scrapers, retouched blades, blades and flakes display the highest richness with five different contact materials each[37]. Points, *quartiers d'orange*, serrated flakes and bifacially retouched tools display the lowest richness. These categories were used for working one specific contact material[38]. Artifact categories with the highest evenness[39] (i.e. artifacts which have been used to a similar extent for the working of different contact materials) are retouched core rejuvenation pieces, retouched flakes, combination tools and pointed blades. Scrapers display the lowest evenness (tab. 14) and are therefore most specific in terms of the contact material which was worked with them. The majority of the artifact categories shows a rather high heterogeneity[40], which implies that they have been used for working a diversity of contact materials. Retouched blades and combination tools are the most heterogeneous tool classes[41]. In contrast, scrapers display a much lower heterogeneity because they have primarily been used for one contact material.

The richness of motions executed is rather small (tab. 15). Artifact categories represented with ten or more used edges are (with the exception of the retouched blades) employed for three different motions. It appears from the evenness index that retouched flakes and retouched core rejuvenation pieces have been put to a variety of motions. In contrast, scrapers and retouched blades are the most specific in terms of applied motion. The heterogeneity indices display a rather large diversity in terms of excecuted motions across the various artifact categories. Retouched flakes turn out to be the most versatile.

From these diversity indices it can be concluded that scrapers are the most function specific. From the wear trace analysis it appears that this general tool type is strongly associated with the treatment of hides. Incidentally, they have also been used for cutting or scraping silicious plants or material '10' and to cut antler and meat. Remarkably enough, it was possbile to demonstrate differences in applied use between the different types of scrapers.
A number of types[42], for the most part with only one used edge, have only been used for scraping hide (fig. 5a).
On the other hand, scrapers with retouched lateral edges (fig. 5b) have also been employed on other materials and according to various motions; these scrapers regularly possess three or four used edges[43].

Borers, axes and points appear to be function specific as well. However, it concerns rather small numbers which makes it difficult to draw definite conclusions. The points are most probably been employed as projectile only.
No evidence was found for other functions such as for sawing, boring or cutting (Cahen *et al.* 1986; Odell 1988).

Table 12. Maastricht-Klinkers: artefact categories versus worked material inferred by used edges.

						plant						
	meat	hide	meat/bone	bone	antler	silicious	non-sil	wood	'23'	'10'	stone	soil
point	-	-	-	1	-	-	-	-	-	-	-	-
pointed retouched blade	-	12	-	-	-	2	-	-	-	4	-	-
scraper	1	61	-	-	1	3	-	-	-	3	-	-
borer	-	-	-	-	-	-	-	-	-	-	-	-
combination tool	-	3	-	-	-	1	-	2	-	-	-	-
retouched blade	-	8	-	2	-	9	-	5	-	16	-	-
notched blade	-	-	-	-	-	-	-	-	-	-	-	-
retouched flake	-	5	-	-	-	-	-	2	-	-	-	-
denticulated flake	-	-	-	2	-	-	-	-	-	-	-	-
truncated flake	-	-	-	-	-	-	-	-	-	-	-	-
retouched block	-	2	-	-	-	-	-	-	-	-	-	-
retouched core rej. flake	-	2	-	-	-	-	-	2	-	-	-	-
bifacial retouched tool	-	-	-	-	-	-	-	-	-	-	-	1
splintered/bifacial ret.piece	-	-	-	-	-	-	-	-	-	-	-	-
quartier d'orange	-	-	-	-	-	-	-	-	-	2	-	-
axe	-	-	-	-	-	-	-	-	-	-	-	-
blade	-	10	1	-	-	-	-	16	3	9	-	-
flake	-	3	-	-	-	-	1	9	-	5	1	-
block	-	-	-	-	-	-	-	-	-	-	-	-
total	1	106	1	5	1	15	1	36	3	39	1	1

	animal			vegetal		inorganic		unsure				
	soft	medium	hard	medium	hard	soft	hard	soft	medium	hard	unsure	total
point	-	-	-	-	-	-	-	-	-	1	-	2
pointed retouched blade	-	-	-	-	-	-	-	-	1	-	-	19
scraper	-	2	-	1	-	-	-	1	-	1	2	76
borer	-	-	-	-	-	1	-	-	-	-	-	1
combination tool	-	-	1	-	-	-	-	-	1	-	2	10
retouched blade	-	-	-	-	-	-	-	-	4	2	4	50
notched blade	-	-	-	-	-	-	-	1	-	-	-	1
retouched flake	-	-	-	-	-	-	-	2	1	-	-	10
denticulated flake	-	-	-	-	-	-	-	-	-	-	-	2
truncated flake	-	-	-	1	-	-	-	-	-	-	-	1
retouched block	-	-	-	-	-	-	-	-	-	-	-	2
retouched core rej. flake	-	-	-	-	-	-	-	1	1	-	-	6
bifacial retouched tool	-	-	-	-	-	-	-	-	-	-	1	2
splintered/bifacial ret.piece	-	-	-	-	3	-	-	-	3	1	3	10
quartier d'orange	-	-	-	-	-	-	-	-	-	-	-	2
axe	-	-	-	-	-	-	-	-	-	-	1	1
blade	1	1	-	1	1	-	-	4	2	1	1	51
flake	-	-	-	1	-	-	-	-	5	-	2	27
block	-	-	-	-	-	-	1	-	-	-	1	2
total	1	3	1	4	4	1	1	9	18	6	17	275

Table 13. Maastricht-Klinkers: artefact categories versus inferred motion.

	longitudinal	transverse	carving	boring	piercing	chopping	wedging	pounding	milling	hoeing	unsure	total
point	-	-	-	-	2	-	-	-	-	-	-	2
pointed retouched blade	11	6	-	1	-	-	-	-	-	-	1	19
scraper	23	48	1	-	-	-	-	-	-	-	4	76
borer	-	-	-	1	-	-	-	-	-	-	-	1
combination tool	2	7	1	-	-	-	-	-	-	-	-	10
retouched blade	31	13	1	-	-	-	-	-	-	-	5	50
notched blade	1	-	-	-	-	-	-	-	-	-	-	1
retouched flake	4	6	-	-	-	-	-	-	-	-	-	10
denticulated flake	-	2	-	-	-	-	-	-	-	-	-	2
truncated flake	1	-	-	-	-	-	-	-	-	-	-	1
retouched block	1	-	-	1	-	-	-	-	-	-	-	2
retouched core rej.flake	1	4	-	-	-	-	-	-	-	-	1	6
bifacial retouched tool	-	-	-	-	-	-	-	-	-	1	1	2
splintered/bif. ret.piece	-	1	-	-	-	2	7	-	-	-	-	10
quartier d'orange	1	1	-	-	-	-	-	-	-	-	-	2
axe	-	-	-	-	-	1	-	-	-	-	-	1
blade	31	15	2	-	-	-	-	-	-	-	3	51
flake	7	15	-	-	-	-	1	-	-	-	4	27
block	-	-	-	-	-	-	-	1	1	-	-	2
total	114	118	5	3	2	3	8	1	1	1	19	275

Combination tools (figs 14a, b) and retouched flakes (fig. 14d) are the least function specific. Retouched flakes have mostly been used for scraping and cutting hide, as well as for the working of wood. It should be noted that not less than 67% (N = 12) of this artifact category lacks traces of use, whereas 89% of the retouched blades (figs 13d, e) displays wear traces. The number of retouched flakes without wear traces is remarkably high, considering the fact that they were, albeit marginally, retouched with the intention of putting them to use. One possible explanation could be the short use to which these artifacts were put. Another explanation may be that they were employed in activities which hardly leave recognizable traces of wear, such as working soft materials.

No significant differences in diversity could be demonstrated between specifically modified, not specifically modified and unmodified artifacts. With respect to the unmodified implements, it was determined whether those displaying wear traces with the naked eye (often referred to as 'used' artifacts in typological descriptions), indeed turned out to be used; it is possible that these forms of damage, usually consisting of edge removals, are the result of, for instance, post-depositional processes. It appeared that 74% (N = 20) of the 'used' blades display use wear traces, whereas 47% (N = 16) of the flakes show such traces. Remarkably enough, 60% (N = 9) of the blades with no macroscopically visible wear traces, were nevertheless used; this applied to only one 'unused' flake. It can be concluded that flakes and blades which, macroscopically seen, display damage, have indeed more frequently been used, than those implements which do not display macroscopic traces. Furthermore, blades have been used more frequently than flakes. Both categories show a broad range of executed activities and cannot be designated as function specific. Blades have for the most part been employed for cutting, whereas flakes were applied for scraping purposes. The activities which are represented most frequently on blades include sawing and scraping of wood, and the cutting or slicing of hides and unknown material '10'. Flakes, in contrast, have mostly been used for transverse motions, such as the planing of wood and the treatment of unknown material '10'.

Specifically modified artifacts such as pointed blades (figs 4e-h), highly characteristic of the Michelsberg culture, cannot be associated with only one activity and are therefore not function specific. Despite the fact that half of these artifacts have solely been used for the working of hides (cutting, scraping and boring), other activities have been carried out with these implements as well, such as the harvesting of silicious plants and the working of material '10'.

Diversity indices have not been calculated for splintered pieces or bifacially retouched artifacts, because the contact material is so difficult to interpret in these cases. The edge damage indicated contact with a hard or medium hard material, but polish has seldomly been found, making it

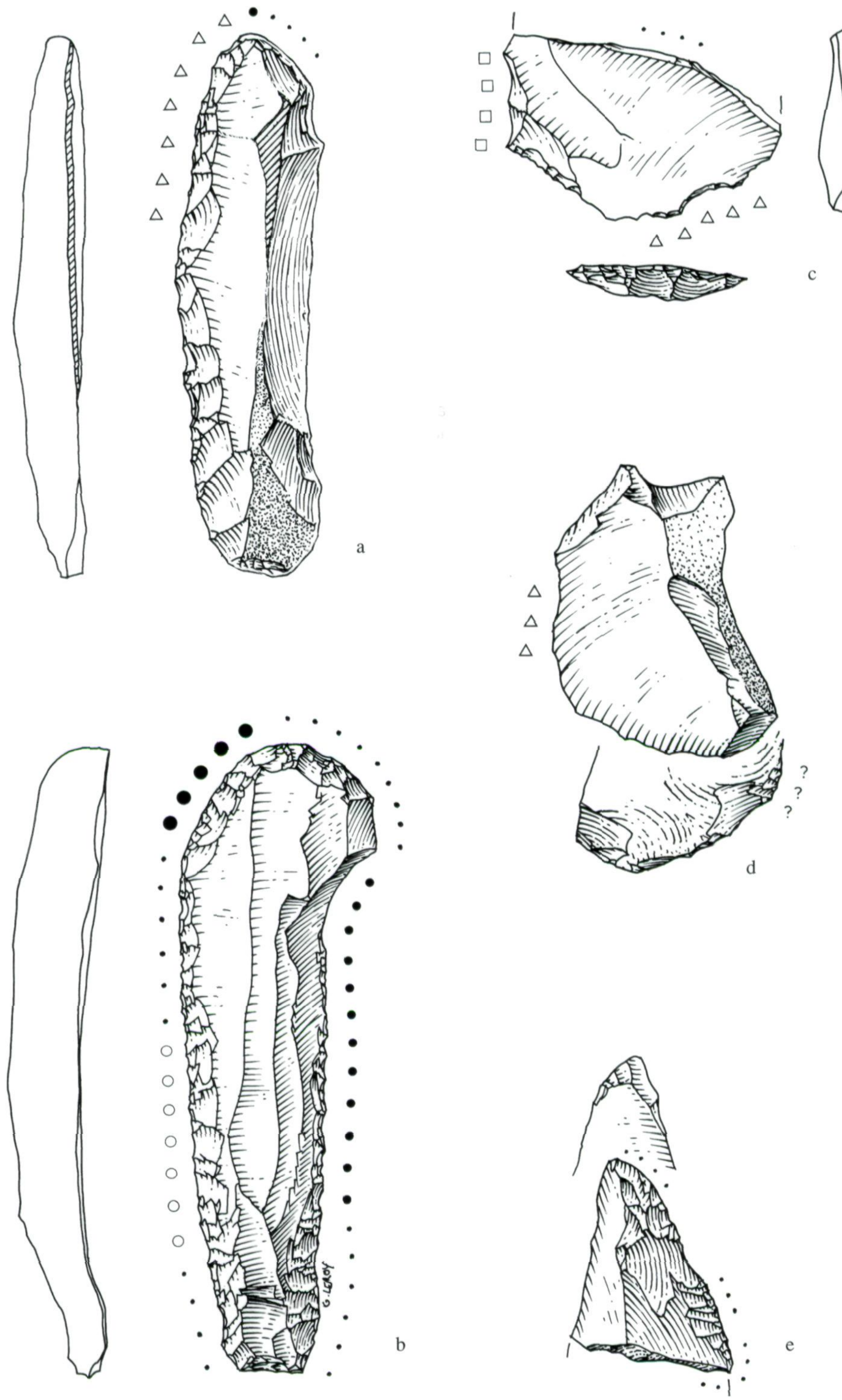


Figure 14. Maastricht-Klinkers:
a) combination-tool with polished fragments, used for cutting wood △ and scraping hide ● (nr. 418),
b) combination tool used as sickle knive ○ and hide scraper ● (nr. 4),
c) core rejuvenation platform used for scraping material '10' □, planing wood △ and cutting and scraping hide ● (nr. 231), d) flake with traces from a hard unknown material △ used for wedging (nr. 7),
e) retouched core rejuvenation piece used for boring and cutting hide ● (nr. 232). Scale 2:3.

Table 14. Maastricht-Klinkers: richness, evenness and heterogeneity indices for used edges and worked materials for each artefact category (indices have only been calculated for artefact categories containing four or more used edges).

	richness	evenness index	heterogeneity indices		
		Pielou	Shannon	Brillouin	Simpson
pointed retouched blade	3	1.6191	0.7725	0.7526	0.7407
scraper	5	0.4484	0.3134	0.2902	0.2678
combination tool	3	1.9295	0.9206	0.9099	0.9167
retouched blade	5	1.2744	0.8908	0.8859	0.9141
retouched flake	2	2.8672	0.8631	0.8307	0.8163
retouched core rejuvenation flake	2	3.3219	1.0000	1.0000	1.0000
blade	5	1.1949	0.8352	0.8292	0.8826
flake	5	1.1616	0.8119	0.7970	0.8449

Table 15. Maastricht-Klinkers: richness, evenness and heterogeneity indices for used edges and motion for each artefact category (indices have only been calculated for artefact categories containing five or more used edges).

	richness	evenness index	heterogeneity indices		
		Pielou	Shannon	Brillouin	Simpson
pointed retouched blade	3	1.5791	0.7534	0.7392	0.7685
scraper	3	1.3245	0.6319	0.6258	0.6800
combination tool	3	1.5297	0.7298	0.6923	0.6900
retouched blade	3	1.3356	0.6372	0.6270	0.6622
retouched flake	2	3.2256	0.9710	0.9670	0.9600
retouched core rejuvenation flake	2	2.3981	0.7219	0.6564	0.6400
splintered/bifacial retouched piece	3	1.5297	0.7298	0.6923	0.6900
blade	3	1.4848	0.7084	0.6986	0.7253
flake	3	1.4827	0.7074	0.6917	0.7202

impossible to make a more precise statement concerning the character of the contact material. These artifacts have mostly been used as wedges or hoes, suggesting that they were quite function specific.

The last artifact category which will be discussed in these terms is that of the hammerstones. Interestingly, hammerstones often constitute re-used artifacts. Seven out of ten such implements have been made on depleted cores or axe fragments. One has secundarily been used as core. The majority (90%) of the battered edges of hammerstones is indeed used as hammerstone; one was used as a pounding or hoeing implement. It is possible that re-use is related to the fact that no specific morphological pre-requisites were necessary for a function as hammerstone.

Last, some remarks must be made about the macrolithic artifacts, although they do not constitute a real typological category. Macrolithic artifacts form a regular occurrence in Michelsberg assemblages. One could suppose that artifacts of such a large size would have been used for specific purposes, for example as support for specific artifact categories and/or specific activities. The site Maastricht-Klinkers has yielded 31 macrolithic artifacts. These have for the most part been modified into scrapers (N = 10), retouched blades (N = 5), pointed blades (N = 3) and combination tools (N = 3). Only six blades and one flake have been left unmodified. It is clear that the artifact categories produced on these macrolithic supports vary considerably. Only the pointed blades seem to have been produced relatively frequently on macrolithic blades[44]. The contact materials which were worked with these artifacts varies as well: hide (N = 31), material '10' (N = 16), wood (N = 8) and silicious plants (N = 8). It can be concluded therefore that no specific uses could be demonstrated for the category of the macrolithic artifacts.

5.4. Hafting

Direct evidence for the practice of hafting implements, such as the presence of remnants of adhesives, binding materials, hafts or fittings, have not been encountered at Maastricht-Klinkers. However, there are three indirect indications which are suggestive of the former presence of a haft: wear traces, technological or morphological transformations, and breakage patterns.

First, wear trace analysis may provide indications about hafting (Cahen *et al.* 1979; Keeley 1982; Odell 1994). Traces which are interpreted as resulting from the former presence of a haft, such as friction gloss and clustered 'use retouch', have been noted on 26 artifacts (tab. 7). These traces have been observed most frequently on scrapers (N = 10)[45] and on retouched blades (N = 8). With respect to the unmodified implements, only four blades display hafting traces. It is remarkable that no evidence for hafting was seen on the sickle blades, in contrast to those from the Linearbandkeramik period (Cahen *et al.* 1986; Van Gijn 1990; Schreurs 1989).

The artifacts with traces of hafting have, on the average, 1.7 used edges. This is relatively low. Half of the artifacts has been used for only one activity. One possible explanation for this phenomenon is that the presence of a haft reduces the number of motions to which an artifact can be put; consequently, they are less versatile than implements which have not been hafted (Odell 1994).

The former presence of a haft can also be inferred from technological or morphological characteristics. Notches and the like occur only sporadically and they cannot be associated with hafting. On the basis of morphology and function it can be assumed that points and axes have formerly been hafted.

Keeley (1982) assumes that hafted implements possess smaller dimensions and have been more intensively retouched than unhafted tools, even if they are functionally equivalent. However, at Maastricht-Klinkers this assumption could not be corroborated: the dimensions of the artifacts with traces of hafting do not significantly differ from those without such traces. Despite of the fact that the majority of the formerly hafted implements is retouched, the intensity of this retouch does not differ greatly from that observed on unhafted tools.

A third indication for the former presence of a haft is the breakage pattern. It is possible to exert more force when using a hafted tool but at the same time the chances of breaking the implement increase. On the basis of the typomorphological description it could be concluded that especially pointed blades, retouched blades and unretouched blades have broken relatively more frequently than other categories of tools. With respect to the scrapers and retouched blades[46] it was checked whether the sizes of broken and complete specimens significantly differed.
It was expected that the narrow, thin, long artifacts would break sooner and more frequently than broad, thick, short specimens. This did not turn out to be the case for the retouched blades. Only the thickness of broken and complete scrapers appeared to differ to a significant extent ($X^2 = 15.126$, df = 7, p = 0.0344). The thinner scrapers (measuring 3-10 mm) are broken more frequently than expected (E = 4, O = 8), whereas the thicker specimens (with sizes between 11 and 18 mm) display breakage less frequently than expected (E = 6.7, O = 2).

5.5. DEGREE OF USE OF THE ARTIFACTS

In order to better interpret the archaeological data, it is possible to measure or estimate the tool-class use life (Ammerman/Feldman 1974; Shott 1989). Unfortunately, archaeological and ethnographic information about the duration of use of various tools is very scarce. A comparison of the intensity of similar types of wear traces can, however, provide an impression of the extent to which an artifact was used and therefore of its use life[47]. Subsequently, the use life of the various artifact categories can be compared.

The intensity of the wear traces on scrapers and combination tools is rather variable (tab. 16). Retouched flakes, unretouched blades and especially unretouched flakes have for the most part been lightly or modestly used. In contrast, pointed blades and retouched blades have been modestly or heavily used. From these observations, it can be concluded that unmodified or not specifically modified artifacts have a relatively shorter use-life than specifically modified artifacts.

5.6. THE NUMBER OF USED EDGES

More than half (56.8%) of the used artifacts turns out to possess more than one used edge (tab. 17). Most probably, the number of used edges cannot be related to the extent of the modification or to certain artifact categories: no significant differences could be determined. The largest difference in number of used edges could be demonstrated to exist between unmodified artifacts, which more often have only one used edge, and the modified tools which display more than one such edge. Again, the differences are not significant when using a X^2-test.

It has also been verified whether a relationship exists between the number of used edges on an artifact and the contact material. It turns out that c. 86% of the artifacts (N = 127, including those for which the contact material worked could not be exactly interpreted) has been used for the working of one contact material only. The number of edges used varies from one to four. Table 18 displays the number of used edges for those artifacts with one, exactly interpreted material (N = 92). Silicious plants and hide have been worked mostly with artifacts with only one used edge (resp. 60% and 51.1%). In contrast, artifacts used for the treatment of wood or material '10' more often display two used edges (resp. 58.8% and 50%). Only 21 implements

Table 16. Maastricht-Klinkers: artefact categories versus intensity of wear.

	probably used	lightly worn	medium worn	heavily worn	resharpening	total
point	-	2	-	-	-	2
pointed retouched blade	1	-	9	9	-	19
scraper	8	25	22	20	1	76
borer	-	-	-	1	-	1
combination tool	3	1	4	2	-	10
retouched blade	5	7	17	21	-	50
notched blade	1	-	-	-	-	1
retouched flake	3	1	6	-	-	10
denticulated flake	-	-	2	-	-	2
truncated flake	-	1	-	-	-	1
retouched block	-	-	2	-	-	2
retouched core rejuvenation flake	1	1	4	-	-	6
bifacial retouched tool	2	-	-	-	-	2
splintered/bifacial retouched piece	-	6	4	-	-	10
quartier d'orange	-	1	1	-	-	2
axe	-	-	-	-	1	1
blade	10	17	22	2	-	51
flake	14	6	5	2	-	27
block	-	-	2	-	-	2
total	48	68	100	57	2	275

Table 17. Maastricht-Klinkers: artefact categories versus number of used edges.

	number of used edges				total	average	total tools
	one	two	three	four			
point	2	-	-	-	2	1.0	2
pointed retouched blade	3	2	-	3	19	2.4	8
scraper	19	10	7	4	76	1.9	40
borer	1	-	-	-	1	1.0	1
combination tool	-	2	2	-	10	2.5	4
retouched blade	6	12	4	2	50	2.1	24
notched blade	1	-	-	-	1	1.0	1
retouched flake	2	4	-	-	10	1.7	6
denticulated flake	-	1	-	-	2	2.0	1
truncated flake	1	-	-	-	1	1.0	1
retouched block	-	1	-	-	2	2.0	1
retouched core rejuvenation flake	2	-	-	1	6	2.0	3
bifacial retouched tool	-	1	-	-	2	2.0	1
splintered/bifacial retouched piece	2	1	2	-	10	2.0	5
quartier d'orange	-	1	-	-	2	2.0	1
axe	1	-	-	-	1	1.0	1
blade	12	14	1	2	51	1.8	29
flake	10	5	1	1	27	1.6	17
block	2	-	-	-	2	1.0	2
total	64	54	17	13	275		148

Table 18. Maastricht-Klinkers: worked materials versus number of edges artefacts used for one material.

	number of used edges				number of artefacts
	one	two	three	four	used for one material
meat	-	-	-	-	-
hide	24	14	5	4	47
meat/bone	-	-	-	-	-
bone	1	2	-	-	3
antler	-	-	-	-	-
silicious plant	3	1	-	1	5
non-silicious plant	1	-	-	-	1
wood	6	10	-	1	17
'23'	1	1	-	-	2
'10'	4	8	2	2	16
stone	1	-	-	-	1
soil	-	-	-	-	-
total	41	36	7	8	92

have been used on different contact materials. There are also no indications that specific combinations of worked materials occur on a systematic basis. Traces from silicious plants, one of the more frequently occurring contact materials, are visible quite often alongside traces from other materials (50%).

To conlcude, it turns out that the mean number of used edges per implement is considerably high. The majority of the artifacts with more than one used edge has been employed for the treatment of one contact material. Sometimes, the two edges of one artifact were used for the same motion, sometimes one edge displayed the traces from different movements.

6. Integrating functional and typological data

Until recently, a functional classification of sites was often done on the basis of a comparison of the typological composition of the various flint assemblages. The combination of a typological analysis with the results from a study of the wear traces allows for a more complete insight in the way flint was used and thereby in the function of the site and its place in the settlement system.

The relationship between the typology of artifacts and the actual use they are put to, can be investigated with the concept of tool-use behavior. It can be hypothesized that it is necessary to dispose of an efficient toolkit in order to carry out specialized activities or tasks which have to be done frequently. Such activities will have been carried out with a more precisely designed set of tools and each kind of tool is used repeatedly in task performance (see Aldenderfer *et al.* 1989; Chatters 1987; Torrence 1983). In contrast, generalized tasks (maintenance tasks) will have been done with a smaller number of versatile tools.

This hypothesis about tool use behavior can be measured by comparing the characteristics of the toolkits used on the different materials. Table 19 displays various characteristics of the implements in relation to the most important contact materials.

The wear trace analysis reveals that hide is the most frequently worked material. The toolkit employed shows a broad range of artifacts, among which a number of specifically modified implements. Because of the predominance of scrapers, the heterogeneity of the used artifact categories is relatively low. The majority of the artifacts has been used exclusively for the treatment of hide. Approximately one quarter of the tools shows traces of hafting. A large number of used edges is moderately or heavily used. From these data it can be concluded that the tools have probably been repeatedly used for the same activity.

The tool use behavior connected with the working of hides agrees with the hypothesis that specialized or frequently occurring activities have been carried out with a more precisely designed set of tools and that each kind of tool is used repeatedly in task performance. This also applies to the toolkit for the treatment of material '10'. This latter kit differs from that for hide working in the sense that it displays a larger heterogeneity in used artifact categories. Moreover, the artifacts have seldomly been specifically modified: for the most part, it concerns retouched and unretouched blades. Finally, they frequently display more than one used edge. Nevertheless, most of the artifacts used on material '10' have been exclusively used for this material category. They can be considered artifacts which

Table 19. Maastricht-Klinkers: tool use behavior concerning the worked materials occuring mostly.

	hide	material '10'	wood	silicious plant
number of used edges	106	39	36	15
number of artefacts	61	19	24	10
average number of used edges	1.7	2.1	1.5	1.5
percentage of artefacts with one used edge	51	25	36	30
percentage exclusively used for material ×	77	84	71	50
number of used artefact categories	9	6	6	4
evenness used categories (Pielou)	0.7050	1.1120	1.0493	1.2911
heterogeneity used categories (Shannon)	0.6727	0.8653	0.8165	0.7773
percentage of hafted artefacts	23	26	4	10
intensity of use (light, medium, heavy)	M/H	M/H	L	M/H

have been used in a specialized way but which were not precisely designed.

Retouched blades have been specifically used for the working of silicious plants[48]. More often than was the case for tools used on hide or material '10', it concerns versatile, unhafted implements. This agrees with the hypothesis for generalized tasks. Unlike predicted by this hypothesis however, the tools are moderately or heavily used.

The tool use behavior for wood differs considerably from that for silicious plants, material '10' or hide. For the most part, wood working was carried out with unmodified and unhafted implements, which seldomly have been heavily used. This agrees more with the picture emerging from those activities which are represented with fewer artifacts or fewer used edges. Examples include the treatment of material '23', soft plant, meat, antler, bone and butchering. The extent to which these artifacts have generally been used, can be characterised as 'likely', light or moderate; the artifacts display slightly more often traces from more than one contact material. In comparison, fewer specifically modified implements have been applied for these tasks.

Despite the small number of indications for hunting, the working of soils and heavy wood working, it appears that these activities were carried out with specifically designed implements because they demanded efficient tools.

7. Conclusions

In this article the results of the research into the function of the Michelsberg site of Maastricht-Klinkers have been presented. This site forms part of a series of Michelsberg sites which are investigated in order to obtain insight into the settlement system of the Michelsberg culture. Because of the specific character of the archaeological data-set, emphasis was put on the the analysis of the flint assemblage, with a central role for the investigation of the wear traces on the artifacts. The results of the wear trace analysis have been evaluated in connection with other find categories or contextual information from the site such as the location, the features, the pottery and the ground stone material. In the following, I will subsequently discuss the natural surroundings of the site, the social environment and the nature of the occupation.

7.1. The environment

The site is located on a promontory of the Caberg Plateau between two rivervalleys (the Meuse and the Heeswater, fig. 1). On three sides it is surrounded by rather steep descents varying between 8 and 10 degrees[49]. The location offers a wide view of the surroundings and is easily accessible from only one direction. From a defensive point of view the site is certainly strategically located.

The distance to the two rivers measures less than 150 meter. Fishing grounds and drinking water were therefore at hand in the near vicinity of the site. Stone material could have been collected on the river terraces; some of the flint found on the site displays a rolled or slightly abraded cortex. The rivers could also have served as transport route or as orientation point.

The vegetation during the time of the Michelsberg occupation[50] consisted of thick lime wood on the loess and the sand, and alder carr in the lower zones of the river valleys (Bakels in press a; Kalis 1988). On the more elevated areas of the river valleys a mixed oakforest will have thrived, with oaks, lime, elm, hazel, maple and possibly other low bushes as well (Bakels *et al.* 1994, 37)[51]. It is possible that the steep parts of the inclines were mainly covered with bushes (Bakels in press a). Concerning the mode of subsistence, it can be assumed that the optimal location for the collection of plant products was probably the intermediate zone between the river valleys and the higher grounds.

Information about the fauna at the time of the Michelsberg occupation is scarce. With respect to the Belgian Michelsberg sites, Vermeersch (1988) mentions remains from wild boar, beaver, marter, wild cat, brown bear, deer, roedeer, aurochs, wild horse, fox and hare.

Because of the rather monotonous character of the lime forests, it is likely that only little nutrition was available to the wild fauna. In contrast, the intermediate zone between the river valleys and the higher grounds constituted an area with sufficient nutrition for game such as wild boar, deer, roedeer and aurochs. This area also may have attracted wild horses, hare and fox, which have a predilection for more open landscapes and tend to avoid the thick lime forests. It is therefore likely that game was present in the near vicinity of the site.

The location of the site and its direct surroundings were suitable for agriculture and animal husbandry. A supporting argument for such a suitability forms the presence of a Bandkeramik settlement on the same terrain, for which a fully agrarian economy has been established (Bakels 1978). Clearly, the Caberg plateau and the dryer zones of the valley of the Meuse are suitable for agriculture. It cannot be determined whether the erosion on the plateau is related to agricultural activities during the Michelsberg period. Except for the open spaces, the Michelsberg-people had created as living areas, pollendiagrams do not show indications for extensive transformations of the landscape during this period (Bakels in press a, in press b; Bakels *et al.* 1994; Kalis 1988, 136). If cultivated fields had been present, they must have been quite small. The Michelsberg people cultivated a variety of cereals, such as barley, emmer, einkorn and wheat (Bakels in press a, in press b; Heim 1979, 1987; Kalis 1988). With respect to animal husbandry, it is likely that especially the wetter zones of the river valleys and perhaps abandoned fields, were eminently suitable as pasture grounds for the herds of cattle. The use of the sandy upland for herding cattle cannot be excluded either. The pigs will have found their food mostly at the borders and the more elevated areas of the river valleys with mixed oak forests.

It is beyond doubt that the site Maastricht-Klinkers is situated in an ecotone, which allows the exploitation of several ecological zones. The natural surroundings demonstrate that a number of different subsistence modes and site functions are possible at this location.

The social surroundings can also have influenced the choice of the location. In the vicinity of Maastricht-Klinkers a number of other Michelsberg sites have been identified, such as Maastricht-Vogelzang (Brounen 1994; Knippels/Orbons in prep.), Rijckholt-Sint Geertruid (De Grooth 1991), Valkenburg-Heunsberg (Brounen this volume), Gulpen-Gulpenerberg, Wittem-Beutenaken (Brounen, pers. comm.), Meeuwen-Donderslagheide (Creemers/Vermeersch 1989) and Opgrimbie (Fourny *et al.* 1993). Furthermore, it still cannot be excluded that the system of ditches, located c. 0.5 km south of Maastricht-Klinkers, is a Michelsberg defensive structure (Thanos 1994). Although it is impossible to determine the contemporaneity of Maastricht-Klinkers with any of the above-mentioned sites, it is clear that the site is situated in an area which was intensively used by the Michelsberg population.

7.2. The settlement

Due to post-depositional processes as erosion and extensive cultivation, it is difficult to obtain insight into the structure of the site. Definitely, large pits were dug and settlement debris, such as flint and pottery sherds were discarded there. Unfortunately, no structures could be identified. The site covers an area of approximately one hectare. Most of the features and the find concentrations have been discovered in the central part of the plateau, in an area of c. 70 × 50 meters.

The duration of use of the site is difficult to determine. The stratigraphic sequence does not reveal indications for re-use and no cross-cutting features were noticed. It is hypothesized that the kind of archaeological remains and the results of the wear trace analysis can give an indication of the duration of occupation.

The finds point towards a broad range of activities which suggest that the site was used for an extensive period of time. Moreover, the flint has been flaked on the spot and was intensively used. The assemblage includes hammer-stones, end-products of flint, by-products and worn and discarded artifacts. The typological analysis indicates that a broad range of tool categories was present, with scrapers forming the largest category. Among the stone remains, a number of fragments from grinding stones was identified. Pottery was found in considerable quantities; again, a large variety of types could be demonstrated. The pottery seems to resemble the 'domestic range', featuring tulip beakers, carinated vessels and baking plates.

The presence of the pits on a rather restricted area within the site can be an indication for internal structuring. The filling of the pits indicate that secondary deposition of debris has taken place, a feature which is also indicative of a more extended use of the site.

The information obtained with the wear trace analysis of the flint also suggests that the site was in use for a lengthy period of time. First, a high percentage of the artifacts displays traces of wear. A considerable number shows more than one used edge which implies intensive use. Secondly, the diversity of worked materials is high. In addition, activities requiring a high input of labor were demonstrated, such as dry hide and wood working; it is often assumed that these activities were not carried out at briefly occupied sites (Gallagher 1977; Van Gijn 1990; Juel Jensen/Brinch Petersen 1985). Last, the occurrence of a number of maintenance activities (see below) and suggestions for re-tooling of artifacts (Keeley 1982) are also associated with a more extended stay at a location.

The materials most frequently worked include hide and the unknown material '10'. The toolkits for the treatment of these contact materials are suggestive of specialized or frequently occurring activities for which efficiency was a prerequisite. Generally speaking, the artifacts have been used repeatedly and exclusively for the same contact material. The implements were frequently hafted. The main difference between the toolkit for hide working and the one for treating material '10' lies in the fact that the former consists of specifically modified implements, whereas the toolkit for material '10' is characterized by not-specifically modified artifacts. Besides hide and material '10', wood is the most frequently worked material. It is remarkable that the tool use behavior with respect to wood working is clearly different; for the most part, unmodified and unhafted artifacts were employed which seldomly display traces of heavy or repeated use. This implies that wood working did not constitute a specialized or frequently occurring activity.

Considering the above information, evidence for maintenance activities seems to predominate at Maastricht-Klinkers (Binford/Binford 1966). Examples of such maintenance activities are the production of other implements or objects from hide, wood, flint and possibly pottery. Pottery, grinding stones and a number of flint artifacts such as those for cutting meat, can be associated with the preparation and conservation of food products. The combination of all these activities is clearly indicative of a residential site (Yellen 1977).

Additionally, evidence concerning certain procurement activities can inform us about the subsistence economy. Indications for the use of plants are especially evident. It is, however, difficult to determine the character of the plants exploited: did it concern wild or domesticated plants? A small number of charred seeds from naked six-row barley (*Hordeum vulgare var. nudum*) and emmer (*Triticum sp.*), which were found in the features, forms an indication for domesticated plants. Implements with sickle gloss point to the harvesting of silicious plants, a category that, among others includes cereals. Evidence supporting the interpretation of the implements with sickle gloss as cereal harvesting tools derives from slight indications for land clearance (wear traces from heavy woodworking, broken axes) and the working of soil. It is, however, rather risky to draw far-reaching conclusions about agriculture only on the basis of these indications. Because of the fact that only a limited amount of plant food could be collected on the plateau, the hypothesis can be put forward that cultivated fields may have been present, possibly located on the fertile loess. The interpretation of material '10' remains problematic, but it cannot be excluded that this category of wear is associated with the procurement of plant foods.

This study yielded very little evidence for the practice of hunting. Only a few projectile points were found and the analysis of the wear traces has indicated that antler and bone have rarely been worked. Although the natural environment is suitable for animal husbandry, archaeological evidence for this practice is lacking. The question remains whether is was practised at all and what its importance in relation to agriculture may have been (cf. Bakels in press a; Vermeersch 1988). Direct evidence about the food economy is virtually lacking; what little we have, however, indicates that the emphasis lay on the cultivation of plant foods.

To conclude, it is probable that the variety of activities carried out at the settlement of Maastricht-Klinkers is indicative of a residential settlement, used for a considerable period of time. If this interpretation is correct, it is remarkable that no remains of houseplans are found. However, houseplans are rare in the Dutch, Belgian and German Michelsberg culture at large. Probably this is due to alternative ways of sheltering (e.g. huts), or to a specific house building construction, resulting in a low archaeological visibility. More insight into the nature of Michelsberg sites in general, and the specific role of Maastricht-Klinkers in the settlement system, can only be ascertained after studying more sites.

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notes

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2 Topographical map Maastricht 61F, coordinates 175.35/320.73.

3 These excavations revealed the presence of a system of ditches. An attribution of these ditches to the Michelsberg culture could as yet not be confirmed (Thanos 1994).

4 Michelsberg features and find concentrations discovered prior to the excavation are designated with numbers starting with a zero, those encountered during the excavation have numbers which begin with the trench number, and those found after the excavation have a Roman number.

5 Due to time pressure the excavators refrained from sieving the pit contents and it is likely that not all flint artefacts present were retrieved. It is assumed however, that the sample is representative, with the exception of the smaller fraction (< 1.5 cm).

6 It often turns out to be impossible to exactly determine the location of origin of flint. Petrographically the flint from the mines of Rijckholt, Jandrain-Jandrenouille (Orp-le Grand, Province of Liège, Belgium) and Spiennes (Province of Hainaut, Belgium) cannot be differentiated (Kars *et al.* 1990). For this reason it is preferable to refer to types of flint: Rijkcholt type, Rullen type etc. (Louwe Kooijmans 1980). In this article, when I refer to Rijckholt flint, I mean Rijckholt type of flint.

7 During the period of the Michelsberg culture eluvial flint has been mined in Jandrain-Jandrenouille (Hubert 1974). Eluvial flint has also been won at Rullen, Banholt, Mheer, Rijckholt (De Warrimont/Groenendijk 1993) and Valkenburg (Brounen this volume).

8 The data were statistically tested with the aid of the X^2 method. For the calculations use was made of a computer program, Fisher 3.0, designed by Verbeek and Kroonenberg (1990) and specifically suitable for the comparison of samples containing very few numbers. For the X^2-tests reported in this article a rejection region of 0.05 was used; X^2 determinations which refer to values less than 0.05 will be considered significant.

9 Flint from unknown origin and flint from the river terraces has not been included in the counts. Flint from terrace deposits is defined on the basis of the presence of rolled cortex.

10 Only the complete blades and those artefacts which were studied for the presence of use wear traces were measured (N = 226).

11 The artefacts with a length between five and eight cm are produced from Rijckholt (N = 86), Rullen (N = 2), Simpelveld (N = 3), light-grey Belgian (N = 4) and other (N = 4) type of flint. Every artefact with a length beyond eight cm is made from Rijckholt type of material.

12 Apart from numerous large paleolithic blade cores with rolled cortex, neolithic blade cores are known, such as a specimen from the area around the river Roer, from which macrolithic blades have been struck (Brounen, pers. comm.; the implement derives from the collection of H. Schmitz in Posterholt).

13 The Michelsberg site Maastricht-Vogelzang (Knippels/Orbons in prep.; Brounen 1994), where almost all the flint derives from eluvial deposits, probably dates to the period before exploitation of the Rijckholt mines began.

14 According to the newly proposed chronological system for Dutch prehistory (Van den Broeke et al. in prep.).

15 Artefacts which have been secundarily used and have changed their original function as a consequence, were classified in the category of their last appearance.

16 Dimensions vary from 3.0 to 7.5 cm, whereas the majority displays a length between 4.5 and 6.5 cm. De maximum length of the negatives on the cores varies from 1.5 to 4.5 cm. The largest group has a length between 2.5 and 4.0 cm.

17 Macrolithic blades are defined by their dimensions: a minimum length of 80 mm and a minimum width of 25 mm (De Grooth 1991, 159).

18 All retouched or otherwise modified artefacts.

19 Blocks have not been included in these calculations because they are defined by the very fact of being broken.

20 Similar to the majority of the Dutch Michelsberg sites tranchet axes and stone axes are lacking.

21 A bifacially retouched blade fragment, classified as retouched blade, possibly constitutes a fragment of a pointed blade as well.

22 This type of rolled pebble frequently occurs in the sediments of the Meuse river (C. Bakels, pers. comm.). A similar type of pendant has been found in the Belgian Michelsberg site of Boitsfort (Lüning 1968, 191, fig. 1.20).

23 On a few locations both Michelsberg and Linearbandkeramik material has been found. The excavators have tried as much as possible to separate the material from both periods. As a consequence, typical Michelsberg tools are overrepresented with respect to the debitage in those parts of the assemblage deriving from outside the features. The features could all be attributed to a specific period.

24 Smaller features contain an average of 27% (ranging from 0-50%) tools, middle sized features 11.8% (varying from 7-17%) and large features 37.2% (varying from 24-44%).

25 Initially, the artefacts were cleaned with HCl and KOH according to the procedure suggested by Keeley (1980). However, this did not remove the manganese which is present on virtually all the artefacts. It was therefore decided to refrain from any further chemical cleaning. Subsequently, the artefacts were cleaned in an ultrasonic cleaning tank (3 × 20 minutes), immersed in water. This produces similar results as the chemical approach but is less cumbersome. During the analysis the artefacts were regularly cleaned with alcohol to remove finger grease.

26 For the low power analysis a Wild M3Z stereomicroscope was used with magnifications ranging from 10 to 160 ×.

27 For the high power analysis use was made of a Nikon Optiphot with magnifications ranging from 100 to 560 ×. Most of the interpretations took place with a 300× magnification.

28 In order to allow a comparison with other wear trace analyses, the percentage counts reported in this article do not include the stone artefacts nor the hammerstones, grinding and rubbing stones from flint.

29 It is possible to butcher and debone animals without frequently touching the bones (Patterson 1981). If the bones only incidentally come into contact with the flint implement, the resulting traces will not be as wide-spread as when the tool had been used for the working of bone only.

30 Artifacts which have been employed for 2.5 hours only display an insignificant number of striations (Van Gijn 1990, 81), whereas harvesting for seven hours produces wear traces which, because of the numerous striations, are very much similar to the traces encountered on archaeological specimens (Juel Jensen 1988).

31 Edge angles have been taken at different locations along the working edge; the resulting mean has been rounded off to five degrees.

32 Not all the edge angles have been measured. With respect to motion (table 9), pointed edges were not included in the measurements. In table 10 only exactly interpreted worked materials have been incorporated. Furthermore, sixteen used edges were not available for taking measurements. To conclude, with respect to table 9, 42 used edges were not measured, with respect to table 10 this pertained to 80 used edges.

33 Longitudinal movements have been carried out more frequently than expected with edges having an angle between 25-50 degrees (E = 55.3, O = 85) and transverse motions more often with edges displaying angles between 55-110 degrees (E = 69.5, O = 83).

34 The comparisons between edge angle and contact material were only performed for materials evident on at least 15 used zones.

35 Edges employed for the working of wood and hide differ significantly in terms of their angle ($X^2 = 18.399$, df = 8, p = 0.0184). An edge of 25-50° occurs more frequently than expected with the working of wood (E = 16.3, O = 25). Angles of 55-110° are observed more often on edges used on hide (E = 54.3, O = 63).

36 It was decided to determine both the heterogeneity as well as evenness and richness as separate values in order to better evaluate the heterogeneity (see ; Bobrowski/Ball 1989, 8; Kintigh 1984, 44-45; Shott 1989, 285).

37 These counts only include those materials which were exactly inferred, such as hide, wood etc.

38 The sample size could have influenced the difference in richness between the various artifact categories (Bobrowski/Ball 1989; Kintigh 1989). Using the Spearman rank correlation coefficient, it could be determined that a strong relationship exists between the number of used edges and the number of different contact materials (Rs 0.88), as well as between the number of used edges and the number of motions executed (Rs 0.87). The number of worked materials and executed motions per artifact category appears to have reached the maximum richness with a quantity of 19 and 10 used edges respectively. A larger sample turns out to have no effect on the richness. Some artifact categories such as points, which are represented by only a few used edges, will probably display the maximum diversity when incorporating a much lower quantity of used edges in the calculations. Despite of the fact that a correlation exists between sample size and richness, it is assumed that the differences in richness between various artifact categories, as displayed in this analysis, are meaningful (see Plog/Hegmon 1993).

39 The evenness is determined with the use of the J-statistic (Pielou 1966).

40 Three methods have been used to determine the heterogeneity: the Shannon-Weaver Information Statistics which is designed for infinite populations and which is weighted in favor of rare species, de Brillouin and the Simpson index, both developed for finite populations, whereby the latter is weighted in favor of the most common species. To obtain the calculations, use was made of a computer program designed by Kintigh (1988).

41 The differences between the various indices are small: Shannon and Brillouin provide the same ranking of artifact categories. Simpson, who takes small numbers into account to a lesser extent, has calculated a lower heterogeneity for the retouched flakes with respect to the other two indices.

42 Side-scrapers, horse-shoe shaped scrapers, single and double end-scrapers are all, with the exception of one single short end-scraper, used for scraping hide.

43 Single and double long end-scrapers with retouched edges display, for the most part, three or four working edges (resp. 55% and 100%).

44 One third of the pointed blades display macrolithic sizes. In addition two broken pointed blades have a width of minimally 25 mm; possibly these two originally were macrolithic artifacts as well.

45 Divided according to type, it concerns five long end-scrapers with retouched lateral ends, four horse-shoe shaped scrapers and one short end-scraper with retouched lateral ends.

46 The X^2 was calculated because these artefact categories display the highest percentage of hafting traces.

47 Considering the large variation in the origin and development of wear traces, we have to be very careful with statements about the duration and intensity of use of the various artefacts. The extent of use can therefore not be compared between types of wear traces (hide, wood, etc.).

48 Three of them display macrolithic sizes.

49 The first part of the slope at the eastern edge is extremely steep and displays an angle of 20 degrees.

50 It is assumed that the vegetation completely regenerated after the time of the Linearbandkeramik occupation.

51 These species have been found in pollenspectra from Maastricht-Randwijck, collected at a distance of only a few kilometers from Maastricht-Klinkers.

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