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THE END OF OUR THIRD DECADE

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Editorial

In 1992 the Institute of Prehistory celebrated its 30th anniversary. Although a celebration of a 25th anniversary is more common, the Institute has a tradition of celebrating events every ten years. The survival of the first ten years after its foundation in 1962 was marked by special festivities. Ten years later, the second special occasion was the retirement of the founder, Professor Dr P.J.R. Modderman. The year 1992 marked the end of the third decade. In 1992 there was another event to commemorate. The first volume of Analecta Praehistorica Leidensia was published in 1964. The second followed in 1966 and the third in 1970. After that the volumes appeared every year – 1992 should bring number 25. Therefore the idea was born to bring out a jubilee volume to which all current researchers would contribute. As usual with this kind of enterprise, the collecting of the copy took some time, but in the end almost everybody produced a paper. Moreover, the volume will include the very last report on an excavation executed by the founder of both the Institute and the Analecta, Prof. Dr. P.J.R. Modderman. With the publication of "Meindling" all his excavations will have been made public, a rare feat.
The amount of pages offered was such, that it was decided to publish a double volume: Analecta Praehistorica Leidensia 25 and 26. The first mentioned contains the articles on Palaeolithic, Mesolithic and Neolithic sites in Europe, although some of them reach further where methods and problems are concerned. Volume 26 will contain articles on later periods, non-European sites and all remaining subjects. The two volumes together provide a review of the kind of work that was done in the early nineties. They present the *status quo* at the time of the Institute's 30th anniversary. A comparison with the first volume of Analecta Praehistorica Leidensia shows that the Institute has grown, both in numbers of people using it as main base for their scientific work and in variety of subjects treated. The fourth decade awaits us.

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Wil Roebroeks
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Paul Hennekens
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"A veil of stones": on the interpretation of an early Middle Palaeolithic low density scatter at Maastricht-Belvédère (The Netherlands)

At Maastricht-Belvédère an attempt was made to document the low-density scatter of flint artefacts against which the 'rich' sites are present within the 250,000 years old interglacial deposits there. A short presentation and interpretation of the low-density scatter (Site N) is followed by a brief discussion of the implications this work might have for our understanding of the archaeological record.

1. Introduction

The majority of Palaeolithic fieldwork is heavily site-oriented, rather than on studies of the way palaeolithic foragers moved through former landscapes. Raw material studies however begin to shift our attention towards such a landscape perspective (*cf.* Geneste 1985, 1988; Roebroeks *et al.* 1988; Féblot-Augustins 1993), which has always been rather central in many ethno-archaeological studies of the spatial organization of hunter-gatherers. Such studies resulted in concepts like Binfords distinction between *collecting* versus *foraging* modes of landuse, coupled with logistical and residential forms of settlement mobility (Binford 1980). Though implicitly or explicitly used by many archaeologists such concepts are in fact hard to work with: the differences between actually observing people moving through landscapes and interpreting material remains of such former activities — encased in various forms in a variety of sedimentary envelopes — make for a big discrepancy between the two levels of analysis: in the archaeological practice we have to deal with problems such as the contemporaneity of sites, their horizontal and vertical integrity and other aspects of site-formation. These factors, together with the very patchy exposure of sediments, the scarcity of well-studied sites and the absence of a solid chronological framework, are among the reasons for the domination of site-oriented studies in Palaeolithic archaeology (*cf.* Villa 1991).

Furthermore, most of the excavated sites are, in the words of the late Glynn Isaac, "... concentrated, localised accumulations of refuse which represent acts of discard repeated by numbers of individuals over a span of time." (Isaac 1981, 133-34). These concentrated patches of relics, however, represent only a part of the traces of earlier human behaviour, as they are mostly present against a background of low density scatters of isolated or small sets of artefacts, subtle marks with a low visibility, the kinds of things one occasionally encounters when surveying sections (*i.e.* cross-sections through earlier landsurfaces).

Isaac (1981) has described these isolated artefacts as the archaeological correlates of fundamental particles. In his hierarchical model of the structure of the spatial array, these isolated artefacts form the first level. The next level is formed by single action clusters, for instance a set of conjoinable flakes from one knapping episode. The third level can be of a very variable scale, but it is always a complex cluster of first and second level occurrences, representing a number of episodes or a number of different actions. Most archaeological sites are composed of materials at this level, *i.e.* clusters of clusters. Such entities can be *organized* or *compound*, as discussed by Kroll and Isaac (1984). At a still higher level are the regional site configurations. Isaac sees sites as forming a patterned set across the face of a region, with locations determined by such factors as distribution of resources, networks of communication and population density. This fourth level is commonly referred to as a 'settlement pattern' or 'regional system'.

This model (see Isaac 1981 for more details) stresses the importance of treating the distribution of sites and of isolated artefacts as parts of one single system (see also Foley 1981a, 1981b). Study of the overall distribution of artefacts on the palaeolandscape was for instance a main part of Isaac's Koobi Fora research project. Apart from this project, the 'scatters and patches' approach has received little attention however (but see: Stern 1993), although its importance for the study of former land use patterns has been well advocated by Isaac (1981).

This short paper takes up some elements of Isaac's approach by presenting and discussing the results of the excavation of a "scatter between the patches": a very low-density distribution of stone artefacts and some bone fragments, excavated over a large area in 250,000 years old river sediments at Maastricht-Belvédère (The Netherlands). We recorded this distribution in order to document the 'off-site' character of the former usage of the river valley at

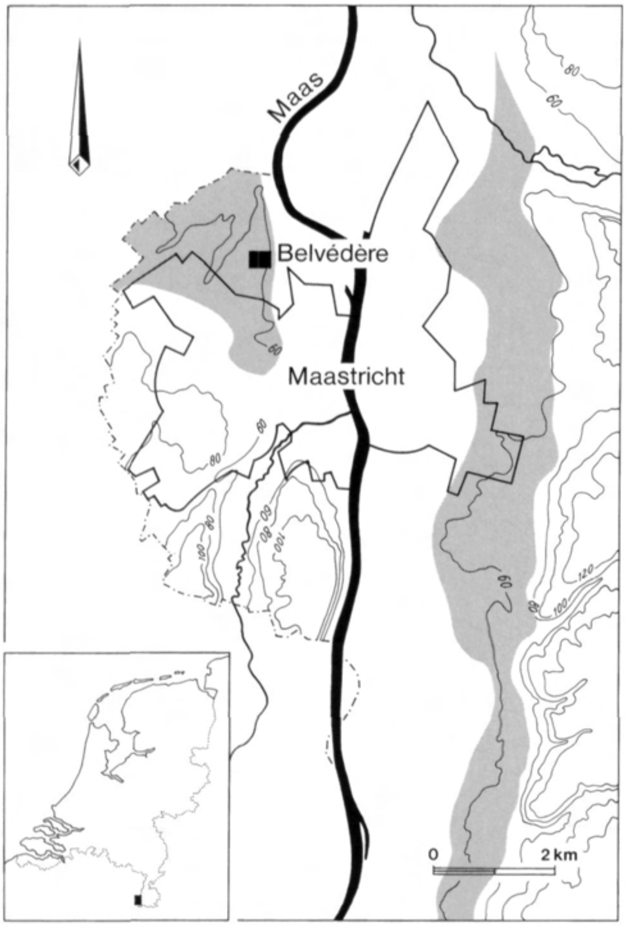


Figure 1. Situation of the Maastricht-Belvédère pit. The shaded area shows the distribution of the Caberg Middle Terrace sediments (after Brueren 1945). The Caberg plateau coincides with the western distribution of the Middle Terrace sediments.

Belvédère. By doing this we hoped to obtain an impression of the overall lithic 'output' of Middle Pleistocene hominids within a small segment of the river valley, which comprised both the patches and the scatters, essentially the 'Veil of Stones' left on the landscape. We were interested in the distribution of these finds and in comparing them in technological and typological terms and in terms of raw material with the assemblages from the patches, the 'classical' sites excavated at Belvédère.

The paper first gives a short presentation of this scatter (Site N): its geological context, excavation method and description of the flint assemblage. Next, the interpretation of this kind of artefact distributions will be discussed briefly, by comparing the scatter with previously excavated Maastricht-Belvédère patches, and by a more general discussion pertaining to the value of the information generated by the study of these scatters.

2. Maastricht-Belvédère: Site N

2.1. The topographical and geological setting of the Belvédère site

The Maastricht-Belvédère project focussed on an interdisciplinary study of 250,000 years old fine grained river deposits, exposed in a loess and gravel quarry about 1 km north-northwest of the Dutch town of Maastricht (fig. 1). These deposits yielded a rich, full interglacial fauna and abundant traces of human activities, in the form of sites (first to third level entities) containing middle palaeolithic flint assemblages, occasionally associated with faunal remains (see Roebroeks 1988; Vandenberghe *et al.* 1993). Over an area of about 6 hectares a dozen scatters and patches were discovered and excavated (tab. 1 and fig. 2), amongst them Site N, presented here. As stated above, this scatter was recorded specifically to get an impression of what happened between the patches.

The geological context of the Maastricht-Belvédère sites has been described in detail elsewhere (Roebroeks 1988; Vandenberghe *et al.* 1993). Here, it suffices to say that the archaeological material from the main find level was recovered in the upper fine grained part of sediments, deposited by a meandering river in a late Middle Pleistocene interglacial. These sediments are well dated and correlated with oxygen isotope Stage 7 (Roebroeks 1988; Kolfschoten *et al.* 1993). The fine grained interglacial river deposits were subsequently covered by a thick sequence of Saalian and Weichselian silt loams (*i.e.* reworked and primary loess).

The fluvial sequence at Belvédère (fig. 3) started during a Saalian cold period with an aggrading braided river system, followed by an incision at the end of this period, and a slight accumulation by a meandering system during the succeeding warmer period. Sedimentological analyses resulted in the division of the deposits of the meandering system into three phases. The last two phases are associated with full interglacial conditions and with abundant traces of human activities. The meander infillings show a fining upward sequence for each phase, with the uppermost meander filling being the finest. In this final phase the meander depression terminates with an extensive clay/silt loam deposition in standing water.

The Site N artefacts were present in these clayey silts, layer 7 in the section drawing in figure 4. The meander would have run dry occasionally, as attested by the large dessiccation cracks and abundant traces of biological activity present in the deposits (*cf.* Vandenberghe 1993). It is possible that the artefacts were discarded on temporary dry surfaces in what had become a very shallow meander loop.

Although the fauna recovered from the Site N matrix itself is very poor (see below), sedimentological analysis

Table 1. Survey of the Maastricht-Belvédère sites.

site	field designation	date	excavated area (m^2)	period of excavation
A	Trench East I	Saalian	5	March 1981
B	Trench North	Saalian	19/23	July-Sept.1981
C	Trench South	Saalian	264	1981-1983
D	Trench East II	Saalian	-	August 1982
E	Trench WG	Weichselian	50	Nov.-Dec.1982
F	Trench East III	Saalian	42	June-July 1984
G	Site G	Saalian	50	1984-1985
H	Site H	Saalian	54	March 1987
J	Site J	Weichselian	210	May-June 1986
K	Site K	Saalian	370	Dec.1986-July 1987
N	Site N	Saalian	765	Feb.1988-Sept.1989

Figure 2. Situation of the archaeological sites (A-N) in the Belvédère pit, scale 1:2500 (the numbers refer to the coordinates of the topographical map, sheet no. 61 F, 1:25,000).

Figure 3. Photo of the southern part of the Belvédère pit, summer 1987, showing units III to VII. This section in fact was the northern boundary of the excavated Site N area.

showed a continuity of deposition within a single climatic and environmental regime, strongly suggesting that the climatic conditions at the time of the formation of the deposits were interglacial, similar to the lower, non-decalcified part of the meander infilling (*cf.* Kolfschoten *et al.* 1993).

2.2. The site N scatter and its finds

In total an area of 765 square metres was excavated in the period from February 1988 to September 1989 (fig. 5). All finds were recorded three-dimensionally and several long sections were studied. The excavation yielded in total the low number of 450 flint artefacts, tiny chips included, and some badly preserved faunal remains. More than 500 square metres did not contain any artefact at all.

The faunal remains from the scatter are few in number and badly preserved. They were studied by T. van Kolfschoten, who was able to identify thirteen of them, virtually all consisting of teeth and fragments of teeth. Among these are remains of red deer (*Cervus elaphus*), horse (*Equus* sp.) and a bovid (*Bos* sp.). The left half of a lower jaw of red deer was relatively well preserved (*cf.* fig. 6), though broken and twisted in the matrix, while the teeth and molars from the right half were distributed over an area with a diameter of approximately 7 metres.

The flint artefacts from Site N display in general a white patination. About three quarters of the assemblage has a maximum dimension smaller than 2 cm (fig. 7). About one fifth of the larger pieces are tools and tool fragments (n= 26), with many scrapers (fig. 8). Of these larger pieces around 60% was recovered broken. The artefacts were made out of at least 8 different nodules, judging from the characteristics of the flint material (texture, inclusions, cortex, colour). Compared to other artefact distributions at Belvédère this is a high number, especially when the low number of artefacts at Site N is taken into consideration.

Decortication flakes are virtually absent in the assemblage (only 3.3% (n= 15) of the flakes had 50% or more cortex on their dorsal side, and 84.4% had no traces of cortex at all), indicating that the first stages of the core reduction occurred elsewhere. Technological and typological details on the assemblage are given in tables 2 and 3 and figures 9 and 10.

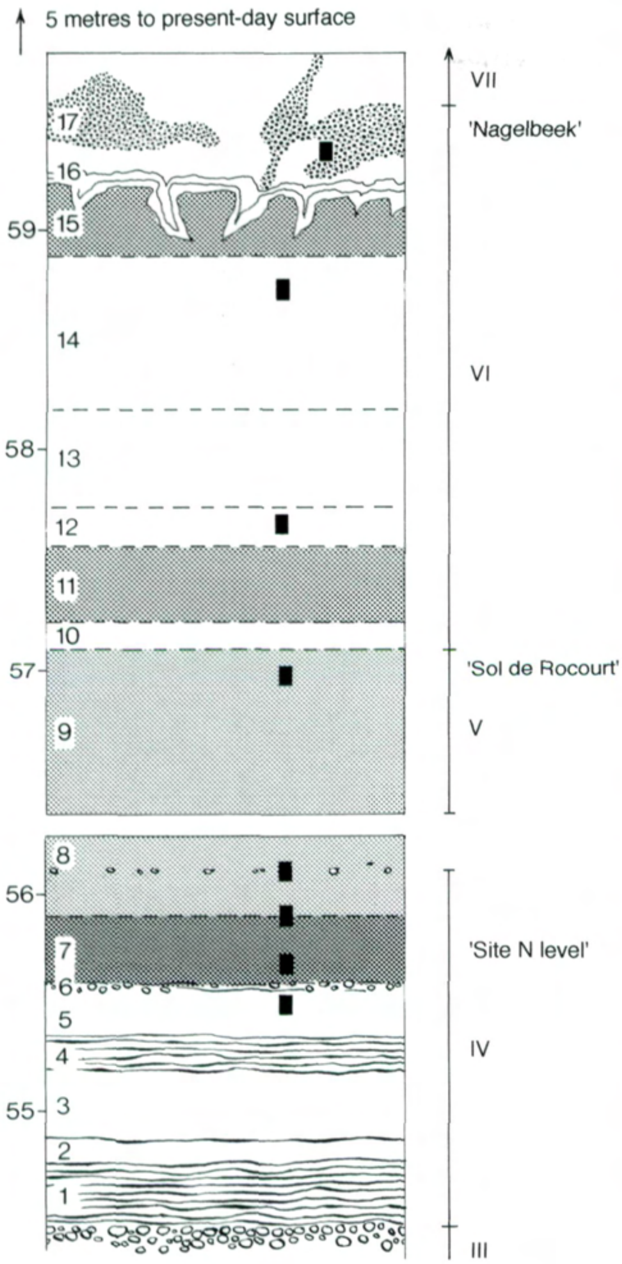


Figure 4. Site N: composite section of the sediments above the Unit III gravels, at the southern limit of Site N (square 51/476; description by H. Mücher and W. Roebroeks, July 24th 1989, conform FAO Guidelines for soil description). To the left: height in m above NAP, to the right interpretation in lithostratigraphical units (III to VII). The boxes are thin section samples for micromorphological analysis, the Site N finds were recoverd in layer 7.

1. Sand (10 YR 8/1), calcareous, slight horizontal lamination, massive, loose-very friable (C-horizon).
2. Sandy loam (10 YR 7/2), with Fe mottles (5 YR 6/6) of abt. 1 cm. Massive, friable, with few common Mn-nodules (<5 mm). A smooth and clear boundary with the horizon below (C-horizon).
3. Silty clay (10 YR 7/2), with Fe mottles (5 YR 6/8) <10 mm, grey (10 YR 7/1) mottles <10 mm and very few Mn-mottles (10 YR 2/1), 5 mm, massive, firm. Lower boundary smooth and clear (C-horizon).
4. Sand (10 YR 7/6-7/4), weakly laminated, with common Mn-mottles <5 mm, loose, with a smooth and clear lower boundary.
5. Silt loam (7.5 YR 6/2), with Fe mottles (5 YR 5/8) <5 mm, massive, firm, abrupt and smooth boundary with the horizon below (thin section 100).
6. Gravel layer with loam (7.5 YR 4/4), no mottles, loam massive and friable, with common to many rounded rocks <15 mm, and a smooth and abrupt lower boundary.
7. Silt loam (10 YR 5/6, towards the base: 10 YR 4/6), no mottles, massive, firm, Mn-nodules <5 mm, concentrated in a horizontal layer of 10 cm, the lower 15 cm pan, very firm to firm, **with artefacts**. Lower boundary smooth and abrupt. Thin section 154 and 122.
8. Silt loam (10 YR 6/8), no mottles, massive firm, common pores (medium, 2-5 mm and very fine), few Mn-Nodules (<5 mm), lower boundary smooth and clear. Thin section 160 (B_3 of the Eemian *Sol de Rocourt*).
9. Silt loam (10 YR 5/6), few distinct, medium sized, sharp silt mottles (10 YR 7/4), massive friable, cutans, clay in ped surfaces, common very fine (<1 mm) and few medium (2-5 mm) Mn-nodules, few to common pedotubules (<5 mm), lower boundary not observed. Thin section 10 (B_t of the Eemian *Sol de Rocourt*).
10. Silt loam (10 YR 7/4-7/6), few mottles (10 YR 6/6), massive, very friable, very few very fine pores, Mn-nodules <5 mm, very locally excrements, lower boundary clear and wavy.
11. Silt loam (10 YR 5/6), weak platy, very friable, very few very fine pores, few to common Mn-nodules <5 mm, lower boundary smooth and clear.
12. Silt loam (10 YR 5/4-5/6), platy structure, very friable, very few aggritubules, lower boundary smooth and gradual. Thin section 3 (dark horizon of the *Sol de Warneton*).
13. Silt loam (10 YR 6/6), very friable, platy structure, Mn-cutans, continuous and thin, in vertical root channels. Few very fine pores, lower boundary smooth and gradual.
14. Silt loam (10 YR 6/6), with coarse Fe-mottles (7.5 YR 5/8), common in the lowermost 20 cm, coarse grey reduction mottles (7.5 YR 6/2), common in the lowermost 20 cm, very friable, locally patchy cutans, very fine very few pores, rounded gravel (c. 1 cm), few Mn-nodules, lower boundary smooth and clear. Thin section 148.
15. Silt loam (10 YR 6/8), very friable, massive, very few to common pores, few vertical root imprints, lower boundary smooth and diffuse. Thin section 101 (B_2 horizon).
16. Silt loam layered in laminae <1 cm (colour varies with laminae: 10 YR 6/6 and 10 YR 5/8), with mottles, very friable, very calcareous, lower boundary abrupt and irregular.
17. Silt loam, grey 10 YR 7/4, cryoturbated with an amplitude of c. 30 cm, common medium prominent and clear Fe-mottles (7.5 YR 7/8) very few medium (2-5 mm) and very few very fine pores, very calcareous, lower boundary irregular and abrupt. Thin section 123 (*Nagelbeek Horizon*).

Figure 5. A view of the Site N excavation area seen from the west, July 1988.

Refitting of the small assemblage resulted in the conjoining of 71 artefacts, distributed over 23 groups. Eighteen of these groups consist of refitted *broken* artefacts (n= 54). Seventeen (non-modified) flakes could be incorporated in 5 groups of ventral-dorsal refits, with a group of 5 being the largest.

A very conspicuous element of the Site N assemblage is the presence of core trimming flakes, struck from the side of the core's working surface. They present a sharp cutting edge on one margin and a back, a surface perpendicular to the flaking surface of the blank, on the other. Struck from Levallois-like cores, these are called *éclats débordants* by Beyries and Boëda (1983). There are two of these typical *éclats débordants* present in the assemblage, and nine flakes with a comparable form, *i.e.* triangular in cross-section and with a clear back, thus resembling 'backed knives' (although not all cutting edges present traces of utilization). The implications of the presence of these objects in the scatter will be discussed below.

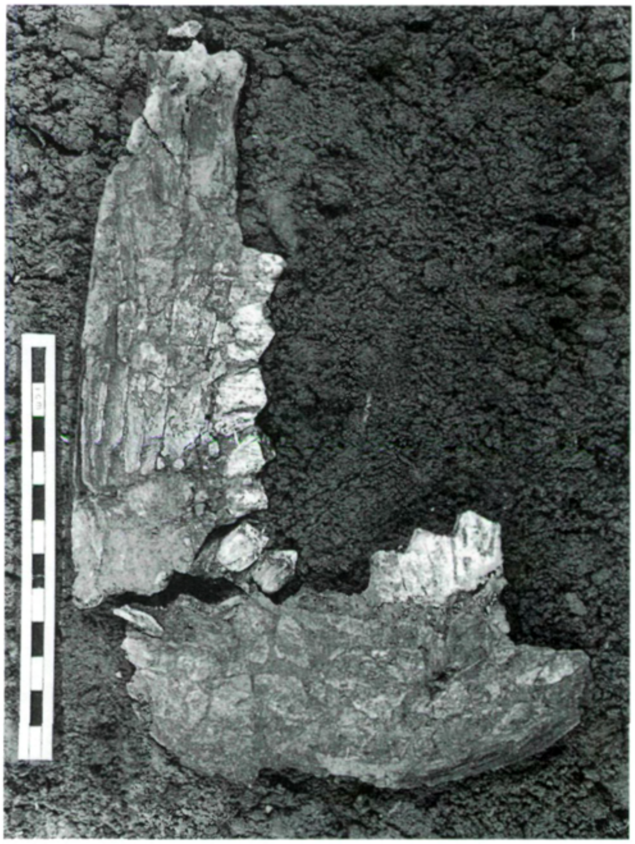


Figure 6. The left half of a red deer mandible, broken and twisted in the matrix (square 55/500). Scale in cm.

2.3. Site formation

The sedimentary envelop of the Site N scatter consists of a silty clay, deposited in a very low energy environment in shallow, almost standing water, within a depression that occasionally fell dry. While the geological evidence indicates that the assemblage might have been recovered in primary context, the results of refitting studies of the small assemblage indicate that some horizontal displacement of the artefacts took place. The horizontal distribution of these

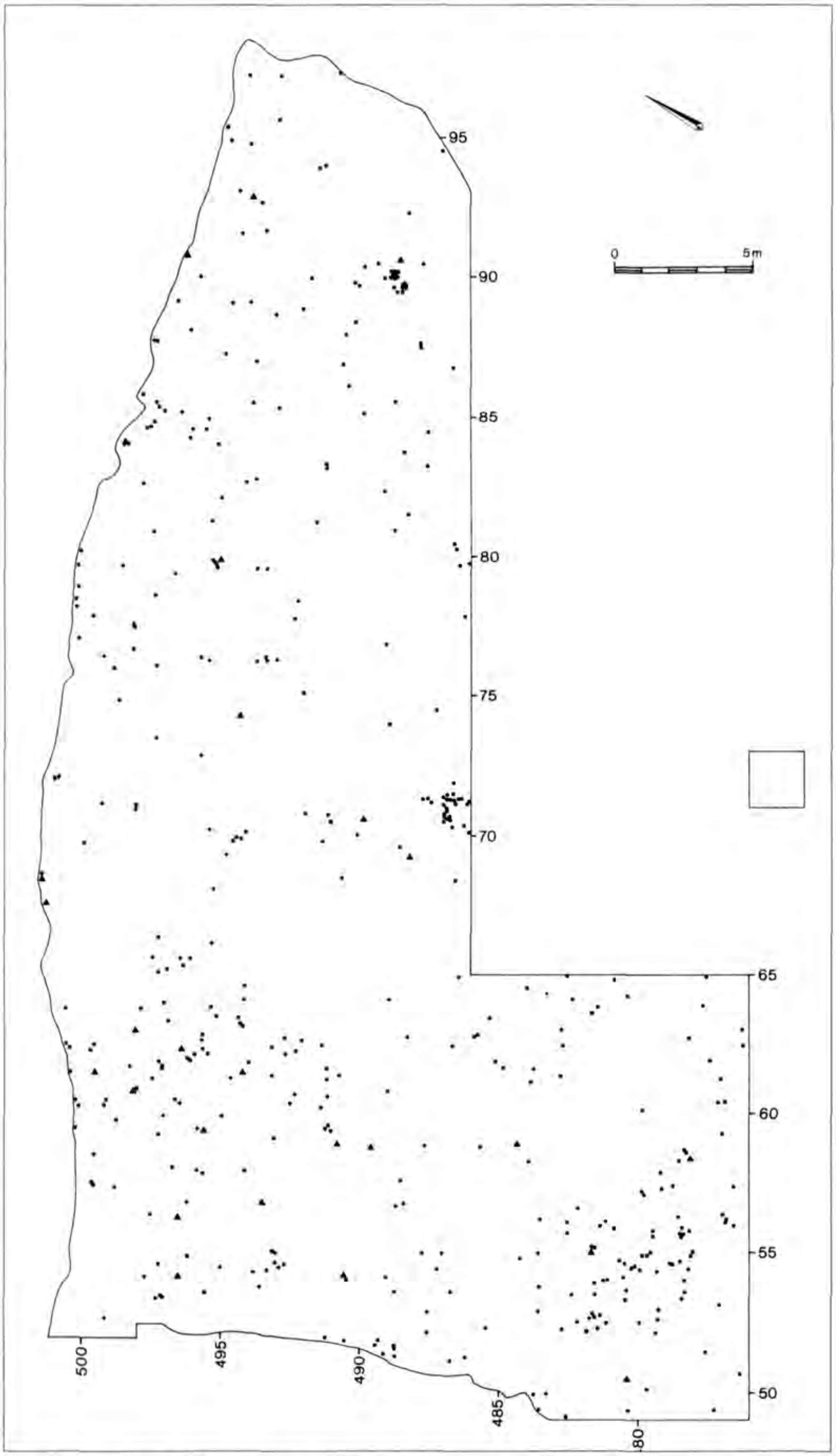


Figure 7. Map of the Site N excavation area, showing the horizontal distribution of flint artefacts (triangles stand for tools, dots for other artefacts, including tiny chips). Coordinate system in m.

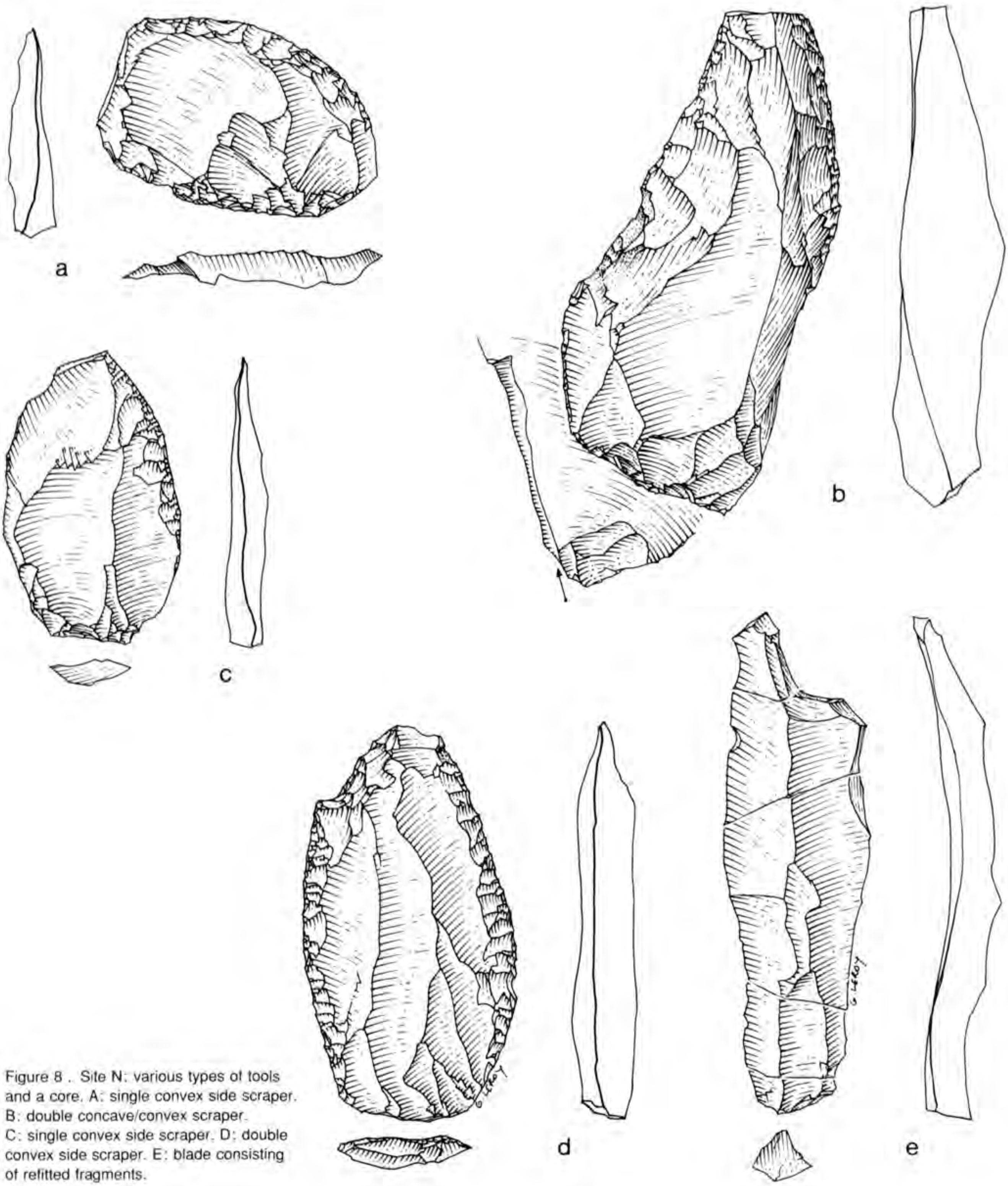
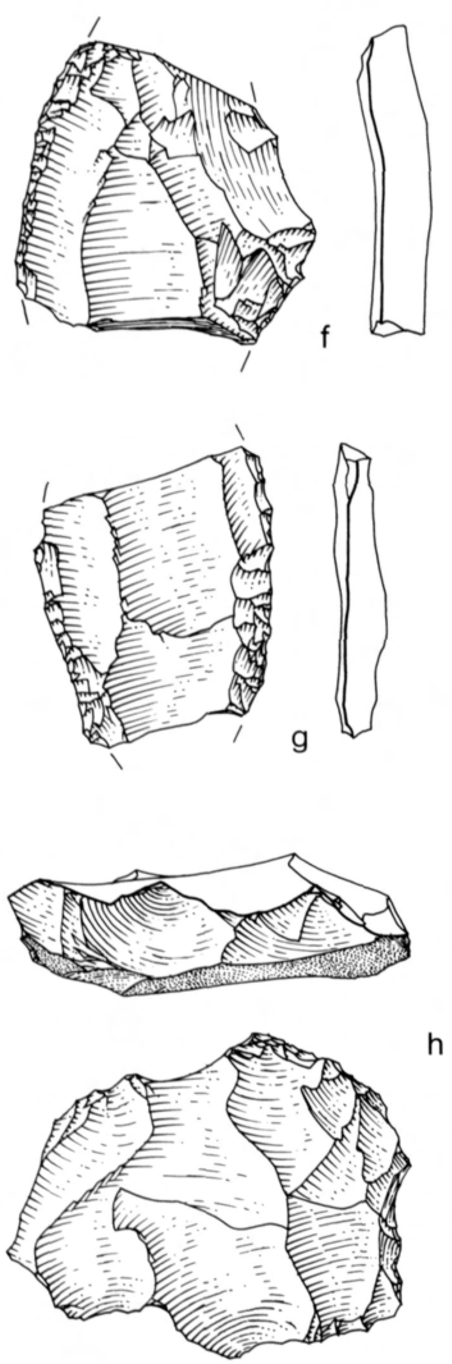


Figure 8 . Site N: various types of tools and a core. A: single convex side scraper. B: double concave/convex scraper. C: single convex side scraper. D: double convex side scraper. E: blade consisting of refitted fragments.



F&G: double straight/convex side scraper.
H: disc core. Scale 2:3.

and of the broken artefacts are shown in figure 11. The rather large distances between conjoining broken fragments and between dorsal/ventral refits can be seen as indicating some reworking of the material in the shallow meander depression.

Study of the distribution of faunal remains supports this interpretation. The best example is provided by the distribution of the remains of the lower jaw of a red deer mentioned above. The distribution indicates a lateral displacement in the same order of magnitude as that recorded for the flint artefacts.

In an area as large as the Site N scatter some parts may be less disturbed than others; the concentration of very small debris in and around square 85/497 in the central-southern part of the excavation might for instance indicate that a small knapping event was well preserved there, while the horizontal distances between refitted elements in the eastern part of the excavated area (fig. 12) are considerably smaller than those from the western half.

3. Interpretation and discussion

Judging from the variety of the raw materials present and the refitting data of the small assemblage, a large part of the artefacts discarded were introduced to the site as isolated pieces. Among them are tools that had been previously resharpened many times. These tools were made elsewhere, and discarded away from their place of manufacture. Here Isaac's distinction (1981) between locations where the technology was maintained and locations where it was used in direct subsistence or 'non-maintenance' activities seems to make sense. At the denser patches like Site C, F and K maintenance of technology took place, as reflected in the accumulations of flint debitage, while the Site N scatter might reflect the use of technology in other activities. This interpretation has some implications for our understanding of the archaeological record and these will be discussed here briefly in terms of four issues: firstly, the implications for our understanding of ancient technologies, secondly the interpretation of the 'classical' sites (patches) as related to the scatters, thirdly, the data used in the current discussions on former subsistence strategies, and fourthly, the implications for fieldwork and aspects of site conservation in the domain of cultural resource management.

Firstly, low-density sites can give us new kinds of information on the 'function' of stone artefacts. Almost all of the artefacts present at the Site N scatter were imported, selected from the products of previous knapping episodes. This makes the presence of 'core trimming flakes' conspicuous. As mentioned above, 11 of such backed knives are present in the assemblage, flakes with a sharp cutting edge and a back consisting of the side of a core.

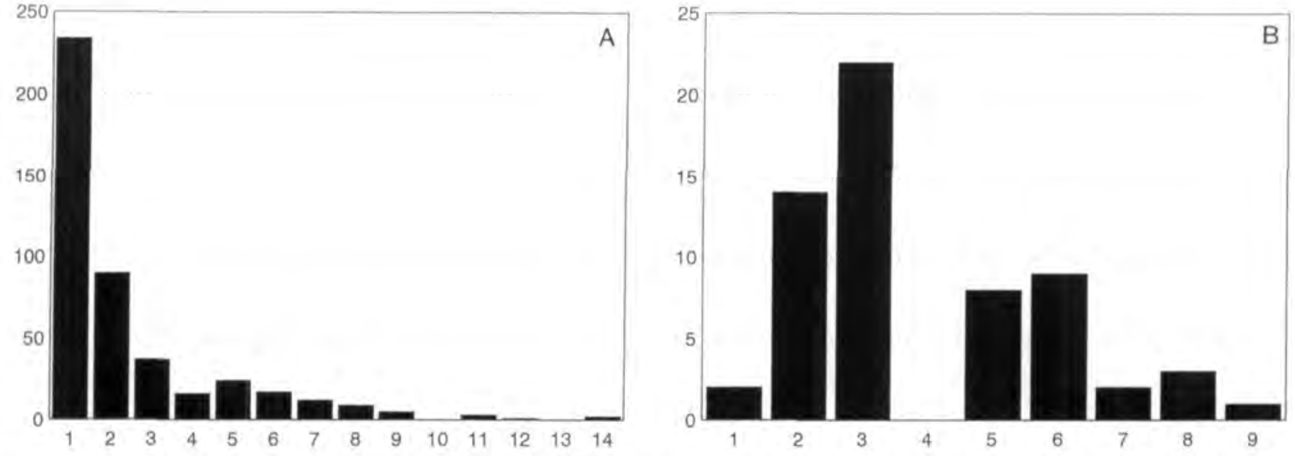


Figure 9. Size distribution of the Site N flint assemblage (a; n=450)) and of the refitted artefacts (b; n=71); maximal dimension in cm.

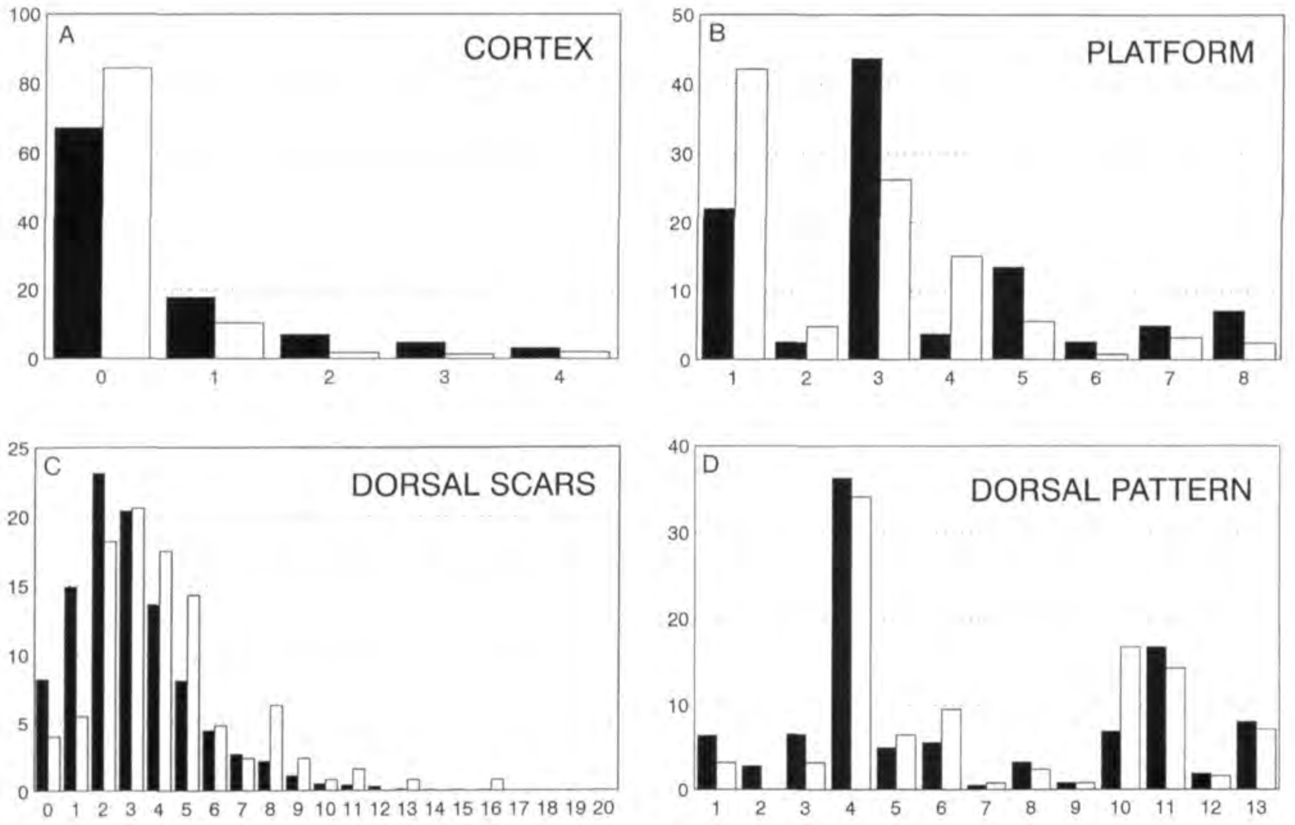


Figure 10. Some technological characteristics of Site N flakes larger than 2 cm (white bars, n=126) compared to the same variables from the Site K assemblage (black bars, n=3687).

A: Cortex: 0= no cortex, 1=< 25% of the dorsal surface, 2=25 to 50%, 3=50 to 75%, 4=75 to 100%.

B: Platform: 1=missing, 2=cortical, 3=plain, 4=facetted/retouched, 5=dihedral, 6=polyhedral, 7=punctiform, 8=indeterminate

C: Number of dorsal scars

D: Dorsal pattern: 1= Cortical, 2=natural cleavage plain, 3= plain, 4="parallel" unidirectional, 5=convergent unidirectional, 6= centripetal or radial, 7=ridge, 8=lateral unidirectional, 9="parallel" opposed unidirectional, 10="parallel" bidirectional, 11="parallel" + lateral unidirectional, 12=opposed + lateral unidirectional, 13=indeterminate.

Table 2. A comparison of the Unit IV primary-context sites.

	area	number of artefacts found				ratio		density/m²	
site	excavated (m²)	tools & -fragments	cores	flakes & chips	total	tools:waste	cores:waste	artefacts	tools
B	20	-	-	5	5	-	-	0.25	-
C	264	3	4	3060	3067	1:1020	1:765	11.6	0.01
F	42	1	1	1213	1215	1:1213	1:1213	28.9	0.02
G	50	3	-	48	51	1:16	-	1.0	0.06
H	54	12	-	254	266	1:21	-	4.9	0.22
K	370	137	91	10684	10912	1:79	1:117	29.4	0.37
N	765	26	1	423	450	1:16	1:423	0.6	0.03

Table 3. A typological survey of the Site N flint assemblage.

	type	number	%	number complete	% complete
6	Mousterian point	1	3.9	1	16.7
10	simple convex-side scraper	6	23.1	1	16.7
13	double straight-convex side-scraper	2	7.7		
15	double convex side-scraper	1	3.9		
17	double convex-concave side-scraper	1	3.9	1	16.7
37	atypical backed knife	3	11.5		
38	naturally backed knife	1	3.9	1	16.7
43	denticulate	1	3.9		
98	pieces with signs of use	9	34.6	2	33.3
99	retouched pieces	1	3.9		
TOTAL		26	100.3	6	100.1

Judging from the variety of their raw materials they derive from at least 6 different cores, and they must have been struck outside the excavated area, as no debris could be refitted to them. In the context of this site — and certainly at Site G, discussed below — they were obviously more than just waste of the *remise en forme du nucléus pour une deuxième série d'enlèvements*, as technologists studying the *chaînes opératoires* often describe them (*cf.* Boëda *et al.* 1990, 61; but see also: Beyries/Boëda 1983). Such an observation puts the whole practice of ordering debitage products into "preparation" and "selected" items into question.

The second issue is related to the fact that, at least at Belvédère, "rich sites" are present against the background scatter of isolated artefacts. This implies that at least some of the artefacts excavated in the patches have nothing to do whatsoever with the activities that produced the majority of the finds from these patches. And in fact, one can actually 'see' these isolated objects within the 'richer sites'. About 100 metres to the north of the Site N scatter, for instance, we excavated Site K, a patch with about 11,000 artefacts recovered from an area of 370 square metres, in a stratigraphic position comparable to Site N (De Loecker 1992, 1994; Roebroeks 1988). 91 Cores were present in the assemblage — mainly discs and discoidal ones — and 111 *sensu stricto* tools, mainly scrapers. Judging from the large amount of refits and their spatial patterns the material was recovered in primary context. In the more than 1,100 refits established at present hardly any of the 111 *sensu stricto* tools and tool fragments have been incorporated, and judging from the raw materials — different from those of the refitted knapping debitage and cores — this will not change significantly. We do not suggest here that all these tools were discarded during events totally unrelated to the production of the 99% rest of the material, as part of the background scatter produced before and/or after the knapping events took place. The 'Veil'-model however implies that we have to deal with this possibility, and that we can not simply assume that the tools and debitage were discarded in one continuous use of the place: simply put, tools could have been discarded in activities that had nothing to do with the visits during which the huge accumulation of flaking debris was produced and this shows the importance of dealing with the Veil for the interpretation of a site, be it on aspects of typology, technology, spatial distribution of tools, *etc.*

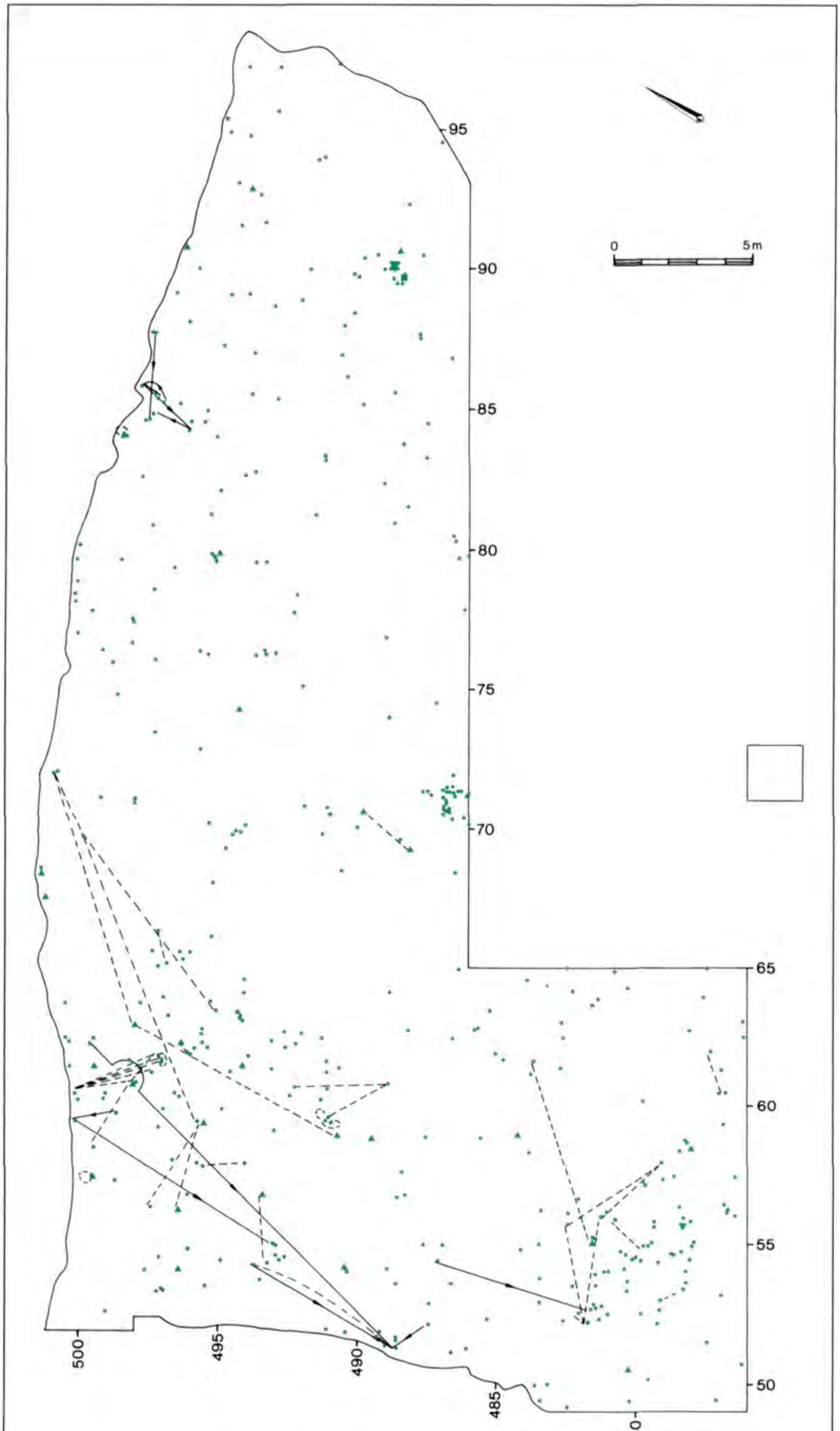


Figure 11. Map of the Site N excavation area, lines indicating the liaisons between refitted artefacts: dashed lines indicate refits between broken artefacts, dorsal/ventral refits are indicated by solid lines following the reduction sequence as indicated by the arrows.

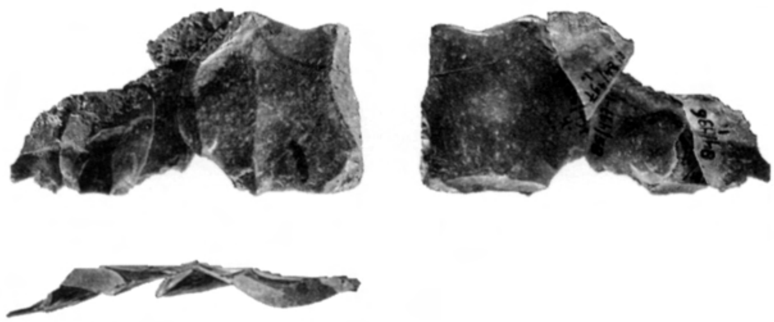


Figure 12. A group of five refitted flakes, from the eastern part of the excavated area (scale 2:3).

Another perspective given by the Veil-approach is its focus on the context of a "site", assessable in terms of the character of the Veil surrounding it. In the main level at Belvédère the background scatter is conspicuously present, very probably with significant variations in density according to such factors as rate of sedimentation, accessibility of specific areas and distributions of former resources. Higher up in the stratigraphy a flint rich patch was excavated in a rescue dig in 1986, encased in Early Weichselian loess with an estimated age of about 80,000 years (Roebroeks 1988; Roebroeks *et al.* 1987). This site, only partially excavated, yielded 2,800 flint artefacts of which about 40% was refitted sofar. In comparison to the Early Saalian scatters and patches, this Early Weichselian patch Site J was surrounded by sediments that over the pit area were considerably less rich in terms of the background scatter, and the site really seems to have been 'parachuted' there. One could suggest that in the Early Weichselian the Belvédère area was used in a completely different way by the hominids responsible for the formation of the Site J assemblage: 170,000 years earlier the Veil was formed in a river valley whose waters covered the finds with finegrained deposits. Around 80,000 BP the river had cut metres deeper and the site was on the edge of a terrace, vertically separated from the main find level by about three metres of Saalian loess-like sediments. The Veil-model thus adds a new attribute to describe and analyze sites: the character of the background scatter, that can testify to a rather intensive use of an area or, alternatively, can tell us whether a site fell out of the air, so to speak. Differences like these are, of course, important to assess the former uses of landscapes, and to detect chronological shifts in these. The Belvédère main-level scatters and patches seem to have been formed in a riverine area that was frequently visited by late Middle Pleistocene hominids. Comparable evidence is known from many Middle Pleistocene sites. In fact, almost all well preserved palaeolithic sites come from such fluvial settings, but only rarely does one pay explicit attention to the background scatters there. Studying these background scatters is relevant for our understanding of how earlier humans moved through the landscape, whether they operated out of base camps, like modern hunter-gatherers, or whether "rich sites" are just the results of accumulations of materials over many, independent episodes of use of a location.

Thirdly, if it makes sense to differentiate between places where technology was maintained and places where it was used, one could argue that we use a biased sample of archaeological sites for answering questions on earlier subsistence strategies, as the majority of the data on this topic are coming from various forms of flint rich patches and only few are from low density distributions. At Belvédère there was only one site where we could make rather positive statements about the relationship between bones and stones. Other sites yielded only a spatial relationship between lithics and faunal remains. The site just mentioned was a low-density distribution again, Site G. This site (Roebroeks 1988) contained some very fresh artefacts, that were studied for traces of use (Van Gijn 1988). For one of the artefacts, a typical *éclat débordant*, Van Gijn inferred that it had been used to cut the hide of an animal with a thick skin, a rhino or an elephant. The traces observed matched traces for instance obtained in her own experiments with elephant skin. At the time of her study of the artefacts Van Gijn had no knowledge of the presence of faunal remains at this scatter. In actual fact, the backed knife was indeed found amongst rhino remains. The artefact distribution of Site G was also very clearly only a small part of a larger horizontal continuum, reflecting the former, spatially continuous, use of the landscape by mobile groups.

Finally, the Veil-model has implications for the way we deal with archaeological remains both in terms of fieldwork and in cultural resource management. It is clear that, in order to put sites in their larger spatial context, we will have to pay more attention to the background scatter. Whether such a documentation has to take place by means of excavation, as reported here for the Site N scatter, or by means of the section-surveying techniques described by Isaac (1981) is another, secondary problem. Paying attention to this kind of distributions is a logical outcome of the trend in increasing the scale of excavations and digging larger surfaces in order to obtain better and new information on earlier forms of land use. This trend reflects the recent shift in palaeolithic archaeology towards the development of a kind of 'landscape archaeology' (*cf.* Villa 1991). In cultural resource management we should not only try to preserve the 'classical' patches, but indeed also the relatively sterile blankets of sediments surrounding them. This already is important for geological and palaeoecological studies, but the "Veil" adds an extra dimension to this discussion: for the interpretation of a site knowledge of the character of its artefactual surroundings is of crucial importance.

In short, we have to start discussing the incorporation in our studies, as well as in the management of the archaeological 'heritage', of the 'non-site' distributions discussed here. These distributions, preserved in sediments or even as surface scatters, yield important information on earlier land use patterns and earlier subsistence strategies. By concentrating only on the 'classical' patches, we might, to paraphrase the title of a paper by Binford (1987) indeed be "Searching for Camps, but Missing the Crucial Evidence".

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Variabilité ou spécialisation fonctionnelle? Une révision du rapport entre forme et fonction au Moustérien

Dans cet article nous avons vérifié si, dans les industries lithiques moustériennes, certains types d'outils peuvent avoir une spécialisation en ce qui concerne les actions effectuées. Se concentrant plutôt sur l'étude des corrélations possibles entre le type et la matière travaillée, les recherches précedentes ont peu examiné cet aspect.

Nous avons étudié quelques-uns des types les plus représentés dans les industries lithiques moustériennes et nous avons analysé leurs caractéristiques fonctionnelles en utilisant les données tracéologiques de l'industrie lithique de Grotta Breuil (Latium, Italie) et d'autres gisements en Europe et au Proche-Orient. La comparaison types-fonctions a démontré que les pointes et les racloirs convergents accomplissent plusieurs fonctions, tandis que les couteaux à dos, les encoches, les denticulés et les autres racloirs présentent une certaine spécialisation en ce qui concerne les actions effectuées.

1. Introduction

Pour analyser le rapport qui existe entre la forme et la fonction des pièces lithiques préhistoriques il faut connaître les variables morphologiques que les hommes préhistoriques prenaient en considération en choisissant une pièce plutôt qu'une autre pour accomplir une certaine action ou pour travailler une certaine matière.

L'observation ethnographique des groupes humaines qui, aujourd'hui encore, utilisent la pierre taillée ou qui en gardent la mémoire récente, a souligné que c'est la morphologie du tranchant plutôt que la morphologie de la pièce qui détermine le choix fonctionnel. Surtout l'angle du tranchant est important; s'il est peu épais, il est choisi pour des actions longitudinales de découpage ou d'amincissement; s'il est épais, il est choisi pour des actions transversales en percussion posée (raclage, rabotage etc…) ou en percussion lancée (hacher etc…) (Gould *et al.* 1971; White *et al.* 1977).

La morphologie de la pièce gagne en importance dans le cas où une signification symbolique se superpose à la fonction (voir, par exemple, le *pitjuru-pitjuru* des Aborigènes du désert occidental de l'Australie, un petit éclat avec une zone pointue épaisse et étroite qui est utilisé par les mâles adultes pour graver des dessins sacrés sur des objets en bois; Gould *et al.* 1971, 155).

Les données ethnographiques nous montrent que la morphologie du tranchant détermine l'utilisation d'une pièce pour une fonction donnée et qu'il n'y a que très peu ou point de standardisation de la forme des pièces en rapport avec leur fonction, à l'exception des cas où cette forme obtient une valeur symbolique. L'observation qu'il y ait si peu de caractérisation morphologique de ces *tool kits*, est attribuée par les chercheurs au fait qu'aujourd'hui la plupart des groupes ont des outils métalliques avec lesquels ils accomplissent toutes sortes de fonctions et que, en général, ils utilisent la pierre de façon occasionnelle pour satisfaire des besoins immédiats (Cross 1983).

Ces considérations pourraient expliquer le contraste entre les industries lithiques ethnographiques et les industries préhistoriques qui, au contraire, présentent beaucoup de formes récurrentes, classées en types par les archéologues.

Les types pourraient donc se rapporter à des fonctions différentes, les caractéristiques morphologiques qui les individualisent n'ayant aucune rélation avec une fonction spécifique?

L'analyse tracéologique a souligné que pour l'homme préhistorique, de façon analogue à ce qu'on a pu observer dans des milieux ethnographiques, le tranchant, soit retouché, soit brut de retouche, avait un rapport prioritaire avec la fonction.

En effet, il paraît que la morphologie du tranchant en général et l'angle du tranchant en particulier sont très importants pour le choix des actions à effectuer et, de façon mineure, des matières à travailler (Van Gijn 1990).

Néanmoins, l'analyse fonctionnelle a démontré qu'il y a une certaine relation entre la forme et la fonction pour certains types qui se rapportent soit au Paléolithique Supérieur, soit au Néolithique.

Par exemple, dans le Paléolithique Supérieur et Final les fronts retouchés des grattoirs, qui constituent presque toujours la partie active de ces pièces, ont été utilisés surtout pour le traitement (raclage, assouplissage, épilage etc.) de la peau humide ou sèche. Dans le Mésolithique et le Néolithique, la fonction des fronts des grattoirs est moins spécifique par rapport aux matières travaillées; néanmoins, les actions effectuées sont presque toujours le raclage et l'amincissement (Juel Jensen 1988).

Un rapport étroit entre forme et fonction a été démontré pour les «quartiers d'orange», un type de pièce lié aux sites de la culture LBK du Néolithique Ancien de l'Europe du Nord. Ces pièces-ci présentent toutes un poli caractéristique, le poli «23», produit par une ou plusieures matières encore inconnues travaillées toujours avec un movement transversal (Van Gijn 1990).

Quant aux industries moustériennes du Paléolithique Inférieur et Moyen, les études fonctionnelles paraissent avoir montré qu'il n'existe aucune relation entre la forme et la fonction. Des types différents ont effectué les mêmes fonctions; un outil peut avoir accompli des fonctions différentes avec un ou plusieurs de ses tranchants, retouchés ou bruts de retouche (Anderson-Gerfaud 1981; Beyries 1987). L'unique exception à ce manque de rapport entre la forme et la fonction paraît le cas des encoches liées surtout au travail du bois (Beyies 1987).

A notre avis, cette conclusion qui nie l'existence d'un certain rapport entre la forme et la fonction des outils utilisés dans les industries du Moustérien, devrait être revisée à la lumière de quelques considérations.

Avant tout, dans ces études on n'a pas mis suffisamment l'accent sur la fonction du tranchant ou des tranchants qui déterminent le type d'outil; il est évident que, quand on examine tous les tranchants utilisés (retouchés et bruts de retouche) de chaque outil, on conclura presque toujours que ces outils ont accompli des fonctions les plus différentes.

De plus, on a considéré comme spécialisation fonctionnelle le rapport éventuel entre un type de pièce et le travail d'une matière spécifique, tandis qu'on n'a pas pris en considération le rapport entre le type et les actions effectuées.

Enfin, les industries anciennes telles que celles du Paléolithique Moyen et, encore plus, celles du Paléolithique Inférieur présentent des problèmes de consérvation des polis qui parfois ne permettent pas de les identifier ou qui en permettent une évaluation plutôt générique (par exemple, on peut identifier le mouvement effectué, mais pas l'action spécifique; il y a parfois des polis d'usage peu développés dont il est impossible de retrouver la matière qui les a produits). Ce manque de «détails» pourrait réduire les différences et donner la fausse impression qu'avec toutes sortes de pièces on a accompli toutes sortes de fonctions.

Le but de cette étude est de réviser les données fonctionnelles de quelques-uns des types les plus représentés dans les sites moustériens pour examiner s'ils ont une spécialisation en ce qui concerne les actions effectuées.

De chaque type étudié nous donnerons la définition de François Bordes. Cela nous permet de connaître précisément les caractéristiques qui déterminent le type et de savoir si Bordes leur attribue directement ou indirectement des significations fonctionnelles.

Ensuite, nous considérerons comme *case study* les outils de l'industrie de Grotta Breuil (Latium, Italie) dont l'auteur est en train d'achever l'analyse tracéologique (Grimaldi/Lemorini 1993; Lemorini 1990/1991). Nous prendrons en considération, type par type, les données fonctionnelles de 78 outils qui proviennnent de la couche la plus ancienne du gisement, la couche XX (n= 52 outils), des couches supérieures 3,4 et 5 (n= 16 outils) et des deux couches intermédiaires, les couches XI et XII (n= 10 outils) (Bietti *et al.* 1990/1991).

Pour chaque type examiné nous présenterons aussi les données fonctionnelles des industries lithiques des couches moustériennes d'autres gisements en Europe et au Proche-Orient. De cette façon nous pourrons vérifier si les caractéristiques fonctionnelles de chaque type changent selon le site ou si elles ont une validité plus générale.

Il s'agit de plusieurs sites français: les grottes de Vaufray et du Renne (Arcy-sur-Cure), les grottes/abris de Combe-Grenal, de Morillac et de Pech de l'Azé I et IV, l'abri de Pie Lombard, les sites en plein air de Corbehem, de Riencourt-lès-Bapaume, de Biache-Saint-Vaast et de Corbiac (Anderson-Gerfaud 1981; Beyries 1987, 1988, 1993); de deux gisements en l'Arménie: Yerevan I et Lusakert I (Kazaryan 1993) à l'industrie obsidienne; de la grotte de Taglar (Azerbaïdjan) et de la grotte de Sakajia (Géorgie) (Shchelinskij 1993); de quelques sites au Proche-Orient: les grottes de Kebara, de Tabun, de Hayonim (Israël) et l'abri de Tor Faraj (Jordanie) (Shea 1993).

2. Les pointes (figs 1, 2g)

«Nous appellerons pointes des objets dont la première caractéristique sera d'être pointus» (Bordes 1981, 37).

Les cinq pointes de Grotta Breuil que nous avons analysées (trois pointes levallois, une pointe pseudo-levallois, une pointe moustérienne) n'ont été utilisées ni comme perçoirs ni comme projectiles.

Nous n'avons jamais trouvé des traces d'utilisation sur les zones pointues. Au contraire, nous avons toujours individualisé des traces sur les tranchants latéraux, avec lesquelles surtout des actions transversales en percussion posée ont été effectuées (nous avons reconnu des actions de rabotage et de raclage) et, en deux cas, des actions longitudinales. Avec ces pièces-ci on a travaillé surtout des matières demi-dures[1] et dures[2]. Les données tracéologiques montrent qu'on effectuait plusieures actions différentes avec les pointes en utilisant les tranchants latéraux et pas forcément la zone pointue.

Cette observation vaut aussi pour d'autres industries lithiques moustériennes.

	TYPE			ACTIONS					MATIERES											
		No. outils	No. tranch.	Transv.	Long.	Rot.	Mixte	Indét.	Teindre	D. dure	Dure	Tiss. ch.	Peau	Os	Peau/Os	Bois	Bois/Plantes	Bois/Os	Bois an	Indét.
3	Pointe levallois	3	5	3	2					1							2		2	
5	Pointe pseudo levall.	1	2	2							1		1							
6	Pointe moustérienne	1	2	2												2				
9	Racl. simple droit	11	11	9	1			1				2	2	2		1		1		3
10	Racl. simple convexe	19	17	13	2			2		1		3	3	2		4			1	3
11	Racl. simple concave	4	4	2	2								1							3
12	Racl. double droit	1	1	1												1				
13	Racl. double convexe	1	2					2				2								
14	Racl. double concave	1	1	1									1							
15	Racl. double biconvexe	1	2	1	1															2
17	Racl. d. convexe-concave	1	1	1							1									
18	Racl. convergent droit	1	1			1							1							
19	Racl. converg. convexe	1	1			1					1									
20	Racl. converg. concave	3	5	5									2			3				
21	Racloir déjeté	4	5	4				1			1		2							2
22	Racl. transv. droit	3	4	3	1								3							1
23	Racl. transv. convexe	4	5	3	1		1				1	1				2				1
24	Racl. transv. concave	2	2	2									1		1					
27	Racl. à dos aminci	1	1				1									1				
29	Racl. à retouche alterne	2	3	1	2														2	1
38	Couteau à dos nat.	6	6	4	1		1		1	4									1	
42	Encoche	7	7	6			1			1	3			1		1				1
43	Denticulé	3	3	3						1	1	1								
	Total	81	91	66	13	2	4	6	1	8	9	9	17	5	1	15	2	1	6	17

Figure 1. Grotta Breuil. Tableau des actions faites et des matières travaillées par chaque type d'outils. Nous avons pris en considération seulement les tranchants qui caractérisent les types. Deux matières divisées par une barre (/) témoignent une identification incertaine de la polis.

En effet, les pointes ont été utilisées surtout pour couper ou comme projectiles dans les industries lithiques du Proche-Orient; celles qu'on a trouvées dans la grotte de Taglar ont servi comme outils de découpage et de perçage et comme projectiles et celles de la Grotte de Sakajia ont été utilisées aussi pour des actions transversales. Près du site en plein air de Riencourt-lès-Bapaume, les pointes ont été utilisées pour percer de la matière dure, tandis qu'à Biache-Saint-Vaast les tranchants latéraux seulement ont été utilisés pour des actions soit longitudinales, soit transversales. Enfin, dans les deux gisements de l'Arménie, Yerevan I et Lusakert I, les pointes ont été utilisées pour faire de la boucherie.

Les données présentées nous montrent que ce type est caractérisé par trois zones potentiellement fonctionnelles, les deux tranchants latéraux et la pointe. La «zone pointue» accomplit des actions spécialisées (elle est utilisée comme perçoir ou comme projectile); au contraire, les tranchants latéraux effectuent des actions variées soit longitudinales, soit transversales, en percussion posée.

Nous pouvons conclure que les pointes ont une forme qui leur permet d'accomplir plusieurs actions et que celle-ci est la caractéristique spécifique du type.

3. Les racloirs (figs 1, 2a)

«Nous appellerons racloir un objet fait sur éclat ou lame, Levallois ou non, par retouche plate ou abrupte, écailleuse ou non, d'un ou plusieurs bords, de façon à donner un fil semi-tranchant, droit, convexe ou concave, sans encoche ni denticulation volontaire marquée. .... Contrairement à une opinion assez répandue, nous pensons que la retouche du racloir ne tend nullement à l'aiguiser (rien n'est aussi tranchant que le bord brut d'un éclat frais de silex ou d'obsidienne), mais au contraire à l'émousser partiellement tout en le régularisant, et à lui donner ainsi plus de résistance pour un travail de raclage, travail effectué perpendiculairement à l'allongement de l'objet.» (Bordes 1981, 50).

Les données fonctionnelles concernant Grotta Breuil nous ont montré que parmi les 67 racloirs examinés, il n'y a que sept qui ne présentent aucune trace d'usage sur les tranchants retouchés. De plus, parmi les 91 tranchants avec des traces d'usage identifiées sur les racloirs, il y en a 66 (73%) qui sont retouchés. Donc, il parait que, du point de vue fonctionnel, les tranchants retouchés sont les parties les plus significatives de ces outils (voir aussi, pour des résultats pareils, Beyries 1987, 1988).

Des 66 tranchants retouchés 46 (70%) ont accompli des actions transversales en percussion posée; en particulier, 20 tranchants ont effectué du raclage, deux du rabotage, un seul de l'assouplissage (de peau) et 23 ont effectué des actions transversales indéterminées.

Parmi les autres tranchants il y en a dix (15%) qui ont été utilisés pour des actions longitudinales, deux pour le perçage (3%) et deux pour des actions mixtes (3%); sur les six tranchants (9%) qui restent nous n'avons pas pu déterminer les actions effectuées.

Quant aux matières travaillées, seulement les tranchants aux actions transversales présentent une certaine préférence pour le travail de la peau (15 cas, 32%) et du bois (10 cas, 21%). Néanmoins, la signification de ces données est plutôt relative parce qu'il y a dix tranchants qui ont un poli indéterminé.

L'utilisation des tranchants retouchés surtout pour des actions transversales en percussion posée est aussi observée sur les racloirs qui proviennent de quelques gisements moustériens au Sud-Ouest de la France (Anderson-Gerfaud 1981) et sur les racloirs du site de Riencourt-lès-Bapaume (Beyries 1993), où on a spécifiquement du raclage et du rabotage du bois.

Quant aux sites de Corbehem, d'Arcy-sur-Cure, de Morillac, de l'abri Pie Lombard, de la grotte de Vaufray, et de la grotte/abri de Combe-Grenal, Sylvie Beyries ne parle pas des actions effectuées; toutefois, elle souligne que les tranchants retouchés ont été utilisés surtout pour travailler du bois.

Au contraire, les recherches sur le site de Biache-Saint-Vaast ont donné des résultats en partie différents (Beyries 1988). Dans ce site-là, on a utilisé les «racloirs courts» pour le découpage des matières animales.

Nous pouvons conclure que les racloirs présentent, en général, une spécialisation de leurs tranchants retouchés pour des actions transversales en percussion posée, avec une certaine préférence pour le raclage. De plus, il paraît que les matières les plus travaillées avec ces tranchants sont le bois et la peau.

Toutefois, en quelques cas particuliers, quand l'angle du tranchant est plutôt aigu (et cela arrive si le support de l'outil est peu épais et la retouche est plate comme dans le cas des «racloirs courts» de Biache-Saint-Vaast, mais aussi dans le cas de certains racloirs de Grotta Breuil; voir, Grimaldi/Lemorini 1993) la morphologie des tranchants est plus indiqués pour des actions de découpage de matières tendres.

4. Les racloirs convergents (figs 1, 2b)

Ce type-ci présente des caractéristiques fonctionnelles qui diffèrent partiellement de celles des autres racloirs. En effet, sa morphologie, qui est presque pareille à celle des «pointes» (il a deux tranchants latéraux et une zone pointue), lui donne des possibilités fonctionnelles plus variées.

Même l'indétermination des définitions que Bordes utilise pour distinguer entre pointes moustériennes et racloirs convergents (Bordes 1981, 38, 43) témoigne de cette ressemblance, ce qui cause de grandes difficultés pour la classification en types.

Les cinq racloirs convergents de Grotta Breuil présentent, en trois cas, des actions transversales sur les tranchants, tandis que, en deux cas, ils présentent du perçage sur la zone pointue.

Il y a aussi d'autres industries lithiques où ce type a un haut niveau de variabilité fonctionnelle. Dans des sites du Proche-Orient (Shea 1993) les racloirs convergents ont été utilisés comme projectiles, comme racloirs, comme perçoirs et comme couteaux. A Biache-Saint-Vaast ils n'ont jamais été utilisés sur la zone pointue, mais seulement sur les tranchants pour effectuer des actions transversales et longitudinales (Beyries 1988). Enfin, ils ont été utilisés comme des couteaux de boucherie dans les deux gisements de Yerevan I et de Lusakert I (Arménie) (Kazaryan 1993).

Nous pouvons conclure que ce type d'outil présente une forme et des caractéristiques fonctionnelles qui sont tout à fait pareilles à celles des pointes, et donc, dorénavant, nous considérerons les deux comme un type unique.

5. Les couteaux à dos (figs 1, 2e-f)

«On appelle couteau à dos un outil sur éclat ou lame dont un des bords est formé par un tranchant brut, non retouché (mais qui présente des traces d'utilisation) et dont l'autre bord est abattu par retouche ... ou présente une surface de cortex jouant le rôle du dos obtenu par retouche.» (Bordes 1981, 51). D'après Bordes, mais il s'agit d'une définition acceptée par tout le monde, les «couteaux» sont des outils qu'on peut utiliser pour plusieures actions différentes, même si on leur attribue le découpage comme tâche principale (Bordes 1992, 433).

A Grotta Breuil on a individualisé jusqu'à présent six couteaux à dos naturel qui présentent des traces d'utilisation; quatre sont associés à des actions transversales (parmi lesquelles on a reconnu une action de rabotage) sur de la matière dure (3 cas) ou demi-dure (1 cas); les deux autres outils ont effectué respectivement du découpage de

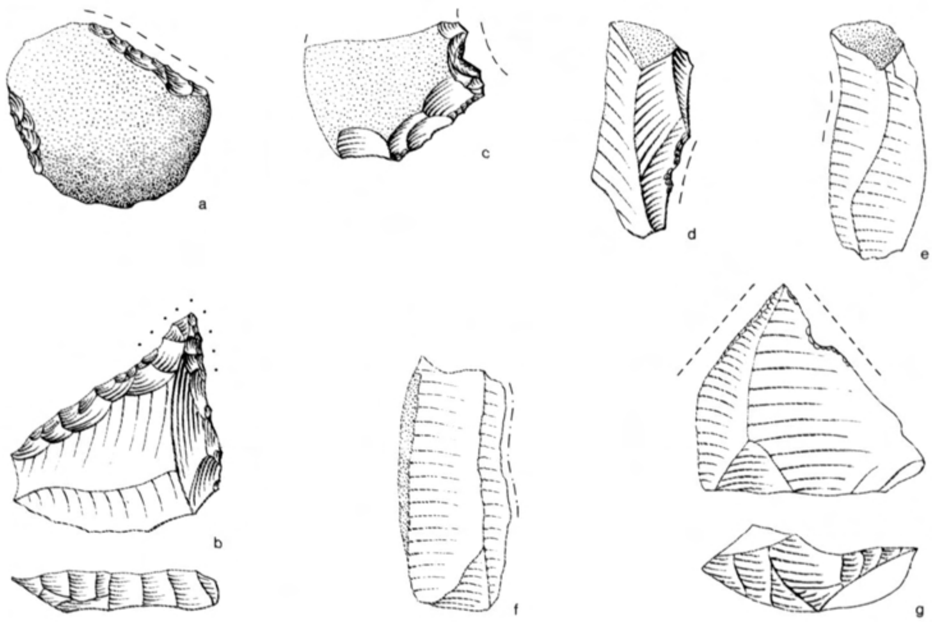

Figure 2. Grotta Breuil: quelques exemples d'outils avec des traces d'usage. **a.** *Racloir transversal* droit; assouplissage de la peau. **b.** Racloir convergent concave; perçage de matière dure. **c.** Encoche; action transversale sur l'os. **d.** Denticulé; Raclage des tissus charnus et de l'os. **e.** Couteau à dos naturel; action transversale sur de la matière demi-dure. **f.** Couteau à dos naturel; découpage de matière teindre. **g.** Pointe pseudo levallois; *1:* raclage de la peau; *2:* action transversale sur de la matière dure. **(-----)** action transversale en percussion posée; **(-.-.-.-)** action longitudinale; **(......)** action de rotation. Dessins de S. Grimaldi (n° 1, 2, 3, 4, 7) et A. Lemorini (n° 5, 6).

matières tendres[3] et de l'amincissement (mouvement transversal + longitudinal) d'une matière demi-dure, probablement du bois.

Dans d'autres sites (Corbehem, la grotte de Vaufray, Combe-Grenal, l'abri Pie Lombard et Riencourt-lès-Bapaume; Beyries 1987, 1993) les couteaux à dos naturel ont effectué surtout le découpage de matières différentes, bien que des actions tranversales soient aussi reconnues.

Selon ces données il paraît donc que les couteaux à dos ont servi surtout pour effectuer le découpage de plusieurs matières, soit tendres, soit dures. Toutefois il faut souligner que, en ce qui concerne les angles du tranchant plutôt épais, on peut avoir des couteaux à dos très propres à des actions transversales comme dans le cas des couteaux de l'industrie lithique de Grotta Breuil.

6. Les encoches (figs 1, 2c)

Bordes a inséré dans ce type les encoches crées par une retouche, mais aussi celles qu'il définit comme «encoches d'utilisation» en disant: «il est probable que certaines petites encoches peu profondes sont dues à une simple utilisation: raclage, par exemple, d'un objet dur à section arrondie.» (Bordes 1981, 55).

Etant donné que la définition typologique de Bordes se base sur une morphologie particulière du tranchant qu'on retrouve même sur des tranchants bruts, nous avons pensé d'assimiler aux encoches retouchées de Grotta Breuil les encoches brutes de retouche qui présentent des traces d'usage. Nous allons présenter les caractéristiques fonctionnelles de trois pièces avec une encoche retouchée et de quatre pièces avec une encoche brute de retouche.

Avec six encoches on a effectué des actions transversales en percussion posée et on a travaillé de l'os (1 cas), de la matière dure (3 cas), de la matière demi-dure (1 cas) et une matière indéterminée. Une seule encoche a été utilisée pour une action mixte d'amincissement du bois.

Ces données confirment l'hypothèse de Bordes que la morphologie de l'encoche crée un tranchant fort, propre aux actions transversales sur de la matière demi-dure et dure.

Cette caractéristique fonctionnelle est observée aussi sur les encoches de Riencourt-lès-Bapaume (France) (Beyries 1993) avec lesquelles on a raclé de la peau sèche. Pour les sites de Corbehem, de la grotte Vaufray, de Combe-Grenal, d'Arcy-sur-Cure et de Morillac les actions effectuées par les encoches ne sont pas indiquées; toutefois, en ce qui concerne les matières travaillées, il y a une certaine préférence pour le travail du bois, suivi par le travail de l'os.

On peut conclure que le type encoche présente une certaine spécialisation fonctionnelle en ce qui concerne les actions effectuées, transversales en percussion posée, mais aussi en ce qui concerne les matières travaillées, qui sont toutes dures ou demi-dures.

7. Les denticulés (figs 1, 2d)

«Ce sont des outils sur éclat ou lame, présentant sur un ou plusieurs bords non adjacents une série d'encoches contiguës faites soit par petites retouches, soit par larges encoches de type clactonien» (Bordes 1981, 54).

Le tranchant denticulé de trois pièces de Grotta Breuil a été utilisé, en deux cas, pour effectuer des actions transversales en percussion posée sur de la matière dure ou demi-dure; un troisième tranchant a été utilisé pour racler des tissus charnus et de l'os.

P. Anderson a déterminé beaucoup d'actions transversales liées au travail du bois sur les denticulés de quelques sites du Sud-Ouest de la France; elle a aussi observé quelques actions de sciage, toujours du bois (Anderson-Gerfaud 1981). A Riencourt-les-Bapaume le seul denticulé analysé présente du travail de décharnage (avec un mouvement transversal) de la peau (Beyries 1993). Une fonction pareille a été individualisée par Shchelinskij sur les denticulés de la station de Novoso I (Beyries 1993). Sur les sites de Combe-Grenal, d'Arcy-sur-Cure, de Morillac et dans la grotte Vaufray, on a travaillé du bois avec des tranchants denticulés.

Il paraît donc, que les tranchants denticulés ont accompli de préférence des actions transversales, telles que le raclage ou le grattage. Le bois est la matière la plus travaillée; néanmoins, les tranchants denticulés paraissent être utilisés aussi pour le traitement des matières animales.

8. Conclusions

En résumant les données présentées ci-dessus, nous avons le schéma suivant:

1. les pointes et les racloirs convergents sont des outils utilisables pour n'importe quelle fonction; ils peuvent être des projectiles ou des perçoirs, mais aussi des racloirs ou des couteaux;
2. les racloirs sont utilisés surtout pour effectuer des actions transversales en percussion posée sur de la matière telle que la peau et le bois;
3. les couteaux à dos sont associés surtout au découpage de matières différentes;
4. les encoches sont associées à des actions transversales en percussion posée et à des matières dures et demi-dures, parmi lesquelles le bois est très représenté;
5. les denticulés s'associent surtout au raclage et au grattage du bois.

D'après ces données nous pouvons conclure que même les industries moustériennes présentent des formes qui sont liées à certaines fonctions. En effet, les racloirs, les couteaux à dos, les encoches et les denticulés ont effectué certains types d'actions qui réapparaissent dans les industries de plusieurs sites dont la localisation géographique et la chronologie est différente.

De plus, nos données ont confirmé ce que d'autres chercheurs avaient souligné précédemment (Anderson-Gerfaud 1981; Beyries 1987), c'est-à-dire que les racloirs, les encoches et les denticulés présentent eux-aussi une certaine spécialisation en ce qui concerne les matières travaillées.

Néanmoins, il faut souligner que la forte présence du travail du bois qui a été déterminée surtout dans les gisements du Sud-Ouest de la France, pourrait être expliquée plutôt par des phénomènes d'altération qui ont déformé les polis d'usage et, par conséquant, les données de l'analogie fonctionnelle, que par une effective spécialisation fonctionnelle au niveau des matières travaillées (Beyries 1991).

Au contraire, les pointes et les racloirs convergents ont une forme non spécialisée qui obtient des caractéristiques fonctionnelles particulières par rapport aux activités effectuées dans chacun des sites étudiés, mais aussi par rapport aux types de matières premières utilisées et aux choix des techniques faits qui déterminent la taille des supports et par conséquent leur morphologie (on peut facilement imaginer la différence en possibilités fonctionnelles entre les grands supports laminaires des industries du Proche-Orient et les petits supports de l'industrie de Grotta Breuil). De plus, il serait intéressant d'examiner si la variabilité fonctionnelle de ces types peut se rapporter même à la présence de différences culturelles entre chaque site ou entre groupes de sites à la localisation géographique diverse.

notes

1 On considère certains types de bois, certaines plantes herbacées et la peau humide comme des matières demi-dures.

2 On considère certains types de bois, la peau sèche, l'os, le bois animal, le coquillage et la pierre comme des matières dures.

3 On considère les tissus charnus, la peau fraîche et certaines plantes herbacées, comme des matières tendres.

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mit einem Beitrag
von C.C. Bakels

Linearbandkeramik aus Meindling, Gem. Oberschneiding, Ldkr. Straubing-Bogen

Inhalt:

Die Absicht der Grabungen in Meindling war, Vergleichsmaterial zu erhalten zu den Hienheimer Resultaten. Nicht nur Fragen zur ältesten LBK, sondern auch zur Botanik hofften wir zu lösen.

Die Hoffnung, einen Hausgrundriß der ältesten LBK zu finden, wurde nicht erfüllt. Leider lagen die Gruben und Gebäudespuren so eng aufeinander, daß sie schwer zu entwirren waren. Die Gebäude 2 und 6 zeigten im Wohnteil eine bis dahin noch nicht festgestellte Pfostenkonstruktion, welche als Krüppelypsilon umschrieben ist. Seitdem ist diese Eigentümlichkeit an mehreren Fundstellen der LBK in Niederbayern entdeckt worden. Die Gebäude 1, 2 und 3 sind an der gleichen Stelle erbaut worden. Meines Wissens ist es das erste Mal, daß ein solcher Befund aus der LBK bekannt wird.

Selten sind auch Öfen, wovon ein Beispiel ausgegraben werden konnte.

Als bemerkenswerte keramische Funde seien ein vollplastisches Schweinchen und ein Fußgefäß erwähnt. Die mit organischem Material gemagerten Scherben spielen eine nicht genau zu erfassende Rolle bei der Keramik.

Die bis auf eine Ausnahme aus Amphibolit angefertigten Dechsel erreichten die Siedlung offenbar als Fertiggeräte. C.C. Bakels berichtet über diese Fundgruppe. M.E.Th. de Grooth bearbeitete den Silex, worüber in diesem Band ein gesonderter Aufsatz erscheint.

Ausnahmsweise wurde eine Bestattung gefunden. Wie öfters in einer Siedlung, handelte es sich auch dieses Mal um ein Kind. In diesem Falle erreichte es etwa das dritte Lebensjahr.

Das botanische Material wurde von C.C. Bakels bearbeitet. M.E.Th. de Grooth berichtet über Silex und Geräte aus Silex.

Im Vergleich mit Hienheim wurden viel mehr Tierknochen geborgen, welche von A.T. Clason bearbeitet sind.

Viel Mühe haben wir uns gegeben, die Umwelt der Siedlung Meindling besser kennenzulernen. H.A. Groenendijk berichtet darüber separat in diesen Analecta.

1. Einführung

Die Ausgrabungen in Meindling stehen in engem Zusammenhang mit denen in Hienheim, wie schon in der Einführung zum zweiten Teil der Publikation über dieser Untersuchungen mitgeteilt wurde (Modderman 1986). Die Absicht war, zum Abschluß unserer Feldarbeiten zur Donaubayerischen Bandkeramik in einer sechswöchigen Grabung Fragen zu lösen zur Paläobotanik und Archäologie an einer anderen und möglichst älteren Fundstelle. Wir sind zum Gäuboden zurückgekehrt, wo 1964 in Otzing, Ldkr. Deggendorf angefangen wurde. An drei Fundstellen der ältesten Bandkeramik wurden Bohrungen durchgeführt, damit die günstigste Lage gewählt werden konnte. Meindling sollte die besten Verhältnisse bieten, verglichen mit Bachling und Irlbach. Die Fundstelle Meindling ist schon Jahrzehnte bekannt auf Grund der Funde, welche Frau Engl ständig dem Straubinger Museum übergab. Hinter dem Hofe der Familie Ebner-Engl wurde denn auch gegraben (Abb. 1). Wir sind die Familie Engl nicht nur für die Genehmigung zur Grabung, aber vor allem für die reichliche Gastfreundschaft zu großem Dank verpflichtet. Unvergeßlich ist auch die Unterstützung, welche wir seitens Dr.R. Christlein von der bayerischen Bodendenkmalpflege, damals in Landshut, empfangen haben. Am Tage der Bohrungen hat er mir sogar das Mittagsbrot mit einem Hubschrauber besorgt. Viel Dank gebührt auch Herrn und Frau Kohlhäufl aus Oberwalting; ohne Ihre Geländebegehungen sind die Untersuchungen in und rings um Meindling nicht zu denken. Das Gemeindeamt in Oberschneiding war uns in jeder Hinsicht behilflich, wie auch die Gastfreundschaft des Landkreises großartig war.

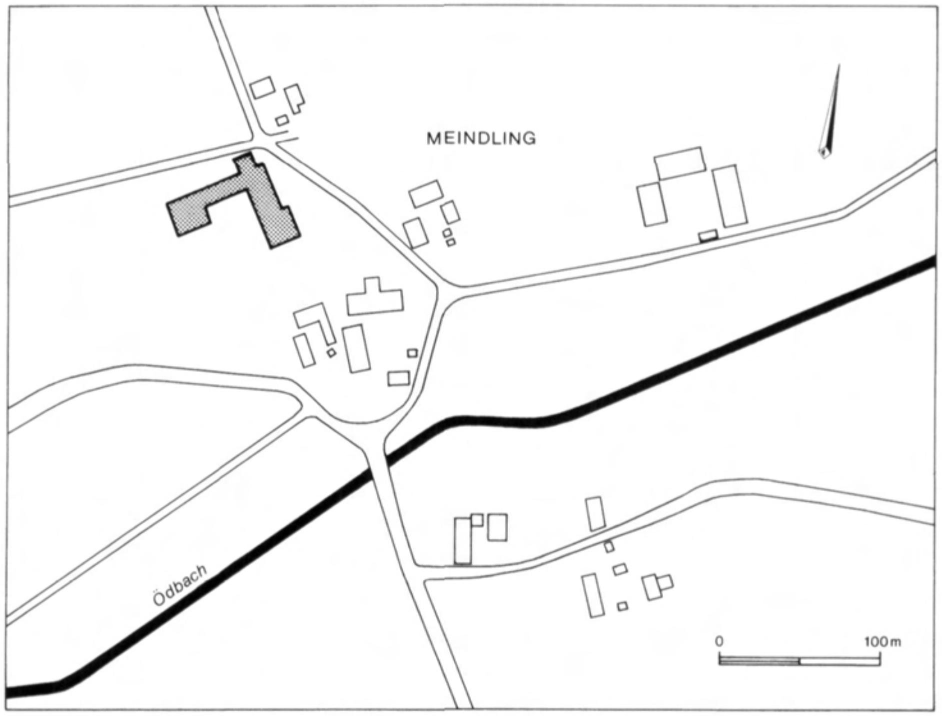

Abbildung 1. Meindling, Lkdr. Straubing-Bogen; Lage der Ausgrabungsfläche (grau).

Es wurde gegraben vom 15.08 bis zum 23.09 1977. Seitens des Instituut voor Prehistorie der Leidener Universität (IPL) waren neben den Autor Herr J.P. Boogerd, Frau Dr.C.C. Bakels und Herr W. Kuijper wieder dabei. Überdies machten die Studenten A.B. Döbken, H. Groenendijk und R.M. van Heeringen sich sehr verdient. Fünf bis sechs Arbeiter waren täglich auf der Grabung. Die Ackerkrume wurde von einem Bagger abgetragen. Bei der Bearbeitung der Funde und Befunde haben die Studenten H. Groenendijk und Frau P. de Groot den Löwenanteil auf sich genommen.

Für die Grabung stand uns eine Fläche von 73 zu 80 m zur Verfügung. Darin befand sich in der Längsrichtung eine Störung von einem ehemaligen Hohlweg, Römerweg genannt. Im Norden war die Störung nur 2.5 m breit, aber auf der Südseite in Richtung des nahe gelegenen Ödbachtales war sie 15 m breit. Überdies wurde das Gelände noch von einem Wasserleitungsgraben geschnitten und zeigten sich während der Grabung im Südosten mehrere rezente Störungen. Am Nordrand der Parzelle an einem Feldweg entlang zeigte sich bei unseren Bohrungen ein gestört anmutender Boden. Es handelte sich um einen grauen Boden, welcher auf dem braunen B2t ruht; aber an der Stelle, wo wir die Lage etwas eingehender studieren konnten, zeigte es sich daß es darin noch Scherbennester gab. Auch oben in den Grubenfüllungen gab es gelegentlich diese graue Erde. Zuerst meinten wir, es wäre eine A2-Bildung, aber andererseits scheint die graue Schicht dazu zu dick. Schon auf 50-60 m der Nordgrenze hatte die Abschwemmung so stark zugegriffen, daß die B-Schicht komplett verschwunden ist. Etwa 120 m südlich des Feldweges befindet sich eine Verbindungsstraße. Unweit davon gibt es eine Geländestufe, welche von der Abschwemmung stark abgeflacht worden ist. Während auf den ersten 100 m von Norden her das Gelände ca 1.50 m abfällt, geht es auf den nächsten 20 m noch einmal 1.50 m herunter. Der heutige Talboden befindet sich 150 m südlich der Straße. Der Höhenunterschied auf dieser Strecke beträgt 3 m. Der Ödbach befindet sich 50 m weiter südlich. Vom Feldweg bis zum Ödbach senkt sich das Gelände 6.25 m. Es steht fest, daß dieser Unterschied ursprünglich größer war. Bohrungen im Talboden zeigten, daß es dort keinen Loess gab, sondern einen grauen, weichen Ton. Die Entwässerung der besiedelten Fläche kann also kaum ein Problem gewesen sein.

Die besten Verhältnisse für eine Grabung befinden sich in einem Streifen von 20-40 m der Nordseite der Parzelle. Wir haben uns nicht auf diesen Teile beschränkt, weil in der sudöstlichen Ecke Scherben der ältesten LBK gesammelt worden waren. An der östlichen Grenze entlang wurde ein bis 30 m breiter Streifen untersucht. Dabei wurden im Südosten zwei Gruben mit nur Scherben der ältesten LBK gefunden, aber leider keine mit Sicherheit dazu gehörenden Pfostenspuren. Im Quadrat F, G-1 waren die Pfosten nur noch erkennbar auf Grund ihres Schattens im C-Horizont. Das heist, daß unter den Pfostengruben eine 5-10 cm dicke B-Formung stattgefunden hatte, wie wir unter besseren Verhältnissen mehr nördlich auf der Grabung feststellen konnten. In F, G-1 waren also die Pfostengruben völlig abgeschwemmt, und man konnte ihre Stellen nur noch wegen dieser Bodenbildung erkennen.

2. Datierung

Auf Grund der Typologie der verzierten Keramik umfaßt die Besiedlung in Meindling die ganze Zeitspanne der LBK. Abgesehen von einigen Münchshöfener Scherben ist das Mittelneolithikum in der Grabungsfläche nicht vertreten.

Es ergab sich die Möglichkeit, an Hand von vier Proben C14-Datierungen durchzuführen, welche alle von der Abteilung für Isotopenphysik des Laboratoriums für Allgemeine Physik der Universität Groningen freundlicherweise übernommen wurden.

Die älteste rührt aus einer »Gerbegrube« (Fundnr. 203) her: 6.380±130 BP, GrN-8687. Klasse C nach Waterbolk 1971.

Die Zweitälteste datiert einen Pfosten aus einer Palisade (Fundnr. 397): 6.190±100 BP, GrN-9139. Klasse A nach Waterbolk 1971.

Die beiden letzten Datierungen stehen wohl in engem Zusammenhang. Die eine gehört höchstwahrscheinlich zu einem Pfosten des Hauses 2 (Fundnr. 301): 6.130±40 BP, GrN-8688, während die andere aus der Füllung der Grube 66 herrührt, welche zum gleichen Hause 2 gerechnet wird: 6.030±60 BP, GrN-9138. Die beiden Proben darf man den Klassen A und C nach Waterbolk 1971 zurechnen.

Im folgenden werden diese Datierungen weiter diskutiert.

3. Hausgrundrisse

Auf einer Oberfläche von 1750 m² wurden insgesamt neun Hausgrundrisse festgestellt. Nur vier sind relativ komplett; keiner ist vollständig (Abb. 2, 3). Die Verhältnisse sind leider ungünstig, weil die Gruben und Gebäudespuren eng aufeinander liegen. An einer Stelle wurden sogar nacheinander drei Häuser erbaut. Diese drei, im äußersten Westen der aufgedeckten Fläche gelegen und noch ein vierter im Nordosten, lohnen sich, sie ausführlich zu beschreiben. Die übrigen Hinweise für Häuser werden nur kurz erfaßt.

Wir haben uns viel Mühe gegeben, die drei übereinander liegenden Hausgrundrisse zusammen mit einem östlich angrenzenden Hause chronologisch einzuordnen. Vor allem Frau P. de Groot hat sich in Ihrer Doktorandenarbeit eingehend mit dieser Frage beschäftigt. Zunächst wird vieles dieser Arbeit entnommen.

Schon während der Grabung konnte die Abfolge der drei übereinander liegenden Hausgrundrisse im großen und ganzen einwandfrei festgelegt worden. Dazu dienten nicht nur Überschneidungen von Pfostengruben, sondern eine große Hilfe war es, daß das zweite Haus offensichtlich durch Brand zerstört war, weswegen viele Pfostenlöcher stark mit gebranntem Lehm gefüllt waren, während das dritte und jüngste Haus sich durch die graue Füllung der Pfostengruben von den bräunlichen der beiden vorangehenden unterscheidet. Theoretisch sollte also der Inhalt der Gruben neben den Häusern einen Niederschlag von deren Aufeinanderfolge geben. Diese Hoffnung ist leider nur teilweise erfüllt. Zunächst wird anhand eines vereinfachten Planes zusammengefaßt, welche Überlegungen gemacht sind (Abb. 4, 5). Die elf in Betracht genommenen Gruben haben auf diesem Plan eine besondere Numerierung erhalten.

Dem Grabungsplan kann man entnehmen, daß die drei Gruben 4-6 innerhalb des zweiten und dritten Hauses liegen und entlang dem ältesten, was ein Hinweis für die Datierung des Inhaltes dieser drei Gruben sein dürfte. Überdies sei darauf aufmerksam gemacht, daß Grube 4 geschnitten wird vom östlichen Wandgräbchen des Hauses 2. In zwei Gruben konnte eine Menge an gebranntem Lehm gesammelt werden. Grube 2 enthielt vor allem ganz unten 31.705 Gramm und Grube 9 14.295 Gramm. Auch die Gruben 3 mit 7.935 und 1 mit 4.650 Gramm gebrannter Lehm könnte man vielleicht noch zum 2ten abgebrannten Hause rechnen. Die sonstigen fünf Gruben enthielten höchstens nur 1.500 Gramm Hüttenlehm.

Selbstverständlich sind die verzierten Scherben zur Analyse stark benutzt worden (Abb. 6, 7, 8). So wurde viel Zeit aufgewandt, Scherben eines Topfes aus zwei oder mehr Gruben zusammenzufügen. Als solche wurden selbstverständlich zusammenpassende Stücke betrachtet, aber auch Scherben, welche einwandfrei zu einem Topf gehören. Bei der Grabung sind die Funde der oberen 10 cm der Grubenfüllung unter eigener Fundnummer vom daruntergelegenen Grubenteil separat gehalten, weil dadurch vielleicht jüngere Scherben von älteren geschieden werden konnten. Auf Grund dieser Kriterien wurde eine ganze Reihe dieser »Verbindungen« festgestellt. Nur die Gruben 4 und 10 haben in dieser Hinsicht nichts ergeben. Es ist zu verstehen wenn die Gruben 1, 2 und 3 untereinander verbunden sind, in der Annahme daß alle zu Haus 2 oder 3 gehören, was immerhin fraglich ist, weil unbekannt ist, was sich westlich der ausgegrabenen Fläche abgespielt hat. Auch die Gruben 5 und 6 sind miteinander verbunden, aber Grube 6 kennt außerdem noch Verbindungen mit den Gruben 2, 8 und 9. Aus Grube 7 ist nur ein Fall bekannt, und zwar eine Scherbe aus der oberen Schicht paßt zu einer aus der oberen Schicht der Grube 8. Grube 8 hat überdies Verbindungen mit den Gruben 1, 6 und 9. Aus dem Vorstehenden ist zu entnehmen, daß Grube 9 verbunden ist mit 6 und 8, dazu

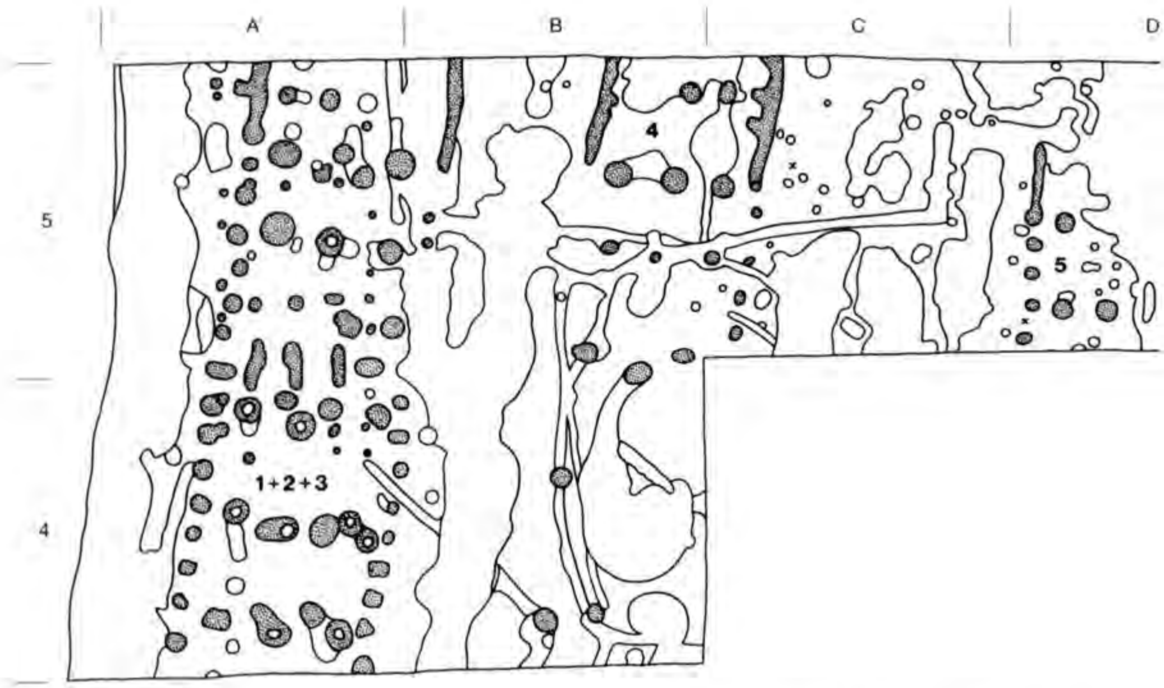

Abbildung 2. Plan der westichen Teiles der Grabung Meindling mit den Gebäuden 1-5 (grau). M 1:250.

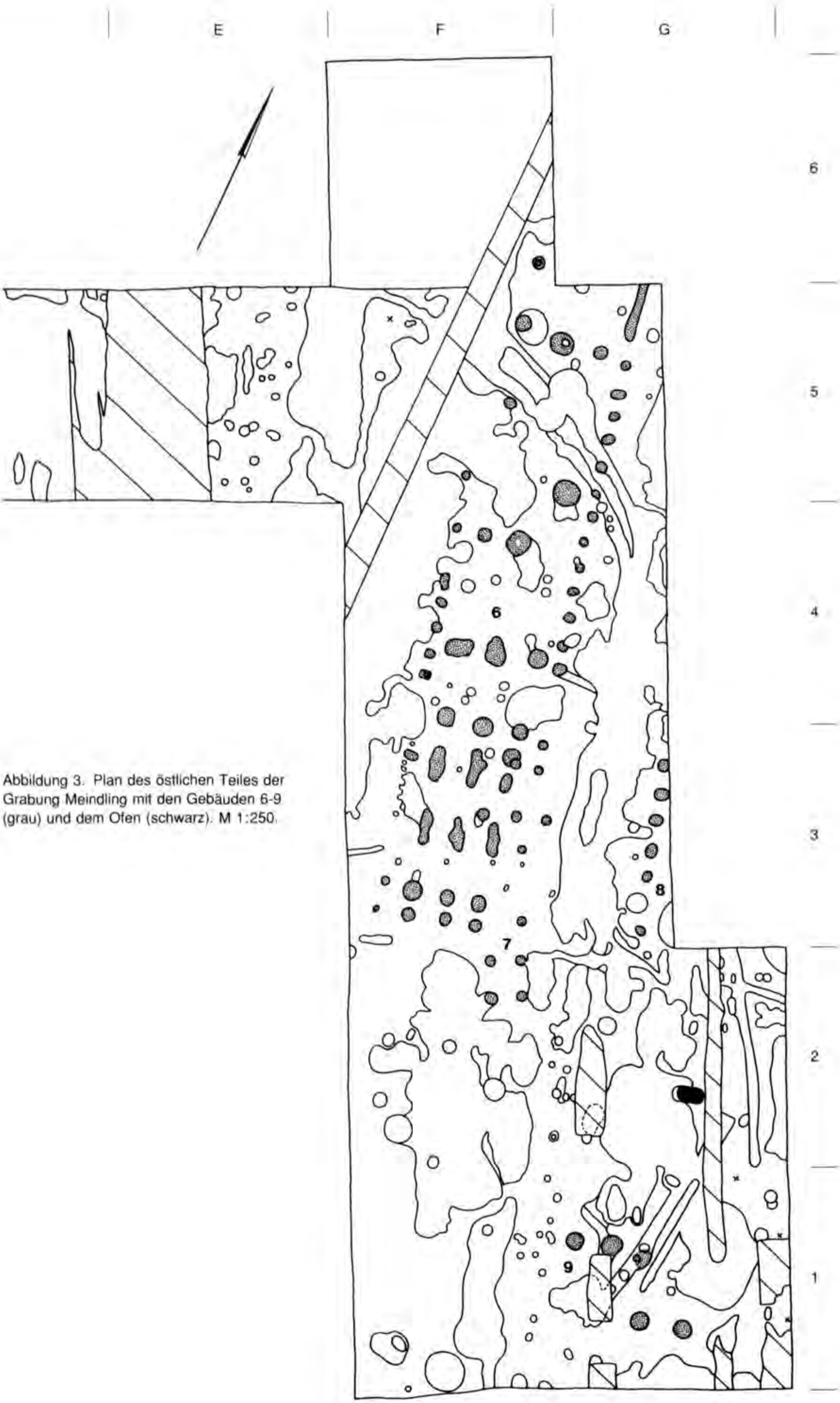

Abbildung 3. Plan des östlichen Teiles der Grabung Meindling mit den Gebäuden 6-9 (grau) und dem Ofen (schwarz). M 1:250.

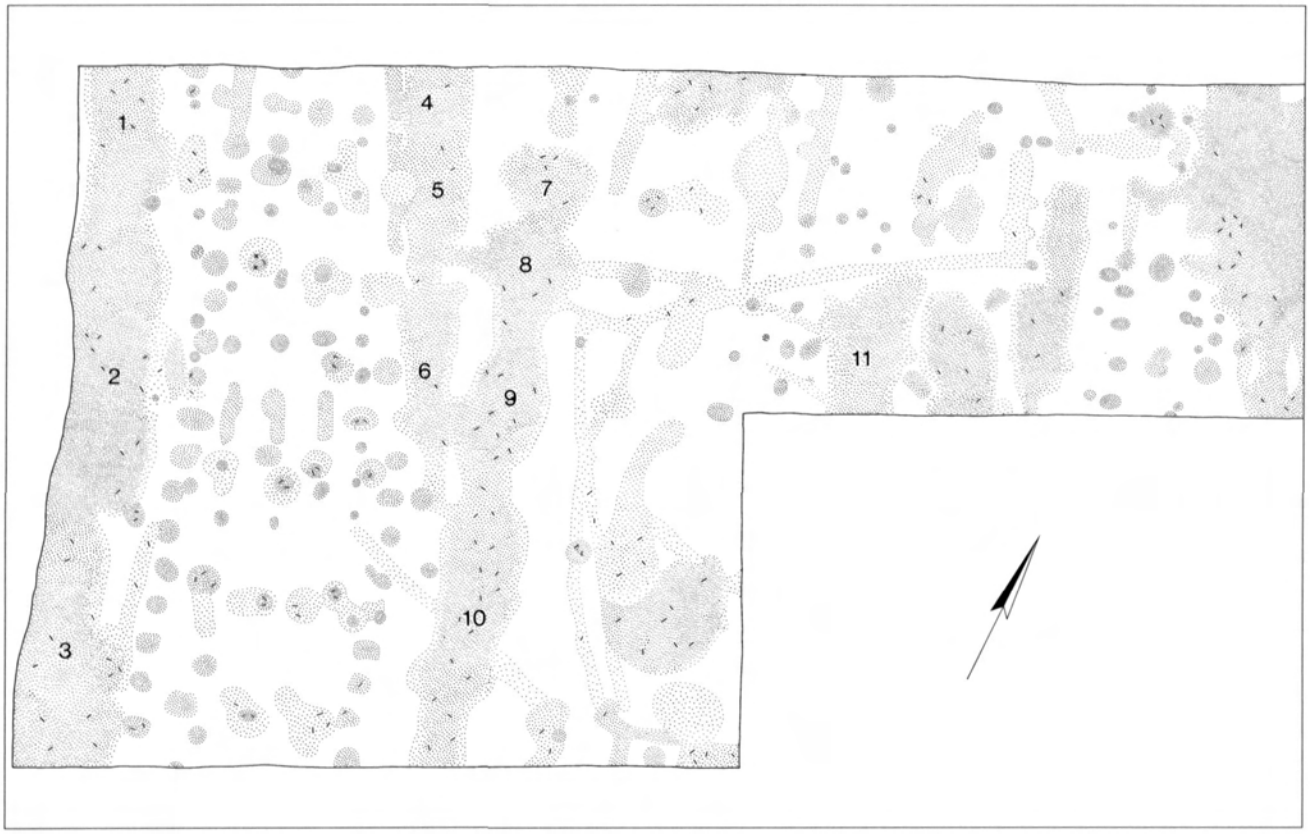

Abbildung 4. Plan der Gebäude 1-4 mit den dazugehörenden Gruben 1-11.

kommt aber auch noch Grube 11. Diese Beobachtungen beruhen auf folgenden Zahlen verzierter Scherben, darunter auch grobwandige Ware. Zwischen den Klammern sind die Zahlen für den oberen 10 cm Schichten gegeben.

Gr.1:	64	(31)
Gr.2:	308	(38)
Gr.3:	111	(31)
Gr.4:	33	(16)
Gr.5:	23	(23)
Gr.6:	48	(25)
Gr.7:	33	(21)
Gr.8:	47	(26)
Gr.9:	276	(43)
Gr.10:	56	(36)
Gr.11:	156	(48)

Bemerkenswert ist, daß die beiden sehr reichen Gruben 2 und 9 keinen einzigen Topf gemein haben, während sie auf Grund des hohen gebrannten Lehmgehaltes zum abgebrannten Hause 2 gehören könnten. Aneinanderpassende Scherben aus den tieferen Teilen der Gruben 8, 9 und 11 bilden einen Hinweis, daß sie gleichzeitig sind. Die Rolle der Gruben 5 und 6 ist unklar. Das trifft vor allem für die Grube 6 zu, welche mit 2, 8 und 9 verbunden scheint.

Nun stehen uns zwei Mittel zur Nachprüfung zur Verfügung. Erstens haben wir das Verhalten der organisch gemagerten Tonware gegenüber der anorganischen notiert. Zweitens kann die typologische Chronologie der verzierten Tonware angewandt werden.

Wenn man die Mengen an organisch und anorganisch gemagerter Keramik vergleicht, so liegt dem der Gedanke zu Grunde, daß die organische Magerung zur Anfang herrschend war und im Laufe der Zeit ersetzt wurden von anorganischen. Für jede Grube wurde das Verhalten der organischen und anorganischen Ware berechnet, also in diesem Falle die verzierte und die unverzierte Keramik zusammen. Anhand der Gewichte der Scherben wurden die Prozentsätze der ganzen Grubeninhalte berechnet. Zwischen den Klammern sind wieder die % der oberen Schichten angegeben. Die meisten organischen Scherben rühren aus Grube 9 her mit 50% (52%). Es folgen dann die gruben 3, 2 und 10 mit 33.5, 33 und 32% (34, 33 und 37%). Zunächst kommen die Gruben 4 und 8 mit 29 und 28% (34.5 und 27%), während die Gruben 11, 6 und 1 am wenigsten

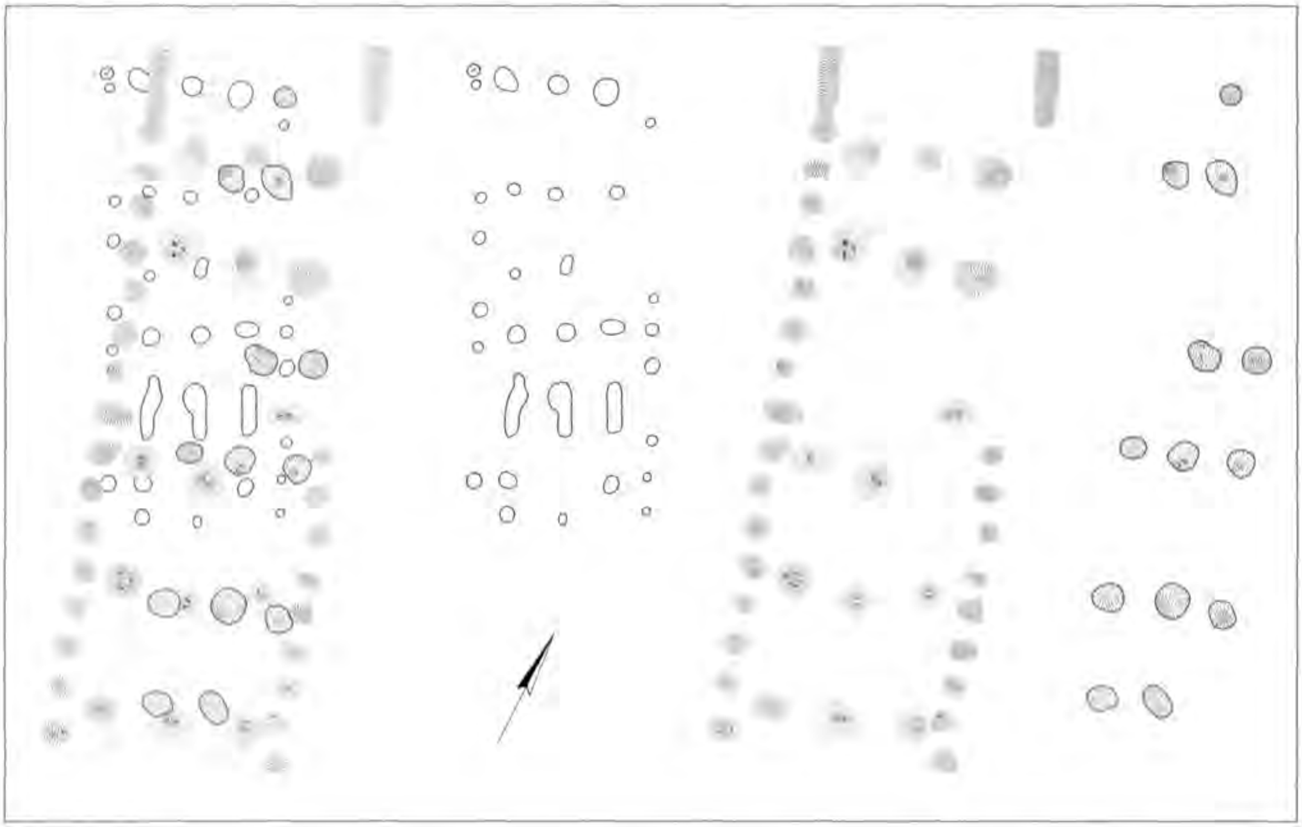

Abbildung 5. Hausgrundrisse 1-3 übereinander und die einzelnen Gebäude für sich in chronologischer Abfolge.

organische Ware enthalten mit Werten von 24.5, 18.5 und 15.5% (15, 16 und 9%). Über die Gruben 5 und 7 sind keine Daten vorhanden. Überraschend in dieser Aufzählung ist, daß Grube 4 nur einen Mittelwert vertritt, während sie aus horizontal-stratigraphischen Gründen unbedingt zum ältesten Hause 1 gehört. Grube 1, welche man entweder Haus 1 oder Haus 3 zuordnen würde, gehört in diesem Gedankengang zum letztgenannten Hause. Die Gruben 2, 3, 8 und 10 zeigen keine großen Unterschiede, wodurch sie alle für Haus 2 kandidieren. Außer der Reihe geht unbedingt Grube 9, welche die älteste sein sollte wegen dem hohen Prozentsatz an organisch gemagerter Ware. Die Ergebnisse dieser Betrachtungsweise stehen wenig im Einklang mit den Verbindungen zwischen den Gruben aufgrund der zusammenpassenden Scherben. Wahrscheinlich spielt eine uns unbekannte Streuung der organischen Scherben eine Rolle, welche dem Häuserbau an dieser Stelle vorangeht.

Schließlich gibt es noch ein Mittel, die Gruben chronologisch einzuteilen, und zwar auf Grund der verzierten Keramik. Herr K. Reinecke aus Bochum hat uns dankenswerterweise seine typologische Chronologie für die bayerische LBK zur Verfügung gestellt. Bei der Verwendung für die Meindlinger Funde wurde zuerst nur auf die Grubenteile tiefer als 10 cm geachtet. Es ergibt sich dann, daß die Gruben 1 und 6 auf Grund von 33 und 23 verzierten Scherben die ältesten sind. Es folgen dann die Gruben 8 und 7 mit 21 und 12 verzierten Scherben. Zunächst kommen die Gruben 2, 11 und 4, welche 270, 108 und 17 Scherben ergaben, während die Gruben 3, 10 und 9 mit 80, 20 und 233 Scherben zu den jüngsten zu rechnen sind. Die Gruben 2, 3, 9 und 11 mit ihren großen Scherbenzahlen werfen unbedingt am meisten Gewicht in die Waagschale.

Wenn man alle diese Versuche zu einer chronologischen Aufeinanderfolge der Lehmgruben neben den Häusern 1-4 nebeneinander legt, so bekommt man ein trauriges Bild. Die Übereinstimmungen sind nur gering, wie aus der folgende Übersicht hervorgeht.

Auf Grund der Grabungsergebnisse: 4+5+6; 2+9.

Auf Grund zusammenpassender verzierter Scherben läßt sich kaum eine Abfolge ablesen.

Auf Grund der organisch gemagerten Scherben: 9; 2+3+10; 4+8; 1+6+11.

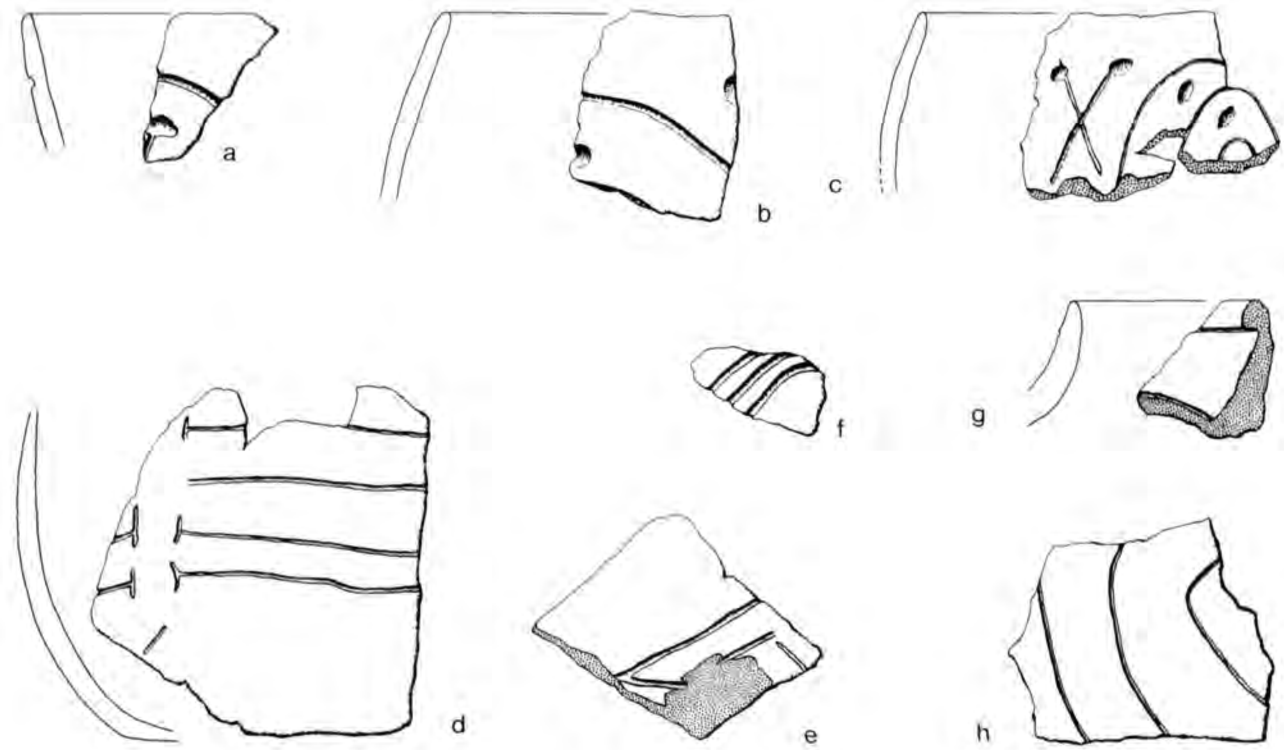

Abbildung 6. Funde aus der Grube 5 (Fundnrn 84 und 85) zu Gebäude 1. M 1:2.

Auf Grund der Typologie K.Reinecke's: 1+6; 7+8; 2+4+11; 3+9+10.

Zufriedenstellend sind diese Erfolge keineswegs, weswegen ich, alle Hinweise zusammenfassend, noch einmal versuchen möchte, ein Bild zu skizzieren, wie die Entwicklung gewesen sein mag.

Zuerst sei vorausgesetzt, daß es ein Merkmal der donaubayerischen LBK ist, daß die Zahl der verzierten Scherben mit diagnostischem Wert relativ klein ist. Viele zeigen nur ein oder einige eingeritzte Linien, wozu höchstens ein bis zwei Eindrücke kommen. Überdies kennt die LBK in dieser Region kaum Verzierungsvarianten im Laufe der Entwicklung. Das Linienmuster bleibt bis zum Ende das Hauptelement. Daneben spielen die Eindrücke oder Einstiche eine untergeordnete Rolle, welche nur im Laufe der Zeit zunimmt. Unter Berücksichtigung dieses Merkmales habe ich versucht, die Zusammenstellung der Verzierungen der Scherben aus den elf Gruben chronologisch einzuordnen. Folgendes läßt sich mit Vorsicht sagen. Unbedingt die älteste ist Grube 4. Es ist fraglich, ob Grube 1 gleichzeitig ist. Wenn nicht, dann ist sie nicht viel jünger. Vielleicht gehören die Scherben zu einem unbekannten Hause westlich gelegen. Die Gruben 5 und 6 sind nicht gleichzeitig mit Grube 4, im Gegensatz zu dem, was man aus dem Plan erwarten wurde, weil die drei Gruben in einer Reihe dem Hause 1 entlang liegen. Grube 5 hat nur verzierte Scherben aus den oberen 10 cm ergeben, welche unbedingt später sind als die aus Grube 4. Grube 6 enthält im tieferen Teile zwar alte Elemente, aber in der oberen Schicht unbedingt jüngere, welche gleichzeitig zu sein scheinen mit den Gruben 2 und 10. Eine Erklärung dieser Fundverhältnisse wäre, daß die Füllung der Gruben 5 und 6 zusammengeschrumpft ist, bevor und in der Zeit, als die Gruben 2 und 10 zugefüllt wurden. Man kann sich diese Lage denken während der Besiedlung des Hauses 2, wozu dann aus typologischem Grunde die Gruben 2, 3 und 10 gehören sollten. Diese Dreizahl scheint gleichzeitig zu sein, wiewohl Grube 2 etwas jünger anmutet.

Grube 9 ist unbedingt die jüngste der elf Gruben. Meinetwegen gehört sie zu Haus 3. Nicht eingeteilt sind jetzt noch die Gruben 7, 8 und 11. Der Inhalt der tieferen Teile der Grube 11 mutet etwas älter an als die aus 3 und

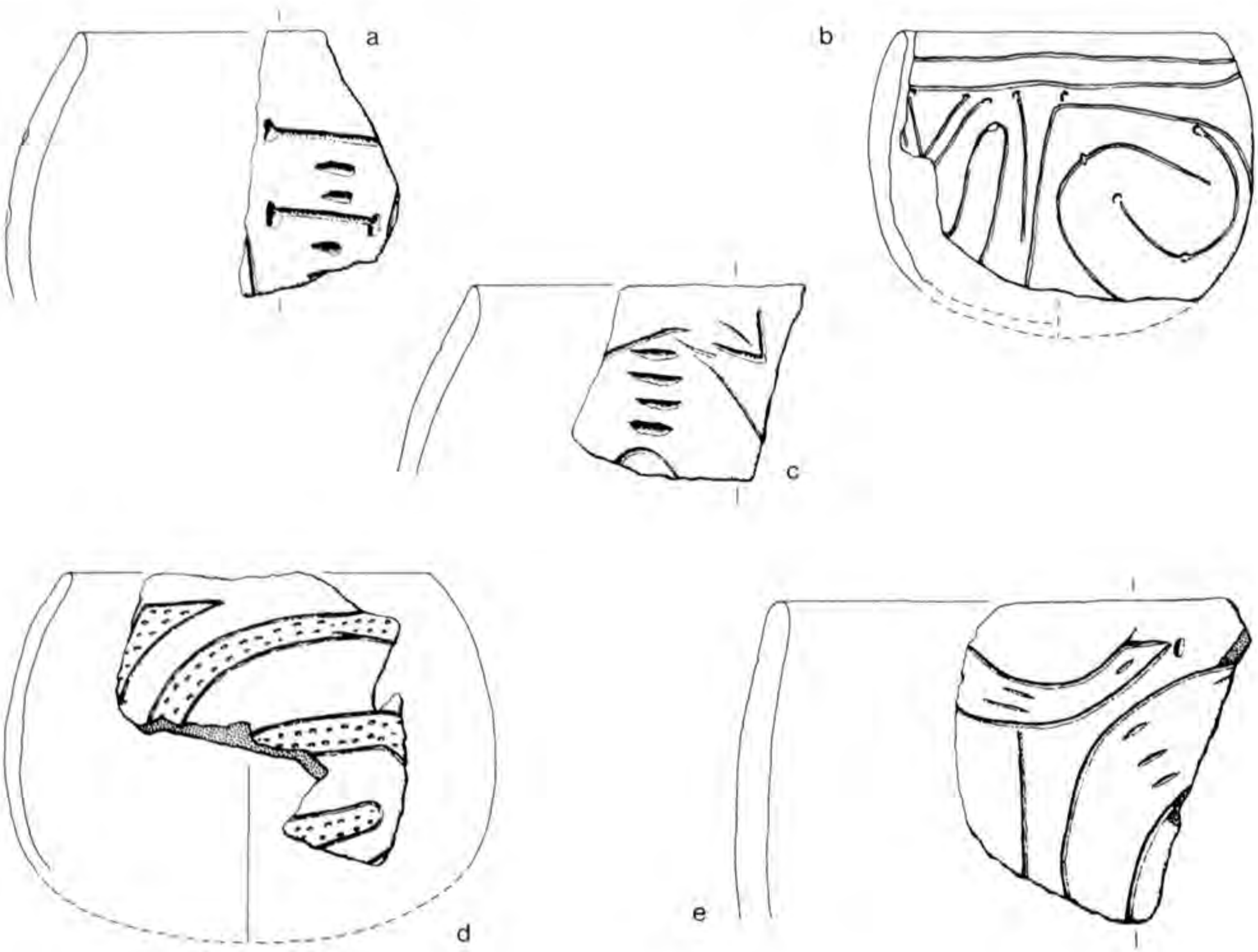

Abbildung 7. Funde aus der Grube 2 (Fundnr. 66) zu Gebäude 2. M 1:2.

10. Wenn diese Einschätzung richtig ist, so würde Haus 4 zeitlich Haus 2 vorangehen. Dieser Gedanke läßt sich leider auf Grund der verzierten Scherben aus den Gruben 7 und 8 kaum bestätigen. Es bleibt eine offene Frage, wie die Häuser 2 und 4 sich zeitlich zueinander verhalten.

Es folgt jetzt die Beschreibung der einzelnen Hausgrundrisse.

Haus 1: Die Länge ist wenigstens 13 m, die Breite nur 4.8. Angaben über den Nordteil fehlen, der Mittelteil hat mehr als 8 m Länge, der Südteil genau 5 m. Die Abstände zwischen den Dreipfostenreihen (DPRn) betragen 3.2, 5.3 und 1.6 m. Die Pfosten der Ostwand stehen 85 bis 100 cm auseinander. Bei der Westwand ist es nicht wesentlich anders. Die Tiefen der Pfostengruben der Ostwand reichen von 4 bis 14 cm mit einem Mittelwert von 8.5 cm. Die der Westwand reichen etwas tiefer, und zwar 8 und 24 cm mit einem Mittelwert von 14 cm. Bei den DPRn findet man den höchsten Wert bei der Reihe unmittelbar nördlich der länglichen Pfostengruben, zwei davon reichen bis 40 cm, eine bis 24 cm. Die beiden tiefsten zeigten im Schnitt eine Pfostenspur von 14 und 19 cm, welche als Mindestmaße zu betrachten sind. Jedoch sind diese Werte niedrig, verglichen mit anderen Fällen wo die Dicke der Pfosten bis über 50 cm reichen kann. Im Falle des Hauses 1 sind die geringen Stärken der Mittelpfosten wohl verständlich, wenn man die geringe Breite beachtet. Die länglichen Pfostengruben sind im Norden etwas tiefer als im Süden. Die Unterschiede sind 40 gegen 24, 20 gegen 15 und 20 gegen 18. Bei acht der übrigen Innenpfosten haben wir die Tiefen der Gruben kennen gelernt; vier davon haben 20 cm, die übrigen 12, 15, 23 und 30 cm.

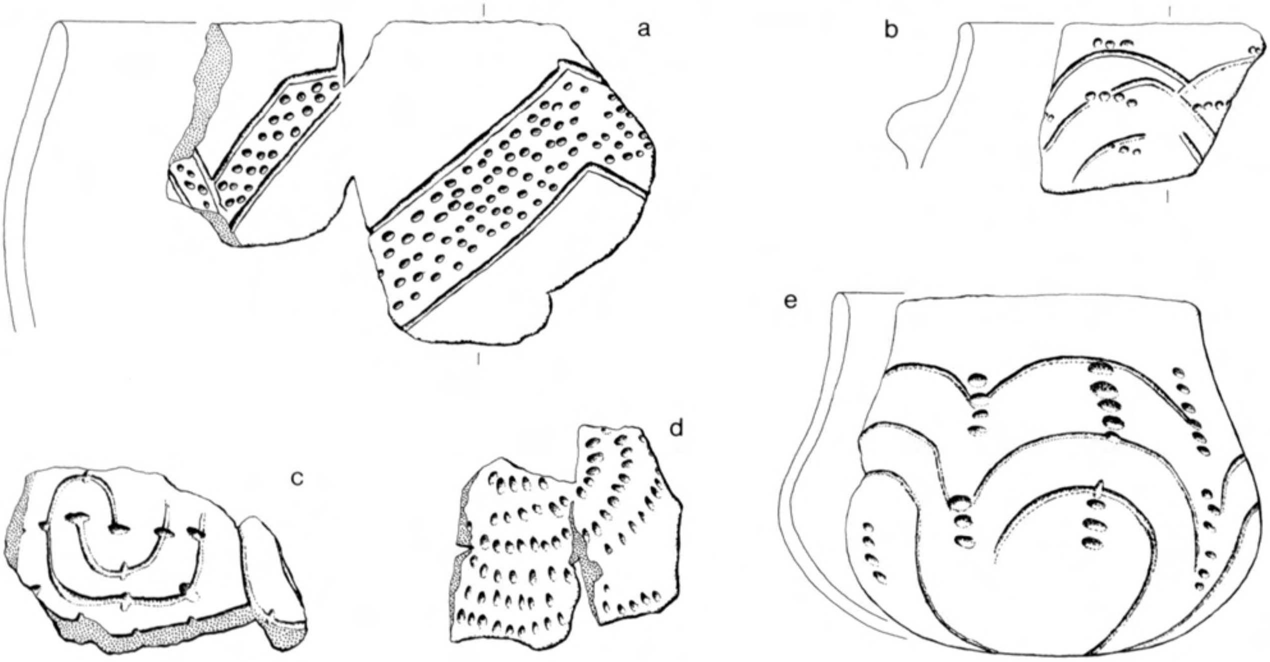

Abbildung 8. Funde aus der Grube 9 (Fundnr 91, 135 und 322) zu Gebäude 3 (?). M 1:2.

Haus 2: Die Länge beträgt mehr als 20 m bei einer Breite von 6.2 m. Der Nordteil hat wenigstens 3.6 m Länge, der Mittelteil mehr als 16.4 m. Angaben für einen Südteil fehlen. Die Abstände zwischen den DPRn betragen 2.8, 6.1, 3.5 und 3.3 m. Die meisten Pfosten der Ostwand stehen 100 oder 110 cm auseinander, mit einer Ausnahme van 130 cm. Die gleichen Zahlen findet man bei der Westwand, aber in vier Fällen beträgt der Abstand 120 cm und einmal 125 cm. Die Tiefen der Pfostengruben der Ostwand schwanken zwischen 4 und 20 cm mit einem Mittelwert von 15 cm. Bei der Westwand sind diese Zahlen etwas höher, sie liegen zwischen 14 und 24 cm mit einem Mittelwert von 19 cm. Das östliche Wandgräbchen des nördlichen Teiles reicht bis max. 26 cm. Die Tiefen der Innenpfostengruben sind sehr unterschiedlich und zwar von 22 bis zu 60 cm. Die Mittelwerte der Dreipfostenreihen von Nord nach Süd lauten 38, 31, 35, 50 und 35 cm. Es ist bemerkenswert, daß die Reihe südlich des Krüppelypsilons am tiefsten reicht, während das im allgemeinen bei der ersten Reihe innerhalb des Wohnraumes der Fall ist. Bei neun Pfosten haben wir die Stärke annäherend messen können. Die dicksten findet man in Krüppelypsilon mit 60, 60 und 56 cm. Die DPR südlich davon hat Werte von 50, 44 und 45 cm. Der westliche Pfosten der am meisten nördlichen Reihe hat nur 30 cm. In den beiden übrigen DPRn gibt es dann noch einen Pfosten mit 50 cm Stärke. In acht der fünfzehn Pfostenlöcher wurde eine relativ große Menge an gebranntem Lehm festgestellt. Diese Eigentümlichkeit findet man vor allem in den drei südlichsten DPRn. Bei der nördlichen fehlt es, während die nächste Reihe nur einen Pfosten mit Lehm kennt.

Haus 3: Von diesem mindestens 14.6 m langen Hausgrundriß sind nur die Innenpfosten übrig geblieben. Die Reihen stehen 5, 3.1, 3.5 und 2.2 m auseinander. Die Pfostengruben waren fünfmal nur bis 12 cm Tiefe erkennbar. Höchstwerte sind zweimal 28 cm in der zweiten und fünften DPR vom Norden, welche überhaupt am tiefsten eingegraben worden sind. In einer der beiden Gruben der nördlichsten DPR haben wir die Stärke des Pfostens messen können: 35 cm.

Haus 4: Die Länge dieses schlecht erhaltenen Hausgrundrißes kann mehr als 19.6 m gewesen sein. Die Breite beträgt 5.6 m. Der Nordteil war länger als 4.2 m. Die DPRn stehen 3, 2.8, 4.4, 4.4 und 4.6 m. auseinander. Die Abstände zwischen den wenigen östlichen Wandpfosten lauten 80, 120 und 100 cm. Die Tiefen der Innenpfosten schwanken zwischen 10 und 46 cm mit einem Mittelwert von 21 cm. Der Ausnahmefall von 46 cm befindet sich in der Mitte der

DPR auf der Grenze zwischen Nord- und Mittelteil. Ohne diesen Pfosten wäre der Mittelwert fast 19 cm!

Haus 5: Die wenige Spuren dieses Hauses weisen auf eine Mindestlänge von 7 m hin. Die Breite kann 5.2 m gewesen sein. Der Nordteil hat eine Länge von 2.2 m. Die beide DPRn stehen 2.6 m auseinander. Die Abstände zwischen den westlichen Wandpfosten lauten 80, 85, 108 und 100 cm. Die Tiefen der Spuren sind unbekannt, weil sie nicht geschnitten wurden. Westlich des Hauses befinden sich zwei Lehmgruben. Die nördliche hat nur 26 cm Tiefe, die südliche reicht bis 60 cm. Die letzte hat einige mit Ritzlinien verzierte Scherben geliefert, nur eine hat dazu noch gestreute Eindrücke im Bande.

Haus 6: Es handelt sich hierbei unbedingt um den imposantesten Hausgrundriß aus Meindling mit seiner Länge von über 30 m und einer Breite von 6 m. Nur Haus 2 kann sehr wohl größer gewesen sein. Der Nordteil hat eine Länge von wenigstens 3.5 m, während die beiden anderen Teile 17.5 und 9 m messen. Die DPRn stehen 3, 9, 5, 3, 1.5, 2, 2.5 und 1 m auseinander. Die Abstände zwischen den östlichen Wandpfosten schwanken von 100 bis 135 cm mit einem Mittelwert von 108 cm. In der Westwand sind die äußersten Maße 100 und 130 cm mit einem Mittelwert von 110 cm. Die Tiefen dieser Wandpfostengruben waren leider nur sehr vage zu beobachten. Sie reichen von 10 bis 24 cm. Die Mittelwerte der Ost- und Westwände betragen 17 und 13 cm. Die tiefsten Gruben der Innenpfosten findet man im Norden des Mittelteiles. So hat die Reihe zwischen Nord- und Mittelteil einen Mittelwert von 44 cm. Der westliche Pfosten des Krüppelypsilons reicht sogar bis 60 cm. Die folgende DPRn kennen ablaufende Mittelwerte und zwar 34, 26, 18, 14, 14 und 14 cm. Im Wohnteil sind Pfosten mit einer Stärke von 45-50 cm benützt worden. Gebrannter Lehm ist in gut erkennbaren Mengen festgestellt worden in der DPR südlich des Krüppelypsilons, in dessen beiden westlichen Pfostenlöchern und in dem westlichsten Pfosten der nächsten DPR in nördlicher Richtung. Erstgenanntes Pfostenloch enthielt neben gebranntem auch rohen Lehm. Diese Feststellungen sind in Übereinstimmung mit denjenigen des Hauses 2, was abermals ein Hinweis dafür ist, daß im Wohnteil eine Feuerstelle war.

Die verzierte Keramik aus den Lehmgruben neben dem Hause datieren die Benutzung gleichzeitig oder etwas früher wie die des Hauses 2. Vielleicht ist Haus 2 der Nachfolger des Hauses 6. Großbauten wie diese beide pflegen im allgemeinen unweit voneinander erbaut zu werden, wie z.B. die Pläne von Bylany, Elsloo, Stein und Cuiry-lès-Chaudardes zeigen.

Haus 7: Am südöstlichen Ende des Hauses 6 befinden sich neun Pfostengruben, welche sich zu einem Hausgrundriß zusammenfügen lassen. Es könnte sich um ein Haus mit einer Länge von 8 m oder mehr handeln. Die Tiefen dieser Pfostengruben schwanken zwischen 7 und 20 cm mit einem Mittelwert von 11.5 cm. Gegen diese Rekonstruktion wäre anzuführen, daß keine Lehmgruben eindwandfrei zum Grundriß gehören.

Haus 8: Auch in diesem Falle sind die Spuren sehr spärlich. Nur eine 7.5 m lange Wandpfostenreihe, begleitet von Lehmgruben, ist vorhanden. Weitere Reste sind außerhalb der ausgegrabenen Fläche zu erwarten. Die Pfosten stehen 120 bis 130 cm auseinander und kennen Tiefen zwischen 8 und 18 cm mit einem Mittelwert von über 13 cm. Die wenigen verzierten Scherben aus den Gruben sprechen für eine etwas ältere Datierung als die für Haus 6. Es ähnelt genau der Lage bei Haus 5.

Haus 9: Am Südende der Fläche befinden sich die unverkennbaren Spuren von einem Hause, vielleicht sogar von zwei Häusern. Am deutlichsten ist eine Pfostenreihe, welche zusammen mit einigen Lehmgruben einen deutlichen Hinweis für eine Westwand bilden. Es zeigen sich einige Mittelpfostengruben mit Durchschnitten von 70 bis 90 cm. Wegen der Abschwemmung sind die Tiefen der Pfostengruben nur sehr gering: 2 bis 16 cm. Die ganz wenigen verzierten Scherben aus den Lehmgruben erlauben keine Datierung.

4. Palisaden

Im Vergleich mit anderen Fundstellen wurden in Meindling relativ viele Palisadengräbchen aufgezeichnet. Zum besseren Verständnis des Phänomens werden besprochen:

1. die Datierung mittels Funden,
2. die relative Datierung auf Grund der Ausgrabungsergebnisse und
3. der eventuelle Zusammenhang gewisser Palisaden mit Hausgrundrissen, wie es zum Beispiel beim Hause Hienheim 3 belegt wurde.

Es gibt eine C14 Datierung für Meindling u.z. GrN-9139: 6.190±100 BP, wozu Holzkohle des angebrannten Fußes eines Pfostens benützt wurde.

Die wenigen Funde aus den Palisadengräbchen sind merkwürdig einheitlich. Mit Ausnahme des breiten Gräbchens im Quadrat G-1 welches nur organisch gemagerte Scherben enthielt, haben alle anderen fast nur anorganisch gemagerte Tonware geliefert. Darunter sind elf nur mit Linien verzierte Scherben. Man darf m.E. aus dieser Gegebenheit nicht allzuweite Schlüsse ziehen, weil die donaubayerische Bandkeramik durch ein Überwiegen der einfachen Linienverzierung gekennzeichnet wird. Eine weitere Unterteilung auf Grund der Funde ist unmöglich.

Pfostengruben der Häuser 4 und 6 überschneiden die dort befindlichen Palisadengräbchen, was sie nicht allzu jung macht. Die beiden Palisaden beim Haus 6 brauchen nicht gleichzeitig zu sein, weil die äußere, kürzere keine einzige Scherbe enthielt, während die längere fast 200 Gramm Scherben und ein Schleifsteinfragment ergab, welche beim Einfüllen in das Gräbchen hineingeraten sein müssen.

Im letztgenannten Palisadengräbchen mit einer Länge von 45 m ist eine Reihe von Pfostenspuren festgestellt worden. Sieben Pfosten waren 22 bis 25 cm stark, während einer bis 30 cm dick war. Die Abstände zwischen den Pfosten, von Mitte zu Mitte gemessen, sind sehr unregelmäßig: 45-80 cm mit einem Mittelwert von 63 cm. Die Pfosten neigen etwas gegen Westen. Die C14 Datierung eines der Pfosten, 6.190±100 BP könnte ein Hinweis sein, daß die Palisade etwas älter ist als der Pfosten des Hauses 2, welcher 6.130±40 BP datiert wurde. Haus 2 ist vielleicht der Nachfolger des Hauses 6.

Ob es sich beim ältesten aller Gräbchen im Südosten der Grabung um ein Palisadengräbchen handelt ist fraglich. Die Breite ist größer als normal, und das Gräbchen endet sehr abrupt. Am SW-Ende befindet sich eine Grube (257), welche im Schnitt fast frei vom Gräbchen war, aber man muß damit rechnen, daß in diesem Quadrat die Abschwemmung stark zugegriffen hat, wodurch vieles verloren ging. Aus Grube und Gräbchen wurden nur organisch gemagerte Scherben geborgen. Typologisch ist es der älteste Fundkomplex aus Meindling.

Auf der Suche nach Zusammenhängen zwischen Palisaden und Häusern gibt es nur in einem Falle eine Wahrscheinlichkeit zu melden. Zum Hause 5 könnte das drei Meter westlich des NW-Teiles des Hauses erkennbare 3.3 m lange NS-Gräbchen gehören, welches sich mit einem Haken in westliche Richtung verfolgen läßt. Nach 11 m biegt es nach Süden ab, um nach 12 m wieder in östlicher Richtung weiterzulaufen.

5. »Gerbegruben«

Es sind fünf »Gerbegruben« oder Schlitze zu melden. Folgende Daten dürfen reichen. Alle Tiefen sind gemessen ab der Grabungsfläche.

1. Hinweise für Schlitze könnten festgestellt werden unter einer Grube gegen den Westrand des Quadrates A-5. L. > 105 cm, Br. ?, Ti. 77 cm. Orient. fast O-W. Keine Funde, nur gebrannter Lehm.
2. Gegen den Nordrand des Quadrates A-5. L. > 30 cm, Br. ca 50 cm, Ti. > 90 cm. Orient. etwa 370 Centigrad. Funde unter Nr. 64 fünf organisch gemagerte Scherben, darunter eine Randscherbe mit cylindrischer Knubbe; ein wenig gebrannter Lehm.
3. Unter dem westlichen Wandgräbchen des Hauses 4 im Quadrat B-5. L. 190 cm, Br. 56 cm, Ti. 108 cm. Orient. etwa 370 Centigrad. Die Füllung zeigte eine Schichtung. Die Grube war relativ fundreich; Fundnr. 190. Keramik 470 Gramm, davon 265 Gramm organisch gemagert. Fünf mit Linien verzierte, anorganisch gemagerte Scherben (55 Gr.), 5 Randscherben, eine Knubbe, ein Henkel, 2 Silices, ein Mahlsteinfragment, 3 Bröckchen Sandstein und ein wenig gebrannter Lehm.
4. In der Fläche nicht geahnte Gerbegrube im Quadrat C-5. L. 160 cm, Br. 70 cm, Ti. 123 cm. Orient. etwa 370 Centigrad. Aus der Füllung wurde nur Holzkohle geborgen unter Fundnr. 203, welche die älteste Meindlinger Radiokarbondatierung ergab; GrN-8687: 6380±130 BP.
5. Im Quadrat F-3. L. > 150 cm, Br. > 30 cm, Ti. 65 cm. Orient. 60 Centigrad. Keine Funde in der geschichteten Einfüllung.

6. *Gruben*

In diesem Zusammenhang beschränken wir uns auf einige Bemerkungen zu den Grubenkomplexen.

Im Raume des Hauses 4 befinden sich einige Gruben (siehe Quadrat B-4). Die ovale in der südöstlichen Ecke ist von ganz wenigen Münchshöfener Scherben datiert. Für die beiden zusammenstossenden Gruben gilt eine späte LBK Datierung. Unter den Scherben befinden sich jedoch auch einige, welche zur ältesten Phase gehören könnten, darunter ein becherartiges Gefäß mit kleinem Standring (Abb. 11).

Der Grubenkomplex im Quadrat D-5 wurde wegen Zeitmangel nicht weiter untersucht.

Im Quadrat F-1,2 befindet sich ein richtiger Grubenkomplex. In den Schnitten konnten mehrere einzelne Gruben unterschieden werden. Aus dem Scherbeninhalt tritt hervor, daß ein Teil der Gruben zur nächstältesten Phase zu rechnen ist, während andere hingegen Beispiele jüngster LBK Tonware enthielten.

Der Grubenkomplex im Quadrat F, G-2 ist relativ spät zu datieren. Ausnahmen davon bilden die am meisten südwestlich gelegene Grube und der mit einem Ofen in Zusammenhang stehende Grubenteil; beide sind relativ früh. Übrigens sei darauf hingewiesen, daß sich etwa 2.5 m südlich des Komplexes die älteste Grube befindet, welche im Zusammenhang zu stehen scheint mit dem breiten, gerade verlaufenden »Palisadengräbchen«. An der südlichen Grabungsgrenze trafen wir einige hallstattzeitliche Scherben in einer Grube.

7. Ein Ofen

Im Quadrat G-2 ist ein 1.5 m langer und sich von WSW nach ONO verengender Ofen festgestellt. Die lichten Maße der Breite betragen 0.90 und 0.65 m. Der Boden wurden gebildet von einer rotgebrannten Lehmschicht, welche sich gegen ONO verjüngte, was ein Hinweis sein kann, daß die Ofenmündung im WSW lag. Trümmerspuren eines Zusammengestürtzten Daches wurden schon im ersten

Planum beobachtet durch eine Rotfärbung. Vergleichbare Verhältnisse wurden in Vilsbiburg (Ldkr. Landshut) rekonstruiert (Petrasch 1986). Im Schnitt zeigten sich in der Ofenfüllung zwei Schichten; die untere war viel schmutziger als die obere. Auf der Grenze der beiden traf man relativ viel gebrannten Lehm. Spuren einer ehemaligen senkrechten Höhlung sind mitten an der ONO-Wand gefunden, als wenn es dort ein Ziehloch gegeben hätte. Ein dritter Hinweis daß die Ofenmündung im WSW gelegen war, ist daß sich auf dieser Seite eine Grube befindet, deren Boden zwar nur 7 cm tiefer liegt als der des Ofens, aber die Grube macht die Arbeit im Ofen um so bequemer. Für die Datierung des Ofens stehen uns nur die Scherben aus der Grube zur Verfügung, weil der Ofen selber keine ergeben hat. Acht verzierte Scherben weisen auf eine Gleichzeitigkeit mit Haus 1 hin. Die verzierte Tonware kennt eine anorganische Magerung. Daneben gibt es aber eine große Menge (2.500 Gr.) organisch gemagerte Scherben, welche wohl zu einem Topf gehören können. Der Ofen wurde also in einer frühen Phase der Besiedlung benutzt.

8. Tonware

Die große Menge der Scherben ist linearbandkeramisch zu datieren. Daneben gibt es nur eine Grube mit wenigen Münchshöfener Scherben und zwei Gruben mit hallstattzeitlicher Tonware. Ein Henkelfragment weist auf Tätigkeit der Badener Kultur hin. Bei der Besprechung der Häuser 1-4 wurde klar gemacht, daß die LBK Besiedlung in der ausgegrabenen Fläche zeitlich schwer zu trennen ist. Mit einer Horizontalstratigraphie ist hier überhaupt nichts anzufangen. Wiederholt hat man an der gleichen Stelle gegraben und gebaut. Dieser Situation ist es zu verdanken, daß die Reste früherer Tätigkeiten sich mit jüngeren mischen. Bis in nach-bandkeramischer Zeit trifft man also Scherben der ältesten Phase in den Gruben. Kein Grubeinventar repräsentiert daher die Zeit ihres Entstehens, ausgenommen die einer Grube, welche zur ältesten Phase gerechnet werden darf. Es hat m.E. wenig Zweck, den Inhalt der Gruben detailliert zu dokumentieren, weswegen ich darauf verzichte. Die ausführlichen Beschreibungen stehen einem jeden zur Verfügung im Instituut voor Prehistorie zu Leiden. Ich beschränke mich deswegen auf einige bemerkenswerte Funde.

Zur Zuverlässigkeit der in diesem Aufsatze benutzten Datierungen innerhalb der LBK sei bemerkt, daß diese auf der allgemeinen für den donaubayerischen Raum gültigen Chronologie beruht. Es würde zu weit führen, diese hier ausführlich auseinanderzusetzen. Der rote Faden zieht sich in den Funde aus den Gruben neben den Häusern 1-4 hindurch (Abb. 6, 7, 8).

Aus der als ältesten zu betrachtenden Grube 257 auf der Scheide der Quadrate F-1 und G-1 wurden 1978 schon die wichtigste Funde publiziert (Abb. 9). Insgesamt wurde etwa 2.900 Gramm organisch gemagerter Tonware gesammelt. Darunter befindet sich ein rekonstruierbares Gefäß mit flachem Boden und höchst wahrscheinlich drei Doppelknubben. Eine Scherbe weist auf das Vorhandensein eines Fussgefäßes hin, während eine zweite Scherbe zum Rand einer Amphore gehört. Ausserdem sind noch zwei eingedellte Knubben, ein Henkelfragment, ein abgebrochener Knubbenansatz und sieben Randscherben zu erwähnen. Auf der Ostseite der Grube 257 befindet sich ein S-N verlaufendes Palisadengräbchen (Fundnr. 359). Daraus sind 620 Gramm organisch gemagerter Scherben geborgen worden. Das Gräbchen ist möglicherweise gleichzeitig, aber eher jünger als die Grube. Jedenfalls kann man die Scherben zum Repertoire der Grube 257 rechnen. Dadurch wird die Zusammenstellung bereichert durch zwei Schalen mit flachem Boden; eine ist rekonstruierbar (Abb. 10).

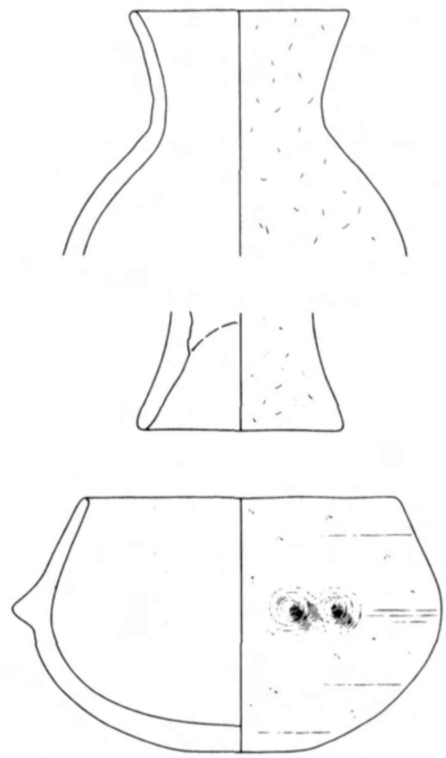

Abbildung 9. Funde der ältesten LBK aus der Grube 257. M 1:4.

Unweit der Grube 257, etwa 2.5 m nördlich, befindet sich eine 2×2 m große Grube (Fundnr. 256). Darin wurden neben 655 Gramm unverzierter, organisch gemagerter Scherben zwei (15 Gramm) verzierte, anorganisch gemagerte gefunden. Die Verzierung besteht nur aus

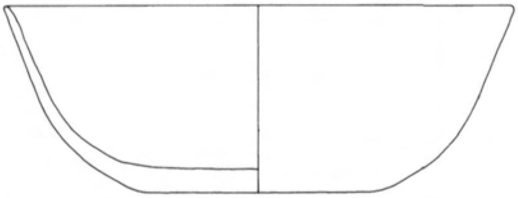

Abbildung 10. Schale der ältesten LBK (Fundnr. 359), sehr wahrscheinlich gleichzeitig mit Grube 257. M 1:4.

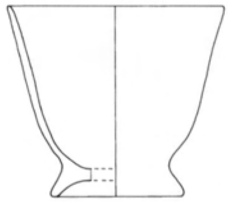

Abbildung 11. Becherartiges Gefäß (Fundnr. 282). M 1:4.

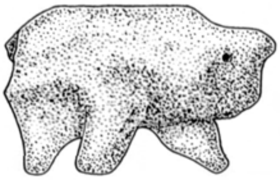

Abbildung 12. Linearbandkeramisches Schweinchen (Fundnr. 197). M 1:2.

eingeritzten Linien. Man darf theoretisch nicht ausschliessen, daß die Gruben 257 und 256 gleichzeitig sind, weil sie so eng nebeneinander liegen. Die Grube 257 würde alsdann zufälligerweise keine verzierte Scherbe erhalten haben.

Zwei weitere, organisch gemagerte Scherben hoher Standfüße rühren aus dem komplizierten Gruben im Quadrat G-4 her. Eine Datierung ist also sehr schwer zu geben. Schließlich sind noch zu erwähnen zwei Scherben (ohne organische Magerung!) eines becherartigen Gefässes mit kleinem Standfuß (Abb. 11; Fundnr. 282). Sie wurden gefunden in einem Grubenteil in B-4 zusammen mit relativ viel organisch gemagerter Tonware, aber die Fundverhältnisse weisen abermals auf eine komplizierte Entstehungsgeschichte des Grubenkomplexes hin. Daher steht eine Datierung aus. Sie kann jedoch typologisch nicht sehr früh sein, sondern vielleicht zu einer zweite Besiedlungsphase gehören.

Aus der Grube östlich des Hauses 4, oben erwähnt unter Nummer 11, rührt ein Tonfragment her, daß wohl zu einem Idol gehört haben kann. Das 10 cm lange cylindrische Stück hat einen Durchmesser von 3 cm. Eine Seite ist stumpf, während die andere abgebrochen ist.

Schließlich sei noch auf das 1978 schon publizierte Schweinchen hingewiesen, welches aus einer 90 cm tiefen Grube westlicht des Hauses 6 herrührt, aber nicht dazugehört (Abb. 12; Fundnr. 197). Es wurde in einer Tiefe von mehr als 30 cm gefunden. Der Ton enthält nur etwas groben Sand und seltene feine Kieselemente. Vollplastische Tierfiguren aus der LBK sind mir außer diesem Beispiel nicht bekannt. Die verzierten Scherben aus der gleichen Grube (Fundnrn 107, 167) zeigen eine Mischung älterer und jüngerer Elemente.

9. **Dechsel und ein Beil** (von C.C. Bakels)

Insgesamt wurden 22 Artefakte und Artefaktfragmente gefunden die zur Klasse der Dechsel und Beile gerechnet werden können. Zwanzig Geräte haben die Form eines Dechsels, eins ist das Fragment eines durchbohrten Gerätes und das letzte Stück bildet der Nacken eines Beiles. Rohlinge und Trümmer ohne Schliffspuren welche zu solchen Geräten gehört haben möchten, sind nicht vorhanden.

Neun Dechsel konnten gemessen werden (Tab. 1). Fundnr. 1a ist ein großer, hoher Dechsel. Fundnr. 14a, nicht meßbar, dürfte auch einer gewesen sein. Der Typus der kleinen schmalen hohen Dechsel ist mit Fundnr. 83 vertreten. Soweit erkennbar sind die sonstigen Stücke flache Geräte gewesen. In diesen flachen Modellen werden keine weiteren Klassen unterschieden (Bakels 1987). Es gibt Exemplare mit zwei durch Kanten abgesetzten Seitenflächen und einem daher rechteckigen bis trapezoidalen Querschnitt (Fundnrn 1b, 34, 179, 216) und Stücke wobei diese undeutlich (Fundnr. 95) oder abwesend (Fundnrn 249, 379) sind. Alle haben die größte Breite an der Schneidenseite.

Die zwei kompletten, hohen Dechsel sehen wenig gebraucht aus. Die flachen Geräte dagegen sind intensiv benutzt worden. Die Fundnr. 379 ist der Schneideteil eines längeren Exemplares, das jemals quer gebrochen ist (Abb. 13). Die Bruchfläche, der neue Nacken, wurde nicht besonders hergerichtet. Sie zeigt nur den von der Schäftung erzeugten Gebrauchsglanz. Alle Schneiden der flachen Dechsel sind nachgeschliffen worden, was bei der Fundnr. 34 am stärksten der Fall ist (Abb. 13). Diese wurde sowohl dorsal alsauch ventral dermaßen nachgeschliffen, daß sie fast eine Beilform bekommen hat.

Wie öfters geschrieben wurde, sind flache Dechsel typisch für Siedlungen (Bakels 1986; Reinecke 1978). Sie werden dort vielfach weitgehend abgenutzt vorgefunden. Hohe Dechsel sind selten. Vielleicht wurden sie weniger beim Arbeiten in der Siedlung gebraucht. Wie und warum ein unbenutzter Dechsel wie die Fundnr. 83 zwischen Abfälle in eine Grube geraten ist, bleibt vorerst rätselhaft. Wäre es ein Pfostenloch, so konnte dieser kleine, hohe Dechsel als Bauopfer gedeutet werden, aber das ist hier nicht der Fall.

Das Fragment Fundnr. 36 rührt von einem durchbohrten Gerät her. Es mutet mittelneolithisch an und dürfte wohl mit der sparsam vertretenen Münchshöfener Kultur in Verband gebracht werden, obschon in der Grube keine Münchshöfener Scherben vorlagen. Es ist ja auch nicht ausgeschlossen daß einige der flachen Dechsel zu dieser Kultur gehört haben; nicht alle dürfen linearbandkeramisch gewesen sein.

Wohl nicht bandkeramisch ist die Fundnr. 167a, ein Beilnackenfragment. Dessen Rohstoff, Serpentinit, weicht auch völlig von den übrigen Geräten ab.

Bis auf einem sind die anderen Stücke aus Amphibolit gefertigt. Die Ausnahme betrifft den Dechsel Nr. 349 aus Basalt. Die Grundmasse dieses Gesteines ist reich an Plagioklas, Augit und Magnetit. Augit und fast ganz umgewandelte basaltische Hornblende formen die Einsprenglinge. Plagioklas fehlt in dieser Kategorie.

Tabelle 1. Die Maße der Dechsel in mm, Winkel der Schneide in °.

Fundnr.	Länge	Breite	Höhe	Winkel
1a	136	24	30	50
1b	81	62	21	60
34	42	36	9	40
83	81	16	17	50
95	59	13	45	60
179	43	23	9	40
216	58	33	10	40
249	51	34	10	50
379	60	42	11	50

Basalt ist als Rohmaterial für Dechsel im Gäuboden seltsam. Üblich ist Amphibolit, eine Bezeichnung die hier im weitesten Sinne benutzt wird. Zwei Dechsel, die Fundnr. 14a und 216, gehören zur Gruppe des sehr feinkörnigen Gesteins, welches dünne und häufig etwas unregelmäßige Schichten aufweist. Dieses ist inhomogen infolge heller gefärbten Schichten und schräg zur Hauptrichtung verlaufenden Ader. In der Siedlung Hienheim »Am Weinberg«, Ldkr. Kelheim, wurde dieser Amphibolit als Gruppe I bezeichnet, ebenso wie in der Siedlung Sallmannsberg bei Landshut. Eine andere Bezeichnung dafür ist Strahlsteinschiefer (Arps 1992; Bakels 1986). Die anderen Amphibolite sind grobkörniger und homogener. Sie weisen oft eine Richtung im Gefüge auf. Diese Richtung wurde bei der Herstellung der Geräte berücksichtigt. Ihre Verwitterungsfarbe ist bestimmt grüner als bei der Gruppe I. Dünnschliffe sind nicht angefertigt worden, aber, so weit ersichtlich, ist die Hienheimer Materialgruppe II bzw. die Sallmannsberger Materialgruppe III vorhanden. In Hienheim ist die Verwendung der Amphibolitgruppe I hauptsächlich auf der Linearbandkeramik beschränkt. In Sallmannsberg wurde dieser Rohstoff auch während der Altheimer Kultur benutzt. Die in der Publikation über Hienheim ponierte Hypothese, daß die Zufuhr von Amphibolit aus der Gruppe I in dem Zeitraum nach der Linearbandkeramik stark nachließ oder vielleicht sogar aufhörte, kann also nicht für den gesamten Gäuboden beibehalten werden. Meindling hat hier leider nichts hinzuzufügen weil ein Vergleich mit nachlinearbandkeramischem Material hier nicht möglich ist.

Die Dechsel müssen anderswo hergestellt sein, da Abfälle von der Bearbeitung des Gesteins in Meindling fehlen. Von woher die Geräte kamen ist noch immer nicht bekannt.

Die Siedlung ist nicht besonders arm an Dechseln und dessen Trümmerstücken. Es gibt immerhin 20 von diesen Artefakten auf 9 Häusern, das macht 2,2 Stück pro Haus. In Hienheim »Am Weinberg« wurden 25 Gebäude linearbandkeramisch datiert; dazu gehören wenigstens 60 Geräte (Abfälle ohne Schliffspuren nicht einbegriffen), also 2,4 Stück pro Haus. Diese Rate dürfte höher ausfallen, da die nicht mit Sicherheit datierten Stücke ausgeklammert sind. Das Maximum liegt wohl bei 3,8. Sallmannsberg erbrachte 14 Häuser und 32 Artefakte (unbestimmbare Trümmer nicht mitgerechnet, Gänslmeier 1992), das macht 2,4 Geräte pro Haus. Die Werte sind vergleichbar mit denjenigen der kleineren Siedlungen im nordwestlichen Bereich der Linearbandkeramik, namentlich Laurenzberg 7 (2,5) und Langweiler 16 (3,0) im Merzbachtal. Großflächiche Siedlungen haben dort weniger Funde erbracht, zum Beispiel Elsloo (0,4), Stein (0,4), Sittard (0,5), Langweiler 8 (0,6), Langweiler 2 (1,1) und Langweiler 9 (1,8) (Bakels 1987). Es wurde suggeriert daß die Einwohner der kleineren Siedlungen sich am Ende einer Distributionskette befanden und deswegen mehr abgenutzte Geräte wegzuwerfen hätten. Ob das in Niederbayern auch der Fall war, wäre heute noch zu überprüfen. Die relativ kürzere Entfernung zu den Amphibolitvorkommen im Vergleich mit dem Nordwesten dürfte eine Rolle spielen. Auch der Faktor Zeit ist noch unbekannt. Leider konnte die Grabung zu Meindling keine Information liefern über Änderungen in der Rohstoff- und Dechselversorgung im Laufe der Zeit.

10. Sonstige Funde

Zu den sehr seltenen Funde gehören einige Stückchen Hämatit.

In einer relativ jungen Grube im Quadrat G-2 wurde die Spitze eines Knochengerätes gefunden.

11. Eine Bestattung

In der Füllung der Grube 296 im Quadrat G-2 wurde das Skelett eines Kindes entdeckt. Der Fund wurde eingehend bearbeitet von Herrn A.B. Döbken, derzeit Student, mit Hilfe der Herren K.S. Groos und dr.G.J.R. Maat des

Abbildung 13. Oben: Stark nachgeschliffener Dechsel aus Amphibolit, Materialgruppe I (Fundnr. 34). Mitte: Dechsel aus Amphibolit, Materialgruppe I (fundnr. 216), Unten: Dechsel hergestellt aus dem Bruchstück eines längeren Exemplares, Amphibolit, Materialgruppe II (Fundnr. 379). M 1:1.

Anatomisch-Embyrologischen Laboratoriums der Leidener Universität. Folgendes ist eine Zusammenfassung des im Archiv des IPLs befindlichen Rapports.

Das Skelet wurde gefunden beim Schneiden einer 90 cm langen und 50 cm breiten Ausbuchtung der großen Grube 296. Der Tote wurde auf den Boden des bis 20 cm unter die Grabungsfläche reichende Annexes gelegt. Fraglich ist es, wie weit die Ausbuchtung zur Bestattung gegraben wurde, oder ob sie schon da war und lediglich ein wenig ausgeräumt wurde. Letzteres hat die größte Wahrscheinlichkeit, weil das Kind diagonal im Grubenteil lag. Es handelt sich um eine Hockerbestattung in Ost-West-Richtung. Die Beine wurden hoch gezogen und umarmt. Der Kopf befand sich im Osten mit Blickrichtung zum Süden. Das Alter beim Sterben wurde anhand von Röntgenaufnahmen der rechten Oberkieferhälfte und der linken Unterkieferhälfte auf 3±1 Jahr bestimmt. Die Bestattung kann nur indirekt datiert werden, weil Beigaben fehlen. Aus der Füllung des Grabes wurden einige LBK Scherben und ein Stückchen Stein gesammelt, während die große Grube nur mehrere verzierte und unverzierte LBK Scherben enthielt. Man kommt kaum darum herum, die Bestattung als linearbandkeramisch zu betrachten.

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Chert procurement strategies in the LBK settlement of Meindling, Bavaria

In this paper the chert assemblage of the Linearband-keramik site at Meindling in southeastern Bavaria is analyzed. The settlement is located at a distance of at least seventeen kilometres from the nearest outcrops of chert bearing rocks. Its inhabitants practised a procurement strategy different from that known at Bandkeramik sites in flint-bearing regions, such as Hienheim. This strategy involved a more careful selection of raw material at extraction sites. However, there was no evidence for a dearth of raw material, nor for parsimonious behaviour once the chert had arrived at the settlement.

1. Introduction

During the trial excavation performed in 1977 at the Linear Bandkeramik (LBK) site of Meindling (Gde. Oberschneiding, Ldkr. Straubing-Bogen) by the Leiden University Institute for Prehistory (Modderman 1978, in press) a total of 236 chert artefacts were recovered. A detailed study of the small assemblage seemed worthwhile, since this could provide insight into the lithic procurement system of a Bavarian LBK settlement located far from raw material sources, thus supplementing previous work on Hienheim (Ldkr. Kelheim), which is situated close to several outcrops of high-quality chert (De Grooth 1977, 1994, in press). Given the small number of artefacts, it was decided to study them only at site-level — individual pits contained 18 artefacts at the most —, and to include the few artefacts recovered from the mechanically removed topsoil as well. This procedure seems justified, as all but one of the artefacts are Linear Bandkeramik in character. The one exception is the fragment of a bifacially worked sickle or knife (fig. 2, M81), made from tabular chert of the Baiersdorf type and characteristic for the regional Late Neolithic Altheim and Cham Cultures (Binsteiner 1989; De Grooth 1977, 76; Driehaus 1960). The reference material from Hienheim used in this study consists of a sample of 754 artefacts stemming from sixteen Early and Middle LBK refuse pits (De Grooth 1994) and made on nodular cherts originating from the surrounding Franconian Alb. Both assemblages were coded using the same list of variables, although for Meindling a number of variables were added, allowing for a more accurate characterization of the kinds of raw material present.

The excavation techniques used in Meindling and Hienheim were similar, as were the amount of erosion, and the general character of the settlements in terms of the density of houses and the frequency of refuse pits. Therefore, assessing the density of artefacts from both excavations provided a suitable starting point for a comparison of the lithic procurement systems of both sites (Torrence 1986).

In Meindling 235 LBK flint artefacts were found in 1400 square metres of excavation (surface finds included), i.e an average of one flint artefact per 6 m^2. The first series of excavations at Hienheim (up till and including 1970), with an excavated surface of 7356 m^2 (Modderman 1977), yielded 2750 LBK flint artefacts from dated pits alone (De Grooth 1977, 69, tab. 1), i.e. at least one flint artefact per 2.7 m^2. Thus, the overall density in Hienheim was at least twice as high as that found in Meindling.

The difference in *tool* density, however, is much smaller, Meindling having 1 tool/14.6 m^2, and Hienheim 1 tool/18.0 m^2. This indicates that the inhabitants of Meindling displayed behaviour different from those at Hienheim as regards raw material acquisition and tool *production*, but not in tool *consumption*. The settlement's location, relatively distant from sources of raw material, may be regarded as an obvious cause.

2. Raw material

Meindling is situated in the loess-covered *Gäuboden*, an area without chert-bearing layers in its subsoil. The nearest outcrops occur at a distance of some seventeen kilometres to the north-west, on the other bank of the Danube, where small residual outcrops of Jurassic (more specifically Malm beta) chalks at the Buchberg and the Helmberg near Münster (Ldkr. Straubing-Bogen) contain nodular cherts (fig. 1). Similar exposures occur c. 35 and c. 50 km to the south-east at Flintsbach-Hardt (Ldkr. Deggendorf) and in the Ortenburg (Ldkr. Vilshofen) region (Binsteiner 1990b; Röhling 1987; Weißmüller 1991). Following Weißmüller's suggestion (1991, 35) I shall use the name 'Ortenburger Jurassic chert' (*Ortenburger Jurahornstein*) for this type of raw material. At present, exploitation of the Münster outcrops can only be presumed (Binsteiner 1990b), but at

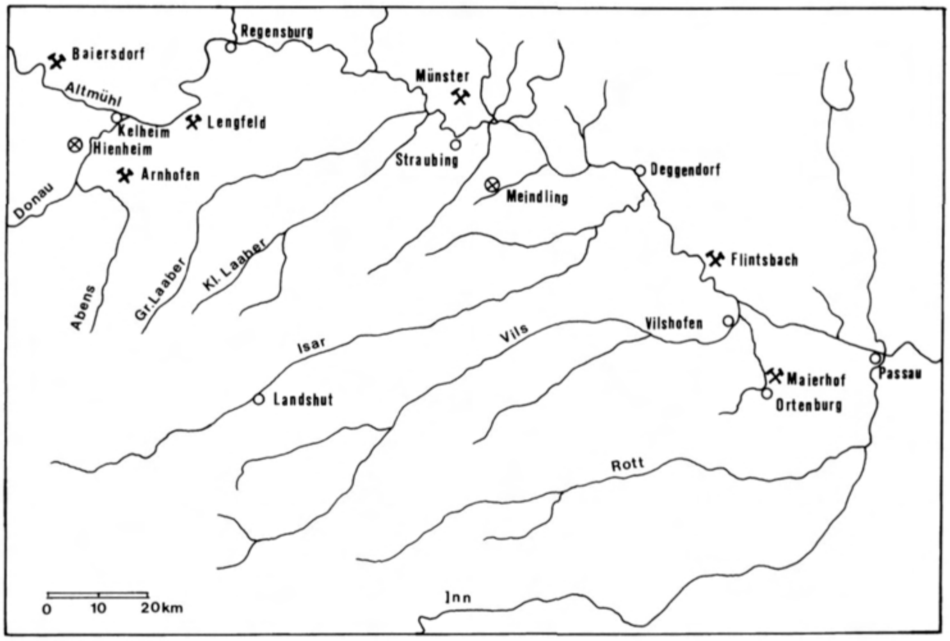

Figure 1. Map showing the location of settlements and chert extraction sites mentioned in the text.

both Flintsbach and Maierhof/Weng (Ldkr. Vilshofen) systematic exploitation of residual deposits of this type of silex has been documented (Moser 1980, 450; Weißmüller 1991).

Other important sources of chert are located to the west of Regensburg, at a distance of more than 65 km from Meindling, in the southernmost part of the Franconian Alb. Some of the concretions extracted here are Cretaceous in age (Birnbach near Hausen, Ldkr. Kelheim; Moser 1980, 451), but most belong to the Jurassic Malm zeta (Binsteiner 1990b, 1992; Moser 1980). They are present not only in the bedrock, but also in residual loams (*lehmig-kieselige Albüberdeckung*), which cover large parts of the region. The investigated Neolithic mines in the Kelheim area all exploited residual cherts: Arnhofen-Abensberg (Binsteiner 1990a; Engelhardt/ Binsteiner 1988), Baiersdorf (Binsteiner 1987, 1989) and Lengfeld (Reisch 1974; Rind 1992).

The varieties of chert present in Meindling can nearly all be assigned to the two provenances described, although in some cases the heavily rolled cortex points to an origin in chert-bearing river gravels, as may be found in the Danube valley close to Straubing (Ganslmeier 1984). Table 1 demonstrates that approximately 50% came from the Ortenburger outcrops and c. 35% from the Franconian Alb. The nearest two Ortenburger outcrops, Münster and Flintsbach, may have been exploited by inhabitants of Meindling during short trips. The material from the Franconian Alb could have been obtained either during longer expeditions or by means of indirect supply. For a more detailed analysis of the prevailing procurement strategies one must first determine whether or not both groups of raw material were treated in different ways and whether the situation in Meindling differs in this respect from that in Hienheim.

3. Technology

The three assemblages under consideration (cherts from the Ortenburger and Franconian Alb at Meindling, as well as material from the Franconian Alb at Hienheim, to be abbreviated as M-ORT, M-ALB, and H-ALB respectively) do not differ as regards the average dimensions of blades and flakes (maximum width, maximum thickness, platform width and thickness), indicating that similar knapping techniques were used at both sites (tab. 2).

Because of the small number of complete blanks in Meindling their average length could not be compared. The degree of fragmentation differs only slighty. The length of flakes and flake fragments is also similar. The mean length of all blades (i.e. including fragments) of both types of chert is somewhat shorter at Meindling.

Between the samples, however, marked differences are found in the frequency of the various categories of artefacts. (tab. 3). Thus, we find in Hienheim for every ALB core/hammerstone twice as many blades, and almost four times as many flakes as in Meindling. In Meindling the proportion of flakes is identical for both types of raw material, but the Ortenburg chert has even fewer blades for every core (tab. 4). In this respect the Meindling figures are

Table 1. Meindling: review of raw materials.

type		provenance	number
1.	Brownish or greyish nodules with many dots (< 2 mm) and/or specks; sometimes with a zoning of lighter and darker areas. Artificial surfaces generally are smooth. The cortex is mostly thin and rough*	Ortenburger Jura	114
2.	Greyish brown homogeneous nodules, again mostly with a rough cortex and smooth artificial fracture surfaces	Ortenburger Jura	6
3.	Whitish-, bluish- or dark grey nodules with a homogeneous structure and predominantly smooth fracture surfaces. The thin cortex is either rough or smooth	Residual loams Franconian Alb	12
4.	Bluish- or dark grey nodules with a gradually zoned structure, smooth artificial surfaces and a thin, smooth cortex**	Residual loams Franconian Alb	30
5.	Bluish-, whitish- or dark grey banded nodules, with sharply defined bands/stripes, smooth or shiny artificial surfaces and a thin, rough cortex	Probably Arnhofen-Abensberg	15
6.	Bluish grey striped tabular cherts with smooth or shiny fracture surfaces, and a thin, rough cortex	Arnhofen-Abensberg	14
7.	Greyish specked, zoned, or striped cherts (mostly nodules, but also some tablets), that have become multi-coloured (reddish, ochre, greenish), perhaps through secondary infiltration of iron- or manganese-hydroxides. In some cases, however, patination or slight thermal alteration cannot be excluded as causes for this colouring	Arnhofen-Abensberg or Lengfeld	10
8.	Miscellaneous. This group comprises single pieces, most of them probably stemming either from residual loams of the Franconian Alb or from river gravels. Remarkable is the fragment of an end-retouched bladelet, reddish in colour with a thin, shiny, dark red cortex	Residual loams or Danube river gravels	18
9.	Unidentifiable, mostly because of thermal alterations		16

* Five cores and one flake show heavily rolled natural surfaces, indicating these originate from river gravels.
** The heavily rolled natural surfaces of three cores in this group, however, indicate a (secondary) river gravel context.

Table 2. Measurements of blanks in Meindling and Hienheim.

	M-ORT flakes	M-ORT blades	M-ALB flakes	M-ALB blades	H-ALB flakes	H-ALB blades
Width (when complete), mm	x=24.5 s=6.0 N=28	x=17.6 s=3.8 N=43	x=24.9 s=6.7 N=16	x=16.8 s=3.7 N=32	x=27.3 s=12.7 N=203	x=16.7 s=5.1 N=153
Thickness (when complete), mm	x=6.4 s=2.3 N=48	x=4.9 s=1.6 N=54	x=7.5 s=4.1 N=27	x=5.4 s=2.1 N=44	x=7.9 s=5.1 N=326	x=5.3 s=2.0 N=301
Platform width (when complete), mm	x=13.9 s=7.4 N=39	x=9.0 s=2.6 N=25	x=12.7 s=7.8 N=23	x=9.4 s=2.7 N=21	x=14.0 s=9.4 N=223	x=9.4 s=3.2 N=151
Platform thickness (when complete), mm	x=4.6 s=2.6 N=39	x=3.5 s=1.5 N=25	x=4.3 s=3.0 N=23	x=4.0 s=1.8 N=21	x=5.4 s=3.8 N=225	x=4.2 s=1.7 N=151
Length (fragments included), mm	x=26.9 s=7.6 N=48	x=29.6 s=9.2 N=54	x=27.1 s=9.3 N=27	x=31.6 s=11.6 N=44	x=30.6 s=12.9 N=323	x=33.4 s=12.1 N=302

Table 3. Meindling and Hienheim, principal artefact categories.

	M-ORT		M-ALB		M-total		H-ALB	
	n	%	n	%	n	%	n	%
Blades, tools	40	33.3	26	32.1	72	30.6	141	18.7
Blades, non-tools	14	11.7	18	22.2	41	17.4	162	21.5
Flakes, tools	14	11.7	10	12.3	26	11.1	68	9.1
Flakes, non-tools	34	28.3	17	21.0	59	25.1	258	34.2
Cores	13	10.8	7	8.6	21	8.9	22	2.9
Chips	0		0		2	0.9	21	2.8
Artefact fragments	5	4.2	2	2.5	12	5.1	81	10.7
Natural blocks	0		1	1.2	2	0.9	1	0.1
total	120		81		235		754	

Table 4. Proportions of cores, flakes and blades in Meindling and Hienheim.

	M-ORT	M-ALB	H-ALB
Core : flake	1:4	1:4	1:15
Core : blade	1:4	1:6	1:14

comparable to those from LBK settlements in the Lower Vils Valley, situated some 20-30 km to the southeast, where Ortenburger Jurassic cherts were the predominant raw material (Schötz 1988).

This could mean that the cherts were transported to Meindling at a later stage of the reduction sequence than that at which they reached Hienheim, i.e. not as unprepared blocks or initially prepared cores (De Grooth 1977, 1994), but as completely prepared or even partially reduced cores. This hypothesis may be tested through a detailed comparison of technological variables for all three assemblages, based on the following propositions:

If the initial stages of the reduction sequence had indeed been performed elsewhere, one would expect to find in Meindling:

1. fewer artefacts with cortex;
2. fewer blanks with striking platforms consisting of cortex and/or natural surfaces.

If at Meindling cores were also worked more intensively (because of a relative scarcity of raw material), one would expect to find:

3. more blanks with a primary or secondary facetted platform, the result either of more careful platform preparation or of a more frequent use of exhausted core faces as striking platforms;
4. more rejuvenation blanks;
5. the average number of striking platforms and core faces on the cores would be higher;
6. the average size of the exhausted cores would be smaller.

If the small amount of blades in the ORT assemblage was caused by smaller dimensions and/or lower quality of the initial nodules, one would expect to find:

7. more cortex on ORT than on ALB blanks;
8. a smaller average number of negatives of removed blanks pro core;
9. a smaller average number of previous negatives on the dorsal faces of flakes and blades.

The data summarized in table 5 clearly support the first three assumptions, the proportion of cortex and natural fracture surfaces being much lower at Meindling than at Hienheim, whilst more facetted platform surfaces are present. Core rejuvenation also seems to have been practised more frequently at Meindling.

The fifth proposition, unfortunately, cannot be evaluated for the Meindling ALB cores, as all but two of them are completely covered by hammerstone traces. It must be rejected for the ORT group, however. Moreover, the average weight of cores of both ORT and ALB chert at Meindling is not lower, but higher than at Hienheim.
In combination with the higher proportion of facetted platforms and core rejuvenation, this could mean that at Meindling cores were not actually worked more intensively, but that a higher proportion of blanks derive from later stages in the reduction sequence, when platforms generally were prepared more carefully (Cahen 1984; De Grooth 1987, 1988). The last three propositions, concerning possible differences between the two groups of raw material, are weakly supported by the slightly lower average number of negatives on the Ortenburger in

Table 5. Comparison of technological data for Meindling and Hienheim nodular chert.

	M-ORT	M-ALB	H-ALB
Artefacts with cortex (%)	49.2	49.4	66.7
Striking platforms on blanks (%)			
– cortex	17.4	16.0	23.6
– smooth	39.1	43.0	45.7
– facetted	37.7	42.0	22.6
– other	5.8	8.0	8.2
Dorsal scars (blanks)	x = 1.9 s = 1.1 N = 83	x = 2.0 s = 1.2 N = 54	x = 2.0 s = 1.1 N = 496
Rejuvenation blanks (%)	6.9%	7.0%	5.1%
Weight of cores (gr)	x = 88.6 N = 13	x = 111.7 N = 7	x = 77.6 N = 22
Negatives on cores	x = 5.8 s = 3.1 N = 9	(x = 7.0 N = 2)	x = 7.2 s = 3.8 N = 15
Core faces/ striking platforms	x = 3.2 s = 1.0 N = 9	(x = 5.5 N = 2)	x = 3.8 s = 1.2 N = 16

Table 6. Meindling, retouched tools and artefacts with macroscopically visible traces of use wear.

type		ORT	ALB	?	n	%
arrowheads		1			1	0.9
borers			1		1	0.9
end-scrapers		7	11		18	15.2
single	11					
double	2					
+ end-retouche	1					
+ side-retouche	4					
sickle blades		21	7	1	29	24.6
single	11					
double	1					
+ end-scraper	1					
+ end-retouch	16					
end-retouched blades		6	5	3	14	11.9
single	11					
double	2					
+ side-retouch	1					
side-retouched blades		6	4	3	13	11.0
single	11					
double	2					
utilised blades		12	7	1	20	16.9
splintered pieces/hammerstones		9	11	2	22	18.7
total		62	46	10	118	

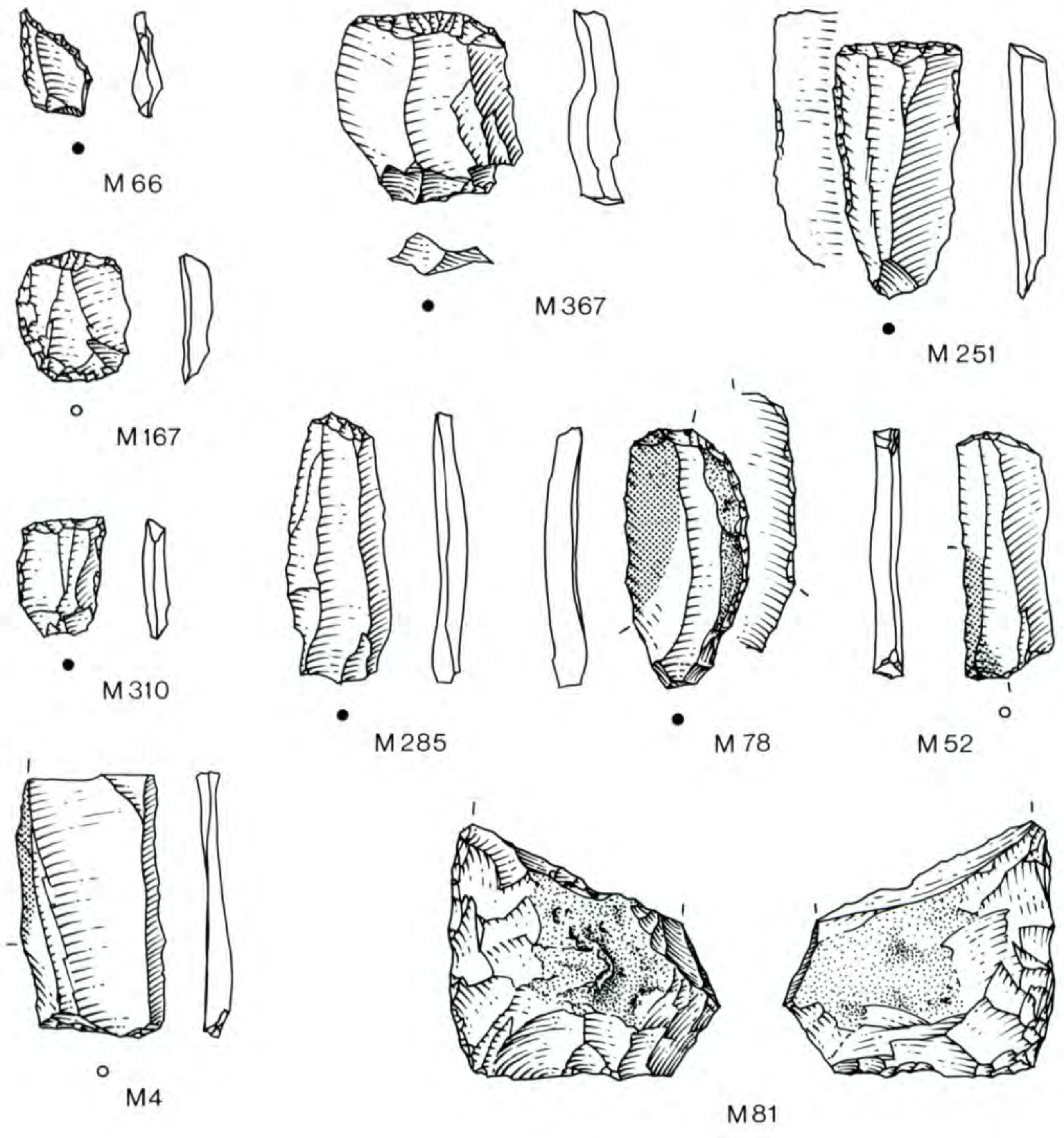

Figure 2. Characteristic tools from Meindling.
M66: borer; M251, 367: end-scrapers; M167: double end-scraper; M285, 310: end-retouched blades; M4, 52, 78: sickle blades; M81: fragment of bifacially retouched knife or sickle (Late Neolithic). M 1:1.

Table 7. Tool frequencies in Meindling compared to those in a sample of 240 LBK tools from sixteen dated pits in Hienheim.

	Hienheim observed (%)	observed	Meindling expected	(O-E)²/E
Arrow / borer / burin	9.6	2	11.3	7.65
End-scraper	11.7	18	13.8	1.28
Sickle blade	11.3	29	13.4	18.16
End-retouch	7.9	14	9.3	2.38
Side-retouched / utilised	33.3	33	36.9	0.41
Splintered pieces / hammerstones	28.3	22	33.3	3.83

Table 8. Average number of modifications on main tool types in Meindling and Hienheim.

tool type	Meindling			Hienheim		
	x	s	N	x	s	N
Sickle blades	4.1	1.6	29	4.0	0.9	26
End-scrapers	3.2	1.2	18	2.6	0.8	23
End-retouched blades	2.5	1.2	14	2.8	1.4	19
Side-retouched blades	3.1	1.3	13	2.8	0.9	44

comparison to Hienheim's ALB cores (again, the two Meindling ALB cores must be disregarded).

Thus, the analysis of technological variables confirmed that both ALB and ORT chert arrived in Meindling in a later stage of the reduction sequence than did the ALB cores in Hienheim. No indications for a more intensive working of cores were found, however.

4. Tools

The tools may offer additional information on the availability of raw material.

Table 6 and figure 2 show that all 'classical' LBK tool types are represented among the 50.2% of the assemblage with intentional retouch or macroscopically visible traces of use-wear. Their relative frequencies are rather remarkable, however: not only are sickle-blades by far the most frequent type, but both borers and arrowheads are represented by only one, rather atypical, specimen (fig. 2).

If we compare these figures with expected values, as derived from the observed frequencies in, once more, the Hienheim sample, the differences turn out to be significant indeed (tab. 7), with a χ^2 value of 33.68 ($p < 0.001$).

Arrowheads, borers and hammerstones/splintered pieces are strongly under-represented, whilst there is a disproportionally high number of end-scrapers, sickle blades and end-retouched blades. This leads to the following interpretation: in the excavated part of Meindling chert tools were used mainly for primary subsistence and household tasks, like harvesting grain and working hides (Van Gijn 1990, 92, 95). Given the relatively small scale of the excavation, it remains unclear whether perhaps a boring machine stood in another part of the settlement, or whether drilling must be considered not to have been a 'basic' LBK activity. Unclear is too whether the inhabitants of Meindling used weapons other than bows with chert-tipped arrows, or indeed did not hunt at all. I intend to pursue these questions further by means of a Principal Components or a Correspondence Analysis in a forthcoming study of the patterns of co-variation of tool types in Hienheim.

The mean length of complete end-scrapers on blades is considerably shorter in Meindling (x = 29.3 mm, s = 9.2, N = 10) than it is in the Hienheim sample (x = 42.1, s = 3.6, N = 7), perhaps indicating a more intensive use of these tools. If one takes into account the general shorter length of the Meindling blades, however, the difference seems to become less significant. Moreover, the intensity of tool maintenance and recycling, as estimated on the basis of the average number of modifications visible on the main tool types, turned out to be very similar to that in Hienheim (tab. 8). Thus, the tools do not support the idea of constrained availability of raw material either.

5. Procurement strategies

As a final step one should ascertain how the acquisition of both types of raw material was organised in terms of the heuristic models developed in previous studies for the analysis of lithic production and distribution mechanisms (De Grooth 1991, 1994, in press).

According to these models, both assemblages could be the result of several procurement strategies:

1. If the inhabitants of Meindling had direct and open access to the sources of raw material, they themselves would have completely prepared the cores at the extraction sites, bringing them home for further reduction (a variety of model C0).
2. In the case of an indirect supply system, two distribution mechanisms would be possible:
2a. People having direct access to the resources worked according to the system described above and subsequently exchanged some of the prepared cores (corresponding to model C2).
2b. The producers transported selected, unworked nodules to their settlements for further reduction, and exchanged some of the cores after preparation, or possibly even after an initial series of blanks was produced (corresponding to model D2).

In general, access to lithic resources present in an LBK settlement's home range (i.e. the area within a six-hour walking distance) is considered to have been unrestricted (Bakels 1978; Bogucki 1988, 126-127; De Grooth 1994; Lech 1987; Zimmermann 1991; but see Cahen *et al.* 1990 for a different view). According to Zimmermann (1991, 100), in the Rhineland the transition zone between direct and indirect supply of Rijckholt-type flint is situated at a distance of c. 30-45 km of the resources. For the striped tabular cherts mined at Arnhofen-Abensberg during the post-LBK Middle Neolithic in the present study area, a direct supply zone of c. 20 km was inferred (De Grooth 1994).

Thus, for the Ortenburger cherts direct acquisition as depicted in the first model would be more probable than the two possibilities involving exchange. The additional evidence supporting this interpretation is rather flimsy: The data from the Lower Vils Valley indicate that people there, living at a distance of 10-15 km from the extraction sites, also adhered to the strategy of performing the initial stages of core reduction elsewhere (Schötz 1988). Moreover, the debris excavated at the Flintsbach quarries shows that a substantial amount of core preparation and blank production was indeed performed in the extraction area, whilst the discarded cores are very similar in type to the cores at Meindling (Weißmüller 1991). However, some caution is called for here, firstly because the mining activities cannot be dated precisely, and secondly, because we do not know, whether the Meindling cherts were actually collected at Flintsbach or at Münster. The considerable distance between settlements and exploitation areas (as well as other factor such as difficulties crossing the Danube or the unpredictability of raw material quality) may have led to the practice of performing the first stages of the reduction sequence at the quarry site, thus reducing the risk of transporting substantial amounts of unsuitable/worthless nodules. A similar strategy was described for the LBK exploitation at the Tomaszów 'chocolate-flint' mines in Poland, located at a distance of more than one day's walk form the nearest settlements (Lech 1989).

Following the same line of reasoning, the cherts form the Alb region would have been acquired indirectly. In this case, the last possibility depicted seems the most plausible, as it is compatible with the procurement strategy practised by the inhabitants of the Southern Franconian Alb, who took unworked nodules home for further reduction (Davis 1977; De Grooth 1977, 1994; Tillmann 1989; Weinig 1989) and thus could conceivably distribute prepared or initially reduced cores through down-the-line exchange networks. The same system of production and exchange is thought to have functioned in other areas where LBK settlements are situated close to outcrops of high-quality silex (Cahen *et al.* 1986; Caspar *et al.* 1989; Kaczanowska *et al.* 1987; Lech 1987; Zimmermann 1991).

This would mean that two types of raw material, even though arriving at the site at the same stage of reduction, were procured through different strategies, based on direct acquisition for the regionally available Ortenburger cherts, and on down-the-line exchange for the material from the distant Franconian Alb. Moreover, the direct acquisition of Ortenburger chert was organised in a way different from that which seems to have been usual in LBK settlements located close to sources of raw material.

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Fruits and seeds from the Linearbandkeramik settlement at Meindling, Germany, with special reference to Papaver somniferum

The crops of Linearbandkeramik Meindling were emmer wheat, einkorn wheat, pea, lentil, linseed and poppy, if the latter was indeed cultivated. The fields were infested with a special weed flora whose composition differed slightly from the classical Bromo-Lapsanetum praehistoricum. The carbonized waste consisted of grain that was not yet been dehusked and discarded chaff. As far as could be ascertained, excess chaff was dumped to the west of the houses. One Hallstatt pit contained gold of pleasure.

1. Introduction

Meindling, Ldkr Straubing-Bogen, is situated in the loess district of Lower Bavaria, Germany (fig. 1). The settlement lies at the edge of a plateau, on ground that slopes gently towards the left bank of the rivulet Ödbach. The distance to the watercourse is 100 m. Most traces of habitation are of the first agrarian settlers of Central Europe: the people of the Linearbandkeramik culture. Even the earliest phase of this culture is represented, which is why P.J.R. Modderman decided to excavate the site. He hoped that he would be able to fill the gap in the information obtained in his large-scale investigations at Hienheim "Am Weinberg", Ldkr. Kelheim, where this earliest phase was not represented (Modderman 1992).

Unfortunately Meindling proved to have been inhabited from the earliest phase up to and including the late phases of the Linearbandkeramik culture; the site contained many intersecting features. This made it rather difficult to distinguish between the various phases of occupation. Nevertheless it proved possible to date some features in relative terms, as early and late in the Linearbandkeramik sequence. Fortunately, occupation remains of other cultures were rare; they were restricted to two pits containing Münchshöfener remains and two pits containing Hallstatt remains. The other remains were all Linearbandkeramik. Four C14 dates are available for this period: 6380 ± 130 BP (GrN-8687), 6190 ± 100 BP (GrN-9139), 6130 ± 40 BP (GrN-8688) and 6030 ± 60 BP (GrN-9138).

2. The samples

During the Meindling excavation sampling for botanical remains was a standard procedure. Samples were taken from pit fills which were found to date from one occupational phase only; no samples were taken from areas of intersection. With one exception (No. 95-1), no samples were taken from the top ten centimetres of the fills, because it was believed that they may have contained secondary sediments, deposited in the depression remaining after the original fill had settled. Samples were taken from different layers in the case of stratified fills; when no clear layers were observed only one sample was taken. Only three pits that were dug for the erection for posts (Nos 75, 138, 166) were investigated because in previous excavations of Linearbandkeramik sites these pits had yielded virtually no evidence of fruits and seeds whatsoever. Three samples were taken from true postholes (Nos 119, 157, 169). All in all 84 Linearbandkeramik samples, three Münchshöfener samples and two Hallstatt ones were obtained for analysis.

The material was sieved by hand in water, using a series of sieves with meshes of 1.0, 0.5 and 0.25 mm. The loess-loam matrix did not allow the use of flotation methods. The size of the samples was therefore restricted to 2 dm^3, with only three exceptions. In one case only one dm^3 was available (No. 179-3), in a second case the layer in question contained so much charred material that the sample size was increased to 4 dm^3 (No. 115-3) and in a third case a sample of 5 dm^3 was sieved for no specific reason (No. 121). The residues were air-dried. The evidence was sorted and identified in the laboratory at Leiden using a microscope with magnifications of up to 50×.

All the fruits and seeds that were not carbonized were considered to be of a relatively late date. Only carbonized matter survives long periods of burial in loess soils. Seeds with a natural dark colour, such as *Chenopodium album* and *Veronica hederifolia*, were sectioned after identification. Some *Chenopodium* and all *Veronica hederifolia* proved to be of recent date. They included all of the 126 *Chenopodium album* seeds obtained from the only secondary top fill layer sampled (No. 95-1). The carbonized remains are listed in tables 1 and 2.

In addition to soil samples, sherds were investigated and silicon rubber casts were made of promising impressions. The search for seed impressions was rewarding (figs 2, 3). The results are given in table 3.

Table 1. The most common carbonized fruits and seeds found at Meindling. 66-1 is the uppermost layer of pit 66 etc; 194a en b are from the same layer. E: Early Bandkeramik, L: Late Bandkeramik.

Feature	Triticum dicoccum	Triticum monococcum	Triticum sp.	Glume bases	Other cultivated plants	Chenopodium album	Bromus secalinus/hordeaceus	Polygonum convolvulus	Setaria viridis/verticillata	Other	Density	Phase
35	-	-	-	-	-	3	1	2	-	-	3.0	
49	-	1	2	4	-	4	-	-	-	-	5.5	
52	1	-	3	22	1	40	4	5	3	2	40.5	
55	-	-	1	-	-	-	-	-	-	-	0.5	
66-1	1	-	-	1	-	2	1	-	1	-	3.0	
66-2	-	-	4	9	-	11	-	1	1	1	13.5	
66-3	-	1	-	-	-	1	-	-	-	-	1.0	
66-4	1	-	2	1	-	2	-	-	-	-	3.0	
67	1	-	-	-	-	-	-	-	-	-	0.5	
74	-	-	2	3	-	3	-	1	-	-	4.9	
75	-	-	2	-	-	1	-	-	-	-	1.5	
83-1	-	-	-	-	-	-	-	2	-	-	1.0	
83-2	-	-	-	-	-	-	-	-	-	-	0.0	
85	-	-	-	-	-	-	-	1	-	-	0.5	E
87	-	-	-	-	-	-	-	-	-	-	0.0	
88	2	-	5	11	-	12	8	2	-	-	20.0	
89	-	-	1	-	-	-	-	-	-	-	0.5	
90	1	-	2	14	-	7	2	2	4	3	17.5	L
91	-	-	-	-	-	-	-	-	-	-	0.0	L
92	-	-	9	7	-	6	-	-	1	-	11.5	L
93-1	1	-	1	9	-	-	2	1	-	-	7.0	L
93-2	1	-	14	21	-	47	4	6	1	1	47.5	L
93-3	-	-	2	10	-	5	-	1	-	-	9.0	L
95-1	1	-	12	19	-	-	13	2	-	3	25.0	
95-2	-	-	4	-	-	-	-	-	-	-	2.0	
96	-	-	-	3	-	-	1	1	-	-	2.5	E
97	-	1	7	13	-	39	2	1	-	3	33.0	L
98	6	7	35	77	1	28	13	4	3	18	96.0	
99	2	-	8	11	-	12	1	-	-	2	18.0	E
100-1	2	1	22	50	-	26	15	6	3	2	63.5	
100-2	2	-	12	17	-	18	21	2	3	2	38.5	
102	1	-	5	17	-	14	2	1	5	-	22.5	
103	-	-	2	6	-	16	1	2	1	-	14.0	E
115-1	-	-	21	42	2	31	7	14	5	14	68.0	L
115-2	-	-	3	-	-	1	-	-	-	1	2.5	L
115-3	10	-	72	259	-	9	5	10	9	8	95.5	L
117	3	2	13	28	-	9	9	1	-	2	33.5	L
119	1	-	-	8	-	-	-	-	-	-	4.5	
121	3	1	15	38	-	21	1	1	-	1	16.2	E
122-1	1	1	3	16	-	61	3	2	4	2	46.5	E
122-2	-	-	1	5	-	7	2	1	-	1	8.5	E
122-3	1	-	4	8	-	15	3	2	-	1	17.0	E
138	1	-	4	9	-	13	6	6	-	1	20.0	E
143	2	-	4	5	2	1	1	-	-	-	7.5	
150	-	-	4	-	-	-	-	1	-	-	2.5	

Feature	Triticum dicoccum	Triticum monococcum	Triticum sp.	Glume bases	Other cultivated plants	Chenopodium album	Bromus secalinus/hordeaceus	Polygonum convolvulus	Setaria viridis/verticillata	Other	Density	Phase
157	-	-	6	8	-	6	6	1	-	1	14.0	E
166	-	-	1	16	-	1	1	1	-	1	10.5	
169	-	-	1	4	-	4	1	1	-	-	5.5	
176	-	-	2	4	-	2	-	1	-	-	4.5	
179-1	-	-	4	4	-	-	1	1	-	-	5.0	
179-2	2	-	7	-	-	-	1	1	-	-	5.5	
179-3	1	-	3	-	-	-	-	-	-	-	4.0	
184	-	-	-	-	-	-	-	-	-	-	0.0	
186	-	-	1	30	-	4	1	1	-	-	18.5	
190	4	2	14	20	2	32	20	1	-	-	47.5	
191	-	-	-	-	-	-	-	-	-	-	0.0	E
193-1	-	-	1	2	-	-	-	-	-	-	1.5	E
193-2	2	-	7	239	-	-	-	1	-	2	125.5	E
193-3	-	-	-	-	-	-	-	-	-	-	0.0	E
194-a	-	-	5	52	-	3	2	1	-	-	31.5	E
194-b	1	-	5	35	-	6	3	-	1	1	26.0	E
197	3	-	4	8	-	-	3	2	-	2	11.0	E
199	-	-	2	12	-	-	2	-	-	1	8.5	
203	1	-	-	-	-	-	-	-	-	-	0.5	
209	1	-	1	31	-	4	9	1	-	-	23.5	
211	-	-	-	2	-	-	-	-	-	-	1.0	
223	-	-	4	8	-	13	-	3	2	-	15.0	L
224	-	-	-	-	-	-	-	-	-	-	0.0	L
228-1	-	-	-	2	-	-	-	1	-	-	1.5	L
228-2	-	-	-	-	-	-	-	-	-	-	0.0	L
235-1	-	-	11	22	1	8	2	5	1	-	25.0	L
235-2	-	-	-	1	1	1	1	-	-	-	2.0	L
235-3	-	-	5	3	1	6	3	1	-	1	10.0	L
238	-	-	-	-	-	-	-	-	-	-	0.0	
239	-	-	-	-	-	1	-	-	-	-	0.5	E
248	1	-	1	6	-	2	-	-	-	2	5.0	
251	-	-	6	20	-	-	-	-	-	1	13.5	
253	1	-	4	4	-	1	-	-	-	1	5.5	
258	-	1	3	6	-	8	1	1	-	-	10.0	
266	-	-	4	7	1	7	1	1	-	1	11.0	
289	-	-	1	10	-	3	3	1	-	-	9.0	
305	4	3	23	38	1	7	47	6	-	4	66.5	L
306	-	-	7	1	1	-	1	2	-	2	7.0	E
307	-	-	3	2	-	2	-	-	-	-	3.5	L
Münchshöfen												
225	-	-	-	2	-	-	-	-	-	-	1.0	
226-1	-	-	-	-	-	-	-	-	-	-	0.0	
226-2	-	-	-	-	-	8	-	-	-	2	5.0	
Hallstatt												
162	-	-	6	6	2	116	-	3	13	19	82.5	
259	-	-	3	-	3	3	-	-	1	-	5.0	

Table 2. Less common fruits and seeds; number of specimens between brackets.

Linearbandkeramik, cultivated:	
Lens culinaris	235-1 (1)
Linum usitatissimum	115-1 (1), 266 (1)
Papaver somniferum	115-1 (1), 305 (1)
Pisum sativum	52 (1), 98 (1), 143 (2), 190 (2), 235-2 (1), 235-3 (1), 306 (1)
Linearbandkeramik, wild:	
Brassica sp./*Sinapis* sp.	99 (1)
Bromus sterilis/tectorum	115-3 (1)
Caryophyllaceae indet.	95-1 (2)
Chenopodium ficifolium	122-1 (1)
Chenopodium polyspermum	98 (1)
Compositae indet.	115-1 (1)
Corylus avellana	122-2 (1)
Echinochloa crus-galli	97 (1), 98 (3), 115-1 (1), 115-3 (1), 166 (1)
Fragaria sp./*Potentilla* sp.	90 (1), 98 (6), 100-1 (1), 115-1 (8), 306 (1)
Galium aparine	115-3 (3), 194-2 (1)
Galium spurium	93-2 (1), 98 (1), 100-2 (1), 115-3 (1), 117 (2), 197 (1), 199 (1), 266 (1), 305 (2)
Galium sp.	115-1 (1)
Gramineae sp.	97 (1)
Knautia arvensis	98 (1), 100-2 (1)
Lotus corniculatus/Trifolium repens	122-3 (1)
Poa sp. *non annua*	98 (1)
Phleum sp.	115-1 (1), 115-3 (1), 253 (1)
Polygonum lapathifolium	66-2 (1), 95-1 (1), 248 (2), 251 (1), 305 (2)
Rumex sp.	97 (1), 98 (3), 197 (1)
Silene vulgaris	90 (1), 98 (2), 99 (1), 115-1 (1)
Solanum nigrum	52 (2), 100-1 (1), 115-2 (1), 157 (1), 193-2 (2), 235-3 (1)
Stipa sp.	122-1 (1), 306 (1)
Vicia hirsuta/tetrasperma	115-1 (1)
Indeterminatae	90 (1), 115-3 (1), 121 (1), 138 (1)
Münchshöfener Gruppe:	
Galium cf *mollugo*	226-2 (1)
Phleum sp.	226-2 (1)
Hallstatt:	
Camelina sativa	259 (1)
Lens culinaris	162 (2)
Pisum sativum	259 (2)
Artemisia sp.	162 (3)
Compositae indet.	162 (1)
Corylus avellana	162 (1)
Galium spurium	162 (2)
Euphrasia sp./*Odontites* sp.	162 (3)
Vicia sp.	162 (3)
Indeterminatae	162 (6)

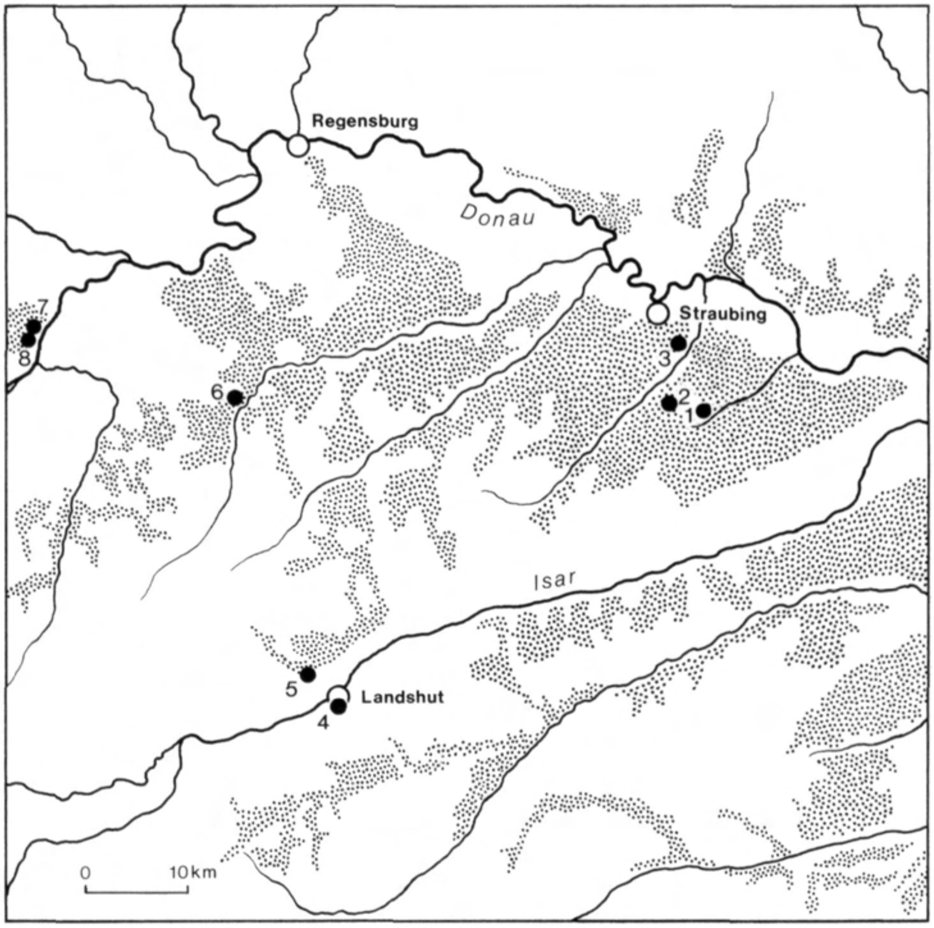

Figure 1. The loess district of Lower Bavaria showing the Linearbandkeramik settlements mentioned in the text: 1. Meindling, 2. Oberpiebing, 3. Aiterhofen, 4. Sallmannsberg, 5. Altdorf, 6. Leitenhausen, 7. Hienheim, 8. Fuchsloch. Shaded areas: loess

Table 3. Species identified from impressions in pottery.

Triticum dicoccum, grain	12
Triticum dicoccum, spikelet	2
Triticum dicoccum, spikelet fork	2
Triticum monococcum, grain	3
Triticum monococcum, spikelet	3
Triticum dicoccum or *Tr. monococcum*, grain	1
Triticum dicoccum or *Tr. monococcum*, spikelet fork	2
Cerealia indet., grain	5
Lens culinaris	1
Pisum sativum	2
Malus sp.	1
Polygonum convolvulus	1

3. Results

As already mentioned above, most of the material is Linearbandkeramik. The Münchshöfener samples contained so few remains that it is not even sure that the remains in question are of Münchshöfener date. The pits also contained stray Linearbandkeramik sherds; the few carbonized particles may be associated with those earlier finds. The Münchshöfener samples will therefore not be discussed any further below. The above may also be true of the Hallstatt evidence, but as one of the pits contained many finds and the other contained a typical Metal Age plant species, they will both be included in the discussion.

3.1. Cultivated plants from Linearbandkeramik contexts

The cultivated plants encountered in Linearbandkeramik contexts comprise six species: emmer wheat (*Triticum dicoccum*), einkorn wheat (*Triticum monococcum*), pea (*Pisum sativum*), lentil (*Lens culinaris*), linseed (*Linum usitatissimum*) and poppy (*Papaver somniferum*). Four of these were encountered both as carbonized specimens and as impressions. Only the oil seeds were not observed in the pottery; in the case of linseed this may be due to mere chance, whereas poppy seeds are so small that they usually remain undetected.

Figure 2. Impression left by an emmer grain.

The carbonized peas were angular in outline with maximum diameters of between 3 and 4 mm. Pea impressions were round and had diameters of 5.8 and 5.9 mm. The carbonized lentil seed measured 2.4 × 1.4 mm, the impression 4.1 × 1.7 mm. This difference may be due to shrinkage during carbonization on the one hand and swelling caused by the absorption of water on the other. Similar dimensions and similar differences were found in the case of the Linearbandkeramik material from Hienheim (Bakels 1978, 176-178). No such differences were observed in the case of the wheats. A carbonized linseed measured 2.9 × 1.7 × 0.8 mm.

The large amount of einkorn in relation to emmer suggests the presence of both wheat species. Einkorn types of grains are formed in some spikelets of an emmer ear, but in normal crops they represent a minority. The two types may be represented in more or less equal proportions in samples of poor emmer crops. However, it is not to be assumed that all of the Meindling crops were of inferior quality. Emmer and einkorn were common in the Linearbandkeramik culture. The same holds for pea, lentil and linseed. Poppy is a different story and the presence of poppy will be commented on in Section 4 below.

3.2. Wild plants from Linearbandkeramik contexts

The remains of gathered wild plants are limited to one carbonized fragment of a hazelnut shell (*Corylus avellana*) from an early phase of occupation and one impression of an apple pip (*Malus*, presumably *sylvestris*). Wild strawberry (*Fragaria* sp.) may also have been collected if the seeds identified as either *Fragaria* or *Potentilla* are of the first genus. The seeds had a badly damaged surface and could therefore no longer be identified with certainty (fig. 4). The large number of unripe seeds suggests that fat hen (*Chenopodium album*) was also collected for consumption. The seeds may have been thrown away during vegetable cleaning, as K.-H. Knörzer (1967) has suggested. In the area that he studied he found concentrations of these seeds, suggesting that the plant was appreciated for its own worth. Unfortunately, no such concentrations were encountered at Meindling, so we have no evidence to support the hypothesis that *Chenopodium album* was gathered as a vegetable.

Nevertheless, *Chenopodium album* was the most common wild herb at Meindling, not only in numbers but also in frequencies. The plant was encountered in 52 out of 84 Linearbandkeramik samples (tab. 4). Next came *Polygonum convolvulus*, a *Bromus* and *Setaria viridis* or *S. verticillata*. It was difficult to identify *Bromus* species because the seeds were broken. One narrow fragment with a pointed apex was classed as *Bromus sterilis* or *Br. tectorum*. All the other fragments were broader and had rounded apices. The only virtually complete specimen is shown in figure 4. Ten measurable fragments from sample No. 1190 had widths of 1.48 (1.2 - 1.7) mm, which is too wide for *Bromus arvensis*. The seeds were therefore classed as *Bromus secalinus* or *Br. hordeaceus*, although they were fairly narrow.

Chenopodium album, *Polygonum convolvulus*, *Bromus secalinus/hordeaceus* and *Setaria viridis/verticillata* are also the herb species most frequently found at other Lower Bavarian sites. This is apparent from table 4, in which the frequencies of their occurrence in the Meindling samples are compared with their frequencies at other sites where samples were taken from several features. Their frequencies of occurrence at all Lower Bavarian sites investigated are shown in table 5. Similar investigations have been published for the northwestern area of Linearbandkeramik occupation: the German Rhineland, Belgium and the Netherlands (Bakels/Rousselle 1985). *Chenopodium album*, *Bromus secalinus/hordeaceus* and *Polygonum convolvulus* also feature at the tops of the lists for this area, but otherwise there are a few striking differences. *Setaria viridis/verticillata* and *Solanum nigrum*, which scored high

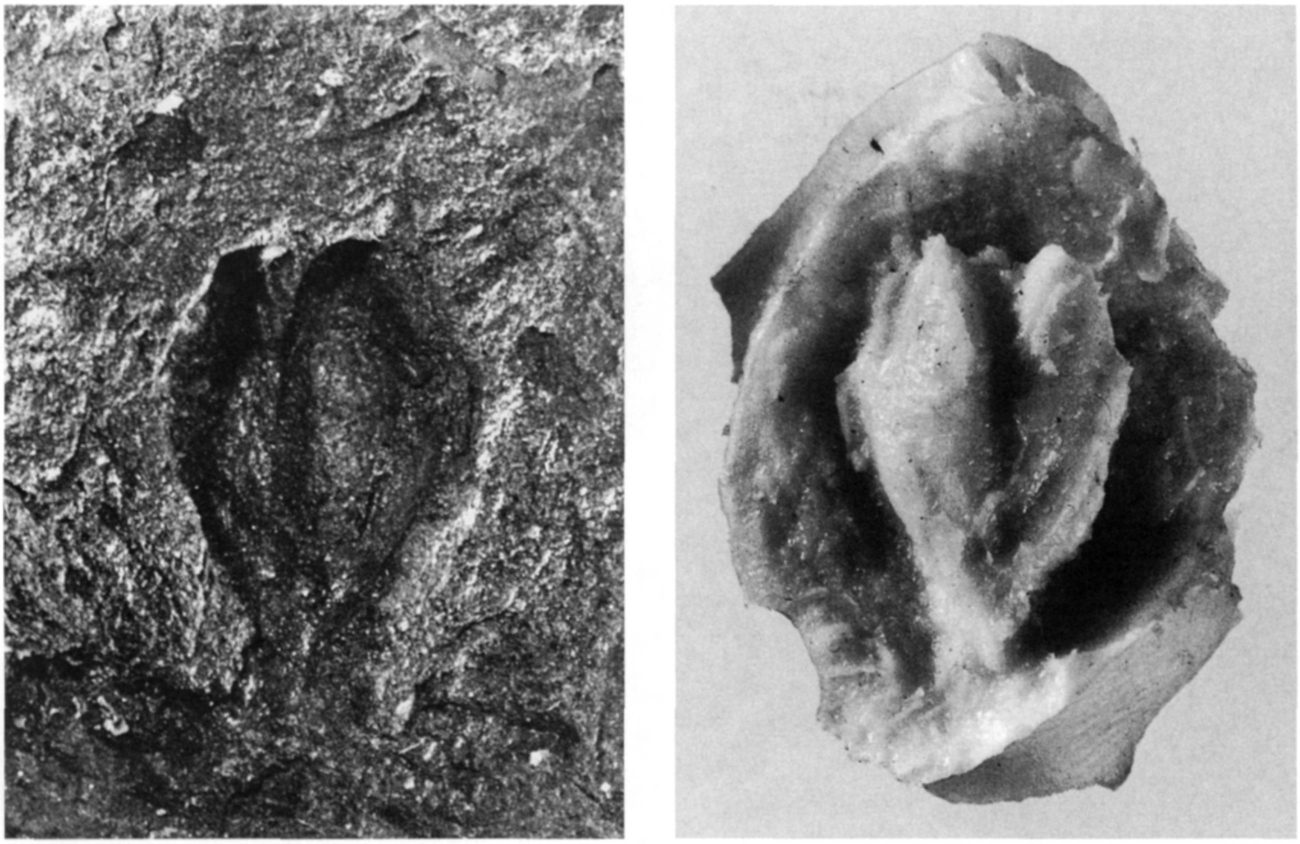

Figure 3. Impression and cast of an emmer spikelet.

Table 4. Frequencies of plants present in Lower Bavarian Linearbandkeramik settlements where samples were taken from several features. Not mentioned are species with frequencies of less than 2. After Bakels 1983/84 and 1986.

	Meindling	Hienheim	Fuchsloch	Aiterhofen
number of samples	84	40	7	7
Chenopodium album	52	9	4	5
Polygonum convolvulus	49	21	3	5
Bromus secalinus/hordeaceus	45	18	1	2
Setaria viridis/verticillata	17	5	3	1
Galium spurium	9	6	-	-
Polygonum lapathifolium	5	-	-	-
Solanum nigrum	5	5	1	1
Echinochloa crus-galli	5	3	1	-
Fragaria/Potentilla	5	-	-	-
Silene cucubalus	4	1	-	-
Phleum sp.	3	-	-	1
Knautia arvensis	2	-	-	-
Rumex sp.	2	1	-	-
Galium aparine	2	-	-	-
Stipa sp.	2	-	-	-
Chenopodium hybridum	-	2	-	-
Bromus tectorum/sterilis	1	2	-	-

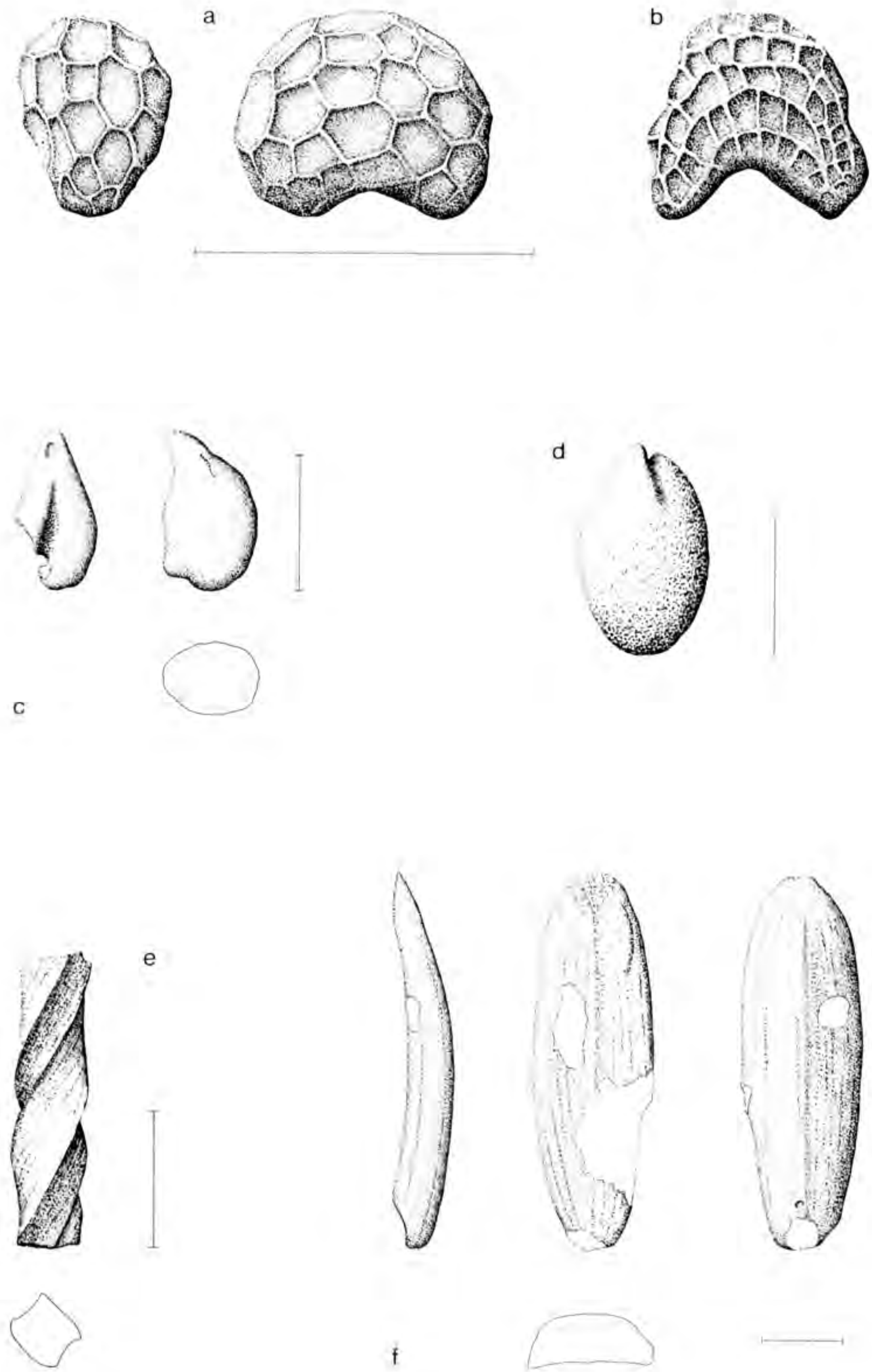

Figure 4. Carbonized seeds and fruits: a. Papaver somniferum, b. Papaver dubium/rhoeas from Hienheim, c. Fragaria sp./Potentilla sp., d. Camelina sativa, e. Stipa sp., f. Bromus hordeaceus/secalinus. Scale bars: 1 mm.

Table 5. Frequencies of the most common plants found in Lower Bavarian Linearbandkeramik settlements. After Bakels 1983/84 and 1986.

	Meindling	Hienheim	Fuchsloch	Aiterhofen	Altdorf	Sallmannsberg	Leitenhausen	Oberpiebing	Frequency
Chenopodium album	+	+	+	+	+	+	-	+	7
Polygonum convolvulus	+	+	+	+	+	+	+	+	8
Bromus secalinus/hordeaceus	+	+	+	+	+	+	+	+	8
Setaria viridis/verticillata	+	+	+	+	+	+	-	-	6
Galium spurium	+	+	-	-	-	-	-	-	2
Polygonum lapathifolium	+	-	-	-	+	-	-	-	2
Solanum nigrum	+	+	+	+	-	+	-	-	5
Echinochloa crus-galli	+	+	+	-	-	-	-	-	3
Silene cucubalus	+	+	-	-	-	-	-	-	2
Phleum sp.	+	-	-	+	+	-	-	-	3
Rumex sp.	+	+	-	-	-	-	-	-	2
Bromus tectorum/sterilis	+	+	-	-	-	-	-	-	2

in Lower Bavaria, are scarce in northwestern Linearbandkeramik contexts. On the other hand, *Lapsana communis* was almost completely absent at the Lower Bavarian sites; the species has been encountered in only one sample from Hienheim so far. Moreover, whereas *Polygonum persicaria* was common in the northwest, *Polygonum lapathifolium* occurred in the south. On the basis of the finds from the northwest K.-H. Knörzer (1971) introduced the *Bromo-Lapsanetum praehistoricum*, a plant community characteristic of Linearbandkeramik fields. It would seem that this *Bromo-Lapsanetum praehistoricum* looked somewhat different in Lower Bavaria.

Most of the herbs are rather common species. There are, however, two interesting exceptions. The first is *Stipa* sp., which was encountered as awn fragments in two early Linearbandkeramik features (fig. 4). *Stipa* awns were also found in the settlements at Eitzum and Niedereschbach, both dating from the earliest Linearbandkeramik (Phase I), and Bruchenbrücken (Phase I or later) (Kreuz 1990). The grass is typical of steppe vegetations. Steppe-like conditions therefore may have occurred in the surroundings of Meindling, or at least in Lower Bavaria, that is, if the possibility of long-distance transport can be excluded. There may have been areas with steppe-like conditions on the steep slopes of hills and on cliffs where no trees could grow, for instance in the Fränkische Alb. Ethnographic evidence led A. Kreuz to the hypothesis that *Stipa* awns may have been used as personal adornment and we should therefore not rule out the possibility of import. Luxury articles tend to be widely distributed; we know of several examples of such articles that were imported from sources more than several hundreds of kilometres away. If the Stipa awns were imported, they even may have come from Hungary.

The second unusual species is *Knautia arvensis*, which was encountered in two not very early, but also not very late contexts. This is an early occurrence of this species. The plant grows at the fringes of woods, along roadsides, in fields, but nowadays mostly in meadows.

3.3. The nature of the Linearbandkeramik waste

The subject of the origin of the carbonized seeds has already been touched upon in Section 3.2. with, for instance, the suggestion of a Bavarian facies of the *Bromo-Lapsanetum praehistoricum*. The question is whether most of the carbonized remains indeed made their way into the settlement as parts of crops. The analysis of the assemblages of seeds found may yield an answer to this question.

Most samples had low find densities (see tab. 1). It is most improbable that the carbonized seeds found in them were thrown away together. They form part of the scattered waste encountered everywhere that has been described elsewhere as "settlement noise" (Bakels 1991). These low densities show a Poisson distribution. A calculation of the best fitting Poisson distribution for all Meindling samples together reveals that samples with densities of 20 or more carbonized seeds and fruits per dm^3 of soil do not show this distribution. They are possibly not the result of chance.

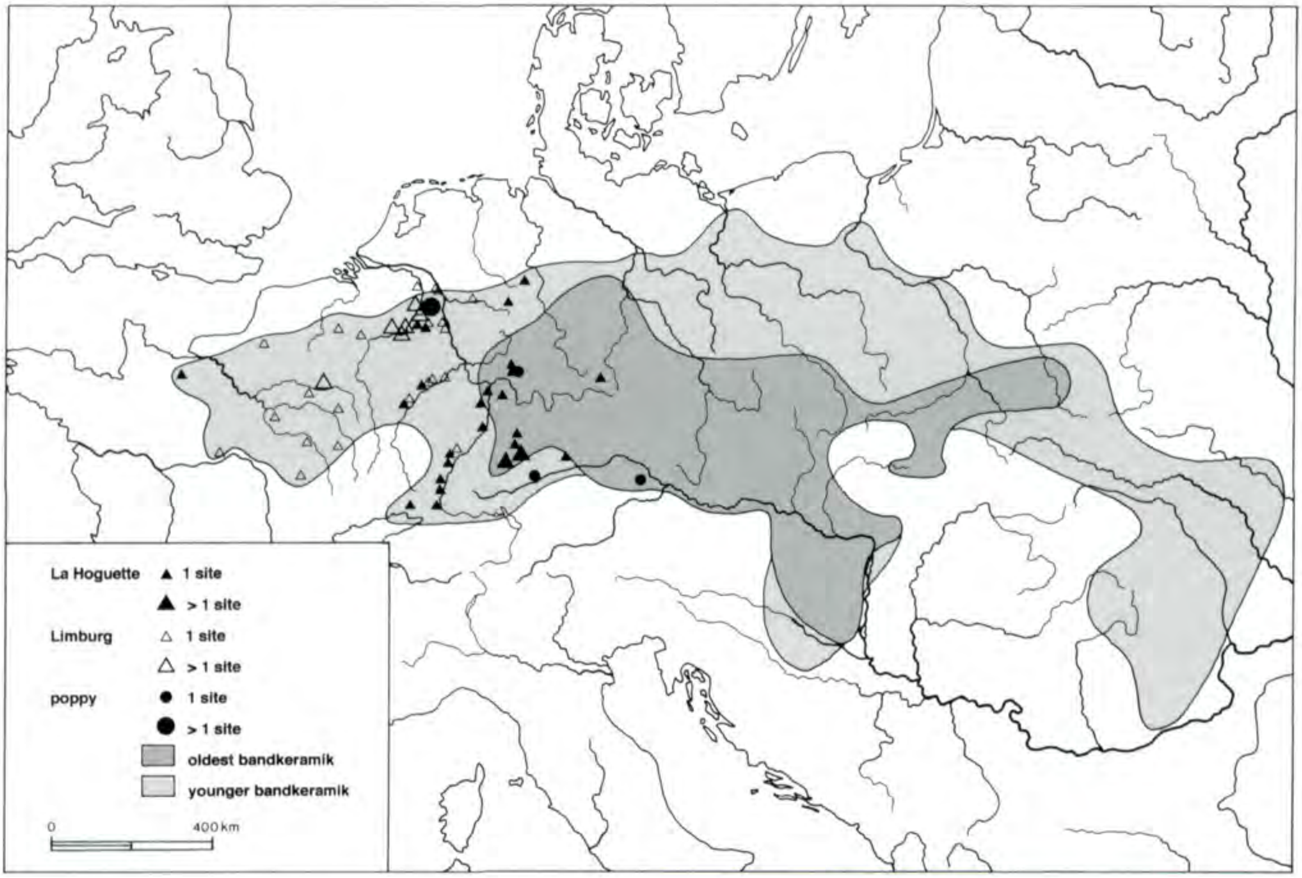

Figure 5. Distribution of La Hoguette pottery, Limburg pottery and poppy seeds. Map mainly after Bakels 1982 and Lüning *et al.* 1989.

All the samples in question contained wheat grains, wheat chaff (mostly lemma bases) and seeds of wild herbs. Table 6 gives the chaff and grain ratios. Emmer wheat has a chaff/grain ratio of 1, einkorn has 2. Most of the values in table 6 are of the same order of magnitude and lead to the conclusion that the wheat was carbonized before it had been dehusked. The fact that grain and chaff no longer adhere to one another is not incongruous because the chaff will have been quite loose after carbonization and will have been separated from the grain during any rough handling of the grain, which, being carbonized, will have been treated as waste. The wild herbs in the samples, most of them potential field weeds, are interpreted as weeds that were harvested together with the crop plants and were discarded together with the spoiled grain. Dehusking is thought to have been done on a day-to-day basis (Hillman 1984). If the wheat was a little damp, dehusking could be facilitated by roasting it lightly. If this accidentally went too far, some of the wheat may have been burnt or carbonized. Small household accidents could account for the presence of most of the waste. As the "noise" has a similar composition, that, too, may be the, scattered, result of the same food-processing activity. However, the common occurrence of this kind of domestic waste should not lead to the assumption that food was wasted every day. A few accidents per year may have led to the effect observed. The presence of sherds does not imply that people broke their pots every day either.

Three samples, Nos 193-2, 194a and 209, contained too much chaff for the explanation presented above. Sample 193-2 had the highest density of all the samples (125.5 specimens per dm^3) and this is almost completely due to the presence of chaff. It was taken from a very black layer in the pit fill.

Concentrations of burnt chaff are a common kind of Linearbandkeramik "fruit and seed" concentration. Such concentrations are encountered in almost all large excavations. They are interpreted as residues of the burning of superfluous material. Some chaff was used for instance for the tempering of clay but there seems to have been a certain excess that had to be discarded. At Langweiler 8, a settlement in the Rhineland, K.-H. Knörzer found the burnt chaff exclusively in the western and northern parts of the farm yard. This led him to the conclusion that this is the special activity area where the grain was dehusked and the chaff was burnt. The choice might have been influenced by the prevailing westerly or southwesterly winds (Knörzer 1988). Similar studies at the settlements at Schwanfeld Ldkr. Schweinfurt, Germany, and Geleen, the Netherlands, also revealed such activity areas, only there the chaff was found exclusively in the eastern parts of the yards (Bakels 1995). A plausible explanation for the difference has not yet been found. Winds were westerly or southwesterly in all of the three cases mentioned above; they cannot have been solely responsible for the pattern observed.

Meindling constitutes a second example of chaff deposition to the west of the house. Pit No. 193 was situated to the west of house 6 and its contents are thought to have derived from this household. Pits 194 and 209 may also be associated with this house; they also lay to the west of the house. In spite of this evidence, Meindling is not entirely comparable with Langweiler 8, because the three pits belonged to a system of pits dug along the wall of the house. Such pits, which are interpreted as the sources of loam for the wattle-and-daub walls, never contained chaff remains at the Langweiler 8 settlement, nor at Schwanfeld for that matter. The chaff was found in pits of the type "isolated pit in yard". At Geleen, on the contrary, pits dug along the walls were used for dumping chaff, but, as indicated above, in this case the eastern ones. It is possible that there was an activity area for the disposal of excess chaff, and its position within the yards of an individual Linearbandkeramik settlement may have been fixed, but there seem not have been general, culturally prescribed, rules (tab. 7).

The assemblage from pit 193 is conspicuous for a different reason, too: weeds are almost absent. It is inconceivable that the weed seeds were already discarded during an earlier stage of crop processing. Weeds with heavy seeds or with seeds having the same dimensions as cereal grains are not easily discarded. Examples are *Polygonum convolvulus* and *Bromus secalinus/hordeaceus*. The crop must have been clean already when it arrived in the settlement. Such a clean crop may have been obtained by carefully harvesting the ears by hand, by thoroughly weeding the fields or by sowing well cleaned sowing grain in soil not yet infested with weeds, *i.e.* virgin forest soil.

Analyses of Linearbandkeramik assemblages from the Rhineland, the Netherlands and Belgium have yielded some evidence supporting the last hypothesis (Bakels 1991). Finds from the pioneer phase of a newly settled area contained less weeds than those from later phases.

Table 6. Chaff/grain and chaff/weed seed ratios in samples with densities of 20 specimens or more per dm^3 of pit fill.
E: Early Bandkeramik, L: Late Bandkeramik.

Feature	Chaff : Grain	Chaff : Weeds	Phase
122-1	3.2	0.22	E
138	1.8	0.35	E
193-2	26.6	79.67	E
194a	10.4	8.67	E
194b	5.8	3.12	E
52	5.5	0.41	
88	1.6	0.50	
95-1	1.5	1.06	
98	1.6	1.17	
100-1	2.0	0.96	
100-2	1.2	0.37	
102	2.8	0.77	
190	1.0	0.38	
209	15.5	2.21	
93-2	1.4	0.80	L
97	1.6	0.29	L
115-1	2.0	0.59	L
115-3	3.2	6.32	L
117	1.6	1.33	L
235-1	2.0	1.38	L
305	1.3	0.59	L

Table 7. The positions of carbonized chaff concentrations in relation to the house. The pits marked 'W' and 'E' indicate isolated pits in the western and eastern parts of the farm yard, respectively. Those marked 'WL' and 'EL' are elongated pits running parallel to the western and eastern walls of the house, respectively

	W	E	WL	EL
Langweiler 8	+	-	-	-
Schwanfeld	-	+	-	-
Geleen	-	+	-	+
Meindling	-	-	+	-

However, the comparison of Meindling chaff/weed ratios of assemblages early in the sequence with those of late assemblages does not reveal a convincing trend (tab. 6). At first sight the early assemblages seem to have the highest ratios, but the list of these five assemblages is headed by Nos 193-2, 194a and 194b. Pits 193 and 194 are near neighbours and their contents may not be entirely unconnected. When they are considered together, the difference between "early" and "late" ratios is not very great.

The question may even be asked whether the crops were perhaps always brought into the settlement clean, which leads to the question whether the weeds observed are to be considered ordinary byproducts of cereal cleaning as was already assumed above. There may very well be no immediate connection whatsoever between the herbs and cereal processing. As a matter of fact, the majority of the seeds are of four species, *Chenopodium album*, *Bromus secalinus/hordeaceus*, *Polygonum convolvulus* and *Setaria viridis/verticillata*, which may have been collected for food to supplement the cultivated products. An objection to this hypothesis is that these plants have not been found separate; they are always associated with chaff. That is why it is most probable that most herbs are indeed byproducts of crop processing. The background of the clean harvest is therefore not yet clear.

Almost all of the herbs found are tall plants or climbers. The exceptions are *Fragaria/Potentilla* and *Trifolium repens/Lotus corniculatus* and, with *Stipa*, these are the only ones which do not occur in fields and may not be connected with crop processing. The former could be gathered wild strawberry and the latter grows on grassy patches. The others can be found in fields or gardens and the fact that they are tall species can be explained by assuming the use of a certain harvesting method with which the culms are cut high above the ground.

Unfortunately the weed species provide no good clues as to the sowing season. The *Bromus* species indicate autumn-sown crops, but others are usually associated with spring-sowing, at least nowadays. Some plants are even perennials. Fields or gardens may have been sown both in the autumn and in the spring, depending on the crop. The soils seem to have been quite ordinary, certainly not acid or poor.

3.4. The Hallstatt period

The Hallstatt samples contained a hulled wheat, which might be emmer, einkorn or both, lentil and the plant referred to above, gold of pleasure, *Camelina sativa* (fig. 4). Gold of pleasure is not known from the Linearbandkeramik. The oldest example of this species found in Central Europe is that from Auvernier in Switzerland (Villaret-von Rochow 1971), of late Neolithic date. The species became more common during the Bronze Age; in the Iron Age it was grown all over the northern parts of Central and Northwest Europe (Knörzer 1978). Finds from southern Germany are still very scarce; so far no finds whatsoever have been reported for Lower Bavaria (Hofmann 1983/1984). The nearest evidence of its occurrence is an impression in pottery from the Heuneburg Ldkr. Sigmaringen, in southern Württemberg (Hopf/ Blankenhorn 1983/1984), which also dates from the Hallstatt period. The Meindling specimen measures 1.55 × 1.00 × 0.95 mm and is therefore considered to be a cultivated gold of pleasure.

Hazelnuts were gathered. Of the herbs *Artemisia* sp., *Euphrasia* sp./*Odontites* sp. and an unidentified Compositae should be mentioned.

4. Poppy (*Papaver somniferum*)

The discovery of two poppy seeds was a big surprise. They were found in two totally unrelated pits lying far apart from one another and have to be interpreted as separate finds. Their date is Younger Bandkeramik. Only one was complete enough to be measured (0.7 × 0.55 × 0.4 mm) and drawn (fig. 4). The poppy is thought to be of the variety *setigerum*. The contemporaneous *Papaver dubium/rhoeas* from Hienheim is shown next to it to enable comparison (fig. 4).

The surprise was that Meindling lies further to the east than all of the other Linearbandkeramik settlements where poppy has been found. The concentration of finds is situated between the Rhine and the Meuse, in the northwestern part of the distribution area of this culture. The only sites at which poppy has been found east of the Rhine are Bruchenbrücken (Kreuz 1990) and Ulm (Gregg 1989). Here too, the *Papaver somniferum* did not date from an early phase of the culture, whereas in the northwest it is known from phase II ("Flomborn") onwards. The earliest Linearbandkeramik phase, Phase I, is not represented in this region.

Poppy has drawn special attention because it is the only crop plant whose origin cannot be traced back to the Near East. Its source is to be sought in the surroundings of the Western Mediterranean Basin (Bakels 1982). It is questionable whether the plant is a crop plant; it may have been a crop weed, but even as a weed it must have had a Western Mediterranean origin. The discovery of a pot made from clay purposefully tempered with poppy seeds however suggests that the plant was not considered to be an everyday weed. Its oily seed is not particularly suitable for use as temper (Bakels/Constantin/Hauzeur 1992).

It has been suggested that the plant was introduced into Linearbandkeramik agriculture through cultural contacts with contemporaneous farmers with roots in France (Bakels 1982). The La Hoguette Group has been mentioned in this context, a group only known from its pottery. It is possible that the La Hoguette people had contacts with the Cardium culture or its "aura" and hence indirectly with the Western Mediterranean agricultural world (Lüning/Kloos/Albert 1989). Unfortunately, so far no poppy seeds have been found in Cardium contexts, but this may be due to the small number of thorough investigations carried out.

The distribution of La Hoguette finds is shown in figure 5. Sites have been found east of the Rhine, but not yet as far east as Meindling. However, in view of the late date of the Meindling poppy seeds, the La Hoguette distribution area need not have extended that far east. If the poppy travelled from the west to the east there need not have been any direct contact. If La Hoguette passed the poppy on to the phase II farmers in the northwest, the latter may in turn have passed on the new plant to the later Linearband-keramik occupants of other regions.

Another group that may have been involved is that of the so-called Limburg Pottery. The status of this cultural group is not very clear either. It is contemporaneous with the Linearbandkeramik, but apparently not with its earliest phase. Its has a western distribution area, but the group is thought to be less associable with the Neolithic of southern France (Lüning/Kloos/Albert 1989).

5. Conclusions

The main motive for starting an excavation at Meindling was to investigate the Linearbandkeramik Phase I, the founding phase of the Linearbandkeramik, in Lower Bavaria. Unfortunately, Meindling proved not to be the ideal site for this purpose. It was not possible to follow the development of Linearbandkeramik agriculture at this site either. Nevertheless, the botanical investigations yielded some interesting results. One of these is the conclusion that the field weed vegetation of Linearbandkeramik Lower Bavaria was different from that of the Rhineland and its adjacent area. Much research has been carried out in the latter areas and the evidence obtained has always been regarded as representative of the Linearbandkeramik as a whole. This now proves not to be the case. A second interesting discovery was the presence of *Stipa* sp., a plant from steppe environments, which may indicate either the existence of steppe environments in the neighbourhood or import from more eastern regions with such an environment. Thirdly, the occurrence of poppy seeds so far east must be mentioned. To conclude, as is usual at this kind of sites, the waste concentrations encountered are the results of the domestic activities of dehusking grain and dumping excess chaff.

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The Linearbandkeramik farmers of Meindling, their livestock and gamebag

In 1977 part of an early Linearbandkeramik settlement near Meindling was excavated by the IPL; ca. 453 bones of cattle, sheep, goat, pig, dog, wild boar, roe deer, red deer and aurochs were collected. The percentage of domestic animals was resp. 83.4 and of the wild mammals 16.6% in terms of numbers of bones. For bone weight, these figures were 90.8% and 9.2%.

It is proposed that a percentage higher than 10% of wild mammals may be connected with the proximity of broad river valleys.

1. Introduction

In 1977 the *Instituut voor Prehistorie* of Leiden University excavated a small part of an early Linearbandkeramik settlement north of the village of Meindling in Bavaria in Southern Germany. The excavation was directed by Professor P.J.R. Modderman, at that time director of the *Instituut* (Modderman, this volume).

The settlement was situated on the left bank of the Ödbach, a small stream flowing SW-NE in a loessic plain, which joins the Irlbach stream north of Haberkofen (Groenendijk this volume) and reaches the river Danube east of Irlbach (fig. 1). The total length of the river system is 15 km. The sources of the Ödbach are some 5 km southwest of Meindling.

Near the village of Irlbach a second settlement of the earliest Linearbandkeramik was found. During a survey in the early eighties a third settlement of this period was found near Haberkofen. In the area between Siebenkofen and Haberkofen five settlements of the younger Linearbandkeramik came to light (fig. 1).

Meindling was excavated in the first place because traces of the earliest Linearbandkeramik had been found at that place, but later phases of the Linearbandkeramik were present as well. Also a pit of the Münchshöfener culture and two of the Hallstatt period were found. However, the faunal material belongs mainly to the earliest Linearbandkeramik phase. Four ^{14}C dates are available for the Linearbandkeramik, ranging from GrN-8687:6380±130 BP through GrN-9139:6190±100 and GrN-8688:6130±40 BP to GrN 9138:6030±60 BP, indicating a habitation period of c. 350 years. Nine houses were partly excavated (Modderman this volume).

2. The faunal material

The bones were mainly retrieved from pits situated outside the houses, but occasionally also from a posthole or the foundation trench of a wall. The pits were not very deep and the conservation of the bones in the upper part of the pits was very poor; in the lower parts the conservation ranged from poor to fairly reasonable. Part of the bones had been in contact with fire and were to some degree calcined. The bones have been counted (tabs. 1, 2, 3) and weighed (tabs. 2, 3). When considering the information that the bone-counts and the bone-weight might yield, we have always to keep in mind that, owing to the varied conservation of the bones and the time-span of ca. 350 years that the habitation covers, these can be no more than approximations. Of the ca. 455 bones, 254 could be identified to species. Fifty-three bones could be identified to family or possible family, and another 108 to the size class of the animal they had belonged to. For 40 bones it was not possible to make an assessment (tabs 1, 2).

3. The species

The bones belonged to nine species; five domesticated mammals, four wild mammals and one wild bird (tab. 1). Owing to the poor conservation and the fragmentation of the bones it was in many cases not possible to measure the bones (tab. 5). In the case of the cattle and pig remains I have separated the bones of the wild parent species — aurochs and wild boar — from the domesticates — domestic cattle and domestic pig — to the best of my ability; on considerations of size, thickness, etc.

3.1. Dog – *Canis familiaris*

The caput of a femur of a dog was found. It was not yet fused with the *diaphysis* and belonged to an animal not older than 6-9 months. Dogs were probably common animals in Bandkeramik villages. They are unlikely to have been on the menu.

3.2. Domestic pig – *Sus domesticus*

Of the domestic pig, 42 bones, weighing 610 gr., were collected. With the exception of the skull and toes all skeletal parts are present. Pigs were killed at various ages,

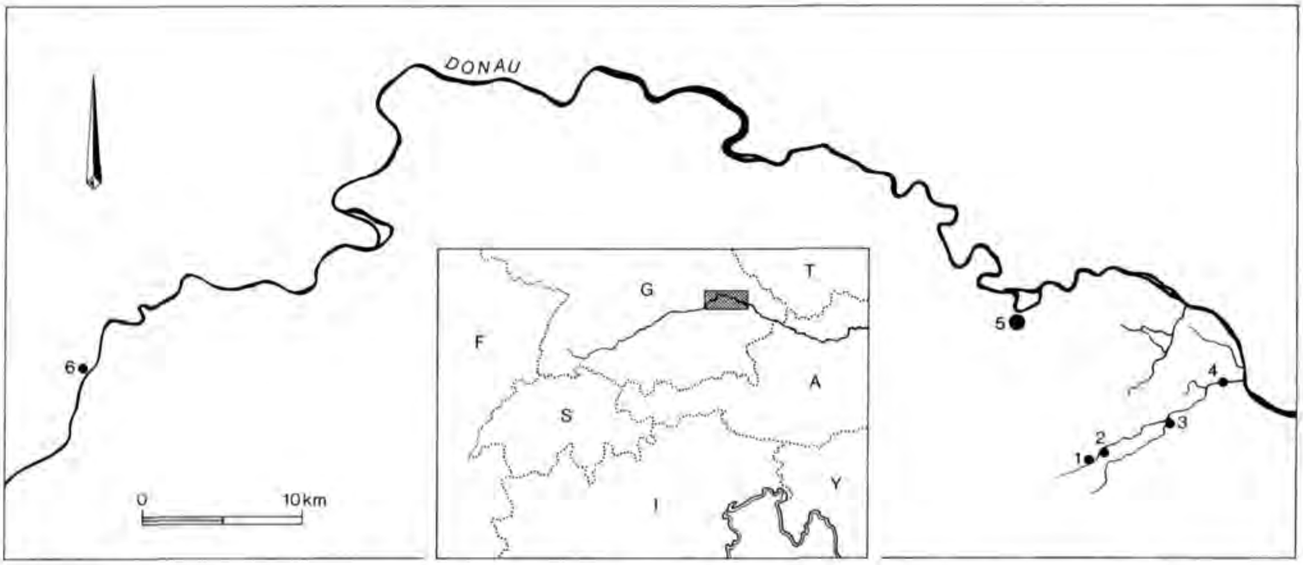

Figure 1. The geographical situation. 1. Meindling, 2. Siebenkofen, 3. Haberkofen, 4. Irlbach, 5. Straubing-Lerchenheid, 6. Hienheim.

Table 1. The number and weight of the bones that could be identified to species.

Species	N	%	Weight	%
domestic mammals:				
Canis familiaris	1	0.47	2.7	0.02
Sus domesticus	42	19.90	610.1	5.51
Ovis aries	2	0.94	108.6	0.98
Capra hircus	2	0.94	107.0	0.96
Capra/Ovis	32	15.16	266.4	2.40
Bos taurus	132	62.55	9964.1	90.10
sum	211		11058.9	
wild mammals:				
Sus scrofa	3	7.14	113.1	10.08
Capreolus capreolus	15	35.71	68.4	6.09
Cervus elaphus	15	35.71	826.5	73.68
Bos primigenius	9	16.66	113.7	10.13
sum	42		1121.7	
birds:				
Corvus corone	1		0.4	

insofar as this can be concluded from the few data available on the age at which individuals were killed (tab. 4).

3.3. Domestic sheep – *Ovis aries*

Two horncores of sheep were found. They were broken.

3.4. Domestic goat – *Capra hircus*

Of domestic goat, a horncore and a metacarpus could be identified. The horncore was lenticular in cross-section and curved slightly backward.

3.5. *Capra/Ovis*

Of goat and sheep, 32 bones could not be identified to species. With the exception of the skull and toes all skeletal parts are represented (tab. 3). One mandible was of a ca. 3-month-old kid, other animals reached maturity (tab. 4).

3.6. Domestic cattle – *Bos taurus*

The majority of the bones that could be identified to species belonged to domestic cattle: 62 percent by number

Table 2. The number and weight of the bones that could not be identified to species.

	N	Weight
Bos sp.	9	222.3
cf *Bos*	1	113.7
cf *Capra*/*Ovis*	23	55.7
Sus sp.	9	87.5
cf. *Sus*	11	57.7
The size of Bos/Cervus	60	959.3
The size of Capra/Ovis/Sus	48	250.8
?	40	181.7

and even 90 percent by bone weight. All parts of the skeleton are represented (tab. 3). Calves as well as mature animals were slaughtered (tab. 4).

3.7. Wild boar – *Sus scrofa*

Three bones of the wild boar could be identified (tables 1, 3).

3.8. Roe deer – *Capreolus capreolus*

Of the roe deer 15 bones could be identified (tabs 1, 2). Two mandibles were of animals between 3-4 and 12-13 months of age.

3.9. Red deer – *Cervus elaphus*

Of red deer also 15 bones were retrieved (tabs 1, 2). A left P_3 indicates that animal not yet two years old was hunted and killed.

3.10. Aurochs – *Bos primigenius*

Nine bones of the aurochs could be identified with certainty, the majority belonging to the foreleg.

3.11. Crow – *Corvus corone*

The distal part of right femur of a crow was found (tabs 1, 2).

3.12. Mites and insects

Sample no. 367 was a big lump of loess in which poorly preserved bone and teeth fragments were visible. The loess sample was investigated by Dr. J. Schelvis to see whether it contained remains of mites and insects. The sample was sieved over a 106 μm mesh sieve and subsequently a Paraffin-Flotation was carried out to extract all chitinous remains. This resulted in the recovery of only very few arthropod remains (< 10), most of which were very poorly preserved. Two remains of oribatid mites were found, one of which was tentatively identified as a representative of the genus *Tectocepheus*.

The conclusion of this small pilot study is that the usefulness of these samples for the analysis of arthropod remains is very restricted. The shallowness of the sampled features is the most probable explanation.

4. Bone tools

Part of the *diaphysis* of ulna of cattle was used to make a small chisel: No. 263/cb.

What could have been a rib-point, was made from a rib of cattle or deer. The 'point' was rounded through use: Nr. 277.

5. Discussion

Recently Döhle (1993) in an article that appeared in the *Festschrift für Haus-Hermann Müller* discussed all that is known about stockbreeding and hunting in Bandkeramik times.

Müller (1964) was the first to work systematically on the faunal remains of Bandkeramik sites. He found that in most of the Bandkeramik sites hunting was of no great importance, never reaching more than 10% of the identified bones. At Meindling the percentages for domestic and wild mammal species are 83.4 and 16.6 in terms of number of bones or 90.8 and 9.2 in terms of weight. The 10% limit for wild-mammal bone numbers is exceeded by a mere 6% and 16% is low compared with two other sites in southern Bavaria: Straubing-Lerchenheid (37.2%) and Hienheim (41.0%) (Döhle 1993; Clason 1977).

The generally low number of bones of wild animals in Bandkeramik sites is not surprising. The deciduous forest that covered those parts of Europe that were settled by Bandkeramik farmers were not teeming with wildlife. Iversen in 1973 already pointed to the fact that the fullgrown deciduous forest in Europe offered poor grazing for ungulates and thus not much food for hunter-gatherers and their successors, the Neolithic farmers. It was therefore impossible for the Bandkeramik farmers to hunt for food on a large scale.

There are also a few other exceptions to the 10% limit and an explanation Döhle (1993) offers is (following Sielmann 1972) that the Bandkeramik farmers settled in areas with different climates in different *Ökologie Kreise*. *Ökologie Kreis* A was warm and dry, *Ökologie Kreis* B had more rain and even higher temperatures than *Kreis* A.

However there may be a different and/or additional explanation for the high percentage of wild animals at Hienheim and Straubing-Lerchenheid. Both settlements were situated in the vicinity of the Danube valley. At that time the Danube had no fixed streambed and next to the mainstream small streams must have existed. In contrast to the woods of the higher loessic plateaus, the *Auenwälder* of the Danube valley would have been a favourable biotope for small and large game animals, which were exploited by the inhabitants of Hienheim and Straubing-Lerchenheid.

Table 3. A survey of the distribution of the bones.

	Bos taurus	*Bos* sp.	*Bos primigenius*	cf. *Bos*	*Ovis aries*	*Capra hircus*	*Capra/ Ovis*	cf. *Ovis/ Capra*	*Sus domesticus*	*Sus* sp.	*Sus scrofa*	cf. *Sus*	*Canis familiaris*	*Capreolus capreolus*	*Cervus elaphus*	*Corvus corone*
Antler	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	-
Horn-cores	4	1	-	-	2	1	-	-	-	-	-	-	-	-	-	-
Cranium	3	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-
Dentes	1	-	-	-	-	-	3	-	4	-	-	-	-	-	-	-
Mandibula	11	-	1	-	-	-	1	-	5	2	-	1	-	2	-	-
Dentes	5		-	-	-	-	-	-	2	-	-	-	-	-	2	-
Dentes	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atlas	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Epistropheus	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vertebrae	15	-	-	-	-	-	6	3	2	3	1	3	-	2	-	-
Costae	16	1	-	-	-	-	1	20	-	-	-	7	-	-	-	-
Scapula	6	-	1	-	-	-	-	-	2	-	-	-	-	1	1	-
Humerus	8	-	2	-	-	-	-	-	3	-	-	-	-	1	-	-
Radius	10	-	4	-	-	-	4	-	1	1	-	-	-	2	2	-
Ulna	4	-	-	-	-	-	-	-	5	-	1	-	-	-	2	-
O.carpi	8	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Metacarpus	1	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-
Pelvis	4	-	-	-	-	-	1	-	3	2	1	-	-	1	1	-
Femur	5	2	-	-	-	-	2	-	5	-	-	-	1	1	1	1
Patella	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tibia	4	-	-	-	-	-	1	-	3	-	-	-	-	1	1	-
O.centrotarsale	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Calcaneus	1	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
Astragalus	6	-	-	-	-	-	4	-	1	-	-	-	-	1	-	-
Metatarsus	4	-	-	-	-	-	1	-	1	-	-	-	-	2	-	-
Metacarpus/metatarsus	-	-	-	-	-	-	2	-	-	1	-	-	-	-	1	-
Phalanx I	5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Phalanx II	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4. Age at death. If not otherwise stated the age is given according to the criteria of Habermehl (1975, 1985). The fusion of diaphyses with the epiphyses of the tibia of the beaver according to Iregren/ Stenflo (1982). p.= proximal; d= distal; f= fused; u= unfused; m= month; y= year.

Canis familiaris			
Skeleton		N.f	N. u
6-9 m		-	1
femur p.			
Sus domesticus			
dentition			N
13-22 m	P_3 M_1 M_2(M_3 not erupted)		2
18-24 m	M_3		2
Skeleton		N, f	N, u
1 y	humerus d.	2	-
2-2.5 y	tibia d.	2	1
3-3.5 y	radius d.	-	1
	ulna d.	1	1
	femur p+d	-	2
4-7 Y	vertebrae	-	2
Capra/Ovis			
			N
3 m	P_3 M_1 erupting		
2 y	P_2 P_3 P_4 M_1 M_2 M_3		3
Skeleton		N,f	N, u
15-20 m	tibia d.	1	-
3 y	calcaneum p.	-	2
3.5 y	radius d.	-	1
	femur d+p	1	1
4-5 y	vertebrae	1	2
Bos taurus			
dentition		N	
1.5 y	P_3 M_1 (M_2 erupting)	1	
3 y	M_1 M_2 M_3	2	
Skeleton		N, f	N, u
7-10 m	scapula	2	-
12-15 m	radius p.	3	-
	phalanx II p.	1	1
15-20 m	humerus d.	2	2
20-24 m	phalanx I p.	2	2
2-2.5 y	tibia d.	3	-
	metatarsus d.	3	-
c. 3 y	calcaneum	1	-
3.5-4 y	radius d.	4	1
	femur p+d.	2	2
	tibia p.	1	-
4-5 y	vertebrae	3	6

Meindling however was situated some 10 km away from the Danube valley and the way to the valley was blocked by another contemporaneous early Bandkeramik settlement near Irlbach (fig. 1).

If there still were extensive woods in the close surroundings of Meindling, these could not have supported much big game. The relatively high percentage of roe deer however indicates that the landscape was fairly open

Table 5. The measurements in mm.
(-) measurement is not certain, 1) length alveolus

Bos taurus - Bt. *Bos primigenius* - Bp	Bp		Bt				
Mandibula	66	M3	251				
Height after M_3	87.5						
Max. Length M_3	40.0[1)]		36.5				
Max. Width M_3	-		13.5				
	Bt	Bt	Bp				
Scapula	66	291	338				
Smallest hight of the neck	60.0	-	70.0				
Lenght of the articular surface	-	61.0	68.5				
Width of the articular surface	(47.0)	-	57.0				
	Bt	Bt	Bt	Bp			
Humerus	289	66	289	87			
Max. distal width	79.5	84.5	(85.0)	(97.0)			
Width of the trochba	(74.0)	77.0	(78.0)	-			
	Bt	Bp	Bp	Bp	Bt	Bt	Bt
Radius	330	284	66	110	66	182	289
Max. prox. width	67.5	85.0	87.0	100.5	-	-	-
Width prox. art. surface	62.5	79.0	79.5	-	-	-	-
Max. dist. width	-	-	-	-	76.0	77.0	81.5
Max. width dist. art. surface	-	-	-	-	70.5	68.0	79.5
	Bt						
Metacarpus	66						
Max. prox. width	73.5						
Min. width diaphysis	40.0						
	Bt						
Pelvis	66						
Length acetabulum	83.5						
	Bt						
Femur	66						
Max. width caput	58.5						
	Bt	Bt					
Tibia	66	238					
Max. prox. width	102.0	-					
Max. dist. width	-	70.0					
	Bt	Bt	Bt	Bt			
Metatarsus	367	66	367	367			
Max. prox. width	45.5	-	-	-			
Max. dist. width	-	48.5	51.0	55.5			
Max. width over the condyles	-	61.5	54.0	69.0			
	Bt	Bt	Bt				
Astragalus	323	277	257				
Max. lat. length	-	71.0	73.0				
Max. med. length	59.0	66.0	63.5				
Width trochlea	34.0	44.5	45.0				

Thickness lat.	-	39.5	37.5
Thickness med.	33.5	36.0	(37.0)
	Bt		
Centrotarsale	251		
Max. width	61.0		
	Bt	Bt	
Phalanx I	276	66	
Max. lat. length	62.5	63.5	
Max. prox. width	33.0	31.0	
Max. dist. width	27.0	27.5	
Smallest width of the diaphysis	25.5	26.0	
	Bt	Bp	
Phalanx II	276	338	
Max. lat. length	40.0	51.5	
Max. prox. width	29.5	39.5	
Max. dist. width	26.0	30.0	
Smallest width of the diaphysis	23.0	30.0	
	Bt		
Epistropheus	289		
Max. width cranial art. surface	96.0		
Max. width dens	46.5		
Sus domesticus - Sd			
Sus scrofa - Ss			
	Sd	Sd	
Humerus	369	204	
Max. dist. width	40.5	42.0	
Max. width trochlea	31.5	31.5	
	Sd	Sd	
Ulna	305	93	
Width art.surface	19.0	(24.0)	
	Ss		
Pelvis	66		
Length-acetabulum	43.5		
	Sd	Sd	
Tibia	115	289	
Max. dist. width	27.5	29.5	
Capra hircus			
Horncore	289		
Maximum diameter at the base	37.5		
Minimum diameter at the base	25.5		
Capra/Ovis			
Radius	289		
Max. dist. width	26.0		

Femur	369	
Max. dist. width	34.0	
Metatarsus	367	
Max. prox. width	16.5	
Astragalus	367	305
Max. lat. length	22.5	31.5
Max. med. length	24.0	29.5
Width trochlea	15.0	20.0
Centrotarsale	92	
Max. width	24.0	
Capreolus capreolus		
Scapula	129	
Max. lenght proc. art.	23.0	
Length art. surface	21.5	
Width art. surface	30.5	
Radius	240	
Max. distal width	26.5	
Max. width dist. art. surface	23.5	
Min. width diaphysis	16.0	
Tibia	305	
Max. dist. width	24.5	
Cervus elaphus		
Scapula	66	
Smallest height of the neck	36.5	
Max. length art. surface	46.5	
Min. length art. surface	43.0	
Radius	251	
Max. prox. width	51.5	
Min. width diaphysis	32.0	
Ulna	167	251
Width art. surface	30.0	31.5
Pelvis	66	
Length acetabulum	50.5	
Femur	66	
Max. dist. width	61.5	
Tibia	367	
Max. dist. width	50.5	
Corvus corone		
Femur	?	
Max. dist. width	10.77	

(Bakels, this volume). In other parts of the Bandkeramik realm as well, a high percentage of wild animals, as found in Juvigny in the Ile de France (Döhle 1993), may be explained by the vicinity of a wide river valley with rich wildlife. I had no time to pursue this point any further at present, but it might be a worthwile topic for future research. I know however that there was no wide river valley in the vicinity of the settlement at Bylany in Bohemia (Clason 1968).

As for Meindling and the Ödbach system in southern Germany, it would be possible by excavating the other Bandkeramik sites found in that area to see whether there is a gradient showing a high percentage of wild animals near the Danube valley, which declines in the villages further to the southwest.

6. Acknowledgements

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Das Ödbachtal im niederbayerischen Gäuboden als Siedlungsraum im Alt-, Mittel- und beginnenden Jungneolithikum

Aus Anlaß der Ausgrabung zu Meindling wurde das ganze Ödbachtal archäologisch inventarisiert und die Ergebnisse für das Alt-, Mittel- und beginnende Jungneolithikum einer bodenkundlichen Feinkartierung gegenübergestellt. Es zeigt sich, daß die heute erkennbare Verbreitung der Siedlungen der damaligen Situation vermutlich nahe kommt. Die Fundstellendichte und eine extreme Bindung der Siedlungsstellen an der schmalen Talrandzone deuten auf eine zunehmend intensive Nutzung dieses Donaunebentälchens im Mittelneolithikum.

1. Ein archäologisch-bodenkundliches Unternehmen im Ödbachtal

Die Ergebnisse der archäologischen Ausgrabung zu Meindling 1977 veranlaßten den Projektleiter Prof. Dr. P.J.R. Modderman, siedlungsgeographische Fragen in Bezug auf Meindlings Umfeld zu formulieren. Weniger das Fundspektrum der Grabungsstelle selbst — außer Linearbandkeramik wurden noch wenige Scherben der Münchshöfener Gruppe geborgen, s. Modderman in diesem Band — als das Vorhandensein weiterer alt- und mittelneolithischer Fundstellen in der direkten Umgebung erhob die Frage nach räumlichen Aspekten des Besiedlungsvorgangs in einem anscheinend bevorzugten, zugleich kleinen und vermutlich als Einheit zu betrachtenden Siedlungsgebiet wie das des Ödbachtals. Um zu einer zeitlichen und räumlichen Abgrenzung der Frage zu kommen, bedarf es zunächst einer Inventarisierung aller bekannten archäologischen Fundstellen in diesem Abschnitt des niederbayerischen Gäubodens. Für eine Bestandsaufnahme gab es zu jener Zeit bereits eine solide Grundlage: die bisherige Anzahl der Fundstellen im Ödbachtal, seit Ende des vorigen Jahrhunderts registriert im Gäubodenmuseum Straubing, war im Laufe der siebziger Jahre erheblich gesteigert worden durch die Sammeltätigkeit des Oberstudienrats R. Kohlhäufl, Oberwalting, Ldkr. Straubing-Bogen. Seine Feldbegehungen unterstrichen, daß die Fundstelle zu Meindling längst nicht die einzige bandkeramische Siedlung an den lößbedeckten Terrassenkanten zum Ödbach hin gewesen sein konnte.

Für eine erste Sichtung der archäologischen Quellen waren die Bedingungen 1977 also durchaus günstig. Nun galt es aber auch, einen fachübergreifenden Rahmen für die durch Oberflächenfunde festgehaltenen Fundstellen zu schaffen. Die rege Zusammenarbeit der Fachrichtungen Bodenkunde und Archäologie, von Modderman in den Niederlanden stark propagiert, ermöglichte bereits 1978 den Beginn eines archäologischen Forschungsprogramms unter Mitarbeit von Bodenkundlern[1]. Sie führten in Teilbereichen des Ödbachtals eine physisch-geographische Kartierung durch, unter Berücksichtigung zuvor ausgewählter vorgeschichtlicher Siedlungsplätze (Mulder *et al.* 1980). Mittlerweile begann die archäologische Bestandsaufnahme im Gäubodenmuseum Straubing sowie der Privatsammlung Kohlhäufl. Anschließend fanden Geländekontrollen statt[2].

Der archäologisch offenbar gleichmäßig erfaßte Ödbachraum ermutigte es, Fragen zum physisch-geographischen Umfeld der linearbandkeramischen Siedlung zu Meindling mit solchen Fragen zum prähistorischen Besiedlungsablauf im ganzen Ödbachtal zu verbinden. Ziel der interdisziplinären Zusammenarbeit war es, die Fundverbreitung sowie die Datierung der Fundstellen der Bodenbeschaffenheit sowie der Fundstellentopographie gegenüberzustellen.

Im Rahmen dieses Beitrags werden nur die Ergebnisse für die Stufen Linearbandkeramik, Oberlauterbach, Stichbandkeramik und Münchshöfen dargestellt[3]. Dies hängt mit dem Wunsch zur zeitlichen Einschränkung der siedlungsgeographischen Thematik zusammen, bildete doch die altneolithische Siedlung zu Meindling den Beginn der ständigen Besiedlung des Ödbachtals. Weiterhin sind die noch immer nicht bewältigten Datierungsprobleme mit dem jungneolithischen Fundmaterial mit ein Grund zur Ausklammerung jüngerer Perioden. Wie es K.Schmotz (1989) in seiner umfassenden Arbeit als Forschungshintergrund für das benachbarte Isarmündungsgebiet zusammenfaßte, gibt es innerhalb der gewählten Perioden noch genügend Anhaltspunkte zur Erkundung kleiner Wandlungen in der Besiedlungsintensität. Freilich findet die Kolonisierung des ganzen Ödbachtals, von der Quelle bis zur Mündung, in dieser Zeitspanne statt.

2. Naturräumliche Gliederung und Abgrenzung des Untersuchungsgebietes

Der Ödbach bildet einen der vielen kleinen, SW-NO verlaufenden Taleinschnitte in der Lößplatte des niederbayerischen Gäubodens (Beilage). In seinem größten Bereich wird der Bach im Abstand von 1 km und weniger flankiert von Irlbach und Niederastgraben. Auf die geogenetischen Hintergründe dieser Landschaftsgliederung braucht hier nicht eingegangen zu werden; von mehr Interesse erscheint die kleinräumige geologische und bodenkundliche Beschaffenheit des Ödbachtals selbst[4].

Von seinem Quellgebiet bis zu seiner Einmündung in die Donau legt der Bach insgesamt eine Strecke von etwa 15 km zurück; das Gefälle beträgt mehr als hundert Meter (ca. 420-315 m NN). Das Quellgebiet liegt im reliefreichen Tertiärhügelland, einem Gebiet, das vom Donauregime nie beeinträchtigt wurde. Ansonsten verläuft der Ödbach in einer Flußterrassenlandschaft, bzw. der Hoch-, Mittel- und Niederterrasse. Im oberströmigen Bereich, von Riedling bis etwa Siebenkofen über eine Strecke von etwa 4 km, hat sich der Ödbach mit scharfen Abbruchkanten verhältnismäßig tief eingeschnitten (Abbn 2, 6). Er nimmt dort einige, vorwiegend vom Süden her kommende Trockentälchen sowie quellwasserführende Seitentälchen auf (Abb. 3). In diesem Abschnitt der Hochterrasse befindet sich die Meindlinger Grabungsstelle. Stromabwärts, zwischen Siebenkofen und Straßkirchen (Mittelterrasse), hat sich das System erheblich flacher ausgeprägt. Mit sanften Talhängen wirkt die Landschaft hier wesentlich anders. Bei der Ortschaft Haberkofen kommt der südlich benachbarte Irlbach mit dem Ödbach zusammen und fließt dann als Irlbach weiter donauwärts[5]. Zwischen Straßkirchen und der Ortschaft Irlbach verläßt der Bach die mittlere Donauterrasse und erreicht somit die heutige Donauebene (Niederterrasse).

Der räumlichen Begrenzung des Untersuchungsgebietes liegen sowohl geographische als auch z.T. ausführungstechnische Überlegungen zugrunde. Folgende Annahmen sind maßgebend gewesen. Die Fundstellenverteilung läßt bei dem heutigen Bearbeitungsstand auf eine stark am Bachlauf orientierte Lage der prähistorischen Siedlungsplätze schließen. Daher wurde als Gebietsgrenze womöglich das schmale Lößplateau zwischen Ödbach und den benachbarten Bachläufen Irlbach sowie Niederastgraben genommen und im Quellgebiet des tertiären Hügellandes den Wasserscheiden gefolgt. Im Norden bildet der Niederastgraben ein gesondertes Bachsystem. Ödbach und Niederastgraben zeigen einen getrennten, wenn auch weitgehend parallelen Verlauf: die Gebietsgrenze verfolgt die Höhe zwischen den beiden Tälern. Die Abgrenzung zum Süden hin erfolgt streckenweise mehr oder weniger artifiziell. Bei Haberkofen stoßen Ödbach- und Irlbachsystem zusammen; die Gebietsgrenze wurde dort quer durch das Irlbachtal gezogen. Teilweise wegen des abweichenden Forschungsstandes wurde das Irlbachtal in seinem oberen Verlauf aus der Inventarisierung herausgelassen. Wichtiger erschien es, ein einziges Bachsystem — den Ödbach — von seinem Quellgebiet bis zur Donaueinmündung zu verfolgen und als Fallstudie zu betrachten. Sicherlich ist damit im Bereich des Unterlaufes die Aussagekraft der Fundverbreitung eingeschränkt worden. Neuere Gesichtspunkte zu den Fundverhältnissen in größeren Talauen (etwa Böhm/Schmotz 1979/1980) machen auch weiterhin klar, daß die bisherigen archäologischen Verbreitungskarten in Flußbereichen ziemlich unvollständig sind.

3. Die archäologische Quellenlage

Lößlandschaften sind bekanntlich erosionsanfällig, besonders wo Lößplateaus zu Talkanten hin abbrechen. Die sich dort öfters massierenden archäologischen Fundstellen sind — nicht nur innerhalb von Niederbayern — durch Abschwemmung häufig stark angegriffen (etwa Modderman 1976). Eine solche Fundlage und Gefährdung gilt gleichermaßen für das Ödbachtal.

Der Hausacker der Familie Engl-Ebner, wo 1977 die Ausgrabung der Universität Leiden stattfand, wurde seit den dreißiger Jahren von Frau Maria Engl abgesammelt. Mit seinem großen Fundanfall, wie aus den Akten des Gäubodenmuseums Straubing hervorgeht, bildete diese bandkeramische Fundstelle schon damals kein isoliertes Phänomen mehr im Bereich des Ödbachtals. In den Jahresberichten des Historischen Vereins für Straubing und Umgebung tauchen auch anderenorts jahrzehntelang die gleichen Flurnamen auf als Fundstellen von »Keramik mit Linearverzierung«. Ihre Fundträchtigkeit zeigt zugleich ihre Gefährdung: es fragt sich heute, ob nicht der Pflug den unteren Bereich der Abfallgruben schon erreicht hat.

Seit den 70er Jahren haben die Fundstellen an den Talhängen des Ödbachs durch Anpflügen und Abschwemmung plötzlich verstärkt an Substanz verloren. Dieser Prozeß trifft zweifelsohne auch auf andere, vorgeschichtlich besiedelte Lößlandschaften zu. Als Tatsache ist dies natürlich schwer zu beweisen, aber im Falle des Ödbachtals und seines Umfeldes wird die Erosion nun demonstriert anhand der seit 1976 von R.Kohlhäufl gesammelten Fundmengen. In diesem Zeitraum wurden viele neue Fundstellen entdeckt, oft zunächst als Bodenverfärbung wegen der frisch angeschnittenen Abfallgruben. Es ist davon auszugehen, daß mit diesen Fundstellen tatsächlich Siedlungen vertreten sind; Grubenverfärbungen sowie die Art der Silex-, Stein- und Keramikinventare schließen andere Deutungen nahezu aus. Weniger die (langfristige) Abschwemmung als vielmehr der Einsatz schwererer Landwirtschaftsmaschinen hat dazu geführt, daß seither das

Abbildung 2. Der Ödbach (Pfeil) im Wiesengelände, Quellgebiet beim Dorf Riedling. Rechts der steilere Talhang, links der sanfte Anstieg zum Plateau mit der FStNr. 1. Aufnahme Sommer 1978 (H.A.Groenendijk).

Fundmaterial auch von den bereits bekannten Fundplätzen massenweise aufgesammelt werden konnte. Seit einigen Jahren aber nimmt die Fundmasse in dem von Kohlhäufl betreuten Gebiet wieder ab. Nach den Erfahrungen des Finders hat sich die Pflugtiefe vorübergehend stabilisiert und sind außerdem die Äcker durch Veränderungen in der Bewirtschaftung während der Winterperiode kaum noch unbestellt. Die rapide fortschreitende Erosion würde somit vorübergehend etwas verzögert. Die Chance, frisch angepflügte Fundschichten zu registrieren und sie darauf absuchen zu können, ist damit auch wesentlich geringer geworden als etwa noch zu Anfang der 80er Jahre. Es ist für die Erforschung dieses Bereiches daher als ein Zufall zu betrachten, daß sich Kohlhäufls Geländetätigkeit gerade in einer Periode verstärkten Abpflügens von fundtragenden Schichten — so ungefähr zwischen 1975 und 1985 — entfaltete. Somit trafen Faktoren zusammen, die unbewußt zu einer günstigen Forschungsbasis führten: ein intensiv besiedelter und in seinem westlichen Bereich auch intensiv erfaßter Kleinraum. Dennoch ist der Gesamtraum nicht planmäßig im Sinne einer Landesaufnahme dokumentiert worden. Im unteren Bachlauf beruht die archäologische Information statt auf Oberflächenfunden überwiegend auf kleinere Aufschlüsse mittels Kies- und Baugruben; hier sind die Siedlungsareale aufgrund der heutigen Topographie schwerer zu begrenzen. Des weiteren bilden Auebereiche immer noch Fundlücken, obwohl auch hier die Fundmenge zunimmt.

4. Ergebnisse der archäologischen Inventarisierung

Die Fundberichte im Gäubodenmuseum Straubing sowie die Dokumentation zur Sammlung Kohlhäufl ermöglichten eine Kartierung der Fundstellen auf Flurkarten im Maßstab 1:5.000. Beide Quellen erwähnen deckungsgleiche Fundareale. In einigen Fällen gelang es auch, innerhalb der Fundstellen Gebiete abzugrenzen, welche im wesentlichen einer einzigen Kulturphase angehören. Die Verbreitungskarte (Abb. 4) differenziert womöglich nach diesen Befunden. Die kulturelle Zuweisung fand in erster Linie aufgrund der verzierten Keramik statt.

Besonders hervorzuheben wäre hier die räumliche Verteilung der Fundstellen, sprich Siedlungen am Ödbachtal. Zum einen dehnen sich die Siedlungen sehr in die Länge, d.h. sie liegen isohypsenparallel offensichtlich

Abbildung 3. Talschluß eines der wasserführenden Seitentälchen im Quellgebiet des Ödbachs (Bereich Riedling-Padering). Aufnahme Sommer 1978 (H.A.Groenendijk).

am Bach orientiert. Zum anderen sind die »leeren« Zwischenräume im mittleren Bereich des Bachlaufes recht gleichmäßig verteilt (400-900 m Freiraum). Unkenntnis der Verhältnisse am parallel südlich verlaufenden Irlbach sowie am parallel nördlich verlaufenden Niederastgraben stört zwar die Aussagemöglichkeit des Ödbachtalmusters, bleibt es doch auffällig, wie schnurartig die Ödbachsiedlungen aufgereiht sind. Zählt man die jüngeren, hier nicht kartierten vorgeschichtlichen Fundstellen hinzu, so ist dieses Muster noch eindrucksvoller.

Die hier vorgeführten Fundstellen enthalten meistens Keramik verschiedener Kulturphasen und bilden somit den Fundniederschlag mehrerer »Siedlungsmomente« des Jungneolithikums. Eine daraus erfolgende Zunahme des Fundareals hat dennoch nicht unbegrenzt stattgefunden. Die Längen schwanken zwischen 150-725 m mit einem Mittelwert von 450 m, die Breiten schwanken »nur« zwischen 100-225 m mit einem Mittelwert von 150 m. Fundstellen geringen Umfangs (etwa FStNr. 24, 150 × 100 m) sind ausgesprochen selten.

Stark vereinfacht sind in der nachstehenden Tabelle folgende Merkmale der älter- bis frühjungneolithischen Fundplätze wiedergegeben:

- Ausdehnung (L × Br, die Längen isohypsenparallel, die Breiten im Verlauf quer zum Gefälle)
- Hangrichtung der Siedlungslagen
- Gefälle gemäß Neigungsklassen < 1%, 1-2%, 2-4%, 4-8% und >8%
- Zeitstellung, unterschieden nach ältester LBK (äLbk) nach Quitta (1960), jüngerer LBK (Lbk), Stichbandkeramik (Sbk), Gruppe Oberlauterbach (Olb) — beide letztere womöglich separat erwähnt — und Gruppe Münchshöfen (Mü)

Verzichtet wurde auf die Angabe der vereinzelten Böden; alle Siedlungen liegen auf einem Lößsubstrat und zeigen einen davon abgeleiteten Bodentypus auf. Die Bedeutung der heutigen bodenkundlichen Verhältnisse kommt im folgenden Abschnitt zur Sprache. Nicht sinnvoll erschien mir die jeweilige Erwähnung der Entfernung zum heute offenen Wasser: sie beträgt selten mehr als 300 m, mit einem Schwerpunkt um 100 m, und es handelt sich demnach stets um wassernahe Standorte. Auf dem Plateau wurden (noch) keine Siedlungen angetroffen.

5. Ergebnisse der Bodenkartierung unter Berücksichtigung archäologischer Fragen

Zwischen den miozänen Sedimenten im Quellgebiet und den Talsedimenten im Mündungsbereich erstreckt sich die Lößplatte auf dem Hochterrassenschotter. Im Untersuchungsgebiet herrschen Lößablagerungen unterschiedlicher

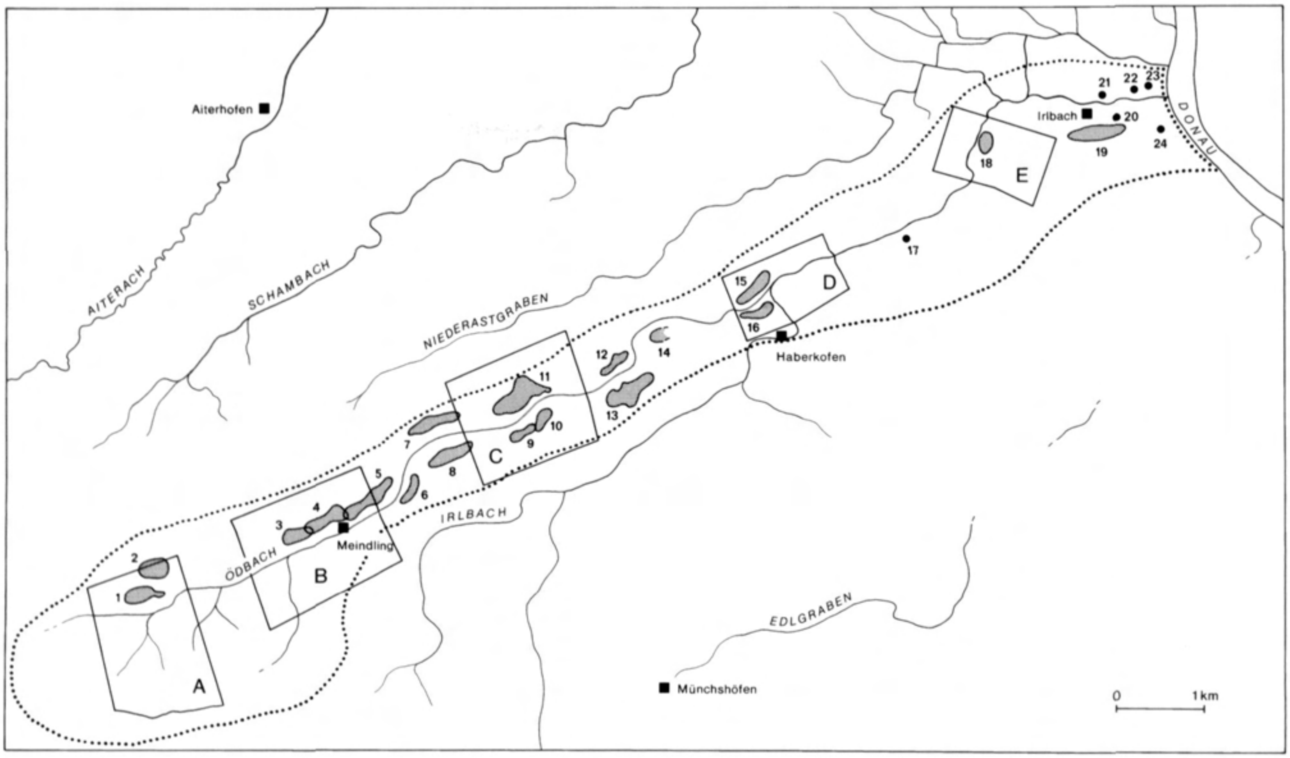

Abbildung 4. Verbreitungskarte der alt-, mittel- und früh-jungneolithischen Siedlungsstellen am Ödbach (FStNr. s. Tabelle im Text) mit der Begrenzung des untersuchten Gebietes sowie der Lage der fünf Bodenkartierungsgebiete A-E. Das Gewässernetz zeigt eine Verdichtung im Bereich des Ödbachs.

Mächtigkeit vor; innerhalb davon wurde eine große Verschiedenheit an Böden angetroffen: Parabraunerden, Braunerden, Pararendzinen, Pseudogleye sowie Gleye, Niedermoore und Tschernidzas. Erosionsformen der Parabraunerde überherrschen das Gesamtbild. Kolluvium hat sich überall in den Talauen angesammelt; es ist also stellenweise mit einer erheblichen Reliefumwandlung zu rechnen. So entstand für den Kleinraum eine Aussagemöglichkeit über die Zuverlässigkeit der Fundverbreitungskarte.

Im Maßstab 1:10.000 wurden fünf Teilbereiche entlang des Ödbachs u.a. nach Relief (Hangklassen, Hangrichtung) und nach bodenbildenden sowie bodenphysikalischen Eigenschaften (Bodenprofil, Hydrologie) mit dem Bohrstock kartiert (Gebiete A-E; für die Lage s. Abb. 4). Für jeden Teilbereich wurde außerdem ein geologisches Profil angefertigt. Zur Auswahl der fünf Gebiete galt das Vorkommen archäologischer Fundstellen und das Vorhandensein der für das Bachtal repräsentativen geomorphologischen Gradiente, nämlich (ein Teil der) Lößplatte mit seiner zum Tal hin gerichteten Abbruchkante. Vorgesehen war, die Effekte der Erosion seit der Bodenbildung festzulegen und somit die heute bekannte Verbreitung der Siedlungsplätze einigermaßen in den Griff zu bekommen. Als Beispiele dienen hier die Kartierungen bei Riedling (A), Meindling (B) und Taiding (C) samt ihren geologischen Querprofilen, welche Gebiete für den heutigen Zweck in Bezug auf Abschwemmung hervorgehoben und interpretiert worden sind (Abbn 5, 6). Sie vergegenwärtigen das Quellgebiet mit starkem Relief bis hin zum mittleren Bachlauf mit sanften Hanglagen. Dieser Trajekt mag repräsentativ sein zur Erkundung der Frage, inwiefern Erosion und gegebenenfalls Überschichtung das Fundbild beeinträchtigt haben können. Auf die bodenkundlichen Ergebnisse der Niederterrasse nimmt diese Diskussion also keine Rücksicht.

Die Kartierung unterscheidet nach Abschwemmung (1. nicht erodiert: vollständige Parabraunerden (P1), auch Pseudogleye und im geringen Maße Braunerden in Plateaulage; 2. leicht erodiert: gekappte Parabraunerden (P2), Braunerden und Pseudogleye in Hanglage; 3. stark erodiert: Rendzinas in starker Hanglage), bzw. nach Überlagerung durch Akkumulation von Bodenmaterial (4. überschichtet: Kolluvium, kolluviale Braunerden und Gleye in Talbereichen). In der Kategorie 2 (leicht erodiert) wurde im Zweifelfall nach Neigungsklasse interpretiert.

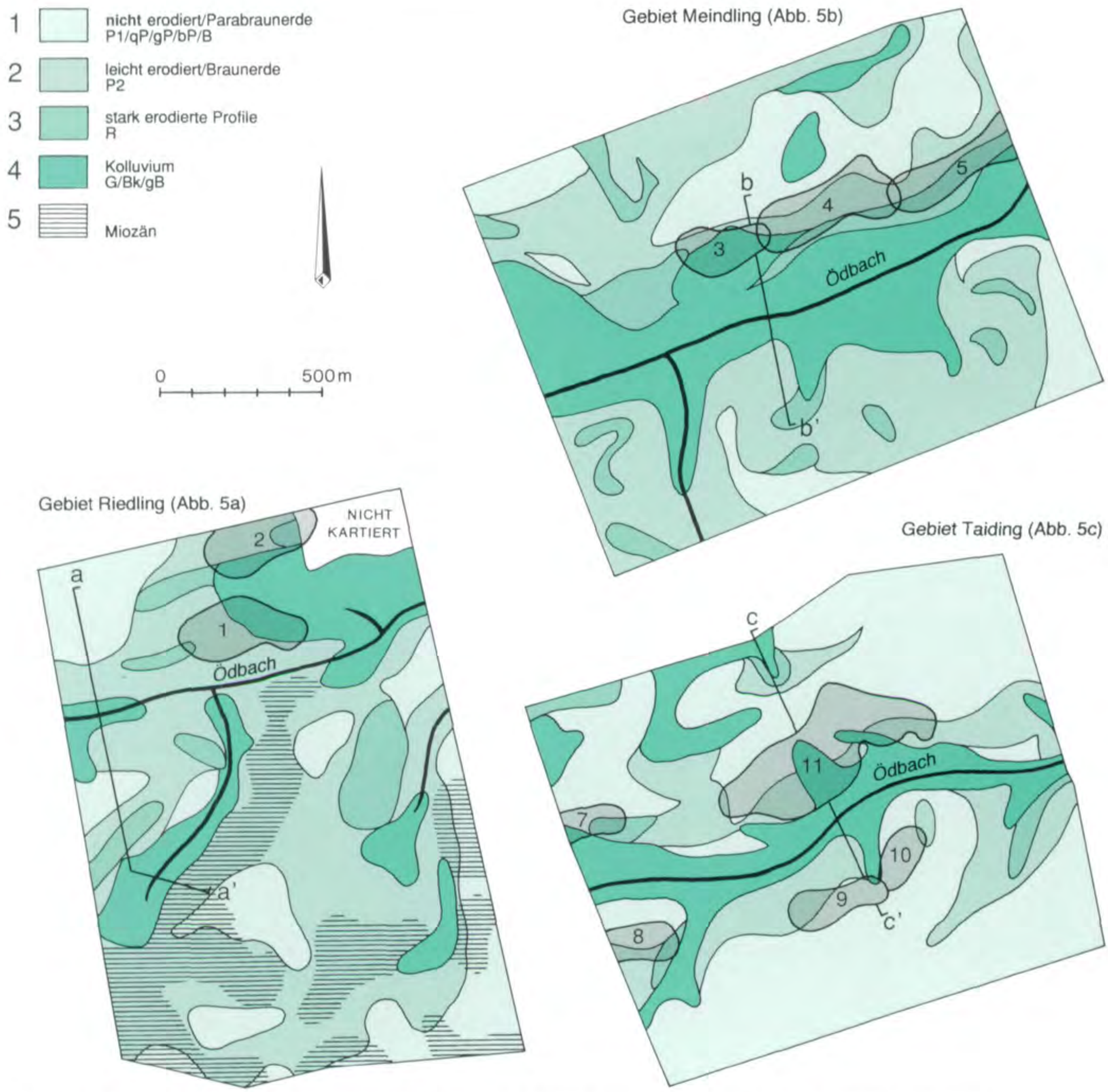

Abbildung 5. *Interpretierte Bodenkarte der Teilgebiete Riedling (A), Meindling (B) und Taiding (C) mit den jeweiligen Fundstellen. Die geologischen Profile (s. Abb. 6) sind verzeichnet.*

Besonders aufschlußreich wirkt die Kartierung in Hinsicht auf Relief und Abschwemmung. Seit der ersten seßhaften Besiedlung muß in Hanglagen eine beträchtliche Reliefveränderung stattgefunden haben. Wie Van de Wetering für den LBK-Siedlungsbereich Hienheim feststellte, konnten sich auch neue Tälchen oder Erosionsrinnen an jenen Stellen bilden, wo vorher keine waren, und wurden andererseits alte Täler völlig verfüllt

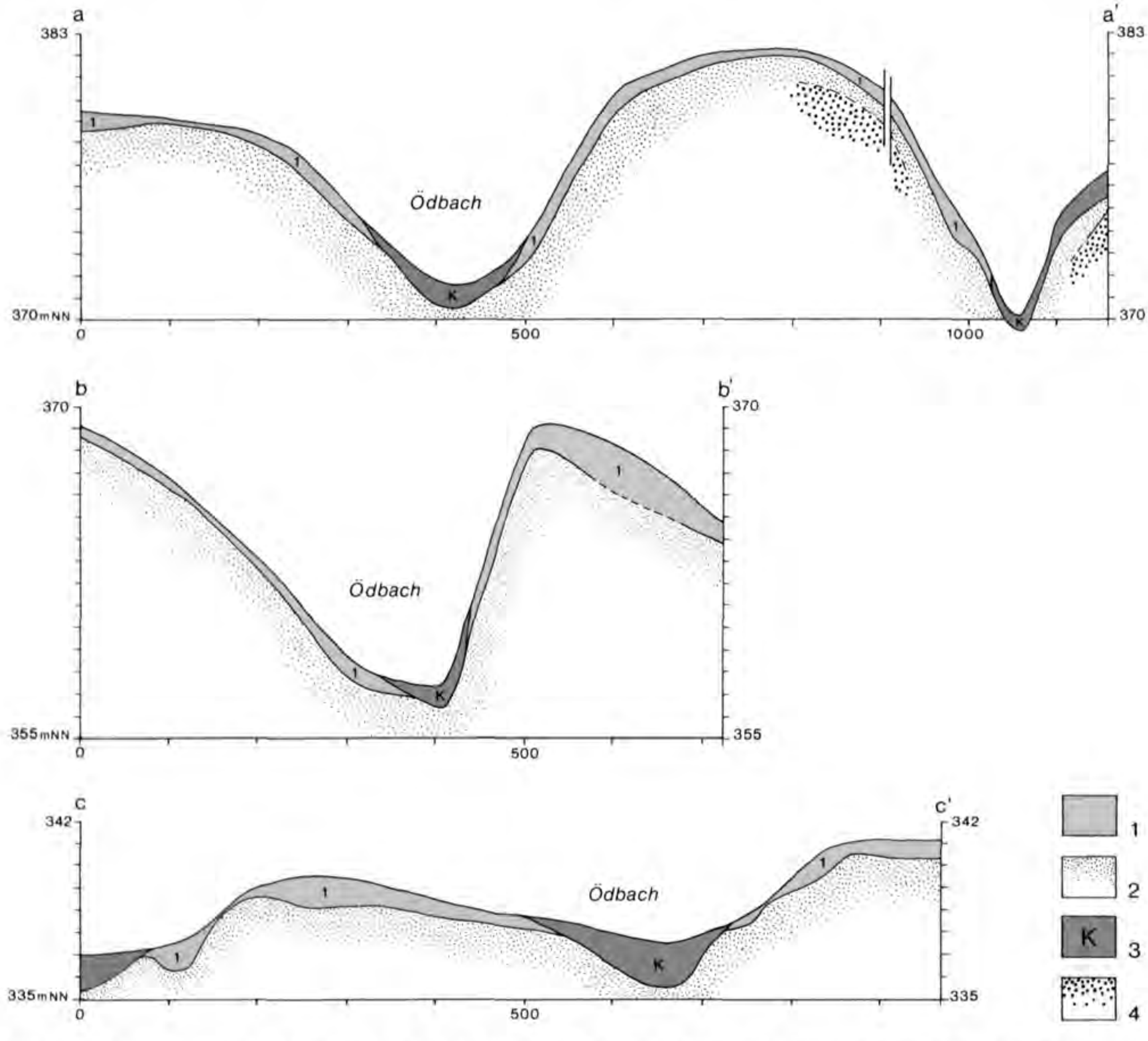

Abbildung 6. Vereinfachte geologische Profile der Gebiete Riedling (a-a'), Meindling (b-b') und Taiding (c-c'). Legende: 1 = Bodenbildung in Löß, 2 = Würmlöß (unverändert), 3 = Kolluvium, 4 = Terrassenschotter.

(Modderman 1986, Taf. 59; Slager/Van de Wetering 1977). Durch Lößverlagerung sind alte Taleinschnitte also teilweise unerkennbar. In diesen Bereichen dürften Fundstellen im ungünstigsten Fall durch anfängliche Erosion und spätere Akkumulation restlos verschwunden, das Fundmaterial dabei stark auseinandergerissen sein. Man könnte den Eindruck bekommen, eine neolithische Siedlungsverbreitungskarte sei grundsätzlich unzuverlässig. Es gibt aber nicht nur Negatives zum Thema Erosion zu melden. Die leicht erodierten Geländepartien an den oberen Hangschultern bieten gerade auch die Möglichkeit, dort gelegene Siedlungsplätze neu zu entdecken. Daß die Erosionsformen der Kategorie 1, 2 und 3 oft zugleich in einer Fundstelle auftreten, letztere sich aber gut begrenzen lassen, trägt zur Vollständigkeit des Verbreitungsbildes bei. Dies soll bei der Bewertung solcher Karten sicher berücksichtigt werden.

Bemerkenswert ist schließlich das offensichtliche Vorhandensein von Fundmaterial auf Flächen mit Kolluvium, eine Situation, welche ziemlich großflächig auftritt in den Gebieten Riedling (A) und Meindling (B). Kolluvium wurde während der Kartierung erst in Mächtigkeiten zwischen 40 und 80 cm erfaßt, so daß hier anscheinend eine Verlagerung der Funde stattgefunden hat: der Pflug konnte dort ja keine Fundschichten berühren. Es ist immerhin möglich, daß die Besiedlung jüngeren Datums ist als die erste Kolluviumbildung, aber dies wurde nicht untersucht. Wegen der benachbarten Lage erodierter Bodenprofile innerhalb der Fundflächen ist jedoch anzunehmen, daß Verlagerung des Fundmaterials in großem Umfang nicht stattgefunden hat. Dennoch wird die kartierte Ausdehnung der Fundstellen hangabwärts verhältnismäßig noch die größte Fehlerquote enthalten.

6. Rückschlüsse auf die Besiedlungsintensität im älteren, mittleren und beginnenden jüngeren Neolithikum

Die Verbreitungskarte der älter-, mittel- und frühjungneolithischen Siedlungsplätze entlang des Ödbachsystems ist gekennzeichnet durch eine dichte Besetzung der Talflanken und das Fehlen siedlungsanzeigender Funde auf der Lößplatte. Diese Feststellung trifft im allgemeinen zu für Lößlandschaften mit einem dichten Gewässernetz (niederländisch Limburg: Bakels 1978, 1982; Modderman 1958/1959; Rheinland: Lüning 1982; Österreich: Lenneis 1982). Für den Gäuboden wurde dieses Verbreitungsbild erstmals durch Brunnacker und Kossack (1956/1957) erfaßt und später von Böhm und Schmotz (1979/1980) auch periodisiert. K. Schmotz (1989) betonte für das dem Ödbachsystem angrenzenden Isarmündungsgebiet außerdem einen Bezug zum Wasser für jene Siedlungslagen, wo nur indirekt auf Wasservorkommen hingewiesen werden kann, wie entlang heute nur noch als Trockentälchen erkennbarer Senken. Die Reliefumwandlung durch Abschwemmung mag sodann auch die hydrologischen Verhältnisse gestört haben, muß das gelegentliche Vorkommen von Siedlungen im »Hinterland«, d.h. abseits der Talrandlagen, daher eigentlich von der heutigen Topographie losgelöst betrachtet werden (vgl. Schmotz 1989, 58). Andererseits hat die Entdeckung eines bandkeramischen Brunnens bei Erkelenz im Rheinland, kilometerweit vom Bachlauf entfernt (Weiner 1992), die Plateaulage bandkeramischer Siedlungen in einem anderen Licht erscheinen lassen. Für den Ödbachbereich kommt ein Hinterland aber kaum in Betracht, da Irlbach und Niederastgraben den Bachlauf über etwa 10 km Länge eng begleiten. Da diese beiden Systeme unerforscht blieben, konzentriert sich unsere Untersuchung auf die angenommene lineare, am Ödbach orientierte Siedlungsverteilung.

Das lückenhafte Besiedlungsbild des Ödbachquellgebietes dürfte gerade als ein Merkmal für das Tertiärhügelland gelten, wenn dies auch durch den Forschungsstand stark bedingt zu sein scheint (Schmotz 1989, 36f). Im oberen Verlauf des Ödbachs fanden sich auf einem Lößsubstrat nur Siedlungen auf den nach SO gerichteten Talhängen (Gebiet Riedling, Abb. 5A), d.h. an der nördlichen Talflanke. Erst im mittleren, viel flacheren Ödbachbereich wurden auch die Nordhänge besiedelt. Gerade die südliche Talflanke im Bereich des Tertiärhügellandes ist durch wasserführende Nebentälchen gekennzeichnet, was durchaus als siedlungsgünstiger Faktor gelten dürfte. Hier treten aber miozäne Ablagerungen an die Oberfläche; sie bilden darüber hinaus überwiegend Nordhänge. Obwohl diese miozänen Böden heute beackert werden, fehlen siedlungsanzeigende Funde. Daher kann bei gleichbleibenden Fundverhältnissen nicht der Forschungsstand für die Siedlungsleere verantwortlich sein. Mit landschaftlichen Argumenten ließe sich diese Situation nun folgendermaßen erklären. Es treten hier Hangneigungen von über 8% auf, gegen die sonst im Arbeitsgebiet vorherrschenden Neigungswinkel bis zu 4% — ausgenommen die schmalen Talrandzonen welche Neigungswinkel von 4-8%, teilweise über 8% aufzeigen können. Mit dem insgesamt stärkeren Relief verbunden ist die Orientierung der unbesiedelt gebliebenen Hanglagen, nämlich um Norden; die geringere Dauer der Sonneneinstrahlung dürfte der neolithischen Ackerbestellung in dem anfangs noch stark bewaldeten Gebiet hier kritische Grenzen gesetzt haben. Die gleichen Lagen blieben jedoch auch während des ganzen Neolithikums und später unbesiedelt. Auch aus dem praktischen Gesichtspunkt des Häuserbaus müssen Einschränkungen in bezug auf das Gefälle gegolten haben. Solche Überlegungen treffen auch auf das Substrat zu; kieshaltige Miozänböden würden im Vergleich zu den tiefgründigen Lößböden mehr Aufwand bei der Errichtung der Ständerpfosten erfordern. Es liegt nahe, wirtschaftlichen Faktoren, welche zu einer negativen Platzwahl führten, großes Gewicht beizumessen (vgl. Bakels 1978).

Trotzdem weisen die Fundareale, liegend auf der Hangschulter, im unteren Bereich mehrfach ein Gefälle zwischen 4 und 8% auf. Der obere Bereich des gleichen Fundareals befindet sich dann aber zugleich in nur wenig, bis zu 2% geneigtem Gelände, was besser paßt zu den von C.C. Bakels gefundenen Werten für niederländisch Limburg und für Hienheim (Bakels 1978, 133). Hier zeigt sich die Einschränkung der heutigen Meßwerte, unkorrigiert für den Erosionsfaktor: das Gelände mit dem stärksten Gefälle — die Abbruchkante zum Tal hin — vertritt zugleich die am stärksten erodierten Bodenprofile. Rendzinas als Erosionsform herrschen hier vor.

Tabelle 1. Einige Merkmale der Ödbachtalsiedlungen aus dem älteren Neolithikum bis zum frühen Jungneolithikum.

Fundstellenummer	1	2	3	4	5	6	7	8	9	10	11	12
Ausdehnung in M.	450/ 175	325/ 225	350/ 150	500/ 175	725/ 175	375/ 100	600/ 150	550/ 150	325/ 125	275/ 125	700/ 225	400/ 125
Hangrichtung	SO	SO	O	S/SO	O/SO	W/NW	SO	NO	W/NW	NO	SO	SO
Gefälle (%)	<1-4	1-4	2-8	1-4	1-4	2-8	<1-4	<1	<1-4	<1-2	<1-4	<1-4
Periode	Sbk Olb Mü	Sbk Olb Mü	Sbk Olb Mü	äLbk Lbk Sbk Olb Mü	Sbk Olb	Olb	Sbk Olb Mü	Sbk	Sbk Mü	äLbk Lbk Sbk Mü	äLbk Lbk Sbk Olb Mü	Lbk Sbk Olb

Fundstellenumme	13	14	15	16	17	18	19	20	21	22	23	24
Ausdehnung in M.	650/ 225	-/ 150	500/ 125	400/ 125	-	250/ 150	650/ 175	-	-	-	-	150/ 100
Hangrichtung	NW	W	SO	NW	-	N/NW	N	W/NW				
Gefälle (%)	<1-4	1-4	1-8	<1-8	<1	1->8	1->8	>8	<1	<1	<1-2	2-8
Periode	Lbk Sbk Olb Mü	Lbk	Lbk Sbk Mü	Olb	Mü	Mü	äLbk Lbk Sbk Olb Mü	Mü	Lbk	Lbk Sbk	Lbk Sbk	Olb Mü

Für die älteste Linearbandkeramik sind vier Fundstellen als Siedlungsplätze belegt: Meindling (FStNr. 4), nördlich Taiding (die gegenüber einander liegenden FStNr. 10-11) und Irlbach (Quitta 1960; FStNr. 19). Obwohl an diesen Stellen zugleich jüngere Linearbandkeramik nachgewiesen wurde, stehen diese primären Siedlungsplätze noch als ziemlich isoliertes Phänomen da. Der freie Raum zwischen den ältesten Siedlungskernen beträgt 3, bzw. 7 km. Fundstellen der jüngeren LBK weisen hingegen eine auffällige Ballung im Raum Siebenkofen-Haberkofen auf; hier reihen sich innerhalb von 2 km sechs linearbandkeramische Siedlungsplätze am Ödbach entlang.

Folgendes Entwicklungsmodell möchte ich nun anhand der Fundstelle Meindling darreichen. Die Siedlungskerne der ältesten LBK an der schmalen Talrandzone standen noch nicht in einer räumlichen Konkurrenz mit Nachbarsiedlungen. Häuser und Felder lagen in einem wenig ausgedehnten, waldfreien Raum, in dem sich nur geringfügige Verschiebungen des Siedlungskernes ereignen konnten. Da aber der Talrand als Standort bevorzugt war, fand bei zunehmendem Siedlungsdruck eine allmähliche laterale Ausdehnung des belegten Areals statt. So konnte eine ausgedehnte Fundstreuung entstehen. Am Falle Meindling wäre anhand der Kohlhäuflschen Angaben zu demonstrieren, daß es einen Kernbereich mit ältester und jüngerer LBK gegeben hat (Ausdehnung i.d. Länge etwa 500 m; die älteste Besiedlung konnte während der Ausgrabung 1977 aber nicht isoliert werden) und anschließend eine laterale Erweiterung im Mittelneolithikum (Stichbandkeramik/Gruppe Oberlauterbach) sowie im beginnenden Jungneolithikum (Gruppe Münchshöfen) stattfand. Es scheint hier eine kontinuierliche Entwicklung vorzuliegen. Die Gesamtausdehung des geschlossenen Fundareals »Meindling« (FStNr. 3/4/5) beträgt etwa 1500 m!

In den Fällen Taiding-Nord und Irlbach wäre aufgrund des Fundinventars ebenfalls zu vermuten, daß die jüngere LBK, bzw. die Stichbandkeramik und Oberlauterbacher sowie Münchshöfener Gruppe der ältesten LBK folgte.

Bemerkenswert ist das während der älteren LBK bereits erschlossene und während der jüngeren LBK stark ausgebaute Siedlungsareal Siebenkofen-Haberkofen. Letzteres liegt im flacheren Bereich des Ödbachtals; sowohl südlich als auch nördlich des Baches findet man nur sanfte Hanglagen. Als besonderes Merkmal ist das hiesig mehrfach auftretende Phänomen der »Verdoppelung« der Siedlungsplätze zu bezeichnen: beidseits des Bachlaufes liegen die gleichphasigen (aber auch zeitgleichen?) LBK-Fundstellen 10-11 und 12-13 einander gegenüber, nur die FStNr. 14 liegt vereinzelt. Diese »Verdoppelung« trifft in der flacheren Terrassenstufe ab Siebenkofen sogar viermal bei gepaarten mittelneolithischen Siedlungsplätzen zu (die FStNr. 5-6, 7-8, 9/10-11 und 12-13). Der bodenkundlichen Situation auf Abb. 5C ist zu entnehmen, daß es sich in diesen Fällen nicht unbedingt um ein geschlossenes Fundareal handeln muß und die beträchtliche Fundlücke von ca 200 m kein Beobachtungshiatus sein kann. Erstmals am Ödbach liegen die Siedlungen an den beiden Hangschultern, während sie westlich Siebenkofens — stromaufwärts — nur an der nördlichen Talseite vorkommen. Möglicherweise sind diese »Zwillingsdörfer« tatsächlich als eine funktionale Einheit zu betrachten, indem nebeneinander existierende Häusergruppen, nur durch den schmalen Ödbach getrennt, eine gemeinsame wirtschaftliche oder soziale Basis oder eine gegenseitige Abhängigkeit besaßen. Bei dem heutigen Kenntnisstand ist für eine zeitgleiche Besiedlung jedoch noch keinerlei Beweis da. Eine »Ausweichstrategie«, d.h. eine unmittelbare Zeitabfolge in den benachbarten Siedlungsstellen (Modderman 1982), aus welchem Grunde auch immer, gehört jedenfalls zu den Möglichkeiten. Weitgehend unbekannt ist, welche wirtschaftliche Rolle das schmale Ödbachtal hier gespielt haben kann. In dem hiesigen flachen, siedlungsgünstigen Bereich, im größeren landschaftlichen Zusammenhang aber eingeklemmt zwischen Niederastgraben und Irlbach, könnte eine landwirtschaftliche Nutzung des Talbereichs in Erwägung gezogen werden: ein theoretisches Modell über das noch ungenügend Daten vorliegen (zusammenfassend Bakels 1978, 139). Falls die Täler von Niederastgraben und Irlbach eine ähnliche Besiedlungsdichte aufweisen wie das des Ödbachs (und es gibt noch keinen Grund diese Annahme zu bezweifeln), müssen die jeweiligen *site territories* wegen des geringen Abstandes zum Nachbartal entsprechend wenig tief (höchstens 500 m, nämlich bis zur Wasserscheide), dafür aber mehr ausgedehnt gewesen sein, nämlich dem Talrand angeglichen. Für die mittelneolithischen Siedlungen am Ödbach gelten jedoch laterale Freiräume von knapp unter 400 bis zu 700 m, was die Größe der Territorien (35 Hektar und weniger) wiederum erheblich schrumpfen ließe. In diesem Licht wären die Möglichkeiten zur Beackerung des Plateaurandes sowie der Hangschulter bald erschöpft und zwingt sich eine zwangsläufige Konzentration der Wirtschaftsflächen in Bachnähe auf. Von selbstversorgenden Einheiten kann bei dem Umfang nicht mehr die Rede sein (vgl. Bakels 1982, 37ff). Dieser Model zu testen bedarf aber zunächst weiterer Inventarisierung auch der benachbarten Täler, würde sich aber angesichts der u.a. von Bakels (1982) und Lüning (1982) entwickelten *cluster* Theorien für LBK-Ballungsräumen sehr empfehlen.

Betrachten wir die jeweiligen Bachsysteme als gesonderte, mehr oder wenig gleich intensiv benutzte Siedlungsräume, so fällt die Ähnlichkeit mit dem korridorartigen Muster der Aldenhovener Platte auf (Lüning 1982). Die dortigen LBK-Siedlungsstellen innerhalb des Merzbachsystems erwiesen sich aber nur teilweise als zeitgleich. Für den noch knapperen Ödbachraum sollte daher vorläufig, mangels einer Feindatierung durch Ausgrabungen, eine zeitliche Abfolge wenigstens einiger der älter- und mittelneolithischen Siedlungsstellen angenommen werden.

Allemal hat der winzige Ödbach kaum eine Grenze zwischen Siedlungsterritorien bilden können, sondern erscheint der Bach eher als deren Mittelachse. Eine Territoriengrenze muß dort gesucht werden, wo die geographische Trennung zu den parallelen Bachsysteme verlief: etwa über die Wasserscheiden, in etwa 500 m Entfernung zum Ödbach.

Im Kleinraum Ödbachtal ist der Besetzungsgrad mit Fundstellen der Linearbandkeramik, Stichbandkeramik, sowie der Oberlauterbacher und Münchshöfener Gruppe hoch. Vom Quellgebiet bis zur Donaumündung vermehren sich die Siedlungsplätze stark ab dem Mittelneolithikum und stabilisiert sich die Situation anscheinend vorübergehend am Beginn des Jungneolithikums. Nur drei neue Standorte sind der Münchshöfener Gruppe zuzuweisen. Ansonsten verschieben sich die jeweiligen Siedlungsareale nur geringfügig, was ein großes Maß an Kontinuität in der Platzwahl bedeutet. Im Rheinland beispielsweise deuten siedlungsgeographische und botanische Untersuchungen eher auf ein Diskontinuum zwischen LBK und Mittelneolithikum hin (Bakels 1992). »Kontinuität« kann wegen des Zeitabstandes zwischen diesen Gruppen in Niederbayern auch keine direkte zeitliche Abfolge beinhalten, sondern läßt lediglich auf eine Wiederbesiedlung zuvor benutzter Standorte schließen, so K. Schmotz (1989, 75). Der Fall Meindling zeigt aber, daß sich die jeweiligen Siedlungsareale auch räumlich ausschließen können. Möglicherweise wurden hier doch altbesiedelte Plätze bewußt gemieden, blieb man aber im gleichen Siedlungsraum tätig. Wie im anschließenden Isarmündungsgebiet ist im Ödbachtal wenigstens auch eine Tendenz der Zunahme mittelneolithischer Siedlungen sichtbar (s. Schmotz 1989, 75).

Die jung- und endneolithischen Altheimer und Chamer Gruppen sind im Untersuchungsgebiet spärlich vertreten, nämlich mit nur vier, bzw. zwei Siedlungsplätzen. Dagegen findet eine explosive Zunahme der Siedlungen in der Bronzezeit statt; die Bronzezeit ist im ganzen mit 16 Fundstellen belegt. Diese Befunde sind vorerst völlig im Einklang mit jenen aus dem Isarmündungsgebiet. Da jedoch mit dem Jungneolithikum erstmals einen Trendbruch in der Besiedlung des Ödbachtals auftritt — ob nun aus realen Gründen entstanden, oder durch ungünstigeren Fundchancen verzerrt — möchte ich meine Erkundung von »Meindlings Umfeld« mit dem frühen Jungneolithikum beenden.

Anmerkungen

1 Die bodenkundliche Geländeaufnahme wurde von den Fachstudenten F. Mulder, H. Vissers, P. Carpay und B. Marx unter Leitung von Ir. H.T.J. van de Wetering, alle am (jetzt aufgelösten) *Bodemkundig Instituut*, Universität Utrecht, im Sommer 1978 durchgeführt. Obengenannte Personen schulde ich Dank für die Zustimmung, ihre Ergebnisse für diesen Aufsatz benutzen zu dürfen.

2 Die archäologische Inventarisierung fand durch Verf. 1978 und 1979 im Rahmen seines Studiums Prähistorie unter Leitung von Prof. Dr. P.J.R. Modderman beim *Instituut voor Prehistorie*, Universität Leiden statt. Neufunde bis zum Jahre 1982 wurden noch verarbeitet. Herrn Dr. K. Schmotz (Kreisarchäologe des Ldkr. Deggendorf) habe ich für fachinhaltliche Diskussionen und Verbesserungsvorschläge des vorliegenden Textes sehr zu danken.

3 Für eine vollständige Wiedergabe der archäologischen Inventarisierung, s. H. Groenendijk, 1979. Dieses Manuskript wurde jedoch in nur wenigen Exemplaren verbreitet. Zusammenfassend für das ältere und mittlere Neolithikum auch: Modderman, 1982, 36f.

4 Zur Geologie des Gebietes liegen vor: Brunnacker, 1956; zur Bodenkunde: Brunnacker, 1957.

5 Wenn im weiteren von *Ödbach* die Rede ist, sei nunmehr der Gesamtverlauf des Ödbachs sowie des Irlbachs ab Haberkofen gemeint.

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Do we have cremation graves of the Michelsberg culture in The Netherlands?

In 1927 a so called Robenhausien-grave was discovered in Stein. A re-examination of the find material and find circumstances revealed that the interpretation as a grave is doubtful. Other possible interpretations are put forward and discussed.

1. Introduction

In the first volume of Analecta Praehistorica Leidensia an excavation report was published by Professor P.J.R. Modderman concerning the burial vault of Stein (Modderman 1964). In an attempt to trace parallels for this unique grave he referred in passing to an enigmatic find from Stein that had been discovered as early as the twenties by H.J. Beckers Sr. and G.A.J. Beckers Jr. This find, better known as the *Robenhausien*-grave, consisted of a cremation and a large number of flint implements. In discussing this find, Modderman expressed some doubts whether the cremation and the finds actually belonged together.

As part of the Meuse Valley Project, a cooperative effort between the Institute of Prehistory and the National Museum of Antiquities, this find was re-examined in 1990. In this re-examination the question whether this was a grave did not need a direct answer. However, the *Robenhausien*-grave once more became the centre of attention when in the autumn of 1992 a cremation without any grave gifts was discovered during the excavation of a Middle Neolithic settlement near Sint-Odiliënberg. Since all finds in the immediate vicinity of the grave dated from the Michelsberg phase, it was not impossible that this grave would be from the Michelsberg phase as well (fig. 1).

This article focusses on these two supposed graves in order to reach a functional interpretation and to determine an age and cultural attribution.

2. The discovery of the so-called *Robenhausien* grave of Stein

In 1940 Beckers and Beckers published their "Voorgeschiedenis van Zuid-Limburg". In this book they described the archaeological investigations they had carried out in the neighbourhood of their domicile of Stein over twenty years. In the small paragraph concerning the Late Neolithic a *Robenhausien*-grave was mentioned that had been discovered during the excavation of the Bandceramic settlement along the Kerkweg, now called the Keerenderkerkweg, in Stein (fig. 2). Shortly after 1927 during an excavation of the Bandceramic settlement area Keerenderkerkweg a grey-white discolouration was noticed at the south of plot 1074, at 2.30 m from the boundary of this plot, at a depth of 75 cm. In this discolouration ash and some burned bone flakes were discernible. It was decided to extend the excavation to the east. The soil was more contaminated there and more ash and fragments of bones were discovered. It appeared to be 'piles' of burned bones with a diameter of 35 cm and a thickness of 20 cm. Nearby, about 30 cm west of the pile of burned bones, nine large flint implements were uncovered together with some flakes. According to Beckers and Beckers this were grave gifts.

It is unclear whether one or two 'piles' were discovered. Beckers and Beckers (1940, 149) write about one pile of bones and in the next sentence about two piles found alongside each other. It is also mentioned that the pile was taken away and closely examined at home. In the collection at Stein, however, only a single block of soil was found from this grave. We assume that only a single pile has been preserved.

The dating of the find as *Robenhausien* was based on typological similarities between the large scraper and Belgian finds. At that time, *Robenhausien* was used for a conglomerate of finds characterised by the occurrence of large flint implements and polished axes. It was supposed to date from the period after the Bandceramic, but nowadays we attribute such finds to the Middle Neolithic, more in particular to the phase of the Michelsberg Culture (MK).

3. The finds

Most finds of Beckers and Beckers have been preserved and are stored in the municipal depot in Stein. Four small boxes were found there with remains of cremations. One of the boxes could be identified with the aid of a photograph published by Beckers and Beckers (1940, 151, fig. 47) as a remnant of the *Robenhausien*-grave. The associated artefacts were found in a small box and at present consist of one unretouched flake, two small unretouched blades, one small flake scraper, two large flake scrapers and four long

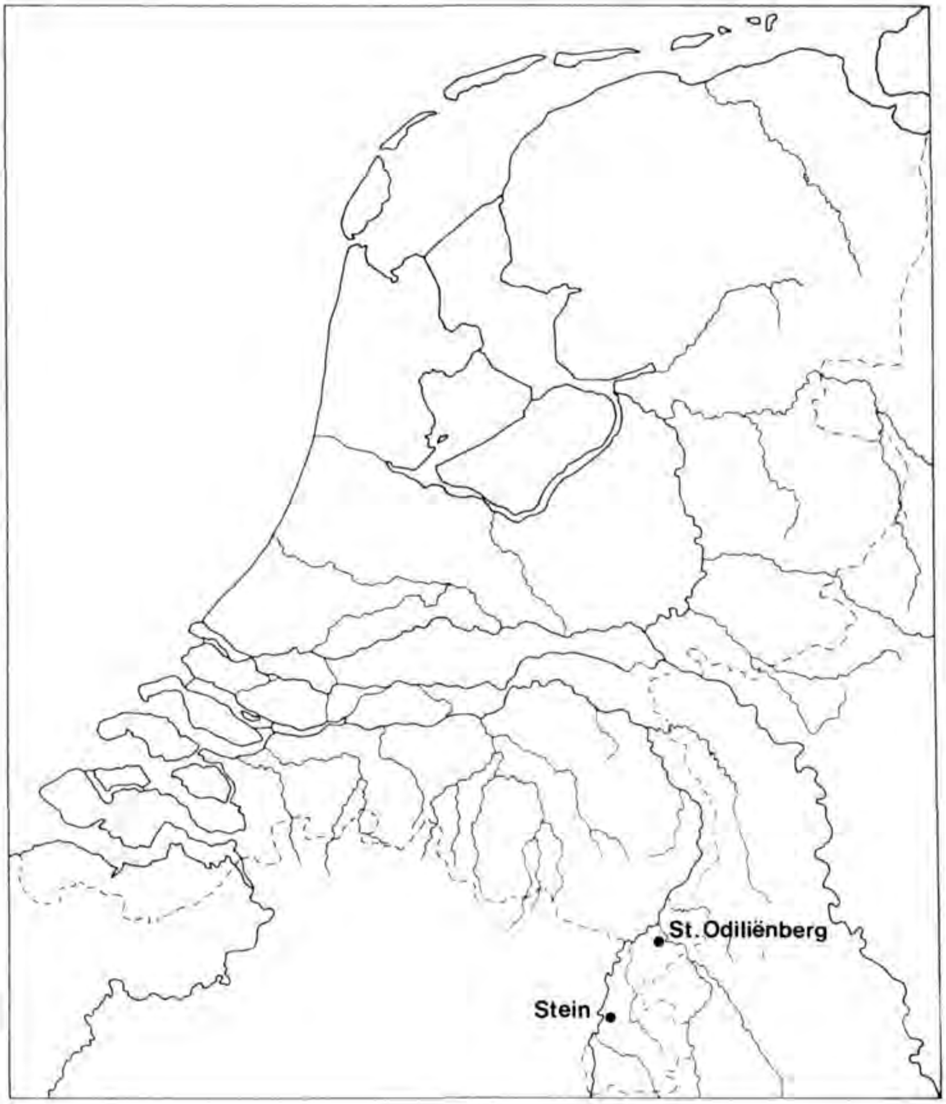

Figure 1. The Netherlands and the location of the sites mentioned in the text.

retouched blades. In all, these are ten artefacts (figs 3, 4), but it is unclear whether there are finds missing. Beckers and Beckers mention in their publication nine large flint implements and some flakes. They depicted nine pieces, among them one flake, one small blade and one flake scraper. The flints are numbered consecutively IE1 through IE10. There appears to be no number missing. It is, however, possible that some artefacts have been lost between the retrieval of the finds in 1927 and the publication of the book in 1940.

4. The cremation

The cremation has been removed carefully from the cardboard tray and sieved (mesh size 1 mm). No artefacts were found, not even a little bit of charcoal to date the cremation. The total weight of the remaining bone material was 677 gram. The remains proved to have belonged to a female individual, between 20 and 30 years old. Although the bone material was strongly fragmented, all skeletal elements appear to be present.

5. Flint

Six macrolithic tools have all been retouched and show traces of use in the shape of splinters and abrasions on the working surfaces and a heavy gloss. With the exception of one scraper (fig. 4, left) all pieces are made of mined flint of the Rijckholt type. The scraper is made of light greyish Belgian flint and has a cortex surface which gives the impression of an eluvial origin. The smaller artefacts are made of flint of the Rijckholt type.

The blades have regular parallel sides; on just one single piece the striking platform has been preserved. The regular sides, the reduction of the striking platform and the other knapping characteristics all indicate the use of a soft (indirect) hammer technique. The scraper of light greyish Belgian flint has been struck off with a hard hammer technique.

6. Dating

In view of the absence of charcoal among the cremation remains it has been attempted to obtain from the cremated bone material enough collagen to determine the age with the aid of an AMS-dating technique. It, however, turned out that the bones had been heated to such a degree during the cremation that insufficient amounts of collagen were left in the sample. So it was impossible to obtain a direct date and we had to resort to a typological comparison of the artefacts and a cultural comparison with other grave finds from the Middle Neolithic.

The flint type used, the working technique, the lengths of the blades and the morphology of the tools all indicate a Middle Neolithic date. The macrolithic implements are characteristic of the Michelsberg complexes known from the east and south-east of the Netherlands (Louwe Kooijmans/Verhart 1990; Theunissen 1990; Verhart/Louwe Kooijmans 1989; Wansleeben/Verhart 1990).

It is more problematic to attribute cremation, as a way of dealing with the dead, to the Michelsberg Culture. No cremation burials from that period are known from the Netherlands, only inhumation burials like those at Zoelen and Swifterbant (Constandse-Westermann/Meiklejohn 1979; Hallewas *et al.* 1992, in press). Cremation of the dead evidently was a rare phenomenon within the Michelsberg Culture. There are indeed reports of cremation remains in settlements (Nickel 1992). Many of these, however, concern old find reports or accidental finds that did not receive the archaeological attention they deserved. Most (inhumation) burials of the Michelsberg Culture are discovered in causewayed enclosures (Nickel 1992). The range of burial practices is remarkably wide, from the deposition of a single skeletal element to complicated interments of several individuals. The 'graves' all consist of skeletal remains occurring in association with pottery, worked bone or antler, stone and flint. The grave goods appear in various combinations and it is remarkable how rarely flint artefacts have been used as grave gifts. There is not a single MK-grave where flint is found exclusively. Therefore, the find at Stein would be unique in two respects — a cremation and an association with flint as grave gifts — if this turns out to be a Michelsberg Culture grave.

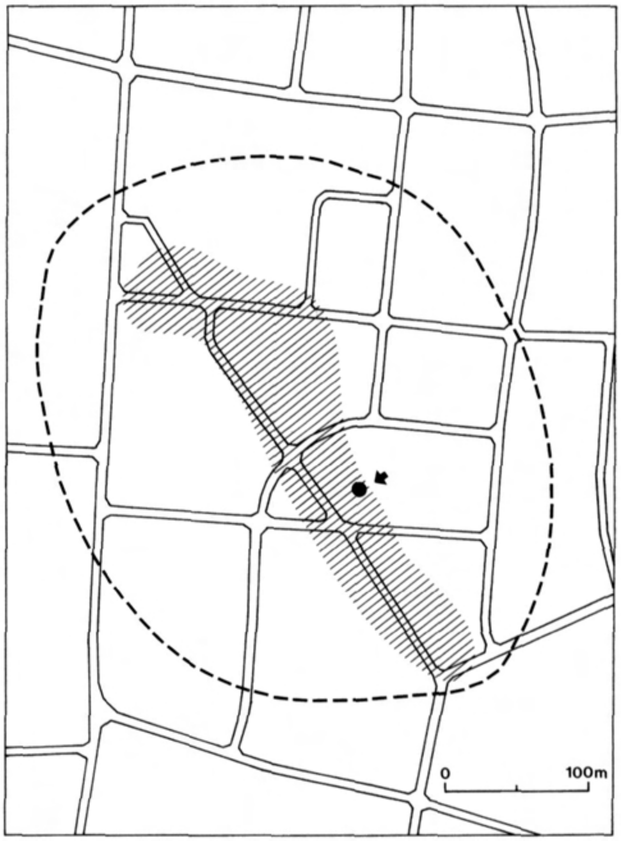

Figure 2. Modern topography of Stein. The outline of the Bandceramic settlement is indicated by a dotted line. The hatched area represents the Iron Age urnfield. The *Robenhausien*-grave is indicated by the dot.

7. Association

Above we have ascertained that cremations are a rare phenomenon in the Michelsberg Culture. This raises the question whether possibly flint and cremation do not belong together. Regarding the association of the finds Beckers and Beckers write that the cremation and the flint tools were discovered 30 cm apart.

Cremations are known from the Bandceramic and Iron Ages. It is significant that the excavated area has been in use as a settlement in Bandceramic times and as a urnfield cemetery in the Late Bronze Age/Early Iron Age. Even close to the location of the 'grave', an urn with cremation was found in a pit fill during a later excavation. This pit had the same depth as the nearby pit of the *Robenhausien*-grave (Schuyf/Verwers 1976, 77). There are however no indications for the presence of Bandceramic graves on the site, as opposed to Iron Age graves.

A second argument against an association of flint and cremation is that the flint tools were not burned with the

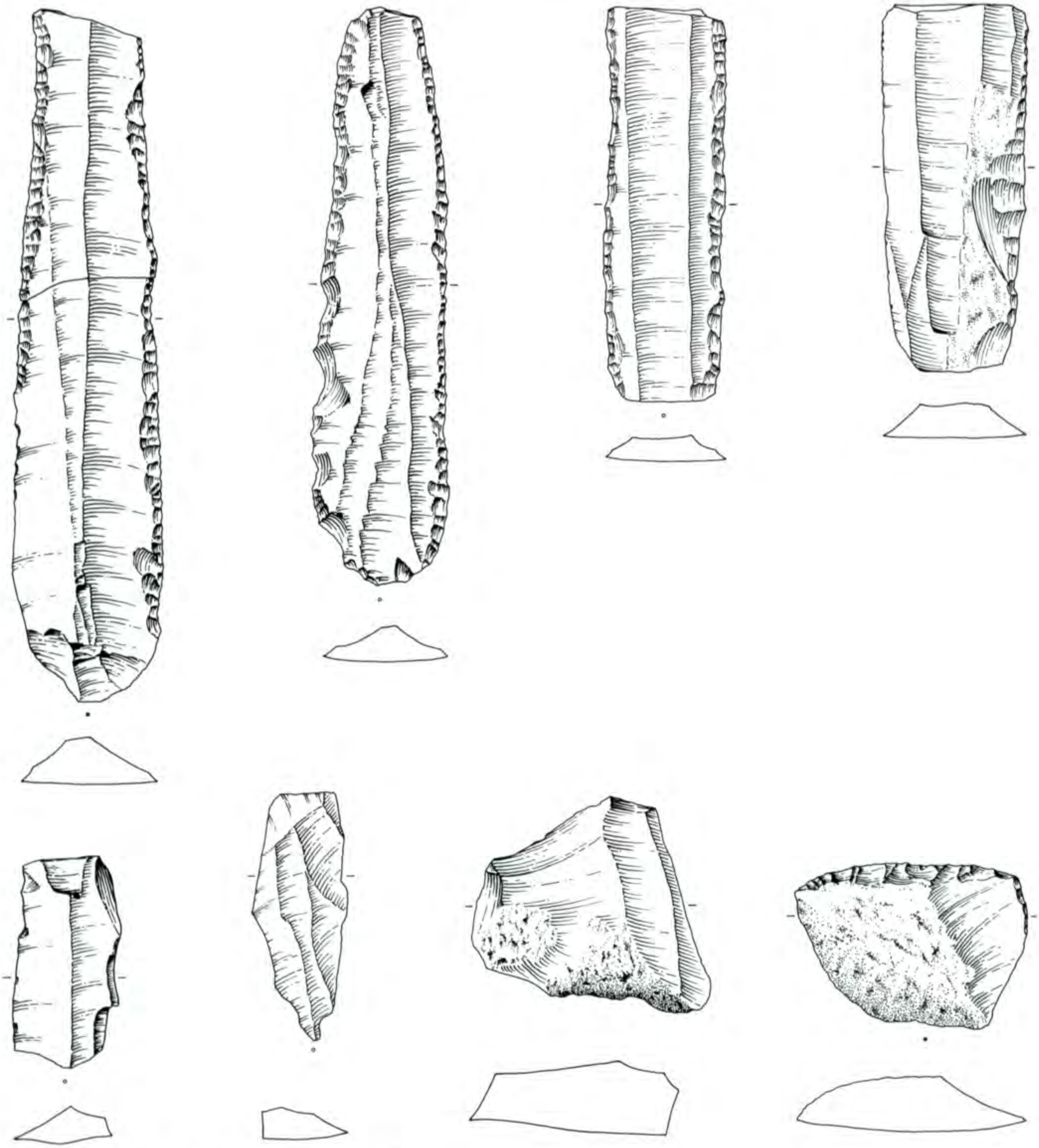

Figure 3. Stein. Flint. Blades, flake and scraper. Scale 1:1.

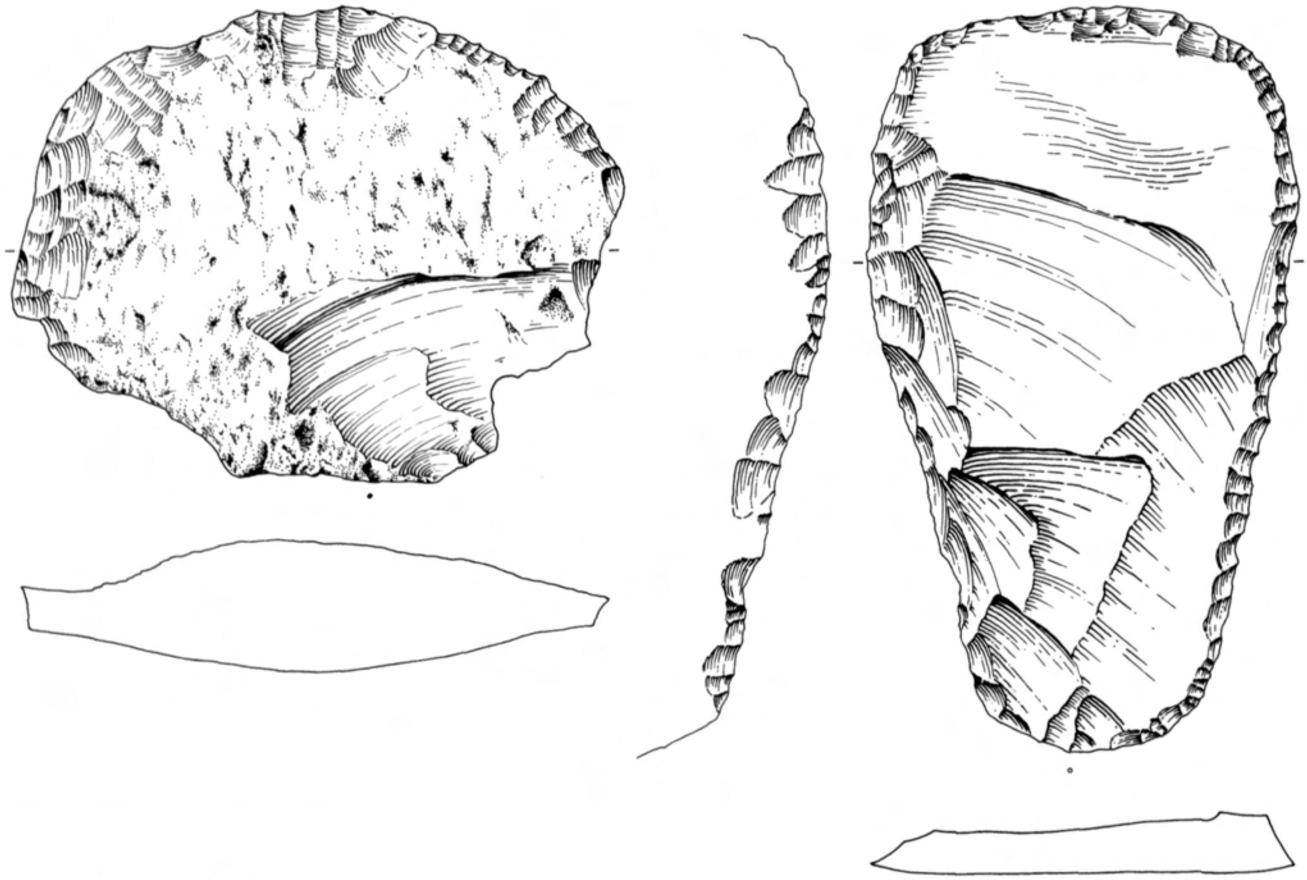

Figure 4. Stein. Flint, Scrapers. Scale 1:1.

dead. Not a single artefact shows any trace of burning. The data provided by Beckers and Beckers do not allow any statements on whether the body was burned on the spot or whether cremated bone material was deposited in the pit afterwards. The many skeletal elements present suggest a burning on the spot or in the immediate vicinity. If this truly is a case of association, the flint tools must have been added after the cremation of the body and deposited with the bone material.

This makes the association of flint and cremation questionable.

8. Interpretation

Assuming this is not a case of association, but of a grave of younger date (Iron Age) discovered next to some flint implements from the Michelsberg Culture, the flint could be settlement debris or a hoard.

The composition of the assemblage may not, however, be considered the usual Michelsberg settlement debris. After all, it is a group of complete tools and fragments, all of a high quality. In settlement areas usually a wide variation of tool types occurs, in connection with waste. This is a clearly different situation, so an interpretation as a hoard might be considered. Hoards from the Netherlands and surrounding areas appear to consist mostly of rough-outs and blanks, mainly blades, only rarely of finished tools (Harsema 1981; Louwe Kooijmans/Verhart 1990; Willms 1982). Hoards with finished tools are known almost exclusively from a ritual context. In many causewayed enclosures pits and ditches have been found where complete pots, remains of meals and flint implements had been deposited on purpose (Lüning 1967; Marolle 1990; Nickel 1992). Traces of such monuments and associated finds have, however, not been ascertained in Stein.

So at the moment we have to conclude that regarding the discovery of the flint artefacts and the cremation, called a *Robenhausien*-grave by the excavators, no unequivocal interpretation can be offered. It may be considered either a

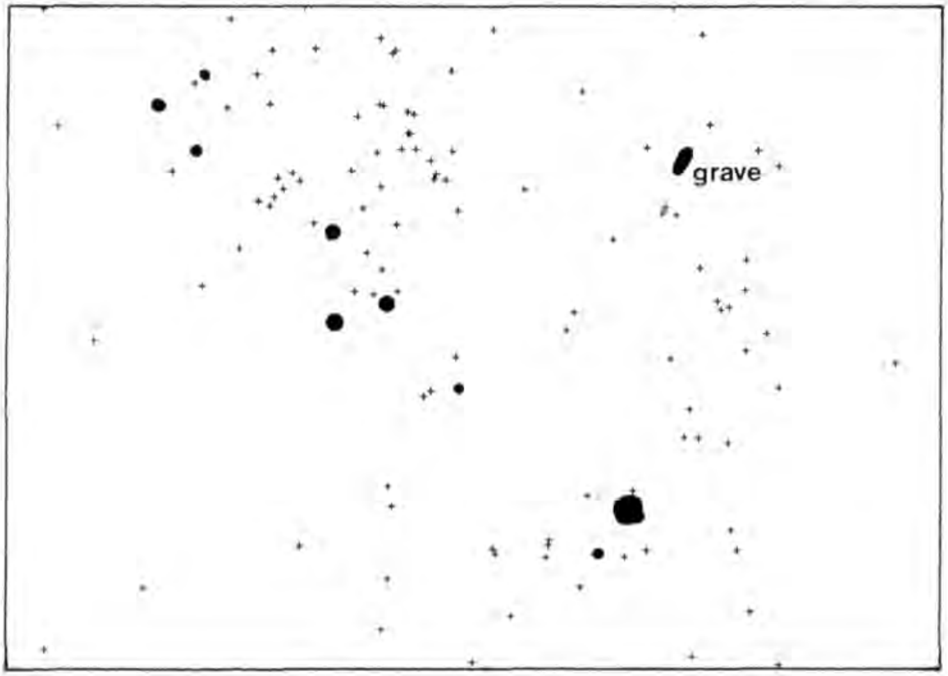

Figure 5. Sint-Odiliënberg. Distribution of pottery and flint indicated by a cross. Black are prehistoric soiltraces.

hoard or a grave. Shortly after this inconclusive investigation we excavated a cremation in a Michelsberg settlement. This find might alter our views.

9. The presumed Michelsberg grave of Sint-Odiliënberg

In the autumn of 1992 the Institute for Prehistory and the National Museum of Antiquities investigated, in cooperation with the Heemkunde Vereniging Roerstreek, a Middle Neolithic settlement near Sint-Odiliënberg (Wansleeben/Verhart 1993). During this investigation a concentration of flint and pottery was excavated overlapping an oblong cluster of post holes. Apart of these post holes a cremation without grave gifts was uncovered as well (fig. 5). Among the cremation remains a sliver of burned flint was found.

During the excavation the 30-cm thick layer of disturbed plough soil was removed mechanically. In doing this, the grave was encountered. Since the bottom was exactly at the transition between the plough soil and the undisturbed soil and the erosion at that location must have been negligible, we assume that the grave pit will not have been much deeper than approx. 35 cm.

The cremation remains were sieved with a 1-mm mesh. Besides the human bones a piece of burned flint and some bits of charcoal were collected. The cremation remains, not more than 300 grams, have been investigated forensically. The amount and size of the bone remnants are indicative of an incomplete and strongly fragmented cremation. Only a single bone fragment provides a clue to the sex. The cremation seems to belong to a female between 40 and 60 years of age.

We suspected that this might be a Michelsberg grave because of the spatial association with the excavated artefacts and the fact that during the excavation no younger (e.g. Late Bronze Age/Iron Age) cremations and artefacts had been discovered. In order to be able to make a definitive statement a piece of charcoal from the sieved cremation material has been dated. The result was, however, not in accordance with our expectations. The cremation had an age of 1980±50 uncal. BP (UtC-2640). This unexpected result can be explained in two ways. Either this really is a burial dating from the Late Iron Age/Early Roman Period or the sample is older but contaminated by humus infiltration. A factor in favour of the contamination is the complete absence Iron Age and Roman finds and the location of the cremation in the centre of distribution of Neolithic find material. The excavation results are still being processed, so as yet no final choice is possible.

10. Conclusion

The interpretation of the *Robenhausien*-grave of Stein and the cremation of Sint-Odiliënberg poses some problems. The new data about Sint-Odiliënberg only increase the uncertainty, instead of furthering a solution. Almost all options — Michelsberg grave, hoard or a combination: the casual co-occurence of a MK-hoard with a younger cremation — have their merits.

Based on the present data we prefer a cautious interpretation of the find from Stein. We assume at the same time a non-Neolithic age for the grave of Sint-Odiliënberg. The find of the *Robenhausien*-grave may be considered a hoard from the Michelsberg Period found together with a cremation. We do emphasize, however, that because of the large number of implements the hoard differs in composition from the pattern known from a Michelsberg context. The cremation most probably dates from the Iron Age and can therefore not be linked to the flint.

For the present, the question "Do we have graves of the Michelsberg Culture in the Netherlands?" should therefore be answered in the negative.

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The Meuse Valley Project: GIS and site location statistics

The application of Geographical Information Systems in Archaeology is growing fast. With this a more critical attitude towards methodological issues arises. Here the statistical ways to relate site locations to landscape attributes are evaluated and some alternatives for the commonly used Chi-square test are presented.

1. Introduction

Of late, the use of Geographical Information Systems has increased dramatically in archaeological research. In the last 4 to 5 years GIS have caught on in a big way. The number of articles about GIS, in the annual proceedings of "Computer Applications and Quantitative Methods in Archaeology" (CAA), has grown from 1 in 1986 (Harris) and 1 in 1988 (Wansleeben) through 6 in 1991 and to 16 in 1995. A few years ago no one could have imagined that this technique from the fields of physical geography, geology and remote sensing would be taken up in such a big way. With hindsight there were of course indications to explain the GIS-"boom". On the one hand there are developments in automation technology. Rapid advances in capacity and processing speed of personal computers and reductions in price have provided many people with the opportunity to process extensive geographical data. On the other hand archaeology displays several traits of a typical spatial science. The source material of archaeology consists of course of the (mobile and immobile) artefacts themselves, on the other hand the spatial distribution (context) of those sites is of equal importance.

Many European archaeologists have discovered the ease of using GIS for analysing and presenting spatial information. A growing number of specialised articles (e.g. CAA), monographs (e.g. Allen *et al.* 1990, *Interpreting space: GIS and archaeology*) and meetings (e.g. *Impact of Geographic Information Systems on Archaeology*, fall 1993, Italy) has been the result. As with most new methods, at first everybody is overjoyed. After a while, however, the drawbacks become clearer and this is happening to GIS as well. In geography, people have been critical of GIS for many years and fundamental research is done into some crucial elements of GIS. For example, to what degree do the choice of grid size and errors in the basic maps influence the end result of the analyses. In archaeology Kvamme is one of the more critical users of GIS (Kvamme 1990, 1993). In this context, Allen, Green and Zubrow were right too to conclude:

> "*In either case, we caution against the use of GIS as an end in itself. Good research and management is based on asking good* [archaeological] *questions – something GIS does not do for us.*" (Allen *et al.* 1990, 383, [text] added).

In future, more if these criticisms will probably be forthcoming. This article is an expression of the more critical attitude towards GIS.

2. GIS

The strength of GIS is to a great extent the ability to manipulate spatial information in a quick and simple way. One of the best known examples is the conversion of a map of rivers into one showing the distances to those rivers. Something almost impossible to do by hand. In archaeology, other widely used options are computing the gradient and the exposure from a digital elevation model (DEM). The origins of GIS, in geography and geology, are however still very obvious. Many options refer to the representation and analysis of areas (e.g. soils) and lines (e.g. rivers). A soil map can be compared with a geological map and a new overlay containing all combinations of legend units is easy to compile. Archaeological information, however, has a character of its own. In regional research all archaeological sites are represented as specific points. Some GIS are not really suited to represent and analyse point data. In a grid cell the frequency of sites can be recorded in an overlay, but the archaeological overlay is treated like a soil map, when trying to correlate sites with a geographical variable. The unit of observation is not the archaeological site, but the grid cell. A cell containing 3 sites would count for only one in a statistical analysis. It is typical that a separate routine had to be written, when using the popular, DOS-based GIS program Idrisi, to allow the Chi-square calculation of the relationships between archaeological sites and a geographical variable, a common procedure in archaeology. It is great that a GIS allows easy and quick manipulation of geographical data, but in archaeological research the point of the exercise is to access the relationships between sites and geography. In this article we shall examine the statistical techniques available in GIS and their usefulness for answering archaeological questions.

3. Meuse Valley Project

In the regional archaeological research into the transition from Mesolithic to Neolithic in the southeast of The Netherlands, GIS has been used almost from the start in 1986. This so-called Meuse Valley Project, attempts to trace the economic changes during this transition with the aid of changes in the settlement system (Wansleeben/Verhart 1990). We defined the settlement system as the combination of the *nature*, *distribution* and *geographical location* of sites from a specific archaeological period. A more or less random distribution pattern of almost equal Mesolithic base camps along brooks and rivers represents an economic system entirely different from clustered villages with wooden buildings, inhabited for 400 years, lying in the fertile loess soils in the first phase of the Neolithic. Next to the nature and distribution, the geographical location is an important source of information, to gain insight into the neolithisation process in the southeast of The Netherlands. Traditionally, the geographical location is investigated in archaeology using site location and site catchment analyses.

In the Meuse Valley Project research takes place on four different spatial levels. The data presented here refer to the highest, so-called macroregional level. Over an area of more than 4400 square kilometres data about almost 4000 Stone Age sites were compiled from literature and from the archaeological data bank of the State Service for Archaeological Investigations in the Netherlands (ROB). The quality of the data obtained about the sites differs widely. Still, by considering the presence or absence of guide artefacts to be a major factor in dating, many sites can be ascribed to one or several archaeological periods. In all, 8 archaeological periods could be distinguished. On the basis of the maps available (scale 1:25.000), geographical data were compiled about 7 different geographical characteristics. These data were stored in a raster-based GIS grid with unit cells of 1 square kilometre. In the past, the GIS was only used for the site location analysis of these sites on the macroregional level. At present, the spatial information on each spatial levels is stored and edited using GIS technology, and the applications are no longer confined to location analysis. However, this intensive use had also led to a more critical attitude towards GIS.

4. Site location analysis and GIS

Site location analysis is a technique describing the geographical position of sites, to detect locational preferences, if any, of a given society. This revolves around two questions. Taking for example the soil type, these are:

- Is the soil something that people took into account when deciding on the location for a settlement?

And if so:

- Which types of soils were selected?

When it is clear which geographical units were preferred, these can be correlated with certain economic activities. The economic interpretation is certainly not exclusively based on this location, but as mentioned also on the nature of the site and the presence of other sites nearby. That is why in the Meuse Valley Project the *settlement system* is the true archaeological correlate of the economy. Methodologically, it is useful to have a closer look at site location analysis and see how the two questions can be answered with the aid of GIS.

The 'standard' method to investigate the distribution of sites in relation to a geographical variable is the Chi-square test. The distribution of sites is compared to the distribution of the geographical units (tab. 1).

In this example the distribution of the sites of the first Neolithic society in the southeast of The Netherlands, the Linear Bandceramic Culture (LBK) is compared to the soil texture type (fig. 1). The Chi-square test compares the frequency of sites observed in each geographical legend unit to an expected frequency. The expected frequency is based on a random distribution pattern. Let's assume that the LBK-people were not at all interested in the soil type when choosing a location for their settlements. In that case, the 39 sites would be distributed proportionaly over the legend units. In the sandy area, comprising 57.84% of the research area, 57.84% of the 39 sites would be located (= 22.6). The Chi-square value of 91.082 indicates a significant deviation from a random distribution.

Before continuing in this vein, some points must be made in order not to complicate matters needlessly. This discussion is based on the hypothesis, not very realistic in everyday archaeological research, that the observed distribution is not caused by other factors, like postdepositional processes or investigative influences, but is solely the result of behaviour in the past. Furthermore it should be noted that the Chi-square test in this situation does not meet all statistical requirements. To recall a famous rule of dumb: *When the number of classes (k) is larger than 2, the Chi-square test may be used if fewer than 20 per cent of the cells have an expected frequency of less than 5 and if no cells have an expected frequency of less than 1* (Siegel 1956, 110). In the example given above two classes have an expected value lower than 5 and one class lower than 1. The result of the Chi-square may therefore be suspect.

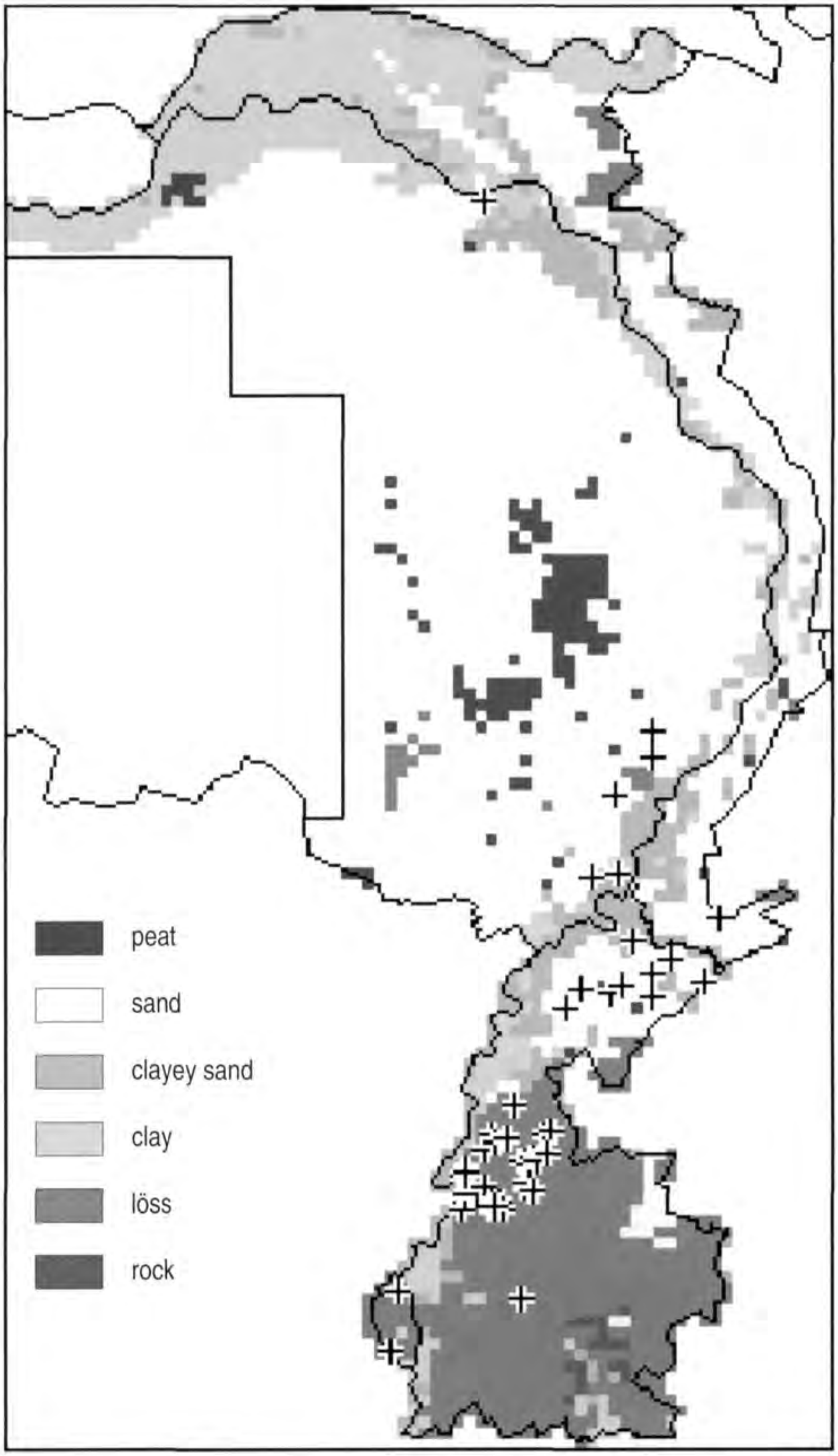

Figure 1. The spatial distribution of settlements of the Linear Bandceramic Culture in relation to the soil texture types in the southeast of The Netherlands.

Table 1. Chi-Square Goodness-of-Fit Test.

	population (texture)		sample (LBK) number of sites		
class	number of cells	proportion	observed	expected	Chi-square
peat	139	.0315	0	1.2	1.23
sand	2553	.5784	8	22.6	9.39
clayey sand	388	.0879	3	3.4	.05
clay	653	.1479	1	5.8	3.94
löss	663	.1502	27	5.9	76.30
rock	18	.0041	0	.2	.16
totals	4414	1.0000	39	39.0	91.08

Chi-Square = 91.082 d.f. = 5 $p < 0.000$

Table 2. Density and proportion of LBK sites.

class	number of cells	number of sites observed	proportion	density
peat	139	0	.0000	.000
sand	2553	8	.2051	.003
clayey sand	388	3	.0769	.008
clay	653	1	.0256	.001
löss	663	27	.6923	.041
rock	18	0	.0000	.000
totals	4414	39	1.0000	

A possible solution to this problem is applying Yates' correction of continuity (Thomas 1986). Application of this correction yields a new Chi-square of 84.771, significant in itself ($p < 0.001$). If the number of cases becomes very small, even the correction of continuity is no longer applicable. *If the number of cases is less than 20, or if the number of cases is between 20 and 40 and the smallest expected frequency is less than 5, the Fisher exact probability test should be used* (Siegel 1956, 110). Our example meets this last condition, but even then the Chi-square is significant ($p < 0.001$).

Keeping in mind these limitations, we can draw the conclusion that there clearly is a significant deviation from a random site location pattern. The LBK-people made, directly or indirectly, a whole-hearted decision in favour of certain soil types. This makes it clear that the Chi-square test can answer the first question.

To gain insight into the choice of soil types, we may look for high Chi-square values per class. These occur in this case for sand and loess and refer to too few sites on sand and too many on loess. This should lead to the archaeological conclusion that the loess was preferred and sand was avoided. However to us this conclusion poses some questions. There are still 8 sites (20.5%) located in the sand. Did these have no economic significance for the LBK-people at all? Likewise, the mean density of sites in the loess area is in an absolute sense low (0.041 sites/square km), but relatively the highest (tab. 2). Second in order is the clayey sand area with 0.008 sites/square km. In spite of the fact that the frequency observed hardly deviates from the expectation, should the conclusion be drawn that the clayey sand area was important as well? So the Chi-square test seems to present difficulties in choosing the relevant legend units and as such, to the archaeological interpretation. Still, this is almost the only way in which point locations can be analysed in GIS.

An other way to choose between legend units might be attributing relative weights to the various units. An easy to use weight is the proportion of the number of sites in a unit: 69% of the LBK-sites is located in the loess area (tab. 2).

It can be assumed that the greater the proportion, the greater the economic importance of a unit. Loess is economically the most important soil type, followed by sand, clayey sand and clay. Peat and rock did not have sufficient economic importance to be settled. In itself, this approach seems archaeologically meaningful, but it does not lead to any kind of generalisation or choice of legend units. Furthermore the information that there are far less sites in the sand area than expected is not taken into account.

An alternative is provided by Atwell and Fletcher (1985, 1987). They try to define for each class a so-called weight-factor, that can be considered as an estimate of relative importance of a geographical unit.

"*... to access the relative importance of eight environmental characteristics in the choice of cairn locations...*" (Atwell/Fletcher 1987, 2).

Assuming there are three geographical units α, β and γ, this leads to the following formulas for the weight-factors (A, B and C):

A = a'bc / (a'bc + ab'c + abc')
B = ab'c / (a'bc + ab'c + abc')
C = abc' / (a'bc + ab'c + abc')
where:
a , b , c = proportion of the geographical units α, β and γ.
a', b', c' = proportion of the number of sites in geographical units α, β and γ.

The values of A, B and C range from 0 to 1 and are 0.33 for each class in a random site distribution. In general, the expected value is 1 divided by the number of classes. The higher the weight-factor, the greater the relative importance. Referring to the LBK-example, the weight-factors are shown in table 3.

The weight-factors seems to reflect the relative importance of the legend units well. In the calculations the size of the legend unit is taken into account, comparable to the effect of that size in the Chi-square test. The large sand area receives a smaller weight-factor than the small clayey sand area, in spite of the fact that in an absolute sense, there are more sites there. The Atwell and Fletcher procedure is an improvement over the proportions in themselves, however there is still no statistically based criterion for choosing legend units.

To this end, Atwell and Fletcher (1985) propose a test: is there a significant deviation from the expected value for one or more observed weight-factors? Atwell and Fletcher use a simulation to determine the expected value. In this procedure, a random site distribution is simulated one hundred times and all weight-factors are calculated. For each simulation, the highest weight-factor is determined. In this way a distribution is obtained of the maximum weight-factor (fig. 2). With these data a threshold expected value can be determined, for example for a 5% confidence level. All observed weight-factors exceeding that threshold value are considered significant by Atwell and Fletcher (1985). These geographical units clearly were preferred for settlements. In the same way a distribution can be calculated for the minimum weight-factor. All geographical units with an observed weight-factor lower than that 5% threshold were significantly avoided.

We feel that Atwell and Fletcher are wrong to use the highest and lowest weight-factors per simulation in calculating the distributions. For each simulation, a different legend unit may show this minimum or maximum. In our opinion, a theoretical distribution should be calculated for each legend unit separately. To test this hypothesis, the LBK-example was used in a computer simulation. The experiment proved that each geographical unit did have its own theoretical distribution, very much different from the maximum or minimum (fig. 3). The shape of the distribution depends on the size of the legend unit; for small units erratic fluctuations may occur. At the same time, the shape of the distribution proved to be dependent on the total number of sites.

The procedure suggested by Atwell & Fletcher results in very conservative tests. Both preferred and avoided legend units are considered not significant too easily. Only the loess would be preferred significantly ($p = 0.003$). If our criticism of Atwell and Fletcher is valid, the judgement of the weight-factors should be adjusted. In our approach, the loess is significantly preferred ($p < 0.001$) and sand ($p = 0.013$) and clay ($p = 0.005$) are significantly avoided.

Using this procedure, a statistically based choice of relevant legend units seems feasible, answering the second question. The Atwell-Fletcher test or its modification, does not take into account the simultaneous differences for all legend units. The Chi-square test is therefore still valuable. Both procedures, Chi-square and Atwell-Fletcher, might be combined, or is there still another approach?

Especially in Cultural Resource Management it is attempted to model the distribution of archaeological sites. For a geographical variable it is decided which legend units are likely and which are unlikely to contain archaeological sites. This in order to select legend units and allow the management of the archaeological soil archive to be as efficient as possible. The decision to drop certain units almost always means that a number of sites are not included in the model. Many archaeologists feel more or less justified in doing so when most sites turn out to be included in the model and the model covers only a relatively small part of the research area. Some examples are:

"*By applying Bayes' Theorem to the model results it can be suggested that about 72 per cent of the prehistoric sites in the region should occur in 45 per cent of the available land area*" (Carmichael 1990, 222).

"*Although more than 95 percent of the known sites fall within the favourable area, this region covers only about 50 percent of the total study area, pointing to the predictive gain of this model*" (Kvamme 1989, 181).

We used this principle to define a kind of site location parameter (K_j). We feel two points should be stressed. First

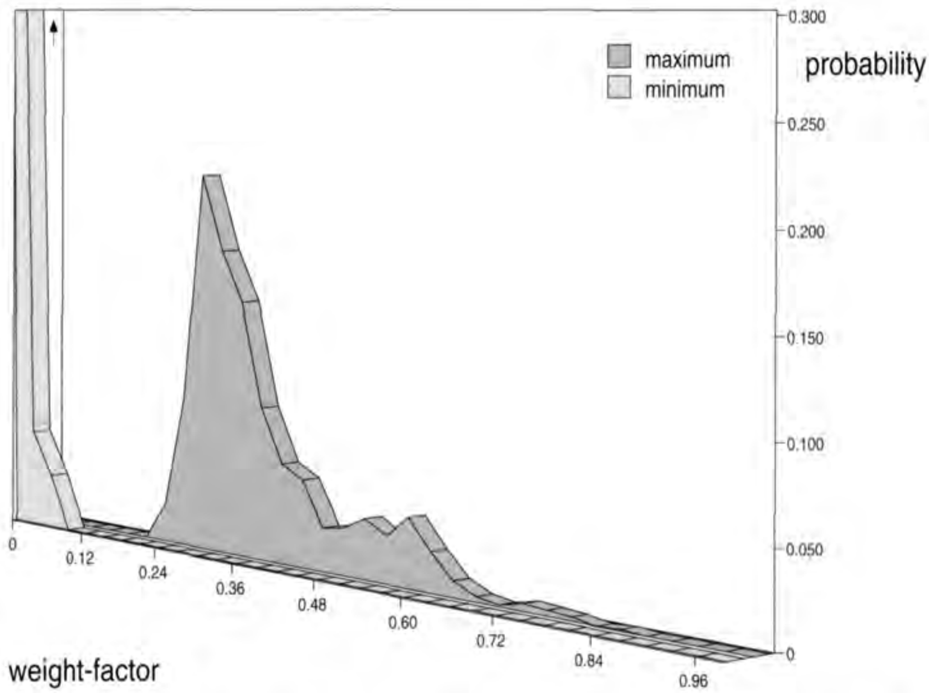

Figure 2. The distribution of the minimum and maximum values for the Atwell-Fletcher weight-factor obtained by a simulation using the data in table 1.

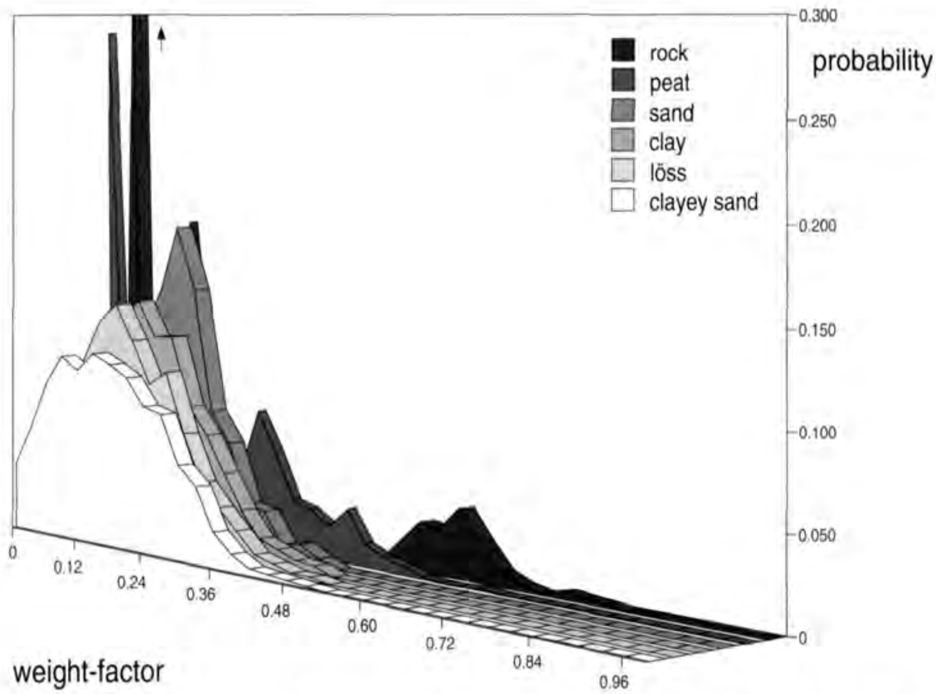

Figure 3. The distribution of the Atwell-Fletcher weight-factor for each soil texture class obtained by a simulation using the data in table 1.

Table 3. Atwell-Fletcher Weight-factors.

class	population (texture)		sample (LBK)		weight-factor
	number of cells	proportion	number of sites observed	proportion	
peat	139	.0315	0	.0000	.000
sand	2553	.5784	8	.2051	.059
clayey sand	388	.0879	3	.0769	.146
clay	653	.1479	1	.0256	.029
löss	663	.1502	27	.6923	.767
rock	18	.0041	0	.0000	.000
totals	4414	1.0000	39	1.0000	1.000

Expected value of Weight-factor: 0.167

Table 4. Site Location Parameter K_j

class	population (texture)		sample (LBK)		highest K_j	(after step)
	number of cells	proportion	number of sites observed	proportion		
peat	139	.0315	0	.0000	.622	(4)
sand	2553	.5784	8	.2051	.393	(6)
clayey sand	388	.0879	3	.0769	.641	(2) ←max
clay	653	.1479	1	.0256	.572	(5)
löss	663	.1502	27	.6923	.615	(1)
rock	18	.0041	0	.0000	.639	(3)
totals	4414	1.0000	39	1.0000		

of all the proportion of sites included in the model (p_s) is incorporated into the parameter. A model including all sites (p_s=1.00) is better than one where only a small percentage of the sites is represented. Secondly, the difference between the proportion of sites (p_s) and the proportion of the research area (p_a) is an important factor in this parameter. This difference (p_s-p_a) indicates the relative gain of the model. In a valuable model this difference is large. Kvamme's example yields a relative gain of 0.45 (0.95 minus 0.50). A small difference on the other hand indicates a low predictive value of the model.

Both factors, p_s and p_s-p_a, should be as high as possible. In the case where an entire research area is included in the model, the value of p_s equals 1.00, but since p_a=1.00 as well, there is no relative gain at all (p_s-p_a=0.00). Therefore the model has hardly any predictive value, and the parameter K_j should have a low value. Arithmetically this can be achived by using the product of the two factors. Multiplication of 2 ratios however yields a distribution with an underrepresentation of the higher values, hence the decision to use the root of the product.

A formula for the location choice parameter K_j could be as follows:

$$K_j = \sqrt{[p_s * (p_s - p_a)]}$$

One more refinement is necessary: theoretically, the maximum value of p_s is 1.00. However, the maximum difference between p_s and p_a does not equal 1.00, therefore both factors do not contribute equally to K_j. The maximum difference depends on the degree to which the sites are clustered in the research area. Let us assume that 5 sites are located in 4 cells of a research area of 16 square kilometres (fig. 4). A perfect model comprises the 4 cells with sites (p_s = 1.00). The differences p_s-p_a is however only 1.00 - 0.25 = 0.75. This value equals the proportion of the area without sites. The difference is corrected for the degree of clustering of the sites. To do so, p_s-p_a is divided by the proportion of the research area containing no sites (p_w). In this example, 12 of the 16 cells contain no sites (p_w=0.75). The corrected value $(p_s-p_a)/p_w$ rises to 1.00. Both factors now have the same maximum and the maximum of K_j equals 1.00 as well. In formula, K_j is now defined as:

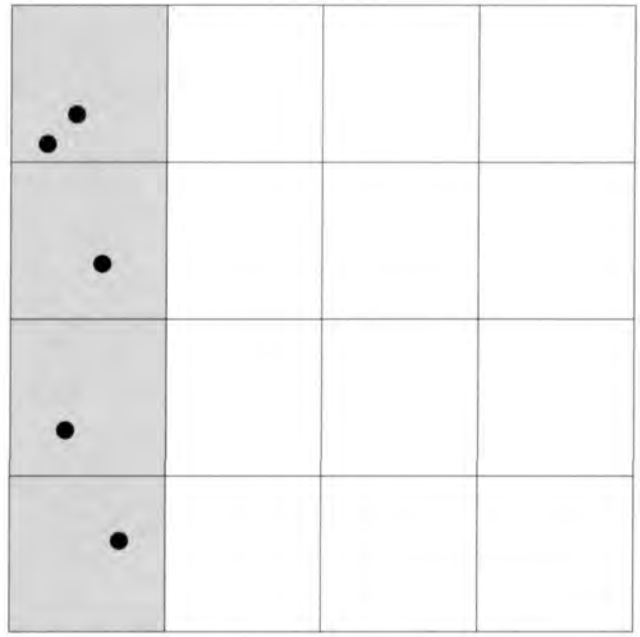

Figure 4. The maximum predictive gain of a model depends on the degree to which the sites are clustered. For the best possible model (shaded area) the value of p_s-p_a is only 0.75.

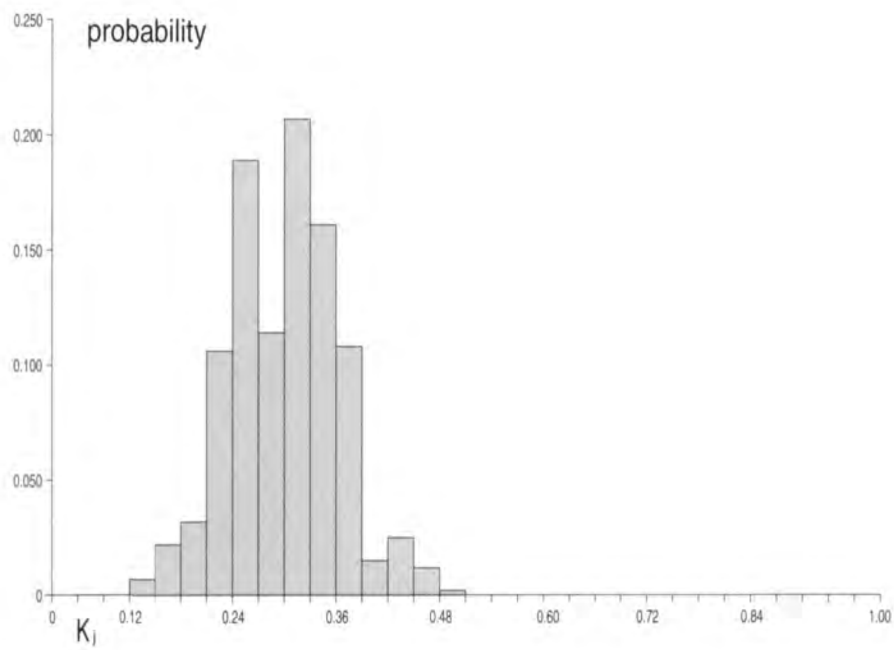

Figure 5. The distribution of the K_j values obtained by a simulation using the data in table 1.

$$K_j = \sqrt{[p_s * \frac{p_s - p_a}{p_w}]}$$

where:
The average site density is less then 1 per unit cell
p_s = the proportion of the sites incorporated in the model
p_a = the proportion of de area incorporated in the model
p_w = the proportion of the area without archaeological sites

To calculate K_j let us once again return to the LBK-people and the soil types. First of all (step 1), for each legend unit the K_j value is calculated. If the proportion of sites is lower than the proportion of the area (cells), K_j is not applicable. In that case, the value of p_s-p_a is negative and the root can not be extracted. This situation will however only occur in the calculations of the first step.

The highest value at this first step, as marked with (1) in table 4, is found with loess (K_j=0.615). By including only all loess cells in the model and leaving out all other units, 69.2% of the sites are already included in a model covering only 15.0% of the research area (relative gain: 54.2%). The logical next question is: can the K_j value be improved by adding one or more legend units? New calculations (step 2) are made for each combination of loess with the other geographical units. This makes it clear that the model can at best be improved by adding the clayey sand soils (highest value of K_j after step 2: 0.641). The relative gain of the model is somewhat smaller (53.1%), but the proportion of sites added to the model (7.7%) makes amply up for that loss. To our minds, this is a better model then the previous one. Adding another legend unit results in a deterioration of the model (highest value of K_j after step 3, adding rock: 0.639). The best model has already been obtained after the second step. When only the loess and clayey sand soils are included (23.8% of the research area), 76.9 % of the sites are represented anyway.

Calculating K_j is a continuous addition of a single unit to an existing model. Strictly, the process could be stop when there is no longer any improvement in K_j. The geographical units included in the model may be considered the areas that the LBK-people preferred. Calculation of the K_j value does not shed any light on the avoided geographical units.

It is possible to test whether the value found for K_j deviates significantly from the value obtained when there is absolutely no preference for a geographical variable. In that case the value of K_j should be 0.00, but there are always accidental variations. One thousand times a random site distribution over the given legend units has been simulated. Every time the K_j value has been calculated. The distribution obtained in this way (fig. 5) gives an idea how reliable the observed result is. The shape of this distribution proved to vary with the number of legend units and the total number of sites. There is a significance of less than 0.001 for the observed K_j value of the LBK-sites in relation to the soil type. So it seems that the LBK-people did take the soil into account when deciding on the location of a settlement. Not only was the loess of major importance, but beyond that the clayey sand soils seem to have been attractive as well.

So, the site location parameter K_j can be used both for testing the importance of a geographic variable (first question) as for highlighting the most important legend units (second question). However, it does not uncover which units were significantly avoided.

5. Conclusions

In almost all Geographic Information Systems the emphasis is on ways to manipulate and present geographical information. This is easily explained by the geographical origin of GIS. There is only a very limited supply of the kind of statistical procedures that are of paramount importance to archaeologists: those that test the relationship between point data (sites) and the landscape. Some GIS do still not offer the possibility to treat the sites as a unit of observation, but results are always based on cells.

Fortunately in most GIS a Chi-square test is available. The Chi-square test is the most common way to investigate the relationship between sites and terrain characteristics, but it has its limitations both methodologically and theoretically. Alternatives are almost never available in GIS. Both the (modified) Atwell-Fletcher test and the newly proposed site location parameter K_j may be useful in site location analyses. Probably, both will not perform well under all circumstances, but they do offer the opportunity to look at the same data in a way different from the Chi-square test.

The limitations due to the article size prevent us from a discussion of other problems connected with site location analysis. To name but three. First of all, how can the mentioned tests be applied to non-nominal variables, as e.g. altitude, gradient and other geographical interval or ratio data? Is the regularly used Kolmogorov-Smirnov one-sample test (D) an archaeologically useful alternative? Secondly the choice between a univariate and multivariate approach is an important methodological decision, deserving elaboration. And in the third place in the examples provided here the entire research area has been included in the analysis. This implies the assumption that there is not a single archaeological site in the empty cells. In practice, however, there may be lots of reasons for the lack of sites in no way connected to the habitation in the past. How to take this into account in a site location analysis is a problem on its own. In the Meuse Valley Project a pilot study is run to look at these and other methodological problems and decisions. The choice of statistical test as discussed here is one of the problems being investigated.

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Donk Dissection: spatial attribution through reprojection of Hazendonk Unit C

The purpose of this study was the development and successful implementation of spatial analysis through reprojection. The method was devised to cope with an orientational problem of a coordinate system used at the excavations of the Hazendonk, a Neolithic site in the western Netherlands. Misalignment of the axes (related to the most important find complex), combined with lacking lithological layer attribution of the finds in situ made dissecting the artefact clusters into archaeologically relevant units impossible, shielding a potentially rich database from further investigation.

Ultimately, through three dimensional modelling based on lithological interpretations of stratigraphy a correction factor was found to rotate the original coordinate axes, dispensing with one dimension in the process. The remaining two made correct cross section views of the artefact clusters possible, as well as relating them to stratigraphic features and each other. Thus distinct concentrations of artefacts could finally be identified and related to archaeologically defined culture phases.

1. Geomorphology

If archaeological aspects of prehistoric settlement in the western Netherlands are to be examined, the interpretation of the geomorphological development of the landscape is often essential, for few regions in Western Europe have undergone as many changes in their natural environment during the post-Pleistocene era (Louwe Kooijmans 1974). Nearly half the deposits covering the Dutch landscape date from the Holocene (Hageman 1969; Zagwijn 1986), often carried to the region by large rivers. Rhine, Meuse, and Scheldt spread out in the flatlands to form a delta, creating an irregular triangle with its apex near Nijmegen and its base along the Dutch coastline (Louwe Kooijmans 1987). Between the eastern river clay area and the western sea clay area extensive peat bogs, formed during the Atlantic, remained relatively undisturbed through much of the Holocene. Particularly the southern half of this area (the Alblasserwaard) always remained a tidalfree freshwater environment (Van der Woude 1981). This wetland region was doubtless rich in wildlife and easily accessible over water.

When Neolithic man came to hunt, fish and gather, he sought a dry refuge to venture from into the wilds, to use as a seasonal hunting basecamp or even for permanent inhabitation. He settled on *donken*, the surfacing tops of riverdunes (Verbraeck 1974). These dunes were formed in the dried out riverbeds of the Rhine and Meuse rivers, as a result of aeolic deposition of river channel sands. This deposition took place up until the Boreal, when the younger sediments of peat and clay started covering the sides under the influence of the rising waterlevel. When further aeolic sedimentation was prevented by the increasing wetness of the river valley the dunes became a fossilised part of the landscape. The post-Boreal sedimentation sequence was characterised by a succession of peat formation and clastic sedimentation by lakes and creeks (Louwe Kooijmans 1982; van der Woude 1981).

Though the base of the prehistoric settlements was presumably made on the dry top, former living areas extended downslope and into the surrounding sedimentation zone. There surfaces and refuse concentrations are well preserved in and between the Holocene deposits covering the slopes. (Louwe Kooijmans 1982).

The *Hazendonk* had good prospects to become an interesting archaeological site. Sedimentation had covered occupational refuse soon after deposition. Up to ten meters of Holocene peat deposits right next to the donk created favourable conditions for palynological research (Louwe Kooijmans 1980). In addition, the Hazendonk is both small and isolated, resulting in densely concentrated artefact scatters.

2. Excavation

After amateur finds and test excavations had indicated repeated human influence in the immediate vicinity of the donk, a more thorough, large scale investigation took place during three campaigns of the National Museum of Antiquities under Dr. Louwe Kooijmans in the period 1974-1976. Both the dune top and the slopes were tested for Neolithic artefacts in an effort to establish the nature and extent of the different settlement phases. The excavation eventually yielded over 30,000 finds, which were plotted in three dimensions. In view of the extension of the site, the amount of refuse, the thickness of the archaeological layers and the typological variation of the pottery, seven culture phases were postulated, ranging from Hazendonk 1, 2 and 3 through Vlaardingen 1a, 1b and 2b to Bell Beaker (Louwe Kooijmans 1976). See the Rommertsdonk-article of M. Verbruggen in this volume for the latest postulated calibrated radiocarbon datings of these archaeological layers and a map of the Hazendonk region.

The most important location was the pit complex known as Unit C; ten pits on the eastern tip of the donk. There traces of no fewer than five of the seven postulated culture phases (Hazendonk 1, 2 and 3, and Vlaardingen 1a and 1b) had been found in dense scatters covering several pits. This location became the foundation for the chronological sequence of regional culture phases.

Unfortunately a serious problem related to Unit C had arisen during excavation. The Hazendonk's roughly elliptical body is oriented NE-SW, with steep slopes on the northeastern side and a long stretching, southwest pointing tail. Taking into account that all pits had to be relative to one grid, the orientation of the axes of the coordinate system followed the elongated sandbody, to keep as many pits as possible oriented perpendicular to the slope contours. It was believed existing computer technology would be able to solve any orientational problems of pit locations suffering from shifted axis perspectives. This potentiality soon became reality. Following Murphy's Law, the cross section (or downslope) angle of Unit C — the most important find complex — was located almost precisely in between the two axis angles. No matter which of the two axes was disregarded, looking at Unit C from the south or the east created a serious distortion as the clay and archaeological layers followed gravity's commandment down the slope and into the peat, whilst the axes continued to follow the compass. To make matters worse, the artefacts had not been given stratigraphic attribution codes *in situ*, which would have enabled the separation of the different archaeological layers even without downslope cross section slice views. After the last excavation season, high hopes of computer capabilities remained unfulfilled, as the moloch database sullenly defied further analysis. After many attempts to correct the distortion the project was laid to rest, waiting for more advanced techniques and technology.

3. Methodology

In 1989 the current Hazendonk research got under way to solve this problem. The investigations can be divided in two unequal parts. During the first phase, the rough data were extracted from the old storage media, chopped up into separate variables and stored in databases. Preliminary statistics were performed to get to grips with the problem. Finally a strategy was devised to deal with the spatial problem using modelling and mathematics. The aim was to link stratigraphy to artefact scatters, to enable establishment of position of all artefacts relative to each other and to relevant layers. Thus, a spatially interpreted layer attribution would be given to each artefact after the fact (that is, excavation), based on density differences.

To this end all finds would have to be reprojected onto a new axis running downslope at the designated location, combining the coordinates of the older EW and NS grid system. This involved three distinct stages:

1. the reconstruction of the relevant stratigraphy to define the correct reprojection angle;
2. the reprojection itself;
3. the analysis of the results, leading to attribution of all artefacts to larger spatial units.

4. Reconstruction

The first step involved the physical reconstruction of the stable donk substratum. The existing datasets could obviously not provide significant information about the subsoil; not only were they part of a different matrix, 'hovering' above the dune; their spatial relationships were also the ultimate goal of the enterprise, and including them in the first step of the solution would create a circular argument. Donk data therefore had to be independent of archaeological interpretations. Two other sources provided the required information. Part of the documentation of a geological survey of the site executed in 1976 still existed, and the lithological descriptions of 102 borings were among the material, as was a map of their positions. These locations were digitised in AUTOCAD and stored in a database with their respective depths of the donk sand. The second source of donk data was even more concentrated around the pit complex; these depths were obtained by measurements taken from the pit profile drawings.

The next segment of the process involved the translation of these (484) donk depths into a regularly spaced grid model of the dune surface. This was achieved with the SURFER software package using kriging, which assumes an underlying linear variogram. An area measuring 30 by 30 meters around Unit C was selected for reconstruction (fig. 1). Due to the limitations of the program the generation of an acceptable representation took up a lot of time and made the initially desired resolution of 10 × 10 cm for each grid cell impossible. Nevertheless, 20 × 20 cm still seemed dense enough to represent the peculiarities of a landscape area of 900 m^2. One aspect of this analysis was the interdependence of control values from borings and profiles; neither could independently provide enough information about the contours of the sandbody, although the boring rays did an over all better job than the (densely spaced) profiles. Used in conjunction they yielded 22,500

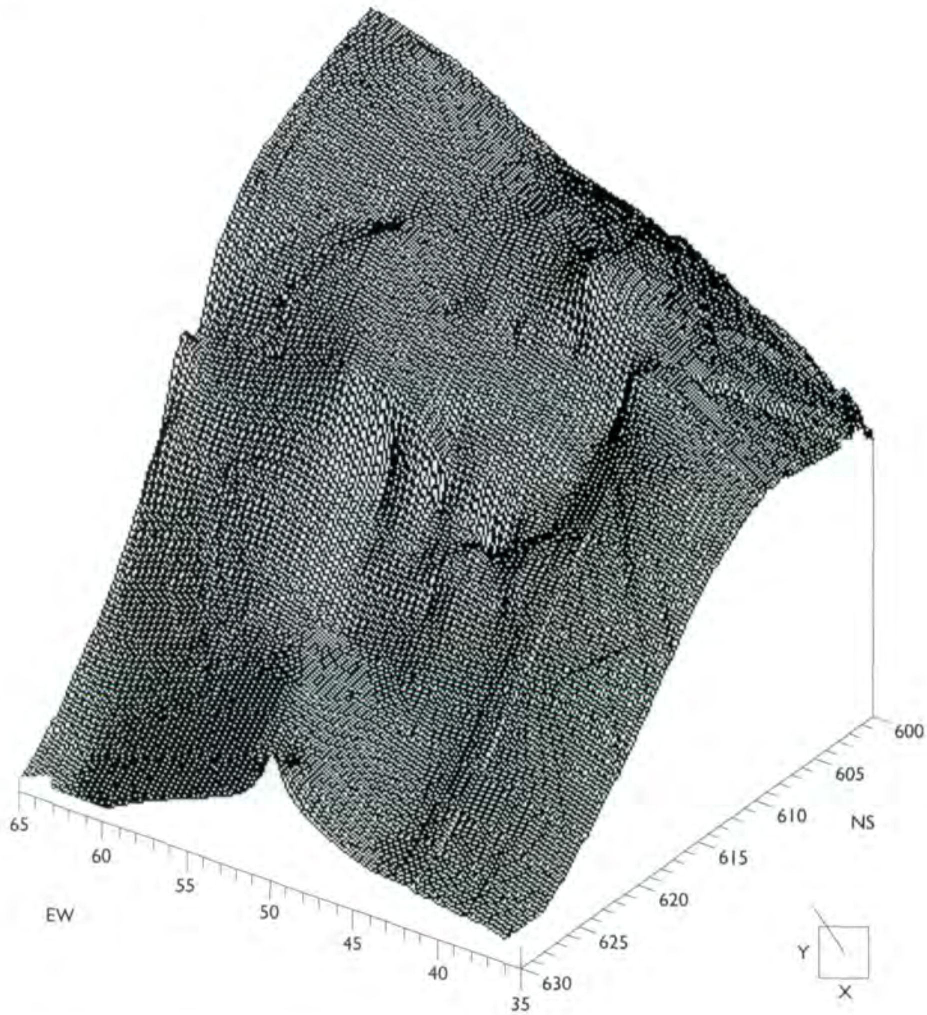

Figure 1. Orthographic projection of Unit C and vicinity (30 × 30 m).

calculated, regularly spaced heights as well as visual interpretations (such as figure 1). Unfortunately, the output of SURFER did not abide by the rules of standard exchange formats, so a separate program (named RECALC) was written to reshape the results into a structured database of three coordinates. This completed the first phase.

5. Reprojection

The second, reprojection stage can itself be split in two parts: the determination of the slope of the slicing function, and the actual reprojection itself.

The first part of the second phase was given substance in another custom made program (REGRES). When given a set of coordinates and a height interval, it would locate the depth of the donk sand at that position on the grid map generated with SURFER. Then it would proceed by searching all nearest points, of which the donk depth was a given multiple of the height interval above and below the central point. These locations were subsequently stored in a separate database. This implied that from each contourline the point nearest to the given location was found and stored (after which the process was repeated with other central locations). These data points were then submitted to simple linear regression analysis in SAS (a statistical analysis software package), resulting in a number of slicing functions through Unit C, perpendicular to the contour lines of the donk. Several functions were finally combined into one averaged function (fig. 2).

Because the slope difference (or angle relative to an axis) between the most diverging functions was relatively small, the local distortions on the fringes of the pit complex resulting from the use of only one averaged function were minimal. In addition, using only one function to reproject all data points had advantages for later software

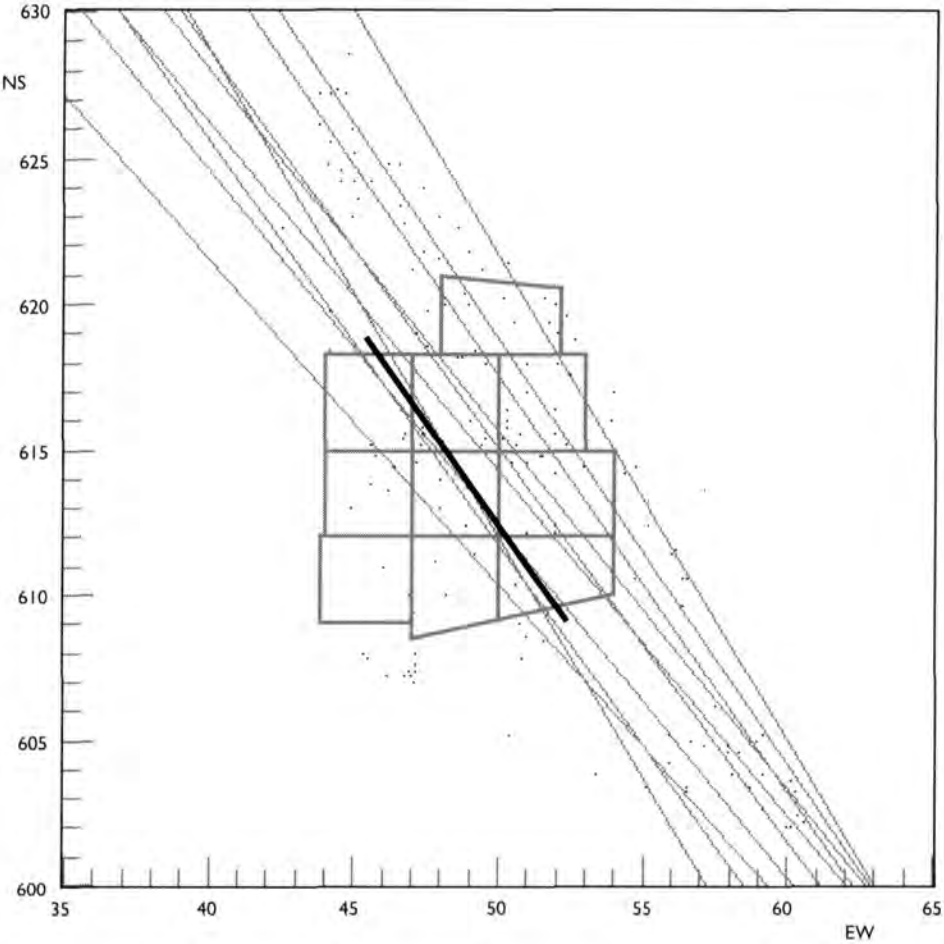

Figure 2. Sample points and regression functions through Unit C. The thick line in the middle is formed by all reprojected (artefact) datapoints together.

implementation. Last but not least, the use of multiple functions fanning out downslope would give rise to a coverage problem; where near to each other, several functions could lay claim to the same data point at a given distance from the function, but far from the top the vectors would be much farther apart. This could create holes in the coverage of data points, and would certainly cause artefact density to drop downslope. For these three reasons only one function was used for all artefacts.

The second step of phase two involved the actual reprojection. Once again this task was performed by a tailor made program (PRO). It involved a dimension reduction; the Cartesian EW-NS grid had to be reduced to one axis. The third, vertical dimension would become the second axis in the reprojection plane. This was achieved by using known artefact data and applying general trigonometric principles (Ayres 1954). Thus for each artefact were recorded (A) its 'plotted' location on the regression function through Unit C, relative to a new origin, and (B) the absolute distance between the data point and its reprojected equivalent. This allowed the artefacts to be ordered from the extreme south northward and made user defined slices of varying density possible, by which the touching and overlap of different spatial units could be controlled. At every position a balance could be struck between the minimum number of points necessary to identify the extent of the visible units, and the maximum Z difference not yet resulting in the mixing of clusters. Since density was relatively uniform throughout Unit C, slices of a fixed number of artefacts could be used throughout the complex, excepting the outer limits (where the number of artefacts notably decreased) and one area where a collapsed profile had created a large gap in the stratigraphy.

6. Dissection

These slices where visualised in the third stage of the investigation using MOLE, another member of the family of software tools developed for the Hazendonk project. It combined graphic displays of reprojected artefacts and the donk subsoil, a dynamic flow analysis, a digitiser to define layer boundaries and a data interface to link output to SURFER.

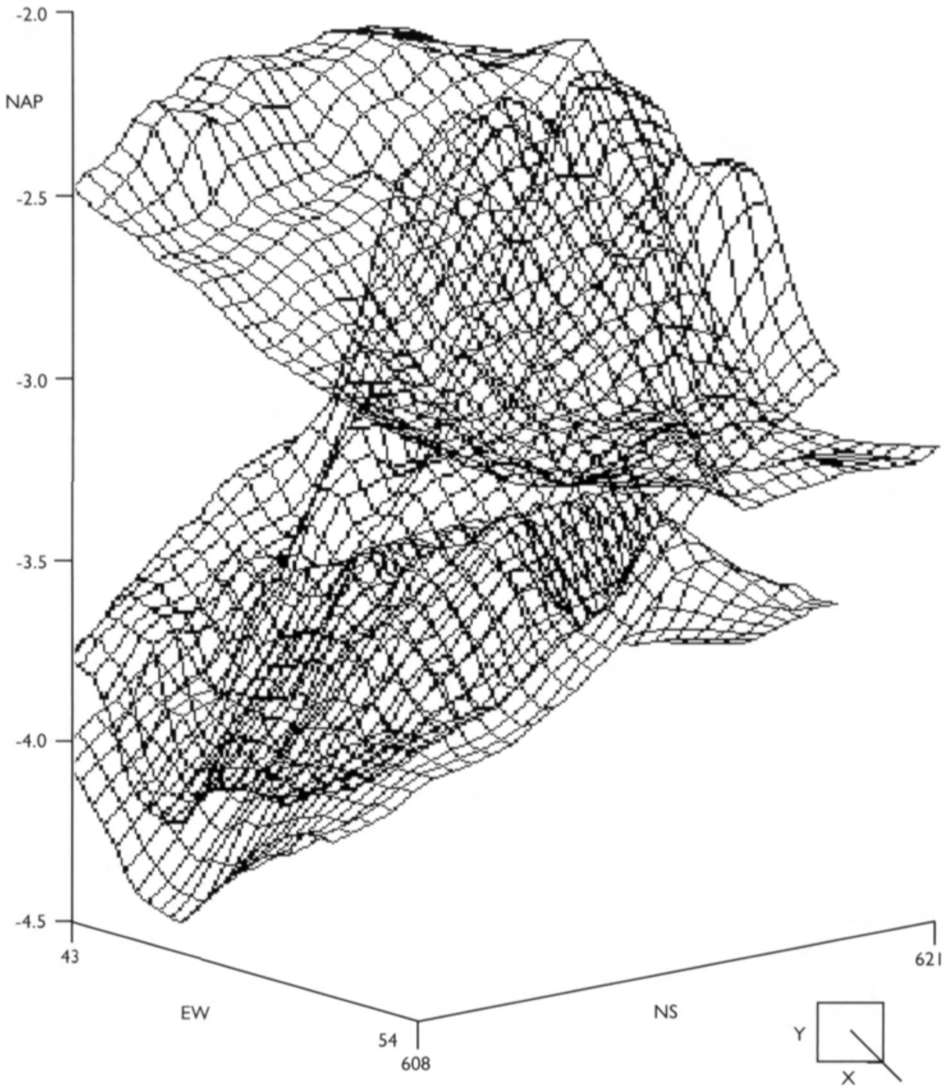

Figure 3. Abstracted orthographic impression of the separator gridnets.

On first examination, the deep southern part of Unit C contained three or possibly four layers (Hazendonk 1, 2, 3, and Vlaardingen 1b), of which the deepest two gradually disappeared when the section was shifted northward. Of the three or four scatters, the second highest (Hazendonk 3) was at places the best defined, clearly separated from the artefacts below and above it. These sterile strata in between provided the key to translating the visual impression into spatial attribution through SURFER. So far, grids generated by SURFER had always represented parts of the landscape. Their similarity to fishing nets, however, helped to inspire a new usage (fig. 3).

If a sufficient number of three dimensional coordinates in the sterile layers between the artefact clusters could be extracted from the MOLE views, these control values could function as hooks to hang a gridnet from, taking the place of the sterile stratum. If the mesh was small enough, a handy fisherman should be able to catch all artefacts swimming above or below the grid. When taken one step further, a system of several nets hovering at different depths simultaneously, could likewise separate all artefacts in one major haul, simply by establishing each artefact's vertical position relative to the different gridnets. This was accomplished with the FISHER program.

Using MOLE's digitiser module reduced the definition of boundary planes to less than an hour's work. Hundreds of points were stored, SURFER calculated dense nets, the program RECALC turned them into databases, which were loaded and combined with the artefact database in FISHER. Of course reality was slightly more complicated. No matter how small the mesh, always there would be dozens of data points, with ostensibly the wrong spatial attribution. When

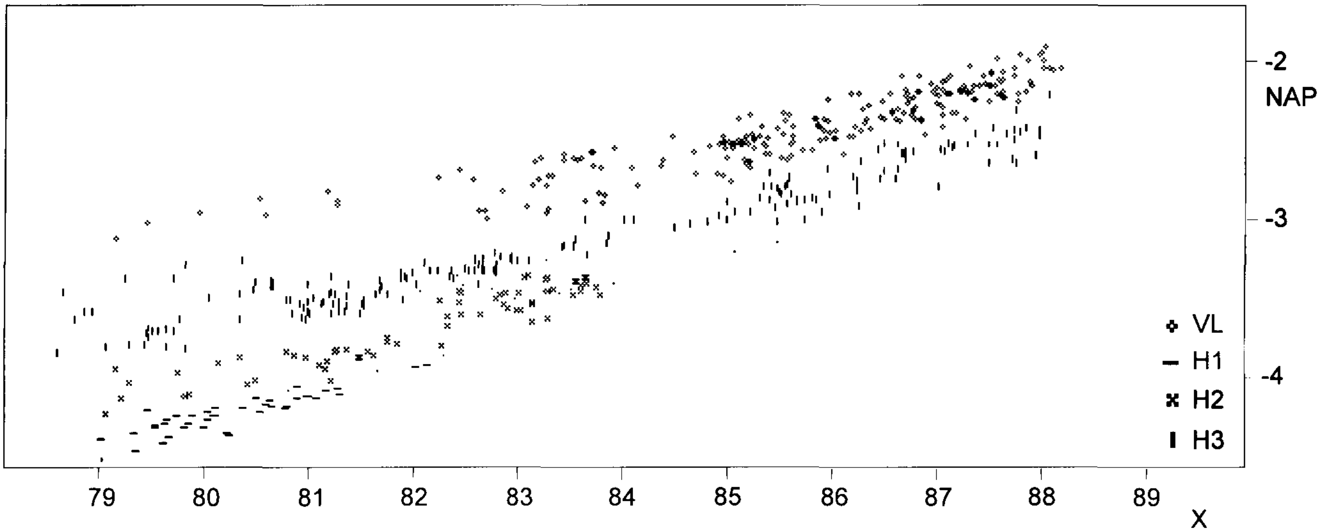

Figure 4. The result of reprojection; a clearly separated Hazendonk 3 level. Above it hovers Vlaardingen material; below two older strata (Hazendonk 1 and 2) can be distinguished. The small dots denote "inbetweens".

seen as the first artefact of a slice, such a point would seem to belong to one cluster, but if the slice was shifted far enough to make it the last one (as hundreds of new points had been plotted on one side and as many had been erased on the other), it would clearly seem to belong to another cluster. This was mostly due to the vertical variation of the different layers. Broadening the slice could not clarify the attribution either; the disputed location then became part of a vague, dense zone of overlap, where even more points seemed wrongly attributed. A satisfactory solution to this problem was not found. In the end 158 (of a total of 6671) datapoints were given separate spatial codes, designating them as inbetweens. This was done by individual encoding of the questionable artefacts (a separate feature of MOLE).

7. Attribution

Although the process was relatively successful, the important question remained to what extent the perceived density differences truly represented local minimums ('sterile' zones, separating different archaeological layers). This was especially pressing in the deep south of Unit C, where a large cluster could be interpreted as consisting of two smaller ones (Hazendonk 1 and 2). Only after detailed density analysis could a local minimum be established, although extremely weak and subsequently difficult to detect. Thus, these two earliest Hazendonk phases were finally (spatially) appreciated as separate density scatters. To what extent the weakness of the separation will lead to a review of the distinction between Hazendonk 1 and 2, which in pottery typology is also rather vaguely distinguished, remains an open question. (Once again I refer to M. Verbruggen's article on the Rommertsdonk, where a more comprehensive analysis of the phasing of these archaeological layers is given in the broader context of donk inhabitation throughout the Alblasserwaard.) The other two strata were labelled Hazendonk 3 and VLaardingen-1b, based on earlier radiocarbon datings, pollen diagrams and typology. No separate Vlaardingen-1a layer could be spatially identified.

When the results of MOLE were deemed satisfactory, another program (BIRD) was written. In internal structure it closely resembled MOLE, but instead of a subterranean view, the old EW-NS grid was resuscitated to generate a bird's eye view of Unit C. Data points were sorted by depth (variable NAP), creating horizontal section views of specified thickness. BIRD also identified another few points with obvious incorrect coordinates, and had the option of showing all artefacts of a selected spatial code. This completed the last stage of the analysis (fig. 4).

8. Discussion

In evaluating the above, a few concluding remarks can be made. The method is only indirectly connected to archaeology. This is both its forte and its weakness. Omitting most earlier interpretations from the analysis (based on stratigraphical and typological characteristics) adds strength to the claims of independent results, but at the same time loses the foundations of a firmly established scientific discipline. A functional approach of the site, incorporating assumptions regarding activity areas (based on specific artefact context) might have yielded better spatially defined units, with a more vivid human component as well. Further typological evidence from related sites could possibly also provide a less sterile picture of regional culture complexes. Subsistence models based on palynological evidence and landscape reconstruction likewise present a vision, whereas this technique only creates a (slightly different) view.

But although the method under review may be limited and lacking something in human interest, it did succeed within the confines of the spatial interpretation. Stratigraphic data were used to build a model, which yielded the desired slope coefficient information. The reprojection itself was successful, and the custom made programs performed adequately to render hitherto unseen (virtual) subterranean images. The angle correction also resulted in distinct, spatially defined artefact clusters, to which over 97% of the data points could be attributed. When combined with knowledge from related disciplines (notably archaeology, paleo-ecology and geology), these scatters can be dated and culturally attributed, thus rendering information on artefact assemblages representative of the phases under investigation.

So finally, over a decade after the end of the initial excavations, the Hazendonk datasets have become available for further analysis, enabling comparison of the spatially defined scatters to artefact clusters from other, similar sites in the region. At long last, computer technology is catching up with expectations raised years ago.

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Geoarchaeological prospection of the Rommertsdonk

The river dune district in the western part of the river area in the Netherlands is an area of high archaeological potential. A prospection method by means of gouge-auger borings proved to be very successful in the discovery of four middle neolithic refuse layers on the Rommertsdonk, a river dune in the vicinity of the Hazendonk. This method permits a proper evaluation of the representativeness of the Hazendonk occupation chronology.

1. Introduction

1.1. An archaeological problem

To create a picture of the early and middle Neolithic human occupation of the Holocene sedimentation area of the western and central Netherlands, only three sites are at our disposal. The sites concerned, Swifterbant, Hazendonk and Bergschenhoek, were all excavated more than 15 years ago. Since then attention has focused mainly on the interpretation of the archaeological, zoological, paleobotanical and geological data of the sites. No serious attempts have been made to solve the crucial problem of how to increase the number of sites for a period lasting as long as two thousand years in an area covering as much as 40% of the surface of the Netherlands!

The Rhine-Meuse delta, is an area of high archaeological potential. The excavation of the Hazendonk (Louwe Kooijmans 1987), a neolithic site located on a river dune surrounded by extensive peatbogs, yielded as many as seven occupational phases between 5300 and 3750 BP. Large quantities of domestic refuse were found in layers starting on the dune slope extending for 10 m into the surrounding peat. The large number of occupational phases on the dune is attributed to its function as a high and dry base for gathering, hunting and fishing in the surrouding wetlands.

However, the Hazendonk is not the only high and dry place in the Rhine-Meuse delta east of the coastal barriers. More than a hundred river dunes (Verbraeck *et al.* 1974; Verbruggen in prep) have been discovered, every one of them with the same archaeological potential as the Hazendonk.

Keeping this large number of potential sites in mind, the representativeness of the Hazendonk is under discussion. In order to decide whether the Hazendonk chronology can serve as a model for early and middle Neolithic occupation of the Rhine-Meuse delta, new sites are urgently needed.

1.2. The geoarchaeological approach to the problem

In 1990 the Institute of Prehistory of Leiden University initiated the Donkenproject in order to verify the representativeness of the Hazendonk occupational chronology.

At least 20 river dunes west of Geldermalsen will be investigated for Neolithic occupation by means of handborings. During the excavation of the Hazendonk in 1976 the use of a gouge with a diameter of 3 cm proved to be very successful for following the refuse layers stratigraphically (Van Dijk *et al.* 1991). It will be clear from the diameter of the gouge that one can not rely on the chances of boring-up the finds themselves. However, pieces of charcoal of various sizes, charred bone often smaller than a pin-head and dune sand could easily be recognised in the peat layers. Especially the contrasting colours facilitated the recognition of the find-layers, the deep black of the charcoal and bright white of the bone in a matrix of brown peat. The experience gained by more than 400 borings along the borders of the Hazendonk laid the foundation of the Donkenproject.

The Rommertsdonk is only one of 20 investigated river dunes. It was selected for further research because of its proximity to the Hazendonk. It is located only 600 m away, facilitating a comparison of their occupational chronologies

1.3. Geological context

The Rommertsdonk is a small river dune situated in the centre of the peat district (see fig. 1). Several authors look upon this district as the central part of the Rhine-Meuse delta extending from Nijmegen in the east to the coastline in the west (Van Dijk *et al.* 1991; Louwe Kooijmans 1987; Törnqvist *et al.* 1993). Others (Hageman 1969; Zagwijn 1986) avoid the term delta and emphasize that the accumulation of peat and clay "took place under the direct influence of the relative sealevel movements but where marine or brackish sediments themselves are absent" (Hageman 1969, 377). The Rhine-Meuse delta is strictly

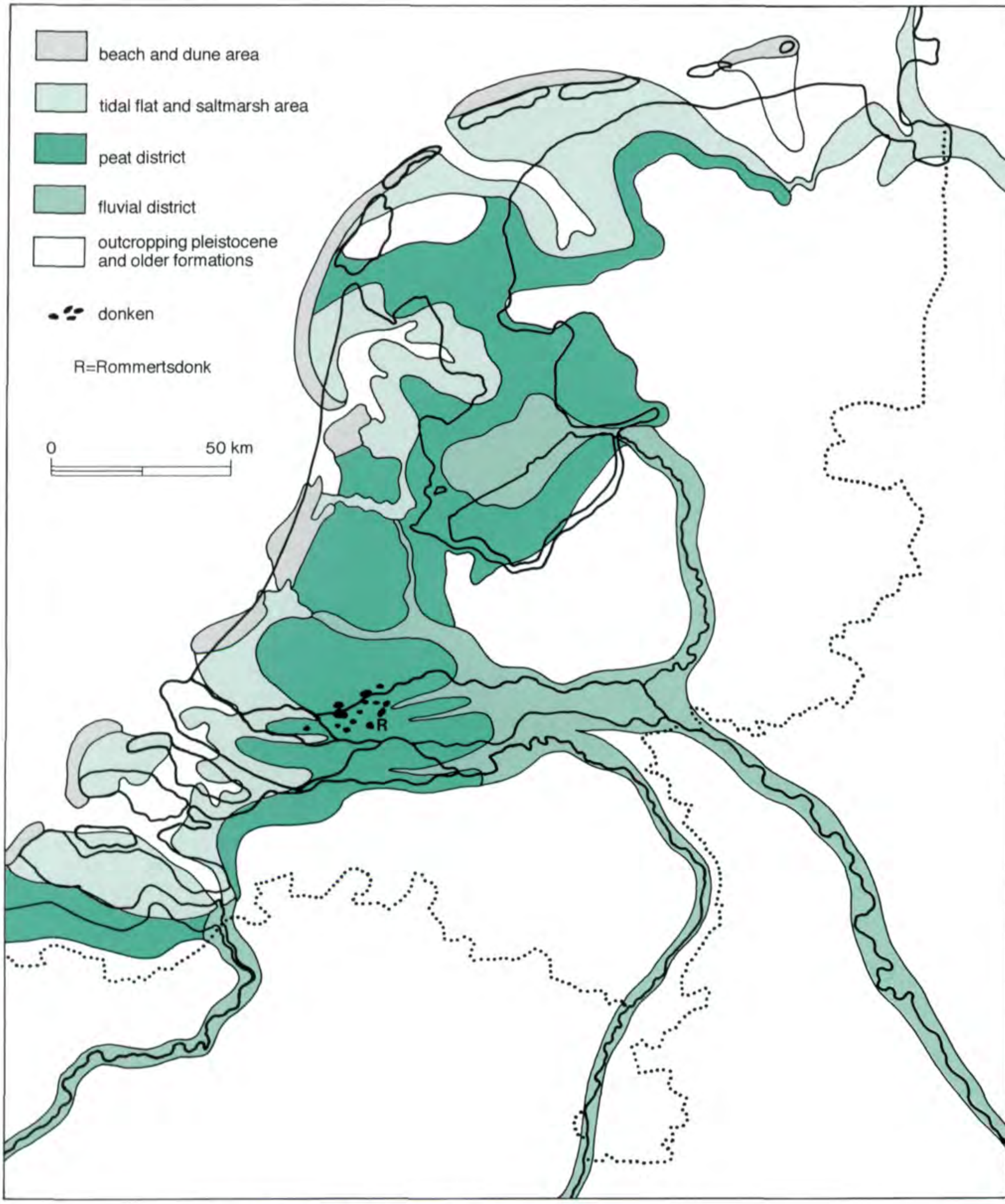


Figure 1. Holocene landscapes of the Netherlands and location of the Rommertsdonk

speaking not a delta. Not in a morphological sense because the "delta" is not a discrete shoreline protuberance. And not in a sedimentological sense as the central and western part of the "delta" have a perimarine and marine genesis respectively (see Bhattacharya/Walker 1992).

From an archaeological point of view the term delta has the advantage of being short and easy to combine with other words, such as "the delta neolithic". In my opinion there are no objections to the use of the term delta, as long as it is made clear that this delta consists of several distinctive landscapes (see Louwe Kooijmans 1987): a beach and dune district, tidal flats and lagoons, a peat district and a fluvial district (see fig. 1).

Although opinions differ on the use of the term delta, the above mentioned authors do agree on the overall determinant role of the relative sealevel rise in the Holocene development of this sedimentation area. Due to a relative sealevel rise of almost 15 m since 7500 BP, a thick sequence of peat and clay layers came into being in an ever changing landscape of lagoons, tidal flats and peat bogs. In the Rommertsdonk-Hazendonk area the peat and clay layers deposited on top of the pleistocene substratum attain a thickness of about 10 m.

The river dunes, locally known as donken, were formed during the Younger Dryas Stadial of the Weichselian (Verbraeck *et al.* 1974) on top of the floodplain of the then braided rivers Rhine and Meuse. However, it can not be excluded that the dunes remained active during the Preboreal and Boreal (Van der Woude 1981). The donken became submerged and fossilised due to extensive peat and clay accumulation under a rising water table, linked to the general sealevel rise. As more than 80 donken are located in the western part of river area, this region sometimes is referred to as the donken area.

The Rommertsdonk was discovered by R. Steenbeek in 1977 during geological fieldwork in the area surrounding the Hazendonk (Steenbeek 1977). Nowadays the Rommertsdonk is no longer surfacing, the dune top is located 1 m below the present-day surface. Only the undulations in the landscape reveal its presence.

The geological fieldwork provided data for a detailed reconstruction of the former Holocene landscapes of the Rommertsdonk-Hazendonk area (Van der Woude 1981). In the following, the paleoenvironmental evolution of the area as described by Van der Woude, is summarized.

From c. 7400 BP onwards extensive fluvial clay deposition in a so-called fluvio-lagoonal environment took place. This environment was characterised by permanent open-water surfaces criss-crossed by many river branches with wooded levees.

Around 6100 BP the fluvio-lagoonal environment gave way to extensive alder carr with numerous lakes in which organic accumulation occurred under very quiet conditions. Although much of the alder carr persisted for a period of 2000 years, the lakes expanded untill around 5300 BP also clay deposition took place. Figure 2 shows a landscape reconstruction of this so-called fluvio-lacustrine environment. In this reconstruction, based on hundreds of borings, the Hazendonk as well as the Rommertsdonk are visible amidst alder carr and shallow basins with subaquatic channels. Around 4800 BP the lakes reached their maximum extension. Closed alder carr and reed marshes precede a period of extensive fluvial deposition in, again, a fluvial lagoonal environment, which lasted until 3300 BP.

Closed alder carr returned and persisted at least till 2000 BP. A thin clay bed covers the sedimentary sequence.

The two millennia of alder carr (c. 6100 BP - c. 4100 BP) are of special interest to the Neolithic occupation history of the donken area, since almost all of the Hazendonk layers date to this period. As will be shown below also the four Rommertsdonk layers date to this period.

2. The prospection method

2.1. Basic concepts

The prospection method presented in this article focuses on the prospection of so-called archaeological layers, according to geological procedures. These procedures cover the method of data collection as well as the rules according to which the data should be described and classified (Hedberg 1976). The prospection method also includes mapping and dating of the archaeological layers.

Archaeologists tend to classify layers (sediments) containing artefacts according to cultural criteria, i.e. the artefact assemblage. Linking archaeological data to geological data requires compatible terminologies. To prevent any misinterpretation of the results of the prospection, the concept of the archaeological layer will be defined first.

An archaeological layer is a lithostratigraphic unit distinguishable in the field and defined on the basis of its lithological content, i.e. the archaeological indicators. The indicators used in this prospection method are: charcoal, (burnt) bone, ceramics, flint and river dune sand, embedded in a matrix of (clayey) peat or clay. The overall lithological homogeneity of the layers points to more or less constant physical conditions, during which the aggregates were laid down in one depositional event (see Klein 1987; Reineck/Singh 1980, 96). Of course, post-depositional processes, such as trampling, may have contributed to a great extent to this homogeneity.

It cannot be stressed enough that a single archaeological layer is not identical to a cultural layer, cultural phase or other terms based on interpretation rather than direct observation. The age of a great number of layers, together

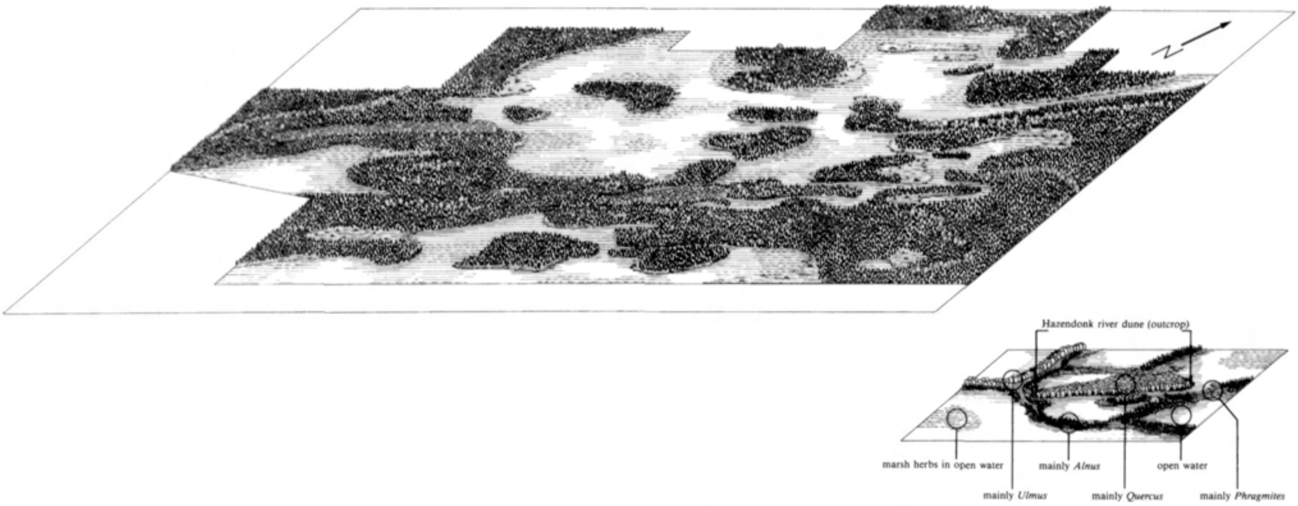


Figure 2. Fluvio-lacustrine environment of the Rommertsdonk-Hazendonk area, around 5300 BP. The Rommertsdonk is visible on the left-hand side of the reconstruction (after Van der Woude 1981).

with their cultural assignment, make up the database on the basis of which the true duration of prehistoric cultural phases can be established.

2.2. Dating of archaeological layers

In order to determine the chronostratigraphy of layers three courses are open to us.

First, we can date layers by dating the artefacts embedded in them. Since charcoal is one of the indicators on the basis of which layers are defined, it is pertinent to date the charcoal, by the radiocarbon method. The perfect conservation of the artefacts, even the most fragile fish remains, point to a contemporaneity of the artefacts and their age of deposition. Thus, the only age difference between the 14C age of the charcoal and the age of the depositional event may arise from the fact that it is not the age of the manufacture that is dated but the wood itself.

The second method for dating layers is based on their depth below NAP (Normal Amsterdam Level), in relation to the growth of carr peat on the slope of the donk. The concept of juncture-point is of crucial importance in this method. It is defined as the point (in cross section) where the top of the archaeological layer rests directly on the sloping river dune sand. Up slope the layer is no longer present, or the matrix has changed from peat or clay to dune sand. Down slope the layer is separated from the dune slope by a "sterile" peat layer. Since the top of the archaeological layer coincides with the peat surface at the moment the artefacts are deposited, dated initial peat growth on river dune slopes can be used to date the depositional event. Van Dijk *et al.* (1991) studied the Holocene water level development in the Netherlands' river area. For their reconstruction of the water level development, they constructed isochrones of initial peat formation on compaction-free river dune sand, in an east-west cross-section through the donken area. These isochrones offer a unique opportunity to date archaeological layers. Simply by plotting the altitude of the juncture-point of the layer at the correct place along the x-axis in the cross-section, the age can be obtained by interpolating between the isochrones. As the juncture-point of the top of the layer is used, the outcome most likely will date the end of the deposition of the artefacts just before peat growth restarted.

Dating the beginning of the depositional event using the lower boundary of the layer seems problematic. Trampling of the archaeological indicators into the soft peat, thereby lowering the lower boundary of the layer, will most certainly have occurred.

Archaeological layers can with the third method also be dated by dating the peat matrix. This method has the advantage of being able to date a layer in those cases where not enough charcoal is present. However, radiocarbon ages of peat samples can be less reliable. Rejuvenation of peat resulting from root contamination is a serious problem, whereas mechanical contamination of clayey peat may result in an ageing effect (Törnqvist 1992). Furthermore sampling and dating the peat around trampled charcoal will probably show a considerable difference in age between peat and charcoal. For example, assuming a sedimentation rate of 15 cm per 100 years, a lowering of the lower boundary with 15 cm (before compaction), will result in a date 100 years too old.

Concluding, it should be noted that there is a fair chance that dating the peat matrix instead of the artefacts themselves, causes more problems than it solves.

2.3. Field strategy

Prospection for archaeological layers begins in the field. The type of equipment, selecting the best locations to place the borings, as well as the choice of where to take the radiocarbon samples, all contribute to the success of the prospection method.

2.3.1. Equipment

The field data were all obtained with the use of handboring equipment. Gouge-augers, 1.5 m long with extension rods proved to be very useful in gouging the peat and clay layers in an undisturbed state. To achieve reliable depths of juncture-points, all borings were levelled relatively to NAP, with the aid of a Wild levelling instrument.

2.3.2. Location of the borings/boring density

As pointed out earlier the prospection focuses on the peat and clay layers surrounding the river dune, and not on the dune itself. On the steep dune slope denudation prevails, whereas on the surrounding peat the eroded artefacts and dune sand are (re)deposited. Except for some crushed charcoal, hardly any artefacts will be found directly on the donk. The deposition of artefacts on the peat offers a great advantage. As a result of the rapid sedimentation rate, the different archaeological layers are separated by sterile peat layers, instead of being deposited on top of each other. Thus every layer has its "own" artefact assemblage and its own juncture-point.

In figure 3 the location and distribution of the borings are shown. They are located in a narrow zone all round the donk and concentrated in rows perpendicular to the strike of the dune slope. The width of the zone around the dune is determined by the distance at which the artefacts were deposited on the peat (the width of the activity zone). The distance between the borings in a row varies from 1 to 5 m, whereas the distance between the rows preferably should not exceed 20 m. The rows enable the construction of cross-sections for unravelling the complex lithostratigraphy and for assessing the altitude of the juncture-point. The smaller the distance between the rows, the better the chances of finding layers of limited dimensions.

3. Results and discussion

3.1. The archaeological layers

On the basis of 135 borings, 4 archaeological layers were identified at a depth of between 2.6 and 5.1 meters below NAP. (see fig. 3). The layers were mapped in detail and dated by means of radiocarbon dating and the altitude of the juncture point. The layers together with their juncture points are depicted in figure 4.

All layers are basically similar. General characteristics are:

- charcoal particles ranging in size from < 1mm to 10 mm, burnt bone, and riverdune sand are present in every layer. Ceramics and small flint flakes were found in layer 3
- the layers have a matrix of (sometimes slightly clayey) unoxidised fen-wood peat. The layers exhibit a strong heterogeneity, which in itself constitutes a kind of unity when compared to the adjacent "sterile" peat layers. Thus the upper and lower boundary are defined by the uppermost and lowermost presence of the archaeological indicators.
- the layers have a clear juncture point on the dune slope and extend for 10 to 15 m into the surrounding peat. Except for some pulverised charcoal, no indicators were found on the slope of the donk itself.

3.2. Radiocarbon ages and calendar age ranges of the layers

Charcoal samples were obtained from layers 2, 3, and 4. To avoid contamination of the samples by pulverised (older) charcoal present on the dune slope, the cores were taken more than 2.5 m from the juncture-point of the respective layers. After sieving, only particles > 2.5 mm were selected.

To form an opinion about the representativeness of the Hazendonk occupational phases, the Rommertsdonk and Hazendonk 14C ages had to be correlated (tab. I).

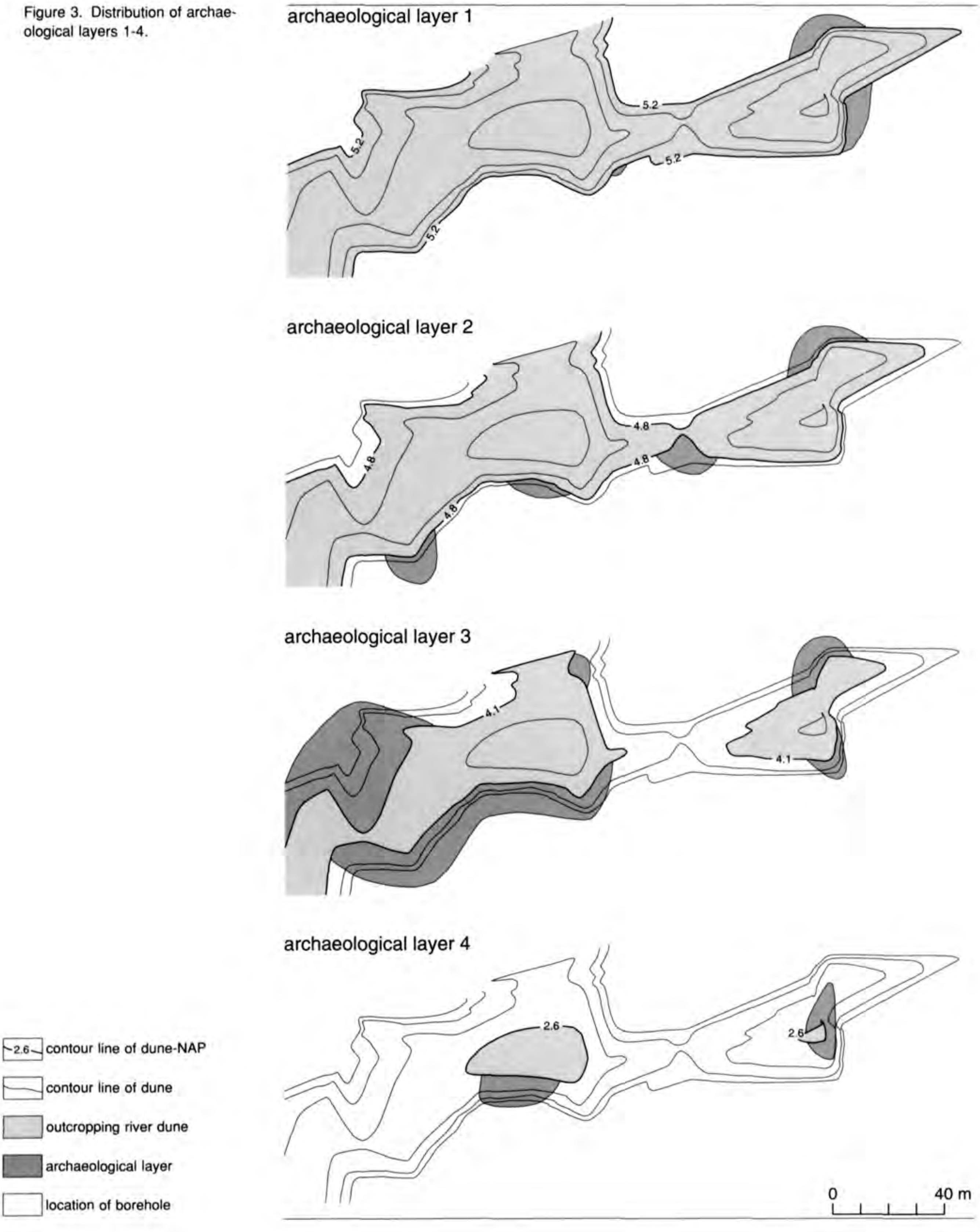
So far only a few Hazendonk 14C dates have been published (Louwe Kooijmans 1974). For no other reason than that these samples were peat samples obtained from pollencores, and therefore do not necessarily date the archaeological layer, they were not deemed to be relevant. Fortunately a well documented set of 24 unpublished 14C ages were found in the archives of the National Museum of Antiquities at Leiden. From this data set 16 charcoal/charred wood samples were selected.

Because of the inconstancy of the atmospheric 14C content, all dates were converted to calendar age ranges.

The calibration program Cal 15 (Van der Plicht 1993; Van der Plicht/Mook 1989) was used to convert the 14C ages.

First the sample time width was estimated at at least 60 years. This figure is based on the thickness (age) of the branches normally used in campfires for food processing. Furthermore the possibility cannot be excluded that the layers represent an interval of time themselves due to either multiple occupational phases of short duration or one longterm occupational phase. Then a smoothing of the

Figure 3. Distribution of archaeological layers 1-4.



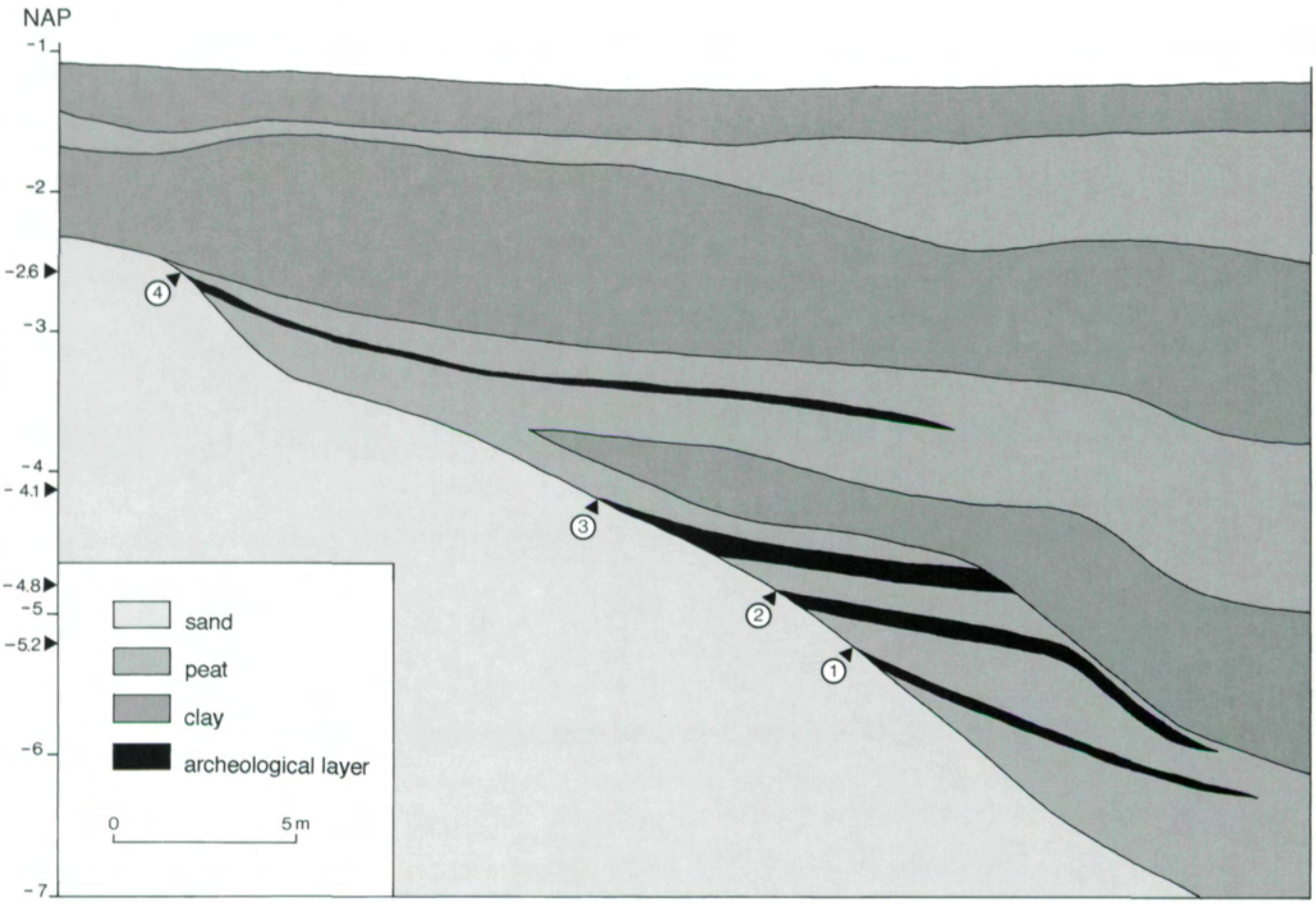


Figure 4. Schematic cross section showing the Rommertsdonk with covering peat and clay layers. Archaeological layers are numbered from bottom to top.

calibration curve was performed to suit sample time width (Mook 1983). The smoothing calculation is one of the standard options of Cal 15. And lastly for the (actual) calibration the two standard deviation (2 sigma) confidence interval was chosen. The calibration yielded calendar age ranges spanning 200 to 300 years.

Table I and figure 6 present the calendar age ranges and related information of the Rommertsdonk and Hazendonk 14C ages.

However, the interpretation of the dating results in terms of contemporaneity of occupational phases, is far from easy. When the calendar age ranges are compared a number of questions arise. Firstly, how do we have to interpret the age differences between 2 or more calendar age ranges of one single layer (for example the Hazendonk 1 layer)? Does it reflect the nature of the radiocarbon dating method, i.e. the Gaussian probability distribution of the radioactive decay measurement? Could the different ranges date the beginning and end of one occupational phase? Or is it the result of (different percentages of) wood of various ages present in the charcoal samples. Probably all factors will affect the 14C age to some degree. Secondly, when comparing the Rommertsdonk and Hazendonk age ranges, does a partial overlap of age ranges mean that the occupational phases are comtemporaneous? For instance, is Rommertsdonk layer 3 contemporaneous with Hazendonk 1, Hazendonk 2 or with neither of them.

A solution to the above problems could be to use the probability distributions of the calendar age ranges, calculated by the Cal 15 calibration program. When the peak in the probability distribution with the highest probability is selected then comparing calibrated age ranges simply amounts to a comparison of the calendar ages of the peaks. However, selecting the highest peak means the preclusion of a large part of the calendar age range, and this will seriously affect the outcome of the comparison.

3.3. Reducing the calendar age ranges

In this paragraph an explanation will be given of the method of reducing the calendar age ranges by using the

Table 1. 14C ages of Rommertsdonk and Hazendonk archaeological layers. Reduced calendar age ranges date the top of archaeological layers

Layer	Sample No.	GrN	Age (conv. C-14 y BP)	Reduced cal. age range
Rom. 4		19080	4425 ±35	3290..2990
Rom. 3		19079	5130 ±60	4000..3880
Rom. 2		19078	5390 ±60	4290..4170
Rom. 1				4460..4340
Haz. VL 2b	9	8233	4000 ±25	2570..2470
Haz. VL 2b	7 b	9132	4015 ±30	
Haz. VL 2b	8 c2	9133	4010 ±35	
Haz. VL 1b	11	9135	4435 ±50	3260..2960
Haz. VL 1b	12 c	9136	4445 ±35	
Haz. VL 1b	12 d	8234	4505 ±40	
Haz. VL 1b	10	9134	4535 ±40	
Haz. VL 1b	13	9137	4450 ±40	
Haz. 3	20	8236	4735 ±35	
Haz. 3	19 a	9193	4810 ±35	3670..3610
Haz. 3	18	9192	4830 ±40	
Haz. 3	17 b	9191	4870 ±55	
Haz. 2	23	8330	5020 ±30	3910..3790
Haz. 2	24	8237	5090 ±40	
Haz. 1	26 a	8331	5165 ±30	4020..3690
Haz. 1	26 c	9196	5265 ±60	

isochrones of peat formation on river dunes (see fig. 5). The actual reduction comprises three successive steps:

1. As stated earlier, isochrones of peat formation on riverdunes offer an opportunity of dating archaeological layers. The other way around, dated archaeological layers can be used to date initial peat growth. In other words, the time-depth points of peat growth and archaeological layers are interchangeable. The first step involves the creation of a large data set of calendar age ranges: a combination of the peat data of Van Dijk *et al.* (1991) and the archaeological data of Verbruggen (in prep.).
2. The second step involves the construction of the isochrones through interpolation of the calendar age ranges. In fact, drawing the isochrones means determining the most probable part of the age range. It will be clear that the larger the number of age ranges on which the isochrones are based, the smaller the margins for the isochrones will be.
3. Finally, the reduced age range is calculated by adding the margins of error to the age of the most probable part of the age range (see above). The margin of error is related to the rate of the water level rise and the margin of error of the altitude of the juncture point of the archaeological layer. It is estimated to range from 60 yrs for the period before 3800 cal BC to 200 yrs for the period after 3000 cal BC. As a result the reduction of the age range varies from 0 to c. 200 yrs.

In conclusion, determining the most probable part of the calendar age ranges through the construction of isochrones of initial peat formation, means selecting the age which has the best goodness of fit with all other age ranges of the data set.

3.4. Comparison of the reduced calendar age ranges

Figure 6 (black bars) shows the reduced age ranges of the Hazendonk and Rommertsdonk layers. The reduction of the ranges by 50% up to 3800 cal BC provides a proper evaluation of the representativeness of the Hazendonk.

For Rommertsdonk layer 1, there is no equivalent on the Hazendonk.

Rommertsdonk layer 2 shows a considerable overlap with the oldest calendar age range of Hazendonk 1. However, the reduced age ranges show no overlap. Thus for Rommertsdonk layer 2 there is no equivalent on the Hazendonk either.

The reduced age range of Rommertsdonk layer 3 partly overlaps with Hazendonk 1 as well as with Hazendonk 2. Since the reduced age ranges date the end of the occupational phase (see section 2.2), the contemporaneity of Rommertsdonk layer 1 with Hazendonk 1 or 2 or neither of them, depends on the duration of the respective occupational phases. As stated before, age differences between some radiocarbon ages of a single layer, provide insufficient argument for assessing the duration of the

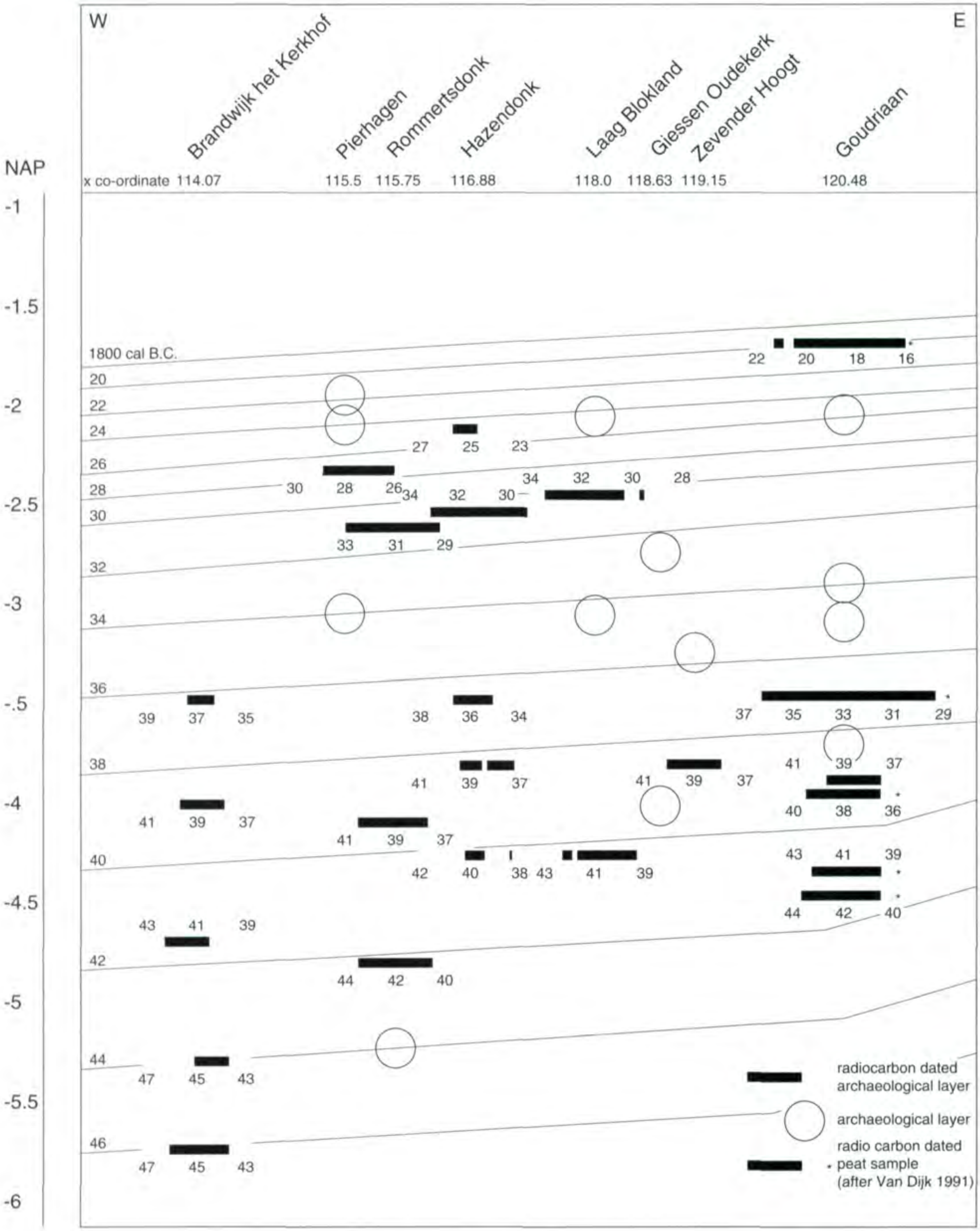


Figure 5. Isochrones of peat formation based on calendar age ranges of radiocarbon dated archaeological layers and peat samples.

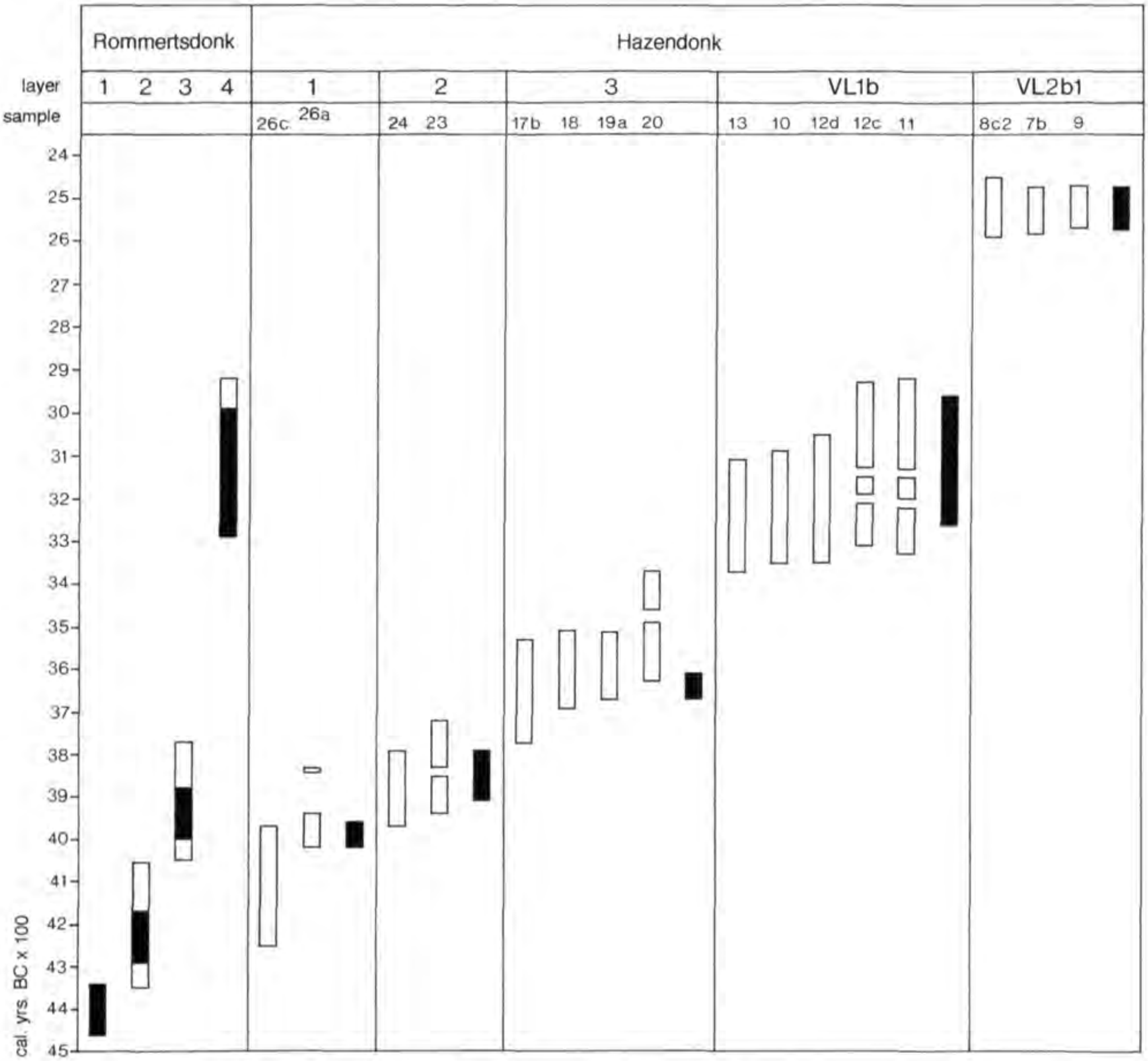


Figure 6. Reduced calendar age ranges of the Hazendonk and Rommertsdonk archaeological layers.

occupational phases. Consequently, the above problem remains unsolved here.

For Rommertsdonk layer 4, no reduction of the age range could be achieved, due to the slow rate of peat accumulation in this period. Since the calendar age range overlaps completely with the Hazendonk VL 1b phase, there is a fair chance that the layers are contemporaneous.

Finally, no equivalents were found on the Rommertsdonk for the Hazendonk 3 and Hazendonk VL 2 layers.

To sum up, of the four archaeological layers of the Rommertsdonk, one is probably contemporaneous, one is possibly contemporaneous and two are by no means contemporaneous with Hazendonk layers. Furthermore, the Hazendonk 3 and VL 2 layers have no counterparts on the Rommertsdonk.

4. Conclusion

The main reasons for carrying out this study were:

- to increase the number of Early and Middle Neolithic sites in the donken district.
- to develop a method for the prospection of refuse layers buried up to 6 m below the present day surface.
- to evaluate the Hazendonk chronology.

The discovery, mapping and dating of four Neolithic refuse layers clearly shows the efficiency and advantages of a prospection by means of hand borings.

A comparison of the reduced calendar age ranges of the Rommertsdonk and Hazendonk layers leads to the following conclusions:

- the Hazendonk chronology is not representative for the respective layers.
- in general, the Hazendonk can serve as a model for a phased Early and Middle Neolithic occupation chronology of the donken district.

Comparing two chronologies in order to decide which one can serve as a model for a large area, can be seen as a useful exercise. The comparison should be considered as a "half-time score".

Expectations are that the donken project will result in a data base of more than 50 refuse layers, on the basis of which the Neolithic occupation chronology of the entire donken district can be drawn up.

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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

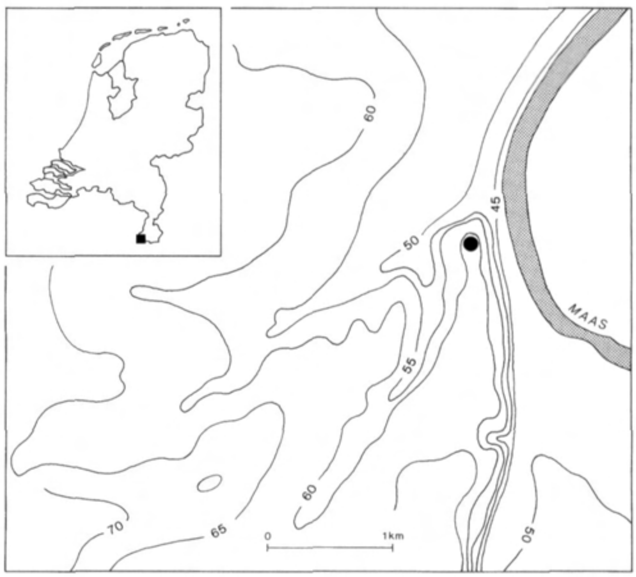


Figure 1. Location of Maastricht-Klinkers in the Netherlands and contour map of the site location. Height in m. above NAP (scale 1:25 000).

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

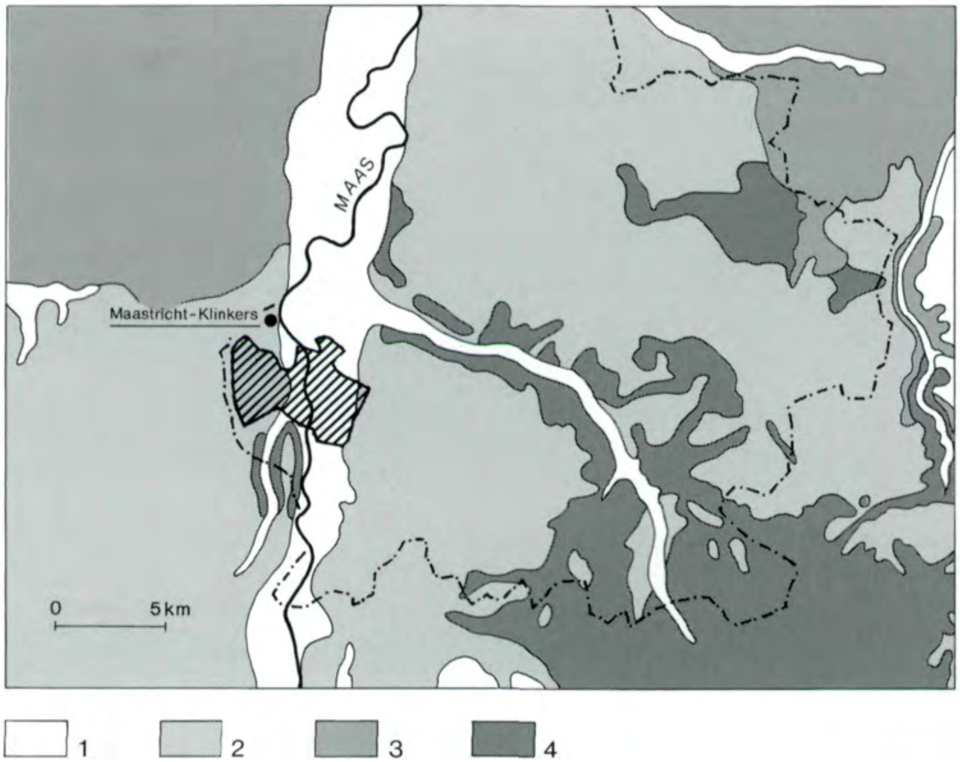


Figure 2 . Geological map of Southern Limburg. Legend units: 1. Holocene deposits, 2. Pleistocene loess, 3. Pleistocene sand, 4. Tertiary and older deposits.

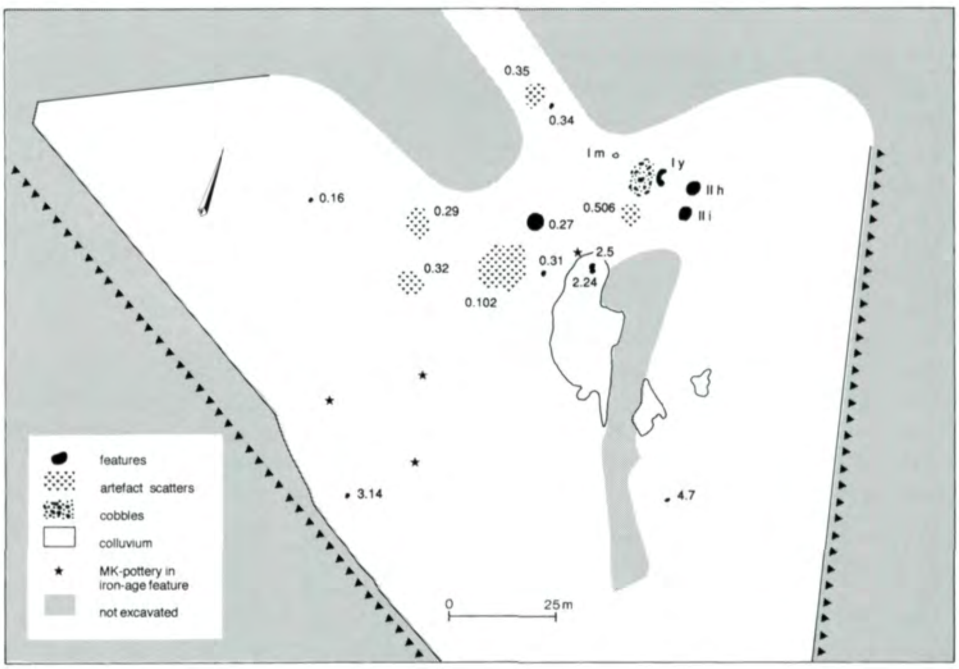


Figure 3. Maastricht-Klinkers: excavation plan.

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
.ly	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 $E = 95.8$, $O = 85$).

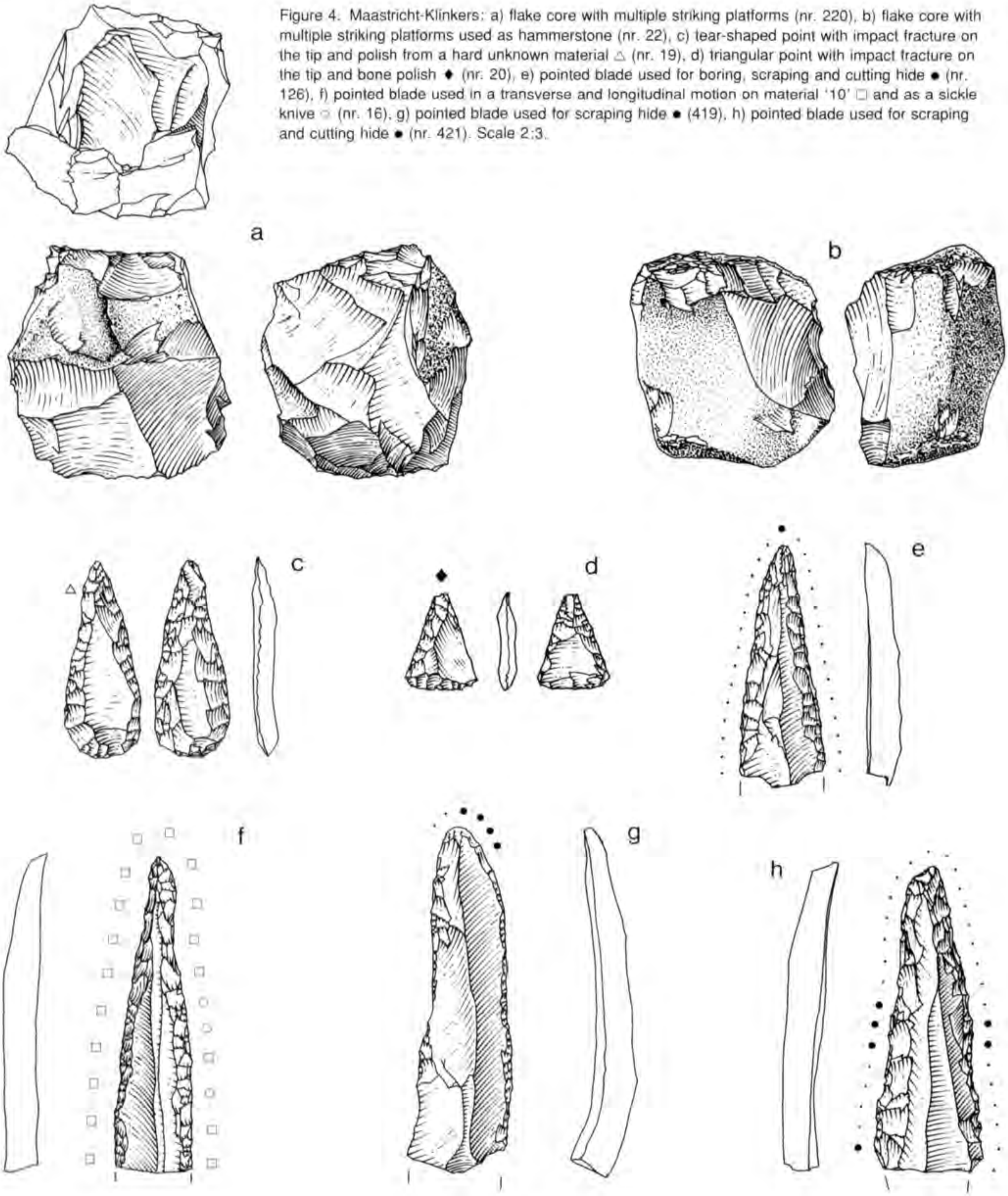


Figure 4. Maastricht-Klinkers: a) flake core with multiple striking platforms (nr. 220), b) flake core with multiple striking platforms used as hammerstone (nr. 22), c) tear-shaped point with impact fracture on the tip and polish from a hard unknown material △ (nr. 19), d) triangular point with impact 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

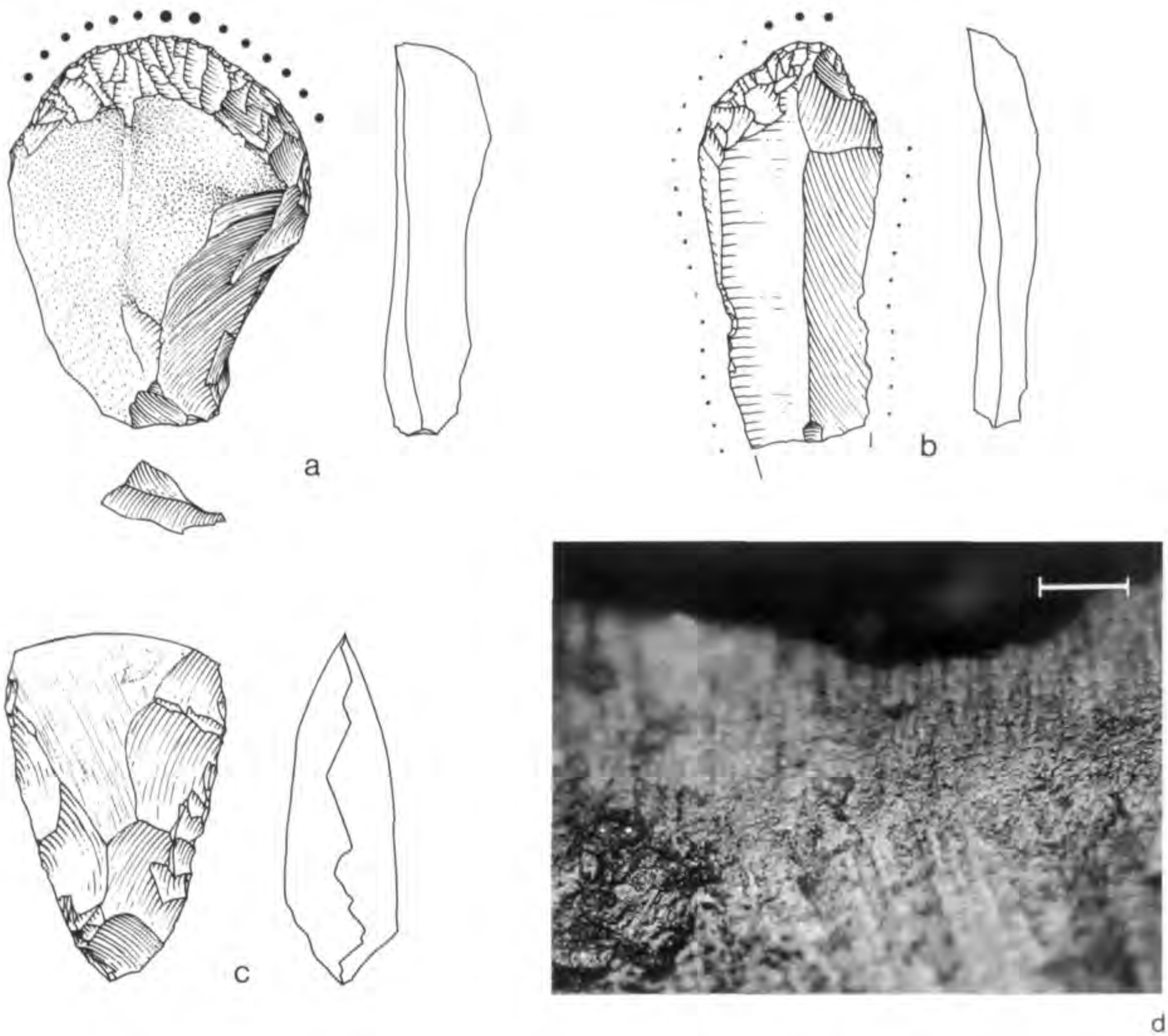
Nine pointed blades have been recovered[21]. Generally, they display rather steep, lateral retouch over the entire length of the blade . Five tools have a slightly rounded point (figs 4e, f), one a tongue-shaped tip (fig. 4g) and one an acutely angled tip (fig. 4h) (Fiedler 1979). Two pieces could not 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.



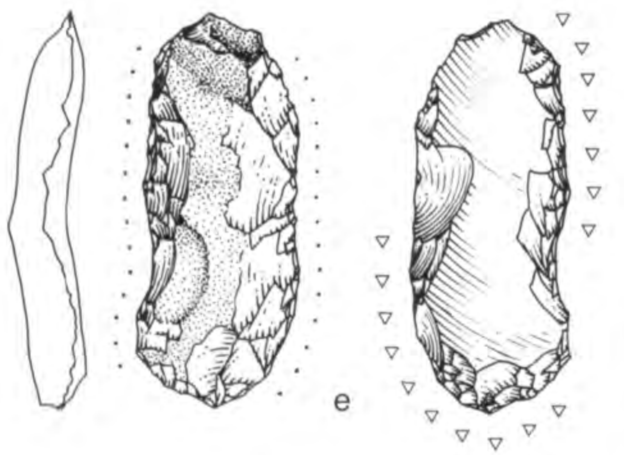


Figure 5. Maastricht-Klinkers: a) horseshoe shaped scraper used for scraping hide • (nr. 349), b) scraper on a blade used voor scraping and cutting hide • (nr. 246), c) polished axe with probably resharpened cutting edge (nr. 314), d) micrograph of observed polish on cutting edge axe (artifact nr. 314, 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).

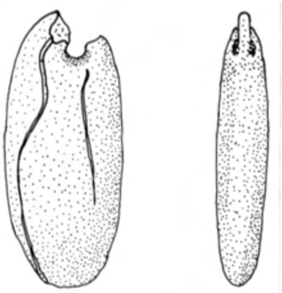


Figure 6. Maastricht-Klinkers: rolled pebble with double conical perforation (drawing by L. Theunissen). Scale 2:3.

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

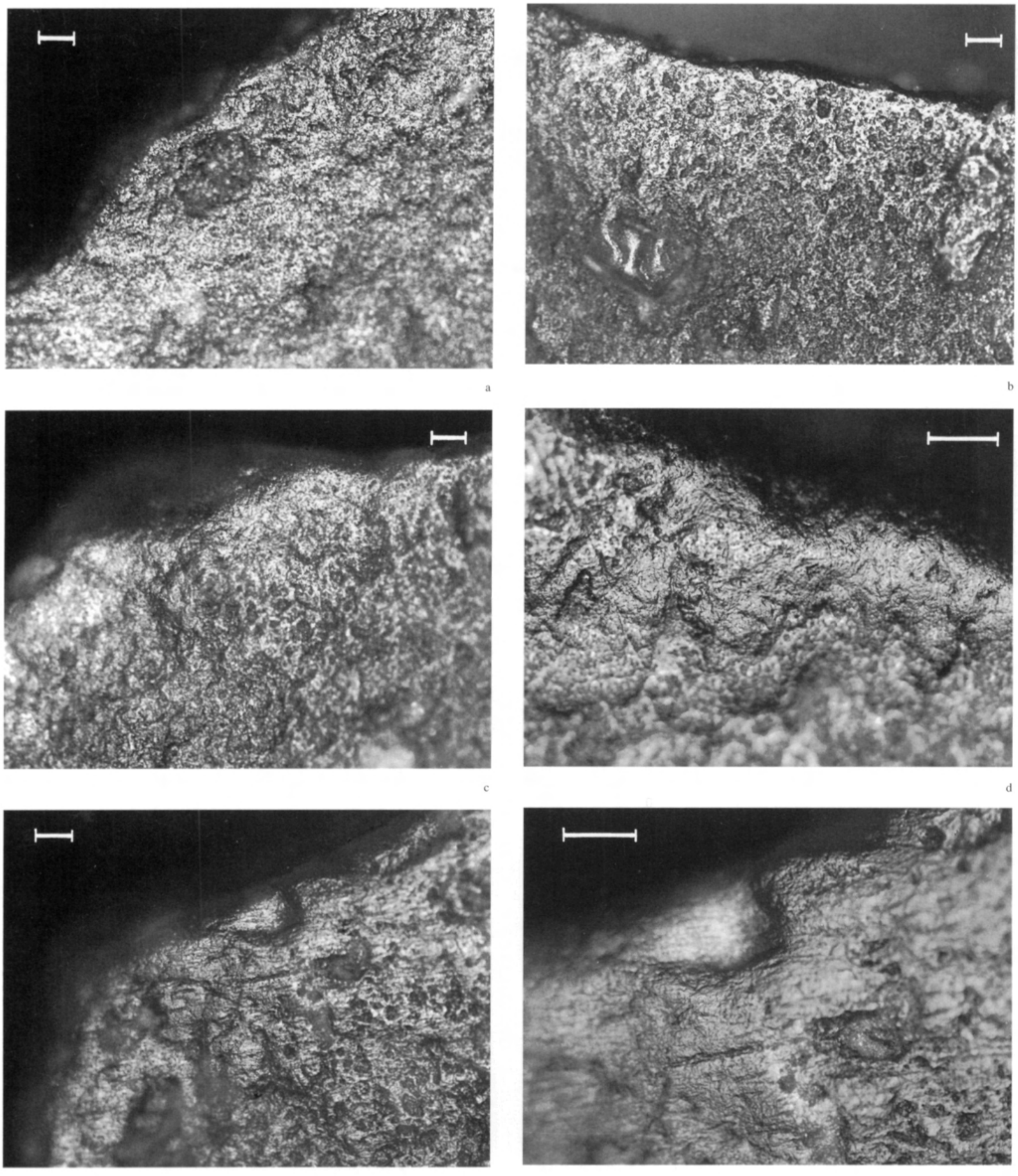


Figure 7. Maastricht-Klinkers: micrographs of observed wear-traces from hide working. All bars equal 50 μ. a) scraping fresh hide (artifact nr. 14, 150×), b) scraping hide (artifact nr. 201, 150×), c) scraping hide (artifact nr. 312, 150×), d) scraping hide (artifact nr. 423, 300×), e) boring hide (artifact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

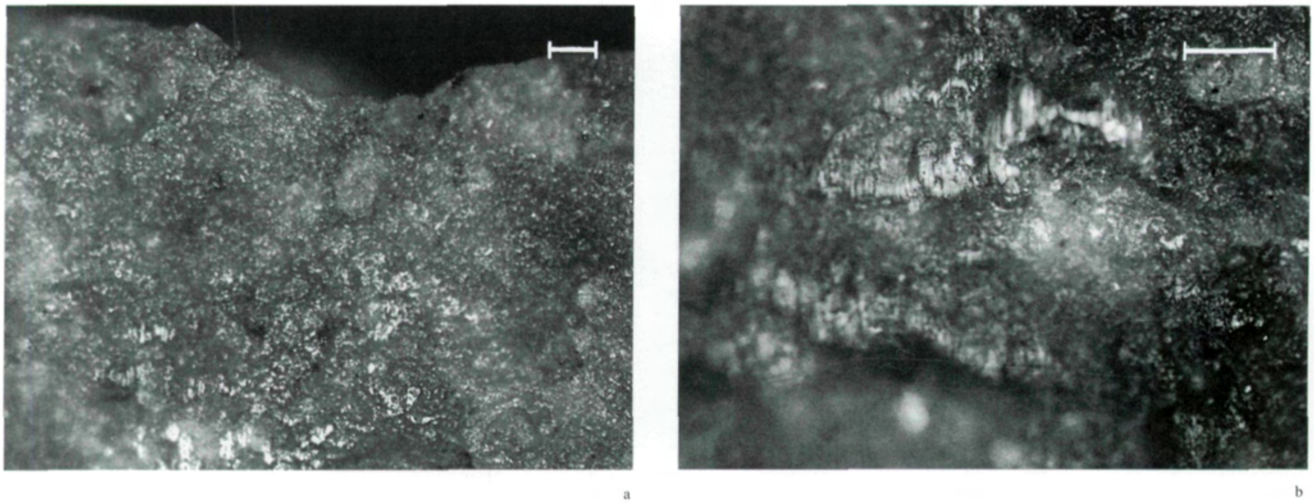
In the following pages the activities which were executed will be discussed. The treatment of animal, plant, mineral and unknown materials will be drawn on. The characteristics of the wear traces will only be summarily described. For further information concerning the appearance of various wear traces 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



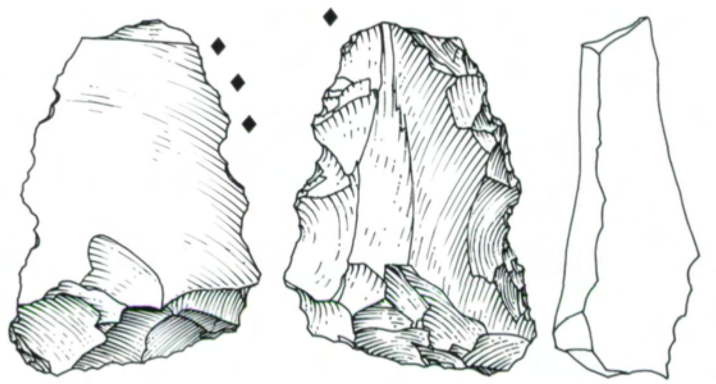


Figure 8. Maastricht-Klinkers: micrographs of traces from scraping bone. All bars equal 50 μ. a) artifact nr. 413 (150×), b) same artifact (300×), c) retouched flake used for scraping bone ◆ (nr. 413). Scale 2:3.

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 Linearbandkeramik 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

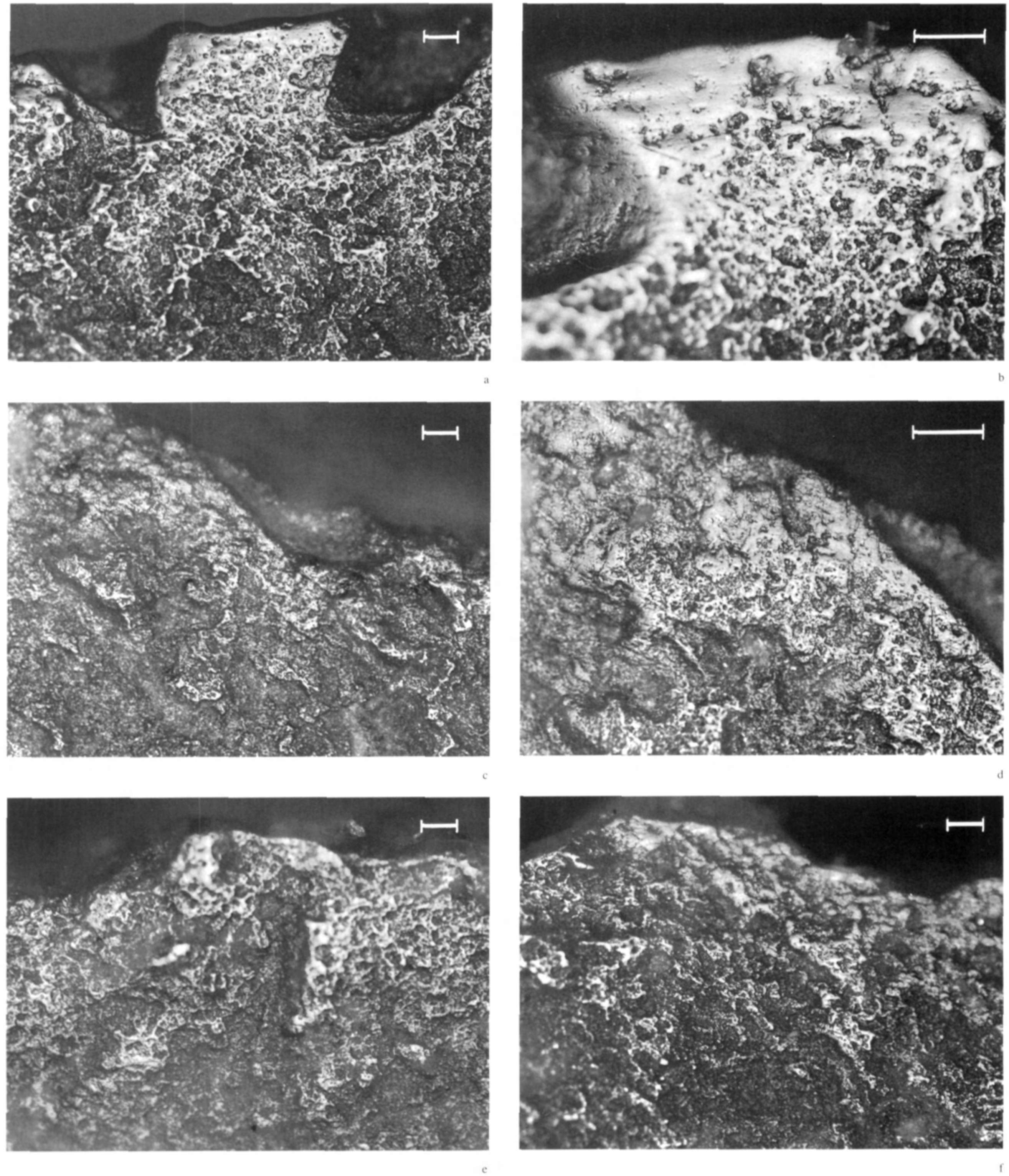


Figure 9. *Maastricht-Klinkers: micrographs of traces from cutting silicious plants. Typical sickle gloss as observed on LBK tools a) artifact nr.* 196 (150×), b) same artifact (300×), c) less spread, rougher polish on artifact nr. 417 (150×), d) same artifact (300×), e) smoother polish with less striations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

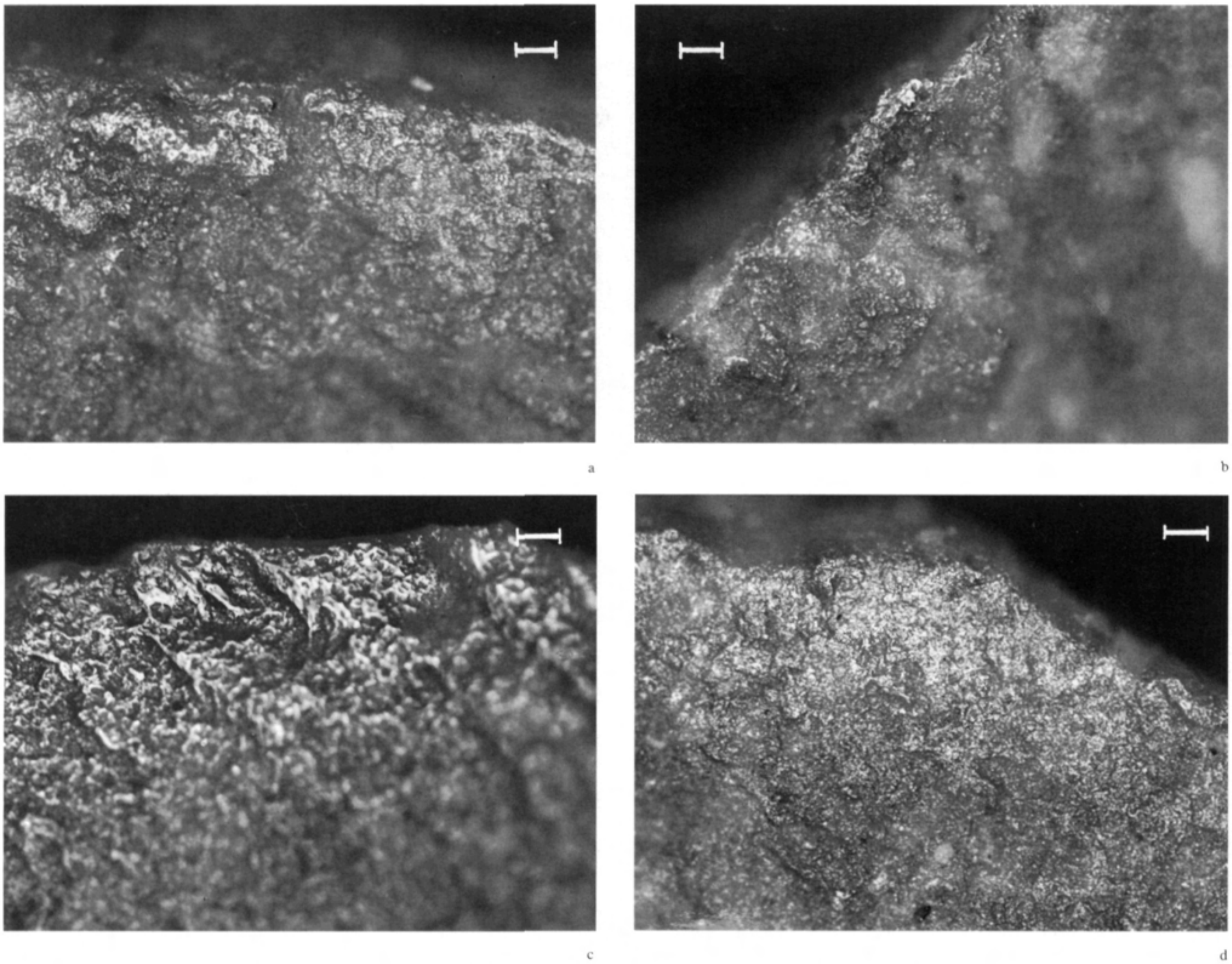


Figure 10. Maastricht-Klinkers: micrographs of traces interpreted as being from contact with wood. All bars equal 50 μ. a) longitudinal motion artifact nr. 418 (150×), b) longitudinal motion artifact nr. 308 (150×), c) transverse motion artifact nr. 416 (150×), d) wood planing artifact nr. 75 (150×).

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

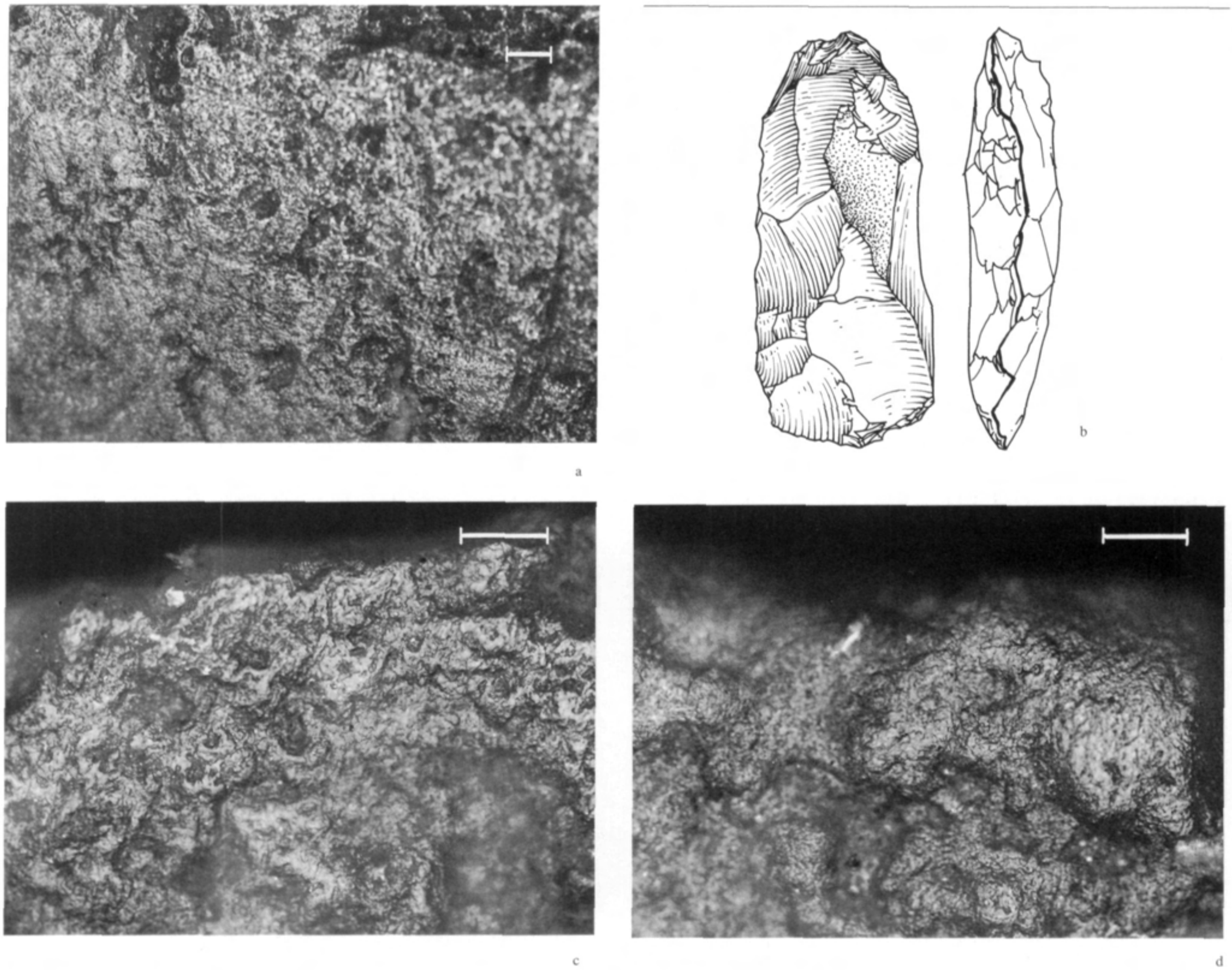


Figure 11. Maastricht-Klinkers: micrographs of hoeing-traces and polish '23'. All bars equal 50 μ. a) hoeing traces (150×) seen on bifacially retouched tool (nr. 214), b) bifacially retouched tool (nr. 214) probably hafted and used as a hoe (scale 2:3), c) polish '23', smooth polish on the dorsal side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

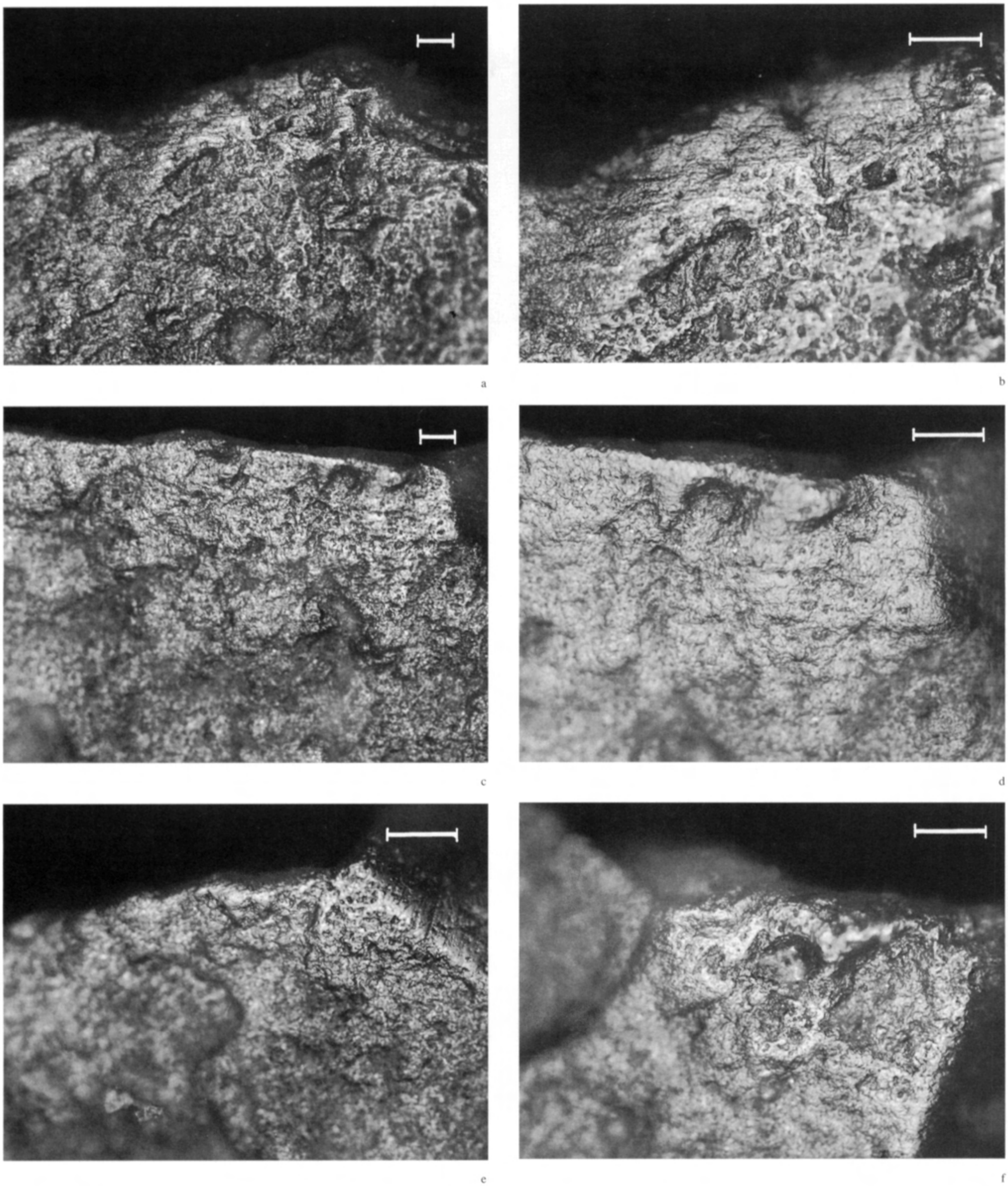


Figure 12. Maastricht-Klinkers: micrographs of traces of material '10'. All bars equal 50 μ. Longitudinal motion, rough and cratered polish a) seen on artifact nr. 124 (150×), b) same artifact (300×), c) transverse motion, rough and cratered polish seen on artifact nr. 165 (150×), d) same artifact (300×),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

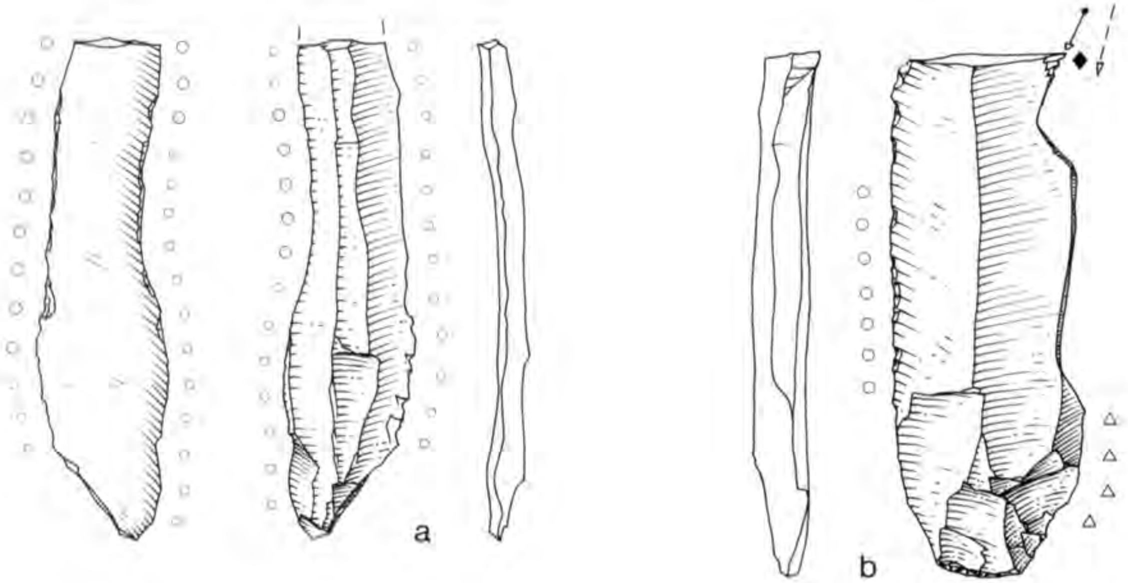
	25-30°	35-40°	45-50°	55-60°	65-70°	75-80°	85-90°	95-100°	105-110°	total
longitudinal	18	42	25	10	6	1	1	2	-	105
transverse	2	11	17	21	29	20	9	3	1	113
carving	-	-	-	-	3	-	-	-	-	3
chopping	-	-	-	-	2	1	-	-	-	3
wedging	-	-	-	2	4	1	1	-	-	8
hoeing	-	-	-	-	1	-	-	-	-	1
total	20	53	42	33	45	23	11	5	1	233

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



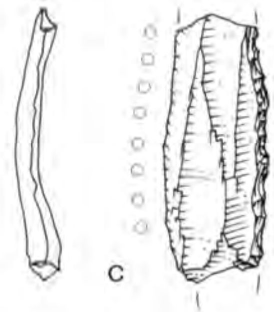
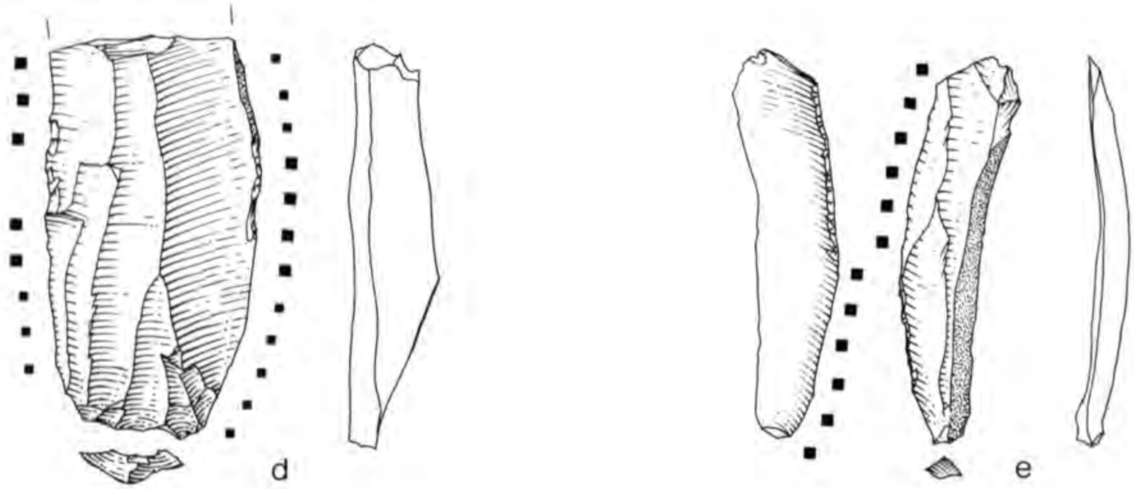


Figure 13. Maastricht-Klinkers: a-c implements with sickle gloss ○ a) blade (nr. 194), b) macrolithic combination tool also used for carving bone ♦ and scraping a medium-hard material △ (nr. 198), c) retouched blade (nr. 196), d) macrolithic blade, probably hafted and used in a transverse and longitudinal 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

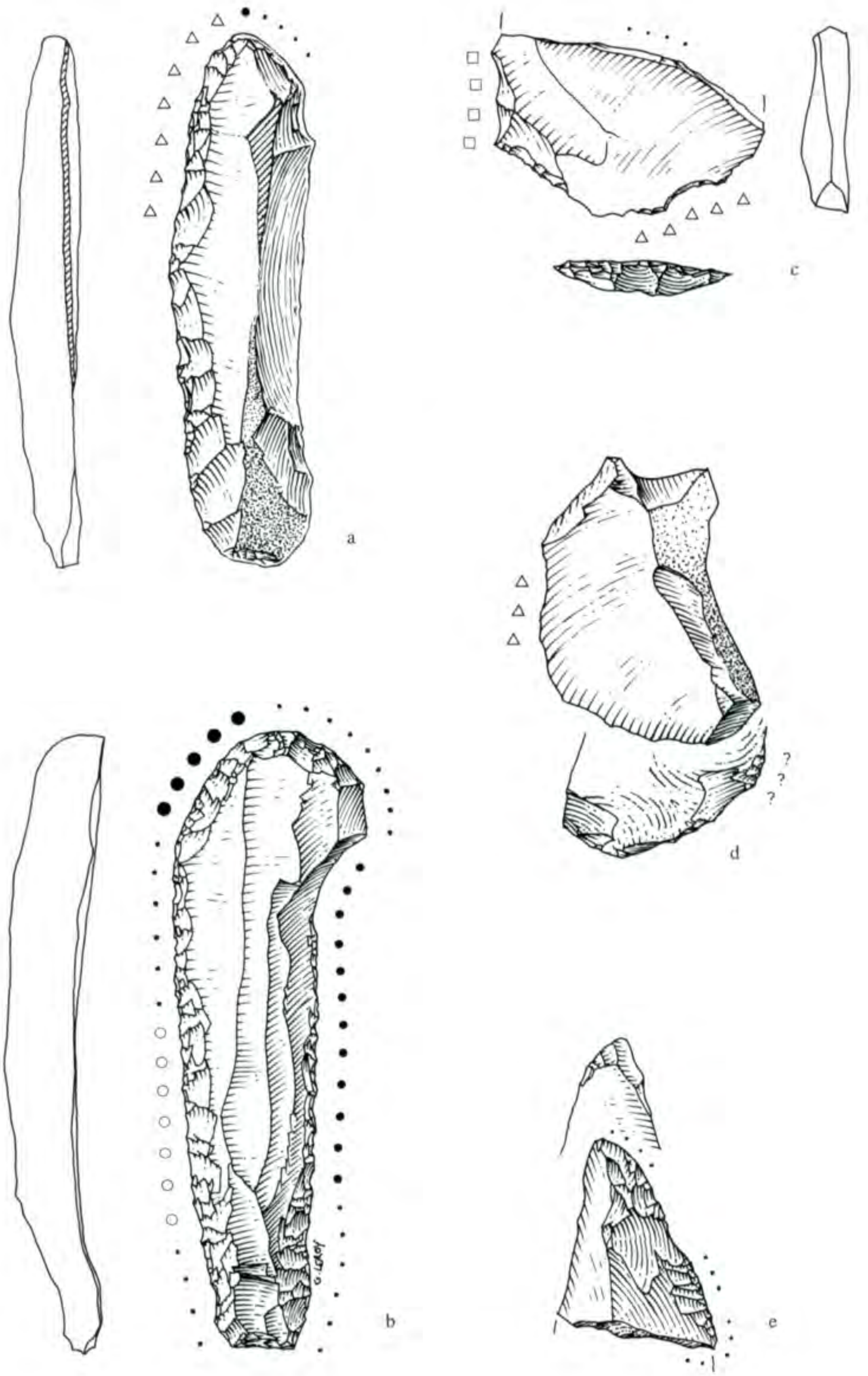


Figure 14. Maastricht-Klinkers:
a) combination-tool with polished fragments, used for cutting wood △ and scraping hide ● (nr. 418),
b) combination tool used as sickle knive ○ and hide scraper ● (nr. 4),
c) core rejuvenation platform used for scraping material '10' □, planing wood △ and cutting and scraping 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 typo-morphological 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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Dust and ashes: the two Neolithic cemeteries of Elsloo and Niedermerz compared

In a re-analysis of the bandkeramik cemeteries of Elsloo and Niedermerz the vexed problem of the many missing dead is solved by reference to statistical theory and prehistoric context. Gender and status of the burials are determined from the grave gifts, although not to full satisfaction for the Niedermerz data. Several differences between the two cemetries are noted; however, their basic matrilinear composition suggests similar social structures. Earlier analyses are discussed as well.

1. Introduction

Cemeteries constitute a rather special archaeological category: they can be thought of as sets of conscious "statements" meant for the World Beyond The Grave. The archaeologist plays the role of an anachronistic, un-initiated gatekeeper of that Afterworld; his/her problem is to re-establish communion over time by assigning meanings to these statements. Death and burial pose a crisis moment in the life of a community (Van Gennep 1909) as one of the positions in the social formation is no longer occupied — the mourners have no recourse than to fill the gap. In many societies the funeral rites provide an excellent opportunity for this re-negotiation of positions as gifts donned by survivors testify to. Even if the absolute amount of grave gifts is small they derive from a kind of mini-*potlatch* ceremony — valuables are withdrawn from regular use. They tell us of grief and pity, but also of the merit of sacrifice incurred by the donor.

In my PhD thesis (Van de Velde 1979) I analysed the funerary furnishings of the neolithic cemetery at Elsloo in the Netherlands as a pilot study of Bandkeramik social structure, followed by tests against settlement data. From hindsight, there were some flaws in my arguments; also, I did not discuss the 'missing data' and the 'missing dead' in Bandkeramik grave yards. The 25th *Analecta* seems a nice occasion to mend these faults. As a further test of my approach as well as for substantive and comparative reasons I will bring in Niedermerz, another Bandkeramik cemetery, just across the border with Germany. The latter has been excavated between 1969 and 1975, Elsloo in 1959 and 1966 (Dohrn-Ihmig 1983; resp. Modderman 1970). The two cemeteries have different life histories: Niedermerz has been in use for six or seven generations, coincident with the second half of the local Bandkeramik, whereas Elsloo dates from the latest two phases of the Dutch Bandkeramik and covers three or four generations only, partially contemporaneous with Niedermerz. Both cemeteries contained well over a hundred burials.

The majority of the graves held grave gifts (tab. 1). The skeletons have virtually dissolved, although a few from Niedermerz could still be examined as to their (biological) sex. One important point in my analysis will be the reconstruction of (social) gender — as distinct from

Table 1. The numbers of graves per gift category.
Sources: Modderman 1970, Dohrn-Ihmig 1983.

	Elsloo	Niedermerz
ceramics	56	48
red ochre	19	18
querns	14	10
arrowheads	13	23
blades	21	18
pyrite	3	6
thick adzes	21	17
flat adzes	15	18
no grave gifts	38	43
total graves	113	112

biological sex — among these burials: without that category hardly anything interesting can be said. Before doing so, I first have to discuss the missing dead — which may be few- and the missing data — which may be unimportant. Meantime I can also introduce the excavation data.

2. The missing dead

In their popular summary of the Aldenhovener Platte Project (which included the Niedermerz excavations) Stehli and Lüning argue that the quantitatively important yet archaeological untraceable category of lost corpses renders the few recovered graves by definition exceptional (Stehli/ Lüning 1989). As they see it, the number of Bandkeramians that have lived on the Aldenhoven Plateau can be estimated as in the order of five to ten thousand. Yet at best about 120 graves have been observed in the area. We may be pretty certain that there have been no more grave pits, as the entire plateau has been removed under archaeological supervision of the recent open pit mining operations. One possible allowance should be made for burials within the settlements: there, the erosion of the top soil may have caused the loss of graves. Judging from settlement data elsewhere, their numbers will not be very large, though (Veit 1989). A comparable argument holds for Elsloo: a similar number of Bandkeramians has lived on the Graetheide Plateau where the Elsloo cemetery with its 113 graves is located. At Elsloo the archaeological conditions were also quite favourable although the surrounding plateau is still in its place and therefore may hold some surprises. However that may be, from the Stehli and Lüning argument it follows that the few graves that have been recovered (one hundred plus from among five to ten thousand, approximately 1% or 2% of the expected numbers) should be considered exceptional in *both* regions.

In my opinion this latter conclusion of exceptionality does not follow from the premiss. For, according to statistical theory a sample of a hundred or more elements should suffice to get rather precise estimates of the background population *no matter the size of the latter* (e.g. Hays 1973) provided the set is drawn at random as far as the dimensions of interest are concerned. As each of the two cemeteries contains over one hundred graves at least some of the inferences from them should be reliable, therefore; the problem is to decide which of the variables conforms to the specification of randomness. Still, when not everybody in the community has been buried in the cemetery it may be suspected that the selection has been on social grounds. Most of the inferences of my earlier analysis are precisely in that field, and if the graveyard constitutes a selection they are therefore open to statistical criticism.

However, the Elsloo cemetery has been in use for three or four generations, while eight to eleven houses stood in the village next to it (Van de Velde 1979, 145). They will have been inhabited by 40 to 60 people at a time. Summed over the generations between 120 and 250 people must have lived and died there, then. In other words, the Elsloo cemetery received at least half when not all of the village's contemporaneous population and consequently the inferences derived from the analysis should be not too far off the mark — unless one would be willing to assume that people from other Bandkeramik settlements farther away have been buried there, too.

For Niedermerz it has been stated that a considerable but unspecified number of cremations has been lost because of the agricultural use of the land from Roman times onward. Stehli & Lüning (1989) even write that for the use life of the cemetery there must have been a supply of about 1,000 dead bodies, from among whom "only a minority" was buried as corpses, and the remainder as cremations — since lost. They apparently suppose that all the Bandkeramik people from the entire Merzbach area (five to ten settlements) have buried their dead in this cemetery, probably because they cannot positively locate the settlement it belonged to. Again, even if they are right, 112 graves should provide statistically reliable inferences for that population. But then the settlement closest by (c. 500 m) is Langweiler 8, which happens to be the largest and longest inhabited settlement of the whole area (as is Elsloo on the Graetheide), with an occupation which lasted for 14 generations. On the overview plans (see esp. Stehli 1989) that settlement consists of two or three house groups, which merge in the 11th phase/generation, the penultimate phase of the Niedermerz cemetery. To me this is a suggestive analogue to Dohrn-Ihmig's description of the growing together of the two original grave groups at Niedermerz. This certainly is far from anything like a proof for a Langweiler 8 - Niedermerz connection; the proposition is merely a suggestion. However, if so, all figures compare well with those for Elsloo. Stehli's plans of Langweiler 8 show between 7 and 11 houses per generation during the cemetery's use; together 57 houses. If on the average 5 or 6 people have lived per house, then 250 to 350 have died during the six to seven generations of the existence of the cemetery. With slightly over 100 corpses and ten cremations, approximately one third of the original population has been recovered; again, the outcome of the analyses will not be an exact replication of earlier arrangements, but as an approximation it should do — most archaeological traces have much lower recovery rates.

I submit that Stehli and Lüning (1989) have been too fast in labelling and dismissing the Niedermerz data 'exceptional'. As explained above, Elsloo can be seen as unexceptional (even fairly representative) data, too.

3. The missing data

Conceivably gift categories in the graves relate to different spheres of interaction in the past: the 'gifts' may have been tokens for the game on different societal fields (*sensu* Bourdieu). Table 1 presents counts of the grave gifts from the Elsloo and Niedermerz cemeteries as conventionally rendered; categories with less than 5 occurrences have not been entered. In the table, the number of graves with gifts is relatively small: for 21 graves at Elsloo containing thick adzes, another 113-21 = 92 interments do not contain these tools; at Niedermerz 17 vs. 95; and similarly so for the other categories. The number of graves without any gift at all is not negligible: Elsloo has 38 graves without archaeological visible grave goods, and Niedermerz 43 graves. At first sight this scarceness of gifts again suggests the impossibility of valid analysis: from the many empty entries, it might be inferred that correlations are meaningless.

On second thoughts the prospects are less gloomy, as differential preservation per (observable) category *within a cemetery* is rather unlikely: most grave gifts are found at depths of half a metre or more below the present surface, well out of reach of ploughing. Hence it can be said from a post-depositional point of view that what is not there now, has never been there (with the obvious restriction to inorganic materials); no pots now means no pots ever. In other words absence seems relevant to early practice and may not be interpreted as *missing data* — a 'nought' entry is rather more appropriate than an empty cell therefore, providing a firm footing for computations. Against this it will be observed that individual gift categories are rather thinly represented, except pots. If they each and every one relate to a different societal field, then that social formation must have been very diverse, when not fragmented.
It seems more likely that sets of categories jointly refer to such fields — high correlations should be indicative here.

But then I still owe an account of the various reasons which may individually or jointly contribute to the absence of gifts. Age or rank, and gender are important social parameters in every social formation, and probably the most important ones in neolithic communities (e.g. Conkey 1991, 67); there is a fair chance that they will be expressed in the grave gifts one way or another.

On an *a priori* account, and assuming random sampling from the original population, approximate estimates can be given for the socio–demographic composition of cemeteries of communities similar to the Bandkeramik:

= regarding rank: 30% children (perinatal mortality not included), 60% adults, and 10% elders.

= regarding gender: half of the adults, or 30%, are females, the other half males; for the remainder not applicable (30% children, 10% aged) — it will be noted that I consider gender classes for adults only.

Table 2. Relative chronology of a number of graves at Niedermerz as indicated by a Principal Components Analysis ('scores'), and as presented by Dohrn-Ihmig ('phase').

scores	grave nrs.	phase	scores	grave nrs.	phase
-3.50	15	-	0.05	11	3
-2.41	40	1	0.07	34	4
-1.13	35	2	0.11	49	4
-1.05	4	-	0.12	22	3
-0.96	41	2	0.14	45	3
-0.73	20	4	0.18	14	4
-0.52	58	2	0.20	60	4
-0.39	55	3	0.26	77	4
-0.37	83	3	0.28	107	4
-0.28	51	2	0.31	31	5
-0.27	37	4	0.49	114	4
-0.26	6	4	0.97	28	6
-0.22	54	3	0.97	44	-
-0.14	32	4	1.40	23	6
-0.10	98	5	1.40	25	6
-0.09	99	5	1.40	29	6
-0.07	68	2	1.40	100	6
-0.07	46	3	1.40	102	6
-0.01	13	5	1.40	115	6

Both factors are susceptible to contingencies, too, for in a society with restricted resources not every burial will have been accorded all customary appurtenances normally due. If several independent gift categories are equally indicative of a similar status, then some of the relevant graves will possibly contain all categories and also some graves none, whereas a fair number will be doted with either of the gifts. Accordingly, it can be seen that not all missing gifts are missing data in a strict sense: there are graves with no observable gifts at all which nonetheless cannot rightly be classified as *missing* data as their indicators have never been there; at the same time they can neither positively be recognised from the grave gifts nor distinguished from truly missing data.

Therefore the numerical significance of missing data is probably not really important in the two cemeteries: the distribution of grave gifts is sufficiently stable to support further analysis.

4. Relative chronologies

The Elsloo graves have been dated mainly by means of a Principal Components Analysis of the decoration on the pots in the graves. There is no need to repeat those computations here.[1] Rather more to the point is the computation of a comparable ordering of the Niedermerz graves as Dohrn-Ihmig's chronology was achieved in a different (and so incomparable) way. At Elsloo, the relative chronology was calculated from counts of the main elements of decoration: lines, points, hatching and stab-and-drag; also, the use of single– and multidented spatula was incorporated. Other attributes of the pot decorations were not chronologically relevant there (Van de Velde 1979, 85). At Niedermerz multidented spatulas have not been used on the pots in the graves; this variable was left out of the computations, therefore. Most other variables do not seem to have chronological significance either: motives nor structures, not even presence of rim decoration can be considered relevant. This leaves only four attributes for the computations for Niedermerz: the numbers of lines, points, hatches, and stab-and-drag points in the decoration. 38 among the 112 graves held decorated pots, 10 from the Northern and 28 from the Southern grave group.

Results are presented in table 2, where the factor (component) scores are shown as computed from the decoration of the pots in the graves (cf. Van de Velde 1976; 1979, 8, 20-24); the third column renders the phases from a seriation of 15 'stylised attributes' of the decoration of pots (Dohrn-Ihmig 1983, 92, 95). The correlation (Spearman's ρ) of the PCA scores and the seriation phases is 0.76, which is not bad given the fundamentally different assumptions and techniques.[2]

The relative chronological ordering of these 38 graves more or less confirms Dohrn-Ihmig's observation of two separate nuclei in the graveyard which in the later phases merged. In table 2 the Northern group (graves nrs 62 and higher) does not appear in the older phases; the first entry for that group (nr 83) is listed only after eight burials in the Southern group of the cemetery. The earlier graves in the Northern group which Dohrn-Ihmig incorporates (nrs 74, 84, 92, 96) have been dated by her through shards *in the graves' fillings* (Dohrn-Ihmig 1983, 95), which strikes me as unjustified. In the present table only true grave gifts (i.e. from the bottoms of the grave pits) have been entered in the computations.

5. Gendering the burials, Elsloo

As part of the present exercise I checked the logic behind my 1979 argument on the gender of the burials. I would now rephrase it partially as follows: if the Bandkeramik knew a sexual division of labour (i.e., a definition of gender grounded in the economic) then it is likely that this division was expressed with different sets of grave gifts. More specifically, if two classes of gender have been differentiated in the death rites, then two separate tool kits should be discernible in the graveyard's inventory. I also assumed that assemblages not manifestly female, should not automatically be interpreted as male burials, and *vice versa*. Finally, not everybody will necessarily have been defined according to gender, as children and aged will have been categories outside the primary division of labour, probably.

A Principal Components Analysis of the correlations among the gifts was used to get my first bearings on the data. One of the Components correlated with thick adzes, blades, undecorated earthenware, and especially with arrowheads. Another Component was neutral to these tools, but instead showed affinities with 'querns', red ochre, and flat adzes. I then hypothesised that the arrowheads were more likely a male attribute than female — to avoid unnecessary andro-centric bias I added the condition that only if a consistent pattern would follow I should trust the assumption. More or less compelled by this initial argument the 'querns'/ochre Component was interpreted as a female expression. The two groups indexed by these Components were of equal size: 21 burials each.

On inspection of the geographical distribution of the graves it occurred to me that the distances between graves of opposite gender (as established above) were consistently smaller than between graves of equal gender, they seemed paired; apparently pair-bonding reflected and transcended the primary division of labour. A Nearest Neighbour Analysis brought out many more such couples, numbers of which had one element attributed to either of the two groups, with the partner graves having none or no characteristic gifts (cf. tab. 3). By extension the unrecognisable partner grave should contain the remains of the opposite gender. This resulted in a list of 71 graves (Van de Velde 1979, tab. 18) with 25 male, 13 probably male, 21 female, and 12 probably female interments — "probably" indicating the Nearest Neighbour argument. A major miss in my 1979 text was not to have presented an explicit summary, which would have strengthened my case considerably as it clearly showed the consistent patterning I was after to validate my assumptions.

Table 3. Average Nearest Neighbour distances between the graves at Elsloo. R: nearest neighbour coefficient (R=0.0 one position only; R=1.0 random dispersal; R=2.15 regular hexagonal grid). Van de Velde 1979, tab. 38.

	distance (m)	R	n
all graves	2.78	0.96	111
M - M	5.62	0.90	25
F - F	5.97	0.87	21
F - M	2.55	-	10
F - x, M - x	2.26	0.36	25

Table 4 (meant to correct my earlier omission) clearly shows *three* sets of gifts: two specific to gender and one general category. Male interments are identified by thick adzes and arrowheads as burial gifts, and female graves from lumps of red ochre and 'querns'; undecorated ceramics is a general category, as are decorated

Table 4. Frequencies of grave gift categories at Elsloo arranged according to gender classes.
Computed from Van de Velde 1979, tab. 18.

	female	male	unclear
plain ceramics	13	19	7
decorated ceramics	17	14	6
lumps ochre	15	2	1
'querns'	9	1	1
arrowheads	2	10	1
blades	7	7	1
thick adzes	2	15	-
flat adzes	6	7	2
total	33	38	42

earthenware, blades, and flat adzes[3]. Additionally, each grave has a selection only, rarely all of the relevant gifts: between none and all of the gender specific categories are represented, and similarly so from the general categories. I.e., there are two sets (one gender specific, and one general) incorporated in every (adult) inventory. I think this so-called polythetic composition of grave gifts — no doubt a general feature in many more cemeteries — has been the most important barrier in archaeological attempts at gender recognition (including Elsloo and Niedermerz) in cemeteries.

6. An analysis of the anomalies

When for the sake of argument the conclusions derived from table 4 are provisionally accepted, then the several anomalies in it call for consideration and explanation.

Thus, there are two graves with lumps of ochre which have been incorporated with the *male* group (nrs 1 and 14). Apart from the ochre, they also contain a small bundle of arrowheads at the knees (grave 1) or a single arrowhead with the tip behind the head (grave 14); thick adzes are present in both graves, too, as are blades in grave 1. In other words, the masculinity seems rather emphasised, perhaps to compensate for the ochre. Below, I will argue that the sexes were on an equal footing in the cemetery — hence, *macho*-exclusivity will not have been appreciated, and an occasional reference to the opposite gender may not have been too incorrect politically. In my earlier account (Van de Velde 1979, tab. 18) I incorporated grave 14 with the 'female' group; I would rather join it to the 'males' now; if so, then its partner grave (nr 13, without gifts) should switch from the 'male' to the 'female' column. The plain and decorated ceramics associated with grave 1 in the table should also be removed, as they have been found in the grave's fillings near the surface.

A thick adze in a *female* grave (nr 83) is accompanied by ochre and a 'quern', a small decorated pot, a sickle blade, and a flat adze at the head end of the grave pit; the thick adze was found at her feet. Here again the gender (femininity now) is emphasised by the presence of the two gender specific gift categories, as if to compensate for the thick adze; as before, an explanation may be sought in the equal status of both gender classes.

In the table, there is a male grave with a 'quern' (nr 71); also a thick adze, three blades and decorated earthenware have been found with this cremation. The shape of the 'quern' is very different from the other 'querns' in this cemetery: Modderman (1970, 57) explicitly labels it a 'whetstone' (*Schleifstein*), in contrast to all other 'querns' which are called 'rubbing stones' (*Reibsteine*) in the descriptions of the graves. I submit that this anomaly may be removed from the list; below I will no more speak of 'querns' but of 'rubbing stones' instead.

In my earlier text (p. 89) I devoted some text to an "ambiguous" grave (nr 87), which I was "inclined to think of as a rich female". The gifts in that grave included a rubbing stone and red ochre, 2 blades, an adze of the rare type I, and a flat adze, too; here, an arrowhead was responsible for the ambiguity. However, this arrowhead was found higher in the grave than the other gifts, and may therefore be unintended; if so, the ambiguity of the female attribution disappears.

Another female grave with an arrowhead (nr 106) held a body that "had apparently been *killed* by the arrowhead … as it was sticking into her skull" (Van de Velde 1979, 89, emphasis original; also cf. Modderman 1970 (II), pl. 160). Apparently, this arrowhead had a more functional than a ritual nature.

An anomaly not apparent in table 4 is that of a male grave (nr 21) with two arrowheads (and some more goods); one of the points seems to be localised in the shoulder region, possibly in the spine, the other one perhaps in the head (cf. Modderman 1970, pl. 130; the second point is shown in the section only, not in the plan and may therefore be situated elsewhere), and may once again have been an agent of death rather than a ritual deposit.[4]

When these mutations and corrections are applied to the data in table 4, table 5 is the result. The distribution of the gift categories over female and male graves shows significant χ^2-values for red ochre and rubbing stones as female indices, and for arrowheads and thick adzes as male indicators, leaving the other categories (decorated and plain ceramics, blades, and flat adzes) as general grave gifts.

It seems not unduly speculative to see here a confirmation of my assumptions — I may be accused of *bourgeois* ideas, yet I think that a division of labour to gender (though differently constructed from society to society) is quite universal. As Murdock noted long ago, it is the structure of this division, not its specific contents, which

Table 5. Frequencies of grave gift categories at Elsloo arranged according to gender classes, and anomalies mended. Computed from table 4, with accountable anomalies removed. χ^2, Chi–square values computed over male and female columns; in 95% of the cases $\chi^2 \leqslant 3,84$ at $v = 1$.

	female	male	unclear	χ^2
plain ceramics	11	17	7	1.29
decorated ceramics	14	15	8	0.00
lumps ochre	15	2	-	11.57
rubbing stones	12	-	-	12.00
arrowheads	-	10	-	10.00
blades	12	7	1	1.90
thick adzes	1	16	-	11.57
flat adzes	7	7	1	0.00
total	34	38	41	

is universal (Murdock 1949, 7; also, for a recent reformulation, Conkey/ Gero 1991, 8). Something similar holds for pair-bonding, the constitution of couples from opposites, too (Conkey 1991). These inferences do not imply in any way that Bandkeramians lived in nuclear families; elsewhere I have shown that they rather formed stem extended families — in this (patrilocal) case, father and son plus their wives and their unmarried children (Van de Velde 1979, 149).

A little bit of a sideline, in my 1979 text I did not emphasise the two violent deaths I then thought to have seen (graves nrs 14 and 106); in the primary publication (Modderman 1970) no such inference was made at all. Meantime, we have been treated on the Bandkeramik atrocities in the Talheim massacre (Wahl/ König 1987) and from other prehistoric periods as well (e.g. Louwe Kooijmans in press), and we have also become more conscious of our romantic drives when pursuing the past (Shanks/Tilley 1987), so that now I do not hesitate to draw attention to the possibly unnatural end of the individual in grave nr 21 (and, perhaps, but with reservations, grave 25, too). Which means that among 113 graves, at least three are witness of a less than peaceful neolithic; it should be added that death by clubbing, or killings by adzes (as so clinically described by Wahl/König 1987) cannot be made out at Elsloo, simply because the skeletons have been dissolved before this could be discovered.

7. Gendering the burials, Niedermerz

For the Niedermerz cemetery the excavator has published her interpretations regarding gender (esp. Dohrn-Ihmig 1983). Yet there is one statement in that essay which makes me distrusting of all other points she made:

'Wealthy graves' … are 29 in number. They are interments of male persons exclusively. … Beyond that, the 'male' status may have additional meanings, such as e.g. 'respected'. … Among the graves with only one or two categories of gifts the majority should be classified 'female'. It is the absence of certain grave gifts which characterises the female graves (Dohrn-Ihmig 1983, 100–102).

There are two reasons for my suspicion: one ideological (I am not really prepared to assume without further discussion a male dominated neolithic), and another methodical (if this were true of the Niedermerz cemetery, and if my Elsloo analysis above is acceptable, then there should have been major differences in social structure between the two regions. At a distance of no more than 40 kilometres this would really pose a problem).

Accordingly, I reworked the Niedermerz data along similar lines as in the Elsloo analysis. To no avail, however: the Principal Components did not distinguish between tool kits, but scaled wealth or diversity of the graves' inventories only — and this even on an absence/ presence basis. Except for the arrowheads (which went into the assumptive part of the argument) no gift categories could be reasonably partitioned off as distinct or independent tool kits: to my despair all combinations seem to occur, even though lately Zimmermann (1988) has been able to establish several distinct tool kits in the Aldenhoven *settlements*.

Dissatisfied I turned the procedure on its head, and started from a Nearest Neighbour Analysis of the geographical distribution of the graves; if it may be assumed that the division of labour is visible in the tool kits, then graves of opposite gender should be paired. I also hoped that for a sufficient number of grave pairs at least one would be interpretable as either 'male' or 'female', from which I would then be able to derive the attributes of either gender. The Nearest Neighbour Analysis is summarised in table 6 (see also the appendix).

The distances within pairs are quite small as compared with the mean nearest neighbour distances; the prospects for further exploration seem promising. However, a listing of the grave inventories of these pairs resulted in only ten "recognisable" males, from whom ten putative females could be deduced.

The distributions of the gift categories over these pairs of graves are presented in table 7. The exclusivity of the arrowheads does not carry any weight as it was the only criterion for a 'male' attribution of a grave. It is apparent from the table that flat adzes perhaps should be considered male indices, too. Regrettably, no gift category suggests itself as a 'female' index.

Taking flat adzes in consideration for the paired graves, the previous table becomes table 8; another six grave pairs are added. Only one contradiction emerges in the arrowhead

Table 6. Nearest Neighbour Analysis of grave distribution at Niedermerz.

Average Nearest Neighbout Distance, all graves:	1.2 m	n= 112
Expected Average Nearest Neighbout Distance:	1.5 m	$R = d_O/d_E = 0.80$ ($p = 0.28$)
Number of recursive pairs:	27	
Average distance within these pairs:	0.7 m	

in grave 96 which can perhaps be related to its partner grave (nr 93) which contains much more flint than any of the other graves, and also 2 flat adzes. However, in this enlarged set still no specifically female grave gift is turning up, only male graves seem to be marked differentially.

Of course, the next step is to add all graves containing arrowheads and/or flat adzes (as in tab. 9); that way the solution suggested by one of the Principal Components is approximated. The problem remains that no specific female index is apparent among the surviving elements of the graves' inventories, and one is *almost* forced to agree with

Table 7. Frequencies of grave gift categories at Niedermerz arranged according to sex, as inferred from a Nearest Neighbour Analysis.

	male	female
plain ceramics	2	1
decorated ceramics	7	5
lumps ochre	3	1
rubbing stones	2	1
arrowheads	10	-
blades	2	1
thick adzes	3	2
flat adzes	6	-
	10	10

Table 8. Fequencies of grave gift categories at Niedermerz arranged according to sex, as worked out from table 7.

	male	female
plain ceramics	3	3
decorated ceramics	8	8
lumps ochre	5	1
rubbing stones	2	2
arrowheads	11	1
blades	6	1
thick adzes	4	3
flat adzes	11	-
	16	16

Dohrn-Ihmig's inferences quoted above, viz., that as far as presently perceptible male graves in Niedermerz are marked by wealth, and female graves by the absence of grave gifts. Note that even if all 'other' graves were added to the 'female' inventories still no gift category could be singled out as an index for this latter set.

However, if 30 graves stand out as 'male', it does not obtain that the 41 graves with no male-specific gifts (and presumably those other 41 without grave gifts at all, too) are 'females': some may belong to elder people or children (i.e., have had statuses of non-adults and thus possibly beyond the gender dichotomy), or even to 'undistinguished' males as proposed by Dohrn-Ihmig. The possibly 'female' graves inferred from the Nearest Neighbour Analysis are entered separately, and all the other graves with grave gifts have been headed as 'others' in the table, and not as 'female'. The remaining 36 graves without any archaeological obvious offerings constitute a different set, as they do at Elsloo.

8. Discussion

In the Niedermerz data, a partition of the grave goods into separate sets has not been possible: a Principal Components Analysis registered only the amount of gifts in the graves. However, from a Nearest Neighbour Analysis flat adzes have been recognised as a possible male attribute (assuming a male context for arrowheads; cf. tab. 7, 8). The graves without arrowheads or flat adzes supposedly belong to the opposite sex and/or to non-adult status categories. To assume that *all* graves not so marked were of female gender would imply a much de-emphasised, or even a negatively defined female ritual. Possibly, the partner graves of male burials stand a better chance of having been female. The remaining graves should incorporate some females, too, but also people not in that category (children, aged, some males). After all, one would expect approximately similar counts of female and male (adult) graves (as described in an earlier section), and not the dissimilarities as in table 9. On *a priori* grounds it seems probable that at least half of those "others" should have been female; no identification criterion has been found.

Table 9. Frequencies of grave gift categories at Niedermerz, with arrowheads and flat adzes considered 'male' attributes χ^2, Chi–square values computed over male and female columns in 95% of the cases $\chi^2 \leq 3,84$ at $\nu = 1$.

	male	female	other	χ^2
plain ceramics	8	3	12	0.39
decorated ceramics	14	8	16	0.00
lumps ochre	13	1	3	4.98
rubbing stones	5	2	4	0.00
arrowheads	22	1	-	9.40
blades	12	1	4	5.20
thick adzes	9	3	2	0.37
flat adzes	18	-	-	9.00
with grave gifts	30	16	25	
without gifts			41	

In her account, Dohrn-Ihmig ends up with a slightly different list of male and female graves (Dohrn-Ihmig 1983, 112-114). Her starting point apparently has been — she is not explicit here — a morphological analysis of the teeth found in 30 graves (by A. Czarnetzki, and summarised in Dohrn-Ihmig 1983, 105-111). From the results, she probably has inferred the gender specific grave gift categories; unfortunately, the contents of the nine odontologically identifiable female graves are little distinctive.[5] As in the present text, in Dohrn-Ihmig's account social gender and biological sex are not equated: four discrepancies among 22 cases are reported (Dohrn-Ihmig 1983, 107).

Regarding the gender indices, there is a difficulty with the logic of her argument, though. Dohrn-Ihmig sets out from the archaeological wisdom which associates arrow-heads to male activities (p. 71, acknowledging Modderman 1970, 67), and which is not falsified by the odontological identification. She then observes that among the 24 graves with arrowheads, 19 also possess adzes. Therefore, adzes should be reckoned male attributes as well, according to her. This 'male' identification is then extended to all graves with an adze, even when they do not contain any arrowhead.

Two problems: There is also an allusion here to Pavúk's analysis of the Nitra graveyard (Pavúk 1972); however, Nitra is quite a distance away, and one wonders about its analogical relevance for the Niedermerz analysis (Hodder 1982). More important though is the following: in this part of her argument Dohrn-Ihmig does not differentiate between thick and flat adzes, yet I contend that if either or even both of the two adze types have been in use as 'general' (i.e., not gender specific) tools then the inference of adze bearing graves being male is invalid. The disjunctive distributions of both types, each occurring in 16 graves with at the most only two overlaps (or possibly one only; p. 72) indeed appear to point to different functions.[6]

A further instance can be found in my 1979 analysis of the nearby and partially contemporaneous Elsloo cemetery (Van de Velde 1979, 89). The Nearest Neighbour Analysis summarised in tables 7 and 8 also suggests separate associations of the two adze types, and going by this more restricted inference, table 9 has been calculated; for what it is worth, on the evidence of table 7 I still consider the flat adzes markers of male graves, while the thick adzes may have been in general use at Niedermerz.

9. On the status of the burials

It is difficult to establish criteria of status which do not immediately remind us of our own society. That is to say, all of the literature dealing with authority, status and power from Marx and Weber onwards to and including Foucault and Bourdieu, associates social standing with differential access to the means of production (including women-producers) and products. In archaeological texts superiority is usually translated as association with goods: wealth and status, authority and power are almost inevitably equated. Elsewhere I have sought to go beyond this facile association (Van de Velde 1990), the outcome remained similar, however — differential power was expressed in differences in material wealth in Bandkeramik society. I will therefore propose a grading of the burials according to the number of artefacts in the graves, and another one to the number of gift categories, in the awareness of a very high correlation of both measures.

Table 10. Elsloo and Niedermerz, burial rites (Van de Velde 1979, 182; Dohrn–Ihmig 1983, 96, 114).

	Elsloo	Niedermerz
inhumations with gifts	55	66
inhumations without gifts	11	36
cremations with gifts	29	5
cremations without gifts	18	5

There may be other criteria, though, for which we do not possess the apposite interpretation — cremation *vs.* inhumation, or orientation suggest themselves as possible though presently unintelligible alternatives for the counts of furnishings of the graves. Table 10 compares the numbers of burials at Elsloo with those at Niedermerz as regards to what are commonly called the burial rites. Nothing very different emerges, except for the larger number of cremations recovered at Elsloo or the larger number lost at Niedermerz: if comparable, Niedermerz should have had some 75 cremations instead of the ten reported. Table 11 presents summary data on the orientation of the graves in both cemeteries. Note that the directions of the graves in the

Table 11. Elsloo and Niedermerz, graves' orientations. a: direction of the head when perceptible; b: direction of gravepit axis when head's position indeterminable, including the graves listed in table 11a.

	Elsloo	Niedermerz
a. direction of the head:		
S	-	1
SW	-	22
W	1	3
NW	11	1
N	1	6
NE	-	32
E	-	2
SE	9	-
b. direction of the gravepit axis:		
W-E	10	11
NW-SE	48	2
N-S	8	12
NE-SW	3	77
not clear	44	9

two yards are at cross angles to each other: at Niedermerz the SW-NE orientation is favoured, while at Elsloo the NW-SE azimuth appears predominant. Within both sets of graves about equal numbers are aligned to opposite directions as far as still can be discerned. Dohrn-Ihmig (1983, 61) infers family relations between burials on the basis of similar alignments. If this were extended to its logical consequences it would entail either an "All in the Family" for almost the entire Niedermerz population (as in tab. 11b) or the existence of two lineages (NE heading, SW heading; tab. 11a) since the deviants are really few in number. There is also an implicit tautology behind it: in small communities like Niedermerz, people are *inevitably* kin to one another, if not by blood then by affiliation, and if not by affiliation then by neighbourhood — and possibly along all three lines together at the same time. This holds for Elsloo, too, of course.

The perpendicular orientations of the graves at Niedermerz and Elsloo may be instances of Bourdieu's "cultural distinction": being close to one another (less than 40 km distant) the communities will have been aware of each other's customs on the one hand, and on the other they will have had sufficient reasons to elaborate their differences. Modderman (1970, 75) already pointed to the differences in general orientation between Elsloo and Central German burials; he related them to different directions of the *houses* in both areas. Yet the houses on the Aldenhoven Plateau have similar directions as those in Dutch Limburg, while the gravepits do not. The 'sleep' connotation of the majority of Bandkeramik burials (the *Hocker)* suggests a travelling metaphor for death; if so they have been lain along the path towards their destinations: the summer sunset or the winter sunrise at Elsloo, the summer sunrise or the winter sunset at Niedermerz — in order that they may be kept separate after death, too?

To continue along a different tack, table 12 shows the tallies of grave goods in the two cemeteries. All shards in a grave together have been counted as one single artefact, as are traces or smears of red ochre, and of pyrite; the other artefacts have been entered separately. It turns out that the Niedermerz graves have a wider range of numbers than those at Elsloo; moreover, at the latter place the inventories with only few gifts are more frequent than at the former.

Table 12. The numbers of artefacts in the grave inventories at Niedermerz and Elsloo.

	Niedermerz	Elsloo
0	44	38
1	16	22
2	13	21
3	7	7
4	9	8
5	6	5
6	3	2
7	2	3
8	3	2
9	2	1
10	-	-
11	1	2
12	1	2
13	1	-
-		
15	1	-
-		
21	1	-
-		
47	1	-

Indeed, the total count of grave goods is appreciably smaller at Elsloo than at Niedermerz (246 *vs.* 322) although the numbers of graves are almost equal; consequently the average numbers of artefacts in the inventories are different, too (2.18 *vs.* 2.90 per grave). This difference is mainly caused by the two graves with many arrowheads (11, 20 pieces) and one with many blades (25) at Niedermerz which together account for two thirds of the difference. The greater wealth at Niedermerz as suggested by the average numbers of *artefacts* per grave is not very impressive then. When the *categories* are counted instead — viz. presence of ceramics may be attested by a single shard or by 4 pots, etc. — the two distributions look only marginally dissimilar (tab. 13) and the averages do not differ appreciably (about 1.4 categories per grave in both places).

Table 13. The numbers of gift categories per grave at Elsloo and Niedermerz.

	Elsloo	Niedermerz
0	38	44
1	34	30
2	18	12
3	12	8
4	5	11
5	4	6
6	2	-

Allowing for the many more graves with arrow tips at Niedermerz — with their obvious connotations of hunting or war — the differences between the two cemeteries seem to be contingent only, and certainly not of a qualitative nature.

10. Gender and social position

Table 14 presents the gift categories by gender at Elsloo and Niedermerz. As regards the small number of putative female graves at Niedermerz with only 0, 1 or 2 categories not too much weight should be attached, as women's graves

Table 14. Niedermerz and Elsloo: gender *vs.* status as indicated by the numbers of gift categories per grave.

	Niedermerz				Elsloo			
	m	f	?	Σ	m	f	?	Σ
0	14	6	24	44	5	3	32	40
1	4	1	25	30	12	9	9	30
2	5	-	7	12	9	9	-	18
3	3	4	2	9	7	5	-	12
4	3	3	5	11	4	5	-	9
5	1	1	4	6	1	2	-	3
6	-	-	-	-	-	1	-	1
total	30	15	67		38	34	41	

cannot positively be discerned there: their scanty occurrence in the table is entirely due to analytical bias. The at first similar frequencies for the two genders there may even turn out to be an *under*-representation, as the number of female graves in that table is exactly half that of the male burials; if the numbers were equalised, more female graves would be in the wealthier categories than male ones (the 'undecided' category amply allows for that). Needless to say that this is the opposite of one of Dohrn-Ihmig's inferences:

> "If the social standing of the dead in the community is … mirrored in the grave inventories [at Niedermerz], then the position of the men should have been higher than that of the women, in common with many other traditions" (Dohrn-Ihmig 1983, 102).

On the other hand, if the figures are not too much biased by the low numbers, the distributions from both cemeteries hardly differ in their steepness: Niedermerz had only a few more gifts in the wealthier graves than had Elsloo, be they male or female.

11. Social group membership

Two related topics have still to be discussed: the spatial subdivisions of the cemeteries, and the Bandkeramik definition of group membership.

Dohrn-Ihmig has described the existence of two groups or descent lines in Niedermerz on the basis of the spatial distribution of the graves. The oldest graves are in the centres of the northern and the southern halves of the cemetery, neatly separated by a low rise in the field. More graves have been added later, and in the final phases the two groups have merged (cf. the section on chronologies). A Kmeans cluster analysis of the geographical distribution of the graves supports that conclusion; even with four or five groups imposed, the border between the north and the south halves remains between the same graves (nrs 64/65 and 66) which is precisely the axis of the ridge between the two centres. Dohrn-Ihmig, though, puts the border a few metres to the South, between graves 61 and 62 (Dohrn-Ihmig 1983, 68); she does not present her reasons for that line.

At Elsloo I laboriously derived a grouping of the graves into four geographical sets on the assumption of similar inventories per set (Van de Velde 1979, 96). I ended up with two only slightly dissimilar alternative groupings (p. 98) and preferred one above the other mainly on the basis of a more even count of male and female graves in the groups. The rejected solution is almost identical to the one turned out by a Kmeans cluster analysis of the grid co-ordinates of the graves: for three, four and five groups the same borders between the groups are indicated. Being grounded in both sociological and distributional reasoning I still prefer the other partition for the strictly geographical clustering result; as Dohrn-Ihmig also did for Niedermerz. The four geographically defined groups at Elsloo held different counts of the several gift categories; this distribution could quite simply be related to generalised linear exchange relations between the four groups. At Niedermerz only two groups are represented in the cemetery; if they reflect social groupings and if our understandings of neolithic societies are correct, they have exchanged gifts in a symmetrical system (cf. Van de Velde 1979, 101 plus references). That is, between them the two groups would of necessity have exchanged women and smaller presents to lubricate their relations; some gift categories should be more frequent in one group then the other, and different categories the other way around.

Table 15. Distribution of artefacts over the grave groups
$\chi^2 \leqslant 3.84$ for $\nu = 1$ and 95% significance.

	North	South	χ^2
plain ceramics	11	14	0.00
decorated ceramics	15	40	7.73
hematite	7	13	0.93
rubbing stones	3	8	1.47
arrowheads	15	57	10.13
scrapers	5	1	2.66
blades	31	25	1.79
other flint	13	4	5.90
thick adzes	5	11	1.01
flat adzes	11	13	0.00
total	51	60	

Table 15 shows the counts of artefacts in the two groups; significant deviations from marginal equality are seen only with decorated ceramics, arrow tips, and 'other' flint. Correcting for the 'specialist' graves (arrowheads, flint blades, other flint), only decorated ceramics and blades have significantly unexpected distributions over the two groups, the Southern grave group being dominant in both cases; again, important gift categories seem to have vanished from the inventories (also cf. the section on gender, above). It seems to me that on the evidence at hand (two deviant categories among ten) inferences about group relations become no more than educated guesses, and the case must be dropped.

Finally, the Bandkeramik definition of group membership. In my 1979 analysis (see esp. p. 112) I noted that in the Elsloo cemetery the structures of ceramic decoration (curvilinearity and rectilinearity of design) were asymmetrically distributed over the sexes. In male graves rectilinear and curvilinear decoration occur side by side, in female graves only one or the other. An explanation can be provided by assuming matrilineal affiliation — males being wedded to the other moiety than that of their birth (group exogamy may always be assumed) they would be associated with both moieties at death, while the females expressed their birthright until their final hour. The matrilineal inference was corroborated by the subsequent analysis of the settlement debris.

One of the reasons for writing the present paper is curiosity about the state of affairs in this respect on the Aldenhovener Platte. Table 16 sums up the evidence for Niedermerz, and compares it with Elsloo. Apparently, the Niedermerz Bandkeramik had similar combinatory rules for the pottery in the graves. It is clear that the groups have been exchanging labels/names/symbols — one way or another they sought to express a kind of (habitual) relationship which in our language is translated as matrilinearity. With all the differences between Niedermerz and Elsloo Bandkeramik, one of the most basic structures of these societies, viz., the rules of intermarriage and alliance are similar; they even find expression in the same medium: pottery decoration.

12. On the balance, concluding remarks

My final discussion bears on method, technique, and a number of substantial differences and agreements between the two Bandkeramik cemeteries of Niedermerz and Elsloo.

This essay began with a discussion of the representativity of Bandkeramik graveyards regarding their cultural and demographic background populations. Contrary to received wisdom there should hardly be problems in the two cases analysed. Firstly, with over one hundred graves each, the statistical basis for inferences is sound, no matter the number of missing dead. Secondly, on the demographic side that figure which is sometimes estimated to run into the thousands, can more realistically be put at two hundred at the most (and that is a conservative estimate). Hence, (social) inferences from the cemeteries will not be wildly off the mark although the statistical condition of (socially) random selection for incorporation into the graveyard has probably not been met.

As regards missing data in the graveyards, its incidence should be rather small (barring organic materials) as most grave gifts have been buried at depths of 50 cm or more, out of reach of plough and erosion. As long as the bottoms of the graves — where the gifts have been deposited — are visible in the excavations, nothing would suggest differential post-depositional processes *within a graveyard as a whole*. Both at Niedermerz and at Elsloo the grave gifts were elements of polythetic sets: sometimes only one, sometimes two, and sometimes no gifts were given to the dead.

To analyse the grave gifts I used a number of computational techniques in conjunction: Principal Components Analyses as an heuristic, but Nearest Neighbour Analyses were necessary to extend the outcome to more data. After these general approaches I also had to regroup the graves' inventories manually, assisted by χ^2-tests to arrive at my final results.

The Elsloo and Niedermerz graveyards show partially different styles of burials. Generally, the Niedermerz graves have slightly more contents than the Elsloo ones. Noteworthy is the preference for a NE-SW orientation of the graves at Niedermerz in contrast to the general NW-SE direction at Elsloo. Also in the former graveyard two lineages have buried their dead, and in the latter four groups made use of the burial ground.

The Dutch grave gifts lend themselves to an interpretation in terms of a gender division, whereas the Rhenish material is difficult in this respect. In both places male indicators are arrow tips and adzes: thick adzes at Elsloo, and flat ones at Niedermerz. At Elsloo rubbing stones and red ochre are indicators of female gender but an equivalent female set of gifts cannot be reconstructed from the surviving remains at Niedermerz. That way, females come to be defined as "¬M" ('non-male'), as if there were no independent female sphere attested in the grave gifts at Niedermerz. As other dimensions have been represented in similar ways in the two cemeteries (e.g., male representation, emphasis on main orientation, amounts and ranges of gifts in individual graves, pair-bonding, grouping in larger groups, matrilinearity, etc.) it looks as if female burials at Niedermerz have been marked by gifts made from perishable material such as shells or wood, since lost.

There are two consequential differences between Dohrn-Ihmig's analysis and mine. Firstly, she considers all adzes a male index — it then follows that almost all graves with two or more gifts belong to males, leaving the poorer graves to females and 'undistinguished' males. My Principal Components Analysis suggests a separation of thick and flat adzes (in line with an earlier analysis of the use wear of these tools by Dohrn-Ihmig), which results in a less lopsided distribution of wealth over male and non-male graves. Secondly, her end list of 'male' attributes for the Niedermerz cemetery also includes rubbing stones and red ochre (also contrary to my findings), precisely the indices of 'female' burials at Elsloo. If the Elsloo cemetery were interpreted following the Niedermerz criteria then hardly any female, only poor graves would be left there — which is my major problem with the Niedermerz study.

There are also notable similarities between the two cemeteries, of which the signification of matrilineal affiliation of the dead is sociologically the most important. Perhaps because of these matrilineal tendencies, female graves have comparable amounts of grave gifts and so equal statuses for Bandkeramik women and men can be inferred at both graveyards. This is contrary to Dohrn-Ihmig's interpretation of the data where males are accorded higher statuses.

It should be emphasised that the inference of matrilinearity is crucially dependent upon the correct derivation of male and female grave gift categories. If the analysis would prove insufficient on this point, then this arrangement cannot be maintained as the structure shown by table 16 would cease to exist. However, in my 1979 essay I have shown that the highly structured distribution of Bandkeramik settlement debris can be explained only from matrilineal arrangements between the lineages in the villages (Van de Velde 1979, 150), and not in any other way; this provides a kind of *construct validation* for the matrilineal inference from the graveyard, and beyond that even for the gender indices at the root of it.

Tabel 16. Distribution of decorative designs by gender. C: curvilinear design; R: rectilinear design data for Elsloo from Van de Velde 1979, 195.

	Elsloo				Niedermerz			
	M	F	x		M	F	x	
C or R	7	16	3	26	9	8	14	31
C & R	6	-	2	8	4	-	3	7
total	13	16	5	34	13	8	17	38

Finally, the basic social structure is apparently similar in both cemeteries: matrilinearity is fairly evident. Yet the geographical separation of the two habitation areas — Aldenhovener Platte for Niedermerz, and Graetheide for Elsloo — has had historical effects in the emergence of different cultural specialities (a geographical variation on the theme of 'cultural distinction', as described by Bourdieu) such as an emphasis on hunt or war at Niedermerz, a slightly more egalitarian society at Elsloo, and that weird phenomenon of distinct main orientations of the grave pits. That way it has been shown that within our category 'Bandkeramik' considerable variation (albeit on common themes) should be acknowledged, even over relatively small geographical distances.

notes

1 In fact, although the original ordering has been established through the SPSS-package on a mainframe computer, and my present statistics are worked out in SYSTAT on a Macintosh PC, there was a one-to-one correspondence of the outcomes as regards the relative chronology.

2 The high correlation between the two orderings attests mainly of Dohrn-Ihmig's profound knowledge of the local Bandkeramik sequences (e.g. Dohrn-Ihmig 1973) as it seems rather unlikely that our widely divergent techniques would have such remarkably similar results. For instance, her description of the decoration at the basis of the seriation is logically inconsistent as the attributes are of a composite nature instead of either irreducible elements or an exhaustive array of all possible combinations (Van de Velde 1976). Also, the method of seriation is logically faulty as all variation in the data is supposed to be on one single dimension only (Audouze 1974), which is interpreted as chronology; social, economic and geographic differences (sources of variation) are not considered. Finally, the computing technique of seriation is mathematically suspect as there is no stable outcome irrespective of the order of data entry (Graham *et al.* 1976). It should be remarked that until recently the other members of the former Aldenhovener Platte Project (e.g., Stehli, and even Ihm) used the same technique for their chronologies. Principal Components Analysis has less assumptions, and yields stable results; also the use of attributes rather than types in the computations is logically more consistent.

3 In 1979 I also incorporated undecorated ceramics with the male grave furnishings. This category is indeed assymetrically distributed among the putative gender classes, with a preponderance in male graves, while the reverse is true for decorated ware. However, as discussed below, closer analysis shows that the differences are not significant.

4 Something similar may have been the case with the interment in grave 25 (cf. Modderman 1970, pl. 132) although the evidence is more ambiguous.

5 There are some minor inconsistencies in her text. E.g., grave 84 is labeled 'female' on p. 107, but is incorporated among the 'male' graves in the table on p. 112; or grave 72 which is 'male' on p. 107, *vs.* 'undefinable, probably female or child' on p. 113.

6 Why Dohrn-Ihmig ignores an earlier analysis of hers (Dohrn 1980) is not clear to me. On the bases of usewear and hafting she distinguished thick adzes from flat ones, worked as planes and as chisels, respectively. Moreover, in a study of adze distributions (in which I did not differentiate to type) I found that they were significantly related to the larger settlements, and within the villages to the larger housetypes (Van de Velde 1990) — from which it can be inferred that there is more about them than simple technotools. The one unquestionable double occurrence in the Niedermerz cemetery (grave nr 93) being precisely in a grave with a very 'outlandish' inventory renders it a dubious contribution to Dohrn-Ihmig's argument; the other twin occurrence (grave nr 60) could have been occasioned by the later cremation grave nr 61 cutting into it (Dohrn-Ihmig 1983, 72).
With separate distributions of the two types as in Niedermerz, it is small wonder that one Principal Component shows bipolar characteristics for the two types, with loadings of –.75 and +.66, and correspondingly strong separation of the associated graves. However, Dohrn-Ihmig reports that a Factor Analysis did not bring out a separation of the two (Dohrn Ihmig 1983, 72).

APPENDIX:
LISTINGS OF GRAVES ACCORDING TO GENDER, NIEDERMERZ

From a Nearest Neighbour Analysis the following recursive pairs have been derived (with approximate distances between parentheses): 1-3 (1.7m), 4-9 (1.3m), 5-6 (0.4m), 10-14 (0.8m), 11-12 (0.8m), 15-16 (1.3m), 18-19 (0.8m), 22-23 (0.4m), 27-28 (0.8m), 31-115 (0.8m), 34-35 (0.4m), 43-44 (0.4m), 47-48 (0.8m), 50-51 (0.8m), 55-58 (0.8m), 56-57 (0.4m), 64-65 (0.8m), 68-71 (1.3m), 69-72 (0.8m), 75-83 (0.4m), 86-87 (0.4m), 93-96 (0.4m), 94-95 (0.4m), 98-102 (0.8m), 99-107 (0.8m), 100-103 (0.4m), 109-110 (1.7m).

If the pairing of the graves is indicative for pair-bonding, then the following graves would qualify as 'female', assuming arrowheads and flat adzes as 'male' indices (between parentheses the 'male' partner graves): 01 (03), 10 (14), 15 (16), 22 (23), 28 (27), 44 (43), 47 (48), 50 (51), 58 (55), 65 (64), 68 (71), 95 (94), 96 (93), 98 (102), 103 (100), 107 (99).

Table 17. The probably male graves at Niedermerz as indicated by the presence of arrowheads and/or flat adzes compared with an odontological determination
cols. 1: catalogue numbers of probably male graves
cols. 2: anthropological determination (from Dohrn-Ihmig 1983: 107)
Other graves listed as 'male' by Dohrn-Ihmig (1983: 112), and not included in the table above: 8, 13, 14, 16, 23, 24, 28, 30, 44, 49, 84, 86, 89, 91, 106.

1	2	1	2	1	2
02	-	39	f ?	66	m
03	-	41	m	71	?
07	-	43	-	77	m
13	m ?	45	-	90	-
14	?	48	f ?	93	-
16	?	51	m ?	94	m
23	-	55	m ?	96	-
24	m	60	f ?	99	m ?
27	m	62	-	100	m ?
37	-	64	-	102	-

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A Tale of the Unexpected: Neolithic shaft mines at Valkenburg aan de Geul (Limburg, the Netherlands)

In the first part of this paper we focus on the principal characteristics of a lithic raw material type known as Valkenburg flint and on chronological aspects of its use in prehistory. In the second part the results of a trial excavation at a recently discovered procurement site with shafts and galleries at Valkenburg aan de Geul are dealt with.

1. Introduction

During a survey in 1970 geologists came across a series of prehistoric flint procurement sites in the valley slopes near Valkenburg aan de Geul (Felder/Bosch 1971a, 1971b). The type of flint extracted was named Valkenburg flint after the municipality concerned. A preliminary inventory of archaeological finds from the region showed that some workshops and exploitation zones had been known to local amateur archaeologists for a long time (Brounen *et al.* 1993). In private collections, dating back to the thirties, rough-outs for axes and several (fragments of) antler "picks" were present (Eggen 1971; Felder 1975a). The antler tools had been found in a chalk-rubble deposit which formed the top layer of chalk pits that had destroyed parts of the procurement sites Hoorensberg/Geböschke and Schaelsberg (fig. 1) (ibid. Brounen *et al.* 1993).

It was assumed that the flint nodules had been extracted in shallow open pits, dug into the weathered chalk (Felder 1975a, 1980; Felder/Bosch 1971a). Surface finds of flakes and rejects indicated that the raw material had been processed at the quarry sites as well as in workshops in the surroundings (Felder 1975a, 1980). The latter waste concentrations are situated at the edge of plateaus, up to 5 kms from the primary sources. At both types of sites predominantly rough-outs for axes seem to have been produced.

The exploitation zones known are located in the slopes of river-valleys (Geul and Maas) edging the so-called Margraten plateau and in the slopes of dry valleys eroded into that edge.[1]

2. Valkenburg flint

2.1. Sources and characteristics

In a primary geological position Valkenburg flint occurs in the Maastricht lithofacies of the Upper Cretaceous Maastricht Formation in south-west Limburg and a neighbouring part of Belgium (Felder 1975b, 1989; Marichal 1983, 7). Within this formation the vertical distribution of flint layers is limited to a few stratigraphical units (fig. 2). Though in the Nekum Chalk sporadically a flint nodule may occur (Felder 1989, 26; Felder *et al.* 1979, 8), the raw material is found in exploitable quantities mainly in the Schiepersberg and in the Emael Chalk (Felder 1975a, 1980).[2] The horizontal distribution of flint nodules within these beds varies locally. In some places there is a concentration of these, whereas in others only a few scattered nodules can be found or none at all (Felder/Bosch 1971a, 10). In the Schiepersberg Chalk their shape is mostly irregular, but locally even tabular and nodular flints occur (Felder 1980, 568, 1989, 25). In the Emael Chalk the flints are more or less evenly shaped (ibid., 26). Especially the tabular nodules can be strikingly big (Felder *et al.* 1979, 7, 40), up to a few meters long and some decimetres thick.

Besides the natural outcrops of chalk where flint in a primary position was won, the raw material could be extracted from residual deposits.[3] These nodules often show natural fractures and contain hidden cracks. They tend to be inferior in quality compared to the *Bergfrisch* (Louwe Kooijmans 1980, 165) raw material.

Since the Maastrichtian chalk was cut by the Pleistocene Maas some of the flints found in an archaeological context can have been gathered in gravel deposits (Heymans/ Vermeersch 1983, 39).

The flint generally is described as coarser grained than the Rijckholt (Lanaye) type, predominantly light grey to bluish grey and brownish grey in colour, matt and granular looking at the fracture and completely opaque (Felder 1975a, 1989; De Grooth 1987; Marichal 1983; Zimmermann 1988). Different kinds of grey and textural differences usually occur within a nodule. The lighter the material, the more coarse-grained, matt and opaque it is.

This however is but one of the two characterised subtypes that at the gross can be distinguished within the range of textural and colour varieties (Pisters 1983). The other one is finer grained, greyish brown, semi-translucent and it has a slight lustre and a smoother looking fracture. It contains many light dots, often only the size of a pin's

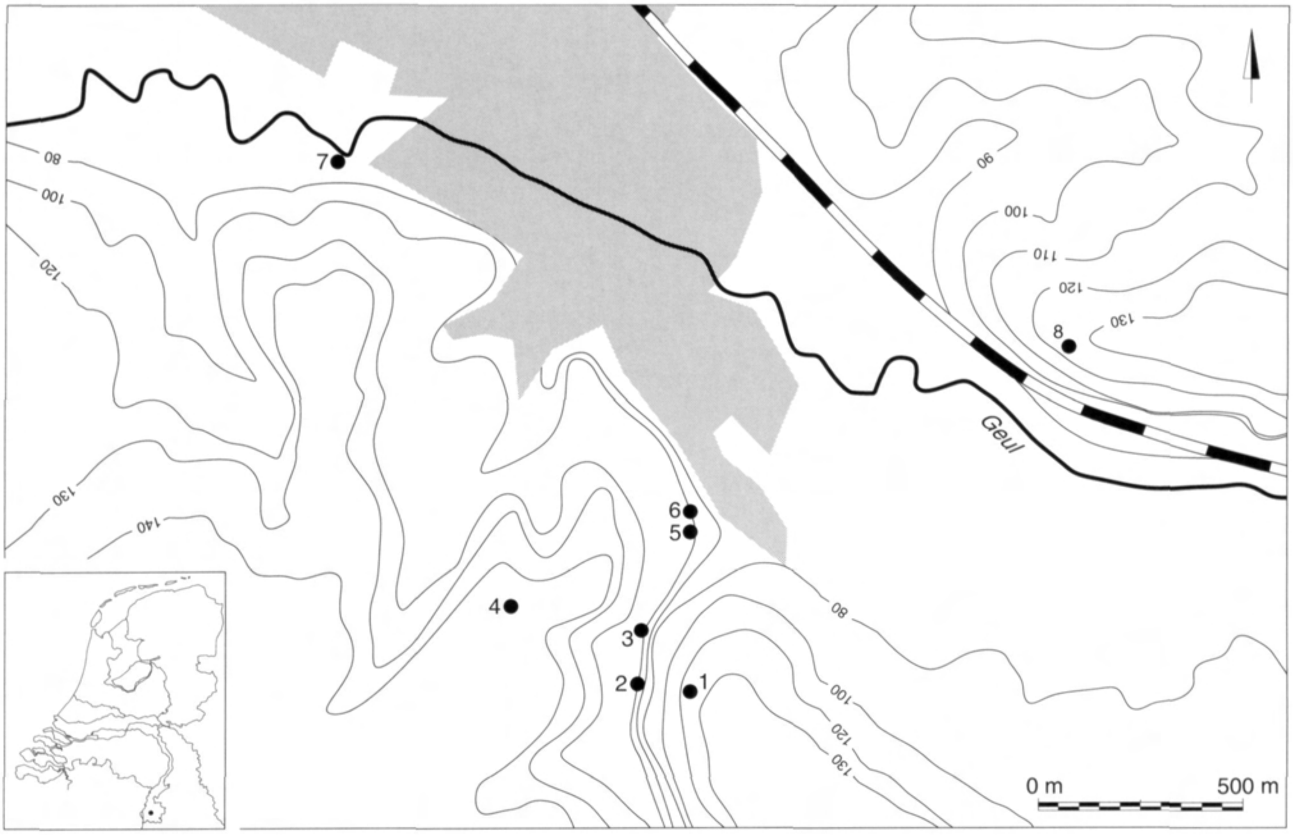

Figure 1. Valkenburg. Location of main sites in the region mentioned in the text. 1. Biebosch mines. 2. Wiegersdel. 3. Chalk quarry. 4. Heunsberg. 5. Sprookjesbos. 6. Hoorensberg/Gebőschke. 7. Plenkertstraat mines. 8. Schaelsberg.

head. As for the granularity it falls well within the range of the Rijckholt type. It is supposed to usually be located under the cortex of nodules of the coarser subtype (ibid.), but "pure" nodules are certainly not the exceptions. Both subtypes have in common that they may be banded and have a granular, rough, but mostly even and rather well delineated cortex of a few millimetres to about a centimetre thick. They differ in their susceptibility to chemical alterations (Pisters 1983, 8). In general it can be put that, irrespective of the subtype, the flint looks coarser grained and more "porous" when it originates from the more or less weathered upper part of the limestone or from residual deposits (Felder 1975a, 1980). The colour then often has changed to a (very) pale brown. Yet it seems that the coarse-grained subtype is more sensitive. In a fresh condition it may easily be mistaken for a variety of Rijckholt flint. Fortunate for the archaeologist it tends to be easier to identify when it is found in an archaeological context. The surface of the artefacts changes in much the same way as the nodules from the weathered and residual deposits have done, that is it shifts to a pale brown on the löss (Zimmermann 1988, 605) or a smudged light grey on (poor) sandy and gravely soils and it has a coarser grained appearance (Pisters 1983). The deterioration of surface finds collected on the calcareous soil of the exploitation zone at the Biebosch (fig. 1) had advanced so far, that Neolithic flakes up to 5 millimetres in thickness were almost completely de-silicified and could easily be broken by hand. The finer grained subtype — as far as we know it from Neolithic surface scatters — patinates at a slower rate. It develops a shade of light blue and becomes slightly more lustrous.

2.2. Chronology and products

Valkenburg flint has been used for the production of artefacts since the Middle Palaeolithic (Janssens 1987, 1989; Kelderman/Wouters 1985; Pisters *et al.* 1984; Roebroeks 1983a, 1983b; De Warrimont, in press; Wouters 1980: 48, 51). The oldest pieces known so far form part of the Saalian Belvédère C and K assemblages (fig. 3) (De Loecker 1992, 1993; Roebroeks 1988). Site K has an absolute age of 250 ± 22 Ka, site C is somewhat older

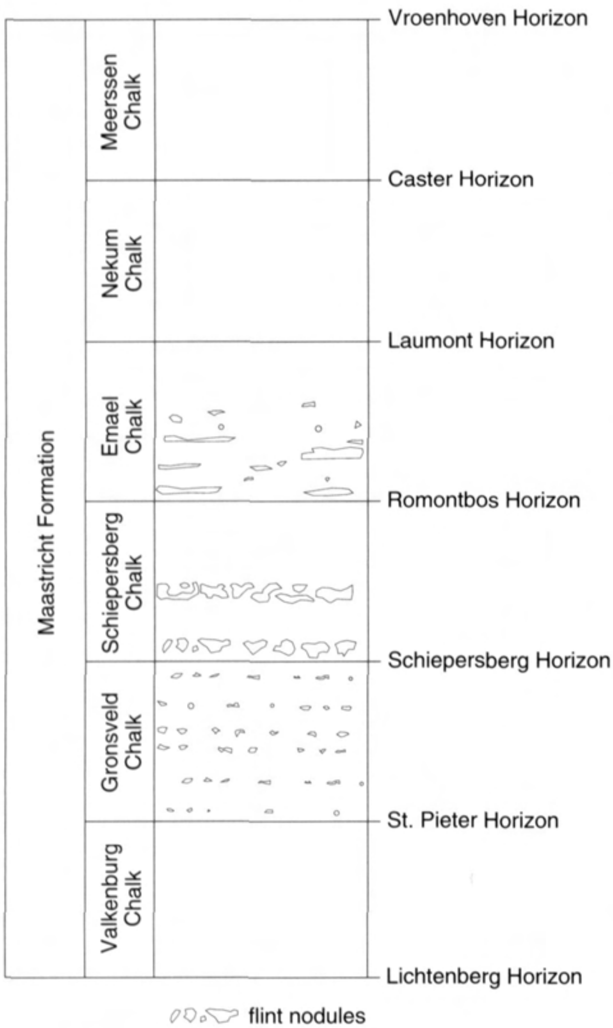

Figure 2. Schematic lithological section of the Maastricht Formation in the Valkenburg region (after Felder et al. 1979).

(ibid.). One of the few typologically datable strayfinds which was found at Wijlre is thought to have been produced in the Eemian or in the first half of the Weichselian (Roebroeks 1983b). Judging from the condition of the cortex, the nodules used were collected in Pleistocene terraces or the streambed of the Maas as well as in chalk cliffs or residual slope deposits.[4] The latter assumption is supported by the fact that several pieces were found close to natural outcrops of Valkenburg flint. The artefact types comprise among other things Levallois flakes and hand axes. The number of indisputable and "uncontaminated" Late Palaeolithic sites in southern Limburg is rather limited. Consequently so are data on the use of Valkenburg flint in this period. As far as known but one of the few excavated assemblages comprises artefacts of this type of flint. At the Late Magdalenian camp site of Eyserheide (Brounen 1987a) 2% of the artefacts were made of it (Rensink 1992). Notwithstanding the rather coarse-grained character of the raw material it was used to produce large blades. An allegedly Late Magdalenian assemblage collected in the slope of the procurement site Schaelsberg (fig. 1) (Arts 1988, 303; Arts/Deeben 1987, 52) comprises blades of Valkenburg flint as well.[5] Apart from a few strayfinds of points (Rensink 1990), Federmesser artefacts from the southern part of Limburg are almost unknown (Arts 1988, 354). The Ahrensburgian site of Valkenburg-Heunsberg (Wouters 1983) has yielded only a few pieces of the flint type under consideration. It is unclear whether these indeed are of Late Palaeolithic age, since the assemblage may be mixed with Mesolithic material. This is indicated by the presence of several pieces of Wommersom quarzite and a surface-retouched triangular point.[6]

Southern Limburg has long been considered to have only very sparsely been inhabited by Mesolithic hunter/gatherers (Arts 1985a, 306, 1985b, 149). A survey of private collections has shown that sites do occur in substantial numbers though (Van der Graaf 1988). A few flakes of Valkenburg flint occasionally occur in these. At Vaals-Vallis (Van Trierum 1980/1981) some pieces were identified, among which is a pick (Marichal 1983, 12). Others are part of a Late Mesolithic assemblage from Schinnen (Voormolen 1994). In the Valkenburg region (*e.g.* Vilt-Scoutshill) small blade cores are found in mixed surface scatters that comprise Mesolithic as well as Neolithic guide artefacts. As the coarser grained flint subtype is not very suitable for the production of bladelets, predominantly the greyish brown, relatively fine-grained facies was used.

It is to be expected that as a result of the non-sedentary mode of life of Palaeolithic and Mesolithic societies and perhaps through exchange occasionally Valkenburg flint artefacts may have been transported for some distance. To our knowledge none are mentioned in literature on the middle and northern part of Limburg and the neighbouring German and Belgian area (*e.g.* Arora 1979; Arts 1988; Lausberg *et al.* 1985; Lauwers 1986; Lauwers/Vermeersch 1982). In general raw material identification for the periods concerned is often frustrated by patination or by colouration that results from the artefacts having been embedded in humid soils. Moreover, since the flint type occurs in alluvial deposits, it may be hard to demonstrate a south Limburg origin for an occasional blade or flake.

From the Early Neolithic A of the new Dutch chronology on the use of Valkenburg flint is no longer practically limited to the source area. In the Linearbandkeramik (LBK) the distribution of the raw material got underway, be it in

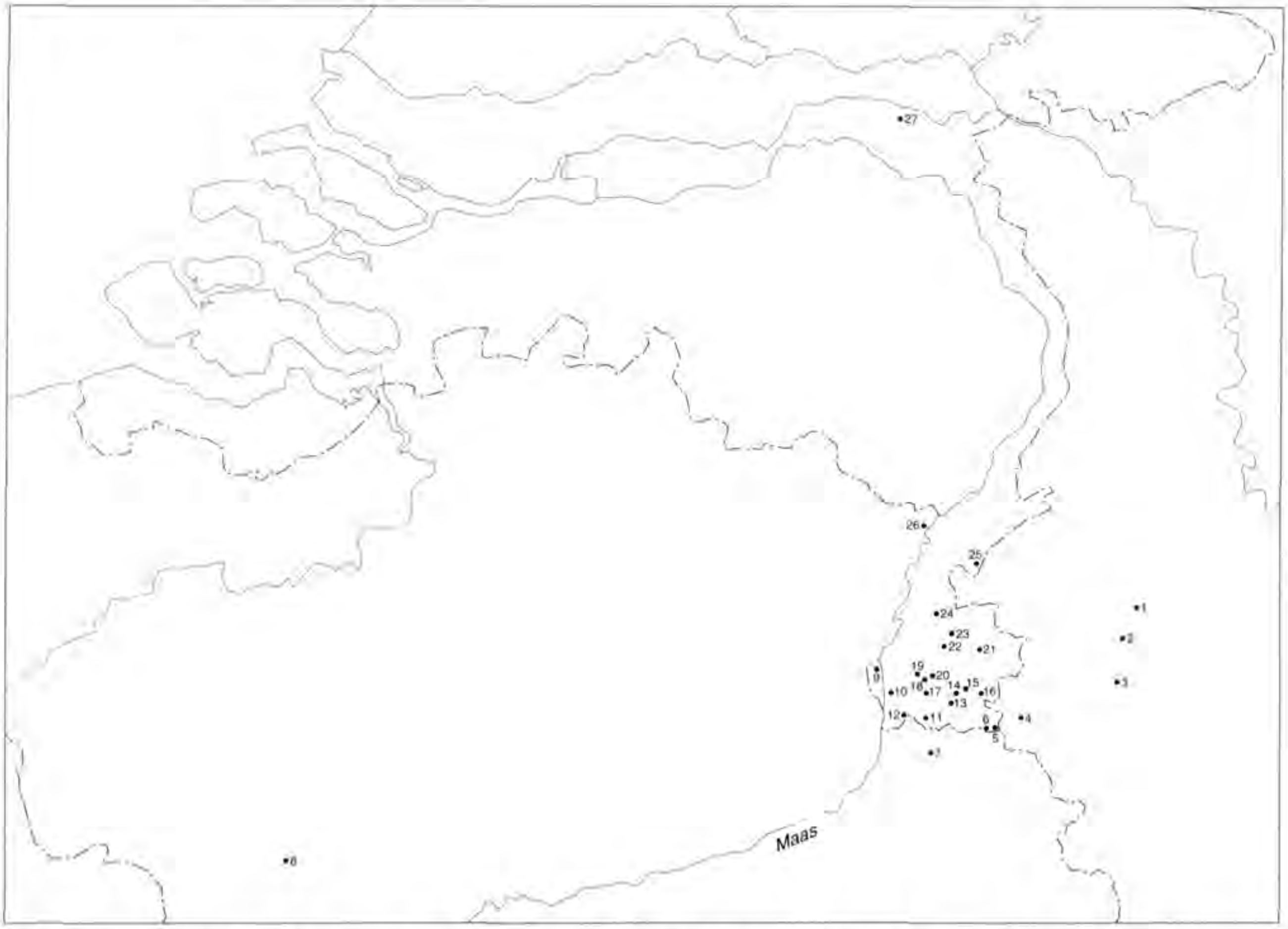

Figure 3. Geographical location of places and sites mentioned in the text. 1. Hasselsweiler. 2. Koslar. 3. Inden. 4. Lousberg. 5. Vaals. 6. Einrade. 7. Rullen. 8. Thieusies. 9. Maastricht-Bélvedère/Klinkers. 10. Maastricht-Randwijck/Aubeldomein/Vogelzang. 11. Banholt. 12. Rijckholt. 13. Gulpen. 14. Wijlre. 15. Eyserheide. 16. Simpelveld. 17. Groot Welsden. 18. Vilt. 19. Geulhem. 20. Valkenburg. 21. Heerlen. 22. Nuth-Grijzegrubben. 23. Schinnen. 24. Geleen. 25. Echt-Koningsbosch. 26. Geistingen. 27. Ewijk.

small quantities and over relatively short distances, that is mainly within the "home range" (Bakels 1978). Inhabitants of several villages within the Graetheide *Siedlungskammer* and from a site belonging to the Heeswater cluster transported nodules 10-15 kms to their settlements and produced mediolithic blades at the habitation site (Groenendijk 1980, 1980/1981; De Grooth 1986, 1987; Theunissen 1990). In the recently excavated settlement of Geleen-Janskamperveld (Louwe Kooijmans 1992; Kamermans *et al.* 1992) artefacts of Valkenburg flint occured in pits of the Older LBK. Finds in the other settlements in general belong to the later phases of the Younger LBK (De Grooth 1987). The Valkenburg flints that were found in several settlements of the Merzbach cluster in the German Aldenhovener Platte area (Langenbrink 1992; Marichal 1983; Zimmerman 1988) reached the consumers in the form of blanks or tools (Zimmermann 1988, 605).

Some remarks should be made with regard to the origin of the flint that was used during the Early Neolithic. From excavations we know that in most Dutch Bandkeramik sites (residual) Rijckholt flint was used almost exclusively (De Grooth 1987). Valkenburg flint was used to a far lesser extent. With these raw material types that occur at several dispersed natural outcrops however it is hard to trace where they were won. De Grooth (1986, 24), presumably referring to the Savelsbosch, correctly argues that Rijckholt and Valkenburg flint could have been collected at one and the same location. Hypothetically the Rijckholt type could even have been transported from Spiennes (*cf.* Kars *et al.* 1990). In the last decade several Early Neolithic artefacts have been found in the Limburg flint region. The recovery rate in the area, that for its richness in lithic finds has since long attracted the attention of many amateur archaeologists, is likely to be relatively high compared to the from a collectors' point of view less "attractable" rather "empty" central parts of the löss plateaus to the north of it. Consequently the seemingly significant relation between the finds concerned and geological aspects of the region may represent nothing more than a small fraction of a veil of artefacts that came into being as a result of the same non-procurement-related activities taking place in different landscapes. After all Linearbandkeramik finds are also known from the middle Limburg coversand area (Brounen 1985; Van der Graaf 1987; Smeets 1991a, 1991b, 1991c; Wansleeben 1987). The proximity of most of the artefacts fore-mentioned to procurement sites leads us to suppose however that they probably were lost or discarded by "working parties" engaged in the acquisition of raw material and probably the production of blanks. A lydite adze and a flake of another one was found at Rijckholt (Weerts 1990), inbetween an exploited outcrop of Rijckholt flint (Schoone Grub) and a Valkenburg flint exploitation zone 750 m to the north of it (pers. com. G. Fonteijn, Duizel). At Banholt-De Hei, at about 250 m from the residual Rijckholt flint procurement site (Nijst 1933), two amphibolite adzes, a number of mediolithic blade cores and some typologically Early Neolithic flint tools have been collected over the years by H. Nelissen (Banholt). A lydite adze was found at the same site by M. Vandewall (Eckelrade).[7] At two locations quite near to the exploitation zone at Valkenburg-Schaelsberg a lydite adze, two concave-based asymmetrical projectile points and some mediolithic blade cores were found by H. Pisters (Valkenburg) and G. Weggemans (Strucht). Another adze forms part of the lithic inventory of a site at Valkenburg-Emmaberg (coll. H. Pisters). Furthermore adzes are known from the Simpelveld region and from two sites in the surroundings of Gulpen (Brounen 1987b).

The distribution of Valkenburg flint artefacts in small numbers and in the form of blanks seems to go for the Early Neolithic B as well (Marichal 1983; Zimmermann 1988, 605). 1.4% of the flints at the Rössen settlement site Inden 1 were produced from this raw material type (ibid.). In the Netherlands only one Rössen site has been discovered and investigated so far (Brounen/Dijkman 1988; Louwe Kooijmans 1988). Though it is situated at less than 3 km from a procurement site, Valkenburg flint is almost absent in the assemblage (Oude Rengerink 1991, 28-29).

With the introduction of the flint axe, replacing crystalline rock adzes and related tool types, the specific properties of Valkenburg flint seem to have led to a gradual intensification of its use. Being coarse-grained and thus tough — that is relatively shock-resistant — it is well suited for tools that fulfill a heavy duty task. It should be noted that the assumption of an increased production for the moment rather is based on observations at and data from exploitation zones and workshops, than on the number of tools recovered in individual settlement sites. The use of Valkenburg flint for the production of axes starts in the Middle Neolithic A, at an early stage of the Michelsberg Culture (MK). At Koslar 10 a flake of a polished Valkenburg axe was found in a pit, in association with pottery from the older phases of the MK (Marichal 1983, 8). The assemblage from the site comprises a few artefacts more of the raw material type concerned, among which are two other fragments of axes (ibid.). In all Valkenburg flint forms less than half a per cent of the totall flint inventory (Höhn 1984).[8] At Maastricht-Klinkers (Theunissen 1990) likewise but a few pieces were found (ibid; Schreurs, this volume). The fill of a refuse pit at a recently discovered MK site at Maastricht-Vogelzang contained the edge of an axe (coll. B.Knippels, Maastricht). In an assemblage from a rather uncontaminated MK surface scatter at Valkenburg-Heunsberg, presumably representing a settlement site, the flint type is present among other things in the form of macrolithic scrapers and large blade cores (coll. H. Pisters). A similar site at Nuth-Grijzegrubben revealed some waste material, robust scrapers and a flake of a polished axe (coll. A. van Deijck, Hoensbroek).

With the MK not only changed the way in which the raw material was used, but the distance across which it was transported also increased. MK-associated Valkenburg flint artefacts have been found in the coversand region of middle Limburg (pers. com. M. Wansleeben on HVR 22) and in the river area, at sites of the Dutch facies of the MK, that is Hazendonk 2 and 3 (Louwe Kooijmans/Verhart 1990; Verhart/Louwe Kooijmans 1989). It mostly concerns fragments of axes. In mixed assemblages from two sites in Westphalia a blade scraper and a fragment of a robust blade were identified, that typologically may belong to the MK (Arends 1990; Gaffrey 1990).

The maximum exploitation of Valkenburg flint seems to have happened in the period following that of the MK. Indications for this primarily come from the procurement sites themselves. Radio-carbon dating of antler fragments from three different quarry sites indicated that the exploitation had taken place in the Middle Neolithic B and the Late Neolithic A (fig. 24) (Felder 1981). Recent excavations have fortified this information (cf. below). In cultural terms the dates are contemporary with the Stein component of the Wartberg/Stein/Vlaardingen Complex (De Grooth 1991; Louwe Kooijmans 1983). In the archaeological record this is corroborated by the presence of Valkenburg flints in excavated assemblages of the culture group concerned. At Ewijk, a Vlaardingen site in the river area, some flakes of polished Valkenburg axes were found (Asmussen/Moree 1987, 101). The fill of a refuse pit (HW 1/433) at Hasselsweiler 1 contained "Vlaardingen" pottery and among other things several artefacts of Valkenburg flint (Schwitalla 1984, 58)[9]. The raw material of a number of axes that antecedent to the excavation of the rather uncontaminated (Louwe Kooijmans 1983) Stein Group site Echt-Koningsbosch 27 were collected at the surface, at the time was described as "quartzitic flint" (Van Haaren/Modderman 1973, 11). Meanwhile these tools have appeared to be made of Valkenburg flint (pers. com. J. Schaap, Geleen). Furthermore there are several surface scatters with Stein and *Jungneolitikum 2* pottery or guide artefacts, that have yielded Valkenburg flints (Aldenhovener Platte 1977, 496, 532, 1979b, 386-400; Schreurs 1991; Arora 1986a). The artefacts of this raw material type that have been excavated at the mixed Stein Group site of Geistingen (Heymans/Vermeersch 1983) are thought to have been produced on flint from gravel deposits (ibid.:39).

Flint artefacts that typologically can be attributed to the Late Neolithic Beaker period are not scarce in private collections in Limburg. Some of the tanged-and-barbed points observed are made of Valkenburg flint, that admittedly may have been collected in gravel beds. The number of pottery fragments (Beckers/Beckers 1940; Bursch 1933, 92) and assemblages from indisputably "pure" sites in the southern part of the province on the other hand certainly is very small. As the Beaker cultures in general preferably used local raw materials, excluding the artefacts of exotic flint acquired through exchange, it can be assumed that this will have been the case in the area concerned too. Nevertheless not a single "unimpeachable" piece of Valkenburg flint from this period can be traced in literature or in collections. As far as mention is made of sites, there is always the problem that the assemblages seem to be mixed. At Vilt (Pisters/Schrooders 1987) for example among other things tanged and tanged-and-barbed points occur, which as a rule are thought to be part of the lithic inventory of respectively the Stein Group and the AOO/BB phases of the Beaker period. Though the latter type of point is considered to occur in the Belgium S.O.M. (Cauwe 1988, 54), the data-base for the Late Neolithic of the southern Netherlands for the time being does not allow for a similar conclusion regarding the Stein Group. In other words a mixture of artefacts belonging to different cultures in the assemblage fore-mentioned is likely. This problem goes for an interesting settlement site at Heerlen (Van Deijck 1987), where at a rough estimate about 70% of the artefacts is made of Valkenburg flint, as well.

On the eventual post-Neolithic use of the raw material little can be said. The Bronze Age in southern Limburg is a major *Forschungslücke*. Apart from burial mounds (Beckers/Beckers 1940; Hooijer 1961) and a number of strayfinds of bronze axes (*e.g.* Brounen 1988; Willems 1983) the area still is devoid of cultural remains. In the neighbouring Rhineland and at Maastricht-Aubeldomein fragments of Valkenburg flint axes have been found in Early Iron Age refuse pits (Arora 1986b, 33; pers. com. B. Knippels, Maastricht). Leaving out of consideration the possibility of contamination with older artefacts, the occasional use of "pick-ups" can not be ruled out. A regular production of Valkenburg flint tools after at the latest the Early Bronze Age for the moment seems rather unlikely (*cf.* Gronenborn 1992, 186; De Grooth 1991).

In the Roman period the use of the raw material finally changed to that of building stones for the foundations of villas.

In conclusion it can be put that Valkenburg flint, like most other suitable lithic raw materials, was used throughout a large part of the stone age. It has in common with other flint types as well, that a long period of equable low level use is followed by an intensification of the procurement, in a period when its specific lithological properties best met the requirements of a new artefact type, that is axe blades. Judging from the data available so far, the exploitation seems to have been "stepped up" at a lower rate than that of Rijckholt flint. It may have culminated at the time when the procurement of the latter flint type was gradually levelling off compared to the preceding Middle Neolithic A (*cf.* De Grooth 1991). With the intensification of the production the geographical distance across which the products were distributed augmented as well, which once again is not different from to the "behaviour" of other flint types.

2.3. Associated raw materials

A supplementary indication for the cultural identity of the miners in the Valkenburg region might be several finds of Lousberg flint axes in the above-mentioned workshops (Pisters 1986; database Valkenburg project). Lousberg axes from the southern part of the Netherlands are preferably assigned to the Stein Group (Gronenborn 1992; Louwe Kooijmans 1983; Modderman 1980a). Apart from a single blade of this raw material type that has been found in a secured Vlaardingen context in the western Netherlands (Louwe Kooijmans 1983, 62; Verhart 1990, 577) and from a flake of an axe at Hasselsweiler 1/433 (Schwitalla 1984), the finds from most (assumed) settlement sites form part of assemblages that were collected on the surface or in the ploughzone. This goes for Dutch sites (Van Haaren/Modderman 1973; Schreurs 1991, 90) as well as for several *Jungneolitikum 2* sites in the Rhineland (Aldenhovener Platte 1979a, 327, 1979b, 393; Arora 1986a). In Drente fragments of a Lousberg axe have been found at a surface site of the contemporary TRB-culture (Beuker 1986). Some of the southern Lousberg axes collected may have belonged to members of the Michelsberg Culture population (Gronenborn 1992; Van Haaren/Modderman 1973, 17; Louwe Kooijmans/Verhart 1990; Weiner 1986). Besides by C14 dates from the procurement site itself, the assumption is fortified by finds at for example Koslar 10 (Aldenhovener Platte 1981, 256), Hambach 11 (Gronenborn 1992), Thieusies (Vermeersch/Vynckier/Walter 1990, 7, 63) and in the above-mentioned surface scatter at Nuth-Grijzegrubben. An assemblage from the southernmost part of Limburg (Einrade-Holset: Arora/Franzen 1987, 27) comprises besides Lousberg and Simpelveld flint artefacts some tanged-and-barbed points (observation by one of the authors), which may extend the span of quarrying at the Lousberg into the Beaker period. Affirmation for this is given by Gronenborn (1992, 186), mentioning some tanged-and-barbed points made of the raw material type under consideration. So it appears that the time span in which Lousberg flint was used for the production of axes is too long to make these tools a satisfactory chronological marker for workshops and thus flint exploitation in the Valkenburg region.

Another raw material type that stands out for its "exotic" quality should be mentioned, namely Romigny-Lhéry flint (Arts 1986; *cf.* De Grooth 1983). A handful of artefacts, comprising unpolished robust blades, blade-tools and a large triangular projectile point, is part of a typologically well datable Michelsberg Culture assemblage collected at a surface site at Valkenburg-Heunsberg (*cf.* above). The association of this flint type from northern France with MK guide artefacts goes for several sites in middle and northern Limburg and the Rhineland too (Höhn 1984; Mooren 1993; Smeets 1993). For the south Limburg löss region a number of artefacts from the MK surface scatter at Nuth-Grijzegrubben and from a MK refuse pit at Maastricht-Vogelzang (coll. B. Knippels, Maastricht) can be added.

3. The Biebosch excavation

Untill recently information about the nature of the extraction of Valkenburg flint was limited to a hypothesis that mainly was derived from geological characteristics of the procurement sites (Felder 1975a). In order to verify it, the Institute of Prehistory of Leiden University (IPL) carried out a trial excavation in 1990 and 1991 at a site called Biebosch (Brounen 1992). The place-name refers to a wooded promontory along the Geul valley to the south-east of Valkenburg (fig. 1). About half-way the slope of the headland a zone where nodules had been extracted could be traced for more than 1500 m through the mapping of flint debris on the surface.

In testpits the assumed practice of open exploitation was confirmed by the uncovering of shallow diggings with a maximum depth of about 1.9 m. Higher up the slope a trench of 5.5 m long, 1 m wide and 3 m deep, sunk into the solid Emael chalk, was discovered. At both extremities it appeared to be extended with small subterranean workings, which made this extraction point a true flint mine. The largest of these measures 2.5 m long by 1.5 m wide. A narrow passage in its side-wall connected it with the gallery of an adjacent mine.

Among the excavated artefacts antler objects were conspiciously absent. The miners' implements consisted almost exclusively of notched flint picks, so-called *Kerbschlägel* (Aldenhovener Platte 1980, 281; Weiner/Weisgerber 1980).

In the chalk-rubble deposit of the trench the remains of a hearth were found that contained charcoal particles of *Alnus spec.*. By means of radio-carbon dating the age of the mine was established at 4330 ± 60 BP (GrN-19832), that is between 3280 and 2780 cal B.C. (fig. 24; Brounen *et al.* 1993).[10] This result, that is quite in accordance with the date known for another exploitation site in the Valkenburg region (Felder 1981), indicates that the flint from the Biebosch mine has been extracted by miners of the Stein Group.

4. Flint mines at the Plenkertstraat

4.1. Introduction

In consequence of the Biebosch research a survey for other features connected with an underground extraction of flint was instigated. At several locations to the south of Valkenburg such prehistoric cavities were discovered in man-made chalk-bluffs (fig. 1). Some of these can be seen in a rock-face at the edge of the Sprookjesbos (*cf.* Felder 1975a). In an abandonned chalk quarry lying in the west slope of the Sibbergrubbe a partly sectioned shaft was observed. It cuts through several meters of löss before reaching the chalk deposits. Its precise depth is unknown at the moment but it certainly surpasses 4 meters. In the following another site — situated opposite of hotel Brouwers and the Leeuw brewery in the Plenkertstraat (fig. 8) — will be dealt with.

In januari 1992 workshops on the plateau bordering the south slope of the Geul valley were surveyed. The artefacts collected represented a facies of Valkenburg flint that was thought to originate from a hypothetical procurement site somewhere along the Plenkertstraat (Pisters/Schrooders 1987). The subsequent visit of a bluff with nodules of this specific type of raw material in the Plenkertstraat led to the recognition of three cavities (fig. 4) that clearly showed characteristics of prehistoric galleries (Brounen 1993; Brounen *et al.* 1993). They had been cut as a result of chalk

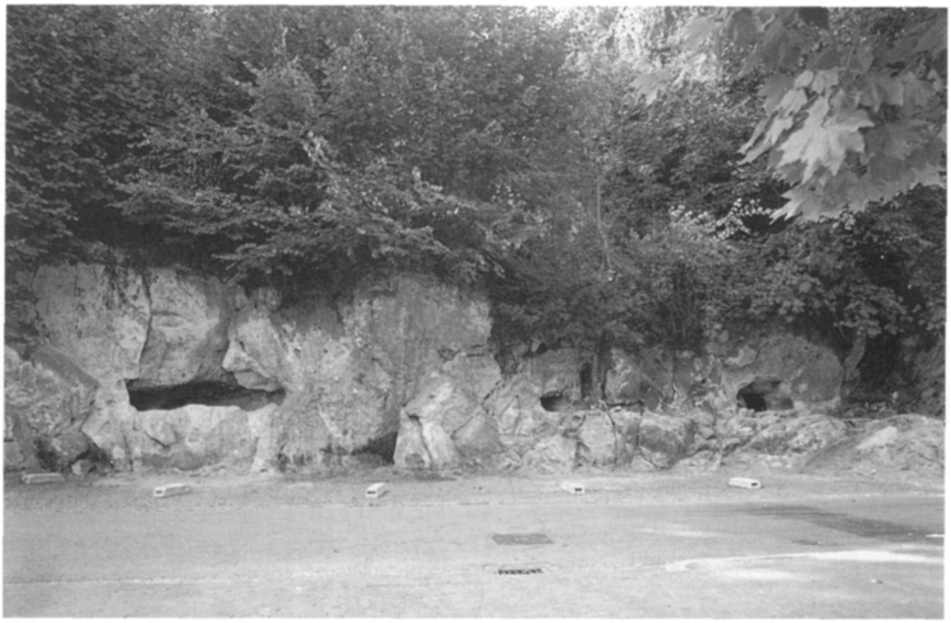

Figure 4. Valkenburg-Plenkertstraat. Galleries (mines I, II, III) cut by chalk quarrying.

quarrying. When an adjacent part of the rock-face opposite of the Leeuw brewery was examined two partially sectioned shafts were discovered (fig. 5). From their dimensions and shape and from the geological aspects of the site it could be inferred that these features represented an unexpected phenomenon for the Valkenburg region, that is deep shaft mining.

Consultation with the provincial archaeologist of the State Service for Archaeological Investigations resulted in the task of valuating the relics, so an opportunity for research presented itself. In the summer of 1992 the IPL executed a trial excavation at the site. The investigations comprised the documentation of visible remains and a search for hidden features in a plot of about 40 × 10 m. Most of the shafts and galleries discovered were investigated by means of test pits and trenches. The aim of the excavation was to assess the extent and the nature of the exploitation, to collect a sample of flint waste and tools and to gain datable material from the fill of the mines.

The investigations formed part of a research project that was subsidized by the Foundation for Archaeological Research (ARCHON), which is subsidized by the Netherlands Organization for Scientific Research (N.W.O.).

4.2. Location and geology

In contrast to the Biebosch mines, that are situated halfway the slope of a dry valley, these Plenkertstraat mines lie in the foot of a slope that joins the Geul valley bottom. The lower part of the slope has been dug off, most probably because of road construction and the building of a gunpowder mill in the early 19th century or previously (fig. 6). On that occasion a zone with hypothetical traces of open extraction and flint production may have got lost. What is left is a narrow remnant of an exploitation zone, only a few meters wide and displaying the remains of several mines that strangely enough have never been identified as such since their exposure.

The average altitude of the resulting rock-face is about + 73 N.A.P. (Dutch Ordinance Level). Its height does not surpass 5 m.

In the investigated part of the bluff three units of the Maastricht Formation can be distinguished (fig. 7): Nekum, Emael and Schiepersberg Chalk (*cf.* Felder 1975b). These relatively soft but solid beds are separated by horizons of shell debris: the Laumont and the Romontbos Horizon. At the site and in its vicinity the rock has cracked into large vertical slabs and smaller blocks.

The maximum dimensions of tabular flint nodules observed in the Emael Chalk at the Plenkertstraat site are about 55×12 cm. As only the upper part of the Schiepersberg Chalk was exposed, no observations on flint in that bed have been done. From literature and observations at other geological exposures it is known that these nodules can reach considerable dimensions.

4.3. The mines

Within a strip of 40 m seven mines have been discovered, each some 5 m apart from the other (fig. 8). None is intact nor is any of them fully excavated. As a

Figure 5. Valkenburg-Plenkertstraat. Upper part of a shaft (mine IV) sectioned by chalk quarrying.

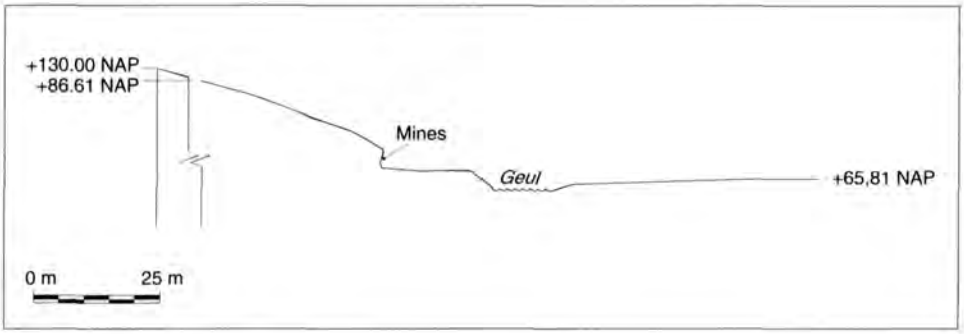

Figure 6. Valkenburg-Plenkertstraat. Cross-section of the lower part of the valley slope and the Geul valley bottom.

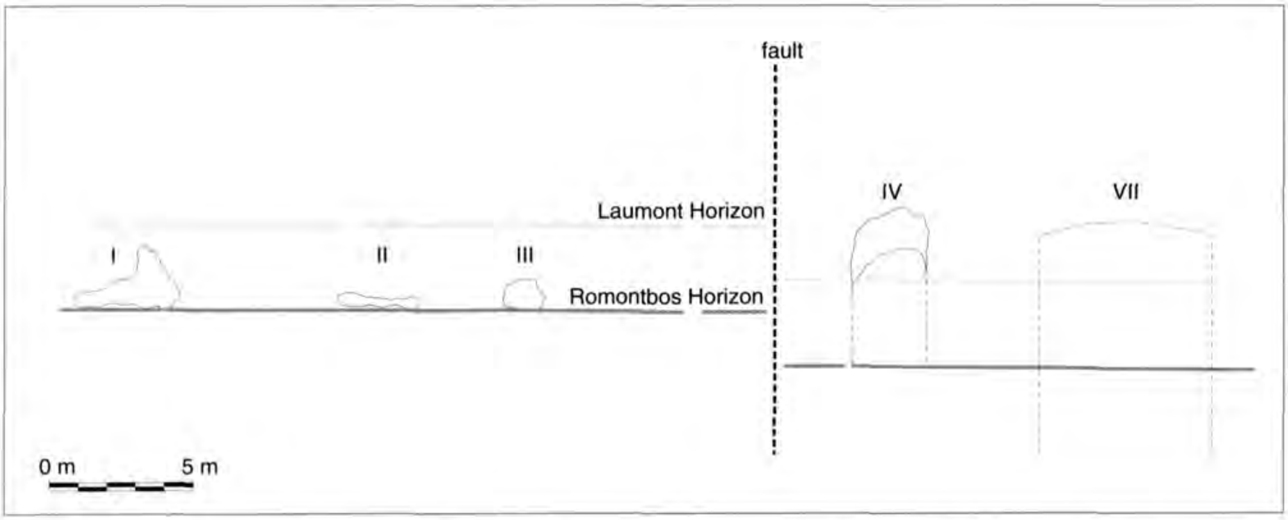

Figure 7. Valkenburg-Plenkertstraat. Lithological section of the Maastricht Formation with the position of the mines I, II, III, IV, VII.

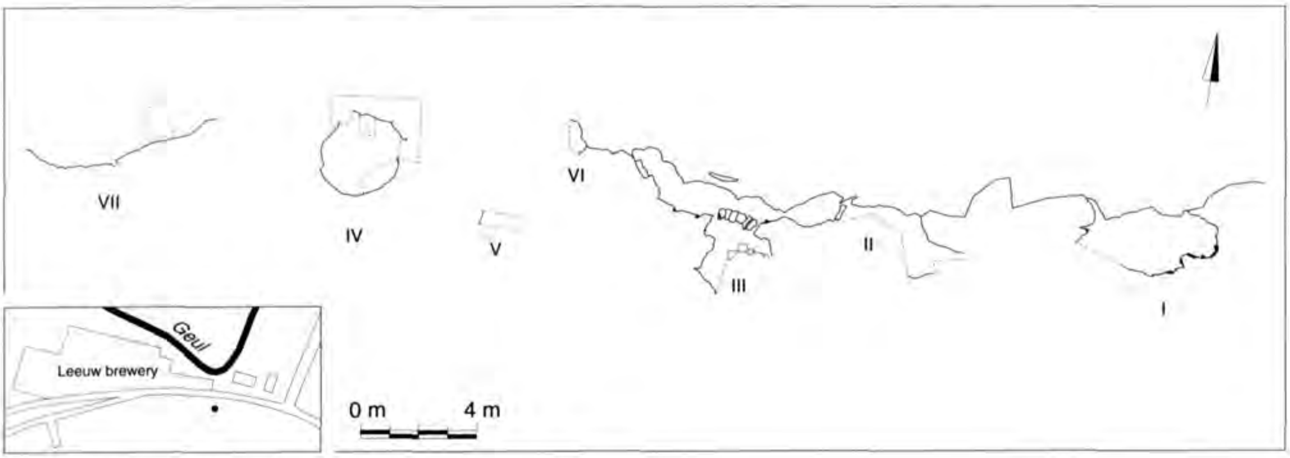

Figure 8. Valkenburg-Plenkerstraat. Site location and excavation plan.

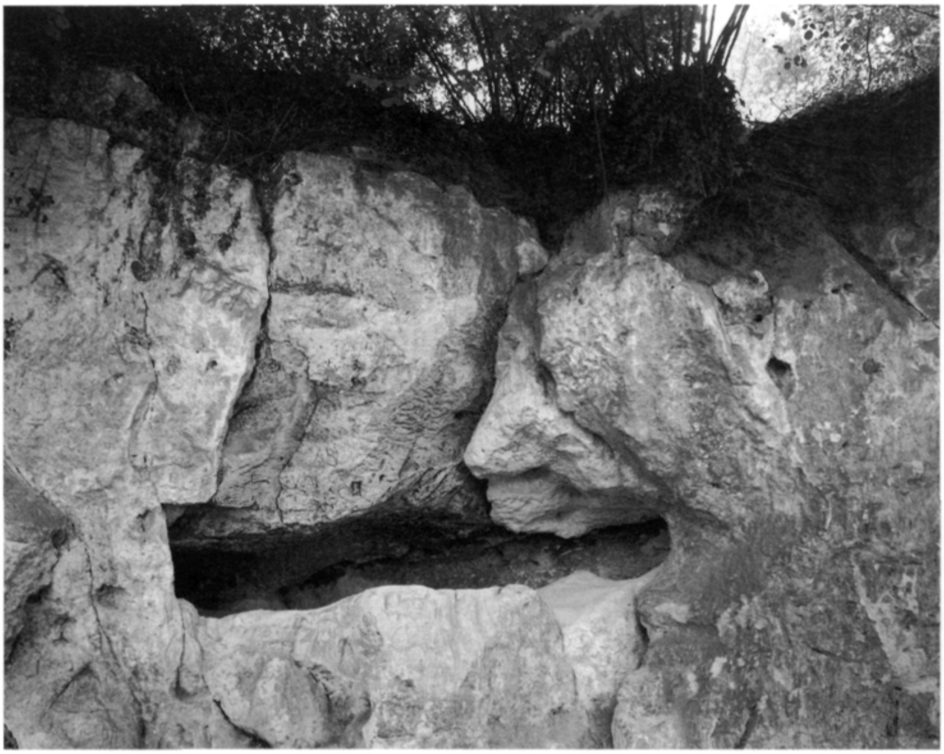

Figure 9. Valkenburg-Plenkert-straat. Gallery and part of the shaft's wall of mine I.

result the database and the conclusions to be drawn from it are subjected to limitations. The interpretation of the nature of two features is but a (strong) supposition. In the testpit of mine number VII no artefacts have been found because the chalk-rubble deposit at the base, which contrary to the backfill usually contains flint waste, was not layed bare. The same goes for number V, though a few flakes were found in the backfill, about 2 m below the present-day surface. The contour of both shafts is unknown, as is the possible existence of subterranean workings. The reason to interpret them nevertheless as a mine is because it concerns deep pits adjacent to and with characteristics similar to those of the investigated mines. In the same way the distinctive appearance of their fill corresponds with the other ones.

Of four mines in the eastern half of the site only (parts of) galleries are left and occasionally a small part of the shaft's wall (figs 9, 13). The other three are less damaged: sections of the shafts and about half of the fill are left. Their subterranean workings presumably are untouched. Apart from the measure of chalk quarrying and the position of the mines in the slope, this difference in affection is caused by the respective depth of the two groups, which in turn is determined by geological factors (*cf.* below). The lower part of deeper pits was well below the level of the recent chalk digging.

Another aspect of differential preservation should be mentioned. In spite of the fact that the features have been exposed to wind and weather for probably more than one and a half century, the walls of three mines are still covered with very well preserved pick marks (fig. 10). The Nekum and especially the Emael Chalk are known for their resistance to atmospheric action (Diederen 1989; Felder 1979). The walls of other mines, sunken into the same beds, however are weathered. Differences in preservation at so short a distance must be imputed to changing lithological proporties of the rock, that can occur within a few meters on the same level (Felder 1979, 21).

The diameter of the shafts known shows that the miners did not keep to a more or less standardized dimension such as seems to have been the case in Rijckholt for example (Bosch/Felder 1990; Felder/Rademakers 1973). The flint was extracted by means of wide shafts that, with the mines investigated, vary in diameter between some 3 and at least 6 m (fig. 11). Their depth is conditioned by the location in the slope, the relief of the surface, the level of the flint layers exploited and geological factors. The Maastricht Formation and thus the flint layers embedded in it inclines to the west (Felder 1979, 42) thereby affecting the depth of the shafts in that direction.[11] At less than 100 m to the west of mine VII the flint bearing beds are situated at an inexploitable depth, that is below the present-day water level of the Geul

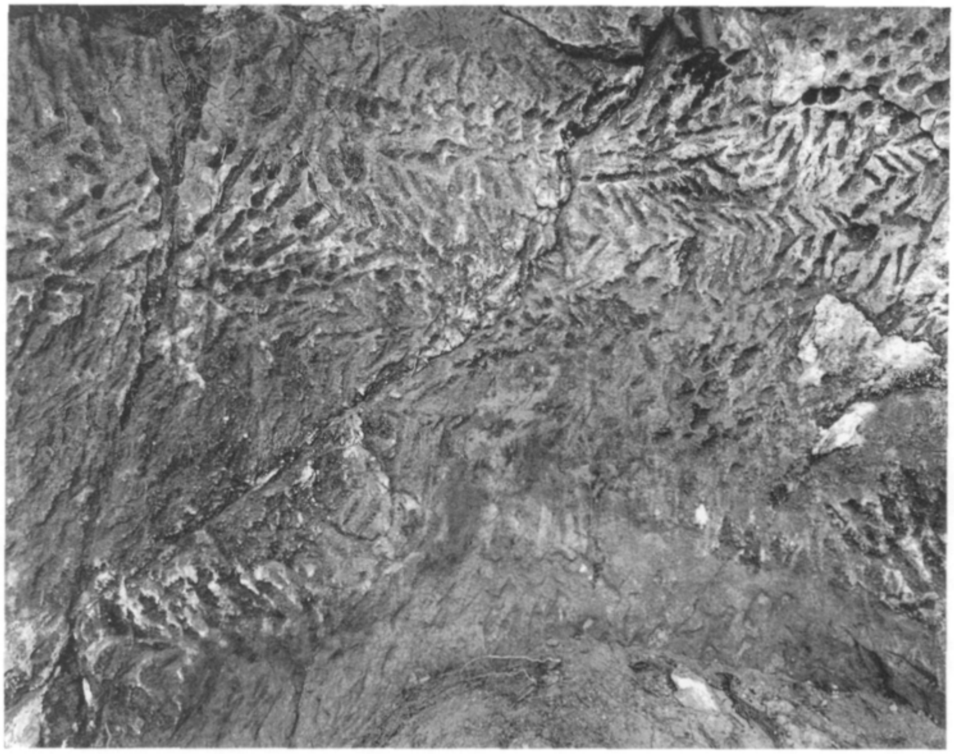

Figure 10. Valkenburg-Plenkert-straat. Pick marks in the wall of a shaft (mine IV).

river (ibid.). Between mine III and IV a minor fault seems to be present in the rock. The result of this is a difference in levels of the Romontbos Horizon in the respective mines of 2 m (fig. 7). In all but one mine flint from the lower part of the Emael Chalk was exploited. On several occasions it was observed that a shaft was sunk untill the Romontbos Horizon was reached, no further. Only one shaft (VII) cuts through it for several meters (fig. 7). This exception to the rule might be the result of a local absence of nodules in the Emael Chalk (Felder 1980; Felder/Bosch 1971a). Consequently the raw material had to be extracted from the lower Schiepersberg Chalk. The shafts vary in depth between 4 m in the east to more than $8\frac{1}{2}$ m in the west. Their original depth may have been larger as part of the slope deposits are likely to have eroded.

With the shallow mines the shafts gave access to galleries of modest proportions. As far as could be ascertained their length hardly surpasses 3 m. Large vertical fissures in the rock that presumably represent lines of fracture along which slabs of chalk moved vertically, in part determined the shape and dimensions of the galleries. They provided a natural fall-away surface on the one hand (Mortimore 1979) and formed the joint where the level of a flint layer exploited abruptly could change, on the other. These shallow mines are representatives of an underground exploitation system that is called *Duckelbau* (Fober/Weisgerber 1980).

The roughly circular shape of the deep shaft IV was interrupted in the East. At that location part of a plateau situated beside the shaft was uncovered at an estimated 1 m above the shafts floor. It may represent a niche that was partly destroyed by the chalk quarrying. Taking into account the gradient of the slope and thus the lesser height of the wall at that side it may also have provided an entrance to the mine and a transportation platform. At the base of the shaft a for the greater part filled artificial cavity was observed in a trial pit (fig. 12). It clearly represented a working. Since there was no compelling reason for further investigation, dimensions on this phenomenon are lacking.

Information on the lay-out of the subterranean area of the mines could only (in part) be retrieved in one case. From the (not preserved) shaft of mine III short workings spread out in three, originally probably four directions (fig. 13). Some of the galleries of abreasting mines did communicate with one another. The underground connection between II and III was marked by a threshold in the floor (figs 8, 13).

The fill in the lower part of shafts and galleries consists of chalk-rubble. It contains fragments of flint nodules, flakes and mining tools. In two mines bits of charcoal were found. The dimensions of the waste chalk diverge from meal to chunks of 5 to 6 decimetres in length. Part of the prehistoric excavation is likely to have been done by block chalk digging. In the gallery of mine III it was observed

Figure 11. Valkenburg-Plenkertstraat. Schematic representation of the results of the trial excavation. S: shaft; G: gallery; F: flint debris; T: tools; C: charcoal; Pm: pick marks.

mine	remains	diametre shaft	depth shaft	finds	particulars
I	(S)G	?	± 4 m	F T	Pm
II	G	?	± 4 m	F T C	-
III	G	?	± 4 m	F T	Pm
IV	S(G)	> 2.7 m	6 m	F T C	Pm
V	S	> 1.7 m	?	F	-
VI	G	?	?	F	-
VII	S	> 6 m	> 8.5 m	-	Pm

that a large chunk was wedged between the floor and the ceiling, presumably to support a part of the latter (fig. 14). The deposit on top of the rubble comprises a series of layers consisting of a mixture of loam, gravel and chalk. The stratigraphy and the laminated structure of some layers indicates that the filling of the shaft at least in part was a gradual natural process. Part of the sediment has entered the galleries and in some instances filled them up. In the shallow mines silt may as well have penetrated the galleries through fissures in the rock.

Information on the processing of extracted flint on the site was presumably lost with the above-mentioned 19th century chalk quarrying. In the vicinity of the mines not a trace of knapping debris on the surface was left. Flakes and rejected rough-outs (*cf.* below) that were found in and on top of the chalk-rubble deposit in a shaft and in galleries show that at least part of the reduction did take place at the procurement site.

4.4. The miners' implements

A total of 39 (recognizable fragments of) tools has been collected, excluding flakes that display macroscopically visible use-wear traces, sharpening flakes and a hammerstone (fig. 15). All but three were found in or on top of the chalk-rubble deposit. Judging from the adhering chalk residue and the secondary position it was found in, one of these originally has been embedded in the chalk detritus. An exception to the rule is the finding of a positively used *Kerbschlägel* (*cf.* below) in a layer of lumps of chalk and loam and gravel situated at about 2 m above the chalk-rubble deposit. It may have been used in an adjacent mine and discarded in the partly filled shaft it was found in or it may simply have slided in from a rubbish heap next to the shaft. None of the tools is an antler object. Except for a quartzite hammerstone the implements are made of Valkenburg flint. As far as could be inferred from cortex remains, it mostly concerns mined raw material. In some instances the flint used was of residual origin or extracted close to the ground level, as is reflected by deviations in colour and texture and to a lesser extent the cortex. The tools are mainly produced on large primary flakes and lumps of "less suitable" raw material, such as flint rich in fossils, chalk-filled cavities or cracks. Besides debris and "second-rate" material good quality flint was used, but scarcely. Judging from the context they were found in, it is to be expected that most of the implements in one way or another have been used in the process of raw material procurement. Not all of them can be classified as mining tools though. Some are likely to have been employed after the actual extraction.

The miners used a diverse tool-kit. Functionally a subdivision can be made in heavy-duty and light-duty instruments: the ones primarily intended to work the solid chalk and others that were possibly meant to carve out nodules or prepare them for flaking. Typologically several categories can be distinguished. The bounds between these are not as clearcut as one might wish, especially when it comes to differentiating "flake-axes" (*cf.* below) from other instruments. With some tools difficulties arise as to whether metrical, morphological or functional aspects should be determinant in the denomination (Bostyn/Launchon 1992, 174, 209; Hubert 1974, 31). Considerable dimensional differences occur between specimens that morphologically are representatives of the same type of tool (fig. 15). Most implements display almost identical macroscopically visible traces of use and were found in the same archaeological context, which makes it hard to differentiate on these aspects. Morphological criteria have been decisive in categorizing.

Kerbschlägel

These are often crudely produced picks of varying shape and cross-section, with characteristic notches on the sides meant to facilitate the hafting of a handle (Weiner 1986, 109). The notches are situated at the middle part of the tool or slightly to the back of it with respect to the funtional

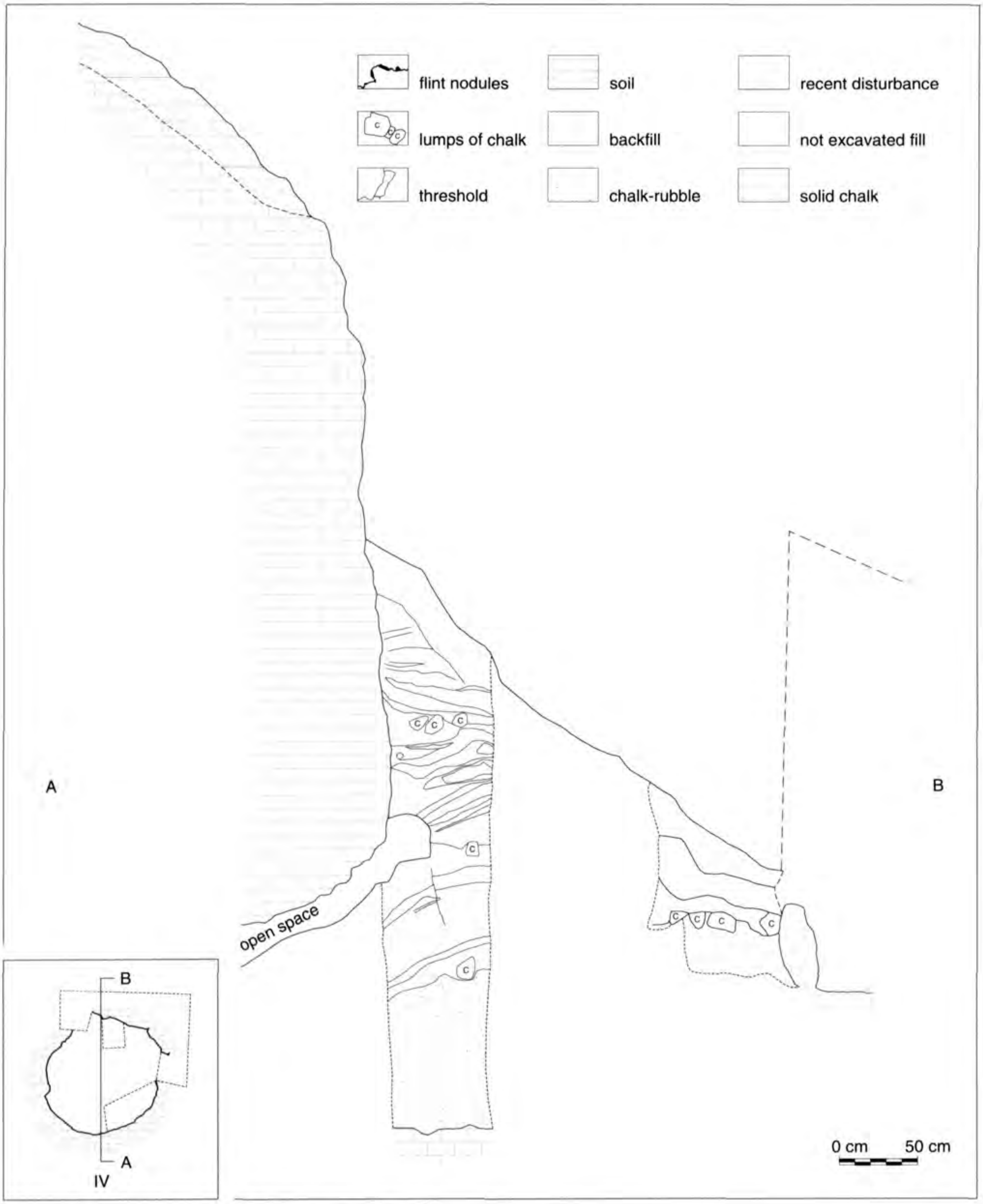

Figure 12. Valkenburg-Plenkertstraat. Cross-section of mine IV.

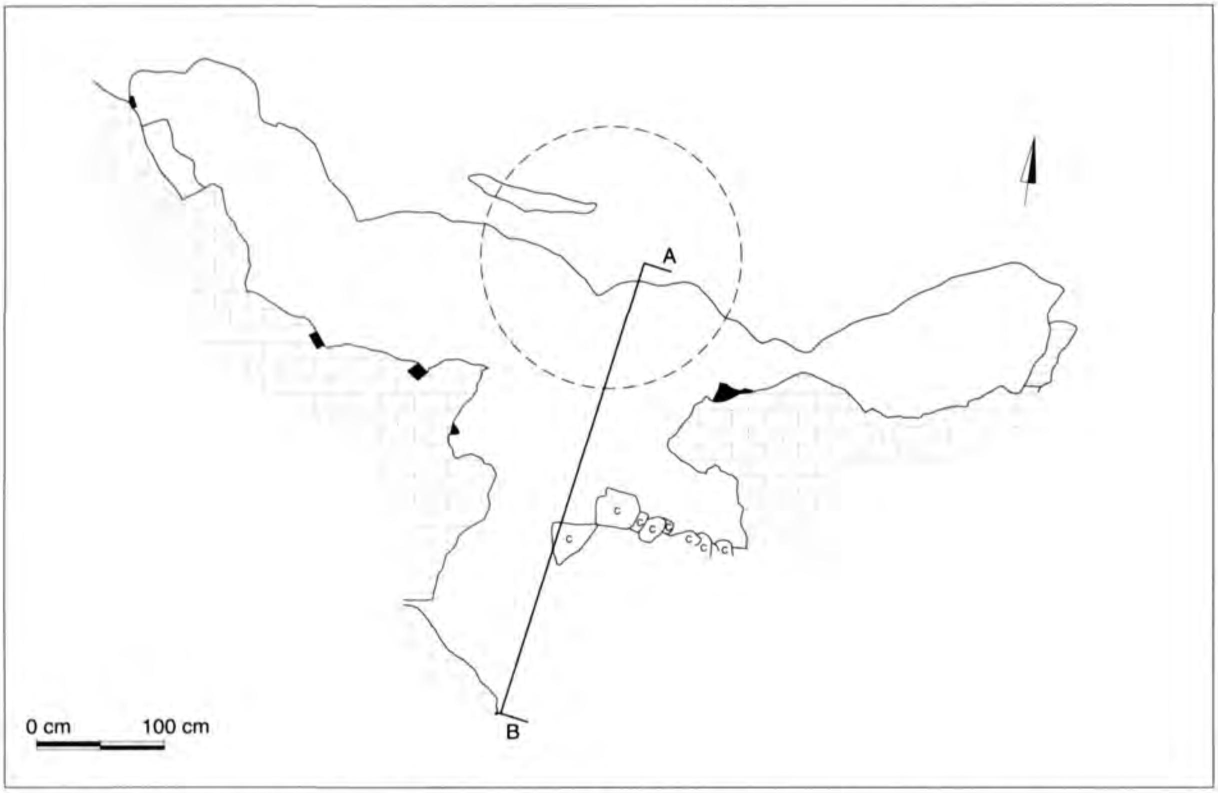

Figure 13. Valkenburg-Plenkertstraat. Plan of the preserved part of mine III with reconstructed position of the shaft.

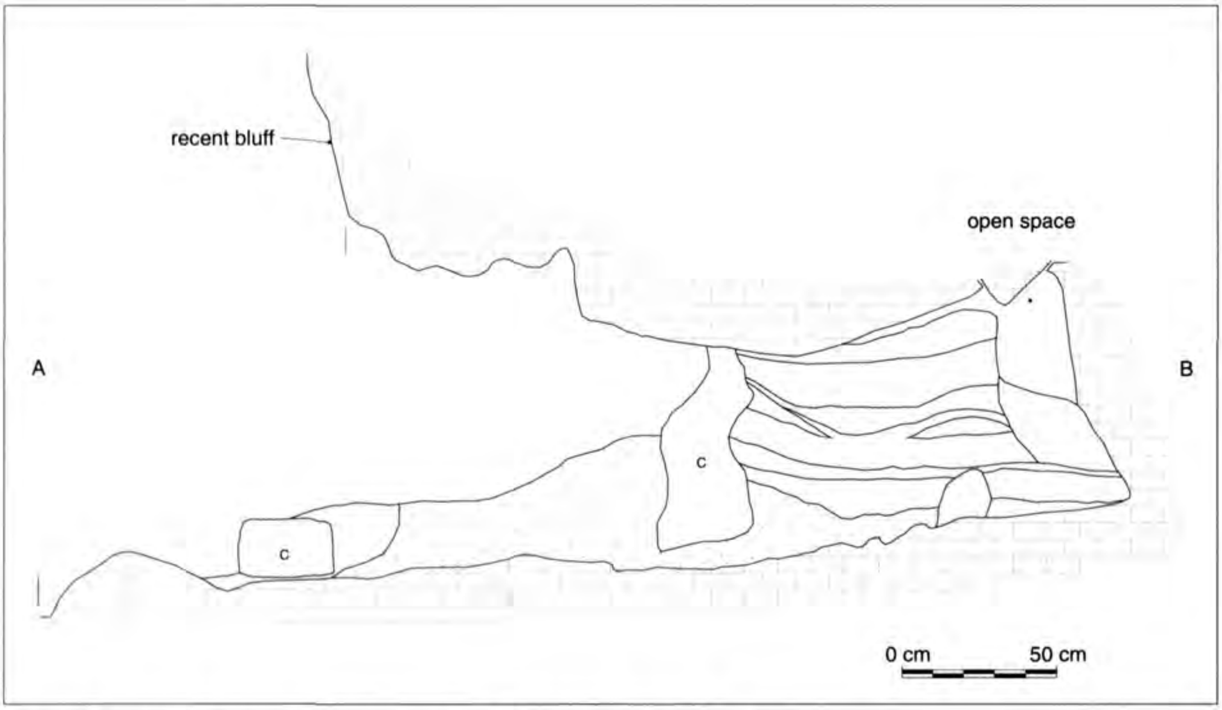

Figure 14. Valkenburg-Plenkertstraat. Cross-section of the south-gallery of mine III.

Figure 15. Valkenburg-Plenkertstraat. Characteristics of the intact implements found.

type of tool	weight	length	width	thickness	blank	workings ends	mine
Kerbschlägel	372	146	73	47	?	2	IV
	473	162	89	48	flake	1	I
	560	185	59	53	?	2	I
	567	194	72	52	flake	1	II
	605	156	93	54	flake	1	IV
	607	151	89	65	flake	1	IV
	634	148	80	65	?	2	IV
	720	177	84	51	flake	1	I
	734	156	92	67	?	1	I
	1002	169	66	68	tub.nodule	1	III
	1038	182	101	75	chunk	2	IV
	1044	178	70	71	?	2	IV
	1190	194	101	69	flake	2	IV
	4150	360	181	78	chunk	1	II
Pick	539	230	67	54	?	1	II
Flake-axe	63	119	44	16	blade	1	I
	63	123	45	19	blade	1	II
	107	114	51	22	flake	2	II
	133	140	54	25	?	1	II
	134	116	51	30	flake	1	III
	134	116	53	32	flake	2	II
	161	138	49	34	flake	1	II
	161	140	52	37	flake	1	I
	165	115	63	33	flake	1	II
	208	145	58	34	flake	1	II
	224	145	68	28	flake	1	I
	258	141	61	39	flake	1	I
	309	129	68	36	?	1	I
	316	150	68	41	?	1	II
	382	171	69	43	flake	1	II
Rough-out	190	138	52	34	flake	1	II
	444	150	82	41	?	1	II
Retouched	356	140	96	38	flake	-	II
	354	135	88	33	flake	-	II

end. They were created by flaking and often additionally blunted by pecking. The same goes for ribs and edges in height of the notches. Large primary flakes and chunks of flint were used as blanks. In side-view the majority of these implements is roughly boat- to sickle-shaped (fig. 16). The location of macroscopically visible use-wear traces enables us to reconstruct the position in which they were hafted. Traces are present not only on the working-end(s) but on the convex side as well, indicating that this was the upper side of the tool. *Schlägel* with one and with two working-ends occur, as do heavy and relatively light specimens. A conspicuously big example, weighing 4.15 kilograms, is an exception to the rest of the group, that for the greater part weigh less than one kilogram (fig. 15). This piece may have been intended to become a rough-out for an axe but was discarded at an early stage of the reduction sequence, presumably because of inferior raw material quality (residual flint). It can hardly have been a manageable tool. Nevertheless it displays slight traces of use.[12] A slightly curved tubular nodule that was sharpened to a point lacks notches but displays use-wear traces similar to those of the other instruments in this category. It too is likely to have been used as a *Schlägel*.

That *Kerbschlägel* were used to hew is clearly shown by their splintered edges and powdery chalk still embedded in flake-scars at the ends. Striking pick marks particularly in the walls of shafts bear testimony to their use (fig. 10).

The finding of this type of implement in the Plenkertstraat is anew an affirmation that *Kerbschlägel* are characteristic flint mining tools for the Valkenburg region. Apart from the pieces the Biebosch and the Plenkertstraat mines have produced, specimens have been collected as

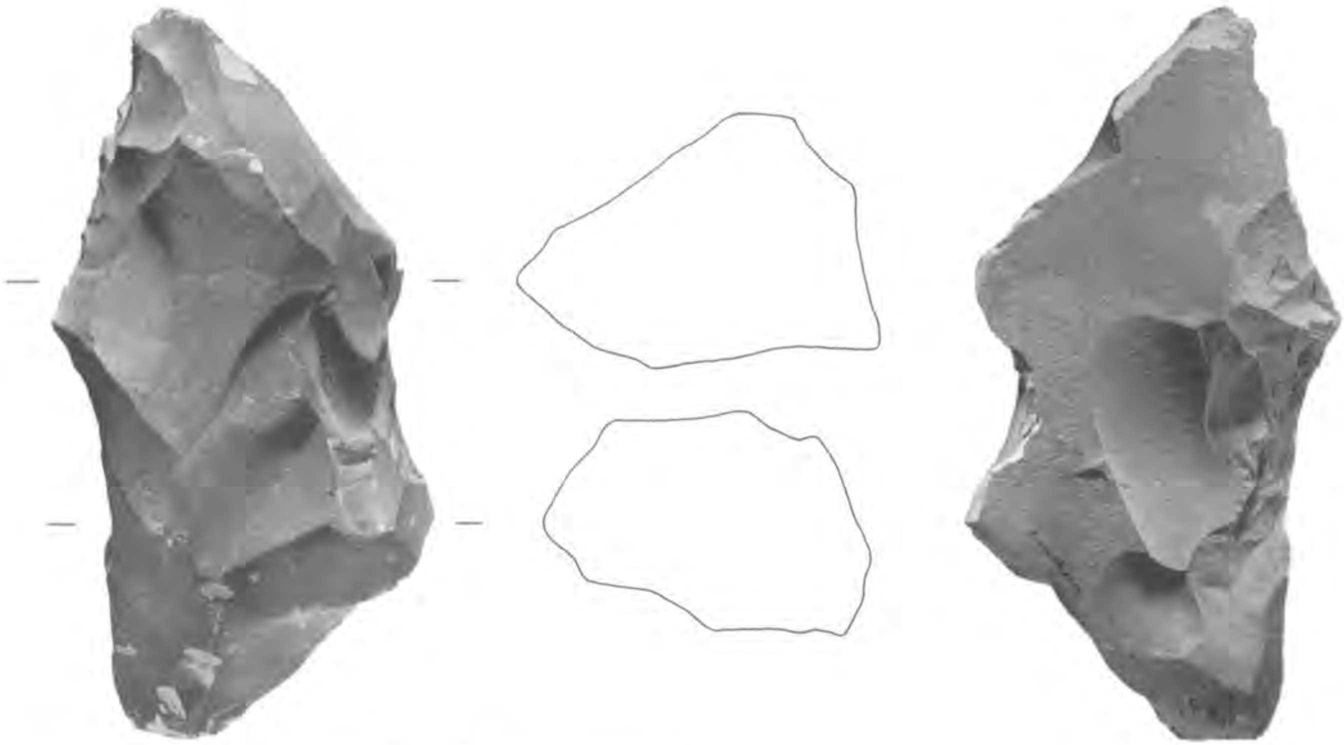

Figure 16. Valkenburg-Plenkertstraat. *Kerbschlägel* (mine IV). Scale 1:2.

surface finds at other (disturbed) procurement sites (fig. 1) in the surroundings (coll. H. Pisters). Some of these artefacts were found at the Schaelsberg (Marichal 1983; Pisters 1986). Others were picked up just outside the edge of the Biebosch, in the south slope of the Geul river valley. They form part of an assemblage gathered in a patch of chalk-rubble in a ploughed field, that indicates the presence of a small isolated extraction unit in the subsoil. Another findspot of *Kerbschlägel* is the Wiegersdel, which is the place-name for a part of the west slope of the Sibbergrubbe.

Pick

One specimen only that resembles the familiar type of pick as it is known from dozens of European exploitation sites has been found (fig. 17). It should be noted that this piece can have been hafted in the same way as the implements in the previous category. Picks have also sporadically been found at the Schaelsberg (pers. com. H. Pisters).

Rough-outs for axes

Three artefacts have been collected that may be called rough-outs or fragments of these, not including the large piece mentioned above. None of these could have been finished to a satisfying axe because of a flaw in the raw material or technological problems the knapper encountered. Two (almost) complete specimens, one of which is rather small (fig. 18), clearly have been used to hew chalk (*cf.* Bostyn/Launchon 1992, 174). A secondary use of unfit pieces seems likely. The fragment may have entered the mine as a reject, without having been put into use (cf. Felder/Rademakers 1973).

Flake-axe-like instruments

The category of "flake-axes" comprises a morphologically rather heterogeneous group of tools. They share the presence of one or two steeply retouched sides and/or a working-end with uniform traces of use.

As has been noticed for specimens from other European mine sites (Fober/Weisgerber 1980, 47; Hamal-Nandrin/Servais 1923, 388), the Valkenburg "flake-axes" deviate from the standard Mesolithic tool type in several aspects. They are rather oblong, with parallel to converging or slightly convex sides. Some of the parallel-sided examples in fact are robust blades (fig. 19). Of those that display converging sides the broader end is a striking platform and thus unfit for use (fig. 20), or it is unused (fig. 21). The narrow end usually is the functional part of the tool (*cf.* Weiner/Weisgerber 1980, 117). A few have been used on both ends (fig. 22). Apart from the lateral retouch some

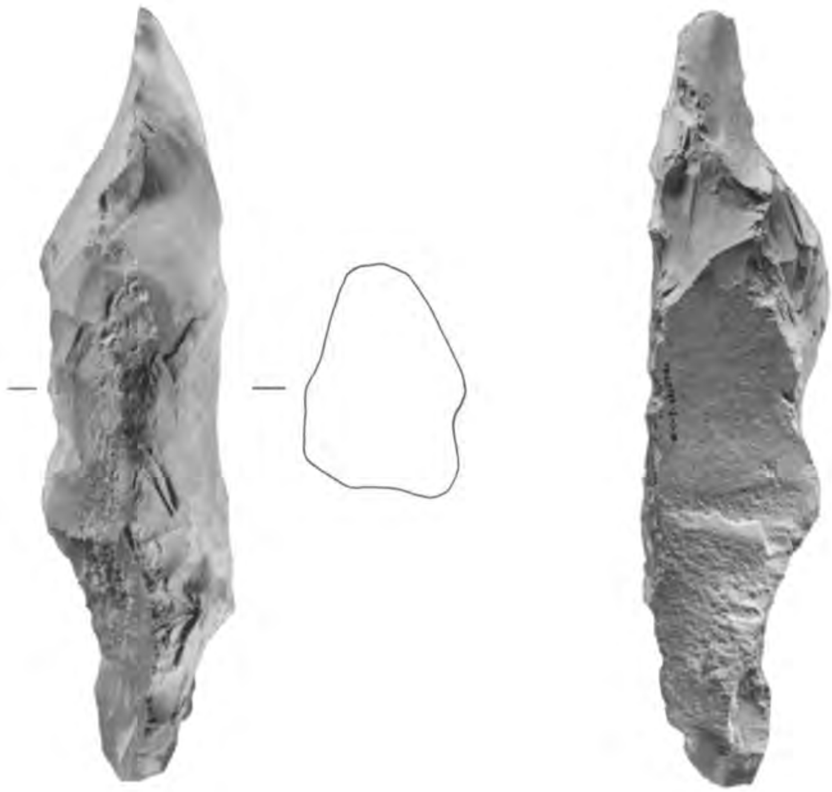

Figure 17. Valkenburg-Plenkertstraat. Pick (mine II). Scale 1:2.

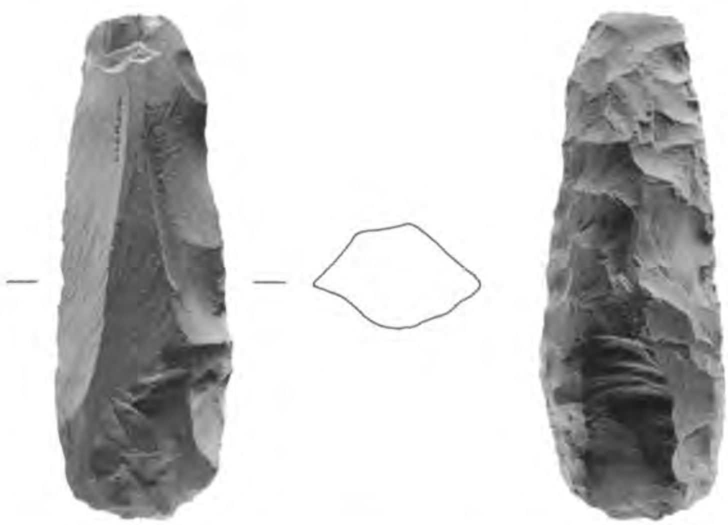

Figure 18. Valkenburg-Plenkertstraat. Small rough-out for an axe (mine II) Scale 1:2.

have been flaked on the ventral and dorsal side as well. With most tools there is insufficient evidence for thinning and shaping of the proximal part in order to make it fit a socket or another hafting-device. The presence of broken pieces displaying an end shock fracture and others with a lateral straight edge however rules out the possibility that they were hold by hand. Since no organic remains were found and indicative aspects like notches (*cf.* Weiner/Weisgerber 1980, 116) are lacking it is yet unclear in what way they were hafted.

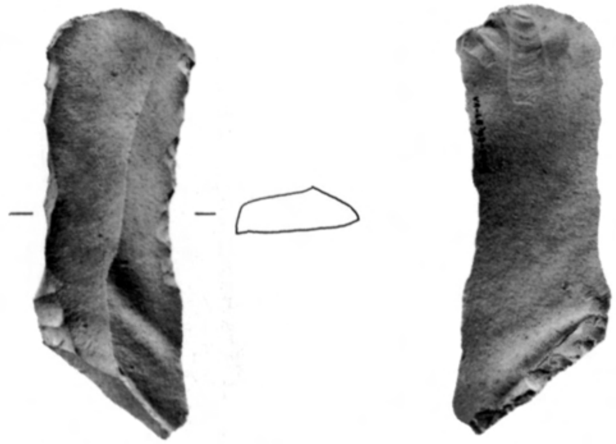

Figure 19. Valkenburg-Plenkertstraat. Retouched robust blade displaying use-wear traces at the distal part (mine I). Scale 1:2.

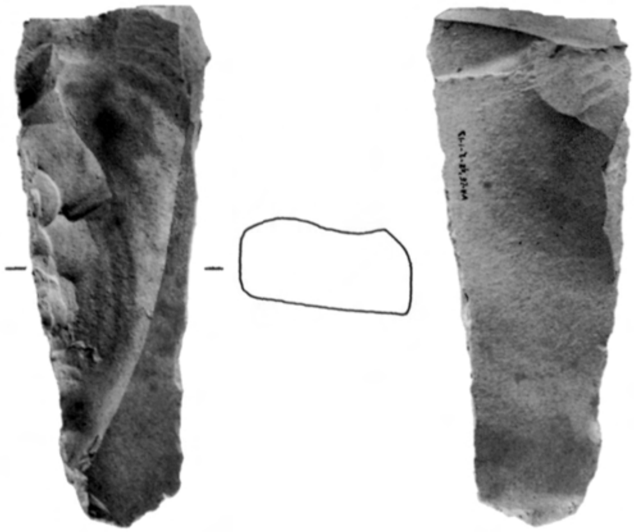

Figure 20. Valkenburg-Plenkertstraat. Flake-axe-like implement (mine II). Scale 1:2.

Though authors agree on the fact that "flake-axes" have been used at mine sites (Fober/Weisgerber 1980; Olausson *et al.* 1980, 195; Rudebeck 1987, 153) the function of the pieces concerned is not quite clear. It has been suggested that they have served to remove adhering limestone from extracted nodules (Fober/Weisgerber 1980, 47; Weiner/Weisgerber 1980, 117). This being an activity that preceeds the primary reduction, the assumption is supported by the fact that this type of implement is mainly found at locations were rough-outs and blanks were produced.

Most "flake-axes" from the Plenkertstraat have been used to hew chalk. They show splinterings on and rounding of the edge or point and the distal part of their sides. Powdery chalk is embedded in flake-scars at the working end. Some broken pieces display an end shock fracture. As the implements have been found in the chalk-rubble deposit of the galleries, they supposedly were used in the mines. In view of the fact that in most subterranean workings the space is rather cramped, the cleaning of the cortex would have to be done at the base of the shaft. Considering the relative softness of the chalk, the removal of the remaining sediment could easily be undertaken with any simple flake or scraper. Since the latter artefact type and flakes displaying edge-damage were found in the deposit as well (cf. below), this may suggest that nodules largely were prepared for flaking underground.

Some comments should be be made on the supposed cortex cleaning by means of "flake-axes". From the debris it is clear that part of the chalk came off still adhered to large flakes, that is it was not removed before the reduction proces started. From the average weight and maximum thickness of the two categories of tools (fig. 15) it can be inferred that "flake-axes" were intended to fulfill a less "heavy" task than *Kerbschlägel*. Yet there is no obvious reason why the chalk removal could not have been done with the same *Schlägel* by means of which the nodule was won or simply with a flake (*cf.* Weiner 1986, 111). The lithological properties of the Maastrichtian chalk are such that a special purpose tool for the activity mentioned is not required. Moreover flake-axes do appear at sites where cleaning seems superfluous because the nodules are embedded in sandy, residual deposits, like in the Belgian Voer region (Hamal-Nandrin/Servais 1921, 1922; Straet/Buntgens 1980). The "flake-axe" seems to have been a multi-functional tool employed in various ways in different situations and at different types of sites.

Weiner (1986, 111) suggests that some heavy flakes from the Lousberg could have been used during the actual mining-process. Elaborating this option for the Valkenburg mines, a "flake-axe" may have been a specific type of light-duty tool that was used for a more "delicate" task like carving out flint nodules (*cf.* Schmid 1980, 164; Weiner 1984). As part of the nodules observed in the Plenkertstraat mines are situated half-way or in the upper part of the gallery walls (especially mine I), they presumably were extracted by removing the chalk underneath and dislodging them then (*cf.* Bosch 1975; Bosch/Felder 1990, 260; Felder/Rademakers 1973). With a narrow, low-pitched front at the end of a gallery the comparatively light "flake-axes" may have been the instruments to do the job.[13] The rounding of the distal part of the sides may indicate that the implement has been used in such a way that the working-end was orientated at a right angle to the floor. In that position its side(s) will have been in contact with the chalk and be worn

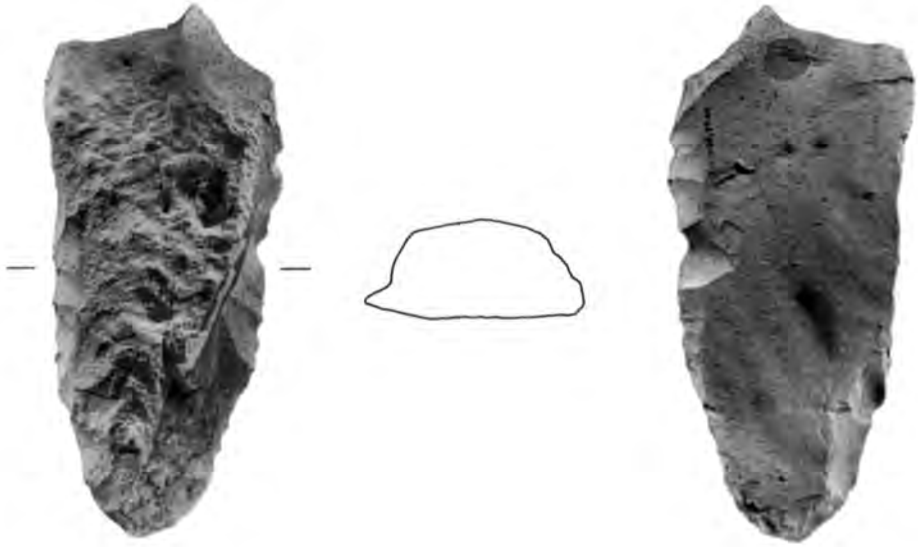

Figure 21. Valkenburg-Plenkert-straat. *Flake-axe-like implement* (mine I). Scale 1:2.

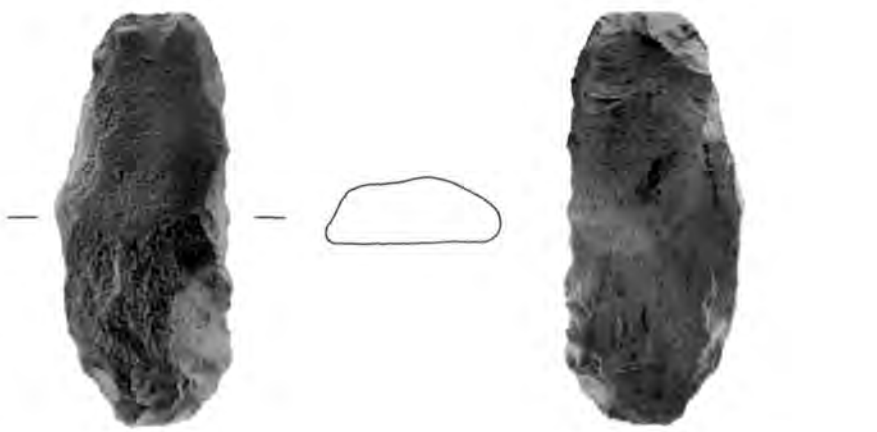

Figure 22. Valkenburg-Plenkert-straat. *Flake-axe-like implement* (mine II). Scale 1:2.

in hewing. Curvilinear marks that have been observed in especially the extremities of gallery floors seem to correspond with the assumption. As the narrow end is the functional part of most pieces, an alternative application might be the carving of narrow grooves that would have facilitated the cleaving of blocks of chalk (Weiner/Weisgerber 1980, 118). Several options will have to be tested experimentally.

Retouched flakes

A number of flakes shows intentional retouch, in a continous or denticulate, unifacial or bifacial way. Judging from use-wear traces they have been used to work an abrasive material like chalk. A removal of sediment adhering to the cortex seems likely (fig. 23). Two specimen are massive scrapers, similar to those from e.g. Rijckholt-St. Geertruid and several Polish procurement sites (Hamal-Nandrin/Servais 1923, 362, 395; Lech 1981, 44; Schild *et al.* 1985, 199).

Some unretouched flakes show use-wear traces like edge-removals and edge-rounding. Their function may correspond with the intentionally retouched pieces.

A last group of artefacts showing intentional and unintentional removals are for the greater part small pieces that are characterized by powdery chalk embedded in flake-scars and edge rounding, indicating that they once formed part of a working edge or end. This is corroborated by the refitting of such a chip to a tool (fig. 23). Some may have come off as a result of an impact-fracture, when the implement hit a flint nodule during mining. Others display

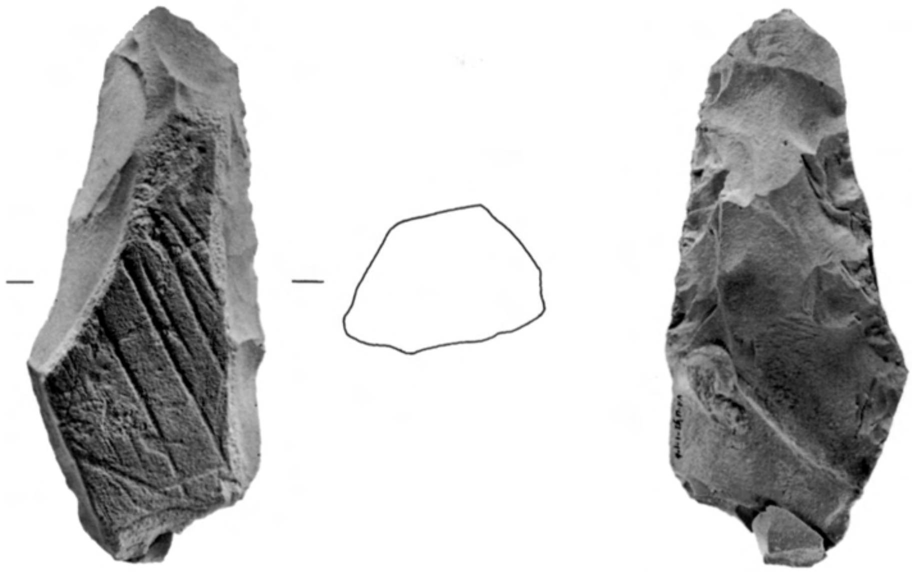

Figure 23. Valkenburg-Plenkertstraat. Flake-axe-like implement displaying parallel scratches in the cortex, presumably due to chalk removal (mine I). Note the refitted chip at the working end. Scale 1:2.

characteristics that match those of Middle Paleolithic long and transverse sharpening flakes (Cornford 1986). They will have been produced in the curation of implements.

The only hammerstone found may have served several purposes: to detach sharpening flakes, to remove protuberances from nodules or to do some primary flaking at the base of or next to the shaft. It is a nearly 6 cm thick and roughly triangular quartzite pebble of 1.14 kilograms.

In general the lithic tool-kit used at Valkenburg-Plenkertstraat shows some remarkable resemblances to that of the Lousberg (*cf.* Pisters 1986). *Kerbschlägel* occur at both locations. In contrast to the Plenkertstraat site, at the Lousberg not only flint was used to produce them but boulders as well. The partial differences in raw materials used at the two sites are likely to be caused by different lithological properties of the sediments to be worked: soft homogeneous chalk at Valkenburg versus heterogeneous, partly hard limestone at the Lousberg (Aldenhovener Platte 1979b, 375; Weiner 1986). In Limburg a cutting end was needed to work the matrix-sediment, at the German site primarily a pounding end.[14] Flint *Schlägel* are thought to have been used at the Lousberg on softer sections of the limestone (Weiner 1984). The two sites share the occurrence of "flake-axes" as well (Weiner 1986; Weiner/Weisgerber 1980), be it that they occur in different numbers. The major disparity lies with the antler tools, which are prominent at the Lousberg (Weiner/Weisgerber 1980, 114) and at some sites in the Valkenburg region (Brounen *et al.* 1993) but have neither been found in the Plenkertstraat nor in the Biebosch. This too may be imputed to a different geological setting and to differences in the way of exploitation (Fober/Weisgerber 1980, 45).

Limiting a survey for a comparable lithic tool-kit to other Limburg procurement and production sites and those from the neighbouring Belgian area, it appears that researchers occassionally have come across *Kerbschlägel*. This type of implement is for example known from a few relatively shallow mines with short galleries at the fringe of the Rijckholt Grand Atelier; pers. comm. W.M. Felder; (*cf.* Bosch/Felder 1990; Felder *et al.* 1979: 62). "Flake-axes" are reported from another part of the Rijckholt exploitation site, that is from a mine and from workshops at the Schoone Grub (Hamal-Nandrin/Servais 1923, 362, 382). In the Belgian Voer region, in which flint of the Rullen type was exploited, *Kerbschlägel* have been found at the production sites of Vrouwenbos and Rullen (De Warrimont/Groenendijk 1993, 38). Their occurence surprises in much the same way as the "flake-axes" from these locations do (*cf.* above), since Rullen flint is supposed not to have been extracted from solid chalk beds, but from residual deposits (Albers/Felder 1980). Two alleged *Kerbschlägel* are reported from workshops in southeast Limburg in which Simpelveld flint was processed (Arora/Franzen 1987, 27; Franzen 1986, 65). None of the sites mentioned, including the Lousberg, is situated at more than 20 kilometers distance from the Plenkertstraat.

Outside the south Limburg and bordering Belgian/German area procurement sites in Europe where *Kerbschlägel* have been found are rare. To our knowledge this type of implement is only reported from Saint-Mihiel and Champignolles in France (Guillaume 1975, 22; 1980) and from Peppard in England (Aldenhovener Platte 1980, 281 referring to Peake 1914, 408).

4.5. Charcoal

In the limestone-rubble deposit at the base of gallery II and shaft IV scattered pieces of charcoal have been found. Occasionally burnt bits of chalk were observed in gallery II. Both categories of finds have been embedded in the deposit during the transport of detritus, so while the exploitation was still going on.[15] It is unlikely that under those conditions the remains of a hearth in the vicinity of the mine should have entered it as a deliberate backfill. The amount of charcoal in the gallery was too large to originate from an accidental fall into the shaft (*cf.* Bosch/Felder 1990, 252). This implicates that for whatever reason a fire may have been made at the base of the shaft and the ashes cleared away afterwards (*cf.* Schild *et al.* 1977, 36, 129). With the broad shafts and short galleries observed a need for additional light in the subterranean workings can hardly be the reason sought.

4.6. Chronology

The excavation has not revealed any typologically datable flint artefacts or pottery sherds. Two moments within the total time span of extraction were assessed by radio-carbon dating of charcoal samples from the mines II and IV. The resulting dates match up rather well, as is to be expected with extraction units that are situated at short range of one another (*cf.* De Grooth 1991, 159). The dates are 4670 ± 60 B.P. (GrN-19831) and 4610 ± 80 B.P. (GrN-19830), that is 3620-3090 cal B.C. and 3630-3340 cal B.C.[16] Compared to the dates of the Biebosch mine and those of other extraction zones in the Valkenburg region (Brounen *et al.* 1993; Felder 1981) the flint exploitation in the Plenkertstraat seems to have taken place at an earlier stage (fig. 24). The Plenkertstraat dates equal the end of the Middle Neolithic A and the Middle Neolithic B. In cultural terms this means that not only the Stein Group may have been responsible for the exploitation but that the flint could as well have been extracted by the (late) Michelsberg Culture (MK). Though on account of other C14-dates on Valkenburg flint procurement sites an exploitation by Stein Group miners seems preferable, the data on settlement assemblages prevent us from rejecting the alternative option. In the Valkenburg region at least one site (Heunsberg) with a characteristic MK flint inventory is situated in the vicinity of an exploitation zone. Valkenburg flint is present in the assemblage, but not prominent.
To clarify the chronological picture additional dates from other Valkenburg flint procurement sites and more data on especially Stein/ *Jungneolithikum 2* settlement sites are needed. It is tempting to presume for example that the raw material for MK Valkenburg flint artefacts exclusively was won quite close to the well-known procurement site at Rijckholt-St. Geertruid, that is in the Savelsbosch (Felder 1980, 560).

5. Final remarks

From the excavations at Biebosch and Plenkertstraat and from observations of sectioned extraction units at other sites in the area in between, it has become clear that flint mining was a regular way of raw material extraction in the Valkenburg region, along with open diggings. All sites concerned are situated in the south slope of the Geul Valley, the Plenkertstraat being an geographical extension of a series of sites mentioned by Felder (1975a). They once may have formed part of a continuous exploitation zone of about $2\frac{1}{2}$ kilometer in length, starting at the Biebosch and for reasons of inaccessibility of the flint layers coming to an end at the Plenkertstraat. Unfortunately the greater part of the valley slope is severely damaged by chalk digging and occupied by buildings, so it is difficult to prove this supposition. Strayfinds of flakes in the few plots spared seem to support the assumption however. Assuming that the option is valid, this would mean that, averaging a mine every 5 m, a considerable amount of raw material was won. Taking into account that this is only one of the procurement sites known, it is surprising to find that, apart from German literature on research in the Aldenhovener Platte region and Dutch publications on Linearbandkeramik flint (Groenendijk 1980, 1980/1981; De Grooth 1986, 1987), Valkenburg flint artefacts are rarely mentioned. Several factors may be responsible for this "lack". Compared to Rijckholt the Valkenburg raw material and the procurement sites have only recently been discovered and described by (semi-)-professional archaeologists (*cf.* Brounen *et al.* 1993). The appearance of the flint type consequently has been unknown to researchers for a long time and maybe still is to quite a lot of them. As for the texture and colour it can be mistaken for a variety of Rijckholt (Lanaye) flint. Most of the finds of Valkenburg flint artefacts at somewhat more remote German sites are mentioned by authors that participated in the excavation of or have worked out sites in the Aldenhovener Platte region, where they presumably have become acquainted with the raw material. It is to be expected that within the vague category of *Maasfeuerstein* or *westischer Feuerstein* a number of Valkenburg flints may be "hidden". Supposing that the peak in the exploitation indeed occurred in the period that the area was inhabited by people of the Stein Group, it is a fact that we know but few well documented sites (Louwe Kooijmans/Verhart 1990), in fact even little about their material culture in general (Louwe Kooijmans 1983). Alternatively there is the possibility that the Valkenburg industry has been nothing but an "insignificant" regional industry after all (Marichal 1983, 20).

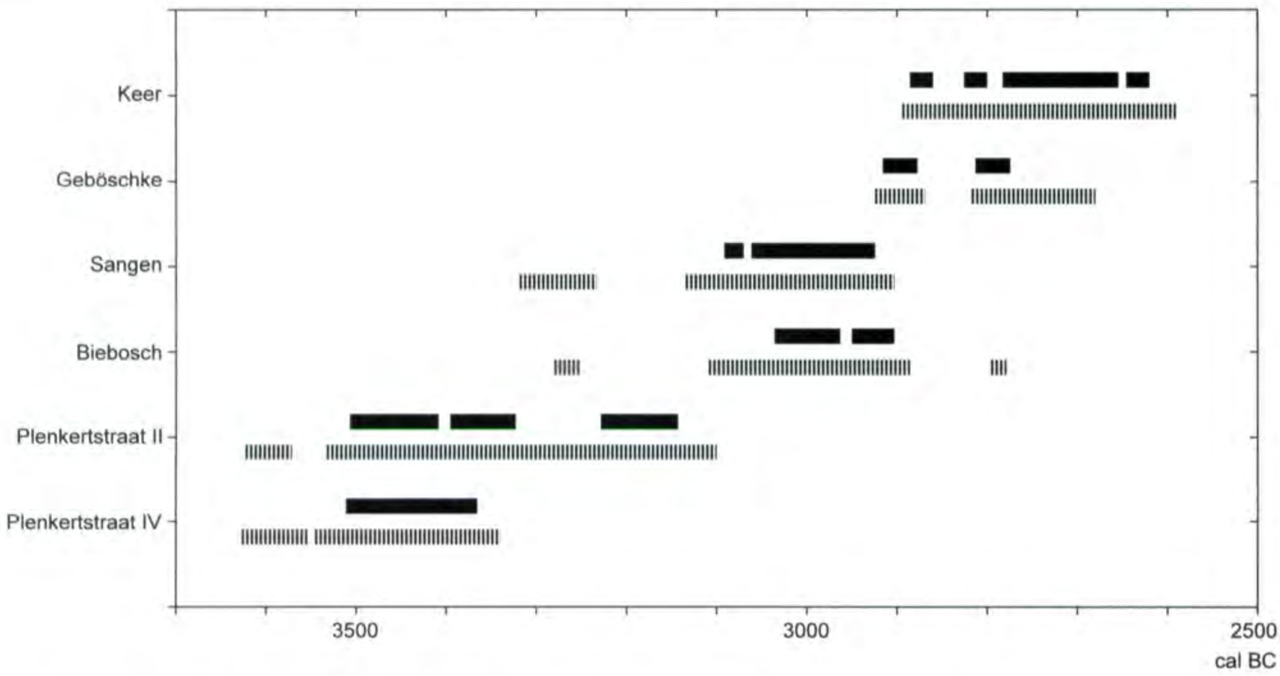

Figure 24. Valkenburg. Calibrated dates of antler tools and charcoal found at Valkenburg flint procurement sites.

Two considerations, admittedly speculative for the time being, may suggest that this is not the case. Assuming that the practice of underground raw material extraction goes for other Valkenburg flint procurement sites known as well, this would almost double the area where flint could have been won (pers. com. W.M. Felder). Adding up the individual sites, the total procurement area would be about equivalent to that of the Rijckholt shaft mining area (ibid.). Furthermore the supposition seems to be contradicted by identified finds of Valkenburg flint axes as far as Drente (Beuker 1988, pers. comm.), Overijssel (observation by one of the authors), Westphalia (Arends 1990; Bakdach 1990, 1991, 114; Eckert 1987; Gaffrey 1990; Marichal 1983, 8; Rüschoff-Thale 1992, 234), Luxemburg (Binsfeld *et al.* 1987, 373; Marichal 1983, 8) and the neighbouring part of the Rhineland (Marichal 1983). In this respect it would be interesting to verify wether "southern" axes from Gelderland that are described as having been produced from "quartzitic flint" (Hulst 1970, 27; Schut 1987, 7, 11) in fact are made of the Valkenburg raw material. Lousberg flint axes, being easier to identify, have been found north of the Rhine (Beuker 1986; Louwe Kooijmans 1985; Hulst 1988, 185; Scholte Lubberink 1991; Schut 1987, 1991; Van der Walle-van der Woude 1983). In view of the (partly) contemporaneous exploitation and associated finds of the two flint types, as well as the short distance between the respective procurement sites, Valkenburg axes may have been distributed along the same lines of exchange as their Lousberg counterparts. Both raw materials predominantly were used for the production of axe blades. Though the distribution map of Valkenburg flint products for reasons above-mentioned seems to be far from complete, the products of the two procurement areas partly are recovered in the same regions, even at a distance of about 200 km from the source area that is in south-east Drente.

On the subject of distribution of Lousberg flint some preliminary comments should be made in order to fill in an apparent *Forschungslücke.* It has been suggested that finds of Lousberg flint artefacts are lacking in southern Limburg because of the "competition" of local raw material supplies (Modderman 1980a). The "blind spot" on the distribution map apparently was caused by a lack of data at that time for the area concerned. Nowadays a fair number of Lousberg axes is known in the Limburg chalk (and flint) region, be it that specimens are rarely mentioned in literature (e.g. Pisters 1986; Stoepker 1991, 275). Quite a lot of them were found in the surroundings of Valkenburg. Apart from sites refered to by Pisters (1986) an older find is mentioned by Modderman (1980b, 219; Geulhem) and others have been collected by one of the authors in the course of a survey. In private collections additional pieces from the same area are present, but cannot at the moment be pin-pointed to a precise location. Several of the sites have produced more than one artefact of Lousberg flint. Not all of them are axes. Occasionally small flakes are found amidst of debris of other flint types. As mentioned above Lousberg axes remarkably often were found in Valkenburg flint workshops. This might be the result of the specific attention these waste concentrations are given in search of rough-outs and so be the product of a recovery bias. Yet we do not know any Lousberg axe from the area concerned that has been found in an off-site situation, whereas strayfinds of other axes do occur. Assuming that the association of the Lousberg pieces with the artefact scatters is valid, a possible explanation may be the retooling and reworking of damaged axe blades, embedded in the production of Valkenburg flint rough-outs. Of course this presupposes the presence of spare blades in the working-kit, since a rough-out needs to be polished before hafting; the finishing off — being a laborious job — is usually presumed to have taken place at the settlement (Vermeersch 1987-1988, 7) or, judging from etnographic information, at polishing "factories" (Vial 1940, 160).[17]

The Valkenburg region is not unique in its presence of axes "exotic" to the raw material procurement area. On the plateau ("Kaap/de Hej") bordering on the exploitation site at Rijckholt-St. Geertruid (*cf.* De Grooth 1991, 157) a great number of axes and fragments of these are found that are made of a raw material other than the Rijckholt flint type (ibid. 1990, 176; pers. com. W. Roebroeks). Unlike the Valkenburg area Lousberg specimen are rare among these.

It has been argued that the Lousberg and Valkenburg flint procurement sites have been in operation at the same time. De Grooth (1991) suggests that at Rijckholt-St. Geertruid flint was still being extracted at that time (*cf.* Schwitalla 1984, 58). Leaving out of consideration the possibility that part of the artefacts may have originated from the "scavenging" of older flint debris accumulations (*cf.* Borkowski *et al.* 1989, 201; Pisters 1983, 6; Pisters/Schrooders 1987) or simply are "pick-ups", this would mean that three mine sites were simultaneously being exploited within half a day's march distance. The presence of a limited number of Lousberg and Valkenburg flint artefacts at the Simpelveld flint workshops (Franzen 1986, 64) may even indicate that a fourth quarry, of which the location and the extent is yet unknown, can be added to this series. With that arises the question as to whether the respective exploitation was done by a single or by a number of separate communities, in other words: does the appearance of flint types "exotic" to the micro-region reflect open access or restricted access followed by exchange (within-group or between-group transport; De Grooth 1991, 167). The resemblance of the tool-kits from the Lousberg and Valkenburg, both being somewhat at variance with the standard equipment of most other procurement sites, has hypothetically been interpreted as an indication for a "close relationship" between the miners concerned (Pisters 1986). As recently emphasized by De Grooth (1991), to enable one to decide on the matter of control over resources however, a complex of data on different types of sites within the lithic production system is required. At present for none of the raw material types concerned these conditions are fulfilled.

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The Plenkertstraat site would perhaps still not have been recognized as a prehistoric monument without the inspiring enthousiasm of our fellow-discoverers Karen van der Graaf and Hub Pisters to whom we are greatly indebted. Special thanks are owed to Prof. Dr. L.P. Louwe Kooijmans for bearing with us in times when progress was only vaguely discernable. We are much obliged to the Stichting Valkenburg Omhoog, for allowing us to excavate on their property. We thank the municipality of Valkenburg aan de Geul, the foundation In onsen Lande van Valckenborgh and the Historische Kring Valkenburg en Heuvelland for financially supporting the excavations. A great number of colleagues, students and amateur archaeologists kindly made available yet unpublished data from which this publication benefitted. Students and amateur archaelogists spent — admittedly pleasant — weeks in the field and contributed in making the excavation successful.
J.-A. Schenk spent part of his leisure doing those puzzling things that transform computer data into comprehensible plots. A.E. de Hingh changed seemingly identical charcoal particles into different species of trees. The drawings and computer plots were made by H.A. de Lorm and P. Heavens, photographs by J. Pauptit. Their craftsmanship should be obvious for every reader.

Anthracological aspects of Valkenburg-Plenkertstraat
by A.E. de Hingh

About 25 fragments of charcoal from the mines II and IV at Valkenburg-Plenkertstraat were available for determination. The analysis of the material produced the following results:

	mine II	mine IV
Alnus glutinosa	+	-
Buxus sempervirens	-	+
Corylus avellana	-	+
Fraxinus excelsior	+	-

The charcoal particles obviously are remains of burned wood, but this does not necessarily imply that the wood concerned was intended as fuel primarily. Part of the charcoal may originate from discarded (components of) implements or from the production of those.

Though hard to demonstrate, the assumption may fit the case with *Buxus sempervirens*. The boxtree is likely to have been comparatively rare at the time. *Buxus* supposedly could only be acquired at specific locations and in limited amounts. Nowadays this species is quite rare in the Moselle valley and in the Belgian Meuse valley, where a relatively warm microclimate in the deeply incised valleys with steep chalk cliffs creates an ideal environment for this shrub. During the Atlanticum and the Subboreal the average temperatures were higher and the extreme northern limit of the species of *Buxus* is supposed to have been situated more northerly.

The wood of boxtree is not likely to have been collected as fuel, as other species that are more attractive as fire-wood, were more available. Moreover, in comparison to other woods available during the Neolithic in south Limburg it is characterized by certain properties that should have made it a valued organic raw material. It is rather heavy, hard and flexible. For these reasons it may have been used in the process of quarrying, as a digging stick, lever, bar or a wedge (cf. Crabtree 1972, 25). Alternatively it should be noted that contemporary European flintknappers use it to produce a billet, that is a club-like rod to detach flakes by direct and indirect percussion (Beuker 1983, 36; Tixier 1982, 15; Tixier *et al.* 1980, 98).

Another interesting species with respect to the archaeological context in which it was found is *Corylus avellana*. Split twigs of hazel are supposed to have been used as a wrap-around handle for *Kerbschlägel* (Weiner 1984). *Fraxinus* (Ash) and occasionally *Alnus* (Alder) are known to have been used as handles for lithic tools as well (*cf.* Baudais 1987, 199).

notes

1 Since the survey by Felder et al. in 1970, additional exploitation zones have been discovered at Visé-St. Pietersberg (Marichal 1983, 6) and near Groot-Welsden (municipality Margraten; pers. com. J.H.G. Franzen/W.M.Felder).

2 The Gronsveld Chalk contains many — rather sprawling — flint nodules as well (Caspar 1984, 112; Felder *et al.* 1979, 6). To date there is no evidence for a prehistoric exploitation of these.

3 The amassment of flint nodules found in residual deposits is considered to lie in a secondary position. Sometimes flint from gravel deposits, however, is incorrectly defined with the same term (e.g. Bakels 1978, 101; Newell 1970, 145). Admittedly the differences between the two categories of raw material are not always clearcut when found in an archaeological context, as is demonstrated by intermediary categories as *Rijckholt-Schotter* and *Schotter-Rijckholt* in German literature. Yet in using the term for both residual and fluviatile transported flint the economic implications that are behind it are lost sight of. Residual flint can be won in considerable quantities by means of extraction pits and with a rather predictable degree of result, whereas alluvial flint in general must be gathered from bare lying gravel beds (cp. Vermeersch *et al.* 1984, 1991). Moreover, as for its procurement residual flint usually can be pin-pointed to a location or a region, whereas rolled flint cannot. For these reasons in regard to flint from gravel deposits the term tertiary position should be used.

4 A Middle Palaeolithic exploitation of flint in a primary geological position is also suggested for the Rijckholt area (Roebroeks 1980, 21, 32).

5 Since the 1987 publication by Arts & Deeben several dozens of artefacts more have been collected. Though Magdalenian guide artefacts still are lacking, the assemblage displays technological characteristics that reinforce the interpretation given by the authors fore-mentioned.

6 Wommersom quarzite has been mentioned to be present in other Late Palaeolithic assemblages (e.g. Machiels 1993, 61, 63; Vermeersch 1984, 185). In general however it is assumed to have been used only since the Mesolithic.

7 J.P. de Warrimont (1994) mentions additional finds of adzes from Banholt-De Hei and from Rijckholt.

8 We are grateful to J. Schreurs for offering us the opportunity to study part of the lithic inventory of the site for raw material types. It was kindly made available for study at the Leiden Institute of Prehistory by Prof. Dr. J. Lüning and Dr. B. Höhn.

9 We are greatly indebted to Prof. Dr. J. Lüning and Dr. G. Schwitalla for allowing us to use data from the unpublished graduate thesis (Schwitalla 1984; Köln).

10 Calibration was done by means of Cal10 of the Groningen Centrum voor Isotopen Onderzoek, based on Pearson et al. 1986, using a double s.d.

11 The measure of inclination can best be illustrated by comparing the Biebosch mines with their Plenkertstraat counterparts. The sites are situated at about 1600 m from one another. At both locations a flint layer in the Emael chalk was exploited. The difference in altitude between the sites is more than 50 m.

12 As for a comparable weight of a *Schlägel* cf. Weiner/Weisgerber 1980, 117. The underground use of the Valkenburg specimen seems rather unlikely.

13 At the Biebosch mine, where a layer of flint was exploited at floor level, no "flake-axes" have been been found.

14 Recently a quartzite boulder with two picked grooves, a so-called *Rillenschlägel,* was found at the Schaelsberg procurement site (Pisters, in press). It may have been used to shatter a hardground in the chalk (cf. Felder 1975b)

15 The occurence of large primary flakes in the chalk-rubble deposit of galleries can be explained in the same way.

16 Cf. note 10.

17 As far as "factories" are concerned: a comparable situation occurs with for example the location of the grindstone at Slenaken (Modderman 1980c).

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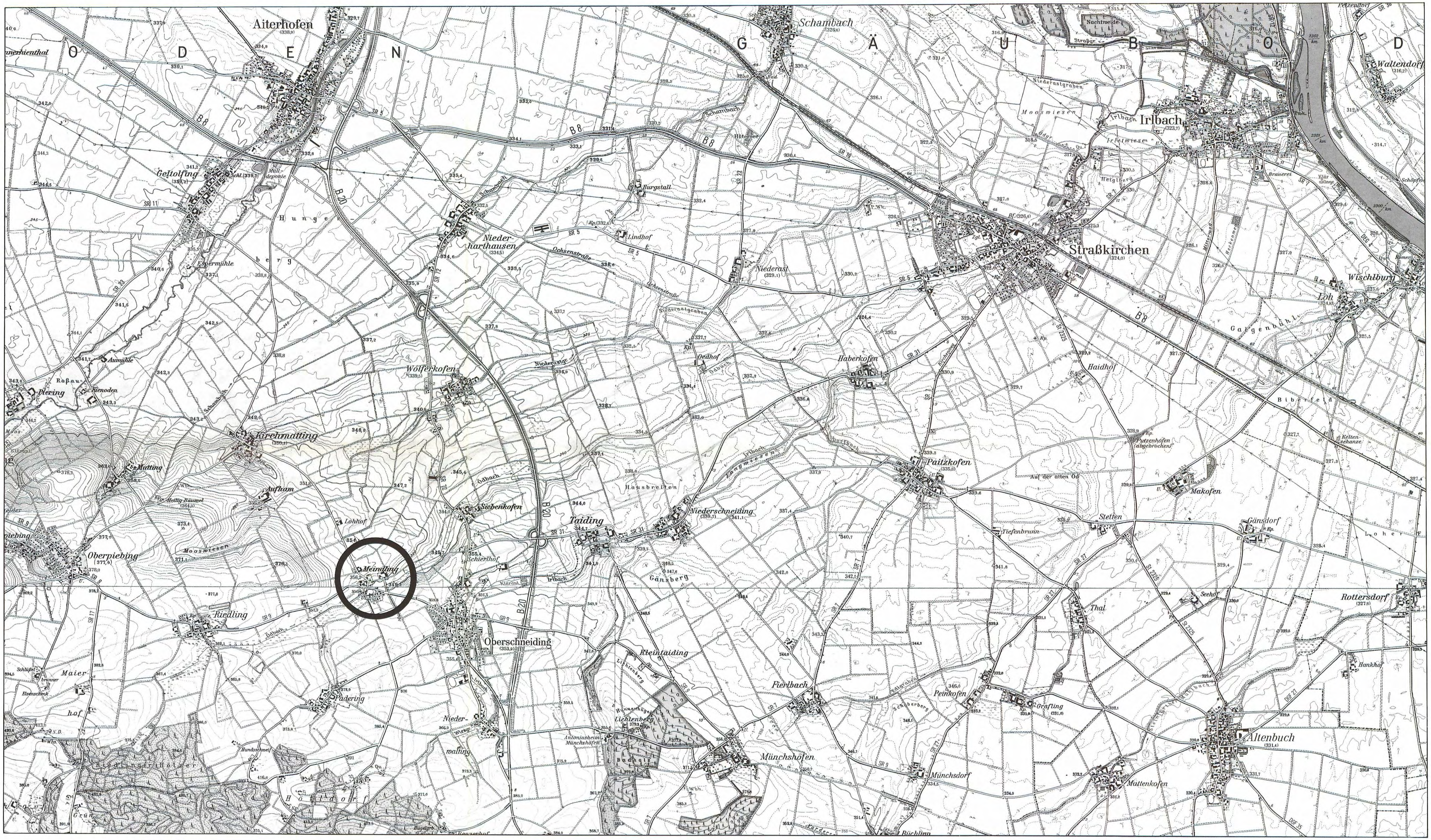

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Das Untersuchungsgebiet Ödbachtal mit der Lage des Dorfes Meindling.
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