Analecta Praehistorica Leidensia 42 / Eyserheide : a Magdalenian open-air site in the loess area of the Netherlands and its archaeological context
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ANALECTA PRAEHISTORICA LEIDENSIA 42

PUBLICATION OF THE FACULTY OF ARCHAEOLOGY
LEIDEN UNIVERSITY

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EYSERHEIDE

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

LEIDEN UNIVERSITY 2010

Series editors: Corrie Bakels / Hans Kamermans

Editor of illustrations: Joanne Porck

Translation: Kelly Fennema

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

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

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

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

5 Lithic functional analysis

Katsuhiro Sano

5.1 Samples and methods

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

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

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

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

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

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

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

5.2 Results

5.2.1 Blades

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

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

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

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

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

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

Table 5.2 Functions by IUZ of blades from Eyserheide.

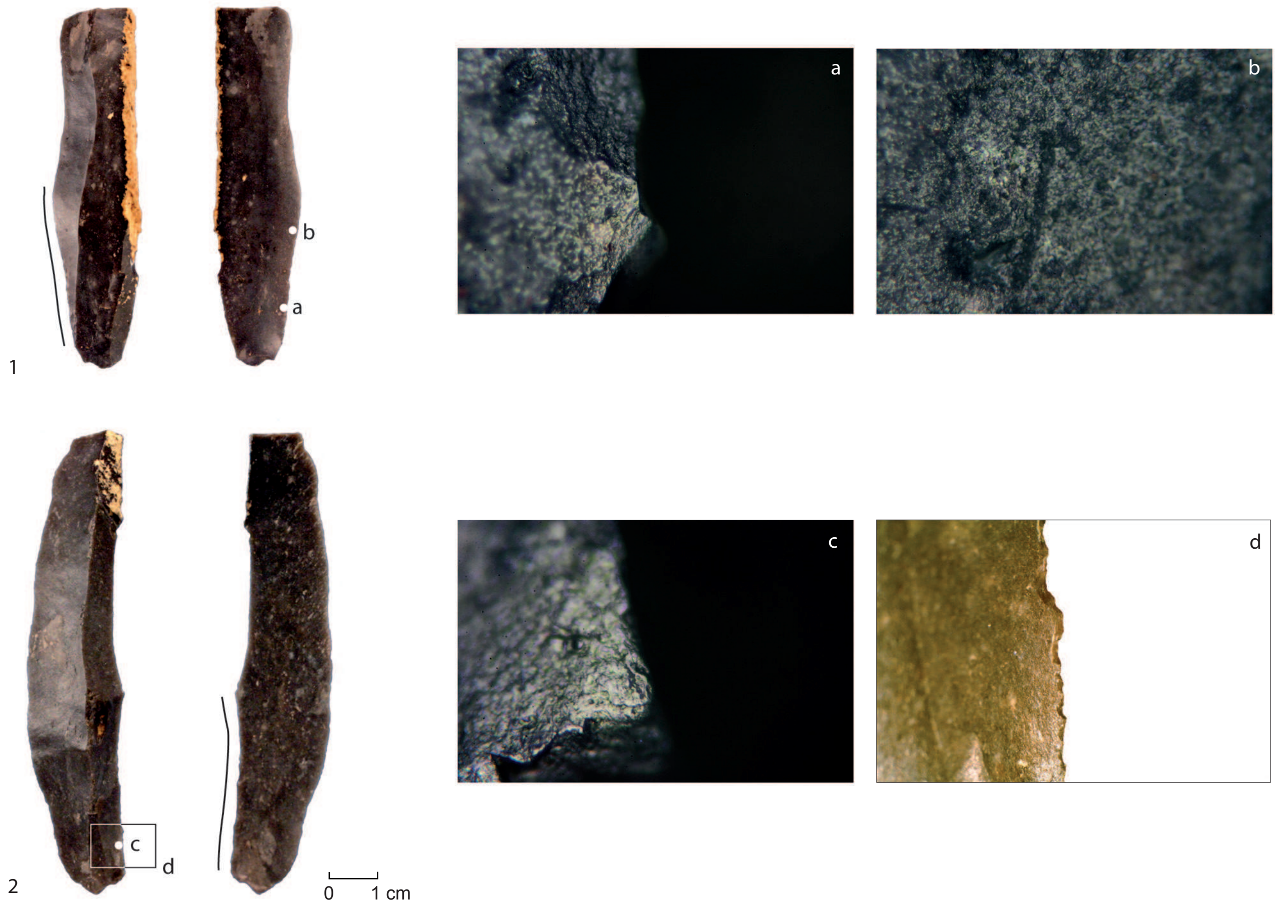

Figure 5.1 Blades 53/200 42 (1) and 53/204 10 (2). Solid lines show edges used in a longitudinal motion. a, c: polish resulting from ABI sawing (200x); b: GWP and striation (200x); d: edge removals (10x).

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

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

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

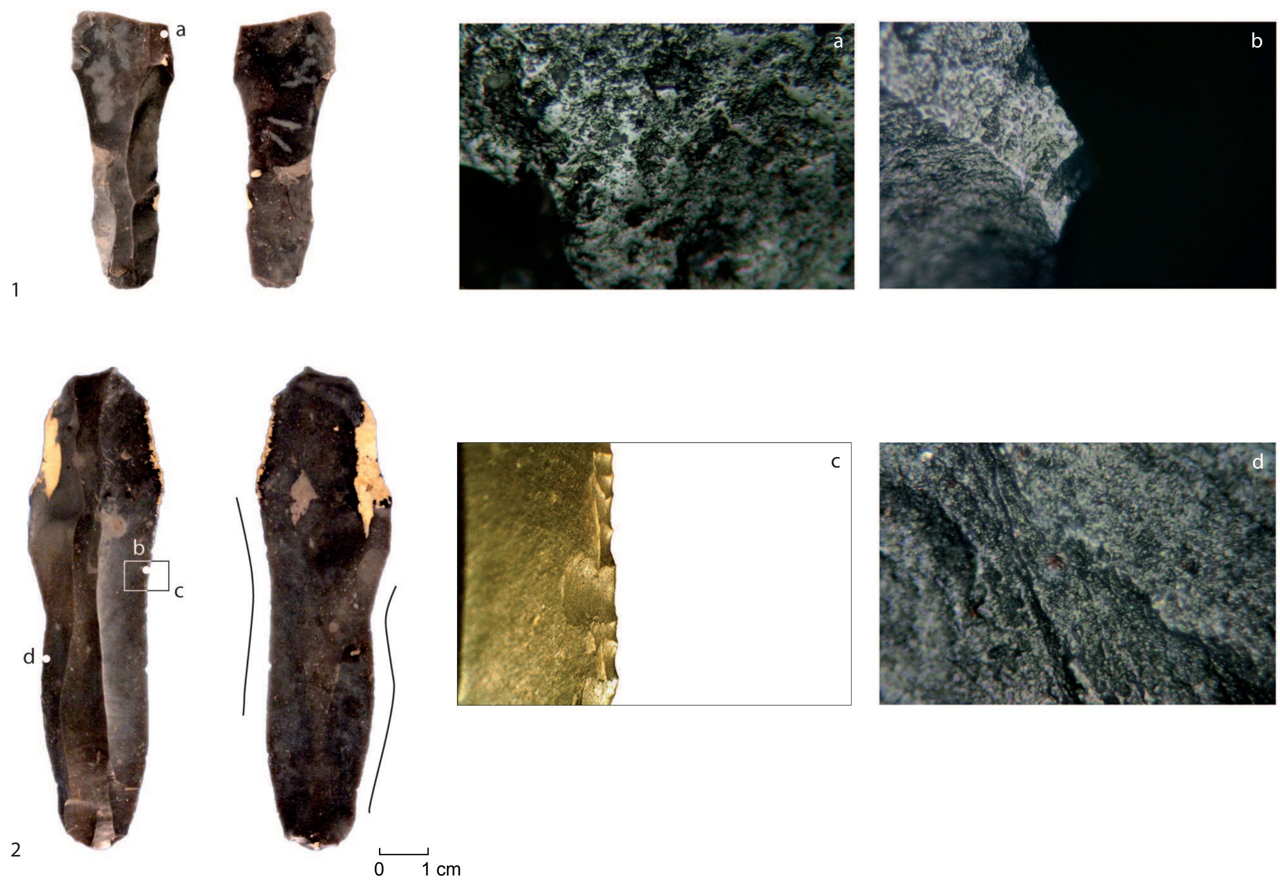

Figure 5.2 Blades 54/202 23 (1) and 54/202 50 (2). Solid lines show edges used in a longitudinal motion.
a: bright spots (100x); b: polish resulting from ABI sawing (200x); c: edge removals (10x); d: GWP and striation (200x).

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

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

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

5.2.2 Flakes

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

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

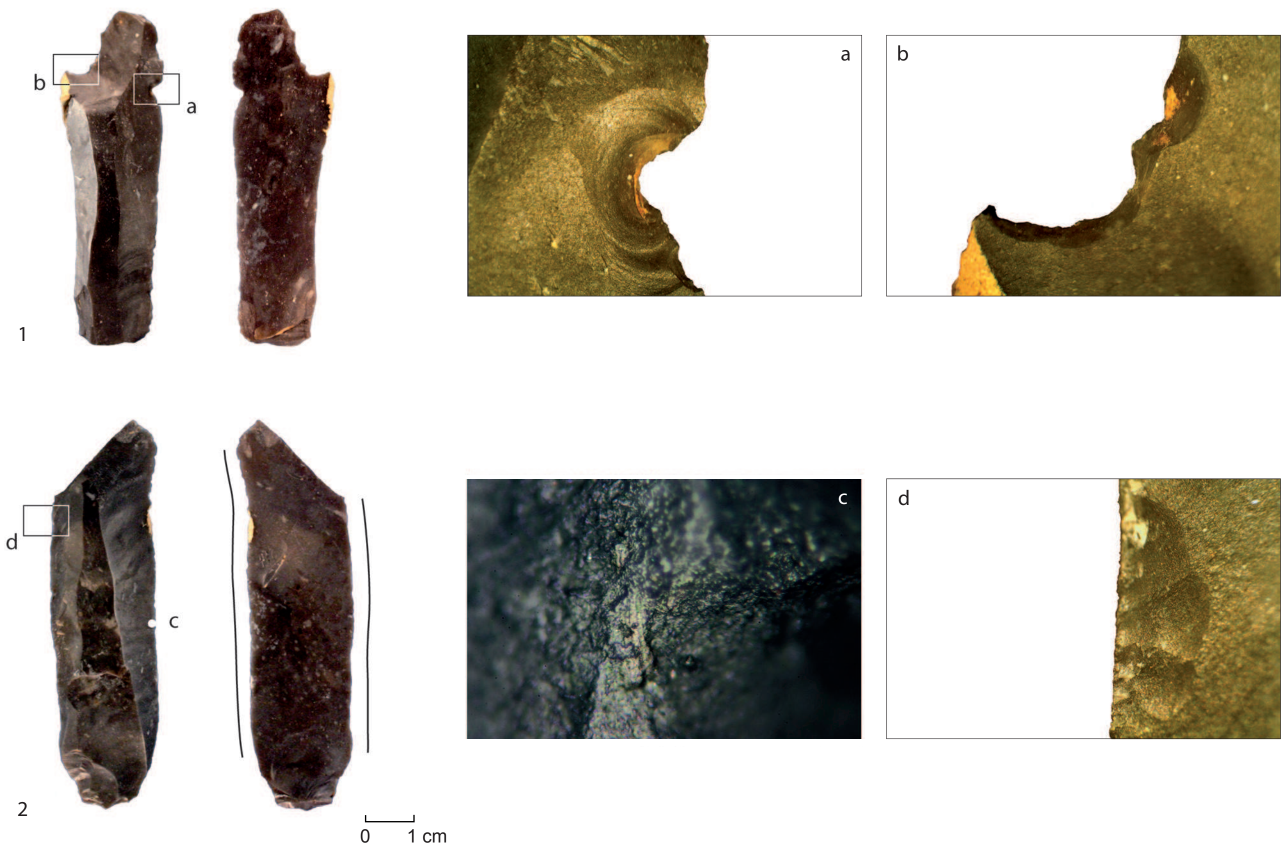

Figure 5.3 Blades 57/203 13 (1) and 54/202 136 (2). Solid lines show edges used in a longitudinal motion. a, b, d: edge removals (10x); c: polish resulting from ABI sawing (200x).

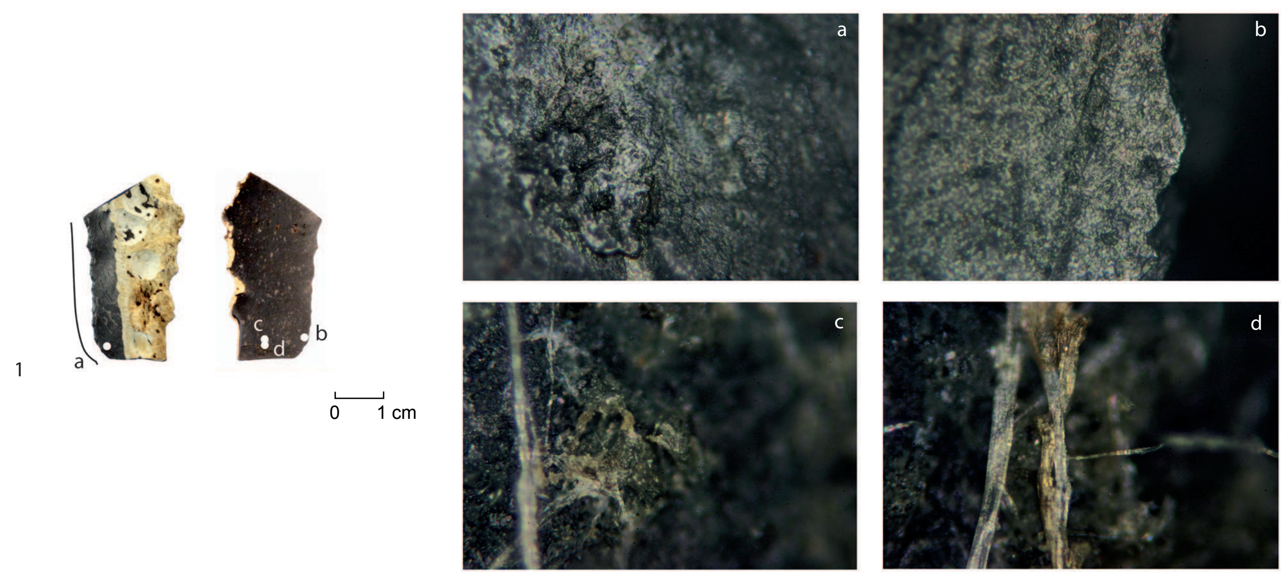

Figure 5.4 Blade 53/200 89 (1). Solid line shows edges used in a longitudinal motion. a: polish resulting from ABI (200x); b: GWP with striation (200x); c, d: residues (200x).

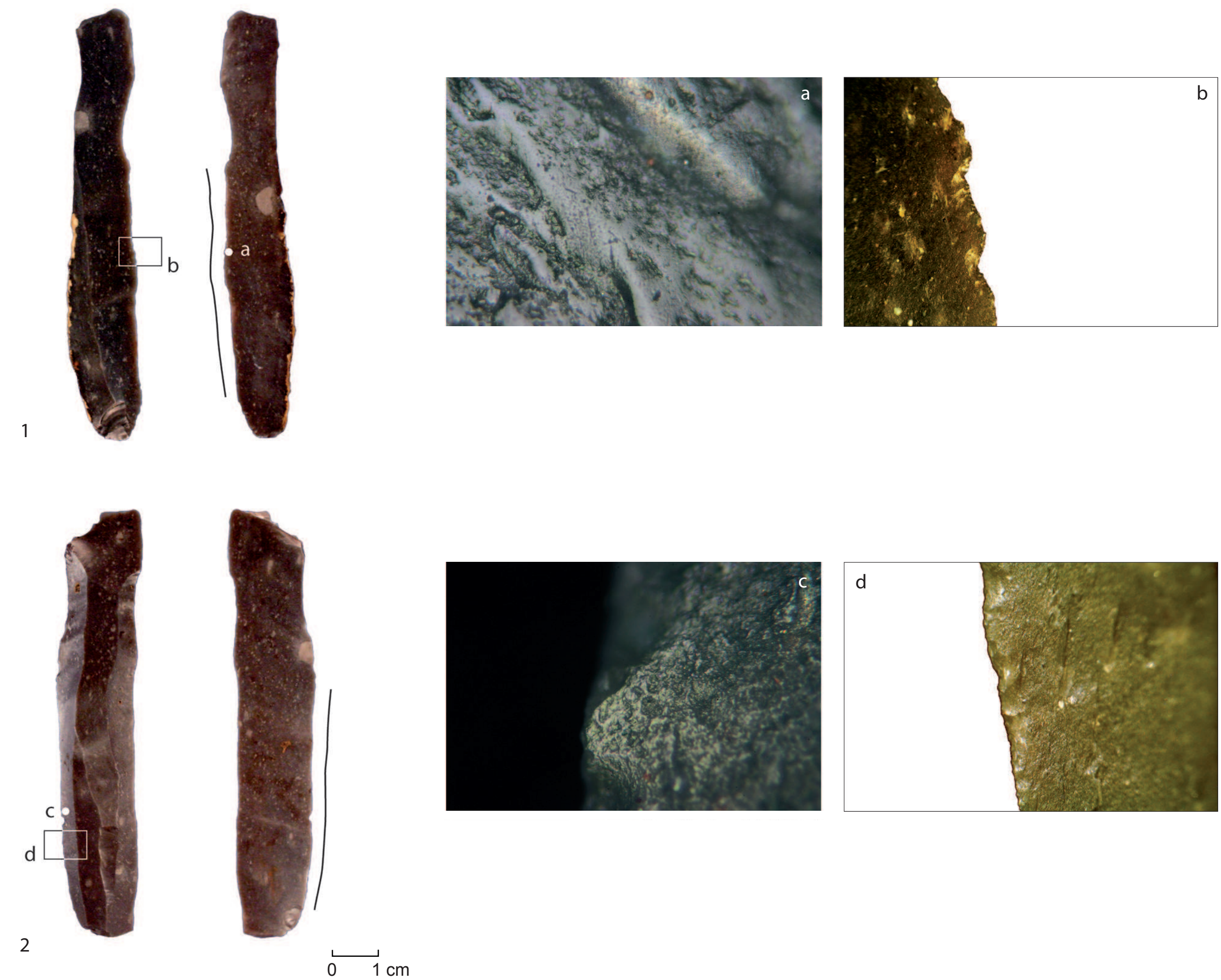

Figure 5.5 Blades 55/202 13 (1) and 55/203 3 (2). Solid lines show edges used in a longitudinal motion. a: polish resulting from plant/wood working (200x); b, d: edge removals (10x); c: SPP (200x).

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

Table 5.3 Functions by IUZ of flakes from Eyserheide.

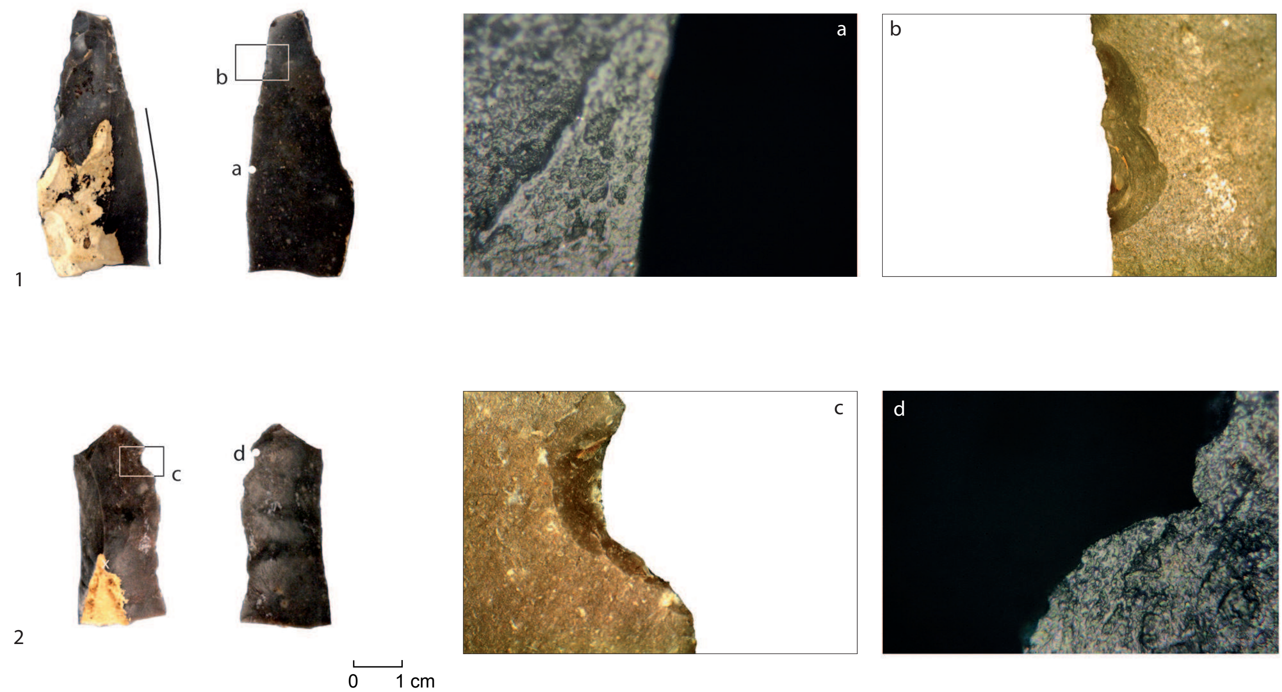

Figure 5.6 Blades 53/200 34 (1) and 52/201 20 (2). Solid line shows edges used in a longitudinal motion. a: polish resulting from hide cutting (200x); b, c edge removals (10x); d: SPP (200x).

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

5.2.3 Burins

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

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

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

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

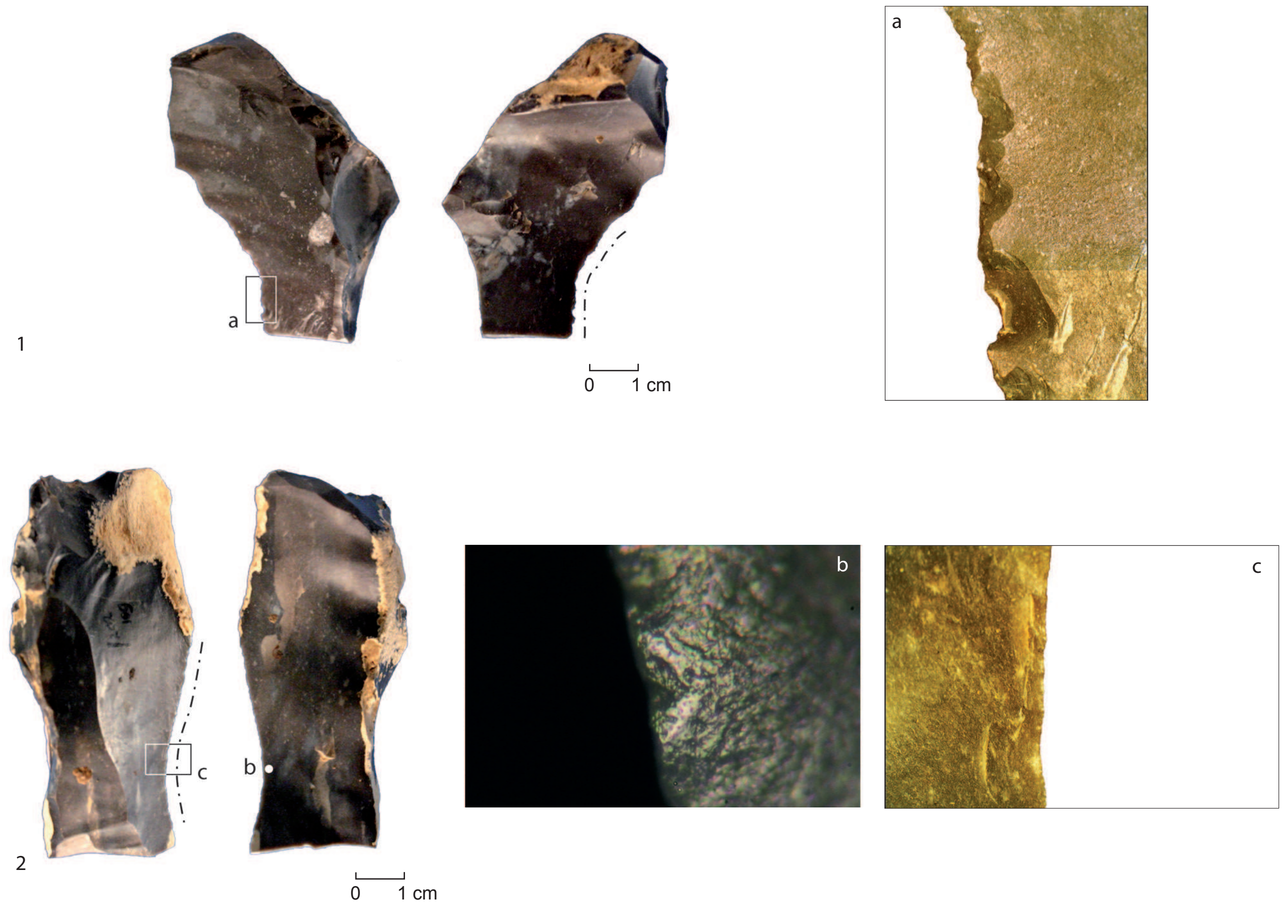

Figure 5.7 Blades 53/199 2 (1) and 54/202 109 (2). Dashed lines show edges used in a transverse motion. a, c: edge removals (10x); b: polish resulting from ABI working (200x).

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

Table 5.4 Functions by IUZ of burins from Eyserheide.

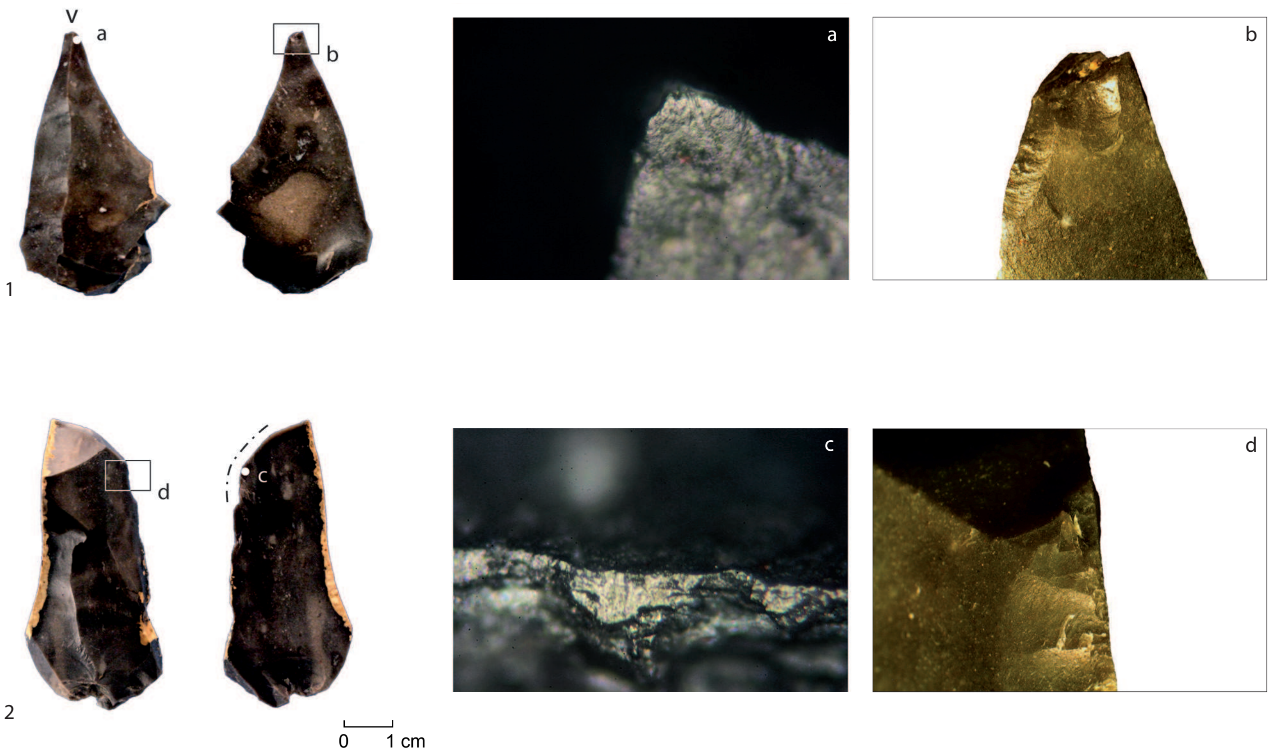

Figure 5.8 Flakes 58/203 12 (1) and 55/200 1 (2). Dashed line shows edge used in a transverse motion. V shows an edge worked for engraving. a: polish resulting from ABI working (200x); b: flute-like fractures (10x); c: polish resulting from ABI scraping (200x); d: edge removals (10x).

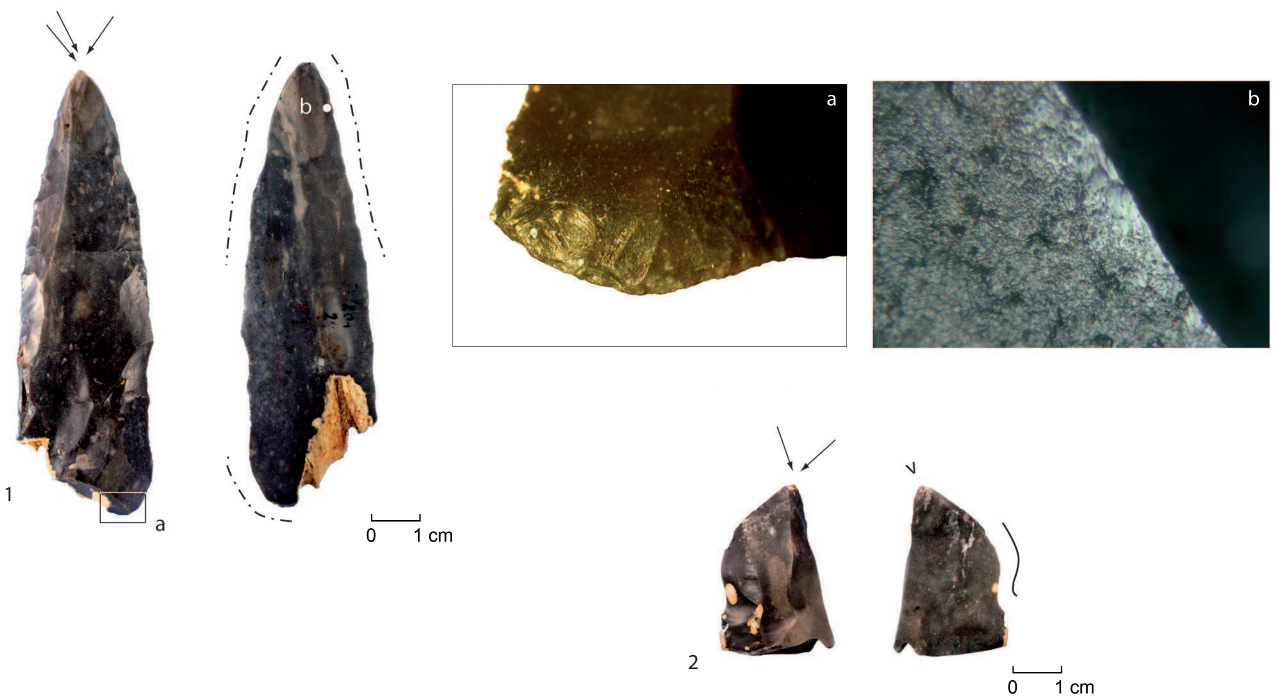

Figure 5.9 Burins 54/204 24 (1) and 57/199 5 (2). Dashed lines show edges used in a transverse motion. Solid line shows edge worked in a longitudinal motion. a: edge removals (10x); b: polish resulting from ABI scraping (200x).

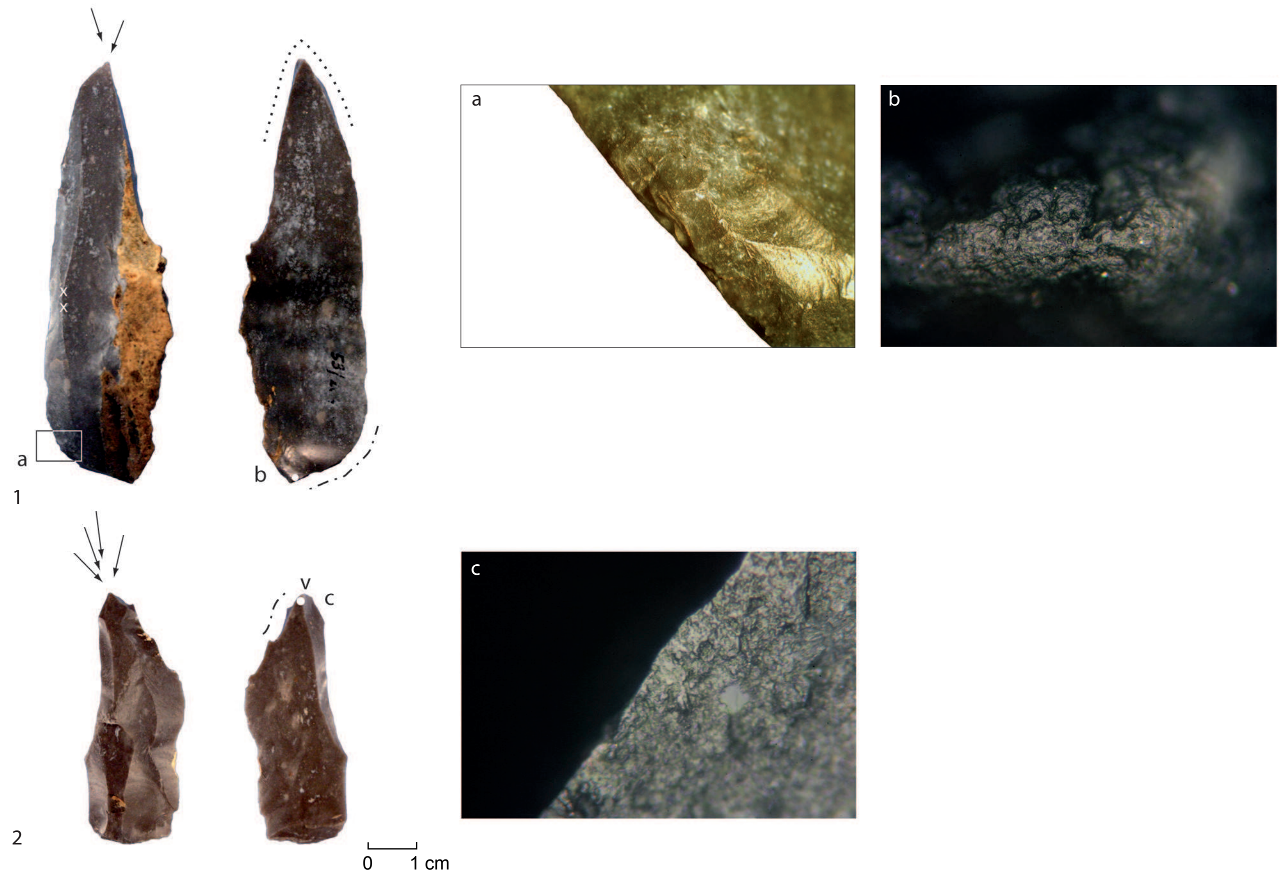

Figure 5.10 Burins 53/204 8 (1) and 54/202 121 (2). Dashed lines show edges used in a transverse motion. Dotted line shows an edge used, but motion is uncertain. X shows traces of hafting. a: edge removals (10x); b: polish resulting from hide scraping (200x); c: polish resulting from ABI graving (200x).

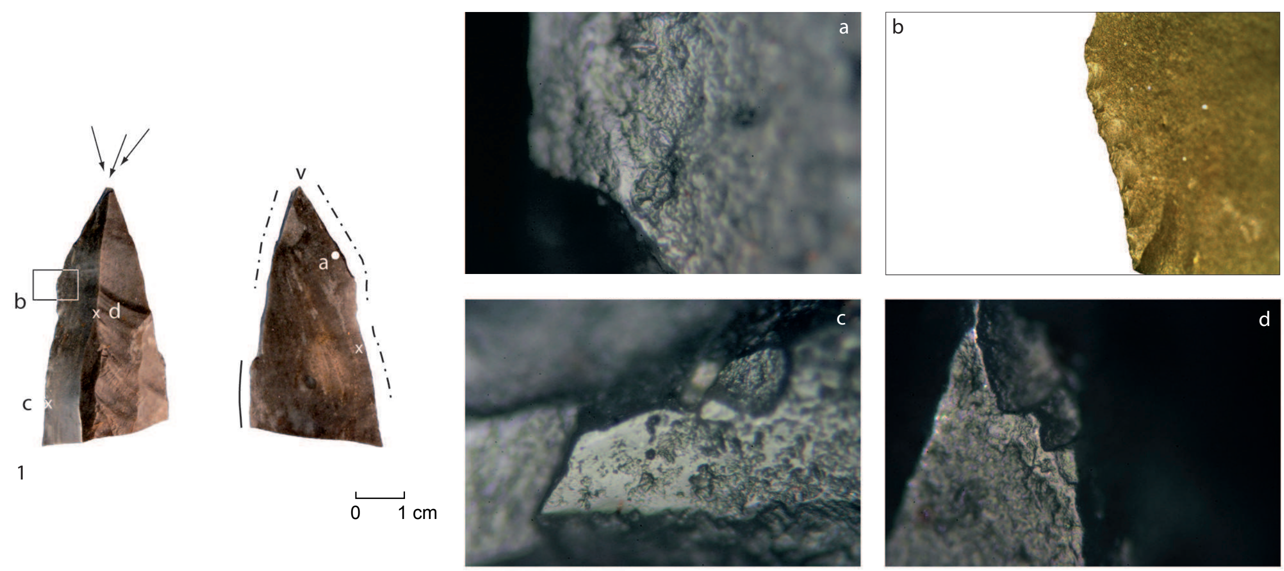

Figure 5.11 Burin 53/202 81 (1). Dashed lines show edges used in a transverse motion. Solid line shows an edge used in a longitudinal motion. X shows traces of hafting. a: polish resulting from ABI working (200x); b: edge removals (10x); c: bright spots (200x); d: polish possibly caused by hafting (200x).

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

5.2.4 *End scrapers*

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

5.3 Discussion and Conclusion

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

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

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

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

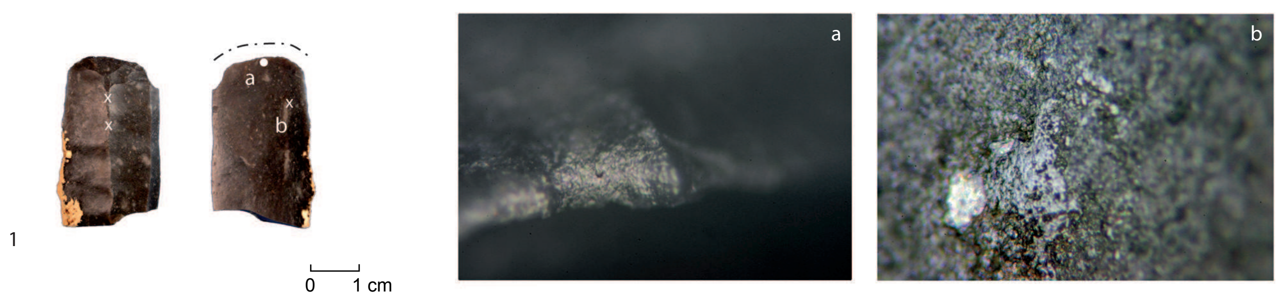

Figure 5.12 End scraper 58/203 10 (1). Dashed line shows edge used in a transverse motion. X shows traces of hafting. a: polish resulting from hide scraping (200x); b: bright spot (200x).

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

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

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