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Workshop sites in a Neolithic quarry landscape (Geul valley, Southern Limburg, the Netherlands)

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A sample of Middle Neolithic workshop sites from Southern Limburg (the Netherlands) indicates the exploitation of mined Valkenburg flint for the production of axes. The paper addresses the geography of production through an analysis of the composition of survey material. The workshops are discussed with respect to settlement activities and the ordered use of the landscape.

1 Introduction

This contribution describes a small collection dominated by so-called Valkenburg flint from Limburg, Southern Netherlands. The collection consists of surface finds from surveys between 1990 and 1992 in the area around Valkenburg where several extraction sites of Valkenburg flint were excavated by the former Institute of Prehistory in Leiden (IPL) (Brounen and Ploegaert 1992; Brounen 1998). This paper will focus on 'workshops', localities with collections dominated by unretouched and frequently cortical flakes, mostly from the production of flint axes. They are generally dated in the Middle Neolithic (following the Dutch periodization, see Van den Broeke *et al*. 2005, 28).

The baseline for this paper is provided by current knowledge about the use of Valkenburg flint. It can be summarized in the following points:

1. The geological source of Valkenburg-type flint is the Upper Cretaceous Maastricht Formation of south-western Limburg and adjacent Belgium (see Felder and Bosch 2000 for details on the geology of the limestone). Flint nodules are most frequent in the Emael and Schiepersberg Members of the Maastricht Formation. The Geul valley forms the northern limit of its distribution.
2. Exploitation of Valkenburg-type flint is documented by open-cast mining as well as the use of shafts and galleries. Shafts and galleries have been excavated at Biebosch and Plenkertstraat in Valkenburg aan de Geul (Brounen and Ploegaert 1992; Brounen 1998).
3. The use of Valkenburg-type flint is documented from the Early Middle Palaeolithic onwards. The use for flint axes is first documented in the older Michelsberg of Koslar 10 (Marichal 1983, 8). However, the use of *mined* Valkenburg-type flint is known only from the late Michelsberg phase IV/V and the Middle Neolithic B (Brounen and Ploegaert 1992; Brounen 1998; Schreurs 2005).
4. The extracted flint is mostly used for the production of polished axes of S3 type with an oval to pointed-oval cross-section (Hoof 1970).
5. The distribution of artefacts of Valkenburg-type flint reaches from the Northern Netherlands (Drenthe) to Luxemburg and from Central Belgium to Westphalia in Germany (Marichal 1983; Brounen and Ploegaert 1992). The distribution in different phases is not well known, but the most distant finds are all undated flint axes and fragments or flakes of flint axes.
6. The distribution of Valkenburg axes in the Meuse valley shows clusters (Verhart 2010). The distribution pattern does not seem to be consistent with classic down-the-line exchange. The clusters can reflect the spatial distribution of collection and research activity, but they can also reflect patterning in past discard behaviour.
7. Almost all Valkenburg axes are surface finds with limited spatial information. The axes have been frequently re-used as hammerstones and as cores for flakes. There are no documented cases of special depositional contexts such as burials. One long, wide and thin unpolished axe has a light-brown patina suggesting a possible marshy depositional context in the vicinity of Montfort (Limburg) (Mans 2011).

The wider framework is formed by the cultural changes in the Middle Neolithic of Northwestern Europe (Augereau 1996; Fabre 2001; van Gijn and Louwe Kooijmans 2005; Thirault 2005; Zimmermann *et al*. 2006; Bradley 2008; Petrequin *et al*. 2008; Vanmontfort *et al*. 2009; van Gijn 2010a; 2010b; Wentink *et al*. 2011). In the culture-historical sequence for the study region, the Middle Neolithic entails the Michelsberg culture (Middle Neolithic A) and the Stein group (Middle Neolithic B). The Stein group is more or less contemporary with the Seine-Oise-Marne and Escaut-Deule groups in Belgium and the *Spätneolithikum* of the German Rhineland. One of the changes in the fourth to third millennium BC is a shift in the role of flint axes as valuables. The distribution patterns of flint axes decrease in size from a supraregional to a regional scale. It is accompanied by the growth of exploitation of new, local lithic sources such as

Valkenburg and Lousberg. If stone axes were distributed through exchange networks, the shorter distances suggest that either the networks changed or that the role for axes in these networks changed. Several authors have attributed the decline of stone axes to competition of other items of value, in particular the arrival of copper in northwestern Europe (e.g. Thirault 2005).

The changes in exchange networks coincide with a shift in the rest of the flint tool kit. Large blades and imported tools are almost entirely replaced by a less diverse tool kit dominated by small flake scrapers and simple retouched working edges (van Gijn 1998; 2010a; 2010b; Beugnier and Crombé 2007; Vanmontfort *et al*. 2009). The dichotomy in the Late or Final Neolithic between basic skill in stone-working for every day domestic tools and craftsmanship for special, prestigious artefacts such as fine daggers seems to develop from the organization of Middle Neolithic flint technology.

The primary goal of the paper is descriptive as none of the many known Valkenburg workshops have been described and compared in some detail. But the workshops raise many more questions. Why are there only workshops for axes and not for other tool types or general-purpose cores? Why is there a distinct and spatially segregated operational scheme for the production of axes, but undifferentiated production of other tool types? Are the axes of high economic, social and symbolic value when they normally end as flake core or hammerstone? Is the exploitation of flint and production of axes organized in response to immediate or delayed need of tools of a regional population, embedded in the seasonal cycle of agricultural practice or related to the needs to participate in exchange networks?

The following research questions have been formulated to analyse the collection:

1. What is the size and composition of the collected samples?
2. Are all the workshops dominated by flint axe production or are there also other products?
3. What stages of reduction of a flint axe can be identified?
4. What is the degree of variability between the workshops?
5. Is there any typochronological dating evidence?
6. Are there indications for the presence of workshops in a settlement context?

The paper will first consider the main approaches to the study of workshops. Subsequently I will describe the materials and methods used in this study. After the description of the collection, I will discuss the results in their regional archaeological context.

2 Approaches to workshops

Quarry and workshop studies frequently start with a quote from Ericson (1984, 2) about the “shattered, overlapping, sometimes shallow, nondiagnostic, undatable, unattractive, redundant, and at times voluminous material record”. The nature of quarry and workshop studies has changed considerably since. Davis and Edmonds (2011) and Cooney (2011) provide recent reviews of research projects, the progress in the scientific techniques of sourcing and the overarching framework of a biographical approach to objects. For the purposes of this paper, I single out two different theoretical perspectives on the archaeological study of the quarry landscape (Heldal 2009).

The significant role of stone as “animate, alive, with rich symbolic potential” is particularly emphasized by Cooney (2011, 145). He argues that, therefore, the source of stone is a place of special meaning and stone-working an activity of metaphysical meaning as much as functional value. Bradley (2000, 88) has referred to the significance of chert sources by considering artefacts such as axes not only as objects with a history of their own, but as “pieces of places”. Whittle (1995) described Neolithic flint axes as “gifts from the earth” in a paper focusing on the symbolic dimensions of the use and production of axes. In this perspective, the quarry landscape is full of social and symbolic meaning and the working of stone mobilizes a web of meanings in a cosmological as well as socio-political sense.

A very different approach to the quarry landscape is represented by economic approaches to the supply of stone. A study of North-American bifacial points by Beck *et al*. (2002) provides a good example of this approach. They show how transport costs impact the variability of quarry assemblages. Their results suggest that bifacial points are further processed near the quarry if the distance to the residential site is greater. Decisions to transport nodules or remove low-utility cortex at the procurement site depend on the trade-off between the time spent on decortification and the cost of transporting low-utility weight. Bamforth and Bleed (2007) suggest that risk is a more important factor determining the variability in quarries and workshops. Risk consists of two components – the probability that a problem will occur and the costs if the problem actually occurs. In terms of procurement of raw materials, the risks lie in the absence of appropriate material when needed and the costs of not having new material for the replacement of tools. In terms of production of tools, the risks lie in failures during production and the consequence of additional time spent on production, including perhaps getting new raw material. Bamforth and Bleed (2007) suggest that technologies have different options to reduce the risk of failure during procurement, production or use of tools. By caching roughouts, production by specialists and/or production at a quarry site, the risks and costs of failure during the production of stone axes can be reduced. From the perspective of supply economics, the quarry landscape reflects the accumulated costs-and-benefits in terms of time, energy and risks for users of the quarried raw materials including the socio-economic organization to deal with them.

The ethnographic axe studies in Irian Jaya by Petrequin and Petrequin (1993; 2011) show that both economic and symbolic approaches are important and that they can be united. The symbolic potential of stone resonates strongly with ideas that 'raw material' is in fact a sacred material in a sacred place and should only be dealt with by initiated people and after appropriate rituals have taken place. Petrequin and Petrequin (1993; 2011) show that the meaning of the source and the materials is pervasive in the access to the quarry by initiated men, in the rituals taking place and in the place-names (cf. Basso 1996). The procedures of stone working that take place at the quarries, in workshops or in settlements also make sense in economic terms. The episodes of high risk are all realized at the extraction sites with easy access to new material in case of breakage during testing and first shaping. Roughly shaped nodules are further reduced into pre-forms to reduce the weight for transport. Petrequin and Petrequin (1993; 2011) emphasize a third element – the demand for rock is determined by the cycles of ceremonial exchange between villages for renewing marriage alliances, establishing peace or for funerary payments. Expeditions to extract raw materials are not a response to the direct need for a tool nor for creating a store or reserve, but to the direct demand to participate in the social life of the community through exchange. This is very similar to what Spielmann (2002) has described as the "ritual mode of production". The "ritual mode of production" is clearly distinct from production for elites – it is not for the political aspirations of a few, but for the participation of many in exchanges that are at the heart of small-scale societies (Spielmann 2002, 202). The wider social context is critical for a better understanding of the organization of the quarry landscape (cf. De Grooth 1991; 1998).

In this study I have tried to approach the material first of all from an economic perspective. This helps to identify the stages of production that actually took place at the workshop locations. However, these economic practices are not a goal in themselves. The decisions in terms of risk and transport costs are part of a wider system.

3 Materials and methods

3.1 Materials

The materials studied for this paper were collected during surface surveys in agricultural areas. The documentation from the time of collection is limited, but additional information was provided by one of the surveyors (F. Brounen). Most sample locations were only visited once. The spatial information was documented on find cards. Coordinates in the Dutch grid system were derived from 1:25,000 topographic maps. A total of 57 localities with over 3000 artefacts were studied. I should emphasize here that this collection is only a small sample of the material that has been collected by numerous amateur archaeologists in the region over the past decades (some of the collections were studied by Marichal (1983), others were published by amongst others Pisters (1983; 1986; 2008) and Pepels (2009), many await analysis).

3.2 Methods

Collections with more than 10 artefacts of Valkenburg flint were counted in basic categories. The flakes of Valkenburg flint were described individually for selected samples. A list of the categories and variables used is given in table 1.

4 Results

4.1 Spatial distribution

The sample locations were plotted on a digital elevation map to inspect their spatial distribution visually (fig. 1). There are five main clusters of workshop sites: Waterval, Raar-Amstenrood, Vilt, Groot-Welsden, and Kloosterbosch. The sites are located on plateaus and plateau edges. All clusters are associated with dry valleys. Many workshops are found within or on the northern boundary of the geological distribution of the Maastricht Formation. Some samples near Waterval are located more north of the Maastricht Formation.

4.2 Sample size

The collections are relatively small – all samples are smaller than 320 pieces (fig. 2). Following Bradley and Edmonds (1993), the sample size is limited to the classes 1 to 6. The

Categories	Variables
Artifacts	Fragmentation
Artifacts of Valkenburg-flint	Length
Flakes	Width
Cores	Thickness
Roughouts	Platform width
Retouched flakes	Amount of cortex
Axes	Cortex location
Ax flakes	Platform preparation
Hammerstones	Dorsal preparation
Extraction tools	Distal end
Raw material blocks	
Rijckholt-type flint	
Lousberg-type flint	
Simpelveld-type flint	

Table 1 Categories and variables used for the description of the samples.

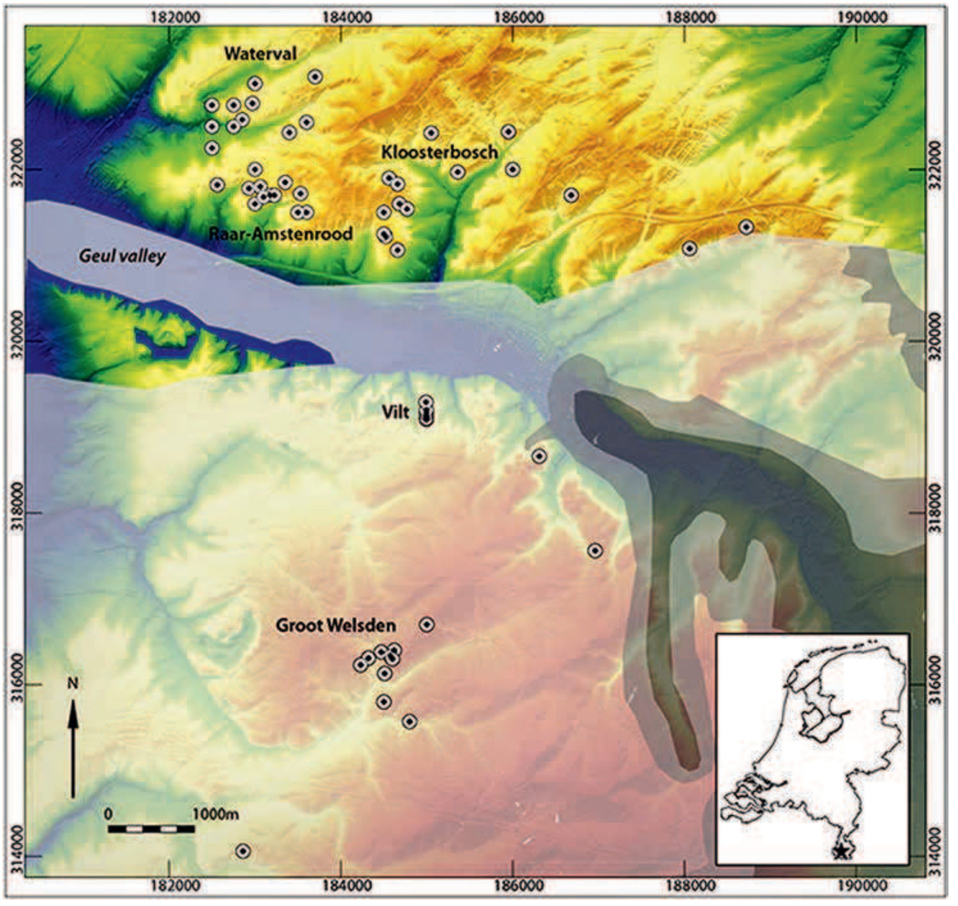

Figure 1 The distribution of sample locations plotted with the distribution of the Cretaceous limestone in grey-tones, based on Felder and Bosch (2000). Background: AHN.

majority of the samples consist of less than 10 artefacts – most of them must be considered as collections of dispersed, single finds. A second group of samples contains 40 to 160 pieces. If we consider the samples from the locality Vilt as representing one large accumulative flake scatter, then the sample size of Vilt raises to less than 450 pieces (class 7).

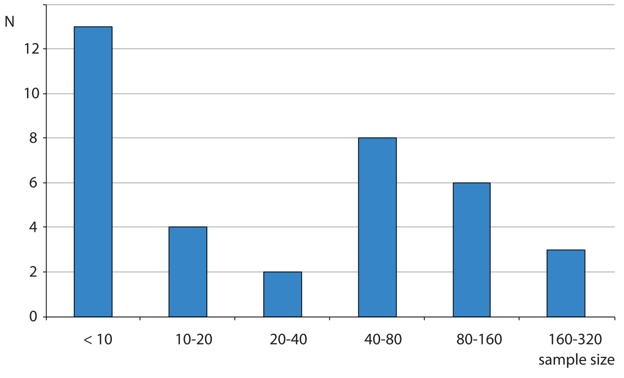

Figure 2 Histogram of sample sizes; classification following Bradley and Edmonds (1993).

4.3 *Composition* (table 2; figs 3 and 4)

Most samples consist for 80 to 100% of Valkenburg flint. However, 8 samples contain larger proportions of artefacts from other flint sources. The most frequent are Rijckholt-type flints. Cortical pieces usually show rolled cortex and it is likely that most of the flint is derived from local fluvial gravels (Meuse terrace flints). Twelve samples contain a small amount of Simpelveld flint, including a flake core. Two samples contain 1 piece of Lousberg flint including one flake core. A large flake scraper of Wommersom quartzite was found in a sample from the Groot-Welsden cluster. Flakes of so-called “Belgian light-grey” flint are also present.

The majority of samples consists of flakes and their fragments (fig. 5). Raw material blocks with a few flake

SampleID	Cluster	Toponym	Weight	Nf	NVK	% VK	Nflake	Ncore	Nrough	Nret	Nax	Naxfl	Nhammer	Nextract	Nrawmat	Rijckholt	Lousberg	Simpelveld
1	GW	Holleweg		55	22	40.0	14	2	0	2	1	0	1	1	0	y	n	n
6	RA	Amstenrood I		23	10	43.5	10	0	0	0	0	0	0	0	0	y	n	n
9	GW	Groot-Welsden		15	11	73.3	10	0	0	0	0	1	0	0	0	y	n	n
10	KB	Kloosterbosch Holswick		21	3	14.3	2	0	0	0	0	0	1	0	0	y	n	y
12	GW	Groot-Welsden		15	7	46.7	6	0	0	1	0	0	0	0	0	y	n	y
13	KB	Broemkuilweg		11	6	54.5	4	1	0	0	0	0	1	0	0	y	n	n
16	RA	Amstenrood		11	5	45.5	5	0	0	0	0	0	0	0	0	y	n	n
20	WA	Waterval III	850	85	85	100	82	0	1	0	0	1	0	0	1	n	n	n
21	KB	Haasdal-Op den Billick		28	9	32.1	8	0	0	1	0	0	0	0	0	n	n	n
23	RA	Amstenrood II	4540	303	264	87.1	245	0	1	16	0	1	1	0	0	y	n	y
24	GW	Groot-Welsden		107	84	78.5	79	0	0	2	0	0	1	0	2	y	y	n
25	KB	Haasdal-Elsenweg	2895	199	164	82.4	161	0	0	1	0	1	1	0	0	y	n	y
26		Klimmen-Hellebeuk	4040	215	151	70.2	133	2	0	13	0	1	1	0	1	y	n	y
27	RA	Raarveld	1450	83	69	83.1	65	1	0	2	0	1	0	0	0	y	n	y
28		Sibbe	2390	63	36	57.1	36	0	0	0	0	0	0	0	0	y	n	y
29	GW	Groot-Welsden Kop Kaap		163	105	64.4	103	0	1	1	0	0	0	0	0	y	n	y
30	RA	Raar		102	74	72.5	69	1	1	2	0	0	0	1	0	y	n	n
31	RA	Raar-Amstenrood		336	195	58	185	1	2	1	1	3	0	0	2	y	n	y
32	KB	Ravensbosplateau	5440	321	117	36.4	95	2	3	16	0	0	1	0	0	y	n	y
34	VI	Vilt-Scouting 1	1275	72	72	100	71	0	0	1	0	0	0	0	0	n	n	n
35	VI	Vilt-Scouting 1uitlopers	1890	81	72	88.9	64	0	0	7	0	0	1	0	0	y	n	y
36	VI	Vilt-Scouting 1A	3045	72	65	90.3	61	0	1	3	0	0	0	0	0	y	n	n
37	VI	Vilt-Scouting 1B	1880	73	72	98.6	67	1	0	3	0	0	0	1	0	y	n	y
38	VI	Vilt-Scouting 1C	3080	95	95	100	87	1	1	5	0	1	0	0	0	y	y	n
39	VI	Vilt-Scouting 3	1200	41	41	100	36	0	0	4	0	0	1	0	0	n	n	n
40	VI	Vilt-Lijkweg	1725	72	71	98.6	67	0	0	2	0	0	0	2	0	y	n	n
		total	35700	2662	1905		1765	12	11	83	2	10	10	5	6			

Table 2 Composition of all samples with 10 or more artifacts of Valkenburg-type flint. GW = Groot-Welsden, RA = Raar-Amstenrood, WA = Waterval, KB = Kloosterbosch, VI = Vilt.

removals are found at five localities. Roughouts are also rare and only found at 8 localities. Four fragments of polished Valkenburg axes have been documented from 4 localities. Eight samples contain flakes from polished Valkenburg axes. In addition, there are 18 fragments of polished axes of Rijckholt-type flint (fig. 6). Fifteen hammerstones have been documented, most of them in workshop context, but several are single finds. Four clusters of workshops (Raar-Amstenrood, Vilt, Groot-Welsden, Kloosterbosch) are associated with extraction tools such as *Kerbschlägel*. Most larger workshops contain small amounts of simple retouched Valkenburg flakes, dominated by flake scrapers. Three samples have larger numbers of retouched flakes and blades on other flint types, but none has more than 30 retouched pieces.

4.4 Products

The broad, cortical flakes, roughouts of axes and partially worked blocks indicate that axe production is the dominant goal of the production at all workshop locations. No blade cores are documented in the samples. Only three 'macrolithic' blades of Valkenburg flint were documented: two at the locality Vilt and one scraper on a macro-blade for Ravensbosplateau. Flake cores (N=13) are relatively frequent and present in 10 samples.

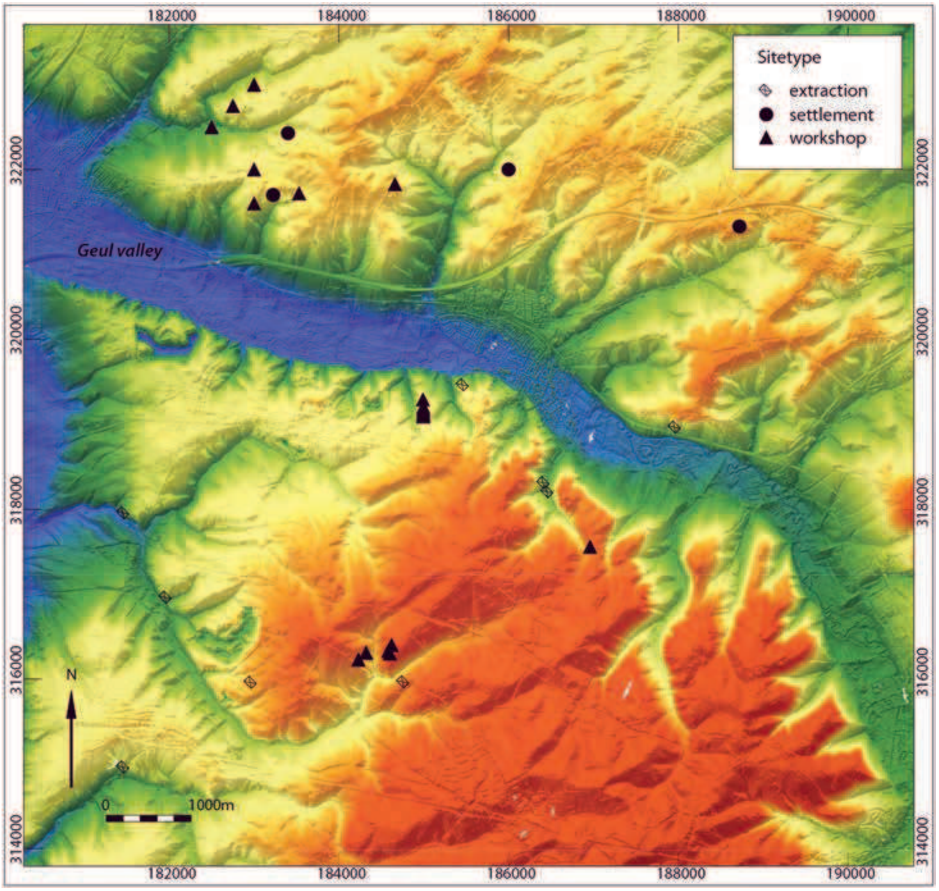

Figure 3 The distribution of site types.

4.5 Dating elements

Elements of typochronological value are very rare in the samples (table 3). Where they are present, the association of the 'tooltypes' with the rest of the sample material cannot be taken for granted. An additional problem are the diagnostic types for the Middle Neolithic. The *Michelsberg* flint technology is generally characterized by retouched tools on large flakes and blades, but very few types are diagnostic for the Middle Neolithic B or Late Neolithic. A dominance of small scrapers on flakes, a low percentage of blades and transverse and stemmed arrowheads are frequently mentioned, but few excavated and well-dated assemblages are available from Belgium, the Netherlands and adjacent Germany (e.g. Vanmontfort *et al*. 2009). It is not possible on current evidence to distinguish lithics from the Stein group, the Seine-Oise-Marne group or the German *Spätneolithikum*.

Despite these limitations, the few typochronological elements in the collection all indicate the Middle to Late Neolithic period. The presence of a few large 'macrolithic' blades, a large flake scraper and a basal fragment of a point with ventral retouch probably indicate land-use by *Michelsberg* groups. The small flake scrapers and an atypical transverse arrowhead are provisionally assigned to the Middle Neolithic B or Late Neolithic.

4.6 Comparison of samples

Twelve larger samples were selected for more detailed technological description of the Valkenburg flakes (table 4). Two samples from Vilt were combined because they are part of a single scatter and four samples are only analysed for a few variables at the moment.

The flakes are generally as broad as long – samples vary from broader flakes to somewhat longer flakes. Mean length of flakes is between 40 and 50 mm. Mean width varies between 40 and 60 mm. The mean elongation ranges between 0.88 and 1.14 mm. The ratio of length to thickness ranges around a mean value of 4 – values vary between 3.1 and 4.5. Mean platform widths are generally between 17 and 34 mm. Relative platform size, the ratio of platform width to length, varies from 1.3 to 2.9. Samples also differ

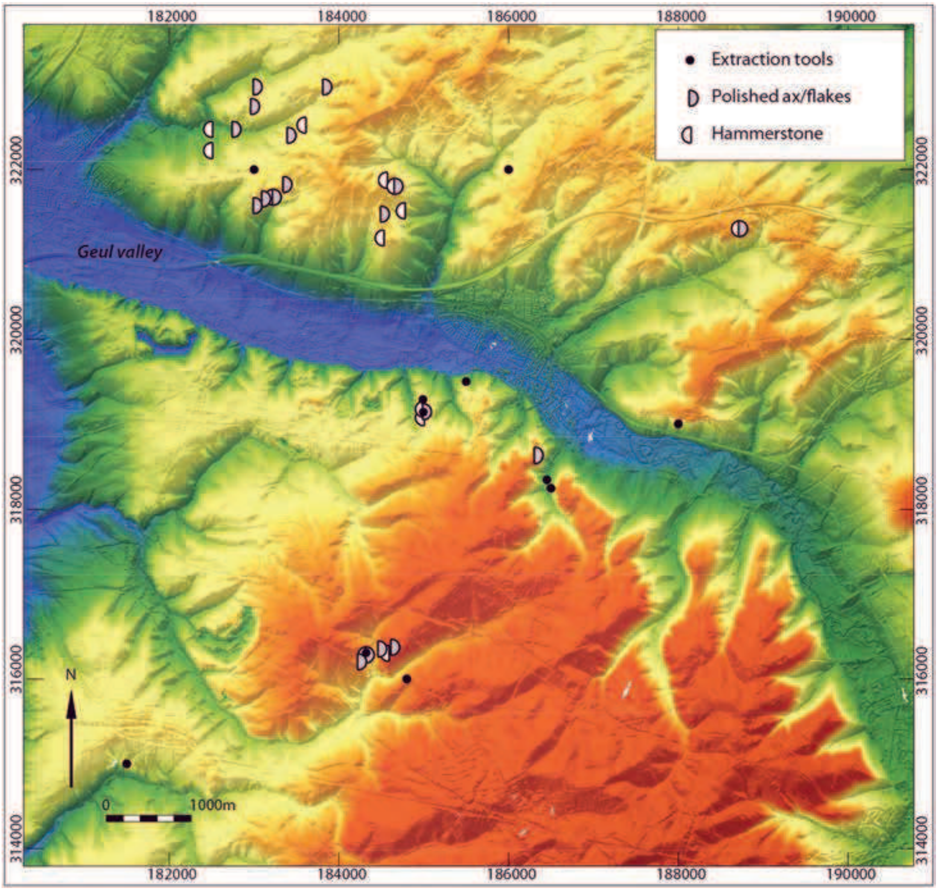

Figure 4 The distribution of extraction tools, fragments and flakes of polished axes, and hammerstones.

Sample ID	Cluster or Location	Tool types	Period
1	Groot-Welsden	Thick large flake scraper (Wommersom quartzite)	Middle Neolithic A?
12	Groot-Welsden	Transverse arrowhead	Middle Neolithic B (or A)
23	Raar-Amstenrood	Point, basal fragment, straight base with ventral retouch Retouched blade	Middle Neolithic A?
26	Klimmen-Hellebeuk	Small flake scrapers Notched pieces	Middle Neolithic B or Late Neolithic?
32	Ravensbosplateau	Small flake scrapers Endscraper on denticulated macrolithic blade	Middle Neolithic A or B?
35	Vilt	Flake scraper	Middle Neolithic B or Late Neolithic?
36	Vilt	Macrolithic blade	Middle Neolithic A (Michelsberg?)
39	Vilt	Macrolithic blade, notched	Middle Neolithic A (Michelsberg?)

Table 3 List of diagnostic artifacts identified in the collection.

Cluster or Location	**Groot-Welsden**			**Klimmen-Hellebeuk**	**Raar-Amstenrood**		**Vilt**			**Kl.**	**Ra.**
SampleID	*1*	*24*	*29*	*26*	*23*	*27*	*35+37*	*34*	*40*	*25*	*32*
N	14	79	99	133	36	63	102	72	71	164	117
elongation	0.88±0.16	0.97±0.31	1.14±0.42	1.00±0.32	0.89±0.2	1.09±0.48	1.14±0.59				
thinning	3.06±1.0	4.25±1.42	4.48±1.84	4.06±1.23	3.53±0.95	4.29±1.38	4.18±1.61				
relative platform size	1.3±0.3	2.9±2.3	2.8±2.3	2.7±6.1	1.8±1.2	2.5±1.2	2.6±1.6				
cortex											
absent	7	48	58	74	43	52	54	75	60	64	52
present	93	52	42	26	57	48	46	25	40	36	48
> 75%	36	6	5	1	9	6	11	3	4	7	8
cortexlocation											
proximal	14	6	6	4	0	6	10				
distal/lateral	33	39	28	24	54	27	19				
platform preparation											
facetted/diedric	21	18	24	28	40	21	25				
plain	21	48	31	13	43	29	20				
dorsal preparation	21	39	52	42	46	40	26				
% hinge	14	4	5	6	1	2	5				
chips < 2 cm				x	present	x	present				

Table 4 Summary data on technological aspects for selected samples (Kl. = Kloosterbosch; Ra. = Ravensbosplateau).

in the amounts of cortex. One sample, though small, contains almost only cortical flakes, many of which have more than 75% cortex. The presence of cortex in the other samples ranges from 25 to 57%. Flakes with more than 75% cortex vary between 1 and 11%. Cortex is usually located on the distal and/or lateral part of a flake. Percentages are between 19 and 54% for cortical flakes. Samples also differ in the preparation of platforms. Platforms frequently contain evidence of faceting by two or more flakes, but the frequency varies from 18 to 40%. Plain platforms, i.e. using one flake scar as platform for removal, are also frequent, but vary between 13 and 43%. Many flakes are also prepared on the dorsal face – the proportions range between 21 and 52%. Many flakes are fragmented and the fragmentation is greater among smaller and thinner flakes. Among the preserved distal ends, the number of hinges was noted – the percentages vary between 1 and 14%. Finally, there are also differences in the presence of chips smaller than 20 mm. Only two samples contain substantial amounts of small flakes.

5 Discussion

5.1 Dating

The dating of workshop sites remains highly problematic. Indications such as the presence of a few ‘macrolithic’ blades and small scrapers on flakes all hint at (rather than date to) the Middle and/or Late Neolithic. Moreover, the integrity of the workshop material and the association of

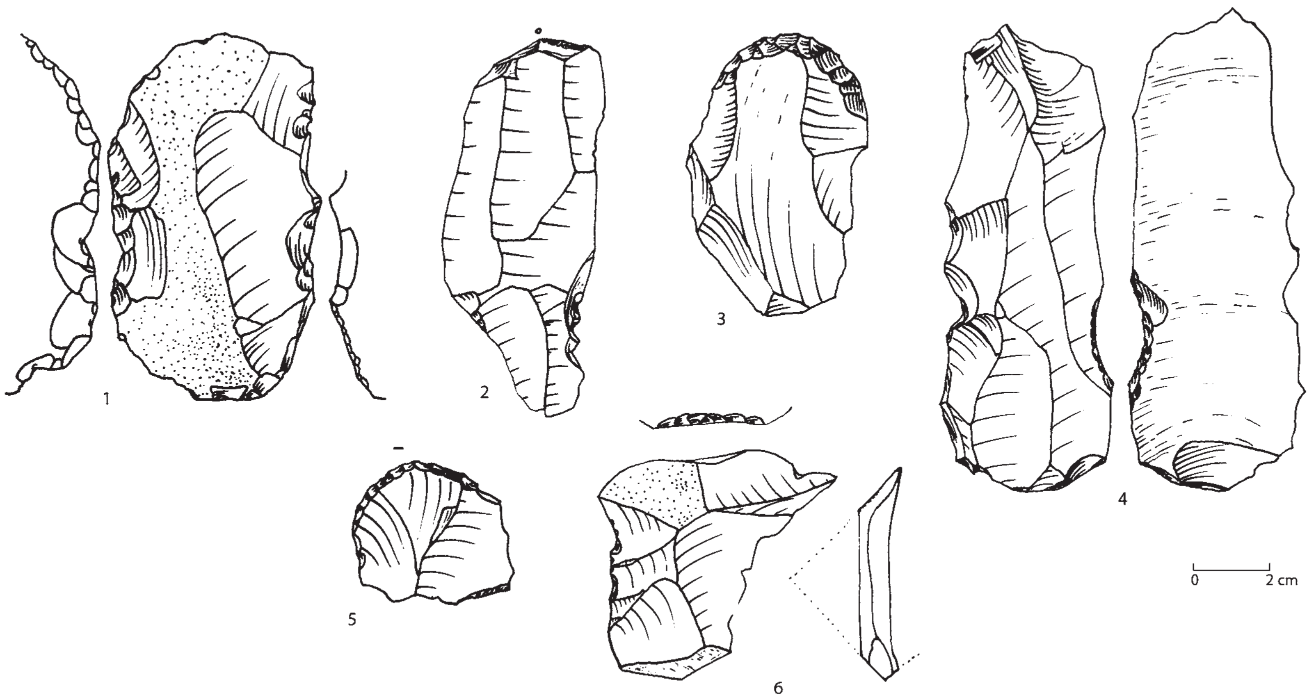

Figure 5 Selected artefacts of Valkenburg flint from different locations. 1 notched flake with ventral retouch (Vilt-Lijkweg); 2 endscraper with denticulate edge on blade (Ravensbosplateau); 3 flake endscraper (Ravensbosplateau); 4 macrolithic blade with lateral notch (Vilt-Scouting); 5 flake endscraper (Ravensbosplateau); 6 denticulated flake with distal ventral retouch (dotted is the reconstructed outline of angular raw material block) (Amstenrood II).

Site	Material	Lab number	14C-age	CalBC (95%)
Plenkertstraat, mine II	Charcoal (*Corylus* or *Buxus*)	GrN-19831	4670±60	3634-3350
Plenkertstraat, mine IV	Charcoal (*Corylus* or *Buxus*)	GrN-19830	4610±80	3631-3095
Biebosch	Charcoal (*Alnus*), fireplace	GrN-19832	4330±60	3312-2778
Sangen	Antler tool	GrN-6782	4385±60	3329-2894
Geboschke	Antler tool	GrN-6783	4235±45	2921-2669
Keerderbosch	Antler tool	GrN-10463	4150±60	2889-2577

Table 5 14C dates for extraction sites of Valkenburg flint.

typochronological indicators with Valkenburg flakes cannot be taken for granted.

Additional evidence for the dating of the workshops comes from six ^{14}C-dates from extraction sites of Valkenburg flint (table 5). Some comments are necessary: 1 the charcoal samples may suffer from the old wood effect, that could explain the relatively old dates for the two Plenkertstraat mines (cf. Schyle 2006 for similar effects at the Lousberg); 2 the context of the charcoal is the infill of the shafts – in a strict sense, it dates a point in time prior to infilling, but it is not clear how it relates to the construction of the pit and the extraction of flint; 3 the exact relationship of the dated antler tools to extraction features is unknown – the dates refer to the time of death of the deer. In other words, the six dates indicate some points in time during the exploitation of Valkenburg flint, but they date neither the beginning nor the end nor the duration of mining activities (cf. Ambers 1998).

The relatively early dates for the Plenkertstraat mines have been argued to indicate exploitation in the Late Michelsberg phase (MK IV/V) (Brounen and Ploegaert 1992). There are two reasons to question this interpretation: on the one hand, the possibility of an old wood effect, and on the other hand,

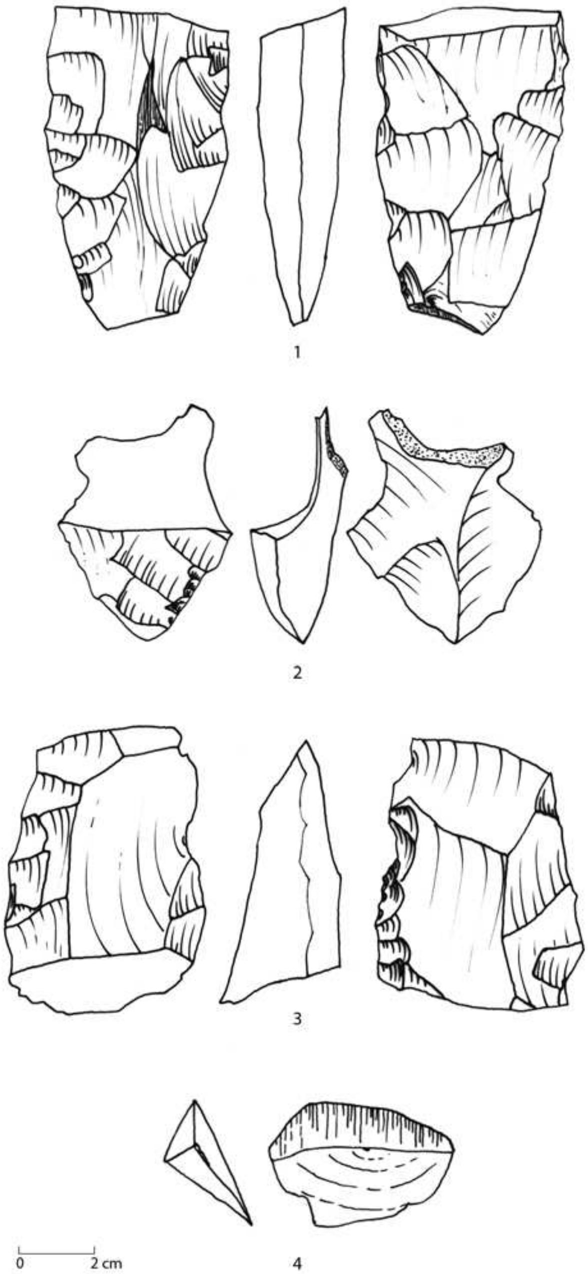

Figure 6 Fragments of axes of Valkenburg flint from different locations. 1 fragment of ax, with small polished part indicating later bifacial reworking, on thick elongated flake (Vilt-Scouting); 2 bifacially worked distal fragment (Vilt-Scouting); 3 asymmetrical bifacially worked distal fragment (Waterval III); 4 cutting edge of polished ax (Vilt-Scouting).

the overlap with dates for the Stein burial vault. The alternative would be that the mining of Valkenburg flint is limited to the Middle Neolithic B (*Stein* group). However, the current dating evidence of the Stein group is also limited and questionable (table 6; van Hoof *et al*. 2012): 1 the unidentified wood charcoal from the Stein burial vault can also be affected by the old wood effect (Verhart 2010), and 2 the other samples are all from pit infillings and it is not clear how the age relates to the beginning or end of occupation. The presence of two *Michelsberg*-like macrolithic blades of Valkenburg flint in the cluster of Vilt and one in Ravensbosplateau at least suggests mining during the Middle Neolithic A period. A better knowledge of the beginning and end of the mining of Valkenburg flint requires more dates from better provenanced samples.

Finally, a clear distinction should be made between the dating of the exploitation/production and the cultural affinities of the exploiters/producers. The similarity of the current dates for the exploitation of Valkenburg-type flint and the Stein group is only an indication of the period of exploitation and production of axes, but not an indication of the identity of the producers. The producers of flint axes could be from the southern Seine-Oise-Marne-groups or *Spätneolithikum*-inhabitants of the German Rhineland – as their lithic technologies are virtually unknown, it is impossible to attribute workshops and flint scatters to a specific archaeological group.

5.2 Production and products

The evidence from the extraction sites, the workshops and the products can be organized in a schematic operational scheme for Valkenburg flint. The dominant scheme is for the production of axes. Angular nodules are selected. The nodules are then coarsely shaped by bilateral bifacial knapping into roughouts. Some large, thick and elongated flakes are shaped into roughouts; others are shaped into *Kerbschlägel*. The roughouts are regularized by bifacial removal of small flakes around the periphery. The regularized axe is ready to be polished. The large flakes resulting from the shaping and roughing-out stages are frequently retouched into scrapers, notches and bruised flakes. Nodules of any shape as well as axes are also turned into flake cores to produce relatively small flakes. These small flakes are retouched into scrapers including thumbnail scrapers, becs, borers, notches and other retouched pieces. Both axes and flake cores are frequently re-used as hammerstones. Similar operational schemes are described for other flint mines, such as Hallencourt (Fabre 2001) and Jablines-Le Haut Château (Bostyn and Lanchon 1992).

A realistic estimate of the output is impossible for the samples in this collection. Still the size of the samples is indirectly also related to the number of axes that were

Site	Material	Lab number	14C-age	CalBC (95%)
Stein, burial	Charcoal	GrN-4831	4780±60	3660-3375
Stein, burial	Cremation	GrN-16185	4570±60	3517-3092
Ittervoort	Charcoal	UtC-1478	4303±40	3023-2877
Randwyck	Charcoal	GrN-14237	4180±60	2900-2582
Hof van Limburg	Charcoal	GrN-27837	4140±60	2887-2506
Hof van Limburg	Charcoal	Poz-14566	4095±35	2866-2497

Table 6 14C dates for the *Stein* group.

produced. Based on the weight of Valkenburg flint, I calculated minimal numbers of axe semi-products for a number of workshop locations. The weight of the 13 largest samples was determined. The total weight is almost 30 kilograms. Taking a rough estimate of 1000 gram of debris for the production of 1 axe (derived from Schyle 2006), the 13 samples represent a minimum of 30 axes. Though this is a serious underestimation of the actual production, it does suggest that the workshops are generally small scale and limited to an output of 5 to 10 axes.

It is also impossible to reconstruct the size and shape of the axes that were produced at the workshops. The available data for roughouts (Marichal 1983) and for the Montfort region (Mans 2011) suggest that most axes conform to a narrow range of width-to-thickness ratios (fig. 7). However, there is one outlier - a regularized, unpolished, 247 mm long axe (Mans 2011) with an exceptionally large width-to-thickness ratio, meaning the axe is exceptionally thin for its width. Current evidence does not allow us to evaluate the frequency of such axes or to identify workshops where such relatively thin axes may have been produced.

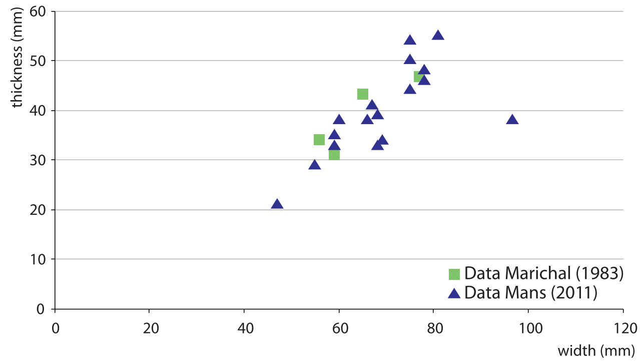

Figure 7 Scatterplot of width and thickness of axes of Valkenburg flint based on data from Marichal (1983) and Mans (2011).

5.3 Variation among workshops

Both the composition of the samples and the technological description of the Valkenburg flakes show variation among the workshops. The interpretation of the variability is limited by several factors: 1 sample sizes differ; 2 the representativeness of the samples differs for example in the amount of small flakes; 3 description was performed by multiple persons, yet checked by the author. Therefore it remains open to what extent the samples as well as the technological analysis actually monitor variability in prehistoric knapping routines. Perhaps the most prudent way to interpret the data is to formulate hypotheses for future work:

1 The variation between samples from the Groot-Welsden cluster are consistent with spatial differentiation between locations for testing of nodules and initial shaping (near the extraction site?) (sample 1) and locations for the stages of initial shaping and roughing out (samples 24 and 29).

2 Most workshops contain evidence of initial shaping and the production of roughouts. Only two samples have small chips interpreted as the debris from regularization of roughouts. Regularization as well as polishing usually took place elsewhere, presumably at settlements. The variation in the degree of regularization near the source can be interpreted as indication for further transport of these roughouts – this would mean that the settlements to which the roughouts were transported were located at larger distance from the Valkenburg source area.

3 Workshops vary considerably in terms of indications of knapping skill (percentages of dorsal and platform preparation, percentages of hinge negatives interpreted as knapping errors). Experimental and comparative studies need to be performed to evaluate whether this indicates average skill levels available to most practitioners or not (cf. Labriffe *et al*. 1995; Augereau 1996).

4 The workshops of the Waterval cluster do not contain extraction tools and they are probably located outside the geological distribution of Valkenburg flint. Most samples of the Waterval cluster are however too small and not representative for further statements. It is worth noting that Pepels (2009) has also found 'polissoirs' at one of the workshops near Waterval.

5.4 *Other activities?*

One common question regarding the geography of production concerns the relation with settlements. Many samples contain some tools, especially flake scrapers. Three samples stand out because of the number of retouched tools in other flint types (mostly Meuse terrace flint). The locality of Amstenrood contains over 300 pieces of which 87% is Valkenburg flint representing debris from axe production, including small chips from regularization. Sixteen retouched tools were found among the Valkenburg flakes. Among the other flint types, there are 13 flake scrapers, 1 retouched blade and a basal fragment of a point. The locality of Ravensbosplateau also contains over 300 pieces, but here Valkenburg flint counts for only 36% of the total. The Valkenburg flint includes two flake cores and 16 retouched pieces. The majority of the sample consists of other flint types and at least 33 retouched tools were recognized. Most are simple retouched flakes and flake scrapers. There are also one scraper on a denticulated ‘macrolithic’ blade, one large borer, a burin, a flake from a polished axe and a few blade fragments. The sample of Klimmen-Hellebeuk, not located in one of the five clusters, consists of 215 pieces. Seventy percent is Valkenburg flint, including 2 flake cores and at least 13 retouched flakes. More retouched tools are present among the other flint types: 19 flake scrapers, 3 borers, 2 notched pieces, 1 splintered piece, 4 retouched blades and 1 flake from a polished axe (fig. 8a and b).

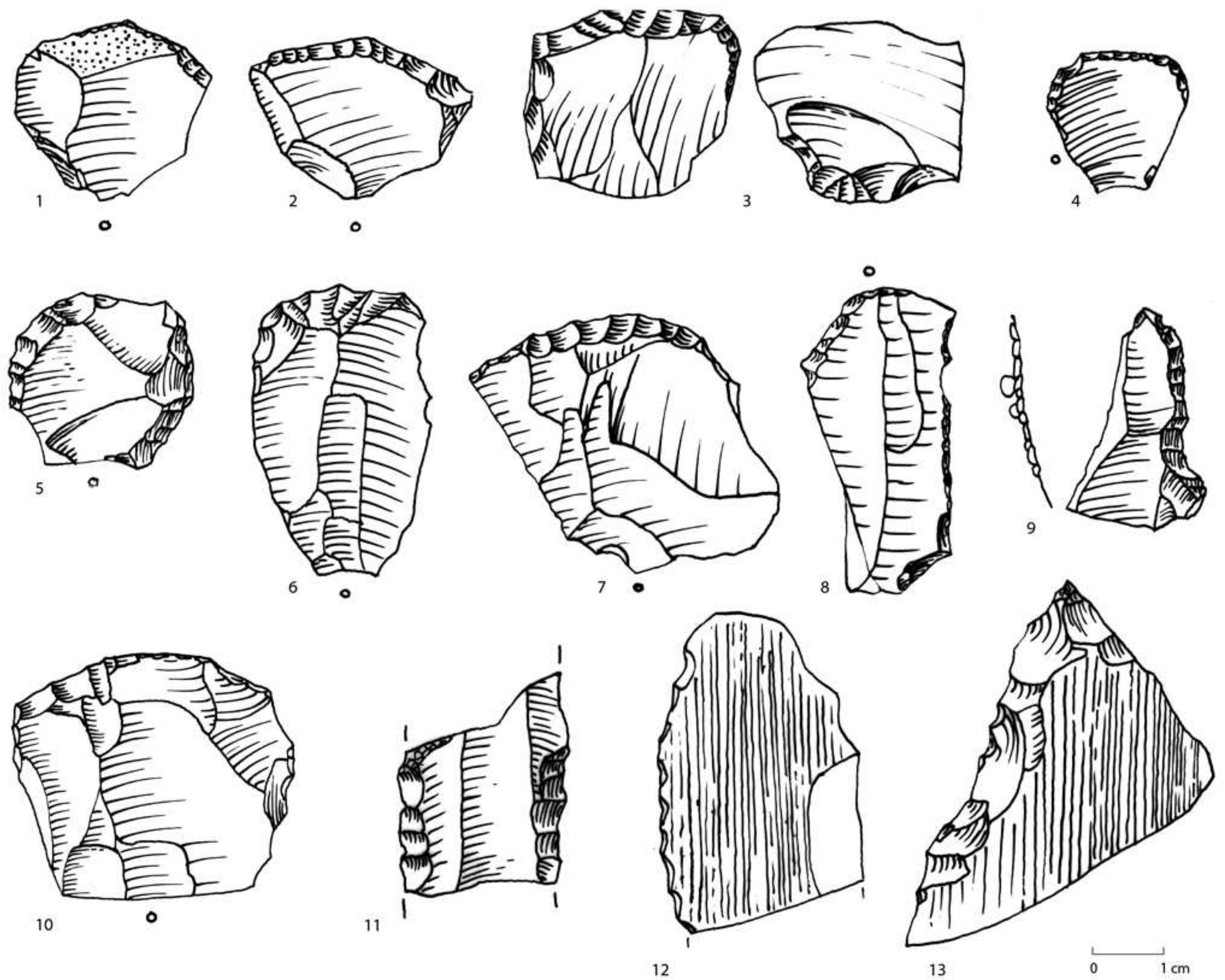

Figure 8a Selected artefacts from Klimmen-Hellebeuk. 1-8, 10 flake endscrapers; 9 borer? on fragment; 11 retouched blade (burned fragment); 12 flake from polished ax; 13 retouched flake from polished ax (borer?). Valkenburg flint: 1, 2, 12 (ax-manufacturing flake:12); Simpelveld flint: 7, 10; ‘light-grey Belgian’ flint(?): 4, 13; ‘Rijckholt’-type flint: 3, 5, 6, 8, 9; indeterminate: 11.

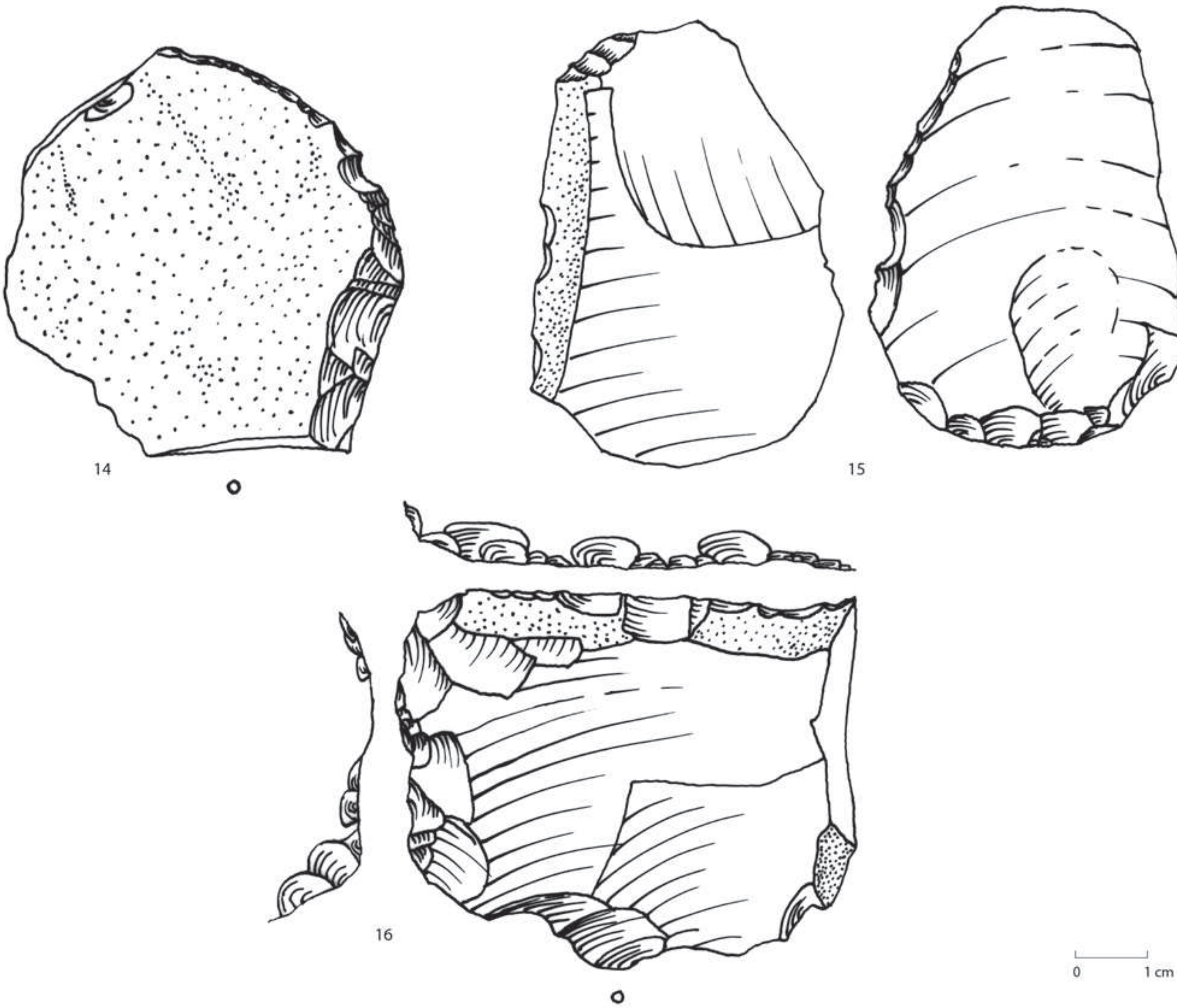

Figure 8b Selected artefacts from Klimmen-Hellebeuk. 14 sidescraper; 15 scraper with denticulated edge; 16 scraper with lateral notch. Valkenburg-flint 14, 15, 16 (axe-manufacturing flakes: 14, 15, 16).

I interpret the samples of Ravensbosplateau and Klimmen-Hellebeuk as indicating settlement debris: the proportion of other flint types relative to Valkenburg workshop debris is relatively large, the number of retouched tools is larger than in other samples and the tool assemblage contains different tool types in addition to flake scrapers. The presence of a blade endscraper, some large blade scrapers and blade fragments suggest a possible Middle Neolithic A attribution for (some of) Ravensbosplateau. For Klimmen-Hellebeuk, the flake scrapers and absence of large flake tools and macrolithic blades is consistent with a date in the Middle Neolithic B. Amstenrood is probably different. The sample is dominated by workshop material and the tools are limited to flake scrapers – some other activities, perhaps in the frame of the acquisition of stone, have taken place here, but it is limited compared to the other two samples.

5.5 *Geography of production*

De Grooth (1998) has proposed eight models for archaeological inferences about the organization of production. Key to the models is the spatial relationship between the four main stages of production: acquisition of stone, the production of blanks, the production of tools, and the use of tools. The focus of the spatial relationships of the stages of production is a useful analytical tool for the Valkenburg area. The geography of production in the Valkenburg area is most similar to De Grooth's model C:

1 the production of blanks c.q. axe roughouts (more or less regularized) is separated from the production of tools c.q. the finishing of the axe roughout by polishing;
2 the production of blanks is clustered around acquisition sites;
3 the presence of discarded polished axes and flakes from polished axes could indicate that the tools were also used in the vicinity of the extraction sites and workshop clusters.

The geography of production indicates that the most risk-prone stages of production – the testing, initial shaping and roughing out of stone axes – dominate the workshops.

The position of the workshops in the landscape is characterized by the vicinity of dry valleys. Perhaps it can be explained by the strategy of prospecting for raw materials that was observed by Petrequin in Irian Jaya and then applied to the region of Plancher-les-Mines in the Vosges (Petrequin and Jeunesse 1995). The strategy involves searching for and testing of raw material blocks in fluvial and slope deposits. Where good quality material was found, the upslope area was prospected for primary outcrops.

5.6 A settled landscape?

Bradley (2000) and others have argued that lithic sources are often located in remote places that are difficult or hazardous to reach. The choice of raw material in such places as Langdale in Northumbria suggests that even some lower quality sources were selected because they were difficult to reach. Such qualities of the sources are embodied by the stone axes. Their value as "pieces of places" is circulating in wide-ranging exchange networks. Similar arguments have been used with regard to mining for flint. De Grooth (1997) explains the laborious mining activities to obtain Arnhofen flint with reference to the distinctive characteristics of the flint itself – an object of Arnhofen flint is distinctive. Rudebeck (1998) refers to the presence of small remnants of cortex on Scandinavian axes. The cortex allows the identification of the source – the axe can be identified as a piece from a specific quarry place. According to Bradley (2000), the flint mines have to be seen in the context of the significant role of pits and shafts in Neolithic ritual life (Thomas 2000). The special nature of mining is emphasized in the distribution of flint mines of southern England that avoids the distribution of settlement sites.

How do the Valkenburg flint sources fit in this discussion? Are the workshops located in a settled landscape or "well beyond the limits of the settled landscape" (Bradley 2000, 87)? The Neolithic quarry landscape of Valkenburg flint is formed by a number of extraction locations with clusters of workshops. The workshops are specialized in the production of flint axes, sometimes, perhaps, for exceptionally thin axes. Settlement debris is limited – only two samples may represent workshop material in a settlement context.

Rather than a *Fundlücke*, the Middle Neolithic B and Late Neolithic are better characterized by a *Befundlücke* (Schyle 2006). Despite the absence of house plans and settlements – not a single *spätneolithische Siedlung* is presented in ten years of the journal *Archäologie im Rheinland* - flint scatters, sometimes with some ceramics, are frequent in the German loess area (Nehren 2001; Zimmermann *et al*. 2006; Matzerath 2007). Estimates of the production and consumption of Lousberg axes also suggest a substantial human presence in the loess area. Schyle (2006) estimated a population density of 2.8 households per km^2. In addition, the lack of features is not limited to the Middle Neolithic B or Late Neolithic, but also for the Michelsberg group and the Bronze and Iron Ages. The recent excavation of a late neolithic house plan in Waardamme (Flanders, Belgium) (Beugnier and Crombé 2007) is a warning against underestimating the combination of post-depositional processes and research intensity. The scarcity of features in the loess area could be mainly determined by post-depositional factors.

Another line of evidence about the settled landscape is provided by the evidence of human impact on the landscape. For the loess region of Southern Limburg, the impact of human settlement must have been limited, because the regional pollen records indicate a high degree of forestation during the Early and Middle Holocene. This is supported by dating of the sediments in the Geul valley. The dates indicate low sedimentation rates probably because the vegetation fixed the sediments and limited the availability for erosion (de Moor *et al*. 2008). Lechterbeck *et al*. (2009) and Verstraeten *et al*. (2009) argue that the Middle Holocene human impact on vegetation is too small scale to be recorded in regional pollen records and that opening of the vegetation caused only local colluvial sedimentation in dry valleys and at the foot of hillslopes, but did not impact sedimentation rates in the entire catchment area.

Indications of small-scale local impact were noticed in a pollen record from Maastricht-Randwyck dating between 5000 and 1750 cal BC. Shifts in woodland taxa indicate human impact between 3000 and 2000 cal BC (Bakels *et al*. 1993; Bakels 2008). Wessel and Wohlfarth (2008) refer to an increase in birch and hazel from 3800 cal BC in the German Rhineland. They relate the change to the use of the forest for keeping livestock such as pigs.

There is both archaeological and paleobotanical evidence to support an interpretation of almost continuous occupation of the Meuse valley area from the Early Neolithic B (*Rössen*) onwards (Bakels 2008). A good analogy for the Valkenburg area and perhaps Southern Limburg is provided by the evidence from the Somme valley in Northern France (Fabre 2001). The mine of Hallencourt is located on a plateau adjacent to a dry valley. Evidence of settlement in the immediate surroundings of the mine is limited – the main settlement sites are predominantly located in the river valley itself. A similar pattern is documented for the Bergerac region in Southwest France (Delage 2004). Rather than acquisition of stone "well beyond the settled landscape", the evidence indicates the acquisition of stone from the forested plateau edges near the settled landscape. I would expect that the Meuse valley is the most likely area to search for Middle Neolithic and/or Late Neolithic settlement sites, but the forested plateaus were used for subsistence activities and inhabited as well.

5.7 An ordered landscape?

The Middle Neolithic B is characterized by a very ephemeral archaeological record of small find scatters and pits, with few structures like houses, earthworks, field systems or fences (Van Gijn en Bakker 2005; Schreurs 2005; Zimmermann *et al*. 2006; Vanmontfort *et al*. 2009; Amkreutz 2010; Verhart 2010). Is this an indication of higher levels of mobility of groups and the importance of wild resources in an 'extended broad spectrum economy'? Does this mean that 'nature' was valued as an important resource rather than feared as a wild and dangerous place? Does it indicate the 'Mesolithic' roots of the Middle Neolithic? Or is it a bias due to site formation processes and are we dealing with fully agricultural societies making a sharp contrast between the cultivated lands of fields and farms and uncultivated, wild places, similar to the Middle Bronze Age (Arnoldussen and Fontijn 2006)?

To what extent, then, can we speak of an 'ordered' landscape in the Middle Neolithic? Arnoldussen and Fontijn (2006) refer to an "ordered" landscape when there is evidence of the categorization of place. The landscape is ordered for example into zones for the living and zones for the dead. Places are differentiated by the deposition of specific find categories such as axes, swords or razors - in other words, "everything in its right place" (Fontijn 2008). The evidence from the Southern Netherlands for the Middle and Late Neolithic is limited. Not more than hints are available at the moment. Finds of single Vlaardingen and Stein pots suggest deposition practices related to high and dry coversand ridges away from settlements (Arts 2010; Louwe Kooijmans 2010). A few complete flint axes suggest selective deposition related to wet, marshy places (Mans 2011), whereas most axes end their life cycle as hammerstone or flake core. The location of workshops on the edge of plateaus is consistent with the idea of an 'ordered' landscape, where also production of flint axes has its right place.

6 Conclusion

Middle Neolithic flint axes were probably important as tools for maintaining small-scale fields and managing woodland, as general woodworking and cutting tools, and as valuables. The sample of workshop material from the Valkenburg area indicates that the exploitation was almost entirely focused on the production of flint axes. The production of axes was organized spatially with the most risky stages taking place in the vicinity of the raw material source. Roughouts were processed to reduce the weight of transport to settlements or other locations for finishing regularized roughouts by polishing. Workshops vary in technological characteristics that could indicate some differences in skill. The evidence is consistent with a clear-cut division in the organization of flint technology: on the one hand, production of flint axes from mined flint dominating in separate workshop locations, and on the other hand, production of the domestic tool kit from raw materials collected at the surface, presumably taking place in settlement context. However much remains conjecture and hypothetical. Only more intensive fieldwork, including excavations of workshops and possible settlement sites, can provide us with a clearer picture of the Middle Neolithic landscape in the loess region.

According to Whittle (1995), the axe is first of all significant as symbol of control over nature. In my view, it is this interpretation of the Neolithic as control over nature which needs to be extended because it is too one-sided. Not that domestication of animals, the growth of crops, the clearing of forest for fields and settlements do not involve control over nature. Not that prehistory cannot be described as a process of imposing cultural order on nature. But it is the ambiguous power of nature that needs to be acknowledged (Oudemans and Lardinois 1987, 61): "on the one hand all that is natural is condemned as being wild, raw, unsophisticated and therefore polluted. On the other hand the garden of civilization needs to be fed with nature's power, which is polluting but lifegiving as well." Rather than a symbol of control, the axe is a symbol of ambiguous nature, its unlimited power that is feeding culture and civilization, its ambiguity that undermines the unity of categories such as the clear differentiation of place. The axe is tragic – the very instrument of civilization for imposing order upon nature requires the very power of nature that it has to subdue: to make an axe is all too human.

Acknowledgements

The study of the lithics was inspired by the silence of the past in the landscape of the present, by the abyss between the science of prehistory and the land of early agrarian societies, neglected, forgotten and lost in the loudness of the heritage industry. This paper is dedicated to the skeptical bachelor students who described the material during practical work. They frequently questioned the archaeological value of the surface material – what can you do with just a bag of stones? This is my attempt to an answer. Special thanks to Ron Mans for information and to David Fontijn for constructive criticism.

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