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10 Flint: procurement and distribution strategies; technological aspects

Marjorie de Grooth

10.1 Introduction, research aims and procedures

The main objective of this study was to investigate the way flint working was organized at the JKV site, thus getting an insight in the procurement strategies and the technological choices made at this early stage of Bandkeramik habitation west of the river Rhine.

A quick scan at the beginning of this study revealed that the JKV flint assemblage showed the same technological characteristics as those from other well-studied Bandkeramik settlements in the Rhine-Meuse region, e.g. Beek-Kerkeveld (De Grooth 1987), Langweiler 8 (Zimmermann 1988) and Liège-Place Saint-Lambert (Cahen 1984). Given the limited amount of time available for study at that time (2001), it was decided not to perform a time-consuming technological study of individual artefacts (*Merkmalanalyse*, cf. Zimmermann 1988), but to concentrate on a spatial and diachronic analysis of the assemblage, whilst A.E. van Gijn and her collaborators carried out use-wear analyses on a large sample of tools and blades. Hence, in keeping with work done previously on the Elsloo flints (De Grooth 1987), features (pits) were used as the unit of analysis, grouping the artefacts recovered in every pit into broad typomorphological categories that were counted and weighed. In addition, for every artefact class, the number of specimens with cortex and the number of burned pieces were registered. Next, the dimensions (length, width and thickness) of complete tools, blades and cores were measured. Finally, for a sample of blades and blade tools, attributes thought to be relevant to determine the knapping technique applied were recorded; for a second sample, parameters deemed relevant for establishing the provenance of the flints were registered as well.

At the time of the initial analysis, the flint material from six excavation trenches in the northwestern part of the settlement could not be examined (De Grooth 2003b). In later years, most of these missing artefacts, as well as some additional material from the southern part of the settlement, gradually became available for study, filling in some annoying gaps on the distribution map and allowing a more detailed spatial analysis to be performed. Ultimately (up till August 2006), 7941 flint artefacts, with a total weight of *c*. 58 kg, were analysed. 5883 of these were recovered from 54 pits containing at least 15 flints and dated by their ceramic content (Table 10.1). The composition of these sub-assemblages is remarkably stable, indicating that the assemblage is homogeneous to a large extent.

10.2 Raw material procurement

The flints used at JKV originated almost exclusively from the limestone area south of the river Geul, at a distance of 20-30 km from the settlement (Fig. 10.1). This region is considered to be the major procurement area for Bandkeramik settlements in the Graetheide cluster (Bakels 1978; De Grooth 1987), as well as the Rhineland (e.g. Zimmermann 1995; Zimmermann *et al*. 2004). It has been recognized for a long time that the flints used in Bandkeramik times are very similar to those exploited in the well-known Middle Neolithic flint mines located between Rijckholt (mun. Eijsden NL) and St.-Geertruid (mun. Margraten NL) (cf. Bakels 1978).These flints are now known to originate in the western facies of the Lanaye member of the Gulpen Formation (Felder and Felder 1998; Felder *et al*. 1998; Felder and Bosch 2000).

The initial investigation of the JKV flints, in 2001, showed almost all of the material to be of the Lanaye type. Therefore, it was decided not to invest time in a registration of specific raw material attributes for individual artefacts. In retrospect, as it became clear that Lanaye flints from different geological positions could be distinguished macroscopically (De Grooth forthcoming a) and taking into account new evidence for possible Early Neolithic activities at the Banholt and Rijckholt extraction sites presented by Brounen and Peeters (2000/2001), this was found to be an unwise decision. In 2006 a set of variables now known to be diagnostic were recorded for a sample of material from well-dated pits belonging to all settlement phases. Thus a more precise assessment of the actual extraction sites used by JKV's inhabitants could be made.

The western part of the Lanaye member contains 23 different seams of flint (numbered from bottom to top). Of these, layer 10 comprises the largest amount of usable flint. This was the seam mainly exploited in open-cast workings and deep pits at Rijckholt/St. Geertruid.

In places, for instance in the slopes of the 'Schone Grub' dry valley, small quantities of flints from the other seams may have been extracted as well (Felder *et al*. 1998: 11-12).

	All			≥ 3 artefacts 179 pits			≥ 15 artefacts 77 pits			≥ 15 artefacts dated 54 pits		
TYPE		N	%		N	%		N	%		N	%
CORES		26	0.3		23	0.3		18	0.3		15	0.3
HAMMERSTONES		59	0.7		52	0.7		44	0.7		40	0.7
FLAKES		5744	72.3		5418	74.6	72.8	4815	73.5		4391	73.6
primary cortex *	219			206			191			161		
secondary cortex*	1327			1211			1099			969		
no cortex	2784			2641			2422			2158		
rejuvenation flakes	195			174			155			131		
chips (< 15 mm)	1026			1007			948			843		
hammerstone fragments	193			179			154			129		
BLADES		1083	13.6		1007	13.6		891	13.2		789	13.2
entire no cortex	69			67			59			50		
proximal fragm. no cortex	362			334			293			261		
medial fragm. no cortex	226			215			194			169		
distal fragm. no cortex	147			139			124			112		
entire cortex	38			36			34			31		
proximal fragm. cortex	95			84			71			64		
medial fragm. cortex	44			41			37			30		
distal fragm. cortex	46			40			39			36		
crested blades	56			51			40			36		
ARTIFICIAL BLOCKS		148	1.9		142	1.9		134	2.0		122	2.0
TOOLS (cf. Table 10.5)**		890	11.2		785	10.6		701	10.4		611	10.2
SUM		7950	100.0		7427	100.0		6757	100.0		5968	100.0

* Primary cortex flakes: at least 85% of dorsal surface covered by cortex or natural fractures;
Secondary cortex flakes: less than 85% of dorsal surface covered by cortex/natural fractures.
** the fragment of a polished flint axe found in the upper fill of pit 18056 is not included.

Table 10-1 Composition of the flint assemblage

The flints from layer 10 are nodular in shape and in general have a length, width and thickness of at least 30 cm. The cortex is thin, rough and whitish. Natural fracture planes often are covered with iron incrustations. The internal colour varies from very dark to very light grey, both sometimes with a hint of blue. The surface of artificial fractures is smooth but dull, the texture is mainly fine grained. Both colour and texture may vary within individual nodules; the lighter grey parts often contain zonated areas, with gradual transitions. Sometimes the zone directly under the cortex is the darkest, with a smoother, more vitreous texture. The main types of inclusions are (De Grooth 1998; Felder *et al.* 1998):

– concentrations of light (white or light grey) round specks (<1 mm); isolated small (1-3 mm) and medium-sized

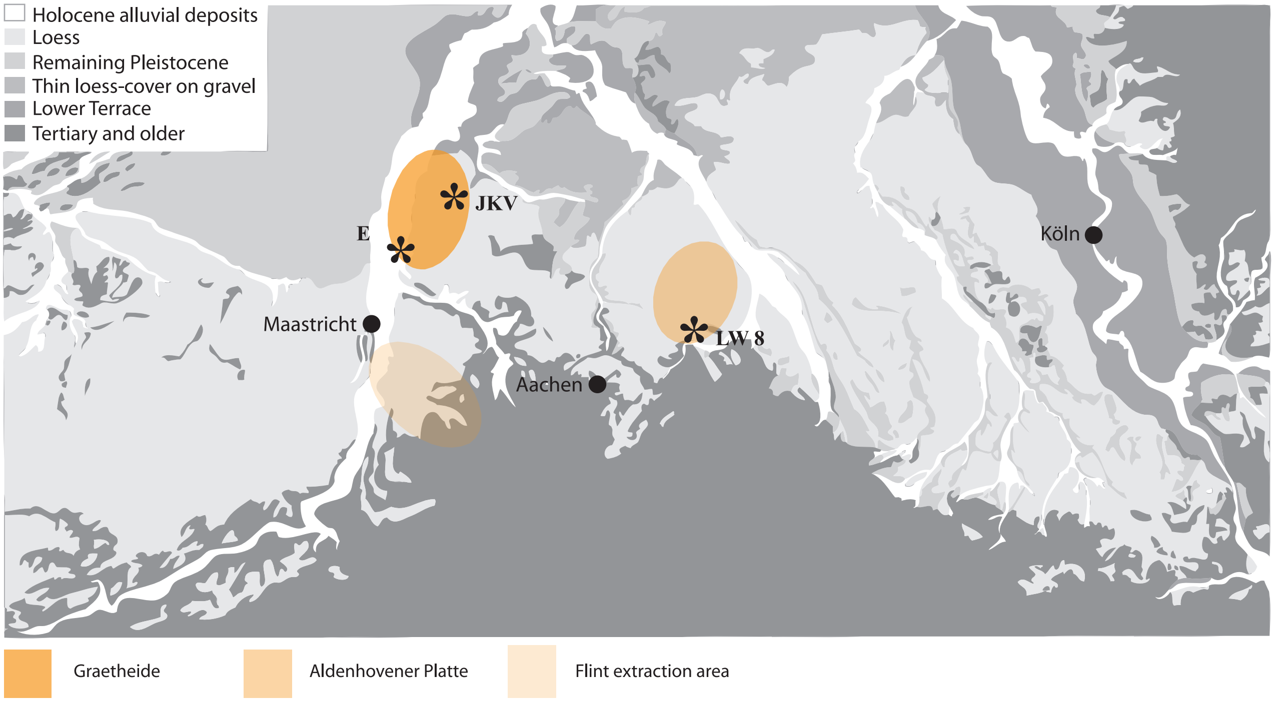

Fig. 10-1 JKV's position in relation to the flint-bearing limestone area and to other sites mentioned in the text. Map based on Modderman 1970 and Zimmermann 2002.

(3-10 mm) round or ovoid spots, light grey or white, with the same texture as the matrix;

- small (1-3 mm), medium-sized (3-10 mm) and large (>10 mm) ringed spots, round or irregular in shape, with a smooth whitish outer ring and a smooth or rough darker centre;
- large (>10 mm) spots, round or irregular, abrupt border, light grey or whitish, with a rougher texture than the matrix;
- large, vague lighter grey flecks;
- concentrations of black round specks (<1 mm); small and medium-sized (between 1 and 10 mm) black or very dark grey round, ovoid or sickle-shaped spots; dark wisps or tendrils;
- small angular cavities.

Flints from the other seams within the Western Lanaye member for the most part have the same characteristics, notably as regards colour, texture and the presence of both dark and light spots and specks. A detailed study of four of these showed the following divergences: dense concentrations of small white spots are present in layer 01; the flints from layer 2A often contain seemingly overlapping inclusions, and fossils that are not completely silicified; abrupt transitions in colour occur in the zonated areas in layer 12A. Also, the cortex may be thick (e.g. layer 02A, 12A) or irregular, with hollows and protuberances (layer 01).

The combined presence of several kinds of dark inclusions is the major characteristic distinguishing Lanaye flints from other flint types in the region. They occur as specks (<1 mm), small and medium-sized spots (1-10 mm), that may be round, ovoid or sickle-shaped, or long wisps. These attributes are shared with some of the flint varieties found in the Hesbaye – such as the so-called silex grenu (coarse-grained flint) used in small quantities at Verlaine-Petit Paradis (Allard 2005), the material from the mines at Jandrain-Jandrenouille (comm. Jodoigne, B) and the flints from the Craie de Spiennes, in the Mons area of southwestern Belgium. De Grooth (forthcoming a) discusses the possibilities of distinguishing between these.

Lanaye flint nodules could have been extracted from four different depositional contexts:

Firstly from their primary position, in the chalk bedrock. Secondly, from slope, talus or scree deposits, that came into being when the valleys which had developed during the Pleistocene cut into the chalk beds, thus exposing and eroding them. Thirdly, from residual loams (also known as eluvial deposits) that are the result of disintegration of the chalks during the Tertiary. Finally, from gravels deposited by the river Meuse during the Pleistocene and the Holocene.

The conditions prevailing in these secondary deposits sometimes led to visible alterations in the aspect of the flints. Flints from slope deposits differ from the material in primary context only as regards a slight weathering of the cortex and other natural surfaces. Material collected in river gravels may be identified as such only when parts of the cortex or other natural surfaces are still present, as the river transport led to heavy abrasion of cortex, to a decrease in size of the flints, and to an increase in the frequency of non-cortical natural surfaces. These often have a battered aspect and carry a glossy patina (pebble patina, Verhart 2000). The most extensive alterations, however, are present on flints embedded in residual loams, especially when these are mixed with iron-rich Oligocene sands.

Prehistoric extraction points that probably were in use during the Early Neolithic are known for three of the four depositional contexts (Fig. 10.2, Table 10.2). With the exception of Rodebos, artefacts probably dating to the Early Neolithic have been found at, or in the immediate vicinity of, all sites under consideration.

1. Lanaye nodules from both a primary context and from slope deposits may have been extracted in the mining area situated between Rijckholt (mun. Eijsden, NL) and Sint-Geertruid (mun. Margraten, NL). The well-known

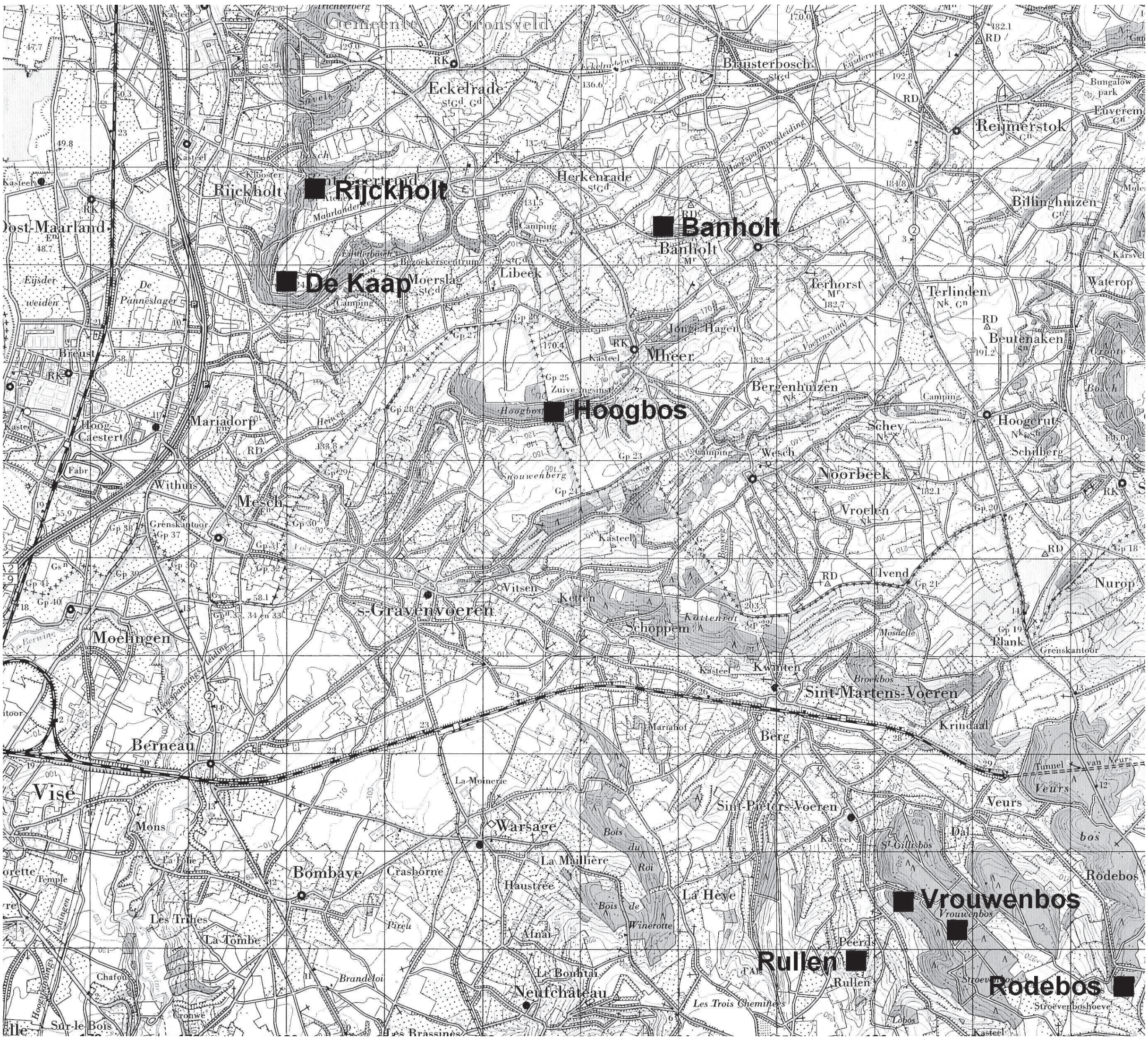

Fig. 10-2 Possible Early Neolithic extraction sites. Map: Zuid-Limburg, 1:50.000 (topografische dienst Nederland 1980).

	Rijckholt Mines	Rijckholt slopes; de Kaap	Mheer	Banholt	Rullen	Rodebos
Primary context	X					
Slope deposits		X				
Residual loams			X	X	X	X
Oligocene sands				X	X	X
Oligocene cobbles					X	X

Table 10-2 Geological characteristics of known extraction points

underground mining activities there are contemporary with the Michelsberg culture (Felder *et al*. 1998). Earlier mining of primary material, by means of shallow pits, cannot be excluded *a priori*. In the immediate vicinity, flints were extracted from slope deposits as well, as has been shown by the excavations in the Schone Grub, a dry valley in the northwest of the prehistoric mining area (Rademakers 1998; Felder *et al*. 1998).

2. The steep slopes between the Upper Terrace and the Middle Terrace surrounding the plateau known as De Kaap, located some 500 m further to the south may also have been exploited (Felder 1998). At present these activities cannot be dated but some Bandkeramik adzes have been found on the Rijckholt plateau (Brounen and Peeters 2000/2001).

Early Neolithic exploitation of residual flint deposits may have taken place at the following sites. All deposits are composed mainly of Western Lanaye flints, with an admixture of material from the underlying Lixhe member (cf. Felder 1998):

3. Hoogbos, between Mheer (mun. Margraten, NL) and ’s Gravenvoeren (mun. Voeren, B). Discovered in 1908, preliminary investigation by Hamal-Nandrin and Louis (Louis 1936). Exploitation is thought to have taken place in the steep valley slope where the material crops out. Nothing is known about age and character of the mining activities, but Louis reported that some of the cores and rejuvenation tablets collected here resemble those found at Omalien (i.e. Bandkeramik) sites in the vicinity of Liège.

4. Banholtergrub, close to Banholt (mun. Margraten, NL), situated on the northern slope of a narrow dry valley. The eluvial deposits lie on the remaining chalks and are covered by Quaternary gravels. Some Oligocene sands are mixed with the loams (W.M. Felder, oral communication 29/06/2006). Recently, Brounen and Peeters (2000/2001) presented plausible evidence for (open-cast) mining and knapping activities at this site during Early Neolithic, more specifically Bandkeramik times.

5. A cluster of extraction sites at Rullen and Sint Pieters-voeren (Vrouwenbos according to Felder 1998; also known as Bois Communal and Bois des Sapins, De Warrimont and Groenendijk 1993) in the municipality of Voeren (B). The material extracted here is commonly known as Rullen flint. At these sites, the residual loams are mixed with important amounts of Oligocene sands, rich in iron oxides, displaying intense red and yellow colours. The flints derived directly from the Lanaye and Lixhe members are mixed with some cobbles from a Tertiary pebble floor, i.e. a littoral deposit on the shore of the upper Oligocene sea (Felder 1998: 174). These had their origin in the Lanaye chalks as well. Since the discovery of the sites at the end of the nineteenth century, huge amounts of knapping waste, blades and blade cores, as well as (rough outs for) axes have been collected and excavated. In 1998, during a rescue excavation prior to the construction of a liquid gas pipeline, traces of a funnel-shaped extraction pit, with a preserved depth of *c*. 3 m and a reconstructed diameter of 7.20 m, were found at Rullen (Vermeersch *et al*. 2005). The available Radiocarbon dates correspond to the end of the Neolithic or even later. The presence of blanks and tools in earlier Neolithic settlements, however, points to extensive extraction activities in this period: Rullen flints are encountered sporadically during the LBK, but are an important to predominant raw material in settlements of the Grossgartach, Planig-Friedberg and Rössen cultures (Gehlen and Schön in press).

6. Rodebos, close to Remersdaal (mun. Voeren, B). Discovered in 1919; preliminary investigation by Hamal-Nandrin and Servais (Hamal-Nandrin and Servais 1921). The site is undated and the character of the mining activities unknown. The geological situation is identical to that at Rullen, i.e. residual loams mixed with Oligocene sands.

No specific extraction points for gravel flints are known, but the material was widely used during the Neolithic, especially in areas where it formed the nearest source of raw material (Weiner 1997; Mischka 2004).

A number of researchers have sought to develop sets of variables with which the flints from the relevant extraction sites can be reliably described at a macroscopic level; moreover several petrographical and geochemical analyses were undertaken, as an independent method of characteris-ing raw material and studying within- and between-source variation (cf. Felder *et al*. 1998: 13-16). Initial geochemical research was performed by a.o. Bakels *et al*. (1975; Bakels 1978) looking for differences in trace element content by means of neutron activation analysis. Fifty artefacts from pit 334 of the Bandkeramik settlement at Elsloo were analysed. They indeed were very similar to the material mined in the Rijckholt flint mines, but it proved to be impossible to distinguish the material of the Rijckholt flint mines from that found at the exploitation sites of Banholt, Mheer and Rullen. Subsequent research by Kars et al. (1990) and McDonnell *et al*. (1997) found differences between material from these different extraction points, using both macroscopic and petrographical and geochemical methods. Kars *et al*. (1990) recorded that a noteworthy character of the Western Lanaye Chalk flints is the sometimes high amount (varying between 5 to 50%) of carbonate. This carbonate is partly present as dispersed micrite (finely crystalline marine calcium carbonate), and as angular to rounded or elongated bioclasts (fossil debris). Later on, McDonnell *et al*. (1991) reported that a combination of petrographical and geochemical analyses made it possible to distinguish between flints originating from Rijckholt and from the Rullen area, with Banholt and Mheer having an intermediate position. Finally, in 1993 De Warrimont and Groenendijk offered an important contribution to the characterization and distinction of the flints under consideration, in a study that combined a macroscopic assessment with Munsell colour measurements using a spectrophotometer. They reached the conclusion that the sites can be subdivided into two groups. The first comprises Rijckholt (chalk bedrock and slope deposits), Hoogbos and Banholt; the second consists of Rullen, St. Pietersvoeren (Bois Communal and Bois des Sapins) and Rodebos. In both cases, a subdivision was suggested: Banholt was separated from Rijckholt/ Hoogbos and Rodebos from Rullen/St. Pietersvoeren.

De Warrimont and Groenendijk considered five attributes to be diagnostic in distinguishing the flints from these sites:

– the dominant colours, expressed according to the Munsell System, the scores for hue and value being of special importance;

– a thick (>1 mm) white zone under the cortex;

– a clear reddish brown zone under the cortex;

– concentrations of white specks (<1 mm) and small white spots (indicating the presence of flints from Lanaye layer 01 and/or the Lixhe member).

To these may be added (De Grooth forthcoming a):

– differences in colour and texture of the cortex;

– the presence of yellowish or brown streaks penetrating deeply into the nodules;

– natural and artificial fracture planes with a ‘dusty’ aspect, due to the presence of dense concentrations of minuscule, vermiculate, spots;

– differences in the degree of translucency. Using a method devised by Ahler (1983), unweathered freshly knapped flakes were studied in a darkened room with a light source (provided by a 12 V/20 W halogen desk lamp) diagonally behind them. The boundary between the opaque and translucent parts of the pieces was then marked in pencil, and the thickness measured with a pair of sliding callipers. The measurements then were grouped into 5 classes: T1: translucency ≤ 2.4 mm (opaque); T2: translucency between 2.5 and 4.9 mm (low); T3: translucency between 5.0 and 7.4 mm (medium); T4: translucency between 7.5 and 9.9 mm (high); T5: translucency greater than 10.0 mm (very high). Into this last class falls very translucent material such as obsidian, and most of the north-European “Baltic” flint. Translucency is not directly correlated to grain size: some coarse-grained flints show high translucency (for instance the so-called Valkenburg flint from the Emael Member), whilst others, such as the flints from the Lixhe member, combine a low translucency with a smooth, shiny surface.

Using these attributes, the flints found at the extraction sites under consideration may be characterized in the following way.

Rijckholt plateau and De Kaap:

The artefacts studied here are thought to result partly from the deep-mining activities and partly from nodules collected in slope deposits (cf. De Warrimont and Groenendijk 1993).

	JKV	Rijckholt	Hoogbos	Banholt	Rullen c.s.	Rodebos
White zone	14%	No	No	Common	Common	Common
Red zone	23%	No	Rare	Common	Frequent	Frequent
Brown wisps	4.5%	No	Rare	Common	Frequent	Rare
Dusty surface	No	No	No	No	Frequent	Rare

Table 10-3 Comparison of raw material characteristics of JKV and extraction points

The material is identical to that extracted in the deep shaft mines and to the geological samples of Lanaye 10 flints. The translucency is low to medium.

Mheer-Hoogbos:
In colour, texture and inclusions this material is identical to the flints encountered at Rijckholt; the cortex, however, is rough, thin and brownish. Yellowish streaks are infrequently present, as are concentrations of small light spots. Opaque reddish brown zones are very rare. The translucency is low to medium.

Banholt:
Again, the material is similar to the Rijckholt sample. The cortex, however, is rough, thin, brown or grey. Frequently a thin reddish brown, glass-like zone below the cortex is present, and a thick white layer may occur; brown or yellowish streaks are common, as are concentrations of light specks (<1 mm); the fracture surface lacks the dusty appearance typical of Rullen (see below). The translucency is medium to high.

Rullen/Sint Pietersvoeren:
At the Rullen/Sint Pietersvoeren sites, material originally deriving from all the levels within the Lanaye member were exploited. This follows from the observation that concentrations of light specks (<1 mm) the size of a pinhead and concentrations of small light spots are common, whilst abrupt transitions in colour and sharply defined stripes parallel to the cortex occur as well. The cortex is brown, sometimes rough, sometimes smooth; mostly thin, but sometimes thick. A thick, white layer is often present, especially in material from the Sint Pietersvoeren (Bois Communal and Bois des Sapins) sites. As befits their origin in the Western Lanaye deposits, the basic colour of the flints found at the different Rullen/ Sint Pietersvoeren extraction sites was grey. Three phenomena, however, caused alterations that make it possible to distinguish these flints from the Lanaye material from primary chalk deposits. Firstly, their long stay in an eluvial matrix gave them a 'bleached' aspect, possibly caused by the dissolution of the carbonates that are present in large amounts in primary Lanaye material (cf. MacDonnell *et al*. 1997; Giot *et al*. 1986 describe the same loss of carbonates for flints from Le Grand-Pressigny). This bleaching sometimes affected the dark inclusions as well. And possibly because of the same loss of carbonate content, Rullen flints have a high translucency (predominantly class 4-5). Thirdly, infiltration of the iron compounds present in the matrix led to a yellowish-brown discoloration. At its most intense, this results in the 'honey' or 'egg-yolk' coloured nodules often seen as typical Rullen flint (esp. Löhr *et al*. 1977). In many artefacts found at the Rullen and Sint Pietersvoeren sites, however, solid reddish or yellowish brown colours are limited to the outer part of the nodules, whilst the rest of the piece is grey, with just some brown, yellow or orange streaks. The fracture planes are dull and mostly have a 'dusty' aspect, probably because the bleaching has made the presence of dense concentrations of minuscule, vermiculate, spots visible.

Rodebos:
Besides the basic Lanaye attributes, this material is characterized by the frequent presence of a reddish brown glassy zone under the cortex. Sometimes a thick white zone occurs as well. Specks, yellowish streaks and fracture planes with a dusty aspect are rare. The fracture surfaces are more reflective than those at Rijckholt and Rullen, and the translucency is extremely high, almost 60% of the sample belongs to classes 4 and 5.

By comparing the raw material characteristics of the different extraction points with those of the JKV flints, the latter's probable origin could be established. As their slightly weathered cortex shows, the JKV flint material was not acquired from a primary chalk deposit. Nor did river gravels play an important role as raw material source: only two of the cores display the heavily abraded natural surfaces characteristic of material transported in river gravels. This leaves the residual loams and the slope deposits as possible sources.

In a sample of 358 well-dated JKV artefacts, 82 pieces (23%) showed a glass-like reddish-brown zone underneath the cortex; 50 times (14%) a thick white zone was present under the cortex, and 16 artefacts (4.5%) had yellowish brown streaks. The concentrations of small light round spots and the dusty fracture surfaces characteristic of Rullen flint, however, were all but absent. Thus, the JKV material shows characteristics not encountered in the Rijckholt samples, but resembles best the raw material collected at Banholtergrub and Rodebos (Table 10.3).

Subsequently, the translucency of 271 unweathered JKV artefacts was measured. Of these 3% were opaque, 46% slightly translucent, 35% showed a medium translucency and 16% were highly translucent. Moreover, 181 of the artefacts (67%) were completely translucent (Fig 10.3). This phenomenon reflects partly the relatively low thickness of the JKV artefacts, but it also points to an overall high translucency of the raw material utilized. In order to make a comparison possible with the data from the extraction sites, the measured translucency was presented in three ways: 1. raw data; 2. increase with one mm for all entirely translucent artefacts; 3. increase with 2.5 mm. This, of course leads to an increase of pieces in the higher translucency classes. Again, the JKV sample does not resemble the

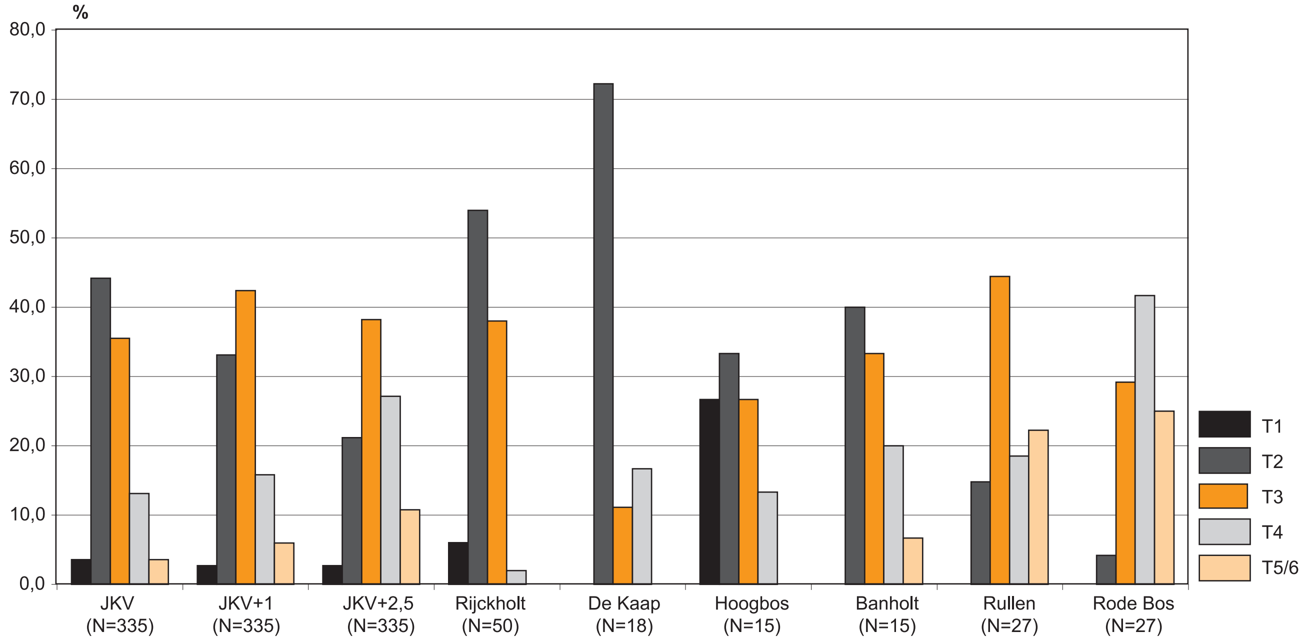

Fig. 10-3 Comparison of translucency of JKV and extraction points

	Hesbaye	Emael	Gravels	Rullen	Zeven Wegen
Cores	2		3		
Flakes	5	17	12	1	1
Blades	11	9	2	1	
Tools	15	1		3	3
N	33	27	17	5	4

Table 10-4 Occurrence of rare flint types

Rijckholt material, even when only the 'raw' data are considered. The correspondence with the data from Rullen, Banholt and Mheer is much better, and increases when regarding the enhanced data; Rodebos, on the other hand, seems a less likely source, because there flints with a low or medium translucency are scarce (Fig. 10.3).

Thus, it seems highly probable that the majority of the JKV raw material was collected at the Banholtergrub (or at one or more as yet unknown extraction sites where the flints were embedded in similar conditions), with Mheer-Hoogbos and Remersdaal-Rodebos as possibilities of secondary importance.

The flints of the Bandkeramik sites at Elsloo and Beek-Kerkeveld display the same characteristics (observation by the present author). Given the mention of transparent reddish-brown zones as typical of the so-called 'Rijckholt' flint encountered elsewhere in the Bandkeramik world (e.g. Deutmann 1997; Löhr *et al*. 1977; Zimmermann 1988: 606), it seems plausible that all this material mainly originated from Banholt as well. Therefore, it seems advisable for archaeologists to comply with the recommendation made by geological experts (cf. P.J. Felder 1998: 159; Felder *et al*. 1998) and use 'Western Lanaye' (or, for the more cautious) 'Western Lanaye-Lixhe' instead of 'Rijckholt' as denomination for this type of raw material. The Banholt variety of Lanaye flint even reached as far east as Friedberg-Bruchenbrücken in Hesse, where at least two artefacts were identified among the Oldest Bandkeramik material by A.L. Fischer and the present author, using the author's reference collection (Fischer 2005; De Grooth forthcoming a).

Apart from the ubiquitous Western Lanaye flints of the Banholt variety, a small number of artefacts made of other raw material types was recovered at JKV (Table 10.4). The majority of 'other' flints belong to the so-called 'light-grey Belgian' flints, that have their origin in the Hesbaye region near Liège in Belgium (cf. Löhr *et al*. 1977; Cahen *et al*. 1986; Caspar 1984; Allard 2005). Fifteen of these are blade tools (45%). Not all this material reached the settlement as blades or tools however, as is witnessed by the presence of one core on which a hammerstone fragment and a flake could be refitted and of an end-scraper made on a crested blade. Seventeen artefacts – including three cores but no retouched tools – originate from river gravels, three of these could be classed as Oligocene beach pebbles ("Maasei"), on the basis of their heavily rolled, thick yellow or red cortex. Flints from the Emael member – known to archaeologists as Valkenburg flint (e.g. Brounen and Ploegaert 1992) – are mainly represented in the waste material, one retouched flake and one hammerstone fragment being the exceptions.

Only five artefacts, four of them tools, were identified as flint of the Rullen type. Finally, four tools – one of whose LBK age is dubious – were made of the very dark grey, glossy and highly translucent flint originating from the Late Campanian Zeven Wegen member (Felder and Felder 1998). For a detailed description of these flint types please refer to De Grooth (forthcoming a)[1].

10.3 The process of flint working

The chaîne opératoire (Pelegrin *et al*. 1988) chosen by JKV's inhabitants to transform their raw material into manufactured products greatly resembles the one practised at other regional Bandkeramik sites, such as Beek-Kerkeveld (De Grooth 1987), Liège-Place St. Lambert (Cahen 1984), or Verlaine-Petit Paradis (Allard 2005). It can be summarized as follows:

Striking platforms were made by the removal of one or several large decortication flakes. Although preparation of the core face often consisted only of the removal of bulges and decortication, sometimes a rough crest was prepared to guide the first blade (witness the presence of crested blades in the assemblage). This preparatory work was performed in the hard hammer mode.

The flaking angle of the core was regularly improved by centripetal removal of flakes from the striking platform (witness the faceted aspect of striking platforms on the cores and the presence of many dihedral butts on blanks). If that did not suffice, the whole striking platform could be rejuvenated by hard hammer removal of a core tablet. The same core face remained in use, but the blades produced were 1-2 cm shorter. The removal of tablets also took care of damages on the upper part of the core face when, owing to a wrong flaking angle or irregularities in the flint, hinge fracturing had occurred. Axial or lateral flanks (Cahen 1984), meant to correct damage at the bottom part of the core face, are but rarely encountered at JKV.

Only three blade cores and one flake core have more than one striking platform and/or core face. All blade cores had faceted platforms, as did 10 of the hammerstones still recognizable as former blade cores. Four of the flake cores turned hammerstone had a faceted striking platform as well, suggesting that they too may have been used to produce blades in an earlier stage of reduction. Nine of the blade cores were worked along the whole periphery, seven over three quarters of the periphery. Most blade cores are cylindrical in shape, only three could be described as pyramidal; with two exceptions, they had only a single striking platform. Three of the flake cores belong to the 'flaked flake' category; one was made on a naturally fractured block.

The reduction was aimed at the production of blades, with more or less parallel edges, this notwithstanding the fact that also flakes were produced rather often.

For a sample of 83 well-dated blades and blade tools, attributes visible on the proximal part and thought to reflect the knapping techniques applied, were recorded. The butts of these blades are mostly oval in shape (63%), with a surface that may be flat (52%) or dihedral (46%). They are comparatively large (platform width mean 10.6 mm, sd. 3.1; platform thickness mean 4.3 mm, sd. 1.4). Although a slight lip is often present on the edge between butt and ventral surface (66%), and the bulbs of percussion mostly are diffuse (75%), lance scars and pronounced eraillures (bulbar flakes) also occur quite often (59%). A slight, rather irregular form of dorsal reduction is common (60%), whilst primary faceted butts are completely absent. The flaking angles (between the butt and the ventral surface of the blanks) approximate 90°. The mean L:W index of complete blades is 2.6; the mean index for L:W:Th is 0.6; for the complete blade tools these figures are 1.9 and 0.3 respectively. Thus, JKV's blades show a combination of attributes described by Mateicucová (2003, 2004) as characteristic of direct soft hammer percussion and indirect percussion (punching). In a technological sense, the JKV blades neither resemble the long, narrow regular blades characteristic of Earliest LBK assemblages, with their preponderance of primary faceted butts – thought to be of southern Central European Late Mesolithic origin (Tillmann 1993; Gronenborn 1997), nor the blades with small, smooth, almost point-like butts that were present in small numbers at Friedberg-Bruchenbrücken, whose origin is sought in the Late Mesolithic of the North European plain, northwest continental and western Europe (Gronenborn 1999).

As the newest Radiocarbon-based Bandkeramik chronology indicates that the Flomborn LBK may have co-existed for about 150 years with the later phase of the Earliest LBK found at e.g. Friedberg-Bruchenbrücken (Lüning 2005), a new assessment of the origins and technological affinities of Early Bandkeramik flint technology clearly is called for (De Grooth forthcoming b). This study should evaluate the complete chaîne opératoire, with special focus on raw material sources and on the technology of blade production, rather than on comparisons of single tool types, such as arrowheads (see below).

The toolkit used by JKV's inhabitants is extremely conventional, both in composition and in morphology (Table 10.5). Arrowheads, borers (or rather: inserts for drilling machines), truncated blades, blades with lateral retouches, end-scrapers and side-scrapers are the main standardized tool types. Following common practice (e.g. Allard 2005; Bohmers and Bruijn 1958/59; Cahen *et al*. 1986; Gronenborn 1997; De Grooth 1987; Zimmermann 1988), to these are added the blades with intensive gloss, interpreted as sickle inserts, even though they often are not modified by intentional retouch. Only one 'quartier d'orange' in the strict, typo-morphological sense of the word (Cahen *et al*. 1986) was found at JKV, an isolated find from an undated pit. Tools of aleatory morphology (Hauzeur 2006) comprise retouched flakes, notches, denticulates, burins, and splintered pieces.

Standardized tools were almost exclusively made on blades – with the exception of end- and side-scrapers. Also arrowheads at JKV were mainly made on blades, although their small size often makes it difficult to determine the type of blank. Most retouched tools show a direct steep retouch, only arrowheads sometimes displaying bifacial or inverse flat retouch.

Among the standardized tools, the arrowheads alone merit special attention because of the role assigned to them in recent discussions on Mesolithic-Neolithic interactions and

	All material		Pits ≥3 artefacts		Pits ≥15 artefacts	
Types	N	%	N	%	N	%
Arrowheads	74	8.3	65	8.2	56	8.0
Borers	47	5.3	39	5.0	36	5.1
End-scrapers	264	29.7	229	29.2	197	28.1
Side-scrapers	23	2.6	20	2.6	18	2.6
Truncated blades	62	7.0	58	7.4	55	7.8
Retouched blades	179	20.1	157	20.0	146	20.8
Sickle blades	131	14.7	121	15.4	106	15.1
Retouched flakes	44	4.9	38	4.8	35	5.0
Splintered pieces	37	4.2	32	4.1	27	3.9
(micro) Burins	5	0.6	4	0.5	4	0.6
Notches	11	1.2	10	1.3	10	1.4
Denticulates	4	0.5	4	0.5	4	0.6
Microliths	3	0.3	3	0.4	3	0.4
Quartiers d'orange	1	0.1	1	0.1	0	
Non-sickle gloss	5	0.6	4	0.5	4	0.6
	890	100.1	785	100.0	701	100.0

Table 10-5 The main tool types

the relationships between the LBK and the La Hoguette and Limburg Groups (Löhr 1994; Gronenborn 1997, 1999; Jeunesse 2002; Gehlen 2006; Heinen 2006; cf. De Grooth forthcoming b).

For a long time, asymmetric triangular points (especially those on which the base and the least-retouched side meet in an obtuse angle) were considered to be the typical, classic Bandkeramik type of arrowhead and accordingly dubbed Bandkeramik or Danubian point (e.g. Ankel 1964; Bohmers and Bruijn 1958/1959). Recently, however, this type is seen to epitomize LBK interactions with indigenous groups, and their origin is sought in (south)western European Mesolithic traditions (Löhr 1994; Jeunesse 2002; Gronenborn 1999).

This view is based on two typomorphological observations. The first of these considers regional traditions in the lateralisation of trapezes and asymmetric triangular points. According to Löhr and Jeunesse right-winged arrowheads are predominant in the LBK of Dutch Limburg, Belgium and northwestern France. Left-winged arrowheads prevail in the Alsace, along the Neckar and the Moselle river area. This east-west dichotomy is thought to have its origins in Late Mesolithic traditions, where right-winged asymmetric trapezes are found mainly in the area between the river Seine and the Lower Rhine (as well as on the Northwest European Plain and in Denmark). Left-winged trapezes have a more southerly distribution, with concentrations in southern France, Switzerland and northern Italy.

The second observation has to do with the occurrence of an invasive retouch on the ventral surface (retouche inverse plate or RIP, Löhr 1994; retouche plate inverse or RPI, Jeunesse 2002) on the base of both symmetric and asymmetric arrow-heads. This trait too is encountered on many Late Mesolithic trapezes, and its origins are sought in central and southwestern France (Gehlen 2006), where it is commonly found on both trapezes and triangular points belonging to the Early Neolithic Rocadourian Culture (Roussot-Larroque 1990).

The combination of these two phenomena on many arrowheads found in the flint industry of western Bandkeramik groups and their successors such as the RRBP and the Villeneuve-Saint-Germain group (Allard 2005) is seen as evidence for interactions between the LBK newcomers and a local substrate. Moreover, both Löhr and Jeunesse see a connection between the distribution areas of asymmetric arrowheads and the Early Neolithic non-Bandkeramik pottery groups La Hoguette and Limburg: left-winged points mainly occur in the area where La Hoguette pottery prevails, whilst right-winged points have a similar distribution as Limburg pottery has. Finally, the use of the micro-burin technique is also seen as evidence of Mesolithic influence. JKV is located in an area where both La Hoguette and Limburg pottery has been recovered, not only from Bandkeramik rubbish pits but

	All	angle > 90°	RIP
Symmetric	18		7
L-winged triangle	10	5	5
R-winged triangle	11	5	4
R quadrilateral	3		1
irregular	6		3
All	48		20 (42%)

Table 10-6 Characteristics of arrowheads

also on independent sites – e.g. Sweikhuizen (Modderman 1987) and Haelen (Bats *et al*. 2002) for La Hoguette pottery and its Begleitkeramik and Kesseleik (Modderman 1974) and Roermond-Musschenberg (Tol 2000) for Limburg pottery. Therefore, and especially given its Early LBK date, a study of its arrowheads may provide a valuable contribution to this ongoing discussion (De Grooth forthcoming b).

Of the 48 arrowheads that could be described in typo-morphological terms, 21 were asymmetric triangles, and three asymmetric quadrilaterals, thus fifty percent may be described as asymmetric. Pronounced asymmetry, with an obtuse angle between the base and one of the long sides, however, is found on only ten specimen, equally divided among the right- and the left-winged specimens (Table 10.6). In only one case a diagnostic scar visible at the tip demonstrates that the so-called micro-burin technique was used to obtain a blank with the required length. Four times the tips was positioned at the proximal end of the blank, once the remains of the butt were preserved at the base. Only four arrowheads were recovered from pits ceramically dated to the second, LBKII habitation phase (2 symmetric, 1 right-winged and one irregular), consequently there was no need to consider them separately.

In terms of the interpretation advocated by Löhr and Jeunesse, the high percentage of asymmetric arrowheads would indicate that the indigenous (and partly southwestern) influence on arrowhead morphology was already clearly present in the Graetheide region during the Early LBK. Additionally, the presence of almost equal amounts of left- and right-winged points would refute Jeunesse's claim that the Dutch LBK belonged exclusively to his right-winged region, inhabited by people making Limburg Pottery, but would be in accordance with JKV's location in a region where La Hoguette and Limburg pottery are both found (even though La Hoguette pottery is absent at the site itself).

Three microlithic points were found at the site, all in pit 91.124, dating to ceramic phase 1. Two of these are so-called B-points: they show a steep direct retouch running from the tip part way down the left side of the blank. One (25-12-3 mm) has a truncated base, the other (22-11-3 mm), made on a flake fragment, has a fracture at its base. The third is a fragment that could not be classified. As B-points mainly occur during the Early Mesolithic, they must be regarded as remnants from an earlier occupation of or visit to the site. Characteristic Late Mesolithic artefacts, such as broad trapezes or mistletoe leaf points, are absent.

At the other side of the time-scale, the fragment of a polished axe with oval cross-section clearly postdates the Bandkeramik occupation, as – probably – does a high, double end-scraper made of flint of the Zeven Wegen type.

In Chapter 11 A.E. van Gijn discusses the results of an extensive use-wear analysis, showing among other things that tools may have been used for several different activities, regardless of their morphology. Actual retooling, i.e. turning one tool type into another through retouching, was not a common practice, the most striking examples being three arrowheads and one borer made out of former sickle inserts.

10.4 Dimensions of cores, blanks and tools

The cores and hammerstones recovered at JKV are quite small. With a mean length of 55.2 mm the discarded blade cores are considerably shorter than those of the younger LBK site Beek-Kerkeveld (mean length 71.6 mm) and at the Banholt extraction site (87.4 mm). This even holds true for the cores of the second habitation period that are coeval with the Beek material.

Given the low numbers of dated cores in most of the phases, it was decided to group cores from the four first settlement phases together (Table 10.7). There are no differences in

Phase mean (mm) median stdev range	L	W	Th
Early (Habitation Phase 1-4) N= 44	53.7 54 11.6 31-80	44.9 47 9.6 24-67	34.0 34 8.1 13-53
Late N=8	56.1 54 13.3 42-87	46.5 43.5 10.1 37-69	38.1 38.5 11.0 24-57
X N=29	57.2 57 15.3 31-111	48.8 48 15.8 24-109	38.3 38 15.3 12-100
All N=81	55.2 55 13.1 31-111	46.4 47 12.2 24-109	36.0 36 11.5 12-100

Table 10-7 Dimensions of cores

average size between cores subsequently used as hammerstones and the unmodified cores (Table 10.8), or between blade cores and flake cores (Table 10.9).

The core rejuvenation tablets present at the site show, however, that the blade cores initially were considerably larger: on average at least 18 mm in length (corresponding to the mean thickness of the rejuvenation tablets), at least 15 mm in width and at least 10 mm in thickness (Table 10.10).

The blades are rather stocky, three quarters (76.5%) of them have a length:width ratio between 1:2 and 1:3. (48.1% between 1:2 and 1:2.5). (Fig. 10.4). With a mean length of 40 mm, they fit nicely with the size of the cores. The blades from the LBK II habitation seems to be slightly shorter than average, a surprising observation as in general the Younger LBK blades in the region are longer than the early ones (cf. Newell 1970; Bohmers and Bruijn 1958/1959; De Grooth 1987).

	Cores				Hammerstones			
		Length	Width	Thickness		Length	Width	Thickness
Early (phase 1-4)	mean	52.7	41.2	26.2		54.1	46.3	37.1
	median	51	41.5	26.5		55.5	48	36
	sd	14.2	11.2	5.1		10.6	8.7	7.0
	range	31-75	24-67	13-33		32-80	28-64	25-53
	N=12				N=32			
All	mean	55.2	44.9	30.4		55.2	47.2	38.5
	median	55	43	30		54.5	47.5	38
	sd	14.1	12.6	9.5		12.8	12.1	11.5
	range	31-87	24-69	12-57		32-111	25-109	24-100
	N=25				N=56			

Table 10-8 Comparison of unmodified cores and hammerstones

	Blade Cores/Hammerstones				Flake Cores/Hammerstones			
		L	W	Th		L	W	Th
Early	mean	48.4	43.2	35.8	mean	55.3	45.4	33.5
	median	49	42.5	35.5	median	56	47	32
	sd	7.3	7.7	6.2	sd	12.2	10.1	8.6
	range	36-70	33-62	25-50	range	31-80	24-67	13-53
	N=10				N=34			
All	mean	55.0	47.3	39.3	mean	55.3	46.1	34.5
	median	54.4	47.5	40	median	55	47	33
	sd	11.6	9.7	8.2	sd	13.8	13.2	12.4
	range	35-87	35-69	25-57	range	31-111	24-109	12-100
	N=22				N=51			

Table 10-9 Comparison of blade cores and flakes cores

	Tablets					Cores			
		L	W	Th	Surface		Platf L	Platf W	Surface
Early	mean	60.8	47.7	17.5	2520		42.5	36.5	1580
	median	60	44	17	2795		42.5	35.5	1438
	sd	12.1	12.3	5.7			7.1	7.6	
	range	37-82	30-77	9-30			33-54	25-52	
	N= 31					N=10			
All	mean	62.1	48.7	18.2	3003		47.6	39.7	1946
	median	61	47	17	3039		46	40	1955
	sd	12.0	10.9	5.9			10.0	8.6	
	range	37-93	30-77	9-35			33-69	25-57	
	N=52					N=24			

Table 10-10 Dimensions of core rejuvenation tablets compared to blade cores

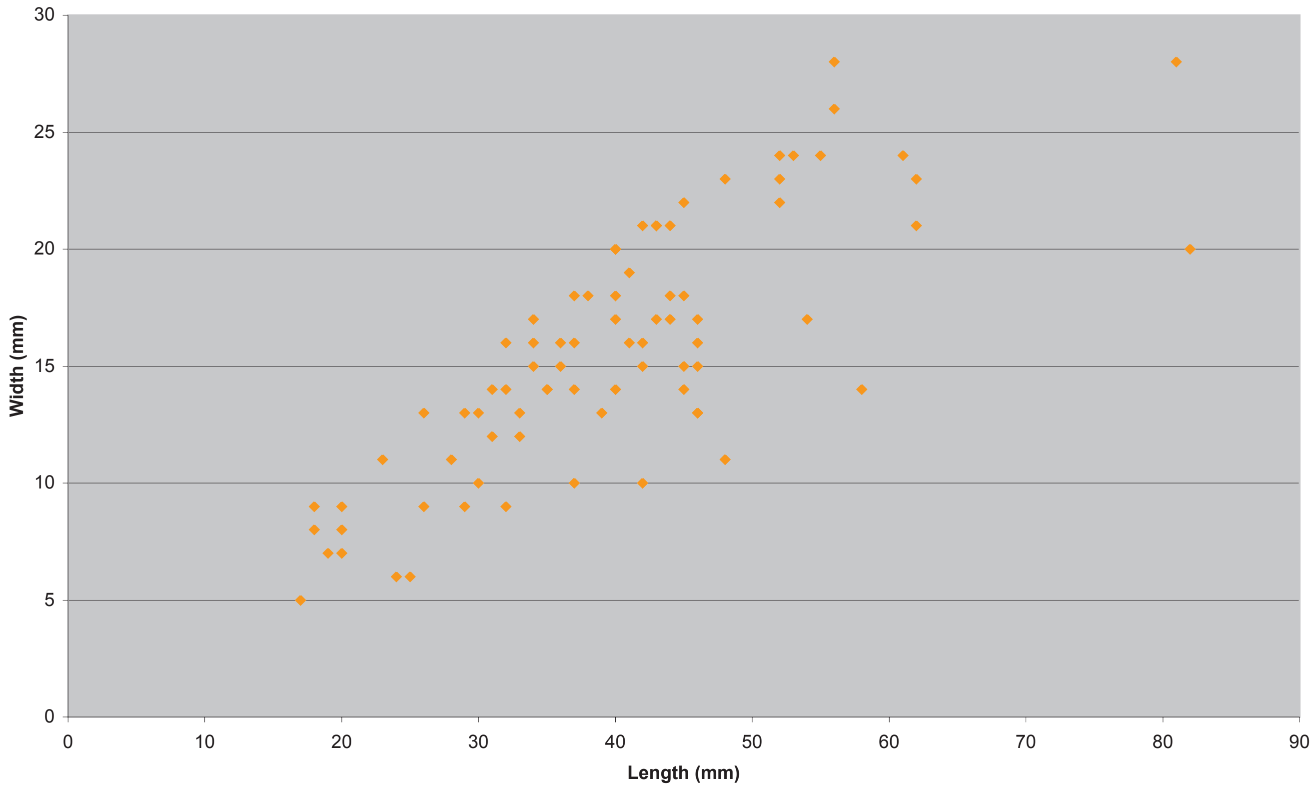

Fig. 10-4 Dimensions of complete blades

At first sight, the dimensions of the blade tools (sickle inserts, truncated blades, borers, and end-scrapers made on blades) are similar to those of the unmodified blades (Tables 10.11, 10.12). These figures are, however, negatively influenced by the end-scrapers. The other blade tools categories are considerably longer and wider than the unmodified blades (Fig 10.5). This indicates that many of the complete unmodified blades were discarded as wasters, unsuitable for making tools (but see Van Gijn, Ch. 11, on their use). End-scrapers differ from the other blade tools in having the working edge perpendicular to the long axis of the blank, and thus get shortened during use. It remains puzzling however that the borers are not affected in a similar way.

10.5 Spatial observations

By students of Bandkeramik settlements it is generally assumed that most of the material found in the pits of a farmstead was secondary rubbish, discarded close to the places of origin during the time the farm was in use. Apart from this direct discard, the pits would have contained in the

Phase mean median stdev range	L	W	Th
Early (Habitation phases 1-4)	40.3	16.0	5.5
N=53	40	15.5	5
	12.3	5.5	3.7
	17-81	5-28	2-21
Late	26.0	10.0	3.7
	27.5	9	3
N=6	5.9	2.5	1.8
	18-33	7-13	2-7
X	43.0	16.6	5.5
	44	17	5
N=23	12.6	4.6	2.3
	18-82	8-24	3-12
Total	40.0	15.7	5.3
	40	15.5	5
N=82	12.6	5.3	3.2
	17-82	5-28	2-21

Table 10-11 Dimensions of entire unmodified blades

Phase mean median stdev range	L	W	Th
1 N=25	39.3 36 13.2 23-81	21.2 21 5.2 11-33	6.5 6 2.3 4-14
2 N=20	44.9 44.5 15.3 22-86	21.6 20 4.8 15-30	7.5 7 2.8 4-15
3 N=31	38.5 39 11.1 16-65	22.4 22 5.9 13-39	7.1 7 2.1 4-13
4 N=26	37.9 36 10.6 24-76	22.7 22 4.7 15-31	7.0 7 1.5 5-9
Early N=102	39.8 38 12.5 16-86	22.0 22 5.2 11-39	7.0 7 2.2 4-15
Late N=27	37.7 36 9.0 24-60	22.7 23 4.6 12-31	7.7 8 2.0 4-12
X N=45	39.3 38 11.1 21-74	20.4 21 5.7 8-30	7.3 8 2.5 4-13
All N=174	39.3 37 11.6 16-86	21.7 22 5.3 8-39	7.2 7 2.2 4-15

Table 10-12 Dimensions of complete blade tools (arrowheads excluded)

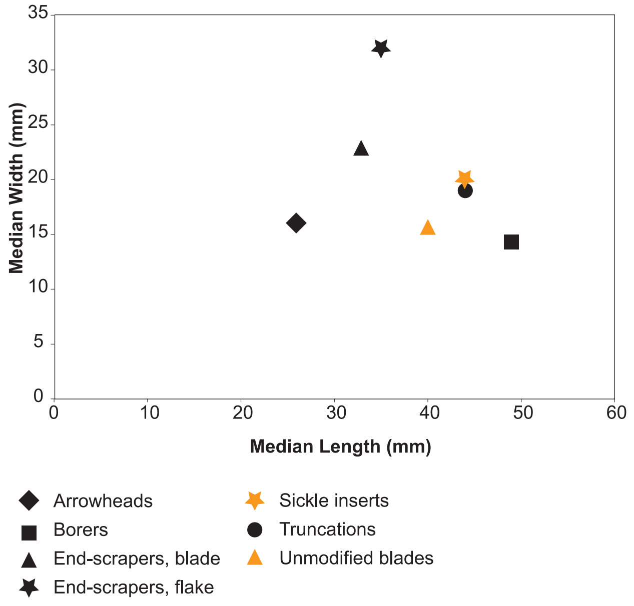

Fig. 10-5 Dimensions of complete tools and blades

	mean	Npits
Associated with houses	54.0	123
Not associated	14.1	56

Table 10-13 Average number of flints in pits (containing at least three artefacts)

lower layers some accidentally washed-in surface material from all stages prior to the digging and, in the top of the fill, a mixture of contemporary, earlier and later primary and de facto refuse, which was discarded on the surrounding surface and had slipped down during the filling-in process (Schiffer 1976; Van de Velde 1979; De Grooth 1987).

At JKV, the majority of flints were recovered from the lateral construction pits (*Längsgruben*) situated alongside the houses (Table 10.13). In the Early habitation phase there are, however, some well-dated pits containing considerable numbers of flint artefacts that could not be assigned to a specific house. Pits connected with all house types contained on average a considerable amount of flints. This picture is however somewhat distorted because of the huge amount (N = 593) of flints recovered from pit 48021, alongside the type1a house 39 of the Late habitation phase. In the early habitation phase, pits along the type 1b and 1c houses contained the highest amounts of flints (Table 10.14).

Despite the good state of preservation, no pits filled with huge masses of flint debris (*amas de débitage* cf. Allard 2005), as found at Beek-Kerkeveld (De Grooth 1987) and many Belgian Bandkeramik sites, e.g. Liège-Place St. Lambert (Cahen 1984), Verlaine-Petit Paradis (Allard 2005), were excavated at JKV. Apparently at those sites a different method of refuse disposal was used.

In an earlier analysis (Louwe Kooijmans *et al*. 2003), different spatial groupings were suggested for the JKV house plans. Where Louwe Kooijmans postulated the existence of four ‘yards’ and three ‘activity areas’, Van de Velde saw two wards, in the northeastern and southwestern part of the settlement respectively. As it is the simplest, here the latter division is used as the basis for an analysis of the spatial aspects of JKV flint working.

House type	All			Early		
	Mean	N pits	N houses	Mean	N pits	N houses
1a	48.2	20	6	22.3	16	5
1b,1c,1x	60.1	69	27	73.8	53	21
2b,2c,2x	36.9	19	10	38.3	17	7
3c,3x	41.0	14	8	42.5	11	5

Table 10-14 Average number of flint artefacts in pits associated with different house types; pits containing at least 3 flint artefacts

In both wards the highest amounts of flints were retrieved from the lateral extraction pits. The NE and SW wards comprise an equal number of houses (each c. 30), and a similar number of pits contained at least 3 flint artefacts (82 in the northeastern and 97 in the southwestern ward). There are, however, striking differences in the amounts of flint found at these spatial entities (Table 10.15). Only 34% of all flint artefacts are associated with the NE ward, and 66% with the SW ward[2].

As the SW pits with the highest amounts of flakes were mainly investigated during the 1990 campaign, at first this pattern was thought not to be the result of past human behaviour, but to derive from differences in excavation strategies, with more careful retrieval of material during the trial excavation. A comparison of the upper quartile of flint-rich pits, however, falsified this assumption: the 1990 SW pits did not differ from the 1991 ones (both SW and NE) in the average weight of unmodified flakes or in the percentage of chips, and the pits were evenly distributed over the three entities (Table 10.16). Moreover, Van de Velde noted one important disparity regarding the pottery associated with houses from both wards. The average numbers of pots per house are 54.8 in the SW ward, *vs*. 38.5 in the north-eastern one, and the numbers of thin-walled pots are 22.6 and 14.1 respectively. According to Van de Velde (Chapter 15), these differences are in part the result of real differences in household size, and in part the effect of erosion, as more erosion took place in the northeastern part of the settlement. Therefore, the SW-NE dichotomy in the amount of flints should also be explained in terms of past human behaviour.

The figures are not stable but change with time (Table 10.17). Of the 42 pits dated to the Early LBK and containing at least 15 flint artefacts, 24 are located in the SW ward (= 57%), and 18 (43%) in the NE ward. 76% of the dated ‘Early’ flints, however, derived from SW pits, and only 23% from NW ones. Consequently, the SW pits contain higher amounts of flints (mean 154.6) than those in the NW (mean 63.8, both for pits containing at least 15 artefacts[3]). In the Late (LBKII) occupation this is the other way round: whilst 8 dated pits (67%) lie in the SW ward and 4 pits (33%) in the NE ward, 70% of all dated flint artefacts are associated with the NE ward, and only 30% with the SW ward. In this phase, the average amount of flint in NE pits is much higher than that of the SW ones (193 vs. 42). Moreover, the two wards do not only differ in the absolute amounts of flint recovered, but also in proportions of main artefact categories.

Type N column % row %	NE	SW	All
Cores/hammerstones	30 1.2 40.0	45 0.9 60.0	75 100.0
Flakes	1798 71.3 33.2	3620 73.8 66.8	5418 100.0
Blades	346 13.7 34.5	661 13.5 65.5	1007 100.0
Tools	294 11.7 37.5	491 10.0 62.5	785 100.0
Others	54 2.1 38.0	88 1.8 62.0	142 100.0
N	2522 100.0 34.0	4905 100.0 66.0	7427 100.0

Table 10-15 Comparison of the amounts of flints in the two wards (pits with at least 3 flints)

	SW90	SW91	NE91
Chips (%)	15.2	15.3	17.2
Mean weight flakes (gr)	5.5	7.6	6.0
Mean weight All	5.5	6.3	5.3
N pits	6	7	6

Table 10-16 Comparison of upper quartile of pits (according to total amount of flints), between South-western ward (excavation 1990 and 1991) and North-eastern ward (excavation 1991)

	Early			Late			X		
Types N Column % Row %	NE	SW	All	NE	SW	All	NE	SW	All
Cores/	16	31	47	3	5	8	3	4	7
Hammerst.	1.4	0.8		0.4	1.5		1.1	0.8	
	34.0	66.0	100.0	37.5	62.5	100.0	42.9	57.1	100.0%
Cort. flakes	235	733	968	102	60	162	49	111	160
	20.4	19.7		13.2	18.0		17.3	22.1	
	24.3	75.7	100.0%	63.0	37.0	100.0	30.6	69.4	100.0
Noncort.	369	1363	1732	323	103	426	108	156	264
Flakes	32.0	36.7		41.9	31.0		37.8	31.0	
	21.3	78.7	100.0%	75.8	24.2	100.0	40.9	59.1	100.0%
Chips	97	526	623	183	37	220	24	81	105
	8.4	14.2		23.7	11.1		8.4	16.1	
	15.6	84.4	100.0%	83.2	16.8	100.0	22.9	77.1	100.0%
Blades	183	487	670	68	51	119	33	69	102
	15.9	13.1		8.8	15.4		11.5	13.7	
	27.3	72.7	100.0%	57.1	42.9	100.0%	32.4	67.6	100.0%
Tools	152	356	508	57	46	103	45	45	90
	13.2	9.6		7.4	13.9		15.7	9.0	
	29.9	70.1	100.0%	55.3	44.7	100.0%	50.0	50.0	100.0%
Others	101	216	317	35	30	65	24	37	61
	8.8	5.8		4.5	9.0		8.4	7.3	
	31.9	68.1	100.0%	53.8	46.2	100.0	39.3	60.7	100.0%
N	1153	3712	4865	771	332	1103	286	503	789
	100.0%	100.0%		100.0%	100.0%		100.0%	100.0%	
	23.7	76.3	100.0%	69.9%	30.1	100.0%	36.2	63.8	100.0%
N pits	18	24	42	4	8	12	11	12	23
	43%	57%	100%	33%	67%	100%	48%	52%	100%

Table 10-17 Differences in important artefact categories between the wards in Early, Late and undated pits (for pits containing at least 15 flint artefacts)

It is not easy to assess these figures looking only at percentages, firstly because of their interdependence and secondly because of the enormous difference in frequency between e.g. unmodified flakes and cores. Therefore, the mutual proportions of the categories are given as well (Table 10.18).

	Early		Late	
	NE	SW	NE	SW
Flakes : Blades+Tools	2.3:1	3.3:1	5.1:1	2.3:1
Flakes : Cores	48.2:1	89.3:1	210.3:1	44.4:1
Blades+Tools : Cores	21.0:1	27.2:1	41.7:1	19.4:1

Table 10-18 Proportions of main artefact categories in the two wards in Early and Late habitation

Although during the Early LBK all artefact categories are underrepresented in the pits of the NE ward, this is especially the case for the unmodified flakes and the chips. The distribution of cores/hammerstones, rejuvenation pieces and tools (and to a lesser extent unmodified blades) is considerably less biased. A more detailed analysis, at the level of house generations, is hazardous because of the very low number of datable pits per ward in most of the phases (Table 10.19). The main SW flint working activities however seem to be concentrated continuously in the same area until phase 4, when the distribution becomes more balanced. In the Late habitation, pit 48021 (belonging to type 1 house 39) contained debris resulting from similar intensive flint working.

There is however no evidence for specialist activity in the use of tools at either the ward or the household level. During

	E1		E2		E3		E4	
	NE	SW	NE	SW	NE	SW	NE	SW
Cores	8	5	7	4	0	18	1	4
Flakes	173	498	413	615	44	1320	141	334
Blades	47	111	76	97	11	214	49	65
Tools	27	75	68	61	6	176	52	44
N	265	712	583	780	61	1760	245	460
Npits	7	3	6	2	2	14	3	5
Mean	37.9	237.3	97.2	390.0	30.5	125.7	81.7	92.0

Table 10-19 Main artefact categories in the two wards, during the four Early LBK habitation phases

	NE Ward	SW Ward	Total
Hesbaye	12	21	33
Emael	9	18	27
Gravels	8	9	17
Rullen	2	3	5
Zeven Wegen	1	3	4
N	32	54	86
	37.2%	62.8%	100.0%

Table 10-21 Distribution of rare raw materials in the two wards

all phases the main tool categories were discarded (after use and/or maintenance) in both NE and SW wards by several coeval households (Table 10.20). Nor is there any evidence for differences in the rate of recycling and/or retooling, or in the use of rare raw materials between the two wards (Table 10.21). The lower amounts of tools (and blades) discarded in the northeastern ward may be seen as another indication for the difference in household sizes postulated by Van de Velde on the basis of the amounts of pottery (cf. Chapter 15).

10.6 The organisation of flint working

To get a better insight into the mechanisms underlying the spatial variation observed in the previous section, and thus in the way flint working was organised at JKV, a Principal Component Analysis was performed, as this statistical technique had proven a useful aid in distinguishing underlying patterns of co-variation in the comparable data-set of Elsloo (De Grooth 1987).

Principal component analysis is a method of transforming a given set of variables into a new set of composite variables or principal components that are orthogonal (uncorrelated) to each other. It determines what would be the best linear combination of variables, the best in the sense that the particular combination of variables would account for more of the variation in the data as a whole than any other linear combination of variables. The first principal component, therefore, may be viewed as the single best summary of linear relationships exhibited in the data. The second component may be defined as the linear combination of variables that accounts for most of the residual variance after the effect of the first component is removed from the data etc (Doran and Hodson 1975; Nie et al. 1975).

The eigenvalues associated with each component represent the amount of total variance accounted for by the factor. Therefore, the importance of a component may be evaluated by examining the proportion of the total variance accounted for. By selecting only PCs with an eigenvalue greater than (or equal to) 1, one ensures that only components accounting for at least the amount of total variance of a variable will be treated as significant.

The analyses were performed by P. van de Velde with the SPSS statistical package.

Because of the often wide scatter of ceramic dates for pits associated with many houses (cf. Ch. 14), it was decided to

Ward	Phase	arrowheads	borers	end-scrapers	sickle inserts	truncations
NE	E1 (7)	4 (4)	2 (2)	12 (3)	4 (2)	1 (1)
	E2 (6)	4 (3)	5 (4)	15 (4)	10 (5)	10 (5)
	E3 (3)	2 (1)	1(1)	2 (1)	5 (3)	2 (2)
	E4 (3)	2 (1)	1 (1)	22 (3)	5 (3)	4 (2)
	L (5)	3 (2)		20 (5)	6 (4)	3 (2)
	X (58)	9 (8)	4 (4)	27 (20)	12 (7)	4 (4)
SW	E1 (3)	3 (1)	4 (1)	23 (2)	13 (2)	5 (3)
	E2 (2)	8 (1)	6 (1)	8 (2)	16 (2)	4 (2)
	E3 (15)	18 (7)	6 (4)	49 (12)	26 (11)	16 (8)
	E4 (6)	2 (2)	5 (3)	15 (4)	8 (3)	1 (1)
	L (10)	4 (3)	2 (2)	9 (4)	6 (3)	2 (2)
	X (61)	6 (6)	3 (2)	27 (18)	15 (9)	4 (4)

Table 10-20 Distribution of main tools types in the two wards through time (Npits)

CORES
HAMMERSTONES
HAMMERSTONE FRAGMENTS
PRIMARY CORTEX FLAKES
SECONDARY CORTEX FLAKES
CRESTED BLADES
REJUVENATION FLAKES
FLAKES WITHOUT CORTEX
CHIPS
COMPLETE BLADES
PROXIMAL BLADE FRAGMENTS
MEDIAL BLADE FRAGMENTS
DISTAL BLADE FRAGMENTS
ARTIFICIAL BLOCKS
ARROWHEADS
BORERS
END-SCRAPERS
SICKLE INSERTS
TRUNCATED BLADES
SIDE-RETOUCHED BLADES
OTHER TOOLS

Table 10-22 Variables used in initial Principal Component Analysis

	PC1 Eigenvalue 2.2 Variance 28.1%	PC2 Eigenvalue 1.5 Variance 18.8%	PC3 Eigenvalue 1.4 Variance 17.2%
CORTPRIM	-0,10	-0,51	0,61
CORTSEC	0,36	-0,01	0,75
REJU	0,49	0,60	-0,11
NOCORTFL	-0,79	0,01	-0,07
CHIPS	-0,61	0,06	-0,35
COREHAM	0,11	0,82	0,25
BLADEPM	0,67	-0,20	-0,39
TOOLS	0,64	-0,40	-0,30

Table 10-23 Result of final Principal Component Analysis

use the pits rather than the houses as the unit of analysis, with the exception of five cases where the pits associated with a house were reliably dated to the same ceramic phase. To decrease the influence of missing values, only pits containing at least 15 flint artefacts were used as cases. Initially, 21 main artefact categories served as variables (Table 10.22). Their raw counts were converted to percentages to ensure that the smaller finds counted as heavily as the large ones.

The initial results indicated that several typomorphologically related variables behaved in a similar way. They were lumped together, again in an effort to reduce noise. This concerned all tools, cores and hammerstones, proximal and medial blade fragments. Finally, variables that did not load significantly (i.e. at least +/- 0.4) on one of the first three PCs were discarded. Thus, the final analysis comprised 49 well-dated pits/houses as the cases, and eight artefact categories as the variables: primary cortex flakes; secondary cortex flakes; flakes without cortex; chips; rejuvenation flakes; cores/hammerstones; proximal/medial blade fragments and tools.

The SPSS mineigen criterion (eigenvalue higher than 1) selected three PCs, accounting for 64% of total variance (Table 10.23). The first two PCs are bipolar, with both high positive and high negative loadings for some variables, the third is specific, with only high positive scores (Table 10.24). On the first PC, high positive loadings for tools and proximal/medial blade fragments oppose high negative loads for non-cortical flakes and chips. Thus, this PC seems to reflect an opposition between pits filled with production waste and pits where tools were discarded after use. The high positive loadings for unmodified proximal and medial blade fragments on this first PC indicates that they may have served to a large extent as tools too (cf. Chapter 11 on use wear analysis).

The second PC has to do with different stages in the core reduction, as decortication flakes are opposed to rejuvenation and discard of exhausted cores. It indicates that (some of the) cores circulated within the settlement after initial preparation, and subsequently were reduced and rejuvenated elsewhere.

The third, specific, PC again should have something to do with the first stage (decortication) of the reduction sequence.

	PC1	PC2	PC3
High positive	tools proximal/medial blade fragments	cores/hammerstone rejuvenation flakes	primary and secondary cortex flakes
High negative	non-cortical flakes chips	primary cortex flakes	

Table 10-24 Highest loadings in final Principal Component Analysis

FEATURE	Ward	HOUSE	type	PHASE	PC1	PC2	PC3	PC1loading	PC2loading	PC3loading
41019	N	24	t1a	E3	-2,20	-0,11	-1,75	H –		
48021	N	39	t1b	L	-1,57	-0,18	-0,84	H –		
94052	S	.		E2	-1,25	-0,21	-1,02	H –		
44012	S	14	t3	E4	-1,23	-0,11	-0,88	H –		
58016	S	16	tx	L	-1,16	-0,36	-1,08	H –		
H02	S	02	t2	E3	-1,12	-0,05	0,60	H –		H +
10036	N	36	t1a	L	-1,02	-1,78	0,44	H –	H –	
19087	N	57	t2	E1	-1,02	-0,86	0,54	H –	H –	H +
24026	S	?35	t1a	L	-0,99	0,92	0,17	H –	H +	
91123	S	.		E4	-0,89	-1,77	2,66	H –	H –	H +
91117	S	?01	t1b	E3	-0,78	1,18	-0,59	H –	H +	
92023	S	04	t1b	E2	-0,77	-0,27	-0,33	H –		
20027	N	49	t2	E2	-0,70	-0,29	0,34	H –		
31021	S	?12	t2	L	-0,63	0,44	1,56	H –		H +
49104	N	24	t1a	E1	-0,61	1,17	0,18	H –	H +	
53037	N	62	tx	L	-0,53	0,14	-0,59	H –		
31075	S	13	t1b	E3	-0,51	-0,22	0,20	H –		
10040	N	?58	t2	L	-0,43	0,84	-0,47		H +	
H09	S	09	t1b	E4	-0,35	-0,34	0,70			H +
92001	S	04	t1b	E3	-0,26	-0,56	-0,95		H –	
32145	S	.		E1	-0,25	-0,73	0,24		H –	
22019	N	37	t3	E1	-0,20	2,85	0,61		H +	H +
91124	S	03	t1b	E1	-0,10	-0,46	0,48			
26090	N	57	t2	E2	-0,09	-0,02	2,62			H +
H17	S	17	t3	E3	-0,09	-0,34	-1,99			
54001	S	?19	t3	E3	-0,03	0,36	-1,91			
10027	N	.		E2	-0,01	-0,16	0,50			H +
H08	S	08	tx	L	0,03	-1,16	0,71		H –	H +
32142	S	.		E3	0,04	0,42	0,54			H +
33065	N	.		E4	0,17	0,15	-1,43			
12002	N	.		E1	0,18	2,98	-0,30		H +	
32144	S	?34	t3	L	0,28	0,75	0,05		H +	
32052	S	33	t3	E3	0,40	-0,17	1,24			H +
45004	N	25	t3	E3	0,45	-0,56	-0,20		H –	
28061	S	10	t2b	L	0,50	0,98	-0,42	H +	H +	
19078	N	59	t1b	E1	0,51	-0,16	0,64	H +		H +
32143	S	?34	t3	E3	0,51	0,86	0,12	H +	H +	
57020	N	41	t3	E4	0,61	-1,51	-0,47	H +	H –	
53010	N	42	t3	E2	0,75	-0,49	-0,55	H +		
H23	S	23	t2	E3	0,75	-0,34	-0,33	H +		
55003	N	45	t3	E4	0,95	-1,59	-0,79	H +	H –	
10038	N	?58	t2	E2	0,97	0,45	-0,27	H +		
54028	S	19	t3	E4	1,20	-0,75	-0,20	H +	H –	
46004	S	.		E1	1,40	0,36	-0,17	H +		
15005	N	56	t3	E1	1,42	2,41	1,80	H +	H +	H +
59007	N	44	t3	E2	1,62	-0,56	0,23	H +	H –	
31125	S	.		L	1,95	-0,26	-1,99	H +		
49098	N	?23	t2	E1	1,99	-0,97	1,22	H +	H –	H +
14002	S	19	t3	E3	2,60	-0,39	-1,15	H +		

Table 10-25 Distribution of factor scores in final PCA (units sorted according to scores on PC1). Col. 'ward': N=NE, S=SW.

In a subsequent step, the cases that show many of the characteristics compounded by these PCs were identified through computing their so-called 'factor scores' (Table 10.25).

For all three PCs houses/pits with high positive and high negative factor scores occur in all habitation phases, indicating that none of the PCs should be interpreted in chronological terms. This is not really surprising, given the limited time depth of habitation at JKV (and the substantial hiatus between the Early and Late habitation phases).

A cluster of pits, whose factor scores indicate that they were important in the early stages of the reduction process, is located in the central part of the southwestern ward, whereas pits with high positive scores on PC1 (connected with tool use) have a more marginal position in the southwestern ward, and in the northeastern part of the settlement (Fig. 10.6).

The pattern, however, is much less clear cut than one would have liked: although the PCs are by definition (mathematically) independent of one another, about half of the pits/houses marked as 'consumers of tools and blades' by their scores on PC 1, also have high scores for one or both of the other PCs, and thus would have contributed to the production as well.

Nevertheless, it seems plausible to conclude that different production strategies were employed by JKV's inhabitants. Although in every habitation phase flint was worked in most of the households (witness the ubiquitous presence of unmodified flakes and rejuvenation pieces), during the Early LBK habitation households in the central part of the south-western ward were slightly more intensively involved in the early stages of core reduction than others. Some of the prepared cores were subsequently transferred to the NE ward, where the further reduction and tool production took place (but see section 8 for an alternative interpretation).

A similar overlapping of different modes of production (Van de Velde 1979) has been described for Elsloo (De Grooth 1987). There too evidence for the presence of

Fig. 10-6 Location of features with high loadings for tool use on PC1

'ad hoc' specialists was found. During every micro-phase one of the households worked more flint, in a more efficient way, and transferred part of the blanks and tools manufactured to be used and discarded by the other households in the settlement. It should be stressed, however, that both at Elsloo and at JKV, this 'loose mode of production' was of minor importance in comparison to the domestic one.

10.7 Diachronic observations

Apart from the spatial differences outlined in sections 5 and 6, the JKV assemblage also displays important diachronic variation (Table 10.26). In all habitation phases, the percentage of unmodified flakes at JKV is very high (between 67.4% and 77.3%), as is the percentage of unmodified flakes with cortex (between 34 and 39%). Again, not only the percentages but also the mutual proportions of main artefact categories are helpful in an assessment (Table 10.27).

In the first habitation phase (E1) the proportion of flakes to cores is considerably lower than in the other phases, as is the proportion of flakes to blades plus tools. Two main interpretations are feasible for this phenomenon. In the first, the phase E1 assemblages have too few flakes for every core, and the situation in the other phases is regarded as standard. If, alternatively, the phase E1 situation is regarded as standard, the other phases would have too many flakes, i.e. too few cores.

Phase	JKVE1		JKVE2		JKVE3		JKVE4		JKVL	
	N	%	N	%	N	%	N	%	N	%
Type										
Cores/hammerst.	13	1.3	11	0.8	18	1.0	5	0.7	8	0.8
Hammerstone fragm.	27	2.8	28	2.1	43	2.4	11	1.6	20	1.8
Crested blades	10	1.0	7	0.5	11	0.6	4	0.6	2	0.2
Rejuvenation flakes	22	2.3	29	2.1	46	2.5	9	1.3	25	2.3
Flakes with cortex	213	21.8	261	19.2	356	19.6	138	19.6	162	14.7
Flakes without cortex	354	36.2	466	34.2	693	38.1	219	31.1	426	38.6
Blades with cortex	34	3.5	41	3.0	46	2.5	19	2.7	18	1.6
Blades without cortex	114	11.7	125	9.2	166	9.1	91	12.9	99	9.0
Tools blades/flakes	102	10.4	129	9.5	182	10.0	96	13.6	103	9.3
Chips (<15 mm)	55	5.6	244	17.9	226	12.4	98	13.9	220	19.9
Artificial blocks	33	3.4	22	1.6	32	1.8	15	2.1	20	1.8
Total	977	100.0	1363	100.0	1819	100.0	705	100.0	1103	100.0

Table 10-26 Amounts and percentages of artefacts through time

	JKVE1	JKVE2	JKVE3	JKVE4	JKVL
Flakes: Blades+Tools	2.6	3.4	3.4	2.3	3.8
Flakes: Cores	51.6	93.5	75.8	95.0	106.6
Blades+Tools: Cores	20.0	27.5	22.5	42.0	27.8
Blades: Tools	1.6	1.3	1.2	1.2	1.2
N	977	1363	1819	705	1103

Table 10-27 Proportions of main artefact categories through time

In the first case, during phase E1 flakes would have been underrepresented at JKV because the preparation of (some of the) cores had taken place elsewhere, e.g. at the extraction sites, whilst during the other phases unprepared cores were brought into the settlement. As this practice would not influence the intensity of blade and tool production at the site, one would expect the proportions of blades and tools to cores to be similar for all phases. This clearly not being the case, the alternative interpretation seems to fit better. As it is known that flints of the Western Lanaye type circulated widely throughout the Bandkeramik world, the most plausible scenario would be based on the assumption that production and use of cores was a local affair during phase E1, but that in the other phases part of the cores prepared at the settlement were not discarded there but exported. Moreover, the fluctuations in the ratio of cores to blades plus tools, and of flakes to blades plus tools indicate that this export may have occurred at different stages in the reduction process as well. It is not easy to interpret these figures in more detail, partly because they may be the result of several different strategies, partly because of the many parameters involved. A tentative interpretation would be:

E1: local production; no cores, but some (un)modified blades were exported (hence the relatively low proportion of blades and tools in relation to both flakes and cores).

E2: local production, but part of the cores were exported (hence the higher ratio of flakes : cores), possibly some of them after preparation, some after initial blade production (resulting in a higher ration of blades plus tools to cores).

E3: part of the cores were exported after preparation (given the low ratio of blades plus tools to cores); the amount of exported cores may have been somewhat lower than in the preceding phase.

E4: the amount of exported cores increased again, but export mainly took place after initial blade production (hence the high ratio of blades plus tools to cores).

A corroboration of this interpretation is provided by a comparison of the size of blade cores and rejuvenation tablets discarded at JKV. The differences in surface of the striking platforms and of the complete rejuvenation tablets, allow for an estimate of the amount of blades to be made (Fig. 10.7). The median platform surface of cores is

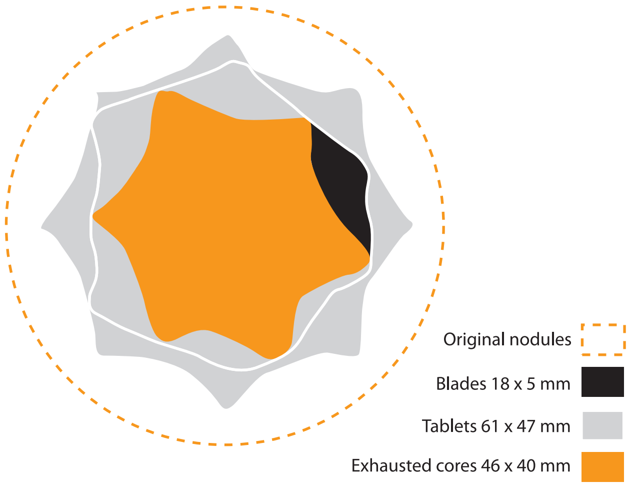

Fig. 10-7 Relationships between surface of blades, blade cores and tablets

1955 mm², the complete tablets have a median surface of 3039 mm² . Thus, a median surface of 1084 mm² was removed during one stage of blade production. Given a median surface (i.e. width × thickness) of 90 mm² per blade, c. 12 blades would have resulted (Table 10.28). Presuming that the same number of blades was produced before core rejuvenation, every core might have yielded some 25 blades. If most cores discarded at JKV originally produced blades, the proportions of cores to blades plus tools for the phases E2 and E3 would correspond quite nicely to this estimate, supporting the idea that some nodules were prepared as cores at JKV, but exported before blades were struck from them. In E1 the number of blades/tools is somewhat lower, and in E4 much higher than would be expected. Thus, during phase E1 some (un)modified blades may have been exported, whereas in E4 cores were used for initial blade production at JKV before leaving the settlement.

10.8 Inter-site comparisons

To assess the value of this interpretation, one would like to compare the JKV data with those from the settlements that could have received its flints, especially sites further to the east that used important quantities of Western Lanaye flints, as well as from contemporary settlements in the Graetheide region, located at approximately the same distance from the extraction sites (De Grooth in press).

Unfortunately, at the moment it is impossible to synchronize the JKV chronology with the four micro habitation phases that comprise the Early LBK period at Elsloo (cf. Van de Velde 1979). On the other hand, I am fairly confident that, despite the differences in the analytic techniques applied, one may equal the JKV habitation phases as defined by Van de Velde (Ch. 15) with the House Generations (HG) of the Rhineland, as they are based on the analysis of quite similar decorated pottery. Both phase JKV-E1 and House Generation I belong to the beginning of Modderman's (1970) phase Ib, JKV's generation E4 is situated somewhere during Modderman Ic, as are House Generations IV and V, with HG VI and VII representing Modderman Id, when JKV had been abandoned (cf. D. Mischka 2004, Abb. 9).

The overall number of flint artefacts at LW 8 is considerable: 9532 (Zimmermann 1988, Abb. 576), of which 7554 are assignable to dated features (D. Mischka 2004, Abb. 15). The amount of flint recovered at Langweiler 8 and the other settlements on the Aldenhovener Platte during the Early LBK (comprising the first seven House Generations), however, is so small as to preclude a meaningful comparison at the level of House Generations (Table 10.29). At best one may observe

Blades/blade tools	median width (mm)	median thickness (mm)	median surface (mm^2)
	18	5	90
Blade cores/hammerstones	median platform length (mm)	median platform width (mm)	median surface (mm^2)
	46	40	1955
Rejuvenation tablets	median length (mm)	median width (mm)	median surface (mm^2)
	61	47	3039

Table 10-28 Estimates of the average amounts of blades produced

JKV	E1	E2	E3	E4			
N	977	1360	1819	705			
% unmodified flakes	68.7	75.6	75.0	67.4			
LW8	I	II	III	IV	V	VI	VII
N	49	230	209	553	774	188	262
% unmodified flakes	59.1	61.7	67.5	62.0	64.2	64.9	64.5

Table 10-29 Comparison of the number of flint artefacts and of unmodified flakes at JKV and at LW8 (LW8 according to D. Mischka 2004)

that the percentage of unmodified flakes at JKV is consistently higher than that at Langweiler 8. Given the high percentage of unmodified flakes and of pieces with cortex, as well as a lower amount of unretouched blades and tools than is found at its neighbours, Langweiler 8 is often interpreted as having played a central role in the production and distribution of flint cores and blanks (Kegler-Graiewski and Zimmermann 2003; Zimmermann 1995, 2002). In this early period, however, the differences with the presumed consumer settlements of the Middle Merzbach valley are not really clear-cut. Obviously, it took time for Langweiler 8 to establish itself as a regional flint redistribution centre. Weisweiler 17 is also described as a flint producing central place (Kegler-Graiewksi and Zimmermann 2003; Zimmermann 2006). As this site provided only 214 datable flint artefacts (of which 126 belong to the Early LBK), it is difficult to assess this claim.

Therefore, the comparison had to be performed at a more general level, concentrating on JKV, Langweiler 8 and Elsloo, and looking at the Flomborn period as a whole. Of course, the data may not be used directly to infer differences in the ways flints were worked, without taking differences into account in excavation and sampling methods and in post-depositional processes. The three sites share two handicaps: firstly, the topsoil was removed mechanically, causing the loss of a considerable amount of mainly tools and blades, as witnessed by the excavation at Sittard. There the manually removed topsoil contained 55% of the tools, 56% of the cores and hammerstones, but only 37% of the waste flakes and blades (Modderman 1958/59: 113). Secondly, the pits' contents were not systematically sieved, resulting in the possible underrepresentation of smaller artefacts (Gronenborn 1997). Elsloo and Langweiler 8 were investigated during rescue excavations, often under extreme time stress (Zimmermann 1987: 636), whilst JKV, as a student training project, could be investigated in a (somewhat) more leisurely way. Moreover, the preservation at JKV is considered to be better than at the other sites (Louwe Kooijmans et al. 2003). Both at Elsloo (observation by the present author) and at Langweiler 8 (Zimmermann 1988: 635) only *c*. 3% of the unmodified flakes have a length under 15 mm, against 18% at JKV. The mean weight of unmodified flakes also differs: 5.8 g. (or 7.0 g when the chips are excluded) for JKV *vs*. 9.7 g. for Langweiler 8 (no data on weight are available for Elsloo). These differences, however, could also partly have to do with the intensity of flint working *per se*: where more preparation takes place, more chips and smallish flakes are produced. To neutralize the possible bias caused by JKV being more carefully excavated, its data will be presented with and without chips. Moreover, in view of the observations from the previous sections, data for both wards will be given as well (Table 10.30). From this data a number of observations may be derived:

- The percentage of unmodified flakes at both JKV and Elsloo is considerably higher than that at LW8. At JKV this holds true especially for the southwestern ward.
- The percentage of cores is lowest at JKV, and highest at Elsloo, with LW8 in an intermediate position.
- The ratio of flakes to cores at JKV is very much higher than at both LW8 and Elsloo, not only in the southwestern, but also in the northeastern ward.
- At JKV there are 14 blades and 11 tools for every core; at LW8 7.7 blades and 6.6 tools, and at Elsloo only 3.9 blades and 2.4 tools.
- At JKV seven (or six) flakes are present for every tool; at LW8 four and at Elsloo 10.5.
- At JKV there are 5.4 (or 4.4) flakes for every blade, at LW8 3.6 and at Elsloo 6.4.

	JKVE NE	JKVE SW	JKV Early	JKVEarly (no chips)	LW8 Early	Elsloo Early
% flakes	66.8	74.5	72.7	68.7	63.2	76.0
% cores/hammerst.	1.4	0.8	1.0	1.1	2.3	2.9
% blades/tools	29.2	22.7	24.2	27.8	32.8	18.9
N	1154	3712	4866	4241	1351	3515
Flakes: Cores	48.2	89.3	75.3	62.0	27.5	26.4
Blades: Cores	11.4	15.7	14.2	14.2	7.7	3.9
Tools: Cores	9.6	11.5	10.8	10.8	6.6	2.4
Flakes: Tools	5.0	7.8	7.0	5.7	4.2	10.5
Flakes: Blades	4.2	5.7	5.3	4.4	3.6	6.4

Table 10-30 Comparison of the intensity of flint working at JKV, Langweiler 8 and Elsloo during the Flomborn period. (Elsloo: De Grooth 1987; Langweiler 8: Zimmermann 1988, Abb. 596)

These observations may be interpreted in the following way:

– The three sites under consideration all have very high percentages of unmodified flakes, and thus would qualify as sites where flint has been worked locally. In terms of the models developed by Zimmerman (1995) to study exchange mechanisms on the Aldenhovener Platte, the difference in the percentage of unmodified flakes between JKV and Elsloo on the one hand and Langweiler 8 on the other hand, would indicate that the earlier stages of core reduction were better represented at the former settlements. In other words: some of the cores arriving at Langweiler 8 had been prepared elsewhere.
– As JKV and Elsloo both have a very high percentage of flakes, the low index of flakes to cores at Elsloo cannot be explained by assuming that core preparation was not performed locally. Therefore, I think that the Elsloo cores remained in the settlement, whilst part of the JKV cores were exported. Instead, Elsloo was an exporter of blades, witness its low ratio of blades plus tools to cores. This is corroborated by the high index of flakes to blades plus tools.
– If Langweiler 8 was a receiver of JKV cores, one would expect the flake:core index at this site to have been lower than that of Elsloo. The relatively high index can be understood however when taking into account that Langweiler 8 in its turn was an exporter of further reduced (and rejuvenated) cores (cf. Kegler-Graiewski and Zimmermann 2003). Moreover, if the blades missing at Elsloo were in part transferred to LW8, they help to account for the low ratio of flakes to blades and tools, and the high ratio of blades plus tools to cores.
– A nice corroboration of the idea that JKV exported part of its cores to Langweiler 8 is provided by the size of the core rejuvenation tablets (Table 10.31). Whereas the exhausted cores of JKV and Langweiler 8 have similar sizes, the tablets discarded at Langweiler 8 are considerably smaller, they have served to rejuvenate cores in a later stage of the reduction sequence. The data for the Aldenhovener Platte as a whole and for Hambach 8 (some 10 km to the north-east) confirm the trend, especially as they comprise material from both the Older and the Younger LBK (when cores tend to be larger).
– Both wards at JKV seem to have participated in the export of cores.

The debris recovered at the Banholt extraction site makes the pattern even more complicated, as it yielded not only exhausted blade cores but also quite a number of rejuvenation tablets (collected by the present author). Although the extraction activities here are undated, apart from large polyhedral blades cores such as published by Brounen and Peeters (2009/2001), that bring to mind the cores worked at Beek-Kerkeveld and other Younger LBK sites, smaller cores, closely resembling the JKV material are present as well. Therefore it seems plausible that during some of the time, some of the material was brought into some of the settlements under consideration in the shape of blades produced at the extraction site, as was the case in e.g. the Gäuboden area of southeastern Bavaria (De Grooth 2003a). Thus, although the three settlements were located at approximately the same distance from the extraction sites, they used different procurement strategies, and Langweiler 8 was in part dependent on cores and blades from the Graetheide settlements (Fig. 10.8).

At first sight, this variability in procurement and exchange strategies is surprising, as Bandkeramik long-distance exchange networks generally are thought to be based on long-standing, stable kinship ties that were carefully maintained from one generation to the next (e.g. Krahn-Schigiol 2005; Lech 2003). A general overview of Flomborn-period population dynamics may provide an explanation.

Radiocarbon and ceramic dates alike indicate that JKV was a 'first generation' settlement, as were Geleen-Kluis,

		JKV Early	LW 8 Early (I-VII)	Ald. Platte, general	Hambach 8
Tablets	N	31	8	163	48
	Mean L (mm)	60.8	54.3	56.2	52.0
	Mean W (mm)	47.7	38.5	41.9	37.8
Cores	N	44	18	628	28
	Mean L (mm)	53.7	51.8	56.8	50.6
	Mean W (mm)	44.9	41.2	43.7	34.9
	Mean Th	34.0	28.3	32.1	22.7

Table 10-31 Comparison of the size of rejuvenation tablets and exhausted cores (Ald. Platte & Hambach 8: Hohmeyer Taf. 54, 59; 71, 72. LW 8 Early: data made available by A. Zimmermann, Cologne)

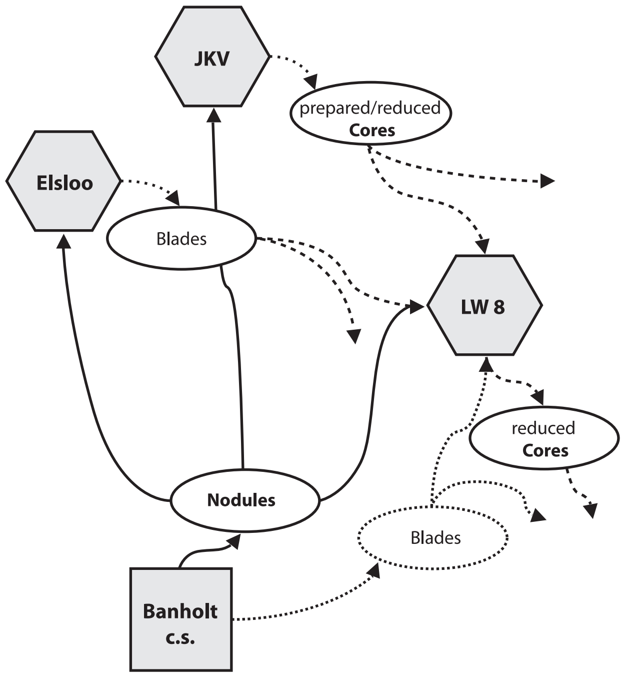

Fig. 10-8 Possible procurement and exchange strategies practised during the Early LBK in the Rhine-Meuse area.
Thick continuous line: direct procurement of nodules. Thick dotted line: transport in the framework of down-the-line exchange.
Thin dotted line: transport after direct procurement and production of blanks at extraction sites.

House generation	N settlements	N Houses
I	1	4
II	7	14
III	8	20
IV	9	23
V	8	24
VI	9	26
VII	9	29

Table 10-32 Summary of Early LBK settlement dynamics along the middle Merzbachvalley and its surroundings during the Flomborn period (after Münch 2005)

Sittard, Elsloo and Stein. In other words, inhabitation west of the river Rhine was not a gradual, tentative step-by-step process, but started with a great leap westward, followed by filling-in of the areas in between during the next generations. Several sites in this Hinterland were settled in the same early stage as well, the best-studied being Langweiler 8 on the Aldenhovener Platte. Münch's (1999, 2005; cf. Mischka 2004; Zimmermann 2002) recent re-analysis of this area's decorated ceramics enabled her to give an exemplary insight into the dynamics of settling in the seven house generations of the Flomborn period for this settlement and its neighbourhood, comprising an area of some 25 square kilometres. Inhabitation began at Langweiler 8, with four contemporary houses. In the next generation, not only did the number of houses there increase to 7, but at least six new settlements started, mostly inhabited by a single household. In the next house generations, some of these too grew in size, others remained single farmsteads, or were abandoned. In the last Flomborn generation, almost 30 houses are known to have been inhabited (Table 10.32). Similar dynamics are documented for other parts of the Rhineland (Zimmermann et al. 2004; Claßen 2006), even Erkelenz-Kückhoven, located some 23 km to the north on the northern fringe of the Rhenish loess area, was first settled in House Generation III (Lehmann 2004). At all of these sites, Lanaye flints, in part definitely of the Banholt variety, played an important role.

Given the fact that all settlements under consideration were located within one day's walking distance from the extraction sites, and could acquire alternative raw material of reasonable quality in local river gravels (Weiner 1997), there was no intrinsic need for the establishment of the exchange routines that were shown to exist between JKV (and other early Graetheide settlements) and the Rhenish settlements. On the contrary, the major incentive to maintain alliances with eastern neighbours and kin may have been the western settlers' need of a continuous supply of amphibolite and basalt adzes.

On the one hand, the pioneer situation outlined above would induce people to cherish and maintain kinship ties. On the other hand, this was a time of immense change in settlement and habitation, where one could not depend on traditional, fixed exchange networks alone, but had to be flexible and opportunistic. Yesteryear's trusted exchange partner and his family today may have moved on, or may be bound by obligations to other relations. In such an unstable situation, differentiated procurement and exchange strategies were called for, even on a micro-regional scale. Therefore, the fluctuations in the export of flint found at JKV, in my view are perfectly compatible with the alternation of expansion and consolidation and the multiple networks visible in the Rhineland.

Notes

1 Although this study demonstrated that it is possible to attribute artefacts encountered in a settlement context to specific extraction sites, especially at the assemblage level, a cautionary note should be added: Given the often ephemeral character of the differences described, it seems highly advisable not to rely solely on the descriptions offered in this study, or even on photographs, but to consult the well-documented reference collections established at the archaeological centres in Leiden, Maastricht, Leuven and Cologne.

2 These figures differ from De Grooth 2003b, where it was stated that equal amounts of flints were retrieved at both wards. This discrepancy is caused by the fact that several flint-rich southern pits from the1990 excavation could not be considered at the time of the initial analysis as the relationship between find numbers and features was insufficiently clear.

3 Again, this observation differs from De Grooth 2003b because after Van de Velde's new ceramic analysis presented in this volume, the flint-rich northern pit 48021, belonging to house 39 is now dated to the Younger LBK.

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