Appendix: Overview of geological outcrops, extraction sites and flint types

A.1. Flint types from the western part of the study area

A.1.1. Zeven Wegen

A.1.2. Lixhe

A.1.3. Lanaye
A.1.3.1. Lanaye: seam 10
A.1.3.2. Lanaye: other seams
A.1.3.3. Lanaye: extraction of primary deposits
A.1.3.4. Lanaye: extraction of slope deposits
A.1.3.5. Lanaye: extraction of eluvial deposits
A.1.3.5.1. Rullen and Sint Pietersvoeren
A.1.3.5.2. Banholt
A.1.3.5.3. Hoogbos
A.1.3.5.4. Rodebos
A.1.3. 6. Lanaye: extraction of river gravels

A.1.4. Emael

A.2. Flint types from the eastern part of the study area

The geological descriptions are mainly based on FELDER/BOSCH (2000). Fuller decriptions of mines and extractions sites in the study area are offered by FELDER (1998). Additional information may be found in the Bochum Flint Mining Catalogue (WEISGERBER ET AL. 1980/1999), its Appendix (KOBILINSKI/LECH 1995), in GAYCK (2000), and at http://www.Flintsource.net.
Coordinates for sites in the study area are given in the official Dutch grid system, Rijksdriehoekmeting (RD) that is also used on the Dutch geological maps referred to in this study (RIJKS GEOLOGISCHE DIENST 1984; 1988; 1989).

A.1 Flint types from the western part of the study area

A.1.1. Zeven Wegen
Late Campanian, Gulpen Formation (FELDER/BOSCH 2000)

The occurrence of this member is limited to the southern part of the chalk area. Our geological sample was collected in the C.B.R. chalk quarry at Lixhe (B; NITG outcrop 61H-19; FELDER/BOSCH 2000, 116; coordinates 174.000/307.500). No extraction sites are known, but the material may have been exposed in erosional slopes of the river Geul valley, that nowadays are covered by colluvium (DE MOOR 2006). It was probably worked extensively in a Late Mesolithic site at Mesch-Steenberg (Eijsden NL). Interpreting this assemblage is not altogether unproblematic (DE GROOTH 2008). In the original publication (DE WARRIMONT/ WOUTERS 1981), A. Wouters assigned a northern, erratic origin to the flints (and thus suggested the presence or influence of northern Mesolithic traditions in the southern parts of the Netherlands). Meanwhile, this attribution had been revised to Zeven Wegen flint, thought to have been collected from a secondary depositional context in the slopes of the river Voer valley (DE WARRIMONT pers. comm. November 2007).
Artefacts made of this type of flint occasionally are found in Neolithic settlements as well (e.g. at the LBK settlement of Geleen-Janskamperveld; DE GROOTH 2007).

Characteristics (**Fig. 9**)
Shape: nodules.
Size: small.
Cortex: sometimes rough, sometimes smooth, very thin (under 1 mm) and whitish; abrupt transition to the flint.
Primary colour: homogeneous, very dark grey to black.
Texture: homogeneous, vitreous; sometimes described as greasy and velvety.
Lustre: shiny.
Translucency: medium.
Inclusions: There are few different kinds of inclusions present, occurring in low density: concentrations of light specks; small and medium-sized light spots, texture equal to that of the matrix, sometimes with a light rim and a darker centre; and very rarely medium-sized or large ovoid spots that are rougher to the touch than the matrix. Dark inclusions are absent. Instead, isolated red specks (smaller than 1 mm) and small spots appear occasionally.
Diversity of inclusions: low.

A.1.2. Lixhe
Early Maastrichtian, Gulpen Formation (FELDER/BOSCH 2000)

The Lixhe member is subdivided into three parts, each containing dozens of flint seams. With the exception of two seams in the Lixhe 3 member, the nodules in most of them are so small and irregular as to be unsuitable for human use. Our sample was collected at a geological outcrop on the eastern slopes of the Gulperberg (Gulpen-Wittem, NL; coordinates 191.200/313.500).
Prehistoric flakes of Lixhe 3 material occur on The Kaap –the southernmost part of the Rijckholt/St. Geertruid extraction area–, indicating that material has been extracted from outcrops exposed in the slopes (FELDER 1998). Other small extraction sites, probably dating to the Mesolithic, are known close to outcrops in the slopes of the Geul valley, at Gulpen and Wijlre (FELDER/ FELDER 1998). Moreover, several artefacts made of Lixhe flints from an eluvial context were collected at the Neolithic extraction sites of Banholt, Hoogbos and Rodebos (see below), where most of the material is of Lanaye origin. Some artefacts strongly resembling Lixhe (or nodular Orsbach, cf. A.2.3) material, rather surprisingly, were recognized recently by D. Schimmelpfenning and the present author in the LBK assemblage of Herxheim (Landau/Pfalz, south-western Germany).

Characteristics (**Fig. 10**)
Shape: the nodules comprised in the Lixhe 1 and 2 members are small and very irregular in shape, the Lixhe 3 material is larger and more regular.
Size: small.
Cortex: rough, thick (2-3 mm), off-white or brownish, often with a white zone underneath it. As the cortex is irregular with cavities and protuberances, this white zone penetrates deeply into the nodules, leaving white, often chalky inclusions.
Primary colour: homogeneous, black to very dark grey.
Texture: mostly homogeneous, vitreous. Very rarely some fine-grained patches are present.
Lustre: shiny to medium.
Translucency: low or opaque.
Inclusions: most conspicuous are middle-sized and large bright white ‘chalky’ spots on fracture planes that originally were located close to the cortex, remains of the deeply penetrating white zone under the irregular cortex; in addition: concentrations of small light grey spots; isolated diffuse light flecks; ringed spots with a smooth whitish outer ring and a smooth or rough darker centre. Incompletely silicified fossils may be present as well. Black or dark grey specks, spots or wisps are absent.
Diversity of inclusions: medium.

A.1.3. Lanaye
Early Maastrichtian, Gulpen Formation (FELDER/BOSCH 2000)
The western part of the Lanaye member contains 23 different seams of flint (numbered from bottom to top). The descriptions are based on geological samples from the ENCI quarry (Maastricht, NL; NITG outcrop 61F-19; FELDER/ BOSCH 2000, 103; coordinates 175.000/314.500), from recent flint exploitation sites near Eben Emael (Bassenge, B), and on archaeological material collected at the extraction sites mentioned below.
Of all flint types in the region, Lanaye flint was the most widely used, circulating over a vast area (cf. WILLMS 1982; DE GROOTH 1991;1997; ZIMMERMANN 1995). The material displays a large variability, both between nodules and within single nodules. Moreover, Lanaye flints deriving from all the depositional contexts mentioned above, have been systematically exploited during the Neolithic. To provide a basis for attempts at detailed sourcing, an extensive discussion of attributes characteristic for these different depositional contexts is called for.

A.1.3.1. Lanaye seam 10
This seam comprises the largest amount of usable flint, and was most widely exploited. It was the main seam worked at the Rijckholt-Sint Geertruid flint mines.

Characteristics (**Fig. 11-14**)
Shape: nodular.
Size: large.
Cortex: thin (1 mm), rough and whitish. Natural fracture planes often are covered with iron incrustations.
Primary colour: inhomogeneous, varying from very dark to very light grey, both sometimes with a suspicion of blue. The lighter grey parts often contain areas with concentric laminations, with gradual transitions between lighter and darker greys. Sometimes the zone directly under the cortex is the darkest.
Texture: fine-grained, sometimes gradual transitions to more granular parts; sometimes a more vitreous texture directly under the cortex.
Lustre: matt.
Translucency: low to medium; 70% of the sample measured had a translucency under 5 mm.
Inclusions:
- concentrations of black round specks (< 1mm); small and medium-sized (between 1 and 10 mm) black or very dark grey round, ovoid or sickle-shaped spots; dark wisps/tendrils;
- concentrations of light (white or light grey) round specks (<1mm); isolated small (1–3) and medium-sized (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 of rough darker centre;
- medium-sized and large (>10 mm) spots, round or irregular, abrupt border, light grey of whitish, rougher to the touch than the matrix;
- large, vague lighter grey flecks;
- small angular cavities.

Diversity of inclusions: high.

A.1.3.2. Other Lanaye seams
The flints from the other seams within the Lanaye member for the most part have the same characteristics, as regards colour, texture, lustre, translucency and the presence of both dark and light spots and specks.
Marked differences are:
Seam 01

Cortex: thick (2-3 mm), irregular, with cavities and protuberances; inclusions: dense concentrations of small light spots.
Seam 02A
Cortex: thick (2-3 mm); inclusions: seemingly interpenetrating (overlapping) inclusions; incompletely silicified fossils.
Seam 12A
Cortex: very thin (under 1 mm after washing off an adhering soft chalky crust); colour: abrupt transitions in colour in the laminated zones.
Seams 20-22
Cortex: very thin (under 1 mm); colour: abrupt transitions in colour in the laminated zones.

A.1.3.3. Lanaye: extraction of primary deposits
Primary deposits of Western Lanaye flints have been exploited in the well-known mines situated between Rijckholt and Sint-Geertruid (mun. Eijsden and Margraten NL; WEISGERBER ET AL. (1980): NL 1; FELDER 1998: Nr. 2; GAYCK 2000: Nr. 48; coordinates 180.200/311.700.). The site was discovered in 1881 by the Belgian prehistorian Marcel de Puydt. From1964 to 1972, the 'Prehistoric Flint Mines Working Group' of the Dutch Geological Society, Limburg Section carried out excavations, proceeding from a tunnel, almost 150 m long, which was driven right across the mining area. On either side the prehistoric galleries were examined over a width of 10 metres. A total of 75 shafts and 1,526 square metres of galleries were encountered and examined. The underground mining area extended over c. 8 hectares, flint was extracted by other methods from c. 12 hectares, while the region with prehistoric knapping debris measures almost 25 hectares. Radiocarbon dating of charcoal found in underground shafts and galleries yielded an age range of 3,970-3,700 cal BC, but mining activities probably continued till 3,400 cal BC or even 2,650 cal. BC (FELDER ET AL. 1998; RADEMAKERS 1998). Extraction focused on layer 10, although it may be assumed that flint layers 1-3 were exploited in open cast mines, and layers 4, 5 and 6 were worked in open mines as well as underground (FELDER ET AL. 1998; FELDER/FELDER 1998).

Characteristics
The material is identical to that of the geological samples of Lanaye layer 10.

A.1.3.4. Lanaye: extraction of slope deposits
Slope deposits containing western Lanaye flints have been exploited in the vicinity of the Rijckholt mines, as has been shown by the excavations in the Schone Grub, a dry valley in the north-western part of the prehistoric mining area, by e.g. Hamal-Nandrin, the French Dominican friars and Van Giffen in the late nineteenth and early twentieth century (RADEMAKERS 1998; FELDER ET AL. 1998). 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). Although most of the extracted material originally derived from layer 10, small quantities of flints from the other seams have been worked as well (FELDER ET AL 1998, 11-12).

Characteristics
Flints from slope deposits differ from the material in primary context only as regards a slight weathering of the cortex and other natural surfaces.

A.1.3.5. Lanaye: extraction of eluvial deposits
A number of extraction sites in areas with eluvial deposits of Lanaye flints are known as well (cf. FELDER 1998).

A.1.3.5.1. Rullen and Sint Pietersvoeren The best known of these eluvial extraction sites are located at Rullen (FELDER 1998 Nr. 3; coordinates 185.670/303.470) and Sint Pietersvoeren (Vrouwenbos, or Bois communal: FELDER 1998 Nr. 4, coordinates 186.250/304.500; Sparrenbos or Bois des Sapins: FELDER 1998 Nr. 6, coordinates 186.720/304.220) in the

municipality of Voeren (B). They are summarized under the heading Aubel in WEISGERBER ET AL. (1980) under B9, and in GAYCK (2000) under Nr. 48.
Here, the eluvial clays 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, enormous 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 ca. 300 cm and a reconstructed diameter of 7,20 m, were found (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 (Early Neolithic A and B according to the Dutch chronological system; Early and Middle Neolithic in terms of the German chronology), 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/SCHÖN IN PRESS). Even at the Rössen settlement Maastricht-Randwyck, located in the Maas valley, only some 4-6 kilometres to the north-west of Rijckholt, almost 50% of the flints are of the Rullen type (LOUWE KOOIJMANS 1988; OUDE RENGERINK 1991). In (sub)recent times flints mined in the area of prehistoric exploitation, were used in paving field roads.

Characteristics (**Fig. 15-17**)

Shape: identical to geological sample of Lanaye 10 flint.
Size: identical to geological sample of Lanaye 10 flint.
Cortex: mostly brown, rarely white; sometimes rough, sometimes smooth; mostly thin (1 mm), but sometimes thick (2-10 mm).
Primary colour: identical to geological sample of Lanaye 10 flint.
Texture: identical to geological sample of Lanaye 10 flint.
Lustre: identical to geological sample of Lanaye 10 flint.
Translucency: medium to very high.
Inclusions: all inclusions present in geological sample of Lanaye 10 flint; additionally, concentrations of light specks (<1 mm) the size of a pin's head and concentrations of small light spots (as found in flints from Lanaye layer 01) are common, whilst the abrupt transitions in colour and sharply defined concentric laminations, characteristic for Lanaye 12A and 20-22, occur as well.
Diversity of inclusions: identical to geological sample of Lanaye 10 flint
Post-genetic alterations: infiltration of the iron compounds present in the matrix led to a yellowish-brown discoloration. Frequently this is manifested only as brown streaks, although some specimens are coloured throughout. In other cases, saturated reddish- or yellowish-brown colours are limited to the outer part of the nodules, whilst the rest of the piece is grey, with just a suggestion of brown, yellow or orange. The grey flints often have a 'bleached' aspect, possibly as a result of the dissolution of the carbonates that are present in large amounts in primary Lanaye material (cf. MACDONNELL ET AL. 1997). This bleaching sometimes affected the dark inclusions as well. GIOT ET AL. (1986) describe the same loss of carbonates for flints from Le Grand-Pressigny, where it resulted in an notable improvement of knapping quality. The fracture planes mostly have a 'dusty' aspect, probably because bleaching has made the presence of dense concentrations of minuscule vermiculate spots visible. Often a thick, white layer is present under the cortex, especially in material from the Sint Pietersvoeren (Vrouwenbos and Sparrenbos) sites.

A.1.3.5.2. Banholt

This site (Margraten NL; FELDER 1998 Nr. 11, coordinates 183.950/311.375), discovered in 1937, is 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). BROUNEN/PEETERS (2000/2001) have presented plausible evidence for (open-cast) mining and knapping activities at this site during Early Neolithic, more specifically Bandkeramik times. Subsequently, it was shown that Banholt flints were worked extensively at the Early LBK settlement of Geleen-Janskamperveld (DE GROOTH 2007). Part of the prehistoric exploitation area has been destroyed in (sub)recent times through mining and quarrying activities. The resulting pits have been filled-in with rubbish.

Characteristics (**Fig. 18, 19**)
Shape: identical to geological samples of Lanaye 10 flint.
Size: identical to geological samples of Lanaye 10 flint.
Cortex: rough, thin (1 mm), brown or grey.
Primary colour: identical to geological samples of Lanaye 10 flint.
Texture: identical to geological samples of Lanaye 10 flint.
Lustre: identical to geological samples of Lanaye 10 flint.
Translucency: medium to high.
Inclusions: identical to geological samples of Lanaye 10 flint; but in addition concentrations of light specks (<1 mm) are common.
Post-genetic alterations: Frequently a reddish brown, vitreous zone below the cortex is present, and a thick white layer may occur as well; brown or yellowish streaks are common, the dusty appearance typical for Rullen flints was found on only one specimen of the sample.

A.1.3.5.3. Hoogbos
This extraction site, located between Mheer and 's Gravenvoeren (Margraten NL and Voeren, B: FELDER 1998 Nr. 5, coordinates 182.650/309.500), discovered in 1908, was subjected to preliminary investigations by Hamal-Nandrin and Louis (LOUIS 1936). The flints are embedded in residual loams. 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.

Characteristics
Shape: identical to geological samples of Lanaye10 flint.
Size: identical to geological samples of Lanaye 10 flint.
Cortex: rough, thin (1 mm) and brownish.
Primary colour: identical to geological samples of Lanaye 10 flint.
Texture: identical to geological samples of Lanaye 10 flint.
Lustre: identical to geological samples of Lanaye 10 flint.
Translucency: identical to geological samples of Lanaye 10 flint.
Inclusions: identical to geological samples of Lanaye 10 flint; some concentrations of small light spots occur.
Post-genetic alterations: Yellowish streaks are occasionally present. Opaque reddish brown and white zones are very rare.

A.1.3.5.4. Rodebos
This little-known extraction site, close to Remersdaal (Voeren B: FELDER 1998 Nr. 7, coordinates 188.550/303.570), discovered in 1919, also was only subjected to preliminary investigation by Hamal-Nandrin and Servais (HAMAL-NANDRIN/SERVAIS 1922). The site is undated and the character of the mining activities unknown. A macrolithic retouched blade (*Spitzklinge)* found at Spaubeek (Beek NL), highly resembling some of the Rodebos specimens, indicates, however, that part of the exploitation took place during the Dutch Middle Neolithic (cf. BROUNEN/VROMEN 2005).The geological situation is identical to that at

Rullen; i.e. residual loams mixed with Oligocene sands. Most of this extraction area, too, has been destroyed in (sub)recent times by the mining of flints used to pave field roads.

Characteristics (**Fig. 20**)
Shape: identical to geological sample of Lanaye 10 flint.
Size: identical to geological sample of Lanaye 10 flint.
Cortex: mostly thin (1 mm), rough and of variable colour (whitish, grey or brown).
Primary colour: identical to geological sample of Lanaye 10 flint.
Texture: identical to geological sample of Lanaye 10 flint.
Lustre: shiny.
Translucency: very high, almost 60% of the sample belong to class 4 and 5.
Inclusions: identical to geological sample of Lanaye 10 flint; small white specks are rare. One specimen possessed isolated red specks, which might indicate that this extraction point contains some flints from the Zeven Wegen member as well.
Post-genetic alterations: frequent presence of a reddish brown vitreous and more translucent zone under the cortex. Sometimes a thick white zone occurs as well. Yellowish streaks and fracture planes with a dusty aspect are rare.

A.1.3. 6. Lanaye: extraction of river gravels
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). Although the flints were originally transported by the river Meuse, they may also be found in Rhine deposits, because during the Pleistocene Rhine and Meuse repeatedly changed their course and thus alternately cut into each other's deposits (BERENDSEN 2004).

Characteristics
Lanaye flints collected from river gravels may be identified as such only when part of the cortex is present. The river transport ultimately led to a heavy abrasion of the cortex, and to a decrease in size of the flints. Natural fracture surfaces may carry a glossy patina and occur more frequently than in samples from a primary and eluvial context (ZIMMERMANN 1988; WEINER 1997). According to these authors, interior colours may be somewhat lighter than those on fresh material, but that phenomenon is found on flints embedded in residual loams as well. It should be noted, moreover, that flints transported only over shortish distances, still may possess a seemingly unweathered rough cortex.

A.1.4. Emael
Late Maastrichtian, Maastricht Formation (FELDER/BOSCH 2000)

The deposits on top of the Lanaye Member belong to the Maastricht Formation. Two of them, the Emael Member and the Schiepersberg Member, contain what archaeologists know as Valkenburg flint. To date, prehistoric extraction is only known for the Emael member, not only in open-cast or shallow bell-shaped pits, but also in deep-shaft mines. Based on the presence of knapping waste close to raw material outcrops, FELDER (1998) listed some 24 possible extraction sites, located on the upper valley slopes of the river Maas and Geul, and of deep dry valleys that run into these river valleys from the loess plateau. Only a few of them have been systematically investigated, however: Biebos 2 (Valkenburg a.d. Geul, NL; FELDER 1998 Nr. 21; KOBYLINSKI/LECH 1995: NL3; GAYCK 2000: Nr. 47; coordinates 186.500/318.400) – with open pits and an shallow shaft and gallery mine–, and Plenkertstraat (Valkenburg a.d. Geul NL, FELDER1998: Nr 33; KOBYLINSKI/LECH 1995: NL3;GAYCK 2000: Nr. 47; coordinates 185.700/319.520) where several deep shaft-and-gallery mines were excavated (BROUNEN/PLOEGAERT 1992; BROUNEN 1995). Although Emael flints were already used in small quantities during the Early Neolithic LBK –period, systematic extraction probably started during the younger phases of the Michelsberg Culture and had its maximum intensity at the time of the Wartberg/Stein/Vlaardingen Complex. This notion is

supported by the available Radiocarbon dates, that lay between c. 3500 and c. 2600 cal. BC. (BROUNEN/PLOEGAERT 1992).
The geological samples described in this study were collected in the 't Rooth quarry (Margraten NL; NITG outcrop 62A-7, FELDER/BOSCH 2000, 106; coordinates 182.750/316.300;) and near the Plenkertstraat site at Valkenburg (FELDER 1998 Nr. 33, coordinates 185.700/319.520). The archaeological material originates from the Keerderbos and Schiepersberg extraction sites (Cadier en Keer, Margraten NL ;FELDER 1998, Nr. 8 and Nr 17, coordinates 181.300/314.910 and 182.800/315.700), and the Schaelsberg and Biebos sites in Valkenburg a.d. Geul (FELDER 1998 Nrs.12 and 20-23; coordinates 187.500/319.200; 180.600/318.400).

Characteristics (**Fig. 21-24**)
Shape: nodules, tablets and pipes.
Size: large.
Cortex: rough, very thin to thick (under 1 – 3 mm), brown, or grey, rarely irregular; rarely a white zone is visible under the cortex.
Colour: inhomogeneous, varying between brownish grey and dark grey and light grey; different colours usually occur within individual nodules, with gradual transitions. Occasionally, concentric zonations are present.
Texture: inhomogeneous; mainly coarse-grained, although the zone directly under the cortex may look smoother; the lighter the colour of the material, the more coarse-grained it is.
Lustre: matt.
Translucency: although the material used to be described as 'completely opaque' (e.g. DE GROOTH 1987; BROUNEN 1995), many unweathered pieces examined for this study show a medium and even high translucency.
Inclusions: isolated small light spots, but also medium-sized and large ones, with and without a dark centre are common; dark specks, spots and wisps are absent. The inclusions often seem to be arranged in horizontal planes.
Diversity of inclusions: medium.

Comments
KARS ET AL. (1990) found that Emael flints often contained nearly equal amounts of carbonate and silica. A feature of this flint type is that most of the original carbonate grains are covered by neomorphic calcite crystals. Artefacts made of Emael flint often look very granular. This may be due to a high porosity of the material, which also causes it to weather quite easily. During this process most of the silica dissolves, resulting artificial surfaces that are very rough to the touch (sandpapery). Dirt particles subsequently easily get stuck in the pores, giving the artefacts a splodgy and pitted aspect.

A.2. Flint types from the eastern part of the study area

A.2.1. Lousberg
Maastrichtian, eastern Lanaye facies, Gulpen Formation (FELDER/BOSCH 2000) or Vetschau Member, Maastricht Formation (HISS 2006B)

Opinions differ on the lithostratigraphical unit containing flints of the Lousberg type. Some authors (HISS 2006B; LÖHR ET AL. 1977; WEINER 1997) consider these flints to originate from the Vetschau Member, and consequently from the Kunrader facies of the Maastricht Formation. Others (FELDER/BOSCH 2000; FELDER/FELDER 1998; FLOSS 1994) assign them to the eastern facies of the Lanaye Member of the Gulpen Formation.
This best known and most characteristic of the eastern flints crop out on the Lousberg in Aix-la-Chapelle (Aachen, D; WEISGERBER ET AL. 1980 D1; FELDER 1998 Nr. 1, GAYCK 2000: Nr. 50; coordinates 204.000/310.800), where they have been exploited by open cast mining to such extent that only very few flints still remain in situ (WEINER/WEISGERBER 1980; WEINER 1984). This extraction mainly took place at the time of the late Michelsberg Culture and the

subsequent Wartberg/Stein/Vlaardingen Complex (BROUNEN/PLOEGAERT 1992; WEINER 1997).

Characteristics (**Fig. 25, 26**)
Shape: tabular.
Size: small; thickness up to 8 cm.
Cortex: brown, rarely greyish; rough and thick (2-11+mm), sometimes with cavities and protuberances.
Colour: brownish or bluish grey; many specimens carry a vague parallel lamination throughout.
Texture: homogeneous, fine-grained.
Lustre: medium to matt.
Translucency: medium.
Inclusions: there are few different kinds of inclusions, present in low frequencies; small and medium-sized light spots, sometimes with a light rim and a darker centre are common, oblong medium-sized spots occur as well. They do not differ in texture from the matrix. Dark specks, medium-sized spots and wisps are absent, but occasionally isolated small dark spots are found.
Diversity of inclusions: low.
Post-genetic alterations: Most (but not all!) specimens we collected have an opaque, 'chocolate brown' to purplish infiltration zone under the cortex, varying in thickness from just a few mm to several cm and sometimes penetrating the whole tablet.

Comments
According to LÖHR ET AL. (1977) flints of the Lousberg type also were found (in small numbers) on the slopes of the Schneeberg, where they occur above outcropping Vetschau flints. The tabular flints I collected on the Schneeberg and on the upper slopes of the Wilkensberg, however, were of the nodular and tabular Orsbach variety (cf. A.2..3).

A.2.2. Vetschau
Maastrichtian, Maastricht Formation (HISS 2006B)

The Vetschau Member belongs to the Maastricht Formation, and is thought to correspond either to the Emael Member (FLOSS 1994) or, more generally, to the Kunrader facies (HISS 2006B; FELDER/BOSCH 2000; LÖHR ET AL. 1977; WEINER 1997).
Vetschau type flints were collected on the southern slopes of the Vetschauerberg (D, near Laurensberg; coordinates 201.100/312.600) and on the lower slopes of the Wilkensberg (D, to the east of Seffent; coordinates 201.400/311.200), both situated to the north-west of Aachen. No extraction sites are known, but the material was used during the Mesolithic (Arora 1979) and the Early Neolithic (e.g. LÖHR ET AL. 1977; ZIMMERMANN 1988;1995; GRONENBORN 1997).

Characteristics (**Fig. 27, 28**)
Shape: tablets, nodules.
Size: small.
Cortex: thick (2-5+mm), rough and whitish, with deep cavities and protuberances (especially on the nodules) and a thick white zone underneath it.
Colour: greyish brown, sometimes black core; the tabular variety often is finely and vaguely laminated, whilst the nodular material displays vague transitions in colour, with lighter and darker wisps (*Schlieren*).
Texture: coarse-grained.
Lustre: matt to medium.
Translucency: medium to high (although even slightly weathered material looks completely opaque!).

Inclusions: medium sized white spots with a chalky aspect, often rough to the touch; isolated small light spots, sometimes with a dark core and lighter rim; and elongated medium-sized spots. Only one specimen carried isolated dark specks.
Diversity of inclusions: low.
Post-genetic alterations: One specimen, a nodule collected on the Wilkensberg, had an opaque brown infiltration zone under the cortex (that became visible only after a fresh surface was produced).

A.2.3. Orsbach
Maastrichtian, Gulpen Formation, (HISS 2006a)

The Orsbach Member belongs to the Gulpen Formation and is thought to correspond to the Lixhe and Lanaye Members (HISS 2006a; FELDER/BOSCH 2000), or specifically to the Lixhe Member (FLOSS 1994). Flints of the Orsbach type crop out on the southern slopes of the Schneeberg (D, between Orsbach and Seffent, coordinates 201.100/310.200), as well as on the upper slopes of the Wilkensberg (D, to the east of Seffent, coordinates 201.400/311.200). No prehistoric extraction sites are known, but the material was used from the Magdalenian onwards (RENSINK1992), and FELDER/FELDER (1998) report a small, possibly Mesolithic knapping site in the vicinity of Orsbach. Neolithic use has still to be established (but recently some material resembling Orsbach or Lixhe flints have been recognised in the LBK assemblage of Herxheim near Landau in South-western Germany). The material occurs both as nodules and tablets. As they display different characteristics, they will be described separately.

A.2.3.1. Orsbach nodules

Characteristics (**Fig. 29**)
Shape: nodules.
Size: small.
Cortex: rough, white to greyish in colour, of varying thickness (1-10+mm), often showing cavities and protuberances and carrying a thick white zone underneath.
Colour: black to very dark grey, homogeneous (no laminations).
Texture: homogeneous, vitreous
Lustre: shiny .
Translucency: low to medium.
Inclusions: Most conspicuous are medium-sized and large white ovoid spots with a chalky aspect but smooth to the touch (remains of the deeply penetrating white zone under the irregular cortex); small light spots may occur isolated or in concentrations.
Diversity of inclusions: low.

A .2.3.2. Orsbach tablets

Characteristics (**Fig. 30**)
Shape: tablets.
Size: small.
Cortex: rough, white to beige in colour, of varying thickness (1-10+mm), rarely showing cavities and protuberances.
Colour: black to very dark grey, homogeneous (no laminations).
Texture: homogeneous, fine-grained.
Lustre: medium.
Translucency: low to medium.
Inclusions: very few, most conspicuous are small light spots occurring isolated or in concentrations. Small dark spots occur occasionally too.
Diversity of inclusions: low.

Post-genetic alterations: on the tablets a brownish to purplish infiltration zone, resembling that found on most flints of the Lousberg type, may be present.

A.2.4. Simpelveld
Maastrichtian, probably Eastern Lanaye Member, Gulpen Formation (FELDER/BOSCH 2000)

This type of raw material is named for the knapping site where it was first recognized by J.H.G. Franzen in the nineteen-eighties (FRANZEN 1986; ARORA/FRANZEN 1987).
This flint is thought to originate from the Eastern facies of the Lanaye Member (FELDER/FELDER 1998; FELDER/BOSCH 2000), or from the Kunrader facies of the Maastricht Formation (ARORA/FRANZEN 1987). Outcrops are located at Overeys (NL), in the valley slopes of the Eyserbeek, between Eys-Wittem and Simpelveld (FELDER 1998 Nr. 30; coordinates c. 195.5/315.5). During a field trip in April 2007 the Flintsource-team and the present author discovered some fifteen artefacts in the slope of a dry-valley next to the Vogelzang farm at Overeys (coordinates 195.250/315.500). The small assemblage suggests the presence of an extraction site at this location, as the single core (for bladelets) and four of the flakes were clearly patinated, and thus result from prehistoric knapping activities. At the Simpelveld-Bahneheide (NL) knapping site, characteristic flakes document the production of oval axes during the Middle Neolithic (FRANZEN 1986). Unworked raw material also was found by Mr. L. Blezer some 5 km tot the north of Simpelveld, west of the Bergerweg between Ubachsberg and Kunrade (Voerendaal NL coordinates 193.450/320.000; BROUNEN, oral communication 2005). In the heaps of stones dumped by farmers at the edge of these fields I recently found other flint types as well, indicating that this material stems from a secondary depositional position.

Characteristics (**Fig. 31-33**)
Shape: tablets.
Size: small to large.
Cortex: mostly white, sometimes brown, rarely grey; rough and thick (2-20+mm), sometimes deep cavities and protuberances and a white zone underneath.
Colour: dark grey, either with fine laminations or vague transitions; visibility of the lamination is better when pieces are weathered (or moistened).
Texture: fine-grained, homogeneous.
Lustre: medium.
Translucency: medium.
Inclusions: small light spots occur both isolated and in concentrations; medium sized spots may be smooth or rougher than the matrix, and sometimes possess a darker core. Large spots (smooth and rough) are found occasionally as well. Although dark specks (< 1mm) are frequent, dark spots and wisps are absent.
Diversity of inclusions: medium.
Post-genetic alterations: the sample we collected at the Baneheide knapping site contained some artefacts with reddish brown infiltration zones.

Comments
Even slightly weathered pieces, such as found at the Simpelveld-Bahneheide knapping sites, may seem coarse-grained, matt and opaque, with a pronounced lamination. As befits its position as a knapping site located close to a number of outcrops and extraction points, the material discarded at Simpelveld-Baneheide is divers in character. Although the majority of the artefacts in our reference collection are of the Simpelveld type as characterized by Franzen and Arora, we encountered artefacts closely resembling the materials found at the Lousberg, the Schneeberg and the Vetschauerberg as well.

A.3. Related flint types from outside the study area

A.3.1. Silex à grain fin de Hesbaye

Late Campanian, Nouvelles Formation? (cf. ROBASZYNSKI ET AL. 2001; ALLARD 2005)

Geological samples were collected at Avennes – where mine shafts were discovered during construction of a railroad in the nineteenth century (WEISGERBER ET AL. 1980: B11; GAYCK 2000: Nr. 43)–, in the cutting of the former railroad track and on adjacent fields; and at Verlaine, in fields close to the Bandkeramik site of "Petit Paradis" (ALLARD 2005). In addition, some artefacts from the LBK sites of Dommartin and Vaux-et-Borset were studied. Our geological samples originate from residual loams (cf. ALLARD 2005), but material from a primary context was used at the LBK settlement of Vaux-et-Borset (CASPAR/BURNEZ-LANOTTE 1994; 2006), whilst at the Bandkeramik sites of Liège-Place Saint Lambert the nodules were collected from the local river gravels (CAHEN ET AL. 1986).

Characteristics (**Fig. 34-36**)
Shape: nodules.
Size: small.
Cortex: smooth, very thin (under 1 mm) and either white (on material from a primary geological position) or beige (on material from residual loams). Very occasionally, the cortex has rough parts.
Primary colour: light to dark grey; within individual nodules gradual transitions in basic colour may occur.
Texture: vitreous.
Lustre: medium to matt (on fresh fractures; even slightly weathered archaeological artefacts often have a shiny lustre).
Translucency: medium to high (although some samples from Avennes had a low translucency).
Inclusions: Many different kinds of inclusions, occurring in high frequencies, often give the material a mottled aspect. The most characteristic inclusions are:

- medium-sized and large oblong light spots, that are mostly rougher to the touch than is the matrix;
- ribbon-like arrangements of small light spots, arranged like beads on a string;
- reticular (or criss-cross) patterns of dark lines, giving the inclusion a sponge-like aspect;

Apart from those one commonly finds:

- small light specks, either isolated or in concentrations;
- concentrations of small and medium-sized light spots, sometimes with light rim and a darker core; sometimes more granular (rougher to the touch) than the matrix;
- medium-sized and large ovoid light spots, similar or rougher to the touch than the matrix.
- Small and medium-sized diffuse light spots.

Dark medium-sized ovoid or sickle-shaped spots occur infrequently.
Alterations: sometimes a white zone under the cortex; very infrequently yellowish streaks.
Diversity of inclusions: high.

A.3.2. Obourg
Late Campanian, Obourg Formation (cf. ROBASZYNKI ET AL. 2001)

We collected geological samples from the Craie d'Obourg, of Campanian age, in the CBR quarry at Harmignies (Hainault) in south-western Belgium. Extraction sites are known from Obourg (comm. Mons; WEISGERBER ET AL. 1980: B2; GAYCK 2000: Nr. 35).

Characteristics (**Fig. 37**)
Shape: nodules.
Size: small.
Cortex: rough, smooth, very thin (under 1 mm) and whitish.

Primary colour: homogeneous, very dark grey to black, occasionally darker zone directly under the cortex.
Texture: homogeneous, vitreous.
Lustre: shiny.
Translucency: high.
Inclusions: There are few different kinds of inclusions present, occurring in low density: concentrations of light specks; small and medium-sized light spots, texture equal to that of the matrix, sometimes with a light rim and a darker centre; and very rarely medium-sized or large ovoid spots that are rougher to the touch than the matrix. Dark inclusions are absent. Instead, isolated red specks (smaller than 1 mm) and small spots appear occasionally.
Diversity of inclusions: medium.
Post-genetic alterations: yellowish brown infiltration zones under the cortex occasionally are present on Obourg flints found in secondary depositional positions, e.g. at Obourg-La Haute Folie.

A.3.3. Silex grenu de Hesbaye
The lithostratigraphical position of the Silex grenu de Hesbaye is unclear, but it may well originate from the Lanaye member. For this study, geological samples were collected on fields to the north of the cemetery of Latinne (Braives, Liège B). According to ALLARD (2005) the material is embedded in residual loams and was used in small quantities at Linear Bandkeramik sites, e.g. Verlaine-Petit Paradis, where it would have been locally available.

Characteristics
Shape: nodules.
Size: large.
Cortex:
Primary colour:
Texture:
Lustre:
Translucency:
Inclusions:
Diversity of inclusions:

8.3.4. Jandrain-Jandrenouille
The lithostratigraphical position of these flints is unclear (ROBASZYNSKI ET AL. 2001).
The material was extracted by deep-shaft mining at Jandrain-Jandrenouille (Orp-Jauche, Jodoigne, Brabant B; WEISGERBER ET AL. 1980: B12; GAYCK 2000: Nr. 45) at the time of the Michelsberg Culture.

Characteristics
Shape: nodular.
Size: large.
Cortex:: thin (1 mm); whitish, rarely brown; rough. Natural fracture planes often are covered with iron incrustations.
Primary colour: inhomogeneous, varying from very dark to very light grey, both sometimes with a suspicion of blue. The lighter grey parts often contain areas with concentric laminations, with gradual transitions between lighter and darker greys. Sometimes the zone directly under the cortex is the darkest.
Texture: fine-grained, sometimes gradual transitions to more granular parts; sometimes a more vitreous texture directly under the cortex.
Lustre: matt.
Translucency: low to medium; 70% of the sample measured had a translucency under 5 mm.
Inclusions:

- concentrations of black round specks (< 1mm); small and medium-sized (between 1 and 10 mm) black or very dark grey round, ovoid or sickle-shaped spots; dark wisps/tendrils;
- concentrations of light (white or light grey) round specks (<1mm); isolated small (1–3) and medium-sized (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 of rough darker centre;
- medium-sized and large (>10 mm) spots, round or irregular, abrupt border, light grey of whitish, rougher to the touch than the matrix;
- large, vague lighter grey flecks;
- small angular cavities.

Diversity of inclusions: medium.

A.3.5. Spiennes
Late Campanian, Spiennes Formation (ROBASZYNSKI ET AL. 2001)

The material originates from the Spiennes Formation (Craie de Spiennes). Formerly this unit was placed in the Maastrichtian (HUBERT 1980; CASPAR 1984), or even correlated with the Lanaye member (STOCKMANS ET AL. 1981; FELDER/BOSCH 2000), but the most recent lithostratigraphical studies consider it to be of Campanian Age (ROBASZYNSKI ET AL. 2001). Extraction at Spiennes (Mons, Hainault B, WEISGERBER ET AL. 1980: B1; GAYCK 2000: Nr. 34) was undertaken by means of extensive deep shaft-and-gallery mines at two locations, called Camp-à-Cayaux and Petit Spiennes, separated by the valley of the river Trouille. Systematic mining started in an early phase of the Michelsberg Culture, and is thought to have continued well into the Bronze Age (HUBERT 1980; COLLET ET AL. 2006).
For the present study, both geological samples from the different mined seams and artefacts collected on the surface at the Camp-à-Cayaux and at Petit Spiennes were examined.

Characteristics (**Fig. 38,39**)
Shape: nodules.
Size: large.
Cortex: rough, very thin or thin (under 1 – 1.5 mm), white/yellowish.
Primary colour: very dark grey to light grey; it may be homogeneous, but often changes gradually from dark to light within individual nodules. Concentric laminations may occur.
Texture: inhomogeneous, fine-grained, with some coarser parts; sometimes the zone under the cortex is more vitreous.
Lustre: matt.
Translucency: medium to high (60% of the sample is translucent to a thickness of over 5 mm
- Inclusions: concentrations of black round specks (< 1mm); small and medium-sized (between 1 and 10 mm) black or very dark grey round, ovoid or sickle-shaped spots; dark wisps/tendrils;
- concentrations of light (white or light grey) round specks (<1mm); isolated small (1–3) and medium-sized (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 of rough darker centre;
- medium-sized and large (>10 mm) spots, round or irregular, abrupt border, light grey of whitish, rougher to the touch than the matrix;
- large, vague lighter grey flecks;
- small angular cavities.

Diversity of inclusions: high.