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Beyond ‘15-minutes’: revisiting the late Middle Pleistocene archaeological record of Maastricht-Belvédère (The Netherlands).

Dimitri De Loecker and Wil Roebroeks

The record from the late Middle Pleistocene site complex Maastricht-Belvédère has been studied for more than three decades, with new analyses still ongoing. The 1980s excavations uncovered a series of well-preserved find distributions, which reflect episodic short-term occupation of parts of the river Maas valley during a full interglacial period. While Middle Palaeolithic technologies are often envisaged as ‘15-minute cultures’, the Maastricht-Belvédère studies of specific find categories, e.g. flint raw materials, possibly hafted artefacts, hematite finds and heated artefacts, suggest that early Neandertal behaviour may have gone beyond the limits of ‘15-minute’ flint knapping episodes or short butchering events.

1 Prologue

Neandertals are generally seen as having had a very mobile lifestyle, characterized by a high residential mobility (Binford 1980). In fact, until the later phases of the Palaeolithic, Pleistocene foragers in general invested very little in camp layout, in dwelling structures, or in the construction of formal hearths. The late Middle Pleistocene (Marine Isotope Stage [MIS] 7, see below) Maastricht-Belvédère-evidence is also generally seen as reflecting episodic and short-term occupation of parts of the river Maas valley, minimally 250,000 years ago, in line with the dominant view of Middle Palaeolithic technologies as ‘15-minute cultures’ (cf. McCrone 2000; Hallos 2005).

More than three decades after the start of the excavations (Roebroeks 1988), the study of the Maastricht-Belvédère record is still ongoing. Specific find categories, e.g. lithic raw materials in relation to different technological approaches (De Loecker 2006), hafting/microwear analysis of pointed tools (Rots, in press; Rots and De Loecker, in prep.), studies of hematite finds (Roebroeks *et al*. 2012), and spatial interpretation of heated artefacts and charcoal particles (Stapert 1990; 1992; 2006; 2007a and b), suggest that some of the activities performed there may have gone beyond the limits of opportunistic ‘15-minute’ flint knapping episodes or short butchering events (cf. Roebroeks and Tuffreau 1999); instead, some data suggest that considerable time, energy and skill was invested at certain localities, in order to execute specific technology (or food) related maintenance and production tasks.

This paper integrates data from these recent Maastricht-Belvédère studies and demonstrates that we are only dealing with a ‘hit-and-run’ record at first sight: at Sites C, G, K and N, early Neandertals entered the localities with finished tools, well-prepared technological products as well as with raw materials, in anticipation of tasks to be performed on the spot. Each of these elements required special consideration, time investment and control of raw materials. While equipped with tools produced elsewhere, these foragers also used locally available raw materials to produce ‘situational gear’ (De Loecker 2006). We will focus here on the use and organization of technology, to illustrate and explain the complexities of the artefact distributions recorded at Maastricht-Belvédère. After a brief introduction to the Maastricht-Belvédère site and the studies thereof, a summary of the local Pleistocene archaeology is given. Next, the specific find categories are presented, together with their interpretations. We will end with a brief discussion of the results.

2 Introduction to the Maastricht-Belvédère setting

The former Maastricht-Belvédère loess and gravel pit is located on the left bank of the river Maas (or Meuse), approximately one km north-northwest of the Dutch town of Maastricht (50° 52’09.40’’N, 5°40’27.33’’E). The early Middle Palaeolithic site complex, which has been under study since the 1980s, is situated on the northern border of the Northwest European loess-belt. Fieldwork at this locale focused on an interdisciplinary study of flint distributions, which occasionally were associated with faunal remains (Roebroeks 1988; De Loecker 2006). The hominin traces, in the form of artefact scatters and patches (cf. Isaac 1981), were generally preserved in a primary archaeological context in fine-grained sediments of the Middle Pleistocene River Maas. High rates of sedimentation created assemblages of a very limited time-depth (in Pleistocene terms) and enabled extensive refitting, spatial analyses and interpretations beyond the site-level. By the end of 1990 excavations had uncovered a total of eight archaeological sites, together with a series of test pits (see table 1). In total, a surface of 1577 m² was excavated of an area of approximately six hectares of quarry (Roebroeks 1988; Roebroeks *et al*. 1992; De Loecker 2006).

Site	Area dug (m²)	Total number of artefacts	Heated artefacts		Heated-natural-flints	Charcoal
			n	%	n[2]	
A	5	80	1	1.3	-	-
B	20	6	-	-	-	-
C	264	3067[1]	132[1]	4.3[1]	27	Many (>5800) particles, clusters
D	-	11	-	-	-	-
F	42	1177	15	1.3	-	Few particles
G	61	75	-	-	32	-
H	54	270	1	0.4	-	-
K	370	10,912	617	5.7	-	Few particles
N	765	450	1	0.2	-	-

[1] Site C figures after Roebroeks (1988; n= 3067).
[2] Not counted as artefacts.

Table 1 Maastricht-Belvédère. A comparison of fire related relics from the Unit IV primary context sites. (The figures are mainly after De Loecker 2006).

The Middle Pleistocene river deposits yielded a full interglacial vertebrate fauna with 26 species (van Kolfschoten 1993) and a rich mollusc fauna containing more than 70 land and freshwater species (Meijer 1985). The terrace and loess stratigraphy, as well as the mammal and mollusc biostratigraphical evidence, indicate an age before the next-to-last glacial, *i.e.* prior to MIS 6 (van Kolfschoten *et al.* 1993). Thermoluminescence dating of heated flint artefacts yielded an age of 250 ± 20 ka (Huxtable 1993), and electron spin resonance dating of shells gave an age of 220 ± 40 ka, all corresponding to MIS 7 (van Kolfschoten *et al.* 1993). However, amino acid racemization dating of *Corbicula* shells from the interglacial deposits as well as biostratigraphically important elements of the mollusc fauna itself suggest an earlier, MIS 9 age for the Belvédère interglacial and its associated archaeology (Meijer and Cleveringa 2009). For this paper it is sufficient to say that the archaeological material from the main find-bearing sediments, Unit IV, was recovered in the upper fine-grained part of a series of sediments deposited by a meandering river during MIS 7 (or possibly MIS 9). These fine-grained late Middle Pleistocene river deposits were subsequently covered by a thick sequence of Saalian and Weichselian silt loams (*i.e.* reworked and primary loesses).

3 Theoretical background: from east Africa to southern Limburg

While documenting the spatial distribution and the nature of Lower Palaeolithic stone artefacts and faunal remains in the Koobi Fora area (East Turkana, Kenya), Isaac and his colleagues observed that "... concentrated, localised accumulations of refuse ...." (Isaac 1981, 133) were mostly present against a background of diffuse find scatters. Their 'scatters-between-the-patches' project proposed a hierarchy of levels for structuring and understanding the spatial configurations across Palaeolithic landscapes. The diversity of recovered artefact (and bone) distributions ranged from high-density patches of stone artefacts associated with bones from several different animal species, through concentrations of lithics associated with bones from a single large animal, and lithic clusters without the associated bones (or *vice versa*), to the low-density scatters of lithic artefacts and/or bones. Isaac (1981) eventually suggested that there may have been significant functional differences between the high-density patches and the diffuse scatters between these places. Focusing on tool compositions, the latter were thought to represent recurrent activities possibly associated with foraging activities. As a result of these variations in quantity and composition, the examined surfaces were described as different types of 'sites', suggesting distinct behavioural patterns (*e.g.* Isaac and Harris 1978; Isaac 1978; 1981; Isaac and Crader 1981; Isaac *et al.* 1981; Stern 1991). Although these 'site types' readings of the record have been criticized (cf. Stern 1993; 1994), Isaac's scatters and patches model stresses at least the analytical (comparative) importance of treating the 'high and low' artefact distributions as parts of a 'single system' (see also Foley 1981a and b). It was amongst others through the work of Stern (1991; 1993), Roebroeks *et al.* (1992) and Conard and Adler (1997), that Isaac's notion of spatial, quantitative and typo-/technological artefact variations in a palaeo-landscape gained attention in the 1990s. Archaeologists came to realize that they needed to overcome the 'solitary site' focus in order to learn more about the spatial movements and activities of Palaeolithic foragers. Hunter-gatherers operate in a landscape and therefore both the low-density scatters and high-density patches should be studied as the output of former mobile systems, not only the highly visible 'rich' sites. On top of that, archaeologists also needed to keep in mind that they were probably looking at archaeological landscapes "generated episodically and not (at) the remains of a cultural geography wherein populations operated out of 'camps' into an environment, as do modern human populations." (Binford 1987, 29).

In an effort to explain the spatial distributions at Maastricht-Belvédère, Isaac's scatters and patches approach was used as a heuristic device. This resulted in the excavation of a 'non-site', Site N. Here, a surface of 765 m^2 was meticulously excavated and recorded with the explicit aim of studying the 'background scatter' of flint artefacts and bones present in the interglacial river deposits. The information from this low-density scatter was used to interpret the large-scale and continuous artefact distribution, both in low and high densities, referred to as a 'veil of stones' by Roebroeks *et al.* (1992). A comprehensive lithic analysis showed that the main differences between the various sites, apart from differences in find densities, were to be found in fine-tuned typo-/technological variations (differences in percentages and ratios). At the same time, quantitative and qualitative refitting studies proved to be fundamental for the study of these subtle yet important differences (De Loecker *et al.* 2003; De Loecker 2006).

4 Analyses 'beyond the site-level'

At Maastricht-Belvédère an effort was made to transcend the individual 'site-level' by integrating all the available data into an 'off-site' approach (Foley 1981a and b; Isaac 1981). The several find distributions were treated as part of 'one single' system, in which different activities were performed in different parts of the landscape (cf. Roebroeks *et al.* 1992; De Loecker and Roebroeks 1998). At least at Belvédère it seemed legitimate to compare the different lithic scatters and patches, all recorded from the same fine-grained Unit IV sediments and probably contemporaneous in Pleistocene terms – having been formed during a relatively short phase within the same warm-temperate interglacial period. Furthermore, the find distributions were documented in a rather small area, which would suggest that they were formed under the 'same' micro-environmental conditions, with no reasons to assume that any significant changes in raw material availability had taken place. Precisely these research conditions were the inspiration for the long-lasting field efforts, and created the right setting for high-resolution analyses and interpretations of a technological landscape.

5 Characterization of the Maastricht-Belvédère 'Veil of stones'

The artefact distributions at Maastricht-Belvédère documented a number of well-preserved 'on-site' activities which left a continuous artefact distribution on the palaeo-surface (Roebroeks *et al.* 1992). Generally, two different kinds of find distributions can be distinguished within this spatial continuum. On the one hand, there are the 'high density patches' Sites C, F, H and K. These are characterized by clusters of flint knapping debris, with many dorsal/ventral refits realized during conjoining studies (Roebroeks 1988; Schlanger 1994; 1996; De Loecker 2006). At the other end of the density scale are the low density 'off-site' distributions of Sites G and N. These predominantly consist of isolated and/or small groups of flakes, tools which yielded relatively few dorsal/ventral refits. Tools are far more important in the scatters than in the patches. Site K stands out as relatively high numbers of tools were recorded here. Most of these tools may have arrived at the findspot as well-prepared finished (Levallois) products. The high number of cores at Site K is also striking, with all produced on the spot. The fact that cores were discarded in large quantities suggests that they were probably intended for local use only (De Loecker 2006). The Site K, F and H assemblages are mainly the result of a disc/discoidal reduction strategy (cf. Boëda 1993) with limited attention for core preparation. It can be concluded that these 'high density patches' are characterized by an *ad hoc* (expedient) technology.

A completely different kind of 'high density' find distribution was excavated at Site C (Roebroeks 1988). Here, several 'smaller' clusters were situated close to each other. The Site C flint assemblage is characterised by a well-prepared core approach, with several 'classic' Levallois flakes and the products of a *débitage Levallois recurrent* (*cf.* Boëda 1986; 1993; 1994). Refitting showed that several cores (and tools and flakes), in various stages of reduction, were introduced at the Site C location to be further worked on, and subsequently transported away from the excavated area. This is in clear contrast to Sites K, F and H where most of the reduction sequences started and ended within the excavated area.

Between the large clusters of artefacts, a diffuse artefact distribution was present all through the fluvial sediments at Maastricht-Belvédère. Segments of this low density distribution have been excavated at Sites G and N (Roebroeks 1988; Roebroeks *et al.* 1992). No clear artefact concentrations could be described. The mean artefact density was very low, ranging between 0.58 (Site N) and 1.22 (Site G) artefact/m^2. The highest percentages of tools were recorded at these scatters, with the tools recovered as stray finds and 'worn out'. These implements are considered to represent the discarded parts of transported 'tool kits'. Only very few refits could be established, which represent small parts of spatially fragmentized reduction/retouching sequences, while more than half of the Site G and N conjoinings consist of broken artefacts. Moreover, the flakes from these low density scatters are larger than the ones from the rich sites, and beyond being voluminous, they have the highest mean number of scars and they show low cortex and flaw percentages. Their butts and dorsal surfaces are better or more often prepared, while the faceting indices are among the highest at Belvédère. The used raw materials show a large heterogeneity, which is also clear from the rather negative refitting results: *i.e. Aufeinander-passungen* (cf. Cziesla 1986; 1990). This seems to suggest that the 'low density' scatters reflect a series of non-related activities (separated in time and space) of early Neandertals in the river valley landscape during various foraging trips.

All in all, compared to the 'high density' patches, these 'low density' scatters show distinct differences in the spatial patterning of the finds, in typology, technology and in raw material composition (for an overview of the inter-site differences, see, Tables 5.1 up to 5.20 in De Loecker 2006).

6 Organization of technology: data collection

Besides flint knapping, other activities may have been performed at the Maastricht-Belvédère locales. It is however impossible to indicate the exact nature of these other site functions, as we are dealing here with a number of analytical limitations. For instance, only limited amounts of (usually badly preserved) bone material were recovered. This could simply mean that at certain localities (*e.g.* Site K) there never were faunal remains present, or it could be an outcome of decalcification of the site-matrix. Post-depositional processes were also responsible for the virtual absence of unambiguous use-wear traces. Some artefacts did display microscopic traces of use, but weathering prevented determination of the exact type of former use (van Gijn 1988; 1989). However, there is some data indicative of the character of some activities, *e.g.* food (meat) acquisition, as suggested for Site C and especially for Site G (Roebroeks 1988).

6.1 Lithic raw material acquisition in relation to different technological approaches: Sites K and C

The Middle Palaeolithic record indicates that Neandertals were continuously transporting lithic equipment across the landscape. Since the 1980s a wide variety of studies showed that a broad assortment of morphological forms, usually made on non-local materials, was part of the mobile tool kit, *e.g.* scrapers, Levallois flakes/cores and handaxes (Geneste 1985; Roebroeks *et al.* 1988; Féblot-Augustins 1993; 1999). In addition, several authors (Roebroeks *et al.* 1992; Meignen *et al.* 2009) stated that irregular flakes, cortical flakes, flake fragments, *éclats debordants* and even small chunks (Roebroeks *et al.* 1992; Floss 1994) were transported as well. Raw material studies also suggested that the travelled distances sometimes exceeded 100 kilometres (Roebroeks *et al.* 1988; Roebroeks and Tuffreau 1999).

Understanding the initial choice and selection of raw materials for production of specific tools and cores and/or tasks is a difficult endeavour. Contextual factors such as raw material quality, abundance and accessibility, as well as thoughts about activities to be carried out in the future are amongst the determinants in raw material procurement and consumption processes (Dibble 1995; Ashton and White 2003). Each type of raw material required a separate evaluation, or better, a different 'conceptual scheme', to predict the eventual suitability for specific activities (Andrefsky 2009).

At Maastricht-Belvédère Site K an extensive refitting programme resulted in the conjoining of 1828 artefacts (16.8% of the total number of artefacts), *i.e.* 60.4 kg (61.7%) of the total weight of the flint assemblage (97.8 kg). These conjoinings, together with high percentages of cortex, indicate that several flint nodules entered the area without any (or hardly any) preparation, decortication or testing (figs 1 and 2). Within the excavated area the flint blocks were initially split into smaller units and decorticated. Intra-site spatial patterning shows that the individual parts or cores were subsequently transported to other zones within the excavated area. There further core-reduction and finally discard took place (De Loecker 2006). Although occasionally larger flakes were used as cores, natural flaws clearly played a major part in this initial 'flaking' or splitting of the nodules. Together with some technological 'flaking failures' (cf. Shelley 1990), this could indicate an unselective choice of raw material or a lack of better quality raw material. The Site K assemblage is generally characterized by large dimensions and few but large dorsal negatives on both cores and flakes, with minimal attention for core preparation. Usually the negatives of flakes from an earlier stage in the reduction process are used as striking platform. The elaborate refitting study shows a strategy in which long 'uninterrupted' sequences of flakes were produced by means of a 'unifacial' and/or an interchanging bifacial disc(oidal) core approach (cf. Boëda 1993). Cores were constantly turned and twisted to maintain good flaking angles. As a result the assemblage can be described as reflecting a continuous, sometimes radial, removal of flakes. This makes it very difficult, or even impossible, to distinguish separate groups of flakes as 'waste' or as 'desired' products.

Strikingly, Levallois products (cf. Bordes 1961; Boëda 1984; 1986; 1988; 1993; Van Peer 1992) are virtually absent in the Site K assemblage. Refitting results show however that for a limited number of nodules, and/or phases in reduction sequences, more attention was paid to the preparation of the core. This concerned higher-quality, 'finer' grained flint and

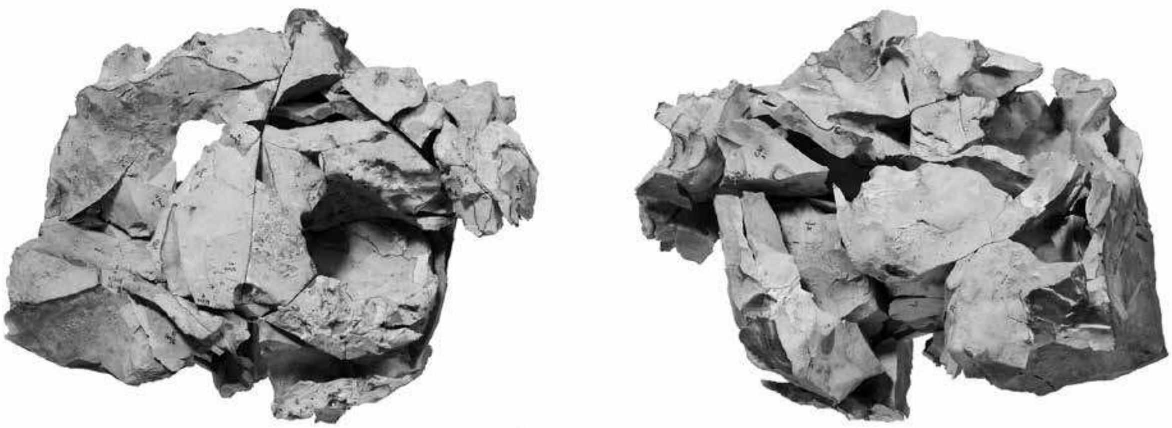

Figure 1 Maastricht-Belvédère Site K. Refitted composition I shown from two sides (length = 253 mm, width = 330 mm, thickness = 285 mm). The nodule weighs 9.286 kg (15.4% of the total weight of all conjoined Site K artefacts) and consists of 160 artefacts. It represents nine separately reduced parts or cores. (Figure after De Loecker 2006, 41).

Figure 2 Maastricht-Belvédère Site K. Refitted composition II measures 350 mm in cross-section and weighs 0.775 kg (1.3% of the total weight of all conjoined Site K artefacts). The nodule consists in total of 146 artefacts and represents eight separately reduced parts or cores. (Figure after De Loecker 2006, 54).

some of these products can even be interpreted as 'preferential' Levallois-like flakes (*e.g*. De Loecker 2006, composition X). One could suggest that at Site K a disc/discoidal core approach was applied as an immediate response to 'inferior' quality raw material. By means of this flexible reduction strategy, technological errors can 'easily' be repaired and natural imperfections surmounted quite economically (Boëda 1993). However, when a 'finer' grained flint nodule (or part of it), less affected by flaws, was used it seems that the technological strategy was slightly adjusted. Striking platforms and especially striking surfaces are now better prepared and the core-reduction strategy seems more oriented towards the production of 'desired products' (*éclats préférentiels*).

Such a technological adaptation to flint quality is also suggested by the Site C assemblage (Roebroeks 1988). Here, a *débitage Levallois recurrent* core approach (Boëda 1986; 1993; 1994) was used for the reduction of very 'fine' grained flint cores, while a discoidal one was used in the reduction of more 'coarse' grained flint. It should be mentioned though that the technological behaviour as described for Site K, is different from that at Site C (Roebroeks 1988), where most of the cores were carefully prepared and reduction reflects a more economical behaviour than at Site K. Moreover, the amount of cortex and refitting showed that at Site C a number of cores (and flakes) were introduced into the excavated area in already reduced forms, while at Site K all stages of the core reduction were performed on-the-spot. Beside some backed knives, notched pieces, denticulates and pieces with signs of use, various types of scrapers dominate the Site K tool assemblage. Refitting and a raw material study showed that only few flakes were selected from the bulk of debitage to be used for tool (*sensu stricto*) production. For tools produced on-the-spot the emphasis was clearly on implements other than scrapers: virtually all scrapers were introduced at Site K as ready-made objects. These products, mostly convergent and double-edged side scrapers, were already retouched into their final form outside the excavated Site K area (fig. 3a and 3b), made on 'fine' grained and well-prepared (Levallois *sensu stricto*) blanks. Hence, the transported Site K tool assemblage shows a clear relationship between a Levallois *sensu stricto* core approach, performed on transported 'fine' grained raw materials, and the occurrence of convergent (including Mousterian point) and double-edged side scrapers (cf. Geneste 1985). Other inter-site information is given by the few non-conjoinable (re)sharpening flakes (cf. Cornford 1986). They represent tools which were introduced and maintained at Site K, and subsequently transported away from the excavated area. Refitting also shows that some of the introduced flakes (blanks) were on-the-spot transformed into tools and discarded at the place of their production (fig. 4).

In summary, a 'tool kit' consisting of well-prepared flakes and scrapers entered the excavated Site K area, perhaps for subsequent use or maintenance. Part of the 'tool kit' was discarded on the spot. Another part, possibly supplied with newly-made tools, was transported away from the site. All this suggests a technological interaction between Site K and other locations in its surroundings. Moreover, the main Site K reduction strategy was not directly aimed at the production of well-prepared cores to be transported to other locations, as suggested for Site C (Roebroeks 1988). On the contrary, the intensive local knapping was mainly concentrated on the production of flakes and to a minor degree on tool manufacture. The many technological 'flaking failures/errors', together with the coarse-grained flint quality and the many natural imperfections, could support this assumption. Site K can, therefore, be seen as a space where technology was produced and maintained, while most of the technology was used elsewhere in direct subsistence and 'non-maintenance' activities (Isaac 1981; Roebroeks *et al*. 1992). However, beside flake production, a range of other activities, involving the use of flint tools (mainly scrapers and possibly hafted implements, see sub-section 6.4), could have been practised on the spot as well. This is suggested by the locally produced flakes and tools, which sometimes ended up at some distances from their production debris. Perhaps controlled fire was involved as well (see sub-section 6.2).

We have mentioned striking differences in raw material quality between locally produced items (more 'coarse' grained flint with abundant natural imperfections and flaws) and transported Levallois (-like) objects (predominantly 'fine' grained flint). Since the Levallois technique has a complicated *chaîne opératoire*, it can be stated that time and energy have been invested in the procurement and selection of suitable raw materials. In general the Pleistocene gravel beds of the river Maas (Unit III in the local sequence) contain pebbles of several different types of flint, and in that sense all Maastricht-Belvédère flints are 'local', as the gravels also contained the finer grained flint. At all Maastricht-Belvédère Unit IV sites fluvially abraded cortex was present. This indicates that raw materials (*i.e*. large flint cobbles at Site K) were probably collected from nearby river Maas deposits (Roebroeks 1988). According to palaeoenvironmental reconstructions based on the work of Meijer (1985) and Duistermaat (1987), the Unit IV archaeological sites were located at *c*. 100 to 200 metres from the main river stream, located near a shallow pool with gently flowing or stagnant water surrounded by abundant marshy vegetations, changing into alder forests with ash trees higher up in the landscape (van Kolfschoten 1985; Meijer 1985; Duistermaat 1987). This means that no gravel beds (raw material sources) were present within a radius of at least 100 to 200 metres around Site K. This possibly also means that after procurement, energy and time was invested in transporting the large and 'heavy' nodules, at least 97.8 kg in total weight (De Loecker 2006),

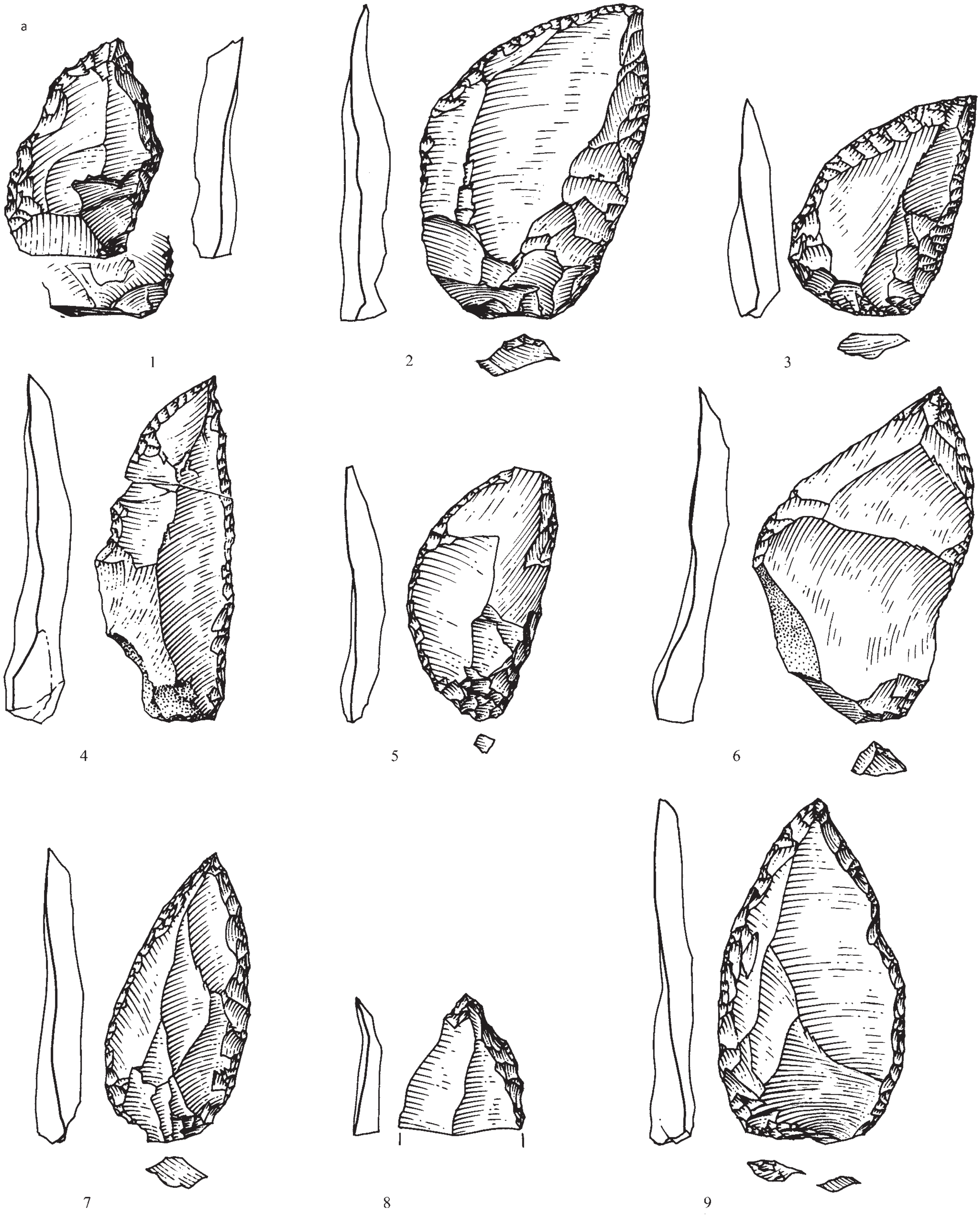

Figure 3a Maastricht-Belvédère Site K. Some of the 111 retouched tools *sensu stricto* (déjeté scrapers). The tools show a rather triangular morphology and could not be incorporated in one of the many refit sequences from Site K. Scale 2:3. (Figure after De Loecker 2006, 509).

b

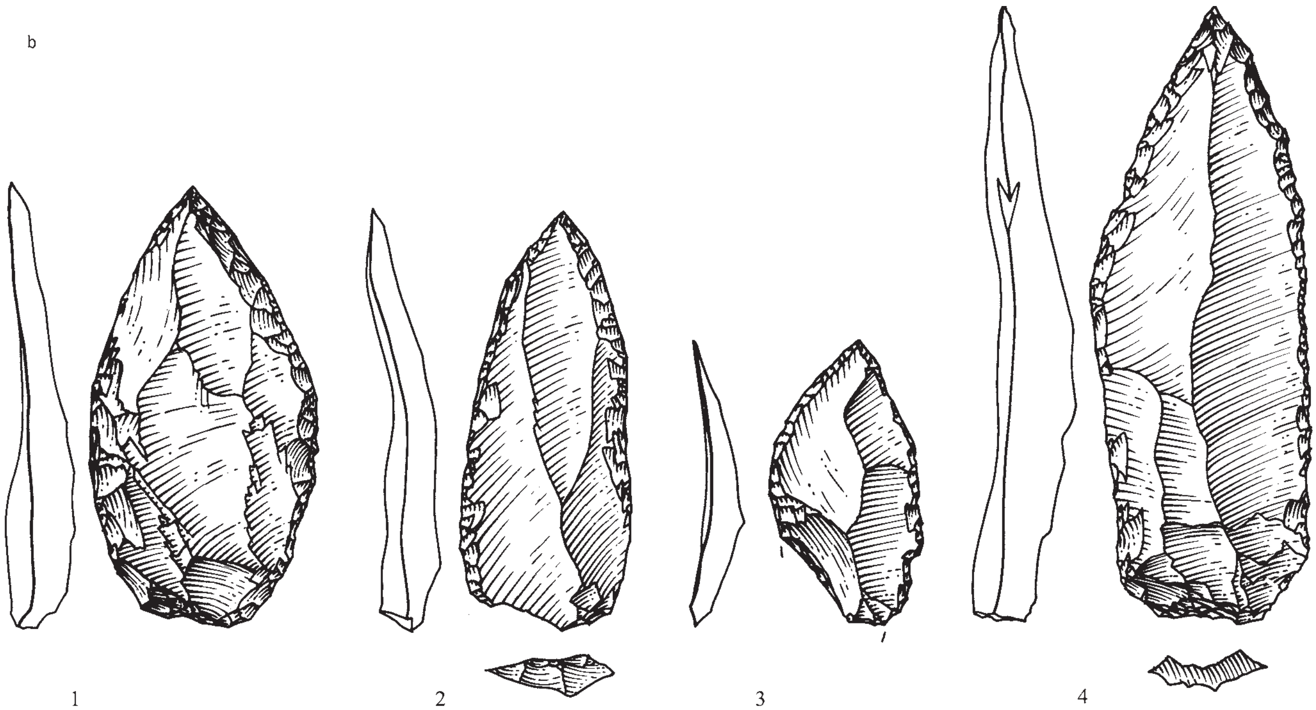

Figure 3b Maastricht-Belvédère Site K. Some of the 111 retouched tools *sensu stricto* (Mousterian points/convergent side scrapers). The tools show a rather triangular morphology and could not be incorporated in one of the many refit sequences from Site K. Scale 2:3. (Figure after De Loecker 2006, 507).

over a minimum distance of 100 to 200 metres, to the Site K locus. The fact that these nodules entered the area without any (or hardly any) preparation, decortication or testing implies a rather opportunistic behaviour, parallel to, or complementary to, the well-planned activities suggested by proper-prepared mobile (Levallois) items. At least it can be assumed that Site K was of such importance to early Neandertal foragers, that a considerable amount of energy and time was invested in carrying large and heavy flint nodules to the activity area. Together with the transported tool kit this emphasizes a capacity to anticipate needs and suggests that sometimes longer periods of time were spent at a certain location.

6.2 Clustered heated artefacts, charcoal particles and heated-natural-flints at Sites C, G, F and K

Especially the rich artefact clusters of Sites K and C, and to a lesser degree Site F, yielded considerable numbers of heated flint artefacts (table 1). In all three cases they were recovered together with (some) charcoal particles. Site C produced two dense concentrations of charcoal fragments, up to one cm in size (Roebroeks 1988). Heated-natural-flints were found at Site C, but the largest counts were realized at the low-density Site G.

At Site G a total of 75 flint artefacts were excavated together with poorly preserved faunal remains (Roebroeks 1988; van Kolfschoten 1990; 1993). The Site G spatial distribution shows a scattered occurrence of flint artefacts, together with a more clustered appearance of different faunal remains (mostly molars). None of the recovered artefacts showed signs of heating, but 32 heated-natural-flints were excavated, concentrated in the north-western part of the site (see figure 72 in Roebroeks 1988). It is impossible to say whether these heated-natural-flints are related to human activities or not. Roebroeks (1988, 69-70) stated that “the rather concentrated character of the distribution of these finds indicates that we may be dealing with the consequences of a fire that burned inside or close to the area sampled in the Site G excavation”, but did not go any further than this observation.

Besides some charcoal particles, Site F yielded 1177 lithic artefacts. Most artefacts were clustered in the northern part of the excavation, partly already destroyed by quarrying activities. The flint material includes 15, mostly small, heated artefacts which, together with a few charcoal particles, could indicate the presence of fire at the site. Again, it is difficult to say whether these heated artefacts relate to human activities or to natural fire.

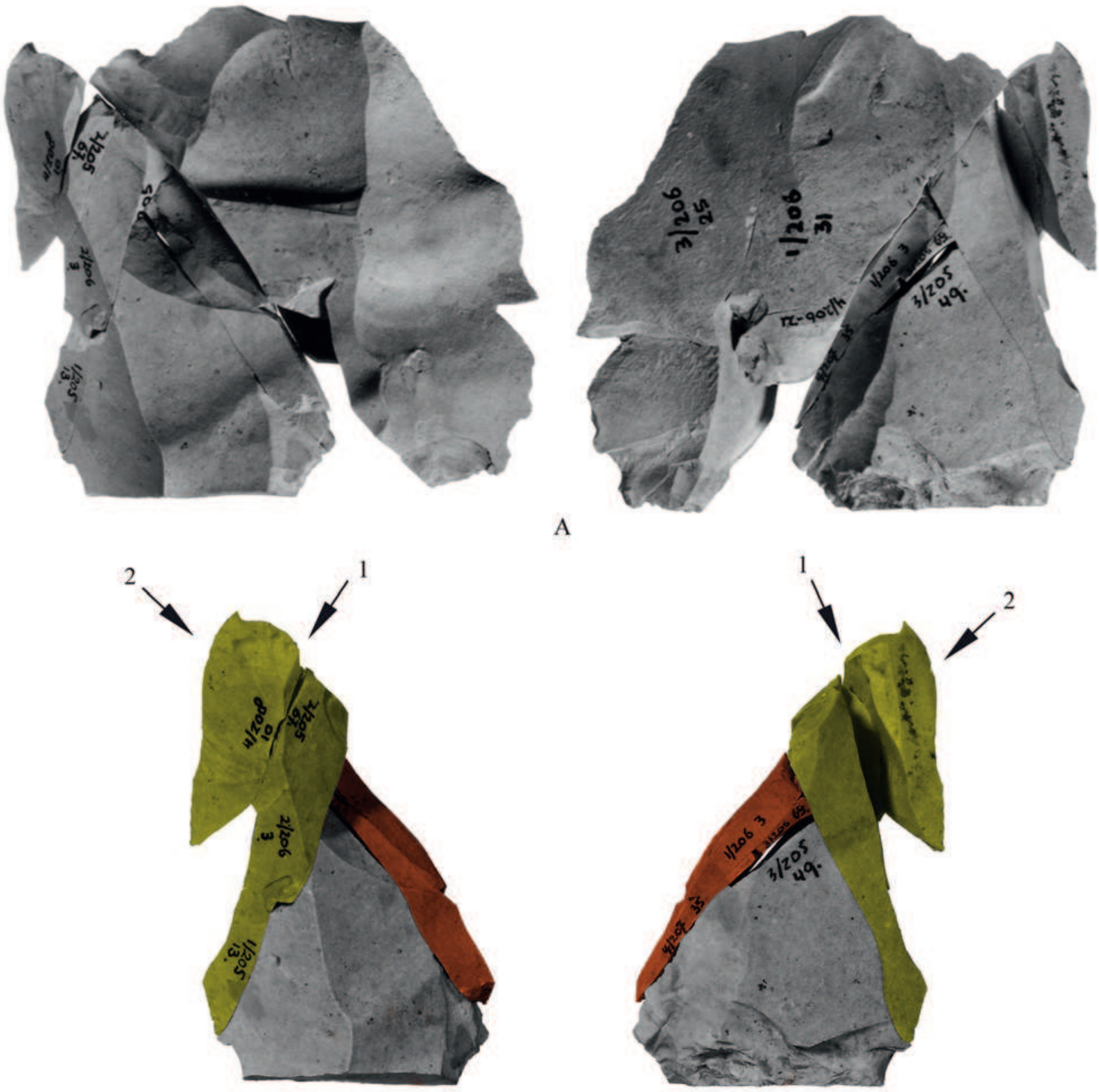

Figure 4 Maastricht-Belvédère Site K. Refitted composition XVI has a maximum dimension of 94 mm and weighs 0.084 kg (0.1% of the total weight of all conjoined artefacts). The large flake (A) consists of 11 artefacts and represents a transported item. Subsequently the flake was reduced into a typical burin (B) and a notched piece. 1 (yellow): Sequence of burin spalls, flaked from a lateral side of the artefact. 2 (orange): ‘Second’ series of burin spalls, produced from the other lateral side, using the scars of the previous flakes as striking platform. Scale 1:1. (Figure after De Loecker 2006, 106)

Between December 1986 and July 1987 Site K was excavated. Apart from some badly preserved possible bone fragments and some scattered particles of charcoal, the Site K assemblage consisted of 10,912 lithic artefacts. The flint assemblage includes 137 tools (mostly scrapers), 91 cores (mostly disc and discoidal) and 10,684 pieces of flaking debris. As discussed above, the refitting programme resulted in the conjoining of 1828 artefacts. The spatial distribution maps show a very dense cluster of artefacts in the south-eastern part of the excavated area. This concentration consists mainly of cores and conjoinable *débitage*. Tools *sensu stricto* are clustered in the centre of the excavated area (De Loecker 2006).

A total of 617 artefacts (5.7% of the total number of artefacts) were identified as heated. The highest densities of heated artefacts occur in the southern part of the excavated area, exactly the area where the bulk of flaking debris was present (fig. 5). Two zones with relatively high densities of heated artefacts (up to 30/m²) are in the south-eastern and south-western part of the site. Amongst the heated artefacts, two pieces with macroscopic use-wear and a convergent straight side scraper were identified in the south-eastern cluster. A heated core (tool?) was located in the north-west. The refitting exercise resulted in the conjoining of small potlids onto their 'parent' pieces. In total 61 *Einpassungen* (heat-damage/inserts, cf. Cziesla 1986; 1990) were established, which spatially coincide with both southern clusters. The largest refitted group of heated elements, a large imported ('non-local') flake consisting of 15 elements and measuring 85 mm, was recovered from the south-western smaller cluster (see figures 3.74 and 3.75 in De Loecker 2006). In addition, a few charcoal particles were scattered over the entire excavated area of 370 m² (see table 1).

The horizontal patterns and especially the conjoining results suggest that a fire burnt on the spot. It is, however, difficult to distinguish between natural (wild) fires and those for which early humans were responsible. Some observations could be relevant here though. First of all, at Site K there are

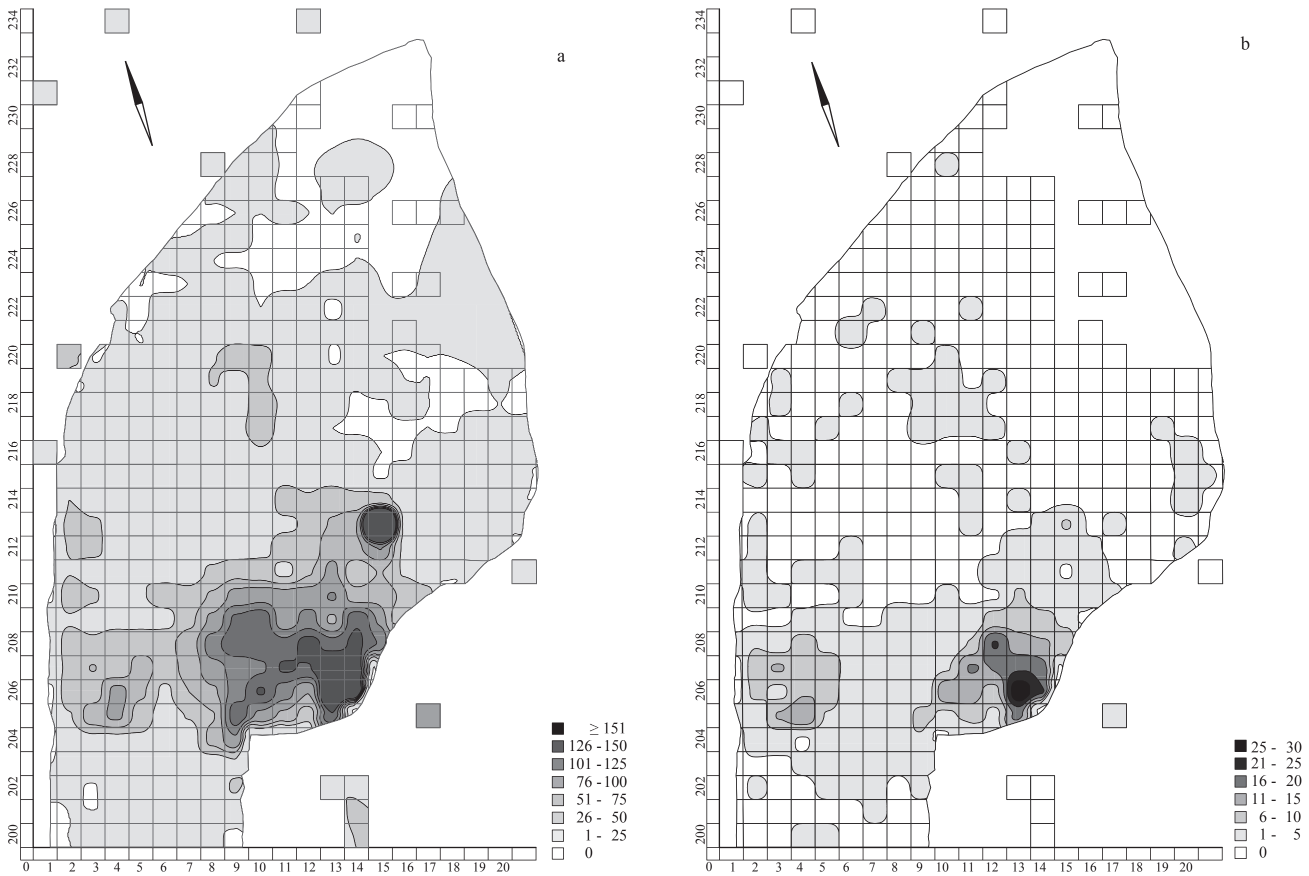

Figure 5 Maastricht-Belvédère Site K. Density contour map of the total number of artefacts (A), (n= 10,912) and separately of the total number of heated artefacts (B), (n=627). The excavation coordinate grid is in square metres. (Figures after De Loecker 2006, 125 and 133).

no features that could be seen as reflecting fireplaces, such as lenses of reddened sediments, clustered charcoal remains, clusters of heated-natural-flints, concentrated charred bone fragments, and/or depressions with heated material surrounded by rocks (cf. discussion in Roebroeks and Villa 2011). Secondly, heated artefacts are found among different typological classes, *e.g*. small and large flakes, cores and tools. In addition, locally produced as well as imported ('non-local') material shows traces of heating. Thirdly, beside the refitted groups exclusively consisting of heated artefacts, some of the heated flakes could be integrated into two refitted compositions (De Loecker 2006, 40-66). Compositions I and II (figs 1 and 2) show that the heated artefacts were refitted into separately reduced parts or cores (of the large nodule) and that there is no evident relationship between the knapping stages and the heating of the artefacts. The latter implies that, at least for compositions I and II, heating occurred after flint knapping. This could also indicate a chronological gap between an earlier production of compositions I and II, their heating and a later reduction of the non-heated nodules in the same area. Time differences, however, may have been limited (*e.g*. a few hours or a night). Nevertheless, if there was an anthropogenic fire, it must have burnt in the southern part of the excavated Site K surface. In an alternative scenario the heated elements can be interpreted as the remnants of a spontaneously combusted natural fire that rapidly 'passed through' the site after occupation (cf. James 1989), or at least after some stages of flaking were executed.

Beside 3067 flint artefacts (*c*. 74% is <2 cm), which included four cores and 23 tools, the Site C excavation yielded poorly preserved bone material, a large quantity of clustered charcoal particles and some dots of reddish material, haematite. The lithic debris was recovered from three separate concentrations (the southern, northern and eastern, *i.e*. Roebroeks 1988; Stapert 1990), while the charcoal particles were clearly clustered in the western part of the excavated area. A second smaller charcoal cluster was situated at the periphery of the eastern flint concentration. The assemblage amongst others consisted of 132 heated flakes (4.3% of the total number of artefacts), which were mainly recovered in the southern concentration (see figures 27 and 40 in Roebroeks 1988). A density contour map of the heated artefacts from the southern concentration (see figure 5 in Stapert 1990) shows that the heated pieces clustered (see figure 3 in Roebroeks *et al*. 2012; figure 27 in Roebroeks 1988). There are only few scattered pieces of charcoal and some faunal remains in this area. Interestingly, flint artefacts of two different Raw Material Units (RMUs) were recorded in the southern part of Site C. The majority of the heated artefacts belong to RMU 5 (Roebroeks 1988), while none of the RMU 6 artefacts are heated. RMU 5 entered the excavated area as a partly reduced core. Within the Site C area it was further exploited, but the actual core was not found within the excavation boundaries. About 10% of the 162 elements that formed the refitted RMU 5 'core' was heated (fig. 6) and the heated flakes were randomly distributed within the southern concentration of the RMU 5 debris. At exactly the same location RMU 6 was partly reduced. This implies that some time elapsed between the initial flaking of RMU 5, the presence of fire at the same time or later, and the subsequent reduction of RMU 6 when the

Figure 6 Maastricht-Belvédère Site C, Raw Material Unit 5. The refitted composition consists of 162 elements and shows the flaking debris of a flat disc(oidal)-like core. The actual core was not recovered within the excavation boundaries, but must have been nearly exhausted. The initial flaking and decortication occurred outside the excavated area. About 10% of the elements were burned. (Figure after Roebroeks 1988, 53).

fire had died down. Again, time differences may have been limited. According to Stapert (1990), it is unlikely that the latter scenario had a natural cause.

Within the western charcoal concentration (heated) lithic artefacts are lacking and only few heated-natural-flints were recovered. Moreover, two heated-natural-flints, shattered during heating, could be refitted (*Einpassungen*, cf. Cziesla 1986; 1990). This led Roebroeks (1988) to conclude that the charcoal concentration was very probably formed as a result of a fire on the spot. However, this fire burned outside the main flint artefact and bone distribution. Again, it is difficult to say whether humans were involved or not. In an alternative scenario the charcoal elements could for example be considered as remnants of fluvial deposited charred driftwood. The latter could possibly also explain the smaller charcoal patch in the western part of the excavation. Conspicuously, the spatial distribution of the hematite concentrates more or less coincides with that of the southern heated flints and that of the western charcoal cluster (see below).

During the early 1990s Stapert (1989; 1990; 1992; Boekschoten and Stapert 1993; 1996; Stapert and Johansen 1995) introduced a relatively simple technique for intra-site spatial analysis of Stone Age sites. The idea was based on the analysis of several Late and Upper Palaeolithic *structures évidentes* (Stapert 1989). This 'ring and sector' method was amongst others intended to determine the presence or absence of dwellings, in the absence of clear physical structures. It was designed especially for sites characterized by the presence of a central hearth, closely associated in space with artefact clusters. However, since visual fireplaces are rarely recovered from the Middle Palaeolithic, other indicators, like heated artefacts, can be applied to calculate the position ('centres') of former 'phantom' hearths (cf. Alperson-Afil *et al*. 2007; Villa 2010).

At Sites C and K larger quantities of heated artefacts co-occurred with dense clusters of debitage, tools and sometimes cores. To investigate the possibility that maintenance and production related tasks were associated with (inferred) anthropogenic fires, Stapert (1990; 1992; 2006; 2007a and b) performed a number of 'ring and sector' analyses at Maastricht-Belvédère. In the absence of physical structures he used the density contour maps (centroids) of the heated artefacts to (re)construct and pinpoint the centre of these former hearths. For Site C the southern concentration was used, at Site K the south-eastern and south-western clusters.

In total 186 artefacts were included in the Site C analysis and the produced histogram showed a unimodal distribution. According to Stapert (1990; 1992) this is characteristic of man-made hearths in the open air. He further concluded that flint-working was done near a campfire, and more precisely at the southwest and south of it. Due to the fact that a considerable amount of faunal remains were recovered at some distance to the northwest, together with the use-wear results by van Gijn (1988; 1989), he further suggested that butchering activities were possibly performed in the vicinity of the hearth.

At site K a proportion map of heated artefacts (Stapert 2007a, figure 4) showed two distinct clusters in the south, located about five metres from each other. The significance of the proposed clusters was statistically grounded by chi-square and binomial tests (Stapert 2007a, 26). The analysis also showed a weak signal in the north, where the heated core was found (see above). Next, centroids were calculated for both southern clusters. All in all, this resulted in Stapert's (2007a and b) interpretation of at least two anthropogenic 'phantom' hearths in the south. If there was a third fire place in the north, it was probably used less intensively or only briefly. Another indication in support of the southern hearths is the spatial pattern of larger unheated artefacts (≥ 60 mm) which seem to 'avoid' the burned clusters. Apparently they concentrate halfway between the two projected hearths. This is also an area where a denser cluster of cores is present (cf. see figure 3.76 in De Loecker 2006; figure 6 in Stapert 2007a). Moreover, refitting showed intense knapping around the conceivable fire places. While tools generally show a scattered appearance across the Site K surface, there is a cluster in the vicinity of the south-eastern 'hearth'. This cluster also includes a single convex side scraper, which was possibly used for woodworking (see sub-section 6.4). Eventually the southern Site K situation was interpreted as a location where flint knapping activities were performed near fires, since "…, the two presumed hearth locations are associated with the artefact-densest parts of the site." (Stapert 2007a, 30).

6.3 Ochre-rich liquid substance (drops) at Site C and Site F

Between 1981 and 1983 Site C was excavated and documented over an area of 264 m², which included a three-dimensional recording of several thousands of charcoal particles (>5800 fragments) and 15 tiny concentrates of red material (Roebroeks 1988, 38). To study the physical properties of the reddish material, in the late 1980s samples were submitted to a variety of analyses. As an outcome of these studies, the red stains were interpreted as hematite (red ochre), (Arps 1988; Roebroeks 1988). A few more pieces of red material were documented at Site F, an area (42 m²) situated *c*. 300 m southeast of Site C. Despite the carefully excavated surfaces at the low-density scatters of Site G (50 m²) and Site N (765 m²), no further ochre particles were recorded over the years. This applies also to Site H (54 m²) and the rich Site K artefact distribution (370 m²). Given current debates on the use of ochre during the Palaeolithic (see Roebroeks *et al*.

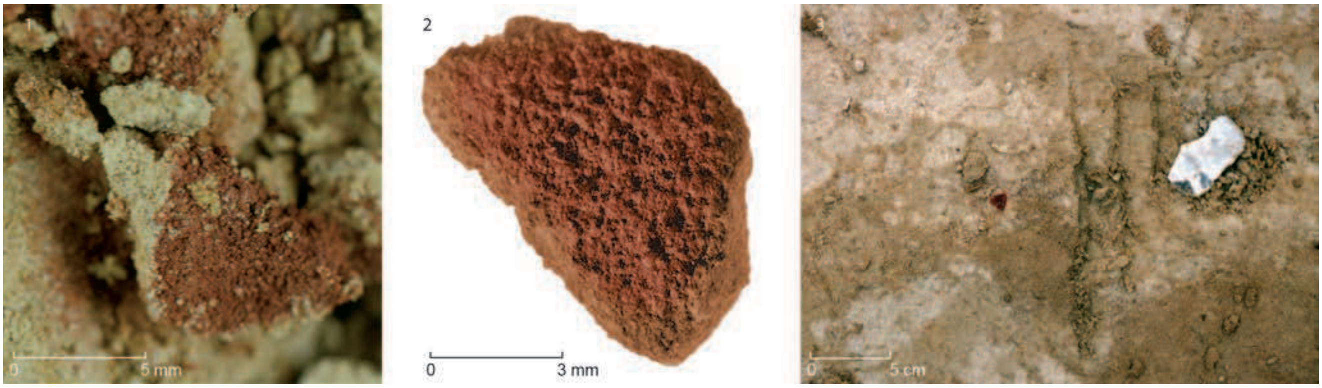

Figure 7 Maastricht-Belvédère Site C. Two of the selected hematite concentrates, which were submitted for further analysis. (1) Concretion Dz23-16 against the background of the fine-grained fluvial deposit from which it was recovered. Dessication of the matrix caused breakage of the concentrate. (2) Concretion Bv-894, ~2 mm thick. (3) A flint flake was recovered next to hematite concentrate Bu-894. (Figures after Roebroeks *et al.* 2012, 1890).

2012 for references) and the new high resolution identification methods that have become available since the late 1980s, three of the Site C finds and from Site F, were submitted to a range of detailed studies in 2010-2011 (see Roebroeks *et al.* 2012 for details), (fig. 7). These investigations confirmed earlier interpretations: we are indeed dealing with hematite dots. Roebroeks *et al*. (2012) concluded that the red ochre stains did not belong to the natural sedimentary environment, but had entered the matrix after formation, with the non-local material introduced to the sites by early Neandertals. The nearest natural sources of hematite are situated in the German Eifel region and in the Belgian Ardennes (Liège-Dinant-Namur vicinity), *i.e*. at a distance of at least 40 km from Maastricht. However, since the Belgian Ardennes are positioned in the catchment basin of the river Maas and its tributaries, small quantities of hematite could have been collected from the late Middle Pleistocene point bars of the meandering stream, even though this is considered highly improbable (see Roebroeks *et al*. 2012 for discussion). Overall, the combined evidence of on-site observations, studies on raw material provenance, and the character of the red concentrates, justifies the inference that the hematite fragments at Sites C and F were related to early human activities.

Roebroeks *et al*. (2012, 1891) hypothesized that the fine hematite material was originally concentrated in a liquid solution, and that blobs of this ochre-rich substance became embedded in the sediments during use of the liquid, spilled on the soil surface. To test this interpretation, they performed an experiment to observe the impact of drops of a hematite-rich liquid on the site C sediment. The similarity of the experimentally produced concentrates to the archaeological concentrates at both macroscopic and microscopic levels was remarkable and hence supported the interpretation of how the material became embedded in the Site C matrix.

The spatial and functional data from Site C and Site F did not yield any clear-cut evidence on the possible use of the red ochre, as no traces of hematite were detected on any of the Maasticht-Belvédère artefacts. Strikingly however, the hematite was recovered at sites with evidence of fire and where subsistence- and maintenance-related tasks may have taken place (*e.g*. Keeley 1980; Phillibert 1994; Wadley *et al*. 2009). At the very least, the reported small hematite concentrates represent a very early case of red ochre use and manipulation, which minimally dates to MIS 7 (Roebroeks *et al*. 2012, 1893).

6.4 Hafted implements at Site K?

During the late 1980s limited functional analyses were performed on artefacts (n=55) recovered from several Maastricht-Belvédère sites (*i.e*. Sites B, C, E, F and G). Eventually seven flakes appeared fresh enough for interpretation, while only three tools actually showed wear traces. Amongst these pieces is a large *éclat débordant* (cf. Beyries and Boëda 1983), recovered at the low-density Site G (Roebroeks 1988). The flake was interpreted as a 'backed knife' and functional analysis suggested cutting activities on an animal with a thick skin (van Gijn 1988; 1989).

In the context of a study on hafting and site function during the Middle Palaeolithic (Rots, in press; Rots and De Loecker, in prep.), in 2010 another attempt was made to study the possible use-wear traces on the Belvédère material. Because of the 'large' quantity of triangular (pointed) tool forms at Site K, the focus was on the Site K implements (fig. 3a and 3b). The assemblage contains 137 (1.3% of a total of 10,912 artefacts) complete and fragmented tools, including 111 (81.0%) tools *sensu stricto* and 26 (19.0%) artefacts with macroscopic signs of use. Various types of scrapers dominate (60.6% or n= 83) and the scraper index (SI)

Figure 8 Maastricht-Belvédère Site K. Single straight side scraper (Type 9, *i.e.* Bordes 1961), which is interpreted by Rots and De Loecker (in prep.) as projectile point. The implement was possibly hafted on a thrusting spear. (Figure after Rots in press).

is 57.7 (De Loecker 2006). A total of 103 tools were selected by Veerle Rots for further functional analysis. Her study is still in progress and hence the following results are preliminary. So far 52 tools have been examined; as stated by van Gijn (1988, 152-153), their preservation is poor as a result of de-silification and patination. Thusfar (Rots, in press; Rots and De Loecker, in prep.) 14 tools show evidence of use (27% of a total of 52 tools). Interestingly, at least one piece, a single straight side scraper (fig. 8) has been identified as a possible projectile or spear point (likely a thrusting device). The wear-pattern observed on this implement shows a combined presence of an end-on and rotating impact (cf. Rots 2009). According to Rots (in press) this typical wear-pattern is often described on hafted implements used to finish-off prey, when spears (or knives) were twisted upon insertion (Frison 1978; 1989; Hughes 1998). The point was recovered from the eastern edge of the excavated surface, together with two other tools. Less certain is the interpretation of an artefact possibly used for woodworking. The latter, a single convex side scraper, was located in a central area where considerably more tools were recorded. Apart from some minor scraping and grooving activities, the Site K functional analysis suggests that butchering activities were predominant (see table 2). Site K thus seems to have been a place where subsistence-related as well as tool maintenance-related tasks were executed. This interpretation is supported by the presence of two so-called (re-)sharpening flakes (cf. Cornford 1986), (fig. 9). Given the large quantity of *ad hoc* produced flakes with large potential cutting edges (De Loecker 2006) and the 'small' amount of (used) tools, it is clear that flake production activities were predominant.

The functional analysis indicates that hafting practices occurred at Site K. The stone tool at stake was probably mounted at the extremity of a (wooden?) shaft, and probably attached with bindings (*e.g.* sinew, leather or vegetal). The use of adhesives for fixation can however not be excluded

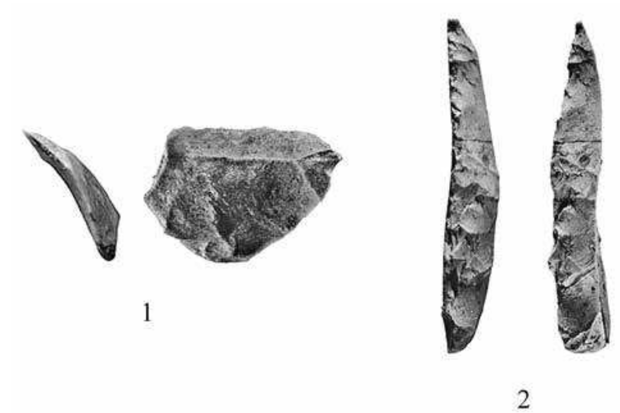

Figure 9 Maastricht-Belvédère Site K. 1: 'Transverse Sharpening Flake' (TSF). 2: 'Long Sharpening Flake' ('LSF'). Scale 1:2. (Figure after De Loecker 2006, 32).

Site	Sample	**Subsistence**				**Tool manufacture**						**Uncertain**			
		Animal hunting	Animal processing	Vegetal processing	% of identified tool uses	Wood percussion	Wood working	Grooving / perforating	Scraping hide	Other scraping	% of identified tool uses	Briquet	Other cutting	Other	% of identified tool uses
Maastricht-Belvédère	52	1	4		36	1	1	3		2	50		2		14

Table 2 Maastricht-Belvédère Site K. Results of a preliminary use-wear study (after Rots, in press).

(Rots, in press), as the Middle Palaeolithic record contains a number of examples of the use of adhesives. The earliest of these are the finds from the Campitello quarry in Italy, where flakes were found still enveloped in birch-bark pitch (Mazza *et al*. 2006), dating to minimally MIS 7. These (and later) finds are a good demonstration of Neandertal pyrotechnological knowledge (Roebroeks and Villa 2011).

The above presented studies allowed a more detailed insight into the potentially different activities that took place at the Maastricht-Belvédère scatters and patches, beyond the well-documented flint knapping episodes. Stone artefacts probably played a major role in animal procurement and food processing activities, but beyond these subsistence-related activities we infer that at the excavated locales time was also invested in the maintenance of technology. A variety of tasks were executed close to a fire and some of these involved the use of 'liquid' ochre; some of these activities, involving the use of transported materials, were probably well planned for execution at known places in the landscape.

7 Discussion and conclusion

Large-scale excavations at the open-air sites of Maastricht-Belvédère and the subsequent typo-/technological, refitting and spatial analyses allowed detailed interpretations of late Middle Pleistocene Neandertal behaviour (Roebroeks 1988; De Loecker 2006). The find distributions are the outcome of episodic visits to a riverine landscape, where flint artefact discarding behaviour eventually resulted in a number of 'high and low density' find distributions, with clear quantitative and qualitative variations. The data suggest that a considerable amount of time, energy and skill were invested at certain localities, to carry out all sorts of subsistence and maintenance tasks. Moreover, they give detailed insights into the spatial organization of raw material acquisition, production, usage and discard of a variety of artefacts (and raw materials) in a Middle Palaeolithic landscape. For this paper we mainly focused on Sites K and C.

The spatial and refitting data of Site K show that the various 'activity-related' discard areas were related. Functional and typo-/technological analyses indicate that retooling (hafting) could have been one factor in artefact distribution. At least one recovered tool, a single straight side scraper can be interpreted as a hafted projectile point (Rots, in press; Rots and De Loecker, in prep.). If butchering indeed occurred at the Site K locale, the meat was processed with large cutting edges. The latter were, on the one hand, produced on the spot using large raw material nodules, which were collected at a minimum distance of about 100 to 200 metres from the site. On the other hand large ready-made cutting tools were introduced to the excavated area, as part of a mobile tool kit (*e.g*. well-prepared scrapers, backed knives and large flakes at Sites K, G, N and C). In addition, the hunting gear was directly maintained on the spot. Points were dismounted from their shafts and subsequently 'new' tools were made (or were part of the mobile tool kit). The raw material of the (supposedly) hafted side scraper as well as of a large quantity of other tools (mainly scrapers, see figure 3a and 3b, differs from the rest of the assemblage. Moreover, none of these pieces could be incorporated in one of the abundant refit sequences at Site K. The recovered (re)-sharpening flakes positively indicate that, within the excavation boundaries of site K (and Sites A and G), at least some maintenance activities took place.

Exhaustive conjoining studies combined with spatial analysis show that each refitted sequence, each *chaine opératoire*, has its own specific history and complexity. Some of the Belvédère sites represent core reduction sequences that largely overlap spatially (Site K), whereas others represent sequences that succeeded each other both in space and in time (Site C). At Site C the refitted spatial configurations seem to represent flint-working events, the products of which were transported from one area to another, where they were then abandoned and where a new reduction sequence of another RMU 'started'. Next, this new flaking sequence (or core) was transported to a 'third' locus where its use-life again ended and where yet again a new one 'started', etcetera. The Site C (and Site K) analysis indicates that we are dealing here with the remnants of two different, but related, technological strategies. On the one hand, a number of well-prepared *Levallois recurrent* cores and flakes (cf. Boëda 1986; 1993; 1994), produced on finer grained flint, entered the excavated Site C area in already reduced forms. This means that the initial flaking sequences were executed at other places in the landscape. Within the 'site' boundaries they were, subsequently, further reduced, parts of the *chaines opératoires* were discarded on-the-spot, while reduced cores and produced flakes were transported to other locations (Roebroeks 1988; Roebroeks *et al*. 1992). On the other hand, a disc(oidal) core approach (cf. Boëda 1993), with minimal attention for preparation, was used for the reduction of more 'coarse' grained local flint. Most of these products were probably intended for *ad hoc* use only. The occurrence of a considerable amount of poorly preserved bones (Roebroeks 1988; van Kolfschoten 1993), together with the limited results of a functional analysis (van Gijn 1988; 1989), suggests that both transported and expedient lithic components were intended for butchering activities. Theoretically these tasks could have been related to the presence of a hearth, and could have involved the manipulation of red ochre (Roebroeks *et al*. 2012), but there is simply no proof to link these various find categories in such a way.

At some of the Maastricht-Belvédère sites (*e.g*. Sites C and K) a variety of specific tasks was carried out at one and the same location. The Site K high-density artefact distribution, with some 'signals' for an organized use of space, probably represents a passing visit related to the maintenance of technology in combination with other activities like food procurement and tool kit maintenance. The well-equipped Late Middle Pleistocene foragers may have been attracted to the area by its diversity of natural resources, which included flint, fresh water, fuel for fires and food supply. Investigations of the spatial layout of lithic artefact distributions (*i.e.* raw materials and technology) show that these Neandertals were highly mobile indeed (in the 'residential' sense of Binford). Moreover, the spatial artefact distributions can be portrayed as fossils of their 'foraging trails' in the landscape. Although the scatters and patches generally reflect short-term visits, some time was clearly invested at specific locations. This agrees with data obtained in larger-scale studies, e.g. those of Neandertal raw material transport behaviour and the environmental background of their presence in northwestern Europe: "All evidence suggests that Middle Palaeolithic groups were highly mobile, and ranged over the northern areas over distances sometimes exceeding 100 km. Recurrent patterns, in both raw material procurement and the specific use of locations, over very long periods of time indicate that knowledge on specific landmarks was transmitted over many generations, probably including knowledge necessary for coping with a wide range of environments. Despite all the resolution problems …, it is clear that Middle Palaeolithic groups were able to cope with a wide range of environments, from cold and open, windswept, mammoth steppes to the more forested interglacial environments, where open river valleys may have formed the main focus of their wanderings." (Roebroeks and Tuffreau 1999, 129).

The early Neandertals who created the Maastricht-Belvédère archaeological record by their episodic visits to the river Maas area, were well-equipped foragers, carrying stone tools, probably including hafted ones, flakes and cores, fire (or even: fire production tools), pieces of ochre and, most importantly, the knowledge to put these items to good use in a wide range of environments. The 'catchment area' of their technology, the know-how needed to turn birch-bark into glues, and in general terms their long-term survival in Pleistocene Europe are simple illustrations of a mobile adaptation which was based on a way of life which greatly surpassed the 15-minute culture often envisaged for these hunter-gatherers.

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References

Alperson-Afil, N., D. Richter and N. Goren-Inbar 2007. Phantom hearths and the use of fire at Gesher Benot Ya'aqov, Israel. *PaleoAnthropology* 2007, 1-15.

Andrefsky Jr., W. 2009. The analysis of stone tool procurement, production, and maintenance. *Journal of Archaeological Science* 17, 65-103.

Arps, C.S. 1988. Appendix III - The identification of haematite as the colouring agent in red ochre from the Middle Palaeolithic site C at Maastricht-Belvédère, The Netherlands, by means of x-ray diffraction analysis. In: W. Roebroeks (ed.), *From Find Scatters to Early Hominid Behaviour. A Study of Middle Paleolithic Riverside Settlements at Maastricht-Belvédère (The Netherlands)*, Leiden, Leiden University Press (Analecta Praehistorica Leidensia 21), 163-165.

Ashton, N. and M. White 2003. Bifaces and raw materials: flexible flaking in the British Early Paleolithic. In: M. Soressi and H.L. Dibble (eds), *Multiple Approaches to the Study of Bifacial Technologies*, University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia (University Museum Monograph 115), 109-124.

Beyries, S. and E. Boëda 1983. Etude technologique et traces d'utilisation des 'éclats débordants' de Corbehem (Pas-de-Calais). *Bulletin de la Societé Préhistorique Française* 80, 270-275.

Binford, L.R. 1980. Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45, 4-20.

Binford, L.R. 1987. Searching for Camps and Missing the Evidence? Another Look at the Lower Palaeolithic. In: O. Soffer (ed.), *The Pleistocene Old World. Regional Perspectives*, New York/London, 17-32.

Boëda, E. 1984. Méthode d'étude d'un nucléus Levallois à l'éclat préférentiel. *Cahiers géogr. physique* 5, 95-134.

Boëda, E. 1986. Le débitage de Biache-Saint-Vaast (Pas de Calais): première étude technologique. *Bulletin Association Française pour l'Etude du Quaternaire suppl*. 26, 209-218.

Boëda, E. 1988. Le concept Levallois et évaluation de son champ d'application. In: M. Otte (ed.), *L'homme de*

Néandertal, 4: LA TECHNIQUE, Liège (Etudes et recherches archéologiques de l'Université de Liège 31), 13-26.

Boëda, E. 1993. Le débitage discoïde et le débitage Levallois récurrent centripète. *Bulletin de la Société Préhistorique Français* 90 (6), 392-404.

Boëda, E. 1994. *Le Concept Levallois: Variabilité des Méthodes*, Paris (Monographie De CRA. 9).

Boekschoten, G.R. and D. Stapert 1993. Rings and Sectors: a computer package for spatial analysis; with examples from Oldeholtwolde and Gönnersdorf. *Helinium* XXXIII (1), 20-35.

Boekschoten, G.R. and D. Stapert 1996. A new tool for spatial analysis: 'Rings and Sectors 3.1 plus Density Analysis and Trace Lines'. In: H. Kamermans and K. Fennema (eds), *'Interfacing the Past'. Computer applications and quantitative methods in Archaeology. Proceedings of the 23rd CAA conference held at Leiden University, Leiden 31st March – 2nd April 1995*, Leiden (Analecta Praehistorica Leidensia 28), 241-250.

Bordes, F. 1961. *Typologie du Paléolithique ancien et moyen*, Bordeaux.

Conard, N.J. and D.S. Adler 1997. Lithic reduction and hominid behaviour in the Middle Palaeolithic of the Rhineland. *Journal of Anthropological Research* 53, 147-175.

Cornford, J.M. 1986. Specialized resharpening techniques and evidence of handedness. In: P. Callow and J.M. Cornford (eds), *La Cotte de St-Brelade, Jersey. Excavations by C.M.B. McBurney 1961-1978*, Norwich, 337-351.

Cziesla, E. 1986. Uber das Zusammenpassen von geschlagener Steinartefakte. *Archäologisches Korrespondenzblatt* 16, 251-265.

Cziesla, E. 1990. On refitting stone artefacts. In: E. Cziesla, N. Eickhoff, N. Arts and D. Winter (eds), *The Big Puzzle: International Symposium on Refitting Stone Artefacts*, Bonn, 9-44.

De Loecker, D. 2006. *Beyond the Site. The Saalian Archaeological Record at Maastricht-Belvédère (the Netherlands)*, University of Leiden, Leiden (Analecta Praehistorica Leidensia 35/36).

De Loecker, D. and W. Roebroeks 1998. Excavating 'empty' square meters at Maastricht-Belvédère, Site N (The Netherlands): implications for our understanding of the Middle Palaeolithic record. *Proceedings of the XIII U.I.S.P.P. Congress (8-14 September 1996, Forli, Italy) Volume 6 - Tome I*, 269-278.

De Loecker, D., J. Kolen, W. Roebroeks and P. Hennekens 2003. 'Refitter's Paradise: on the conjoining of artefacts at Maastricht-Belvédère (The Netherlands). In: N. Moloney and M.J. Shott (eds), *Lithic Analysis at the Millennium*, London, 113-136.

Dibble, H.L. 1995. Middle Paleolithic scraper reduction: Background, clarification, and review of the evidence to date. *Journal of Archaeological Method and Theory* 2, 299-368.

Duistermaat, H. 1987. *Voorlopig resultaat van een malacologische analyse van een profiel uit Site G van de Belvédère*, Leiden (unpublished typescript, Institute of Archaeology, University of Leiden).

Féblot-Augustins, J. 1993. Mobility Strategies in the Late Middle Palaeolithic of Central and Western Europe: Elements of Stability and Variability. *Journal of Anthropological Archaeology* 12, 211-265.

Féblot-Augustins, J. 1999. Raw material transport patterns and settlement systems in the European Lower and Middle Palaeolithic: Continuity, change and variability. In: W. Roebroeks and C. Gamble (eds), *The Middle Palaeolithic Occupation of Europe*. University of Leiden, Leiden, 193-214.

Floss, H. 1994. *Rohmaterialversorgung im Paläolithikum des Mittelrheingebietes*, Habelt, Bonn (Monographien des Römisch-Germanischen Zentralmuseums Mainz 21).

Foley, R. 1981a. Off-site archaeology: an alternative approach for the short-sited. In: I. Hodder, G. Ll. Isaac and N. Hammond (eds), *Pattern of the Past: Studies in Honour of David Clarke*, Cambridge, 157-183.

Foley, R. 1981b. A model of regional archaeological structure. *Proceedings of the Prehistoric Society* 47, 1-7.

Frison, G.C. 1978. *Prehistoric Hunters of the High Plains. New York*, Academic Press.

Frison, G.C. 1989. Experimental use of Clovis weaponry and tools on African elephants. *American Antiquity* 54, 766-784.

Geneste, J.M. 1985. *Analyse lithique d'industries moustériennes du Périgord: une approche technologique du comportement des groupes humaines au Paléolithique moyen*, Bordeaux (Thèse Sc., University of Bordeaux, Bordeaux I).

Gijn, A.L. van 1988. Appendix I. A functional analysis of the Belvédère flints. In: W. Roebroeks (ed.), *From Find Scatters to Early Hominid Behaviour. A Study of Middle Paleolithic Riverside Settlements at Maastricht-Belvédère (The Netherlands)*, Leiden, Leiden University Press (Analecta Praehistorica Leidensia 21), 151-157.

Gijn, A.L. van 1989. *The wear and tear of flint, principles of functional analysis applied to Dutch neolithic assemblages*, Leiden, Leiden University Press (Analecta Praehistorica Leidensia 22).

Hallos, J. 2005. "15 Minutes of Fame": exploring the temporal dimension of Middle Pleistocene lithic technology. *Journal of Human Evolution* 49, 155-179.

Hughes, S.S. 1998. Getting to the Point: evolutionary change in prehistoric weaponry. *Journal of Archaeological Method and Theory* 5, 345-408.

Huxtable, J. 1993. Further thermoluminiscence dates for burnt flints from Maastricht-Belvédère and a finalised thermoluminiscence age for unit IV Middle Palaeolithic sites. *Mededelingen Rijks Geologische Dienst* 47, 41-44.

Isaac, G.Ll. 1978. Food sharing and human evolution: archaeological evidence from the Plio-Pleistocene of East-Africa. *Journal of Anthropological Research* 34, 311-325.

Isaac, G.Ll. 1981. Stone age visiting cards; approaches to the study of early land use patterns. In: I. Hodder, G. Ll. Isaac and N. Hammond (eds), *Pattern of the Past: Studies in Honour of David Clarke*, Cambridge, 131-155.

Isaac, G.Ll. and J.W.K. Harris 1978. Archaeology. In: M.G. Leakey and R.E.F. Leakey (eds), *Koobi Fora Research Project. Volume 1, The Fossil Hominids and an Introduction to their Context, 1968-1974*, Oxford, 47-76.

Isaac, G.Ll. and D. Crader 1981. To What Extent Were Early Hominids Carnivorous - An Archaeological Perspective. In: R.S.O. Harding and G. Teleki (eds), *Omnivorous Primates: Gathering and Hunting in Human Evolution*, New York, 37-103.

Isaac, G.Ll., J.W.K. Harris and F. Marshall 1981. Small is informative: the application of the study of mini-sites and least-effort criteria in the interpretation of the early Pleistocene archaeological record at Koobi Fora, Kenya. In: J.D. Clark and G.Ll. Isaac (eds), *Las Industrias más Antiguas. X Congreso de la Unión Internacional de Ciencias Prehistóricas y Protohistóricas, México*, 101-119.

James, S.R. 1989. Hominid use of fire in the Lower and Middle Pleistocene: A review of the evidence. *Current Anthropology* 30, 1-26.

Keeley, L.H. 1980. *Experimental Determination of Stone Tool Uses: A Microwear Analysis*, University of Chicago Press, Chicago.

Kolfschoten, T. van 1985. The Middle Pleistocene (Saalian) and Late Pleistocene (Weichselian) mammal faunas from Maastricht-Belvédère (Southern Limburg, the Netherlands). *Mededelingen Rijks Geologische Dienst* 39 (1), 45-74.

Kolfschoten, T. van 1990. The evolution of the mammal fauna in The Netherlands and the middle Rhine area (Western Germany) during the late Middle Pleistocene. *Mededelingen Rijks Geologische Dienst* 43 (3), 13-21.

Kolfschoten, T. van 1993. The mammal fauna from the interglacial deposits at Maastricht-Belvédère. *Mededelingen Rijks Geologische Dienst* 47, 51-60.

Kolfschoten, T. van, W. Roebroeks and J. Vandenberghe 1993. The Middle and Late Pleistocene sedimentary and climate sequence at Maastricht-Belvédère: The type locality of the Belvédère interglacial. *Mededelingen Rijks Geologische Dienst* 47, 81-91.

Mazza, P.P.A., F. Martini, B. Sala, M. Magi, M.P. Colombini, G. Giachi, F. Landucci, C. Lemorini, F. Modugno and E. Ribechini 2006. A new Palaeolithic discovery: tar-hafted stone tools in a European Mid-Pleistocene bone-bearing bed. *Journal of Archaeological Science* 33 (9), 1310-1318.

McCrone, J. 2000. Fired up: Theory on when prehistoric man first used fire. *New Scientist* 166 (2239), 30-35.

Meignen, L., A. Delagnes and L. Bourguignon 2009. Patterns of lithic material procurement and transformation during the Middle Paleolithic in Western Europe. In: B. Adams and B.S. Blades (eds), *Lithic Materials and Paleolithic Societies*, Blackwell Publishing, 15-24.

Meijer, T. 1985. The pre-Weichselian non-marine molluscan fauna from Maastricht-Belvédère (Southern Limburg, the Netherlands). *Mededelingen Rijks Geologische Dienst* 39 (1), 75-103.

Meijer, T. and P. Cleveringa 2009. Aminostratigraphy of Middle and Late Pleistocene deposits in The Netherlands, with notes on published data from the southern part of the North Sea Basin. *Global Planet Change* 68, 326-345.

Phillibert, S. 1994. L'ocre et le traitement des peaux: Révision d'une conception traditionelle par l'analyse fonctionelle des grattoirs ocrés de la Balma Margineda (Andorre). *Anthropologie* 98, 447-453.

Roebroeks, W. 1988. *From Find Scatters to Early Hominid Behaviour. A Study of Middle Paleolithic Riverside Settlements at Maastricht-Belvédère (The Netherlands).* Leiden, Leiden University Press (Analecta Praehistorica Leidensia 21).

Roebroeks, W. and A. Tuffreau 1999. Palaeoenvironment and settlement patterns of the Northwest European Middle Palaeolithic. In: W. Roebroeks and C. Gamble (eds), *The Middle Palaeolithic Occupation of Europe*. University of Leiden, Leiden, 121-138.

Roebroeks, W. and P. Villa 2011. On the earliest evidence for habitual use of fire. *Proceedings of the National Academy of Sciences* 108 (13), 5209-5214.

Roebroeks, W., J. Kolen and E. Rensink 1988. Planning depth, anticipation and the organization of Middle Palaeolithic technology: the 'archaic natives' meet Eve's descendants. *Helinium* 28, 17-34.

Roebroeks, W., D. De Loecker, P. Hennekens and M. van Ieperen 1992. 'A veil of stones': on the interpretation of an Early Middle Palaeolithic low density scatter at Maastricht-Belvédère (The Netherlands). *Analecta Praehistorica Leidensia* 25, 1-16.

Roebroeks, W., M.J. Sier, T.K. Nielsen, D. De Loecker, J.M. Parés, C.E.S. Arps and H. Mücher 2012. Use of red ochre by early Neandertals. *Proceedings of the National Academy of Sciences* 109 (6), 1889-1894.

Rots, V. 2009. The functional analysis of the Mousterian and Micoquian assemblages of Sesselfelsgrotte, Germany. Tool use and Hafting in the European Late Middle Paleolithic. *Quartär* 56, 37-66.

Rots, V. in press. Hafting and site function in the European Middle Palaeolithic. In: N. Conard (ed.), *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age*, Vol. 4, Kerns Verlag, Tübingen.

Rots, V. and D. De Loecker in prep. *Functional analysis of site K at Maastricht-Belvédère*.

Schlanger, N. 1994. *Flintknapping at the Belvédère: Archaeological, Technological and Psychological Investigations at the early Palaeolithic Site of Maastricht-Belvédère (Limburg, The Netherlands)*, Cambridge (unpublished PhD thesis University of Cambridge).

Schlanger, N. 1996. Understanding Levallois: Lithic Technology and Cognitive Archaeology. *Cambridge Archaeological Journal* 6 (2), 231-254.

Shelley, P.H. 1990. Variation in Lithic Assemblages: An Experiment. *Journal of Field Archaeology* 17, 187-193.

Stapert, D. 1989. The Ring and Sector Method: Intrasite Spatial Analysis of Stone Age Sites, with Special Reference to Pincevent. *Palaeohistoria* 31, 1-57.

Stapert, D. 1990. Middle Palaeolithic dwellings: Fact or fiction? Some applications of the ring and sector method. *Palaeohistoria* 32, 1-36.

Stapert, D. 1992. *Ring and Sectors: Intrasite Spatial Analysis of Stone Age Sites*, Groningen (unpublished PhD thesis University of Groningen).

Stapert, D. 2006. Jeugdige vuursteenbewerkers bij het kampvuur: een andere visie op Maastricht-Belvédère, Site K. (L.). *Paleo-Aktueel* 17, 9-17.

Stapert, D. 2007a. Youngsters knapping flint near the campfire: an alternative view of Site K at Maastricht-Belvédère (the Netherlands). *Archäologisches Korrespondenzblatt* 37, 19-35.

Stapert, D. 2007b. Neanderthal children and their flints. *PalArch's Journal of archaeology of northwest Europe* 1, 2, 16-39.

Stapert, D. and L. Johansen 1995. Ring & sector analysis, and site 'IT' on Greenland. *Palaeohistoria* 37/38, 29-69.

Stern, N. 1991. *The Scatters-Between-the-Patches: A Study of Early Hominid Land Use Patterns in the Turkana Basin, Kenya*, Massachusetts (unpublished PhD thesis Harvard University Cambridge).

Stern, N. 1993. The Structure of the Lower Pleistocene Archaeological Record. A Case Study from the Koobi Fora Formation. *Current Anthropology* 34, 201-225.

Stern, N. 1994. The implication of time-averaging for reconstructing the land-use patterns of early tool-using hominids. *Journal of Human Evolution* 27, 89-105.

Van Peer, Ph. 1992. *The Levallois Reduction Strategy*, Madison Wisconsin (Monographs in World Archaeology 13).

Villa, P. 2010. A view from Western Europe. In: N. Alperson-Afil and N. Goren-Inbar (eds), *The Acheulian Site of Gesher Benot Ya'aqov, Volume II. Ancient Flames and Controlled Use of Fire*, Springer, London, 9-13.

Wadley, L., T. Hodgskiss and M. Grant 2009. Implications for complex cognition from the hafting of tools with compound adhesives in the Middle Stone Age, South Africa. *Proceedings of the National Academy of Science* 106 (24), 9590–9594.

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