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Human presence in the central Netherlands during early MIS 6 (~170-190 Ka): evidence from early Middle Palaeolithic artefacts in ice-pushed Rhine-Meuse sediments

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Abstract

Part of the gravelly deposits of a combined Rhine-Meuse river of Middle Pleistocene age in the central Netherlands contains early Middle Palaeolithic artefacts. Although not in their original position, a significant part of these artefacts is hardly abraded, indicating limited fluvial transport. The artefacts have mainly been made from fluvial flint gravel boulders, originating from the Meuse catchment. Thus far, inferences for the age of the artefacts are based on the stratigraphic context and floral and faunal remains, which suggest a MIS 7 age. In this paper, OSL dating carried-out in the framework of a research aimed at the paleogeographical reconstruction of the Rhine-Meuse fluvial system in the central Netherlands and a review of published data are used to provide absolute age constraints for the artefact-bearing deposits. It is argued that the deposits were formed during the glacial phase directly preceding the Drenthe substage of the late Saalian (early MIS 6), and that at least a part of the artefacts has approximately the same age.

Keywords: Rhenen, artefacts, late Saalian, MIS 6, the Netherlands

Introduction

The ice-pushed ridges in the central Netherlands are find spots of early Middle Palaeolithic artefacts, especially the ridges surrounding the Gelderse Vallei (the Utrechtse Heuvelrug and Wageningen-Lunteren ridge; Fig. 1). Thousands of artefacts have been found, mainly in quarries. The artefacts (mainly scrapers, see below) show little variation throughout the find area, and seem to occur in one stratigraphic position. Stapert (1987) has proposed the name 'Rhenen Industry' for the artefacts. A complicating factor is that the artefacts are not in-situ but are part of the gravelly lag of fluvial deposits.

The ice-pushed ridges were formed during the maximum expansion phase of the Scandinavian Saalian ice-sheet (Marine Isotope Stage (MIS) 6; Fig. 2). Internally, the ridges consist of syn- and pre-glacial deposits which have been folded and faulted. They consist of Lower and Middle Pleistocene sediments of the Rhine-, Meuse- and Baltic (Eridanos) rivers, as has been demonstrated in sand- and gravel pits, and in railway- and road cuts. The youngest part of pre-glacial sequence has been laid down by a combined Rhine-Meuse fluvial system. In several quarries and exposures this unit showed a gradual transition to syn-glacial, sandur deposits (Ruegg & Burger, 1999; Ruegg, 1991; Ruegg, 2008). Archaeological research carried out in sand and gravel pits revealed that the artefacts occur near the base of this Rhine-Meuse unit (Stapert, 1987, 1991).

Until now the absolute age of the Rhenen Industry is uncertain. Pollen, molluscs and other faunal remains point to interglacial conditions for a deposit underlying the artefact-bearing sediments in the quarry Wageningen-Fransche Kamp (Van Kolfschoten, 1991; Meijer 1991). Based on its stratigraphic position (the first interglacial pre-dating MIS 6), the interglacial is correlated to MIS 7. The assumption thus far is that the artefacts were made during this time-period, although they were never found in these deposits. The sediments at the Wageningen-Fransche Kamp pit have also been tentatively correlated to the Hoogeveen Interstadial (Zagwijn, 1973), and to the Belvédère Interglacial (Van Kolfschoten et al., 1993).

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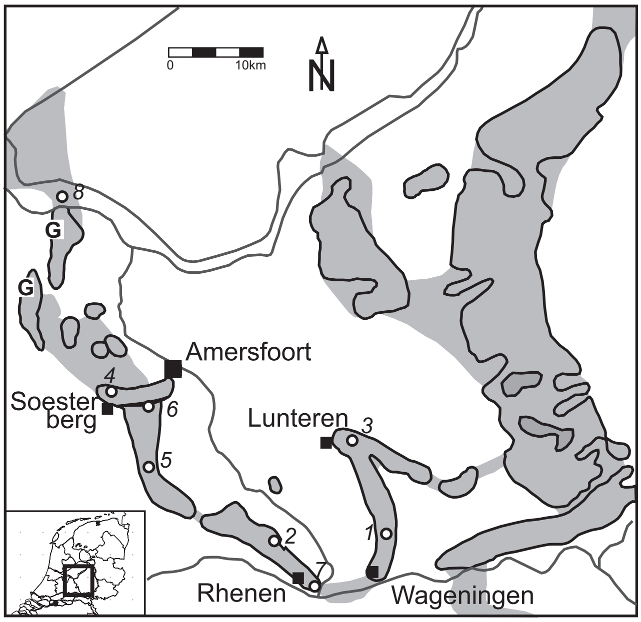

Fig. 1. Map of the Gelderse Vallei and surrounding ice-pushed ridges, with the main find spots indicated. 1 – Fransche Kamp (Wageningen), 2 – Kwintelooijen (Veenendaal), 3 – De Goudsberg (Lunteren), 4 – De Paltz (gr. Tammer, Soesterberg), 5 – Zanderij (Maarn), 6 – Ecoduct (Leusderheide), 7 – Kesteren (Rhenen), 8 – Gooimeer (dredging 'quarries'), G = scattered surface finds. Modified after Stapert (1987).

The latter correlations are however uncertain since these interstadials have been defined at other locations, even outside the central Netherlands. In addition, these correlations are not very helpful since the Hoogeveen Interstadial has not been dated absolutely, and the absolute age of the Belvédère Interglacial is subject of discussion (Schokker et al., 2005; Meijer & Cleveringa, 2009). In this paper we will use results from a new OSL supported paleogeographic study and a review of published data to further constrain the absolute ages of the deposits and the artefacts.

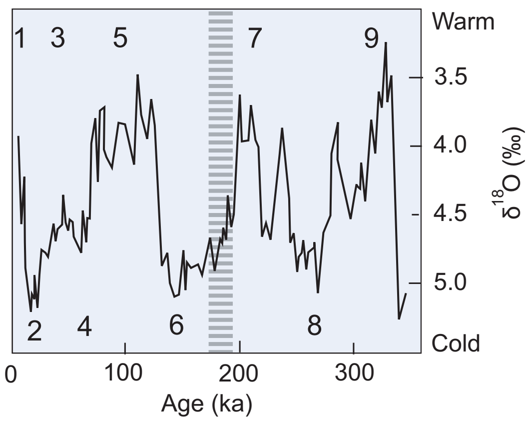

Fig. 2. The ODP 677 benthonic $\delta^{18}O$ curve proxy as an illustration of the evolution of climate during the past 350 Ky (based on Shackleton et al., 1990; Schokker et al., 2005). Numbers represent marine isotope stages (MIS). The thick dashed line indicates the approximate age of the artefacts.

Previous work

Stapert (1987, 1991) has given excellent overviews of the results obtained from the archaeological research in quarries. The artefacts are characterized by the Levallois technique. The tools are dominated by scrapers (Fig. 3; Stapert, 1987; Van Zon, 2008). Additionally, bifaces, denticulates and notches occur, and Mousterien points and handaxes are rare. The artefacts are made from fluvial gravel and boulders. Flint is the dominant lithology, but also quartzite and lydite have been utilized. The average core-size is 5-11 cm, and cores up to a length of about 20 cm have been found (De Moor, 2008). In one of the investigated collections there are indications for a geographic trend in artefact size, decreasing in size from south to north, which would be in line with an expected fluvial gravel size trend (Van Balen et al., 2007).

Based on Stapert, we assume that there is only one artefact-bearing deposit, which can be correlated between different quarries and other exposures. The artefacts occur at or near the base of a coarse-grained unit, in very coarse gravel lag deposits.

b.

Fig. 3. Examples of artefacts of the 'Rhenen Industry'. a. Scraper (Maarn); b. Mousterien point (de Paltz). Both examples are from the collection of Jonny Offerman-Heykens.

In the quarry Kwintelooijen this unit contains frost-weathered pebbles and gravel originating from Scandinavia (Zandstra, 1971). In the pit Wageningen-Fransche Kamp the unit also contains fragmented pebbles, and in addition to that a syn-genetic ice-wedge cast and a large rock fragment (0.7 m) suggesting transport by means of ice-rafting (Ruegg, 1991). In several quarries and exposures the unit showed a gradual transition to syn-glacial deposits (Ruegg & Burger, 1999; Ruegg, 1991; Ruegg, 2008). The sedimentary structures indicate deposition by a braided river type (Ruegg, 1991, 2008). Altogether, this indicates that the unit was laid down during cold conditions, prior to the Saalian ice advance in the central Netherlands.

The faunal remains in the unit represent a mixture of warm and cold elements, which can only be the result of reworking of older deposits (Stapert, 1987). Cold fauna is represented by *Mammuthus primigenius*, *Coelodonta antiquitatis* and *Ovibos moschatus*. Remains of *Elephas namadicus*, *Dicerorhinus kirchbergensis*, *Sus scrofa* and *Cervus elephas* are examples reflecting a more temperate climate (see Van Kolfschoten, 1981, for a complete overview). Interestingly, a Mammuthus mandibula found in Maarn in the 1930's showed traces of butchering (Stapert, 1987). In the pit Leccius de Ridder, where the artefact-bearing unit was also present (Stapert, 1981), the basal part contains (reworked?) clay layers and clay lumps besides large (ice-rafted) blocks (>0.3 m; De Jong 1981), comparable to the situation in Kwintelooijen (Ruegg, 1981). One of the clay layers contains molluscs and molars of *Arvicola terrestris*, pointing at interglacial conditions during the original (and thus older) deposition of the clay (Van Kolfschoten, 1991). Importantly, the evolutionary stage of *Arvicola terrestris* in this site is younger than those encountered at Maastricht Belvédère (Van Kolfschoten et al., 1993), which has been absolutely dated at ~250 Ka (late MIS 8, early MIS 7) (see below).

Recently Meijer & Cleveringa (2009) have reviewed and re-analyzed the AAR (amino acid racemization) data of fossil molluscs of the Netherlands. This resulted in a new proposition for the age of the deposits underlying the artefacts in the quarry Wageningen-Fransche Kamp. The age estimate results from correlation of groups of AAR data, AAR zones, to the marine oxygen-isotope curves. The AAR zone of molluscs in the clay underlying the artefacts in Wageningen-Fransche Kamp (zone D) would correlate to MIS 9, an age that implies a hiatus between formation of the clay and deposition of the overlying artefact-bearing level. Although this reasoning would have no direct implications for our interpretation of the age of the artefacts, we still would like to point out that we disagree with Meijer & Cleveringa's interpretation of the ages these sites. Meijer & Cleveringa (2009) suggest that their AAR zone C correlates to early MIS 7 on basis of OSL ages published by Wallinga (2001). As a result they assume that their AAR zone D, and therefore both the Maastricht Belvédère and Wageningen-Fransche Kamp, must predate MIS 7 and hence would correlate to MIS 9. The uncertainty associated to the quartz OSL ages does however not allow such detailed intra MIS stage correlations to be performed, making a late MIS 7 age for AAR zone C also possible. Besides, the OSL ages have been revised and may also be older as indicated by two papers from Busschers et al. (2007, 2008). Even more problematic is that their renewed age suggestions for the Maastricht Belvédère and Wageningen-Fransche Kamp are in conflict with all currently available absolute dating constraints at the first site. Thermo-luminescence and ESR dating at Maastricht Belvédère both suggest an MIS 7 age (Roebroecks, 1988; Huxtable, 1993; Huxtable & Aitken 1985). Secondly, a heavy mineral change of Meuse sediments found at the Belvédère site, related to an abrupt change in the Meus headwaters catchment, has been dated by uranium series dating on speleothems further upstream, near Toul. The results there give an age range of 250-270 ky indicating an MIS 7/8 age for this event and hence most likely an MIS 7 age for the overlying interglacial sediments (Cordier et al., 2009).

Rhine-Meuse paleogeography

Recently, the Middle Pleistocene paleogeographic evolution of the Rhine and Meuse fluvial system in the central Netherlands has been analysed by Busschers et al. (2008; Fig. 4). Based on sedimentary analyses of continuous cores and OSL dating, they provide a reconstruction of the interaction between the Saalian ice-margin and the Rhine-Meuse river system. The age of the studied stack of sediments as a whole is constrained by bracketing dates from the Eemian sediments (~130 Ka, Busschers et al., 2007) and by the Ar/Ar dated Middle Pleistocene Eifel volcanic events incorporated in the heavy mineral part of the Rhine deposits (since 490 Ka; Boenigk and Frechen, 2001, 2006). Busschers et al (2008) discriminated 3 units that predated the maximum ice-sheet expansion (Amersfoort stadium; Busschers et al., 2008). The presence of augite and a quartz OSL date indicate that the oldest unit, S1, is younger than 490 ka. Based on gravel petrography and heavy mineral content, the next younger unit, S2, is a Meuse dominated deposit (contemporaneous Rhine deposits were laid down in the northeastern part of the Netherlands). Therefore, and because of its geographic extent, it can be correlated to the Beegden Formation (formerly the Veghel Formation; Doppert et al., 1975) situated to the south-southeast of our study area, on the Peel Block and in the Roer Valley Graben. Unit S2 has quartz OSL ages indicating deposition between 400 and 250 ka (MIS 11 to 8).The last unit that formed prior to the maximum ice-sheet expansion phase is Unit S3 (Busschers et al., 2008). The presence of large Meuse-derived boulders and gravel mixed within a Rhine dominated matrix suggests this is a mixed Rhine-Meuse deposit. One successful OSL age on a sample in a temporary exposure along the A28 motorway (Van Balen et al., 2006) indicated an age of 168±19 Ka pointing at deposition during MIS 6. Unit S3 contains the artefacts (Van Balen et al.,

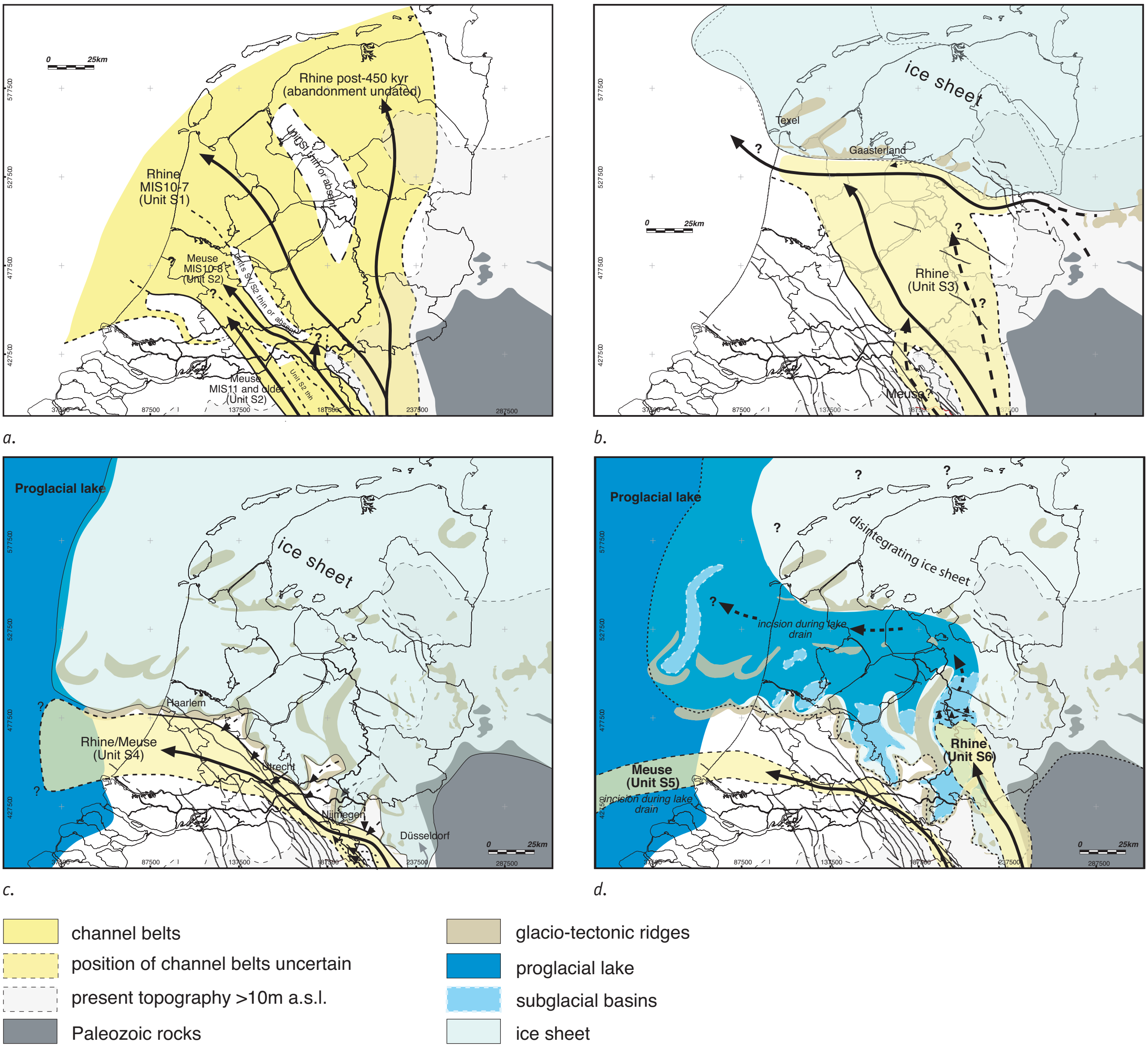

Fig. 4. Four phases in the drainage development of the Rhine-Meuse system in the Netherlands prior to and during the late Saalian glaciation (MIS11-6; modified after Busschers et al., 2008). The artefacts are situated in deposits of unit S3 (B).

2007; Busschers et al., 2008) and is regarded the equivalent of the coarse-grained Rhine unit described above.

The last unit of interest, Unit S4, has again been recognized in cores in the central Netherlands. It is laterally connected to the fluvio-glacial (sandur) deposits fringing the ice-pushed ridges, and it contains gravels of northern (Scandinavian) provenance. This is in agreement with OSL results indicating an age of 130-160 Ka, indicating deposition during MIS 6.

Fluvial conditions during deposition of the artefact-bearing deposits

The paleogeographic reconstructions presented above indicate that the artefact-bearing unit was deposited during the early stage of the Saalian ice advance in the Netherlands. This is in agreement with indicators for cold climatic conditions like the ice-wedge cast, the frost weathered pebbles, and the ice-rafted blocks. This is also compatible with the coarseness of the deposits and the braided river type, indicating energetic fluvial conditions. The top of the depositional unit grades in to fluvio-glacial deposits. Because the Saalian glacial deposits in the Netherlands were laid down during one un-interrupted sequence of events (Rappol, 1987; Kluiving et al. 1991), the whole unit is likely to have been deposited during the Saalian ice advance in the Netherlands.

The Gelderse Vallei glacial basin and its surrounding ice-pushed ridges is a quite linear feature in the glacial landscape, with a NNW-SSE orientation, deviating from the general trend of ice-movement. This is best explained by assuming that the glacier ice which invaded the basin has used pre-existing

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morphology. Glaciers, or tongues of the advancing ice-sheet, will have invaded the lowest parts in the proglacial landscape. The only candidates for such low parts are incised fluvial valleys. The ice-pushed ridges surrounding the Gelderse Vallei contain a remarkable relatively large contribution of Meuse gravels (Maarleveld, 1953), which indicates that the river responsible for this possible incised valley was a combined Rhine-Meuse branch. In this hypothesis the artefact-bearing unit S3 was deposited in an incised valley, which was subsequently invaded by ice forming the surrounding ice-pushed ridges. The mechanisms causing the incised valley might be related to conditions of low base-level and high peak discharges and/or to incision in response to glacio-isostatic uplift during MIS 6. Similar valleys were formed later on through the central Netherlands during and following the deglaciation (Busschers et al., 2008). We consider the incised valley hypothesis for the Gelderse Vallei and its imprint on the ice-movement as additional, circumstantial evidence for deposition of the artefact-bearing unit during the Saalian ice-advance.

Discussion

The artefacts occur in fluvial gravel lags and have been transported, implying that they are older than the deposits in which they are situated. But, despite the transport, an important part of the artefacts have hardly been abraded (Stapert, 1987; De Moor, 2008; Van Zon, 2008; Van Homelen, 2009). During one of the archaeological excavations (Kwintelooijen), 17% of the artefacts turned out to be not or hardly abraded (Stapert, 1987). In one of the amateur-archeologist collections the percentage was 60% (Van Zon, 2008), which could be influenced by selective picking by the collector. Additionally, the absence of damage caused by frost-weathering implies that the artefacts have been buried rapidly and that they have not been exposed to surface conditions for long time periods (Van Homelen, 2009).

Harding et al. (1987) describe the results of an experiment in which modern facsimile handaxes were placed in a gravel-bed river. The handaxes were recovered after having been moved by flood water. Considerable damage was already noted after 57 m of transport. Edge damage stabilized and edge polish became developed after 150 m. The river in which the experiments were made was characterized by a relatively steep gradient (4 m/km), a median grain size of 16-32 mm and a peak discharge of 300 m^3/s. This gradient is much steeper and the peak discharge is much lower than what can be considered likely for the Rhine-Meuse river. In terms of energy, these two parameters have however opposite effects, so that the 'abrasiveness' of the river might be comparable to some extent. In any case, the experiment shows that the hardly abraded artefacts can not have experienced a large amount (kilometres) of transport. Although they are not in-situ, an important part of the artefacts are approximately at the spot where they were made.

Considering the age, there are two possibilities for the nearly intact artefacts. They can have been eroded from non-preserved deposits. This hypothesis requires a complete erosion of the original artefact-bearing deposits, since in none of the quarries or exposures this deposit has been encountered. This is at odds with the fact that these artefacts have hardly been abraded, implying short transport distances. Therefore this hypothesis is unlikely. The other possibility is that the artefacts have been made in the bed of the Rhine-Meuse river and they have been buried rapidly by contemporaneous fluvial deposition. In this more likely case the artefacts have the same age as the deposits.

A larger part of the artefacts is weathered and abraded. For them there are also two possibilities. First, they can have approximately the same age and history as the nearly intact artefacts, but they suffered more from transport. Second, they can be older, and thus they can have a more complex history of erosion, transport and redeposition. The assemblage of artefacts than has not one age, but instead it has an age span (Stapert, 1987). But, how much older can the artefacts be?

None of the units underlying the artefact-bearing layers contain gravel which is large enough to be used for artefact making (Stapert, 1981). It shows that the source material for the artefacts was not present in the study area before deposition of unit S3 during MIS 6. In addition, it should be kept in mind that during the temperate MIS 7, the supply of coarse gravels towards the river systems was likely limited due to a denser vegetation cover and lower periglacial activity in the catchment. Also, transport capacity of the rivers was likely smaller due to lower peak discharges and a reduction in gradients as a response to a high sea-level. Altogether these conditions do not favour transport of large pebbles and boulders into this area, which could be used by humans for making artefacts during MIS 7. The clay at Wageningen-Fransche Kamp and the reworked clay in the other pits represent the fine-grained deposits that we expect during MIS 7 (floodplain clays of meandering rivers). In contrast, the expedient style of the artefacts suggests the opposite to have been the case: there was no scarcity of suitable boulders and gravel at the time the artefacts were made (M. Langbroek, pers. comm. 2008).

Conclusions

We favour an age of the artefacts in the central Netherlands which is early MIS 6 (~170-190 Ka). Our interpretation is based on 1) an important part of the artefacts show no sign of significant transport; 2) the OSL-constrained paleogeography of Rhine and Meuse during the Middle Pleistocene; 3) the cold-climatic and coarse-grained nature of the artefact-bearing deposits; 4) the landscape- and fluvial conditions during MIS 6 and MIS 7. The makers of the artefacts lived in the central Netherlands during cold-climate conditions, in a braided river valley. They used the gravel and boulders abundantly available in the river bed to make their tools. The cold climate hypothesis is in agreement with the find of a Mammuthus mandibula with traces of butchering.

Human presence during glacial conditions may seem exceptional. However, our age proposition is in accordance with observations elsewhere in western Europe. Cranial remains of pre-Neanderthal origin in a crater filling in the East Eifel (close to the Rhine, Germany) have been assigned an early MIS 6 age (Von Berg et al., 2000). Intriguing is the fact that these fossils are associated with similar artefacts (scraper, discoid core and a flake) as in the central Netherlands, and made from the same rocks (respectively Meuse flints and quartzite). U-Th dating of mammoth-teeth associated with Middle Palaeolithic artefacts in terrace deposits of the Emsche (a tributary of the Rhine in northern Germany) provided pre-Eemian ages. The artefacts are made from glacially transported northern (Scandinavian) flints, which limits these pre-Neanderthals to the Warthe substage of the Saalian (very late MIS 6; Schmitz, 1990). MIS 6 age terrace gravels from the Somme river in NW France and the Tagus river in Spain contain abundant artefacts (references in Bridgland et al., 2006). Interestingly, a compilation of archaeological data from terraces in the UK shows that by MIS 6 humans had apparently disappeared from the British landscape (White et al., 2006). The reasons for the difference might be due to the large-scale paleogeographic changes triggered by the late Saalian glaciation(s) and formation of the Dover Strait (Busschers et al., 2008).

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