Human occupation of the Late and Early Post-Glacial environments in the Liereman Landscape (Campine, Belgium)

Bart Vanmontfort, Marijn Van Gils, Etienne Paulissen, Jan Bastiaens, Marc De Bie and Els Meirsman

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Abstract

Large-scale archaeological and palaeoenvironmental research in the Liereman Landscape (Landschap De Liereman) in the northern Campine (Belgium) revealed a very extensive and well-preserved prehistoric site complex at Arendonk Korhaan (fig. 1). Remains include Final Palaeolithic scatters associated with the Usselo horizon buried below aeolian sand overlain by podzol soil containing Mesolithic assemblages. The Korhaan site complex is a rare example in this coversand area where Final Palaeolithic and Mesolithic are separated stratigraphically. Combined with an intact toposequence (the Usselo horizon grading into peat deposits), this site offers unique potential for ongoing archaeological, geomorphological and palaeoecological research on Late Glacial and Early Holocene settlement systems. This paper outlines the discovery of the complex, presents some primary research results and discusses land use patterns of hunter-gatherers recurrently returning to persistent places across the Pleistocene-Holocene transition.

Keywords: Belgium, Campine region, archaeological survey, Usselo horizon, Late Glacial aeolian sand deposits, Final Palaeolithic, Mesolithic.

1 Introduction

The Final Palaeolithic and Mesolithic occupation of the Belgian Campine region has long been known only from surface collections and small-scale excavations. Archaeological research projects were conducted at site level, concentrating on data from one or a few artefact scatters. As a consequence of this approach it was generally accepted that Late Glacial and Early Holocene hunter-gatherers left discrete and variable artefact concentrations at distinct and widely separated spots in the landscape. Recently the research focus has shifted to a larger landscape-oriented scale. Large-scale fieldwork since 1999, using adapted survey methods, has revealed numerous well-preserved new sites and has placed known sites in a larger context. All evaluated sites since then have proved to be very extensive, sometimes spread over several kilometres, and always situated on dry surfaces, mostly on sand ridges along former marshes or open water. Their dimension and nature has led to the idea that these site complexes were 'persistent places' (Schlanger 1992), visited time and again by small groups of hunter-gatherers over a period of several centuries or even millennia. It is not yet clear, however, how these site complexes are positioned in the wider landscape and how they functioned in the hunter-gatherer settlement system.

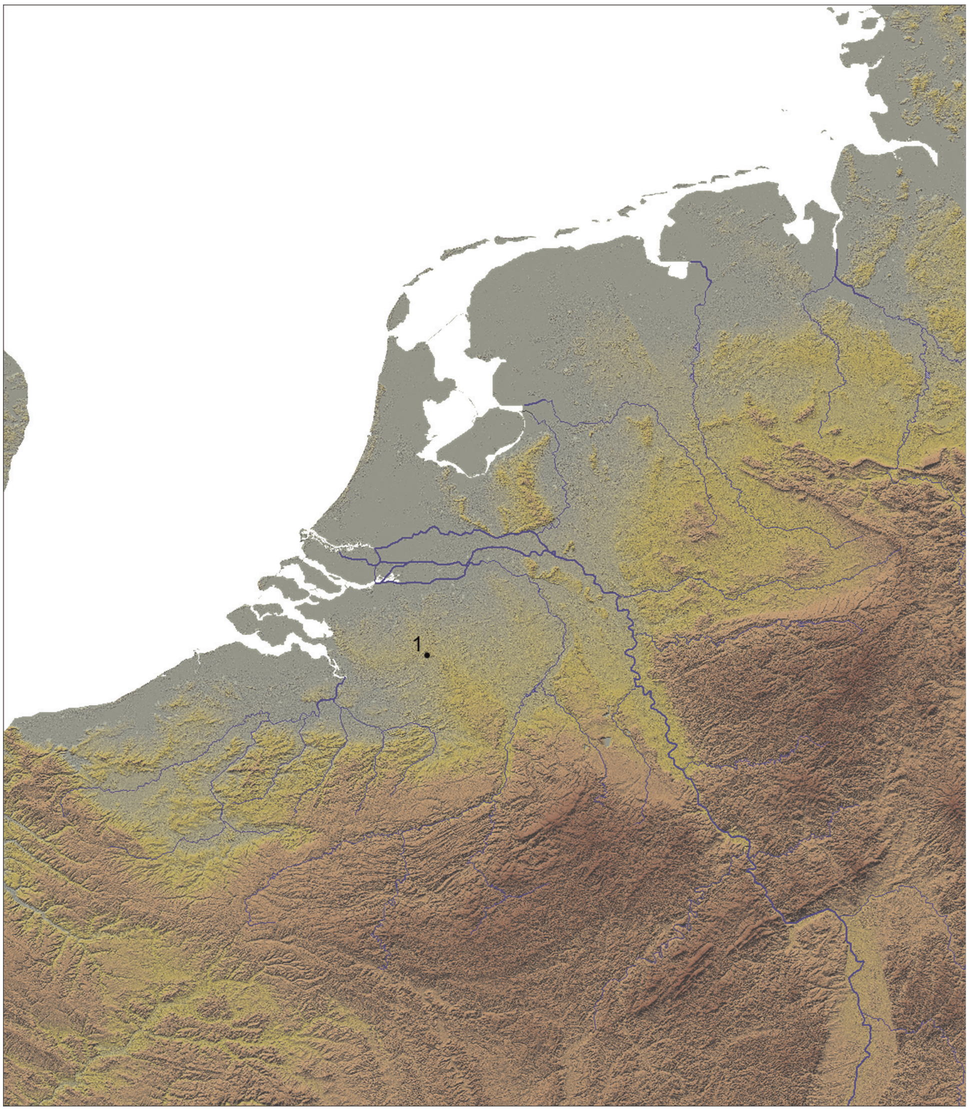

Fig. 1 Location of Arendonk Korhaan.

At Arendonk Korhaan, a Stone Age surface site in such a landscape context has been known since the early 20th century. Several finds were reported on a sand ridge bordering fens or in the immediate surroundings (fig. 2: 5, 6, 7). One of the most remarkable finds was a very rich but as yet unpublished site on a levelled field at approximately 1 km west of Korhaan (fig. 2: 8). This surface site apparently almost completely resulted from a Final Palaeolithic Federmesser occupation (C. Verbeek, pers. comm.).

The combination of these finds at and near Korhaan suggested the presence of an extensive site complex, rather than several individual sites. The actual extension of the site complex and the precise position of the archaeological remains in the landscape remained, however, unanswered. New fieldwork was conducted at the Arendonk site in 2003 and 2008 to answer these questions. This paper presents the first results and proposes new hypotheses regarding the Late Glacial and early Holocene settlement patterns at Korhaan in particular and in the coversand region in general.

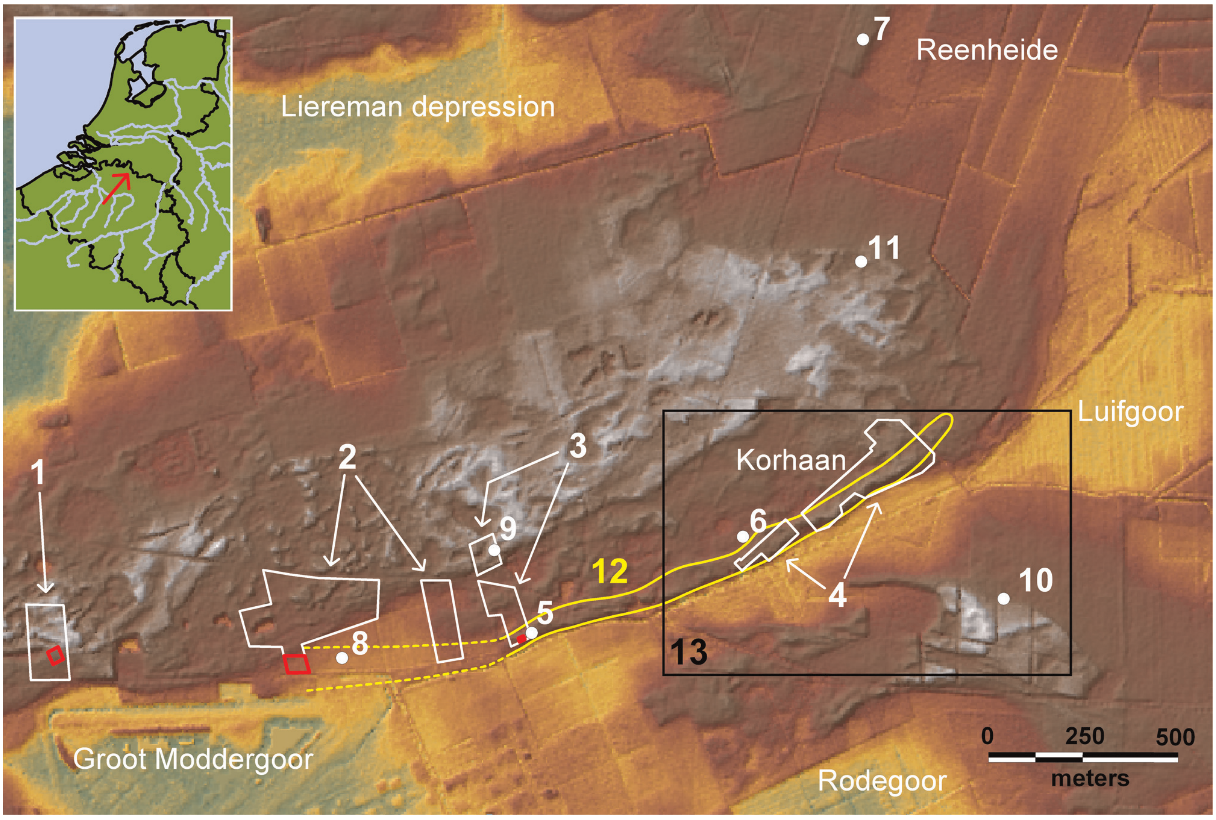

Fig. 2a Part of Landschap De Liereman on DEM constructed from Lidar data (© Flemish Community).
Zones:
1, 2, 3 White polygons: soil evaluation by 7 cm drillings; red polygons: surveyed by 20 cm drillings
4 Arendonk Korhaan, surveyed by 20 cm drillings
Surface and auger finds:
5 Oud-Turnhout Heihuisken, early 20th century
6 Arendonk Korhaan I-IV, Arendonk Reenheide IV (Heirbaut 1999)
7 Arendonk I, 82 DJ (Heirbaut 1999)
8 Oud-Turnhout Bergstraat
9 Surface and auger finds (Van Gils et al. 2009)
10 Surface and auger finds near Luifgoor depression (Van Gils & De Bie 2002)
11 Arendonk II, Reenheide I and II, Surface finds on arable land (Heirbaut 1999: 81 DI) and auger finds in forest
12 The Korhaan sand ridge
13 Figures 1b and 9

2 The setting

The Liereman Landscape is a 1020 ha nature reserve in the Belgian Northern Campine region (fig. 2). In this area podzols (spodosols) and peaty soils on coversands predominate. Central to this paper is a large southwest-northeast oriented dune complex with a typical blown sand topography consisting of a variety of low dunes and depressions of which the easternmost extension is situated in the municipality of Arendonk and known under the toponym Korhaan. To the east and south it is bordered by a number of depressions. Altitudes in the Liereman Landscape range from 29 m a.s.l. in the dune complex to 23 m in the depression.

Landschap De Liereman was formerly part of a vast heathland area with marshes and/or open water, as shown on 18th- and 19th-century maps (fig. 3). Sheep grazing and sod cutting were the main activities. From the 19th century onwards, most heathland and marshes have been reclaimed and transformed into arable land, grassland and pine forests. For reasons of habitat restoration, the pine forests in the dune belt are nowadays cut and the sods are removed to recreate heathland. There are no indications, archaeologically or otherwise, so far of human occupation of any importance after the prehistoric periods discussed in this paper.

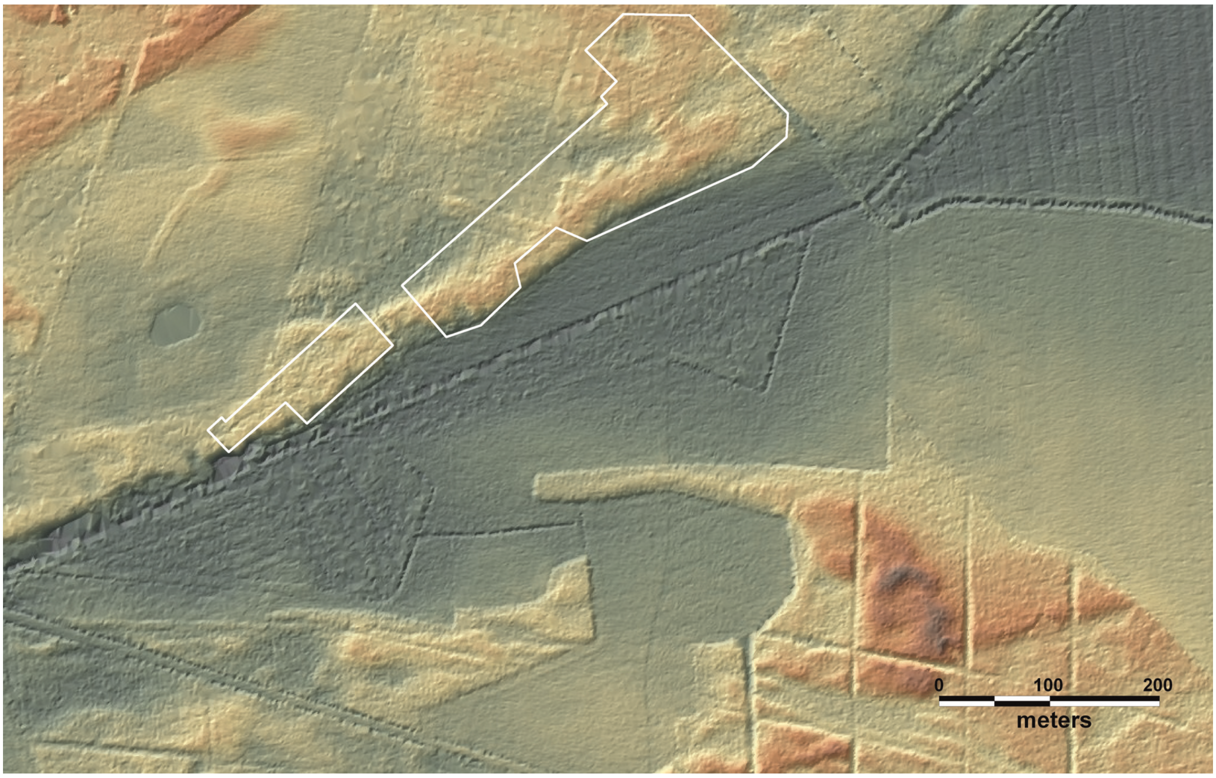

Fig. 2b Detail of the Korhaan sand ridge with zone 4.

Fig. 3 19th-century map depicting only parcels and land-use clearly showing wet depressions. The Korhaan sand ridge is indicated by the yellow line ("map of Belgium, reduction of the cadastral plans", 1852).

Fig. 4 The Korhaan sand ridge, covered with pine, as seen from the depression nowadays in use as grassland (Van Gils et al. 2009).

3 Methodology

The research strategy and field methods were designed to evaluate the prehistoric habitation on the local landscape level. Sampling through augering has proven very effective for this type of research (Bats 2007; De Bie & Van Gils 2009). It enables the investigation of large surfaces with a reasonable amount of fieldwork. Augering is aimed at identifying the locations of artefact concentrations. A restriction of this sampling technique is that it mostly yields undiagnostic artefacts and that a precise interpretation of the size of the identified concentration, its function, date or spatiotemporal homogeneity is not possible.

As the southern fringe of the dune complex of the Liereman Landscape proved too extended for complete coverage even with this methodology, several sample areas were selected at approximately regular intervals (fig. 2: 1-4: white polygons). The survey and evaluation research was conducted in three phases for which different field methods were employed.

First, a reconnaissance augering survey with a 7 cm diameter Edelman auger in a 50x50 m rectangular grid was conducted to locate zones where the pre-Holocene topography seemed (nearly) intact. The presence of a well-developed podzol soil on top of this topography was considered the key indicator for both the absence of recent human disturbance and of (sub-) recent deflation. Field observations and cartographical information on land-use, hydrography and topography were added. Detailed topographical information was derived from Lidar data, on the basis of which a digital elevation model (DEM) with 1m grid cells was constructed (fig. 2a and 2b).

In a second phase, selected zones where the palaeolandscape was thought to be well-preserved were investigated for the presence of archaeological remains (fig. 2: 1-3: red polygons; 4: white polygons). In a 5x6 m triangular grid, and for some peripheral areas in a 10x12 m grid, an Edelman auger with a 20 cm diameter was used to sample the deposits to an average depth of 85 cm, i.e. well below the B-horizon of the podzol. The sediment column of each core was divided in three equal parts in function of depth and sieved on a 3 mm mesh. Archaeological finds, sediment and soil characteristics were recorded.

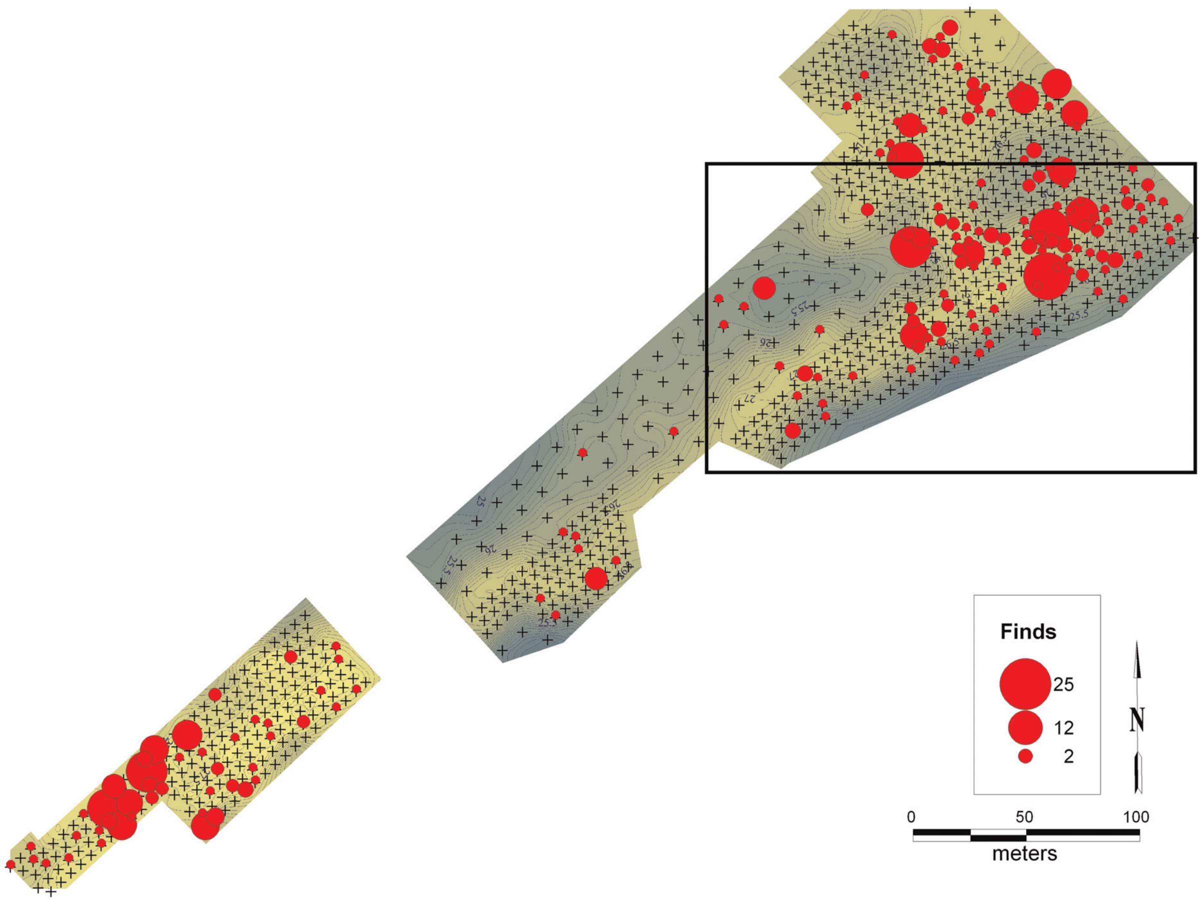

Fig. 5a Archaeological survey in zone 4 on elevation map (yellow: high; blue: low; heights were measured at each auguring location).
Red dots: corings with lithic artefacts, dot size correlates with the number of finds.
Crosses: other corings.
Black square: figure 5b.

Finally, test pits were dug in zones 2 and 4 to provide detailed information on the stratigraphical relation between the artefact scatters and the formation history of the ridge. More precise information was also expected on preservation conditions and scatter densities, and more diagnostic artefacts should improve the chrono-cultural identification. In zone 4, three pits and a coring transect from the top of the sand ridge towards the eastern depression were studied in detail (fig. 5b). The test pits were dug by trowelling, while the finds were recorded in three dimensions. Additionally, the sediment was sieved per square metre and per 10 cm on a 3 mm mesh.

A test pit in zone 4 confirmed a clear association of artefacts with a whitish horizon, which was interpreted as the result of a bleaching process typical for the Usselo horizon (see below). The horizontal extent of this horizon and the presence of associated artefact concentrations was prospected in a 0.5 ha area (fig. 5b: red line). The 20 cm Edelman corings were extended there to an average depth of 135 cm to trace the Usselo horizon, which was sieved separately when present. For transect drilling, a 3 cm gouge auger was used in order to maximise visibility as the bleached horizon was not always clearly visible.

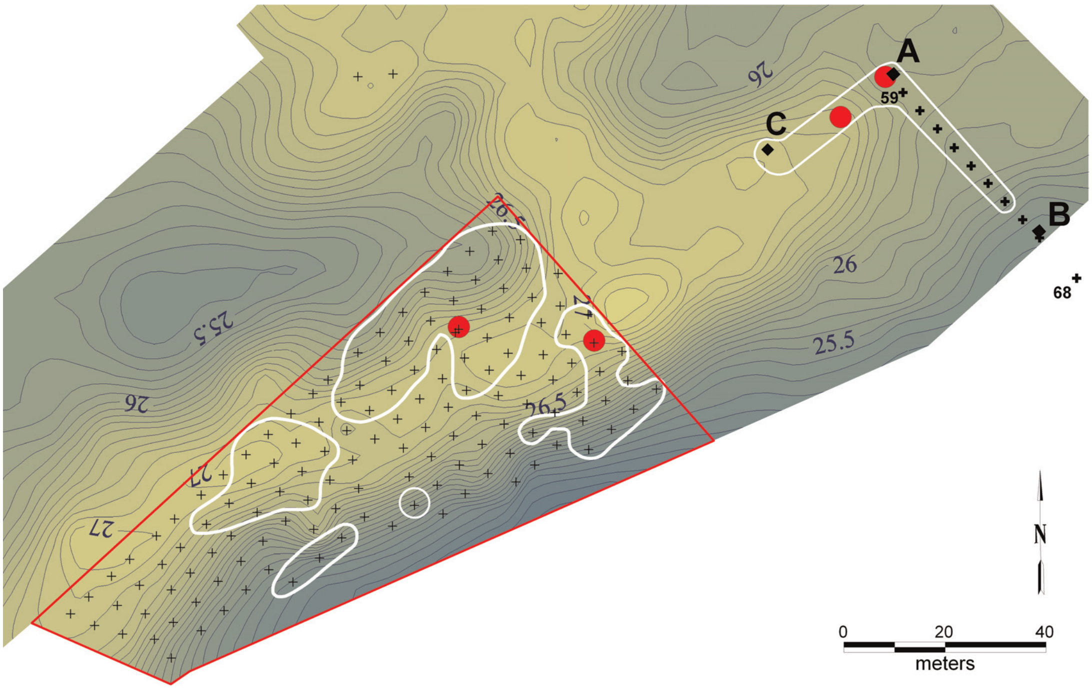

Fig. 5b Zone 4, northeastern part, with pits A-C.
Red line: systematic survey of Usselo horizon.
Small crosses: corings.
Thick crosses: transect of geomorphological corings (fig. 7).
White polygons: Usselo horizon attested.
Red circles: corings with lithic artefacts in Usselo horizon.

4 Geomorphology

4.1 Data

The three pits and the coring transect in zone 4 together provide a section with key information on the formation history of the Korhaan sand ridge. The complex history of the sand ridge is reflected by a series of lithological and pedological units (fig. 6: 10-3).

A coring in the bottom of pit A at 3.4 m below the current surface revealed (fig. 6: 13-11) a c. 10 cm thick organic sand layer containing macroscopic plant remains. They most likely represent a short interruption in aeolian activity prior to the ridge formation.

Crucial to the understanding of the ridge building processes is the 1.3 m thick sand deposit with unidirectional cross-bedding obliquely to the ridge below the Usselo horizon in pit A (fig. 6: 9). This structure is identical to sedimentary facies 4 as defined by Kasse (2002, and references therein), of which only a few examples have been attested in the Late Pleistocene aeolian deposits of Western Europe. This facies 4 is truncated by a veneer of coarse sands (fig. 6: 2) and covered by horizontally stratified sands (fig. 6: 8).

Layers 9, 8 and 2, which contain no artefacts, are interpreted as a single unit that reflects the dune building processes. The cross-bedded sands, which were built up by northwestern winds, correspond with the lee side of a dune progressing towards the southeast. As the dune progressed, windblown sands were transported over the windward side of the dune which was eroded, resulting in a lag formed by coarser grains on its top. The horizontally stratified sands were deposited at the end of the dune building process.

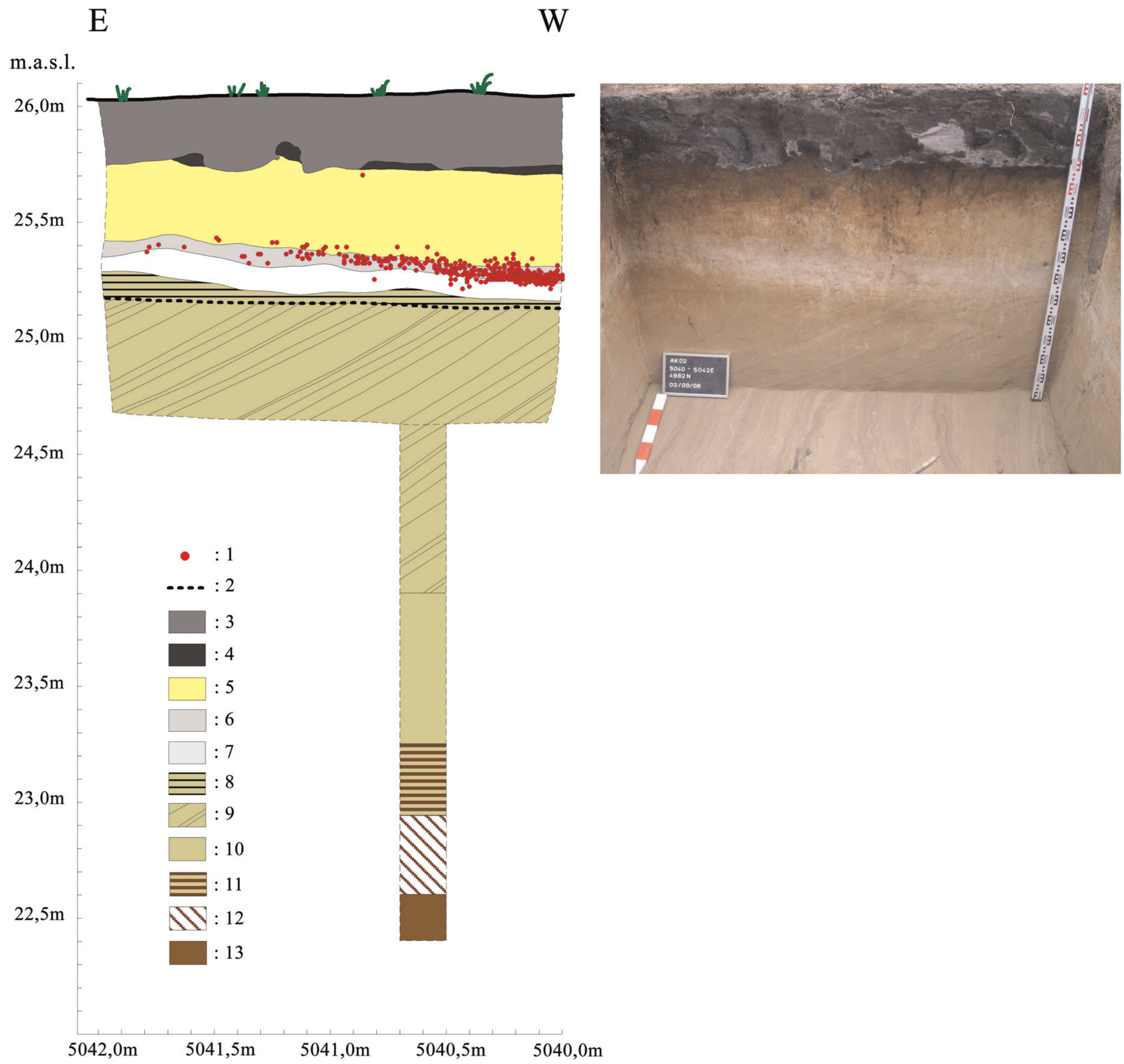

Fig. 6 Pit A, southern section: drawing and photograph, with coring below pit bottom.
1 *Lithic artefacts.*
2 *Deflation level, characterized by coarse sands.*
3 *Disturbed podzol horizons in aeolian sands.*
4 *In situ compact humic and iron B horizon of the podzol soil in aeolian sands.*
5 *BC and C horizon of the podzol soil in aeolian sands.*
6 *Whitish silty sand upper part of the Usselo horizon.*
7 *Whitish sand lower part of the Usselo horizon.*
8 *Horizontally stratified aeolian sands.*
9 *Unidirectional cross-laminated aeolian sands.*
10 *Sands with no visible layering.*
11 *Organic layer with macroscopic plant remains.*
12 *Sands with organic layers.*
13 *Reddish brown humic sands.*

In pit A, the 10 to 15 cm thick bleached horizon with few, very small and dispersed charcoal fragments on top of these sands (fig. 6: 7-6) is interpreted as the Usselo horizon. It is subdivided into two sub-units: a very pale sub-unit of pure sand at the base and a more greyish sub-unit containing about 5% silt at the top. The texture differences are based on detailed grain size analysis (not presented here). This profile, with low amounts of fine material, was sampled for micromorphological analysis (Derese *et al.* in press). The analysis was not conclusive on the processes that resulted in the whitish horizon. Illuvial textural features, composed of coarse or fine clay, are absent below the Usselo horizon but two lateral samples of the layered deposits directly underlying the Usselo horizon do include horizontal bands with brown limpid illuvial clay, recording the occurrence of clay illuviation in the area at some stage. Final Palaeolithic artefacts have been recovered from this horizon in pit A and in the test pits in zone 2 (fig. 6: 1).

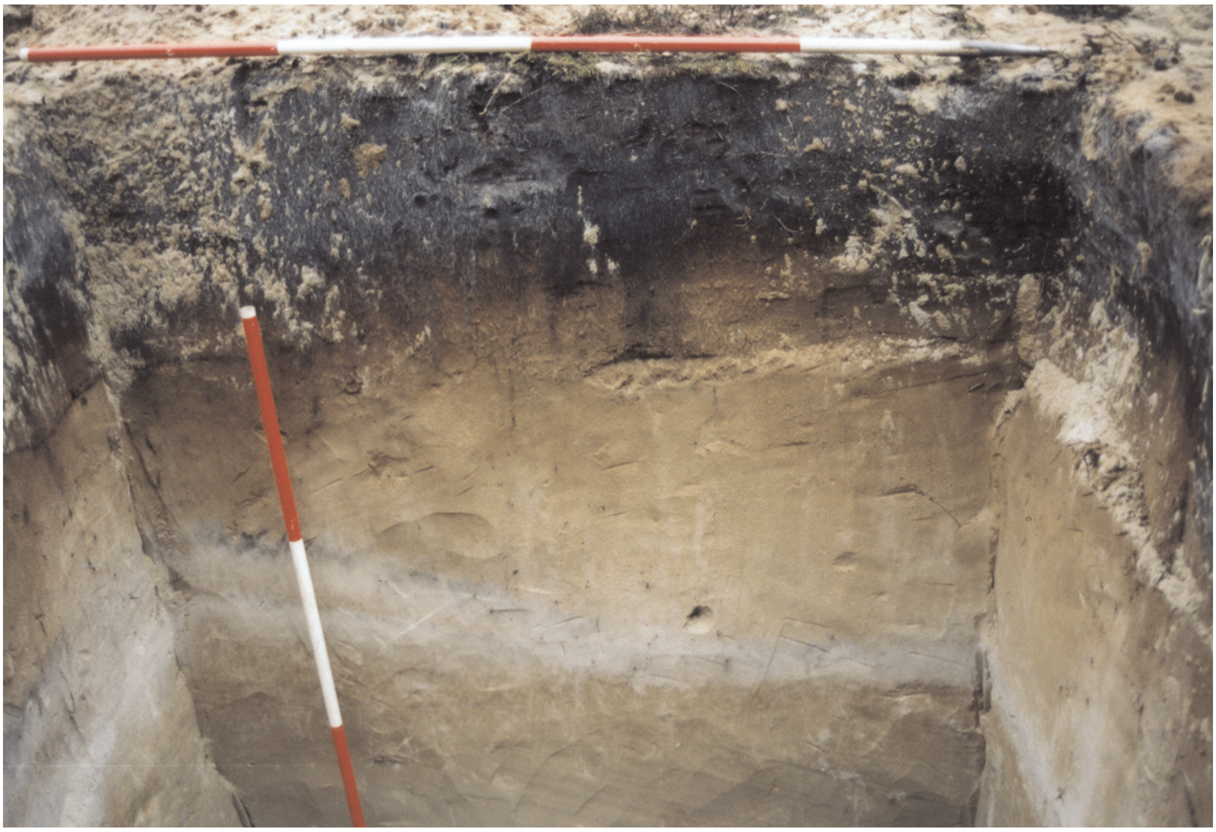

Fig. 7 Pit C, northeastern section. The bleached horizon splits towards the left in two distinct levels, each containing charcoal (Van Gils et al. 2009).

Charcoal fragments are abundant in the Usselo horizon in pit C, 25 m towards the southwest. This horizon is locally subdivided into two distinct bleached levels containing charcoal, the top of which is 0.2 m apart (fig. 7). The charcoal is concentrated in the top of both, but with a denser concentration for the upper level. No artefacts were recovered from the bleached horizons in this pit. A core transect between pits A and C with an average core interval of 3 m confirmed that the horizons in both pits are interconnected and represent the same stratigraphical level. It is not clear whether the absence of charcoal on top of the bleached horizon in pit A is a primary phenomenon or the result of later deflation.

The core transect from pit A towards the southeastern depression (fig. 8) shows the continuous presence of the Usselo horizon. From core 65 on, a thin peat layer covers its top, laterally rapidly evolving into a 40 cm thick, well-preserved and stratified peat layer (at core 67). A 2x2 m large pit was dug in the latter location (fig. 5b and 8: Pit B). In the entire transect both the Usselo horizon and the peat have been covered by a thin bed of yellowish gray aeolian sands in the top of which small but deep frost wedges and a podzol soil have developed (fig. 6: 5-3 and fig. 8: 4-1). The Usselo horizon was systematically prospected by drilling over a surface of 0.5 ha in zone 4 (fig. 5b: red line), as mentioned above. It was clearly separated from the podzol soil by yellowish grey sands in 44% of the cores (fig. 5b: white polygons).

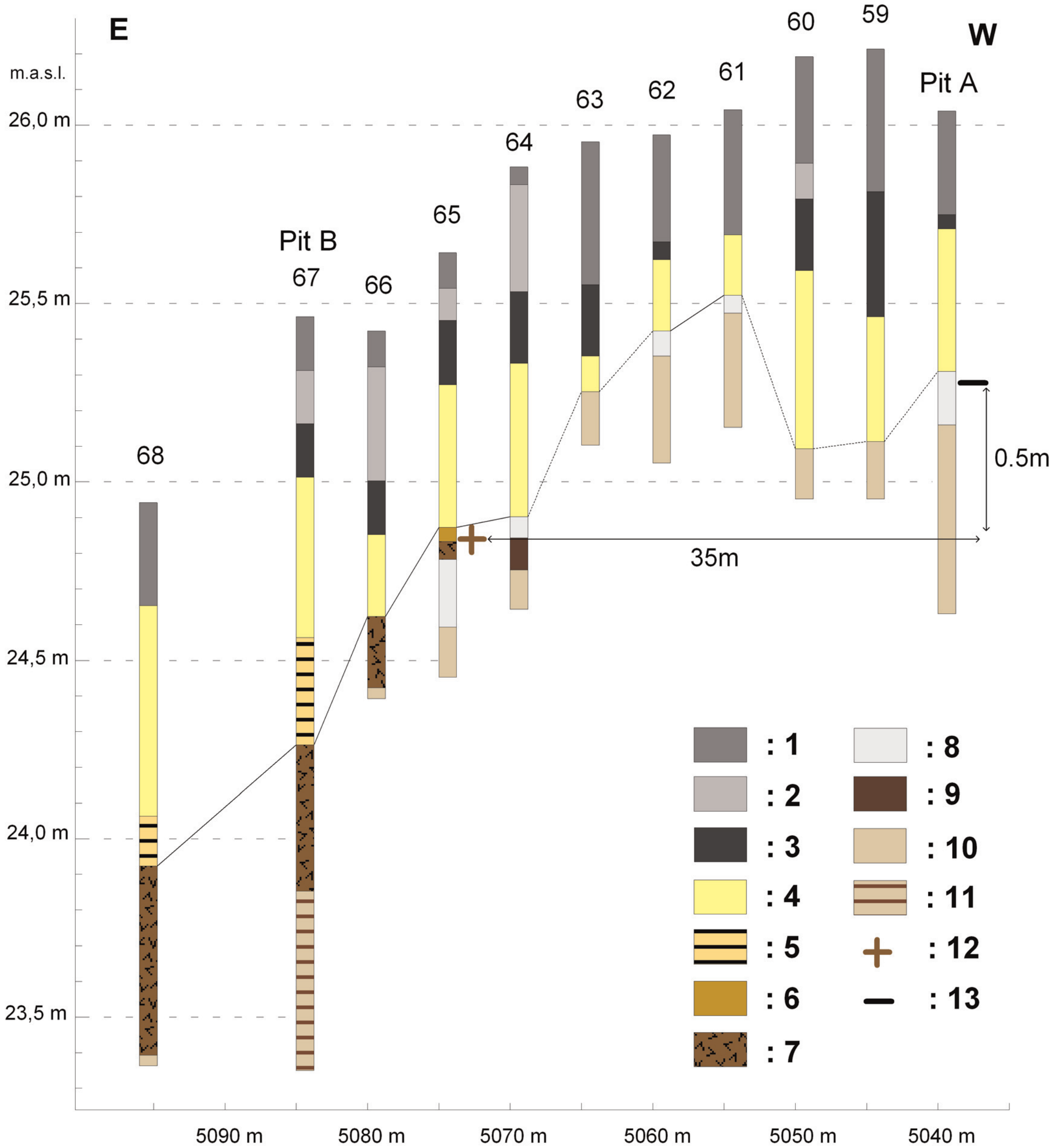

Fig. 8 Core transect, including pits A and B. The connecting lines mark the topography at the Allerød-Younger Dryas transition after the formation of the peat. The indicators of Final Palaeolithic occupation in pit A, at 35 m from the western border of the late Allerød marsh, are situated only 0.5 m above the contemporaneous water level.

1 *Disturbed podzol horizons.*
2 *E-horizon of podzol.*
3 *B-horizon of podzol.*
4 *Yellowish-gray sands (C-horizon of podzol).*
5 *Sands with organic layers.*
6 *Clayey sands.*
7 *Peat.*
8 *Usselo horizon.*
9 *Dark brown sands.*
10 *Yellowish-gray sands.*
11 *Sands with organic layers.*
12 *Location and level of the border of the Allerød swamp.*
13 *Location and level of the Final Palaeolithic occupation in pit A (fig. 6: 1).*

4.2 Chronology

Optical dating results combined with field evidence (Derese *et al.* in press) show that the upper 1.5 m aeolian sand sequence was deposited from the final phase of the Late Pleniglacial up to the Younger Dryas. A more detailed chronology is based on five AMS radiocarbon dates: one sample of uncharred seeds from the very top of the peat in pit B and four samples from charcoal, two in the lower and two in the upper bleached horizon in pit C (table 1 and fig. 9). The end of the peat growth is AMS dated on uncharred seeds at 11,000 ± 60 BP (Poz-28168), or 13,065-13,010 (5.1%) and 12,985-12,672 (90.3%) cal BP according to IntCal09 (Reimer *et al.* 2009). As no charred seeds were recovered from the bleached horizons, charred wood remains were dated instead. Radiocarbon dating of a sample containing different charcoal fragments implicitly risks producing a mean age of several fire events. This is especially true for samples, which have been radiocarbon dated by the conventional method, needing significantly higher amounts of carbon and thus more charcoal pieces. Therefore single small charcoal fragments have been submitted for AMS dating. Fragments of small branches were selected, as evidenced by their form and growth rings, in order to largely eliminate old wood effect.

Sample number	Locus	Context	Material	Remarks	Conventional Age	2 Sigma Calibration in Cal BP	1 Sigma Calibration in Cal BP
Poz-28168	Korhaan pit B	top peat layer	uncharred seeds		11000 ± 60 BP	13084 (95,4%) 12688	12965 (68,2%) 12735
Poz-28515	Korhaan pit C	upper bleached layer	one single charcoal piece		10480 ± 60 BP	12581 (88,9%) 12204 12197 (6,5%) 12140	12558 (59,8%) 12380 12263 (8,4%) 12223
Poz-28516	Korhaan pit C	upper bleached layer	one single charcoal piece	0.8 mg Carbon	10880 ± 60 BP	1290 (95,4%) 12610	12835 (68,2%) 12655
Poz-28517	Korhaan pit C	lower bleached layer	one single charcoal piece		11010 ± 50 BP	13085 (95,4%) 12699	13049 (3,5%) 13,033 12967 (64,7%) 12752
Poz-28518	Korhaan pit C	lower bleached layer	one single charcoal piece	0.4 mg Carbon	11240 ± 120 BP	13358 (95,4%) 12797	13276 (58,5%) 13058 13023 (9,7%) 12970
Weigthed mean age samples 28516, 28517 and 28518					10983 ± 37 BP	13065 (5,1%) 13010 12985 (90,3% 12672	12925 (68,2%) 12742

Table 1 Details of the ^{14}C *age determinations. All ages have been calibrated with IntCal09 (Reimer et al. 2009) – Oxcal v4.1.5 (Bronk Ramsey 2009).*

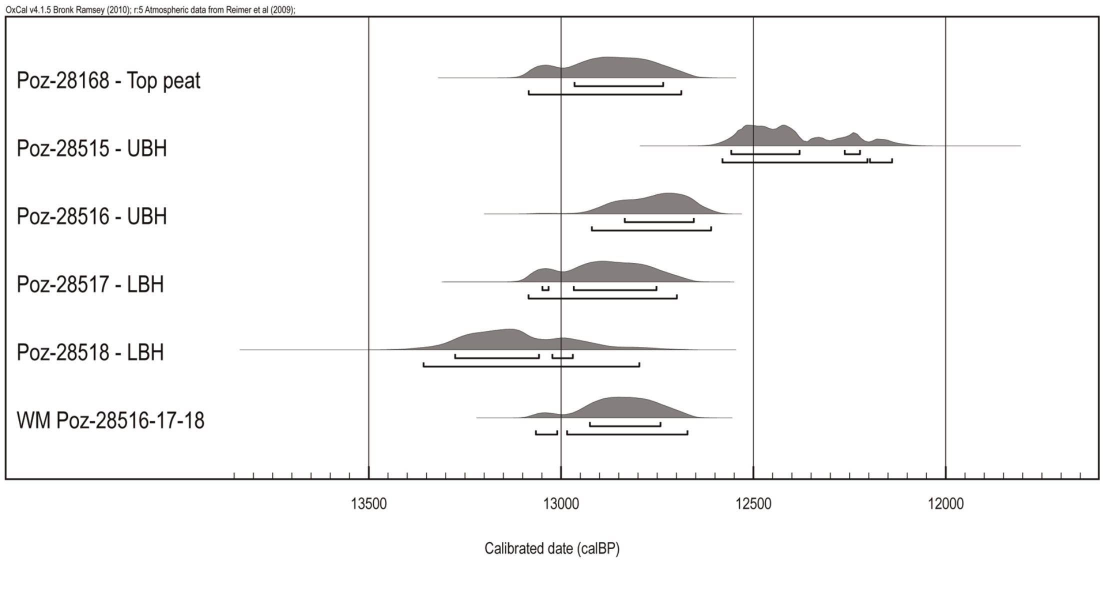

Fig. 9 Calibrated calendar age probability distribution for the samples from the bleached horizons in pit C. UBH: upper bleached horizon, LBH: lower bleached horizon, WM: weighted mean. All ages have been calibrated with IntCal09 (Reimer et al. 2009) in Oxcal v.4.1.5 (Bronk Ramsey 2009).

For three charcoal pieces (Poz-28516, Poz-28517 and Poz-28518) the possibility that they represent different fire events cannot be excluded on the level of a single standard deviation, but on the 95% confidence level all three dates overlap. The question arises whether or not the four charcoal dates belong to the same normal distribution. As a result of the calculation and for a 1% probability, Poz-28515 is significantly different from the other three samples (Poz-28516, Poz-28517, and Poz-28518), which, although originating from both the upper and lower bleached horizons, may belong to the same normal distribution. The weighted mean of these samples is 10,983 ± 37 BP or 13,065-13,010 (85.1%) and 12,985-12,672 (90.3%) cal BP (fig. 9).

4.3 Environmental reconstruction

The bleached horizon with charcoal that covers the cross-bedded sands of layer 9 (fig. 6), interpreted as the Usselo horizon, is a key horizon in the stratigraphy of the Korhaan sand ridge. The weighted mean of the three individual charcoal pieces that were sampled from this layer is 10,983 ± 37 BP, which is in agreement with the ages of around 10,950 BP on charcoal fragments from pine found in the Usselo horizon at many sites (van der Hammen & Van Geel 2008). The Korhaan data, however, suggest fire events not only at the transition between Allerød and Younger Dryas (YD) but also during the YD (Poz-28515). A disruption of the local vegetation during a very short period with an influx of sands is suggested to explain the split of the Usselo horizon at this particular spot. Its timing remains however unclear: did it occur at 10,983 ± 37 BP or during the YD? The presence of YD charcoal in the upper whitish layer of the Usselo horizon in any case confirms that this soil surfaced during the earlier part of the YD.

The presence in pit B of small but deep frost wedges suggests that the Usselo horizon is buried under a cover of YD aeolian sands, with a maximum thickness of 140 cm and a mean of 80 cm for all observations where the Usselo horizon is attested. In the transect in figure 7 it is on average 75 cm with a maximum of 100 cm. It cannot be excluded that the Usselo horizon has been obliterated elsewhere by the later podzolisation as a result of a thinner YD sand cover. The YD cover thus slightly influenced the height of the sand ridge, but barely its morphology. This is mainly an inherited (pre-)Allerød morphology, which is mostly determined by the unidirectional cross-laminated sands deposited by northwestern winds and prograding towards the southeast.

The top of the peat allows a precise environmental reconstruction for the transect between pit A and the Luifgoor depression at the transition Allerød-Younger Dryas. The Final Palaeolithic artefact scatter (see below) at the top of the Allerød horizon in pit A is situated only 0.5 m above and 35 m from the border of the wet depression (Fig. 8).

A simulation of the wider environment is based on the present-day DEM and the maximum elevation of the peat (fig. 10). It shows an extended marshy area towards the east, possibly with open water in its lower parts. This image is considered to be an underestimation of its real extent because of the later sediment deposition in the area, with the YD cover probably the most important. An interdisciplinary study is in progress to specify the chronology of the ridge building and the paleoenvironment based on investigations of both pollen and macroremains.

5 Archaeological evidence

5.1 Final Palaeolithic and Mesolithic artefact scatters

Artefacts have been preserved in two distinct stratigraphic positions associated with the Usselo horizon and with the podzol. The buried Usselo horizon was only sampled systematically over a surface of 0.5 ha in zone 4, but at least four augerings most likely yielded artefacts connected with the Usselo horizon (fig. 5b: red circles). Many more flint scatters associated with the Usselo horizon can be expected beyond this area. The association with the Usselo horizon was confirmed in a 2x2 m test pit (pit A; fig. 5b: A) in which 1080 artefacts were excavated.

The vertical distribution of the artefacts is very restricted. The majority originate from within the 5-10 cm thick more silty top of the Usselo horizon (fig. 6: 1). The few artefacts found in the first centimetres of the yellowish sands above the silty top and in the bleached sands below seem to be associated with the traces of bioturbation visible at the transitions between these layers. The artefacts are extremely sharp and 'fresh' and often have a sediment capping of consolidated sands on the upper surface. These characteristics exclude an artefact concentration due to deflation and suggest exceptional preservation conditions of a nearly intact site. During the YD sand deposition most bioturbation seems to have halted and thus provided an excellent protection of the scatters. This is confirmed by the horizontal distribution of the artefacts, showing a discrete concentration rather than an ephemeral scatter (fig. 10).

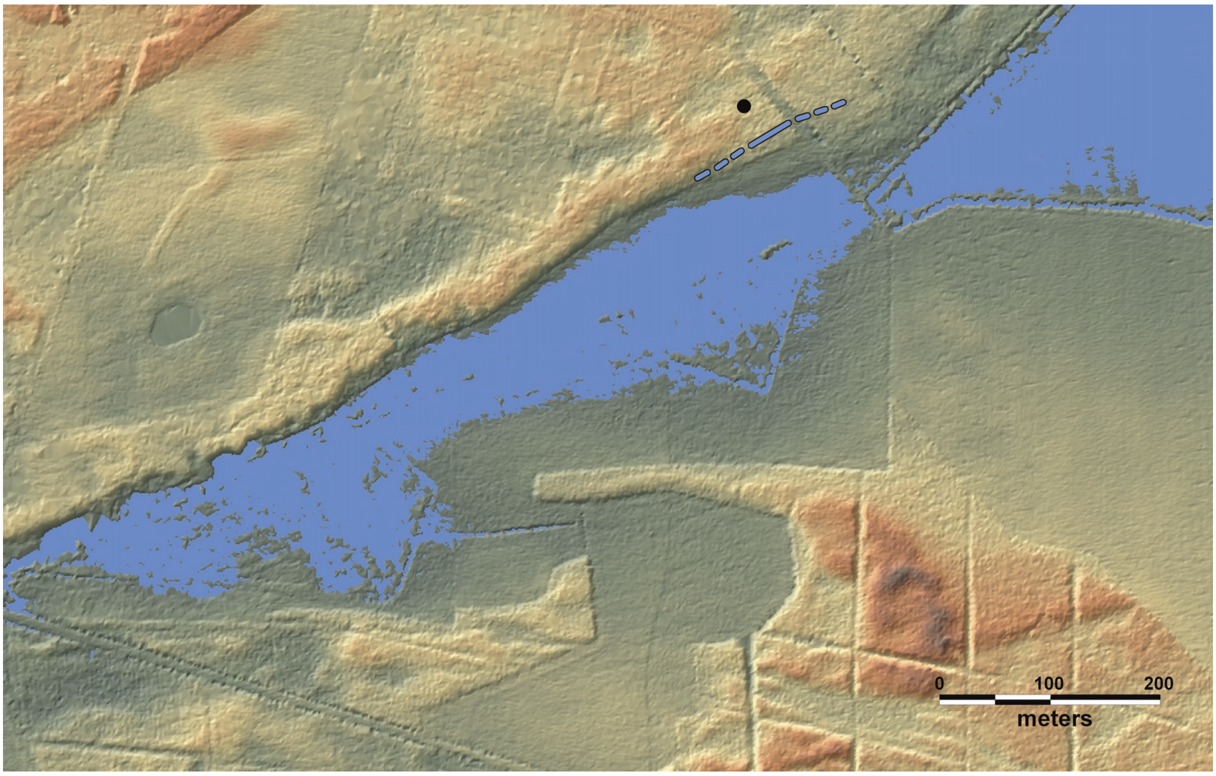

Fig. 10 Simulation of the wet area at the Allerød-Younger Dryas transition, using the present day DEM. The maximum level of the peat layer in the coring transect, 24.8m a.s.l. (fig. 8: core 65), is used as indicator for the minimum extension of the wet area (blue zone). This extent is considered to be underestimated (see text), as is shown by the known northwestern extent of the peat layer (blue line) in the coring transect (fig. 8: core 65). The Final Palaeolithic finds associated with the Usselo horizon in pit A (black dot) are situated at 25.3m a.s.l.

The assemblage's range of tools mainly consists of rather small burins, including a Lacan burin, three backed bladelet fragments, a borer and a truncated piece (table 2). Tool waste is dominated by burin spalls. The typology of the finds allows an attribution to one of the Final Palaeolithic traditions. The backed bladelet fragments and the small dimensions of most burins fit better with the *Federmessergruppen* rather than with Ahrensburgian assemblages. Unfortunately points, the most diagnostic artefacts to distinguish between both lithic traditions, are absent.

Also in zone 2, two test pits of 1 m² yielded 3 and 96 finds respectively associated with the Usselo horizon. The artefacts of this assemblage, including four burins, two scrapers and one fragment of a backed bladelet (table 2), can also be attributed to the *Federmesser* tradition and are thus connected with the large surface assemblage recovered from the neighbouring field (see above).

The attribution of these assemblages to the *Federmesser* concurs with the observation in the coversand area that to date only *Federmesser* assemblages are associated with the Usselo horizon itself, while Ahrensburgian artefacts have only been found above the Usselo horizon (Arts 1988; Deeben & Arts 2005, 142).

type	**zone 2**	**zone 4**
debitage		
core	1	
crest		1
tablet	1	1
crested blade	1	3
crested blade fragment	1	
blade	1	2
blade fragment	2	19
bladelet	2	8
bladelet fragment		8
flake	26	110
fragment	15	115
chip	37	769
debris	3	7
total debitage	**90**	**1043**
tools		
burin on truncation	1	4
double burin on truncation	1	3
dihedral burin	2	5
double dihedral burin		1
scraper	2	
backed bladelet fragment	1	
borer		1
truncated piece		1
retouched blade fragment		2
retouched flake		2
retouched fragment		1
total tools	**7**	**20**
tool waste		
burin spall		16
burin spall fagment	2	1
total tool waste	**2**	**17**
total	**99**	**1080**

Table 2 Artefacts associated with the Usselo horizon from the test pits in zones 2 and 4.

Due to the absence of reliably associated datable material, absolute dating of the assemblage has not yet been possible. It can therefore only be dated relative to the stratigraphy. As the top of the Usselo horizon surfaced at least locally during both the Allerød and the early Younger Dryas, this is the time frame in which the artefacts were deposited. The vertical position of the artefacts, within the silty top of the Usselo, could be explained by its deposition after the most intense soil formation and bioturbation of the Allerød soil, which would date the occupation at the end of the Allerød interstadial or during the early Younger Dryas. In order to confirm this hypothesis, more information is needed on the soil formation and bioturbation during and after the Allerød interstadial and its impact to lithic scatters. Additionally, a radiocarbon date well associated with the lithic scatter is needed and it should be tested even if other sites where artefacts were found in relation to the Usselo horizon display the same vertical distribution.

Federmesser groups are assumed to have largely disappeared at the abrupt start of the Younger Dryas stadial (De Bie & Vermeersch 1998; Vermeersch 2010). Absolute dating of *Federmesser* sites is, however, often problematic. The Usselo horizon often contains charcoal fragments that can be the result of natural fires and as *Federmesser* sites are generally found within or on top of this horizon, the association of charcoal dates with the lithic assemblages is rarely entirely secured (Vermeersch 2010). One reliable sample of resin attached to a backed point at Rekem is dated to the Allerød interstadial: 11,350 ± 150 BP (OxA-942, De Bie & Caspar 2000), or 13,571-12,872 (95.4%) cal yr BP according to IntCal09 (Reimer *et al.* 2009).

The podzol horizons yielded most auger finds across the entire ridge. A 2x2 m large test pit in zone 4 (Pit C, only 25 m from pit A; fig. 5b: C) yielded 139 artefacts from the podzol, mainly from the E and B horizons. The assemblage mostly consists of undiagnostic debitage waste, but a point with unretouched base and a notched bladelet suggest an attribution to the Mesolithic (table 3). It is unlikely that the Holocene soil would contain Final Palaeolithic artefacts at this place as the Usselo horizon was well preserved at a minimum of 0.5 m below the B horizon of the podzol (Van Gils *et al.* 2009).

type	**n**
debitage	
core	1
blade (fragment)	1
bladelet (fragment)	15
flake (fragment)	54
chip	58
debris	8
total debitage	**137**
tools	
point with unretouched base	1
notched bladelet fragment	1
total tools	**2**
total	**139**

Table 3 Artefacts associated with the podzol soil in zone 4 (Pit C).

In the Dutch Campine and Peel regions, some other *Federmesser* sites have also been associated with a buried Usselo horizon and/or stratigraphically distinguished from Mesolithic occupation (*e.g.* Milheeze Hutseberg (Arts 1988), Westelbeers Zuidwest (Snijders 2000), and Geldrop III 4 (Deeben 1988)). At Verrebroek Dok 2, in Sandy Flanders, a *Federmesser* assemblage was associated with a buried Late Glacial paleosol (Crombé 2005). In the Belgian Campine region several artefacts were associated with the Usselo horizon at Opgrimbie (Vermeersch 1971; Paulissen & Vermeersch 1978), and large site complexes with stratigraphically separated Final Palaeolithic and Mesolithic assemblages have been surveyed and partly excavated at Lommel Maatheide (De Bie *et al.* 2009) and at Lommel Molse Nete (Van Neste *et al.* 2009). Elsewhere, Final Palaeolithic and Mesolithic remains were found intermixed, which hampers the characterisation of both industries. This is for instance the case at Meer Meirberg (Van Noten 1978) and other locations at Lommel Maatheide (De Bie *et al.* 2009), where remains of both periods were mixed within the Holocene podzol soil, or at Weelde *Eindegoorheide* (De Wilde *et al.* 2007) and at Zundert De Matjes (Van Heymbeeck *et al.* in press), two examples of plough zone assemblages.

5.2 A large and rich site complex

Thus far every surveyed sub-zone of the Liereman Landscape yielded artefacts (table 4). The artefact density varies, with in general more artefacts and cores containing artefacts at higher zones (see *e.g.* fig. 5a). The association of finds with the more elevated areas recurs at all comparable sites in the Campine region, indicating a strong correlation with the natural topography (Arts 1988; Deeben 1992; Van Gils & De Bie 2008; De Bie & Van Gils 2009). Based on extent and nature, they should be considered site complexes rather than large sites (De Bie & Van Gils 2009). By analogy with these site complexes, the presence of artefacts in every surveyed sub-zone indicates that the Korhaan site in fact is part of an extensive and continuous site complex. It stretches along the wet depressions, over a length of approximately 3 km (Meirsman *et al.* 2008). This seems, moreover, valid for both the Final Palaeolithic and Mesolithic occupation. While the auger and survey finds confirm a stratigraphic distinction between both, no clear spatial distinction can be observed. Additional fieldwork is however needed to reliably date the artefact concentrations.

	cores	**cores containing lithic artefacts**	**lithic artefacts**
	n	*n*	*n*
zone 1	28	3	3
zone 2	34	8	10
zone 3	9	2	2
zone 4	958	189	481
total	**1029**	**202**	**496**

Table 4 Corings and finds of lithic artefacts in zones 1 to 4.

The finds are, however, not restricted to the southern, higher dune ridge. The up to 1.5 m lower interdune areas, northwest of the Korhaan ridge, also yielded artefacts and in the wider landscape several findspots have been located through field walking (fig. 1: 9-11). Sometimes these surface finds were confirmed by finds in drillings (Van Gils & De Bie 2002; Van Gils *et al.* 2009).

All these findspots, including the earlier finds and those gathered during the recent augering campaigns, reveal the human exploitation of the wider landscape. They show that the Korhaan site complex forms part of an extensive Stone Age occupation area of at least 150 ha.

Based on the present data, the occupation intensity in this landscape can be roughly estimated by comparing the percentage of cores containing artefacts, the number of finds per core containing artefacts and the maximum number of finds in a single core. As can be expected, most indicators for an intense occupation can be found on the southern ridge, overlooking the southern fens. At those places, the auger finds possibly reflect cumulative or spatial palimpsests (see Bailey 2007).

Some variability can be observed across this ridge. New and extensive excavations may reveal whether this variability is connected with the particular characteristics or ecological conditions of the ridge at a certain moment in time or rather a random variability resulting from the accumulation of site remains in an extensive but ecologically largely uniform area. New fieldwork is also needed to characterise and date the findspots in the lower lying periphery of this ridge, but their lower number and distribution over a wide area make it possible that these are the result of single occupation events, the total of which more or less corresponds to what Zvelebil *et al.* (1992) define under the term 'lithic landscape'.

The Korhaan site complex yielded the richest dataset in terms of density of the prehistoric occupation, as compared to similar sites in the Campine region and based on the aforementioned criteria. Only Meer Meirberg and Lommel Molse Nete offer a comparable context (table 5).

site	cores	cores containing lithic artefacts	cores containing lithic artefacts	lithic artefacts	lithic artefacts per core containing artefacts	max. artefacts per core
	n	*n*	%	*n*	*n*	*n*
Landschap De Liereman *Duinengordel*	1029	202	20	496	2,46	80
Lommel *Molse Nete 2003*	188	46	24	120	2,61	26
Meer *Meirberg*	2045	360	18	859	2,39	28
Ravels *Witgoor*	1462	65	4	115	1,77	10
Opglabbeek *Ruiterskuilen*	1396	66	5	102	1,55	5
Wuustwezel *Het Moerken*	467	42	9	57	1,36	3

Table 5 Comparison of intensively surveyed site complexes in the Campine region showing occupational intensity. The proportion of cores containing artefacts, the number of finds per core containing artefacts and the maximum number of finds in a single core may not be the best criteria since they can be affected by the sampling strategy at each site, but they do offer a good indication when combined.

6 Discussion

The data currently available in the Liereman Landscape point to an extensive *Federmesser* occupation that focused on the northeast-southwest oriented wet depression. It is likely that this depression formed part of a wider hydrographic system, playing a major role in people's orientation and mobility (see De Bie & Van Gils 2009). Most traces of occupation have been observed to the north of this depression, where waste material accumulated on a 3 km long dune ridge. The lateral extension of this site only seems delimited by the geomorphological situation.

Such Final Palaeolithic (and Mesolithic) extensive site complexes on well-drained terrain, often low ridges, bordering former wet depressions with possibly open water are typical for the Campine coversand region. Their size in terms of number of artefacts is most likely the result of repeated visits of hunter-gatherer groups over a period of several centuries and they seem to be the standard rather than an exceptional situation. Returning to the same or different spots at the same preferential location, people gradually littered the entire ridge with the waste of their lithic production, eventually creating a huge site complex. Most probably some of the finds in the wider environment also form part of this settlement pattern, which makes the Liereman Landscape a microregional version of the idea of 'persistent place'.

Two hypotheses can be formulated to characterise this 'persistent microregion' and to interpret the difference between the intensive occupation on the southern ridge and the ephemeral findspots in the wider region. In the first hypothesis, all of these remains reflect similar activities that took place all over the landscape. This makes the relationship between two distinct concentrations on the ridge similar to that between concentrations on and off the ridge. The higher concentration of activities on the southern ridge can in this view be explained by the advantageous conditions of this zone in terms of the particular topographical and ecological conditions and the availability of water.

In the second hypothesis activities deployed on and off the ridge were different. Off-ridge sites could be the remains of particular activity areas in relation to habitation on the southern ridge. Such a hypothesis best fits the idea of nomadic groups travelling within a landscape and orienting themselves on the basis of the hydrographical network. Revisiting the southern ridge along the wet depression would then not be a random act, but one reflecting a clear planning of movement within a familiar landscape. This hypothesis fits with the idea of a high residential mobility in an immediate return economy as for instance defined by Binford (1980; see also Amkreutz 2009).

Interpreting individual locations within this landscape, or even individual scatters on the southern ridge, both in terms of their function and of their precise position within a settlement system can, evidently, only be based on their detailed characterisation by further fieldwork. Palaeo-ecological research on Allerød peat will also provide a better understanding of the changes in the past environment, and the role played by fires and human occupation in these changes (as presumed at Milheeze for these early periods by Bos & Jansen 1996). The Allerød peat also offers excellent opportunities to study the *Federmesser* material culture if organic archaeological remains may be conserved and buried artefacts can be dated.

Very little information on the ecology of the early Holocene is available. Although the general morphology of the region was not significantly altered by the Younger Dryas aeolian deposits, the continuous presence, nature and extent of the wet depressions is unknown. The presence of numerous artefact scatters within the upper horizons of the Holocene podzol profile, attested in nearly every surveyed zone on the southern ridge, however suggests a similar occupation pattern for at least the Early Mesolithic period. The occupation was possibly interrupted during the major part of the Younger Dryas, for which no occupation in the region has been attested thus far. Whether the pattern persists to the end of the Mesolithic needs to be confirmed by further fieldwork. In any case, aside from clear evidence for Final Palaeolithic and Mesolithic occupation at the same locations, intermittent occupation continued over thousands of years in the same preferred zones in the Liereman Landscape during both the Allerød and the Early Holocene (Van Gils & de Bie 2008; De Bie & Van Gils 2009).

7 Conclusion

Like elsewhere in the Campine Region, intensive coring for archaeological remains at a well-chosen location was also successful at the Korhaan ridge in the Liereman Landscape. Conditions for palaeo-ecological and geomorphological research are truly unique in this area. The combination provides insight in the geomorphology of extensive areas and in the position of the archaeological remains within the natural landscape. Further research can help us to understand the evolution of the local landscape, specifically with respect to the formation history of Late Glacial aeolian relief and the general landscape evolution in the Campine region.

Being larger in extent and richer in finds than most comparable findspots in the region, this site is a prime example of the extensive site complexes that are typical for the Final Palaeolithic and Mesolithic occupation of the Campine region. At several locations within this site complex, the Final Palaeolithic and Mesolithic remains are stratigraphically separated by Younger Dryas sands which offer exceptional conservation conditions for the buried Final Palaeolithic artefacts and enables comparative studies of both industries. Based on their typology, an attribution of the buried Final Palaeolithic artefacts to the *Federmesser* groups seems most likely. Their stratigraphic position, restricted to the upper part of the Usselo horizon, is remarkable in this light and suggests that the artefacts were deposited at the end of the Allerød or at the very beginning of the Younger Dryas. The finds are laterally dispersed over at least 3 km with a variation in intensity which is strongly associated with the higher parts of the terrain along the (wet) depression. This distribution is thought to be the accumulation of debris left during repeated visits by small hunter-gatherer groups over a period of several centuries, or even millennia if both Final Palaeolithic and Mesolithic remains are taken into account. The data enable us to debate the settlement systems involved and two resulting hypotheses, one in which a homogeneous set of activities was 'randomly' distributed over the micro region, and another in which the artefact scatters are related to different activities. The precise position of each of the scatters within that settlement system, however, can only be determined on the basis of further and large-scale fieldwork. Furthermore, the persistence of the same settlement system throughout the Mesolithic period still has to be verified via further research. The exceptional preservation of the wider landscape around the site complex allows for such research. This opens perspectives for testing hypotheses on microregional land use of hunter-gatherers recurrently returning to persistent places across the Pleistocene-Holocene transition.

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Bart Vanmontfort (fieldwork and archaeology),
Katholieke Universiteit Leuven,
bart.vanmontfort@ees.kuleuven.be

Marijn Van Gils (fieldwork and archaeology),
Flemish Heritage Institute and Katholieke Universiteit Leuven,
marijn.vangils@rwo.vlaanderen.be

Etienne Paulissen (geomorphology),
Department Earth and Environmental Sciences
Katholieke Universiteit Leuven,
etienne.paulissen@ees.kuleuven.be

Jan Bastiaens (landscape study),
Flemish Heritage Institute,
jan.bastiaens@rwo.vlaanderen.be

Els Meirsman (fieldwork),
Katholieke Universiteit Leuven,
elsmeirsman@hotmail.com

Marc De Bie (archaeology),
Flemish Heritage Institute and Vrije Universiteit Brussel,
marc.debie@rwo.vlaanderen.be

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