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Deep Mechanical Coring Delivers New Pleistocene Archaeological Sites up to Eight Metres Below Surface in the Flemish Valley (Belgium)

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Abstract

Our study reveals multiple signals of Palaeolithic occupation in the Flemish Valley, a large depression in coastal northwestern Europe with an extremely sparse Pleistocene archaeological record until now. We show that mechanical coring can reveal archaeological evidence of hominin presence from deep palaeolandscapes that are inaccessible for standard survey techniques. At nine out of 41 coring sites, we encountered a total number of 56 lithic artefacts at depths up to 8 m below the surface. We conclude that this unexpected success rate indicates a widespread archaeological record. We believe that this survey method has the potential to increase the number of Palaeolithic sites in northwestern Europe by an order of magnitude, leading to a very different image of Pleistocene hominin settlement in this vast European lowland.

Keywords: Pleistocene; archaeology; survey; Flemish Valley; microdebitage

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1. Introduction

Palaeolithic sites older than 15,000 years in the northwest European coastal lowlands beyond 50° of latitude are extremely thin on the ground, in stark contrast to the mid-altitude regions to the south [1]. While this pattern has been interpreted in terms of a limited ecological tolerance of Neanderthals in particular [2–4], other authors have pointed out a potentially severe bias in the data as a consequence of the taphonomic histories of the Pleistocene landscapes concerned [5–7]. If not eroded, the latter are buried under massive sediment covers where they cannot be detected by conventional survey methods. As a consequence, surveys have been geared towards suitable regions, amplifying the distortion of the distribution pattern. Our Flemish Valley Survey Project [8] was executed in the Flemish Valley [9], located at the western fringe of the North European plain (Figure 1). It is a 2000 km^2 depression of probable late Middle Pleistocene origin and with a sediment fill dating to the Upper Pleistocene [9,10]. Its stratified archaeological record is extremely sparse, leading to its perception as an unoccupied lowland [11].

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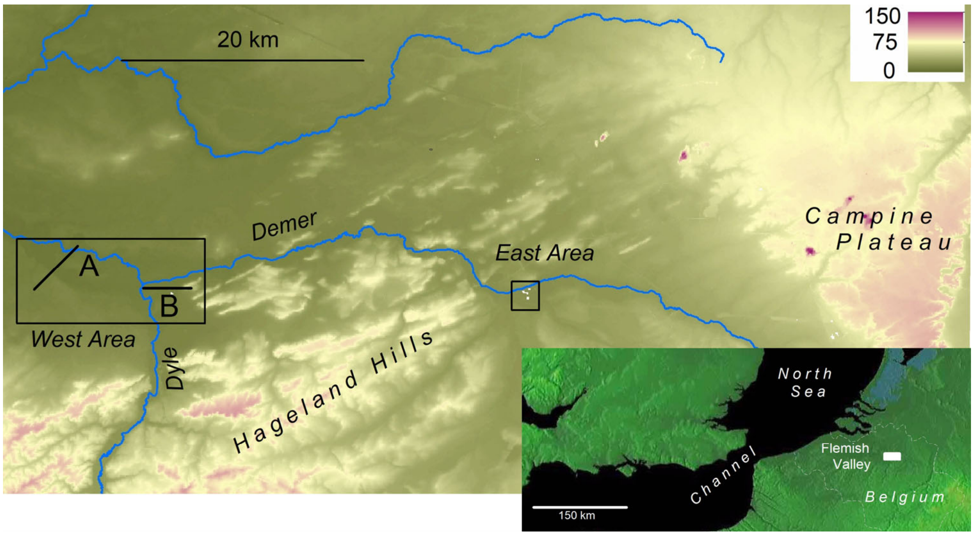

Figure 1. Digital elevation model of the Southeastern branch of the Flemish Valley. Black rectangles indicate the location of our two research areas. Thick black lines A and B show the positions of the composite sections discussed in the text The white rectangle in the inset shows the location of the study area in Northwestern Europe.

2. Research Design

2.1. Premises

The project was conceived as a proof-of-concept study (see Appendices A and C for details on methods) to investigate the potential of mechanical deep coring in a conventionally inaccessible taphonomic context. While augering is commonly used for near-surface surveying to detect sites that were left in basically present topographies, its application at large depths is considered unfeasible [12]. Its major challenge is the seemingly unresolvable paradox between the vast stretches of unknown palaeolandscapes to be sampled and the inherently limited sampling fractions of mechanical deep coring. Resulting in extremely low encounter probabilities, this unavoidably appears to reduce discovery to an unlikely chance event.

We proceeded on two initial premises. First, we assumed that the present topographies of the eastern Flemish Valley are sufficiently preserving Pleistocene landforms to allow some informed selection of coring sites in areas suitable for occupation (see Appendix Table A1). Second, the density of Palaeolithic settlement in such areas is such that at least one successful encounter in a comparatively small set of cores is probable. This assumption was particularly informed by the evidence from three sand quarries in the eastern Flemish Valley that had been simultaneously in operation during highway construction of the 1970s [13]. On all three accounts, Middle Palaeolithic artefacts and large bone assemblages had been collected by amateur archaeologists.

We chose two research areas of different spatial scales. The first (Figure 1, West Area; Figure 2A) is the wide and low confluence area of the Dyle and Demer rivers, amounting to 84 km^2. Here we drilled 352 cores distributed across 40 selected locations, with coring densities varying between 1000 and 480 m^2/core. Our first aim here was to assemble stratigraphic and palaeotopographic data to serve as a guideline for reconstructing local Pleistocene topographies at better resolution and for selecting additional coring locations. The second (Figure 1, East Area; Figure 2B) is the area of Schulensbroek upstream in the Demer Valley, a six km^2 depression in which several Demer tributaries discharge [14]. We executed a total of 112 drillings at one selected coring site with an initial size of three ha, immediately to the west of the former sand quarry. Our aim here was to execute palaeotopographic reconstruction at high resolution and to conduct archaeological coring in order to reveal actual site locations. Hence, these drillings were staged in four subsequent research phases, whereby core density was gradually increased.

Figure 2. Photographs of selected coring locations. (**A**) Coring site N6.1—West Area in the foreground, looking north towards coring site N6.3 in the background; (**B**) Coring site AZ8.1—East Area, looking east towards the former sand quarry visible in the background.

2.2. Stratigraphic Method

Given that each individual core contains a succession of small layer fragments, we needed to establish both intra- and intersite correlations across 2071 stratigraphic units in a total set of 464 cores. We proceeded with this correlation effort on the simple premise that the most proximate cores will have the largest number of layer continuities, and we used lithological, pedogenetic, and taphonomic criteria to establish the latter. On the condition that lateral facies variation in natural layers is sufficiently controlled [15], this procedure of core chaining is akin to the construction of a Harris matrix [16] at historical excavation sites and produces the same result: a local lithostratigraphic succession with the smallest number of multilinearities, i.e. uncorrelated fragments, possible. Furthermore, in the same way as the Harris matrix is essential for the construction of a composite site plan, the spatial distribution of our correlated cores enables the making of a palaeotopographic model of a given area at a particular time.

Using the same principles, the local stratigraphic successions were correlated across our entire set of coring sites. We reiterated the procedure of inter-site core chaining until the cross-correlations became stable and multilinearities became neglectably rare. At that stage, we started using the chronostratigraphic model as a reference scale for direct correlation of new cores.

3. Results

3.1. Upper Pleistocene Stratigraphy and Archaeological Evidence

The sediment lithologies of the two research areas are similar, allowing the construction of one overall stratigraphic framework for the eastern branch of the Flemish Valley. In contrast to the Holocene [17], the Pleistocene stratigraphy of this far eastern part of the Flemish Valley is hardly known. Following the procedure described above, the initial variation in our set of stratigraphic units was reduced to 34 layers, allocated to 10 Phases. This Upper Pleistocene sequence overlies the Palaeogene substrate [18], the top of which is variably reached at depths between 3 m and >9 m below the surface.

Our chronostratigraphic framework is anchored by numerous radiocarbon dates (Table 1; Appendix Table A2). The limit of reliable radiocarbon detection is at Phase III/IV, and these four dates from the West Area should be regarded as minimal age estimations. The latter gravels and coarse sands mark an important downcutting of the Flemish Valley, causing a stratigraphic hiatus of unknown duration. Phase II below the hiatus shows a cyclic occurrence of the same lithologies, indicating a recurrent pattern of interstadial and stadial conditions. Phases VI (gravels) and X (coarse sands) represent recent periods of river incision and erosion, the former dating to MIS 2 and the latter most likely to the Younger Dryas.

Table 1. General chronostratigraphy of the Eastern Branch of the Flemish Valley. For the West Area, only a selection of uncalibrated ^{14}C dates is shown. For a complete list, see Appendix B. Dates for Phases III/IV are close to the radiocarbon blank and should be regarded as minimum dates. The date in red is stratigraphically inconsistent. DAE = Direct Archaeological Evidence.

Phase	Layer	Lithology	^{14}C BP West	^{14}C BP East	DAE Sites (*n*)	Artefacts (*n*)
X	**2–4**	*coarse grey or brown sands grading to gravel at the sharply incised base*			2	2
IX	**5–8**	*peat overlying brown or blue clay; laminated organic sands at the base*	11,051 ± 38 11,053 ± 35 11,149 ± 40 11,172 ± 37			
VIII	**9–10**	*silty sands, occasionally loess, on top of consolidated grey sands*				
VII	**12–14**	*peat or organic sands with intercalated mottled sands*				
VI	**15–17**	*Fining up sequence with gravel at the base, grading to coarse sands and fine glauconiferous sands*	22,544 ± 88	22,668 ± 83	4	9
V	**18a–18b**	*peat overlying fine grey sands*	34,888 ± 290	29,265 ± 138 31,164 ± 125 31,079 ± 185	1	15
	18c–20	*brown loam overlying laminated organic sands or peat*	40,558 ± 415 43,385 ± 596 44,311 ± 639		5	13
IV	**21a–21c**	*fine sands, aeolian with intercalated gravel*	48,200 ± 1300 49,900 ±1700 46,700 ± 1100	24,604 +/− 83		
III	**22**	*gravel or coarse brown sands*	59,906 ± 4091		1	10
II	**23–24**	*fine sands over brown loam*				
	25–26	*fine yellow sands overlying brown loam or peat*			1	6
	27–28	*fine yellow or white sands overlying brown loam or peat*			1	1
I	**29**	*gravel*				
	30–31	*organic sands grading into peat below*				
	32	*quartz or mica sands*				
	33	*base gravel*				
PALAEOGENE						

Direct archaeological evidence (DAE) was retrieved at 9 out of 41 coring sites from depths below the surface ranging between 160 and 850 cm (see Appendix Table A3). The large majority are microdebitage [19] (*n* = 53; Figure 3, 1–4), unequivocally distinct from natural conchoidal clasts (see Appendix C for definition and criteria). In three cases, larger lithic artefacts were encountered (Figure 3, 5–6). 21 lithic artefacts were recovered from a secondary context in the erosive Phases III, VI, and X. Seven artefacts were found in Phase II. By far the largest number of artefacts comes from Phase V, which is to be subdivided into a lower and upper part. The lower deposits, peats and clays, indicate temperate climatic conditions during which Dyle and Demer build up large floodplains up to ~8 m above sea level in the West Area and ~17 m in the East. The generally sharp interface with the underlying sands suggests an initial channel re-incision. The radiocarbon dates are very consistent, placing this lower part of Phase V between ~46,000 and ~37,000 ^{14}C BP, GI 12 through GI 11 [20]. This comprises the warm Hengelo interstadial, even though its precise correlation with the ice core record is controversial [21]. The upper part starts with Layer 18b. During cooler and drier conditions, aeolian sands were deposited, after which peat formation resumed. We discuss both the research areas in some more detail.

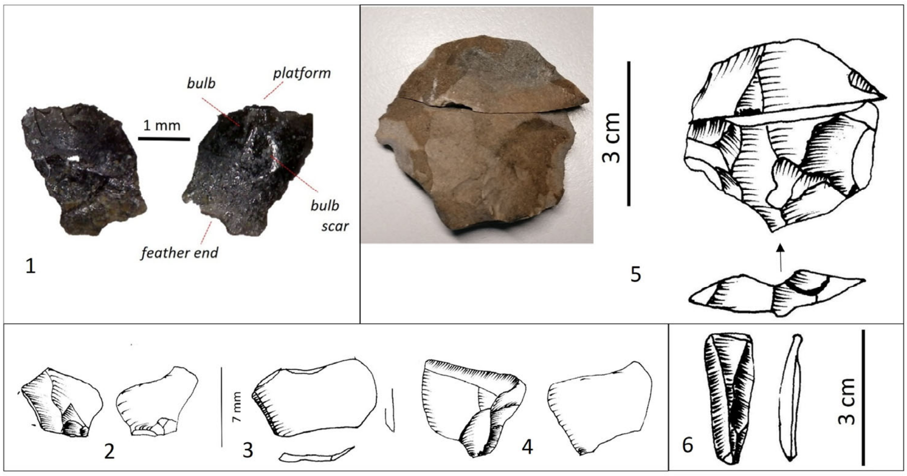

Figure 3. Lithic artefacts retrieved at various coring sites. (1) microchip out of black Obourg flint from N6.1., Core 29-Phase V; (2) microchip from AZ8.1, Core 258-Phase VI; (3) microchip from X8.1, Core 117-Phase V. It is out of phtanite, a distinct chert variety outcropping from the Cambrian in the upper Dyle valley; (4) microchip from V8.2, Core 428-Phase V; (5) Levallois flake out of coarse-grained grey flint from AZ8.1, Core 533-Phase II; (6) bladelet out of fine yellow-grey Hesbaye flint from AZ8.1, Core 480-Phase V.

3.2. West Area

Our 40 coring locations are shown in Figure 4. We constructed two composite geomorphological sections (Figure 5), one lateral across the fossil southern Dyle channel and the other more or less longitudinally aligned along the present Dyle course (see Figure 1 for location). The Phase II archaeological evidence comes from coring sites W8.1 and X8.1. At the latter, which is close to the Rotselaar Toren-ter-Heide quarry site [22], we encountered a microchip in Core 117 at a depth of 520 cm, in the brown loam of Layer 28. At W8.1, a total of 10 artefacts were retrieved from Phase III, which erodes into Phase II sediments, at depths ranging between 380 and 460 cm. 9 are microchips, 5 of which were found in the same core (Core 195), and one is a small side scraper on a frost-cracked flint fragment.

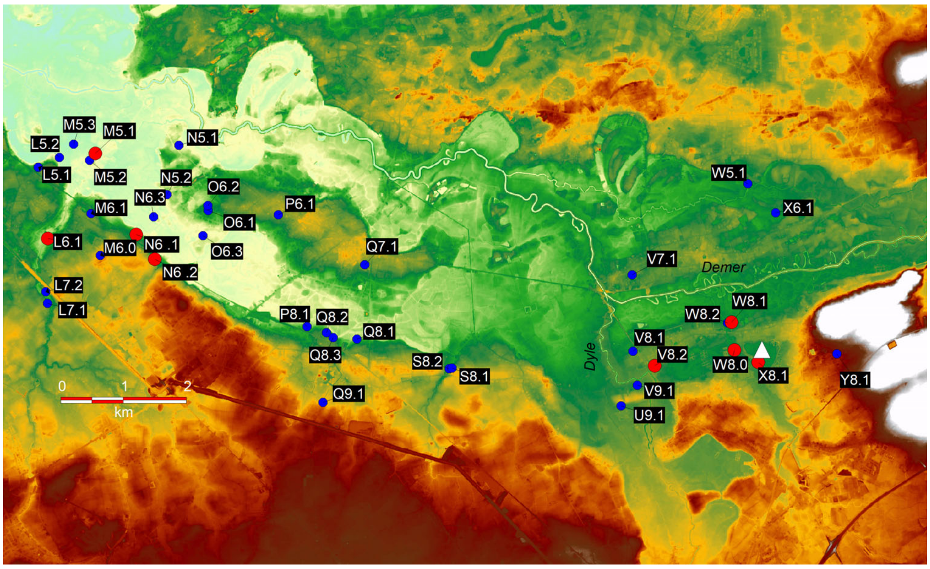

Figure 4. Digital elevation model of the West Area (altitudes between 6 m [blue] and >16 m [white] above sea level) showing the locations of 40 coring sites. Red dots indicate sites where DAE was retrieved from one or more cores. Blue dots without DAE. The white triangle indicates the location of the sand quarry of Rotselaar-Toren ter Heide [8].

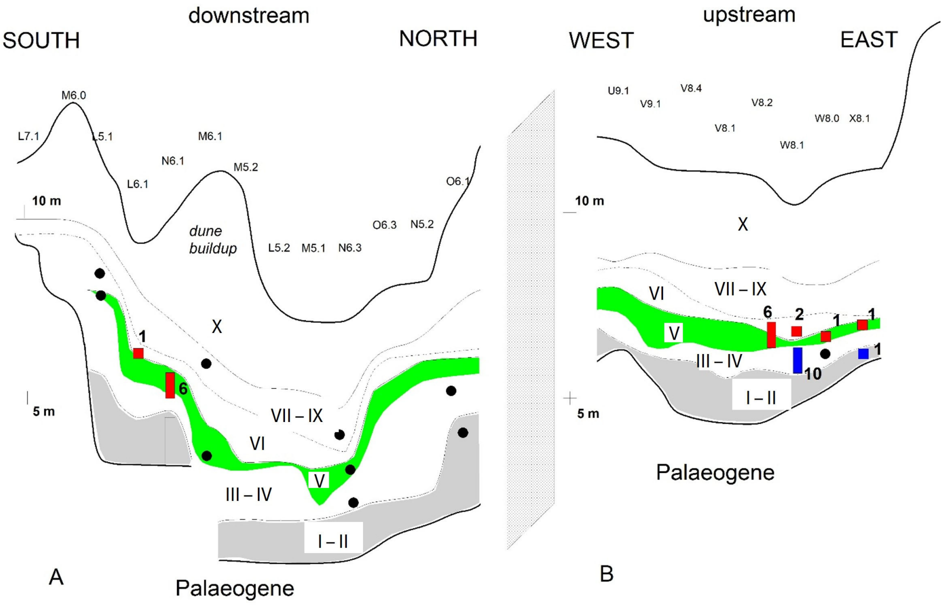

Figure 5. Simplified correlated stratigraphic sequences in the West Area. (**A**) downstream of Dyle-Demer confluence and (**B**) upstream of confluence (see Figure 1 for locations). Coring sites are indicated by their code ID. Elevation scale in m above sea level. Upper thick black lines indicate the present surface, lower thick black lines the base of the Quaternary. Roman numerals indicate stratigraphic phases as listed in Table 1. Black dots indicate positions of ^{14}C dates. Red and blue rectangles indicate positions of archaeological finds, with the number of finds added in bold. Green and grey areas indicate phases with primary context DAE.

At 7 different locations, all situated at the edges of the Phase V floodplain, we encountered microchips. At L6.1 and W8.1, they occur at the base of Phase VI gravels and were probably eroded out of the underlying sediments. At N6.1 (Figure 2A) and W8.0, the microchips occur in direct association with dated organic materials, at 44,311 ± 639 ^{14}C BP (RICH-31610) and 40,979 ± 634 ^{14}C BP (RICH-31605) respectively.

3.3. East Area

Based on the stratigraphic evidence derived from 33 cores drilled in the first fieldwork stage at this location (AZ8.1; Figure 2B), the palaeotopographic development of our 3 ha research area was reconstructed. The base of Phase V appears to outline a shallow depression (Figure 6). To the east, a deeply incised Phase VI channel has eroded the earlier sediments, leaving only a small remnant of Phase II deposits below the base of the channel. In the subsequent archaeological testing stage, we executed 48 pulse drillings (see Appendix A) at the edges of the Phase V depression. In Core 480 (Figure 6) in the northern zone, we retrieved a complete bladelet (Figure 3, 6) in mint taphonomic condition in the 250–300 cm sample window. Another 31 drillings using the same technique were executed in a limited zone around Core 480, delivering a few more microchips. The total number of microchips from Phase V, dated to 31,164 ± 125 (RICH-28033), amounts to 12. They appear concentrated in the northern zone and most likely indicate the position of a Palaeolithic site sensu stricto. From the southern zone, only one microchip has been recovered from a reworked context in a recent channel fill.

During that same fieldwork stage, we executed 2 pulse drillings down to 800 cm in the southern area of the coring site. From Core 533 (Figure 6), we retrieved a broken Levallois flake (Figure 3, 5) in Phase II sediments at a depth between 750 and 800 cm below the surface. It is made out of coarse-grained dark grey flint of the same variety as was observed in a number of artefacts that had been collected during the quarry exploitation of the 1970s [14]. Except for the fracture that occurred when the pulse sample was emptied into a container, the artefact is in mint condition. From this same Core 533, another 5 microchips were retrieved after sieving the residue at 250 µm.

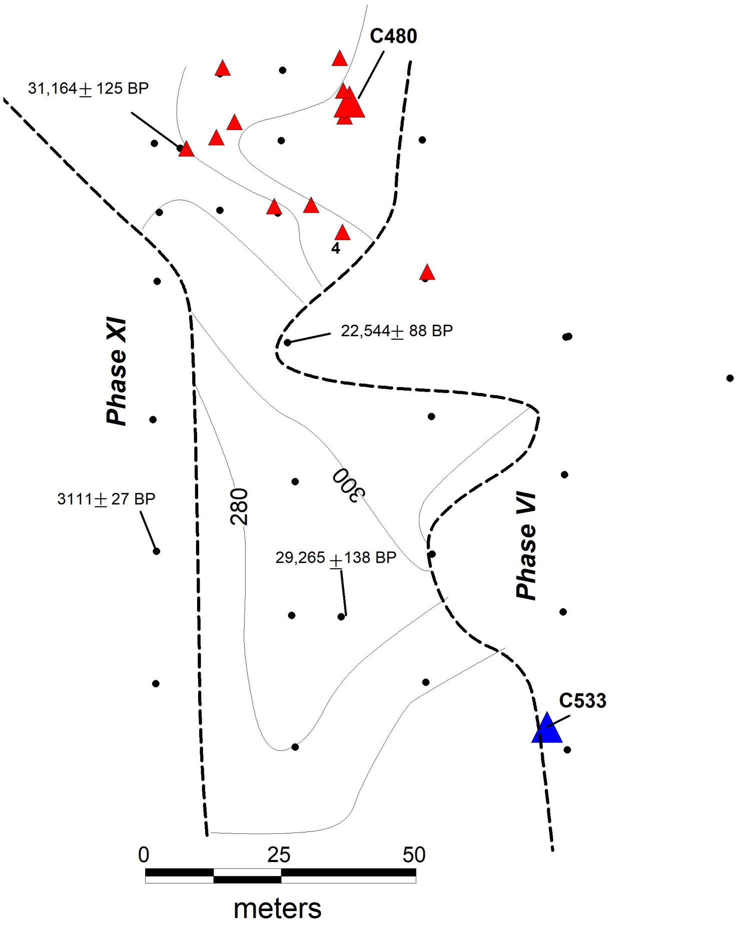

Figure 6. Topographic reconstruction of Phase V at AZ8.1. Isohypses (cm below surface) show the base of a shallow depression filled in with organic sediments and eroded to the west and east in later Phases. Black dots indicate positions of initial palaeotopographic coring. Small red triangles indicate subsequent cores containing Phase V chips or microchips. '4' is the number of microchips from the core concerned. The large red triangle is the position of the bladelet in Core 480, and the blue triangle is the Levallois flake in Core 533.

4. Discussion

Notwithstanding the very small sampling fractions of our surveys by means of mechanical coring [23], we have found direct archaeological evidence from deep contexts at one in five of our initially selected coring sites. Except for the formerly known quarry sites at Rotselaar Toren-ter-Heide [8] and Schulensbroek [14], none of these locations had previously produced any archaeological evidence. This unexpectedly high success rate not only establishes mechanical coring as a viable survey strategy but also indicates that the Pleistocene archaeological record is far more widely and densely distributed across palaeolandscapes than previously anticipated.

At those two quarry sites, we have now clarified the stratigraphic positions of Middle Palaeolithic occupations, which were until now merely known from surface collections. At Schulensbroek (coring site AZ8.1), the position of a Middle Palaeolithic site in a lacustrine environment during Phase II is now established with certainty. At Rotselaar Toren-ter-Heide (coring site X8.1), we found a microchip at the base of the Layer 28 brown loam. Geochemical analysis of diagenetic depositions on the 1970s surface artefacts had already shown a close match with the geochemical signature of that same brown loam at nearby coring site W8.0 [8]. At site W8.1, we found numerous microchips and a side scraper on a frostsplit pebble, a type also present at the Early Glacial site of Remicourt [24]. These artefacts are in a reworked position in Phase III gravels, but they were undoubtedly derived from Phase II sediments underneath. The presence of another concentration site sensu stricto here seems beyond doubt as well. This new evidence establishing three Middle Palaeolithic sites in the low wetland environment of northwestern Europe opens up a considerably important new window on the ecology of late Neanderthals [25].

At the coring site AZ8.1 (Schulensbroek), stratified ~5 m above the Middle Palaeolithic occupation level, we have encountered a concentration site in a stratigraphic context at ~30,000 ^{14}C BP according to 3 radiocarbon dates. In the 1970s, amateur archaeologists had collected an engraved mammoth long bone [26–28] which was recently dated at 27,417 ± 225 ^{14}C BP [14]. This establishes general contemporaneity with the late Phase V depositional context and a likely association with the lithics encountered here. The bone object is similar to items recovered at the contemporaneous early Gravettian of Maisières-Canal in the Haine basin of Belgium [29]. This multiple evidence strongly suggests the presence of an Upper Palaeolithic open-air site with excellent organic preservation and with bone tools at AZ8.1 [30].

Five coring sites in the West Area have delivered microchips in Phase V deposits, which, according to multiple ^{14}C dates, belong in the later part of Greenland Interstadial 12 [19]. They are all situated in topographic positions at the edges of a large floodplain, and they occur in two spatial clusters (Figure 4). This strongly suggests that they identify areas in which one or more concentration sites are present. As the evidence consists exclusively of the microscopic part of the archaeological record concerned, we cannot assess it culturally, but it is in all likelihood penecontemporaneous and perhaps part of the same settlement system as the cave occupations in the Meuse Valley [2].

These results largely exceed our expectations at the outset, and they do amply fulfil the proof-of-concept aim of the Flemish Valley Survey Project. A particularly important contribution is the demonstration of a microscopic archaeological record which appears to be widely dispersed in palaeolandscapes, well beyond the boundaries of our classic concentration sites. If future middle range research can establish the precise relationship between microscopic and macroscopic records, this can provoke a fundamental shift in archaeology's survey methods, opening up deep valley and lowland contexts for systematic archaeological research.

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Data Availability Statement: All data are available in the main text and Appendices A–C.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A. Sampling and Coring Techniques

The size of individual plots selected for coring was pragmatically determined by the present land registry, and it varies from a few hundred m^2 up to several hectares. Drilling points were distributed judgmentally across a given plot at an initial average coverage of ~1000 m^2/core. The maximal density reached in the most intensively studied locations of the West Area was 480 m^2/core.

Table A1. Complete list of selected coring sites in the West Area. East and North are coordinates (unit m) in the Lambert 1972 projection. Locations are grouped according to topographic setting, which was the basis for inclusion in the initial sample of coring sites. Result 'positive' indicates sites where Direct Archaeological Evidence was encountered.

Location ID	East (Lambert 1972)	North (Lambert 1972)	Result	Landscape Type	% Positive
L5.1	163,705	186,357		topographic ridge bordering fossil Dyle channel	18
L5.2	164,039	186,513			
M6.1	164,546	185,615			
N5.2	165,758	185,918			
N6.1	165,268	185,283	Positive		
N6.2	165,560	184,887	Positive		
P8.1	167,988	183,809			
Q8.1	168,787	183,611			
Q8.2	168,297	183,714			
Q8.3	168,404	183,633			
N5.1	165,946	186,708			
W5.1	175,017	186,096		topographic ridge bordering fossil Demer channel	0
X6.1	175,463	185,627			
L6.1	163,853	185,218	Positive	alluvial plain of deeply incised Dyle tributaries with probable presence of Pleistocene terraces	20
L7.1	163,851	184,181			
L7.2	163,824	184,367			
S8.1	170,299	183,148			
S8.2	170,256	183,139			
M5.1	164,613	186,582	Positive	isolated elevation within the present Dyle floodplain, probable Pleistocene terrace remnant	19
M5.2	164,524	186,468			
M5.3	164,269	186,727			
N6.3	165,541	185,561			
O6.1	166,412	185,663			
O6.2	166,408	185,743			
O6.3	166,332	185,261			
P6.1	167,530	185,593			
Q7.1	168,910	184,800			
U9.1	172,995	182,545			
V7.1	173,172	184,637			
V8.1	173,186	183,417			
V8.2	173,600	183,145	Positive		
V9.1	173,254	182,872			
W8.1	174,760	183,880	Positive		
W8.2	174,694	183,871			
M6.0	164,691	184,948		pediment of Middle Pleistocene Dyle terraces bordering the Late Pleistocene Flemish Valley	0
Q9.1	168,242	182,600			
Y8.1	176,438	183,377			
AZ8.1	185,383	166,644	Positive	location near sand quarry with recorded middle palaeolithic finds during quarry exploitation	100
W8.0	174,805	183,435	Positive		
X8.1	175,185	183,244	Positive		

Our 800 kg hydraulic coring rig is a dual-tube system, consisting of a steel outer casing and an inner tube containing the plastic liner to sample sediment columns (Ø = 6.5 cm) in successive 100 cm sections. Usually, this technique has allowed us to reach the base of the

Quaternary deposits, which is at <10 m below the surface in both study areas. During the laboratory analysis, the plastic liners were cut into two longitudinal halves, of which one was sampled in 20 cm increments for sieving at 1 mm mesh. The other half was prepared for stratigraphic description, analysis, and palynological sampling in appropriate cases. A representative sample of these cores is permanently stored in the facilities of the Centre for Archaeological Research of Landscapes, University of Leuven, Belgium.

At the coring site AZ8.1 (Schulensbroek), we additionally used a pulse coring technique in the fieldwork stage following the initial palaeotopographic coring. We sampled sediments in 50 cm windows, using a valve-operated steel inner tube with a diameter of 16.8 cm to retrieve fluid bulk sediment samples. These were sieved at a 2 mm mesh in the field. The remaining residua were collected and screened for direct archaeological evidence, using a 250 µm mesh sieve in the laboratory.

Appendix B. Radiocarbon Dates

The complete list of radiocarbon-dated Layers is given in Table A2.

Table A2. Complete list of ^{14}C-dated stratigraphic units at Flemish Valley Survey Project coring sites.

Coring Site	Core ID	Sample Depth (cm)	Phase	Layer	Sample Material	^{14}C BP	Lab Code	Remark
M6–1	449	420–440	IX	5	Charcoal	10,099 ± 35	RICH–31648	
N6–3	308	260–280	IX	8	Charcoal	11,051 ± 38	RICH–31641	
N6–3	306	280–300	IX	8	Charcoal	11,149 ± 40	RICH–31639	
N6–3	314	220–240	IX	8	Charcoal	11,172 ± 37	RICH–31640	
N6–3	314	240–260	IX	8	Charcoal	11,053 ± 35	RICH–31638	
Q8–1	188	340–360	IX	8	Charcoal	11,267 ± 39	RICH–31629	
AZ8.1	254	397	VI	16	Charcoal	22,544 ± 88	RICH–31619	
L5–2	202	248	VI	17	Charcoal	22,668 ± 83	RICH–31621	
V8–4	428	340–360	V	18a	Charcoal	27,966 ± 145	RICH–31647	
AZ8.1	48	270–275	V	18a	Charcoal	31,164 ± 125	RICH–28033	
AZ8.1	49	270–280	V	18a	Charcoal	29,265 ± 138	RICH–31608	
M6–1	447	659	V	18b	Charcoal	43,850 ± 620	RICH–31649	
N6 –3	5	408–420	V	18b	Charcoal	39,048 ± 337	RICH–31637	
N6 –1	12	522–530	V	18c	Charcoal	44,311 ± 639	RICH–31610	
M6–1	390	873	V	20	Charcoal	44,631 ± 888	RICH–31642	
N6 –1	20	426–436	V	20	Charcoal	40,558 ± 415	RICH–31607	
N6 –1	17	565–573	V	20	Charcoal	43,385 ± 596	RICH–31606	
V8–4	426	380–400	V	20	Charcoal	46,241 ± 7991	RICH–31651	
W8–0	95	565–573	V	20	Charcoal	40,979 ± 634	RICH–31605	
W8–0	228	550–600	V	20	Organic	42,400 ± 700	RICH–31599	
W8–0	239	450–500	III	22	Organic	46,700 ± 1100	RICH–31602	
W8–0	225	500–550	III	22	Organic	48,200 ± 1300	RICH–31596	
W8–0	233	400–450	III	22	Organic	49,900 ± 1700	RICH–31601	
N6–3	339	275	III	22	Organic	48,289 ± 1345	RICH–31636	
O6–1	364	380–400	III	22	Charcoal	50,339 ± 1247	RICH–31644	
O6–1	365	460–480	III	22	Organic	59,906 ± 4091	RICH–31646	
P8–1	*181*	*140–160*	*VII*	*13*	*Charcoal*	*34,888 ± 290*	*RICH–31624*	*Reworked from Phase V?*
L5–1	*198*	*280–300*	*VI*	*16*	*Charcoal*	*36,932 ± 267*	*RICH–31620*	
AZ8.1	*262*	*720–740*	*VI*	*17*	*Bone*	*31,079 ± 185*	*RICH–31612*	

Table A2. *Cont.*

Coring Site	Core ID	Sample Depth (cm)	Phase	Layer	Sample Material	^{14}C BP	Lab Code	Remark
M6–1	*390*	*880–890*	*V*	*20*	*Charcoal*	*37,802 ± 416*	*RICH–31643*	
AZ8.1	*48*	*481*	*IV*	*21c*	*Charcoal*	*24,604 ± 83*	*RICH–31604*	*stratigraphically inconsistent/intrusive?*
N6 –1	*32*	*600–620*	*III*	*22*	*Charcoal*	*33,812 ± 155*	*RICH–31603*	
W8–0	*229*	*450–500*	*III*	*22*	*Organic*	*39,210 ± 521*	*RICH–31600*	

Appendix C. Microdebitage Identification

Microdebitage is the general category containing complete artefacts having a maximal dimension ≤ 1 cm. Individual specimens are here termed microchips. All the items were examined under a stereomicroscope (maximum magnification ×56). This examination process was repeated several times over a period of four years. Only items that scored positively at each examination stage were kept in the final sample of artefacts.

The distinction of artefactual forms produced by anthropogenic flaking from ecofacts resulting from natural fracturing processes is a matter of probabilistic interpretation, as the morphological epiphenomena can be similar. As a general rule, this interpretation becomes more difficult when the following conditions are considered:

- Simple conchoidal flaking resulting in few morphological epiphenomena.
- Unique objects isolated from a technological assemblage of objects.
- Small to microscopically small items requiring low levels of fracture energy.

In such cases, it is essential to take recourse to taphonomic and lithological observations in addition to technological ones to pass judgment on its artefactual nature. We have established a list of 12 criteria, each of which must be present on a particular item to allow for identification as a microchip. These are the following:

- Conchoidal ventral face.
- Large angled striking platform, approaching 90°.
- Bulb of percussion.
- 45° striations at the periphery of the ventral face.
- Ridges on the dorsal face.
- Item must be complete and free of cortex.
- Feather distal end.
- Normal relative thickness.
- Snormal relative elongation.
- Edges are sharp and fresh.
- Raw material is either flint or phtanite.
- Flint type (colour) is different from the background matrix suite.

The probability that this association is present in a natural clast is negligibly small: a small flake is still a flake. Artefacts identified according to these criteria appear to occur in distinct patterns:

- There are 10 cores in which more than 1 microchip comes from the same stratigraphic context.
- At 4 coring sites, microchips occur in the same stratigraphic context in multiple cores, including the 10 above.

This contextual patterning constitutes additional support for the legitimacy of the artefact identifications.

Table A3. Complete list of all lithic finds at Flemish Valley Survey Project coring sites, by chronostratigraphic phase.

Phase	Coring Site	Sample ID	Core ID	Depth Below Surface (cm)	Lithics (*n*)	Illustration in Text
X	M5.1	**333**	383	160–180	1	
	V8.2	**336**	425	240–260	1	
			Total		2	
VI	AZ8.1	**144**	262	720–740	1	
	AZ8.1	**206**	258	380–400	1	Figure 3, 2
	AZ8.1	**208**	269	200–220	1	
	AZ8.1	**253**	262	720–730	1	
	L6.1	**371**	343	360–380	1	
	V8.2	**361**	418	450–500	2	
	W8.1	**229**	195	360–380	1	
	W8.1	**342**	451	280–300	1	
			Total		9	
V	AZ8.1	**131**	250	260–280	1	
	AZ8.1	**139**	268	280–300	1	
	AZ8.1	**373**	255	265–281	1	
	AZ8.1	**374**	48	273–288	1	
	AZ8.1	**375**	505	250–300	3	
	AZ8.1	**376**	478	200–250	1	
	AZ8.1	**377**	477	300–350	1	
	AZ8.1	**378**	480	300–350	2	
	AZ8.1	**379**	505	300–350	1	
	AZ8.1	**380**	468	200–250	1	
	AZ8.1	**383**	485	300–350	1	
	AZ8.1	**N**	480	250–300	1	Figure 3, 6
	N6.1	**41**	34	385	1	
	N6.1	**42**	29	470	1	Figure 3, 1
	N6.1	**49**	32	–	2	
	N6.1	**97**	12	530–522	2	
	N6.2	**50**	37	392	1	
	V8.2	**340**	428	320–340	2	
	V8.2	**344**	428	380–400	1	Figure 3, 4
	V8.2	**349**	427	380–400	1	
	W8.0	**82**	95	573–565	1	
	X8.1	**148**	117	380–360	1	Figure 3, 3
			Total		28	

Table A3. *Cont.*

Phase	Coring Site	Sample ID	Core ID	Depth Below Surface (cm)	Lithics (*n*)	Illustration in Text
III	W8.1	**245**	193	380–400	1	
	W8.1	**331**	195	450–440	1	
	W8.1	**334**	195	434–448	2	
	W8.1	**335**	195	457–435	1	
	W8.1	**345**	436	380–400	1	
	W8.1	**358**	195	435–457	1	
	W8.1	**369**	437	440–460	3	
			Total		10	
II	AZ8.1	**381**	533	750–800	3	
	AZ8.1	**382**	534	800–850	2	
	AZ8.1	**383**	533	750–800	1	Figure 3, 5
	X8.1	**45**	117		1	
			Total		7	
		Grand total			56	

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